BASICS OF BRAKING

Brakes are arguably the most important feature of any modern vehicle. This leaflet is designed to give you an insight into the types of braking systsems and their basic operation. We hope it helps you satisfy your customers.

A typical modern vehicle weighs around 1.4 tonnes, has a 3.5 litre engine, and accelerates from 0 to 100kph in approximately 10 seconds.

To do this, it has a sophisticated engine, transmission and driveline system. This system consists of thousands of mechanical and electronic parts and makes up nearly half the vehicles weight.

Yet, to meet the expectations of today's driver, the braking system which usually

comprises some 200 components and weighs less than 40kg needs to be capable of stopping the car from this speed in only 3-5 seconds.

The braking system is a means of converting the vehicles momentum (called kinetic energy) into heat by creating friction in the wheel brakes. The heat is then dissipated into the air from the brake discs and drums. The ability to absorb and dissipate heat rapidly is the controlling factor in preventing brake fade under severe conditions.

Of course, final contact between the vehicle and the road is made through the tyres – hence their importance in braking performance. Bald or defective tyres will make even the best brakes ineffective.

The modern braking system consists of a pedal and booster assembly to which a master cylinder and proportioning valve are attached.

At the wheels there are either disc calipers and rotors, drums and brake shoes, or a combination of both.

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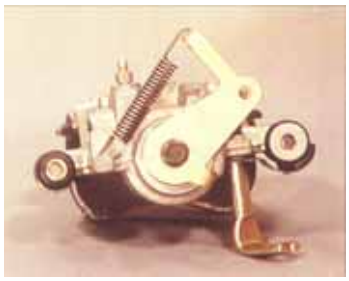
The system also has a park brake. Park brakes can be either part of or separate from the main system. Park brakes are usually applied with a hand lever.



And that's it. The safety of the vehicle rests largely on these few components, so their condition is obviously extremely important.

Some vehicles are fitted with anti-lock brakes that prevent wheel lock-up under adverse road and braking conditions. These add weight and complexity to the braking system but give the driver far better control in an emergency.

Most larger vehicles have disc brakes all round. Smaller vehicles sometimes have drum brakes on the rear wheels.

Disc brakes dissipate heat quicker than drums so they are usually fitted to the front where most of the braking happens.

Wheel brakes are applied by hydraulic pressure. The pressure is produced in a master cylinder and delivered to the disc calipers or drum wheel cylinders by tubes and flexible hoses.

Whilst some master cylinder pistons are operated by a push-rod connected to the brake pedal, most have a power brake booster that helps the driver by increasing the force on the piston, and reduces the driver's pedal effort.

The individual brake disc calipers or wheel cylinders generate braking force by bringing lining material into contact with the discs or drums. The amount of force generated on each set

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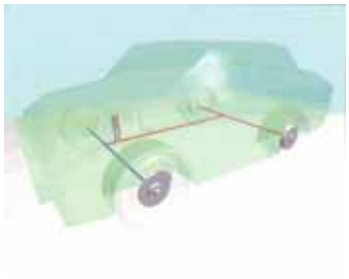
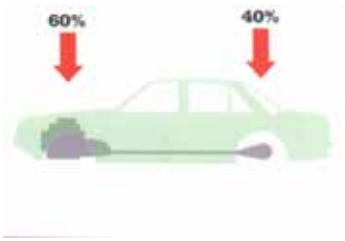
of brakes is determined by the area of the hydraulic piston its size and its type.

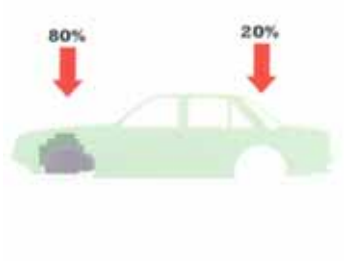
TANDEM MASTER CYLINDER

A tandem or dual master cylinder is one of the most important safety devices in any vehicle. It operates a divided or split hydraulic system so that if one circuit fails, the other will still operate. Most front engine rear wheel drive vehicles have one circuit connected to the front brakes and the other to the rear.

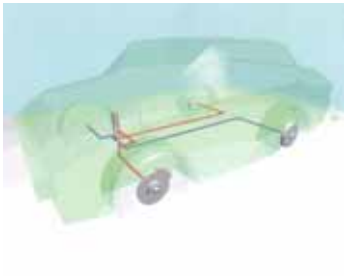


If there's a failure in one circuit, the amount of available braking force corresponds to the amount of weight on the axle. Front engine rear wheel drive vehicles usually have 60% of their weight acting on the front wheels and 40% on the rear. By contrast, on front engine front wheel drive vehicles, the weight distribution is significantly different, with about 80% of the weight being on the front wheels and only 20% on the rear.





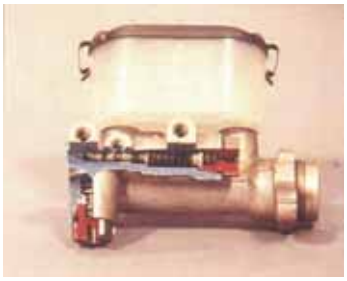
To allow for the possibility of a single circuit failure, a diagonal or cross-split layout is used.



This has one front wheel and the diagonally opposite rear wheel connected to each circuit. Should either circuit fail, an equal amount of braking will still be available.

It would still, of course, be only half the normal braking force of a fully-operational braking system.

Most tandem master cylinders have a warning switch to alert the driver to a circuit failure. They also have a proportioning valve (or valves) that provides balanced braking by reducing the hydraulic pressure to the rear wheels. This helps to prevent rear wheel lock-up, too.



Modern disc brakes have more space between the disc and the pad than in the past.

This reduces drag and improves fuel economy. However, to avoid increased pedal travel, some master cylinders are fitted with a "fast fill" valve, often called a quick take-up.

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PROPORTIONING VALVES

Proportioning valves may be integral to the master cylinder housing to reduce the weight and complexity of the hydraulic piping, or they can be mounted separately.

There are various types of proportioning valves :

Single

Dual Pressure Sensitive

* *utes* – "Australian word for bakkie / small pick-up truck" changed to bakkie

BRAKE BOOSTER OR SERVO UNIT

The brake booster reduces the effort involved in braking which is, after all, one of a driving's most repetitive functions.

Mounted on the firewall between the brake pedal and the master cylinder,

Deceleration

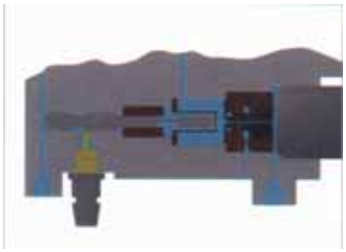
Load Sensitive

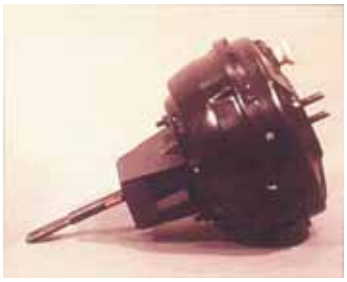
When a vehicle brakes, its weight is transferred to the front. The nose will dip as it gets heavier, and the rear will raise as it gets lighter. The rear wheels need less hydraulic pressure, hence the purpose of proportioning valves.

brake boosters vary in size, and can be either single or double diaphragm.

Where a large variation in axle loading at the rear takes place, such as in station wagons, bakkies, and trucks, load or height sentitive proportioning valves regulate hydraulic pressure to the rear axle in the amount needed.

Some vehicles with front/rear split braking systems have a proportioning valve by-pass which allows full pressure to the rear if the front brakes fail.





There is a vacuum in the manifold of all four stroke petrol motors. Brake boosters use this to increase the force applied to the master cylinder by three to five times without losing brake sensitivity or response. On diesel engines, an

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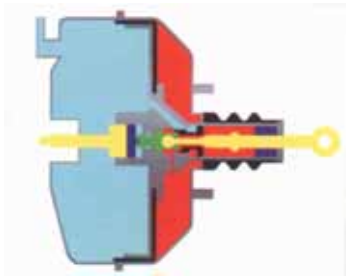
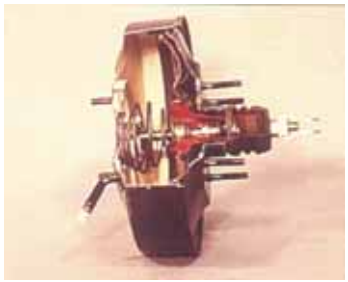
auxiliary vacuum pump is utilised to supply vacuum.

Brake boosters have two chambers : one at the front which is always at a constant pressure, and one at the rear where the pressure varies. These are separated by a pressure plate and valve body, and are sealed from one another by a rubber diaphragm.

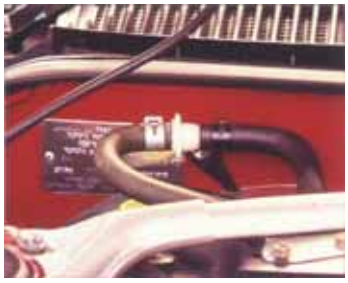


A control valve regulates the amount of atmospheric pressure let into the rear chamber. Operated by the pedal pushrod, the valve is directly connected to the output pushrod, and includes a vacuum valve.



A vacuum non-return or check valve is fitted either to the booster or in the hose from the engine manifold.

If the engine stops, this will retain enough vacuum in the booster for up to three brake applications.

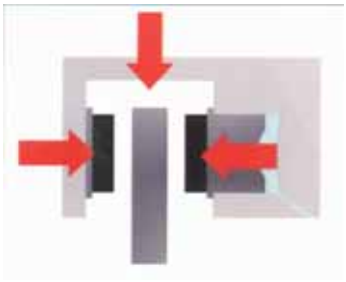


If the vacuum supply is totally lost, the control valve rod assembly and output rod act as a single pushrod. The brakes can still be operated, but the driver will have to push a lot harder to stop the vehicle.

FOOT OR SERVICE BRAKES DISC BRAKES

Because they're very stable and very safe, disc brakes are fitted to just about all of today's passenger vehicles.

In its simplest form, a disc brake is a cast iron rotor that turns with the wheel, and two fixed pads with friction material bonded to them.



When the driver puts the brakes on, pressure from the master cylinder forces the pads against the rotor. The resulting friction develops the braking force needed to slow or stop the vehicle. The force with which the pads clamp the rotor governs the amount of brake force generated.

Most of the rotor is exposed to the air so friction heat is easily radiated away. This minimises brake fade and helps keep the braking stable at all speeds.

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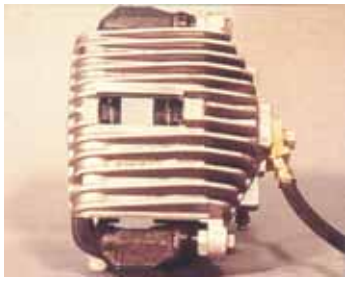
Since the rotors spin with the wheels, they will literally spin themselves dry if they get wet.

The disc caliper holds one or more pistons which force the pads against the disc rotor. Calipers may be either :

Fixed Head Opposed Piston, or

Floating Head Single Piston.

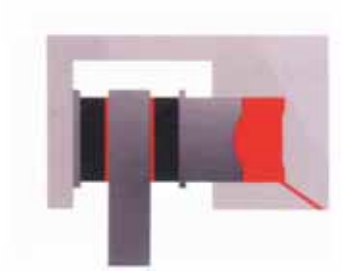


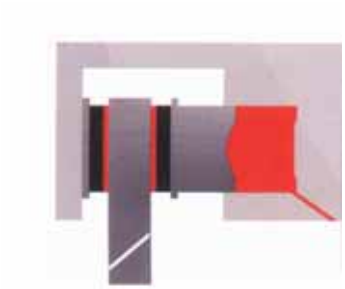
While fixed head calipers may have four opposed pistons, some floating head calipers have two. Multiple pistons are used when more force is needed, like heavy or high performance vehicles.

The rotors themselves can be either solid or ventilated design, depending on the application. Since the ventilated type has more surface area, it radiates heat faster so it suits heavy duty use.

Disc brakes don't need periodic brake adjustments (to keep the distance between the pad and the rotor constant) because they adjust automatically in use.

This is so for all disc brake calipers, even those including integral parking brakes.





Where four wheel disc brakes are installed, the parking brake in many instances has been incorporated into the rear caliper. These days a growing number of vehicles have a separate brake assembly fitted inside the disc for that purpose.

DRUM BRAKES

Brake shoes are anchored to a backing plate and lined with friction material. They are mounted inside a brake drum which turns with the wheel. Pressure from the master cylinder forces the shoes against the spinning drum to prevent it from rotating.

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The pressure with which the shoes are forced against the drum controls the amount of friction heat and hence the braking force.

The most common type of rear drum brake assembly in today's vehicles is the leading and trailing shoe design.

This has gained favour over the earlier duo-servo design, though both feature automatic adjusting systems.

Both types provide a parking brake operated by a driver's lever connected via cables to a lever-and-strut mechanism that expands the brake shoes against the drum.

The force applied by the driver is usually multiplied by an intermediate lever, and an equaliser ensures the same force is applied to each brake.