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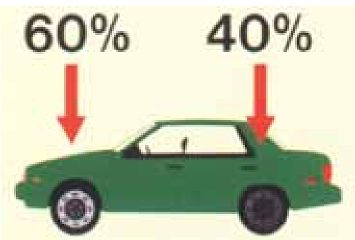
BRAKE AND STEERING CENTRE
WE'LL STOP YOU IN YOUR TRACKS

PROPORTIONING & LOAD SENSING VALVE DIAGNOSIS

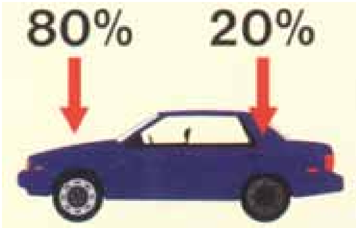
Wingate, suppliers of braking systems to the world market, would like to welcome you to this pamphlet on the diagnosis of proportioning and load sensing valve concerns.

As with any diagnosis procedure, a clear understanding of a components purpose and operation is vital, and is therefore where we shall start this text. When a vehicles brakes are applied the nose dips, and there is a transfer of weight from the rear to the front wheels. This makes the percentage of work that can be done by the front brakes before the onset of wheel lockup higher than what can be done by the rear brakes.

As we stated in the "Basics of Braking" a typical rear wheel drive sedan has a sixty forty percent ratio split between front and rear braking force.



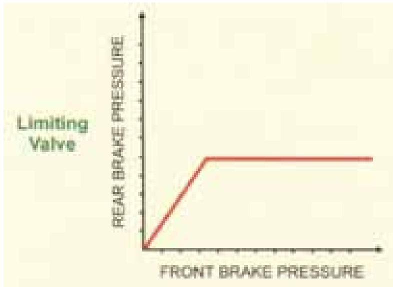
While the front wheel drive equivalent, has an eighty twenty percent split.



In the majority of cases up until the early seventies this ratio split was determined by the relative sizes of front and rear hydraulic cylinders, and brake design alone. To maintain vehicle stability brake engineers designed a system that would minimise rear wheel lock up under maximum braking force conditions.

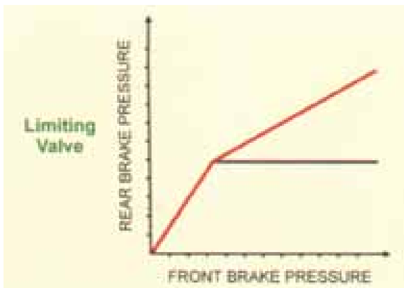
Whilst this was achieved, it meant that the amount of work that the back brakes performed during normal braking, was lower than it could have been.

Early attempts to overcome this problem used a limiting valve, which stopped the pressure to the rear brakes rising above a preset level.



These valves, whilst an improvement, still prevented the rear brakes working at their optimum under all braking conditions.

What was needed was a valve that whilst still allowing pressure to increase to the rear brakes as front brake pressure increased, prevented the pressure reaching a level which caused the rear wheels to lock.



This would then allow the rear brakes to work at their optimum throughout the braking

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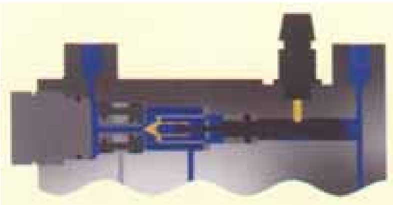
range, which would in turn remove some of the load on the front brakes, delaying the onset of brake fade.

In modern braking systems the component that performs that function is the proportioning valve.



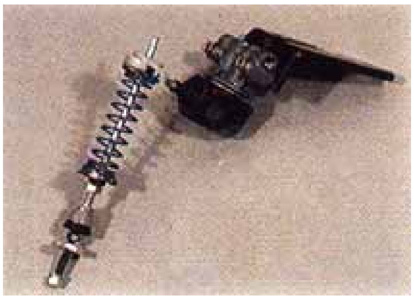
Early systems saw the valve inserted in the line to the rear brakes, and some modern front wheel drive vehicles still mount their proportioning valves remotely on the vehicles bulk-head.

Whilst with an ABS system, the valves may even be incorporated in the modulator unit itself.

However, by far the most common mounting see's the valve or valves, incorporated in the master cylinder.

Along with these different mountings also comes different types of proportioning valves. Valves may be either single, or dual pressure sensitive, or pressure sensitive with a bypass feature, that allows full pressure to the rear brakes should the front hydraulic system fail.

Variations on the same theme are the load sensing proportioning valves, and the single or dual deceleration sensing proportioning valves.



The load sensing proportioning valves are often used on vehicles which operate with widely differing rear axle loads, such as wagons and bakkies.

As the load on the axle increases, so does the amount of braking force that can be directed to the rear wheels. The load sensing proportioning valve authomatically does this by varying the rear brake pressure in relation to vehicle ride height.

Deceleration sensitive proportioning valves on the other hand, are similar to load sensing valves, in the respect that they react to vehicle conditions.

However, these valves use the rate at which the vehicle is slowing down, or it's attitude to the horizontal, as a measure of the load on the rear wheels, and consequently, how much pressure can be applied to the rear hydraulic cylinders.

As the principle of operation of all pressure sensitive proportioning valves is basically the same, we shall use as our

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example one of the most common types – that fitted integrally with the master cylinder.

This type of proportioning valve consists of a seal block into which fits a moveable poppet piston, along with a poppet valve, which clips over the end of the pressure differential warning switch spool. The poppet piston, is initially held bottomed in it's bore in the seal block, by the pressure spring.

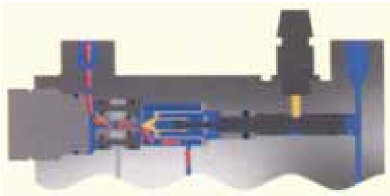
The valve assembly is connected internally to the master cylinder by a drilled passage, which leads into the main chamber housing

But as the driver presses harder on the brake pedal, and the pressure rises, the force produced by the fluid acting on the large end of the poppet piston, starts to overcome the pressure of spring force, and fluid pressure acting on the small end of the piston.

When this happens, the poppet piston is forced to the right. The passage to the rear

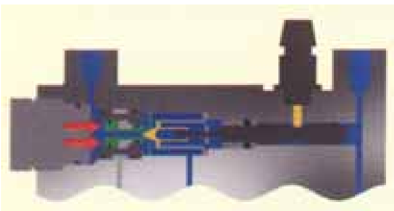
the poppet valve, and pressure spring.

During light braking, fluid flows from the master cylinder into the proportioning valve main chamber, through the poppet piston, and out to the rear brakes.



At this stage, the pressure delivered to the rear hydraulic cylinders is totally controlled by the driver pressing on the brake pedal.

As the driver continues to increase pressure on the brake pedal, brakes is now blocked by the poppet valve, and the pressure to the rear brakes momentarily held constant.



A futher increase in pressure on the brake pedal by the driver, causes a corresponding increase

hydraulic pressure builds equally on either side of the moveable poppet piston. Movement of this piston is controlled by a balance of forces acting on it. Holding the valve to the left in it's bore, we have the force of the pressure spring, plus fluid pressure acting on the small area of the piston.

Initially, spring force and fluid pressure acting on the small end of the piston, hold it at the bottom of it's bore.

A look at the pressure graph would reveal that pressure is rising equally in the front and rear brakes.

in brake fluid pressure in the main chamber.

This then increases the force being applied to the small end of the poppet piston. When this increases in pressure, it causes the force acting on the small end of the valve to become greater than the force acting on the large end of the valve, the poppet piston will again move to the left, and allow the pressure in the rear

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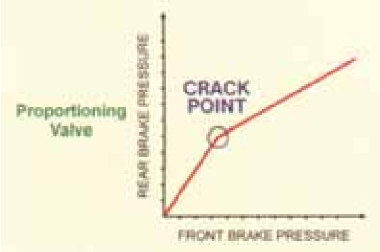
braking system to again increase.

This pressure will however, only increase until the force being applied to the large end of the valve, again overcomes the force acting on the small end. When this happens the poppet piston will move to the right, and the poppet valve will again stop fluid entering the rear brake circuit.

Another look at our pressure graph shows that as the pressure is increased in the front system, by the driver increasing pressure on the brake pedal, the pressure also rises in the rear system. This pressure rise is however less than the front system, in other words, it is in proportion to the front system.

Now before we leave our pressure graph we need to point out two more things. The first is that where the graph starts to show a reduction in pressure to the rear brakes, it is known as the valve's crack point.



This crack point is controlled by the strength of the pressure spring, and there are different springs to suit different applications.

The second point is that the rate at which the pressure rises in the rear system, represented by the slope of the graph, is controlled by the relative sizes of the large and small ends of the valve.

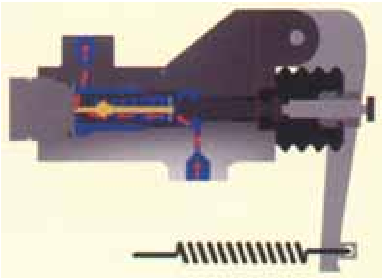
The second valve that we shall examine, the load sensing proportioning valve, is really only a derivative of the previous proportioning valve.

A typical load sensing valve consists of a body, which is mounted to the vehicle's chassis, and into which is placed a plunger and hollow piston assembly.

Inside the piston is a poppet valve and spring, which controls the flow of fluid to the rear brakes. The valve is initially held off it's seat due to the piston being held at the bottom of the bore.

An external lever, which is pivoted from the bottom of the body, has an adjusting bolt which contacts the end of the plunger.

On the other end of the lever is a spring, which is linked to the rear suspension. This is the pressure spring, which via the lever, holds the piston at the bottom of the bore, and therefore controls the crack point of the valve.



When the driver presses on the brake pedal, fluid enters the inlet port, travels through the hollow piston, past the poppet valve and out to the rear brakes.

As was the case with the previous proportioning valve, fluid pressure acting on the small area of the piston, plus spring tension, opposes fluid pressure acting on the

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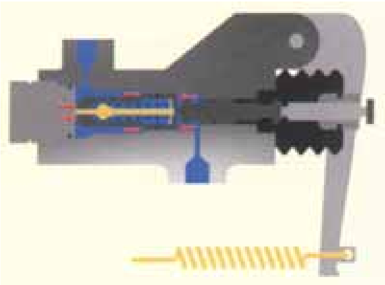
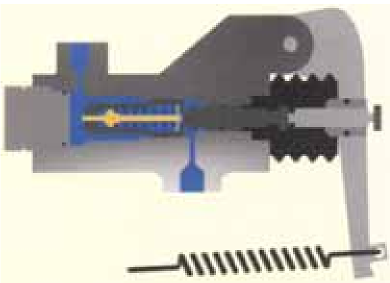
large area of the piston.



When the force developed by the fluid pressure action on the large area of the piston overcomes the combined forces of the small area the pressure spring, the piston moves to the left.



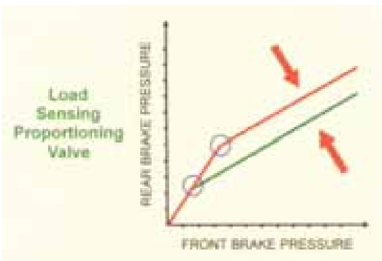
The small spring acting on the poppet valve now pushes it to the right, sealing the passage to the rear brakes.

As the driver continues to increase pressure on the brake pedal, the same chances of relative force occur on each end of the piston as they did in the conventional proportioning valve. This causes the piston to move back and forth, gradually increasing pressure to the rear brakes.

The load sensing part of the valves operation comes from the fact that as the body is loaded, the external spring is streched, raising the crack point of the valve.

Our pressure graph shows that with a lightly loaded vehicle, the crack point is relatively low. But as the vehicle load increases, and the spring is streched further, the crack point also rises.

The rate at which the pressure rises in the rear brakes is still controlled by the relative area's of each of the piston, represented here by the slope of the graph. Customer concerns with proportioning valves will usually centre around premature locking of the rear brakes.



And providing the vehicle is safe to drive, a road test on a quiet stretch of road is recommended to confirm the existence of the concern.

Once it has been confirmed that there is reason for concern, the vehicle should be returned to the workshop for a further inspection.

The rear brakes should first be examined for obvious faults.

Drum brakes should be checked for adjustment, and lining material inspected for oil or grease contamination, both of which will cause brake locking.

Disc brakes are likewise susceptible to oil or grease contamination, and should also be checked for the correct lining material being fitted. A significant increase in the co-efficient of friction of a lining

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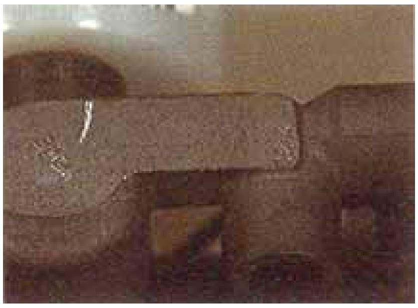
material, from what was originally specified for the vehicle, may be a cause for premature wheel locking, whilst a lowering of the friction co-efficient on the front wheel, may also give the same symptoms.

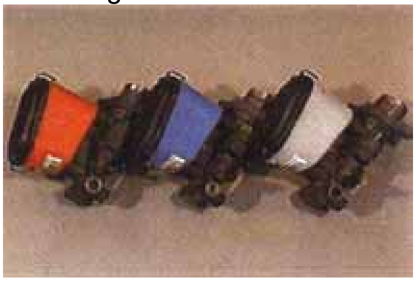
Should these checks reveal no faults, the proportioning valve itself should be checked against manufacturers specifications, to ensure that it is the correct one for the vehicle.

It is common for proportioning valve crack points, or pressure characteristics, to differ between sedans, wagons or bakkies of the same make and model.

On master cylinders with integral proportioning valves, the crack point is often stamped on the end of the cylinder.



Or, in some cases, the brake fluid reservoirs are colour coded, to help identify special features.



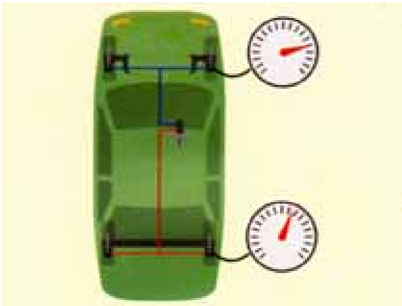
Remote mounted valves may have identification markes stamped, or cast into their bodies.

The earlier design of combined proportioning valve and pressure valve and pressure differential warning switch, as fitted to some General Motors vehicles, has a by-pass feature incorporated in it's design, allowing full pressure to the rear brakes in the case of a front brake circuit failure.

Later designs overcame this by designing the valve to automatically re-set.

However, no matter which type is fitted, a circuit failure will still be indicated by the brake warning light being illuminated. Should all of these checks reveal no faults or mis-matched components, operation of the valve itself will need checking. Fortunately, due to their design, proportioning valves do not tend to only partially fail, making diagnosis a relatively simple task.

By using two high pressure gauges, tapped into the bleeder nipple thread of one front, and one rear caliper, or in the case of a front wheel drive vehicle with two proportioning valves, one front and a diagonally opposite rear caliper, the relative pressures between the input and output of the proportioning valve can be checked against manufacturers specifications.



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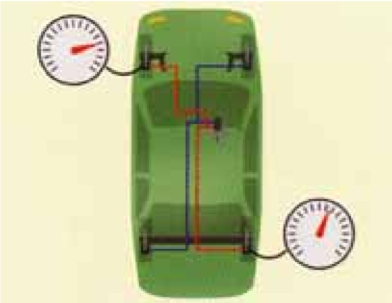

Should these gauges not be available, the valve itself will have to be disassembled for inspection.

Valves should be inspected for seized poppet pistons, broken poppet valve springs, or differential warning switch spools jammed in the secondary circuit failure position.

The load sensing propositioning valve on the other hand, whilst not suffering problems related to the differential warning switch spools, does have the added complication of having to be correctly adjusted in order to function correctly.

Because the valve's crack point is altered in relation to changes in vehicle ride height, there is always a setting given for the valve at standard vehicle height.

This setting may take the form of a measurement between two points, or a pressure difference between the inlet and outlet of the valve.

But whatever method of checking is employed, the vehicle will have to be sitting at the standard ride height before any checking or adjustments can be made.

This means that vehicles that have been extensively lowered or raised above normal ride height, will have to be returned to standard height before any checks can be made.

Should testing reveal a faulty valve, apart from some master cylinders with integral proportioning valves, which come with complete assemblies supplied in their overhaul kits, faulty proportioning valves cannot be repaired, and must be replaced as complete assemblies if found to be defective.