AUTOMOTIVE INDUSTRY TRAINING
RETAIL, SERVICE AND REPAIR
AUR05

Learning & Assessment Resource

AURT210170A

INSPECT AND SERVICE BRAKING SYSTEMS

Automotive Training Board nsw

NEW SOUTH WALES DEPARTMENT OF EDUCATION AND TRAINING

State Training Services

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Acknowledgement

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Contents

AURT210170A Inspect and Service Braking Systems

Pre Requisite Units of Competence

Nil

Overview

This unit covers the competence required to inspect and service braking systems and/or associated components, including pneumatic over hydraulic, air, hand and parking brake systems in an automotive retail, service and/or repair context.

The unit includes identification and confirmation of work requirement, preparation for work, conduct of brake system wear analysis, servicing of braking systems and completion of work finalisation processes, including clean-up and documentation.

All work and work practices must be undertaken to regulatory and legislative requirements. It is applicable in both a learning and assessment pathway and an assessment only pathway.

This competence is performed in the context that all materials and equipment needed to carry out this function have been provided, including learning materials, learning programs and learning resources.

Elements of Competence

To achieve competency in this unit you must demonstrate your ability to:

1. Prepare to undertake braking system inspection;
2. Conduct braking system wear analysis;
3. Prepare to service braking system and/or associated components;
4. Carry out servicing of braking systems and/or associated components; and
5. Prepare equipment for use or storage.

1.0 How do Car Brakes Work?

We all know that pushing down on the brake pedal slows a car to a stop. But how does this happen? How does your car transmit the force from your leg to its wheels? How does it multiply the force so that it is enough to stop something as big as a car?

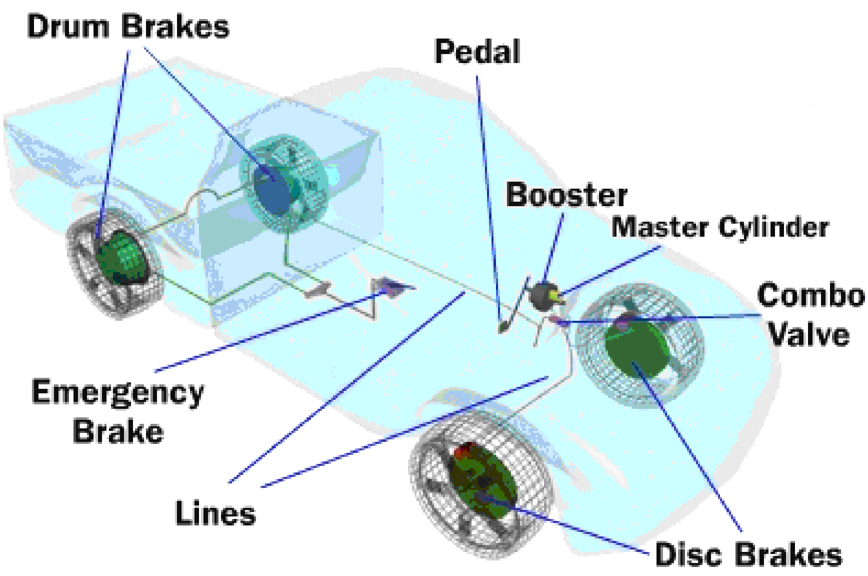

Figure 1

When you depress your brake pedal, your car transmits the force from your foot to its brakes through a fluid. Since the actual brakes require a much greater force than you could apply with your leg, your car must also multiply the force of your foot. It does this in two ways:

- Mechanical advantage (leverage); and
- Hydraulic force multiplication**.**

The brakes transmit the force to the tyres using friction, and the tyres transmit that force to the road using friction also. Before we begin our discussion on the components of the brake system, we'll cover these three principles:

- Leverage;
- Hydraulics; and
- Friction.

1.1 Leverage and Hydraulics

In the figure below, a force (F) is being applied to the left end of the lever. The left end of the lever is twice as long (2X) as the right end (X). Therefore, on the right end of the lever a force of 2F is available, but it acts through half of the distance (Y) that the left end moves (2Y). Changing the relative lengths of the left and right ends of the lever changes the multipliers.

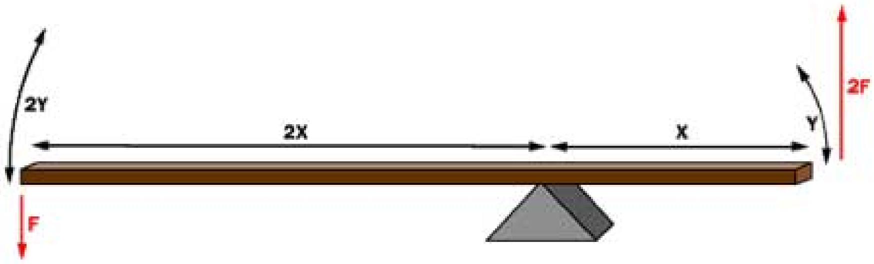

Figure 2 - The pedal is designed in such a way that it can multiply the force from your leg several times before any force is even transmitted to the brake fluid.

The basic idea behind any hydraulic system is very simple: Force applied at one point is transmitted to another point using an incompressible fluid, almost always an oil of some sort. Most brake systems also multiply the force in the process.

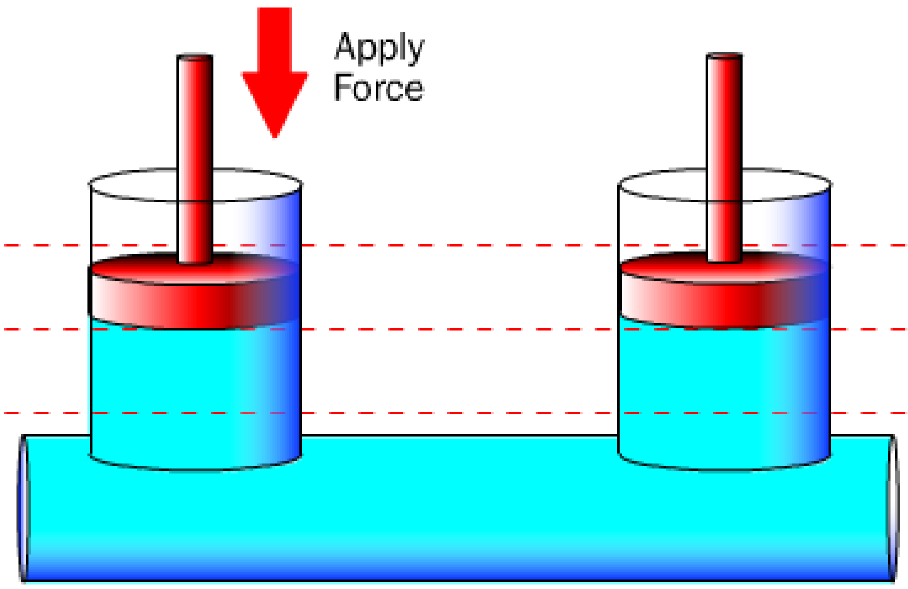

Figure 3 - Simple hydraulic system

In Figure 3 above, two pistons (shown in red) are fit into two glass cylinders filled with oil (shown in light blue) and connected to one another with an oil-filled pipe. If you apply a downward force to one piston (the left one, in this drawing), then the force is transmitted to the second piston through the oil in the pipe. Since oil is incompressible, the efficiency is very good -- almost all of the applied force appears at the second piston. The great thing about hydraulic systems is that the pipe connecting the two cylinders can be any length and shape, allowing it to snake through all sorts of things separating the two pistons. The pipe can also fork, so that one master cylinder can drive more than one slave cylinder if desired, as shown in here:

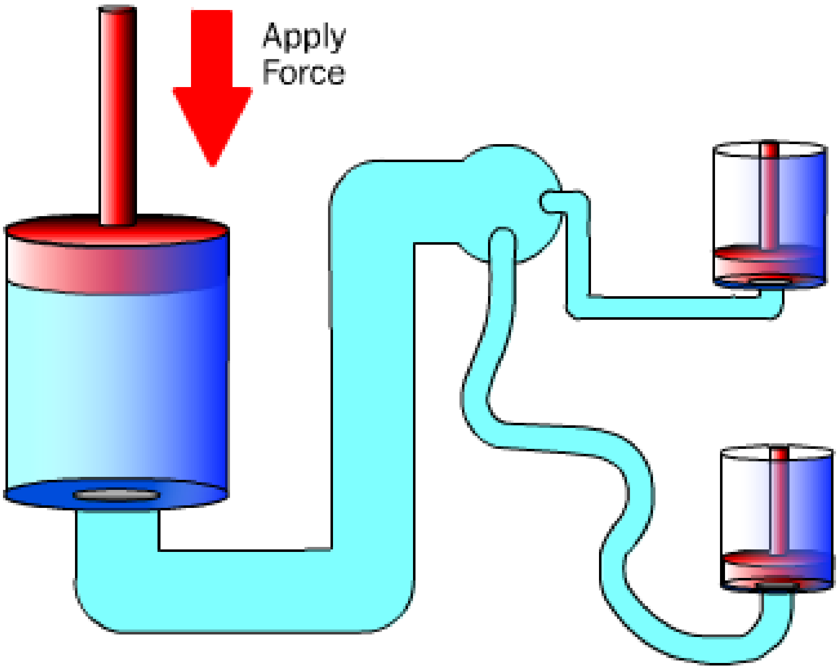

Figure 4 - Master cylinder with two slaves

The other neat thing about a hydraulic system is that it makes force multiplication (or division) fairly easy. If you have an understanding how a block and tackle works or how a gear ratio works, then you know that trading force for distance is very common in mechanical systems. In a hydraulic system, all you have to do is change the size of one piston and cylinder relative to the other, as shown here:

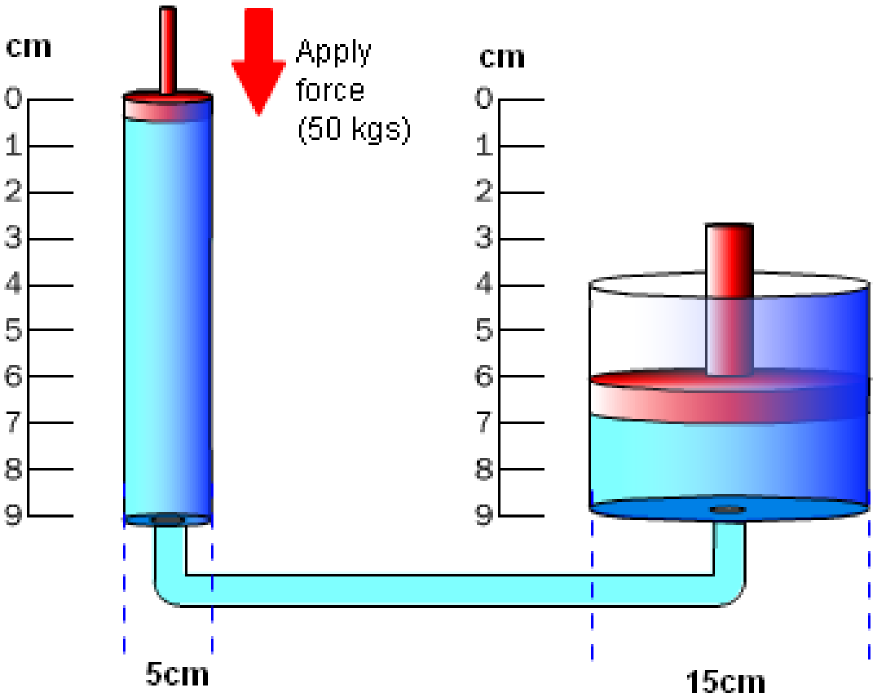

Figure 5 - Hydraulic multiplication

To determine the multiplication factor in the Figure 5 above, start by looking at the size of the pistons. Assume that the piston on the left is 5cm) in diameter 2.5cm radius, while the piston on the

right is 15 cm in diameter 7.5cm radius). The area of the two pistons is Pi * r^2. The area of the left piston is therefore 19.64, while the area of the piston on the right is 176.74. The piston on the right is nine times larger than the piston on the left. This means that any force applied to the left-hand piston will come out nine times greater on the right-hand piston. So, if you apply a 50kg downward force to the left piston, a 450kg upward force will appear on the right. The only catch is that you will have to depress the left piston 9 cm to raise the right piston 1 cm.

1.2 Friction

Friction is a measure of how hard it is to slide one object over another. Take a look at Figure 6 below. Both of the blocks are made from the same material, but one is heavier. I think we all know which one will be harder for the bulldozer to push.

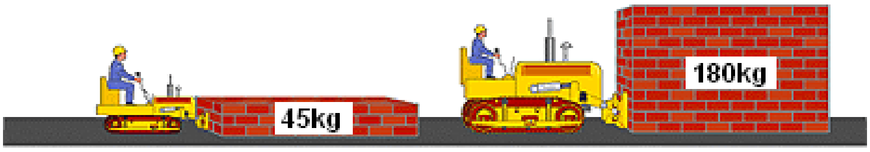

Figure 6 - Friction force versus weight

To understand why this is, let's take a close look at one of the blocks and the table:

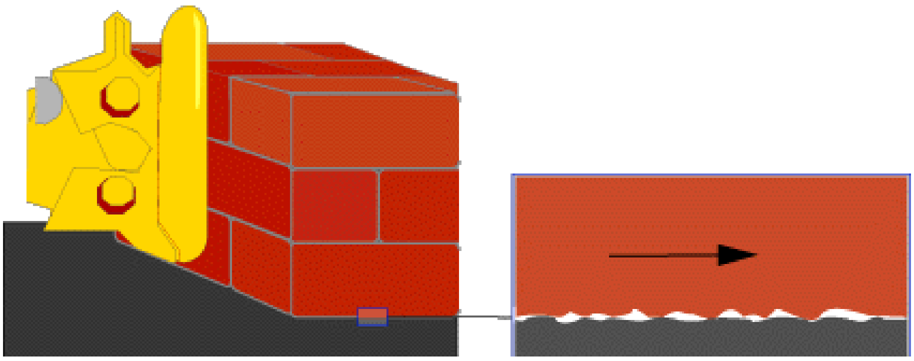

Figure 7 - Because friction exists at the microscopic level, the amount of force it takes to move a given block is proportional to that block's weight.

Even though the blocks look smooth to the naked eye, they are actually quite rough at the microscopic level. When you set the block down on the table, the little peaks and valleys get squished together, and some of them may actually weld together. The weight of the heavier block causes it to squish together more, so it is even harder to slide.

Different materials have different microscopic structures; for instance, it is harder to slide rubber against rubber than it is to slide steel against steel. The type of material determines the coefficient of friction, the ratio of the force required to slide the block to the block's weight. If the coefficient were 1.0 in our example, then it would take 45kg of force to slide the 45kg block, or 180kg of force to slide the 180kg block. If the coefficient were 0.1, then it would take 4.5kg of force to slide to the 45kg block or 18kg of force to slide the 180kg block.

So the amount of force it takes to move a given block is proportional to that block's weight. The more weight, the more force required. This concept applies for devices like brakes and clutches, where a pad is pressed against a spinning disc. The more force that presses on the pad, the greater the stopping force.

Coefficients

An interesting thing about friction is that it usually takes more force to break an object loose than to keep it sliding. There is a coefficient of static friction, where the two surfaces in contact are not sliding relative to each other. If the two surfaces are sliding relative to each other, the amount of force is determined by the coefficient of dynamic friction, which is usually less than the coefficient of static friction.

For a car tyre, the coefficient of dynamic friction is much less than the coefficient of static friction. The car tyre provides the greatest traction when the contact patch is not sliding relative to the road. When it is sliding (like during a skid or a burnout), traction is greatly reduced.

2.0 A Simple Brake System

Before we get into all the parts of an actual car brake system, let's look at a simplified system:

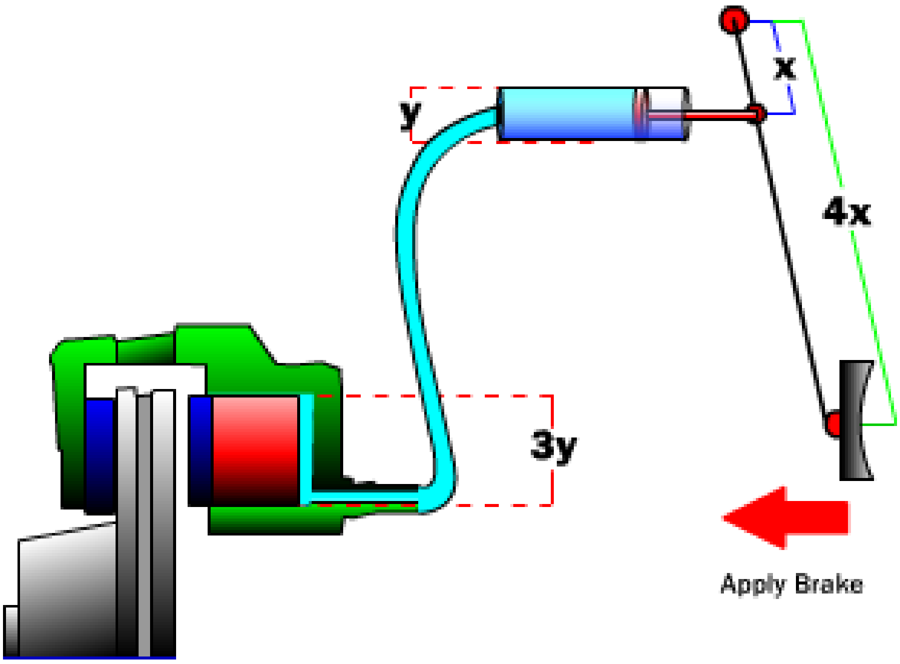

Figure 8- A simple brake system

You can see that the distance from the pedal to the pivot is four times the distance from the cylinder to the pivot, so the force at the pedal will be increased by a factor of four before it is transmitted to the cylinder.

You can also see that the diameter of the brake cylinder is three times the diameter of the pedal cylinder. This further multiplies the force by nine. All together, this system increases the force of your foot by a factor of 36. If you put 5kg of force on the pedal, 180kg will be generated at the wheel squeezing the brake pads.

There are a couple of problems with this simple system. What if we have a leak? If it is a slow leak, eventually there will not be enough fluid left to fill the brake cylinder, and the brakes will not function. If it is a major leak, then the first time you apply the brakes all of the fluid will squirt out the

leak and you will have complete brake failure. The master cylinder on modern cars is designed to deal with these potential failures.

3.0 How Master Cylinders and Combination Valves Work

To increase safety, most modern car brake_systems are broken into two circuits, with two wheels on each circuit. If a fluid leak occurs in one circuit, only two of the wheels will lose their brakes and your car will still be able to stop when you press the brake pedal.

The master cylinder supplies pressure to both circuits of the car. It is a remarkable device that uses two pistons in the same cylinder in a way that makes the cylinder relatively failsafe. The combination valve warns the driver if there is a problem with the brake system, and also does a few more things to make your car safer to drive.

3.1 The Master Cylinder

Here is where you'll find the master cylinder (Figure 9):

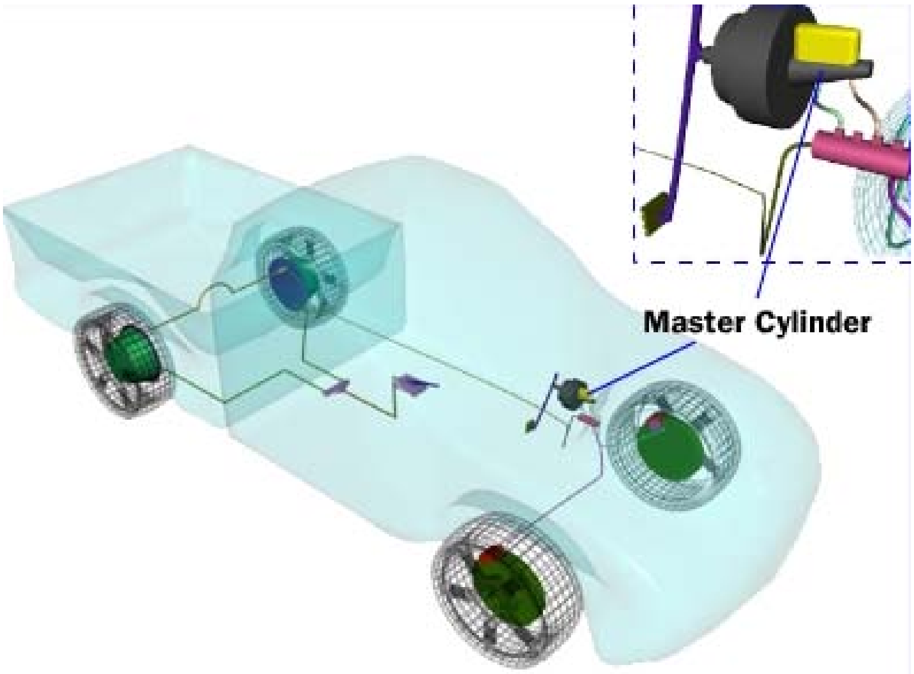

Figure 9

In Figure10, the plastic tank you see is the brake-fluid reservoir, the master cylinder's brake-fluid source. The electrical connection is a sensor that triggers a warning light when the brake fluid gets low.

Figure 10

As demonstrated in Figure 11, there are two pistons and two springs inside the cylinder.

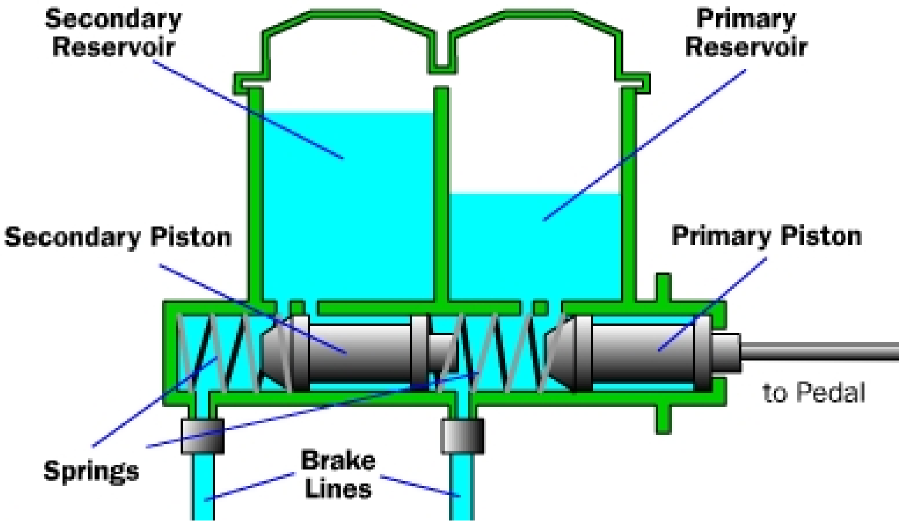

Figure 11

3.2 The Master Cylinder in Action

When you press the brake pedal, it pushes on the primary piston through a linkage. Pressure builds in the cylinder and lines as the brake pedal is depressed further. The pressure between the primary and secondary piston forces the secondary piston to compress the fluid in its circuit. If the brakes are operating properly, the pressure will be the same in both circuits (Figure 12).

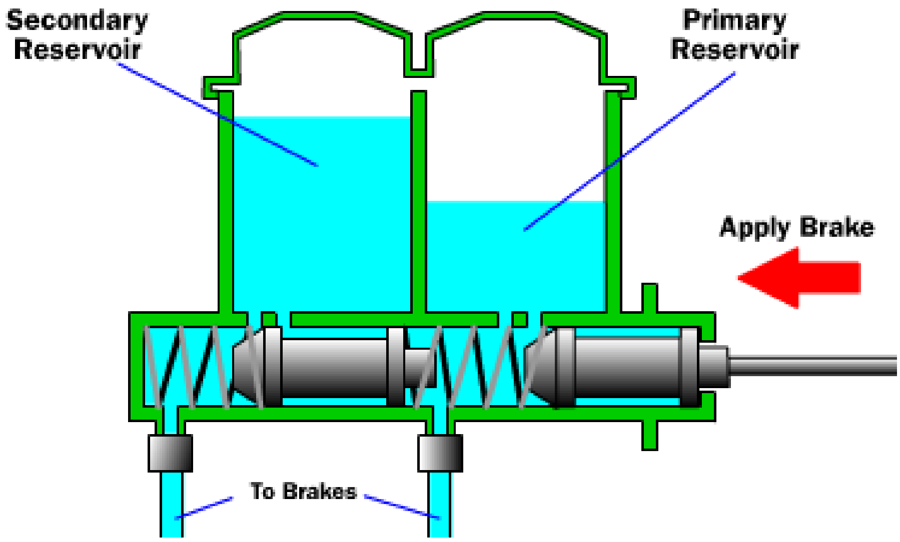

Figure 12

If there is a leak in one of the circuits, that circuit will not be able to maintain pressure. Figure 13 demonstrates what happens when one of the circuits develops a leak.

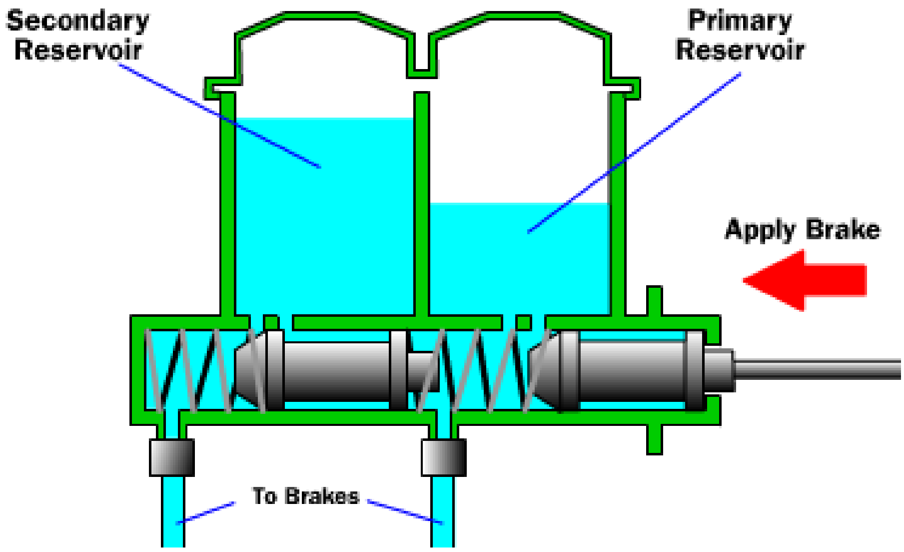

Figure 13

3.3 How the Master Cylinder and its Combination Valve Works

The Combination Valve

You will find a combination valve on most cars with front disc brakes and rear drum brakes Figure 14.

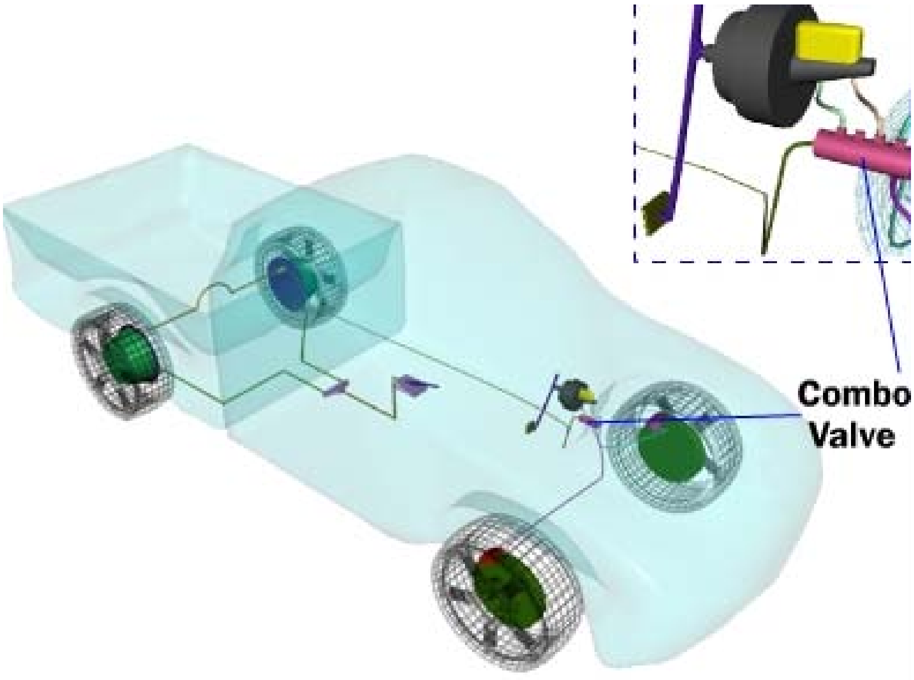

Figure 14

The valve does the job of three separate devices:

- The metering valve;
- The pressure differential switch; and
- The proportioning valve.
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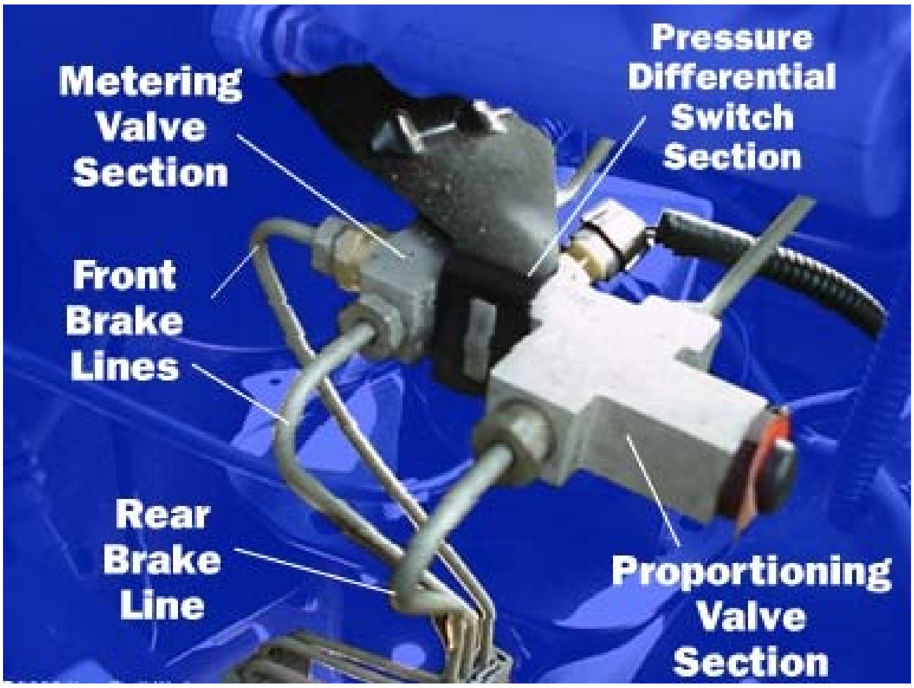


Figure 15

3.3.1 Metering Valve

The metering valve section of the combination valve is required on cars that have disc brakes on the front wheels and drum brakes on the rear wheels. This configuration requires that the disc brake pad is normally in contact with the disc, while the drum brake shoes are normally pulled away from the drum. Because of this, the disc brakes are in a position to engage before the drum brakes when you push the brake pedal down.

The metering valve compensates for this, making the drum brakes engage just before the disc brakes. The metering valve does not allow any pressure to the disc brakes until a threshold pressure has been reached. The threshold pressure is low compared to the maximum pressure in the braking system, so the drum brakes just barely engage before the disc brakes kick in.

Having the rear brakes engage before the front brakes provides a lot more stability during braking. Applying the rear brakes first helps keep the car in a straight line; much like the rudder helps a plane fly in straight line.

3.3.2 Pressure Differential Switch

The pressure differential valve is the device that alerts you if you have a leak in one of your brake circuits. The valve contains a specially shaped piston in the middle of a cylinder. Each side of the piston is exposed to the pressure in one of the two brake circuits. As long as the pressure in both circuits is the same, the piston will stay centred in its cylinder. But if one side develops a leak, the pressure will drop in that circuit, forcing the piston off-centre. This closes a switch, which turns on a light in the instrument panel of the car. The wires for this switch are visible in the picture above.

3.3.3 Proportioning Valve

The proportioning valve reduces the pressure to the rear brakes. Regardless of what type of brakes a car has, the rear brakes require less force than the front brakes.

The amount of brake force that can be applied to a wheel without locking it depends on the amount of weight on the wheel. More weight means more brake force can be applied. If you have ever slammed on your brakes, you know that an abrupt stop makes your car lean forward. The front gets lower and the back gets higher. This is because a lot of weight is transferred to the front of the car when you stop. Also, most cars have more weight over the front wheels to start with because that is where the engine is located.

If equal braking force were applied at all four wheels during a stop, the rear wheels would lock up before the front wheels. The proportioning valve only lets a certain portion of the pressure through to the rear wheels so that the front wheels apply more braking force. If the proportioning valve were set to 70 percent and the brake pressure were 6,900 kPa for the front brakes, the rear brakes would get 4,800 kPa.

3.4 How Disc Brakes Work

Most modern cars have disc brakes on the front wheels, and some have disc brakes on all four wheels. This is the part of the brake system that does the actual work of stopping the car. The most common type of disc brake on modern cars is the single-piston floating calliper (Figure 16)**.**

Figure 16

3.4.1 Disc Brake Basics

Figure 17 demonstrates the location of the disc brakes in a car:

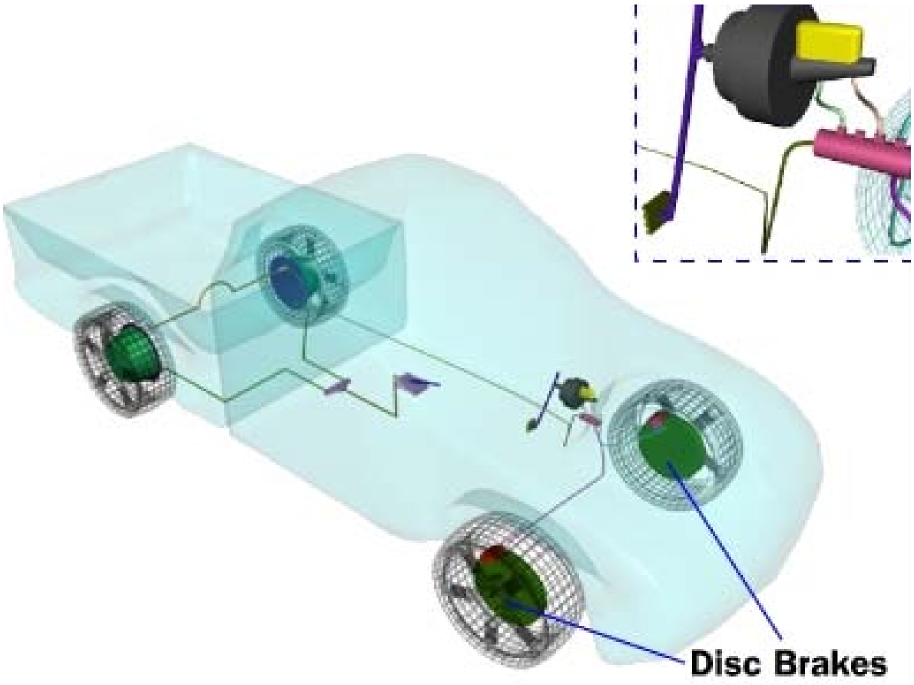


Figure 17

The main components of a disc brake are:

- The brake pads;
- The caliper, which contains a piston; and
- The rotor, which is mounted to the hub.

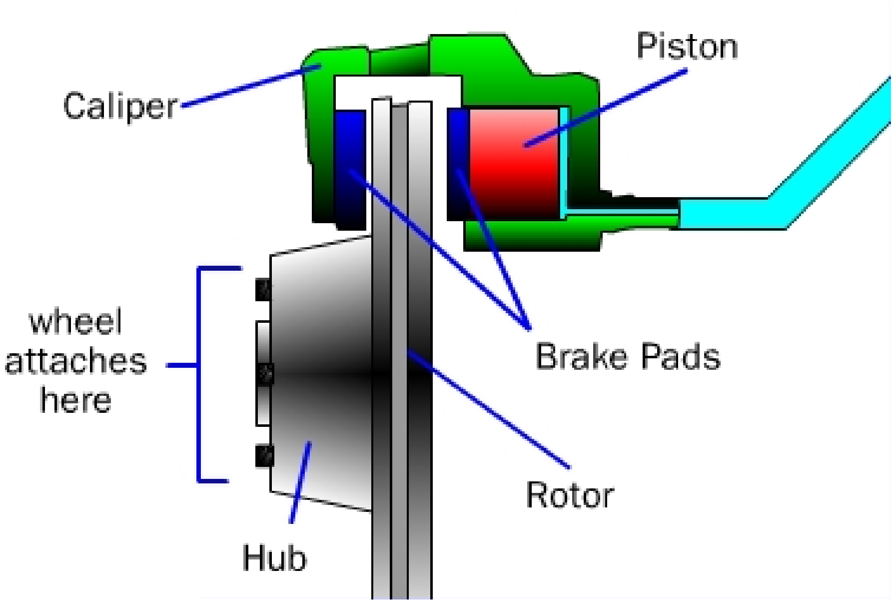


Figure 18

The disc brake is a lot like the brakes on a bicycle. Bicycle brakes have a caliper, which squeezes the brake pads against the wheel. In a disc brake, the brake pads squeeze the rotor instead of the wheel, and the force is transmitted hydraulically instead of through a cable. Friction between the pads and the disc slows the disc down.

A moving car has a certain amount of kinetic energy, and the brakes have to remove this energy from the car in order to stop it. How do the brakes do this? Each time you stop your car, your brakes convert the kinetic energy to heat generated by the friction between the pads and the disc. Most car disc brakes are vented.

Figure 19

Vented disc brakes have a set of vanes, between the two sides of the disc that pumps air through the disc to provide cooling.

3.5 Self-Adjusting Brakes

The single-piston floating-caliper disc brake is self-centring and self-adjusting. The caliper is able to slide from side to side so it will move to the centre each time the brakes are applied. Also, since there is no spring to pull the pads away from the disc, the pads always stay in light contact with the rotor (the rubber piston seal and any wobble in the rotor may actually pull the pads a small distance away from the rotor). This is important because the pistons in the brakes are much larger in diameter than the ones in the master cylinder. If the brake pistons retracted into their cylinders, it might take several applications of the brake pedal to pump enough fluid into the brake cylinder to engage the brake pads.

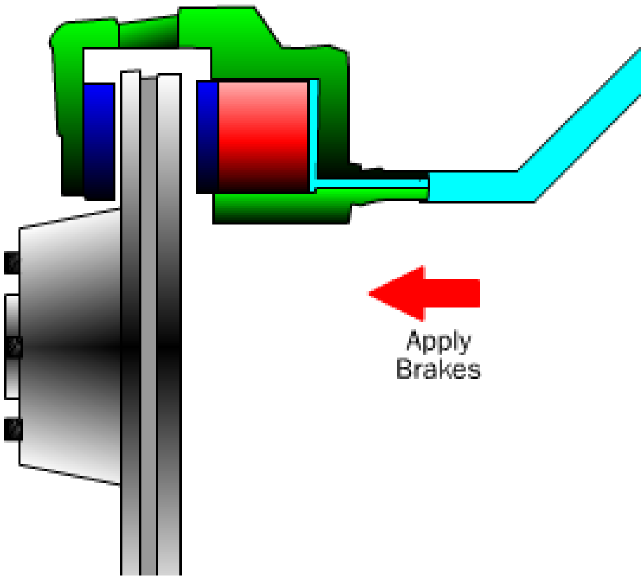


Figure 20

Older cars had dual or four-piston fixed-caliper designs. A piston (or two) on each side of the rotor pushed the pad on that side. This design has been largely eliminated because single-piston designs are cheaper and more reliable.

3.6 Hand/Emergency Brakes

In cars with disc brakes on all four wheels, an emergency hand brake has to be actuated by a separate mechanism than the primary brakes in case of a total primary brake failure. Most cars use a cable to actuate the emergency hand brake.

Other cars have a lever that turns a screw, or actuates a cam, which presses the piston of the disc brake (Figure 21).

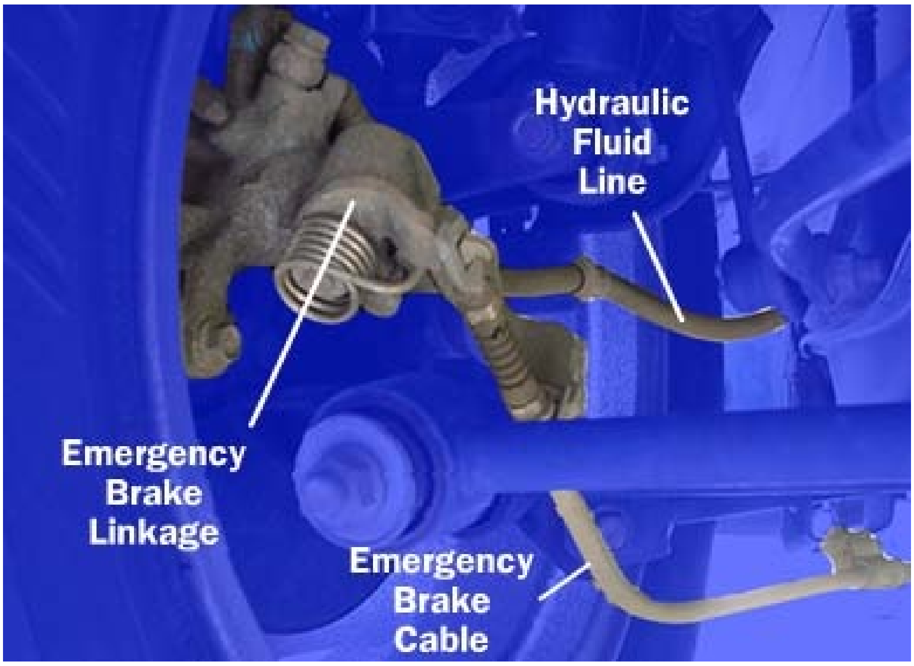


Figure 21

4.0 Servicing Your Brakes

The most common type of service required for brakes is changing the pads. Disc brake pads usually have a piece of metal on them called a wear indicator (Figure 22).

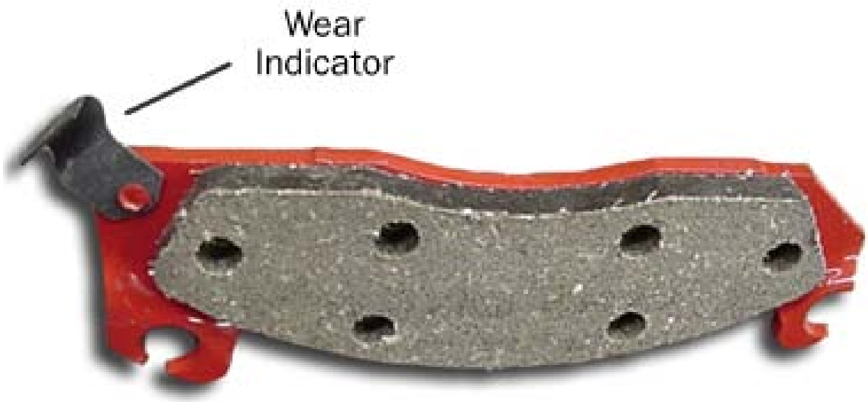


Figure 22

When enough of the friction material is worn away, the wear indicator will contact the disc and make a squealing sound. This means it is time for new brake pads.

There is also an inspection opening in the caliper so you can see how much friction material is left on your brake pads (Figure 23).

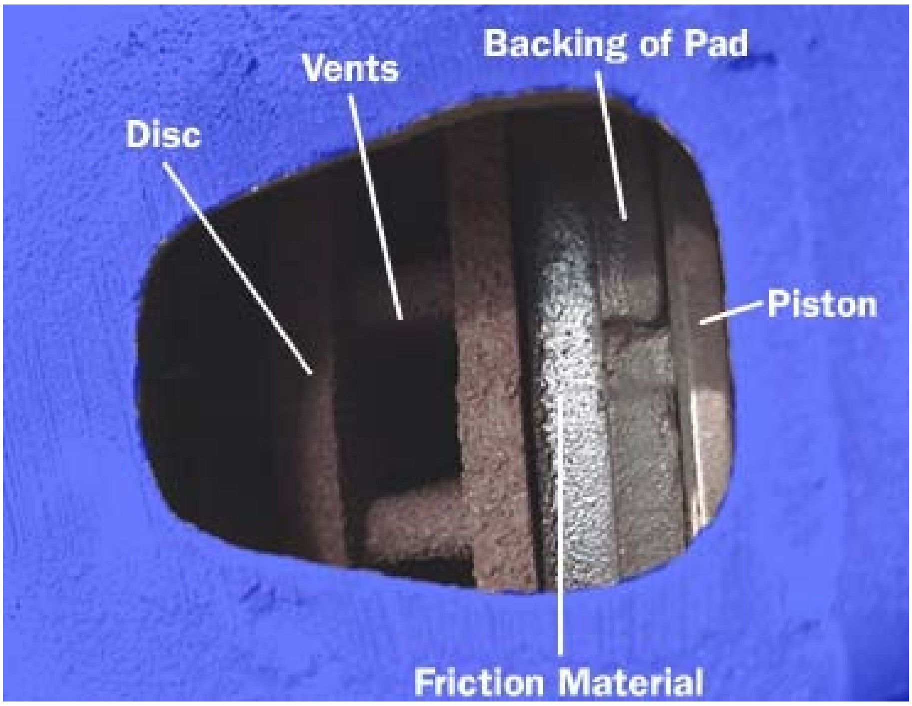


Figure 23

Sometimes, deep scores get worn into brake rotors. This can happen if a worn-out brake pad is left on the car for too long. Brake rotors can also warp; that is, lose their flatness. If this happens, the brakes may shudder or vibrate when you stop. Both of these problems can sometimes be fixed by refinishing (also called turning or machining) the rotors. Some material is removed from both sides of the rotors to restore the flat, smooth surface.

Refinishing is not required every time your brake shoes are replaced. You need it only if they are warped or badly scored. In fact, refinishing the rotors more often than is necessary will reduce their life. Because the process removes material, brake rotors get thinner every time they are refinished. All brake rotors have a specification for the minimum allowable thickness before they need to be replaced. This specification can be found in the manufacturer's manual for each vehicle.

5.0 How Drum Brakes Work

Drum brakes work on the same principle as disc brakes: Shoes press against a spinning surface. In this system, that surface is called a drum.

Many cars have drum brakes on the rear wheels and disc brakes on the front (Figure 24). Drum brakes have more parts than disc brakes and are harder to service, but they are less expensive to manufacture, and they easily incorporate an emergency hand brake mechanism.

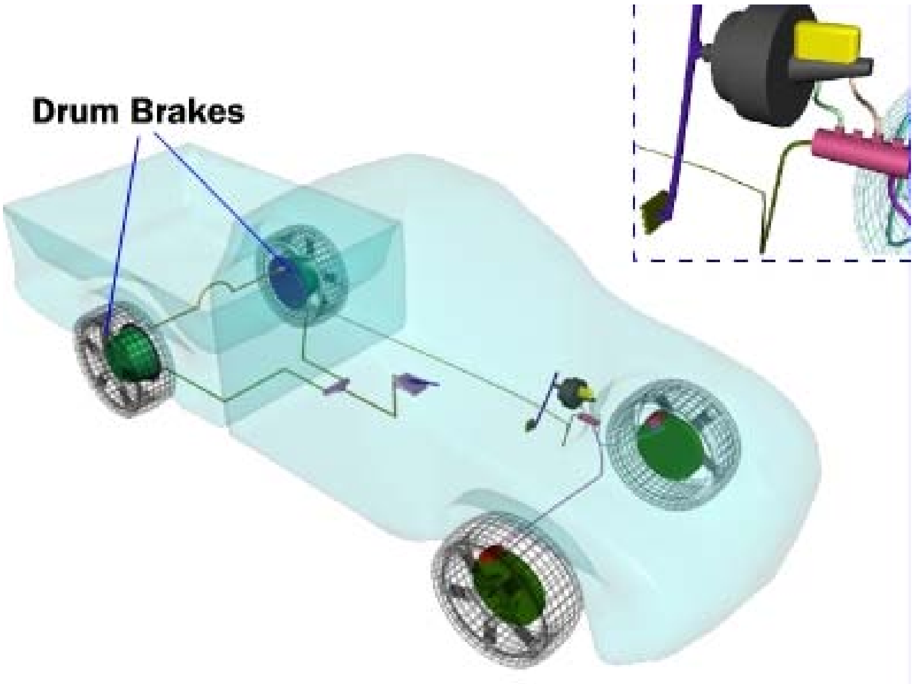


Figure 24

Figure 25

5.1 The Drum Brake

The drum brake may look complicated, and it can be pretty intimidating when you open one up (Figure 25 & 26).

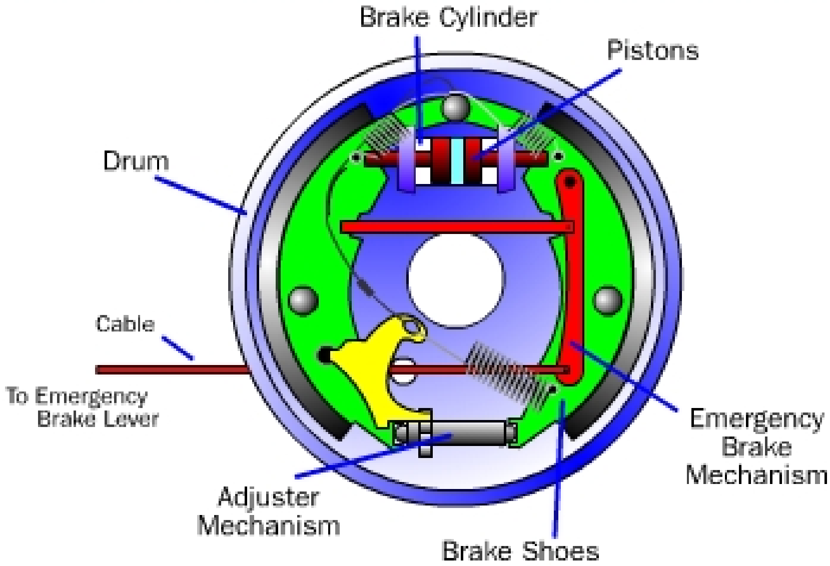


Figure 26

Like the disc brake, the drum brake has two brake shoes and a piston. But the drum brake also has an adjuster mechanism, an emergency hand brake mechanism and lots of springs.

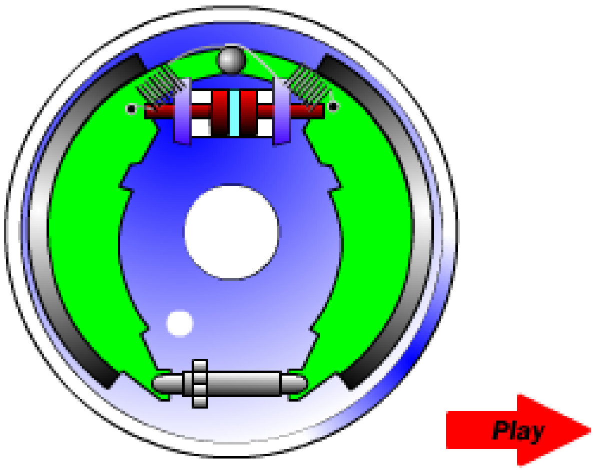


Figure 27

When you hit the brake pedal, the piston pushes the brake shoes against the drum. That's pretty straightforward, but why do we need all of those springs?

This is where it gets a little more complicated. Many drum brakes are self-actuating. Figure 27 shows that as the brake shoes contact the drum, there is a kind of wedging action, which has the effect of pressing the shoes into the drum with more force.

The extra braking force provided by the wedging action allows drum brakes to use a smaller piston than disc brakes. But, because of the wedging action, the shoes must be pulled away from the drum when the brakes are released. This is the reason for some of the springs. Other springs help hold the brake shoes in place and return the adjuster arm after it actuates.

5.2 Brake Adjuster

For the drum brakes to function correctly, the brake shoes must remain close to the drum without touching it. If they get too far away from the drum (as the shoes wear down, for instance), the piston will require more fluid to travel that distance, and your brake pedal will sink closer to the floor when you apply the brakes. This is why most drum brakes have an automatic adjuster (Figure 28).

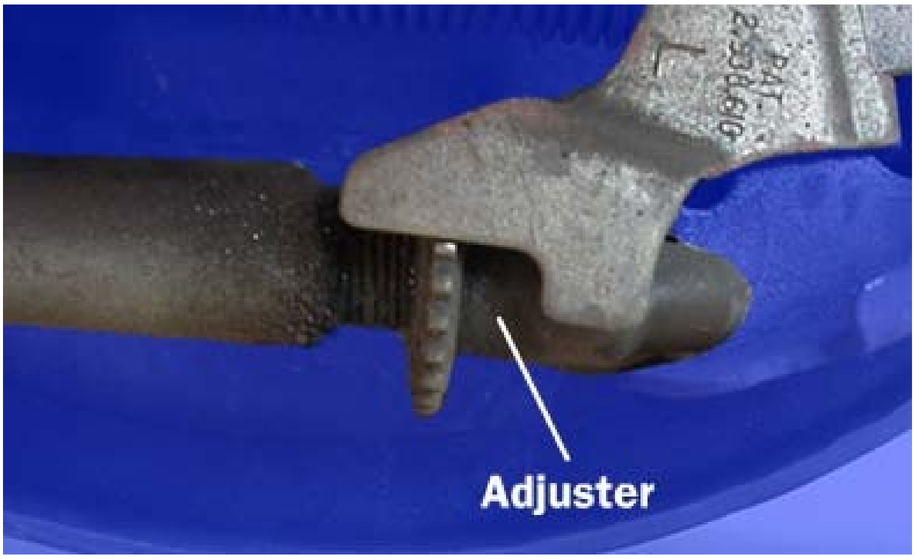


Figure 28

Now let's add in the parts of the adjuster mechanism. The adjuster uses the self-actuation principle discussed above.

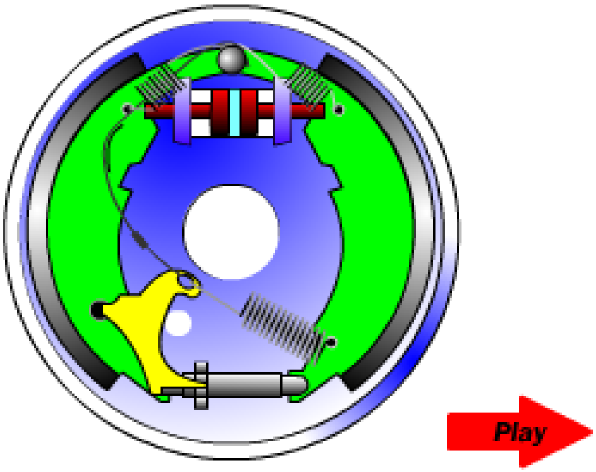


Figure 29

In Figure 29, you can see that as the pad wears down, more space will form between the shoe and the drum. Each time the car stops while in reverse, the shoe is pulled tight against the drum. When the gap gets big enough, the adjusting lever rocks enough to advance the adjuster gear by one tooth. The adjuster has threads on it, like a bolt, so that it unscrews a little bit when it turns, lengthening to fill in the gap. When the brake shoes wear a little more, the adjuster can advance again, so it always keeps the shoes close to the drum.

Some cars have an adjuster that is actuated when the emergency brake is applied. This type of adjuster can come out of adjustment if the emergency brake is not used for long periods of time. So if you have this type of adjuster, you should apply your emergency brake at least once a week.

5.3 The Emergency Hand Brake

The emergency hand brake on a car has to be actuated by a different power source than the primary braking system. The drum brake design allows for a simple cable actuation mechanism.

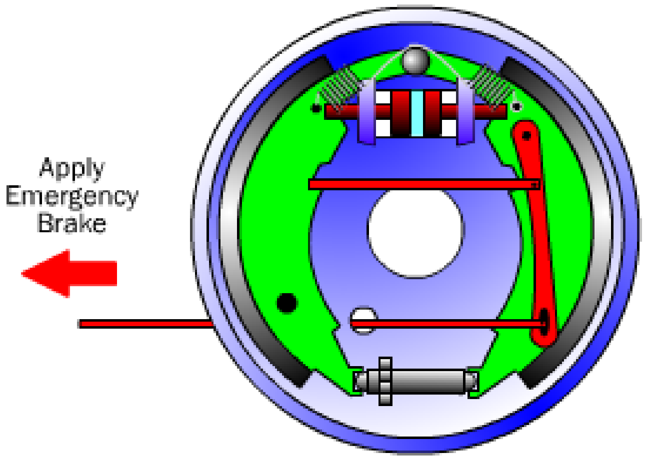


Figure 30 - Emergency brake in operation

When the emergency brake is actuated, a cable pulls on the lever, which forces the two shoes apart (Figure 30).

6.0 Servicing

The most common service required for drum brakes is changing the brake shoes (Figure 31). Some drum brakes provide an inspection hole on the back side, where you can see how much material is left on the shoe. Brake shoes should be replaced when the friction material has worn down to within 0.8 mm of the rivets. If the friction material is bonded to the backing plate (no rivets), then the shoes should be replaced when they have only 1.6 mm of material left.

Figure 31

Just as in disc brakes, deep scores sometimes get worn into brake drums. If a worn-out brake shoe is used for too long, the rivets that hold the friction material to the backing can wear grooves into the drum. A badly scored drum (Figure 32) can sometimes be repaired by refinishing. Where disc brakes have a minimum allowable thickness, drum brakes have a maximum allowable diameter. Since the contact surface is the inside of the drum, as you remove material from the drum brake the diameter gets bigger.

Figure 32

7.0 How Power Brakes Work

If you've ever opened the hood of your car, you've probably seen the brake booster (Figure 33). It's the round, black canister located at the back of the engine compartment on the driver's side of the car.

Figure 33

Back in the day, when most cars had drum brakes (Figure 34), power brakes were not really necessary - drum brakes naturally provide some of their own power assist. Since most cars today have disc brakes, at least on the front wheels, they need power brakes. Without this device, a lot of drivers would have very tired legs.

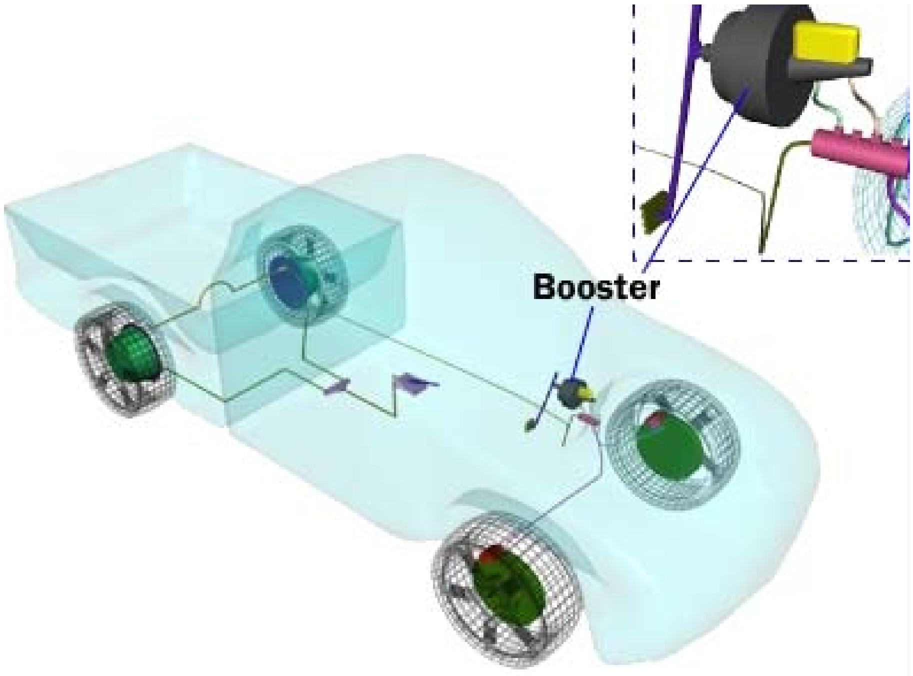


Figure 34

The brake booster uses **vacuum** from the engine to multiply the force that your foot applies to the master cylinder.

7.1 The Vacuum Booster

The vacuum booster is a metal canister that contains a clever valve and a diaphragm. A rod going through the centre of the canister connects to the master cylinder's piston on one side and to the pedal linkage on the other (Figure 35).

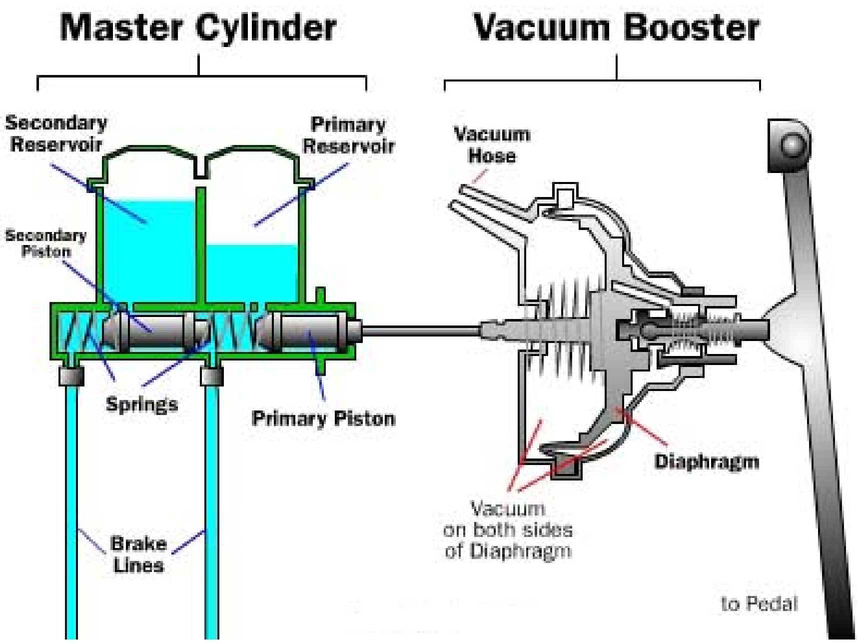


Figure 35

Another key part of the power brakes is the check valve (Figure 36).

Figure 36

The figure above shows the check valve, which is a one-way valve that only allows air to be sucked *out* of the vacuum booster. If the engine is turned off, or if a leak forms in a vacuum hose, the check valve makes sure that air does not enter the vacuum booster. This is important because the vacuum booster has to be able to provide enough boost for a driver to make several stops in the event that the engine stops running - you certainly don't want to lose brake function if you run out of petrol on the highway.

7.2 The Booster in Action

The vacuum booster is a very simple, elegant design. The device needs a vacuum source to operate (Figure 37). In petrol powered cars, the engine provides a vacuum suitable for the boosters. In fact, if you hook a hose to a certain part of an engine, you can suck some of the air out of the container, producing a partial vacuum. Because diesel engines don't produce a vacuum, diesel-powered vehicles must use a separate vacuum pump.

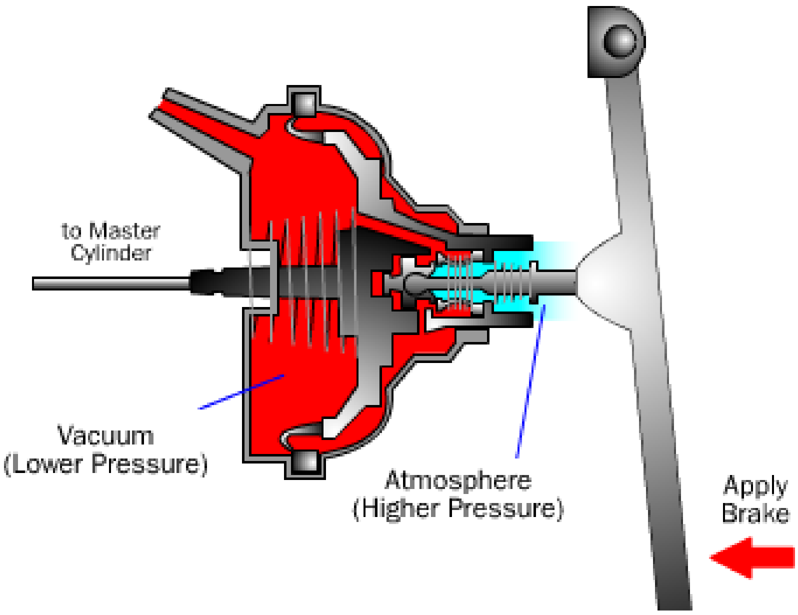


Figure 37

On cars with a vacuum booster, the brake pedal pushes a rod that passes through the booster into the master cylinder, actuating the master-cylinder piston. The engine creates a partial vacuum inside the vacuum booster on both sides of the diaphragm. When you hit the brake pedal, the rod cracks open a valve, allowing air to enter the booster on one side of the diaphragm while sealing off the vacuum. This increases pressure on that side of the diaphragm so that it helps to push the rod, which in turn pushes the piston in the master cylinder.

As the brake pedal is released, the valve seals off the outside air supply while reopening the vacuum valve. This restores vacuum to both sides of the diaphragm, allowing everything to return to its original position.

8.0 How Anti-Lock Brakes Work

Stopping a car in a hurry on a slippery road can be very challenging. Anti-lock braking systems (ABS) take a lot of the challenge out of this sometimes nerve-wracking event. In fact, on slippery surfaces, even professional drivers can't stop as quickly without ABS as an average driver can with ABS.

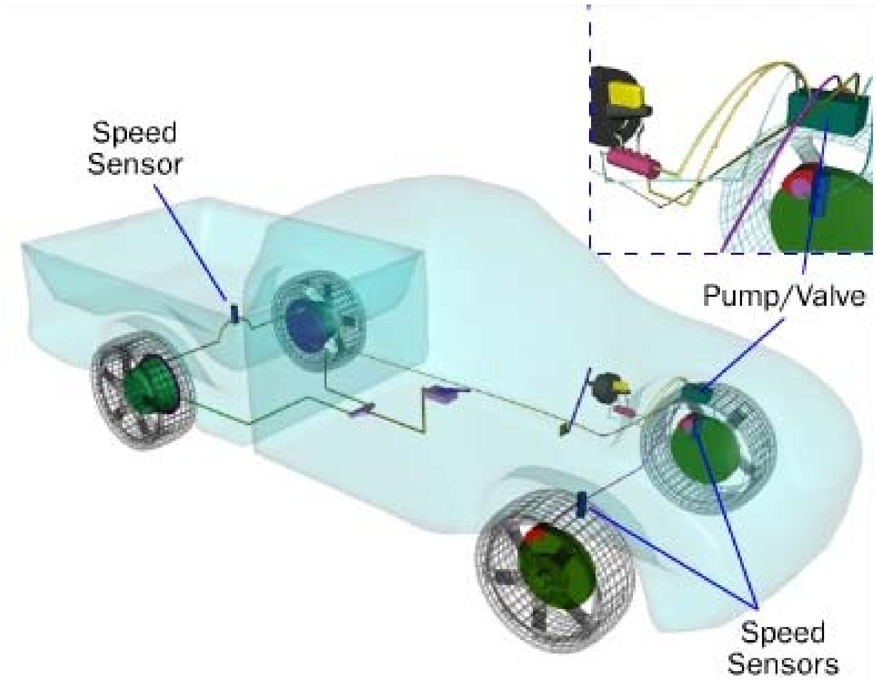


Figure 38

8.1 The ABS System

The theory behind anti-lock brakes is simple. A skidding wheel (where the tyre contact patch is sliding relative to the road) has less traction than a non-skidding wheel. By keeping the wheels from skidding while you slow down, anti-lock brakes benefit you in two ways: You'll stop faster, and you'll be able to steer while you stop.
There are four main components to an ABS system:

- Speed sensors;
- Pump;
- Valves; and
- Controller.

Figure 39

8.2 Speed Sensors

The anti-lock braking system needs some way of knowing when a wheel is about to lock up. The speed sensors, which are located at each wheel, or in some cases in the differential, provide this information.

8.3 Valves

There is a valve in the brake line of each brake controlled by the ABS. On some systems, the valve has three positions:

- In position one, the valve is open; pressure from the master cylinder is passed right through to the brake;
- In position two, the valve blocks the line, isolating that brake from the master cylinder. This prevents the pressure from rising further should the driver push the brake pedal harder; and
- In position three, the valve releases some of the pressure from the brake.

8.4 Pump

Since the valve is able to release pressure from the brakes, there has to be some way to put that pressure back. That is what the pump does; when a valve reduces the pressure in a line, the pump is there to get the pressure back up.

8.5 Controller

The controller is a computer in the car. It watches the speed sensors and controls the valves.

8.6 ABS at Work

There are many different variations and control algorithms for ABS systems. We will discuss how one of the simpler systems works.

The controller monitors the speed sensors at all times. It is looking for decelerations in the wheel that are out of the ordinary. Right before wheel lock up, it will experience a rapid deceleration. If left unchecked, the wheel would stop much more quickly than any car could. It might take a car five seconds to stop from 100 kph under ideal conditions, but a wheel that locks up could stop spinning in less than a second.

The ABS controller knows that such a rapid deceleration is impossible, so it reduces the pressure to that brake until it sees acceleration, then it increases the pressure until it sees the deceleration again. It can do this very quickly, before the tyre can actually significantly change speed. The result is that the tire slows down at the same rate as the car, with the brakes keeping the tires very near the point at which they will start to lock up. This gives the system maximum braking power.

When the ABS system is in operation you will feel a pulsing in the brake pedal; this comes from the rapid opening and closing of the valves. Some ABS systems can cycle up to 15 times per second.

9.0 Anti-Lock Brake Types

Anti-lock braking systems use different schemes depending on the type of brakes in use. We will refer to them by the number of channels - that is, how many valves that are individually controlled - and the number of speed sensors.

- Four-channel, four-sensor ABS - This is the best scheme. There is a speed sensor on all four wheels and a separate valve for all four wheels. With this setup, the controller monitors each wheel individually to make sure it is achieving maximum braking force.

- Three-channel, three-sensor ABS - This scheme, commonly found on pickup trucks with four-wheel ABS, has a speed sensor and a valve for each of the front wheels, with one valve and one sensor for both rear wheels. The speed sensor for the rear wheels is located in the rear axle.

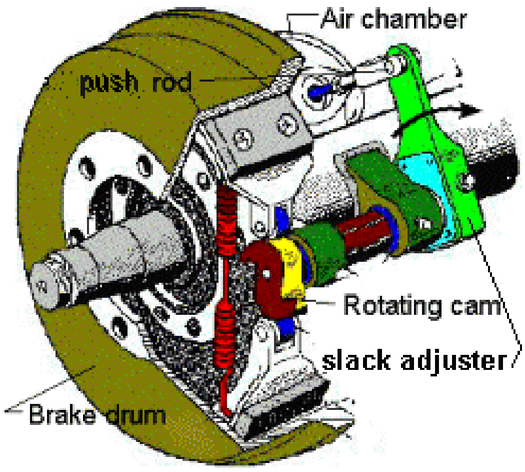
  This system provides individual control of the front wheels, so they can both achieve maximum braking force. The rear wheels, however, are monitored together; they both have to start to lock up before the ABS will activate on the rear. With this system, it is possible that one of the rear wheels will lock during a stop, reducing brake effectiveness.

- One-channel, one-sensor ABS - This system is commonly found on pickup trucks with rear-wheel ABS. It has one valve, which controls both rear wheels, and one speed sensor, located in the rear axle.

  This system operates the same as the rear end of a three-channel system. The rear wheels are monitored together and they both have to start to lock up before the ABS kicks in. In this system it is also possible that one of the rear wheels will lock, reducing brake effectiveness.

This system is easy to identify. Usually there will be one brake line going through a T-fitting to both rear wheels. You can locate the speed sensor by looking for an electrical connection near the differential on the rear-axle housing.

10.0 Air Brakes



10.1 Basics

Heavy trucks use air brakes exclusively. Most of these are drum type units like the one shown above. Air enters the chamber when the brakes are applied, the push rod moves out turning the slack adjuster which rotates the "S" cam and forces the shoes into the drum.

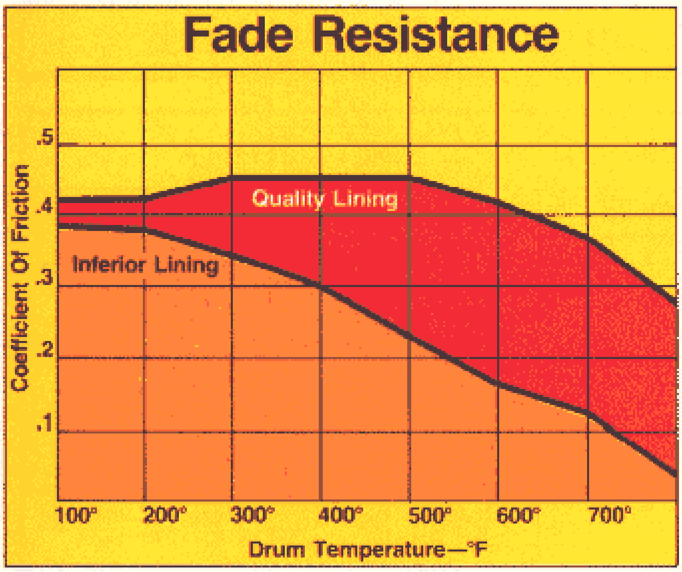
10.2 Heat Engine

Brakes are a heat engine; they convert kinetic energy (motion) into thermal energy or heat. It interesting to figure out just how powerful your brakes must be to do the job of stopping your rig. Suppose you've got a 298 kW engine and are about grossed out at 36,000 kg your engine can probably get you to about 25 kph in 400 metres. Your brakes should be able to stop you in about 40 M with this speed and weight, making them 10 times as powerful as your engine!

A full stop from 100 kph might raise your drum temperatures to 315 ºC. This is about the limit for safe operation. If the brakes aren't right, or the load is not distributed properly, then some drums might go to 425 - 540ºC. This is definitely dangerous. The drum will increase in diameter about 0.254mm per 40 degree temperature rise. So that even 315 ºC your drums will be 1.4mm larger than at 10 ºC. This will increase the pushrod stroke about 12mm. The question is: Do you have that much additional stroke available?

10.3 Brake Fade

This chart shows what happens when brake linings get hot. The friction provided by the linings decreases. The linings no longer offer the same resistance to the rotation of the drums, they get slick.



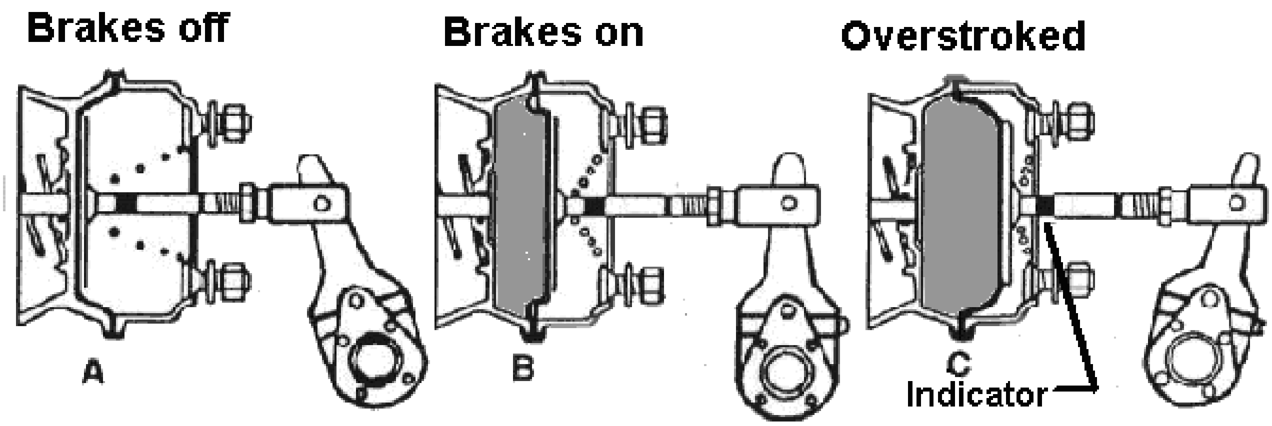
ºF	ºC
100	56
200	111
300	168
400	222
500	278
600	333
700	389

Organic brake linings are essentially composed of glue and a strengthening material, this used to be asbestos but today different materials are used because asbestos is a health hazard. When the linings get hot, the glue softens and starts to melt and the linings get slick.

The phenomenon of brake fade is not just a matter of lining fade however. As the drum heats up it expands and moves away from the shoes. With an air brake system the stroke of the pushrod and thus the distance that the shoes can be moved out into the drum is limited. If the brakes are improperly adjusted, when they get hot it is possible to run out of stroke before the shoes make good contact with the drums.

10.4 Adjusting Air Brakes

Air brakes should be adjusted in the shop with the wheels off the ground according to the manufacturer's instructions. But if you're on the road and you're looking at 10 km of a 6% downgrade here is what to do if you're not sure your brakes are right:



See how far the adjusting arm will move with air pressure (550 kPa or above) or by manually turning the arm with a pry bar. It should not go beyond the 90 degree point illustrated in figure B. You may or may not have the visual over-stroke indicator on the pushrod that is shown here. At very least, adjust the slack until the stroke does not go beyond the 90 degree mark. Ideally you should bring the free play in the arm down to 10 mm and the adjusting arms should all be at the

same angle with the same pressure applied. Don't over tighten. Bang the brake drum with a hammer with the pressure off. The drum should ring hollow if the shoes are clear of the drum. A dull thud means you still have lining-drum contact and you should back off the adjustment. When you bring the free play down to about 10mm, the stroke should be well short of the 90 degree point.

11.0 Summary

Automotive brake servicing is a specialist task. The opening statement of this learning resource tells us “We all know that pushing down on the brake pedal slows a car to a stop. But how does this happen? How does your car transmit the force from your leg to its wheels? How does it multiply the force so that it is enough to stop something as big as a car?” We as operators don’t really need to need to know as we can rely of the technicians’.

11.1 Servicing Documentation

Documentation provides valuable descriptions of an organisation’s development, acquisition, and operating environments and significantly enhances an organisation’s ability to administer, operate, and maintain technology systems. Primary advantages for technicians’ involves having access to operation manuals and on-line application help features. Documentation enhances administrators’ and technicians’ ability to maintain and update systems efficiently and to identify and correct programming defects.

Developing and maintaining current, accurate documentation can be complicated, time consuming, and expensive. However, standardised documentation procedures and the use of automated documentation software can facilitate an organisation’s ability to maintain accurate documentation.

11.2 Final Inspection

Consumers expectations are that they will receive their vehicle back in a serviceable condition and in a better operational condition than when it was delivered to the workshop. This expectation requires two (2) critical components:

- A final inspection must be completed by the service technician to ensure that all of the protective features for the braking system have been refitted is replaced to the required specifications; and
- A final inspection must be completed by the service technician to ensure that all of the work that was commenced on the system was completed to workplace, customer and manufacturers expectations.

11.3 For the Technician

There are some tasks that a technician will not carry out frequently. It would be unrealistic for a technician to have a detailed knowledge of seldom-performed procedures. In these circumstances, job cards or checklists are very useful as they give a step-by-step guide to follow whenever the rarely-used procedure needs to be performed. The required knowledge is often kept in manuals which may not be easily accessible. However, going through a large manual, possibly in front of a customer, does nothing for time effectiveness or professional image.

A job card is also used as the basis of a recording process for the organisation. In addition to refreshing the process for the technician it will be a list of the workplace expectations as well. It is suggested that the final task on a job card will be to ensure that the equipment is cleaned for use or storage.

End

12.0 Competency Based Training and Assessment Tool

• Are you ready for assessment?	Yes	☐	No	☐
• Do you understand the assessment process?	Yes	☐	No	☐
• Have you considered the Recognition of Prior Learning (RPL) process?	Yes	☐	No	☐
• Do you understand the term evidence and how it is to be collected?	Yes	☐	No	☐

If you have answered YES to these four questions you are ready to proceed to the assessment phase of this unit of competence. If you have answered NO you need to discuss your progress with a qualified assessor.

Introduction

Competency Based Training is always concerned with what a participant will be able to do at the end of training. What the inputs are or how the participant got there will vary, however it is critical that the participant achieves the listed competencies and that a quality assessment be undertaken by a competent trainer/assessor.

Assessment Coversheet

Participant Name			
Participant Email		**Telephone Number**	

Receipt of Assessment

Receiver's Signature		**Date**	
Signature of assessor		**Result**	

I certify that this assessment is my own work based on my personal study and /or research and that I have acknowledged all materials and resources used in the preparation of this assessment whether they are books, articles, reports, lecture notes and any other kind of document, electronic or personal communications. I also certify that the assessment has not previously been submitted for assessment in any award or course and that I have not copied in part or whole or otherwise plagarised the work of other students and/or persons. I can produce another hard/soft copy of this assessment within 24 hours if requested.

Participant Signature		**Date**	

This assignment/assessment will not be marked unless the the above declaration is signed

Please copy this page and attach it to each submission for assessment

Observation Assessment

To be administered by the RTO Assessor

Purpose of the task

The purpose of the observations is to assess your competency in the inspection and servicing of braking systems.

Instructions for the observation component

You will be required to participate in servicing sessions whilst being observed by an assessor who is qualified in this unit of competency. You may use an assessor from your preferred registered training organisation, or alternatively, you may source your own assessor (this person must use the observation checklist and provided a certified copy of their qualifications).

You will need to be observed in a **minimum of three (3)** service sessions:

- These sessions can be conducted by a workplace supervisor but must be completed by an suitably qualified assessor from a Registered Training Organisation on at least one occasion if you are submitting this assessment for recognition towards a nationally recognised qualification.

You will be assessed on the following required skills and attributes:

- Customer service
- Oral communication and interpersonal skills
- OHS skills
- Workshop practice skills

Please refer to the observation checklist for specific observation requirements under the above skills groups. Competency will need to be demonstrated over a period of time reflecting the scope of the role, as reflected by all components of this unit.

Where assessment is part of a structured learning experience, the evidence collected must relate to a number of performances assessed at different points in time and separated by further learning and practice with a decision of competence only taken at the point when the assessor has complete confidence in the ability of the person.

Where assessment is for the purpose of recognition (RCC/RPL), the evidence provided will need to show that it represents competency demonstrated over a period of time and is current.

Evidence must show the ability to transfer skills to different environments.

Observation Report/Third Party Assessment

To be administered by an Assessor and/or a Workplace Supervisor

Candidate Name:	
RTO Assessor Name:	
Unit/s of Competency:	
Name of Workplace:	
Date of Assessment:	

During the Observation Assessment, did the candidate:	**PC**	**S**	**NS**
Identify and confirm the nature and scope of work requirements	1.1	☐	☐
Observe throughout the work OH&S requirements, including individual State/Territory regulatory requirements and personal protection needs	1.2	☐	☐
Source procedures and information such as workshop manuals and specifications and tooling required	1.3	☐	☐
Prepare in accordance with standard operating procedures methods appropriate to the circumstances	1.4	☐	☐
Sources and support equipment is identified and prepared for inspection of braking systems	1.5	☐	☐
Observe warnings in relation to working with braking systems	1.6	☐	☐
Implement in accordance with road safety legislation, workplace procedures and manufacturer/ component supplier specifications a braking system analysis	2.1	☐	☐
Indicate compliance or non-compliance with brake wear measurement results and compare them with manufacturer/ component supplier specifications	2.2	☐	☐
Results are documented with evidence and supporting information and recommendation(s) made	2.3	☐	☐
A report is processed in accordance with workplace procedures	2.4	☐	☐
Observe throughout the work OH&S requirements, including individual State/Territory regulatory requirements and personal protection needs	3.1	☐	☐
Identify and source and procedures and information required	3.2	☐	☐
Identify and prepare resources and support equipment required for servicing braking systems	3.3	☐	☐

Servicing is implemented in accordance with workplace procedures and manufacturer/component supplier specifications	4.1	☐	☐
Adjustments made during the servicing are in accordance with manufacturer/component supplier specifications	4.2	☐	☐
Documentation for the servicing schedule is completed	5.1	☐	☐
Ensure protective features are in place by completing a final inspection	5.2	☐	☐
Ensure work is to workplace expectations by completing a final inspection	5.3	☐	☐
Ensure that equipment is cleaned for use or storage to workplace expectations	5.4	☐	☐
Process the job card in accordance with workplace procedures	5.5	☐	☐

Legend

S	NS	**NS** = Not Satisfactory. The participant requires more training, instruction and/or experience prior to re assessment
		S = Satisfactory
		NOTE : Always indicate an outcome

Feedback Comments:

Result for Assessment:	☐ **Satisfactory (S)** ☐ **Not Satisfactory (NS)**		
Candidate Signature:		**Date:**	
RTO Assessor Signature:		**Date:**	

Portfolio of Evidence

To be completed by the candidate and submitted to the RTO Assessor

Candidate Name:	
RTO Assessor Name:	
Unit/s of Competency:	
Name of Workplace:	
Date of Assessment:	

This assessment covers components of the elements required for competency in

Element 1 Prepare to undertake braking system inspection

Element 2 Conduct braking system wear analysis

Element 3 Prepare to service braking system and/or associated components;

Element 4 Carry out servicing of braking systems and/or associated components; and

Element 5 Prepare equipment for use or storage.

Purpose of the task

As you work through the steps in assessing competence, you must collect documentation or work samples that "prove" what you do.

Indicative examples of the type of evidence you should collect at different stages of your program are listed below. There may be other pieces of evidence that you could collect. You are encouraged to discuss any other options with your assessor.

Instructions

You are required to provide evidence of:

- Gather information about the OH&S and environmental regulations/requirements, equipment, material and personal safety requirements as applied to your workplace;
- Develop a list of dangers of working with braking systems;
- Detail the operating principles of braking systems, components and their relationship to each other;
- Make a list of different types and layout of service/repair manuals (hard copy and electronic);
- Provide a written description about a braking system analysis procedure;
- List the steps in a braking system service procedure;
- Provide your enterprise quality procedures; and
- Detail your work organisation and planning processes.

S	NS	**NS** = Not Satisfactory. The participant requires more training, instruction and/or experience prior to re assessment
		S = Satisfactory
		NOTE : Always indicate an outcome

Feedback Comments:

Result for Assessment:	☐ **Satisfactory (S)**	☐ **Not Satisfactory (NS)**

Candidate Signature:		**Date:**	
RTO Assessor Signature:		**Date:**	

Sources of Acknowledgement

Boyce Automotive Data @ www.boyce.com.au

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Gregory's *Automotive Mechanics Fundamentals* 6th edition Gregory's Automotive Publications 2005

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