BRAKE

A hydraulic disc brake is used on each wheel for superior braking performance and high reliability. The major components of each disc brake are the brake lever (front) or the brake pedal (rear), master cylinder, brake line, caliper assembly, and disc. The brake lever is pulled or the brake pedal is pushed to move a piston in the master cylinder and pressurize the brake fluid. Fluid pressure is transmitted through the brake line to operate the caliper. The caliper grips the disc attached to the wheel, slowing wheel rotation. Front brake lever pushes the front brake light switch, and the rear brake pedal pulls the rear brake light switch. Each switch turns on the brake light.

Unlike a drum-type brake, the components of the disc brake which perform the actual braking action, i.e., the disc and pads, are open to direct contact with the air flow past the motorcycle. This provides for excellent dissipation of the heat from brake friction, and minimizes the possibility of brake fade common to drum brakes.

The automatic wear adjustment mechanism of the rear caliper is the same as that of the front caliper, and caliper operation is the same as for the front caliper except that the rear caliper is held stationary and has two pistons. So a separate explanation of the braking and release strokes of the rear caliper will be omitted.

Automatic Wear Adjustment

When fluid pressure develops in the cylinder, the piston is pushed exerting pressure against the brake pad, which in turn presses against the brake disc. The pressurized fluid is prevented from leaking by a fluid seal fitted into the cylinder wall. The seal is pressed against the piston and, instead of sliding when the piston moves, the seal is only distorted, allowing no fluid leakage at all (See Fig. J14). When the brake lever or pedal is released and fluid pressure lowers, the elasticity of the seal returns the piston to its original position.

After the brakes are used for a while and the pads wear slightly, the rubber seal will no longer be able to distort the additional amount that the piston travels. Instead, when piston travel forces the seal past its limit, the seal slips on the piston. The seal then returns the piston to a new rest position that is closer to the disc.

A small amount of fluid from the reservoir supplements the fluid in the brake line to compensate for the difference in piston position. Consequently, the length of the brake lever or pedal stroke remains unchanged, and the brake never needs adjustment.

The seal and the cup at the head of the master cylinder piston are made of special heat resistant rubber for best performance and to prevent deterioration. For this reason, only standard parts should be used.

Braking Stroke

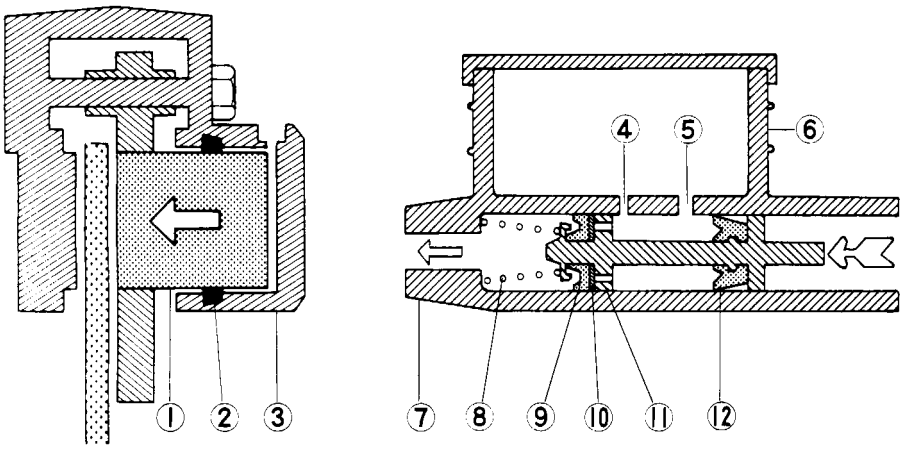
When the brake lever is pulled, the piston ⑪ in the master cylinder is pushed and moves forward against the force of the return spring ⑧. At this time, the primary cup ⑨ at the head of the piston closes the small relief port ④, which connects the pressure chamber and the reservoir ⑥. Until this port is fully closed, the brake fluid does not start being pressurized, in spite of the forward movement of the piston.

The pressure stroke starts as soon as the relief port is closed. The piston compresses the brake fluid, which is being used as the pressure medium, forcing it out into the brake line. The pressure is transmitted through the line to the cylinder portion of the caliper assembly, where it forces the piston ① towards the disc. The piston presses pad A against the disc, but since the disc is immovable, further pressure cannot move the pad any farther. Instead, the entire caliper assembly moves in the opposite direction such that pad B is also forced against the disc. In this manner, the disc is gripped between the two pads, and the resulting friction slows wheel rotation.

Braking Release Stroke

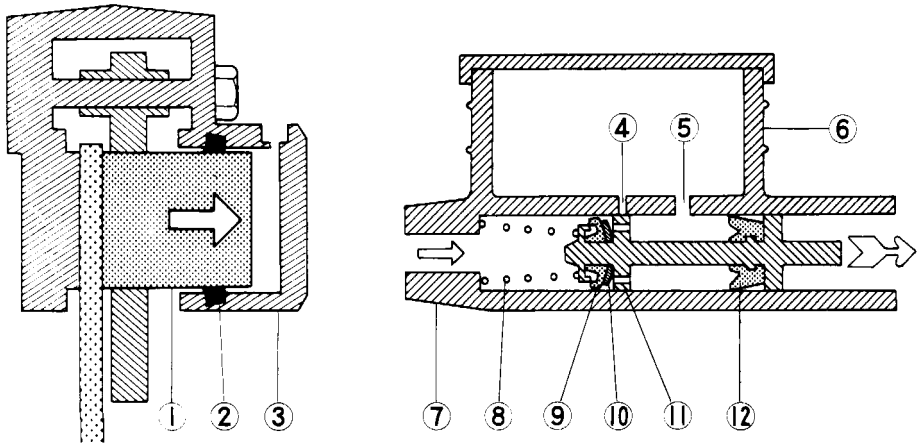
When the brake lever is released, the piston in the master cylinder is quickly returned toward its rest position by the spring ⑧, and brake fluid pressure drops in the line and in the caliper cylinder. The elasticity of

Braking Stroke (J13)



1. Piston
2. Fluid Seal
3. Caliper
4. Relief Port
5. Supply Port
6. Reservoir
7. Master Cylinder
8. Spring
9. Primary Cup
10. Non-return Valve
11. Piston
12. Secondary Cup

Braking Release Stroke (J14)



1. Piston
2. Fluid Seal
3. Caliper
4. Relief Port
5. Supply Port
6. Reservoir
7. Master Cylinder
8. Spring
9. Primary Cup
10. Non-return Valve
11. Piston
12. Secondary Cup

the fluid seal ② in the cylinder then returns the piston. This leaves no pressure against either pad A or B so that slight friction against the disc pushes them both slightly away from the disc.

As the master cylinder piston moves back further, the brake fluid in the line rushes to fill the low pressure area in front of the primary cup at the piston head. At this time, fluid from the reservoir flows through the large supply port ⑤ into the space between the primary and secondary cups, through the non-return valve ⑩, and passes around the edges of the primary cup to fill the vacuum. When the piston has returned to its rest position against the stop, the small relief port is uncovered. As the brake fluid returns from the line, excess fluid passes through the relief port into the reservoir until the brake line pressure returns to zero.

Master Cylinder

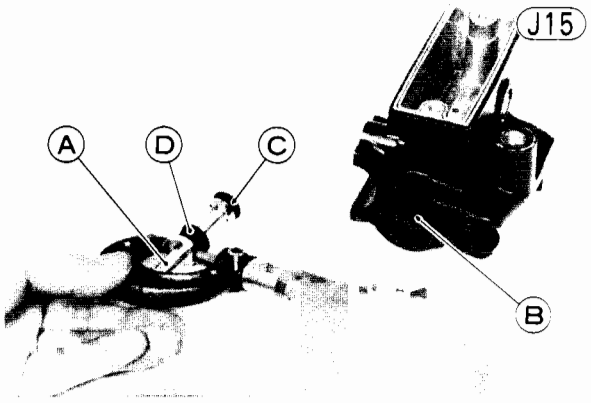
The master cylinder assembly includes the reservoir ⑤, piston ⑩, primary and secondary cups ⑧, ⑩, non-return valve ⑨, and spring ⑦. The reservoir has two holes at the bottom: a relatively large supply port ③ to supply fluid to the lines and a small relief port ② to admit excess fluid from the line. The primary and secondary cups stop the fluid from leaking back around the piston while the piston is moving forward to pressurize the line. The non-return valve is in the head of the piston; it stops backward fluid flow when the brake is applied. When the brake lever is released, the valve allows flow around the cup to fill the vacuum in front of the piston so that the piston can return easily.

Master cylinder part wear

When master cylinder parts are worn or damaged, proper brake fluid pressure cannot be obtained in the line, and the brake will not hold.

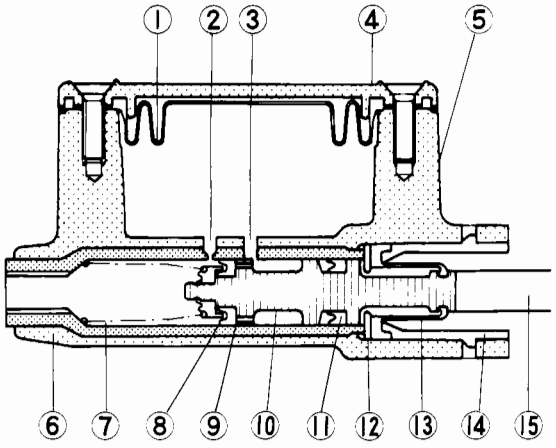
If the small relief port becomes plugged, especially with a swollen or damaged primary cup, the brake pads will drag on the disc.

- Check that there are no scratches, rust or pitting on the inside of the master cylinder, and that it is not worn past the service limit.
- Check the piston for these same faults.
- Measure the cylinder inside diameter, and measure the piston, primary cup, and secondary cup outside diameter.

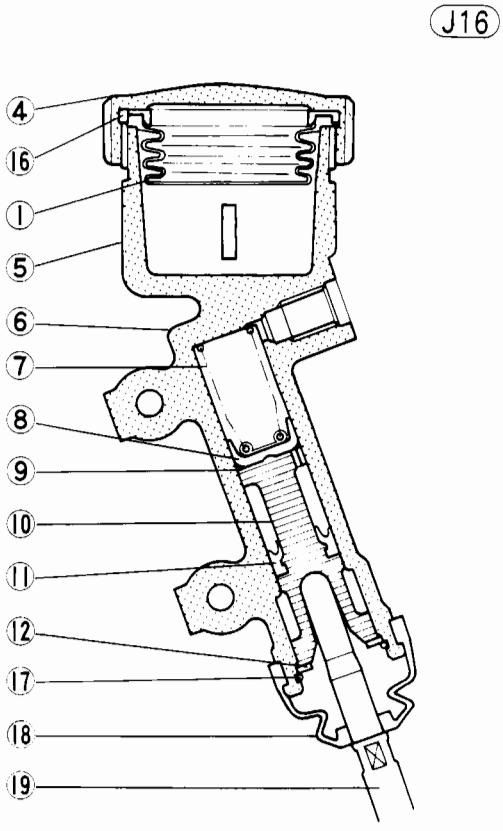


A. Piston
B. Cylinder
C. Primary Cup
D. Secondary Cup

Front and Rear Master Cylinders



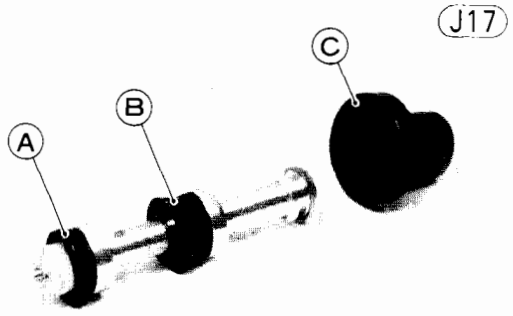
1. Diaphragm
2. Relief Port
3. Supply Port
4. Cap
5. Reservoir
6. Master Cylinder Body
7. Spring
8. Primary Cup
9. Non-return Valve
10. Piston
11. Secondary Cup
12. Piston Stop
13. Dust Seal
14. Liner
15. Brake Lever
16. Plate
17. Retainer
18. Dust Cover
19. Push Rod



NOTE: The cups and spring are part of the piston assembly. Replace the piston assembly if any one of the cups or the spring requires replacement.

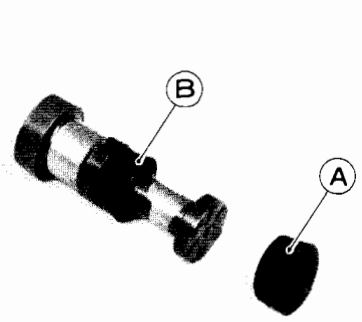
- Inspect the primary and secondary cups. If a cup is worn, damaged, softened (rotted), or swollen, replace it. If fluid leakage is noted at the brake lever, the cups should be replaced.

Front



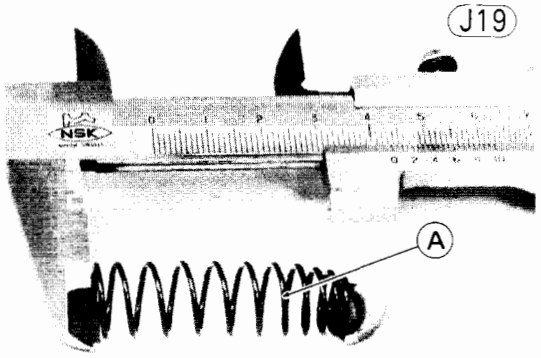
A. Primary Cup **C. Dust Cover**
B. Secondary Cup

Rear



A. Primary Cup **B. Secondary Cup**

- Replace the dust seal if damaged.
- Check that the spring is not damaged and the spring free length is not shorter than the service limit.



A. Spring

Table J10 Master Cylinder Parts

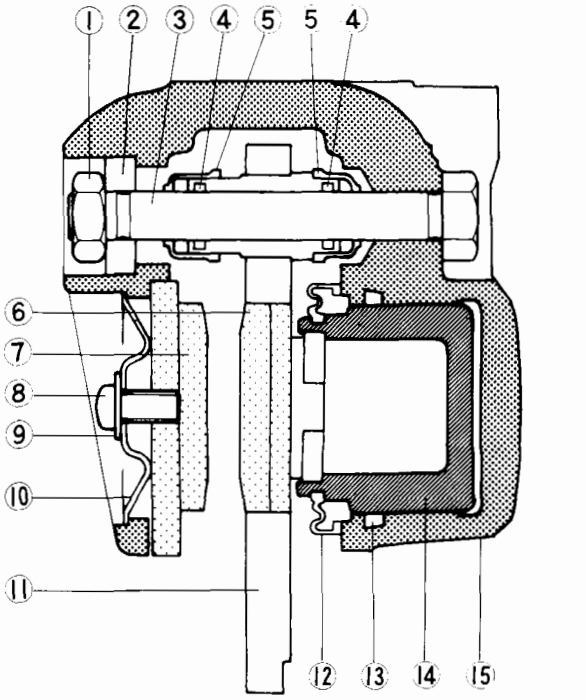
	Measurement	Service Limit
Front	Cylinder Inside Diameter	15.95 mm, Ⓢ 14.08 mm
	Piston Outside Diameter	15.80 mm, Ⓢ 13.90 mm
	Primary Cup Diameter	16.0 mm, Ⓢ 14.1 mm
	Secondary Cup Diameter	16.4 mm, Ⓢ 14.5 mm
	Spring Free Length	34.7 mm, Ⓢ 40.5 mm
Rear	Cylinder Inside Diameter	15.95 mm
	Piston Outside Diameter	15.80 mm
	Primary Cup Diameter	16.3 mm
	Secondary Cup Diameter	16.3 mm
	Spring Free Length	37.2 mm

Ⓢ : Single disc brake model

Caliper

The front wheel has a floating-type caliper. The front caliper assembly includes pad A (6), pad B (7), and the piston (14), which is inside the caliper cylinder. Through the caliper run two shafts (3), which also pass through the caliper holder (11) to mount the assembly to the fork leg. When the piston forces pad A against the disc, the shaft portion of the caliper assembly slides through the holder such that pad B is also forced against the disc, both brake pads being kept parallel to the disc.

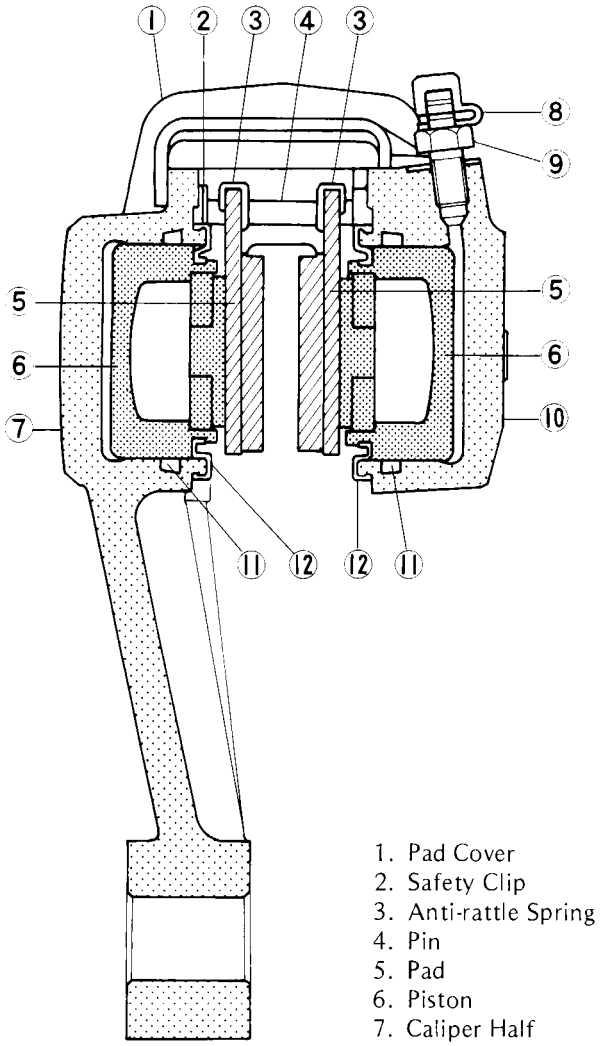
Front Caliper



1. Nut
2. Spacer
3. Holder Shaft
4. O Ring
5. Dust Cover
6. Pad A
7. Pad B
8. Mounting Screw
9. Lockwasher
10. Metal Plate
11. Caliper Holder
12. Dust Seal
13. Fluid Seal
14. Piston
15. Caliper

The rear wheel has a fixed caliper. The rear caliper assembly consists of two caliper halves 7, 10, bolted together, with each half containing a cylinder; a set of opposed pistons 6 ; and two pads 5 . The pad anti-rattle springs 3 hold the pads in position apart from the disc when the rear brake is not applied. When the brake is applied, the pressurized fluid is delivered to the piston areas on both sides of the caliper at the same time. Each piston goes forward until it is pressed against the disc, so no lateral movement of the disc and caliper is needed. There is a drilled internal fluid passage which is sealed by O ring where the two caliper halves join.

Rear Caliper J21

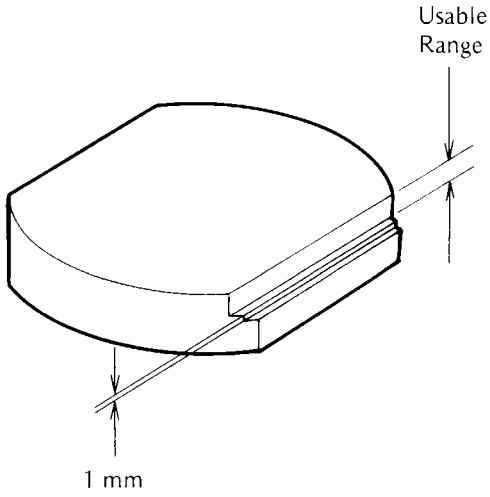


1. Pad Cover
2. Safety Clip
3. Anti-rattle Spring
4. Pin
5. Pad
6. Piston
7. Caliper Half
8. Valve Cap
9. Bleed Valve
10. Caliper Half
11. Fluid Seat
12. Dust Seal

Pad wear

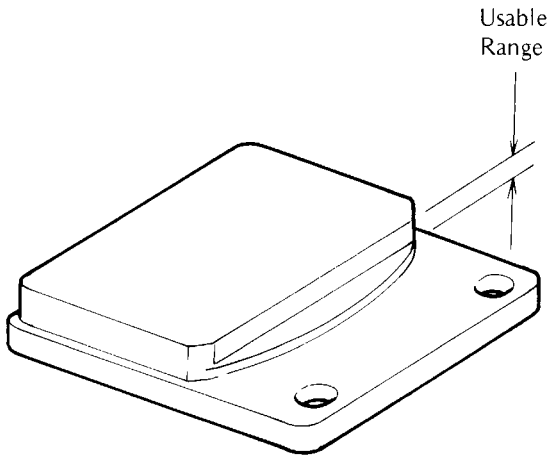
Inspect the pads for wear. For the front disc brakes, check the thickness of the pad linings, and replace both pads as a set if the thickness of either pad is less than 1 mm.

Front Brake Pad J22



For the rear disc brake, if either pad is worn down through the stepped portion, replace both pads as a set.

Rear Brake Pad J23

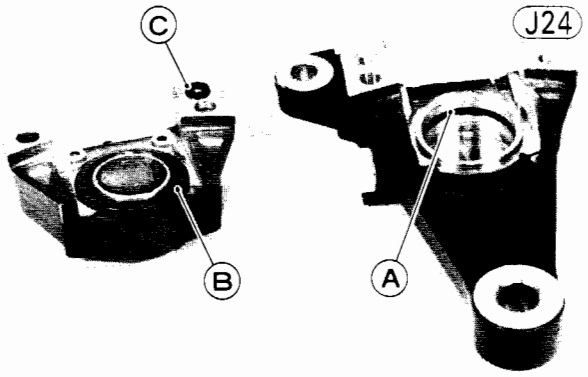


If any grease or oil spills on the pads, wash it off with trichloroethylene or a high flash-point solvent. Do not use one which will leave an oily residue. If the oil cannot be thoroughly clean off, replace the pads.

Fluid seal damage

The fluid seal around the piston maintains the proper pad/disc clearance. If this seal is not satisfactory, pad wear will increase, and constant pad drag on the disc will raise brake and brake fluid temperature.

Replace the fluid seals under any of the following conditions: (a) fluid leakage around the pad; (b) brakes overheat; (c) there is a large difference in left and right pad wear; (d) the seal is stuck to the piston. If the fluid seal is replaced, replace the dust seal as well. Also, replace all seals every other time the pads are changed.



A. Fluid Seal B. Dust Seal C. "O" Ring

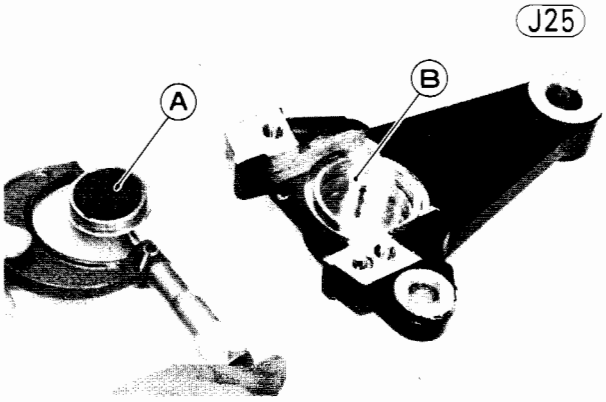
Dust seal, cover, O ring damage

Check the dust seals, covers, **O** ring, and replace any that are cracked, worn, swollen, or otherwise damaged.

Piston, cylinder wear

Measure the cylinder inside diameter and piston outside diameter.

Replace the cylinder and piston if they are worn out of tolerance, badly scored, or rusty.



A. Piston B. Cylinder

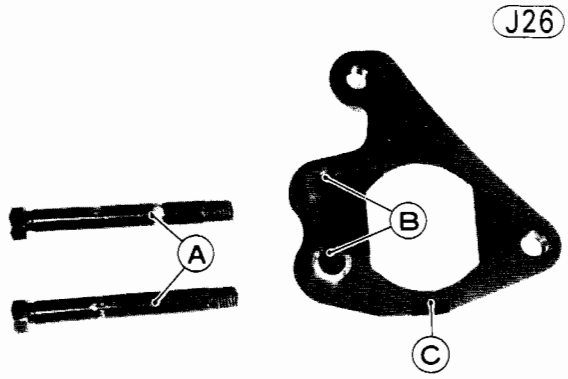
Table J11 Caliper Parts

	Measurement	Service Limit
Front	Cylinder Inside Diameter	38.25 mm, Ⓢ 42.92 mm
	Piston Outside Diameter	38.08 mm, Ⓢ 42.75 mm
Rear	Cylinder Inside Diameter	42.92 mm
	Piston Outside Diameter	42.75 mm

Ⓢ : Single disc brake model

Caliper holder shaft wear

Caliper holder shafts must slide smoothly in the caliper holder. If the shafts do not slide smoothly, one pad will wear more than the other, pad wear will increase, and constant drag on the disc will raise brake and brake fluid temperature. Check to see if the caliper holder shafts are nor badly worn or stepped, or **O** rings are not damaged. If the shafts or **O** ring are damaged, replace the shafts, **O** rings, and the caliper holder.



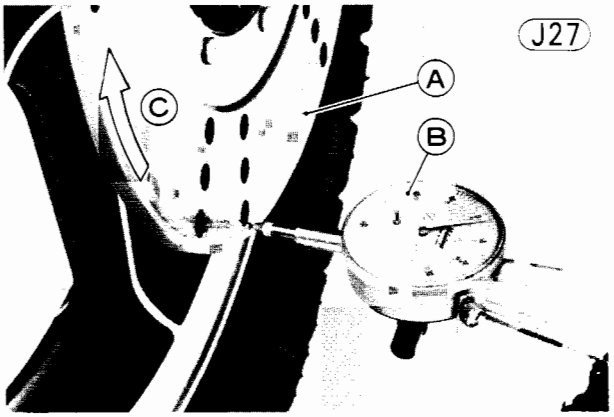
A. Caliper Holder Shafts C. Caliper Holder
B. "O" Rings

Brake Disc

Besides wearing down, the disc may warp. A warped disc will cause the brake pads to drag on the disc and will wear down both the pads and disc quickly. Dragging will also cause overheating and poor braking efficiency.

Disc warp

Jack up the motorcycle so that the front wheel is off the ground, and turn the handlebar fully to one side. Set up a dial gauge against the front disc as illustrated, and measure disc runout. Remove the jack, set the motorcycle up on its center stand, and then measure the rear disc runout. If runout exceeds the service limit, replace the disc.



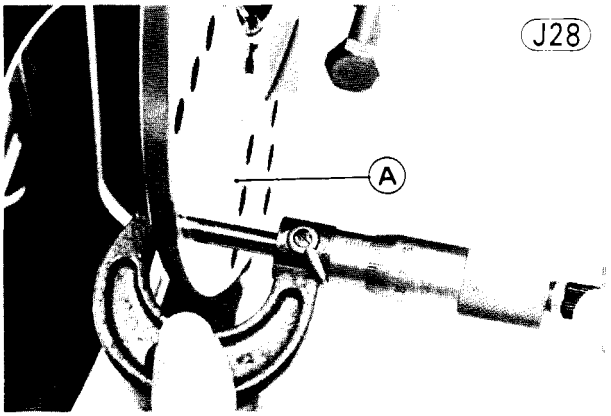
A. Disc B. Dial Gauge C. Turn.

Table J12 Disc Runout

Service Limit	0.3 mm

Disc wear

Measure the thickness of each disc at the point where it has worn the most. Replace the disc if it has worn past the service limit.



A. Disc

Table J13 Disc Thickness

	Front	Rear
Service Limit	4.5 mm, Ⓢ 6.0 mm	6.0 mm

Ⓢ : Single disc brake model

Disc cleaning

Poor braking can also be caused by oil on the disc. Oil on the disc must be cleaned off with trichloroethylene or a high flash-point solvent. Do not use one which will leave an oily residue.

Brake Fluid

The brake fluid is an extra heavy duty type with a high boiling point to withstand the heat produced by friction of the caliper pads on the disc. Since the boiling point and thus the performance of the fluid would be reduced by contamination with water vapor or dirt from the air, the reservoir is sealed with a rubber diaphragm under the cap. This cap seal also prevents fluid evaporation and spillage should the motorcycle fall over. The fluid is further protected by rubber seals in the caliper assembly and at the master cylinder brake line fitting.

When the brake is applied, heat is generated by the friction between the disc and the brake pads. While much of this heat is immediately dissipated, some of it is transmitted to the brake fluid and may raise fluid temperature to as high as 150°C (300°F) during brake operation. This temperature could boil the brake fluid and cause a vapor lock in the lines unless fluid with a high boiling point is used and has been kept from being contaminated with dirt, moisture, or a different type of fluid. Poor quality or contaminated fluid can also deteriorate from contact with the recommended brake fluids.

The graph of Fig. J29 shows how brake fluid contamination with moisture lowers the fluid boiling point. Although not shown in the graph, the boiling point also lowers as the fluid gets old, is contaminated with dirt, or if two different types of brake fluid are mixed.

WARNING

When working with the disc brake, observe the precautions listed below.

1. Never reuse old brake fluid.
2. Do not use fluid from a container that has been left unsealed or that has been open a long time.
3. Do not mix two types of fluid for use in the brake. This lowers the brake fluid boiling point and could cause the brake to be ineffective. If may also cause the rubber brake parts to deteriorate. Recommended fluids are given in the table.
   NOTE: The type of fluid originally used in the disc brake is not available in most areas, but it should be necessary to add very little fluid before the first brake fluid change. After changing the fluid, use only the same type thereafter.

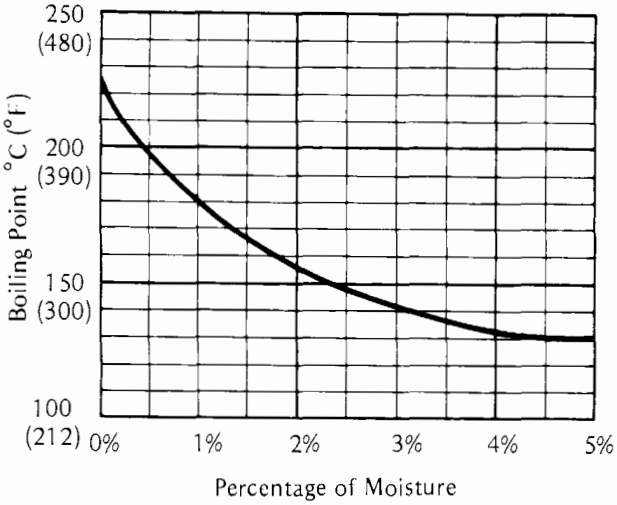
Table J14 Recommended Disc Brake Fluid

Atlas Extra Heavy Duty
Shell Super Heavy Duty
Texaco Super Heavy Duty
Wagner Lockheed Heavy Duty
Castrol Girling-Green
Castrol GT (LMA)
Castrol Disc Brake Fluid

The correct fluid will come in a can labeled D.O.T.3. Do not use fluid that does not have this marking.

4. Don't leave the reservoir cap off for any length of time to avoid moisture contamination of the fluid.
5. Don't change the fluid in the rain or when a strong wind is blowing.
6. Except for the disc pads and discs, use only disc brake fluid, isopropyl alcohol, or ethyl alcohol for cleaning brake parts. Do not use any other fluid for cleaning these parts. Gasoline, motor oil, or any other petroleum distillate will cause deterioration of the rubber parts. Oil spilled on any part will be difficult to wash off completely and will eventually reach and break down the rubber used in the disc brake.
7. When handling the disc pads or disc, be careful that no disc brake fluid or any oil gets on them. Clean off any fluid or oil that inadvertently gets on the pads or disc with a high flash-point solvent. Do not use one which will leave an oily residue. Replace the pads with new ones if they cannot be cleaned satisfactorily.
8. Brake fluid quickly ruins painted surfaces; any spilled fluid should be completely wiped up immediately.
9. If any of the brake line fittings or the bleed valve is opened at any time, the **AIR MUST BE BLED FROM THE BRAKE.**
10. When installing or assembling the disc brake, tighten the disc brake fittings to the values given in Table G1. Improper torque may cause the brake to malfunction.

Brake Fluid Boiling Point (J29)



Changing the brake fluid

The brake fluid should be changed in accordance with the Periodic Maintenance Chart (Pg. 10) and whenever it becomes contaminated with dirt or water.

- Attach a clear plastic hose to the bleed valve on the caliper, and run the other end of the hose into a container.
- Remove the reservoir cap, and remove the rubber cap on the bleed valve.
- Open the bleed valve (counterclockwise to open), and pump the brake lever or pedal until all the fluid is drained from the line.
- If a dual disc brake is used, repeat the previous step one more time for the other side.
- Close the bleed valve(s), and fill the reservoir with fresh brake fluid.
- Open the bleed valve, apply the brake by the brake lever or pedal, close the valve with the brake held applied, and then quickly release the lever or pedal. Repeat this operation until the brake line is filled and fluid starts coming out of the plastic hose. Replenish the fluid in the reservoir as often as necessary to keep it from running completely out.
- Bleed the air from the lines.

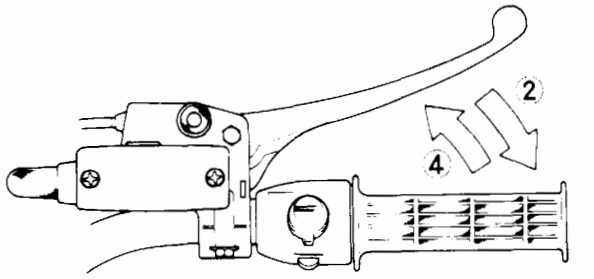
Bleeding the brake

The brake fluid has a very low compression coefficient so that almost all the movement of the brake lever or pedal is transmitted directly to the caliper for braking action. Air, however, is easily compressed. When air enters the brake lines, brake lever or pedal movement will be partially used in compressing the air. This will make the lever or pedal feel spongy, and there will be a loss in braking power.

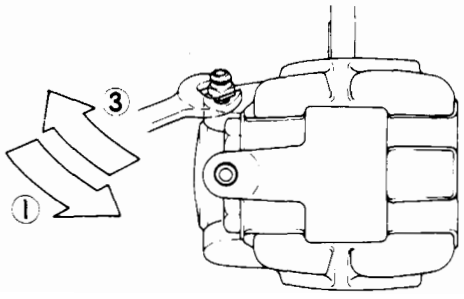
Bleed the air from the brake whenever brake lever or pedal action feels soft or spongy, after the brake fluid is changed, or whenever a brake line fitting has been loosened for any reason.

- Remove the reservoir cap, and check that there is plenty of fluid in the reservoir. The fluid level must be checked several times during the bleeding operation and replenished as necessary. If the fluid in the reservoir runs completely out any time during bleeding, the bleeding operation must be done over again from the beginning since air will have entered the line.

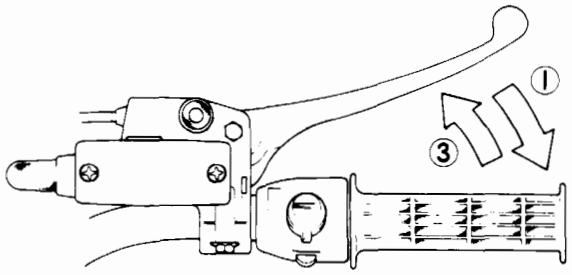
Filling up the Brake Line (J30)



1. Open the bleed valve.
2. Apply the brake, keeping the brake applied.
3. Close the bleed valve.
4. Then quickly release the brake.



Bleeding the Brake Line (J31)



1. Hold the brake applied.
2. Quickly open and close the valve.
3. Release the brake.