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PORSCHE - DISC BRAKES

General

The Porsche 356 B/2000 GS is equipped with Porsche-ATE disc brakes. Only the first units of this model were equipped with standard drum brakes.

The disc brake differs from the customary drum brake in the following ways: Flat brake lining segments of equal area are pressed against the surfaces of a disc by hydraulic pistons situated in a caliper which encloses the disc. Since equal pressure is exerted on both sides of the disc, no deformation of the disc occurs.

The disc, due to its ability to dissipate heat rapidly, is less temperature sensitive and therefore does not fade like the drum brake. The heat generated during braking is dissipated quickly because the disc rotates exposed to the air on all sides. Cooling is even better since the friction surface is directly exposed to the air while the heat in a drum must first be transmitted through the drum wall. In addition, the expansion resulting from increased temperature is primarily radial and therefore has no effect on the braking surface.

In contrast to the drum brake, the disc brake is not self-servo acting and therefore is not as greatly affected by changes in the coefficient of friction.

In the event that water or dirt comes in contact with the drum, the centrifugal force of rotation or the application of the brake linings quickly cleans the disc.

### Description of the Brake System

The service brake is hydraulically operated consisting of:

- a) master cylinder which transmits pedal pressure to the hydraulic system,
- b) wheel cylinders located in the brake calipers which press the linings against the discs,
- c) the discs which are attached to the wheels retard the wheel rotation,
- d) the hydraulic lines feed equal pressure to all points in the system giving equal braking to the front and rear wheels respectively.

The hydraulic system makes use of the principle of fluid mechanics which states that pressure in a fluid is equally distributed in all directions.

The master cylinder converts mechanical pedal pressure to hydraulic pressure in the lines which forces the wheel cylinders in the calipers against the brake jaws.

Through this direct transmission of force, the braking effort increases linear to the increase of pedal pressure.

When the pedal is released a return spring in the wheel cylinders pulls back the pistons a fixed predetermined distance. This spring is part of the automatic adjustment device.

### Master Cylinder

The master cylinder is equipped with a special large bore check valve which prevents residual pressure in the lines. The valve has a 0.7 mm dia. bore which allows rapid return of brake fluid upon release of the pedal.

This valve is the only item in which the master cylinder for disc brakes differs from the master cylinder for drum brakes.

Note: The master cylinder is not the same as the one for drum brakes and is not interchangeable. For this reason the master cylinder has a metal band with the inscription "Zylinder hat Spezial-Bodenventil" (cylinder has special bottom valve).

#### Brake Caliper

The brake caliper is clamped on to a fin extending from the axle bracket so that the disc which is supported on a spider is grasped from within. Two cylinders are located in each jaw of the caliper. Equal pressure is led to all four pistons which are held by automatic adjusters within the cylinder. The equal pressure assures that no net lateral forces act to bring the disc out of alignment.

The cylinder diameter of the front calipers is larger, 33 mm dia., than the diameter of the rear calipers, 25 mm dia., so that maximum braking can be obtained from weight shift.

#### Automatic adjustment

The disc brake caliper contains a self adjusting mechanism, which keeps the gap between the lining and disc constant. The adjustment device is contained within each cylinder. If the mechanism becomes defective, a new cylinder should be installed. Repair of the defective unit should not be attempted.

Note: The automatic adjustment requires no servicing.

#### Brake Discs

The discs of front and rear brakes are of equal thickness and differ only in that the rear disc has a hand brake shoulder on the inside. When new, the disc thickness is 9,95 mm  $\pm$  0,5 mm. The rear disc may be reworked to a minimum of 9,0 mm and the front disc to a minimum of 9,3 mm. The surfaces must be plane and parallel within 0,02 mm to prevent brake chatter.

Brake discs should not be resurfaced unless absolutely necessary. Surface grooves in circumference have no effect on the function of the brake.

## Removal

1. Hoist car. Remove wheels.
2. Remove splash shields.
3. Rotate the spider until the brake retaining pin is exposed.

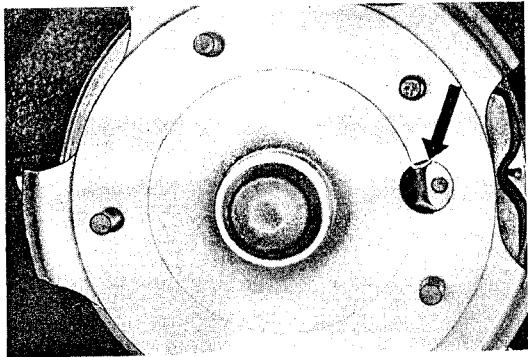


Fig. 1

4. Remove the cotter key and extract the retaining pin.

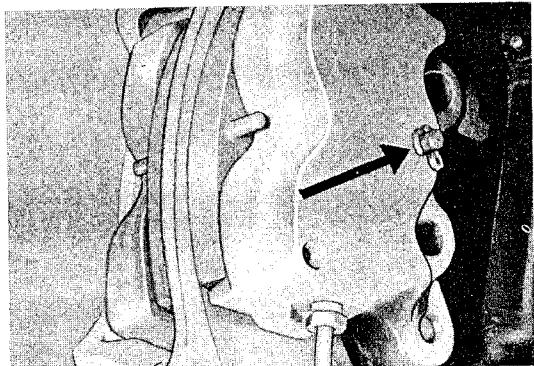


Fig. 2

5. Remove brake lining pads.

6. Disconnect and remove hydraulic lines from the caliper.

7. Rotate the spider until one of the large allen screws is visible. Using tool P 81 (Inhex 54 IC, 12 mm), 12 mm allen wrench to remove the screw. Remove second allen screw in the same manner.

8. Remove caliper halves using a soft hammer if necessary. Mark caliper halves in pairs so that they can be installed in the same positions as they were. The inner halves have tapped holes for mounting the splash shield.

## Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. The mating surfaces of the caliper halves and the holder plate must be meticulously clean.
2. Tighten the allen screws to 8 mkg (58 ft. lb.) torque.
3. The brake pads are to be placed in the same locations where they were.
4. Carefully bleed the entire system.

## Renewing brake pads

### General

The thickness of the linings should be visually inspected at every servicing. The new lining not including the backing plate is 10 mm thick. The wear limit is 2 mm front and 4 mm rear. For best performance all linings of the front wheels or rear wheels should be renewed together. The front and rear pads differ slightly and are therefore marked "V" and "H", front and rear (in German) respectively on their back sides. Never use different lining materials front and rear. Only Porsche approved linings are to be installed.

The standard brake pads have "Textar 504" lining material. These are marked "TE 1" on the back.

For competition use "Ferodo DS 11" linings are available as optional extra. These pads which are marked "FE 4" can be installed on request.

Textar lining material has a dark grey color and contains visible brass fibers. The Ferodo lining has a black copper toned color. The Textar lining is somewhat softer than the Ferodo lining and therefore wears more rapidly. In contrast the harder Ferodo lining requires more pedal pressure.

The lining wear depends among other things on driving style and driving conditions. Wet winter driving with sand and salt on roads or muddy surfaces increase wear considerably. For sporting events where high braking demands are met, the splash shields may be removed for better cooling and decreased wear.

Changing brake pads:

1. Hoist car. Remove wheels.
2. Rotate the spider until the brake pad retaining pin is exposed.

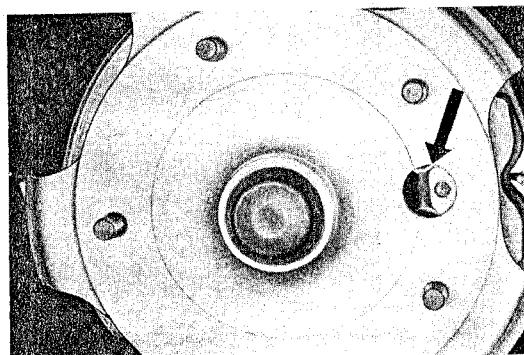


Fig. 3

3. Remove the cotter key and extract the retaining pin.

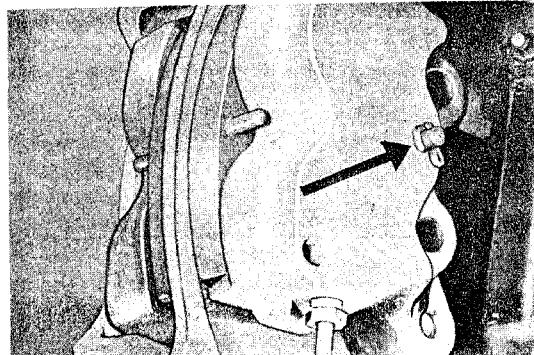


Fig. 4

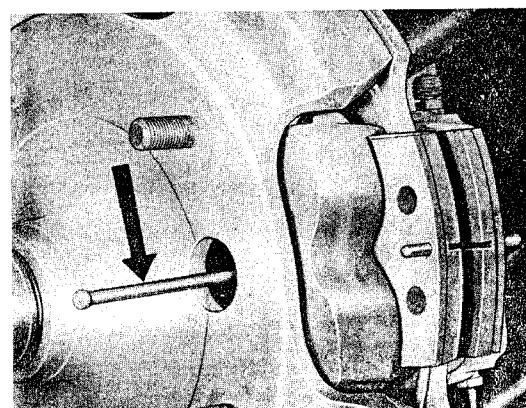


Fig. 5

4. Remove only one brake pad.
5. With a suitable tool press the pistons back to the stop.

Note! Take care not to damage the rubber dust covers.

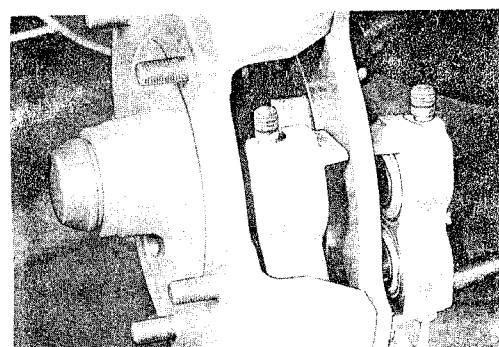


Fig. 6

6. Scrape away caked up dirt and blast clean with compressed air.

Note! Do not use rubber dissolving agents to clean the brake caliper since these will damage the dust covers.

7. Insert new lining pad. The pads for the front and rear brakes differ slightly and are therefore marked "V" and "H" for front and rear (in German) respectively.
8. Remove the second brake pad and proceed as before to return the pistons, clean the caliper and insert a new brake pad.
9. Install brake pad retaining pin and secure with a cotter key.
10. Repeat the same operations on the remaining brake calipers in the same manner.
11. With the car on the hoist, actuate the brake pedal several times until the pads are against the discs. Until the brakes are worn in, the pedal travel will be somewhat greater than normal.

12. When pressing the piston into the caliper, brake fluid is returned to the reservoir. When installing new brake pads, a full reservoir will overflow. For this reason it is necessary to top up the brake fluid after installing brake pads.

Use "ATE blue" or "Pentosin Super" fluid. These may be mixed.

13. New linings must be worn in through moderate application at intervals until a "solid" feeling is obtained. Only after proper wearing in can full braking be achieved.

14. If old linings are installed they must be marked so that they are re-installed in the same location.

#### REMOVING AND INSTALLING BRAKE DISCS

#### FRONT WHEEL

##### Removal

1. Hoist car. Remove wheels.
2. Remove splash shield.
3. Rotate the spider until the brake pad retaining pin is exposed.
4. Remove the cotter key and extract the retaining pin.
5. Remove both brake pads and mark according to position.
6. Punch mark the spider and disc for proper match.
7. Remove the 5 retaining nuts (13 mm wrench). Using a soft mallet, remove the disc from the spider.

8. Remove the spider as described in section ST 2 of the Shop Manual 356 B.

9. Remove disc.

##### Note

Brake discs should not be resurfaced unless absolutely necessary. Surface grooves in circumference have no effect on the function of the brake. The disc may be turned down on a lathe using its mating spider mounted on special tool P 38.

## REAR BRAKE

### Removal

1. Loosen rear axle nut.
2. Hoist car. Remove wheels and axle nut.
3. Remove splash shield.
4. Rotate the spider until the brake pad retaining pin is exposed.
5. Remove the cotter key and extract the retaining pin.
6. Remove both brake pads and mark their positions.
7. Mark the location of the spider on the axle shaft and the disc on the spider.
8. Remove the 5 nuts (13 mm wrench) of the brake disc and remove the spider using a soft mallet if necessary.
9. Remove the two allen screws of the caliper and remove the brake disc.

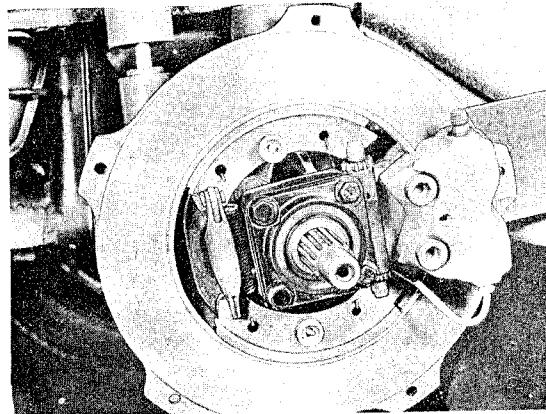


Fig. 11

### Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Brake disc wobble must be less than max. 0.2 mm. To measure alignment the axle nut must be tightened to at least 20 mkg (145 ft. lb.) torque. If necessary reposition the spider on the axle until the disc runs true.
2. The allen screws of the caliper must be tightened to 8 mkg (58 ft. lb.) torque.
3. The brake pads must be installed in their original positions.

## REMOVING AND INSTALLING CALIPER PISTONS

### Removal

1. Remove caliper half.
2. Remove the retaining ring from the dust cover.
3. Remove dust cover.

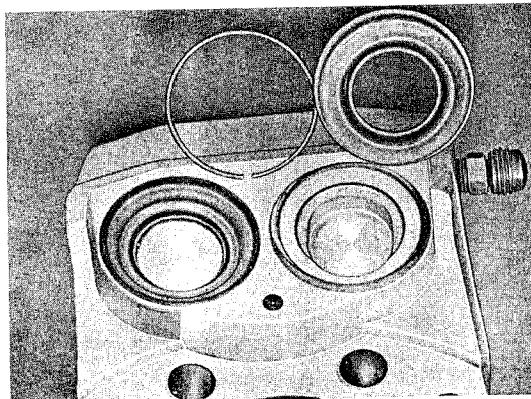


Fig. 12

4. Using compressed air or better a hydraulic master cylinder, press the piston out of the caliper. The automatic adjustment is not to be disassembled in Porsche shops. When the adjuster is defective always install a new piston.

## Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. The piston ring must be fully seated in the groove of the piston.

2. Carefully insert the piston in the caliper using ATE paste. All parts must be entirely clean. To prevent damage to the cylinder and piston ring, do not cant the piston.

3. Install cleaned dust covers. If covers show wear install new ones.

## Renewing Hand Brake Linings

1. Loosen rear axle nut.

2. Hoist car. Remove wheel and axle nut.

3. Remove splash shield.

4. Remove the service brake pads.

Warning! Do not depress the brake pedal since this will press the pistons out of the caliper.

5. Remove the 5 nuts (13 mm wrench) of the brake disc and remove the spider using a soft mallet if necessary. Mark mating parts before removal.

6. Remove retaining spring and retainer pins.

7. Disconnect return spring and remove brake shoes.

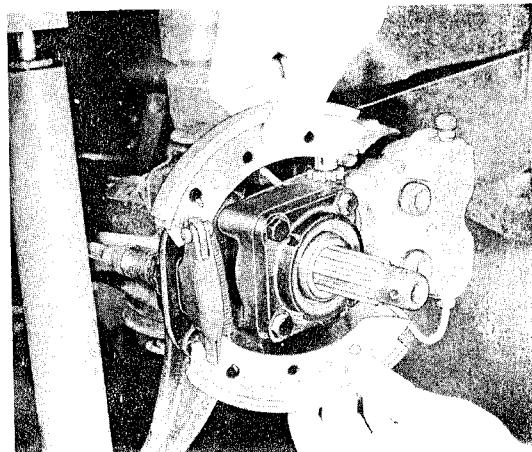


Fig. 14

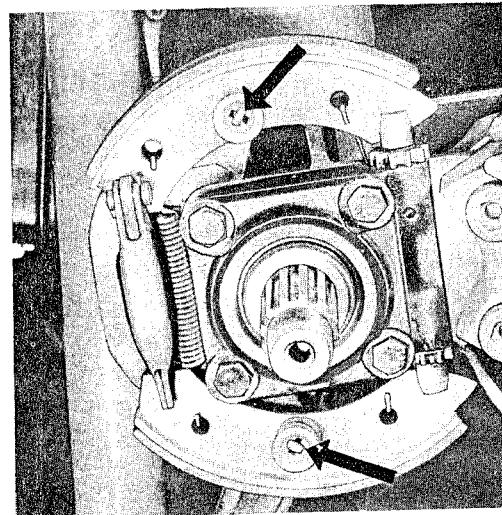


Fig. 13

8. Assemble the brake in the reverse order. The actuating mechanism is the same as the VW Standard mechanical brakes (see Fig. 15 + 16).

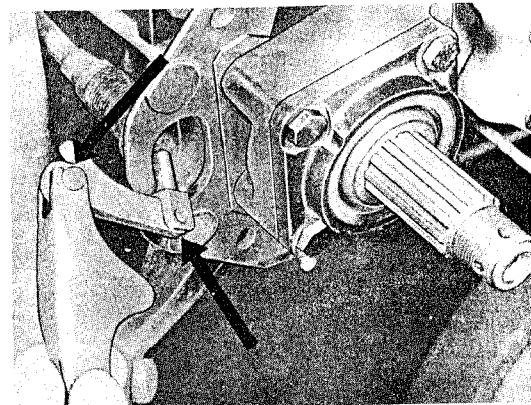


Fig. 15

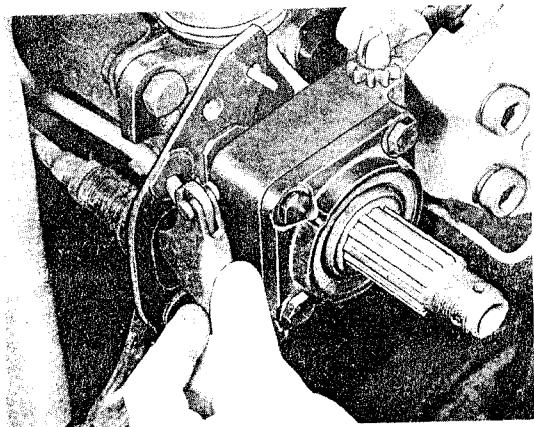
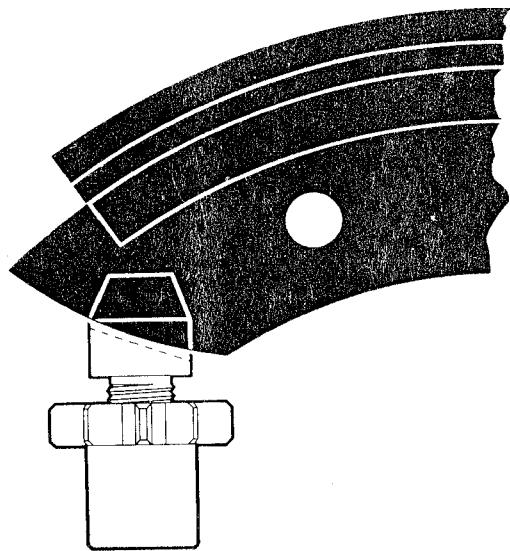


Fig. 16

Note that the slanted slot of the adjustment screw corresponds to the angle of the brake shoes as in Fig. 17.

This part is not identical to any part of the VW or Porsche drum brake.



9. Adjust the handbrake. The brake must be adjusted again after the first use.

#### Adjusting the Handbrake

The adjustment is primarily performed at the brake shoe as with drum brakes. The adjustment screw is accessible through the hole in the spider. Both the upper and lower shoe must be adjusted equally. The adjusting screw is turned until the brake shoe is tight against the disc and turned back 3 to 4 clicks.

For the adjustment of the hand brake cables see sections 17 and 18 ST of the shop manual.

It is to advantage to remove the brake pads while adjusting the hand brake.

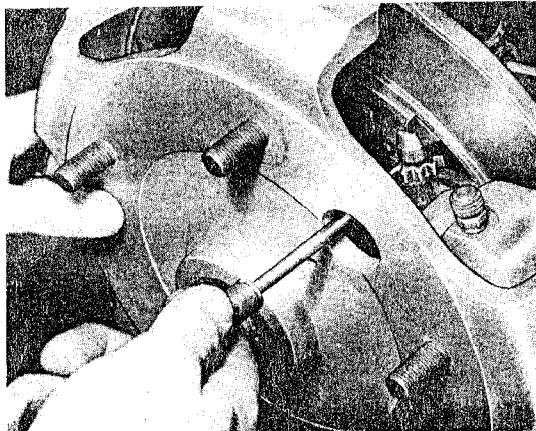


Fig. 18

COMMON FAILURES AND CORRECTIVE MEASURES

Failure	Cause	Corrective action
Brake pedal goes to floor or is very spongy	a) Air in hydraulic system b) Low on brake fluid	a) Bleed system b) Fill reservoir and then bleed system
Brake pedal goes to floor after bleeding. No brake action	a) Leaking brake line b) Bad main or wheel cylinder (adjuster)	a) Repair leak b) Install new piston ring or new brake pads
Poor braking even though pedal pressure is high	a) Oiled brake pads b) Scorched linings	a) Repair axle seal or oil cooler leak. Install new brake pads b) Install new brake pads
Brakes heat up when not in use, brakes do not release	a) Return bore in master cylinder clogged b) Insufficient play between push rod and master cylinder piston c) Sticking wheel cylinder d) Rubber parts have swollen as a result of contact with improper brake fluid e) Discs run untrue or axle shaft bent f) Lining separating from backing plate	a) Clean out obstruction b) Adjust free pedal travel c) Install new piston and seal using ATE paste d) Drain and dismantle entire brake system and replace all rubber parts, hoses and brake light switch. Fill with ATE blue fluid e) Replace disc or axle shaft as necessary f) Renew all pads of both wheels

Failure	Cause	Corrective action
Brakes pull to one side	a) Oiled brake linings b) Extremely worn brake linings on one side c) Front brake caliper not parallel to disc d) Brakes not properly bled	a) Renew rear axle seal and install new brake pads b) Install new brake pads c) Inspect seating of caliper plate, install new support plate if necessary d) Bleed brakes
Squeaking brakes	a) Linings are loose on backing plates	a) Install new brake pads on both wheels
Brakes chatter	a) Brake disc runs out of true b) Brake linings are not seated c) Excessive wobble of the wheel rim d) Loose wheel leavings, king pin, or tie bolts	a) Align brake disc b) Wear in linings through moderate use c) Inspect wheels and install new rims if necessary d) Adjust where necessary and replace worn parts
Brake fluid reservoir needs refilling often	a) Leaks in the system b) Leaking master cylinder c) Leaking wheel cylinder	a) Inspect all lines and connections for leaks while applying pressure to the brake pedal b) Inspect master cylinder and repair or replace c) Inspect wheel cylinder and renew piston ring if necessary
Leaking wheel cylinder	a) Piston ring has shrunk b) Scored cylinder wall c) Rusty cylinder wall	a) Install new piston ring b) Install new caliper c) Remove rust traces. Install new caliper in case of reserve rust. Install new dust covers
Hand brake gives pulsating effect	a) Unround disc b) Hand brake cable casings severely bent	a) Mount disc and spider on tool P 38 and turn out on lathe. Allowable tolerance 0.15 mm b) Slacken brake cable and adjust at front for proper alignment

## ATE DISC BRAKE (DUNLOP-LICENSE)

The ATE disc brake is standard equipment in Type 356 C cars, with the following chassis serial numbers applying:

Coupe	126 001
also	215 001
Cabriolet	159 001

## General

The ATE disc brake is very simple in design and consists basically of the pot-shaped brake disc and the caliper assembly (see Fig. 1).

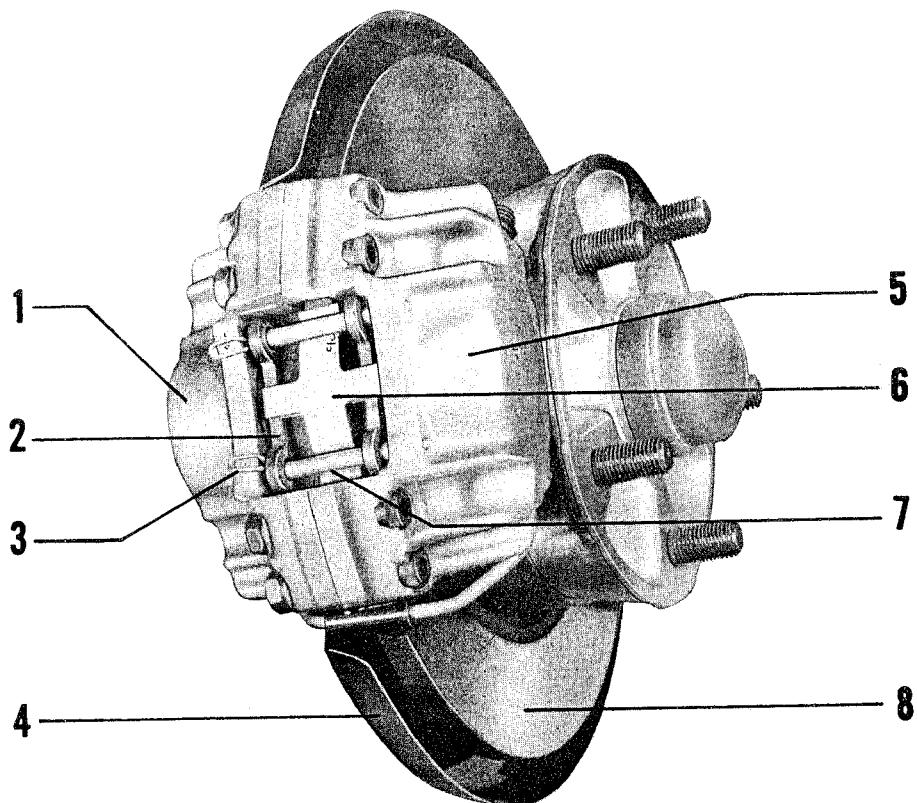


Fig. 1

- |                     |                      |                 |                 |
|---------------------|----------------------|-----------------|-----------------|
| 1 Flange housing    | 3 Pin retaining clip | 5 Cover housing | 7 Retaining pin |
| 2 Brake pad segment | 4 Disc shroud        | 6 Cross-spring  | 8 Brake disc    |

The front wheelbrake disc is attached to the wheel hub flange by separate retaining bolts and is centered by the collar on the wheel hub flange.

The rear wheel brake disc is also centered by the collar on the wheel hub flange, and fastened to the flange by two countersunk screws; however, the rear wheel brake disc is held in place primarily by the wheel lugs.

The brake caliper wraps around the outside of the disc and is fastened to the steering knuckle or the axle flange, respectively, by two bolts.

The flange housing (Point 1, Fig. 1) and the cover housing (Point 5, Fig. 1) are bolted together with four bolts and make up the caliper assembly.

The brake cylinder bore in each housing has a machined groove for the accommodation of a brake piston seal. The brake cylinders and pistons are protected against the effects of dust, road dirt, and moisture by a dust cap. A clamp ring holds the dust cap on the housing collar and the inherent tension holds it on the extended piston body.

The brake pad segment (brake pad and brake pad plate) has axial freedom within the well of each housing and is held in place by two retaining pins which are secured by retaining clips.

A cross-spring, situated beneath the retaining pins and exerting radial pressure upon the brake pad segments, keeps the brake pad segments from rattling and serves as a brake pad wear indicator.

The brake disc is protected against dirt and water spray by an inboardly mounted disc shroud.

**Note:**

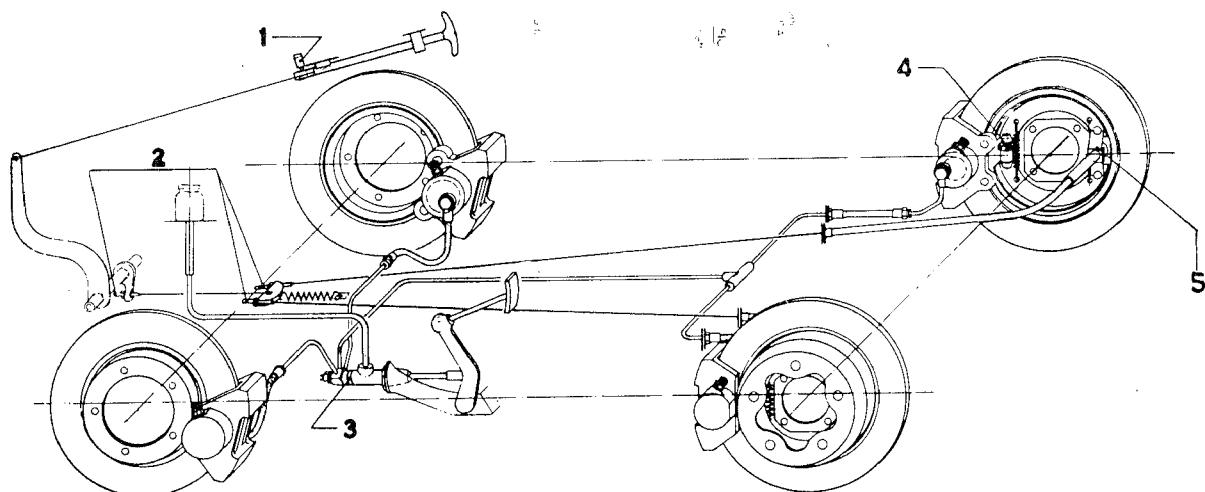
When the brakes are put to hard use, such as in competition driving or the like, it is recommended that the disc shrouds be removed to facilitate a better cooling of the brake discs and, consequently, reduce the wear factor.

**Caution:**

When greasing the car, make certain that no grease is deposited on the brake discs or the calipers. Place a piece of paper or sheetmetal between the link pin joints and the brake discs, wiping off all excess grease from the link pin heads.

When spraying the underbody with corrosion preventives, make positively sure that the brake disc assemblies are covered up.

Disc Brake Schematic



1 Parking brake control switch  
2 Adjusting nuts

3 Metal band  
4 Adjusting assembly

5 Mechanical expander

Fig. 2

**Brake Operating Principle**

When the foot brake is applied, the piston in the brake master cylinder is forced forward transmitting fluid pressure to cylinders in the brake calipers through hydraulic lines and hoses. The fluid pressure acts on the brake caliper pistons causing the brake pad segments to bear against the rotating discs, squeezing these from both sides and creating the friction required for stopping. The brake pedal pressure is in proportion to brake pad pressure being exerted upon the brake discs and, thus, the degree of braking action.

When the brake pedal is released, the hydraulic system connecting to the brake caliper cylinders is rendered fully depressurized, the pistons and brake pad segments move slightly away from the friction surfaces of the brake discs, freeing these completely, and the unbraked condition is regained.

**Brake Master Cylinder**

The brake master cylinder is equipped with a purging check valve which causes a complete depressurization within the hydraulic lines.

The purging check valve differs from the normal check valves inasmuch that the check valve cone has a bored-out pressure purging passage of 0,7 mm (.276 in.) diameter. The purging provision ensures a full depressurization of the system but also a "repumping" by fast actuation of the brake pedal as is required in refilling and bleeding operations carried out without the usual bleeding aids. The hydraulic fluid reservoir is located in the forward luggage compartment next to the spare wheel.

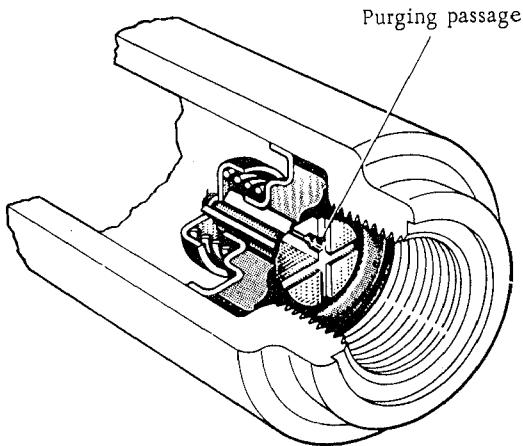


Fig. 3

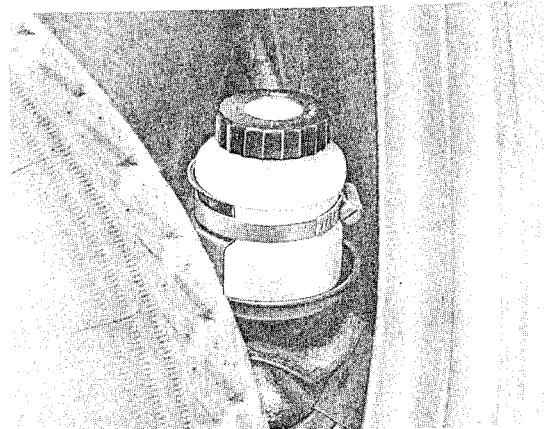


Fig. 3a

**Caution:**

This brake master cylinder is not interchangeable with brake master cylinders utilized in drum-type brake systems. For this reason, the brake master cylinder has been identified with a metal band reading: "This cylinder has a purging check valve" (German: "Zylinder hat Spezial-Bodenventil").

**Brake Calipers**

The brake calipers differ in size for front and rear wheels and are, therefore, not interchangeable.

The diameter of the brake master cylinder is 48 mm (1.890 in.) at front and 35 mm (1.378 in.) at rear.

### **Brake Discs**

The outside diameter of the front wheel disc is 274, 5 mm (10.81 in.) and rear wheel disc 285 mm (11.22 in.). Factory new brake discs for front wheels have a thickness of 10, 5 - 10, 3 mm (.413 - .406 in.) and for rear wheels 10, 0 - 9, 8 mm (.394 - .386 in.). Slightly damaged or worn brake discs may be refinished providing that the disc thickness is not reduced by more than 0, 5 mm (.020 in.).

The maximum permissible tolerance for thickness variations of the braking surfaces is 0, 03 mm (.0012 in.) since otherwise the brake will tend to chatter.

The brake discs should be machined only if absolutely necessary. Linear grooves in the brake disc have no detrimental effects and it is, therefore, not necessary to refinish the surface.

### **Automatic Adjustment**

The disc brake pads need not be adjusted (the hand brake is an exception) due to a built-in self-adjusting mechanism. The mechanism is contained within the pistons in the calipers and includes an arresting element which, in connection with a stud in the flange and cover housing, effects the automatic brake pad adjustment.

The self-adjusting device with its clearance provision cannot be modified or repaired. In the event that malfunctions occur, it will be necessary to replace the complete piston assembly.

### **Hand Brake**

The hand brake is of the twin-servo type and provides good braking effect through high exploitation of the self-energizing forces. The pot-shaped part of the rear wheel discs serves as the brake drum; thus, the hand brake drum and the brake disc are one unit.

The brake linings are riveted to the brake shoes in the usual way. Only brake linings recommended by the Porsche Company may be utilized.

The hand brake is mechanically actuated and acts on rear wheels only. The hand brake and service brake systems are two completely separate systems.

### **Hand Brake Operating Principle**

When the hand brake is pulled out, two brake shoes in each rear wheel are pressed against the drum part of the rear disc, the force being transmitted by brake cables and mechanical expanders. If the wheels turn forward or backward, a self-energizing effect is created by the action of the advancing primary shoe. Since the free-floating adjusting assembly serves as an anchoring point for both brake shoes, the anchoring force of the primary shoe provides additional forces for pressing the secondary brake shoe. As a result, the receding brake shoe is also activated and the braking effect equally good in both directions of rotation.

### **Specifications**

#### **Service brake**

Effective braking area per wheel: front 52, 5 cm<sup>2</sup> (8.14 sq. in.), rear 40, 0 cm<sup>2</sup> (6.20 sq. in.)  
Total effective braking area: 40, 0 cm<sup>2</sup> (28.68 sq. in.)

#### **Hand brake**

Brake drum diameter: 180 mm (7.1 in.)  
Brake lining width: 30 mm (1.18 in.)  
Total effective braking area: 194 cm<sup>2</sup> (30.1 sq. in.)

Rear Wheel Brake  
Cross-sectional View

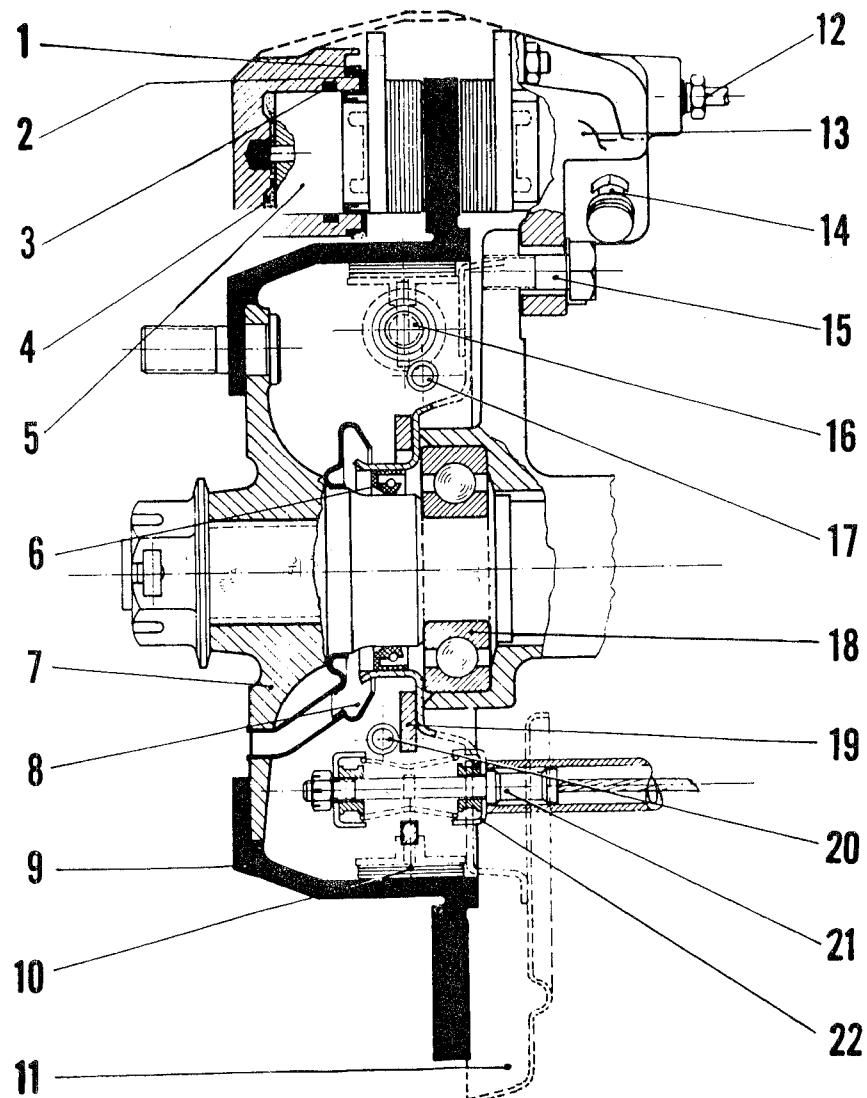


Fig. 4

- |                    |                        |
|--------------------|------------------------|
| 1 Clamping ring    | 12 Hydraulic line      |
| 2 Dust cover       | 13 Brake caliper       |
| 3 Piston seal      | 14 Bleeder valve       |
| 4 Brake fluid      | 15 Retaining screw     |
| 5 Piston           | 16 Adjusting assembly  |
| 6 Oil seal         | 17 Return spring       |
| 7 Wheel hub        | 18 Wheel bearing       |
| 8 Oil deflector    | 19 Anchor plate        |
| 9 Brake disc       | 20 Return spring       |
| 10 Hand brake shoe | 21 Brake cable         |
| 11 Disc shroud     | 22 Mechanical expander |

Hand Brake  
Cross-sectional View

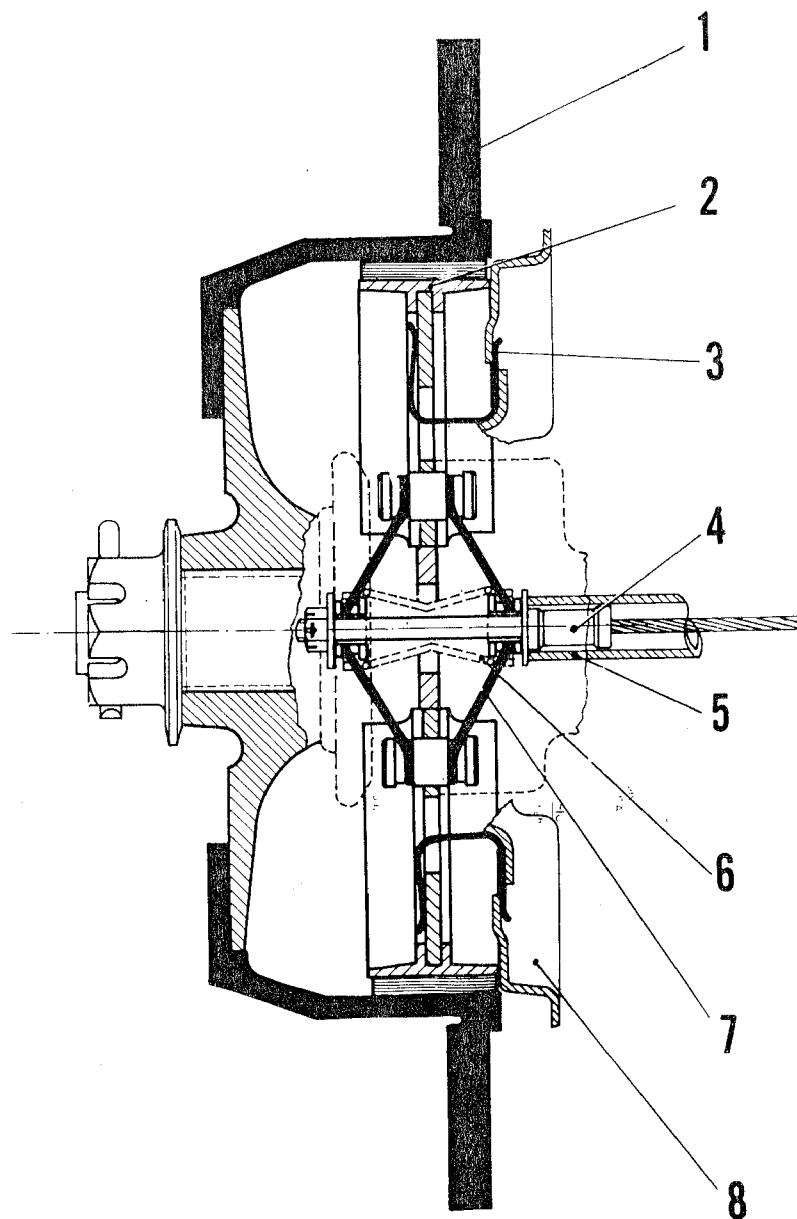


Fig. 5

1 Brake disc  
2 Hand brake shoe w/lining  
3 Retaining spring  
4 Brake cable

5 Brake cable conduit  
6 Spring  
7 Mechanical expander  
8 Anchor plate

## Service Operations

## Bleeding Hydraulic Brake System

## Note:

It is necessary to bleed the entire hydraulic brake system whenever any hydraulic brake connection had to be disconnected for any reason (an exception to the above is the hydraulic fluid line connecting the fluid reservoir with brake master cylinder).

The brake system should be bled also when the brake pedal travel is too long or the braking action uneven.

If the hydraulic brake system has been completely drained for any reason (brake overhaul, etc.), it may have to be bled for the second time subsequent to a short test drive.

The pedal free travel will remain constant due to the automatic brake self-adjustment, providing that the brake system has been properly bled; pedal travel to the point of brake actuation is about 30 to 50 % of the total brake pedal travel. The pedal travel normally will be somewhat greater following the installation of new pads and until these are run in.

## Caution:

The hydraulic brake fluid will run out of the fluid reservoir, through the by-pass port in the brake master cylinder, when any hydraulic connection is detached. This may be avoided by propping the brake pedal in a slightly depressed position, thus bringing the piston cup past the compensating (by-pass) port.

## Bleeding Brakes without Filling and Bleeding Devices

Two persons are required for this operation. The procedure is always initiated at the farthest point from the brake master cylinder in the following order (applies to cars with left-hand drive):

1. Left rear wheel, outer bleeder valve, inner bleeder valve.
2. Right rear wheel, outer bleeder valve, inner bleeder valve.
3. Right front wheel, outer bleeder valve, inner bleeder valve.
4. Left front wheel, outer bleeder valve, inner bleeder valve.

## Note:

When the system has been drained, it must first be filled. Open bleeder valve by one-half turn, depress brake pedal, close bleeder valve, and release brake pedal. Repeat the above until brake fluid begins to come out through the bleeder hose, continuing on all bleeder valves in the above given sequence and performing the actual bleeding operation only after the primary filling has been accomplished.

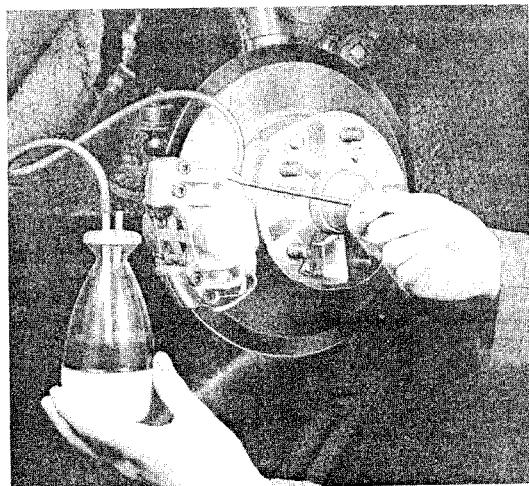


Fig. 6

## Bleeding the Brake System

1. Remove dust cap from bleeder valve and attach bleeder hose.
2. Place the free end of the bleeder hose into a glass container partly filled with brake fluid so that hose end is submerged.
3. Quickly pump the brake pedal several times until pressure can be felt. Holding the pedal down, open the bleeder valve by one-half turn and push the pedal all the way down. Do not release pedal pressure until the bleeder valve has been closed. This procedure is to be repeated until there are no more air bubbles in the brake fluid coming out of the bleeder hose.
4. Remove bleeder hose and replace dust cap.
5. Repeat the above procedure on the remaining bleeder valves by following the above given sequence. It should be ensured that the brake fluid reservoir does not run dry since this would allow more air to enter the system.

**Caution:** Hydraulic brake fluid may damage painted surfaces.

Hydraulic brake fluid which has been pumped out of the brake system may not be reused.

6. Check for proper bleeding and absence of leaks by applying pressure to the brake pedal.
7. Replenish hydraulic brake fluid in the reservoir.

The hydraulic fluid level in the reservoir must be checked at regular intervals and replenished if necessary. Due to the relatively large cylinder cross-section in the brake calipers, the brake fluid level in the reservoir will decrease much faster as a result of brake pad wear than is the case with drum-type brakes.

Use only original ATE-BLAU (blue) hydraulic brake fluid.

### Replacing Brake Pads

#### General

Severity of use as well as road conditions are some of the wear factors for brake pads. Increased wear may be anticipated especially when driving over wet, dirty roads (winter-serviced), and as a result of hard use (generation of high temperatures).

The brake pad thickness should be visually checked during all service operations.

A clearance must exist between the cross-spring and the brake pad segment (see Fig. 7). The permissible wear tolerance is reached when the brake pad segment touches the cross-spring or if its thickness is reduced to 2 mm (.5/64 or .079 in.).

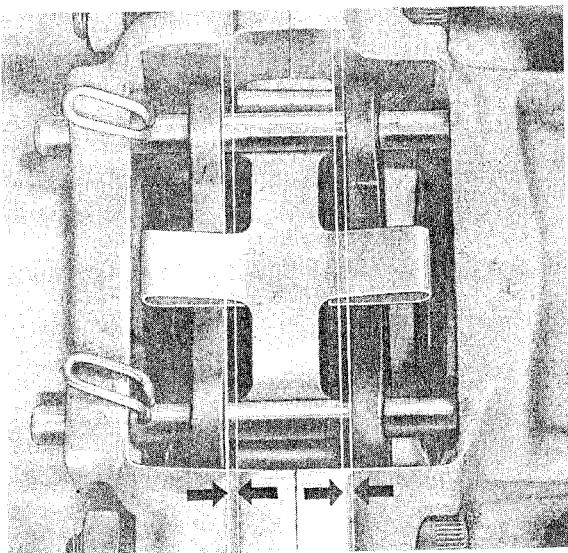


Fig. 7

The thickness of the brake pad segment at installation is about 15 mm (19/32 or .591 in.). Brake pad segments for the front and rear wheels differ in size and are, therefore, not interchangeable.

Two types of brake pads are available, that is, one type for normal use and the other for competition driving. The pads for competition use will wear slower but require higher pedal pressures. The brake pads are identified as to type by inscription on the pad plate. The designation "FE 4" is for competition brake pads and "TE 5" for normal brake pads.

The competition brake pads should be exchanged for normal brake pads at the beginning of the cold season. Only brake pads recommended by the Porsche Company may be utilized.

Same type of brake pads must be used on the front or the rear axle. Even though the brake pads can be replaced individually, we recommend that at least all brake pads of one particular axle are replaced at any one time.

#### Note:

Used brake pads must be marked prior to removal from the caliper to ensure proper reinstallation (in the original position). Used brake pads may not be interchanged or installed in different brake calipers.

## Replacing Brake Pad Segments

1. Place car on stands and remove wheels.
2. Remove pin retaining clips.

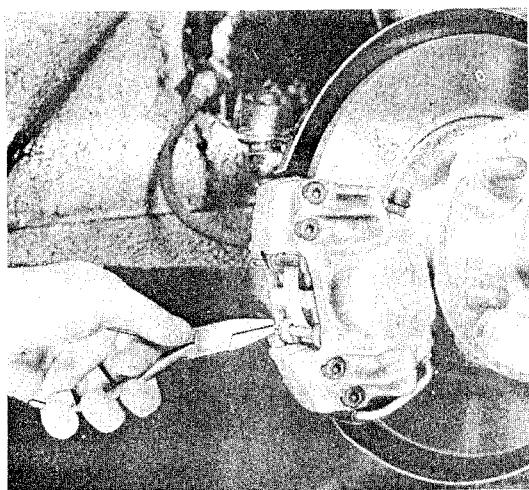


Fig. 8

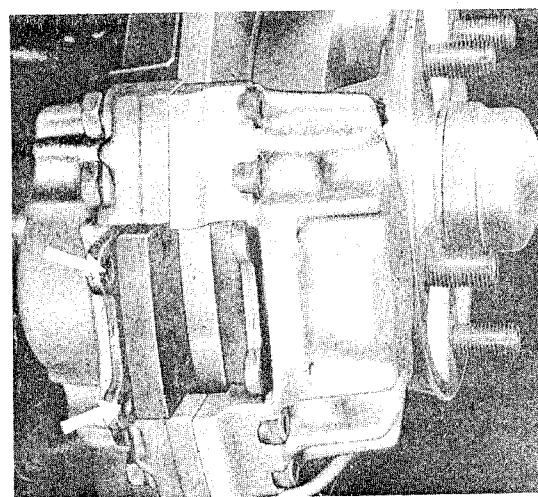


Fig. 10

3. Remove retaining pins (towards center of car) while depressing the cross-spring.

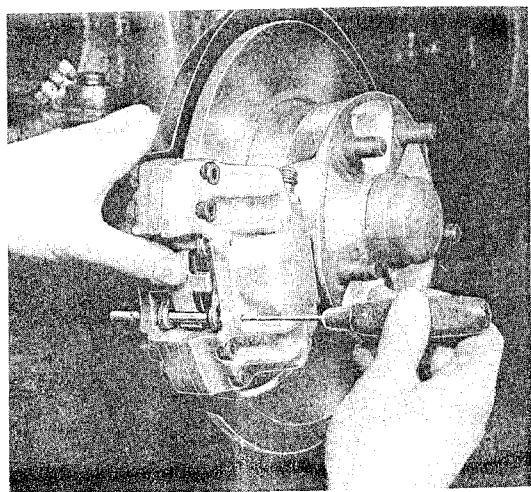


Fig. 9

6. Force pistons fully back by using the piston depressor (P 83); if not available, a piece of hardwood may be used for this purpose. Different tools may not be used due to the possibility of damaging the pistons or brake discs,

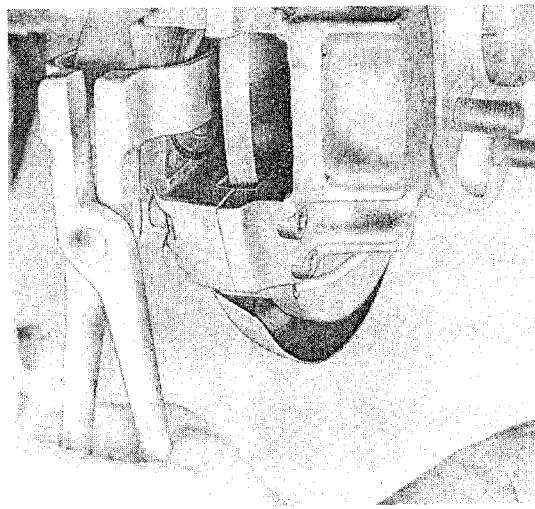


Fig. 11

4. Appropriately mark brake pad segments which may still be used.

#### **Caution:**

When the pistons are forced back, hydraulic brake fluid flows back into the reservoir. To prevent spillage, syphon the fluid out of the reservoir. The syphon or suction aid used must be clean and free of any substance other than hydraulic brake fluid.

7. Clean seating and supporting surfaces of brake pads within the respective wells. Do not use mineral solvents or sharp-edged metal tools; if necessary, alcohol may be used.
8. Check dust covers and clamping rings for serviceability. Hardened and porous dust covers must be replaced with new.
9. Clean brake discs with fine-grade emery cloth.
10. Install new brake pads in the housing wells and secure with retaining pins, cross-spring, and pin retaining clips; check pin retaining clips and replace if damaged or deformed in any way. The brake pad segments must freely move within their wells.

11. Repeat the above procedure on all other brake calipers.

#### **Caution:**

Before the car is driven, the brake pedal should be depressed a few times as far as is possible in order to bring the brake pistons and pads into their normal position. Afterwards check the level of hydraulic fluid in the reservoir.

#### **Running-in Brake Pads**

Factory new brake pads will lose their braking efficiency (fade) once, after installation, but this occurrence will disappear after a running-in distance of about 125 miles (200 km). During the run-in period, the brakes should not be used hard at high speeds unless absolutely necessary since new brake pads must be run in at light pedal pressures applied at not too frequent intervals. It is only after the run-in period that the brakes become fully effective.

#### **Removal and Installation of Disc Brakes**

##### **Front Wheel Brakes**

###### **Removal**

1. Place car on stands and remove wheels.
2. Remove brake pad segments (refer to outline pertaining to replacement of brake pad segments, page ST 23, Points 2 to 5).
3. Loosen brake hose at brake caliper by one turn (prior to this, prop brake pedal in slightly depressed condition to avoid brake fluid spillage).
4. Remove brake caliper retaining bolts, withdraw brake caliper, and detach brake hose.

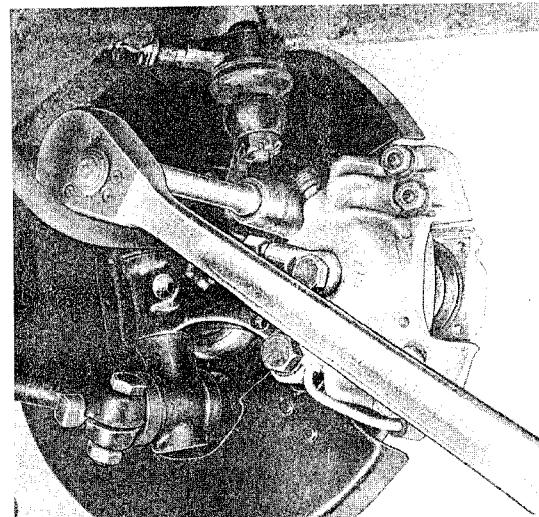


Fig. 12

5. Remove grease cup by using two large screwdrivers (remove cotter key from speedometer drive in left grease cup.)

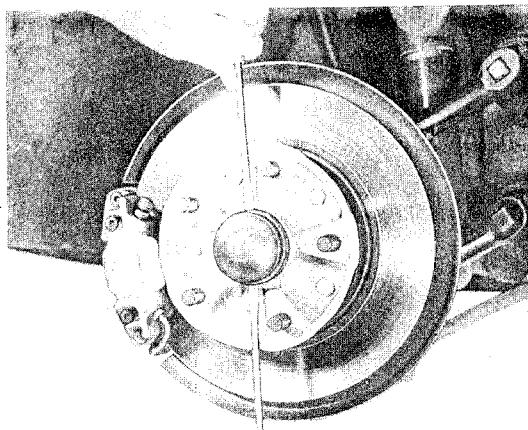


Fig. 13

8. Undo safety locks which secure disc shroud retaining bolts, remove bolts and disc shroud.

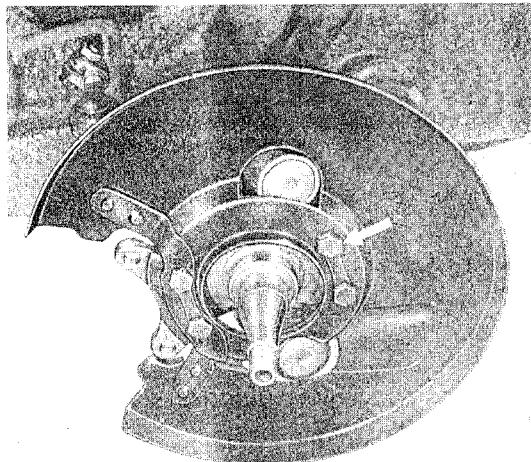


Fig. 15

6. Loosen Allen-head bolt in clamping nut and unscrew clamping nut.

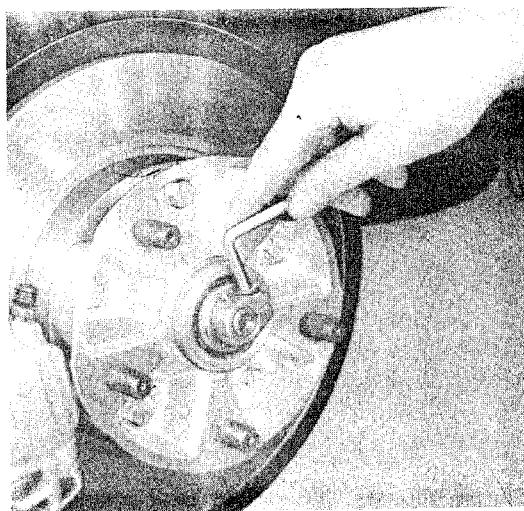


Fig. 14

7. Holding the brake disc with both hands, withdraw with a quick draw; if disc does not come off, use a puller but in no case should the disc be hammered on.

## Installation

The front wheel brake disc is installed in the reversed order of the above by noting the following points:

1. Clean all parts from dirt and grease.
2. Check wheel bearing, spacer, and seal for serviceability, replace if necessary.
3. Fill bearings with about  $50 \text{ cm}^3$  or 45 g (3 cu. in. or 1 1/2 oz.) of multi-purpose Lithium grease as indicated in the lubrication plan.
4. Use new safety lock plates and tighten disc shroud retaining bolts to 2,5 mkg (18.1 lbs/ft).
5. Ensure that the wheel bearings are properly adjusted, as outlined in the basic volume of the 356 B Workshop Manual, Section 4 ST, page S 11.

- Maximum permissible lateral whip of the brake disc is 0,2 mm (.079 in.). Fig. 16 shows method of checking lateral whip.

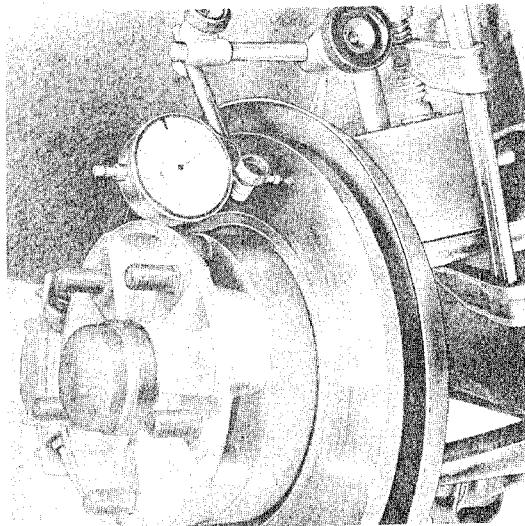


Fig. 16

- Tighten brake caliper retaining bolts (front) to 7,8 mkg (56.4 lbs/ft); use new spring washers.

- Install all brake pad segments in their original locations.

- Bleed brakes.

#### Removing and Installing Front Wheel Bearings

##### Removal

- Mark brake disc and wheel hub, remove disc retaining bolts and withdraw wheel hub.

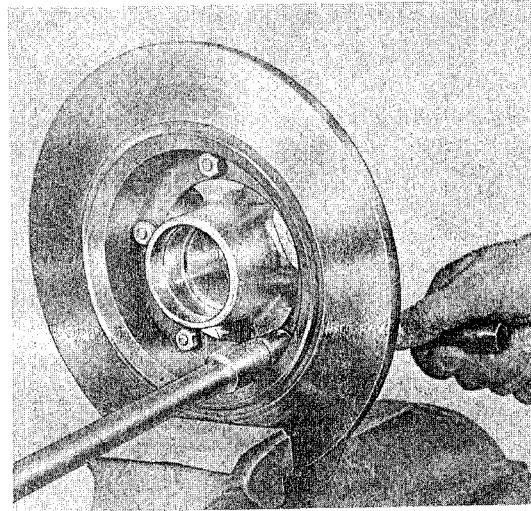


Fig. 17

- Heat wheel hub to 120 - 150° C (248 - 270° F).

- Press out inner taper-roller bearing and the seal on VW Press 400F, using special tools VW 407, VW 421 and VW 447g.

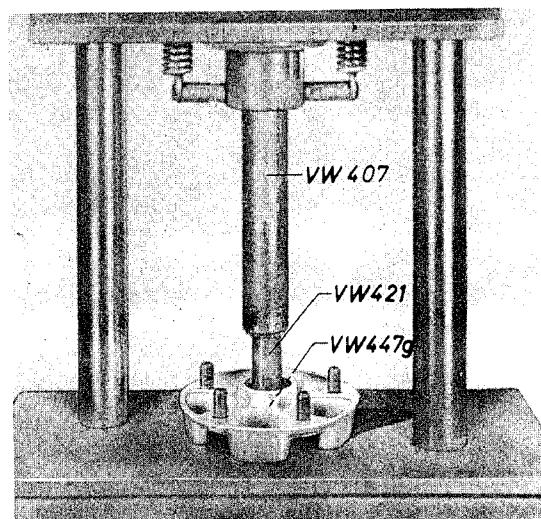


Fig. 18

4. Press out race of outer taper-roller bearing on VW Press 400 F, using special tools VW 407, VW 418, VW 447f, Spacer 1, and VW 401.

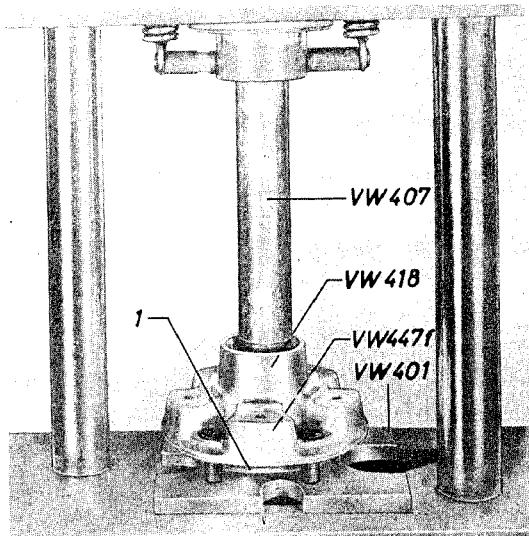


Fig. 19

Sketch for local manufacture of Spacer 1

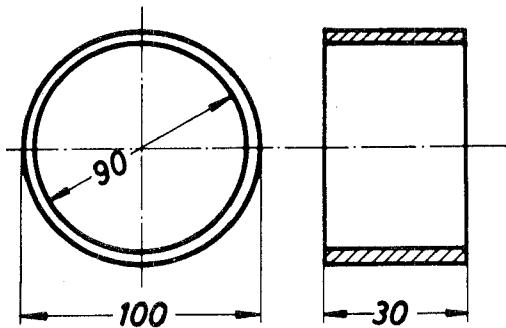


Fig. 20

90 mm = 3.54 in., 100 mm = 3.94 in., 30 mm = 1.18 in.

#### Installation

The following should be observed during installation:

##### General

Taper-roller bearings of various brands (SKF, FAG, and Timken) are used during assembly at the plant.

New bearing components, such as the outer race or the inner race with rollers, may be interchanged within a given brand but care must be taken that the complete bearing consists of components manufactured by the same company.

- Thoroughly clean both taper-roller bearings and check for wear or damage, replace if necessary.
- Heat wheel hub to 120 - 150° C (248 - 270° F).
- Press in the race of the inner taper-roller bearing on VW Press 400 F, using special tools VW 407, VW 447i, Spacer 1, and VW 401.

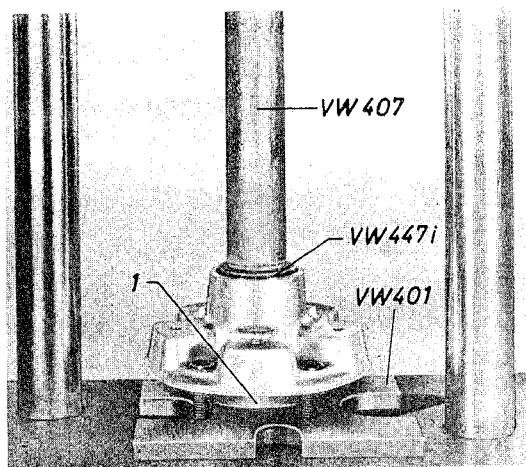


Fig. 21

- Insert the inner race into the inner taper-roller bearing and press oil seal on VW Press 400F, using special tools VW 410, VW 433, Spacer 1, and VW 401 until the oil seal is flush with the wheel hub housing.
- Press in the outer race of the outer taper-roller bearing on VW Press 400 F, using special tools VW 407, VW 447h, and VW 401.

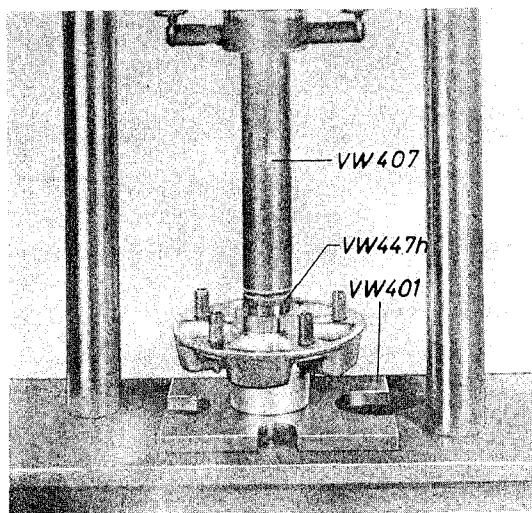


Fig. 22

6. Fill wheel hub with about  $50 \text{ cm}^3$  or 45 g (3 cu. in. or 1 1/2 oz.) of multi-purpose Lithium grease as in the lubrication plan.
7. Place brake disc on the wheel hub so that the markings line up.

8. Tighten brake disc retaining bolts (at wheel hub) to 2, 2 - 2, 4 mkg (15.9 - 17.4 lbs/ft). Make certain that 1 spacer is placed under the bolt head and a new spring washer is placed under the nut.

#### Removing and Installing Oil Deflector at Rear Wheel Hub

##### Removal

1. Bend back safety-flared tube end of oil deflector.
2. Withdraw oil deflector by using 2 large screwdrivers and 2 spacer plates.

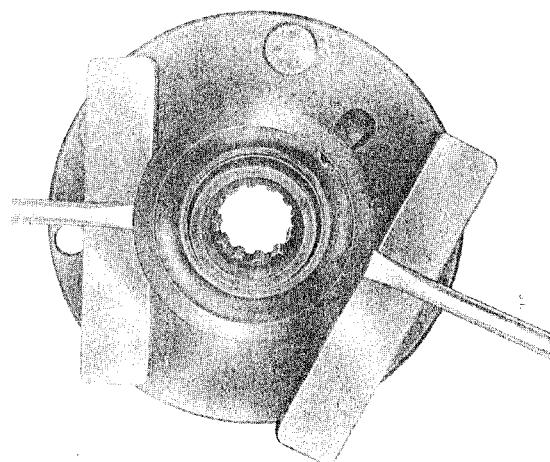


Fig. 23

##### Installation

1. Place oil deflector on the wheel hub by inserting the drain tube into the appropriate hole.
2. Press on the oil deflector on VW Press 400F, using special tools VW 412, Pipe 2, VW 432, and VW 401.

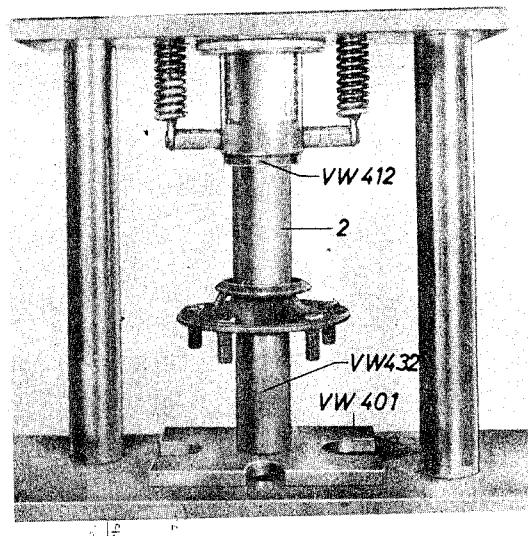


Fig. 24

3. Using a flare punch, flare out the drain tube end to secure it.

Sketch for local manufacture of Pipe 2

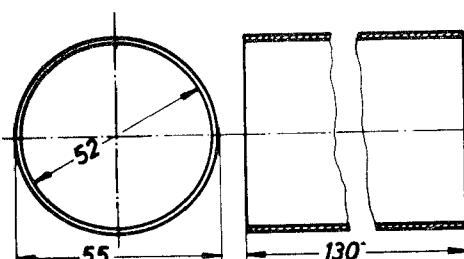


Fig. 25

52 mm = 2.05 in., 55 mm = 2.17 in., 130 mm = 5.12 in.

**Rear Wheel Brakes****Removal**

1. Place car on stands and remove wheels.
2. Remove brake pad segments (refer to outline pertaining to replacement of brake pad segments, page ST 23, Points 2 to 5).
3. Loosen brake line at the brake caliper (prop brake pedal in slightly depressed condition to prevent spillage of brake fluid).
4. Remove brake caliper retaining bolts and withdraw the caliper forward and up, away from the brake line.

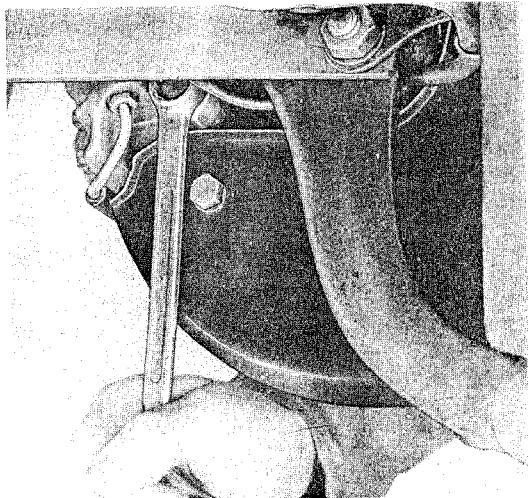


Fig. 26

5. Remove countersunk disc retaining screws and withdraw disc.

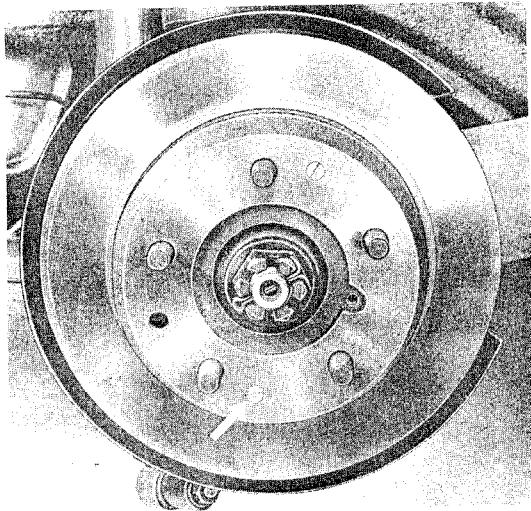


Fig. 27

6. Pull out cotter key and unscrew castellated nut from brake cable, pull out cable towards the car's center.

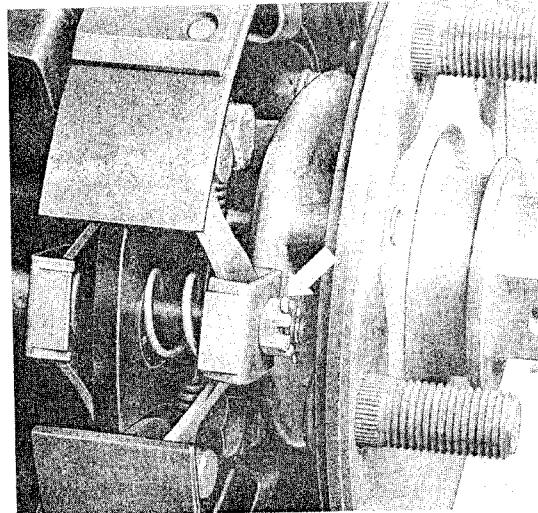


Fig. 28

7. Using a screwdriver, raise brake shoes at rear and remove mechanical expander and spring.

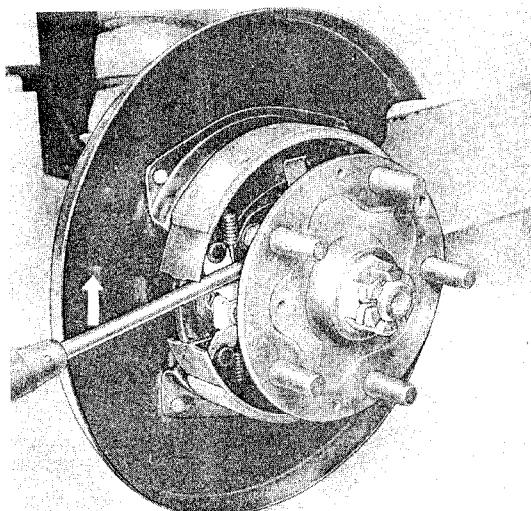


Fig. 29

8. Using a screwdriver, raise brake shoe at front and withdraw adjusting assembly.

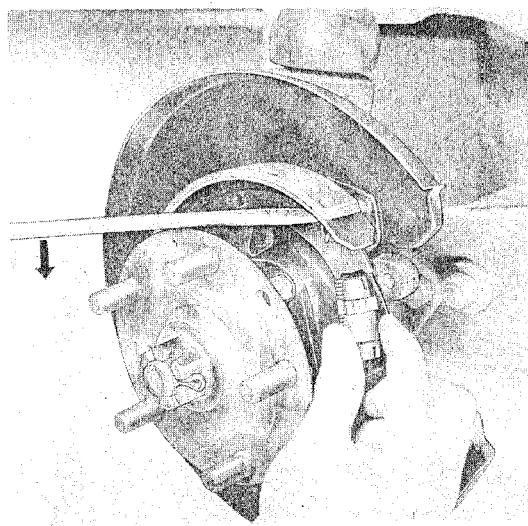


Fig. 30

13. Remove cotter key from castellated rear axle nut and remove nut using special tool P 36.

14. Mark wheel hub and axle shaft with center punch, remove wheel hub by lightly tapping it with a rubber mallet or the like.

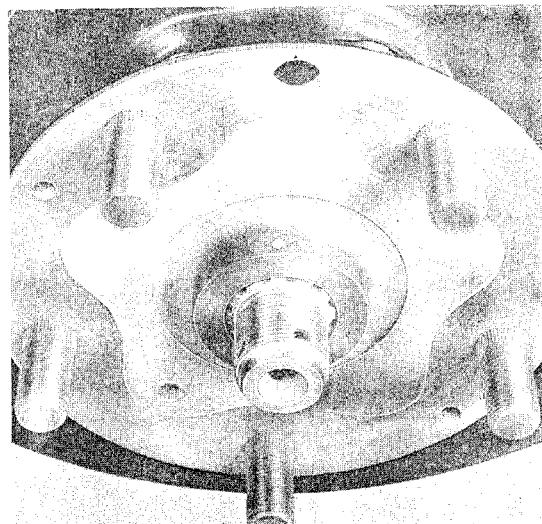


Fig. 32

9. Detach forward return spring.  
10. Spread brake shoes apart at front until retaining springs are free, then remove both brake shoes rearward.  
11. Remove brake shoe retaining springs.  
12. Remove disc shroud retaining bolts and remove shroud.



Fig. 31

Note: Transmission oil will drain out through axle tube, therefore drain first if deemed necessary.

15. Remove hand brake anchor plate retaining bolts and remove anchor plate.

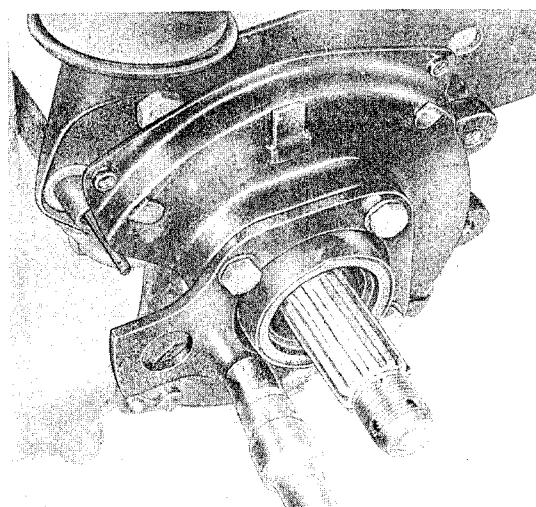


Fig. 33

**Installation**

Installation is accomplished in the reversed order of the above order. The following should be noted:

1. Clean all parts from dirt.
2. Check wheel bearing, seal, and seal race, replace defective or worn parts.
3. Install new O-rings pasting the large O-ring in groove with a little grease. Tighten anchor plate retaining bolts to 2,5 mkg (18.1 lbs/ft).

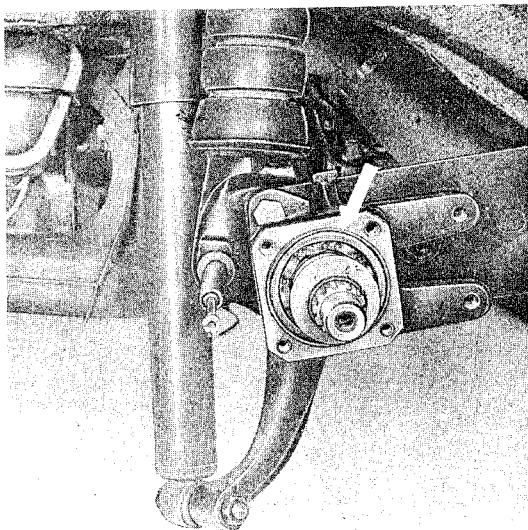


Fig. 34

4. Install wheel hub in such manner that the punch marks line up.
5. Tighten rear axle nut to 55 mkg (397.8 lbs/ft).
6. Install lower brake shoe and retaining spring.
7. Install upper brakes shoe retaining spring.

8. Attach rear return spring to lower brake shoe, then to the upper brake shoe. Pull the brake shoe up and insert in its proper place.

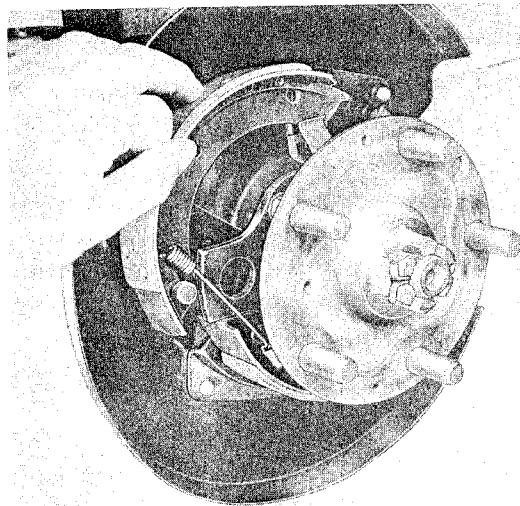


Fig. 35

9. The rear return spring should be so mounted that the spring windings point towards the center of the axle (Fig. 36). Ensure proper seating of spring.

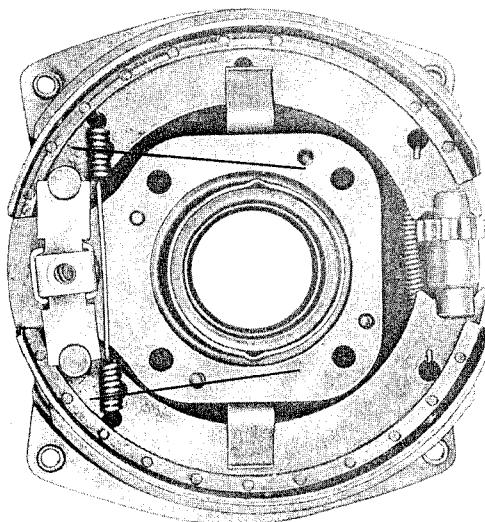


Fig. 36

10. Attach forward return spring from the back and install adjusting assembly (Fig. 36).

11. Install adjusting assembly so that the adjusting spur wheel points up at the right brake, and down at the left brake.

12. Make sure that the mechanical expander is well seated in the brake shoe studs (see Fig. 5).

13. Turn castellated nut at the end of the brake cable until the hole for the cotter pin lines up with one of the slots in the nut, then safety with a new cotter pin.

14. Check brake disc for lateral whip. This is accomplished by first fastening the brake disc with wheel lug nuts. However, to prevent warping the disc, flat-machined spacers must be placed under the nuts. The nuts are then tightened across (in star pattern) to 10 mkg (72.3 lbs/ft). The maximum permissible lateral whip is 0,3 mm (.118 in.). Minor deviations can be corrected at times by resetting the wheel hub in relation to the axle, in the splines, until a satisfactory condition is effected. When checking for lateral whip, the rear axle must be pushed towards the differential.

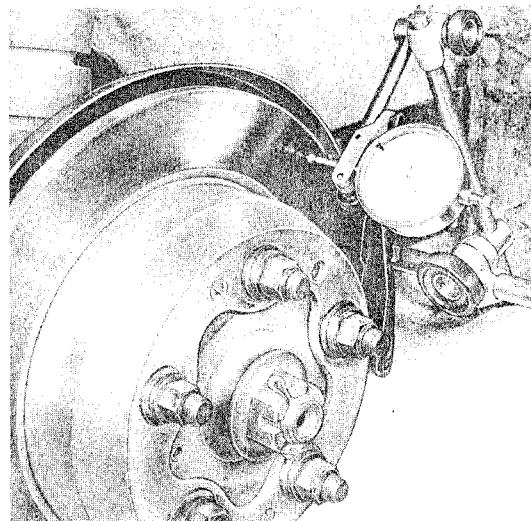


Fig. 37

15. Tighten brake caliper retaining bolts (at rear) to 6,5 mkg (47.0 lbs/ft) using new spring washers.
16. Install brake pad segments in their original positions.
17. Bleed brakes.
18. Check level of transmission oil and replenish if necessary; car must stand on wheels.
19. Adjust hand brake (see instructions below).

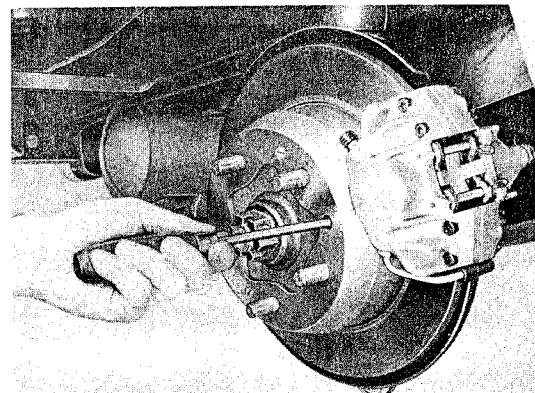


Fig. 38

#### Adjusting Hand Brake

1. Place car on stands and remove rear wheels.
2. Release hand brake and push brake pads back until the brake discs can be turned freely.
3. Turn the adjusting spur wheel with a screwdriver inserted through the opening in the rear brake disc until it begins to drag but so that it still can be turned by hand.

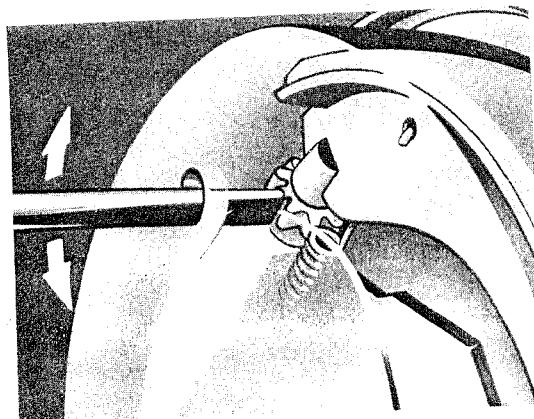


Fig. 39

4. Repeat the above procedure on the opposite brake.
5. Remove rubber covering from the center tunnel in front of the gearshift lever. Check if the brake cables, equalizer is at a right angle to the brake cables. The cable adjusting nuts should rest against the equalizer without play. If necessary, correct the cable adjustment.

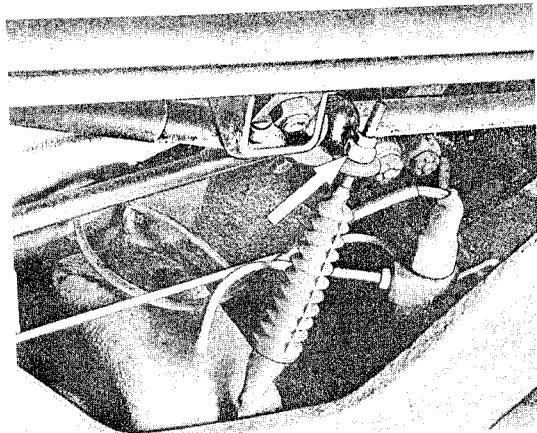


Fig. 41

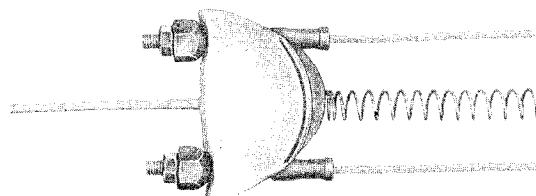


Fig. 40

6. Adjust forward brake cable at the pivot arm until there is no play at the hand brake handle.
7. Back off hand brake adjusting spur wheel by 4 to 5 teeth.

**Caution:**

Prior to driving the car, depress the foot brake pedal several times as far as it will go to bring the pistons and brake pads into their normal position, afterwards check level of hydraulic brake fluid in reservoir and replenish if necessary.

**Removing and Installing Disc Shrouds****Removal (front wheel brakes)**

Follow procedures applying to the removal of front disc brakes on page ST 24. The applicable points are: 1, 4 (do not detach brake hoses), 5, 6, 7, and 8.

**Caution:** Do not let the brake calipers to hang free on the brake hoses but attach to the car underside.

**Installation (front wheel brakes)**

Installation is accomplished in reversed order of the above by noting the following points, as described under installation of front disc brakes, in the following sequence: 1, 2, 3, 4, 5, and 7; see page ST 25.

### Removal (rear wheel brakes)

Follow procedures applying to the removal of rear wheel brakes on page ST 29. The applicable points are: 1, 4 (slightly bend the brake line clamping strap and loosen holder at axle tube), 5, 6, and 12 – in that order.

**Caution:** Do not bend the brake line. Attach brake caliper to the underbody; do not let it hang free on the brake line.

### Installation (rear wheel brakes)

Installation is accomplished in reversed order of the above by noting the following points, as described under installation of the rear disc brakes, in the following sequence: 1, 13, 15, and 19; see page ST 31.

#### Caution:

Prior to driving the car, depress the foot brake pedal several times as far as it will go to bring the pistons and brake pads into their normal position, afterwards check level of hydraulic fluid in reservoir and replenish if necessary.

### Removing and Installing Pistons in Brake Calipers

#### Removal

1. Remove brake caliper from vehicle according to instructions outlined in sections applicable to removal of the front and / or rear disc brake, Points 1 - 4.
2. Remove brake line connecting both housing halves.
3. Remove the 4 Allen-head screws in the brake caliper and separate both housing halves.
4. Remove clamping ring which secures dust cover.

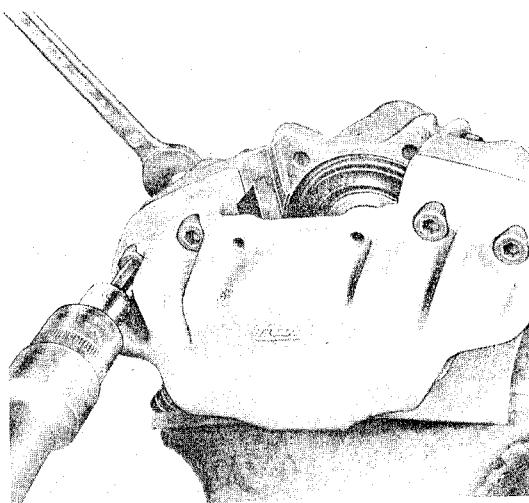


Fig. 42

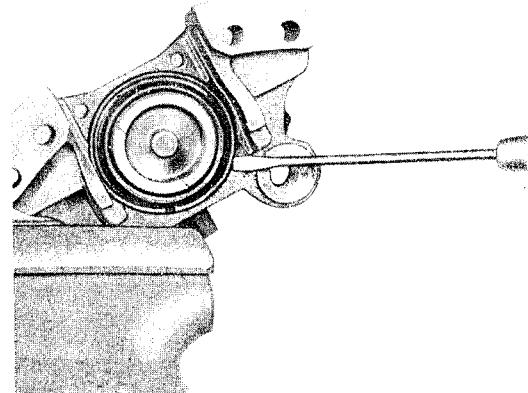


Fig. 43

5. Remove pistons from the cylinders by applying compressed air (max. pressure 2 atm. or 29.4 psi) to the inlet opening; during this operation, keep the piston from popping out by using the piston depressor (P 83) or by holding the housing half with the piston facing the work bench.

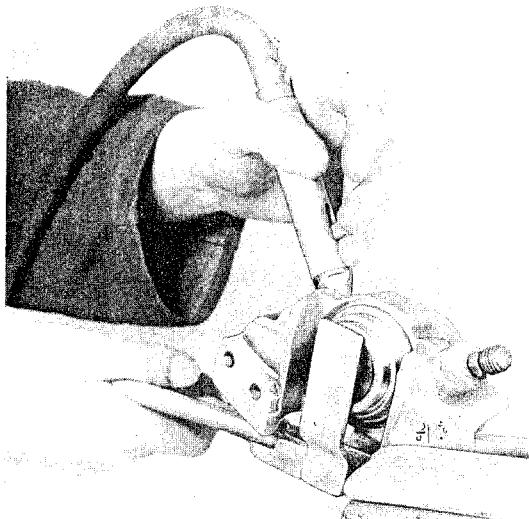


Fig. 44

3. To ease assembly and to provide protection against corrosion, the cylinder bore, piston, and piston seal should be treated with a thin layer of ATE brake cylinder compound.  
 4. Insert piston seal in the groove provided within the cylinder.

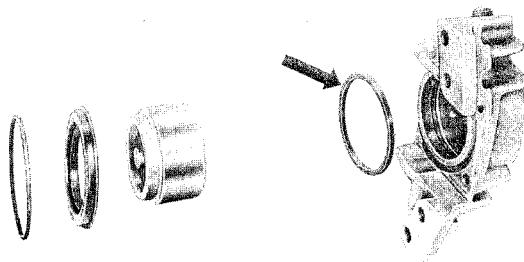


Fig. 45

6. Remove the piston seal from its groove (make sure not to damage the groove).

**Note:**

Handle the housing half with care so as not to damage the flange surfaces. Clean all parts in alcohol. Components of the self-adjusting mechanism cannot be exchanged; if found defective, the whole piston unit must be replaced.

5. Using the piston gauge (P 84), install the piston in such way that the stepped-down part of the piston pressure area faces towards the brake disc's rotational entry.

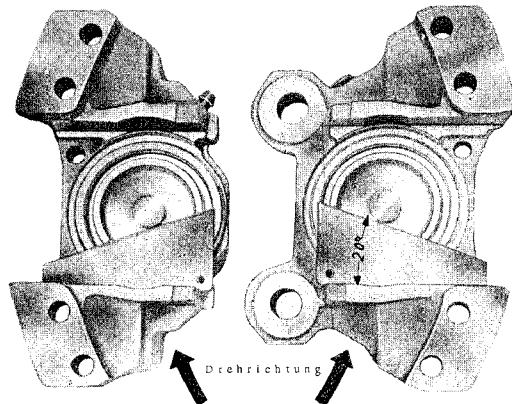


Fig. 46

**Installation**

1. Check cylinder bore and piston for possible damage; defective parts must be exchanged.
2. A new piston seal, dust cover, Allen-head screws, spring washers, and nuts must be installed whenever the unit has been disassembled.

- The piston gauge must be inserted into the brake caliper always from the direction of the axle's center and the stepped-down part of the piston must line up with the slanted edge of the piston gauge. When aligning the pistons in the front brake calipers, the right-angle edge of the gauge is placed on the bottom edge of the caliper. When aligning the rear brake calipers, the right-angle edge of the gauge is placed against the upper edge of the calipers. Fig. 47 shows a brake caliper for the front brake.
- Tighten the bolts in two stages (in first stage, apply 50% of the specified torque, in second stage 100%) and in the sequence shown in Fig. 48.

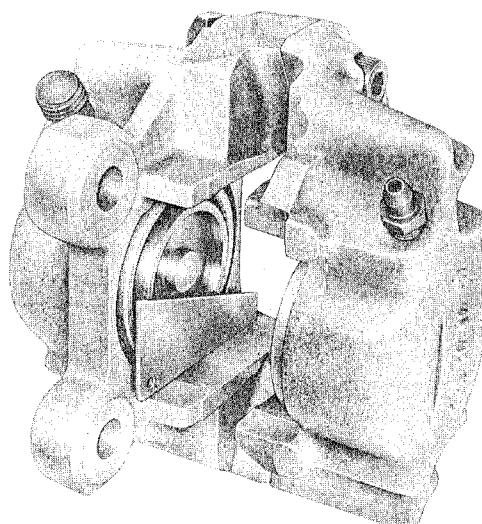


Fig. 47

- Once again clean the flange mating surfaces of both housings with alcohol and bolt the two halves together. With the nuts tightened only slightly, align both housing halves in such way that the machined surfaces within the brake pad well are flush one with another.

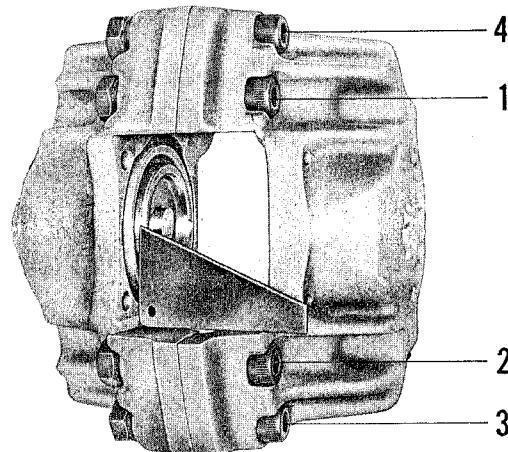


Fig. 48

#### Torque Specifications:

Front brake calipers, Allen-head bolts M 8 x 50 (10 k):	3,4 mkg (24.6 lbs/ft)
Rear brake calipers, Allen-head bolts M 6 x 45 (12 k):	1,8 mkg (13.0 lbs/ft)

When tightening the Allen-head bolts, mount the caliper assembly in a vice provided with protective jaws by holding the caliper by its mounting ears. Make certain that the mounting surfaces are not damaged.

- Install dust cover and clamping ring.
- Install hydraulic line connecting both housing halves.
- Install brake caliper assembly in vehicle by adhering to the instructions outlined in the section dealing with disc brake installation, page ST 25 or ST 31, respectively.

#### Caution:

The banjo brake line connector in the front brake caliper should not rest against the milled edge of the housing. To prevent this, it is necessary to select a gasket of appropriate thickness for insertion between the caliper housing and the banjo connector.