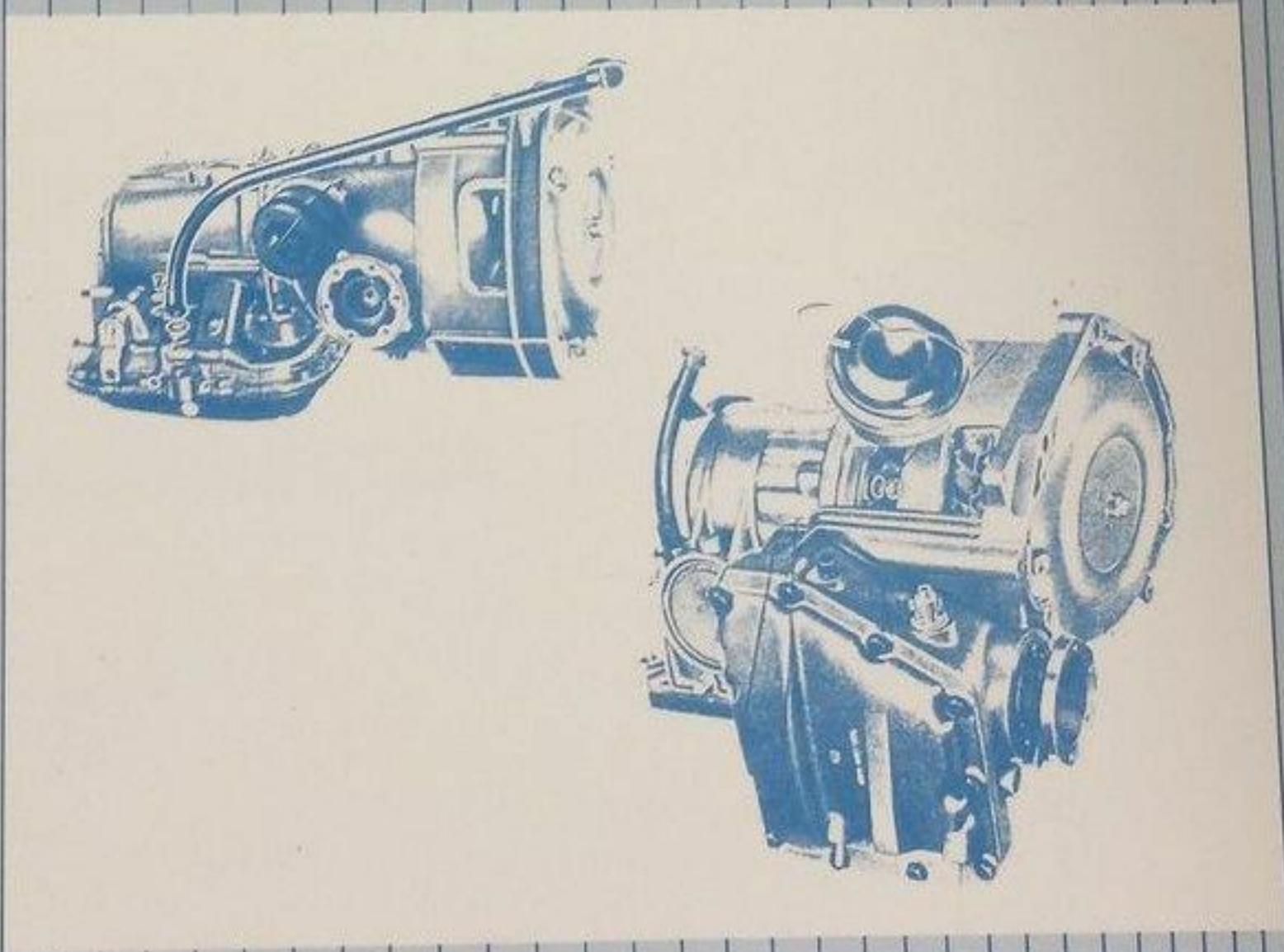




# VOLKSWAGEN

Models 003 - 010

TECHTRAN™ MANUAL



**AUTOMATIC TRANSMISSION SERVICE GROUP**



## Technical Service Information

# INTRODUCTION

This manual covers both the model 003 and model 010 transmissions. The model 003 first appeared in Fastback and Squareback Volkswagon 1968-1973 and in some Audi models. The model 010 unit first appeared in 1972 Volkswagon Rabbits, and Scirocco and in Audi vehicles.

We thank Volkswagon for the information and illustrations that have made this booklet possible.

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AUTOMATIC TRANSMISSION SERVICE GROUP



## 1. GENERAL DESCRIPTION

The automatic transmission is housed in a case assembled from two main castings. At the front of the assembly is a cast aluminum transmission case containing the automatic transmission fluid (ATF) pump, the hydraulic controls, and the planetary gear system. Attached at the rear of this case by four steel studs is a final drive housing cast in light magnesium alloy. The drive pinion, ring gear, and differential assembly are mounted on tapered-roller bearings in a separate cast iron carrier bolted inside the magnesium casting. The bellhousing for the torque converter is an integral part of the final drive housing.

### Torque Converter

The torque converter is a large doughnut-shaped assembly located between the engine and the automatic transmission. The converter not only receives engine output and passes it on to the transmission, but also multiplies engine torque at low vehicle speeds and serves as a fluid coupling between the engine and the transmission. The converter housing spins with the engine's crankshaft. Curved vanes inside the housing set up a flow of ATF that drives another vaned wheel called the turbine. The turbine drives a hollow shaft that transmits power to the transmission.

### ATF Pump

ATF must be circulating under pressure before the automatic transmission can function. The ATF pump that creates this pressure is located at the extreme front of the transmission case. A long pump driveshaft that passes through the center of the hollow turbine shaft drives the ATF pump.

The pump driveshaft is splined directly into the converter housing. The pump therefore circulates ATF whenever the engine is running, regardless of selector lever position. Since circulating ATF is also the transmission's only lubricant, it is important to remember that ATF does not circulate when the engine is not running and the car is being towed.

#### **CAUTION** —

*Never tow a car with automatic transmission faster than 30 mph (48 kph) or farther than 30 miles (48 kilometers). Bearings can be damaged by lack of lubrication. If you must tow the car farther, lift the rear wheels or remove the rear wheel driveshafts that connect the rear wheels to the transmission.*

## Planetary Gears

A torque converter alone cannot supply the torque multiplication needed for all driving conditions. The output of the torque converter is therefore routed into a planetary gearset. The planetary gearset is located at the rear of the transmission case, just ahead of the final drive housing.

The planetary gear system used in the VW automatic transmission operates on the same principles as similar gearsets found in other automatic transmissions but differs in numerous construction details. The planetary gear system has one large sun gear (51 teeth), one small sun gear (30 teeth), three small planet pinions (16 teeth each), three large planet pinions (35 teeth each), and one large annulus (ring) gear. The planet pinions are all mounted on the planet carrier which is coupled to the final drive pinion (transmission output shaft). The annulus has a one-way roller clutch to provide free wheeling when the driver takes his foot off the accelerator with the selector lever at **D** and the transmission in 1st gear.

## Clutches

Two hydraulically operated multiple disk clutches control the delivery of turbine output to the planetary gear system. The clutch at the front of the transmission is called the direct and reverse clutch because it transfers power to the small sun gear of the planetary gearset only when the transmission is in direct (3rd gear) or in reverse. The other clutch, located between the direct and reverse clutch and the planetary gearset, is called the forward clutch because it transfers power to the large sun gear in all forward gears.

## Brake Bands

Two hydraulically operated brake bands are used to hold various parts of the planetary gear system stationary, thereby obtaining reverse and 2nd gears. One brake band operates on the outer surface of the planetary gearset annulus (ring) gear. It is called the 1st and reverse brake band because its purpose is to provide reverse operation and to keep the transmission from freewheeling in 1st gear when the selector lever is in 1. This brake band does not engage when the transmission is in 1st gear and the selector lever is at **D**.

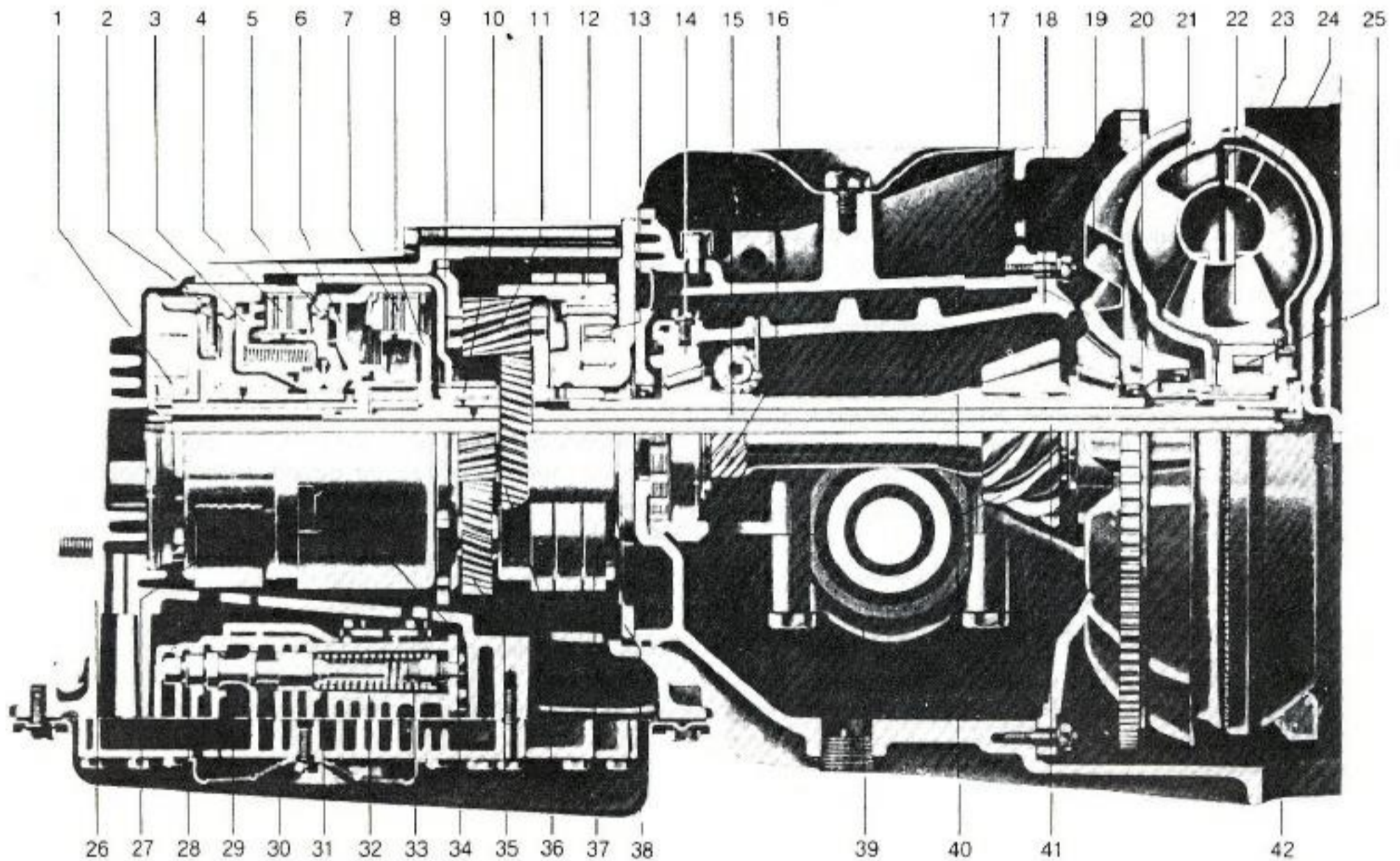
The other brake band locks the drum that houses the direct and reverse clutch and thereby prevents free rotation of the small sun gear in the planetary gearset. It is called the 2nd gear brake band because it is applied in 2nd gear with the selector lever at **D** or at **2**, or during 2nd gear kickdown. Both brake bands are fitted with adjusting screws. However, adjustments can be performed only after the transmission has been removed from the car.

## Hydraulic Controls

The hydraulic control system directs and regulates hydraulic pressure from the ATF pump, thereby controlling shifting of the planetary gearset. Shifts are produced by applying ATF pressure to the ring-shaped clutch pistons and the two piston-type brake band servos in the bottom of the transmission case. Hydraulic pressure is directed to the proper clutch or brake band servo by a number of spring-loaded control valves inside cylinders machined into the valve body. Three primary control devices regulate the movement of these valves:

(1) The manual valve, which is connected to the selector lever by a flexible cable. Moving the lever changes the setting of the valve to produce the necessary application of hydraulic pressure for the drive range selected. (2) The primary throttle pressure valve, which operates on engine vacuum. The pressure valve makes the transmission responsive to variations in engine speed and load. (3) The governor, which is gear-driven off the final drive pinion and controls ATF pressure relative to its rotational speed. The governor makes the transmission responsive to variations in vehicle speeds.

Fig. 1-1. Fully automatic transmission, cutaway view.



- |   |                                       |                                  |
|---|---------------------------------------|----------------------------------|
| 1. Pump                                 | 14. Adjusting ring for pinion bearing | 28. Control valve                |
| 2. Clutch drum                          | 15. Turbine shaft                     | 29. Transfer plate               |
| 3. Piston for direct and reverse clutch | 16. Governor drive                    | 30. ATF strainer                 |
| 4. Direct and reverse clutch            | 17. Final drive housing               | 31. Separator plate              |
| 5. Forward clutch drum with ball valve  | 18. Differential carrier              | 32. Valve body                   |
| 6. Piston for forward clutch            | 19. Cooling fins                      | 33. Spring for valve             |
| 7. Forward clutch                       | 20. One-way clutch support            | 34. Driving shell                |
| 8. Forward clutch hub                   | 21. Impeller                          | 35. Large planet pinion          |
| 9. Planetary gear carrier               | 22. Stator                            | 36. Large sun gear               |
| 10. Small sun gear                      | 23. Converter housing                 | 37. 1st and reverse brake band   |
| 11. Small planet pinion                 | 24. Turbine                           | 38. Bearing flange               |
| 12. Annulus or ring gear                | 25. One-way clutch                    | 39. Bearing cap for differential |
| 13. 1st gear one-way clutch             | 26. Transmission case                 | 40. Pinion with shaft            |
|   | 27. 2nd gear brake band               | 41. Pump shaft                   |
|   |                                       | 42. Connecting lug               |



## Final Drive

The final drive consists of a hypoid drive pinion and ring gear with a differential gearset. The cast-iron final drive carrier in which it is mounted also provides a mounting point for the torque converter support tube.

## 2. MAINTENANCE

The fully automatic transmission requires regular maintenance at specified intervals. In fact, many automatic transmission malfunctions can be traced to dirty ATF, too little or too much ATF, or other improper maintenance and lubrication conditions. The following operations for the automatic transmission are covered in **LUBRICATION AND MAINTENANCE** in detail:

1. Checking ATF level
2. Checking transmission pan screws
3. Checking constant velocity joint screws
4. Checking constant velocity joint seals
5. Checking kickdown operation
6. Changing ATF, cleaning the sump and strainer
7. Filling transmission
8. Changing final drive hypoid oil
9. Lubricating rear wheel bearing.

## 3. TROUBLESHOOTING

Before diagnosing automatic transmission troubles, review the history of the unit. Such a review may offer important clues to present difficulties. The following should be checked before making any repair or adjustment:

1. Be sure the engine is tuned up and running right.
2. Inspect the transmission for external damage, loose or missing screws, and obvious leaks. Check the final drive hypoid oil for ATF contamination.
3. Check the ATF level. Rub some ATF between your fingers and sniff it to detect the burned odor that means burned friction linings. If the ATF is dirty, it may be clogging the automatic controls.
4. Check the adjustment and operation of the kick-down switch and the adjustment of the selector lever cable. See if the vacuum unit for the primary throttle pressure valve is bent.

### 3.1 Road Testing

Drive the car in all transmission ranges and under as many different road conditions as possible. Note the shift points both up and down. They should take place without interrupting the power flow. Listen for engine racing between gears, a possible indication of slipping clutches or brake bands. **Table a** suggests remedies for defects you observe. The numbers in bold type in the **Remedy** column refer to numbered headings in **AUTOMATIC TRANSMISSION**.

**Table a. Automatic Transmission Troubleshooting**

Problem	Probable Cause	Remedy
1. No drive in any selector lever position	a. Automatic transmission fluid level low b. Manual valve not hooked to selector lever c. Pump or pickup screen clogged d. Defect in transmission pump or pump drive e. Broken shaft or planetary gear set	a. Check and correct ATF level. Repair any leaks. ** b. Replace Bowden cable or attachments. See <b>12.1</b> . c. Clean pump and pickup. ** *d. Repair or replace pump. If drive is broken check pump bushing axial play. See <b>10.6</b> . *e. Replace broken parts. See <b>10</b> .
2. ATF dark colored and smells burned	This may accompany or signal the start of trouble caused by burned friction linings on the brake bands or clutches	Drain contaminated ATF. Remove as much ATF as possible from converter. Replace with fresh ATF. See <b>8.5</b> . **
3. No drive in forward gears	Forward clutch defective	*Repair clutch. See <b>10.2, 10.8</b> .
4. No drive in <b>R</b> and no engine braking with lever at <b>1</b>	1st and reverse band or servo defective	*Check and repair 1st and reverse band and servo. See <b>6, 10.2, 10.4</b> .
5. Car will not move off when lever is at <b>2</b> or <b>D</b>	1st gear one-way clutch in annulus defective	*Replace annulus gear and one-way clutch. See <b>10.2, 10.9</b> .
6. No drive in 2nd gear when lever is at <b>2</b> or <b>D</b>	2nd gear band or servo defective	*Repair band or servo. See <b>6, 10.2, 10.4</b> .
7. Transmission stays in 1st gear with lever at <b>2</b> or <b>D</b>	a. Governor dirty or defective b. Valve body assembly dirty	a. Clean or repair governor. Fit new lock washer if old one is missing. Remove pan to retrieve old washer. See <b>7</b> . b. Remove oil pan. Clean valve body. See <b>5</b> .
8. No drive in 3rd gear or reverse	Direct and reverse clutch defective	*Repair clutch. See <b>10.2, 10.7</b> .



# Technical Service Information

**Table a. Automatic Transmission Troubleshooting (continued)**

Problem	Probable Cause	Remedy
9. Erratic power transmission, reverse noisy (accelerator may have to be depressed several times before car moves)	a. ATF level too low or high b. Selector lever out of adjustment c. Oil strainer dirty d. Primary throttle pressure valve sticking	a. Check and correct ATF level. Repair any leaks.** b. Adjust cable. See 12.2. c. Remove oil pan, clean strainer.** d. Check valve, replace if necessary. See 3.3, 4.
10. Engine surges on upshifts. Shift time too long	a. ATF level too low or high b. Primary throttle pressure valve misadjusted c. Direct and reverse clutch defective	a. Check and correct ATF level. Repair any leaks.** b. Adjust primary throttle pressure. See 3.3, 4. *c. Repair clutch. See 10.2, 10.7.
11. Shifts take place at too low speeds	a. Primary throttle pressure valve misadjusted b. Governor or governor drive defective c. Valve body assembly dirty	a. Adjust primary throttle pressure. See 3.3, 4. b. Inspect and repair governor. See 7. c. Remove oil pan. Clean valve body.**
12. Shifts take place at too high speeds	a. Primary throttle pressure valve misadjusted b. Vacuum hose leaky c. Kickdown switch out of adjustment d. Kickdown solenoid switch defective e. Valve body assembly dirty f. ATF pressure low due to internal transmission leaks	a. Adjust primary throttle pressure. See 3.3, 4. b. Replace hose. See 4. c. Adjust kickdown switch.** d. Replace solenoid. See 5.2. e. Remove oil pan. Clean valve body.** f. Disassemble transmission and replace all seals and gaskets. See 10, 7, 8.3.
13. Transmission does not shift into 3rd gear with lever at <b>D</b>	a. Governor or governor drive defective b. Valve body assembly dirty c. Direct and reverse clutch defective	a. Inspect and repair governor. See 7. b. Remove oil pan. Clean valve body.** *c. Repair clutch. See 10.2, 10.7.
14. Heavy jerk when selecting a drive range (from neutral)	a. Engine idle too fast b. Primary throttle pressure valve misadjusted c. Vacuum hose leaky d. Primary throttle pressure vacuum unit leaking	a. Adjust idle speed. See <b>FUEL SYSTEM</b> . b. Adjust primary throttle pressure. See 3.3, 4. c. Replace hose. See 4. d. Replace primary throttle pressure valve. See 4.
15. Kickdown will not function	a. Kickdown switch defective or misadjusted b. Kickdown solenoid switch defective	a. Adjust or replace kickdown switch.** b. Replace solenoid. See 5.2.
16. Poor acceleration. Top speed low despite good engine output	a. ATF level too low or high b. Torque converter one-way clutch defective c. Forward clutch defective d. Direct and reverse clutch defective e. 2nd gear brake band or servo defective	a. Check and correct ATF level. Repair any leaks.** b. Replace torque converter. See 8.1. *c. Repair clutch. See 10.2, 10.8. *d. Repair clutch. See 10.2, 10.7. *e. Repair brake band or servo. See 6, 10.2, 10.4.
17. Screeching noise when moving off or accelerating	a. Torque converter one-way clutch defective b. 1st gear one-way clutch in annulus defective	a. Replace torque converter. See 8.1. *b. Replace annulus gear and one-way clutch. See 10.2, 10.9.
18. Scraping, grinding noise from converter. Fluid silver-colored	Thrust washer in converter worn	Replace annulus gear and one-way clutch. See 10.2, 10.9.
19. High ATF consumption without external leak	a. Leaking vacuum chamber on primary throttle pressure valve (exhaust will be smoky) b. Oil seals for pinion or governor shafts leaking (oil may be leaking from transmission breather)	a. Replace primary throttle pressure valve. See 4. *b. Replace seals. See 7, 11.1, 11.2.
20. Parking lock will not hold vehicle	a. Selector lever out of adjustment b. Parking lock linkage defective	a. Adjust cable. See 12.2. b. Repair linkage. See 10.11.
21. Heavy leakage of ATF. Transmission case and under side of car oily	Leaking converter oil seal. On cars to chassis No. 318 102 505 welded seam in converter may be leaking	Replace oil seal, or seal and converter if necessary. See 8, 11.2.

\* Transmission must be out of the car and disassembled for this repair

\*\* See LUBRICATION AND MAINTENANCE



When troubleshooting the automatic transmission, try to pin down the main component involved: converter, planetary gear system, or hydraulic controls. If **Table a. Automatic Transmission Troubleshooting** has failed to pinpoint the malfunction adequately, the following tests should help to isolate the problem.

### 3.2 Stall Speed Testing

This test provides a quick check of the torque converter operation, but should be performed only if the car accelerates poorly or fails to reach the specified maximum speed. An electronic tachometer is required.

#### **CAUTION** —

*Never extend this test beyond the time it takes to read the gauges. Doing so may overheat the transmission and damage the oil seals.*

#### To test:

1. Connect the tachometer according to the manufacturer's instructions. Then start the engine.
2. Set the parking brake and depress the foot brake firmly to hold the car stationary.
3. Shift the selector lever to position **D** and floor the accelerator pedal. Instead of revving up, the engine will run at a reduced rpm, known as stall speed.

If the rpm at stall is about 400 rpm below the specified 1900 to 2000 rpm stall speed, and the engine is in a proper state of tune, something is wrong with the torque converter. If the rpm at stall is too high, something is wrong in the forward clutch or the 1st gear one-way clutch located in the annulus gear. The test can also be made with the selector lever at **R**. If the reverse stall speed is too high, it indicates slippage in either the direct and reverse clutch or the 1st gear brake band.

### 3.3 Testing Hydraulic Control System

A stall speed test is valuable mainly for isolating problems in the converter and the planetary gear system. Troubleshooting the hydraulic control system requires pressure testing. Although the pressure tests described here do not include tests for every valve in the hydraulic control system, the tests are adequate for determining whether or not the trouble is in the hydraulic controls. The actual source of the trouble is not significant since you will have to remove the valve body to correct the trouble, regardless of where it lies. If there are physical defects—even minor ones—the entire valve body and governor must be replaced. In many cases, however, a thorough cleaning will be all that is required.

The components of the hydraulic control system can be divided into three basic groups: pressure regulating valves, shift valves, and operating controls. A description of each group follows:

#### Pressure Regulating Valves

Leading this category is the main pressure valve. This valve receives pump output and controls main line pressure relative to engine (and pump) rpm. Next is the converter pressure valve that regulates ATF pressure to the converter and also lubricating pressure to the transmission bearings. The governor, which is a centrifugal valve, also belongs in this group. It regulates ATF pressure, to the large ends of the shift valves and controls upshift and downshift speeds.

The primary throttle pressure valve is another important pressure regulating device. It consists of a diaphragm sealed inside a vacuum chamber and a spool-like valve that regulates the ATF pressure reaching the shift valves relative to intake manifold vacuum. The vacuum chamber is visible on the outside of the transmission at the point where the primary throttle pressure valve is inserted into the transmission case. This valve regulates ATF pressure to the smaller ends of the shift valves, opposing governor pressure.

The modulator valve, working under the influence of governor pressure, connects the pressure limiting valve with the primary throttle pressure line at 18 mph (29 kph). The pressure regulator valve then limits the flow from the primary throttle pressure valve to about 28 psi (2.0 kg/cm<sup>2</sup>). This, in turn, limits the maximum pressure delivered by the main pressure valve to 88 psi (6.18 kg/cm<sup>2</sup>). There is also a secondary throttle pressure valve that increases primary throttle pressure by mixing it with main pressure. Its function is to raise the speed at which shifts occur when the engine is operating under heavy loads.

#### Shift Valves

All other valves in the hydraulic control system move under the influence of the pressure regulating valves to produce automatic shifts. The valves do this by sending ATF pressure to the operating controls. Valve movement is determined by springs and the balance of opposing hydraulic forces. In some cases ATF pressure is applied equally to opposite sides of a valve. The valve moves despite the identical pressures because the areas of the two valve surfaces differ in size. The psi is the same on both sides, but the number of square inches is not.

#### Operating Controls

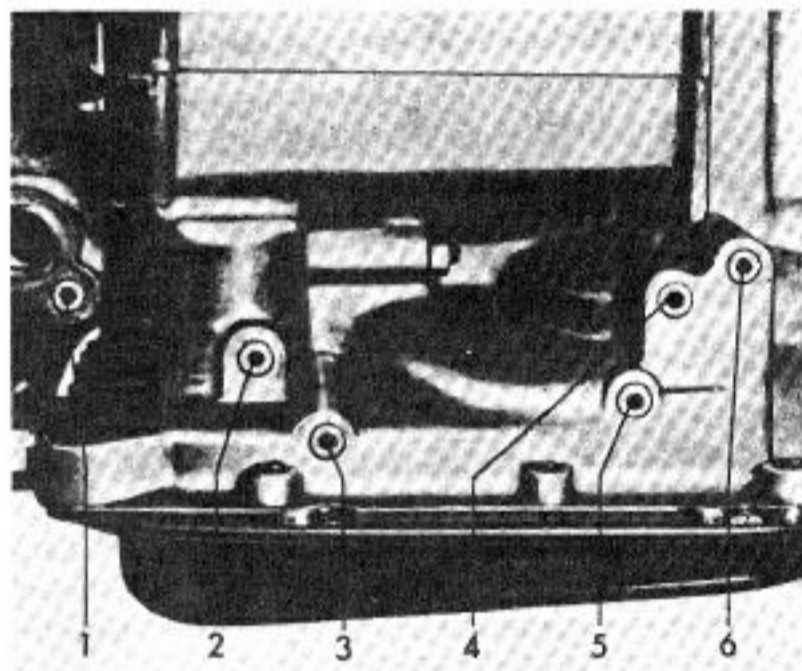
The brake band servos and clutches put the commands of the shift valves into operation. The accumulator is a device which slows application of the 2nd gear brake band for smooth shifts and kickdown engagements.



## Pressure Testing

Only two of the six pressure test connections need be used. One is for checking primary throttle pressure and the other for checking main pressure. By attaching pressure gauges at these points using long hoses, it is possible to find internal leaks, wear, clogged ATF passages, or sticking valves.

Most automatic transmission malfunctions can be isolated without pressure tests. However, such tests are often valuable for confirming the need for certain repairs or isolating one of two possible causes for the same malfunction. A gauge reading from 0 to 140 psi (0 to 10 kg/cm<sup>2</sup>) is needed to measure primary throttle pressure and a gauge with a 0 to 350 psi (0 to 25 kg/cm<sup>2</sup>) range is needed to measure main pressure. Fig. 3-1 shows the test connection points on the transmission case.



1. Regulator pressure
2. Main pressure
3. Primary throttle pressure
4. Main pressure. Release side of 2nd gear brake band servo piston
5. Secondary throttle pressure
6. Main pressure. Apply side of 2nd gear brake band servo piston

**Fig. 3-1.** Pressure test connections. The main pressure and primary throttle pressure connections are the most important points to know.

### CAUTION —

*If you lack the skills, tools or a suitable workshop for automatic transmission work, we suggest you leave such repairs to an Authorized VW Dealer or other qualified shop. We especially urge you to consult your Authorized VW Dealer before attempting repairs on a car still covered by the new-car warranty.*

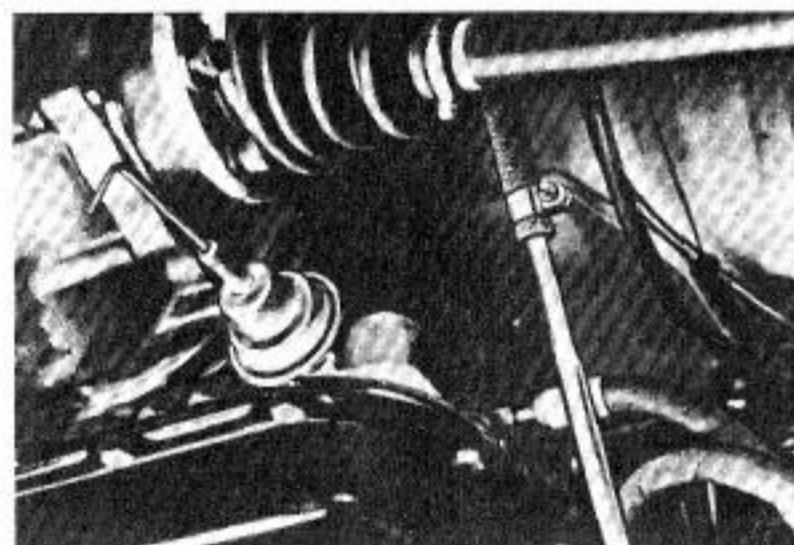
### To test pressures:

1. Connect the 0 to 350 psi (0 to 25 kg/cm<sup>2</sup>) gauge to the main pressure test point.
2. Connect the 0 to 140 psi (0 to 10 kg/cm<sup>2</sup>) gauge to the primary throttle pressure test point.
3. Route the long gauge hoses into the car.

### CAUTION —

*The car must be driven during this test. Be sure the hoses do not drag on the pavement or rub the wheels of the car. This could damage the testing equipment.*

4. Remove and plug the vacuum line. See Fig. 3-2.



**Fig. 3-2.** Disconnecting vacuum hose. Pull the hose off the vacuum unit and seal it with an 8-mm ( $\frac{5}{16}$ -in.) punch. The test connection is behind the punch. The hex key in the vacuum unit's hose connection is in position to adjust the primary throttle pressure.

5. Move the selector lever to N, start the engine and measure both pressures at a fast (1000-rpm) idle. The throttle pressure should be 42 psi (3.0 kg/cm<sup>2</sup>) on pre-1972 models and 45.5 psi (3.2 kg/cm<sup>2</sup>) on 1972 and 1973 models. On all models, the main pressure should be 116 to 120 psi (8.2 to 8.4 kg/cm<sup>2</sup>).
6. If the throttle pressure is not within specifications, correct it using the adjusting screw inside the vacuum chamber connection. Replace valves that will not adjust to specifications.

### NOTE —

Be careful not to bend the vacuum unit. It must be perfectly straight to work properly.

7. Reconnect the vacuum hose and again measure the pressures at a fast idle. The throttle pressure should be 5 to 6 psi (0.35 to 0.42 kg/cm<sup>2</sup>) and the main pressure 47 to 50 psi (3.30 to 3.50 kg/cm<sup>2</sup>).

8. Move the selector lever to **D**.
9. Check both pressures at full throttle while you hold the car stationary with foot and parking brakes. The throttle pressure should be 40 to 42 psi (2.8 to 3.0 kg/cm<sup>2</sup>) and the main pressure 114 to 120 psi (8.0 to 8.4 kg/cm<sup>2</sup>).

**CAUTION —**

Never continue a full-throttle pressure test longer than it takes to read the gauges. Doing so may overheat the transmission and damage the oil seals.

10. Move the selector lever to **R**. Check the main pressure while you hold the car stationary with the foot and parking brakes. It should be 95 to 110 psi (6.7 to 7.7 kg/cm<sup>2</sup>) at a fast idle and 213 to 284 psi (15.0 to 20.0 kg/cm<sup>2</sup>) at full throttle.
11. Take the car on the road and measure the main pressure at speeds above 19 mph (30 kph). It should be between 87 and 90 psi (6.1 and 6.3 kg/cm<sup>2</sup>).
12. After removing the test hose connections, run the engine and check the pressure connection plugs for leaks.

Pressures lower than those specified mean one or more of the following: (1) a worn pump; (2) internal ATF leaks past seals, gaskets, and metal mating surfaces; (3) sticking pressure regulating valves. High pressures always indicate sticking valves or a bent primary throttle pressure valve.

## 4. REPLACING PRIMARY THROTTLE PRESSURE VACUUM UNIT

The primary throttle pressure vacuum unit screws into the transmission case. A hex below the vacuum chamber provides a grip for the wrench. When installing a new unit, lubricate the threads lightly with a good anti-seize compound. Torque to 2.5 mkg (18 ft. lb.).

Make certain that the vacuum hose to the engine is in good condition. Replace it if it is cracked or fits loosely. Do not overtighten the hose clamps.

**NOTE —**

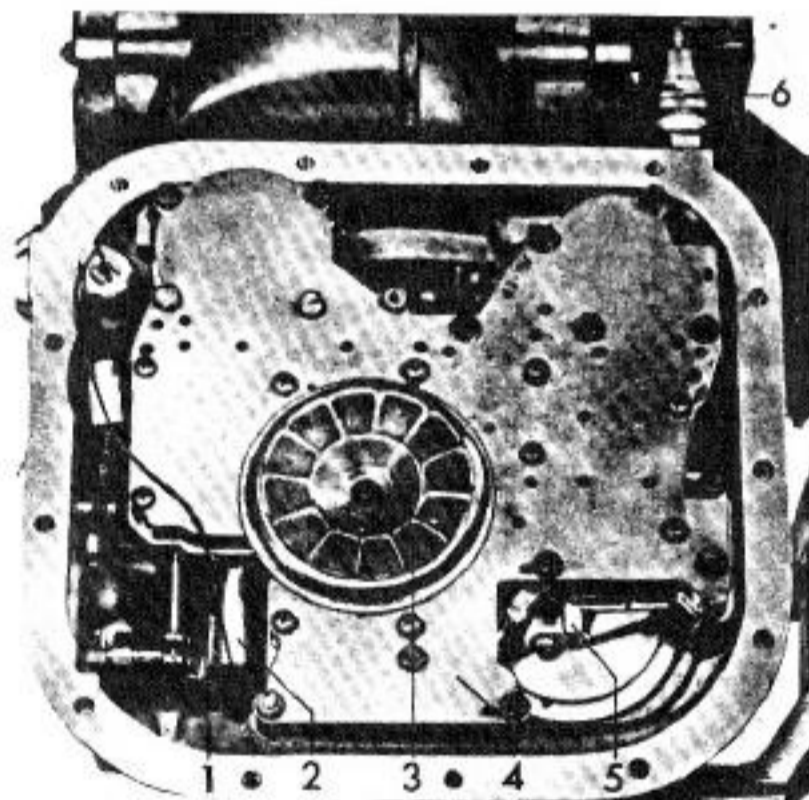
When replacing the primary throttle pressure vacuum unit or installing a new or exchange transmission, check the primary throttle pressure to bring it within the specifications given under step 5 of the pressure testing procedures. A hex key is inserted in the vacuum connection to make any adjustment required, as shown in Fig. 3-2.

## 5. SERVICING VALVE BODY AND VALVE BODY ASSEMBLY

Servicing the valve body assembly normally involves only removal and cleaning. It may also be necessary, however, to remove the assembly from the transmission to replace a faulty kickdown solenoid.

### 5.1 Removing and Installing Valve Body Assembly

The valve body assembly can be removed with the engine and transmission in the car. It must also be removed for cleaning during more extensive repairs with the transmission out of the car. The location of the valve body assembly and related parts in the transmission case can be seen in Fig. 5-1.

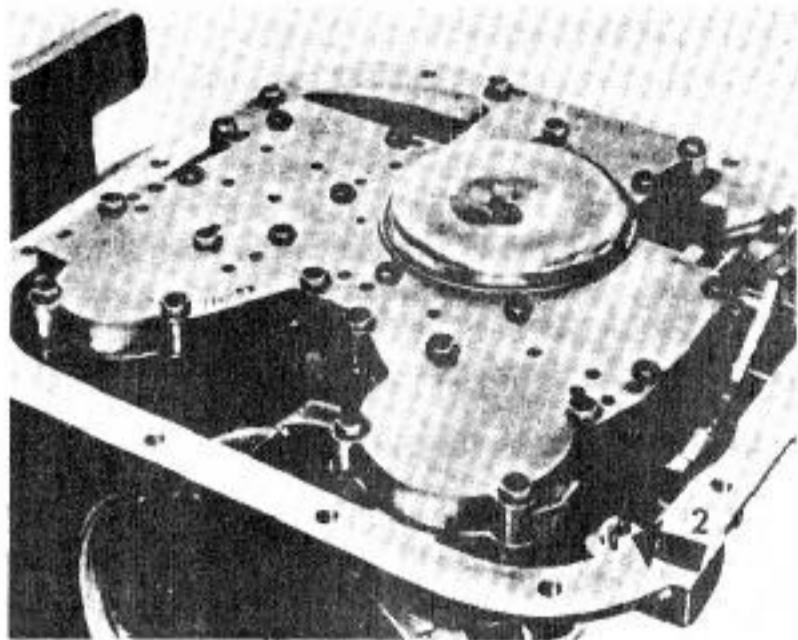


- |                      |  |
|----------------------|--|
| 1. Manual valve      | 5. Valve body                                      |
| 2. Kickdown solenoid | 6. Vacuum unit for primary throttle pressure valve |
| 3. ATF strainer      |  |
| 4. Transfer plate    |  |

Fig. 5-1. Valve body and related parts in place. The transmission pan has been removed.

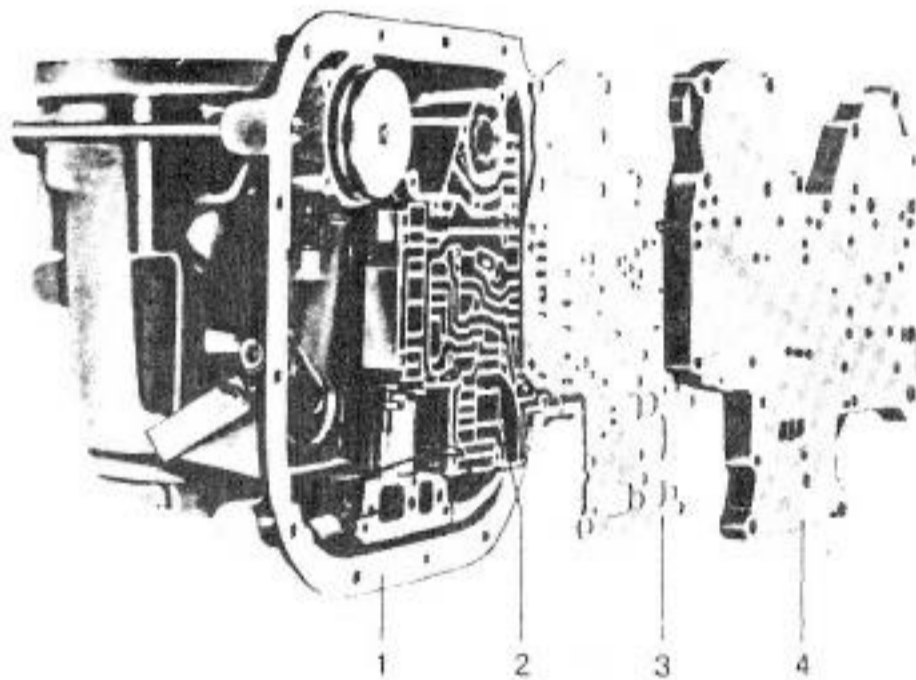
**To remove:**

1. Remove transmission pan screws.
2. Take off transmission pan and gasket.
3. Disconnect the solenoid electrical wire from its terminal on the transmission case.
4. Fourteen bolts and a screw hold the valve body together and fasten it to the transmission. These fasteners are shown in Fig. 5-2. Take out the 14 bolts, but for the moment leave the screw in place.



**Fig. 5-2.** Fasteners for the valve body assembly. Arrow 1 points to screw which is the fifteenth and last fastener to be removed. Arrow 2 points to the electrical connection for the kickdown solenoid.

5. Remove the screw. Take off the valve body assembly, but do not separate it into its three main components as shown in Fig. 5-3 or you may lose the ball valves.



- |                      |                    |
|----------------------|--------------------|
| 1. Transmission case | 3. Separator plate |
| 2. Valve body        | 4. Transfer plate  |

**Fig. 5-3.** Valve body assembly apart. Disassemble only on a clean workbench after removal.

**CAUTION** —

If the valve body assembly is removed while the transmission is in the car, the servo piston for the 1st gear band can fall out. Be ready to catch it.

**To install:**

1. Attach the valve body assembly to the transmission case with the screw indicated by arrow 1 in Fig. 5-2. The manual valve (arrow 3) must be engaged in the operating lever.
2. Install the 14 bolts and washers finger-tight.
3. Torque all bolts to 0.4 mkg (3.0 ft. lb.) and the screw to 0.35 mkg (2.5 ft. lb.) working diagonally.
4. Connect the wire to the kickdown solenoid.
5. Fit a new pan gasket. Torque the pan screws diagonally to 1 mkg (7 ft. lb.).
6. Wait 5 minutes for the new gasket to compress, then retorque the screws to 1 mkg (7 ft. lb.).

**CAUTION** —

Never tighten the transmission pan screws over 1 mkg (7 ft. lb.) in an attempt to cure a leaking gasket. Overtightening will deform the pan and make it impossible to get a good seal. Always install a new gasket to correct leaks.

## 5.2 Removing and Installing Kickdown Solenoid

The kickdown solenoid is an electromechanical device that moves the kickdown valve in the hydraulic control system. It is operated by an electrical switch on the engine. If the transmission will not kick down, check with a voltmeter the wire leading to the transmission. If current is reaching the transmission, the solenoid may be at fault.

Test the solenoid for continuity by removing the wire from the outside of the transmission. Attach a battery-powered test light to the terminal on the transmission case and to the case itself. If the test light does not come on, the solenoid is faulty or disconnected from the terminal inside the transmission case. Remove the transmission pan in order to inspect the wire's connection.

**To replace solenoid:**

1. Take off the transmission pan.
2. Remove the valve body assembly.
3. Remove the two screws holding the solenoid to the valve body.

**NOTE** —

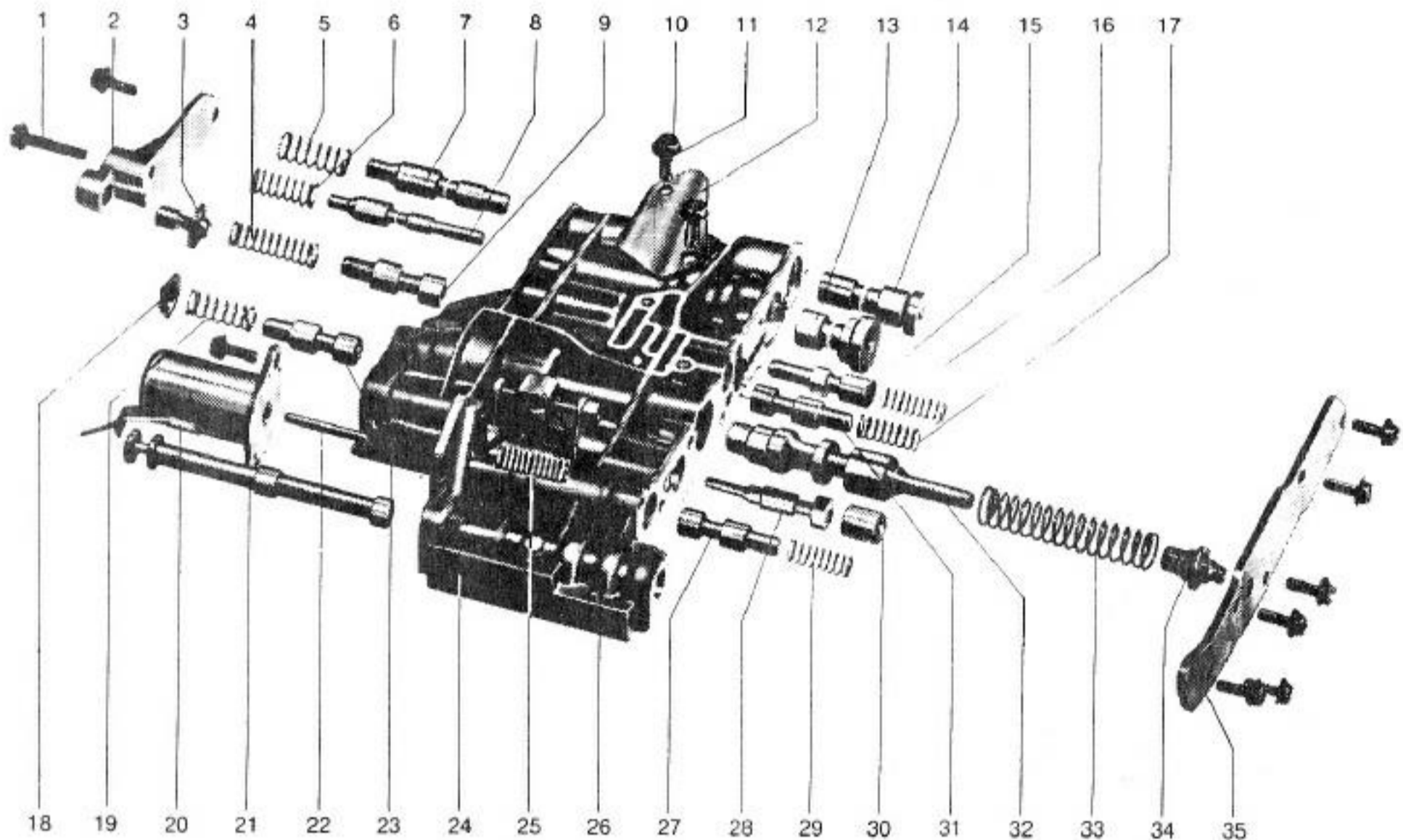
The solenoid mounting screws are inaccessible while valve body is in place.

## 5.3 Disassembling and Assembling Valve Body

As a rule, the valve body is disassembled only for cleaning. Unless the fluid is very dirty or contaminated by large solid particles, it usually is sufficient to immerse the complete assembly in cleaning fluid and dry it with compressed air. Be careful, however, that the air jet is not held so close that it moves the valves violently. This could damage the springs.

**Fig. 5-4.** Valve body. The kickdown valve, governor pressure valve, throttle pressure limiting valve, and converter pressure valve are physically identical. Used valves, however, must not be interchanged.

Fig. 5-4 is an exploded view of the valve body. Because many of the parts look alike, it is easy to mix them up. This is especially true of the springs. Unless you keep the springs separated and marked for identification, you will have to measure each spring with a micrometer prior to reassembly in order to find its correct place. See 13. **Automatic Transmission Technical Data** for spring dimensions. To avoid this trouble, use a compartmental storage tray. Such a tray will also keep the springs from getting bent or stretched, which would upset their precisely calibrated tensions.



- |   |  |  |  |
|---|--|--|--|
| 1. Screw M 5 x 28 (2)                       | 10. Screw M 5 x 15 (11)                  | 19. Spring, converter pressure valve             | 28. Secondary throttle pressure valve                |
| 2. End plate, front                         | 11. Spring washer B 5 (12)               | 20. Solenoid                                     | 29. Spring, kickdown valve                           |
| 3. Adjusting screw with spring seat         | 12. Cover plate                          | 21. Manual valve                                 | 30. 1st gear plug, secondary throttle pressure valve |
| 4. Spring, throttle pressure limiting valve | 13. Governor plug 1st/2nd gear           | 22. Solenoid plunger                             | 31. Modulator valve                                  |
| 5. Spring, shift valve 2nd/3rd gear         | 14. Governor plug 2nd/3rd gear           | 23. Converter pressure valve                     | 32. Main regulating valve                            |
| 6. Spring, shift valve 1st/2nd gear         | 15. Control valve 3rd/2nd gear           | 24. Valve body                                   | 33. Spring, main regulating valve                    |
| 7. Shift valve 2nd/3rd gear                 | 16. Spring, control valve 3rd/2nd gear   | 25. Spring, secondary throttle pressure valve    | 34. Adjusting screw with spring seat                 |
| 8. Shift valve 1st/2nd gear                 | 17. Spring, modulator valve              | 26. Adjusting screw, secondary throttle pressure | 35. End plate, rear                                  |
| 9. Throttle pressure limiting valve         | 18. Spring cup, converter pressure valve | 27. Kickdown valve                               |  |

If a storage tray for the valve body components (Fig. 5-5) is not available, you can make one by drilling holes in a thick board and numbering them.

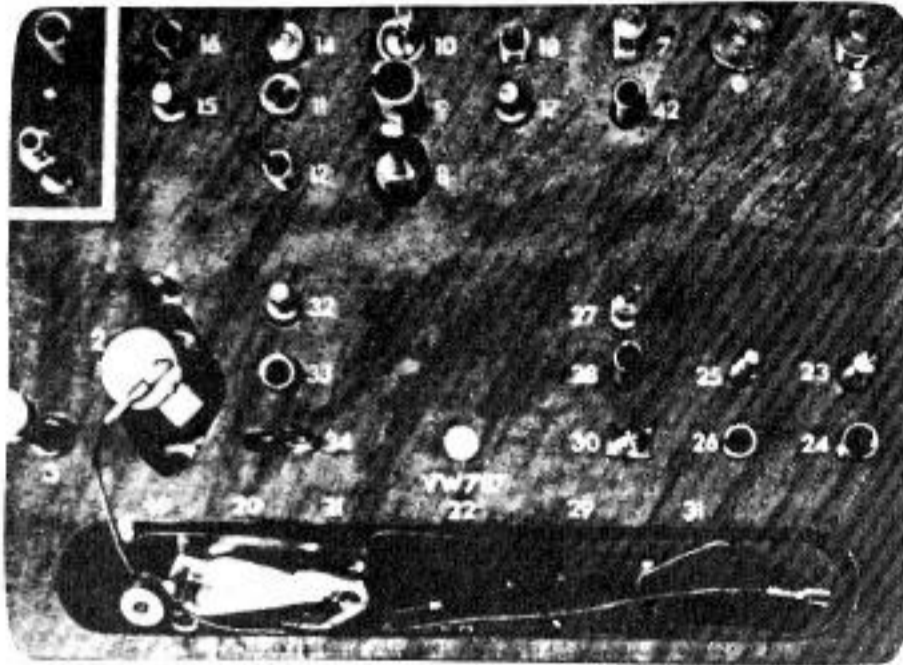
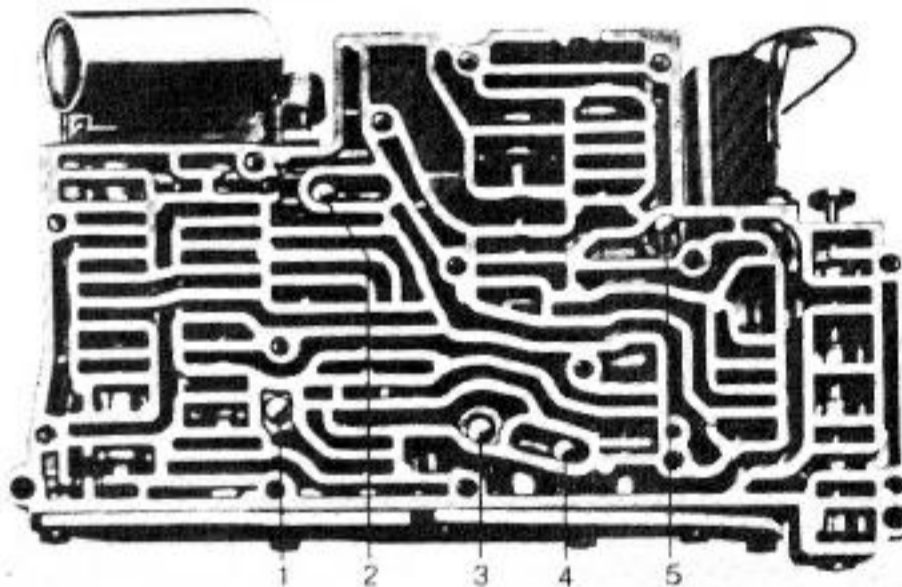


Fig. 5-5. Storage tray for valve body parts. Number holes to conform with part numbers in Fig. 5-4.

**To disassemble:**

1. Remove the valve body assembly from the transmission.
2. Place the assembly on a clean workbench and lift the transfer and separator plates off the valve body.
3. Remove the five ball valves and the two springs from the fluid channel side of the valve body. Place them in the storage tray. Fig. 5-6 shows their locations.



- |                                    |                                     |
|------------------------------------|-------------------------------------|
| 1. 2nd/3rd gear valve              | 4. 1st and reverse brake band valve |
| 2. Direct and reverse clutch valve | 5. Pressure relief valve            |
| 3. 1st gear valve                  |                                     |

Fig. 5-6. Ball valve locations. The 6-mm balls control ATF flow to and from the valve body through holes in the separator plate.

4. Remove the rear end plate.

**CAUTION** —

Do not, under any circumstances, alter the setting of the main pressure regulating valve adjusting screw that is under the end plate. This can be adjusted properly only at the factory. The adjusting screws for the pressure limiting and secondary throttle pressure valves must also be left alone for the same reason.

5. Take out the kickdown valve and its spring.
6. Take out the 1st gear plug for the secondary throttle pressure valve, the secondary throttle pressure valve and its spring, and the main pressure valve and its spring.
7. Remove the governor pressure (modulator) valve and spring, the 3rd/2nd gear control valve and spring, the 1st/2nd gear governor plug, and the 2nd/3rd gear governor plug.

**NOTE** —

Use a brass rod to press out sticking or tight-fitting valves. Work carefully.

8. Remove the cover plate. Carefully remove the front end plate. Take off the solenoid and plunger.
9. Take out the manual valve, the throttle pressure limiting valve with its spring, and the 2nd/3rd gear shift valve with its spring.
10. Take off the spring cup for the converter pressure valve and remove the valve with its spring.

After disassembling the valve body, wash all parts in cleaning solvent and dry them with compressed air.

**CAUTION** —

Never use water to clean the valves and valve body or dry the parts with fluffy rags or by rubbing them against your clothing. Even a microscopic piece of lint or a small patch of rust can cause a valve to stick in its bore.

Reassembly is basically the reverse of disassembly. Carefully clean the bench on which you are going to reassemble the valve body before starting to work. Lubricate all parts with ATF as you reinstall them and make certain that all valves move freely in the bores of their own weight. Used valves that have worn to fit individual bores must be returned to their original locations. When installing the end plates, be careful not to overtighten the screws. The threads in the light alloy valve body can strip easily. After putting the valve body assembly back into the transmission, make sure that the manual valve contacts the solenoid lug.

## 6. REMOVING AND INSTALLING SERVO PISTONS AND ACCUMULATOR

The servo pistons and accumulator can be removed and installed with the transmission in the car. Fig. 6-1 shows the relative positions of the parts in the transmission case.

### To remove:

1. Remove the transmission pan and the valve body assembly. Take out the 1st gear band piston and remove its seal ring.
2. Take the 9-mm and 6-mm E-clips off the piston rod and disassemble the piston and springs. Check the parts for wear.
3. Remove the sealing cover circlip. Take out the sealing cover for the 2nd gear band piston. Take out the piston and remove its two seals.
4. Replace the O-ring on the sealing cover.
5. Take out the accumulator spring and the accumulator piston. Remove the piston seal.

### To install:

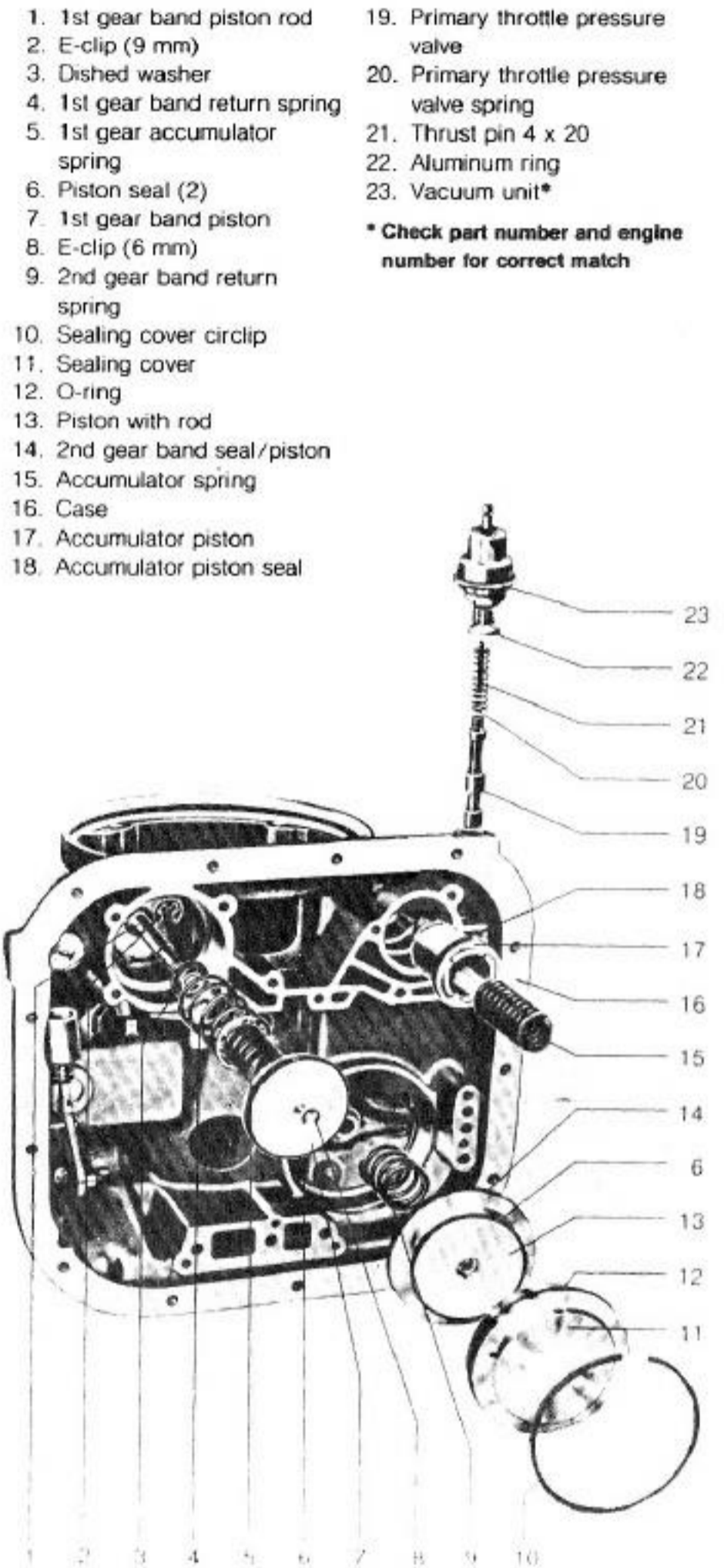
1. Dip new seals in ATF and install them on their respective pistons.

#### NOTE —

When installing the seals on the pistons, be sure to position them with the seal lips toward the pressure side of the pistons. The lip of the large seal on the 2nd gear brake band servo piston will point upward, the lip of the small seal downward. The lip of the accumulator piston seal points upward and the 1st and reverse servo piston seal points downward.

2. Lubricate the 2nd gear band servo piston with ATF and insert it into the sealing cover using a twisting motion.
3. Insert the cover with the piston and band return spring into the transmission case. Install the circlip.
4. Assemble the piston, spring, and piston rod for the 1st and reverse brake band servo using the two E-clips.
5. Install the accumulator piston and spring and the 1st and reverse band servo piston with its springs. Lubricate them with ATF and insert them into the transmission case using a twisting motion.
6. Install the valve body assembly in the transmission case and replace the transmission pan using a new gasket.

Fig. 6-1. Exploded view of servo assemblies.



\* Check part number and engine number for correct match

## 7. SERVICING GOVERNOR

The governor for the hydraulic control system is located beneath a round, black pressed sheet metal cover just ahead of and slightly above the left drive-shaft on the transmission. The cover is held in place by a spring wire clip.

### 7.1 Removing and Installing Governor

The governor can be removed with the engine and transmission installed in the car. It is usually removed for cleaning or for replacing worn parts. Since each governor is matched to a particular valve body at the factory, it is not recommended that a different governor be installed in the car.

#### To remove:

1. Release the clip and take off the cover. Pull the governor out of the transmission case.
2. Inspect the thrust plate and the drive end of the shaft for wear and scoring.

#### NOTE —

Because the governor should not be replaced without also installing a matched valve body, new shafts are available separately to replace those that are worn or damaged.

#### To install:

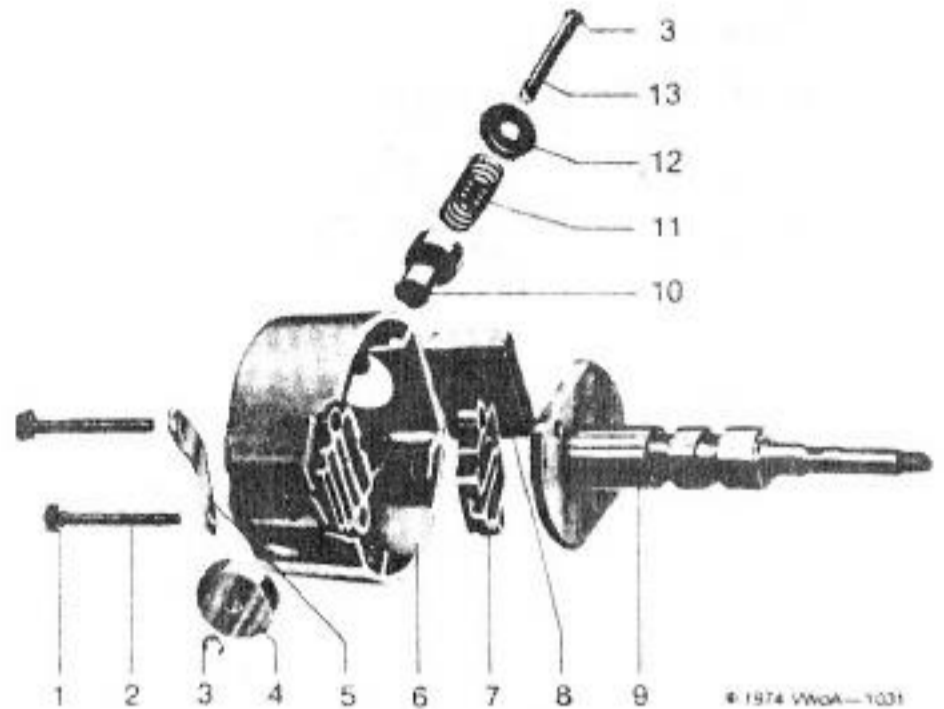
1. Make certain the governor and the valve body are a matched pair.
2. Insert the governor into the transmission case, making sure that the square drive at the end of the shaft engages the drive gear.
3. Check the O-ring for the cover. Replace it if broken or deformed.
4. Install the cover and secure it with the clip.

### 7.2 Disassembling and Assembling Governor

Unless transmission trouble has burned the clutch friction linings and contaminated the ATF, or the governor parts are worn, there is no reason to take the governor apart. It can usually be cleaned just by dipping it in solvent and drying it with compressed air.

#### To disassemble:

1. Remove the governor from the transmission.
2. Remove the two M 5 x 40 screws and take off the thrust plate and housing (see Fig. 7-1).



- |                           |                   |
|---------------------------|-------------------|
| 1. Spring washer B 5 (2)  | 8. Balance weight |
| 2. Screw M 5 x 40 (2)     | 9. Governor shaft |
| 3. E-clip 3.2 mm dia. (2) | 10. Valve         |
| 4. Centrifugal weight     | 11. Spring        |
| 5. Thrust plate           | 12. Dished washer |
| 6. Housing                | 13. Pin           |
| 7. Transfer plate         |                   |

**Fig. 7-1.** Centrifugal governor disassembled. Shaft and thrust plate are usual wear points.

3. Take out the transfer plate and the balance weight.

#### NOTE —

The balance weight has been matched to the governor. Do not exchange the balance weight with one from another governor.

4. Take off the E-clip and remove the valve, spring, centrifugal weight, and dished washer.

#### To assemble:

1. Wash all the parts in cleaning solvent and dry them with compressed air.
2. Lubricate the parts with ATF as you install them.
3. Install the valve, spring and dished washer in the housing. Install the E-clip.
4. Install the balance weight and the transfer plate.

#### NOTE —

When the transfer plate is installed correctly, the drillings open toward the governor shaft and taper toward the centrifugal weight.

5. Assemble the housing and shaft. Attach the thrust plate so that the angle of the plate is toward the center of the housing, where the cover will bear against it.

## 8. TORQUE CONVERTER

Up to this point we have covered service operations that can be carried out with the engine and transmission in the car—although they may also be done with the transmission removed. Servicing the torque converter, however, demands that the engine be removed from the car.

### 8.1 Removing and Installing Torque Converter

The torque converter is usually removed to replace the oil seal or bushing or to clean the converter after a transmission failure has contaminated the ATF. Since the converter is a welded assembly, replace it if it is leaky or noisy, if it has a defective starter ring gear, or if a stall speed test shows the unit to be outside specifications.

#### To remove:

1. Take the engine out of the car, as described in **ENGINE**.
2. Remove the securing bracket installed temporarily during engine removal.
3. Grasp the converter with both hands. Remove it by pulling it with a twisting motion off its support tube on the final drive carrier.

#### CAUTION —

*Do not rock or tilt the converter when removing or installing it. This could damage the oil seal, the one-way stator clutch, or other parts in the hub.*

Installation is basically the reverse of removal. Before you install it, inspect the converter thoroughly as described in **8.2 Inspecting Converter**. If the oil seal seat on the hub is rough, worn, or pitted, you should replace the torque converter. Otherwise the seal will wear out in a very short time. Slowly turn the converter clockwise and counterclockwise as you install it so that the turbine and pump shaft splines can engage.

### 8.2 Inspecting Converter

Inspect the converter seal inside the support tube on the final drive carrier. Replace the seal if necessary. Check the converter hub for signs of scoring from the oil seal. If the scoring is deep, replace the converter. Check for broken welds on the starter ring gear and air deflector plate. Remove any burrs from the ring gear. Insert the turbine shaft and turn the turbine to see that it spins freely. Check the condition of the torque converter bush-

ing. It must be within the specifications given in **8.4 Replacing Converter Bushing**.

### 8.3 Replacing Converter Seal

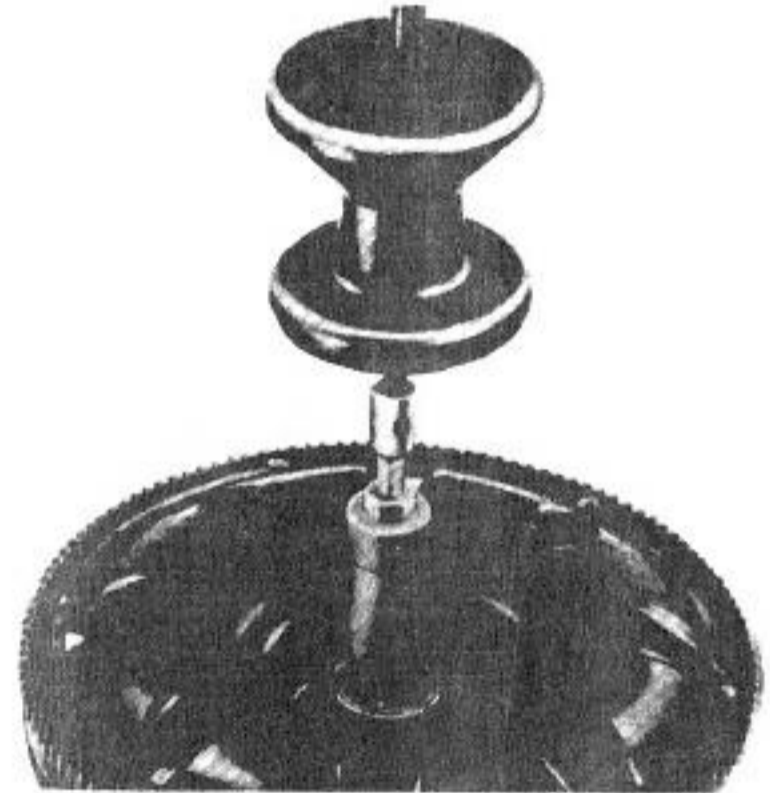
The converter seal is located inside the support tube on the final drive carrier. The old seal can be pried out and a new one installed with an appropriate seal-installing tool. Early transmissions had black seals. Since July, 1971, a creamy-white silicone rubber seal has been used. It is less sensitive to temperature change and is the standard replacement part. These seals, however, are soft and easily damaged. If exposed to gasoline or cleaning solvents they must be replaced.

### 8.4 Replacing Converter Bushing

A worn bushing in the converter hub is usually the cause of leaking or damaged oil seals. Check the bushing every time you replace a seal. The bushing inside diameter must not exceed 34.25 mm (1.348 in.). Maximum out-of-round is 0.03 mm (0.001 in.).

#### To replace:

1. Use an extractor and a slide hammer to remove old bushing, as shown in Fig. 8-1.



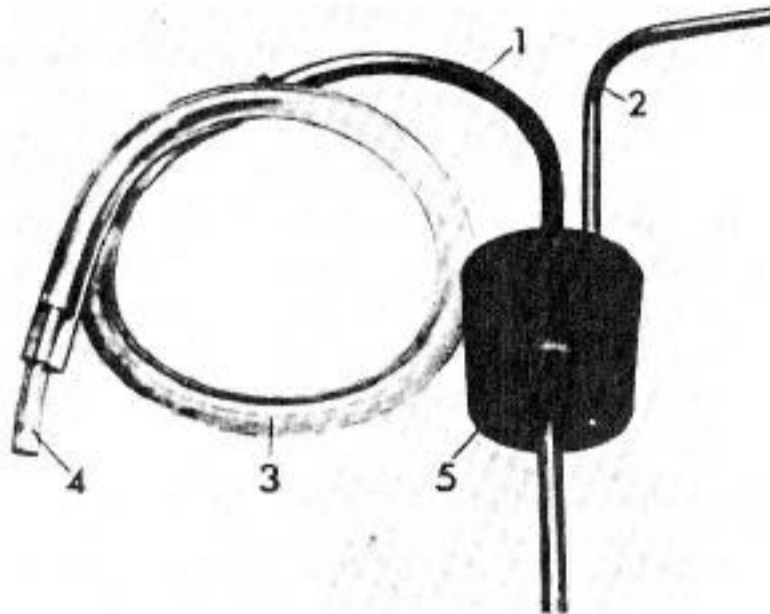
**Fig. 8-1.** Extracting converter bushing. Use clean tools to keep dirt out of converter.

2. Drive the new bushing in with a properly fitting bushing driver. The special VW driver is made to just come free easily after the bushing is pressed in. The fitted inside diameter must be between 34.03 and 34.10 mm (1.340 and 1.343 in.).



## 8.5 Cleaning Torque Converter

If particles from a burned clutch disk or other debris has polluted the ATF, use a home-made siphon (Fig. 8-2) to remove as much ATF as possible from the converter.



1. Steel or copper tube 3 mm x 200 mm (1/8 in. x 8 in.)
2. Steel or copper tube 3 mm x 150 mm (1/8 in. x 6 in.)
3. PVC hose 3 mm x 150 mm (1/8 in. x 6 in.)
4. PVC hose 3 mm x 30 mm (1/8 in. x 1 1/4 in.)
5. Rubber conical plug 35 mm (1 3/8 in.) diameter

Fig. 8-2. Siphon parts obtainable from auto stores.

### To drain:

1. Install the siphon, as shown in Fig. 8-3.

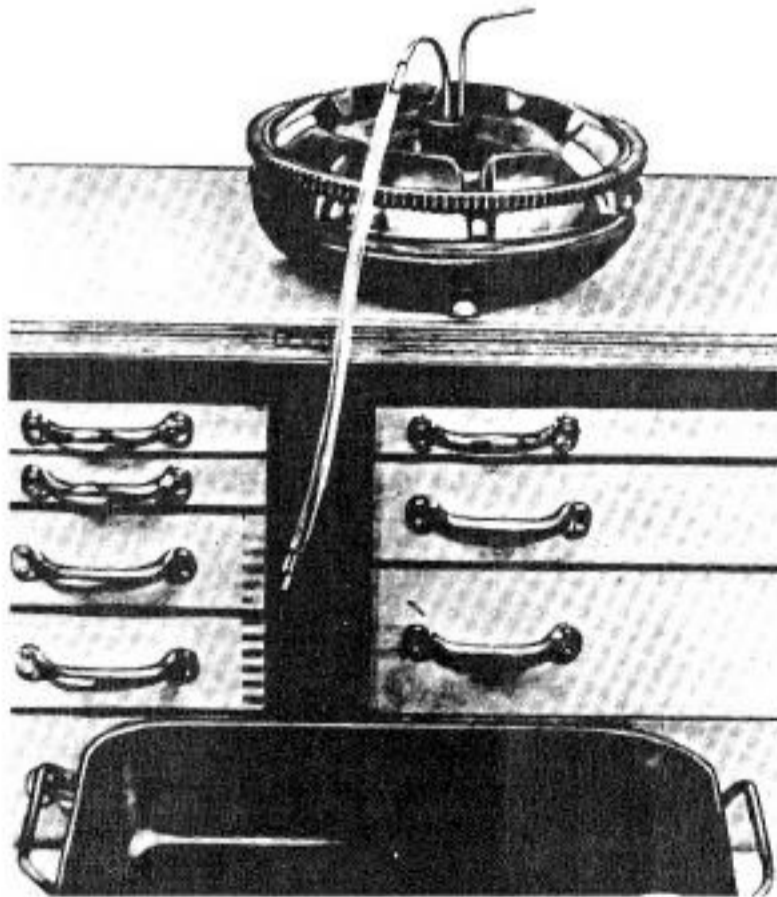


Fig. 8-3. Siphon and oil receptacle in position.

2. Push the siphon line pipe through the rubber plug until it contacts the converter bottom.
3. Place the siphon hose over the oil receptacle and blow into the short tube to start the siphon.
4. Let the converter drain overnight or about eight hours.

### NOTE —

A small diameter siphon pipe is necessary because the ATF drains off the converter vanes slowly. A larger pipe would draw off the accumulation too quickly and stop the siphon. After draining, clean the converter further with special pressure equipment.

## 9. REMOVING AND INSTALLING AUTOMATIC TRANSMISSION

The automatic transmission and the engine can be removed from the car individually or as a unit. The procedure for removing the automatic transmission is virtually the same as for removing the manual transmission with double-jointed rear axle. Follow the instructions given in **TRANSMISSION AND REAR AXLE**, with the additional steps shown in Fig. 9-1.

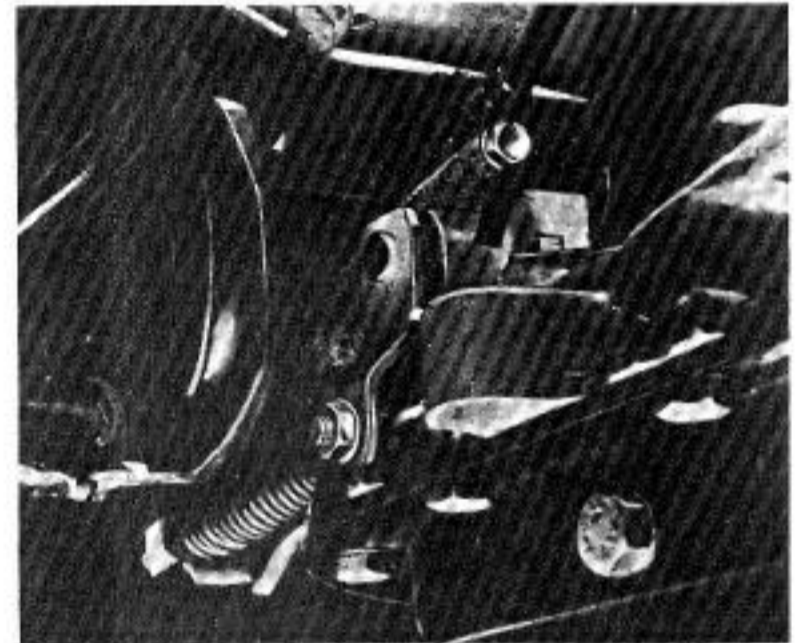


Fig. 9-1. Transmission removal. Loosen the selector cable clamp nut (center arrow), push the boot away, screw apart the cable sleeve (left arrow), and remove the sleeve. Remove the ground strap (upper arrow).

It is also necessary to take out the four bolts holding the front transmission mount and disconnect the kick-down solenoid wire. The 1972 cars sold in California have another wire to disconnect. Adjust the selector lever cable, as described in 12. **Selector Lever and Bowden Cable**, after the transmission is back in car.

## 10. REPAIRING AUTOMATIC TRANSMISSION

Thoroughly clean the outside of the transmission before disassembly so dirt will not enter the hydraulic controls or mechanical parts. Study the repair procedures on the following pages. If they require equipment you do not have, the transmission should be turned over to a specialist before any disassembly.

### CAUTION —

*If you lack the skills, tools, or a suitable workshop for transmission work, we suggest you leave such repairs to an Authorized VW Dealer or other qualified shop. We especially urge you to consult an Authorized VW Dealer before attempting repairs on a car still covered by the new-car warranty.*

### 10.1 Separating Transmission Case from Final Drive Housing

A suitable transmission stand is a great help when taking the automatic transmission apart. Do not disassemble the unit on the shop floor where dirt and debris may enter the working parts.

#### To disassemble:

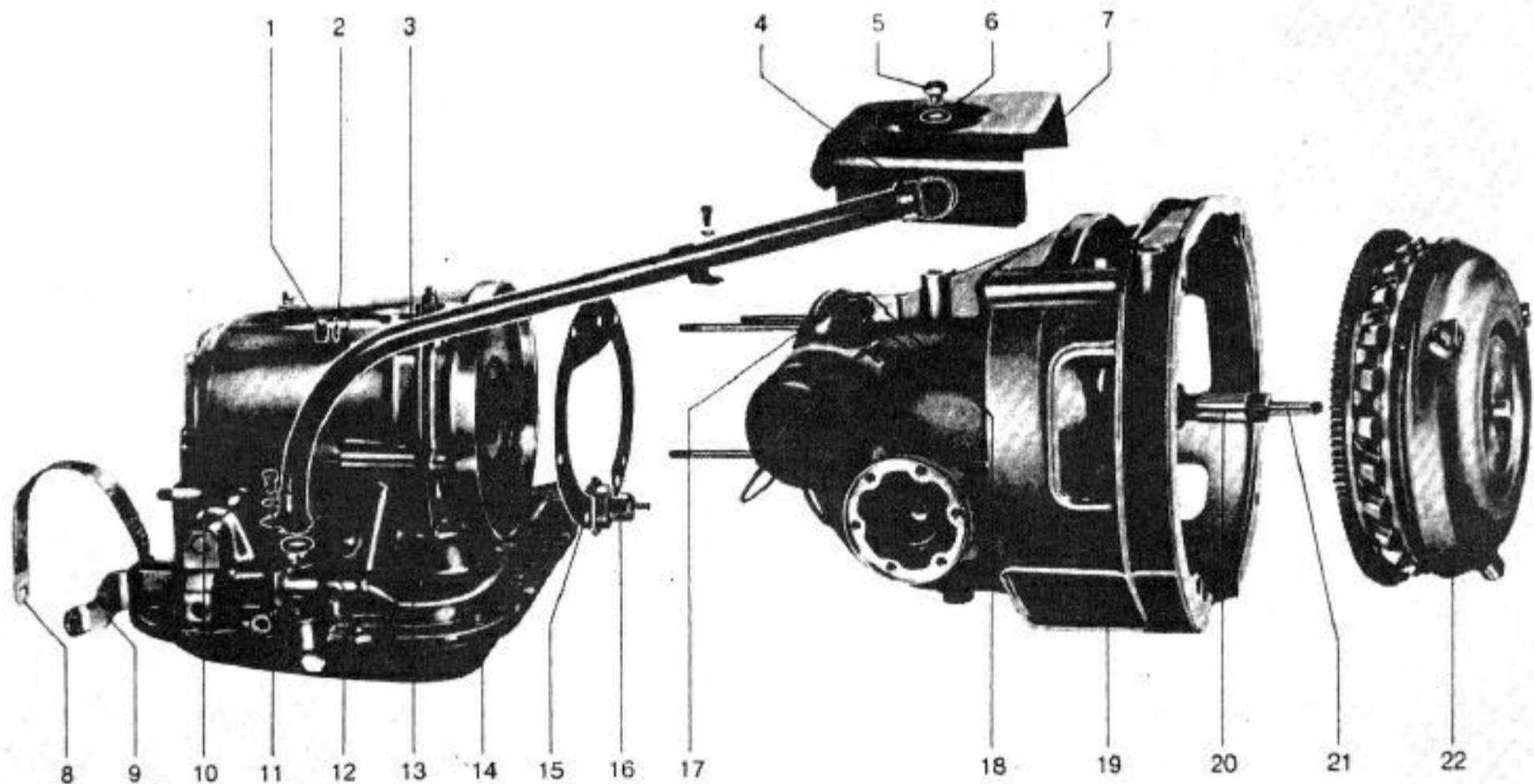
1. After cleaning the outside of the transmission and draining the ATF, remove the converter and withdraw the pump shaft.

#### NOTE —

The hypoid oil need not be drained unless you intend to disassemble the final drive.

2. Remove the four M 8 nuts from the steel studs holding the final drive housing to the transmission case. Separate the main parts as shown in Fig. 10-1.

Fig. 10-1. Main parts of the transmission separated.



1. Nut M 8 (4)
2. Spring washer B 8 (4)
3. Oil filler tube
4. Oil dipstick
5. Capscrew
6. Spring washer
7. Air deflector plate
8. Ground strap

9. Bracket
10. Bolt M 6 (2)
11. Spring washer B 6 (2)
12. O-ring
13. Connecting piece with O-ring
14. Transmission assembly (complete)

15. Gasket
16. Vacuum unit
17. O-ring
18. Cover for breather pipe (2)
19. Final drive (complete)
20. Turbine shaft
21. Pump shaft
22. Torque converter

- Cover the converter hub opening and the final drive housing to prevent dirt from entering. Take the transmission itself to the workbench.

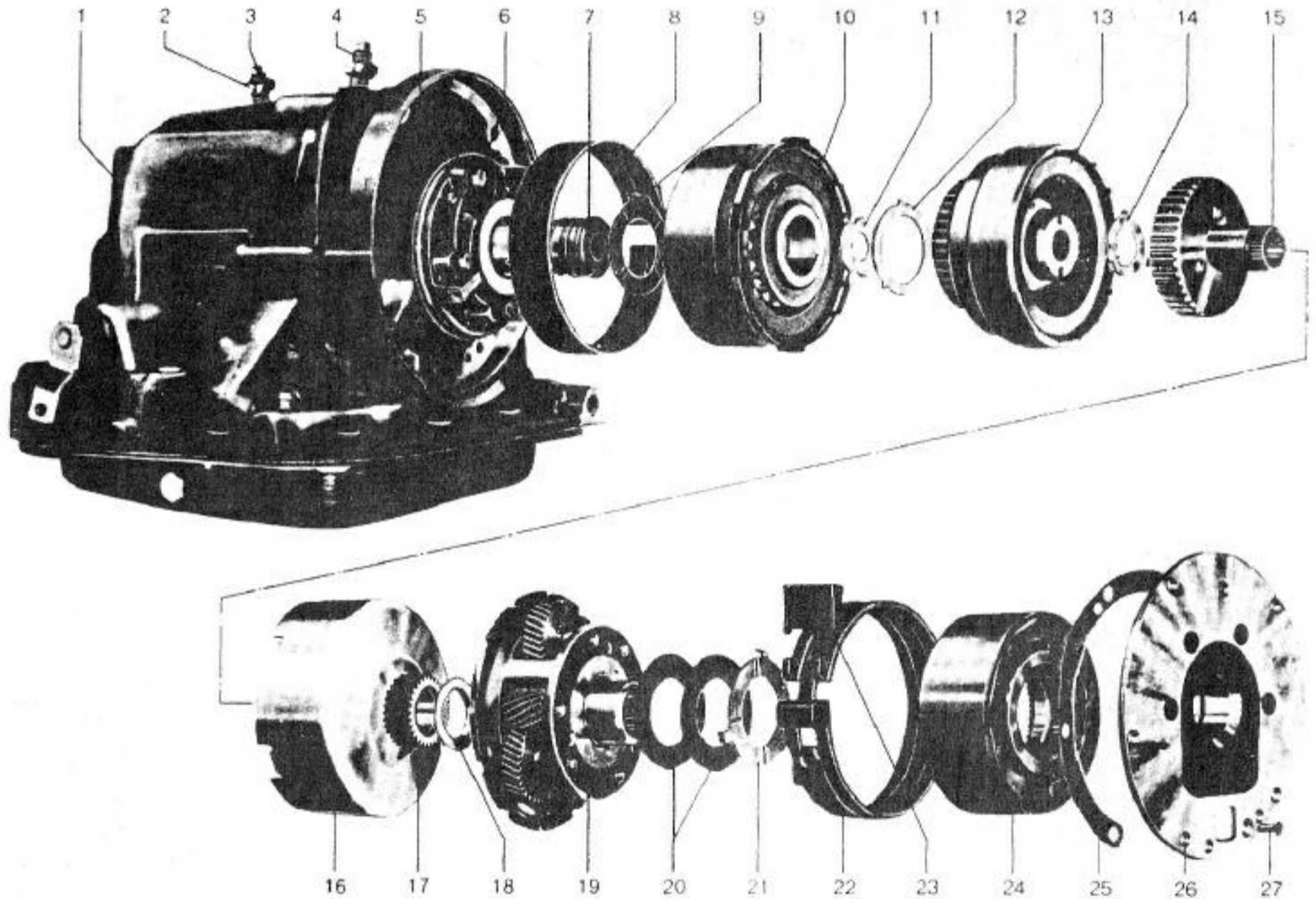
**NOTE —**

A special stand is used in Authorized VW Dealers' shops to hold the transmission while the transmission case and final drive housing are separated and to hold the transmission for subsequent repair.

## 10.2 Disassembling and Assembling Automatic Transmission

Study Fig. 10-2 carefully so that you become familiar with the correct names for the various parts. These names will be referred to frequently on the following pages. The illustration also shows the order in which you will remove the planetary gearset and related parts from the transmission case. Keep them in order for future assembly.

**Fig. 10-2.** Disassembled planetary gear system. The bearing flange bolts to the transmission case.



- Transmission case
- Nut for adjusting screw
- Adjusting screw for 2nd gear band
- Adjusting screw for 1st gear band
- Spring washer B 6 (5)
- Bolt M 6 x 35
- ATF pump
- 2nd gear band

- Thrust washer 1
- Direct and reverse clutch
- Thrust washer 2
- Thrust washer 3
- Forward clutch
- Thrust washer 4
- Clutch hub
- Driving shell
- Sun gear, small
- Thrust washer 5

- Planetary gear set
- Shim(s)
- Thrust washer 6
- 1st gear band
- Support fork
- Annulus gear with one-way clutch
- Gasket for bearing flange
- Bearing flange
- Screw M 6 x 15 (2)

## To disassemble:

1. Hold the transmission in a stand, as shown in Fig. 10-3, or secure it to the workbench.

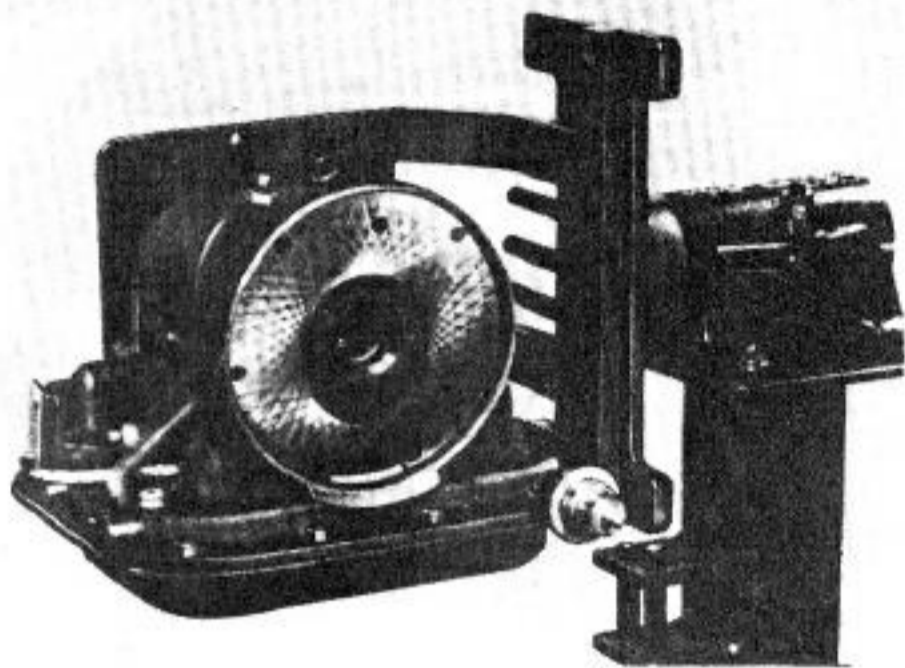


Fig. 10-3. Bearing flange for planetary gearset. Transmission case is held on a repair stand.

2. Remove the countersunk bearing flange screw(s). Later transmissions have only one screw.
3. Using a slide hammer and puller hook, as shown in Fig. 10-4, pull out the bearing flange.

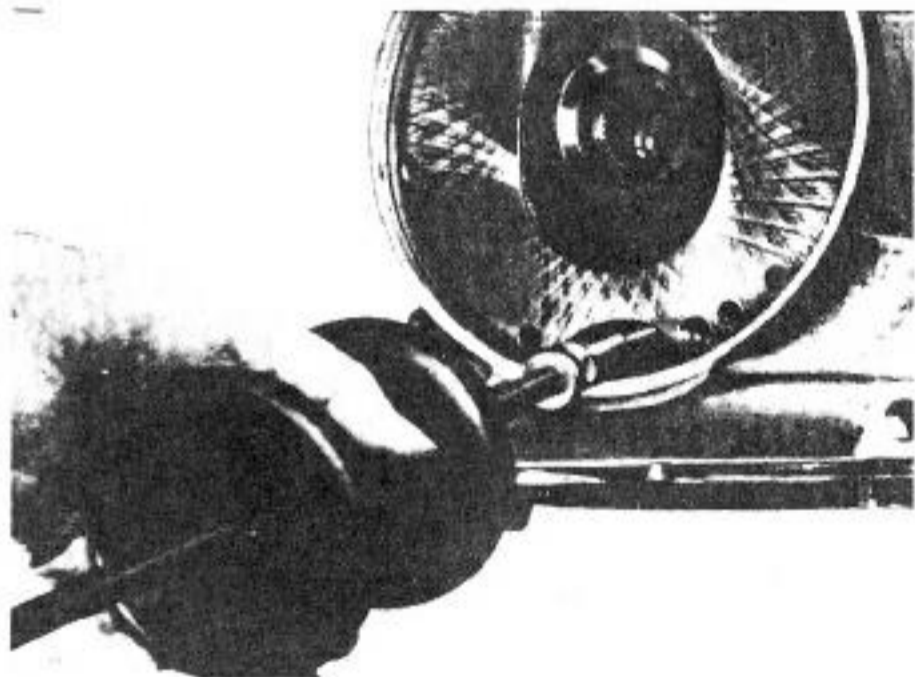


Fig. 10-4. Using slide hammer to pull bearing flange.

4. Loosen brake band adjusting screw. Lift out the 1st gear band, the annulus gear with one-way clutch, and the planetary gearset.

## NOTE —

Record the number and thickness of shims you find in the gearset.

5. Remove the driving shell, the small sun gear, the clutch hub, and the forward clutch.
6. Take out the direct and reverse clutch and the 2nd gear brake band. Remove the pump bolts and lift out the ATF pump. (If you are also removing the transmission pan, keep these bolts separate from the bolts you will find in the valve body.)

## To assemble:

1. Insert the pump in the case so that the single lug and the part number face upward (see Fig. 10-5). Insert the five pump bolts together with the spring washers and screw them in by hand to uniform tightness. Finally, tighten the bolts to 0.4 mkg (3.0 ft. lb.).

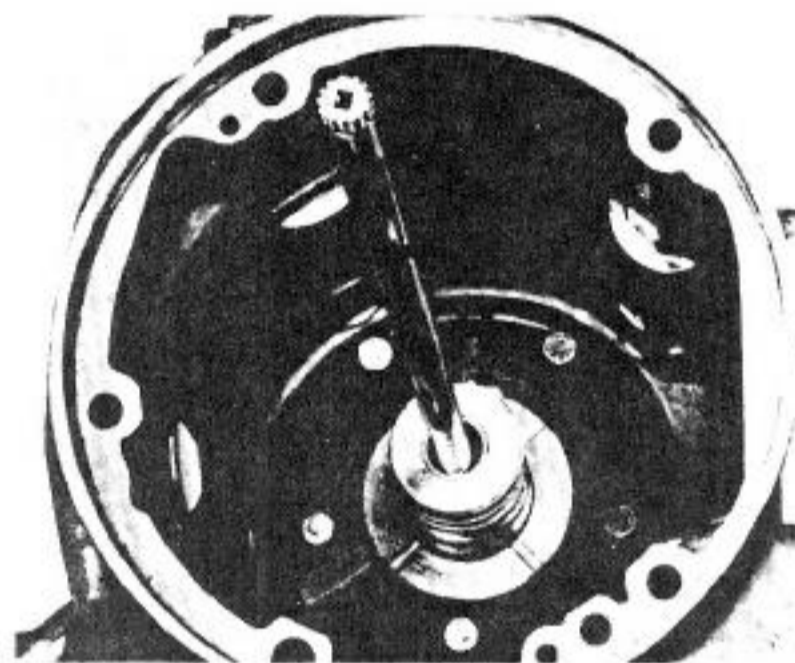
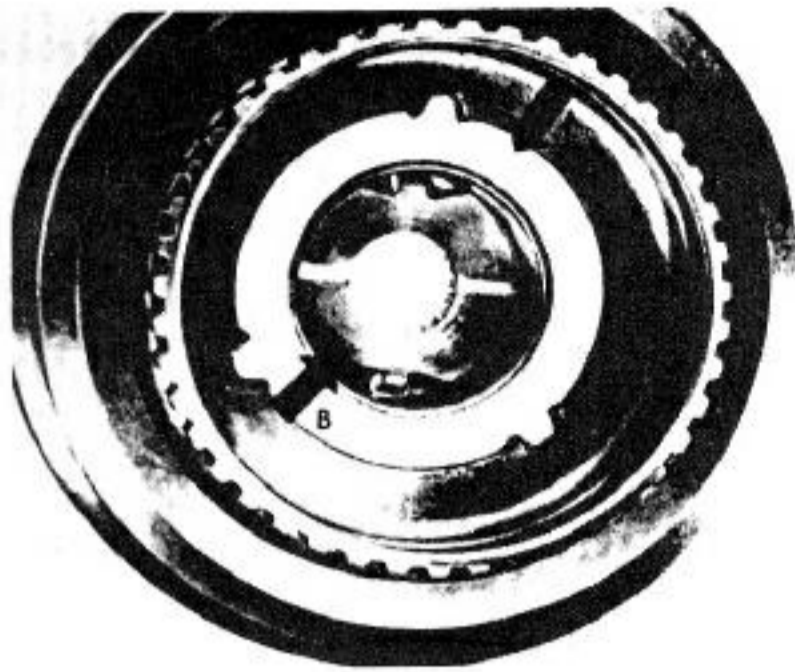


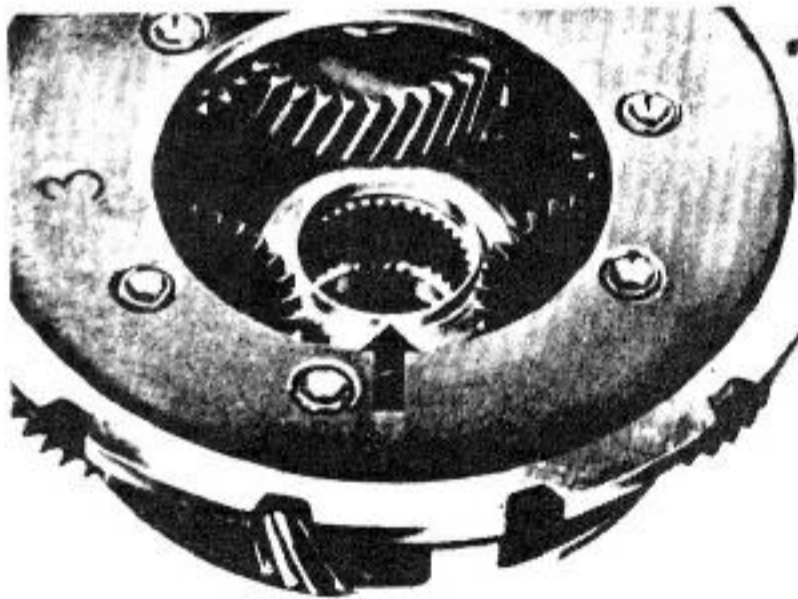
Fig. 10-5. ATF pump installed. Lower arrow indicates the lug that must face upward. Test the installation by turning the pump as shown by curved arrow.

2. Turn the pump with the pump shaft. It should turn smoothly and easily.
3. Slide thrust washer 1 for the direct and reverse clutch over the pump housing and engage the washer on the lug.
4. Install the 2nd gear brake band and turn the adjusting screw until it enters the recess in the band.
5. Install the direct and reverse clutch and press it down in the case until the clutch bears on the thrust washer.
6. Put grease on thrust washers 2 and 3 and stick them to the inside of the forward clutch (see Fig. 10-6). Install the forward clutch in the case.



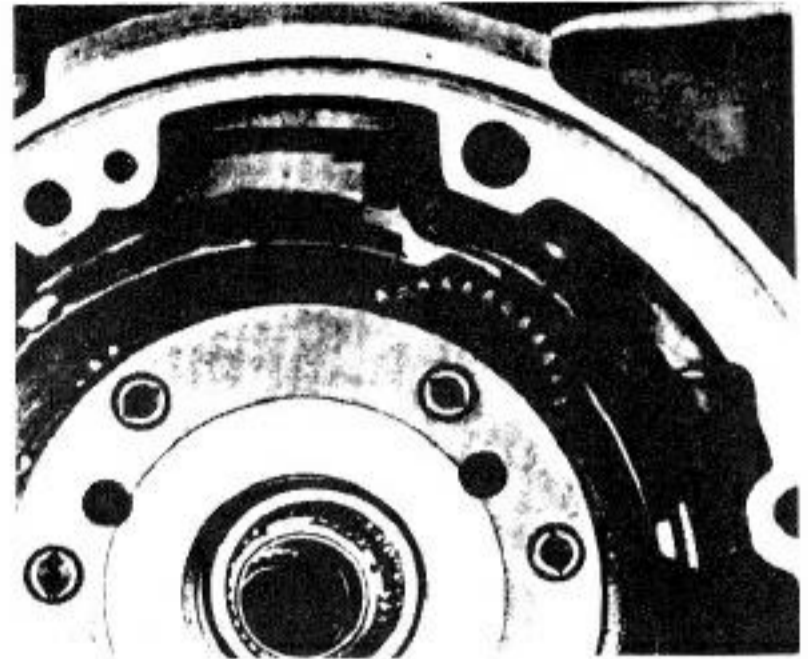
**Fig. 10-6.** Thrust washer 3 (arrow **A**) and thrust washer 2 (arrow **B**) in forward clutch.

7. Use a screwdriver to align the internal splines of the forward clutch plates to receive the hub.
8. Stick thrust washer 4 on the forward clutch hub with grease. Insert the hub into the clutch splines.
9. Install the drive shell and the small sun gear. Engage the skirt notches with the lugs on the direct and reverse clutch drum.
10. Insert thrust washer 5 between the large planet pinions so that the projecting shoulder faces the small sun gear, as in Fig. 10-7.



**Fig. 10-7.** Thrust washer 5 for large sun gear. Shoulder (arrow) should face the small sun gear.

11. Install the planetary gearset. All the parts are correctly installed if the planet carrier and parking lock pawl are aligned axially, as shown in Fig. 10-8.



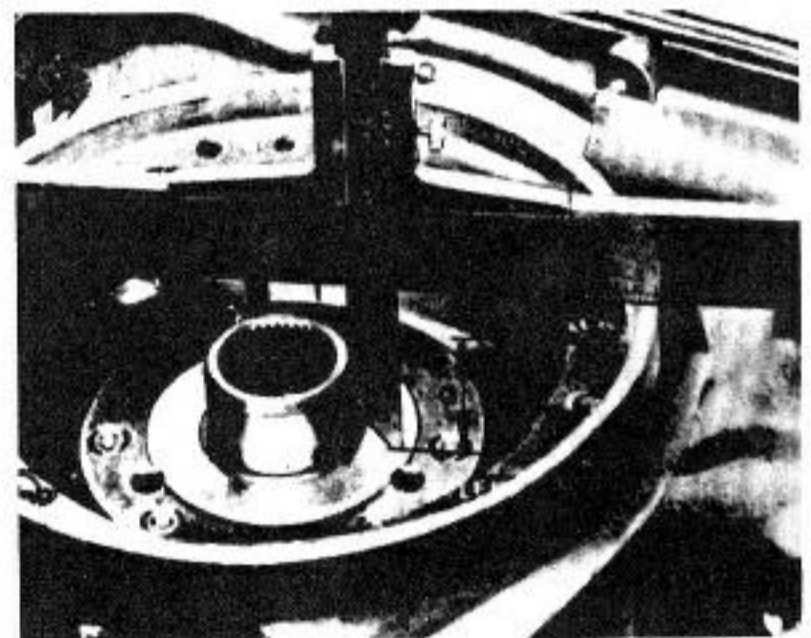
**Fig. 10-8.** Transmission parking lock. Arrow indicates the pawl, which snaps into carrier notches.

### 10.3 Adjusting Axial Play

Axial play of 0.45 to 1.05 mm (.018 to .041 in.) is specified for the planetary gears and clutches when installed in the transmission case. It may be necessary to install shims to bring the axial play within this range.

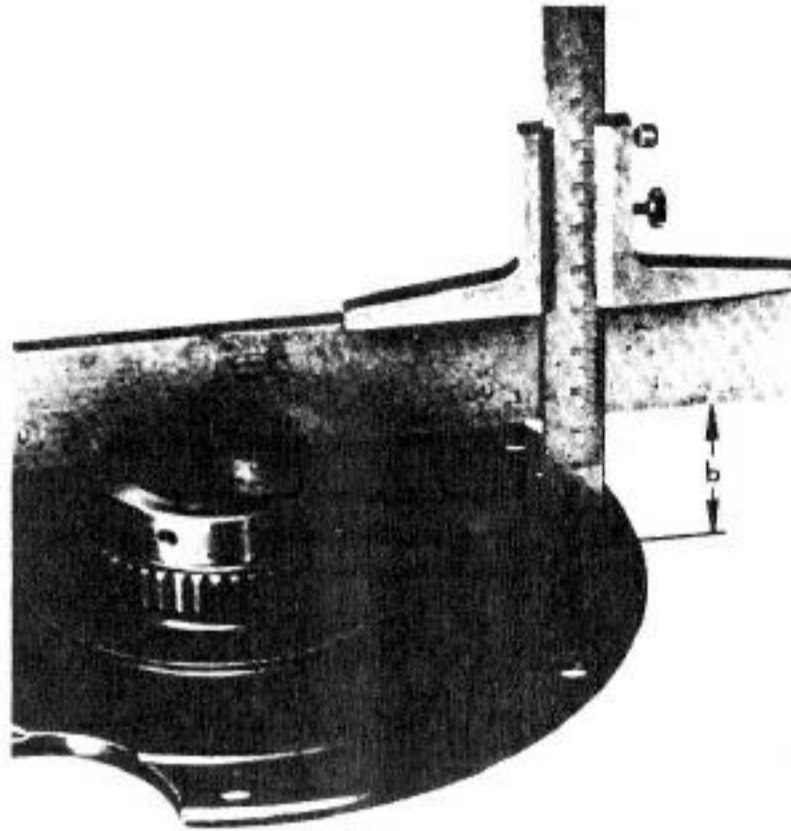
#### To adjust axial play:

1. Measure to find dimension **a** as shown in Fig. 10-9.



**Fig. 10-9.** Dimension **a**. For this measurement the gasket between the transmission case and the gear-set bearing flange must be in place on the sealing surface. Dimension **a** is the distance from this gasket to the planetary gear carrier. In this first step, use a depth gauge to measure the distance from case rim to planet carrier.

2. Measure the distance between the rim and the gasket on the sealing surface. Subtract this measurement from the previous one to obtain dimension **a**.
3. Measure dimension **b** on the bearing flange, as shown in Fig. 10-10.



**Fig. 10-10.** Dimension **b** on the transmission bearing flange. Note that the measurement is taken from the mating surface near the rim of the flange.

4. Subtract **b** from **a** to obtain the axial play, called dimension **x**.
5. From **Table b** select the shims that will adjust the transmission to the specified axial play.

**Table b. Axial Play**

Computed "x" Value	Number and Thickness of Shims
1.95-2.25 mm (.077-.089 in.)	Thrust washer only
2.25-2.65 mm (.089-.104 in.)	one 0.4 mm (.0157 in.)
2.65-3.05 mm (.104-.120 in.)	two 0.4 mm (.0157 in.)
3.05-3.45 mm (.120-.136 in.)	one 1.2 mm (.0472 in.)
3.45-3.85 mm (.136-.152 in.)	one 0.4 mm (.0157 in.) and one 1.2 mm (.0472 in.)

6. Place the gearset shims under thrust washer **6** and install the annulus gear with one-way clutch.

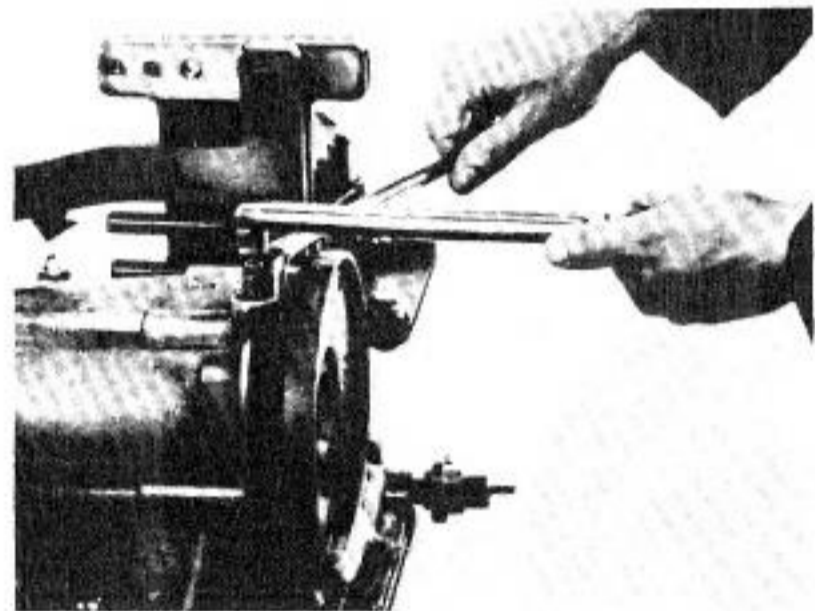
7. Slip the 1st gear brake band with support fork over the annulus gear. Turn the adjusting screw into the fork.
8. Install the bearing flange and gasket. Tighten the screws.

## 10.4 Adjusting Brake Bands

The transmission must be in a horizontal position for these adjustments. If the transmission is not horizontal, your adjustments will be inaccurate.

### To adjust:

1. Center the 2nd gear brake band by tightening the adjusting screw to a torque of 1.0 mkg (86.8 in. lb.).
2. Loosen the screw and retighten it to a torque of 0.5 mkg (43 in. lb.).
3. From this setting, back the screw out from 1 $\frac{3}{4}$  to 2 turns and secure the screw with the locknut.
4. After adjusting the 2nd gear brake band, use the same procedure for adjusting the 1st and reverse gear band, but back the screw out 3 $\frac{1}{4}$  to 3 $\frac{1}{2}$  turns instead. See Fig. 10-11.



**Fig. 10-11.** Torquing 1st and reverse brake band adjusting screw. Arrow indicates 2nd gear brake band screw.

## 10.5 Installing Final Drive on Automatic Transmission

For this procedure the transmission should be in a vertical position on a repair stand.

### CAUTION

When moving or carrying the transmission, do not use the filler tube as a handle. You could bend it or cause a leak.

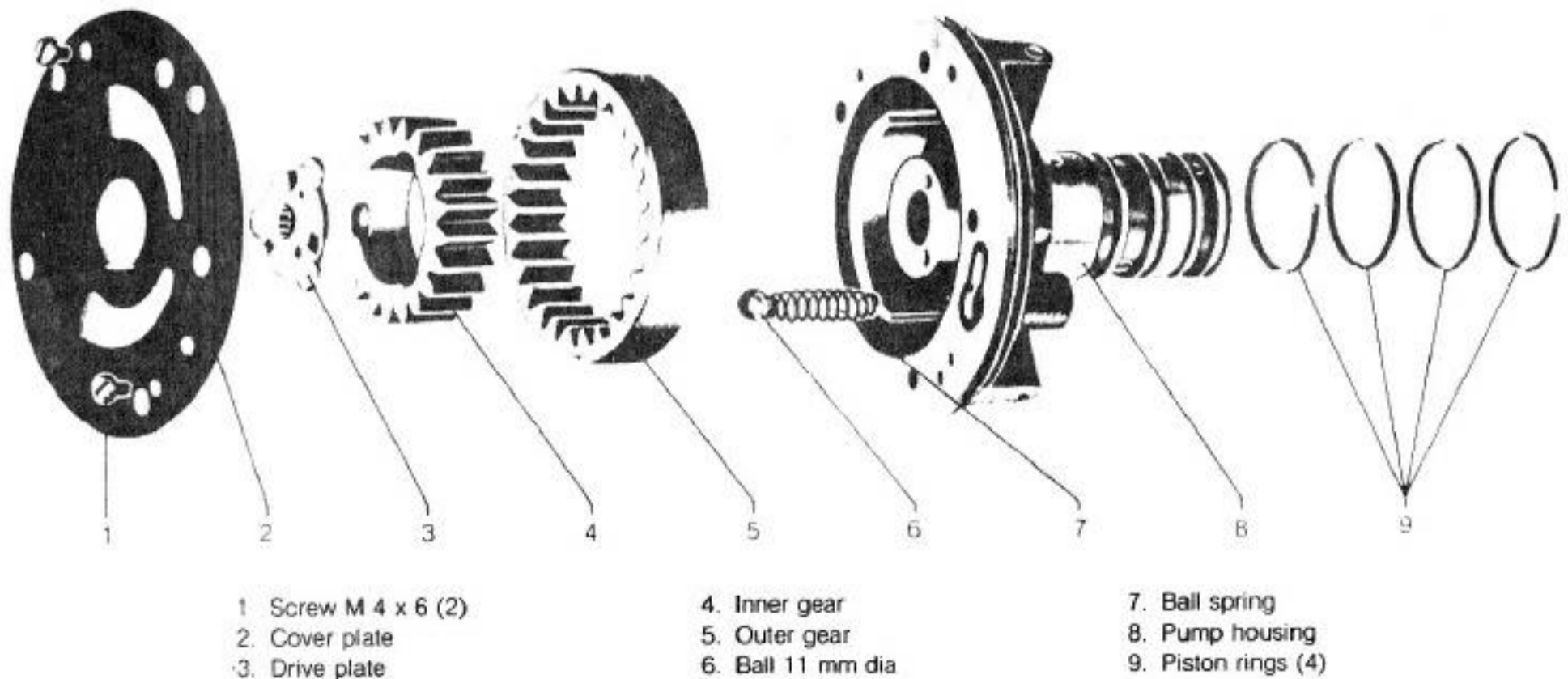
### To assemble:

1. Inspect the chamfer on the transmission case. Remove any burrs, dirt, or rust.
2. Dip the O-ring in ATF.
3. Place a new paper gasket on the transmission case sealing surface and carefully set the final drive housing on it. Be careful not to crush or otherwise damage the O-ring when you install the housing.
4. Tighten the four attaching nuts diagonally to 2.0 mkg (14.0 ft. lb.).
5. Insert the pump and the turbine shafts. (The splined end of the turbine shaft goes into the transmission.)
6. Set the converter in place over the end of the turbine shaft, turning the converter clockwise and counterclockwise until it engages the turbine shaft splines.

### 10.6 Disassembling and Assembling ATF Pump

A shaft extending forward from the torque converter through the hollow turbine shaft drives the transmission pump shown in the exploded view of Fig. 10-12. Any time you have occasion to remove the pump, inspect the housing, both gears, and the cover plate carefully for wear and damage.

Fig. 10-12. ATF pump



### To disassemble:

1. Remove the two slotted M 4 x 6 screws from the cover plate and take it off.
2. Remove the ball valve and ball spring, the inner gear, outer gear, and drive plate.
3. Use needle nose pliers to unhook the piston rings, as in Fig. 10-13, and remove the rings.

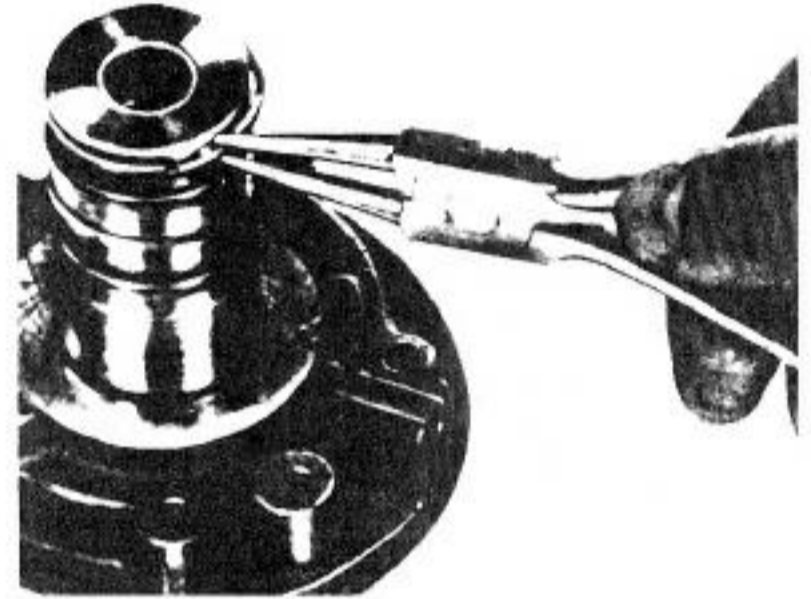


Fig. 10-13. Removing clutch piston rings from pump.

### To check pump:

1. Clean all parts thoroughly. Blow out the fluid passages with compressed air.
2. Inspect the drive plate and the piston rings. Replace if worn or damaged.
3. If the pump housing, gears, or cover plate are worn or damaged, replace the pump.

### To assemble:

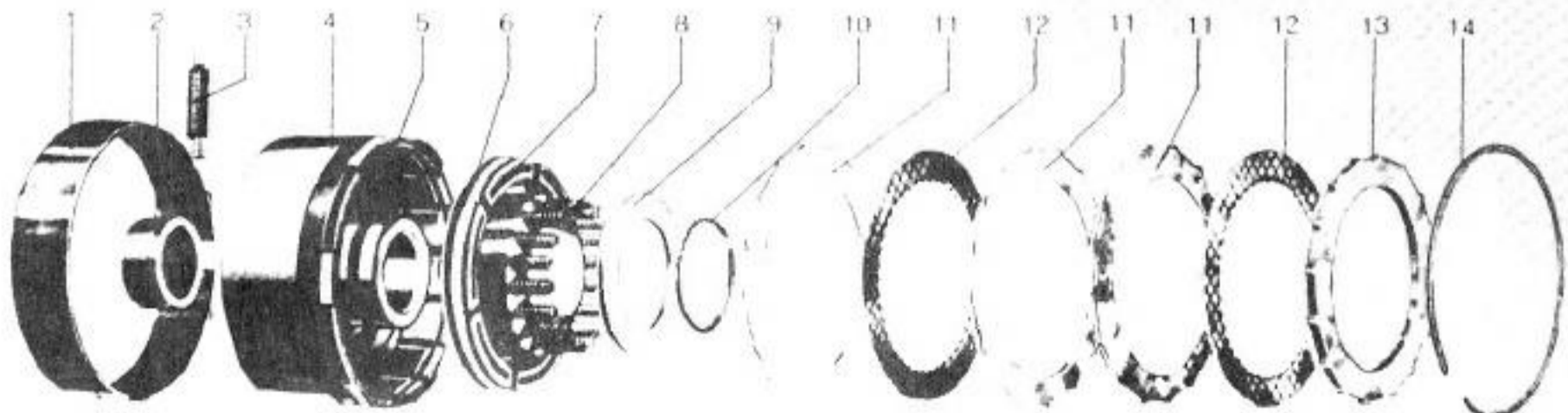
1. After lubricating all parts thoroughly with ATF, install the gears and the drive plate. Be sure that the drive plate is in the position shown in Fig. 10-12, with the long hub side toward the pump body.
2. Insert the spring for the ball valve and the ball.
3. Screw on the cover plate.
4. Insert the pump shaft and turn the drive plate by hand in a clockwise direction to check the installation. Improper assembly or excessive torque on the retaining bolts are the usual causes of binding.

## 10.7 Disassembling and Assembling Direct and Reverse Clutch

The direct and reverse clutch and the 2nd gear brake band that operates against the clutch drum are shown in an exploded view in Fig. 10-14. Become familiar with the part names. They are used frequently in the disassembly and repair procedures which follow this illustration.

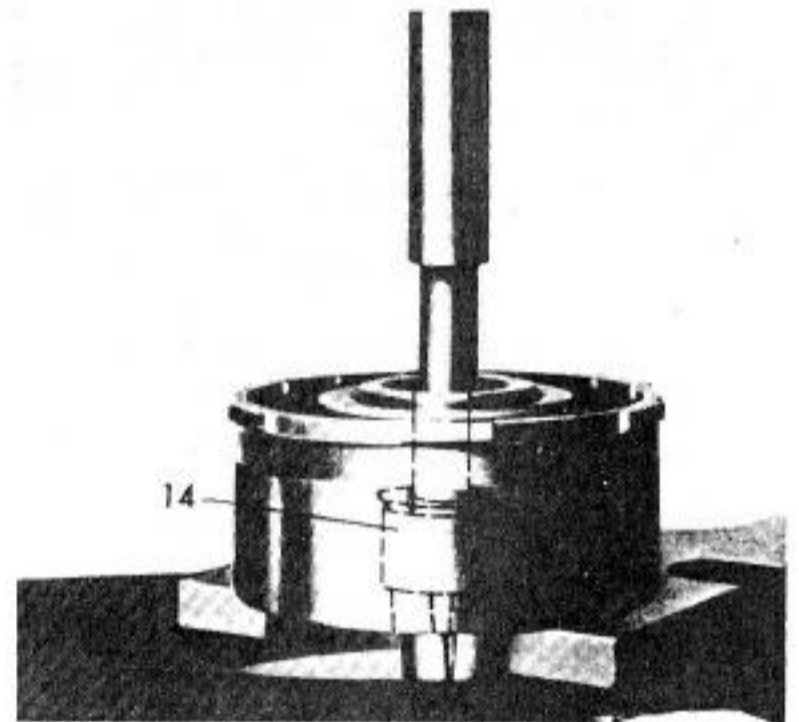
**Fig. 10-14.** Direct and reverse clutch. Note that two steel clutch plates are installed together in the middle of the clutch pack, separated from the third by a lined plate.

- |   |                       |                       |
|---|-----------------------|-----------------------|
| 1. 2nd gear brake band                  | 5. Clutch drum seal   | 10. Circlip (small)   |
| 2. Clutch drum bushing                  | 6. Clutch piston seal | 11. Plate (steel) (3) |
| 3. Adjusting screw with large dog point | 7. Clutch piston      | 12. Plate (lined) (2) |
| 4. Clutch drum                          | 8. Return spring (18) | 13. Pressure plate    |
|   | 9. Spring plate       | 14. Circlip (large)   |



### To disassemble:

1. Use a screwdriver to pry out the large circlip.
2. Take out the pressure plate, the two lined plates, and the three steel plates.
3. Put the clutch on a press and force down the spring plate until you can pry out the small circlip.
4. With a twisting movement, pull the clutch piston with return springs out of the clutch drum. Take off the piston seal and the clutch drum seal.
5. Use a press to pull the drum bushing (Fig. 10-15).



**Fig. 10-15.** Removing clutch drum bushing. Phantom drawing (dashed lines) shows extractor.



### To check clutch:

1. Look for wear or damage on the friction surfaces of the piston and the clutch drum and in the grooves in which the steel clutch plates ride.
2. Check the ball valve for freedom of movement. Make sure the drilling is clear.
3. Inspect the steel clutch plates. Replace any plate that is scored or grooved.
4. Check the lined plates. Replace any plate that is worn, damaged, or burned.
5. Check the 2nd gear brake band. Replace it if worn, damaged, or burned.

### To assemble:

1. Install new seals on the clutch drum and the piston. The seal lips must point into the drum toward the source of hydraulic pressure.
2. Lubricate the seals well with ATF. Insert the piston into the drum with a twisting motion.
3. Insert the 18 return springs and the spring retainer plate. Press the parts together on the repair press until you can snap the small circlip into its groove.

#### NOTE —

The lined plates for the front clutch have waffled surfaces, shown in Fig. 10-16. Do not confuse them with the forward clutch lined plates, which have grooved surfaces. New lined plates should be soaked in ATF fluid for at least an hour before installation.



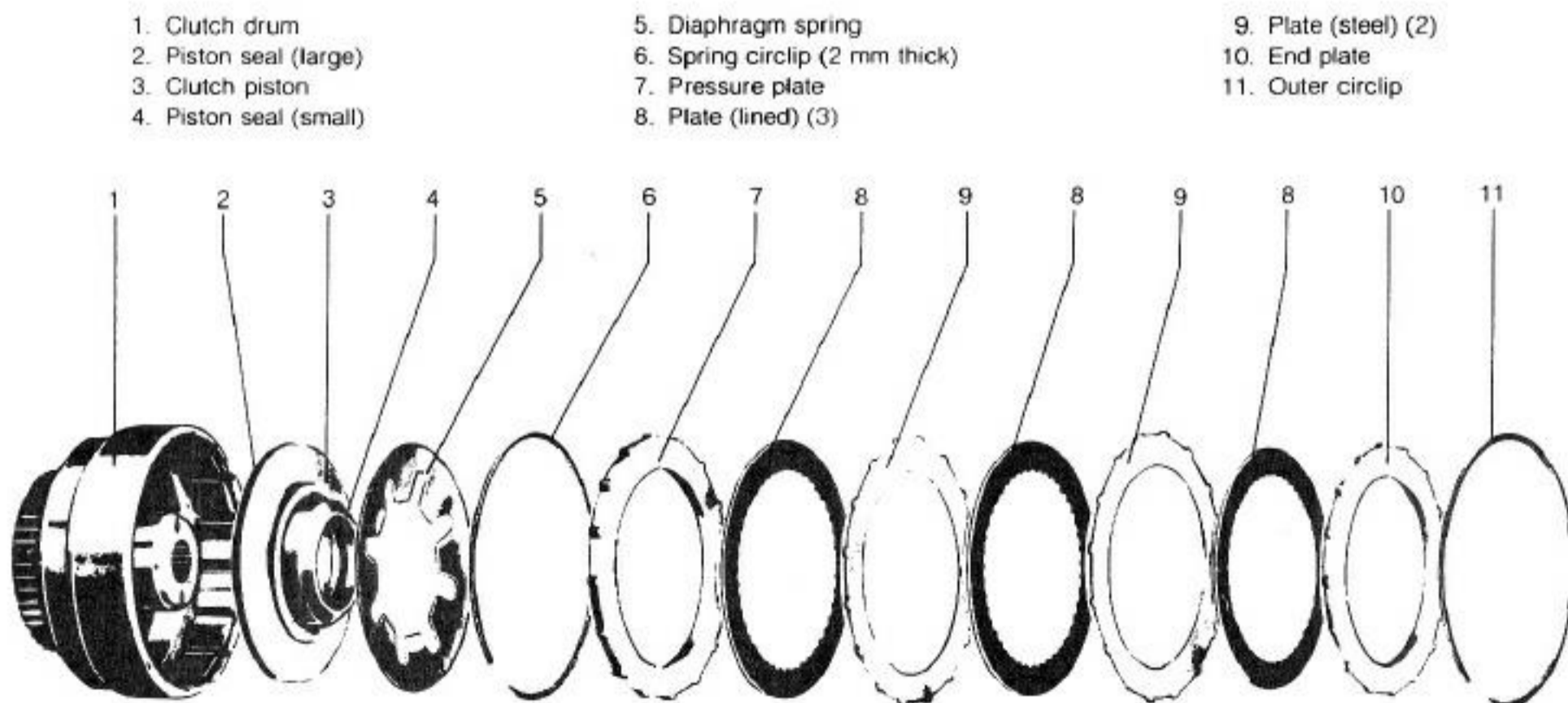
Fig. 10-16. Front clutch lined plate. The waffled surface of the lining distinguishes these plates.

4. Install the clutch lined plates and the steel plates. The order is important. Check your work by referring to Fig. 10-14.
5. Install the pressure plate and the large circlip. The tolerance range for the thickness of the plate is 6.15 to 6.30 mm (.242 to .248 in.). The thickness of the circlip is specified at 1.7 mm (.067 in.) only.
6. Press a new clutch drum bushing into place using an appropriate tool and a hydraulic press.

## 10.8 Disassembling and Assembling Forward Clutch

The forward clutch transmits torque from the converter turbine to the direct and reverse clutch and the large sun gear. Fig. 10-17 gives an exploded view.

Fig. 10-17. Forward clutch disassembled. Note that the steel plates in this clutch are separated. The outer circlip is a selective fit.



## To disassemble:

1. Pry out the outer circlip with a screwdriver and remove the clutch plate pack.
2. Pry out the spring circlip. Remove the diaphragm spring.
3. Withdraw the piston from the clutch drum, then remove the small and large piston seals.

## To check clutch:

1. Shake the drum. If the drilling shown in Fig. 10-18 is clear, you will hear the ball valve rattle.

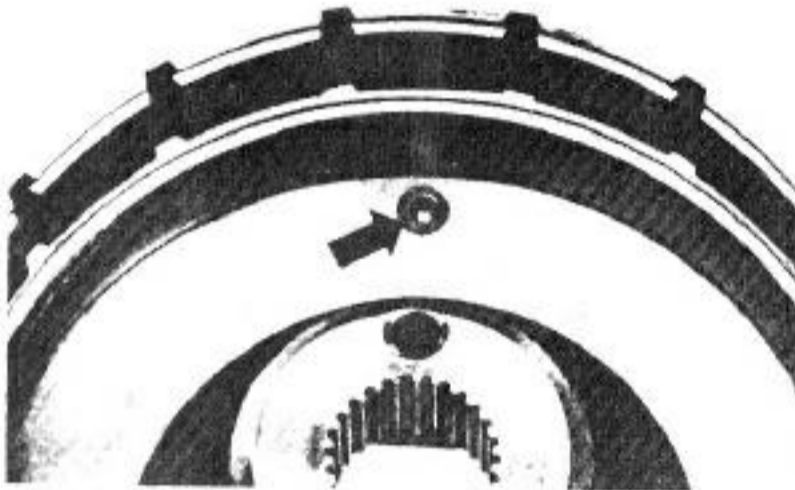


Fig. 10-18. Ball valve (arrow) in clutch drum.

2. Check the diaphragm spring. When the piston is installed, the spring should reach at least to the lower edge of the circlip groove.
3. Inspect the steel clutch plates. Replace any plate that is scored or grooved.
4. Look for signs of burning and wear on the lined plates. Replace damaged plates.

## To assemble:

1. Install new piston seals. The seal lips must point into the drum toward the source of hydraulic pressure.
2. Lubricate the seals well with ATF. Insert the piston into the drum with a twisting motion.
3. Install the diaphragm spring with the curved side toward the piston. Use only a 2-mm (.079 in.) thick circlip with a lug to retain the diaphragm.

### NOTE —

The diaphragm spring should be under some tension when the circlip is installed and it should not be easy to snap the circlip into its groove. If insertion of the circlip does not put the diaphragm spring under tension, replace the spring.

4. Install the pressure plate with the chamfered side toward the diaphragm spring.
5. Soak new lined plates (Fig. 10-19) in ATF for at least one hour. Used plates can merely be lubricated with ATF before reinstalling.
6. Install lined plates alternately with steel plates.



Fig. 10-19. Forward clutch lined plate. Note the concentrically grooved surface of lining.

7. Install the end plate and outer circlip. The specified thickness of the end plate is 6.15 to 6.30 mm (.242 to .248 in.).
8. Using a feeler gauge, check the clearance between the end plate and the outer circlip, as in Fig. 10-20. The clearance should be from 0.80 to 1.20 mm (.031 to .047 in.). Select a circlip to give this fit. Table c lists the circlips available at Authorized VW Dealers.

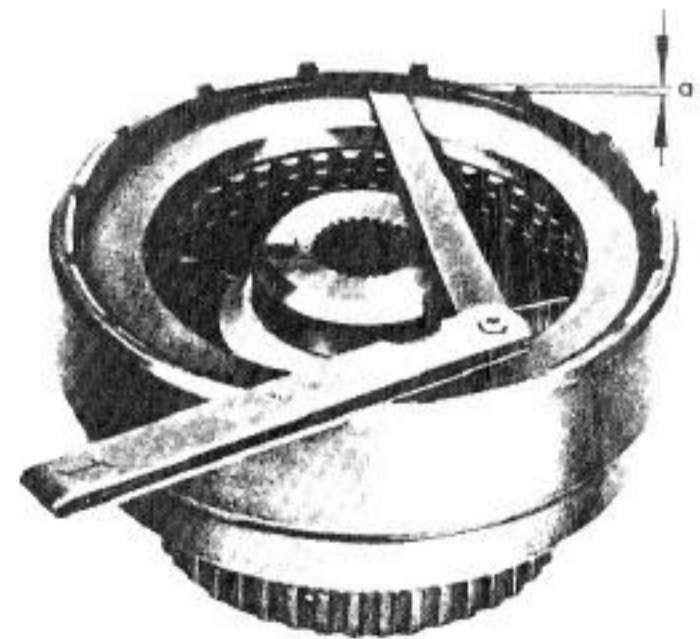


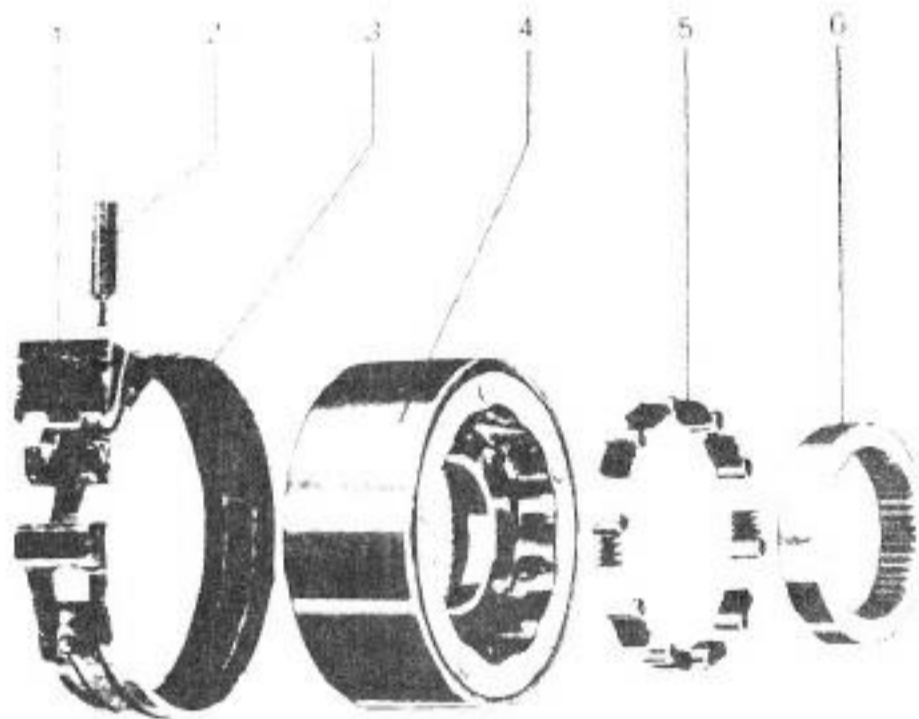
Fig. 10-20. Measuring forward clutch end play. Use a feeler gauge to measure clearance *a* between the end plate and the large outer circlip.

**Table c. Circlip Thickness**

Thickness	Part No.
1.50 mm (.0590 in.)	003 323 157 D
1.70 mm (.0669 in.)	003 323 157
2.00 mm (.0787 in.)	003 323 157 A
2.30 mm (.0905 in.)	003 323 157 C
2.50 mm (.0984 in.)	003 323 157 B
2.70 mm (.1063 in.)	003 323 157 E

## 10.9 Disassembling and Assembling Annulus Gear

The annulus gear assembly includes the annulus gear with the one-way clutch and the 1st gear brake band. Fig. 10-21 gives an exploded view of the assembly. Become familiar with the part names. They are used in the following text. The annulus engages the small pinions of the planetary gear set.



- |                        |   |
|------------------------|---|
| 1. Support fork        | 5. Spring spacers and rollers (10 each) |
| 2. Adjusting screw     | 6. One-way clutch inner ring            |
| 3. 1st gear brake band |   |
| 4. Annulus gear        |   |

**Fig. 10-21.** Annulus gear. The adjusting screw for the 1st gear brake band goes through the transmission case into a recess in the support fork on the end of the band. The spring spacers and rollers are part of the one-way clutch assembly.

### To disassemble:

1. Pull the inner ring of the one-way clutch out of the annulus gear.
2. Take out the 10 rollers and 10 springs.

### To check gear:

1. Look for scoring and other signs of wear on the annulus gear, all the gear teeth, the outer ring, the one-way clutch hub, and the rollers. Replace damaged parts.

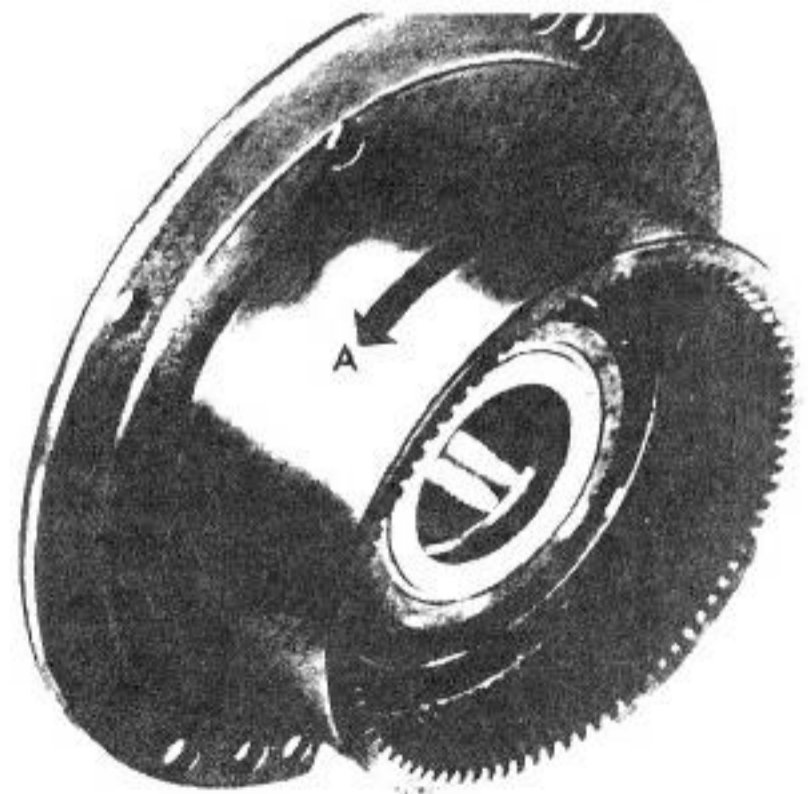
#### NOTE —

The one-way clutch must be in perfect condition if it is to hold the annulus against the turbine shaft rotation.

2. Inspect the 1st gear brake band. Check the lining for burning and excessive wear. Remove any embedded bits of metal. Check the operating parts for wear.

### To assemble:

1. Insert the inner ring of the one-way clutch in the annulus. Then insert the 10 rollers into the space between the one-way clutch inner ring and the annulus gear assembly.
2. Put the spring spacers between the lugs and the rollers. As you look down on the gear the installation sequence should be: lug, spring, roller, lug, spring, roller . . . and so on.
3. Install the one-way clutch on the bearing flange so that the splined part of the flange meshes with the inner ring.
4. To check the locking effect and the direction of rotation, try to turn the clutch both clockwise and counterclockwise (Fig. 10-22).



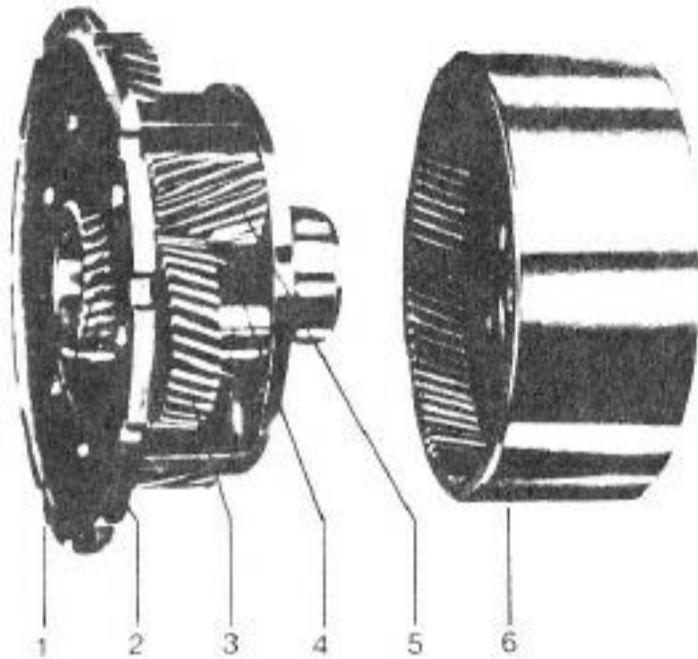
**Fig. 10-22.** One-way clutch. When installed on the bearing flange, the clutch turns in direction A but holds in direction B.

## 10.10 Planetary Gears

The planetary gearset should not be disassembled. The planetary pinions run on needle bearings on peened-in shafts that can be properly installed only at the factory. The gearset is shown in Fig. 10-23.

**NOTE** —

Worn or damaged gearsets must be replaced as a unit since individual parts are not supplied.



- |                        |                        |
|------------------------|------------------------|
| 1. Small sun gear      | 4. Large sun gear      |
| 2. Planet carrier      | 5. Small planet pinion |
| 3. Large planet pinion | 6. Annulus (ring) gear |

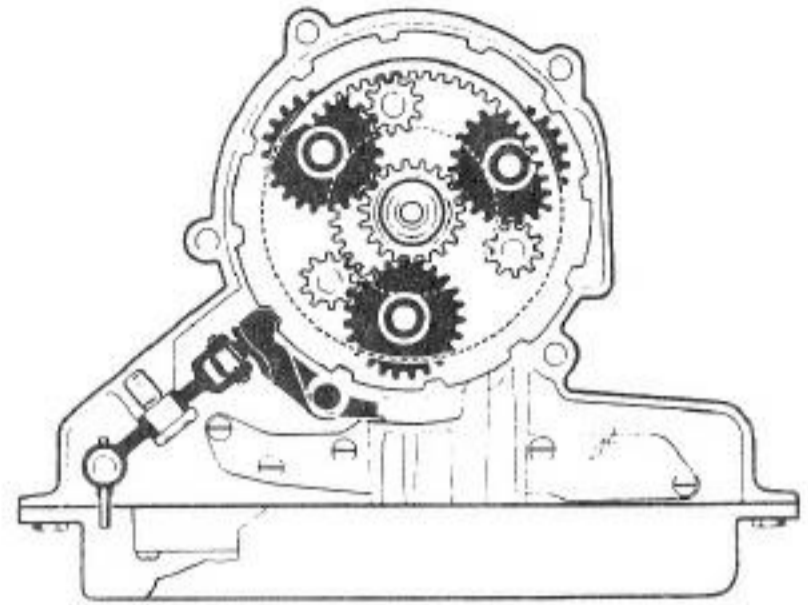
**Fig. 10-23.** Planetary gear system with annulus removed. The annulus engages the small pinions only.

**To check:**

1. Inspect all gear teeth and thrust surfaces.
2. Check the backlash in meshing gears.
3. Check the radial play of the planetary gears.
4. Examine the flange of the parking lock for wear. Remove any burrs.
5. Check the internal splines for wear. Replace worn parts.

## 10.11 Parking Lock

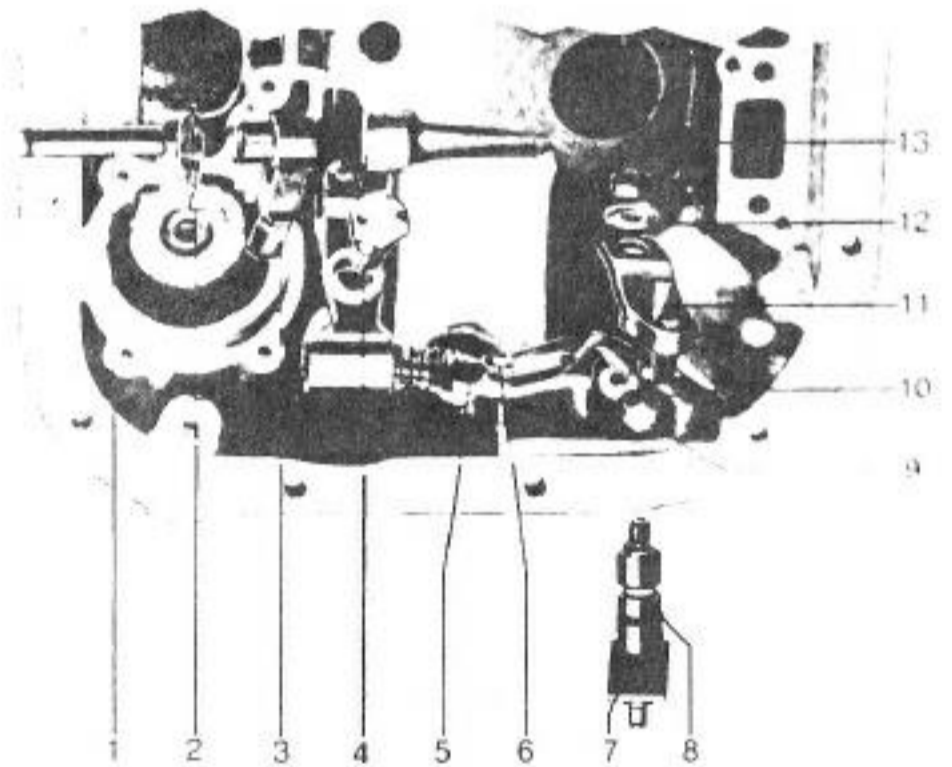
Disassembly of the parking lock requires removal of the transmission pan and the valve body. Read the instructions for those procedures before you start this task. The position of the parking lock relative to the planetary gearset is shown in Fig. 10-24.



**Fig. 10-24.** Parking lock in engaged position. Shape of the notches around the edge of the planet carrier is designed to retain the pawl firmly with the vehicle stationary, but to force the pawl from engagement if the selector lever is accidentally moved to P while the car is rolling.

**To disassemble:**

1. Remove the transmission pan and the valve body (Fig. 10-25). Unscrew the threaded pin for the operating lever. Take off the E-clip and remove the lever.



- |                          |                          |
|--------------------------|--------------------------|
| 1. Pawl pin              | 8. O-ring                |
| 2. Return spring         | 9. Retaining bolt        |
| 3. Pawl                  | 10. Spring washer B 6    |
| 4. Threaded pin          | 11. Manual valve lever   |
| 5. Operating lever       | 12. Washer A 8.4         |
| 6. E-clip (2)            | 13. Self-locking nut M 8 |
| 7. Cable lever and shaft |                          |

**Fig. 10-25.** Parking lock assembly. The view is from below. The engine would be to the left.

2. Drive out the pawl pin. Take off the pawl and the return spring.
3. Remove the self-locking nut from the manual valve lever, then press off the lever.
4. Remove the retaining bolt and take out the cable lever and the shaft.

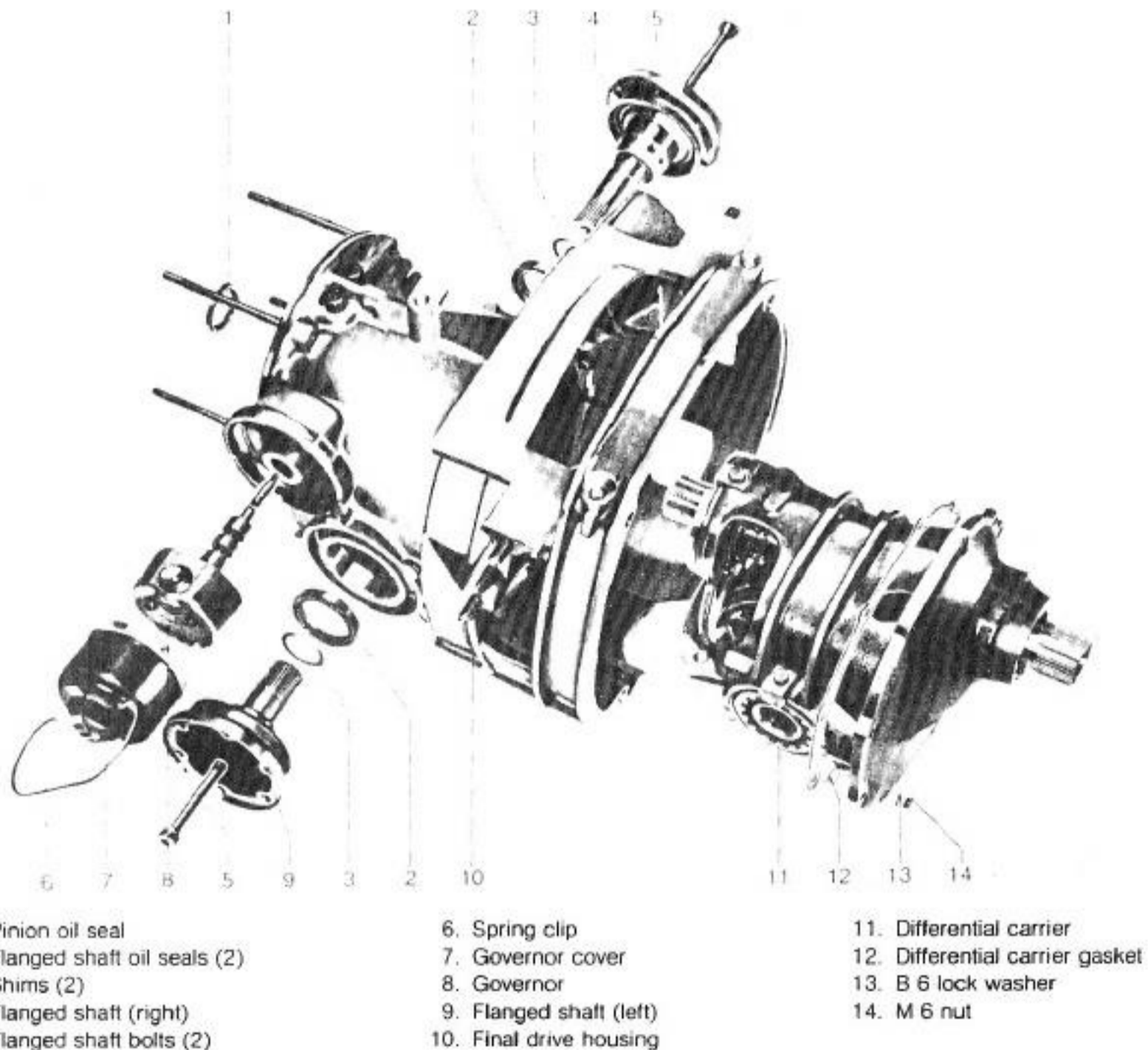
**To assemble:**

1. Install the lever shaft using a new O-ring. Install the manual valve lever together with a washer and a self-locking nut. Tighten the nut to 0.6 mkg (4.5 ft. lb.). Insert the retaining bolt together with a spring washer.
2. Insert the pawl together with a return spring. Hold the pawl away from the planet carrier and drive in the pawl pin.
3. Install the operating lever and then the E-clip. Tighten the threaded pin to 2.5 mkg (18 ft. lb.).
4. Check the operation of the parking lock. Reinstall the valve body and the transmission pan.

## 11. FINAL DRIVE

The final drive consists of two flanged shafts that are coupled to the rear wheels, the differential gears, the ring gear and drive pinion, and the differential carrier that contains these parts. The differential gears and the ring and pinion used with the automatic transmission are entirely different from those used in the four-speed fully synchronized transmission. The differential carrier is bolted inside the final drive housing and is easily removed. All adjustments to the final drive gears may be made on the differential carrier and the carrier then bolted back inside the final drive housing. Fig. 11-1 shows the disassembly required to remove the differential carrier.

**Fig. 11-1.** Final drive in exploded view. After removing the governor and flanged shafts the differential carrier can be unbolted and taken out of the final drive housing.



## 11.1 Removing and Installing Differential Carrier

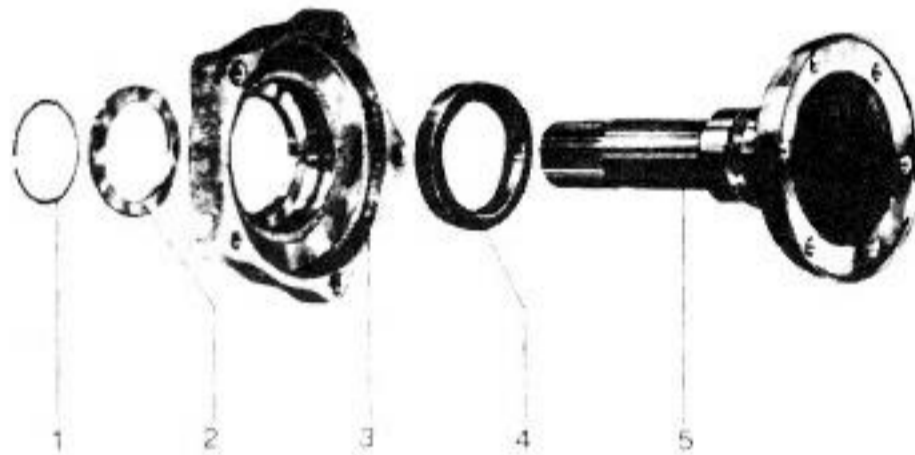
Because dirt will invariably enter the transmission and difficulty may be encountered during reinstallation, it is recommended that you do not attempt to remove the differential carrier while the transmission is mounted in the car.

### To remove:

1. Take out the torque converter. Pull out the pump shaft and turbine shaft.
2. Separate the final drive housing from the transmission case.
3. Secure the final drive housing to the assembly stand.
4. Remove the governor.
5. Remove the flanged shafts.

#### NOTE —

On 1970 and later cars, the flanged shafts can be withdrawn after removing the socket head bolts from their centers as was shown in Fig. 11-1. On earlier cars, the flanged shafts come out with the side covers after the side covers are unbolted. See Fig. 11-2.

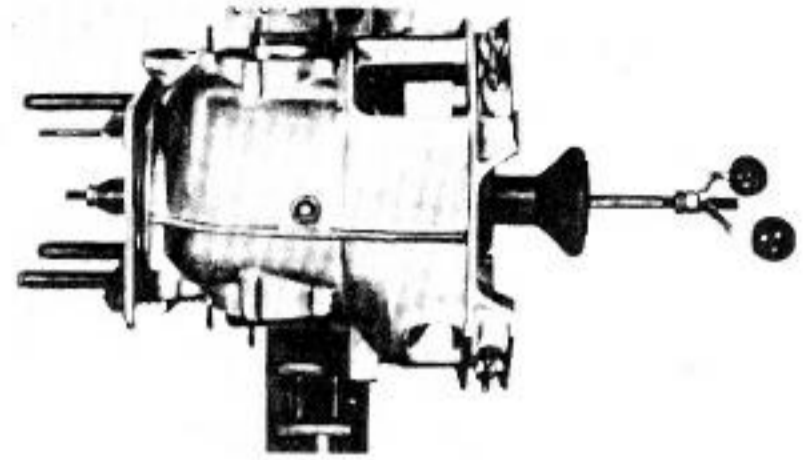


- |                  |                  |
|------------------|------------------|
| 1. Circlip       | 4. Oil seal      |
| 2. Thrust washer | 5. Flanged shaft |
| 3. Side cover    |                  |

**Fig. 11-2.** Early flanged shaft. 1968 and 1969 cars have flanged shafts retained in side covers. Later cars have no side covers and the flanged shafts are retained by bolts.

6. Remove the nuts holding the differential carrier inside the final drive housing.
7. Pass a long threaded shaft through the hollow drive pinion and secure the shaft with nuts and washers at the transmission end.

8. Attach a slide hammer to the threaded shaft and use the hammer to pull the differential carrier free of the housing, as shown in Fig. 11-3.



**Fig. 11-3.** Pulling differential carrier. The slide hammer held in the pinion with the long threaded shaft can also be used to lift the carrier from the housing.

9. Check the pinion oil seal. Pry it out if faulty.
10. Check the governor oil seal and O-ring. Replace them if necessary.

#### NOTE —

A hook-shaped tool can be used to remove the governor shaft seal if the transmission is installed in the car. If you disassemble the transmission, you can drive out the seal with a drift.

11. Check the flanged shaft oil seals in the final drive housing and replace them if cracked or worn.

#### NOTE —

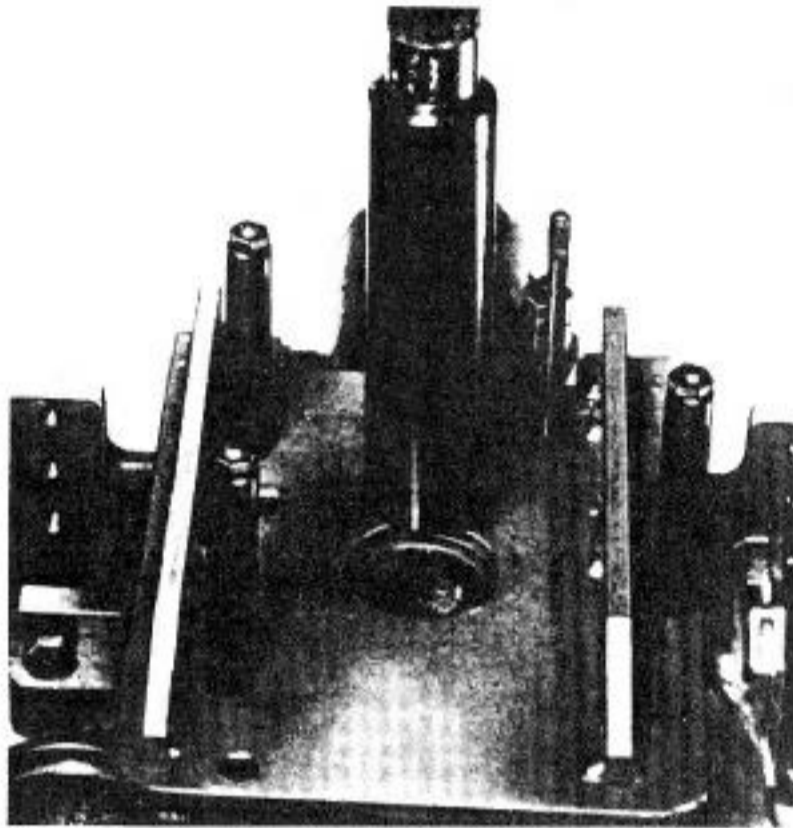
On early model transmissions having the flanged shafts retained in the side covers, it is necessary to take off the circlip holding the flanged shaft in the cover and remove the flanged shaft to inspect the oil seal. The oil seal is pressed into the side cover. It is always best to replace the seals.

### To install:

1. Coat the outsides of the flanged shaft seals with hypoid oil and press them into the side covers or final drive housing. Pack the seal lips with lithium grease.
2. On early transmissions only, install the flanged shafts in the side covers and install the snap rings.
3. Drive in a new governor oil seal. The seal lip must point outward, toward the governor. Use a proper seal-driving tool.
4. Use the proper sleeve-type driver to press in the pinion oil seal. Have the seal lip toward the final drive. Seat the seal flush with the housing.

**NOTE —**

The proper setup for driving in the pinion seal is shown in Fig. 11-4. Prior to January 1971, the drive pinion seal was installed with the sealing lip toward the transmission. If you replace one of these earlier installations, put the new seal in with the lip toward the final drive.



**Fig. 11-4.** Driving in new pinion seal. This is a very critical seal, so makeshift installation methods should not be used.

5. Put a new paper gasket over the studs in the housing before installing the differential carrier.
6. Lower the differential carrier onto the studs in the final drive housing using the long threaded shaft passed through the drive pinion.
7. Put spring washers and nuts on the studs and tighten uniformly by hand. Then, working diagonally, torque the nuts to 0.8 mkg (6 ft. lb.).
8. Install the flanged shafts, using a new gasket under the side covers on early transmissions.

**NOTE —**

The long shaft goes on the left side of the final drive.

9. Torque the socket head flanged shaft retaining bolts to 2.5 mkg (18 ft. lb.).
10. On the earlier type transmission, put the spring washers and nuts on the side cover studs and tighten them uniformly by hand. Working diagonally, torque them to 0.8 mkg (6 ft. lb.).

**NOTE —**

Flanged shafts with two spline designs were used in the years covered by this Manual. The spline angle was changed from 45° to 30° and the number of splines from 34 to 33. Make sure the splines match if you replace either the flanged shafts or the differential side gears.

11. Install the O-ring for the governor cover.
12. Install the governor and the cover.
13. Clean the mating surfaces of the final drive housing and transmission case. Install a new gasket and O-rings and reinstall the final drive on the transmission.

**NOTE —**

Always remove burrs, corrosion, and dirt from the chamfers around the studs before installing the O-rings. Dip the O-rings in ATF prior to installation. Be careful not to crush or tear the rings during assembly.

14. Working diagonally, tighten the nuts on the four studs to 2 mkg (14 ft. lb.).
15. Insert the transmission pump shaft and the turbine shaft. The end of the turbine shaft with the short pilot ahead of the splines should point toward the transmission.

**NOTE —**

The shafts must turn easily by hand. Check this by turning them in both directions after installation.

16. Install the ATF filler tube, the air deflector plate, and other external parts.
17. Install the torque converter. Turn it clockwise and counterclockwise until it engages the turbine shaft and pump shaft splines.

**CAUTION —**

*If the converter comes part way off its support tube, or if the converter is again removed after installing it, the transmission pump shaft may come along with it far enough to disengage the shaft splines from the pump drive plate. Unless the pump shaft is then reinserted in the splines by hand, the next operation of the transmission may damage the pump. To correct the damage would require complete removal and disassembly of the automatic transmission.*

18. Secure the torque converter in the transmission with a retaining bar to prevent the converter from falling out prior to installation of the engine.

## 11.2 Disassembling and Assembling Differential Carrier

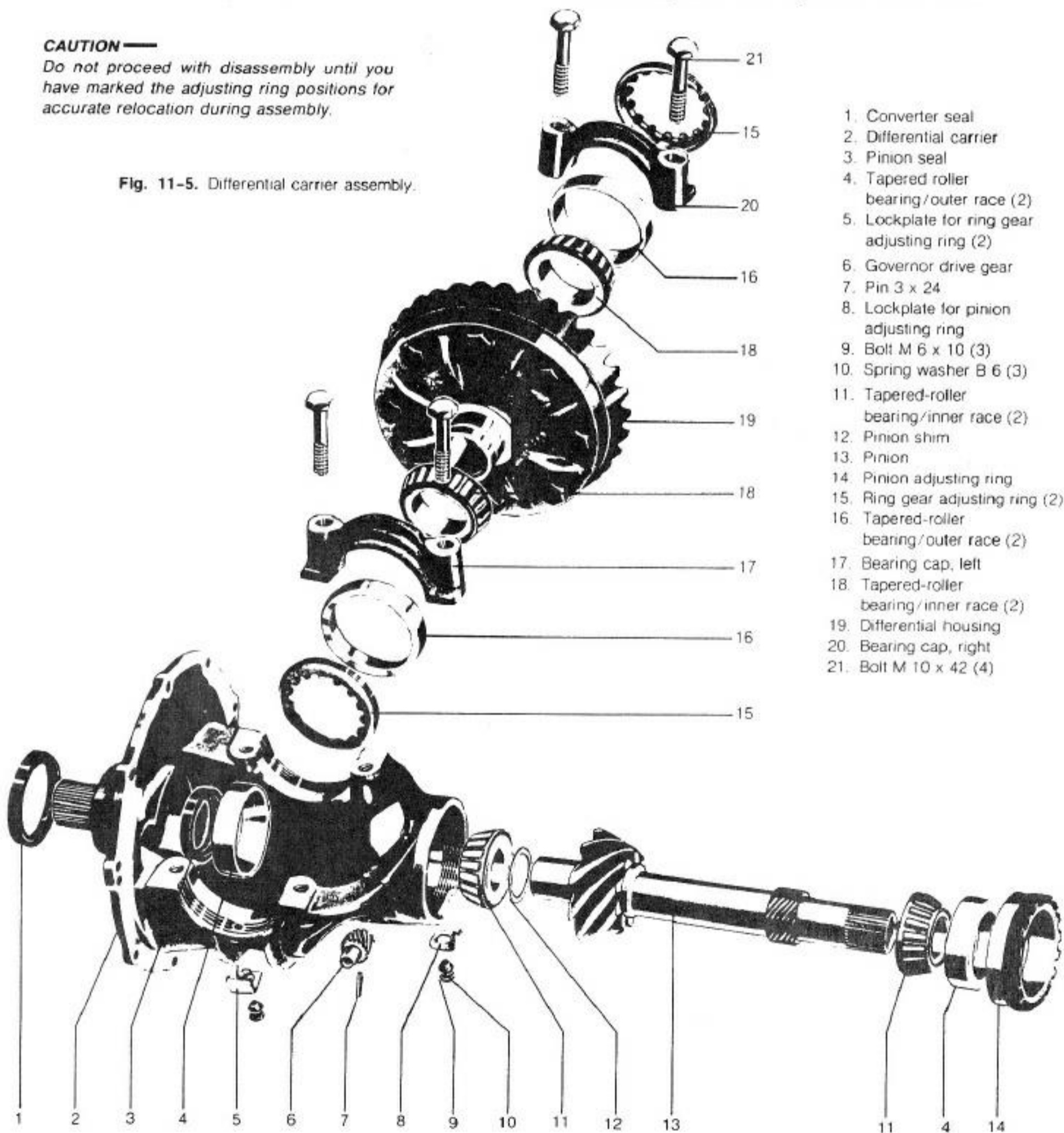
The differential carrier assembly is shown in the exploded view in Fig. 11-5. Become thoroughly familiar with the names of the various parts. They will appear frequently in our description of the disassembly and assembly procedures you must use when servicing the final drive.

**CAUTION** —

Do not proceed with disassembly until you have marked the adjusting ring positions for accurate relocation during assembly.

The procedure you will follow in disassembling the differential carrier depends on whether or not you intend to adjust the ring and pinion gearset. When you do not intend to adjust the ring or pinion, you begin by recording the ring gear backlash. (This job will be described later.) Next, carefully mark the positions of the pinion adjusting ring and the two ring gear adjusting rings. During reassembly the rings are returned to these marks and the backlash adjusted to the figure recorded earlier.

Fig. 11-5. Differential carrier assembly.

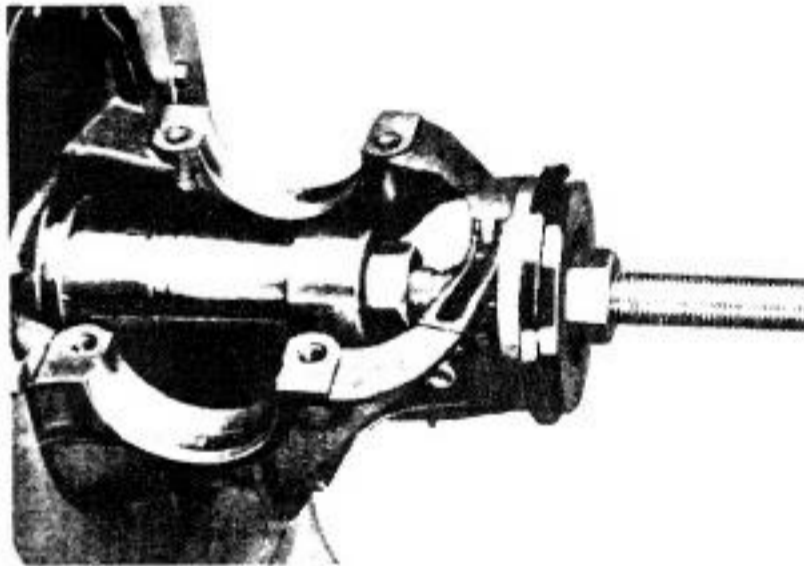


1. Converter seal
2. Differential carrier
3. Pinion seal
4. Tapered roller bearing/outer race (2)
5. Lockplate for ring gear adjusting ring (2)
6. Governor drive gear
7. Pin 3 x 24
8. Lockplate for pinion adjusting ring
9. Bolt M 6 x 10 (3)
10. Spring washer B 6 (3)
11. Tapered-roller bearing/inner race (2)
12. Pinion shim
13. Pinion
14. Pinion adjusting ring
15. Ring gear adjusting ring (2)
16. Tapered-roller bearing/outer race (2)
17. Bearing cap, left
18. Tapered-roller bearing/inner race (2)
19. Differential housing
20. Bearing cap, right
21. Bolt M 10 x 42 (4)



**To disassemble:**

1. Mount the assembled differential carrier in a suitable holding device.
2. Remove the lockplates that hold both ring gear and pinion adjusting rings. Do not reuse the lockplates.
3. Remove the four bearing cap bolts and take off the bearing caps. Remove the differential assembly from the carrier.
4. With a special wrench, unscrew the pinion adjusting ring and take out the pinion.
5. Knock out the pin that secures the governor drive gear. Remove the gear.
6. Use a threaded extractor with a special ring-removing tool to pull the outer race of the pinion tapered-roller bearing out of the converter end of the carrier. Fig. 11-6 shows the setup.

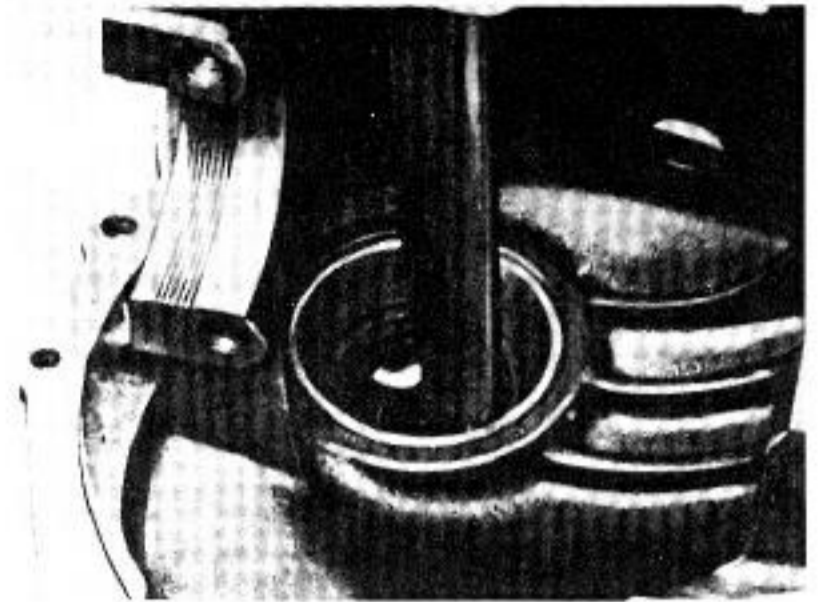


**Fig. 11-6.** Setup for pulling the outer race of the pinion tapered-roller bearing from converter end of carrier. Sleeve on threaded spindle of extractor expands inside the bearing race and enables the race to be pulled from carrier.

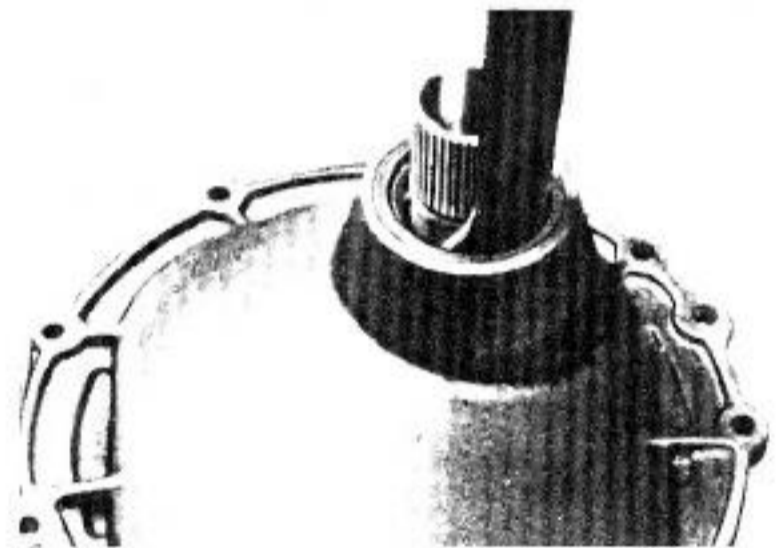
7. Use a hooked-shaped tool to pry out the drive pinion seal as shown in Fig. 11-7.
8. Pry out the converter seal as in Fig. 11-8.
9. With the setup shown in Fig. 11-9, press the pinion tapered-roller bearing outer race out of the adjusting ring.

**NOTE —**

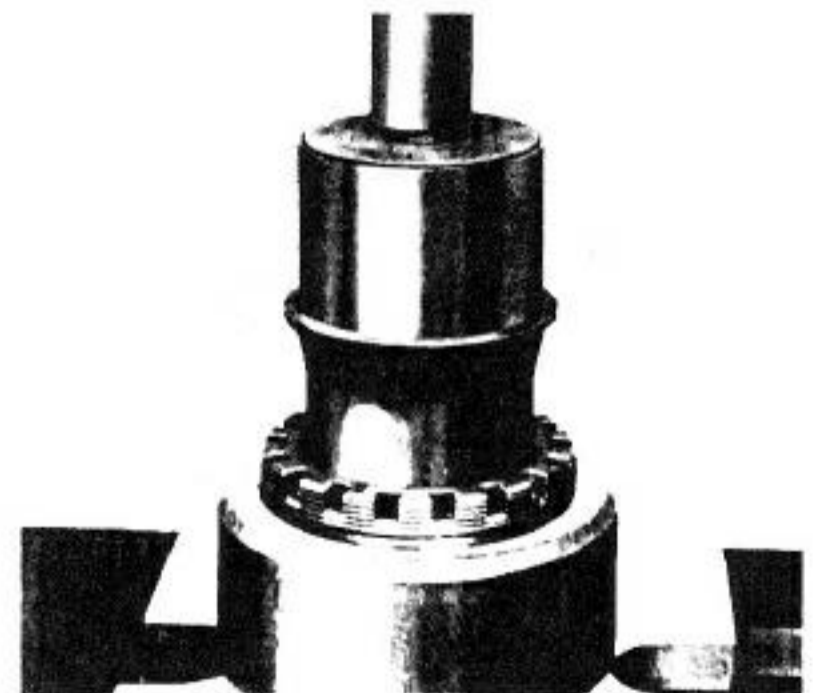
In model year 1969, a strengthened pinion gear was introduced. The new shape requires a different setup for pressing off the inner race of the tapered-roller bearing. Fig. 11-10 shows the setup for the early version. Fig. 11-11 shows the setup for the post-1969 version. With either it is difficult to avoid ruining the bearing.



**Fig. 11-7.** Prying out drive pinion seal. A special lever with a hooked end is used for this operation in VW shops.



**11-8.** Prying out converter seal with the special hooked lever.



**Fig. 11-9.** Pressing out the outer race.

10. Press the tapered-roller bearing inner race off the pinion with the setup shown in Fig. 11-10 or Fig. 11-11.

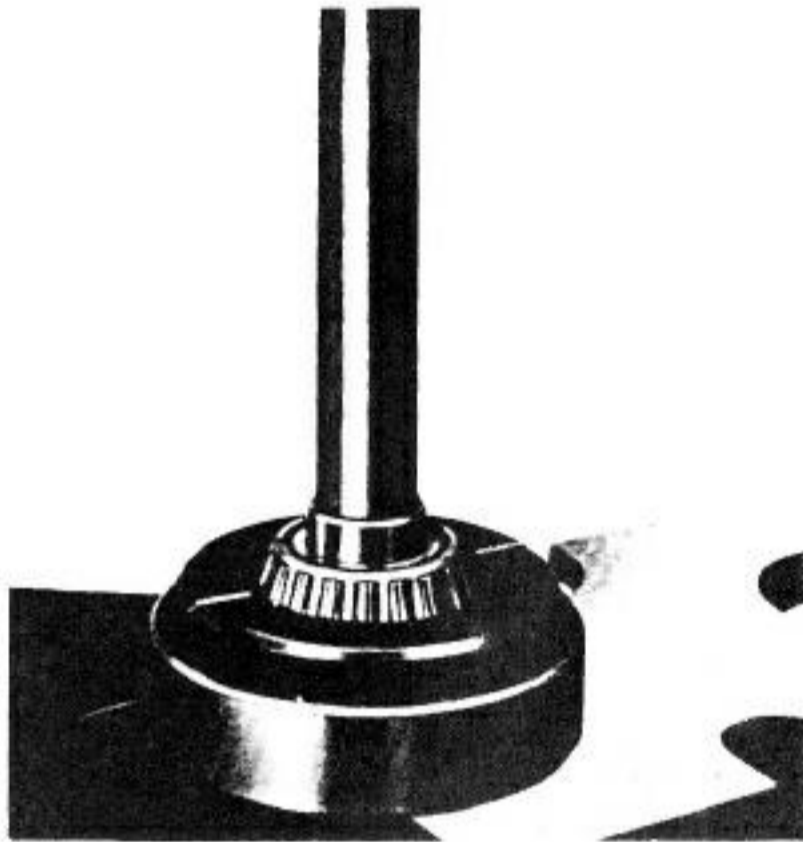


Fig. 11-10. Press setup for pressing off inner race of pinion tapered-bearing in early version.

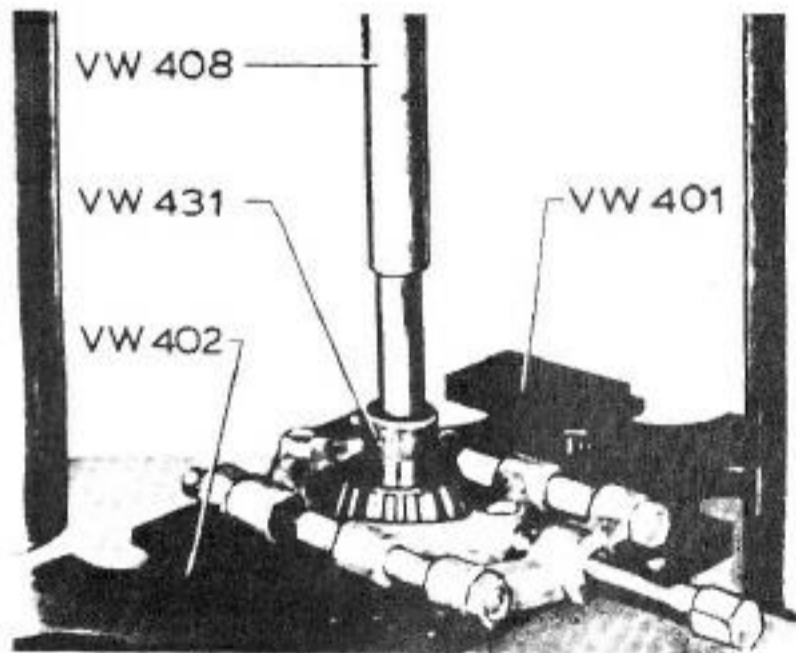


Fig. 11-11. Separator device for pressing off late-type inner race of pinion tapered-bearing.

**NOTE** —

If you intend to replace some part or parts when you assemble the carrier, first read 11.5 **Adjusting Pinion** and 11.6 **Adjusting Ring Gear** for instructions regarding necessary additional work. Replacement of a part will require readjustment of the final drive gearset.

**To assemble:**

1. Insert the governor drive gear. Drive in the retaining pin.
2. Press the differential carrier down on the torque converter oil seal, as shown in Fig. 11-12.

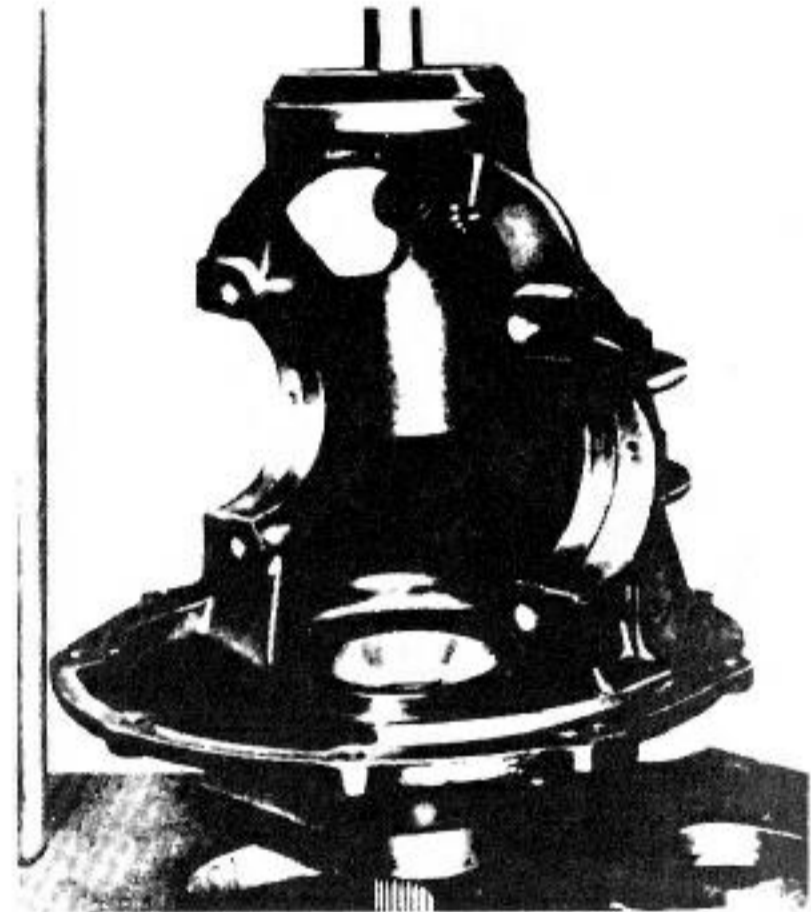


Fig. 11-12. Pressing carrier onto converter seal.

3. Drive in the pinion seal, as shown in Fig. 11-13.

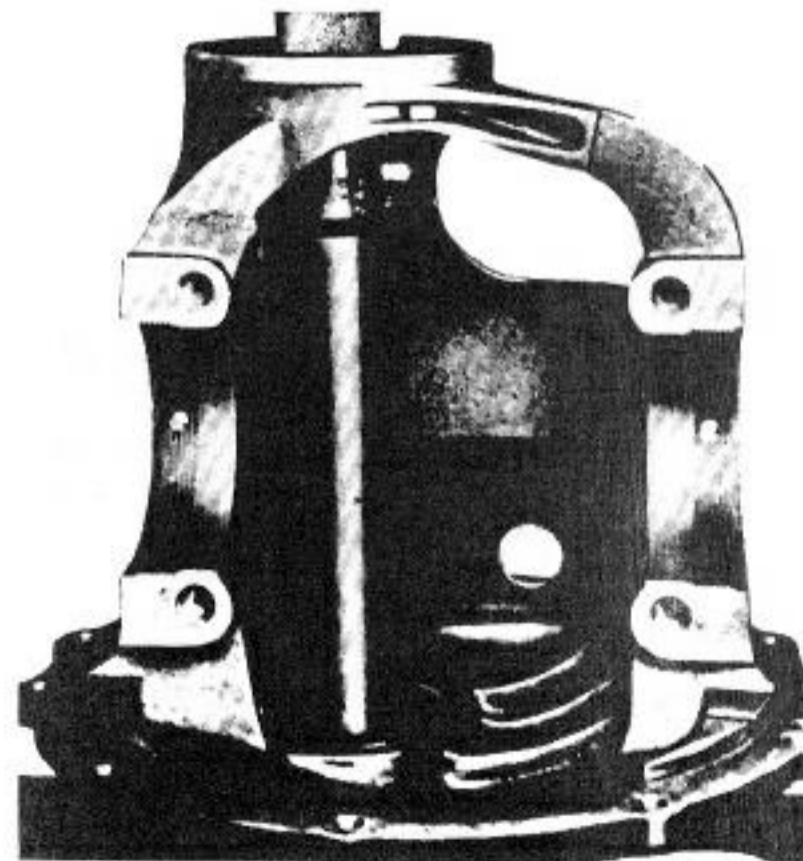


Fig. 11-13. Seating the pinion seal with a seal driver.

4. Press the outer race of the pinion tapered-roller bearing into the differential carrier, as illustrated in Fig. 11-14.

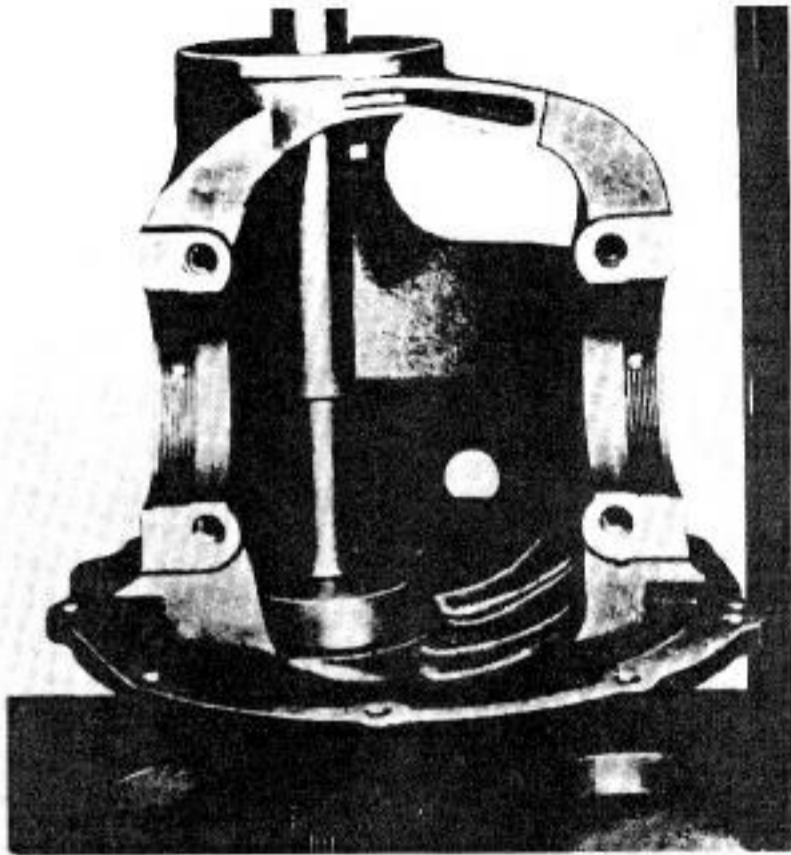


Fig. 11-14. Seating outer race of pinion tapered-roller bearing in differential carrier.

5. Heat the pinion adjusting ring to 100°C (212°F) and install the tapered-roller bearing outer race in it. When the adjusting ring has cooled, seat the bearing race completely under 3 tons (2721 kg) of pressure (see Fig. 11-15).

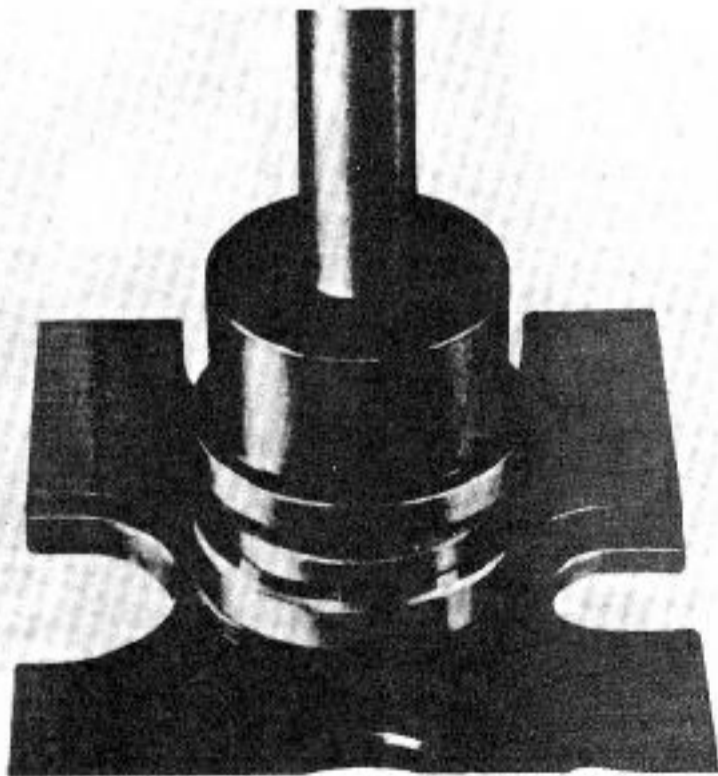


Fig. 11-15. Pressing tapered-roller bearing outer race into the pinion adjusting ring.

6. Heat the pinion tapered-roller bearing inner races to 100°C (212°F). Start them on the pinion. When the races have cooled, seat them completely under 3 tons (2721 kg) of pressure (see Fig. 11-16).

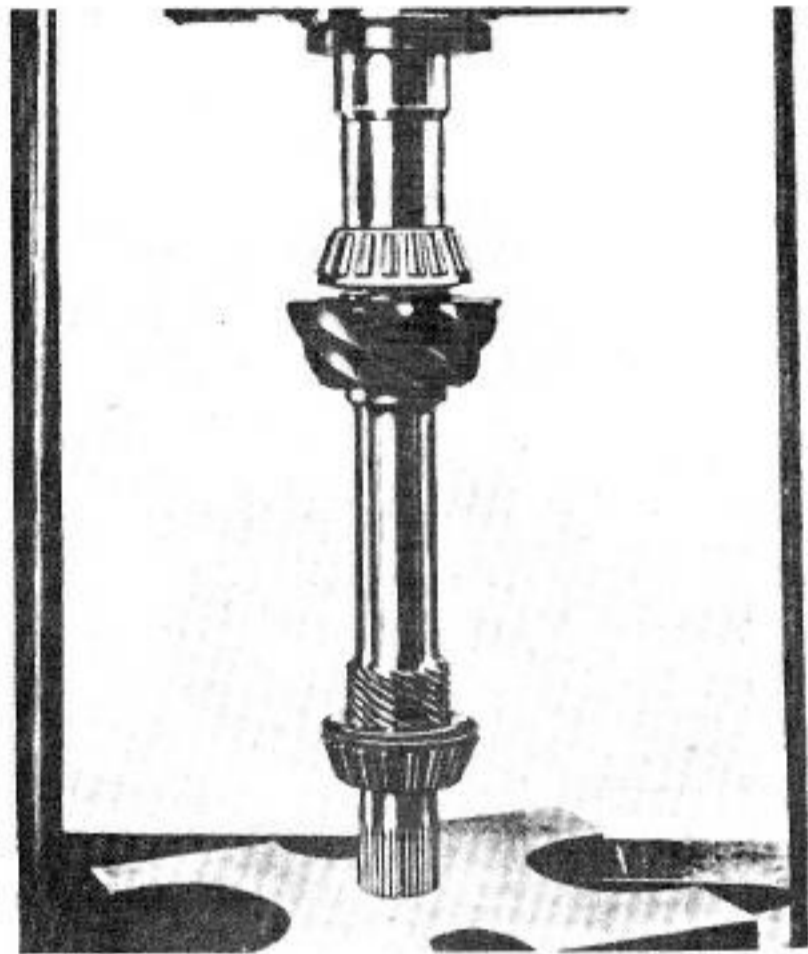


Fig. 11-16. Pressing cooled bearing inner races onto the pinion.

**NOTE** —

Be sure to oil all tapered-roller bearings thoroughly with hypoid oil before you install them in the differential carrier.

**NOTE** —

Before you proceed with final assembly of the differential carrier, read 11.5 **Adjusting Pinion** for instruction on the selection of S<sub>3</sub> shims for adjustment of the pinion. Install all replacement S<sub>3</sub> shims behind the outer bearing race, not under the inner race. Only in factory assembly are shims installed under the inner race.

7. Install the correct thickness of S<sub>3</sub> shims behind the outer bearing race.
8. Install the pinion. If you have not replaced any parts, screw in the adjusting ring to line up the marks you made during disassembly. Lock the ring.
9. Install the differential in the differential carrier along with the tapered-roller bearing outer races and adjusting rings.

10. Install the bearing caps. Torque the bolts to 6.0 mkg (43 ft. lb.) as in Fig. 11-17.

**CAUTION —**

Before you tighten the bearing cap bolts fully, be sure that the adjusting rings are correctly located in the threads. Otherwise, the threads will be deformed.

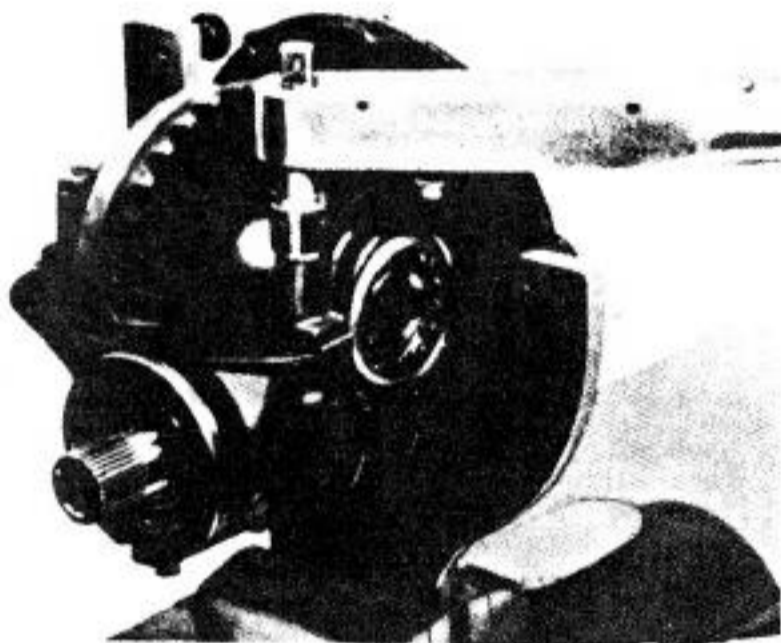


Fig. 11-17. Torquing bolts on the differential carrier bearing cap.

11. Use a special wrench to turn the adjusting rings to adjust the bearing preload and backlash. If you are reinstalling the original parts, set the rings to the reference marks you made before removal. Otherwise, follow the instructions in **11.5 Adjusting Pinion**.
12. Secure the adjusting rings with new lockplates. One of the two available types of plates will fit.

## 11.3 Disassembling and Assembling Differential

The differential used in the fully automatic transmission is shown in an exploded view in Fig. 11-18. Part names from this figure will be used frequently in the instructions for disassembly and assembly as well as in the procedures for making adjustments. Become thoroughly familiar with these part names before undertaking any work.

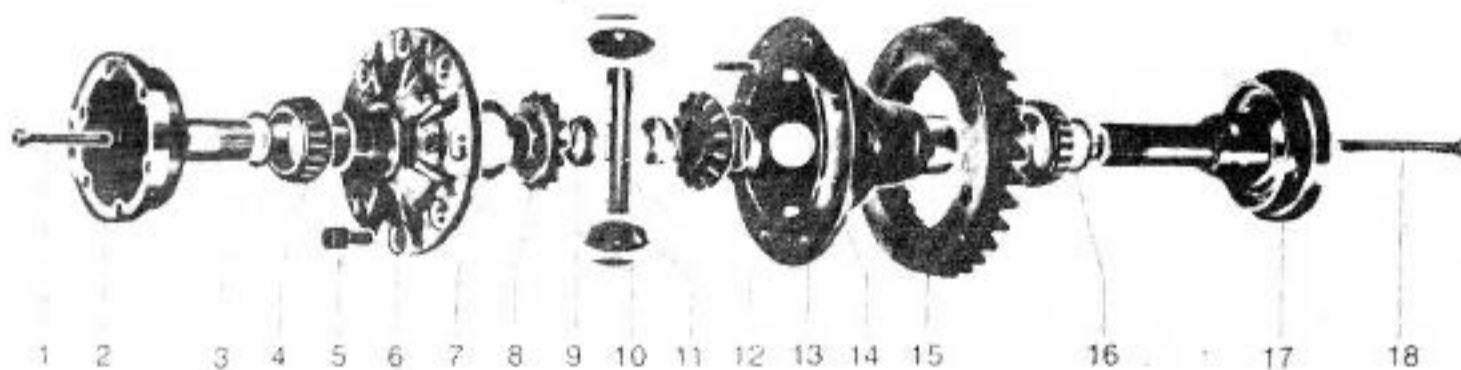
**CAUTION —**

If you lack the skills, tools, or a suitable workshop for differential service, we suggest you leave such repairs to an Authorized VW Dealer or other qualified shop. We especially urge you to consult your Authorized VW Dealer before attempting repairs on a car still covered by the new-car warranty.

The differential side gears and the flanged shafts are splined together. In cars covered by this Manual, gears and shafts of two designs are used. The spline angle was changed from 45° to 30°, and the number of splines reduced from 34 to 33. If you replace a side gear or flanged shaft, make sure the new part matches the splines of the old.

There has also been a change in the mounting of the flanged shafts, which will be explained later. On all transmissions built since 1970, it is necessary to check flanged shaft axial play, as described in **11.7 Adjusting Flanged Shaft Axial Play**, when replacing differential parts.

Fig. 11-18. Disassembled differential. Early type does not have parts 1, 3, 9, 16 or 18.



1. Bolt for left flanged shaft
2. Left flanged shaft
3. Shim, left
4. Tapered-roller bearing, inner race
5. Bolt and lock washer
6. Cover for housing

7. Thrust washer, large
8. Side gear, left
9. Nut for flanged shaft bolt
10. Thrust washer, small
11. Differential pinion
12. Shaft

13. Spring pin\*
14. Differential housing
15. Ring gear
16. Shim, right
17. Right flanged shaft
18. Bolt for right flanged shaft

## To disassemble:

1. Press the tapered-roller bearing inner races off the differential housing and cover, as shown in Fig. 11-19.

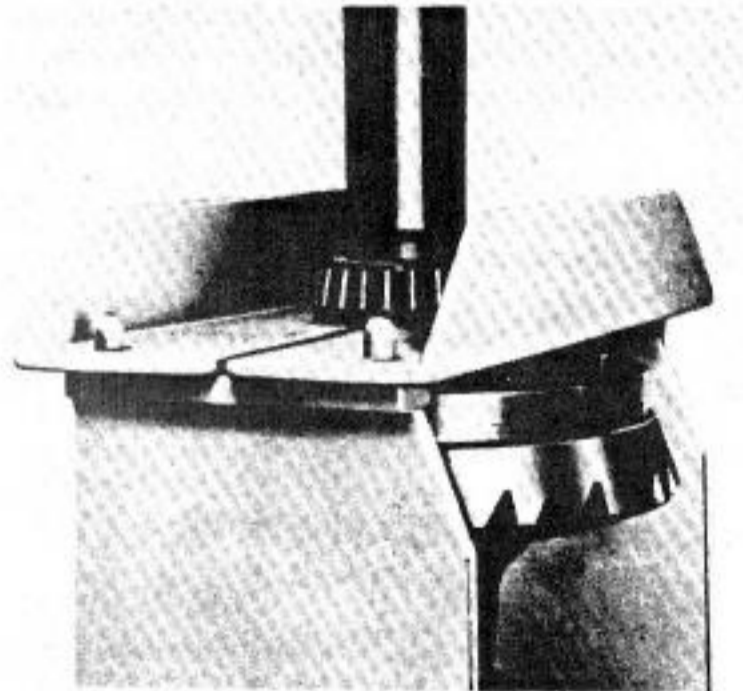


Fig. 11-19. Setup for pressing tapered-roller bearings off differential housing and cover.

2. Clamp the differential housing in a vise with soft jaw covers. Take out the ring gear bolts and knock the ring gear loose with a rubber mallet. Either put rags under the ring gear to soften the fall or, as in Fig. 11-20, leave three bolts loosened but still threaded so they will catch the gear when it comes loose.

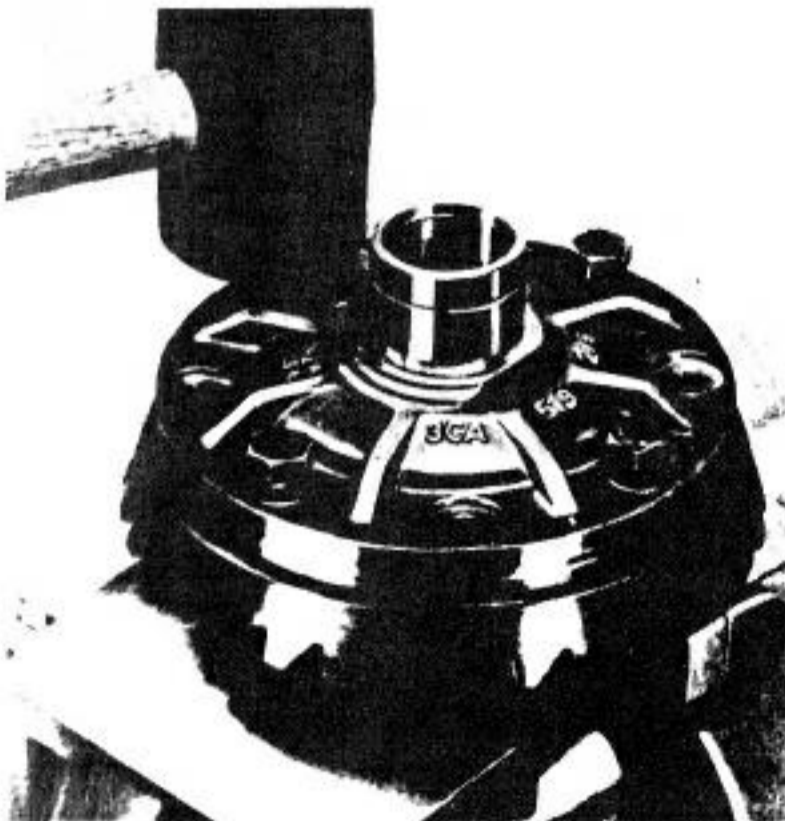


Fig. 11-20. Knocking ring gear loose.

3. Using a lever, and working carefully to avoid damage, pry the cover loose from the housing, as shown and described in Fig. 11-21.

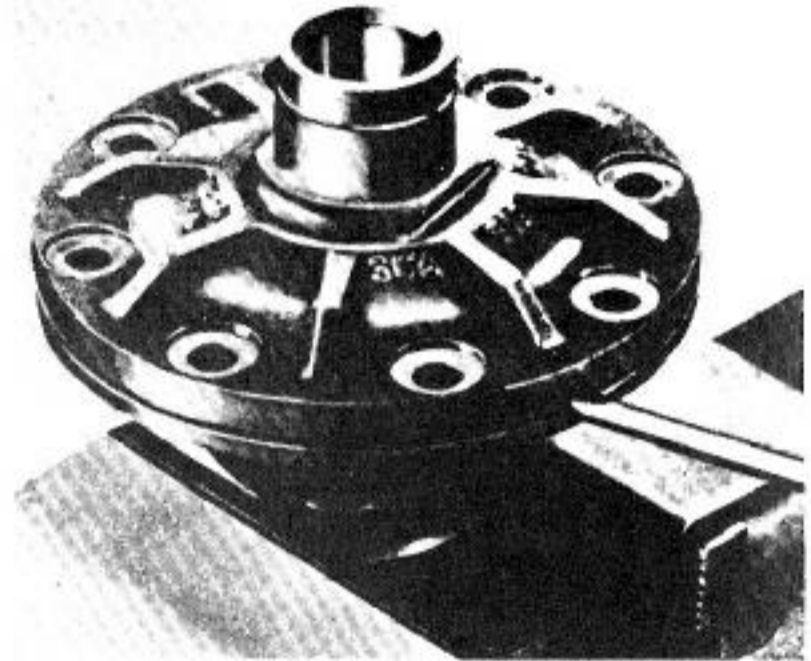


Fig. 11-21. Prying cover off the differential housing with a lever. Start the lever in the joint between the parts, then gradually work around the circumference of the housing.

4. Knock out the spring pin and the shaft.
5. Inspect the large and small thrust washers, side gears, pinions, and other thrust surfaces for wear.

### CAUTION —

If you are going to install during assembly a new differential side gear, flanged shaft, large thrust washer, differential housing, or differential housing cover, perform the checks and adjustments described in 11.7 **Adjusting Flanged Shaft Axial Play**. Not doing so will cause binding of the flanged shafts or abnormal gear wear. This caution applies only to flanged shafts held by a central socket head bolt.

## To assemble:

1. Install the side gears, differential pinions, thrust washers, and shaft.
2. Drive in a new spring pin. Secure it at both ends by peening the housing over it.

### NOTE —

In order to obtain a tight fit between the ring gear and differential cover, make certain that the contact surfaces are clean, level, and smooth. Use an oilstone to polish away burrs and pressure marks.

- Heat the ring gear to 100°C (212°F) and put it in place on the housing. Lower it over the two centering pins, as illustrated in Fig. 11-22.

**NOTE —**

The retaining bolts for the ring gear are supplied complete with lockwashers. Replace these bolts and washers whenever you remove the ring gear. Do not reuse old bolts and washers.

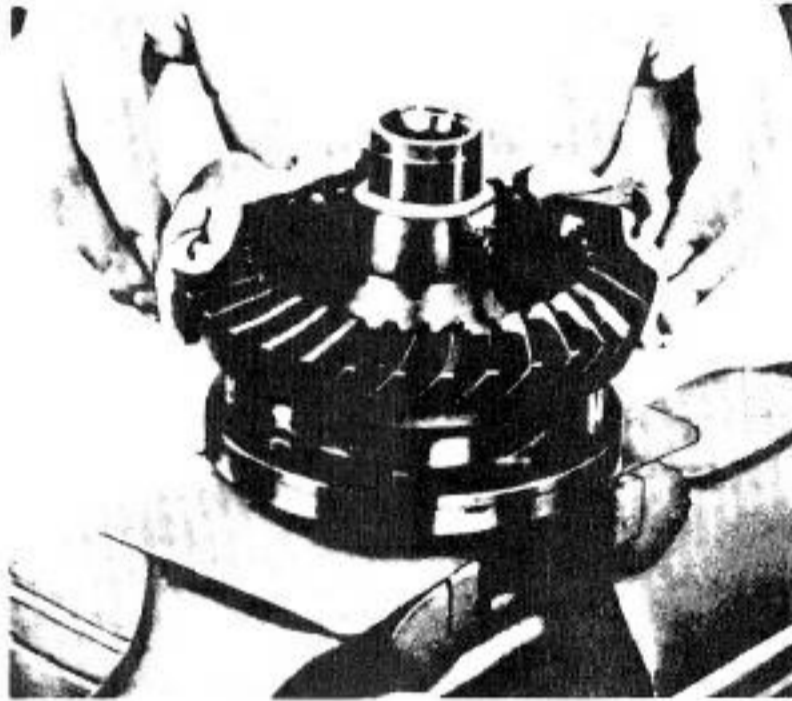


Fig. 11-22. Installing heated ring gear on the differential housing. Note the centering guide pin at each side of the housing.

- Heat the differential cover to 100°C (212°F). Install it on the differential housing.
- With the ring gear and cover in place on the housing, tighten the ring gear bolts to 4.5 mkg (32.5 ft. lb.), working diagonally as shown in Fig. 11-23.

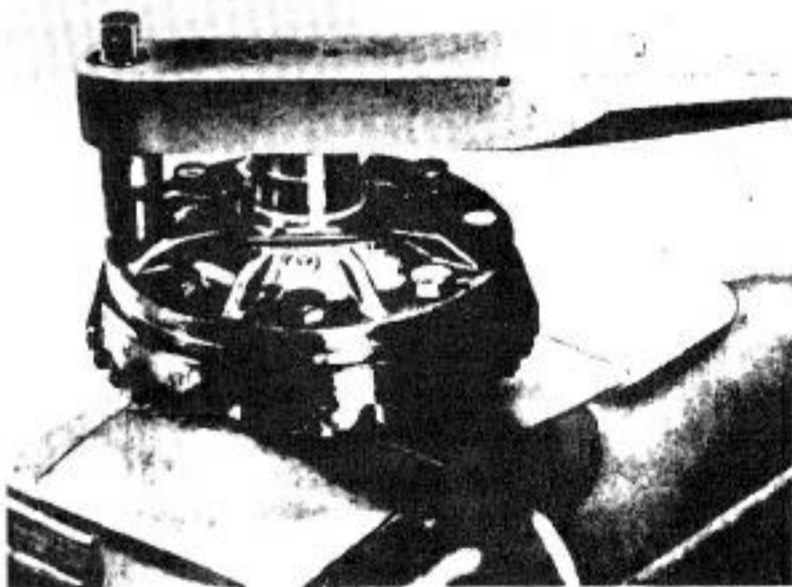


Fig. 11-23. Torquing ring gear bolts.

- Heat the two tapered-roller bearing inner races to 100°C (212°F) and seat them on the cover and housing. Fig. 11-24 shows the press setup. Apply a pressure of 3 tons (2721 kg).

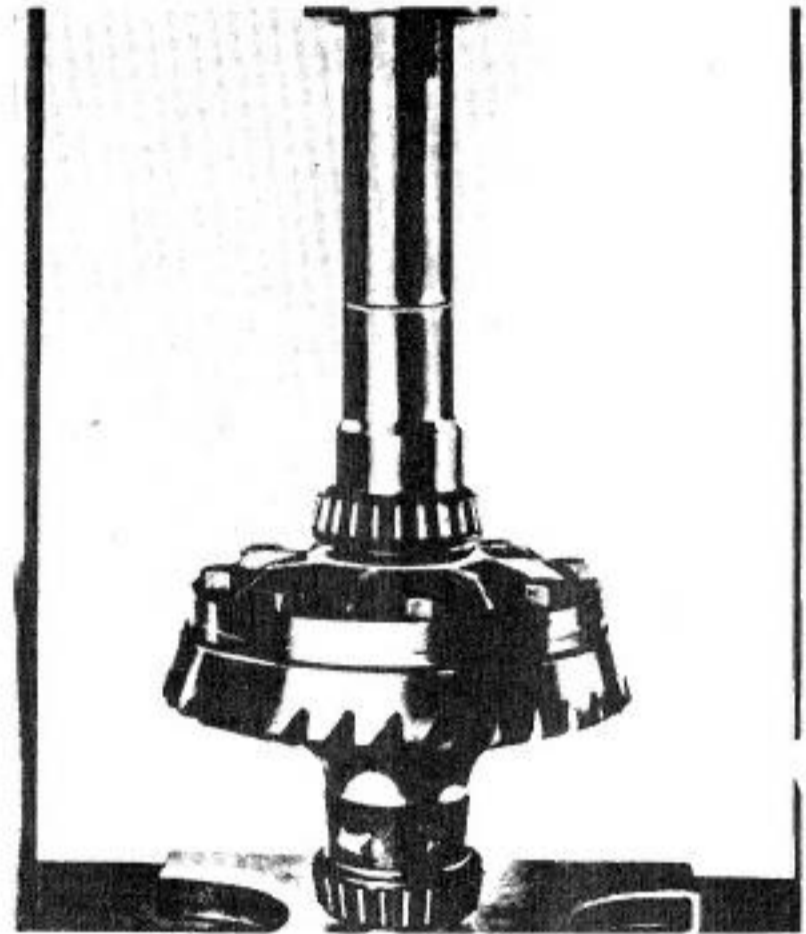


Fig. 11-24. Pressing heated inner bearing races home on the differential.

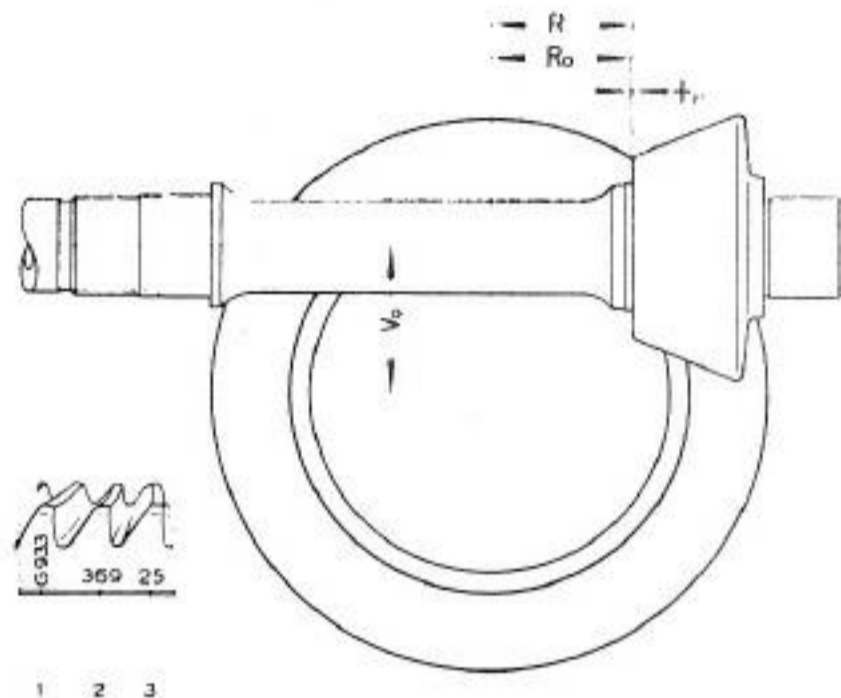
## 11.4 Adjusting Pinion and Ring Gear

The pinion and ring gear together make up the hypoid gearset. In a hypoid gearset the axis of the pinion is in a different plane from that of the ring gear. Precise meshing of the two is necessary for silent running and long service life.

A special testing machine at the factory adjusts ring and pinion gear mesh. Both gears are stamped with a matching number obtained from the machine measurements and can be replaced only as a set. Readjust the ring and pinion gear mesh only when you replace parts directly affecting the adjustments. For example, if you are replacing the differential housing, housing cover, or a tapered bearing, you need adjust only the ring gear. If the pinion bearings or pinion is replaced, you need adjust only the pinion. If both gears in the set are new or fitted with new bearings adjust the set as a unit.

The following is the standard gearset adjustment sequence: (1) Adjust the pinion tapered-roller bearings. (2) Adjust and check the pinion depth of mesh. (3) Adjust the differential tapered-roller bearings and set the backlash.

On the factory testing machine, a master gauge is applied to set the initial engagement of the pinion and ring gear. This setting determines the specified distance  $R_o$  between the end face of the pinion and an imaginary vertical line passing through the exact center of the ring gear (see Fig. 11-25).



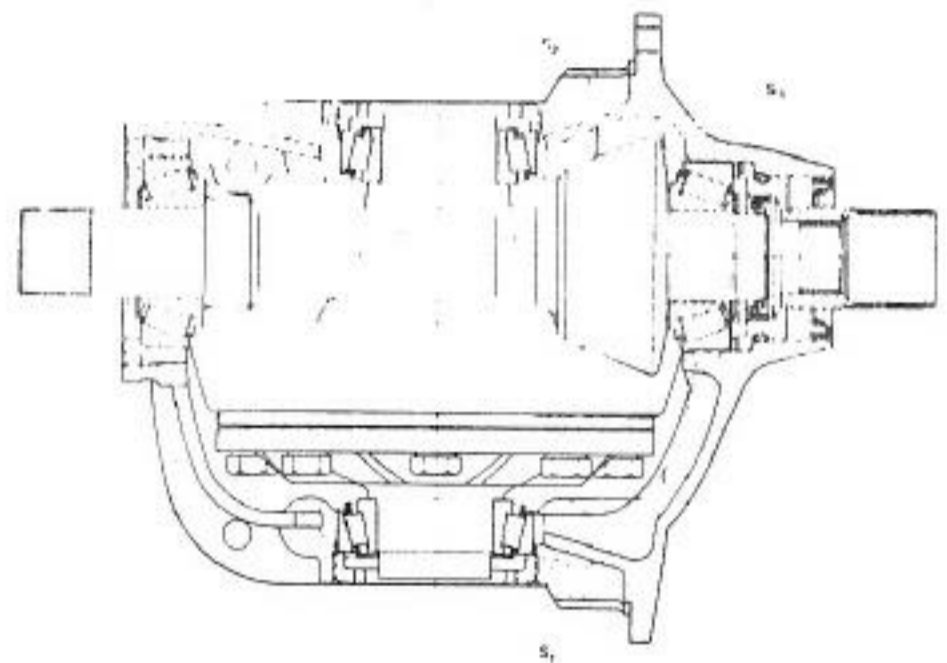
- $R_o$  Master gauge setting 40.55 mm (1.5965 in.)
- $R$  Actual setting for particular gearset
- $V_o$  Hypoid offset (distance between gear axes) 43.50 mm (1.7126 in.)
- 1 G 933, code for Gleason gearset, ratio 9.33
- 2 369 matching number for gearset
- 3 Deviation  $r$  given in hundredths of mm, 25 = 0.25 mm (.010 in.)

**Fig. 11-25.** Pinion and ring gear adjustment for quiet running. In this representation, the pinion would move only left or right, the ring gear only away from you and back again. Setting  $R_o$  and  $R$  and deviation  $r$ , as well as other markings, are vital to proper readjustment of gearset.

From the initial setting  $R_o$ , the pinion is moved axially and the ring gear moved outward from a no-play mesh. A tolerance range for play (backlash) between the gears is specified. Repeat the trial adjustments until you find the gearset's position of quiet running and best contact pattern. In that position the measurement from the ring gear centerline to the end face of the pinion will differ from  $R_o$  by a deviation  $r$ . The  $r$  deviation is stamped on the outer face of the ring gear as shown in Fig. 11-25.

Fig. 11-26 shows the adjusting rings and pinion shim in the differential carrier. The shims inserted between the pinion shoulder and the tapered-roller bearing or between the bearing and the differential carrier determine  $R$  for the gearset. The pinion adjusting ring determines the preload on the tapered-roller pinion bearings. The adjusting rings in the differential carrier determine the backlash

between the ring and pinion gears. The adjusting rings also determine the preload of the differential tapered-roller bearings.



- $S_3$  Shim for pinion
- $S_1$  Screw-in depth of adjusting ring (ring gear end)
- $S_2$  Screw-in depth of adjusting ring (opposite end)

**Fig. 11-26.** Hypoid gearset shims. Shop adjustments of the pinion and ring gear mesh require the shims shown here.  $S_1$  and  $S_2$  determine ring gear position.  $S_3$  determines depth of pinion engagement.

**Table d** lists the components of the differential carrier and shows whether replacement of each part will require adjustment of the pinion, the ring gear, or both.

**Table d. Required Final Drive Adjustments**

Part replaced	Adjust Pinion	Adjust Ring Gear (differential bearings)
Differential carrier	X	X
Differential tapered-roller bearings		X
Adjusting rings for differential		X
Differential housing		X
Differential housing cover		X
Pinion tapered-roller bearing	X	
Adjusting ring for pinion	X	
Pinion and ring gear. Installation of new gear set requires replacement of tapered-roller bearings	X	X

## 11.5 Adjusting Pinion

In the procedures covering this and other final drive adjustments you will frequently find tables listing the specifications and shim sizes needed to perform the work. The tables contain a number of standard terms and symbols used to designate gearset measurements. **Table e** describes all the terms and symbols.  $S_3$  is the first of these symbols that you will encounter. Establishing the thickness of the shim controlling this dimension is an important part of pinion adjustment.

**Table e. Standard Symbols**

Symbol	Description	Dimension
$S_1$	Screw-in depth of adjusting ring (ring gear end)	
$S_2$	Screw-in depth of adjusting ring (opposite end)	
$S_3$	Shim between tapered roller bearing and pinion or between bearing outer race and differential carrier	See table for thickness
$R_0$	Length of master gauge used on special testing machine	40.55 mm (1.5965 in.)
$R$	Position of pinion in relation to centerline of ring gear at quietest running point (nominal dimension)	$R = R_0 + r$
$r$	Deviation from $R_0$ , marked on gear set	
$Sv_0$	Backlash	0.15–0.25 mm (.0059–.0098 in.)
$V_0$	Hypoid offset	42.5 mm (1.6732 in.)
G 933	Gear set: G = Gleason; 933 = 9/33 number of teeth	$i = 3.67$
$D/2$	Half diameter of setting mandrel	$D/2 = 10.00$ mm (.3937 in.)
$E_0$	Length of setting gauge VW 380/3; $E_0 = R_0 + D/2$ mm	$E_0 = 50.55$ mm (1.9902 in.)
$e$	Difference between mandrel and setting gauge	measured in 1/100 mm

Pinion adjustment should be carried out in four stages: (1) measuring the preload on the tapered-roller bearing races; (2) determining the shim thickness  $S_3$  required for the particular pinion/ring gear combination; (3) setting the pinion; and (4) checking the adjustment.

**NOTE** —

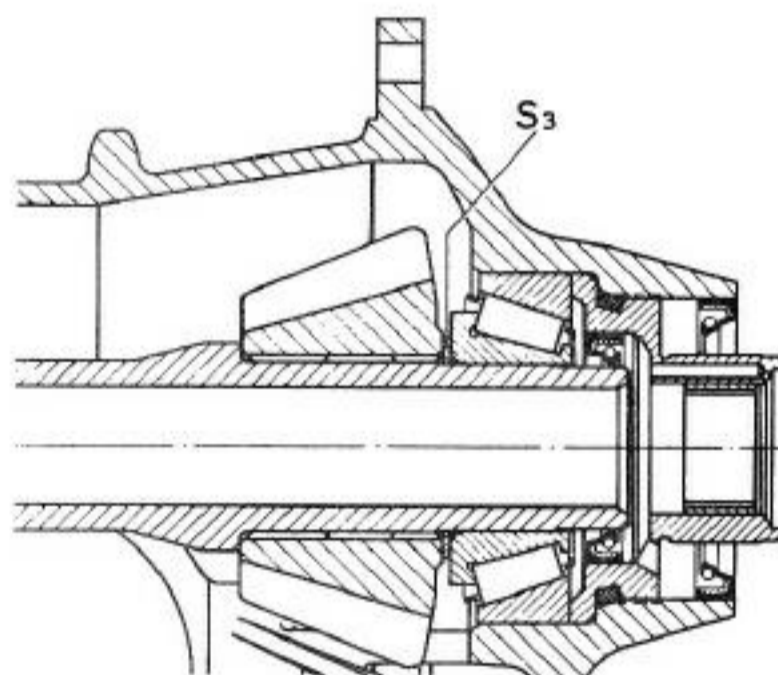
Lubricate the bearings only with hypoid oil during final drive adjustments. Other oils will run off, leaving the bearings dry.

Accurate measuring methods at the factory make it practical to place the  $S_3$  shim between the pinion and the tapered-roller bearing inner race. However, trial and error measurements are needed during repair operations. You should therefore put the  $S_3$  shim between the tapered-roller bearing outer race and the converter one-way clutch support. This will make it far easier to exchange the shim for one of a different size if the pinion position must be corrected. See Fig. 11-27.

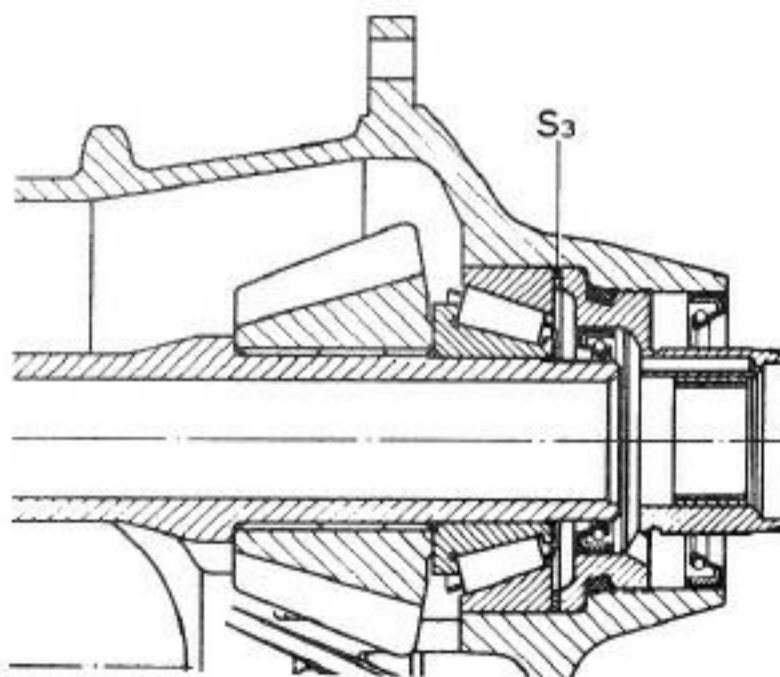
The procedures for adjusting the pinion require two special tools, a torque gauge with adapter and a dial gauge with holder. The torque gauge is used in measuring the preload on the bearing races.

**Fig. 11-27.** Pinion  $S_3$  shim locations. The factory placement should not be used after a repair or re-adjustment has been made.

Factory location



Repair location





### To measure preload:

1. Put the carrier in the holding plate and clamp the plate with the carrier in a vise, as in Fig. 11-28.



Fig. 11-28. Pinion and carrier in vise for preload measurement.

2. Install the inner bearing race behind the pinion.
3. Install the pinion in the carrier and tighten the adjusting ring to remove all axial play.
4. Clamp the torque gauge adapter in the pinion and attach the gauge.
5. Spin the pinion rapidly 15 or 20 revolutions in each direction.
6. While still spinning the pinion, screw in the adjusting ring to bring the torque within the specified tolerance (Table f). Make a note of the exact torque recorded. You will use this value later in adjusting the ring gear.

Table f. Pinion Turning Torque

Nominal value	cmkg	in. lb.
New bearings	8-12	7-10
Used bearings [after 30 mi. (48 km)]	0-4	0-3.5

In the next stage of the procedure for adjusting the pinion, use a special mandrel to establish the equivalent of the ring gear center line in the carrier. Install the mandrel where the differential would normally be. Using a dial gauge mounted on the mandrel, measure to the end face of the pinion. This is to determine the appropriate  $S_3$  shim thickness for the pinion adjustment.

### To find $S_3$ :

1. Place the dial gauge in the holder on the setting block, as in Fig. 11-29. Set a 1-mm preload and then zero the gauge.
2. Put the setting mandrel in the differential carrier with the outer bearing races and the adjusting rings in place. Attach the bearing caps and tighten the bolts to 5.5 mkg (40 ft. lb.). Turn the adjusting rings to position the mandrel. You should just be able to turn the mandrel by hand.

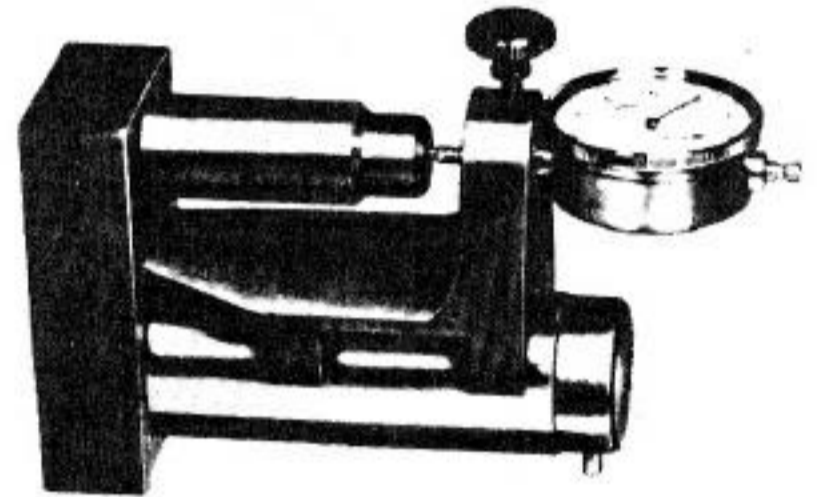


Fig. 11-29. Dial gauge on setting block, set to zero with 1-mm (.040-in.) preload.

3. Set the dial gauge holder on the pinion shaft and press the holder snugly against the end face of the pinion. (See Fig. 11-30.) Carefully move the holder until the dial gauge pin rests on the highest point of the polished cylindrical section of the mandrel. Take the reading at that point.

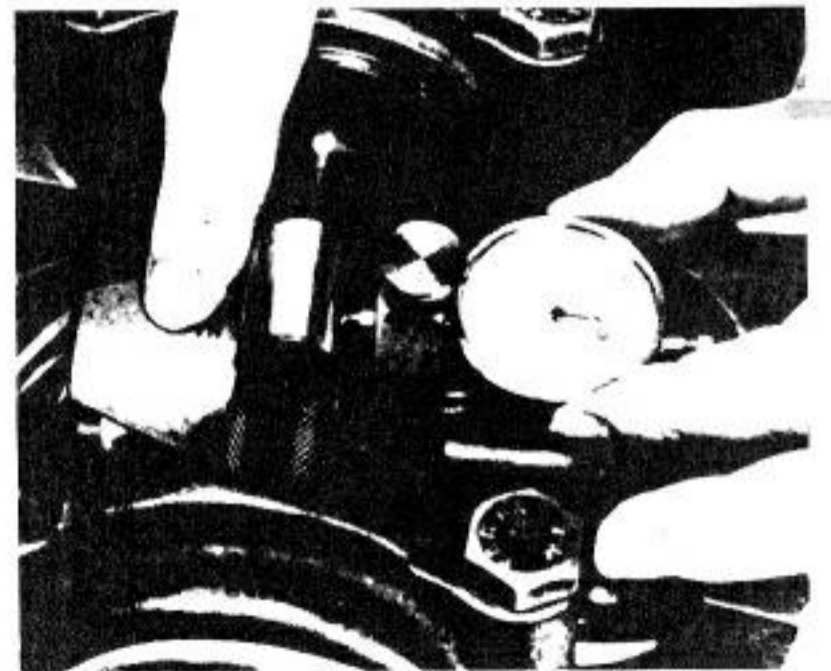


Fig. 11-30. Mandrel and dial gauge measuring pinion position. Gauge pin rests on mandrel while gauge holder is pressed lightly against pinion.



4. Look at the stamped coding on the pinion for deviation  $r$  of the gearset. Subtract this  $r$  from the measurement you have just taken with the dial gauge. The difference obtained is called the  $S_3$  nominal range. Using the arithmetic described here you can use this result to find the actual  $S_3$  shim thickness needed for pinion adjustment.

**CAUTION** —

Every number or setting in the following example is imaginary. Using them as specifications for a car could cause serious damage.

A fictitious example will show you how to use the  $S_3$  nominal range to find the  $S_3$  shim thickness. For our example the following data are given:

$r$ (stamped on the gearset)	0.23 mm
$E_0$ (dial gauge input from setting block)	50.55 mm
$R_0$ (factory master gauge pinion setting)	40.55 mm
$D/2$ (half mandrel cylinder diameter)	10.00 mm

Assume the following dial gauge measurement:

$$e = 1.64 \text{ mm}$$

We can now find the required  $S_3$  shim thickness by simple arithmetic. We take the value we calculated for the nominal pinion dimension and subtract it from the actual pinion dimension we measured without the shims:

$$\begin{array}{r} 52.19 \text{ mm} \\ - 50.78 \text{ mm} \\ \hline S_3 = 1.41 \text{ mm} \end{array}$$

Analysis of the step-by-step calculation reveals the following simple formula:

$$S_3 = e - r$$

In our example:

$$\begin{array}{l} S_3 = 1.64 - 0.23 \text{ mm} \\ = 1.41 \text{ mm} \end{array}$$

The formula says that you take the gauge reading  $e$  between the pinion end face and the far surface of the mandrel cylinder (1.64 mm in our example) and subtract from it the deviation  $r$  (0.23 mm in our example) to obtain  $S_3$ , which in our example turned out to be 1.41 mm. Thus the formula requires you to make only one actual measurement using the stampings on the gearset.

**Table g** gives a list of the shims that are available to match the  $S_3$  nominal ranges you are likely to find in actual gearsets. The shim numbers and their replacement part numbers are included.

**NOTE** —

When selecting a shim from the table, measure it carefully at several points with a micrometer. Check the shim for burrs or damage. Use only shims in perfect condition.

**Table g.  $S_3$  Shims**

$S_3$ Nominal Range mm (Inch)	$S_3$ Actual $\pm 0.01$ mm ( $\pm .0004$ in.)	Shim No.	Part No.
0.98-1.02 (.0385-.0400)	1.00 (.0395)	1	003 519 141A
1.03-1.07 (.0405-.0420)	1.05 (.0415)	2	003 519 142A
1.08-1.12 (.0425-.0440)	1.10 (.0435)	3	003 519 143A
1.13-1.17 (.0445-.0460)	1.15 (.0455)	4	003 519 144A
1.18-1.22 (.0465-.0480)	1.20 (.0470)	5	003 519 145A
1.23-1.27 (.0485-.0500)	1.25 (.0490)	6	003 519 146A
1.28-1.32 (.0505-.0520)	1.30 (.0510)	7	003 519 147A
1.33-1.37 (.0525-.0540)	1.35 (.0530)	8	003 519 148A
1.38-1.42 (.0545-.0560)	1.40 (.0550)	9	003 519 149A
1.43-1.47 (.0565-.0580)	1.45 (.0570)	10	003 519 150A
1.48-1.52 (.0585-.0600)	1.50 (.0590)	11	003 519 151A
1.53-1.57 (.0600-.0620)	1.55 (.0610)	12	003 519 152A
1.58-1.62 (.0620-.0635)	1.60 (.0630)	13	003 519 153A
1.63-1.67 (.0640-.0655)	1.65 (.0650)	14	003 519 154A
1.68-1.72 (.0660-.0675)	1.70 (.0670)	15	003 519 155A

**To set and check pinion:**

1. Remove the pinion and pull out the outer bearing race.
2. From **Table g** select the  $S_3$  shim of the correct size to satisfy the equation and install it. Press in the outer race again.
3. Reinstall the pinion and adjust it to give the same torque that you obtained previously in step 4 of the procedure for measuring the preload.
4. Repeat the measurement between the end face of the pinion and the measuring surface on the mandrel. (Fig. 11-31 is a cross section of the setup.) Remember that the gauge pin is half the diameter of the mandrel shaft (shaded circle) beyond the ring gear centerline. If you have installed the correct  $S_3$  shim, the dial gauge reading should equal the deviation  $r \pm 0.04$  mm (.0015 in.).

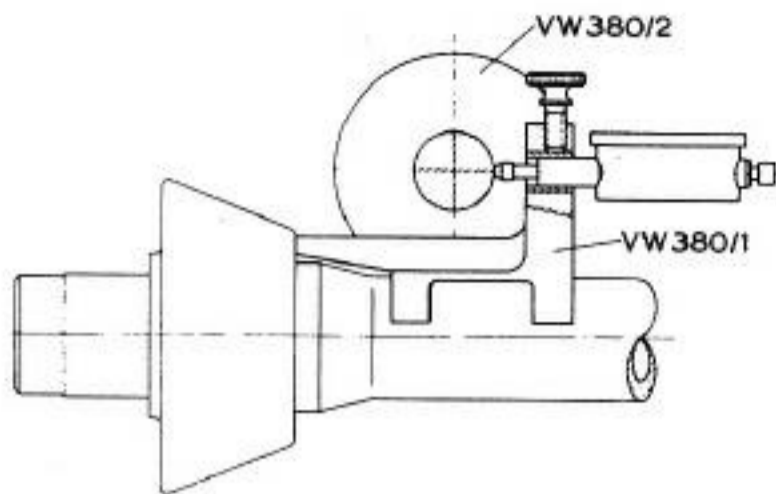


Fig. 11-31. Gauge holder placed against pinion face with dial indicator pin against mandrel.

5. Lock the pinion adjusting ring. Two different lock-plates are available. One of them will fit.

## 11.6 Adjusting Ring Gear

Smooth operation of the final drive requires correct clearance between the pinion and the ring gear teeth. The ring gear adjustment includes bringing this backlash within the specified tolerance.

The adjusting rings under the bearing caps at the sides of the differential carrier move the ring gear toward or away from the pinion. When you screw the right adjusting ring out and at the same time screw the left adjusting ring in, the ring gear is moved away from the pinion. When you reverse the procedure by screwing the left ring out and the right ring in, the ring gear is moved toward the pinion. The complete procedure for adjusting the ring gear can be divided into three stages: (1) measuring the pinion torque and adjusting the pinion, (2) measuring the total torque on the final drive, and (3) checking the backlash.

Measuring pinion torque and adjusting the pinion are described in 11.5 Adjusting Pinion. Measuring the total torque requires the same tools. You will also need to know the exact pinion torque gauged in the earlier procedure in order to determine the total torque. The dial indicator is used with two special brackets to check backlash.

### To measure total torque:

(It is assumed in the following instructions that you have already adjusted the pinion and that you have made a note of the exact pinion torque.)

1. With the differential and the ring gear bolted together and with the roller bearings and the adjusting rings in place, put the differential in the carrier. Attach the bearing caps and tighten the cap bolts to 5.5 mkg (40 ft. lb.).

### NOTE —

Lubricate the tapered-roller bearings thoroughly with hypoid oil. If you use another kind of oil or leave the bearings dry, measurements will be inaccurate.

2. Clamp the torque gauge adapter in the pinion and attach the gauge. Spin the pinion with the gauge handle to turn the differential and ring gear 15 to 20 times in each direction.
3. Look in the two left hand columns of **Table h** for the exact pinion torque you gauged when adjusting the pinion. Note that new bearing and old bearing values are different. When you find the entry corresponding to your value, move across the same row to the right-hand columns for the matching **Total Torque** entry.
4. Tighten the adjusting ring opposite the ring gear to obtain the same torque you found in the **Total Torque** column in **Table h**. This procedure is illustrated in Fig. 11-32.

**Table h. Total Turning Torque**

Actual Pinion Torque cmkg (in. lb.)		Total Torque cmkg (in. lb.)	
New bearings	Used bearings run 30 mi. (48 km)	New bearings	Used bearings run 30 mi. (48 km)
8 (7.0)	0 (0.0)	10-12 (8.5-10.5)	1-3 (1.0-2.5)
9 (8.0)	1 (1.0)	11-13 (9.5-11.0)	2-4 (1.5-3.5)
10 (8.5)	2 (1.5)	12-14 (10.5-12.0)	3-5 (2.5-4.0)
11 (9.5)	3 (2.5)	13-15 (11.0-13.0)	4-6 (3.5-5.0)
12 (10.5)	4 (3.5)	14-16 (12.0-14.0)	5-7 (4.0-6.0)



Fig. 11-32. Using special wrench with screwdriver to tighten ring gear adjusting ring.

## To check backlash:

1. Insert dial indicator (3-mm range) in the special L-shaped holder illustrated in Fig. 11-33.

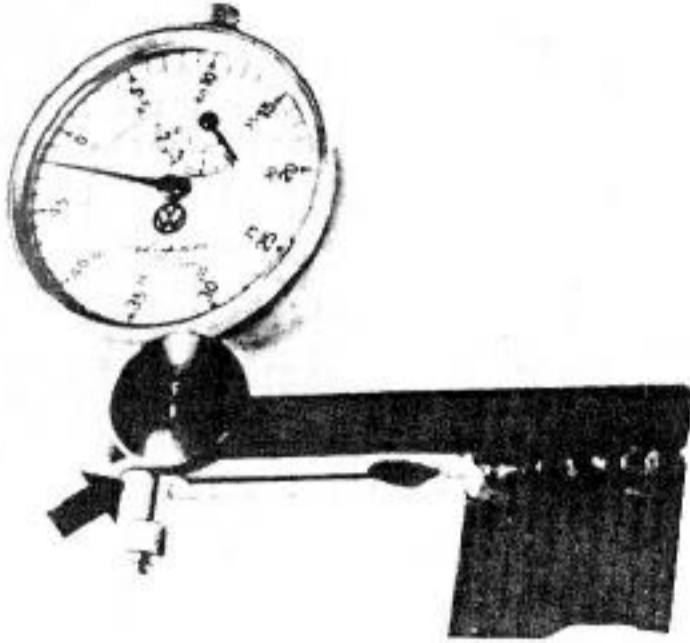


Fig. 11-33. Bracket for measuring backlash. Dial indicator neck is flush (arrow) with bracket edge.

2. Secure the bracket together with the gauge to the support plate that holds the differential carrier.
3. Remove the two ring gear bolts at the top of the gear and install the T-shaped bracket shown in Fig. 11-34.

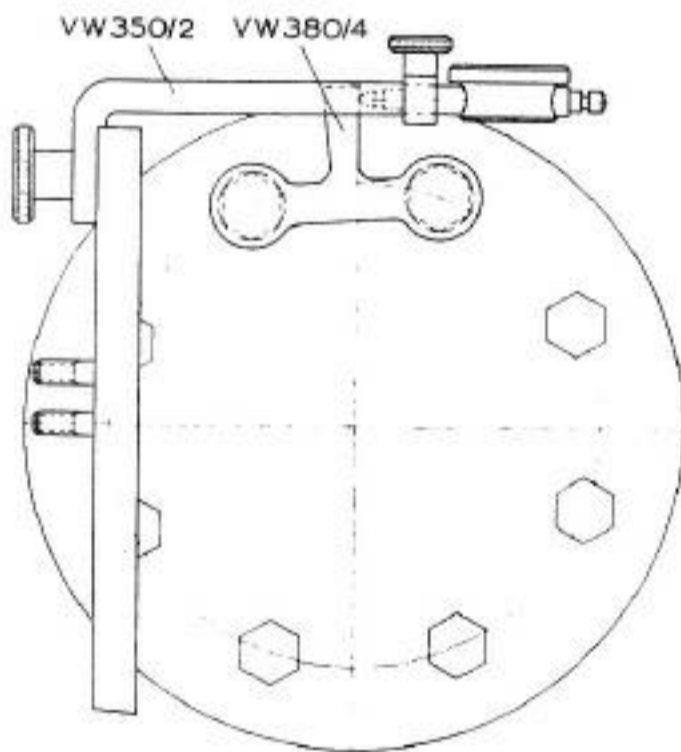


Fig. 11-34. Ring gear rotation being measured. The indicator pin contacts the plastic bracket slipped over the ring gear bolts.

4. Turn the ring gear until the gauge shows a 1.5-mm (.059-in.) preload.

5. Turn the ring gear clockwise and counterclockwise to measure backlash, as in Fig. 11-35.



Fig. 11-35. Measuring backlash. The dial indicates the amount of ring gear rotation.

6. Move the bracket and take readings at four points, 90° apart. Then average the readings. The average should be  $Sv_0 = 0.15$  to  $0.25$  mm (.006 to .010 in.).

### NOTE —

If the four readings vary by more than 0.05 mm (.002 in.), something is wrong either with the ring gear installation or with the gearset. Recheck the assembly procedure. Replace the gearset if necessary.

7. Screw in the adjusting ring opposite the ring gear while screwing out the other adjusting ring exactly the same number of turns until you obtain a backlash of 0.20 mm (.008 in.). This is  $Sv_0$ .
8. Lock the adjusting rings. Two lockplates are available. One or the other always fits.

## 11.7 Adjusting Flanged Shaft Axial Play

The flanged shafts, held by central bolts and installed on 1970 and later cars, float axially in the differential housing and housing cover. Adjust the axial play when installing new side gears, new thrust washers, or a new flanged shaft, housing or cover.

### To adjust:

1. Insert the flanged shaft into the differential housing or housing cover.
2. Place the thrust washer, side gear and nut on the shaft.

- Torque the flanged shaft bolt to 2.5 mkg (18 ft. lb.).
- Measure the clearance as shown in Fig. 11-36. Then select the shim to suit the clearance from Table I.

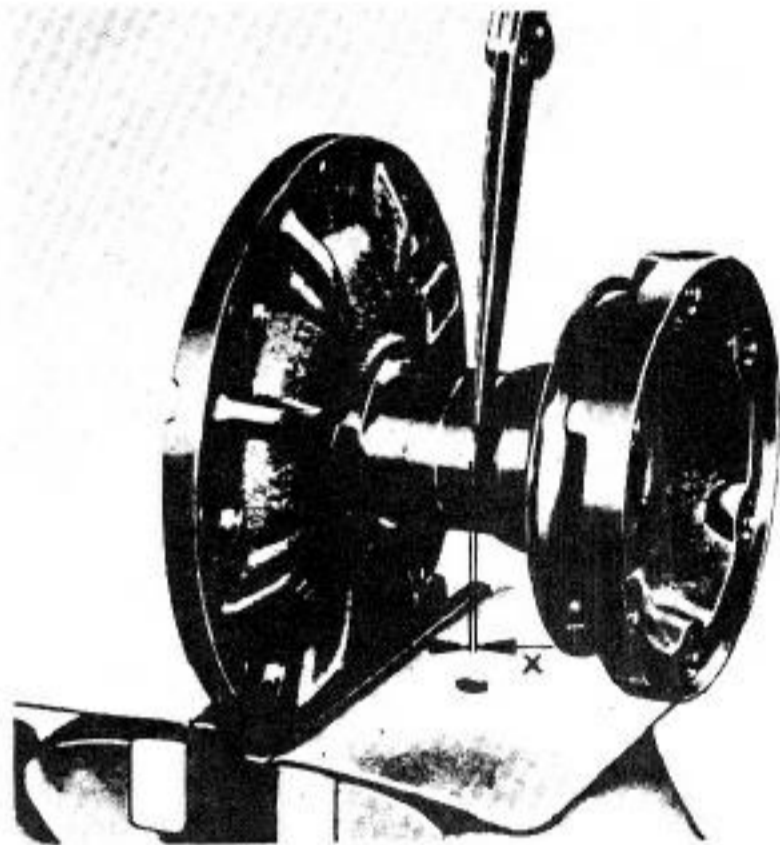


Fig. 11-36. Checking axial play x with a feeler gauge.

Table i. Flanged Shaft Shims

Clearance "x" mm (in.)	Shim Thickness mm (in.)	Part No.
1.05-1.13 (.041-.044)	1.00 (.0394)	003 507 401
1.14-1.20 (.045-.047)	1.07 (.0421)	003 507 402
1.21-1.27 (.048-.050)	1.14 (.0449)	003 507 403
1.28-1.34 (.050-.053)	1.21 (.0476)	003 507 404
1.35-1.41 (.053-.056)	1.28 (.0504)	003 507 405
1.42-1.48 (.056-.058)	1.35 (.0532)	003 507 406
1.49-1.55 (.059-.061)	1.42 (.0559)	003 507 407
1.56-1.62 (.061-.064)	1.49 (.0587)	003 507 408
1.63-1.69 (.064-.067)	1.56 (.0614)	003 507 409
1.70-1.76 (.067-.069)	1.63 (.0642)	003 507 410
1.77-1.83 (.070-.072)	1.70 (.0669)	003 507 411
1.84-1.90 (.072-.075)	1.77 (.0697)	003 507 412
1.91-1.97 (.075-.078)	1.84 (.0724)	003 507 413
1.98-2.04 (.078-.080)	1.91 (.0752)	003 507 414
2.05-2.11 (.081-.083)	1.98 (.0780)	003 507 415
2.12-2.14 (.083-.084)	2.05 (.0807)	003 507 416

- Reassemble the shaft in the housing or cover together with the selected shim. With the side gear held in, the play must measure 0.05 to 0.15 mm (.002 to .006 in.).

It is also possible to check the flanged shaft axial play with the final drive and flanged shafts installed in the final drive housing. This check can be an important part of troubleshooting final drive noises. With care, it is possible to replace shims with the transmission installed.

### To check:

- Install a dial indicator with a 10-mm (.400-in.) range as shown in Fig. 11-37.

#### NOTE —

The flanged shaft must be installed with at least the thinnest available shim in place to keep the nut for the flanged shaft from contacting the differential pinion shaft.

#### CAUTION —

When removing the flanged shafts, do not let the shims fall into the final drive. The transmission would have to be removed and disassembled to retrieve them.

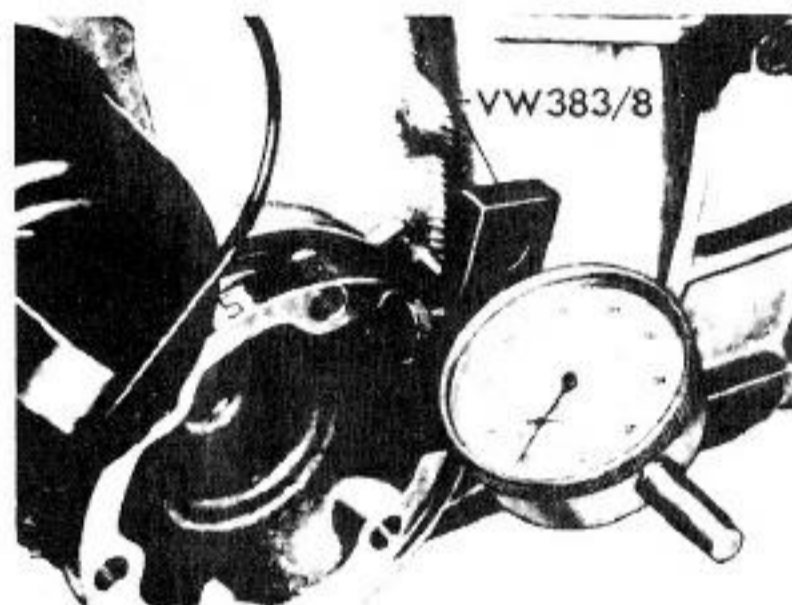


Fig. 11-37. Checking axial play, shaft installed.

- Move the flanged shaft in and out axially. Read the axial play on the dial indicator.

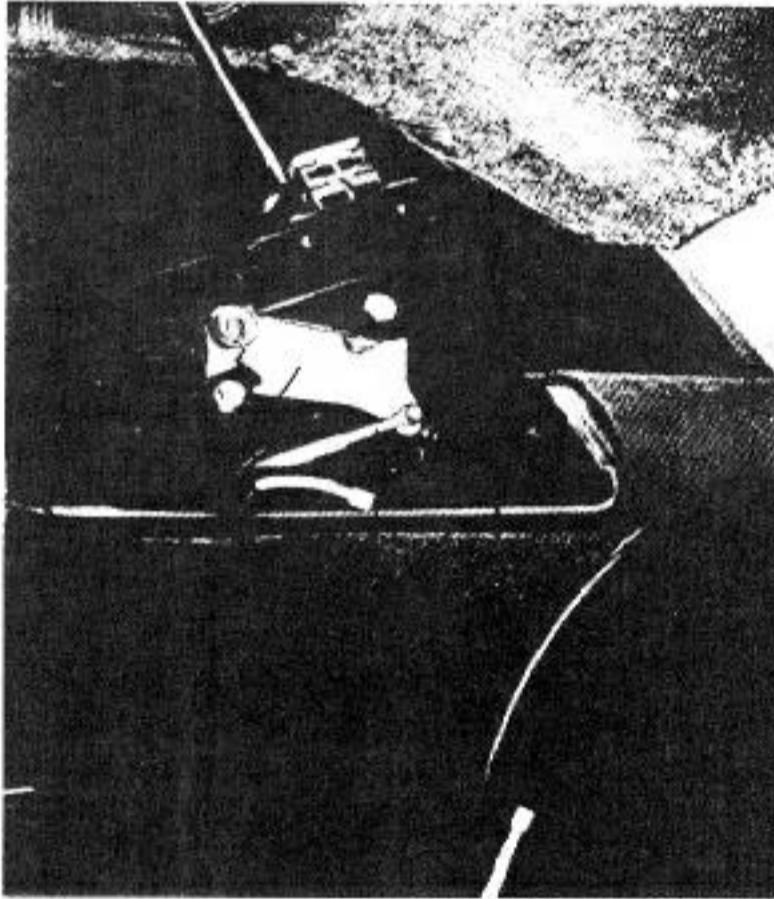
## 11.8 Part Interchangeability

The differential side gears used with 1970 to 1973 flanged shafts that have a bolt through their center can be installed without difficulty in the 1968 to 1969 transmission. However, do not install the earlier-type differential side gears in a transmission having flanged shafts with center bolts. The older-type gears are thicker and would cause the flanged shaft retaining bolt nuts to contact the differential pinion shaft. The later-type gears are marked with a groove around their outermost surface.

The differential housing and cover used with the later flanged shafts cannot be installed in an earlier transmission unless they are chamfered to a depth of 2.00 mm (.080 in.) with a 45° cutter to provide clearance for the corner radius on the old-style flanged shafts. If this is not done, related parts may be damaged during installation and the flanged shafts will bind, preventing proper differential operation.

## 12. SELECTOR LEVER AND BOWDEN CABLE

The gear selector control assembly can be unbolted from the frame tunnel for access to the parts listed in Fig. 12-1. The assembly is usually removed to test or replace the neutral safety/back-up light switch or to replace a faulty Bowden cable.



1. Selector segment
2. Bowden cable
3. Neutral safety/back-up light contacts

Fig. 12-1. Selector control assembly unbolted from the frame tunnel.

### 12.1 Removing and Installing Bowden Cable

The Bowden cable extends from the gear selector control assembly, through the frame tunnel, to the manual valve lever on the left side of the transmission. A rubber boot covers the cable near the transmission. This boot should always be replaced, if it is torn or cracked, to keep road splashes from entering the cable.

#### To remove:

1. Take the rubber plug around the cable out of the frame.
2. Loosen the clamp nut shown at arrow **A** in Fig. 12-2. Detach the cable.

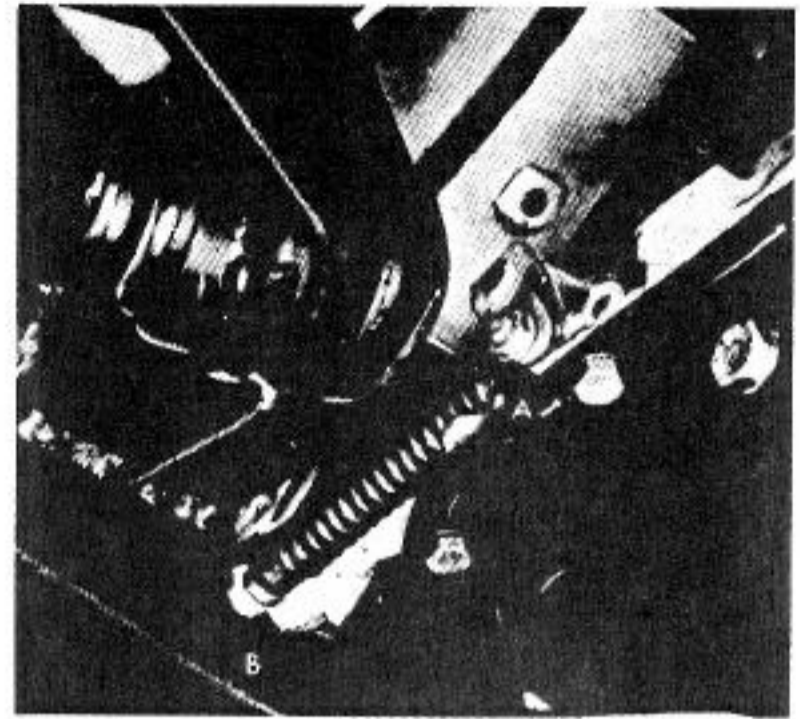


Fig. 12-2. Cable connection at transmission. The clamp nut is at arrow **A**, the retaining nut at arrow **B**.

3. Fasten a long piece of flexible wire to the rear end of the cable. You will use this to pull the new cable through the frame tunnel.
4. Push away the rubber boot and remove the retaining nut (arrow **B** in Fig. 12-2). Push the cable forward out of the subframe.
5. Take off the selector lever knob, remove the cable, and take up the floor mat. Remove the wires from the neutral safety switch. Unbolt the gear selector control assembly and lift it from the frame tunnel.
6. Detach the Bowden cable from the selector segment.

Using the long flexible wire, pull the new cable back toward the transmission. Otherwise installation is the reverse of removal. Then adjust the cable.

### 12.2 Adjusting Bowden Cable

Adjust the Bowden cable when replacing it or when troubleshooting shows it to be out of adjustment. Many supposed transmission troubles can be traced to an improperly adjusted Bowden cable.

#### To adjust:

1. Loosen the clamp nut at the rear of the cable.
2. Move the selector lever to **P**.
3. Press the manual valve lever on the transmission fully to the rear. Turn the rear wheel slightly until the parking lock engages.
4. Tighten the clamp nut, being careful to keep the manual valve lever all the way to the rear.



## 13. AUTOMATIC TRANSMISSION TECHNICAL DATA

### I. General Data

Type/model	Transmission type	Code letter	Final drive ratio	Engine capacity	Valve body code letters	Remarks	Manufacturing dates
3	Automatic	EB	9:33	1600	B	M236 (Fuel injection)	Aug. 1968-

### II. End Play Adjustments

Adjustment	New Part Installation mm (Inches)
1. Planetary gear end play	0.45-1.05 (.018-.041)
2. Forward clutch end play a Use lined plates with annular grooves only and a pressure plate $6.10 \pm 0.25$ mm (.240 $\pm$ .010 in.) thick. Note thickness of circlip	0.80-1.20 (.032-.047)
3. Direct and reverse clutch end play a. Circlip thickness for clutch with 2 plates b. Circlip thickness for clutch with 3 plates Use lined plates with waffled surface only and a pressure plate $6.30 \pm 0.15$ mm (.248 $\pm$ .006 in.) thick	1.70 (.067) 1.70-2.20 (.067-.087)

### IV. Final Drive Adjustment

1. Preload for drive pinion bearings	New bearings: 14.0-20.0 cmkg (12.1-17.4 in. lb.)  Used bearings: 2.0 cmkg (1.7 in. lb.) [more than 30 mi. (48 km)] Measure backlash and total torque before disassembly. If total torque is at least 3.0 cmkg (2.6 in. lb.) and pinion torque at least 2.0 cmkg (1.7 in. lb.), mark position of adjusting rings and align marks in reassembly. If pinion torque is less, set to 2.0 cmkg (1.7 in. lb.) in assembly. Replace bearings if play exists.
2. Total preload for drive pinion with differential	New bearings: 22.0-24.0 cmkg (19.1-20.8 in. lb.)  Used bearings: 3.0-5.0 cmkg (2.6-4.3 in. lb.) [more than 30 mi. (48 km)]

### III. Valve Body Spring Table

Description	Part No.	Dimensions			
		No. of Coils	Wire Thickness mm (in.)	Free Length (approximate) mm (in.)	Coil Inner Dia. $\pm 0.3$ mm ( $\pm .012$ in.)
Main pressure valve spring	003 325 131	16.5	1.50 (.0590)	68.5 (2 $\frac{1}{16}$ )	11.90 (.469)
Secondary throttle pressure valve spring	003 325 157 A	12.5	0.85 (.0335)	29.1 (1 $\frac{1}{32}$ )	7.35 (.289)
Kickdown valve spring	003 325 175	10.5	0.63 (.0248)	23.8 ( $\frac{1}{16}$ )	7.70 (.303)
Modulator valve spring	003 325 185	11.5	0.80 (.0315)	28.5 (1 $\frac{1}{8}$ )	7.75 (.305)
2nd/3rd shift valve spring	003 325 207	8.5	1.00 (.0393)	25.4 (1)	9.00 (.354)
1st/2nd shift valve spring	003 325 217	9.5	1.00 (.0394)	23.6 ( $\frac{7}{32}$ )	8.00 (.315)
Throttle pressure limiting valve spring	003 325 227 A	12.5	1.00 (.0394)	32.4 (1 $\frac{1}{32}$ )	7.70 (.303)
Converter pressure valve spring	003 325 247	9.5	1.25 (.0492)	27.3 (1 $\frac{1}{16}$ )	8.13 (.320)
Pressure relief valve spring	003 325 267	15.5	0.80 (.0315)	27.7 (1 $\frac{3}{32}$ )	4.70 (.185)
2nd/3rd valve spring	003 325 269	4.5	0.20 (.0079)	5.8 ( $\frac{7}{32}$ )	4.30 (.169)
Primary throttle pressure valve spring	003 325 295	10.5	0.63 (.0248)	36.3 (1 $\frac{1}{16}$ )	9.00 (.354)
3rd/2nd control valve spring	003 325 119 A	15.0	0.56 (.0220)	24.5 ( $\frac{3}{16}$ )	6.40 (.238)



# Technical Service Information

## V. Automatic Transmission Test Data

Stall Speed (1900-2000 rpm) Pressure Table			
Selector Lever Position	Pressure	psi (kg/cm <sup>2</sup> )	Remarks
N	Primary throttle pressure	42 (3.0) 45.5 (3.2) after Aug. 1971	Increase idle speed to 1000 rpm with vacuum hose off and plugged
	Main pressure	116-120 (8.2-8.5)	
	Primary throttle pressure	5-6 (0.35-0.40)	
	Main pressure	47-50 (3.3-3.5)	
R	Main pressure	95-110 (6.7-7.7)	
D	Primary throttle pressure	40-42 (2.8-3.0)	At stall torque speed (full throttle) with vacuum hose on
	Main pressure	114-120 (8.0-8.4)	
R	Main pressure	213-284 (15.0-20.0)	
D	Main pressure	87-90 (6.1-6.3)	At full throttle with a road speed of over 19 mph (30 kph)
Gear shift speeds in mph (kph)			
Gear	Part throttle	Full throttle	Kickdown
1st/2nd	10-13 (16-21)	17-19 (27-31)	31-40 (50-64)
2nd/3rd	15-17 (24-27)	43-50 (70-80)	54-59 (87-95)
3rd/2nd	15-12 (24-19)	37-30 (60-49)	55-50 (89-80)
2nd/1st	10-8 (16-13)	15-11 (24-18)	35-27 (56-44)

## VI. Ratios

Gear	Ratio
Transmission:	
1st gear	2.65
2nd gear	1.59
3rd gear	1.0
Reverse	1.8
Converter:	
Maximum torque multiplication	2.5
Final drive	3.67

## VII. Tightening Torques

Description	Thread	Grade	mkg	ft. lb.
Fluid pump to transmission case bolt	M 6 x 1	8G	0.4	3.0
Transfer plate on valve body screw	M 5 x 0.8	8G	0.35	2.5
Valve body to transmission case bolt	M 6 x 1	8G	0.4	3.0
Pan to transmission case bolt	M 8 x 1.25	8G	1.0	7.0
Fluid strainer to valve body screw	M 6 x 1	8G	0.3	2.0
Manual valve lever/cable lever nut	M 8 x 1.25	8G	0.6	4.5
Cable lever retaining screw	M 6 x 1	8G	0.5	3.5
Operating lever pin in transmission case	M 10 x 1.5	8G	0.6	4.5
Cable bracket on transmission case bolt	M 8 x 1.25	6G	1.5	11.0
Filler tube to transmission case bolt	M 6 x 1	8G	0.5	3.5
Pressure connection plugs in transmission case	M 10 x 1	—	1.0	7.0
Vacuum unit in transmission case	M 14 x 1.5	—	2.5	18.0
Lock nut for band adjusting screw	M 12 x 1.75	8G	2.0	14.0
Air deflector on final drive housing bolt	M 10 x 1.5	8G	1.0	7.0
Differential carrier on final drive housing nut	M 6 x 1	8G	0.8	6.0
Side cover/final drive housing nut	M 6 x 1	8G	0.8	6.0
Starter/final drive housing nut	M 10 x 1.5	8G	2.5	18.0
Bearing cap/differential carrier bolt	M 10 x 1.5	10K	6.0	43.0
Ring gear/differential housing bolt	M 9 x 1	10K	5.0	36.0
Transmission case/final drive housing nut	M 8 x 1.25	8G	2.0	14.0
Converter to drive plate bolt	M 8 x 1.25	8G	2.5	18.0
Drive shaft/flange socket head screw	M 8 x 1.25	10K	3.5	25.0
Brake band adjusting screws on top transmission case (Have transmission horizontal when adjusting bands. When new bands are installed, tighten adjusting screws to 1 mkg (7 ft. lb.) and release them (to center bands) before carrying out adjustments.)				
Adjusting screw for front brake band	M 12 x 1.75	—	0.5	3.5
Adjusting screw for rear brake band	M 12 x 1.75	—	0.5	3.5



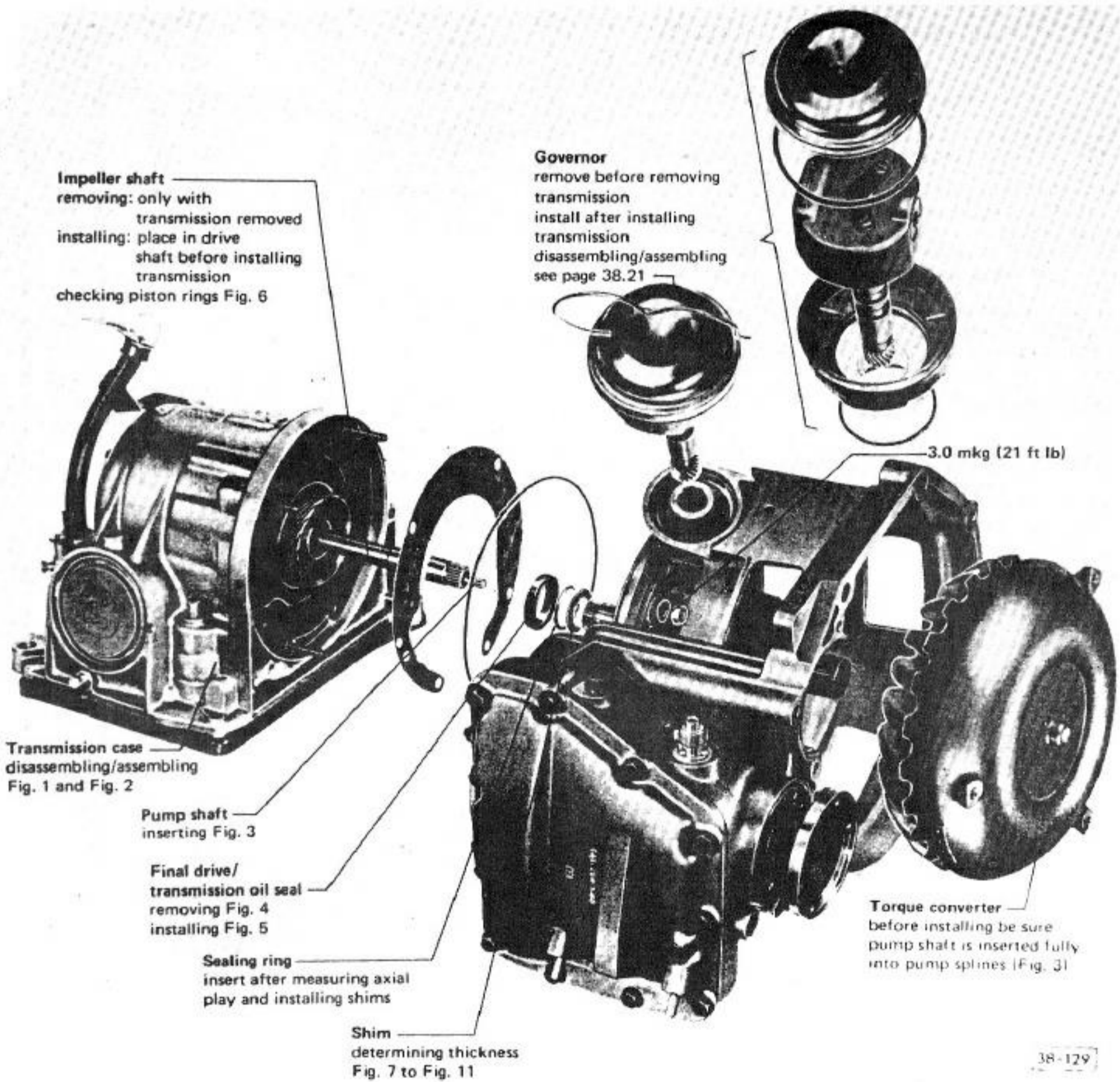
**Note**

Final drive/transmission oil seal is installed in final drive but sealing lip fits a shoulder on ring gear in transmission.

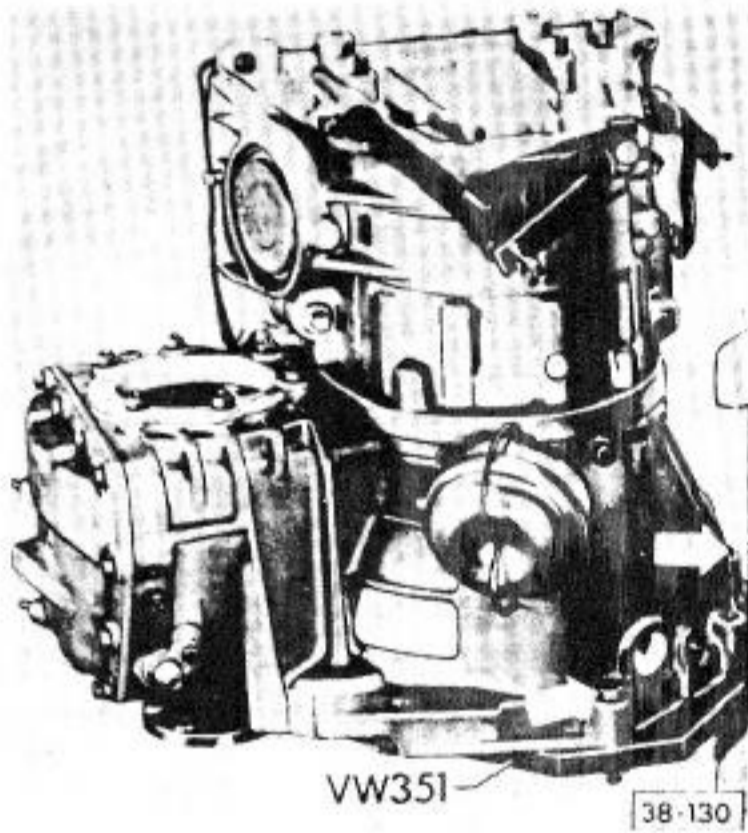
If only oil seal is to be replaced transmission should not be tilted when removing from final drive to avoid oil leakage and mixing.

**Caution**

When replacing final drive or transmission check axial play if necessary adjust

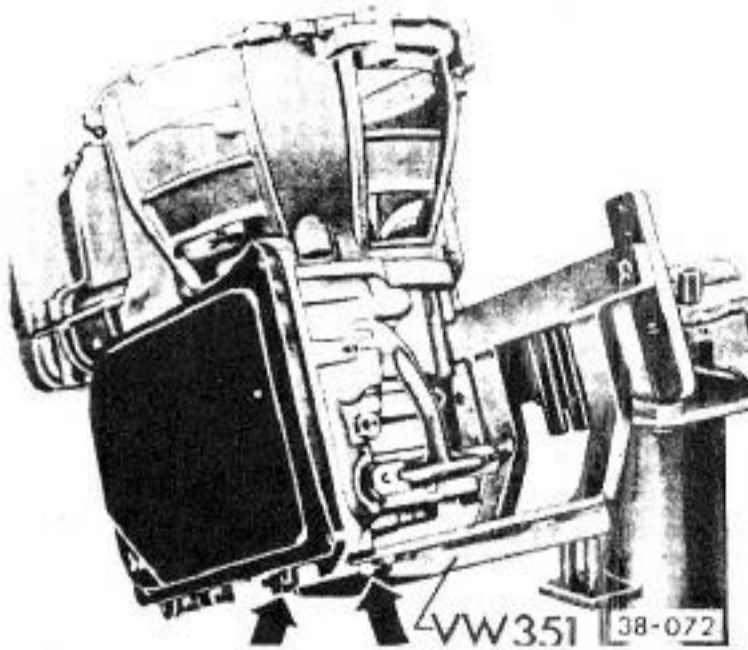


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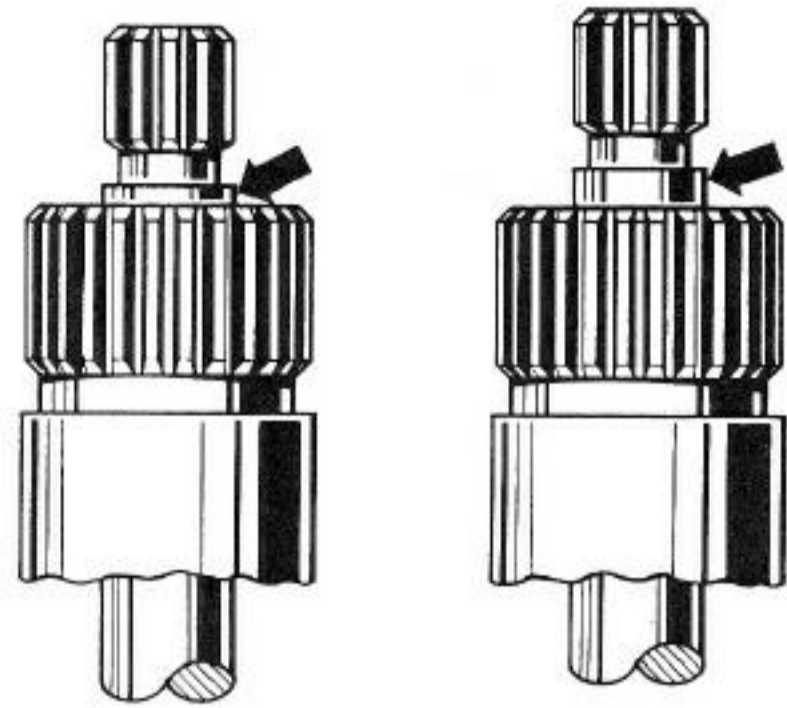
**Fig. 1** Transmission case, disassembling/ assembling

- mount case on fixture as shown (arrows)
- drain oil from final drive
- remove governor
- turn transmission so that ATF cannot leak
- detach transmission



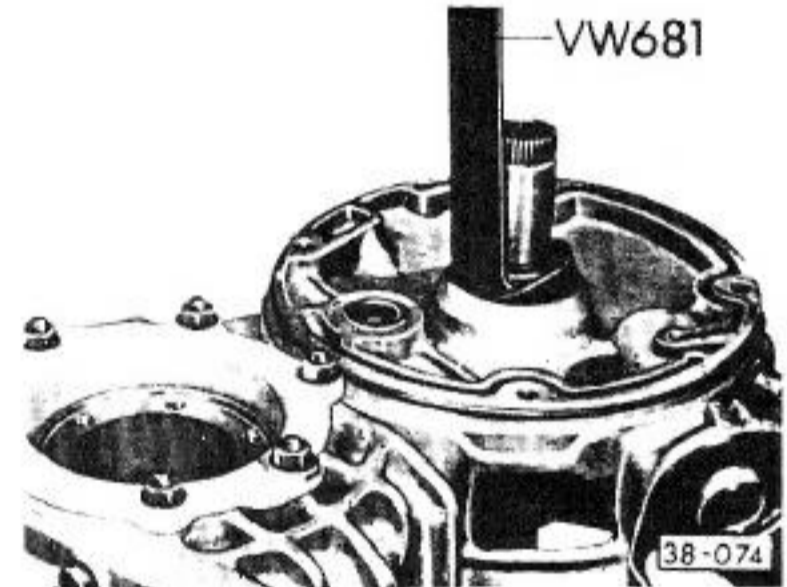
**Fig. 2** Transmission case, disassembling / assembling

- mount case as shown
- drain ATF
- remove final drive

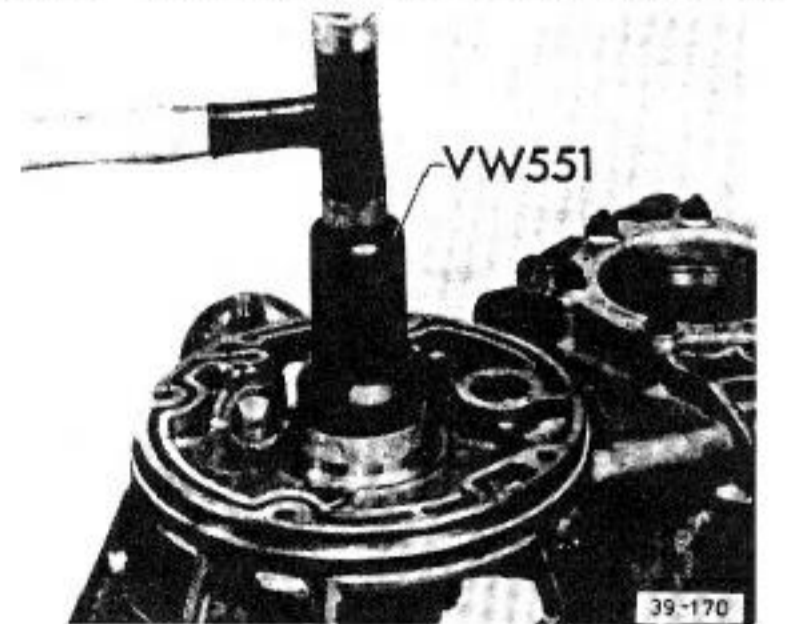


**Fig. 3** Pump shaft, inserting

- insert fully into pump splines before installing converter

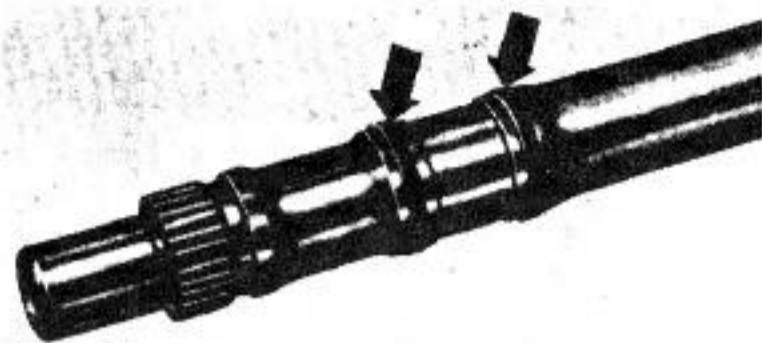


**Fig. 4** Final drive / transmission oil seal, removing



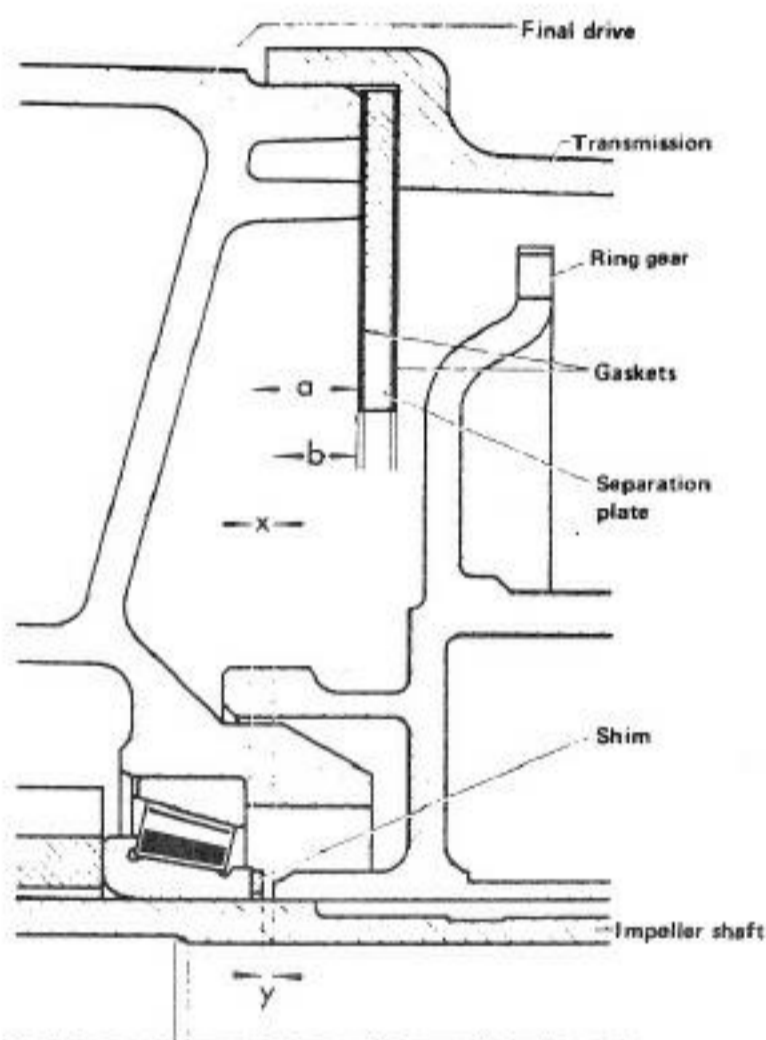
**Fig. 5** Final drive / transmission oil seal, installing

- before installing measure axial play; select and insert shims
- seal lip faces final drive



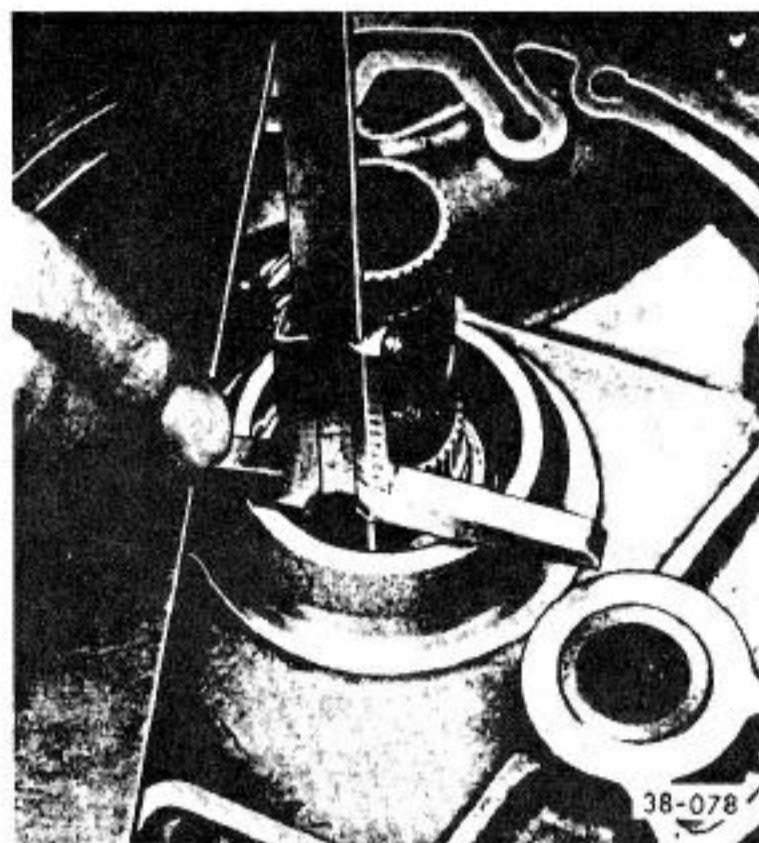
38-076

**Fig. 6 Impeller shaft / piston rings, checking**  
 - check piston rings (arrows) for radial and axial wear  
 - compare with new ring if necessary



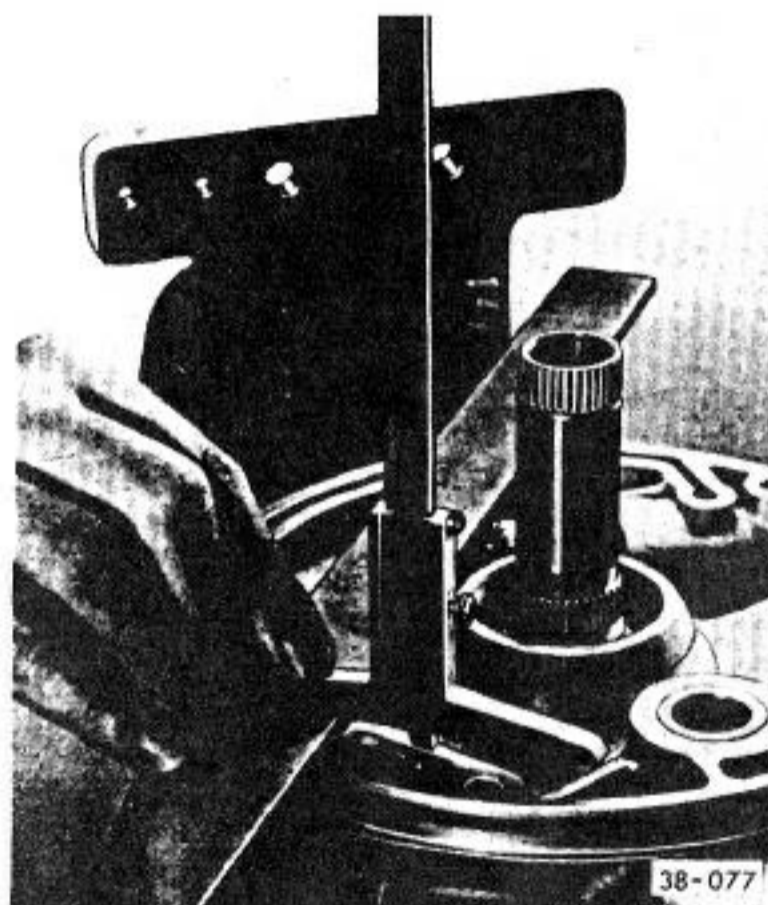
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**Fig. 7 Axial play transmission / final drive, adjusting**  
 - play "y" between transmission and final drive must be adjusted to limit axial movement of ring gear  
 a - housing joint to bearing inner race  
 b - shim contact shoulder to separation plate with gasket



38-078

**Fig. 8 Measuring dimension "a" on final drive**  
 - place straightedge ruler on housing and measure down to inner race of tapered roller bearing



38-077

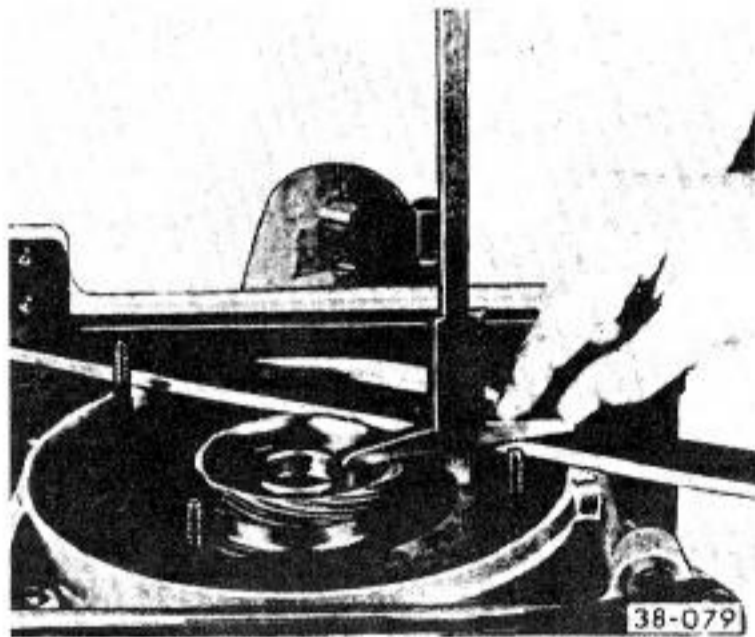
**Fig. 9 Measuring dimension "a" on final drive**  
 - measure from straightedge ruler to housing joint

**Example:**

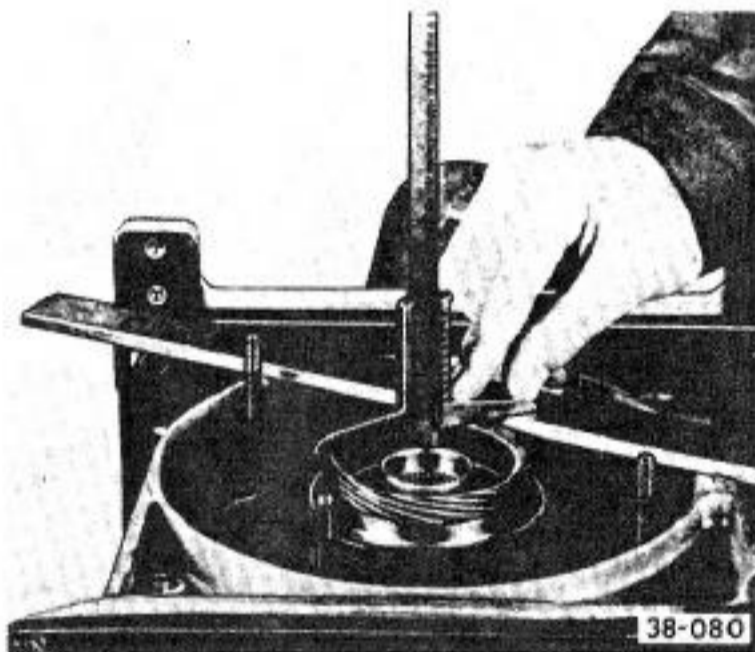
from straightedge to bearing inner race 18.7 mm  
 from straightedge to housing (straightedge thickness) - 8.0 mm

---

Dimension "a" = 10.7 mm



**Fig. 10 Measuring dimension „b“ on transmission**  
 — place straightedge ruler on housing and measure to gasket on plate



**Fig. 11 Measuring dimension “b” on transmission**  
 — measure from straightedge to shoulder for shims

**Example:**

from straightedge to plate	19.2 mm
from straightedge to shoulder	— 10.0 mm
<b>Dimension “b”</b>	<b>= 9.2 mm</b>

**Determining shim thickness**

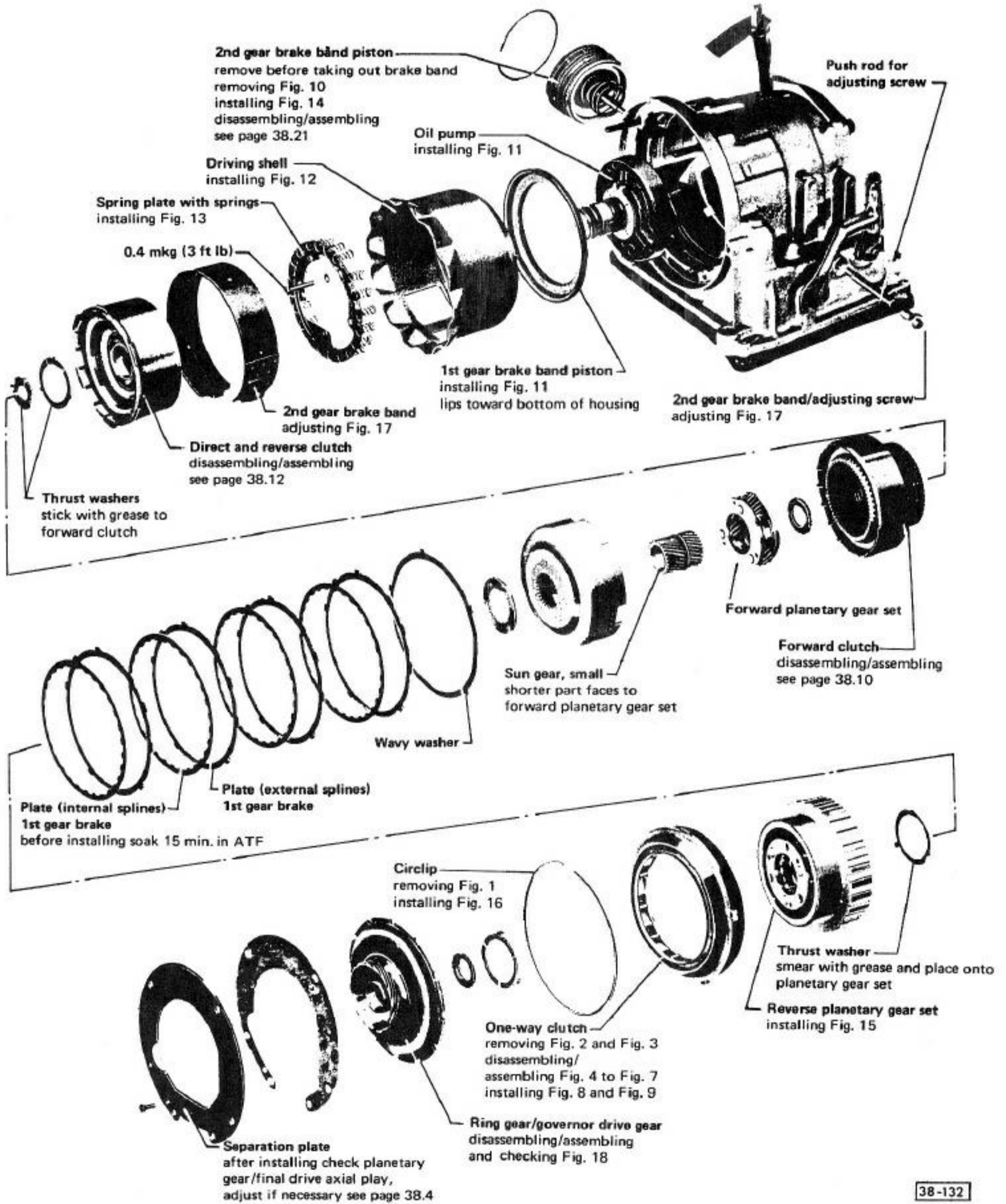
— deduct “b” from “a” result is dimension “x”

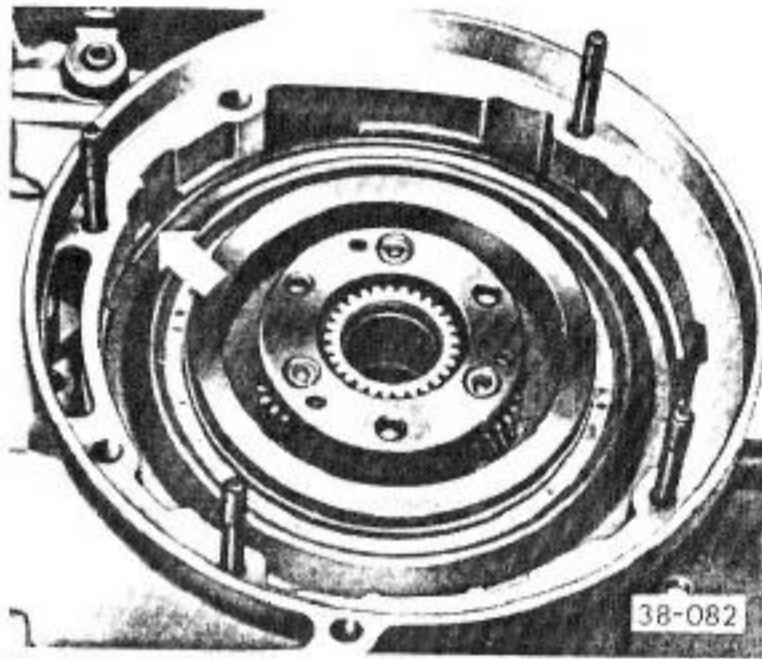
**Example:**

Dimension “a”	10.7 mm
Dimension “b”	— 9.2 mm
<b>Dimension “x”</b>	<b>= 1.5 mm</b>

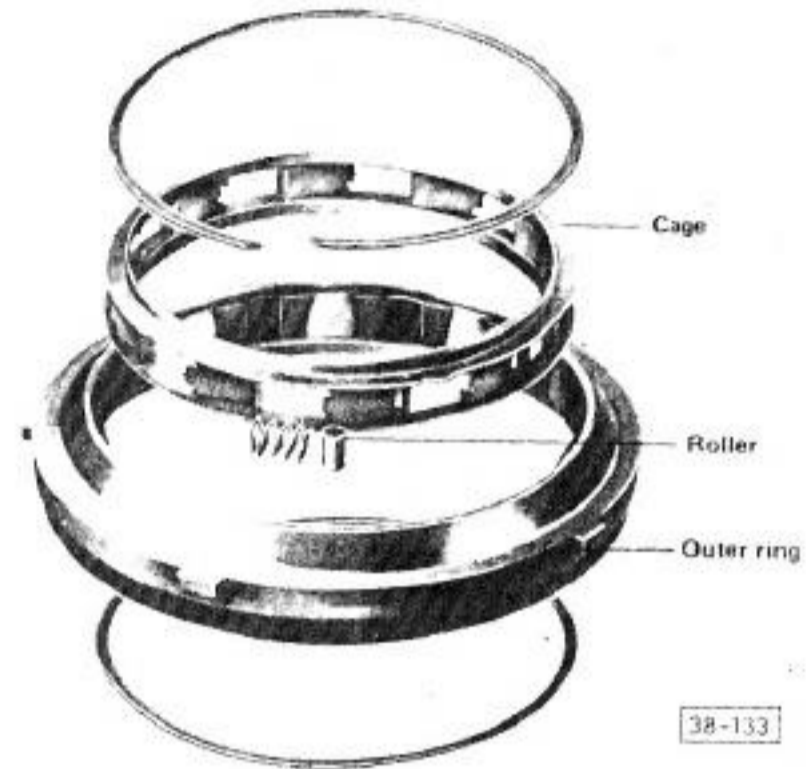
— select shim from tabel; shims are available in two thicknesses 0.4 mm and 1.2 mm

Dimension X” mm	Shim mm
0.23 . . . . . 0.84	—
0.85 . . . . . 1.24	1 x 0.4
1.25 . . . . . 1.64	2 x 0.4
1.65 . . . . . 2.04	1 x 1.2
2.05 . . . . . 2.44	1 x 0.4
	1 x 1.2
2.45 . . . . . 2.84	2 x 0.4
	1 x 1.2
2.85 . . . . . 3.24	2 x 1.2
3.25 . . . . . 3.64	1 x 0.4
	2 x 1.2
3.65 . . . . . 3.88	2 x 0.4
	2 x 1.2



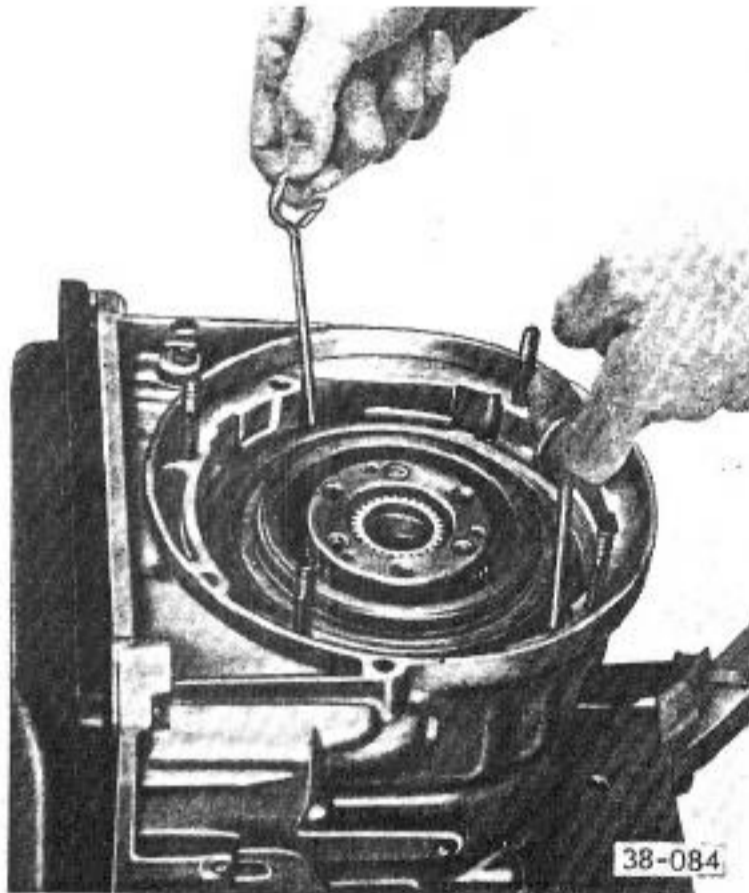


**Fig. 1 Circlip, removing**  
 — take out of groove (arrow)

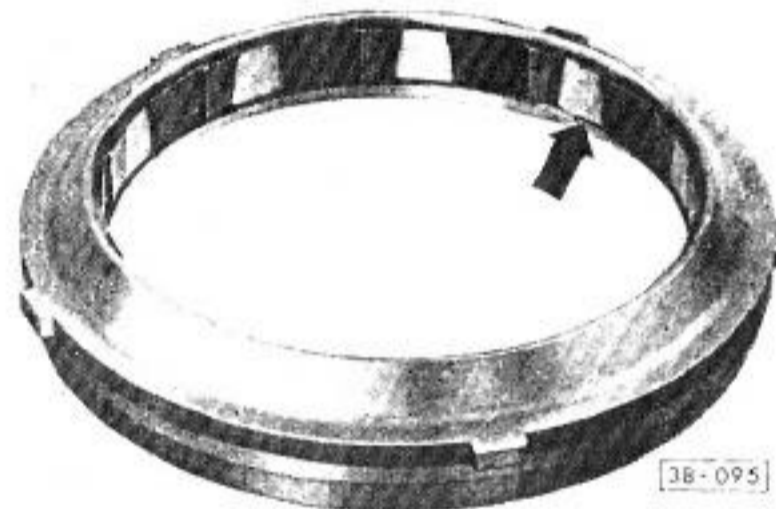


**Fig. 4 One-way clutch, disassembling / assembling**

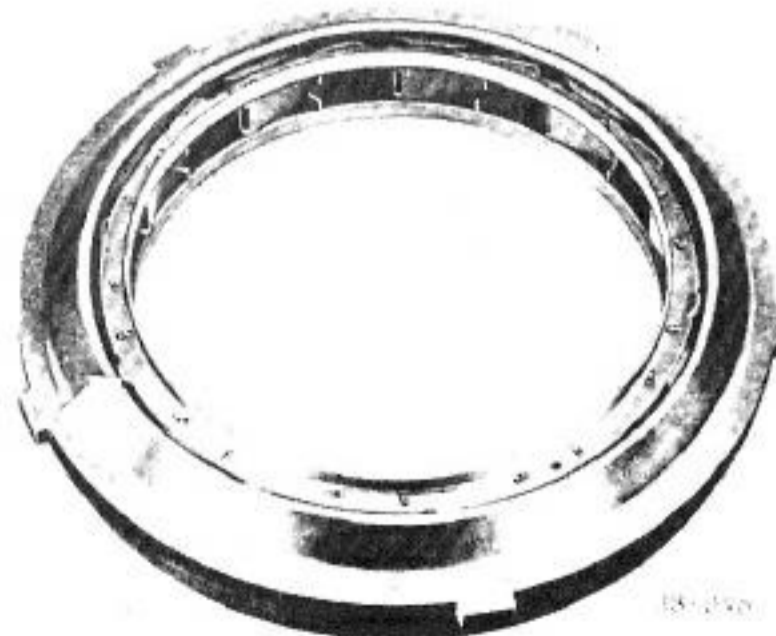
**Fig. 2 Hooks for lifting out one-way clutch**  
 — to be made from welding rod (3/16 in.)



**Fig. 3 One-way clutch, lifting out**



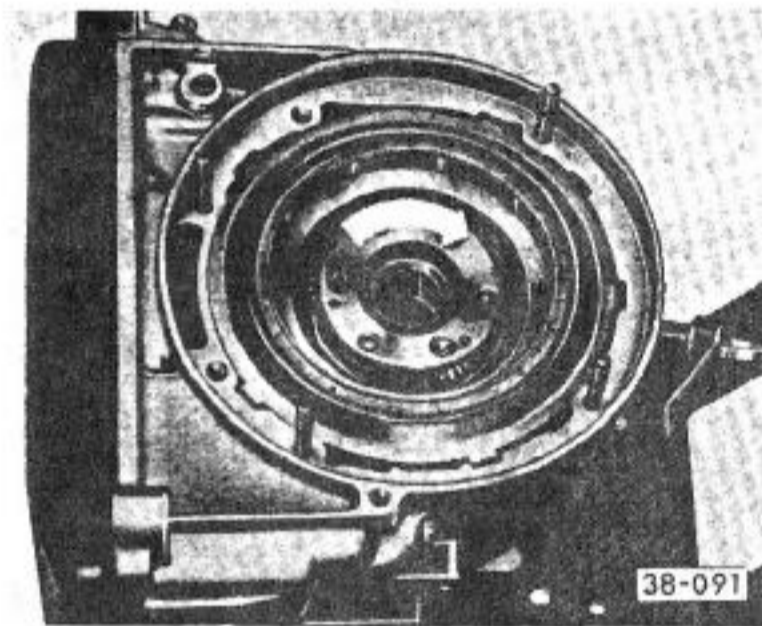
**Fig. 5 One-way clutch / circlip, inserting**  
 — place lower circlip in outer ring (arrow)



**Fig. 6 One-way clutch / cage, assembling**  
 — install cage in outer ring without spacer springs and rollers and with lugs upward (arrow)



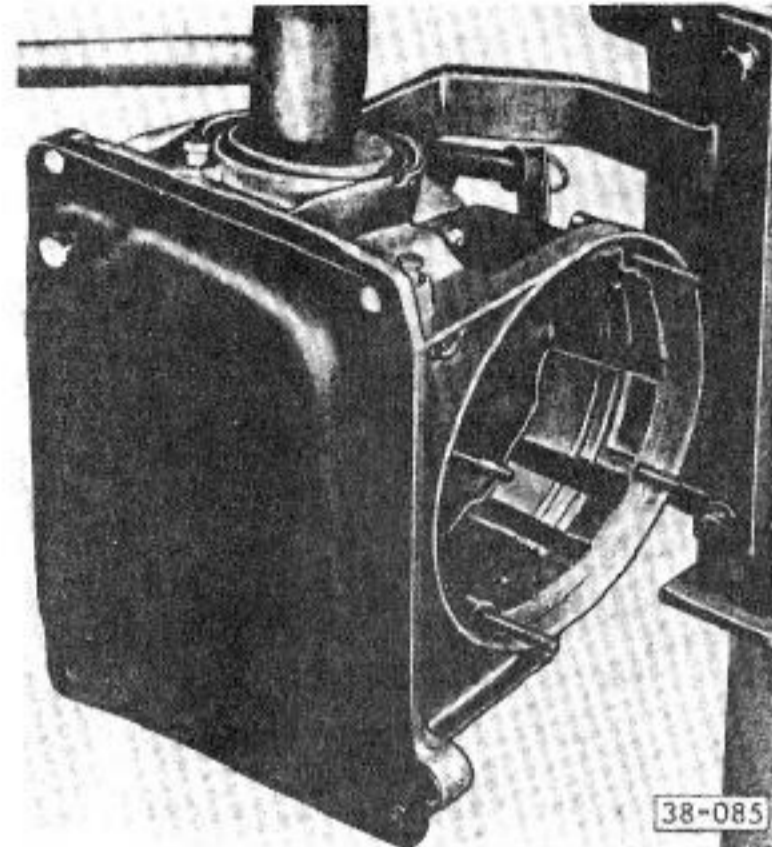
**Fig. 7 One-way clutch / spacer springs and rollers, assembling**  
 — rollers must be assembled in cage as shown (arrow)



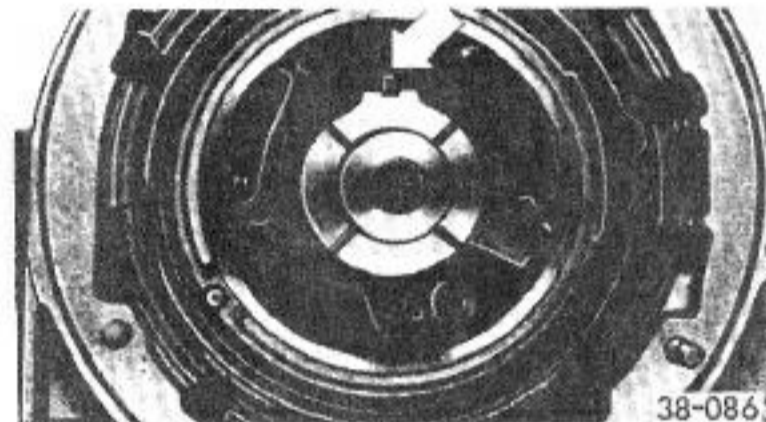
**Fig. 8 One-way clutch, installing**  
 — can only be inserted in one position  
 — turn gear set in direction of arrow (see also Fig. 9) and press one-way clutch down at same time.



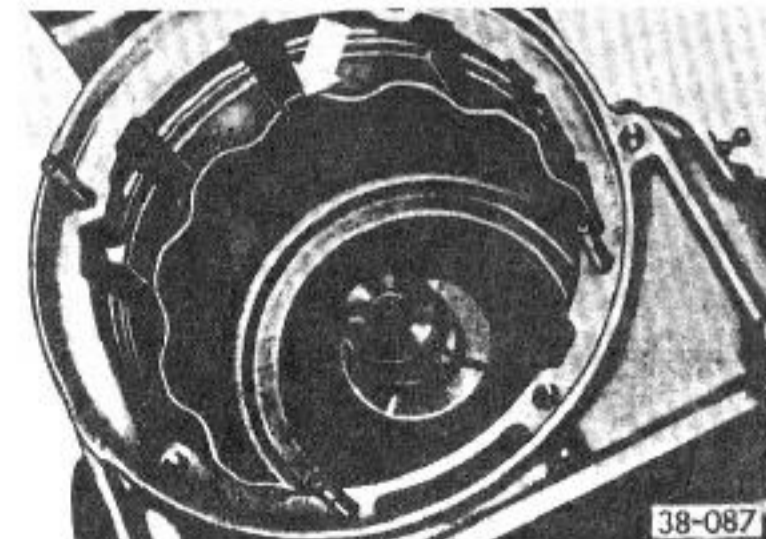
**Fig. 9 One-way clutch, installing and checking**  
 — clutch can also be turned with tool as shown  
 — **checking:** it must not be possible to turn planetary gear set counterclockwise



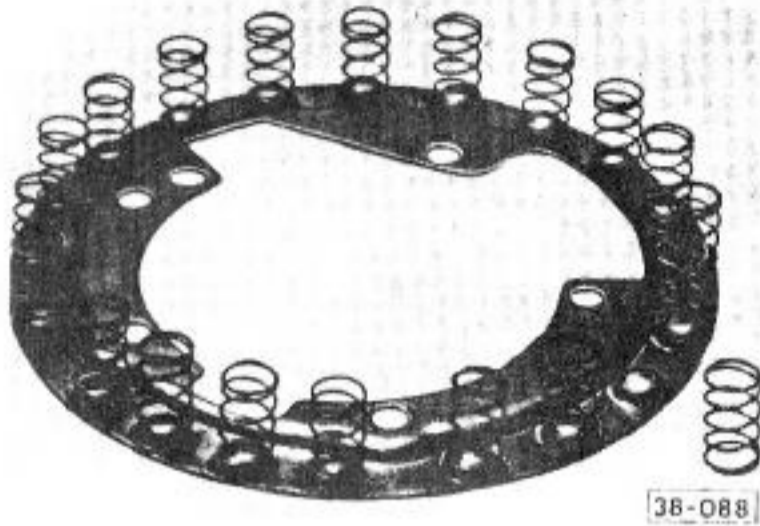
**Fig. 10 2nd gear brake band piston, removing**  
 — remove circlip  
 — remove piston by tapping lightly with rubber hammer



**Fig. 11 Piston for 1st gear brake band and oil pump, installing**  
 — push piston onto pump housing and insert pump in housing  
 — thin rib (arrow) must point upward  
 — insert in drive plate and turn check that pump turns freely

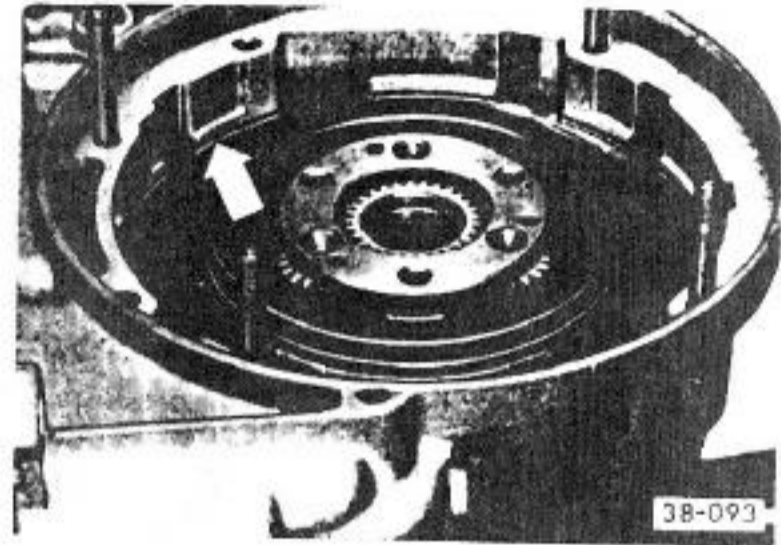


**Fig. 12 Driving shell / 1st gear brake band, inserting**  
 — insert with lug (arrow) in marked groove



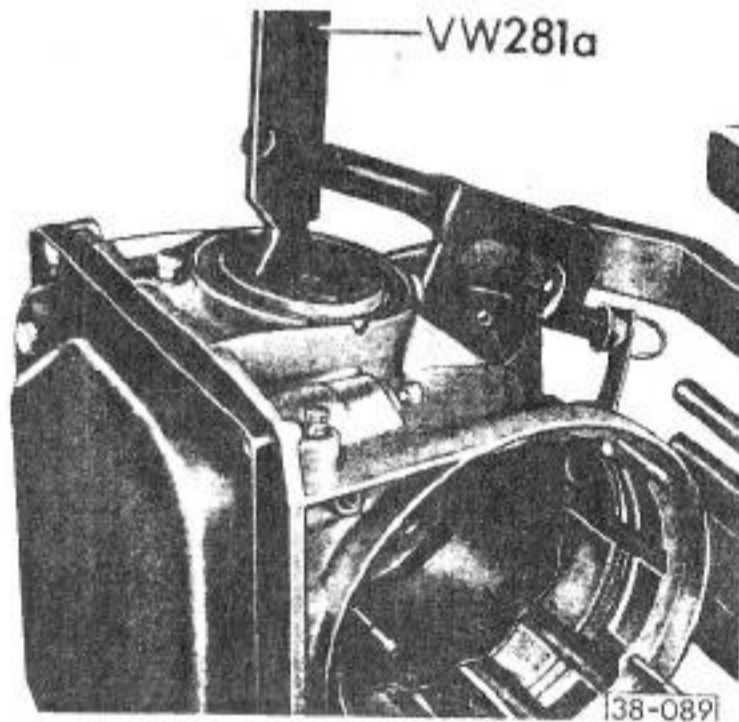
**Fig. 13 Spring plate with springs, installing**

- place springs on plate
- place in housing with springs downward and tighten in this position with bolts



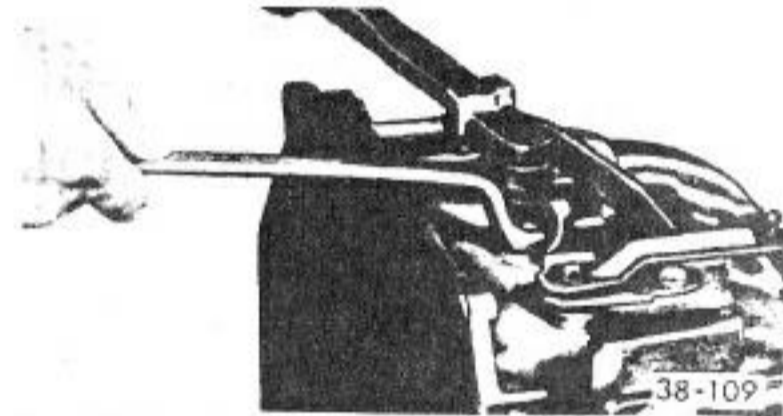
**Fig. 16 Circlip, installing**

- parts are installed properly if groove for circlip is exposed (arrow)



**Fig. 14 Piston for 2nd gear brake band, installing**

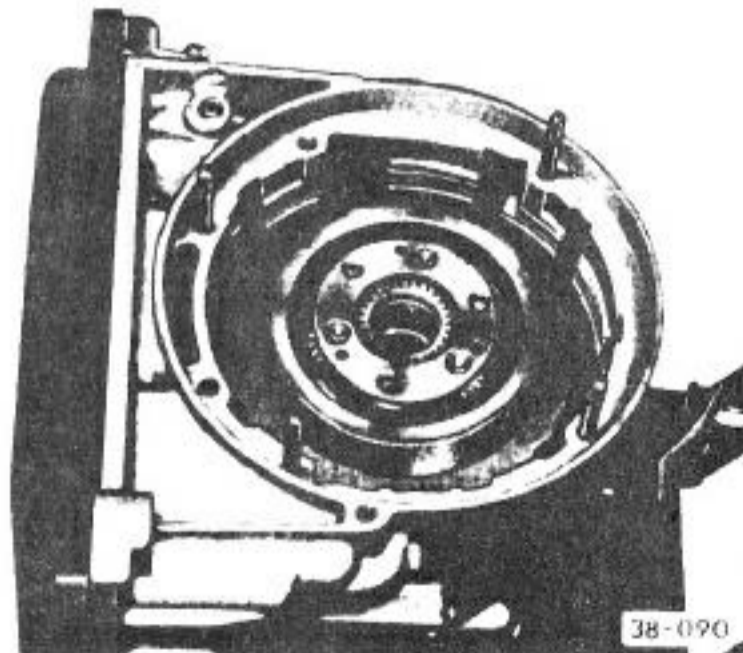
- press piston down as shown
- insert circlip



**Fig. 17 2nd gear brake band, adjusting**

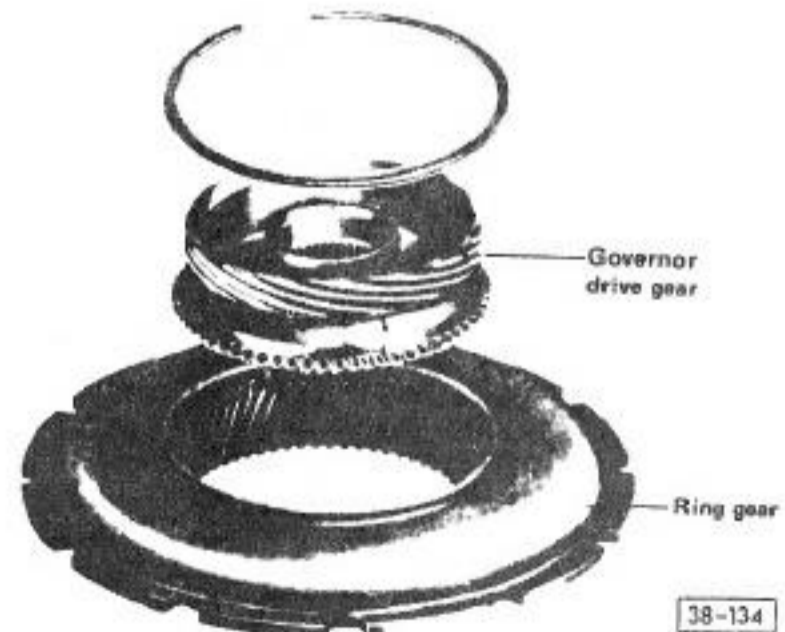
- first tighten adjusting screw to 1 mkg (7 ft lb) loosen and tighten finally to 0.5 mkg (4 ft lb) from this position loosen exactly 2 1/2 turn and secure with lock nut.

**Caution**  
Transmission must be horizontal when adjusting brake bands; otherwise bands may jam.



**Fig. 15 Reverse planetary gear set, installing**

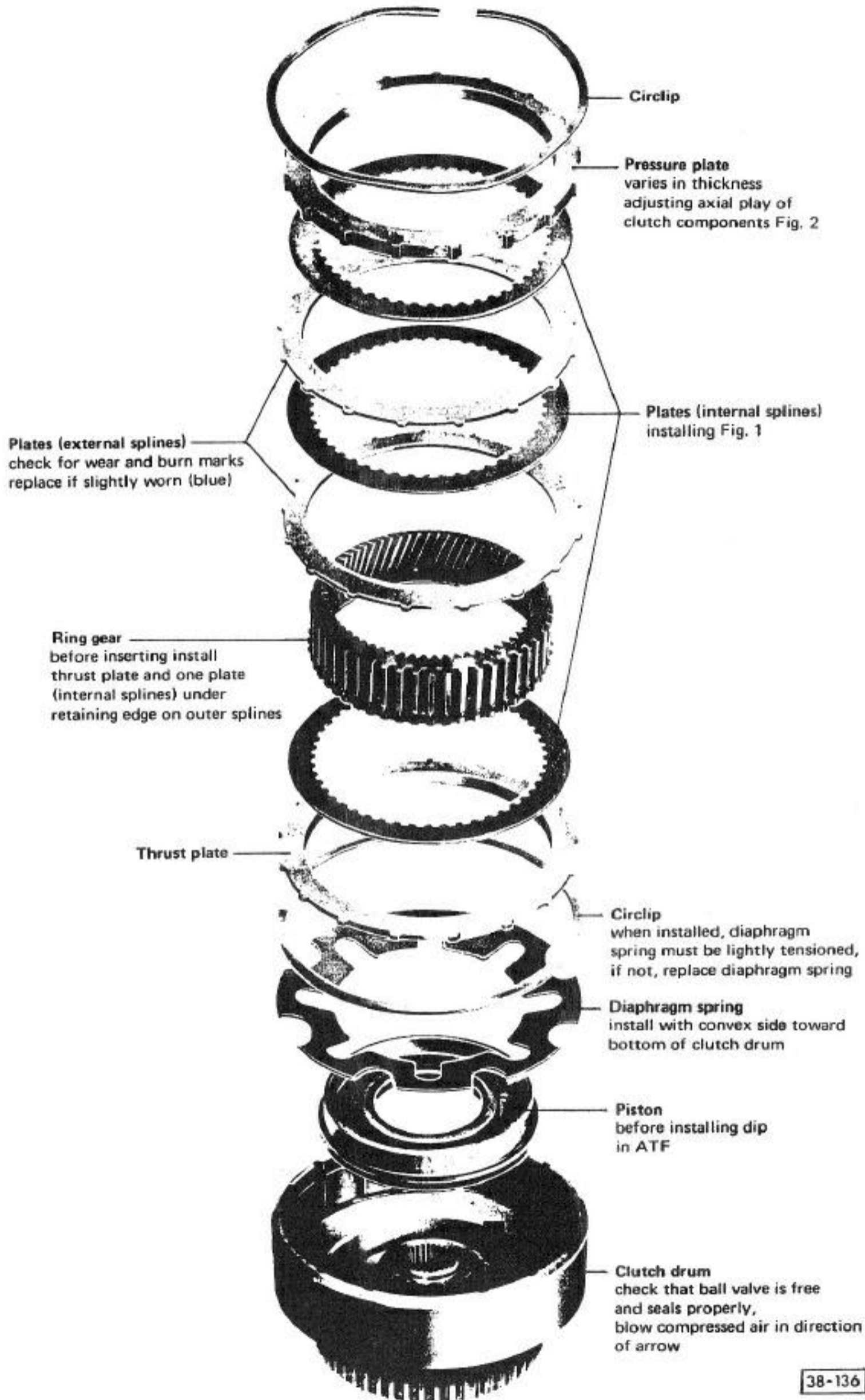
- first insert planetary gear set
- insert wavy spring and plates



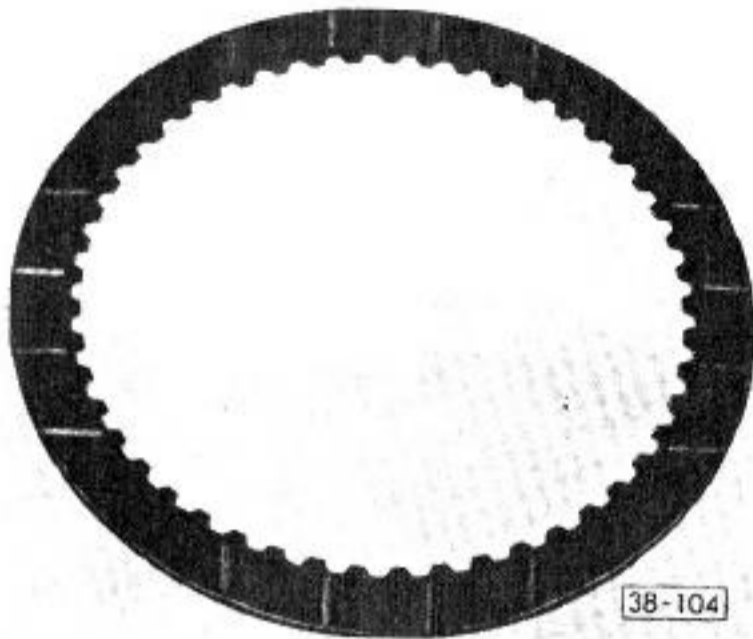
**Fig. 18 Ring gear / governor drive gear, checking**

- ring gear, check parking lock notches for wear
- governor drive gear, check oil seal surface for wear



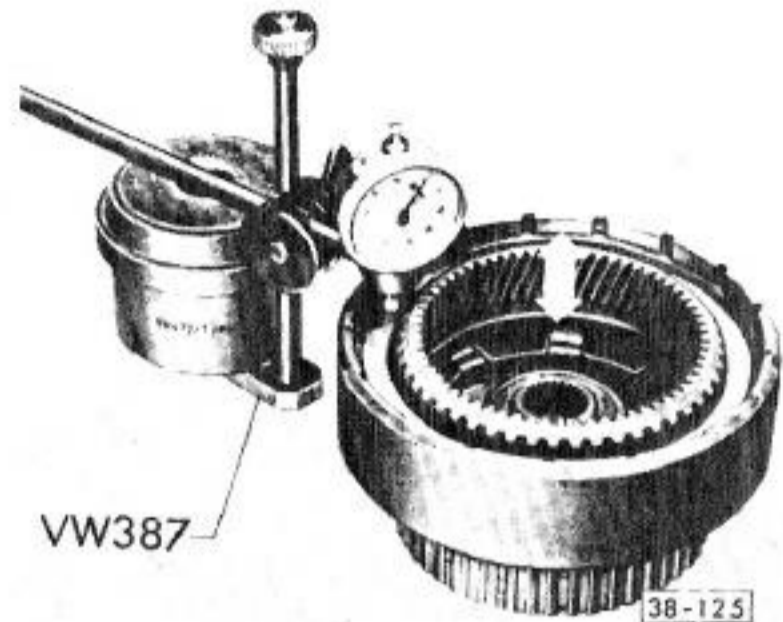


38-136



**Fig. 1 Plate (internal splines), installing**

- only install plates with linings which are marked as shown
- soak new plates in ATF 15 minutes before installing

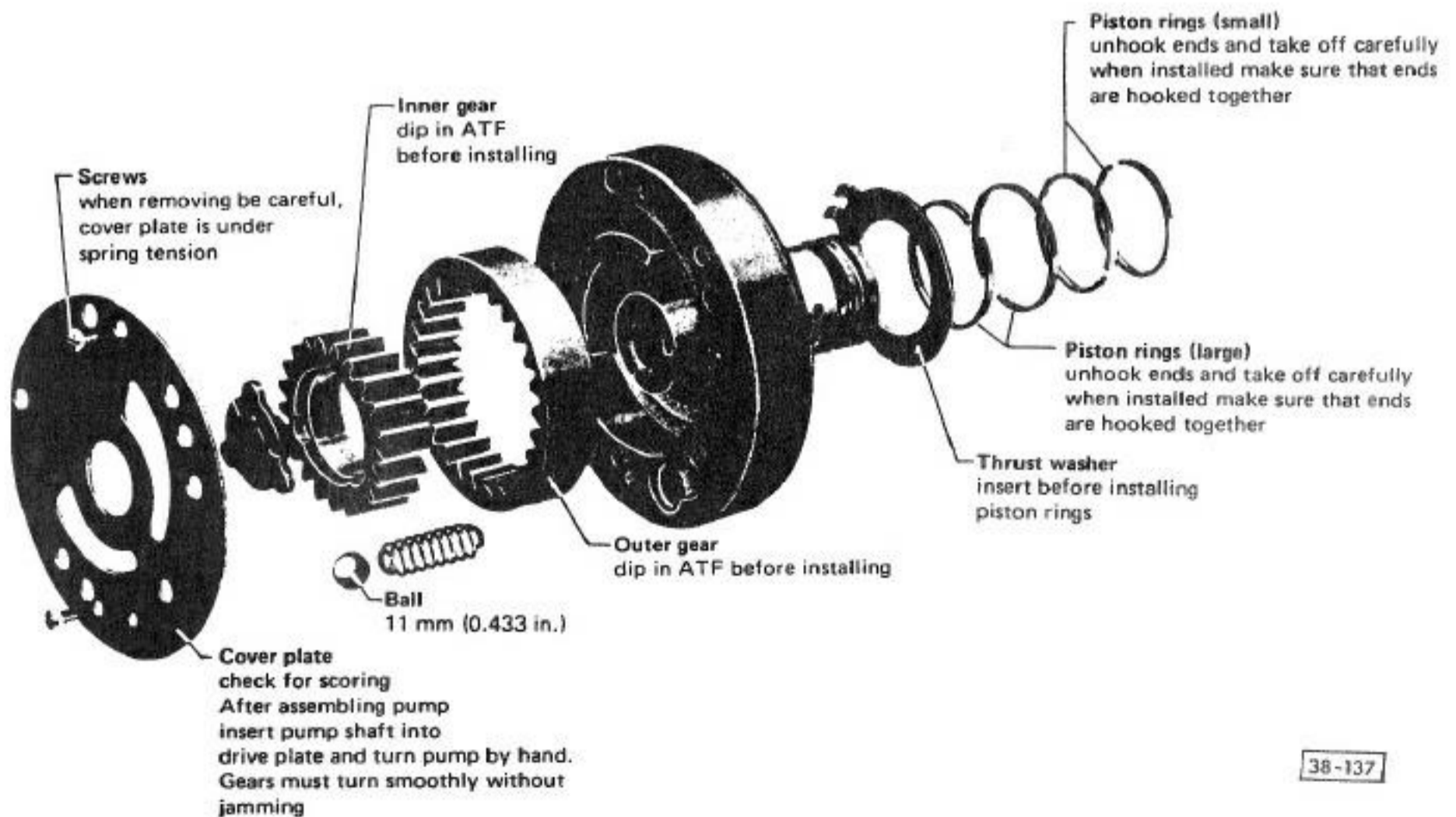


**Fig. 2 Forward clutch, adjusting axial play**

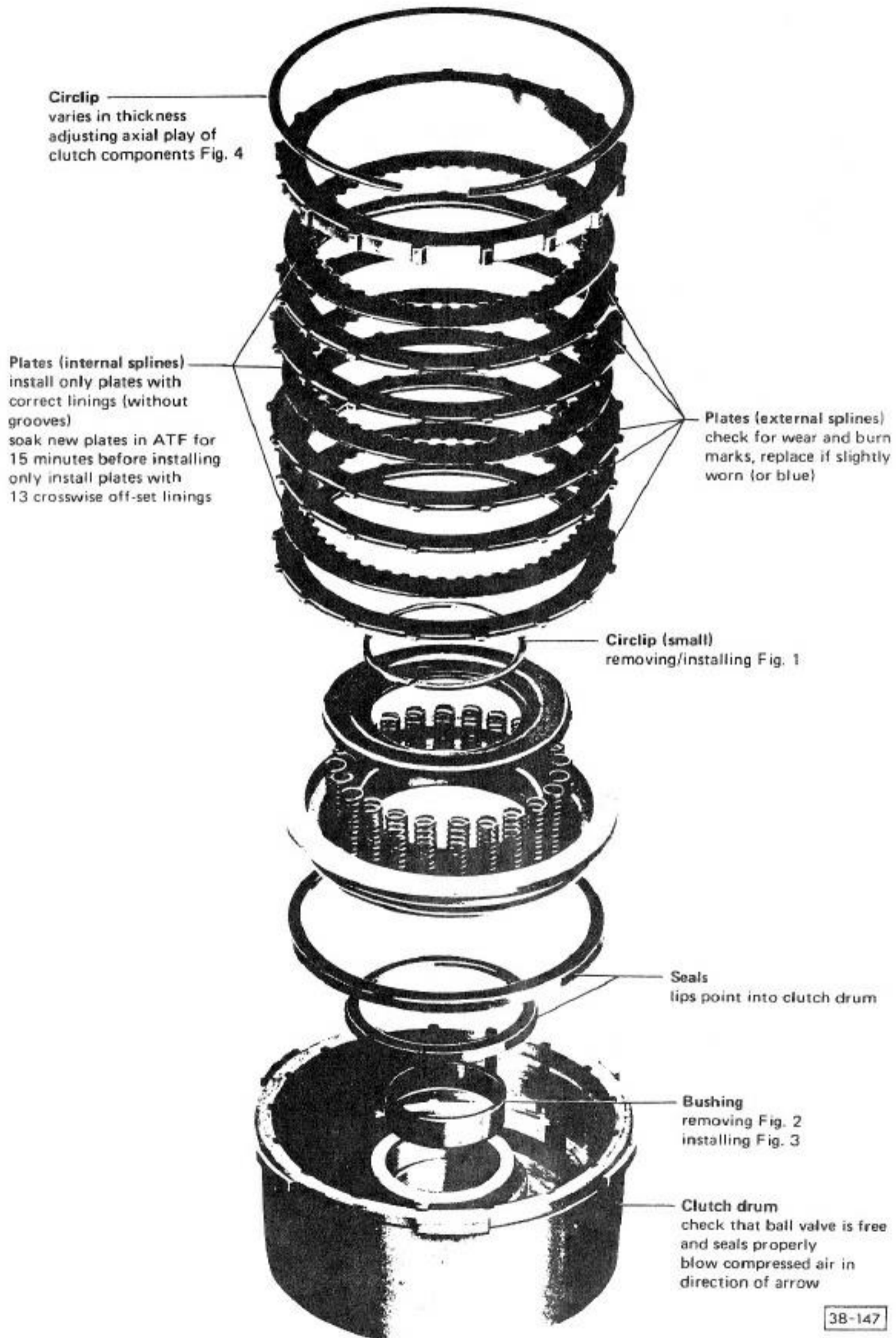
- measure play (arrow) should be between 0.5 to 1.15 mm
- otherwise select new pressure plate from table

Thickness (mm)	Part No.
6.5	010 323 253 A
6.7	010 323 253 B
7.0	010 323 253 C
7.3	010 323 253 D
7.5	010 323 253 F

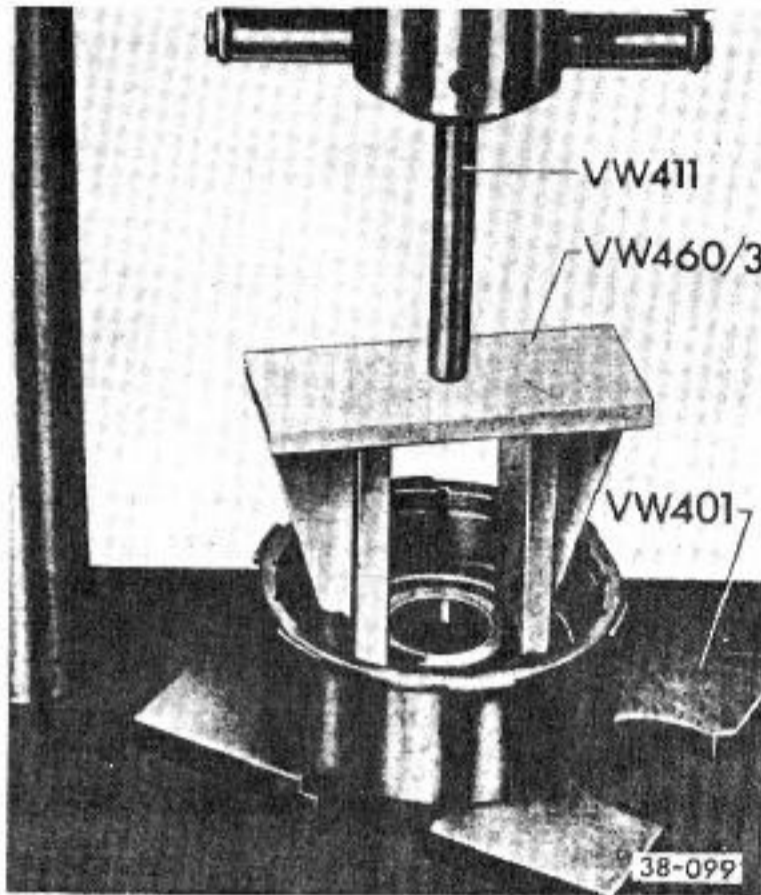
## Oil pump assembly



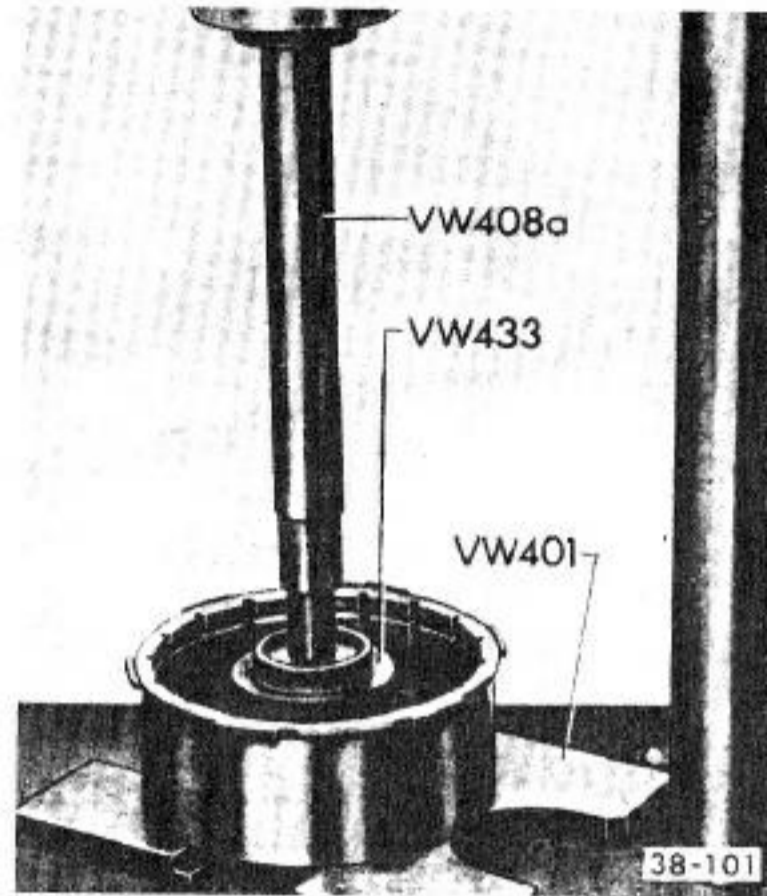
38-137



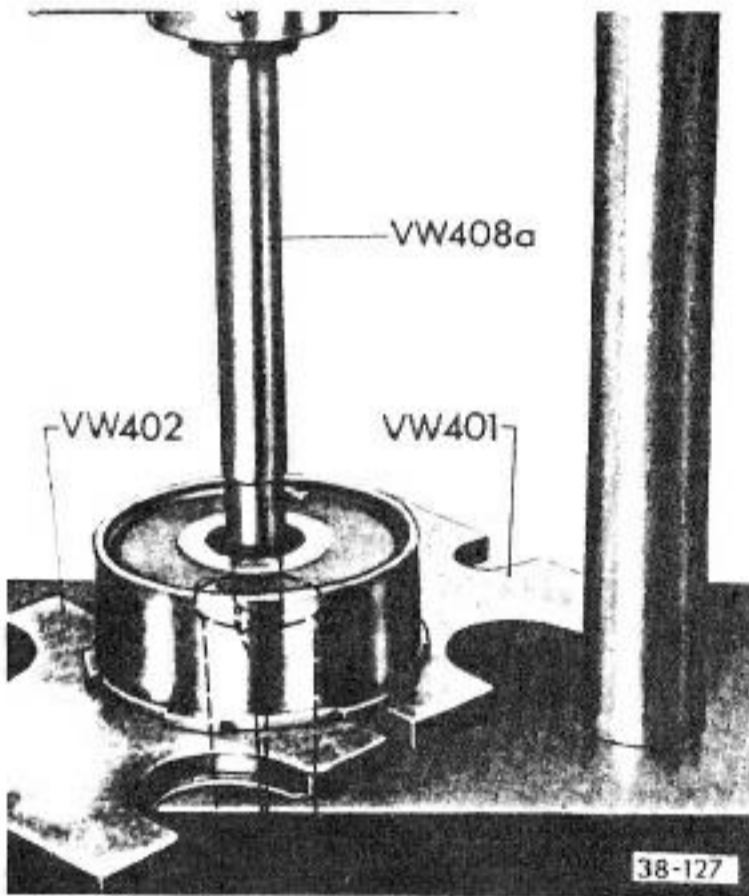
38-147



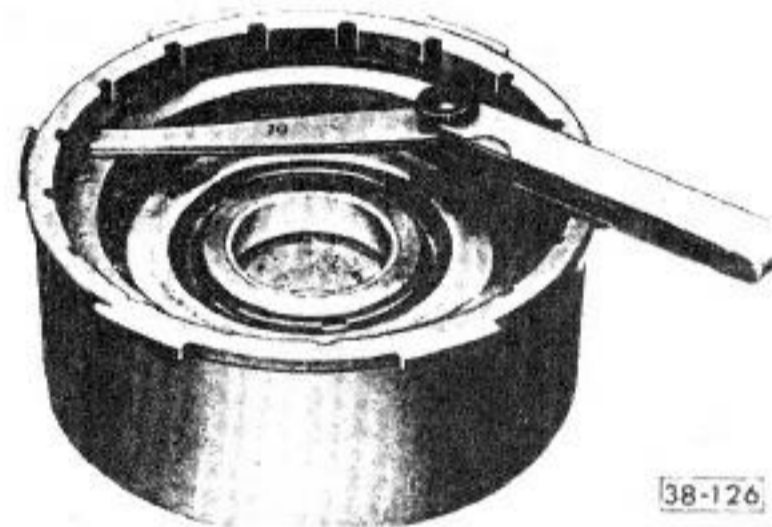
**Fig. 1 Circlip (small), removing / installing**  
 – press spring plate down to remove or install circlip



**Fig. 3 Bushing in clutch drum, installing**  
 – press in

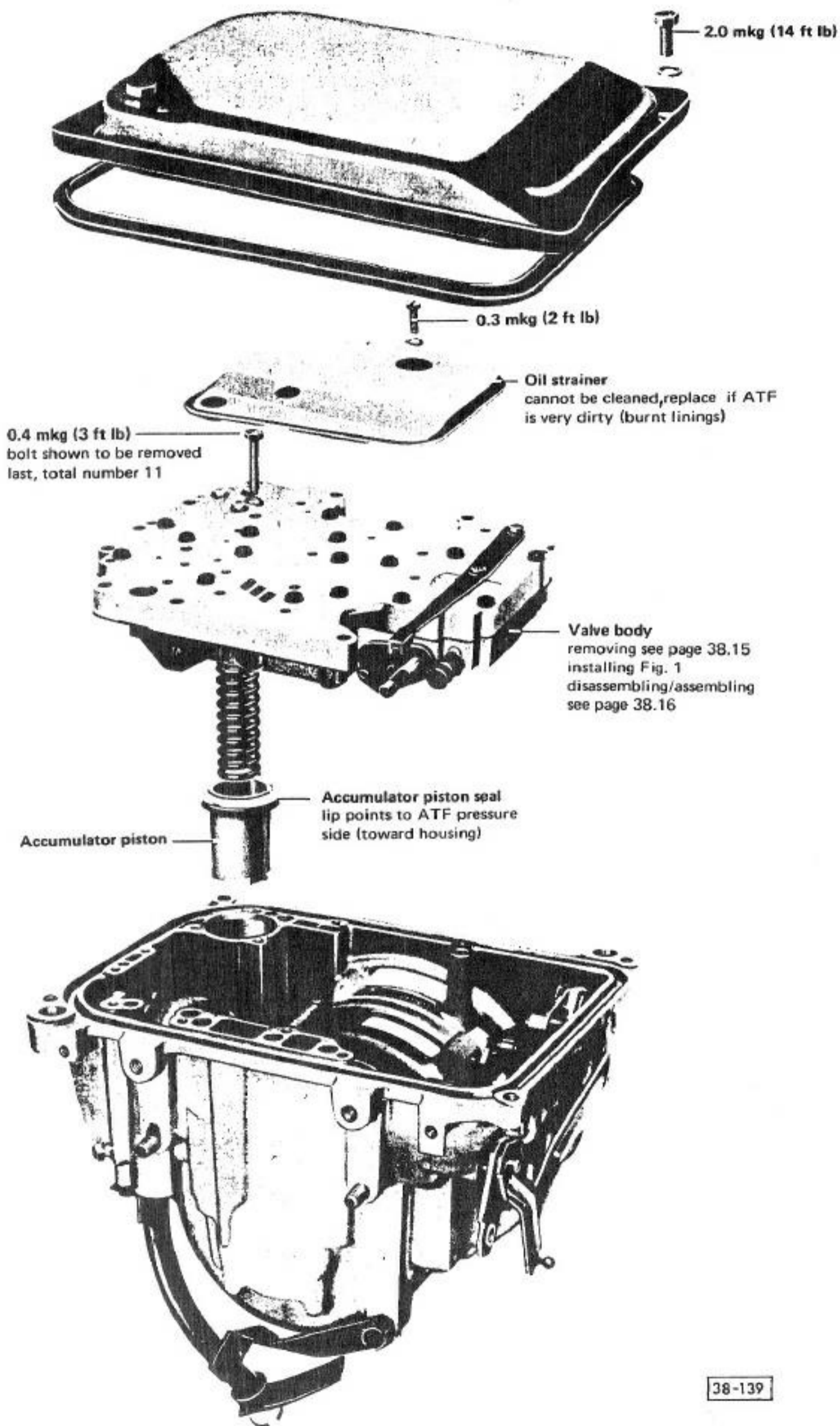


**Fig. 2 Bushing in clutch drum, removing**  
 – press out  
 A = US 1099



**Fig. 4 Direct and reverse clutch, adjusting axial play**  
 – measure play  
 should be between 2.05 to 2.50 mm  
 otherwise select new shim from table

Thickness (mm)	Part No.
1.5	010 323 157 A
1.7	020 323 157 B
2.0	010 323 157
2.3	010 323 157 C
2.5	010 323 157 D



## Valve body removing and installing

### Note

Valve body can be removed and installed with transmission in vehicle. Drain ATF and remove oil pan first.

### Caution

Do not run engine or tow vehicle when oil pan is off or with no oil in transmission.

Valve body should only be disassembled for cleaning or when transmission failure was caused by burnt linings or very dirty ATF. If fluid is still fairly clean, flush valve body with fresh cleaning solution without dismantling it. Afterwards it should be dried with compressed air.

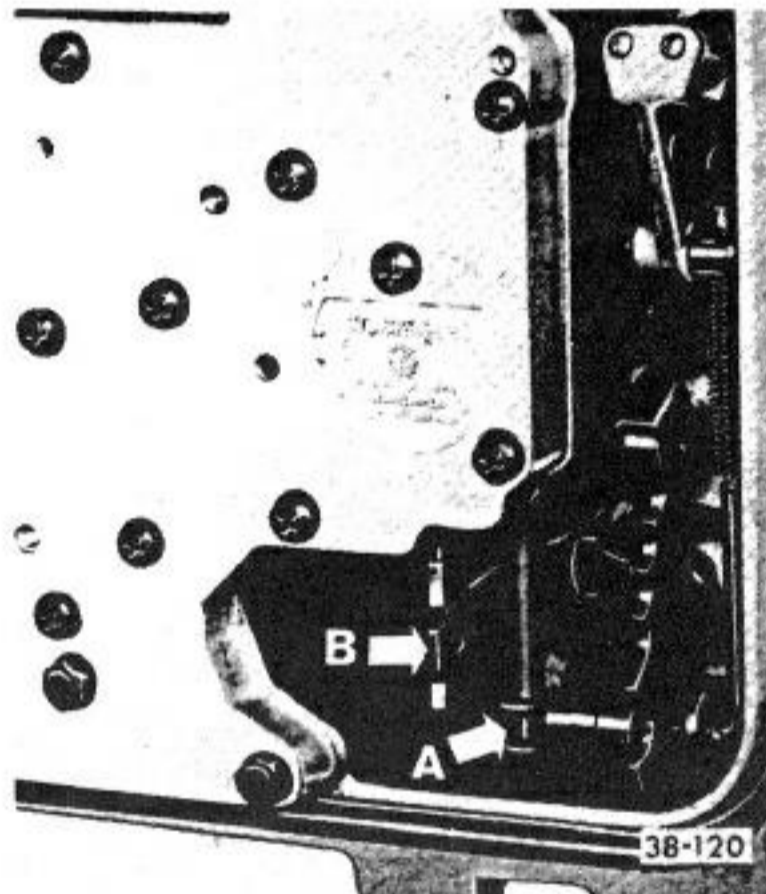


Fig. 1 Valve body, installing

- attach valve body to housing
- engage manual valve (arrow A) and operating lever (arrow B)
- tighten all bolts diagonally to correct torque (0.4 mkg/3ft lb)

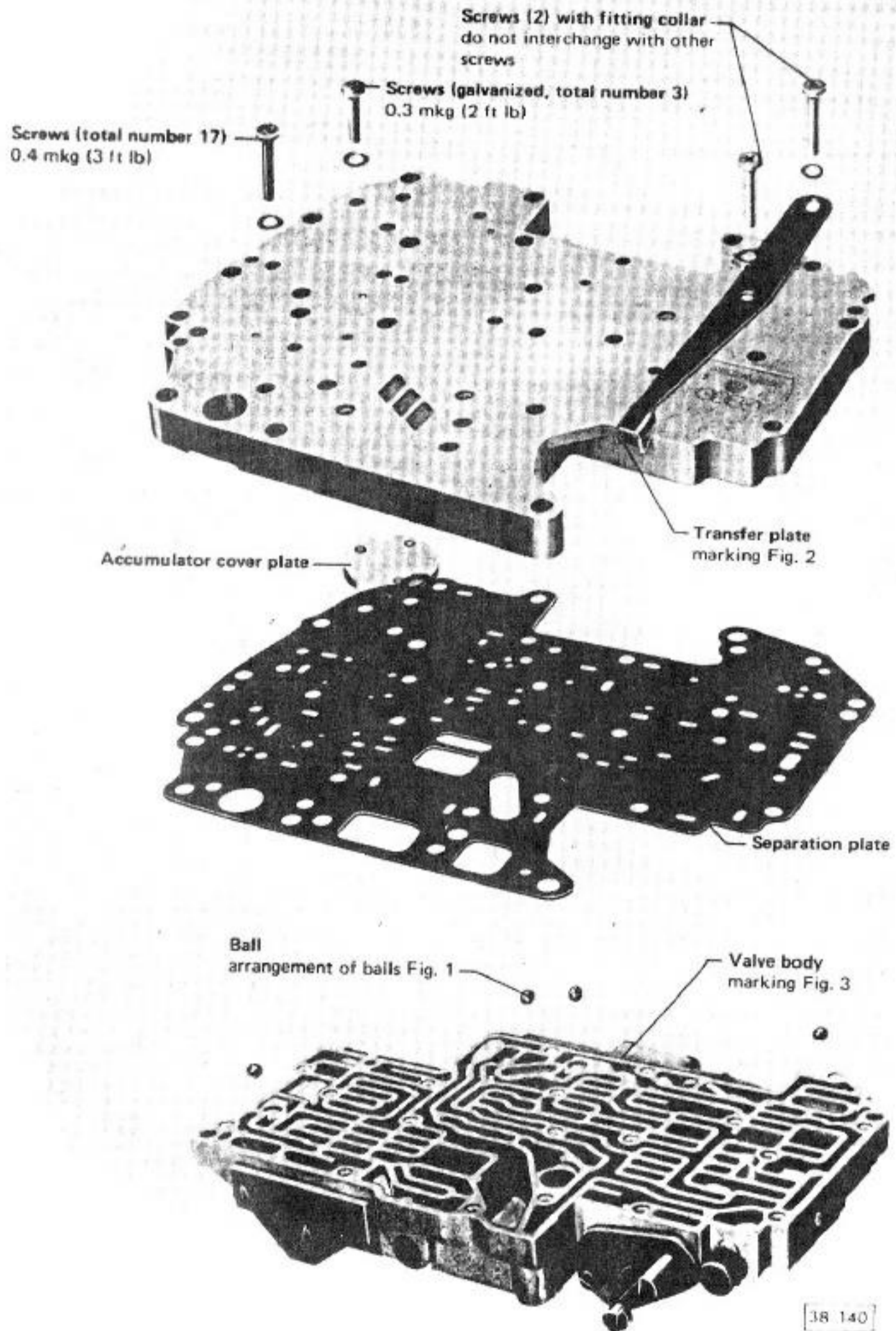
## Filling transmission with ATF

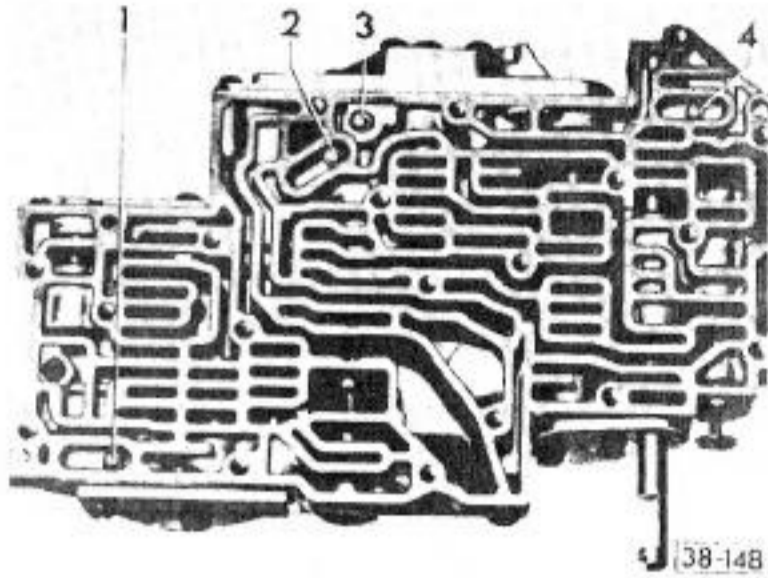
Put in 2.5 qts ATF first, using a clean funnel with an extension. Start engine and select all lever positions once with vehicle stationary. Then check fluid level on dipstick with selector lever in neutral (N).

Fluid level should now be up to lower end of dipstick. Drive car for short distance to warm fluid up. Correct fluid level if necessary.

### Caution

Only automatic transmission fluids labeled Dexron<sup>®</sup> with a five-digit number preceded by the letter "B" may be used. All approved fluids can be mixed with one another. Do not use any additives.

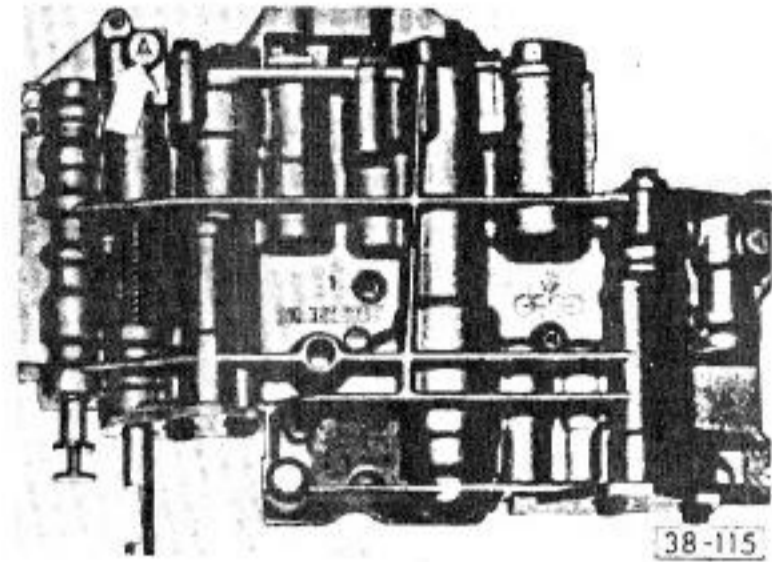




**Fig. 1** Ball valve arrangements

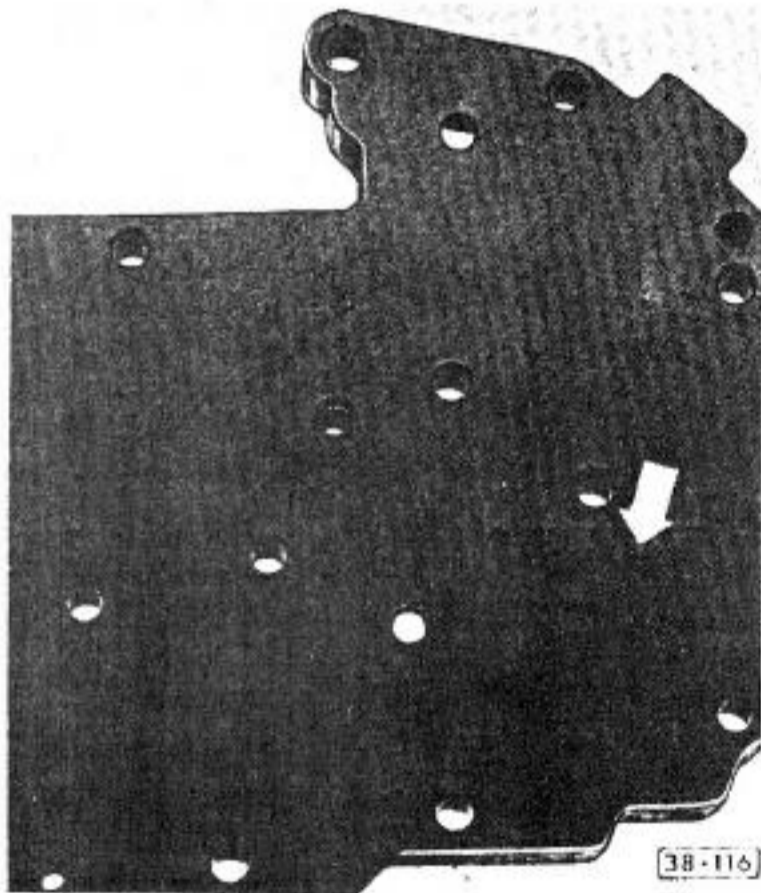
- 1 — ball for direct + reverse clutch valve
- 2 — ball for 1st gear brake
- 3 — ball for 1st gear valve
- 4 — ball for 1st drive range valve

— all balls are 6 mm (5/64 in.) in diameter



**Fig. 3** Valve body assembly marking

Code letter "A" (arrow)

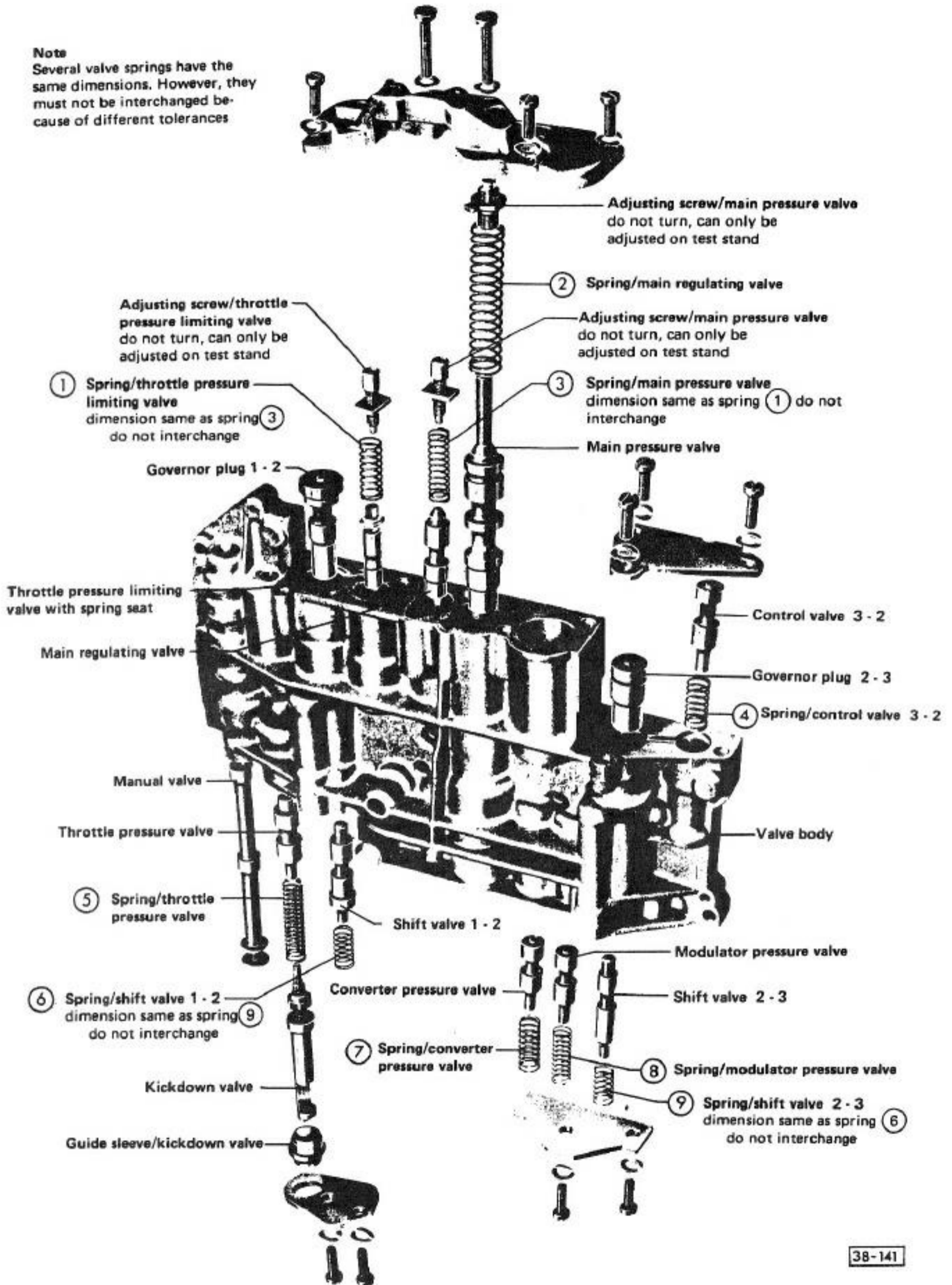


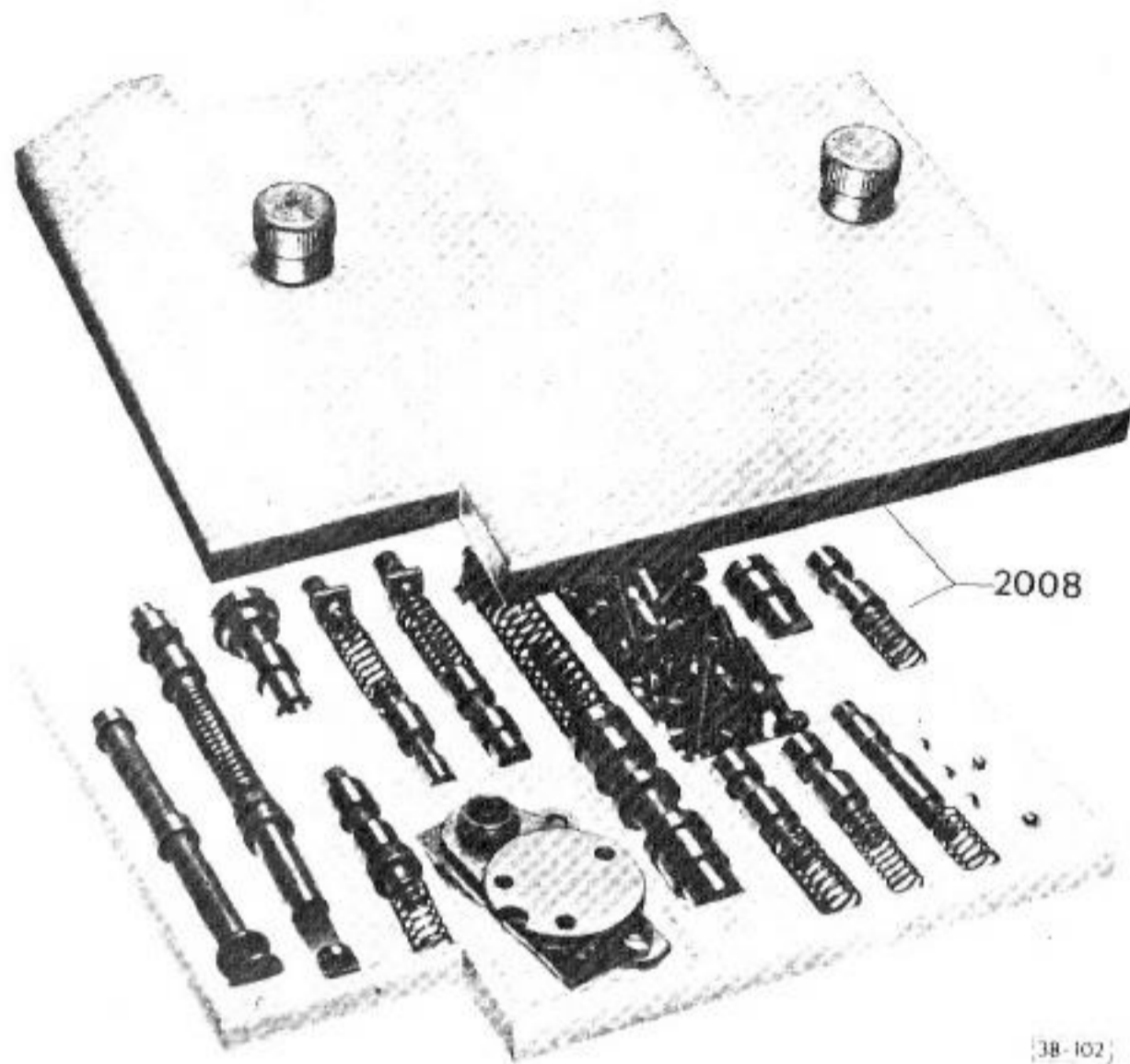
**Fig. 2** Transfer plate marking

Part No. (arrow)



**Note**  
Several valve springs have the same dimensions. However, they must not be interchanged because of different tolerances





## Disassembling

### Note

Valve body assembly should only be disassembled for cleaning or when transmission failure was caused by burnt friction linings or excessively dirty ATF. If ATF is still fairly clean it will suffice in most cases to place the complete valve body in cleaning solution and then dry it afterwards with compressed air.

A storage tray is used to store various valves, springs and screws from valve assembly.

To be sure that parts are reinstalled in their original places they should be placed in a storage tray.

Tray outer shape roughly corresponds with shape of valve assembly.

- remove rear end plate, take out valves and springs one after another and place them in tray
- remove end plate from other side and repeat procedure.
- place lid on tray
- immerse tray complete with parts in cleaning solution. Dry with compressed air. Do not use water and do not use fluffy rags or clothes when cleaning parts.

## Assembling

Valves and springs must be put back into same holes in valve body.

Insert springs and valves into one side in locations shown in exploded view and then install end plate before proceeding with other side.

### Note

Lubricate all parts with ATF when assembling and check for free movement. Valves should slide under their own weight.



## Technical Service Information

### Spring table

Always refer to spring table to identify individual springs when selecting springs by their dimensions.

As differences can occur in coil diameters and free lengths of new and used springs (settling), wire thickness and total numbers of coils should be used first to identify the springs. If this is insufficient, free length and inner diameter of coil should also be used to differentiate between various springs.

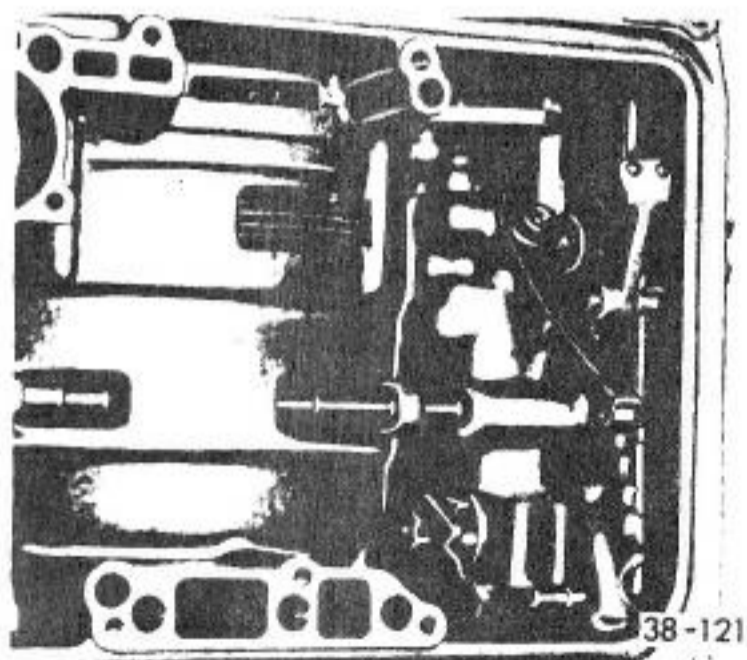
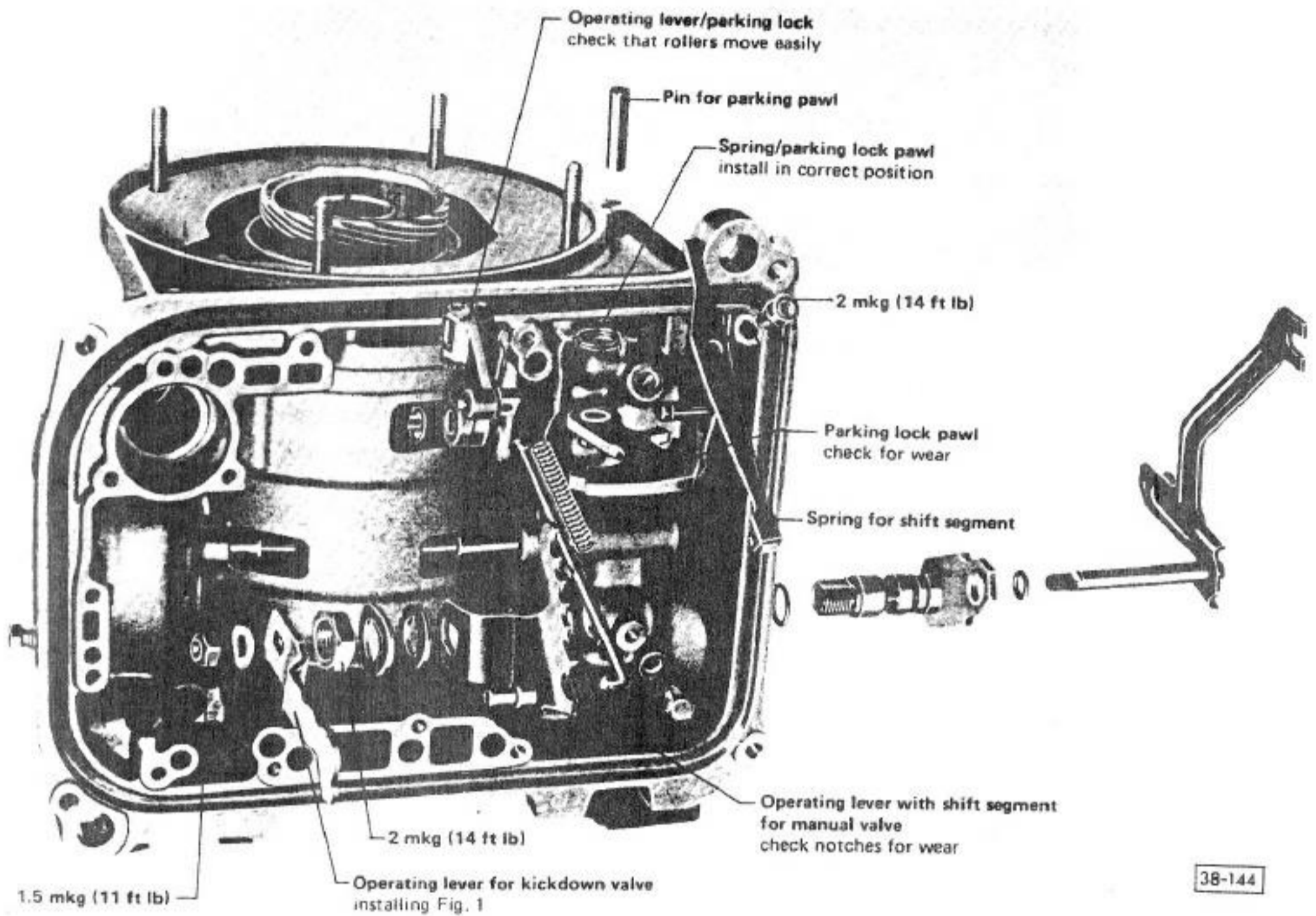
### Valve

Several valve springs have similar dimensions. However, they must not be interchanged because they have different tolerances.

Description	Part No.	coils	wire thickness mm (in.)	free length <sup>1)</sup> mm (in.)	inner diameter <sup>2)</sup> of coil mm (in.)
① Spring/throttle pressure limiting valve	003 325 119	14,5	1,1 (0,042)	35,3 (1.388)	7.7 (0.302)
② Spring/main pressure valve	003 325 131	16,5	1.5 (0.059)	68.5 (2.696)	11.9 (0.468)
③ Spring/main pressure limiting valve	003 325 119	14.5	1.1 (0.042)	35.3 (1.388)	7.7 (0.302)
④ Spring/control valve	003 325 227 A	12.5	1.0 (0.039)	32.4 (1.274)	7.7 (0.302)
⑤ Spring/throttle pressure valve	010 325 175 B	16.0	1.25 (0.048)	43.3 (1.703)	7.75 (0.304)
⑥ Spring/shift valve 1-2	010 325 207	6.5	0.9 (0.035)	19.9 (0.783)	8.1 (0.317)
⑦ Spring/converter pressure valve	003 325 247	9.5	1.25 (0.048)	27.3 (1.073)	8.13 (0.319)
⑧ Spring/modulator pressure valve	003 325 185	11.5	0.8 (0.031)	28.5 (1.121)	7.75 (0.304)
⑨ Spring/shift valve 2-3	010 325 207	6.5	0.9 (0.035)	19.9 (0.783)	8.1 (0.317)

1) Unloaded length is subject to tolerances and setting

2) Inner coil diameter is within a tolerance of  $\pm 0.3$  mm (0.012 in.)



**Fig. 1** Operating lever for kickdown valve, installing

— angled end of kickdown valve operating lever points toward center of transmission

## 2nd gear brake band piston assembly

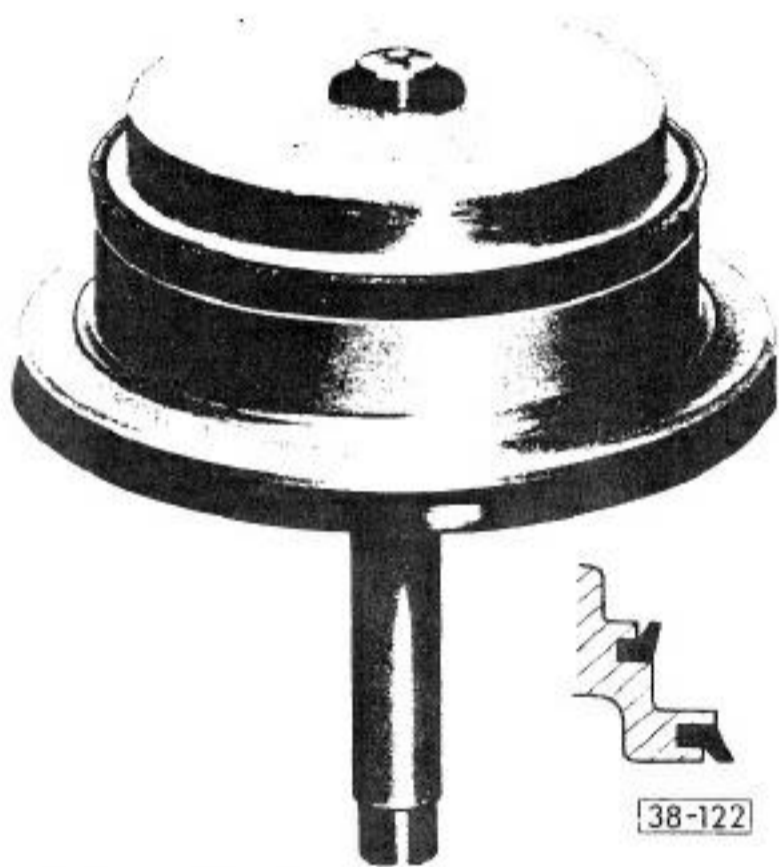
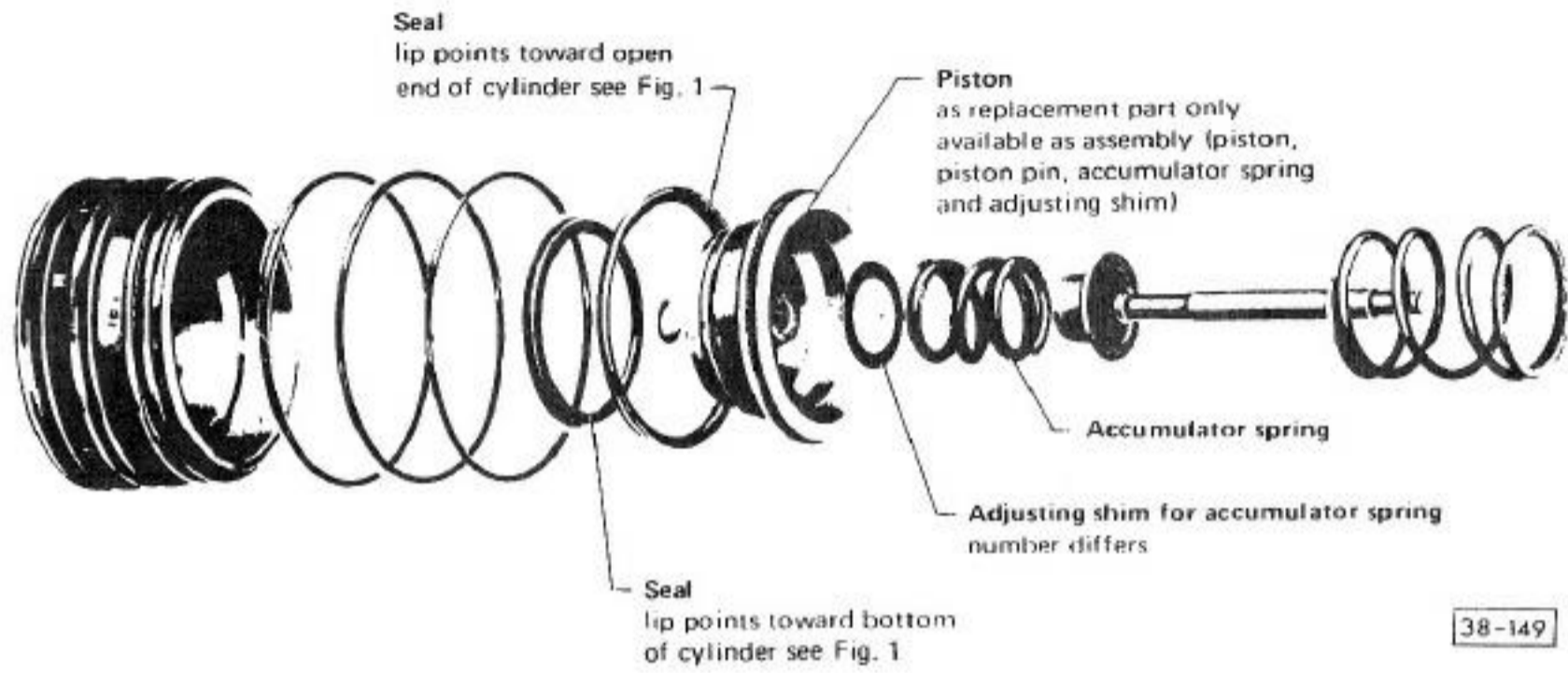
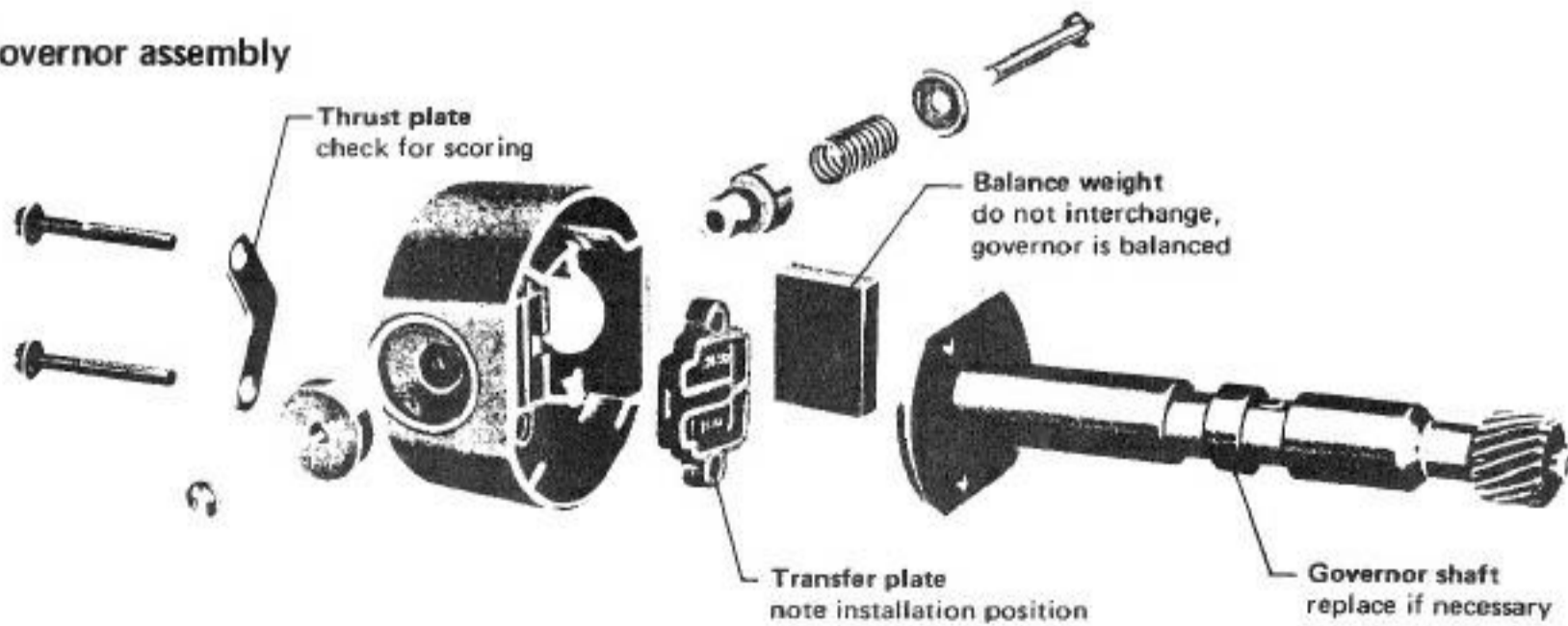
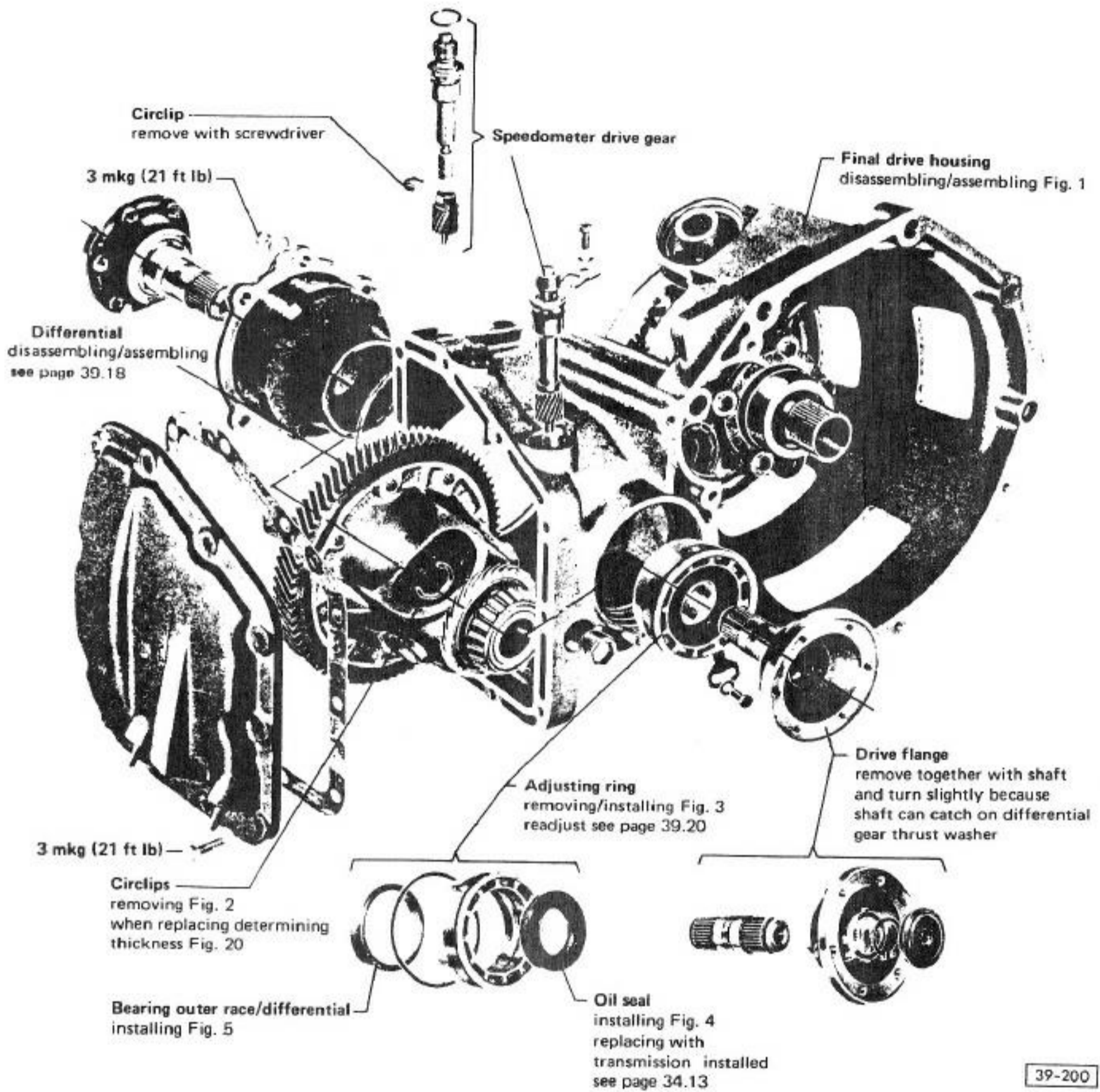


Fig. 1 Seal, installing

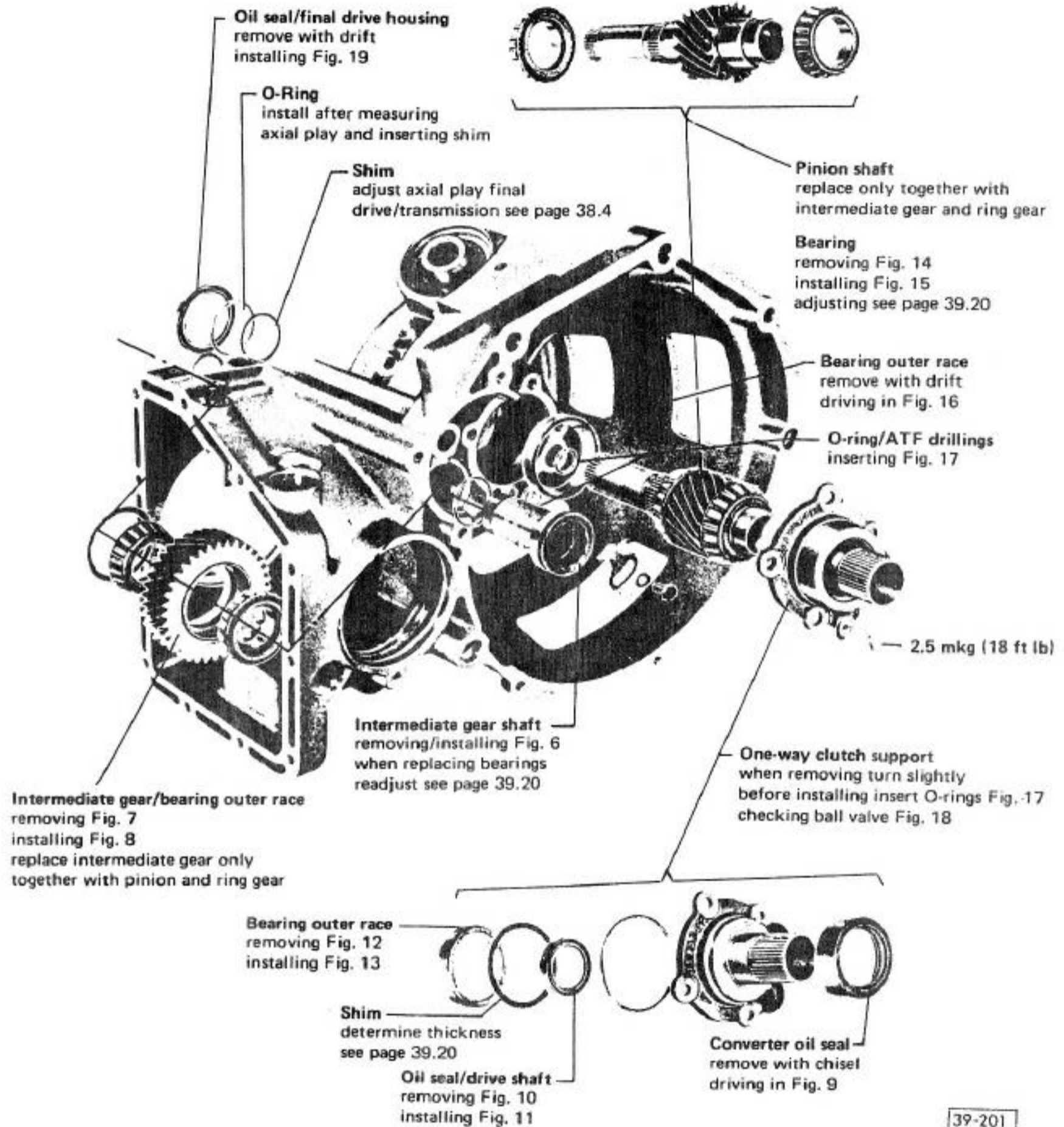
## Governor assembly





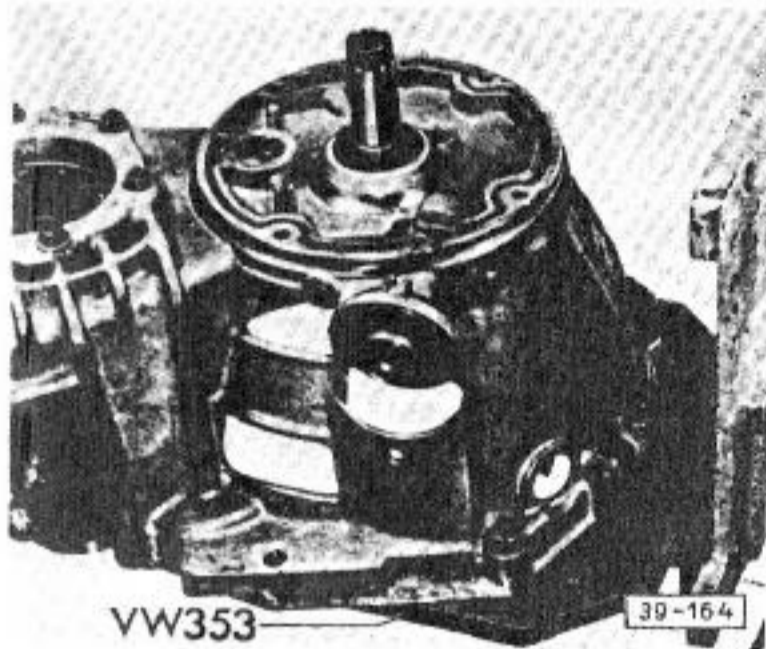
39-200

**Final drive lubricant:**  
Hypoid oil SAE 90, MIL-L 2105 B  
**Capacity:**  
0.8 US qts. (0.65 Imp. qts.)

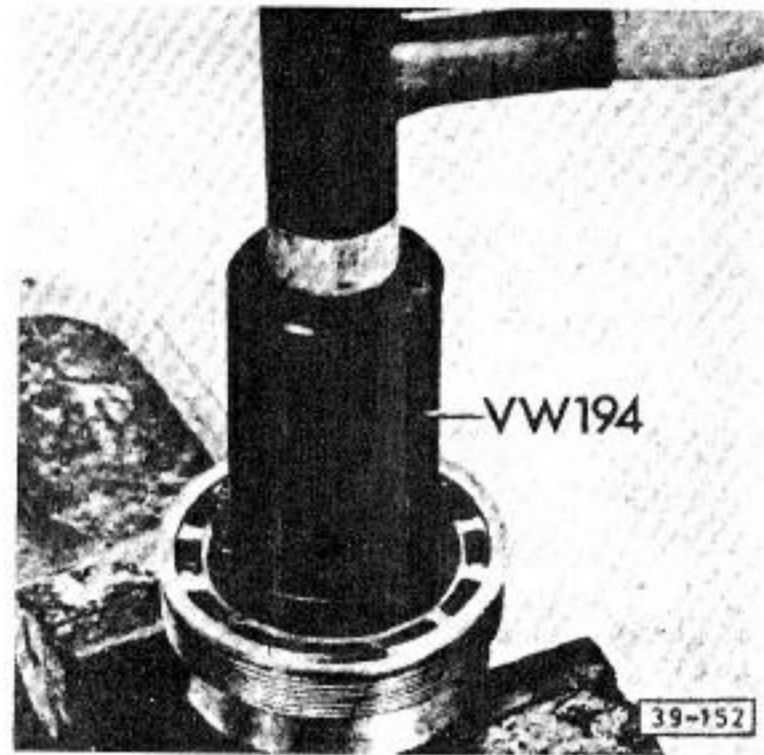


39-201

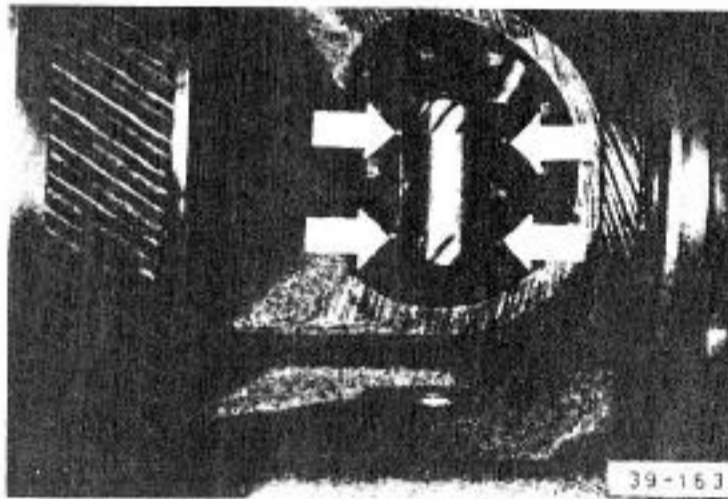
**Final drive lubricant:**  
Hypoid oil SAE 90, MIL-L 2105 B  
**Capacity:**  
0,8 US qts. (0.65 Imp. qts.)



**Fig. 1** Final drive housing, disassembling/ assembling  
 – mount in repair fixture



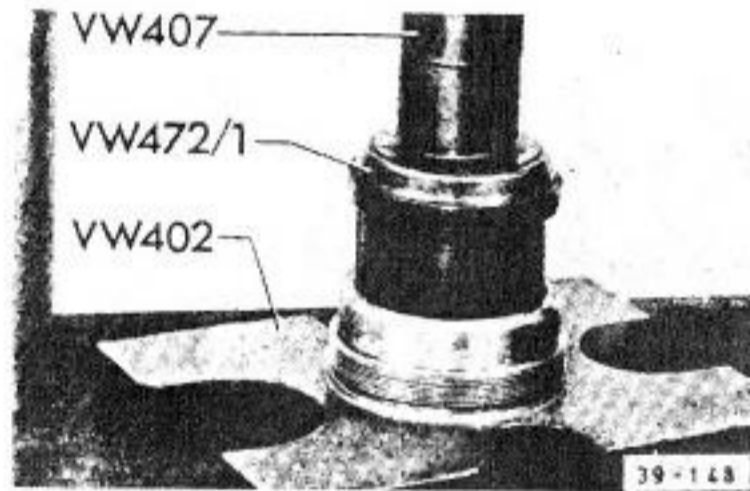
**Fig. 4** Oil seal / drive flange, installing  
 – lubricate sealing lips with multipurpose grease  
 – drive in flush



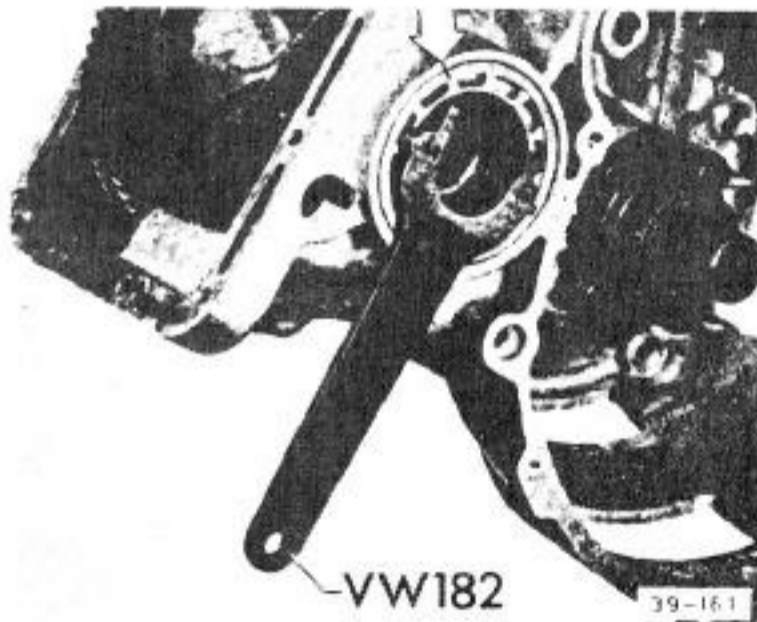
**Fig. 2** Circlips / drive flange, removing  
 – press off with two screwdrivers (arrows)  
 – remove flanges with shafts

**Note**

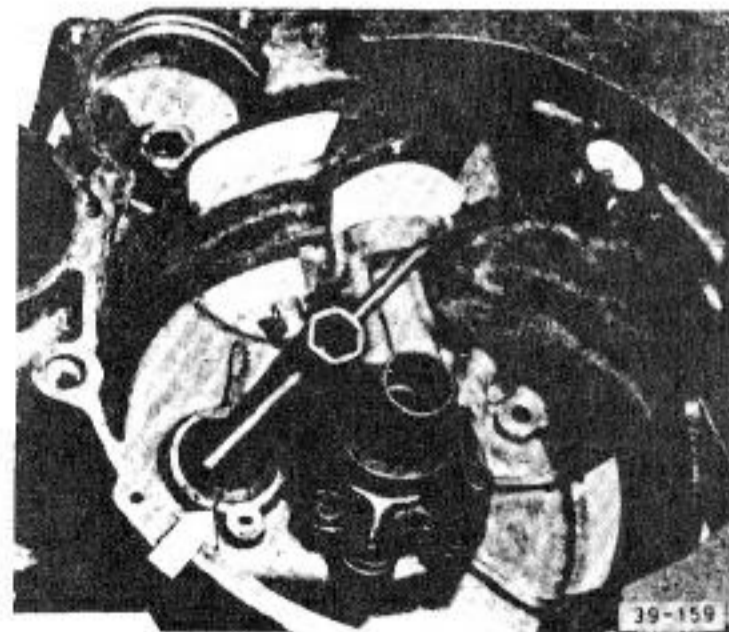
When pulling out shafts turn slightly to avoid catching on thrust washers



**Fig. 5** Bearing outer race, removing / installing  
 – heat adjusting ring to approx. 100° C (212° F) and press race out or in

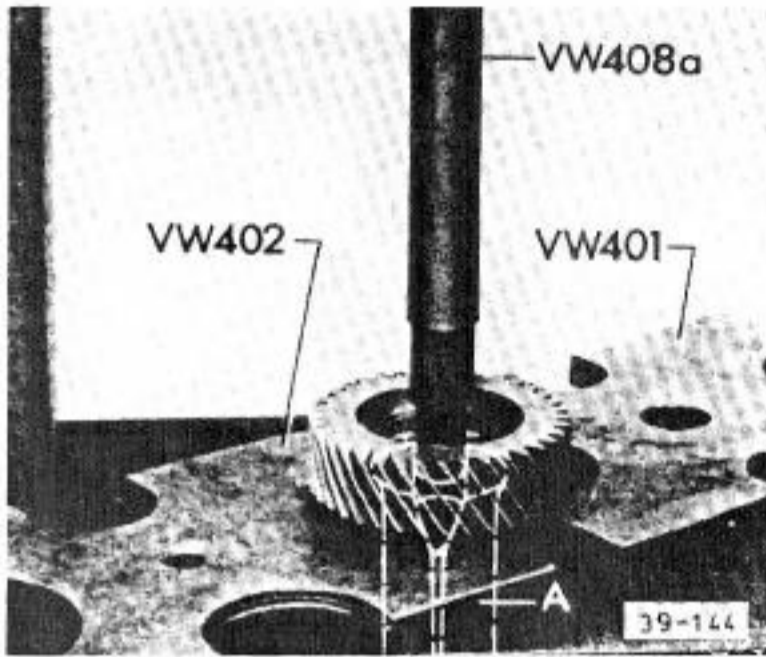


**Fig. 3** Differential adjusting ring, removing / installing  
 – before removing mark position  
 – when installing reset to mark (arrow)

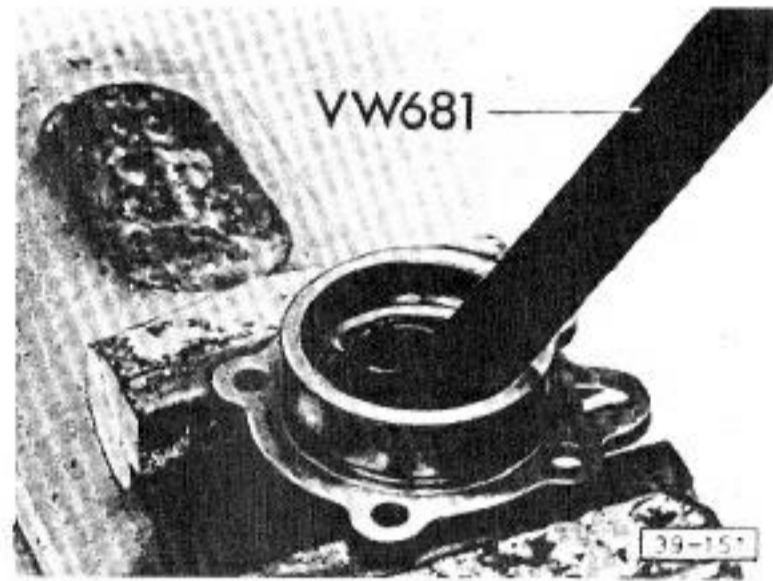


**Fig. 6** Intermediate gear shaft, removing / installing  
 – before removing mark position  
 – when installing reset to mark (arrow)

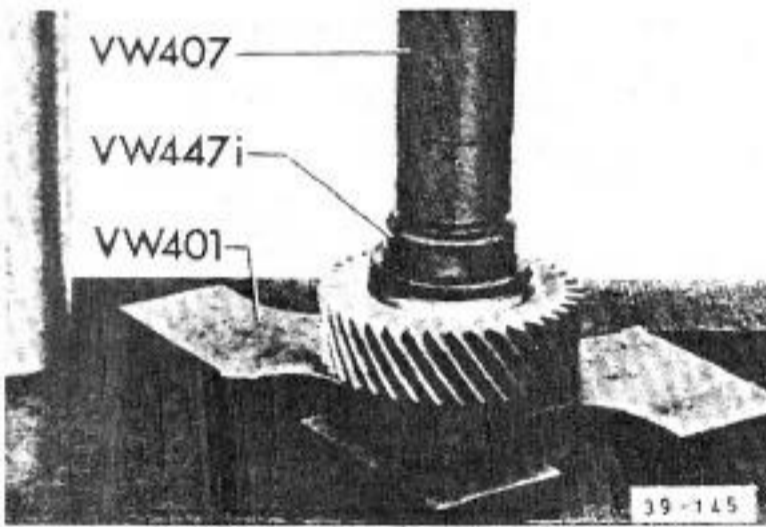




**Fig. 7 Intermediate gear/bearing outer race, removing**  
 – press out (A) – US 1099



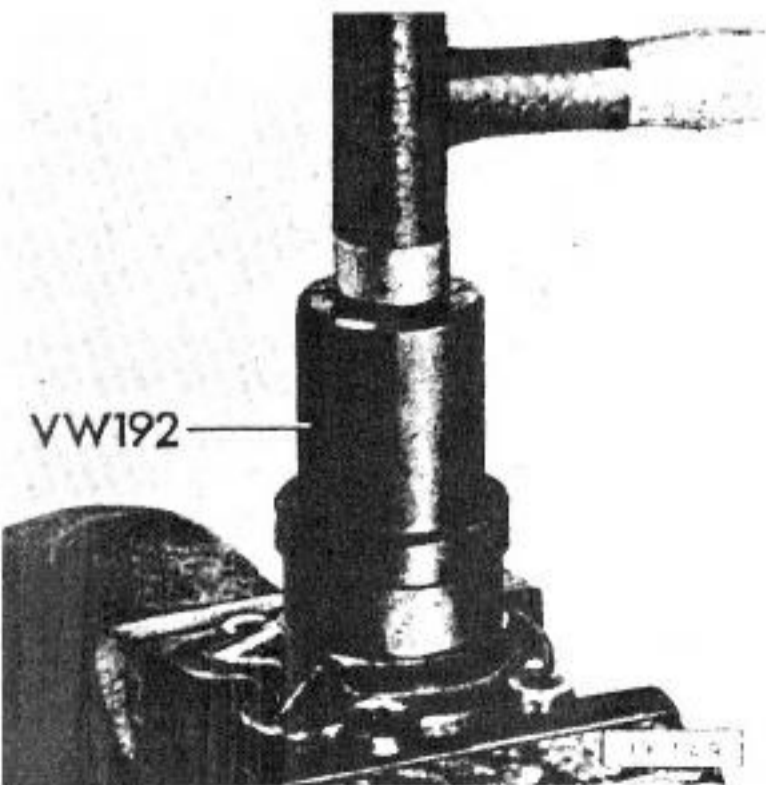
**Fig. 10 Oil seal/pinion shaft, removing**  
 – pry out of one-way clutch support



**Fig. 8 Intermediate gear/bearing outer race, installing**  
 – heat intermediate gear to approx. 100° C (212° F)



**Fig. 11 Oil seal/pinion shaft, installing**  
 – sealing lip toward converter



**Fig. 9 Converter oil seal, driving in**

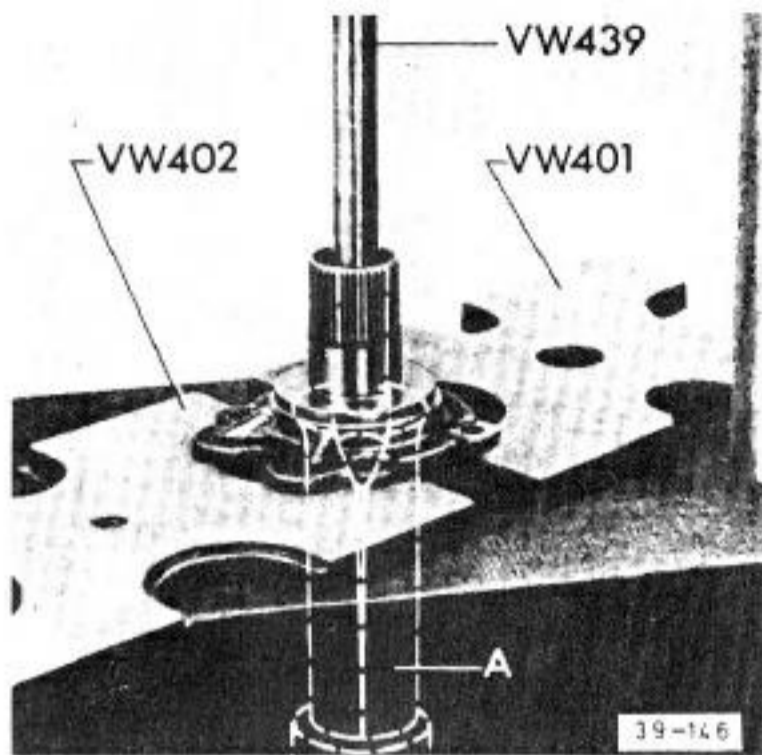


Fig. 12 Bearing outer race, removing  
 — do not interchange (A) — US 1099

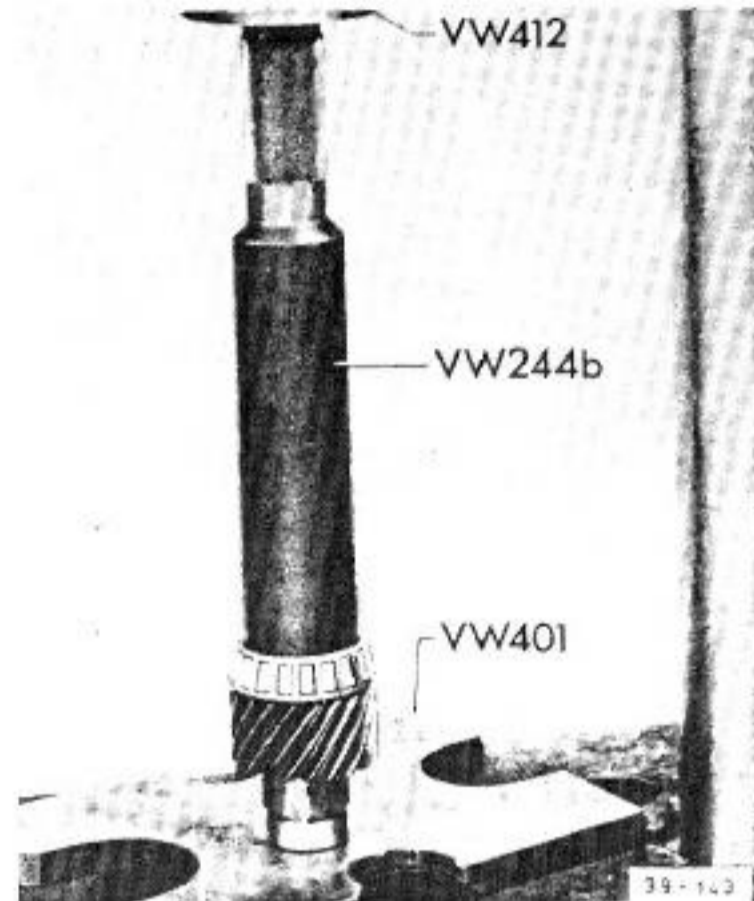


Fig. 15 Bearing/pinion shaft, installing  
 — heat to approx. 100° C (212° F) and press on

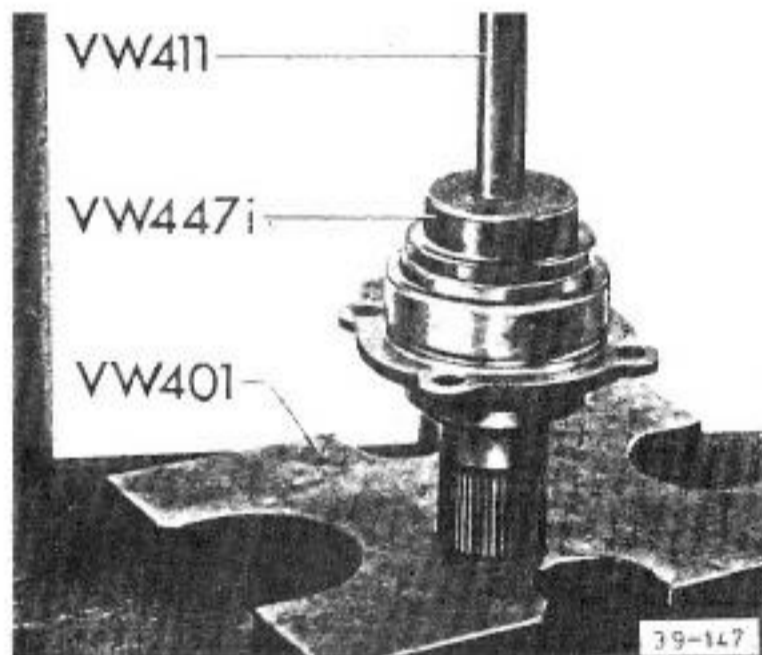


Fig. 13 Bearing outer race, installing  
 — heat support to approx. 100° C (212° F) and fully press outer race

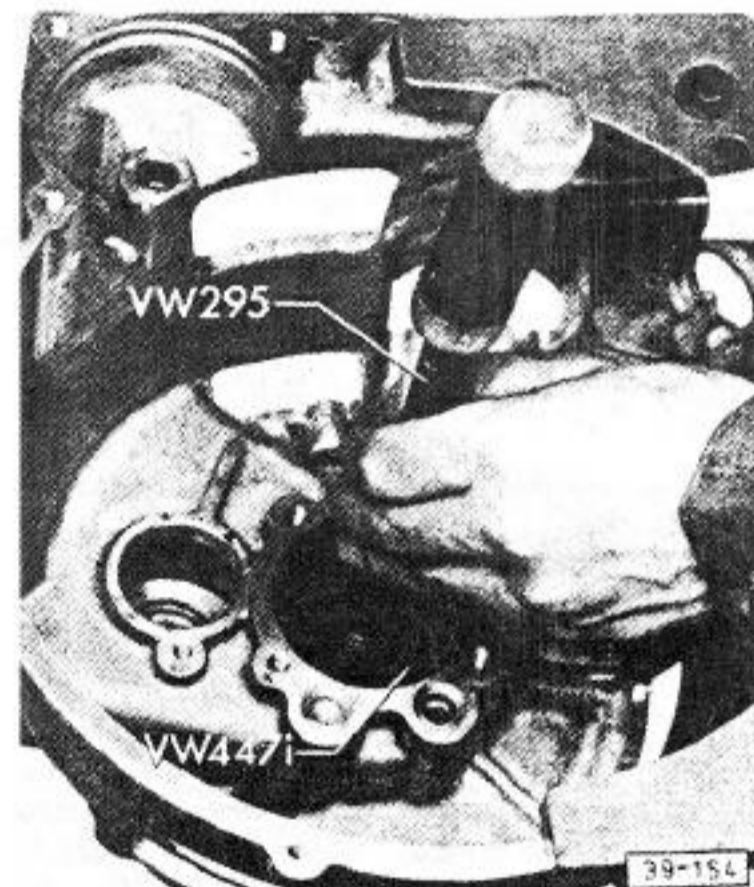


Fig. 16 Bearing outer race, driving in

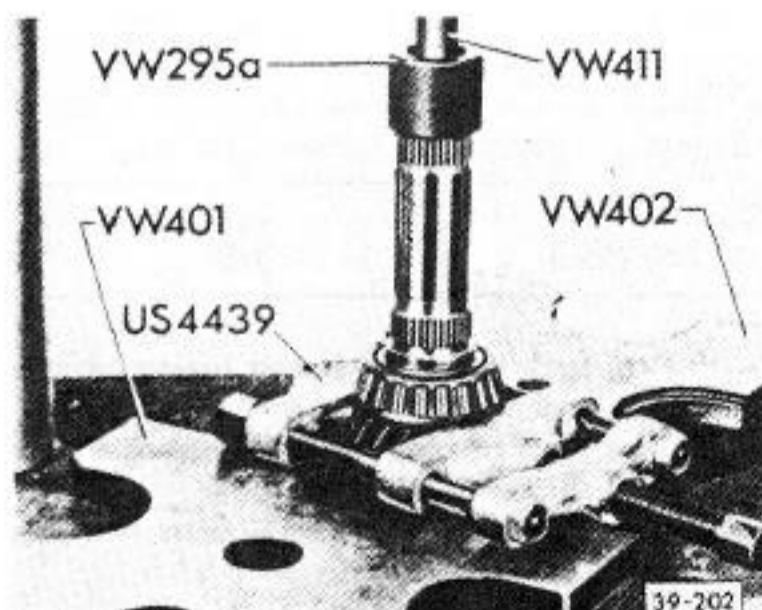
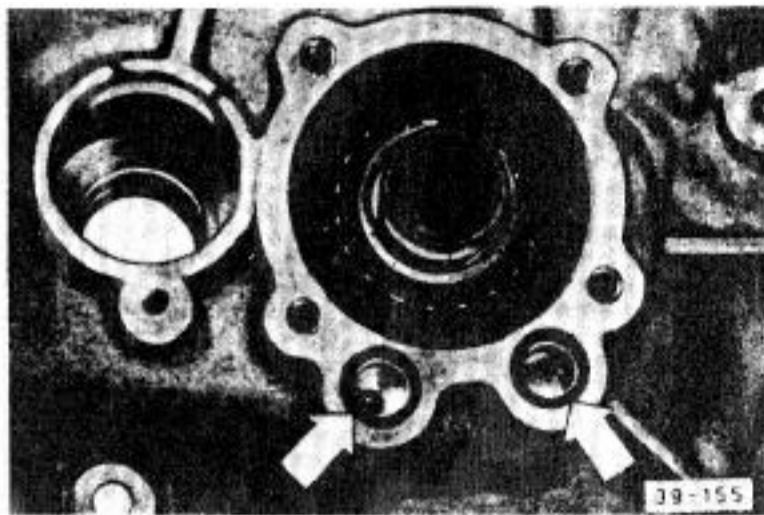


Fig. 14 Bearing/pinion shaft, removing  
 bearing cannot be reused after removal



**Fig. 17 O-rings/ATF drillings, inserting**  
 – insert (arrows) before installing one-way clutch support

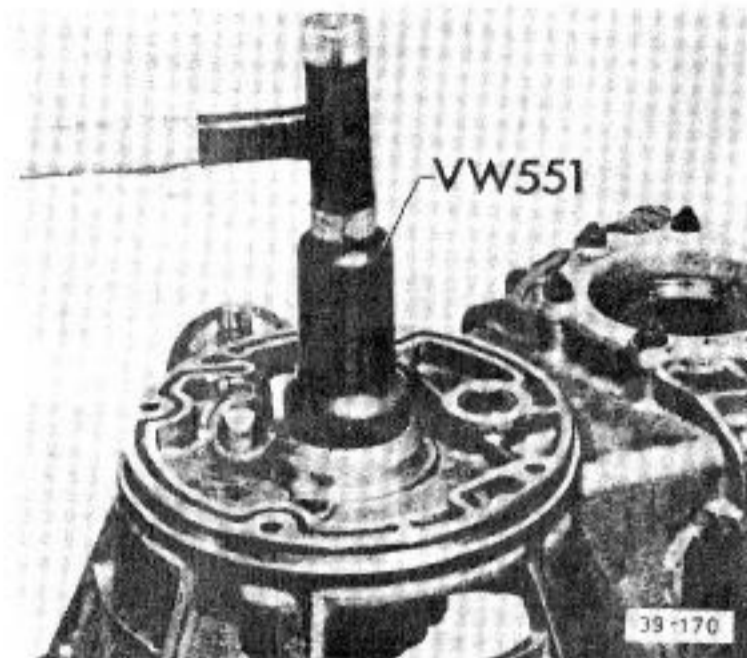


**Fig. 18 One-way clutch support, checking ball valve**

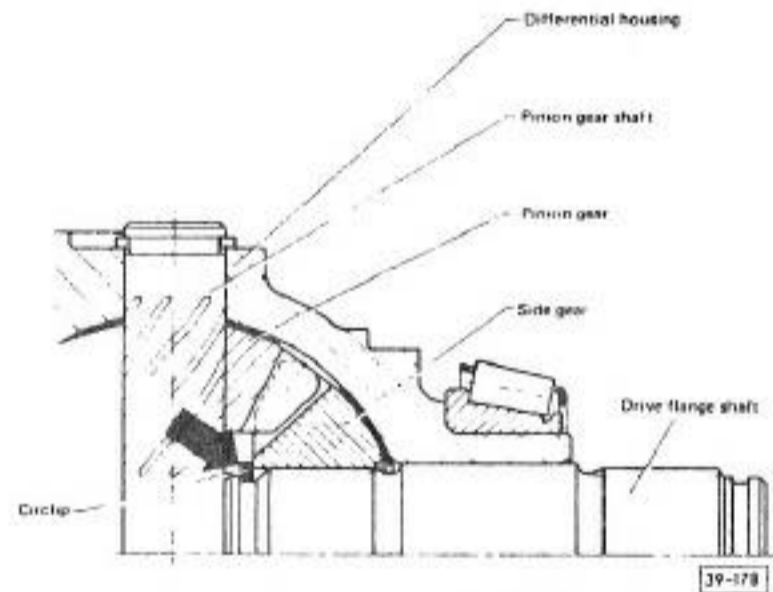
**Note**

Ball valve in one-way clutch support prevents ATF from draining out of converter when engine is not running.

- check sealing of ball valve by inserting piece of hose into hole (arrow) and sucking



**Fig. 19 Oil seal/final drive housing, installing**  
 – before installing adjust axial play and insert shim (see page 38.4)  
 – sealing lip toward final drive



**Fig. 20 Circlips/drive flange, determining thickness**

**Note**

When replacing circlip, drive flange shaft, differential housing or pinion/side gears, thickness of circlips (arrow) must be determined.

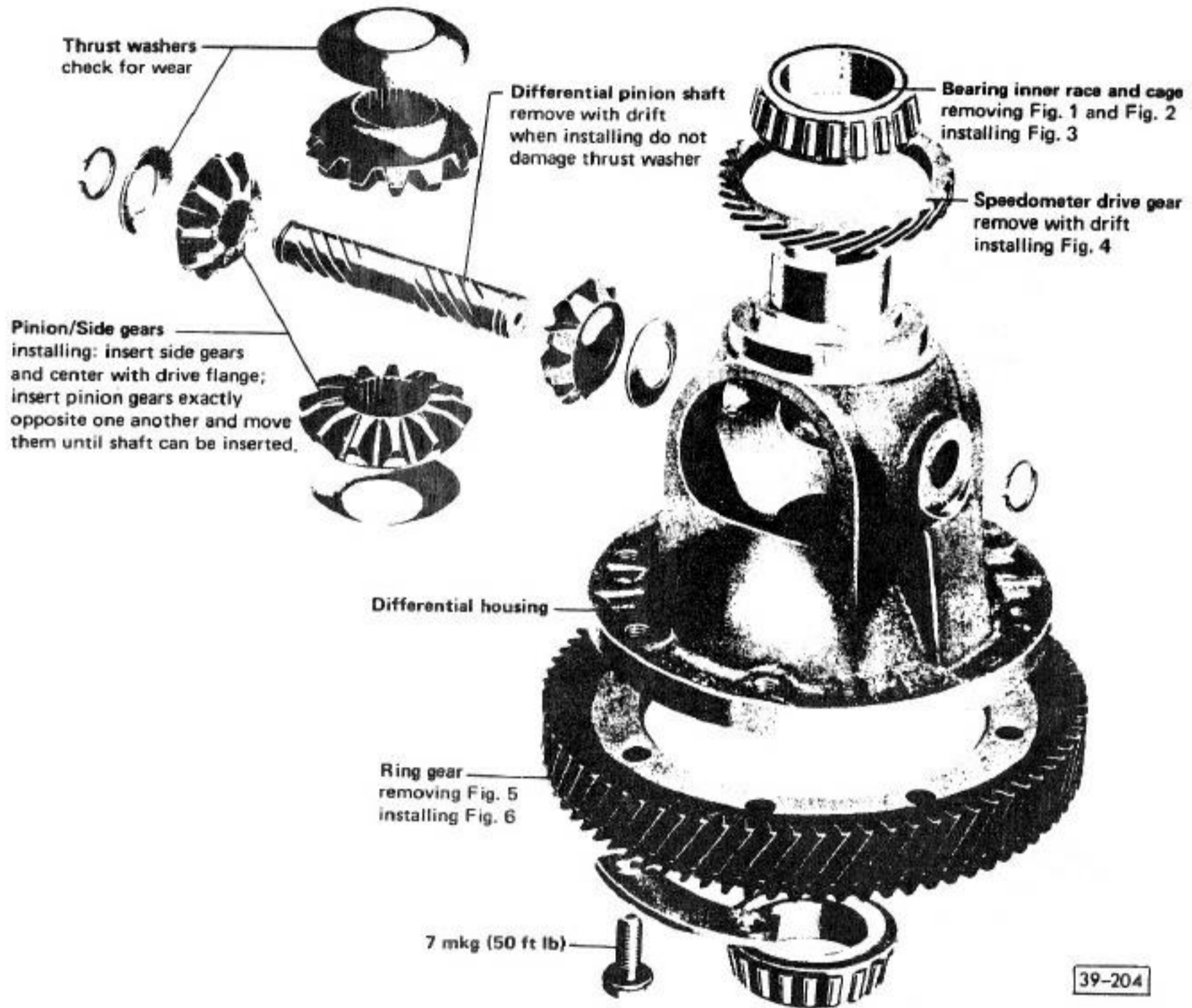
**Circlips available**

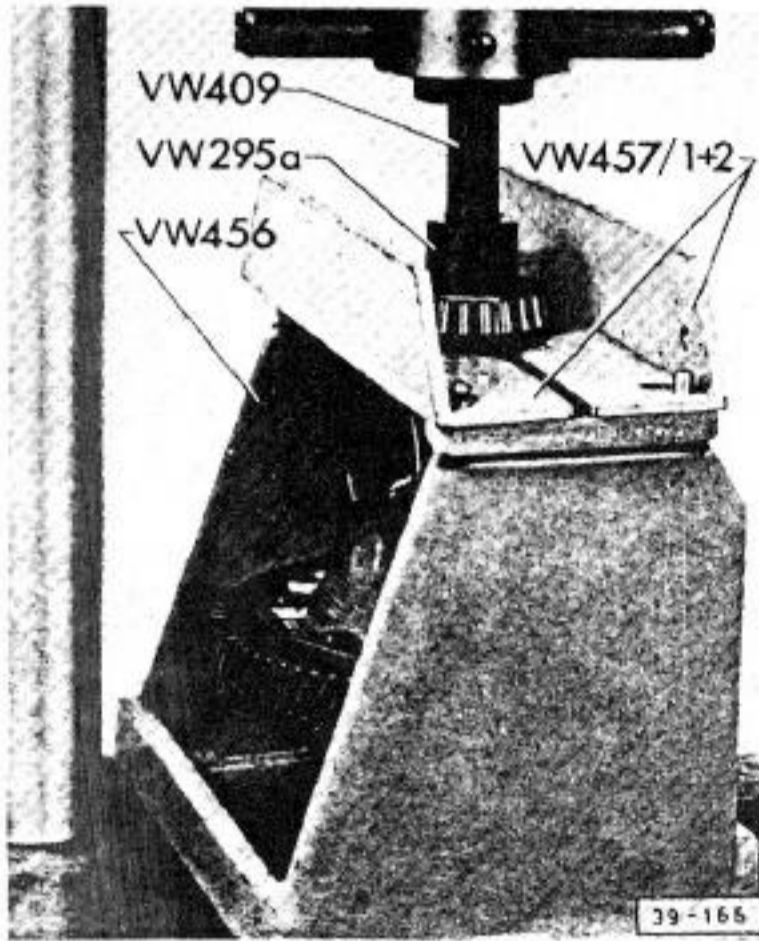
Part No.	Thickness (mm)
020 409 299	2.0
020 409 299 A	2.3

- press drive flange shaft against pinion gear shaft
- press side gears against housing and insert thicker circlip into groove.  
 Circlip must not jam at sides, if it does, use thinner circlip

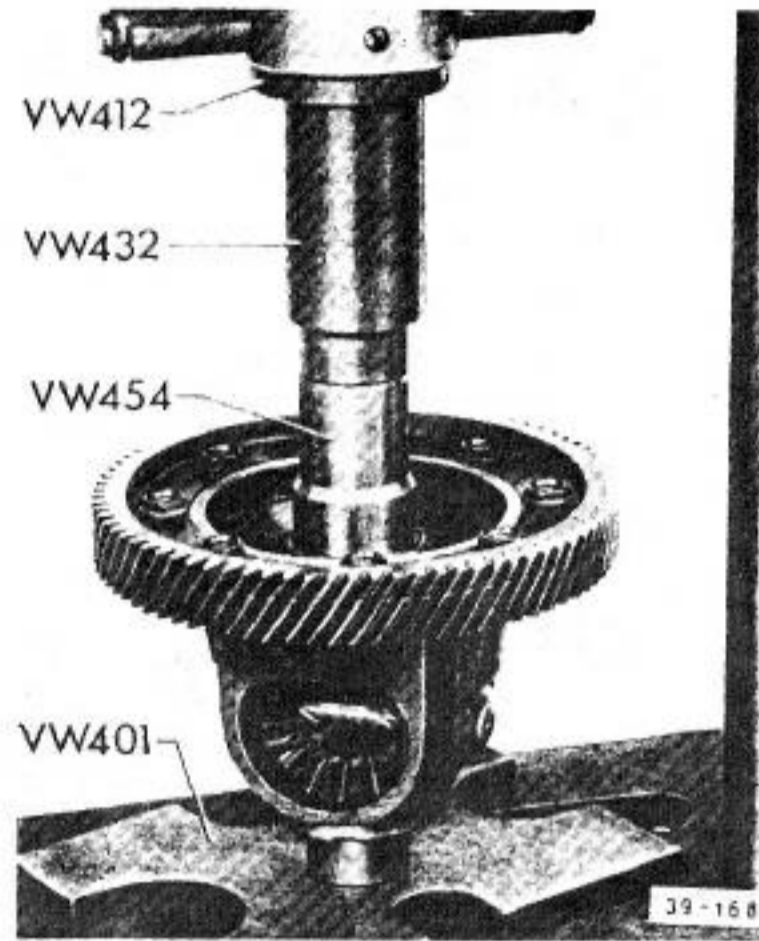
**Note**

When replacing thrust washers, pinion/side gears or differential housing determine thickness of circlip/drive flange see page 39.17 Fig. 20

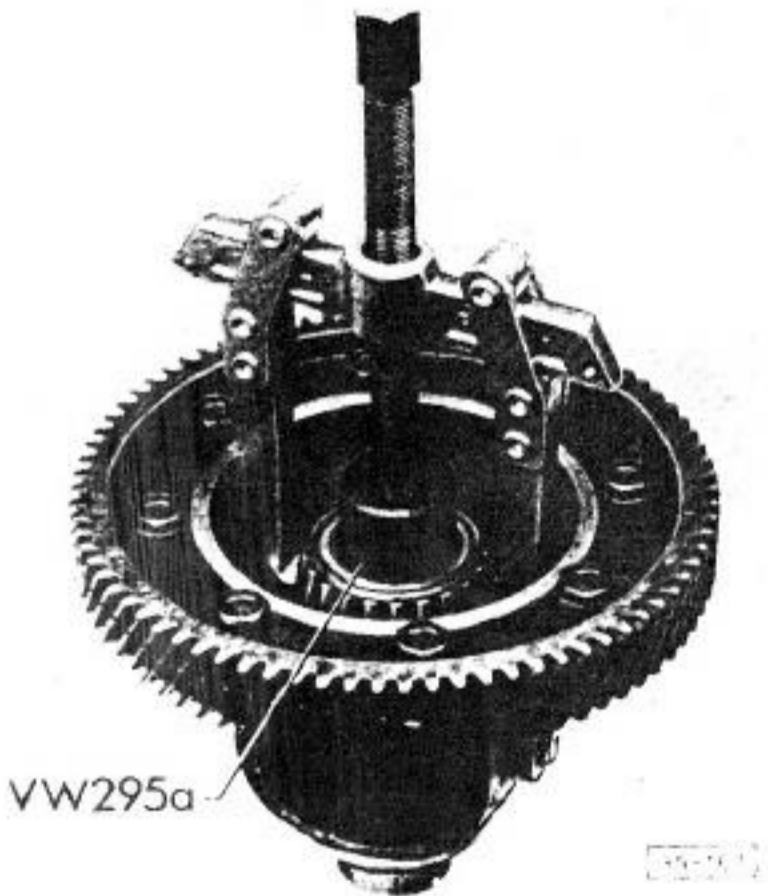




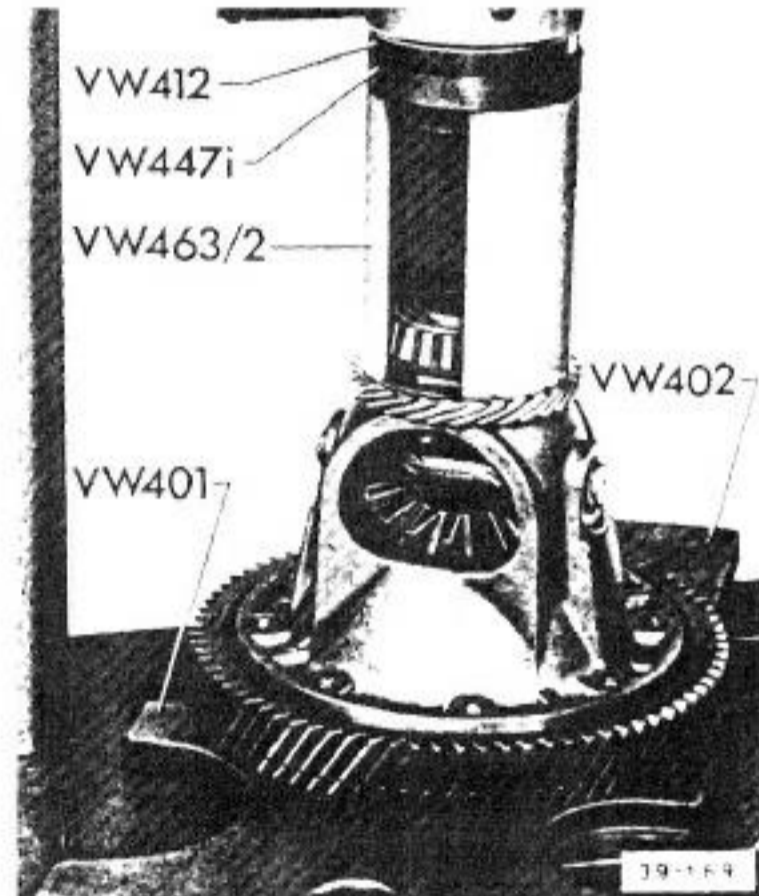
**Fig. 1** Bearing inner race and cage, removing  
do not interchange



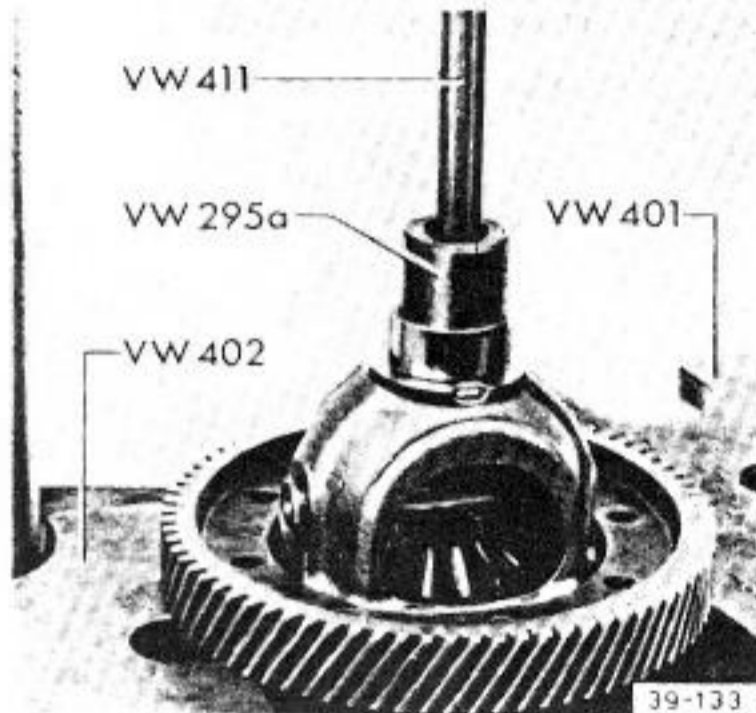
**Fig. 3** Bearing inner race and cage, installing



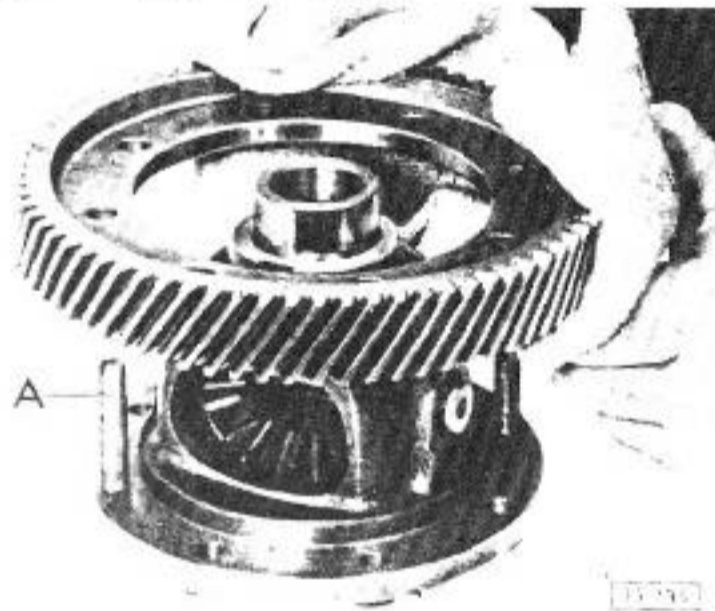
**Fig. 2** Bearing inner race and cage, removing  
do not interchange



**Fig. 4** Speedometer drive gear, installing



**Fig. 5** Ring gear, removing



**Fig. 6** Ring gear, installing  
 — replace only together with intermediate gear and drive shaft  
 — heat to approx. 100° C (212° F) and press on  
 A — centering pins (local manufacture)

**Final drive adjusting**  
 (when using new bearings /  
 if bearings are reused see page 39.14)

**Note**

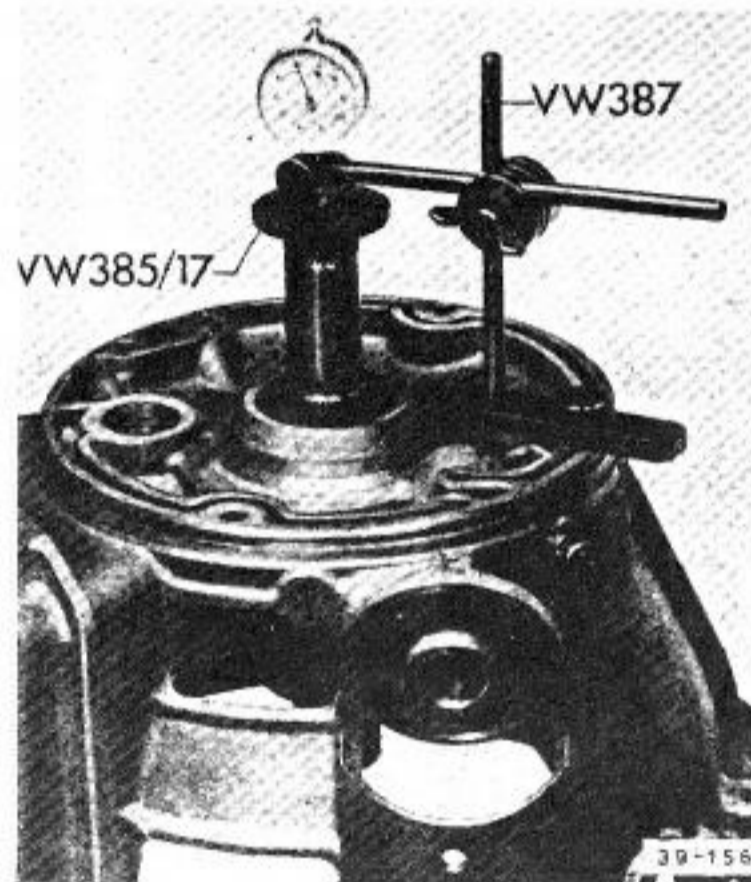
Follow instructions only if bearings are replaced. Only preload for bearings of drive shaft, intermediate gear and differential has to be adjusted.

When reusing bearings, intermediate gear shaft and differential adjusting ring should be set to marks made before removing see page 39.14.

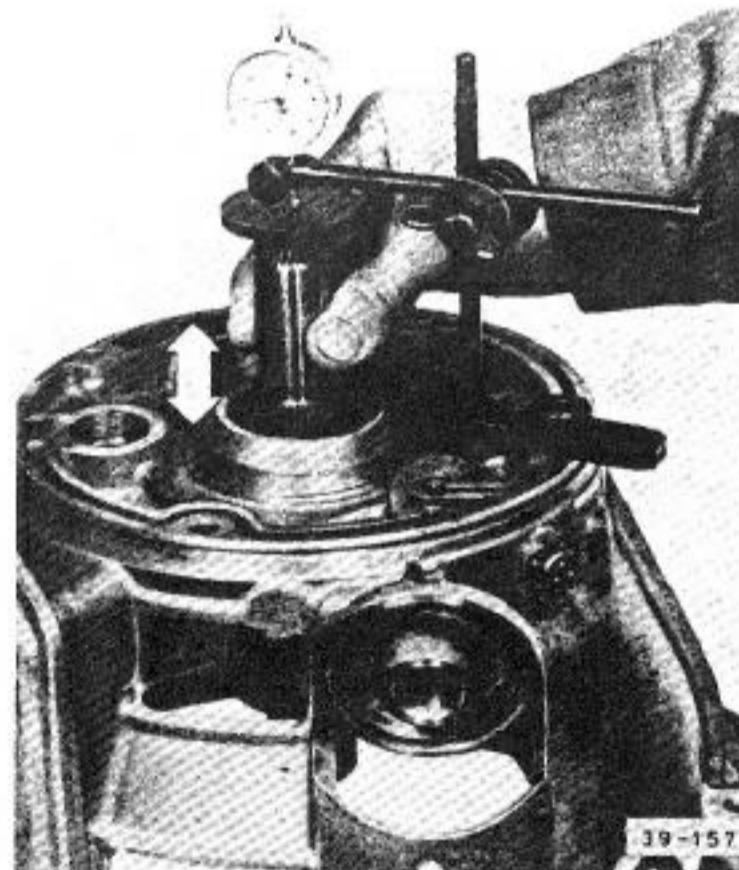
When measuring turning torque (preload) bearings must be lubricated with hypoid oil. If other oils are used measurements will be incorrect.

Proceed as follows:

- install bearing outer race in housing
- install bearing outer race in one-way clutch support (without shim)
- install drive shaft and one-way clutch support



- position end plate and dial gauge holder and zero dial gauge with no preload



- move shaft up and down (arrow) without turning and note reading

**Caution**

Do not turn shaft as this will give an incorrect reading

- determine thickness of shim and add 0.20 mm for preload to reading

**Example**

Reading	1.38 mm
Preload (constant value)	+ 0.20 mm
	<hr style="width: 50px; margin-left: auto; margin-right: 0;"/>
Shim thickness	<u>= 1.58 mm</u>

- remove final drive cover, select shim according to table

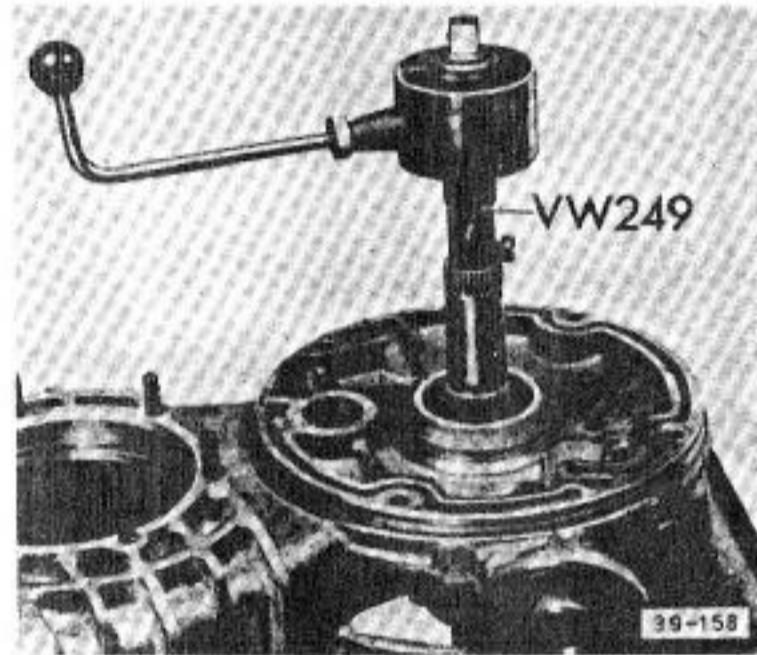
Axial play mm	Shim thickness mm	Part No.
0.95 - 1.00	1.00	010 519 141 AA
1.01 - 1.05	1.05	010 519 141 AB
1.06 - 1.10	1.10	010 519 141 AC
1.11 - 1.15	1.15	010 519 141 AD
1.16 - 1.20	1.20	010 519 141 AE
1.21 - 1.25	1.25	010 519 141 AF
1.26 - 1.30	1.30	010 519 141 AG
1.31 - 1.35	1.35	010 519 141 AH
1.36 - 1.40	1.40	010 519 141 AJ
1.41 - 1.45	1.45	010 519 141 AK
1.45 - 1.50	1.50	010 519 141 AL
1.51 - 1.55	1.55	010 519 141 AM
1.56 - 1.60	1.60	010 519 141 AN
1.61 - 1.65	1.65	010 519 141 AP
1.66 - 1.70	1.70	010 519 141 AQ
1.71 - 1.75	1.75	010 519 141 AR
1.76 - 1.80	1.80	010 519 141 AS
1.81 - 1.85	1.85	010 519 141 AT
1.86 - 1.90	1.90	010 519 141 BA
1.91 - 1.95	1.95	010 519 141 BB
1.96 - 2.00	2.00	010 519 141 BC
2.01 - 2.05	2.05	010 519 141 BD
2.06 - 2.10	2.10	010 519 141 BE
2.11 - 2.15	2.15	010 519 141 BF
2.16 - 2.20	2.20	010 519 141 BG

**Note**

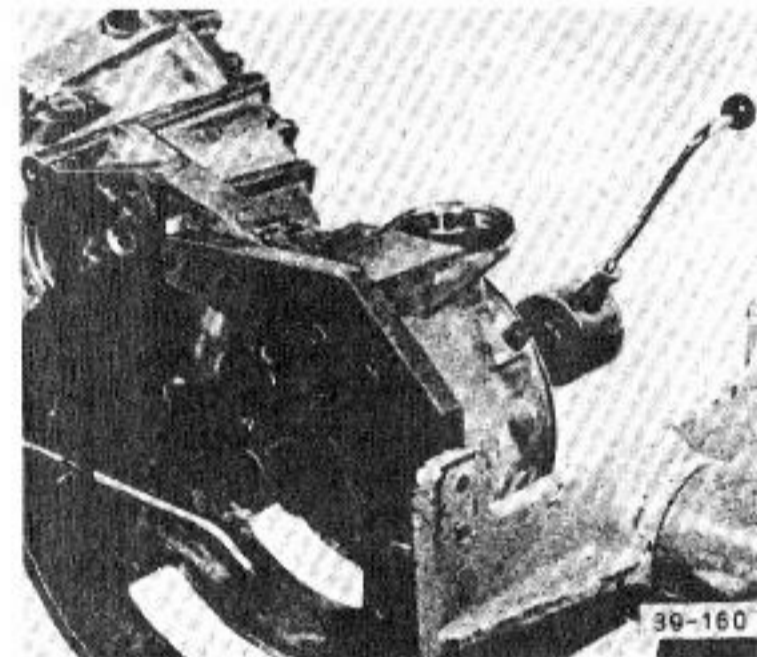
Measure shims at several points with a micrometer. Check for burrs and damage. Use only good shims.

- insert shim and install cover again

Bearings for intermediate gear and differential are measured for turning torque as follows:



- measure turning torque of drive shaft and note reading



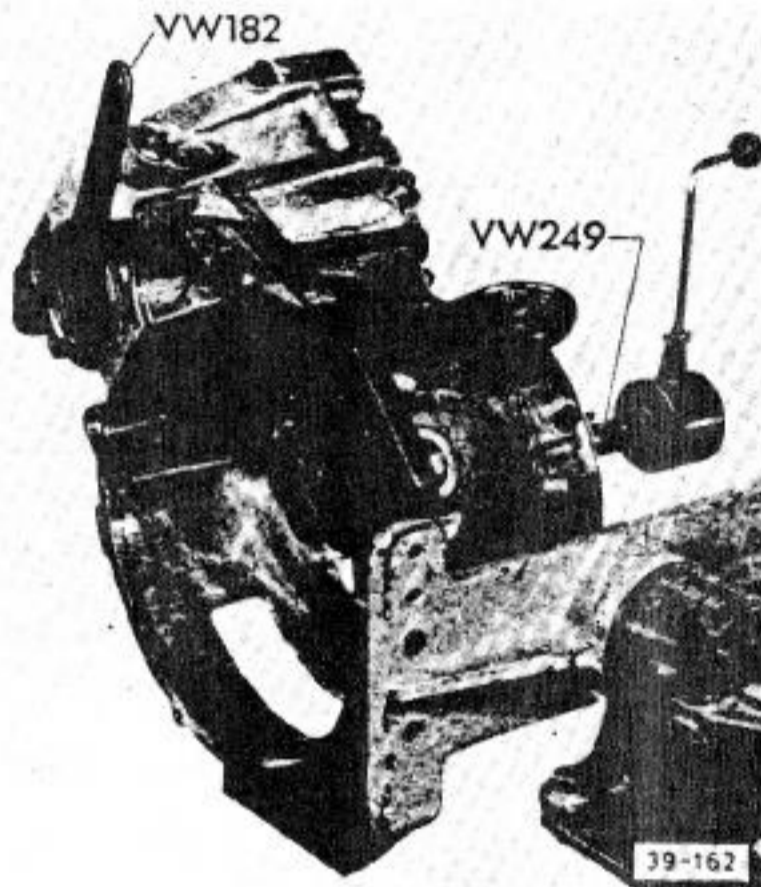
- install intermediate gear and shaft
- measure turning torque on drive shaft, it must be 15 cmkg (13 in. lb) higher than reading for drive shaft alone

**Example**

Reading for drive shaft	12 cmkg (11 in.lb)
Torque for intermediate gear (constant value)	+ 15 cmkg (13 in.lb)
	<hr style="width: 50px; margin-left: auto; margin-right: 0;"/>

Total torque measured at drive shaft	27 cmkg (24 in.lb)
--------------------------------------	--------------------

- install locking plate for intermediate gear shaft
- insert differential and install side cover



- turn in differential adjusting ring and measure turning torque at same time. It must be 7 cmkg (6 in.lb) higher than 27 cmkg (24 in.lb) (total torque measured at drive shaft)

**Example**

Torque for drive shaft and intermediate gear	27 cmkg (24 in.lb)
Torque for differential (constant value)	+ 7 cmkg (6 in.lb)
Total torque measured at drive pinion	<u>34 cmkg (30 in.lb)</u>

- install locking plate for adjusting ring





## Technical Service Information TROUBLESHOOTING

COMPLAINT	CAUSE	CORRECTION
No drive in all gears	a) Low fluid level b) Manual valve disconnected c) Converter bolts broken d) Defective oil pump	a) Add as required b) Remove valve body and repair c) Remove transmission and repair d) Replace oil pump/drive
No drive in forward gears	a) Defective oil pump b) Forward planetary failed	a) Overhaul clutch b) Replace planetary
No drive in 1st gear	a) One-way clutch failed b) Defective forward clutch	a) Replace clutch b) Overhaul clutch
No drive in 2nd gear	a) 2nd gear brake band failed	a) Overhaul transmission replace band
No drive in 3rd gear	a) Direct and reverse clutch failed	a) Overhaul clutch
No drive in Reverse	a) 1st and reverse clutch failure b) Direct and reverse clutch failed c) Defective forward clutch	a) Overhaul transmission replace clutch ass'y b) Overhaul clutch c) Overhaul clutch
Drive in Neutral	a) Forward clutch seized	a) Overhaul clutch
No 2nd gear upshift	a) Defective governor b) Accumulator cover loose c) Valve body dirty d) 2nd gear brake band failed	a) Overhaul or replace b) Check accumulator, cover and seals c) Clean, change filter and fluid d) Overhaul transmission and replace band
No 3rd gear upshift	a) Governor dirty b) Valve body dirty c) 2-3 Shift valve sticking d) Check balls out of place	a) Remove, disassemble and clean b) Clean, change filter and fluid c) Clean valve body d) Remove valve body, replace check balls as required
Noisy in Drive during start	a) 1st gear one-way clutch failed	a) Replace clutch and affected parts
Shift speed above or below normal speed	a) Governor dirty b) Valve body dirty	a) Remove, disassemble and clean b) Clean, change filter and fluid
No kickdown	a) Accelerator cable out of adjustment	a) Adjust cable to specifications