

1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul

1986-91 AUTOMATIC TRANSMISSIONS

Type 090 3-Speed Diagnosis & Overhaul

APPLICATION

TRANSAXLE APPLICATION

Application	Transaxle Model
Vanagon	Type 090

IDENTIFICATION

Transaxle type number is cast into top of transaxle case over transaxle portion. Code letters and date of manufacture are stamped into machined flat on bellhousing rim. Valve body identification tag is secured with valve body mounting screws. Torque converter code letter is stamped on side of attaching lug.

TYPE 090 COMPONENT IDENTIFICATION

Component	Identification Code
Transaxle Type	090
Transaxle Model	NH
Valve Body	FFA
Torque Converter	Z

DESCRIPTION

Transaxle assembly consists of two main units: Automatic transaxle and final drive assembly. The transaxle housing contains two planetary gear sets, two multi-disc clutches, one brake band and servo, one multiple-disc brake, a one-way clutch, and a hydraulic control system. The final drive housing contains the torque converter, governor assembly for transaxle, ring and pinion gear, and the differential assembly. An ATF cooler is mounted to the rear of the transaxle case and cooled by water, circulated from the cooling system.

LUBRICATION & ADJUSTMENTS

NOTE: See appropriate **SERVICING** article.

ON-VEHICLE REPAIRS

DRIVE AXLE SHAFTS

NOTE: See appropriate **AXLE SHAFTS** article in **DRIVELINE/AXLES**.

TROUBLE SHOOTING

NO MOVEMENT

1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul

In Any Gear

Low ATF fluid level. Manual lever disconnected from manual valve. Drive plate broken or not bolted to torque converter. Main pressure valve sticking. Oil pump or pump drive faulty/no pressure. Broken gear or shaft, possibly in final drive.

In Forward Gears

Forward clutch internal damage (worn plates, broken diagram spring, seals leaking, etc.). Forward planetary gear set damaged.

In 1st Gear in "D" Or "2"

1st gear one-way clutch not holding. Forward clutch internal damage.

In 1st Gear In "1"

1st-reverse brake plates worn or burnt.

In 2nd Gear

2nd gear brake band out of adjustment or burnt, or servo defective.

In 3rd Gear

Direct-reverse clutch internal damage (worn and/or burnt plates, seals leaking, etc.).

In Reverse

1st-reverse brake plates worn or burnt. Direct-reverse clutch internal damage. Forward clutch seized in applied position.

NO UPSHIFT

Into 2nd Gear

Governor drive defective. Governor dirty or improperly assembled during repair. Accumulator cover plate loose. Valve body assembly dirty. 1st/2nd gear shift valve sticking. 2nd gear brake band burnt or worn.

Into 3rd Gear

Governor dirty. Valve body assembly dirty. 2nd/3rd gear shift valve sticking. Sealing balls missing from transfer plate.

NO DOWNSHIFT

Into 2nd And/Or 1st Gear

1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul

Governor or valve body dirty. Check 1st/2nd and/or 2nd/3rd gear shift valves for sticking in valve body.

DELAYED ENGAGEMENT ON UPSHIFTS

1-2 Upshift

Low fluid level. Dirty valve body assembly. 2nd gear brake band worn, burnt or out of adjustment. 2nd gear servo defective, possible wrong piston.

2-3 Upshift

Low fluid level. Dirty valve body. 2nd gear brake band worn, burnt or out of adjustment. 2nd gear servo defective. Direct-reverse clutch plates worn or burnt. Wrong direct-reverse clutch installed.

ERRATIC DRIVE

Low fluid level. Bushing in one-way clutch support and turbine shaft worn. Oil filter dirty.

SHIFT SPEEDS ABOVE OR BELOW NORMAL

Governor or valve body assembly dirty, damaged or improperly installed. Paper gasket for transaxle or intermediate plate damaged.

CLUTCH & BAND APPLICATIONS

Lever Position	Forward Clutch	Direct Reverse Clutch	First-Reverse Brake	Second Gear Band	One Way Clutch
Drive					
First	X				
Second	X			X	Holding
Third	X	X			Overrun
2-Intermed					
First Gear	X				
Second Gear	X			X	Holding
1-Low	X		X		Overrun
Reverse		X	X		
Neutral/Park-All clutches, brake & bands released &/or ineffective.					

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Fig. 1: Clutch & Brake Band Application Chart (Elements In Use)

PERFORMANCE TESTS

ROAD TEST

1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul

1. Before road testing, be certain that fluid level and condition, and control linkage adjustments have been checked and corrected as necessary. During the test, transaxle should upshift and downshift at approximately the speeds shown in **SHIFT SPEED SPECIFICATIONS** table. All shifts may vary somewhat due to production tolerances or tire size. The important factor is the quality of the shifts. All shifts should be smooth, responsive, and with no slippage or engine speed runaway.
2. Slippage or engine runaway in any gear usually indicates clutch, band or brake problems. The slipping unit in a particular gear can usually be identified by noting transaxle operation in other selector positions and comparing which internal units are applied in those positions. See **Fig. 1**.
3. This process of elimination can be used to detect, any unit which slips, and to confirm proper operation of good units. However, the actual cause of the malfunction usually cannot be easily determined. Most conditions can be caused by leaking hydraulic circuits or sticking valves. Therefore, unless an obvious condition exists, do not disassemble transaxle, until a hydraulic pressure test has been made.

SHIFT SPEEDS SPECIFICATIONS

Application	Full Throttle (MPH)	Kickdown (MPH)
1-2 Upshift	16-25	31-33
2-3 Upshift	37-46	53-55
3-2 Downshift	27-36	50-52
2-1 Downshift	11-14	24-26

HYDRAULIC PRESSURE TESTS

1. Connect 0-150 psi (0-10 kg/cm²) pressure gauge to main pressure test point on case (adjacent to servo cover). See **Fig. 2**. Run engine until transaxle is at normal operating temperature. Place selector lever in "D". Run engine to over 30 MPH; release throttle and read pressure on gauge (with engine idling).

NOTE: This test, as well as full throttle test performed next, should be carried out on dynamometer when possible.

2. With transaxle in "D", run engine at full throttle (with vehicle speed above 30 MPH). Note pressure. With vehicle at rest, place selector lever in "R" position. Note reading on pressure gauge with engine idling. Pressures in each part of test should be as shown in **MAIN PRESSURE SPECIFICATIONS** table. If pressures obtained do not match those shown in chart, disassemble and clean valve body and check especially for sticking valves.

MAIN PRESSURE SPECIFICATIONS

Application	psi (kg/cm ²)
"D" @ Idle ⁽¹⁾	41-42 (2.9-3.0)
"D" @ Full Throttle ⁽²⁾	83-84 (5.85-5.95)
"R" @ Idle ⁽¹⁾	108-117 (7.6-8.2)
(1) Test should be performed on a dynamometer whenever possible. Perform idle test with vehicle stationary.	
(2) Full throttle test up to 30 MPH.	

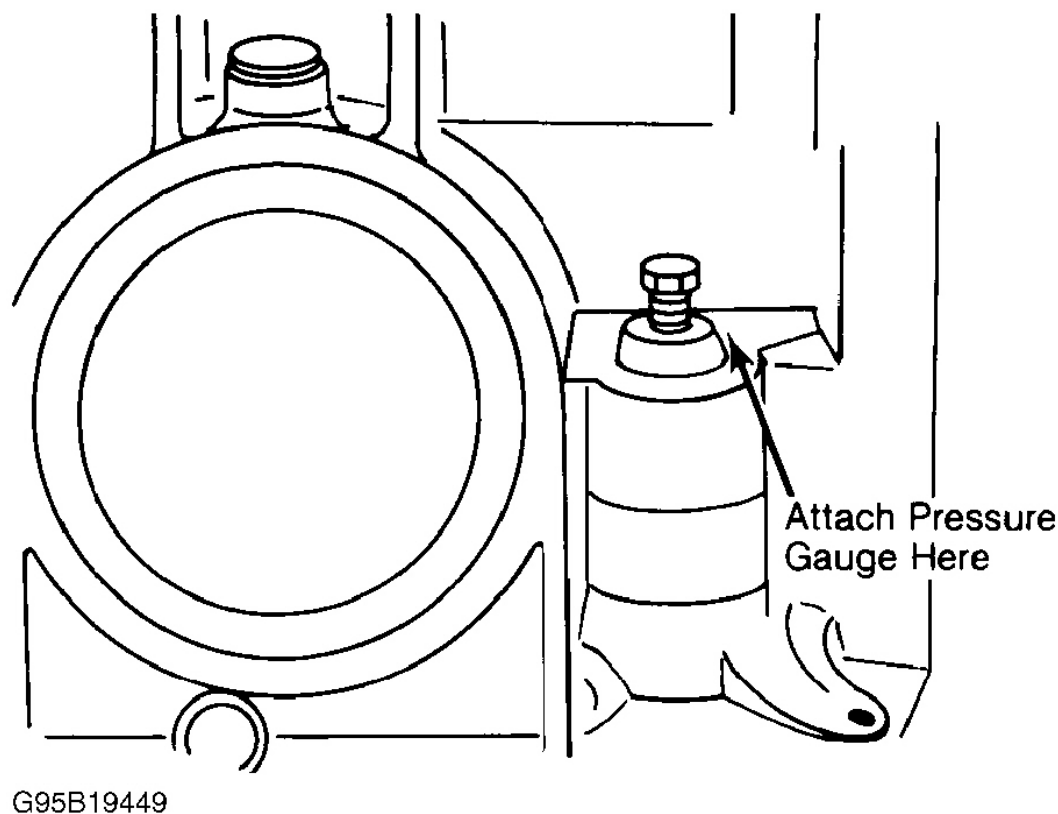


Fig. 2: Pressure Test Port Location

STALL SPEED TEST

Testing Precautions

Check stall speed only if vehicle shows poor performance or acceleration (despite a properly tuned engine). When making test, do not hold throttle open any longer than the time it takes to read tachometer or torque converter will overheat. Maximum stall speed test time is 20 seconds. If test must be repeated, wait at least 20 seconds.

If engine speed exceeds limits shown, release accelerator immediately as clutch or band slippage is indicated. See **STALL SPEED SPECIFICATIONS**.

Testing Procedure

1. With engine at normal operating temperature, connect a tachometer to engine. Start engine and set parking and service brakes. Place selector lever in "D". Depress accelerator briefly to full throttle and note maximum RPM obtained. Repeat test with selector lever in "1" position. Engine speed should be within limits shown in table.

1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul

- Depress accelerator briefly to full throttle and note maximum RPM obtained. Repeat test with selector lever in "1" position. Engine speed should be within limits shown in **STALL SPEED SPECIFICATIONS** table.

NOTE: Normal stall speed will drop about 125 RPM per 3200 feet altitude. Also, stall speed will drop slightly at high ambient temperature.

STALL SPEED SPECIFICATIONS

Application	Stall RPM
Model NH	2450-2750

STALL SPEED TEST RESULTS

- If stall speed is higher than specified, forward clutch or 1st gear one-way clutch is slipping. If stall speed in "D" is too high, repeat stall test in "1". If RPM is within specifications, one-way clutch for 1st gear is defective. If stall speed RPM is still too high, forward clutch is defective.
- If stall speed is approximately 200 RPM below specifications, engine performance may be unsatisfactory. If stall speed is approximately 400 RPM below specifications, torque converter stator one-way clutch is defective and complete converter should be replaced.

REMOVAL & INSTALLATION

TRANSAXLE ASSEMBLY

NOTE: See appropriate REMOVAL & INSTALLATION article.

TORQUE CONVERTER

NOTE: The torque converter is a sealed unit and cannot be disassembled for service. However, the bushing in converter hub may be replaced as follows.

BUSHING REPLACEMENT

- Check bushing wear using an inside micrometer. Wear limit of bushing is 1.348" (34.25 mm), and maximum allowable out-of-round is .001" (.03 mm).
- To replace bushing, use a bushing puller to withdraw bushing from converter hub. Press new bushing into place until it is fully seated in hub. Ensure that inside diameter of new bushing is 1.340-1.341" (34.03-34.05 mm).

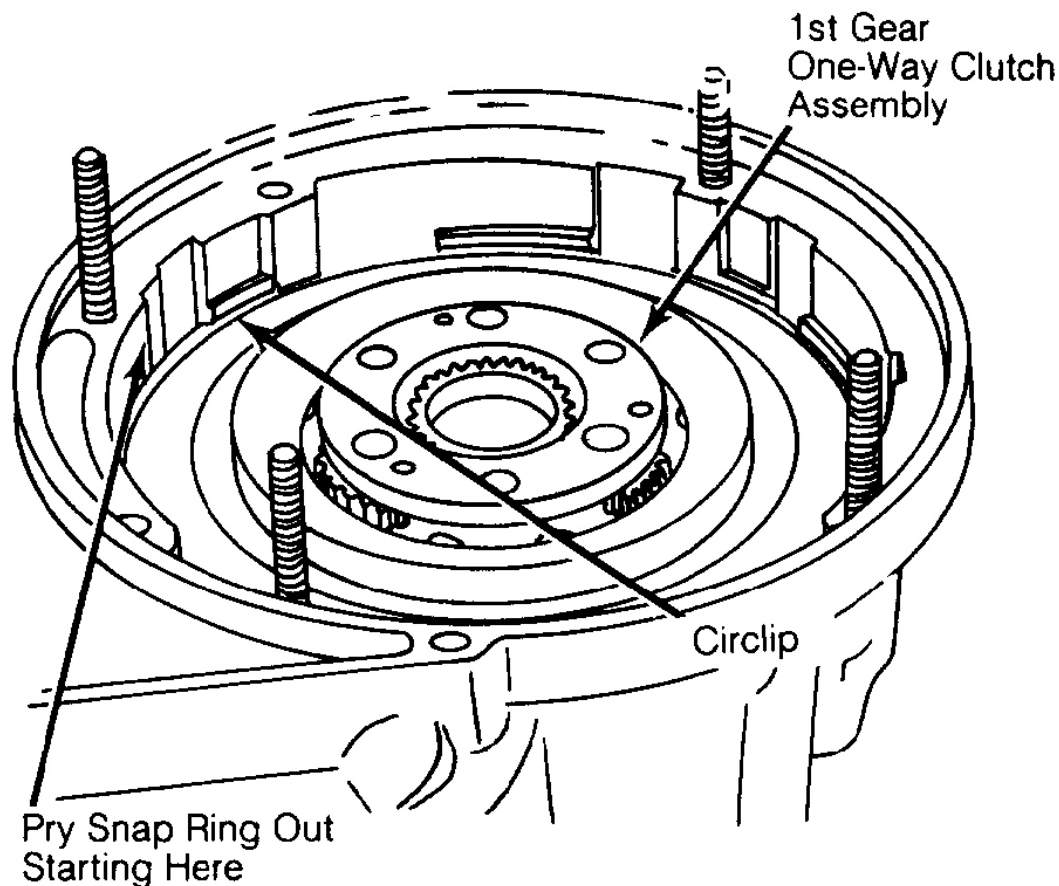
TRANSAXLE DISASSEMBLY

NOTE: For final drive disassembly and assembly, see Final Drive information at end of article.

TRANSAXLE ASSEMBLY

Disassembly

1. To separate transaxle units, withdraw torque converter from final drive housing and remove oil pump shaft from center of turbine shaft. Disconnect oil filler pipe.
2. Remove attaching nuts from transaxle studs that attach final drive to transaxle, then separate final drive unit from transaxle case. Withdraw turbine shaft from final drive assembly pinion shaft.
3. Mount transaxle on work stand. Remove separation plate and gasket from transaxle case. Remove reverse planetary ring gear, and 2 thrust washers behind it, from case.
4. Using a screwdriver, carefully pry large snap ring retaining 1st gear one-way clutch assembly from case. See **Fig. 3**. Lift out one-way clutch, 1st/Reverse gear brake plates, and reverse planetary gear set as a unit.



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Fig. 3: Removing First Gear One-Way Clutch Assembly Retaining Snap Ring

5. Remove thrust washers, then lift the following components from case as an assembly: Sun gear, driving shell, forward planetary gear set, and forward clutch assembly.
6. Remove 2nd gear brake band servo cover snap ring. Then using a rubber mallet, tap cover until cover and piston assembly pop out under spring tension. See **Fig. 4**.
7. Loosen 2nd gear brake band adjusting screw lock nut and remove lock nut and screw, then withdraw push rod for adjusting screw.
8. Lift out remaining planetary gear set components that are housed in 1st/Reverse gear brake shell. Remove bolt from 1st/Reverse brake spring plate, with draw spring plate and springs, then pull driving shell, brake piston, and oil pump from case. See **Fig. 5**.
9. Invert transaxle so that oil pan is facing up. Remove attaching bolts and lift off pan and gasket. Remove screws from oil strainer and separate strainer from valve body.
10. Remove the valve body attaching bolts and lift valve body assembly from case using care not to drop manual valve. Remove attaching screws from accumulator cover plate, then remove cover, spring and accumulator piston. If necessary for parts replacement, disassemble kickdown and selector linkage. See **Fig. 6**.

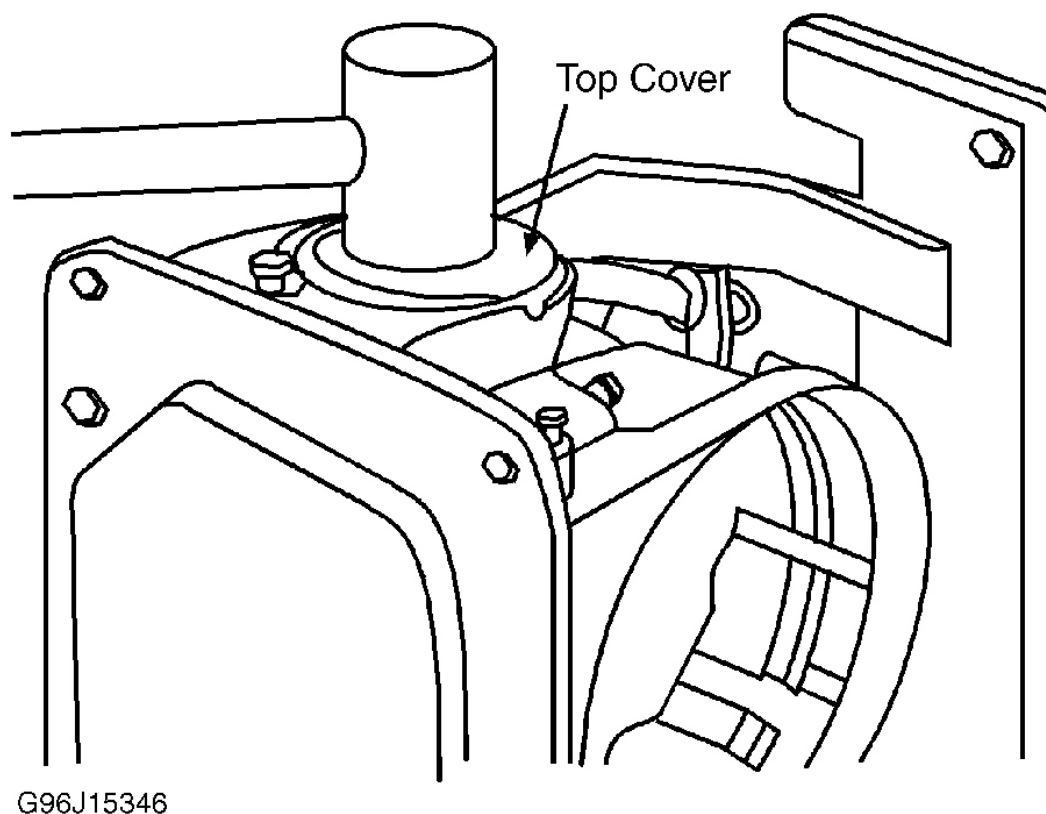
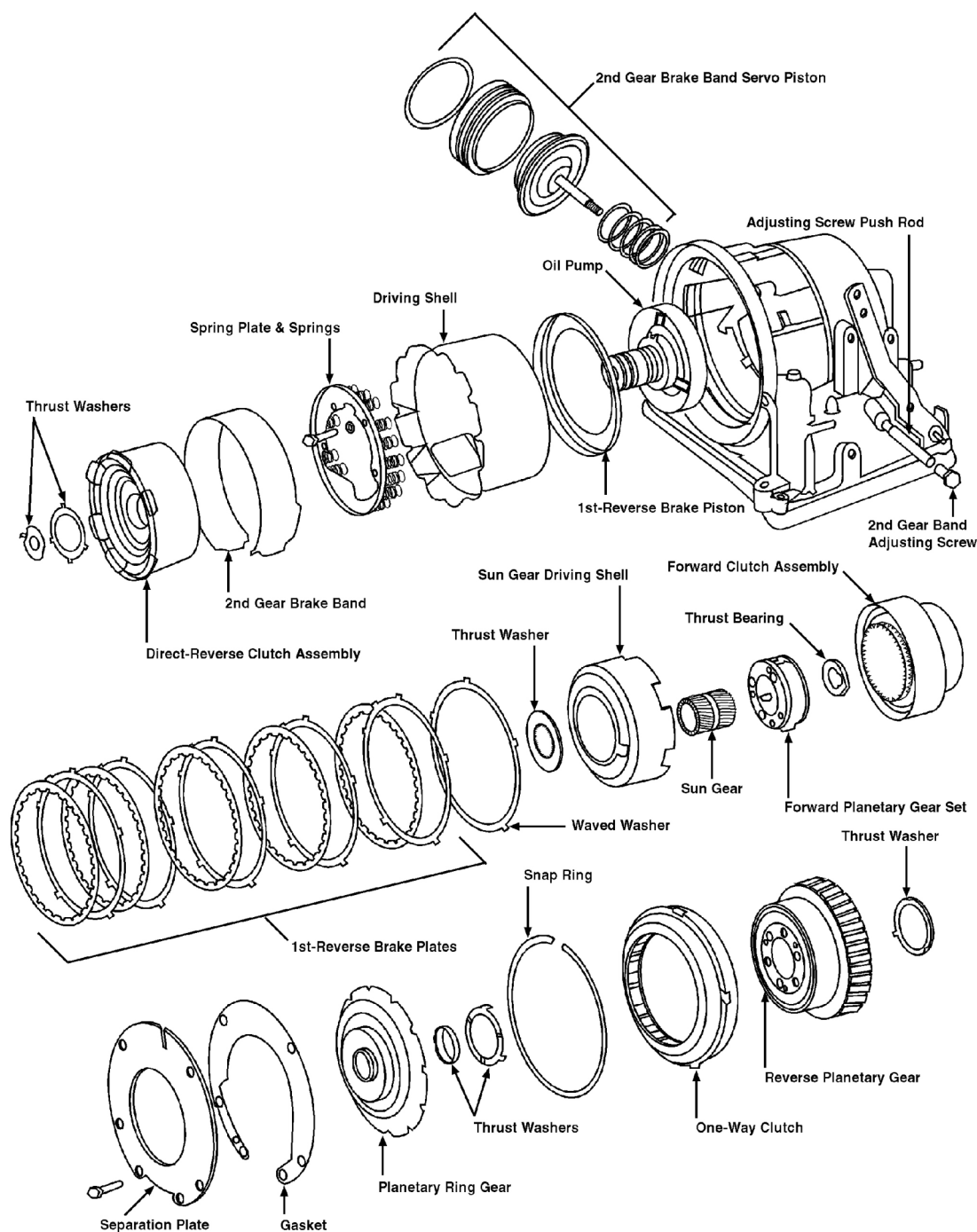


Fig. 4: Removing Brake Band Servo Assembly

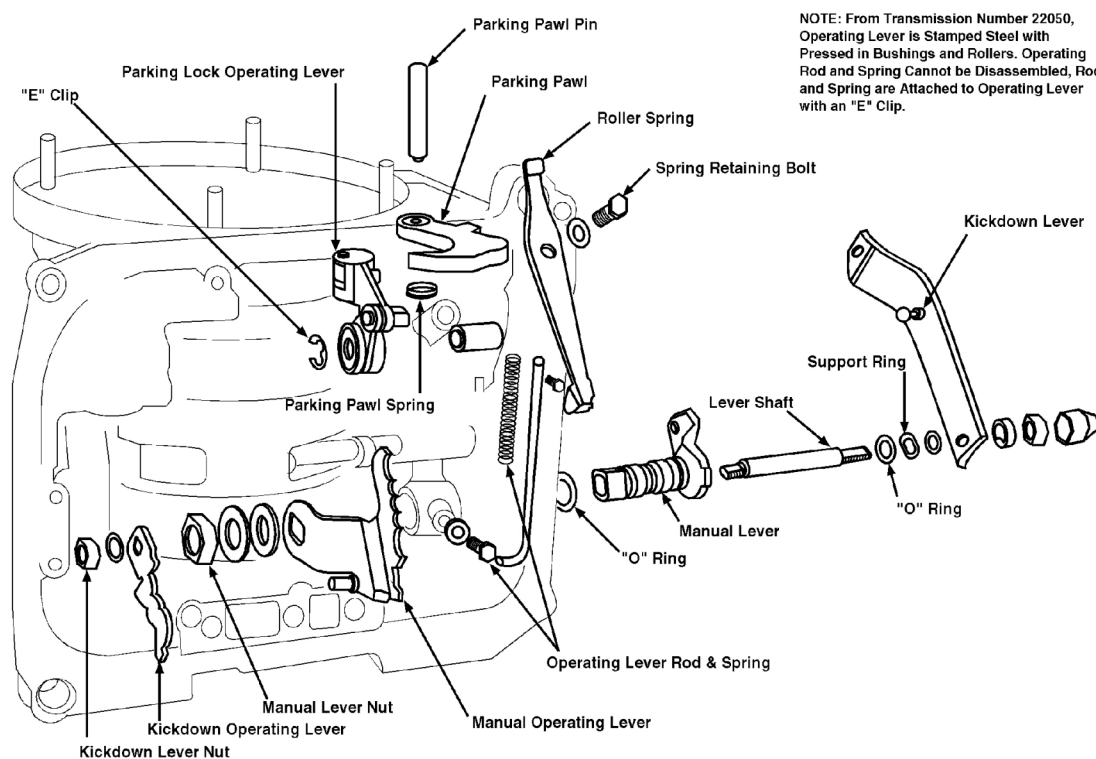
1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul



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Fig. 5: Exploded View Of Automatic Transaxle Assembly



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Fig. 6: Bottom View Of Transaxle Case Showing Kickdown & Selector Linkage

COMPONENT DISASSEMBLY & REASSEMBLY

OIL PUMP ASSEMBLY

CAUTION: Oil pump cover is under spring tension.

Disassembly

1. Remove pump cover attaching screws and separate cover from housing. Remove check ball and spring, then lift out inner and outer pump gears along with drive plate.
2. Using needlenose pliers, unhook oil seal ring ends and carefully remove seal rings from pump housing. Remove thrust washer from pump housing. See **Fig. 7**.

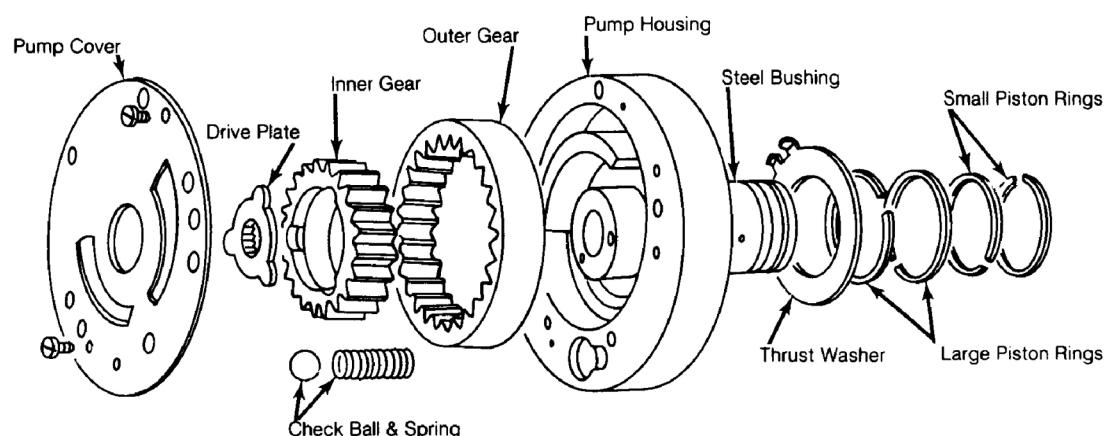


Fig. 7: Exploded View Of Oil Pump Assembly

Inspection

Wash all parts in solvent and clean oil passages with compressed air. Inspect all parts for wear, scoring, chipped teeth or other damage. Replace parts as necessary.

NOTE: If either pump gear, pump housing or cover is damaged, entire oil pump assembly must be replaced. Drive plate, piston rings and thrust washer (thrust bearing and washers) may be replaced individually as needed.

Reassembly

1. Install thrust washer on pump housing. Carefully install first the large oil seal rings and then the small seal rings onto pump housing, ensuring that ring ends hook correctly.
2. Lubricate all parts with automatic transaxle fluid. Install inner and outer pump gears into housing, then install drive plate with extended hub inserted into pump housing shaft opening. Install check ball and spring into housing. Align cover with housing then install and tighten attaching screws: See **Fig. 7**.

NOTE: After pump has been reassembled, insert pump shaft into pump and ensure that gears rotate freely and smoothly. Gear rotation should also be checked after oil pump is installed into transaxle case.

DIRECT/REVERSE CLUTCH

Disassembly

1. Place direct/reverse clutch assembly on clean, flat surface. Using large screwdriver, pry out large outer circlip. Remove pressure plate, internally splined fiber plates and externally splined steel plates.
2. Place clutch drum in a press, apply downward pressure to piston spring retainer and remove snap ring. Release press and remove spring retainer. Using a twisting motion, remove piston with return springs from drum. Remove piston seals and springs from piston. See **Fig. 8**.

3. If necessary for replacement, place clutch drum in a press and drive bushing from drum hub using a driver.

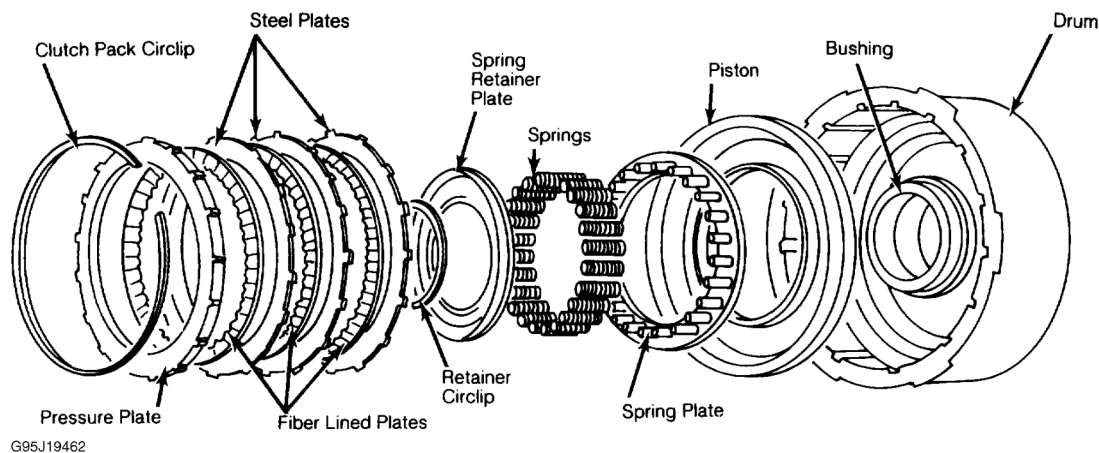


Fig. 8: Exploded View Of Direct-Reverse Clutch Assembly

Inspection

1. Clean all parts in solvent and dry with compressed air. Check for wear or damage on friction surfaces of piston and drum. Check for wear or damage of grooves that externally splined plates ride in.
2. Inspect steel plates for wear and burn marks. Replace if excessively worn or blued from overheating. Check fiber lined plates for wear, cracking or chipping. Replace any damaged plates.
3. Inspect check ball in clutch drum for freedom of operation, and proper sealing. Ensure clutch drum drilled passage for ball valve is clear. Check piston return springs for distortion or collapsed coils. Replace any damaged parts.

NOTE: New lined clutch plates must be soaked in is transaxle fluid for at least 15 minutes prior to installation.

Reassembly

1. If drum bushing is removed, install new bushing. Install clutch drum hub bushing flush with hub surface.
2. Lubricate piston seals with automatic transaxle fluid, then install them into clutch drum with lips facing into drum: Using a stiff plastic sheet to protect seals, install piston into drum using a twisting motion. Remove plastic sheet from drum.
3. Position piston return spring plate and springs on piston. Place spring retainer on springs, compress retainer and install snap ring. Install clutch plates, into drum starting with a steel (external splines) plate and alternating lined and steel plates until all clutch plates are installed. See **DIRECT/REVERSE CLUTCH PLATE APPLICATION** .
4. Install pressure plate and clutch pack retaining snap ring. Using a feeler gauge, measure clearance between pressure plate and retaining snap ring. Clearance should be within .081-.098" (2.05-2.50 mm). See **Fig. 9** . If not, remove clutch pack snap ring and replace with a snap ring of sufficient thickness to

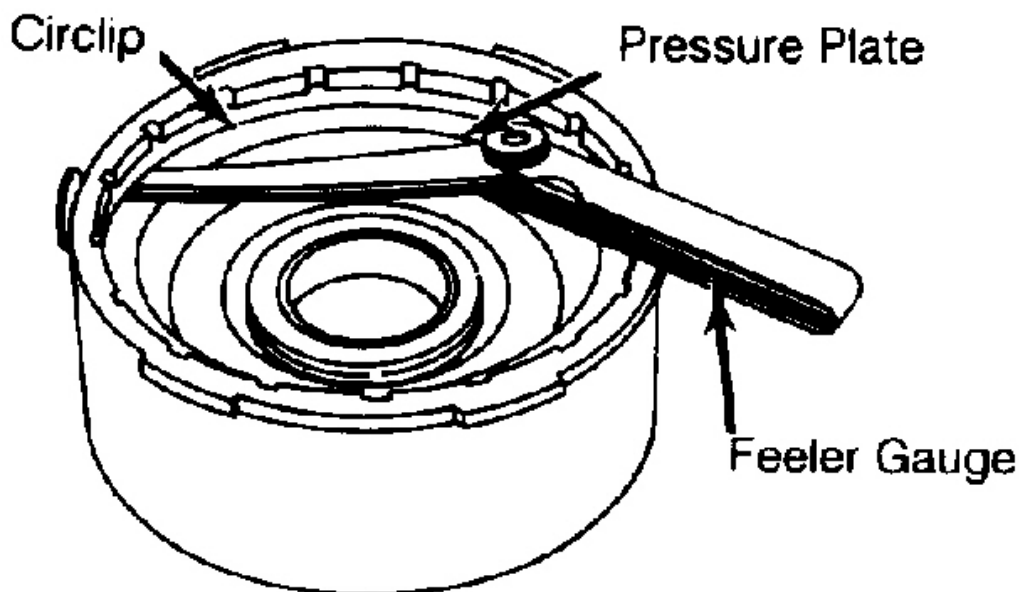
bring clearance within specifications.

NOTE: Direct/Reverse clutch pack snap rings are available in various thicknesses from .059" (1.5 mm) to .098" (2.5 mm).

5. Install correct thickness snap ring. Recheck clutch pack clearance to ensure correct snap ring has been installed.

DIRECT/REVERSE CLUTCH PLATE APPLICATION

Application	Steel Plates	Lined Plates
All Models	4	4



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Fig. 9: Measuring Direct-Reverse Clutch Clearance

FORWARD CLUTCH

Disassembly

1. Using a screwdriver, pry clutch pack retaining snap ring from clutch drum. Then withdraw pressure plate, forward annulus gear, lined and steel clutch plates, and thrust plate.
2. Carefully pry out diaphragm spring snap ring. Remove diaphragm spring. Lift out piston. See **Fig. 10**.

NOTE: It may be necessary to force piston from clutch drum using compressed air.

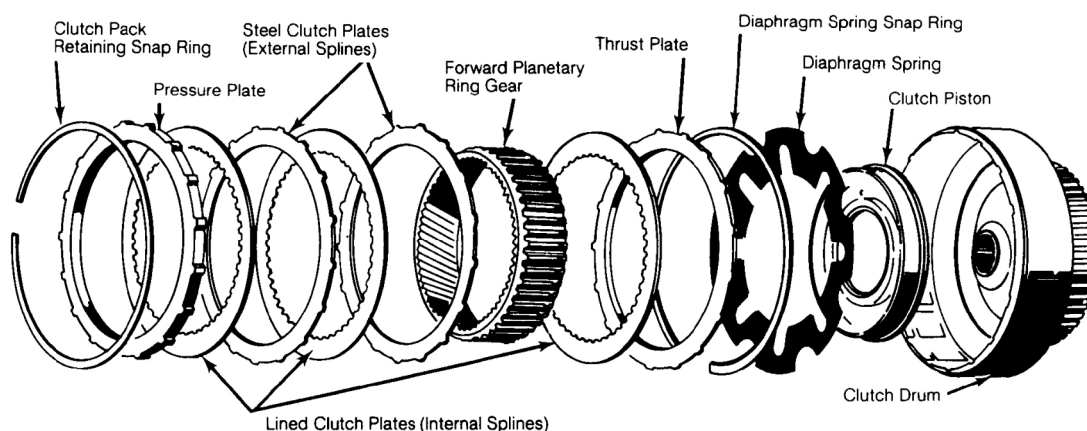


Fig. 10: Exploded View Of Forward Clutch Assembly
Courtesy of VOLKSWAGEN UNITED STATES, INC.

Inspection

1. Clean all parts in solvent and dry with compressed air. Check for wear or damage on friction surfaces of piston and drum. Check for wear or damage of grooves that externally splined plates ride in. Replace piston and/or drum as necessary.

NOTE: The forward clutch piston sealing lips are vulcanized to the piston. Replace the piston if there is damage to the sealing lips or if there is leakage past the sealing lips.

2. Inspect for proper ball valve movement by shaking clutch drum. Rattle of ball valve should be heard. If not, clean drilling. Replace faulty drum as needed, ball valve is not replaceable separately.
3. Inspect steel plates for wear and burn marks. Replace if excessively worn or blued from overheating. Check fiber lined plates for wear, cracking or chipping. Replace any damaged plates.

NOTE: If new lined, (internal splines) clutch plates are to be installed, they must be soaked in automatic transaxle fluid for at least 15 minutes prior to installation.

Reassembly

1. Lubricate piston sealing lips with automatic transaxle fluid, then install piston into drum using a twisting motion. Install diaphragm spring, with convex side toward piston, into clutch drum. Install retaining snap ring.

NOTE: With snap ring installed, diaphragm spring should be lightly tensioned; if not, replace spring.

1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul

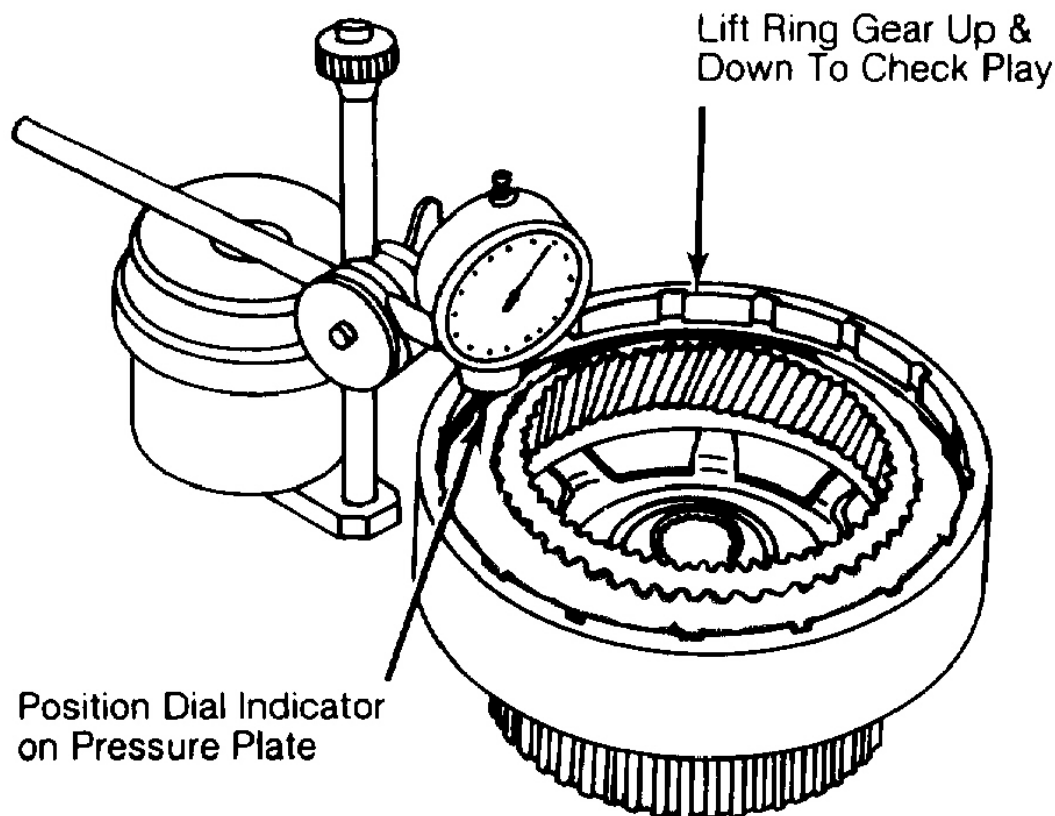
2. Install thrust plate into drum. If one side of thrust plate is chamfered, install chamfered side toward diaphragm spring.
3. Install one lined (internal splines) clutch plate into drum, then install annulus gear so that short splines beneath its retaining ridge are engaged in the lined clutch plate. Install remaining clutch plates starting with a steel (external splines) plate and alternating lined and steel plates until all plates have been installed. See **FORWARD CLUTCH PLATE APPLICATION** table.
4. Install pressure plate and retaining snap ring into clutch drum. Next, position a dial indicator on clutch assembly so that indicator tip contacts pressure plate, then zero dial face.
5. Measure forward clutch end play by moving annulus gear up and down so that dial indicator will show play between pressure plate and snap ring. See **Fig. 11**.

NOTE: Forward clutch pressure plates are available in thicknesses of .236" (6.0 mm) to .299" (7.6 mm) in increments of .016" (.4 mm).

6. Forward clutch end play should be .020-.035" (.50-.90 mm). If not, replace pressure plate with one of sufficient thickness to bring end play within specifications. After correct pressure plate is installed, recheck end play.

FORWARD CLUTCH PLATE APPLICATION

Application	Steel Plates	Lined Plates
All Models	3	4



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Fig. 11: Measuring Forward Clutch End Play

1ST GEAR ONE-WAY CLUTCH

Disassembly & Inspection

Remove one-way clutch rollers and springs. Remove snap rings. Using a plastic mallet, carefully drive roller cage out of outer race. Inspect all parts for wear, scoring, or other damage and replace as necessary.

Reassembly

1. Install lower snap ring in groove of outer race. If necessary, heat outer race to 300°F (150°C). Place roller cage into race using 2 pair of pliers.
2. Install upper snap ring. Install rollers and springs into cage as shown in **Fig. 12** and **Fig. 13**.

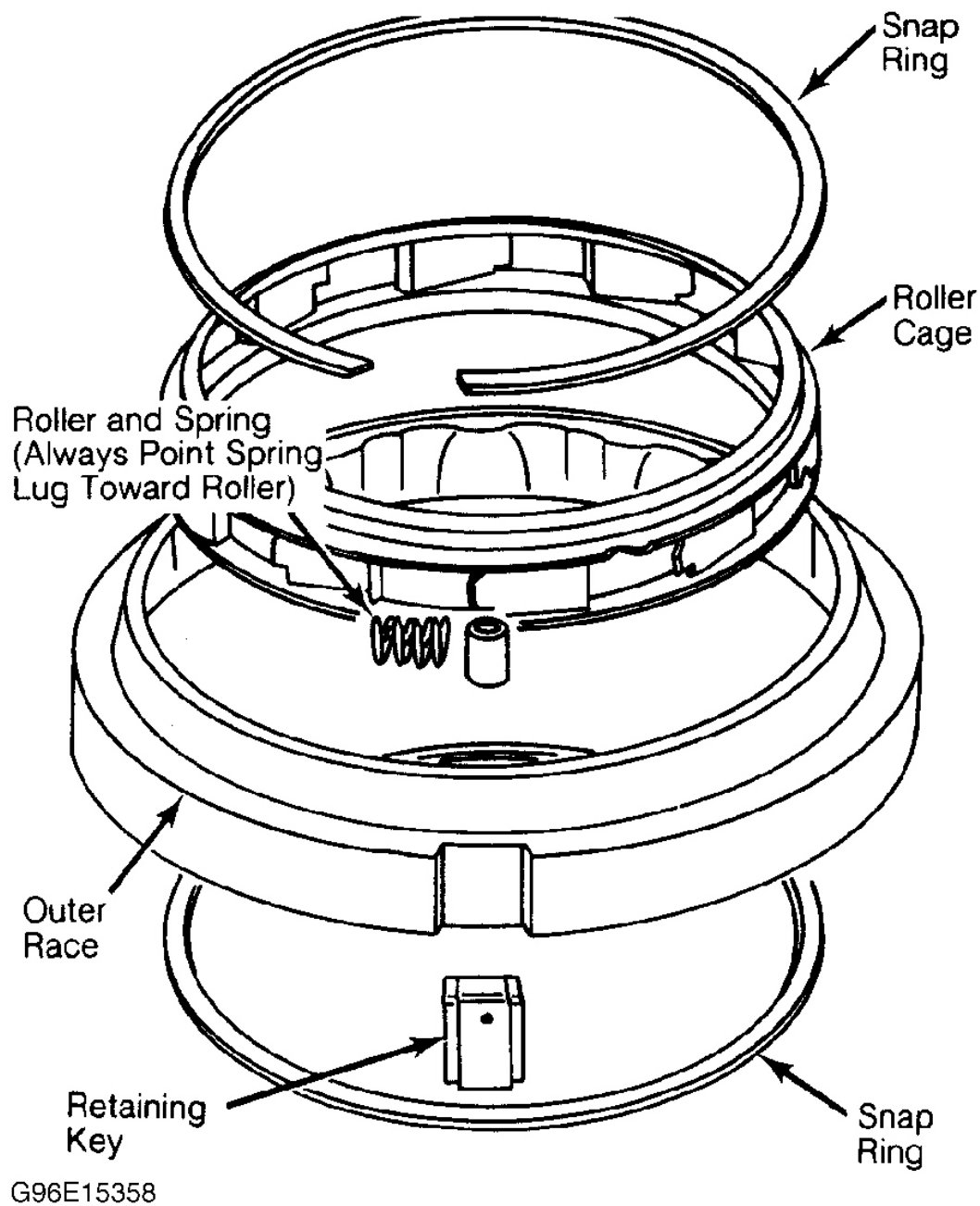


Fig. 12: Exploded View Of One-Way Clutch

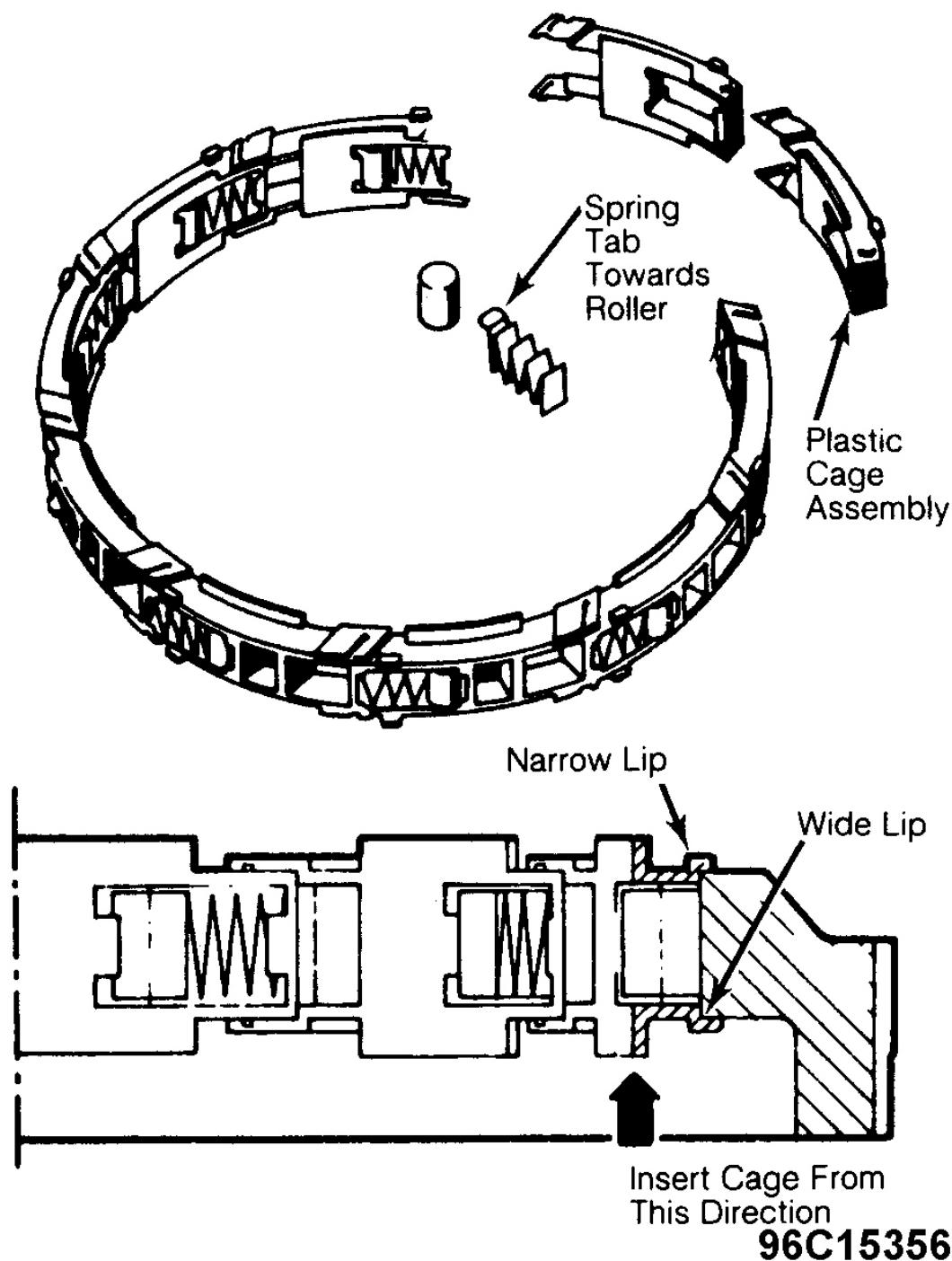


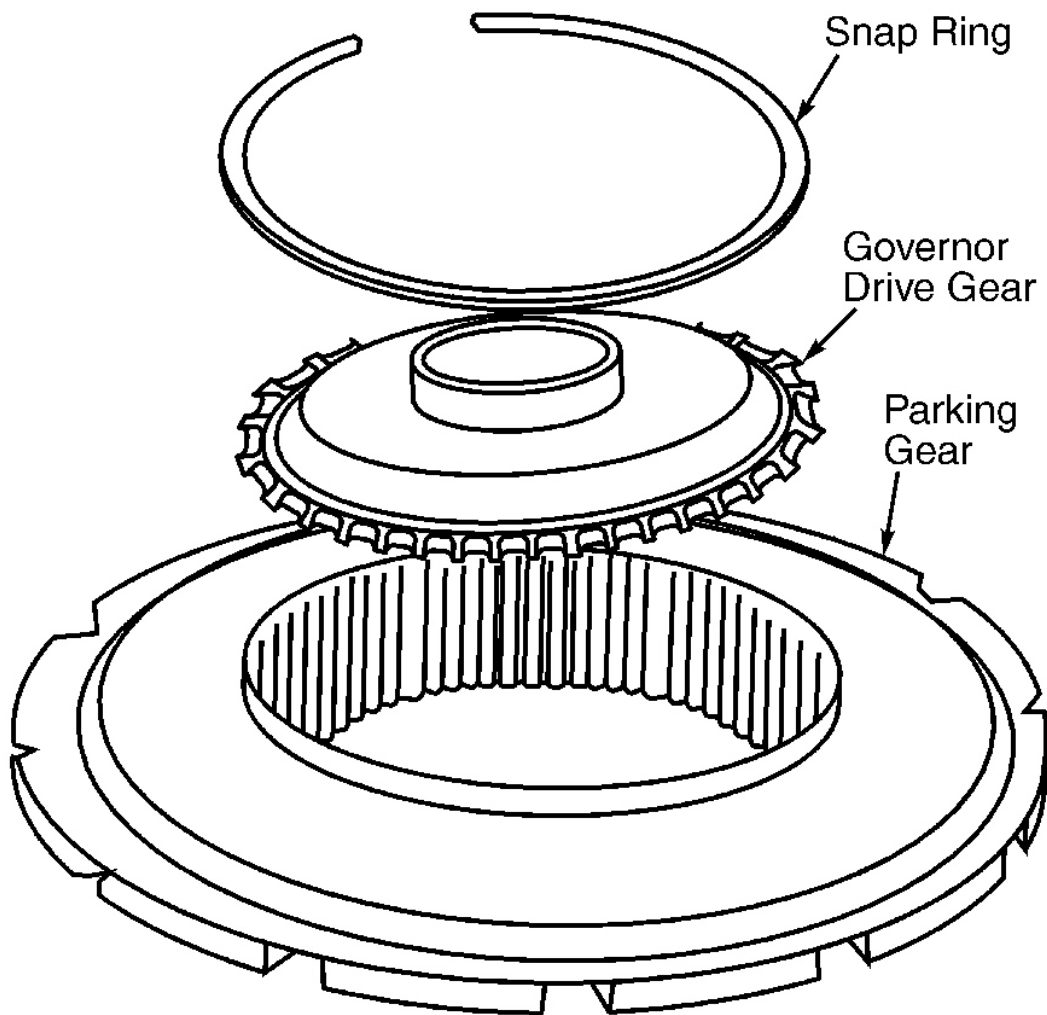
Fig. 13: Assembling One-Way Clutch

REVERSE PLANETARY RING GEAR

NOTE: Reverse planetary ring gear should be disassembled only if parts replacement is necessary.

Disassembly & Reassembly

Remove snap ring and lift governor, drive gear out of parking gear. See **Fig. 14** . Inspect parking lock notches on parking gear and replace worn part. To reassemble, reverse disassembly procedure.



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Fig. 14: Disassembled View Of Reverse Planetary Ring Gear

VALVE BODY ASSEMBLY

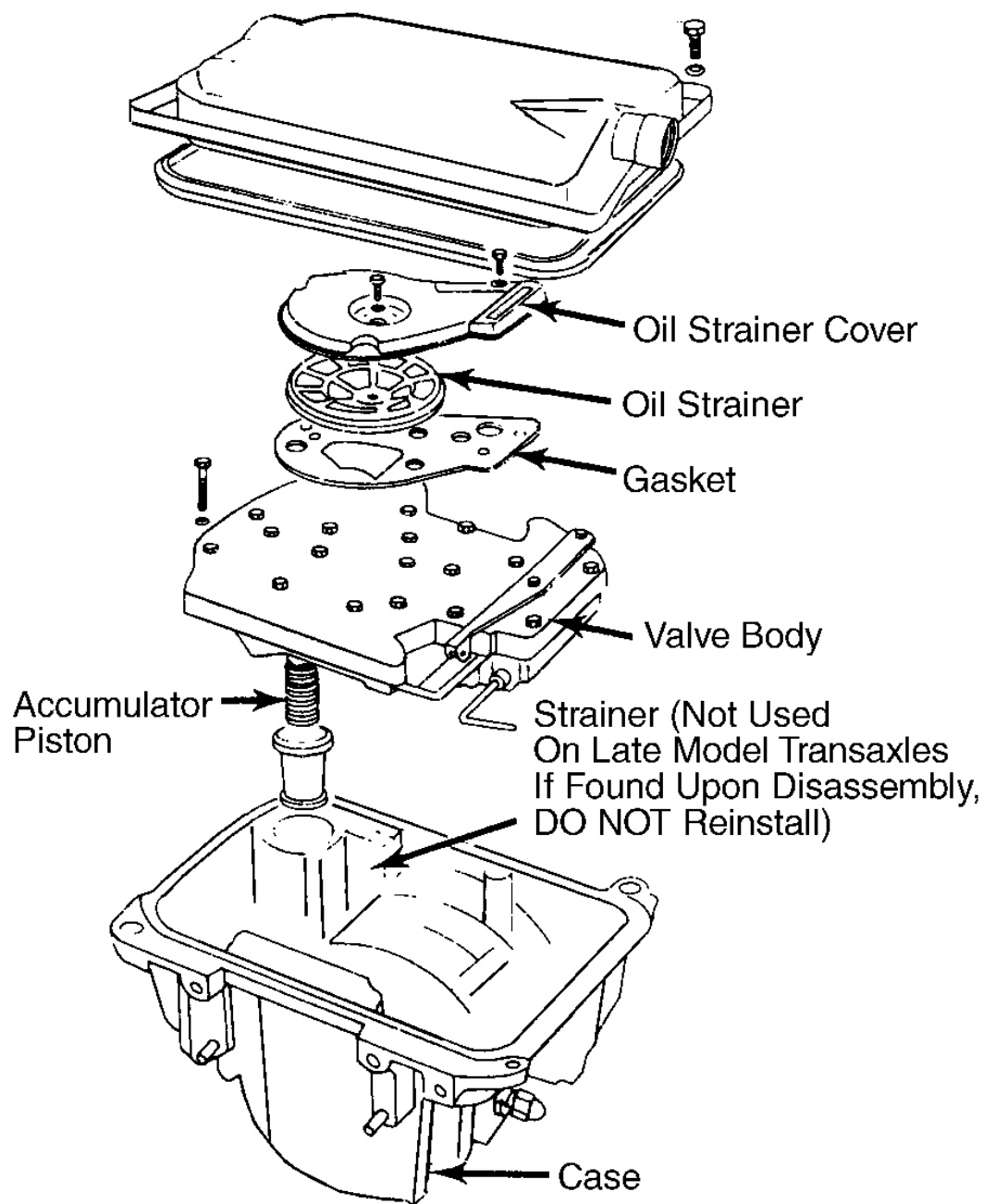
NOTE: As valve body components are removed from each valve bore, place individual

parts in correct order in relative position to valve body to simplify reassembly.

Disassembly

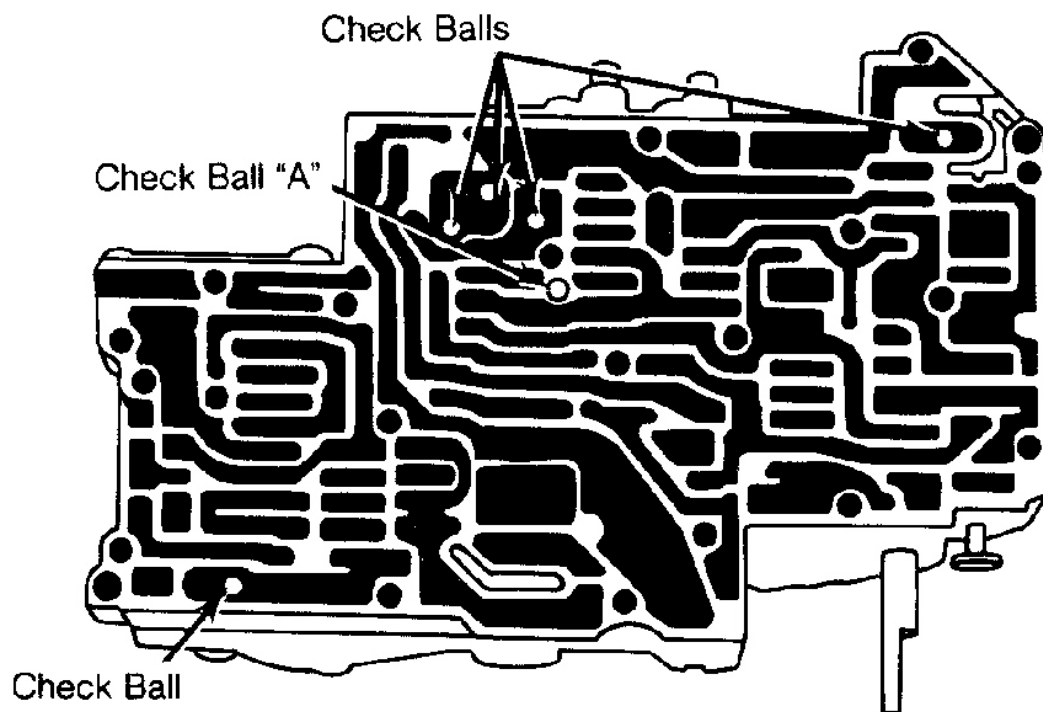
CAUTION: DO NOT alter setting of adjusting screws when removing from valve body.

1. Remove transfer plate-to-valve body attaching screws. Lift transfer plate and separator plate from main valve body. Remove .24" (6 mm) check balls (5) and .12" (3 mm) check ball (1) from valve body. See **Fig. 16** .
2. Remove rear end cover plate and withdraw valves, springs and adjusting screws. Remove remaining end plates, one at a time, and withdraw all valves, plugs, springs and adjusting screws. See **Fig. 17** . Tag all parts for reassembly reference.



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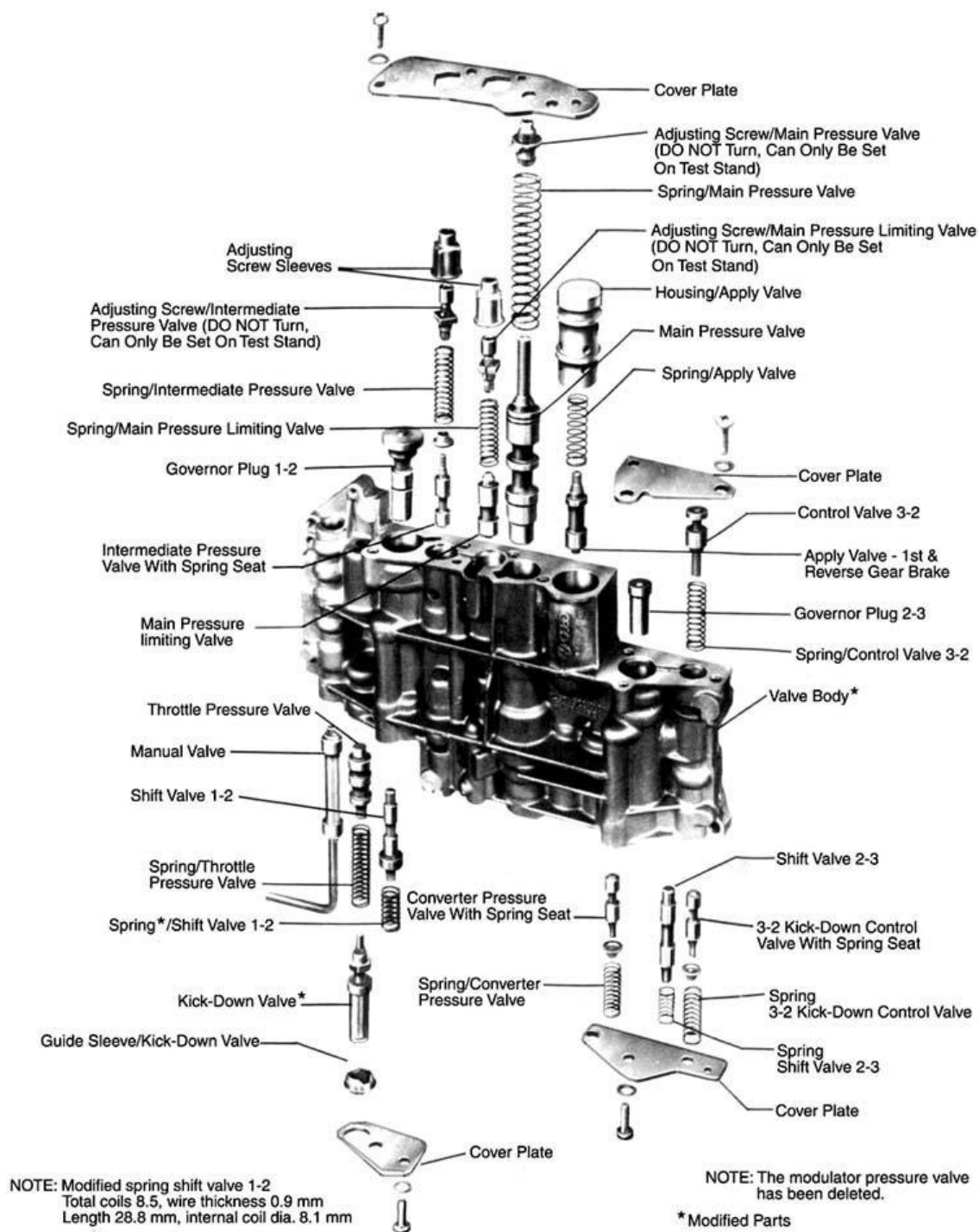
Fig. 15: Exploded View Of Oil Pan, Oil Strainer & Valve Body Assembly
Courtesy of VOLKSWAGEN UNITED STATES, INC.



NOTE — Check ball "A" is .12" (3 mm) in diameter.
All others are .24" (6 mm) in diameter.

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Fig. 16: Location Of Check Balls In Valve Body
Courtesy of VOLKSWAGEN UNITED STATES, INC.



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Fig. 17: Exploded View Of Main Valve Body

Inspection

1. Wash all parts in clean kerosene and dry them with compressed air only (do not use fluffy rags, etc.). Check all parts for burrs and scores; replace assembly if damage is found.

1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul

- When valves are clean and lubricated with fluid, they should fall freely of their own weight in respective bore; if not, check for valve or bore damage.

CAUTION: Several valve body springs have similar dimensions; however, they must not be interchanged as they have different tolerances. See Fig. 18.

- Check all valve body springs for damage or collapsed coils.
- Take care not to disturb settings of adjusting screws, pressures affected by these screws can only be measured and adjusted accurately on a test stand.

Valve Spring	Length In. (mm)	Diameter In. (mm) ¹	Number Of Coils	Wire Thickness In. (mm)
Throttle Pressure Limiting Valve	1.389 (35.3)	.303 (7.7)	14.5	.043 (1.1)
Main Pressure Limiting Valve	1.275 (32.4)	.303 (7.7)	11	.047 (1.2)
Main Pressure Valve	3.031 (77.0)	.468 (11.9)	16.5	.059 (1.5)
3-2 Control Valve	1.275 (32.4)	.303 (7.7)	12.5	.039 (1.0)
Throttle Pressure Valve	1.708 (43.4)	.305 (7.75)	16	.049 (1.25)
1-2 Shift Valve	1.024 (26.0)	.323 (8.2)	9.5	.031 (0.8)
Converter Pressure Valve	0.874 (22.2)	.303 (7.7)	8.5	.049 (1.25)
Modulator Pressure Valve	1.126 (28.6)	.305 (7.75)	11.5	.031 (0.8)
2-3 Shift Valve	1.024 (26.0)	.323 (8.2)	9.5	.031 (0.8)
3-2 Kickdown Valve	1.118 (28.4)	.318 (8.1)	11.5	.035 (0.9)
1st/Reverse Apply Valve	1.118 (28.4)	.318 (8.1)	11.5	.035 (0.9)

¹ - Inner diameter of coils should be within a tolerance of $\pm .012"$ (.3 mm).

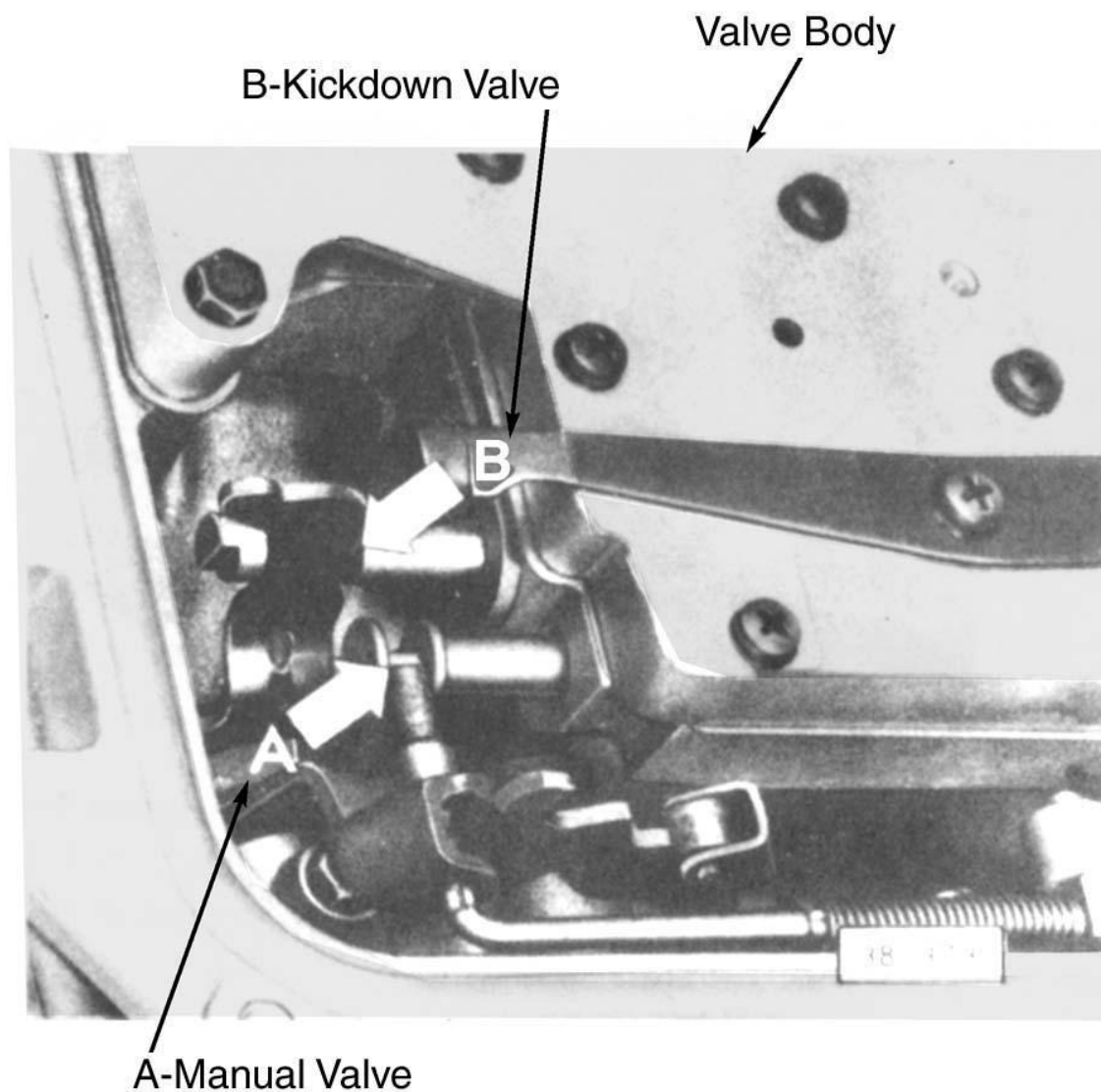
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Fig. 18: Valve Body Spring Identification Chart

Reassembly

- Lubricate all parts with automatic transaxle fluid and install into proper valve body bores, in reverse order of disassembly. When tightening end plate attaching screws, be careful not to overtighten them as this could easily strip the threads or distort the valve body enough to cause a valve to stick.
- Ensure all check balls are installed in proper valve body passages. Install transfer plate-to-main valve body screws and tighten from center outward, taking care not to overtighten.

NOTE: Two collar-type screws are used for attaching roller assembly to body, 3 galvanized screws are for accumulator cover plate, and the remaining 19 screws are used for transfer plate-to-main body attachment.



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Fig. 19: View Of Valve Body Installed**GOVERNOR ASSEMBLY**

Governor unit is not serviceable. Replace as a complete unit. Governor may be cleaned and checked for wear at balance weight pivots. Governor units for gasoline engined vehicles are marked with the code letter "A" on the face of the balance plate. See **Fig. 20** .

Removal

Remove attaching bolts and washers and remove governor cover and, "O" ring from final drive housing. Withdraw governor from housing using a clockwise twisting motion that will allow governor drive gear to disengage drive pinion gear.

Installation

To install, reverse removal procedure. Prior to installation, check governor oil seal and needle bearing in final drive case for damage and wear, and replace if necessary. After installation, rotate governor to engage drive gear.

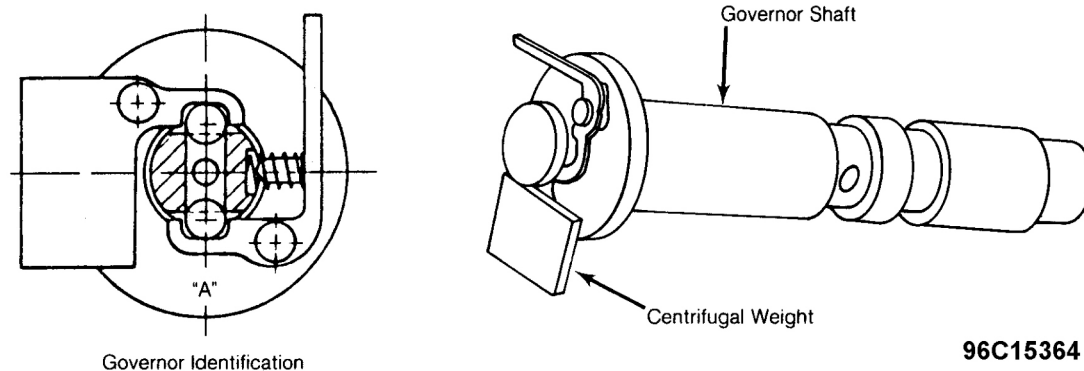


Fig. 20: View Of Governor Assembly

BAND SERVO

Disassembly

Pull servo piston assembly out of cover, then remove "O" ring seals from outside diameter of cover. Remove retaining "E" clip and separate piston pin, accumulator spring, spring seat, and adjusting shim from servo piston. Withdraw 2 lip seals from piston. See **Fig. 21**.

Inspection

Clean all parts and check for wear, scoring, or other damage. If replacement of piston is necessary, pin, spring, spring seat, and shim must also, be replaced as this is serviced as an assembly only.

Reassembly

1. Position spring seat, accumulator spring, and shim on piston pin, install assembly into servo piston, and install "E" clip onto piston.
2. Install lip seals onto piston as, follows: Smaller (upper) seal is installed onto piston with lip facing upward, or into servo cover. Larger seal is installed onto piston with lip pointed downward, or out of servo cover. Lubricate assembly thoroughly and install piston into cover. Install "O" rings onto servo cover.

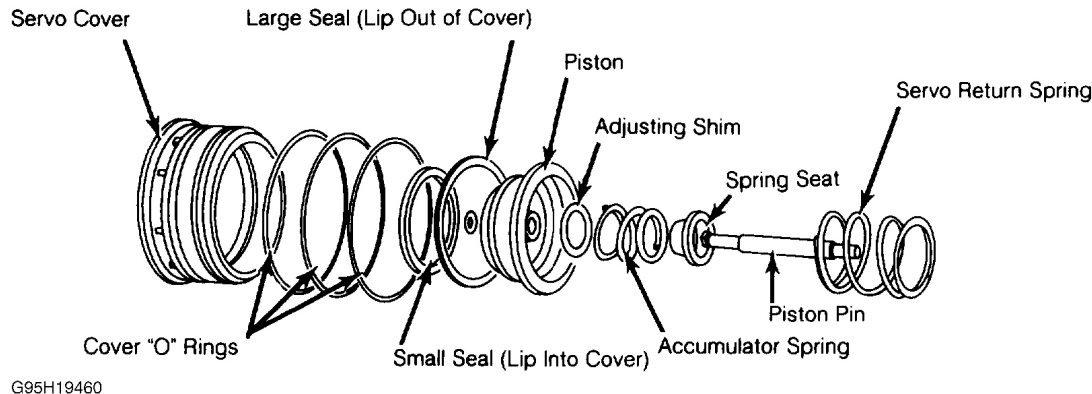


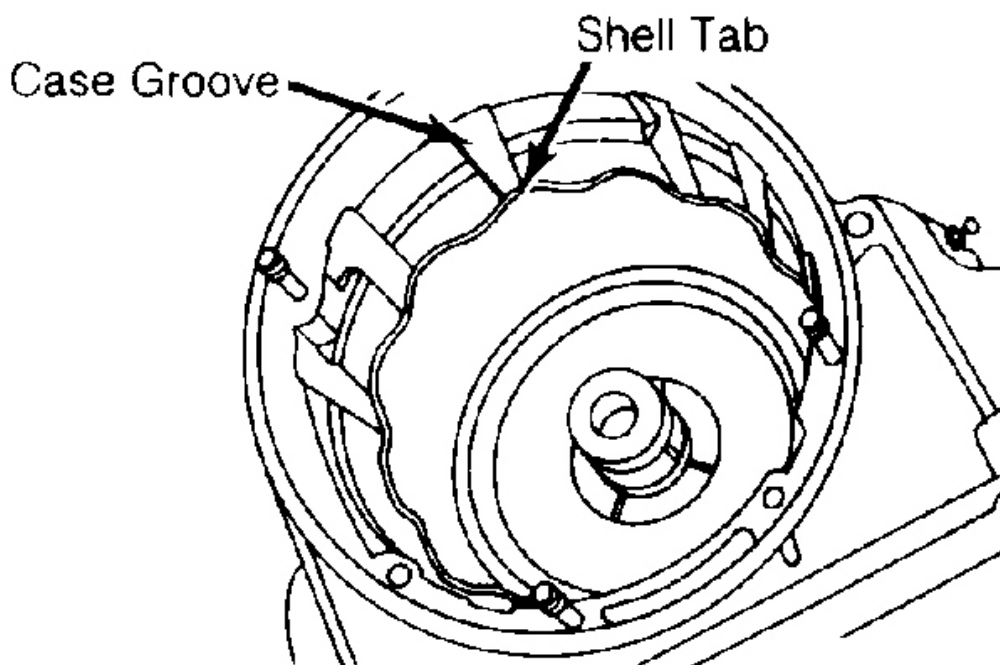
Fig. 21: Exploded View Of 2nd Gear Brake Band Servo Piston Assembly

TRANSAXLE REASSEMBLY

TRANSAXLE COMPONENT INITIAL ASSEMBLY

Reassembly

1. Coat 1st/reverse brake piston with ATF and install on oil pump housing. Insert brake piston/oil pump assembly into transaxle case. Ensure brake piston ball valve lines up with drilling in transaxle housing and anti-rotation lug for thrust washer of oil pump is facing toward top of case.
2. Install 1st/reverse gear brake shell into case so that tab of shell engages upper groove in transaxle case. See **Fig. 22** . Position 1st/Reverse brake piston return springs on spring plate, insert plate into case with springs downward, then install attaching bolts and tighten to specified torque in a diagonal pattern.



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Fig. 22: Installing 1st/Reverse Gear Brake Shell

NOTE: After spring plate installation, insert pump shaft into oil pump and ensure that pump gears rotate freely; if not, remove oil pump and ensure that it is assembled correctly.

3. Lubricate servo cover "O" rings, then install servo assembly into case and install retaining snap ring. Rotate transaxle on work stand so that servo cover points down.
4. Position 2nd gear brake band in case and ensure that it engages servo piston. Loosely install push rod for adjusting screw, then install adjusting screw and lock nut.
5. Lubricate Direct/Reverse clutch assembly, then install it into case, sliding it onto oil pump neck and into 2nd gear brake band.
6. Tighten brake band adjusting screw just enough to prevent band from shifting its position on Direct/Reverse clutch drum. Rotate transaxle case so that open end is facing up.
7. Place thrust washer in position on forward clutch and use, petrolatum to hold it in place. Install forward clutch assembly into Direct/Reverse clutch, making sure splines on forward clutch drum fully engage splines on Direct/Reverse clutch lined clutch plates.
8. Install forward planetary-to-forward clutch thrust washer into forward clutch. Install planetary gear set into forward annulus gear in forward clutch. Install sun gear (short end first) into gear set, then install

driving shell and thrust washer over sun gear.

NOTE: Ensure lugs of driving shell engage tabs of Direct/Reverse clutch drum.

9. Install thrust washer on underside of reverse planetary gear set and use petroleum to hold in place. Install gear set into case and onto sun gear.

NOTE: Lined brake plates must be soaked in automatic transaxle fluid for at least 1 minute prior to installation.

10. Install 1st/Reverse brake waved washer into case. Install 1st/Reverse brake plates into case starting with a steel (external splines) plate and alternating lined (internal splines) plates and steel plates until all brake plates are installed. See **FIRST/REVERSE BRAKE PLATE APPLICATION**.

FIRST/REVERSE BRAKE PLATE APPLICATION

Application	Steel Plates	Lined Plates
All Models	5	5

11. Install 1st gear one-way clutch assembly into transaxle case, then push clutch downward while rotating reverse planetary gear set to fully engage parts.

NOTE: With one-way clutch installed, it should not be possible to rotate reverse planetary gear set counterclockwise due to the locking action of the one-way clutch.

12. Install one-way clutch-to-case snap ring. If all parts are correctly installed, the one-way clutch snap ring groove will be exposed. Do not attempt to force snap ring into groove of an incorrectly assembled transaxle. See **Fig. 23**
13. Position both thrust washers on rear side of reverse planetary gear set annulus gear, then install gear into transaxle case so that it fully engages planetary gear set.
14. Install separation plate gasket over case studs, place separation plate on top of gasket, then install and tighten attaching screws.

NOTE: At this time 2nd gear brake band must be adjusted. To adjust band, the transaxle case must be horizontal to prevent band from jamming. Adjust band as follows:

15. Loosen lock nut and tighten brake band adjusting screw to 87 INCH lbs. (10 N.m). Loosen screw. Retighten again to 43 INCH lbs. (5.0 N.m). Back off adjusting screw 2 1/2 turns and tighten adjusting screw lock nut.
16. If case linkage was disassembled, reassemble in case using **Fig. 5** as an assembly guide.
17. Install a new seal on accumulator piston (lip pointing toward case), and install piston and spring into case. Install valve body assembly into case, making sure manual valve engages manual lever, and that kickdown valve engages kickdown lever. Install valve body-to-case attaching bolts and tighten from center outward.

NOTE: Do not use sealer on oil pan gasket, as any, surplus sealer may find its way into transaxle fluid and cause control valves to stick.

18. Position a new oil pan gasket on transaxle case. Install oil pan and tighten attaching bolts.

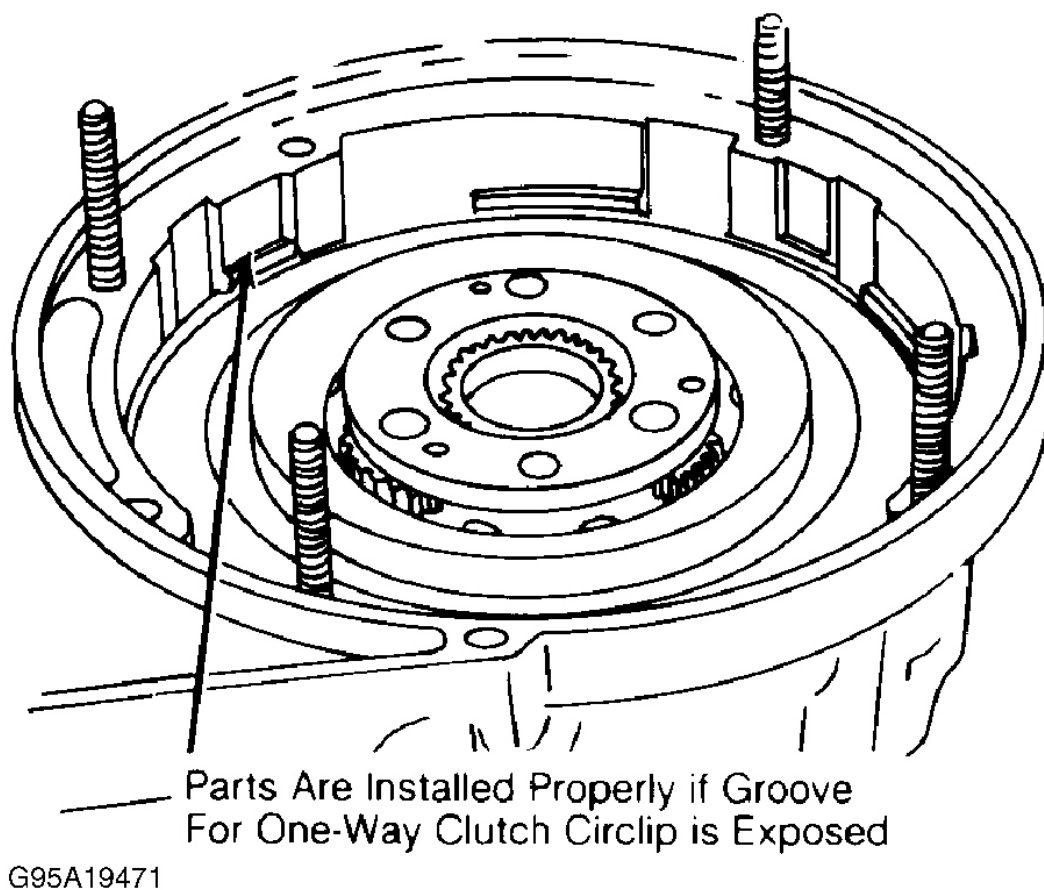


Fig. 23: Installing 1st Gear One-Way Clutch Circlip

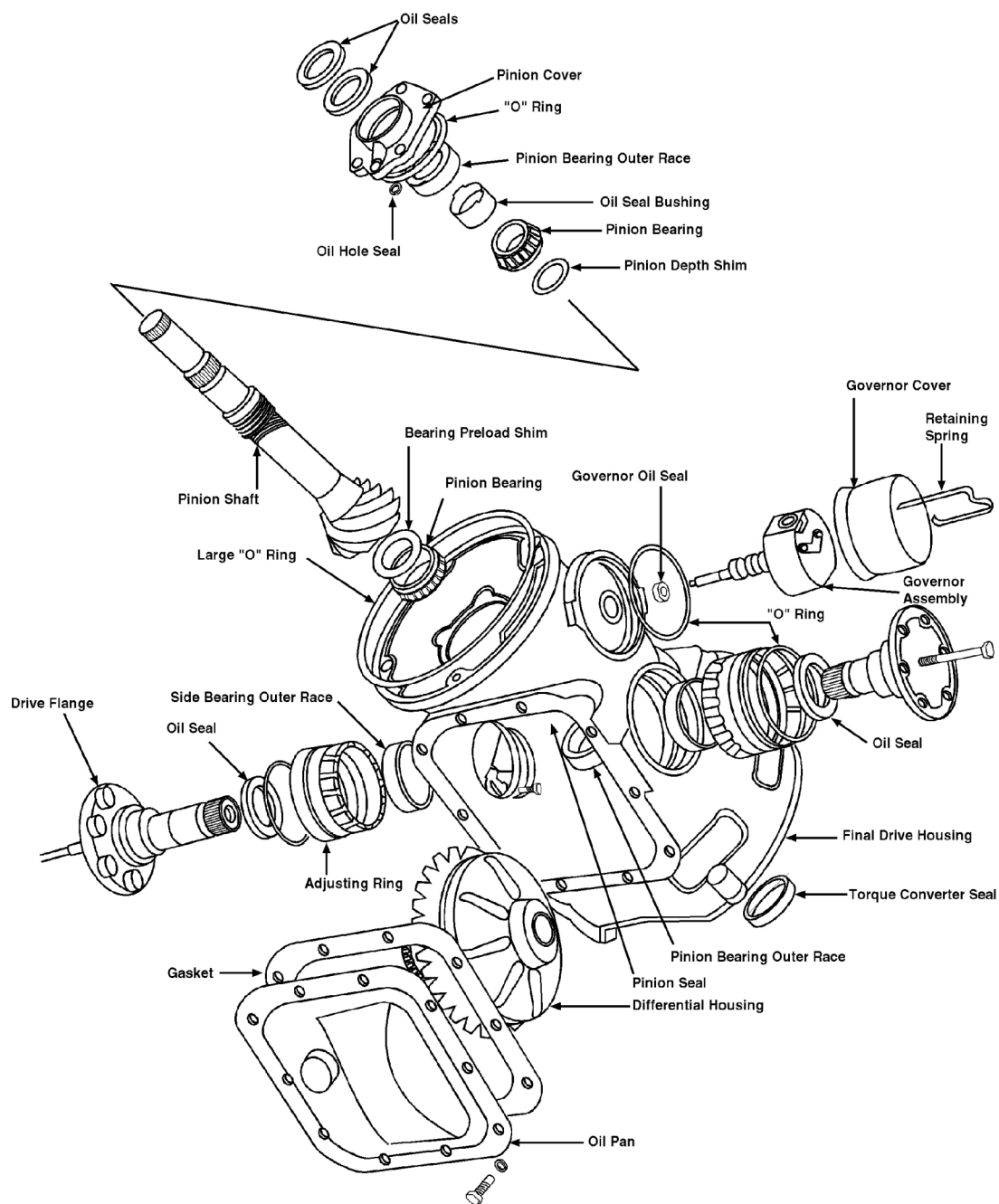
FINAL DRIVE

DISASSEMBLY

NOTE: Measure pinion shaft turning torque before disassembly. See PINION DEPTH & BEARING PRELOAD under REASSEMBLY & ADJUSTMENTS for checking procedure.

1. Remove retaining bolts from center of axle drive flange shafts and pull drive flanges from final drive housing. Mark position of each side bearing adjusting ring on ring and housing, then measure screw-in

- depth of each ring in housing using a micrometer. Record measurements for reassembly reference.
2. Remove final drive pan bolts and pan, then remove side bearing adjusting ring lock plates. While supporting differential, unscrew side bearing adjusting rings, move differential to right side of case, tilt upward, and remove from final drive housing. See **Fig. 24** .
 3. If necessary for replacement, use a hook type puller and remove oil seal from each side bearing adjusting ring.
 4. If differential side bearings are to be replaced, use a drift and drive bearing outer race from each adjusting ring.
 5. Loosen ring gear attaching bolts, tap on bolts with a soft hammer to break loose ring gear, then remove ring gear from differential case.
 6. If side bearings require replacement, pull from case using a puller. Using a screwdriver, pry differential housing cover from housing. Drive out pinion gear shaft, then withdraw differential pinion gears and thrust washers, side gears and thrust washers, and nuts for drive flange shaft retaining bolts. See **Fig. 25** .
 7. Remove pinion shaft cover from final drive housing. Withdraw pinion shaft from final drive housing.
 8. If necessary for replacement, use a press and press pinion oil seals out of pinion cover. If pinion shaft bearings are to be replaced, press bearing outer race from pinion cover.
 9. Use a hook type puller and remove pinion oil seal from final drive housing. Remove other pinion shaft bearing outer race from final drive housing using a puller (US1039 and US 1037). See **Fig. 26** .
 10. If necessary for replacement, use a press (with press plates to support bearing) and press bearings, shims and oil seal bushing from pinion shaft.
 11. Use pulleys to extract torque converter oil seal and governor oil seal from final drive housing.



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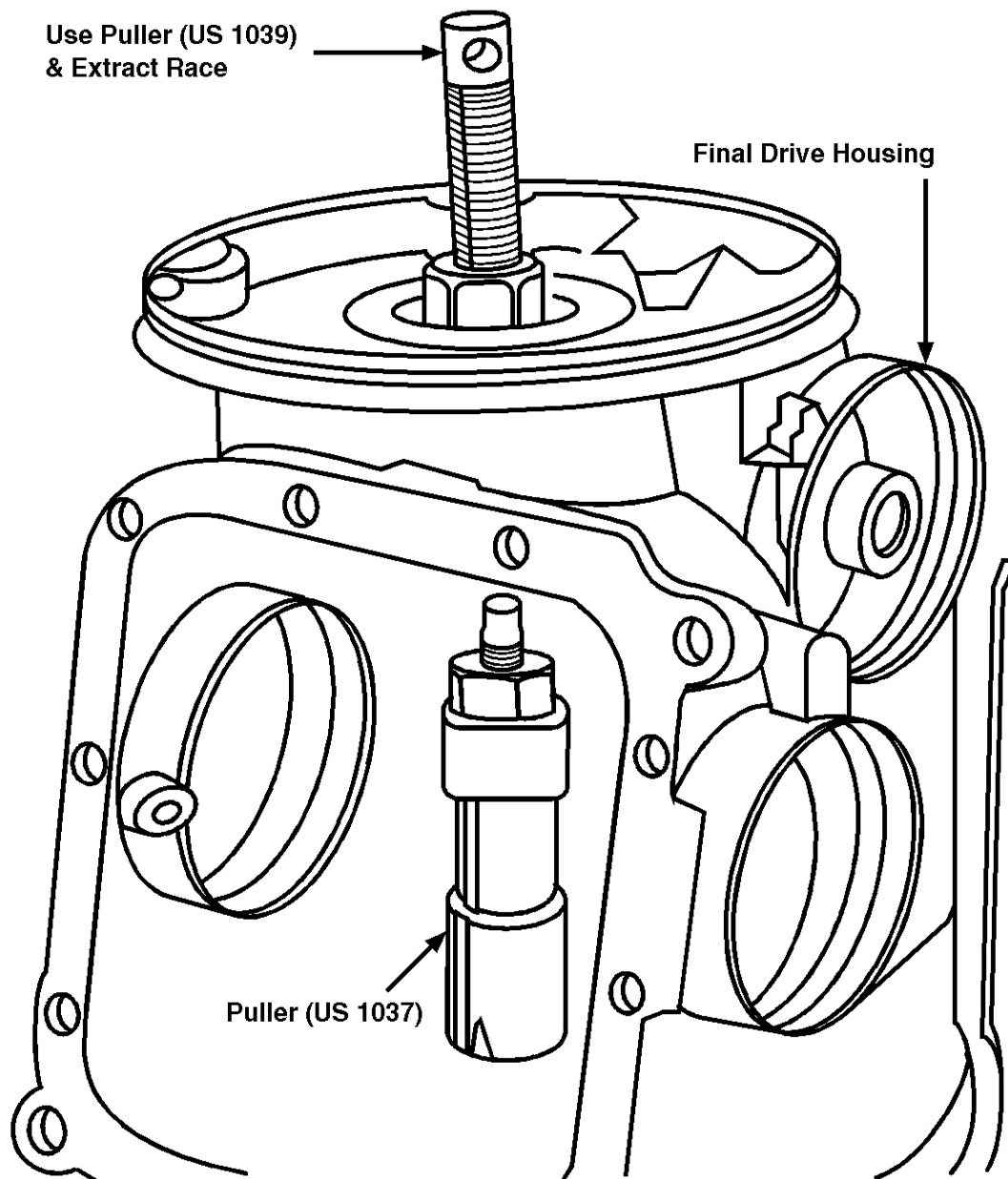
Fig. 24: Exploded View Showing Main Components Of Final Drive Assembly

1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul



Fig. 25: Exploded View Of Differential Assembly



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Fig. 26: Removing Pinion Bearing Outer Race From Final Drive Housing

REASSEMBLY & ADJUSTMENTS

Differential Assembly

1. Inspect all thrust surfaces on differential housing, cover, ring gear, pinion gear shaft and thrust washers. Replace all worn parts. Inspect gear teeth for burrs, or excessive wear and replace as necessary.

NOTE: If ring gear requires replacement, pinion shaft must also be replaced as they are a matched set.

2. Position differential side gears, large thrust washers, dished washers, drive flange retaining bolt nuts and pinion gears in differential housing. Align pinion gear holes with pinion shaft holes in housing, then drive pinion gear shaft through gears.

NOTE: If differential pinion gear shaft does not fit tightly, replace it with a new shaft.

3. Heat ring gear in hot oil to approximately 212°F (100°C). Place differential cover on housing. Install ring gear on housing, then install attaching bolts through cover and into ring gear. Tighten attaching bolts to specified torque.
4. If differential side bearings were removed, heat them in hot oil to approximately 212°F (100°C) and press them onto differential housing and cover. Press side bearing outer races into position in side bearing adjusting rings.

Pinion Depth & Bearing Preload

1. If original parts are reinstalled, use the same thickness pinion depth and bearing preload adjusting shims as were removed. If a new ring and pinion gear set is installed, new adjusting shims must be selected.
2. Press new pinion shaft bearing outer races into final drive housing and pinion cover until they are fully seated. Install new pinion oil seal into final drive case. Install new oil seal into final drive side of pinion cover with open side of seal towards final drive housing, then install a new oil seal into transaxle side of pinion cover with open side towards transaxle.
3. Heat pinion shaft bearings to 212°F (100°C) in hot oil. Install both bearings (without shims) onto pinion shaft until they are seated.
4. Install pinion shaft into final drive housing. Install pinion cover on housing, then install attaching bolts and tighten to 18 ft. lbs. (24 N.m).

NOTE: For correct pinion depth and bearing preload adjustment, measuring tools called out in the following procedures must be used.

5. Attach a dial indicator onto final drive housing using holder (VW 387). See **Fig. 27** . Then, place measuring plate (VW 385/17) on end of pinion. Zero dial indicator without preload.
6. Move pinion shaft up and down (without turning) and note dial indicator reading. To this reading add .004" (.10 mm) for bearing preload and .004" (.10 mm) for settling of bearings. The resulting sum is the total thickness of adjusting shims necessary for correct pinion depth and bearing preload adjustment. Record sum for future reference.
7. Remove pinion shaft. Press bearing from near end of shaft. Select shims of correct thickness as determined in step 6 , and install them on gear end of shaft. Reinstall bearing onto shaft, then install shaft into final drive housing.
8. Install setting gauge (VW 385/22) on pinion. See **Fig. 28** . Hold in place with spring support (VW 385/19).
9. Adjust setting ring on measuring bar (VW 385/1), until distance from center of bar to outside of ring is

approximately 2.9" (74 mm).

NOTE: Refer to **Fig. 29** for the assembling of tools to measuring bar.

10. Slide centering discs (VW 385/2) on measuring bar. Screw measuring pin (VW 385/14) into bar with .118" (3 mm) extension (VW 385/20).
11. Screw left side differential side bearing adjusting ring into final drive housing until it is flush with housing. Place measuring bar assembly in final drive housing. See **Fig. 30** . Install right side bearing adjusting ring into final drive housing.
12. Turn knob on end of measuring bar to move centering discs outward until bar can just barely be turned by hand. Attach a dial indicator to measuring bar. Place setting block (VW 385/21) on measuring bar. See **Fig. 30** . Zero dial indicator without preload. Remove setting block.
13. Rotate measuring bar, until measuring pin rests against setting gauge on pinion face, then rotate bar back and forth over center. Read and record maximum dial indicator reading.
14. Add the dial indicator reading just obtained to the deviation number stamped in ring gear. See **Fig. 31** . The resulting sum is thickness of pinion depth adjusting shim to use at reassembly.

NOTE: The ring gear deviation number is in hundredth millimeters.

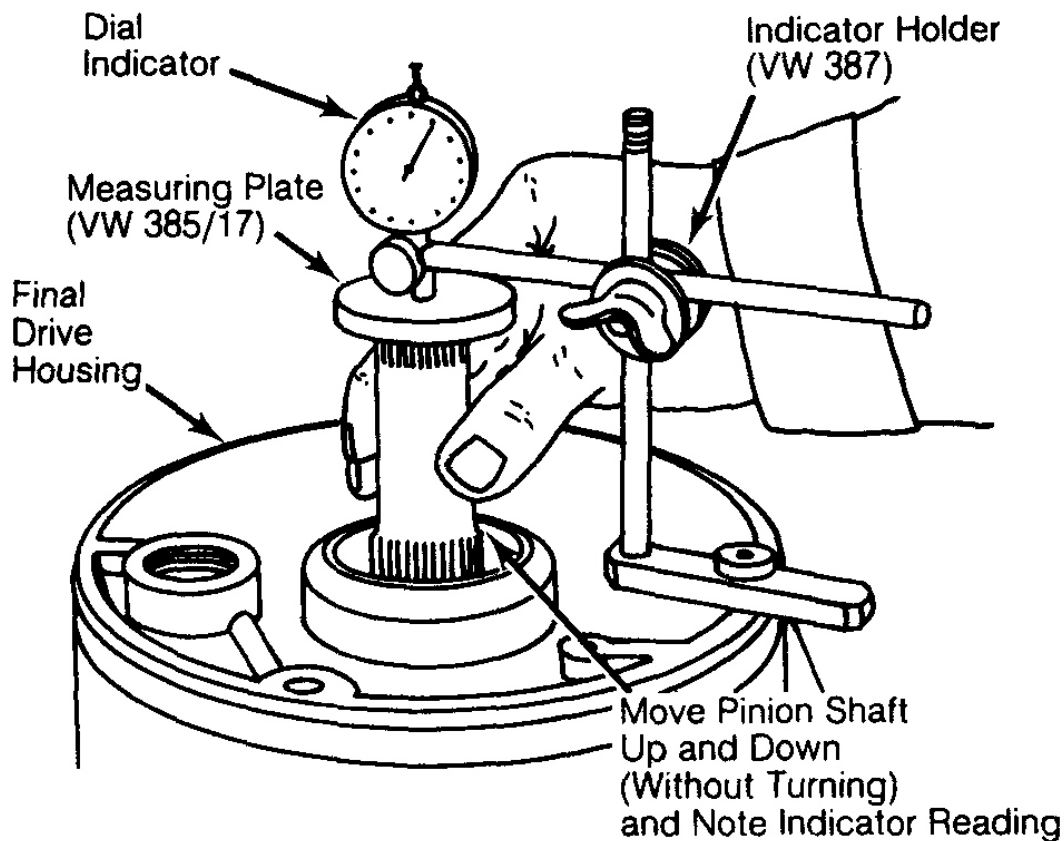
15. Next, subtract the thickness of pinion depth shim just selected from the total pinion adjusting shim thickness obtained in step 6 . The remainder is thickness of pinion bearing preload shim to use at reassembly.

NOTE: Pinion depth and bearing preload shims are available in thicknesses from .043" (1.1 mm) to .075" (1.9 mm) in increments of .001" (.025 mm). Also, shim thickness should be measured at several points on shim prior to installation to ensure correct thickness shims are being installed.

16. Remove measuring tools and pinion shaft from final drive housing. Press bearings from pinion shaft. Install the selected pinion bearing preload shim onto gear end of pinion shaft, then press bearing back onto shaft. Place the selected pinion depth shim on opposite end of shaft, then press remaining bearing onto shaft along with pinion oil seal bushing.
17. Install pinion shaft into final drive housing and lubricate bearings with hypoid gear oil. Reinstall measuring bar into housing and zero dial indicator with .04" (1.0 mm) preload.
18. Recheck pinion depth and bearing preload adjustment. If correct shims have been installed, dial indicator reading should be equal, to the ring gear deviation number with a tolerance of plus or minus .0016" (.04 mm). Remove measuring bar and side bearing adjusting rings.
19. Finally attach a torque wrench to pinion shaft and check pinion shaft turning torque. Turning torque should be at least 12.4 INCH lbs. (1.4 N.m).

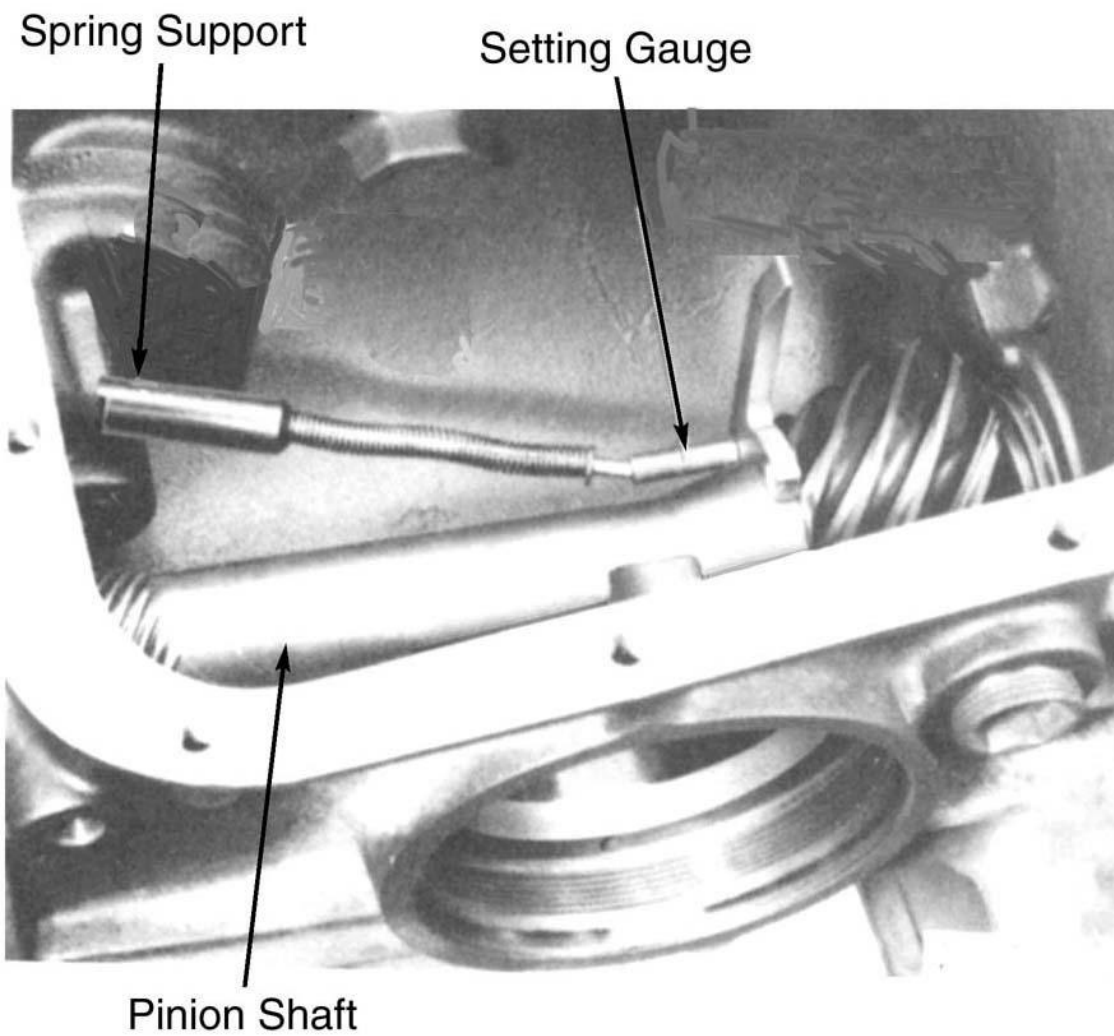
NOTE: Turning torque value given is for new bearings only. If used bearings are installed, turning torque should be measured prior to final drive disassembly. When assembled correctly, turning torque with used bearings should be approximately 1.7-3.5 INCH lbs. (.2-.4 N.m) greater than it was prior to

disassembly.



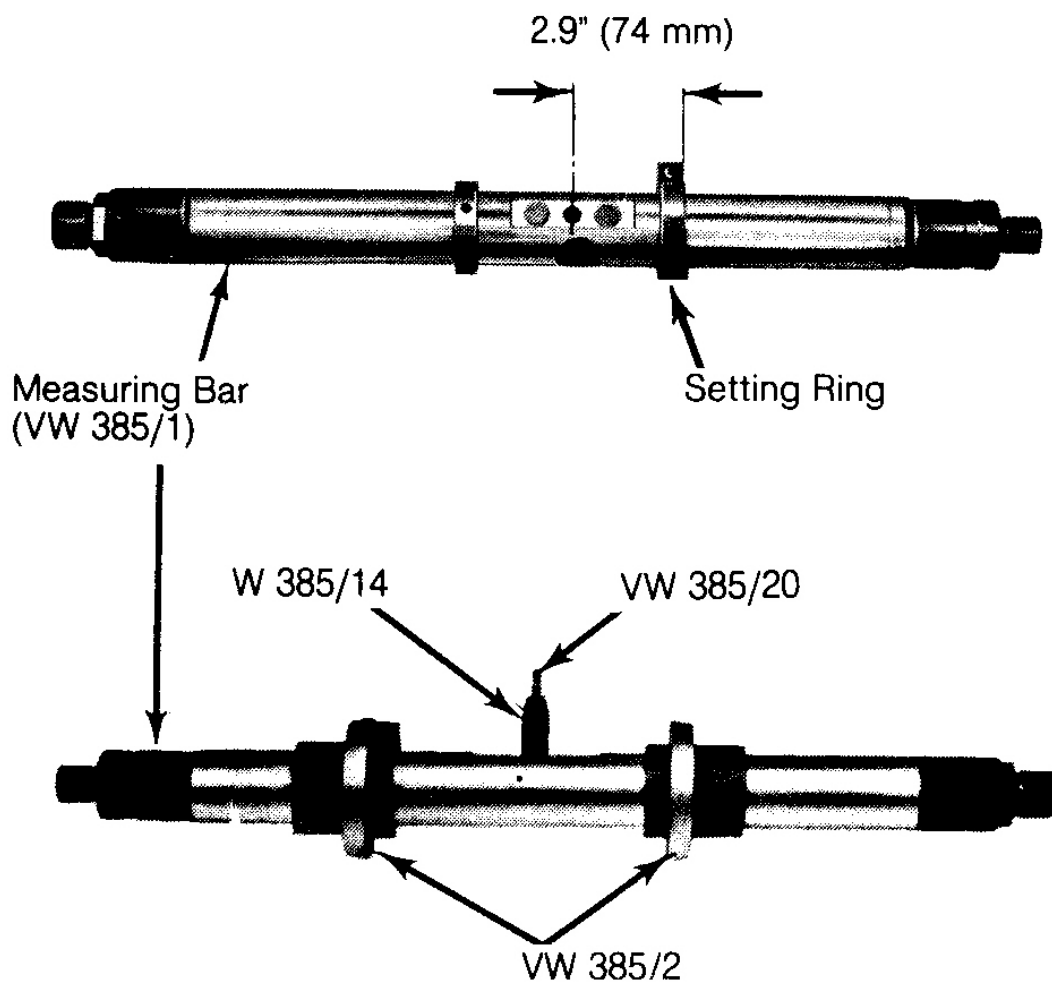
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Fig. 27: Measuring Pinion Shaft Play To Determine Total Pinion Adjusting Shim Thickness



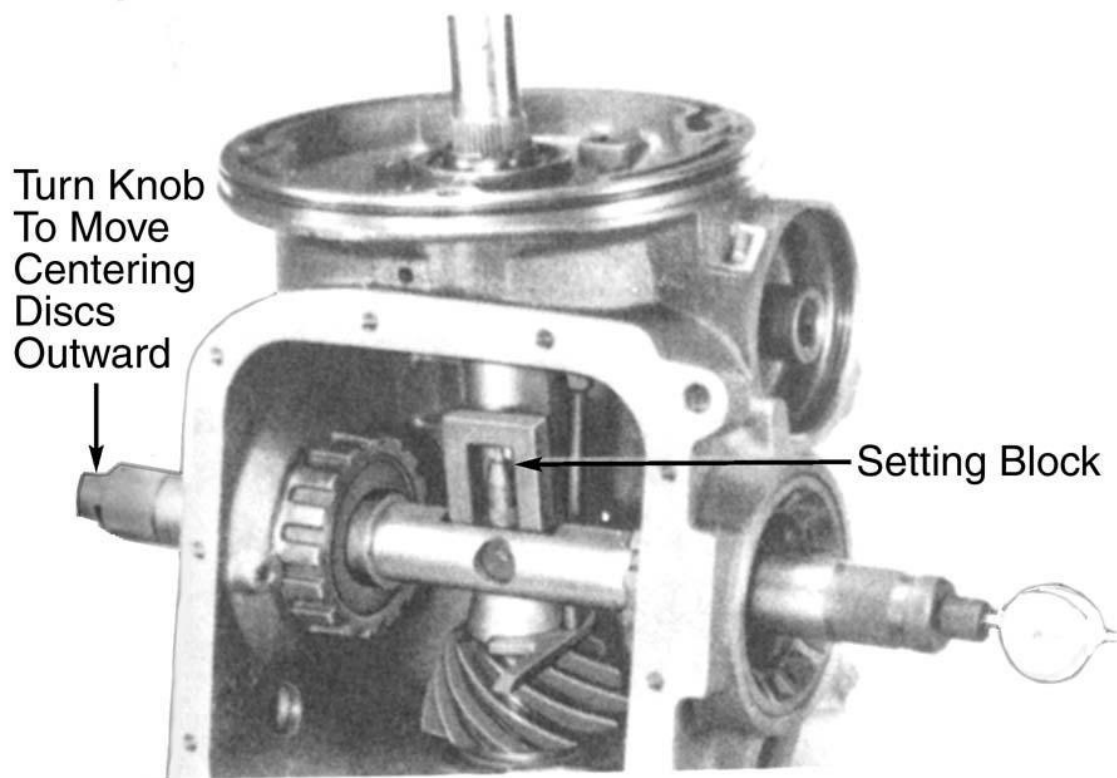
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Fig. 28: Installation Of Setting Gauge On Pinion Shaft



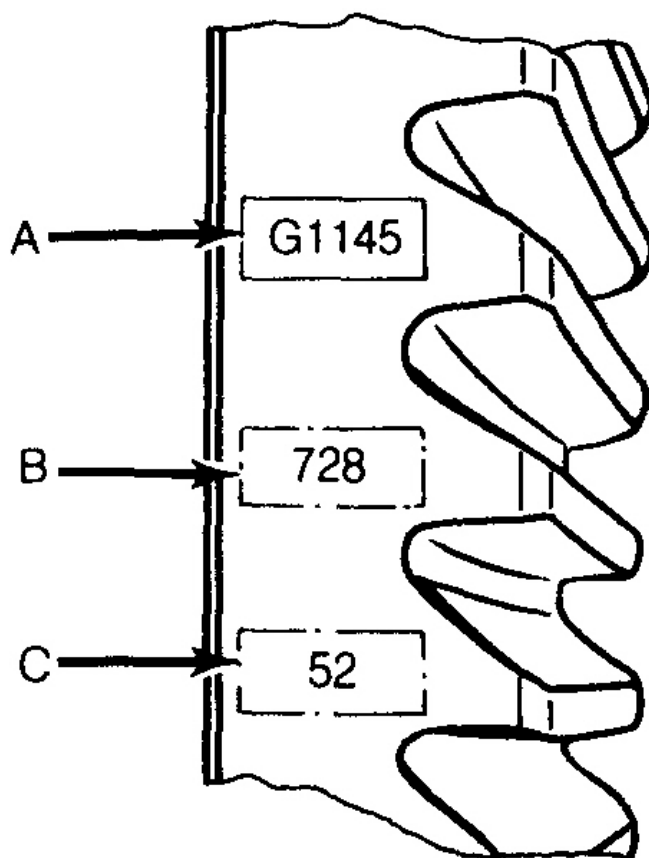
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Fig. 29: Assembling Special Measuring Tools For Pinion Depth Shim Selection



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Fig. 30: Positioning Of Measuring Bar In Housing



A - Gear Ratio (11:45)

B - Serial Number for Matched Gear Set

C - Deviation Number (In Hundredth-Millimeters)

G96B15371

Fig. 31: Location Of Deviation Number On Ring Gear

Side Bearing Preload & Ring Gear Backlash

1. With pinion shaft correctly adjusted, install differential assembly into final drive housing. Coat "O" rings and threads of side bearing adjusting rings with multi-purpose grease and coat side bearings with hypoid gear oil.
2. Install both adjusting rings into final drive housing until they are flush with housing. Next, adjust right side (ring gear end) adjusting ring in until ring gear meshes with pinion shaft gear with no backlash, then screw left ring in and preload slightly so that side bearings have no play. See **Fig. 32**.
3. From this position, unscrew right adjusting ring 2 1/2 teeth, then screw in left adjusting ring 5 teeth. This should correctly set side bearing preload and ring gear backlash.

4. To check ring gear backlash, rotate pinion shaft several times in both directions to settle bearings. Install docking sleeve (VW 521/4) with slotted sleeve (VW 521/7) in differential and secure with nut. See **Fig. 33**.

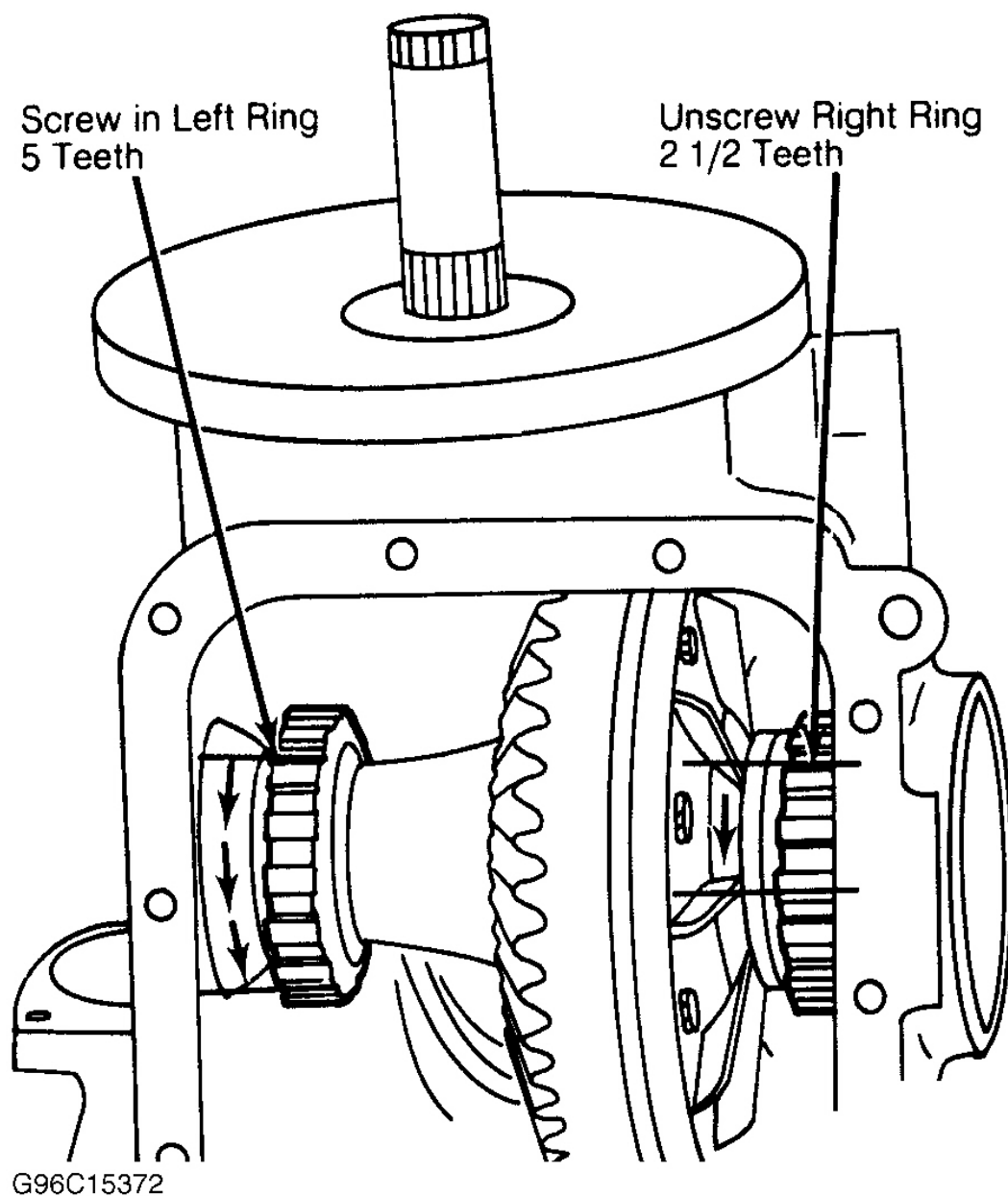
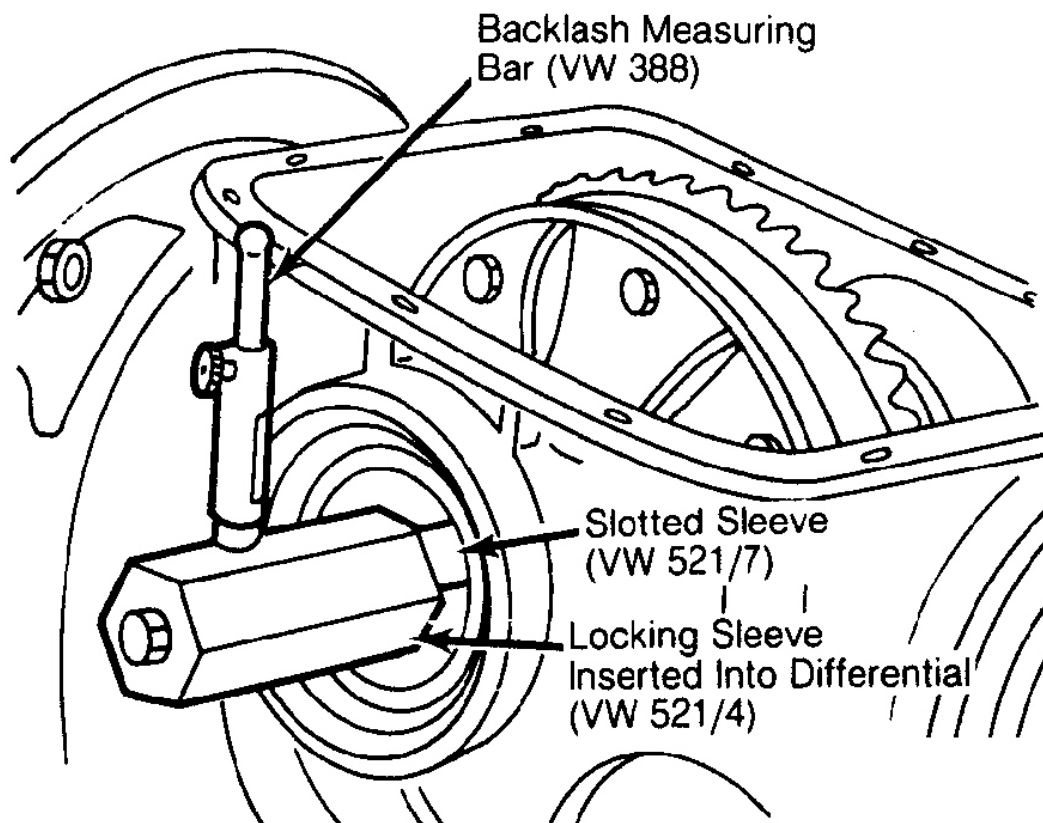


Fig. 32: Adjusting Ring Settings For Side Bearing Preload Adjustment



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Fig. 33: Installation Of Backlash Measuring Bar On Locking Sleeve

5. Adjust length of backlash measuring bar (VW 388) to 3.15" (80 mm)., Attach correctly adjusted measuring bar to locking sleeve.

NOTE: Refer to Fig. 34 for positioning of ring gear backlash measuring tools.

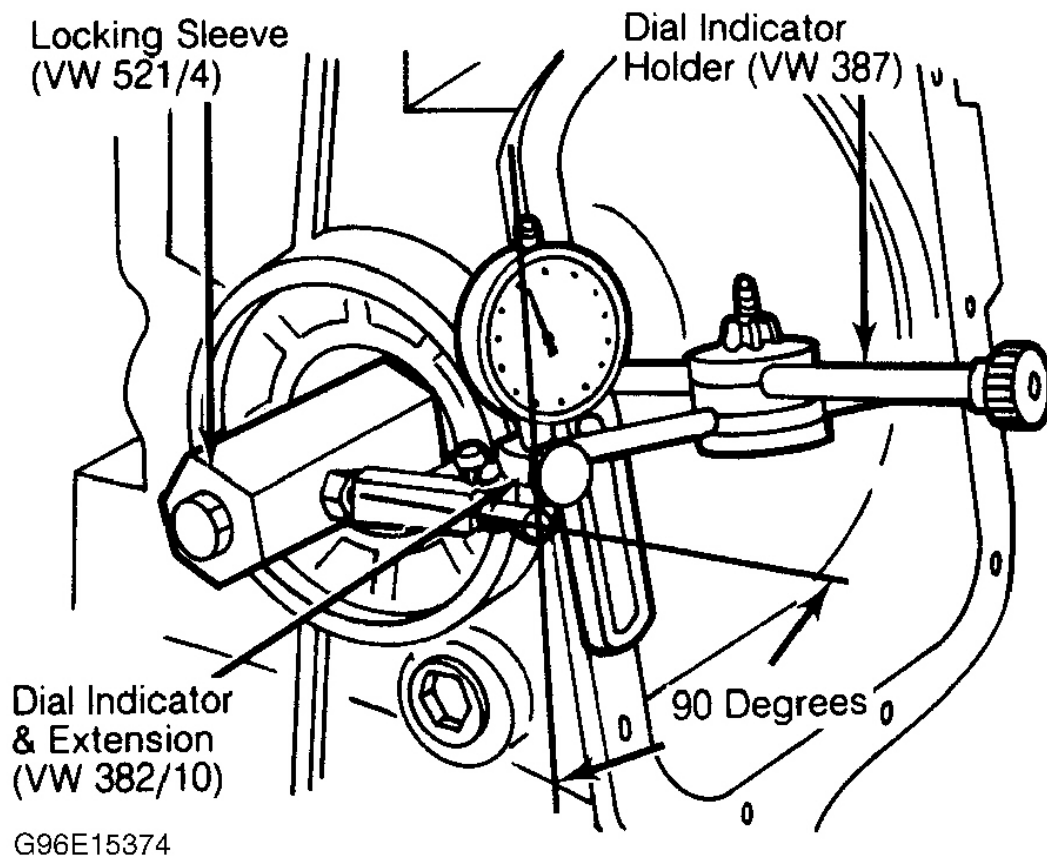


Fig. 34: Installation Of Backlash Measuring Bar On Locking Sleeve

6. Install dial indicator with .24" (6 mm) flat end extension (VW 382/10,) in indicator holder (VW 387). Bolt holder to final drive housing so that indicator is located at a right angle to backlash measuring bar.
7. Turn ring gear (via pinion shaft) until measuring bar contacts dial, indicator gauge pin, then turn ring gear further until indicator shows .04" (1 mm) preload. Attach locking clamp: (VW 386) to pinion shaft. See **Fig. 35** . Tighten clamp screw to lock pinion shaft.

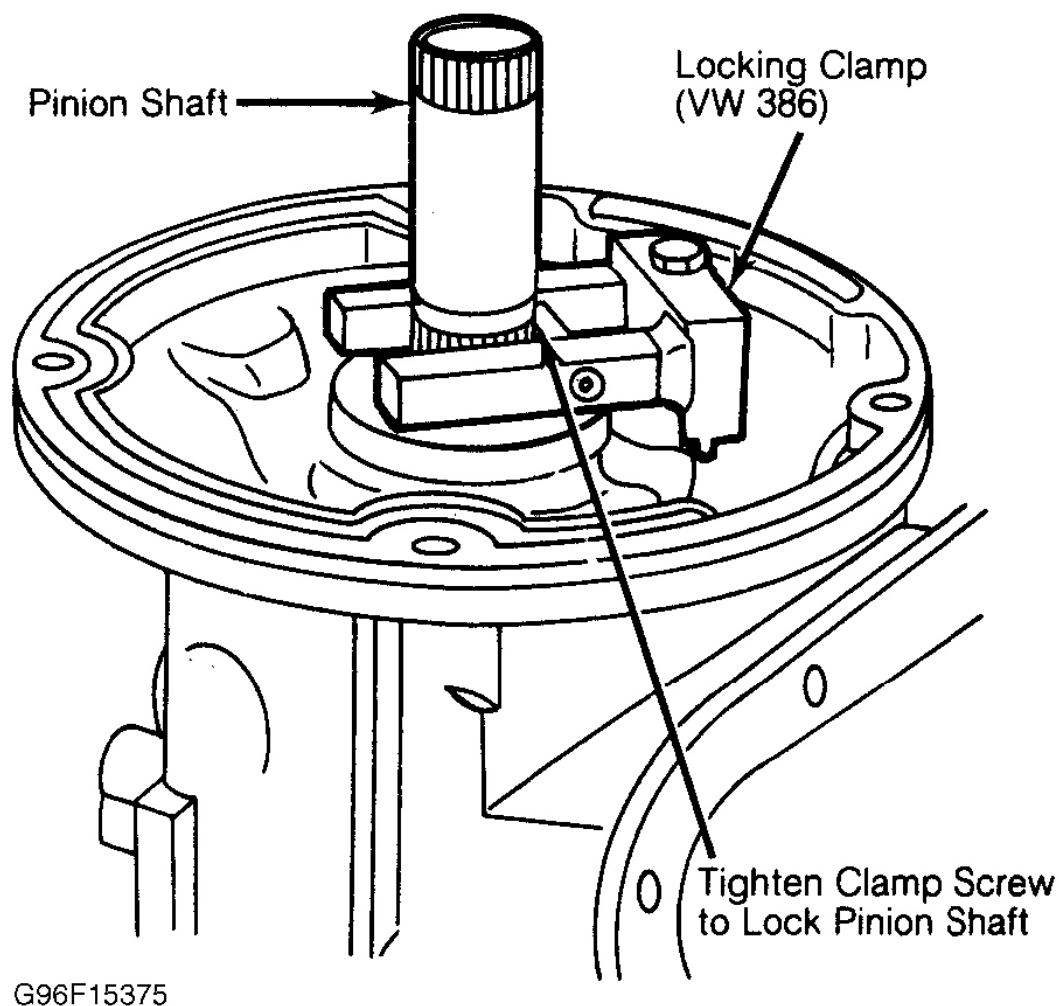


Fig. 35: Attaching Locking Clamp To Pinion Shaft

8. Turn ring gear away from dial indicator until it is stopped by the locked pinion shaft, then zero dial indicator. Next, turn ring gear towards indicator until it is again stopped by pinion shaft. Read and record indicator reading. This reading is the ring gear backlash.
9. Repeat backlash measurement procedure at three other points 90 degrees apart around ring gear. Add the four measurements together; then divide the total by four. The resulting sum is the average ring gear backlash, which should be .006-.010" (.15-.25 mm).

NOTE: The individual backlash measurements should not vary from each other by more than .002" (.05 mm); if they do, ring gear or pinion shaft is worn or they have been improperly installed.

10. If backlash is not within specifications, correct by turning both side bearing adjusting rings an equal

amount in opposite directions so that bearing preload is not altered. Remove measuring tools.

11. With backlash correct, check pinion shaft turning torque. Total pinion shaft turning torque, with differential installed, should be 14.2 INCH lbs. (1.6 N.m).
12. Install side bearing adjusting ring lock plates and tighten bolts to specified torque. Install new oil seals in adjusting rings. Install final drive oil pan using a new gasket.
13. Install a new torque converter oil seal into final drive housing. Install a new governor oil seal into housing with lip pointing toward governor, then install governor assembly.

FINAL ASSEMBLY OF TRANSAXLE

1. To measure play between final drive and transaxle, place a straightedge on transaxle attaching face of final drive housing, and using a depth gauge, measure distance from top surface of straightedge down to edge of pinion shaft oil seal bushing. See **Fig. 36**.
2. Next, measure distance from top surface of straightedge to face of, final drive housing. Subtract this second measurement from first measurement obtained in step 1 and note for future reference.
3. Place a new gasket on transaxle separation plate, position straightedge on transaxle case, and measure distance from top surface of straightedge down to gasket surface. Next, measure distance from top of straightedge down to shim surface on shoulder of annulus gear flange. Subtract this measurement from first measurement obtained in this step and record for future reference.
4. Subtract the last measurement obtained in step 3 from last measurement obtained in step 2. Remainder is end play (without shims) between final drive and transaxle. Select proper end play shim(s) to use by finding applicable end play reading in first column of **END PLAY SELECTION** table, and obtaining shim thickness noted in second column.

NOTE: **Transaxle-to-final drive end play adjusting shims are available in thicknesses of .016" (.4 mm) and .047" (1.2 mm). Combine shim thicknesses to obtain total thickness required.**

5. Install selected shim(s) into final drive case, on top of pinion shaft oil seal bushing. Next, lubricate and install sealing "O" ring into groove on transaxle end of final drive housing.
6. Install turbine shaft into final drive pinion shaft, then install oil pump shaft into turbine shaft. See **Fig. 37**. Position a new final drive-to-transaxle gasket onto transaxle case studs, then mate final drive to transaxle. Install final drive-to-transaxle case nuts and tighten to specified torque.
7. Set torque converter carefully on one-way support, then move converter back and forth and insert into splines ensuring that it does not jam.

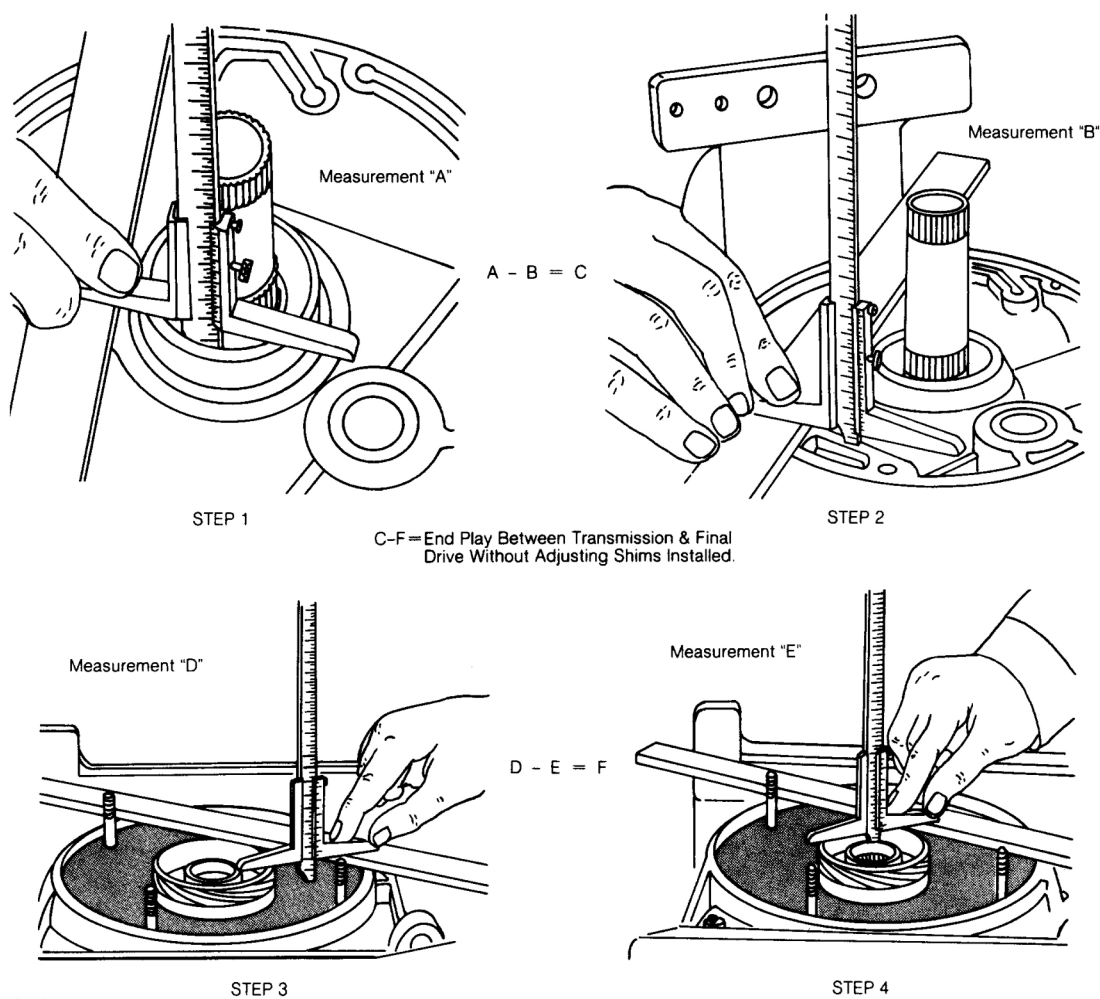
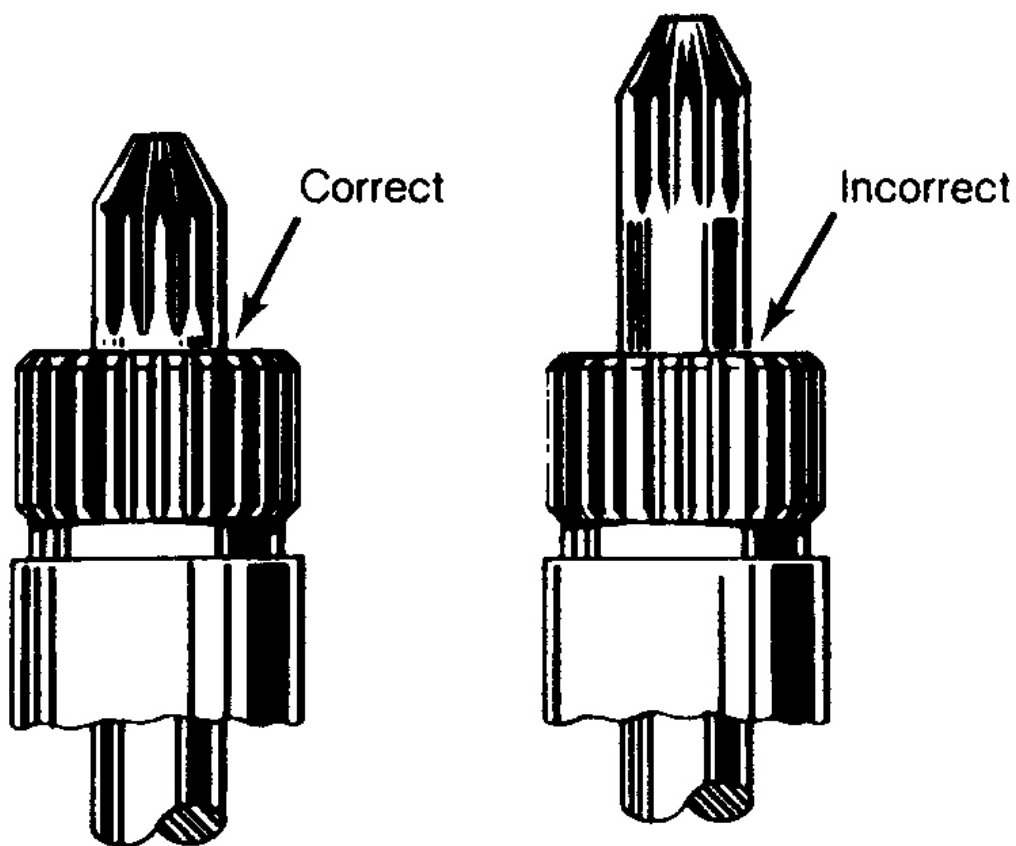


Fig. 36: Using A Depth Gauge To Determine Transaxle-To-Final Drive End Play Shim



96H15377

Fig. 37: Installing Oil Pump Shaft

END PLAY SHIM SELECTION

End Play In. (mm)	Correct Shim In. (mm)
.009-.032 (.23-.84)	None
.033-.049 (.85-1.24)	.016 (.4)
.050-.065 (1.25-1.64)	.032 (.8)
.066-.080 (1.65-2.04)	.048 (1.2)
.081-.096 (2.05-2.44)	.064 (1.6)
.097-.112 (2.45-2.84)	.080 (2.0)
.113-.128 (2.85-3.24)	.096 (2.4)
.129-.143 (3.25-3.64)	.112 (2.8)
.144-.153 (3.65-3.88)	.128 (3.2)

TORQUE SPECIFICATIONS

1990 Volkswagen Vanagon

1986-91 AUTOMATIC TRANSMISSIONS Type 090 3-Speed Diagnosis & Overhaul

TORQUE SPECIFICATIONS

Application	Ft. Lbs.
Final Drive	
Converter-To-Drive Plate	18 (24)
Drive Flange Bolt	14 (19)
Final Drive-To-Engine Bolt	22 (30)
Pan-To-Transaxle Case	7 (10)
Pinion Cover-To-Case	18 (24)
Ring Gear Mount Bolt	51 (70)
Transaxle	
Kickdown Lever Nut	11 (15)
Manual Valve Lever Nut	14 (19)
Pan-To-Transaxle Case	14 (19)
Transaxle-To-Final Drive	22 (31)
INCH lbs. (N.m)	
Final Drive Housing (Differential)	
Adjusting Ring Lock Plate-To-Housing	89 (10)
Transaxle	
ATF Pump-To-Case	62 (7)
Main Pressure Tap Plug	89 (10)
Strainer-To-Valve Body	27 (3)
Valve Body-To-Case	35 (4)