

AUTO TRANS OVERHAUL - 087 & 089

Article Text

1988 Audi 5000S

For Dan's Transmission Service 10 Jefferson Place Fort Walton Beach FL 32548

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ARTICLE BEGINNING

Automatic Transmissions
AUDI, PORSCHE & VOLKSWAGEN
TYPE 087 & 089 3-SPEED

Audi: Coupe GT, 4000S, 4000S Quattro, 5000S, 5000CS Turbo
Porsche: 944
Volkswagen: Quantum

IDENTIFICATION

Transaxle type may be identified by numbers cast into top rear of case. Transaxle model code is identified by figures stamped into torque converter housing. These figures consist of model code and build date code. Turbine shaft length is the primary difference between the 087 and 089 series transaxles. Type 087 uses 16.71" (424.5 mm) shaft and type 089 uses 15.82" (401.7 mm) shaft. Testing, disassembly and reassembly procedures are the same for both types.

TYPE 087-089 COMPONENT IDENTIFICATION

Application	Type	Code	Valve Body	Torque Converter	S.O.P.
4000 Series					
1.8L	089A	KAN	FKB	M	7/84
2.2L	087F	RBE	FGB	L	1/83
5000 Series					
2.2L	087.8	RDN	FJB	G	1/84
2.2L Turbo	087	RDU	FMC	N	7/85
944	087N	RCF	...	K	12/84
Quantum					
1.8L	089B	KAF	FL	M	10/82
2.2L	087F	RBE	FGB	L	1/83

DESCRIPTION

Transaxle assembly consists of automatic transmission and final drive assembly. Transmission housing contains 2 planetary gear sets, 2 multiple-disc clutches, one brake band and servo, one multiple-disc brake, one-way clutch, and hydraulic control system.

Final drive housing contains torque converter, transmission governor, ring gear, and differential carrier with pinion and side gears.

LUBRICATION & ADJUSTMENTS

See the appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANS SERVICING section.

TROUBLE SHOOTING

NO MOVEMENT

In Any Gear

Low fluid level. Manual lever not connected to manual valve.
Torque converter disconnected from drive plate. Main pressure valve sticking. Oil pump or pump drive shaft defective.

In Forward Gears

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

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

One-way clutch not holding. Forward clutch internal damage.

In 1st Gear in "1"

1st-reverse brake plates worn or burnt. Forward clutch damage.

In 2nd Gear

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

In 3rd Gear

Direct-reverse clutch plates burnt or worn.

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

Faulty governor drive. Governor incorrectly assembled or dirty. Loose accumulator cover plate. 1-2 gear shift valve sticking. Brake band for 2nd gear burnt or worn.

Into 3rd Gear

Governor or valve body dirty. 2-3 shift valve sticking. Loose oil pump bolts.

NO DOWNSHIFT

Into Second Gear

Governor dirty. 2-3 shift valve sticking.

Into 1st Gear

Governor dirty. 1-2 shift valve sticking.

DELAYED ENGAGEMENT ON UPSHIFTS

1-2 Upshift

Low fluid level. Dirty valve body. Second gear brake band worn, burnt, or out of adjustment. Second gear servo defective.

possible wrong piston.

2-3 Upshift

Low fluid level. Dirty valve body. Second gear brake band worn, burnt or out of adjustment. Second 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. Governor dirty. Valve body dirty. Planetary gears or separation plate gasket damaged.

TESTING

ROAD TESTING

1) Before road testing, ensure that fluid level is correct and in good condition. Check control linkage adjustments and correct as necessary. During test, transmission should upshift and downshift at correct speeds. See the SHIFT SPEEDS (MPH) chart.

2) Shift speeds may vary slightly due to production tolerances or tire size. Quality of shifts is most important factor. All shifts should be smooth, responsive, and with no slippage or engine speed runaway.

SHIFT SPEEDS (MPH)

Application	Full Throttle		Kickdown
Audi 4000 Series			
087			
1-2 Upshift	22-35	.....	46-48
2-3 Upshift	52-65	.....	77-79
3-2 Downshift	38-52	.....	73-75
2-1 Downshift	16-19	.....	37-39
089			
1-2 Upshift	20-28	.....	34-37
2-3 Upshift	48-61	.....	66-67
3-2 Downshift	35-48	.....	62-64
2-1 Downshift	14-16	.....	37-38
Audi 5000 Series			
087 (Turbo)			
1-2 Upshift .....	....	.....	....
2-3 Upshift .....	....	.....	....
3-2 Downshift .....	....	.....	....
2-1 Downshift .....	....	.....	....
087.8			
1-2 Upshift	19-32	.....	43-45
2-3 Upshift	51-64	.....	74-76
3-2 Downshift	36-50	.....	70-72
2-1 Downshift	14-17	.....	37-39

Porsche 944

087

1-2 Upshift	.....	22-30	.....	45-48
2-3 Upshift	.....	52-65	.....	81-83
3-2 Downshift	.....	37-52	.....	77-80
2-1 Downshift	.....	16-17	.....	42-44

Volkswagen Quantum

087

1-2 Upshift	.....	22-35	.....	46-48
2-3 Upshift	.....	52-65	.....	77-79
3-2 Downshift	.....	38-52	.....	73-75
2-1 Downshift	.....	16-19	.....	37-39

089

1-2 Upshift	.....	22-34	.....	37-40
2-3 Upshift	.....	53-66	.....	68-70
3-2 Downshift	.....	37-52	.....	63-65
2-1 Downshift	.....	14-19	.....	29-32

3) Slippage or engine runaway in any gear usually indicates clutch, band, or brake problems. Slipping unit in particular gear can be identified by noting transmission operation in other selector positions and comparing which internal units are applied. Refer to the CLUTCH & BRAKE BAND APPLICATION chart.

CLUTCH & BRAKE BAND APPLICATION CHART (ELEMENTS IN USE)

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

4) This process of elimination can be used to identify any unit which slips and to confirm correct operation of good units.

5) Most conditions are caused by leaking hydraulic circuits or sticking valves. Unless defined mechanical problems exist, DO NOT disassemble transmission without testing hydraulic pressure.

1) Connect pressure gauge to main pressure test point on case (adjacent to servo cover). Transmission must be at normal operating temperature. See Fig. 1.

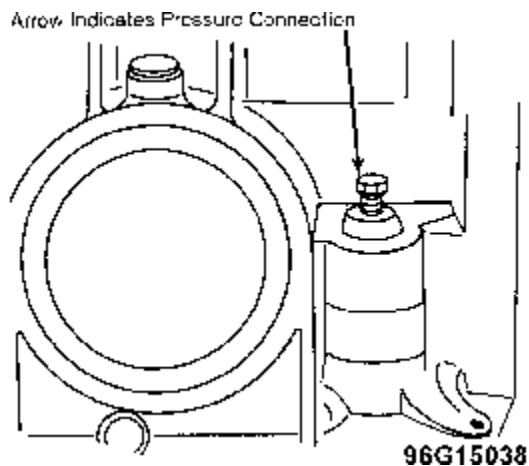


Fig. 1: Pressure Test Port Location

2) Verify that pressures obtained during each phase of test are correct. See MAIN PRESSURES TEST chart below. If pressures are incorrect, check for oil leaks, defective oil pump, or sticking valves in valve body assembly.

MAIN PRESSURE TEST

Selector Lever Position	Accelerator Lever Position	Main Pressure psi (kg/cm ²)	Test Conditions (1)
Drive All Models	Idle Speed	42.06-43.51 (3.0-3.1)	Accelerate to 35 MPH, release the throttle & check pressure.
Drive All (Exc. E-Mode) 087 (exc. 944) 087 (944) 089 (exc. 944) All (E-Mode) (2)	Full Throttle	81.95-83.40 (5.8-5.9) 105.88-107.33 (7.4-7.6) 84.85-86.30 (6.0-6.1) 84.85-86.30 (6.0-6.1)	Vehicle speed above 35 MPH
Reverse All (Exc. E-Mode) 087 Coupe, 4000 & 5000 Quantum	Idle Speed	131.99-140.69 (9.3-9.9)	Vehicle Stationary

944		(9.2-10.2) 133.44-142.14 (9.4-10.0)	
089 Coupe & 4000		131.99-140.69 (9.3-9.9)	
Quantum		130.54-145.04 (9.2-10.2) (6.0-6.1)	
All (E-Mode) (2)		130.54-145.04 (9.2-10.2)	
Reverse 087 (944 Only)	Full Throttle	290.0 (minimum) 20.0 (minimum)	At Stall Speed
(1) - Manufacturer recommends that "D" tests be performed on a Dynamometer. (2) - Specifications for Quantum not available.			

STALL TEST

CAUTION: DO NOT hold throttle open for longer than time needed to read tachometer. Maximum stall speed test time is 5 seconds. Wait at least 20 seconds with transmission in neutral before repeating test. If engine speed exceeds limits, release accelerator immediately as clutch or band slippage is indicated.

Testing Procedure

Connect tachometer. Start engine and set parking and service brakes. Place selector in "D". Depress accelerator briefly to full throttle and note maximum RPM obtained. Engine speed should be within specifications. See the STALL SPEEDS table.

STALL SPEED TEST RESULTS

1) If stall speed is higher than specified, forward clutch or one-way clutch for 1st gear is slipping. If stall speed in "D" range is too high, repeat stall test in "1". If RPM is now within specification, 1st gear one-way clutch is defective. If RPM exceeds specification in "1" also, forward clutch is defective.

2) If stall speed is approximately 200 RPM below specifications, engine performance may be unsatisfactory. If stall speed is more than 200 RPM below specifications, torque converter stator one-way clutch is faulty and complete converter should be replaced.

STALL SPEEDS

Application	(1) Stall RPM
Audi 4000 Series	
087F	2250-2500

089A	2520-2820
Audi 5000 Series	
087.8	2870-3120
087 (Turbo)	3000-3400
Porsche 944	
087	2600-3000
Volkswagen Quantum	
087	2250-2500
089	2330-2630

(1) - Stall speeds will drop 125 RPM for each 3300 ft. increase in elevation. High ambient temperature may cause a slight drop in stall speed.

SERVICE (IN VEHICLE)

DRIVE AXLE SHAFTS

See the AXLE SHAFTS article in the DRIVE AXLES section.

VALVE BODY

NOTE: Governor is mounted in final drive assembly.

With transaxle in vehicle, the valve body may be removed for service or may be serviced in the vehicle. When removing the valve body from the transmission case ensure the sealing balls are in the correct position. For valve body service information see VALVE BODY ASSEMBLY in COMPONENT DISASSEMBLY & REASSEMBLY section of this article.

GOVERNOR

Governor may be cleaned and the pivot points and springs for the centrifugal weights checked for wear and damage. Governor is available for replacement as a complete unit. Governor units for gasoline engine vehicles are stamped with the letter "A" on the top plate.

Removal

Remove cover bolts and washers. Remove governor cover and "O" ring from final drive housing. Withdraw governor from housing with clockwise turning motion to allow governor drive gear to disengage from drive pinion gear.

Installation

Check governor oil seal and needle bearing in housing for damage or wear. Replace if necessary. Reverse removal procedure to install. Rotate governor to engage drive gear.

REMOVAL & INSTALLATION

See the TRANSMISSION REMOVAL & INSTALLATION - A/T article in the AUTOMATIC TRANS SERVICING section.

TORQUE CONVERTER

NOTE: Torque converter is a sealed unit and cannot be disassembled for service.

TORQUE CONVERTOR BUSHING REPLACEMENT

1) Check bushing wear using inside micrometer. Wear limit is 1.343" (34.12 mm). Maximum allowable out-of-round is .001" (.03 mm). If bushing wear exceeds limit, use Bushing Puller (US 691, VW 201 and Adapter US 4452) to withdraw bushing from converter hub.

2) Press new bushing into place using Bushing Driver (VW 474). Measure inside diameter of new bushing after installation. Remove any burrs from edge of converter hub after installation of new bushing.

3) Minimum allowed inside diameter of new bushing is 1.340-1.341" (34.03-34.05 mm). Bushing may seize if inside diameter is less than minimum limit. DO NOT ream out bushing to fit. Repeat replacement procedure with another new bushing if necessary.

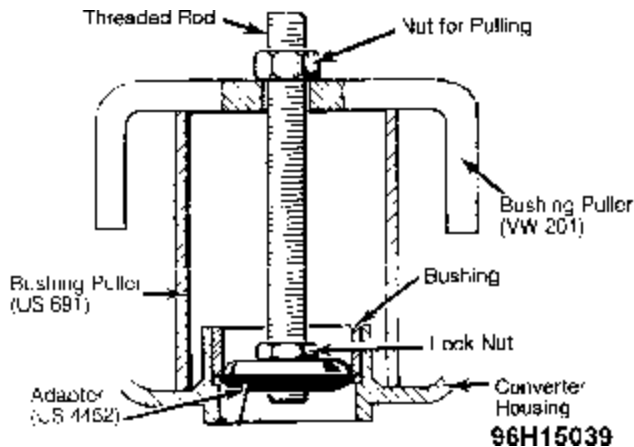


Fig. 2: Removing Torque Converter Bushing
Courtesy of Volkswagen United States, Inc.

TRANSAXLE DISASSEMBLY

TRANSMISSION

1) Remove torque converter from differential housing. Remove oil pump shaft from center of turbine shaft. Disconnect filler pipe from oil pan. Mount transaxle assembly in holding fixture with back of transmission assembly bolted to fixture.

2) Remove nuts from studs attaching final drive to transmission. Separate final drive unit from transmission case.

Withdraw turbine shaft from final drive.

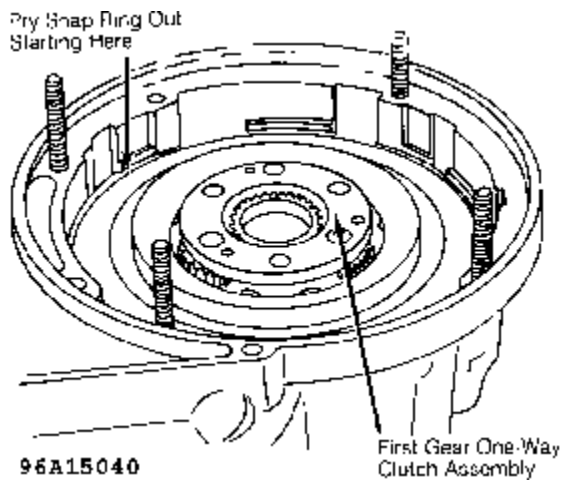


Fig. 3: Location of One-Way Clutch Retaining Snap Ring

3) Remove separation plate and gasket from transmission case. Remove reverse planetary ring gear, needle bearing and thrust washer. Using screwdriver, carefully remove large snap ring retaining 1st gear one-way clutch assembly in case.

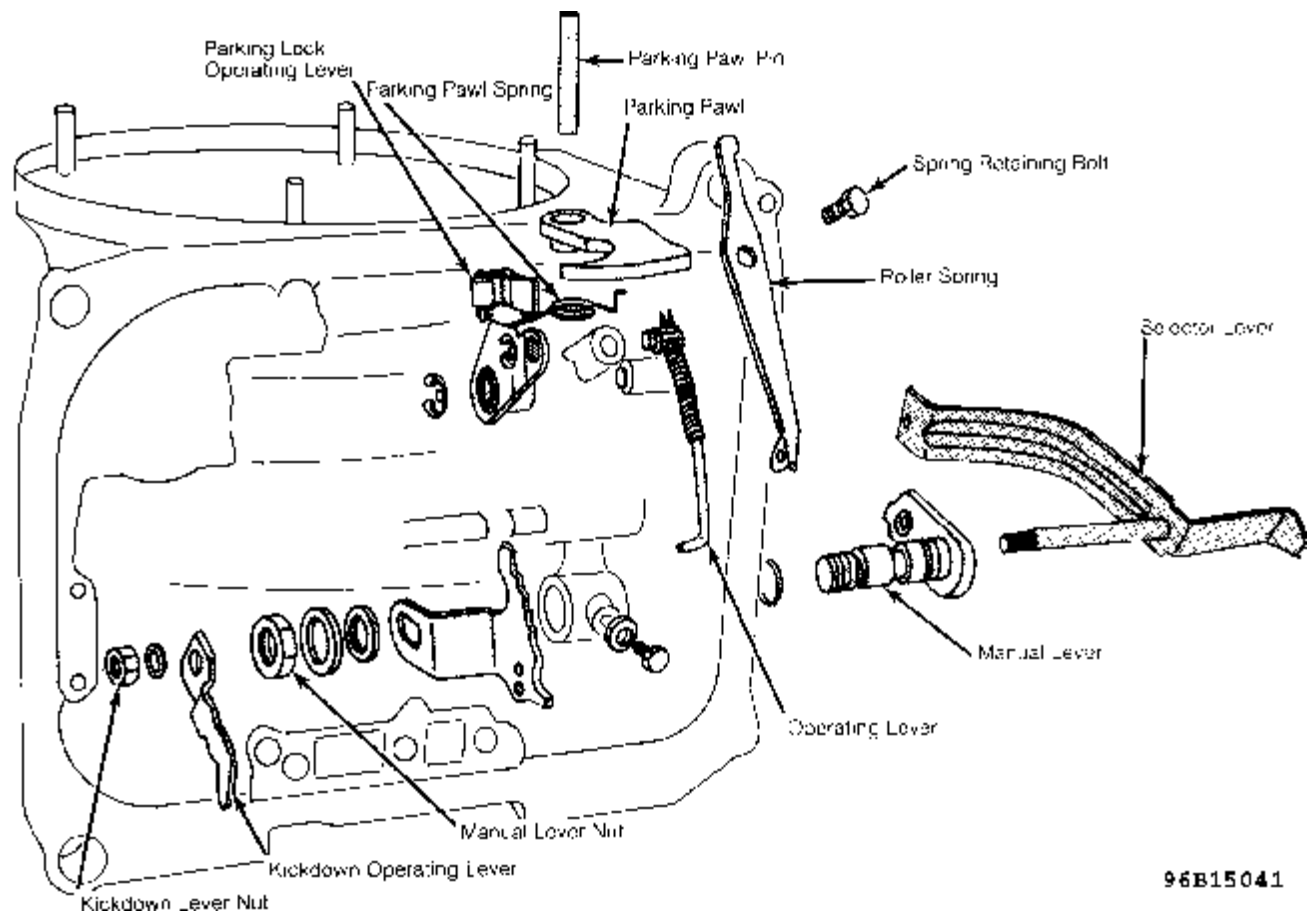
4) Lift out one-way clutch, 1st-reverse gear brake plates, and reverse planetary gear set. Remove thrust washers. Lift sun gear, driving shell, forward planetary gear set, and forward clutch, from case.

5) Remove 2nd gear brake band servo cover snap ring. Use rubber mallet to tap cover until cover and piston pop out under spring pressure. Loosen 2nd gear brake band lock nut and remove adjusting screw and lock nut. Remove adjusting screw push rod.

6) Lift out remaining components that are housed in 1st-reverse gear brake shell. Remove bolts from 1st-reverse brake spring plate, withdraw spring plate and springs. Pull brake shell, brake piston, and oil pump from case.

7) Remove oil pan and gasket. Remove oil strainer and cover from valve body. Remove 11 valve body attaching bolts.

8) Lift valve body assembly from case. DO NOT drop manual valve. Remove accumulator spring and piston from transmission case. If necessary for replacement, disassemble kickdown and selector linkage. See Fig. 4.



96B15041

Fig. 4: Bottom View of Transmission Housing Showing Kickdown & Selector Linkage

AUTO TRANS

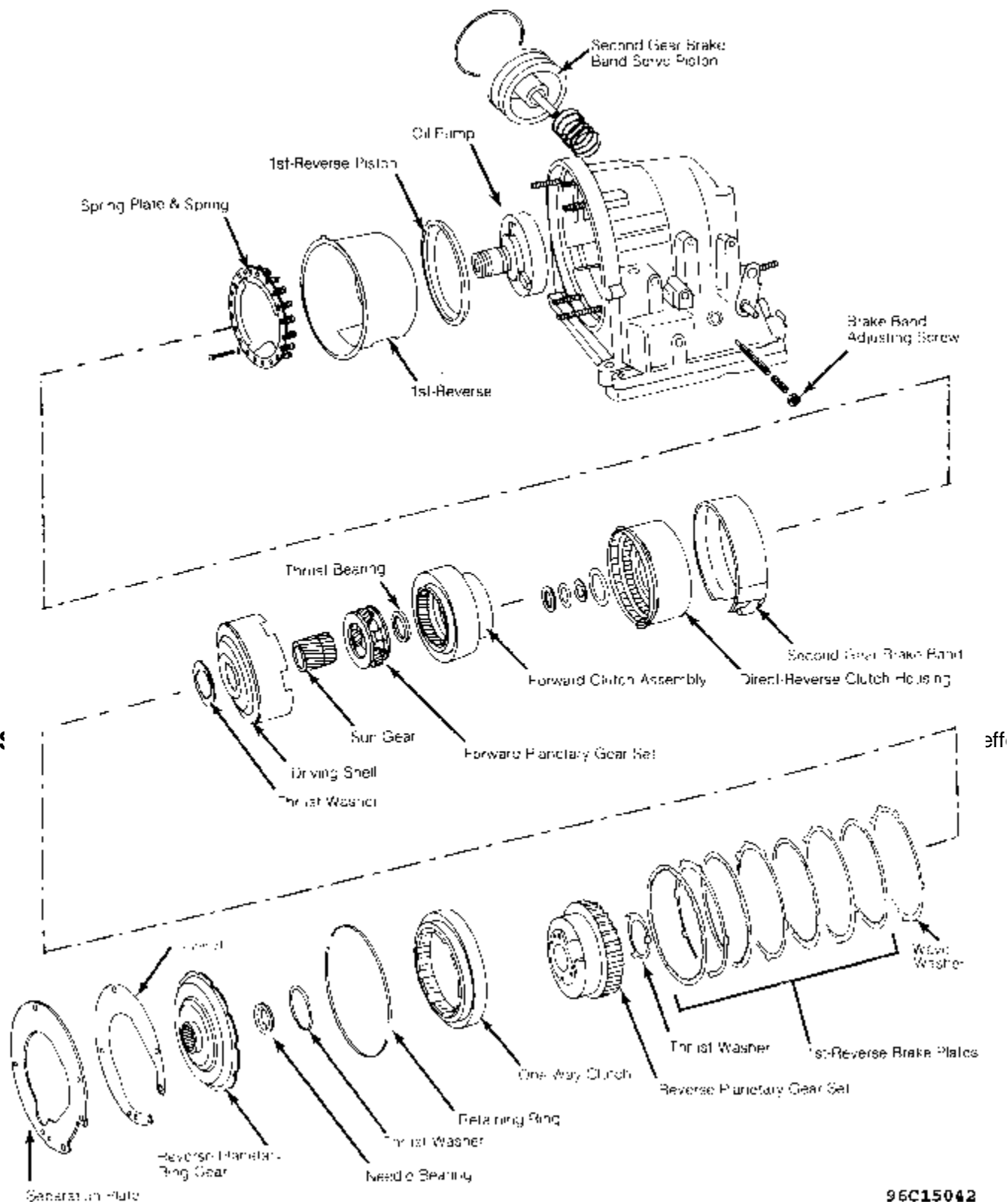


Fig. 5: Exploded View of Transmission Case & Main Components

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DIFFERENTIAL

NOTE: Measure backlash and preload prior to disassembling final

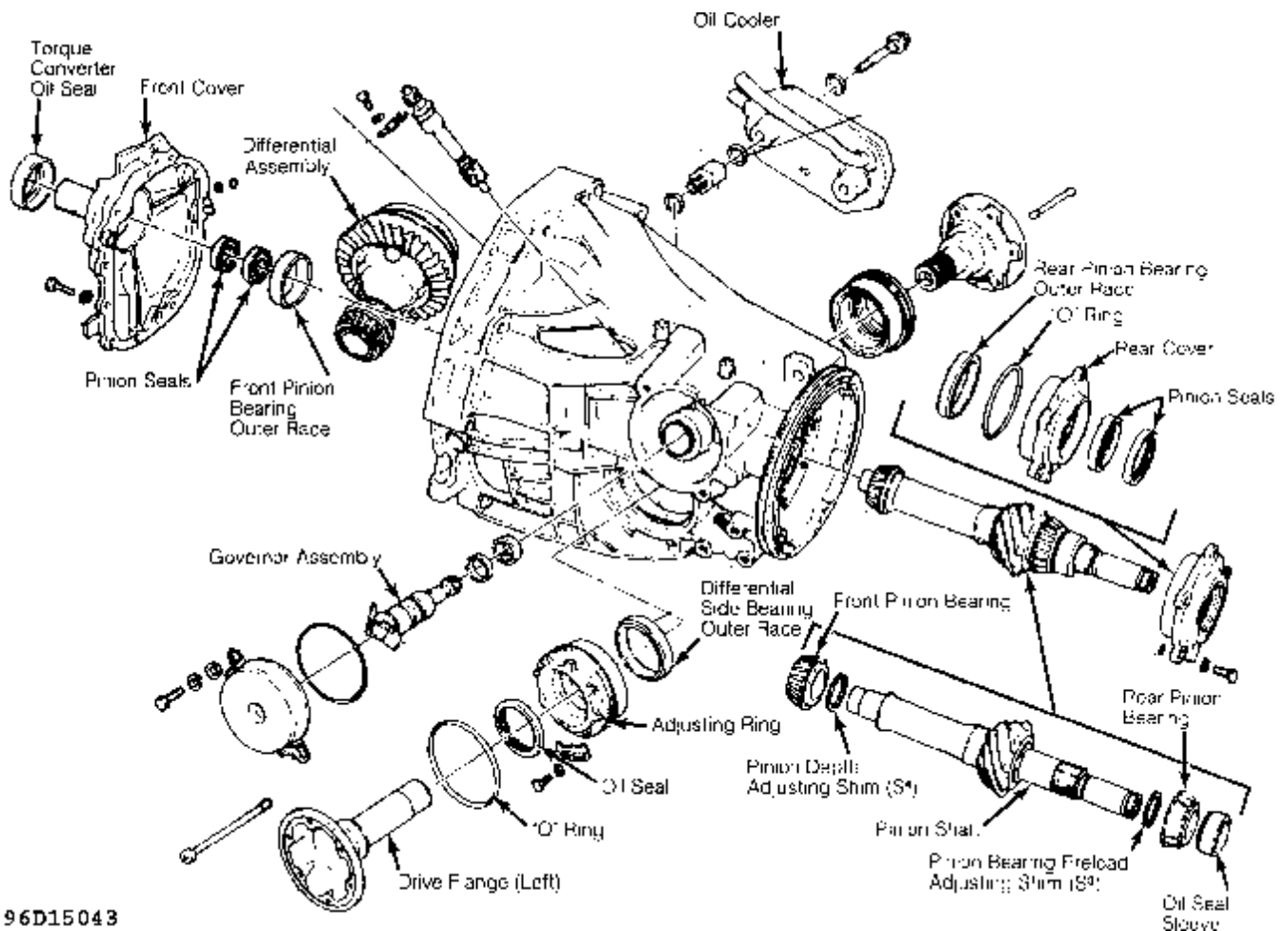
drive. See PINION SHAFT TURNING TORQUE and PINION DEPTH & BEARING PRELOAD procedures in TRANSAXLE REASSEMBLY for measuring instructions.

1) Place final drive housing in holding fixture. Mark position of side bearing adjusting rings before removing. Remove governor assembly from final drive housing. Use slide hammer to remove governor oil seal and needle bearing.

2) Remove ATF oil cooler from case. Remove final drive housing front cover. Remove pinion rear cover. Remove retaining bolt from center of each axle drive flange. Pull flanged shafts out of final drive housing.

3) Remove bolts and lock plates from adjusting rings. Remove adjusting rings using Spanner (VW 544). Pull pinion out slightly. Tilt differential case and remove ring gear. Remove pinion shaft from housing.

4) Place differential in soft jaw vise with ring gear attaching bolts up. Loosen attaching bolts and remove ring gear by tapping lightly on bolt heads.



96D15043

Fig. 6: Exploded View of 087 Model Differential Case Assembly
Courtesy of Volkswagen United States, Inc.

5) Remove pinion gears, side gears, thrust washers and nuts for axle shaft drive flange retaining bolts. Remove differential s

bearings and speedometer drive gear (if equipped) with press or gear puller. Mark side bearings for installation reference.

CAUTION: If original shims are to be reused, note number and thickness of pinion adjusting shims on pinion shaft. When pressing drive pinion bearings on or off, use extreme care to avoid damage to any teeth on shaft.

6) Remove pinion bearings using press. Remove rear pinion bearing and oil sleeve. Pinion bearing outer races and oil seals must be replaced if pinion bearings are replaced. Remove torque converter seal from front cover. Remove front cover pinion seal.

7) Press pinion bearing outer race from front cover. Remove pinion oil seals from rear cover. Press pinion bearing outer race from rear cover using driver.

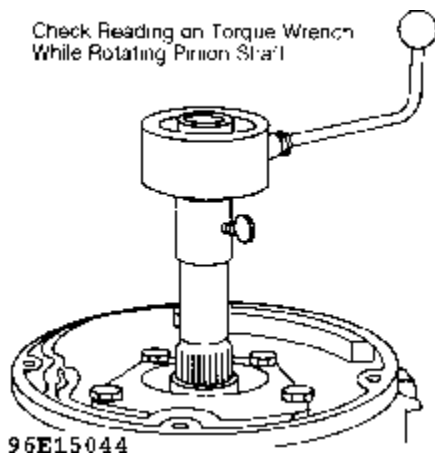


Fig. 7: Measuring Pinion Shaft Turning Torque

NOTE: If pinion bearing outer races are being removed, ensure races are kept with their original bearings.

COMPONENT DISASSEMBLY & REASSEMBLY

OIL PUMP ASSEMBLY

Disassembly

1) Remove pump cover attaching screws and separate cover from pump housing. Remove check ball and spring from pump body. Lift out pump gears and drive plate.

2) Unhook piston ring ends and remove rings from pump body. Remove thrust washer from end of pump housing.

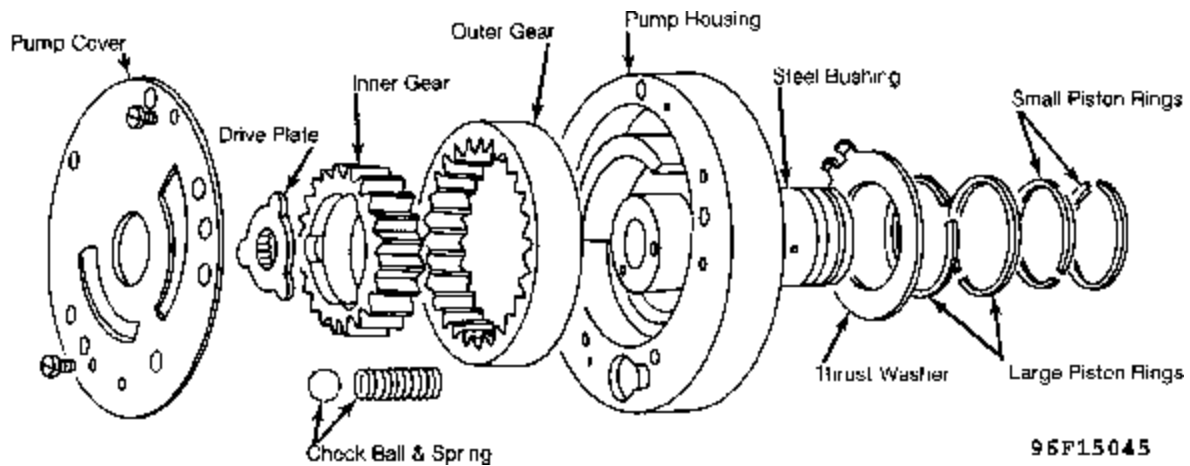


Fig. 8: Exploded View of Oil Pump Assembly

Cleaning & 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. Install piston rings. Ensure ring ends are hooked together correctly. Lubricate all parts with ATF.

2) Install inner and outer gears into housing. Outer gear identification mark must face cover plate. Install drive plate with extended hub inserted into pump body away from cover plate. Install check ball and spring. Align cover with housing and install fasteners.

NOTE: After reassembly, insert pump shaft into oil pump and ensure that gears rotate smoothly without binding. Gear movement should also be checked after pump is installed in transmission case.

DIRECT-REVERSE CLUTCH

Disassembly

1) Pry clutch pack retaining snap ring from clutch drum.

Withdraw clutch pressure plate, lined clutch plates, and steel clutch

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2) Place clutch drum in press, apply downward pressure to piston spring retainer and remove retaining snap ring. Release press and remove spring retainer. Using twisting motion, remove piston with return springs from drum.

3) Remove piston seals and springs from piston. If necessary for replacement, place clutch drum in press and drive bushing out of drum.

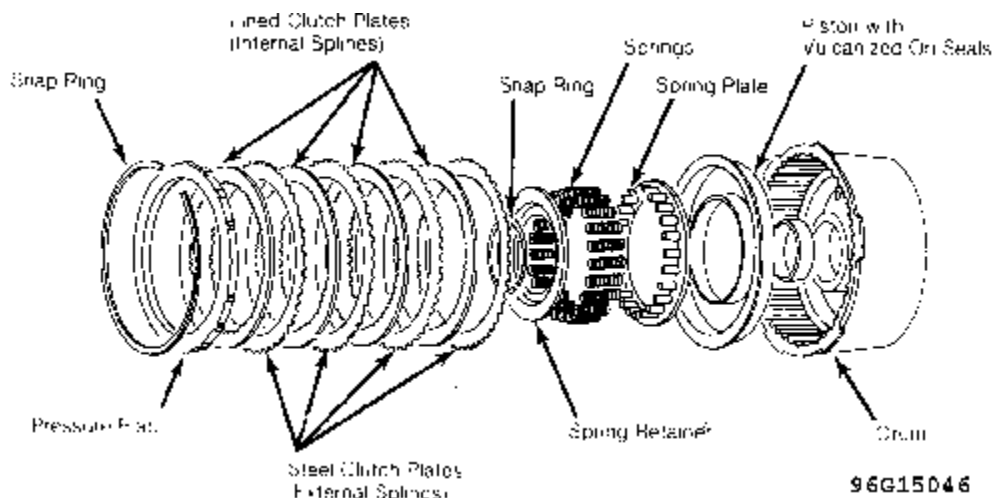


Fig. 9: Exploded View of Model 089 Direct-Reverse Clutch Assembly
Model 087 uses 4 inner and 4 outer splined plates. Courtesy of
Volkswagen United States, Inc.

Inspection

- 1) Inspect friction surfaces of piston and drum for wear or damage. Ensure clutch drum ball valve moves freely. Inspect piston springs for wear or collapsed coils and replace as necessary.
- 2) Inspect steel (externally splined) clutch plates. If plates are scored or have radial grooves, they must be replaced. Discolored plates may be reused.
- 3) Inspect lined (internally splined) clutch plates. Replace any plate that is worn, or damaged.

Reassembly

- 1) If removed, press new bushing into clutch drum .067" (1.7 mm) below lip of drum hub. Lubricate piston seals with ATF. Install them into clutch drum with lips facing into drum.
- 2) Using stiff plastic sheet to protect piston seals, install piston into drum using twisting motion. Position piston return springs on piston.
- 3) Place spring retainer on springs, compress retainer and install snap ring. Lined clutch plates should be soaked in ATF for 15 minutes before installing. Use only replacement clutch plates with identification grooves identical to ones removed.

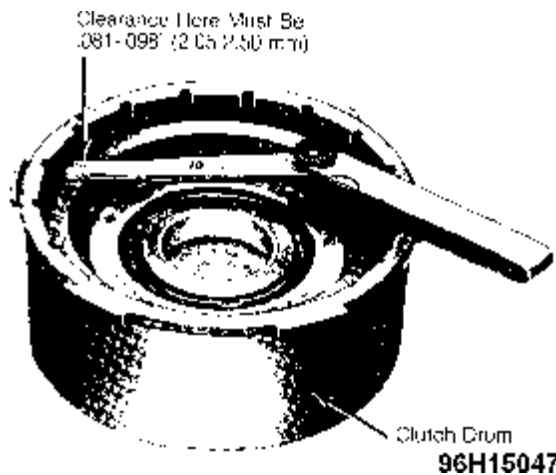


Fig. 10: Measuring Direct-Reverse Clutch Clearance
Change snap ring to adjust clearance.

- 4) Install clutch plates into clutch drum starting with steel (externally splined) plate. Alternate lined and steel plates until all clutch plates are installed. Install pressure plate and clutch pack retaining snap ring.
- 5) Measure clearance between pressure plate and retaining snap ring. See Fig. 10. Clearance should be .081-.098" (2.05-2.50 mm). If not, remove clutch pack snap ring and replace with snap ring of correct thickness to bring clearance within specification.
- 6) Direct-reverse clutch pack retaining snap rings are available in thicknesses from .059" (1.5 mm) to .098" (2.5 mm). Install correct thickness clutch pack retaining snap ring. Recheck clutch pack clearance.

DIRECT-REVERSE CLUTCH PLATES

Application	Steel Plates	Lined Plates
087 Series	4	4
089 Series	3	3

FORWARD CLUTCH
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 Disassembly

- 1) Using screwdriver, pry clutch pack retaining snap ring from clutch drum. Withdraw pressure plate, forward planetary ring gear, lined and steel clutch plates, and thrust plate.
- 2) Carefully pry out diaphragm spring snap ring. Remove diaphragm spring. Lift clutch piston. If necessary, use compressed air to force clutch piston from drum. See Fig. 11.

- Inspection
- 1) Inspect clutch drum for wear or damage. Check clutch drum ball valve for free movement and ensure that oil passage is clear.
 - 2) Inspect diaphragm spring and piston for damage. Place diaphragm spring onto piston and ensure that top of spring reaches lower edge of snap ring groove. If not, replace spring.

NOTE: Forward clutch piston sealing lips are vulcanized to piston. Replace entire piston if there is damage to sealing lip or if there is leakage past sealing lips.

3) Use direct-reverse clutch inspection procedures to inspect lined and steel clutch plates. If new lined (internally splined) clutch plates are to be installed, soak them in ATF for 15 minutes prior to installation.

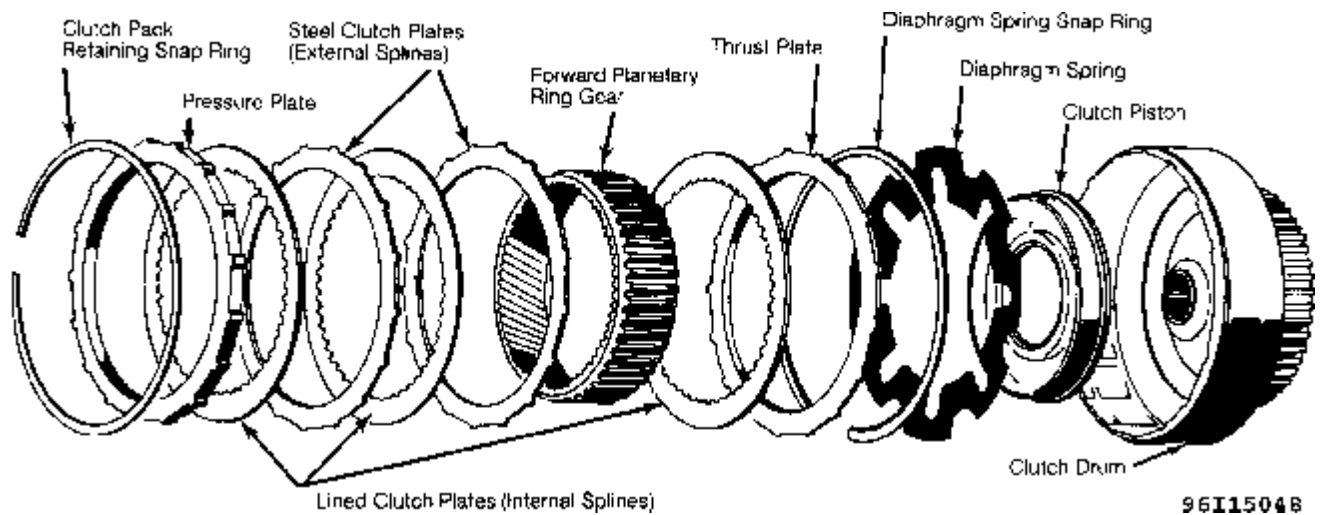


Fig. 11: Exploded View of Forward Clutch Assembly
Courtesy of Volkswagen United States, Inc.

Reassembly

1) Lubricate piston sealing lips with ATF. Install piston into drum using twisting motion. Install diaphragm spring, with convex side toward piston, into clutch drum. Install retaining snap ring.

2) With snap ring installed, diaphragm spring should be lightly tensioned; if not, replace spring. Install thrust plate into drum. If one side of thrust plate is chamfered, install chamfered side toward diaphragm spring.

3) Install one lined (internally splined) clutch plate. Install forward planetary ring gear so that short splines beneath its retaining ridge are engaged in lined clutch plate.

4) Install remaining clutch plates starting with steel (externally splined) clutch plate and alternating lined and steel plates until all clutch plates are installed.

5) Install pressure plate and retaining snap ring into clutch drum. Position dial indicator on clutch assembly so that indicator pointer contacts pressure plate. Zero indicator.

6) Measure forward clutch end play by moving forward planetary ring gear up and down so that dial indicator will read play between pressure plate and snap ring. See Fig. 12.

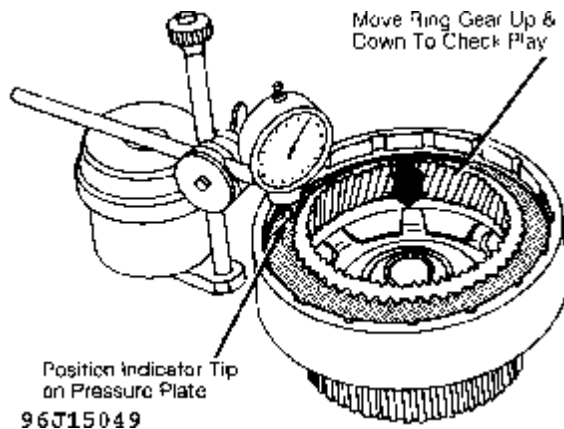


Fig. 12: Measuring Forward Clutch End Play

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

8) Forward clutch pressure plates are available in thicknesses of 2.3-3.9 mm with .4 mm increments for all 087 series except for those in Volkswagen Quantum and Audi 4000 vehicles. Audi and Volkswagen (087F series) uses pressure plates ranging from 6.0-7.6 mm with .4 mm increments.

9) On Audi 5000 (087) series, both 2.3-3.9 mm and 6.0-7.6 mm ranges are available. On Audi 4000 (089) series forward clutch pressure plates are available in thicknesses of 6.0-7.6 mm with .4 mm increments.

1st GEAR ONE-WAY CLUTCH

Disassembly

Remove one-way clutch rollers and spring. Remove snap rings. Using plastic hammer, carefully drive roller cage out of outer race.

Inspection

Inspect all parts for wear, scoring, or other damage and replace parts as necessary.

Reassembly

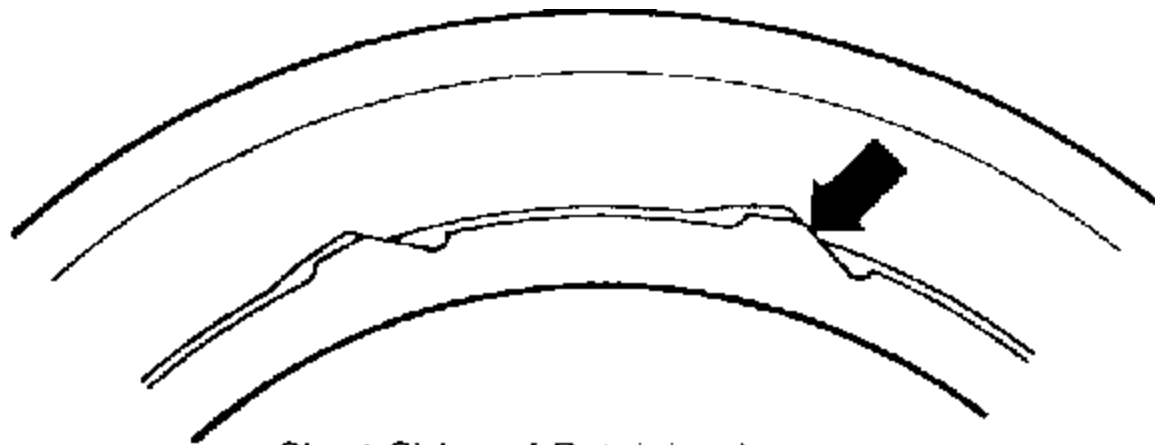
1) Install lower snap ring in groove of outer race. Heat outer race to 300-375°F (150-190°C). Place roller cage into race using 2 pair of pliers.

CAUTION: Heat from outer race will transfer quickly to roller cage, causing cage to stick inside race. If cage is not correctly positioned against lower snap ring and inside race, DO NOT attempt to press it into position after cage has stuck.

Carefully knock cage out of outer race and repeat procedure again after race has cooled down.

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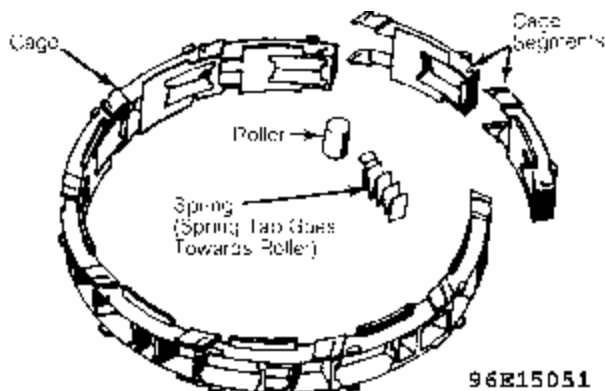
2) Ensure short sides of retaining lugs on cage are positioned correctly against shoulders in outer ring. See Fig. 13. If necessary, turn cage slightly, immediately after installation. Install upper snap ring, rollers, and springs.



Short Sides of Retaining Lugs on
Cage Must Seat Firmly Against
Shoulders in Outer Ring (Arrow)

96D15050

Fig. 13: Installing Cage Into Outer Race
Courtesy of Volkswagen United States, Inc.



96E15051

Fig. 14: Exploded View of One-Way Clutch
Courtesy of Volkswagen United States, Inc.

REVERSE PLANETARY RING GEAR

NOTE: Disassemble reverse planetary ring gear only if replacing component part.

Disassembly & Inspection

Remove snap ring and lift ring gear hub from ring gear.

Inspect parking lock notches on ring gear for wear. Replace if worn.

Reassembly

To reassemble reverse planetary ring gear, reverse disassembly procedure.

VALVE BODY ASSEMBLY

CAUTION: DO NOT interchange valves or valve springs. Several valve springs have identical dimensions but different tolerances.

Individual valve body components are not available. Valve bodies are serviced only as exchange units.

Disassembly

1) Remove screws attaching transfer plate to main valve body. Lift transfer plate and separator plate from main valve body. Remove main valve body check balls from passages in valve body. See Fig. 15.

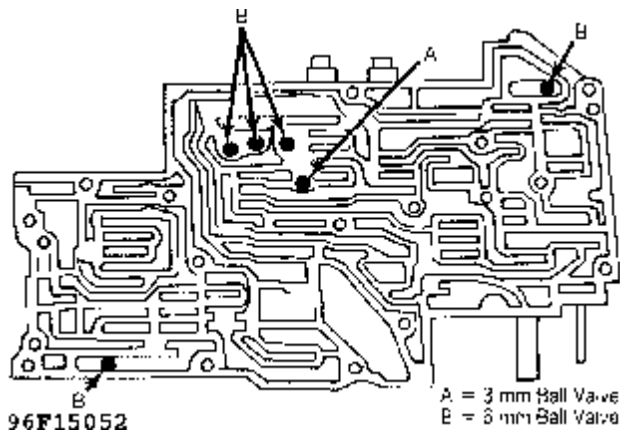


Fig. 15: Main Valve Body Check Ball Locations
Courtesy of Volkswagen United States, Inc.

CAUTION: DO NOT alter settings of adjusting screws. Adjusting screws change pressures and must be adjusted on a test stand. See Fig. 17.

2) Remove rear end cover plate and withdraw valves, springs, and adjusting screws. Remove remaining end plates one at time and withdraw all valves, plugs, springs and adjusting screws. Tag all parts for reassembly reference or use Holding Tray (2008) to hold parts. This tray holds springs and valves in correct order and location.

Cleaning & Inspection

1) Wash all parts in clean solvent and dry them with compressed air. DO NOT use rags or water. Lint from rags may limit ATF flow after reassembly. Check all parts for burrs and scores. Replace assembly if damaged.

NOTE: Valves which are slightly scored may be reused if they slide into the valve body under their own weight after cleaning and lubrication with fresh ATF. Minimal scoring will not affect transmission operation.

2) Check all valve body springs for damage or collapsed coils. Some transfer plates are equipped with 3 sealing balls. See Fig. 16. If transmission will not shift into 3rd gear, trouble may be caused by missing sealing ball.

3) To install new sealing balls, place 3 mm diameter sealing ball on 8 mm diameter punch with small amount of grease and drive ball flush into hole of transfer plate.

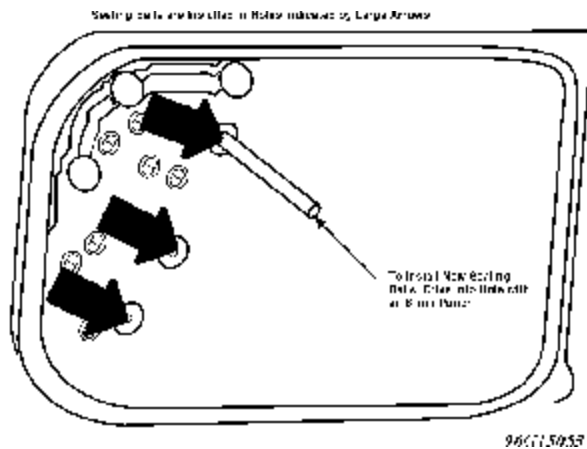


Fig. 16: Sealing Balls in Valve Body Transfer Plate
 Courtesy of Volkswagen United States, Inc.

Reassembly

- 1) Lubricate all parts with ATF and install into correct valve body bores in reverse order of disassembly. DO NOT overtighten plate attaching screws. Overtightening can strip threads or distort valve body enough to cause valve to stick.
- 2) Ensure all check balls are installed in correct valve body passages. Check ball "A" is .118" (3 mm) in diameter. All other check balls are .236" (6 mm) in diameter. See Fig. 15. Install screws attaching transfer plate to main valve body, and tighten from center outward. DO NOT overtighten.

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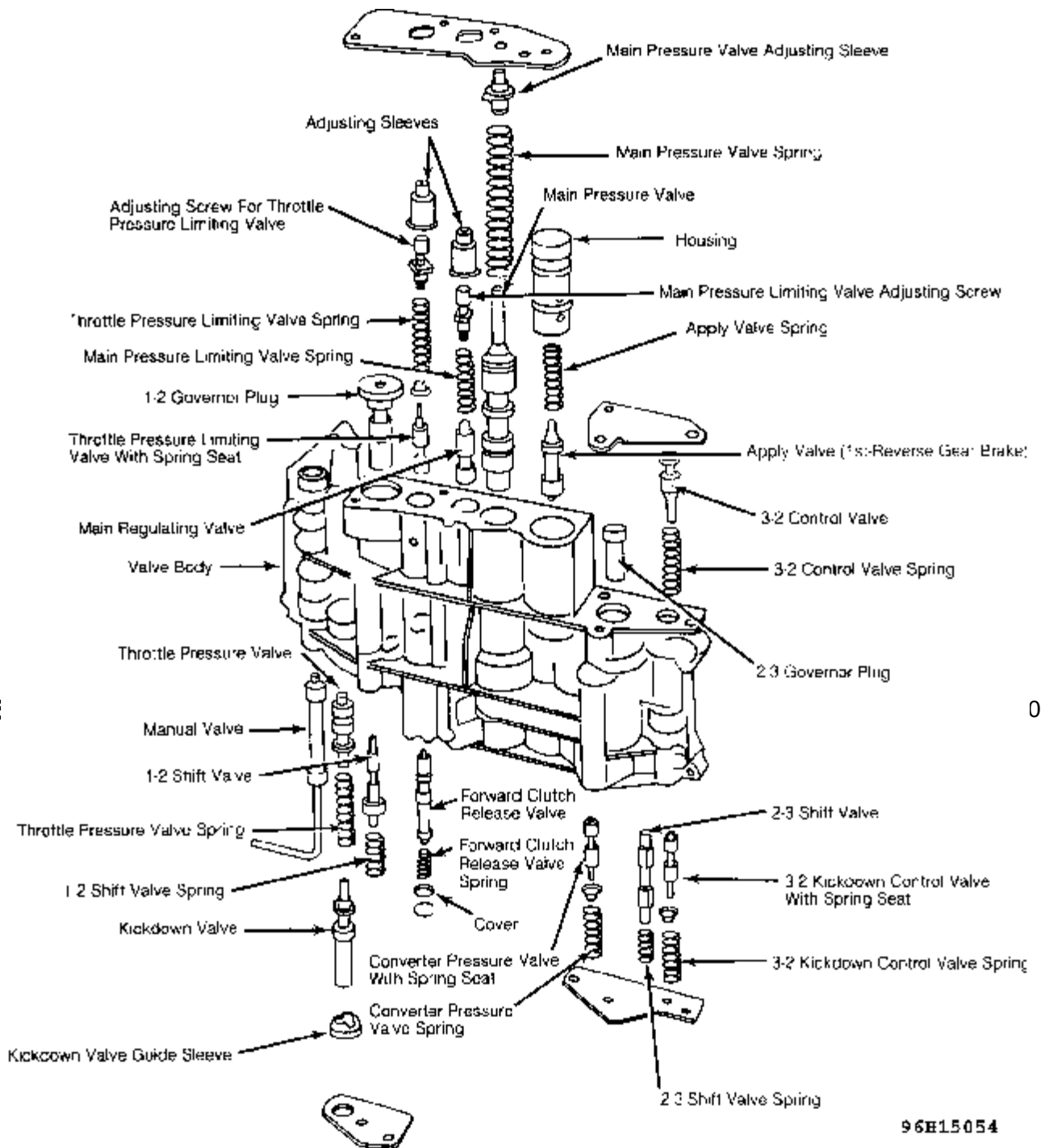


Fig. 17: Exploded View of Typical Valve Body

BAND SERVO

Disassembly

Pull servo piston assembly from cover. Remove "O" ring seals from outer diameter of cover. Remove retaining "E" clip and separate piston pin, accumulator spring, spring seat and adjusting shim from servo piston. Remove 2 seals from servo piston.

Inspection

96H15054

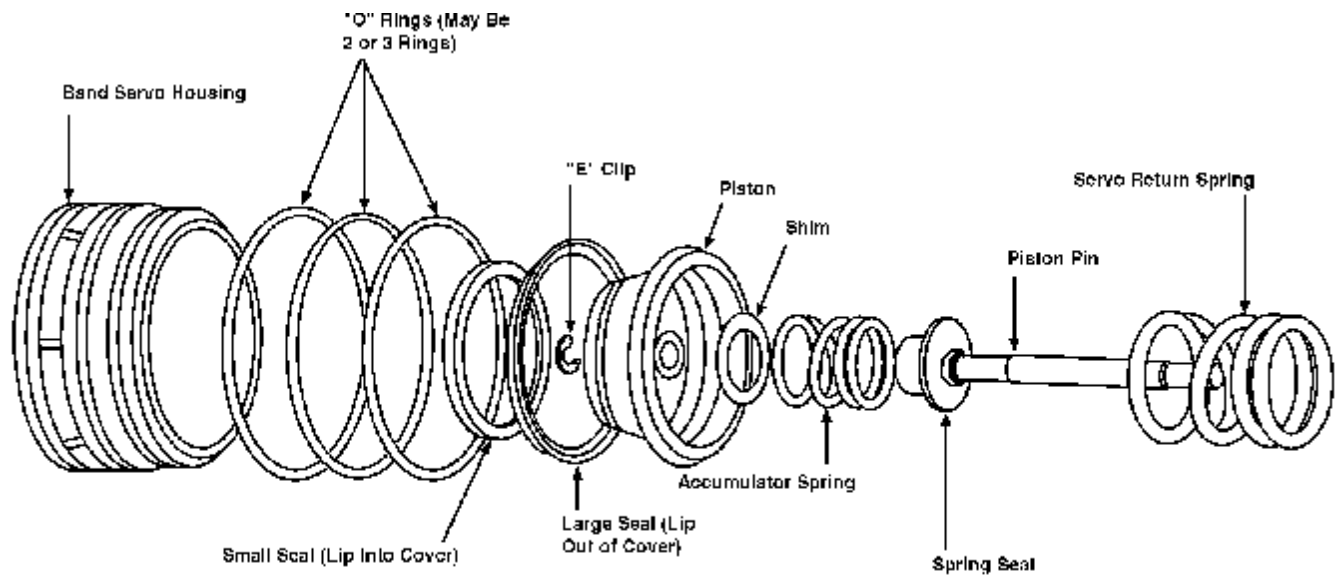
Clean all parts and check for wear, scoring, or other damage.
All parts in assembly must be replaced if piston is damaged.

Reassembly

1) Position spring seat, accumulator spring and shim on piston pin. Install assembly into servo piston and install retaining "E" clip onto pin.

2) Install lip seals onto piston with smaller (upper) seal with lip facing upward into servo cover. Larger seal is positioned with lip facing downward, out of servo cover.

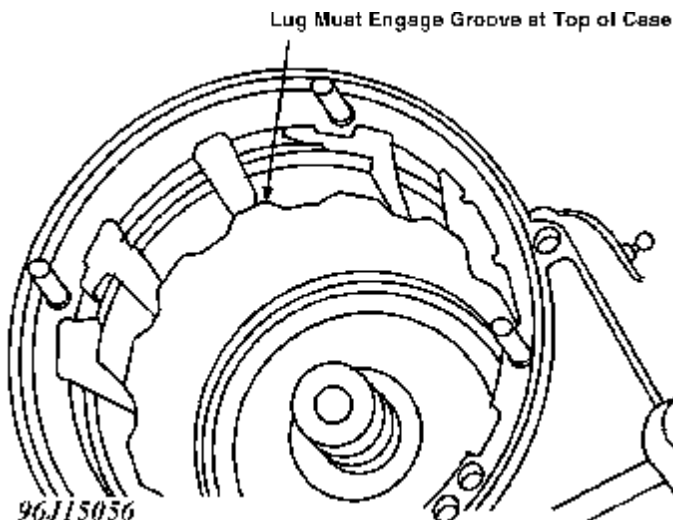
3) Lubricate assembly thoroughly and install piston into cover. Install "O" rings on outer diameter of servo cover.



96J15055

Fig. 18: Exploded View of Band Servo Assembly

Courtesy of Volkswagen United States, Inc.



96J15056

Fig. 19: Installing Brake Shell in Transmission Case

Courtesy of Volkswagen United States, Inc.

TRANSAXLE REASSEMBLY

TRANSMISSION

- 1) Lubricate 1st-reverse brake piston with ATF. Install brake piston on oil pump. Install oil pump and piston assembly in case. Position pump with thin rib on pump body toward top of case. Install thrust washer on pump face.
- 2) Install 1st-reverse brake shell into transmission case with lug engaged in groove at top of case. Install 1st-reverse brake piston return springs on spring plate. Insert assembly into case with springs downward. Install attaching bolts and tighten in diagonal pattern.
- 3) Lubricate 2nd gear brake servo cover "O" rings. Install servo cover in case and install retaining snap ring. Rotate transmission so servo cover faces down.
- 4) Position 2nd gear brake band in case and ensure it engages servo piston pin. Loosely install push rod for adjusting screw. Install adjusting screw and lock nut. Place 2 thrust washers and thrust bearing in position on end of oil pump and hold in place with grease.
- 5) Install forward clutch into direct-reverse clutch, ensure splines on forward clutch drum fully engage splines in direct-reverse clutch lined plates. Turn transmission case with open end pointing downward. Lubricate and install direct-reverse and forward clutch assemblies as a unit.
- 6) Slide clutch assembly unit onto oil pump neck and into 2nd gear brake band. Tighten 2nd gear brake band adjusting screw enough to prevent band from shifting its position on direct-reverse clutch drum. Rotate transmission case so open end is up.
- 7) Install forward planetary-to-forward clutch needle bearing into forward clutch. Needle bearing is installed with smaller inside diameter toward forward planetary gear.
- 8) Install forward planetary gear set into forward planetary ring gear in forward clutch. Install sun gear (short end first) into gear set. Install driving shell and thrust washer over sun gear. Install thrust washers on underside of reverse planetary gear set and hold in place with grease.
- 9) Install gear set into case and onto sun gear. Install 1st-reverse brake waved washer into case. Install 1st-reverse brake plates into case, starting with steel (externally splined) brake plate. Alternate lined and steel plates until all are installed. See 1ST-REVERSE BRAKE PLATE chart.

NOTE: Soak lined clutch plates in ATF for 15 minutes before installing.

1ST-REVERSE BRAKE PLATE

Application	Steel		Lined	
	Plates		Plates	

087 Series 5 5

10) Install 1st gear one-way clutch assembly into transmission case. Insert retaining key between case and one-way clutch. 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 locking of one-way clutch.

11) Install one-way clutch-to-case snap ring. Snap ring opening must be opposite retaining key. If all parts are correctly installed, one-way clutch snap ring groove will be exposed. DO NOT force snap ring into groove of incorrectly assembled unit.

12) Position thrust washer and needle bearing on rear side of reverse planetary gear set. Larger inside diameter collar faces toward reverse planetary gear set. Install reverse planetary ring gear into case. It must fully engage reverse planetary gear set.

13) Install new separation plate gasket over case studs and place separation plate over gasket. Install and tighten retaining screws.

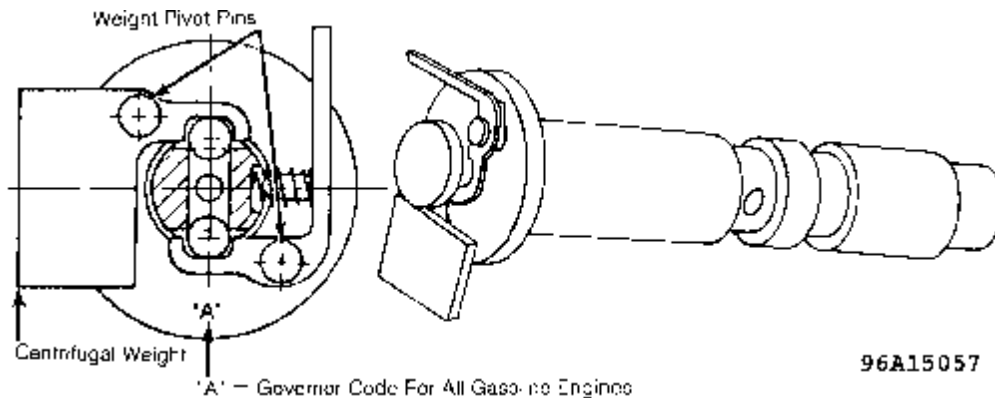


Fig. 20: Installing Governor Assembly
Courtesy of Volkswagen United States, Inc.

NOTE: Second gear brake band must be adjusted at this time. Transmission case must be horizontal during adjustment to prevent band from jamming.

14) Tighten brake band adjusting screw to 87 INCH lbs. (10 N.m). Loosen screw. Retighten to 43 INCH lbs. (5 N.m). Back off adjusting screw exactly 2 1/2 turns on 089 models and on 087 models in Audi 5000 Series vehicles. Back off adjusting screw exactly 2 turns on all other 087 models. Tighten adjusting screw lock nut.

15) If case linkage was disassembled, reinstall in case. Install accumulator piston with seal lip pointing toward case. Install accumulator piston spring in piston.

16) Install valve body assembly into case, ensure manual valve engages manual lever and kickdown valve engages kickdown lever. Install bolts attaching valve body to case. Tighten from center outward.

17) Position new pan gasket on transmission case. Install oil pan and tighten oil pan bolts.

NOTE: See FINAL ASSEMBLY OF TRANSAXLE for installation of turbine and pump shafts and for measurement of end play between transmission and final drive.

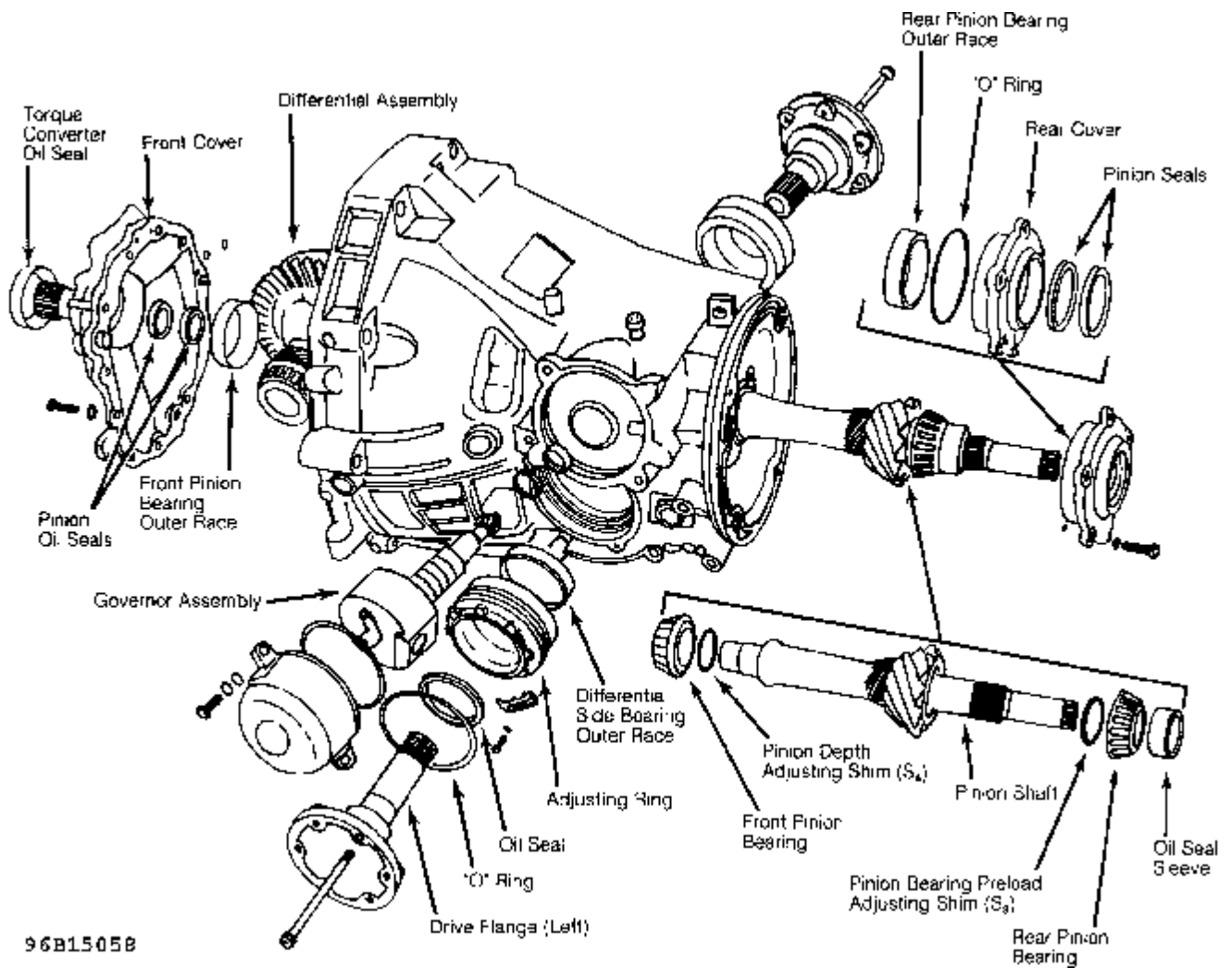


Fig. 21: Exploded View of Final Drive Assembly
Courtesy of Volkswagen United States, Inc.

DIFFERENTIAL

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

NOTE: If either pinion shaft or ring gear requires replacement, replace both pieces.

2) Position differential side gears, large thrust washers, dished thrust washers and pinion gear into differential case. Align pinion gear holes with holes in case. Drive pinion shaft through pinion gear into case.

3) Place differential cover on differential case. Install 2 centering pins in opposite ring gear attaching bolt holes. Heat ring gear to approximately 212°F (100°C). Position on housing. Remove centering pins and tighten attaching bolts.

4) Heat side bearings in hot oil and press them onto differential case and cover. Press side bearing outer races into position in side bearing adjusting rings.

Pinion Depth & Bearing Preload

1) Heat pinion shaft bearings to about 212°F (100°C) in oil bath. Press rear (larger) bearing onto shaft, without shims, until seated at back of gear. Press front (smaller) bearing onto pinion shaft with .043" (1.1 mm) test shim installed behind bearing.

CAUTION: If pinion shaft is installed into housing without this test shim installed, it will contact housing and cause incorrect reading.

2) Install final drive housing front cover (without oil seals) and tighten attaching bolts. Position pinion shaft in place in housing. Install rear cover (without oil seals) and tighten attaching bolts.

3) Install Magnetic Plate (VW 385/17) onto rear end of pinion shaft. Attach dial indicator to final drive housing so indicator tip is touching magnetic plate on pinion shaft. Zero indicator. Move pinion shaft up and down (without turning) and note indicator setting.

CAUTION: If pinion shaft is turned during measurement, readings will be incorrect.

4) Add end play measured on dial indicator, plus .001" (.25 mm) for bearing wear, plus .006" (.15 mm) for bearing preload, plus .043" (1.1 mm) for thickness of test shim. Total is thickness of shims required to obtain correct pinion depth and bearing preload. Record total shim pack thickness.

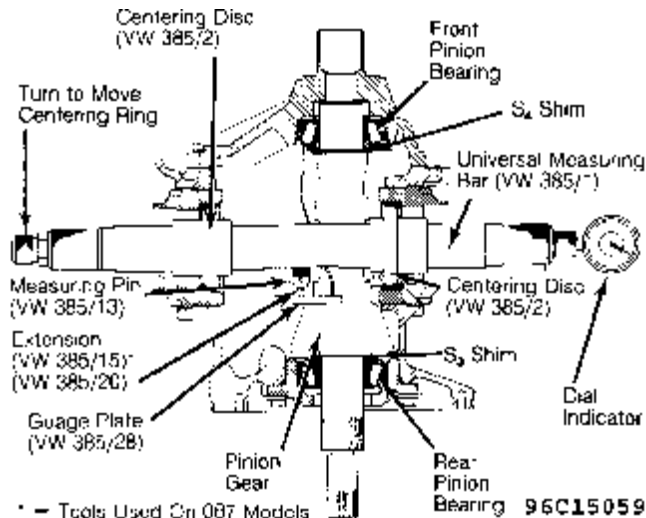


Fig. 22: Installing Measuring Tools for 089 Model Pinion Depth
Tool numbers in parentheses are for 087 models. Courtesy of
Volkswagen United States, Inc.

5) Remove rear cover and pinion shaft from housing. Press front pinion bearing from shaft, remove test shim, and install shims equal to total thickness determined in step 4). Heat and press bearing back onto pinion shaft.

6) Reinstall pinion shaft in housing. Reinstall rear cover and tighten bolts. Turn pinion in both directions several times. Install Gauge Plate (VW 385/28) on pinion shaft. See Fig. 22. Adjust the clamp ring on Universal Measuring Bar (VW 385/1) until distance "A" is 3.23" (82 mm) for 087 models or 2.28" (58 mm) for 089 models. See Fig. 23.

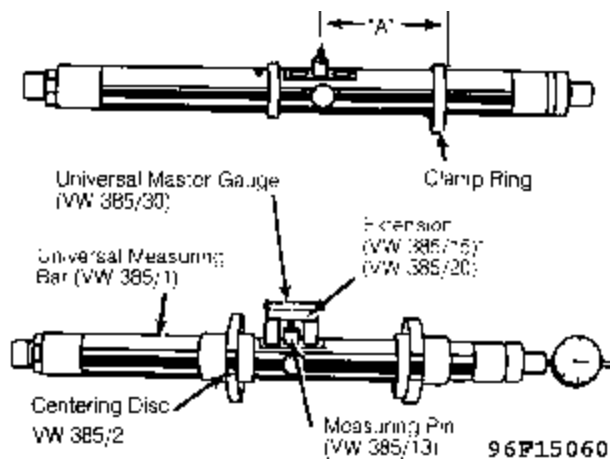


Fig. 23: Measuring Tools for Pinion Depth Shim Selection
Courtesy of Volkswagen United States, Inc.

7) Assemble dial indicator, Centering Discs (VW 385/2), Measuring Pin (VW 385/13), Extension (VW 385/15 for 087 models; VW 385/20 for 089 models) and Master (Setting) Gauge to Measuring Bar (VW 385/1). Master gauge usage varies with model and is needed to adjust measuring bar. Universal Master Gauge (VW 385/30) will work for all models.

8) Universal master gauge sets measuring bar to "R0", which is length of master gauge used in factory testing machine to measure deviation "R". Deviation "R" is found on side of ring gear and is always given in .01 mm. See Fig. 24. Different models have different "R0" values.

9) All 087 models have "R0" of 46.60 mm. All 089 models have "R0" of 40.55 mm. Individual master gauges are available. All 087 models use Master Gauge (VW 385/26). All 089 models use Master Gauge (VW 385/5). With bar assembled and master gauge in place, set dial indicator with .118" (3.0 mm) preload on all models. See Fig. 23.

10) Lightly lubricate left adjusting ring threads with multipurpose grease. Screw left adjusting ring (with side bearing outer race installed) into final drive housing until outer surface of adjusting ring is flush with surface of housing.

11) Insert measuring bar assembly into housing. Lubricate right adjusting ring threads. Install adjusting ring in final drive housing flush with housing. Turn knob on end of measuring bar to move centering disc outward, until bar can barely be turned by hand.

12) Rotate measuring bar until pin extension rests squarely against gauge plate. Slowly rotate bar until pinion is centered.
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gauge plate. Read and record maximum dial indicator deflection, calling this value "E".

13) Subtract deviation "R" (stamped on ring gear in .01 mm; See Fig. 24) from value "E" (recorded in step 12)). The result gives thickness of S3 shim, which goes under rear (large) drive pinion bearing. To determine thickness of S4 shim, which goes under front (small) drive pinion bearing, subtract S3 thickness from total shim thickness (as determined in step 4)).

14) Shims for S3 and S4 are available in thicknesses from 1.100-1.900 mm in increments of .025 mm. Measure selected shims at several points, and check for burrs or other damage. Install selected shims and bearings on drive pinion shaft. Install drive pinion in housing and lubricate bearings with hypoid oil.

15) Reinstall universal measuring bar and ensure indicator reading agrees with deviation "R", $\pm .04$ mm. Remove measuring bar.

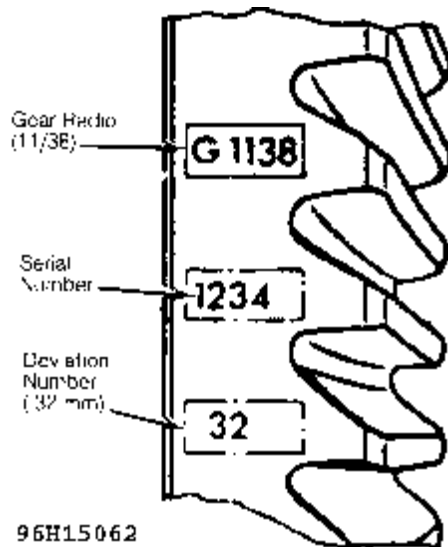


Fig. 24: Numbers on Side of Ring Gear

Deviation number is referred to as "R" in text. Courtesy of Volkswagen United States, Inc.

Pinion Shaft Turning Torque

After installing correct pinion adjusting shims, check turning torque of pinion shaft. Turning torque for all models should be 22-49 INCH lbs. (2.5-5.5 N.m). If turning torque is incorrect, recheck shim thickness. See Fig. 25.

NOTE: Turning torque value is for new bearings only. If used bearings are reinstalled, turning torque should be same as that measured before disassembly.

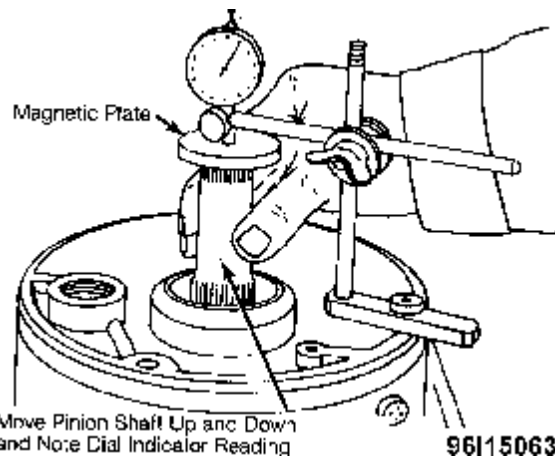


Fig. 25: Measuring Pinion Shaft End Play

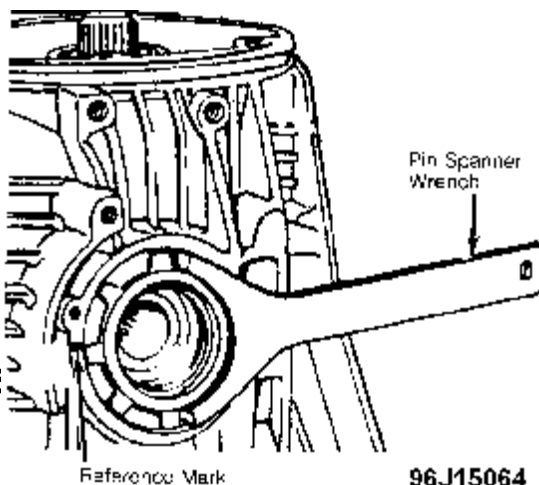
Side Bearing Preload & Ring Gear Backlash

1) After adjusting pinion shaft depth and bearing preload, remove front and rear covers from final drive housing. Withdraw pinion shaft. Install differential assembly and pinion shaft into final drive housing.

2) Install new oil seals into front and rear covers. Install new "O" ring on rear cover. Lubricate "O" ring and pinion shaft bearings. Apply sealer to bolt flange of front cover. Install front and rear covers and tighten attaching bolts.

3) Install new "O" rings on differential side bearing adjusting rings. Lightly coat "O" rings and threads on adjusting rings with multipurpose grease. Lubricate bearings with hypoid gear oil. Install each adjusting ring into housing until surfaces between gear teeth divisions are flush with housing surface.

4) Slowly turn in right adjusting ring until ring gear meshes fully with pinion gear, without backlash. Screw in left adjusting ring (opposite ring gear) as far as possible. Preload left ring slightly to take play out of differential side bearings. See Fig. 26.



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Fig. 26: Adjusting Side Bearing Preload
Courtesy of Volkswagen United States, Inc.

5) Loosen right adjusting ring 1/2 tooth. Turn left adjusting ring 2 tooth divisions in. This should correctly set side bearing preload and ring gear backlash.

6) To check ring gear backlash, turn pinion shaft several times in both directions to settle bearings. Using Holding Fixture (VW 386a), clamp pinion shaft so that it cannot turn.

7) Insert Clamping Sleeve (VW 521/4) with Slotted Sleeve (VW 521/7 on 089 models; 521/8 on 087 models) into differential through adjusting ring and secure with nut. Adjust length of Backlash Measuring Bar (VW 388) to 2.44" (62 mm) on 089 models or to 2.68" (68 mm) on 087 models.

NOTE: See Fig. 27 and 28 for assembly and positioning of ring gear backlash measuring tools.

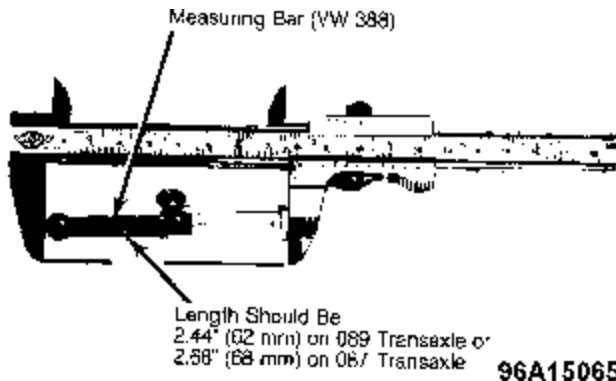


Fig. 27: Adjusting Ring Gear Backlash Measuring Bar
Courtesy of Volkswagen United States, Inc.

8) Attach Measuring Bar (VW 388) to Clamping Sleeve (VW 521/4). Install dial indicator with Square End Extension (VW 382/10) in Holder (VW 387) and attach holder to final drive housing.

NOTE: Dial indicator tip must be located at right angle to backlash measuring lever.

9) Turn ring gear to take up backlash. Zero dial indicator and clamp in holder. Turn ring gear in opposite direction until it touches pinion gear again and note indicator reading. This reading is ring gear backlash.

10) Check ring gear backlash at 4 locations (90 degrees apart) around circumference of ring gear. Add 4 measurements together. Divide total by 4. Resulting figure is average ring gear backlash. Average ring gear backlash should be .006-.010" (.15-.25 mm).

11) Backlash specifications apply to new ring and pinion set. If ring and pinion are being reused, backlash should be set to same value as found prior to disassembly.

CAUTION: Difference between individual backlash measurements must not exceed .002" (.05 mm). If measurements exceed this, correct installation.

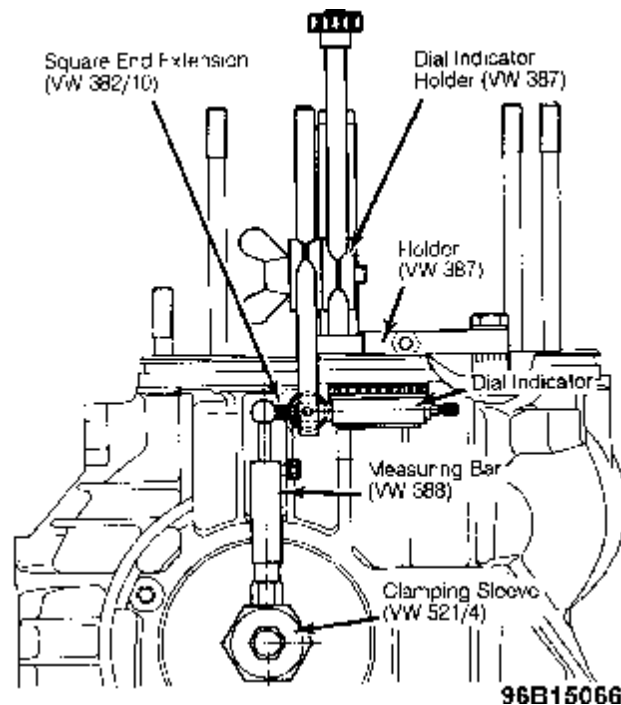


Fig. 28: Measuring Ring Gear Backlash
Courtesy of Volkswagen United States, Inc.

12) If backlash is not within specification, correct by turning both side bearing adjusting rings by equal amounts in opposite directions. Adjusting rings must be moved in equal amounts to maintain bearing preload.

NOTE: If new differential side bearings and pinion bearings have been installed, recheck pinion shaft turning torque. With differential installed, pinion shaft turning torque should be approximately 3.5-4.4 INCH lbs. (.4-.5 N.m) greater than it was when only pinion shaft was installed.

13) Install side bearing adjusting ring lock plate. Recheck total bearing preload to ensure no alterations were made during backlash adjustment.

Final Assembly of Transaxle

1) To measure end play between final drive housing and transmission, place straightedge on transmission attaching face of final drive housing. Using depth gauge, measure distance from top surface of straightedge down to edge of pinion shaft oil seal sleeve.

2) Measure distance from top surface of straightedge to face of final drive housing. Subtract straightedge-to-face distance from straightedge-to-oil seal sleeve distance. Result is measurement "A". See Fig. 29. Note result for future reference.

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straightedge on transmission case. Measure distance from top surface of straightedge down to gasket surface.

4) Measure distance from top surface of straightedge down to shim surface on shoulder of reverse planetary gear set ring gear. Subtract straightedge-to-shoulder measurement from straightedge-to-gasket measurement. Result is measurement "B". See Fig. 29. Note and

record measurement "B".

5) Subtract measurement "B" (obtained in step 4)) from measurement "A" (obtained in step 2)). Result is end play (without shims) between final drive and transmission.

6) Use END PLAY SHIM SELECTION table to select end play shim(s) to use. Use minimum number of shims possible.

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)

7) Transmission-to-final drive end play adjusting shims are available in 2 thicknesses: .016" (.4 mm) and .047" (1.2 mm). Combine shim thicknesses to obtain total thickness required. Install selected end play adjusting shim(s) on top of pinion shaft oil seal sleeve in final drive case.

8) Install "O" ring into groove around final drive housing. Install turbine shaft and pump shaft fully into pinion shaft of final drive. End of turbine shaft with piston rings must be toward transmission with rings inside pinion shaft.

9) Turbine shaft used in 087 models is 16.71" (424.5 mm) with 20.2" (513 mm) pump shaft. Turbine shaft used in 089 models is 15.82" (401.7 mm) with 19.32" (490.6 mm) pump shaft.

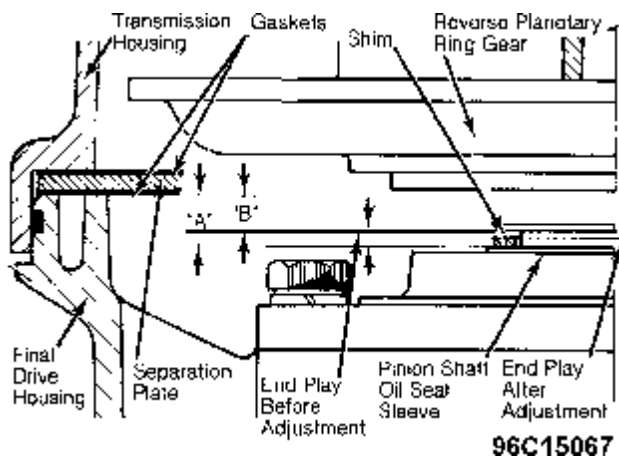


Fig. 29: Measuring End Play Between Transmission & Final Drive
Transmission-to-final drive end play limits end play of reverse planetary ring gear.

10) Join final drive case to transmission case. Install, and tighten, nuts attaching final drive to transmission case. Install

governor needle bearing into final drive case until it bottoms, using Driver (VW 545). Using driver and Collar (VW 545/2), install governor oil seal with lip facing toward governor. Place new "O" rings onto governor cover and speedometer driven gear assembly.

11) Install governor, cover, and speedometer driven gear into case. Install transaxle oil cooler. Ensure pump shaft is fully inserted into pump splines before installing converter. Install torque converter onto stator support to complete assembly. Ensure torque converter engages splines on pump shaft.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs.
Flange-To-Differential	18 (25)
Front or Rear Cover-To-Housing	18 (25)
Kickdown Lever Nut	11 (15)
Manual Valve Lever Nut	14 (19)
Rear Mount-To-Case	40 (54)
Ring Gear-To-Differential Case	
944 Models	58-69 (78-93)
All Other Models	52 (70)
Torque Converter-To-Drive Plate	22 (30)
Transmission-To-Engine	40 (54)
Transmission-To-Final Drive	22 (30)

END OF ARTICLE