

BMW SPLIT HOUSING

633CSi

DESCRIPTION

Final drive assembly has hypoid type ring and pinion gear set. Assembly may have one of two clutch pack type limited slip units (ZF DL-275). Left side of housing is the housing cover and must be removed to expose carrier assembly.

Cover incorporates a ball bearing and oil seal for left axle flange, and a bearing cone for the left differential carrier bearing. Right carrier bearing and seal are incorporated in housing. The pinion gear is supported by roller bearings and preload is maintained by a collapsible spacer and shim.

AXLE RATIO & IDENTIFICATION

Ring and pinion gear set with Klingelberg tooth design can be identified by the letter "K" stamped on the head of the pinion gear; Gleason teeth are noted by an "H" stamping.

To determine axle ratio, divide number of ring gear teeth by number of pinion gear teeth. The number of teeth on ring and pinion, and the code for limited slip differential (S), is stamped below oil filler plug.

REMOVAL & INSTALLATION

DRIVE SHAFT

Removal & Installation

Remove drive shaft from final drive and axle shaft drive flange by removing flange bolts. To install,

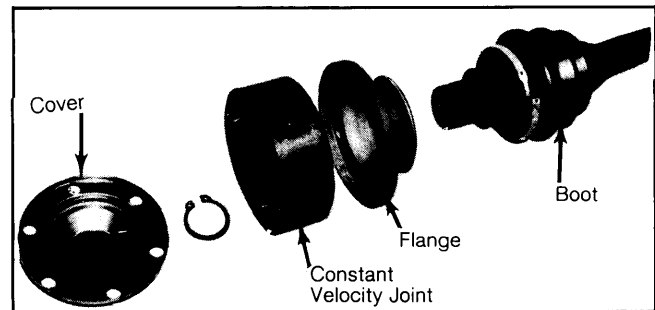
reverse removal procedure using sealer on boot-to-joint surfaces. Install cover after packing joint with lubricant.

CONSTANT VELOCITY JOINT

Removal

Remove cover from joint housing. Remove snap ring from end of drive shaft. Remove clamps from boot. Press drive shaft from joint. Remove dust boot.

Fig. 2: Exploded View of Constant Velocity Joint



Pack joint with lubricant before installing cover.

Installation

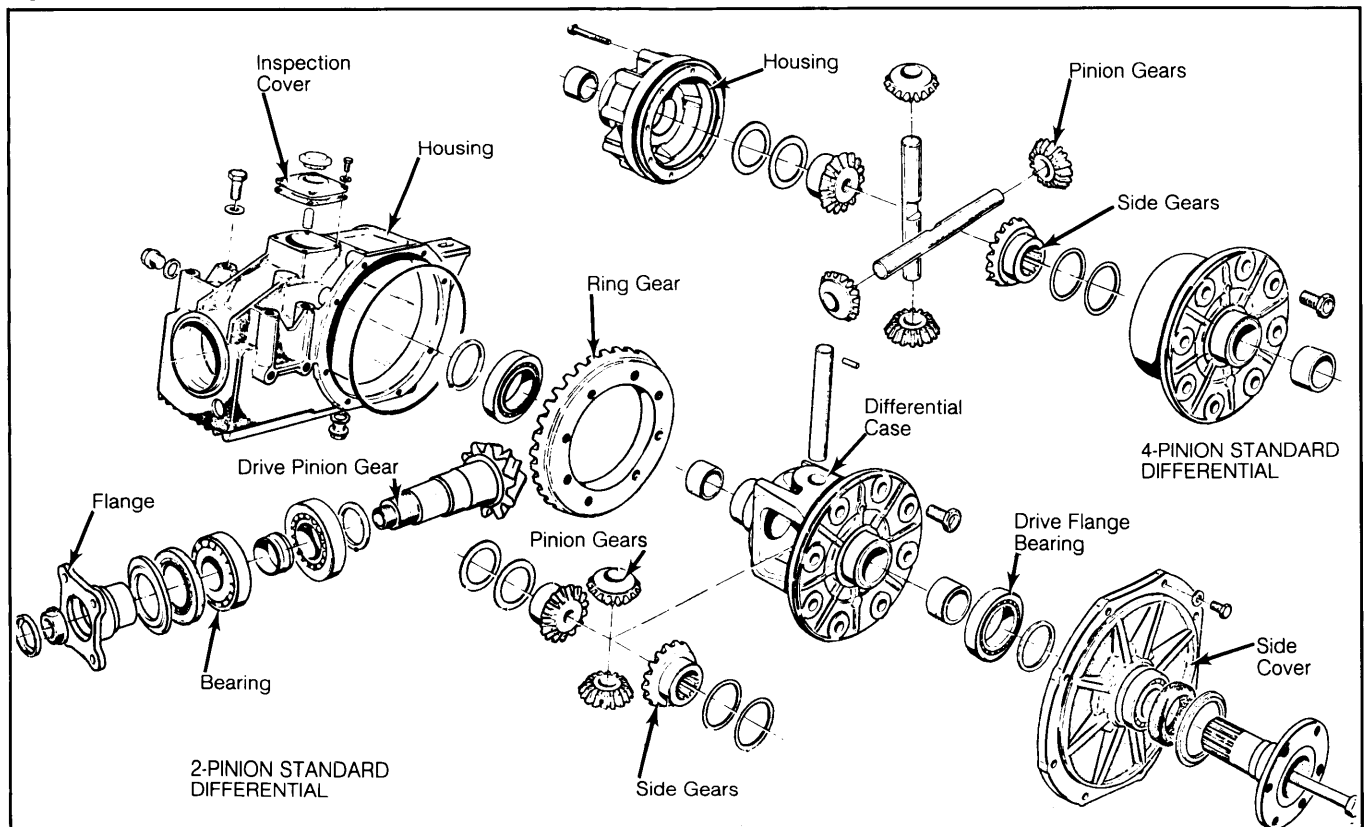
To install, reverse removal procedure. Coat splines of drive shaft with Loctite prior to installation.

AXLE SHAFTS & BEARINGS

Removal

1) Raise and support vehicle. Remove wheel, brake drum, and drive shaft. Remove lock washer. Remove lock nut securing axle flange to axle shaft. Using a puller, remove axle flange.

Fig. 1: Exploded View of BMW Split Housing Differential



Drive Axles

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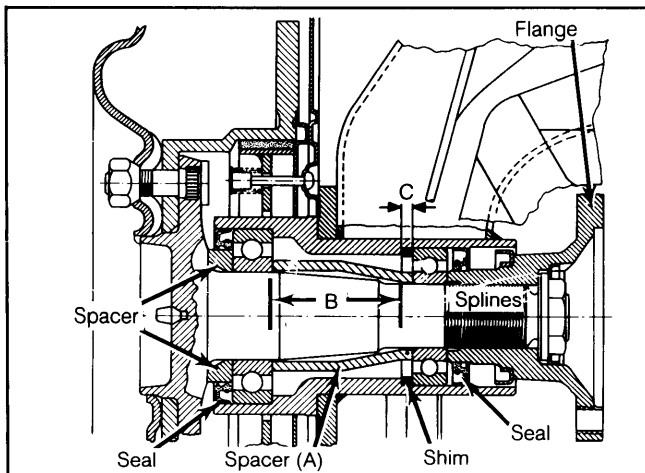
2) Install lock nut on axle shaft and drive axle shaft out of housing with a soft-headed mallet. Drive out bearings and seals, then remove spacer sleeve and shim.

Installation

1) To install, reverse removal procedure noting the following: Install outer bearing then determine distance between outer race of outer bearing and shoulder in hub for inner bearing (dimension "B"). Subtract from spacer length (dimension "A") and use shim ("C") to obtain specified axle shaft end play. See Fig. 3.

2) Pack bearing with grease and lubricate sealing lips of seals. To complete installation, reverse removal procedure.

Fig. 3: Wheel Bearings and Axle Shaft



Spacer and shim determine axle shaft end play.

DRIVE PINION COMPANION FLANGE OIL SEAL

Removal

1) Remove final drive assembly and mount on holding fixture. Drain oil. Remove lock washer. Using a prick punch, mark installed position of companion flange. Using an INCH lb. torque wrench, measure and record pinion gear preload.

2) Hold flange stationary and remove lock nut. Pull off companion flange. Check bearing surface of flange. Replace flange if deeply scored. Pull out seal and discard.

Installation

1) Dip seal in oil. Drive seal into case until flush. Press companion flange onto pinion gear, aligning punch marks made during removal.

2) Loosely install lock nut. Using INCH lb. torque wrench, tighten lock nut. Tighten lock nut to preload value measured during removal PLUS 2 INCH lbs. (.23 N.m) for new seal.

3) If lock nut can not be tightened to specified torque value or if preload value (measured during removal) is exceeded, removal and installation of drive pinion and collapsible spacer is required. If preload value is obtained, install lock washer.

AXLE FLANGE & OIL SEAL

Removal

With final drive assembly mounted in holding fixture, pull off drive flanges. Remove snap ring. Pry out oil seal. Bearings may be removed from cover with puller if required. Replace any loose drive flanges.

Installation

Pack bearings and seal cavity with lubricant. Install bearings and drive seal into housing until it rests against stop. Insert new snap ring into recessed groove in case. Replace drive flange and ensure snap ring engages groove in flange.

DIFFERENTIAL ASSEMBLY

Differential assembly can be removed from housing with differential assembly installed in vehicle. After removing axle flanges, follow Differential Assembly, Disassembly and Overhaul procedures.

FINAL DRIVE UNIT

Removal

Remove propeller shaft and drive shafts, tie shafts up out of way. Support differential and remove mounting bolts. Remove differential assembly.

Installation

To install, reverse removal procedure, ensuring rear support is stress free when installed.

OVERHAUL

DISASSEMBLY

Differential Assembly

1) Remove differential assembly as previously described. Mount assembly in holding fixture. Drain oil and mark pinion shaft and companion flange for reassembly reference. Remove inspection hole cover.

2) Mount dial indicator in 1 cover bolt hole. Measure and record ring gear backlash. Using an INCH lb. torque wrench, measure and record preload of pinion gear and differential gears. Remove drive flanges and side cover.

3) Remove and inspect side cover "O" ring. Replace "O" ring if damaged. Remove differential assembly. Press out drive flange bearings. Note size and location of each shim for reassembly reference. Proceed as follows for standard or limited slip differential disassembly:

Standard 2-Pinion Differential

Pull off side bearings with puller. Remove and discard ring gear bolts. Remove ring gear. Drive out pinion shaft lock pin and differential shaft. Remove pinion gears, side gears, shims, and thrust washers.

Standard 4-Pinion Differential

Pull off side bearings with puller. Remove differential cover retaining bolts and remove cover. Lift out pinion gears and shafts. Remove side gears, shims and thrust washers. Remove and discard ring gear bolts. Remove ring gear.

Limited Slip Differential

Pull off side bearings with puller. Remove case cover bolts and remove cover. Invert case and allow plates, shims, and thrust washers to fall out. Tap case lightly, if required. Lift out clutch and gear assembly. Remove and discard ring gear bolts. Remove ring gear.

Drive Pinion Gear

1) Remove differential assembly as previously described. Remove lock washer. Using a prick punch, mark installed position of companion flange. Using an INCH lb. torque wrench, measure and record pinion gear preload. Perform tooth contact pattern check.

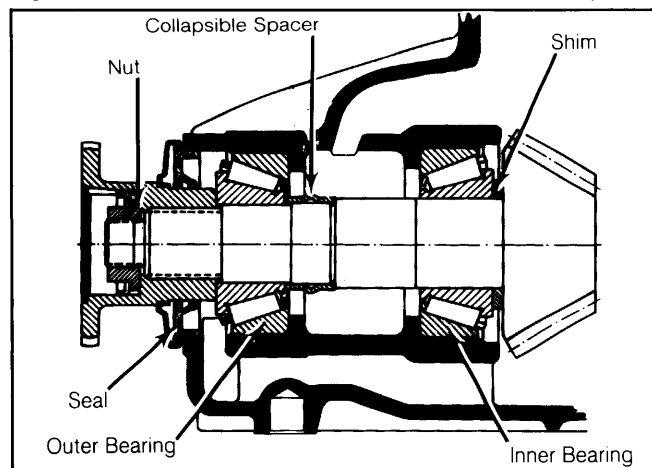
2) Hold flange stationary and remove lock nut. Pull off companion flange. Check bearing surface of

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flange. Replace flange if deeply scored. Pull out seal and discard. Press drive pinion from housing.

3) Remove collapsible spacer and front bearing. Remove front and rear bearing races with puller. Pull off drive pinion rear bearing and note thickness of shim under rear bearing.

Fig. 4: Sectional View of Drive Pinion Gear Assembly



Note position of collapsible spacer and shim.

REASSEMBLY & ADJUSTMENT

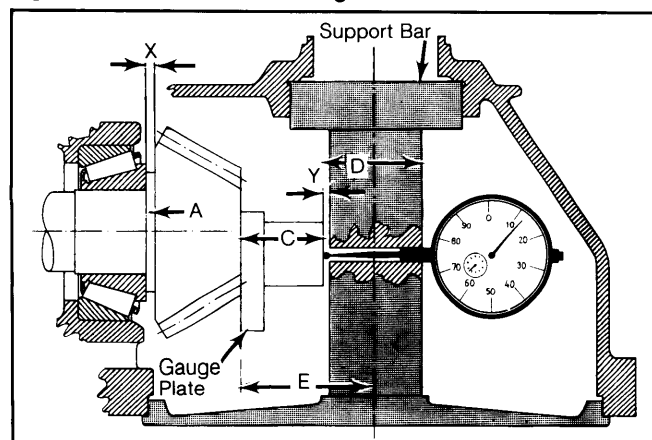
Drive Pinion Gear

1) Install front and rear bearing races in housing. Install original shim on pinion gear shaft with bevelled surface facing pinion gear. Press bearing onto shaft. Note any deviations ("+" or "-") stamped on drive pinion. This amount must be added (if "+") or subtracted (if "-") from measurement "E". See Fig. 5.

2) If original ring and pinion gear set is being installed, and gear tooth pattern and pinion bearing preload were satisfactory at time of disassembly, install drive pinion gear using original shim and new collapsible spacer.

3) If a new gear set is being installed, or gear tooth pattern and pinion bearing preload were not satisfactory at time of disassembly, it will be necessary to determine correct pinion depth shim thickness.

Fig. 5: Pinion Shim Measuring Points



These measurements are critical for correct differential operation.

Drive Pinion Bearing Preload

1) Install pinion gear in housing without collapsible spacer. Press in front bearing. Install companion flange without shaft seal. Tighten pinion shaft nut to obtain 18-20 INCH lbs. (2.0-2.3 N.m) of bearing preload.

2) Measure and record height of gauge plate ("C"). See Fig. 5. Mount dial indicator in support bar. Zero dial indicator on support bar with .157" (4 mm) preload. Measure diameter of support bar (if diameter is not stamped on bar in millimeters). Divide support bar measurement by 2 to obtain distance "D". See Fig. 5.

3) Place gauge plate on pinion gear in housing. Place support bar with dial indicator in housing. Measure distance between support bar and gauge plate with dial indicator (dimension "Y").

4) Basic setting adjustments are: Klingelberg teeth is 2.323" (59.00 mm) and Gleason teeth is 2.435" (61.85 mm). Using dimensions in Fig. 5, determine required shim thickness "X" by the following sample calculations:

SAMPLE PINION BEARING PRELOAD CALCULATIONS

Dimension	Measurement
"E" (Basic Setting)	1 2.323" (59.00 mm)
PLUS or MINUS Deviation	+ .006" (15.00 mm)
"E" Target	2.329" (59.15 mm)
"C" (Gauge Plate Height)	1.496" (38.00 mm)
"D" (Support Bar)	$\div 2 = + .787"$ (20.00 mm)
Total "C" + "D" Distance	2.283" (58.00 mm)
Dial Indicator Preload	.158" (4 mm)
Actual Dial Indicator Reading	-.123" (3.12 mm)
Actual "Y" Distance	.035" (.88 mm)
Total "C" + "D" (from above)	2.283" (58.00 mm)
Actual "Y" Distance (from above)	+ .035" (.88 mm)
"E" Actual	2.318" (58.88 mm)
"E" Target (from above)	2.329" (59.15 mm)
"E" Actual (from above)	- 2.318" (58.88 mm)
Difference =	.011" (.27 mm)
Installed Shim Thickness	.159" (4.05 mm)
Difference (from above)	- .011" (.27 mm)
Shim "X" Thickness	³ .148" (3.78 mm)

- Calculations for Klingelberg tooth gear set.
- If "E target" is larger than "E actual", difference is subtracted from original shim thickness. If "E target" is smaller than "E actual", difference is added to original shim thickness.
- Permissible shim tolerance is:
 ± .0012" (.03 mm) for Klingelberg.
 + .0016" (.04 mm) for Gleason.

5) Remove tools, companion flange and drive pinion gear. Remove rear bearing and shim. Install shim of calculated thickness, ensuring that bevelled inside diameter of shim faces drive pinion. Press on rear bearing.

6) Install collapsible spacer and drive pinion gear. Dip seal in gear oil and install seal and companion flange. Install lock nut and tighten to obtain specified drive pinion gear bearing preload. If preload is exceeded, new collapsible spacer must be installed and procedure must be repeated.

2-Pinion Differential Assembly

1) Heat ring gear to 80-100°F (176-212°C). Coat new ring gear bolts with Loctite and install. Tighten bolts to specification using a criss-cross pattern. Install side bearings.

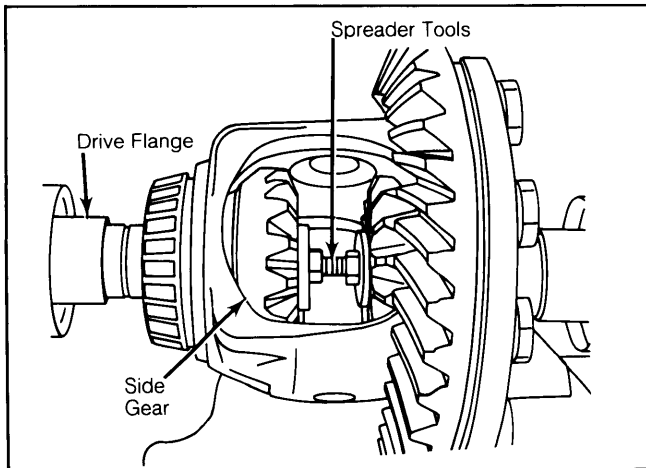
Drive Axles

BMW SPLIT HOUSING (Cont.)

2) Mount differential assembly in vise. Install both differential side gears with thrust washers and shims. Ensure concave side of thrust washer faces side gear. Using drive flanges, center side gears.

3) Install spreader tools. See Fig. 6. Spread side gears by tightening spindle until drive flanges can just be turned. Install pinion gears. Remove spreader tools. Install pinion shaft and lock pin.

Fig. 6: Spreading Differential Side Gears



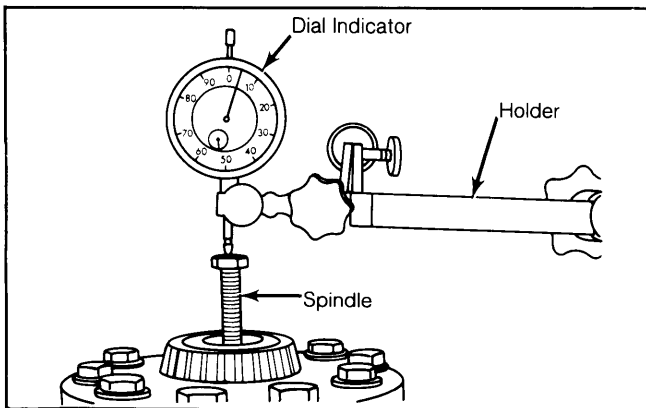
Spread gears until drive flanges can just be turned.

2-Pinion Side Gear Clearance

1) Install side gear gauge plate (between side gear and pinion shaft) and spindle. Tighten spindle to compress thrust washer. Mount dial indicator with tip resting on gauge plate spindle. Zero dial indicator with preload.

2) Loosen spindle until thrust washer is relaxed. Read and record dial indicator reading. Repeat procedure on opposite side gear. See Fig. 7.

Fig. 7: Measuring Side Gear Clearance on 2-Pinion Differential



Measure side gear clearance on both side gears.

3) Adjust specified side gear clearance by installing thicker or thinner shims. Shims are available in .002" (.05 mm) increments. Remove gauge plate and spindle, pinion shaft lock and pinion shaft, pinion gears and side gears. Install shims of calculated thickness and repeat procedure.

4-Pinion Differential Assembly

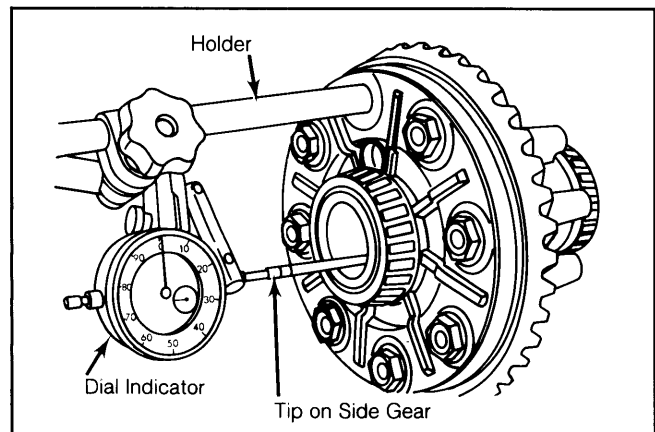
Heat ring gear to 80-100°F (176-212°C). Coat new ring bolts with Loctite and install. Tighten bolts to specification using a criss-cross pattern. Install side bearings.

4-Pinion Side Gear Clearance

1) Install 1 side gear and 1 pinion shaft with both pinion gears installed in differential case. Do not install thrust washer and shim. Install cover and retaining bolts. Tighten bolts.

2) Remove 1 ring gear bolt and install dial indicator holder. Mount dial indicator with tip resting on side gear. See Fig. 8. Using a screwdriver, press side gear firmly against pinion gears. Zero dial indicator.

Fig. 8: Measuring Side Gear Clearance on 4-Pinion Differential



Measure side gear clearance on both side gears.

3) Using screwdriver, press side gear to opposite side (toward differential case). Read and record dial indicator reading. Subtract specified side bearing clearance from dial indicator reading to determine required shim thickness.

4) Remove dial indicator and holder. Remove side gear and repeat procedure on opposite side gear. After determining shim thickness, assemble differential case with correct shims installed. Ensure thrust washers are installed with concave side facing side gear.

5) After assembly of differential case, install both drive flanges. Mount differential by clamping 1 drive flange in vise jaws. Using a torque wrench, check slipping torque of differential assembly. Slipping torque should be 11-18 ft. lbs. (15-24 N.m).

Limited Slip Differential Clutch Assembly

1) Install the following in case: pressure ring, side gears, pinion gears and shafts, and pressure ring. Measure installed height (distance "A") from case edge to pressure ring.

2) Measure distance ("B") from inner face of cover to bottom of well in cover. Measure flange surface (distance "C") from inner face of cover to flange surface. Subtract distance "C" from distance "B". Add sum to distance "A". Divide the total by 2 to obtain distance "D".

3) Subtract specified end play clearance of .004" (.10 mm) from distance "D". Place 1 diaphragm spring, 1 thrust washer and 1 stepped washer together and measure total thickness. Install thrust washers of calculated thickness to obtain specified measurement. Thrust washers are available in .002" (.05 mm) increments.

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4) Remove components from case. Install inner components as follows: spacer, outer plate, inner plate, and pressure ring. Install side gears, pinion gears and shafts, then install outer components. Do not install spacer. Measure distance from case flange surface to outer plate (distance "E").

5) Place both diaphragm springs together and measure combined thickness. Add this thickness to flange surface distance, distance "C" in step 2). Subtract this total from distance "E". The final result should be .004-.016" (.10-.40 mm). If not within these specifications, correct with outer plates of proper thickness.

6) Remove all parts from case. Install thrust washer with oil pockets facing inboard, diaphragm spring with concave side facing differential shaft, and stepped disc with smooth side facing case and tab in opening in case. Complete assembly and tighten to specification.

7) After assembly of differential case, install both drive flanges. Mount differential by clamping 1 drive flange in vise jaws. Using a torque wrench, check slipping torque of differential assembly.

8) Slipping torque should be 36-54 ft. lbs. (49-73 N.m). If not to specification, install thicker or thinner outer plates. Outer plates are available in thicknesses of .075" (1.9 mm), .079" (2.0 mm) or .083" (2.1 mm).

NOTE: Ring gear tooth contact pattern has priority over backlash and preload adjustments. After setting backlash and preload, perform tooth contact pattern and adjust shims accordingly.

Differential Bearing Preload

1) Install drive flange bearing shims equal to thickness of shims removed during disassembly. Ensure shims are installed in original locations. Install drive flange bearing races and bearings. Install differential assembly and side cover. Install and tighten side cover bolts.

2) Using an INCH lb. torque wrench on companion flange nut, check total preload of differential assembly. Compare preload reading with that measured during disassembly. Preload should not exceed specification.

3) If torque is less than specified, install thicker shim under bearing races. If torque is more than specified, install thinner shim. Install shims of proper thickness, if required.

4) After final adjustment or changing shim thickness, always verify adjustment with gear tooth contact pattern. Install new side cover "O" ring and install cover. Recheck preload.

Ring Gear-to-Drive Pinion Gear Backlash

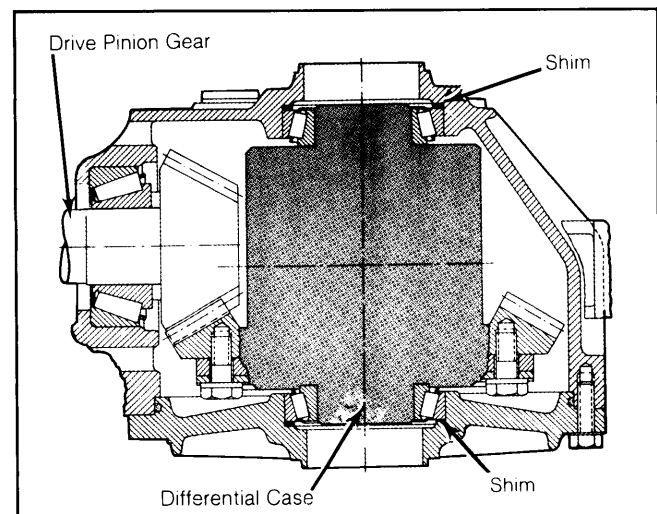
1) With differential bearing preload set, remove inspection hole cover. Mount dial indicator in 1 cover bolt hole. Check ring-to-pinion gear backlash. Check ring gear tooth contact pattern.

2) While maintaining established shim thickness, move drive flange bearing shims from one side to the other as necessary to obtain proper backlash specification. A change in shim thickness of .004" (.10 mm) will change backlash reading about .002" (.05 mm).

3) After final adjustment or changing shim positions, verify adjustment with gear tooth contact pattern. Never change total shim thickness.

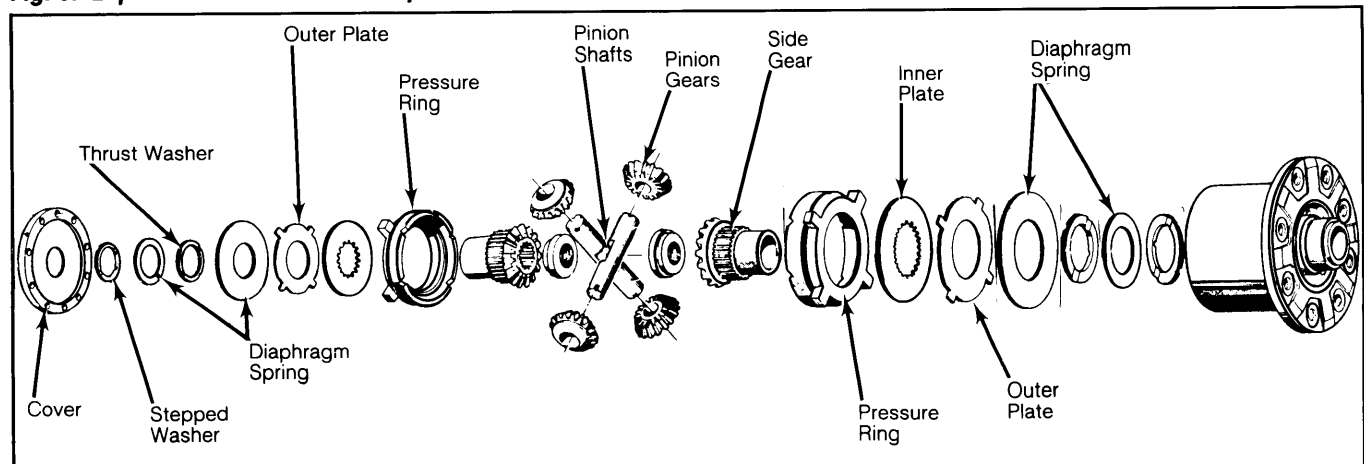
4) After final adjustment, install new inspection hole cover gasket. Install inspection hole cover with vent holes at right angles to ring gear. Fill differential with lubricant.

Fig. 10: Differential and Drive Pinion Preload Shim Locations



Do not change size of shims. Move shims from side to side.

Fig. 9: Exploded View of Limited Slip Differential



Drive Axles

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AXLE ASSEMBLY SPECIFICATIONS

Application	Specification
Axle Shaft End Play002-.004" (.05-.10 mm)
Differential Gear Slipping Torque (At Flange)	
Standard	11-18 Ft. Lbs. (15-24 N.m)
Limited Slip	36-54 Ft. Lbs. (49-73 N.m)
Ring Gear-to-Pinion Gear Backlash002-.004" (.05-.10 mm)
Drive Pinion Gear Bearing Preload	
Without Seal	13-28 INCH Lbs. (1.5-3.2 N.m)
With Oil Seal	15-29 INCH Lbs. (1.7-3.3 N.m)
Total Pinion Bearing & Differential Bearing Preload	
With Oil Seal	4-6 INCH Lbs. (.45-.68 N.m) ¹
Side Gear Clearance001-.004" (.03-.10 mm)
Limited Slip Clutch Assembly Case-to-Plate End Play004-.016" (.10-.40 mm)

¹ — Greater than drive pinion gear bearing preload.

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Side Cover Bolts	15-18 (20-24)
Ring Gear-to-Case Bolts	121-143 (164-194)
Companion Flange Nut (Min.)	111 (150)
Drive Shaft-to-Flange Bolts	44-49 (60-66)
Differential Case Cover Bolts	15-18 (20-24)
Axle Flange Nut	295-332 (400-450)
Final Drive-to-Rear Axle Carrier	53-58 (72-79)
Final Drive-to-Rubber Mount	53-58 (72-79)