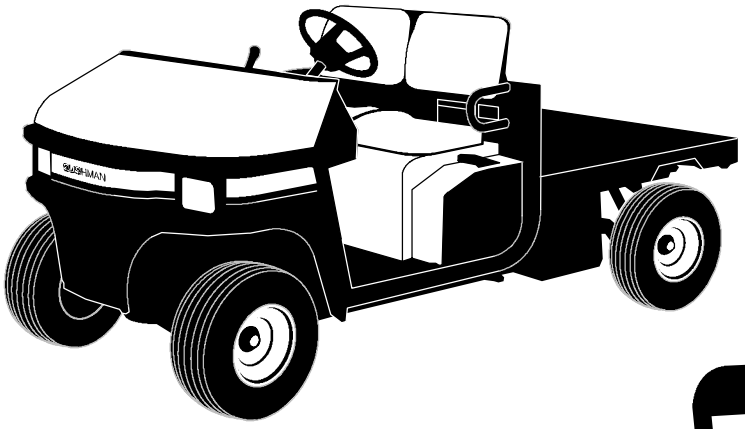
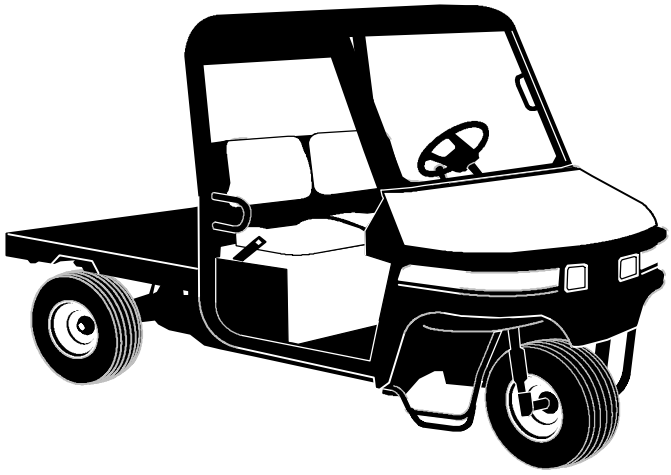
CUSHMAN
A Textron Company

36117G01

SERVICE & REPAIR
INSTRUCTION MANUAL





HAULSTERS®

VOLUME 1

Always Think Safety!

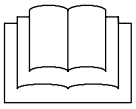
Thank you for purchasing a Cushman product. You are one of our many customers who have voted their confidence in our company by purchasing our products.

This is one of the best designed and built pieces of commercial industrial equipment available. Many safety features have been designed and built into this product. Please ***Do Not*** **remove or defeat any safety features,** as they were installed for your protection.

The useful life and good service you obtain from your vehicle depends to a large extent on the way it is **maintained and operated.**

Treat your equipment properly, lubricate and adjust it as instructed in this manual and it will give you many years of reliable service.

See your Cushman dealer for service and parts. Genuine Cushman parts are manufactured with the same precision and skill as the original parts.



IMPORTANT!

This manual will aid you in the safe operation and proper maintenance of your equipment. Read manual thoroughly before attempting operation. If any portion is not clearly understood, contact an authorized dealer for clarification.

GENERAL INFORMATION

This symbol is used throughout the manual to alert you to information about unsafe actions or situations, and will be followed by the word **DANGER, WARNING,** or **CAUTION. DANGER** indicates immediate hazards that may result in severe injury or death. **WARNING** indicates unsafe actions or situations that may cause severe injury, death and/or major equipment or property damage. **CAUTION** indicates unsafe actions or situations that may cause injury, and/or minor equipment or property damage.

NOTE: This symbol appears next to information or instructions which will help you operate and maintain your equipment the right way.

WARNING

- **The information and instructions included in this manual alert you to certain things you should do very carefully. If you do not, you could:**
  - **hurt yourself or others**
  - **hurt the next person who operates the equipment**
  - **damage the equipment.**

CUSHMAN

TEXTRON

SERVICE & REPAIR INSTRUCTIONS

HAULSTER®

WARNING: If incorrectly used this machine can cause severe injury. Those who use and maintain the machine should be trained in its proper use, warned of its dangers and should read the entire manual before attempting to set up, operate, adjust or service the machine.

SRI-HAULSTER

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SECTION 1
INTRODUCTION

SECTION 1A. GENERAL INFORMATION

CONTENTS

This manual contains repair instructions for truck components, attachments and options. The Table of Contents at the start of each section lists contents of that section. Sections are identified by tabs in the right hand margin.

This manual is to be used in conjunction with appropriate operations and parts manuals for this equipment.

This manual covers models with engine and rear axle variations listed in the table below.

Normal maintenance, adjustment, and operating procedures are also covered in the user operatorís manuals and are only included where appropriate in this manual.

Engine repair is not covered in this manual. Refer to the appropriate engine manufacturerís instructions for engine service and repair.

This manual includes all removal, disassembly, inspection, repair, reassembly, installation, adjustment, and testing procedures. If you, as user of this machine, do not consider yourself or your repair facilities capable of a given procedure, please consult your dealer or distributor.

Information, specifications, illustrations, and procedures in this manual are based on information in effect at the time this manual was published. Improvements and product changes due to continual advancements of the product design may cause changes to your product that may not be included in this manual. Each manual is reviewed and updated as required to include changes and product improvements.

Read each section completely before proceeding with specific repairs in that section. You will minimize errors by understanding what you will be doing and how the component relates to others in its system. Lists of repair tools and materials for each section of the manual are given at the start of that section.

The designations L.H. (left hand) and R.H. (right hand) used throughout this manual refer to the operatorís left or right when sitting in the normal operating position.

REGISTRATION

A registration card is provided in the back of this manual (bottom portion of page). Fill out the card, remove and mail immediately upon opening the manual for the first time.

The registration entitles you to receive manual updates for a period of two years. Updates are sent free of charge.

NOTE

Only the original registration card will be accepted. Photo copies, cards from other manuals, suggestion cards, or any facsimile are not acceptable and will not constitute a registration.

INDEX NUMBERS

Illustrations showing removal, disassembly, reassembly and installation may have index numbers to call out the sequence of procedure.

Where the sequence of procedure is not important or self-evident (e.g. linkages, hoses, clamps, etc.) index numbers are not included.

Repair procedures for items not subject to wear (e.g. panels, brackets, frames) are not included in this manual except for the general procedures given below.

Exercise common sense during disassembly or reassembly; remove only the items required to accomplish necessary repair or service.

MODEL DIFFERENCES

Engine	Rear Axle
Suzuki K6A, 3-cylinder, gasoline, 48 hp (36 kW) at 5800 RPM, 6.7" (170 mm) clutch (Late 2002)	Cushman Worm Gear or Modification 11.16:1 hypoid
Suzuki 660, 3-cylinder, gasoline, 31 hp (23.1 kW) at 4450 RPM, 6.7" (170 mm) clutch (Until late 2002)	Cushman Worm Gear or Modification 11.16:1 hypoid
Perkins 103-10, 3-cylinder, diesel, 22.3 hp (16.6 kW) at 3000 RPM, 7.1" (180 mm) clutch	Cushman Worm Gear or Modification 11.16:1 hypoid

SECTION 1A. GENERAL INFORMATION

REPLACEMENT PARTS

Use the appropriate parts manual when ordering replacement parts. Follow installation instructions shipped with service parts or kits. When ordering parts, always give the model number and serial number of your machine as well as quantity, part number and description of the parts needed (see Figure **1A-1** for model and serial number location).

To eliminate error and speed delivery:

1. Write your NAME and ADDRESS on your order plainly.
2. Explain WHERE and HOW to make shipment.
3. Give MODEL (or PRODUCT) NUMBER, NAME and SERIAL NUMBER that is stamped on name and serial number plates on your unit.
4. Order by QUANTITY DESIRED, the PART NUMBER and the DESCRIPTION OF PART.
5. Send your order to or visit your nearest AUTHORIZED TURF EQUIPMENT dealer and distributor.
6. INSPECT ALL SHIPMENTS ON RECEIPT. If any parts are damaged or missing, file a claim with the carrier before accepting.
7. Do not return material to your AUTHORIZED dealer or distributor without a letter of explanation. Make a list of all returned parts, show your name and address, and include it with the shipment. TRANSPORTATION CHARGES MUST BE PREPAID.

IDENTIFICATION NUMBERS

See Figure **1A-1** for location of vehicle model and serial numbers.

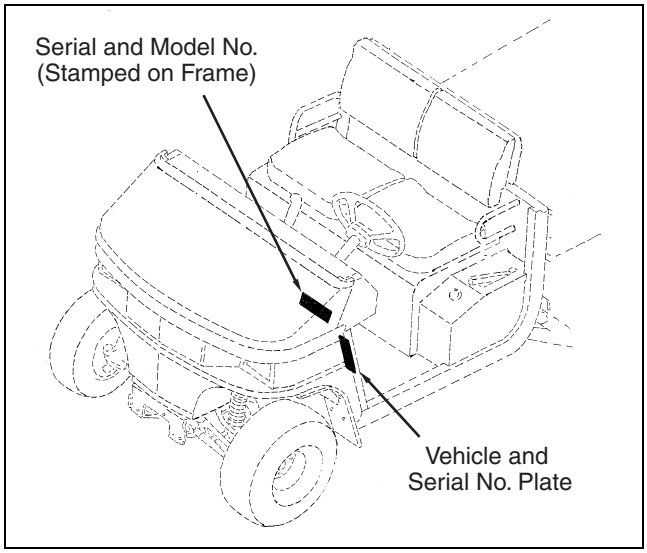

Figure 1A-1. Identification

GENERAL CLEANING

Improper cleaning and lubrication of your vehicle results in many equipment failures. Before any repairs are undertaken, thoroughly clean the exterior of the component to be removed.

Use a clean surface to lay out parts being removed. Keep lubricants clean and cover containers not being used. Plug or cap all hydraulic lines and ports to hydraulic components immediately after disconnecting.

SAFETY

Safety should always be the rule when working on or with machinery. Always use safe practices and common sense when using hand or power tools. Use the suggested procedures in this manual when working with the vehicle.

Throughout this manual signal words will be used to highlight special procedures. The signal words and their meaning are as follows:

NOTE

Any procedure needing special care when performing a procedure.

CAUTION

Hazards or unsafe practices which *could* result in personal injury or product or property damage.

WARNING

Hazards or unsafe practices which *could* result in *severe* personal injury or death.

DANGER

Imminent hazards which *will* result in *severe* personal injury or death if precautions are not taken.

Decals on the machine denote cautions, warnings and dangers. These cautions, warnings and danger decals must be on the machine at all times. If they become worn, torn or painted over, new decals should be installed as shown in SECTION 14 of this manual.

In addition to the decals on the vehicle, you must know and observe all cautions, warnings and danger precautions given in your vehicleís Safety and Operation Manual(s).

SECTION 1A. GENERAL INFORMATION

TORQUE VALUES

Torque values are given in the following ìTorque Specification Chartî. Special torque values are called out on illustrations and text throughout this manual.

TORQUE SPECIFICATIONS

STANDARD SAE GRADE #5 SCREWS

Size	Torque Values	Size	Torque Values
8-32	27 ñ 33 in-lbs. (3 ñ 4 N.m)	1⁄2-13	67 ñ 83 ft-lbs. (90 ñ 113 N.m)
8-36	28 ñ 34 in-lbs. (3 ñ 4 N.m)	1⁄2-20	81 ñ 99 ft-lbs. (110 ñ 134 N.m)
10-24	39 ñ 47 in-lbs. (4 ñ 5 N.m)	9⁄16-12	99 ñ 121 ft-lbs. (134 ñ 164 N.m)
10-32	44 ñ 54 in-lbs. (5 ñ 6 N.m)	9⁄16-18	108 ñ 132 ft-lbs. (146 ñ 179 N.m)
1⁄4-20	7 ñ 9 ft-lbs. (9 ñ 12 N.m)	5⁄8-11	135 ñ 165 ft-lbs. (183 ñ 223 N.m)
1⁄4-28	9 ñ 11 ft-lbs. (12 ñ 15 N.m)	5⁄8-18	162 ñ 198 ft-lbs. (220 ñ 268 N.m)
5⁄16-18	15 ñ 18 ft-lbs. (20 ñ 24 N.m)	3⁄4-10	234 ñ 286 ft-lbs. (317 ñ 388 N.m)
5⁄16-24	17 ñ 21 ft-lbs. (23 ñ 28 N.m)	3⁄4-16	270 ñ 330 ft-lbs. (366 ñ 447 N.m)
3⁄8-16	27 ñ 33 ft-lbs. (37 ñ 45 N.m)	7⁄8-9	360 ñ 440 ft-lbs. (488 ñ 597 N.m)
3⁄8-24	31 ñ 39 ft-lbs. (42 ñ 53 N.m)	7⁄8-14	396 ñ 484 ft-lbs. (537 ñ 656 N.m)
7⁄16-14	45 ñ 55 ft-lbs. (61 ñ 75 N.m)	1-8	522 ñ 638 ft-lbs. (708 ñ 865 N.m)
7⁄16-20	49 ñ 61 ft-lbs. (66 ñ 83 N.m)	1-12	576 ñ 704 ft-lbs. (780 ñ 954 N.m)

NOTE: These torque values are to be used for all hardware excluding: locknuts, self-tapping screws, thread forming screws, sheet metal screws and socket head setscrews.

METRIC

Diameter ñ Coarse Thread	Metric Grade							
	5.6		8.8		10.9		12.9	
	N.m	ft-lbs.	N.m	ft-lbs.	N.m	ft-lbs.	N.m	ft-lbs.
M6	4.6	3.3	10.5	7.7	15	11	18	13
M7	7.8	5.6	17.5	12.9	26	18.4	29	21.3
M8	11	8.1	26	19	36	26	43	31
M10	22	16	51	37	72	53	87	64
M12	39	28	89	66	125	92	150	110
M14	62	45	141	103	198	146	240	177
M16	95	70	215	158	305	224	365	269
M18	130	95	295	217	420	309	500	368
M20	184	135	470	309	590	435	710	623

SECTION 1A. GENERAL INFORMATION

ACCESS LATCHES (See Figure 1A-2)

ACCESS TO ENGINE

WARNING

The engine cover is a MACHINERY GUARD and its removal exposes you to moving parts. Keep hands, hair and clothing away from flywheel, radiator cooling fan, alternator fan, engine belts, pulleys and air intake. Never remove or install the engine cover while engine is running.

For servicing the engine and related components, the engine cover can be tilted forward or removed. To gain access to the engine, push the engine cover latch to the rear of the unit, tilt cover forward. The latch is located at the center rear on top of the engine cover (between the seat cushion(s) and backwall).

NOTE

European market (CE compliant) vehicles have a key which is used to release a locking handle at the side of the engine cover latch. Turn the key to allow the latch to be pushed back.

FRONT COWL ACCESS

The front cowl opens to gain access to the fuse panel, the horn, the master cylinder reservoir as well as various access panels which when removed, allow access to the shifting lever linkage and front suspension.

To open the front cowl, locate the release lever next to the left side headlight.

Pull the lever to the right to release the front cowl latch and at the same time pull up on the front cowl.

Open the cowl allowing it to rest against the ROPS structure (if equipped) or the steering wheel.

The front cowl will not ìspring upî when the release lever is pulled. The cowl will have to be raised when the latch is released.

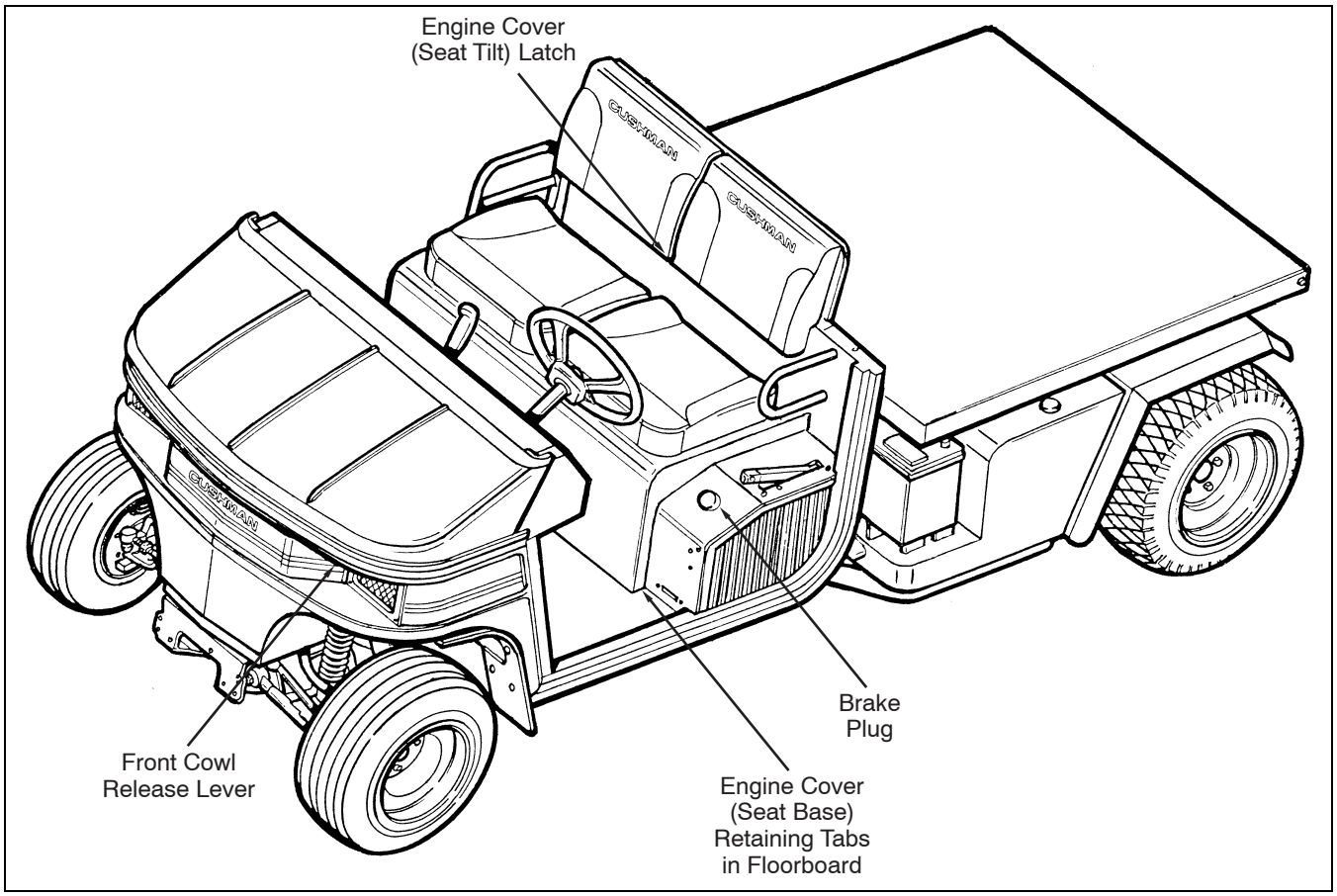

Figure 1A-2. Access Latches

JACKS, JACKING LOCATIONS AND USING A HOIST

A scissors type jack or a floor jack with a 1-1/2 ton (minimum) capacity that can be lowered to 3-3/8 inches (86 mm) height is required.

The jacking locations are shown in Figure **1A-3**.

Put the gear selector in 1st gear. Apply the park brake. Raise the vehicle only enough to perform maintenance required.

Place a jack in the appropriate location (see Figure **1A-3**) and place a block behind (or in front) of the tire diagonally opposite the side which is being raised (see Figure **1A-4**).

WARNING

Do not rely solely on hydraulic or mechanical jacks for support. Use appropriate jack stands or equivalent for supporting the vehicle. If using a hoist, raise vehicle to appropriate height and support using jack stands or equivalent support.

Never place feet, hands or any part of your body under the vehicle when raising it with a hoist.

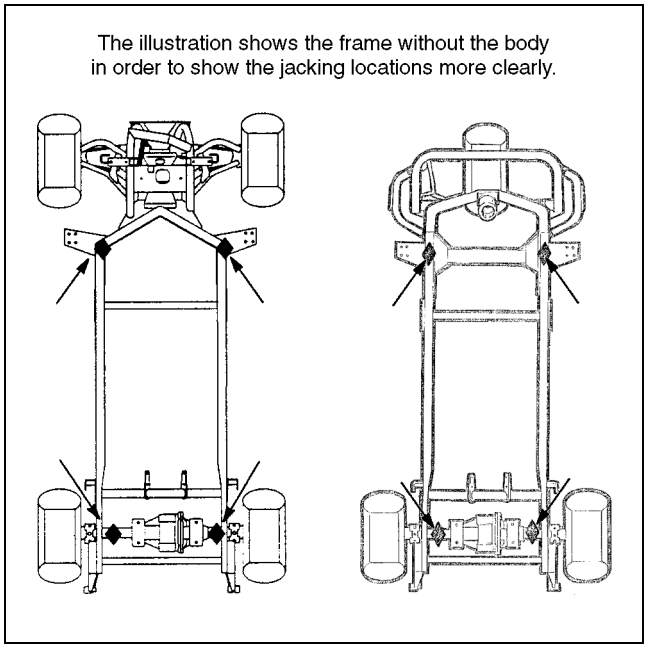

Figure 1A-3. Jacking Locations

Jack the vehicle to the appropriate height and place jack stands or equivalent support beneath the frame near the jack. Lower the jack and allow the vehicle to rest on the jack stands. Raise the vehicle only enough to perform the maintenance required.

Make sure to block the tire diagonally opposite of the side which is being raised (see Figures **1A-4** and **1A-5**).

When using a hoist to raise the vehicle, use the same procedure for supporting the frame and blocking the tires as you would when using a jack.

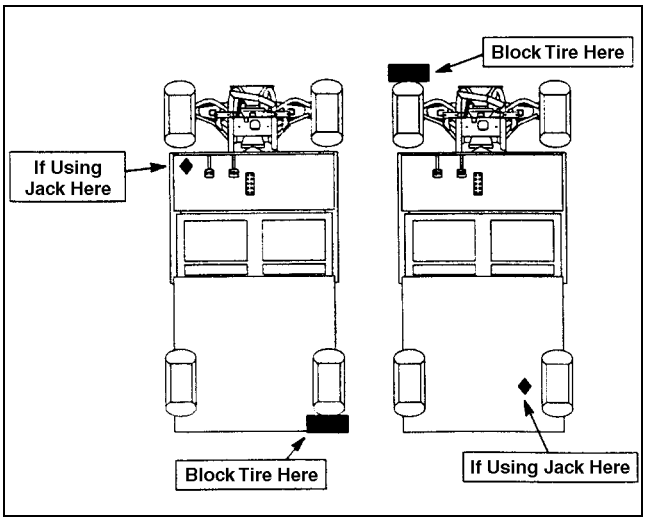

Figure 1A-4. Blocking

CAUTION

To prevent damage to the vehicle or attached accessory, never use a hoist to raise only one corner of the vehicle. Always raise both front or rear corners equally.

SECTION 1A. GENERAL INFORMATION

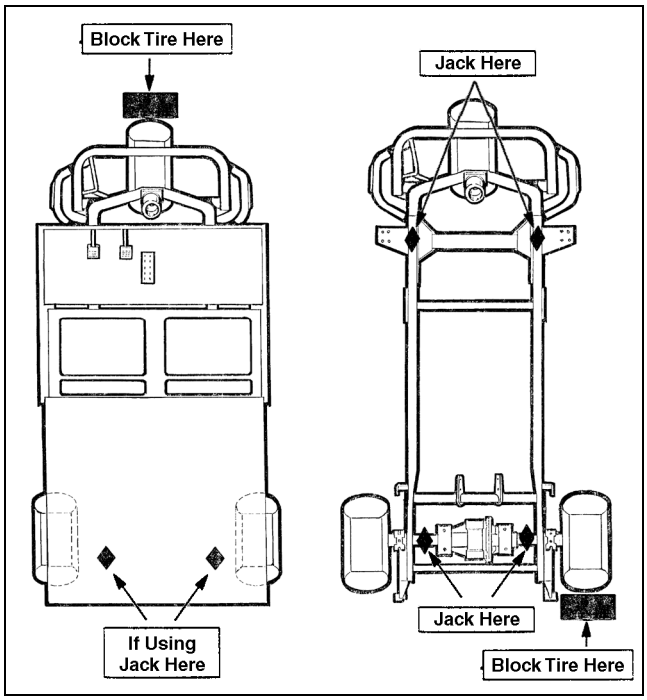

Figure 1A-5. 3-Wheel Jacking and Blocking

TOWING

If for any reason the vehicle needs to be towed, follow the guidelines below to properly tow the vehicle.

If towing the vehicle with a tow-rope or a chain, an operator is required to steer the vehicle and to control the brakes.

Attach a tow line only to the front vertical frame member on either side of vehicle as shown in Figure **1A-6**.

Make sure the drive transmission is in ìneutralî (out of gear) and the park brake is released.

With the tow line attached, have the towing vehicle move forward until the tow line becomes tight.

WARNING

Never tow the vehicle faster than 5 M.P.H. (8 km/h). Towing at excessive speed could cause either vehicle to lose proper steering control.

While towing, try to keep the tow line taut at all times. Be cautious going down inclines and while turning corners.

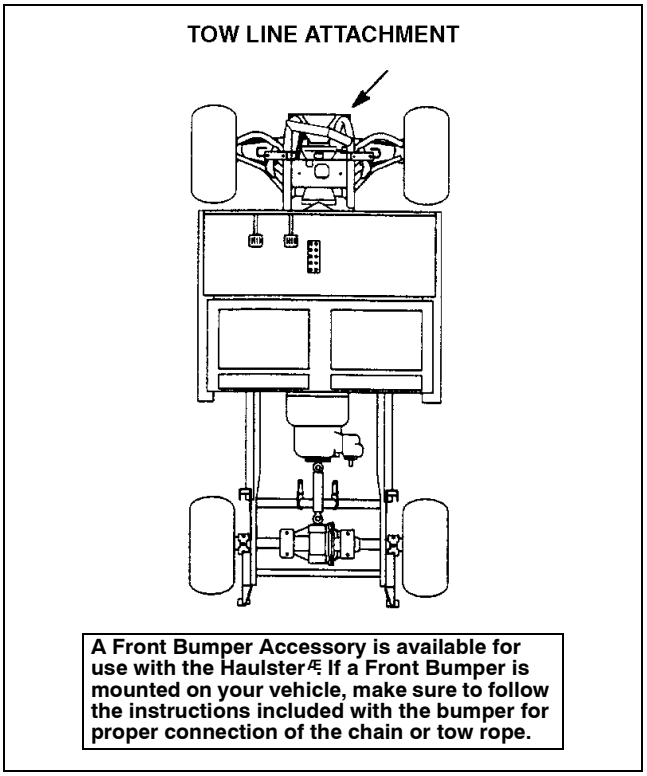

Figure 1A-6. Tow Line Attachment Locations

SECTION 2
CONTROLS

SECTION 2A. REPAIR AND SERVICE TOOLS AND MATERIALS

Tools required:	Standard automotive hand tools.
Cleaning materials:	Stoddard or equivalent solvent. Detergent and water.
Lubricants:	Refer to SECTION 11.

SECTION 2B. FAILURE ANALYSIS

GENERAL

The following table gives common problems, probable causes and suggested remedies.

PROBLEM	PROBABLE CAUSE	REMEDY
1. Engine does not turn over when ignition switch is engaged.	a. Battery dead. b. Circuit breaker tripped. c. Clutch not disengaged. d. Faulty starter. e. Faulty clutch switch. f. Faulty ignition switch. g. Faulty electrical circuit.	a. Charge or replace (Section 10). b. Reset. c. Push pedal and disengage. d. Test (Section 10). e. Test (Section 10). f. Test (Section 10). g. Test (Section 10).
2. Engine turns over but does not start.	a. Battery low. b. No fuel. c. Glow plugs not set (diesel). d. Faulty glow plug switch (diesel). e. Faulty glow plugs (diesel). f. Faulty system relay. g. Faulty fuel solenoid (diesel). h. Faulty ignition system (gas).	a. Charge or replace (Section 10). b. Fill. c. Set for 7 seconds. d. Test (Section 10). e. Test (Section 10). f. Test (Section 10). g. Test (Section 10). h. Test (Section 3E).
3. Parking brake does not hold.	a. Brake not adjusted. b. Worn brakes.	a. Adjust (Section 2). b. Replace (Section 5).
4. Slow traction speed.	a. Parking brake not released. b. Clutch slipping.	a. Release. b. Adjust (Section 4).
5. Instrument(s) do not work.	a. Circuit breaker tripped. b. Faulty instrument(s). c. Faulty electrical circuit.	a. Reset. b. Replace (Section 2D). c. Test (Section 10).
6. Glow plugs do not light (diesel).	a. Circuit breaker tripped. b. Faulty glow plug(s). c. Faulty electrical circuit.	a. Reset. b. Test (Section 10). c. Test (Section 10).

SECTION 2C. CONTROL ADJUSTMENTS

GENERAL

This section covers adjustments to speed controls, parking and service brakes, clutch interlocks, transmission gear selectors and other functional controls which vary according to the engine, transmission, etc. used on your specific vehicle.

SPEED CONTROLS (See Figure 2C-1)

WARNING

It is essential that operators, maintenance and service personnel understand the interrelationship between the accelerator (foot) pedal, hand throttle lever (see Figure 2C-1) and governor controls on the engine in order to safely operate and service this vehicle.

WARNING

On gasoline engine powered vehicles, never attempt to drive the vehicle with the engine speed increased by the hand throttle. The hand throttle also controls the foot throttle, so the foot throttle pedal cannot be used to reduce engine and vehicle speed. Failure to obey this warning may result in losing vehicle control.

1. Only on diesel engine powered vehicles does the accelerator (foot) pedal retain full control of throttle lever position. An internal engine governor adjusts the injector pump to compensate for variations in power requirements (maintains RPM dictated by position of foot pedal accelerator).
2. The engine governor is preset to control engine ground (vehicle) speeds to design limits.

WARNING

To prevent speeds greater than design limits, never alter the governor controls in any manner to increase speed beyond the recommended maximum RPM. Over-speeding may result in engine failure and possible injury to operator and/or bystanders.

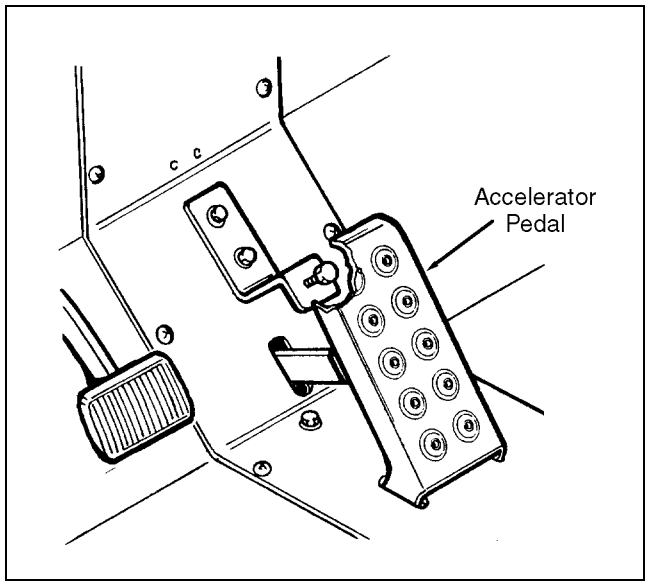

Figure 2C-1. Speed Controls

3. Maximum RPM and low idle speeds for various Haulster® engines are as follows:

Engine	Maximum RPM	Low Idle
Suzuki 660 gasoline	4450 RPM Adjust governor to 4400 RPM max.	950 ± 50 RPM Adjust to 900 RPM.
Perkins 103-10 diesel	3000 RPM Governor is factory preset. See manufacturerís instructions for adjustments.	950 ± 50 RPM See engine manufacturerís instructions for adjustments.

SECTION 2C. CONTROL ADJUSTMENTS

GOVERNOR AND HAND THROTTLE ADJUSTMENTS (Carbureted)

1. Start and warm up the engine to normal operating temperature. Move the hand throttle and governor control levers to forward positions. Adjust the idle speed setscrew to obtain 900 RPM (see Figure **2C-2**).

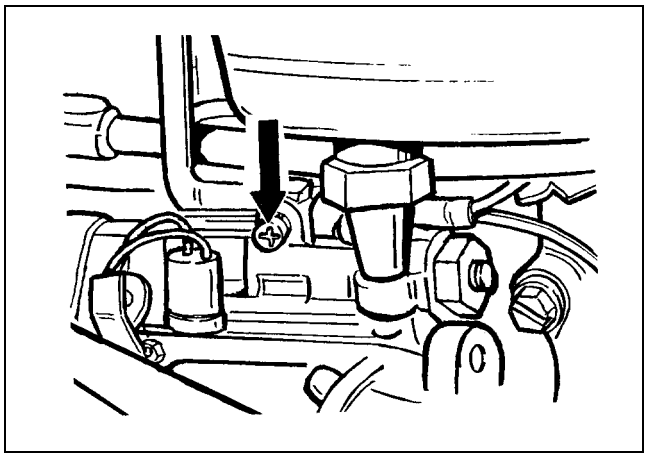

Figure 2C-2. Idle Speed Setscrew

2. Adjust the counterbalance screw (see Figure **2C-3**) to obtain proper deflection in both cables. Proper cable deflection is 1/8 to 3/16 inch.

NOTE
Make sure both cable eyelets move freely.

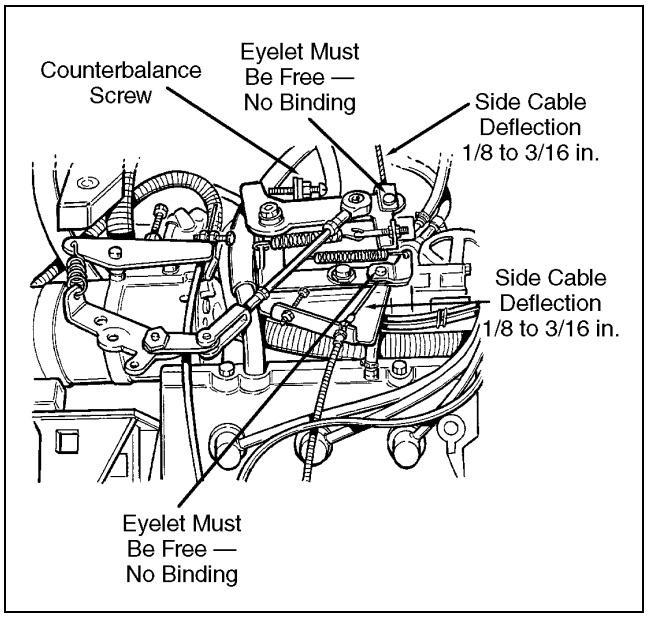

Figure 2C-3. Cable Deflection Adjustment

3. Depress the accelerator pedal down against the pedal stop screw (see Figure **2C-4**). Turn the stop screw out of its bracket one revolution counter-clockwise (against the accelerator pedal) so that the pedal touches the stop screw before reaching its maximum forward (down) travel position.

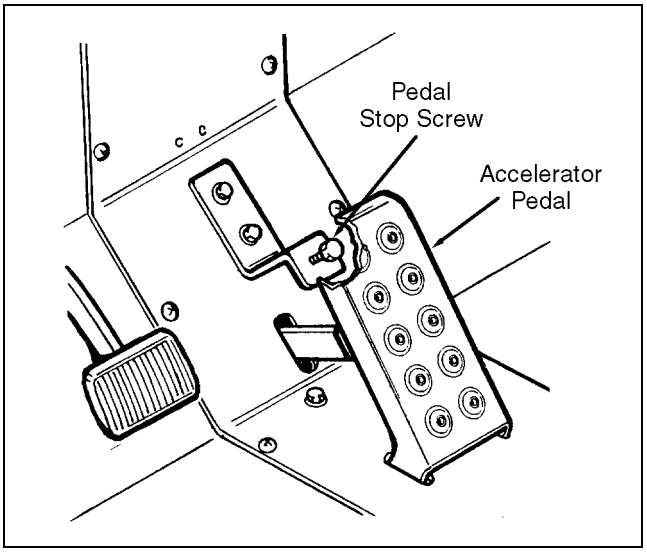

Figure 2C-4. Accelerator Pedal Stop Screw

4. With the accelerator pedal fully depressed, adjust the second throttle stop screw (see Figure **2C-5**). Adjust the second throttle stop screw so that it just touches the counterbalance pivot lever.

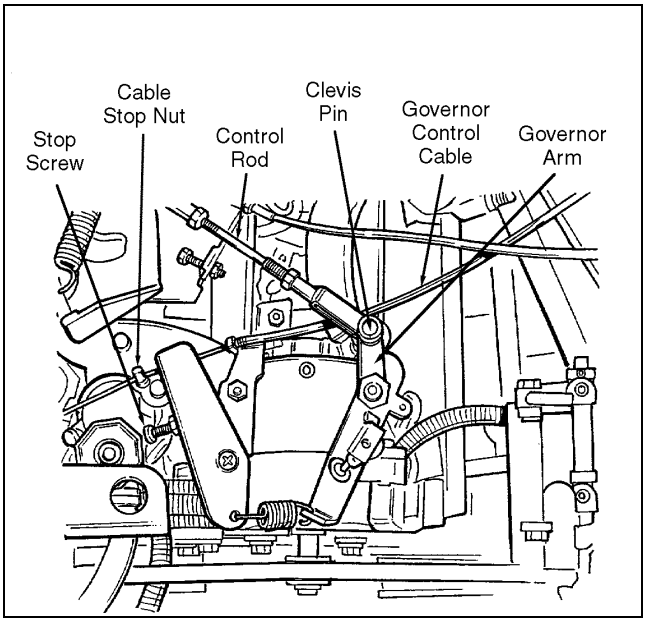

Figure 2C-5. Second Throttle Stop Screw Adjustment

SECTION 2C. CONTROL ADJUSTMENTS

5. With accelerator pedal fully depressed, check throttle plate. Pull spring bracket toward you, the throttle should be 5 degrees from full open (see Figure **2C-6**).

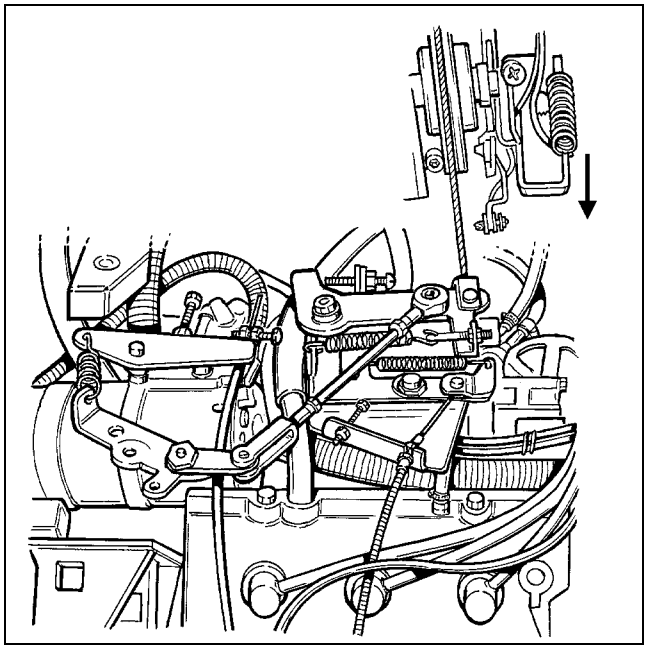

Figure 2C-6. Throttle Plate Check

6. With the accelerator pedal fully depressed, remove the cotter pin, turnbuckle pin and flat washer (see Figure **2C-7**). Disconnect the turnbuckle from the broken knee lever.

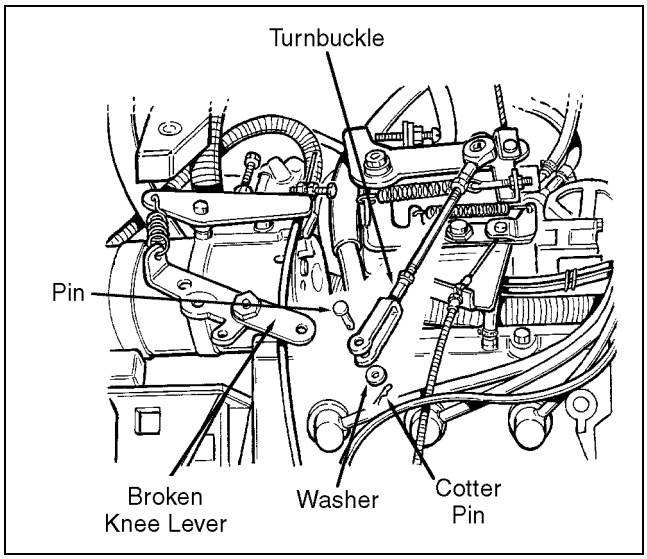

Figure 2C-7. Disconnect Turnbuckle from Broken Knee Lever

7. Push the broken knee lever to its full at rest position (see Figure **2C-8**).

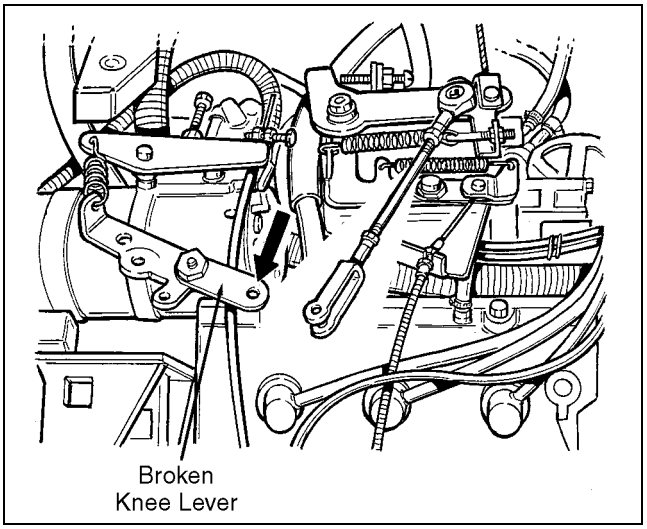

Figure 2C-8. Broken Knee Lever to Full at Rest Position

8. Pull the turnbuckle to the full throttle position (see Figure **2C-9**). Install the turnbuckle pin, washer and cotter pin so that the turnbuckle pin is snug against the broken knee lever when pressure is applied to the lever.

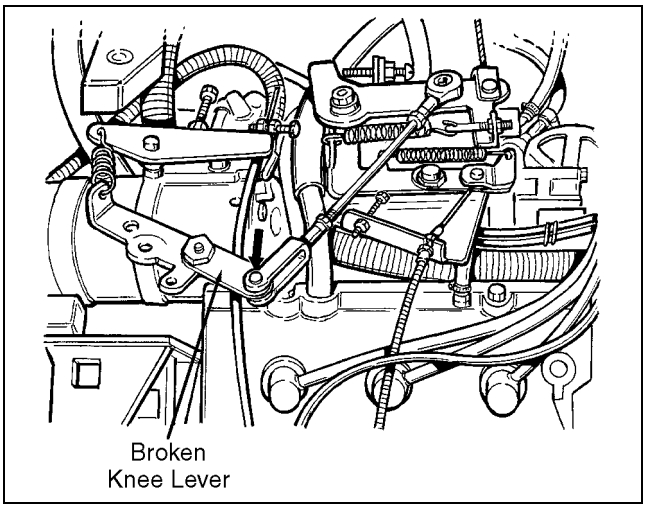

Figure 2C-9. Connect Turnbuckle to Broken Knee Lever

9. Adjust the cable stop screw (see Figure **2C-10**) to obtain 4400 RPM. Adjust the governor stop screw so it just touches the governor body and lock the jam nut.

SECTION 2C. CONTROL ADJUSTMENTS

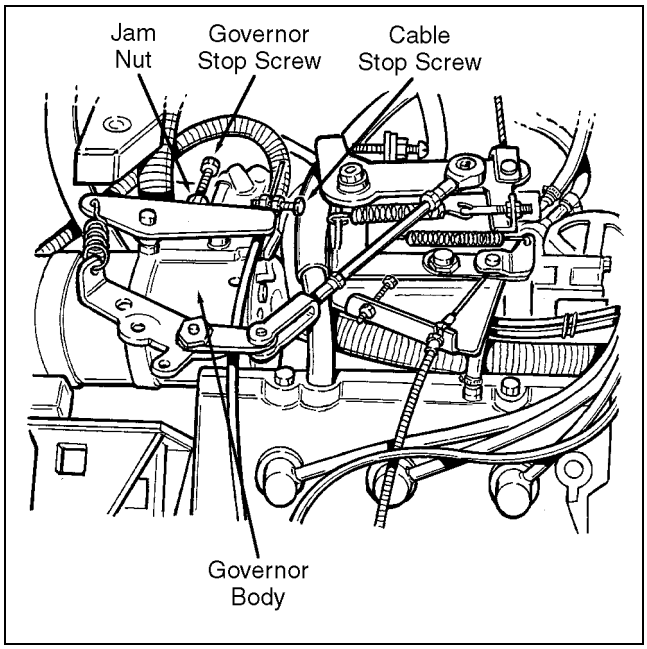

Figure 2C-10. Governor High RPM Adjustment

10. Move the governor lever to the low RPM position (see Figure **2C-11**). Adjust the counterbalance spring by centering the jam nuts on the governor adjustment stud thread. Adjust until low 2500 RPM is obtained.

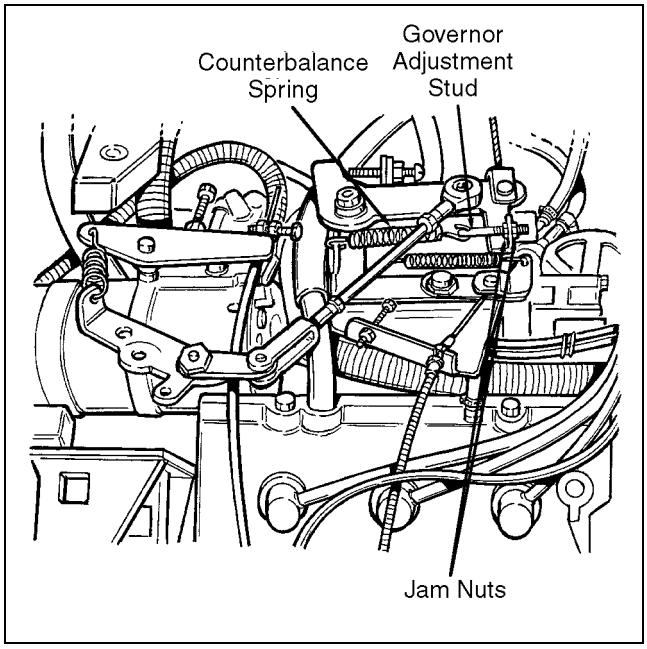

Figure 2C-11. Governor Low RPM Adjustment

GOVERNOR AND THROTTLE ADJUSTMENTS (EFI)

1. Turn the engine off and move the governor control and hand throttle levers (see Figure **2C-1**) to the ìDOWNî (turtle icon) position.
2. Loosen the nut on the large spring (see Figure **2C-12**) tension adjusting eyebolt and turn the eyebolt to its fully tightened (maximum thread exposure) position. Tighten the nut.

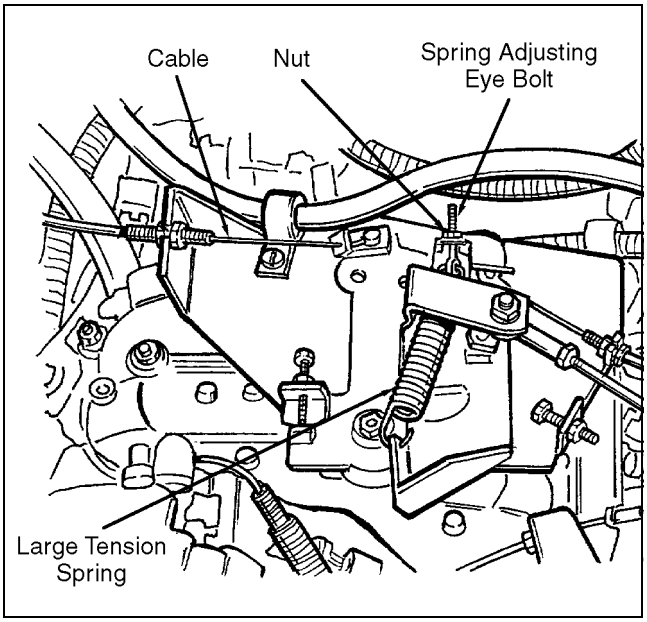

Figure 2C-12. Large Spring Tension Adjustment

3. Check throttle cable deflection (see Figure **2C-13**). Cable deflection should be no greater than 3/32 inch (2.38 mm) for either throttle cable. Make certain that the throttle closes completely with the throttle hand lever in the ìDOWNî (turtle icon) position after adjusting cable deflection. Loosen cable jam nuts to adjust cables. Make sure cable eyelets move freely. Tighten jam nuts after adjustment.

SECTION 2C. CONTROL ADJUSTMENTS

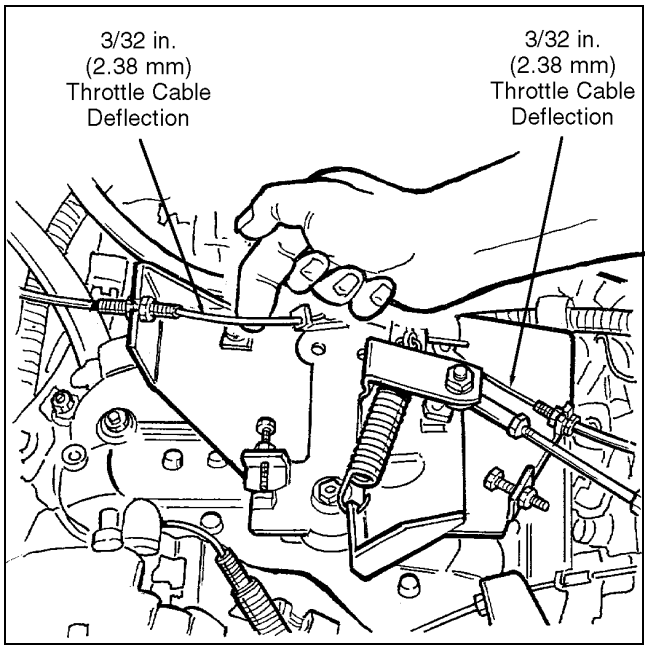

Figure 2C-13. Throttle Cable Adjustment

4. Remove the cotter pin and clevis pin securing yoke and rod to black governor arm (see Figure **2C-14**). Pull the yellow plated governor arm back to the end of travel and hold while adjusting rod so that edge of black governor arm is parallel with the sides of the governor housing. Secure yoke to governor arm with clevis pin only. This is a critical adjustment, make sure you pull the yellow arm back when adjusting the rod. If the rod is too short, correct setting of the high RPM will be affected.

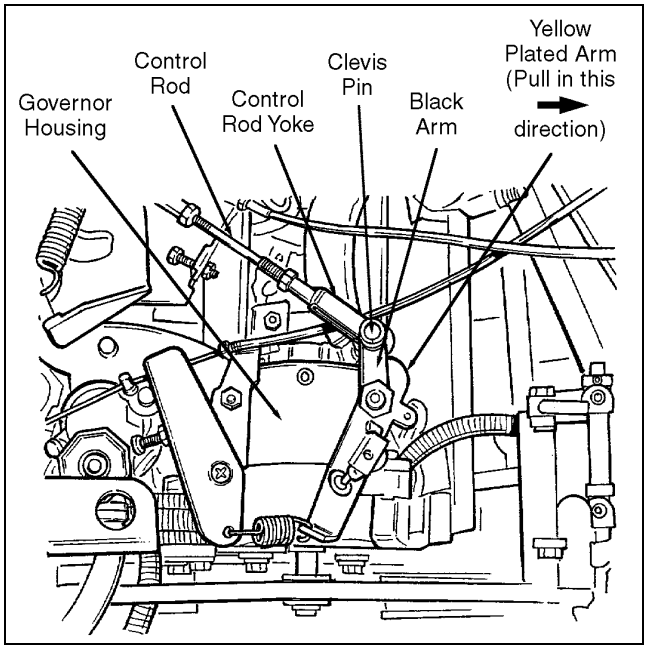

Figure 2C-14. Governor Arm Adjustment

5. Position the shift lever to neutral (N) and make certain the parking brake is applied. Start the engine, allow it to warm up with the hand throttle lever in the ìDOWNî (turtle icon) position and the hand throttle lever in the ìUPî (rabbit icon) position.
6. Loosen the stop nut on the governor cable (see Figure **2C-15**). Move the governor linkage arm by hand until 2500 ± 50 RPM is obtained, then tighten the stop nut.

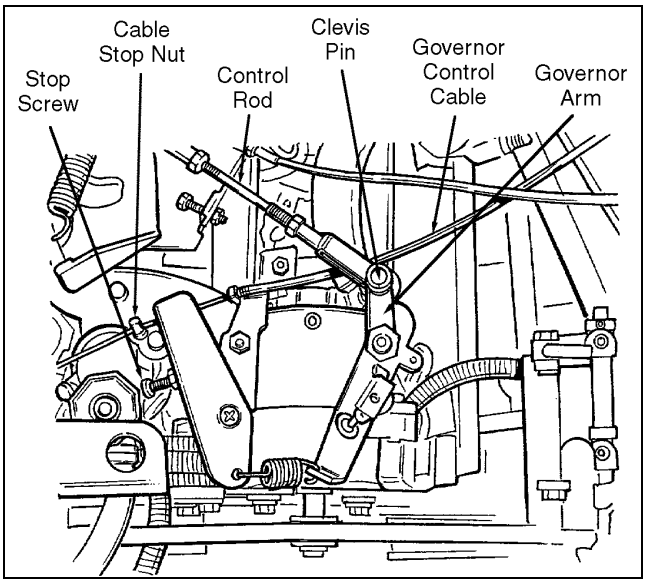

Figure 2C-15. RPM Adjustments

7. Move the handle throttle lever to ìUPî (rabbit icon) position and move the governor control lever ìUPî or ìDOWNî until 3600 ± 50 RPM is obtained. Tighten the governor stop screw (see Figure **2C-15**) to lock the high RPM setting.
8. Push the hand throttle lever to the full ìUPî position, the engine RPM may briefly exceed the adjusted high speed (3600 ± 50 RPM) but should return to that speed almost immediately.
9. If governor hunts during throttle up test, in Step 8 above, remove the clevis pin and adjust governor rod shorter, 1/2 turn at a time (the rod is too long) until the governor stops hunting during the test. The RPM should not be significantly affected. If the RPM increases when making this adjustment the rod is already too short and the adjustment procedure in Step 4 above should be repeated. Install the clevis pin and cotter pin after readjusting.

10. Drive the truck at full governed engine RPM in 4th (high) gear and while keeping the accelerator pedal depressed to maintain full engine RPM, move the shifter to the neutral (N) position. The engine RPM may increase or move slightly, then come back to the set engine RPM. If the engine RPM increases and does not return to the set engine RPM, adjust the governor rod out 1/2 turn at a time (the rod is too short) and repeat the test.

GOVERNOR AND HAND THROTTLE ADJUSTMENTS ó DIESEL ENGINE

1. The diesel engine governor is factory preset and not adjustable.
2. Adjust the throttle cable by moving accelerator to low idle and adjusting the cable connections at the fuel injection pump.

CLUTCH PEDAL FREE TRAVEL

1. Depress clutch pedal, stop as soon as clutch resistance is felt, and measure clutch pedal free travel as shown in Figure **2C-16**.

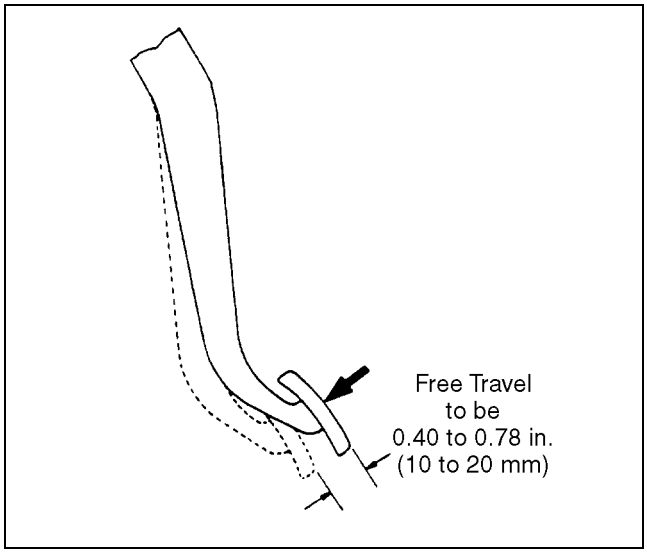

Figure 2C-16. Clutch Free Travel

2. If free travel is out of specification, adjust the clutch outer cable nuts (at both pedal and release arm sides).

NOTE

After adjusting free travel, make sure that clutch cable end protrudes from joint nut as shown in Figure **2C-17**.

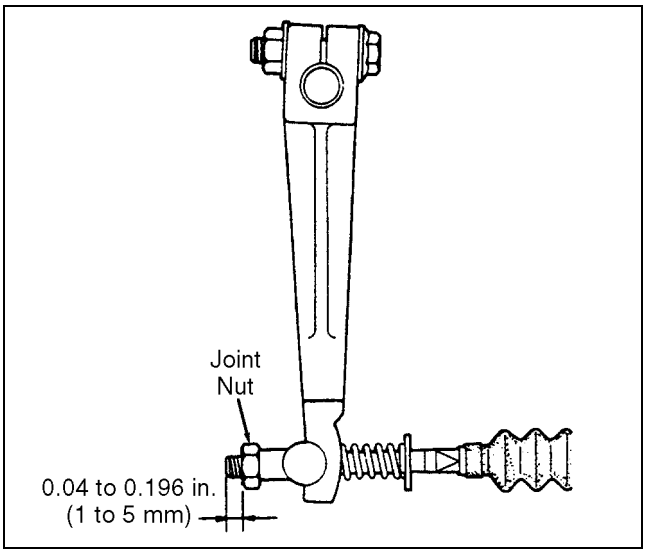

Figure 2C-17. Clutch Cable Adjustment

CLUTCH INTERLOCK SWITCH (See Figure 2C-18)

A clutch interlock switch allows the engine starter to operate only when the clutch pedal is depressed (closing the switch). If the engine starts when the clutch pedal is not depressed, check for a broken damaged switch actuator and/or loose wiring. Test the switch as described in SECTION 10 and replace it if necessary.

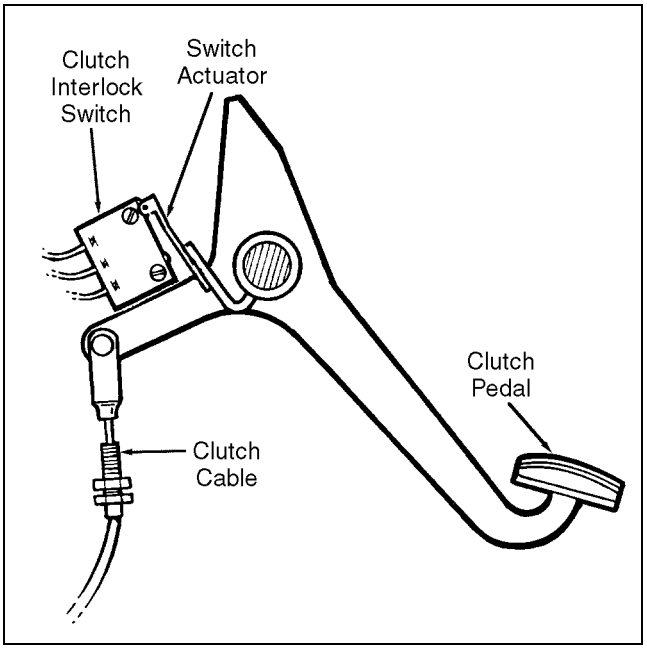

Figure 2C-18. Clutch Interlock Switch

SECTION 2C. CONTROL ADJUSTMENTS

GEAR SELECTOR ADJUSTMENT (MANUAL) (See Figure 2C-19)

NOTE

Before adjustment, check to make sure that each lubrication point is greased properly (see SECTION 11) and that bushings and linkages are not worn. Repair as necessary.

If the gear shift control lever can be shifted from neutral (vertical) position to and between 3rd and 4th positions smoothly, the gear select cable is adjusted properly.

If smooth shifting from neutral position to and between 3rd and 4th positions is not obtained, adjust the select cable as follows:

1. Tilt shift lever a little toward LOW and 2nd position side (selected position) from neutral position. If it can be shifted smoothly to and between 3rd and 4th positions from there, loosen cable clamp A shown in Figure 2C-19 and tighten select cable adjusting nut A until control lever can be shifted smoothly to and between 3rd and 4th positions from neutral position. Tighten cable clamp A.
2. Tilt control lever a little toward REVERSE side (selected position) from neutral position. If it can be shifted smoothly to and between 3rd and 4th positions from there, loosen cable clamp B and then tighten adjusting nut B until control lever can be shifted to and between 3rd and 4th positions smoothly from neutral position. Tighten cable clamp B.

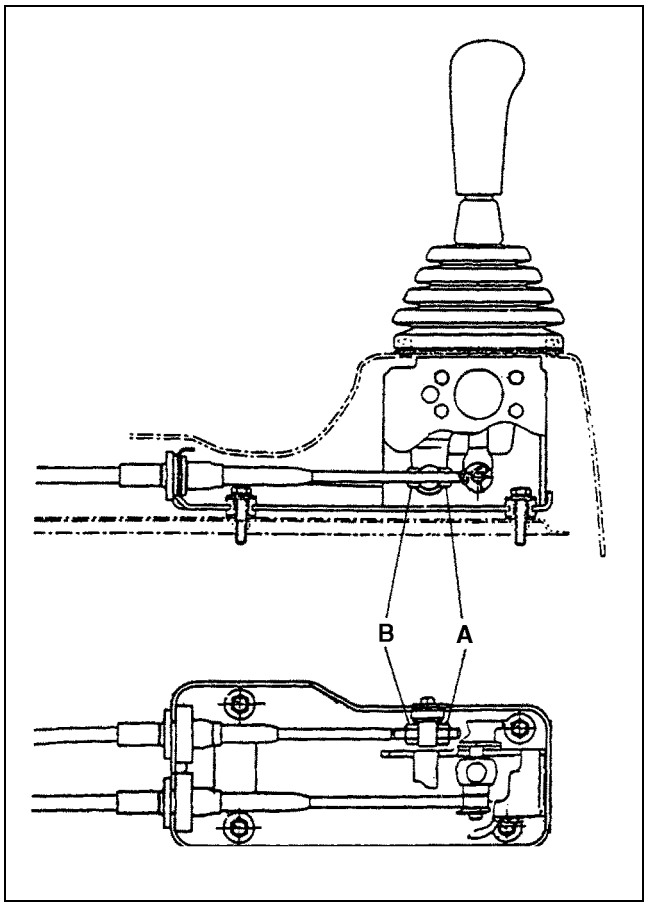

Figure 2C-19. Gear Selector Adjustment

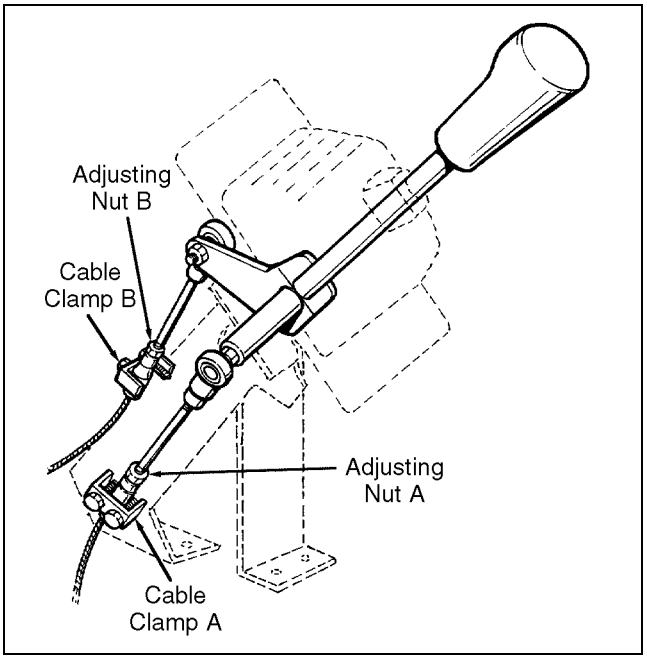

Figure 2C-20. Gear Selector Adjustment (EFI)

SECTION 2C. CONTROL ADJUSTMENTS

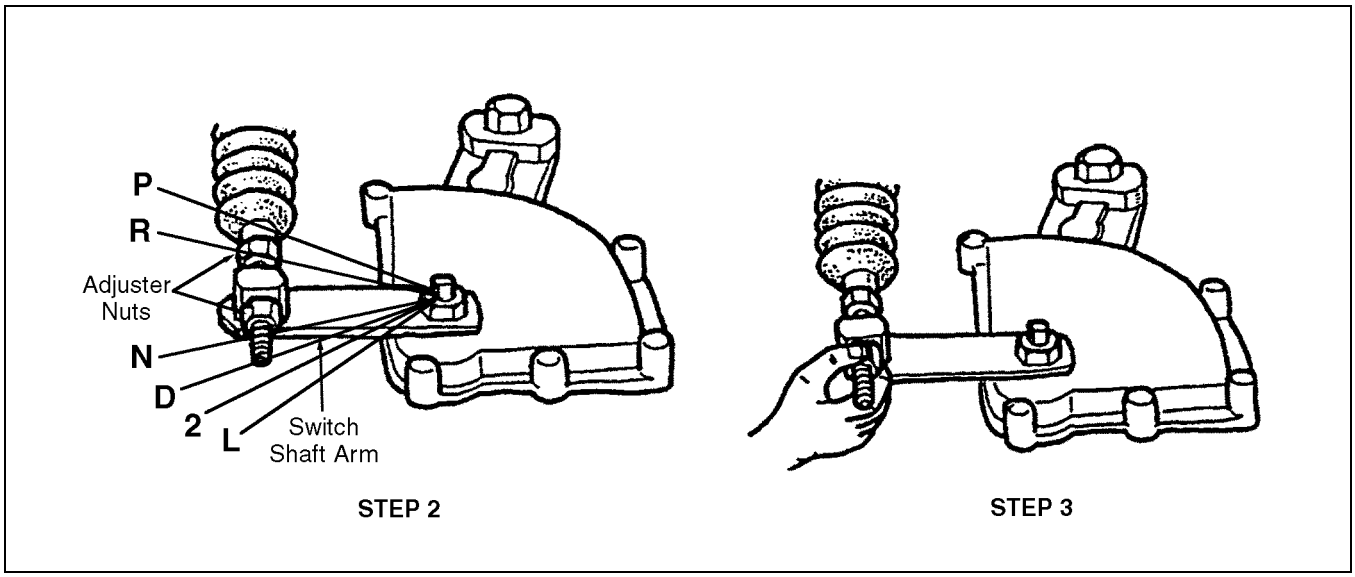

Figure 2C-21. Shift Selector Adjustments

SECTION 2C. CONTROL ADJUSTMENTS

SERVICE BRAKES (See Figure 2C-22)

1. This vehicle is equipped with four hydraulic brakes controlled by the brake pedal. Open the front cowl of the vehicle to gain access to the brake fluid reservoir.
2. A brake fluid indicator light on the control panel (see Figure 2D-1) will come on and stay on if the brake fluid level is low. The fluid level must be maintained between the minimum and maximum markings on the gauge attached to the brake fluid reservoir. Use DOT 3 Type brake fluid.
3. If the brakes do not hold properly, if they feel spongy or if the brake fluid reservoir is allowed to ìrun-dryî, it may be necessary to bleed the brake lines in order to get fluid back into the system. Follow the steps below to properly bleed the brake system.
4. When bleeding the brake system, bleed the left rear brake first, then the right rear, then the right front and finally the left front.
5. Attach a hose to the bleeder screw on top of the left rear dust shield and place the other end of the hose in a container to catch the fluid run-off when bleeding the system.
6. Loosen the bleeder screw. Have an assistant push down on the brake pedal and hold pedal down. Tighten the bleeder screw and release the brake pedal. Loosen the bleeder screw again, press down on the brake pedal, hold pedal down and tighten the bleeder screw, release pedal. Do not release the brake pedal until the bleeder screw is tightened otherwise air will be sucked back into the brake lines.
7. Continue this procedure until all air bubbles are purged from the system and a steady flow of fluid comes from the brake line. Repeat the procedure on the opposite side of the unit, then on the front.

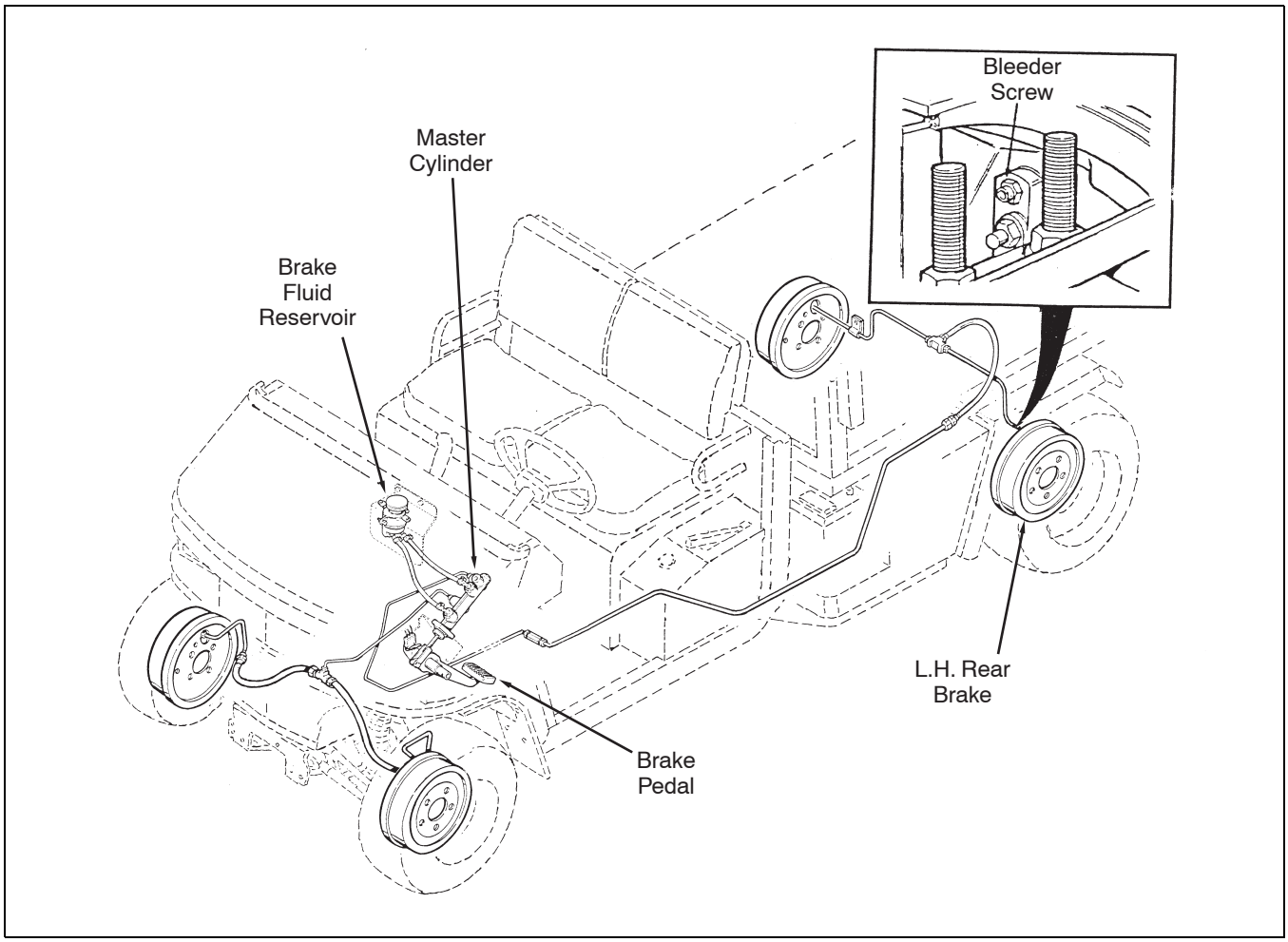

Figure 2C-22. Service Brake System

SECTION 2C. CONTROL ADJUSTMENTS

PARKING BRAKE ADJUSTMENT (See Figure 2C-23)

1. The parking brake activates only the two rear brakes of the vehicle. Raise the engine cover to gain access to the parking brake cables.
2. Release the parking brake lever (lever fully down).
3. Tighten the adjustment nut (1 or 2 turns) and apply the brake lever. Continue tightening the adjustment nut until the lever is at approximately 45∞ when the brake is applied.

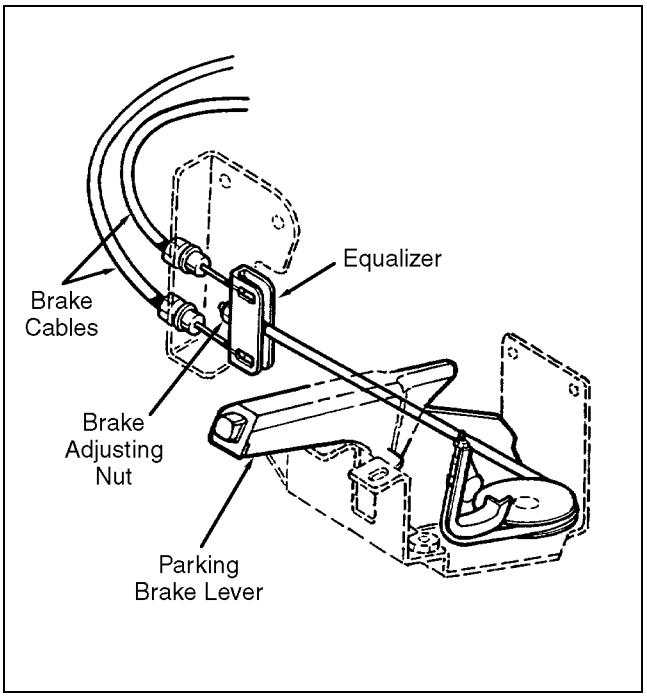

Figure 2C-23. Parking Brake Adjustment

SECTION 2D. GAUGES AND INSTRUMENTS

REPAIR (See Figure 2D-1)

The instrument panel gauges are not individually replaceable. Replace the entire panel if the tachometer, hour meter, fuel gauge, voltmeter or water temperature gauge are defective. See SECTION 10 for electrical testing. Disconnect the battery cables and tag instrument panel wiring prior to replacement.

If a bulb needs replacement, remove the four screws that secure the instrument panel to the dash and tilt the panel forward to gain access to the rear of the panel. Rotate the bulb holder 1/4 turn counterclockwise and pull up the holder to gain access to bulbs.

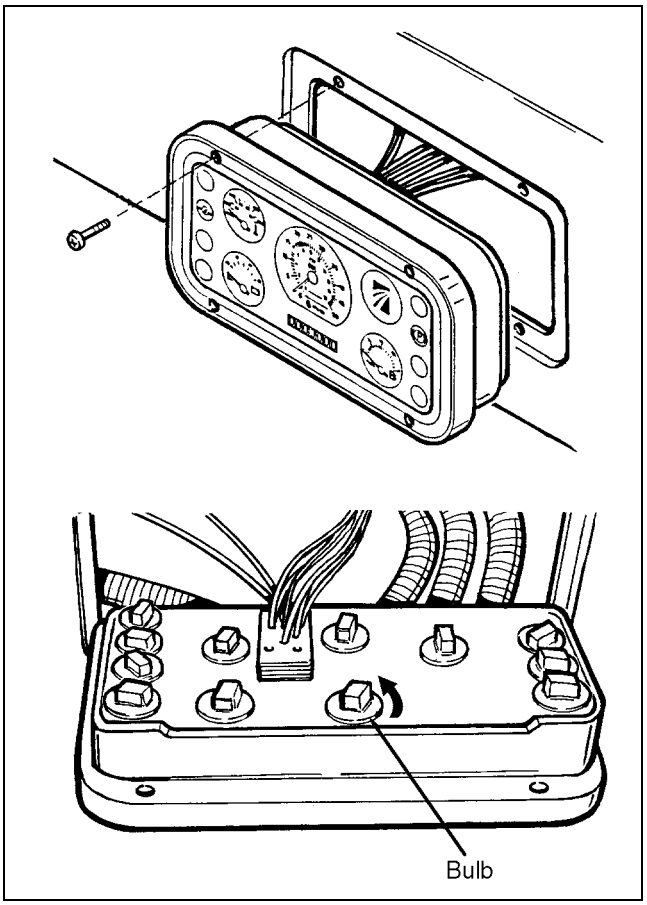

Figure 2D-1. Instrument Panel and Bulb Replacement

SECTION 3
ENGINE

SECTION 3A. REPAIR AND SERVICE TOOLS AND MATERIALS

Tools required:	Standard automotive hand tools.
Cleaning materials:	Stoddard or equivalent solvent. Detergent and water. Anti-rust Never-Seize.
Lubricants:	Refer to SECTION 11.
Other service items:	Compressed air source. Engine hoist. Oil filter. Fuel filter. Air cleaner element. Fan belt. Loctite® 592.

SECTION 3B. FAILURE ANALYSIS

PROBLEM	PROBABLE CAUSE	REMEDY
1. Engine will not start.	a. Parking brake disengaged. b. Glow plug has not timed out (diesel). c. Defective spark plug (gasoline). d. Battery low on charge or defective. e. Fuel tank empty or dirty. f. Main fuse blown. g. Relay defective. h. Gear selector not in neutral.	a. Engage brake. b. Reset ignition switch and allow glow plug to time out before cranking engine. c. Replace (Section 3E). d. Inspect condition of battery and battery connections. e. Fill with fresh fuel. Change fuel filter. Bleed fuel lines (Section 3D). f. Replace fuse. g. Test and replace relay (Section 10). h. Check position of gear shift.
2. Engine hard to start or runs poorly.	a. Fuel level low, fuel or fuel filter dirty. b. Air cleaner dirty. c. Injectors, fuel pump faulty. (Diesel) d. Injectors, engine control (ECU) or fuel pump faulty. (Gas) e. Engine problem.	a. Fill with fresh fuel.Change fuel filter. Bleed fuel lines (Section 3D). b. Inspect and replace air filter (Section 3D). c. Consult engine manufacturerís service manual. d. Consult engine manufacturerís service manual. e. Consult engine manufacturerís service manual.
3. Engine stops.	a. Fuel tank empty. b. Parking brake not set.	a. Fill with fresh fuel and bleed fuel lines (Section 3D). b. Engage parking brake.
4. Engine overheating.	a. Coolant level low. b. Air intake restricted. c. Water pump belt broken or loose.	a. Inspect and add coolant. b. Clean air intake or radiator. c. Tighten or replace belt.

NOTE: See engine manufacturerís service manual for additional Failure Analysis.

SECTION 3C. GENERAL INSTRUCTIONS

CONTENTS

This section covers repairs to the engine associated components (e.g. exhaust system, air cleaners, radiators). Removal and installation of the engine is also covered but engine repair is not included in this manual. Refer to the engine manufacturerís instructions for engine service and repair. Engine manuals are available from your local dealer.

NOTE

Tests for alternators, starters, and control components are included in SECTION 10 of this manual. If these components are found faulty, refer to the engine manufacturerís manual for repair instructions.

Unlatch and tilt the engine cover forward to gain access to the engine (see Figure **1A-2**).

CLEANING AND LUBRICATION

Thoroughly clean each component after removal from the machine. Follow engine manufacturerís instructions for lubrication of engine.

WARNING

Before servicing or doing any maintenance work around the engine area, make sure the engine has had time to cool. Serious burns can result if the engine or surrounding area is hot.

SECTION 3D. DIESEL ENGINE

GENERAL

Diesel engines used on this vehicle are 3-cylinder, 4-cycle, liquid cooled Perkins 100 Series. A ìWorkshopî manual is available from the engine manufacturer.

AIR CLEANER (See Figure 3D-1)

The air cleaner is a dry type with a replaceable element.

The filter element should be replaced before engine performance is affected. This may occur at 250 hours of service in very dirty operating conditions or at 500 hours in normal operating conditions.

Cleaning the filter element is not recommended because of the possibility of damaging the element.

To remove the air cleaner element, release the latches securing the cover to the air cleaner assembly. Remove the filter element.

Check the element for damage, pin holes, etc. by placing a light source such as a flashlight inside.

Clean dust from inside of housing with damp cloth, making sure dust does not enter air intake.

Check all gaskets to be sure they are not damaged or loose.

Replace the element if it is damaged or is excessively clogged with dirt and/or debris.

Insert element in housing open end first.

Position the cover so that the dust collector is pointing down. Clamp cover into position with collector pointing down. The dust collector empties automatically when properly installed with collector down.

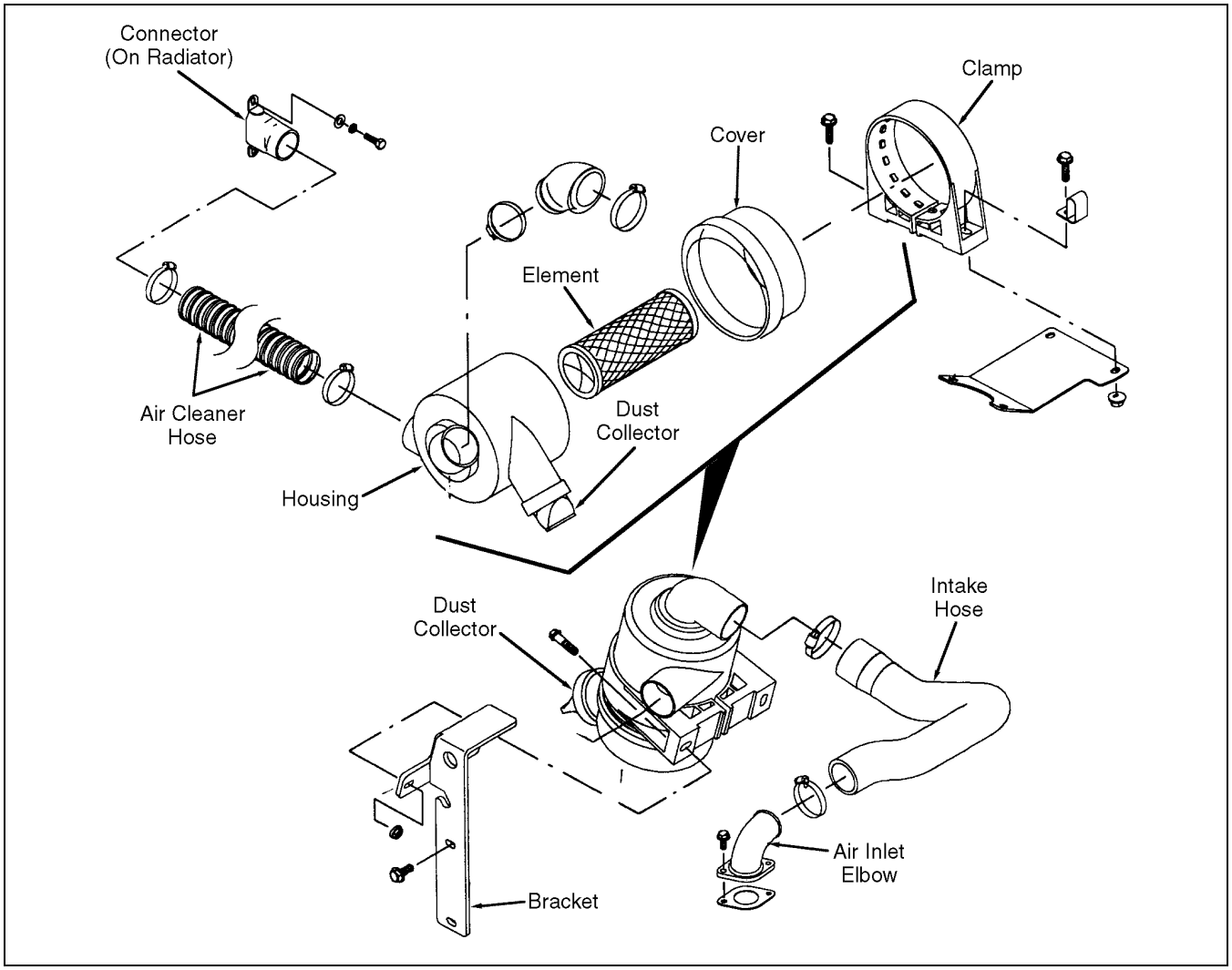

Figure 3D-1. Air Cleaner

SECTION 3D. DIESEL ENGINE

RADIATOR AND COOLING SYSTEM

The engine is equipped with a cooling radiator and an electric cooling fan.

⚠ WARNING

The cooling fan is thermostatically controlled and may start at any time. Even with the ignition key in the off position, do not attempt service without first disconnecting the negative (ñ) battery cable or without first removing the fan fuse.

The cooling system is under pressure, if a leak is present, be careful when raising the seat or when opening the engine cover. Hot coolant can be sprayed causing personal injury.

CHANGING OR REPLENISHING COOLANT

⚠ WARNING

Always make sure the engine is stopped and cool before removing the radiator cap. To prevent scalding by hot water, never remove cap while radiator is hot.

INSPECTING THE COOLING SYSTEM

Check the radiator and coolant hoses for leaks and faulty connections, repair as necessary (see Figure 3D-2).

Inspect the engine belts for fraying or cracking and check the engine for loose hardware.

Check the coolant reservoir (there should be approximately four 4 inches (102 mm) of coolant in the reservoir).

Remove the radiator cap and check the coolant level. The coolant should be at, or within a 1/4 inch (6 mm) from the bottom of the filler port (if coolant is needed, add a 50/50 anti-freeze/water mixture following the procedures stated below).

ADDING ANTI-FREEZE TO THE COOLING SYSTEM

The cooling system should be drained and refilled every 400 hours or nine (9) months.

Make a 50/50 mixture of anti-freeze and water in a separate container before adding coolant to the radiator. Never add straight anti-freeze to the radiator, the mixture must never be more than 50% anti-freeze. Cooling system capacity for the diesel engine is 5.0 qts. (4.7 L).

Unless the radiator is very low, always add coolant to the overflow reservoir, not to the radiator.

With the park brake applied and the gear selector in neutral, start the engine and let idle.

Remove the overflow reservoir cap, add the anti-freeze mixture to the overflow bottle until the coolant level reaches approximately 4 inches (102 mm) in the bottle, replace reservoir cap.

If the radiator level is very low, add the anti-freeze mixture directly to the radiator until it reaches approximately 1/4 inch (6 mm) from the bottom of the filler neck, then start the engine and add mixture to the overflow reservoir until proper level is reached.

CHANGING COOLANT (See Figure 3D-2)

1. Remove the radiator cap when the engine is cool.
2. Remove drain plug and drain coolant.
3. Remove and drain overflow bottle.
4. Reinstall plug.
5. Reinstall overflow tank.
6. Fill the cooling system with 5.0 qts. (4.7 L) of coolant (includes engine, radiator and overflow bottle) and run engine for 2 or 3 minutes at idle. This forces out air which still may be trapped within the cooling system. Stop engine and add coolant as necessary until coolant level reaches the filler throat of radiator. Reinstall radiator cap.
7. Add coolant to reservoir tank so that the level is at the full mark.

CLEANING RADIATOR CORE

Keep the radiator intake screen (see Figure 3D-2), radiator fins and surrounding engine areas free of debris.

If the radiator fins or intake screen become dirty, air cannot circulate well enough to cool the engine sufficiently, therefore you risk the chance of the engine overheating.

Clean the radiator fins with compressed air. If water is used to clean the radiator, use compressed air to blow all the water from the fins. Water left between the fins will collect dirt and plug the radiator, this will reduce the amount of air flow to properly cool the engine.

SECTION 3D. DIESEL ENGINE

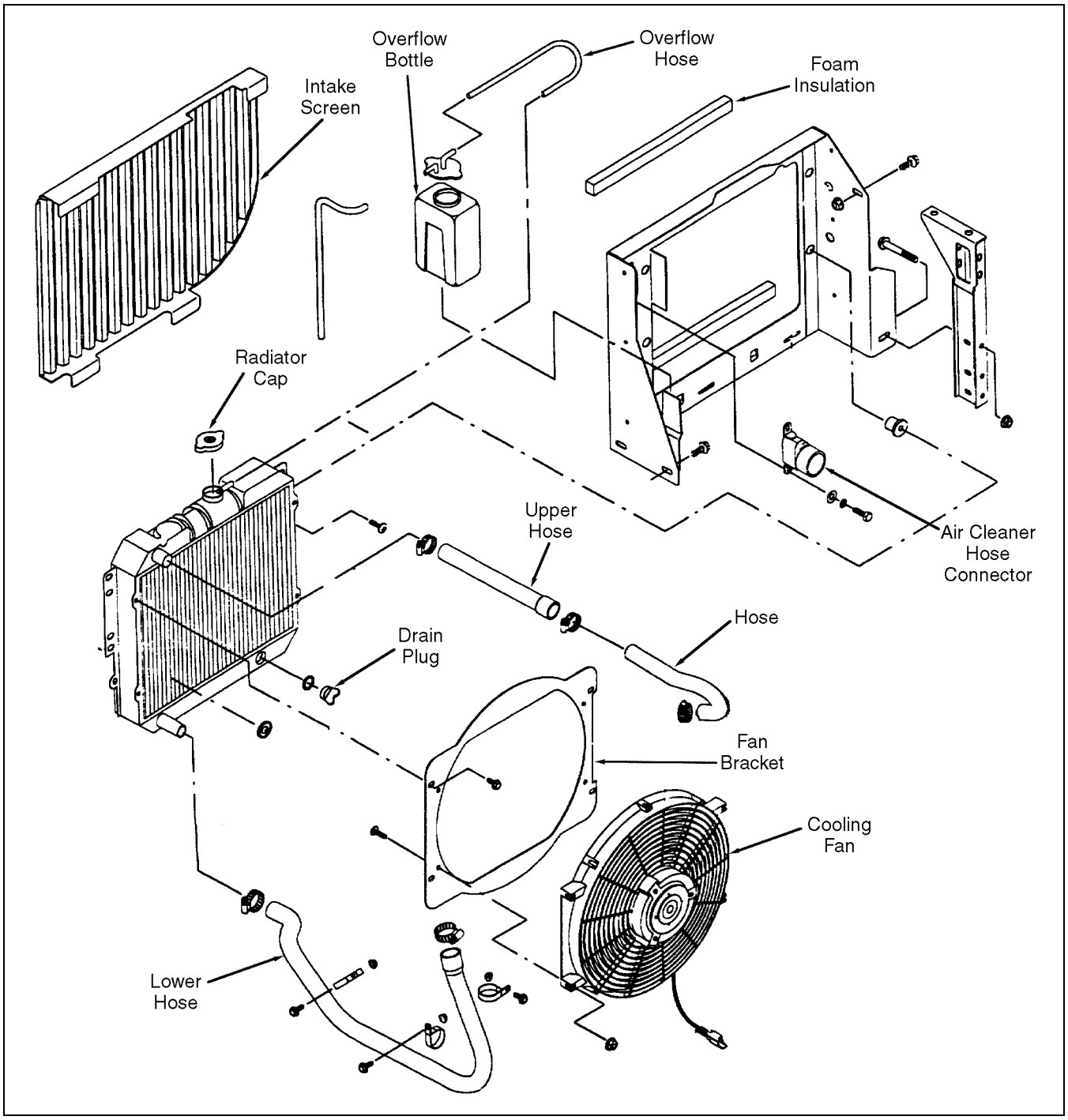

Figure 3D-2. Radiator and Cooling System Repair

SECTION 3D. DIESEL ENGINE

MUFFLER AND EXHAUST SYSTEM (See Figure 3D-3)

WARNING

To avoid danger of being burned, do not touch exhaust system when system is hot. Any service on exhaust system should be performed when system is cool.

INSPECTION

1. Check rubber mountings for damage, deterioration and out of position.
2. Check exhaust system for leakage, loose connections, dents and damages. If nuts or bolts are loose, tighten them to 29 to 43 ft-lbs. (40 to 60 N.m).
3. Check nearby body areas for damaged, missing, or mispositioned parts, open seams, holes, loose connections or other defects which could permit exhaust fumes to seep into the vehicle.

REPAIR

Remove and replace damaged mufflers, hoses and other exhaust system components as shown in Figure 3D-3.

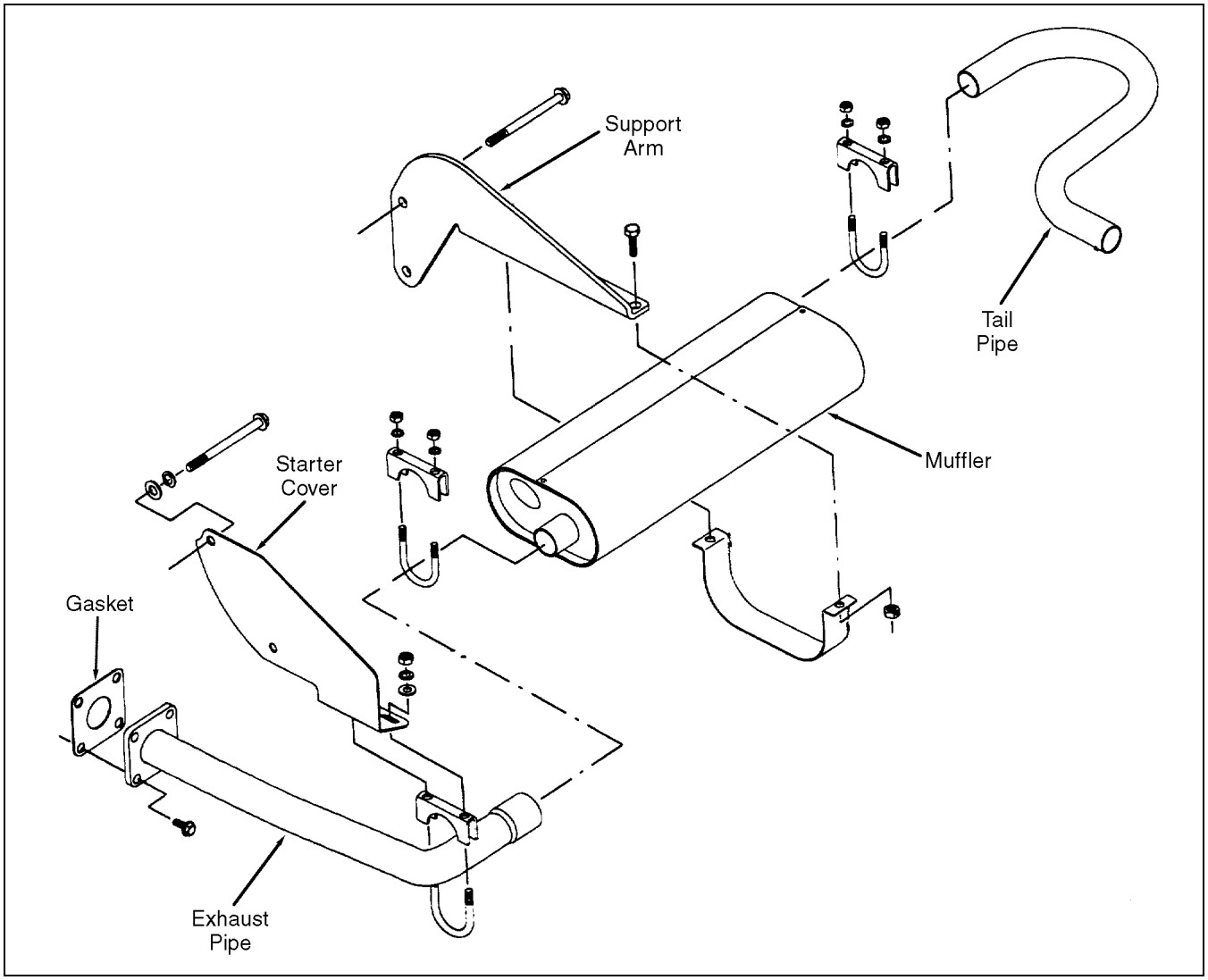

Figure 3D-3. Muffler and Exhaust System

SECTION 3D. DIESEL ENGINE

FUEL FILTER SERVICE (See Figure 3D-4)

There are two fuel filters in the diesel engine fuel system. A pre-filter is located in-line between the fuel tank and inlet to the fuel pump. A larger cartridge filter is located between the outlet of the fuel pump and the engine fuel injection pump.

Moisture and other foreign matter accumulate in the fuel filters. Periodically clear and replace the filter elements (refer to SECTION 11).

Purge air from the fuel system whenever filters are replaced.

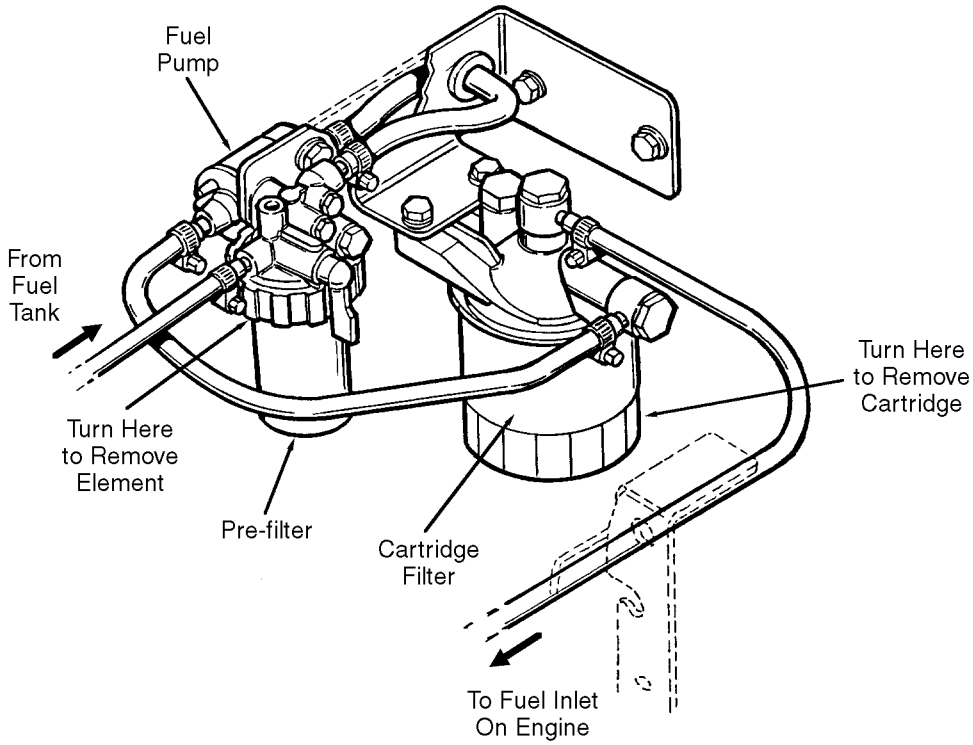

Figure 3D-4. Fuel Filter Service

PURGING THE FUEL SYSTEM

The diesel fuel system must be purged when starting a new diesel engine for the first time, after prolonged storage, the fuel tank is allowed to run dry, or when the fuel filter and/or fuel lines have been loosened, removed or replaced.

Purge the fuel system using one of the procedures as follows:

PURGING FUEL SYSTEM USING A JUMPER WIRE

This method allows the fuel pump to run continuously when purging the system.

1. Turn the ignition key to the ìOFFî position.
2. Disconnect the white/red wire from the starter solenoid.

⚠ WARNING

Failure to remove this wire may result in the starter engaging causing the vehicle to move. This movement could result in personal injury and/or property damage.

3. Clip one end of a jumper wire to the EXC terminal on the back of the alternator as shown in Figure **3D-5**. (This terminal will have a green wire connected to it.)
4. Clip the other end of the jumper wire to the ìIî terminal on the starter solenoid.

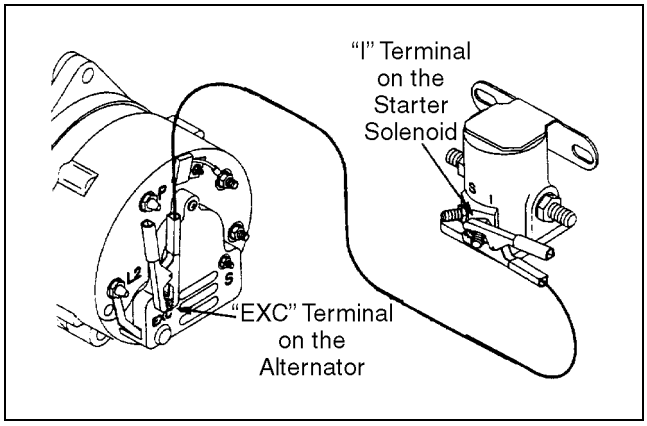

Figure 3D-5. Jumper Wire to Alternator and Solenoid

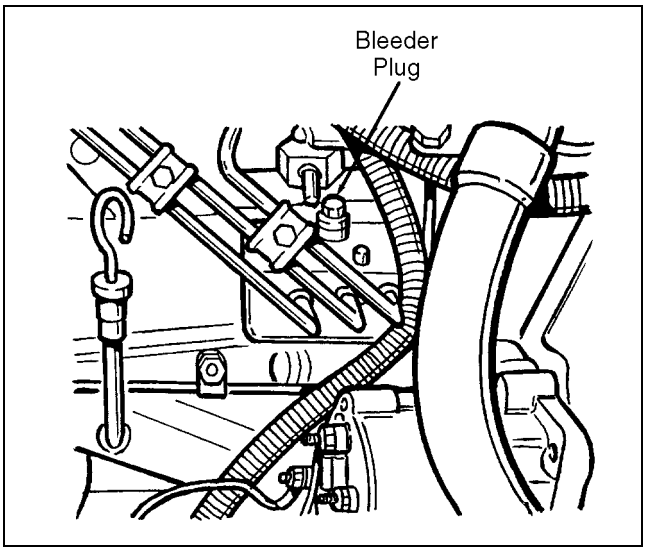

Figure 3D-6. Bleeder Plug

5. Open the bleeder plug located on top of the fuel injector (see Figure **3D-6**).
6. Turn the ignition key to the ìONî position (the fuel pump will begin to pump). When the fuel pump is pumping fuel only, the ìthumpingî sound will become more of a ìpurringî sound, when this occurs tighten the bleeder plug.
7. Turn the ignition key to the ìOFFî position, remove the jumper wire and reconnect the white with red wire onto the starter solenoid.

PURGING FUEL SYSTEM WITHOUT THE USE OF A JUMPER WIRE

Fuel system bleed may be accomplished using the glow plug timer if no jumper wire is available.

1. Open the bleeder plug on top of the fuel injector pump (see Figure **3D-6**).
2. Turn the ignition key to the ìONî position. The fuel pump will be activated for about 20 seconds until the glow plug timer stops.
3. When the timer stops, turn the key to the ìOFFî position, then turn it back to the ìONî position, the fuel pump will run again for approximately 20 seconds, when the glow plug timer stops, turn the key off again. Continue with this procedure until the system is purged. When the fuel pump is pumping fuel only, the ìthumpingî sound will be more of a ìpurringî sound, when this occurs, tighten the bleeder plug.

SECTION 3D. DIESEL ENGINE

ENGINE REMOVAL

1. Open engine cover.
2. Disconnect NEG (ñ) battery cable from battery.
3. Drain engine cooling water and hydraulic fluid.
4. Remove radiator hoses and air cleaner hose.
5. Remove radiator.
6. Tag and disconnect wiring from engine.
7. Disconnect accelerator and governor cables from engine.
8. Remove drive shaft.
9. Shut off the fuel and remove fuel line.
10. Disconnect clutch cable and return spring from clutch lever.
11. Remove transmission mounting hardware from clutch housing.
12. Connect a suitable lifting device to the engine.
13. Remove engine mounting hardware.
14. Using suitable hoist carefully lift engine and pull away from transmission to remove.

NOTE

Clutch disc and cover will be removed with engine.

ENGINE INSTALLATION

1. Using a suitable lifting device, lift engine and position in-line with transmission.
2. Push engine toward transmission so drive shaft splines of transmission engage clutch. It may be necessary to rotate transmission gearing to index clutch disc splines.
3. Fasten engine to bell housing.
4. Install engine mounting hardware.
5. Reconnect clutch cable to clutch arm and reconnect return spring. To adjust see SECTION 2C.
6. Install drive shaft.
7. Reconnect accelerator and governor cables. See SECTION 2C for adjustments.
8. Reconnect exhaust pipe.
9. Reconnect intake and return fuel lines.
10. Reconnect electrical wiring.
11. Install radiator and hoses.
12. Install air cleaner hose.
13. Fill cooling system.
14. Purge air from the fuel system as described in this section.

SECTION 3E. GASOLINE ENGINES

GENERAL

The gasoline engine used in your vehicle is a 3-cylinder Suzuki 660 with either a conventional or electronic fuel injected (EFI) system. An engine service manual for both engines is available from your dealer.

SPARK PLUG WIRES

1. Remove high tension coil cable at ignition coil while gripping its cap.

⚠ CAUTION

Removal of spark plug wires together with clamps is recommended so as not to damage their inside wire. For the same reason, pull out each connection by gripping at the cap.

2. Remove distributor cap with spark plug wires installed.
3. Remove high tension cable clamp from cylinder head cover.
4. Pull out spark plug wire from each spark plug while gripping its cap.
5. Use an ohmmeter to measure spark plug wire resistance. Resistance should be 3 ñ 6.7 k/ft. (10 to 22 k/m).
6. If resistance is outside of specified reading, inspect and replace the distributor cap and/or spark plug wires as required.

⚠ CAUTION

Never use metal conductor high tension wires as replacement parts. Insert each cap portion fully when installing spark plug wires.

SPARK PLUGS

1. Pull out spark plug wires by gripping their caps and then remove the spark plugs.
2. Inspect for electrode wear, carbon deposits and insulator damage.
3. If any problem is found, adjust spark plug air gap, clean with spark plug cleaner or replace them with specified new plugs.
4. Gap spark plugs to 0.032 to 0.035 inch (0.8 to 0.9 mm).
5. Torque spark plugs to 18.5 to 21.5 ft-lbs. (25 to 30 N.m).
6. Install spark plug wires securely by gripping their caps.

IGNITION SYSTEM (CONVENTIONAL)

The basic components of this ignition system are ignition coil, distributor and spark plugs. The components of the distributor are signal generator (signal rotor and pickup coil), igniter, rotor, cap and both vacuum and centrifugal advance.

When the distributor shaft rotates, the magnetic flux passing through the pickup coil varies due to the change in air gap between the pickup coil and the signal rotor. As a result, the alternating current voltage is induced in the pickup coil.

The voltage induced, turns on and off the igniter which switched off the ignition coil primary current. Thus, the high voltage is induced in the secondary winding of ignition coil and ignition sparks are generated at the spark plugs.

The spark advance is produced by the vacuum advancer which operates based on the engine vacuum and centrifugal advancer.

IGNITION COIL TEST (See Figure 3E-1)

Measure resistances of primary and secondary windings of the ignition coil at 68∞F (20∞C). If resistance is out of specification replace coil with a new one.

Primary Winding Resistance	1.08 to 1.32 Ω (Ohms)
Secondary Winding Resistance	22.1 to 29.2 Ω (Ohms)

SECTION 3E. GASOLINE ENGINES

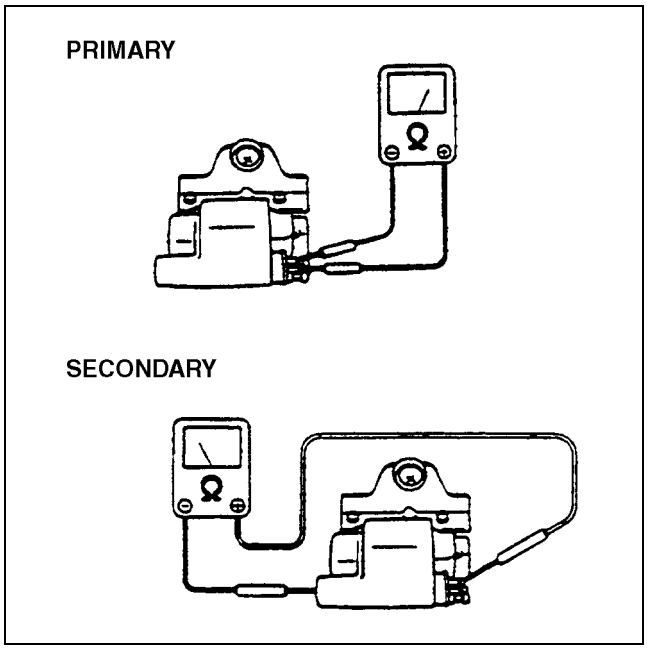

Figure 3E-1. Ignition Coil Test

CARBURETOR (CONVENTIONAL)

Carburetor adjustments (choke/throttle) are covered in SECTION 2C. Cleaning and rebuilding of carburetors is included in great detail in engine manufacturerís Service Manual.

AIR CLEANER (CONVENTIONAL) (See Figure 3E-2)

The air cleaner is a dry type with a replaceable element.

The filter element should be replaced before engine performance is affected. This may occur at 250 hours of service in very dirty operating conditions or at 500 hours in normal operating conditions.

Cleaning the filter element is not recommended because of the possibility of damaging the element.

To remove the air cleaner element release the latches securing the cover to the air cleaner assembly. Remove the filter element.

Check the element for damage, pin holes, etc. by placing a light source such as a flashlight inside.

Clean dust from inside of housing with damp cloth, making sure dust does not enter air intake.

Check all gaskets to be sure they are not damaged or loose.

Replace the element if it is damaged or is excessively clogged with dirt and/or debris.

Insert element in housing open end first.

Position the cover so that the dust collector is pointing down. Clamp cover into position with collector pointing down. The dust collector empties automatically when properly installed with collector down.

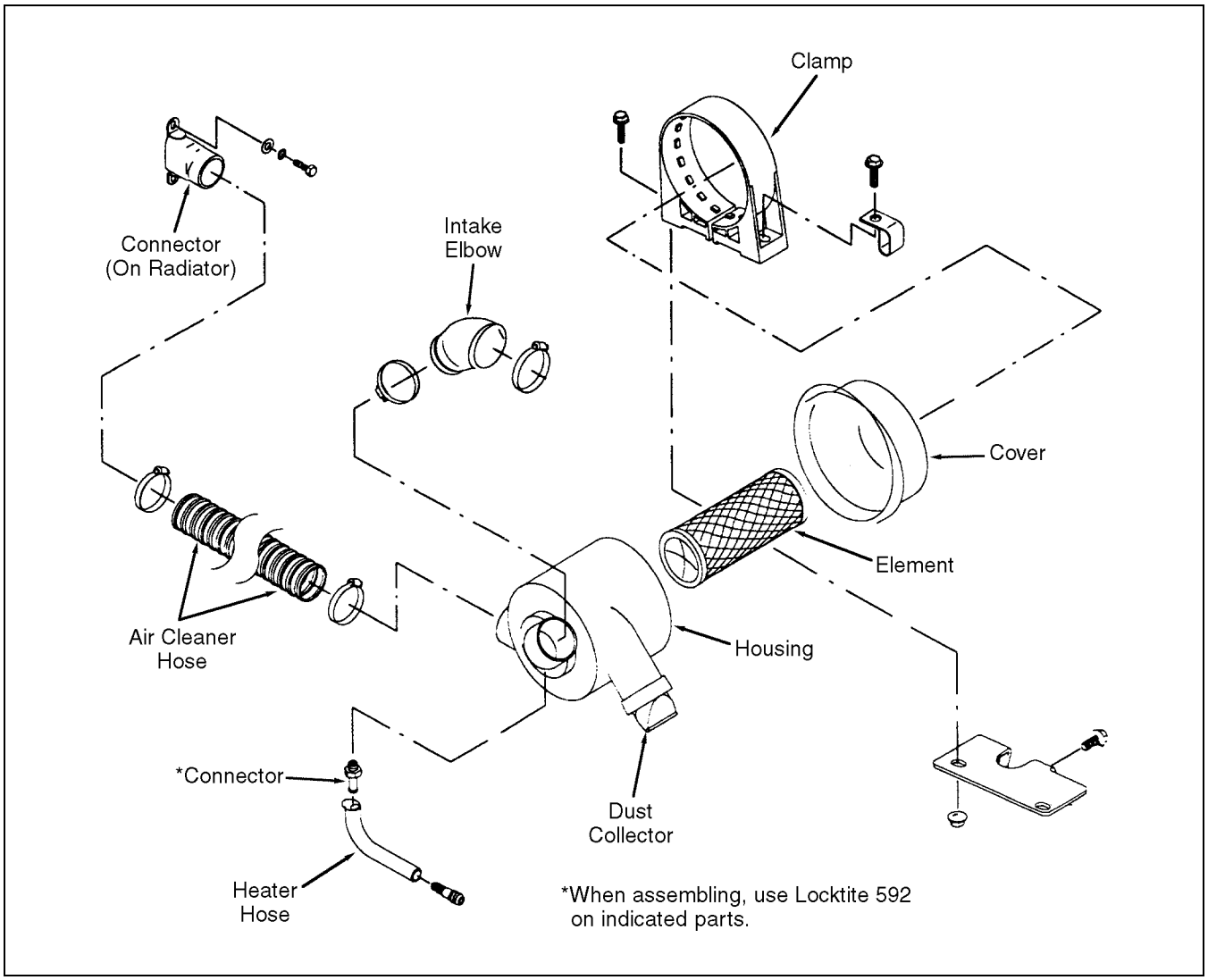

Figure 3E-2. Air Cleaner (Conventional)

IGNITION SYSTEM (EFI)

The engine uses a solid-state ignition system.

The basic components of this ignition system are ignition coil, distributor and spark plugs. The components of the distributor are signal generator (signal rotor and pickup coil), igniter, rotor, cap and both vacuum and centrifugal advance.

When the distributor shaft rotates, the magnetic flux passing through the pickup coil varies due to the change in air gap between the pickup coil and the signal rotor. As a result, the alternating current voltage is induced in the pickup coil.

The voltage induced turns on and off the igniter which switches off the ignition coil primary current. Thus, the high voltage is induced in the secondary winding of ignition coil and ignition sparks are generated at the spark plugs.

The spark advance is produced by the vacuum advancer which operates based on the engine vacuum and centrifugal advancer.

IGNITION COIL TEST (See Figure 3E-3)

Measure resistances of primary and secondary windings of the ignition coils at 68∝F (20∝C). If resistance is out of specification replace coil with a new one.

Primary Winding Resistance	1.08 to 1.32 Ω (Ohms)
Secondary Winding Resistance	22.1 to 29.2 Ω (Ohms)

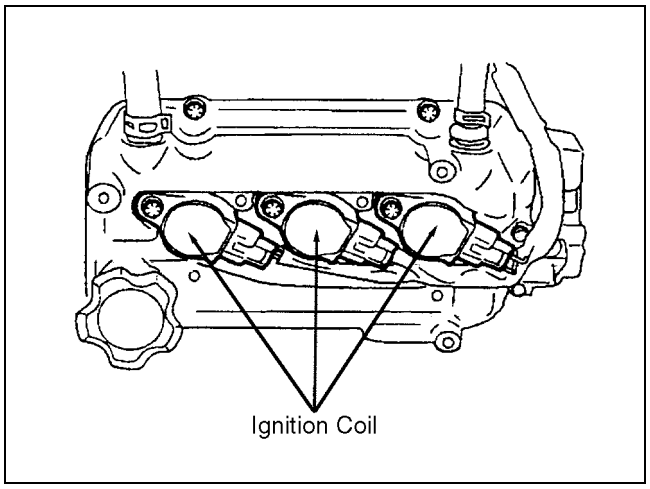

Figure 3E-3. Ignition Coil Test

SPARK PLUG WIRES

1. Remove high tension coil cable at ignition coil while gripping its cap.
2. Remove distributor cap with spark plug wires installed.
3. Remove high tension cable clamp from cylinder head cover.
4. Pull out spark plug wire from each spark plug while gripping its cap.

CAUTION

Removal of spark plug wires together with clamps is recommended so as not to damage their inside wire. For the same reason, pull out each connection by gripping at the cap.

5. Use an ohmmeter to measure spark plug wire resistance. Resistance should be 10 to 20kæ (kilohms).
6. If resistance is outside of specified reading, inspect and replace the distributor cap and/or spark plug wires as required.

FUEL INJECTORS AND ENGINE CONTROL UNIT

This engine utilizes fuel injectors controlled by an electronic engine control unit (ECU). Testing and service of the fuel injector system and the engine control unit is included in the Engine Service Manual (P/N 4115756).

AIR CLEANER (EFI) (See Figure 3D-1)

The air cleaner is a dry type with a replaceable element.

The filter element should be replaced before engine performance is affected. This may occur at 250 hours of service in very dirty operating conditions or at 500 hours in normal operating conditions.

Cleaning the filter element is not recommended because of the possibility of damaging the element.

To remove the air cleaner element remove the cover retainer securing the cover to the air cleaner assembly. Remove the cover and the filter element.

Check the element for damage, pin holes, etc. by placing a light source such as a flashlight inside.

Clean dust from inside of housing with damp cloth, making sure dust does not enter air intake.

Replace the element if it is damaged or is excessively clogged with dirt and/or debris.

Insert element in housing open end first.

Position the housing so that the dust collector is pointing down and secure with cover retainer. The dust collector empties automatically when properly installed with collector down.

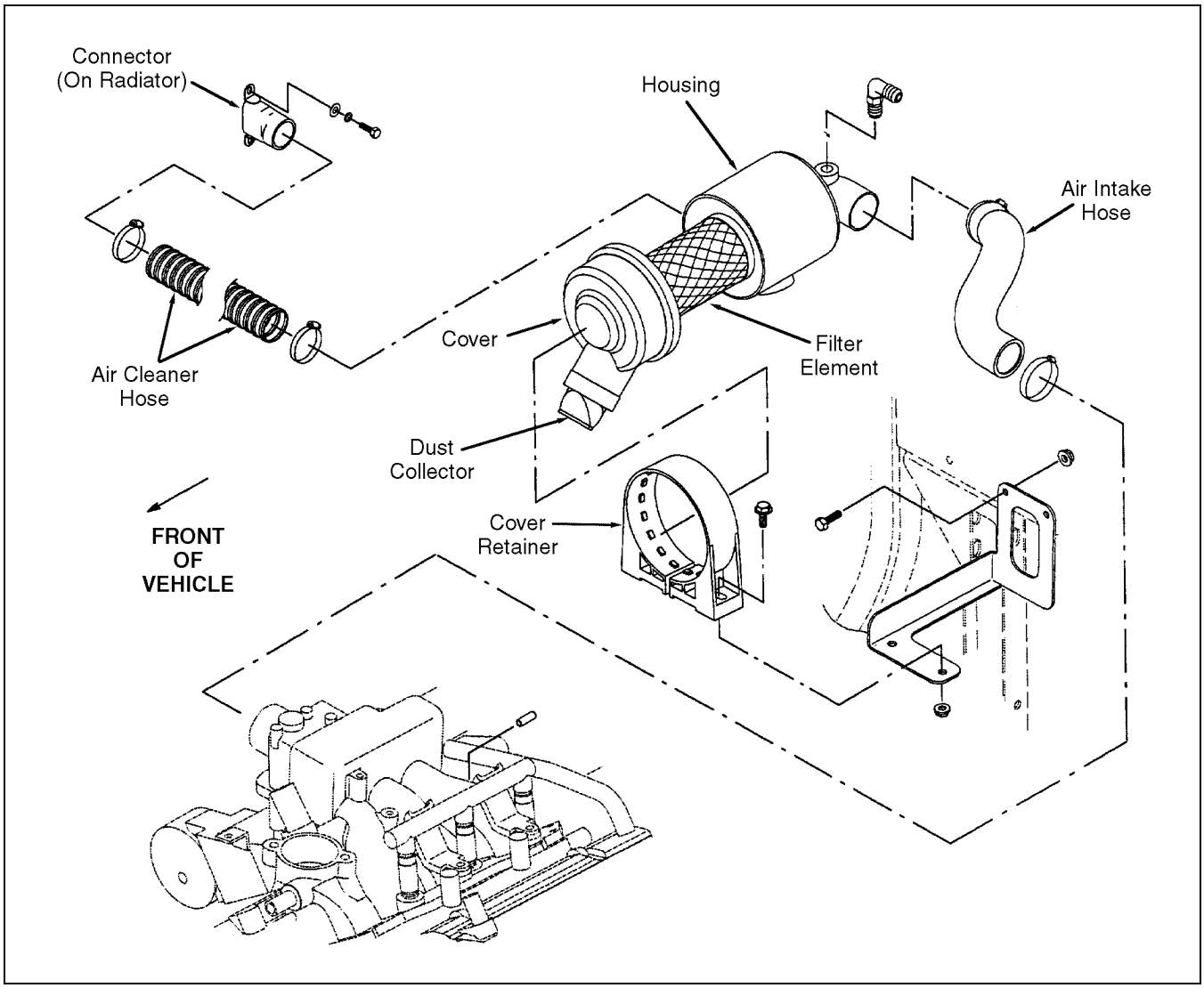

Figure 3E-4. Air Cleaner (EFI)

SECTION 3E. GASOLINE ENGINES

RADIATOR AND COOLING SYSTEM

The engine is equipped with a cooling radiator and an electric cooling fan.

⚠ WARNING

The cooling fan is thermostatically controlled and may start at any time. Even with the ignition key in the off position, do not attempt service without first disconnecting the negative (ñ) battery cable or without first removing the fan fuse.

The cooling system is under pressure, if a leak is present, be careful when raising the seat or when opening the engine cover. Hot coolant can be sprayed causing personal injury.

CHANGING OR REPLENISHING COOLANT

⚠ WARNING

Always make sure the engine is stopped and cool before removing the radiator cap. To prevent scalding by hot water, never remove cap while radiator is hot.

INSPECTING THE COOLING SYSTEM

Check the radiator and coolant hoses for leaks and faulty connections, repair as necessary (see Figures **3E-5** and **3E-6**).

Inspect the engine belts for fraying or cracking and check the engine for loose hardware.

Check the coolant reservoir (there should be approximately 4 inches (102 mm) of coolant in the reservoir).

Remove the radiator cap and check the coolant level. The coolant should be at, or within a 1/4 inch (6 mm) from the bottom of the filler port (if coolant is needed, add a 50/50 anti-freeze/water mixture following the procedures stated below).

ADDING ANTI-FREEZE TO THE COOLING SYSTEM

The cooling system should be drained and refilled every 400 hours or nine (9) months.

Make a 50/50 mixture of anti-freeze and water in a separate container before adding coolant to the radiator. Never add straight anti-freeze to the radiator, the mixture must never be more than 50% anti-freeze. Cooling system capacity for the diesel engine is 5.0 qts. (4.7 L).

Unless the radiator is very low, always add coolant to the overflow reservoir, not to the radiator.

With the park brake applied and the gear selector in neutral, start the engine and let idle.

Remove the overflow reservoir cap, add the anti-freeze mixture to the overflow bottle until the coolant level reaches approximately 4 inches (102 mm) in the bottle, replace reservoir cap.

If the radiator level is very low, add the anti-freeze mixture directly to the radiator until it reaches approximately 1/4 inch (6 mm) from the bottom of the filler neck, then start the engine and add mixture to the overflow reservoir until proper level is reached.

CHANGING COOLANT (See Figures 3E-5 and 3E-6)

1. Remove the radiator cap when the engine is cool.
2. Remove drain plug and drain coolant.
3. Remove and drain overflow bottle.
4. Reinstall plug.
5. Reinstall overflow tank.
6. Fill the cooling system with 5.0 qts. (4.7 L) of coolant (includes engine, radiator and overflow bottle) and run engine for 2 or 3 minutes at idle. This forces out air which still may be trapped within the cooling system. Stop engine and add coolant as necessary until coolant level reaches the filler throat of radiator. Reinstall radiator cap.
7. Add coolant to reservoir tank so that the level is at the full mark.

CLEANING RADIATOR CORE

Keep the radiator intake screen (see Figures **3E-5** and **3E-6**), radiator fins and surrounding engine areas free of debris.

If the radiator fins or intake screen become dirty, air cannot circulate well enough to cool the engine sufficiently, therefore you risk the chance of the engine overheating.

Clean the radiator fins with compressed air. If water is used to clean the radiator, use compressed air to blow all the water from the fins. Water left between the fins will collect dirt and plug the radiator, this will reduce the amount of air flow to properly cool the engine.

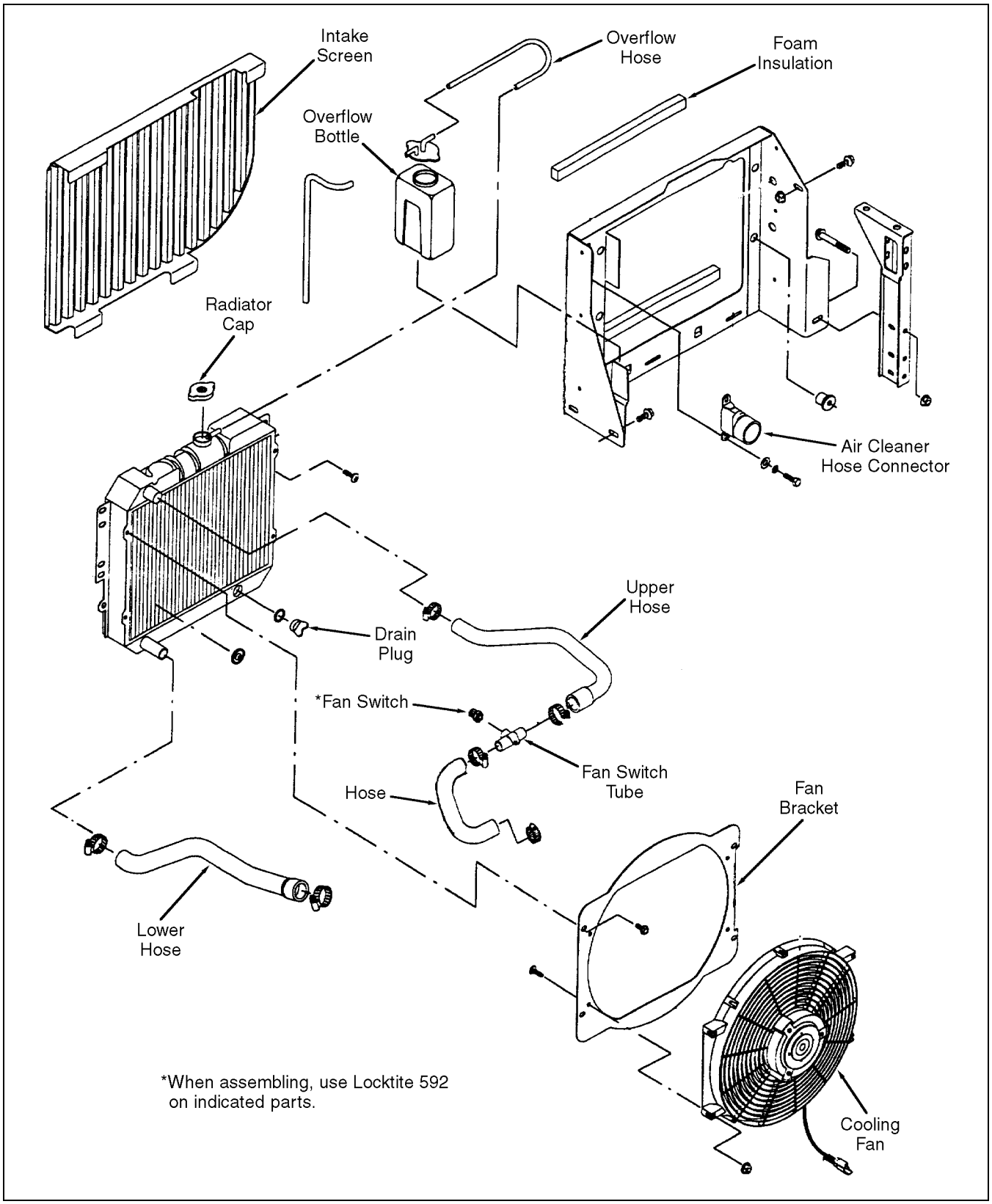

Figure 3E-5. Radiator and Cooling System (Conventional)

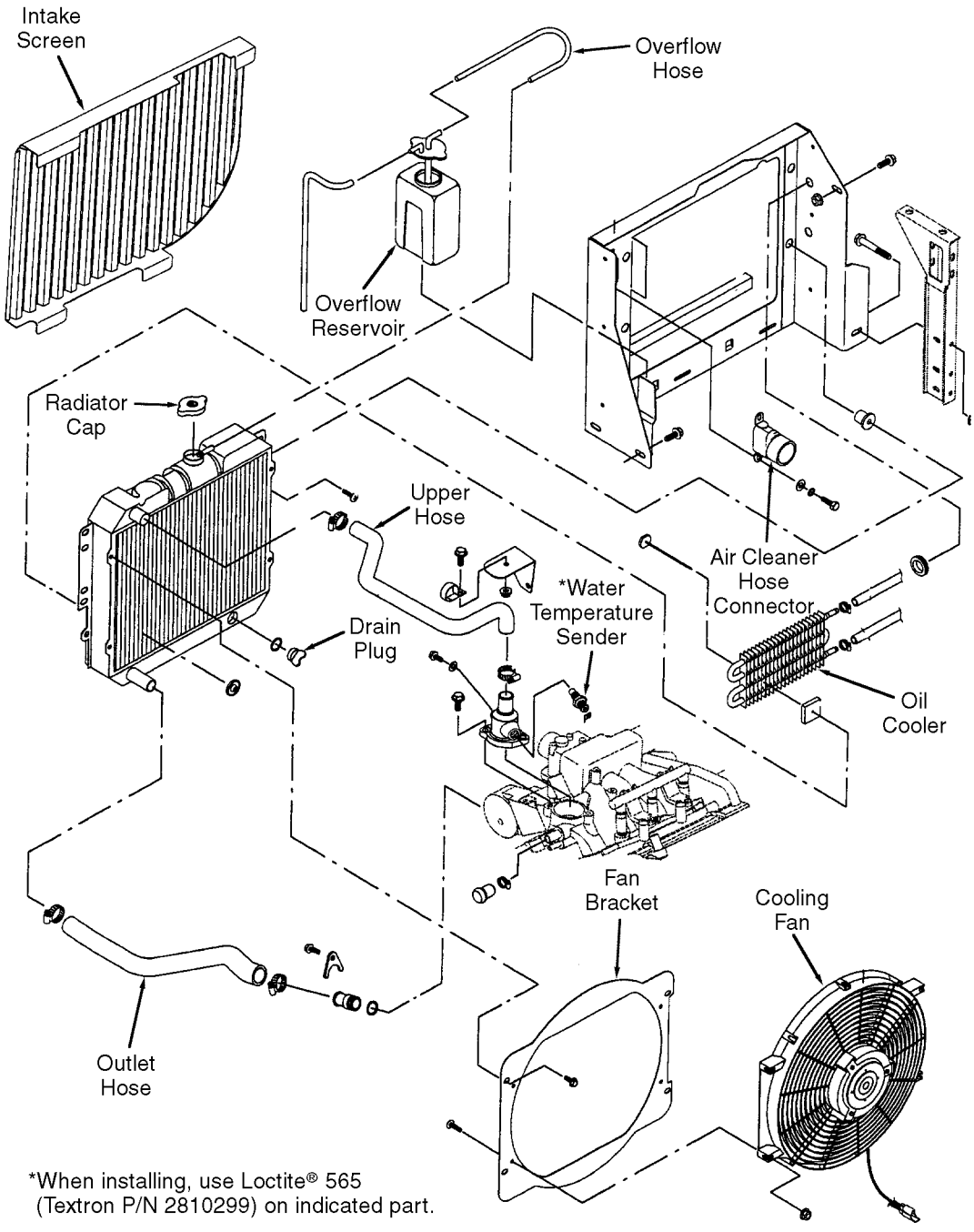

Figure 3E-6. Radiator and Cooling System (EFI)

SECTION 3E. GASOLINE ENGINES

MUFFLER AND EXHAUST SYSTEM (See Figures 3E-7 and 3E-8)

WARNING

To avoid danger of being burned, do not touch exhaust system when system is hot. Any service on exhaust system should be performed when system is cool.

INSPECTION

1. Check rubber mountings for damage, deterioration and out of position.
2. Check exhaust system for leakage, loose connections, dents and damages. If nuts or bolts are loose, tighten them to 29 to 43 ft-lbs. (40 to 60 N.m).
3. Check nearby body areas for damaged, missing, or mispositioned parts, open seams, holes, loose connections or other defects which could permit exhaust fumes to seep into the vehicle.

REPAIR

Remove and replace damaged mufflers, hoses and other exhaust system components as shown in Figures 3E-7 and 3E-8.

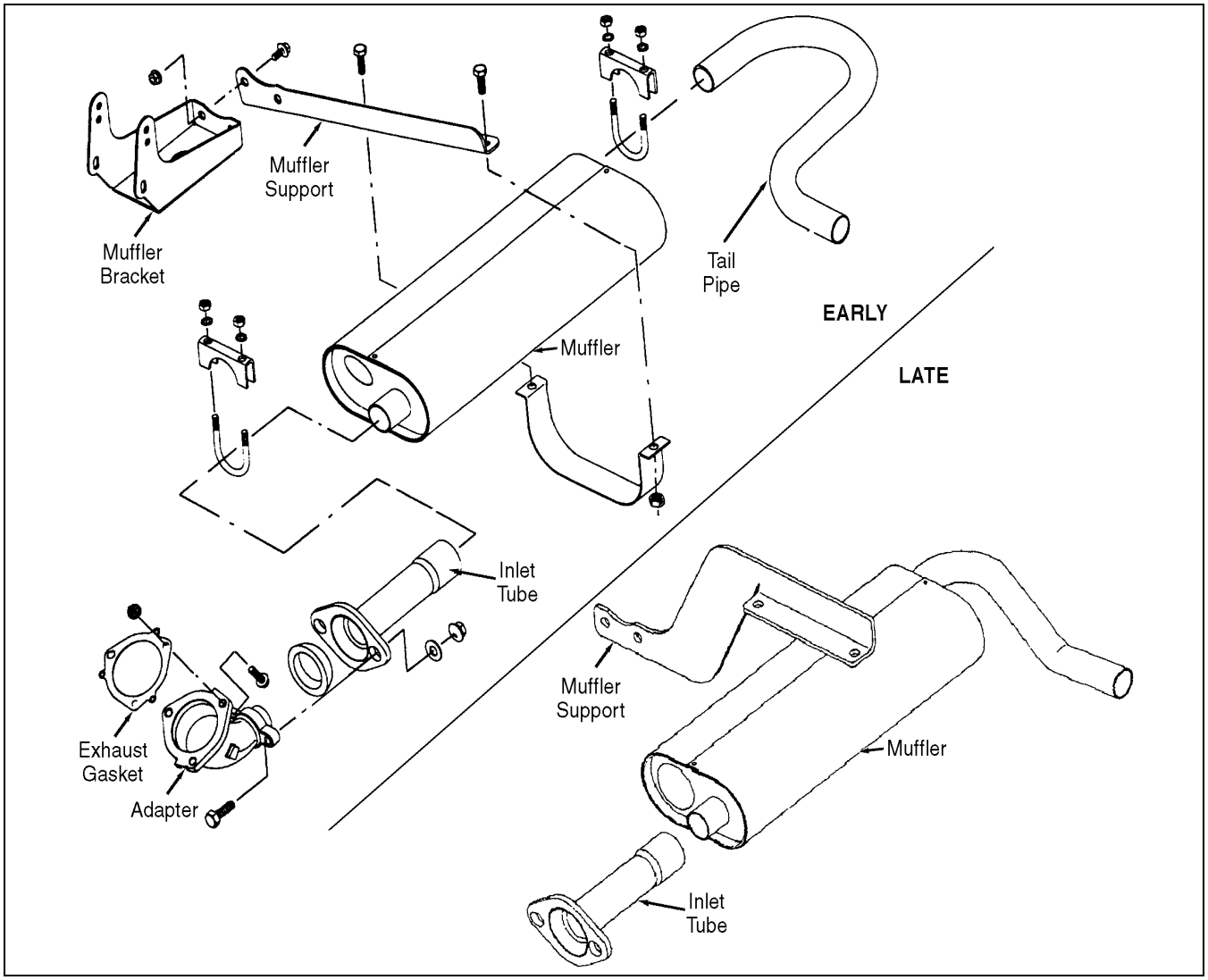

Figure 3E-7. Muffler and Exhaust System ó 3-Cylinder Engine (Suzuki 660)

SECTION 3E. GASOLINE ENGINES

FUEL FILTER SERVICE (See Figure 3E-8)

REMOVAL

1. Remove negative (ñ) battery cable.
2. Remove fuel filler cap from fuel filler neck at fuel tank to release fuel vapor pressure. After releasing vapor, reinstall cap.
3. Hoist vehicle.
4. Place fuel container under fuel filter.
5. Disconnect inlet and outlet hoses from fuel filter using two wrenches.
6. Remove fuel filter from body.

INSTALLATION

1. Position the new filter in place and connect the inlet and outlet hoses to it.
2. Lower vehicle and reconnect negative (ñ) battery cable.

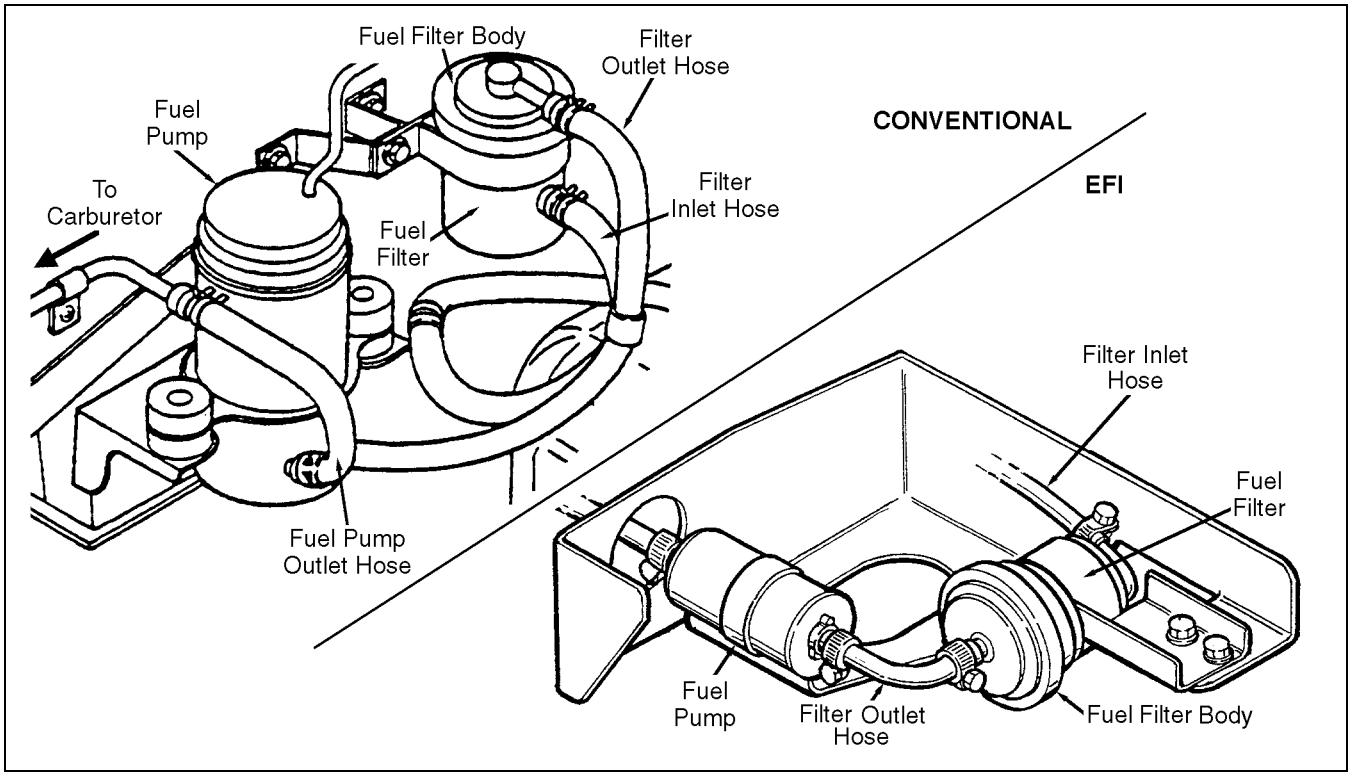

Figure 3E-8. Fuel Filter Service

ENGINE REMOVAL

1. Remove engine cover.
2. Disconnect NEG (ñ) battery cable from battery.
3. Drain engine cooling water and hydraulic fluid.
4. Remove radiator hoses and air cleaner hose.
5. Remove radiator.
6. Tag and disconnect wiring from engine.
7. Disconnect accelerator and governor cables from engine.
8. Remove drive shaft.
9. Shut off the fuel and remove fuel line.
10. Disconnect clutch cable and return spring from clutch lever.
11. Remove transmission mounting hardware from clutch housing.
12. Connect a suitable lifting device to the engine.
13. Remove engine mounting hardware.
14. Using suitable hoist carefully lift engine and pull away from transmission to remove.

NOTE

Clutch disc and cover will be removed with engine.

SECTION 3E. GASOLINE ENGINES

ENGINE INSTALLATION

1. Using a suitable lifting device, lift engine and position in-line with transmission.
2. Push engine toward transmission so drive shaft splines of transmission engage clutch. It may be necessary to rotate transmission gearing to index clutch disc splines.
3. Fasten engine to bell housing.
4. Install engine mounting hardware.
5. Reconnect clutch cable to clutch arm and reconnect return spring. To adjust see SECTION 2C.
6. Install drive shaft.
7. Reconnect accelerator and governor cables. See SECTION 2C for adjustments.
8. Reconnect exhaust pipe.
9. Reconnect intake and return fuel lines.
10. Reconnect electrical wiring.

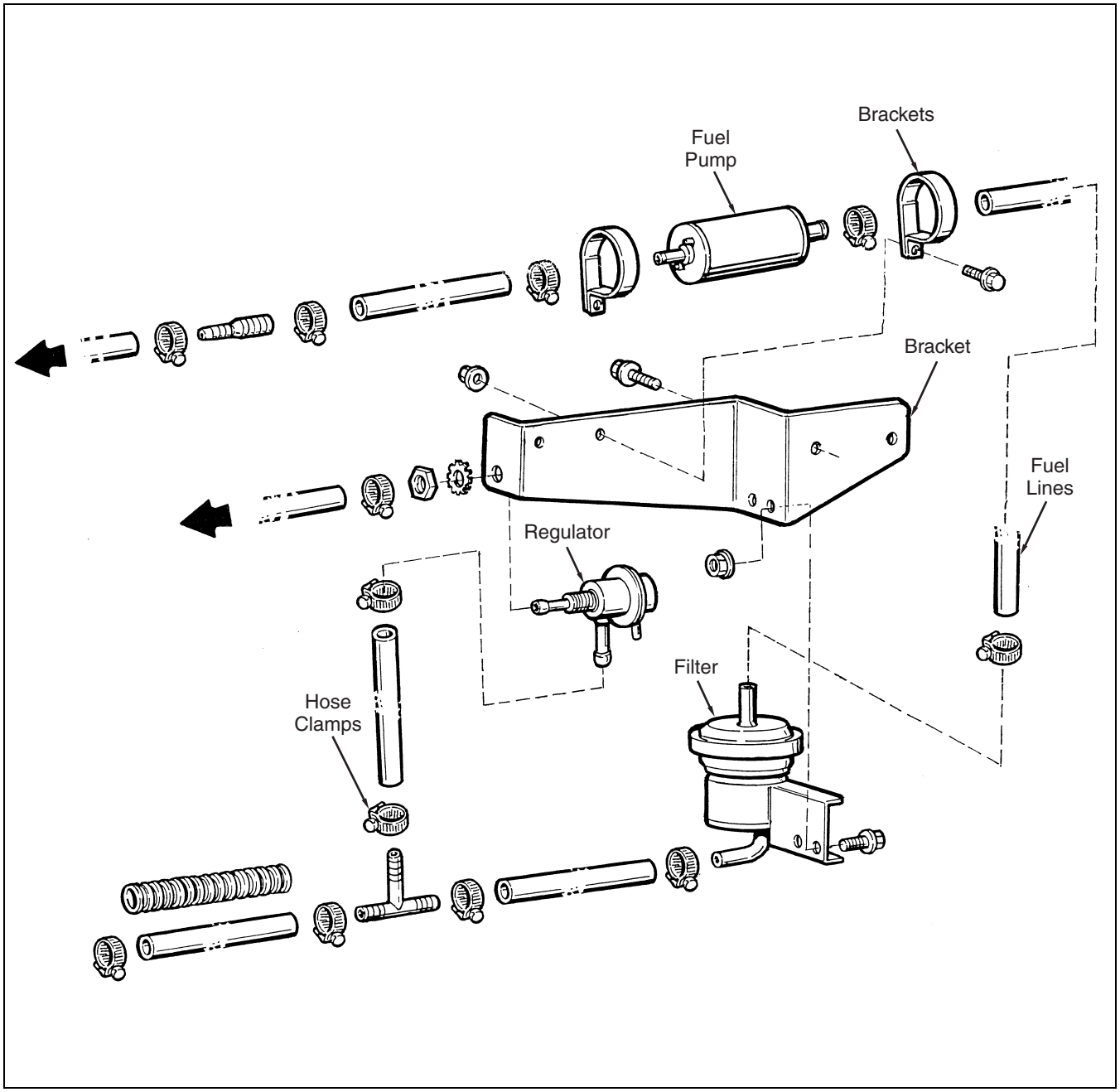

Figure 3E-9. EFI Fuel System

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SECTION 4
DRIVE TRAIN

SECTION 4A. REPAIR AND SERVICE TOOLS AND MATERIALS

Tools required:	Standard automotive hand tools. Blind hole bearing puller. Bearing and gear installation tools.
Cleaning materials:	Stoddard or equivalent solvent. Loctite® ìchiselî gasket remover or equivalent. Loctite® Sealant 518.
Lubricants:	Refer to SECTION 11. Loctite® Blue 243.

SECTION 4B. FAILURE ANALYSIS

PROBLEM	PROBABLE CAUSE	REMEDY
1. Noisy when vehicle moving forward or reverse.	a. Excessive gear backlash. b. Faulty U-joints.	a. Adjust (Section 4G or 4H). b. Repair (Section 4C).
2. Clunking sound when changing direction.	a. Axle drive U-joint faulty. b. Excessive differential gear backlash.	a. Repair (Section 4C). b. Adjust (Section 4I).
3. Control lever moves but will not shift.	a. Control lever assembly broken or damaged. b. Damaged offset lever, shift fork, selector plate or selector arm.	a. Replace control lever or housing assembly (Section 4G or 4H). b. Remove shifter case cover. Check for damaged parts. Replace damaged parts (Section 4G).
4. Hard shift or control lever will not move into gear.	a. Clutch not releasing. b. Improper or low transmission lubricant. c. Shifter shaft or shift rail binding. d. Binding of sliding synchronizer or gears. e. Reverse only, seized backup switch.	a. Adjust or replace clutch (Section 4D). b. Add or drain and replace with proper lubricant (Section 11). c. Remove shifter case cover. Check for damaged parts. Replace damaged parts (Section 4G or 4H). d. Remove shifter case cover. Check that synchronizers and gears (parts with shifting grooves) slide freely on shafts. Remove and replace damaged parts (Section 4G or 4H). e. Remove and check backup switch. Replace if seized (Section 10).
5. Slipping clutch.	a. Loss of clearance at the tip of release fork. b. Clutch facings dirty with oil or excessively worn. c. Weakened diaphragm spring. d. Distorted pressure plate or flywheel surface. e. Improper clutch pedal free travel.	a. Adjust (Section 4D). b. Replace (Section 4D). c. Replace (Section 4D). d. Replace (Section 4D). e. Adjust and/or replace clutch facings (Section 4D).
6. Dragging clutch.	a. Improper clutch pedal free travel. b. Weakened diaphragm spring or worn spring tip. c. Damaged or worn splines of transmission input shaft. d. Front input shaft bearing worn or broken. e. Excessively wobbly clutch disc. f. Clutch facings broken or dirty with oil.	a. Adjust free travel (Section 4D). b. Replace (Section 4D). c. Replace (Section 4G or 4H). d. Replace (Section 4G or 4H). e. Replace (Section 4D). f. Replace (Section 4D).

SECTION 4B. FAILURE ANALYSIS

PROBLEM	PROBABLE CAUSE	REMEDY
7. Clutch vibration.	a. Glazed (glass-like) clutch facings or clutch facings dirty with oil. b. Wobbly clutch disc or poor facing contact. c. Weakened torsion springs (in clutch disc). d. Clutch disc rivets loose. e. Weakened engine mounting or loosened mounting bolt or nut.	a. Repair or replace (Section 4D). b. Replace (Section 4D). c. Replace (Section 4D). d. Replace the disc (Section 4D). e. Retighten or replace.
8. Noisy clutch.	a. Worn or broken release bearing. b. Front input shaft bearing worn down. c. Excessive rattle of clutch disc hub. d. Cracked clutch disc. e. Pressure plate and diaphragm spring rattling.	a. Replace (Section 4D). b. Replace (Section 4D). c. Replace the disc (Section 4D). d. Replace (Section 4D). e. Replace (Section 4D).
9. Grabbing clutch	a. Clutch facings soaked with oil. b. Excessively worn clutch facings. c. Rivet heads showing out of the facing. d. Weakened torsion springs.	a. Replace (Section 4D). b. Replace (Section 4D). c. Replace (Section 4D). d. Replace (Section 4D).
10. Gears clash when shifting.	a. Engine idle speed too high. b. Clutch damaged or out of adjustment. c. Pilot bearing between input shaft and output shaft binding. d. Damaged synchronizer. e. Damaged gear or gears.	a. Adjust idle speed to specifications. b. Adjust or replace clutch (Section 4D). c. Disassemble and check bearing rollers, input shaft ID and output shaft OD. Replace damaged parts. d. Disassemble and check for damaged synchronizer parts. Replace damaged parts (Section 4G or 4H). e. Disassemble and check for gear damage. Replace damaged gears (Section 4G or 4H).

SECTION 4B. FAILURE ANALYSIS

PROBLEM	PROBABLE CAUSE	REMEDY
11. Transmission jumps out of gear.	a. Shifting fork loose on shaft or rail; worn or damaged fork or inserts. b. Loose transmission or flywheel housing bolts. c. Synchronizer damaged or excessively worn. d. Blocking ring damaged, worn index slots or friction surfaces worn or damaged. e. Excessive countershaft end play.	a. Disassemble and check for wear or damage. Replace worn or damaged parts (Section 4G or 4H). b. Torque bolts to specifications (Section 4G or 4H). c. Disassemble and check for worn or damaged synchronizer parts. Replace damaged parts (Section 4G or 4H). d. Disassemble and check blocking ring for war or damage. Replace worn or damaged parts (Section 4G or 4H). e. Disassemble and check. Replace worn or damaged parts. Reshim if roller bearings used (Section 4G or 4H).
12. Transmission locked in one gear.	a. Fork or offset lever loose on shaft or rail. b. Worn or damaged forks, offset lever, shaft or rail. c. Worn or damaged synchronizer. d. Worn or damaged gears.	a. Remove shifter case cover. Check for loose parts on shifter shaft or rail. Replace roll pin(s). If still loose, replace shaft or rail and/or attached parts as required (Section 4G or 4H). b. Remove extension or adapter and case cover. Check for wear or damage. Replace damaged parts (Section 4G or 4H). c. Disassemble and check for worn or damaged synchronizer parts. Replace worn or damaged parts (Section 4G or 4H). d. Disassemble and check for worn or damaged gears. Replace worn or damaged gears (Section 4G or 4H).
13. Transmission noise. **NOTE** Make sure noise is coming from transmission and not clutch throwout bearing or other components.	a. Improper or low transmission lubricant. b. Loose bolts or other attaching parts. c. Noisy transmission bearings. d. Noisy gears.	a. Add or drain and replace with proper lubricant (Section 11). b. Make sure all attaching parts are torqued to specifications (Section 4G or 4H). c. Disassemble and check bearings, bearing rollers and parts in and on which they operate for wear or damage. Replace worn or damaged parts (Section 4G or 4H). d. Disassemble and check for worn or damaged gears (including speedometer gear). Replace worn or damaged gears (Section 4G or 4H).

SECTION 4B. FAILURE ANALYSIS

PROBLEM	PROBABLE CAUSE	REMEDY
14. Transmission leakage.	a. Vent or breather clogged. b. Too much or improper lubricant. c. Loose bolts at sealing faces. d. Improperly applied sealant. e. Worn or damaged oil seal.	a. Remove vent or breather and clean or replace (Section 4G or 4H). b. Remove fill plug to check for excess, or drain and replace (Section 4G or 4H). c. Torque bolts to specifications (Section 4G or 4H). d. Separate and thoroughly clean leaking surfaces. Reapply sealant. Replace parts and torque bolts to specifications (Section 4G or 4H). e. Replace oil seal (Section 4G or 4H).
15. Differential gear noise.	a. Maladjusted backlash between drive pinion and ring gear. b. Damaged gear teeth or improper mesh of drive pinion and ring gear. c. Improper tooth contact in the mesh between drive pinion and ring gear. d. Insufficient or wrong kind of gear oil. e. Ring gear wobbling when turning, or ring gear securing bolts loose. f. Broken or otherwise damaged teeth of side gears or differential pinion gears.	a. Adjust (Section 4K). b. Replace or adjust (Section 4K). c. Adjust (Section 4K). d. Replenish or replace (Section 4K). e. Replace or retighten (Section 4K). f. Replace (Section 4K).
16. Differential bearing noise.	a. (Constant noise.) Insufficient or wrong kind of gear oil. b. (Constant noise.) Damaged or worn bearings or worn parts. c. (Noise during coasting.) Damaged bearings of drive pinion. d. (Noise during turning.) Broken bearings on axle shafts.	a. Replenish or replace (Section 4K). b. Replace (Section 4K). c. Replace (Section 4K). d. Replace (Section 4K).

SECTION 4C. DRIVE SHAFT

GENERAL

The rear differential is driven by a universal joint type drive shaft connected between the transmission and rear differential (axle).

Repairs are limited to renewing the cross and bearings.

If the drive shaft or end yokes become damaged, they must be replaced as an assembly.

REMOVAL (See Figures 4C-1 and 4C-2)

NOTE

At least two service personnel are required to perform this procedure.

1. Disconnect control linkages and any cables that would prohibit pushing the drive shaft end of the transmission downward about 4 inches.
2. Remove hardware at transmission mounting brackets as shown in Figures 4C-1 and 4C-2.
3. Push down on the transmission upper mounting bracket until the drive shaft yoke can be freed of the transmission shaft.
4. Raise and support the transmission to its original mounted position.
5. Hold the input shaft of the differential while loosening the yoke nut with a box end wrench. Remove the nut and washer and pull the assembled drive shaft out of the differential.

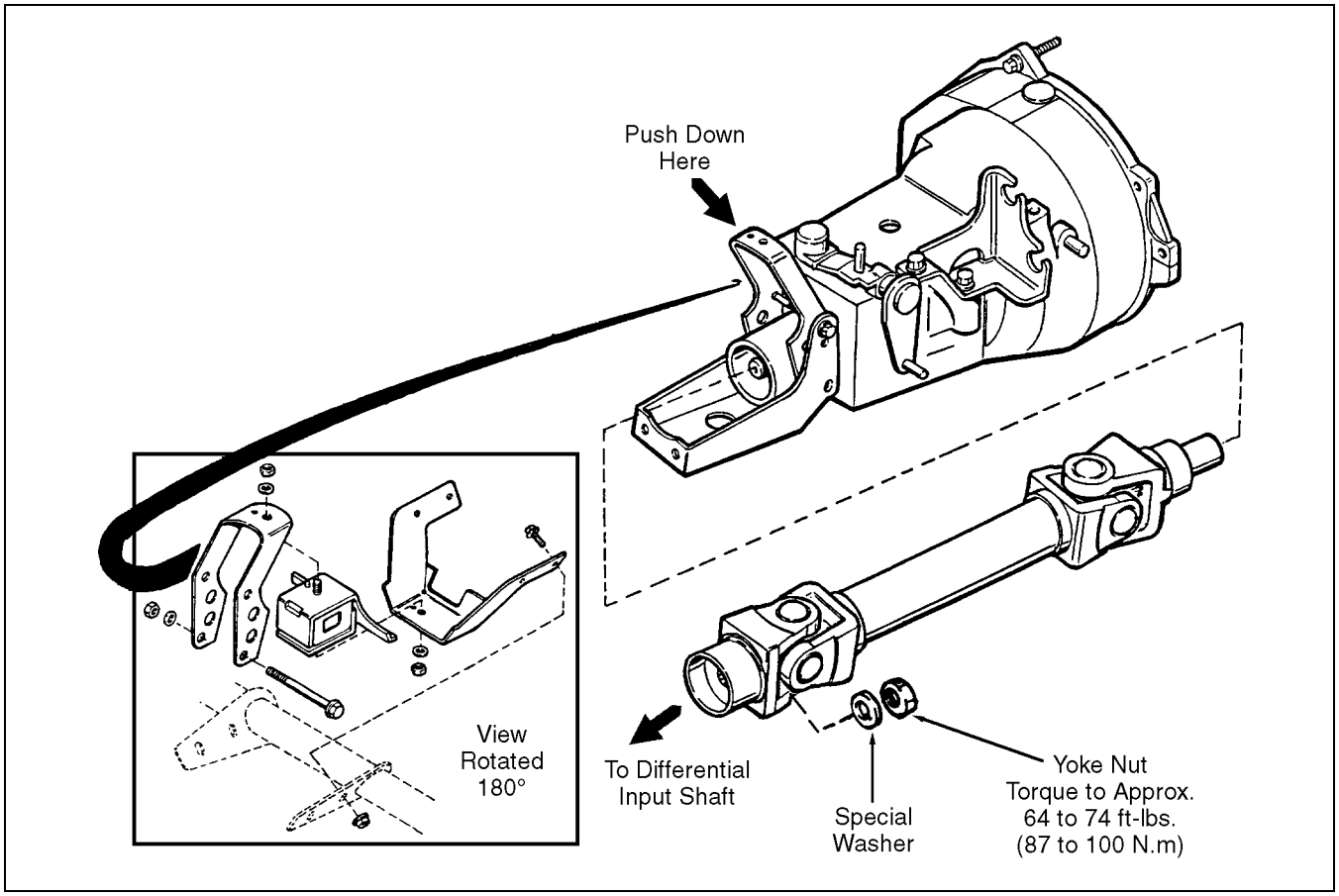


Figure 4C-1. Drive Shaft Removal and Installation ó Vehicles with 3-Cylinder Gasoline Engines

SECTION 4C. DRIVE SHAFT

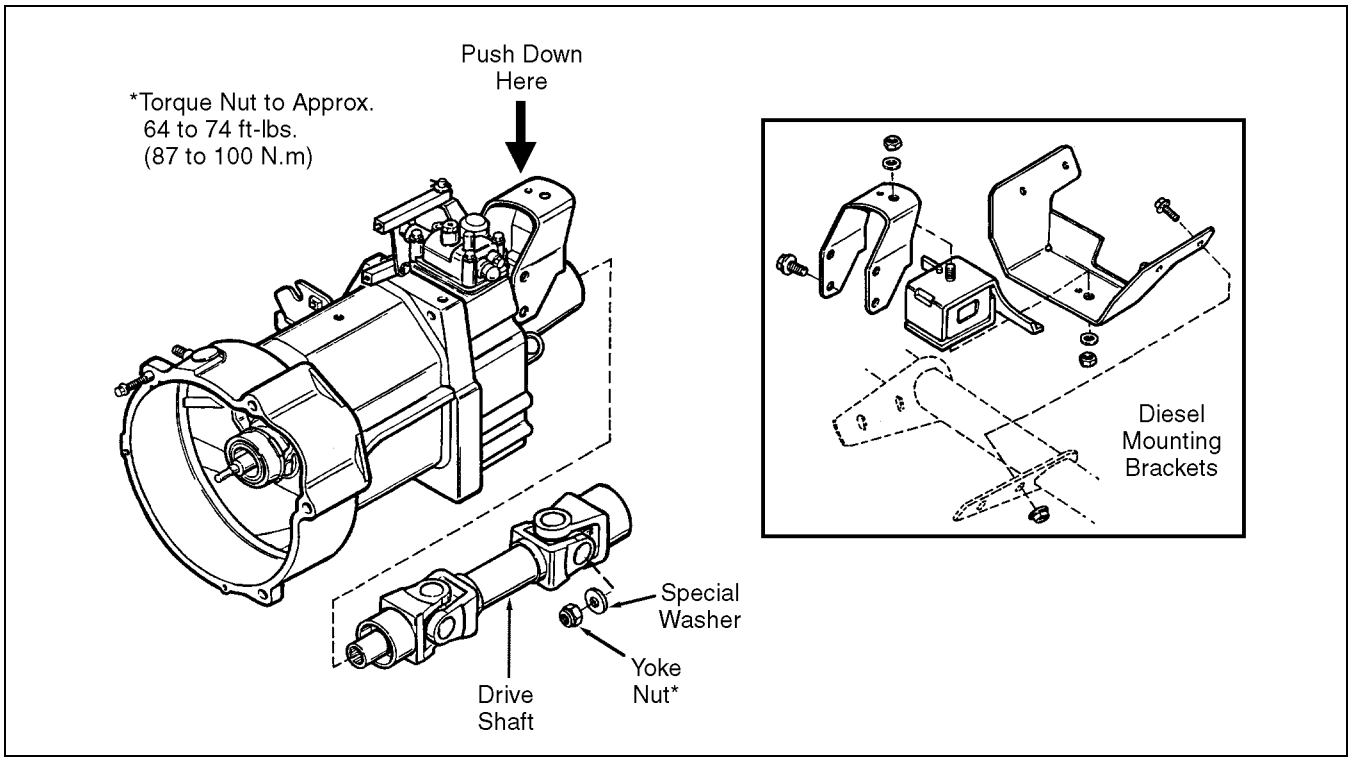


Figure 4C-2. Drive Shaft Removal and Installation

DISASSEMBLY (See Figure 4C-3)

1. Position the joint in a vise as shown.
2. Remove the four snap rings.
3. With a soft face hammer, strike the top ear of the yoke. This will drive the top bearing outward 3/8 inch.
4. Grip the loose bearing in the vise and drive the end yoke off the center cross.
5. Repeat Steps 3 and 4 for the remaining end yoke.

REASSEMBLY (See Figure 4C-3)

NOTE

During reassembly, be sure all the parts are clean and free of dirt. Align yokes as shown in Figures **4C-1** and **4C-2**.

1. Start one bearing in yoke ear and position center cross through yoke.
2. Drive the first bearing flush with outside surface of ear.

NOTE

Do not bend ears of yokes.

3. Support the yoke and, using a socket or mandrel the same diameter as the bearing, drive the bearing slightly past the snap ring groove.
4. Install the snap rings.
5. Repeat Steps 3 and 4 for the other end yoke.
6. After assembly, ensure proper seating by striking the forged surfaces of the yoke ears one sharp blow with a soft mallet.
7. Lubricate the joints as described in SECTION 11.

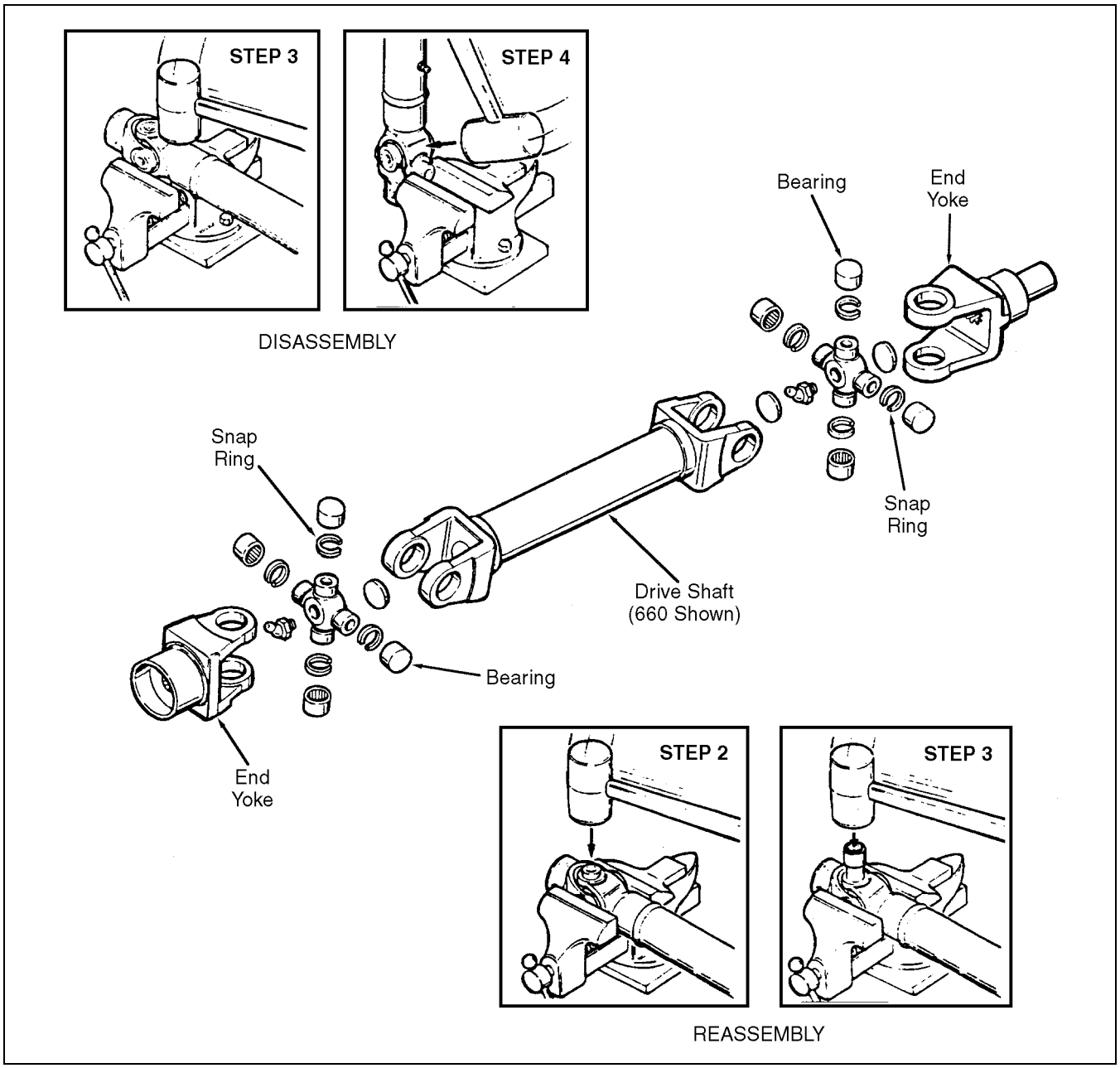


Figure 4C-3. Drive Shaft Disassembly and Reassembly

INSTALLATION
(See Figures 4C-1 and 4C-2)

1. Make certain that the yokes of the drive shaft are correctly aligned with the yokes in the transmission and differential.
2. Install the drive shaft yoke onto the differential input shaft. Hold the input shaft to keep it from turning, install the special washer and yoke nut and use a box wrench to tighten the nut to approximately 64 to 74 ft-lbs. (87 to 100 N.m).

NOTE

The torque of the yoke nut can only be approximately determined.

3. Loosely install the drive shaft in the yoke at the transmission.
4. Lift and/or support the transmission and install transmission mounting brackets and hardware.
5. Connect cables and linkages removed during disassembly. Adjust shift control cables and linkages as described in SECTION 2.

SECTION 4D. CLUTCH

REMOVAL

The clutch components can only be removed when the engine and transmission have been separated.

See Figure **4D-2** for clutch arrangements. To gain access to the clutch components, either remove the engine as described in SECTION 3D or remove the transmission as described in SECTION 4H.

CLUTCH DISASSEMBLY

1. Use a flywheel holder tool to hold the engine flywheel (see Figure **4D-1**) in place and remove the six bolts that secure the clutch cover to the flywheel and remove the clutch cover and disc.
2. Refer to Figure **4D-3**, remove the clutch release bearing from the transmission input shaft retainer.
3. Disconnect spring from clutch release lever.

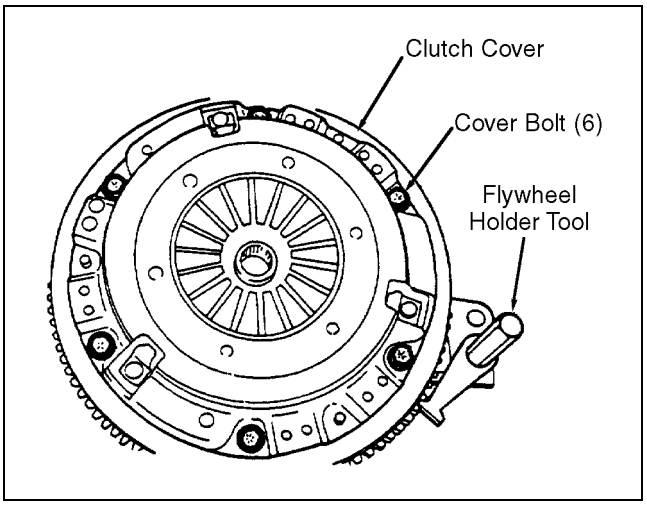


Figure 4D-1. Clutch Cover and Disc Removal and Replacement

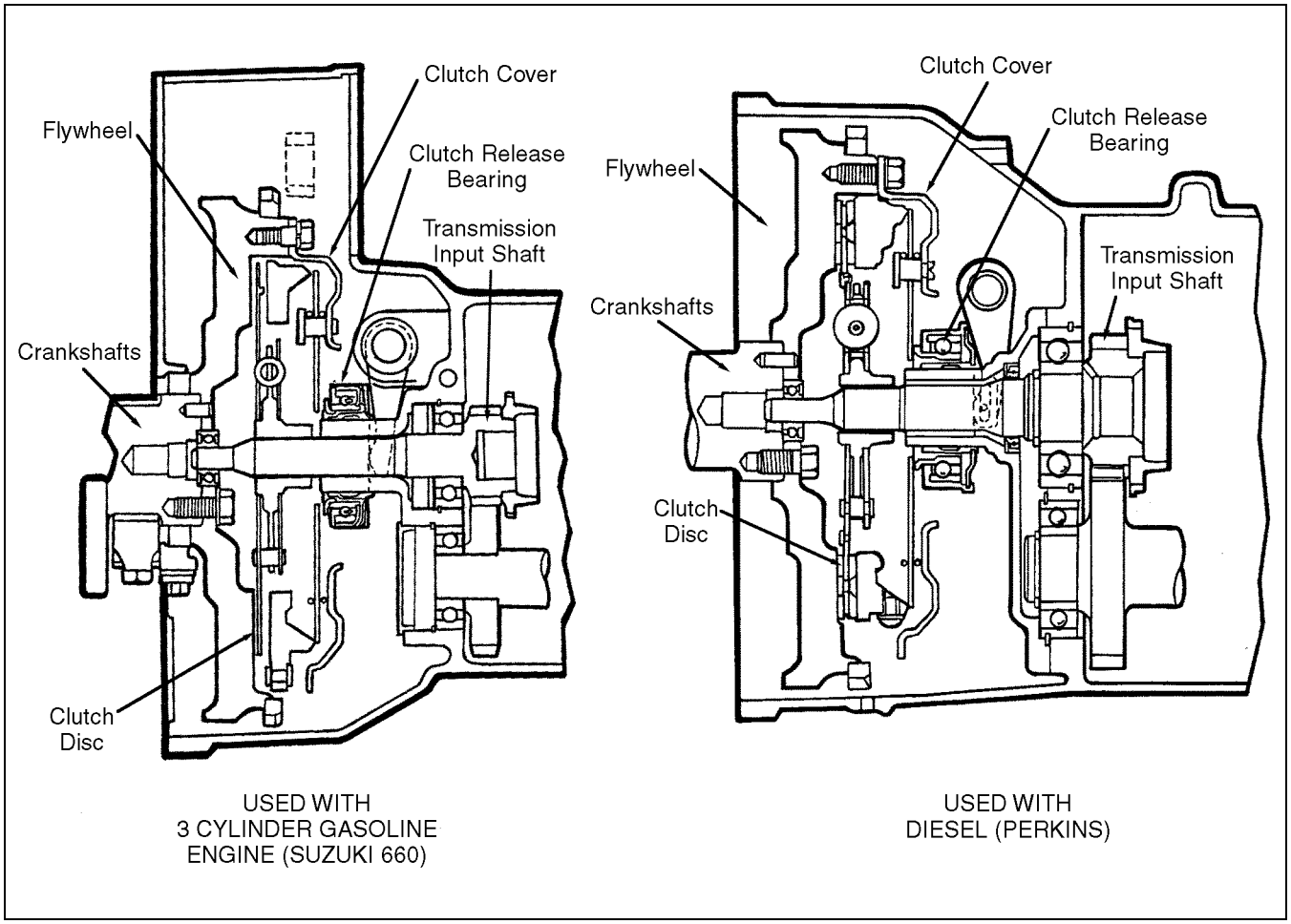


Figure 4D-2. Clutch Arrangements

SECTION 4D. CLUTCH

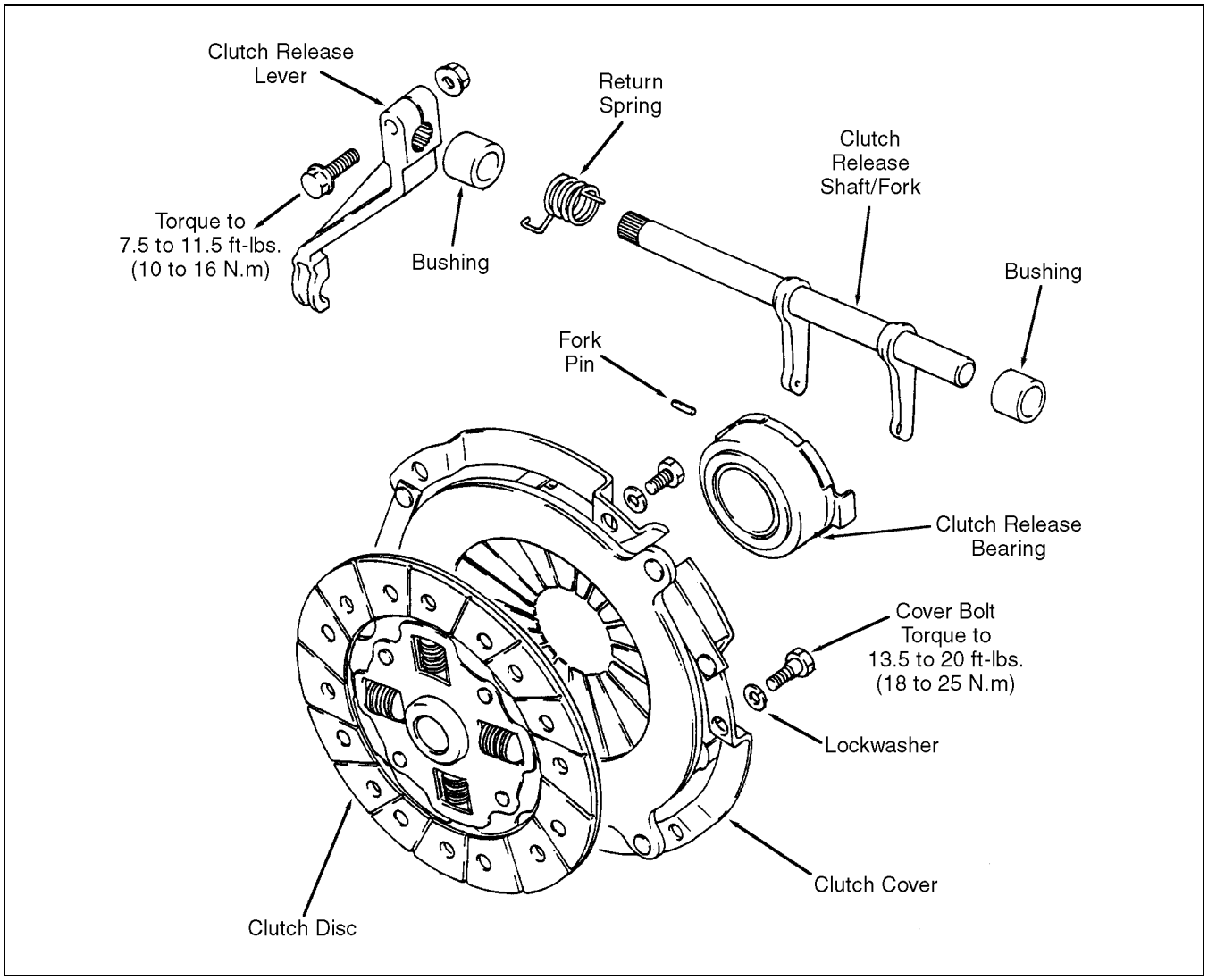


Figure 4D-3. Clutch Repair

4. Remove clutch release lever from shaft/fork. With clutch release bushing removal tool applied as shown in Figure **4D-4** tap its end to remove bushing. If bushing can not be removed from the transmission case in the above manner, grip bushing with pliers and pull out.
5. Remove clutch release shaft/fork from transmission housing.

INSPECTION OF CLUTCH COMPONENTS

1. If the release bearing (Figure **4D-3**) sticks, rattles or makes abnormal noise when turned by hand, replace the bearing.
2. Inspect clutch cover for evidence of diaphragm spring rivets getting loose. If rivets are loose or are getting loose, replace cover assembly with loose rivets, the cover makes rattling noise when clutch pedal is depressed.
3. Inspect tips of tapering fingers (on which the release bearing exerts a push to disengage clutch) for wear. If tips are worn excessively, replace cover assembly.

SECTION 4D. CLUTCH

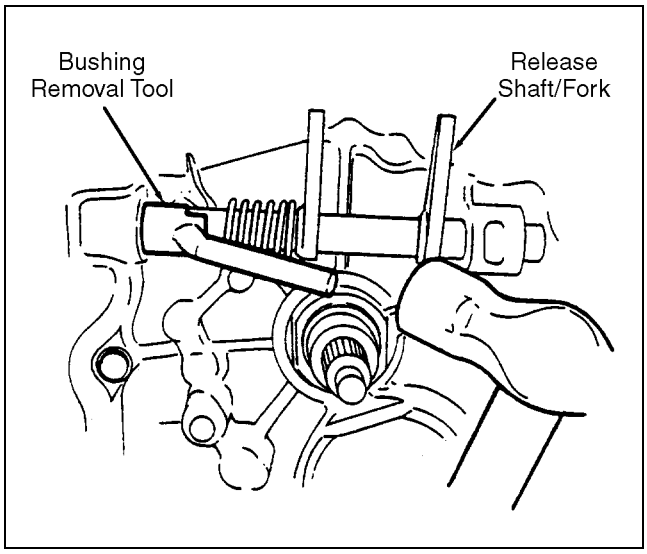


Figure 4D-4. Release Bushing Removal

4. Refer to Figure **4D-5**, check wear of facing by measuring depth of each rivet head depression, i.e. distance between rivet head and facing surface. If depression is found to have reached service limit of 0.02 inch (0.5 mm) at any of the holes, replace clutch disc assembly.

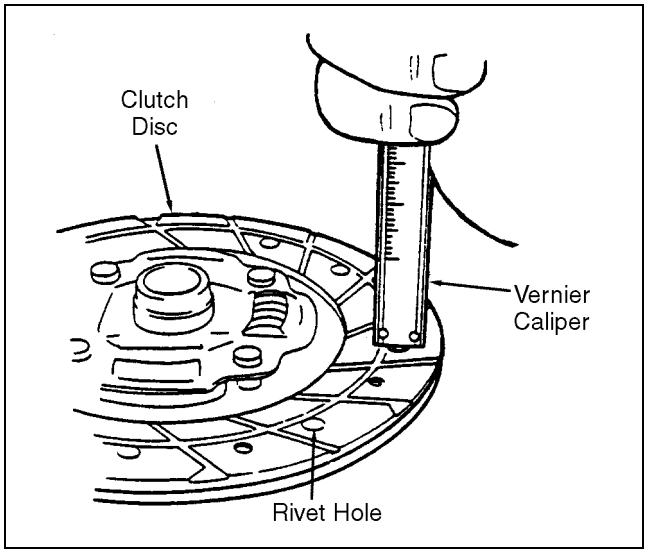


Figure 4D-5. Clutch Disc Facing Inspection

5. Refer to Figure **4D-6**, check backlash by turning disc back and forth as mounted on transmission input shaft. Replace disc assembly if backlash is noted to exceed 0.04 inch (1.0 mm). Backlash here is a circular displacement as measured with a dial indicator.

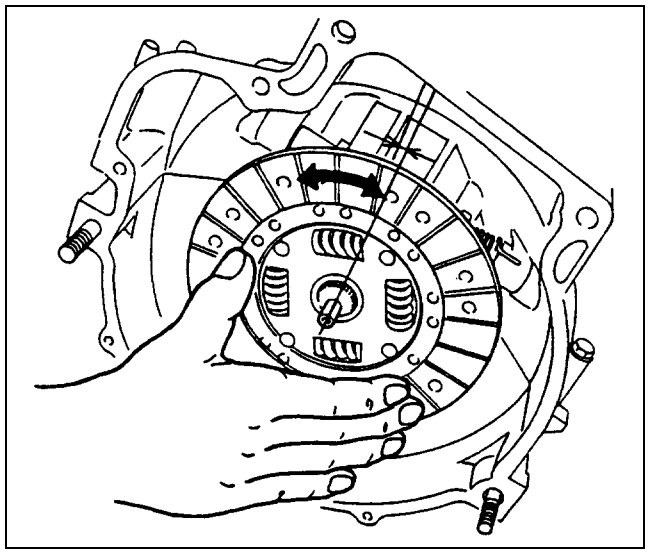


Figure 4D-6. Checking Backlash in Disc Serration

CLUTCH REASSEMBLY

1. Before reassembling the clutch, lubricate the following components (see SECTION 11 for recommended lubricants).
   - Clutch release bearing ó lubricate inner diameter.
   - Clutch release shaft/fork ó lubricate wear surfaces.
   - Transmission input shaft ó lubricate wear surfaces.
   - Clutch release shaft/fork bushings ó lubricate inner diameter.
2. Drive in release shaft/fork bushings to the same level as outside surface of transmission housing as shown in Figure **4D-7**.

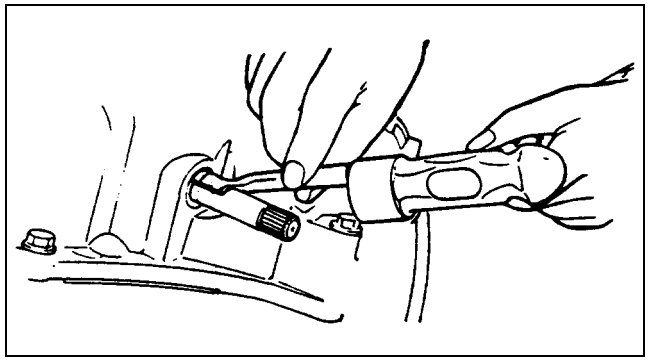


Figure 4D-7. Installing Release Shaft/Fork Bushings

3. After installing release shaft/fork bushings, caulk transmission case against bushings at two points.
4. Position the return spring (see Figure **4D-3**) on the clutch release shaft/fork.
5. Install the clutch release shaft/fork in the bushings. Install the clutch release lever on the shaft/fork as shown in Figure **4D-8**, aligning the two punch marks on the release arm with the shaft/fork.

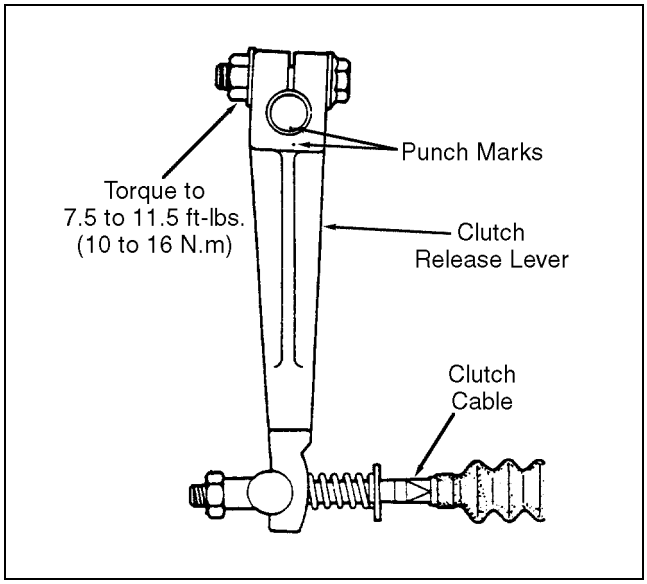


Figure 4D-8. Clutch Release Lever Installation

6. Hook the return spring (Figure **4D-3**) onto the clutch release lever.
7. Install the clutch release bearing on the transmission input shaft retainer.
8. Refer to Figure **4D-9**, use a flywheel holder tool to hold the engine flywheel. Use a clutch center guide tool to install the disc and clutch cover to the flywheel. Secure with six cover bolts. Torque bolts to 13.5 to 20 ft-lbs. (18 to 25 N.m). Remove the center guide tool.

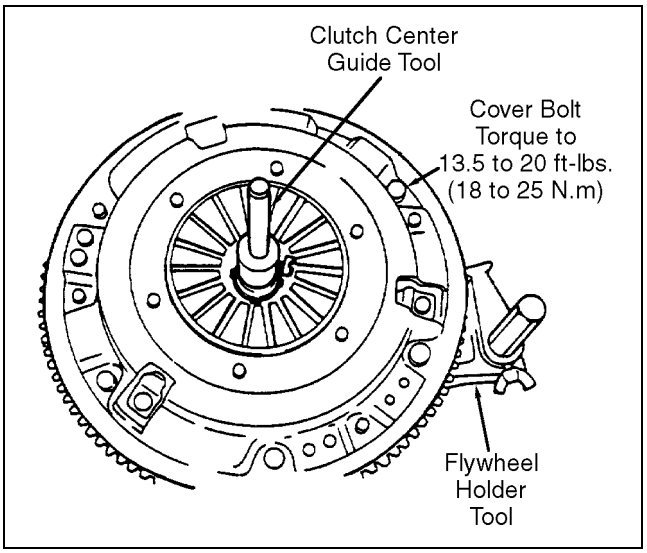


Figure 4D-9. Clutch Cover and Disc Installation

CLUTCH ADJUSTMENTS

After repair of the clutch and/or removal of the engine or transmission, adjust clutch pedal free travel, clutch cable and interlock switch as described in SECTION 2C.

SECTION 4E. GEAR SHIFT CABLES/CONNECTORS

REPAIR (See Figures 4E-1 or 4E-2)

Replace worn or damaged gear shift cables and connectors as shown in Figures **4E-1** or **4E-2**. Adjust shift controls as described in SECTION 2C.

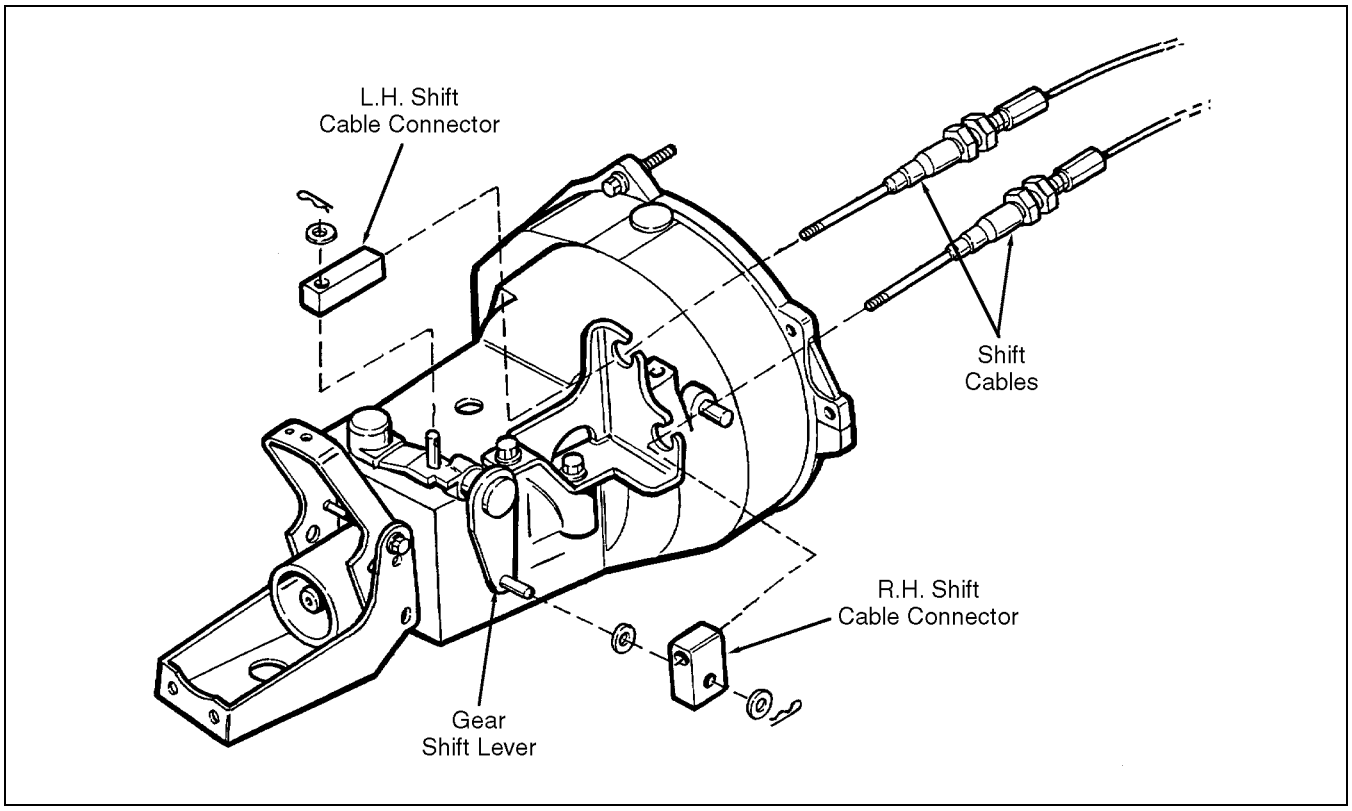


Figure 4E-1. Gear Shift Cables/Connectors (3-Cylinder Gasoline Engine)

SECTION 4E. GEAR SHIFT CABLES/CONNECTORS

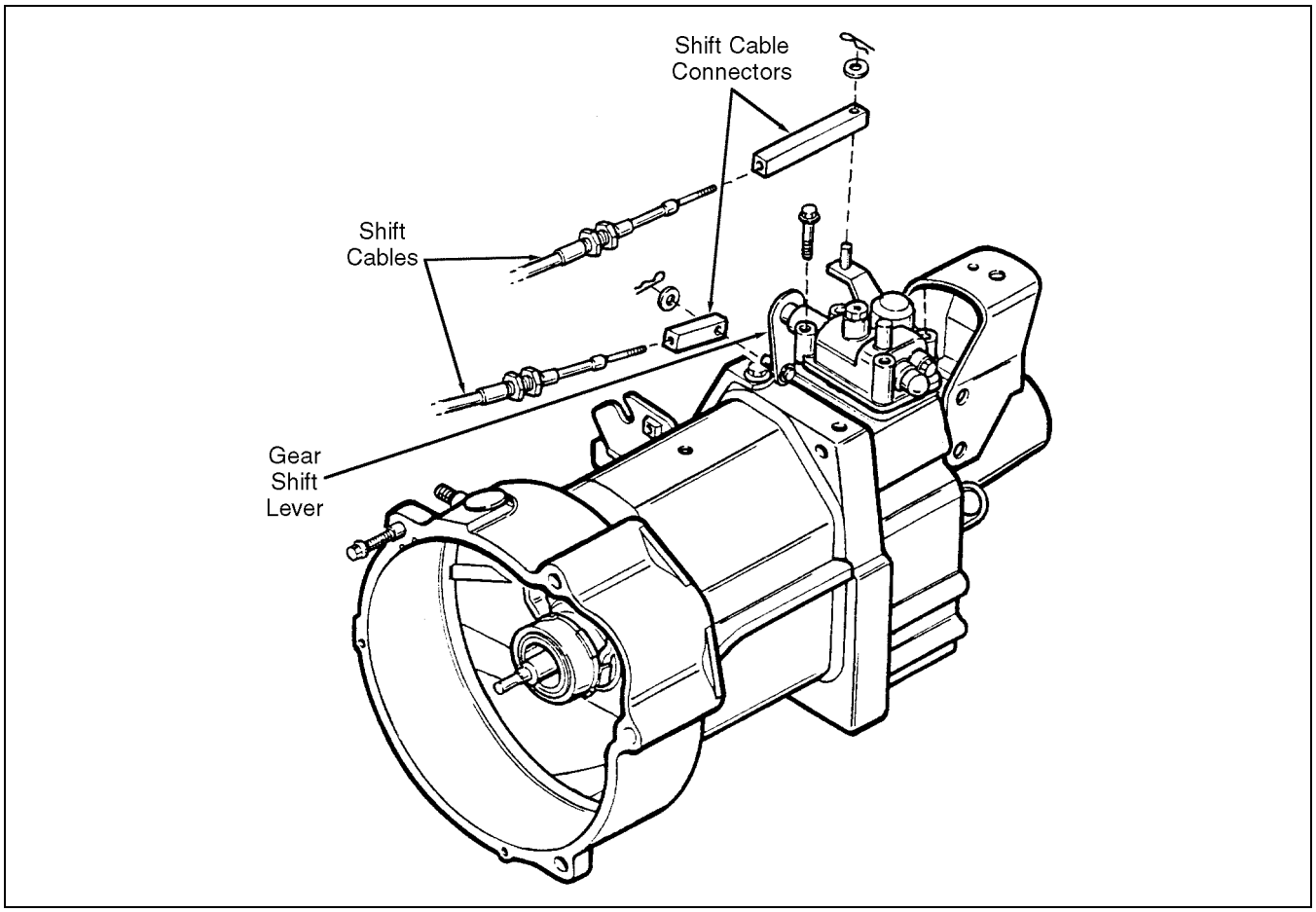


Figure 4E-2. Gear Shift Cables/Connectors (Diesel Engine)

SECTION 4E. GEAR SHIFT CABLES/CONNECTORS

INSTALLING SHIFTER CABLES TO SHIFTER ASSEMBLY

SUZUKI 660 TRANSMISSIONS

1. Attach the cables to the shifter mounting bracket using the M6-1.00 x 20 self-tapping screws and the hold-down brackets. **The filleted area on the cables should be centered between the screws as shown in Figure 4E-3.**
2. Locate the hex nut on the end of each cable. Screw the nut on as far as possible (See Figure **4E-4**).

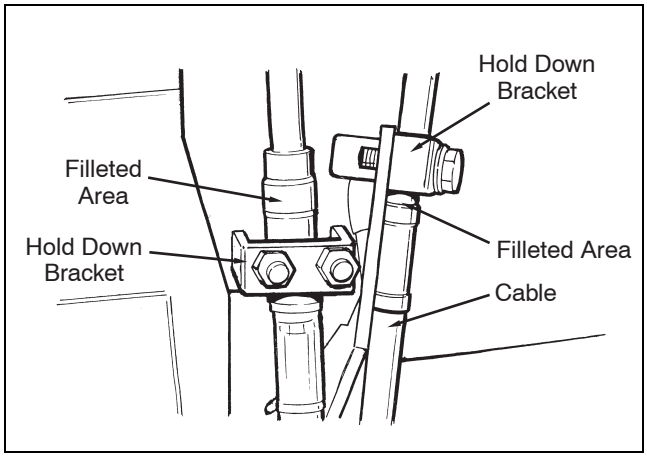


Figure 4E-3. Attach Cables to Shifter Mounting Bracket

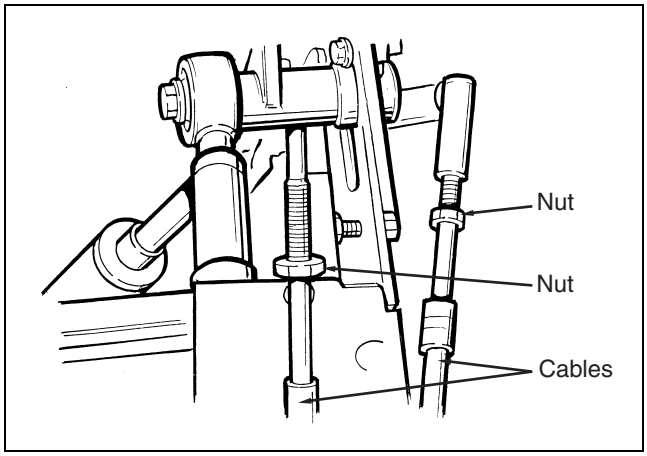


Figure 4E-4. Screw Hex Nut onto Cable End as Shown

3. Screw a ball-joint connector onto the end of the shift cable (screw the ball-joint connector on as far as it will go).

   Unscrew the connector until the ball-joint threads line up with the mating hole in the shift lever and insert through the hole (see Figure **4E-5**). Secure ball-joint with lockwasher and hex nut. Ball-joint connector should be at a 90∞ angle and parallel with the face of the shifter plate.

   ***Do Not* try to align the ball-joint by tightening the connector, turning the connector further clockwise will bind the cable *and* ball-joint.**

   Place a 3/8 wrench on the flat part of the ball-joint to hold it in place while tightening the nut. The nut should be tightened approximately a 1/2-turn past hand tight.

   Make sure the ball-joint is well centered and not being twisted by any binding in the cable. It should be free to pivot in all directions after being tightened.

4. With the ball-joint connector properly aligned, hold it stationary with a 3/8 wrench and tighten the cableís hex nut. The nut should be tightened approximately a 1/4-turn past hand tight.

   The connector should line up with the mating hole without being forced.

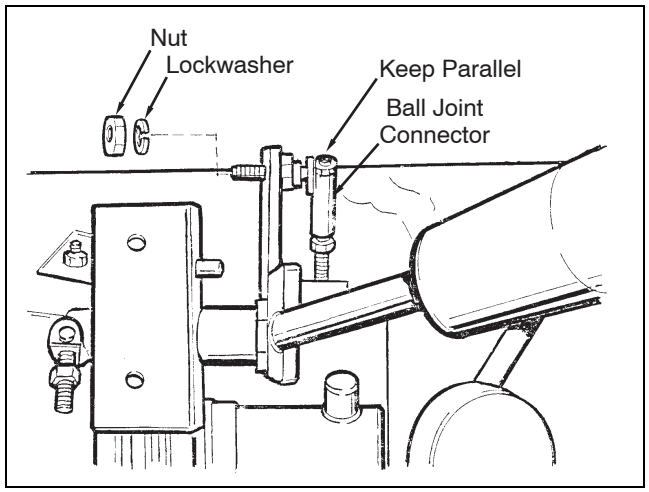


Figure 4E-5. Install Ball-Joint Connector

SECTION 4E. GEAR SHIFT CABLES/CONNECTORS

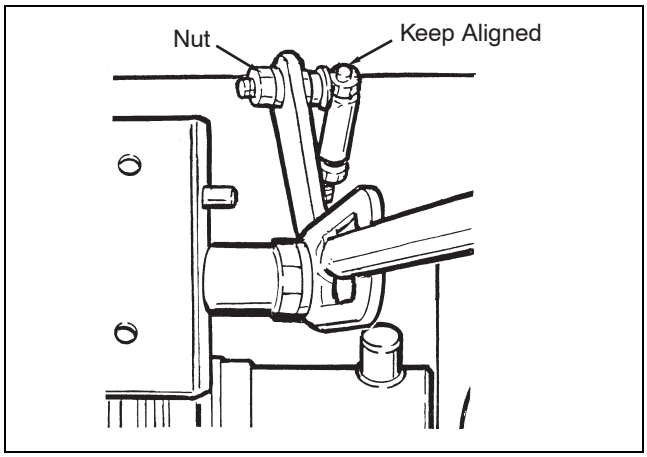


Figure 4E-6. Align Connector and Tighten

5. Screw a ball-joint connector onto the end of the neutral shift cable (screw the ball-joint connector on as far as it will go).

   Unscrew the connector until the ball-joint threads line up with the mating hole in the neutral selector rod.

   ***Do Not* try to align the ball-joint by tightening the connector, turning the connector further clockwise will bind the cable *and* ball-joint.**

   Tighten the ball-joint into the selector rod making sure the ball-joint is well centered and not being twisted by any binding in the cable. It should be free to pivot in all directions after being tightened.

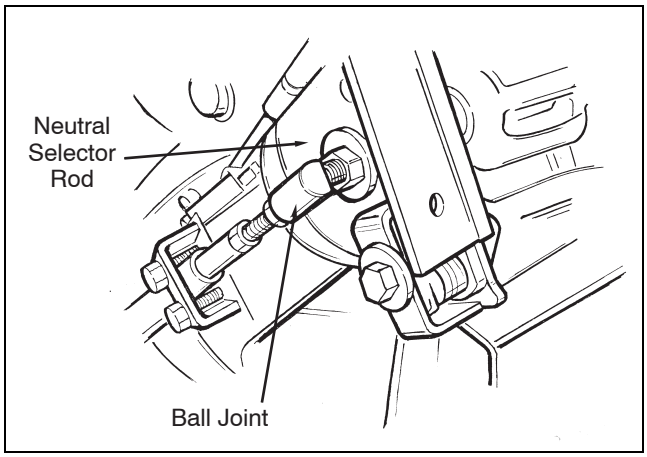


Figure 4E-7. Install Connector on Neutral Selector Rod

6. Hold the connector with a 3/8 wrench and tighten the cableís hex nut keeping the connector centered with the face of the selector rod. The nut should be tightened approximately a 1/4-turn past hand tight.

INSTALLING SHIFTER CABLES TO TRANSMISSION

SUZUKI 660 EFI TRANSMISSION

1. Shift the transmission to 3rd gear by rotating the shift lever all the way counterclockwise (see Figure **4E-8**).

   The transmission must remain in gear while the cables are installed and adjusted.

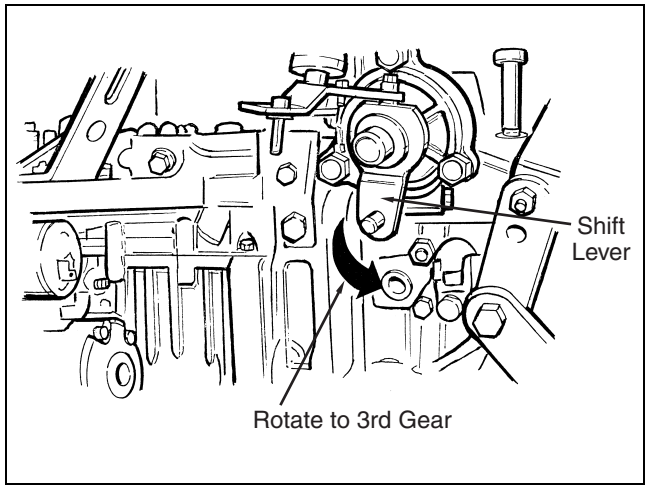


Figure 4E-8. Rotate Shift Lever to Third Gear (660 EFI trucks)

2. Begin with the neutral shift cable (this cable is attached to the shift lever rod on the upper part of the shifter assembly). Note the nuts and washers which will be used to secure the cable to the bracket on the transmission. Position the nuts and washers to the center of the threads on the cable as shown in Figure **4E-9** (leave a gap to allow mounting the cable to the bracket).

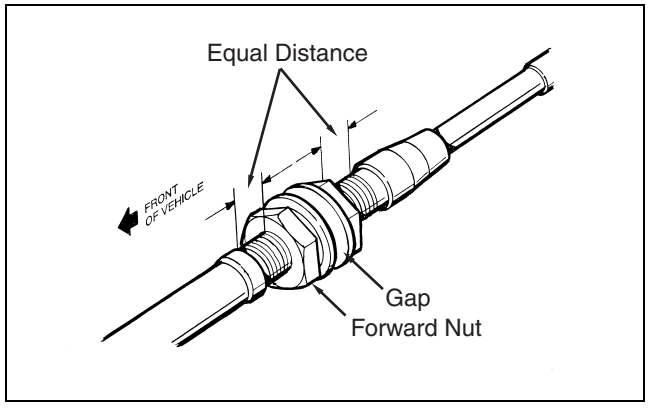


Figure 4E-9. Position Nuts and Washers

Place the cable into the slot on the bracket. The brackets are designed to seat the cable against the bottom of the slot. On trucks with the older cable mounting bracket (Part No. 2701369.7), better alignment with the shifter peg can be achieved by raising the cable higher up in the slot. The cable should point straight at the shifter pegs when the transmission is in neutral. Hand tighten the forward nut until the nuts and washers are snug against the bracket (make sure the cable remains at the bottom of the slot).

3. Place a 15/16" wrench on the forward nut to hold it in place while tightening the rear nut, tighten the nut to 30 ft-lbs. (40.5 N.m).

   Make sure not to turn the forward nut while holding it with the wrench, this can bind the cable.

4. Screw the cableís small nut on as far as possible.
5. Pull the end of the cable to remove any slack within the cable and shifter assembly. Let go of the cable slowly and allow it to slide back to the shifterís neutral position (see Figure **4E-10**.

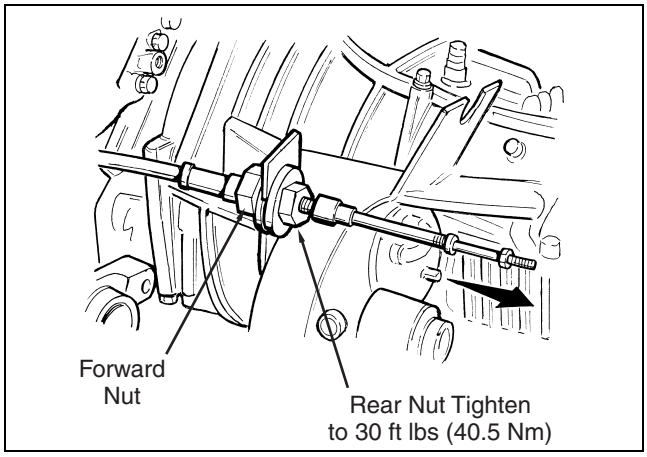


Figure 4E-10. Install Cable onto Bracket

6. Screw the cable connector onto the end of the cable until the hole in the connector aligns with the shifter peg. The cable should slide on and off easily when the connector is properly adjusted (see Figures **4E-11** and **4E-12**).

   If the cable connector can not be adjusted enough to align with the shifter peg, the cable must be repositioned on its mounting bracket. Loosen the hex nuts holding the cable to its bracket. Thread them 1/2" (12.7 mm) in the direction that provides more adjustment of the cable connector. Repeat Steps 2 through 5.

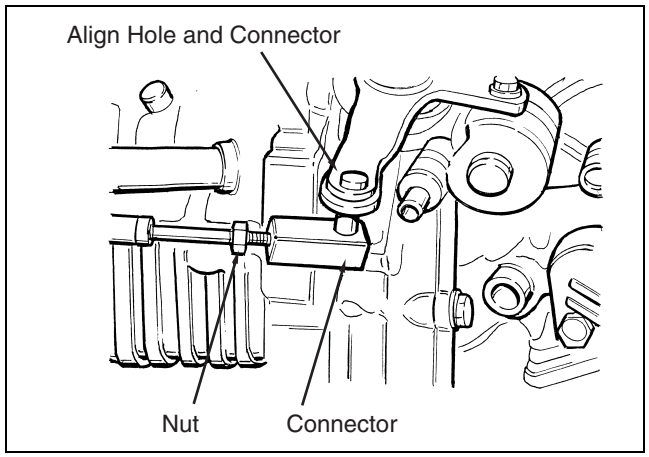


Figure 4E-11. Install Cable Connector

7. Secure the connector to the peg with the cotter pin. Hold the connector with a 1/2" (12.7 mm) wrench and tighten the small hex nut approximately 1/4-turn past hand tight **(the connector should continue to line up with the shifter peg without being forced)**.

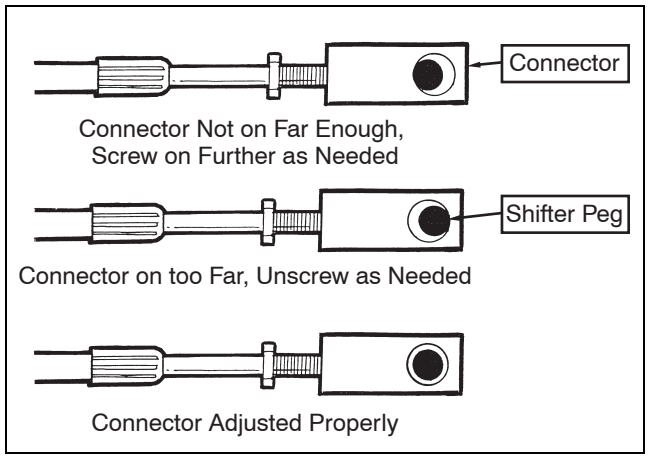


Figure 4E-12. Cable Connector and Shifter Peg Alignment

8. Repeat the previous procedures on the shifter cable, it ***will not*** be necessary to pull any slack from the shift cable as was done with the neutral cable (nothing would happen if the cable were pulled).

   The transmission does not need to remain in third gear after both cables have been properly installed.

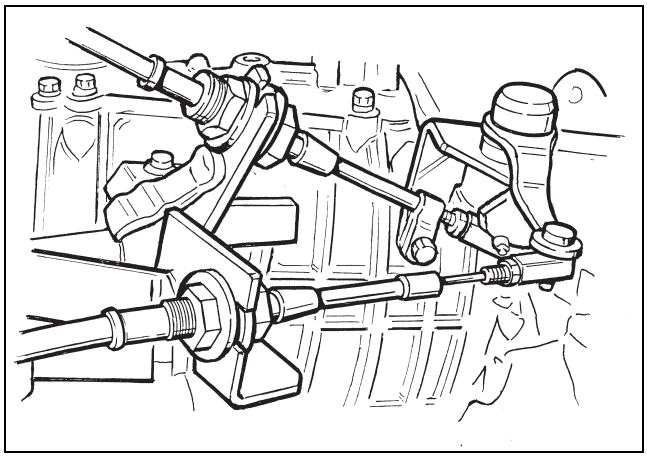


Figure 4E-13. Neutral & Shifter Cables Installed

9. Check the cable installation and adjustment. Verify that the cables have been installed and adjusted correctly by pushing the clutch in and moving the shifter lever through all of the gears. The truck does not have to be running.

   If the shift lever does not push straight up to third gear and down to fourth gear, then do the following. These gears should be directly above and below the hands-off position of the shift lever and engage without requiring the operator to search for them. If this is not true, the neutral cable connectorís adjustment should be checked. Shift the transmission into third gear. Check that the neutral cable connector is centered with the transmission shifter peg. If it is not, readjust the connector per Step 6. When adjustment is satisfactory, tighten the connector per Step 7.

   If the shift lever does not move to the left with the same amount of effort as moving right when truck is in neutral, then do the following. Engaging first or second gears should feel similar to engaging reverse. If this is not true, adjust the neutral cable connector to bias the shifter peg towards the front of the hole. If shifting towards first and second is difficult, turn the connector further ON/OFF the cable. Turn the connector 1/2 turn at a time and then check the ìfeelî at the shifter lever.

NOTE

After many turns, this adjustment will degrade the ìfeelî of the other side. Check both sides of neutral after each adjustment. When done, tighten the connector per Step 7.

INSTALLING SHIFTER CABLES TO TRANSMISSION (Carburated)

SUZUKI 660

Follow the instructions (Steps 1 through 6) on page 4E-6 to attach the cables to the shifter assembly, then begin with the following procedures for the 970 Suzuki transmission.

1. Shift the transmission to third gear by rotating the shift lever all the way clockwise (see Figure **4E-14**).

   The transmission must remain in gear while the cables are installed and adjusted.

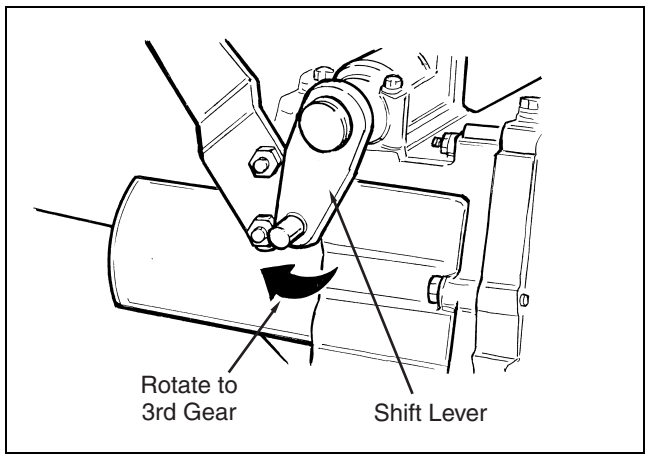


Figure 4E-14. Rotate Shift Lever to Third Gear

2. Begin with the neutral shift cable (this cable is attached to the shift lever rod on the upper part of the shifter assembly). Note the nuts and washers which will be used to secure the cable to the bracket on the transmission. Position the nuts and washers to the center of the threads on the cable as shown in Figure **4E-15** (leave a gap to allow mounting the cable to the bracket).

   Place the cable into the slot on the bracket. Hand tighten the forward nut until the nuts and washers are snug against the bracket (make sure the cable remains at the bottom of the slot).

SECTION 4E. GEAR SHIFT CABLES/CONNECTORS

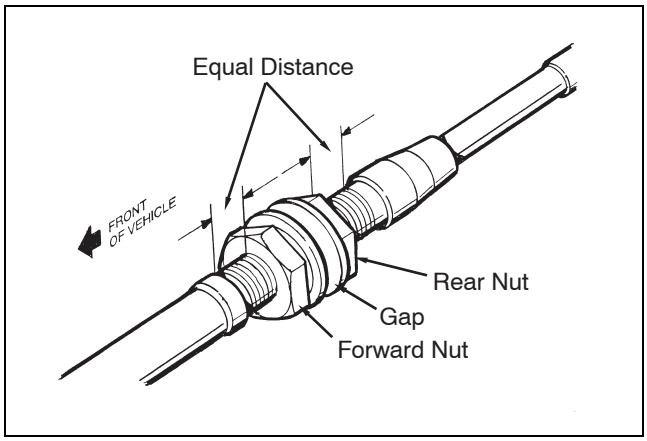


Figure 4E-15. Position Nuts and Washers

3. Place a 15/16" wrench on the forward nut to hold it in place while tightening the rear nut, tighten the nut to 30 ft-lbs. (40.5 N.m).

   Make sure not to turn the forward nut while holding it with the wrench, this can bind the cable.

4. Screw the cableís small nut on as far as possible.
5. Pull the end of the cable to remove any slack within the cable and shifter assembly. Let go of the cable slowly and allow it to slide back to the shifterís neutral position (See Figure **4E-16**).

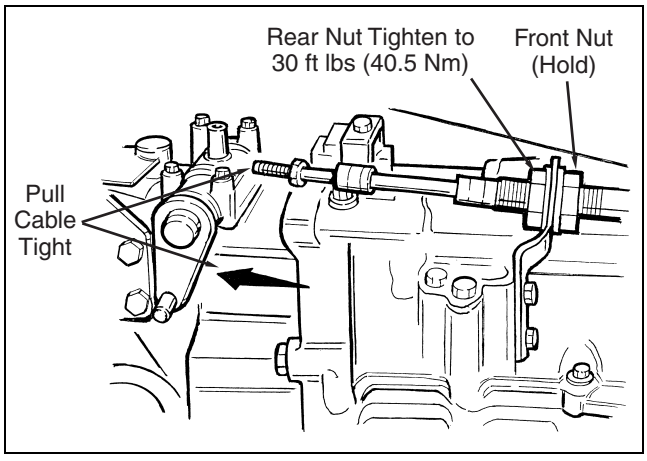


Figure 4E-16. Install Neutral Cable onto Bracket

6. Screw the cable connector onto the end of the cable until the hole in the connector aligns with the shifter peg.

   The cable should slide on and off easily when the connector is properly adjusted (see Figure **4E-17**).

   If the cable connector can not be adjusted enough to align with the shifter peg, the cable must be repositioned on its mounting bracket. Loosen the hex nuts holding the cable to its bracket. Thread them 1/2" in the direction that provides more adjustment of the cable connector. Repeat Steps 2 through 5.

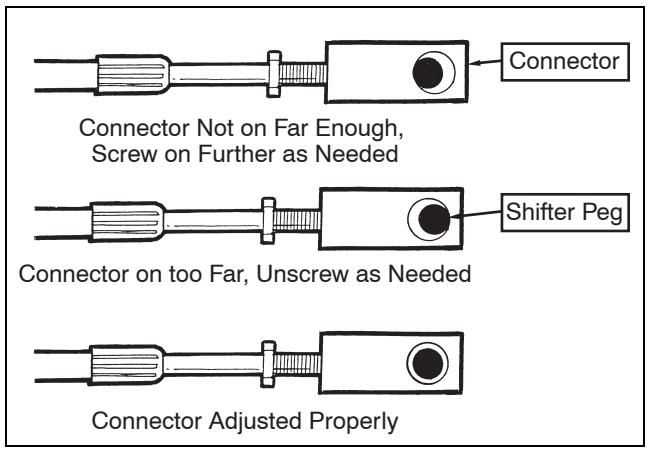


Figure 4E-17. Cable Connector and Shifter Peg Alignment

7. Secure the connector to the peg with the cotter pin. Hold the connector with a 1/2" wrench and tighten the small hex nut approximately 1/4-turn past hand tight **(the connector should continue to line up with the shifter peg without being forced)**.
8. Repeat the previous procedures on the shifter cable. It ***will not*** be necessary to pull any slack from the shift cable as was done with the neutral cable (nothing would happen if the cable were pulled).

   The transmission does not need to remain in third gear after both cables have been properly installed (See Figure **4E-18**).

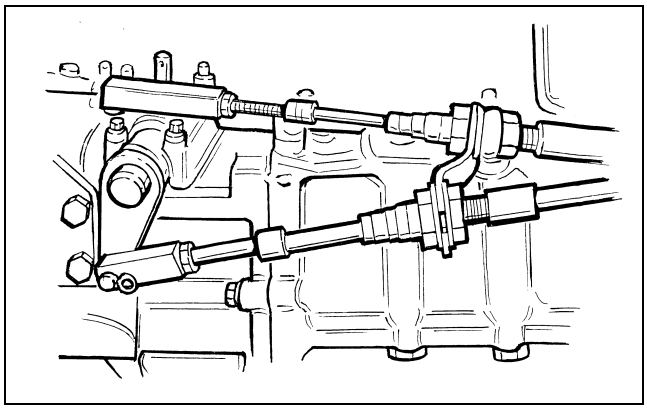


Figure 4E-18. Shifter Cables Installed

9. Check the cable installation and adjustment. Verify that the cables have been installed and adjusted correctly by pushing the clutch in and moving the shifter lever through all of the gears. The truck does not have to be running.

   If the shift lever does not push straight up to third gear and down to fourth gear, then do the following. These gears should be directly above and below the hands-off position of the shift lever and engage without requiring the operator to search for them. If this is not true, the neutral cable connectorís adjustment should be checked. Shift the transmission into third gear. Check that the neutral cable connector is centered with the transmission shifter peg. If it is not, readjust the connector per Step 6. When adjustment is satisfactory, tighten the connector per Step 7.

   If the shift lever does not move to the left with the same amount of effort as moving right when truck is in neutral, then do the following. Engaging first or second gears should feel similar to engaging reverse. If this is not true, adjust the neutral cable connector to bias the shifter peg towards the front of the hole. If shifting towards first and second is difficult, turn the connector further ON/OFF the cable. Turn the connector 1/2 turn at a time and then check the ìfeelî at the shifter lever.

   NOTE

   After many turns, this adjustment will degrade the ìfeelî of the other side. Check both sides of neutral after each adjustment. When done, tighten the connector per Step 7.

SECTION 4F. PRESSURE PLATE RING (DIESEL ONLY)

REPAIR (See Figure 4F-1)

A pressure plate ring is used as an interface between the clutch disc and engine flywheel for diesel engine equipped vehicles only.

If worn or damaged, replace the pressure plate ring as shown in Figure 4G-1.

If necessary, repair the clutch as described in SECTION 4D. Adjust the clutch as described in SECTION 2C.

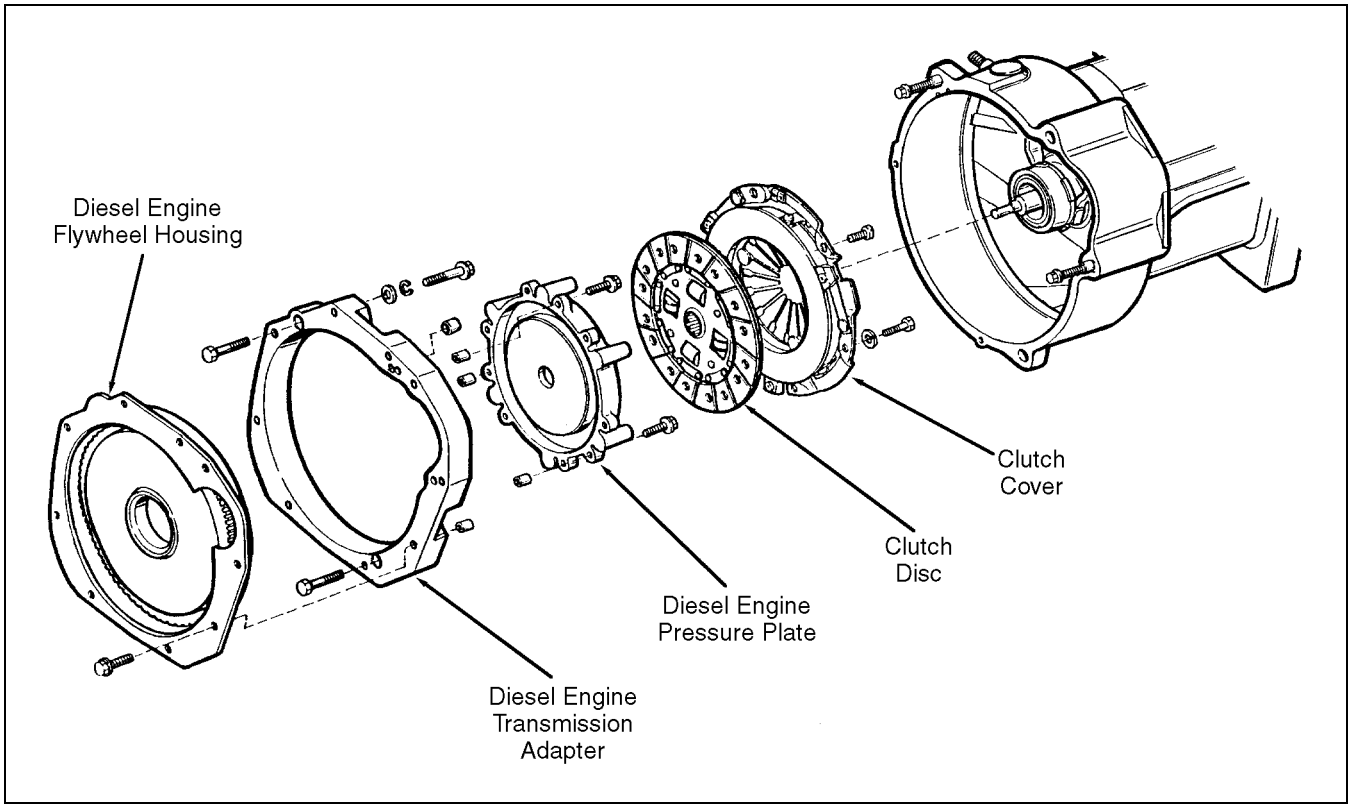


Figure 4F-1. Pressure Plate Ring ó Vehicles with Diesel Engines Only

SECTION 4G. 4-SPEED TRANSMISSION

GENERAL

The transmission is a 4-speed manual shift type. The shift pattern is a standard H pattern with reverse R over to the right and down.

In some cases the entire transmission may not have to be disassembled. Disassemble only what is needed for repair.

TRANSMISSION REMOVAL

1. Disconnect the negative (ñ) and positive (+) battery cables from battery terminals.
2. Tag and disconnect all cables, hoses, tubes or control linkages which would obstruct lifting the transmission out of the frame.
3. Remove any sheet metal which would obstruct lifting the transmission out of the frame.
4. Remove the drain plug and drain oil from the transmission. Replace drain plug and torque to 14.5 to 21.5 ft-lbs. (20 to 30 N.m) for units with 3-cylinder gasoline engines and 26.5 to 36.0 ft-lbs. (36 to 50 N.m) for units with 4-cylinder gasoline or diesel engines.
5. Disconnect the clutch cable from the clutch release lever.
6. Disconnect the shift cables (see SECTION 4E).
7. Disconnect the drive shaft at the transmission (see SECTION 4C).
8. Attach a suitable hoist to the transmission.
9. Remove hardware that fastens the transmission to the engine.
10. Remove any remaining transmission hardware from mounting brackets on the frame until the transmission is free to be lifted.
11. Carefully move the transmission away from the engine flywheel and move the transmission out of the frame to a suitable work stand.

INPUT SHAFT BEARING REPLACEMENT

NOTE

Whenever the engine and transmission are separated, the transmission input shaft bearing mounted in the engine flywheel should be inspected for wear or damage.

1. Turn the bearing by hand, if it sticks, rattles or makes abnormal noise when spun, it should be replaced.
2. Remove the input shaft bearing using a removal tool as shown in Figure **4G-1**.
3. Install a new bearing as shown in Figure **4G-1**.
4. Visually check the flywheel surface, where it contacts the clutch disc, for wear or damage. If wear or damage is determined, replace the flywheel in accordance with engine manufacturerís instructions.

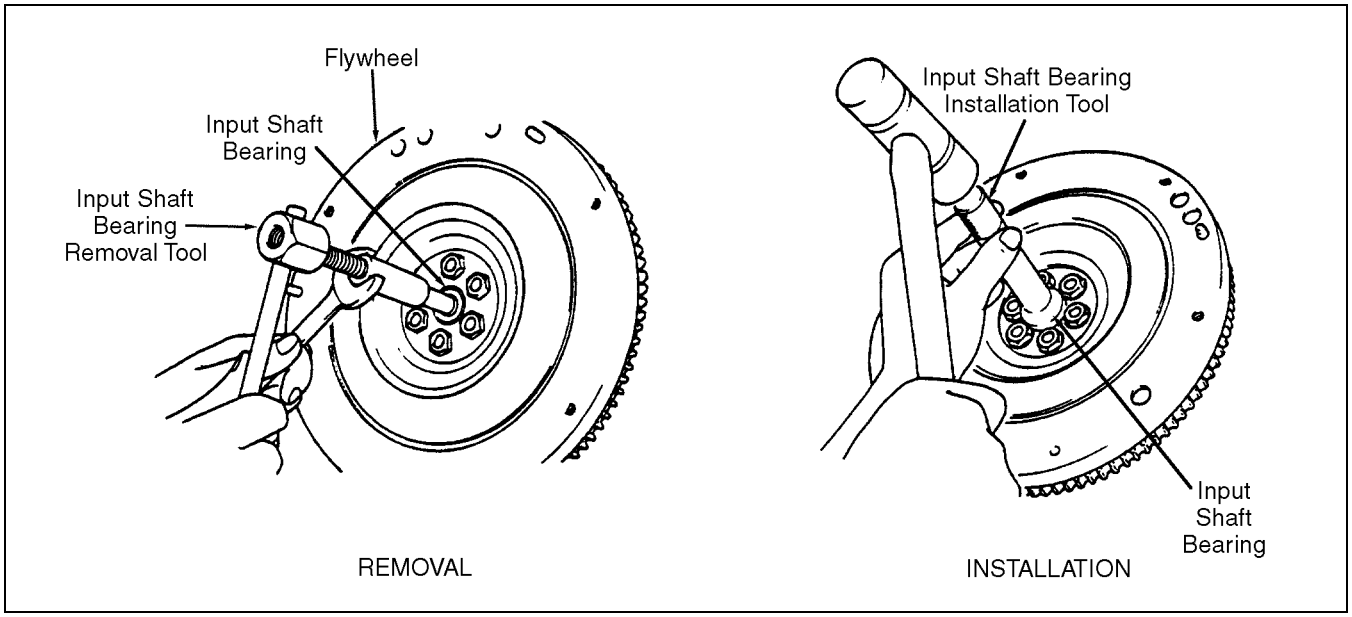


Figure 4G-1. Input Shaft Bearing Replacement

SECTION 4G. 4-SPEED TRANSMISSION

TRANSMISSION DISASSEMBLY

GEAR SHIFT CASE (See Figure 4G-2)

1. Remove the mounting bolts, disengage the gear selector shaft from the gear shift lever in the transmission and lift the assembled gear shift case off the transmission case.
2. If necessary, disassemble the gear shift as shown in Figure 4G-2.

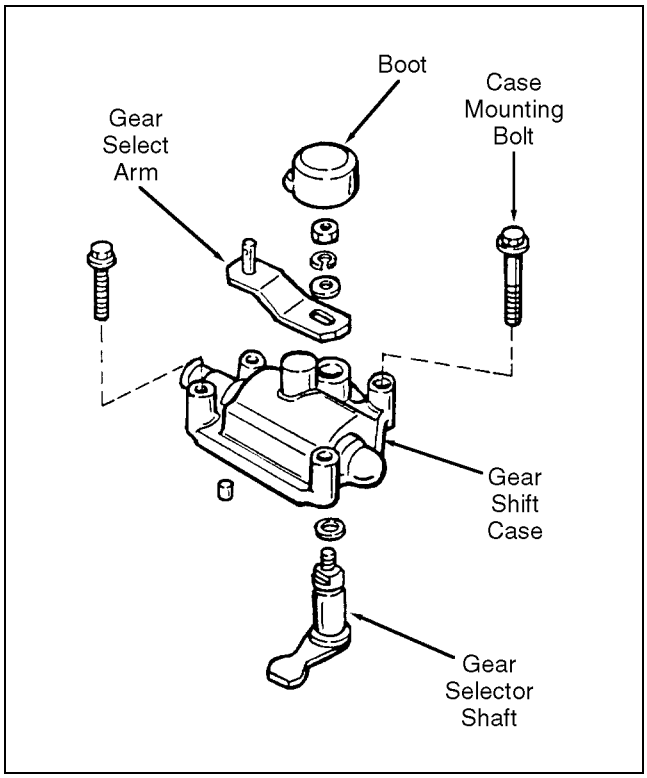


Figure 4G-2. Gear Shift Case

EXTENSION CASE (See Figure 4G-3)

1. Remove the bolts securing the extension case to the transmission case and detach the extension case and mounting bracket.
2. If necessary, remove the mounting bracket from the extension case.

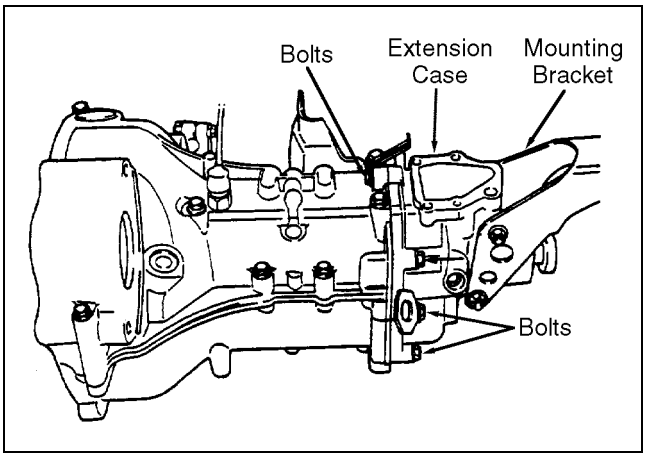


Figure 4G-3. Extension Case

SPLITTING THE TRANSMISSION (See Figure 4G-4)

1. Remove the bolts that fasten the upper and lower transmission cases together.
2. Use a steel pry bar or large screwdriver to pry the two case halves apart being careful not to damage the mating faces.

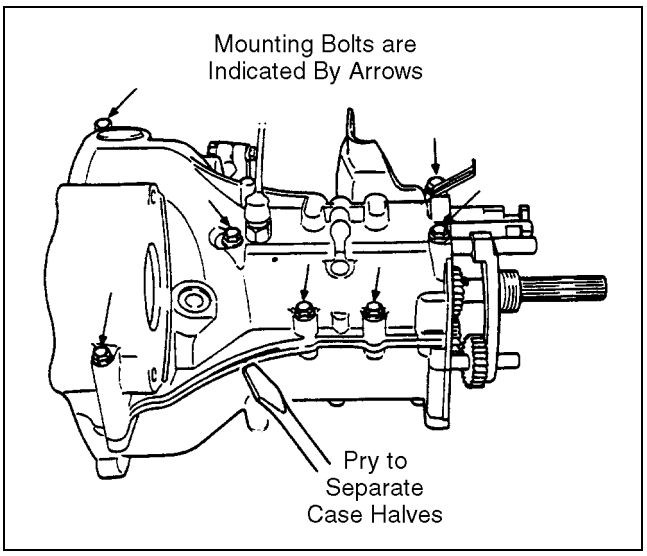


Figure 4G-4. Splitting the Case Halves

GEAR AND SHAFT REPAIR

NOTE

The arrangement of gears and shafts is shown in Figure 4G-5.

SECTION 4G. 4-SPEED TRANSMISSION

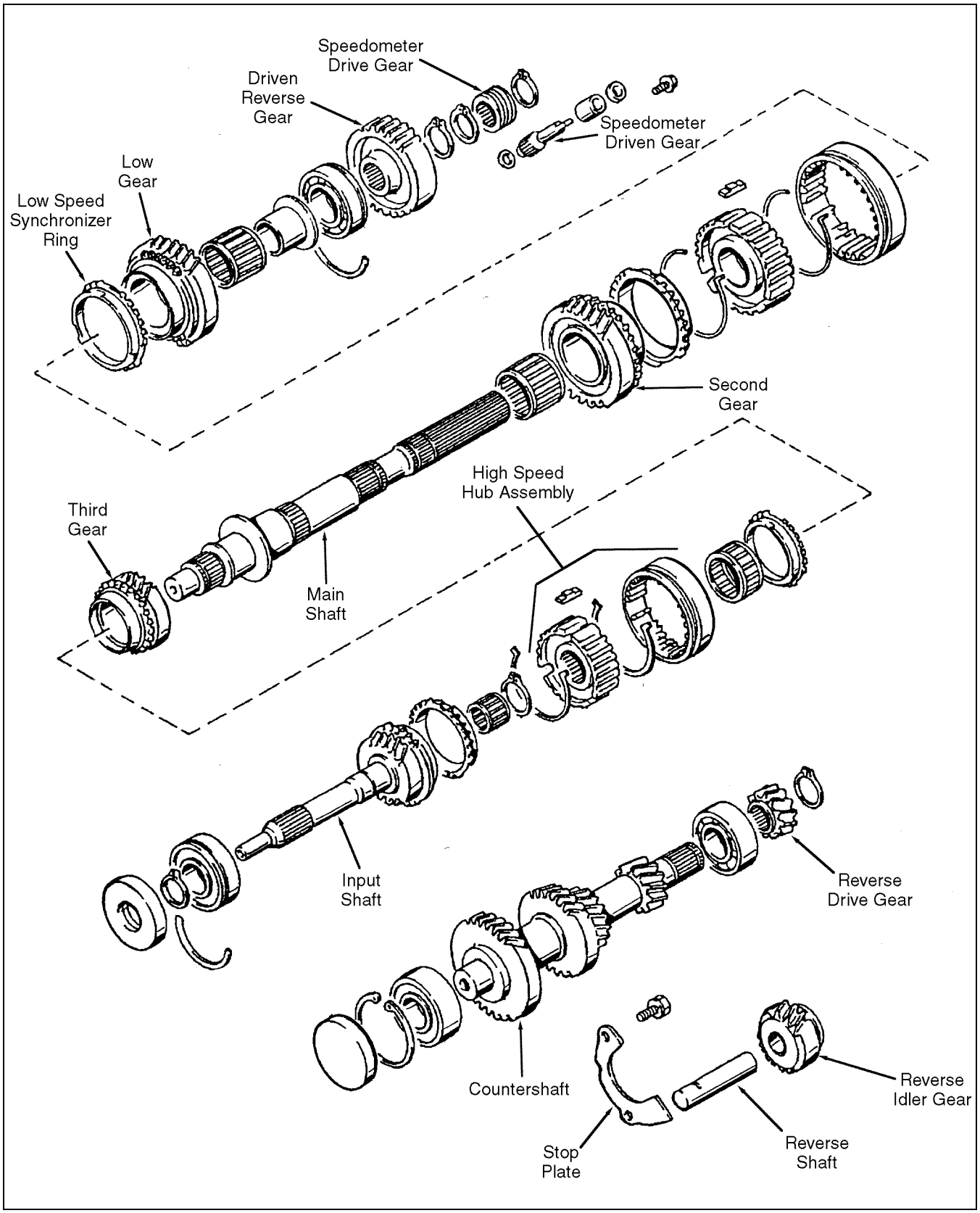


Figure 4G-5. Gear and Shaft Arrangement

SECTION 4G. 4-SPEED TRANSMISSION

COUNTERSHAFT

1. Remove the two bolts securing the stop plate to the case. Remove the stop plate, reverse idler gear and shaft (see Figure **4G-6**).

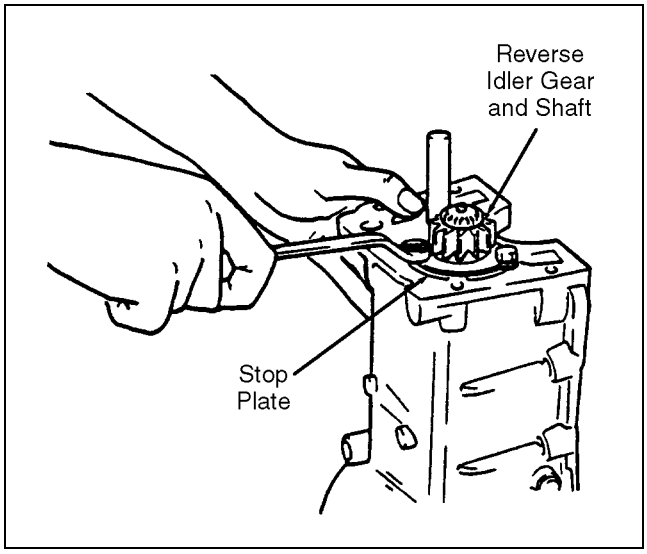


Figure 4G-6. Countershaft ó Step 1

2. Remove the retaining ring from the reverse gear on countershaft and slide the reverse gear off countershaft (see Figure **4G-7**).

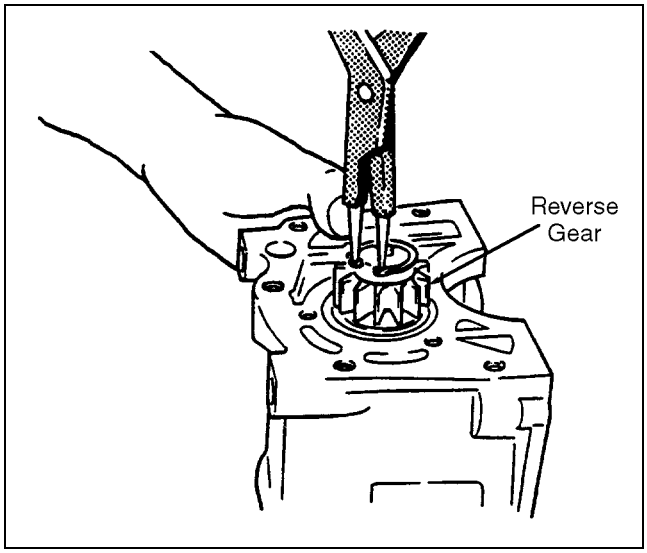


Figure 4G-7. Countershaft ó Step 2

3. Remove the rubber plug and retaining ring from the countershaft (see Figure **4G-8**).

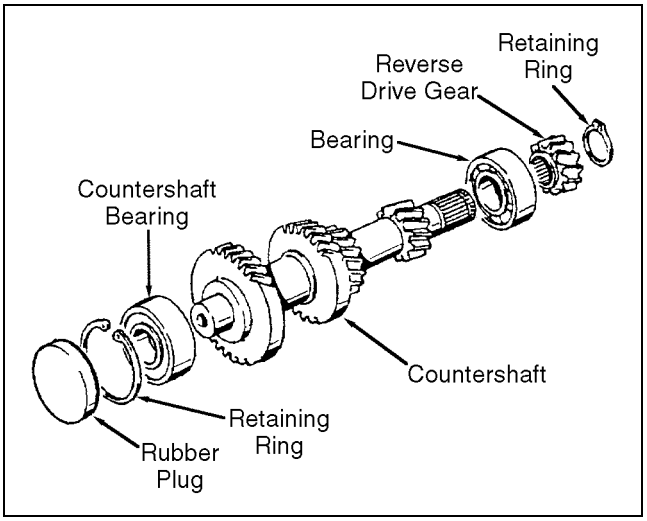


Figure 4G-8. Countershaft ó Steps 3 and 4

4. Pull the countershaft to the low gear side (see Figure **4G-5**). Remove the bearings and remove the countershaft from the case.

INPUT SHAFT AND MAIN SHAFT

1. Refer to Figure **4G-9**, remove the oil seal, retaining ring, bearing and input shaft. Pull out the input shaft, by hand, taking care not to drop the high speed synchronizer rings.
2. Remove the retaining ring, high speed synchronizer rings, needle bearings, high speed hub assembly, and third driven gear from the main shaft.
3. Remove the retaining rings from the speedometer drive gear and remove the speedometer drive and driven gears and reverse gear.
4. Remove the main shaft bearing using a hydraulic press.
5. Remove the low driven gear, low speed synchronizer hub assembly, second driven gear and needle bearings from the main shaft. Make certain the synchronizer rings do not drop when the synchronizer hub assembly is being removed.

SECTION 4G. 4-SPEED TRANSMISSION

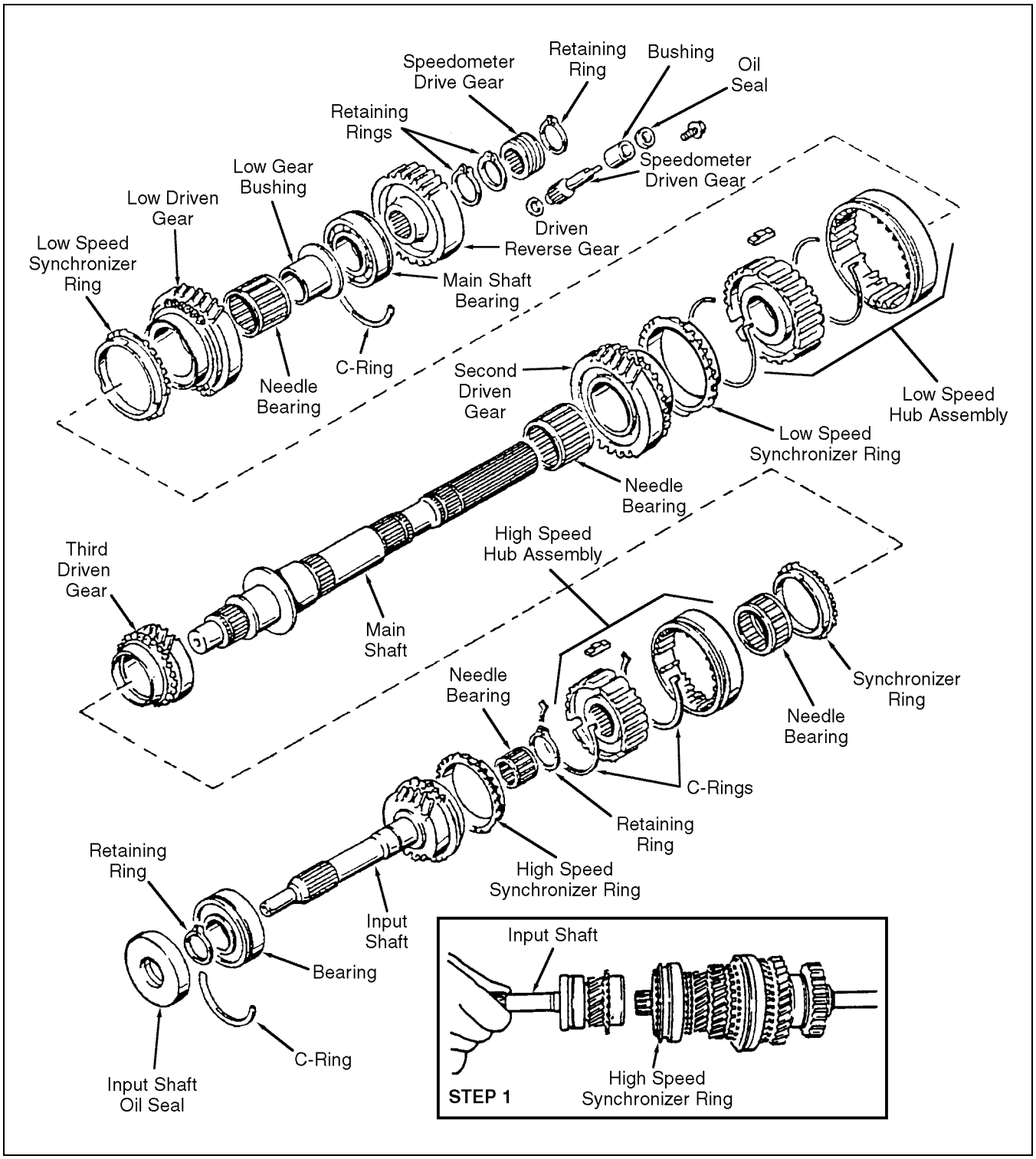


Figure 4G-9. Input Shaft and Main Shaft ó Steps 1 thru 5

SECTION 4G. 4-SPEED TRANSMISSION

SHIFTER SHAFTS AND FORKS (See Figure 4G-10)

1. Before starting the removal work, make sure that all the shifter fork shafts in place are in neutral position. First, remove the stop plate for shifter fork shafts by removing the two bolts securing this plate.
2. It is important that the three shifter fork shafts be kept in neutral position in order to make sure that the interlock balls between two adjacent shafts are seated fully in the detents of respective shafts. If any of these interlock balls are out of the detents, some of the fork shafts will refuse to come out when pulled.
3. Using a spring pin remover, drive out the spring pin on reverse shifter fork, and pull out the reverse fork shaft. As this shaft comes out, the locating ball and spring will jump out of the hole; do not let them fly away.

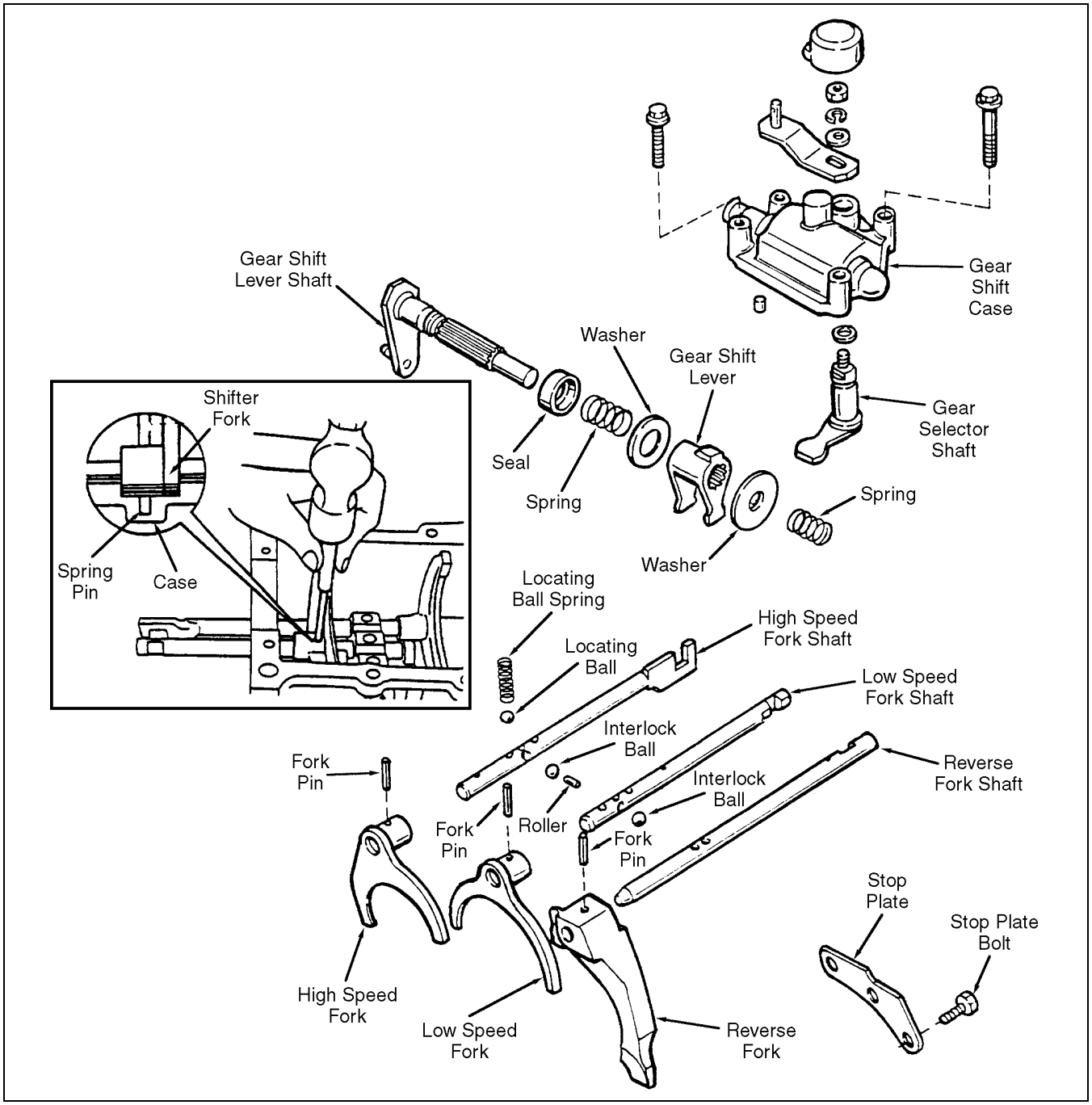


Figure 4G-10. Shifter Shafts and Forks

4. Move the low-speed fork shaft into the position for ìsecondî. This will allow the spring pin to shift into the detent provided in the case. Using a spring remover tool, draw out the spring pin and pull out the fork shaft. Be careful not to let the locating ball and spring fly away.
5. Remove the high-speed shifter fork shaft, as follows: Move this fork shaft into the position for ìthirdî, so that the spring pin will shift into the detent provided in the case; draw out the spring pin by using a spring pin remover tool and remove the shaft by pulling it out.

INSPECTION AND REPAIR

GEAR TEETH

Prior to cleaning, check bottom of transmission case for metal particles. If metal is detected, inspect parts closely for damage and/or wear.

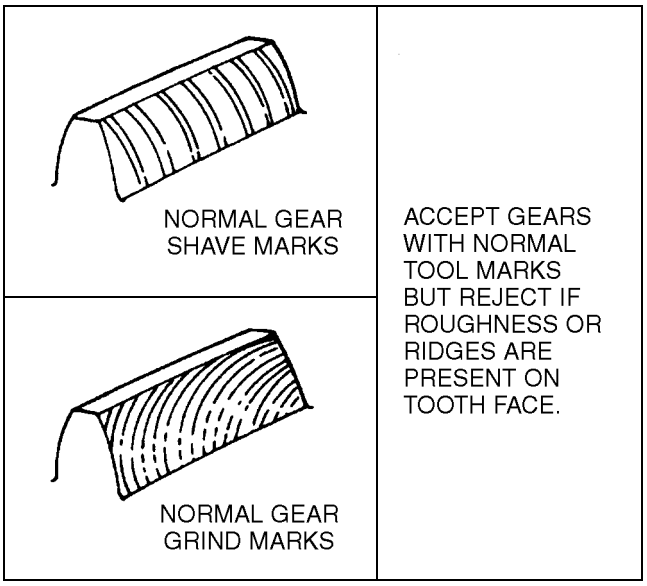


Figure 4G-11. Normal Gear Tooth Tool Marks

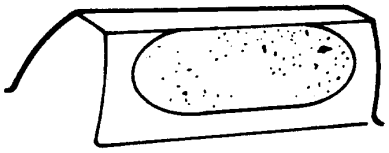
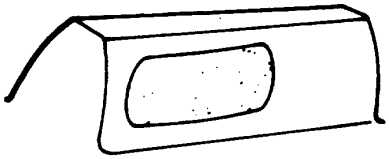
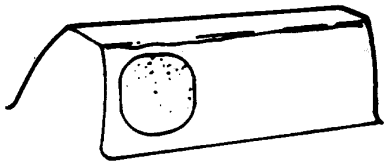
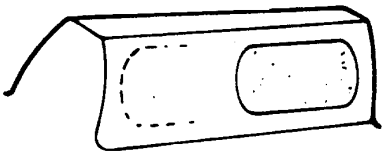
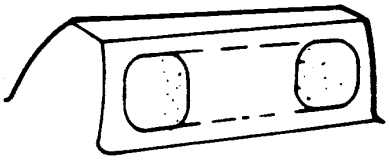
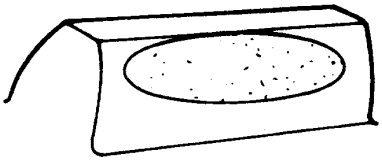
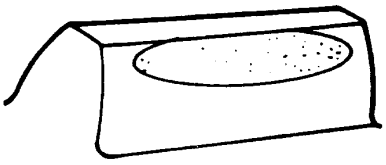
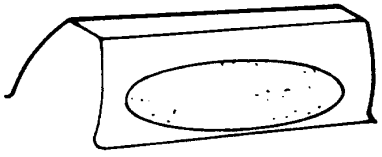
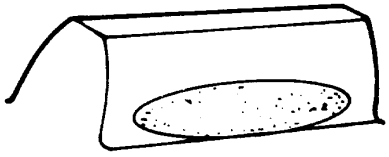
Description	Accept	Reject
DESIRED CONTACT PATTERN		
END CONTACT PATTERN		
TRAVELING CONTACT PATTERN (MOVES FROM SIDE TO SIDE)		
HIGH CONTACT PATTERN		
LOW CONTACT PATTERN		

Figure 4G-12. Gear Tooth Contact Patterns

Clean parts in a suitable non-flammable solvent. Remove old sealant material being careful not to damage seal surfaces.

Dry parts thoroughly. Do not allow bearings to spin dry, lubricate after cleaning (see SECTION 11).

Discard any parts that show signs of damage or wear. Pack bearings with grease and wrap to protect from dirt (see SECTION 11).

NOTE

Do not confuse gear contact patterns with normal tool marks that are a result of manufacture. Typical tool marks are shown in Figure **4G-11**.

Check gear tooth contact patterns (see Figure **4G-12**).

Check gear teeth for chips, see Figure **4G-13**.

Parts with small chips shown in REPAIR column in Figure **4G-13** may be blend-repaired and reused.

Chips or broken teeth as shown in REJECT column in Figure **4G-13** are not repairable and the part must be rejected.

Check clutch teeth for rounding, see Figure **4G-14**.

Face rounding will cause the clutch to jump out. Clutch teeth with rounding on the end are usable, but will cause hard shifting.

Clutch teeth with chips may be blend-repaired in the same manner as gear teeth.

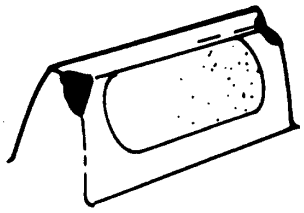
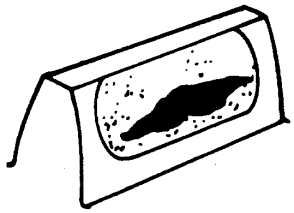
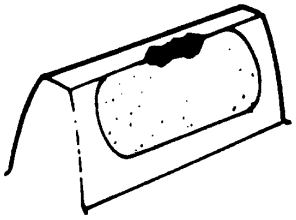
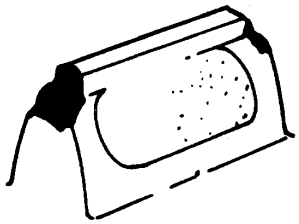
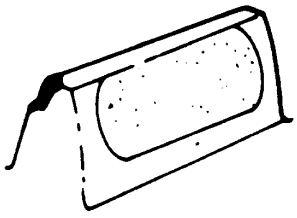
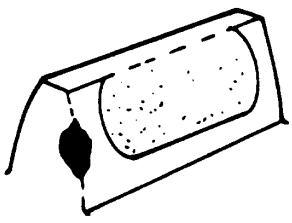
Repair		Reject	
CORNER CHIP AT DRIVE FACE		CHIP WITHIN CONTACT PATTERN	
O.D. EDGE FACE AT DRIVE FACE. MAY EXTEND SLIGHTLY INTO CONTACT PATTERN.		CHIP COMPLETELY THROUGH TOOTH (CONSIDERED TO BE BROKEN)	
CORNER CHIP AT COAST FACE			
SIDE EDGE CHIP AT DRIVE FACE			

Figure 4G-13. Gear Tooth Chips

SPLINE TEETH

Check for broken or chipped spline teeth. Small chips may be blend-repaired in same manner as gear teeth.

If any spline tooth is broken, the part must be rejected.

Spline teeth will not show contact patterns as gear teeth do.

However, they may show evidence of step wear which is cause for rejection.

GEAR REPAIR

Parts which are rejected by inspection are to be replaced, unless repair procedures specified in the following paragraphs, or other obvious minor repair, will restore the part to complete serviceability.

Repair is limited to blend-repair of chips. See Figure **4G-14**.

Blend repair chips using a suitable hand-held, high speed grinding tool.

Blend chip into surrounding base metal, but do not remove any more metal than necessary.

Blend all sharp edges into smooth contour. Sharp edges may chip again or develop cracks.

Use a suitable abrasive stone to remove burrs. Be careful to remove only raised material, not base metal.

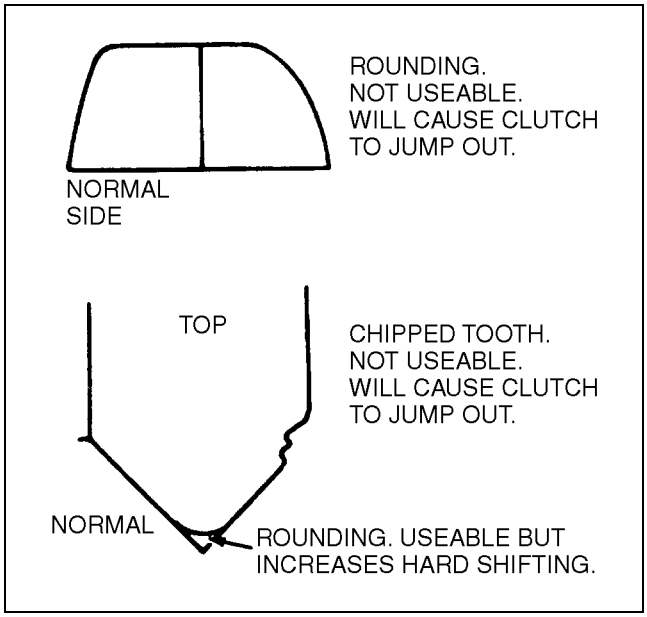


Figure 4G-14. Clutch Tooth Inspection

SYNCHRONIZER RINGS

Fit the rings to the cone of the gear (input gear, or ìthird,î ìsecondî or ìlowî gear), and measure the clearance between the two at the peripheral teeth, as shown in Figure **4G-15**. Standard clearance is 0.03 to 0.05 inch (0.8 to 1.2 mm). If the clearance is less than 0.02 inch (0.5 mm) the ring and gear should be replaced.

Inspect the external cone (of the gear) and internal cone (of the ring) for abnormal wear. Be sure that the contact patterns on these surfaces indicate uniform full-face contact, and that the surfaces are free from any wavy wear. A badly worn ring or gear must be replaced.

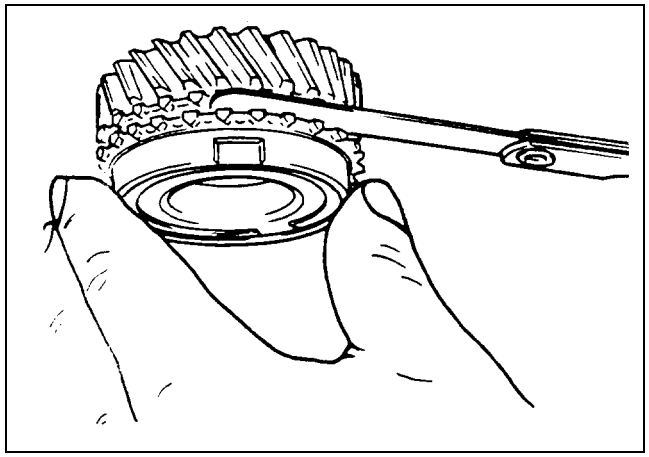


Figure 4G-15. Synchronizer Ring-to-Gear Clearance

Proper synchronizing action on gear shifting can be expected only when the ring-to-gear clearance and the condition of cone surfaces, are satisfactory.

RING (External) AND GEAR SLEEVE (Internal) TEETH

Synchronizer rings and hubs have three slots each, in which the keys are carried as backed by expanding springs, so that the hub and its two rings, one on each end, are capable of running together. Since the sleeve is engaged by its internal teeth with the hub, as if the two were splined together, the sleeve also runs with the hub and rings.

In meshing action, the sleeve is pushed (by the shifter fork) to one side, so that it slides axially on the hub, pushing the ring toward the cone surface of the gear. This push is transmitted by the three keys, which are lightly gripped by the sleeve.

By the friction between the gear cone and the ring cone (internal), the ring begins to rotate but is opposed by the hub because of the keys. In other words, the ring is (at this time) twisted, while the sleeve is

advancing further to push the ring fully against the gear cone.

Since the ring is unable to slide along any further, the sleeve lets go of the keys and rides over to the ring. At this moment, the initial contact between the chamfered ends of teeth of the ring and those of internal teeth of the sleeve occurs. This contact is such that the internal teeth of the sleeve align themselves to those of the ring. When the sleeve advances and slides into the ring, the ring will be rotating nearly with the speed of the gear, so that the sleeve can smoothly slide over into the clutch teeth of the gear.

The initial contactor mesh between sleeve and ring is determined by the widths of key and slot. The key clearance in the slot should extend at least a third (1/3) of the chamfer (see Figure **4G-16**).

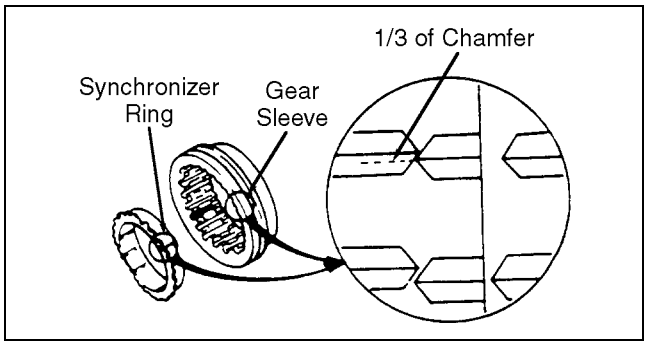


Figure 4G-16. Checking Key Clearance

With the synchronizer properly assembled on the shaft, push in and twist each synchronizer to see if the one-third mesh occurs or not; if not, it means that the overall wear (which is the sum of the wears of slots, keys and chamfered tooth ends) is excessive and, in such a case, the entire synchronizer assembly must be replaced.

Inspect each synchronizer ring for wear of its key slots by measuring the width of each slot. If the width reading exceeds the limit shown in Figure **4G-17**, replace the ring.

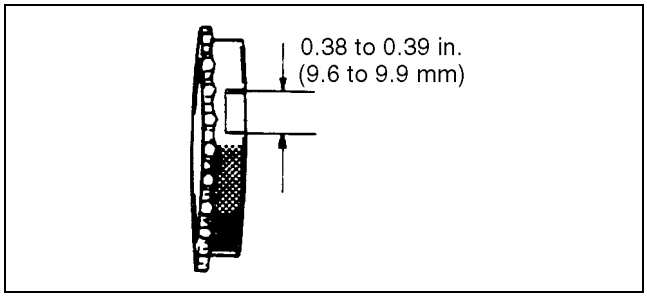


Figure 4G-17. Synchronizer Ring Slot Wear

FORK SHAFT LOCATING SPRINGS

Locating springs are used as retainers for the three shifter fork shafts. If gears have been slipping out of mesh, check these springs for strength by measuring their free lengths (see Figure **4G-18**), and replace them if their free lengths are less than 0.727 inch (18.45 mm).

Spring Free Length ó Standard	Spring Free Length ó Service Limit
0.807 inch (20.5 mm)	0.727 inch (18.45 mm)

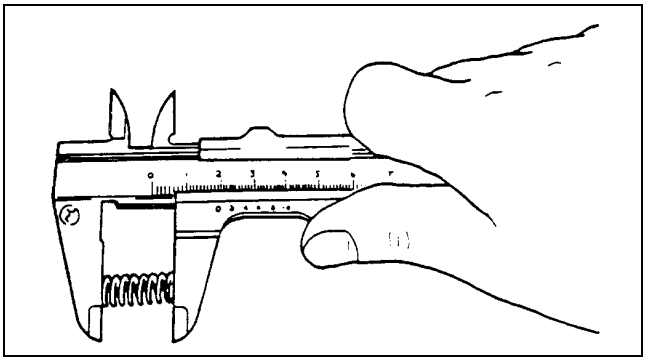


Figure 4G-18. Checking Locating Spring Free Length

GEAR SHIFT FORK SHAFTS

Check the shift fork shafts at the gear shift lever end (see Figure **4G-10**) for uneven wear. Replace worn shift fork shafts.

EXTENSION CASE BUSHING

Check the bushing press-fitted into the extension case for wear by measuring the radial clearance between bushing bore and sliding yoke as shown in Figure **4G-19**. If the sliding yoke is capable of rattling in the bush because of advanced wear it will cause the drive shaft to rattle. For this reason, an extension case found to allow the drive shaft yoke to rattle in excess of 0.004 inch (0.1 mm) must be replaced; replacement of the bushing alone will not fix the problem.

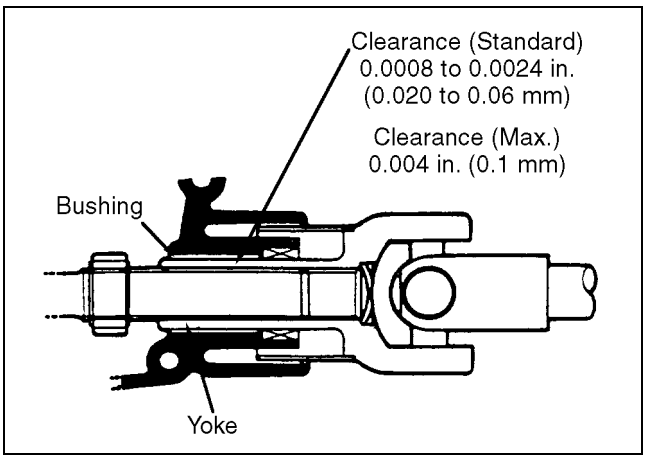


Figure 4G-19. Bushing-to-Yoke Clearance

SECTION 4G. 4-SPEED TRANSMISSION

TRANSMISSION REASSEMBLY

GENERAL

Normally, the entire transmission will not have been disassembled. Reassembly is essentially the reverse of disassembly; however, special procedures are included in the following paragraphs.

SHIFTER SHAFTS AND FORKS

1. See Figure **4G-20** for arrangement of shifter shafts, forks and gear shift case.

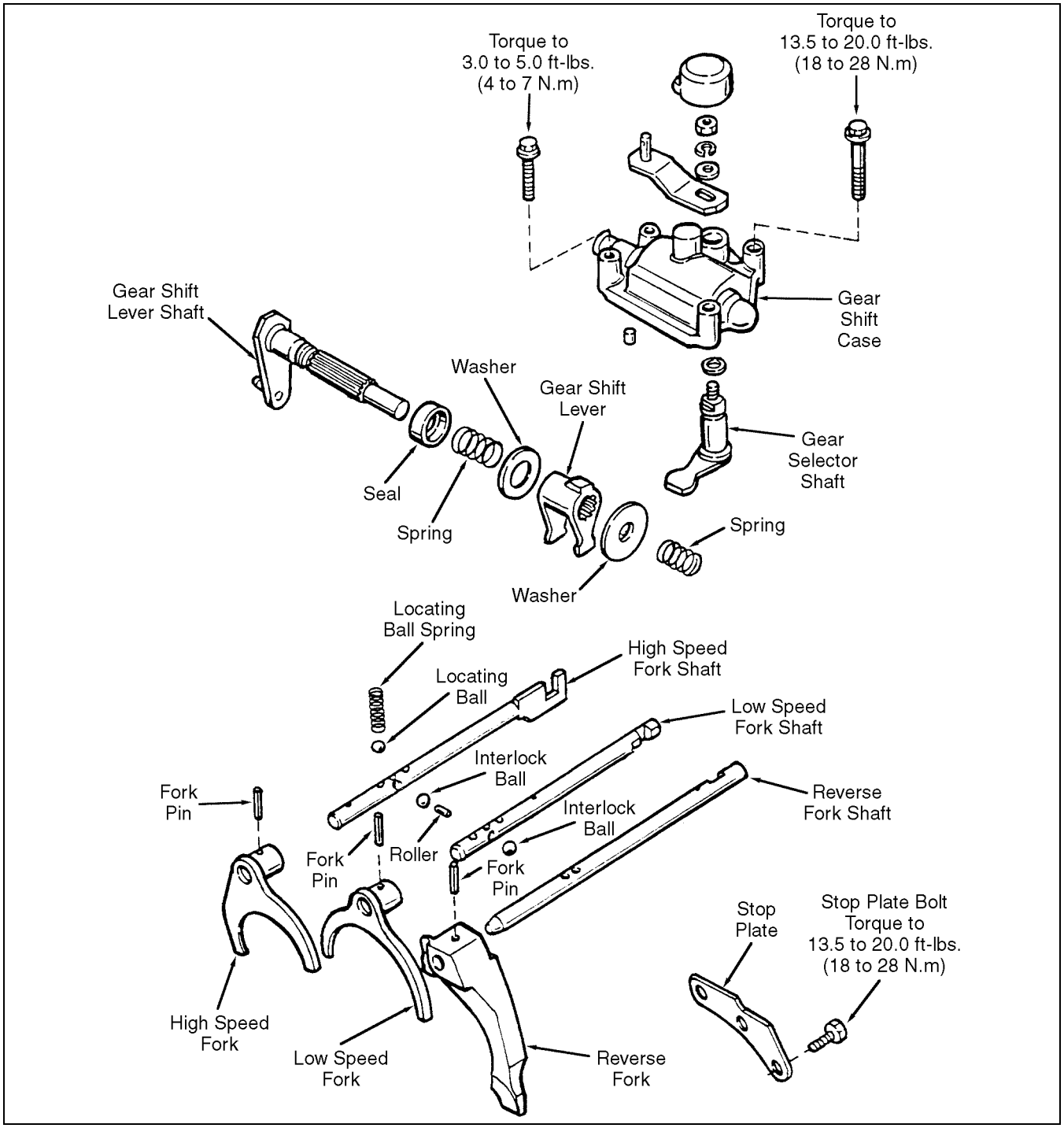


Figure 4G-20. Shifter Shaft and Forks

2. When feeding each shifter fork onto its shaft, be sure to bring the boss (in which the hole for admitting the spring pin is provided) to the extension case side as shown in Figure **4G-21**.

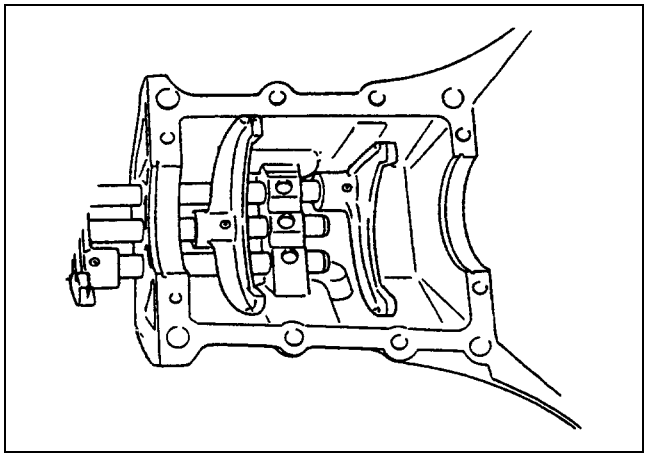


Figure 4G-21. Shifter Fork and Shaft Orientation

3. The coil springs keep the locating steel balls pushed down against the fork shafts (REVERSE, HIGH and LOW) to hold the shafts in respective operating positions as shown in Figure **4G-22**.

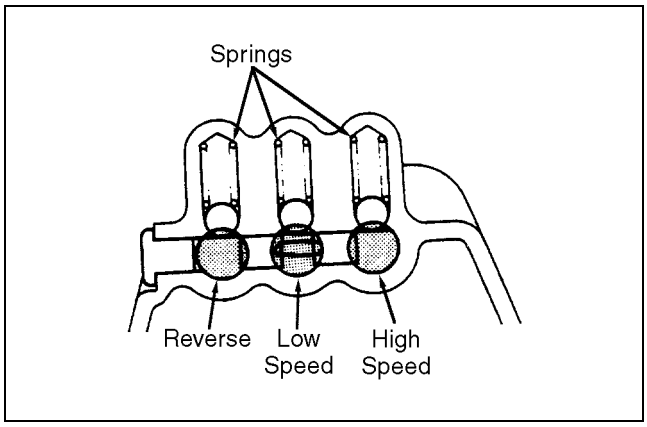


Figure 4G-22. Spring and Locating Ball Assembly

4. The shifter fork shafts are to be installed sequentially. First to be put in place is high speed shaft, followed by low speed shaft and then reverse shaft. The sequence is indicated in the ascending order of numbers as shown in Figure **4G-23**.

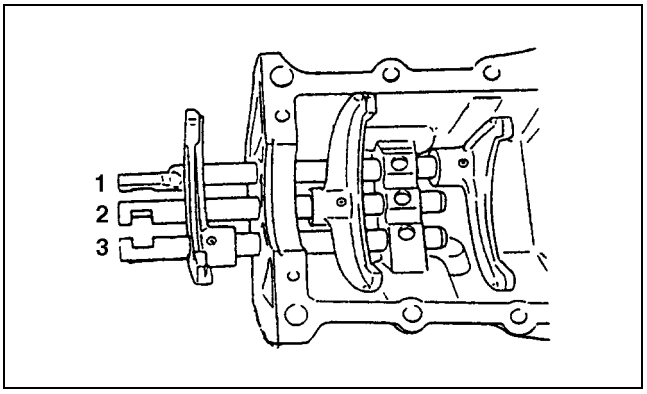


Figure 4G-23. Shifter Fork Assembly

5. Holes for installing the interlock steel balls are in the side wall, next to the reverse shifter fork shaft, of the transmission case. Be sure to feed in one ball after another, positioning each ball between two adjacent shafts, as shown in Figure **4G-24**.

NOTE

Be sure to put in the pin for preventing two shafts from getting shifted at the same time. This pin goes into the hole provided in the low speed shaft.

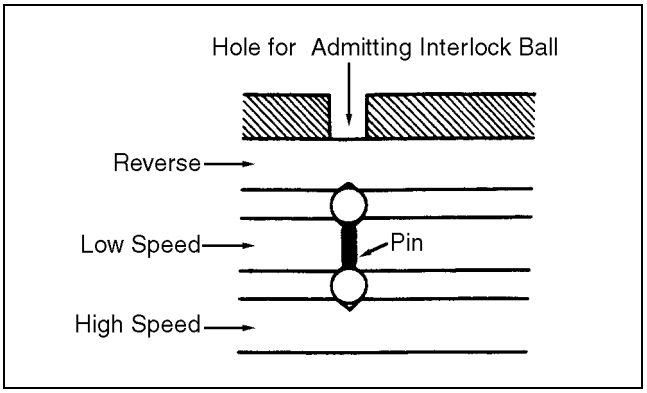


Figure 4G-24. Interlock Ball and Pin Installation

SECTION 4G. 4-SPEED TRANSMISSION

COUNTERSHAFT, MAIN SHAFT, INPUT SHAFT AND STOP PLATE

1. See Figure **4G-25** for general arrangement of the countershaft, main shaft, input shaft and stop plate.

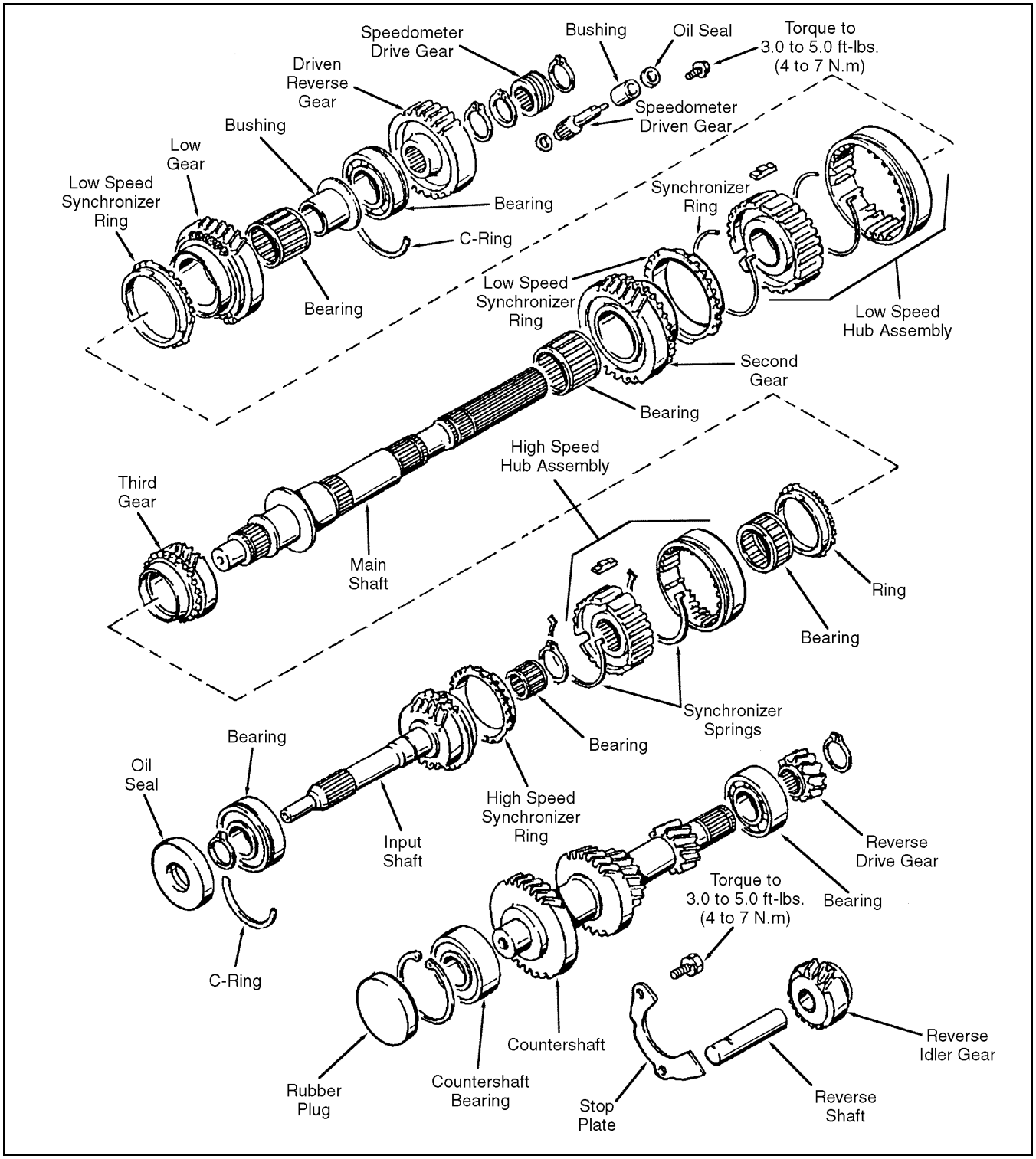


Figure 4G-25. Countershaft, Main Shaft, Input Shaft and Stop Plate

2. When assembling the two synchronizer hubs on main shaft, be sure to position the hub of each correctly as shown in Figure **4G-26**.

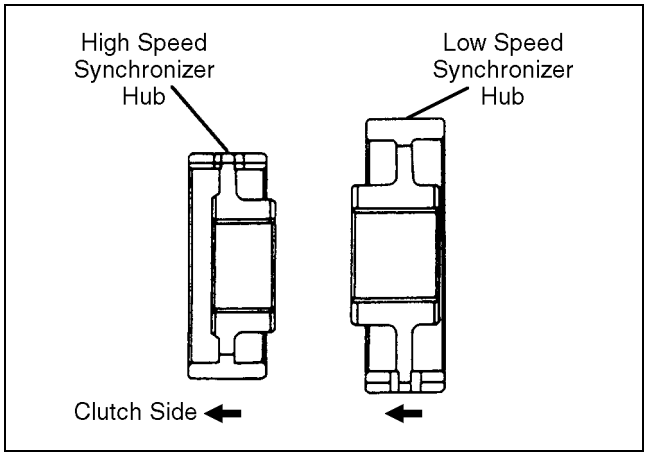


Figure 4G-26. Synchronizer Hub Installation

3. Care must be exercised in positioning the sleeve of each synchronizer. Be sure to bring the groove for admitting the fork to the clutch side.

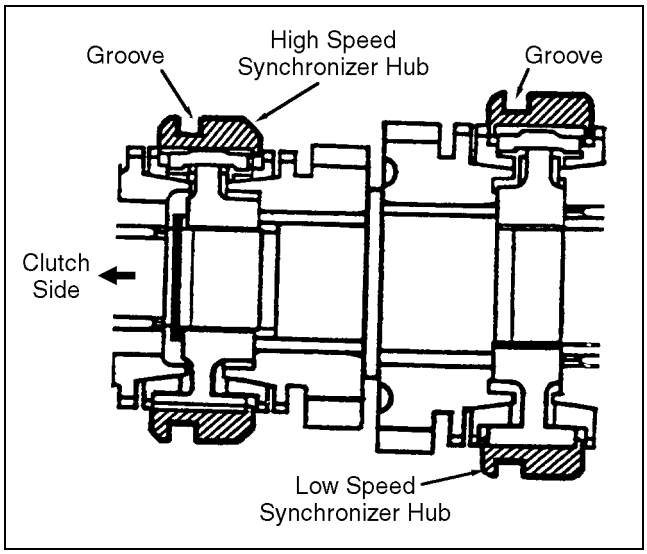


Figure 4G-27. Positioning Synchronizers

4. After installing each synchronizer, be sure that the three keys mounted on the hub fit snugly into the slots provided in the ring.

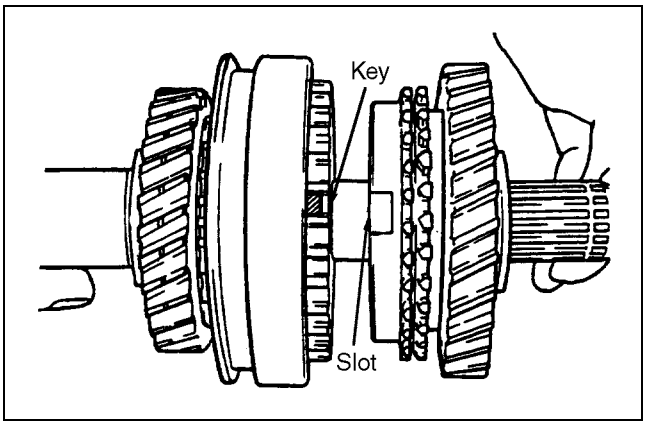


Figure 4G-28. Key and Slot Alignment

5. If it is hard to install the low gear bushing, use hydraulic press and bearing installation tool.

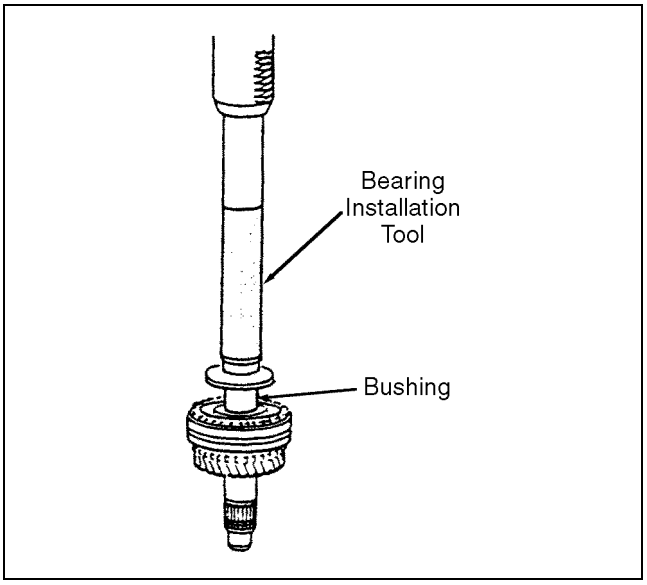


Figure 4G-29. Low Gear Bushing Installation

6. The two reverse gears have their teeth chamfered on one end, and the reverse idle gear is similarly chamfered. When mounting the reverse gears on main shaft and countershaft, respectively, be sure to bring the chamfered end to the outboard side. The chamfered end of the idle gear, however, must face inwardly, as shown in Figure **4G-30**.

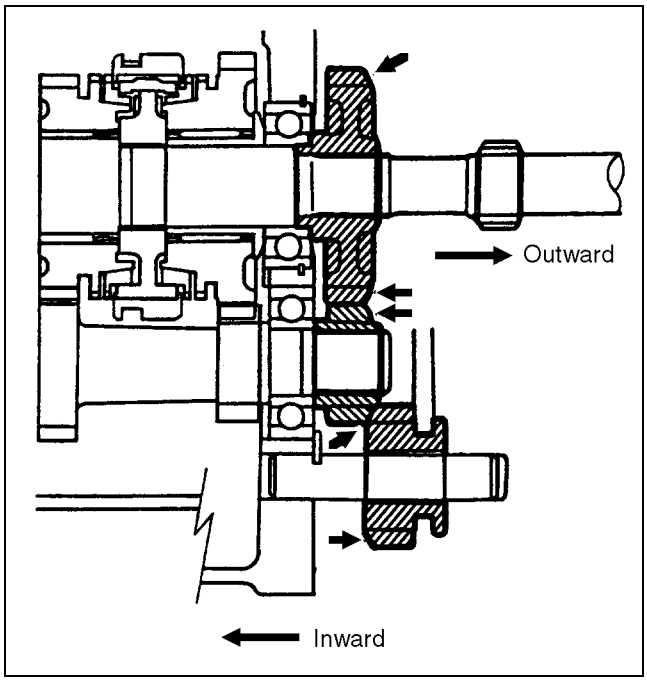


Figure 4G-30. Reverse and Idler Gear Positioning

7. Before installing the input and main shaft assembly on the lower case, be sure to fit the C-rings and dowel pins into the case as shown in Figure **4G-31**.

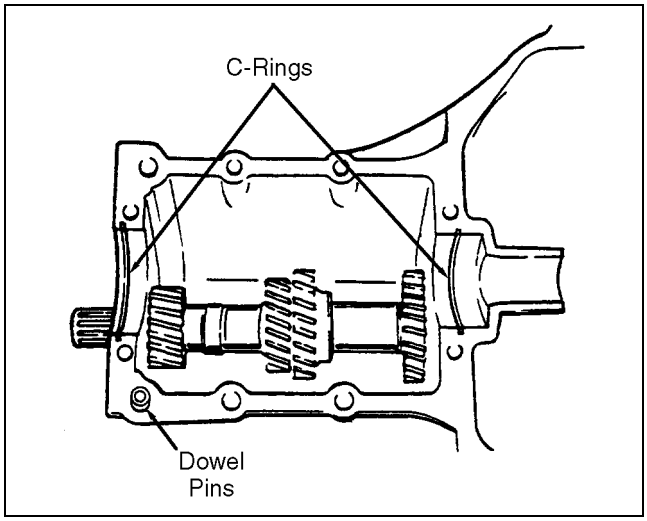


Figure 4G-31. Input Shaft and Main Shaft Installation

JOINING UPPER AND LOWER CASES

1. Clean the joint faces, removing any foreign matters adhering to these faces, and then apply liquid sealing compound to the joint faces, coating each face uniformly with the compound, and match the two cases together.
2. When joining the two cases as shown in Figure **4G-32**, be sure to guide each shifter fork into the groove of its synchronizer sleeve. After putting the upper case on the lower case, tighten the joint bolts uniformly and sequentially so as to equalize the joint pressure all around. Torque bolts to 13.5 to 20.0 ft-lbs. (18 to 28 N.m).

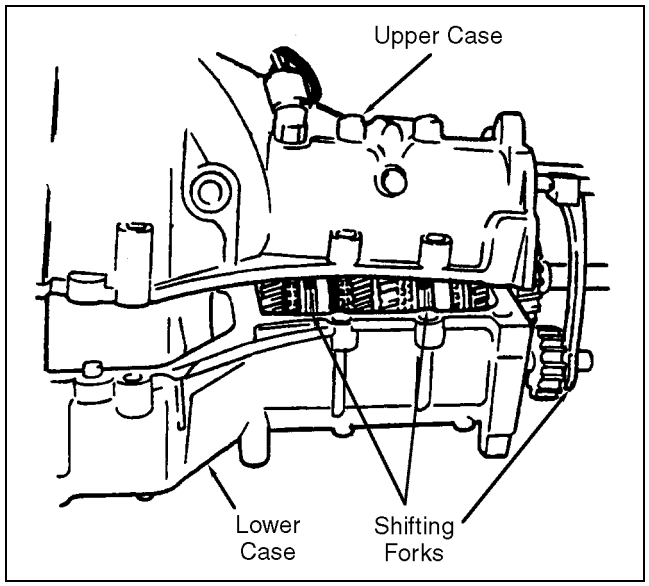


Figure 4G-32. Joining Transmission Cases

EXTENSION CASE

1. When installing the extension case oil seal be sure to position it so that the spring is on the inner side as shown in Figure **4G-33**.

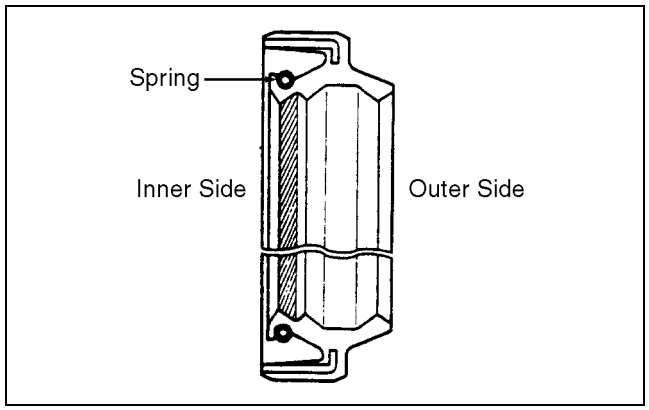


Figure 4G-33. Extension Case Oil Seal

2. Refer to Figure **4G-3**, install the extension case and torque mounting bolts to 13.5 to 20.0 ft-lbs. (18 to 28 N.m).

GEAR SHIFT CASE

Refer to Figure **4G-20**, install the gear shift case and torque bolts as shown.

TRANSMISSION INSTALLATION

Following any clutch repair or any other procedure that involves removal of the transmission from the vehicle the following steps should be taken.

1. Lubricate transmission and fill with fluid as described in SECTION 11.
2. Install mounting brackets as shown in Figure **4C-1**.
3. Using a suitable hoist, position the transmission near the clutch disc.
4. Slide transmission forward until input shaft splines engage clutch disc. It may be necessary to turn the input shaft to index splines.
5. Install transmission mounting hardware, do not tighten.
6. Use Loctite 243 (blue). Install transmission bell housing to engine. Mount with socket head capscrews. Torque to 37 ft-lbs. (51 N.m). Diesel only: Install the two lower socket head capscrews. Torque to 37 ft-lbs. (51 N.m).
7. Install and tighten all transmission-to-frame mounting hardware.
8. Install mounting brackets to transmission extension case and install drive shaft to transmission as described in SECTION 4C.
9. Connect clutch cable on clutch release lever and gear shift cables/connectors on gear shift lever and selector arm as described in SECTIONS 4D and 4E]. Make certain connections to operator controls are correct and shifting/selecting operates smoothly. Adjust as described in SECTION 2C.
10. Install all electrical cables, hoses and tubes disconnected during transmission removal.
11. Install any brackets or sheet metal that were removed.
12. Connect battery cables.
13. Adjust clutch cable, pedal free travel and interlock switch (SECTION 2C).

SECTION 4H. TRANSMISSION (DIESEL ENGINES)

GENERAL

The transmission is a 4-speed manual shift type. The shift pattern is a standard H pattern with reverse R over to the right and down.

In some cases the entire transmission may not have to be disassembled. Disassemble only what is needed for repair.

TRANSMISSION REMOVAL

1. Disconnect the negative (ñ) and positive (+) battery cables from battery terminals.
2. Tag and disconnect all cables, hoses, tubes or control linkages which would obstruct lifting the transmission out of the frame.
3. Remove any sheet metal which would obstruct lifting the transmission out of the frame.
4. Remove the drain plug and drain oil from the transmission. Replace drain plug and torque to 14.5 to 21.5 ft-lbs. (20 to 30 N.m) for units with 3-cylinder gasoline engines and 26.5 to 36.0 ft-lbs. (36 to 50 N.m) for units with 4-cylinder gasoline or diesel engines.
5. Disconnect the clutch cable from the clutch release lever.
6. Disconnect the shift cables (see SECTION 4E).
7. Disconnect the drive shaft at the transmission (see SECTION 4C).
8. Attach a suitable hoist to the transmission.
9. Remove hardware that fastens the transmission to the engine.
10. Remove any remaining transmission hardware from mounting brackets on the frame until the transmission is free to be lifted.
11. Carefully move the transmission away from the engine flywheel and move the transmission out of the frame to a suitable work stand.

INPUT SHAFT BEARING REPLACEMENT

NOTE

Whenever the engine and transmission are separated, the transmission input shaft bearing mounted in the engine flywheel should be inspected for wear or damage.

1. Turn the bearing by hand, if it sticks, rattles or makes abnormal noise when spun, it should be replaced.
2. Remove the input shaft bearing using a removal tool as shown in Figure **4H-1**.
3. Install a new bearing as shown in Figure **4H-1**.
4. Visually check the flywheel surface, where it contacts the clutch disc, for wear or damage. If wear or damage is determined, replace the flywheel in accordance with engine manufacturerís instructions.

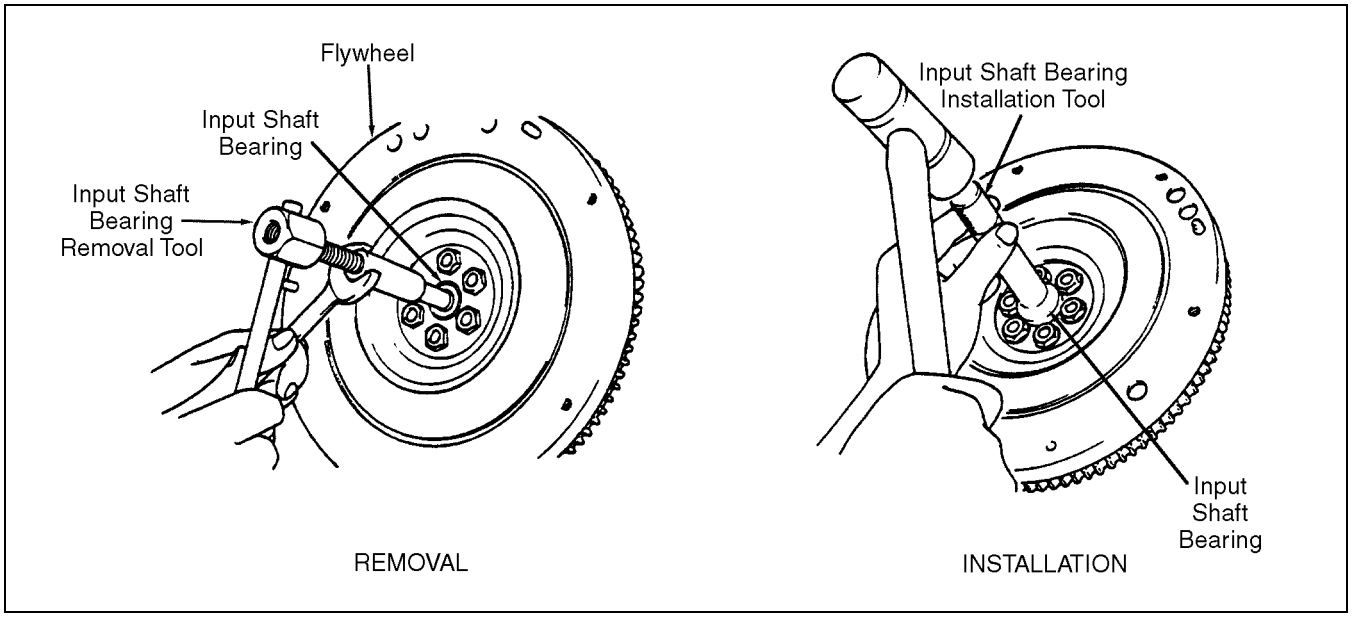


Figure 4H-1. Input Shaft Bearing Replacement

SECTION 4H. TRANSMISSION (DIESEL ENGINES)

TRANSMISSION DISASSEMBLY

GEAR SHIFT CASE (See Figure 4H-2)

1. Remove the mounting bolts, disengage the gear selector shaft from the gear shift lever in the transmission and lift the assembled gear shift case off the transmission case.
2. If necessary, disassemble the gear shift as shown in Figure 4H-2.

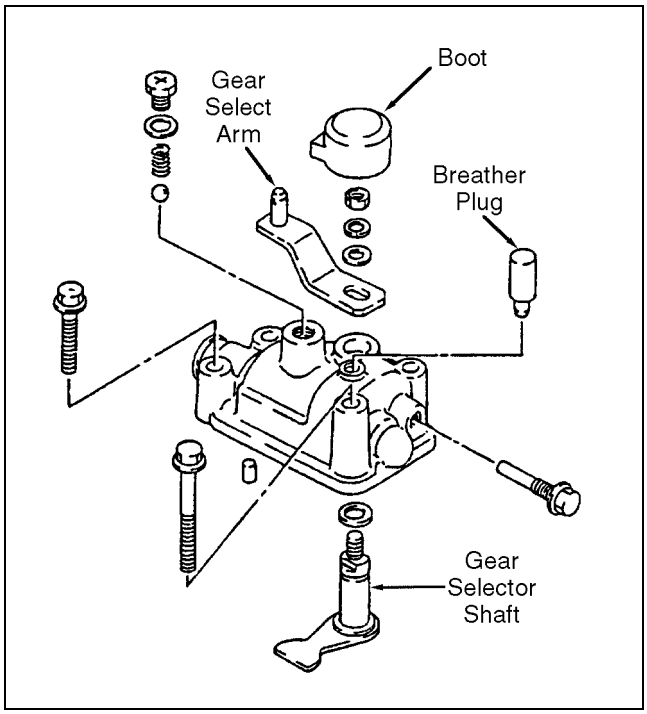


Figure 4H-2. Gear Shift Case

EXTENSION CASE (See Figure 4H-3)

1. Remove the extension case seal from the extension case.
2. Remove the hardware securing the extension case to the transmission case and detach the extension case and mounting bracket.

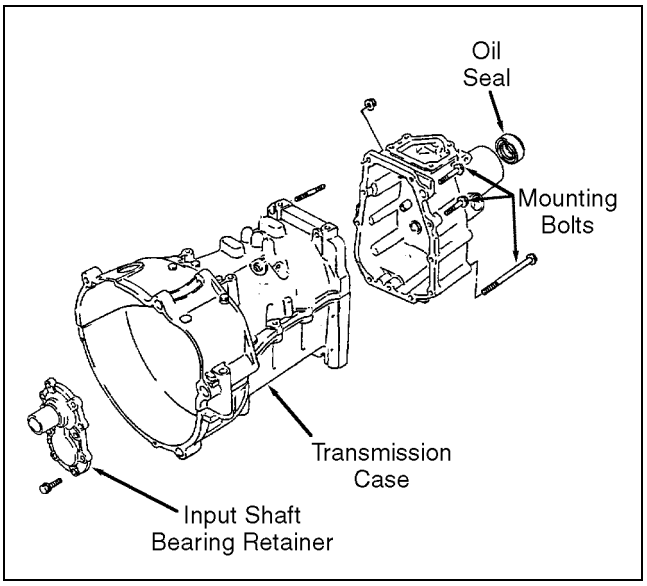


Figure 4H-3. Extension Case

SPLITTING THE TRANSMISSION (See Figure 4H-4)

1. Remove the bolts that fasten the upper and lower transmission cases together.
2. Use a steel pry bar or large screwdriver to pry the two case halves apart being careful not to damage the mating faces.

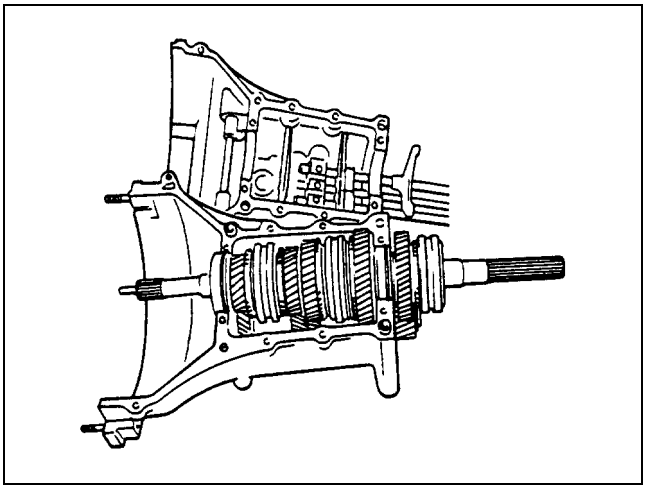


Figure 4H-4. Splitting the Case Halves

GEAR AND SHAFT DISASSEMBLY

NOTE

The arrangement of gears and shafts is shown in Figure 4H-5.

SECTION 4H. TRANSMISSION (DIESEL ENGINES)

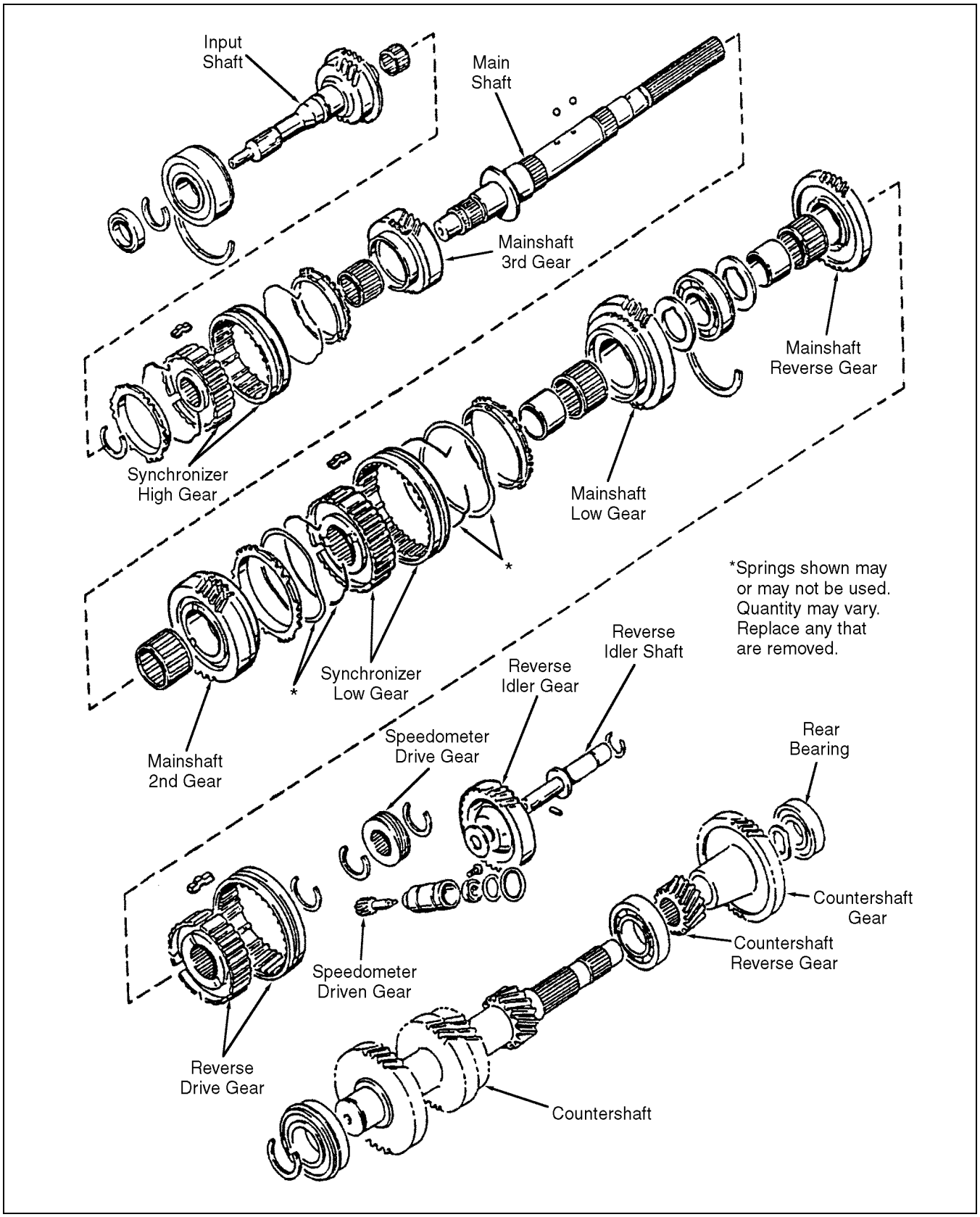


Figure 4H-5. Gear and Shaft Arrangement

SECTION 4H. TRANSMISSION (DIESEL ENGINES)

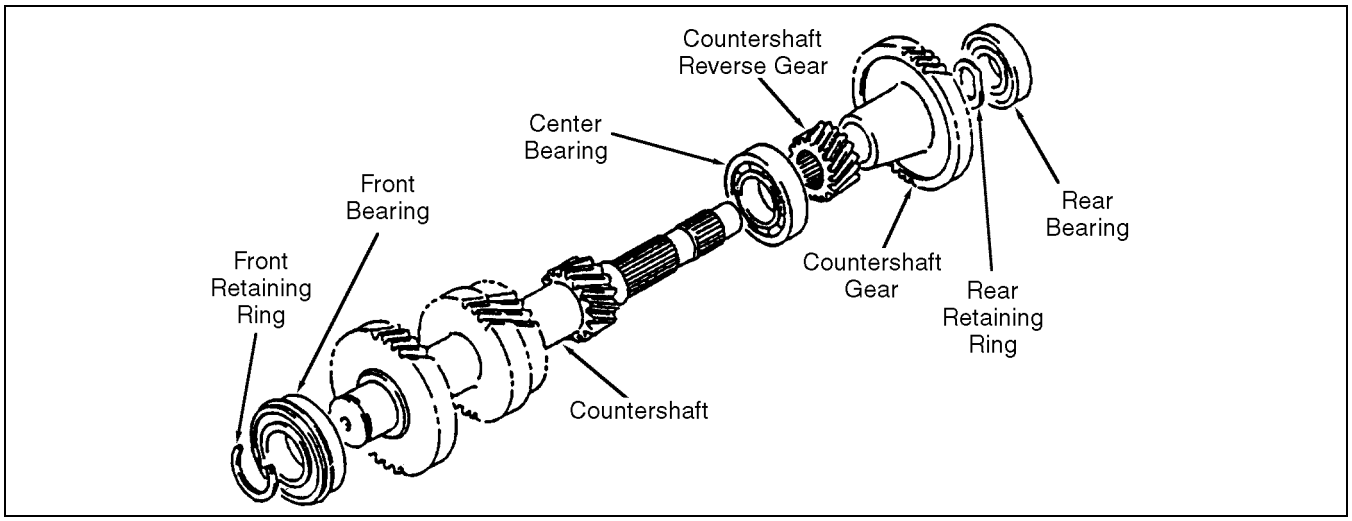


Figure 4H-6. Countershaft Disassembly

COUNTERSHAFT

1. Use a bearing puller to pull the rear bearing (see Figure **4H-6**) off the countershaft.
2. Remove the rear retaining ring and PTO drive gear.

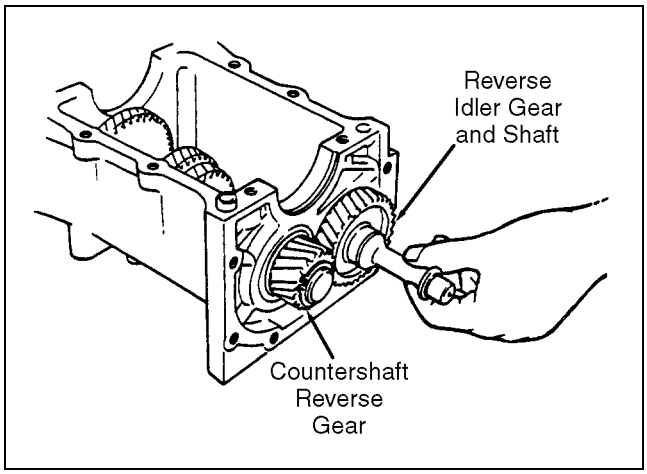


Figure 4H-7. Reverse Idler Gear and Shaft

3. Remove reverse idler gear and shaft (see Figure **4H-7**).
4. Remove the countershaft reverse gear (see Figure **4H-6**).
5. Remove front retaining ring from countershaft. Push out countershaft to extension case side by using hydraulic press. Take countershaft assembly out of case (see Figure **4H-8**).

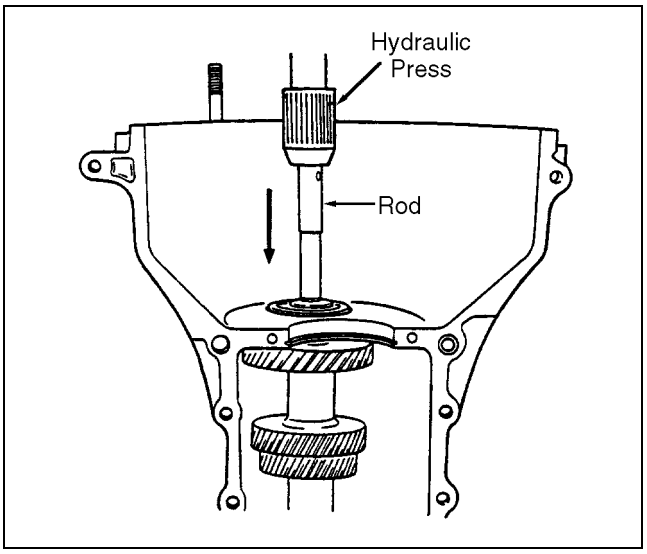


Figure 4H-8. Countershaft ó Step 5

INPUT SHAFT AND MAIN SHAFT

1. Refer to Figure **4H-9**, remove the oil seal, retaining ring, bearing and input shaft. Pull out the input shaft, by hand, taking care not to drop the high speed synchronizer rings.
2. Remove the retaining ring, high speed synchronizer rings, springs, needle bearings, high speed hub and sleeve, and third driven gear from the main shaft.
3. Remove retaining ring for speedometer drive gear and slide off speedometer drive gear.
4. Remove retaining ring and reverse synchronizer hub from main shaft.
5. Remove reverse drive hub, reverse gear and reverse gear needle bearing.

SECTION 4H. TRANSMISSION (DIESEL ENGINES)

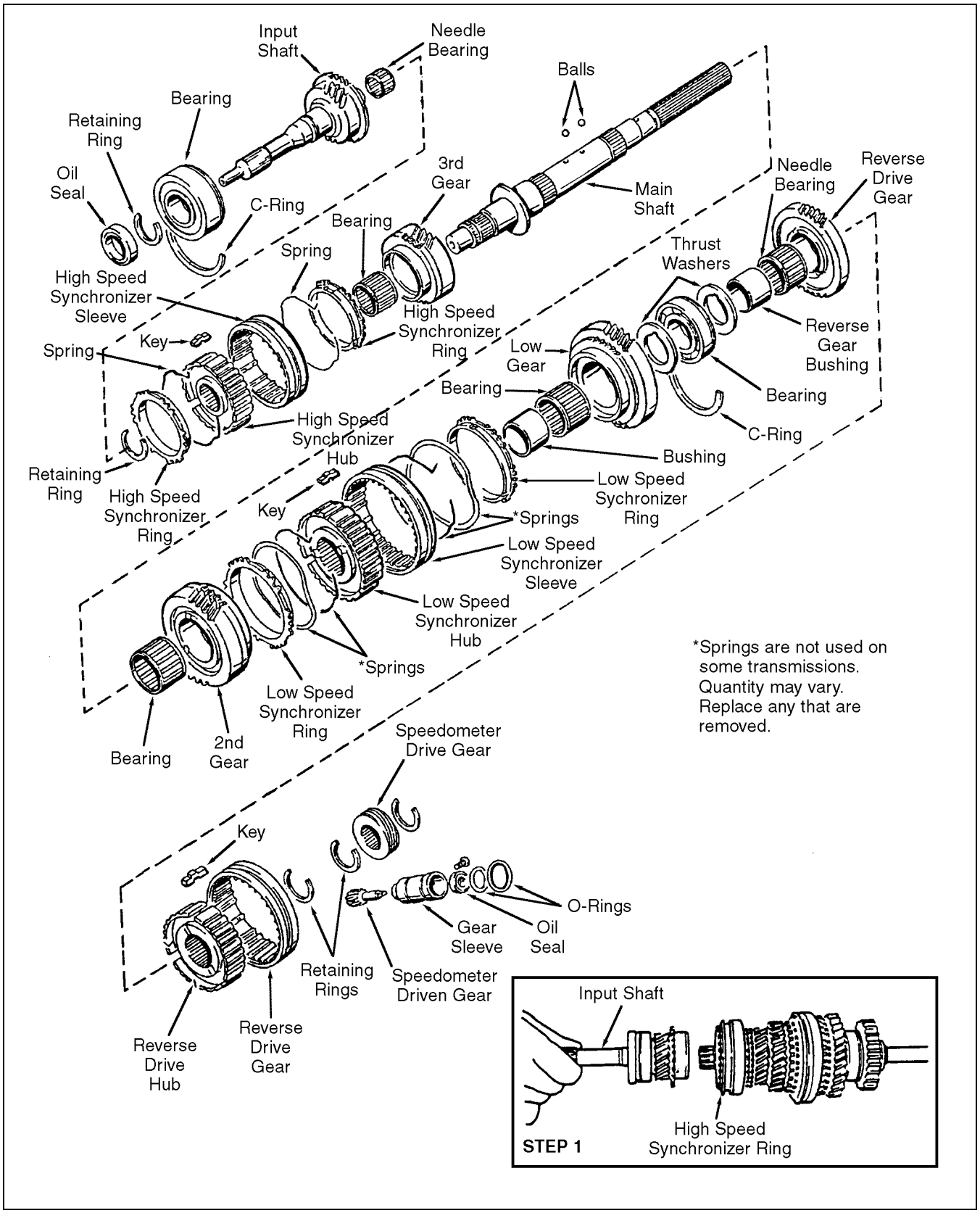


Figure 4H-9. Input Shaft and Main Shaft

6. Remove bearing thrust washer and reverse gear bushing on main shaft by using hydraulic press as shown in Figure **4H-10**.

NOTE

During this removal, watch out for balls which may fall off. They must not be lost. Also, ball bearing should not be removed together with above washer and bushing.

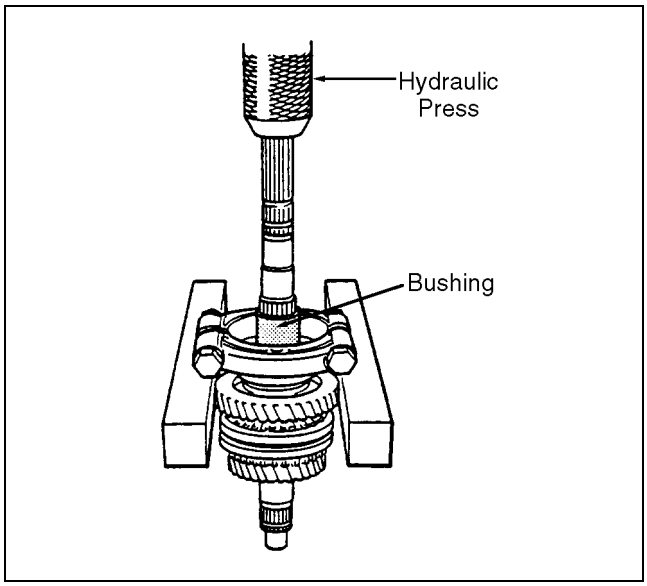


Figure 4H-10. Main Shaft ó Step 6

7. Remove ball bearing and main shaft (center) bearing by using hydraulic press as shown in Figure **4H-11**.

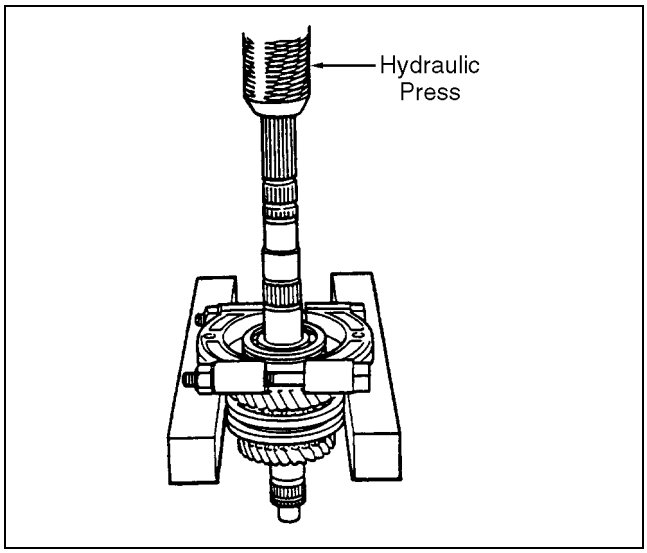


Figure 4H-11. Main Shaft ó Step 7

8. Remove low gear, needle bearing and synchronizer ring from main shaft as shown in Figure **4H-9**.
9. Remove low gear bushing, low speed synchronizer hub, ring, 2nd gear and 2nd gear bearing by using hydraulic press as shown in Figure **4H-12**.

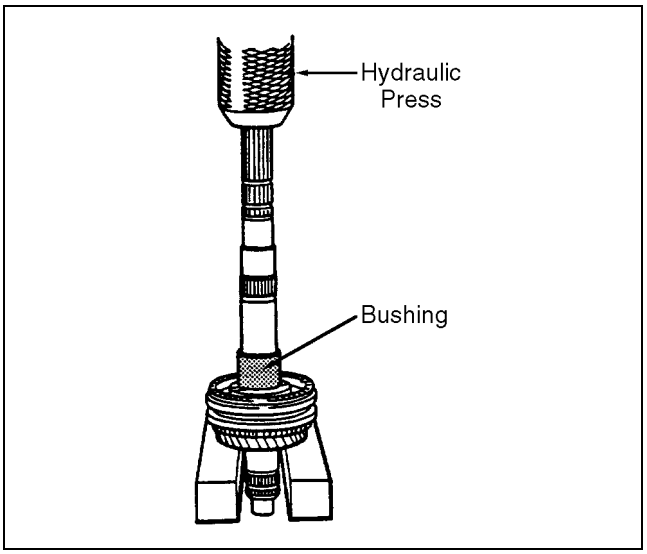


Figure 4H-12. Main Shaft ó Step 9

SHIFTER SHAFTS AND FORKS (See Figure 4H-13)

1. Before starting the removal work, make sure that all the shifter fork shafts in place are in neutral position.
2. It is important that the three shifter fork shafts be kept in neutral position in order to make sure that the interlock balls between two adjacent shafts are seated fully in the detents of respective shafts. If any of these interlock balls are out of the detents, some of the fork shafts will refuse to come out when pulled.
3. Pull out reverse gear shift shaft. As this shaft comes out, locating ball and spring will jump out of hole; do not let them fly away.
4. Using spring pin remover, drive out yoke pin on low speed gear shift fork and pull out shift shaft. During this work, be careful not to let locating ball, interlock ball and spring fly away.

CAUTION

When removing yoke pin, be sure not to drive it out so far as to contact case, or it will cause damage to case.

5. Drive yoke pin out of high speed gear shift fork as in Step 3, and pull out fork shaft and fork.

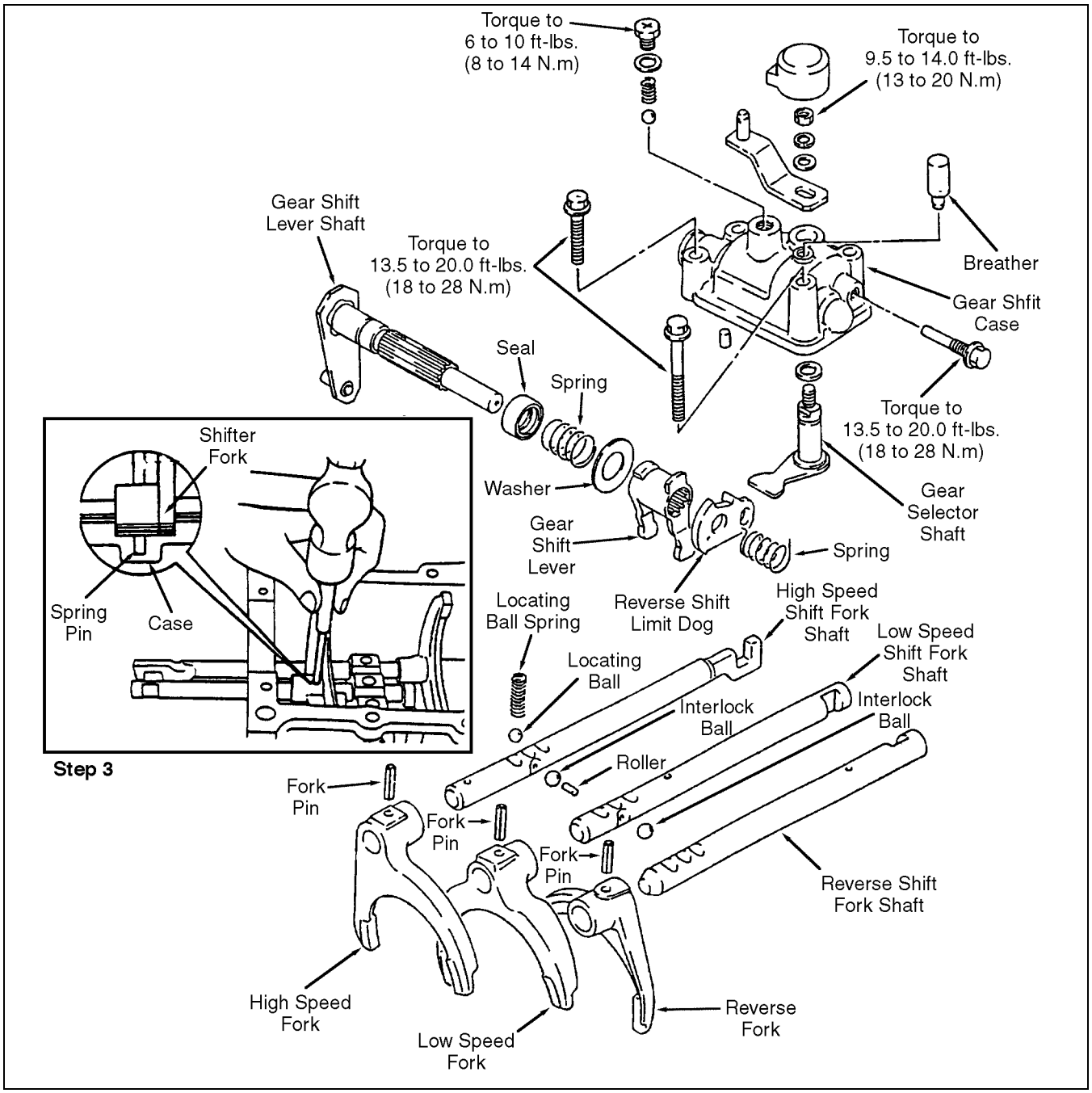


Figure 4H-13. Shifter Shafts and Forks

SECTION 4H. TRANSMISSION (DIESEL ENGINES)

INSPECTION AND REPAIR

GEAR TEETH

Prior to cleaning, check bottom of transmission case for metal particles. If metal is detected, inspect parts closely for damage and/or wear.

Clean parts in a suitable non-flammable solvent. Remove old sealant material being careful not to damage seal surfaces.

Dry parts thoroughly. Do not allow bearings to spin dry, lubricate after cleaning (see SECTION 11).

Discard any parts that show signs of damage or wear. Pack bearings with grease and wrap to protect from dirt (see SECTION 11).

NOTE

Do not confuse gear contact patterns with normal tool marks that are a result of manufacture. Typical tool marks are shown in Figure **4H-14**.

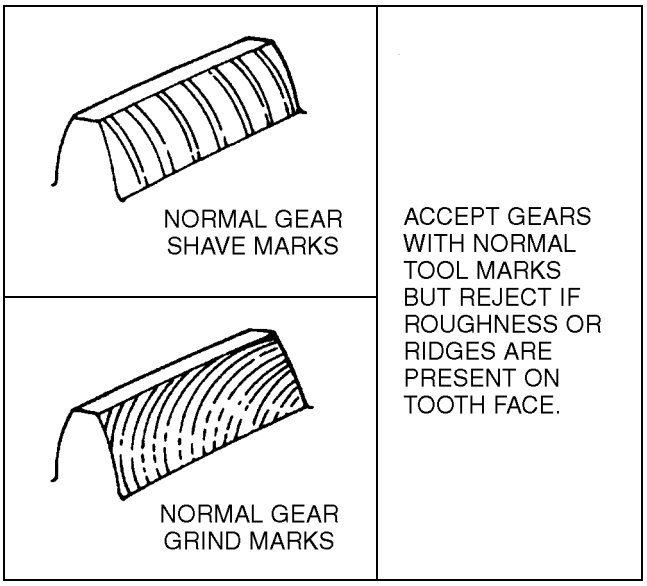


Figure 4H-14. Normal Gear Tooth Tool Marks

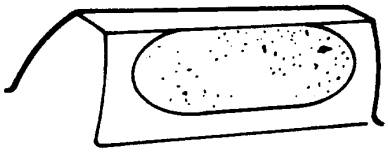
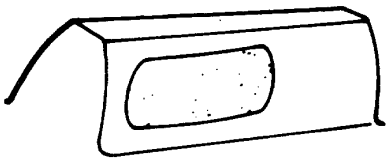
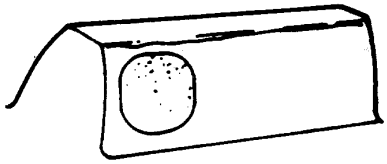
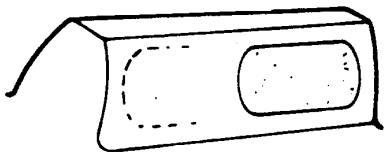
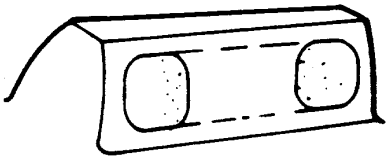
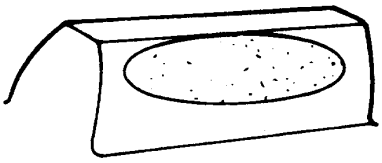
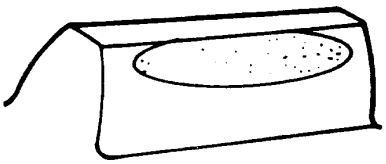
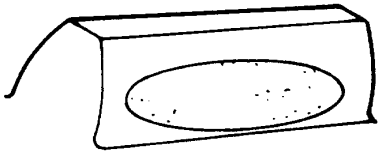
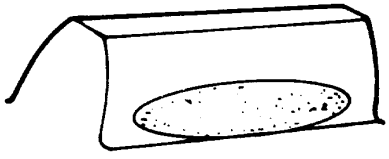
Description	Accept	Reject
DESIRED CONTACT PATTERN		
END CONTACT PATTERN		
TRAVELING CONTACT PATTERN (MOVES FROM SIDE TO SIDE)		
HIGH CONTACT PATTERN		
LOW CONTACT PATTERN		

Figure 4H-15. Gear Tooth Contact Patterns

Check gear tooth contact patterns (see Figure **4H-15**).

Check gear teeth for chips, see Figure **4H-16**.

Parts with small chips shown in REPAIR column in Figure **4H-16** may be blend-repaired and reused.

Chips or broken teeth as shown in REJECT column in Figure **4H-16** are not repairable and the part must be rejected.

Check clutch teeth for rounding, see Figure **4H-17**.

Face rounding will cause the clutch to jump out. Clutch teeth with rounding on the end are usable, but will cause hard shifting.

Clutch teeth with chips may be blend-repaired in the same manner as gear teeth.

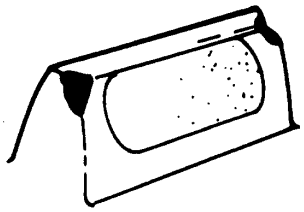
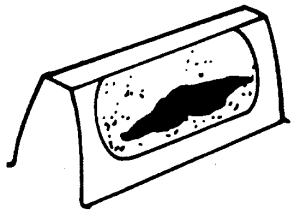
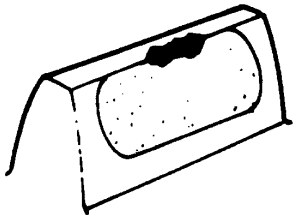
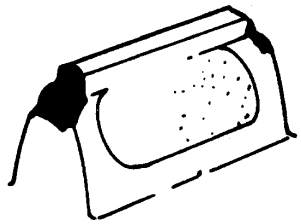
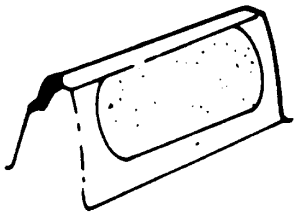
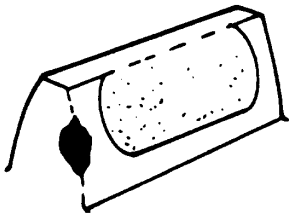
Repair		Reject	
CORNER CHIP AT DRIVE FACE		CHIP WITHIN CONTACT PATTERN	
O.D. EDGE FACE AT DRIVE FACE. MAY EXTEND SLIGHTLY INTO CONTACT PATTERN.		CHIP COMPLETELY THROUGH TOOTH (CONSIDERED TO BE BROKEN)	
CORNER CHIP AT COAST FACE			
SIDE EDGE CHIP AT DRIVE FACE			

Figure 4H-16. Gear Tooth Chips

SPLINE TEETH

Check for broken or chipped spline teeth. Small chips may be blend-repaired in same manner as gear teeth.

If any spline tooth is broken, the part must be rejected.

Spline teeth will not show contact patterns as gear teeth do.

However, they may show evidence of step wear which is cause for rejection.

GEAR REPAIR

Parts which are rejected by inspection are to be replaced, unless repair procedures specified in the following paragraphs, or other obvious minor repair, will restore the part to complete serviceability.

Repair is limited to blend-repair of chips. See Figure **4H-17**.

Blend repair chips using a suitable hand-held, high speed grinding tool.

Blend chip into surrounding base metal, but do not remove any more metal than necessary.

Blend all sharp edges into smooth contour. Sharp edges may chip again or develop cracks.

Use a suitable abrasive stone to remove burrs. Be careful to remove only raised material, not base metal.

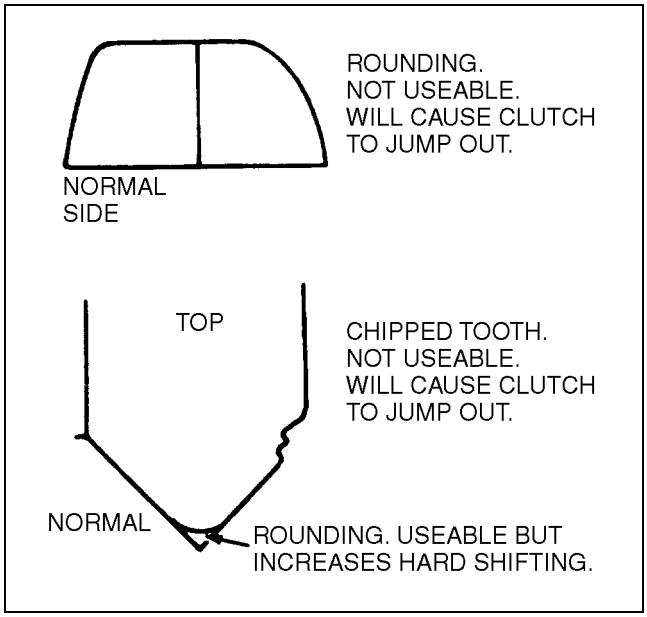


Figure 4H-17. Clutch Tooth Inspection

SYNCHRONIZER RINGS

Fit the rings to the cone of the gear (input gear, or ìthird,î ìsecondî or ìlowî gear), and measure the clearance between the two at the peripheral teeth, as shown in Figure **4H-18**. Standard clearance is 0.039 to 0.055 inch (1.0 to 1.4 mm). If the clearance is less than 0.02 inch (0.5 mm) the ring and gear should be replaced.

Inspect the external cone (of the gear) and internal cone (of the ring) for abnormal wear. Be sure that the contact patterns on these surfaces indicate uniform full-face contact, and that the surfaces are free from any wavy wear. A badly worn ring or gear must be replaced.

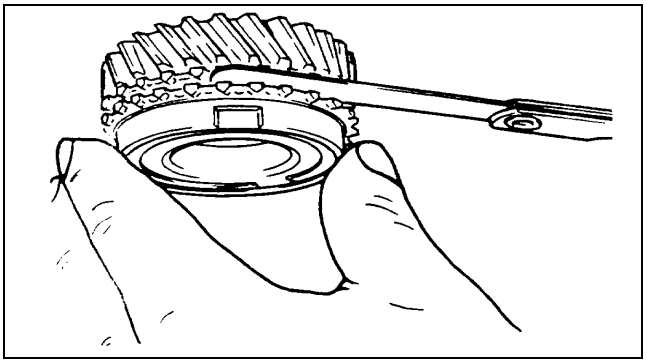


Figure 4H-18. Synchronizer Ring-to-Gear Clearance

Proper synchronizing action on gear shifting can be expected only when the ring-to-gear clearance and the condition of cone surfaces, are satisfactory.

RING (External) AND GEAR SLEEVE (Internal) TEETH

Synchronizer rings and hubs have three slots each, in which the keys are carried as backed by expanding springs, so that the hub and its two rings, one on each end, are capable of running together. Since the sleeve is engaged by its internal teeth with the hub, as if the two were splined together, the sleeve also runs with the hub and rings.

In meshing action, the sleeve is pushed (by the shifter fork) to one side, so that it slides axially on the hub, pushing the ring toward the cone surface of the gear. This push is transmitted by the three keys, which are lightly gripped by the sleeve.

By the friction between the gear cone and the ring cone (internal), the ring begins to rotate but is opposed by the hub because of the keys. In other words, the ring is (at this time) twisted, while the sleeve is advancing further to push the ring fully against the gear cone.

Since the ring is unable to slide along any further, the sleeve lets go of the keys and rides over to the ring. At this moment, the initial contact between the chamfered ends of teeth of the ring and those of internal teeth of the sleeve occurs. This contact is such that the internal teeth of the sleeve align themselves to those of the ring. When the sleeve advances and slides into the ring, the ring will be rotating nearly with the speed of the gear, so that the sleeve can smoothly slide over into the clutch teeth of the gear.

The initial contactor mesh between sleeve and ring is determined by the widths of key and slot. The key clearance in the slot should extend at least a third (1/3) of the chamfer (see Figure **4H-19**).

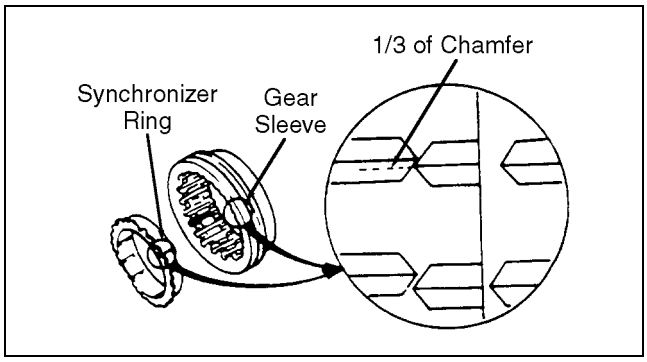


Figure 4H-19. Checking Key Clearance

With the synchronizer properly assembled on the shaft, push in and twist each synchronizer to see if the one-third mesh occurs or not; if not, it means that the overall wear (which is the sum of the wears of slots, keys and chamfered tooth ends) is excessive and, in such a case, the entire synchronizer assembly must be replaced.

Inspect each synchronizer ring for wear of its key slots by measuring the width of each slot. If the width reading exceeds the limit shown in Figure **4H-20**, replace the ring.

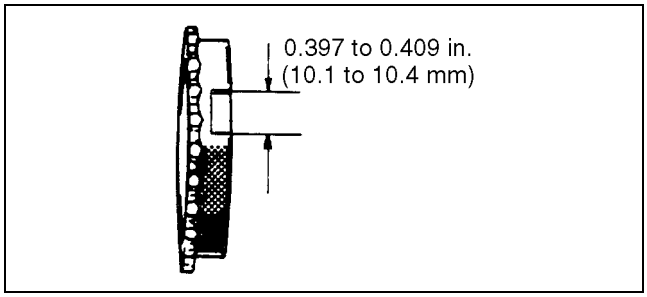


Figure 4H-20. Synchronizer Ring Slot Wear

FORK SHAFT LOCATING SPRINGS

Locating springs are used as retainers for the three shifter fork shafts. If gears have been slipping out of mesh, check these springs for strength by measuring their free lengths (see Figure **4H-21**), and replace them if their free lengths are less than 0.826 inch (21.0 mm).

Spring Free Length ó Standard	Spring Free Length ó Service Limit
1.004 inch (25.5 mm)	0.286 inch (21.0 mm)

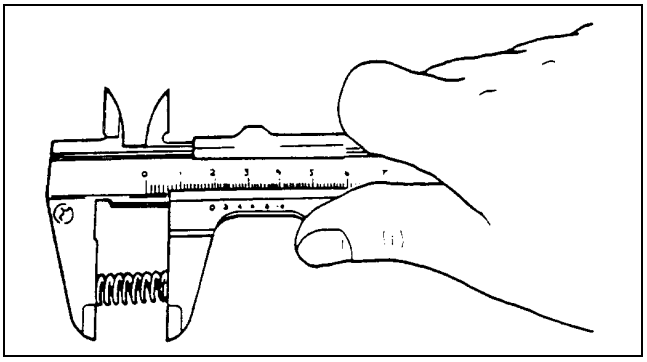


Figure 4H-21. Checking Locating Spring Free Length

GEAR SHIFT FORK SHAFTS

Check the shift fork shafts at the gear shift lever end (see Figure **4H-13**) for uneven wear. Replace worn shift fork shafts.

EXTENSION CASE BUSHING

Check the bushing press-fitted into the extension case for wear by measuring the radial clearance between bushing bore and sliding yoke as shown in Figure **4H-22**. If the sliding yoke is capable of rattling in the bush because of advanced wear it will cause the drive shaft to rattle. For this reason, an extension case found to allow the drive shaft yoke to rattle in excess of 0.0078 inch (0.2 mm) must be replaced; replacement of the bushing alone will not fix the problem.

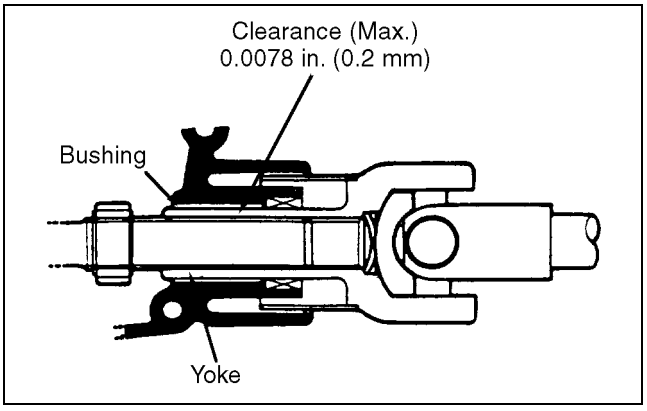


Figure 4H-22. Bushing-to-Yoke Clearance

SECTION 4H. TRANSMISSION (DIESEL ENGINES)

TRANSMISSION REASSEMBLY

GENERAL

Normally, the entire transmission will not have been disassembled. Reassembly is essentially the reverse of disassembly; however, special procedures are included in the following paragraphs.

SHIFTER SHAFTS AND FORKS

1. See Figure **4H-23** for arrangement of shifter shafts, forks and gear shift case.

   Note that three shift shafts individually have a locating ball and locating spring, and that 2 interlock balls and an interlock roller are used between shafts as shown in Figure **4H-24**.

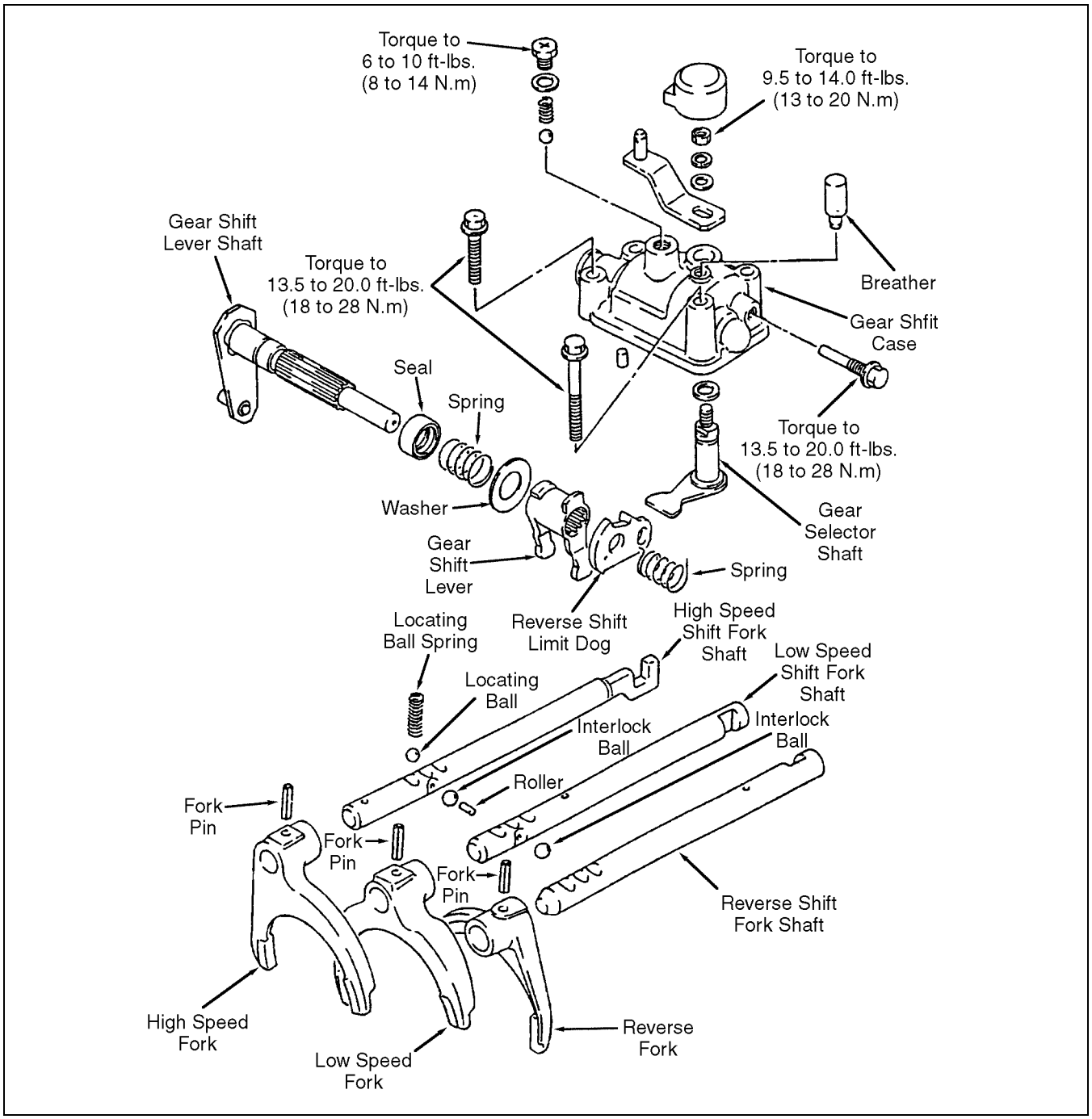


Figure 4H-23. Shifter Shaft and Forks

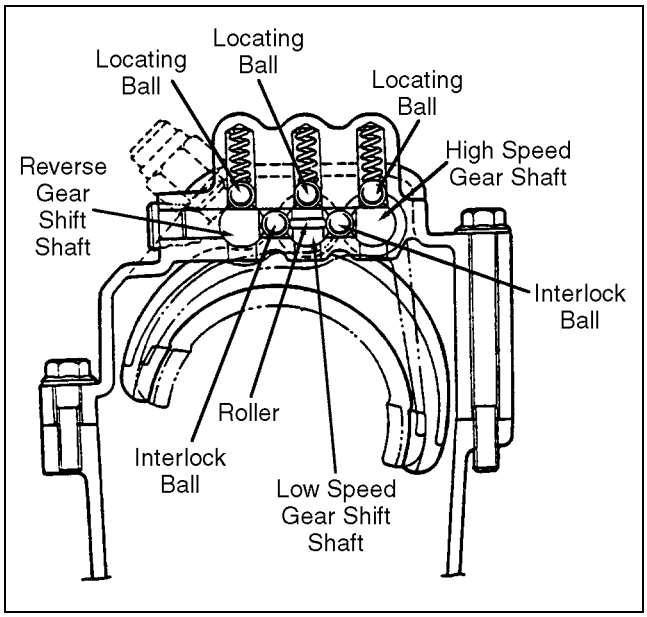


Figure 4H-24. Spring and Ball Arrangement

2. Install high, low and reverse shafts in that order.
3. Install 3 locating springs into 3 holes in upper case. Fit locating ball on top of locating spring in hole as shown in Figure **4H-25**.

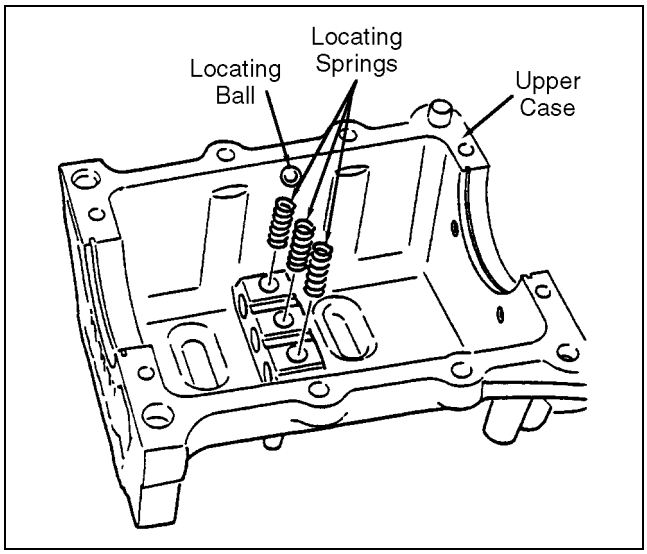


Figure 4H-25. Installing Locating Balls and Springs

4. Insert high speed gear shift shaft into upper case. Push down high speed gear shift shaft locating ball to pass shaft over it and keep inserting shaft until locating ball fits in center slot of 3 continuous slots in shaft.

   Insert high speed shift fork in the direction shown in Figure **4H-23**.

   Drive fork pin into fork and shaft.
5. Refer to Figures **4H-24** and **4H-25**. Install interlock ball and locating ball in upper case. After installing interlock roller in low speed gear shift shaft, insert shaft into upper case as described in Step 4 above.

   Fork should be installed as shown in Figure **4H-24**. Then drive fork pin until it becomes flush with outer surface of fork.
6. Install interlock ball and locating ball into upper case. Then insert reverse gear shift shaft into upper case as shown in Step 4 above.

SECTION 4H. TRANSMISSION (DIESEL ENGINES)

MAIN SHAFT AND INPUT SHAFT

1. See Figure **4H-26** for general arrangement of the countershaft, main shaft and input shaft.

NOTE

Be careful to install each washer, gear, synchronizer hub and sleeve in the proper direction. Make sure that balls are installed on the main shaft.

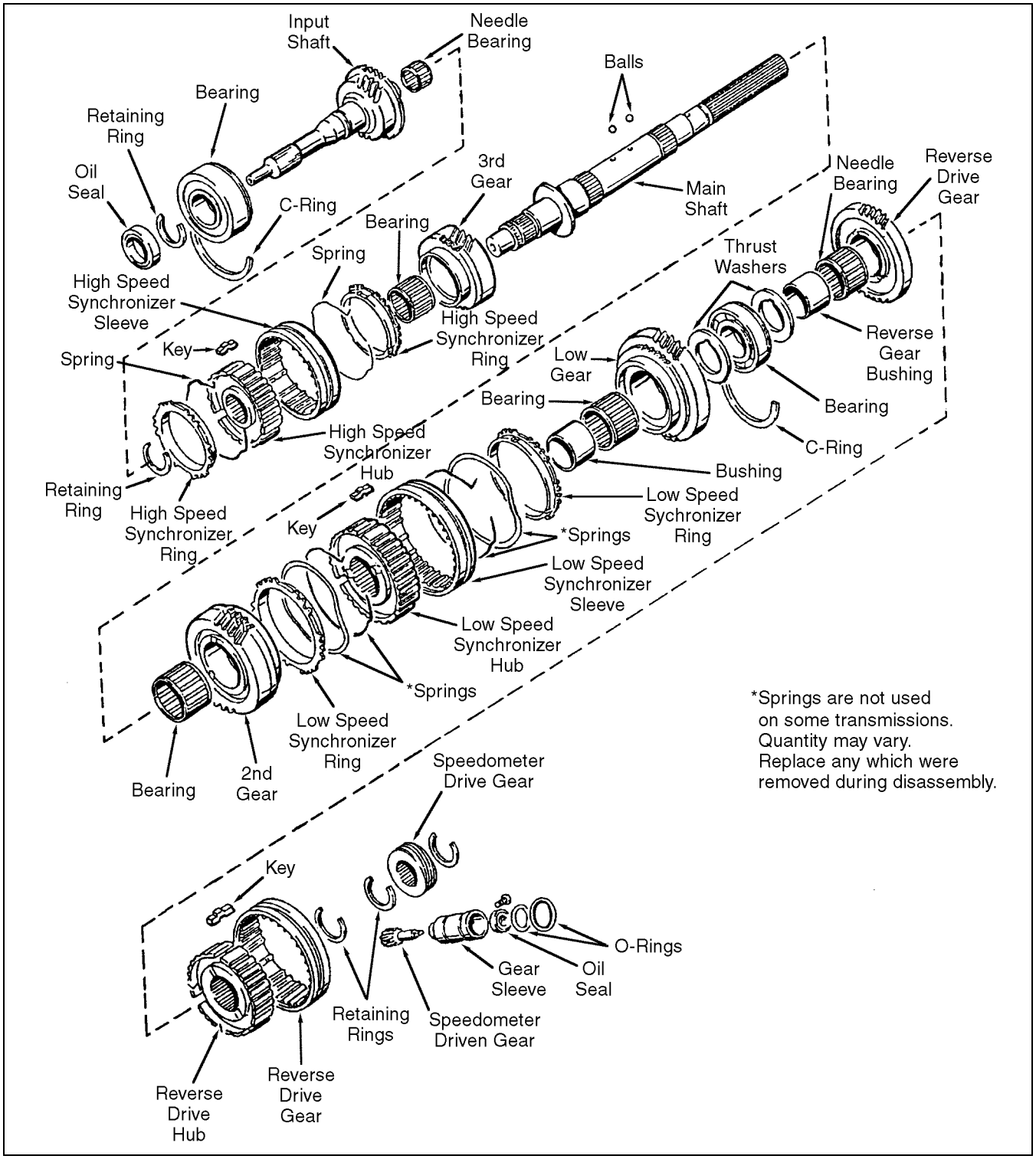


Figure 4H-26. Main Shaft and Input Shaft

2. Install 2nd gear bearing, 2nd gear, synchronizer ring and low speed synchronizer hub/sleeve onto main shaft, using care for installing direction of synchronizer sleeve as shown in Figure **4H-27**.

   After putting on each synchronizer, be sure that 3 keys mounted on hub fit snugly into slots cut in ring.

NOTE

Do not forget to install synchronizer ring spring between synchronizer ring of 2nd gear side and synchronizer hub.

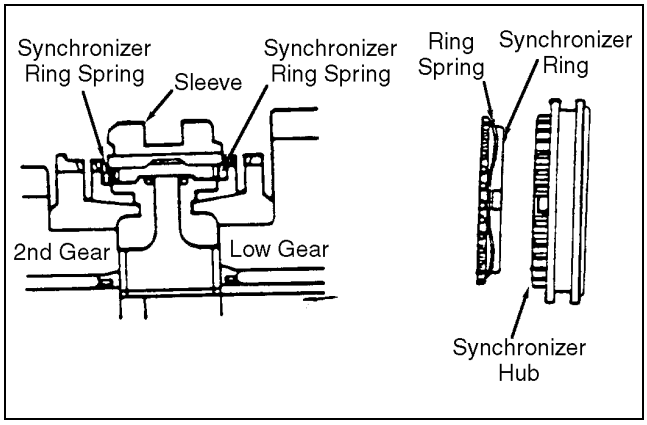


Figure 4H-27. Synchronizer Ring Spring Installation

3. Press-fit the low gear bushing on the shaft using a hydraulic press.
4. Install low gear needle bearing, synchronizer ring spring, synchronizer ring, low gear, ball and washer onto main shaft as shown in Figure **4H-28**.

   Fit ball into hole in shaft and install washer so that its slot comes over ball.

   Install washer so that its chamfered side is on the main shaft center bearing side.

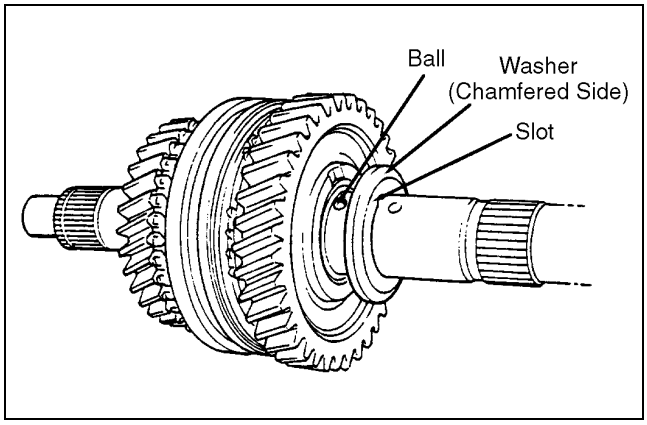


Figure 4H-28. First Ball and Washer Installation

5. Press-fit center bearing with bearing installation tool as shown in Figure **4H-29**, using care for its installing direction.

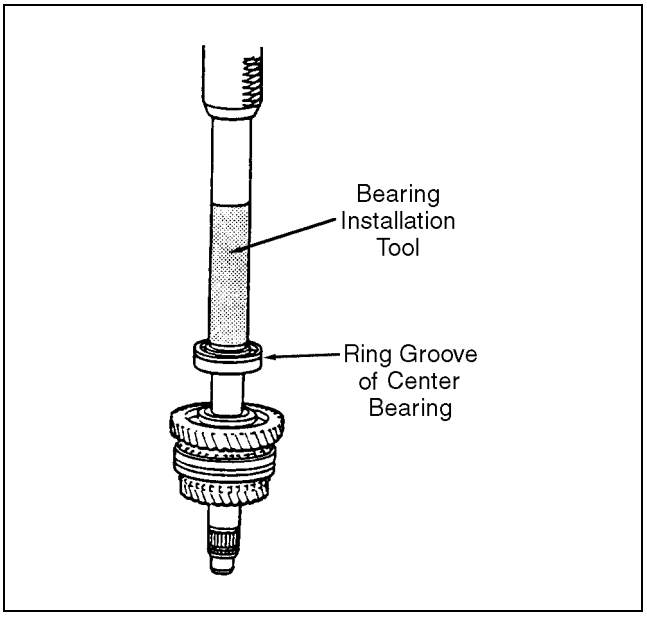


Figure 4H-29. Installing Center Bearing

6. Install ball and washer. As Figure **4H-30** shows, install washer so that its circumference chamfered side faces center bearing and its slot comes over ball.

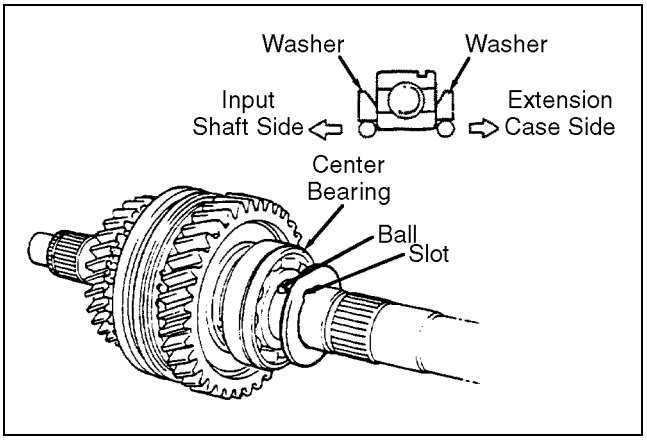


Figure 4H-30. Second Ball and Washer Installation

7. Press-fit reverse gear bushing, preventing ball installed in Step 6 from coming off.

8. Install reverse gear bearing, reverse gear and reverse drive hub/sleeve. For proper direction, make sure to install hub so that the side whose inside boss is smaller in diameter and longer is at the transmission case rear side (see Figure **4H-31**).

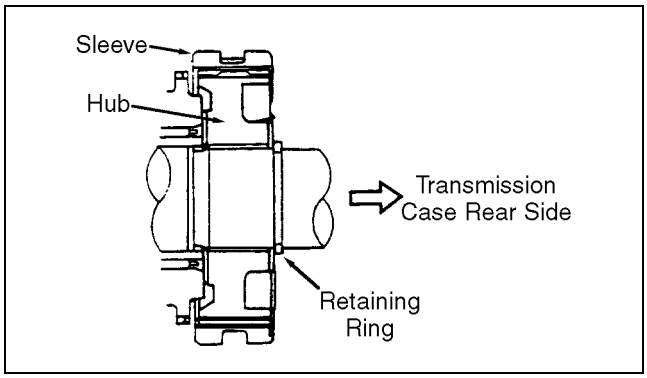


Figure 4H-31. Main Shaft Assembly ó Steps 8 and 9

9. Fit reverse hub retaining ring into groove in main shaft.
10. Install 3rd gear bearing, 3rd gear, high speed synchronizer ring and hub/sleeve. When installing hub, position the side with larger outer diameter boss to 3rd gear side, then fit retaining ring into groove in main shaft.
11. Install speedometer drive gear on the main shaft.
12. Install synchronizer ring, needle bearing and input shaft.

COUNTERSHAFT AND REVERSE IDLER GEAR

1. Drive countershaft front bearing into lower case. Then, using plastic hammer, drive countershaft slightly into front bearing.

   Using bearing installation tool, drive rear bearing onto countershaft and into lower case (see Figure **4H-32**).
2. Fit countershaft front retaining ring into groove in shaft.
3. Install countershaft reverse drive gear (see Figure **4H-33**) onto countershaft, and then fit countershaft rear retaining ring into groove in shaft.

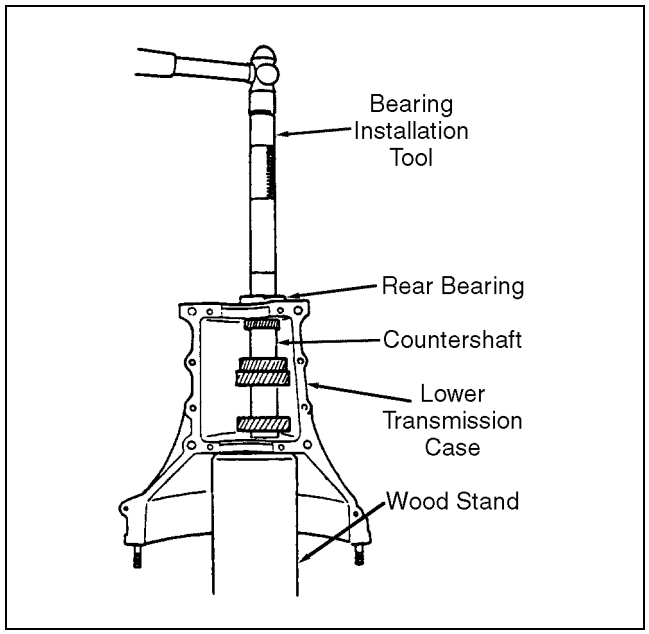


Figure 4H-32. Countershaft Front Bearing

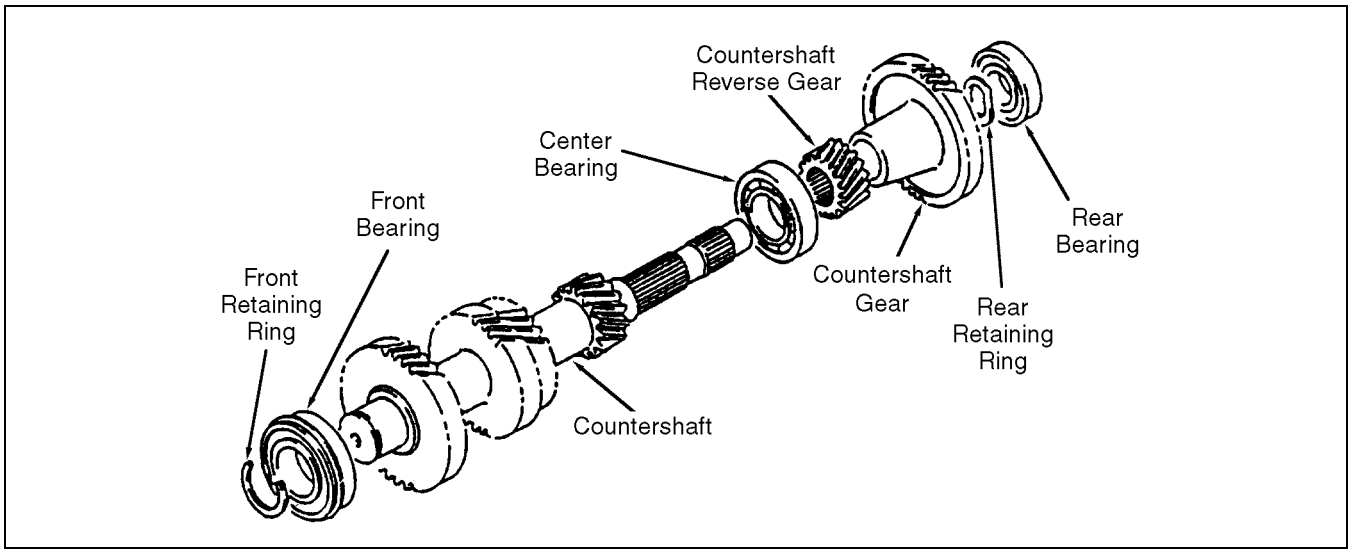


Figure 4H-33. Countershaft Reassembly

4. Install idle gear and washer onto reverse gear shaft and pin into it as shown in Figure **4H-34**.

   Install above as assembled into lower case with pin and washer tongue aligned as shown in Figure **4H-34**.

5. Install the PTO drive gear (see Figure **4H-33**), rear retaining ring, and rear bearing.

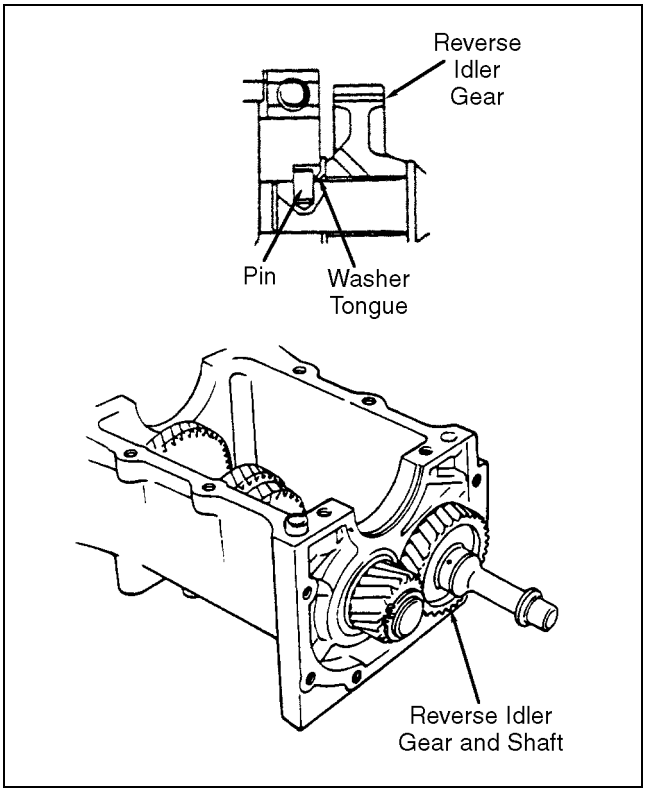


Figure 4H-34. Reverse Idler Gear and Shaft Installation

SECTION 4H. TRANSMISSION (DIESEL ENGINES)

JOINING UPPER AND LOWER CASES
(See Figure 4H-35)

1. Make certain the case alignment pins are fitted on each side of the lower case.
2. Clean the joint faces, removing any foreign matter.
3. Make certain the C-rings are fitting in the shaft bearing grooves.
4. With the forks previously installed in the upper case and the countershaft, reverse idler gear and reverse shaft installed in the lower case, install the assembled main shaft and input shaft in the lower case.
5. Uniformly apply sealant compound to the mating face of the lower case.
6. Match the upper case to the lower case by aligning the three shift forks with the three grooves in the synchronizer sleeve on the main shaft.
7. Check that transmission input shaft rotates easily when turned by hand.
8. Install case bolts and torque to 13.5 to 20.0 ft-lbs. (18 to 28 N.m).

INPUT SHAFT BEARING RETAINER
(See Figure 4H-36)

1. Prior to installing the bearing retainer, grease the clutch release mechanisms as described in SECTION 4D.
2. Install the input shaft bearing retainer in the transmission case and torque the engine mounting bolts to 13.5 to 20.0 ft-lbs. (18 to 28 N.m).

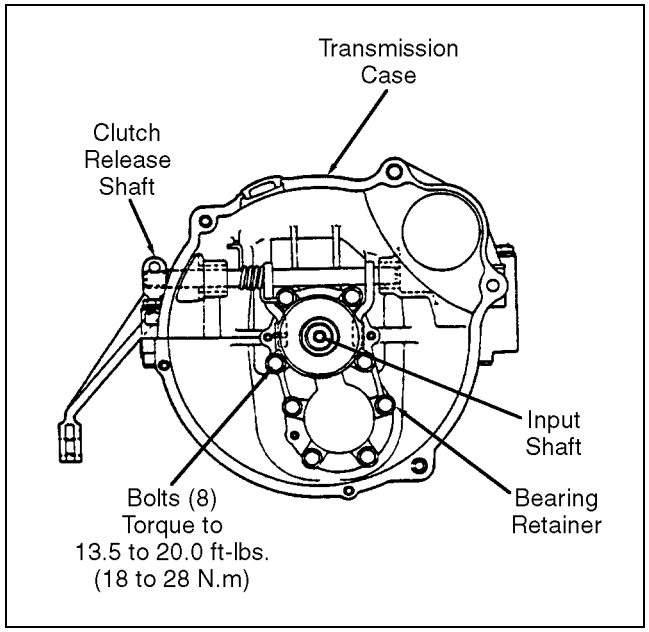


Figure 4H-35. Input Shaft Bearing Retainer Installation

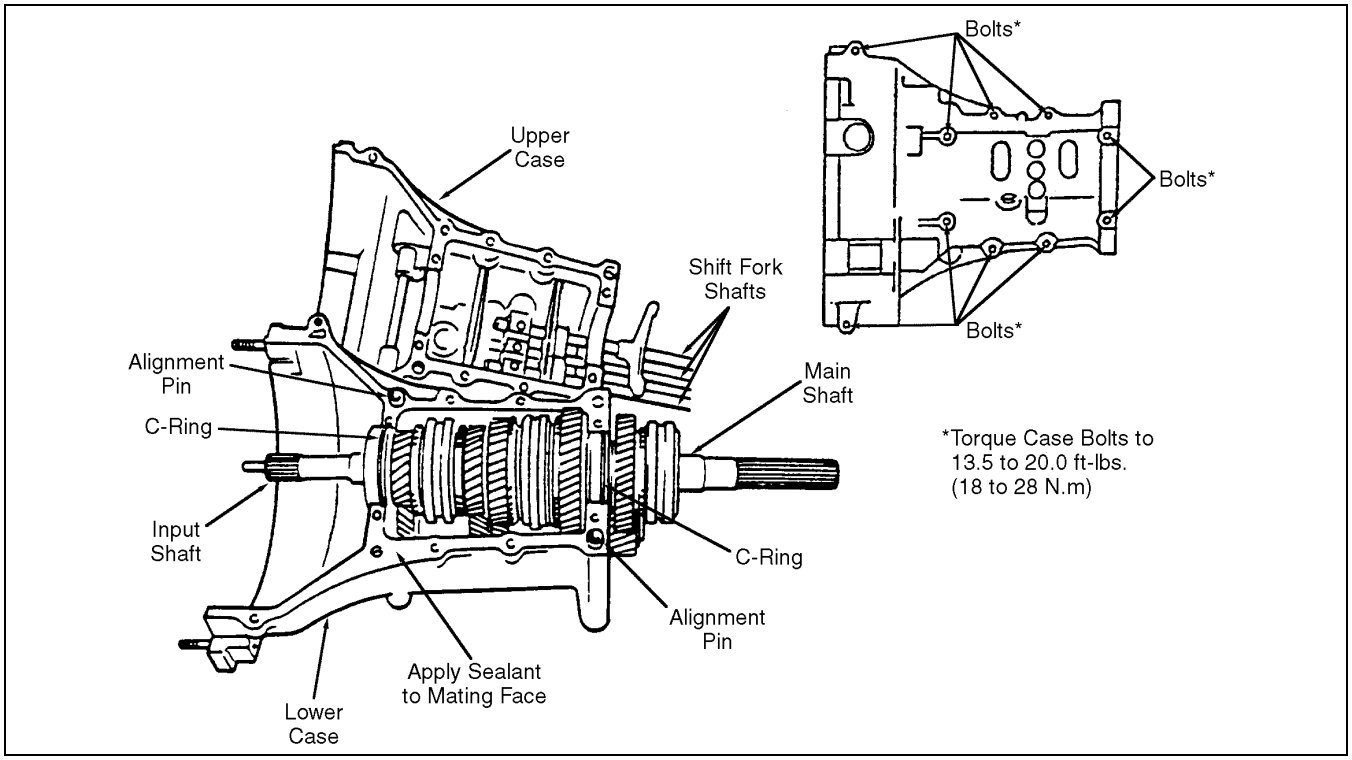


Figure 4H-36. Joining Upper and Lower Case

EXTENSION CASE

1. Install the extension case oil seal (see Figure **4H-37**).
2. Install the extension case on the transmission case and torque bolts to 13.5 to 20.0 ft-lbs. (18 to 28 N.m).

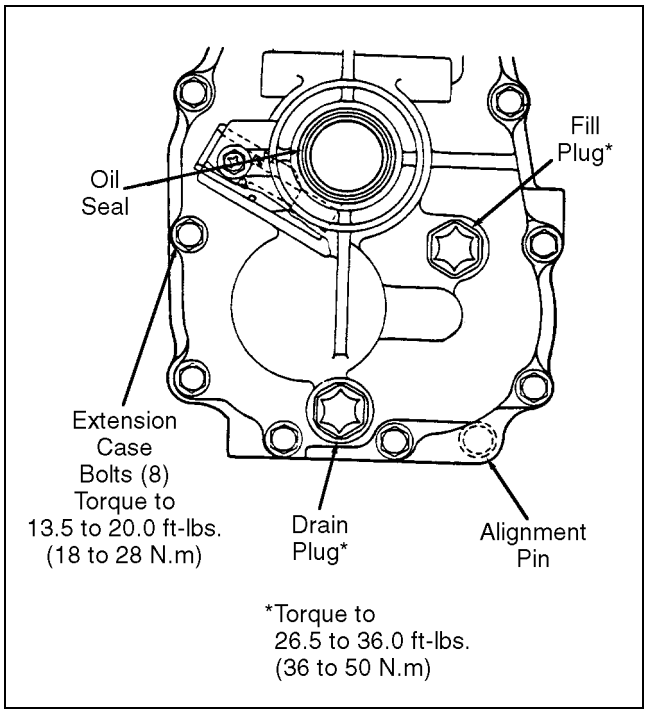


Figure 4H-37. Extension Case Installation

GEAR SHIFT CASE

1. Position the assembled gear shift case on the extension case as shown in Figure **4H-38**.
2. Check operation of the gear shift lever to make certain the gear select arm and gear selector shaft are properly aligned with the gear shift lever.
3. Torque the four gear shift case bolts to 13.5 to 20.0 ft-lbs. (18 to 28 N.m).

TRANSMISSION INSTALLATION

Following any clutch repair or any other procedure that involves removal of the transmission from the vehicle the following steps should be taken.

1. Lubricate transmission and fill with fluid as described in SECTION 11.
2. Install mounting brackets as shown in Figure **4C-2**.
3. Using a suitable hoist, position the transmission near the clutch disc.

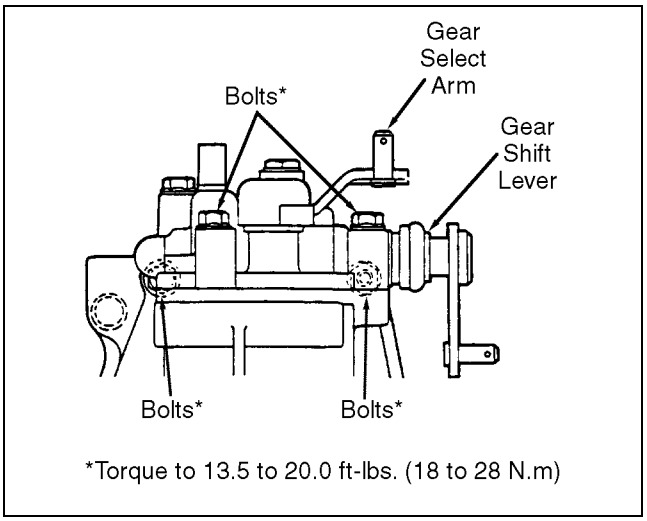


Figure 4H-38. Gear Shift Case Installation

4. Slide transmission forward until input shaft splines engage clutch disc. It may be necessary to turn the input shaft to index splines.
5. Install transmission mounting hardware, do not tighten.
6. Use Loctite 242 (blue). Install transmission bell housing to engine. Mount with socket head capscrews. Torque to 37 ft-lbs. (51 N.m). Diesel only: Install the two lower socket head capscrews. Torque to 37 ft-lbs. (51 N.m).
7. Install and tighten all transmission-to-frame mounting hardware.
8. Install mounting brackets to transmission extension case and install drive shaft to transmission as described in SECTION 4C.
9. Connect clutch cable on clutch release lever and gear shift cables/connectors on gear shift lever and selector arm as described in SECTIONS 4D and 4E. Make certain connections to operator controls are correct and shifting/selecting operates smoothly. Adjust as described in SECTION 2C.
10. Install all electrical cables, hoses and tubes disconnected during transmission removal.
11. Install any brackets or sheet metal that were removed.
12. Connect battery cables.
13. Adjust clutch cable, pedal free travel and interlock switch (SECTION 2C).

SECTION 4I. TRANSMISSION FUNCTIONAL DESCRIPTION

GENERAL

This section is provided to help service/maintenance personnel understand the internal operation of the transmission.

TRANSMISSION COMPONENTS

A cross-sectional view of the transmission/torque converter assembly is shown in Figure 4I-1.

In the low (L), drive (D) and second (2) positions, counterclockwise (CCW) rotation (as viewed from the input shaft end) is directed through the internal gearing to the output shaft which rotates in the same direction (CCW).

In the reverse (R) position, the internal gearing changes to cause the output shaft to rotate in the clockwise (CW) direction (or opposite the rotation of the input shaft). The internal clutches and brakes are operated by oil flow to make changes in gearing direction and rotation speed.

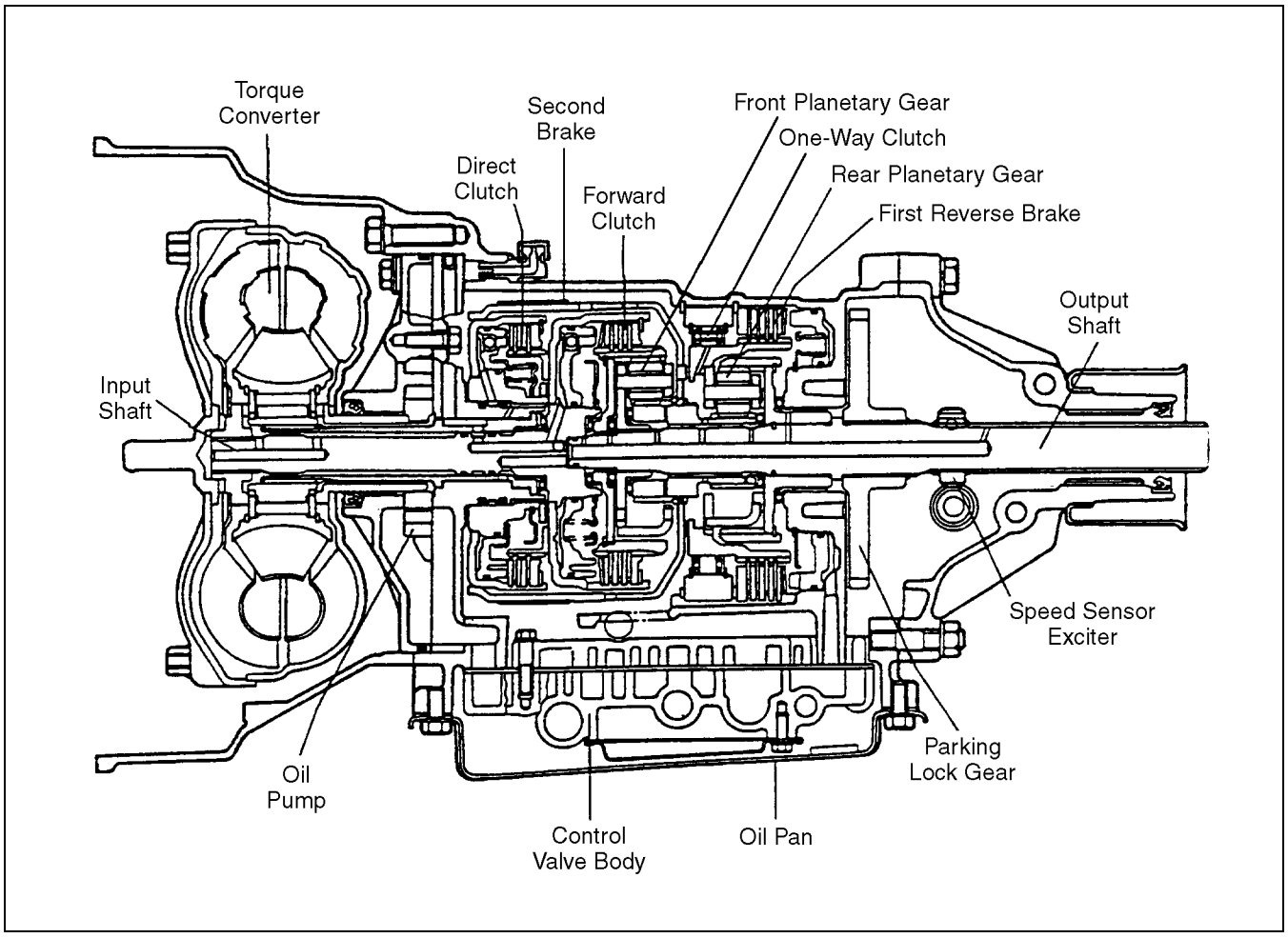


Figure 4I-1. Transmission/Torque Converter Cross-Section

SECTION 4I. TRANSMISSION FUNCTIONAL DESCRIPTION

FLUID FLOW (See Figure 4I-2)

NEUTRAL (N) OR PARK (P) CIRCUIT

When the engine starts, the oil pump rotates and fluid is directed to the pressure regulator valve which opens to pass on pressure to the torque converter. The manually controlled valve at the base of the transmission is closed and there is no rotation of internal transmission gears and shafts.

DRIVE (D) CIRCUITS

When the manual shift control is moved to D, the transmission moves through three speed ranges (automatic shifts) which are controlled by engine speed.

Drive Range 1

The oil pump rotates, the pressure regulator valve controls line pressure and the line pressure is directed through the open manually controlled valve. Pressure is directed from the manually controlled valve to the 1-2 shift valve. No pressure is directed to the 2-3 shift valve.

Pressure activates the forward clutch which switches into low gear. Line pressure also is directed to accumulator No. 1 which uses spring action to relieve shock produced when the forward clutch is engaged.

Drive Range 2

In the second speed range, solenoid valve No. 2 is ON (opens) to provide pressure relief. Pressure passes through the 1-2 shift valve and activates the second brake piston. Both accumulators (1 and 2) are activated to relieve clutch connection shock. (The second brake prohibits sun gear rotation.)

Drive Range 3

When the transmission reaches the third gear range, solenoid valve No. 1 is OFF (closes) and line pressure passes through the 2-3 shift valve. The direct clutch is activated and line pressure changes to back pressure which releases the second brake piston allowing release of the second brake and faster gear rotation resulting in faster output shaft rotation.

LOW (L) AND 2 CIRCUITS

Line pressure passes through the manually controlled valve and activates the forward clutch. On the other side, line pressure passes through the 2-3 shift valve. The low cost modulator valve adjusts that pressure. That pressure passes through the 1-2 shift valve and activates the first reverse brake.

REVERSE (R) CIRCUIT

Line pressure passes the manually controlled valve and activates the direct clutch. On the other side, the line pressure passes through the 1-2 shift valve. That line pressure activates first reverse gear.

Oil passes over the direct clutch. Then the input shaft and the planetary gearís sun gear are engaged. The input shaftís rotation is directly passed on to the sun gear. When the first reverse brake is applied, the action will activate the rear planetary carrier. The rear planetary carrier will activate the pinion gear. The pinion gear will spin by itself but will not pass on revolution. The difference between spin and revolution is that spin is referring to a twisting in place, revolution is orbiting like planets around a sun. The output shaft fits into the internal gear. It rotates in the CW direction and reverses the vehicle.

SECTION 4I. TRANSMISSION FUNCTIONAL DESCRIPTION

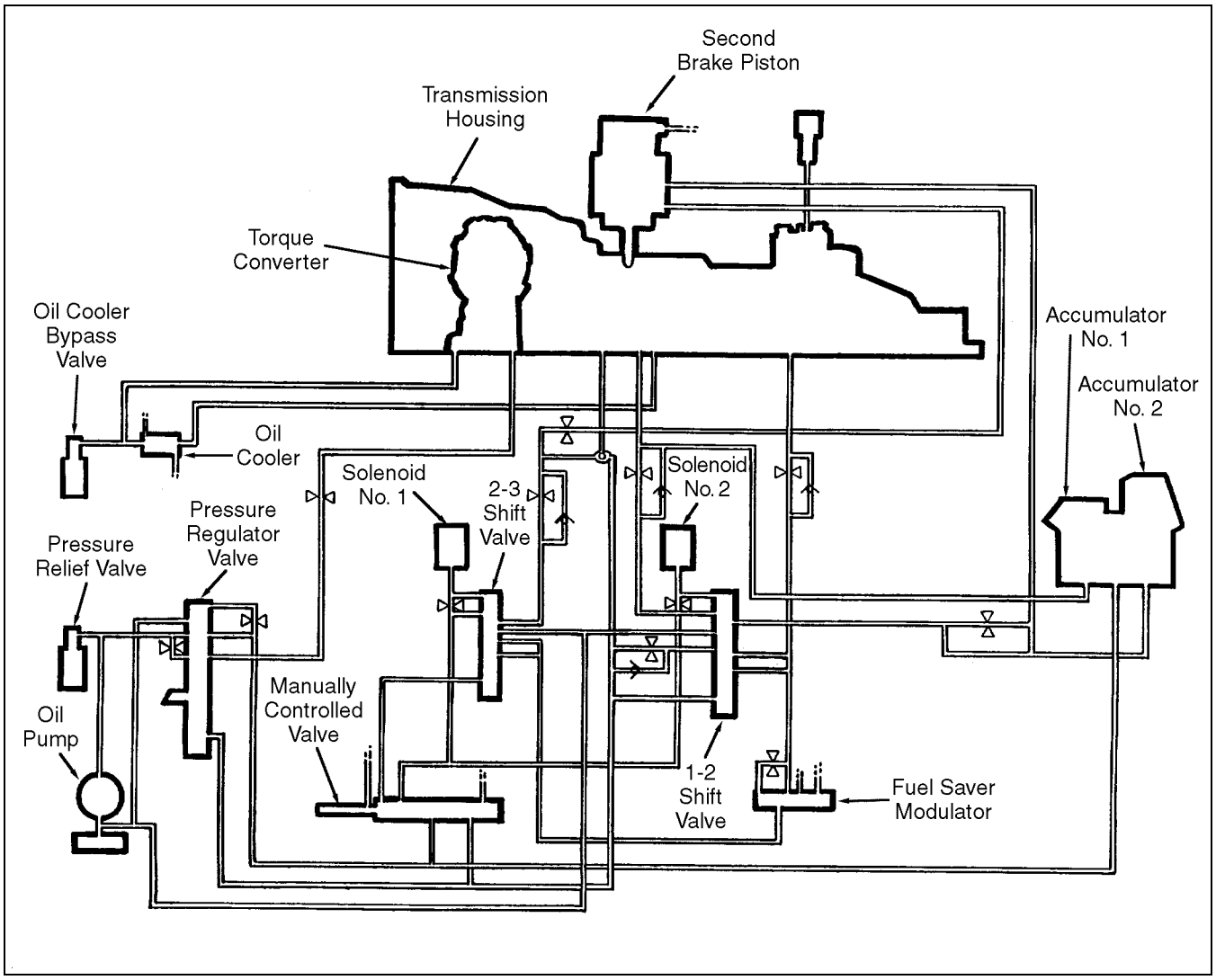


Figure 4I-2. Fluid Flow Diagram

SECTION 4J. AUTOMATIC TRANSMISSION REPAIR

GENERAL

Proceed with repairs in this section only after reviewing the failure analysis steps in Section 4B and performing the operational tests in Section 4C. Table 4G-1 gives a summary of general inspection/repair procedures to be followed throughout the detailed repair procedures.

ITEM	INSPECTION	REPAIR
Cast metal parts and machine processed or tooled parts.	Small marks, scratches, burrs, body damage, deep marks, grooves, oil passage clogged, marks on the surface of the attachment face, gasket remnants, cracks.	Take off small marks with an oil stone. Clean clogs with air or wire. Replace items which can not be repaired.
Bearings.	a. Will not turn smoothly. b. Worn, grooved or cracked.	a. Replace. b. Replace.
Bushings and thrust washers.	Marked or worn out.	Replace.
Oil seals and gaskets.	a. See if the oil seal is marked or scratched up. b. Material very hard. c. Seal ring perimeter and side surface worn out.	a. Replace. b. Replace. c. Replace.
Gears.	a. Mark or burr. b. Teeth worn out.	a. Repair with an oil stone or replace. b. Replace.
Splines.	Dented, twisted.	Repair with an oil stone or replace.
Snap rings.	a. Worn out or burred. b. Shape changed.	a. Repair with an oil stone. b. Replace.
Screws and bolts.	a. Burrs. b. Damaged threads.	a. Repair with an oil stone. b. Replace.
Springs.	Cracked, worn or bent.	Replace.
Clutch disks and brake disks.	Worn out, burned, bent, clutch strained, damaged with nail.	Replace.
Clutch plates and brake plates.	Burned, worn out, badly worn.	Replace.
Seal faces.	Badly scratched or grooved.	Replace.

SECTION 4J. AUTOMATIC TRANSMISSION REPAIR

TRANSMISSION REMOVAL

1. Disconnect the negative (ñ) and positive (+) battery cables from the battery terminals.
2. Disconnect the shift cable from the shift switch.
3. Tag and disconnect all cables, hoses or tubes which are connected to the transmission or which would obstruct lifting the transmission out of the frame.
4. Remove any sheet metal that would obstruct lifting the transmission out of the frame.
5. Remove the transmission drain plug located at the bottom left, rear corner of the transmission oil pan (see Figure **4J-1**) and drain automatic transmission fluid (ATP) into an environmentally approved container. Replace O-ring and install the drain plug and torque it to 13 to 19.5 ft-lbs. (17.6 to 26.5 N.m).
6. Disconnect the drive shaft at the transmission (see SECTION 4C).
7. Attach a suitable hoist to the transmission.
8. Remove hardware that fastens the transmission to the engine.
9. Remove any remaining hardware from mounting brackets on the frame until the transmission is free to be lifted.
10. Carefully move the transmission away from the engine flywheel and move the transmission out of the frame to a suitable work stand.

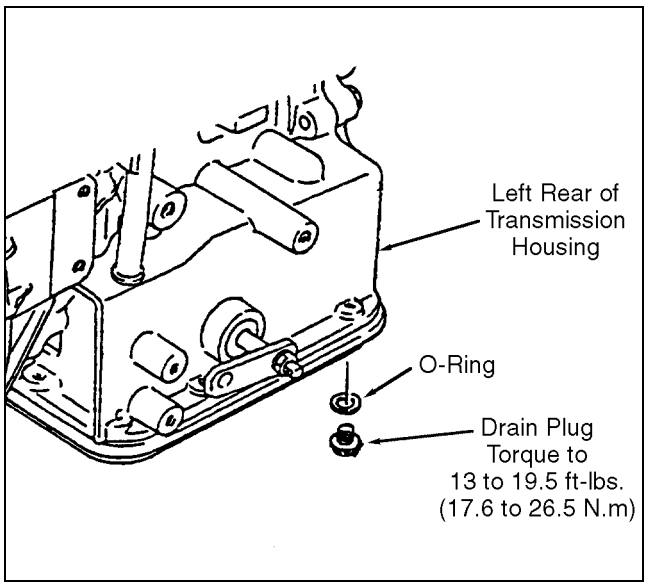


Figure 4J-1. Transmission Drain Plug Location

DISASSEMBLY AND REASSEMBLY

GENERAL

Rarely (if ever) will all the disassembly and reassembly steps in this section be required. Plan ahead to minimize the number of major components to be removed when repairing the transmission. For example, the oil pan and manually controlled valve (at the base of the transmission) and the second brake piston (at the side) can be removed without removing internal gearing.

The sequence of procedures in this section assume major overhaul/repair work which requires repair of the planetary gears, clutches, etc.

Refer to SECTIONS 4B, 4E and 4J to help determine the necessary repairs prior to undertaking the disassembly and reassembly procedures in this section.

ELECTRICAL/ELECTRONIC COMPONENTS (See Figure 4J-2)

After disconnecting all cables from electrical/electronic components mounted on the exterior of the transmission, remove these components as shown in Figure **4J-2**.

Test these components as described in SECTION 10 and replace them if they do not meet test requirements.

In addition to these components, two shift solenoids are mounted on the control valve beneath the oil pan (see ìOil Panî later in this section).

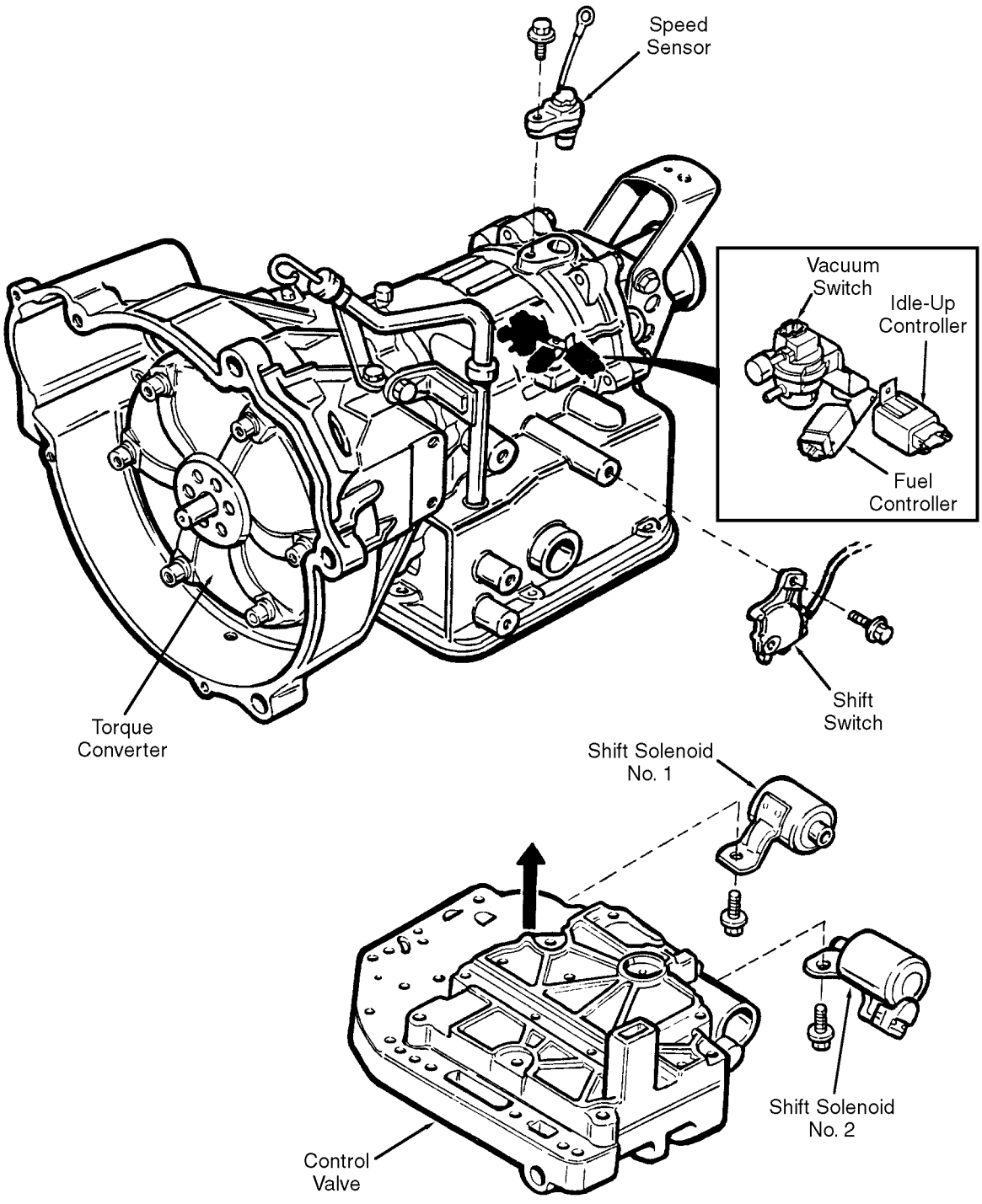


Figure 4J-2. Electrical/Electronic Components Attached to the Transmission

SECTION 4J. AUTOMATIC TRANSMISSION REPAIR

TORQUE CONVERTER (See Figure 4J-3)

1. Remove drive plate hardware and remove flange plate, drive plate and rear drive plate.
2. Remove torque converter by pulling off of transmission input shaft.

NOTE

If additional repair to the transmission is required, perform later repair procedures as required prior to Step 3 below.

3. Assemble and install the torque converter as shown in Figure 4J-3.

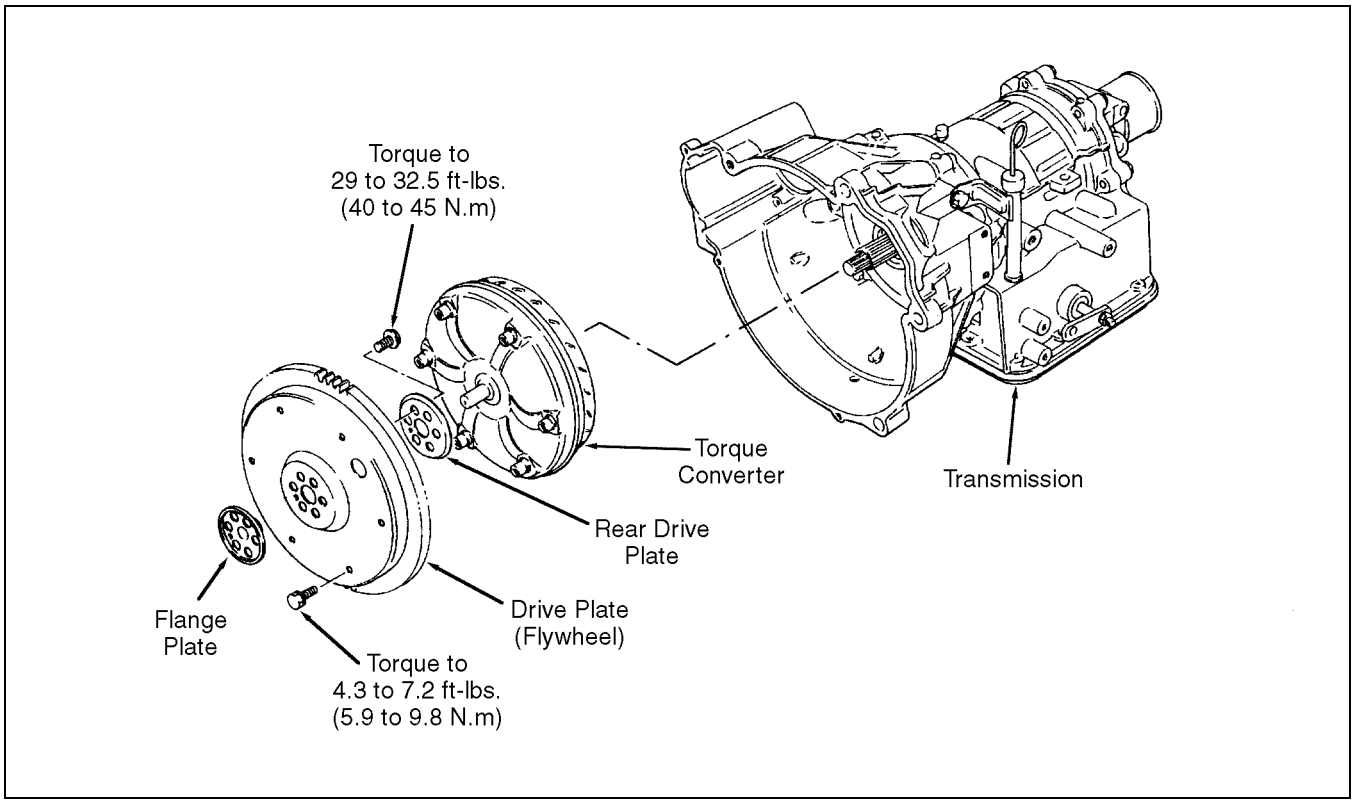


Figure 4J-3. Torque Converter Removal and Installation

FLUID TUBES AND HOSES (See Figure 4J-4)

Remove the dipstick, filler tube and other external tubes and hoses as shown in Figure 4J-4. Replace tube gaskets.

NOTE

If further repairs are required, proceed as described later in this section before installing tubes and hoses.

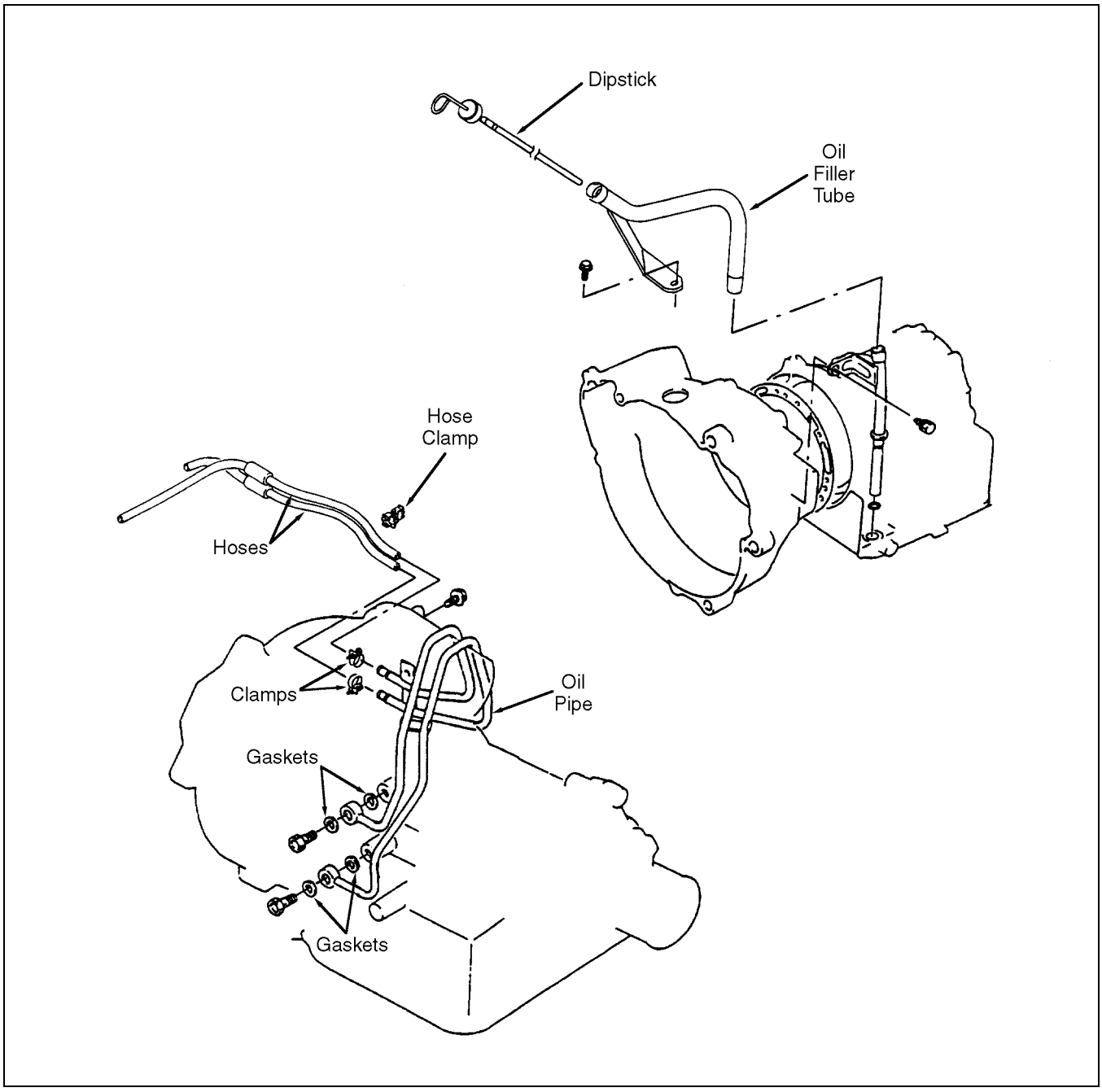


Figure 4J-4. Fluid Tubes and Hoses Removal and Installation

SECTION 4J. AUTOMATIC TRANSMISSION REPAIR

FRONT HOUSING AND REAR EXTENSION
(See Figure 4J-5)

1. Remove the six front housing bolts and tap housing with a rubber or plastic mallet to loosen the front housing from the transmission case. Remove the front housing, checking to see that no damage to joint surface occurred during removal.
2. Remove the seven rear extension bolts and remove the extension case, output shaft cover and seal.

NOTE

If further repairs are required, proceed as described later in this section, before reassembling the front housing and rear extension.

3. Reassemble the front housing and rear extension as shown in Figure 4J-5.

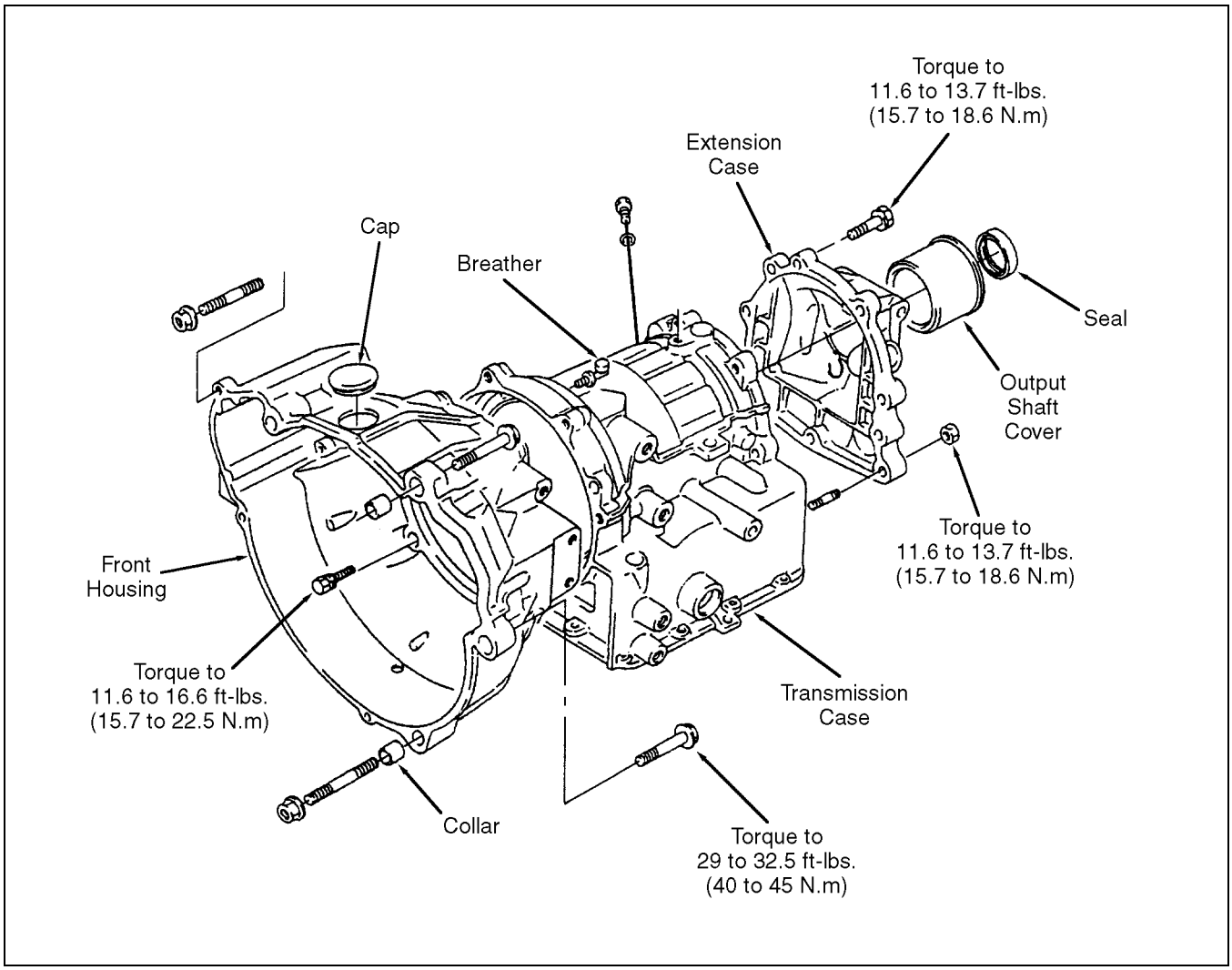


Figure 4J-5. Front Housing and Rear Extension Removal and Installation

SPEED SENSOR EXCITER, PARKING LOCK GEAR AND OUTPUT SHAFT (See Figure 4J-6)

1. At the extension (output shaft) end of the transmission, remove the speed sensor exciter and parking lock gear as shown in Figure **4J-6**.

NOTE

If further repairs to the transmission are required, perform such repairs as described later in this section prior to reassembling the speed sensor exciter, parking lock gear and output shaft.

2. Replace damaged components and reassemble as shown in Figure **4J-6**.

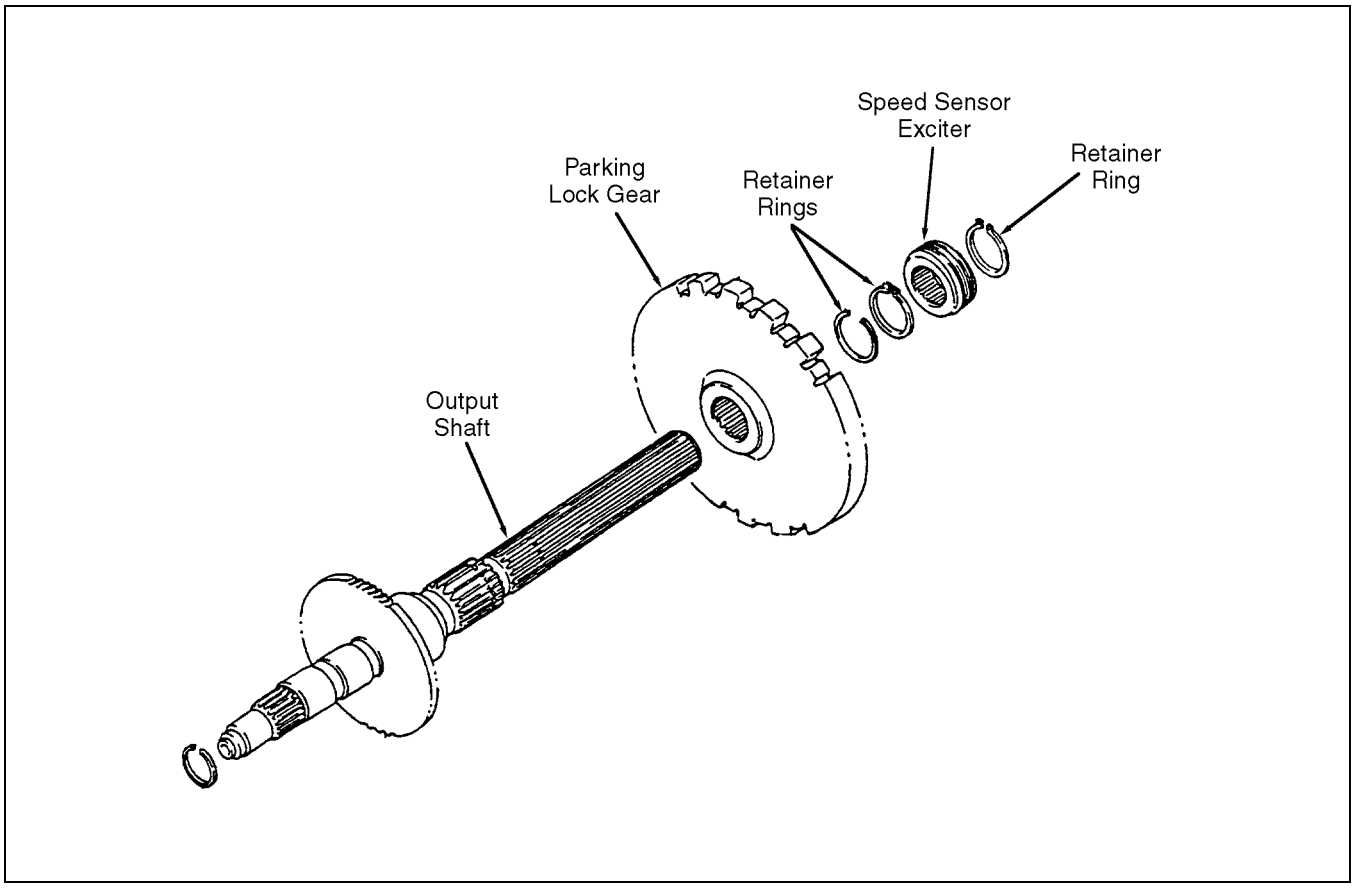


Figure 4J-6. Speed Sensor Exciter, Parking Lock Gear and Output Shaft

OIL PUMP REPAIR

NOTE

If there are other repairs to be made to the transmission, perform such repairs before reinstalling the oil pump.

Removal

1. At the input shaft end, pull out the brake band pin as shown in Figure 4J-7. Note or mark the pin chamfer direction for reassembly.
2. Remove the eight bolts that hold the pump to the transmission housing (see Figure 4J-8). Using a special oil pump removal tool with attachments, loosen the oil pump from the housing.
3. Manually turn and jolt the pump to loosen it from the housing while turning the removal tool with a wrench. Remove the pump by pulling straight upward.
4. Remove and discard the oil pump seal and O-rings.

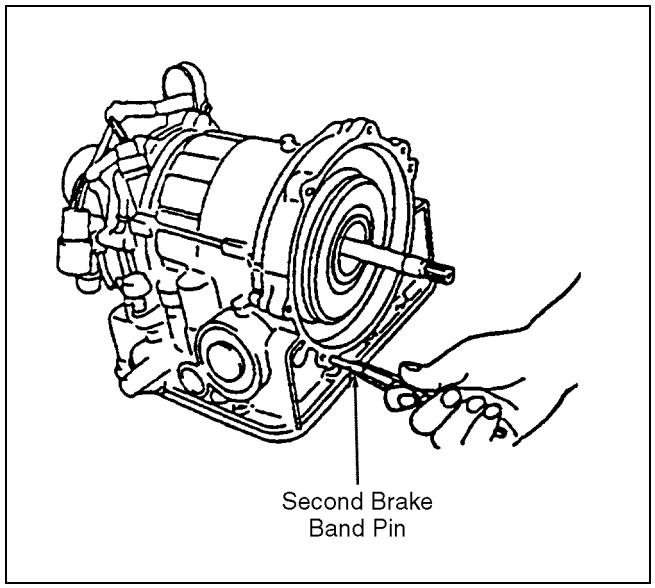


Figure 4J-7. Second Brake Band Pin Removal

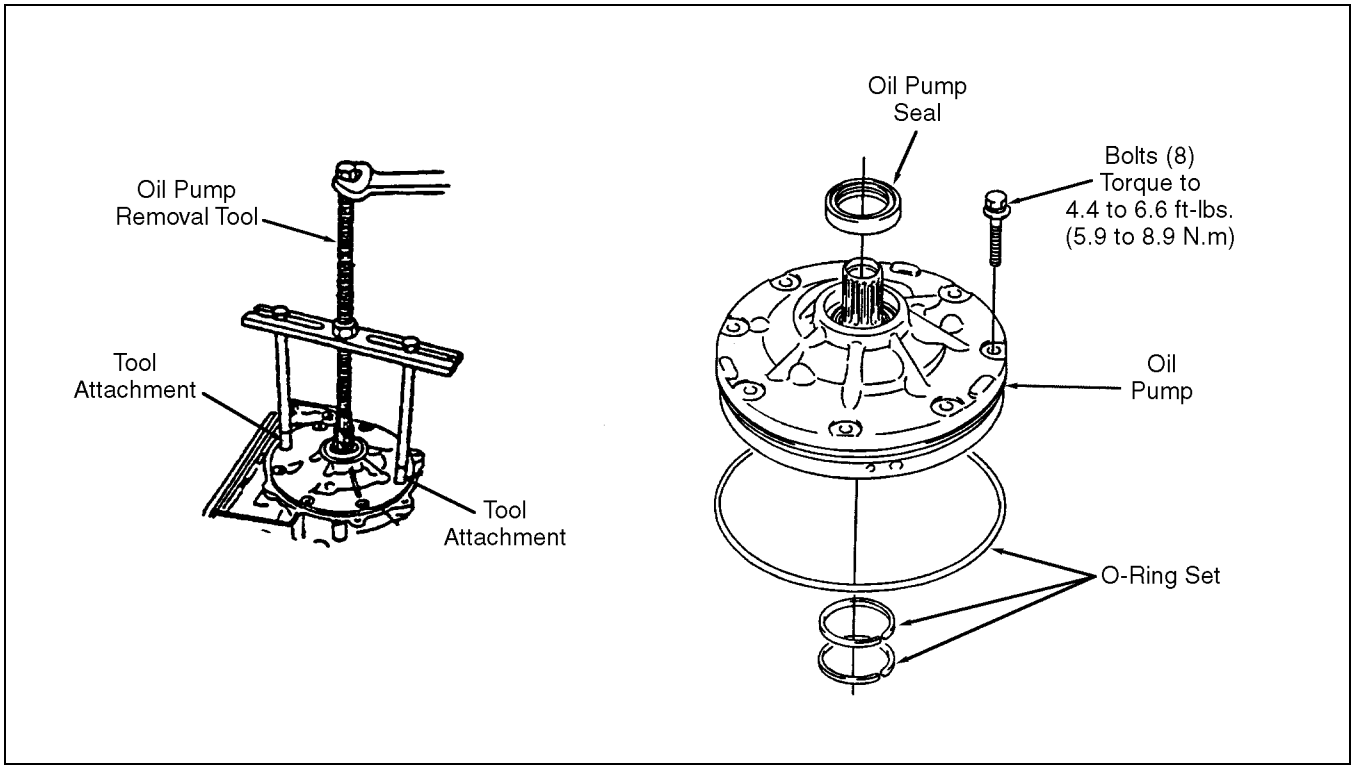


Figure 4J-8. Oil Pump Removal

Disassembly (See Figure 4J-9)

1. Remove the five bolts that hold the pump covers together.
2. Remove and discard the large cover O-ring and two small cover seal rings.

Repair and Reassembly (See Figure 4J-9)

1. Check gear teeth and bushings for damage; replace as required.
2. Apply automatic transmission fluid (ATF) to inner and outer gears before assembling.
3. Replace O-rings and oil seals.
4. Apply ATF to all O-rings and oil seals before installing. Make certain oil seals and O-rings fit in their grooves.
5. Be very careful not to scrape the oil seal when assembling the pump cover.
6. Before assembling the two halves of the pump cover, perform Steps 1 through 3 below.

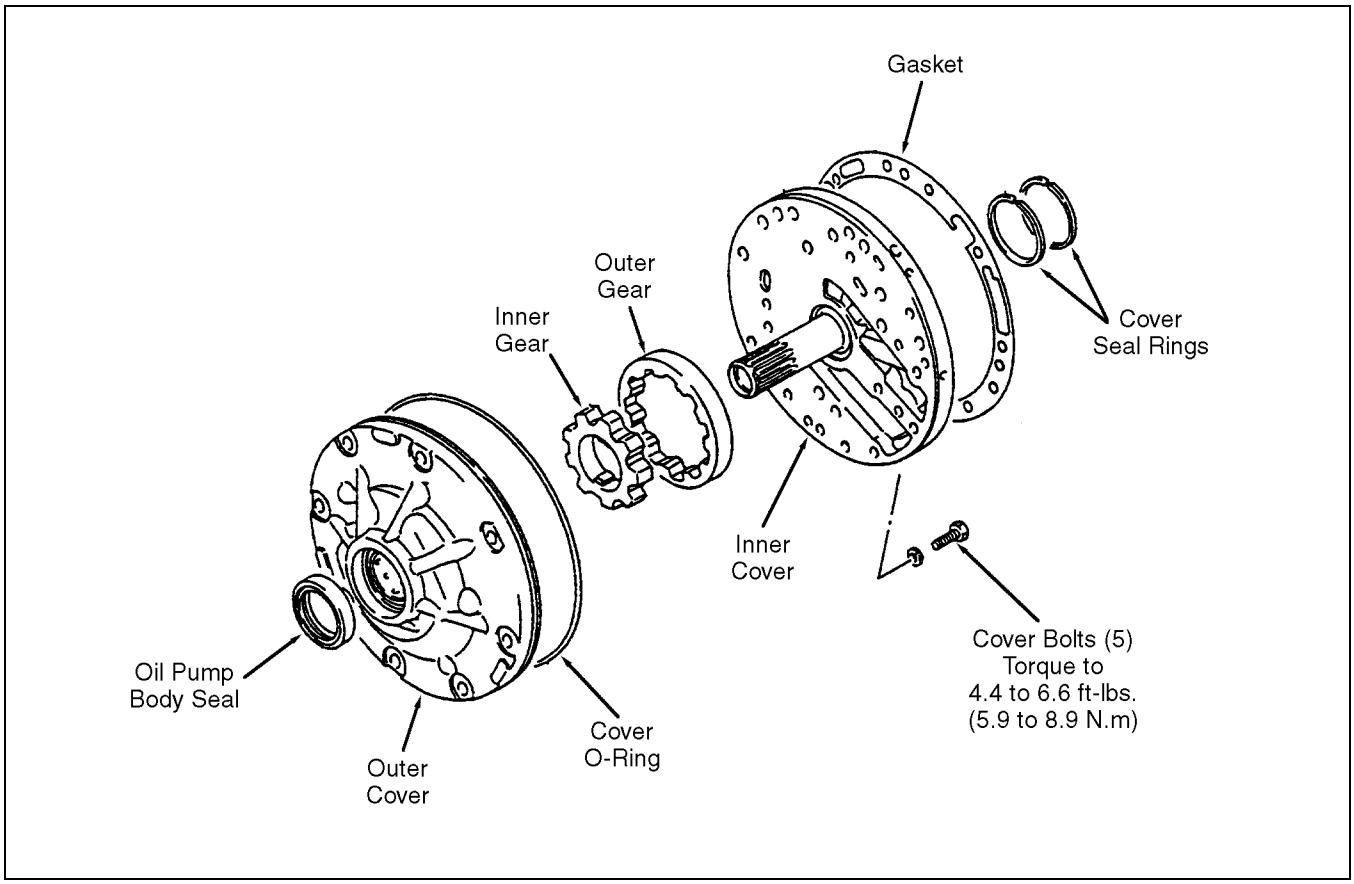


Figure 4J-9. Oil Pump Disassembly and Reassembly

Inspection and Final Assembly
(See Figure 4J-10)

1. Measure the outer gear body clearance with a thickness gauge. Clearance should be 0.003 to 0.012 inches (0.08 to 0.3 mm).
2. Measure the inner gear and outer gear clearance with a thickness gauge. Clearance should be 0.005 to 0.012 inches (0.13 to 0.3 mm).

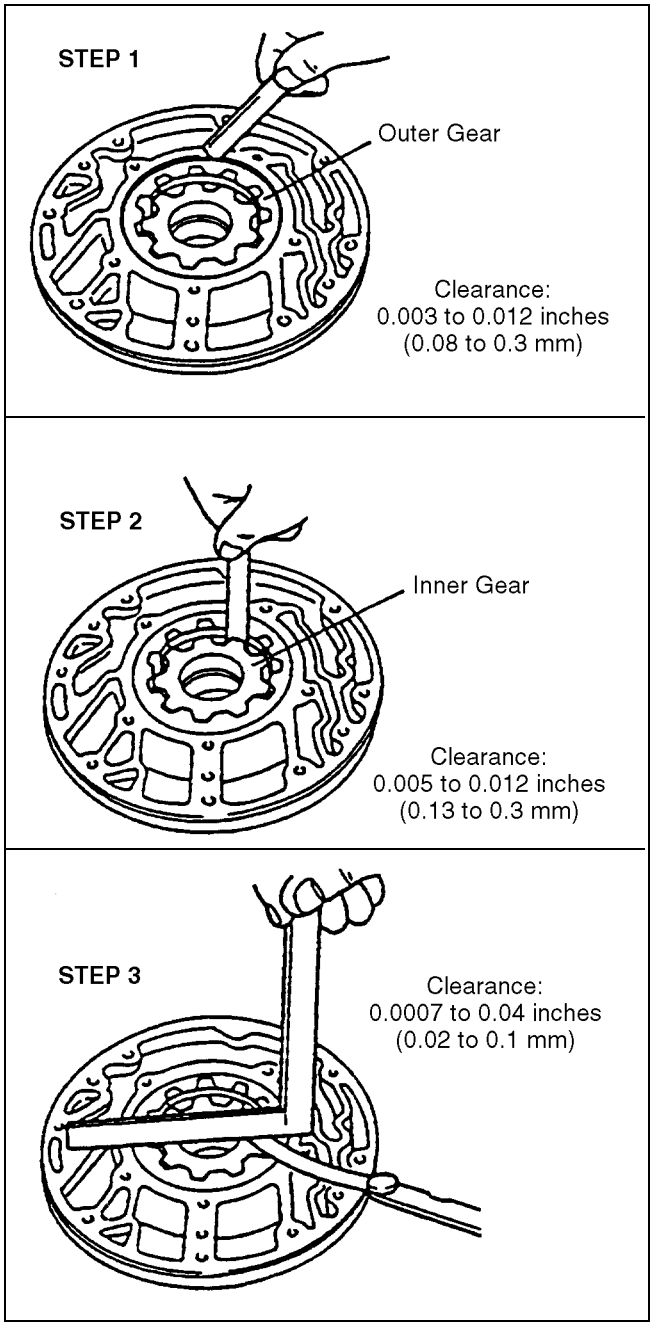


Figure 4J-10. Oil Pump Inspection

3. Measure the inner gear, the outer gear and the pump body for side clearance. Clearance should be 0.0007 to 0.04 inches (0.02 to 0.1 mm).
4. Assemble the two halves of the pump with the gears and new seals and O-rings in place. Before torquing bolts to 4.4 to 6.7 ft-lbs. (5.9 to 8.9 N.m), check for smooth rotation of the gears.

Installation

1. Replace the oil pump O-ring set as shown in Figure 4J-8.
2. Hold the input shaft bearing race and direct shaft in position and attach the oil pump to the transmission housing. Secure with eight mounting bolts and torque bolts to 4.4 to 6.6 ft-lbs. (5.9 to 8.9 N.m).
3. Reinstall the brake band pin as shown in Figure 4J-7 with chamfer toward housing.

DIRECT CLUTCH, FORWARD CLUTCH AND INPUT SHAFT

NOTE

If there are other repairs to be made to the transmission, perform such repairs before installing the direct clutch, forward clutch and input shaft.

Removal

After the oil pump has been removed, the direct clutch, forward clutch and input shaft can be lifted out as an assembly as shown in Figure 4J-11.

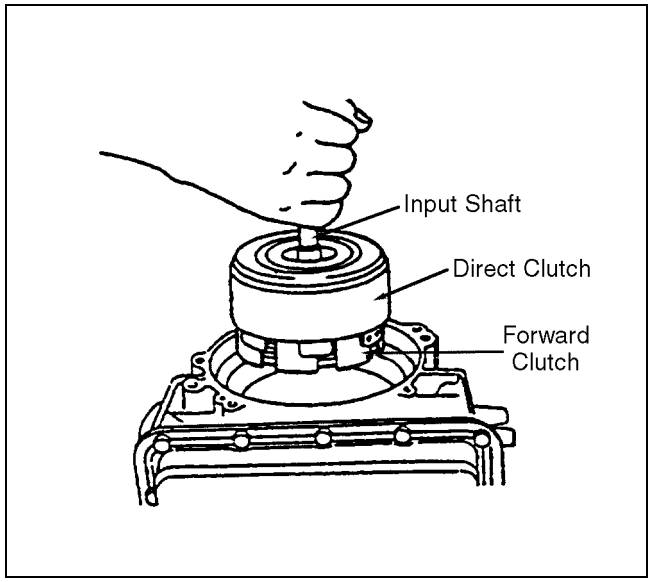


Figure 4J-11. Forward Clutch, Direct Clutch and Input Shaft Removal

Disassembly

NOTE

Be careful not to mix up the order of the ring gear race and the bearings attached to the direct clutch and forward clutch. When the unit is taken apart, be sure to keep the pieces safely together in the appropriate order.

1. Remove the direct clutch flange snap ring and remove the direct clutch flange and disks (see Figure 4J-12).

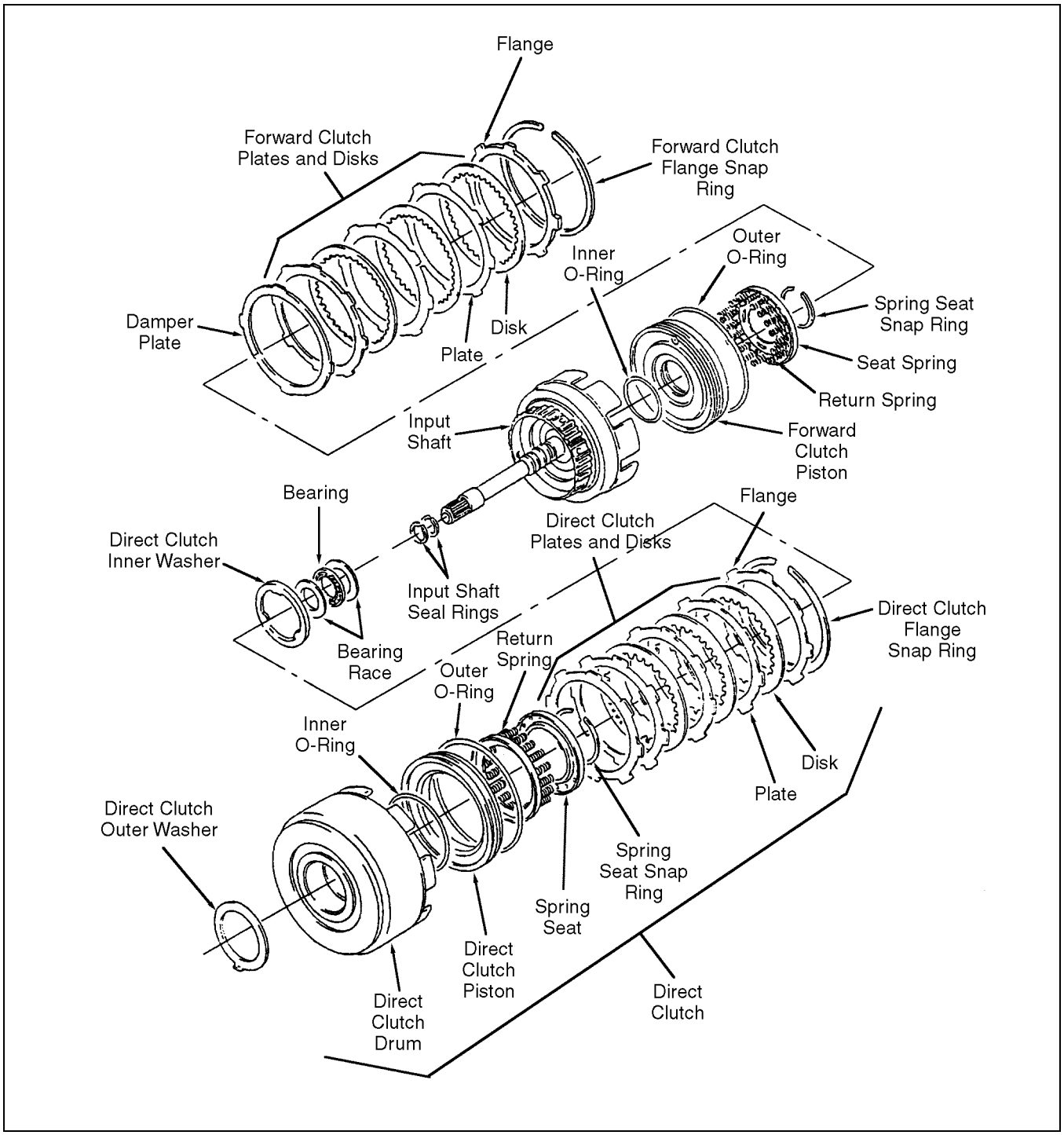


Figure 4J-12. Direct Clutch, Forward Clutch and Input Shaft Disassembly

2. Use a spring compression tool to push down the spring seat far enough to remove the spring seat snap ring as shown in Figure **4J-13**. Remove the spring seat and return spring.

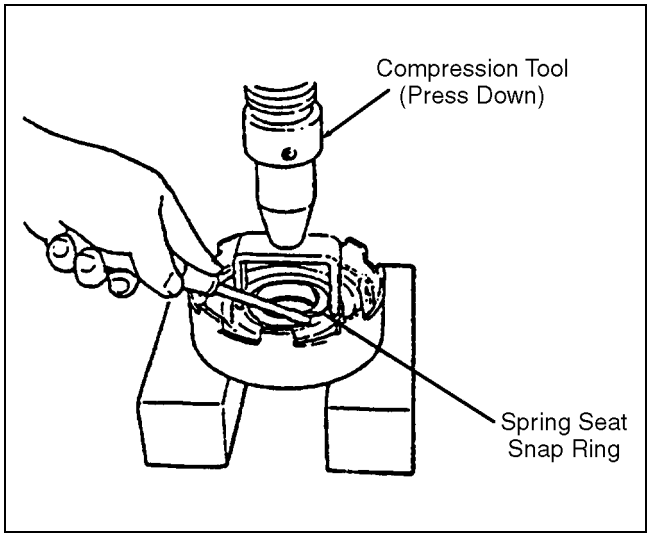


Figure 4J-13. Remove Spring Seat Snap Ring

3. Refer back to Figure **4J-12** and remove the outer O-ring and piston from the direct clutch drum. If necessary, blow air from an air gun through the front hole in the clutch drum to free up the piston from the drum.
4. Make certain that the check valve ball in the piston moves freely. Clean with compressed air to free up the valve ball.
5. Remove the inner O-ring and inner and outer washers.
6. Starting at the forward clutch flange snap ring, repeat Steps 1 through 4 above to remove the forward clutch components from the input shaft drum.
7. If necessary, remove the bearing races, bearing and input shaft seals, check the input shaft spline for wear or damage. Replace worn or damaged parts.

Reassembly (See Figure 4J-12 and the Following Step-by-Step Illustrations)

1. Starting at the direct clutch piston (see Figure **4J-12**), replace the inner and outer O-rings on both sides of the direct clutch piston. Lubricate the new O-rings with ATF before installing.
2. Insert the piston and O-rings into the direct clutch drum being very careful not to twist or drop the O-rings.
3. Install the return spring, spring seat and spring seat snap ring making certain the snap ring fits into the four tabs on the spring seat.
4. Install the clutch plate disks and plates alternately in the direct clutch drum. If new clutch disks are to be installed, soak them in ATF for at least 2 hours prior to installation.
5. Install the flange on the last plate disk with the larger diameter of the flange turned away from the disk.
6. Use a spring compressor to push down on the spring seat and install the direct clutch flange snap ring as shown in Figure **4J-14**.

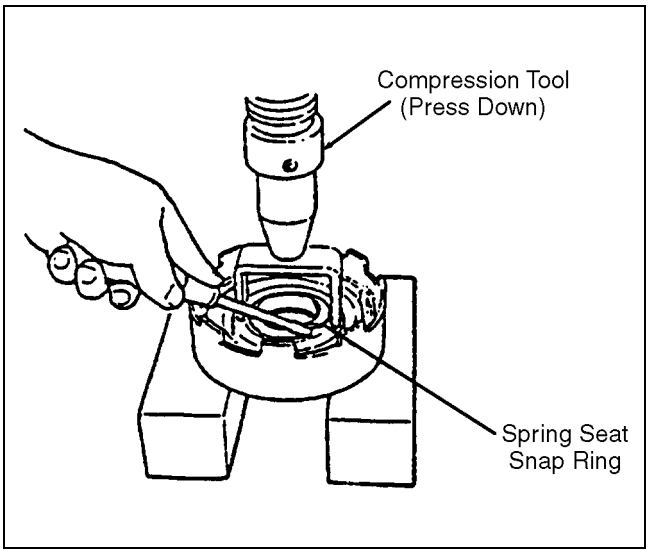


Figure 4J-14. Direct Clutch Reassembly ó Step 6

7. At the forward clutch piston (see Figure **4J-12**), replace the inner and outer O-rings on both sides of the forward clutch piston. Lubricate the new O-rings with ATF before installing.
8. Insert the piston and O-rings into the input shaft drum being careful not to twist or drop the O-rings.
9. Install the return spring, spring seat and spring seat snap ring making certain that the snap ring fits into the four tabs on the spring seat.
10. Install the clutch plate disks and plates alternately in the direct clutch drum. If new clutch disks are to be installed, soak them in ATF for at least 2 hours prior to installation.
11. Install the flange on the last plate disk with the larger diameter of the flange turned away from the disk.
12. Use a spring compressor to push down on the spring seat and install the forward clutch snap ring as shown in Figure **4J-15**.

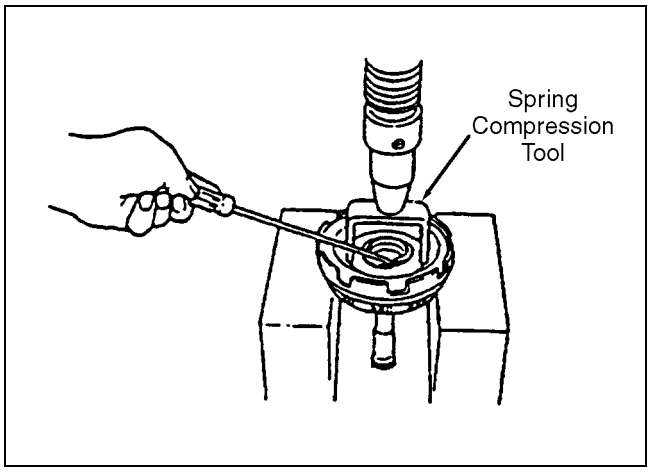


Figure 4J-15. Forward Clutch Reassembly ó Step 12

13. Attach the direct clutch to the input shaft. Lubricate the washer and the washer projections and the interior surface of the direct clutch (see Figure **4J-16**).

NOTE
There is a groove on the washer that indicates the colored top side. The groove is gold colored.

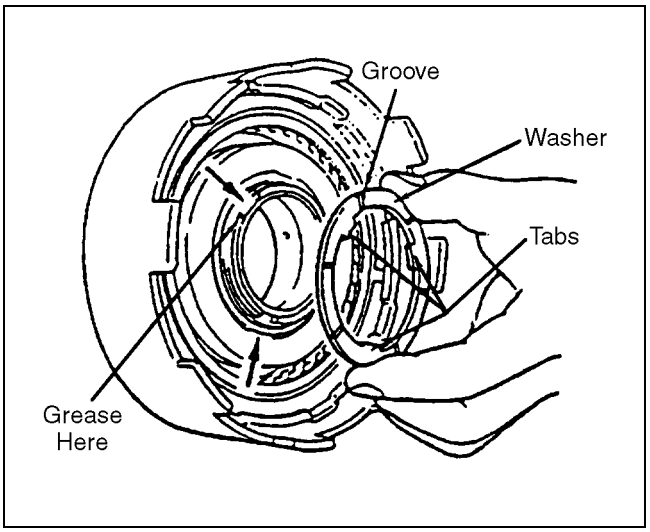


Figure 4J-16. Reassembly ó Step 13

14. Insert the direct clutch into the input shaft as shown in Figure **4J-17**. The teeth of the direct clutch mesh with the input shaft.

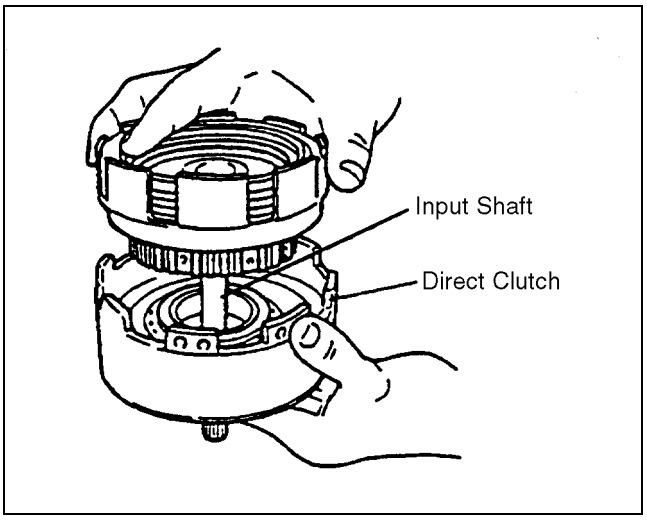


Figure 4J-17. Reassembly ó Step 14

15. Apply ATF to the race (1) and then attach to ring gear on right side. Apply grease to bearing and race (2). Then attach to forward clutch side.

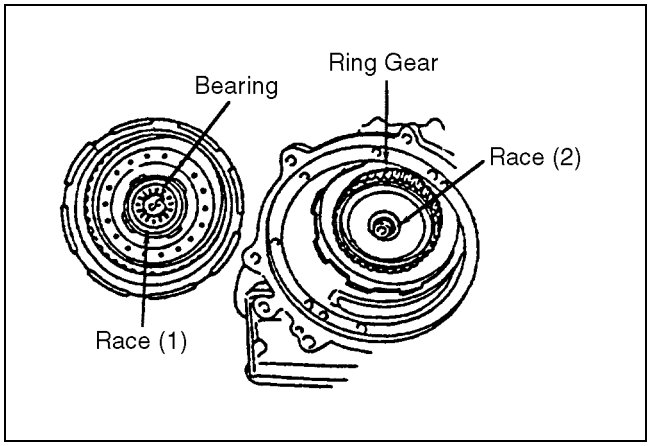


Figure 4J-18. Reassembly ó Step 15

Installation

1. Manually open the second brake band if it has not been previously removed (see ìSECOND BRAKE BANDî later in his section).
2. Insert the assembled input shaft and direct clutch into the transmission housing and turn the assembly onto the output shaft as shown in Figure **4J-19**.

NOTE

When attaching the input shaft, be careful not to drop the bearing and the race.

Be careful that those items do not bite into the output shaft seal ring.

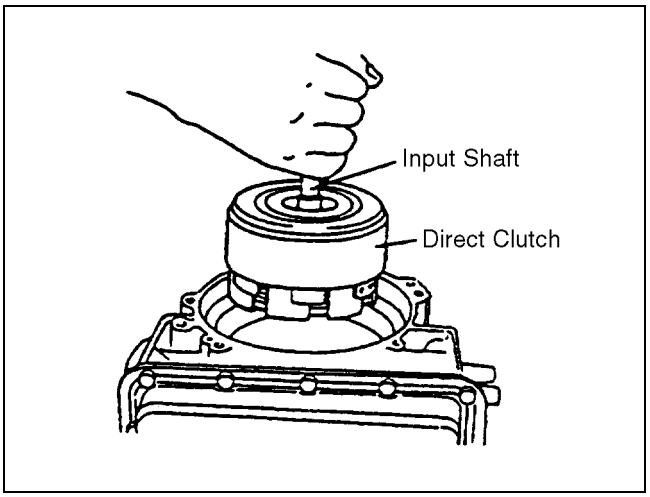


Figure 4J-19. Installing Input Shaft and Direct Clutch

3. Attach the input shaft bearing and race. Apply ATF to bearing and race with flange. Attach bearing race to the input shaft.

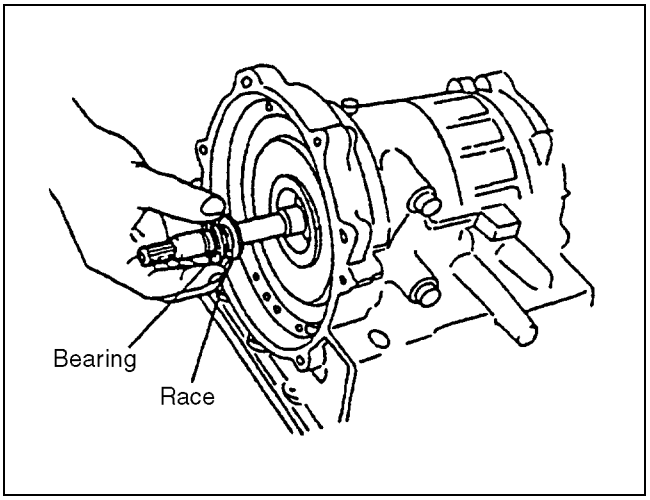


Figure 4J-20. Installing Bearing and Race

SECOND BRAKE BAND (See Figure 4J-21)

Removal

1. Tie the ends of the brake band together with wire to prevent damage to the facing.
2. Compress the ends of the facing and remove the brake band.

Inspection and Replacement

1. Inspect the second brake band for wear or cracking. Replace if required.

NOTE

New second brake bands should be soaked in ATF for 2 hours before installation.

2. Install the brake band pin, pointed end first.

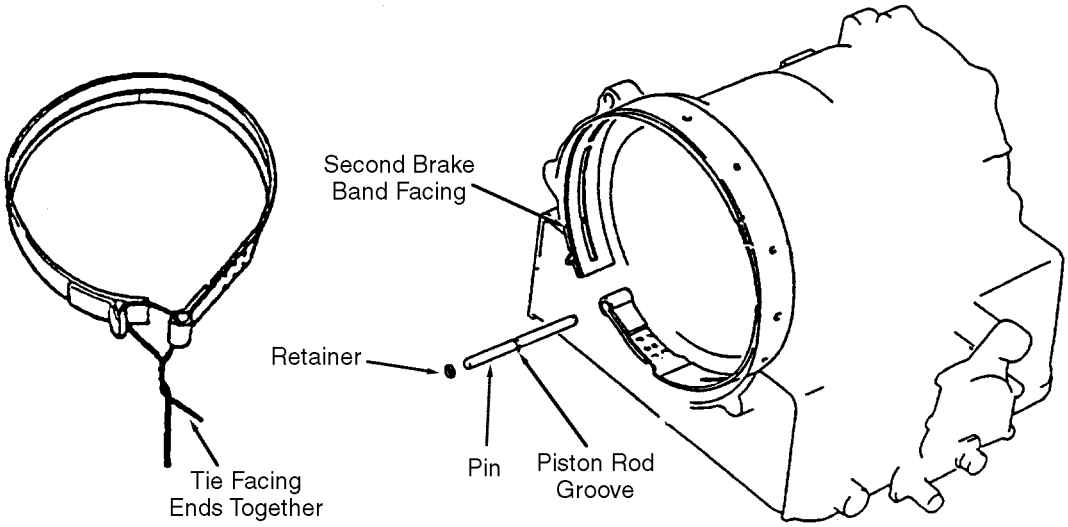


Figure 4J-21. Second Brake Band

SECOND BRAKE PISTON

Disassembly (See Figure 4J-22)

1. Use a spring compression tool (or large clamp) to push the center of the piston cover inward.
2. Remove the large snap ring and piston assembly by slowly loosening the compression tool to relieve spring tension.
3. Remove the return spring, O-rings and piston cover.
4. Remove the small snap ring from the rod and disassemble remaining parts as shown in Figure 4J-22.

Reassembly

1. Replace the piston rod and second brake band (see preceding paragraph) if worn or damaged.
2. Reassemble the piston assembly as shown in Figure 4J-22. Lubricate the small snap ring and make certain it fits in the groove on the piston rod.
3. Install the piston assembly in the transmission case and attach the piston cover and O-rings as shown in Figure 4J-22. Make certain the piston rod fits in the groove of the second brake band pin (see Figure 4J-22).
4. Compress the piston cover as shown in Step 1 of Figure 4J-22 and secure the piston cover and piston assembly with the large snap ring.

PLANETARY GEARS AND ONE-WAY CLUTCH

NOTE

Prior to disassembly of the planetary gears and one-way clutch, the oil pump, direct clutch, forward clutch, input shaft and the second brake band must be removed as described earlier in this section.

Disassembly (See Figure 4J-23)

1. Remove the front planetary ring gear.

NOTE

Be careful not to mix up the order of the thrust bearings attached to the front planetary ring gear. When the unit is taken apart, be sure to keep the pieces safely together in the order removed.

2. Remove the front planetary gear.

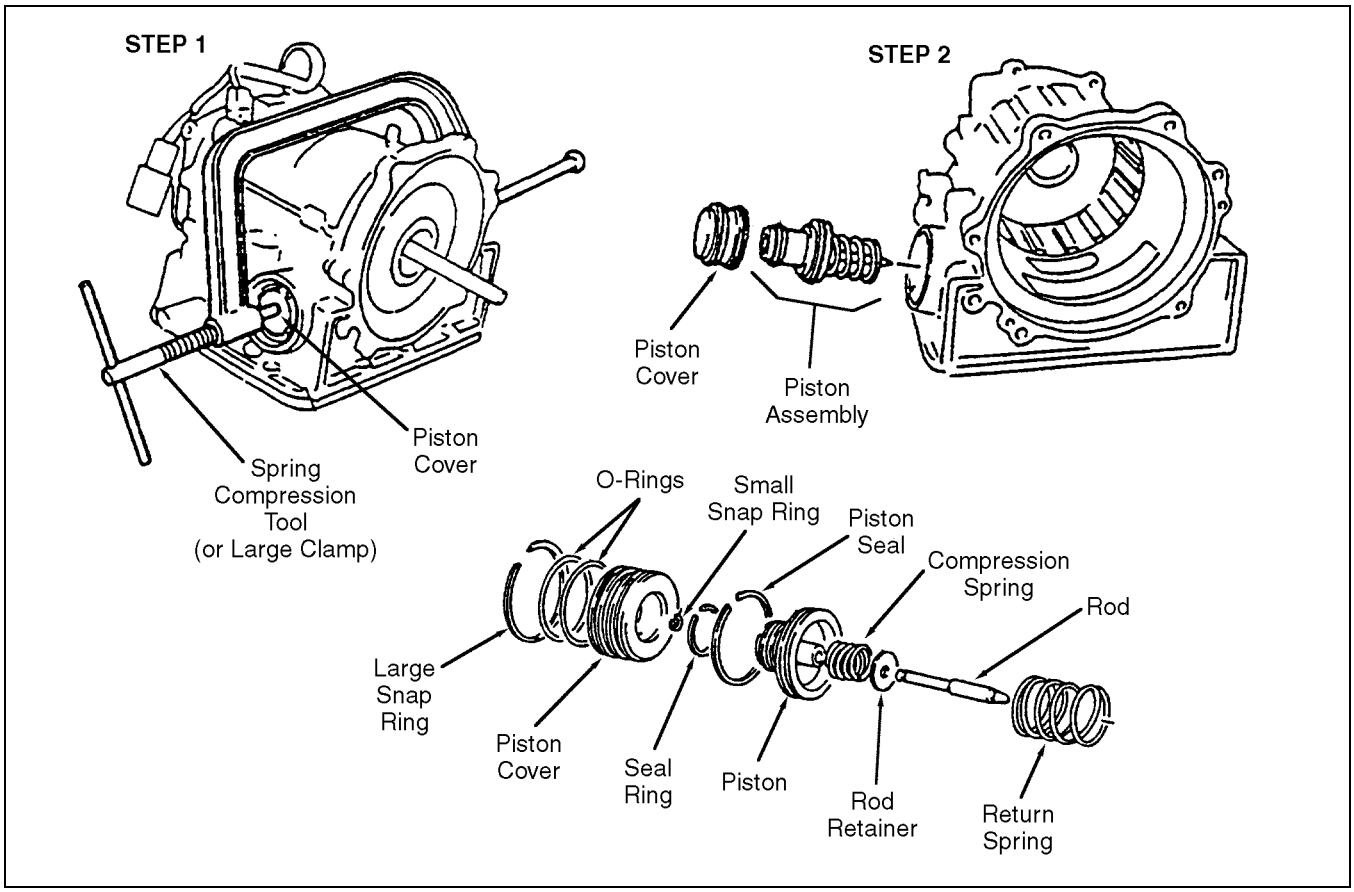


Figure 4J-22. Second Brake Piston Disassembly and Reassembly

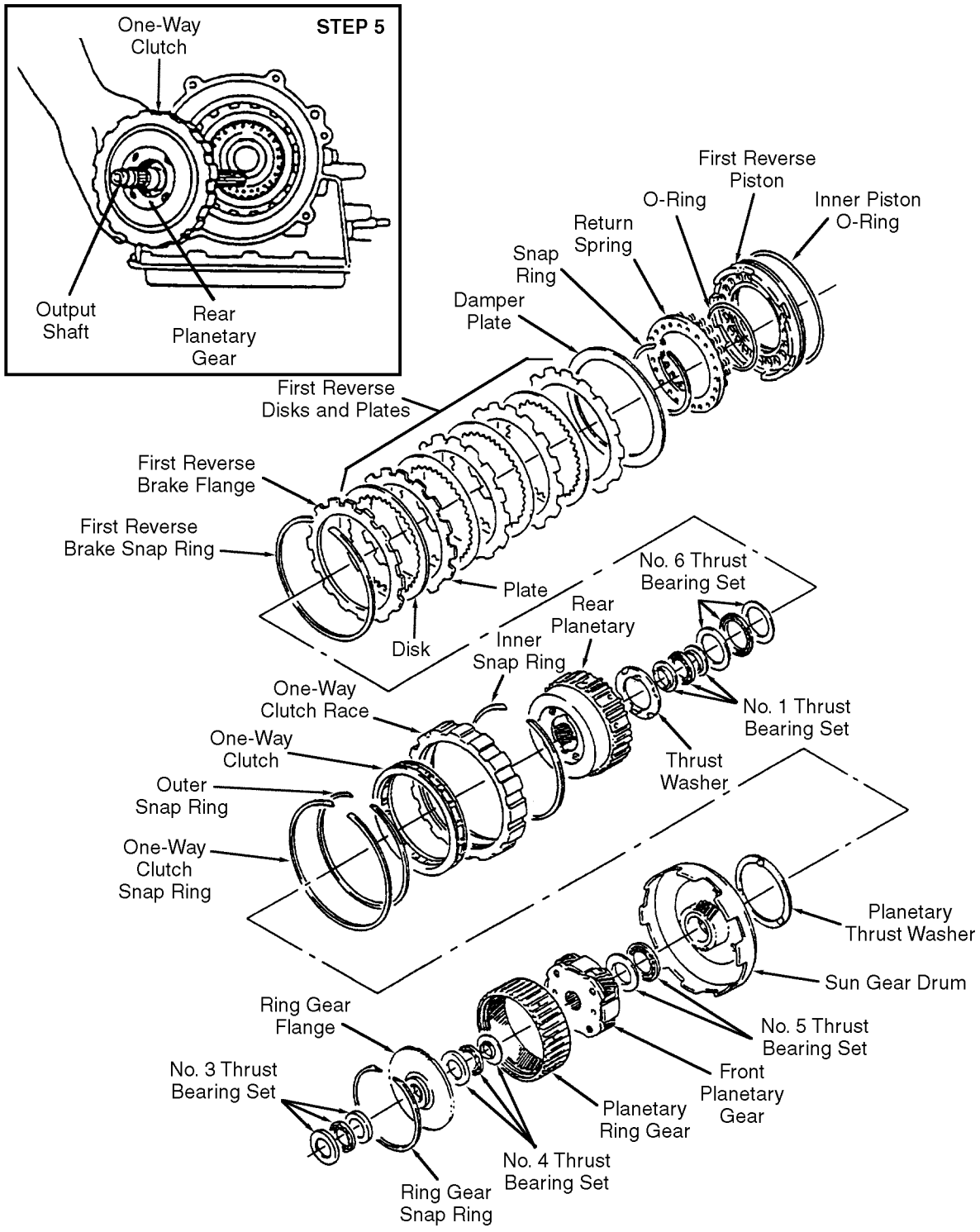


Figure 4J-23. Planetary Gears and One-Way Clutch Disassembly

3. Remove the planetary sun gear and sun gear drum.
4. Remove the one-way clutch snap ring.
5. Remove the one-way clutch, rear planetary gear and the output shaft.
6. Remove the first reverse brake snap ring. Then remove the flange disks, plates and damper plate. Check the gap between the snap ring and the flange, if it exceeds 0.0256 to 0.076 inch (0.65 to 1.94 mm), the first reverse brake disk parts should be replaced.

Reassembly (See Figure 4J-24 and the following procedures)

1. If the output shaft has been removed, it must be installed before the planetary gears and one-way clutch can be reassembled. Make certain the output shaft bearings are installed as shown in Figure 4J-24.

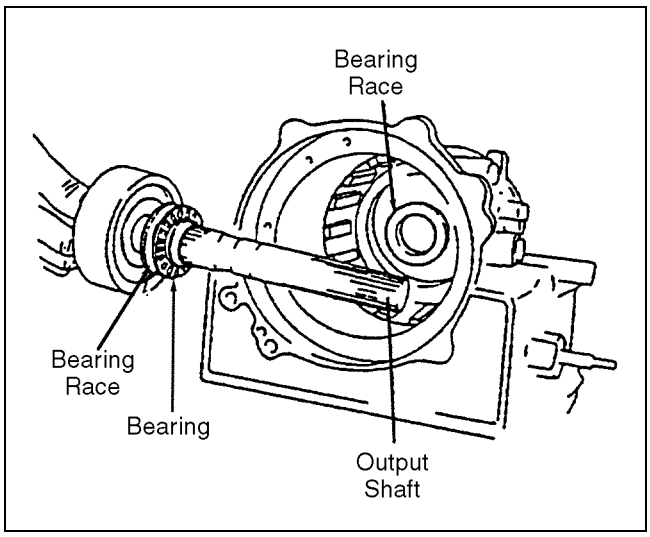


Figure 4J-24. Output Shaft Bearings

2. Assemble the first reverse brake piston as shown in Figure 4J-25, using the oil pump removal tool and tool attachments to compress the return spring until the snap ring can be installed in its groove. Replace the piston O-rings and apply ATF to new O-rings before installing them. Check to see that the piston is free to move in the case bore.

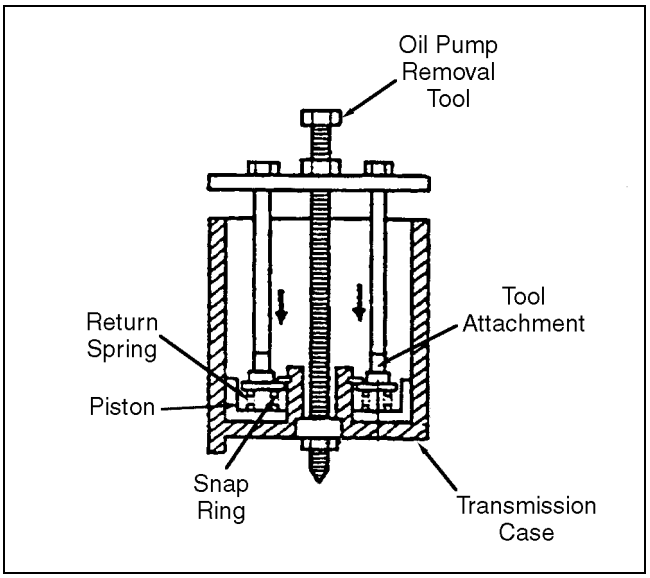


Figure 4J-25. First Reverse Brake Piston Assembly

3. Apply recommended lubricant to grease the thrust washer. Hold the rear planetary gear in a stationary position. Then insert the rear planetary gear (see Figure 4J-26).

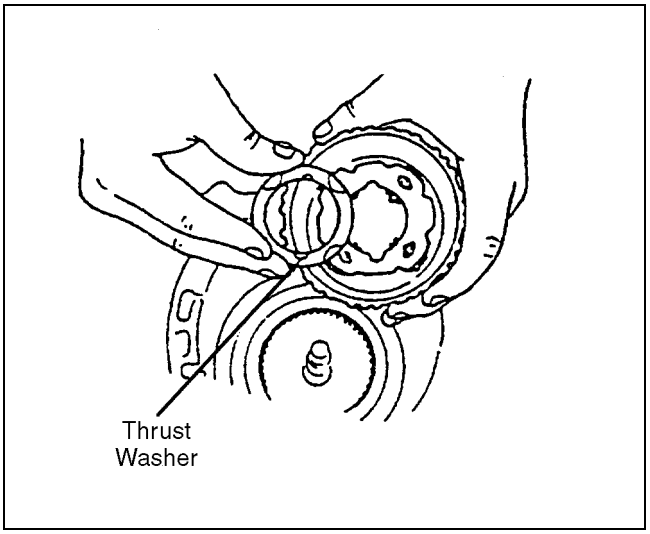


Figure 4J-26. Installation ó Step 3

4. The first reverse brake, damper plate, plate, disk and flange should be attached to the case in that order (see Figure **4J-27**). The damper plate should be installed in the direction shown. Attach the snap ring to secure the plate/disk/flange group.

NOTE
Before installing new disks, make sure to soak them at least two hours in ATF. Do not forget to attach the snap ring.

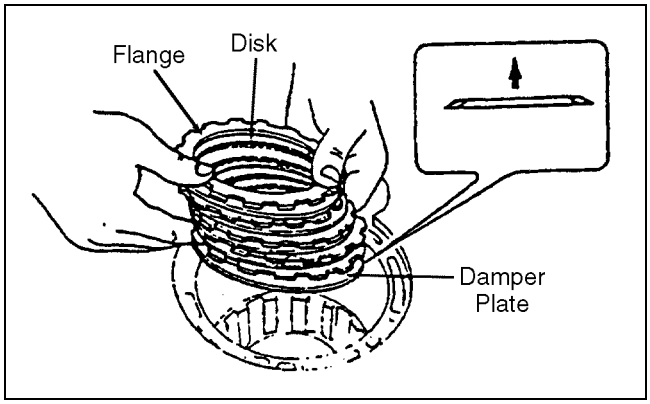


Figure 4J-27. Installation ó Step 4

5. Turn the rear planetary gear clockwise and then push in the one-way clutch until it fits in the groove as shown in Figure **4J-28**.

NOTE
When the planetary is rotated in the clockwise direction, the rotation will be smooth. When the planetary gear is rotated in the counter-clockwise direction, it will be locked.

When the planetary gear is turned to the left, the one-way clutch will go in easily.

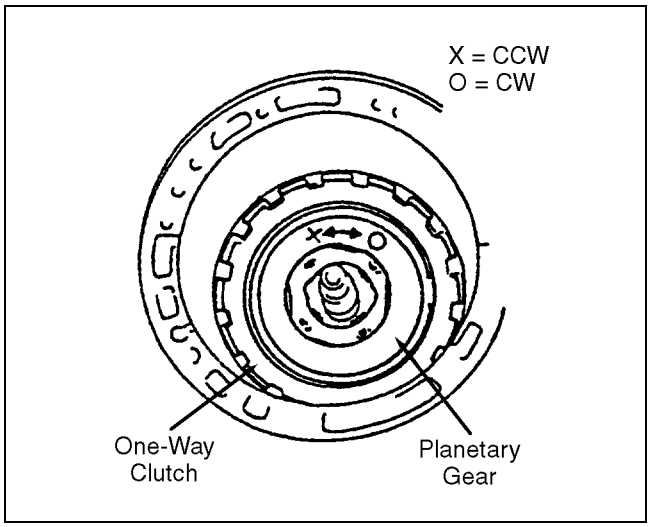


Figure 4J-28. Installation ó Step 5

6. Attach the sun gear and sun gear drum as shown in Figure **4J-29**. Use recommended grease to prevent the thrust washers from falling off when installing them. The thrust washer tabs should be matched up with the holes in the sun gear drum.

NOTE
Before inserting the sun gear, the rear gear race should be matched up at the center.

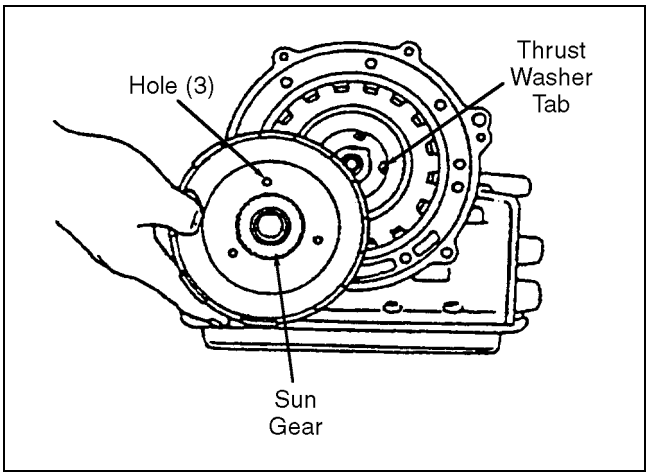


Figure 4J-29. Installation ó Step 6

7. Attach the front planetary gear as shown in Figure **4J-30**. Lubricate thrust bearings with grease prior to installation.

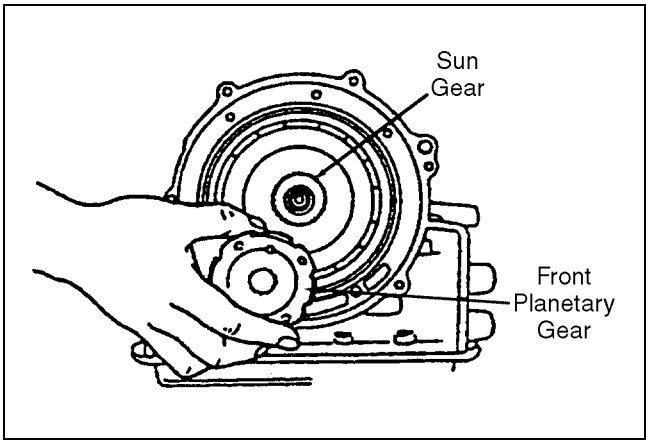


Figure 4J-30. Installation ó Step 7

8. Attach the front planetary ring gear to the front planetary gear as shown in Figure 4J-31. Lubricate the planetary gear race with ATF. Attach the race to the upper portion of the planetary gear.

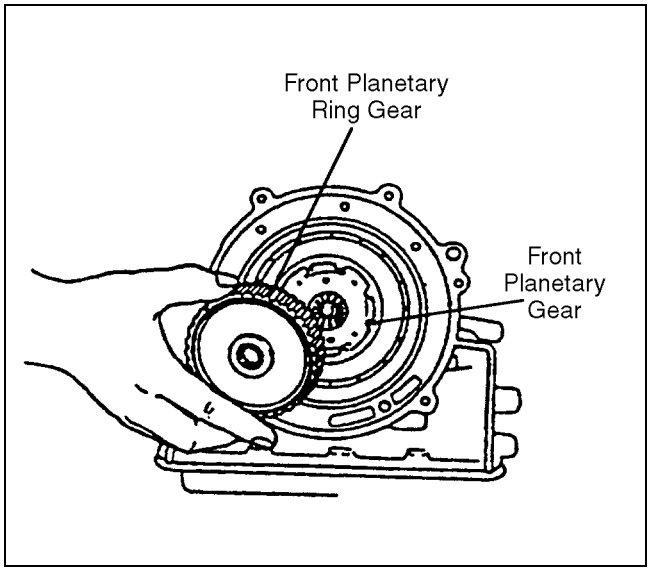


Figure 4J-31. Installation ó Step 8

OIL PAN

NOTE
Leave the oil pan off the transmission housing until procedures in the later paragraphs have been completed.

Removal (See Figure 4J-32).

1. Turn the transmission over so that the oil pan is on the top side of the transmission.
2. Remove the 15 attaching screws. Tap the oil pan around its edge with a soft mallet to free it from the transmission housing.

WARNING

Do not use a screwdriver, or similar tool, to pry the oil pan free. This will likely damage the oil seal surface and require replacement of the pan.

3. Lift the pan off the housing and scrape the oil pan gasket off the mating surfaces.

NOTE
Completely remove the gasket from the joint surface. Make sure there are no small pieces of the gasket loose inside the housing.

4. Remove the oil pan magnet.
5. If necessary, remove the oil pan drain plug and gasket.

Installation (See Figure 4J-32)

1. Install a new oil pan gasket.
2. Attach the oil pan magnet.
3. Install the oil pan and secure with 15 attaching screws. Torque screws to 2.89 to 4.34 ft-lbs. (3.92 to 5.88 N.m).
4. If removed, install the drain plug gasket and drain plug. Torque plug to 13 to 19.5 ft-lbs. (17.6 to 26.5 N.m).

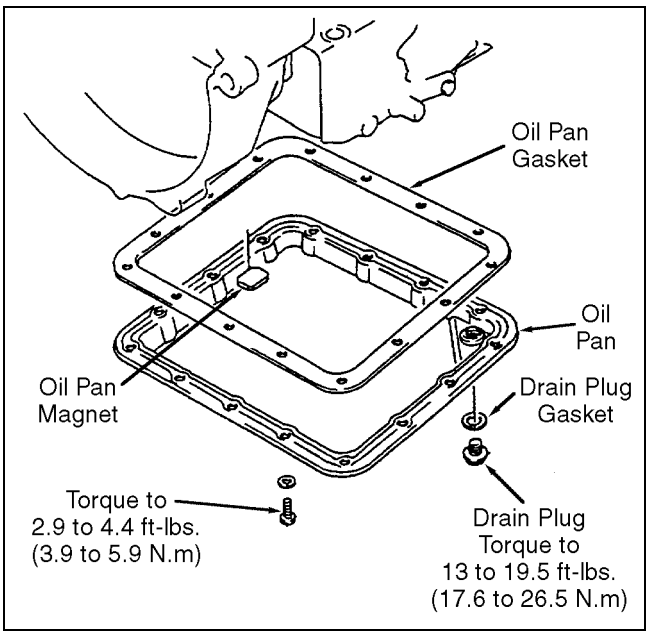


Figure 4J-32. Oil Pan Removal

CONTROL VALVE, CONTROL LEVERS, SHAFTS AND ACCUMULATORS

General

The arrangements (exploded views) of the control valve and its control levers and shafts are shown in Figures **4J-33** and **4J-34**. Figures **4J-33** and **4J-34** are provided for orientation of components only, the actual steps of disassembly and reassembly for the valve and its controls are provided in the following paragraphs.

If the accumulators are to be repaired, the control valve assembly must be removed to gain access to the accumulators.

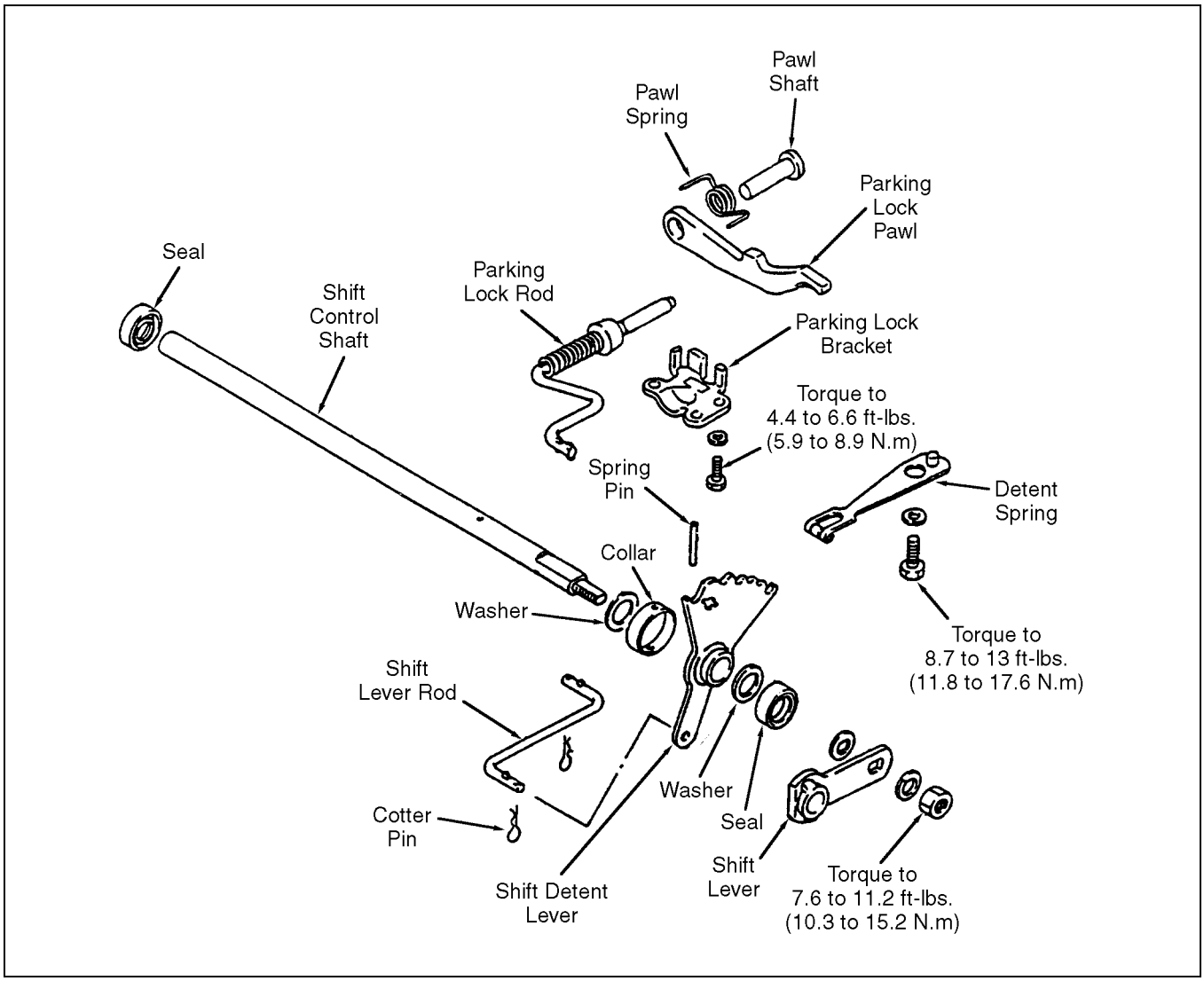


Figure 4J-33. Control Shafts and Levers

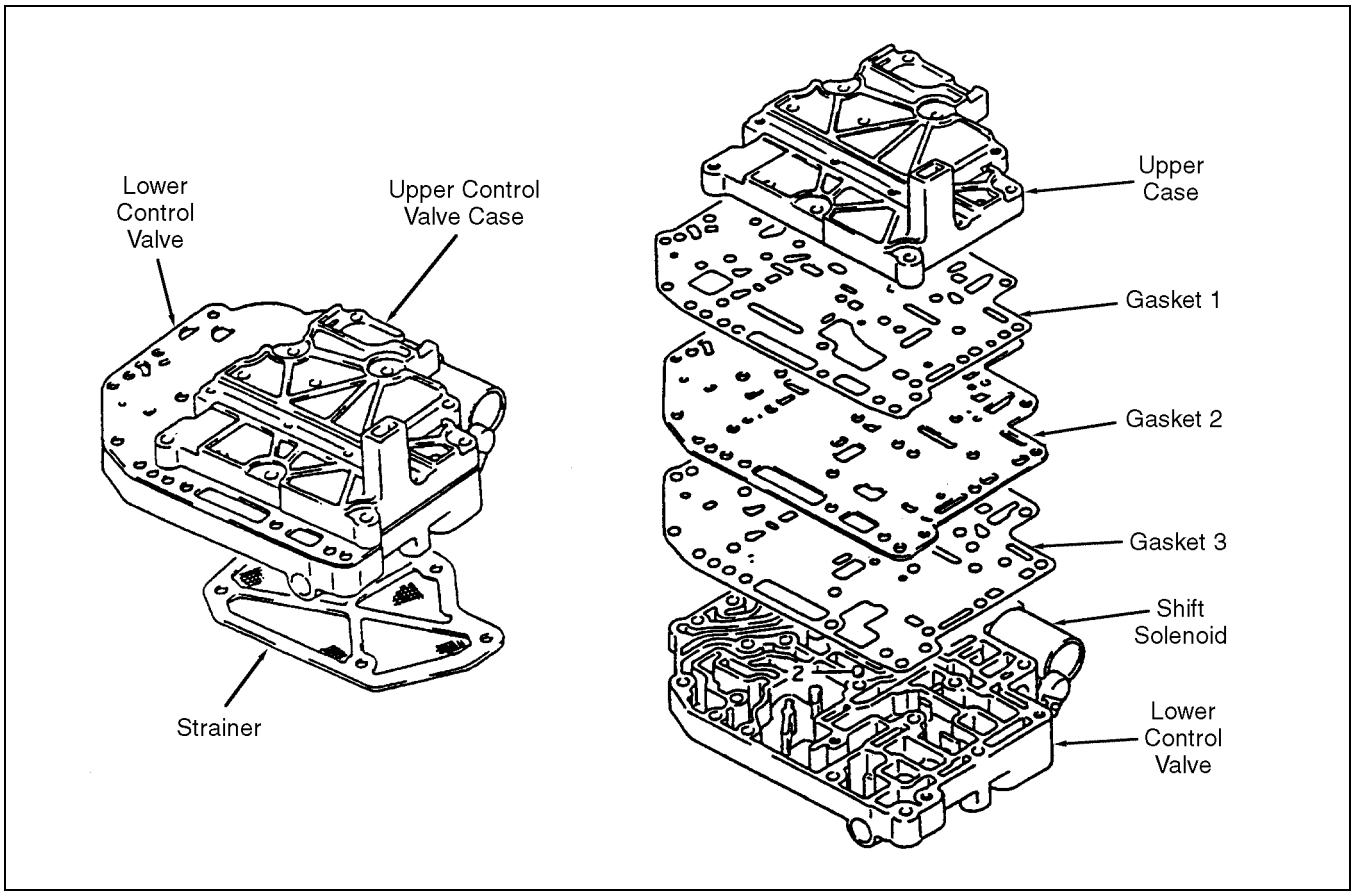


Figure 4J-34. Upper and Lower Control Valve Arrangement

Oil Strainer Removal

With the transmission turned upside down and the oil pan removed, remove the five mounting bolts and pull the strainer off the lower control valve housing (see Figure **4J-34**).

NOTE

After the strainer is removed, the shift solenoids can be removed for testing and/or replacement (see Figure **4J-37** for mounting of solenoids on the control valve lower housing).

Control Valve Removal (See Figure 4J-35)

1. Pull the cotter pins out of the shift lever rods and remove the shift lever rods.
2. Remove the twelve mounting bolts that hold the control valve to the transmission housing and remove the assembled control valve.

NOTE

Code (mark) each of the mounting bolts and its mounting hole; the bolts are of four different lengths.

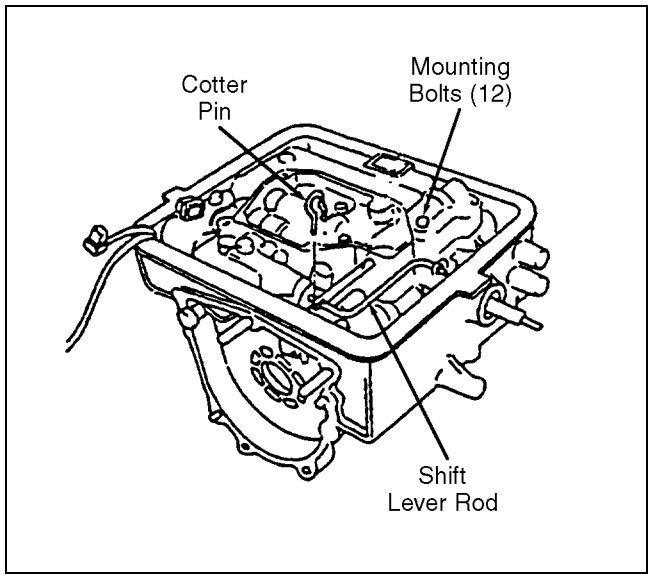


Figure 4J-35. Control Valve Removal

Lower Control Valve Repair

1. Remove the bolts that attach the upper valve case to the lower valve assembly as shown in Figure **4J-34**. Separate the upper case and lower control valve assembly.
2. Remove and replace gaskets 1, 2 and 3 as shown in Figure **4J-34**.
3. Remove the shift solenoids, 1-2 shift valve, 2-3 shift valve, pressure regulator valve, manually controlled valve, and fuel control valve from the control valve lower housing as shown in Figure **4J-36**.
4. Test the shift solenoids as described in SECTION 10 of this manual. Replace defective solenoids.
5. Check valve spools, seats, plungers and springs for damage or wear. Replace as required.
6. Reassemble the lower control valve assembly as shown in Figure **4J-36**.

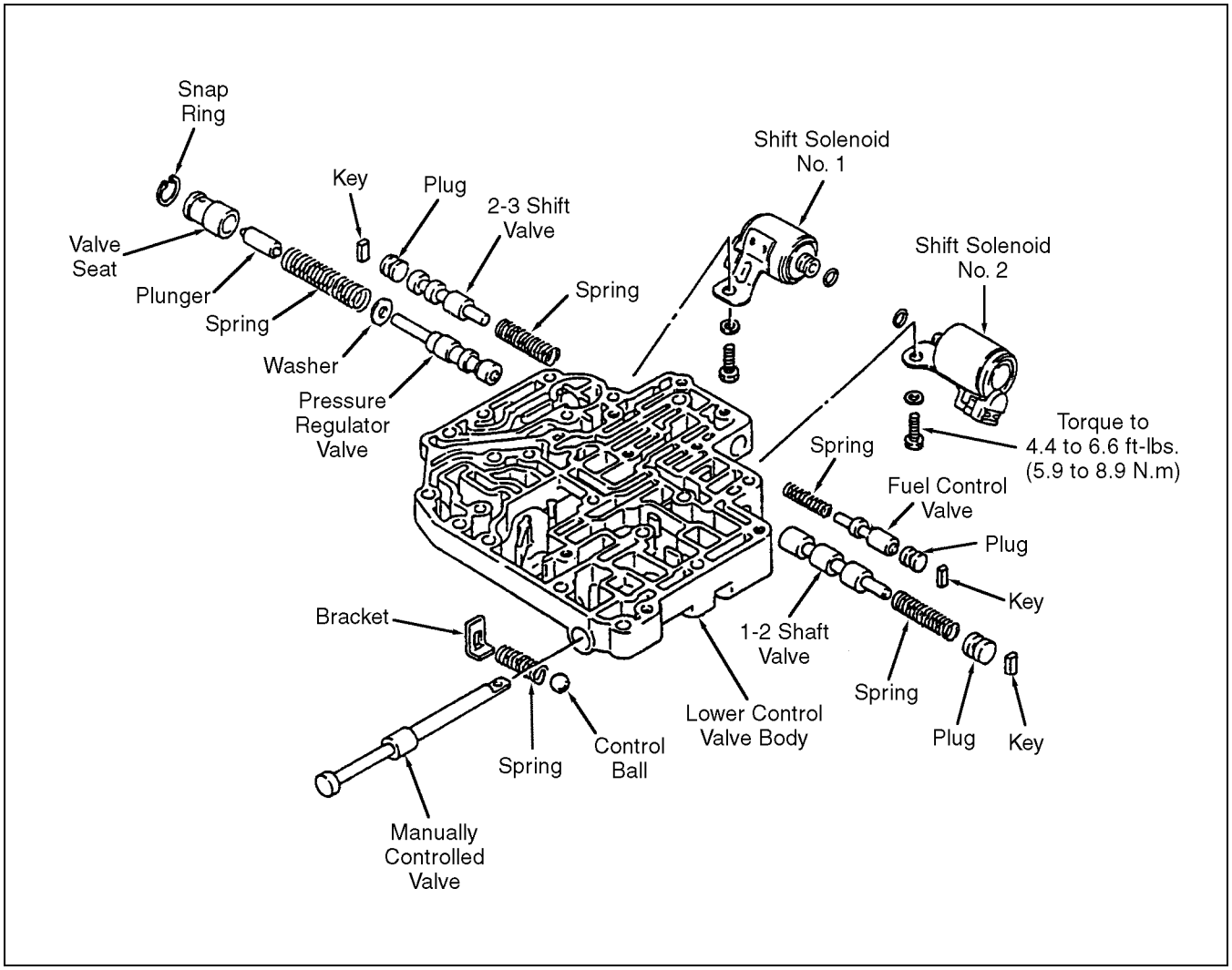


Figure 4J-36. Lower Control Valve Repair

Accumulator Repair (See Figure 4J-37)

1. Use compressed air at approximately 14.22 psi (98 kPa) to dislodge the accumulator pistons from the transmission housing. Insert the air nozzle in the fluid passages shown in Figure **4J-37**, and apply manual pressure to the accumulator pistons to keep them from blowing out.
2. Disassemble the accumulator as shown in Figure **4J-37**.
3. Replace the accumulator O-rings. Apply ATF to lubricate the new O-rings when installing.
4. Replace damaged pistons and springs.
5. Install the accumulators in the transmission housing.

Parking Lock Removal (See Figure 4J-38)

1. Pull out the parking lock pawl shaft and remove the parking lock pawl and spring.
2. Remove the four mounting bolts and remove the detent spring and parking lock bracket.

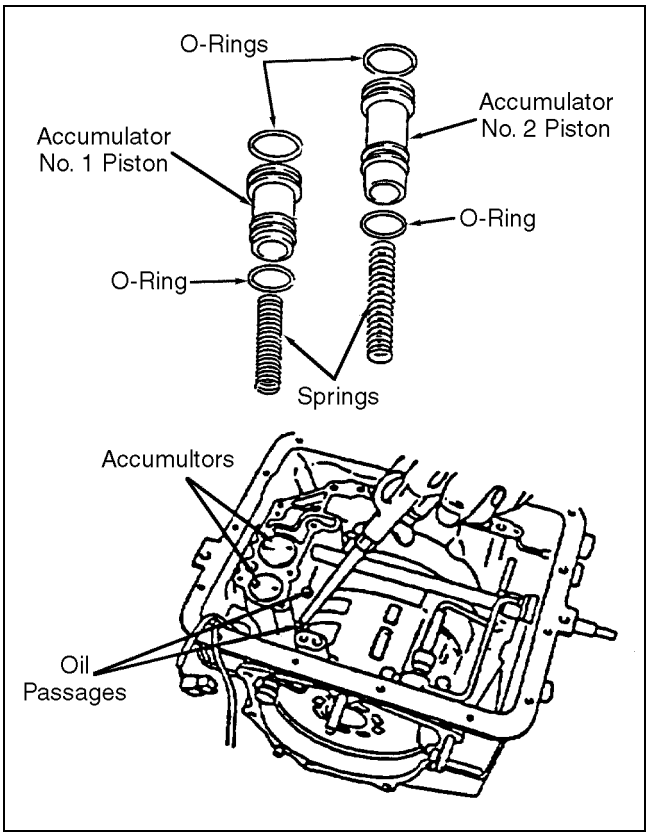


Figure 4J-37. Accumulator Repair

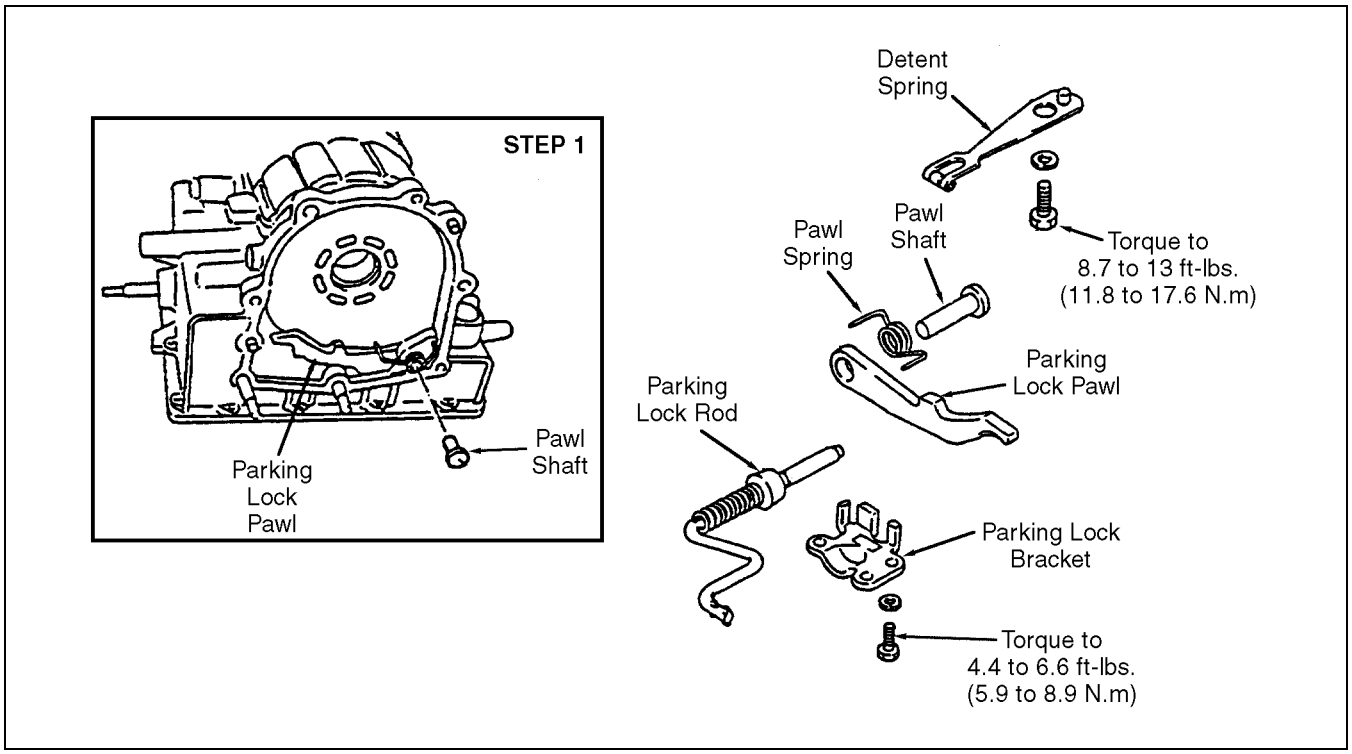


Figure 4J-38. Parking Lock Removal

Control Shafts and Seals Repair (See Figure 4J-39)

1. Use a punch to free up the shift shaft collar.
2. Pull the spring pin and pull the shaft out the shift detent lever side.
3. Lift out the detent lever and the parking lock rod. These pieces should be lifted straight out together and removed.
4. Use a bearing puller to remove the seals from the housing.
5. Use a suitably sized mandrel and mallet to install new oil seals.
6. Position the shift detent lever, washers and collar (concave side toward detent lever) on the inside of the housing as shown in Figure 4J-39. Insert the shift control shaft and pound in the spring pan.
7. Turn the collar 90∞and tighten it against the shift detent lever.
8. Attach the detent spring and parking lock bracket as shown in Figure 4J-38.
9. Attach the parking lock pawl and spring and secure with the pawl shaft as shown in Figure 4J-38.

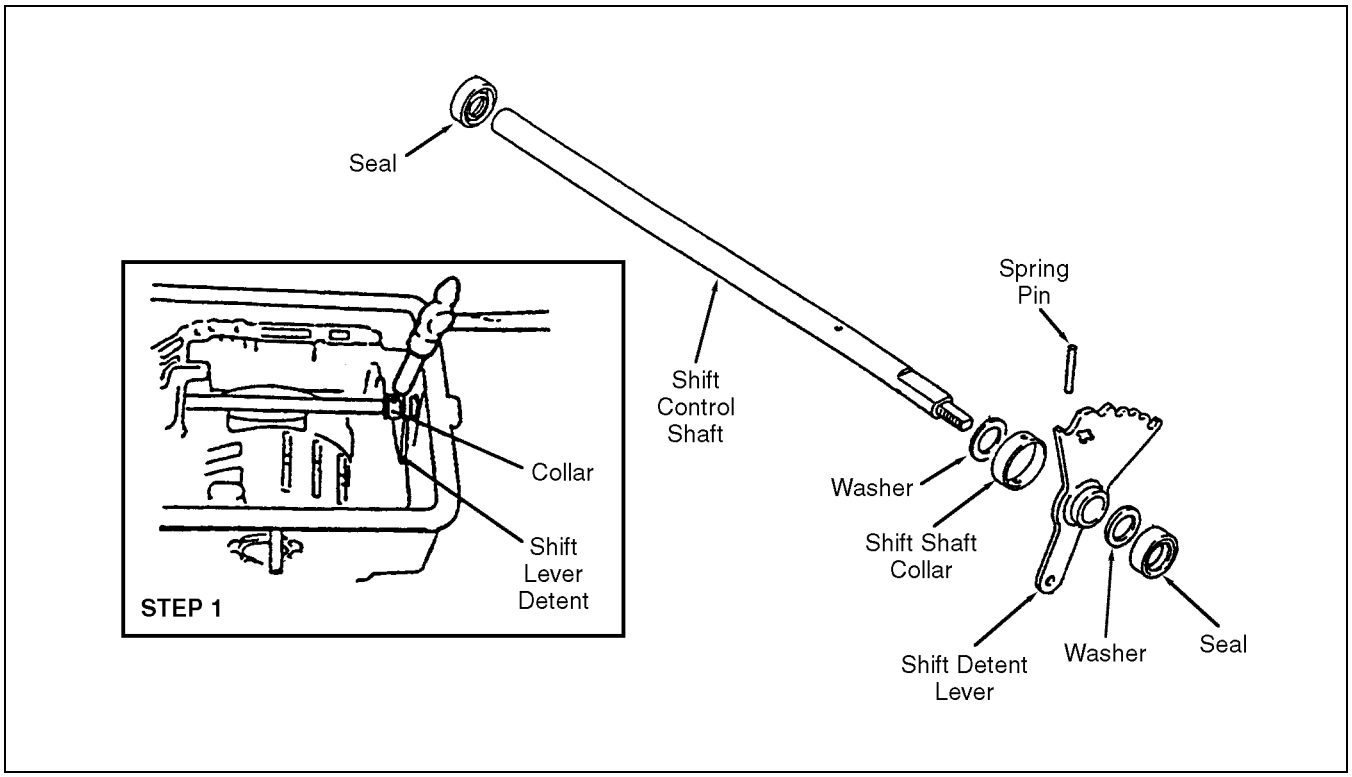
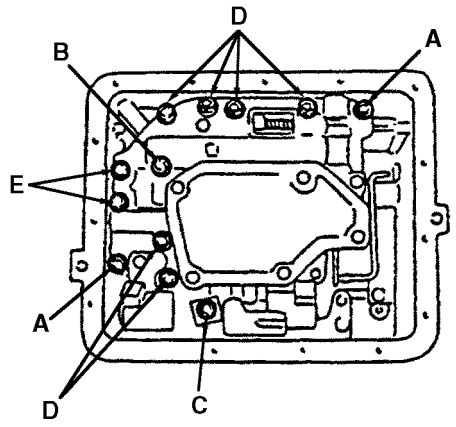


Figure 4J-39. Control Shaft and Seals

Control Valve Installation (See Figure 4J-40)

1. Reconnect solenoid cables.
2. Position the control valve on the transmission housing. Attach the upper valve case to the lower control valve using the two self-tapping bolts marked A in Figure **4J-40** to hold the valve together (do not tighten bolts).
3. Install the remaining bolts B thru D and tighten all twelve bolts A thru D to 3.8 to 4.2 ft-lbs. (5.2 to 5.6 N.m).
4. Install the shift lever and cotter pins as shown in Figures **4J-38** and **4J-39**.



Item	Quantity	Threaded Shank Length
A	2	1.22 inch (31 mm)
B	1	1.77 inch (45 mm)
C	1	1.54 inch (39 mm)
D	6	1.22 inch (31 mm)
E	2	0.98 inch (25 mm)

Figure 4J-40. Control Valve Installation

Oil Strainer and Oil Pan Installation

1. Mount the oil strainer on the control valve. Tighten the five mounting bolts to 3.8 to 4.2 ft-lbs. (5.2 to 5.6 N.m) as shown in Figure **4J-41**.

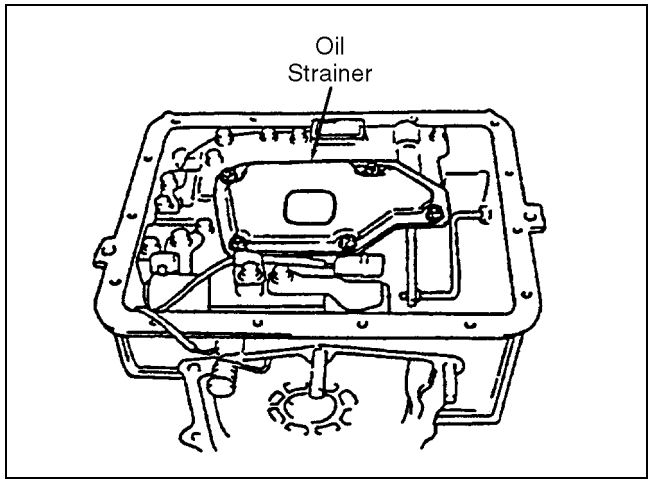


Figure 4J-41. Oil Strainer Installation

2. Position the oil pan magnet under the oil strainer and attach the oil pan as shown in Figure **4J-42**. Tighten the 15 oil pan screws to 2.9 to 4.4 ft-lbs. (3.9 to 5.9 N.m) and tighten the drain plug to 13 to 19.5 ft-lbs. (17.6 to 26.5 N.m).

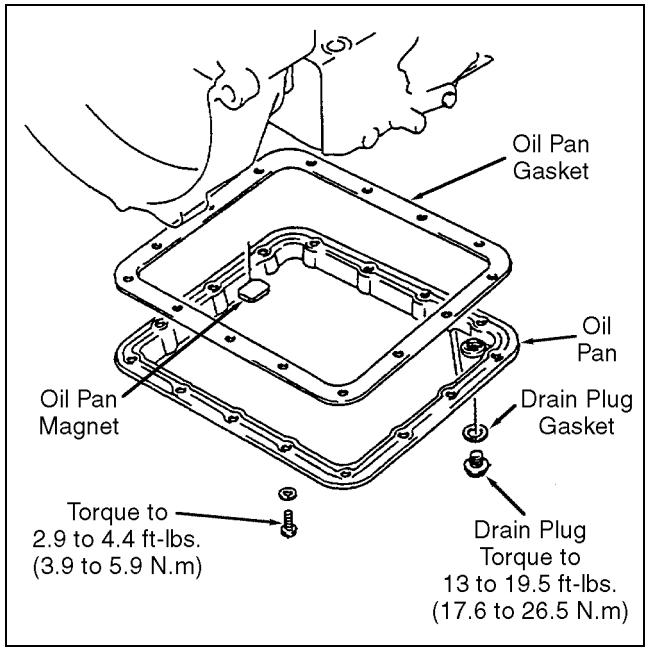


Figure 4J-42. Oil Pan Installation

Parking Lock Gear and Speed Sensor Exciter

1. Attach the parking lock gear and speed sensor exciter to the output shaft as shown in Figure **4J-43**.
2. Secure with three retainer rings.

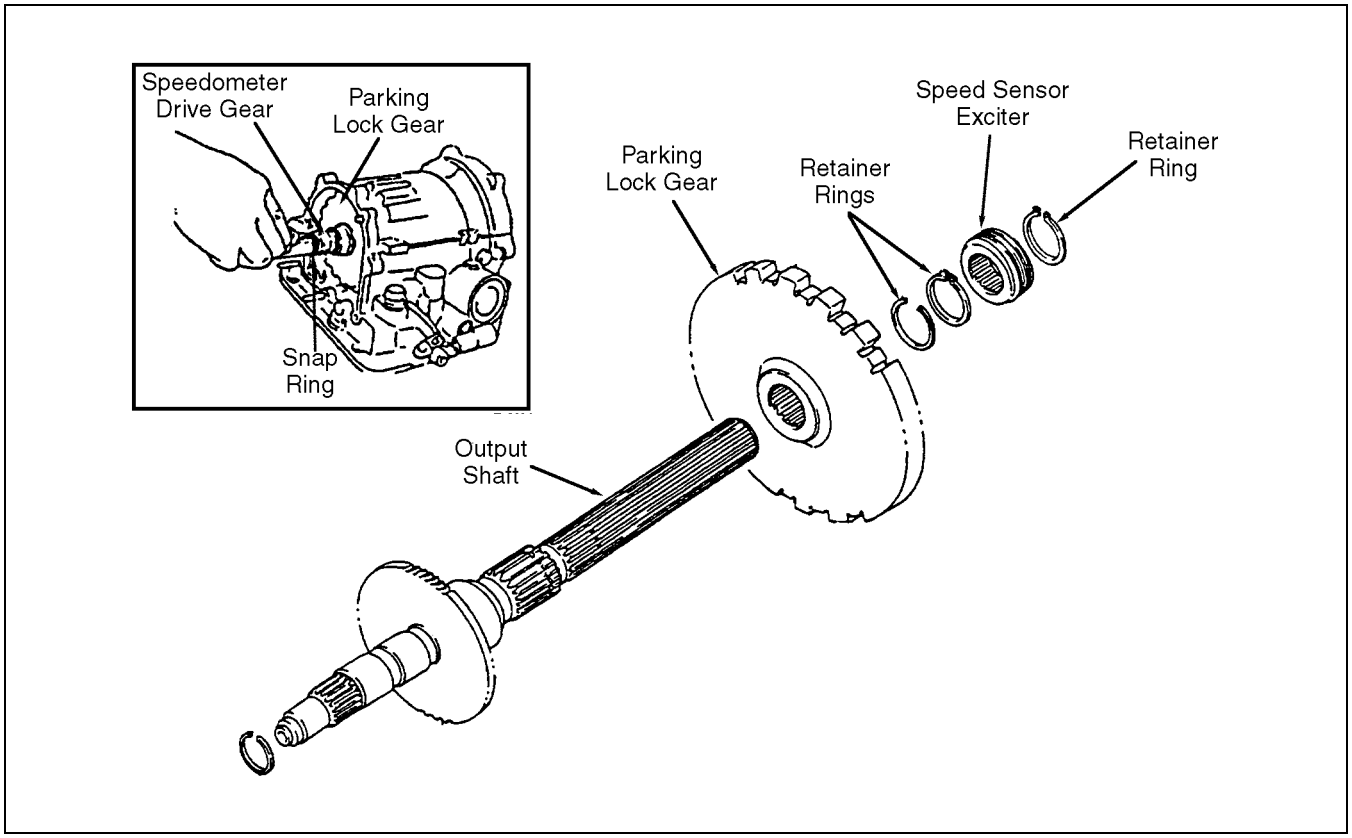


Figure 4J-43. Parking Lock Gear and Speed Sensor Exciter Installation

REAR EXTENSION AND FRONT HOUSING INSTALLATION

Reassemble the rear extension and front housing as shown in Figure **4J-44**.

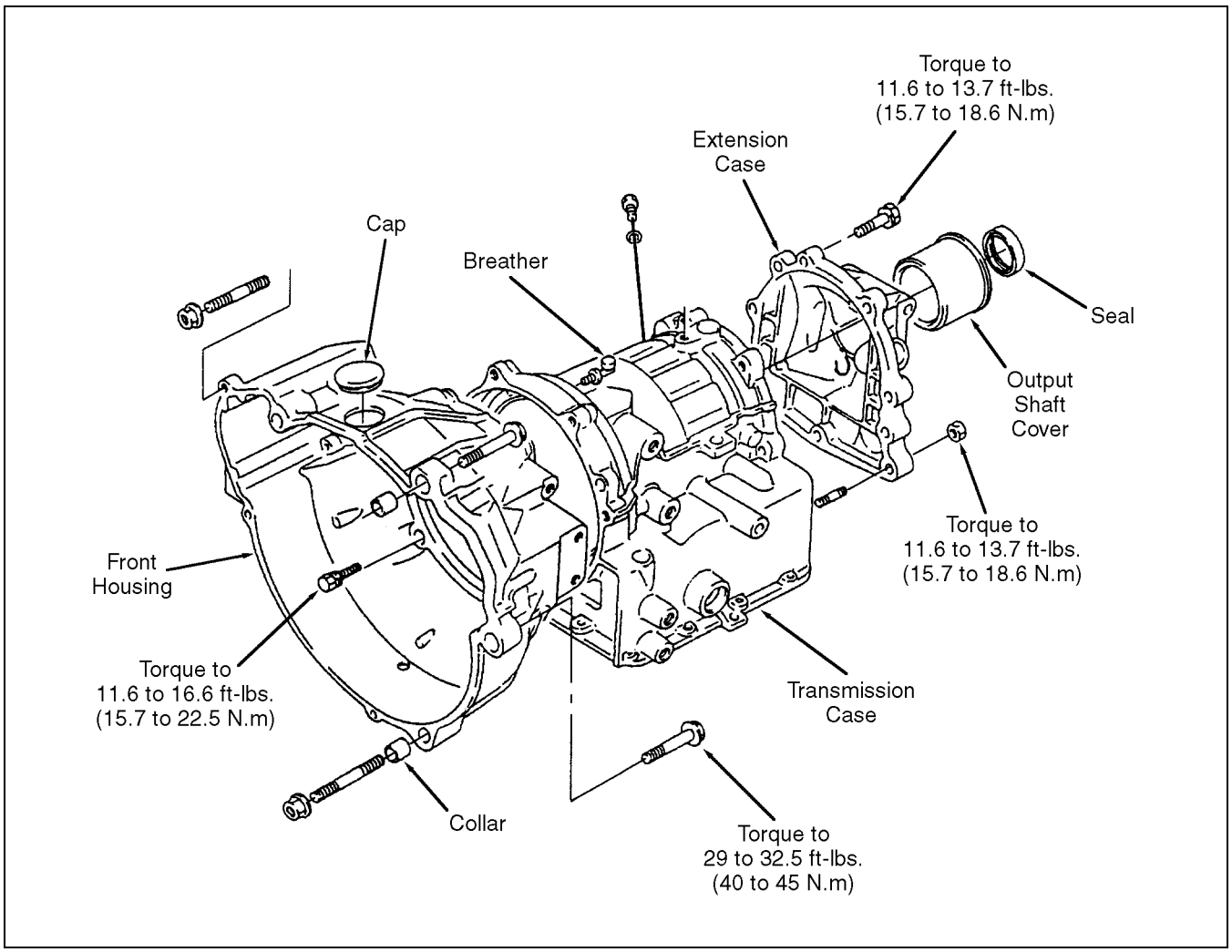


Figure 4J-44. Rear Extension and Front Housing Installation

TRANSMISSION FINAL ASSEMBLY AND INSTALLATION

1. Prior to installing the torque converter, check the end play of the input shaft as shown in Figure **4J-45**.
2. Install the torque converter as shown in Figure **4J-46**, being careful not to damage the oil pump seal on the transmission. Make sure the torque converter fits fully and securely in the transmission front housing.
3. Using a suitable hoist, position the transmission on the engine flywheel and secure with mounting bolts shown in Figure **4J-42**. Torque bolts to 29 to 32.5 ft-lbs. (40 to 45 N.m).
4. Install any mounting, brackets, clamps, etc., removed during removal procedure.
5. Install any fluid tubes and hoses as shown in Figure **4J-4**.
6. Install and reconnect electrical components as shown in Figure **4J-2**.
7. Reconnect the drive shaft as described in SECTION 4C.
8. Fill the transmission with recommended automatic transmission fluid (refer to SECTION 11).

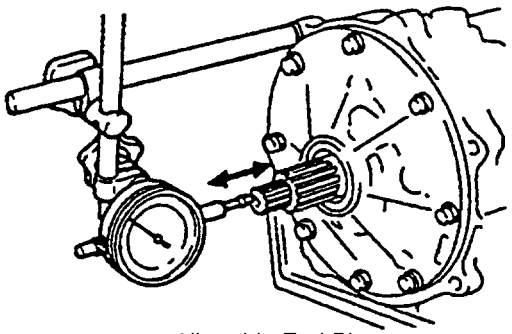


Figure 4J-45. Checking Input Shaft End Play

9. Reattach the shift switch and shift cable to the transmission and adjust the shift selector lever as described in SECTION 2C.
10. Check operation of the manual shift control and cable (see SECTION 4E for shifter and cable linkage).

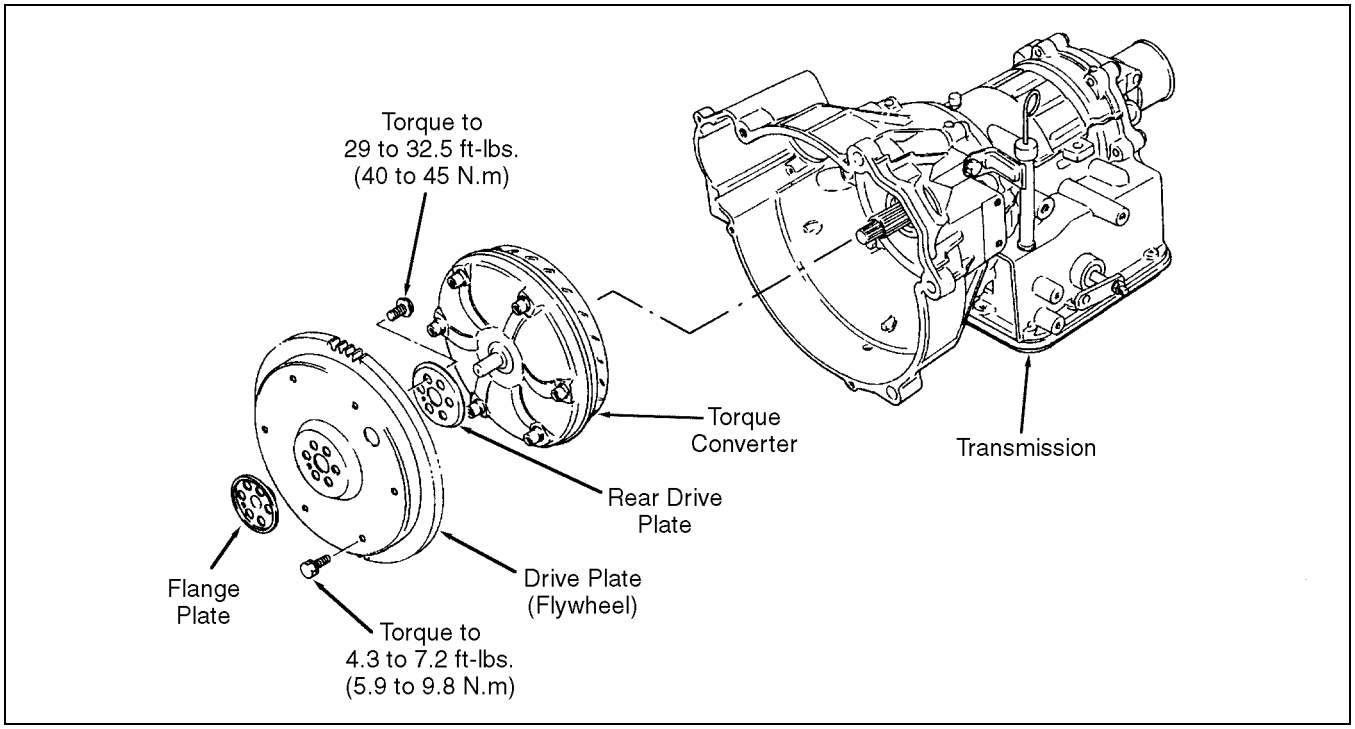


Figure 4J-46. Torque Converter Installation

SECTION 4K. REAR AXLE

GENERAL

The rear axle assembly consists of brakes, wheel hubs, axle shafts, axle housings (tubes) and a differential/2-speed auxiliary transmission.

Wheel hub and brake repairs do not require removal of the axle from the vehicle. Axle shafts and housings may or may not require removal of the entire rear axle differential assembly depending upon the extent of repairs required.

Although some repairs to the differential can be performed with the differential installed on the vehicle, it is almost always more efficient to remove the differential if any of its bearings or gears require repairs.

BRAKES AND WHEEL HUBS (See Figure 4K-1)

REMOVAL

1. Raise and support the rear of the vehicle on jack stands. Remove the rear tires and wheels.
2. Disconnect the parking brake cable from the brake.
3. Disconnect the brake fluid line from the wheel cylinder (cap and plug brake line and wheel cylinder ports).
4. Remove the brake drum.
5. Remove the cotter pin, hub nut, washer and wheel hub. Use a bearing puller to remove the wheel hub.
6. Remove the four screws, backing ring, wheel bearing seal retainer and wheel bearing seal.
7. Remove the four mounting screws and remove the brake assembly from the axle housing.
8. If necessary, repair the brake assembly as described in SECTION 5.

INSTALLATION

1. Position the brake assembly on the axle housing.
2. Lubricate and install a new wheel bearing seal, seal retainer and blocking ring. Secure with four screws. Apply Loctite 243 to these screws and torque to 50 ft-lbs. (68 N.m).
3. Use a rubber mallet to drive the wheel hub on the axle shaft far enough to install the hub washer and nut. Torque the hub nut to 100 to 120 ft-lbs. (135 to 163 N.m). Install a new cotter pin on the nut.
4. Install the brake drum, wheels and tires. Secure with wheel nuts. Torque to 70 to 100 ft-lbs. (95 to 140 N.m).
5. Connect and tighten the brake fluid line.
6. Connect the parking brake cable.
7. Bleed the brake system (see SECTION 2).
8. Check the pressure (see SECTION 7).
9. Lower the vehicle and check brake operation (see SECTION 2).

SECTION 4K. REAR AXLE

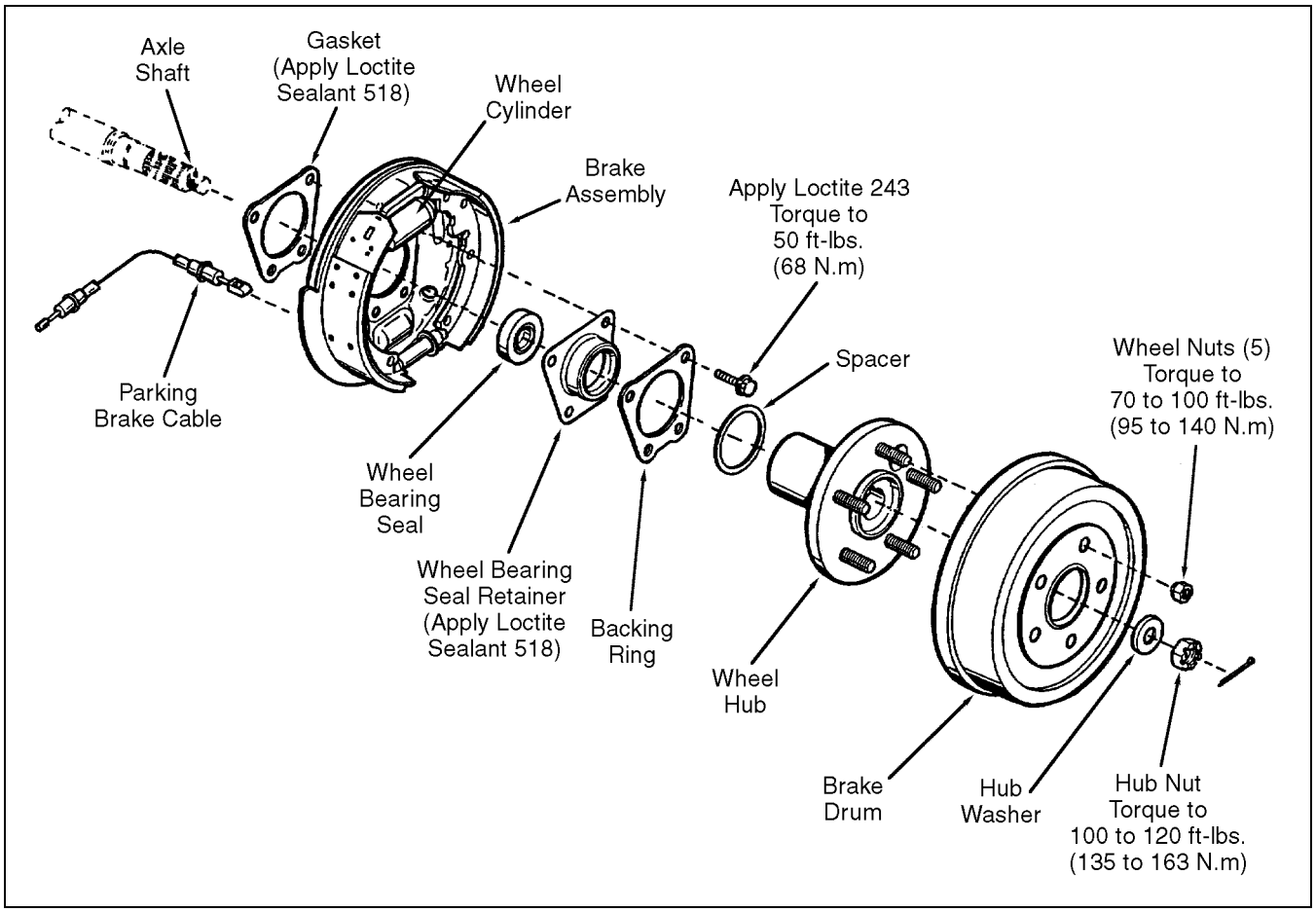


Figure 4K-1. Brake and Wheel Hub Repair

AXLES AND AXLE HOUSINGS

REMOVAL

1. Jack and support the truck chassis on jack stands.
2. Remove the brakes and wheel hubs as described under Brakes and Wheel Hubs.
3. Place a floor jack under the center of the differential housing. Use an overhead hoist or lift truck to take up the weight of the chassis from the rear leaf springs.
4. Disconnect the lower nuts and washers that attach the lower shocks to the studs on the axle tube (see Figure **4K-2**). Push the shock absorbers upwards to the retracted position.
5. Remove the left and right U-bolts from brackets as shown in Figure **4K-2**.
6. Install the wheel hub castellated nut on the axle shaft (see Figure **4K-3**) to protect the shaft threads and pull the axle shaft to remove the wheel bearing, collar and axle shaft. It may be necessary to tap the back of the bearing collar with a rubber mallet to remove it.

NOTE

The wheel bearing cup and cone are cemented together and may separate during removal, leaving the cup in the housing. The cup has a sliding fit in the housing and can be removed by carefully pulling straight out of the housing bore. Replace a separated or worn bearing.

7. Use a seal extractor to remove the oil seal from the axle housing.
8. If the axle housing is damaged, remove the four nuts and washers that mount the axle housing to the differential and remove the axle housing.
9. Clean and inspect the axle shaft, wheel bearing, collar and wheel hub for damage or wear. Replace damaged or worn parts.
10. Clean the axle housing flanges.
11. Remove the O-ring at the groove in the axle housing next to the differential.

SECTION 4K. REAR AXLE

INSTALLATION

1. Refer to Figure **4K-3**, replace the O-ring and oil seal. Lubricate the oil seal. The lip of the oil seal must face inward. Use a plastic tube or seal driver to seat the oil seal.
2. Pack the wheel bearing with clean grease (see SECTION 11). Reassemble the wheel bearing and collar being careful not to damage the oil seal (see Figure **4K-3**). The bearing cup should be to the differential housing side.
3. Refer to Figure **4K-2**, install U-bolts and shocks on axle tubes. Torque as shown in Figure **4K-2**.
4. Install the brakes and wheel hubs as described in the preceding paragraphs.

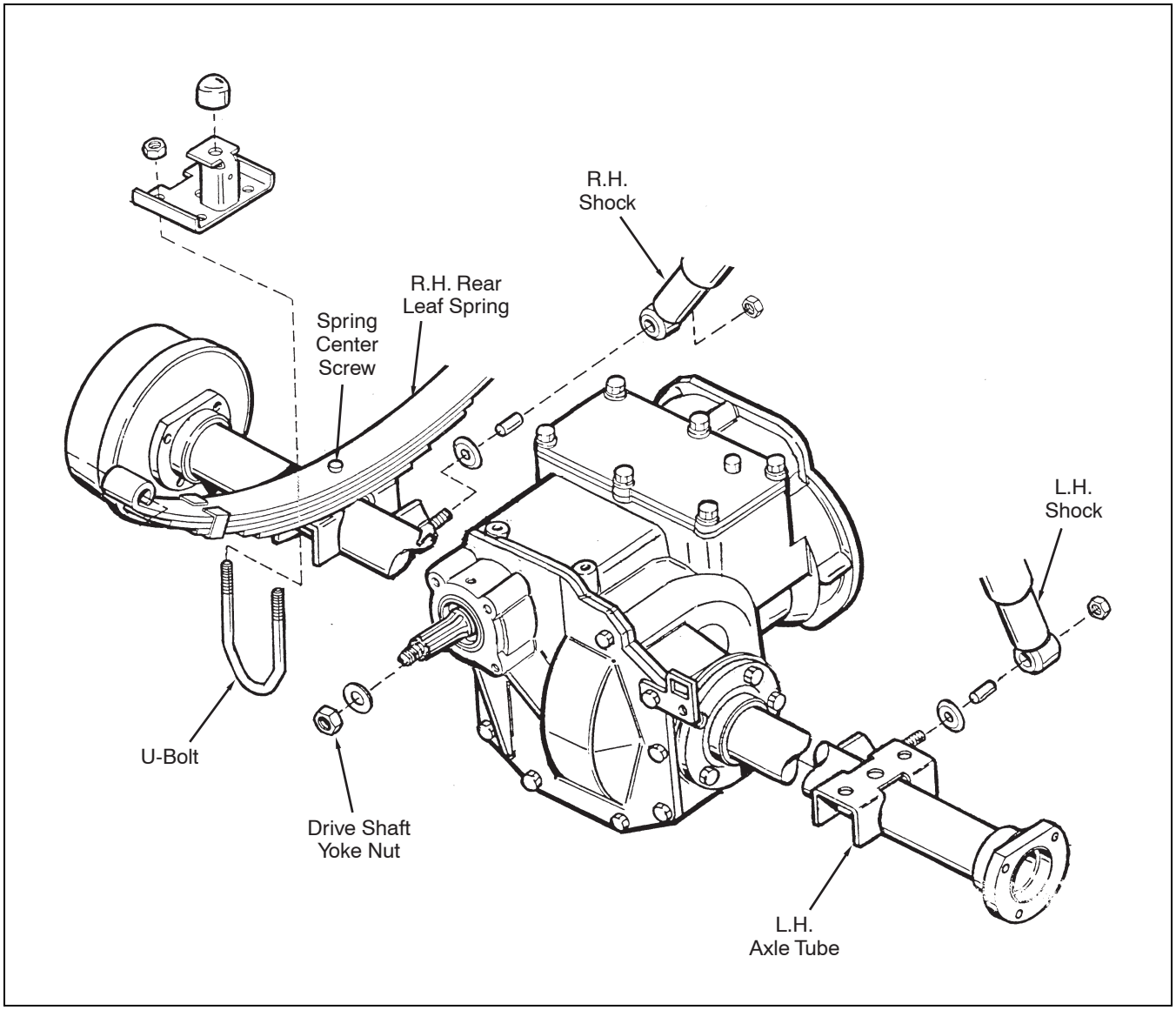


Figure 4K-2. Axle Housings and Differential

SECTION 4K. REAR AXLE

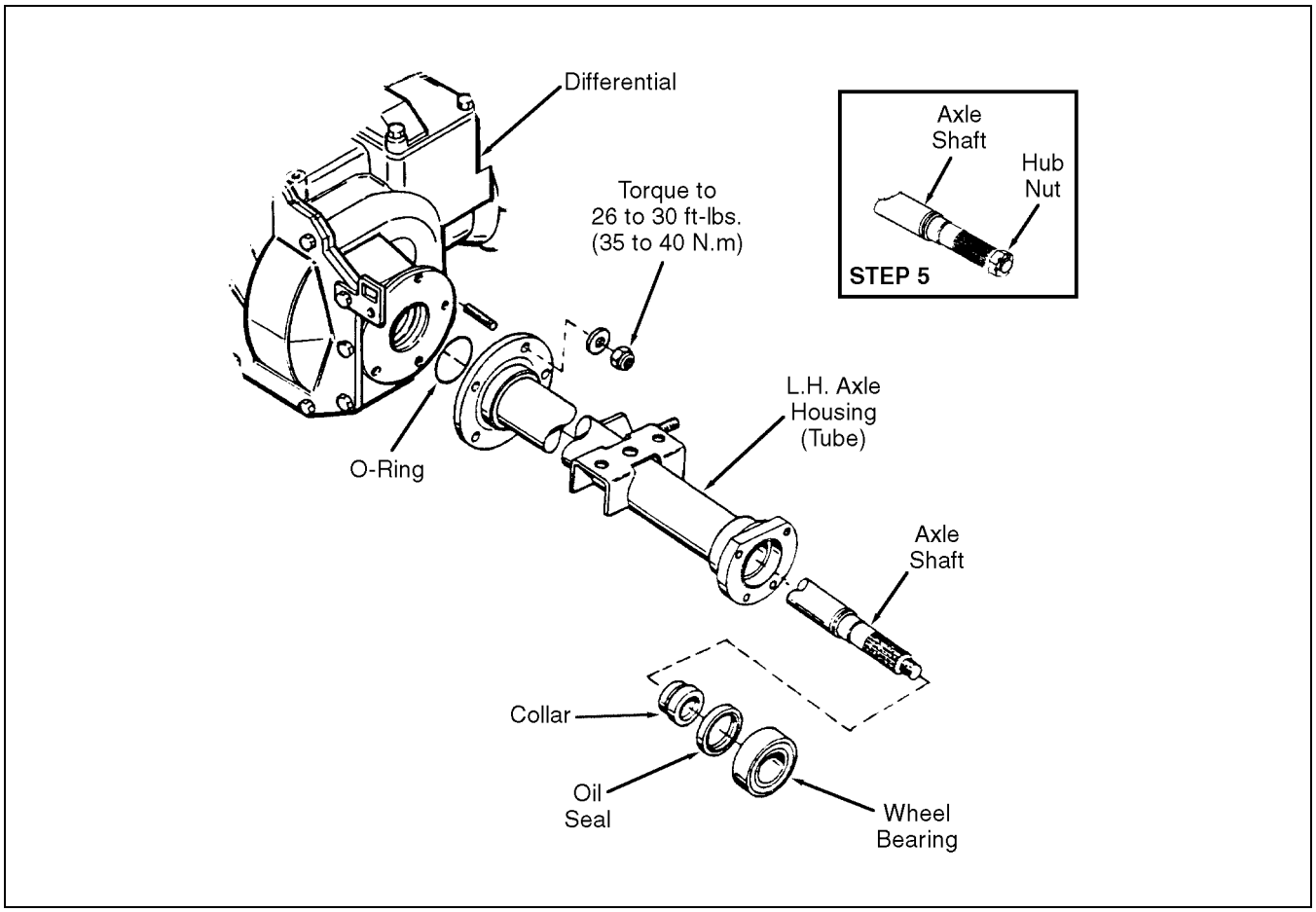


Figure 4K-3. Axles and Axle Housings

SECTION 4K. REAR AXLE

DIFFERENTIAL ASSEMBLY REMOVAL

1. Remove the brakes, wheel hubs, axles and axle tubes as described in the preceding paragraphs.
2. Remove the axle tubes as described in the preceding paragraphs.
3. Remove the brake tubes, brake hose, clamp, tee and bracket from the differential housing as shown in Figure **4K-4**.
4. Remove the drain plug and drain oil from the differential in accordance with environmental regulations. Re-install and tighten the drain plug.
5. Disconnect the drive shaft yoke nut and special washer from the differential input shaft as shown in Figures **4C-1** and **4C-2**.
6. Remove the jack stands from under the axle. Guide and carefully lower the differential until the drive shaft separates from the input shaft. Remove the differential assembly from under the chassis.
7. Clean the exterior of the differential before proceeding with further disassembly and repairs. Move the differential to a suitable work bench or table.

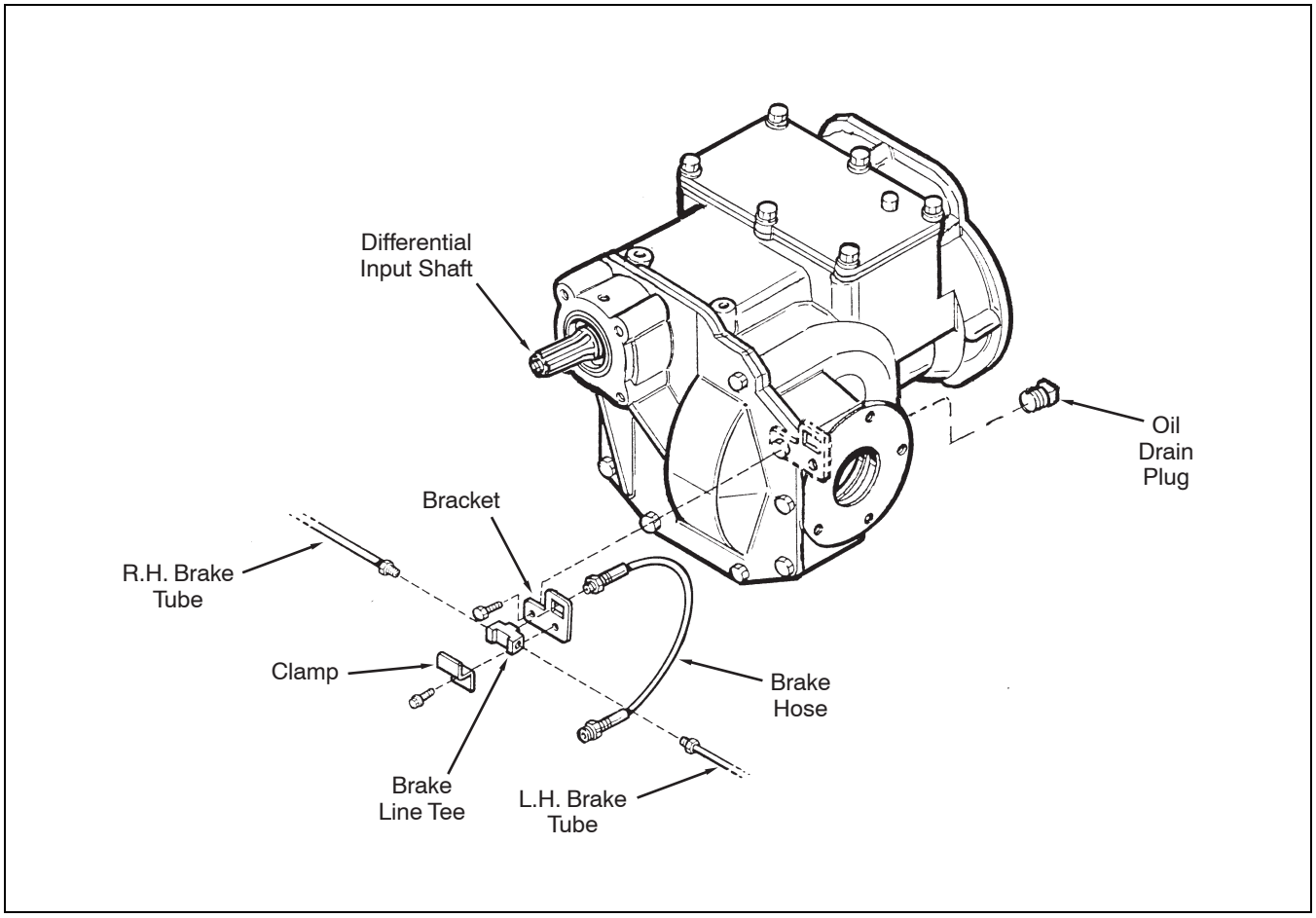


Figure 4K-4. Differential Removal

SECTION 4K. REAR AXLE

DIFFERENTIAL FRONT COVER

DISASSEMBLY

NOTE

The drive shaft yoke nut and special washer (see Figures **4C-1** and **4C-2**.) will have been removed during removal of the differential from the vehicle.

1. Re-install the driveshaft yoke nut and special washer on the input shaft to protect the shaft threads during the following procedure.
2. Remove the cover retaining screws as shown in Figure **4K-5** and the shift cable bracket screws (see Figure **4K-6**).

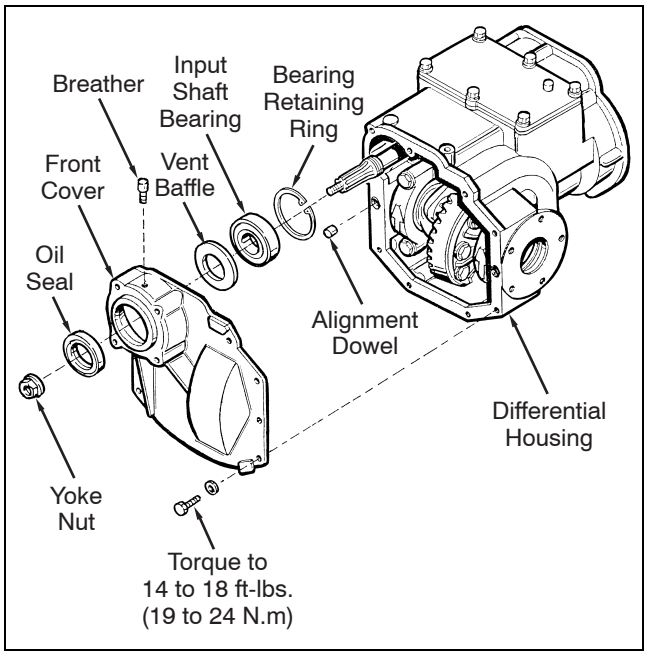


Figure 4K-5. Front Cover Disassembly

NOTE

Steps 3 and 4 below are necessary because the front cover can not be pried from the differential housing by a screwdriver or other metal object which would damage the machined surfaces of the differential housing.

3. Re-install the shift cable mounting bracket using one of the 3/8-16 x 2.75 inches long screws in the threaded front cover holes as shown in Figure **4K-6**.
4. Use a curved bar to pry under the shift cable bracket and against the input shaft to ìbumpî the input shaft bearing from the shaft as shown in Figure **4K-6**.

NOTE

Pressure must be held on the end of the input shaft to hold the shaft rearward in the case. This will prevent the shaft and rear bearing from coming forward out of the case bore.

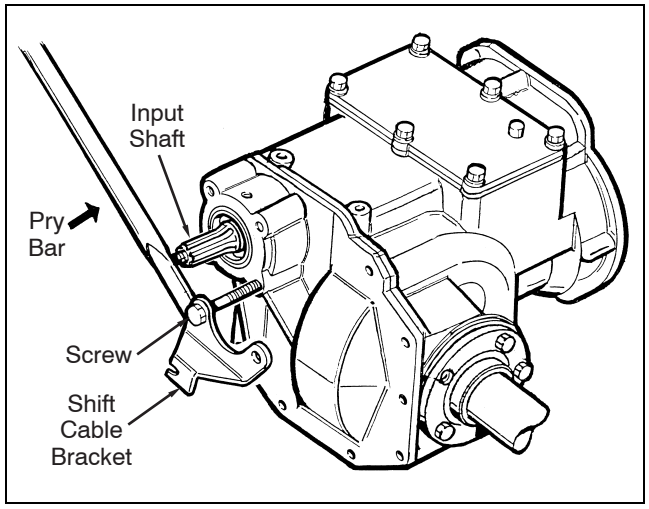


Figure 4K-6. Removing Input Shaft Bearing

5. Remove the cover assembly from the housing. Remove the screw installed in Step 3 above and cable bracket from the cover.
6. Remove the input shaft bearing retaining ring as shown in Figure **4K-5**.
7. Support the front cover on wood blocks. Use a large drift against the inner race of the input shaft bearing. Drive the bearing out of the bore. Be careful not to drive on the vent baffle.
8. Support the cover on wood blocks. Use a large diameter drift to drive out the oil seal from the rear side. The shaft oil seal is retained with Loctite 290 adhesive.
9. Thoroughly clean the front cover and differential housing machined surfaces of all gasket material. Wash all parts in approved cleaning solvent and air dry. Inspect the input shaft bearing for cracked or chipped races, worn or scored balls. Replace the bearing if damaged.

REASSEMBLY

1. Apply Loctite 290 adhesive around the O.D. of a new oil seal.
2. Coat the lips of the oil seal with clean grease. Use a seal driver or tubing to install a new oil seal in the cover until seated.
3. Install the vent baffle in the bottom of the bearing bore and install the bearing in the bore of the cover.
4. Install the bearing retaining ring. The ends of the retaining ring must be in line with the oil drain groove in the cover. Be sure the ring is fully sealed.
5. Apply a bead of Loctite 518 sealant around the machined surface of the cover.

NOTE

If the ball bearing is reused, put clean grease or Lubriplate in the bearing. Use new bearing as received in the package.

6. Install two 5/16-18 pilot studs in the holes of the cover pilot bushings as shown in Figure **4K-7**.

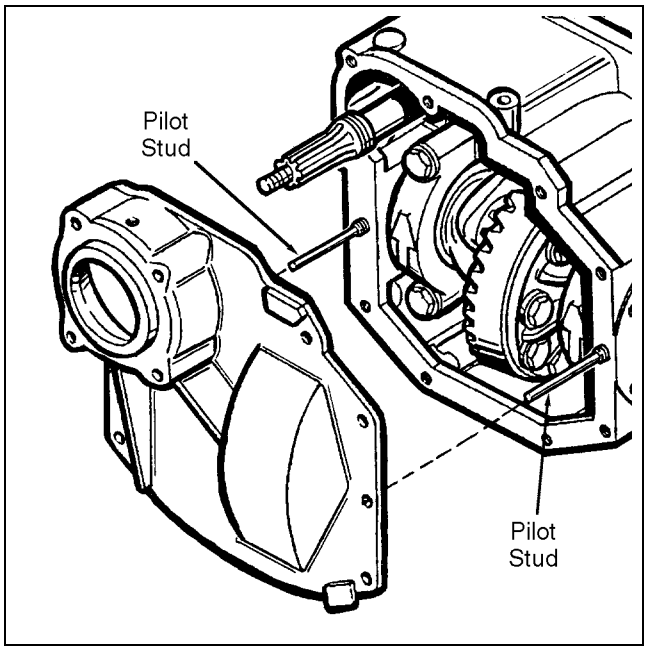


Figure 4K-7. Front Cover Installation

7. Align and push the cover on the shaft as far as possible by hand. Install the three 3/8-16 x 2.75 inches retaining screws and shift cable bracket.
8. Tighten each screw a small amount alternately and evenly to pull the bearing on the input shaft. Tighten the screws only enough to pull the cover up to the housing. Be sure the cover engages the two pilot bushings.
9. Install the 5/16-18 retaining screws and flat washers. Draw all retaining screws up evenly until the cover is firmly against the differential housing. Tighten the 3/8-16 screws alternately and evenly to a final torque of 26 to 30 ft-lbs. (35 to 40 N.m). The lower 3/8-16 screw is used to support the right side brake fluid line. Tighten the 5/16-18 retaining screws alternately and evenly to a torque of 14 to 18 ft-lbs. (19 to 24 N.m).
10. Connect the drive shaft yoke to the input shaft as shown in Figures **4C-1** and **4C-2**. Tighten the yoke nut to approximately 64 to 74 ft-lbs. (87 to 100 N.m). This nut can not be accurately torqued.

SECTION 4K. REAR AXLE

DIFFERENTIAL DISASSEMBLY (See Figure 4K-8)

NOTE

Bearings are a slip fit in the bores of the housing.

1. Push the top shaft assembly back as far as possible. Use a hook type tool to work around the I.D. of the bearing and pull the bearing out of the bore. If the bearing is too tight in the bore of the housing, use a slide hammer type bearing puller.
2. Remove the inner bearing retaining ring, bearing thrust collar and thrust washer.
3. Pull the input shaft pilot bearing out of the bore of the main shaft. Pull the input shaft as far forward as possible in the housing.
4. Tap the input shaft assembly through the housing.
5. Align the input shaft bearing in the bore of the housing. Carefully tap the shaft and bearing assembly toward the rear of the differential housing and through the bearing bore.
6. Align the input shaft bearing in the rear input shaft bearing bore and tap the bearing towards the rear through the bore.
7. Remove the input shaft assembly through the rear of the differential housing.
8. To replace the input shaft intermediate roller bearing, remove the outer and inner retaining rings and use a split, knife-edge bearing remover and hydraulic press to remove the intermediate bearing from the shaft.
9. Use a hydraulic press to install new intermediate bearings. Be certain the bearings are fully seated on the shaft. Lubricate both bearings with clear grease.
10. Install the input shaft inner and outer bearing retaining rings in the grooves of the shaft. Be sure the rings are fully seated in the grooves.

NOTE

The thicker retaining ring must go in the outer (top) groove of the shaft. Install the thinner ring with the beveled side up (away from the bearing).

INSPECTION AND CLEANING

1. Inspect the differential housing, ring gear and pinion gear set and bearings for damage or wear. If damage or wear is found, replace the entire differential and housing assembly.

NOTE

The differential housing, ring and pinion gear set and bearings are serviced as a complete assembly only.

2. Inspect the main shaft and drive gear for damage or wear. Replace the drive gear bushing if worn.
3. Inspect the input shaft bearing thrust washer. If badly scored or worn, replace the thrust washer.
4. Wash all parts in approved cleaning solvent and blow dry. Replace any worn or damaged parts found during inspection.
5. Be sure the differential housing is clean and free of foreign objects before beginning reassembly.

REASSEMBLY (See Figure 4K-9)

NOTE

Lubricants to be added during reassembly are specified in SECTION 11.

1. Install the input shaft through the rear bearing bore.
2. Align and install the input shaft through the intermediate bearing bore as far forward as possible.
3. Lubricate the surface.
4. Install two pilot studs and install the front cover as described in ìFront Cover Reassembly.î
5. Turn the differential assembly on the work bench so that the main shaft is pointing upwards.
6. Lubricate and install the bronze thrust washer over the machined shoulder of the main shaft against the driven gear. Install the bearing collar against the thrust washer.
7. Install the bearing retaining ring in the groove of the housing.
8. Lubricate and install the rear input shaft bearing in the bore of the housing and install the retaining ring (beveled side up) in the groove of the housing.
9. Install the pinion drive gear spacer on the main shaft.
10. Turn the differential assembly so that it is horizontal on the work bench. Install the large driven gear on the pinion shaft.
11. Install the flat washer and new locknut on the pinion shaft. Only tighten the locknut to approximately 50 ft-lbs. (68 N.m) at this time.
12. Install the small pinion drive gear on the input shaft.
13. Use a large wrench on the hub of the large driven gear to hold the gear stationary. Tighten the locknut to a torque of 200 to 225 ft-lbs. (270 to 305 N.m).
14. Install washer on the input shaft.
15. Install a new locknut. Tighten the locknut to a torque of 64 to 74 ft-lbs. (87 to 100 N.m). Use a bar in the input drive yoke to hold the main shaft while tightening the nut.
16. Rotate the input shaft to check operation. Transmission rotation must be smooth with no binding or lockup.
17. Install two pilot studs opposite each other in the threaded holes for the rear cover.
18. Coat the machined flange of the rear cover and align and install the cover.
19. Install cover screws, flat washers and gear ratio tag. Torque screws alternately and evenly to 14 to 18 ft-lbs. (19 to 24 N.m).
20. Install the shift control cover as shown in Figure 4K-9.
21. Install the axle housings and axles as shown in Figure 4K-3.

SECTION 4K. REAR AXLE

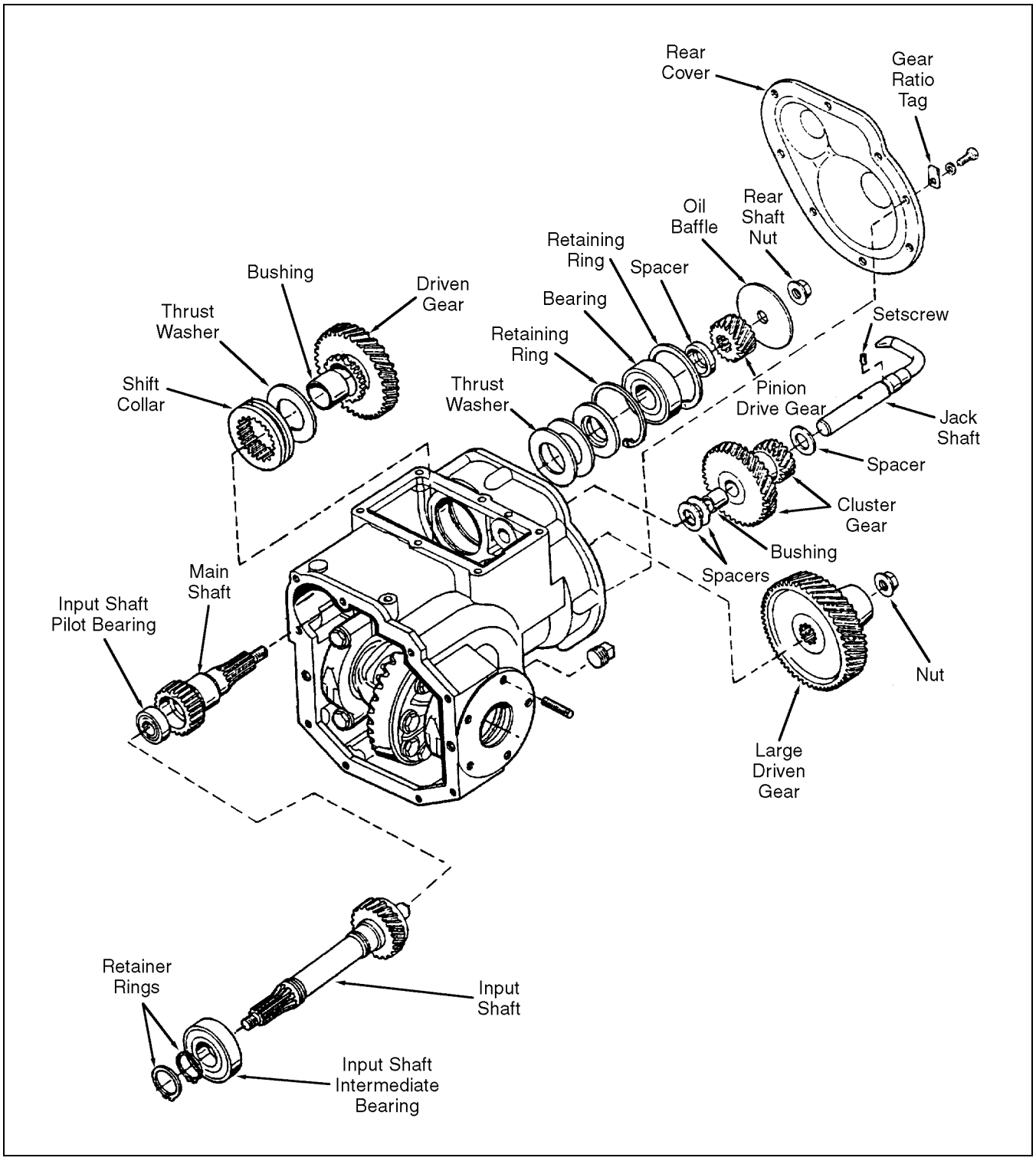


Figure 4K-8. Auxiliary Transmission Disassembly

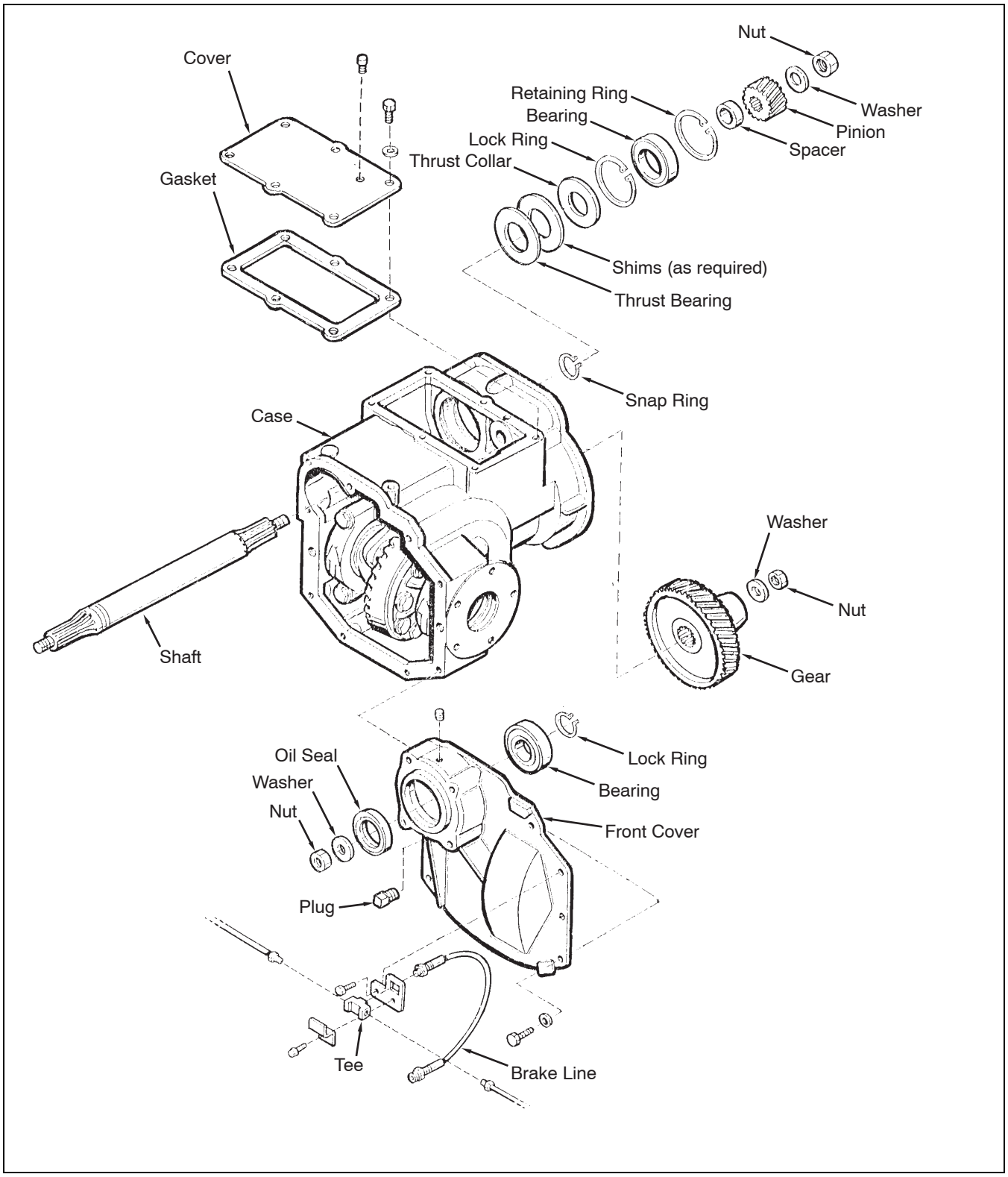


Figure 4K-9. Auxiliary Transmission Reassembly

DIFFERENTIAL AND AXLE ASSEMBLY INSTALLATION

1. With the help of an assistant, position the differential and axle assembly on a floor jack under the chassis. Slowly raise the axle while at the same time aligning and connecting the drive shaft into the splined drive shaft. Place jack stands under the axle for support. Be sure the drive shaft U-joints are aligned correctly (see Figures **4C-1** and **4C-2**). Hold the drive shaft from rotating and install yoke nut and washer and torque to 64 to 74 ft-lbs. (87 to 100 N.m). The yoke nut can not be accurately torqued.
2. Lower the chassis and align the axle so that the spring center screw will engage the center hole in the axle spring mounting pads (see Figure **4K-10**). Install the axle U-bolt clamps and brackets. Tighten the U-bolts alternately and evenly until tight.
3. Install the brakes and wheel hubs as described in ìBrake and Wheel Hub Installationî earlier in this section.
4. Connect brake lines and parking brake cable (see Figures **4K-1** and **4K-10**).
5. Extend and connect lower shock absorbers as shown in Figure **4K-10**.
6. Adjust and bleed the brake system as described in SECTION 2C.
7. Connect and adjust control cables as described in SECTION 2C.
8. Remove the fill plug (see Figure **4K-10**) and fill the differential with specified oil (see SECTION 11). Install and tighten fill plug.
9. Install the wheels and tires. Tighten wheel lug nuts to 70 to 100 ft-lbs. (95 to 140 N.m).

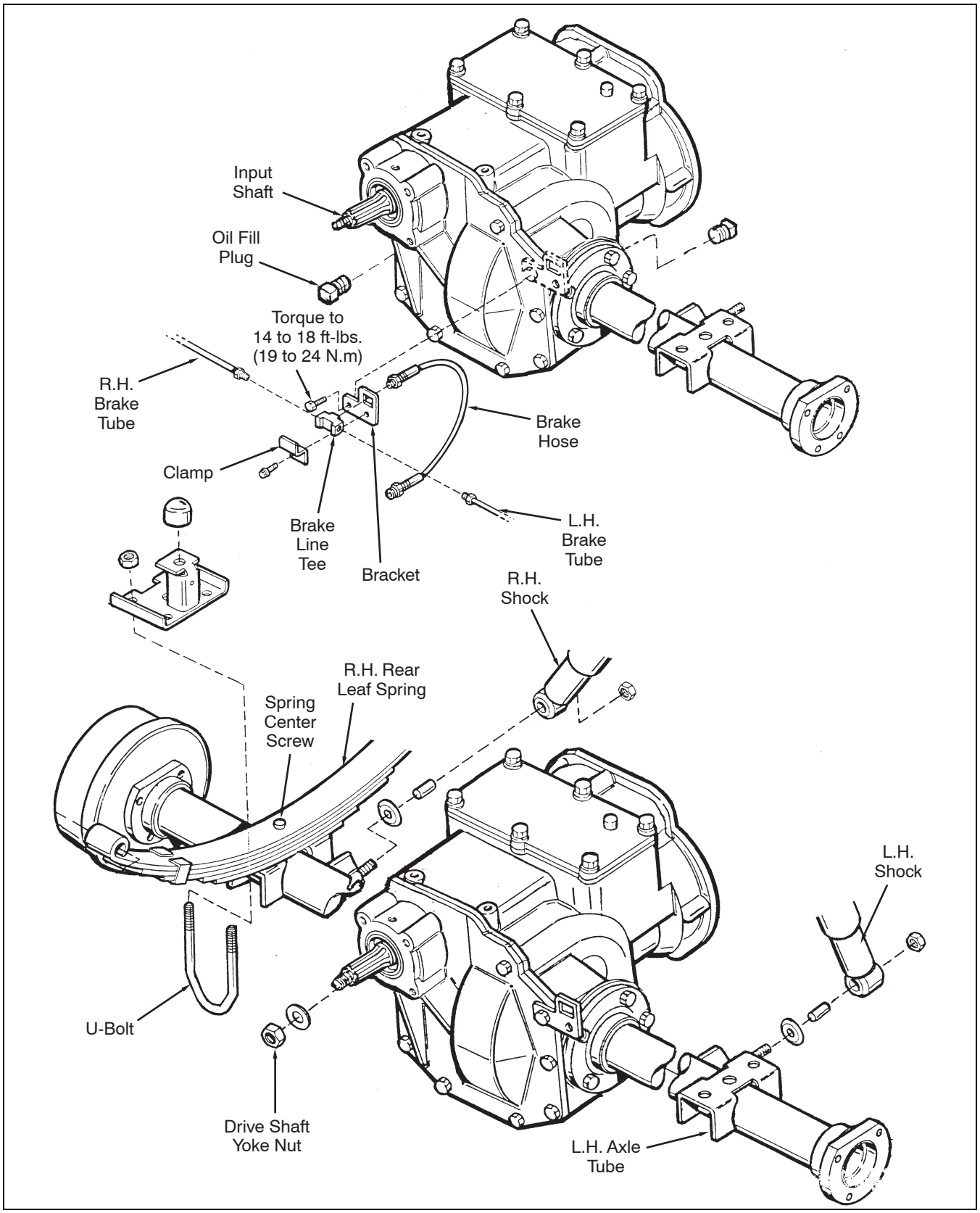


Figure 4K-10. Differential and Axle Assembly Installation

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