IMPORTANT SAFETY NOTICE

IT IS YOUR RESPONSIBILITY to be completely familiar with the warnings and cautions described in this service manual. These warnings and cautions advise against the use of specific service methods that can result in personal injury, damage to the equipment, or cause a vehicle to be unsafe. It is, however, important to understand that these warnings and cautions are not exhaustive. Detroit Diesel Allison could not possibly know, evaluate and advise the service trade of all conceivable ways in which service might be done or of the possible hazardous consequences of each way. Consequently, Detroit Diesel Allison has not undertaken any such broad evaluation. Accordingly, **ANYONE WHO USES A SERVICE PROCEDURE OR TOOL WHICH IS NOT RECOMMENDED BY DETROIT DIESEL ALLISON MUST** first satisfy himself thoroughly that neither his safety nor vehicle safety will be jeopardized by the service methods he selects.

Proper service and repair is important to the safe, reliable operation of all motor vehicles. The service procedures recommended by Detroit Diesel Allison and described in this service manual are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for the purpose. The special tools should be used when and as recommended.

Three types of headings are used in this manual to attract your attention.

WARNING: is used when an operating procedure, practice, etc., which, if not correctly followed could result in personal injury or loss of life.

CAUTION: is used when an operating procedure, practice, etc., which, if not strictly observed, could result in damage to or destruction of equipment.

NOTE: is used when an operating procedure, practice, etc., is essential to highlight.

This manual contains the following warnings. **IT IS YOUR RESPONSIBILITY** to be familiar with **ALL** the instructions contained herein.

WARNING: When conducting a transmission stall test, the vehicle must be prevented from moving. Both the parking and service brakes must be applied and, if necessary, the vehicle should be blocked to prevent movement. Warn personnel to keep clear of the vehicle and its travel path.

WARNING: Do not burn discarded Teflon seals. Toxic gases are produced.

WARNING: Never dry bearings by spinning them with compressed air. A spinning bearing can disintegrate, allowing balls or rollers to become lethal flying projectiles. Also, spinning a bearing without lubrication can damage the bearing.

SA 1239G

Service Manual

Allison Transmissions

V-DRIVE MODELS

VH 2, 4, 5, 7, 9

VS 1-8, 2-6, 2-8

1 JULY 1980

Detroit Diesel Allison
Division of General Motors Corporation
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NOTE: This publication is revised periodically to include improvements, new models, special tools, and procedures. Revision is indicated by letter suffix to publication number. Check with your Detroit Diesel Allison service outlet for currently applicable publication. Additional copies of this publication may be purchased from authorized Detroit Diesel Allison service outlets. See your yellow pages under Engines—Diesel or Transmissions—Truck, Tractor, etc.

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Section 1. GENERAL INFORMATION

1-1. SCOPE OF MANUAL

a. Coverage

(1) This Service Manual covers the description, operation, maintenance and overhaul of the VH and VS series coach transmissions (fig. 1-1 through 1-4).

(2) All text and illustrations in this manual are applicable to both the VH and VS series unless specifically designated.

b. Arrangement

(1) Eight sections. This manual consists of eight sections. Each paragraph and illustration number is prefixed with the applicable section number.

(2) Section content. Section 1 contains general information, specifications and data. Section 2 describes transmission components and explains their operation. Section 3 outlines preventive maintenance procedures. Section 4 contains general information on overhaul procedures. Section 5 covers disassembly of the transmission into subassemblies. Section 6 covers rebuild of the subassemblies. Section 7 covers assembly of the transmission from subassemblies. Section 8 covers wear limits and spring specifications.

(3) Foldout illustrations. Foldout illustrations at the back of the manual include cross-section views, hydraulic schematics and exploded views showing all parts in their assembly relationship.

c. Maintenance Information. Each task outlined in this Service Manual has been successfully accomplished by service organizations and individuals. It is not expected that every service organization or individual will possess the required special tooling, training, or experience to perform all the tasks outlined. However, any task outlined herein may be performed if the following conditions are met:

(1) The organization or individual has the required knowledge of the task through:

Formal instruction in a DDA or Distributor training facility.

"On-the-job" instruction by a DDA or Distributor representative.

Experience in performing the task.

(2) The work environment is suitable to prevent contamination or damage to transmission parts or assemblies.

(3) Required tools and fixtures are available as outlined in the Service Manual.

(4) Reasonable and prudent maintenance practices are utilized.

Note: Service organizations and individuals are encouraged to contact their local DDA Distributor for information and guidance on any of the tasks outlined herein.

1-2. MODEL SERIES DIFFERENCE

a. Two Series. Coach service which requires low-speed runs with frequent stops use the VH, and VS1 models. Coach service which includes longer, higher-speed runs between stops use the VS2 model.

b. Difference. The major differences in design, between the three models, are in the drive clutches and the inclusion of a splitter overdrive arrangement in the input of the VS2 series. These differences can be seen in foldout 1 and foldout 2. Foldouts 3 through 8 illustrate differences in the hydraulic systems in all the series.

1-3. SUPPLEMENTARY INFORMATION

Supplementary information, to be used in conjunction with this Service Manual, will be

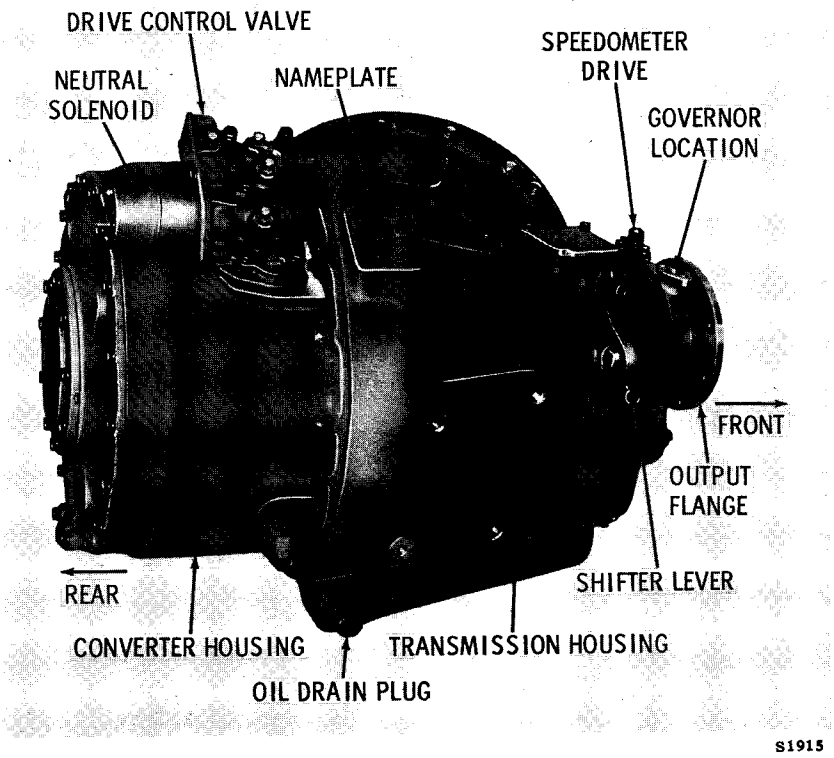

Fig. 1-1 Model VH9, VS1-8 transmission—right-rear view

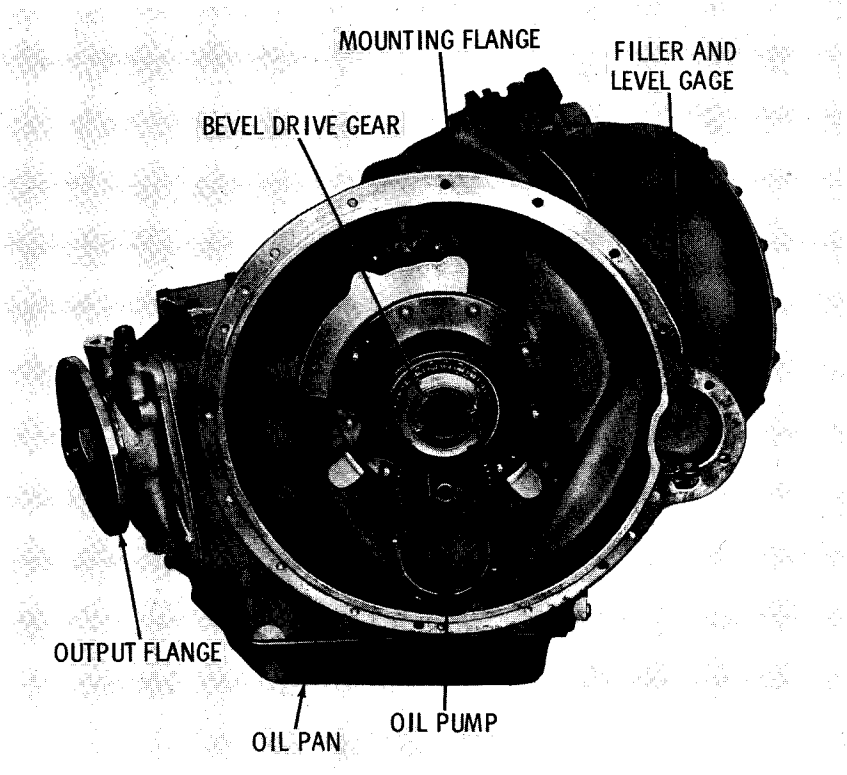

Fig. 1-2 Model VH9, VS1-8 transmission—left-front view

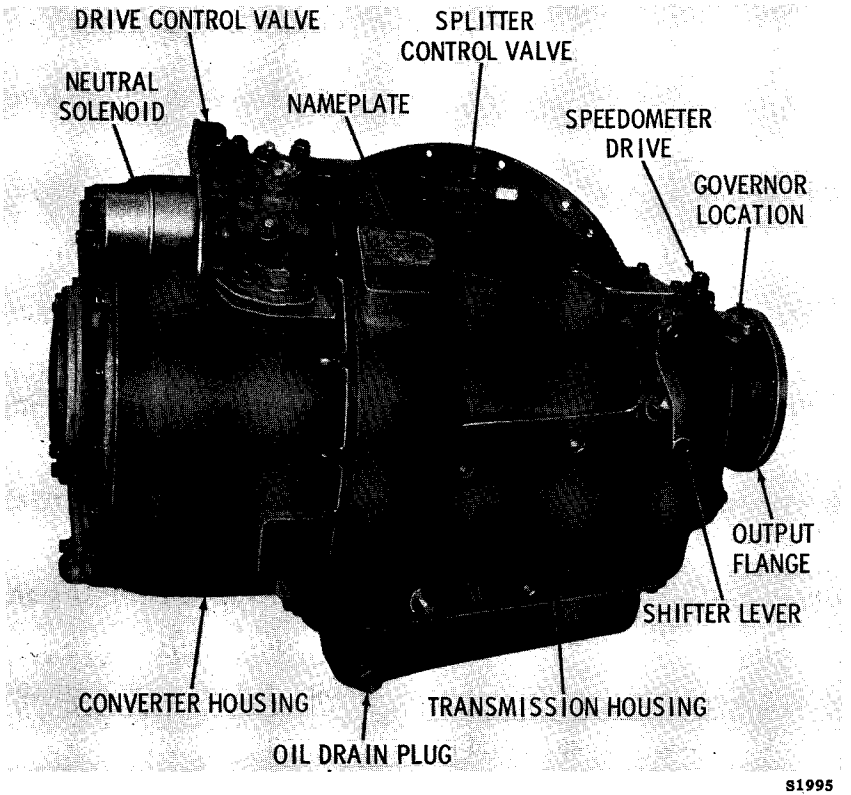

Fig. 1-3. Model VS2-6 transmission—right-rear view

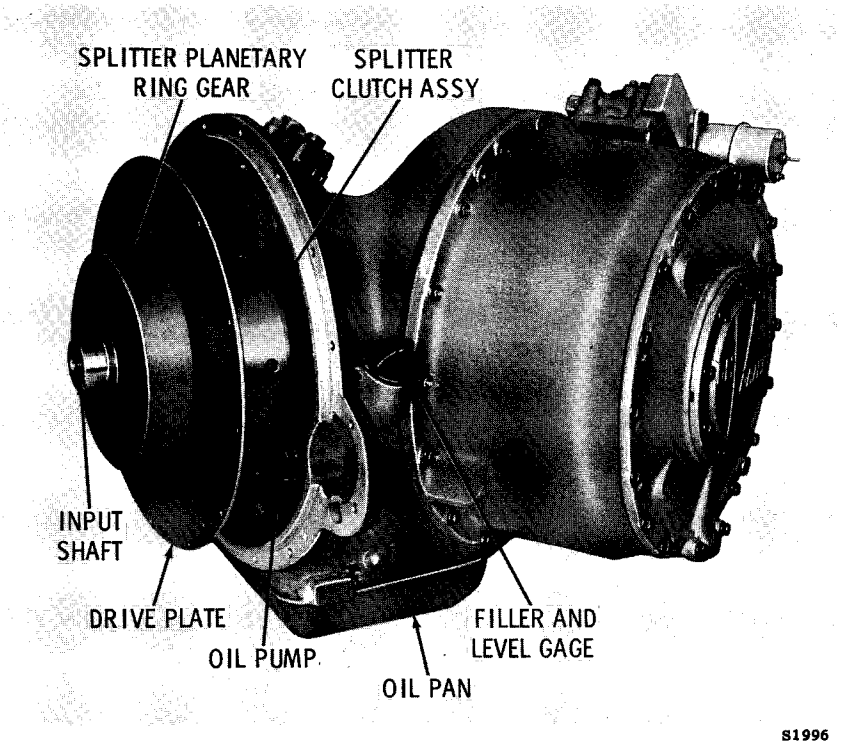

Fig. 1-4. Model VS2-6 transmission—left-rear view

issued to cover any new models or major design changes.

1-4. ORDERING PARTS

a. Transmission Nameplate. The nameplate (fig. 1-5) gives the transmission model number, part number (assembly number) and serial number (refer to fig. 1-1 and 1-3 for nameplate location). To insure that the correct parts will be supplied, furnish all three numbers when ordering parts or requesting service information.

b. Parts Catalog. All replacement parts should be ordered through your dealer. Replacement parts are listed in the current General Motors V-Drive Transmission Parts Catalog (SA 1238). Do not order parts by illustration item numbers listed in this manual.

1-5. DESIGN FEATURES

a. Front, Rear Defined. Certain procedures and explanations in this manual must make reference to front, rear, right or left of the transmission. These references are not to be associated with such terms relating to the vehicle. The front of the transmission is at the output flange location (fig. 1-1). The rear is the torque converter end; right is the side opposite the engine mounting flange; left is the side which mounts on the engine.

b. Basic Design

(1) The VH and VS series are designed so that the input shaft engages the drive shaft at an angle, through spiral bevel gears. It is from this feature that the term V transmission is derived. This compact arrangement of internal drive units facilitates coupling of the transmission to the vehicle driveline when the engine is transversely mounted in the rear of the vehicle.

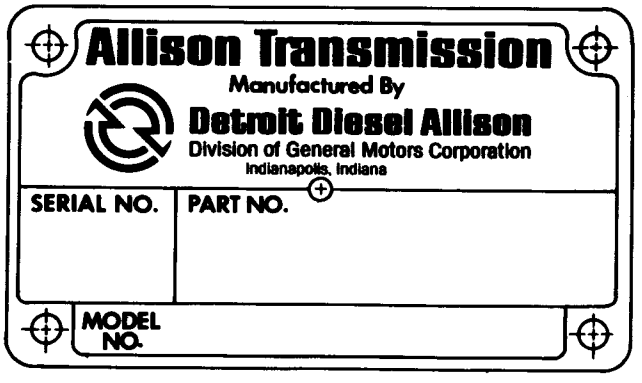

Fig. 1-5. Transmission nameplate

(2) The input shaft drives two clutches through spiral bevel gears. When the hydraulic drive clutch is engaged, its hub drives the torque converter pump. The torque converter pump drives the converter turbine and, through an over-running clutch, the transmission drive shaft. When the hydraulic clutch is released and the direct clutch is engaged, the direct clutch hub, splined to the transmission drive shaft, drives this shaft. The over-running clutch disengages and converter action stops.

(3) The output shaft, a sliding gear arrangement, and two countershafts at the output end of the transmission, provide forward and reverse. An external shifter lever actuates the sliding gears when the driver's control is manually shifted.

(4) The VH, VS1 series is coupled to the engine through a shaft splined directly to the bevel drive gear. The VH, VS1 series has only two drive modes – hydraulic drive through the torque converter or direct drive which bypasses the torque converter.

(5) The VS2 series is coupled to the engine through a drive plate, a splitter planetary gear set, two splitter clutches and a shaft splined to the bevel drive gear. This splitter drive arrangement permits either a direct or overdrive input, in addition to the converter and direct drive described in (4), above. When the splitter direct clutch is engaged, the input shaft rotates at engine speed. When the splitter direct clutch is released and the splitter overdrive clutch is engaged, the input shaft rotates at approximately 1.3 (VS2-6) or 1.45 (VS2-8) times engine speed.

c. Hydraulic System. A single, integral, hydraulic system serves the torque converter and transmission. Oil for all hydraulic operations is supplied from the same sump (oil pan). Oil pressure required for the various hydraulic operations is supplied by the input driven oil pump.

d. Hydraulic, Electrical Controls

(1) Both the VH and VS series have clutcnes which are hydraulically controlled and a control system which is a combination of hydraulic and electrical circuits.

(2) A hydraulic pressure produced in the governor, driven by the transmission output shaft, determines the operating mode. The governor, in the VH series, controls the drive control valve which selects hydraulic drive or direct drive. The governor, in the VS2 series, controls both the drive control valve and the splitter clutch control valve in sequence. These valves select hydraulic drive, direct drive and splitter direct drive and overdrive.

1-6. OPERATING INSTRUCTIONS

Refer to vehicle operating instructions.

1-7. TOWING OR PUSH STARTING

The engine cannot be started by pushing or towing. Before pushing or towing a disabled vehicle more than one-half mile, remove the axle stub shaft from the drive wheels. Cover the hub openings to prevent loss of lubricant and entry of dust and dirt. Also provide an auxiliary air supply to the vehicle to actuate the brakes.

1-8. SPECIFICATIONS AND DATA

The following specifications and data apply to the VH and VS transmissions. Unless specifically designated, information is applicable to both models.

V-DRIVE AUTOMATIC TRANSMISSION

SPECIFICATIONS, DATA

Transmission type . . . . . Torque converter, V drive

Rating:	VH	VS1-8	VS2-6	VS2-8
max input speed	2100 rpm	2100 rpm	2100 rpm	2100 rpm
max net input torque	600 lb ft	750 lb ft	600 lb ft	750 lb ft
max net input power	198 hp	259 hp	198 hp	259 hp

Rotation:
- input (viewed from input side) . . . . . counterclockwise
- output (viewed from output end) . . . . . clockwise

Mounting . . . . . modified SAE flange on converter housing bolts to engine flywheel housing

Gear ranges (forward):
- VH series . . . . . 1 (hydraulic or direct drive)
- VS2 series . . . . . 2 (hydraulic or direct drive in first gear; splitter overdrive in second gear)
- VS1 series . . . . . 1 (hydraulic or direct drive)

Manual selector positions . . . . . Forward, neutral, reverse

Torque converter:
- type 2-stage, 1-phase, 3-element
- torque ratio (at stall) 3.75:1

Component ratios

Model	Bevel gears	Splitter	Reverse
VH	1.04	—	0.96
VH1-8	0.87	—	0.96
VS2-6	1.04	0.77	0.96
VS2-8	0.87	0.69	0.96
VS2-8	1.04	0.69	0.96

Overall ratios

Model	First gear Mechanical	Second gear Mechanical	Reverse gear Mechanical
VH	1.04:1	—	1.00:1
VS1-8	0.87:1	—	0.85:1
VS2-6	1.04:1	0.80:1	1.00:1
VS2-8	0.87:1	0.60:1	0.85:1
VS2-8	1.04:1	0.72:1	1.00:1

Gearing:
- splitter (input of VS series) . . . . . straight-tooth planetary
- bevel . . . . . spiral
- reverse . . . . . straight-tooth spur, countershaft

Clutches:

VH series (2 clutches):
- hydraulic drive . . . . . cone-type, oil-wetted, hydraulic-applied
- direct drive . . . . . multidisk, oil-wetted, hydraulic-applied

VS1 series (2 clutches):
- hydraulic drive . . . . . multidisk, oil-wetted, hydraulic-applied
- direct drive . . . . . multidisk, oil-wetted, hydraulic-applied

VS2 series (4 clutches):
- hydraulic drive, direct drive, splitter overdrive . . . . . multidisk, oil-wetted, hydraulic-applied
- splitter direct drive . . . . . multidisk, oil-wetted, spring-applied

SPECIFICATIONS AND DATA — Continued

Oil system:	
oil pump	2-gear, positive displacement
sump	integral
oil specification:	
above -30°F. (-34°C)	Dexron® or Dexron II® transmission fluid
below -30°F (-34°C)	Dexron® or Dexron II® transmission fluid (auxiliary preheat required to raise temperature in the sump to a temperature above -30°F)
oil capacity (total system):	
all models	initial fill — 28 to 32 US quarts (26 to 30 liters) depending upon installation
oil filters (1 on VH series; 2 on VS series)	full flow (furnished by customer)
oil cooler (heat exchanger)	external (furnished by customer)

	VH	VS2	VS1
Temperatures, pressures:			
max oil temp	250°F (121°C)	250°F (121°C)	250°F (121°C)
normal operating temp	180 to 200°F (82 to 93°C)	180 to 200°F (82 to 93°C)	180 to 200°F (82 to 93°C)
main oil pressure:			
at idle (450 engine rpm)	50 psi (345 kPa) min	50 psi (345 kPa) min	50 psi (345 kPa) min
at 2140 engine rpm	80 to 100 psi (552 to 690 kPa)	80 to 100 psi (552 to 690 kPa)	80 to 100 psi (552 to 690 kPa)
converter-in pressure:			
at idle (450 engine rpm)	12 psi (83 kPa) min	7 psi (48 kPa) min	7 psi (48 kPa) min
at 2140 engine rpm	45 psi (310 kPa) min	45 psi (310 kPa) min	45 psi (310 kPa) min
converter-out pressure:			
at full-throttle stall	55 psi (379 kPa) min	55 psi (379 kPa) min	55 psi (379 kPa) min
at idle (450 engine rpm)	12 psi (83 kPa) min	7 psi (48 kPa) min	7 psi (48 kPa) min
lubrication	—	8 psi (55 kPa) min	6 psi (41 kPa) min

Speedometer drive:	
type	SAE 5/32 heavy duty
ratio	1 x transmission output speed

Dimensions, weights:		
length, overall	33.33 in.	(847 mm)
weight, dry (VH series)	539 lb	(244.5 kg)
weight, dry (VS2 series)	595 lb	(269.9 kg)
weight, dry (VS1 series)	539 lb	(244.5 kg)

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Section 2. DESCRIPTION AND OPERATION

2-1. SCOPE OF SECTION 2

This section describes in detail, and explains the function of the transmission components. Hydraulic circuits and torque paths are explained and illustrated. Three series are covered — VH, VS1 and VS2. All text and illustrations in this section are applicable to all the V series, unless specifically designated.

2-2. MOUNTING AND INPUT DRIVE

a. VH and VS1 Series

(1) The transmission housing is bolted to the engine flywheel housing. Other mounting points are determined by the specific mounting method employed by the vehicle manufacturer.

(2) A flexible coupling, equipped with damper springs, is bolted to the engine flywheel. An input shaft, splined at both ends, connects the flexible coupling hub to the bevel drive gear in the transmission. The flexible coupling and the input shaft are not furnished as parts of the transmission.

b. VS2 Series

(1) The transmission housing is bolted to the engine. The bolts pass through an adapter located between the transmission housing flange and the engine flywheel housing. Other mounting points are determined by the specific mounting method employed by the vehicle manufacturer.

(2) In VS2-6 models, a drive plate 8 (A, foldout 9) is bolted to the engine flywheel. In VS2-8 models, a splined drive plate assembly 9 engages a torsional isolator which is bolted to the engine flywheel. A planetary carrier assembly (items 3 through 7) is bolted to the drive plate. A planetary ring gear 1, in mesh with carrier pinions 6, rotates freely in a bore in the engine flywheel. A splined input shaft 23 (B, foldout 9) connects the planetary ring gear to the internal splines of bevel drive gear 34 in the transmission. Sun gear assembly 13, (A, foldout 9) for the input planetary, is attached to the front of the splitter clutch assembly.

2-3. SPLITTER CLUTCHES (VS2 series)

a. Two Input Speeds (A, foldout 9)

(1) The two multiplate splitter clutches control the input speed of the transmission. The splitter direct drive clutch, when engaged, locks ring gear 1 and sun gear assembly 13 of the input planetary together. This causes the input shaft (splined into the bevel drive gear) to rotate at engine speed.

(2) When the splitter overdrive clutch is engaged, the splitter clutch housing and planetary sun gear are stationary. Input carrier pinions 6, in mesh with the stationary sun gear, overdrives ring gear 1. This causes the ring gear, input shaft and bevel drive gear to rotate at faster than engine speed.

b. Engagement of Splitter Clutches (A, foldout 9)

(1) The splitter direct drive clutch is engaged any time the transmission output speed is below a predetermined point. This is due to the constant pressure of disk-type spring 29 acting against pressure plate 23.

(2) The splitter overdrive clutch engages (and the splitter direct drive clutch releases) when hydraulic pressure moves splitter clutch piston 44. This occurs when the transmission output has reached a desired speed. The increase in transmission output speed increases governor pressure which

shifts the splitter clutch control valve, thus directing the hydraulic pressure to move the clutch piston.

2-4. MATCHED BEVEL GEAR SET

a. VH, VS1 Series (A, foldout 10)

(1) The input drive consists of a matched set of spiral bevel gears (14), which transmits the input torque to the drive clutches, torque converter and drive shaft. Each set of bevel gears form an output gear ratio, which is determined by their number of teeth. The VH series with a 23-tooth drive and a 24-tooth driven gear, form a 1.04 to 1 output ratio. The VS1 series with a 24-tooth drive and a 21-tooth driven gear, form a 0.87 to 1 output ratio. Through each of these combinations, the required torque is produced.

(2) The drive gear is supported on two tapered roller bearing assemblies 25 and 31. The driven gear is keyed to bevel gear sleeve 45, supported by two ball bearings 37 and 39. Both gears are shimmed to establish the proper position and backlash.

b. VS2 Series (B, foldout 9)

(1) This transmission series uses either one of two bevel gear sets to produce the desired speed ratio. A speed reduction ratio of 1.04:1 is produced by a 23-tooth drive gear and a 24-tooth driven gear. An overdrive ratio of 0.87:1 is produced by a 24-tooth drive gear and a 21-tooth driven gear. Either gear set transmits the torque to the drive clutches, torque converter, and drive shaft.

(2) The drive gear is supported on tapered roller bearing assemblies 16 and 22. The driven gear is keyed to sleeve 37, which is supported by two ball bearings 29 and 34. Both gears are positioned by shims to establish proper backlash and gear tooth contact.

2-5. DIRECT, CONVERTER DRIVE CLUTCHES

a. VH Series Drive Clutches. The direct drive clutch and the hydraulic drive clutch are attached to bevel gear sleeve 37 (A, foldout 10) through drive plate assembly 1 (B, foldout 12). The direct drive clutch is a multiplate clutch. VH4, VH5 and VH9 models include plates 10 and 11. VH2, VH6 and VH7 models include plates 45, 46, 47 and 48. The hydraulic drive clutch is a cone-type clutch. Both clutches are actuated by hydraulic pressure and released by spring pressure. When the direct drive clutch is engaged, the bevel driven gear is locked to drive shaft 3 (B, foldout 13). When the hydraulic drive clutch is engaged, the bevel driven gear drives torque converter pump 15 (A, foldout 13).

b. VS Series Drive Clutches (A, foldout 12). The direct drive clutch and the hydraulic drive clutch are attached to the bevel gear sleeve through direct drive clutch cover 2 and clutch drum 12. Both are multiplate clutches, actuated by hydraulic pressure and released by spring pressure. When either of these clutches is engaged, the action is the same as in the VH series (a, above).

2-6. TORQUE CONVERTER

a. Components (A, foldout 13)

The torque converter operates as a hydraulic torque multiplier and a hydraulic coupling. The torque converter is a 3-element arrangement consisting of pump 15, turbine 16 and stator vanes, integral with cover 21.

b. Operation of Torque Converter. The three torque converter elements operate in oil. The pump is driven by the bevel driven gear, through the hydraulic clutch. Vanes of the pump direct oil against the vanes of the turbine first stage, causing the turbine to rotate. The stator redirects the oil into the turbine second stage. From the turbine, oil returns to the converter pump. When the oil re-enters the pump, its unexpended energy helps drive the pump.

c. Over-running Clutch (B, foldout 13). The over-running clutch assembly 7, between the torque converter turbine element and drive shaft 3, transmits torque from the turbine to the drive shaft when the hydraulic drive clutch is engaged. When the direct drive clutch is engaged, the drive shaft over-runs the torque converter, leaving it inactive.

2-7. DRIVE SHAFT, OUTPUT INTERMEDIATE GEAR

a. Main Power Member. Drive shaft 3 (B, foldout 13) is the main power transmitting member which connects the bevel driven gear, the drive clutches and the torque converter to the output components. It is splined to the inner member of the over-running clutch, the direct drive clutch hub, and output intermediate gear 19 (B, foldout 11).

b. Output Intermediate Gear (B, foldout 11). This gear 19 is splined to and supports the rear of the drive shaft. When the transmission is manually shifted to forward detent, the smaller diameter (spline) of the output intermediate gear engages the internal splines of output shifter gear 18. When the transmission is manually shifted to reverse detent, the larger diameter of the output intermediate gear meshes with the reverse gear components. The front side of the gear is internally coned to provide a friction surface for a spring-loaded brake cone (described in 2-8, below).

2-8. BRAKE CONE, OUTPUT, REVERSE COMPONENTS

a. Brake Cone (A, foldout 11)

(1) A spring-loaded brake cone 30 is used to prevent gear clash when shifting the transmission from neutral to forward or reverse detent. The cone is fitted to milled flats on the hub of transmission output shaft 28. Compression of spring 29 pushes the cone into contact with the output intermediate gear.

(2) Thus, when the transmission is mechanically shifted, an external, hydraulic-electric system releases the hydraulic clutch. This allows the brake cone to slow the rotation of the output intermediate gear and the drive shaft.

b. Output Components (A, foldout 11)

(1) Output shaft 28 has two splined diameters. The larger diameter engages the inner splines of output shifter gear 18 (B, foldout 11). Transmission output flange 3 (A, foldout 11) splines onto the smaller diameter of output shaft 28. Speedometer and governor drive worm gear 6 is pressed on and keyed to the hub of the output flange.

(2) Shifter fork 15 (B, foldout 11), with three detent notches, moves output shifter gear 18. Shaft 6, keyed to the shifter fork and splined to external shift lever 11, moves the shifter fork in response to movements of the operator's shift control. The shifter fork is accurately positioned for forward, neutral or reverse by a detent ball 13 (B, foldout 10) and spring 15.

(3) When the output shifter gear is in forward drive (shifter fork toward the rear of the transmission), it engages both the output shaft and the output intermediate gear. This provides a direct connection of the drive shaft to the output shaft for vehicle forward operation.

(4) When the shifter fork is at the middle detent, the transmission is in neutral. The transmission is in reverse drive when the shifter fork is moved to the rear detent (the fork toward the output flange). Reverse operation is explained below.

c. Reverse Components (B, foldout 11)

(1) The reverse components consist of two countershafts located below the output shaft: reverse shifter gear assembly 25 and reverse idler gear 24. The reverse shifter gear has an external collar which engages in the shifter fork groove of output shifter gear 18. Therefore, when the shifter fork moves the output shifter gear forward or rearward, the reverse shifter gear moves accordingly.

(2) Teeth on the rear diameter of the reverse shifter gear are in constant mesh with the reverse idler gear. These same teeth mesh with the output intermediate gear only when the reverse shifter gear is toward the front (reverse drive detent) of the transmission.

(3) As described in (2), above, the teeth on the rear diameter of the reverse idler gear

are in constant mesh with the reverse shifter gear. Teeth, on the front of the reverse idler gear, mesh with external teeth of the output shifter gear when the output shifter gear is moved to the front (reverse drive detent) of the transmission.

(4) Refer to paragraph 2-17 for explanation of power flow through the output and reverse components.

2-9. FLUID PUMP

a. Input Pump (A, foldout 14). Input driven oil pump and gear assembly 2 is mounted on the bottom of the transmission and is enclosed by oil pan 28. It is a conventional gear-type pump assembly and is driven by a gear on the input bevel drive gear (VH, VS1 series) or by a gear on the input shaft (VS2 series). Input oil pump idler gear 15 (B, foldout 9 for the VS2 series) or 9 (A, foldout 10 for the VH and VS1 series) is mounted on the input bevel gear bearing retainer. The spring-loaded converter pressure and main-pressure regulator valves are housed in the input-driven oil pump body.

b. Supplies Pressure, Flow. The input-driven oil pump provides oil pressure for hydraulic application of clutches and oil flow for filling the converter, for cooling and for lubrication.

c. Screen at Pump Intake (A, foldout 14). The input-driven oil pump has a close-mesh wire screen 23 attached to the intake section of the pump. The oil screen projects downward into the oil sump, and screens all oil being drawn into the system.

2-10. GOVERNOR

Transmission governor 19 (A, foldout 11) is driven, through shaft and gear assembly 21, by a worm gear on the transmission output flange. Two types of governors have been used on the VH series. One type is a mechanical flyball governor which completes or breaks an electrical circuit to the control valve. This automatically shifts the transmission into hydraulic or direct drive at predetermined road speeds. On later model transmissions, a hydraulic governor is used, which controls fluid pressure as output speed increases or decreases. This pressure shifts the control valves. The VS series uses only the hydraulic governor.

2-11. DRIVE CLUTCH CONTROL VALVE ASSEMBLY

a. Two Types for VH Series (B, foldout 14). Two types of drive clutch control valve assemblies 11 and 29 are used on the VH series, depending on the type of governor. Transmissions, using a mechanical flyball governor, have a control valve with two solenoids to automatically shift from hydraulic to direct drive. Transmissions, using a hydraulic pressure governor, have a control valve with one solenoid, and utilizes governor pressure to shift from hydraulic to direct drive. The internal construction of both valve assemblies are similar, having three spool valves. The neutral solenoid actuates one of these spool valves to engage the hydraulic clutch. A second spool valve is actuated by a solenoid (on two-solenoid valve assemblies) to engage the direct clutch. The second spool valve is actuated by governor pressure, on valve assemblies with one solenoid. In both types of valve assemblies, the third spool valve is actuated by the movement of the second valve to release the hydraulic drive clutch.

b. VS Series. The VS series has a hydraulic governor, therefore, will use a drive clutch control valve assembly with one solenoid. The solenoid actuates one spool valve to engage the hydraulic clutch. Governor pressure actuates the second spool valve to engage the direct drive clutch and the third spool valve is actuated by the movement of the second valve to release the hydraulic drive clutch.

c. Accumulator Valve (B, foldout 14). The drive clutch control valve assembly works in conjunction with a clutch accumulator valve. This is a spring loaded valve 4, located in a bore beneath the drive clutch control valve body mounting surface. The accumulator valve maintains pressure on the hydraulic

clutch until sufficient pressure is applied to the direct drive clutch to prevent engine runaway.

2-12. SPLITTER CLUTCH CONTROL VALVE (VS2 series only)

a. Controls Two Input Speeds (foldout 15). The purpose of splitter clutch control valve is to engage one of the two splitter clutches — splitter direct or splitter overdrive. The earlier valve body has a single, spring-loaded spool valve 7, which selects the proper splitter ratio. The control valve on later model transmissions has an additional spool valve (splitter clutch exhaust valve 45), working in conjunction with solenoid 40, which softens the downshift from splitter overdrive to splitter direct drive.

b. Governor Controls Valve Position. On transmissions, with the single spool valve, governor pressure controls the valve. At low governor pressure (low output speed), a spring holds the valve against governor pressure to give direct drive. At a predetermined higher output speed, a higher governor pressure will move the valve against spring pressure, allowing main pressure to engage the splitter overdrive clutch. Later model transmissions have the same valve action, as described, but also have a second spool valve, the splitter clutch exhaust valve. This valve is controlled by the action of a solenoid and needle valve, assembled on the valve body. At predetermined speeds, above idle, the solenoid (connected to a switch on the throttle of the engine) is de-energized, closing the spring-loaded needle valve. Main pressure, retained by the closed needle valve, moves the splitter exhaust valve against its spring. This opens a channel to exhaust the splitter overdrive clutch into the lubrication circuit when the transmission is downshifting from splitter overdrive to splitter direct. At a predetermined throttle setting, when the vehicle is decelerating, the solenoid is energized, opening the needle valve. Main pressure is then exhausted from the bore of the valve, and the spring moves the valve. The channel exhausting the splitter overdrive clutch, is now directed through an orifice to the lubrication circuit. This delays momentarily the release of the splitter overdrive clutch, which permits a smoother downshift, from splitter overdrive to splitter direct drive.

2-13. OIL FILTERS, COOLER

a. Not Supplied with Transmission.

While these components are not supplied by the transmission manufacturer, they are necessary for proper transmission operation. The VH and VS series have an oil filter in the main-pressure circuit. The VS series has an additional oil filter (optional on VH series) in the converter-in circuit. All models require an external-mounted oil cooler between the converter-out and converter-in circuits.

b. Externally Mounted. Oil filters and coolers are mounted external of the transmission. All hydraulic connections between these components and the transmission or vehicle are by hoses or tubes.

2-14. HYDRAULIC SYSTEM (VH series with hydraulic governor) (foldout 3 and 4)

Note: Foldouts 3 and 4 differ only in the shift control valve and neutral switch circuit (refer to a(4), below). System is illustrated in neutral.

a. Main-Pressure Circuit

(1) Oil is drawn from the sump, through a screen, by the input-driven oil pump and is directed to four points: the main-pressure regulator valve, through the oil filter to the governor, to the hydraulic drive clutch exhaust valve, and to the direct drive clutch control valve.

(2) At the main-pressure regulator valve (located in the oil pump), oil pressure raises a spring-loaded valve, thereby allowing oil to flow into the lubrication and converter-in circuits. When the oil flow in these two circuits is such that main pressure balances the pressure of the main-pressure regulator valve spring, main pressure is established.

(3) Governor pressure is lower than main pressure. Its value depends upon the rotational speed of the governor.

(4) On earlier models (foldout 3) the operator's shift lever arrangement is designed so that, in neutral detent, the neutral switch is closed, energizing the neutral solenoid. The hydraulic drive clutch valve is moved upward, by the energized solenoid, thus main pressure is blocked by the valve. On later models (foldout 4) the shift mechanism is designed so that the neutral switch is open during neutral operation. Also, the valve body is designed so the action of the solenoid and hydraulic drive clutch valve is modified from that described above. When the switch is open, the solenoid is not energized, thus main pressure is blocked at the valve and the clutch is released. These transmissions will have the hydraulic drive clutch engaged when the neutral switch is closed. Closing of the switch energizes the solenoid. The hydraulic drive clutch valve is moved upward, allowing main pressure to engage the clutch.

(5) At the direct drive clutch control valve, main pressure is blocked until the valve is moved. Then pressure will be directed to the direct drive clutch.

b. Converter-in-Circuit. The converter pressure regulator valve, located in the input-driven oil pump, regulates converter-in pressure by relieving oil to the sump. Converter-in flow passes through a check valve, which prevents back flow, and continues to the inlet side of the torque converter. This circuit keeps the torque converter continuously filled with oil.

c. Lubrication Circuit

(1) The lubrication circuit is derived from the converter-in circuit. However, the lubrication pressure is somewhat lower than the converter-in pressure due to the restriction of flow caused by the orifices in the lubrication circuit.

(2) An additional source of lubrication is derived from the converter-in circuit, through a check valve in the center of the drive shaft. The oil is distributed to various points along the length of the shaft by a passage in the center of the shaft.

d. Converter Internal Circuit. Oil flow within the torque converter is caused by the rotation of the torque converter pump. The converter pump rotates only when the hydraulic drive clutch is engaged. The oil flow is from the converter pump, through the turbine first-stage vanes, through the stator vanes, through the turbine second-stage vanes and back to the pump.

e. Converter-out and Cooler Oil Circuit

(1) In converter operation (torque converter pump rotating), heat is generated by the turbulence within the converter. The rotating converter elements create a pumping action (auto flow), which causes the oil to flow out of the converter, through the oil cooler (heat exchanger) and back into the converter. The circulation of the oil through the cooler removes the heat from the oil.

(2) When the transmission is shifted into direct drive, converter pump action stops and the circulation of oil is dependent upon the input oil pump. The oil from the input pump flows directly into the oil cooler and can leave through either end of the cooler, flowing into the converter and out through the lubrication port in the center of the input shaft. This permits cooler oil flow in direct drive.

(3) On earlier models the converter-in line is attached directly to the cooler line leading into the converter, bypassing the oil cooler. In this system an alternate cooler was required when it was necessary to operate for long periods in direct drive. For a more efficient cooling system, we recommend the circuit flow conform to item (2), above.

(4) At the converter-out line, an air-bleed orifice maintains a continuous small return flow of oil to the oil sump. This bleeds off any air which might accumulate and cause cavitation in the converter.

f. Neutral — Hydraulic Action. The action of the hydraulic system during neutral, engine running, is illustrated in foldouts 3 and 4 and is explained in a through e, above.

g. Forward, Hydraulic Drive Operation — Hydraulic Action

(1) The hydraulic drive clutch is engaged when the shift lever is moved out of

neutral to forward detent. This results from the opening or closing of the neutral switch (see a(4), above).

(2) Moving the shift lever from neutral to forward detent also mechanically moves the output shifter gear from N to F (foldout 3 or 4). The transmission is now in forward mode.

h. Forward, Direct Drive Operation — Hydraulic Action (foldouts 3 and 4)

(1) After starting in forward, as described in g above, and when the vehicle speed reaches a predetermined point, automatic shift to direct drive occurs. Governor pressure, which increases as transmission output speed increases, moves the direct drive clutch control valve upward against its spring. In the upward position, the valve directs main pressure through an orifice to the direct drive clutch circuit, also to the clutch accumulator valve, and to the hydraulic drive clutch exhaust valve.

(2) Main pressure engages the direct drive clutch at a reduced pressure due to the oil flowing into the accumulator valve. The accumulator valve is moved leftward by the oil. As long as the valve is moving, a reduced pressure is applying the clutch. Before the accumulator valve bottoms in its bore, main pressure in this circuit moves the hydraulic drive exhaust valve upward. This exhausts the hydraulic drive clutch. When the accumulator valve bottoms (leftward), full-main pressure engages the direct drive clutch.

(3) In direct drive, the drive shaft is connected directly to the bevel gear and the torque converter pump element is no longer driven. The over-running clutch disengages, which leaves the torque converter inactive.

i. Reverse — Hydraulic Action

(1) When the shift lever is moved to the reverse detent, the output shifter gear is moved to R (foldout 3 and 4). This converts the rotation of the drive shaft to a reverse rotation of the output shaft.

(2) The hydraulic action is the same as forward, hydraulic drive, as described in g(1), above. Normally, only hydraulic drive operation is utilized in reverse due to the lower vehicle speeds used in this mode. However, sufficient reverse speed will cause the shift to direct drive described in h, above.

2-15. HYDRAULIC SYSTEM (VH series with electric governor) (foldout 5)

Note: System is illustrated in neutral.

a. Similar to VH with Hydraulic Governor. This hydraulic system is essentially the same as previously explained for transmissions with hydraulic governor. The drive control valve has an additional direct drive solenoid, plus some minor lubrication and electrical circuit changes in the transmission.

b. Main-Pressure Circuit. The main-pressure circuit functions are the same as described in paragraph 2-14a, above, except that main pressure is not directed to the governor.

c. Converter-in Circuit, Lubrication Circuit, Converter Internal Circuit, Converter-out and Cooler Oil Circuit. These circuits function in the same manner as those described in paragraphs 2-14b, c, d and e.

d. Neutral — Hydraulic Action. The action of the hydraulic system during neutral, engine running, is illustrated in foldout 5.

e. Forward, Hydraulic Drive Operation — Hydraulic Action. Operation of the transmission in this condition is the same as described in paragraph 2-14g, above.

f. Forward, Direct Drive Operation — Hydraulic Action. Operation of the shift to direct drive is the same as described in paragraph 2-14h, above, except for governor action. The governor speed increases with the output speed of the transmission. At a predetermined speed, a switch located in the governor closes, which energizes the direct drive solenoid. This moves the direct drive clutch control valve in its bore, and allows main pressure to flow into the direct drive clutch circuit.

g. Reverse — Hydraulic Action. The hydraulic action in reverse is the same as described in paragraph 2-14i, above.

2-16. HYDRAULIC SYSTEM (VS1 series, foldout 8)

Note: Foldout 8 illustrates the hydraulic circuit of the VS1-8 model with a hydraulic governor. This circuit is very similar in function to the VH series, differing only in the addition of an oil filter in the converter-in circuit, which coordinates with the oil filter in the main-pressure circuit to cleanse the system of foreign material.

a. Main-Pressure Circuit

(1) Oil is drawn from the sump, through a screen, by the input-driven oil pump and is directed to four points; the main pressure regulator valve, through the oil filter to the governor, through the hydraulic drive clutch exhaust valve cavity and to the direct drive clutch and hydraulic drive clutch control valves at which two points it is blocked.

(2) At the main-pressure regulator valve (located in the oil pump), oil pressure raises a spring-loaded valve, thereby allowing oil to flow into the lubrication and converter-in circuits. When the oil flow in these two circuits is such that main pressure balances the pressure of the main-pressure regulator valve spring, main pressure is established.

(3) The decrease or increase of the governor pressure is controlled by transmission output speed. However, governor pressure cannot become greater than main pressure.

(4) The operator's shift lever arrangement is designed so that in neutral detent the neutral switch remains open. Moving the shift lever to forward position closes the neutral switch, energizing the solenoid. This forces the hydraulic drive clutch valve to move upward, thus releasing main pressure to engage the hydraulic clutch.

b. Converter-in Circuit. The converter pressure regulator valve, located in the input-driven oil pump, regulates converter-in pressure by bypassing overage oil to the sump. Converter-in flow passes through a check valve, which prevents drain back at shutdown and then through an oil filter and the oil cooler to the inlet side of the torque converter. This circuit keeps the torque converter continuously filled with oil.

c. Lubrication Circuit

(1) The lubrication circuit cascades from the converter-in circuit. Therefore, the lubrication pressure is always lower than the converter-in pressure.

(2) An additional source of lubrication enters through a check valve in the center of the drive shaft. The oil is distributed to various points via the hollow shaft.

d. Converter Internal Circuit. Oil flow within the torque converter is caused by the rotation of the torque converter pump. The converter pump rotates only when the hydraulic drive clutch is engaged. The oil flow is from the converter pump, through the turbine first-stage vanes, through the stator vanes, through the turbine second-stage vanes and back to the pump.

e. Converter-out and Cooler Oil Circuit

(1) In converter operation the rotating converter elements create a pumping action (auto-flow), which causes the oil to flow out of the converter, through the oil cooler (heat exchanger) and back into the converter. The circulation of the oil through the cooler removes the heat from the oil.

(2) When the transmission is shifted into direct drive, converter pump action stops and the circulation of oil is dependent upon the input oil pump. The oil flowing into the oil cooler can leave through either end of the cooler and flow into the converter, and flow out through the lubrication port in the center of the input shaft.

(3) At the converter-out line, an air-bleed orifice maintains a continuous small return flow of oil to the oil sump. This bleeds off any air which might aerate the converter.

f. Neutral-Hydraulic Action. The action of the hydraulic system during neutral, engine running, is illustrated in foldout 8 and is explained in a, through e., above.

g. Forward, Hydraulic Drive Operation — Hydraulic Action

(1) The hydraulic drive clutch is engaged when the shift lever is moved out of neutral to forward detent. This results from the closing of the neutral switch. (Refer to a. 4, above.)

(2) Moving the shift lever from neutral to forward detent also mechanically moves the output shifter gear from (N) neutral to (F) forward (foldout 8). The transmission is now in forward mode.

h. Forward, Direct Drive Operation — Hydraulic Action (foldout 8)

(1) After starting in forward, as described in g. above, and when the transmission output speed reaches 1300 RPM, automatic shift to direct drive occurs. Governor pressure, which increases as transmission output speed increases, moves the direct drive clutch control valve upward against its spring. In the upward position, the valve directs main pressure through an orifice to the direct drive clutch circuit, also to the clutch accumulator valve, and to the hydraulic drive clutch exhaust valve.

(2) Main pressure engages the direct drive clutch at a reduced pressure due to the oil flowing into the accumulator valve. The accumulator valve is moved leftward by the oil. As long as the valve is moving, a reduced pressure is applying the clutch. Before the accumulator valve bottoms in its bore, main pressure in this circuit moves the hydraulic drive exhaust valve upward. This exhausts the hydraulic drive clutch. When the accumulator valve bottoms (leftward), full main pressure engages the direct drive clutch.

(3) In direct drive, the drive shaft is connected directly to the bevel gear and the torque converter pump element is no longer driven. The over-running clutch disengages, which leaves the torque converter inactive.

i. Reverse — Hydraulic Action

(1) When the shift lever is moved to the reverse detent, the output shifter gear is moved to R (foldout 8). This converts the rotation of the drive shaft to a reverse rotation of the drive shaft to a reverse rotation of the output shaft.

(2) The hydraulic action is the same as forward, hydraulic drive, as described in g. (1), above. Normally, only hydraulic drive operation is utilized in reverse due to the lower vehicle speeds used in this mode. However, sufficient reverse speed will cause the shift to direct drive described in h., above.

2-17. HYDRAULIC SYSTEM (VS2 series) (foldouts 6 and 7)

Note: Foldouts 6 and 7 differ only in the shift control valve and neutral switch (refer to para 2-14a(4), above). System is illustrated in neutral.

a. Similar to VH Series. The VS2 series hydraulic system is essentially the same as the VH series. The differences, in the VS2 series, are an oil filter in the converter-in circuit, a splitter clutch control valve and some lubrication circuit changes. Refer to paragraph 2-14a through e, above, for explanation of the VH series. The differences are outlined in b through d, below.

b. Oil Filter. The VS2 series has an oil filter in the converter-in circuit, in addition to the oil filter in the main-pressure circuit.

c. Splitter Clutch Control Valve. The VS2 series has two splitter clutches, not included on the VH series. Therefore an additional valve assembly is required to control these clutches. The splitter clutch control valve assembly contains a spring-loaded,

spool-type valve which moves lengthwise in its bore. Spring pressure holds the valve leftward. This blocks main pressure, but does allow the lubrication circuit to keep the splitter overdrive clutch circuit filled with oil, although the clutch is not engaged. Governor pressure acts upon the left end of the valve, and when governor pressure is sufficiently high, moves the valve rightward against spring pressure. Later model transmissions (foldout 7) have an additional spool valve (splitter exhaust valve) to soften the downshift as described in paragraph 2-12b, above.

d. Lubrication Circuit. The inclusion of splitter clutches in the VS2 series necessitates differences in the lubrication system to serve the clutches.

e. Neutral — Hydraulic Action. The action of the hydraulic system during neutral, engine running, is as illustrated in foldouts 6 and 7, and as described previously.

f. Forward, Splitter Direct, Hydraulic Drive Operation — Hydraulic Action

(1) Operation of the VS2 series in this condition is essentially the same as the operation of the VH series, described in paragraph 2-14g, above. The splitter direct drive clutch is engaged, causing the bevel drive gear to rotate at engine speed — the same as in the VH series.

(2) The hydraulic action is the same as that in the VH series.

g. Forward, Splitter Direct, Direct Drive Operation — Hydraulic Action. The automatic shift to direct drive operation occurs the same as described for the VH series in paragraph 2-14h, above.

h. Forward, Splitter Overdrive Operation — Hydraulic Action

(1) This drive range is made possible by the input splitter planetary and clutches. The VH series does not have this design feature.

(2) The spring in the splitter clutch control valve is calibrated to oppose a greater governor pressure than is the spring in the direct drive clutch valve. Therefore, the splitter clutch control valve remains leftward (direct drive splitter clutch engaged) until the governor produces a higher pressure than was required to shift the transmission to direct drive (from hydraulic drive). Thus, when the transmission output reaches sufficient speed, governor pressure moves the splitter clutch control valve to the right. In this position, the valve directs main pressure to the splitter clutch piston, moving it rightward. Moving the piston to the right lifts the Belleville spring off the splitter direct drive clutch and forces it against the apply plate of the splitter overdrive clutch, engaging the clutch.

(3) The splitter overdrive clutch, when engaged, stops the entire clutch housing and input planetary sun gear. The planetary carrier, driven by the engine flywheel, then overdrives the planetary ring gear attached to the transmission input shaft.

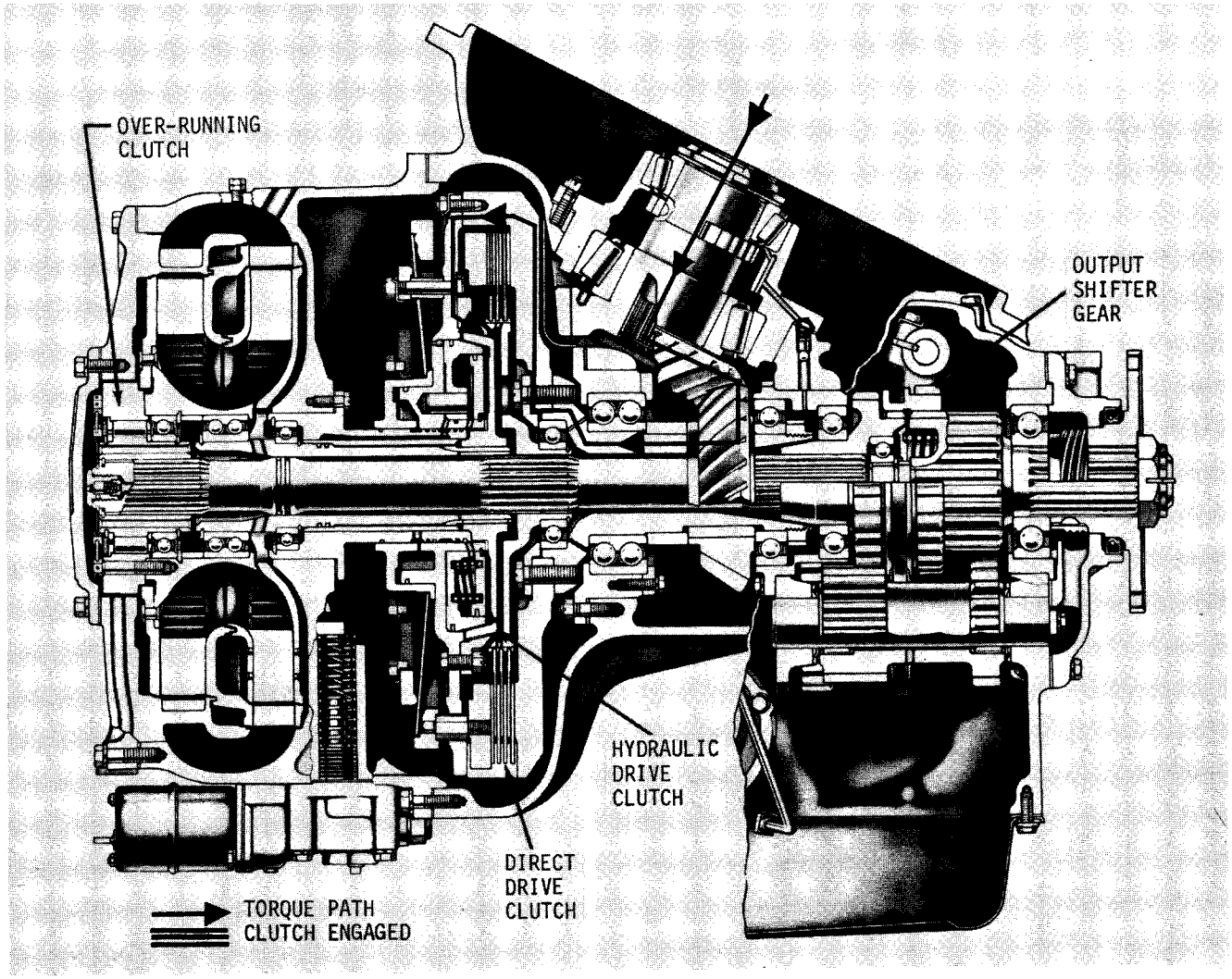

Fig. 2-1. VH Series, neutral—torque path

i. Reverse — Hydraulic Action. Hydraulic action in reverse for the VS2 series is the same as described for the VH series in paragraph 2-14i, above.

2-18. TORQUE PATHS

Note: The torque paths for the VH and VS series transmissions are illustrated in figures 2-1 through 2-13. In all the illustrations, the output shifter gear is shown in the forward drive position (moved to the left). In actual operating conditions, this gear is moved to accomplish the various drive ranges, as explained below.

a. VH Series, Neutral — Torque Path (fig. 2-1)

(1) In neutral, as in all drive ranges, the engine drives the bevel drive gear through a splined shaft. The bevel driven gear, driven by the drive gear, is keyed to and drives a sleeve which is bolted to the drive clutch plate assembly. A cover assembly is bolted to the drive clutch plate assembly. The drive clutch plate assembly and the cover assembly enclose the drive clutches.

(2) The drive clutches are released in neutral, thus torque is not transmitted beyond the clutch.

(3) The output shifter gear is in the neutral (middle) position, and is out of mesh with the output intermediate gear.

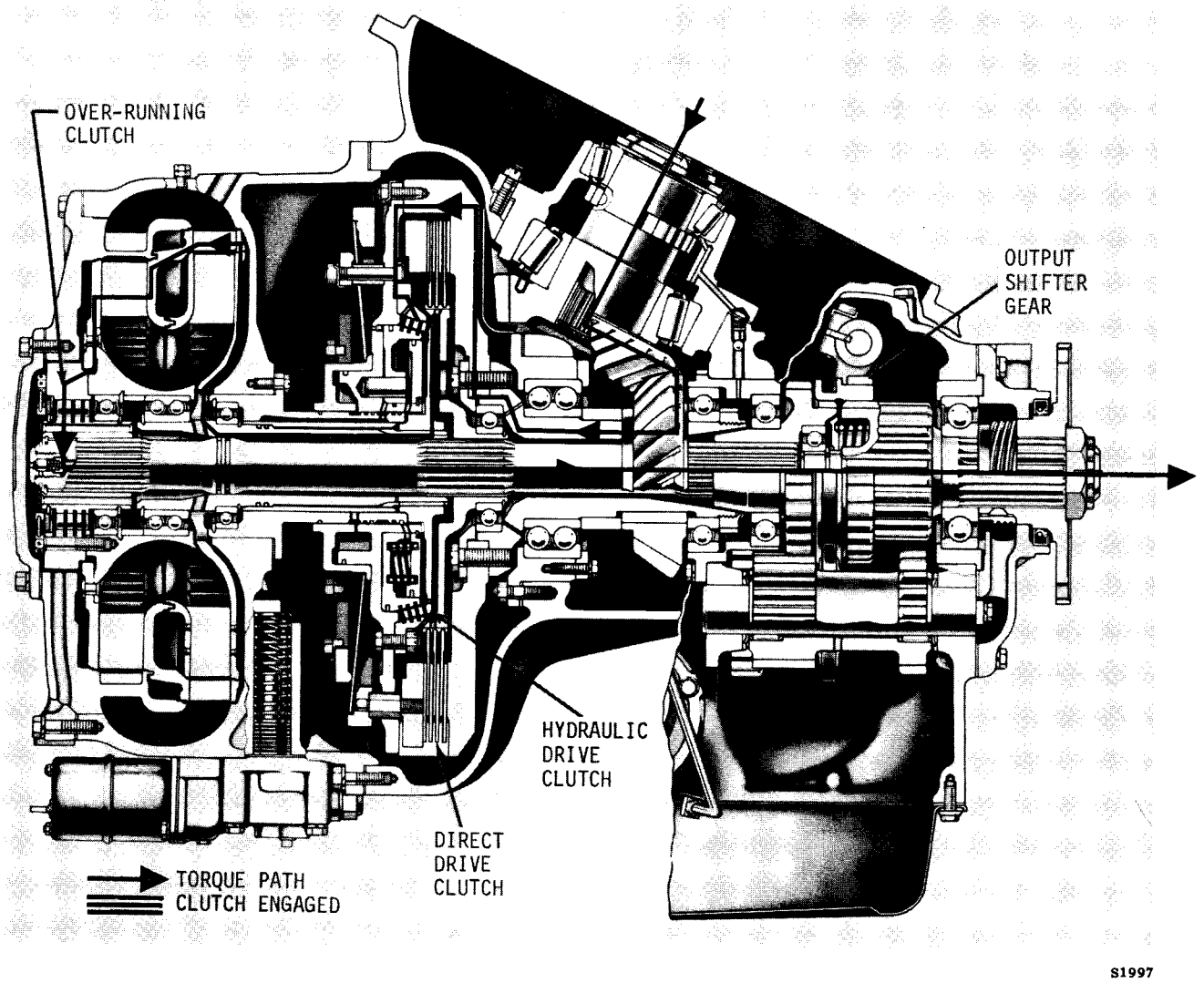

Fig. 2-2. VH Series, forward, hydraulic drive—torque path

b. VH Series, Forward, Hydraulic Drive — Torque Path (fig. 2-2)

(1) The hydraulic drive clutch is engaged when the shift control is moved to the forward (F) position.

(2) When the hydraulic drive clutch is engaged, torque is transmitted mechanically from the engine to the torque converter pump. The torque converter pump rotates and forces oil against the vanes of the torque converter turbine, causing the turbine to rotate. Torque is transmitted hydraulically through the turbine, to the over-running clutch, to the drive shaft and output intermediate gear.

(3) In forward, the output shifter gear is moved to the left and in mesh with the output intermediate gear. The output shifter gear is also splined to the output shaft, therefore the output shaft will rotate with the output intermediate gear.

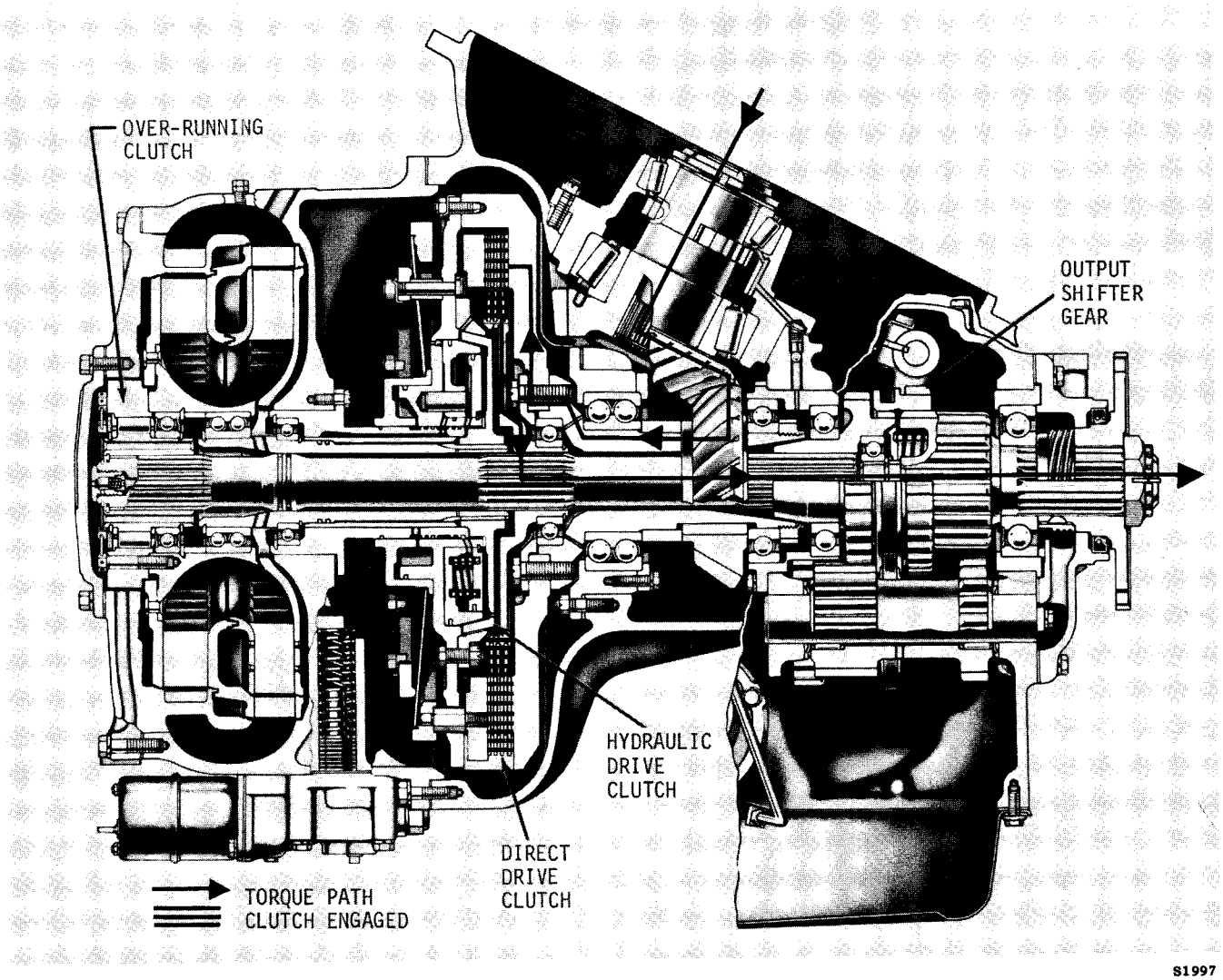

Fig. 2-3. VH Series, forward, direct drive—torque path

c. VH Series, Forward, Direct Drive — Torque Path (fig. 2-3)

(1) The direct drive clutch is engaged and the hydraulic drive clutch is released. Torque is transmitted from the engine to the drive clutches as described previously.

(2) The direct drive clutch hub is splined to, and drives, the drive shaft. Therefore, torque is transmitted from the direct drive clutch to the drive shaft and output intermediate gear, bypassing the torque converter. Rotation of the drive shaft releases the overrunning clutch and causes the drive shaft to rotate independently of the converter turbine.

(3) When the shift lever is moved to forward (F) detent, the output shifter gear is moved to the left and in mesh with the output intermediate gear. The output shifter gear is also splined to the output shaft, therefore the output shaft will rotate with the output intermediate gear.

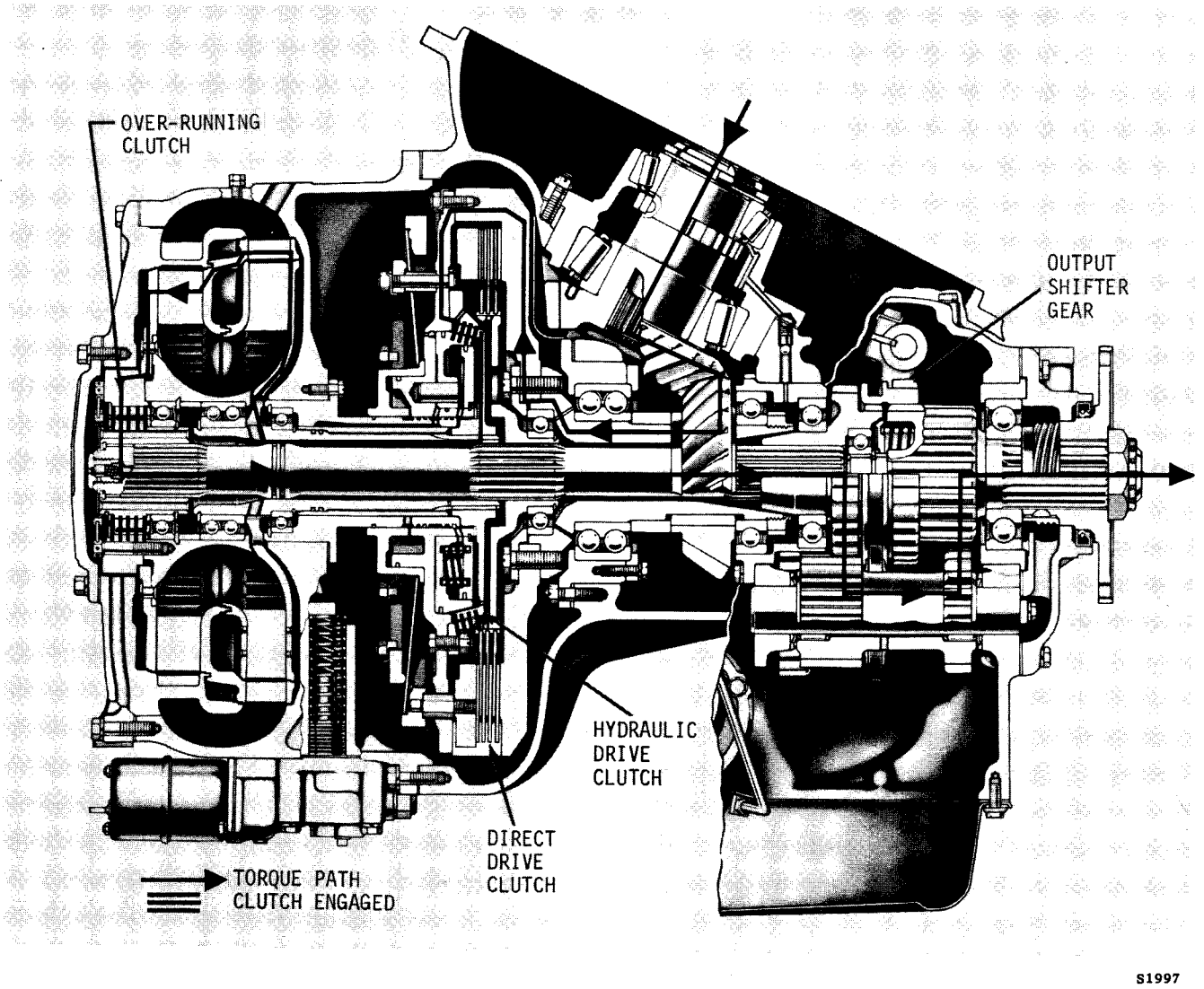

Fig. 2-4. VH Series, reverse—torque path

d. VH Series, Reverse — Torque Path (fig. 2-4)

(1) The torque path from the engine to the output intermediate gear is the same as described previously for forward.

(2) The reverse shifter gear has an external collar which engages in the shifter fork groove of the output shifter gear. In reverse, the output shifter gear is moved to the right and into mesh with the reverse idler gear. Also moving lengthwise to the right with the output shifter gear is the reverse shifter gear. In the rightward position, the reverse shifter gear is in mesh with the output intermediate gear as well as being in constant mesh with the reverse idler gear.

(3) Thus, in reverse, the output intermediate gear drives the reverse shifter gear; the reverse shifter gear drives the reverse idler gear; the reverse idler gear drives the output shifter gear. The output shifter gear is splined to the output shaft and is driven in a direction opposite that of the output intermediate gear.

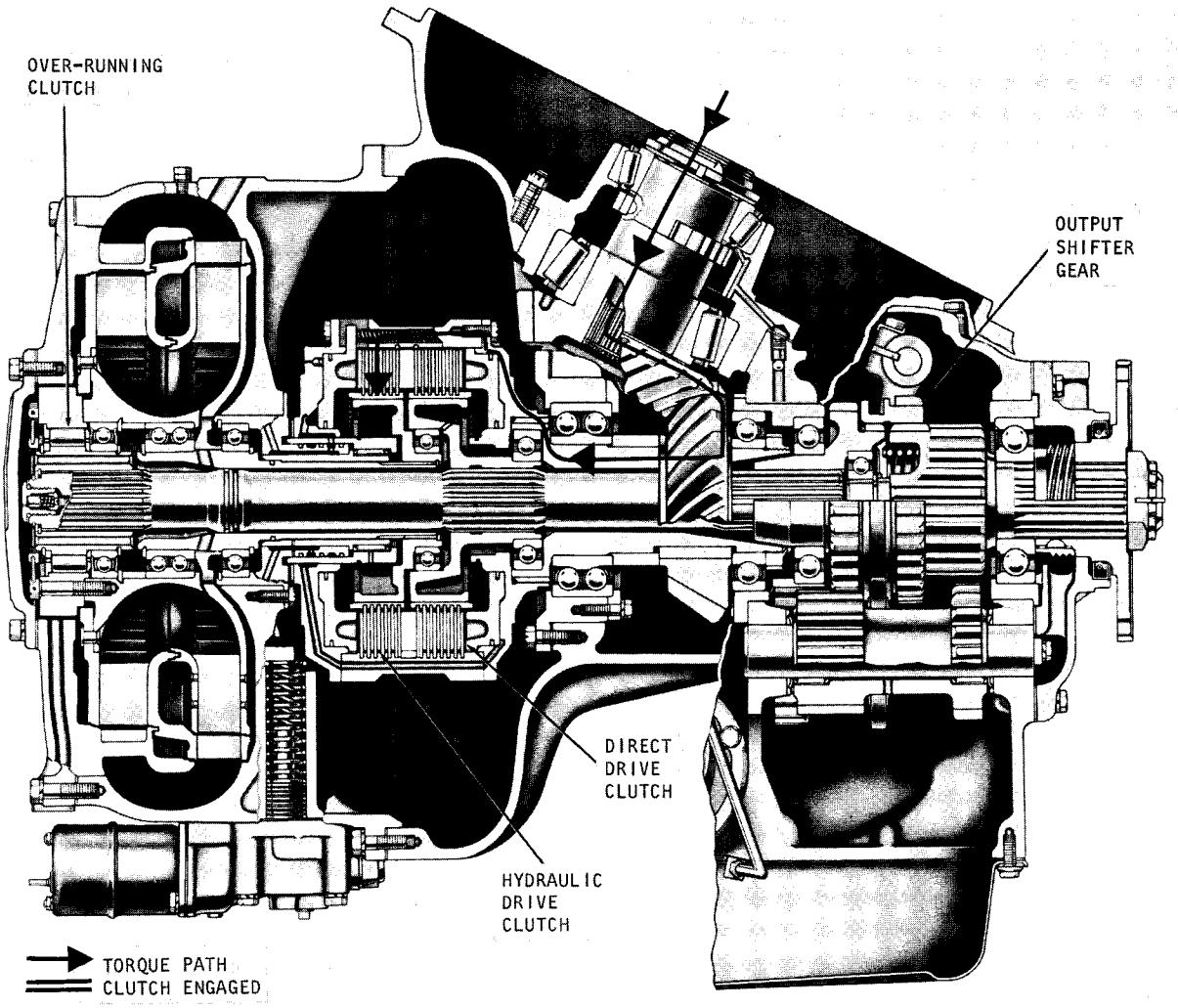

Fig. 2-5 VS1 Series, neutral-torque path

e. VS1 Series, Neutral – Torque Path (fig. 2-5)

(1) In neutral, as in all drive ranges, the engine drives the bevel drive gear through a splined shaft. The bevel driven gear is in mesh with the drive gear and is keyed to a sleeve which is attached to the drive clutch cover and drum.

(2) The drive clutches are not engaged in neutral, thus torque is not transmitted through either clutch.

(3) The output shifter gear is in the neutral (middle) position, and is out of mesh with the output intermediate gear.

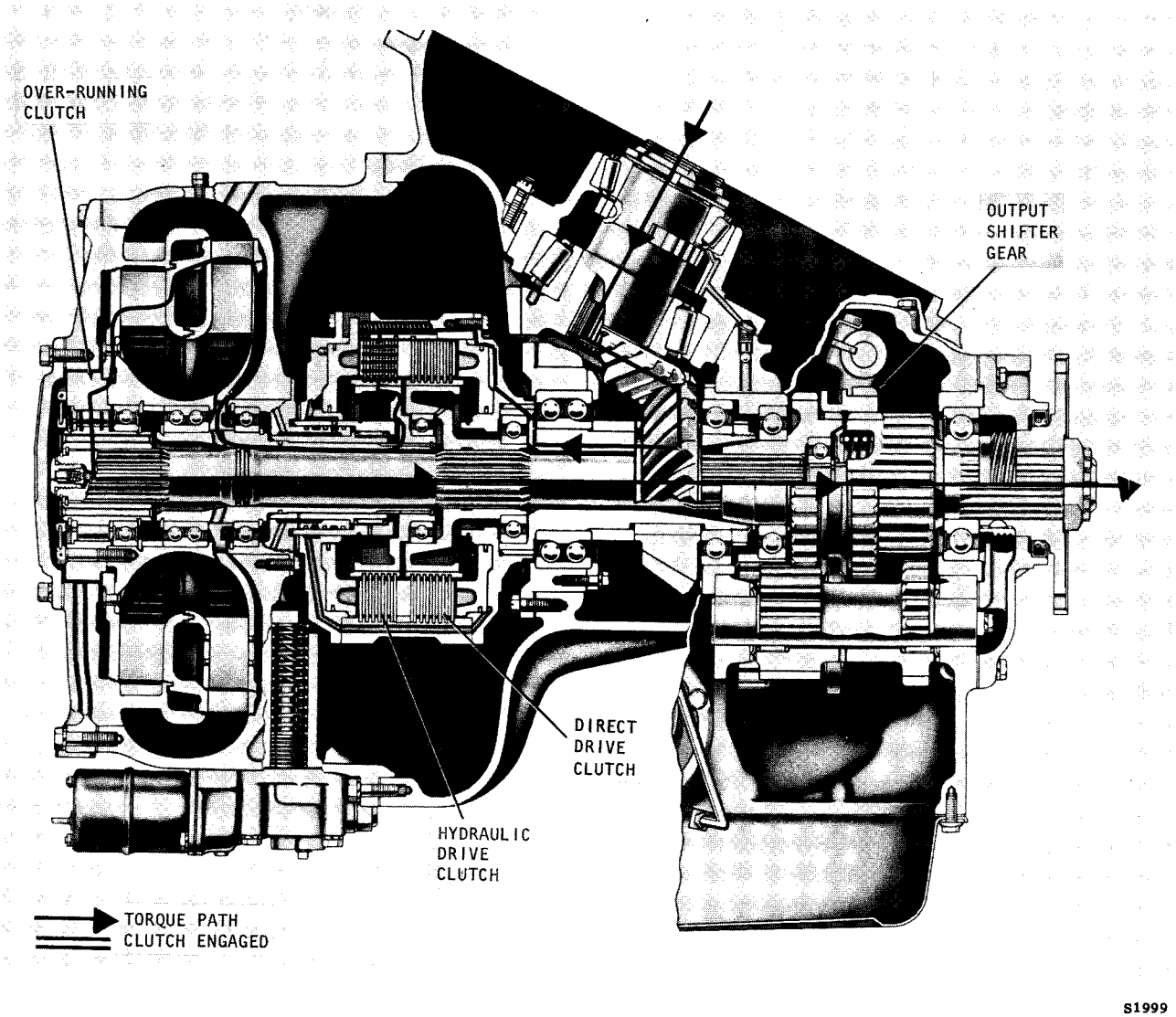

Fig. 2-6 VS1 Series, forward, hydraulic drive—torque path

f. VS1 Series, Forward, Hydraulic Drive — Torque Path (fig. 2-6)

(1) Torque is transmitted from the engine to the drive clutch drum as described previously. The hydraulic drive clutch is engaged when the shift lever is moved to the forward (F) position.

(2) The engaged hydraulic drive clutch rotates the torque converter pump. The pump hydraulically drives the turbine, over-running clutch, drive shaft and output intermediate gear, as explained in b. (2), above.

(3) The remainder of the torque path is explained in b. (3), above.

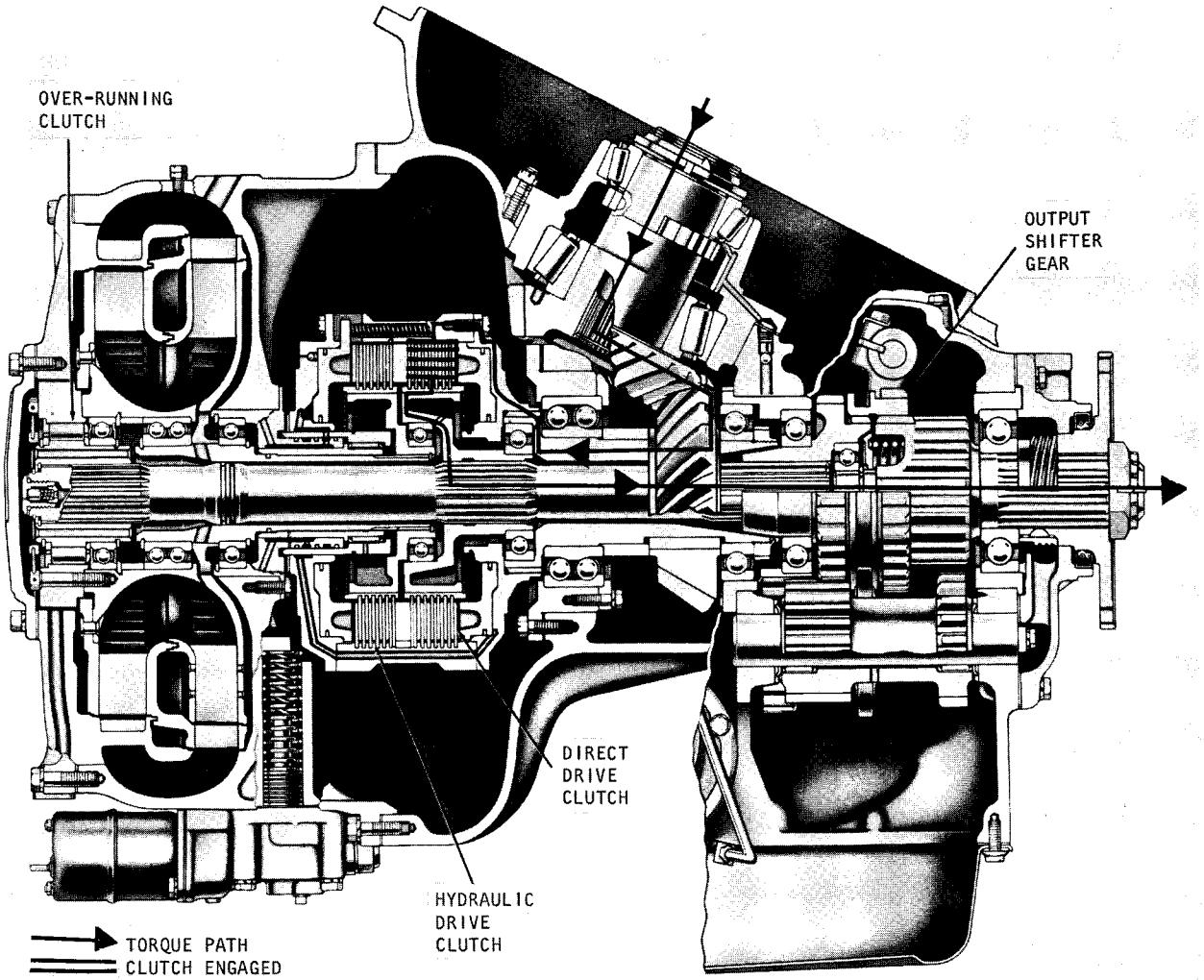

Fig. 2-7 VS1 Series, forward, direct drive—torque path

g. VS1 Series, Forward, Direct Drive — Torque Path (fig. 2-7). The torque path for this operational mode is the same as described in c, above.

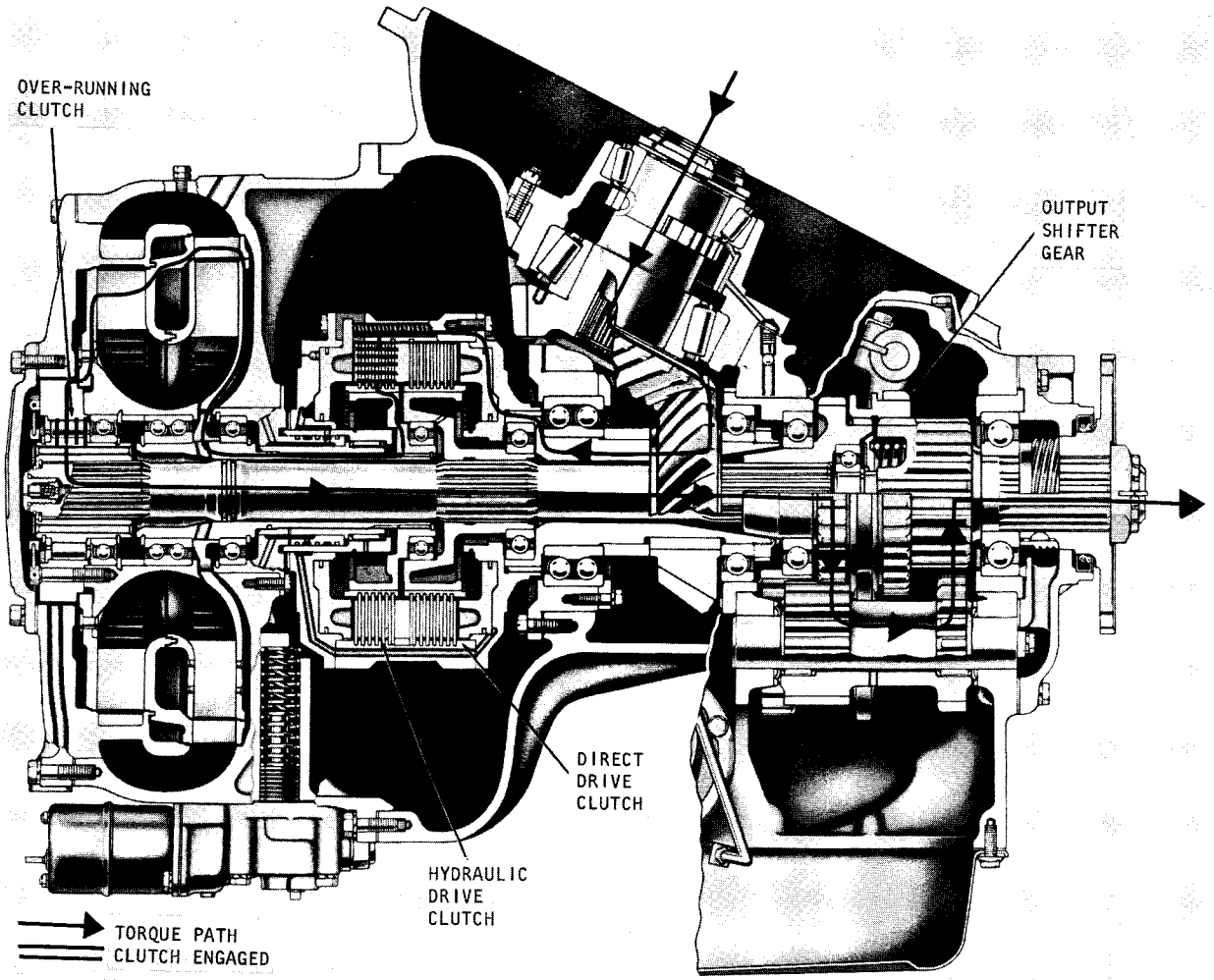

Fig. 2-8 VS1 Series, reverse—torque path

h. VS1 Series, Reverse – Torque Path (fig. 2-8). The torque path for reverse mode is the same as described for the VH series in d, above.

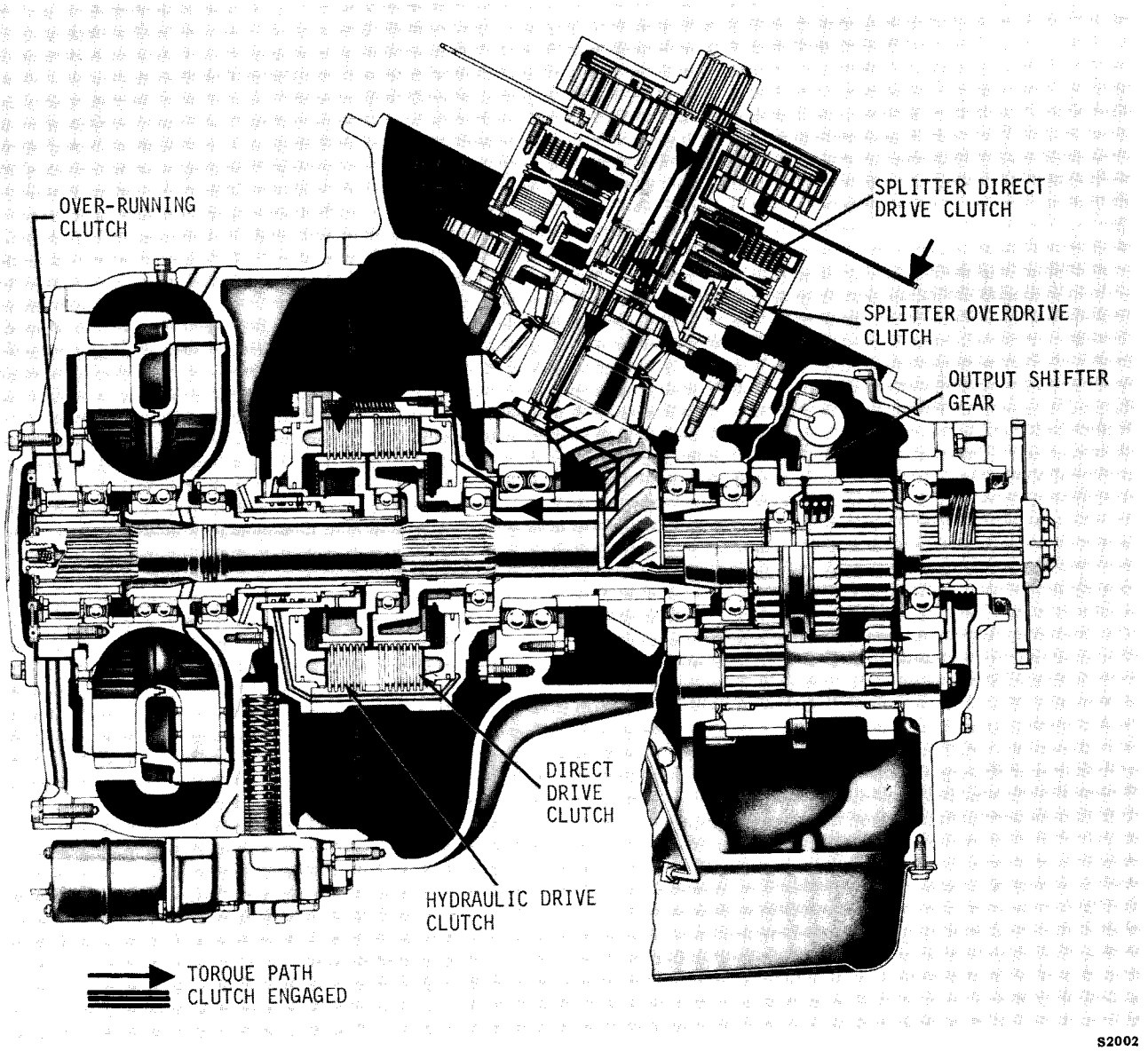

Fig. 2-9 VS2 Series, neutral—torque path

i. VS2 Series, Neutral — Torque Path (fig. 2-9)

(1) Torque is transmitted from the engine to the bevel drive gear by a splitter arrangement consisting of two clutches and a planetary gear set. In neutral, the splitter direct drive clutch is engaged, locking the input shaft and splitter clutch drum together. The splitter planetary ring gear is splined to the input shaft. The splitter planetary sun gear is attached to the clutch drum. Thus, when these two elements are locked together, and driven by the splitter planetary carrier, there is no relative rotational gear action. Since the splitter planetary carrier is attached to the engine flywheel by a drive plate, the drive from the engine to the bevel drive gear is direct (no speed change).

(2) The bevel driven gear is in mesh with the drive gear and is keyed to a sleeve which is attached to the drive clutch cover and drum.

(3) The drive clutches are not engaged in neutral, thus torque is not transmitted through either clutch.

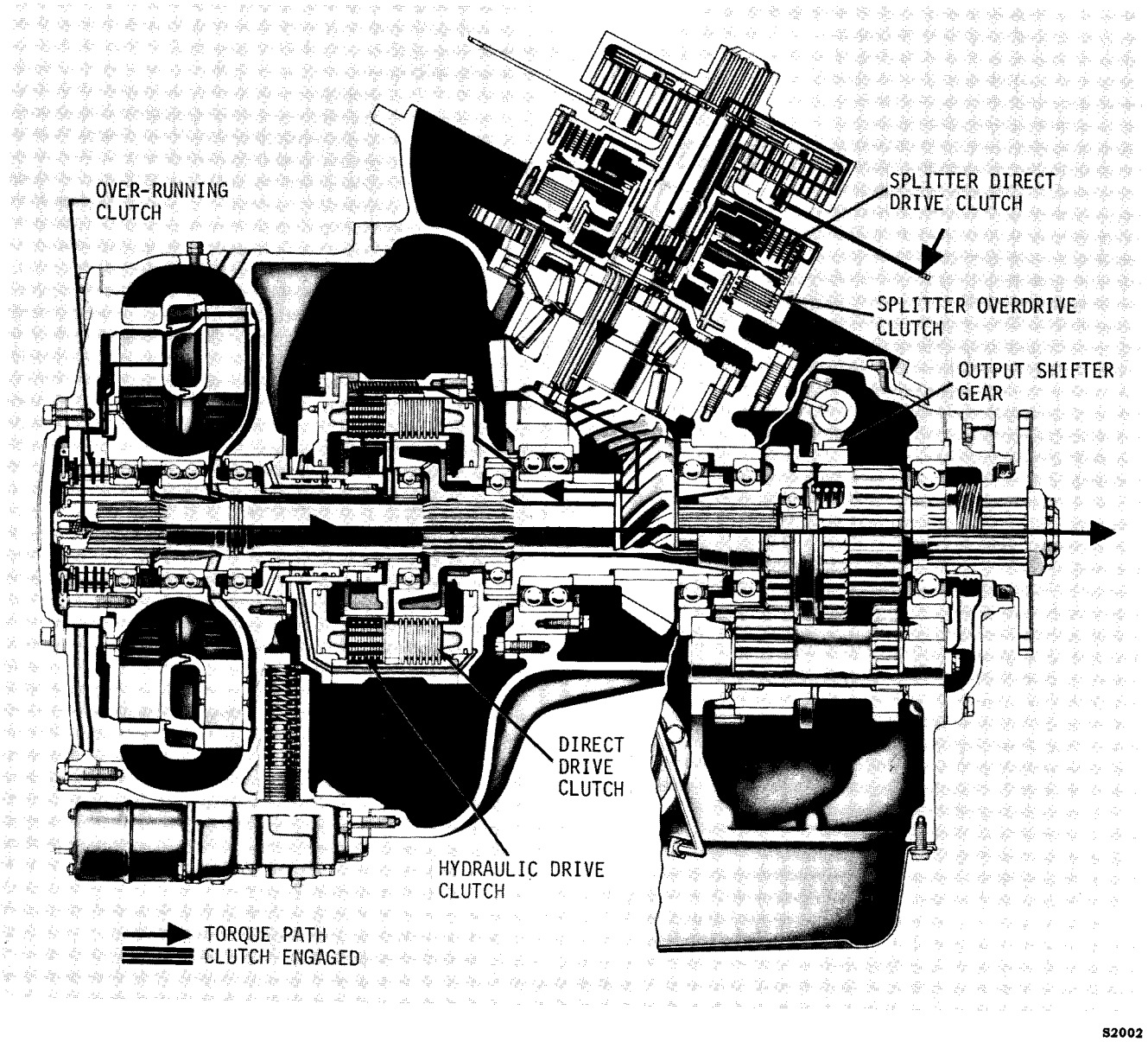

Fig. 2-10 VS2 Series, forward, hydraulic drive, first gear—torque path

j. VS2 Series, Forward, Hydraulic Drive, First Gear — Torque Path (fig. 2-10)

(1) Torque is transmitted from the engine to the drive clutch drum as described previously. The hydraulic drive clutch is engaged when the shift lever is moved to the forward (F) position.

(2) The engaged hydraulic drive clutch rotates the torque converter pump. The pump hydraulically drives the turbine, over-running clutch, drive shaft and output intermediate gear, as explained in b(2), above.

(3) The remainder of the torque path is explained in b(3), above.

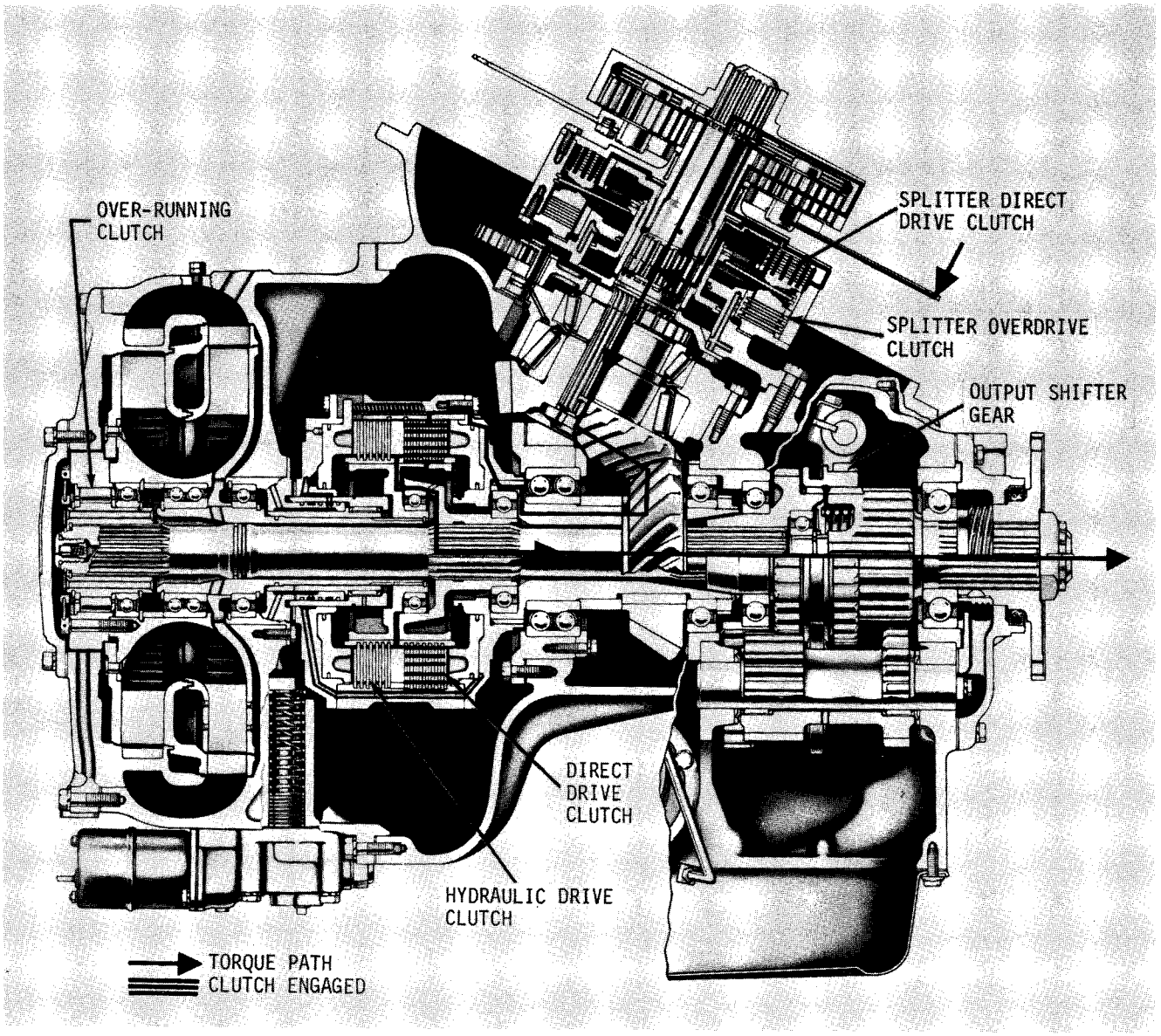

Fig. 2-11 VS2 Series, forward, direct drive, first gear—torque path

k. VS2 Series, Forward, Direct Drive, First Gear — Torque Path (fig. 2-11). The torque path for this operational mode is the same as described in c, above.

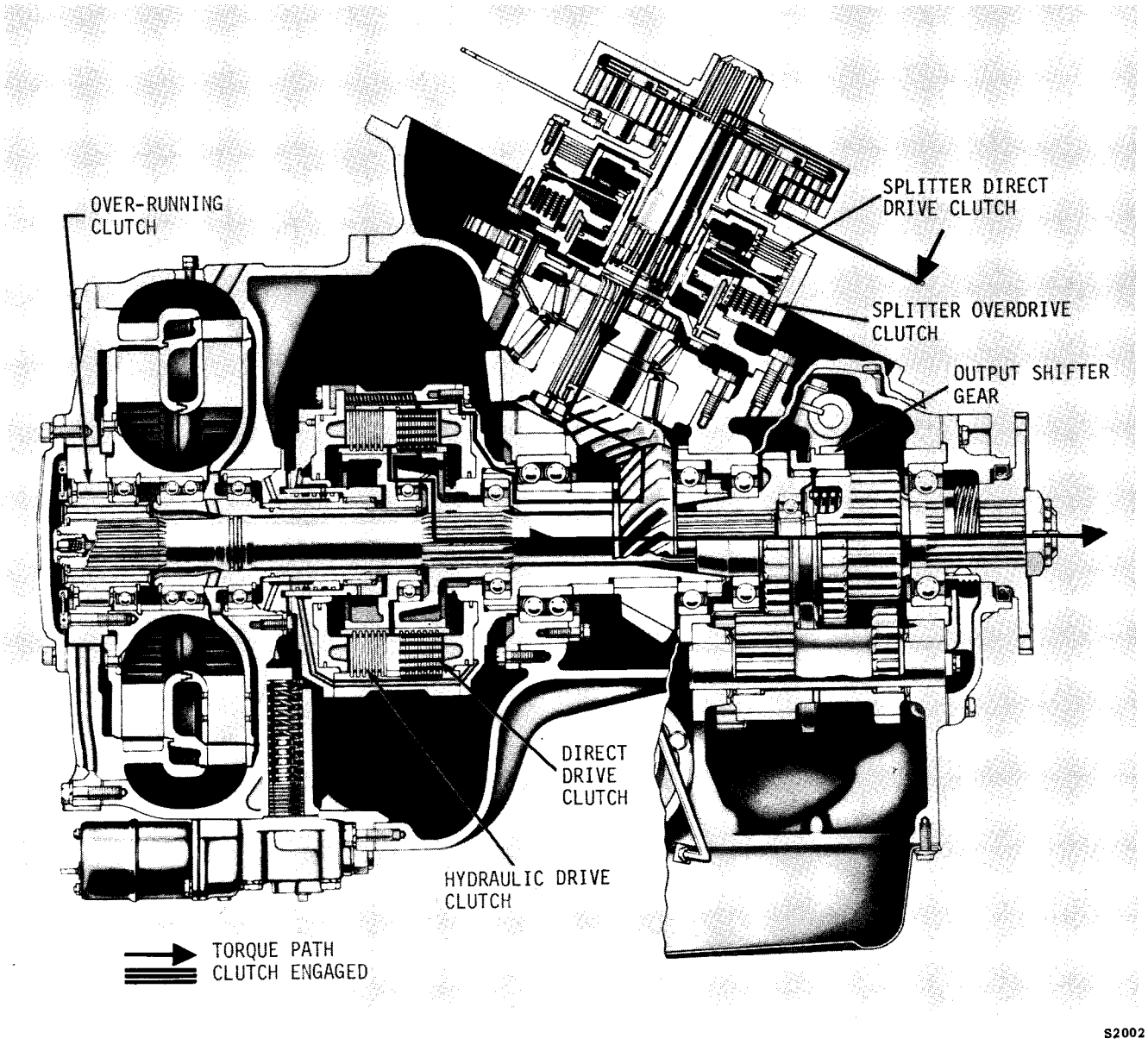

Fig. 2-12 VS2 Series, forward, direct drive, second gear—torque path

1. **VS2 Series, Forward, Direct Drive, Second Gear – Torque Path** (fig. 2-12)

(1) The splitter direct drive clutch is released and the splitter overdrive clutch is engaged in second gear. When the splitter overdrive clutch is engaged, the splitter clutch drum and the splitter planetary sun gear are stationary. The splitter planetary carrier pinions, driven by the carrier which is attached to the drive plate on the engine flywheel, overdrive the splitter planetary ring gear. The ring gear is splined to the input shaft and drives the bevel gear.

(2) The remainder of the torque path, from the bevel drive gear to the output intermediate gear is the same as described in c, above.

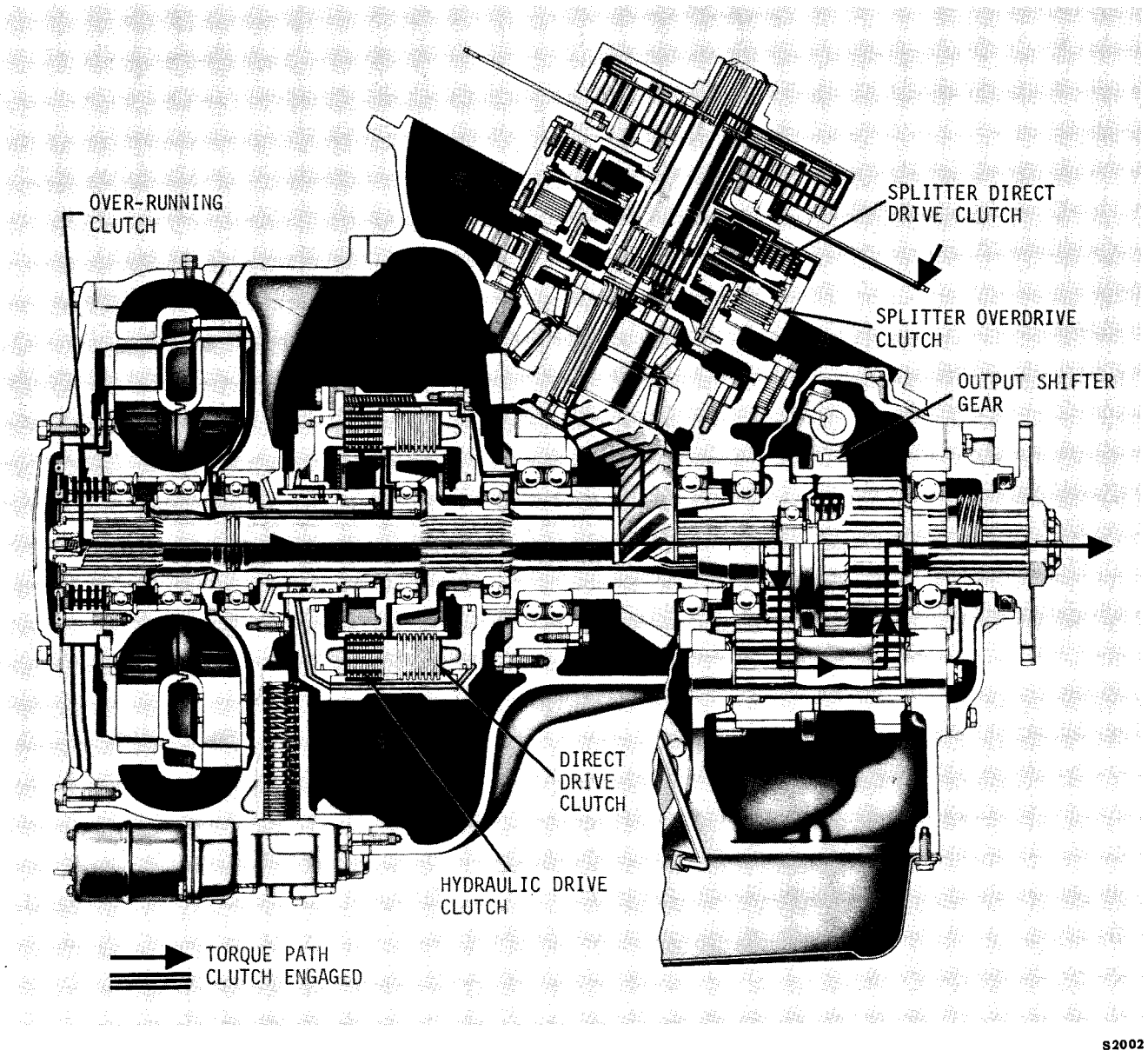

Fig. 2-13 VS2 Series, reverse—torque path

m. VS2 Series, Reverse — Torque Path (fig. 2-13). The torque path for reverse mode is the same as described for the VH series in d, above.

Section 3. PREVENTIVE MAINTENANCE

3-1. SCOPE OF SECTION 3

This section outlines periodic and routine procedures required to maintain the transmission in good operating condition. Included are instructions for care of the oil system, minor adjustments of the transmission and controls, tests to determine condition, instructions for extended storage and troubleshooting.

3-2. PERIODIC INSPECTIONS, CLEANING

a. Inspecting Exterior. The exterior of the transmission should be cleaned and inspected at regular intervals. The severity of service and operating environment will determine the frequency of such inspections. The transmission should be inspected for loose bolts, oil leaks, linkage troubles and damaged or loose oil lines. Oil leaks require immediate attention. Linkage must be kept clean, properly adjusted and lubricated.

b. Cleaning Breather. The prevalence of dust and dirt will determine the frequency at which the breather requires cleaning. Clean the area around the breather base before removing the breather.

> Note: The breather is not furnished with the transmission. Follow the coach manufacturer's instructions on breather maintenance.

c. Water or Dirt in Oil.

(1) At each oil change, examine the oil that is drained for evidence of dirt or water. A normal amount of condensation will emulsify in the oil during operation of the transmission. However, if there is evidence of water, check the cooler (heat exchanger) for leakage between the water and oil areas. Oil in the water side of the oil cooler (or vehicle radiator) is another sign of leakage. However, this may indicate leakage of oil from the engine into the cooling system. Any accumulation of sludge or soft dirt in the transmission sump should be removed by the use of "flushing oil."

(2) If engine coolant containing ethylene glycol leaks into the transmission oil system, immediate action must be taken to prevent malfunction and possible serious damage. The transmission must be completely disassembled, inspected and cleaned. All traces of the coolant and varnish deposits resulting from coolant contamination must be removed.

(3) A Gly-Tek test kit to detect glycol in transmission oil can be obtained from Nelco Company, 1047 McKnight Road South, St. Paul, Minnesota 55119.

> Note: Some transmission oils will give a positive indication because of "additives" in the oil. When test results are questionable, test a clean (unused) sample of the same type or brand to confirm results.

d. Metal Particles in Oil

(1) Metal particles in the oil (except for the minute particles normally trapped in the oil filter) indicate damage has occurred in the transmission. When these particles are found in the sump, the transmission must be disassembled and closely inspected to find the source. Metal contamination will require complete disassembly of the transmission and cleaning of all internal and external circuits, cooler, and all other areas where the particles could lodge. However, repeated cleaning and flushing may not remove all debris from the oil cooler circuit.

(2) To prevent another failure caused by eventual movement of trapped debris, installation of an auxiliary filter between the oil cooler and transmission (in return line) is

recommended. This recommendation applies whether the failed transmission is overhauled or replaced by a new or rebuilt unit.

(3) Forty-micron filter assemblies such as PM 13-7 (P/N 5576446) with a filter element PF 132W (P/N 5573014), manufactured by AC Spark Plug, can be used satisfactorily. Maximum pressure drop across the new filter element must not exceed 3 psi (21 kPa) at 15 gpm (30 liters per minute) flow at 180°F (82°C)

3-3. OIL SYSTEM

a. Checking Oil Level

(1) The transmission oil level should be checked at least every 3000 miles (4827 km). Figure 1-4 shows the location of the oil level gage. Clean the area around the gage top before removing the gage. Unscrew the oil gage to remove it from the filler opening, Wipe the gage clean and re-insert it to the depth allowed without engaging the threads.

Note: The transmission must be at normal operating temperature and the oil should be checked immediately after engine shutdown. Otherwise the oil level reading will be false.

(2) The oil level gage (dipstick) should indicate an oil level between the Add and Full mark. Oil should be added only when the oil level falls to the Add mark (on the oil level gage) or below.

Note: Use only Dexron or Dexron II hydraulic transmission fluid.

(3) Replace the oil level gage by threading it into the oil filler opening and tightening it firmly.

b. Maintenance Intervals. The severity of service and the environment in which the transmission operates, will determine the frequency of some maintenance operations. Under very dusty or dirty operating conditions, the transmission oil and oil filter should be changed more often. Oil should be changed immediately if it has been subjected to overheating. The breather will require more frequent cleaning when dirt and dust conditions are severe. Generally, the transmission oil and filter should be changed every 25,000 miles (40,225 km) and the filter changed at shorter intervals, depending upon the condition of the oil. A dark color or burnt odor does not mean that Dexron fluid needs to be changed. A laboratory analysis is the only suitable method to determine the condition and serviceability of the oil.

c. Changing Oil Filters. Refer to vehicle manual for the procedures necessary to change the transmission oil filter element.

d. Draining Oil, Refilling

(1) The transmission should be as near temperature (180° to 200°F; 82 to 93°C) as possible when the oil is drained. Remove the oil drain plug (fig. 1-1 or 1-3) and the 1/8-inch pipe plug from the bushing at the lower side of the torque converter housing. Allow the transmission to drain thoroughly.

(2) Remove oil sump pan 28 (A, fold-out 14) and gasket 1. Discard the gasket. Remove oil pump strainer screen 23 and clean thoroughly with mineral spirits, using a soft-bristle brush. Install the strainer screen and retain with the retaining spring 24. Clean the oil pan thoroughly.

(3) Place the oil pan gasket onto the oil pan. If adhesives or sealers are required to retain the oil pan gasket, they may be applied onto the pan mounting flange but only on the area outside the flange bead.

Caution: Do not use gasket-type sealing compounds any place inside the transmission or where they might get washed into the transmission. Also, do not use nonsoluble vegetable base cooking compounds or fibrous greases inside the transmission.

(4) Install the oil pan and gasket, carefully guiding them into place. Guard against dirt or foreign material entering the pan. Retain the pan to the housing with four 5/16-18

x 7/8 inch washer-head screws. Install each screw, by hand, one at a time, into each corner of the pan. Install the remaining 15 washer-head screws by hand, carefully threading each one through the gasket. Bottom all screws before tightening them.

(5) Alternately tighten screws 180 degrees apart to 5 lb-ft (6.8 Nm) torque. Repeat the process, tightening the screws to 17-20 lb ft (23-27 N·m) torque.

(6) Refill the transmission with Dexron or Dexron II hydraulic fluid to the Add mark on the level gage (refer to a, above).

Note: Refill will not require as much oil as will initial fill. Initial fill requires 28 to 32 US quarts (26 to 30 liters), depending upon installation.

(7) Start and run the engine until the transmission operating temperature (180° to 200°F; 82 to 93°C) is reached. Then check oil level as outlined in a, above. Add oil, as necessary, until the oil is at the Full mark on the oil level gage. Install and tighten the oil level gage.

3-4. PRESSURES, TEMPERATURE

a. Check Points Similar for Both Models. Figure 3-1 illustrates the oil pressure check points on the transmission. The VS series transmission is illustrated. However, the pressure check points are identical for the VH series except for the lubrication pressure point, which is found only on the VS series. A plug at each check point is removed to attach a pressure check line.

b. Pressure Checks. Pressure checks must be made while the transmission is at normal operating temperature 180° to 200°F, 82 to 93°C). Refer to paragraph 1-7 for normal pressure range.

c. Maximum Temperature. The maximum temperature of the transmission oil at converter-out is 250°F (121°C).

3-5. SHIFT LINKAGE ADJUSTMENT

a. Refer to Coach Service Manual. The shift control linkage between the transmission and the operator's selector lever is not furnished by the transmission manufacturer, and may vary among installations. Refer to the vehicle service manual for specific instructions on linkage adjustments.

b. Shifter Lever Detents. The transmission shifter lever (fig. 1-1) has three detent positions. A spring-loaded detent locates the lever accurately in each position. The transmission is in forward mode when the shifter lever is in the detent that positions the lever towards the rear of the transmission (the torque converter end of the transmission). The transmission is in reverse mode when the shifter lever is in the detent that positions the lever towards the front of the transmission. The detent between these two positions is neutral. The linkage is correctly adjusted when the detent points on the transmission coincides with the detent points on the operator's selector lever (shift tower).

Note: Air shift transmissions have no mechanical neutral. The shift lever passes through the neutral detent point but does not stop there.

3-6. CONTROL VALVE ADJUSTMENT

a. Shims. Two valves require the installations of shims to adjust their spring forces. One of these is direct drive clutch control valve 23 (B, foldout 14) located in the drive clutch control valve assembly and is used on VH transmissions with hydraulic governors and all VS series transmissions. (VH series transmissions with electro-mechanical governor, have a drive clutch control valve assembly with two solenoids, and do not require this adjustment.) The other valve is splitter clutch control valve 7 (foldout 15) located in the input splitter clutch control valve assembly, and used only on the VS2 series. Both valves respond to governor pressure (transmission output speed); there-

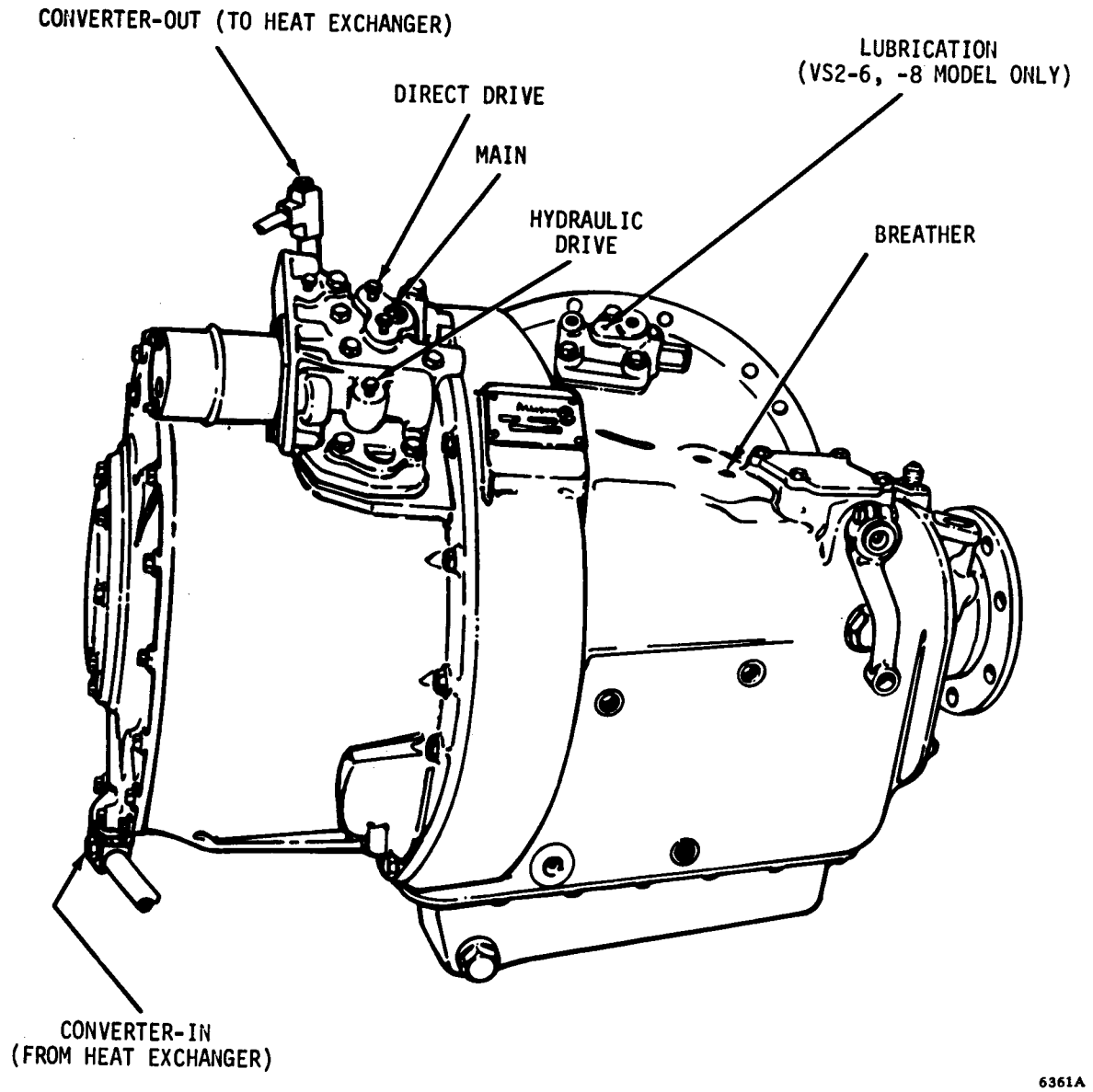

Fig. 3-1. Oil pressure check points

fore, they can be adjusted to shift the transmission at the desired transmission output speed. When the valves are properly adjusted, the transmission should shift at the output speeds (rpm) listed in the chart in d, below.

b. Direct Drive Clutch Control Valve. To adjust this valve, add or remove shims 24 (B, foldout 14) between the valve 23 and spring 25. The valve should shift from hydraulic drive position (spring extended) to direct drive position (spring compressed) at the output speed shown in the chart in d, below. Shim the valve to obtain an upshift at a speed as near that prescribed as possible. Each added shim will increase the shift point approximately 25 rpm. Replace the spring if it cannot be shimmed to the proper output speed. Refer to paragraph 6-3d for assembly instructions.

c. Splitter Clutch Control Valve. To adjust this valve, add or remove shims 9 (fold-out 15) seated in valve cap 12 or shims 23 seated in valve cap 20. Later model transmissions have the shims 9 on rivet 10 or shims 23 on rivet 22, which is then inserted into the cap. The valve should shift from splitter direct drive position (spring extended) to splitter overdrive position (spring compressed) at the transmission output speed shown in the chart in d, below. Shim the valve to obtain an upshift at a speed as near that prescribed as possible. Each added shim will increase the shift point approximately 50 rpm. Replace the spring if it cannot be adjusted to the proper output shaft speed without exceeding the following maximum number of shims. Refer to paragraph 6-4b and d for assembly instructions.

Spring P/N	Max. No. Shims
6835724	10
6835723	7
6830330	10

d. Valve Shim Chart. (Refer to b and c, above.) The following chart indicates speed (rpm) of the transmission output shaft at shift points, when valves are properly adjusted.

3-7. STALL SPEED TEST

a. Definition, Purpose

(1) A stall check determines conditions while the output shaft is prevented from rotating while the engine is running at full throttle. The stall test determines whether or not the engine and transmission are performing satisfactorily as a unit.

(2) The normal stall speed applicable to the specific engine-transmission combination must be known to properly evaluate the test. This data is available from your equipment dealer or distributor.

b. Procedure

WARNING: When conducting a stall speed test, the vehicle must be prevented from moving. Both the parking and service brakes must be applied and, if necessary, the vehicle should be blocked to prevent movement. Warn personnel to keep clear of the vehicle and its travel path.

Transmission Series or Model	VH Series	VS1 Series	VS2 Series
Direct drive clutch control valve:			
hydraulic drive to direct-drive (upshift)	1300	1300	1300
*direct drive to hydraulic drive (downshift)	1150	1150	1150
Splitter clutch control valve:			
splitter direct drive to splitter overdrive (upshift)	—	—	1940
*splitter overdrive to splitter direct drive (downshift)	—	—	1600

*Do not attempt to shim valves to obtain downshift speeds. These only are approximate values to be utilized in troubleshooting. Excessive variations from these downshift speeds may indicate improper torque on valve body mounting bolts. These bolts should be uniformly tightened to 26 to 32 pound feet (35 to 43 N·m) torque.

(1) Connect a tachometer of known accuracy to the engine and bring the transmission to operating temperature (180° to 200°F; 82 to 93°C). Apply the parking brake, block the vehicle wheels for added safety and apply the vehicle service brakes. Shift the transmission to forward operating mode and accelerate the engine to full throttle.

> Caution: Do not operate engine at stall speed for longer than 30 seconds at a time. Do not allow converter-out oil temperature to exceed 250°F (121°C).

(2) Note the engine speed attained during the stall test and compare it with the normal speed for the particular engine-transmission combination being tested. Refer to the Troubleshooting Chart at the end of this section for possible causes of stall speed deviations from normal.

> Note: Because of the effects of ambient temperature, altitude, engine accessory power loss variations, etc., on power input to the torque converter, the actual engine stall speed may vary ± 150 rpm from the established normal value. When the deviation can be attributed to such causes, the actual speed can be accepted as normal.

3-8. PRESERVATION AND STORAGE

a. Storage, New Transmissions (prior to installation). New transmissions are tested with preservative oil and drained prior to shipment. The residual oil remaining in the transmission provides adequate protection to safely store the transmission for six weeks without further treatment.

b. Preservation Methods. When the transmission is to be stored or remain inactive for an extended period (up to one year), specific preservation methods are recommended to prevent damage due to rust, corrosion, and organic growth in the oil. Preservation methods are presented for storage with and without oil.

c. Storage, One Year—Without Oil

(1) Drain the oil and replace the oil filter element(s) (para 3-3d).

(2) Seal all openings and breathers with moisture-proof tape.

(3) Coat all exposed, unpainted surfaces with preservative grease such as petrolatum (MIL-C-11796, Class 2).

(4) Atomize or spray 2 ounces (60 milliliters) of Motorstor®*, or equivalent, into the transmission through the oil pan drain plug.

(5) If additional storage time is required, repeat (2) and (3) above at yearly intervals.

d. Storage, One Year—With Oil

(1) Drain the oil and replace the oil filter element(s) (para 3-3d).

(2) Fill the transmission to operating level with a mixture of one part Motorstor (or equivalent) to 30 parts Dexron or Dexron II transmission fluid. Add 1/4 teaspoon of Biobor JF®** (or equivalent) for each 3 gallons (11 liters) of fluid in the system.

> Note: When calculating the amount of Biobor JF required, use the total volume of the system, not just the quantity required to fill the transmission. Include external lines, filters, and the cooler.

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*Motorstor® is the registered trademark for a vapor phase rust preventive manufactured by Daubert Chemical Company, Chicago, Illinois. Motorstor is covered by Military Specifications MIL-L-46002 (ORD) and MIL-I-23310 (WEP) under the designation of Nucle Oil.

**Biobor JF® is the registered trademark for a biological inhibitor manufactured by U. S. Borax and Chemical Corporation.

(3) Run the engine for approximately five minutes at 1000 rpm with the transmission in neutral.

(4) Drive the vehicle. Make sure the transmission shifts through all ranges.

(5) Continue running the engine at 1000 rpm with the transmission in neutral until normal operating temperature is reached.

Caution: If the unit does not have a converter-out temperature gage, do not stall the converter.

(6) If normal operating temperature is less than 225°F (107°C), shift the transmission to a forward range and stall the converter. When converter-out temperature reaches 225°F (107°C), stop the engine. Do not exceed 225°F (107°C).

(7) As soon as the transmission is cool enough to touch, seal all openings and the breather with moisture-proof tape.

(8) Coat all exposed, unpainted surfaces with preservative grease such as petrolatum (MIL-C-11796, Class 2).

(9) If additional storage time is required, repeat (2) through (8) at yearly intervals; except, it is not necessary to drain the transmission each year. Just add Motorstor and Biobor JF (or equivalents).

e. Restoring Transmission to Service

(1) Remove all tape from openings and the breather.

(2) Wash off all external grease with mineral spirits.

(3) If the transmission is new, drain the residual preservative oil. Refill the transmission to the proper level (para 3-3a) with Dexron or Dexron II transmission fluid.

(4) If the transmission was prepared for storage without oil, refill the transmission to the proper level (para 3-3a) with Dexron or Dexron II transmission fluid.

(5) If the transmission was prepared for storage with oil, it is not necessary to drain and refill the transmission with new transmission fluid. Check for proper fluid level (para 3-3a). Add or drain transmission fluid as required to obtain the proper level.

3-9. TROUBLESHOOTING

a. Importance. Troubleshooting is the systematic search for and location of malfunctions in the engine or transmission, which affect transmission performance. A thorough study of the description and operation of components and of the hydraulic system (Section 2) will be helpful in troubleshooting. The engine and transmission must be regarded as a single package during troubleshooting.

b. Troubleshooting Chart. The following chart outlines the possible causes and remedies for a particular malfunction. When applicable, the remedies are further referenced to the section and paragraph containing the detailed information required for corrective action.

V-DRIVE AUTOMATIC TRANSMISSION

TROUBLESHOOTING CHART

Cause	Remedy
Ⓐ LOW MAIN PRESSURE	
1. Low oil level	1. Add oil (para 3-3a)
2. Main-pressure regulator valve spring weak or broken	2. Replace oil pump (para 6-5)
3. Main-pressure regulator valve sticking open	3. Free valve (para 6-5)
4. Oil pump worn	4. Replace oil pump (para 6-5)
5. Oil leaks in system	5. Check for leaks in lines, fittings, gaskets, piston seals (sect. 5, 6, 7)
6. Aerated oil, or incorrect oil in system (refer to D, below)	6. Check for leaks, overheating, high oil level; change to proper oil (para 3-2, -3)
Ⓑ OVERHEATING	
1. High or low oil level	1. Establish proper oil level (para 3-3)
2. Clutch failed	2. Repair clutch (sect. 5, 6, 7)
3. Vehicle overloaded	3. Reduce load
4. Low main pressure	4. Refer to Ⓐ, above
5. Engine overheated	5. Correct engine cooling troubles
6. Heat exchanger clogged	6. Clean heat exchanger
7. Water circuit to heat exchanger restricted	7. Inspect entire circuit, remove restrictions
Ⓒ LOW CLUTCH APPLY PRESSURE	
1. Low main pressure	1. Refer to Ⓐ, above
2. Clutch piston seals leaking	2. Replace seals (sect. 5, 6, 7)
3. Leaks in valve body mounting gaskets	3. Replace gaskets (sect. 5, 6, 7)
4. Leaks in internal lines or fittings	4. Repair or replace lines or fittings (sect. 5, 6, 7)
Ⓓ AERATED (foaming) OIL	
1. Incorrect type oil in system	1. Drain and refill with proper oil (para 3-3)
2. Low or high oil level	2. Establish proper oil level (para 3-3)
3. Air entering suction side of oil pump	3. Repair or replace oil pump (para 6-5)
Ⓔ VEHICLE WILL NOT TRAVEL	
1. Gears not shifting	1. Check linkage (para 3-5)
2. Clutch slipping	2. Replace clutch (sect. 5, 6, 7)
3. Low main pressure	3. Refer to A, above
4. Failed mechanical components	4. Overhaul transmission (sect. 5, 6, 7)
5. Solenoid not functioning properly	5. Check electrical circuit (refer to coach manual)
Ⓕ VEHICLE TRAVELS IN NEUTRAL WHEN ENGINE IS ACCELERATED (applies only to systems with hydraulic clutch engaged in neutral)	
1. Linkage not adjusted	1. Adjust linkage (para 3-5)

TROUBLESHOOTING CHART (Continued)

Cause	Remedy
(G) VEHICLE WILL TRAVEL ONLY ONE DIRECTION	
1. Linkage not adjusted	1. Adjust linkage (para 3-5)
(H) SHIFT TO DIRECT DRIVE OCCURS AT WRONG SPEED	
1. Spring on clutch control valve weak or broken	1. Replace or shim spring (para 3-6)
2. Clutch control valve sticking	2. Free valve (para 6-3)
3. Valve body bolts incorrectly tightened	3. Tighten bolts properly (para 3-6)
4. Clutch control valve not properly shimmed	4. Adjust valve by shimming (para 3-6)
5. Governor failed	5. Replace governor (refer to coach manual)
(I) SHIFT TO OVERDRIVE OCCURS AT WRONG SPEED (VS2 series only)	
1. Spring on splitter clutch control valve weak or broken	1. Replace or shim spring (para 3-6)
2. Splitter clutch control valve sticking	2. Free valve (para 6-4)
3. Valve body bolts incorrectly tightened	3. Tighten bolts properly (para 3-6)
4. Splitter clutch control valve not properly shimmed	4. Adjust valve by shimming (para 3-6)
5. Governor failed	5. Replace governor (refer to coach manual)
(J) VEHICLE WILL NOT TRAVEL IMMEDIATELY AFTER STARTING ENGINE	
1. Torque converter air locked (Refer to D, above)	1. Check for leaks, overheating, improper oil level, anti-foaming characteristics of oil
(K) STALL SPEED TOO LOW (refer to para 3-7)	
1. Engine not producing full power	1. Tune engine (refer to engine service manual)
2. Transmission not warm	2. Run engine in neutral until transmission sump is at normal temperature (180° to 200°F)
(L) STALL SPEED TOO HIGH (refer to para 3-7)	
1. Hydraulic drive clutch slipping	1. Repair or replace clutch (sect. 5, 6, 7)
2. Low main pressure	2. Refer to A, above
3. Direct drive splitter clutch slipping (VS2 series only)	3. Repair or replace clutch (sect. 5, 6, 7)

Section 4. GENERAL OVERHAUL INFORMATION

4-1. SCOPE OF SECTION 4

This section provides preliminary information necessary for the overhaul of a transmission. Tools and equipment needed are discussed. Replacement parts information is provided. The importance of cleanliness and careful handling is stressed. General information on the removal and installation of the transmission is included. Standard and special torque specifications for bolts and nuts are tabulated. Wear limits and spring information are referenced.

4-2. CHANGES IN MODELS, PROCEDURES

The release of new assemblies and/or product improvements may require the use of new or different procedures. Consult your dealer or distributor for the latest information. Give the information from the transmission nameplate, as outlined in paragraph 1-4a, when requesting information.

4-3. TOOLS, EQUIPMENT NEEDED

a. Common Tools, Equipment. In addition to the tools commonly available to the mechanic, the following items should be available.

(1) Chain hoist (at least 1/2-ton)

(2) Suitable work table

(3) Press (for removal, installation of press-fit parts)

(4) Supply of wood blocks

(5) Clean wiping cloths (do not use linty waste)

(6) Parts receptacles

(7) Cleaning equipment (brushes, solvent, etc.)

(8) Torque wrenches

(9) Oil-soluble grease (Petrolatum)

(10) Dry ice (for cooling press-fit parts)

(11) Heat lamps (for expanding housing bores when installing bearing retainers)

(12) Snapring pliers (for both internal, external rings)

b. Special Tools. Special tools helpful or necessary for overhaul are available from:

Kent-Moore Tool Division
1501 South Jackson Street
Jackson, Michigan 49203

All inquiries, orders, etc., concerning special tools, should be directed to the above organization. A list of the special tools, with references to their use follows.

4-4. REPLACEMENT PARTS

a. Ordering Information. Refer to paragraph 1-4 for information on ordering replacement parts.

b. Parts Normally Replaced. The following parts are normally replaced at each overhaul.

(1) Gaskets

(2) Cotter pins

(3) Lockwire

(4) Lockstrips

Tool No.	Tool Name	Para Ref
J-2619	Slide hammer	5-3k(2)
J-7441	Rear bearing retainer remover	6-9a(5)
J-8176	Bevel gear and front bearing remover	6-9a(2), 6-9b(9)
J-24202-4	Bearing installer	6-9b(3), (7)
J-25456-1	Bevel gear sleeve nut wrench (use with J-26552)	6-9a(2), 6-9b(10)
J-26404	Bevel gear retainer bearing installer (use with J-24202-4)	6-9b(3)
J-26405	Transmission holding fixture	4-7c
J-26551	Bevel gear loading fixture	6-9a(2), 6-9b(9)
J-26552	Bevel gear nut wrench pilot adapter (use with J-25456-1)	6-9a(2), 6-9b(9)

Note: The tools defined in this table may have a different configuration than those shown in the illustrations.

(5) Washers or snaprings damaged by removal

(6) Oil seals (when removed)

Caution: Do not burn discarded Teflon sealrings. Toxic gases are produced by burning Teflon.

c. Service Kits. Make use of the repair and overhaul kits which are available. See paragraph 1-4 on how to order.

4-5. CAREFUL HANDLING

During all rebuild procedures, parts and subassemblies must be handled carefully to prevent nicking, scratching and denting. Parts which fit together closely, but with operating clearance, will stick if damaged only slightly. Parts which depend upon smooth surfaces for sealing may leak if scratched. Such parts should be carefully handled and protected during removal, cleaning, inspection and installation.

4-6. CLEANING, INSPECTION

a. Dirt Causes Malfunction. All parts must be clean to permit effective inspection. At assembly, it is very important that no dirt or foreign material be allowed to enter the transmission. Even minute particles can cause the malfunction of close-fit parts, such as valves.

b. Cleaning Parts

(1) All the metallic parts of the transmission except bearings and friction-faced clutch plates should be cleaned thoroughly with volatile mineral spirits or by the steam-cleaning method. Do not use caustic soda solution for steam cleaning.

(2) Parts should be dried with compressed air. Steam-cleaned parts should be oiled immediately after drying.

(3) Clean oil passages by working a piece of soft wire back and forth through the passages and flushing with spirits. Dry the passages with compressed air.

(4) Examine parts, especially oil passages, after cleaning, to make certain they are entirely clean. Reclean them, if necessary.

c. Cleaning Bearings

Caution: If excessive metal contamination has occurred, replacement of all bearings within the transmission is recommended.

(1) Bearings that have been in service should be thoroughly washed in volatile mineral spirits.

(2) If the bearings are particularly dirty or filled with hardened grease, soak them in the spirits before trying to clean them.

WARNING: Never dry bearings by spinning them with compressed air. A spinning bearing can disintegrate, allowing balls or rollers to become lethal flying projectile. Also, spinning bearings while they are not lubricated can damage the bearing.

(3) Before inspection, oil the bearings with the same type of oil that will be used in the transmission.

d. Keeping Bearings Clean. Since the presence of dirt or grit in ball bearings is usually responsible for bearing failures, it is important to keep bearings clean during removal and installation. Observance of the following rules will do much to insure maximum bearing life.

(1) Do not remove the wrapper from new bearings until ready to install them.

(2) Do not remove the grease in which new bearings are packed.

(3) Do not lay bearings on a dirty bench; place them on clean paper.

(4) If assembly is not to be completed at once, wrap or cover the exposed bearings with clean paper or cloth to keep out dust.

e. Inspecting Cast Parts, Machined Surfaces

(1) Inspect bores for wear, scratches, grooves and dirt. Remove scratches and burs with crocus cloth. Remove foreign matter. Replace parts that are deeply scratched or grooved.

(2) Inspect all oil passages for obstructions. If an obstruction is found, remove it with compressed air, or by working a soft wire back and forth through the passage and flushing it out with cleaning solvent.

(3) Inspect mounting faces for nicks, burs, scratches, and foreign matter. Remove such defects with crocus cloth or a soft stone. If scratches are deep, replace the defective part.

(4) Inspect threaded openings for damaged threads. Chase damaged threads with the correct size used tap.

(5) Replace housings or other cast parts that are cracked.

(6) Inspect all machined surfaces for damage that could cause oil leakage or other malfunction of the part. Rework or replace the defective parts.

f. Inspecting Bearings

(1) Inspect bearings for roughness of rotation. Replace a bearing if its rotation is still rough after cleaning and oiling.

(2) Inspect bearings for scored, pitted, scratched, cracked, or chipped races, and for indication of excessive wear of rollers or balls. If one of these defects is found, replace the bearing.

(3) Inspect a defective bearing's housing and shaft for grooved, burred or galled conditions that indicate the bearing has been turning in its bore or on its shaft. If the damage cannot be repaired with crocus cloth, replace the defective part.

(4) When installing a bearing on a shaft, coat the mating surfaces with white lead and use the proper size installation sleeve and a press to seat the bearing.

(5) If a bearing must be removed or installed without a sleeve, press only on the race which is adjacent to the mounting surface. If a press is not available, seat the bearing with a drift and a hammer, driving against the supported race.

g. Inspecting Bushings, Thrust Washers

(1) Inspect bushings for scores, burs, roundness, sharp edges and evidence of overheating. Remove burs with crocus cloth. Remove sharp edges with a scraper or knife blade. If the bushing is out-of-round, deeply scored, or excessively worn, replace it, using the proper size replacer tool.

Note: Sometimes it is necessary to cut out a defective bushing. Be careful not to damage the bore into which the bushing fits.

(2) Inspect thrust washers for distortion, scores, burs, and wear. Replace the thrust washer if it is defective or worn. It is much less expensive to replace such parts than to replace converter elements or transmission components that can fail due to defective bearings, bushings, or thrust washers.

h. Inspecting Oil Seals, Gaskets

(1) Inspect sealrings for cuts and hardness. Replace sealrings if these defects are found.

(2) When replacing lip-type oil seals, the spring-loaded side must be toward the oil to be sealed in (toward the inside of the unit). Use a nonhardening sealing compound on the outside diameter of the seal to help prevent oil leaks. Coat the inside diameter of the seal with high-temperature grease (MIL-G-3545A, or equivalent) to protect the seal during shaft installation and to provide lubrication during initial operation.

(3) Replace all composition gaskets.

(4) Inspect hook-type sealrings for wear, broken hooks, and distortion.

(5) Install a new hook-type sealring if ring shows wear on outside diameter or excessive side wear.

(6) The sides of the sealring must be smooth (0.005-inch maximum side wear). The sides of the shaft groove (or the bore), in which the sealring fits, should be smooth (50 microinches equivalent) and square with the axis of rotation within 0.002 inch. If the sides of the grooves have to be reworked, install a new sealring.

i. Inspecting Gears

(1) Inspect gears for scuffed, nicked, burred or broken teeth. If the defect cannot be removed with a soft stone, replace the gear.

(2) Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace the gear.

(3) Inspect the thrust face of gears for scores, scratches, and burs. Remove such defects with a soft stone. If scratches and scores cannot be removed with a soft stone, replace the gear.

j. Inspecting Splined Parts. Inspect splined parts for stripped, twisted, chipped or burred splines. Remove burs with a soft stone. Replace the part if other defects are found. Spline wear is not considered detrimental except where it affects tightness of fit of the splined parts.

k. Inspecting Threaded Parts. Inspect parts for burred or damaged threads. Re-

move burs with a soft stone or fine file. Replace damaged parts.

l. Inspecting Snaprings. Inspect all snaprings for nicks, distortion, and excessive wear. Replace the snapring if any of these defects is found. The snapring must snap tight in its groove for proper functioning.

m. Inspecting Springs. Inspect springs for signs of overheating, permanent set, or wear due to rubbing adjacent parts. Replace the spring if any one of these defects is found. Refer to the spring chart at the end of Section 8. Replace springs which do not meet specifications.

n. Inspecting Clutch Plates

(1) Inspect friction-faced plates for burs, imbedded metal particles, severely pitted faces, excessive wear, cone, cracks, distortion, and damaged spline teeth. Remove burs, using a soft honing stone. Replace plates which have other defects.

(2) Inspect steel plates for burs, scoring, excessive wear, distortion, galling, cracks, breaks, and damaged tangs. Remove burs and minor surface irregularities, using a soft honing stone. Replace plates which have other defects.

(3) When assembling a clutch pack, soak the plates in Dexron transmission fluid for at least 2 minutes prior to installation.

4-7. GENERAL ASSEMBLY PROCEDURES

a. Clutches, Pistons

(1) Clutch pack clearances must be established prior to assembly. After clearances have been established, soak each friction-face clutch plate (2 minute minimum) in transmission fluid prior to final assembly.

(2) Apply a generous amount of transmission fluid to the piston cavity prior to final assembly.

(3) Assemble clutch plates so that the cone of each plate faces the same direction as the cone of the adjacent plates.

b. Lubricants Used For Assembly. Use transmission fluid to lubricate splines, bearings, clutch plates, etc. during assembly. A low temperature grease, such as petrolatum, shall be used for internal assembly where it is necessary to use a grease to hold parts in place for assembly. The grease shall have a melting point of 100-140°F (38-60°C) and must be completely soluable in the transmission fluid. Petrolatum equivalent to MIL-VV-236 or Amojell Petrolatum (Amoco Oil Co.) is recommended. High temperature grease having good oxidation and water resistance shall be used at the ID of input and output shaft oil seals. A high temperature grease equivalent to MIL-G-81322, Mobil grease No. 28 (Mobil Oil Co.), or Aeroshell grease No. 22 (Shell Oil Co.) is recommended.

c. External Plugs, Hydraulic Fittings

Caution: Do not use Teflon tape on threaded parts. Slivers can get into the oil and cause the transmission to malfunction.

Prior to installation, apply a small amount of non-hardening sealant into the threads of each plug or fitting. Tighten the plugs or fittings sufficiently to prevent leakage.

d. Oil-soluble Grease

Caution: Do not use oil-soluble grease to retain cork gaskets.

Use oil-soluble grease with a low melting point (petrolatum) to temporarily retain parts, step-joint sealrings, scarf-cut sealrings, and hook-type sealrings during assembly with mating parts.

e. Sealring Compounds, Nonsoluble Greases

Do not use gasket-type sealing compounds, fibrous greases, or nonsoluble, vegetable-base cooking compounds any place inside the transmission. Do not use them any place where they could be flushed into the transmission hydraulic system. However, if adhesives or sealers are required for the oil pan gasket, they may be applied on the pan mounting flange, but only in the area outside of the flange bead.

f. Lip-type Oil Seals

(1) When replacing lip-type oil seals, make sure the spring-loaded lip side is toward the oil to be sealed in (toward the inside of the unit). Coat the ID of the seal with high temperature grease (MIL-G-81322 or equivalent) to protect the seal during shaft installation and to provide lubrication during initial operation.

(2) The circumference of some seals is precoated with a dry sealant. The sealant is usually colored for easy identification. The precoated seals do not require any additional sealant before installation.

(3) The circumference of some seals is not precoated with a dry sealant. A non-hardening sealant should be applied to the circumference of these seals before installation.

g. Interference-fit Parts

Assembly of interference-fit parts may be accomplished by heating and chilling the respective parts. The female part can be heated in an oven or oil bath to 300°F (149°C), and the male part can be chilled in dry ice. Either one or both parts may require a thermal process. However, if the chill process is used for a ferrous alloy part, coat the components with transmission fluid to inhibit rust due to frost and moisture.

h. Sleeve-type Bearings and Bushings

The use of a locking compound is recommended to retain bushings and sleeve-type bearings that have press-fit tolerances. One such compound is Loctite Sleeve Retainer 601. This compound or equivalent should be used.

i. Bearings (Ball or Roller)

(1) When installing a bearing on a shaft, heat the bearing to 200°F (93°C) on an electric hot plate or in an oil bath. Coat the mating surfaces with white lead and use the proper size installation sleeve and a press to seat the bearing.

Note: Bearings must be heated long enough for sufficient expansion. Heating time is determined by the size of the bearing. Forty-five minutes is sufficient for the largest bearing in these transmissions.

(2) If a bearing must be removed or installed without a sleeve, be careful to drive or press only on the race which is adjacent to the mounting surface. If a press is not available, seat the bearing with a drift and a hammer, driving against the supported race.

4-8. WEAR LIMITS

Refer to Section 8 for general and specific information covering parts fits, clearances and wear limits.

4-9. SPRING INFORMATION

Refer to the spring charts in Section 8 for spring identification and specifications.

4-10. REMOVING, INSTALLING TRANSMISSION

a. Drain Oil. Drain the oil from the transmission. For better drainage, the transmission should be warm and allowed to drain overnight. Replace the drain plug. Consult the vehicle service manual for specific instructions for removal and installation, as applications will differ.

b. Check Linkages, Lines. Make sure that all linkages, controls, cooler and filter lines, temperature and pressure connections, input and output couplings, and mounting bolts are disconnected before transmission removal. Oil lines should be carefully placed out of the way of damage and all openings covered to keep them clean. Clean the exterior of the transmission. Steam cleaning should be followed immediately by disassembly since condensation should not be allowed to remain in the transmission to cause rust.

c. Lifting Holes. Three 3/4-10 tapped holes are provided on the right side of the transmission housing. Adapter J-26205 used with a transmission dolly or work stand may be attached by bolts in these holes.

d. Input Planetary Carrier Assembly (VS2 series)

(1) The VS2 series transmission has an input planetary carrier assembly, consisting of an input ring gear and planetary carrier with drive plate. Some applications have the drive plate bolted to the engine flywheel with 12 bolts. Therefore, the carrier assembly will remain with the engine when the transmission is removed. Some applications have a torsional isolator on the engine flywheel with the drive plate splined into the torsional isolator. Thus, the carrier assembly could remain with the engine flywheel or remain with the transmission, when removed.

Note: Do not allow the carrier assembly to fall from the flywheel or input shaft when removing transmissions having the drive plate splined into a torsional isolator. During removal of the transmission, remove the carrier assembly from the splines of the torsional isolator and input shaft.

(2) To remove carrier assembly, bolted to the engine flywheel, remove 12 bolts attaching the drive plate to the flywheel. Remove the drive plate (with carrier assembly) and ring gear from the flywheel.

e. Reconnect at Installation. At installation, all items removed or disconnected should be reconnected. Refer to the vehicle service manual for specific instructions.

4-11. TEFLON SEALRINGS, EXPANDERS

a. Applies to All Clutches

(1) These instructions will apply to all clutches in which Teflon sealrings and steel expanders are used.

(2) Disassembly and rebuild procedures are referenced to this paragraph for removal and installation of Teflon sealrings and expanders.

b. Removal

WARNING: Do not burn discarded Teflon seals. Toxic gases are produced.

(1) Do not remove Teflon sealrings by the use of sharp edged or pointed tools, if the sealrings are to be reused. Place a thin, flat bladed tool into the sealring groove, and work one edge of the sealring out of the groove, until it can be grasped with the fingers.

(2) Remove sealring expander. Clean the sealring groove thoroughly and remove any nicks, burs or rough spots.

c. Assembly

(1) Coil the expanders as shown in figure 4-1. Inspect the expander ends for curvature toward the bottom of the sealring grooves (inward for external grooves; outward for internal grooves).

(2) Install the expander into the groove.

(3) Starting at a point opposite the open ends of the expander, install the Teflon sealring. Do not stretch or deform the sealring more than absolutely necessary for installation. Work both directions from the starting point until the sealring is completely installed. Do not use tools to force the sealring — use fingers only.

(4) Lubricate the sealring and center it radially in respect to the piston or part on which it is installed.

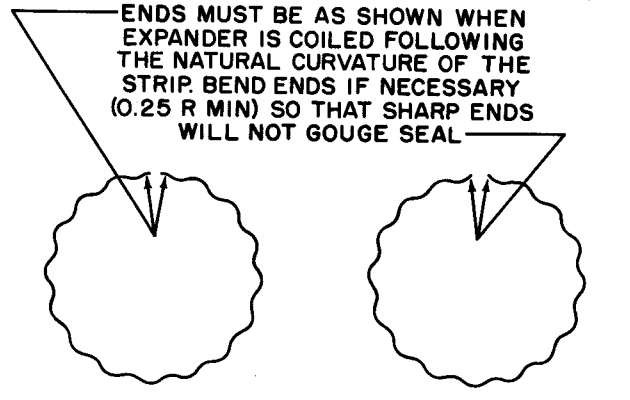


Fig. 4-1. Teflon sealring expanders

4-12. WEAR LIMITS, SPRING INFORMATION

Refer to Section 8 for wear limits and spring data.

4-13. TORQUE SPECIFICATIONS

The assembly procedures in Sections 6 and 7 specify the torque requirement of each bolt and nut. In addition, for convenient reference, all torque requirements are tabulated below.

STANDARD TORQUE SPECIFICATIONS

Note: All torque values are given in pound feet (newton meters).

Size	Threads per inch	Standard heat-treated bolts and screws	Special heat-treated bolts screws, Allen-head screws and self-locking capscrews	Nuts
				
1/4	20	6-8 (8-11)	9-11 (12-15)	
	28	8-10 (11-14)	10-12 (14-16)	
5/16	18	13-16 (18-22)	17-20 (23-27)	
	24	14-18 (19-24)	19-23 (26-31)	
3/8	16	26-32 (35-43)	36-43 (49-58)	
	24	33-40 (45-54)	41-49 (56-66)	17-20 (23-27)
7/16	14	42-50 (57-68)	54-65 (73-88)	
	20	50-60 (68-81)	64-77 (87-104)	
1/2	13	67-80 (91-108)	81-97 (110-132)	
	20	83-100 (113-136)	96-115 (130-156)	

SPECIAL TORQUE SPECIFICATIONS

Output flange nut 2 (A, foldout 11)	300 (408)
Bevel drive gear nut 35 (B, foldout 9)	350 to 400 (475-542)
Clutch pressure plate stud 28 (B, foldout 12)	16 to 19 (22-26)
Bevel gear retainer nut 6, 12 (A, foldout 10)	25 to 30 (34-41)

Section 5. DISASSEMBLY OF TRANSMISSION INTO SUBASSEMBLIES

5-1. SCOPE OF SECTION 5

a. Models Covered. This section describes the disassembly of VH and VS series transmissions.

b. Disassembly Sequence

(1) The sequence of instructions is divided into major groups applicable to:

- VH and VS Series — removal of external components, torque converter, drive control valve, over-running clutch, output flange, end cover, output shaft, main housing, oil pump and oil pan.
- VH and VS1 Series — removal of matched bevel gears, direct and hydraulic clutches.
- VS2 Series — removal of input splitter clutches, matched bevel gears, drive clutches and splitter clutch control valve body.

(2) Each group is identified with the models to which the procedures apply. Any procedure not applicable to the transmission being disassembled may be disregarded, and disassembly continued with the next applicable procedure.

c. Illustrations

(1) Disassembly is referenced primarily to photographs in this section. When necessary, procedures are referenced to parts exploded views (foldout 9 through 15) at the back of the manual.

(2) In addition to the photographs and exploded views, there are two cross-section views (foldouts 1 and 2) in the back of the manual. These show the assembled relationship of parts and are helpful in determining the most expedient method of removing given components during partial disassembly.

5-2. SERVICING OF VEHICLE-MOUNTED TRANSMISSION

a. Service, Maintenance. The VH and VS transmissions are designed so that some service and maintenance operations can be accomplished without removing the transmission from the vehicle. The disassembly procedures in this manual, however, illustrate the operations with the transmission removed.

b. Accessibility. The nature of the service required and the accessibility to that area (or component) will determine the advisability of performing major operations without removing the transmission. Although the procedures for disassembly are essentially the same, the position of the transmission may cause some inconvenience at times. A close inspection should be made, and the foregoing factors weighed, before deciding if the transmission should be removed. Listed below are the transmission components or subassemblies that may normally be removed with the transmission in the vehicle:

(1) Drive clutch control valve assembly

(2) Splitter clutch control valve assembly (VS2 only)

(3) Over-running clutch and drive shaft

(4) Torque converter and housing

(5) Oil (sump) pan

(6) Oil pump

(7) Hydraulic, direct drive clutch pack

5-3. DISASSEMBLY PROCEDURES

a. Removing Exterior Components

(1) The transmission assembly can be raised from the floor or dolly by use of a

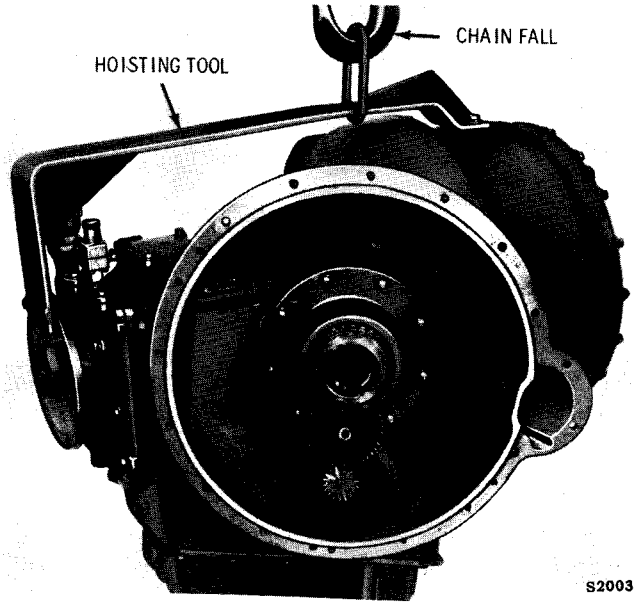


Fig. 5-1. Lifting transmission

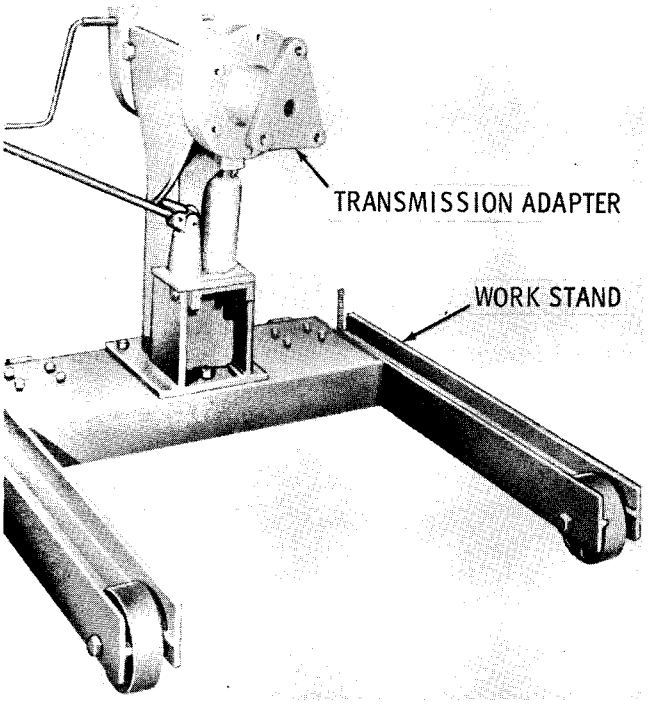


Fig. 5-2. Transmission workstand and adapter

suitable hoisting tool (fig. 5-1). One end of the tool is equipped with pins which engage holes in the transmission output flange and the other end is attached by bolts at the cooler line fitting holes on top of the converter housing. During overhaul procedures, the unit should be mounted in a workstand (fig. 5-2). Raise the unit high enough to aline the tapped holes in the transmission housing with holes in the workstand adapter. Insert three bolts (3/4-10 x 1 1/2) through the stand adapter and into the transmission housing (fig. 5-2).

(2) Remove seven bolts and lockwashers from the drive clutch control valve assembly (fig. 5-3).

(3) Remove the valve assembly, gasket 5 (B, foldout 14), accumulator valve 4, spring 2 and spring 3. Refer to paragraph 6-3 for rebuild of the drive clutch control valve assembly.

(4) On the VS2 series only, remove three bolts and lockwashers from splitter clutch control valve assembly (fig. 5-4). Remove the valve body assembly and gasket. Refer to paragraph 6-4 for rebuild of the splitter clutch control valve assembly.

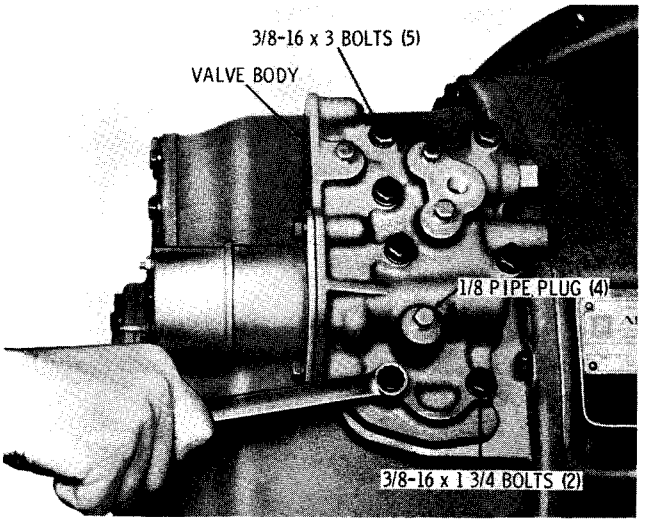


Fig. 5-3. Removing (or installing) drive clutch control valve assembly

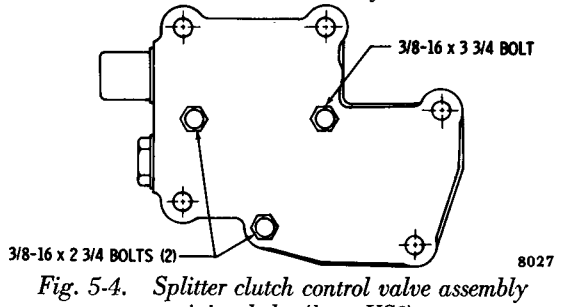


Fig. 5-4. Splitter clutch control valve assembly retaining bolts (later VS2)

b. Removing Oil Level Gage, Oil Pan, Oil Pump

(1) Remove oil level gage and filler cap 8 (B, foldout 10) and gasket 9 from the oil filler hole.

(2) Remove nineteen bolts 29 (A, foldout 14) from oil pan 28 and remove the oil pan and gasket 1. Remove retaining spring 24 and pump screen 23.

(3) Remove two bolts and washers 22 (A, foldout 14). Remove reinforcement 21, pump screen cover 20 and gasket 19.

(4) Remove the control valve body (main pressure) oil line (fig. 5-5) and the converter oil line. Loosen the case oil gallery (lubrication) oil line at the fitting in the housing. This oil line and the outlet housing (bevel gear lubrication) will be removed with the oil pump.

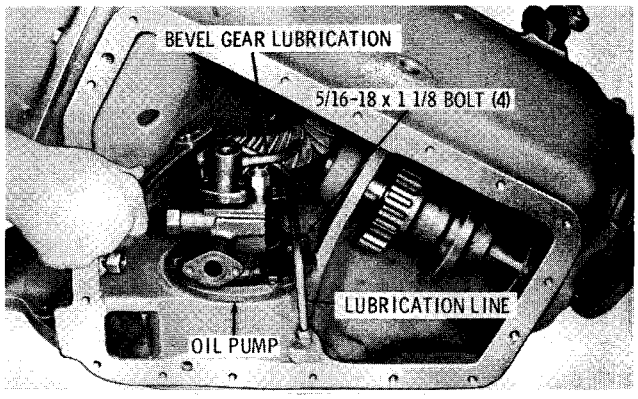
(5) Remove four bolts and lockwashers and remove oil pump (fig. 5-6). Remove outer snapring 7 (A, foldout 14) from pump shaft and remove driven gear 6, and pin 5. Refer to paragraph 6-5 for rebuild of oil pump.

c. Removing Over-running Clutch, Drive Shaft

(1) Remove nine bolts 23 (B, foldout 13) and lockwashers 22 from converter housing cover cap 21. Remove cap and gasket 20.

(2) Remove lockwire 1 (fig. 5-7) and eight bolts 6 that retain outer race 5. Install two 1/4-28 or 3/8-24 bolts into puller bolt holes 7 and remove the over-running clutch and drive shaft as a unit (fig. 5-8).

(3) Remove drive shaft outer snapring 2 (fig. 5-7) and lockring 3 from drive shaft 4.



S2007

Fig. 5-6. Removing (or installing) oil pump

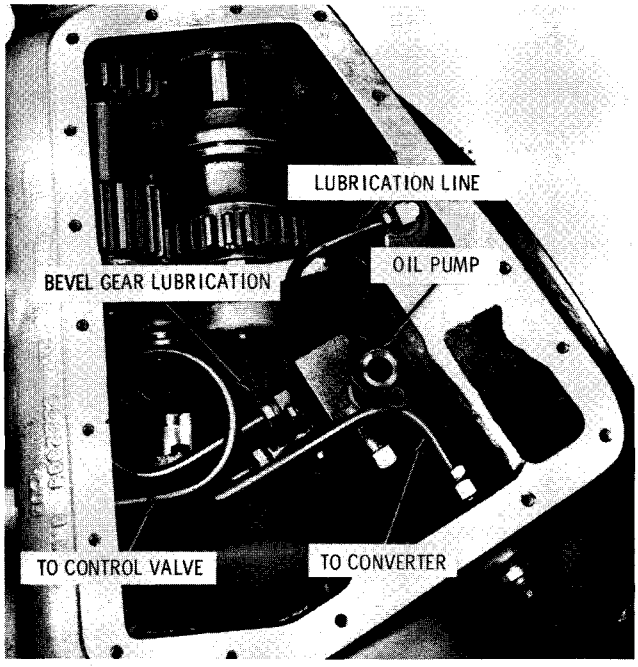


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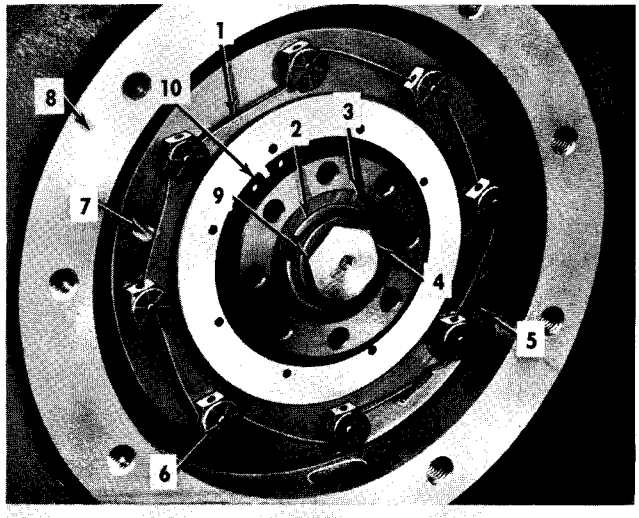
Fig. 5-5. Oil pump and lines, installed



1 Lockwire
2 Drive Shaft Outer Snapring
3 Lockring
4 Drive Shaft
5 Outer Race
6 Bolts
7 Puller Bolt Hole
8 Housing Cover
9 Lube Check Valve
10 Rear Washer Snapring

S2008

Fig. 5-7. Over-running clutch

(4) Remove over-running clutch assembly from drive shaft assembly by sliding the splined inner race off the shaft splines.

(5) Remove the drive shaft retaining internal snapring 17 (B, foldout 13) from the inner race.

(6) Remove the snapring retaining the rear washer to the inner race (fig. 5-9).

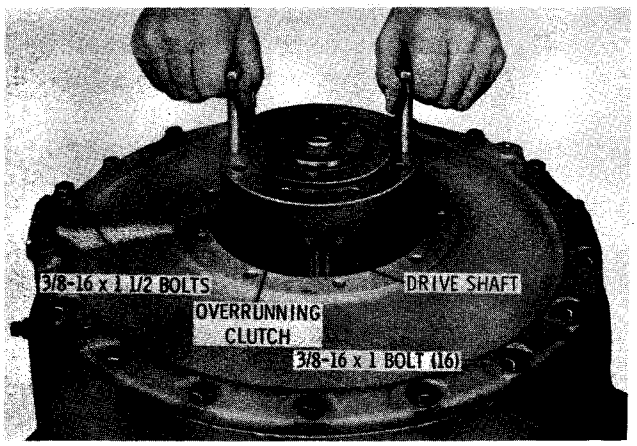


Fig. 5-8. Removing (or installing) over-running clutch and drive shaft assembly

(7) Remove the rear washer, outer race and rollers.

(8) Remove the snapring that retains the bearing on the inner race.

(9) Using a press and press plates, remove the bearing and front washer by supporting the front washer and pressing against the end of the inner race.

(10) Remove check valve assembly, items 5 through 9 (fig. 5-10) from drive shaft 2. Remove sealring 8 from the check valve assembly and discard the sealring.

(11) Remove check valve cap 5 (fig. 5-10) from valve body 9 and remove spring 6 and check valve 7.

(12) Remove hook-type sealring 4 from groove 1 in shaft 2.

(13) Do not remove orifice plug 3 from shaft 2 unless necessary. If necessary, unscrew the plug from the shaft.

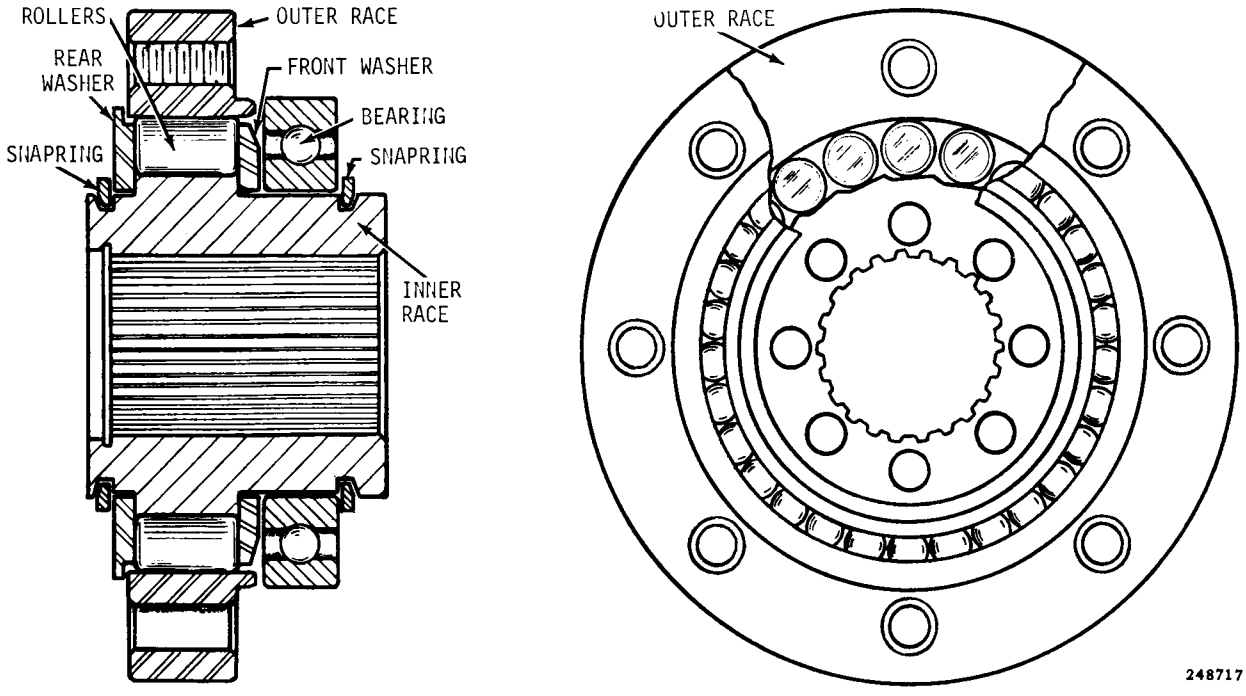


Fig. 5-9. Over-running clutch assembly, roller type

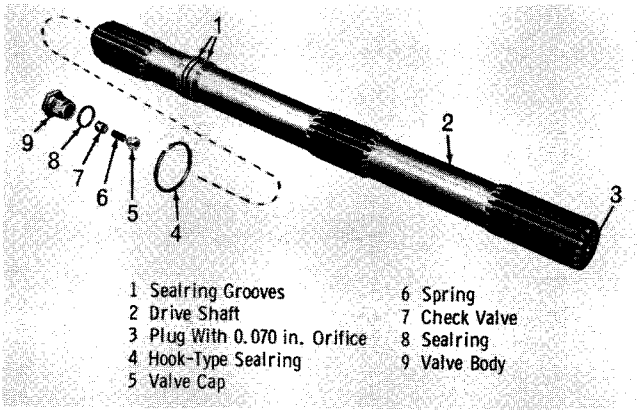


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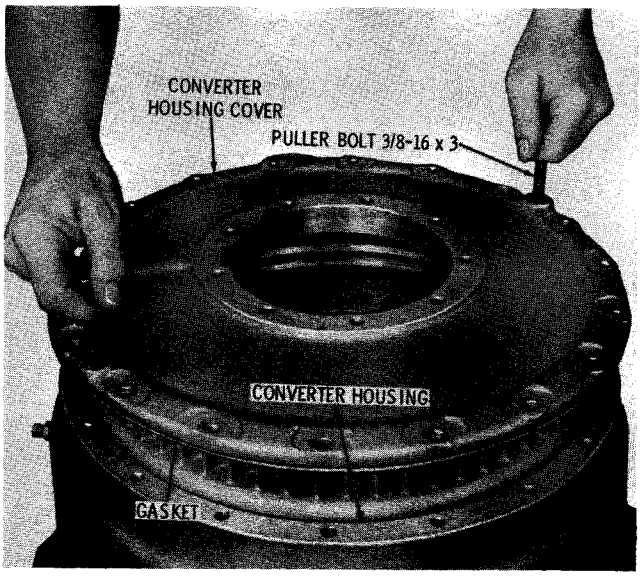
Fig. 5-10. Drive shaft components



S2012

Fig. 5-11. Removing (or installing) converter housing cover

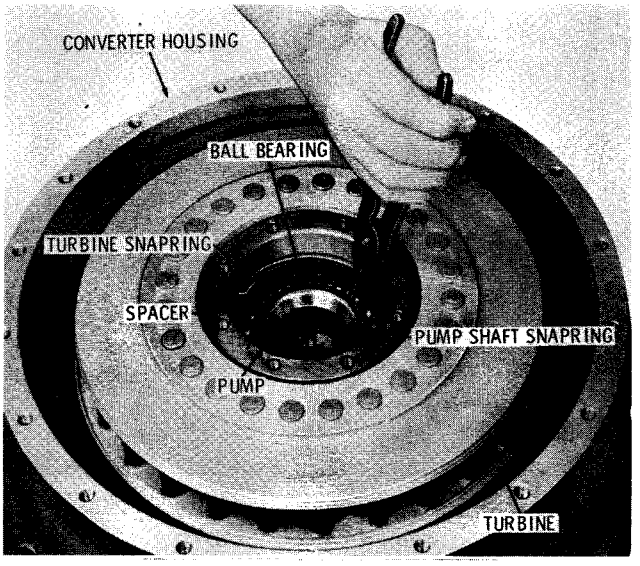
d. Removing Converter Housing Cover, Turbine, Converter Housing, Converter Pump

(1) Remove eighteen bolts 23 and 25 (A, foldout 13) and lockwashers 22 and 24 from converter housing cover 21.

(2) Install two puller bolts into the cover (fig. 5-11). Lift the cover from the converter housing and remove the gasket.

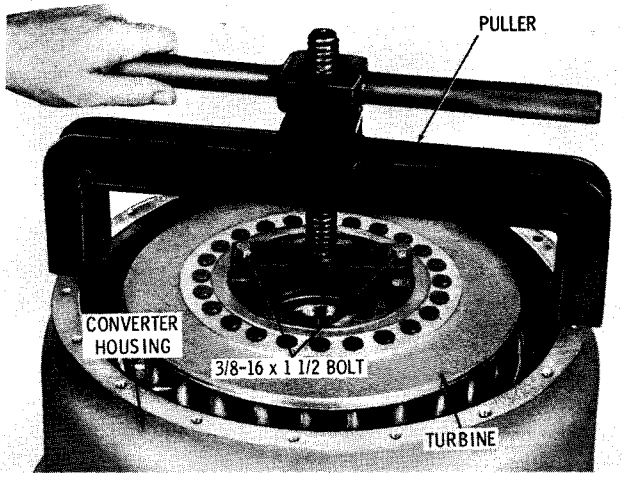
Note: The stator vanes and ring are an integral part of the cover.

(3) Remove the pump shaft snapring (fig. 5-12) that retains the turbine and pump bearing.



S2011

Fig. 5-12. Removing (or installing) turbine and pump bearing retaining snapring



S2013

Fig. 5-13. Removing turbine from pump shaft and converter housing

(4) Install a puller (fig. 5-13) using two 3/8-16 x 1 1/2-inch bolts in the turbine. Remove the turbine, turbine snapring, spacer and ball bearing.

(5) Remove the snapring, spacer and ball bearing from the turbine.

(6) On the VH transmission, remove the inner bearing snapring from the groove in the converter housing flange (fig. 5-14). The snapring cannot be removed from the assembly at this time but should be placed in the groove in the pump.

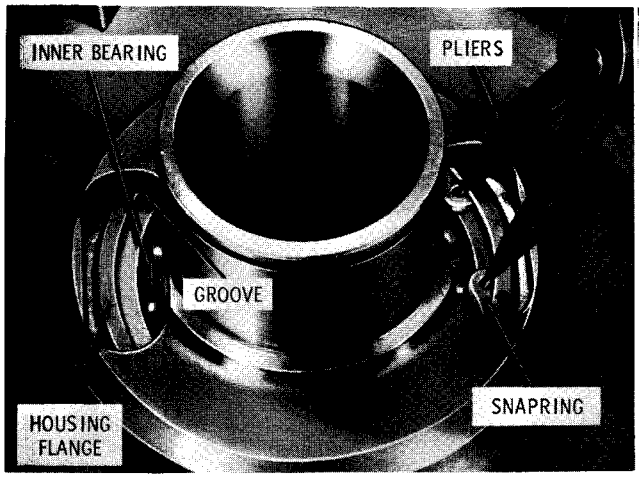


Fig. 5-14. Removing (or installing) inner bearing snapring (VH, VSI series)

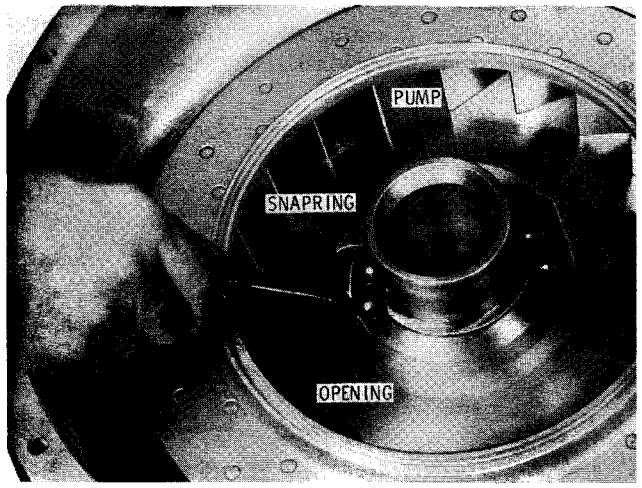


Fig. 5-15. Removing (or installing) inner bearing snapring (VS2 series)

(7) On the VS2 transmission, the snapring (fig. 5-15) can be removed from the pump by lifting the snapring from the groove and rotating the pump, thus working the snapring out of the opening in the pump.

(8) Remove sixteen bolts 9 (A, fold-out 13) and lockwashers 8 from the converter housing to the main housing splitline.

(9) Remove the converter housing (fig. 5-16) from the main housing. The pump, bearing and snapring (VH only) will come off with the housing. Remove a 1/8 pipe plug and a 1/4 pipe adapter from the housing.

(10) Remove the pump assembly (fig. 5-17) by tapping, with a soft hammer, on the

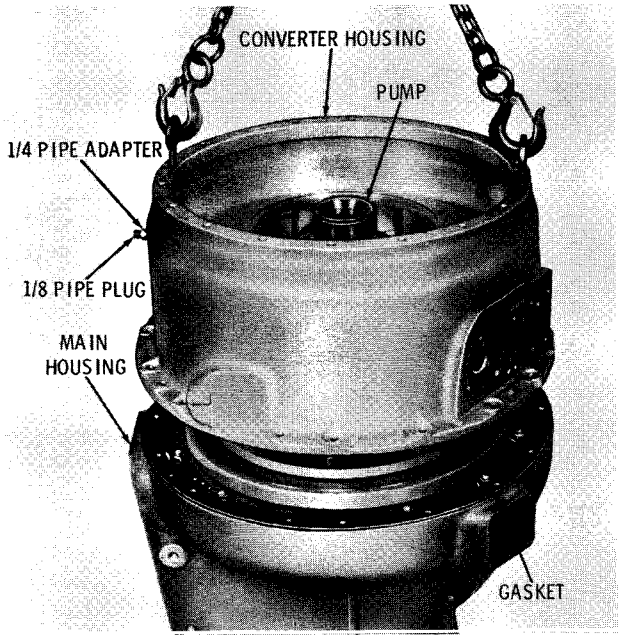


Fig. 5-16. Removing (or installing) converter housing

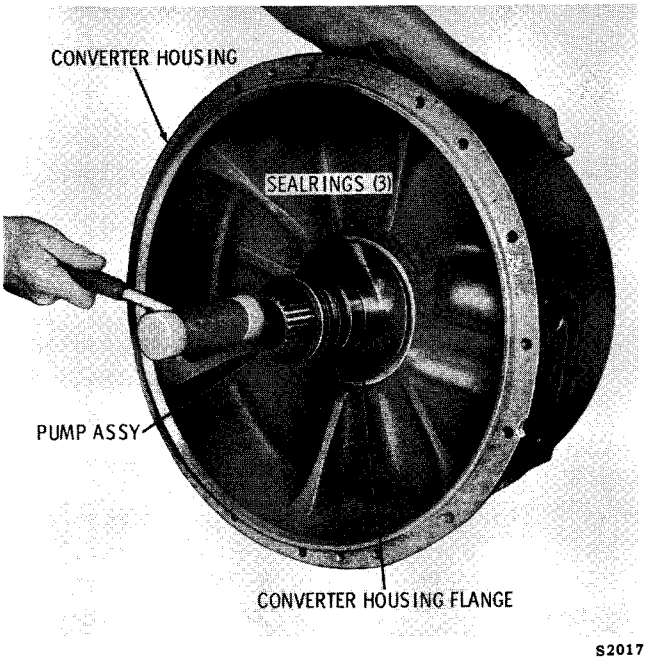


Fig. 5-17. Removing pump assembly from converter housing

splined end of the pump shaft. Remove six bolts from the converter housing flange and remove the flange. (On VH series transmissions, remove converter housing flange gasket.) Remove three sealrings from the flange.

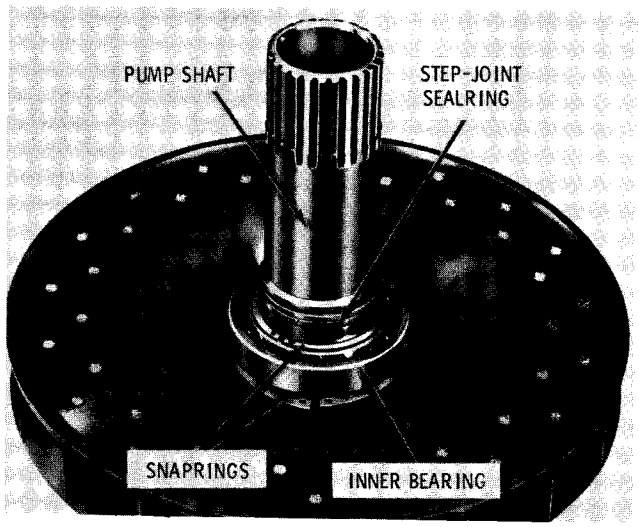
(11) Remove the step-joint sealring (fig. 5-18) from the pump shaft. Remove the external snapring from the pump shaft. Using a soft drift and light hammer, tap lightly on the inner race of the bearing and remove the bearing. On the VH series, remove the internal snapring that was previously removed from the converter housing flange in (6), above. On the VS2 series, the snapring was removed in (7), above. Refer to paragraph 6-12 for rebuild of the converter pump assembly.

e. Removing Direct, Hydraulic Clutches (VH)

(1) Straighten the tangs on the tab locks (fig. 5-19) on nine clutch drive plate stud nuts. Remove the nuts and tab locks. Remove the clutch cover assembly from the drive plate assembly. If necessary, the puller bolt holes, in the clutch cover, can be used to remove the clutch cover.

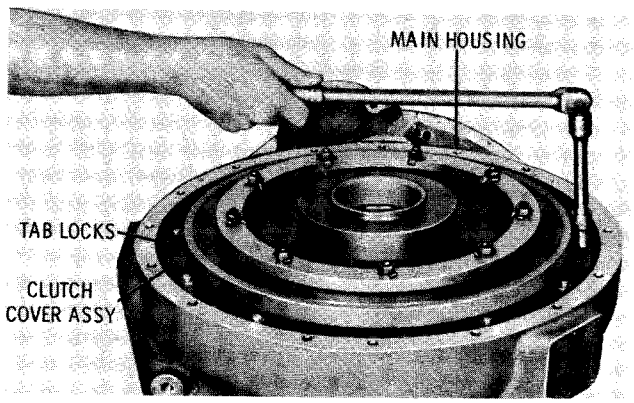
(2) Remove the clutch apply plate (fig. 5-20), four external-tanged and three internal-splined clutch plates from the drive plates. Some earlier model transmissions will have five external-tanged and two internal-splined clutch plates.

(3) Straighten the tangs on the tab locks (fig. 5-21) and remove nine nuts and tab locks from the clutch cover assembly. Remove clutch spring inner ring, Belleville spring and nine spacers. Remove the clutch spring outer ring.



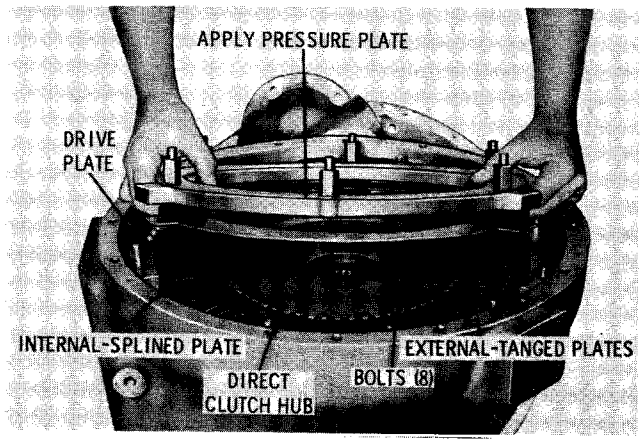
S2018

Fig. 5-18. Pump removed from housing



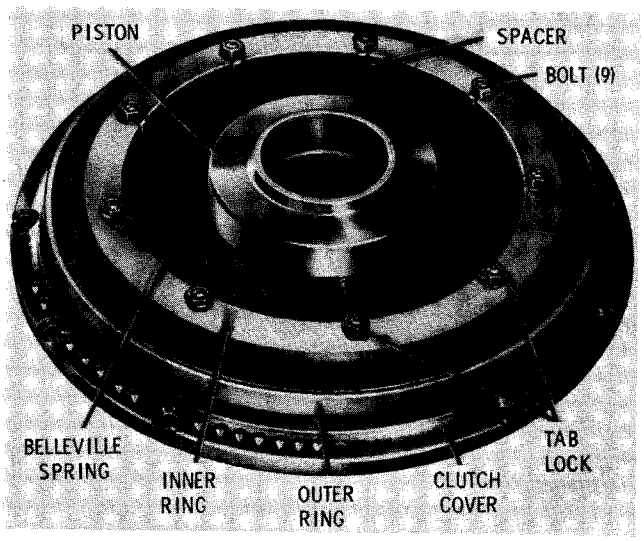
S2019

Fig. 5-19. Removing clutch cover assembly (VH series)



S2020

Fig. 5-20. Removing (or installing) clutch apply plate and direct clutch plates (VH series)



S2021

Fig. 5-21. Clutch cover assembly, removed (VH series)

(4) Remove nine bolts from the opposite side of the clutch cover. Remove the direct drive clutch piston and hook-type sealring from the clutch cover.

(5) Remove nine bolts 35 (B, foldout 12) and nuts 12 and remove hydraulic clutch driving cone 13 from clutch cover 33. Remove clutch cone hub 14 and thrust washer 15.

(6) Position the clutch cover assembly (fig. 5-22) in a press and, using a suitable sleeve, compress the assembly enough to remove the snapring from the groove in the hub of the cover. Remove the spring retainer. Remove the sealring and expander from the outer diameter of the retainer (para 4-8).

(7) Remove six piston return springs 20 (B, foldout 12) and remove clutch piston assembly 21. Remove sealring 24 and expander 25 (para 4-8). Remove hook-type sealring 26 from clutch cover 33.

(8) Remove eight bolts (fig. 5-20), that retain the bearing retainer and clutch drive plate to the bevel gear sleeve, through holes in the direct clutch hub.

(9) Install two 7/16-14 puller screws through the drive clutch hub and bearing retainer, and into the drive plate (fig. 5-23). Remove the clutch drive plate, direct clutch hub with bearing and the bearing retainer from the bevel gear sleeve.

Note: By using long-thread puller screws, the clutch drive plate can be forced upward against the clutch hub. Continue tightening the puller screws until the hub, retainer and bearing, and clutch drive plate can be lifted off.

(10) Remove the puller screws, and remove hub 8 (B, foldout 12) and retainer 7 from drive plate 2. Using snapring pliers, remove bearing retaining snapring 5 from direct clutch hub 8 and remove bearing 6 and retainer 7.

(11) Remove two screws (fig. 5-24) from the oil shield and remove the shield.

f. Removing Direct, Hydraulic Clutches (VS)

(1) The direct and hydraulic clutches can be removed as an assembly, after the completion of a through d, above.

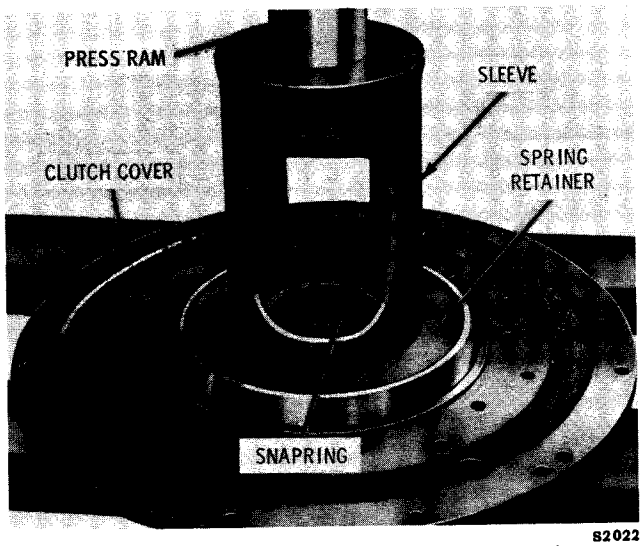


Fig. 5-22. Removing (or installing) spring retainer snapring (VH series)

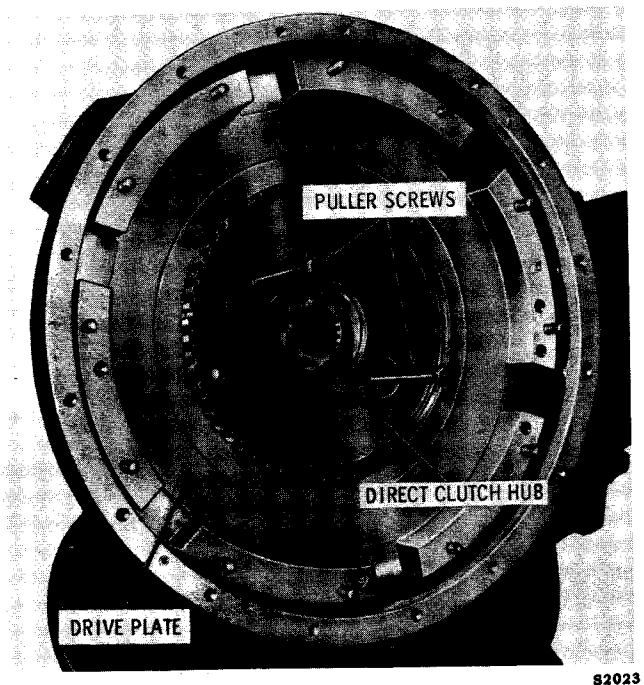


Fig. 5-23. Removing clutch drive plate and direct clutch hub (VH series)

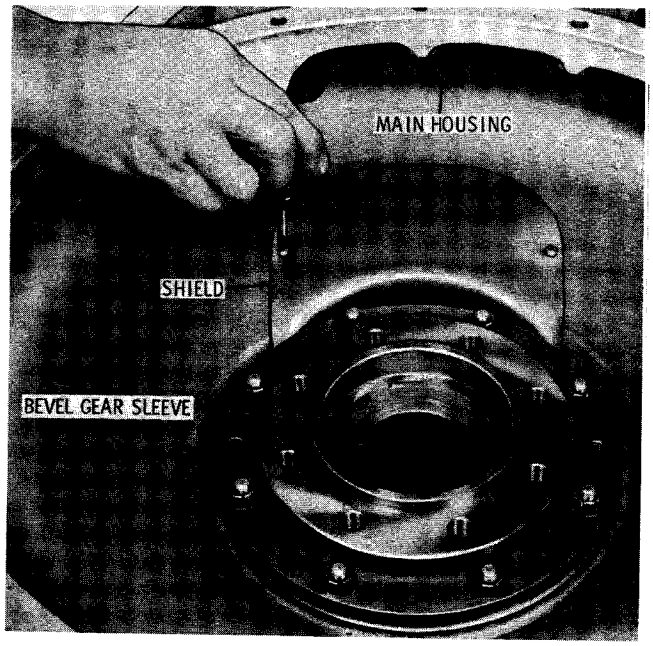


Fig. 5-24. Removing (or installing) oil shield (VH series)

(2) Remove the clutch assembly from the main housing (fig. 5-25). Remove the thrust washer and needle bearing.

(3) Lay the clutch assembly (fig. 5-26) on a flat surface with the hydraulic drive clutch side up.

Note: The hydraulic drive clutch side has the thrust washer surface and the direct clutch side has the ball bearing and internal spline.

(4) Remove nine bolts from the clutch cover. Remove cover and piston assembly by tapping lightly on the edge with a soft hammer.

(5) Remove piston 23 (A, foldout 12) from the cover. Remove seals 25 and 27, and expanders 24 and 26 from the piston (para 4-8).

(6) Remove six piston return springs 22. In earlier model transmissions, remove snapring, spacer and Belleville spring (not illustrated — used instead of springs 22).

(7) Remove the hydraulic clutch hub (fig. 5-27) with bearing and snapring. Remove the bearing and snapring from the hub. Remove six external-splined and six internal-splined clutch plates.

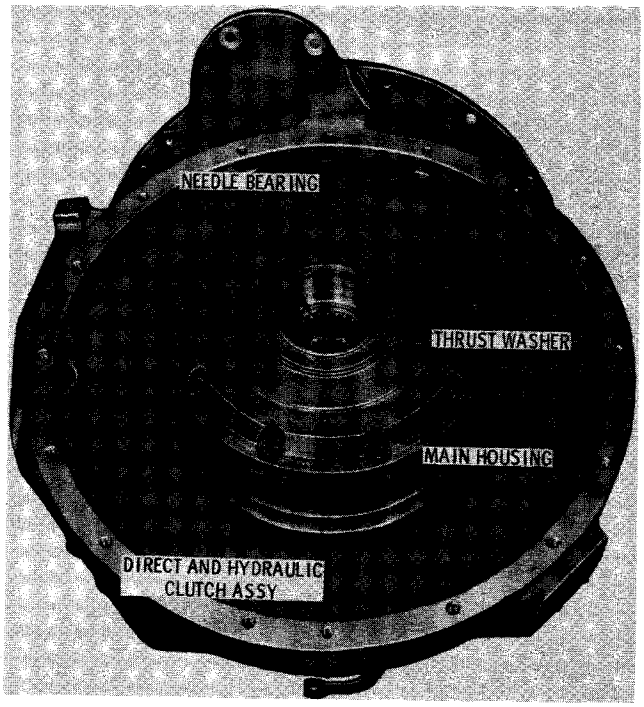


Fig. 5-25. Removing (or installing) direct and hydraulic drive clutch assembly (VS series)

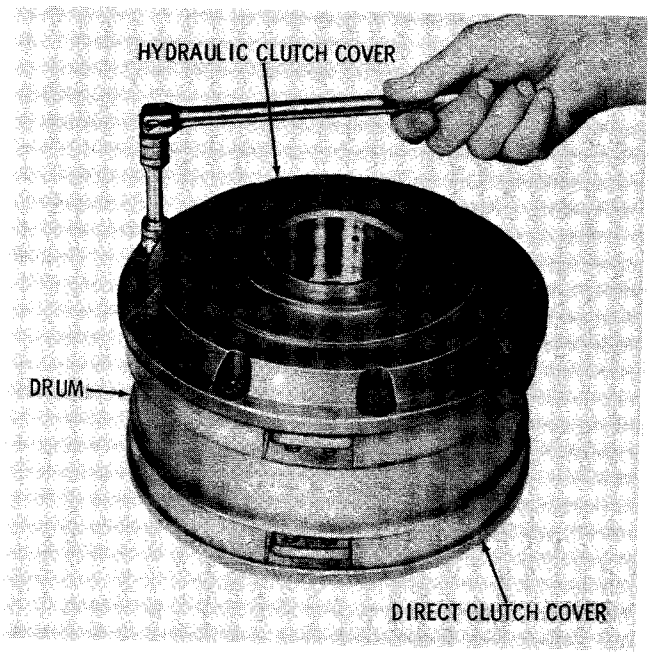


Fig. 5-26. Removing (or installing) hydraulic clutch cover (VS series)

(8) Remove the backup plate snapring (fig. 5-28) from the drum. Remove the backup plate and the other backup plate snapring. Turn drum over and remove seven external- and seven internal-splined plates (plates will drop out).

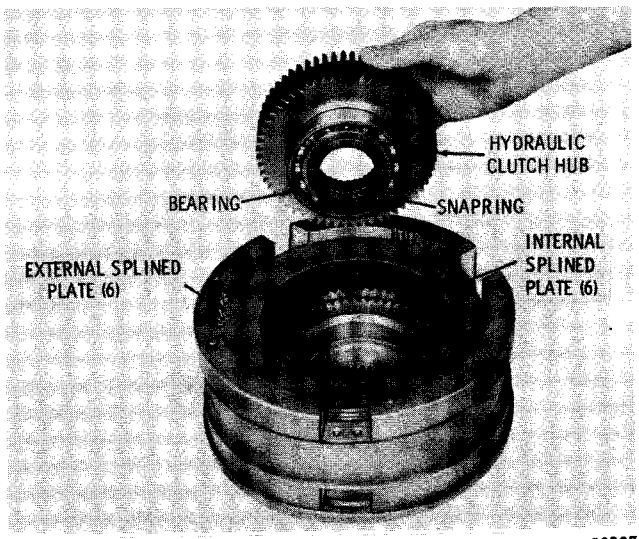


Fig. 5-27. Removing hydraulic drive clutch hub (VS series)

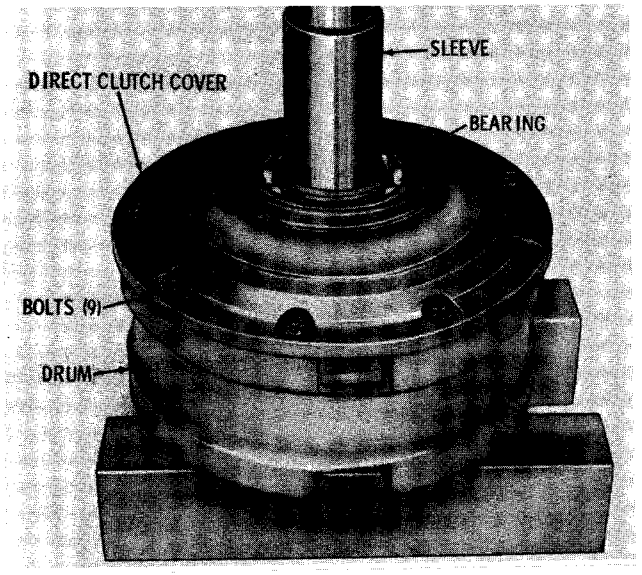


Fig. 5-29. Removing direct clutch hub from bearing (VS series)

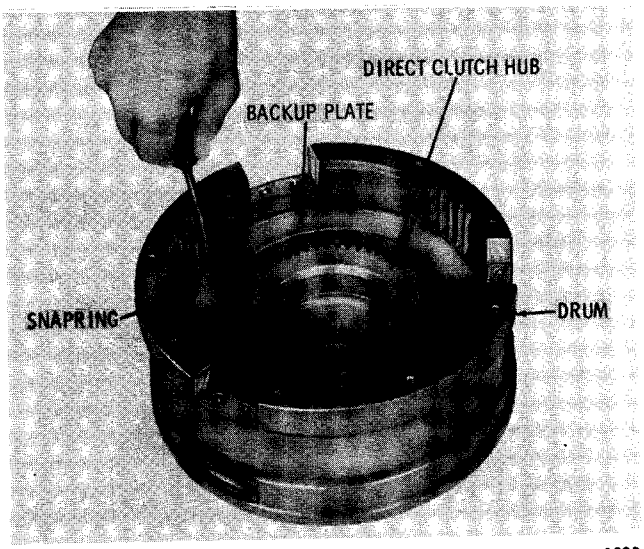


Fig. 5-28. Removing (or installing) backup plate snapring (VS series)

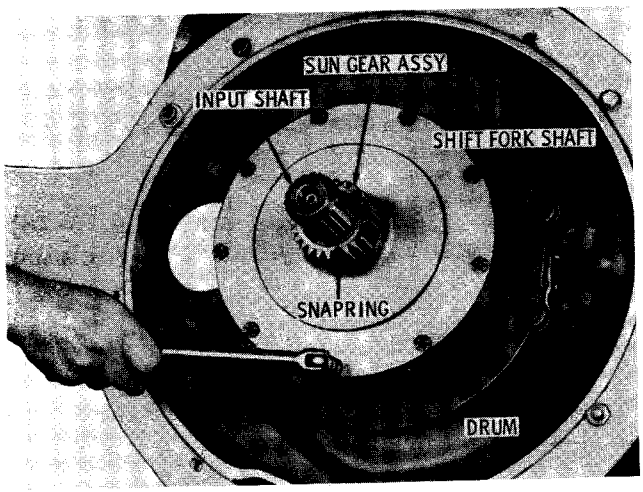


Fig. 5-30. Removing bolts from input splitter carrier sun gear assembly (VS2 series)

(9) Place the clutch drum in a press and press the direct clutch hub out of the bearing (fig. 5-29). Remove the bearing and hub from the clutch drum. Remove nine bolts from the direct clutch cover and remove the cover and piston by tapping on the edge of the cover with a soft hammer.

(10) In earlier model transmissions, remove a snapring and Belleville spring (not illustrated).

(11) Remove piston 7 (A, foldout 12) from cover 2. Remove seals 3 and 5 and expanders 4 and 6 from the piston (para 4-8).

g. Removing Splitter Clutches (VS2, only)

(1) Remove the snapring (fig. 5-30) from the input shaft. Remove nine bolts from the sun gear assembly. Remove the sun gear assembly. Do not remove the bushing from the sun gear assembly, unless it is worn or damaged.

(2) Remove thrust washer 17 (A, foldout 9) from the hub. Remove hub assembly 18, four internal-splined plates 21 and three external-splined plates 22 and pressure plate 23.

(3) Remove wrap-around snapring 24 from splitter clutch piston assembly 43. Remove thrust washer 25, thrust bearing 26 and spring thrust ring 27 from clutch piston assembly 43.

(4) Splitter clutch drum 30 with Belleville spring 29 and splitter overdrive clutch assembly can now be removed from clutch retainer assembly 37.

(5) Place the clutch drum assembly on a table and remove nine bolts 35 (A, foldout 9) from back plate 34. Remove the back plate, four internal-splined clutch plates 32, three external-splined clutch plates 33 and pressure plate 31. Remove two snaprings 28 and Belleville spring 29 from the drum.

(6) Remove thrust washer 2 (fig. 5-31) from clutch retainer 1. Remove five bolts 6 attaching retainer 1 to the transmission housing. Remove the retainer assembly with the piston assembly.

Note: Resistance will be felt when removing the retainer assembly due to the shearing of rubber sealring 10 (B, foldout 9). This is normal for this removal.

(7) Remove three bolts 48 (A, foldout 9) attaching piston retainer 47 to clutch retainer assembly 37. Remove piston assembly 43 from piston retainer, then remove sealring 46 from the piston. Do not remove bushing 45 from piston 44 unless it is worn or damaged. Remove snapring 42 and sealring 41 from the clutch retainer assembly 37.

Note: Direct and overdrive clutches can be built up as a subassembly for assembling into the transmission. Refer to paragraph 6-6 for rebuild.

h. Removing Bevel Drive (Pinion) Gear Assembly (VH, VS1)

(1) Remove eight self-locking nuts from studs 6 (fig. 5-32) retaining bevel pinion gear

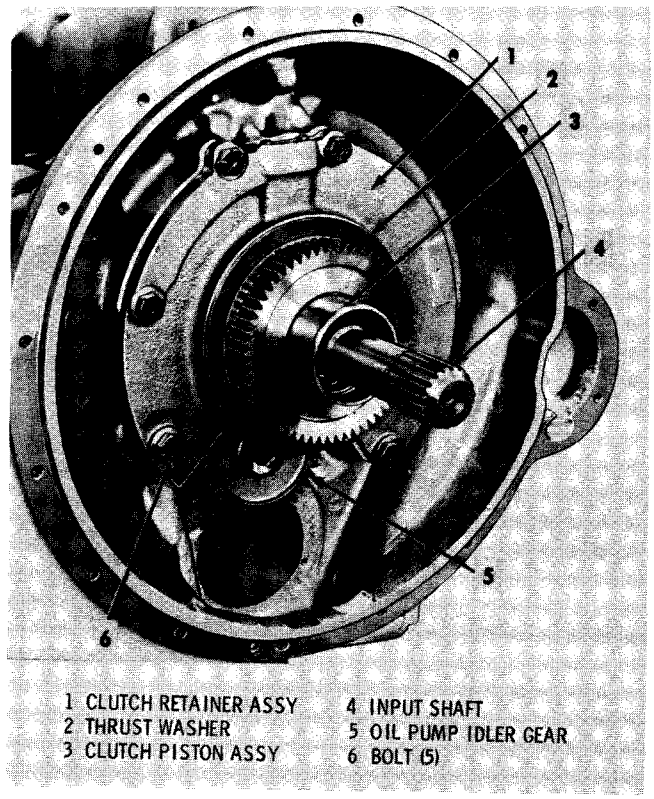


Fig. 5-31. Clutch retainer and input shaft (VS2 series)

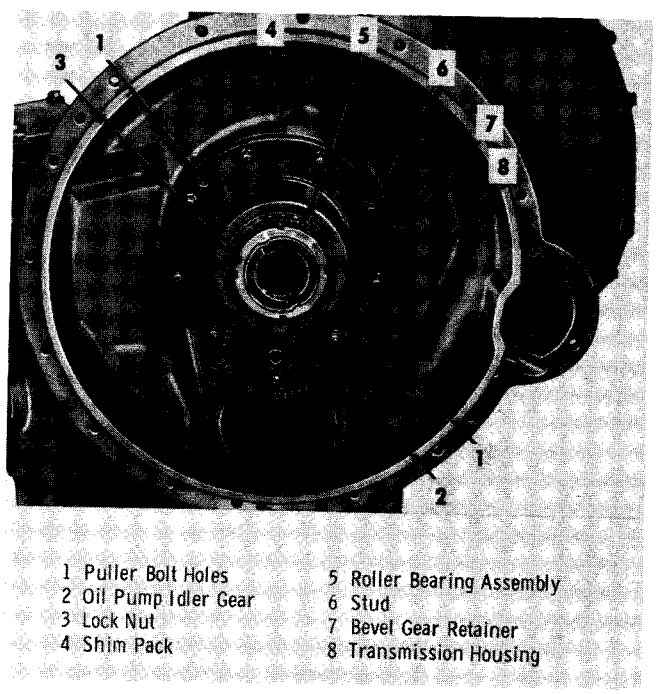


Fig. 5-32. Matched bevel pinion gear, installed (VH, VSI series)

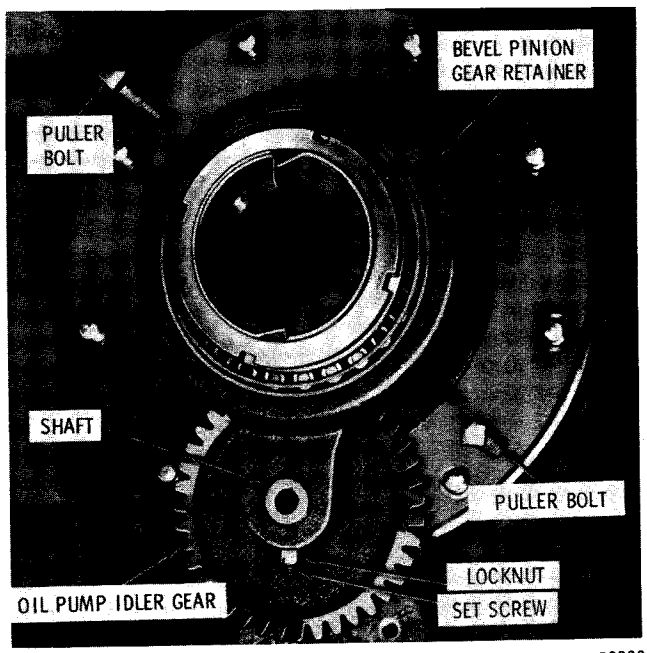


Fig. 5-33. Removing bevel pinion gear bearing retainer (VH, VSI series)

retainer in transmission housing. Later model transmissions will have eight self-locking bolts 39 (A, foldout 10) instead of the eight nuts and studs.

(2) Install two 3/8-16 x 3 puller bolts into the bevel pinion gear bearing retainer (fig. 5-33) and remove the bevel pinion gear bearing retainer, bevel pinion gear, roller bearings, oil pump drive gear and oil pump idler gear as an assembly. For rebuild of this subassembly, refer to paragraph 6-7.

(3) Remove the shims from the main housing and tag for identification.

i. Removing Bevel Drive (Pinion) Gear Assembly (VS2)

(1) Remove snapring 9 (fig. 5-34), retaining oil pump idler gear 8. Remove step-joint sealring 4 and sealring 6 from input shaft 7. Remove idler gear 8 and thrust washer 10.

(2) Remove eight self-locking nuts 5 (fig. 5-34), retaining bevel pinion gear bearing retainer. Later model transmissions will have eight self-locking bolts 17 (B, foldout 9) instead of the eight nuts and studs.

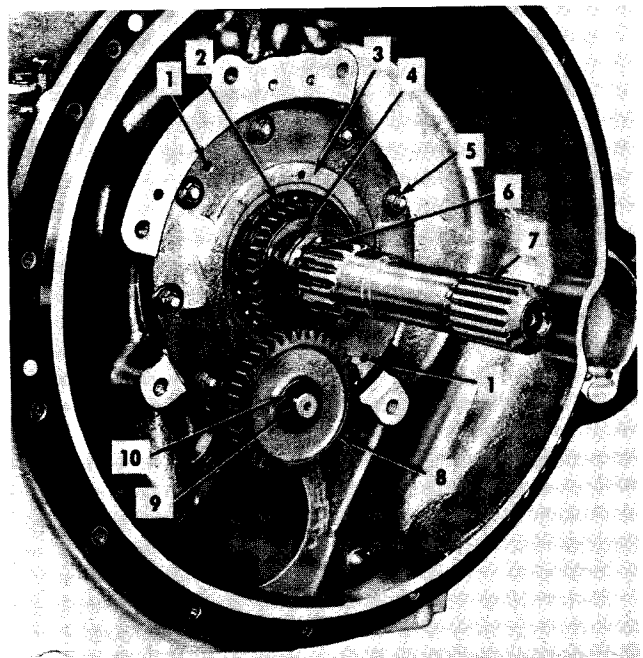


Fig. 5-34. Input shaft and bevel pinion gear bearing retainer, installed (VS2 series)

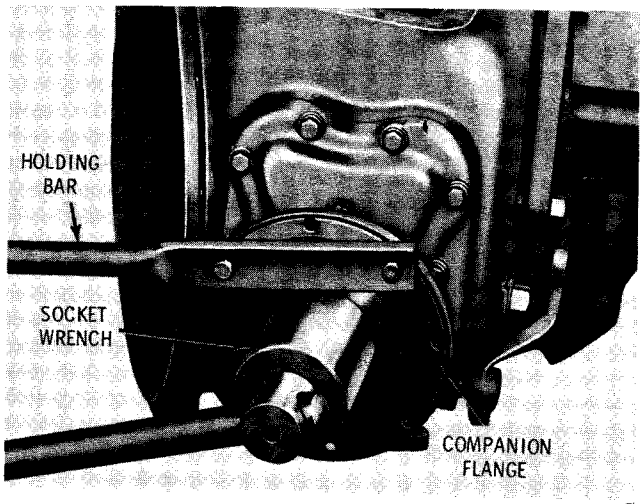
(3) Install two bolts in puller bolt holes 1 (fig. 5-34). Remove, as an assembly, from the main housing, the bevel pinion gear bearing retainer, input shaft, two roller bearing assemblies, oil pump drive gear and the bevel pinion gear. Remove the oil pump idler gear pin. For rebuild of this subassembly, refer to paragraph 6-8.

(4) Remove the shims from the main housing and tag for identification.

j. Removing Companion Flange, End Cover

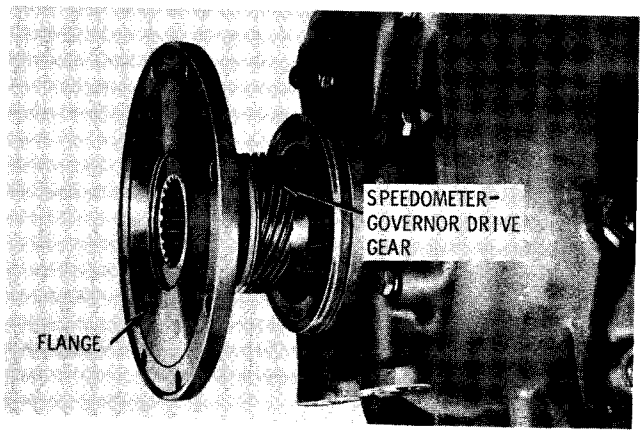
(1) Remove cotter pin 1 (A, foldout 11) from nut 2.

(2) Hold the flange with a holding bar (fig. 5-35). Using a 2 1/2-inch socket wrench, remove the flange retaining nut. Remove companion flange (fig. 5-36) and speedometer-governor drive gear as an assembly.



S2035

Fig. 5-35. Removing (or installing) flange nut



S2036

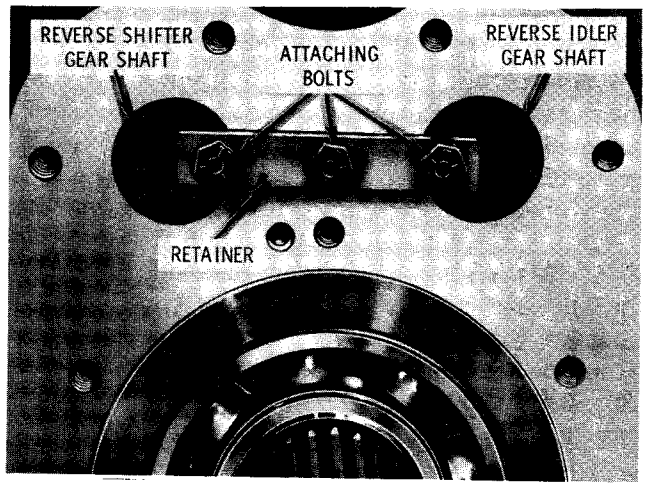
Fig. 5-36. Removing (or installing) companion flange

(3) With a screwdriver, pry the speedometer-governor drive gear from the flange. Remove the gear key from the flange. On earlier model transmissions remove the hook-type sealring from the flange.

(4) Remove ten bolts 34 and 36 (A, foldout 11) and lockwashers 33 and 35 from end cover assembly 22. Remove end cover and oil seal 7 from the transmission housing. If the seal is worn or damaged, remove the seal from the cover.

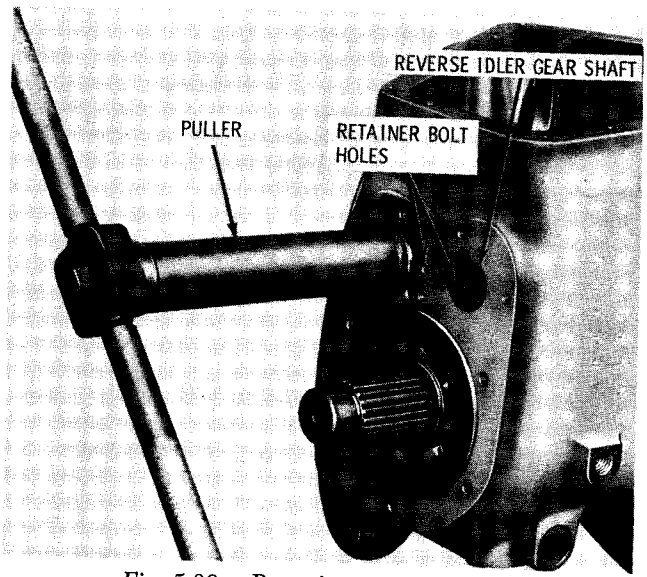
(5) Remove governor driven shaft and gear assembly 21 from the end cover.

(6) Remove two bolts 16 (A, foldout 11) and lockwashers 15 from speedometer drive sleeve assembly 11. Remove sleeve assembly 11, fiber seal washer 9 and gasket 10. Remove speedometer driven shaft and gear assembly 8.



S2037

Fig. 5-37. Reverse shifter and idler shaft retainer



S2038

Fig. 5-38. Removing reverse idler gear and shifter shafts

(7) If necessary, remove bushings 23 from the end cover, using an extractor.

k. Removing Reverse Gears, Output Shaft

(1) Remove three bolts and washers (fig. 5-37) and the shaft retainer.

(2) Using slide hammer J-2619 or a suitable puller screw and puller body, remove the reverse shifter gear and reverse idler gear shafts from the main housing (fig. 5-38).

(3) Remove reverse shifter gear assembly 25 (B, foldout 11), reverse idler gear 24 (including two needle bearings 22), and two reverse idler gear thrust washers 21 from the main housing. Earlier model transmissions will have two bushings 23 instead of two needle bearings 22 in reverse idler gear 24.

(4) Using a hammer and soft drift, tap on the end of output shaft 28 (A, foldout 11) that is inside of the transmission housing. Remove the shaft, bearing 26, spring 29, cone 30, snapring 31 and bearing 32, as an assembly from the transmission housing.

Note: Bearing retainer 27 will usually remain in the transmission housing during this operation, but may remain with bearing 26, when the output shaft and components are removed from the housing. Production tolerances for the fit of the output shaft bearing retainer in the transmission housing is from 0.002-inch tight fit to 0.0005-inch loose fit.

(5) Output shifter gear 18 (B, foldout 11) and shifter fork shoes 16 can now be removed. Remove output intermediate gear 19 and bearing 20 from center bearing retainer.

(6) Do not disassemble the output shaft assembly, removed in (4), above, unless inspection indicates it is necessary. If necessary, proceed as follows.

(7) Position the output shaft assembly in a press. Using suitable remover plates under bearing 26 (A, foldout 11), press the output shaft from the bearing. If bearing retainer 27 remained with the bearing (when the output shaft was removed), press the bearing from the retainer.

(8) Remove bearing 32, snapring 31, brake cone 30 and spring 29 from the other end of the output shaft.

1. Removing Forward, Reverse Shift Controls

(1) Loosen bolt 8 (B, foldout 11) in shifter lever 11. Remove the lever from shifter fork shaft 6.

(2) Straighten the tang on the shifter detent lockwasher (fig. 5-39). Remove nut, detent spring, plunger, detent ball and lockwasher. Remove the barrel from the transmission housing.

(3) Remove four bolts 1 (B, foldout 11) and lockwashers 2 from shifter cover 3. Remove cover 3 and gasket 4 from the transmission housing.

(4) Straighten the lockstrip which retains the shifter fork bolts (fig. 5-40). Remove the bolts and lockstrip, then remove the keys.

Note: Keys are ring shaped, and must be removed from shifter fork (refer to foldout 1 or 2).

(5) Working from the input (engine) side of the transmission housing and using a soft drift, remove shifter fork shaft 6 (B, foldout 11) from the housing. Remove thrust washers 5 and shifter fork 15.

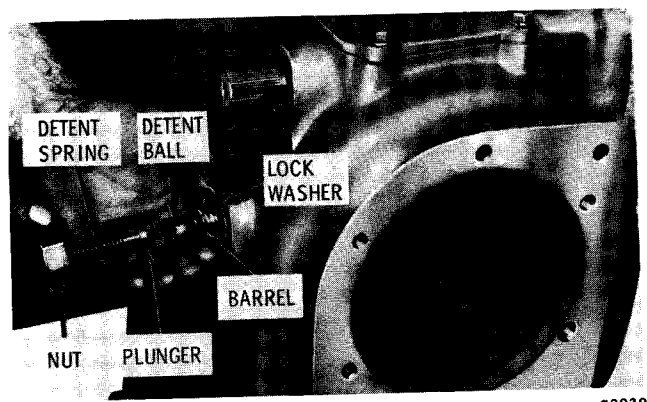


Fig. 5-39. Removing (or installing) shifter detent parts

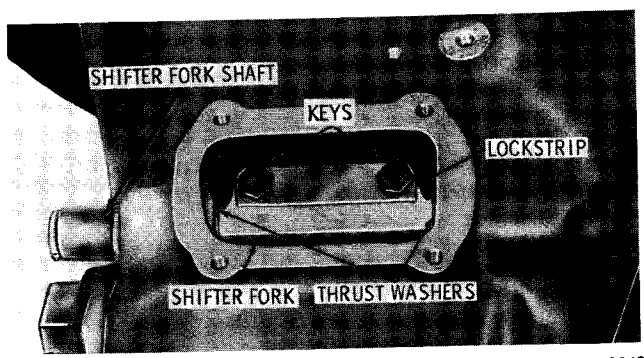


Fig. 5-40. Shifter fork and shifter fork shaft

m. Removing Bevel Driven Gear Assembly

Note: Removal procedures are identical for the VH and VS series. Illustration references, below, are for the VH and VS1 series.

(1) Remove eight self-locking nuts 6 (A, foldout 10) from studs retaining bevel gear bearing retainer 35 in the transmission housing. Later model transmissions will have eight self-locking bolts 38, instead of the eight nuts and studs.

(2) Install two 3/8-16 x 3-inch puller bolts into the bevel gear bearing retainer. Tighten the puller bolts to remove as an assembly, from the transmission housing, bevel gear bearing retainer 35, nut 28, bearing 29, bevel driven gear (part of gear assembly 25), bearing spacer 30, bolts 31, washers 32, retainer 33, bearing 34 and sleeve 37 with two keys 36. For rebuild of this subassembly, refer to paragraph 6-9.

(3) Remove the shims from the main housing and tag for identification.

(4) Do not remove center bearing retainer 3 (A, foldout 10) from the main housing, unless inspection indicates it is necessary. For rebuild of the main housing, refer to paragraph 6-10.

Section 6. REBUILD OF SUBASSEMBLIES

6-1. SCOPE OF SECTION 6

a. This section contains the rebuild procedures for the subassemblies which were removed in Section 5.

b. The subassemblies are presented in this section in the same order as removed in Section 5.

6-2. SUBASSEMBLY REBUILD — GENERAL INFORMATION

a. Tools, Parts, Methods. Refer to paragraph 4-3 through 4-5.

b. Cleaning, Inspection. Refer to paragraph 4-6.

c. General Assembly Procedures. Refer to paragraph 4-7.

d. Torque Specifications. The torque value for each threaded fastener installed in this section is given in the assembly instructions. Refer also to paragraph 4-13.

e. Wear Limits. Refer to Section 8.

f. Spring Information. Refer to paragraph 8-3 for spring identification and specifications.

6-3. DRIVE CLUTCH CONTROL VALVE ASSEMBLY

a. Disassembly (VH series with electric governor) (B, foldout 14)

(1) Remove the two bolts 38 and the lockwashers 37 from the neutral solenoid 36. Remove the solenoid, valve assembly 32 and gasket 35 from valve body 30. Separate the solenoid from the valve by unhooking the solenoid plunger from the slot in the valve. Remove direct drive solenoid 47 in the same manner.

(2) Remove plug 42 and sealring 41 from valve body 30. Remove the sealring from the plug. Remove valve 40 and spring 39.

(3) Remove three plugs 31 from the valve body.

Note: Refer to paragraph 6-2 above.

b. Assembly (VH series with electric governor) (B, foldout 14)

(1) Install three 1/8 NPTF plugs 31 into valve body 30.

(2) Install spring 39 on the smaller diameter end of valve 40 and install the valve, spring end first, into the valve body. Install sealring 41 on plug 42 and install it into the valve body.

(3) Install a new gasket 35 on neutral solenoid 36. Insert the solenoid plunger into the slot in valve assembly 32. Insert the valve into the valve body. Attach the neutral solenoid to the valve body with two 5/16-18 x 1-inch bolts 38 and lockwashers 37. Tighten the bolts to 13 to 16 pound feet torque. Install the direct drive solenoid 47 and the valve assembly 43 in the same manner.

c. Disassembly (VH, VS series with hydraulic governor) (B, foldout 14)

(1) Remove the two bolts 17 and lockwashers 16 from neutral solenoid 15. Remove the solenoid, valve assembly 11 and gasket 14 from valve body 22. Separate the solenoid from the valve by unhooking the solenoid plunger from the slot in the valve.

(2) Remove plug 18 and sealring 19 from valve body 22. Remove the sealring from the plug. Remove valve 20 and spring 21.

(3) Remove retainer plug 27 and washer 26. Remove spring 25, shim(s) 24 and valve 23 from the valve body.

(4) Remove four plugs 28.

Note: Refer to paragraph 6-2, above.

d. Assembly (VH, VS series with hydraulic governor) (B, foldout 14)

(1) Install four 1/8 NPTF plugs 28 into valve body 22.

(2) Install shim(s) 24 and spring 25 on valve 23.

Note: If spring has been replaced, see paragraph 3-6 for valve adjustment procedures.

Install spring, shim(s) and valve, large diameter end first, into the valve body. Install washer 26 on retainer plug 27 and install it into the valve body. Tighten the retainer plug securely.

(3) Install spring 21 onto the smaller diameter end of valve 20 and install the valve, spring end first, into the valve body. Install sealring 19 on plug 18 and install it into the valve body.

(4) Install a new gasket 14 on neutral solenoid 15. Insert the solenoid plunger into the slot in valve assembly 11. Insert the valve assembly into the valve body. Attach the solenoid to the valve body with two 5/16-18 x 1-inch bolts 17 and lockwashers 16. Tighten the bolts to 13 to 16 pound feet torque.

6-4. SPLITTER CLUTCH CONTROL VALVE ASSEMBLY (VS2)

a. Disassembly (early models) (foldout 15)

(1) Remove valve cap 12, washer 11, rivet 10, shim(s) 9 from valve body 6. (Some models will have a pin instead of a rivet in the valve cap.) Remove washer, rivet (or pin), and shim(s) from valve cap.

(2) Remove spring 8 and valve 7 from valve body 6.

Note: Refer to paragraph 6-2, above.

b. Assembly (early models) (foldout 15)

(1) Install washer 11 on valve cap 12. Install rivet 10, head first, into the valve cap and place shim(s) 9 on the rivet.

(2) Install valve 7, small end first, into valve body 6. Install spring 8 into the cup end of the valve.

Note: If spring has been replaced, see paragraph 3-6 for valve adjustment procedures.

(3) Install valve cap, washer, rivet and shim(s) into the valve body. Tighten the cap to 45 to 55 lb ft torque.

c. Disassembly (later models) (foldout 15)

(1) Remove valve cap 20, washer 21, rivet 22 and shim(s) 23 from valve body 33. Some models will have a pin instead of a rivet in the valve cap. Remove the washer, rivet (or pin) and shim(s) from the valve cap.

(2) Remove spring 24 and valve 25 from the valve body.

(3) Remove plug 43 and washer 44 from the valve body. Remove the washer from the plug. Remove exhaust valve 45 and spring 46 from valve body 33.

(4) Remove five bolts 27 and 29; and lockwashers 26 and 28 that retain valve body 33 to separator plate assembly 35. Disconnect the lead of solenoid 40 from connector 32. Do not remove connector 30, sealring 31 and connector 32 from the valve body, unless replacement is necessary.

(5) Remove gasket 34 between valve body and separator plate 36.

(6) Remove two bolts 42 and flat washers 41 from solenoid 40. Remove solenoid 40 and gasket 39 from separator plate 36.

Note: Refer to paragraph 6-2, above.

d. Assembly (later models) (foldout 15)

(1) Install gasket 39 and solenoid 40 on separator plate assembly 35 and retain the solenoid with two 1/4-20 x 3/4-inch bolts 42 and flat washers 41. Tighten the bolts to 9 to 11 pound feet torque.

(2) Install gasket 34 onto separator plate assembly 35.

(3) Connect the lead of solenoid 40 to connector 32 in valve body 33. Install the valve body on the separator plate assembly and retain the valve body with three 3/8-16 x 1 3/4 bolts 27 and two 3/8-16 x 2 3/4 bolts 29, with lockwashers 26 and 28. Tighten the bolts evenly to 26 to 32 pound feet torque.

(4) Place spring 46 on the small diameter end of exhaust valve 45 and install the valve into the bore of the valve body. Install washer 44 onto plug 43 and install the plug into the valve body. Tighten the plug to 45 to 55 pound feet torque.

(5) Install washer 21 onto valve cap 20. Install rivet 22 head first, into the valve cap and place shim(s) 23 on the rivet.

(6) Install valve 25, small end first, into valve body 33. Install spring 24 into the cup end of the valve.

Note: If spring has been replaced, see paragraph 3-6 for valve adjustment procedures.

(7) Install valve cap, washer, rivet and shim(s) into the valve body. Tighten the cap to 45 to 55 lb ft torque.

6-5. OIL PUMP

a. Disassembly (fig. 6-1)

(1) Remove snapring 4, drive gear 3, snapring 2, and roller pin 9, (prior to S/N 1046 on VS2-6, S/N 901 on VS2-8 and S/N 37819 on VH, woodruff key was used) from drive shaft 10.

(2) Remove seven bolts 5, and washers 6 from end cap 1.

(3) Remove pump end cap 1.

(4) Remove drive shaft 10, with drive gears, from oil pump housing 32.

(5) Remove idler shaft 38, with idler gears, from oil pump housing 32.

(6) Remove snaprings 8 and 14. Drive gears 12 and 13 can now be removed from shaft 10. Remove long drive gear key 11.

Note: Prior to S/N 1046 on VS2-6, S/N 901 on VS2-8 and S/N 37819 on VH, only one drive gear was used.

(7) Remove snaprings 34 and 37. Idler gears 35 and 36 can now be removed from shaft 38. Remove long drive gear key 39.

Note: Prior to S/N 1046 on VS2-6, S/N 901 on VS2-8 and S/N 37819 on VH, only one drive gear was used.

(8) Do not remove bearings 7 and 40 from end cap 1, unless necessary.

(9) Do not remove bearings 15 and 33 from pump housing 32, unless necessary.

(10) Remove cap 21 and sealring 20.

(11) Remove spring guide pin 19, spring 18, and valve 17.

(12) Remove cap 27 and sealring 28.

(13) Remove spring guide pin 29, spring 30 and valve 31.

(14) Remove two bolts 26 and washers 25.

(15) Remove lubrication tube housing 22 and gasket 24.

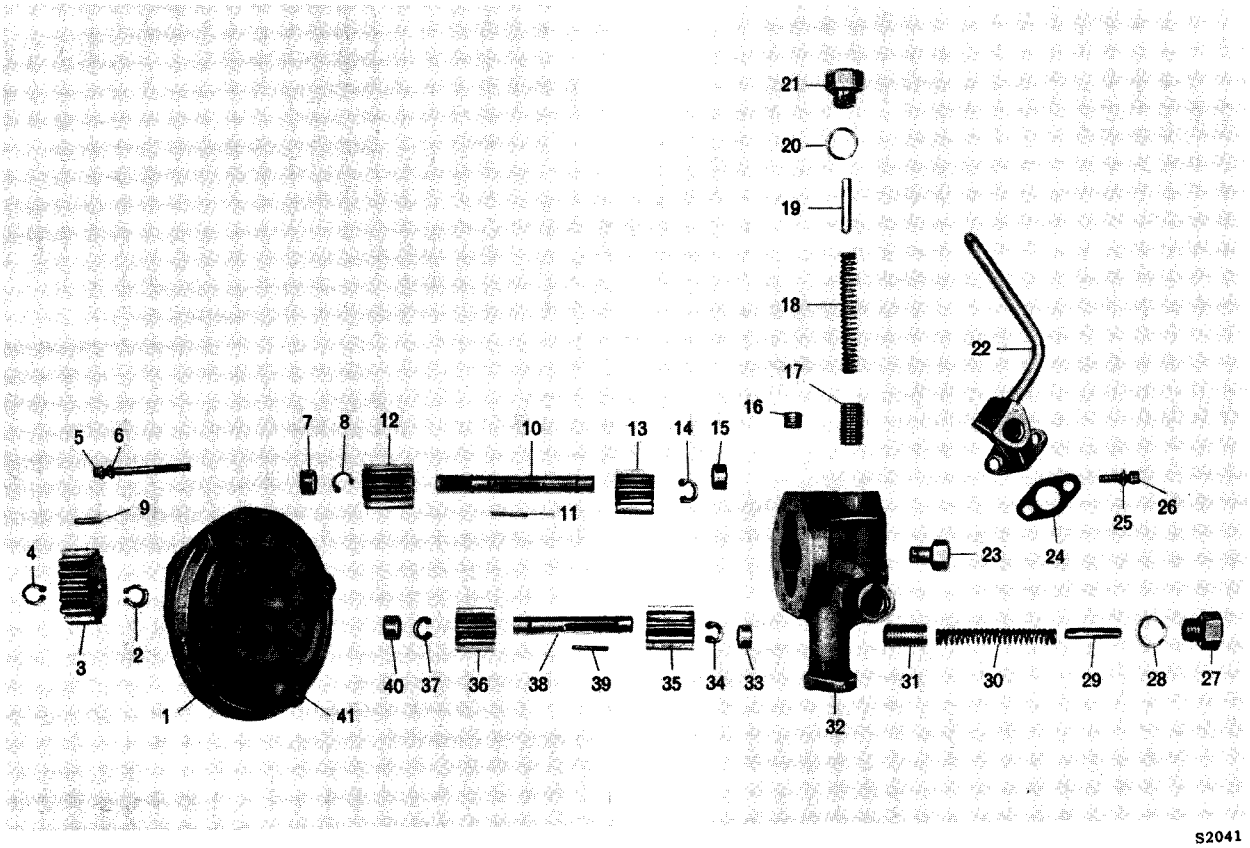
(16) Remove plug 16 and connector 23.

(17) Do not remove dowel pins 41 from end cap 1, unless necessary.

Note: Refer to paragraph 6-2, above.

b. Assembly (fig. 6-1)

(1) If dowel pins 41 were removed from end cap 1, replace with new pins.



1 - End cap
2 - Snapring
3 - Drive gear
4 - Snapring
5 - Bolt
6 - Washer
7 - Caged roller bearing
8 - Snapring
9 - Roller pin
10 - Drive shaft
11 - Rectangular key
12 - Long drive gear
13 - Short drive gear
14 - Snapring
15 - Caged roller bearing
16 - Plug
17 - Converter pressure regulator valve
18 - Pressure regulator valve spring
19 - Spring guide pin
20 - Sealring
21 - Cap
22 - Lubrication tube housing
23 - Connector
24 - Gasket
25 - Washer
26 - Bolt
27 - Cap
28 - Sealring
29 - Spring guide pin
30 - Pressure regulator valve spring
31 - Main pressure regulator valve
32 - Oil pump housing
33 - Caged roller bearing
34 - Snapring
35 - Long idler gear
36 - Short idler gear
37 - Snapring
38 - Idler gear shaft
39 - Rectangular key
40 - Caged roller bearing
41 - Dowel pin

Fig. 6-1. Oil pump

(2) If caged roller bearings 7 and 40 were removed from end housing 1, replace with new bearings.

(3) If caged roller bearings 15 and 33 were removed from pump housing 32, replace with new bearings.

(4) Install snapring 8 on shaft 10. Insert rectangular key 11 (prior to S/N 1046 on VS2-6, S/N 901 on VS2-8 and S/N 37819 on VH, woodruff key was used) in key slot in shaft. Slide long gear 12, recessed end first, and short gear 13, recessed end last, onto shaft 10. Install snapring 14.

Note: Prior to S/N 1046 on VS2-6, S/N 901 on VS2-8 and S/N 37819 on VH, the use of only one gear on each shaft was required.

(5) Install snapring 37 on shaft 38. Slide short gear 36, recessed end first, onto shaft 38. Insert rectangular key 39 in key slot in shaft. Slide long gear 35, recessed end last, onto shaft 38. Install snapring 34.

Note: Prior to S/N 1046 on VS2-6, S/N 901 on VS2-8 and S/N 37819 on VH, the use of only one gear on each shaft was required.

(6) Install shafts 10 and 38, with gears, into oil pump housing 32.

(7) Install end cap 1 onto housing 32. Shaft 10 extends through bearing 7.

(8) Install seven bolts 5 and washers 6 to retain end cap 1 to housing 32. Tighten the bolts to 9 to 11 pound feet torque.

(9) Install pressure regulator valve 17, spring 18, guide pin 19, sealring 20 and cap 21 into housing 32.

(10) Install pressure regulator valve 31, spring 30, guide pin 29, sealring 28 and cap 27 into housing 32.

(11) Install gasket 24 and housing 22. Retain lubrication tube housing 22 onto housing 32 by using two bolts 26 and washers 25.

(12) Install plug 16 and connector 23.

(13) Install snapring 2, drive gear 3, roller pin 9, and snapring 4 onto extended end of shaft 10.

6-6. SPLITTER CLUTCHES (VS2)

a. Disassembly. The disassembly of the splitter clutches was described in paragraph 5-3g. The adjustment and rebuild of these clutches into a subassembly is given in b and c, below.

Note: Refer to paragraph 6-2, above.

b. Adjustment (A, foldout 9)

(1) Before the splitter clutches can be assembled, it is necessary that two checks be made to be sure the Belleville spring is properly positioned. To make these checks, the clutches must be partially and temporarily assembled, as follows.

(2) Install snapring 28 (with the beveled edge of the snapring toward the Belleville spring location) into clutch drum 30. Install Belleville spring 29 into the clutch drum with the fingers of the Belleville spring toward the splitter direct drive clutch side of the drum. Install the other snapring 28 into clutch drum 30 with the beveled edge of the snapring toward the Belleville spring.

Note: The splitter direct drive clutch side of the clutch drum and the splitter direct drive clutch plates and pressure plate are marked with a red dye. The edge of the drum on the splitter overdrive clutch side and the splitter overdrive clutch plates and pressure plate are marked with a green dye. The pieces must be assembled with regard to their color markings.

(3) Install splitter direct drive clutch pressure plate 23 into drum 30, with the crown against the Belleville spring. Starting with an internal-splined plate, install alternately four internal-splined plates 21 and three external-splined plates 22. Install sun gear assembly 13 onto drum 30, retaining it with nine 5/16-24 x 3/4-inch bolts 11. Tighten the bolts evenly to 19 to 23 pound feet torque.

(4) With the assembly resting on the sun gear (fig. 6-2), measure with a depth micrometer the distance from the edge of the drum to the outer edge of the Belleville spring (at snapring gap). Record this measurement. Then measure the distance from the edge of the drum to a point on the Belleville spring opposite to where the pressure plate crown contacts it (fig. 6-3). Record this measurement. The first measurement (outer edge of spring) should be 0.020 to 0.040 inch less than the measurement opposite the pressure plate crown.

(5) If the difference in measurements is not within the above limits, select a different thickness pressure plate 23 (A, foldout 9). There are three plate thicknesses from which to select:

0.469 to 0.473 inch
0.485 to 0.489 inch
0.501 to 0.505 inch

(6) Install the splitter overdrive clutch pressure plate 31 into the drum 30, with the crown of the plate against the Belleville spring. Starting with an internal-splined plate, install alternately four internal-splined plates 32 and three external-splined plates 33.

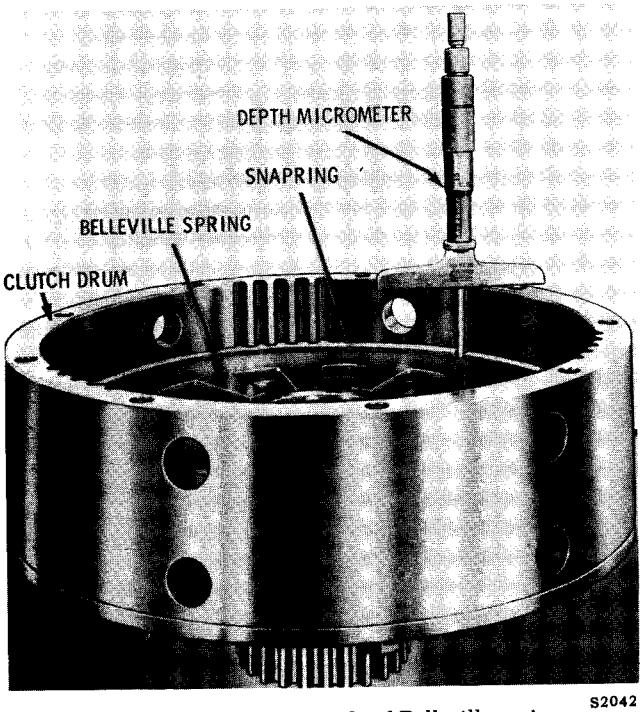


Fig. 6-2. Measuring depth of Belleville spring at outer edge (VS2 series)

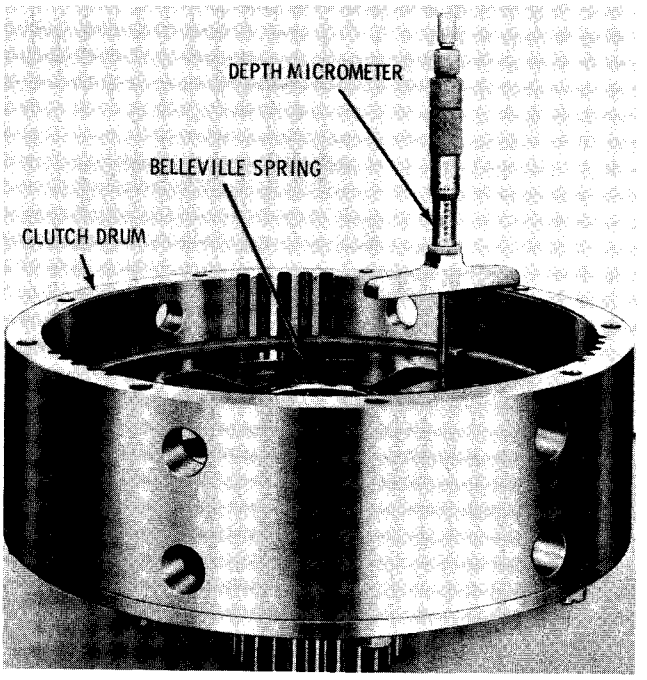


Fig. 6-3. Measuring depth of Belleville spring at pressure plate contact (VS2 series)

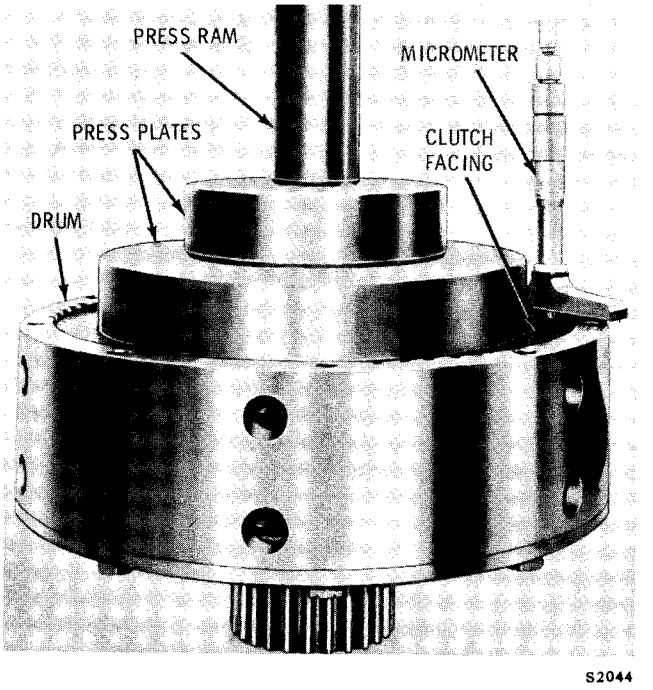


Fig. 6-4. Measuring depth of clutch facing below drum (VS2 series)

(7) Place the assembly in a press (fig. 6-4), install a suitable press plate, and apply 1000 pounds pressure on the clutch plates. Measure the distance from the face of the top clutch plate to the upper edge of the clutch drum. Record this dimension.

(8) Measure the difference in height between the two surfaces of the clutch backplate (fig. 6-5). Subtract this dimension from the dimension obtained in (7), above. The difference should be from 0.056 inch to 0.080 inch.

Note: This is the released clearance of the splitter overdrive clutch at final assembly.

(9) If the difference in measurements is not within the above limits, select a different thickness pressure plate 31 (A, fold-out 9). There are four thicknesses from which to select:

0.453 to 0.457 inch
0.469 to 0.473 inch
0.485 to 0.489 inch
0.501 to 0.505 inch

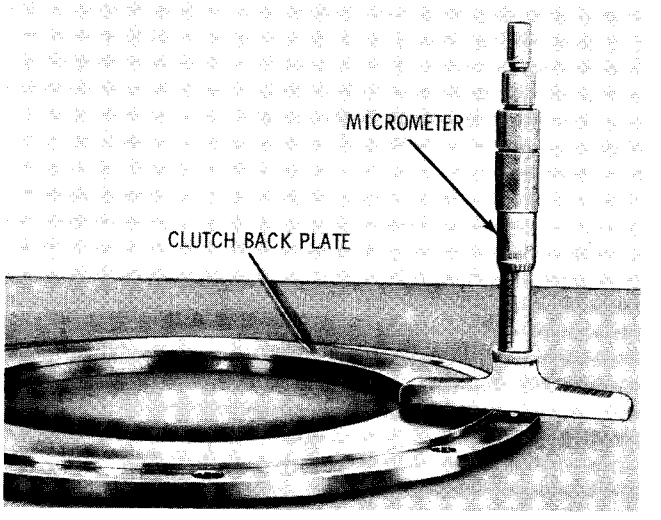


Fig. 6-5. Measuring clutch back plate (VS2 series)

(10) When both of the adjustments are completed, install clutch back plate 34. Install nine 5/16-24 x 3/4-inch bolts 35. Tighten the bolts to 19 to 23 pound feet torque. Then the splitter direct drive clutch side must be disassembled by removing nine bolts 12, sun gear assembly 13, seven clutch plates 21 and 22, and pressure plate 23.

c. Assembly (A, foldout 9)

(1) The assembly of the splitter direct and overdrive clutches to the clutch retainer assembly is given in (2) through (11), below.

(2) Install sealring 41 and snapring 42 into the retainer.

(3) Install sealring 46 onto the splitter clutch piston assembly 43, and install the piston into retainer 38. Install piston retainer 47 onto clutch retainer 38, with three 5/16-24 x 5/8-inch bolts 48. Tighten the bolts to 19 to 23 pound feet torque.

(4) Place the clutch retainer assembly 37, on the piston retainer side, on two blocks of wood.

(5) Install thrust washer 36 onto clutch retainer assembly 37.

(6) Install the splitter overdrive clutch and drum assembly onto the clutch retainer, making certain that the overdrive clutch internal-splined clutch plates mesh with the splines on the clutch retainer.

(7) Install thrust ring 27, thrust bearing 26 and thrust washer 25 onto splitter clutch piston assembly 43.

(8) Install the wrap-around snapring (fig. 6-6) onto the clutch piston. The piston will have to be held upward in the assembly with one hand, as illustrated.

(9) After the snapring is installed, make certain it is properly seated by placing a sleeve (fig. 6-7) on the fingers of the Belleville spring and hitting it sharply with a hammer.

(10) Install splitter direct drive clutch hub assembly 18 (A, foldout 9) into piston 43. Install pressure plate 23 (selected previously in b(4) and (5), above) into clutch drum 30, with the crown against the Belleville spring. Starting with an internal-splined plate, install alternately four internal-splined plates 21 and three external-splined plates 22 into the clutch drum.

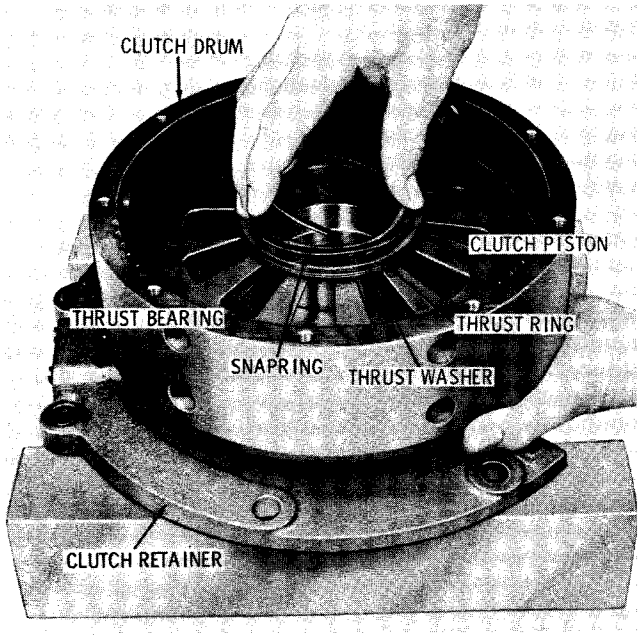


Fig. 6-6. Installing wrap-around snapring on splitter clutch piston (VS2 series)

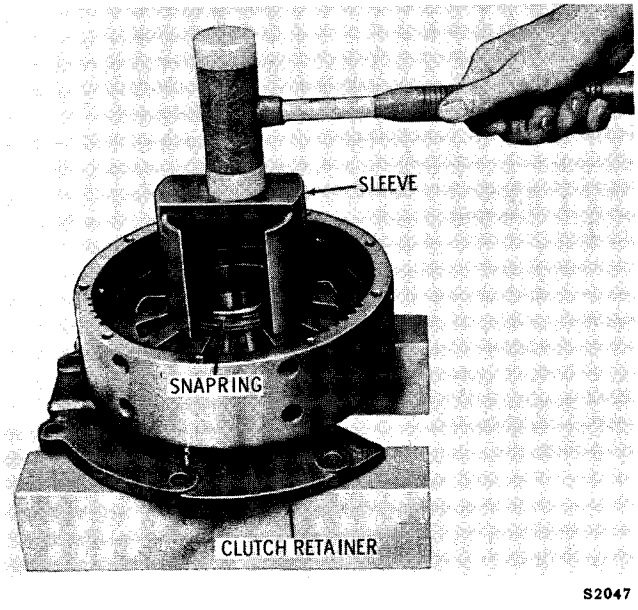


Fig. 6-7. Seating wrap-around snapring in splitter clutch piston groove (VS2 series)

(11) Install thrust washer 17 against hub assembly 18. Install sun gear assembly 13 onto drum 30. Install nine 5/16-24 x 3/4-inch bolts 12. Tighten the bolts evenly to 19 to 23 pound feet torque.

6-7. BEVEL DRIVE (PINION) GEAR ASSEMBLY (VH, VS1)

a. Disassembly (A, foldout 10)

(1) Remove oil pump idler gear shaft setscrew 11 and nut 10 from bevel pinion gear bearing retainer 19. Using a soft drift, drive oil pump idler gear shaft 13 out of the retainer. Remove oil pump idler gear assembly 7.

(2) Use a chisel to lift the staked portion of locknut 15 out of the slot in bevel pinion gear 25. Remove the locknut with a spanner wrench, while holding the bevel gear assembly in a vise with soft jaws.

(3) Support the bevel pinion gear bearing retainer in a press (fig. 6-8) and press the pinion gear out of the retainer. Remove bearing cone 17 (A, foldout 10) from cup 18 in the retainer. Bearing cups 18 and 23 will remain in the retainer and need not be removed, unless replacement is necessary. If removal is necessary, drive the bearing cups from the retainer with a drift.

(4) Remove wave washer 20, oil pump drive gear 21 and key 26 from the pinion gear. Remove snapring 27 from the bore of the pinion gear.

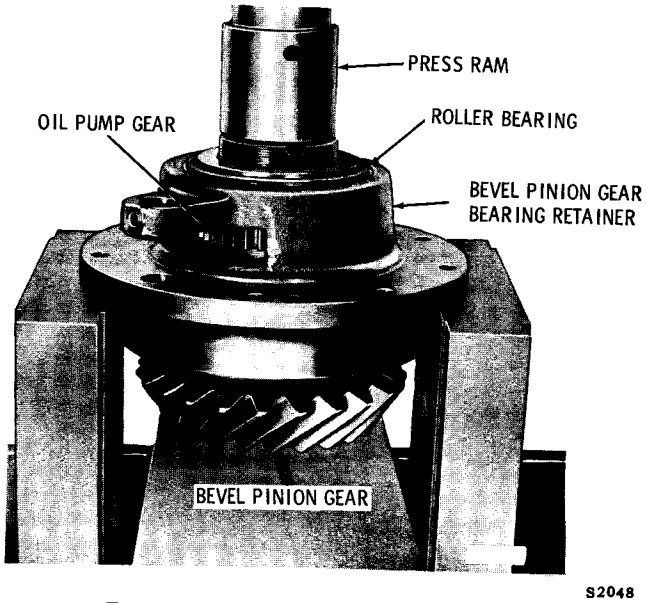


Fig. 6-8. Removing bevel pinion gear from bearing retainer (VH, VSI series)

(5) Do not remove bearing cone 24 from the pinion gear, unless replacement is necessary. If the bearing cone requires replacement, remove the cone from the bevel pinion gear by using a press and remover plates or bearing puller.

Note: Refer to paragraph 6-2, above.

b. Assembly (A, foldout 10)

(1) If bearing cone 24 was removed from the pinion gear, install the cone, using a sleeve (fig. 6-9) and press. Seat the bearing cone firmly on the shoulder of the pinion gear.

(2) Remove the assembly from the press and install oil pump gear key (fig. 6-10) into the slot into the pinion shaft. Install the oil pump drive gear and wave washer.

(3) If bearing cups 18 (A, foldout 10) and 23 were removed, install the bearing cups into retainer 19, using a suitable driver and press (fig. 6-11).

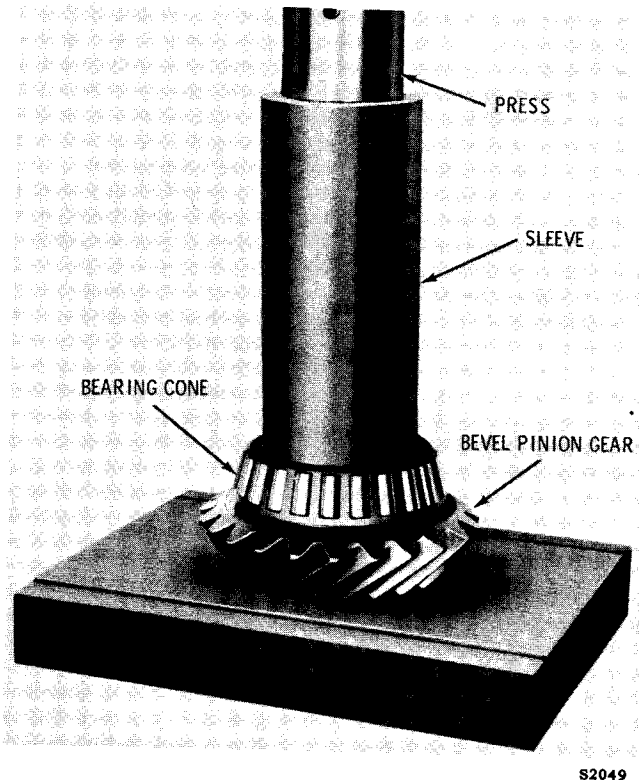


Fig. 6-9. Installing pinion gear bearing (VH, VSI series)

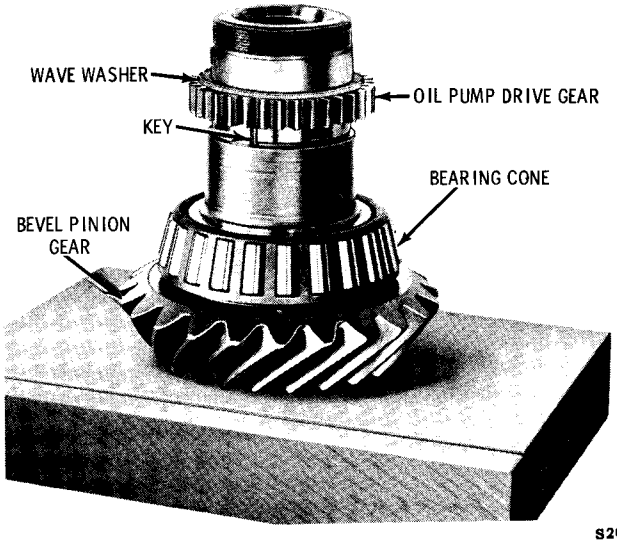


Fig. 6-10. Installing oil pump drive gear and wave washer (VH, VSI series)

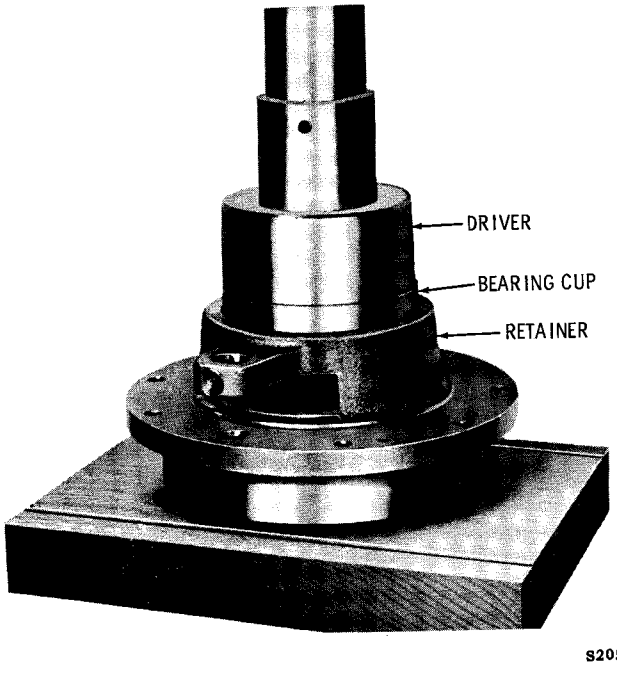


Fig. 6-11. Installing bearing cups into pinion gear bearing retainer (VH, VSI series)

(4) Apply transmission lubricant onto bearing cups 18 (A, foldout 9) and 23, located in the pinion gear bearing retainer 19. Place bearing retainer 19 onto the bevel pinion gear.

(5) Install bearing cone 17 and start nut 15 (use a new nut) onto the threads of the bevel pinion gear.

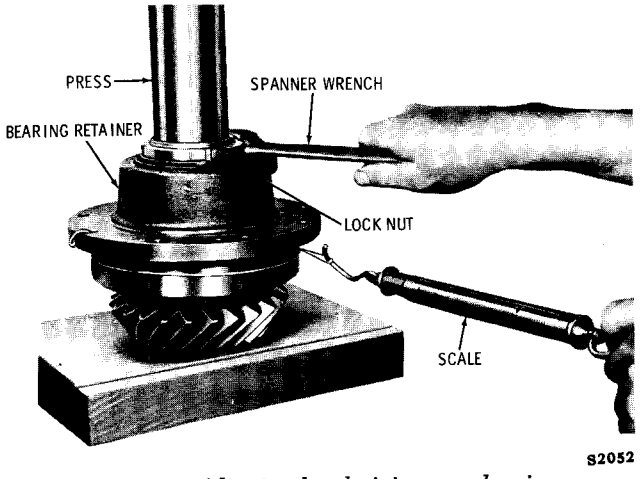


Fig. 6-12. Adjusting bevel pinion gear bearings (VH, VSI series)

(6) Support the bevel pinion gear assembly (fig. 6-12) in a press, on a wooden block. Apply pressure on the end of the bevel pinion gear to keep the assembly from turning while tightening the nut.

(7) Adjust bearing preload as follows:

(a) Wrap a heavy cord around bearing retainer and attach a spring scale to the end of the cord.

(b) Use a spanner wrench to tighten the nut, while rotating the bearing retainer by pulling on the spring scale. The correct bearing preload is established when there is zero end play and a maximum of 2 3/4 pounds (1.25 kg) pull on the scale is required to rotate the retainer (after rotation is started).

(c) When correct preload is obtained, stake the nut in slots at two places in the bevel pinion gear.

(8) Position the oil pump idler gear in the bearing retainer, install the shaft, setscrew and locknut (fig. 6-13).

6-8. BEVEL DRIVE (PINION) GEAR ASSEMBLY (VS2)

a. Disassembly (B, foldout 9)

(1) Place the assembly in a vise with soft jaws, and remove locknut 35 from input shaft 23.

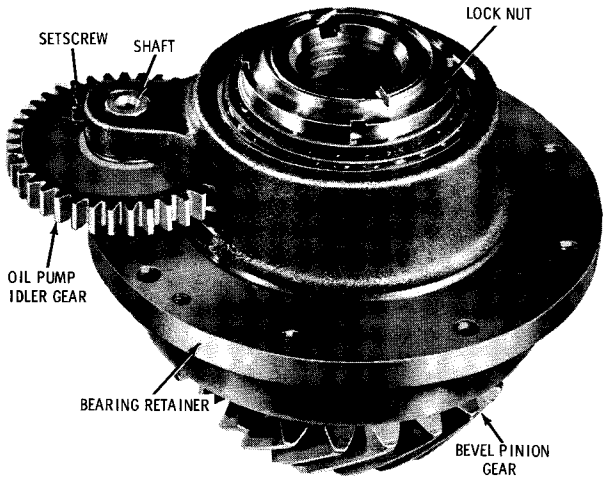


Fig. 6-13. Bevel pinion gear, bearing retainer and oil pump idler gear, assembled (VH, VSI series)

(2) Place the assembly in a press, and press input shaft 23 out of the bevel pinion gear. (On earlier model transmissions, remove shims 46, and tag for identification.) Remove oil pump drive gear 24 from shaft 21.

(3) Support bevel pinion gear bearing retainer 30 in a press and press the pinion gear (with bearing cone 33) from the retainer. Bearing cone 26 will be free to remove from the retainer. (On later model transmissions, remove shims 28 and tag for identification.)

(4) Do not remove bearing cone 33 from the pinion gear unless replacement is necessary. If removal is necessary, drive the bearing cone from the gear by using a drift, through the holes in the gear.

(5) After inspection of bearing cups 27 and 32, if replacement is necessary, use a drift to remove the cups from retainer 30.

(6) Oil baffle 29 (later models only) cannot be removed unless bearing cup 27 is removed from retainer 30.

b. Assembly (B, foldout 9)

(1) If removed, install (later models) oil baffle 29, convex side first, into the smaller bearing bore of bearing retainer 30. Install bearing cups 27 and 32 into the retainer, using a suitable driver and a press. Press bearing cone 33 onto the bevel pinion gear.

(2) Install the pinion gear (with bearing cone 33) into bearing retainer 30. (On later model transmissions, then install shims 28 onto the pinion gear.)

(3) Press bearing cone 26 onto the pinion gear.

(4) Install oil pump drive gear 24 onto input shaft 23. (On earlier model transmissions, then install shims 46 onto input shaft.)

(5) Install the input shaft and drive gear into the bevel pinion gear.

(6) Install locknut 35 onto input shaft 23 and tighten the locknut while checking the bearing preload ((7), below).

(7) Wrap a strong cord around the bearing retainer and, holding the input shaft, pull on a horizontal line with a spring scale, similar to procedure on VH series (fig. 6-12). The rotating (not starting) pull should not exceed 2 3/4 pounds at zero end play. The bearing preload is obtained by increasing or decreasing thickness of shim pack. Proper shimming will permit the locknut to be tightened to 350 to 400 pound feet torque without exceeding zero end play or 2 3/4 pound preload.

(8) After tightening, stake the locknut to the input shaft by shearing the lip of the locknut and driving it against the flats on the shaft.

(9) Install oil pump idler gear pin 19 (B, foldout 9) into retainer 30. Install oil pump idler gear assembly 14, thrust washer 13 and snapring 12 onto gear pin 19.

6-9. BEVEL DRIVEN GEAR ASSEMBLY

Note: Disassembly (or assembly) procedures are identical for the VH (A, foldout 10) and VS2 (B, foldout 9) series. The configuration of the bevel gear sleeve is the only difference. Foldout references below are for the VH series.

a. Disassembly (A, foldout 10)

(1) Use a chisel to lift the staked portion of locknut 28 out of the slots in bevel gear sleeve 37 and 40.

(2) Place the assembly in a press (fig. 6-14) with bevel gear and bearing remover J-8176 installed over the bevel gear. Using fixture J-26551, apply pressure to the bevel gear to relieve tension on the nut and to prevent the assembly from turning. Using pilot adapter J-26552 and wrench J-25456-1, remove the nut from the bevel gear sleeve.

(3) Press the front bearing (fig. 6-15) and bevel gear from the bevel gear sleeve. Remove two bevel gear keys 36 (A, foldout 10) from the slots in the sleeve, and remove bearing spacer 30 from the sleeve.

(4) Remove eight bolts 31 and lockwashers 32 from small retainer 33. Remove the small retainer from bearing retainer 35.

(5) Place the bearing retainer and the sleeve in a press (fig. 6-15) and using J-7441 remover, remove bearing retainer 35 (A, foldout 10) and rear bearing 34 from sleeve 37 or 40.

(6) If replacement is necessary, press the bearing from the bearing retainer.

Note: Refer to paragraph 6-2, above.

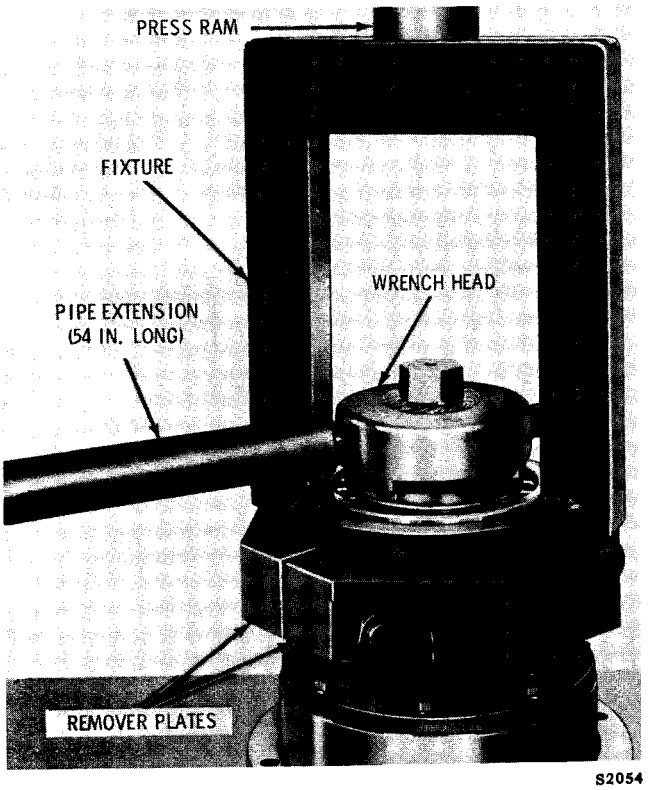


Fig. 6-14. Removing (or installing) bevel gear sleeve nut

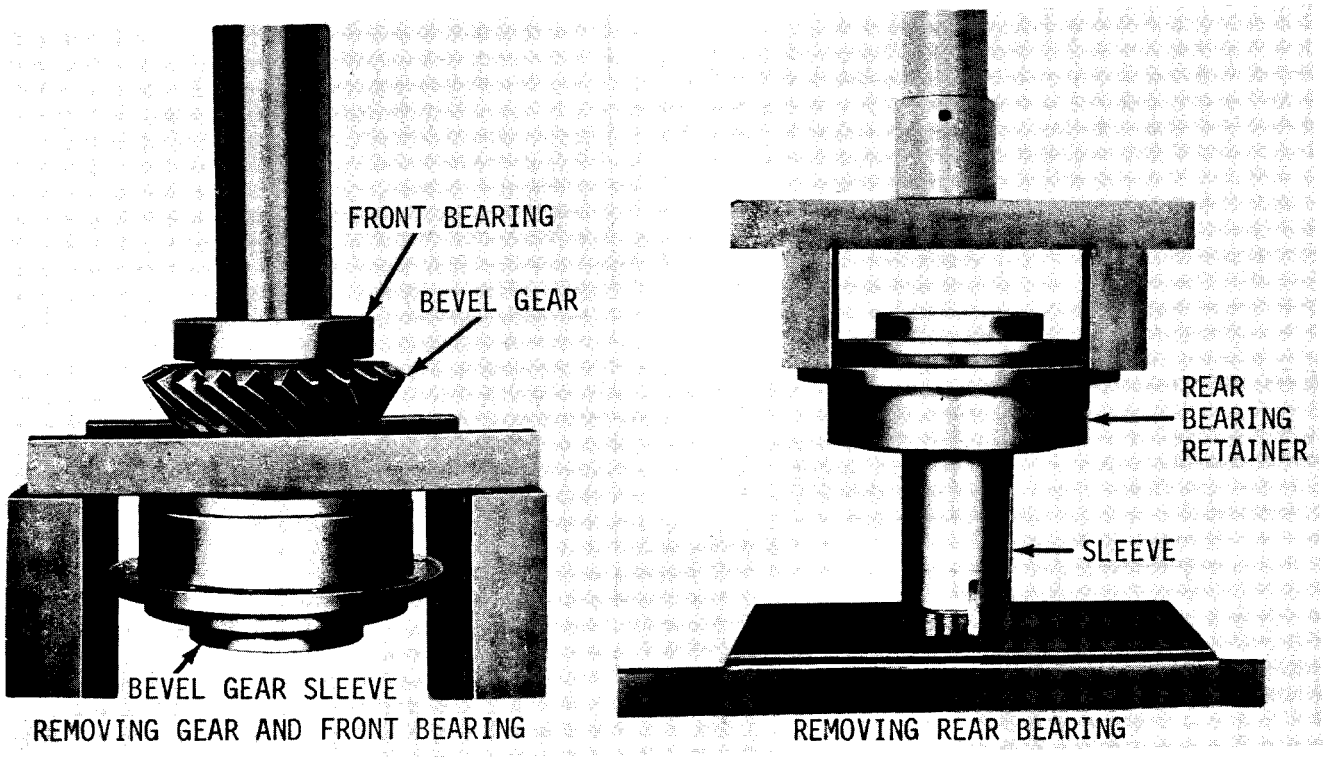


Fig. 6-15. Removing bevel driven gear bearings

b. Assembly (A, foldout 10)

(1) If removed, install rear bearing 34 into bearing retainer 35 as follows. Place the retainer, with flanged surface downward, in a press. Position the rear bearing, loader notch upward, into the retainer bore. Using bearing installer tool J-26404 press the bearing into the retainer bore until seated (fig. 6-16).

(2) Install small retainer 33 (A, foldout 10) on retainer 35, and install eight 5/16-18 x 1-inch bolts 31 and lockwashers 32 to retain it. Tighten the bolts to 13 to 16 pound feet torque.

(3) Place bevel gear sleeve 37 or 40 in a press, with the flange of the sleeve downward. Place the rear bearing and retainer 35 over the shaft of the sleeve, with the flange of the retainer toward the flange of the sleeve. Using installer J-26404 and installer J-24202-4, press the bearing against the seat of the sleeve.

(4) Install the bearing spacer 30 onto the sleeve.

(5) Install two bevel gear keys 36 into the keyways of sleeve 37 or 40.

(6) Place the bevel driven gear on the sleeve, and aline its keyways with the keys in the sleeve. Considerable pressure is needed to press the gear over the keys and down against the spacer.

(7) Place front bearing 29 on the sleeve and, with installer J-24202-4, press the bearing firmly against the bevel gear.

(8) Dip a new nut 28 in oil and install it on the sleeve, with the flat side of the nut against the front bearing.

(9) Place assembled parts in a press, as shown in figure 6-14. Apply a press load of 10 to 15 tons to the bevel driven gear.

(10) Using pilot adapter J-26552 and wrench J-25456-1, tighten the nut to produce 0.002 to 0.004-inch (0.05 to 0.10 mm) elongation of the sleeve.

(11) Remove the bevel gear assembly from the press and peen the nut flange into the locking slots in the bevel gear sleeve, in two places.

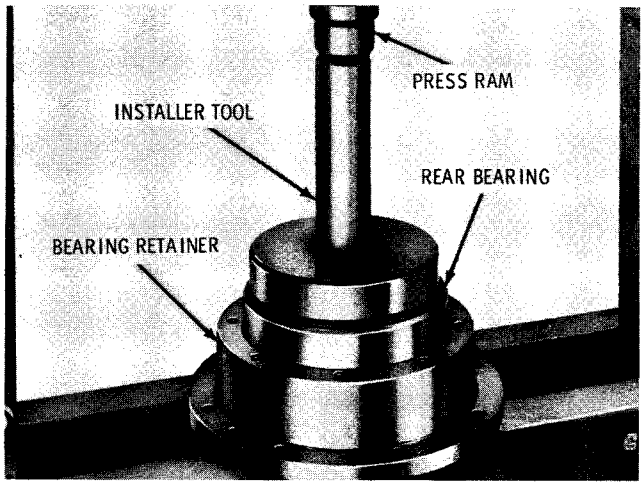


Fig. 6-16. Installing rear bearing

6-10. MAIN HOUSING

a. Disassembly

(1) Do not remove center bearing retainer 2 (B, foldout 9 for VS2) or 3 (A, foldout 10 for VH, VS1) from the main housing, unless necessary. If necessary, remove eight bolts 5 (B, foldout 9 or A, foldout 10) and lockwashers 4 that retain the retainer in the transmission housing. Using a driver, remove the retainer from the housing. The above instructions also apply to output shaft bearing retainer 27 (A, foldout 11), if the retainer remained in the housing during the removal of the output shaft.

(2) If inspection shows shifter fork shaft bushings 4 (B, foldout 10) and shifter fork shaft oil seal 7 (B, foldout 11) need replacing, use driver 81-0159 (fig. 6-17) to remove the parts.

(3) On older model transmissions, remove any retainer studs 5 (B, foldout 10) and 6 that need replacing. Later model transmissions have self-locking bolts 7 and 17 (B, foldout 9) or 38 and 39 (A, foldout 10) to retain the bearing retainers.

Note: Refer to paragraph 6-2, above.

b. Assembly

(1) If any studs were removed, replace as follows: Install 3/8-16 x 1 1/2-inch studs 5 (B, foldout 10) in the transmission housing to a dimension of 29/32 inch. Install 3/8-16 x

1 3/4-inch studs 6 (B, foldout 10) to a dimension of 1 1/8 inch.

(2) If shifter fork shaft bushings 4 (B, foldout 10) or oil seal 7 (B, foldout 11) were removed, install new bushings or oil seal, using a suitable driver (fig. 6-17).

(3) If center bearing retainer 2 (B, foldout 9) or 3 (A, foldout 10) or output shaft bearing retainer 27 (A, foldout 11) were removed, install as follows:

Note: Production tolerance for the fit of the center bearing retainer in the transmission housing is from 0.0015-inch tight fit to 0.001-inch loose fit. The tolerance for the output shaft bearing retainer is from 0.002-inch tight fit to 0.0005-inch loose fit.

(a) Pack the retainer in dry ice for 1 hour prior to assembly.

(b) Use a driver to install the retainer in the transmission housing.

Note: Aline the center bearing retainer over studs (earlier models) or headless guide bolts (later models).

(c) Retain the center bearing retainer with eight 5/16-18 bolts 5 (B, foldout 9 or A, foldout 10) and lockwashers 4. Tighten the bolts to 13 to 16 pound feet torque.

6-11. INPUT RING GEAR, INPUT CARRIER ASSEMBLY (VS2)

a. Disassembly (A, foldout 9)

(1) Lift ring gear 1 from planetary carrier assembly 2.

(2) Remove six bolts 10, attaching drive plate 8 or 9, to carrier 4.

(3) Rotate the plate, as necessary, to remove it from the slots in the planetary spindles.

(4) Use a soft drift to remove planetary spindles 3 from planetary carrier 4. Remove three spindles, three pinions 6, three bearings 7, and six thrust washers 5 from the carrier.

Note: Refer to paragraph 6-2, above.

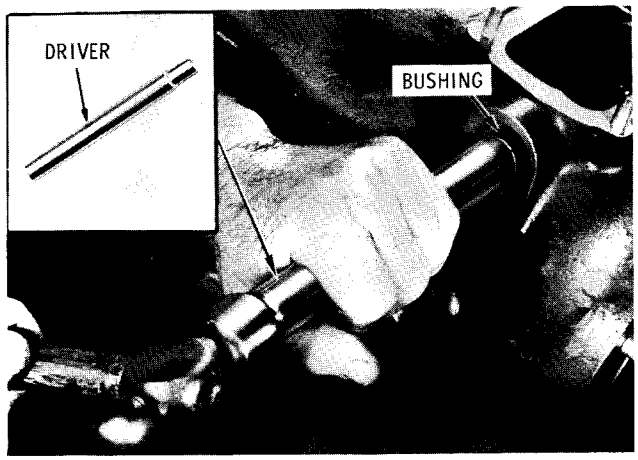


Fig. 6-17. Removing (or installing) shifter fork shaft bushings

b. Assembly (A, foldout 9)

(1) Chill spindles 3 in dry ice at least 1 hour, or heat carrier 4 in an oil bath or oven to 300-350°F. Position carrier 4, side with the six tapped holes upward, in a press.

(2) Install bearing 7 into pinion 6. Place a thrust washer 5 on each side of the pinion and install the pinion (with bearing and thrust washers) in carrier 4.

Note: Replace the pinions only in matched sets — never individually.

(3) Press spindle 3 into the carrier, through the bore of the bearing and thrust washer. The spindle must be installed so the slot in the spindle will allow the drive plate to be rotated clockwise into it.

(4) Repeat (2) and (3) above, for the other two spindles. If chilled spindles were installed into the rebuilt carrier, apply a coating of oil around the spindle locations to avoid rust.

(5) Install drive plate 8 or 9, bevel of teeth first, onto carrier 4 and rotate clockwise until it engages the slots in the spindles.

(6) Install six 3/8-24 x 3/4-inch bolts 10 that retain the drive plate to the carrier. Tighten the bolts to 41 to 49 pound feet torque.

(7) Install ring gear 1 onto carrier assembly 2 for installation as an assembly.

6-12. TORQUE CONVERTER PUMP ASSEMBLY

Note: If the torque converter pump assembly has aluminum blades and wheel ring and they are loose or damaged, the pump assembly can be repaired by replacing the blades and wheel ring with cast steel blades and ring.

a. Disassembly (A, foldout 13)

(1) Using a shallow chisel at the ring 18 side of the pump, drive the chisel between the ring and the end of blades 17. This will break the pins on the blades, permitting removal of ring 18. Discard the ring.

Caution: Hub 16 is reusable. Be sure not to damage the hub during disassembly of the pump assembly.

(2) Using a hammer, strike the side of blades 17 to break the pins at the hub 16 end. Using a pin punch, drive the broken pins out of hub 16 from the blade side of the hub.

b. Assembly (A, foldout 13)

Note: A press having a minimum of 6000 pounds (26688 N) force is required to swage the blade pins of the torque converter pump. The press setup must swage the pins at the ring and hub simultaneously. Two blades may be swaged simultaneously if the press is capable of producing approximately 11,600 pounds (51600 N) force.

(1) Place hub 16, shaft downward, on the press table. Use a suitable steel ring or block between the hub and press table to serve as a reaction member for the blade 17 pins. The press setup should be designed to swage the pins of one blade at a time. Two blades may be swaged simultaneously if the press has sufficient capacity.

(2) Load hub 16 with nineteen new blades 17. Install a new ring 18 onto the blades. Be sure all the blade pins are properly indexed into the ring and hub.

Caution: Press force should not exceed approximately 6000 pounds (26688 N) for one blade, 11,600 (51600 N) for two blades, to avoid cracking ring 18. It may be necessary to vary the force slightly to obtain the desired results.

(3) Using a suitable steel block on the blunt end of the press ram, press the pins of one blade until they are swaged into the chamfer or countersink of the pin hole. Properly swaged pins will be flush to slightly above the surface of the hub and ring.

(4) Press the pins of the blade 180° from the first blade. Continue pressing blades 180° apart until all blades are pressed.

(5) Check to ensure that all blades are tight and that there are no cracks in the ring.

Section 7. ASSEMBLY OF TRANSMISSION FROM SUBASSEMBLIES

7-1. SCOPE OF SECTION 7

a. Procedures, Models

(1) The procedures in this section describe the assembly of the VH and VS series transmissions from the subassemblies rebuilt in Section 6 and the parts removed in Section 5.

(2) Assembly procedures are identified with models only when they are peculiar to that model.

b. Sequence of Operations

(1) All assembly procedures, regardless of model, are included in one sequence. Thus, any model may be assembled by following these instructions.

(2) Headings and notes indicate procedures which are applicable only to a specific model. Any procedure not applicable to the transmission being assembled may be passed over and assembly continued with the next applicable procedure.

c. Illustrations

(1) Assembly procedures are referenced primarily to photographs in this section. When considered helpful, references are made to photographs in Section 5.

(2) Assembly of some components is referenced to foldouts in the back of this manual, especially when several small components are involved, or when the assembled relation of components must be known.

7-2. PARTIAL ASSEMBLY IN VEHICLE

a. Servicing, Maintenance. See paragraph 5-2a.

b. Accessibility. See paragraph 5-2b.

7-3. GENERAL INFORMATION FOR FINAL ASSEMBLY

a. Tools, Parts, Methods. Refer to paragraphs 4-3 through 4-5.

b. Parts Cleaning, Inspection. Refer to paragraph 4-6.

c. Component Cleanliness. Continually check components during assembly to insure they are free of lint, dirt, or foreign particles.

d. General Assembly Procedures. Refer to paragraph 4-7.

7-4. ASSEMBLY PROCEDURES

a. Preparation of Main Housing

(1) After rebuilding the main housing (paragraph 6-10), install it in the holding fixture (fig. 7-1). Install two heat lamps (approximately 400 watts), one in the bevel pinion bore and one in the bevel driven gear bore, in the main housing. Insert aluminum foil

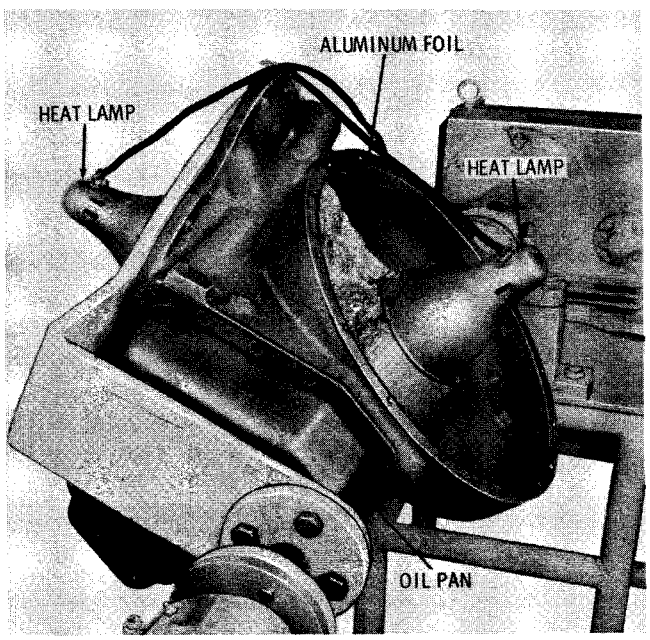


Fig. 7-1. Using heat lamps to expand bearing retainer bores

around the lamps to cover any openings. Install the oil pan with two bolts to secure it to the housing.

(2) Heat the housing for one hour prior to installing the bevel driven and bevel drive gear assemblies. Remove the aluminum foil, heat lamps and the oil pan.

b. Installing Bevel Driven Gear Assembly

Note: The installation of the bevel driven gear is identical for the VH, VS1 and VS2 series, except for the installation of the oil shield on the VH series. Foldout references below are for the VH and VS1 series.

(1) On earlier transmissions, install shims 2 (A, foldout 10) that were removed at disassembly, on the studs in the main housing.

(2) On later transmissions, place the shims on bearing retainer 35 of the bevel driven gear assembly, with holes of the shims alined with the holes in the bearing retainer.

(3) Install the bevel driven gear assembly (items 25, 28 through 36 and 37 or 40, A, foldout 10) into the heated housing and seat it in the housing. On earlier transmissions, studs retain the assembly. On later transmissions, bolts are used.

(4) On earlier transmissions, install eight 3/8-24, self-locking nuts 6 on the studs in the main housing. Tighten the nuts to 25 to 30 pound feet torque.

(5) On later transmissions, install eight 3/8-16 x 1 1/8-inch, self-locking bolts 38 to retain the assembly in the main housing. Tighten the bolts to 36 to 43 pound feet torque.

(6) On VH series, install the oil shield (fig. 5-24) and retain it with two screws.

c. Installing Bevel Drive (Pinion) Gear Assembly

Note: The assembly procedures are identical for the VH, VS1 and VS2 series. Foldout references are for the VH series.

(1) On earlier transmissions, install shims 1 (A, foldout 10) that were removed at disassembly on the studs in the main housing.

(2) On later transmissions, place the shims on bearing retainer 19 of the bevel drive gear assembly, with holes of the shims alined with the holes in the bearing retainer.

Note: When installing the shims in (1) or (2), above, make sure the fluid passage is open (fig. 7-2).

(3) Install the bevel drive gear assembly (items 7 through 11, 13 and 15 through 27, A, foldout 10) into the heated housing and seat it in the housing. On earlier transmissions, studs retain the assembly. On later transmissions, bolts are used.

(4) On earlier transmissions, install eight 3/8-24, self-locking nuts 12 on the studs in the main housing. Tighten the nuts to 25 to 30 pound feet torque.

(5) On later transmissions, install eight 3/8-16 x 1 1/4-inch, self-locking bolts 39 to retain the assembly in the main housing. Tighten the bolts to 36 to 43 pound feet torque.

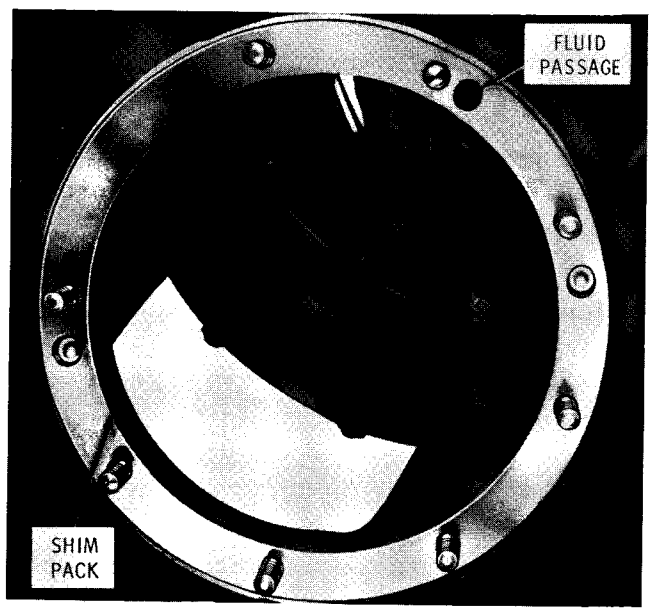


Fig. 7-2. Bevel pinion shims installed

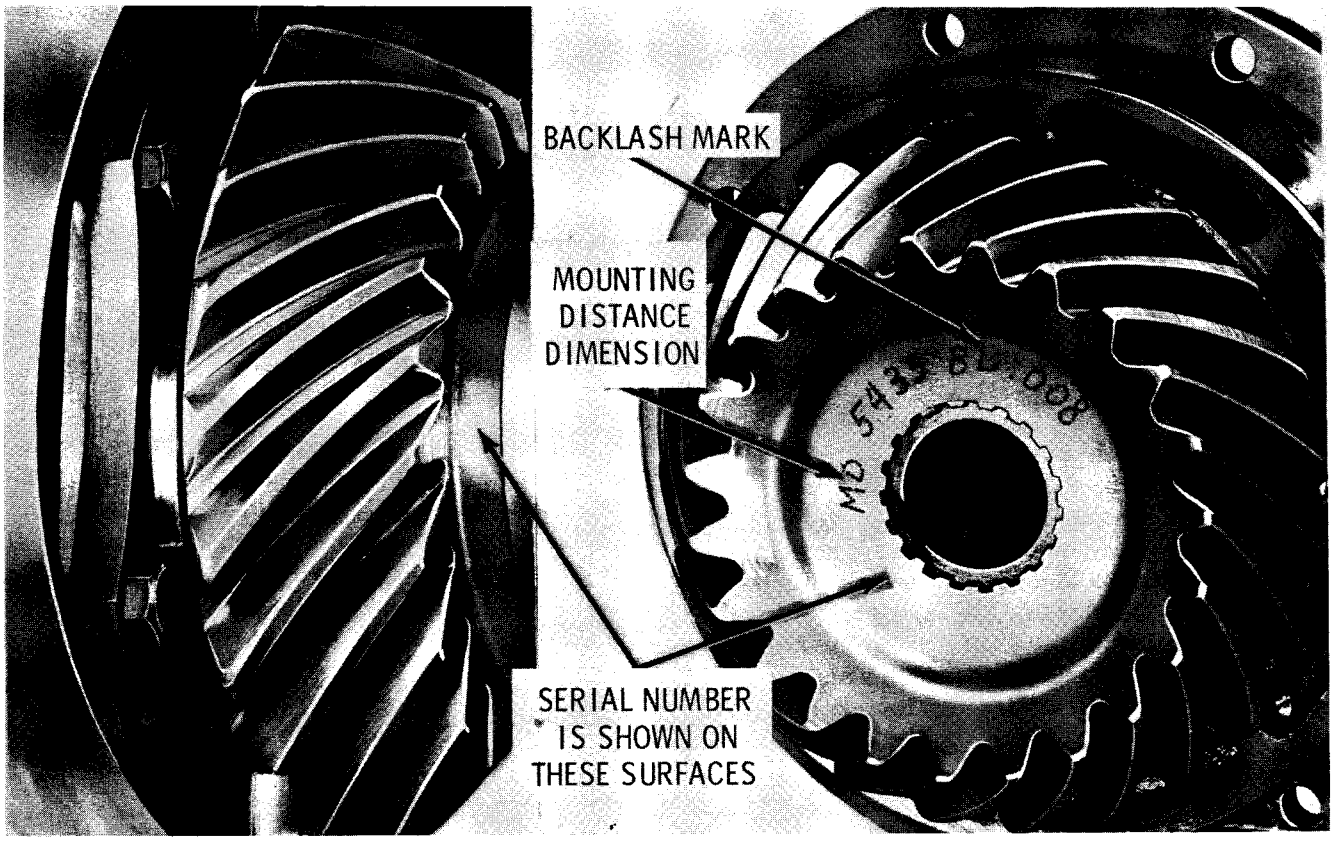


Fig. 7-3. Dimension markings on bevel gears

d. Adjusting Bevel Gear Backlash, Tooth Contact

(1) Adjust backlash to the dimension shown on the pinion gear (fig. 7-3) as follows. On the VH series, temporarily install two 1/2-20 x 3 (approximately) long bolts through the bevel gear sleeve flange to lock the bevel driven gear (fig. 7-4). On the VS series, attach a bar or other suitable object to the housing and lock it in the splines of bevel gear sleeve 45 (B, foldout 9).

(2) Mount the dial indicator on the bolt, as shown in figure 7-4 (or the bar on the VS2) to check gear backlash. If the dimension marked on the gear is not legible, adjust backlash to 0.008-0.012 inch for the 1.04 ratio and 0.007-0.011 inch for the 0.875 ratio. Adjustment can be accomplished through shim packs provided between bevel (pinion) gear bearing retainer (fig. 7-2) and main housing. In each instance, the average shim pack amounts to approximately 0.070 inch. Shims provided are 0.003 inch and 0.010 inch thickness.

(3) To check for proper tooth contact, paint several teeth on the input pinion gear with a mixture of red lead or similar mark-

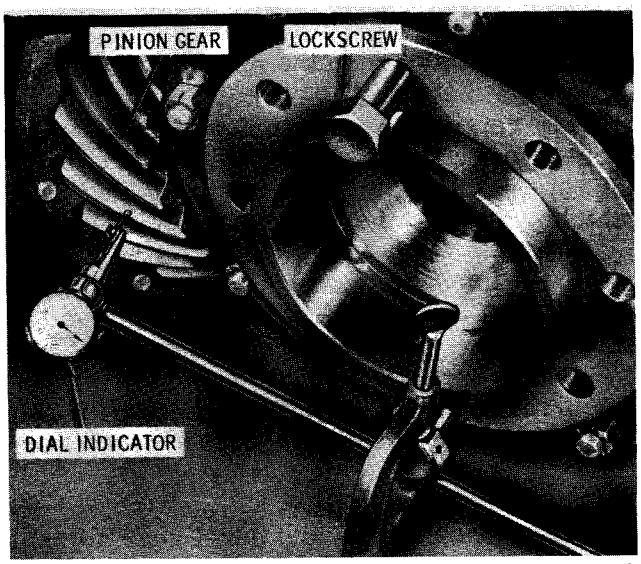


Fig. 7-4. Checking backlash with dial indicator

ing compound. Release the locking bolts or bar (1), above) enough to allow the gears to turn.

(4) Turn the gears and observe tooth contact impression on the drive side of the gear teeth (fig. 7-5, view A). Contact should start at the toe of the tooth (fig. 7-5, view B) and extend about 80 percent of tooth length toward the heel. Contact should be distributed evenly over the flank and face of the tooth, indicating the center of contact on pitch line (fig. 7-5, views A and B).

(5) If tooth contact is too far toward the heel (fig. 7-5, view C), increase the thickness of shim pack 2 (A, foldout 10) or 3 (B, foldout 9) between the bevel gear bearing retainer and main housing, moving the bevel gear toward the pinion. Restore proper backlash by increasing the shims between the bevel (pinion) gear bearing retainer and main housing 1 (B, foldout 9) or (A, foldout 10).

(6) If tooth contact is too far toward the toe (fig. 7-5, view D), move the bevel gear away from the pinion by reducing shims 2 (A, foldout 10) or 3 (B, foldout 9) between the bevel gear bearing retainer and main housing. Restore proper backlash by reducing the shims between the bevel (pinion) gear bearing retainer and main housing 1 (B, foldout 9) or (A, foldout 10).

(7) If the tooth contact is low on the flank of the tooth (fig. 7-5, view E), move the pinion away from the bevel gear by adding shims between the bevel (pinion) gear bearing retainer and main housing. Restore proper backlash by adding shims 2 (A, foldout 10) or 3 (B, foldout 9) between the bevel gear bearing retainer and main housing.

(8) If contact is high on the face of the tooth (fig. 7-5, view F), move the pinion toward the bevel gear by removing shims between the bevel (pinion) gear bearing retainer and main housing. Restore proper backlash by removing shims between the bevel gear bearing retainer and main housing.

(9) When pinion and bevel gear adjustments have been completed, make certain that all retaining nuts or bolts are properly tightened (reference b(4) and (5), and c (4) and (5), above). Recheck adjustments.

e. Installing Output Shaft, Forward-Reverse Shift Controls, Reverse Gears

(1) Position output shaft 28 (A, foldout 11) on a press, with threaded end of shaft up. Position output shaft front bearing assembly 26 on the shaft, with shielded side of the bearing downward. Press the bearing onto the shaft.

(2) Invert the output shaft in a press and position the brake cone spring (fig. 7-6) and brake cone, beveled side upward, on the shaft. Aline flats on the cone and shaft and apply sufficient pressure to the brake cone to permit installation of snapring 31 (A, foldout 11).

(3) Press bearing 32 (A, foldout 11) onto the output shaft until solidly seated against the snapring.

(4) Position output intermediate gear 19 (B, foldout 11) in a press, with the hub upward. Press bearing 20 onto the gear hub until solidly seated.

(5) Install output intermediate gear and bearing into the center bearing retainer in the main housing. With a brass drift and hammer, drive the gear and bearing in until the bearing seats firmly in the retainer.

(6) Install shifter fork 15 (B, foldout 11) into the main housing. While holding it in place, install shifter fork shaft 6 and two thrust washers 5 into the main housing, and through the bore of the shifter fork. Install two shifter fork keys 17, lockstrip 14 and two 3/8-24 x 1 3/8-inch bolts 13 into the shifter fork. Tighten the bolts to 33 to 40 pound feet torque. Bend the lockstrip corners against the flats of the bolt heads (fig. 5-40).

(7) Apply a thin layer of grease on brake cone 30 (A, foldout 11).

(8) Install two shifter fork shoes 16 (B, foldout 11) into the shifter fork. Position output shifter gear 18 in the main housing, with the groove of the gear engaging the shifter

fork shoes and toward output intermediate gear 19. While holding the output shifter gear in place, install the output shaft assembly (items 26 and 28 through 32, A, foldout 11) through the bearing bore in the main housing, and into the output shifter gear.

(9) Start bearing 32 (A, foldout 11) into the bore of output intermediate gear 19 (B, foldout 11). Using a suitable driver against bearing 26 (A, foldout 11), seat bearing 32 in the output intermediate gear, and bearing 26 in the main housing (fig. 7-7).

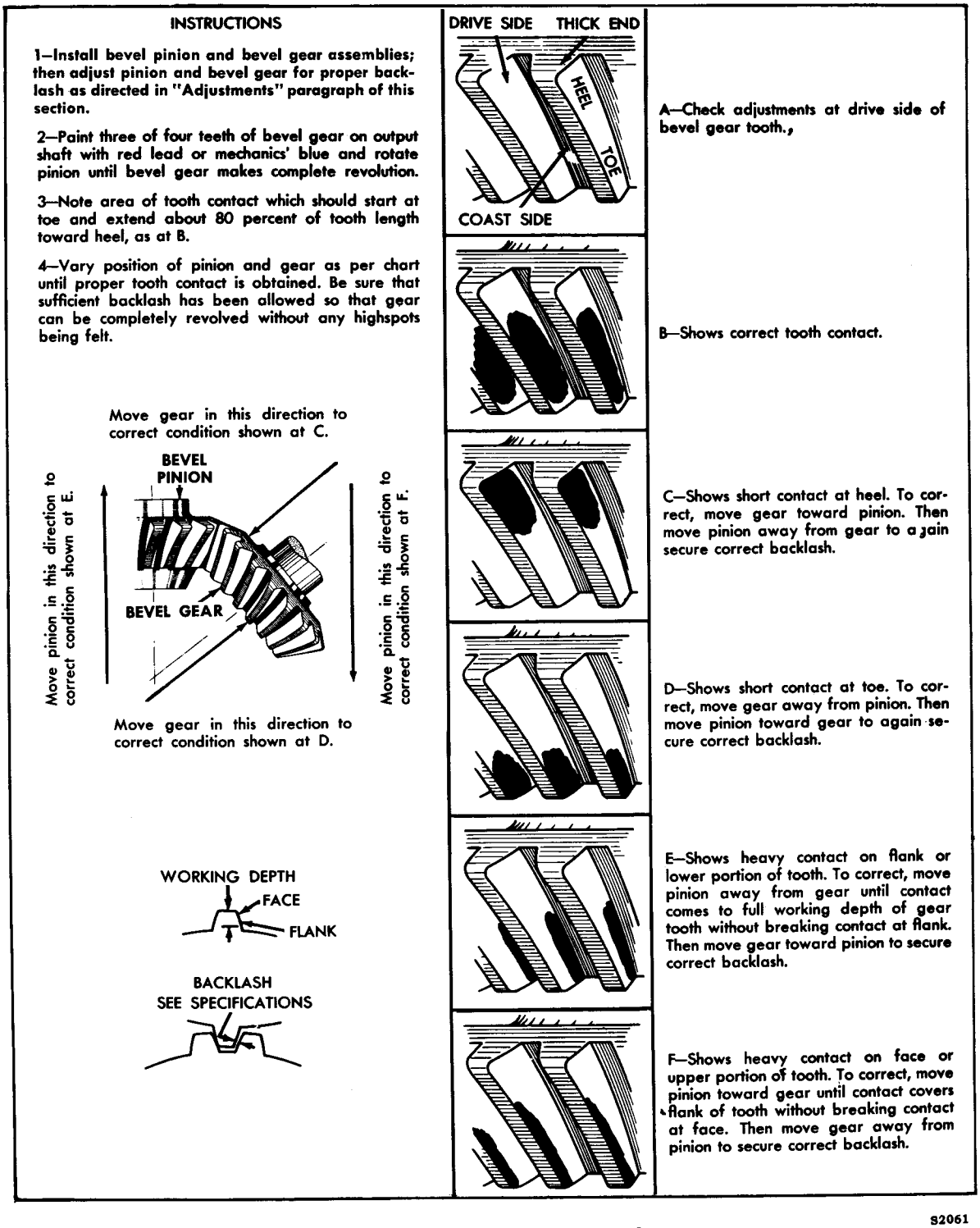


Fig. 7-5. Bevel gear tooth contact chart

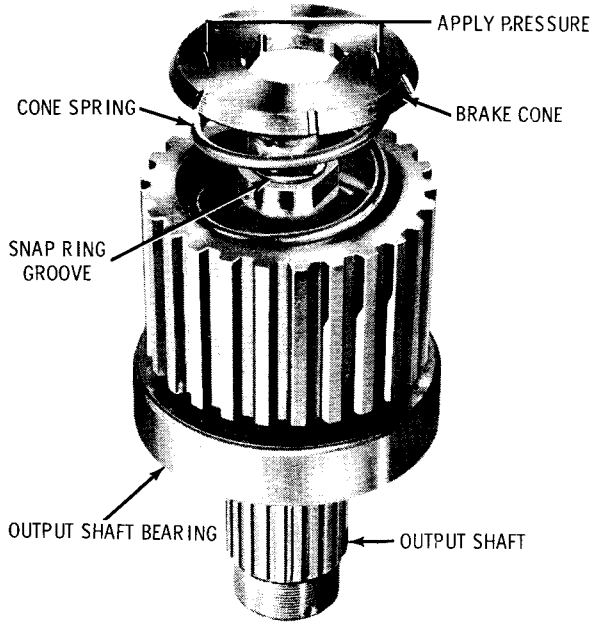


Fig. 7-6. Assembling output shaft

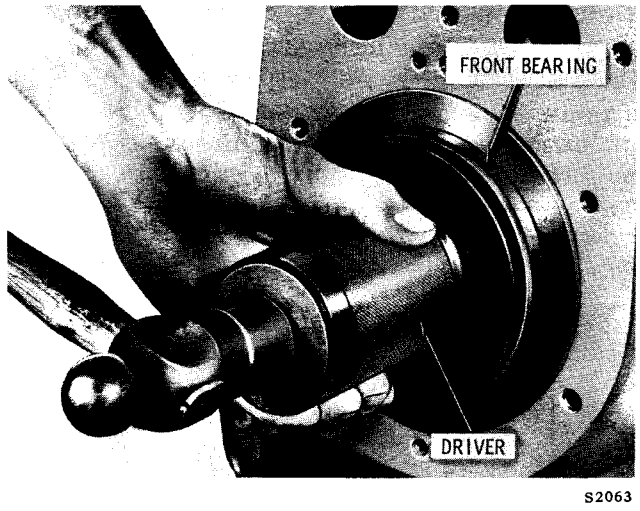


Fig. 7-7. Seating output shaft bearings

(10) Install shifter cover gasket 4 (B, foldout 11) and cover 3 on the main housing. Retain the cover with four 5/16-18 x 1-inch bolts 1 and lockwashers 2. Tighten the bolts to 13 to 16 pound feet torque.

(11) Screw the shifter detent plunger barrel (fig. 5-39) into the bore in the main housing just far enough to contact the shifter fork. Then back the barrel out one-quarter of a turn.

Note: If flats on the barrel are not parallel to flats on the main housing boss, continue backing the barrel out until they are parallel. Do not exceed three-quarters of a turn.

(12) Position the lockwasher over the barrel, with the bent edge of the washer on the flat of the main housing boss.

(13) Insert the ball, plunger, and spring into the barrel. Install the locknut and tighten it firmly. Bend the lockwasher over the nut to lock it securely. Move the shifter fork to the central (neutral) position, so that the detent ball engages the center notch in the shifter fork.

(14) Install shifter lever assembly 10 (B, foldout 11) onto the shifter fork shaft, alining the lever with the shifter detent locknut. Install a 3/8-24 x 1 1/8-inch bolt 8, and lockwasher 9 into the lever. Tighten the bolt to 33 to 40 pound feet torque.

(15) Install a needle bearing 22 (B, foldout 11) into each end of reverse idler gear 24. (On earlier model transmissions, install a bushing 23 into each end of gear 24.)

(16) Install two thrust washers 21 (B, foldout 11) onto the bosses (in the main housing) which are bored for shaft 28. The tangs on washers 21 must engage the slots in the bosses. Use oil-soluble grease to retain the thrust washers in the housing.

(17) Position idler gear 24, in the housing, between the two thrust washers 21, installed in (16), above. The longer teeth of the gear must be toward the rear of the transmission (opposite the output end).

(18) Start the solid end of reverse idler gear shaft 28 into the front of the housing, alining the retainer bolt hole, in the shaft, with the retainer bolt hole in the housing (fig. 5-38). Using a soft hammer or drift, drive shaft 28 (B, foldout 11) into the housing (through the bore of gear 24) until it is flush with the machined front surface of the housing.

(19) Partially insert the reverse shifter gear shaft 29 (B, foldout 11), solid end first, through the bore in the main housing. Install

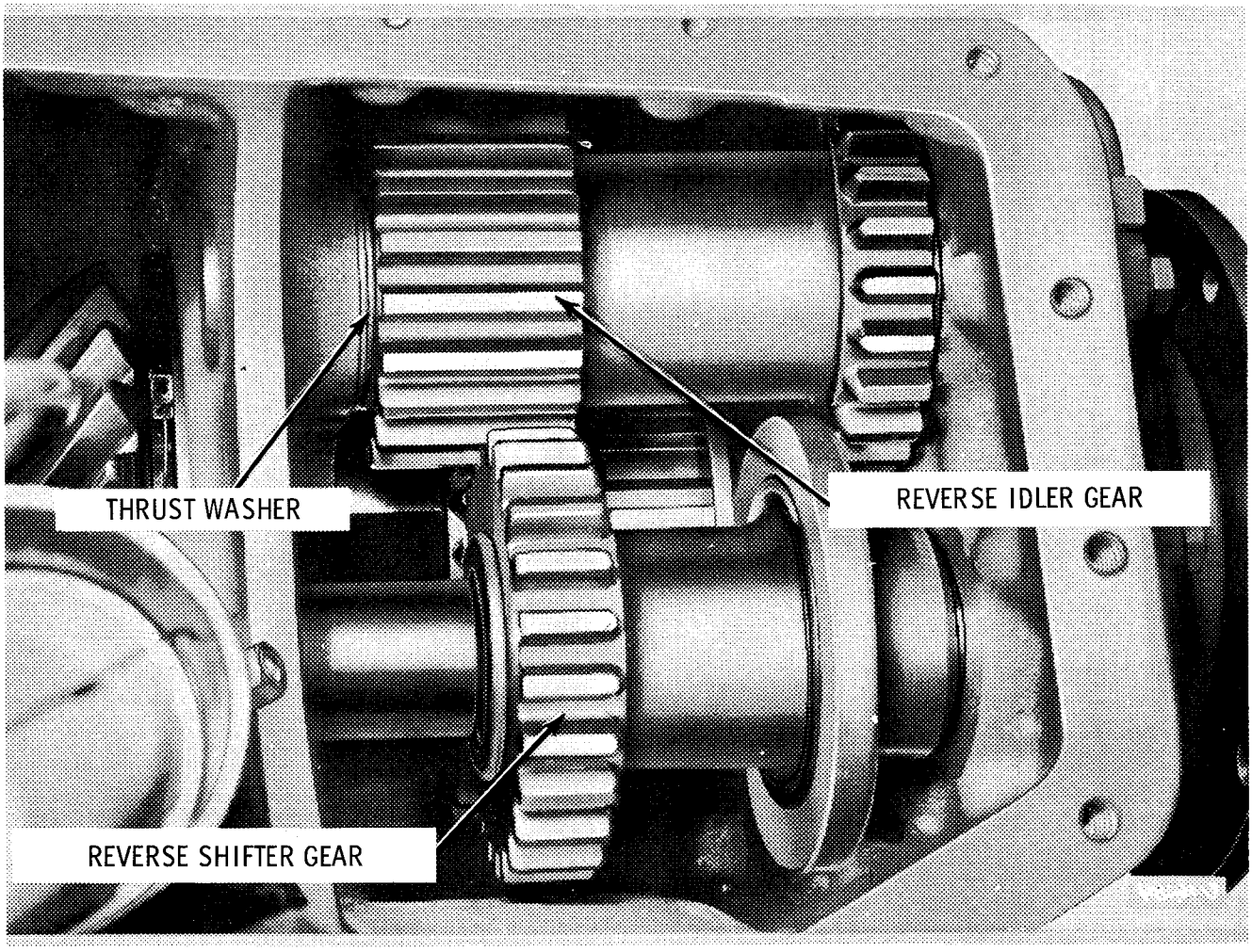


Fig. 7-8. Reverse gears installed

reverse shifter gear 27 into the housing on the shaft. Make certain that the flange of the reverse shifter gear is toward the output end of the transmission, and engages the groove in output shifter gear 18 previously installed ((8), above).

(20) With a soft drift and hammer, drive the reverse shifter gear shaft into the main housing, lining up the retainer bolt hole on the end of the shaft with the retainer bolt hole in the main housing. Drive the shaft in until the outer end is flush with the machined surface of the main housing.

(21) Install the retainer (fig. 5-37), and three 5/16-18 x 3/4 inch bolts and lockwashers. Tighten the bolts to 13 to 16 pound feet torque (fig. 7-8).

f. Installing End Cover, Companion Flange

(1) If speedometer and governor driven gear bushings 23 (A, foldout 11) were removed, install new bushings.

(2) If oil seal 7 was removed, install a new oil seal. Install the seal, lip inward, into the end cover.

(3) Place gasket 25 (A, foldout 11) on the main housing. Install end cover assembly 22, with the oil seal, on the main housing.

(4) Retain the end cover assembly with seven 3/8-16 x 1 1/4-inch bolts 34, three 3/8-16 x 2-inch bolts 36 and ten lockwashers 33 and 35. Tighten the bolts to 26 to 32 pound feet torque. Tighten the three long bolts first.

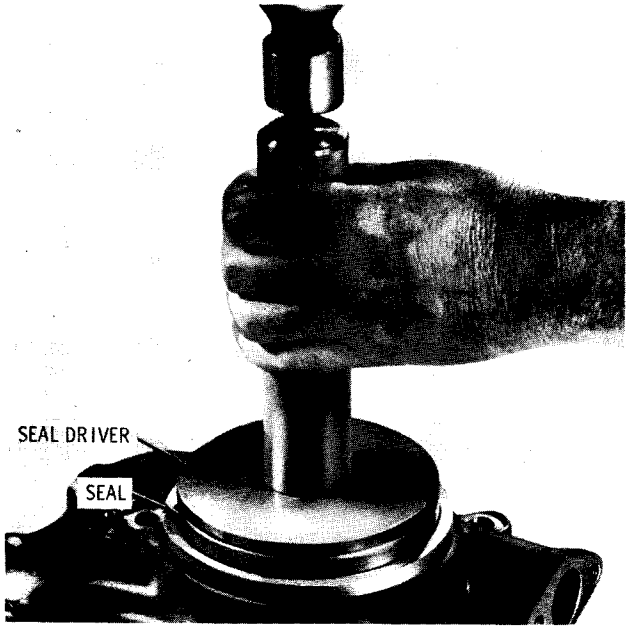


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Fig. 7-9. Installing end cover oil seal

(5) Insert the speedometer and governor drive gear key into the keyway of the companion flange (fig. 7-10). Install the gear on the flange. If necessary, tap the gear with a soft hammer to seat on the shoulder of the flange.

(6) Coat the lip of the oil seal in the end cover with grease. Aline splines of the companion flange and output shaft (fig. 5-36). Install the flange on the shaft, through the end cover.

Note: Hook-type sealring 4 (A, foldout 11) is no longer required, even though its groove may be present.

(7) Install output flange nut 2 (A, foldout 11) onto output shaft 28. Tighten the nut to 300 pound feet torque (fig. 5-35), using a holding bar and a 2 1/2-inch socket wrench. Install a new cotter pin 1 (A, foldout 11) through the nut and the hole in the output shaft.

(8) Install speedometer driven shaft and gear assembly 8 into the bore in the end cover. Install seal washer 9, gasket 10, seal 12, washer 13 and sleeve 14 onto shaft 8.

(9) Retain sleeve assembly 11 with two 5/16-18 x 7/8-inch bolts 16 and lockwashers 15. Tighten the bolts to 13 to 16 pound feet torque.

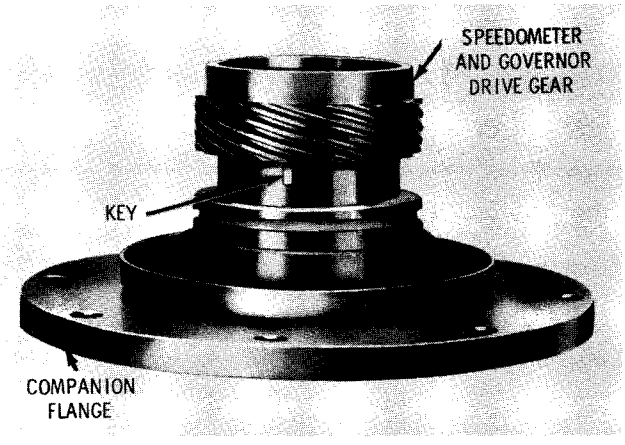

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Fig. 7-10. Installing drive gear on flange

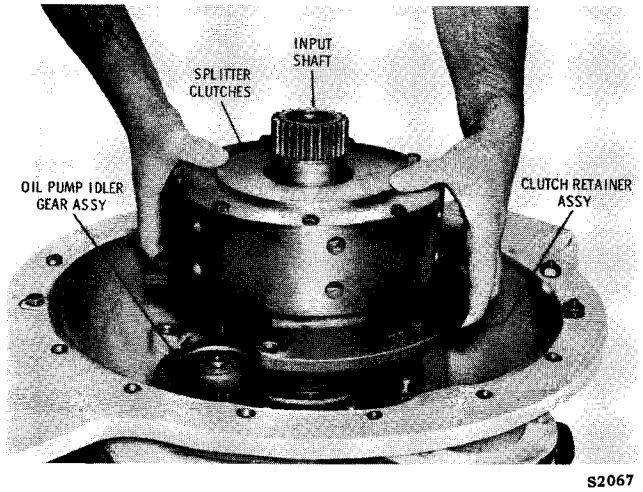

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Fig. 7-11. Installing splitter clutches (VS2 series)

(10) Install governor driven shaft and gear assembly 21 (A, foldout 11) into the end cover. Install governor 19 and gasket 20 (customer furnished) and retain with two bolts 17 and lockwashers 18.

g. Installing Splitter Clutches (VS2)

(1) Lubricate and install step-joint sealring 4 (fig. 5-34) and rubber sealring 6 onto the input shaft.

(2) Install the splitter clutches (as rebuilt in paragraph 6-6) onto the input shaft (fig. 7-11). Use care not to damage the sealrings installed in (1), above.

(3) Install the five 1/2-13 x 1 1/2-inch, self-locking bolts 49 (A, foldout 9) to retain the

clutch retainer to the main housing. Tighten the bolts to 81 to 97 pound feet torque.

(4) Install snapring 9 (B, foldout 9) onto the input shaft.

h. Installing Direct, Hydraulic Clutches (VH)

(1) Install clutch drive plate assembly 1 (B, foldout 12) into the main housing, seating it on the shoulder of the bevel gear sleeve (fig. 5-24). Aline the bolt holes in the plate with holes in the sleeve.

(2) Position bearing retainer 7 (B, foldout 12) on direct drive clutch hub 8. Place the assembly in a press and press bearing 6 onto the clutch hub. Install snapring 5 on the hub, with the beveled edge away from the bearing.

(3) Install the clutch hub and retainer assembly on the clutch drive plate, alining bolt holes in the retainer, drive plate and bevel gear sleeve. Retain these parts with eight 1/2-20 x 1 5/8-inch bolts 9, which are installed through the holes in clutch hub 8. Tighten the bolts to 96 to 115 pound feet torque.

(4) Starting with an external-tanged plate, install alternately, four external-tanged clutch plates 10 (B, foldout 12) and three internal-splined clutch plates 11 into the clutch drive plate assembly. On some earlier VH model transmissions, install five external-tanged plates and two internal-splined plates in the following sequence. One external-tanged plate 45, one internal-splined plate 46, one external-tanged wear plate 47, spring tab first, one external-tanged separator plate 48, then one plate 47, spring tab last, one plate 46, and one plate 45.

Note: Install the tangs of the external-tanged clutch plates and the clutch apply plate in the same slots in the clutch drive plate assembly.

(5) Install six studs 28 with Loctite (Stud-Lock) into apply plate 27. Tighten to 16 to 19 pound feet torque. Install the apply plate on the last external-tanged clutch plate installed.

(6) Install the hook-type sealring (fig. 7-12) onto the inner hub of the clutch cover assembly.

(7) Install sealring and expander (para 4-8) onto the outer diameter of the hydraulic drive clutch piston assembly (fig. 7-12).

(8) Install the hydraulic drive clutch piston, flat side first, into the clutch cover. Aline the three dowel pins in the piston with the dowel holes in the clutch cover (fig. 7-12).

(9) Place six piston return springs 20 (B, foldout 12) into the pockets of piston 21. Install sealring 18 and expander 19 onto the outer diameter of spring retainer 17 (para 4-8).

(10) Position the retainer and sealring assembly in the clutch piston, alining the six return springs with pockets in the retainer. When properly positioned, the retainer will drop into the piston, with the sealring in the retainer about even with the edge of the piston.

(11) Place the clutch cover, with the assembled parts, in a press. Compress the return springs enough to install the snapring (fig. 5-22) into the groove in the clutch cover hub.

(12) Install bronze thrust washer 15 (B, foldout 12) over hydraulic clutch cone hub 14. Position the cone hub on clutch piston 21.

(13) Install clutch driving cone 13 onto cone hub 14 and retain it with nine 3/8-24 x 1 1/8-inch bolts 35 and nine nuts 12. Tighten the nuts to 17 to 20 pound feet torque.

(14) Install hook-type sealring 38 onto the hub of clutch cover assembly 30. Install nine 3/8-24 x 2.38-inch special bolts 29 through holes in the clutch cover.

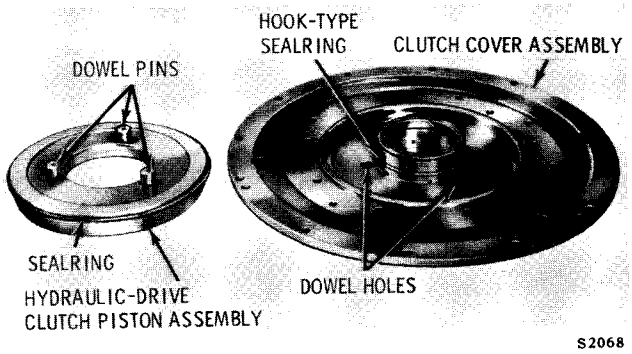

Fig. 7-12. Hydraulic drive clutch piston and clutch cover (VH series)

(15) Position clutch spring outer ring 40 (B, foldout 12) on clutch cover assembly 30. Install nine spacers 34 on nine bolts 29, previously installed.

(16) Install direct drive clutch piston 39, Belleville spring 41 and clutch spring inner ring 42 on bolts 29.

(17) Install nine tab locks 43 and nine 3/8-24 nuts 44 on bolts 29. Tighten the nuts to 17 to 20 pound feet torque. Bend the tab locks against a flat on the nuts and against the inner ring.

(18) Install the clutch cover assembly (fig. 7-13) onto the drive plate.

Note: When installing clutch cover assembly, make sure the six studs 28 (B, foldout 12), on clutch apply plate 27, are seated in the holes in outer ring 40.

(19) Install nine tab locks 36 and nine 3/8-24 nuts 37 on the studs of the drive plate assembly. Tighten nuts to 17 to 20 pound feet torque. Bend tab locks against a flat on the nuts and against the edge of the cover plate.

i. Installing Direct, Hydraulic Clutches (VS2)

(1) Install sealring 3 (A, foldout 12) and expander 4 (para 4-8) on the outer diameter of direct drive clutch piston 7. Install sealring 5 and expander 6 (para 4-8) into the bore of the piston.

(2) Install the piston (with sealrings) into direct drive clutch cover 2.

(3) On earlier model transmissions, install a Belleville spring, concave side first, onto the clutch piston and retain it with a snapring (fig. 7-14).

(4) Install direct drive clutch hub 11 (A, foldout 12) into cover 2. Using a press, install ball bearing 8 (B, foldout 9) onto the hub (fig. 7-15). On later model transmissions, without the Belleville spring, be sure the direct drive clutch piston does not fall out of the clutch cover when installing the bearing and hub. (After installing, the bearing and hub will be loose in the cover.)

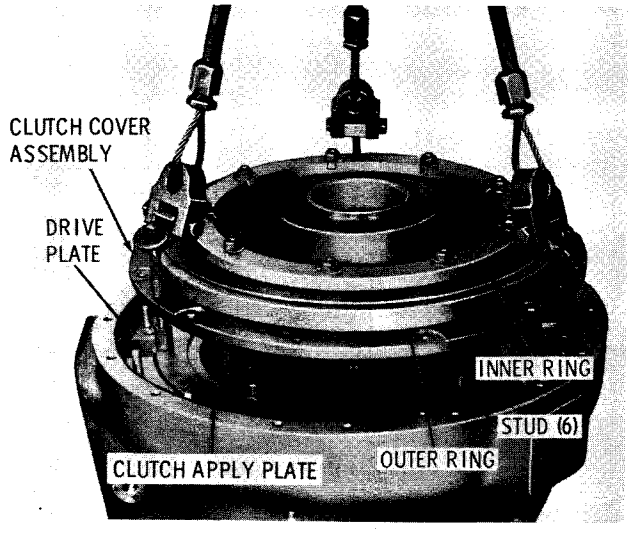

Fig. 7-13. Installing (or removing) clutch cover assembly (VH series)

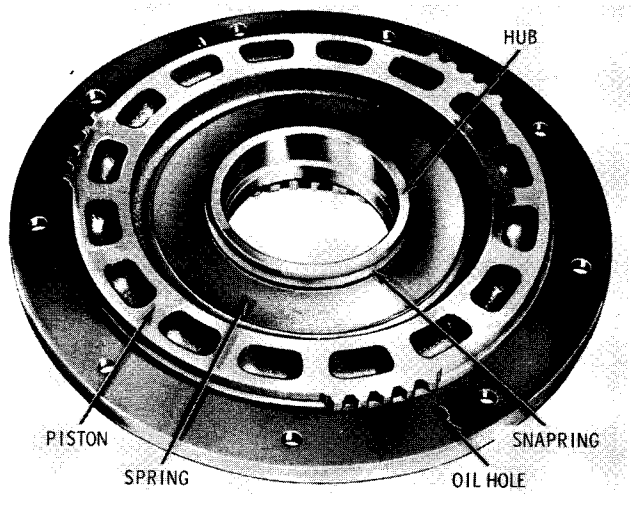

Fig. 7-14. Direct drive clutch piston, installed in cover (earlier model VS2 series)

(5) Place the clutch cover, piston upward, on a table. Install clutch drum 12 (A, foldout 12) with the direct drive clutch side down, onto the clutch cover, alining the oil and bolt holes in the clutch cover (fig. 7-14) with those in the clutch drum.

Note: The direct drive clutch side of the clutch drum is opposite the counterbored end.

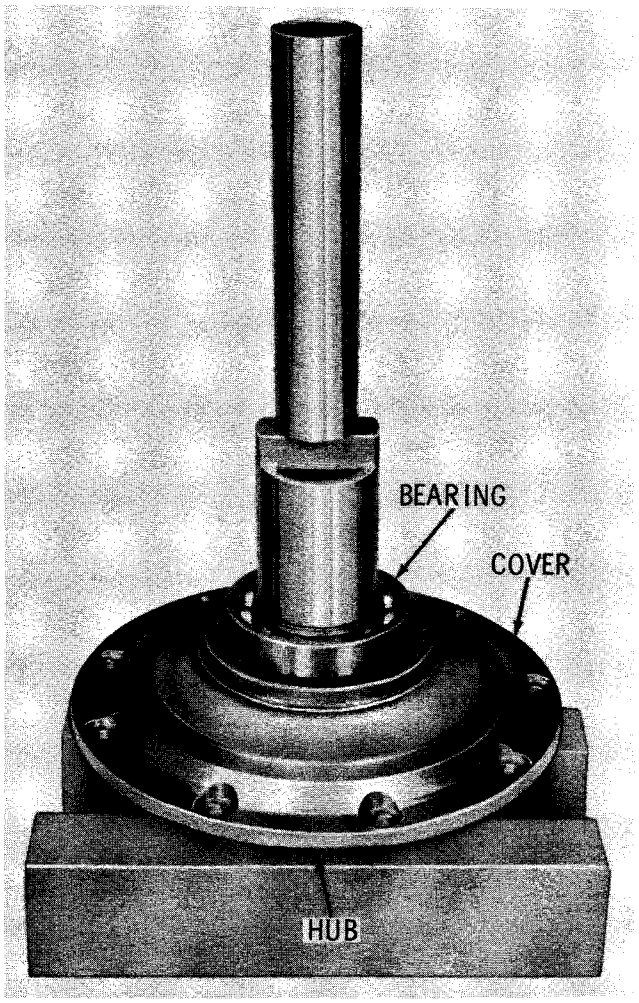

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Fig. 7-15. Installing bearing on direct drive clutch hub (VS2 series)

Install nine 5/16-24 x 3/4-inch, self-locking bolts 1 (A, foldout 12) to retain cover to clutch drum. Tighten the bolts to 19 to 23 pound feet torque.

(6) On later model transmissions, be sure clutch piston is properly seated in clutch cover prior to installing clutch plates. Starting with an external-splined clutch plate, alternately install seven external-splined clutch plates 9 and six internal-splined clutch plates 10 into the clutch drum.

(7) Install a snapring (fig. 7-16) into the bottom groove of the drum. Install the remaining internal-splined clutch plate 10 (A, foldout 12) into the clutch drum.

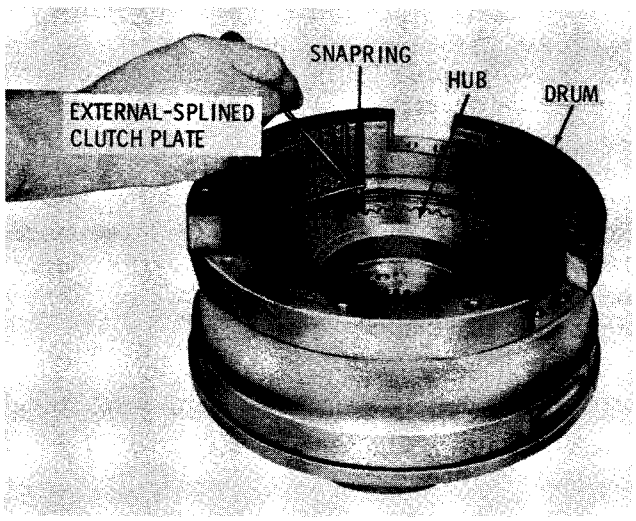

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Fig. 7-16. Installing snapring into drum, against direct drive clutch pate (VS2 series)

(8) Install backup clutch plate 14 (A, foldout 12) into the clutch drum. Then install other snapring 13 into the top groove of the drum, to retain the plate (fig. 5-28).

(9) Install internal snapring 16 (A, foldout 12) into the splined bore of the hydraulic drive clutch hub (fig. 5-27). Install the bearing onto the hub, then install the hydraulic drive clutch hub and bearing into the direct drive clutch hub.

(10) Starting with an internal-splined clutch plate, alternately install six internal-splined clutch plates 18 (A, foldout 12) and six external-splined clutch plates 19 in the clutch drum.

(11) Install sealring 27 and expander 26 (para 4-8) onto the outer diameter of hydraulic drive clutch piston 23. Install sealring 25 and expander 24 (para 4-8) into the bore of the piston.

(12) Install the piston (with sealrings), flat side first, into hydraulic drive clutch cover 28.

(13) On earlier model transmissions, install the Belleville spring, concave side first, and spacer onto the piston, and retain them with a snapring.

(14) On later model transmissions, install six piston return springs 22 (A, foldout 12) into the holes located in the three slots of the clutch drum.

(15) Install the hydraulic drive clutch cover onto the clutch drum, alining the oil holes in the cover and drum. On later model transmissions, without the Belleville spring, be sure the piston does not fall out of the cover during installation.

(16) Install nine 5/16-24 x 3/4-inch, self-locking bolts 29 to retain the cover to the clutch drum. Tighten the bolts to 19 to 23 pound feet torque.

(17) Install needle bearing 31 into hydraulic clutch cover 28. Install bronze thrust washer 30 onto the cover.

(18) Install the assembled direct and hydraulic drive clutches into the main housing (fig. 5-25). Engage the internal splines of the direct drive clutch cover with the splines of the bevel gear sleeve.

j. Installing Converter Pump, Converter Housing, Turbine, Converter Housing Cover

(1) On the VH series, install snapring 14 (A, foldout 13), bevel side toward converter pump 15, into the counterbore on the pump shaft. The snapring will be installed into a groove in the converter housing in a later operation. Using a sleeve and press, install bearing 13 onto the pump shaft (fig. 7-17).

(2) On the VS2 series, install bearing 13 (A, foldout 13), only.

(3) Install snapring 12 to retain the bearing. Install step-joint sealring 11 onto the pump shaft (fig. 5-18).

(4) If converter housing flange 3 (A, foldout 13) was removed from converter housing 5, install a new gasket 4 (gasket used on VH series only) and the flange. Use guide bolts to properly aline the oil passages in the flange and housing (fig. 7-18). Install five 5/16-18 x 1-inch, self-locking bolts 2 (A, foldout 13), to retain the flange in the housing. Tighten the bolts to 17 to 20 pound feet torque.

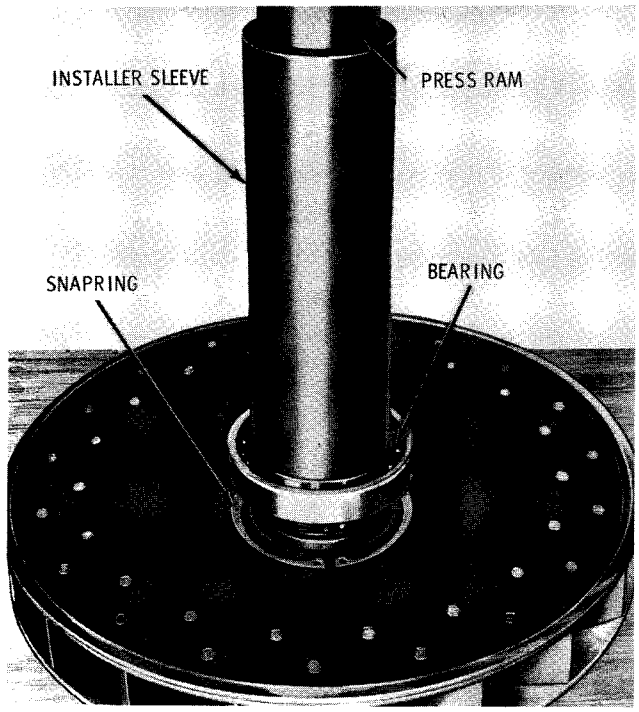

Fig. 7-17. Installing snapring and bearing on converter pump shaft (VH series)

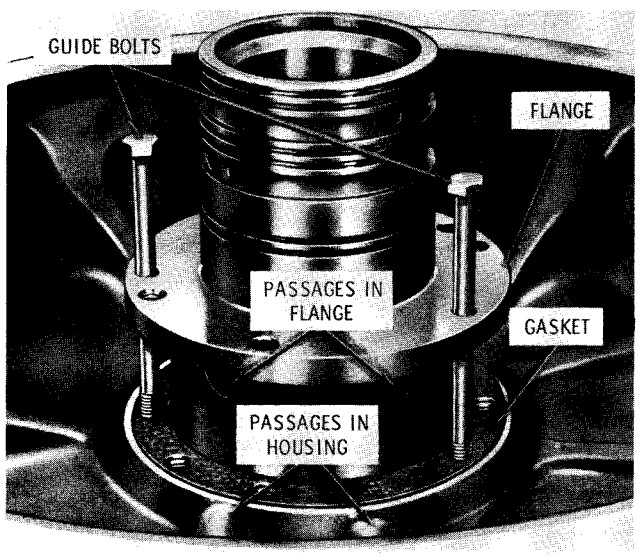

Fig. 7-18. Installing converter housing flange (VH series)

(5) Install three sealrings 1 (A, foldout 13) onto the converter housing flange.

(6) Install pipe reducer bushing 6 and converter drain plug 7 into converter housing.

(7) Install the torque converter pump and the bearing into the converter housing.

On the VH series, install the snapring, that was placed in the pump counterbore, into the groove in the converter housing (fig. 5-14). On the VS2 series, install snapring 14 (A, foldout 13) by inserting it through a slot in the pump and working it into the groove as the pump is rotated (fig. 5-15).

(8) Install converter housing gasket 20 (B, foldout 10) onto the main housing (fig. 5-16). Install the converter housing onto the main housing, alining the splines of the converter pump shaft with the splines of the hydraulic drive clutch hub. Retain the housing with sixteen 3/8-16 x 1 1/4-inch bolts 9 (A, foldout 13) and lockwashers 8. Tighten the bolts to 26 to 32 pound feet torque.

(9) Place torque converter turbine 16 in a press and install double-row ball bearing 17 into the turbine bore (fig. 7-19). Seat the bearing against the shoulder.

(10) Install spacer 18 (A, foldout 13) onto the turbine bearing. Install snapring 19, flat side first, to retain the spacer.

(11) Install the turbine, with the bearing, onto the torque converter pump. Using a suitable driver (fig. 7-20), seat the turbine and bearing on the pump.

(12) Install the turbine and pump bearing retaining snapring (fig. 5-12) into the pump shaft groove.

(13) Install the converter housing cover gasket 10 (A, foldout 13) onto the converter housing. Install converter housing cover 21 onto the housing and retain it with sixteen 3/8-16 x 1-inch bolts 23 and lockwashers 22 and two 3/8-16 x 1 1/2-inch bolts 25 and lockwashers 24. Tighten the bolts to 26 to 32 pound feet torque.

k. Installing Drive Shaft, Over-running Clutch

(1) If orifice plug 2 (B, foldout 13) was removed from drive shaft 3, install the plug.

(2) Install a new sealring 5 onto drive shaft check valve assembly 4. Install the check valve assembly, with the sealring, into the end of shaft 3. Tighten the valve body to 10 to 15 pound feet torque. Install the sealring into the groove in the shaft.

(3) Place front washer 10 (B, foldout 13) onto inner race 11, with the flat side of the washer against the shoulder of the race.

(4) Place the inner race in a press, longest diameter up, and press bearing 9 onto it. Install snapring 8, with flat side of the snapring against the bearing.

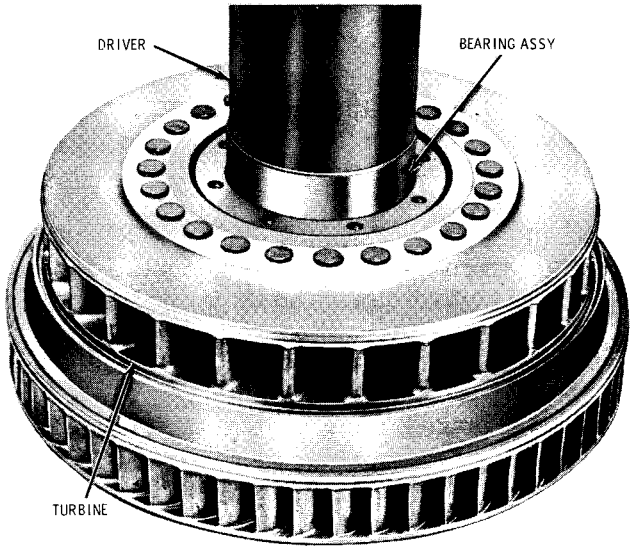

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Fig. 7-19. Installing double-row ball bearing in turbine

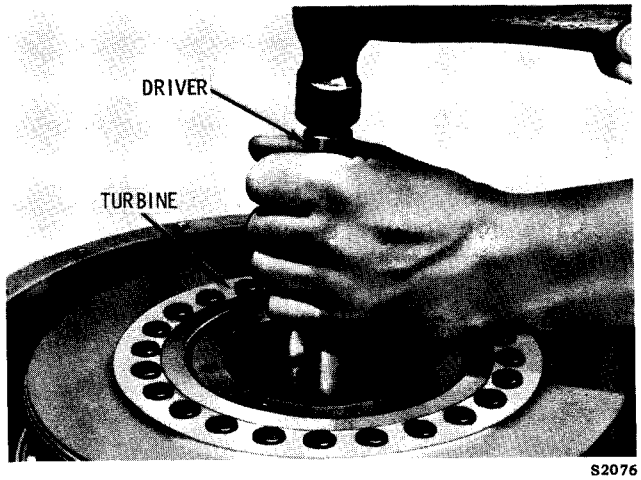

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Fig. 7-20. Installing turbine and turbine bearing

(5) Turn the inner race and bearing over (so the end with the bearing is down) and install outer race 12 with flat side of the outer race up.

(6) Install twenty-two rollers 13 between inner race 11 and outer race 12.

(7) Install rear washer 14, smaller diameter first, to retain the rollers. Install snapring 15 into the groove on the inner race, with the flat side of the snapring against the rear washer. Install the drive shaft retaining internal snapring 17 into the counterbore of the inner race cam.

(8) Install the assembled over-running clutch onto the splines of the assembled main drive shaft. The clutch goes on the splines on the check valve end of the shaft.

(9) Install lockring 18 and external snapring 19.

(10) Install two 3/8-24 x 3 (earlier models) or 1/4-28 x 3-inch (later models) guide bolts (fig. 5-8) into the puller bolt holes of the over-running clutch outer race. Install the drive shaft into the transmission, through the converter. Splines on the drive shaft must engage with the splines of output intermediate gear 19 (B, foldout 11) and direct drive clutch hub 11 (A, foldout 12) or 8 (B, foldout 12).

(11) Remove the two guide bolts and install eight 3/8-24 x 1 3/4-inch bolts 16 (B, foldout 13), later models; or 3/8-24 x 1 5/8-inch bolts, earlier models, to retain the over-running clutch to the converter turbine. Tighten the bolts to 41 to 49 pound feet torque. Install new lockwire (fig. 5-7) through holes in the bolt heads.

(12) Install new gasket 20 (B, foldout 13) onto the converter cover. Install converter housing cover cap 21 and retain it with nine 3/8-16 x 1-inch bolts 23 and lockwashers 22. Tighten the bolts to 26 to 32 pound feet torque.

l. Installing Oil Pump, Oil Pan, Oil Gage

(1) Install pin 5 (A, foldout 14) (on earlier models, install Woodruff key), and driven gear 6 on the shaft of oil pump assembly 3. Retain with snapring 7.

(2) If removed, install oil pump outlet housing 12 (bevel gear lubrication) and gasket 10 to the oil pump, and retain them with two 1/4-20 x 3/4-inch, socket-head screws 15 and flat washers 16.

(3) Install lubrication oil line 9 to the oil pump outlet housing.

(4) Install the oil pump, with the lines, into the main housing (fig. 5-6) and retain it with four 5/16-18 x 1 1/8-inch bolts 17 (A, foldout 14) and lockwashers 18. Tighten the bolts to 13 to 16 pound feet torque. Connect and tighten the lubrication oil line in the main housing.

(5) Install oil pump-to-control valve (main pressure) oil line 13 and oil pump-to-converter oil line 14 on the oil pump. Tighten the oil line fittings at the oil pump and main housing (fig. 7-21).

(6) Install gasket 19 (A, foldout 14), oil pump screen cover 20 and reinforcement 21 to the oil pump. Retain them with two 1/4-20 x 7/16-inch bolts and lockwashers 22. Tighten the bolts to 6 to 8 pound feet torque.

(7) Install oil pump screen 23 and retain with retainer spring 24.

(8) Install oil pan gasket 1 and oil pan 28 onto the main housing (fig. 7-21). Retain the oil pan with nineteen 5/16-18 x 7/8-inch bolts 29 (A, foldout 14). Tighten the bolts to 17 to 20 pound feet torque.

(9) Install gasket 9 (B, foldout 10) onto oil level gage and filler cap 8. Install the cap and gasket into the main housing oil filler hole.

m. Installing Exterior Components

(1) Install the accumulator valve outer spring 2 (B, foldout 14), inner spring 3 and accumulator valve 4 into the bore in the converter housing at the control valve mounting pad.

(2) Install control valve gasket 5 on the control valve mounting pad on the con-

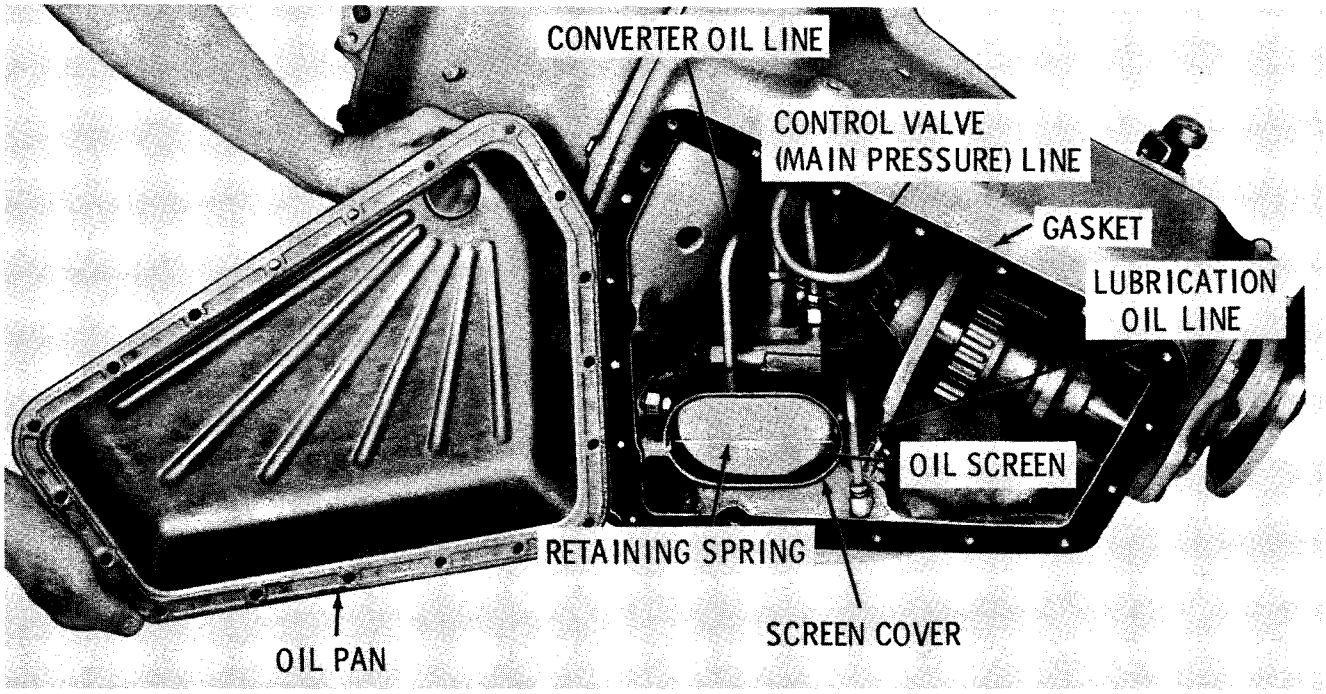

Fig. 7-21. Installing oil pan

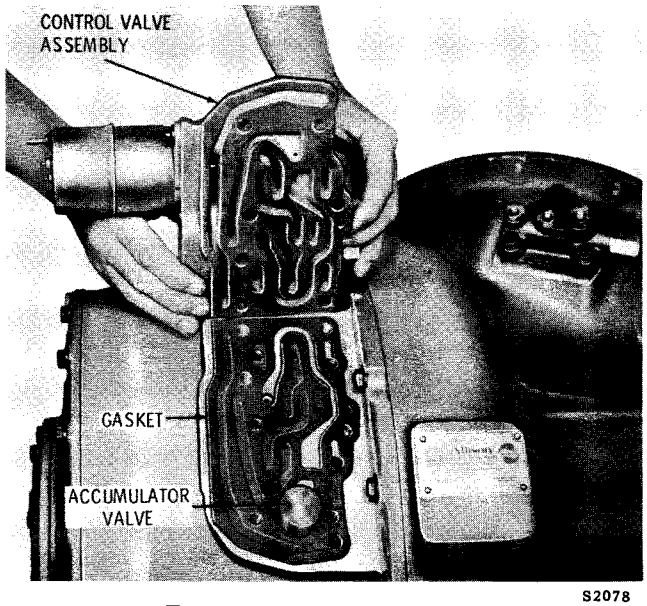

Fig. 7-22. Installing drive clutch control valve assembly

verter housing (fig. 7-22). Install the control valve assembly.

(3) Install five 3/8-16 x 3-inch bolts 7 (B, foldout 14) and lockwashers 6, and two 3/8-16 x 1 3/4-inch bolts 9 and lockwashers 8. Tighten the bolts uniformly to 26 to 32 pound feet torque.

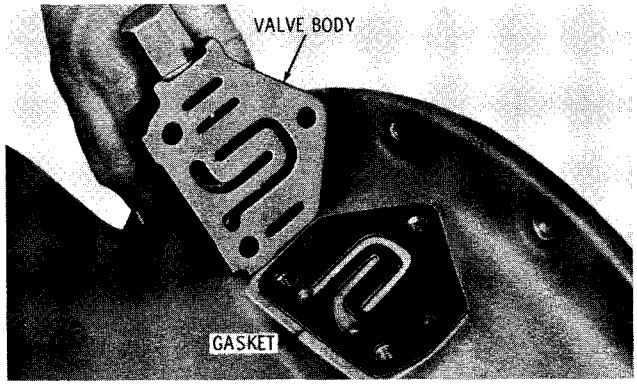

Fig. 7-23. Installing splitter clutch control valve assembly (earlier model VS2)

(4) On earlier VS2 series only, install splitter clutch control valve gasket 4 (foldout 15) on the mounting pad of the main housing (fig. 7-23). Install splitter clutch control valve assembly 5 onto the gasket. Install three 3/8-16 x 2-inch bolts 2 (foldout 15) and lockwashers 3. On later models, install gasket 18 and valve assembly 19. Install two 3/8-16 x 2 3/4-inch bolts 16 and lockwashers 17, and one 3/8-16 x 3 3/4-inch bolt 14 and lockwasher 13 to retain the valve to the housing (fig. 5-4). Tighten the bolts uniformly to 26 to 32 pound feet torque.

Section 8. WEAR LIMITS AND SPRING DATA

8-1. WEAR LIMITS DATA

a. Maximum Variations. Wear limits information in this section shows the maximum wear at which components are expected to function satisfactorily.

b. Cleaning, Inspection. Parts must be clean to permit effective inspection for wear or damage. Refer to paragraph 4-6, above.

c. Bearings, Bearing Journals, Bores. The application of bearings to any product is based on the recommendations of the bearing manufacturer and, therefore, no diametral dimensional deviation should be permitted in the bearing or mated parts. Bearings should be carefully checked for signs of distress before reinstalling in the transmission.

d. Gears. Gears should be inspected for load pattern and signs of distress. Any distress indicates a possible future failure, and the reuse of such gears should be the decision of the individual customer, based on experience. Backlash cannot be used to establish critical wear of a gear. The backlash tolerances are of such nature that a gear usually pits, scuffs, scores, or galls long before the gear wear becomes critical.

e. Splines. Unless severe, spline wear is not considered detrimental except where it affects tightness of an assembly such as driveline flanges. Here, again, backlash cannot be used to establish critical wear because both mating parts must be concentrically located to obtain accurate measurement of backlash.

f. Hook-Type, Step-Type Sealrings

(1) Sides of sealring should be smooth, and not have step wear greater than 0.005 inch. The sides of the groove into which the sealring fits should be smooth (50 microinch equivalent), and square with the axis of rotation within 0.002 inch. A new sealring should be installed if groove is reworked. A new hook-type sealring is required if there is no gap between the hooks when the sealring is set into its bore diameter.

(2) Step-type Teflon sealrings should be inspected for wear, cracks and scoring. New sealrings may require forming immediately prior to installation by wrapping around a circular object approximately two-thirds the diameter of the part into which the seal is to be installed. Teflon seals should be warm when so formed to prevent possible cracking. Teflon seals may be temporarily retained with oil-soluble grease while parts are assembled. If not retained with grease, the seals should be lubricated with transmission oil.

8-2. WEAR LIMITS CHART

The chart which follows lists the wear limits data and is referenced to the exploded views (foldouts 8 through 14) in the back of the manual.

8-3. SPRING DATA

Springs must be clean to permit effective inspection. Springs should be replaced if there are signs of overheating, wear due to rubbing adjacent parts or permanent set. Discard springs which do not meet the load-height specifications in the spring chart.

8-4. SPRING CHART

Inspection criteria (load versus height) and identification characteristics of springs are presented in the chart following the wear limits chart. The spring chart data are keyed to the exploded views (foldouts 9 through 15) in the back of the manual.

8-5. ENGLISH-TO-METRIC CONVERSIONS

A table, listing factors for converting any item expressed in English units to Metric (SI) units is at the back of this section.

WEAR LIMITS CHART

Illustration	Description	Part Number	Dimension	Wear Limit	Cone (max)
A, foldout 9	INPUT PLANETARY AND SPLITTER CLUTCHES (VS2 SERIES)				
2	Input carrier assembly	6778926	Gear end play	0.050	
Part of 4	Thrust washer	6778931	0.092-0.094	0.087	
5	Thrust washer	6830225	0.0615-0.0635	0.055	
13	Sun gear assembly	6778106	Face wear	0.010	
16	Bushing id	6778105	1.7518-1.7598	1.7563	
17	Thrust washer	6778079	0.0615-0.0635	0.055	
19	Bushing id	6778103	2.1896-2.1926	2.1941	
21, 32	Internal-splined plate	6778110	0.104-0.110	0.094*	
		6834425	0.104-0.110	0.094*	
22, 33	External-splined plate	6778108	0.0872-0.0922	0.0786	0.005
23	Pressure plate	6833445	Face wear	0.010	
		6833446	Face wear	0.010	
		6833447	Face wear	0.010	
25	Thrust washer	9422405	0.123-0.126	0.121	
27	Spring thrust ring	6778139	0.123-0.127	0.121	
31	Pressure plate	6833445	Face wear	0.010	
		6833446	Face wear	0.010	
		6833447	Face wear	0.010	
		6833448	Face wear	0.010	
34	Clutch back plate	6778080	Face wear	0.010	
36	Thrust washer	6779757	0.104-0.110	0.094	0.010
		6833899	0.104-0.110	0.094	0.010
45	Bushing id	6830164	2.5946-2.5976	2.5991	
B, foldout 9	MATCHED BEVEL GEAR DRIVE ASSEMBLY (VS2 SERIES)				
16	Oil pump idler gear bushing id	2222325	0.734-0.736	0.738	
A, foldout 10	MATCHED BEVEL GEAR DRIVE ASSEMBLY (VH AND VS SERIES)				
8	Oil pump idler gear bushing id	2222325	0.734-0.736	0.738	
B, foldout 10	TRANSMISSION MAIN HOUSING (VH, VS SERIES)				
4	Bushing id	2222307	0.875-0.876	0.878	
A, foldout 11	FLANGE, END COVER AND OUTPUT SHAFT (VH, VS)				
23	Bushing id	2222424	0.3740-0.3755	0.377	
B, foldout 11	SHIFTER FORK AND SHIFTER GEARS (VH, VS SERIES)				
21	Reverse idler gear thrust washer	2222472	0.061-0.063	0.055	
23	Reverse idler gear bushing id	2222471	1.501-1.502	1.504	
26	Reverse shifter gear bushing id	2222471	1.501-1.502	1.504	

*0.002 minimum groove depth

WEAR LIMITS CHART

Illustration	Description	Part Number	Wear Limit in. (mm)	Cone-max in. (mm)
A, foldout 12 DIRECT AND HYDRAULIC CLUTCHES (VS SERIES)				
9	External-spline plate thickness	6778108	0.0786 (1.996)	0.005 (0.13)
10	Internal-splined plate thickness	6834425	0.094* (2.39)	0.010 (0.25)
14	Backup clutch plate	6778039	0.010 wear step (0.25) each face	
Minimum clutch plate thickness (individual plate total) direct — 1.2684 inches (32.217 mm); hydraulic 1.0872 inches (27.615 mm)				
30	Thrust washer thickness	6778095	0.055 (1.40)	
B, foldout 12 DIRECT AND HYDRAULIC CLUTCHES (VH SERIES)				
10	External-tanged plate thickness	6774173	0.073 (1.85)	0.010 (0.25)
11	Internal-splined plate thickness	6774172	0.105** (2.67)	0.015 (0.38)
13	Hydraulic clutch driving zone	6772639	No visible wear permitted	
14	Hydraulic clutch cone hub	6772640	No visible wear permitted	
15	Thrust washer thickness	6768585	0.055 (1.40)	
21	Hydraulic drive clutch piston assembly	6772637	No visible wear permitted	
B, foldout 14 DRIVE CLUTCH CONTROL VALVE ASSEMBLY (VH, VS SERIES)				
4	Valve clearance in housing 5 (A, foldout 13)		0.0035 (0.089)	
12	Valve clearance in body 22		0.0035 (0.089)	
20	Valve clearance in body 22		0.0035 (0.089)	
23	Valve clearance in body 22		0.0035 (0.089)	
33	Valve clearance in body 22		0.0035 (0.089)	
40	Valve clearance in body 22		0.0035 (0.089)	
44	Valve clearance in body 22		0.0035 (0.089)	
foldout 15 SPLITTER CLUTCH CONTROL VALVE ASSEMBLY (VS2 SERIES)				
7	Valve clearance in body 6		0.0035 (0.089)	
25	Valve clearance in body 33		0.0035 (0.089)	
46	Valve clearance in body 33		0.0035 (0.089)	

*0.002 inch (0.05 mm) minimum groove depth
**0.003 inch (0.08 mm) minimum groove depth

SPRING CHART

Fold-out	Ref	Spring	Part No.	No. coils	Wire dia* in. (mm)	Outside dia in. (mm)	Approx. Free Length in. (mm)	Length under load in. (mm)	lb (N)
A, 9	29	Splitter clutch	6778024	Belleville spring		8.485 (215.52)	0.508① (12.90)		
B, 10	15	Shifter detent plunger	2222477	18.0	0.0630 (1.600)	0.420 (10.67)	1.812 (46.02)	1.421 (36.09)	11 to 13 (49 to 58)
A, 12	22	Piston return	6836543	37.0	0.072 (1.83)	0.382 (9.70)	3.790 (96.27)	3.265 (82.93)	20 to 22 (89 to 98)
			6833926	37.0	0.076 (1.93)	0.382 (9.70)	3.67 (93.2)	3.265 (82.93)	20 to 22 (89 to 98)
			6778286	Belleville spring		5.50 (139.7)	1.40② (35.6)		
A, 14	--	Main-pressure regulator valve (in pump assembly 3)	6776002	23.5	0.065 (1.65)	0.437 (11.10)	2.82 (71.6)	1.75 (44.5)	23.8 to 26.2 (106 to 117)
A, 14	--	Converter-pressure regulator valve (in pump assembly 3)	6776002	23.5	0.065 (1.65)	0.437 (11.10)	2.82 (71.6)	1.75 (44.5)	23.8 to 26.2 (106 to 117)
B, 12	20	Piston return	6771756	5.0	0.1420 (3.607)	1.22 (31.0)	1.422 (36.12)	1.108 (28.14)	46 to 52 (205 to 231)
B, 12	41	Piston return	6835685	Belleville spring		15.266 (87.76)	0.750③ (19.05)		
			763069	Belleville spring		15.279 (388.09)	0.860④ (21.84)		
B, 14	2	Accumulator valve outer	6835342	13.0	0.102 (2.59)	1.30 (33.0)	4.160 (105.66)	3.40 (86.4)	12 to 14 (53 to 62)
			6757110	12.5	0.0630 (1.600)	1.063 (27.00)	5.00 (127.0)	0.880 (22.35)	7.7 to 9.3 (34 to 41)
B, 14	3	Accumulator valve inner	6885167	16.0	0.0800 (2.032)	0.720 (18.29)	3.84 (97.5)	3.40 (86.4)	6.3 to 7.7 (28 to 34)
			6835341	16.0	0.0800 (2.032)	0.560 (14.22)	3.84 (97.5)	3.40 (86.4)	6.30 to 7.70 (28 to 34)
			6770864	11.5	0.054 (1.37)	0.877 (22.28)	4.120 (104.65)	0.880 (22.35)	6.69 to 8.17 (30 to 36)
B, 14	21	Hydraulic drive clutch exhaust valve	6835703	16.0	0.054 (1.37)	0.430 (10.92)	1.970 (50.04)	1.130 (28.70)	9 to 10.4 (40 to 46)
			6835380	18.5	0.054 (1.37)	0.430 (10.92)	1.90 (48.3)	1.13 (28.7)	10 to 12 (44 to 53)
			6769626	17.0	0.0475 (1.207)	0.420 (10.69)	1.90 (48.3)	1.130 (28.70)	6.65 to 7.35 (30 to 33)
B, 14	25	Direct drive clutch control valve	6835704	18.0	0.044 (1.12)	0.410 (10.41)	1.882 (47.80)	1.120 (28.45)	4.99 to 5.49 (22 to 24)
			6830274	18.0	0.044 (1.12)	0.410 (10.41)	1.950 (49.53)	1.186 (30.12)	5.00 to 5.50 (22 to 25)
			6834943	18.0	0.0561 (1.42)	0.410 (10.41)	1.632 (41.45)	1.190 (30.23)	8.35 to 9.35 (37 to 42)
B, 14	39	Hydraulic drive clutch exhaust valve	6835703	16.0	0.054 (1.37)	0.430 (10.92)	1.970 (50.04)	1.130 (28.70)	9 to 10.4 (40 to 46)
			6835380	18.5	0.054 (1.37)	0.430 (10.92)	1.90 (48.3)	1.13 (28.7)	10 to 12 (44 to 53)
			6769626	17.0	0.0475 (1.207)	0.420 (10.69)	1.90 (48.3)	1.130 (28.70)	6.65 to 7.35 (30 to 33)
15	8	Splitter clutch control valve	6835724	19.5	0.065 (1.65)	0.469 (11.91)	2.441 (62.00)	1.691 (42.95)	15.77 to 17.43 (70 to 78)
			6830330	23.0	0.0625 (1.59)	0.469 (11.91)	2.777 (70.54)	1.654 (42.01)	16.55 to 18.25 (74 to 81)
15	24	Splitter clutch control valve	6835724	19.5	0.065 (1.65)	0.469 (11.91)	2.441 (62.00)	1.691 (42.95)	15.77 to 17.43 (70 to 78)
			6835723	20.5	0.067 (1.70)	0.469 (11.91)	2.636 (66.95)	1.751 (44.48)	20.24 to 22.36 (90 to 100)
15	46	Splitter clutch exhaust valve	6779546	14.2	0.426 (10.82)	0.397 (10.08)	1.830 (46.48)	0.78 (19.8)	9.0 to 9.4 (40 to 42)

*Mean diameter shown.

① Replace if not within ±0.028 inch (0.71 mm) of dimension shown.
② Replace if not within ±0.10 inch (2.5 mm) of dimension shown.
③ Replace if not within ±0.020 inch (0.51 mm) of dimension shown.
④ Replace if not within ±0.025 inch (0.64 mm) of dimension shown.

METRIC CONVERSION TABLES
International System of Units (SI)

Multiply	by	to get equivalent number of:
LENGTH		
Inch	25.4	millimetres (mm)
Foot	0.304 8	metres (m)
Yard	0.914 4	metres
Mile	1.609	kilometres (km)
AREA		
$Inch^2$	645.2	$millimetres^2$ (mm^2)
	6.45	$centimetres^2$ (cm^2)
$Foot^2$	0.092 9	$metres^2$ (m^2)
$Yard^2$	0.836 1	$metres^2$
VOLUME		
$Inch^3$	16 387.	mm^3
	16.387	cm^3
	0.016 4	litres (l)
Quart	0.946 4	litres
Gallon	3.785 4	litres
$Yard^3$	0.764 6	$metres^3$ (m^3)
MASS		
Pound	0.453 6	kilograms (kg)
Ton	907.18	kilograms
Ton	0.907	tonne (t)
FORCE		
Kilogram	9.807	newtons (N)
Ounce	0.278 0	newtons
Pound	4.448	newtons

Multiply	by	to get equivalent number of:
ACCELERATION		
$Foot/sec^2$	0.304 8	$metre/sec^2$ (m/s^2)
$Inch/sec^2$	0.025 4	$metre/sec^2$
TORQUE		
Pound-inch	0.112 98	newton-metres (N·m)
Pound-foot	1.355 8	newton-metres
POWER		
Horsepower	0.746	kilowatts (kW)
PRESSURE OR STRESS		
Inches of mercury	3.377	kilopascals (kPa)
Inches of water	0.249 1	kilopascals
Pounds/sq. in.	6.895	kilopascals
ENERGY OR WORK		
BTU	1 055.	joules (J)
Foot-pound	1.355 8	joules
Kilowatt-hour	3.6×10^6 or 3 600 000	joules (J = one W·s)
LIGHT		
Footcandle	1.076 4	$lumens/metre^2$ (lm/m^2)
FUEL PERFORMANCE		
Miles/gal	0.425 1	kilometres/litre (km/l)
Gal/mile	2.352 7	litres/kilometre (l/km)
VELOCITY		
Miles/hour	1.609 3	kilometres/hr (km/h)

Degree (angle) 0.017 5 radians (rad)
Ounce (mass)·inch (balancing) 720.077 8 milligram·metre (mg·m)

TEMPERATURE

To convert Fahrenheit temperature to Celsius temperature, use formula:
$C° = 5/9 (F°-32)$

To convert Celsius temperature (identical to Centigrade temperature), use formula:
$F° = 9/5C° + 32$