

# **Allison**

## **Transmissions**

### **TT, TTB 2001 Series**

### **Service Manual**



## **IMPORTANT SAFETY NOTICE**

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.

It is important to note that some warnings against the use of specific service methods that can damage the vehicle or render it unsafe are stated in this service manual. It is also important to understand these warnings 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 method he selects.

# Service Manual

## Allison Transmissions

### POWERSHIFT MODELS

TT 2221-1, TTB 2221-1

TT 2421-1, TTB 2421-1

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**Detroit Diesel Allison**

Division of General Motors Corporation

Indianapolis, Indiana 46206

**NOTE:**

*Additional copies of this service manual may be purchased from Detroit Diesel Allison Distributors. See your yellow pages—under Engines, Diesel.*

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## FOLDOUTS (back of book)

Cross Section

1. TT 2001 and TTB 2001 transmissions

Exploded Views

- A, 2. Transmission front cover and input components, remote mount
- B, 2. Transmission input components, direct mount
- A, 3. Torque converter
- B, 3. Torque converter housing and turbine drive gears
- A, 4. Turbine driven gears and freewheel clutch
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- A, 8. Output shafts and disconnect assembly
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- A, 9. Oil pump assemblies
- B, 9. Control valve assemblies

## Section 1. GENERAL INFORMATION

### 1-1. SCOPE OF MANUAL

a. Coverage. This Service Manual describes the operation, maintenance, and overhaul procedures for the following Powershift transmissions:

TT 2221-1	TTB 2221-1
TT 2421-1	TTB 2421-1

Figures 1-1, 1-2, and 1-3 are representative of the model configurations covered in this manual. The various features available for these models are discussed, and the function and operation of the hydraulic systems and torque paths are explained. Wear limits information, parts inspection procedures, and torque specifications also are included.

b. Illustrations. The text is illustrated with photographs, line drawings, schematic views, and cross-section and exploded views. Transmission features and overhaul procedures are illustrated mainly by photographs. Line drawings are used to illustrate the hydraulic systems. Cross-section views illustrate the torque paths and the relationship of assembled parts. Exploded views illustrate the relationship of transmission parts. The cross-section and exploded views appear on foldouts at the back of the manual. The foldouts may be opened for reference while studying the text.

### 1-2. MODEL DIFFERENCES

a. Four Models. Four basic models are discussed in this Service Manual. They are:

TT 2221-1	TT 2421-1
TTB 2221-1	TTB 2421-1

Each of these models includes specific assemblies which differ in design or function.

#### b. Differences

(1) The basic difference between a 2221 and a 2421 model is in the diameter and vanes of the torque converter pump, turbines, and stator. The 2421 models have larger converter elements.

(2) The only difference between a TT and a TTB is that the TTB is equipped with an internal, hydraulic-actuated, dynamic disk brake.

### 1-3. SUPPLEMENTARY INFORMATION

Supplementary information will be issued when significant design changes occur. The supplements will pertain only to specific changes and, therefore, must be used in conjunction with this Service Manual.

### 1-4. ORDERING PARTS

#### a. Transmission Nameplate

The nameplate (fig. 1-4), located on the lower left side of the transmission housing, has the serial number, part number (assembly number) and model number assigned to define a specific configuration. Because of the differences in models, options, and component arrangement, be sure to include all three numbers (and metal-stamped letters — if present) when ordering parts or requesting service information.

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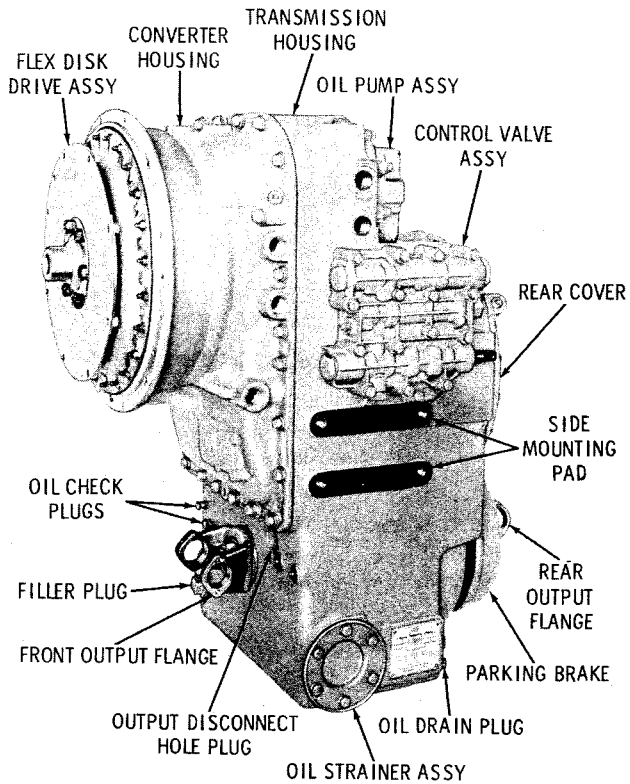


Fig. 1-1. Model TT 2221-1 (or TT 2421-1) transmission equipped for direct-mount installation—left-front view

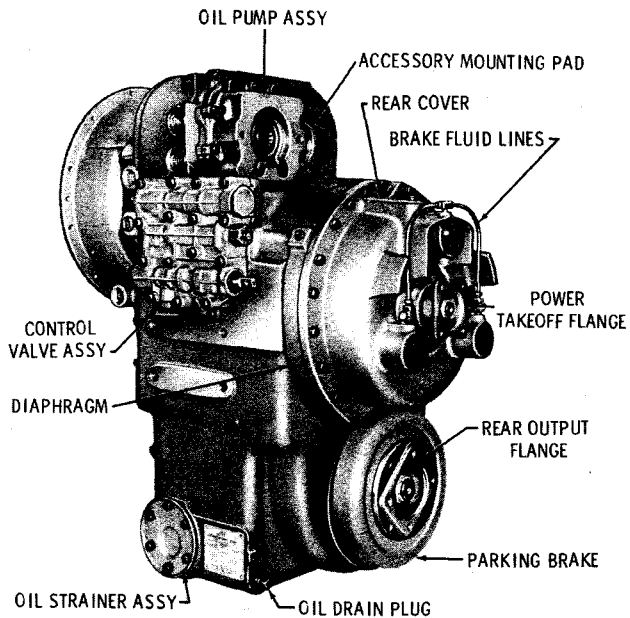


Fig. 1-3. Model TTB 2221-1 (or TTB 2421-1) transmission—left-rear view

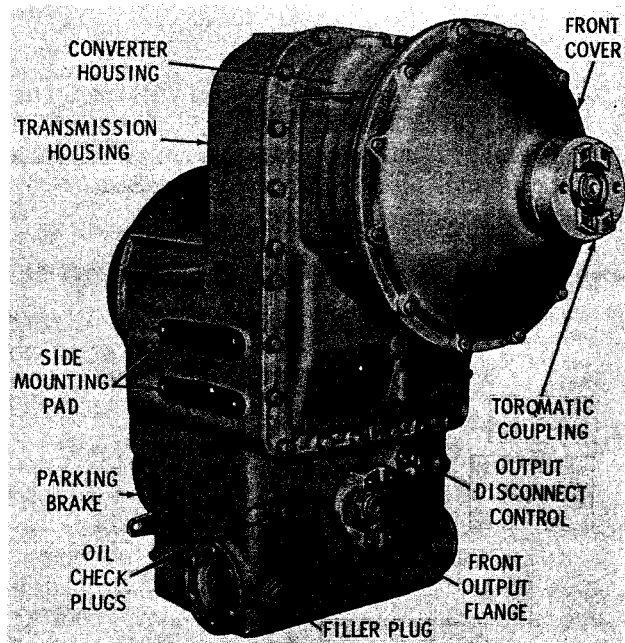


Fig. 1-2. Model TT 2221-1 (or TT 2421-1) transmission equipped for remote-mount installation—right-front view

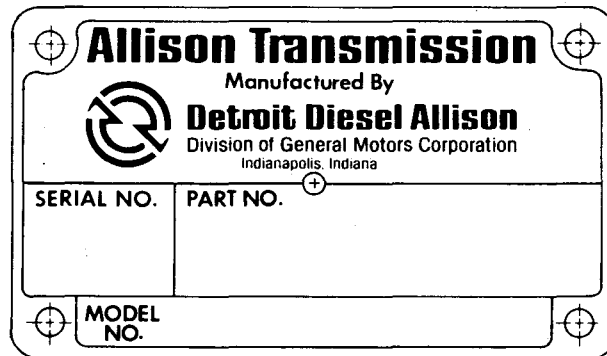


Fig. 1-4. Transmission nameplate

b. Parts Catalog. All replacement parts and service kits should be ordered from your dealer. These parts are listed in the current Series 1200-1400-2000 Allison Powershift Transmission Parts Catalog (SA 1248). Do not order parts by illustration item numbers used in this Service Manual.

## 1-5. DESIGN FEATURES

a. Mounting, Input Drive (foldout 1)

(1) The transmission may be direct mounted or remote mounted. In the direct-mount arrangement, the transmission is coupled to the engine through a modified SAE 3 mounting face on torque converter housing 46, which is bolted to the engine flywheel housing. Flexdisk drive assembly 1 bolts to the engine flywheel. Another direct-mount configuration consists of a splined converter drive cover which is driven by the engine flywheel (or adapter plate) through a splined drive ring.

(2) For the remote-mount arrangement, the transmission is equipped with front cover 4. An input shaft, connected to converter drive cover 5, extends through front cover 4 and receives the customer-selected flange. Input flange 3 is driven by the engine through a drive shaft and universal joints.

b. Twin-Turbine Torque Converter (foldout 1)

(1) Each turbine is connected to its own output gear set. First turbine 7 provides high torque at low speed; second turbine 6 provides higher speed with less torque. There are four elements in the twin-turbine torque converter—pump 9, first turbine 7, second turbine 6, and stator 8.

Note: The converter elements in the 2421 models are larger than those in the 2221 models.

(2) First-turbine drive gear 15, driven gear 42, and freewheel clutch 43 connect the first turbine to the range gears and clutches. Second-turbine drive gear 45 and driven gear 44 connect second turbine 6 to the range gears and clutches. The first-turbine gear set provides a reduction in speed with an increase in torque delivered to the range gearing. The second-turbine gear set provides an increase in speed with a reduction in torque delivered to the range gearing.

(3) When torque demand is high, the freewheel clutch is engaged and the first turbine, assisted by the second turbine, drives

the range gears. When the speed of the vehicle increases, torque demand decreases. When this occurs, the second turbine assumes the entire load and the freewheel clutch disengages. The transition from first turbine to second turbine (high torque to high speed) is automatic, being determined by speed and load conditions.

c. Range Gearing, Clutches (foldout 1)

(1) The transmissions have two planetary range gear sets and three clutches. The reverse-range planetary gear set consists of ring gear 40, carrier assembly 41, and sun gear 26 (integral with low-range sun gear). The reverse-range gear set is controlled by reverse-range clutch 17.

(2) The low-range planetary gear set consists of ring gear 38, carrier assembly 28 and sun gear 26 (integral with reverse-range sun gear). The low-range gear set is controlled by low-range clutch 19.

(3) Torque is supplied to the reverse- and low-range planetary gear sets by the shaft of the second-turbine driven gear, which drives the reverse-and-low-range sun gear. High-range clutch 24, when engaged, gives direct drive from the turbine driven gears to transfer drive gear 22. Each of the three clutches is applied separately. Two forward gears (F1 and F2) and reverse (R) are derived from the range gearing and clutches. All three clutches are multiplate, hydraulically applied, and spring released.

d. Transfer Gears (foldout 1). The transmission output consists of transfer gears 22 and 32 which drive any one of three output shaft configurations—front and rear output, front disconnect output, and rear output. Constant-mesh, spur-type transfer gears are used in-line to provide a 19-inch vertical drop from the input shaft to the output shaft.

e. Output Shafts (foldout 1)

(1) The transmission may be equipped with any one of three output shaft configurations—one-piece shaft 80, two-piece shaft 30 and 36, and rear output shaft 30.

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(2) The one-piece shaft provides identical operation at the front and rear outputs. The two-piece shaft and disconnect coupling 34 allow front output shaft 36 to be disconnected from the driveline while drive at rear output shaft 30 is maintained. The rear output shaft is the same as that used for the two-piece configuration except that the front output and disconnect components are not included.

f. Converter-driven Power Takeoff (foldout 1). The converter-driven power takeoff (PTO) consists of PTO shaft 53 or 78 which extends through the rear cover. Output flange 52 or 77 is splined to the rear end of the PTO shaft. The forward end of the PTO shaft is splined to reverse-and-low-range sun gear 26, which is driven by the torque converter. Thus, regardless of the range selector position, the PTO rotates at the same rpm as the torque converter output.

g. Internal Brake (foldout 1). All TTB models include a multidisk, self-adjusting, hydraulically-applied dynamic brake 60. This brake is connected to the vehicle driveline through transfer drive gears 22 and 32, and the transmission output shaft(s).

#### h. Accessory Drive Pad

(1) An SAE size A, 2-bolt mounting pad is located at the upper-right rear of the transmission housing to accommodate a steer pump or other accessory (in addition to that mounted at the rear of the oil pump).

(2) If no requirement exists for an accessory drive at this location, the drive gear, shaft assembly, and related parts are omitted, and the opening in the housing is closed with a plug.

i. Oil Pump (foldout 1). A positive displacement, gear-type oil pump 13 furnishes the oil flow and pressure necessary for hydraulic operation, lubrication, and cooling of the transmission components. Rotation of the pump is in a clockwise direction (viewed from rear) and is proportional to the speed of the engine. A mounting pad 14 is provided at the rear of the oil pump to accommodate an implement pump.

#### j. Control Valve Body Assembly (B, foldout 9)

(1) Control valve body assembly 5 is mounted on the left side of the transmission housing (fig. 1-1). The significant components contained within the valve body are main-pressure regulator valve 8 (B, foldout 9), trimmer plug 16, range selector valve 27, and either a clutch cutoff valve 20 or an inching control valve 40.

(2) The clutch cutoff valve may be either pneumatically or hydraulically actuated (by air or hydraulic brake pressure). When the vehicle brakes are applied, the valve releases the transmission drive clutch. Thus, when the vehicle is brought to a stop by the brakes, the power-driven pumps may be controlled by opening the throttle without having to shift to neutral. The inching control is manually operated and allows the drive clutch to slip while "inching" or maneuvering in confined areas.

(3) Linkage connects the range selector valve (and inching control valve, if used) to the operator's manual controls. A brake pressure line connects the clutch cutoff valve to the vehicle brake system.

k. Parking Brake (foldout 1). A 10 x 1 1/2-inch (254 x 38.1 mm), expanding shoe-type parking brake 31 is available. The brake is mechanical, and manually operated.

l. Housings (fig. 1-1). The torque converter housing is cast aluminum, and the transmission housing is cast iron. The front cover is cast iron. The rear cover may be either cast iron or aluminum. The lower part of the transmission housing serves as an oil sump. Openings in the transmission housing provide for installation of external piping, oil check plugs, breather, drain plug, oil filler tube and oil strainer.

m. Oil Filter, Cooler. Provision is made for connecting a remote-mount, full-flow oil filter and an oil cooler to the transmission (both customer-furnished). Refer to figure 3-1 for the points at which these items are attached.

## 1-6. OPERATING INSTRUCTIONS

a. Related to Vehicle. For information on controls and linkage provided by the vehicle manufacturer, refer to the vehicle service manual.

b. Range Selection

(1) Position the range selector control in neutral position while starting the engine. A neutral start switch (if used) will prevent the engine from starting if the shift lever is in any other position.

(2) When a shift is made from neutral to any driving range, the engine should be at idle speed. Any shift to a higher speed range, in the same direction, can be made at full throttle, under load. Downshift to the next lower speed range may be made at full throttle, under load, providing the vehicle is not exceeding the maximum speed attainable in the lower range.

c. Changing Direction of Travel. Directional shifts can be made under full-power and/or full-speed conditions in the working ranges (F1 to R and R to F1). Shifts from reverse should be made to F1 drive range—not F2. Direct shifts from R to F2 will adversely affect clutch service life.

d. Clutch Cutoff Control. When the transmission is equipped with the clutch cutoff control, the driving clutch is completely released whenever the vehicle brakes are applied. Air or hydraulic pressure which applies the brakes also actuates the clutch cutoff. Thus, with the clutch released, full engine power is available for PTO-driven equipment without shifting the range selector control to neutral.

e. Inching Control. Applying the inching control releases the driving clutch. The inching control may be used during operation in any range except that its use in high range (F2) is not recommended. Full application will completely release the driving clutch. Lesser application will slip the clutch while it is driving. Very slight and slow movements of the vehicle can be made with this control.

Additional cooling and lubricating oil is supplied to the driving clutch during inching operation in low- and reverse-range operation.

f. Output Disconnect. The transmission front output may be disconnected by actuating the control which moves the disconnect coupling (at the front of the transmission drop box) forward. Rearward movement connects the front and rear output shafts through the splines of the coupling. Two spring-loaded ball detents retain the coupling in either position. The control should never be shifted while the vehicle is moving.

g. Temperatures, Pressures

(1) When a transmission is equipped with a temperature gage, the bulb or sending unit is mounted in the converter-out oil stream (fig. 3-1). Temperature should never be permitted to exceed 250°F (121°C). Extended, severe operating conditions may cause the temperature to reach this maximum. If so, the transmission should be shifted to neutral and the engine should be operated at approximately 1000 to 1500 rpm for several minutes until the normal temperature (180 to 220°F [82 to 104°C]) is restored. If the temperature reaches maximum (250°F [121°C]) during normal operation of the transmission, stop the engine and locate the trouble. Refer to Troubleshooting Chart (para 3-11).

(2) When a transmission is equipped with a clutch (main) pressure gage, it is connected to the front of the control valve body assembly (fig. 3-1). The pressure shown is that which is effective in the operating range clutch. Shifting or use of the clutch cutoff or inching control will cause fluctuations in the pressure indicated. If abnormal pressures are evident, refer to the Troubleshooting Chart (para 3-11).

## 1-7. SPECIFICATIONS, DATA

The following table of specifications and data are applicable to all models within the scope of this Service Manual.

## SERIES TT, TTB 2001 POWERSHIFT TRANSMISSIONS

## SPECIFICATIONS AND DATA

<u>Item</u>	<u>Description</u>
Transmission type	Torque converter and planetary gear
Rating:	
input speed	3000 rpm (max)
input torque	310 lb ft (420 Nm)
input horsepower	177 hp (139.4 kW)
Rotation, viewed from front:	
input	clockwise
output (forward operation)	clockwise
(reverse operation)	counterclockwise
Mounting, drive:	
side	four 5/8-11 tapped holes in side pads, each side
front, direct mounted	modified SAE-3 flange on converter housing bolts to engine flywheel housing, flex plate attaches to engine flywheel (optional splined drive)
front, remote mounted	front unmounted, converter enclosed, input flange for shaft and universal joint coupling
Gear ranges, selector positions	Reverse, neutral, low-range (F1), high-range (F2)
Weight, dry (approx):	
direct mount—TT	760 lb (344.7 kg)
internal brake—TTB (add)	175 lb (79.3 kg)
remote mount (add)	40 lb (18.1 kg)
parking brake (add)	20 lb (9.0 kg)
converter-driven PTO (add)	10 lb (4.5 kg) to TTB and 45 lb (20.4 kg) to TT
larger converter—2421 (add)	15 lb (6.8 kg)
Torque converter	2-stage, 4-element, twin-turbine
*torque multiplication ratios:	
TT, TTB 2221-1	TT 220 — 5.1:1      TT 230 — 7.1:1 TT 240 — 5.1:1      **TT 242 — 3.3:1 **TT 252 — 4.8:1      TT 260 — 4.8:1 **TT 262 — 3.1:1      TT 270 — 6.6:1 **TT 272 — 4.5:1
TT, TTB 2421-1	TT 425 — 5.1:1      **TT 426 — 4.6:1 **TT 427 — 3.3:1      TT 445 — 4.6:1 **TT 447 — 3.2:1

# GENERAL INFORMATION

Para 1-7

## SPECIFICATIONS AND DATA (cont)

<u>Item</u>	<u>Description</u>																		
Gearing	Constant mesh, straight spur, planetary type																		
*Gear ratios	<table><tr><th></th><th>**2nd turbine ratio, 1.21</th><th>2nd turbine ratio, 0.83</th></tr><tr><td>transfer gear set ratios:</td><td>0.846:1 0.685:1</td><td>0.846:1 0.685:1</td></tr><tr><td>low range—standard (F1)</td><td>3.90:1 3.16:1</td><td>2.66:1 2.16:1</td></tr><tr><td>high range (F2)</td><td>1.02:1 0.83:1</td><td>0.70:1 0.57:1</td></tr><tr><td>reverse (R)</td><td>2.88:1 2.33:1</td><td>1.96:1 1.59:1</td></tr><tr><td>low range—high speed (F1)</td><td>2.97:1 2.40:1</td><td>2.03:1 1.64:1</td></tr></table>		**2nd turbine ratio, 1.21	2nd turbine ratio, 0.83	transfer gear set ratios:	0.846:1 0.685:1	0.846:1 0.685:1	low range—standard (F1)	3.90:1 3.16:1	2.66:1 2.16:1	high range (F2)	1.02:1 0.83:1	0.70:1 0.57:1	reverse (R)	2.88:1 2.33:1	1.96:1 1.59:1	low range—high speed (F1)	2.97:1 2.40:1	2.03:1 1.64:1
	**2nd turbine ratio, 1.21	2nd turbine ratio, 0.83																	
transfer gear set ratios:	0.846:1 0.685:1	0.846:1 0.685:1																	
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high range (F2)	1.02:1 0.83:1	0.70:1 0.57:1																	
reverse (R)	2.88:1 2.33:1	1.96:1 1.59:1																	
low range—high speed (F1)	2.97:1 2.40:1	2.03:1 1.64:1																	
Clutch data:																			
type	multidisk, hydraulic-actuated, spring released, oil-cooled; automatically compensates for wear																		
material	external-tanged reaction plates — polished steel internal-splined friction plates — resin-graphite; forward, reverse sintered bronze; high range																		
Parking brake:																			
size and type	10 x 1-1/2 in. (254 x 38.1 mm), expanding shoe, mechanical-applied																		
rating (run-in and burnished)	30,000 lb in. (3389 Nm) at 1500 lb (6672 N) apply force																		
Internal brake (TTB model):																			
type	multidisk, hydraulic-applied, self-adjusting																		
rating (static capacity)	3000 lb ft (4068 Nm) at transmission output shaft with 1500 psi (10 342 kPa) brake apply pressure																		
cooling	forced oil flow																		
hydraulic brake fluid	SAE J70, type 70R1 or 70R3																		
Flanges:																			
input and output	Mechanics 4C, 5C, 6C, 7C; Rockwell 5N plain, 6N plain; Spicer 1480																		
Torqmatic coupling	Mechanics 5C, 6C																		
Oil system:																			
oil pump	input driven, positive displacement, 2 spur gears																		

\* To obtain overall transmission torque ratios, multiply the applicable torque converter ratio times the gear ratio

\*\* Converter models having a 2nd turbine ratio of 1.21:1

## SERIES TT, TTB 2001 POWERSHIFT TRANSMISSIONS

## SPECIFICATIONS AND DATA (cont)

<u>Item</u>	<u>Description</u>
sump	single, integral
oil type: above 32°F (0°C)	Either Type C-2 Grade 10 or Grade 30 hydraulic fluid
32 to -10°F (0 to -23°C)	Type C-2 Grade 10 hydraulic fluid
below -10°F (-23°C)	Type C-2 Grade 10 hydraulic fluid Auxiliary preheat is required to raise the sump temperature above -10°F (-23°C)
oil capacity (less external circuits)	initial fill—8-1/2 US gal (32 litres)
oil filter (customer furnished)	remote mounted, PM-13-2 or equivalent replacement element, PF 151 or equivalent
converter-out oil temperature	250°F (121°C) max
main pressure, at full throttle	†135 to 170 psi (930 to 1172 kPa) (vehicle weight to 28,000 lb 12 701 kg ) †160 to 195° psi (1103 to 1344 kPa) (vehicle weight over 28,000 lb [12 701] kg)
lubrication pressure, at full throttle	15 to 30 psi (103 to 207 kPa)
converter-out pressure, at full-throttle stall	35 psi (241 kPa) (min)
converter-out pressure, at full-throttle, no-load	65 psi (448 kPa) (max)
Control valve body assembly:	
clutch cutoff	hydraulic- or pneumatic-actuated
inching control	manual-actuated
Engine-driven power takeoffs:	
implement pump drive (pad at rear of oil pump)	
ratio — standard	0.91 x engine speed
— optional	1.00 x engine speed
† maximum rating	<u>Continuous</u> <u>Intermittent</u>
horsepower, at	
2000 to 3000 rpm	90 (67.1 kW) 110 (82 kW)
torque, up to 2000 rpm	236 lb ft (321 NM) 288 lb ft (391 Nm)
mounting pad	SAE size C, 2-bolt or 4-bolt
mounting pad	SAE size B, 2-bolt
coupling adapter	Size C-to-B reducer
accessory drive	
ratio — standard	0.91 x engine speed
— optional	1.00 x engine speed

† These pressures are established for a converter-out temperature range of 140 to 165°F (60 to 73.8°C). As converter-out temperature approaches 250°F (121°C), main pressure can drop as much as 15 psi (103 kPa).

# GENERAL INFORMATION

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## SPECIFICATIONS AND DATA (cont)

<u>Item</u>	<u>Description</u>
†† maximum rating	30 hp (22.4 kW) at 2000—3000 rpm
horsepower	79 lb ft (107 Nm) up to 2000 rpm
torque	SAE size A, 2-bolt
mounting pad:	PD = 0.563 (14.30 mm), 30° pressure
A spline data	angle, 9 teeth
B spline data	PD = 0.813 (20.65 mm), 30° pressure
Converter-driven power takeoff:	angle, 13 teeth
ratio — standard	1.21 x converter output speed
— optional	0.83 x converter output speed
rating, continuous	full input (engine) hp (kW)
Speedometer drive pad:	
type	SAE 5/32, heavy duty
ratio	0.846 x transmission output speed

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†† If both drive pads are used simultaneously, their combined duty requirements should not exceed the duty rating for the implement pump PTO.

## Section 2. DESCRIPTION AND OPERATION

### 2-1. SCOPE OF SECTION 2

This section describes the functions of the transmission components. The hydraulic systems are explained and schematically illustrated. The transmission torque paths are also explained for each gear range.

### 2-2. TWIN-TURBINE TORQUE CONVERTER

a. Converter Construction (foldout 1). The torque converter consists of pump 9, first turbine 7, second turbine 6, and stator 8. Pump 9 is the driving member and is driven at engine output speed. First turbine 7 and second turbine 6 are driven members, connected by transfer gears 15, 42, 44, and 45 to the transmission range gearing. Stator 8 is the reaction member.

b. Converter Operation (foldout 1). During operation, the first and second turbines function jointly or separately, depending upon the load demand and speed of the vehicle. The first-turbine gear train consists of gears 15 and 42. The second-turbine gear train consists of gears 44 and 45. The turbines are able to function jointly or separately by means of a freewheel clutch 43. At high load demand and low speed, the freewheel clutch is engaged, permitting both turbines to drive, and providing maximum input torque to the range gearing. As the vehicle speed increases and load demand decreases, the second-turbine speed, as it approaches the first-turbine speed, provides all of the torque. The first turbine then freewheels. Upon an increase in load demand and the resulting decrease in vehicle speed, the freewheel clutch automatically re-engages, permitting both the first turbine and second turbine to again provide the necessary torque multiplication.

### 2-3. LOW-, REVERSE-RANGE GEARING AND CLUTCHES

a. Two planetary gear sets are used in the transmission gear train. One transmits low-speed forward and the other transmits reverse drive. The planetary gear sets are interconnected through integral sun gears 26, (foldout 1) and reverse-range ring gear 40, which is splined to low-range planetary carrier assembly 28.

b. The reverse-range planetary carrier assembly 41 (foldout 1) has four pinions. Low-range planetary carrier assembly 28 may have either a four-pinion or a six-pinion configuration. The four-pinion, low-range planetary provides a standard low-range ratio; the six-pinion planetary is used to obtain a higher speed ratio in low-range operation. Reverse-and-low-range sun gear 26 is driving member for both planetary gear sets. In the reverse-range planetary, carrier assembly 41 is the reaction member and ring gear 40 is the driven member. In the low-range planetary, ring gear 38 is the reaction member and carrier assembly 28 is the driven member.

c. Reverse-range clutch 17 (foldout 1) has five external-tanged reaction plates and five internal-splined friction plates. The reaction plates engage the anchor pins in reverse-and-low-range clutch anchor 33. The friction plates engage the splined hub of the reverse-range planetary carrier. Low-range clutch 19 has four internal-splined friction plates and four external-tanged reaction plates. The friction plates engage the splines of low-range ring gear 38 and the reaction plates engage the anchor pins in reverse-and-low-range clutch anchor 33. Engagement of the reverse-range clutch holds the reverse-range carrier stationary, and engagement of the low-range clutch holds the low-range ring gear stationary.

## SERIES TT, TTB 2001 POWERSHIFT TRANSMISSIONS

### Para 2-4/2-7

#### 2-4. HIGH-RANGE CLUTCH

a. High-range drive is obtained through the high-range clutch—no planetary gearing is involved. High-range clutch 24 (foldout 1) consists of two friction plates and one external-tanged reaction plate. The friction plates are bolted to high-range clutch hub 25, which is driven by reverse-and-low-range sun gear 26. The external tangs on the reaction plate engage the drive pins in transfer drive gear 22.

b. Thus, when the high-range clutch is applied, the transfer drive gear is locked to the reverse-and-low-range sun gear. This causes the transfer drive gear to rotate at a 1 to 1 ratio.

#### 2-5. TRANSFER GEARS, OUTPUT SHAFTS

a. Transfer Gears. The transfer gears consist of two spur gears which are in constant mesh. Transfer drive gear 22 (foldout 1) is splined to the hub of low-range planetary carrier assembly 28. Transfer-driven gear 32 (or 82) is located directly below the drive gear and is splined to output shaft 30 (or 80).

b. One-Piece Shaft. Output shaft 80 provides identical operation at the front and rear outputs. The shifter shaft hole is closed by shifter shaft hole plug 85.

c. Two-Piece Shaft, Front Disconnect. The two-piece shaft configuration allows front output shaft 36 to be disconnected from drive-line. The front disconnect consists mainly of disconnect coupling 34 which is manually shifted by disconnect shifter fork 35 and shaft 39. In the engaged position (rearward), torque from rear output shaft 30 is transmitted through the coupling splines to the front output shaft. In the disengaged position (forward), the coupling rides on the rear splines of the front output shaft and torque to the front output is interrupted.

d. Rear Output Shaft. Rear output shaft 23 (A, foldout 8) provides torque to the rear output only. The front output opening is closed by front output shaft orifice plug 29, and the shifter shaft hole is closed by shifter shaft orifice plug 28.

#### 2-6. CONVERTER-DRIVEN POWER TAKEOFF

a. PTO Components (foldout 1). The converter-driven power takeoff consists of PTO shaft 53 or 78 which is driven at converter output speed by reverse-and-low-range sun gear 26. The PTO shaft extends through rear cover 54 or 71. Output flange 52 or 77 is splined to the rear end of the PTO shaft. The converter-driven PTO is designed so that full engine horsepower can be utilized.

b. Driving, Winching. Although it is both possible and permissible to drive and winch at the same time, this mode of operation splits the torque path. Thus, to achieve full power at the converter-driven PTO, shift the range selector to neutral position.

#### 2-7. INTERNAL BRAKE

a. Brake Components. The brake consists mainly of hub 13 (B, foldout 7), five internal-splined plates 15, six external-tanged plates 14, diaphragm assembly 2, apply plate assembly 20, three pistons 26, and cover assembly 37. The hub of high-range clutch piston housing 22 (or 35, A, foldout 7) is extended to receive brake hub 13 (B, foldout 7). Diaphragm assembly 2 and cover 38 are mounted on the rear of the transmission. These parts house the brake assembly.

##### b. Brake Operation

(1) When the vehicle hydraulic brake master cylinder is actuated, brake fluid pushes three pistons 26 (B, foldout 7) forward. The pistons push apply plate 23 forward, compressing brake plates 14 and 15 against diaphragm 4.

(2) Internal-splined plates 15 are compressed between external-tanged plates 14. Rotation of plates 14 is prevented by anchor pins 6. Plates 15 are slowed or stopped by friction against stationary plates 14.

(3) Adjusting ring 21 has two functions. It continually adjusts the brake to a predetermined clearance, and it controls the flow of

## DESCRIPTION AND OPERATION

Para 2-7/2-10

brake coolant. The ring is attached to apply plate 23 by six spring pins 22. Ring 21 can move lengthwise on the pins when sufficient force is applied. Ring 21 can move a predetermined distance forward and rearward on the inner hub of cover 38. It is restrained from further forward movement by snapping 19.

(4) When the brake is released, springs 11 push apply plate 23 rearward. Plate 23 carries ring 21 rearward until it bottoms on the flat face of the inner hub of cover 38. At this point, the ring and apply plate stop, because springs 11 do not have sufficient force to move pins 22 in ring 21. Also, in this position, ring 21 closes a large opening through which cooling oil (returning from the oil filter) is supplied. A small hole in ring 21 continues to supply sufficient oil for lubrication while the brake is released.

(5) When the brake is applied, plate 23 and ring 21 move forward together. The brake applies when plate 23 compresses the brake plates. Ring 21, in the forward position, uncovers the large oil passage and the brake is flooded with coolant. If there is excess clearance in the brake plate pack (due to wear), ring 21 is stopped by snapping 19 while plate 23 continues to move forward to apply the brake. Pins 22 are pushed forward through the pin holes in ring 21 the distance plate 23 moves in excess of ring 21 movement. This is the automatic adjustment action.

(6) When released, plate 23 and ring 21 move rearward until ring 21 is stopped by the face of the cover inner hub. Thus, brake plate clearance is continually maintained at a dimension equal to the movement permitted the adjusting ring in its travel from the cover inner hub face to snapping 19.

### 2-8. IMPLEMENT PUMP, ACCESSORY DRIVE PADS

Note: Refer to Specifications and Data (para 1-7) for duty ratings.

a. Implement Pump Drive Pad. The implement pump drive pad, located on the rear face of oil pump body 10 (A, foldout 9), may

be any one of three configurations—4-bolt, SAE size C; 2-bolt, SAE size C; or a 2-bolt, SAE size B. Accessory-driven gear 2 (B, foldout 3) is engine driven through accessory drive gear 19 (A, foldout 3) at one of two customer-selected ratios—1 to 1 or 0.91 to 1. Regardless of the range selector position, the shaft rotation is clockwise as viewed from the rear. Adapter drive coupling 18 (A, foldout 9) may be used to accommodate a B-size spline to the C-size splines in gear 2 (B, foldout 3).

b. Accessory Drive Pad. A 2-bolt, SAE size A pad is located at the upper right rear face of the transmission housing. The drive at the pad is provided by accessory drive gear 1 (B, foldout 3) and gear shaft 8, which rotate at a 1 to 1 or 0.91 to 1 ratio. Shaft 8 provides either a size A or size B internal spline at its rear end. Regardless of the range selector position, the shaft rotation is clockwise as viewed from the rear. If no requirement exists for a PTO at this location, the drive gear, shaft, and related parts are omitted, the opening closed by cup plug 12 (B, foldout 4) and the oil passage closed by cup plug 10.

### 2-9. OIL PUMP

Oil pump assembly 2 (A, foldout 9) consists mainly of two spur gears 5 and 7, body assembly 9, and cover 3. The oil pump assembly furnishes the entire oil flow and pressure for all transmission operations (except brake apply pressure on TTB models). The pump is driven by accessory drive gear 19 (A, foldout 3) and rotates any time the engine output shaft rotates. The transmission oil is drawn, through oil strainer 22 (B, foldout 4), into the lower end of suction tube 2 which directs it to the pump assembly. The oil is then directed, under pressure, through passages in the transmission housing to the control valve assembly and other locations for lubrication and cooling.

### 2-10. CONTROL VALVE BODY ASSEMBLY

a. Control Valve Body (B, foldout 9). The control valve body contains a manual-operated range selector valve 27 for reverse, neutral,

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### Para 2-10/2-12

low- or high-range operation, plus main-pressure regulator valve 8, and either clutch cutoff valve 20 or inching control valve 40.

#### b. Main-Pressure Regulator, Selector Valves (B, foldout 9)

(1) Main-pressure regulator valve components and trimmer valve components are contained in the upper bore of the body; clutch cutoff valve (or inching control valve) components in the middle bore; and the selector valve components in the lower bore. The main-pressure regulator valve group includes items 6, 7, 8, 13 and 14. The selector valve group contains items 26 through 33.

(2) Main-pressure regulator valve 8 is spring loaded and regulates the pressure for all hydraulic functions except brake apply pressure for TTB models. The selector valve is a spool-type valve which is manually moved lengthwise to the various range positions. Spring-loaded detent balls 28 position the valve in each range.

#### c. Clutch Cutoff Valve (B, foldout 9)

(1) Clutch cutoff valve 20 is located between the main-pressure regulator valve and selector valve 27. It is a spool-type valve which is moved rearward by spring 19 pressure and forward by plug 21 when brake hydraulic pressure acts on the plug.

(2) When the valve is actuated by brake air pressure, a miniature air cylinder is mounted at the rear of the valve body. A stem of the air cylinder moves plug 45 forward within retainer plug 46.

(3) During normal operation, valve 20 is rearward. This allows main pressure to flow to the selector valve and trimmer plug 16. When vehicle brakes (hydraulic or air) are applied, valve 20 moves against spring 19. This interrupts the flow of main pressure to the selector valve and exhausts clutch apply pressure, releasing the applied clutch.

#### d. Inching Control Valve (B, foldout 9)

Caution: Do not use the inching control while operating in high range.

No provision is made for lubricating and cooling the high-range clutch during inching operation.

(1) Inching control valve 40 replaces the clutch cutoff valve in the valve body when this feature is used. This is a spool-type valve that is manually controlled by the vehicle operator through mechanical linkage attached to one end of the valve. Pressure from spring 41 and main oil pressure hold the valve in the "Clutch-on" (non-inching) position. In the "Clutch-on" position, full main oil pressure is directed to the range selector valve.

(2) When the inching control is moved, main pressure applying the driving clutch is bled off through an oil passage to the driving clutch plate area. This reduces main pressure available to apply the clutch, allowing it to slip. At the same time, the oil being bled off cools and lubricates the slipping clutch. The degree of inching valve movement determines the degree of slippage, from full apply to full release. Inching regulator valve 37 and spring 36 maintain a uniform clutch apply pressure at any given position of the inching valve.

### 2-11. PARKING BRAKE

An expanding shoe-type brake may be mounted at the lower-rear output location on the transmission housing. Brake back plate 2 (B, foldout 8) or 17 is bolted to the transmission housing, and brake drum 7 is bolted to a customer-selected output flange 11, 12, or 14. The brake is manually operated.

### 2-12. HOUSINGS, COVERS

a. Torque Converter Housing. Torque converter housing 38 (B, foldout 3) is cast aluminum. It covers the large front opening of the transmission housing, and it supports and encloses the torque converter components. It is the front support member for the accessory driven gears and the converter driven gears. In direct-mount transmissions, the front of converter housing bolts to the engine flywheel housing. In remote-mount transmissions, the front of the housing is closed by transmission front cover 12 (A, foldout 2).

b. Transmission Front Cover. Transmission front cover 12 (A, foldout 2) is used only on remote-mount transmissions. It is cast iron, and is bolted to the front flange of the torque converter housing. It supports input shaft 17 or 22 in ball bearing 14. Oil seal 10 prevents loss of oil or entry of dirt.

### c. Transmission Housing

(1) Transmission housing 8 (B, foldout 4) is cast iron and is the main structural member of the transmission assembly. It supports and encloses the rear ends of the accessory driven gears and converter driven gears, the range gearing and clutches. It also supports and encloses the output transfer gears and output shaft. It provides an external mounting surface for the transmission oil pump and accessory pump. It includes various oil passages within the casting for oil circuits.

(2) The lower section of the housing provides a sump for the oil necessary for operation, lubrication, cooling, and control functions. Flat mounting surfaces with four tapped holes in each are provided at each side of the housing.

d. Rear Cover—TT Models. The transmission rear cover 4 (B, foldout 6) may be either cast aluminum or cast iron and closes the large circular opening at the rear of the transmission main housing. It supports the rear end of the high-range clutch piston housing and output transfer drive gear. The rear cover includes an oil passage which connects the control valve body and high-range clutch. Rear cover 24 is used on TT models equipped with a converter-driven power takeoff. This rear cover functions in the same manner as cover 4 except it houses the bearings and seals used with PTO shaft assembly 17.

e. Rear Cover—TTB Models. The rear cover 38 (B, foldout 7) used in conjunction with diaphragm 4 form the rear cover components of TTB components. The diaphragm is cast iron and supports the splined rear hub of high-range clutch piston housing 22 (A, foldout 7). It also acts as the anchor and reaction member for the internal brake. The rear cover is cast iron and encloses the internal brake components. Piping attached to

the rear cover directs hydraulic brake pressure to brake pistons 26 (B, foldout 7) and coolant to brake plates 14 and 15. On models equipped with a converter-driven power take-off, the cover also houses the bearings and seals used with PTO shaft assembly 28 (A, foldout 7).

## 2-13. HYDRAULIC SYSTEM

a. System Functions. The hydraulic system generates, directs, and controls the pressure and flow of the hydraulic fluid within the transmission. The hydraulic fluid is power-transmitting medium in the torque converter. Its flow lubricates and cools the transmission components, its pressure applies the clutches, and its velocity drives the converter turbines.

b. System Schematics (fig. 2-1, 2-2, and 2-3). Color-coded schematics are presented which illustrate the two hydraulic systems — clutch cutoff (fig. 2-1) and inching control (fig. 2-2). The additional circuits required for the internal brake and thermostat (fig. 2-3) are also shown.

### c. Oil Pump, Filter Circuit

(1) TT models. Oil is drawn from the transmission sump, through a wire-mesh strainer, into the oil pump. The pump delivers its entire output to a full-flow oil filter which is customer-supplied. The oil filter is mounted external of the transmission. From the filter, the entire oil supply is returned to the transmission and control valve assembly.

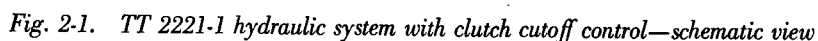
(2) TTB models. The oil pump and filter circuit is the same as that described for the TT models, except an additional circuit is required for cooling and lubrication of the brake components. This circuit is external and extends from the oil filter return circuit to the tapped boss in the rear cover.

### d. Main-Pressure Regulator Valve, Converter-in Circuit

(1) At the control valve assembly, oil from the oil filter (red) enters the valve body, and flows around the main-pressure regulator

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(2) The rightward movement of the valve against the spring exposes the port to the converter-in circuit (yellow). Oil in excess of that required to maintain main pressure is allowed to escape into the converter-in circuit. Under certain conditions, the converter-



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## DESCRIPTION AND OPERATION

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in circuit can be charged with more oil than can be exhausted by the converter pressure regulator valve. When this is the case, the main-pressure regulator valve moves farther to the right and allows oil to flow directly into the exhaust port (blue) at the left end of the valve. This flow occurs between the two short lands at the left end of the regulator valve.

(3) Oil flowing into the converter-in (yellow) circuit is directed to the torque converter. A pressure regulator valve in the circuit limits converter-in pressure to 80 psi.

e. Torque Converter. The torque converter is continuously filled with oil during transmission operation. Rotation of the con-

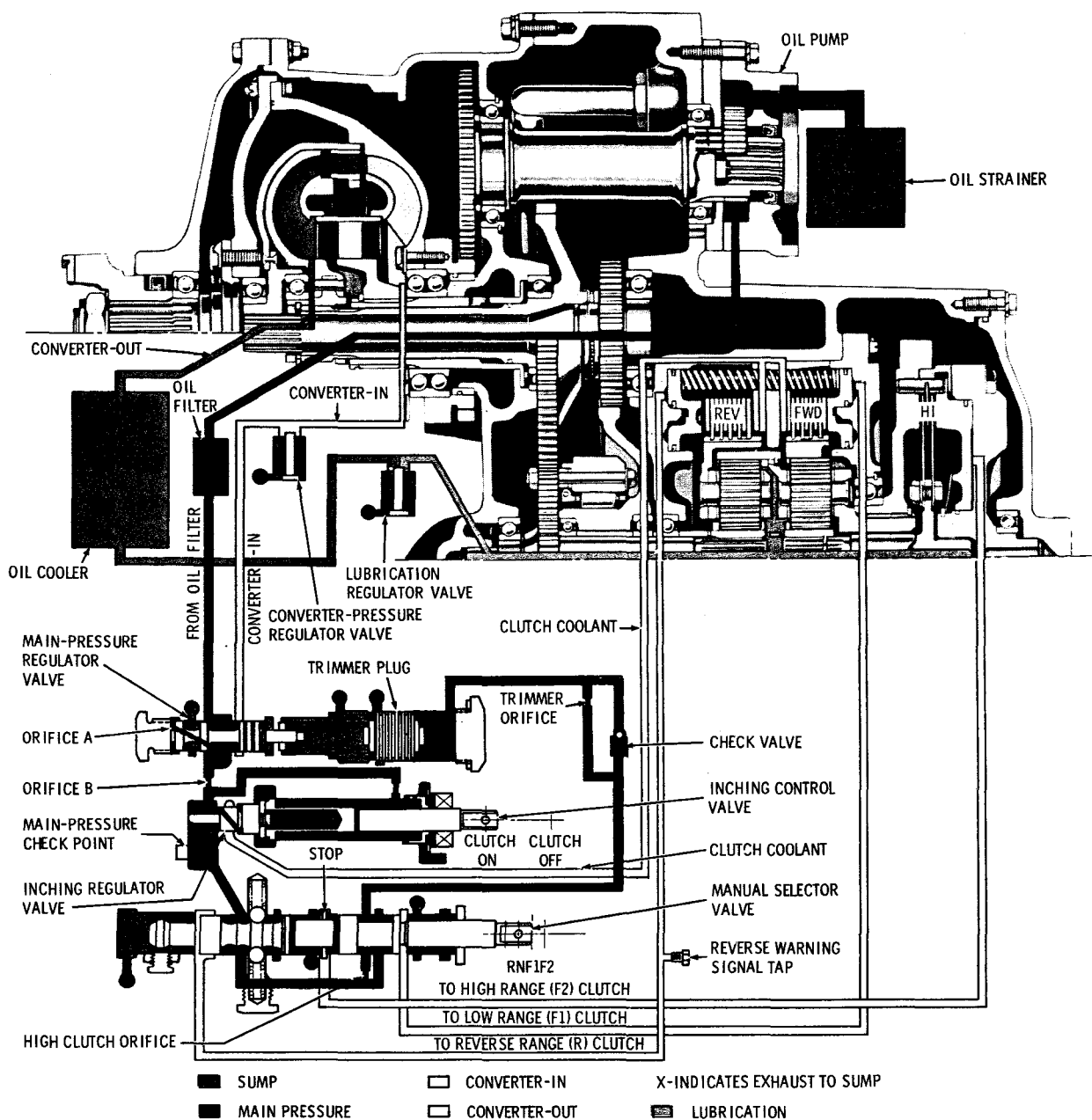


Fig. 2-2. TT 2221-1 hydraulic system with inching control—schematic view

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### Para 2-13

verter pump imparts energy to the oil which, in turn, drives the turbines. The oil then flows between the stator vanes which redirect it to the pump.

#### f. Converter-out, Cooler, Lubrication Circuit (fig. 2-1 and 2-2)

Note: On TTB models, an additional circuit is required to cool and lubricate the brake components. Refer to k.

(1) Oil flowing out of the torque converter (orange) is directed into the oil cooler. The oil cooler, like the oil filter, is customer supplied and vehicle mounted. The oil cooler is a heat exchanger in which the oil flows through water- or air-cooled passages.

(2) On transmissions equipped with a thermostat, a bypass tube provides adequate lubrication when the thermostat is closed. The bypass tube permits a constant low-volume flow from the converter-out circuit to the lubrication circuit. When the oil is warm, the thermostat opens and permits converter-out oil to flow through the cooler.

(3) From the cooler, oil flows to the lubrication circuit (green) for distribution to the transmission components. All oil in excess of that required to maintain lubrication pressure is exhausted to sump (blue) through the lubrication regulator valve.

#### g. Clutch Cutoff Valve Circuit (fig. 2-1)

(1) Main pressure oil (red), supplied from the left end of the main-pressure regulator valve, flows through orifice B to the clutch cutoff valve bore and then to the manual selector valve. From the selector valve the flow is directed back through the clutch cutoff valve bore to the trimmer. The orifice functions in connection with the trimmer (refer to j. below).

(2) The clutch cutoff valve is normally in the position shown and functions only when the vehicle brakes are applied. A spring holds the valve rightward, allowing main oil pres-

sure to flow through the valve bore to the manual selector valve and trimmer.

(3) When the vehicle has hydraulic brakes, hydraulic brake pressure acts directly against a plug which moves the clutch cutoff valve leftward during brake application. When the vehicle is equipped with air brakes, air brake pressure actuates a miniature air cylinder. The air cylinder piston rod pushes the clutch cutoff valve leftward. When leftward against its spring, the clutch cutoff valve interrupts the flow of main pressure oil to the manual selector valve. In this position, the oil in the trimmer circuit is retained, and the charged clutch is allowed to exhaust to sump (blue) through the port shown at the top-center of the valve. Thus, when the vehicle brake is applied, the driving clutch is released.

(4) When the brake is released, the clutch cutoff valve returns to its normal position (as shown). This allows the oil retained at the trimmer to enter the exhausted clutch circuit. This additional volume from the trimmer assists in the quick application of the clutch.

#### h. Inching Control Valve Circuit (fig. 2-2)

(1) Main pressure (red) from the main-pressure regulator connects to the inching control valve at two points. One is at orifice B directly below the regulator valve. The other is through a line running toward the right end of the inching control valve. Pressure at the left passes onto the manual selector valve. Pressure at the right helps retract the valve against its tendency to move rightward because of main pressure at the inching regulator valve. A spring keeps the valve retracted when the engine is stopped.

(2) Main pressure at the left pushes the inching regulator valve rightward against a spring which seats in the left end of the inching control valve. When the inching control valve is released (retracted), main pressure and spring force at its right end are sufficient to hold it leftward. This exerts sufficient pressure on the regulator spring to hold the inching regulator valve leftward far enough to pre-

vent oil escaping to the clutch coolant passage. Thus, main pressure is retained at the left end of the inching regulator valve.

(3) When the inching control is actuated, the valve is pulled rightward (extended). This reduces the force of the spring acting against the inching regulator valve, permitting the valve to move rightward. This uncovers a port which directs cooling oil to the clutch which slips or releases during inching. The amount of oil which goes to the slipping clutch depends upon the degree of movement of the inching control valve. The escape of oil into the clutch coolant line reduces main pressure, which causes the driving clutch to slip. Orifice B, directly below the main-pressure regulator valve, restricts the flow of oil and causes a lower pressure downstream from the orifice.

(4) Full rightward movement of the inching control valve will completely release the driving clutch. Any degree of clutch engagement is possible by allowing the control to retract.

#### i. Manual Selector Valve Circuit

(1) Main-pressure oil from the clutch cutoff (or inching control) valve flows into the manual selector valve bore and surrounds the valve in the area of the detent notches. Main oil then flows, regardless of valve position, to another surrounding area toward the right end of the valve. Here it is available for low range, high range, and for operation of the trimmer.

(2) Three clutch apply lines leave the bottom of the selector valve bore. From left to right these are reverse range (R), high range (F2), and low range (F1). In neutral all three clutch lines are exhausted, and the neutral start switch is actuated. Moving the selector valve one notch rightward will charge the low-range line and thus apply the clutch. This condition provides low-range operation.

(3) Moving the selector valve a second notch rightward will close off oil to the low-range line and allow it to exhaust. At the same time, oil will charge the high-range line and thus apply the clutch. This condition provides high-range operation. When the selector valve

is in the high-range position, oil to fill the high-range clutch must pass through both orifice B and the high-range clutch orifice. The high-range clutch orifice being smaller than orifice B restricts the volume of oil which can flow through in a given time. As a result, the high-range clutch fills at a slower rate and thus provides smoother engagement.

(4) Moving the selector valve one notch leftward of neutral will charge the reverse line and thus apply the clutch. This condition provides reverse operation.

#### j. Trimmer Circuit

(1) The trimmer circuit works in conjunction with orifice B and the high-range orifice. The trimmer regulates clutch apply pressure during initial stages of clutch engagement, and the orifices provide a specific flow at a given pressure. The combination of the trimmer and orifices provide the final pressure and flow pattern to engage the clutches in the desired manner.

(2) Normally, full main pressure (red) holds the trimmer plug leftward against its spring and a shoulder in the valve body bore. This compresses the main-pressure regulator valve spring which causes main pressure to be regulated at maximum psi.

(3) When any shift is made, oil is required to charge the oncoming clutch. This oil must flow through orifice B, directly below the main-pressure regulator valve. The restriction of the oil flow through the orifice causes pressure below the orifice to be reduced. This reduction in pressure allows the trimmer plug to move rightward. Force against the main-pressure regulator valve spring is reduced and main pressure is reduced.

(4) When the clutch being charged is full, flow through the orifice stops and pressure below the orifice rises until it equals main pressure. This increased pressure acts against the right end of the trimmer plug, pushing the trimmer plug leftward. This compresses the main-pressure regulator valve spring and raises main pressure. As main

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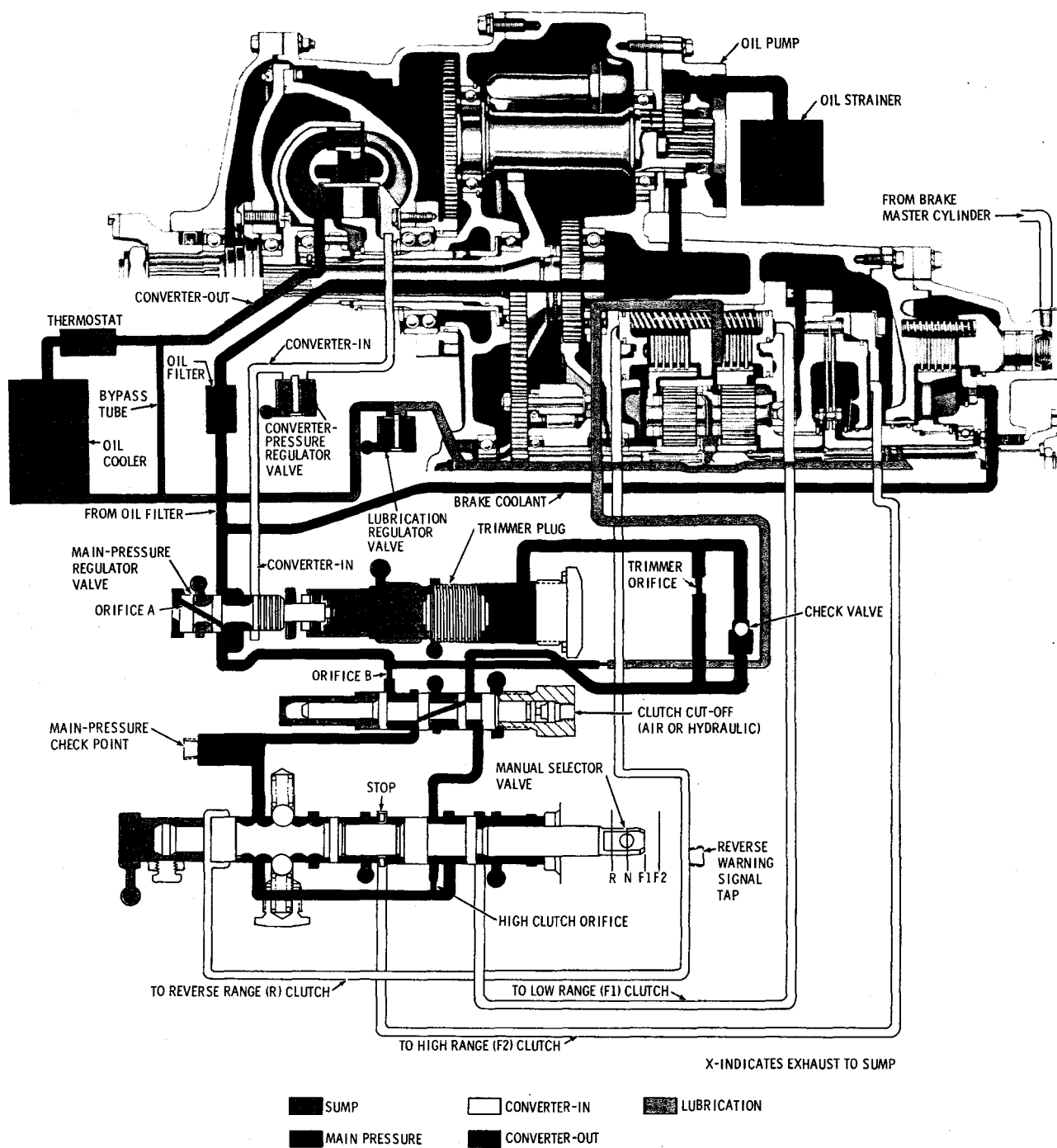


Fig. 2-3. TTB 2221-1 hydraulic system with clutch cutoff control—schematic view

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pressure rises, the trimmer plug moves farther leftward until, finally, main pressure is restored to maximum.

(5) The check valve and orifice in parallel branches of the line connecting the selector valve bore to the trimmer plug bore insure rapid movement of the trimmer plug toward the right (check valve opens) and slower return of the trimmer plug leftward (check valve closes, orifice restricts flow). Main pressure is rapidly reduced but slowly restored.

k. Internal Brake Coolant,  
Lubrication Circuit (fig. 2-3)

(1) Flow in this circuit is controlled by movement of brake adjusting ring 21 (B, fold-out 7). When the brake is applied, the adjusting ring moves forward and uncovers the large port, allowing cooling oil to flood the cavity and cool the brake plates.

(2) When the brake is released, the adjusting ring returns to its seat in the rear cover, closing the large port and stopping the flow of cooling oil. However, a small orifice in the adjusting ring allows oil to bleed into the cavity to provide sufficient lubrication of the released brake components.

## 2-14. TRANSMISSION TORQUE PATHS

a. Component Functions. The torque converter, driven by the engine, directs torque through the first and/or second turbine to the second-turbine driven gear shaft. The shaft, splined to the reverse-and-low-range sun gear, drives the range planetaries and the high-range clutch hub. Hydraulic-actuated clutches, when applied, cause reactions within the involved range components. The interaction within the planetaries or application of the high-range clutch determines the gear ratio and direction of torque imparted to transfer gears. Thus, the torque path changes for each operating condition. Therefore, a knowledge of how these components direct the power flow through the transmission is necessary for proper diagnosis of transmission trouble. An understanding of the accessory gearing and con-

verter-driven PTO is also helpful when the vehicle includes equipment driven by the transmission PTO components.

b. Cross-Section Illustrations

(1) Figure 2-4 is a cross-section view of the twin-turbine torque converter. Figures 2-5 through 2-8 illustrate the paths through which the power flows from the engine to the transmission outputs.

(2) Because the driving turbine is automatically determined by the load and speed requirement imposed by the vehicle, the torque path through the converter is not necessarily confined to a specific operating range. Thus, both paths are shown—a dotted red line indicates the first-turbine torque path and a broken red line indicates the second-turbine torque path. Engagement of the range clutches is indicated by horizontal red bars across the clutch plates.

c. Torque Converter, Freewheel  
Clutch (fig. 2-4)

(1) Power is transmitted from the engine to torque converter pump assembly 6 by either a flex disk drive or an input flange. From the pump, power must be transmitted hydraulically to either first-turbine assembly 3 or second-turbine assembly 4, or to both under certain operating conditions.

(2) Speed and load determine whether the torque flows through the first- and second-turbine assemblies 3 and 4, or only through second-turbine assembly 4. At high-load demand and low speed, freewheel clutch 12 is engaged and first-turbine assembly 3 acts as the driving member. As speed increases and load demand decreases, freewheel clutch 12 disengages and second-turbine assembly 4 becomes the primary driving member. Thus, first-turbine operation is related to higher torque, and second-turbine operation to higher speed. The transition from the torque phase to the speed phase is entirely automatic, governed by the load and speed of the vehicle.

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Para 2-15

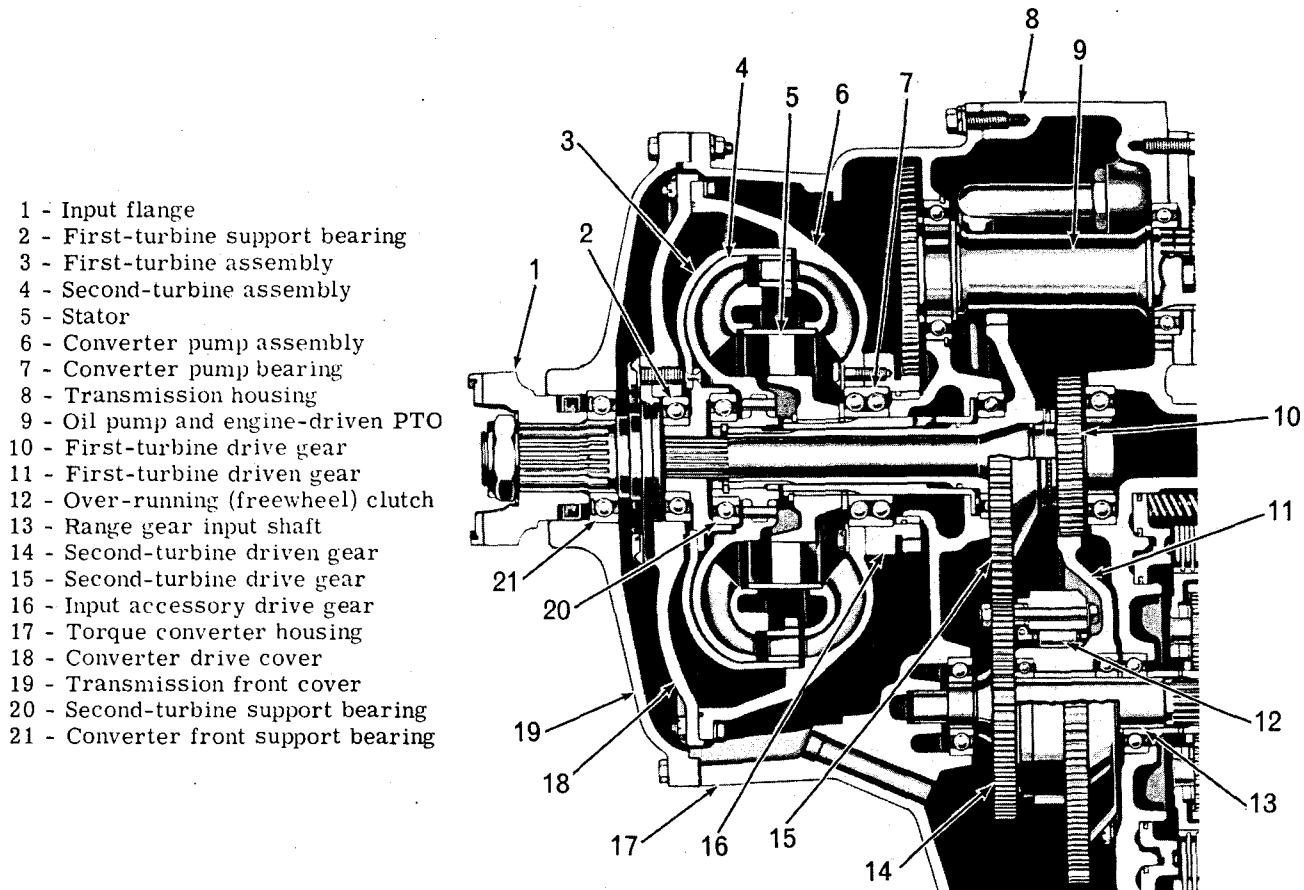


Fig. 2-4. Typical Powershift torque converter and converter gearing—  
cross-section view

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### 2-15. CONVERTER GEARING TO REVERSE- AND-LOW-RANGE SUN GEAR — TORQUE PATH

a. First Turbine (fig. 2-4). Torque from converter pump assembly 6 is transmitted hydraulically to first-turbine assembly 3. The first turbine is splined to first-turbine drive gear 10 which meshes with first-turbine driven gear 11. The first-turbine driven gear is connected by freewheel clutch 12 to second-turbine driven gear 14. The second-turbine driven gear is integral with range gear input shaft 13. The reverse-and-low-range sun gear is splined onto the shaft end. Thus, all these components rotate when the vehicle is operating in a high-load, low-speed condition. The hydraulic action in the converter and the interconnection

of the turbine-driven gears (first and second) permit the second turbine to assist the first until the freewheel clutch disengages.

b. Second Turbine (fig. 2-4). When the output speed of the converter increases, the load is assumed by second-turbine assembly 4, and when it attains sufficient speed, freewheel clutch 12 will disengage. This allows first-turbine assembly 3 to rotate freely, and no drive is contributed by the first turbine. Second-turbine assembly 4 is splined to the hollow shaft of second-turbine drive gear 15. The drive gear meshes with second-turbine driven gear 14 (integral with range gear input shaft 13) which is splined with the reverse-and-low-range sun gear. Thus, all these components rotate when the vehicle is operating in a low-load, high-speed condition.

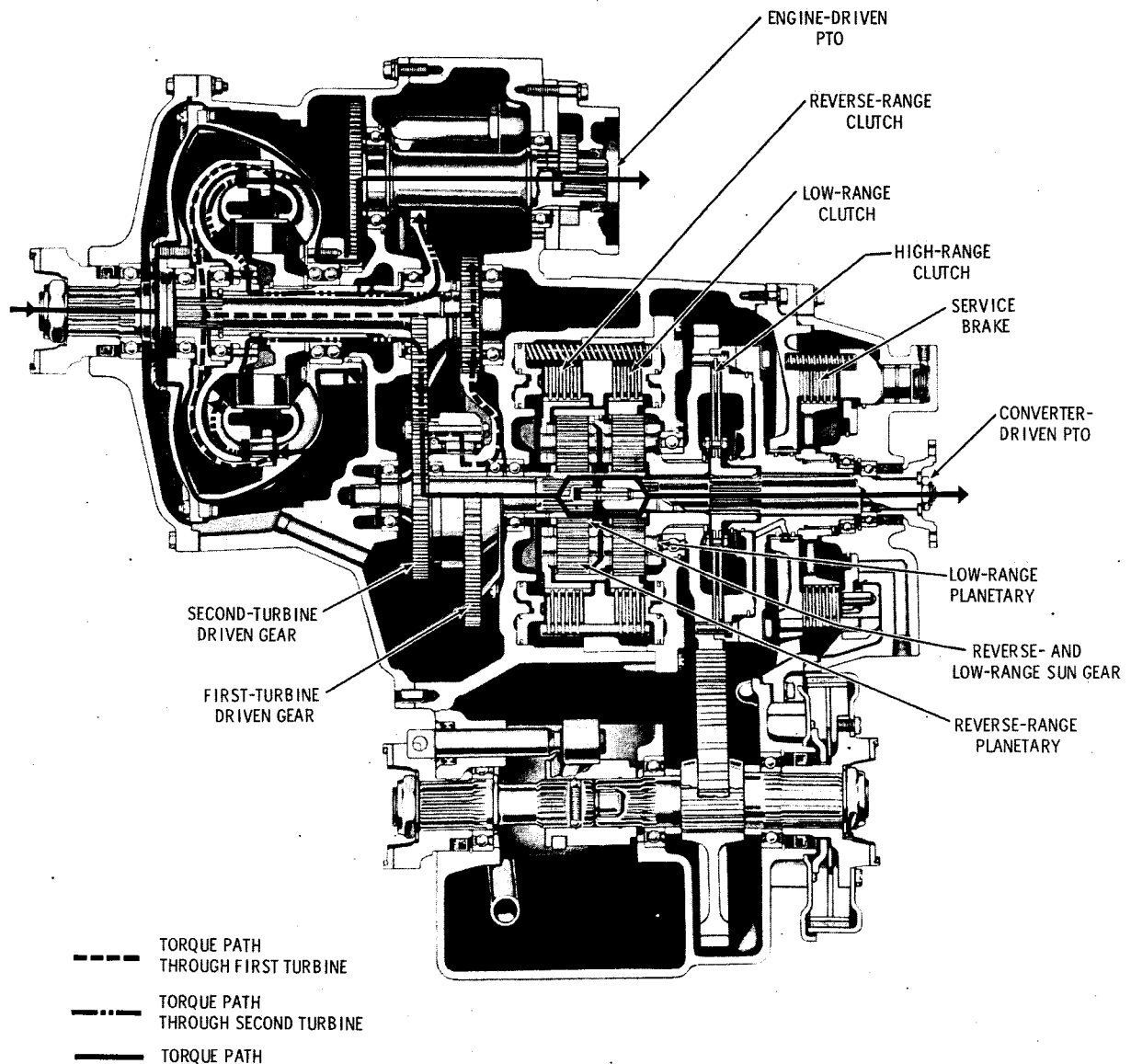


Fig. 2-5. Neutral torque path (TTB 2221-1 with converter-driven PTO)

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## 2-16. NEUTRAL AND POWER TAKEOFF— TORQUE PATH (fig. 2-5)

a. When the range selector is in neutral position, power is transmitted through the torque converter to the reverse-and-low-range sun gear as described in paragraph 2-15. No range clutches are engaged. Thus, rotation of the sun gear causes the planetary pinions to rotate freely, and no power flow occurs in the range gearing. However, on models equipped with a converter-driven PTO, rotation of the sun gear drives the PTO shaft any time the turbines are rotating.

b. Torque from the engine flows through the torque converter pump to the input accessory drive gear. Rotation of the input accessory drive gear drives the engine-driven PTO through the accessory driven gear. If the transmission is equipped with an implement pump drive, rotation of the input accessory drive gear also drives the accessory drive gear and shaft assembly. The gearing for the implement pump drive is located directly behind (relative to illustration) the engine-driven PTO gearing.

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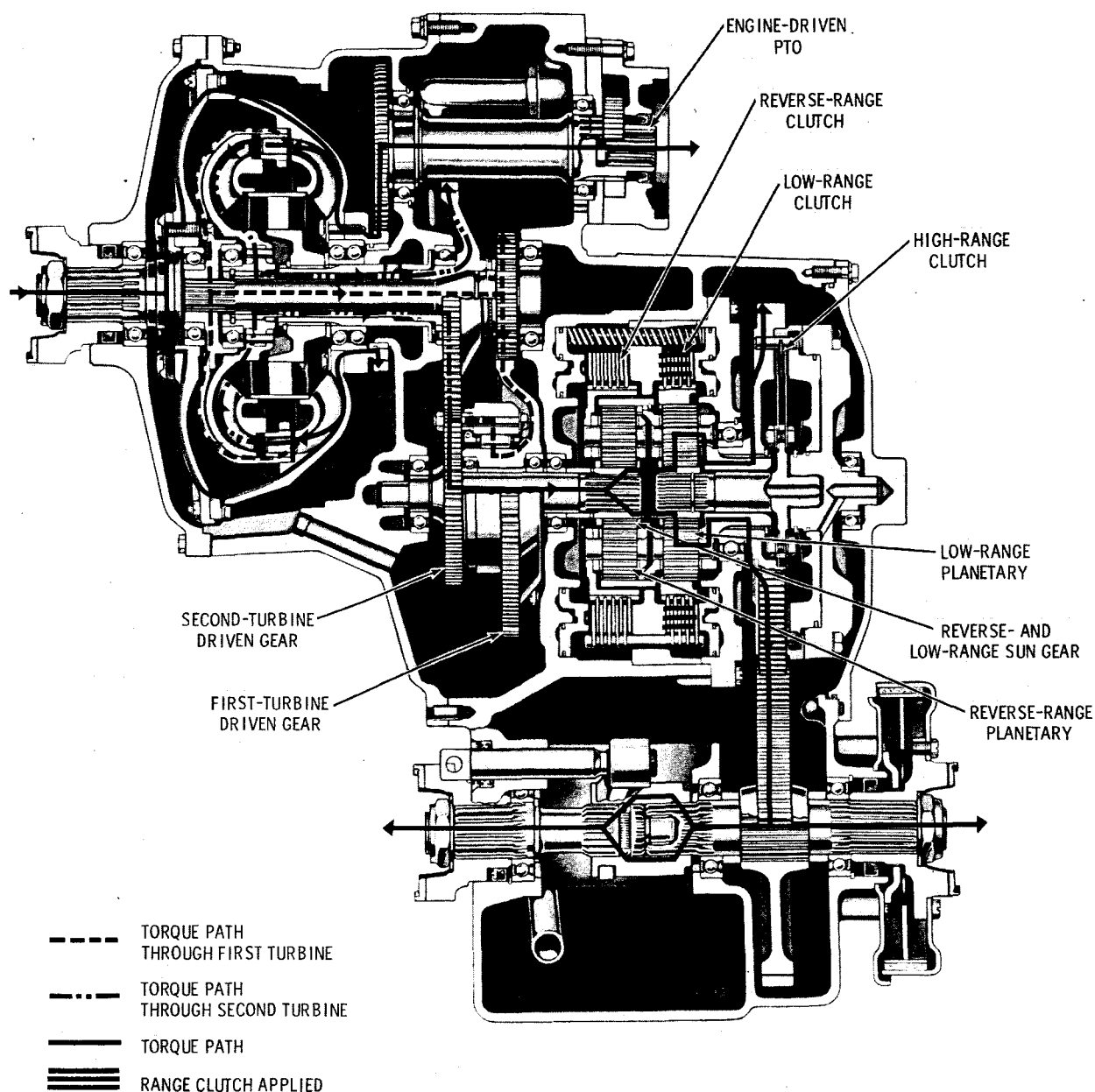


Fig. 2-6. Low-range torque path (TT 2221-1 transmission)

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## 2-17. LOW RANGE – TORQUE PATH (fig. 2-6)

a. In low-range operation, torque is transmitted through the torque converter to the reverse-and-low-range sun gear in the same manner as described in paragraph 2-15. When the range selector is moved from neutral to low range (F1), the low-range clutch engages and holds the low-range ring gear stationary.

b. The rotating reverse-and-low-range sun gear drives the low-range planetary pinions within the stationary ring gear. This causes the low-range planetary carrier to rotate. The hub of the carrier is splined to the transfer drive gear. The drive gear meshes with the driven gear which is splined to the output shaft. The manual-operated disconnect coupling, when moved forward, will interrupt the drive to the front output.

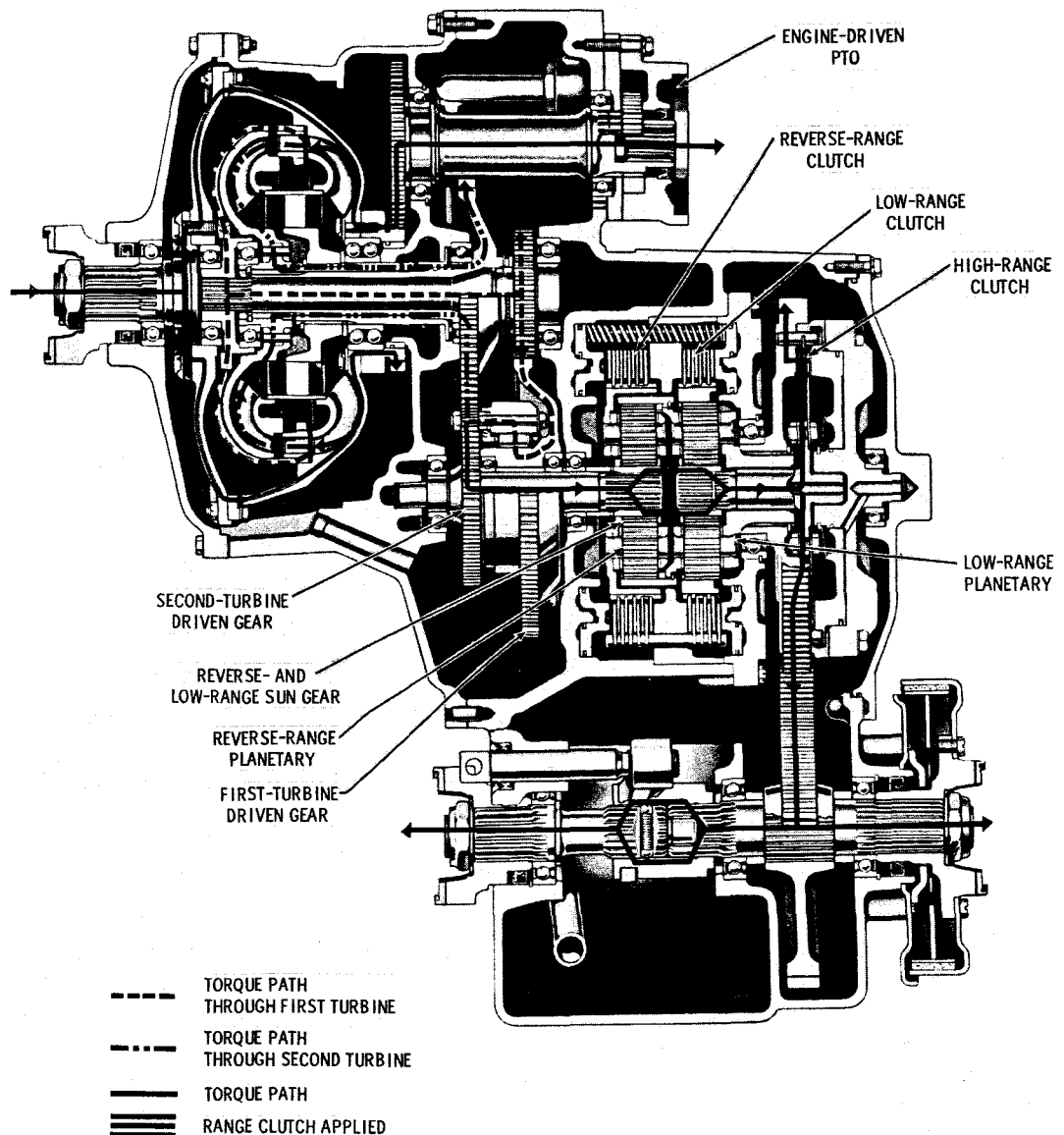


Fig. 2-7. High-range torque path (TT 2221-1 transmission)

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## 2-18. HIGH RANGE – TORQUE PATH (fig. 2-7)

a. In high-range operation, torque is transmitted through the torque converter to the reverse-and-low-range sun gear in the same manner as described in paragraph 2-15. When the range selector is moved from low range (F1) to high range (F2), the low-range clutch releases and the high-range clutch engages.

b. The rotating reverse-and-low-range sun gear drives the high-range clutch hub which is bolted to the high-range clutch friction plates. Engagement of the high-range clutch locks the transfer drive gear to the rotating high-range clutch hub. The transfer drive gear meshes with the driven gear which is splined to the output shaft. The manual-operated disconnect coupling, when moved forward, will interrupt the drive to the front output.

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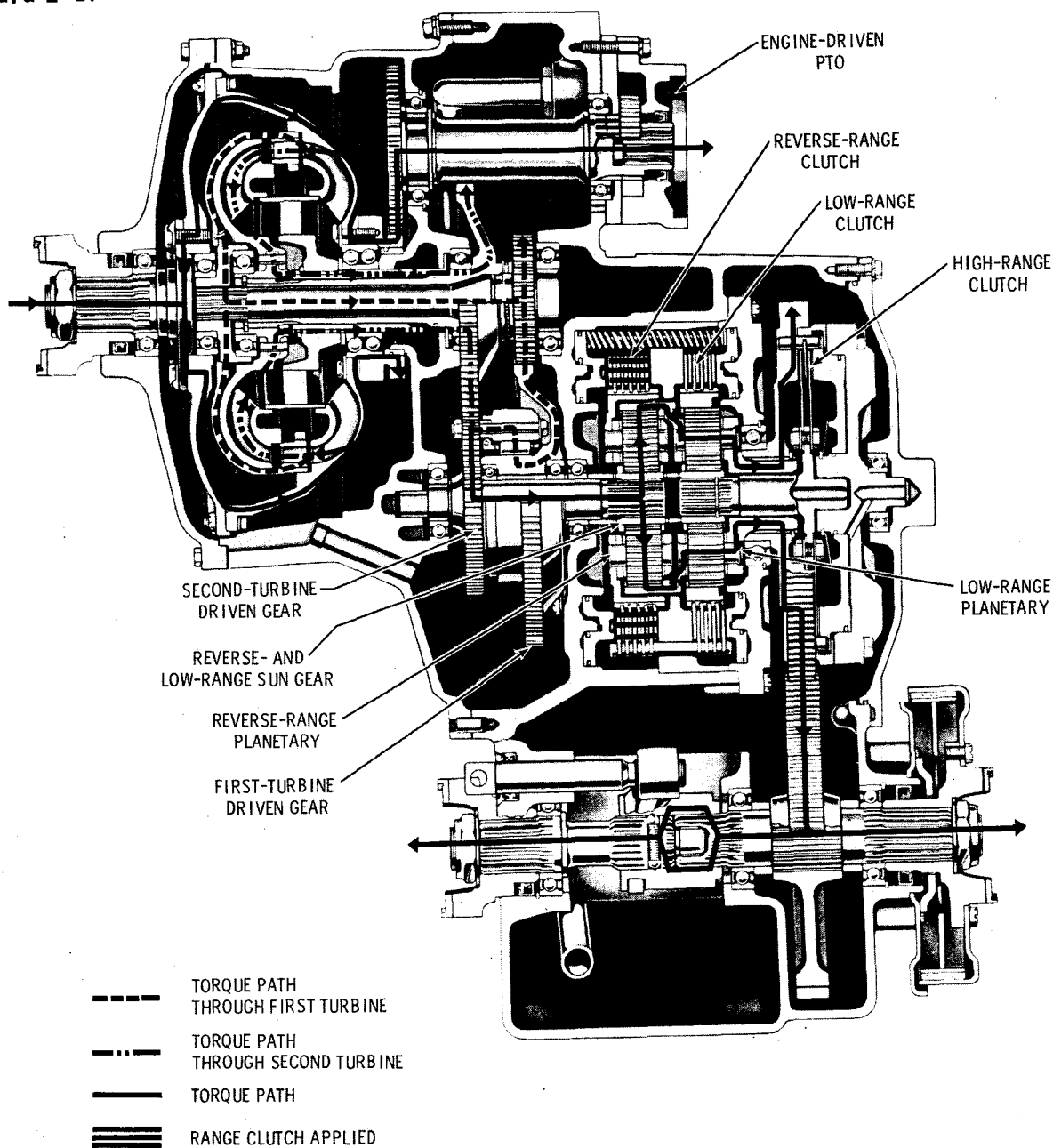


Fig. 2-8. Reverse-range torque path (TT 2221-1 transmission)

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## 2-19. REVERSE RANGE – TORQUE PATH (fig. 2-8)

a. In reverse-range operation, torque is transmitted through the torque converter to the reverse-and-low-range sun gear in the same manner as described in paragraph 2-15. When the range selector is moved to reverse-range position, the forward-range clutches (F1 and F2) are exhausted and the reverse-range clutch engages and holds the reverse-range planetary hub (and carrier) stationary.

b. The rotating reverse-and-low-range

sun gear drives the pinions which also are in mesh with the reverse-range ring gear. This causes the ring gear to rotate in a direction opposite to that of the sun gear. The ring gear is attached to the low-range planetary carrier. Thus, the reverse torque is transmitted from the reverse-range ring gear through the low-range planetary carrier to the transfer drive gear. The transfer drive gear meshes with the driven gear which in turn drives the transfer drive gear and output shaft in reverse. The manual-operated disconnect coupling, when moved forward, will interrupt the drive to the front output.

## Section 3. PREVENTIVE MAINTENANCE

### 3-1. SCOPE OF SECTION 3

This section outlines the routine and periodic 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 control linkages, tests to determine condition, instructions for extended storage, and troubleshooting, in handy chart form.

### 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 procedures. The transmission should be inspected for loose bolts, oil leaks, linkage troubles, and bent or damaged oil lines. Oil leaks that cannot be stopped by tightening the parts require immediate attention. Linkage must be kept clean, adjusted and well 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 stem before removing the breather. Wash the breather thoroughly by agitating it in mineral spirits or cleaning solvent. Dry it thoroughly with compressed air after cleaning. Always use a wrench of the proper size to remove or replace the breather. Pliers or a pipe wrench will crush or damage it and produce metal chips which could enter the transmission.

#### c. Oil Contamination

(1) At each oil change examine the oil which 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 cooler (or vehicle radiator) is another sign of leakage. This, however, may indicate leakage from the engine oil system. Any accumulation of sludge or soft dirt in the sump should be removed with flushing oil.

(2) 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 or on the magnetic drain plug, 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, filter, and all other areas where the particles could lodge.

(3) 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.

### 3-3. CHECKING OIL LEVEL

#### a. Cold Check

(1) Two oil level check plugs are located at the lower-right front of the transmission housing (fig. 1-1 and 1-2). Before starting the engine, remove the upper (Full) plug. If oil flows from the plug opening, the hydraulic system has sufficient oil to permit starting the engine. If no oil flow is present, add sufficient oil to cause a flow from the opening, and replace the plug.

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### Para 3-3/3-5

(2) Start the engine and operate at 1000 to 1500 rpm with the transmission in neutral range. Operate for approximately 1 minute to charge the hydraulic system.

(3) While the engine is running, add oil as required to establish the oil level at the lower (Add) plug. Then, proceed with the hot check (b, below).

Note: An oil check made at a lower engine rpm may result in low oil level at operating speeds. Thermal expansion will raise the oil level when the transmission attains operating temperature.

b. Hot Check. Start the engine and run it at 1000 to 1500 rpm until the transmission reaches operating temperature (180 to 220°F [82 to 104°C]). Then idle the engine and shift through all range positions slowly. This will insure that all parts of the system are filled with oil. Shift to neutral and set the engine speed at approximately 1200 to 1500 rpm. Remove the upper (Full) oil level check plug. Oil should be at the level of the plug opening. Add or drain oil to bring it to this level.

Note: Foaming or spurting may indicate a false oil level. A true level is indicated by a steady trickle of oil flowing from the check plug hole. The transmission may be operated safely as long as the oil is above the level of the lower (Add) oil check plug.

#### c. Dipstick Cold Check

(1) If the transmission is equipped with an oil dipstick, check the oil level before starting the engine. It is safe to start the engine if the oil is near or above the HOT mark. If the oil level is not within this range, add oil. (One quart equals approximately 1/2-inch [12.7 mm] change in oil level.)

(2) Start the engine and let engine idle (500-750 rpm) with the transmission in neutral. Idle engine for approximately 2 minutes to fully charge all oil lines and circuits.

(3) Add oil as required to establish the oil level at the COLD mark. One quart equals approximately 1/2-inch (12.7 mm) change in oil level.

#### d. Dipstick Hot Check

(1) Start the engine. With the engine at idle speed and transmission in neutral range, the oil level should be within the OPERATING RANGE and not exceed the HOT mark.

(2) If oil level is below the COLD mark, add oil. One quart equals approximately 1/2-inch (12.7 mm) change in oil level.

### 3-4. MAINTENANCE INTERVALS

a. Frequency. 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 should be changed more often. Oil should be changed immediately if it has been subjected to overheating—indicated by discoloration and a strong odor. The breather will require more frequent cleaning when dirt and dust conditions are severe.

b. Oil and Filter Change. Generally the oil and filter should be changed after each 1000 hours of operation. For severe service, refer to a, above. Refer also to paragraph 3-2 before changing oil. Do not operate a transmission which is filled with preservative oil except for minimum necessary time and distance.

### 3-5. CHANGING OIL, FILTER

a. Draining Oil. Transmission should be at operating temperature (180 to 220°F [82 to 104°C]) when the oil is changed. Remove the drain plug at the lower-left rear of the transmission housing (fig. 1-1 and 1-3). Remove the oil filter element from the remote-mount filter. Remove and clean the oil strainer assembly (fig. 1-1 and 1-3). Let the oil drain for 30 minutes if time permits. Replace the oil strainer, gasket, and oil drain plug. Install a new oil filter element (PF 151 or equivalent).

b. Refilling Oil System. Add 7-1/2 US gallons (28 liters) of specified transmission fluid after an oil change. Then conduct the hot check as described in paragraph 3-3b, adding oil as necessary to establish the correct oil level for operation.

c. Oil System Capacity. Add 8 1/2 US gallons (32 liters) for an initial fill or after a complete overhaul. This amount does not include the oil necessary to fill the external filter and cooler circuits. Thus, the refill amount is less than the initial fill because some oil remains in the external circuits and transmission cavities.

## 3-6. BLEEDING INTERNAL BRAKE (TTB model)

a. All air must be bled out of the hydraulic brake system before the brake will apply properly. Air in the system will cause the brake apply action to feel soft and springy. Also, air in the system may cause the pedal to completely depress without applying the brake.

b. To bleed the system, use either a pressure bleeder inserted into the master valve or plug. When manually bleeding the system, the reservoir must not be permitted to empty, or more air will be introduced. The bleeder valve, or plug 30 or 36 (B, foldout 7) is located directly opposite the point to which the tube from the master cylinder to the transmission is connected (left or right side).

c. Flush fluid through the system with a pressure bleeder, or pump the brake pedal slowly through complete strokes, until no more air escapes at the bleeder valve or plug. If difficulty is experienced in obtaining a firm, solid feel when the brake is applied after bleeding, loosen one of the nuts at the upper ends of brake manifold 32 or 34 (on transmission) and continue to purge air from the system. When the brake is bled manually, always close the bleeder valve or plug before the pedal upstroke.

## 3-7. PRESSURES, TEMPERATURES

Figure 3-1 illustrates the points where the transmission temperature and pressure may be measured. Vehicle may be equipped with a temperature gage and a pressure gage. If so, the temperature gage registers the converter-out (to cooler) temperature, and the pressure gage registers main (clutch) pres-

sure. Clutch pressure during normal operation in any gear or in neutral is approximately equal to main pressure and may be regarded as main pressure. However, while either the clutch cutoff control or inching control is being used, clutch pressure may fall to practically zero—this does not indicate that main pressure has decreased. Therefore, when checking main pressure, do not actuate either of these controls.

## 3-8. LINKAGE CHECKS, ADJUSTMENTS

a. See Vehicle Manual Instructions. The specific design of control linkages for range selection, inching control, output disconnect, and parking brake depends upon the installation. Control linkages are provided by vehicle manufacturer. Therefore, only general instructions for linkage adjustments can be provided in this manual.

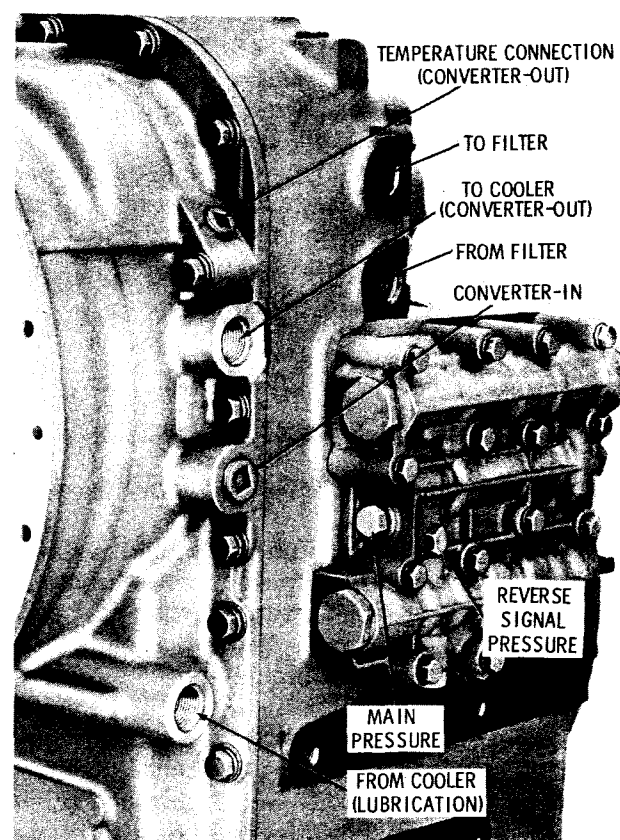


Fig. 3-1. Pressure and temperature check points

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b. Selector, Inching Linkage. The selector linkage must be adjusted so that the operator's control and selector valve are both in desired range at the same time. Make initial adjustment in neutral. Then shift through all range positions to make sure that the selector valve is in full detent position in each range. Adjust the inching valve control linkage so that the valve has full travel from retracted to extended positions. Linkage must be kept clean, adjusted and well lubricated. Bent or damaged linkage must be repaired or replaced.

c. Front Output Disconnect

(1) There are two points of adjustment for the front output disconnect. The shifter shaft must be adjusted first, and then adjust the linkage. Push the shifter shaft inward (toward the rear) to its engaged position. A spring-loaded detent will indicate positive engagement. Adjust the shifter shaft by rotating it until the center of the clevis pin hole is approximately 3/8 inch (9 mm) ahead of the linkage support bracket mounting pad faces.

(2) When the shifter shaft is pulled outward (forward) to its disengaged position the detent ball should seat when the center of the clevis pin hole is approximately 2-1/8 inch (54 mm) ahead of the bracket mounting pad faces. Adjust the linkage so that the engaged and disengaged positions of the operator's control correspond exactly with the detent positions of the shifter shaft.

### 3-9. TRANSMISSION STALL TEST

a. Purpose

(1) A stall test should be conducted when the power package (engine and transmission) is not performing satisfactorily. The purpose of the test is to determine if the transmission is the malfunctioning component.

(2) A stall test is conducted with the engine running at full throttle and the transmission outputs stalled. The data obtained from the test must be used in conjunction with engine-converter matched performance curves. These performance curves can be obtained from your equipment dealer or distributor.

b. Procedure

(1) Connect a tachometer of known accuracy to the engine, and bring transmission to normal operating temperature (180-220°F [82-104°C]).

Caution: The stall condition should never be maintained for more than 30 seconds at any one time because of the rapid rise in oil temperature.

(2) Apply the parking brake, block the vehicle securely, and shift the selector control to high range. (The test may also be conducted to low- or reverse-range, if necessary. However, such tests must be made with extreme caution because of the high torque delivered at the transmission output shaft.)

Caution: Do not apply service brakes if the transmission is equipped with a clutch cutoff.

(3) Accelerate the engine to wide-open throttle. After reaching a stabilized converter-out temperature of 225°F (107°C) minimum, record the engine speed while the engine is at open throttle. Do not let the converter-out temperature exceed 250°F (121°C).

Note: Allow approximately 2 minutes of neutral operation between stall tests to prevent overheating. During the 2-minute period, engine speed should be maintained (except for the momentary throttle release when shifting to neutral).

c. Results. Under stall test conditions, a comparison of actual engine speed with the established normal speed for such conditions will indicate if the engine or the transmission is malfunctioning. The established normal stall speed for a specific engine/transmission combination may be obtained from your equipment dealer or distributor.

Note: Environmental conditions, such as ambient temperature altitude, engine accessory loss variations, etc., affect the power input to the converter. These conditions may cause the stall speed to vary  $\pm 150$  rpm from the established normal value. When deviation can be attributed to such causes, the actual speed can be accepted as normal.

## 3-10. PRESERVATION, STORAGE

a. Preservative Selection. When transmissions are to be stored or remain inactive for extended periods of time, specific preservative methods are recommended to prevent rust and corrosion damage. The length of storage will usually determine the preservative method to be used. Various methods are described below.

b. Storage, New Units. New units contain preservative oil when shipped from Allison and can be safely stored for 6 weeks without further treatment.

### c. Storage, Month to 6 Weeks

(1) The following procedures will prepare a transmission for a month to 6 weeks storage, depending on the environment.

(2) Drain the oil as described in paragraph 3-5a, above. Remove the transmission oil filter element(s).

(3) Install the drain plugs and new filter element(s).

(4) Fill the unit to operating level with any commercial preservative oil which meets US Military specifications MIL-L-21260, Grade 1, to latest specifications.

(5) Operate the unit for at least 5 minutes at a minimum of 1000 rpm. Shift the transmission slowly through all selector positions to thoroughly distribute the oil, then stall the converter to raise the oil temperature to 225°F (107°C).

Caution: Do not allow temperature to exceed 250°F (121°C). If the unit does not have a temperature gage, do not stall for more than 30 seconds.

(6) As soon as the unit is cool enough to touch, seal all openings and breathers with moisture-proof tape.

(7) Coat all exposed, unpainted surfaces with a good grade of preservative grease, such as Petrolatum (MIL-C-11796) Class 2.

(8) Repeat the above procedures ((5) through (7)) at monthly intervals for indefinite storage.

### d. Storage, 1 Year — Without Oil

(1) Drain oil as described in paragraph 3-5a, above.

(2) Seal all openings and breathers, except oil drain hole, with moisture-proof tape.

(3) Coat all exposed, unpainted surfaces with a good grade of preservative grease.

(4) Atomize or spray 2 ounces (59 ml) of Motorstor\*, or equivalent, into the transmission through the oil drain hole. Install the drain plug.

(5) If additional storage time is required, (3) and (4), above, should be repeated at yearly intervals.

### e. Storage, 1 Year — With Oil

(1) Drain the oil as described in paragraph 3-5a, above. Remove the transmission oil filter element(s).

(2) Install the drain plugs and new filter element(s).

(3) Fill the transmission to operating level with a mixture of 30 parts hydraulic transmission fluid, type C2, to 1 part Motorstor preservative, or equivalent.

(4) Operate the unit for approximately 5 minutes at a minimum of 1000 rpm. Shift the transmission slowly through all selector positions to thoroughly distribute the oil, then stall the converter to raise the oil temperature to 225°F (107°C).

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\*Motorstor is a preservative additive manufactured by the Daubert Chemical Company, Chicago, Illinois. Motorstor (under the designation of "Nucle Oil") is covered by US Military Specifications MIL-L-46002 (ORD) and MIL-I-23310 (WEP).

**Caution:** Do not allow temperature to exceed 250°F (121°C). If the unit does not have a temperature gage, do not stall for more than 30 seconds.

(5) As soon as the unit is cool enough to touch, seal all openings and breathers with moisture-proof tape.

(6) Coat all exposed, unpainted surfaces with a good grade of preservative grease.

(7) If additional storage time is required, (3) through (6), above, should be repeated at yearly intervals, except it is not necessary to drain the transmission each year — just add the Motorstor, or equivalent.

#### f. Restoring Units to Service

(1) If Motorstor, or equivalent, was used in preparing the transmission for storage, use the following procedures to restore the unit to service.

(2) Remove the tape from openings and breather.

(3) Wash off all the external grease with solvent.

(4) Add hydraulic transmission fluid, type C2 to proper level.

**Note:** It is not necessary to drain C2 oil and Motorstor mixture from the transmission.

(5) If Motorstor, or equivalent, was not used in preparing the transmission for storage, use the following procedures to restore the unit to service.

(6) Remove the tape from openings and breathers.

(7) Wash off all the external grease with solvent.

(8) Drain oil as described in paragraph 3-5a, above.

(9) Install a new oil filter element(s).

(10) Refill transmission with hydraulic transmission fluid, type C2 to proper level.

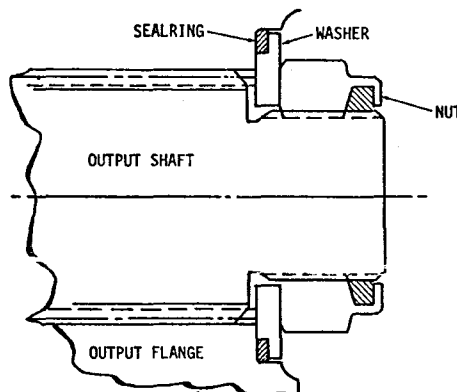


Fig. 3-2. Output shaft retainer washer and seal

### 3-11. FLANGE RETAINER

Oil seepage may occur in some -1 models at the output locations. This seepage can result from a worn lip-type seal within the housing, improper torque at the flange retainer nut, or loss of sealing contact between the retainer washer and the flange seat. If inspection reveals that the seepage is due to the loss of contact sealing at the retainer washer, remove and discard the washer. Replace the flat washer with a stepped washer and seal as shown in figure 3-2. The stepped washer and sealring are available from the dealer or distributor.

### 3-12. TROUBLESHOOTING

**a. Importance.** Troubleshooting is the systematic search for and location of malfunctions in the engine or transmission that affect transmission performance. A thorough study of the description and operation of components and 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 of and remedies for transmission troubles. Capital letters indicate the symptom; numerals following the symptom indicate several possible causes; numerals in the right column indicate remedies for the correspondingly numbered causes in the left column.

## PREVENTIVE MAINTENANCE

Para 3-12

### TROUBLESHOOTING CHART

<u>Cause</u>	<u>Remedy</u>
<b>(A) LOW MAIN PRESSURE</b>	
1. Low oil level	1. Add oil to correct level (para 3-3)
2. Clogged oil strainer	2. Clean strainer (para 3-5a)
3. Clogged oil filter	3. Replace filter element (para 3-5a)
4. Weak or broken main-pressure regulator valve spring	4. Replace spring (para 6-3)
5. Inching control adjustment not fully retracted	5. Check, adjust linkage (para 3-8)
6. Oil pump worn	6. Rebuild oil pump (para 6-22)
7. Air leak at intake side of oil pump	7. Check pump mounting bolts (para 7-10a); check oil pickup tube nut (para 7-7b(4), (5))
8. Internal oil leakage	8. Disassemble transmission; rebuild subassemblies as required
9. External oil leakage	9. Tighten bolts or replace gaskets
10. Brake hydraulic (or air) pressure applying clutch cutoff valve	10. Check brake residual pressure (brakes released); check brakes for full release
<b>(B) OVERHEATING</b>	
1. High oil level	1. Restore proper oil level (para 3-3)
2. Clutch failed	2. Rebuild transmission
3. Vehicle overloaded	3. Reduce load
4. Low main pressure	4. Refer to A, above
5. Engine water overheated	5. Correct engine overheating
6. Cooler oil or water line kinked or clogged	6. Clean or replace line
<b>(C) LOW CLUTCH APPLY PRESSURE</b>	
1. Low main pressure	1. Refer to A, above
2. Clutch piston sealrings failed	2. Overhaul transmission
3. Clutch cutoff control valve sticking	3. Rebuild control valve assembly (para 6-3)
4. Inching control valve sticking	4. Rebuild control valve assembly (para 6-3)
5. Internal oil leakage	5. Overhaul transmission
<b>(D) AERATED (foaming) OIL</b>	
1. Incorrect type oil used	1. Change oil; use proper type (para 3-5)
2. High oil level	2. Restore proper oil level (para 3-3)
3. Low oil level	3. Restore proper oil level (para 3-3)
4. Air entering suction side of oil pump	4. Check oil pump bolts and gasket (para 7-10a); check oil pickup tube and nut (para 7-7b(4), (5))
5. Air entering at clutch cutoff valve (air actuated)	5. Check plug seal and sealing of valve (para 6-3)

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## TROUBLESHOOTING CHART (Continued)

<u>Cause</u>	<u>Remedy</u>
<b>(E) VEHICLE WILL NOT TRAVEL</b>	
1. Low main pressure	1. Refer to A, above
2. Low clutch apply pressure	2. Refer to C, above
3. Selector linkage broken or disconnected	3. Repair or connect linkage (para 3-8)
4. Internal mechanical failure	4. Overhaul transmission
<b>(F) VEHICLE TRAVELS IN NEUTRAL WHEN ENGINE IS ACCELERATED</b>	
1. Selector linkage out of adjustment	1. Adjust linkage (para 3-8)
2. Clutch failed (won't release)	2. Overhaul transmission
<b>(G) VEHICLE LACKS POWER AND ACCELERATION AT LOW SPEED</b>	
1. Low main pressure	1. Refer to A, above
2. Low clutch apply pressure	2. Refer to C, above
3. Turbine freewheel clutch failed	3. Overhaul transmission
4. Engine malfunction	4. Check engine; refer to engine service manual
5. Aerated oil	5. Refer to D, above
<b>(H) STALL SPEED TOO HIGH (see para 3-9)</b>	
1. Clutch slipping	1. Overhaul transmission
2. Low main pressure	2. Refer to A and C, above
<b>(I) STALL SPEED TOO LOW (see para 3-9)</b>	
1. Engine not producing full power	1. Tune or repair engine; refer to engine service manual
2. Torque converter failed	2. Rebuild converter
3. Loss of engine power through accessories attached to engine	3. Disconnect accessories which are absorbing power
<b>(J) SERVICE BRAKE MALFUNCTIONS — TTB</b>	
1. Brake slips when pedal is fully applied	1. Rebuild brake (6-14)
2. Spongy brake pedal	2. Bleed hydraulic brake lines (3-6)
3. Brake pedal bottoms when brake is applied	3. Check for leaks in hydraulic brake lines and for broken linkage. Bleed brake hydraulic system (para 3-6)

## Section 4. GENERAL OVERHAUL INFORMATION

### 4-1. SCOPE OF SECTION 4

This section contains preliminary information required for the overhaul of the transmission. Cleaning instructions, inspection criteria, and recommended rework procedures are discussed. Good shop practices, coupled with the recommended procedures described herein, will aid in restoring high-quality performance.

### 4-2. MODEL CHANGES

The release of new assemblies may require new or different overhaul procedures. Major changes in the transmission will be described in supplementary issues to this manual. Contact your dealer or distributor for the latest information. When requesting service information, be sure to give the model, assembly part number, and serial number as stamped on the transmission nameplate (refer to para 1-4).

### 4-3. TOOLS, EQUIPMENT

The improvised tools required for overhaul are shown in figures 4-1, 4-2, and 4-3.

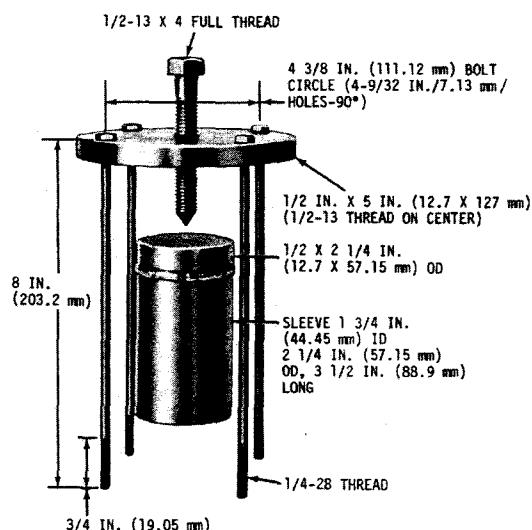
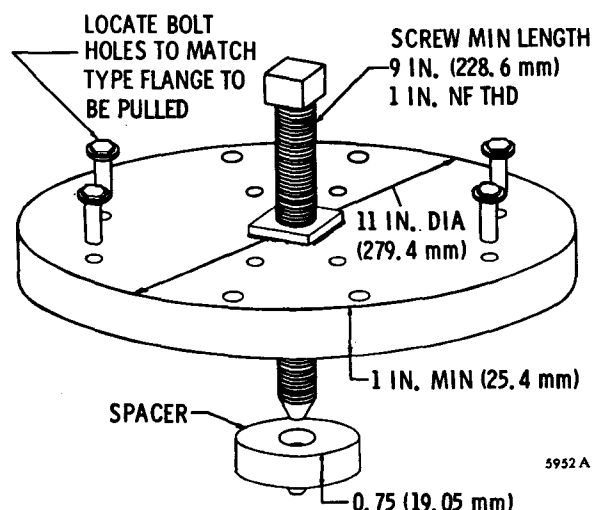


Fig. 4-1. Improvised puller for converter pump assembly

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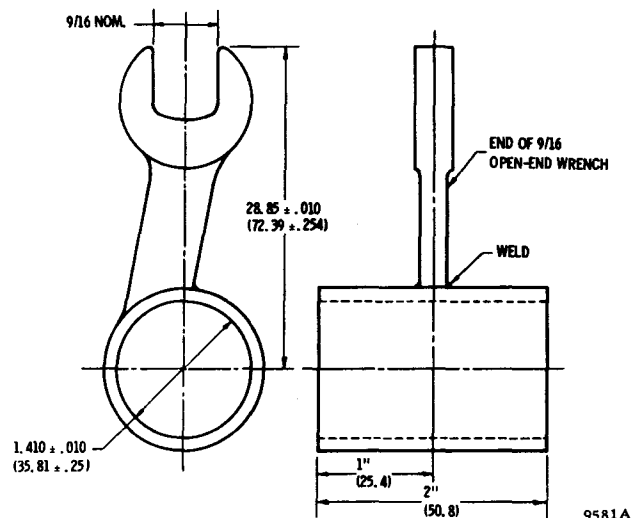
Figure 4-1 illustrates a puller assembly and sleeve used to remove the converter pump, figure 4-2 illustrates a flange puller for removal of interference-fit flanges, and figure 4-3 illustrates a holding fixture used to prevent rotation of the freewheel cam bolts. In addition to ordinary hand tools, the following items should also be available.

- Chain hoist (1/2-ton [453.6 kg] capacity, min)
- Suitable disassembly and assembly table
- Press (for removal and installation of press-fit parts)



5952 A

Fig. 4-2. Typical interference-fit flange puller



9581A

Fig. 4-3. Freewheel cam bolt holding fixture

## SERIES TT, TTB 2001 POWERSHIFT TRANSMISSIONS

### Para 4-3/4-6

- Supply of wood blocks
- Clean wiping cloths (do not use linty waste)
- Parts receptacles
- Cleaning equipment (brushes, solvents, etc.)
- Torque wrenches
- Oil-soluble grease
- Dry ice (for cooling interference-fit parts)
- Heating equipment or hot plate to provide oil at 300°F (150°C) (for heating interference-fit parts)

#### 4-4. REPLACEMENT PARTS

a. Ordering Information. Refer to paragraph 1-4 for information on ordering parts and service kits.

b. Service Kits. Make use of the repair and overhaul kits which contain the gaskets, seals, lockstrips, etc, required for a complete overhaul (refer to para 1-4).

c. Parts Normally Replaced. The following parts are normally replaced during overhaul: gaskets, cotter pins, lockstrips, lip-type oil seals (when removed), damaged snaprings, and washers.

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

#### 4-5. CAREFUL HANDLING

Parts which have close operating tolerances must be handled carefully to prevent nicking, scratching, or denting. The slightest damage to these parts can result in erratic operation and possible malfunction of the transmission. These parts should be carefully handled and protected during removal, cleaning, inspection, and installation.

#### 4-6. CLEANING, INSPECTION

a. Dirt-free Assembly. All parts must be clean to permit effective inspection. During assembly, it is very important that no dirt or foreign matter enters the transmis-

sion. Even minute particles can cause the malfunction of close-fitting parts.

##### b. Cleaning Parts

(1) All metallic parts of the transmission (except bearings) should be cleaned thoroughly with volatile mineral spirits, or by the steam-cleaning method. Do not use a caustic soda solution for steam cleaning. Gum and varnish deposits should be removed by allowing the parts to soak in varnish remover.

(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) After cleaning, examine the parts and especially the oil passages to make certain they are entirely clean. Reclean them, if necessary.

##### c. Cleaning Bearings

(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.

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

**Note:** Never dry bearings with compressed air. Do not rotate bearings while they are not lubricated.

##### d. 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.

## GENERAL OVERHAUL INFORMATION

Para 4-6

(3) Inspect the defective bearing's housing and shaft for grooved, burred, or galled conditions that indicate the bearing has been turning in its housing 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, 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.

(5) 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.

e. Keeping Bearings Clean. The presence of dirt or grit in ball bearings is usually responsible for bearing failures. It is important to keep bearings clean during installation and removal. 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.

### f. Inspecting Cast Parts, Machined Surfaces

(1) Inspect bores for scratches, wear, grooves, and dirt. Remove scratches and

burs with crocus cloth. Remove foreign matter. Replace parts that are deeply grooved or scratched.

(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 honing stone. If scratches are deep, replace the defective part.

(4) Inspect threaded openings for damaged threads. Chase damaged threads with the correct size 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 defective parts.

### g. Inspecting Bushings, Thrust Washers

(1) Inspect bushings for scores, roundness, burs, sharp edges, and evidence of overheating. Remove scores with crocus cloth. Remove burs and 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.

### h. Inspecting Oil Seals, Gaskets

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

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### Para 4-6

(2) When replacing lip-type sealrings, make sure the spring-loaded side is 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 the hook-type sealrings for wear, broken hooks, and distortion.

(5) Install a new hook-type sealring if it is worn so much that there is no gap between the hooks of the sealring when it is installed.

(6) The sides of the sealring should be smooth (0.005-inch [0.12 mm] maximum side wear). The sides of the shaft groove (or the bore) in which the sealring fits should be smooth (50 micro-inches [1.25  $\mu$ m]) and square with the axis of rotation within 0.002 inch (0.05 mm). If the sides of ring grooves have to be reworked (0.020-inch [0.51 mm] maximum side wear), 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 honing 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 faces of gears for scores, scratches, and burs. Remove such defects with a soft honing stone.

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

#### k. Inspecting Clutch Plates

(1) Inspect the 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, cone, distortions, imbedded metal, galling, cracks, breaks, and damaged tangs. Remove burs and minor surface irregularities, using a soft honing stone. Replace plates which have other defects.

(3) The amount of cone is determined by measuring the distance between the inside diameter of the plate and a level surface (fig. 4-4). When assembling a clutch pack, soak clutch plates in type C 2 oil for at least 2 minutes and make sure that each plate is installed so that the cone is in the same direction as the adjacent plates. (Refer to wear limits chart in Section 8 for maximum allowable cone.)

l. Inspecting Threaded Parts. Inspect parts for burred or damaged threads. Remove burs with a soft honing stone or fine file. Replace damaged parts.

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

n. Inspecting Springs. Inspect all the springs for signs of overheating, permanent

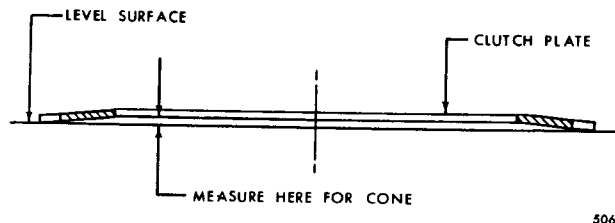


Fig. 4-4. Method for determining cone of clutch plate

set, or wear due to rubbing adjacent parts. Replace the spring if any one of these defects is found. Replace springs which do not meet the load-height specifications in the spring chart in Section 8.

#### 4-7. 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. Clean the exterior of the transmission. If the steam cleaning method is used, the transmission should be disassembled immediately — condensation of the steam will rust the ferrous parts in the transmission.

b. Check Linkages, Lines. Make sure that all linkages, controls, cooler and filter lines, pressure and temperature lines, drive-line couplings and mounting bolts are disconnected before transmission removal. Oil lines should be carefully placed clear of the removal path and all openings covered to keep them clean.

##### c. Reconnect at Installation

(1) At installation, reconnect all linkages and lines which were previously removed. Two 3/4-10 tapped openings are provided at the top of the transmission housing. Bolts or eyebolts may be installed in the openings for lifting the transmission assembly.

(2) On the direct-mount transmissions equipped with torque converter drive cover 16 (B, foldout 2), make sure the counterbore in drive ring 12 is packed with high-quality wheel bearing grease. (Refer to para 7-9b.)

#### 4-8. REMOVING, INSTALLING INTERFERENCE-FIT FLANGES, AND SHIM SELECTION

a. Removal. When the interference-fit flanges are used, they should be removed prior to complete disassembly. A heavy-duty

puller kit or one similar to that shown in figure 4-2 is required. A heavy steel plate may be bolted to the ears of the flange to provide a grip surface for the puller jaws and prevent distortion. A steel bar may be used to prevent rotation of the flange during the pulling process. Removal of the Torqmatic coupling requires a puller which will engage the internal groove within the coupling hub. Always place a spacer between the transmission shaft and puller draw bolt to protect the end of the shaft.

b. Installation. Inspect the shaft and splines for dirt, paint, rust, burs, and rough spots, and remove any of these. Make sure that spacers or other parts are in place on the shaft. Coat the splines with light bearing grease and grease the lip of the oil seal. Heat the flange to approximately 300°F (150°C) for 45 minutes. While the flange is still hot, quickly install it on the shaft. Immediately seat the flange and install the shims, if used (see c, below), retaining washer, and nut. Tighten the nut to the specified torque.

Caution: If the flange seizes to the shaft before it is properly seated, it will be necessary to remove the flange and repeat the assembly procedure. Do not attempt to force the flange with a hammer.

Recheck the nut or bolt torque after the flange cools.

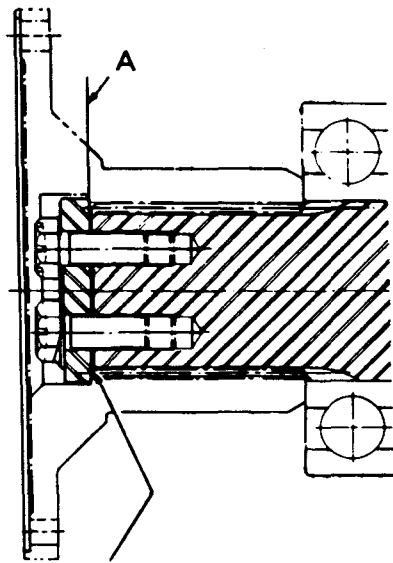
##### c. Shim Selection for Input Flange

(1) If the transmission is equipped with an input flange that requires shims, use the following procedure to determine the shim pack thickness.

(2) Install the flange onto the splined shaft. Install the retaining washer and the two self-locking bolts. Tighten the bolts sufficiently to draw the flange into its final position on the shaft.

(3) Remove the two bolts and retaining washer. Select the proper combination of shims to allow 0.005 to 0.009 inch (0.12 to 0.22 mm) between face A (fig. 4-5) and the surface of the shim pack.

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SHIM AS REQUIRED TO  
0.005-0.009 IN.  
(0.12-0.22 mm)  
BELOW FACE "A" OF FLANGE

Fig. 4-5. Measurement to determine  
flange shim thickness

## 4-9. WEAR LIMITS, SPRING CHART

a. Wear Limits Inspection. When parts are being inspected, those listed in Section 8 should be measured for wear. Those parts which have reached or exceeded the specified wear limit should be discarded and replaced. All wear limits data are tabulated in Section 8. The item numbers are keyed to the parts shown in the exploded views at the back of the book.



b. Spring Inspection. The data presented in the Spring Chart in Section 8 will aid in identification and inspection of the springs within the transmission.

## 4-10. TORQUE SPECIFICATIONS

The assembly procedures in Sections 6 and 7 specify the torque requirements for all bolts and nuts. For general reference, a torque specification chart is presented below. The torque specifications in the chart apply to all assembly procedures unless otherwise specified in the text or cross-section illustration at the end of Section 6. The illustration may be used as a convenient reference for the torque required to tighten the hardware visible in the cross-section view.

### STANDARD TORQUE SPECIFICATIONS

(all torque values, given in pound feet and Newton metres)

Size	Threads per inch	Standard heat- treated bolts and screws		Special heat-treated bolts, screws, Allen-head screws and self-locking capscrews		Nuts	
							
		lb ft	(N·m)	lb ft	(N·m)	lb ft	(N·m)
1/4	20	9-11	(12-15)	9-11	(12-15)		
	28	10-12	(14-16)	10-12	(14-16)		
5/16	18	13-16	(18-21)	17-20	(23-27)		
	24	14-18	(19-24)	19-23	(26-31)	14-18	(19-24)
3/8	16	26-32	(35-43)	36-43	(49-58)		
	24	33-40	(45-54)	41-49	(56-66)	33-40	(45-54)
7/16	14	42-50	(57-67)	54-65	(73-88)		
	20	50-60	(68-81)	64-77	(87-104)		
1/2	13	67-80	(91-108)	81-97	(110-131)		
	20	83-100	(113-135)	96-115	(130-155)		
5/8	11	117-140	(159-189)	164-192	(222-260)		
	18	134-160	(182-217)	193-225	(262-305)	134-160	(182-217)

## Section 5. DISASSEMBLY OF TRANSMISSION INTO SUBASSEMBLIES

### 5-1. SCOPE OF SECTION 5

a. Models Covered. This section describes the disassembly of the transmission into its subassembly components. Procedures are applicable to the TT 2221-1, TT 2421-1, TTB 2221-1, and TTB 2421-1 models.

b. Disassembly Sequence. The instructions depict, in logical sequence, the removal of exterior components, through the torque converter, to the front splitline of the transmission housing. The transmission is then repositioned and the remaining components are removed from the rear.

### 5-2. SERVICING OF VEHICLE-MOUNTED TRANSMISSION

a. Some Servicing Without Removal. The TT and TTB series transmissions are designed so that many service operations may be accomplished without removing the transmission from the vehicle. The disassembly procedures in the manual, however, illustrate operations with the transmission removed.

b. Accessibility in Vehicle. Accessibility of the transmission in the vehicle, the nature of the service required, and other factors will determine the advisability of performing major operations without removing the transmission. A study of the cross-section illustration presented on foldout 1 may be helpful in determining the best disassembly method to remove a given component. Although the position of the transmission in the vehicle may cause some inconvenience at times, in general, all external subassemblies and all components which can be removed from the rear may be serviced. A close inspection should be made to determine if vehicle configuration provides sufficient room, and the foregoing factors weighed, before deciding to remove the transmission.

### 5-3. REMOVAL OF EXTERIOR COMPONENTS

a. Install Eye Bolts. All TT and TTB transmissions in the 2001 Series have two 3/4-10 tapped holes in the top of the transmission housing. Eye bolts may be installed into these holes to provide a means of supporting or positioning the transmission housing during disassembly (fig. 5-1).

b. Oil Pump Drive Coupling. If the transmission is equipped with adapter drive coupling 18 (A, foldout 9) remove the coupling.

c. Oil Strainer Assembly. Remove the six bolts and lockwashers that retain the oil strainer assembly (fig. 5-2). Remove the oil strainer and gasket. Remove the oil drain plug.

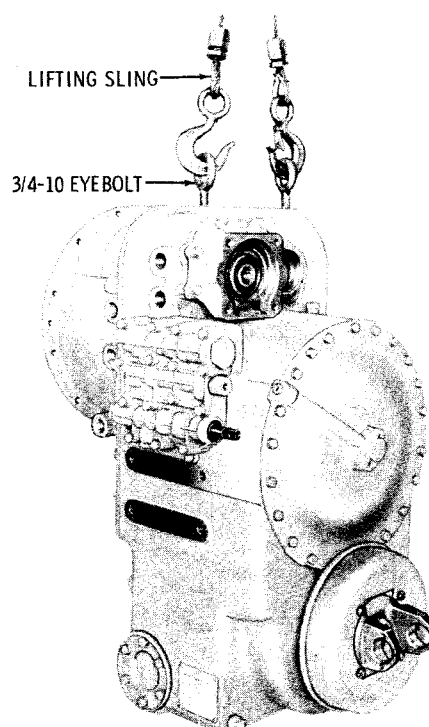


Fig. 5-1. Lifting transmission

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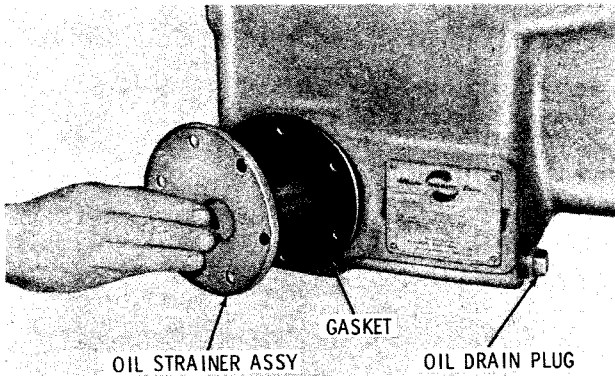


Fig. 5-2. Removing oil strainer and gasket

## d. Parking Brake and Output Flanges

(1) Remove the four self-locking bolts that retain the parking brake drum (fig. 5-3). Remove the drum.

**Note:** Some models are equipped with flanges that are attached to the inside of the brake drum (attaching bolt heads are not accessible). For these models, remove flange retaining nut 10 (B, fold-out 8), washer 9, and remove brake drum 7 and output flange 11 or 12 as an assembly. Remove four self-locking bolts 13 and separate the brake drum and flange.

(2) Using a 1-7/8-inch socket, remove the rear output flange retaining nut and washer (fig. 5-4). To prevent rotation of the flange, install two bolts into the front output flange and place one end of bar stock between the bolts and allow the other end to press against the assembly table. Remove the front output flange retaining nut and washer, using the

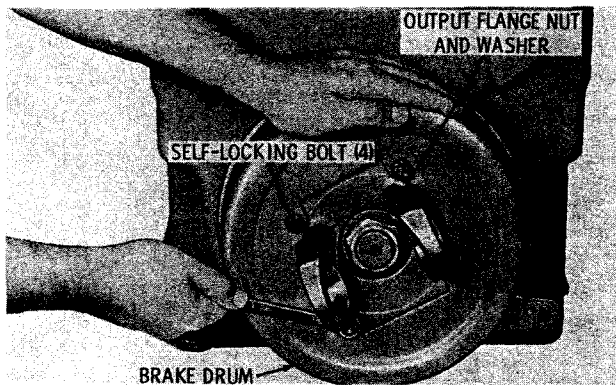


Fig. 5-3. Removing parking brake drum

same procedure. Remove the front and rear flanges. If necessary, use a flange puller of the type shown in figure 4-2.

(3) Remove brake shoe return springs 5 (B, foldout 8) and brake shoes and linings 4, roller 3, and brake apply arm 6. Remove four self-locking bolts 18 and remove brake back plate 2 or 17. Remove spacer 15, if present, from the output shaft.

## e. Control Valve Assembly

(1) Remove 16 bolts and lockwashers that attach the control valve body to the transmission housing (fig. 5-5).

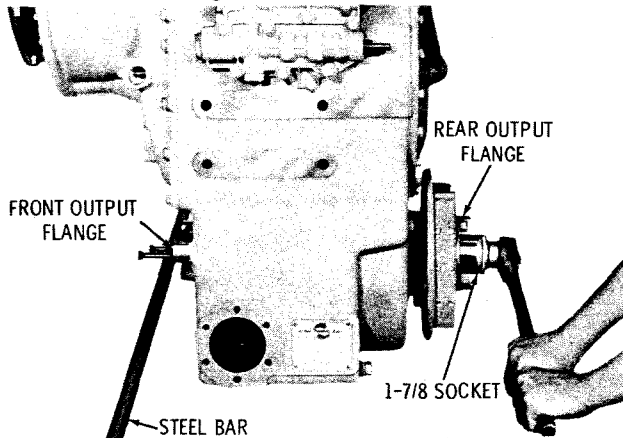


Fig. 5-4. Removing rear output flange nut

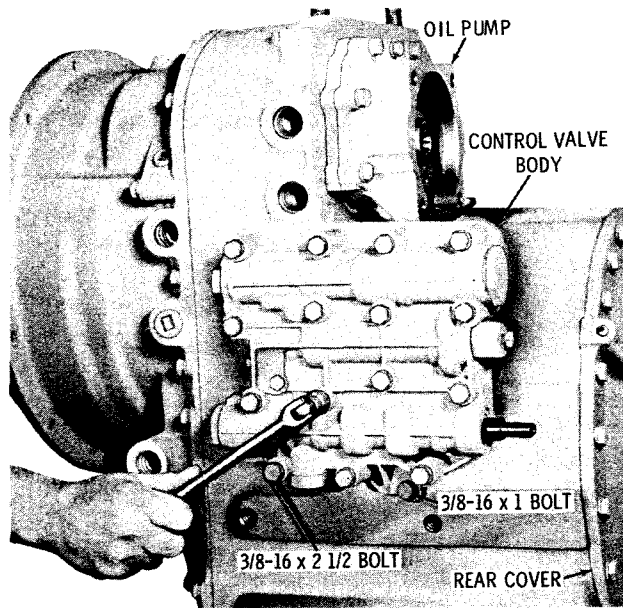


Fig. 5-5. Removing valve body bolts

## DISASSEMBLY

Para 5-3/5-4

(2) Remove the control valve body and gasket (fig. 5-6). Refer to paragraph 6-3 for the control valve assembly rebuild instructions.

### 5-4. REMOVAL OF INPUT COMPONENTS

Note: Position the transmission to rest on its rear surface. Do not allow the transmission to rest on the speedometer drive assembly, if present, or the output shaft.

#### a. Direct Mount (flex disk)

(1) Remove the six self-locking bolts and plate that retain the flex disk assembly (fig. 5-7).

(2) Remove the flex disk plate and flex disk assembly consisting of three flex disks and a disk and washer assembly (fig. 5-7).

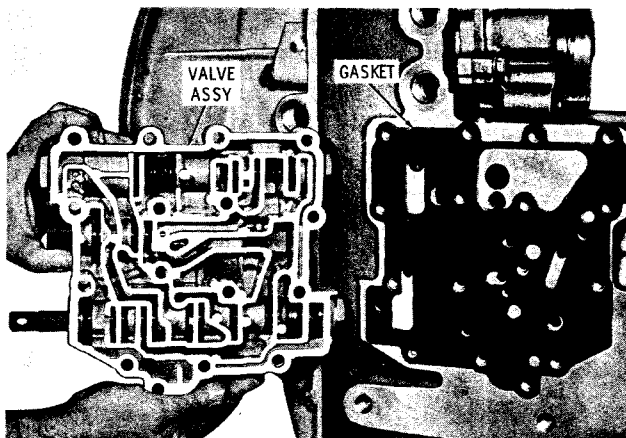


Fig. 5-6. Removing valve body and gasket

S2538

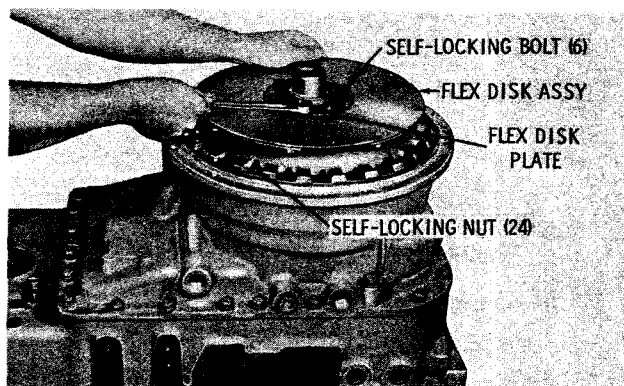


Fig. 5-7. Removing flex disk bolts

S2539

(3) Remove the 24 self-locking nuts that retain the torque converter drive cover (fig. 5-8).

(4) Attach a sling and remove torque converter drive cover (fig. 5-9). Ball bearing 1 (A, foldout 3) may remain in the torque converter drive cover; if so, remove the bearing.

#### b. Direct Mount (drive ring)

(1) Remove sealring 14 (B, foldout 2) and twenty-four self-locking nuts 15 from torque converter drive cover 16. Remove the torque converter drive cover. Ball bearing 1 (A, foldout 3) may remain in the cover; if so, remove the bearing.

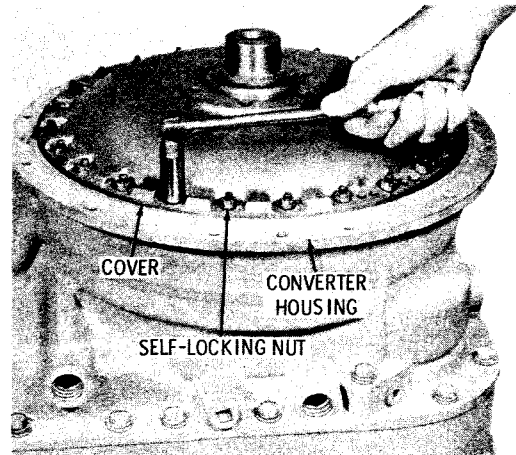


Fig. 5-8. Removing torque converter drive cover nuts

S2540

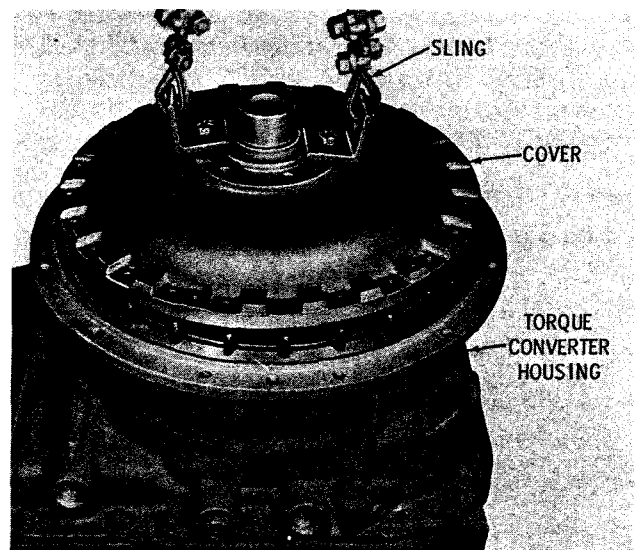


Fig. 5-9. Removing torque converter drive cover

S2541

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### Para 5-4/5-5

(2) Converter drive ring 12 (B, fold-out 2) and eight twelve-point bolts will remain with the engine. Remove the bolts and drive ring, only if necessary.

#### c. Remote Mount

(1) The input flanges are retained with either a single flange retaining nut or two self-locking bolts. If flange retaining nut is used, remove nut 4 (A, foldout 2) and flange washer 5. If necessary, attach an improvised lock bar to the ears of the input flange to prevent rotation of the shaft during removal of the nut. If the self-locking bolts are used, straighten the ears of lockstrip 2 and remove two self-locking bolts 1. Remove lockstrip 2 and flange retaining washer 3.

(2) Remove input flange 7, 8, or 9. If the flange has seized to the shaft splines, use a suitable puller for removal. Refer to paragraph 4-8a if the flange is a tight fit.

(3) If Torqmatic coupling assembly 6 (A, foldout 2) has seized to the shaft splines, use a bearing puller for removal of the coupling assembly. Install the puller so that the puller feet nest in the groove within the inside diameter of the coupling and the puller bolt works against a spacer placed against the end of the input shaft.

(4) Remove twelve bolts 11 (A, fold-out 2), nuts 21, and lockwashers 20, and remove transmission front cover 12 and gasket 13. Refer to paragraph 6-4 for the front cover rebuild instructions.

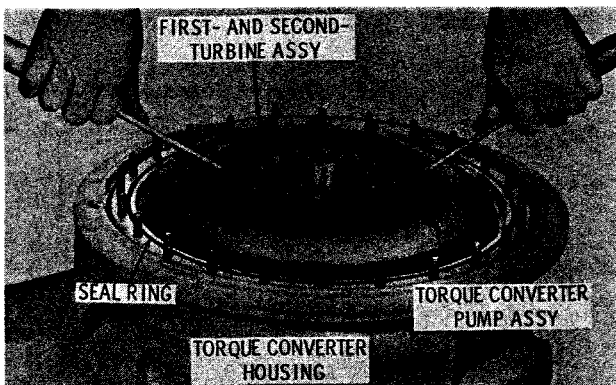


Fig. 5-10. Removing first- and second-turbine assembly

(5) Remove the twenty-four self-locking nuts 18, that retain torque converter drive cover 19 or 23. Remove the torque converter drive cover and attached input shaft 17 or 22 and bearing 14 as an assembly. Refer to paragraph 6-5 for the torque converter drive cover rebuild instructions.

### 5-5. REMOVAL OF CONVERTER COMPONENTS AND HOUSING

#### a. Converter Components

(1) Using two screwdrivers, and lifting straight upward, remove the first- and second-turbine assembly (fig. 5-10). Do not disassemble this unit unless inspection or parts replacement is necessary. If necessary, refer to paragraph 6-6 for turbine assembly rebuild instructions. Remove the sealing, if present, from the converter pump.

(2) Remove the snapping that retains the converter stator and remove the stator from the converter ground sleeve (fig. 5-11).

(3) Remove the stator spacer from the converter ground sleeve (fig. 5-12).

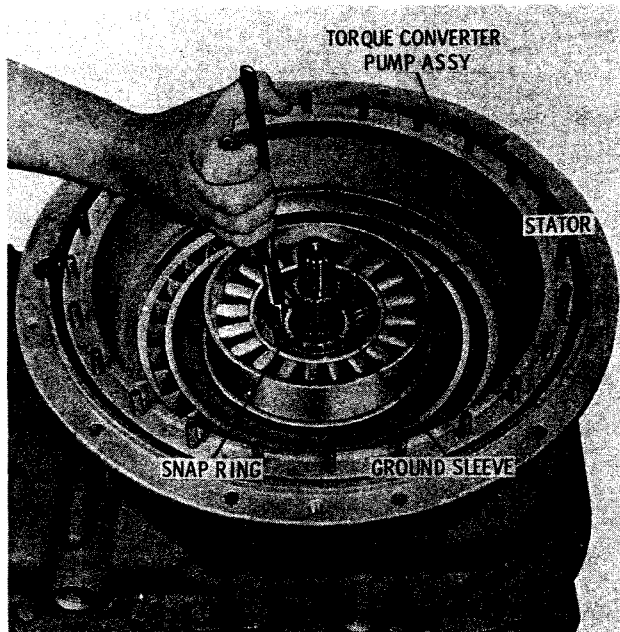


Fig. 5-11. Removing stator snapping

## DISASSEMBLY

Para 5-5/5-6

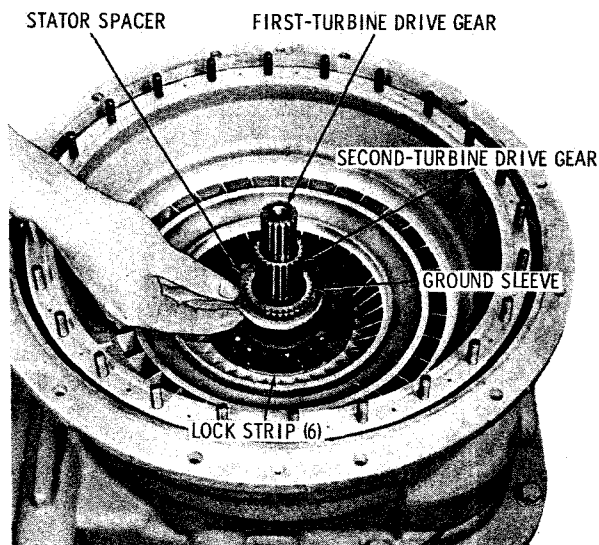


Fig. 5-12. Removing stator spacer

S1403

(4) Straighten the tabs of the lockstrips at four places equidistant around the pump hub and remove four of the 12 bolts (fig. 5-13). Install an improvised puller (fig. 4-1), making sure the puller sleeve rests on the converter ground sleeve and extends above the end of the first-turbine drive gear shaft. Tighten the puller screw.

(5) When the converter pump bearing has been drawn from its seat on the ground sleeve, remove the puller.

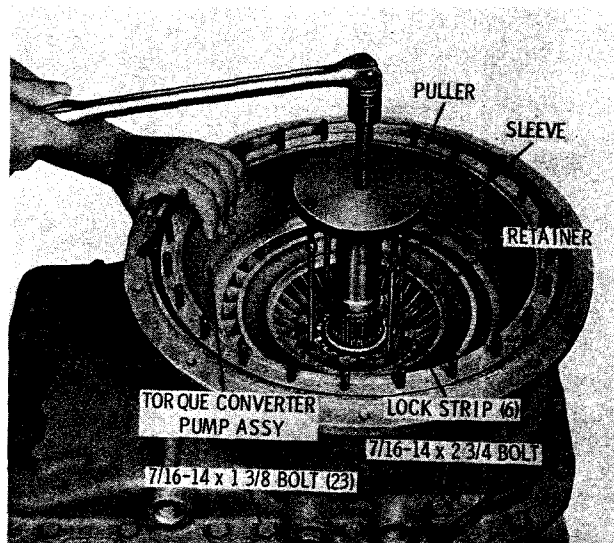


Fig. 5-13. Loosening torque converter pump bearing

S2544

(6) Remove the torque converter pump and reinstall the four bolts removed in (4), above. If further disassembly is planned, refer to paragraph 6-7 for converter pump rebuild instructions. If disassembly is not necessary, tighten the four 1/4-28 x 1 1/4-inch bolts to 10 to 12 pound feet (14 to 16 Nm) torque, and bend the lockstrip tabs against the replaced bolts.

### b. Converter Housing

(1) Remove the 24 bolts, lockwashers, and plain washers that attach the converter housing to the transmission main housing (fig. 5-13).

(2) Attach a sling to the converter housing flange (fig. 5-14). Apply slight tension on the sling and, using a soft hammer, bump the converter housing away from the transmission main housing.

**Caution:** When the converter housing has cleared the transmission housing (approximately 1-1/2 inches (38 mm), check to insure that the second-turbine drive gear and the free-wheel unit remain with the transmission main housing. If necessary, use two long screwdrivers to pry the freewheel front bearing from the converter housing. On units equipped with an internal thermostat, do not pry against the bypass tube. If the freewheel unit is raised with the converter housing, the oil suction tube may be damaged. If the second-turbine drive gear is raised with the converter housing, it may fall unexpectedly, causing damage or injury.

(3) Remove the converter housing and attached parts (fig. 5-14). Remove the gasket. If roller bearing 45 (B, foldout 3) is used with accessory driven gear 2, remove the outer race. Refer to paragraph 6-8 for converter housing rebuild instructions.

## 5-6. REMOVAL OF TURBINE GEARING AND OIL SUCTION TUBE

### a. Turbine Gears and Freewheel Clutch

(1) Remove the second-turbine drive gear and attached parts (fig. 5-15). Remove

## Para 5-6

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the step-joint sealing from the drive gear shaft. Thrust race 25 (B, foldout 3) may remain on the hub of the second-turbine drive gear. If so, remove the race.

(2) Remove the ball bearing from the second-turbine drive gear only if replacement is necessary (fig. 5-15).

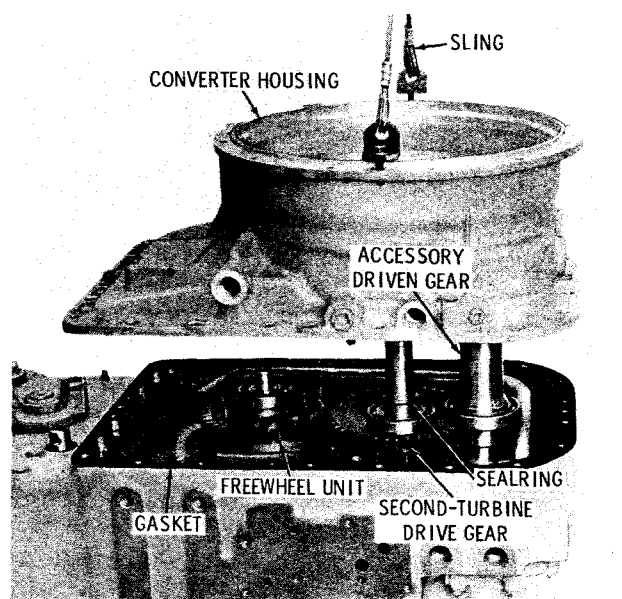


Fig. 5-14. Removing torque converter housing assembly

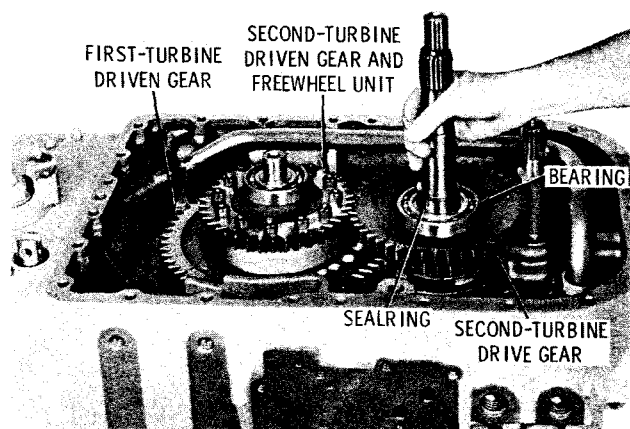


Fig. 5-15. Removing second-turbine drive gear, turbine driven gears, and freewheel unit

(3) Remove the first-turbine driven gear and the second-turbine driven gear and freewheel unit as an assembly (fig. 5-15). Refer to paragraph 6-9 for freewheel unit rebuild instructions.

**Note:** On some models, it may be necessary to remove the oil suction tube prior to removal of the freewheel unit.

(4) If the transmission is equipped to provide a standard speed low-gear ratio, remove the reverse-and-low-range sun gear as shown in figure 5-16. If the transmission is equipped with a high speed low-gear ratio, reverse-and-low-range sun gear 16 (A, foldout 5) cannot be removed as shown (fig. 5-16) but must be removed from the rear of the transmission; however, spacer 8 (A, foldout 5) is accessible and should be removed from the sun gear cavity. Refer to paragraph 5-9c(1) for removal of sun gear 16.

(5) Remove the needle roller bearing, two thrust races, and step-joint sealing from the first-turbine drive gear (fig. 5-16). Remove the first-turbine drive gear and ball bearing as an assembly. Do not remove the bearing unless replacement is necessary. If necessary, refer to paragraph 6-10 for rebuild instructions.

**b. Accessory Drive Shaft.** Remove the accessory drive shaft (fig. 5-16). Remove bearing 9 (B, foldout 3) from accessory drive shaft 8 only if replacement is necessary.

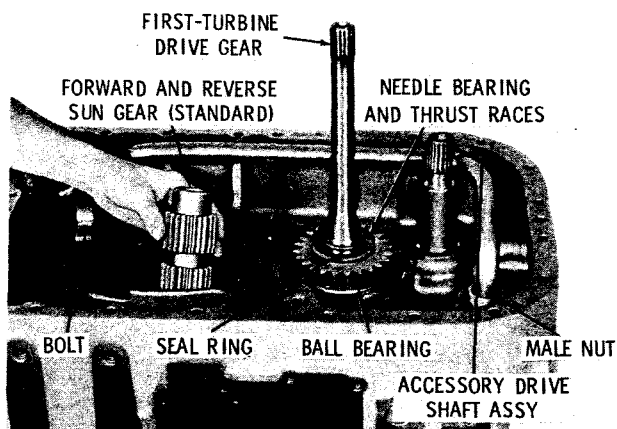


Fig. 5-16. Removing standard speed, forward- and reverse-range sun gear

c. Oil Suction Tube. Using a 1-3/4-inch wrench, remove the male nut that retains the oil suction tube at the top of the housing (fig. 5-16). Also remove the self-locking bolt at the suction tube support. Remove the suction tube, and remove the male nut and compression sealring.

## 5-7. REMOVAL OF REAR COVER AND HIGH-RANGE CLUTCH PISTON HOUSING (TT models)

### a. Rear Cover (TT without PTO)

(1) Position the transmission to rest on wood blocks, front splitline downward. Remove the 19 bolts and lockwashers that attach the rear cover to the transmission housing (fig. 5-17). Remove the rear cover and gasket. Remove sealring 2 (B, foldout 6) from the rear cover. Remove pipe plug 3 only if replacement is necessary.

(2) If the transmission is equipped with a speedometer drive assembly, remove two bolts 15 and lockwashers 14. Remove speedometer drive sleeve assembly 10, gasket 9, speedometer drive adapter 8, and gasket 7 from rear cover 4. Remove lip-type oil seal 11 and washer 12 from drive sleeve 13 only if replacement is necessary.

### b.. High-range Clutch Piston Housing (TT without PTO)

(1) Straighten the lock tabs, and remove the six bolts that attach the high-range clutch piston housing to the transfer drive gear (fig. 5-18). Remove the bolts and lock-tabs.

(2) Using two screwdrivers, pry the high-range clutch piston housing and attached parts from the transfer drive gear (fig. 5-19). Refer to paragraph 6-11 for the high-range clutch piston housing rebuild instructions.

### c. Rear Cover Assembly (TT with PTO)

(1) Using a 1-1/4-inch socket wrench, loosen but do not remove self-locking nut 29 (B, foldout 6). Remove nineteen bolts 30 and lockwashers 31. Attach a hoist to PTO out-

put flange 27. Remove rear PTO cover assembly 22, PTO shaft 17, and attached parts as a unit. Remove gasket 1 and sealring 2.

(2) Remove self-locking nut 29, flange retaining washer 28, and PTO output flange 27. Refer to paragraph 6-12 for rear PTO cover assembly rebuild instructions.

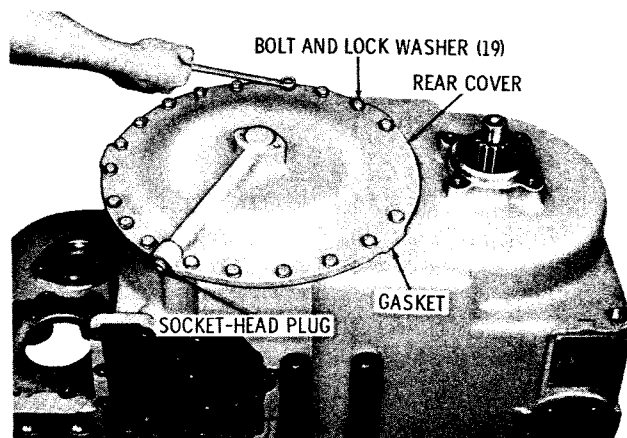


Fig. 5-17. Removing transmission rear cover

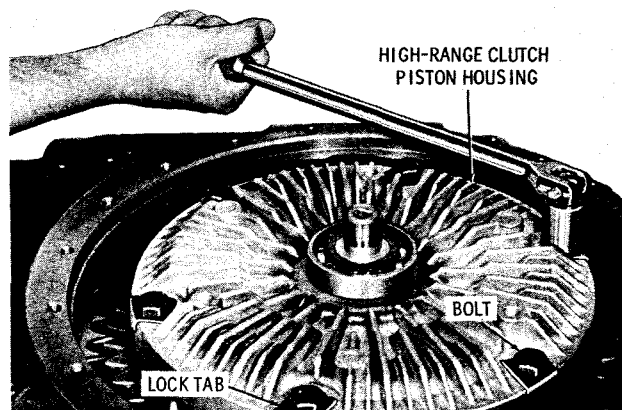


Fig. 5-18. Removing high-range clutch piston housing bolts

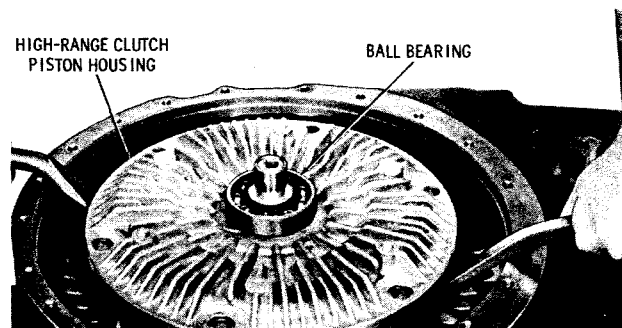


Fig. 5-19. Removing high-range clutch piston housing

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## d. High-range Clutch Piston Housing (TT with PTO)

(1) Remove two step-joint sealrings 37 (A, foldout 6) from high-range piston housing 36. Straighten six locktabs 40, and remove six bolts 39 and the locktabs.

(2) Pry high-range clutch piston housing 36 (and attached parts) from transfer drive gear assembly 2. Refer to paragraph 6-13 for high-range clutch piston housing rebuild instructions.

## 5-8. REMOVAL OF REAR COVER, INTERNAL BRAKE AND HIGH-RANGE CLUTCH PISTON HOUSING (TTB models)

### a. Rear Cover (TTB with PTO)

(1) Using a 1-1/4-inch socket wrench, loosen but do not remove the PTO flange retaining nut (fig. 5-20). Remove the 18 bolts and lockwashers that retain the rear cover assembly. Spring pressure will push the rear cover upward.

(2) Attach a sling to the PTO flange (fig. 5-21). Remove the rear cover assembly, PTO shaft, and attached parts as a unit. Refer to paragraph 6-14a and b for rear cover assembly rebuild instructions.

## b. Internal Brake Components (TTB with PTO)

(1) Remove 12 brake return springs and 12 guide pins from the recesses in the diaphragm (fig. 5-22). Remove the eleven brake plates from the brake hub. Remove the ball bearing from the hub of the high-range clutch piston housing.

(2) Remove the step-joint sealring from the brake hub (fig. 5-22). Remove the snapring that retains the brake hub, and remove the brake hub. Remove the sealring from the diaphragm.

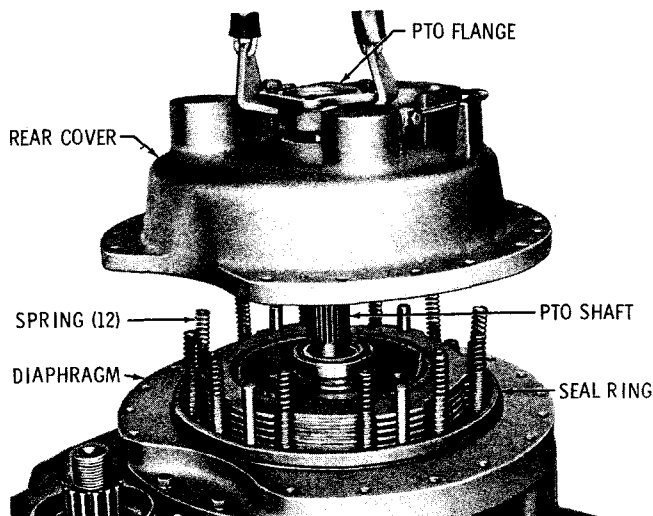


Fig. 5-21. Removing rear cover assembly

S2590

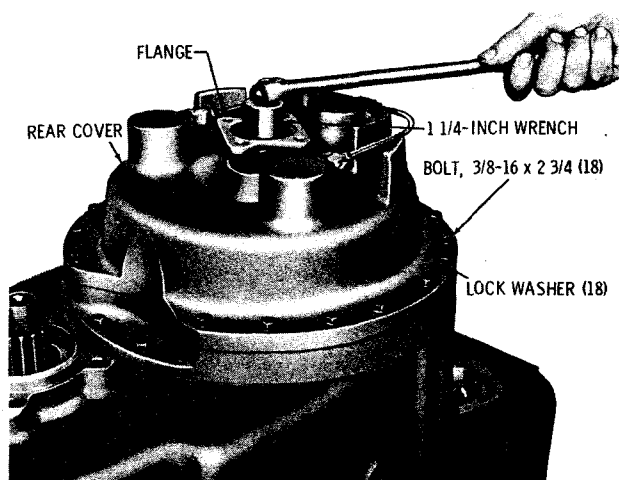


Fig. 5-20. Removing power takeoff flange nut

S2549

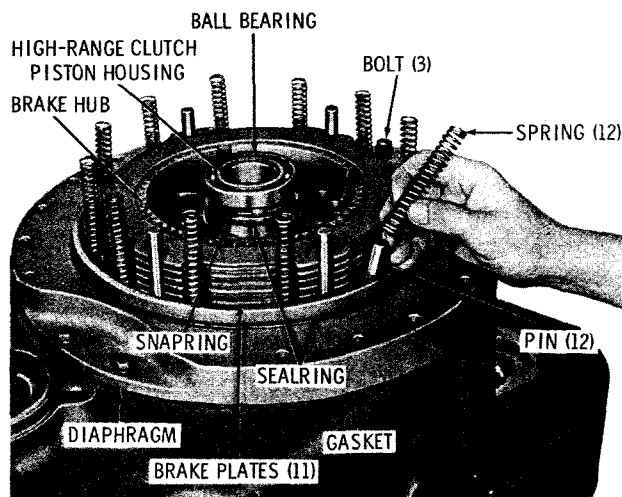


Fig. 5-22. Removing brake return springs and guide pins

S2551

## DISASSEMBLY

Para 5-8/5-9

(3) Remove the three bolts and lockwashers that retain the diaphragm on the transmission housing (fig. 5-22). Remove the diaphragm assembly and gasket. Refer to paragraph 6-15 for diaphragm assembly rebuild instructions.

### c. Rear Cover (TTB without PTO)

(1) Remove the 18 bolts and lockwashers that retain the rear cover assembly (refer to fig. 5-20). Spring pressure will push the rear cover upward.

(2) Attach a sling to the bolt flange of the rear cover, and remove the rear cover and attached parts. Refer to paragraph 6-14c and d for rear cover assembly rebuild instructions.

d. Internal Brake Components (TTB without PTO). Remove the remaining internal brake components in the manner described in b, above.

### e. High-range Clutch Piston Housing (TTB)

(1) Straighten the six locktabs and remove the six bolts and locktabs that attach the high-range clutch piston housing to the transfer drive gear (fig. 5-23). Remove the two step-joint sealrings and the other sealring from the hub of the high-range clutch piston housing.

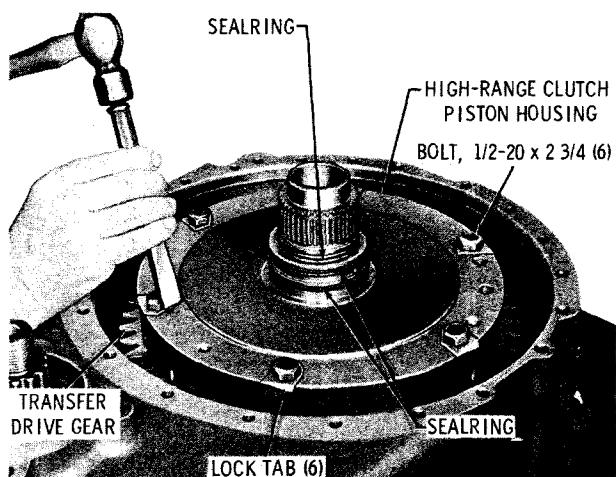


Fig. 5-23. Flattening piston housing bolt locktabs

(2) Pry the high-range clutch piston housing from the transfer drive gear, and remove it as an assembly. Refer to paragraph 6-16 for high-range clutch piston housing rebuild instructions.

## 5-9. REMOVAL OF RANGE GEARING, CLUTCHES, AND OIL PUMP

### a. High-range Clutch Assembly and Transfer Drive Gear

(1) Remove the high-range clutch hub assembly from the transfer drive gear (fig. 5-24). Refer to paragraph 6-17 for high-range clutch hub assembly rebuild instructions.

Note: PTO models have an internal-splined hub.

(2) Remove the snapping from the low-range planetary carrier, and remove the transfer drive gear assembly (fig. 5-24). Refer to paragraph 6-18 for the transfer drive gear rebuild instructions.

### b. Low-range Clutch and Planetary

(1) Replace two of the ten self-locking bolts that retain the low-range clutch piston housing with two 3/8-16 x 2 1/2-inch bolts removed from the control valve assembly in 5-3e, above (fig. 5-25). Install the bolts at opposite sides of the piston housing to restrain the spring pressure.

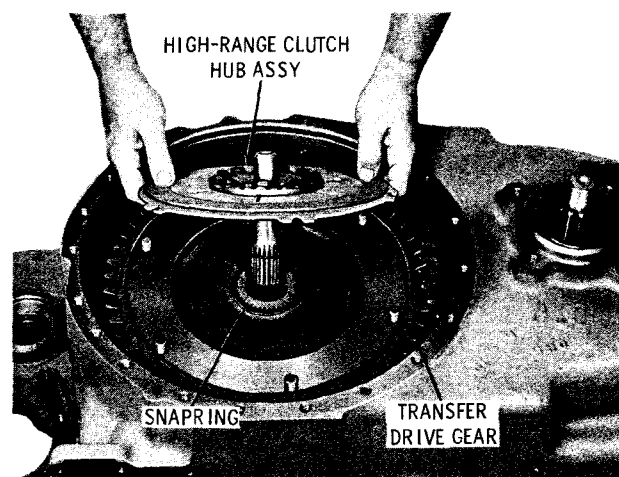


Fig. 5-24. Removing high-range clutch hub assembly (no power takeoff)

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Para 5-9

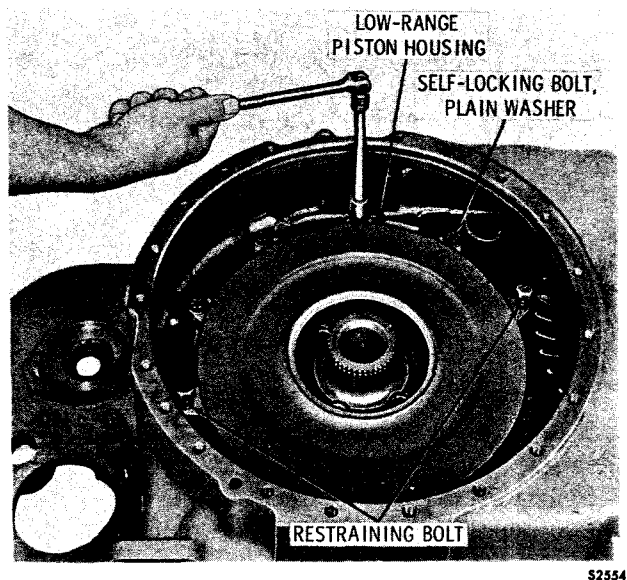


Fig. 5-25. Removing low-range clutch piston housing bolts

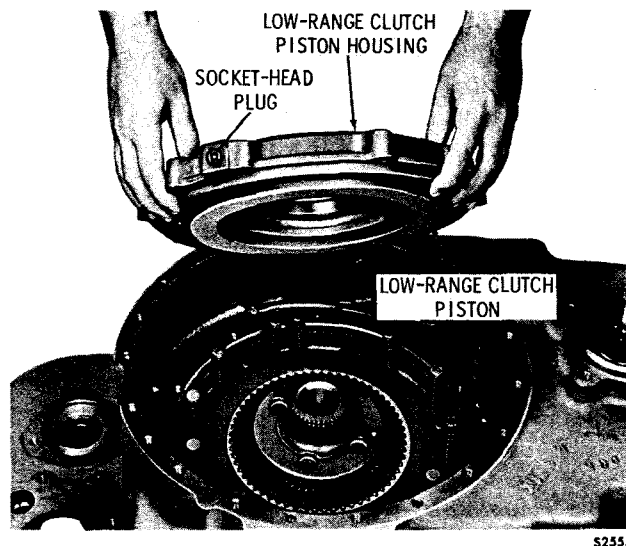


Fig. 5-26. Removing low-range clutch piston housing and piston

(2) Remove the remaining eight self-locking bolts and plain washers which retain the low-range clutch piston housing (fig. 5-25). Then, loosen the two restraining bolts evenly and remove them.

(3) Remove the low-range clutch piston housing and piston as an assembly (fig. 5-26). Remove the low-range clutch piston from the low-range clutch piston housing. Do not remove sealrings unless replacement is necessary. If necessary, refer to paragraph 6-19 for clutch piston assembly rebuild instructions.

(4) Do not remove the socket-head plug from the low-range clutch piston housing unless necessary for replacement, or cleaning of the oil passage (fig. 5-26).

(5) Remove the low-range planetary carrier assembly, low-range ring gear, four clutch plates, and the attached reverse-range ring gear as a unit (fig. 5-27). Remove thrust washer 2 (B, foldout 5) from the carrier, if present.

(6) Separate the clutch plates and low-range ring gear from the planetary carrier assembly. Remove the twelve piston return springs and guide pins, and remove the remaining four low-range clutch plates from the clutch anchor assembly (fig. 5-27).

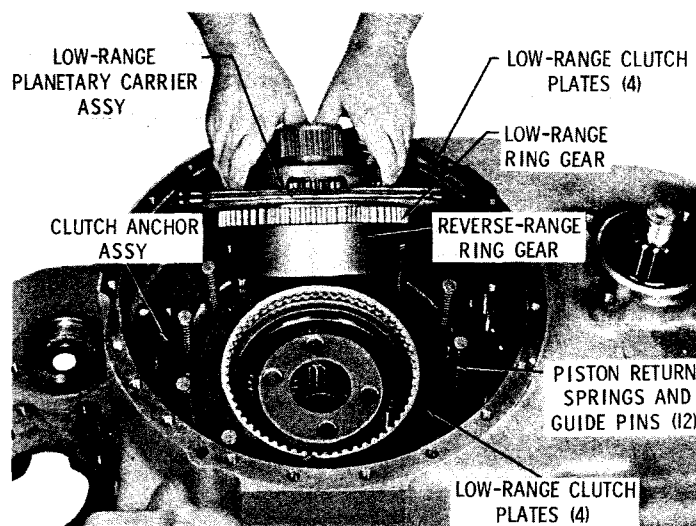


Fig. 5-27. Removing low-range planetary carrier assembly

(7) Remove the snapping that retains the reverse-range ring gear on the low-range planetary carrier assembly (fig. 5-28). Refer to paragraph 6-20 for the low-range planetary carrier assembly rebuild instructions.

### c. Reverse-range Clutch and Planetary

(1) Remove the reverse-and-low-range clutch anchor assembly (fig. 5-29). Remove the anchor pin from the valve body mounting pad.

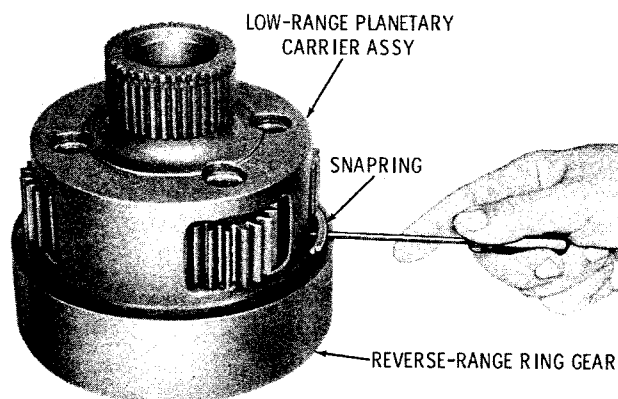


Fig. 5-28. Removing snapring from reverse-range ring gear

S2557

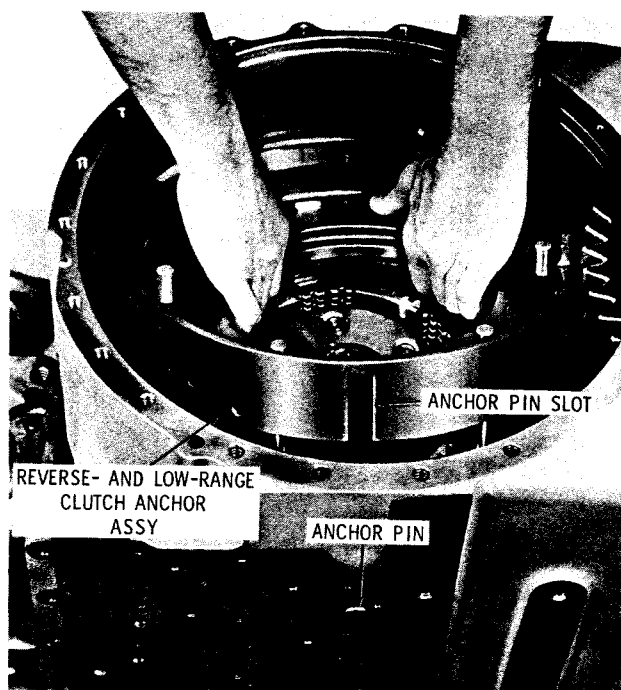


Fig. 5-29. Removing reverse-and-low-range clutch anchor assembly

S1465

**Note:** If the transmission is equipped with a high speed low-gear ratio, remove sun gear 16 (A, foldout 5) and thrust washer 2 (B, foldout 5), if present, from reverse-range planetary carrier assembly 9 (A, foldout 5).

(2) Remove the reverse-range planetary carrier assembly and one internal-splined clutch plate as a unit (fig. 5-30). Separate the clutch plate from the carrier assembly. Refer to paragraph 6-21 for the reverse-range



Fig. 5-30. Reverse-range planetary carrier assembly and clutch plates

S1420

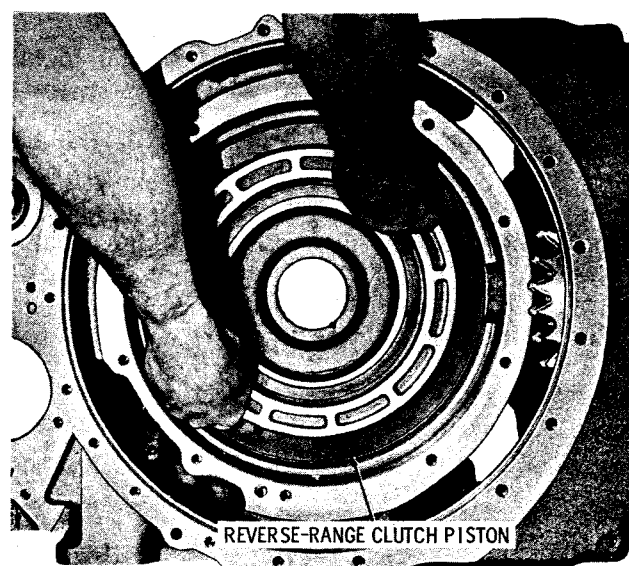


Fig. 5-31. Removing reverse-range clutch piston

S2558

planetary carrier assembly rebuild instructions. Remove the remaining nine reverse-range clutch plates from the transmission housing.

(3) Remove the reverse-range clutch piston from its bore in the transmission housing (fig. 5-31). Do not remove sealrings from the reverse-range piston unless replacement is necessary. If necessary, refer to paragraph 6-19 for clutch piston rebuild instructions.

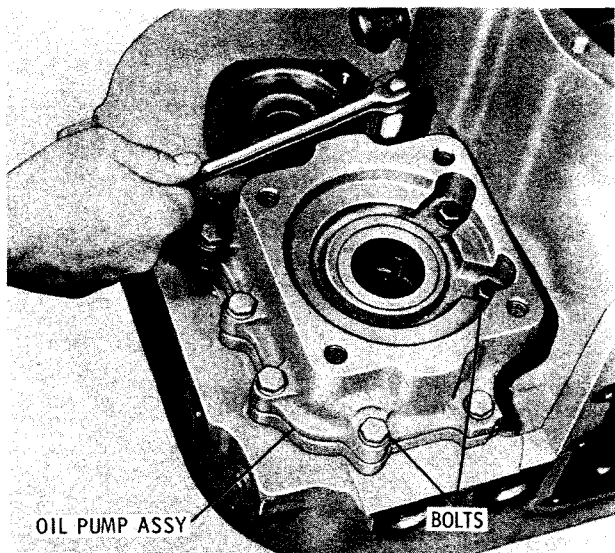


Fig. 5-32. Removing oil pump assembly

S1421

#### d. Oil Pump

(1) Remove the nine bolts and lockwashers that attach the oil pump to the transmission housing (fig. 5-32).

(2) Remove the oil pump and gasket, pump cover, and cover gasket as an assembly. Do not separate the oil pump components unless inspection or parts replacement is necessary. Refer to paragraph 6-22 for oil pump rebuild instructions.

### 5-10. REMOVAL OF OUTPUT COMPONENTS AND TRANSFER DRIVEN GEAR

**Caution:** IF ONLY THE SHAFT SEAL REQUIRES REPLACEMENT, DO NOT REMOVE SHIFTER SHAFT. Removal of the shaft will allow the shifter fork to drop into the sump area, and partial disassembly of the transmission is required to reinstall the shifter components. (Destroy and remove the failed seal. Install the new seal and press it lightly against the shoulder in the bore.)

#### a. One-piece Output Shaft

(1) Using a puller, remove the oil seal from the front of the transmission housing (fig. 5-33).

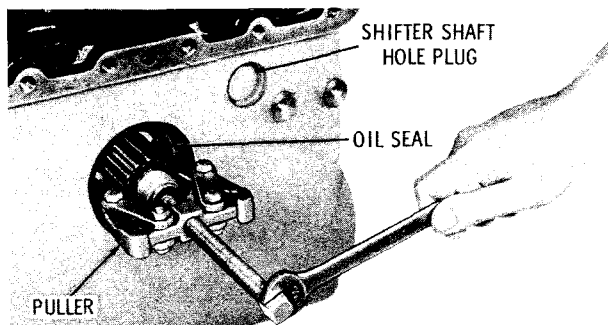


Fig. 5-33. Removing output shaft front oil seal

S1452

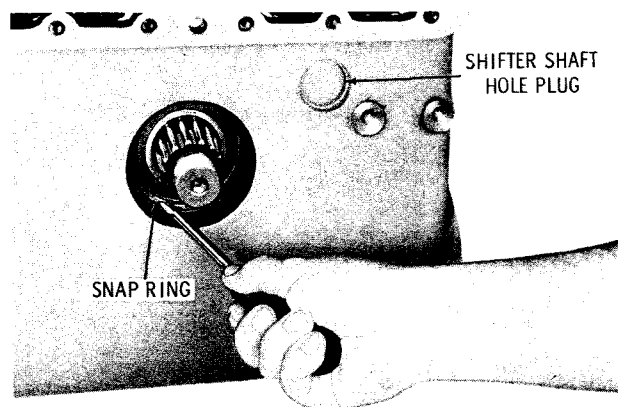


Fig. 5-34. Removing output shaft front bearing snapping

S1453

(2) Remove the snapping that retains the output shaft bearing in the housing bore (fig. 5-34). Do not remove the shifter shaft hole plug unless replacement is necessary.

(3) Using a soft hammer, drive the output shaft forward until the front bearing is free from the housing bore (fig. 5-35).

(4) Remove the output shaft and front bearing as an assembly (fig. 5-36). Remove the front bearing from the output shaft.

(5) Removal of the output shaft will free the transfer driven gear and spacer 24 (A, foldout 8). Remove the transfer driven gear (fig. 5-37) and remove the spacer from the sump area. Remove lip-type oil seal 27 (A, foldout 8) from the rear of the housing. Remove the output shaft rear bearing from its bore (fig. 5-37).

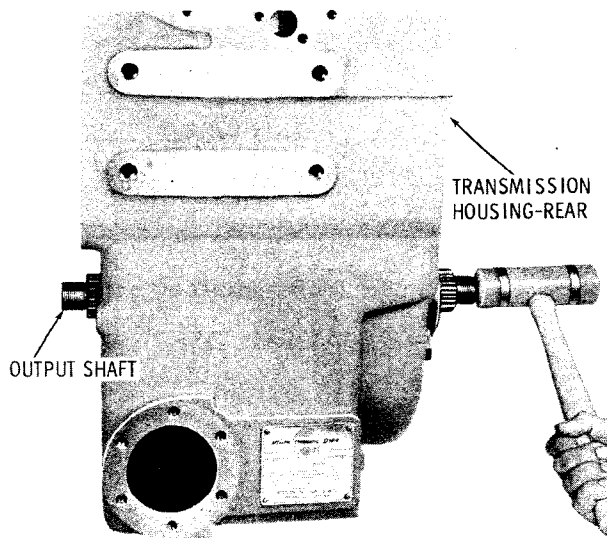


Fig. 5-35. Loosening one-piece output shaft front bearing

S1454

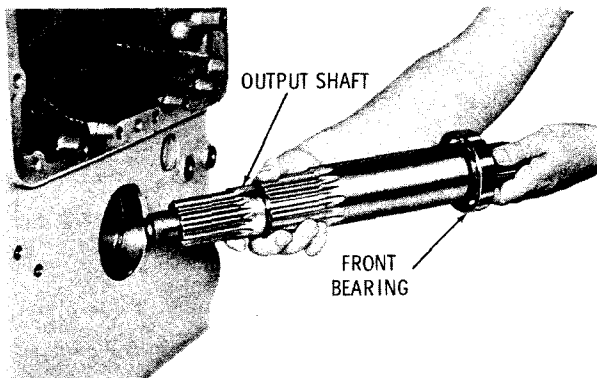


Fig. 5-36. Removing one-piece output shaft

S2559

## b. Two-piece Output Shaft

(1) Rotate shifter fork shaft counter-clockwise to remove it from the front of the transmission housing (fig. 5-38). Removal of the shifter fork shaft will allow the shifter fork to fall into the sump area. Remove the shifter fork. Remove the shifter shaft oil seal only if replacement is necessary.

(2) Using a puller, remove the oil seal from the rear of the transmission housing (fig. 5-39). Remove flange spacer 15 (B, fold-out 8), if present.

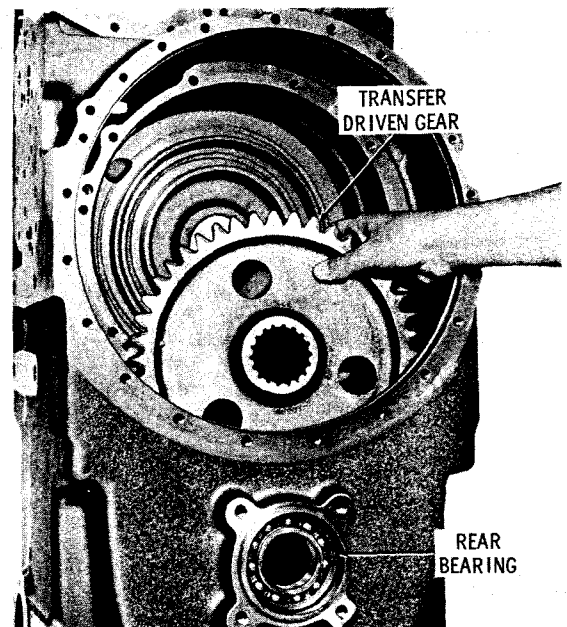


Fig. 5-37. Removing transfer driven gear (one-piece shaft)

S2560

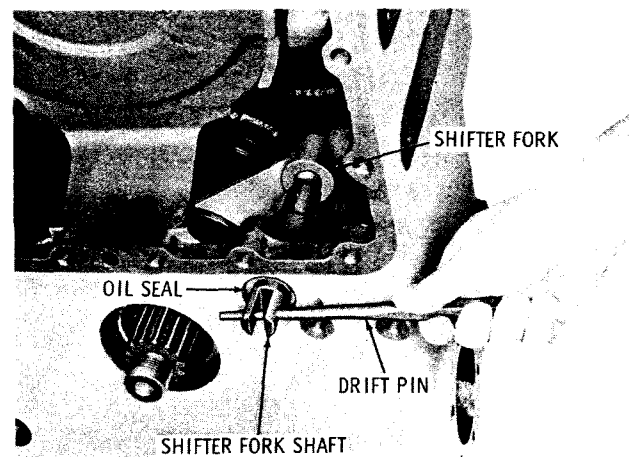


Fig. 5-38. Removing disconnect shifter shaft

S1456

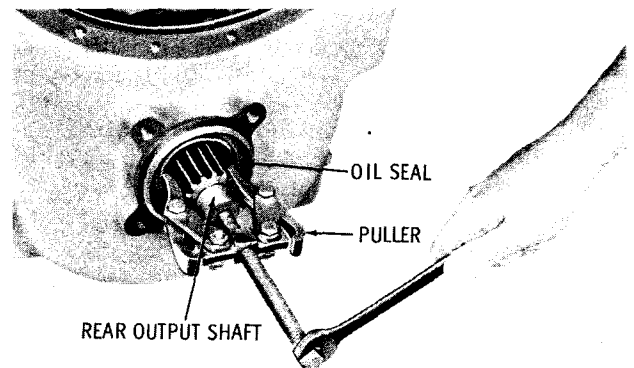
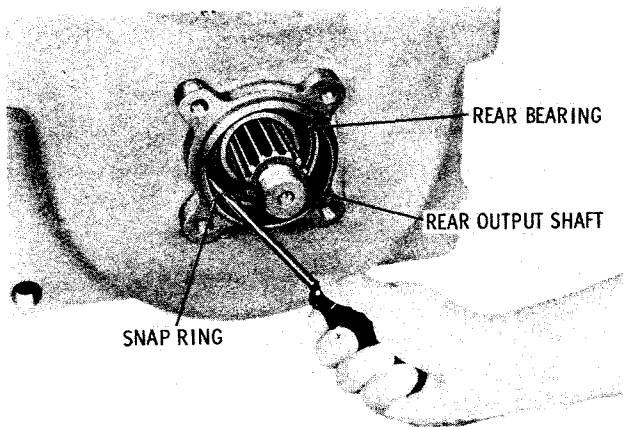


Fig. 5-39. Removing rear output shaft oil seal

S2561

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### Para 5-10



S2562

Fig. 5-40. Removing rear output shaft bearing snapping

(3) Remove the snapping that retains the rear bearing in the housing bore (fig. 5-40).

(4) Using a soft hammer, drive the front output shaft rearward until the bearing on the rear output shaft is free from the housing bore (fig. 5-41). Remove the rear output shaft and the attached bearing and spacer as an assembly (fig. 7-8). Remove the bearing only if replacement of the bearing or spacer is necessary. Do not remove bushing 22 (A, foldout 8) from rear output shaft 23 unless replacement is necessary.

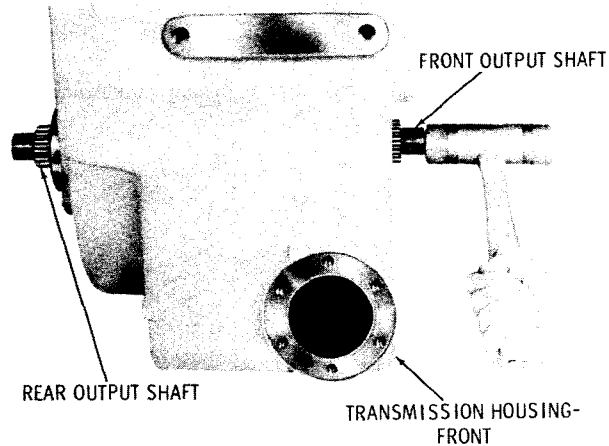
(5) Removal of the rear output shaft from the transmission housing will free transfer driven gear 20 and allow spacer 19 to fall into the sump area. Remove the transfer driven gear (fig. 5-42), and remove the fallen spacer from the sump.

(6) Remove the center bearing from its bore in the housing web (fig. 5-43).

(7) Remove the front output shaft and disconnect coupling as an assembly (fig. 7-6).

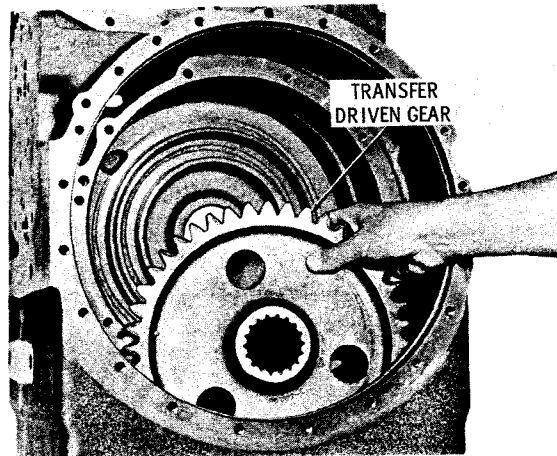
**Note:** A spring and two detent balls will be released when the disconnect coupling is removed from the front output shaft. Drape a shop towel over the assembly to prevent possible loss of the balls.

(8) Remove the disconnect coupling from the front output shaft, and place the two detent balls and spring in a parts receptacle.



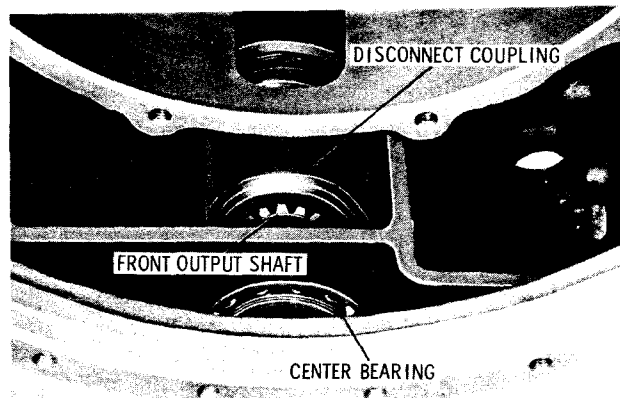
S1457

Fig. 5-41. Driving two-piece output shaft rearward for removal



S2560

Fig. 5-42. Removing transfer driven gear



S1458

Fig. 5-43. Disconnect coupling, front output shaft, and center bearing

## DISASSEMBLY

Para 5-10

(9) Remove the front oil seal only if necessary. If necessary, remove the seal as described in a(1), above.

(10) Remove the front snapring and output shaft bearing (refer to fig. 5-34) only if part replacement is necessary. If necessary, remove the snapring and, using a puller which will apply its force to the rear surface of the outer race, draw the bearing from its bore. If such a puller is not available, use a drift and tap evenly around the outer race to drive the bearing forward.

(11) Remove remaining parts from the transmission housing only if part replacement or additional servicing is required. Refer to paragraph 6-23 for the transmission housing rebuild instructions.

### c. Rear Output Shaft

(1) Using a puller, remove the oil seal from the rear of the transmission (fig. 5-39). Remove flange spacer 15 (B, foldout 8), if present.

(2) Remove the snapring that retains the rear bearing in the housing bore (fig. 5-40).

(3) Remove plug 29 (A, foldout 8) from the front output shaft orifice in the housing. Remove plug 28, if necessary, from the front of the housing. Using a drift, drive rear output shaft 23 rearward until bearing 25 is free in its bore. Remove rear output shaft 23, spacer 24, and bearing 25 as an assembly. Remove the bearing only if replacement of the bearing or spacer is necessary.

(4) Removal of the rear output shaft from the transmission housing will free the transfer driven gear and allow spacer 19 to fall into the sump area. Remove the transfer driven gear (fig. 5-42), and remove the fallen spacer from the sump.

(5) Remove bearing 18 (A, foldout 8) from its bore in the housing web.

(6) Remove the remaining parts from the transmission housing only if part replacement or additional servicing is required. Refer to paragraph 6-23 for the transmission housing rebuild instructions.

## 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 they were removed in Section 5.

### 6-2. GENERAL INFORMATION FOR SUBASSEMBLY REBUILD

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

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

c. Torque Specifications. The specific torque value for each threaded fastener installed in this section is stated in the applicable assembly paragraph. Torque values also are presented in paragraph 4-10 and figure 6-32.

d. Wear Limits, Spring Data. Refer to Section 8 for wear limits and spring data, which includes tabulations.

#### e. Lubrication

(1) Soak each friction (faced) clutch plate in transmission fluid for a minimum of 2 minutes prior to assembly.

(2) Use oil-soluble grease (petroleum jelly) with a low melting point when it is required to facilitate assembly. Do not use animal fats.

(3) Pack the ID of metal-encased, lip-type oil seals with high-temperature grease (MIL-G-3545A or equivalent).

### 6-3. CONTROL VALVE BODY ASSEMBLY

#### a. Disassembly (B, foldout 9)

(1) Remove plug 6 and gasket 7 that retain main-pressure regulator valve 8. Remove the main-pressure regulator valve.

(2) Remove plug 18 and gasket 17 that retain trimmer plug 16. Remove the trimmer plug, and main-pressure regulator spring 14, spring retainer 13, and trimmer spring 15.

(3) Remove main-pressure check plug 34. Remove selector valve plug 33 and gasket 32.

Note: On the models equipped with a clutch cutoff control, follow the procedures described in (4) or (5), below.

(4) For air actuated: Remove retainer plug 46 and gasket 23. Remove cutoff valve plug 45 from retainer plug 46. Remove seal ring 22 from cutoff plug 45. Remove clutch cutoff valve 20 and valve spring 19 from control valve body 9.

(5) For hydraulic actuated: Remove retainer plug 25 and gasket 23. Remove cutoff valve plug 21 from retainer plug 25. Remove seal ring 22 and cup 24 from cutoff valve plug 21. Remove clutch cutoff valve 20 and valve spring 19 from control valve body 9.

Note: On models equipped with an inching control, follow the procedures described in (6) through (11), below.

(6) Remove valve stop 35. Clean paint and dirt away from the valve body in the area of oil seal 44.

(7) Insert a bolt through the linkage pin hole in inching control valve 40, and pull the

## SERIES TT, TTB 2001 POWERSHIFT TRANSMISSIONS

### Para 6-3

valve from its bore in valve body 9. This will remove the valve and items 41 through 44.

(8) Clean the outer stem of valve 40 to permit seal 44 and plug 43 to be easily removed. Remove seal 44, plug 43, sealing 42, and spring 41.

(9) Remove spring 39 from control valve body 9.

(10) Insert a small screwdriver from the inner (mounting) side of the valve body assembly and push inching regulator valve 37 forward to release valve stop 38. Remove valve stop 38.

(11) Remove inching regulator valve 37 and spring 36.

(12) Remove plug 29 and gasket 30, and remove one spring 31 and ball 28. At the inner (mounting) side of control valve body 9, remove valve stop 12 from its position on range selector valve 27.

(13) Insert a bolt through the linkage pin hole in selector valve 27. Pull the selector valve and seal 26 from the bore and remove them from control valve body 9. Remove the seal from the selector valve. Remove the remaining detent ball 28 and spring 31 which were freed during removal of the selector valve.

(14) Do not remove retainer plug 11 and ball 10 from control valve body 9 unless parts replacement is necessary.

Note: Refer to paragraph 6-2, above.

#### b. Assembly (B, foldout 9)

(1) If the retainer plug and ball were removed from the control valve body, install a new ball and retainer (fig. 6-1). Place the retainer plug, open end upward, over the ball. Press the retainer plug until it is flush with, to 0.010 inch (0.25 mm) below, the surface of the three supporting bosses.

(2) Install one spring 31 (B, foldout 9) and detent ball 28 into control valve body 9. Depress the ball against the spring, and install

selector valve 27, linkage end last, through the seal bore of the control valve body.

(3) Install the remaining detent ball 28 and spring 31; install gasket 30 and plug 29 to retain the ball and spring. Tighten the plug securely.

(4) Position the selector valve in the middle detent position (neutral), and install the valve stop in the location shown in figure 6-1.

(5) Coat the outer circumference of the new selector valve oil seal with nonhardening sealer. Install the seal, spring-loaded lip first, over the linkage end of the selector valve into its bore (fig. 6-1). Press the seal into the bore until it is flush with, to 0.030 inch (0.76 mm) below, the surrounding surface.

Note: At assembly, all spool valves must move freely by their own weight within their bores.

(6) Install main-pressure regulator valve 8 (B, foldout 9), and install gasket 7 and plug 6. Tighten plug 6 securely. Install plug 34, and tighten sufficiently to prevent leakage.

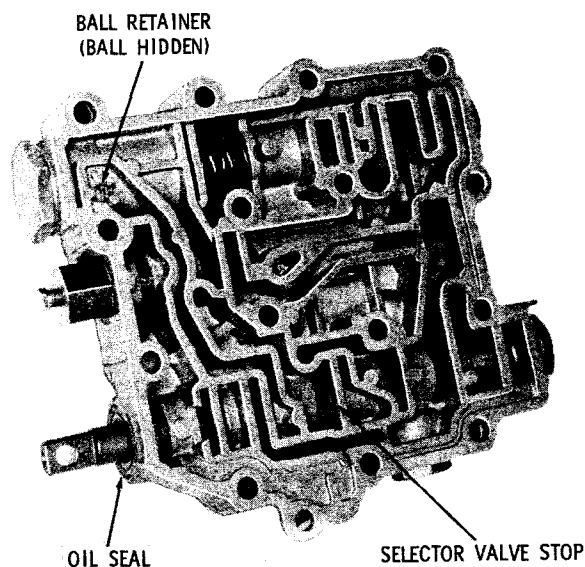


Fig. 6-1. Control valve body assembly—mounting side

## REBUILD OF SUBASSEMBLIES

Para 6-3/6-5

(7) Install spring retainer 13, concave side first, onto the stem end of main-pressure regulator valve 8. Install main-pressure regulator spring 14, trimmer spring 15, and trimmer plug 16 into the valve bore. Install gasket 17 and plug 18, and tighten the plug securely.

Note: On models equipped with an inching control, follow the procedures described in (8) through (12), below.

(8) Install spring 36 and valve 37. Using a small screwdriver, push valve 37 forward and install valve stop 38 to retain valve 37 against spring 36.

(9) Install spring 39, valve 40 and spring 41.

(10) Install sealring 42 onto plug 43.

(11) Install plug 43, larger bore first, over the stem of valve 40. Push plug 43 in until it seats, hold it against spring 41 and install stop 35 to retain plug 43.

(12) Coat the outer circumference of a new oil seal 44 with nonhardening sealer and install it, spring-loaded lip first, over the stem of valve 40. Press the seal in until it is flush with, to 0.030 inch (0.76 mm) below, the rear surface of valve body 9.

Note: On models equipped with a clutch cutoff control, follow the procedures described in (13) and (14), below.

(13) For hydraulic actuated: Assemble valve spring 19 onto clutch cutoff valve 20 and install them, spring first, into valve body 9. Install sealring 22 onto cutoff valve plug 21. Install cup 24, small diameter first, onto the stemmed end of the cutoff valve plug. Lubricate and install the assembled cutoff valve plug, cup first, into the smooth bore end of retainer plug 25. Install retainer plug 25 and gasket 23, and tighten the plug securely. Cover the exposed orifice in the retainer plug until the hydraulic brake line is to be attached.

(14) For air actuated: Assemble valve spring 19 onto clutch cutoff valve 20 and in-

stall them, spring first, into valve body 9. Install sealring 22 onto cutoff valve plug 45. Lubricate and install the assembled cutoff valve plug, seal ring first, into the smooth bore end of retainer plug 46. Install retainer plug 46 and gasket 23 and tighten the plug securely. Cover the exposed orifice in the retainer plug until the air-actuated cylinder assembly is to be connected.

### 6-4. TRANSMISSION FRONT COVER

#### a. Disassembly (A, foldout 2)

(1) If replacement of oil seal 10 is necessary, drive the seal out of the front of front cover 12.

(2) Clean the bore from which the seal was removed.

Note: Refer to paragraph 6-2, above.

#### b. Assembly (A, foldout 2)

(1) Coat the outer diameter of oil seal 10 with nonhardening sealer. Install the seal, spring-loaded lip first, straight into the bore in front cover 12.

(2) If the transmission is equipped with input shaft 17, press oil seal 10 into cover 12 until it bottoms lightly against bore shoulder. If the transmission is equipped with input shaft 22, press oil seal 10 into cover 12 until it is 0.230 to 0.290 inch (5.8 to 7.3 mm) past the lead chamfer in the bore.

### 6-5. TORQUE CONVERTER DRIVE COVER

#### a. Disassembly (A, foldout 2)

(1) Using a puller, remove bearing 14 from input shaft 17 or 22.

(2) Straighten the ears of lockstrips 15, and remove six bolts 16. Remove input shaft 17 from torque converter drive cover 19, or input shaft 22 from torque converter drive cover 23.

Note: Refer to paragraph 6-2, above.

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### Para 6-5/6-6

#### b. Assembly (A, foldout 2)

(1) Install input shaft 22 onto torque converter drive cover 23, or input shaft 17 onto torque converter drive cover 19. Install three lockstrips 15 and six 1/2-13 x 1 1/8-inch bolts 16. Tighten the bolts to 67 to 80 pound feet (91-108 Nm) torque. Bend corners of lockstrips 15 against the heads of bolts 16.

(2) Install shielded bearing 14, shield side upward, onto input shaft 17. Install plain bearing 14, manufacturer's identification upward, onto input shaft 22. Press the bearing firmly against the shoulder of the input shaft.

### 6-6. FIRST- AND SECOND-TURBINE ASSEMBLY

#### a. Disassembly (A, foldout 3)

(1) Locate the index marks (V-groove) in the outer rims of the first-turbine support and the first turbine (fig. 6-2). Make sure these marks are well defined in both parts. If the marks are not prominent, deepen them to 0.040 inch (1 mm) (maximum) before continuing with disassembly.

(2) Drive the six roll pins (nine in the 2421 model series) inward toward the hub un-

til they clear the holes in the first-turbine support (fig. 6-2). Remove the roll pins only if replacement is necessary.

(3) Remove the first turbine from its support (fig. 6-3). Remove the second turbine and its bearing from the first-turbine support.

(4) Remove bearing 8 (A, foldout 3) from second turbine 6 only if replacement is necessary. If replacement is necessary, bearing 8 may be removed by pressing lengths of drill rod through the three removal holes in the hub of second turbine 6. Remove snapping 7 from second turbine 6 only if replacement is necessary.

(5) Remove bearing 1 from first-turbine support 3, only if replacement is necessary. If replacement is necessary, bearing 1 may be removed by pressing lengths of drill rod through the removal holes in the hub of first-turbine support 3.

Note: Refer to paragraph 6-2, above.

#### b. Assembly (A, foldout 3)

(1) If bearing 1 was removed from first-turbine support 3, install its replacement. Position the bearing, manufacturer's identification outward, and press the bearing firmly against its seat on the hub of support 3.

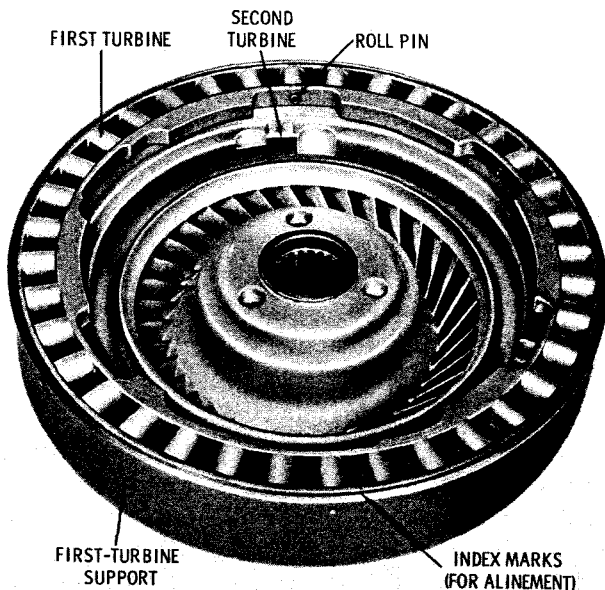


Fig. 6-2. First- and second-turbine assembly S2564

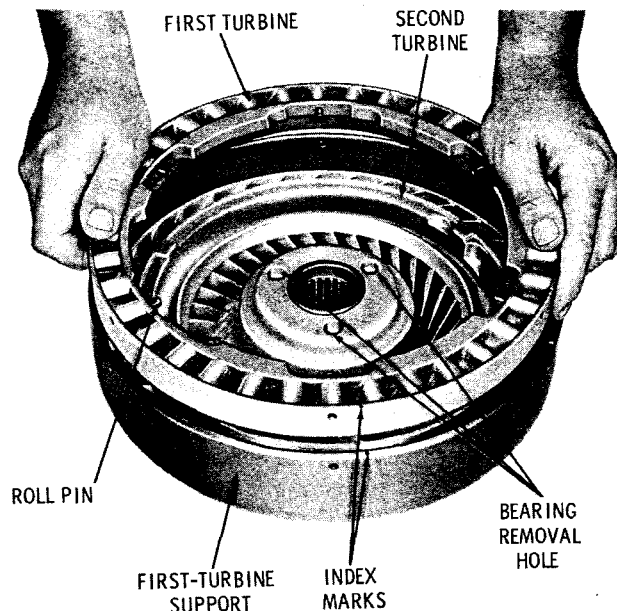


Fig. 6-3. Removing first turbine S2565

(2) If bearing 8 was removed from the second turbine 6, install its replacement. Position the bearing, manufacturer's identification outward, and press the bearing firmly onto its seat in the turbine hub. If snapping 7 was removed, install its replacement.

(3) Install the second-turbine (and bearing) into the first-turbine support (fig. 6-3).

(4) Install the first turbine into the first-turbine support and align the V-groove index marks (fig. 6-3).

(5) Drive the six roll pins (nine in the 2421 model series) outward until they are flush with, to 0.030 inch (0.76 mm) below, the outer surface of the first-turbine support (fig. 6-3).

#### 6-7. TORQUE CONVERTER PUMP

##### a. Disassembly (fig. 6-4)

(1) Straighten the ears of the six lockstrips. Remove the 12 bolts that attach the pump retainer and input accessory drive gear to the torque converter pump. Remove the six lockstrips, pump retainer, input accessory drive gear, and bearing. Remove gasket 17 (A, foldout 3) if present.

(2) Inspect the 24 special bolts around the circumference of the pump. Remove any defective bolts by pressing them from the pump flange.

Note: Refer to paragraph 6-2, above.

##### b. Assembly (fig. 6-4)

(1) If any of the special bolts were removed from the pump, install their replacements. Align the flat side of the bolt head next to the pump and press the new bolt into place.

(2) Install the double-row ball bearing, loading notch upward, into the input accessory drive gear (fig. 6-4).

(3) Place gasket 17 (A, foldout 3) onto the input accessory drive gear and align the bolt holes. (Gasket 17 is not required for

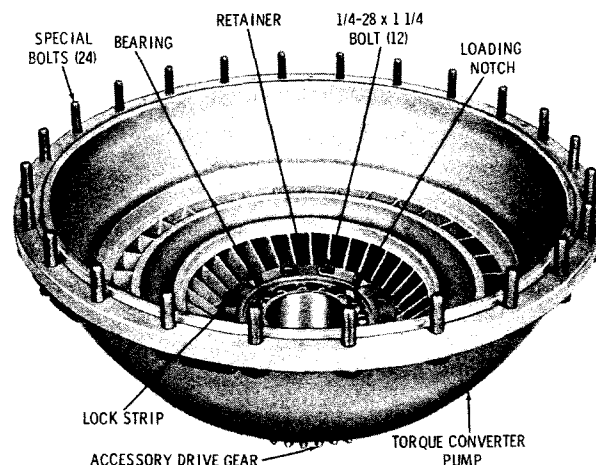


Fig. 6-4. Torque converter pump assembly

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"wet" converter housings.) Install the converter pump onto the drive gear, bearing, and gasket, aligning the bolt holes in the pump with those in the gear and gasket.

(4) Install the pump retainer, and install the six lockstrips and twelve 1/4-28 x 1 1/4-inch bolts. Tighten the bolts to 10 to 12 pound feet (14 to 16 Nm) torque. Bend the lockstrip ears against the bolt heads.

#### 6-8. TORQUE CONVERTER HOUSING

##### a. Disassembly (B, foldout 3)

Note: If the transmission does not include the diaphragm shown in figure 6-5, begin disassembly at (5), below.

(1) If the transmission has a "dry" converter housing, it will have a pressed steel diaphragm and oil seal (fig. 6-5). These must be removed before the accessory gearing can be removed. Removal of the diaphragm destroys the diaphragm and seal.

Note: The seal can not be purchased separately.

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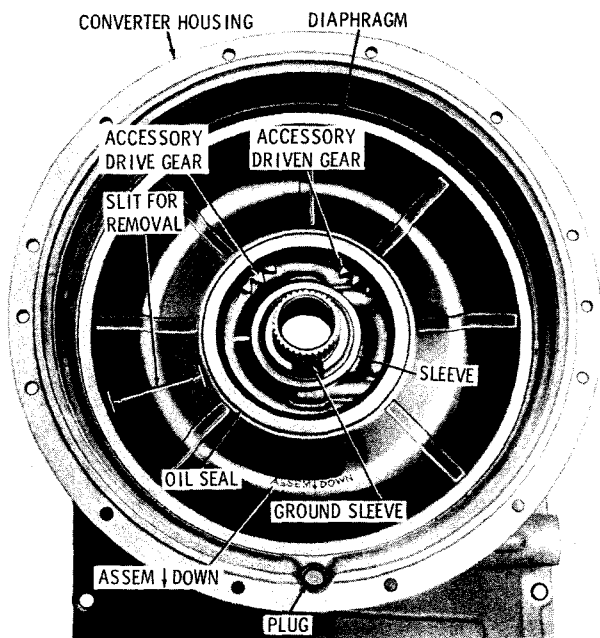


Fig. 6-5. Torque converter housing—front view <sup>S1441</sup>

(2) To remove the diaphragm, cut a slit through the diaphragm, as shown in figure 6-5). Insert a hooked tool into the slit and pry the metal above the slit outward. This will push the metal below the slit inward. Deforming the diaphragm in this manner will reduce its outside diameter and allow the diaphragm to be lifted from the converter housing.

(3) Clean the bore from which the diaphragm was removed. A smooth, clean bore will prevent leakage after the new diaphragm has been installed.

(4) Remove the welch plug from the converter housing only if replacement is necessary (fig. 6-5). If necessary, drive the plug from its bore, and clean the bore from which the plug was removed.

(5) Remove the step-joint seal from the converter housing sleeve (fig. 6-5). If replacement of the converter housing sleeve is necessary, remove it from the front of the housing.

(6) At the rear of the converter housing, remove the snapping from accessory driven gear bearing (fig. 6-6). Tap the accessory driven gear forward and remove it and the attached parts from the housing.

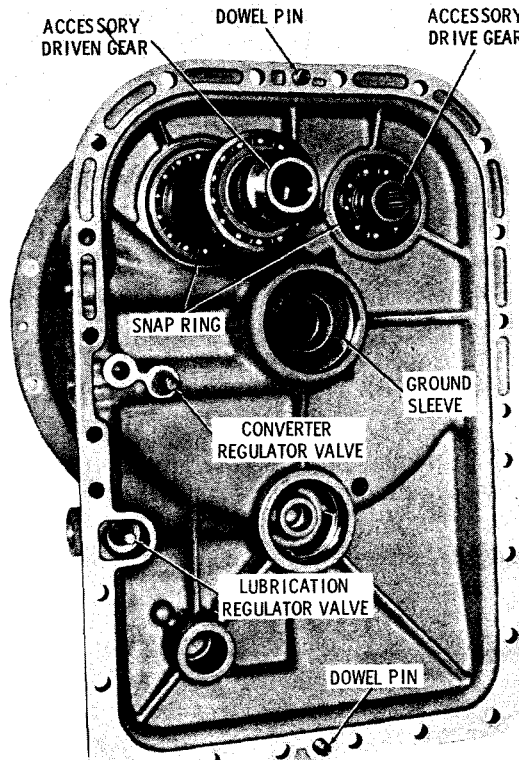


Fig. 6-6. Torque converter housing—rear view <sup>S2567</sup>

(7) Press bearing 12 (B, foldout 3) or inner race of bearing 45 from accessory driven gear 2. Also remove snapping 11 and bearing 10.

(8) On transmissions equipped with an accessory drive gear, remove the snapping from the accessory drive gear bearing (fig. 6-6). Tap the accessory drive gear forward and remove it and the attached parts from the housing.

(9) Remove snapping 7 (B, foldout 3) and bearing 6 from accessory drive gear 1.

(10) If replacement of the ground sleeve is necessary, remove the four attaching bolts and press the sleeve from the converter housing (fig. 6-6). Use care during this operation to prevent damage to the protruding converter pressure regulator valve or lubrication bypass tube 30 (B, foldout 3), if present.

(11) If the converter pressure regulator valve components 21, 22, and 23 (B, foldout 3) require replacement, remove them by twisting pin 21 from the converter housing.

(12) If the lubrication regulator valve components 18, 19, and 20 require replacement, remove them by twisting pin 18 from the converter housing.

(13) If the transmission is equipped with an internal thermostat, remove lubrication bypass tube 30 and thermostat assembly 31. Remove sealring 32 from the thermostat assembly.

(14) Do not remove plugs 37 or 39 unless necessary for cleaning or replacement. Do not remove dowel pins 41 unless necessary for replacement.

Note: Refer to paragraph 6-2, above:

b. Assembly (B, foldout 3)

(1) If plugs 37 and 39 were removed, replace them. Tighten the plugs sufficiently to prevent leakage. If dowel pins 41 were removed, install new dowel pins. Press the pins into their bores until they protrude 0.430 to 0.450 inch (10.92 to 11.43 mm) above the housing splitline.

(2) If the transmission is equipped with an internal thermostat assembly, install lubrication bypass tube 30 into the rear face of converter housing 38. Install sealring 32 onto thermostat assembly 31. Install thermostat assembly into the converter housing, as shown in figure 6-7.

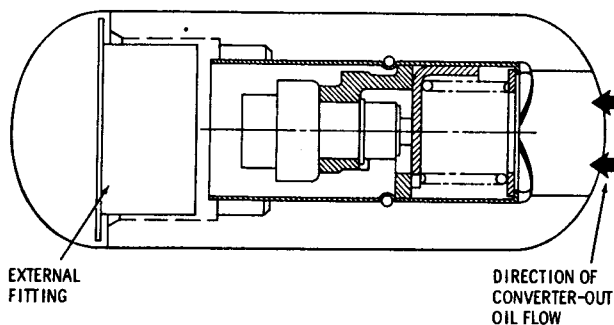


Fig. 6-7. Installation diagram of thermostat assembly

(3) If lubrication regulator valve 20 (B, foldout 3) was removed, install spring 19 and valve 20 onto guide pin 18. Install the assembled parts, pressing pin 18 into housing 38 until it is flush with, to 0.010 inch (0.25 mm) below, the housing splitline.

(4) If converter pressure regulator valve 23 was removed, install spring 22 and valve 23 onto guide pin 21. Install the assembled parts, pressing pin 21 into housing 38 until it projects 1.18 to 1.20 inches (29.9 to 30.4 mm) above the valve seat.

Note: If the press fit of pins 18 or 21 is not satisfactory, apply Loctite Grade B (Loctite Corp., Newington, Conn.) or equivalent. Clean the bore and pin of all oil residue. Apply the sealant to the bore and mating surface of pin and install as described above. Allow the sealant to cure for 2 hours at room temperature.

(5) If ground sleeve 13 was removed, chill the replacement sleeve in dry ice for at least 1 hour. Aline the bolt holes in ground sleeve 13 with those in housing 38, and press the sleeve to a firm seat against the rear of the housing. Install four 5/16-18 x 3/4-inch, self-locking bolts 14, and tighten them to 17 to 20 pound feet (23 to 27 Nm) torque.

(6) If the transmission is equipped with accessory drive gear 1, install bearing 6, with snapping groove away from the gear. Install snapping 7 to retain bearing 6.

(7) Install accessory drive gear 1 and assembled bearing (outer race snapping removed) into the front of housing 38. Install the snapping onto the outer race of the bearing.

(8) Install bearing 10, with its snapping groove away from the gear, onto accessory driven gear 2. Install snapping 11 to retain bearing 10. Press bearing 12 or inner race of bearing 45 against the rearward seat on accessory driven gear 2.

(9) Install accessory driven gear 2 and assembled bearings (outer race snapping removed) into the front of housing 38. Install the snapping onto the outer race of bearing 10.

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### Para 6-8/6-9

(10) If converter housing sleeve 40 was removed from housing 38, install new replacement sleeve. Heat the sleeve for ease of replacement. Install converter housing sleeve 40, sealring groove last, and press it onto the hub of housing 38. Seat the sleeve firmly against the shoulder on the hub. Install step-joint sealring 20 (A, foldout 3) into the groove in the converter housing sleeve. Retain the sealring with oil-soluble grease.

Note: If the transmission is equipped with a "dry" housing, continue assembly procedures as described in (11) and (12), below.

(11) Coat the outer diameter of diaphragm 10 (B, foldout 2) with nonhardening sealer, and start it, convex side first and arrow pointing toward bottom of transmission into the front of the converter housing. Using two soft hammers (one driving against the other or a block of wood contoured to the circumference of the diaphragm), drive the diaphragm onto its seat in the housing bore. Move the driver evenly around the circumference, driving only slightly at each position.

(12) If plug 11 was removed, coat outer diameter of the new plug with nonhardening sealer. Drive plug 11, flat side first, into the converter housing, and seat it against the shoulder in the bore.

### 6-9. TURBINE-DRIVEN GEARS AND FREEWHEEL CLUTCH

#### a. Disassembly (A, foldout 4)

(1) Press the second-turbine driven gear out of the assembled unit (fig. 6-8). This will free spacers 16 and 18 (A, foldout 4) and bearing 19 which may be removed. Remove fifteen rollers 9, also freed.

(2) Remove bearing 17 from gear 15. Remove twelve nuts 2 from bolts 14.

(3) Using a screwdriver, pry cam assembly 10 away from gear 3. Remove spring plate 5 and roller cage 8. Remove three spring pins 6 and springs 7 from the roller

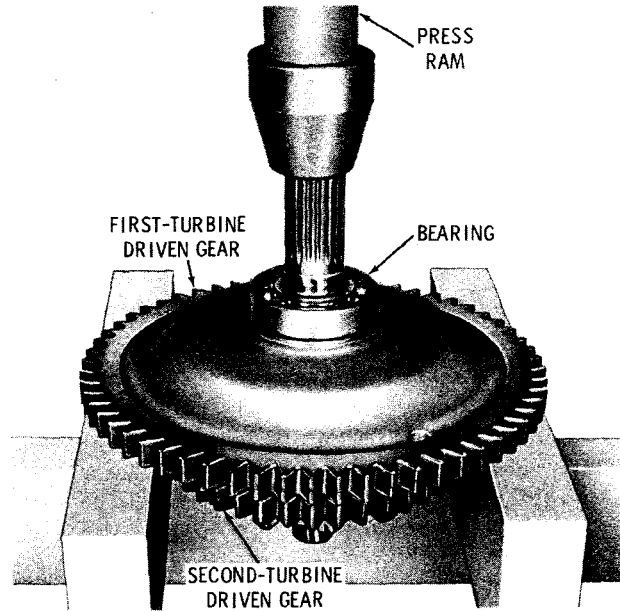


Fig. 6-8. Pressing second-turbine driven gear assembly from freewheel clutch assembly

S2569

cage. Remove bolts 14 and retainer plate 13 from cam assembly 10. Remove roll pin 11 from cam 12 if replacement is necessary.

(4) If replacement is necessary, remove bearings 1 and 4 from gear 3.

Note: Refer to paragraph 6-2, above.

#### b. Assembly (A, foldout 4)

(1) If bearings 1 and 4 were removed from gear 3, install the bearings by pressing them against the shoulders on the gear.

(2) Install the roll pin into the cam and press it to the bottom of the bore (fig. 6-9).

(3) Insert the roller cage into the free-wheel cam, and align the index marks on the cam and cage as shown in figure 6-9. Install the spring retainer plate onto the cam, indexing the small hole with the roll pin.

(4) Install the three springs and spring pins into the bored ears of the roller cage (fig. 6-10).

(5) Place the retainer plate, flat side first, against the rear face of the assembled cam and cage, and insert the twelve bolts (fig. 6-11). Install the assembled cam onto the assembled second-turbine driven gear.