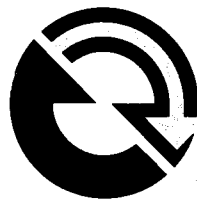


# Allison Transmissions

# TRT 2001 Series Service Manual



**Detroit Diesel  
Allison**

## **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

TRT 2211-3, TRT 2411-3

TRT 2221-1, TRT 2421-1

TRT 2221-3, TRT 2421-3

REVISED 1 AUGUST 1976



**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-Sectional Views

1. TRT 2421-1 Powershift transmission
2. TRT 2211-3 Powershift transmission
3. TRT 2221-3 Powershift transmission (underdrive)
4. TRT 2221-3 Powershift transmission (overdrive)

## Exploded Views

- A, 5. Transmission front cover and remote input drive
- B, 5. Gear and flex disk input drives and diaphragm
- A, 6. Torque converter
- B, 6. Torque converter housing
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- B, C, 14. Brake assemblies
- A, 15. Oil pump assembly
- B, 15. Control valve body assembly

## Section 1. GENERAL INFORMATION

### 1-1. SCOPE OF MANUAL

a. Coverage. This service manual describes the operation, maintenance and overhaul of the following Powershift transmissions:

TRT 2211-3	TRT 2411-3
TRT 2221-1	TRT 2421-1
TRT 2221-3	TRT 2421-3

Figures 1-1 through 1-6 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. Arrangement

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

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

(3) The fifteen foldout illustrations at the back of the manual include transmission

cross-sectional views and exploded views, showing the relation of component parts.

### 1-2. MODEL DESIGNATION

Each prefix letter and number in the model designation has a particular meaning in describing the transmission.

TRT - indicates a transmission having a twin turbine torque converter and an equal number of speeds forward and reverse

2 - (first digit) indicates 2000 series Powershift transmission

2 or 4 - (second digit) indicates either 200 or 400 series converter

1 or 2 - (third digit) indicates transmission forward and reverse speeds

1 - (fourth digit) model change

-1 - (suffix) indicates long drop

-3 - (suffix) indicates short drop

### 1-3. SUPPLEMENTARY INFORMATION

Supplementary information, to be used in conjunction with this manual, will be issued as necessary to cover changes released after the publication of this manual.

### 1-4. ORDERING PARTS

#### a. Transmission Nameplate

The nameplate (fig. 1-7), located on the left side of the -1 model transmission housings

# TRT 2001 SERIES TRANSMISSION

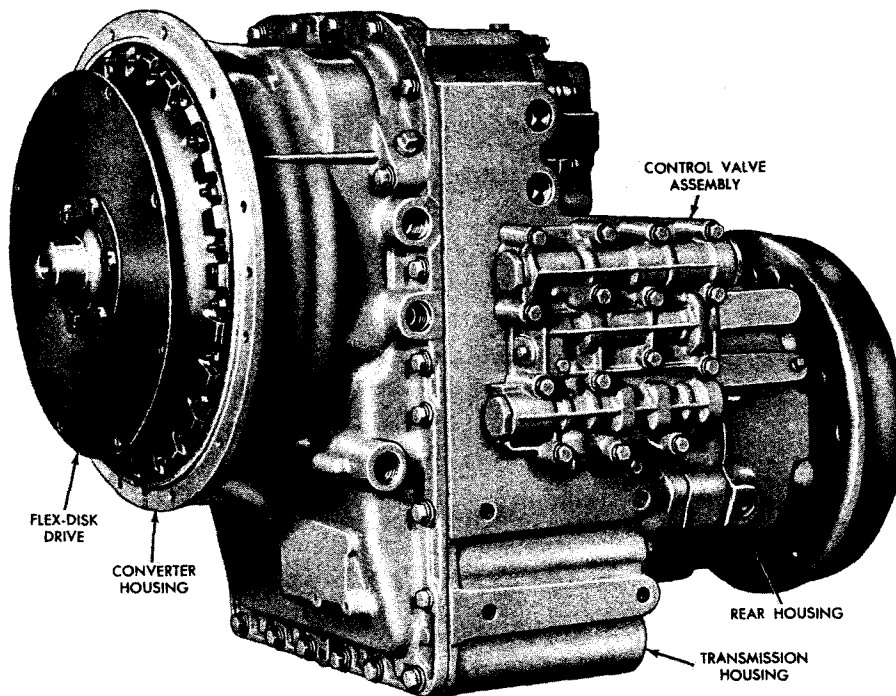


Fig. 1-1. Model TRT 2221-3 (or 2421-3) transmission—left-front view

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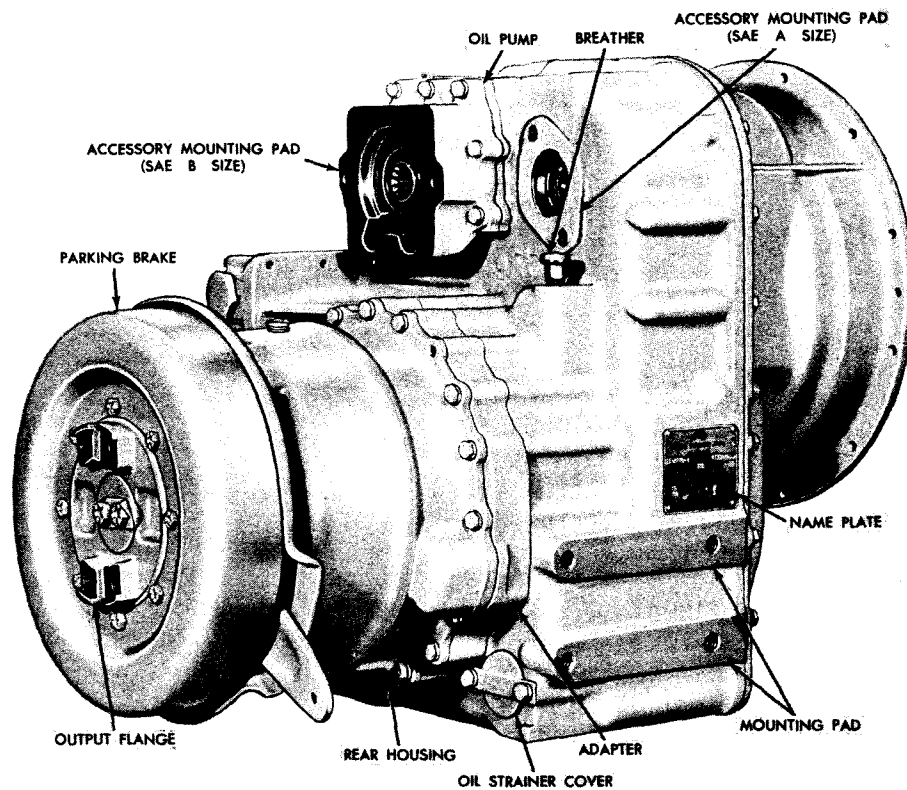


Fig. 1-2. Model TRT 2221-3 (or 2421-3) transmission—right-rear view

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## GENERAL INFORMATION

Para 1-4

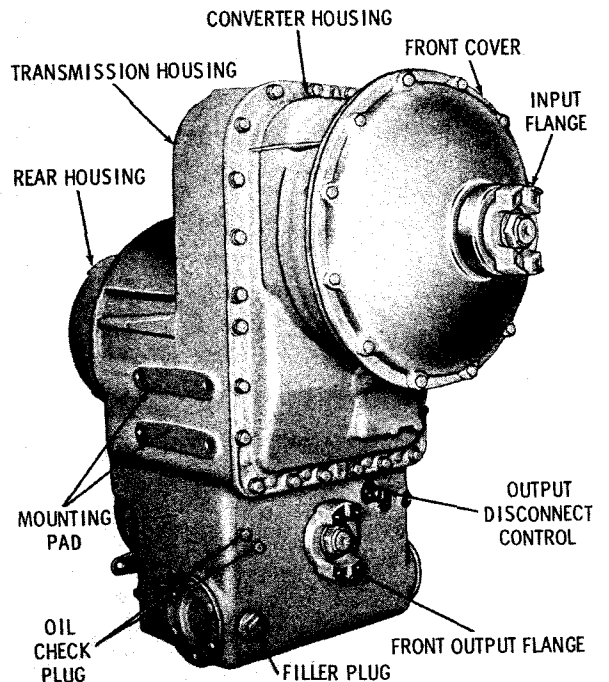


Fig. 1-3. Model TRT 2221-1 (or 2421-1) transmission—right-front view

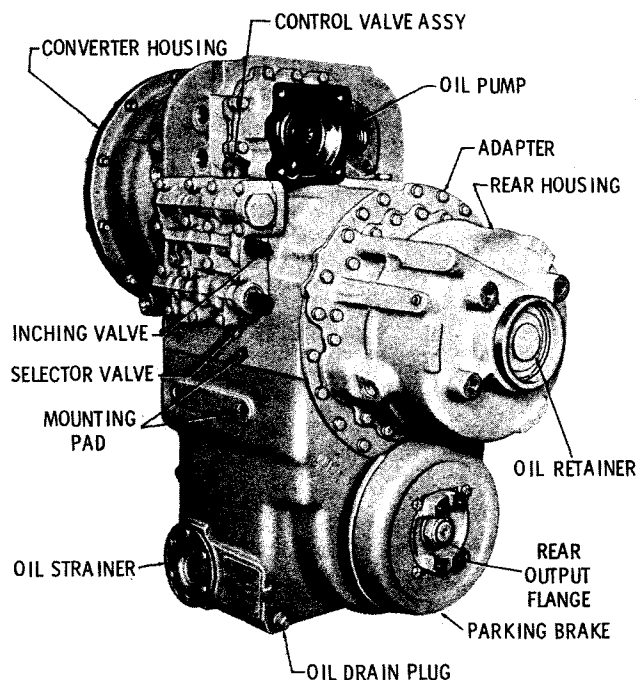


Fig. 1-4. Model TRT 2221-1 (or 2421-1) transmission—left-rear view

and on the right side of the -3 model transmissions, gives the transmission serial number, part number (assembly number), and model number. To insure that the correct

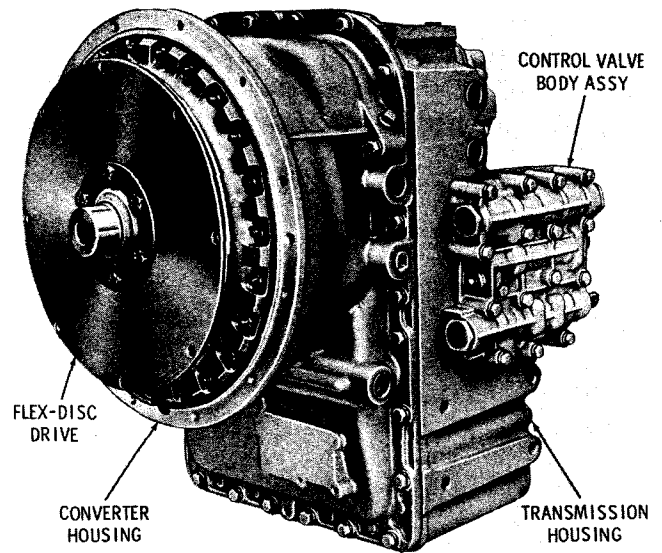


Fig. 1-5. Model TRT 2211-3 (or 2411-3) transmission—left-front view

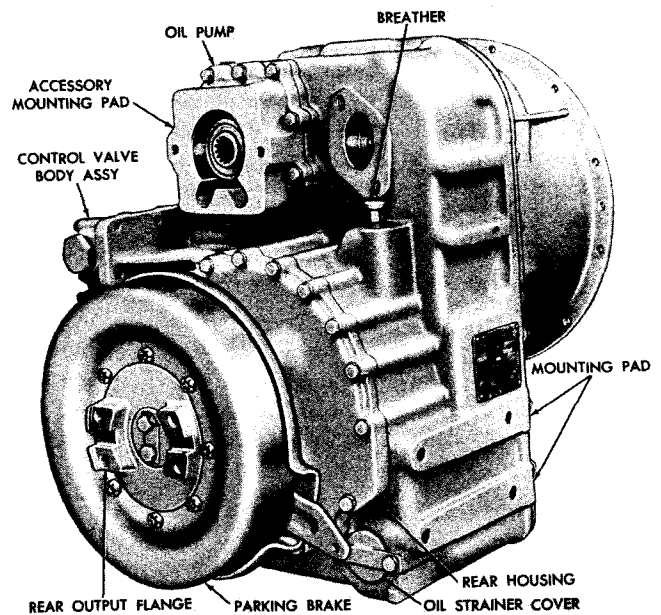


Fig. 1-6. Model TRT 2211-3 (or 2411-3) transmission—right-rear view

parts or information will be supplied, furnish all three numbers when ordering parts or requesting service information.

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

## TRT 2001 SERIES TRANSMISSION

Para 1-5

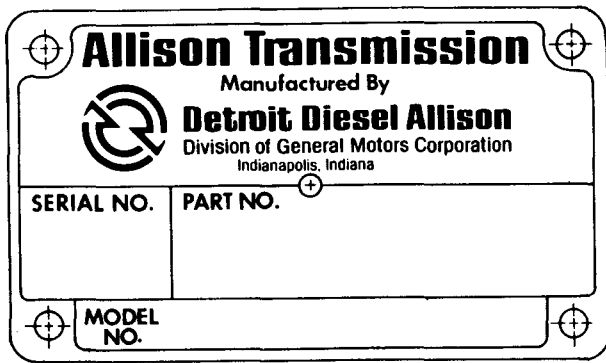


Fig. 1-7. Transmission nameplate

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### 1-5. DESIGN FEATURES AND OPTIONS

a. Model Differences. The basic difference between a 2201 and 2401 series transmission is in the size of the torque converter pump, turbines and stator. The torque converter elements are larger in the 2401 series. The 2221 and 2421 series transmissions provide two mechanical speeds forward and two mechanical speeds reverse with the option of the output drive being 7 inches (177.8 mm) (short drop), or 19 inches (482.6 mm) (long drop), below the transmission input centerline. The 2211 and 2411 series transmission provide one mechanical speed forward and one mechanical speed reverse, with the output drive being 7 inches (177.8 mm) (short drop) below the transmission input centerline.

b. Mounting and Input Drive. The transmission may be direct mounted (fig. 1-1) or remote mounted (fig. 1-3). Direct-mount models are bolted directly to the engine flywheel housing and coupled to the engine flywheel by a flexible disk drive. Provision is made in the direct-mount models to isolate the accessory drive gears from the flywheel cavity, to provide a dry flywheel housing while maintaining lubrication for the gears.

c. Torque Converter and Gearing. All TRT 2001 transmissions have the same basic design in the torque converter (fig. 2-1),

although their sizes and ratings will differ. The torque converter consists of four elements — pump assembly 6, first-turbine assembly 3, second-turbine assembly 4, and stator 5. Each turbine is connected to an output drive gear, 10 or 15. The first turbine, assisted by the second turbine, drives the range gearing at low speeds when load demand is high. As speed increases and load demand lessens, over-running clutch 12 disengages. When this occurs, the first turbine freewheels and the second-turbine transmits all of the drive to the range gearing. The transition from first turbine to second turbine is automatic, being determined by speed and load conditions.

d. Range Gearing and Clutches. The range gearing in the 2221 or 2421 models consist of the forward, reverse, high- and low-range planetaries. The range gearing in the 2211 or 2411 models consist of only the forward and reverse planetaries. The TRT 2221-3 and 2421-3 basic models have overall ratios which give underdrive in both low and high gears. As an option, these models may have a gear ratio which delivers an underdrive in low gear and an overdrive in high gear. Refer to the specifications, data chart at the end of this section. The clutches are the multidisk, hydraulic-actuated type, which automatically compensate for wear.

e. Transfer Gearing and Housing. The output drive of the TRT 2221-1 or 2421-1 transmission is 19 inches (482.6 mm) (long drop) below the transmission input centerline. Transfer gears 17 and 34 (foldout 1), that are necessary to obtain the "long drop" configuration, are enclosed in transmission housing 9. The housing is designed to provide front and rear output drive. The transfer gearing consists of two spur-type gears having a 0.85 to 1 or a 0.68 to 1 drive ratio.

f. Output Disconnect Clutch. The front output of the basic transfer gear model transmission (2221-1 or 2421-1) incorporates a manual disconnect clutch (refer to A, foldout 14). The disconnect clutch permits the front output drive to be disengaged, while maintaining continuous drive at the rear output. A one-piece shaft (foldout 1) is used when the disconnect feature is not required.

g. Oil Pump. A positive displacement, gear-type oil pump furnishes the oil flow and pressure necessary for hydraulic operation, lubrication and cooling of the transmission components. An SAE B or C accessory mounting pad is available on the pump (fig. 1-2).

#### h. Control Valve Body Assembly

(1) The control valve body assembly is mounted on the left side of the transmission housing (fig. 1-1). The control valve assembly is equipped with either a clutch cutoff feature or an inching control valve.

(2) The clutch cutoff valve may be either pneumatically or hydraulically actuated (depending on vehicle brakes). 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 PTO-driven equipment will have full engine power, without shifting the transmission to neutral. The inching control is manually operated and allows the drive clutch to slip while "inching" or maneuvering the vehicle in confined areas.

i. Parking Brake. An internal, expanding shoe-type parking brake is included on some assemblies. The brake is mechanical, and manually operated. A 10 x 1 1/2-inch (254 x 38.1 mm) brake is used on the -1 (long drop) model transmissions and a 13-3/8 x 2-inch (339.7 x 50.8 mm) brake on the -3 (short drop) model.

j. Power Takeoff Locations. The TRT 2001 series transmissions have two locations for accessory power takeoff (fig. 1-2). One location is at the transmission oil pump, which has an SAE C pad with a 4-bolt mounting flange. Optional 2-bolt mounting flanges are available with either an SAE B or C pad (refer to A, foldout 15). The drive ratio is 0.91 (optional 1.00) times engine speed. A second power takeoff pad, located to the right of the oil pump, provides an SAE A, 2-bolt pad (fig. 1-2). The drive ratio is the same at both power takeoff pads.

k. Oil Filter, Cooler. Although the oil cooler and transmission external oil filter are both customer-furnished, they are neces-

sary for proper transmission operation. Refer to figure 3-1 for the points at which these items are connected to the transmission.

## 1-6. OPERATING INSTRUCTIONS

### a. Range Selection

(1) Position the range selector control in neutral position when starting the engine or at any time the vehicle is unattended.

(2) The engine should be at idle speed when shifting from neutral to any driving range. Any shift to a higher speed ratio, in the same direction, can be made at full throttle, under load. Downshifts 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. Downshifting at excessive speeds will overspeed the drive train with possible damage to the components.

b. Changing Direction of Travel. Directional shifts can be made under full-power and/or full-speed conditions within the working ranges (F1 to R1 and R1 to F1). Directional shifts should not be made from the other operating ranges. Shifts of this nature will adversely affect clutch service life.

c. Clutch Cutoff Control. Transmissions equipped with the clutch cutoff control valve have the drive clutch completely released when 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 to neutral.

d. Inching Control. Transmissions that are equipped with inching control permit the vehicle to "creep" or "inch" into confined areas for better maneuverability. Full application will completely release the drive clutch. Lesser application will slip the clutch while it is driving. The inching control may be used in any range, except on the TRT 2221-3

mission should be shifted to neutral and the engine should be operated at approximately 1000 to 1500 rpm for several minutes until the normal temperature (180-220°F/82-104°C/) is restored. If the temperature reaches maximum during normal operation of the transmission, stop the engine and locate the trouble. Refer to the 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, use of the inching control, or use of the clutch cutoff control will cause fluctuation and variations in the pressure indicated. If abnormal pressures are evident, refer to the troubleshooting chart (para 3-11).

## 1-7. SPECIFICATIONS, DATA

The following specifications and data apply to all models, except as indicated for specific models.

<u>Item</u>	<u>Description</u>	
ion type . . . . .	Torque converter and planetary gear	
g (max):		
speed . . . . .	Up to 3000 rpm	
torque . . . . .	Up to 265 lb ft (359 Nm)	
up, net . . . . .	Up to 150 (111.9 kW)	
viewed from input end:		
	<u>-1</u>	<u>-3</u>
. . . . .	Clockwise	Clockwise
— (forward gears) . . . . .	Clockwise	Counterclockwise
(reverse gears) . . . . .	Counterclockwise	Clockwise
drive:		
. . . . .	Four 5/8-11 tapped holes in side pads, ea	
direct mounted . . . . .	SAE 3 flange on converter housing bolts to flywheel housing; flex plate drive from	
remote mounted . . . . .	Front unmounted; converter enclosed; inp for shaft and universal joint coupling	

# GENERAL INFORMATION

Para 1-7

## SPECIFICATIONS, DATA — Continued

<u>Item</u>	<u>Description</u>						
Gear ranges, selector positions:							
TRT 2221, 2421 . . . . .	Reverse 2, reverse 1, neutral, forward 1, forward 2						
TRT 2211, 2411 . . . . .	Reverse, neutral, forward						
Weight, dry (lb):	<u>Model</u>	<u>2221-1</u>	<u>2421-1</u>	<u>2211-3</u>	<u>2411-3</u>	<u>2221-3</u>	<u>2421-3</u>
Remote mount		950	965	700	715	795	810
Direct mount		910	925	660	675	755	770
Without brake (subtract)		20	20	35	35	35	35
*Torque converter:							
<u>Transmission models</u>		<u>2200</u>					<u>2400</u>
<u>Converter model</u>	<u>TT 220</u>	<u>TT 230</u>	<u>TT 240</u>	<u>TT 260</u>	<u>TT 270</u>	<u>TT 425</u>	<u>TT 445</u>
Stages	2	2	2	2	2	2	2
Elements	4	4	4	4	4	4	4
Torque multiplication ratio	5.1:1	7.1:1	5.1:1	4.8:1	6.6:1	5.1:1	4.6:1
Gearing . . . . . Constant mesh, straight spur, planetary type							
*Gear ratios:							
	<u>Model</u>	<u>Forward 1</u>	<u>Forward 2</u>	<u>Reverse 1</u>	<u>Reverse 2</u>		
TRT 2211-3, 2411-3		2.40:1		2.32:1			
TRT 2221-1, 2421-1		2.03:1	0.74:1	1.96:1	0.71:1		
TRT 2221-3, 2421-3 (underdrive)		6.61:1	2.40:1	6.40:1	2.32:1		
TRT 2221-3, 2421-3 (overdrive)		2.40:1	0.83:1	2.32:1	0.80:1		
Clutch data: Type . . . . . Multidisk, hydraulic-actuated, spring released, oil-cooled, automatic compensation for wear							
Material . . . . .	Reaction plates (polished steel)						
	Friction plates (sintered bronze or resin-graphite on steel)						
Parking brake:							
-1 models . . . . .	<u>Type</u>			<u>Rating</u>			
	Drum, 10 x 1 1/2 (254 x 38.1 mm)			30,000 lb in. (3389 Nm) at 1500 lb (6672 N) apply force			
-3 models . . . . .	Drum, 13 3/8 x 2 (339.7 x 50.8 mm)			45,000 lb in. (5084 Nm) at 2100 lb (9341 N) apply force			
Flanges:							
Input . . . . .	Mechanics 4C, 5C; Rockwell 5N; Torqmatic coupling						
Front, rear outputs . . . . .	Mechanics 4C, 5C, 6C, 7C; Rockwell 5N						

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



# TRT 2001 SERIES TRANSMISSION

## SPECIFICATIONS, DATA — Continued

<u>Item</u>	<u>Description</u>
Oil system:	
Oil pump . . . . .	Input driven, gear type, positive displacement
Sump . . . . .	Integral, single
Oil type: above 32°F (0°C) . . . . .	Hydraulic transmission fluid Type C2 Grade 10 or 30
32°F (0°C) to -10°F (23°C) . . . . .	Hydraulic transmission fluid Type C2 Grade 10
below -10°F (-23°C) . . . . .	Hydraulic transmission fluid Type C2 Grade 10. Auxiliary preheat is required to raise temperature in sump to above -10°F (-23°C).
Oil capacity: -1 model (less external circuits) . . . . .	8 1/2 US gal (32 litres) (initial fill)
-3 model (less external circuits) . . . . .	6 1/2 US gal (25 litres) (initial fill)
Oil filter . . . . .	Remote, furnished by customer
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) without thermostat; 65 psi (448 kPa) (max) with thermostat open
Control valve body . . . . .	
Clutch cutoff . . . . .	Hydraulic- or pneumatic-actuated
Inching control . . . . .	Manual-actuated
Accessory drives:	
Implement pump drive (pad at rear of input pump):	
Mounting flange . . . . .	Standard: SAE C, 4 bolt; Optional: SAE B or C, 2 bolt
Rating . . . . .	Intermittent: 110 hp (82 kW) at 2000 to 3000 rpm; Continuous: 90 hp (67.1 kW) at 2000 to 3000 rpm
Ratio . . . . .	Standard: 0.91 x engine speed; Optional: 1.00 x engine speed
Optional pump drive (located to right of input pump):	
Mounting flange . . . . .	SAE A, 2 bolt
Rating . . . . .	30 hp (22.5 kW) at 2000 to 3000 rpm
Ratio . . . . .	Standard: 0.91 x engine speed; Optional: 1.00 x engine speed

## Section 2. DESCRIPTION AND OPERATION

### 2-1. SCOPE OF SECTION 2

This section presents a general description of the TRT 2211, 2221, 2411 and 2421 model transmissions and a detailed description of their components and operation. The hydraulic system for each model is explained and illustrated. The torque paths through the transmission are explained and illustrated for the various models.

### 2-2. GENERAL COMPONENT DESCRIPTION

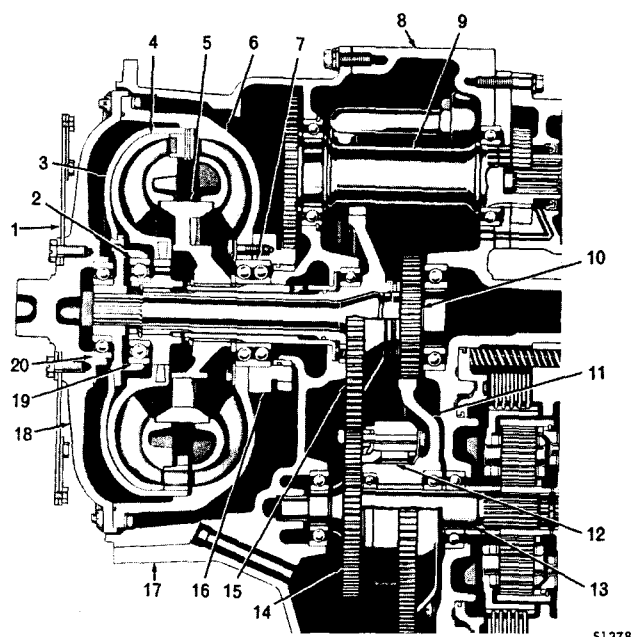
**a. Construction Features.** All the TRT 2211, 2221, 2411 and 2421 models are torque converter, planetary gear-type transmissions. The 2221 and 2421 transmissions provide two speeds forward and two speeds reverse, with either a -1, long drop output (19 inches below input centerline) or a -3, short drop output (7 inches below input centerline). The TRT 2211-3 and 2411-3 transmissions provide only a short drop output, with one speed forward and one speed reverse. The range clutches are multidisk, hydraulic-actuated type, which automatically compensate for wear.

**b. Unique Converter.** The twin turbine-type torque converter extends the torque multiplication of the converter, in each gear range, providing broad torque coverage equal to two normal planetary gear ratios. This extended coverage is accomplished automatically and efficiently.

### 2-3. TWO-TURBINE TORQUE CONVERTER (fig. 2-1)

**a. Converter Construction.** The torque converter consists of pump assembly 6, first-turbine assembly 3, second-turbine assembly 4 and stator 5. Pump assembly 6 is the driving member and is driven at engine speed. First-turbine assembly 3 and second-turbine assembly 4 are driven members, connected by transfer gears 10, 11, 14 and 15 to the transmission range gearing. Stator 5 is the reaction member.

**b. Converter Operation.** 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 10 and 11 (fig. 2-1). The second-turbine gear train



- 1 - Flex disk drive
- 2 - First-turbine support bearing
- 3 - First-turbine assembly
- 4 - Second-turbine assembly
- 5 - Stator
- 6 - Converter pump assembly
- 7 - Converter pump bearing
- 8 - Transmission housing
- 9 - Oil pump and PTO drive
- 10 - First-turbine drive gear
- 11 - First-turbine driven gear
- 12 - Over-running (freewheel) clutch
- 13 - Range gear input shaft
- 14 - Second-turbine driven gear
- 15 - Second-turbine drive gear
- 16 - Accessory drive gear
- 17 - Torque converter housing
- 18 - Converter drive cover
- 19 - Second-turbine support bearing
- 20 - Converter front support bearing

Fig. 2-1. Typical Powershift torque converter and converter gearing—cross-sectional view

## TRT 2001 SERIES TRANSMISSION

### Para 2-3/2-7

consists of gears 14 and 15. The turbines are able to function jointly or separately by means of a freewheel clutch 12. 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 vehicle speed increases and load demand decreases, the second-turbine speed exceeds the first-turbine speed and 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.

### 2-4. FORWARD, REVERSE GEARING AND CLUTCHES

a. TRT 2001 Characteristics. All TRT 2001 series transmissions include forward and reverse gearing and clutch configuration (items 15, 16, 18, 33, 35, 36, 38, 39, 40, 41 and 42, foldout 1). Gearing for forward and reverse consists of a 6- and a 4-pinion planetary gear set, respectively. The planetaries are interconnected and provide the speed and torque ratio for the forward or reverse drive of the vehicle. The multidisk clutches consist of resin-graphite or bronze-faced steel, internal-splined, and external-tanged plain steel clutch plates, alternately assembled. They are hydraulic-actuated and spring released.

b. Construction of TRT 2211 and 2411 Models. These models include only the forward and reverse gearing with clutches, since they have only one speed forward and one speed in reverse (23, 25 foldout 2).

### 2-5. HIGH- AND LOW-RANGE CLUTCHES, PLANETARY

a. Modifies Basic Ratios. The high- and low-range clutch, and a planetary gear set (foldouts 1 and 3) which may be either for high or low range, provide forward-2 and reverse-2 in overdrive models, or forward-1 and reverse-1 in underdrive models. These components, in TRT 2221-1 and 2421-1 models, work with either the forward or reverse planetary basic to all models.

b. Model Variations. In TRT 2221-1 or 2421-1 models, the planetary (28, foldout 1) is an overdrive arrangement and its clutch 23 is high range. In the 2221-3 or 2421-3 underdrive models, the planetary (26, foldout 3) is an underdrive arrangement and its clutch 20 is low range. In the TRT 2221-3 or 2421-3 overdrive models, the planetary (29, foldout 4) is an overdrive arrangement and its clutch 21 is high range.

c. Ratios Explained under Torque Paths. The terms overdrive and underdrive, and the methods by which the various range gear ratios are derived, are explained in paragraphs 21 through 25, below.

### 2-6. PARKING BRAKE

An internal, expanding shoe-type brake is available for mounting at the rear output of either the -1 or -3 model transmissions (fig. 1-2 and 1-4). The shoe assembly back plate is bolted to bosses at the rear of the transmission rear housing of the -3 models, or the transfer gear housing of the -1 models. The brake drum is bolted to the rear output flange. The brake is manually applied. The -1 model transmissions are equipped with a 10 x 1-1/2-inch (254 x 38.1 mm) brake. The -3 model transmissions are equipped with a 13-3/8 x 2-inch (339.7 x 50.8 mm) brake.

### 2-7. POWER TAKEOFF MOUNTINGS

a. Engine-driven Power Takeoff (standard). On the rear surface of the input driven oil pump assembly (fig. 1-2) is an implement pump mounting pad. There are three configurations of mounting pads — 4-bolt, SAE C; 2-bolt, SAE C; 2-bolt, SAE B. Some transmissions using the SAE B pad will have a drive coupling adapter (11, foldout 4) to match drive splines. The speed at the mounting pad is 0.91 times engine speed, or an optional ratio of 1:1 (engine speed).

b. Engine-driven Power Takeoff (optional). A 2-bolt SAE A mounting pad, located at the right rear of the transmission (fig. 1-2) is available for driving a steer pump or other small pump. The standard drive spline is SAE A; an SAE B is optional. The power takeoff rotates at 0.91 times engine speed.

An optional pump drive is available for a 1 to 1 ratio (engine speed). On transmissions which do not include a power takeoff, the drive components are omitted and this outlet is closed.

## 2-8. OIL PUMP

This is a positive displacement, spur gear-type oil pump. The pump is driven by the accessory driven gear and rotates anytime the engine is operating. Oil is provided by this pump for all functions of the transmission. It is located externally, at the top-rear of the transmission (fig. 1-2).

## 2-9. OIL STRAINER, OPTIONAL FILTER

The oil strainer is a wire mesh cylindrical assembly located in the sump of each transmission. It is connected to the oil pump suction tube. It is recommended that a full flow oil filter (customer furnished) be connected into the oil system. Two 1 1/16-12 tapped openings are provided to connect the filter lines, immediately above the control valve mounting pad on the left side of the transmission (fig. 3-1). An external circuit must be connected between these openings prior to operating the transmission.

## 2-10. VALVE BODY ASSEMBLIES

a. Three Types. There are three types of control valve body assemblies used on the TRT 2001 transmissions. They are similar in design. Some models are equipped with the hydraulic clutch cutoff valve feature, in which hydraulic pressure from the vehicle brake system releases the drive clutch. Other models use a variation of this type of control valve in which the clutch cutoff valve is operated by an air cylinder and push rod actuated by the air brake system. The third type of valve system is the inching control, in which a manually-operated valve permits slipping or full release of the drive clutch. Refer to c and d, below, for further information on these controls.

### b. Main-pressure Regulator, Selector Valves (B, foldout 15)

(1) Regardless of which control valve body assembly is used, the major functions —

those of main-pressure regulation, and range selection — are the same in all three valve body configurations. The control valve body of each type includes the main-pressure regulator valve components 8, 13 and 14 in the upper bore of the body; the optional valve in the middle bore; and the selector valve 27 in the lower bore.

(2) Main-pressure regulator valve 8 is spring-loaded and regulates the oil pressures for clutch application. A trimmer plug 16 is included in the main-pressure regulator valve bore to control the rate of clutch application. Selector valve 27 is a spool-type valve that moves lengthwise in its bore to the various range positions. The valve is manually operated, and two spring-loaded detent balls position the valve in each range.

### c. Clutch Cutoff Valve (B, foldout 15)

(1) Clutch cutoff valve 20 is a spool-type valve. It is actuated by spring pressure at one end and by the vehicle brake system pressure (hydraulic or air) at the opposite end. Valves which are actuated by air pressure have a miniature air cylinder (customer-supplied) mounted at the rear of the valve body.

(2) Spring 19 pressure on the valve positions the valve rearward in its bore, allowing main oil pressure to be directed to selector valve 27. When the vehicle brake is applied, hydraulic pressure at the end of plug 21, or the stem of an air actuator against plug 45 moves the valve. The flow of oil to the selector valve is interrupted, and at the same time an exhaust port is opened, exhausting the clutch apply line, releasing whatever drive clutch or clutches are applied.

### d. Inching Control Valve (B, foldout 15)

(1) Inching control valve 40 replaces the clutch cutoff valve in the valve body when this feature is desired. It is a spool-type valve that is manually controlled by the vehicle operator through mechanical linkage attached to one end of the valve. Spring pressure from spring 41 and main oil pressure hold the valve in the "clutch-on" (non-inching)

## TRT 2001 SERIES TRANSMISSION

### Para 2-10/2-13

position. In the "clutch-on" position, full main oil pressure is directed to the range selector valve.

(2) When the inching control is moved (manually), 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. An inching regulator valve 37 and spring 39 maintain a uniform clutch apply pressure at any given position of the inching valve.

(3) On the TRT 2221-1 and 2421-1 model transmissions, the forward and reverse clutches provide inching. On the TRT 2221-3 and 2421-3 underdrive models, the low-range clutch is the one that "slips" to provide inching. These transmissions should not be "inched" in high range. TRT 2221-3 and 2421-3 overdrive model transmissions can be "inched" in forward or reverse, high and low ranges. The TRT 2211-3 and 2411-3 can be inched in forward or reverse range.

### 2-11. LUBRICATION, CONVERTER REGULATOR VALVES

These valves are spring-loaded, disk-type valves located inside the transmission at the rear of torque converter housing 38 (B, foldout 6). Lubrication pressure regulator valve 23 is in the oil cooler return circuit. Its spring 22 will hold the valve closed until lubrication pressure reaches 20 psi (138 kPa). All oil in excess of that required for lubrication returns to sump. Converter pressure regulator valve 20 is in the circuit which carries oil from the main-pressure regulator valve to the torque converter. Its spring 19 will permit a maximum of 80 psi (552 kPa) in the converter-in line. All excess oil returns to sump.

### 2-12. HYDRAULIC SYSTEMS

The hydraulic systems for the TRT 2211, 2221, 2411 and 2421 model transmissions are

similar in design. Basically, the clutch cut-off feature or the inching control feature will determine the differences in the hydraulic system. The number of drive ranges obtained hydraulically is controlled by the pre-determined movement of the selector valve. The various hydraulic systems are described below.

### 2-13. TRT 2221-1, 2421-1 HYDRAULIC SYSTEM (with inching control) (fig. 2-2)

a. Oil Pump and Filter Circuit. Oil is drawn from the transmission sump through a wire-mesh strainer. 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 directed to the control valve assembly.

#### b. Main-pressure Regulator Valve and Converter-in Circuit

(1) At the control valve assembly, oil flows around the main-pressure regulator valve and to the selector valve bore. At the regulator valve, oil flows through a diagonal passage (orifice A), to the left end of the valve. The oil pressure pushes the valve rightward against its spring. This uncovers the port which directs oil to the torque converter. When sufficient oil flow to the converter occurs, main-pressure (red) will establish a balance against the force of the main-pressure regulator valve spring.

(2) Under certain conditions, more oil than the converter-in line can handle must be exhausted to prevent excessive pressure in the system. When this occurs, the main-pressure regulator valve moves farther rightward, to allow oil to flow into the exhaust port (at the left end of the valve), between the two short lands on the valve.

(3) Oil flowing into the converter-in (yellow) line is directed to the torque converter. A pressure regulator valve in the converter-in circuit limits the converter-in pressure to 80 psi (552 kPa).

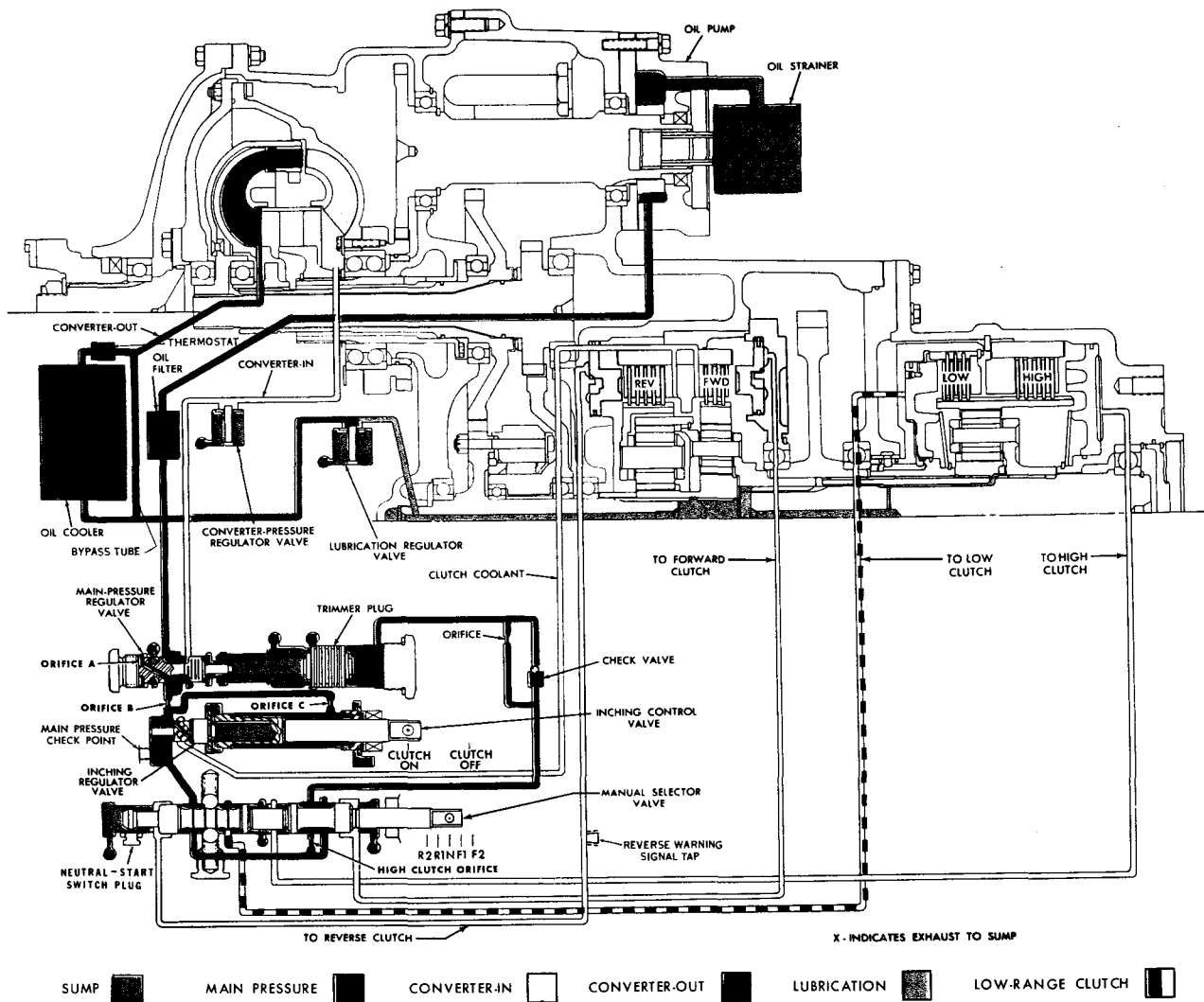


Fig. 2-2. TRT 2221-1 hydraulic system with inching control—schematic view

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### c. Converter-out, Cooler, Lubrication Circuit

(1) Oil flowing out of the torque converter (orange) is directed into the oil cooler. The oil cooler, like the oil filter, is customer furnished and external of the transmission. It is a heat exchanger in which the transmission oil flows through air- or water-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 transmission lubrication circuit (green). All oil in excess of that required to maintain lubrication pressure (20 psi/138 kPa/) is exhausted to sump through the lubrication regulator valve.

### d. Inching Control Valve Circuit

(1) Main pressure (red) from the main-pressure regulator valve connects to the inching control valve at two points. One

## Para 2-13

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 at orifice C. Pressure at the left passes on to 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 prevent 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 oil flow, causing a lower pressure downstream from the orifice.

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

### e. Manual Selector Valve Circuit (fig. 2-2)

(1) Main-pressure oil from orifice B flows into the manual selector valve bore and surrounds the valve in the area of the detent notches. From this area, main oil flows, regardless of valve position, to another area at the right surrounding the valve. Here it is

available for high range and forward clutches and for operation of the trimmer.

(2) Four clutch apply lines leave the bottom of the selector valve bore. From left to right these are reverse, low range, high range, and forward. In neutral, the low range clutch is applied, and the remaining three are exhausted. Moving the selector valve one notch rightward will leave the low-range clutch applied and will charge the forward clutch. This is forward 1.

(3) Moving the selector valve a second notch rightward will close off oil to the low-range clutch and allow it to exhaust. The forward clutch will remain applied and the high-range clutch will be charged. This is forward 2.

(4) Moving the selector valve one notch leftward of neutral will charge the reverse clutch while allowing the low-range clutch to remain charged. This is reverse 1. If the vehicle is equipped with a reverse warning signal, clutch apply pressure in the reverse circuit actuates the warning device.

(5) Moving the valve a second notch leftward will close off oil to the low-range clutch and allow it to exhaust. The reverse clutch will remain applied and the high-range clutch will be charged. This is reverse 2.

(6) When the selector valve is moved to the high-range position (either F2 or R2), oil to fill the high-range clutch must pass through both orifice B and the high-range clutch orifice. This is due to the oil passage immediately to the right of the high-range clutch orifice being blocked by the manual selector valve. The high-range clutch orifice is smaller than orifice B and restricts the flow of oil to the high range clutch. As a result, the high-range clutch fills at a slower rate than other clutches and thus provides smoother engagement.

### f. Trimmer Circuit

(1) The trimmer regulates clutch apply pressure during initial stages of clutch engagement, to obtain smooth operation. Normally, full-main pressure holds the trimmer plug leftward against its spring and a shoulder

in the plug bore. This compresses the main-pressure regulator valve spring and gives maximum main pressure.

(2) When any shift is made (or when any clutch is recharged after inching operation), oil is required to charge the oncoming clutch. This oil must flow through orifice B, located 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.

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

(4) 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.

2-14. TRT 2221-1, 2421-1 HYDRAULIC SYSTEM (with clutch cutoff control) (fig. 2-3)

a. Oil Pump and Filter Circuit. Refer to paragraph 2-13a, above.

b. Main-pressure Regulator Valve and Converter-in Circuit. Refer to paragraph 2-13b, above.

c. Converter-out, Cooler, Lubrication Circuit. Refer to paragraph 2-13c, above.

d. Clutch Cutoff Valve Circuit

(1) Main pressure oil (red), supplied from the left end of the main-pressure regu-

lator valve, flows through orifice B to the clutch cutoff valve bore and then to the manual selector valve. The orifice functions in connection with trimmer action as explained in paragraph 2-13f, above.

(2) The clutch cutoff valve is normally in the position shown, and functions only when the vehicle's brakes are applied. A spring holds the valve rightward, allowing main oil pressure to flow through the valve bore and to the manual selector valve.

(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, clutch apply pressure exhausts to the sump through a port shown at the top center of the valve bore. Thus, when the vehicle brakes are applied, the driving clutch (or clutches) in the transmission is completely 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.

e. Manual Selector Valve Circuit. Refer to paragraph 2-13e, above.

f. Trimmer Circuit. Refer to paragraph 2-13f, above.

2-15. TRT 2211-3, 2411-3 HYDRAULIC SYSTEM (with inching control) (fig. 2-4)

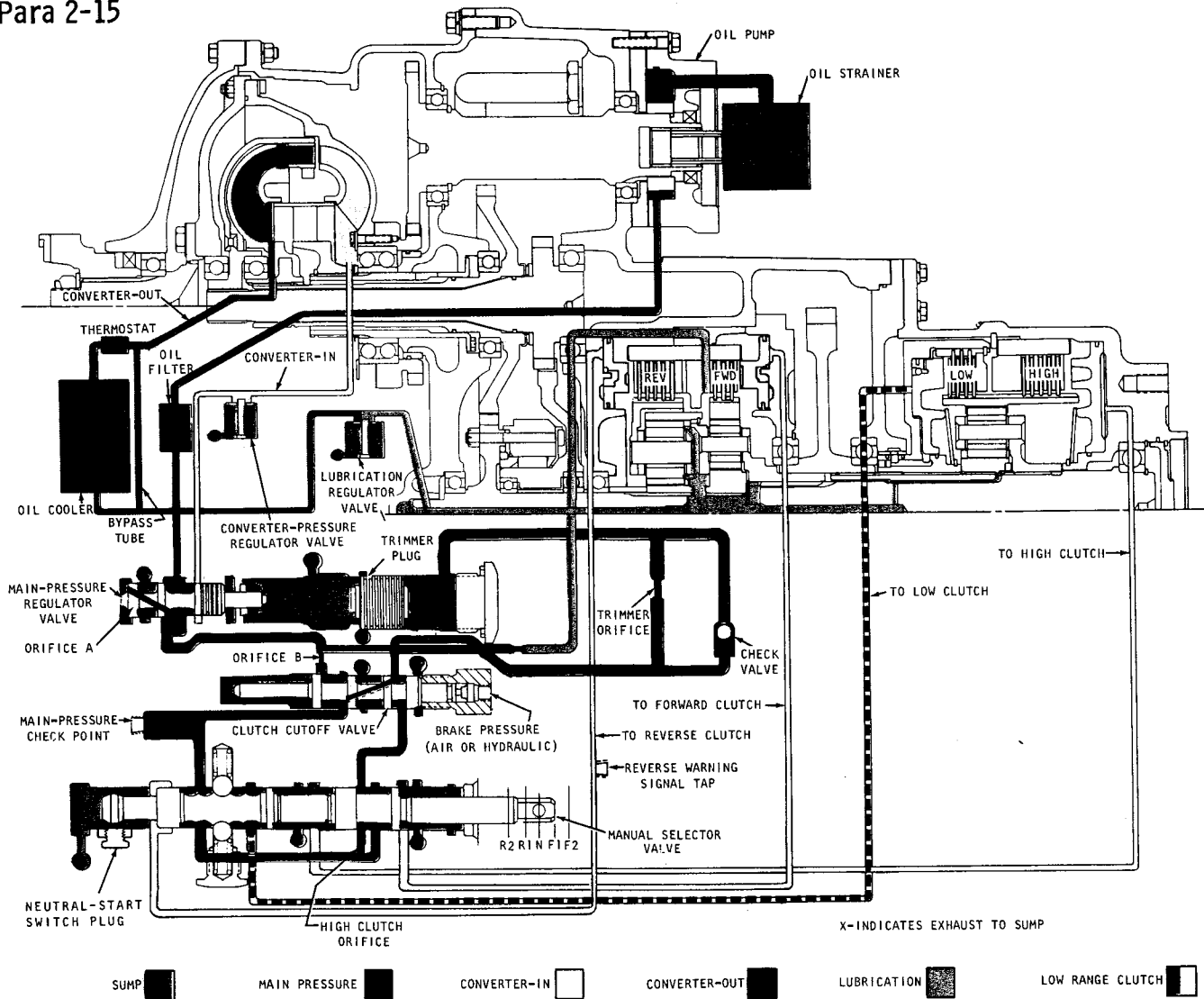
a. Oil Pump and Filter Circuit. Refer to paragraph 2-13a, above.

b. Main-pressure Regulator Valve and Converter-in Circuit. Refer to paragraph 2-13b, above.

c. Converter-out, Cooler, Lubrication Circuit. Refer to paragraph 2-13c, above.



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

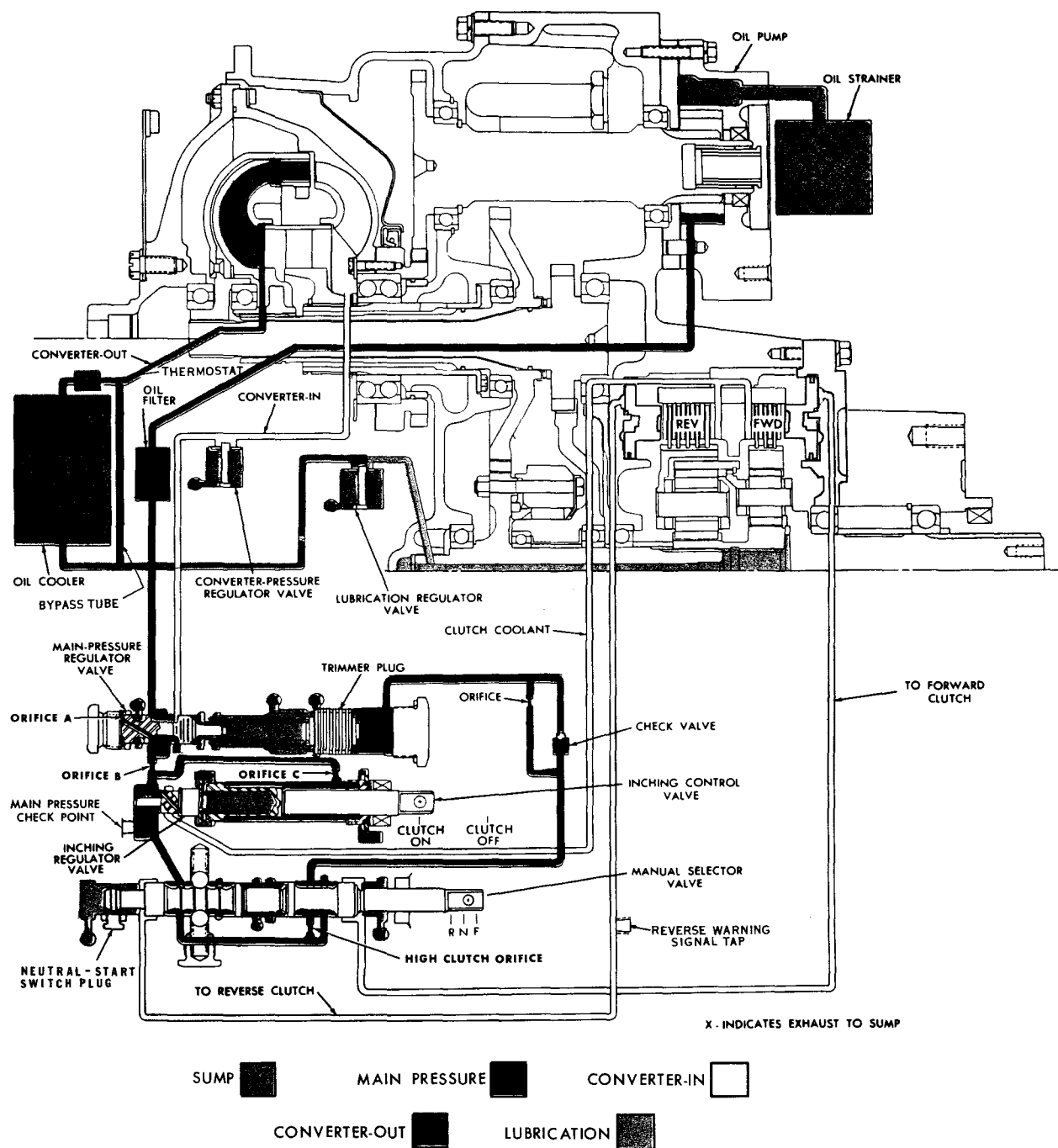
d. Inching Control Valve Circuit. Refer to paragraph 2-13d, above.

e. Manual Selector Valve Circuit. Refer to paragraph 2-13e, above for explanation of the manual selector valve circuit, but disregarding those explanations on the F2 or R2 driving mode. The TRT-2211-3 and 2411-3 manual selector valve is restricted to three

positions. These are neutral, forward, and reverse. Accordingly, only two clutch apply lines lead from the bottom of the selector valve bore. The left-side line goes to the reverse clutch. The right-side line goes to the forward clutch. Movement of the selector valve one notch leftward charges the reverse clutch. In neutral, both clutches are exhausted. Movement one notch to the right charges the forward clutch and exhausts re-

verse. Two valve stops limit the travel of the manual selector valve to these three positions.

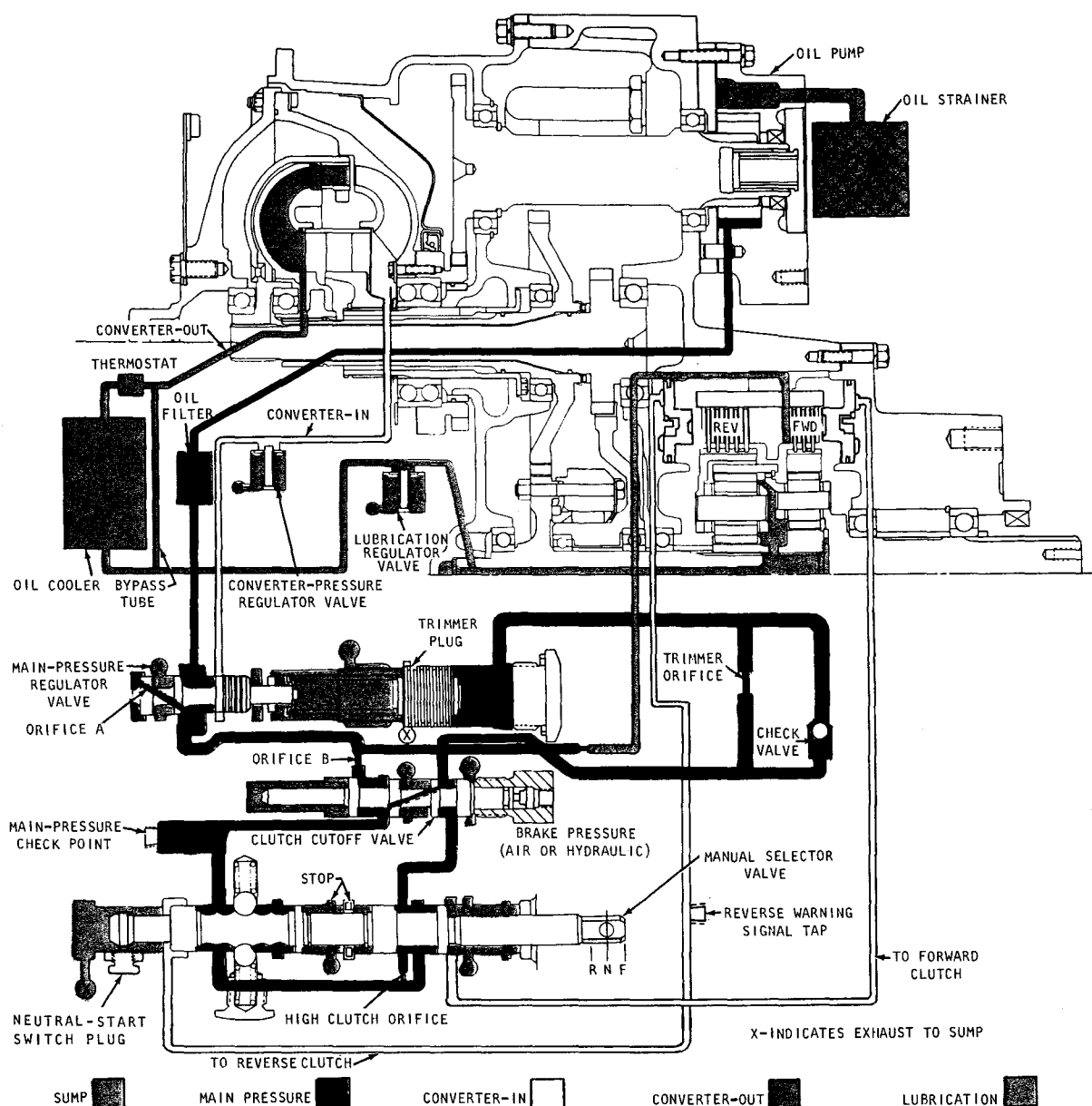
f. Trimmer Circuit. Refer to paragraph 2-13f, above.



*Fig. 2-4. TRT 2211-3 hydraulic system with inching control—schematic view*

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Fig. 2-5. TRT 2211-3 hydraulic system with clutch cutoff control —schematic view

## 2-16. TRT 2211-3, 2411-3 HYDRAULIC SYSTEM (with clutch cutoff control) (fig. 2-5)

a. Oil Pump and Filter Circuit. Refer to paragraph 2-13a, above.

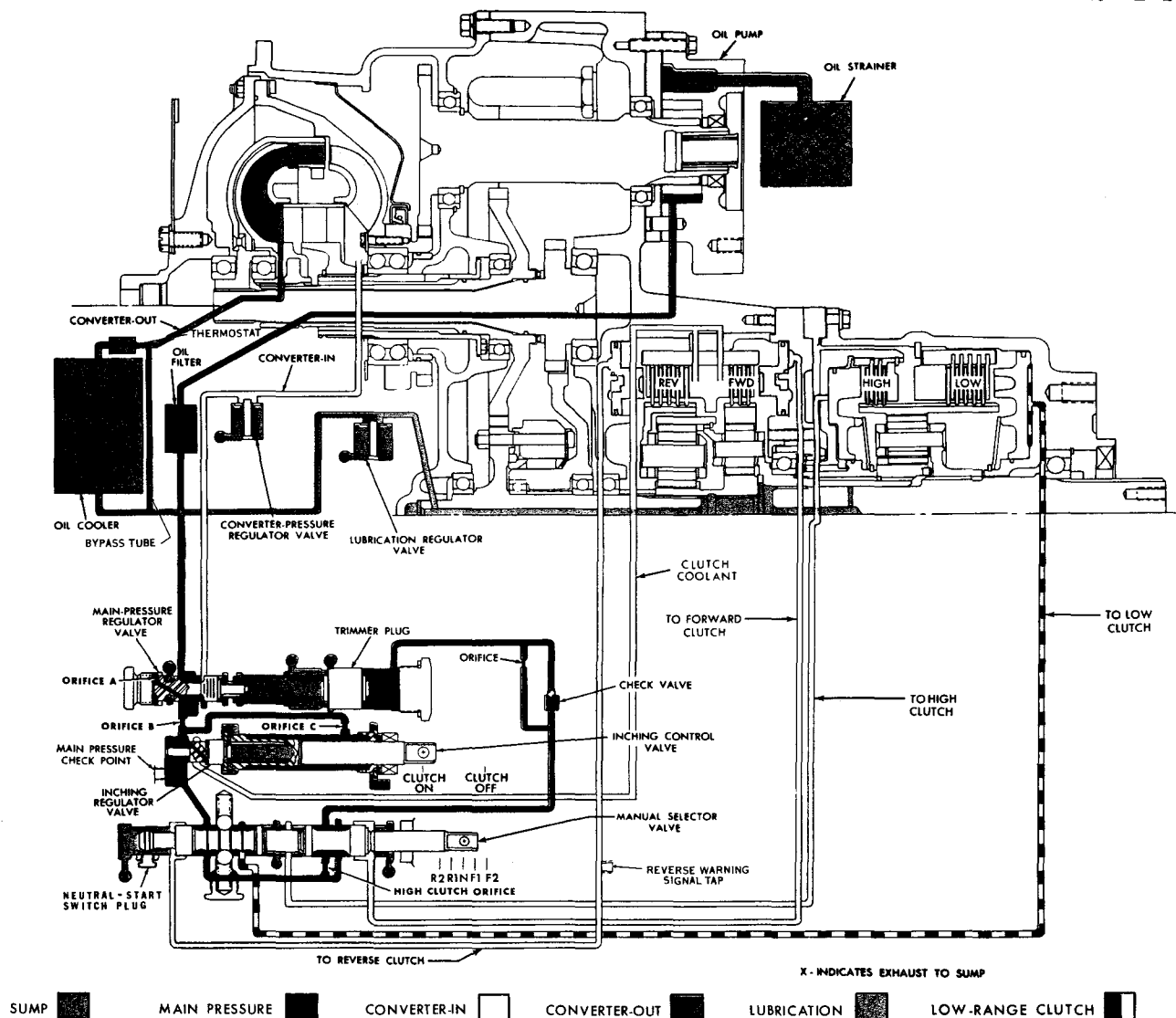
b. Main-pressure Regulator Valve and Converter-in Circuit. Refer to paragraph 2-13b, above.

c. Converter-out, Cooler, Lubrication Circuit. Refer to paragraph 2-13c, above.

d. Clutch Cutoff Control Valve Circuit. Refer to paragraph 2-14d, above.

e. Manual Selector Valve Circuit. Refer to paragraph 2-15e, above.

f. Trimmer Circuit. Refer to paragraph 2-13f, above.



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Fig. 2-6. TRT 2221-3 hydraulic system for underdrive model with inching control—schematic view

2-17. TRT 2221-3, 2421-3 HYDRAULIC SYSTEM (underdrive model with inching control) (fig. 2-6)

a. Oil Pump and Filter Circuit. Refer to paragraph 2-13a, above.

b. Main-pressure Regulator Valve and Converter-in Circuit. Refer to paragraph 2-13b, above.

c. Converter-out, Cooler, Lubrication Circuit. Refer to paragraph 2-13c, above.

d. Inching Control Valve Circuit. Refer to paragraph 2-13d, above. Not all -3 underdrive models use the low-range clutch for inching. Some use the forward and reverse clutches as the slipping clutch. When these clutches are used, the clutch coolant circuit directs the coolant to the slipping clutch.

e. Manual Selector Valve Circuit. Refer to paragraph 2-13e, above.

f. Trimmer Circuit. Refer to paragraph 2-13f, above.

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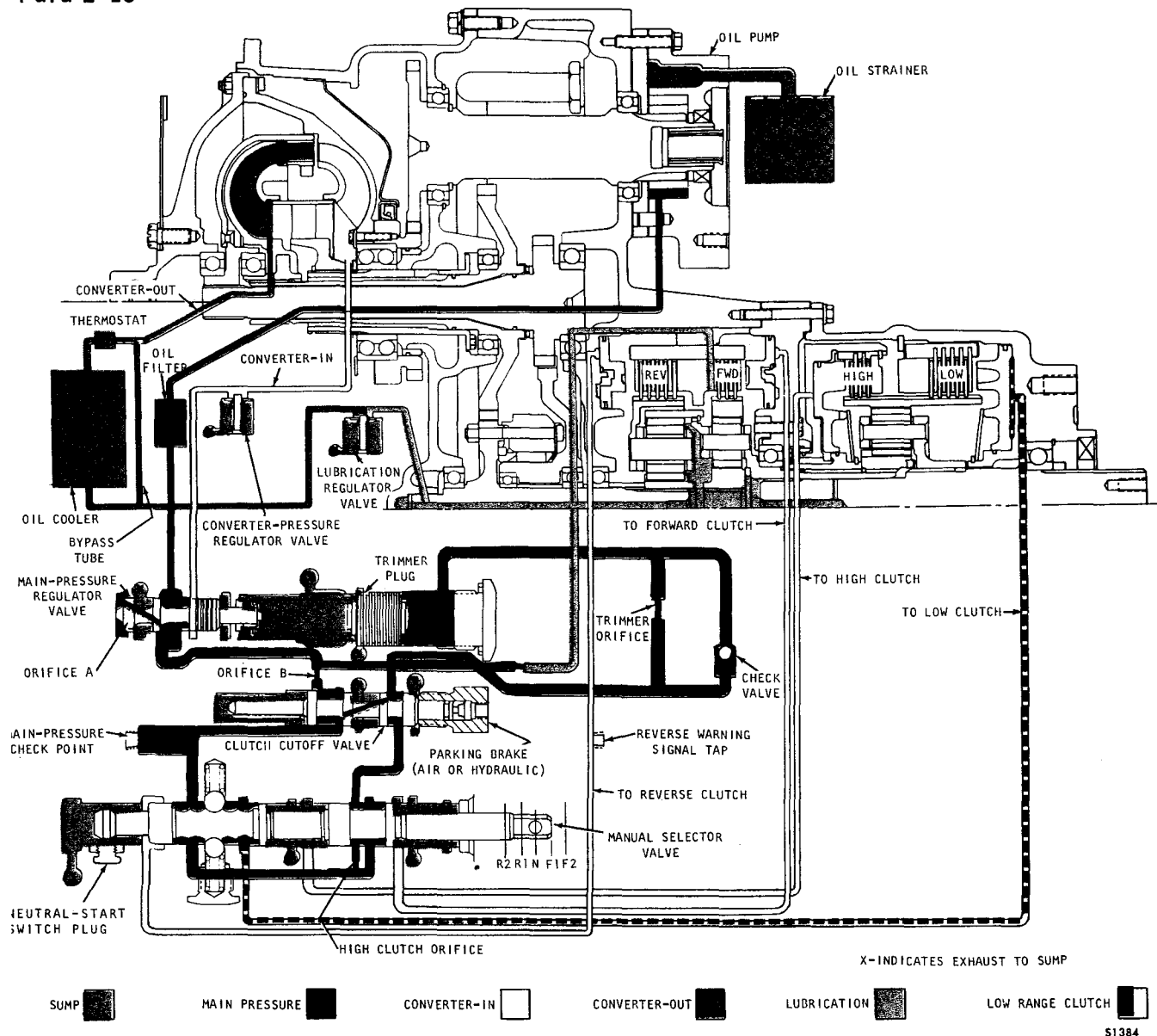


Fig. 2-7. TRT 2221-3 hydraulic system for underdrive model with clutch cutoff—schematic view

## 2-18. TRT 2221-3, 2421-3 HYDRAULIC SYSTEM (underdrive model with clutch cutoff control) (fig. 2-7)

a. Oil Pump and Filter Circuit. Refer to paragraph 2-13a, above.

b. Main-pressure Regulator Valve and Converter-in Circuit. Refer to paragraph 2-13b, above.

c. Converter-out, Cooler, Lubrication Circuit. Refer to paragraph 2-13c, above.

d. Clutch Cutoff Control Valve Circuit. Refer to paragraph 2-14d, above.

e. Manual Selector Valve Circuit. Refer to paragraph 2-13e, above.

f. Trimmer Circuit. Refer to paragraph 2-13f, above.

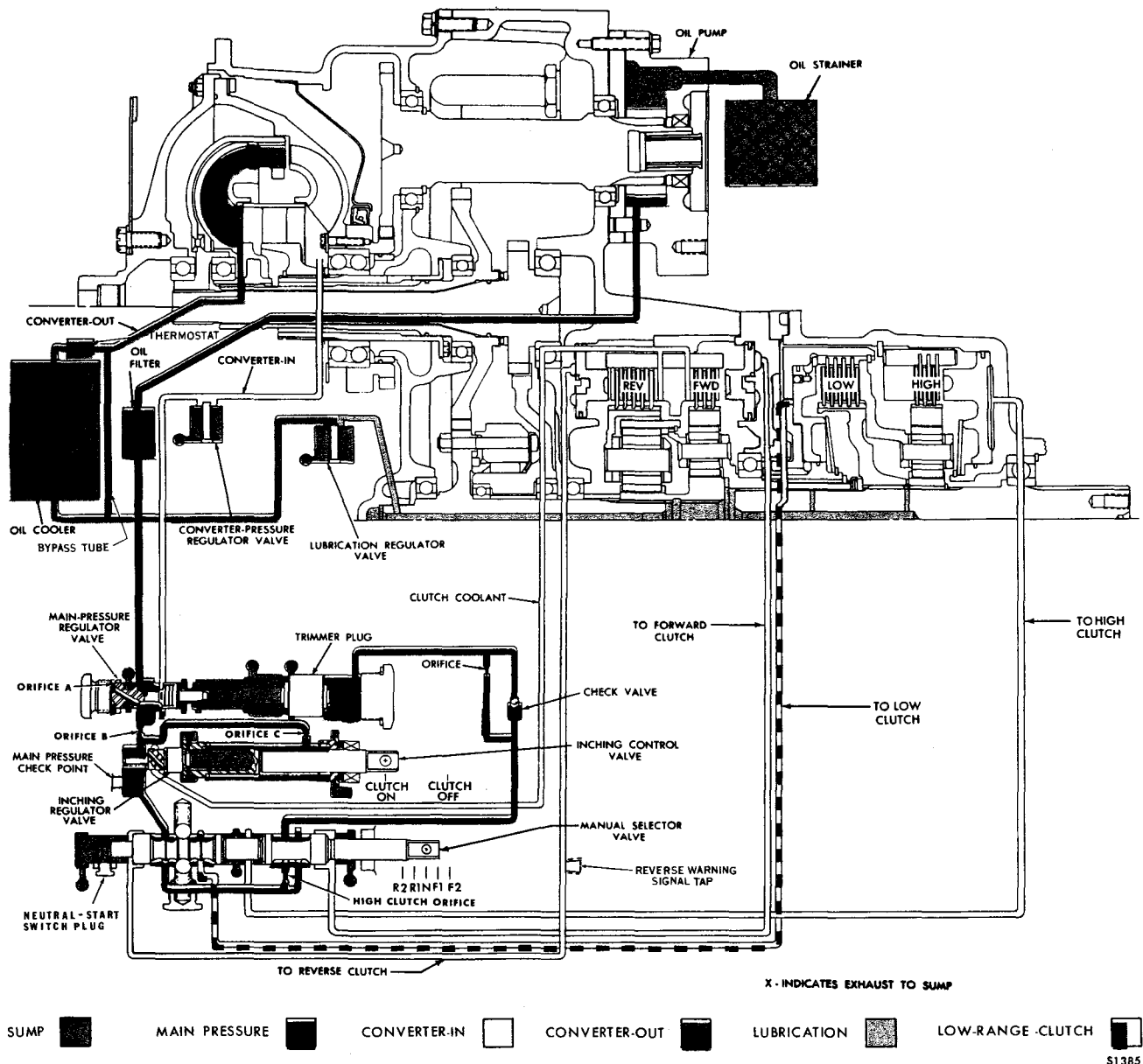


Fig. 2-8. TRT 2221-3 hydraulic system for overdrive model with inching control—schematic view

2-19. TRT 2221-3, 2421-3 HYDRAULIC SYSTEM (overdrive model with inching control) (fig. 2-8)

a. Oil Pump and Filter Circuit. Refer to paragraph 2-13a, above.

b. Main-pressure Regulator Valve and Converter-in Circuit. Refer to paragraph 2-13b, above.

c. Converter-out, Cooler, Lubrication Circuit. Refer to paragraph 2-13c, above.

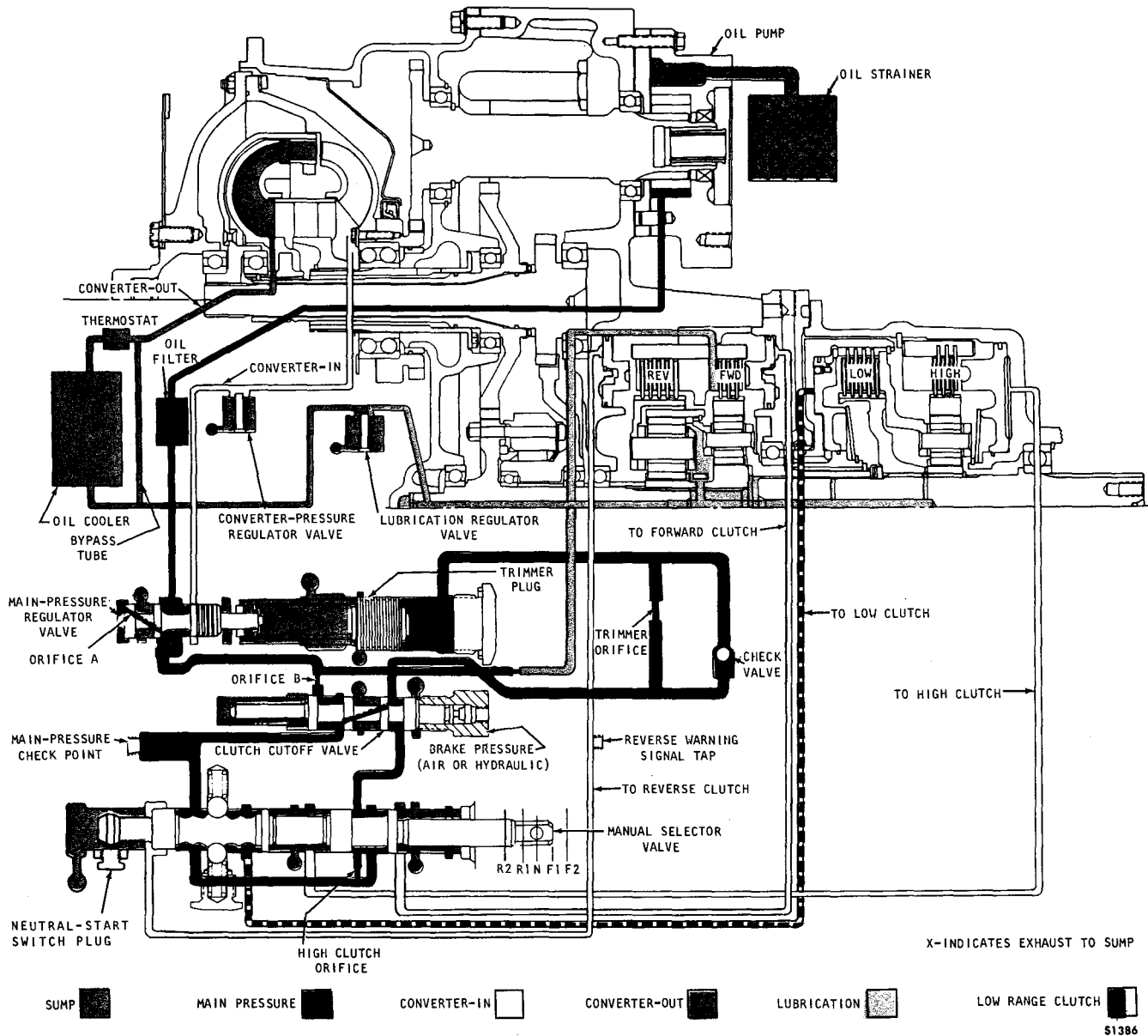
d. Inching Control Valve Circuit. Refer to paragraph 2-13d, above.

e. Manual Selector Valve Circuit. Refer to paragraph 2-13e, above.

f. Trimmer Circuit. Refer to paragraph 2-13f, above.

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## 2-20. TRT 2221-3, 2421-3 HYDRAULIC SYSTEM (overdrive model with clutch cutoff control) (fig. 2-9)

a. Oil Pump and Filter Circuit. Refer to paragraph 2-13a, above.

b. Main-pressure Regulator Valve and Converter-in Circuit. Refer to paragraph 2-13b, above.

c. Converter-out, Cooler, Lubrication Circuit. Refer to paragraph 2-13c, above.

d. Clutch Cutoff Control Valve Circuit. Refer to paragraph 2-14d, above.

e. Manual Selector Valve Circuit. Refer to paragraph 2-13e, above.

f. Trimmer Circuit. Refer to paragraph 2-13f, above.

## 2-21. TORQUE PATHS THROUGH TRANSMISSION

a. How Power Flows, Input to Output. Knowledge of how engine power flows through the transmission under all operating conditions and in all gears is necessary for diagnosis of transmission troubles. The unique torque converter and its gearing, forward and reverse gearing, range gearing, output transfer gearing, and direction and range clutches are all involved in the transmission of power through the transmission to the vehicle driveline. A study also of the accessory gearing is helpful when the vehicle includes equipment driven by the transmission power takeoff components.

b. Schematics and Explanations. Torque paths through the various models of transmissions are covered in paragraphs 2-22 through 2-25, below. All individual conditions for all transmissions are not illustrated by schematics. However, the colored torque path schematics (fig. 2-10 through 2-18) and explanations for specific models can be applied to other models. This will be done by referring, in some instances, to text and illustrations for one model when explaining another model.

### c. Features Common to all Models

(1) Any model transmission may be coupled to the engine with either the remote-type input components (A, foldout 5) or the flex disk arrangement (B, foldout 5).

(2) The function and arrangement of the torque converter elements (A, foldout 6) and converter gearing (B, foldout 6 and A, foldout 7) are the same for all transmission models. Sizes, ratios and converter models are different among various transmission models but do not affect explanation of working principles and torque paths.

(3) The reverse planetary gearing and clutches are identical for all models.

(4) Thus, when studying the power flow through various models, the study of the power path from transmission input to the reverse gearing input need not be repeated.

Accordingly, the explanation of this part of the power flow is made applicable to any transmission model and to any of the torque path schematic diagrams (fig. 2-10 through 2-18).

### d. Power Flow From Engine to Transmission Gearing (fig. 2-1)

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

(2) When first starting the load and bringing it up to a moderate speed, both turbines function. Converter pump 6, rotated by the engine, throws oil outward from its center and directs it forward into the first turbine 3 vanes. The impact of the oil on the first turbine vanes tends to rotate the first turbine. Oil passes between the first turbine vanes and strikes second turbine 4 vanes, tending to rotate the second turbine also. This condition exists until the second turbine reaches a speed which disengages over-running (freewheel) clutch 12 between turbine driven gears 11 and 14 (refer to (5), below).

(3) Oil leaves second turbine 4 near its center and passes between the vanes of stator 5. The stator vanes redirect the oil to enter the pump vanes on a course which will assist pump rotation. This is the key to the ability of the torque converter to multiply torque.

(4) Although both turbines work together at certain speeds, explanation is simplified if the first turbine is considered as the output member of the converter during start and low transmission output speed, and the second turbine is considered as working at higher transmission output speed. Accordingly, when starting, first turbine 3 is the primary torque converter output member. It is splined to the shaft of first-turbine drive gear 10 which meshes with first-turbine driven gear 11.



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(5) First-turbine driven gear 11 is connected by a freewheel clutch 12 to the second-turbine driven gear 14, which is integral with the range gear input shaft 13. Thus, the rotation of the first turbine will rotate the range gear input shaft at a reduction in speed. At the same time, the second turbine will rotate, but at a speed lower than that of the first turbine.

(6) When output speed of the converter increases, the load is assumed by the second turbine, and when it attains sufficient speed the freewheel clutch will disengage. This leaves first turbine 3 rotating freely but contributing no drive. Second turbine 4 is splined to the hollow shaft of the second-turbine drive gear 15 which meshes with the second-turbine driven gear 14.

(7) First-turbine gear set 10 and 11 gives a reduction in speed from the converter to the transmission gearing. Second-turbine gear set 14 and 15 gives an increase in speed. Thus, first-turbine operation may be related to higher power; and second-turbine operation to higher speed. The transition from the power phase to the speed phase is entirely automatic, depending upon only the load and speed demands of the transmission output.

(8) The power flow in specific transmission models, from the direction and/or range gearing input to the transmission output, is explained in paragraphs 2-22 through 2-25, below.

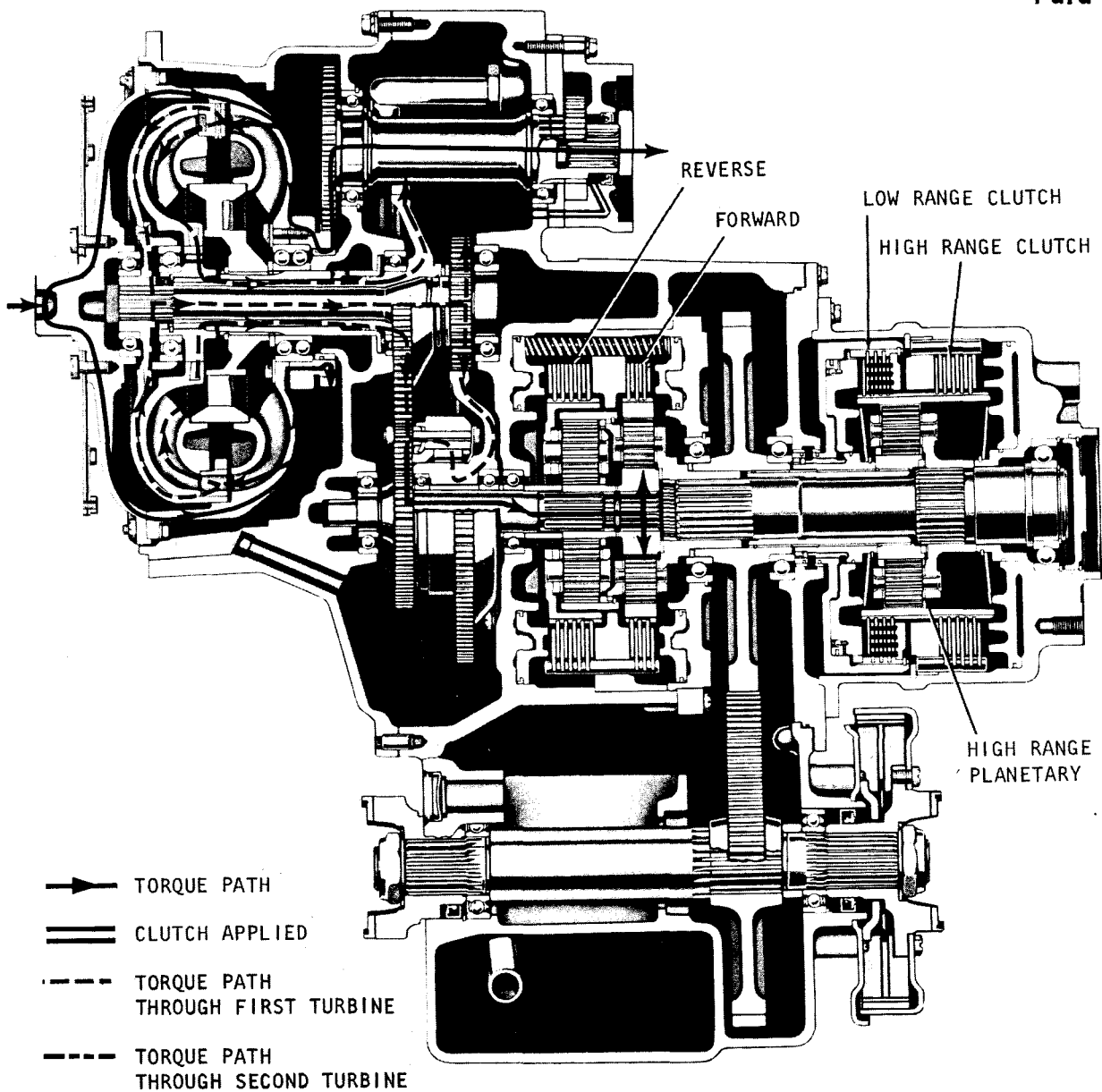


Fig. 2-10. TRT 2421-1 neutral and PTO torque paths

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## 2-22. TRT 2221-1, 2421-1 — TORQUE PATHS

### a. Neutral (fig. 2-10)

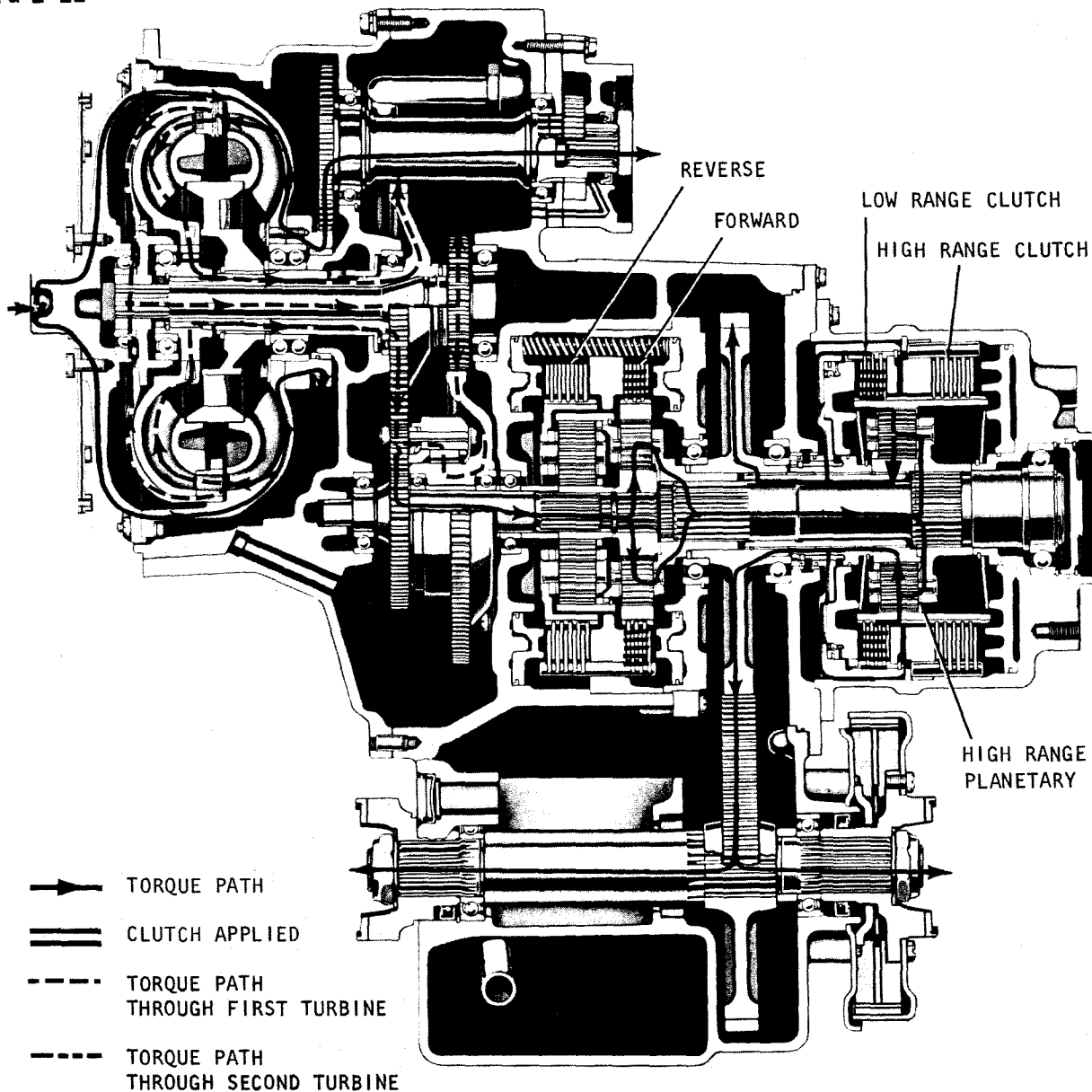
(1) In neutral, power is transmitted only to the combined reverse and forward planetary sun gears (refer to para 2-21d, above). The low-range clutch is engaged but no torque is transmitted because neither the forward nor reverse clutch is engaged. The

reverse carrier and forward ring gear rotate freely.

(2) The power takeoff drive torque path is illustrated in figure 2-10 and is identical in all TRT transmissions. The rotation of either power takeoff spline (refer to fig. 1-2) is opposite engine rotation (or clockwise — viewed from rear). Both power takeoff splines rotate at either 0.91 or 1.00 times engine speed, depending upon the drive gear option.

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Fig. 2-11. TRT 2421-1 forward 1 torque path

## b. Forward 1 (fig. 2-11)

(1) Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector valve was at neutral, the low-range clutch was engaged. In forward 1, it remains engaged while the forward clutch also engages. The forward clutch, engaged, holds the forward planetary ring gear stationary.

(3) The forward planetary sun gear rotates the forward planetary pinions within the stationary ring gear. This causes the forward carrier to rotate in the same direction as the sun gear, but at a reduction in speed. The carrier drives a shaft, the rear end of which is splined to the high-range planetary carrier.

(4) The high-range planetary sun gear is splined to a sleeve, which is splined to both the low-range clutch drum and to the

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transfer drive gear. The high-range ring gear is splined to the low-range clutch internal-splined plates. The low-range clutch external-splined plates engage internal splines in the low-range clutch drum.

(5) Thus, when the forward planetary carrier rotates, the high-range planetary carrier rotates. This causes both the high-range planetary sun gear and ring gear to rotate in the same direction and speed because the low-range clutch is engaged. There is no relative movement of the sun and ring gears.

(6) The low-range clutch drum drives the splined sleeve which, in turn, drives the transfer drive gear. The rotation of the transfer drive gear is opposite that of the converter turbine, and at a reduced speed. This results from the combination of the converter transfer gearing (which may be underdrive or overdrive), and the reduction ratio of the forward planetary.

(7) The transfer drive gear rotates the driven gear and output shaft, and rotation is converted to that of the engine. The output shaft rotates at a speed greater than that of the transfer drive gear. Figure 2-11 illustrates the one-piece output shaft, but some models include a manually operated front output disconnect which interrupts drive to the front output flange.

### c. Forward 2

(1) Refer to foldout 1 while studying the explanation of forward 2 operation. Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted from forward 1 to forward 2, the low-range clutch releases and the high-range clutch engages. The forward clutch remains engaged, holding the forward planetary ring gear stationary.

(3) The forward planetary sun gear rotates the forward planetary pinions, and drive is transmitted to the high-range planetary carrier, as described in b(3), above.

(4) The engaged high-range clutch holds the high-range planetary ring gear stationary. The rotation of the high-range carrier pinions within the stationary ring gear overdrives the high-range sun gear. The sun gear, splined to a sleeve which is splined also to the transfer drive gear, rotates the transfer drive gear.

(5) Refer to b(7), above, for explanation of the remainder of the torque path.

### d. Reverse 1

(1) Refer to foldout 1 while studying the explanation of reverse 1 operation. Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector is shifted from neutral to reverse 1, the low-range clutch remains engaged while the reverse clutch also engages. The reverse clutch, engaged, holds the reverse planetary carrier stationary.

(3) The reverse planetary sun gear rotates the carrier pinions which, in turn, rotate the reverse ring gear in a direction opposite that of the sun gear. The ring gear, being connected by splines to the forward carrier, rotates the forward carrier. The forward carrier drives a shaft, the rear end of which is splined to the high-range planetary carrier.

(4) From this point, to the transmission output flanges, the flow of power is the same as described in b(4) through (7), above, except that all rotations are reversed.

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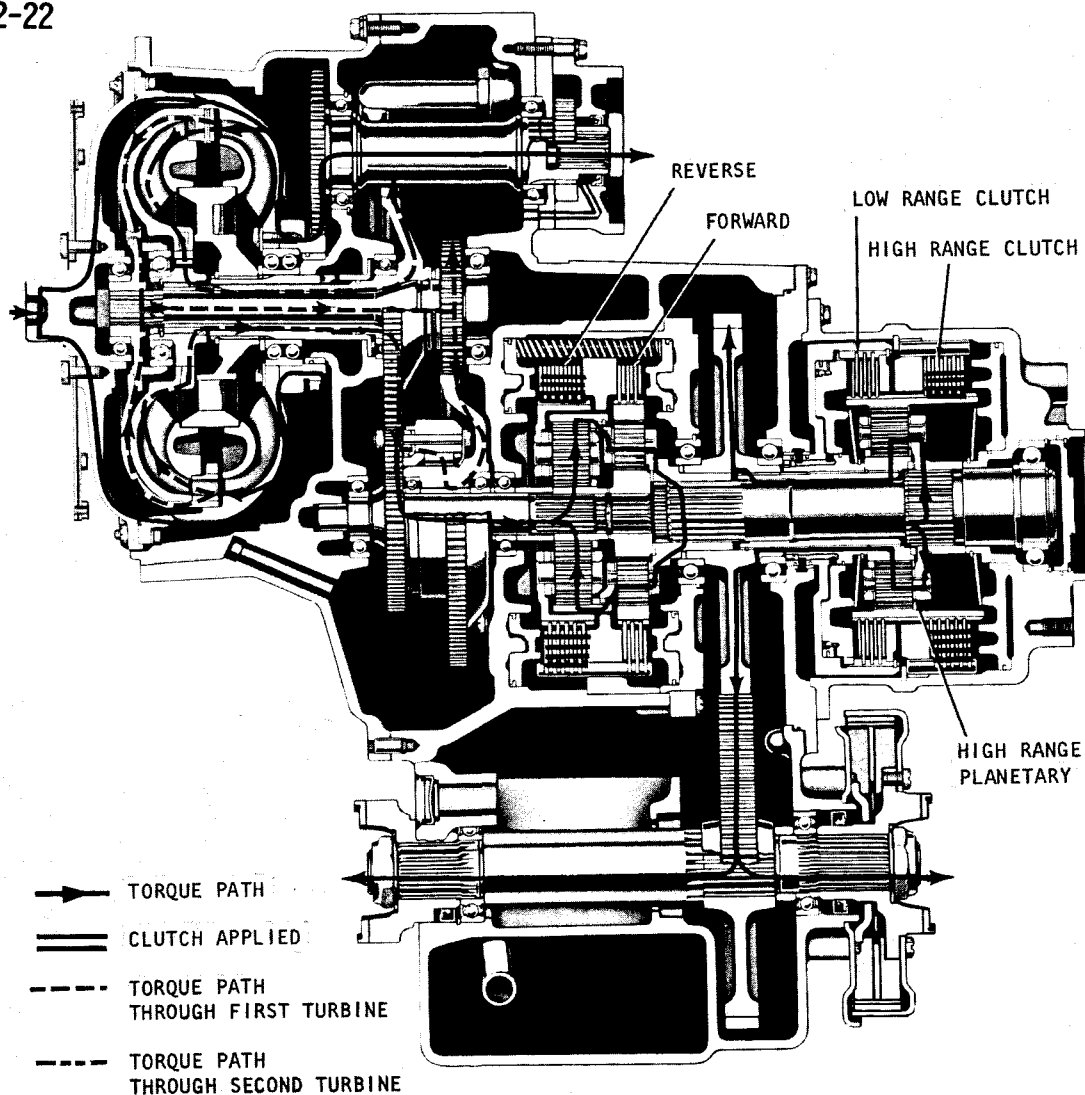


Fig. 2-12. TRT 2421-1 reverse 2 torque path

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## e. Reverse 2 (fig. 2-12)

(1) Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted from reverse 1 to reverse 2, the low-range clutch releases, the high-range clutch engages, and the reverse clutch remains engaged. The high-range clutch, engaged, holds the high-range planetary ring gear stationary.

(3) The reverse planetary sun gear rotates the carrier pinions in the stationary carrier. They, in turn, rotate the reverse ring gear, driving it in a direction opposite

that of the sun gear. The ring gear, being connected by splines to the forward carrier assembly, rotates it. The forward carrier drives a shaft, the rear end of which is splined to the high-range planetary carrier.

(4) The engaged high-range clutch holds the high-range ring gear stationary. The rotation of the high-range planetary carrier within the stationary ring gear causes the carrier pinions to overdrive the sun gear. The sun gear, splined to a sleeve which is splined also to the transfer drive gear, rotates the transfer drive gear.

(5) Refer to b(7), above, for explanation of the remainder of the torque path.

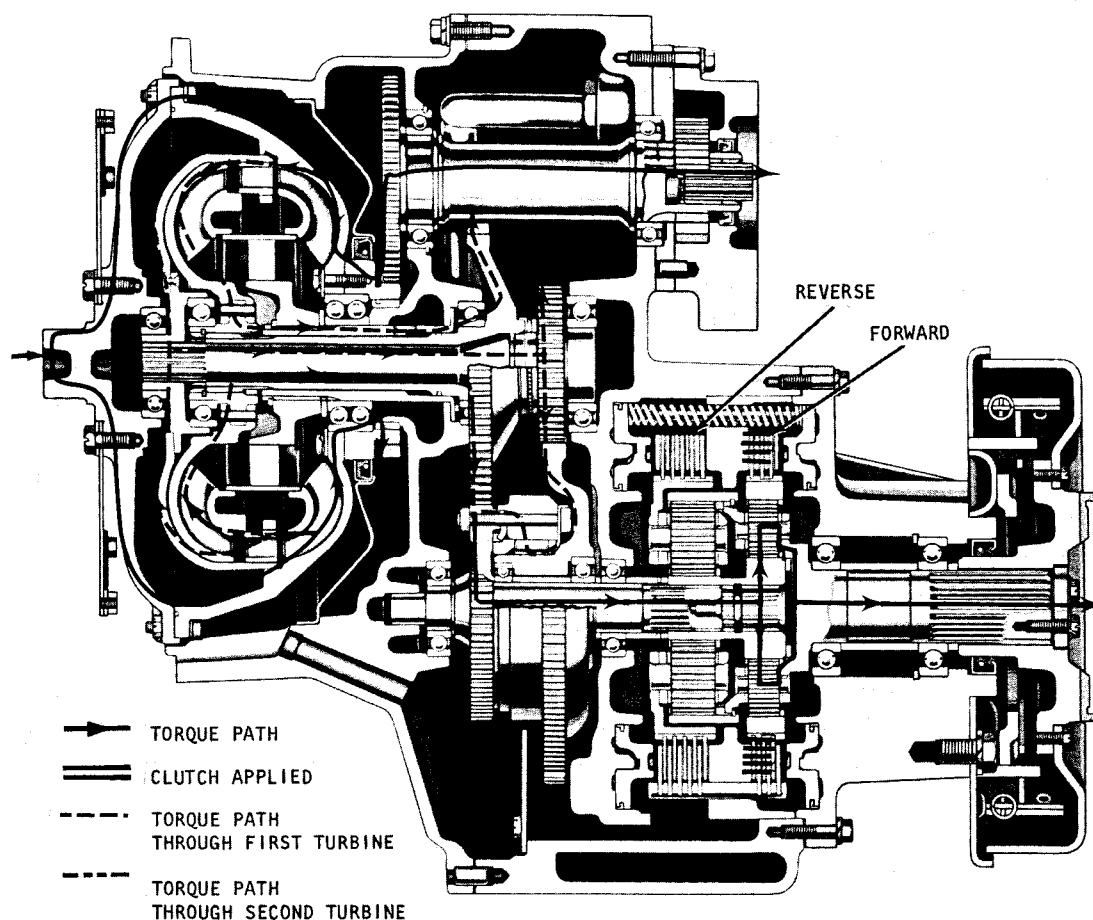


Fig. 2-13. TRT 2211-3 forward torque path

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## 2-23. TRT 2211-3, 2411-3 — TORQUE PATHS

### a. Neutral

(1) Refer to foldout 2 while studying the explanation of power flow in neutral. Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) In neutral, no power is transmitted beyond the forward and reverse planetary sun gear. Refer to paragraph 2-22a(2) and figure 2-10 for explanation of the power takeoff power flow.

### b. Forward (fig. 2-13)

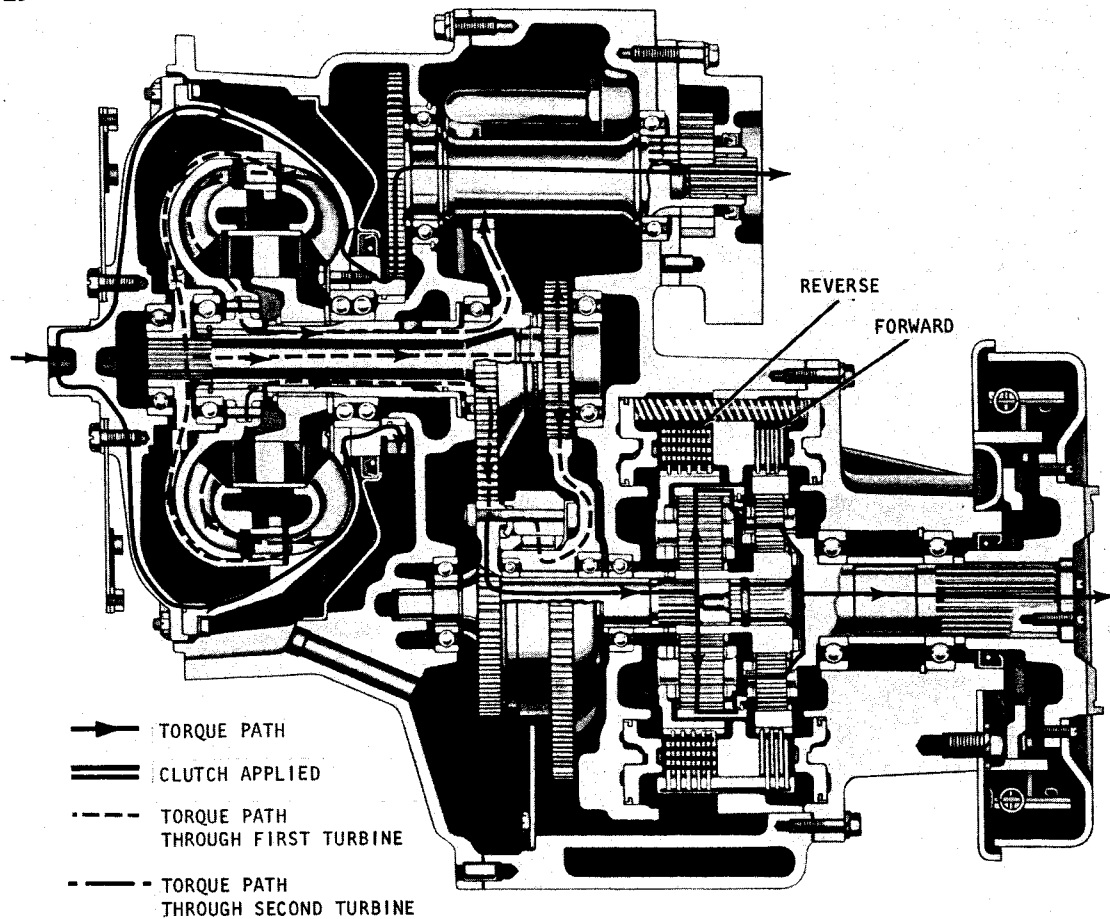
(1) Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted to forward, the forward clutch engages. The forward clutch, engaged, holds the forward planetary ring gear stationary.

(3) The forward planetary sun gear rotates the forward pinions within the stationary ring gear. This causes the forward carrier to rotate in the same direction as that of the sun gear, but at a reduction in speed. The transmission output shaft, to which the output flange is splined, is integral with the forward carrier.

(4) The transmission output thus rotates in a direction opposite to that of the engine, at reduced speed. The reduction in speed is due to the combination of the ratio of the converter transfer gearing (which may be overdrive or underdrive) and that of the forward planetary.

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Fig. 2-14. TRT 2211-3 reverse torque path

## c. Reverse (fig. 2-14)

(1) Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted from forward to reverse, the forward clutch releases and the reverse clutch engages. The reverse clutch, engaged, holds the reverse planetary carrier stationary.

(3) The reverse planetary sun gear rotates the carrier pinions in the stationary carrier. This drives the ring gear in a direction opposite that of the sun gear. The ring gear, being splined to the forward carrier assembly, rotates the forward carrier, its integral output shaft and the output flange.

(4) Rotation is in the same direction as the engine but at a reduction in speed. The reduction in speed is due to the combination of the ratio of the converter transfer gears and that of the reverse planetary.

2-24. TRT 2221-3, 2421-3 (underdrive model) — TORQUE PATHS

a. Neutral

(1) Refer to foldout 3 while studying the explanation of operation in neutral. Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) In neutral, power is not transmitted beyond the reverse and forward sun gear. The low-range clutch is engaged but no torque is transmitted because neither the forward nor reverse clutch is engaged. The reverse carrier and forward ring gear rotate freely.

(3) Refer to paragraph 2-22a(2) and figure 2-10 for explanation of the power take-off torque path.

b. Forward 1

(1) Refer to foldout 3 while studying the explanation of operation in forward 1. Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

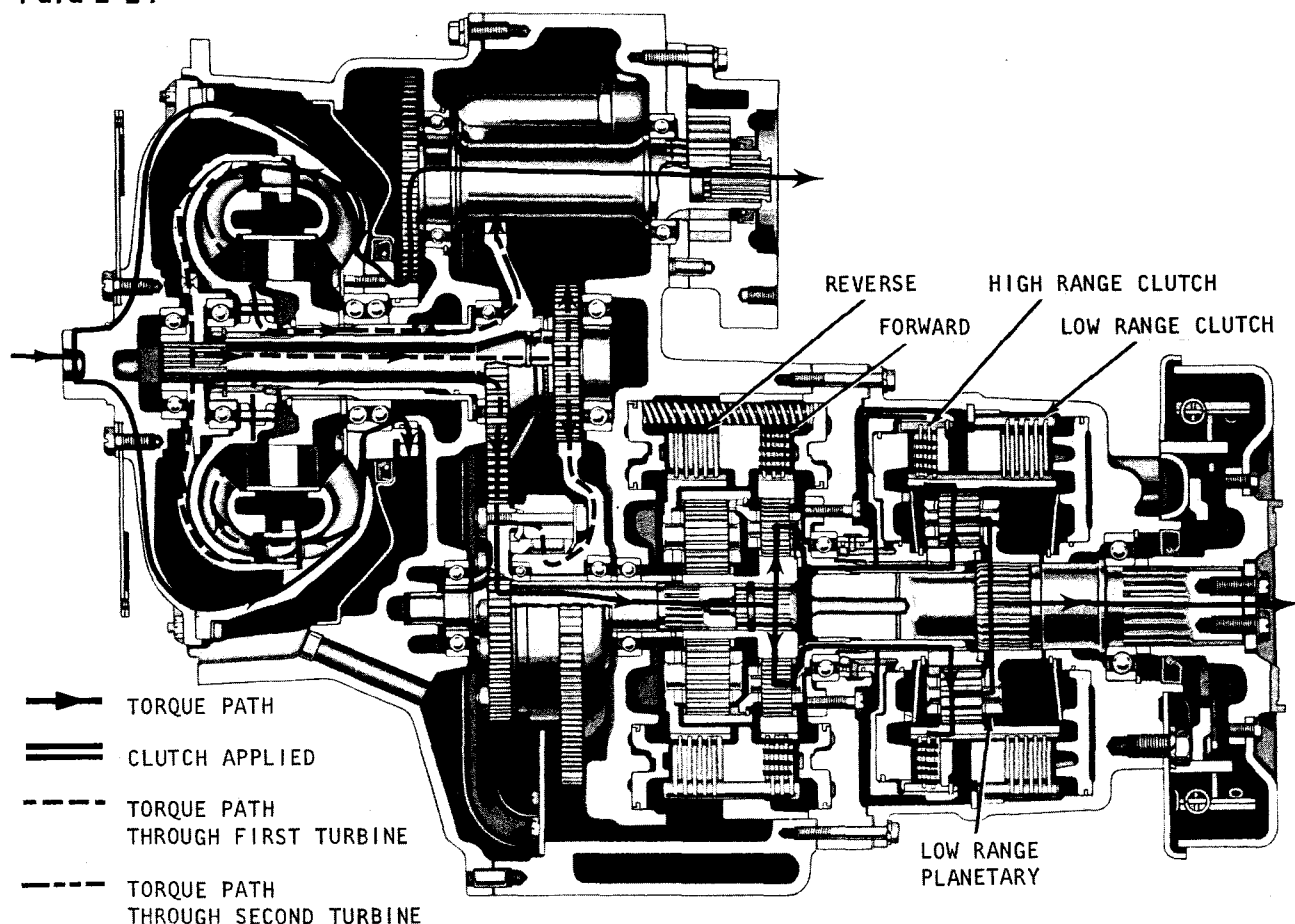
(2) When the manual selector valve is shifted from neutral to forward 1, the low-range clutch remains engaged while the forward clutch also engages. The forward clutch, engaged, holds the forward planetary ring gear stationary.

(3) The forward planetary sun gear rotates the forward planetary pinions within the stationary ring gear. This causes the forward carrier to rotate in the same direction as the sun gear, but at a reduction in speed. The carrier has an integral shaft, splined to the low-range planetary sun gear.

(4) The low-range sun gear, rotating with the forward carrier rotates the low-range planetary pinions within the stationary low-range ring gear. This drives the low-range carrier in the same direction as its sun gear but at a reduction in speed.

(5) The low-range carrier is splined to the transmission output shaft. The transmission output is driven in a direction opposite to that of the engine and at a reduction in speed. The speed reduction is the result of the combination of the converter transfer gear, forward planetary, and low-range planetary ratios.





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Fig. 2-15. TRT 2221-3 forward 2 underdrive torque path

### c. Forward 2 (fig. 2-15)

(1) Refer to paragraph 2-21d, above, for explanation of the power flow from the engine to the transmission gearing.

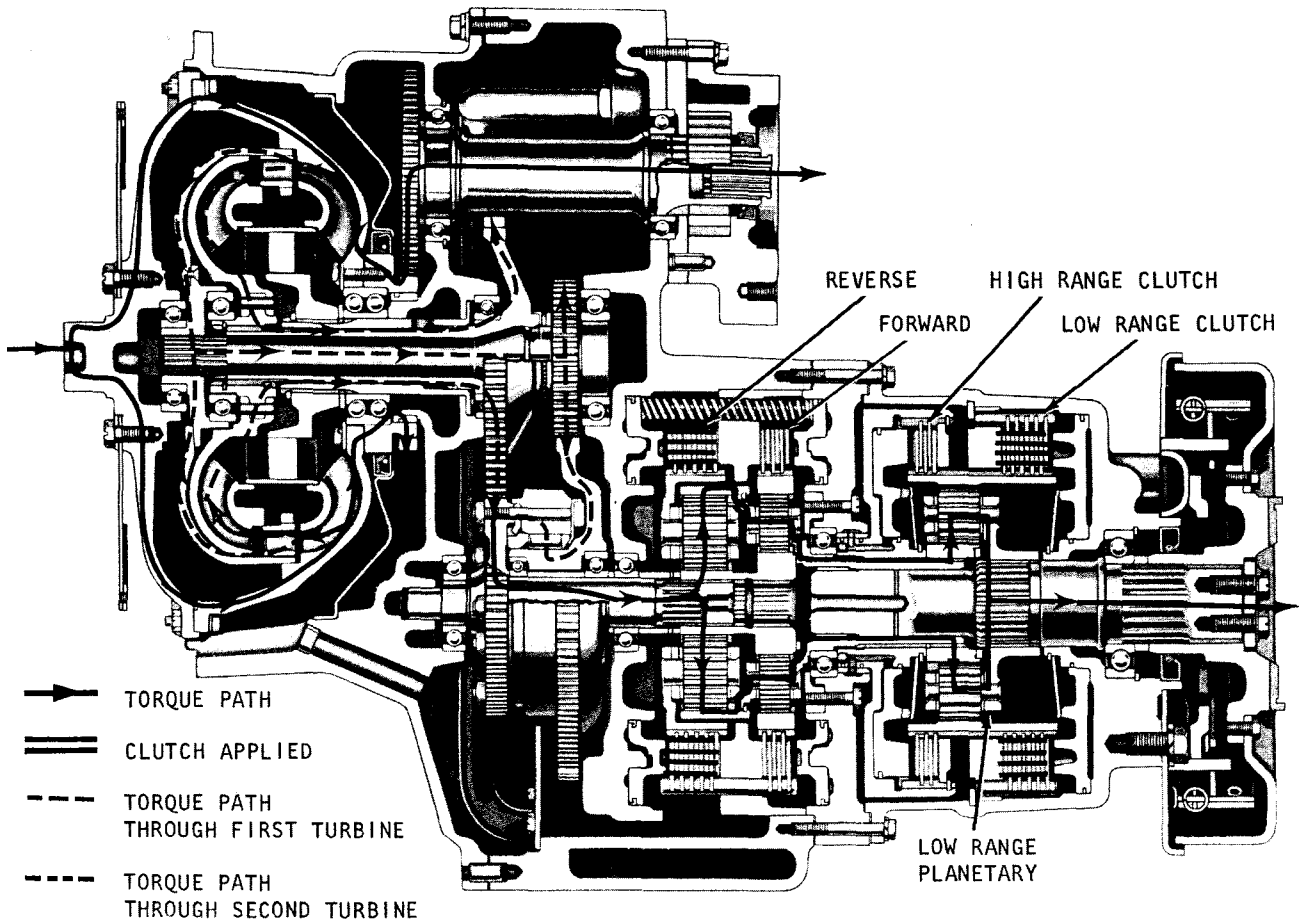
(2) When the manual selector valve is shifted from forward 1 to forward 2, the low-range clutch releases and the high-range clutch engages. The forward clutch remains engaged. The high-range clutch, engaged, locks the high-range clutch drum to the low-range ring gear.

(3) The forward planetary sun gear rotates the forward planetary pinions within the stationary ring gear. This causes the forward carrier to rotate in the same direction as the sun gear but at a reduction in speed. The carrier has an integral hollow

shaft which is splined both to the high-range clutch drum and to the low-range planetary sun gear.

(4) The high-range clutch drum and low-range planetary sun gear thus rotate together, at the same speed. The high-range clutch, engaged, drives the low-range planetary ring gear at the same speed as that of the high-range clutch drum and low-range sun gear. The low-range sun and ring gears drive the low-range carrier and transmission output shaft at an equal speed.

(5) Thus, the final transmission ratio in forward 2 is an underdrive since the combined result of the ratios of the converter transfer gears, the forward planetary and a direct drive in the high-range clutch gives an overall reduction in speed.



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Fig. 2-16. TRT 2221-3 reverse 1 underdrive torque path

**d. Reverse 1 (fig. 2-16)**

(1) Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted from forward 2 to reverse 1, the forward and high-range clutches release, and the reverse and low-range clutches engage. Engaged, the reverse clutch holds the reverse-range planetary carrier stationary, and the low-range clutch holds the low-range ring gear stationary.

(3) The reverse sun gear rotates the reverse planetary pinions in the stationary carrier. The pinions drive the reverse plan-

etary ring gear in a direction opposite that of the sun gear. The reverse ring gear, splined to the forward carrier, drives the forward carrier in reverse. The forward carrier shaft, in turn, drives the low-range planetary sun gear in reverse.

(4) The low-range sun gear rotates the low-range pinions within the stationary low-range ring gear. This causes the low-range planetary carrier and transmission output shaft to rotate. The rotation is in the same direction as that of the engine but at a reduction in speed. The reduction is the result of the combination of the ratios of the converter transfer gears, the reverse planetary (underdrive), and the low-range planetary (underdrive).

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#### e. Reverse 2

(1) Refer to foldout 3 while studying the power flow during operation in reverse 2. Refer to paragraph 2-21d, above, for explanations of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted from reverse 1 to reverse 2, the low-range clutch releases, the high-range clutch engages, and the reverse clutch remains engaged. The high-range clutch, engaged, locks the high-range clutch drum to the low-range planetary ring gear.

(3) The reverse sun gear rotates the reverse planetary pinions in the stationary carrier. The pinions drive the reverse planetary ring gear in a direction opposite that of the sun gear. The reverse ring gear, splined to the forward planetary carrier, drives the forward carrier in reverse. The forward carrier shaft, in turn, drives the high-range clutch drum (and low-range planetary ring gear) in reverse.

(4) The high-range clutch drum and low-range planetary sun gear thus rotate together, at the same speed. The high-range

clutch, engaged, drives the low-range planetary ring gear at the same speed as that of the high-range clutch drum and low-range sun gear. The low-range sun and ring gears drive the low-range carrier and transmission output shaft at an equal speed.

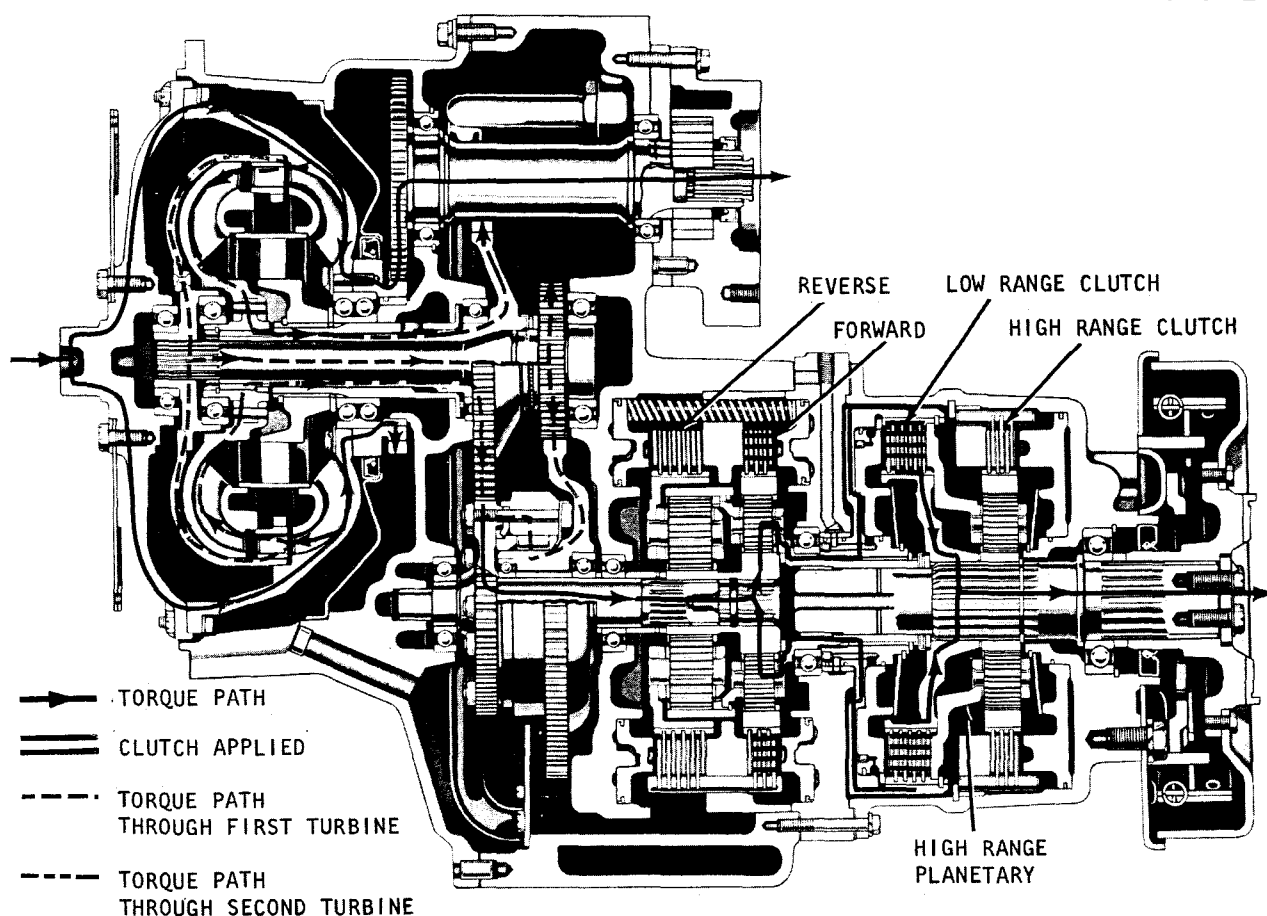
(5) Thus, the final transmission ratio in reverse 2 is an underdrive, resulting from the combined ratios of the converter transfer gears, the reverse planetary (underdrive), and that of the high-range clutch (direct drive).

### 2-25. TRT 2221-3, 2421-3 (overdrive model) — TORQUE PATHS

#### a. Neutral

(1) Refer to foldout 4 while studying the power flow during operation in neutral. Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) Refer to paragraph 2-24a(2) and (3), above, for the remainder of the explanation of power flow in neutral.



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Fig. 2-17. TRT 2221-3 forward 1 overdrive torque path

**b. Forward 1 (fig. 2-17)**

(1) Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted from neutral to forward 1, the forward clutch engages and the low-range clutch remains engaged. The forward clutch holds the forward planetary ring gear stationary, and the low-range clutch locks the low-range clutch drum to the low-range clutch hub, which is splined to the transmission output shaft.

(3) The forward planetary sun gear rotates the forward pinions within the stationary forward ring gear. This causes the

forward planetary carrier and its integral hollow shaft to rotate in the same direction as that of the sun gear, but at a reduction in speed. The carrier shaft is splined to the low-range clutch drum and rotates it and the high-range planetary carrier to which the drum is splined.

(4) The low-range clutch, engaged, drives the clutch hub. The hub, in turn, drives the transmission output shaft, to which it is splined.

(5) The overall transmission ratio is an underdrive, resulting from the combined ratios of the converter transfer gears, the forward planetary, and the direct drive, low-range clutch.

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### Para 2-25

#### c. Forward 2

(1) Refer to foldout 4 while studying power flow during operation in forward 2. Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted from forward 1 to forward 2, the low-range clutch releases and the high-range clutch engages. The forward clutch remains engaged. The high-range clutch, engaged, holds the high-range planetary ring gear stationary.

(3) Refer to b(3), above, for explanation of the function of the forward planetary gearing.

(4) The high-range planetary carrier, splined to the low-range clutch drum rotates within the stationary high-range ring gear. This causes the pinions to rotate and overdrive the high-range planetary sun gear, which is splined to the transmission output shaft.

(5) The overall transmission gear ratio in forward 2 is an overdrive. This results from the combination of the ratios of the converter transfer gears, the forward planetary and the high-range planetary.

#### d. Reverse 1

(1) Refer to foldout 4 while studying power flow during operation in reverse 1. Refer to paragraph 2-21d, above, for explanation

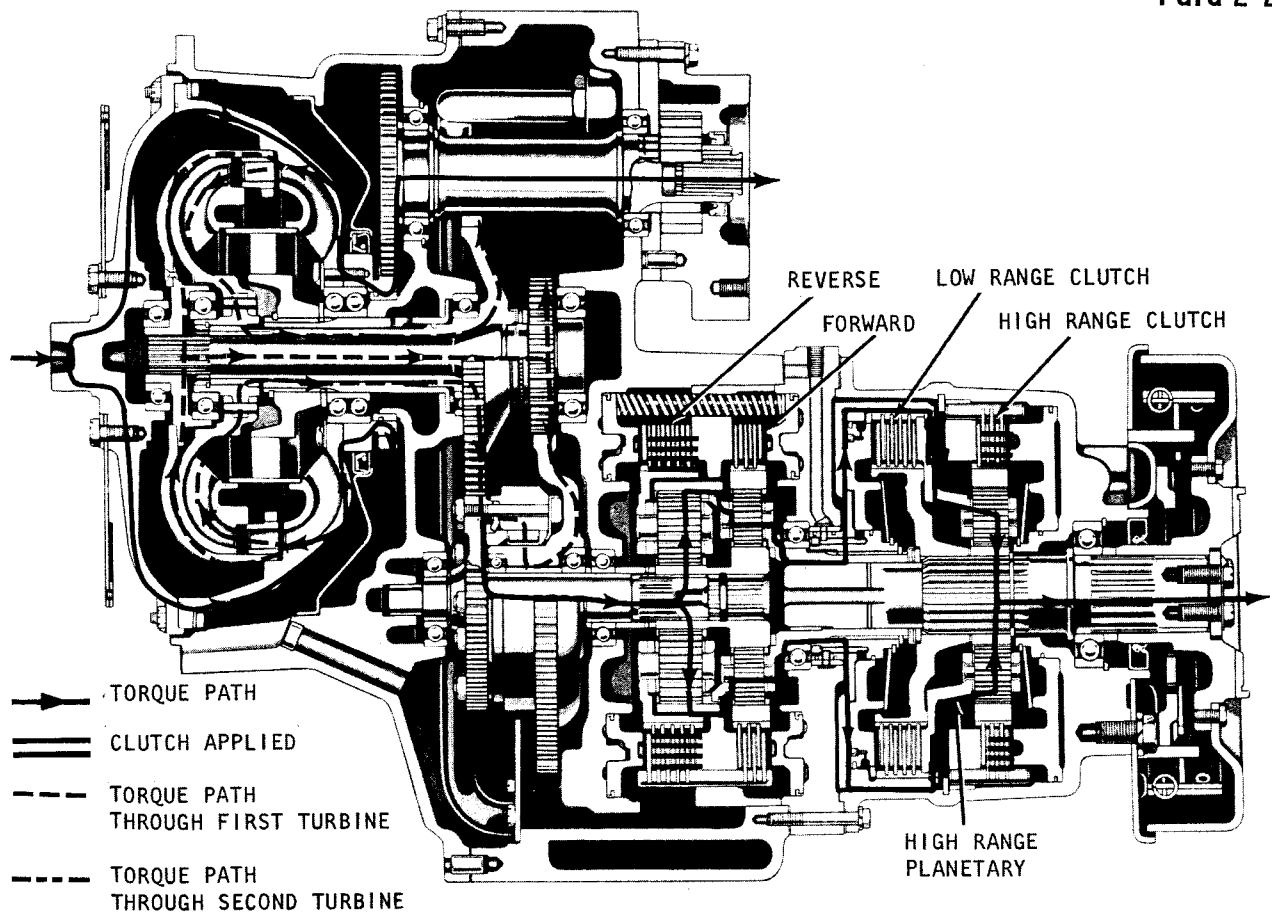
of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted from neutral to reverse 1, the reverse clutch engages, and the low-range clutch remains engaged. The reverse clutch, engaged, holds the reverse planetary carrier stationary. The low-range clutch, engaged, locks the low-range clutch drum to the low-range clutch hub, and to the transmission output shaft which is splined to the hub.

(3) The reverse planetary sun gear rotates the pinions in the stationary reverse carrier. The pinions rotate the reverse ring gear in a direction opposite that of the sun gear. The ring gear, being splined to the forward carrier, causes it to rotate.

(4) The forward carrier has an integral hollow shaft, to which the low-range clutch drum is splined. The low-range clutch drum is splined also to the high-range planetary carrier assembly. The low-range clutch, engaged, locks the clutch drum and low-range clutch hub together. The clutch hub is splined to the transmission output shaft. Thus, when the reverse planetary ring gear rotates, it drives, in succession, the forward carrier, low-range clutch drum, low-range clutch hub, and the transmission output shaft.

(5) The overall transmission ratio is underdrive, resulting from a combination of the ratios of the converter transfer gears, the reverse planetary ratio, and the direct drive, low-range clutch.



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Fig. 2-18. TRT 2221-3 reverse 2 overdrive torque path

**e. Reverse 2 (fig. 2-18)**

(1) Refer to paragraph 2-21d, above, for explanation of power flow from the engine to the transmission gearing.

(2) When the manual selector valve is shifted from reverse 1 to reverse 2, the low-range clutch releases, the high-range clutch engages, and the reverse clutch remains engaged. The high-range clutch, engaged, holds the high-range planetary ring gear stationary.

(3) Refer to d(3), above, for explanation of the function of the reverse gearing.

(4) The forward carrier has an integral hollow shaft which is splined to the low-range clutch drum. The low-range clutch drum, in turn, is splined to the high-range planetary carrier. The high-range carrier, thus, rotates within the stationary high-range ring gear. Rotation of the high-range planetary pinions causes them to overdrive the high-range planetary sun gear, and the output shaft.

(5) The overall transmission ratio is overdrive, resulting from the combination of the ratios of the converter transfer gears, reverse planetary, and the overdrive high-range planetary.

## Section 3. PREVENTIVE MAINTENANCE

### 3-1. SCOPE OF SECTION 3

This section contains preventive checks and measures that should be taken to maintain the transmission in good operating condition. Troubleshooting procedures, and information for extended storage of the transmission, are included.

### 3-2. PERIODIC INSPECTIONS, CLEANING

a. General. The transmission should be inspected for loose bolts, oil leaks, linkage troubles and bent or damaged oil lines. Oil leaks require immediate attention. Linkage must be kept clean and well lubricated.

#### NOTE

If seepage occurs at the output flange locations on a -1 model, refer to paragraph 3-11.

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. 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 damage or crush the breather and produce metal chips which might get into the transmission.

c. Cleaning Oil Strainer. At each oil change, the strainer assembly (fig. 1-2 and 1-4) should be removed and cleaned. A new gasket should be used when the strainer is reinstalled. The interior end of the strainer must slip over the oil pickup tube in the sump. Examine the strainer flange for oil leakage, after the sump is filled.

d. Water or Dirt in Oil. At each oil change, examine the oil which is drained for evidence of water or dirt. A normal amount

of condensation will emulsify in the oil during operation of the transmission. However, if there is evidence of water, check the oil cooler (heat exchanger) for leakage between the water and oil sides. Oil in the water side (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."

#### NOTE

Should engine coolant leak 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.

e. Metal Particles in Oil. Metal particles in the oil (except the usual minute particles normally removed by the oil filter) indicate damage to transmission parts. When this condition is found, the transmission should be disassembled and closely inspected to find the source. Metal contamination will require complete disassembly and cleaning of lines, cooler, filter and all areas where such particles may lodge.

### 3-3. CHECKING OIL LEVEL

#### a. Cold Check

(1) Two oil level check plugs are located at the lower-right front on -1 models (fig. 1-3) and the lower-left rear on the -3 models (fig. 5-7) of the transmission housing. 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.

## TRT 2001 SERIES TRANSMISSION

### Para 3-3

(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.

#### NOTE

An oil check made at lower engine rpm may result in low oil level at operating speeds and temperature. Thermal expansion will raise the oil level to approximately the Full level as the transmission attains operating temperature.

b. Hot Check. Start the engine and run it at 1200 to 1500 rpm until the transmission reaches normal operating temperature (180° to 220°F/82 to 104°C/). Then idle the engine and shift through all the ranges slowly. This will insure that all areas 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 solid oil stream flowing from the opening. The transmission may be operated safely as long as the oil level is above the lower (Add) oil check plug opening.

c. Dipstick Cold Check  
(2-1/2 inches/63.5 mm/between Cold, Hot)

(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 within the operating range (between marks) but not higher than the Hot mark. If the oil level is not within this range, add oil. Drain oil if level is above the Hot mark. One US quart (0.94 litre) equals approximately 1/2-inch (12.7 mm) change in oil level.

(2) Start the engine and let engine idle (500 to 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 US quart equals approximately 1/2-inch (12.7 mm) change in oil level.

d. Dipstick Hot Check  
(2-1/2 inches/63.5 mm/between Cold, Hot)

(1) Start the engine. With the engine at idle speed, oil at operating temperature (180° to 220°F/82 to 104°C/), 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. Drain oil if level is above Hot mark. One US quart (0.94 litre) equals approximately 1/2-inch (12.7 mm) change in oil level.

e. Dipstick Cold Check  
(1 inch/25.4 mm/between Add, Full)

(1) Before starting the engine, remove the dipstick, wipe it clean, and replace it. Remove the dipstick and note the oil level.

(2) If the level is at, or above, the Full mark, it is safe to start the engine.

(3) If the level is below the Full mark, add oil until the level reaches the Full mark. Then the engine may be safely started.

f. Dipstick Hot Check  
(1 inch/25.4 mm/between Add, Full)

(1) Run the engine at 1200 to 1500 rpm until the oil temperature reaches 180° to 220°F (82 to 104°C). Then idle the engine and shift slowly through all operating ranges.

(2) Place the selector in neutral, run the engine at 1200 to 1500 rpm, remove the dipstick, wipe it clean, and replace it. Remove the dipstick and note the oil level.

(3) Add or drain oil to put the oil level at the Full mark.



### 3-4. MAINTENANCE INTERVALS

a. Frequency of Maintenance. Area conditions and type of service will determine the frequency of maintenance operations. Under dusty or dirty operating conditions, the transmission oil should be changed more often. Replace immediately any oil that 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. When to Change Oil. Generally, the oil should be changed after each 1000 hours of operation. However, if the vehicle operates under severe conditions of dust and dirt, the transmission oil should be changed more often. Refer to a, above. Refer also to paragraph 3-2, above, before changing oil.

### 3-5. CHANGING OIL, FILTERS

a. Draining Oil. The transmission should be at normal operating temperature (180°F) when the oil is changed. Remove the oil drain plug (fig. 1-4) from the transmission housing (drain plug at left rear of -3 models). Remove the oil filter element from the remote-mounted filter. Remove, clean and re-install the strainer assembly (fig. 1-2 or 1-4). Install a new oil filter element and gasket. Install the oil drain plug.

#### b. Filling Oil System.

<u>Initial fill (dry)</u>	<u>Add</u>
-3 model	6 1/2 US gal (25 litres)
-1 model	8 1/2 US gal (32 litres)
<u>Refill (after drain)</u>	<u>Add</u>
-3 model	4 1/2 US gal (17 litres)
-1 model	6 1/2 US gal (25 litres)

Conduct oil level checks to establish correct operating level.

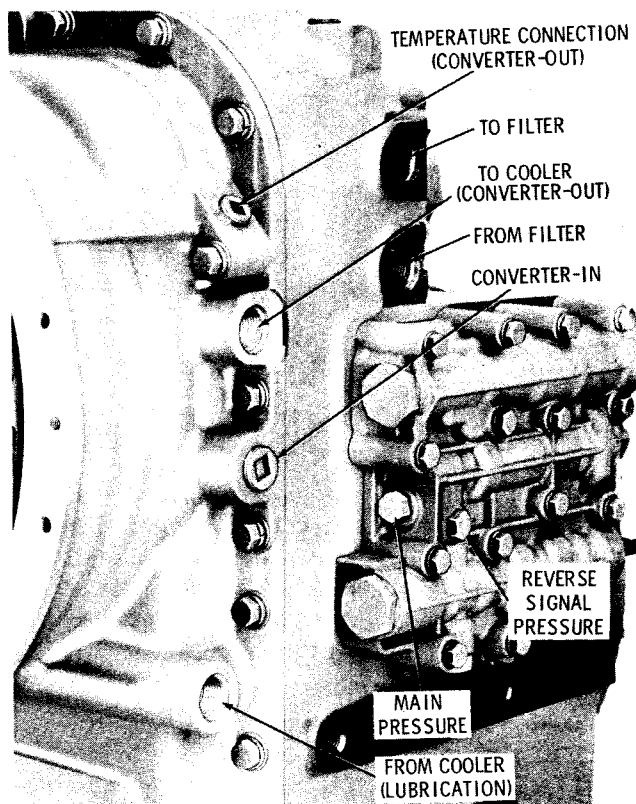
### 3-6. OIL CAPACITY

The short drop (-3) and long drop (-1) transmissions require approximately 6 1/2 and 8 1/2 US gallons (25 litres and 32 litres) of oil respectively (exclusive of the external cooler and filter circuits). However, some

oil will be trapped and will not drain. Thus, refilling at oil changes will not require as much oil as a transmission which is dry after rebuild.

### 3-7. PRESSURES, TEMPERATURES

Figure 3-1 illustrates the points where the transmission temperature and pressures may be measured. The vehicle may be equipped with a temperature gage and a pressure gage. If so, the temperature gage is connected to register the converter-out (to cooler) temperature, and the pressure gage (connected to the main-pressure check point) registers clutch pressure. 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 to the same extent. Therefore, when checking main pressure, neither of these controls must be activated.



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Fig. 3-1. Pressure and temperature check points

### 3-8. CHECKING, ADJUSTING LINKAGE

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

b. Selector and Inching Linkage. The selector linkage must be adjusted so that the operator's control and selector valve are both in the desired range at the same time. Make the 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 and well lubricated. Bent or damaged linkage must be repaired or replaced.

c. Front Output Disconnect. The front output disconnect shaft position must be adjusted by disconnecting the linkage and rotating the shaft. Push the shaft inward (toward the rear) to its engaged position. A spring-loaded detent will indicate engaged position. When the disconnect is engaged, adjust the shaft (by rotating it) until the center of the linkage pin hole in the shaft is 0.170 to 0.210 inch (4.31 to 5.33 mm) behind the front face of the transmission housing (converter housing-to-transmission housing splitline).

### 3-9. TRANSMISSION STALL TEST

#### a. Definition, Purpose

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

(2) It will be necessary to refer to the engine-converter matched performance curve to determine the recommended engine speed at stall. This data is available from your equipment dealer or distributor.

Stall tests may be made in any range, if necessary. However, such tests in the lower range must be made with extreme caution because of the high torque delivered at the transmission output shaft. For this reason, stall tests should be made only in the high range, unless conditions warrant tests in other ranges.

#### b. Procedure

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

#### 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 the actual engine speed with the established normal speed for such conditions will indicate if the engine or transmission is malfunctioning. To determine the desired engine speed at stall, refer to the engine-converter matched performance curve for the particular installation. Refer to the

Troubleshooting chart, end of this section, for possible causes of stall test deviations from normal.

### 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 U.S. 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 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 with moisture-proof tape.

(3) Coat all exposed, unpainted surfaces with a good grade of preservative grease (refer to c(7), above).

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

\*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).

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(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 and 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).

#### 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. (See para 3-3.)

#### 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 the transmission with hydraulic transmission fluid, type C2, to proper level. (See para 3-3.)

### 3-11. FLANGE RETAINER SEALRINGS

Prior to Serial number 23291, 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.

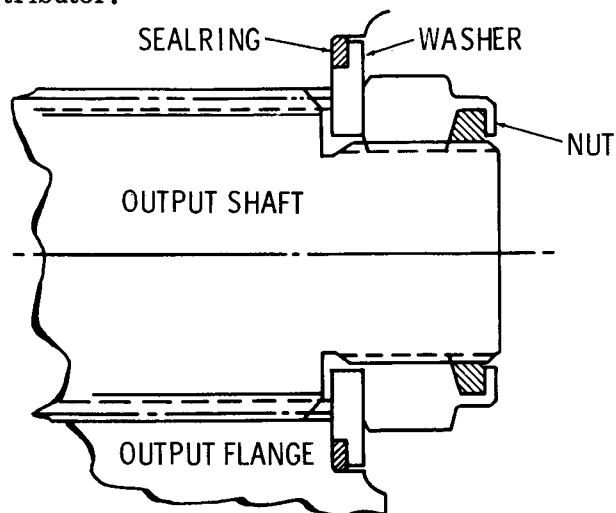


Fig. 3-2. Output shaft retainer washer and seal

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3-12. TROUBLESHOOTING

a. Importance. Troubleshooting is the systematic search for and location of engine or transmission malfunctions which affect transmission performance. A thorough study of the description and operation of components and of the hydraulic system (Section 2)

will be helpful in troubleshooting. The engine and transmission must be regarded as a single package during troubleshooting.

b. Troubleshooting Chart. The following chart outlines the possible causes and remedies for transmission troubles. This chart applies to all models except where indicated.

TRT 2000 TROUBLESHOOTING CHART

<u>Cause</u>	<u>Remedy</u>
<b>(A) LOW MAIN PRESSURE</b>	
1. Low oil level	1. Add oil (para 3-3)
2. Clogged oil strainer	2. Clean strainer (para 3-2c)
3. Clogged oil filter	3. Replace filter element (para 3-5)
4. Weak or broken main-pressure regulator valve spring	4. Replace spring (para 6-27)
5. Inching control adjustment not fully retracted	5. Adjust linkage (para 3-8)
6. Oil pump worn	6. Rebuild oil pump (para 6-26)
7. Air leak at intake side of oil pump	7. Check pump mounting bolts. Check oil pickup tube and nut (para 7-3e)
8. Internal oil leakage	8. Disassemble transmission, rebuild subassemblies as required (sect. 5 thru 7)
9. Brake hydraulic (or air) pressure applying clutch cutoff valve	9. Check brake residual pressure (brakes released). Check brakes for full release
10. External oil leakage	10. Tighten bolts or replace gaskets
<b>(B) OVERHEATING</b>	
1. High oil level	1. Restore proper oil level (para 3-3)
2. Clutch failed	2. Rebuild transmission (sect. 5 thru 7)
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 (sect. 5 thru 7)
3. Clutch cutoff valve sticking	3. Rebuild control valve body assembly (para 6-27)
4. Inching control valve sticking	4. Rebuild control valve body assembly (para 6-27)
5. Internal oil leakage	5. Overhaul transmission (sect. 5 thru 7)

(Continued on next page)

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Para 3-11

## TRT 2000 TROUBLESHOOTING CHART — Continued

<u>Cause</u>	<u>Remedy</u>
<p>Ⓓ AERATED OIL (foaming)</p> <ol style="list-style-type: none"> <li>1. Incorrect type oil used</li> <li>2. High oil level</li> <li>3. Low oil level</li> <li>4. Air entering suction side of oil pump</li> <li>5. Air entering at clutch cutoff valve (air actuated)</li> </ol>	<ol style="list-style-type: none"> <li>1. Change oil, use proper type (para 3-5)</li> <li>2. Restore proper oil level (para 3-3)</li> <li>3. Restore proper oil level (para 3-3)</li> <li>4. Check oil pump bolts and gasket (para 7-6a). Check oil pickup tube and nut (para 7-3e)</li> <li>5. Check plug seal and sealing of valve (para 6-27)</li> </ol>
<p>Ⓔ VEHICLE WILL NOT TRAVEL</p> <ol style="list-style-type: none"> <li>1. Low main pressure</li> <li>2. Low clutch apply pressure</li> <li>3. Selector linkage broken or disconnected</li> <li>4. Internal mechanical failure</li> </ol>	<ol style="list-style-type: none"> <li>1. Refer to A, above</li> <li>2. Refer to C, above</li> <li>3. Repair or connect linkage (para 3-8)</li> <li>4. Overhaul transmission (sect. 5 thru 7)</li> </ol>
<p>Ⓕ CLUTCH CUTOFF VALVE INEFFECTIVE</p> <ol style="list-style-type: none"> <li>1. Valve or plug sticking</li> <li>2. Brake apply hydraulic pressure not reaching control valve</li> <li>3. Brake apply air pressure not reaching air cylinder</li> <li>4. Plunger sticking in air cylinder</li> <li>5. Air entering at valve (air actuated)</li> </ol>	<ol style="list-style-type: none"> <li>1. Rebuild control valve body assembly (para 6-27)</li> <li>2. Check pressure at control valve (min-max limits — 100-2000 psi)</li> <li>3. Check at air cylinder for brake apply pressure (35 lb force required to stroke valve)</li> <li>4. Check operation of air cylinder</li> <li>5. Check operation of air cylinder (seals)</li> </ol>
<p>Ⓖ VEHICLE TRAVELS IN NEUTRAL WHEN ENGINE IS ACCELERATED</p> <ol style="list-style-type: none"> <li>1. Selector linkage out of adjustment</li> <li>2. Clutch failed (won't release)</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust linkage (para 3-8)</li> <li>2. Overhaul transmission (sect. 5 thru 7)</li> </ol>
<p>Ⓗ VEHICLE LACKS POWER AND ACCELERATION AT LOW SPEED</p> <ol style="list-style-type: none"> <li>1. Low main pressure</li> <li>2. Low clutch apply pressure</li> <li>3. Aerated oil</li> <li>4. Turbine freewheel clutch failed</li> <li>5. Engine malfunction</li> </ol>	<ol style="list-style-type: none"> <li>1. Refer to A, above</li> <li>2. Refer to C, above</li> <li>3. Refer to D, above</li> <li>4. Overhaul transmission (sect. 5 thru 7)</li> <li>5. Check engine — refer to engine service manual</li> </ol>

## Section 4. GENERAL OVERHAUL INFORMATION

### 4-1. SCOPE OF SECTION 4

This section provides preliminary information helpful in preparing for the overhaul of a transmission. Tools and equipment needed are discussed. Replacement parts and service kits are covered. The importance of careful handling and cleanliness is stressed. Helpful information on inspection of parts is given. General information on the removal and installation of the transmission is included. Standard torque specifications for bolts and nuts are tabulated. An explanation of wear limits is made.

### 4-2. CHANGES IN MODELS, PROCEDURES

The release of new assemblies and/or product improvements may require new or different overhaul procedures. Changes will be covered in information supplementary to this manual. Consult your dealer or distributor for the latest information. Give the model, assembly part number and serial number stamped on the transmission nameplate (refer to para 1-4a).

### 4-3. TOOLS, EQUIPMENT

The tools required for overhaul are shown in figures 4-1, 4-2, 4-3, and 4-4. Figure 4-1 illustrates a puller assembly and sleeve used to remove the converter pump. This tool, Part No. J23547, may also be obtained from Service Tool Division, Kent-Moore Corporation, 1501 S. Jackson Street, Jackson, Michigan, 49203. 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. Figure 4-4 illustrates a special wrench used to install the male nut that attaches the oil suction tube. 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 (fig. 4-5)
- Press (for removal and installation of press-fit parts)

- 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 (149°C) (for heating interference-fit parts)

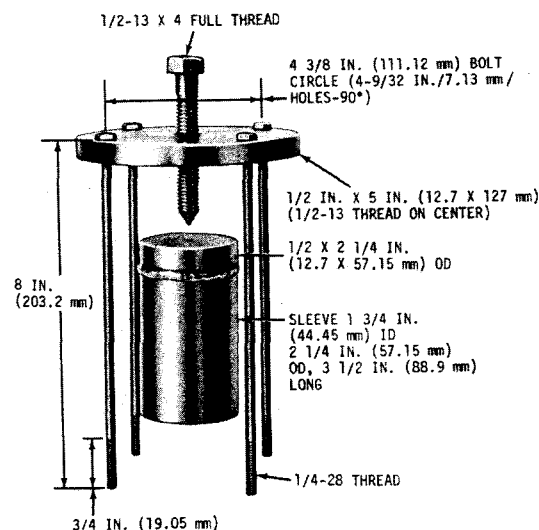


Fig. 4-1. Improvised puller for converter pump assembly

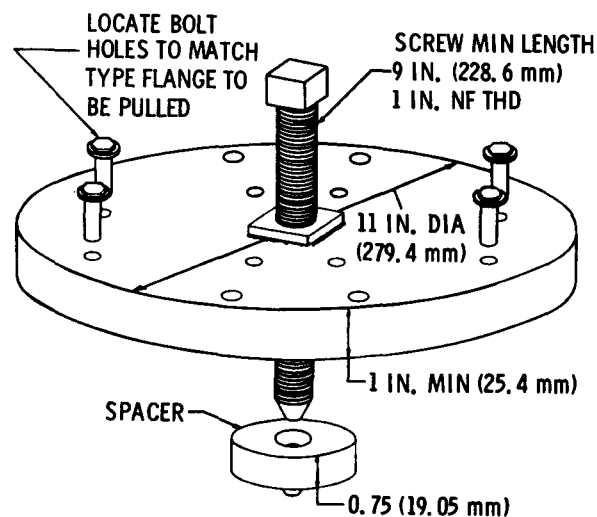


Fig. 4-2. Typical interference-fit flange puller

# Para 4-3

## TRT 2001 SERIES TRANSMISSION

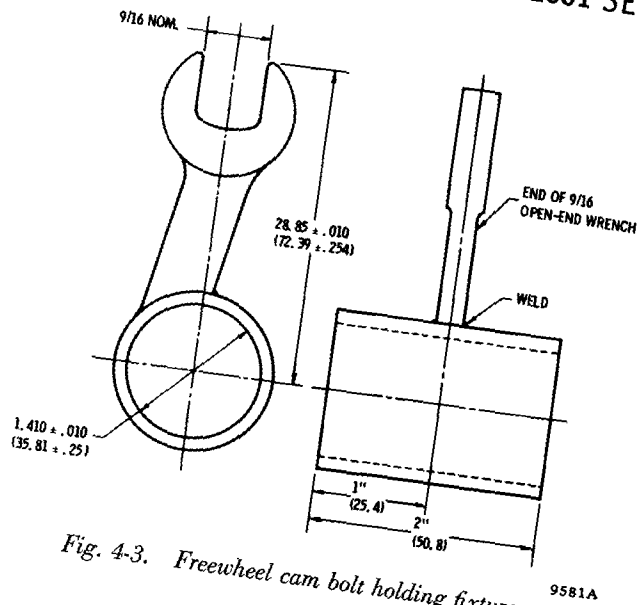


Fig. 4-3. Freewheel cam bolt holding fixture

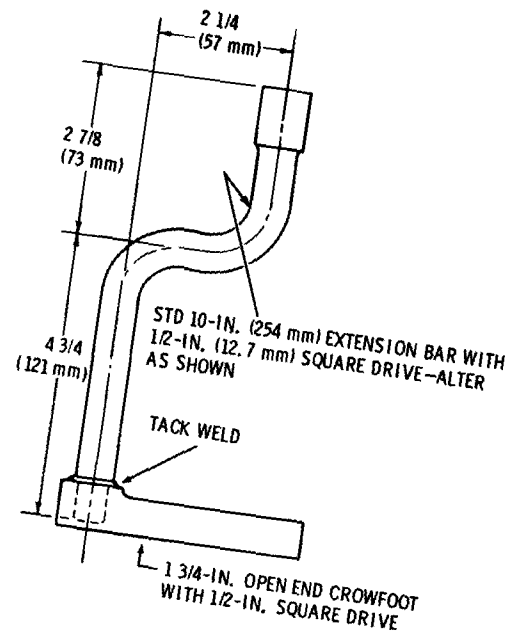


Fig. 4-4. Special wrench for oil suction tube nut

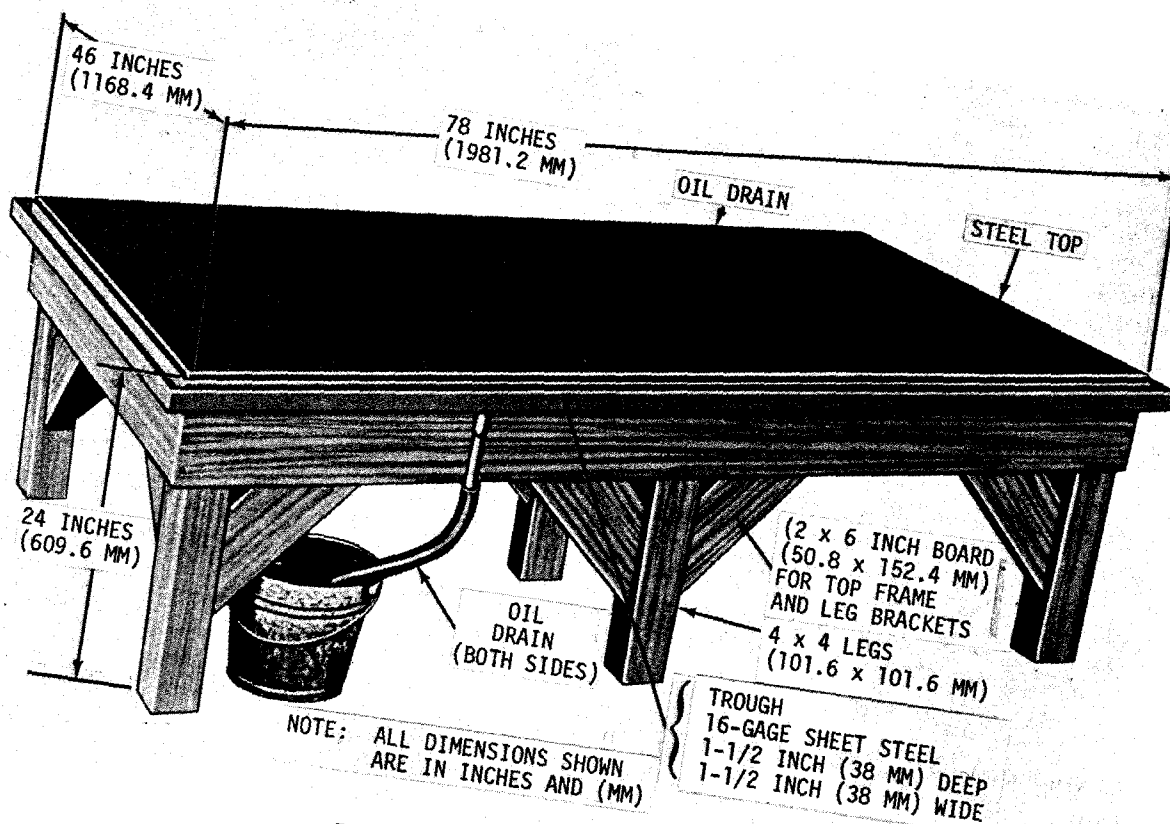


Fig. 4-5. Transmission work table



#### 4-4. REPLACEMENT PARTS

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

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

- (1) Gaskets.
- (2) Cotter pins.
- (3) Lockstrips.
- (4) Washers or snaprings damaged by removal.
- (5) Oil seals (when removed).

#### CAUTION

Do not dispose of Teflon seals by burning. Toxic gases are produced.

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

#### 4-5. CAREFUL HANDLING

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

#### 4-6. CLEANING, INSPECTION

a. Importance of Cleanliness. All parts must be clean to permit effective inspection. At assembly it is very important that no dirt or foreign matter enter the transmission. Even minute particles can cause the malfunction of close-fitting parts such as valves.

#### 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 caustic soda solution for steam cleaning.

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

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

(4) Examine parts, especially the oil passages, after cleaning, 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 spin bearings while they are not lubricated.

d. Keeping Bearings Clean. Since the presence of dirt or grit in ball bearings is usually responsible for bearing failures, it is important to keep bearings clean during 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.

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

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

#### e. Inspection 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 wire back and forth through the passage and flushing it out with cleaning solvent.

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

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

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

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

#### f. Inspecting Bearings

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

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

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

turning in its 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 an arbor press to seat the bearing.

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

#### g. Inspecting Bushings, Thrust Washers

(1) Inspect the 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.

#### NOTE

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

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

#### h. Inspecting Oil Seals, Gaskets

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

(2) When replacing lip-type 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.

- (3) Replace all composition gaskets.
- (4) Inspect 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/0.127 mm/maximum side wear). The sides of the shaft groove (or the bore) in which the sealring fits should be smooth (50 microinches/1.27  $\mu$ m/equivalent) 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/0.50 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 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 stone; or replace the gear.

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

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

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

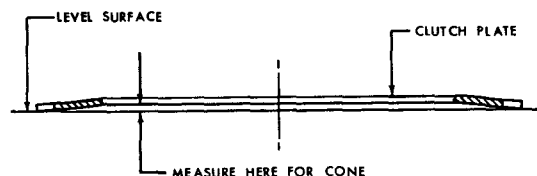


Fig. 4-6. Method for determining cone of clutch plate

m. Inspecting Springs. Inspect all the springs for signs of overheating, permanent set or wear due to rubbing adjacent parts. Replace the spring if any one of these defects is found. Replace springs which do not meet the load-height specifications in the spring table (Sect. 8).

#### n. 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. 4-6). 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.)

### 4-7. REMOVING, INSTALLING TRANSMISSION

Drain the oil from the transmission. If possible, it should be allowed to drain overnight, and while the transmission is warm. Replace the drain plug. Since applications will differ, consult the vehicle service manual for specific instructions for removal and installation. Be sure all linkages, controls,

## Para 4-7/4-8

cooler and filter lines, temperature and pressure connections, input and output couplings, and mounting bolts are disconnected before the transmission is removed, and reconnected after the transmission is installed. Two 3/4-10 tapped openings are provided at the top of the transmission housing for lifting the assembly. Bolts or eyebolts may be installed into these openings. Clean the exterior of the transmission. Steam cleaning should be followed immediately by disassembly since condensation should not be allowed to remain in the transmission to cause rust.

#### 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 (149°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 Flanges

(1) If the transmission is equipped with input and/or output flanges which require shims, use the following procedure to determine the shim pack thickness.

(2) Install the flange onto the splined shaft. Install the flange 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 flange washer. Measure and record the dimension from the flange washer seat in the flange (face A) to the end of the shaft (fig. 4-7).

(4) For input shafts, subtract 0.007 inch (0.17 mm) from the recorded dimension; for output shafts, subtract 0.010 inch (0.25 mm). The remainder is the thickness of the shim pack required for the specific location.

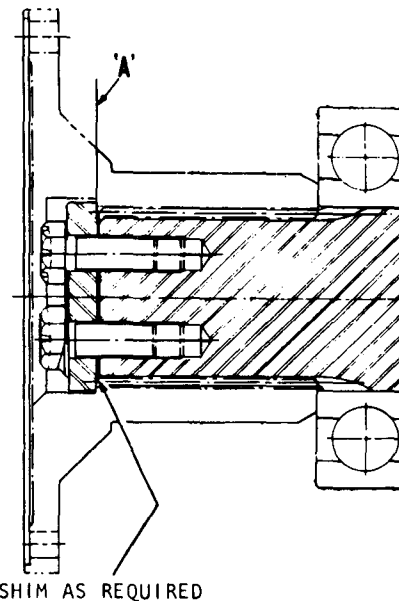


Fig. 4-7. Measurement to determine flange shim thickness

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## GENERAL OVERHAUL INFORMATION

Para 4-8/4-11

Select shims which will equal this thickness (within  $\pm 0.002$  inch/ $0.05$  mm/).

### NOTE

Shims are available in 0.005 inch (0.12 mm) and 0.025 inch (0.63 mm) thicknesses. Combine these as required to obtain the proper pack.

(5) Install shim pack, flange washer, lockstrip, and two flange bolts. Tighten the 1/2-20 bolts to 96 to 115 pound feet (130 to 156 Nm) torque. Tighten the 3/8-24 bolts to 41 to 49 pound feet (56 to 66 Nm) torque. Bend the lockstrip corners against the flats on the bolt heads.

### 4-9. WEAR LIMITS

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

### 4-10. SPRING SPECIFICATIONS





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

### 4-11. 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 are given in pound feet. The Newton meter equivalents are shown in parentheses.)

Size	Threads per inch	Standard heat-treated bolts and screws	Special heat-treated bolts, screws, Allen-head screws and self-locking capscrews	Nuts
			  	
1/4	20	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)	14-17 (19-23)
3/8	16	26-32 (35-43)	36-43 (49-58)	
	24	33-40 (45-54)	41-49 (56-66)	31-37 (42-50)
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)

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### 4-12. CARRIER SPINDLE INSTALLATION

Spindles must be installed into the carrier bores by either one of two methods—either chill the spindles or heat the carrier. Available facilities will determine the most practical method. To chill the spindles, place them in dry ice for at least one hour prior to assembly. To heat the carrier, place it in

an oil bath or oven at 300-350°F (149 to 176°C) for approximately one hour prior to assembly.

#### NOTE

If chilled spindles were installed, and the assembled carrier will not be installed into a transmission in the near future, apply a coating of oil around the spindle locations.

## Section 5. DISASSEMBLY OF TRANSMISSION INTO SUBASSEMBLIES

### 5-1. SCOPE OF SECTION 5

a. Models Covered. This section describes the disassembly of all TRT 2001 model transmissions into subassemblies.

b. Disassembly Sequence. The sequence of instructions is divided into groups. Each group is identified with the models to which the procedures apply. Any procedure not applicable to the transmission being disassembled may be disregarded and disassembly continued with the next applicable procedure.

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

a. Service, Maintenance. The TRT 2001 transmissions are designed so that some service and maintenance operations can be accomplished without removing the transmission from the vehicle. The disassembly procedures in this manual, however, illustrate the operations with the transmission removed.

b. Accessibility. The nature of the service required and the accessibility to that area (or component) will determine the advisability of performing major operations without removing the transmission. Procedures for disassembly are essentially the same, but the position of the transmission may cause some inconvenience at times. In general, though, if the construction of the vehicle provides room, all external subassemblies and all components removed from the rear of the transmission may be serviced. A close inspection should be made and the foregoing factors weighed, before deciding if the transmission should be removed. Refer to paragraph 4-7 for instructions on removal of the transmission from the vehicle.

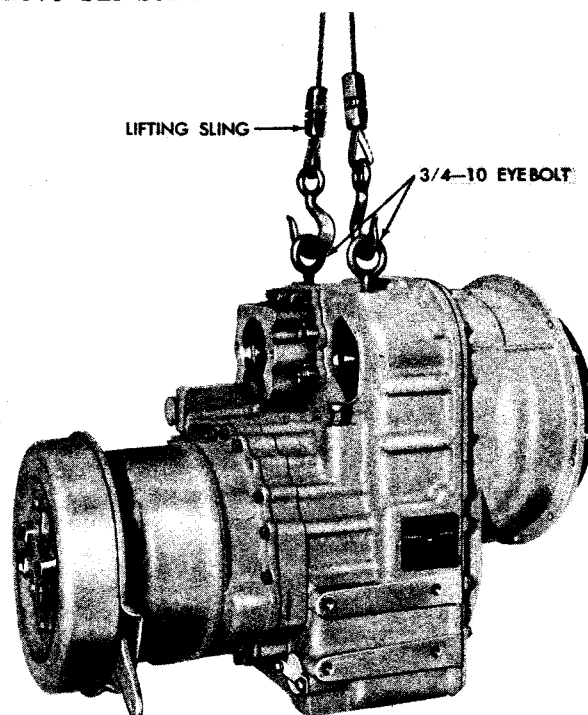
### 5-3. REMOVAL OF EXTERIOR COMPONENTS (all models)

a. Lifting, Handling. All TRT transmissions have two 3/4-10 tapped holes in the top of the main housing of the transmission. Eyebolts may be installed into these holes to provide a means for lifting the transmission while positioning it for disassembly (fig. 5-1).

b. PTO Coupling. If the transmission is equipped with adapter drive coupling 4 (A, foldout 15), remove the coupling.

#### c. Oil Strainer, Drain Plug

(1) On -1 model transmissions, remove six bolts and lockwashers which retain



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Fig. 5-1. Lifting transmission

## TRT 2001 SERIES TRANSMISSION

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the oil strainer. Remove the strainer and gasket (fig. 5-2). Remove the oil drain plug. Remove oil filler components at the lower right-front of the housing.

(2) On -3 model transmissions, remove two bolts and lockwashers which retain the strainer cover. Remove the cover and sealing (fig. 5-3). Remove the strainer. Remove the oil drain plug.

#### d. Flanges, Parking Brake (-1 models)

(1) Remove four self-locking bolts which retain the parking brake drum (fig. 5-4). Remove the brake drum.

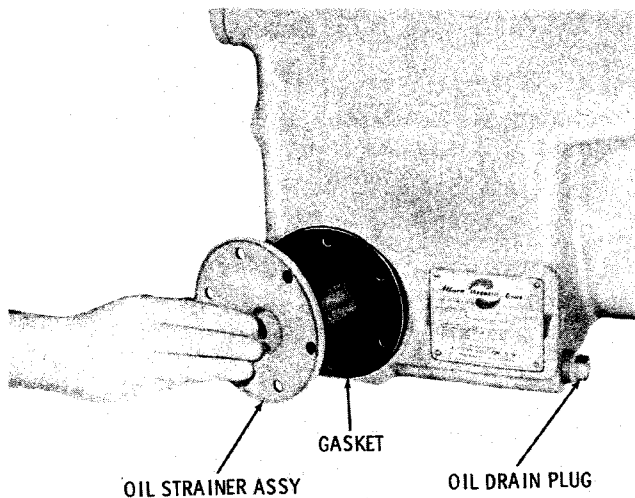


Fig. 5-2. Removing oil strainer and gasket (-1 model)

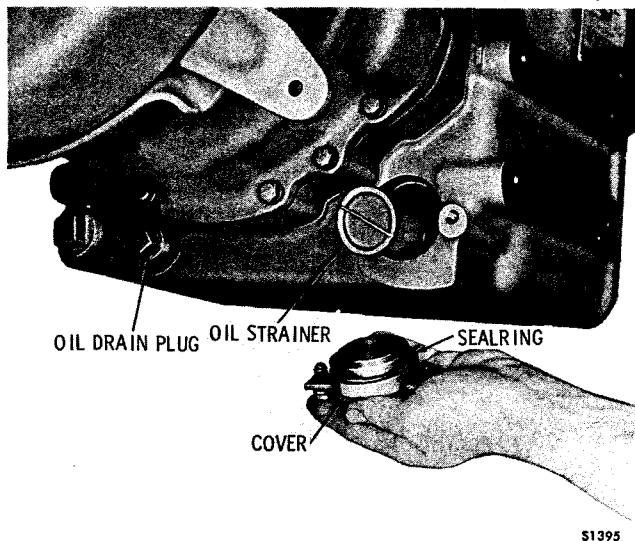


Fig. 5-3. Removing oil strainer and gasket (-3 model)

#### NOTE

Some models are equipped with flanges that are attached to the inside of the brake drum (attaching bolt heads are not accessible). On these models, the output flange must be removed before the brake drum can be removed.

(2) Remove the nuts and washers which retain the output flanges. On later models, remove the sealing from the output shaft. Using a suitable puller, remove the flanges (refer to para 4-8a).

(3) Remove four self-locking bolts which retain the brake back plate (fig. 5-5). Remove the back plate assembly.

(4) Remove two springs 5 (B, foldout 14, two shoe assemblies 4, lever 6, and roller 3.

(5) On remote-mount installations, the input flange also is removed as outlined in (2), above, except a sealing is not used at this location. If the input flange is retained by bolts, refer to e(2) and (3), below.

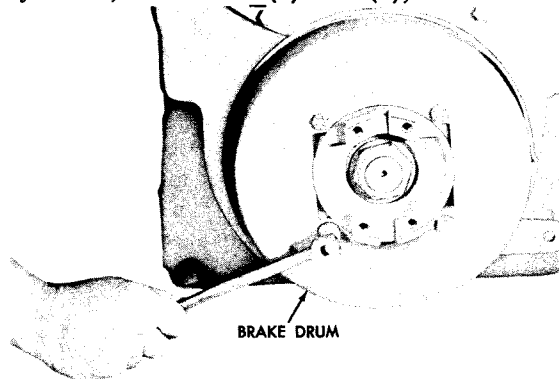


Fig. 5-4. Removing brake drum (-1 model)

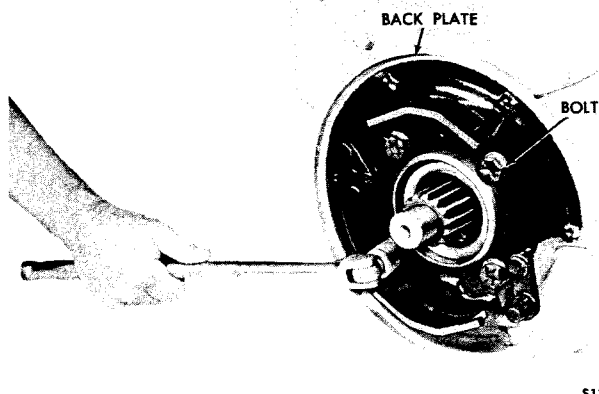


Fig. 5-5. Removing brake back plate bolts (-1 model)



## DISASSEMBLY

### Para 5-3

#### e. Flanges, Parking Brake (-3 models)

(1) Remove the eight self-locking bolts that retain the parking brake drum (fig. 5-6). Remove the drum.

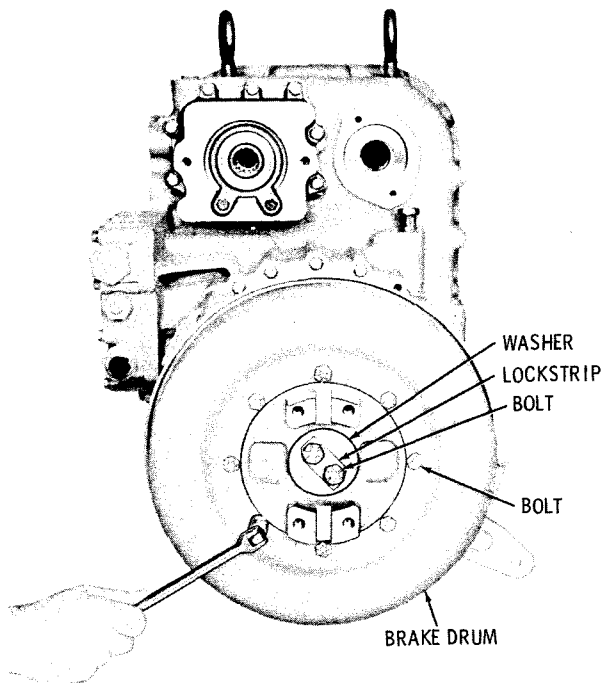
#### NOTE

Some models are equipped with flanges that are attached to the inside of the brake drum (attaching bolt heads are not accessible). On these models, the output flange must be removed before the brake drum can be removed.

(2) Flatten the lockstrip (fig. 5-6) and remove the flange bolts, lockstrip, flange washer and shims.

(3) Using a suitable puller, remove the output flange (refer to para 4-8a).

(4) Remove two springs 5 and 7 (C, foldout 14), two shoe assemblies 4, lever 6 and roller 3.



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Fig. 5-6. Removing brake drum bolts (-3 model)

(5) Remove three bolts 15 and lockwashers 16 which retain back plate assembly 2. Remove the back plate assembly.

(6) Remove the input drive flange on remote-mount installations as outlined in d(2), above.

#### f. Control Valve Assembly

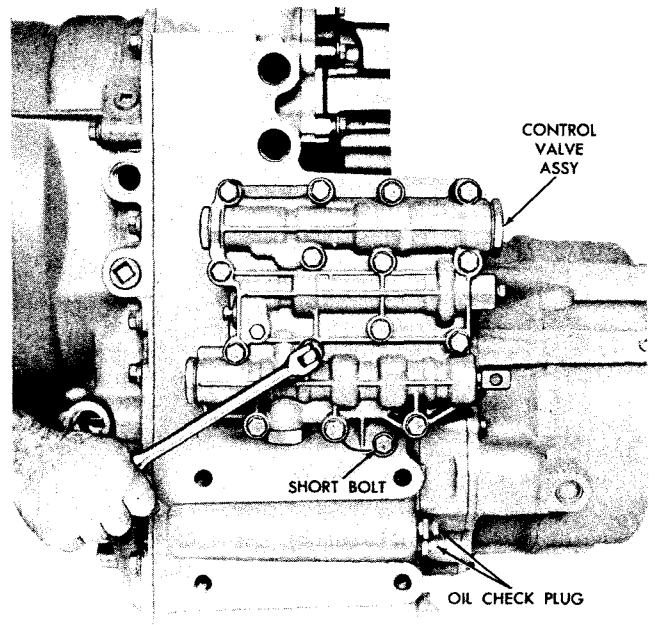
(1) Remove fifteen long bolts and one short bolt that retain the control valve assembly to the transmission housing (fig. 5-7).

(2) Remove the control valve assembly and gasket.

#### NOTE

The forward, reverse clutch anchor pin is retained by the control valve assembly. It should be temporarily retained by a large flat washer and bolt installed into the nearest bolt hole.

(3) Refer to paragraph 6-27 for rebuild of the control valve assembly.



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Fig. 5-7. Removing control valve bolts

## TRT 2001 SERIES TRANSMISSION

### Para 5-4

#### 5-4. REMOVAL OF INPUT, CONVERTER HOUSING COMPONENTS (all models)

##### a. Input Drive Components (remote mount)

(1) Remove twelve bolts 10 (A, fold-out 5), lockwashers 19 and nuts 20 which retain transmission front cover 11. Remove the cover and gasket 12. Refer to paragraph 6-3 for rebuild of the front cover.

(2) Using a puller, remove bearing 13 from input shaft 16 or 22. Flatten the corners of lockstrips 15.

(3) Remove six bolts 14, three lockstrips 15 and shaft 16 or 22.

##### NOTE

Items 13 through 16 (or 22) may remain assembled on cover 18 (or 23) if removal is not necessary for parts replacement.

(4) Remove twenty-four self-locking nuts 17. Remove torque converter cover 18 or 23.

##### b. Input Drive Components (direct mount)

(1) Remove the six self-locking bolts and plate which retain the flex disk assembly (fig. 5-8). Remove the flex disk assembly.

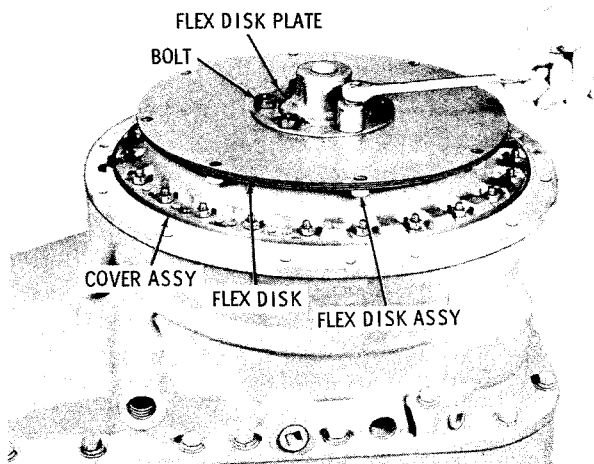


Fig. 5-8. Removing flex disk bolts

(2) Remove twenty-four self-locking nuts which retain the torque converter cover assembly (fig. 5-8).

(3) Remove the converter cover 5 or 11 (B, foldout 5) and sealring 12.

(4) On models which use converter cover 5, remove sealring 3, twenty-four nuts 4, cover 5 and sealring 12.

##### c. Torque Converter Components

(1) Using two screwdrivers, remove the first-and-second turbine assembly (fig. 5-9). Do not disassemble this unit unless inspection or parts replacement is necessary. If necessary, refer to paragraph 6-4 for rebuild of turbine assembly.

(2) Remove the snapping which retains the converter stator (fig. 5-10). Remove the stator.

(3) Remove the stator spacer from the converter ground sleeve (fig. 5-11).

(4) Flatten the corners of the lockstrips and remove four bolts (spaced at 90°) from the converter pump hub. Install a suitable puller assembly (refer to fig. 4-1) and remove the pump assembly (fig. 5-12).

##### NOTE

Any puller assembly used must bear against the end of the ground sleeve and not against either turbine drive gear.

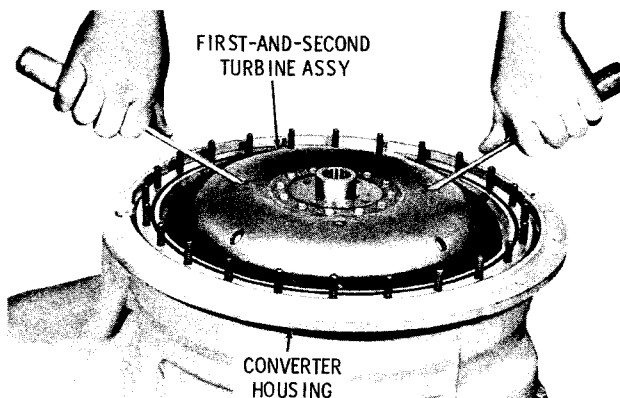
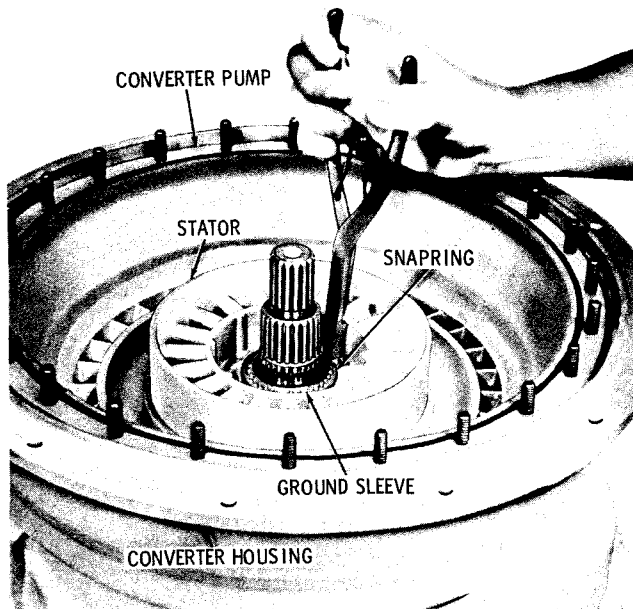


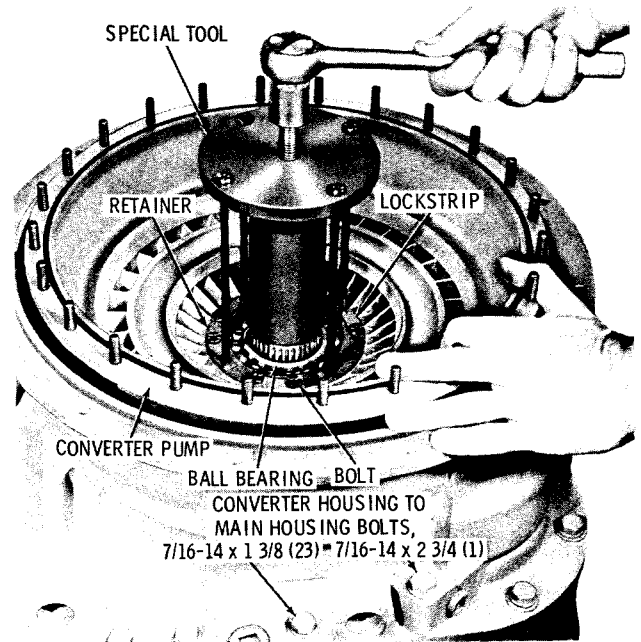
Fig. 5-9. Removing first-and-second turbine assembly

If further disassembly is required, refer to paragraph 6-5 for rebuild of the converter pump assembly. If disassembly is not required, reinstall the four 1/4-28 x 1 1/4-inch bolts removed in (4), above. Tighten the bolts to 10 to 12 pound feet (14 to 16 Nm) torque and bend the lockstrip tabs against the replaced bolts.



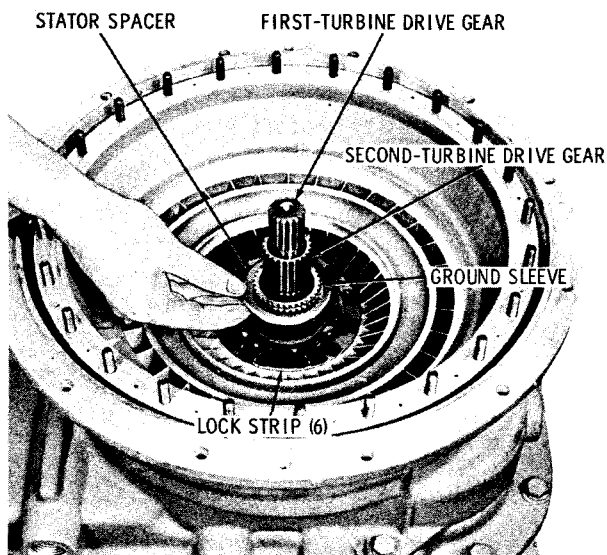
S1402

Fig. 5-10. Removing stator snapping



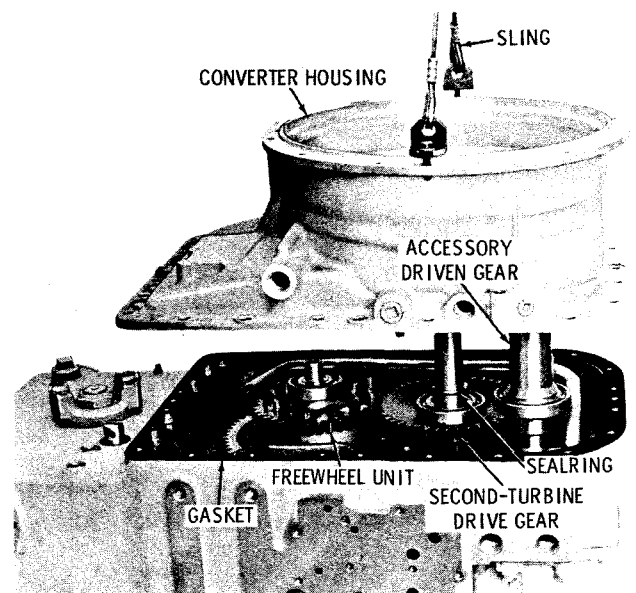
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Fig. 5-12. Removing converter pump assembly



S1403

Fig. 5-11. Removing stator spacer



S1405

Fig. 5-13. Removing torque converter housing