Allison Transmissions

TT, TTB, TRT 2001 Series Service Manual

Detroit Diesel Allison

IMPORTANT SAFETY NOTICE

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

Proper service and repair is important to the safe, reliable operation of the equipment. 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.

WARNINGS, CAUTIONS, AND NOTES

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

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

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

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

LIST OF WARNINGS

This manual contains the following warnings. IT IS YOUR RESPONSIBILITY to be familiar with all of them.

Do not burn discarded Teflon seals. Toxic gases are produced by burning.

Never dry bearings by spinning them with compressed air. A spinning bearing can disintegrate, allowing balls or rollers to become lethal flying projectiles.

During disassembly, do not allow second-turbine drive gear and freewheel unit to remain with the converter housing. The second-turbine drive gear could fall unexpectedly and cause damage or injury.

SA 2003

Service Manual

Allison Transmissions

POWERSHIFT MODELS

TT 2221-1, TTB 2221-1
TT 2421-1, TTB 2421-1
TRT 2211-3, TRT 2411-3
TRT 2221-1, TRT 2421-1
TRT 2221-3, TRT 2421-3

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NOTE:

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

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

Section 4. GENERAL OVERHAUL INFORMATION

TABLE OF CONTENTS (CONT)

Section 5. DISASSEMBLY OF TRANSMISSION

TABLE OF CONTENTS (CONT)

Section 6. REBUILD OF SUBASSEMBLIES

TABLE OF CONTENTS (CONT)

Section 7. ASSEMBLY OF TRANSMISSION

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLES

TABLE OF CONTENTS (CONT)

FOLDOUTS (back of manual)

Exploded Views

Section 1. GENERAL INFORMATION

1-1. SCOPE OF MANUAL

a. Coverage. This Service Manual describes the operation, maintenance, and overhaul procedures for the following Powershift transmissions (fig. 1-1 through 1-5):

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

The function and operation of the hydraulic systems, torque paths, wear limits, inspection procedures, and torque specifications are included.

b. Illustrations. Transmission features and overhaul procedures are illustrated mainly by photographs. Line drawings are used to illustrate the hydraulic systems and to supplement detailed assembly procedures; cross sections show torque paths and the relationship of assembled p a r t s. Exploded views illustrate the relationship of transmission parts. The cross section and exploded views appear on foldouts at the back of the manual. The foldouts m a y be opened for reference while studying the text.

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

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

- Formal instruction in a DDA or Distributor training facility.
- "On-the-job" instruction by a DDA or Distributor representative.
- Experience in performing the task.

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

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

(4) Reasonable and prudent maintenance practices are utilized.

NOTE

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

1-2. SUPPLEMENTARY INFORMATION

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

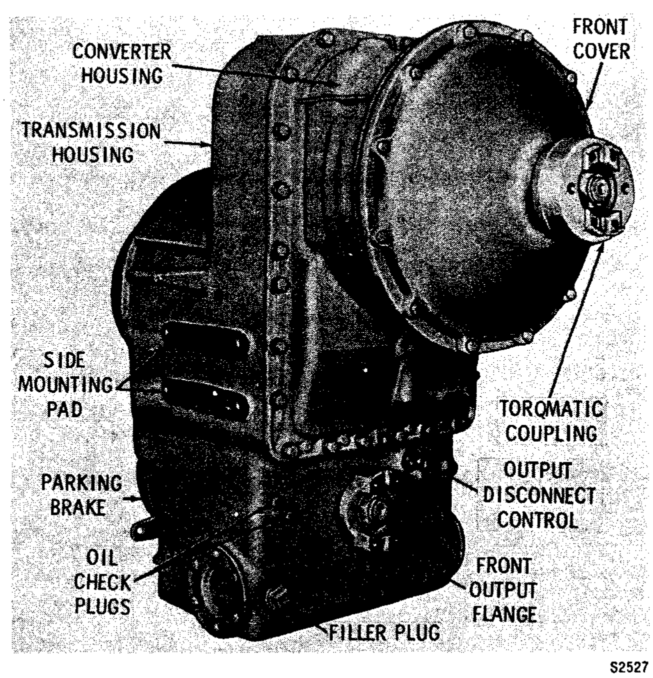


Fig. 1-1. Model TT 2221-1 (or TT 2421-1) transmission--right-front view

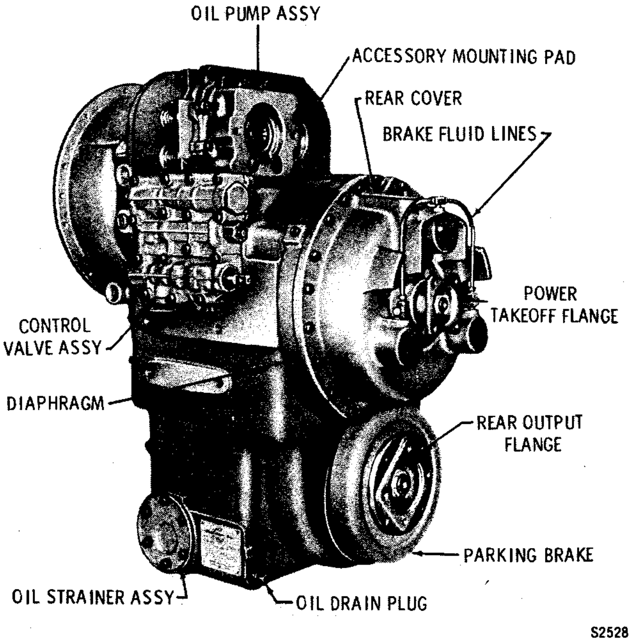


Fig. 1-2. Model TTB 2221-1 (or TTB 2421-1) transmission--left-rear view

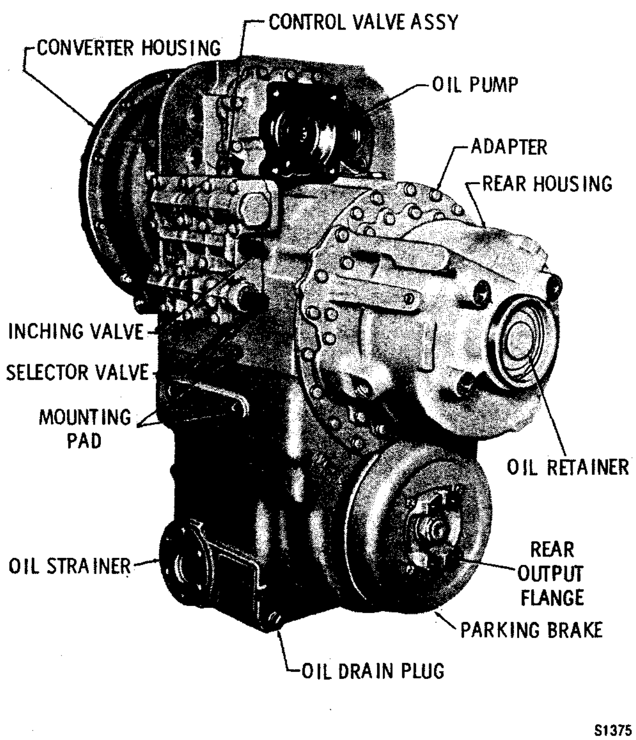


Fig. 1-3. Model TRT 2221-1 (or 2421-1) transmission—left-rear view

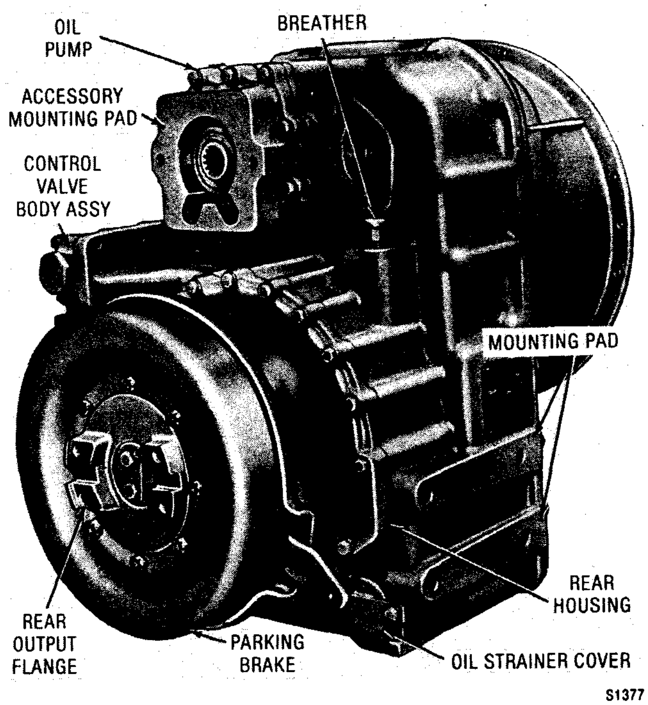


Fig. 1-4. Model TRT 2211-3 (or 2411-3) transmission--right-rear view

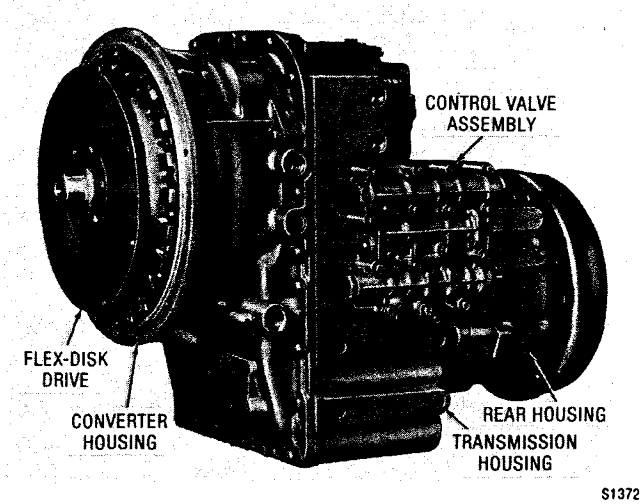
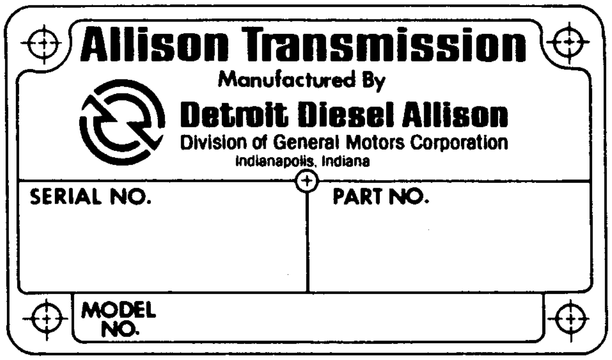


Fig. 1-5. Model TRT 2221-3 (or 2421-3) transmission--left-front view

1-3. ORDERING PARTS

a. Transmission Nameplate. The nameplate (fig. 1-6), located on the lower left side of the transmission housing, has the serial number, part number (assembly number), and



9663A

Fig. 1-6. Transmission nameplate

model number all of which must be supplied when ordering parts or requesting service information.

b. Parts Catalog. All replacement parts and service kits should be ordered from your dealer. These parts are listed in the current Parts Catalog SA 1248. Do not order parts by illustration item numbers used in this Service Manual.

1-4. DESIGN FEATURES

a. Model Differences. Refer to foldout 1, 2, 3, 4, or 5 for the model that is to be serviced or rebuilt. The various features described in this section will not all be on any one model. For detailed description of specific models, refer to Section 2. Basic differences are indicated by the model designation:

TT	-	Twin turbine with two forward ranges, one reverse range
TRT	-	Twin turbine with equal ranges forward and reverse
B	-	Internal service brake
2	-	2000 Series transmission
2 (or 4)	-	Converter series
2 (or 1)	-	Number of drive ranges
1	-	Major model change
-1	-	Long drop transfer housing
-3	-	Short drop transfer housing

b. Mounting, Input Drive

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

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

c. Twin-Turbine Torque Converter

(1) A four-element twin-turbine torque converter transmits power from the engine to the transmission gearing through two sets of turbine gears.

(2) When torque demand is high, the freewheel clutch is engaged and the first turbine, assisted by the second turbine, drives the range gears. When the speed of the vehicle increases and torque demand decreases sufficiently, the second turbine assumes the entire load and the freewheel clutch disengages. The transition from both turbines to second turbine only (high torque to high speed) is automatic, and occurs when the load demand has reduced to a level that can be supplied by the second turbine.

d. Range Gearing, Clutches. The transmissions have two or three planetary gear sets and two, three, or four clutches. Each of the clutches is applied separately. Two forward ranges (F1 and F2) and reverse (R1 and R2) are derived from the range gearing and clutches. All clutches are multiplate, hydraulically applied, and spring released. All gearing is in constant mesh.

e. Transfer Gears. Two transfer spur gears are in constant mesh and in conjunction with the turbine gear, provide either a 19-inch (483 mm) (-1 models) vertical drop or a 7-inch (178 mm) (-3 models) vertical drop from the input shaft to the output shaft. The transfer gears drive the output shaft.

f. Output Shafts

(1) The transmission may be equipped with either a one-piece shaft or a two-piece shaft.

(2) A one-piece shaft may provide for identical operation at the front and rear outputs or may provide for operation at the rear output only. The two-piece shaft and disconnect coupling allow the front output shaft to be disconnected from the driveline while drive at the rear output shaft is maintained.

g. Converter-driven Power Takeoff. Some models include a converter-driven power takeoff (PTO) which consists of a PTO shaft which extends through the rear cover. An output flange is splined to the rear end of the PTO shaft. The forward end of the PTO shaft is splined to the reverse-and-low-range sun gear, which is driven by the torque converter. Thus, regardless of the range selector position, the PTO rotates at the same rpm as the torque converter output.

h. Output-driven Power Takeoff (TT models). Some TT models include an output-driven power takeoff (PTO) which consists of an access to the splines in the rear of the high-range piston housing through the rear cover. With the addition of an OEM furnished hydraulic pump, this PTO-driven pump provides hydraulic pressure for steering in the event of engine failure, as long as the vehicle is still moving.

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

j. Accessory Drive Pad

(1) An SAE size A, two-bolt mounting pad is located at the upper-right rear of the transmission housing to accommodate a steer pump or other accessory (in addition to that mounted at the rear of the oil pump). Rotation at this pad is clockwise (as viewed from the rear). Lubrication is supplied to the splined drive, and a customer-supplied gasket is required at the mounting surface.

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

k. 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. Rotation of the pump is in a clockwise direction (viewed from rear) and is proportional to the speed of the engine. A mounting pad is provided at the rear of the oil pump to accommodate an implement pump. Lubrication is supplied to the splined output drive and a customer-supplied gasket is required at the mounting surface.

l. Control Valve Body Assembly. The control valve body assembly is located on the left side of the transmission housing (fig. 1-2, 1-3, 1-5). Movement of the valves within the valve body controls the functions of the transmission. All shifts are trimmed for a soft-shift capability. The control valve body assembly contains, in addition to the pressure regulator valve, range selector valve, and related components, either a clutch cutoff valve or an inching control valve.

m. Parking Brake. The transmission may be equipped with an expanding-shoe parking brake. The brake is mechanical and is manually operated.

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

1-5. OPERATING INSTRUCTIONS

NOTE

Refer to Operators Manual SA 1336.

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

b. Range Selection

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

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

c. Changing Direction of Travel. Directional shifts can be made under full-power or full-speed conditions in the working ranges (F1 to R1 and R1 to F1). Shifts from reverse should be made to F1 drive range--not F2. Direct shifts from R1 to F2 will adversely affect clutch service life.

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

e. Inching Control

CAUTION

Use of inching control in high range will cause premature failure of the high-range clutch because no cooling oil is present at the clutch during inching.

(1) Applying the inching control releases the driving clutch. The inching control may be used during operation in any range except that its use in high range (F2) is not recommended.

(2) Full application will completely release the driving clutch. Lesser application will slip the clutch while it is driving. Very slight and slow movements of the vehicle can be made with this control.

f. Output Disconnect. The transmission front output may be disconnected by moving the control (at the front of the dropbox) which moves the disconnect coupling forward. Rearward movement connects the front and rear output shafts through the splines of the coupling. Two spring-loaded ball detents retain the coupling in either position. The control should never by shifted while the vehicle is moving; however, slight shaft rotation may be required to obtain correct spline alignment for engagement.

g. Towing. All lubrication and clutch apply oil is provided by the engine-driven oil pump. Because of the pump location, ahead of the transmission gearing and clutches, the oil pump cannot be motored by towing or pushing the vehicle. THEREFORE, ANY TIME THE VEHICLE MUST BE TOWED OR PUSHED FOR MORE THAN A HALF MILE (HALF KILOMETER), THE DRIVELINE MUST BE DISCONNECTED.

h. Temperatures, Pressures

(1) When a transmission is equipped with a temperature gage, the bulb or sending unit is mounted in the converter-out oil circuit (fig. 3-1). Temperature should never be permitted to exceed 275°F (135°C). Extended, severe operating conditions may cause the temperature to exceed this maximum. If so, the transmission should be shifted to neutral and the engine should be operated at approximately 1000-1500 rpm for several minutes until the normal temperature of 180-220°F (82-104°C) is restored. If the temperature reaches a maximum of 275°F (135°C) during normal operation of the transmission, stop the engine and locate the trouble. Refer to the Troubleshooting Chart (para 3-13).

(2) When a transmission is equipped with a clutch (main) pressure gage, it is connected to the front of the control valve body

assembly (fig. 3-1). The pressure shown is that which is effective in the operating range clutch. Shifting or use of the clutch cutoff or inching control will cause a drop in the pressure indicated. If abnormal pressures are evident, refer to the Troubleshooting Chart (para 3-13).

1-6. SPECIFICATIONS, DATA

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

SPECIFICATIONS AND DATA

Item	Description	
Transmission type	torque converter and planetary gear	
Rating:		
input speed	3000 rpm (max)	
input torque (net*)	310 lb ft (420 N·m) (max)	
input horsepower	175 hp (130 kW) (max)	
Rotation, viewed from front:	-1	-3
input	clockwise	clockwise
output (forward operation)	clockwise	counterclockwise
(reverse operation)	counterclockwise	clockwise
Mounting, drive:		
side	four 5/8-11 tapped holes in side pads, each side	
front, direct mounted	modified SAE-3 flange on converter housing bolts to engine flywheel housing, flex plate attaches to engine flywheel (optional splined drive)	
front, remote mounted	front unmounted, converter enclosed, input flange for shaft and universal joint coupling	

Gear ranges, selector positions:

	TRT 2211-3 TRT 2411-3	TT 2221-1 TTB 2221-1 TT 2421-1 TTB 2421-1	TRT 2221-1 TRT 2221-3 TRT 2421-1 TRT 2421-1
Reverse High	-	-	R2
Reverse Low	R	R	R1
Neutral	N	N	N
Forward Low	F	F1	F1
Forward High	-	F2	F2

* Net as installed: inlet restriction, exhaust restriction, alternator, fan, idle steer pump, idle implement pump, and air compressor should be deducted when applicable.

SPECIFICATIONS AND DATA (cont)

Item	Description	
Weight, dry (approx):		
Basic Model	lb	kg
TT 2001-1	760	345
TTB 2001-1	935	424
TRT 2001-1	910	413
TRT 2001-3	755	342
TRT 2011-3	660	299
Add Weight		
Remote mount	40	18
2401 Model (larger converter)	15	7
Torqmatic® coupling	36	16
Flange	6	3
Parking brake (-1 models)	20	9
Parking brake (-3 models)	35	16

Torque converter . . . . two-stage, four-element, twin-turbine

0.826:1 T_2 Converters*	1.211:1 T_2 Converters*
TT 220 -- 5.47:1	TT 252 -- 5.09:1
TT 240 -- 5.44:1	TT 262 -- 3.32:1
TT 260 -- 5.11:1	TT 272 -- 4.81:1
TT 270 -- 6.97:1	TT 426 -- 4.78:1
TT 425 -- 5.19:1	TT 427 -- 3.40:1
TT 444 -- 6.79:1	TT 447 -- 3.34:1
TT 445 -- 4.92:1	
TT 465 -- 4.67:1	

®Torqmatic is the registered trademark of Detroit Diesel Allison, Indianapolis, IN and Detroit, MI.

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

SPECIFICATIONS AND DATA (cont)

Item	Description
Range gearing	constant mesh, straight spur, planetary
Transfer gearing	constant mesh, straight spur, in-line

*Gear ratios:

	0.826:1 T_2 Converters		1.211:1 T_2 Converters	
	Low	High	Low	High
TT(B) 2221-1, 2421-1				
F:	2.663:1	0.699:1	3.902:1	1.024:1
R:	1.964:1	---	2.878:1	---
F:	2.029:1	0.699:1	2.973:1	1.024:1
R:	1.964:1	---	2.878:1	---
F:	2.153:1	0.566:1		
R:	1.588:1	---		
TRT 2211-3, 2411-3				
F:	2.398:1	---		
R:	2.321:1	---		
TRT 2221-1, 2421-1				
F:	2.029:1	0.736:1	2.973:1	1.079:1
R:	1.964:1	0.712:1	2.878:1	1.043:1
TRT 2221-3, 2421-3				
F:	6.612:1	2.398:1	9.689:1	3.514:1
R:	6.398:1	2.321:1	9.375:1	3.401:1
F:	2.398:1	0.826:1		
R:	2.321:1	0.799:1		

Clutch data:

type	multidisk, hydraulic-actuated, spring released, oil-cooled; automatically compensates for wear
material	external-tanged reaction plates--polished steel internal-splined friction plates forward, reverse--resin-graphite high range--sintered bronze
Freewheel clutch	standard or heavy duty, depending on application

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

SPECIFICATIONS AND DATA (cont)

Item	Type and Size	Burnished Rating
Parking brake:		
-1 Models	expanding-shoe, mechanically-applied, 10 x 1-1/2 in. (254 x 38 mm)	30,000 lb in. (3389 N·m) at 1500 lb (6672 N) apply force
-3 Models	expanding-shoe, mechanically-applied, 13-3/8 x 2 in. (340 x 51 mm)	45,000 lb in. (5084 N·m) at 2100 lb (9341 N) apply force

Item	Description
Internal brake (TTB model):	
type	multidisk, hydraulic-applied, self-adjusting, oil cooled
rating (static capacity)	3000 lb ft (4068 N·m) at transmission output shaft with 1500 psi (10 342 kPa) max. brake-apply pressure
hydraulic brake fluid	SAE J70, type 70R1 or 70R3
Flanges:	
input and output	Mechanics 4C, 5C, 6C, 7C; Rockwell 5N plain, 6N plain; Spicer 1480
Torqmatic coupling	Mechanics 5C (TT,TTB,TRT 2221-1) Mechanics 6C (TT,TTB,TRT 2421-1)
Oil system:	
oil pump	input driven, positive displacement, gear type
oil pump output pressure	255 psi (1758 kPa) max (with clean filter) (measure at TO FILTER port)
sump	single, integral
oil	Type C3

Fluid Viscosity and Grade	Ambient Temperature Below Which Preheat is Required
SAE 30	32°F (0°C)
SAE 15W-40	32°F (0°C)
SAE 10W-30	10°F (-12°C)
SAE 10W	10°F (-12°C)
SAE 5W-20	-10°F (-23°C)

SPECIFICATIONS AND DATA (cont)

Item	Description	
Oil system (cont):		
oil capacity:		
-1 model (less external circuits)	initial fill--8-1/2 US gal (32 liters)	
-3 model (less external circuits)	initial fill--6-1/2 US gal (25 liters)	
oil filter (customer furnished)	remote mounted	
filtration	44 micron (max)	
pressure drop across filter	clean 35 psi (241 kPa) max; dirty 45 psi (310 kPa) max	
converter-out oil temperature	275°F (135°C) max continuous	
main pressure, at full throttle, in all ranges	*135 to 170 psi (930 to 1171 kPa)--vehicle weight to 28,000 lb (12 701 kg) *160 to 195 psi (1102 to 1343 kPa)--vehicle weight over 28,000 lb (12 701 kg)	
lubrication pressure, at full throttle stall	10 to 30 psi (68 to 206 kPa)	
converter-out pressure, at full throttle stall	40 psi (275 kPa) (min)	
converter-out pressure, at full throttle, no-load	65 psi (447 kPa) (max)	
Control valve body assembly:		
clutch cutoff	hydraulic- or pneumatic-actuated	
inching control	manual-actuated	
Engine-driven power takeoffs:		
implement pump drive (pad at rear of oil pump):		
ratio--standard	0.91 x engine speed	
--optional	1.00 x engine speed	
maximum rating:	Continuous	Intermittent
horsepower, at 2000 to 3000 rpm	90 (67 kW)	110 (82 kW)
torque, up to 2000 rpm	236 lb ft (321 N·m)	288 lb ft (391 N·m)
mounting pad	SAE size C, two-bolt or four-bolt; SAE size B, two-bolt	
spline size	SAE size B, SAE size C, SAE size B-B (1.00:1 PTO Ratio only)	

* Main pressure in high range may be as much as 10 psi (33 kPa) lower than in other ranges. These pressures are established for a converter-out temperature range of 140 to 165°F (60 to 73.8°C). As converter-out temperature approaches 250°F (121°C), main pressure can drop as much as 15 psi (103 kPa).

SPECIFICATIONS AND DATA (cont)

Item	Description
Engine-driven power takeoffs (cont):	
accessory drive:	
ratio--standard	0.91 x engine speed
--optional	1.00 x engine speed
*maximum rating:	
horsepower	30 hp (22 kW) at 2000-3000 rpm
torque	79 lb ft (107 N·m) up to 2000 rpm
mounting pad	SAE size A, two-bolt
spline size	SAE size A or SAE size B
Converter-driven power takeoff:	
ratio--standard	1.21 x converter output speed
--optional	0.83 x converter output speed
rating, continuous	full input (engine) hp (kW)
Output-driven power takeoff (emergency-steer PTO):	
ratio	0.846 x output speed or 0.684 x output speed, depending on transmission gear ratio
maximum rating	30 hp (22 kW) at 2000-3000 rpm
mounting pad	SAE size A, two-bolt (gasket required)
Speedometer drive pad (some models):	
type	SAE 5/32, heavy duty
ratio	0.846 x transmission output speed or 0.684 x transmission output speed depending on transmission gear ratio
Magnetic speed pickup provision (later models)	3/4-16 UNF-3B tapped port in main housing

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

Section 2. DESCRIPTION AND OPERATION

2-1. SCOPE

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

2-2. GEARING, CLUTCHES, HYDRAULIC SYSTEMS, TORQUE PATHS

Table 2-1 shows the relationship of clutches, planetaries, and ranges for the various TT, TTB, and TRT 2001 Series Transmissions. It also references the paragraphs which explain the hydraulic systems and torque paths.

2-3. POWER TAKEOFF (TT MODELS)

a. Converter-driven PTO (foldout 1)

(1) The converter-driven power takeoff consists of PTO shaft 49 which is driven at converter output speed by forward-and-reverse sun gear 26. The PTO shaft extends through the rear cover. Output flange 48 is splined to the rear end of the PTO shaft. The converter-driven PTO is designed so that full engine horsepower can be utilized.

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

b. Output-driven Power Takeoff

(1) Some TT models include an output-driven PTO which consists of a 2-bolt SAE type-A pad located in the center of the rear cover. A vehicle-furnished pump mounted on this pad will provide hydraulic pressure for emergency steering in the event of engine failure.

(2) As long as the vehicle is moving (without engine running), torque from the vehicle wheels is transmitted back through the driveline to the transfer gears in the dropbox. Rotation of the transfer gears drives the forward clutch piston. Splines in the rear hub of the piston transmit the torque to the PTO pad.

2-4. IMPLEMENT PUMP, ACCESSORY DRIVE PADS

NOTE

Refer to Specifications and Data (para 1-6) for duty ratings.

a. Implement Pump Drive Pad. The implement pump drive pad, located on the rear face of oil pump body 10 (foldout 18,A), may be any one of four configurations—four-bolt, SAE size C; two-bolt, SAE size C; 2- and 4-bolt SAE size C; or a two-bolt, SAE size B. Accessory-driven gear 2 (foldout 7,B) is engine-driven through accessory drive gear 19 (foldout 7,A) at one of two customer-selected ratios—1 to 1 or 0.91 to 1. Regardless of the range selector position, the shaft rotation is clockwise as viewed from the rear. Adapter drive coupling 18 (foldout 18,A) may be used to accommodate a B-size spline to the C-size splines in gear 2 (foldout 7,B).

b. Accessory Drive Pad. A two-bolt, SAE size A pad is located at the upper right rear face of the transmission housing. The drive at the pad is provided by accessory drive gear 1 (foldout 7,B) and drive shaft 8, which rotate at a 1 to 1 or 0.91 to 1 ratio. Shaft 8 provides either a size A or size B internal spline at its rear end. Regardless of the range selector position, the shaft rotation is clockwise as viewed from the rear. If no requirement exists for a PTO at this location, the drive gear, shaft, and related parts are omitted, the opening closed by cup plug 12 (foldout 8,B), and the oil passage closed by cup plug 10.

TABLE 2-1. Model Differences

TRANSMISSION MODELS	TT 2221-1 TTB 2221-1 TT 2421-1 TTB 2421-1		TRT 2221-1 TRT 2221-3 TRT 2421-1 TRT 2421-3				TRT 2211-3 TRT 2411-3	
		FOLDOUT		FOLDOUT				FOLDOUT
		1		2	3	4		5
CLUTCHES	Reverse	17	Reverse	39	36	37	Reverse	25
	Low (forward)	19	Forward	38	33	34	Forward	23
	High	24	Low	21	20	19		
	Internal brake (TTB)	60	High	23	18	21		
		FOLDOUT		FOLDOUT				FOLDOUT
		1		2	3	4		5
PLANETARIES	Reverse	18	Reverse	15	14	15	Reverse	17
	Low (forward)	21	Forward	18	29	32	Forward	22
			High (overdrive)	28	—	29		
			Low (underdrive)	—	26	—		

RANGES

TT 2221-1, TTB 2221-1, TT 2421-1, TTB 2421-1	HIGH	FORWARD	REVERSE
	Clutches Applied		
Reverse			X
Neutral	—	—	—
Forward-1		X	
Forward-2	X		

TRT 2221-1, TRT 2221-3, TRT 2421-1, TRT 2421-3	HIGH	LOW	FORWARD	REVERSE
	Clutches Applied			
Reverse-2	X			X
Reverse-1		X		X
Neutral		X		
Forward-1		X	X	
Forward-2	X		X	

TRT 2211-3, TRT 2411-3	FORWARD	REVERSE
	Clutch Applied	
Reverse		X
Neutral	—	—
Forward	X	

	TT 2221-1, TTB 2221-1, TT 2421-1, TTB 2421-1	TRT 2221-1, TRT 2221-3, TRT 2421-1, TRT 2421-3	TRT 2211-3, TRT 2411-3
HYDRAULIC SYSTEMS	Para. 2-8, 2-9, and 2-10	Para. 2-8, 2-9, and 2-11	Para. 2-8, 2-9, and 2-12
TORQUE PATHS	Para. 2-13, 2-14, and 2-15	Para. 2-13, 2-14, and 2-16 through 2-18	Para. 2-13, 2-14, and 2-19

2-5. OIL PUMP

Oil pump assembly 2 (foldout 18,A) consists mainly of two spur gears 5 and 7, body assembly 9, and cover 3. The oil pump assembly furnishes the entire oil flow and pressure for all transmission operations (except brake apply pressure on TTB models). The pump is driven by accessory drive gear 19 (foldout 7,A) and rotates any time the engine output shaft rotates. The transmission oil is drawn, through oil strainer 22 (foldout 8,B), into the lower end of suction tube 2 which directs it to the pump assembly. The oil is then directed, under pressure, through passages in the transmission housing to the control valve assembly and other locations for lubrication and cooling.

2-6. INTERNAL BRAKE (TTB MODELS)

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

b. Brake Operation

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

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

(3) Adjusting ring 21 has two functions. It continually adjusts the brake to a predetermined clearance, and it controls the flow of brake coolant. The ring is attached to apply plate 23 by six spring pins 22. Rings 21 can move lengthwise on the pins when sufficient force is applied. Ring 21 can move a predetermined distance forward and rearward on the inner hub of cover 38. It is restrained from further forward movement by snapring 19.

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

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

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

2-7. PARKING BRAKE

An expanding shoe-type brake may be mounted at the lower-rear output location on the transmission housing. Brake backplate 2, 8, or 13 (foldout 17,B) is bolted to the transmission housing, and brake drum 9 or 18 is bolted to a customer-selected output flange. The brake is manually operated.

2-8. CONTROL VALVE BODY ASSEMBLY

a. Control Valve Body (foldout 18,B). The control valve body contains a manually operated range selector valve 29 for reverse, neutral, low-, or high-range operation, plus main-pressure regulator valve 8, and either clutch cutoff valve 20 or inching control valve 42.

b. Main-Pressure Regulator, Selector Valves (foldout 18,B)

(1) Main-pressure regulator valve components and trimmer valve components are contained in the upper bore of the body; clutch cutoff valve (or inching control valve) components in the middle bore; and the selector valve components in the lower bore. The main-pressure regulator valve group includes items 6, 7, 8, 13, and 14. The selector valve group contains items 26 through 35.

(2) Main-pressure regulator valve 8 is spring loaded and regulates the pressure for all hydraulic functions except brake apply pressure for TTB models. The selector valve is a spool-type valve which is manually moved lengthwise to the various range positions. Spring-loaded detent balls 30 position the valve in each range.

c. Clutch Cutoff Valve (foldout 18,B)

(1) Clutch cutoff valve 20 is located between the main-pressure regulator valve and selector valve 29. It is a spool-type valve which is moved rearward by spring 19 force and forward by plug 21 when brake hydraulic pressure acts on the plug.

(2) If the valve is actuated by brake air pressure, a miniature air cylinder is mounted at the rear of the valve body. A stem of the air cylinder moves plug 49 forward within retainer plug 50.

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

d. Inching Control Valve (foldout 18,B)

CAUTION

Do not use the inching control while operating in high range. No provision is made for lubricating and cooling the high-range clutch during inching operation.

(1) Inching control valve 42 replaces the clutch cutoff valve in the valve body when this feature is used. This is a spool-type valve that is manually controlled by the vehicle operator through mechanical linkage attached to one end of the valve. Pressure from spring 41 and main oil pressure hold the valve in the CLUTCH-ON (non-inching) position. In the CLUTCH-ON position, full main oil pressure is directed to the range selector valve.

(2) When the inching control is moved, main pressure applying the driving clutch is bled off through an oil passage to the driving clutch plate area. This reduces main pressure available to apply the clutch, allowing it to slip. At the same time, the oil being bled off cools and lubricates the slipping clutch. The degree of inching valve movement determines the degree of slippage, from full apply to full release. Inching regulator valve 39 and spring 38 maintain a uniform clutch apply pressure at any given position of the inching valve.

2-9. HYDRAULIC SYSTEM—ALL MODELS

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

b. System Schematics (fig. 2-1 through 2-11). Color-coded schematics are presented which illustrate the hydraulic systems of the models covered by this manual.

2-10. HYDRAULIC SYSTEM—TT, TTB MODELS (fig. 2-1, 2-2, and 2-3)

a. Oil Pump, Filter Circuit

(1) TT models (fig. 2-1, 2-2). Oil is drawn from the transmission sump, through a wire-mesh strainer, into the oil pump. The pump delivers its entire output to a full-flow oil filter which is customer-supplied. The oil filter is mounted external from the transmission. From the filter, the entire oil supply is returned to the transmission and control valve assembly.

(2) TTB models (fig. 2-3). The oil pump and filter circuit is the same as that described for the TT models, except an additional circuit is required for cooling and lubrication of the brake components. This circuit is external and extends from the oil filter return circuit to the tapped boss in the rear cover.

b. Main-Pressure Regulator Valve, Converter-in Circuit

(1) At the control valve assembly, oil from the oil filter (red) enters the valve body, and flows around the main-pressure regulator valve. The oil also flows through a diagonal passage (orifice A) to the left end of the valve. The resultant pressure at the left end of the valve pushes the valve rightward against a spring until the oil pressure is balanced by spring force.

(2) The rightward movement of the valve against the spring exposes the port to the converter-in circuit (yellow). Oil in excess of that required to maintain main pressure is allowed to escape into the converter-in circuit. Under certain conditions, the converter-in circuit can be charged with more oil than can be exhausted by the converter pressure regulator valve. When this is the case, the main-pressure regulator valve moves farther to the right and allows oil to flow directly into the exhaust port (blue) at the left end of the valve. This flow occurs between the two short lands at the left end of the regulator valve.

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

c. Torque Converter.

The torque converter is continuously filled with oil during transmission operation. Rotation of the converter pump imparts energy to the oil which, in turn, drives the turbines. The oil then flows between the stator vanes which redirect it to the pump.

d. Converter-Out, Cooler, Lubrication Circuit

NOTE

On TTB models, an additional circuit is required to cool and lubricate the brake components. (Refer to para 2-10i.)

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

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

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

e. Clutch Cutoff Valve Circuit (fig. 2-1, 2-3)

(1) Main pressure oil (red), supplied from the left end of the main-pressure regulator valve, flows through orifice B to the clutch cutoff valve bore and then to the manual selector valve. From the selector valve the flow is directed back through the clutch cutoff valve bore to the trimmer. The orifice functions in connection with the trimmer. (Refer to para 2-10h.)

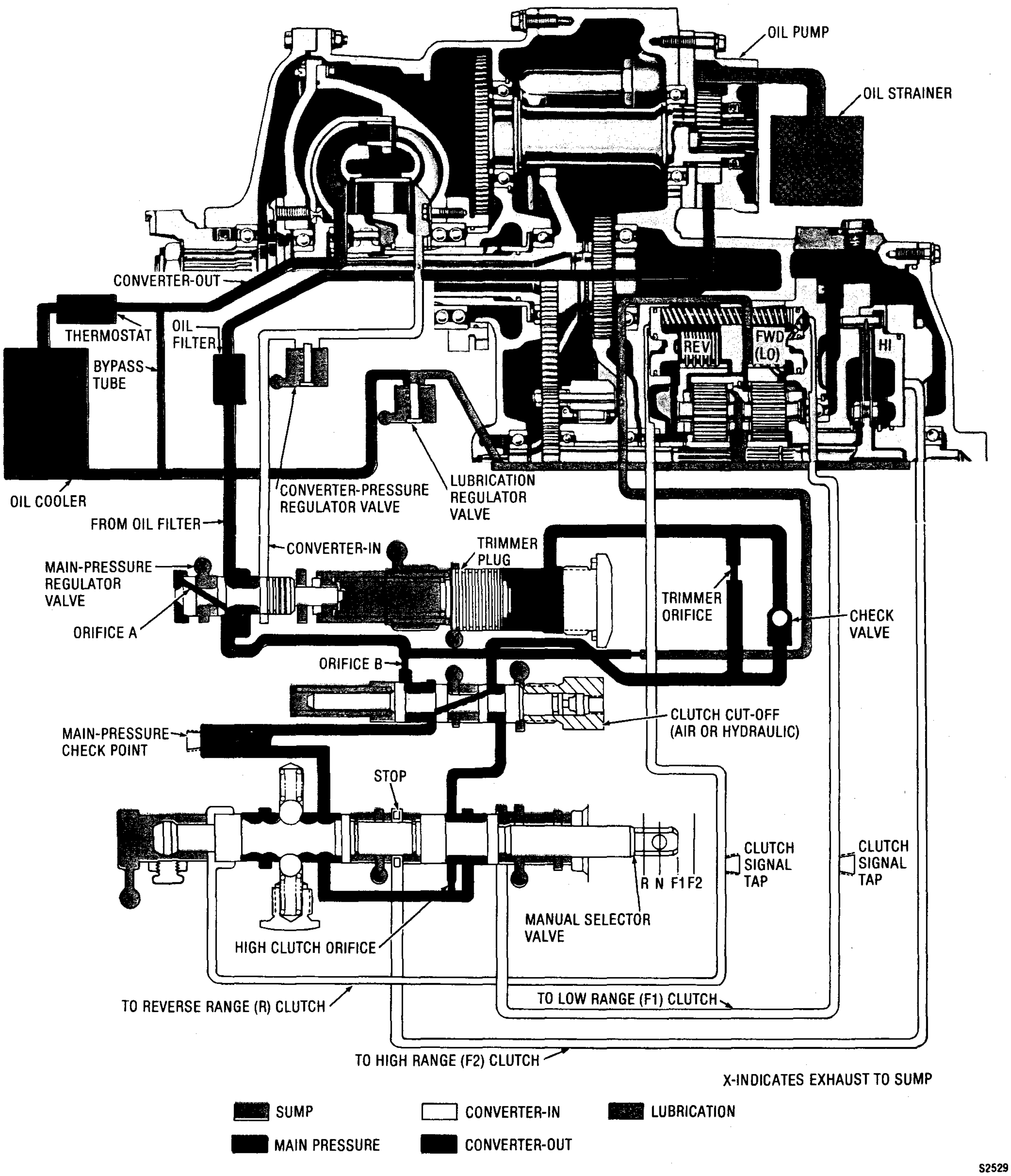


Fig. 2-1. TT 2221-1, TT 2421-1 hydraulic system with clutch cutoff control

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

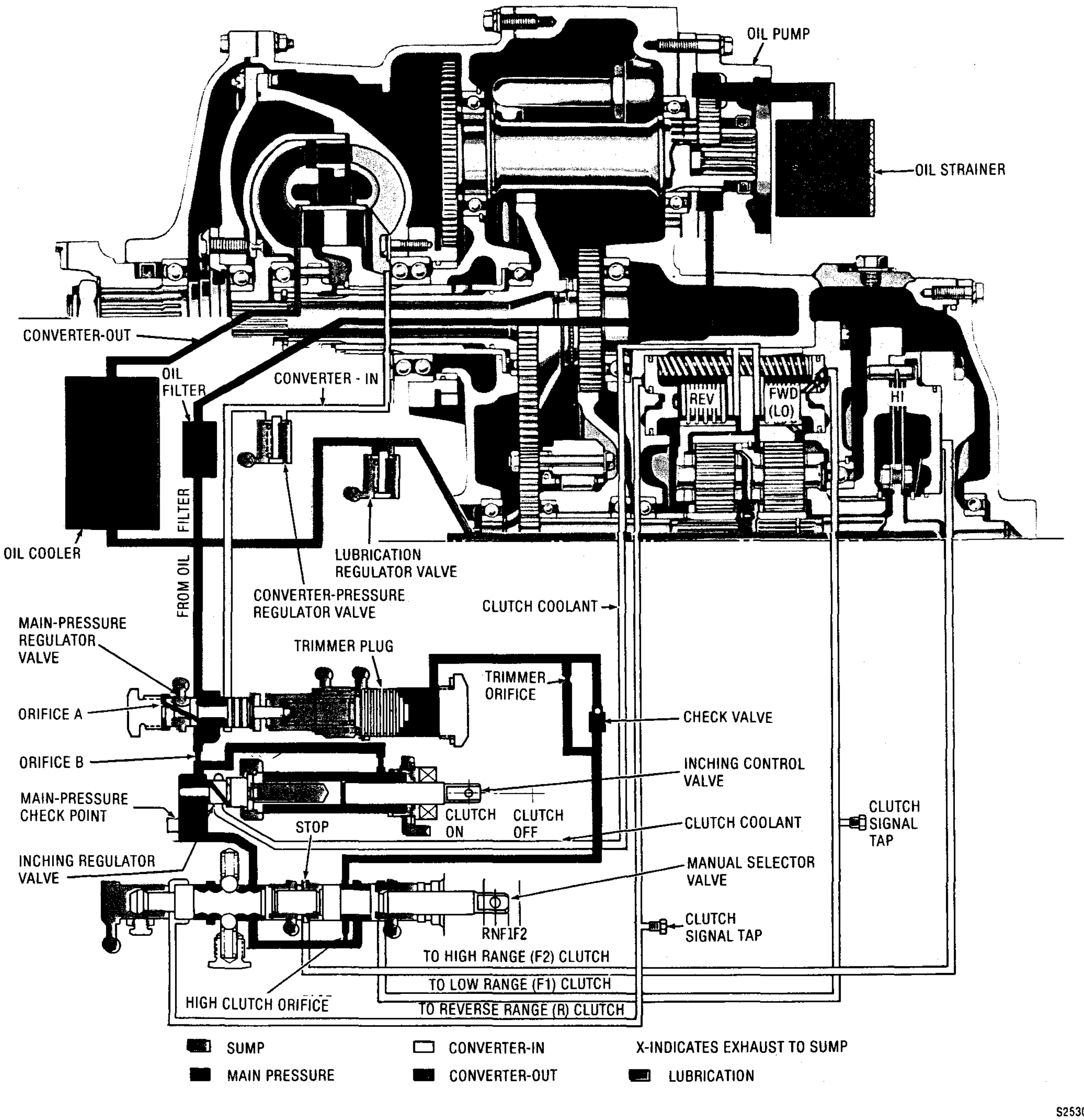


Fig. 2-2. TT 2221-1, TT 2421-1 hydraulic system with inching control

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

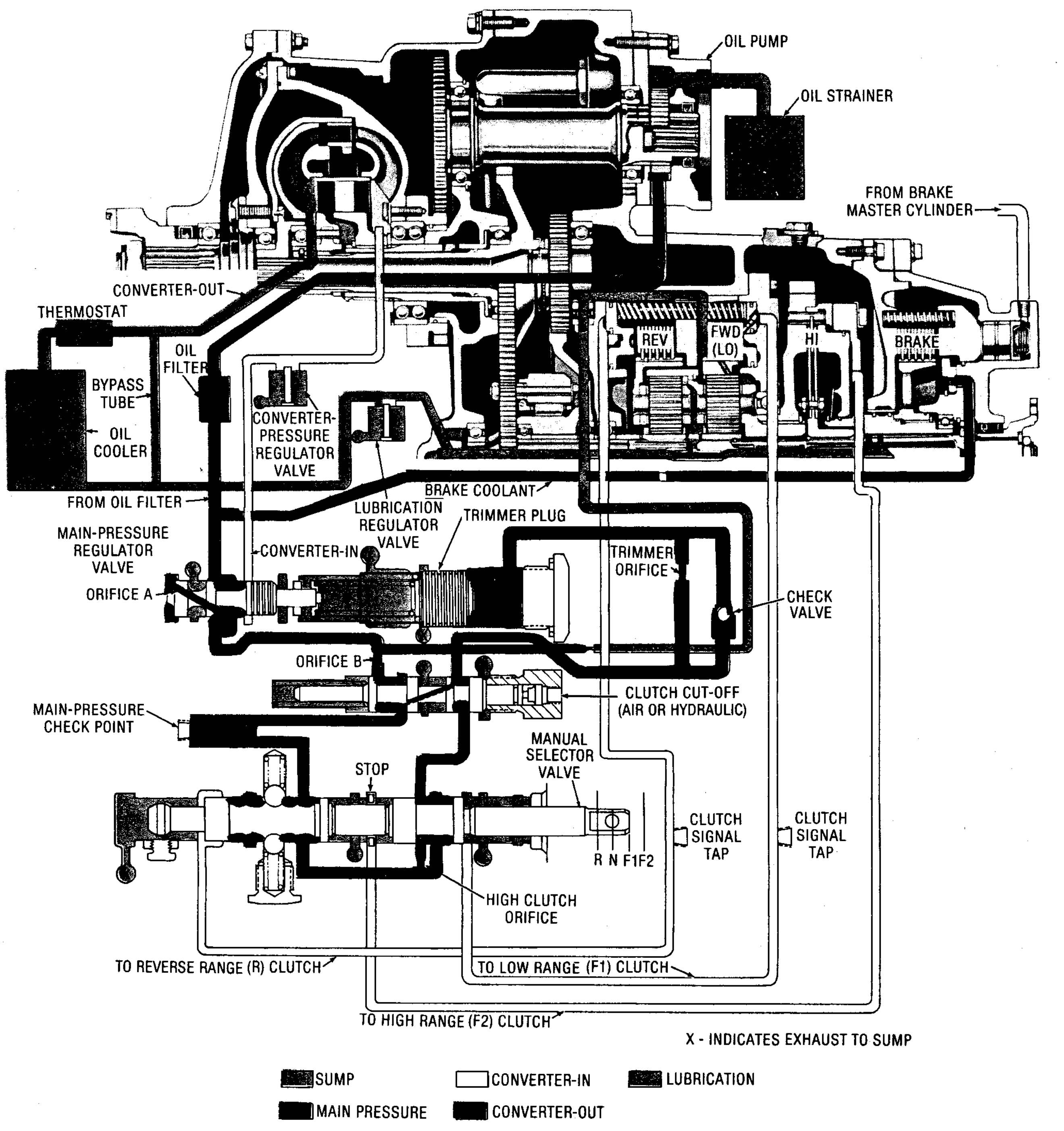


Fig. 2-3. TTB 2221-1, TTB 2421-1 hydraulic system with clutch cutoff control

shown at the top-center of the valve. Thus, when the vehicle brake is applied, the driving clutch is released.

(4) When the brake is released, the clutch cutoff valve returns to its normal position (as shown). This allows the oil re-

tained at the trimmer to enter the exhausted clutch circuit. This additional volume from the trimmer assists in the quick application of the clutch.

f. Inching Control Valve Circuit (fig. 2-2)

(1) Main pressure (red) from the main-pressure regulator connects to the inching control valve at two points. One is at orifice B directly below the regulator valve. The other is through a line running toward the right end of the inching control valve. Pressure at the left passes 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 the flow of oil and causes a lower pressure downstream from the orifice.

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

g. Manual Selector Valve Circuit

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

(2) Three clutch apply lines leave the bottom of the selector valve bore. From left to right these are reverse range, forward-2, and forward-1. In neutral all three clutch lines are exhausted, and the neutral start switch is actuated. Moving the selector valve one notch rightward will charge the forward (low-range) line and thus apply the clutch. This condition provides low-range operation. A pressure tap, located on the control valve body, provides access to the apply pressure for actuating vehicle signals.

(3) Moving the selector valve a second notch rightward will close off oil to the low-range line and allow it to exhaust. At the same time, oil will charge the forward-2 (high-range) line and thus apply the clutch. This condition provides high-range operation. When the selector valve is in the high-range position, oil to fill the high-range clutch must pass through both orifice B and the high-range clutch orifice. The high-range clutch orifice being smaller than orifice B restricts the volume of oil which can flow through in a given time. As a result, the high-range clutch fills at a slower rate and thus provides smoother engagement.

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

h. Trimmer Circuit

(1) The trimmer circuit works in conjunction with orifice B and the high-range orifice. The trimmer regulates clutch apply

pressure during initial stages of clutch engagement, and the orifices provide a specific flow at a given pressure. The combination of the trimmer and orifices provide the final pressure and flow pattern to engage the clutches in the desired manner.

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

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

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

(5) The check valve and orifice in parallel branches of the line connecting the selector valve bore to the trimmer plug bore ensure 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.

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

(1) Flow in this circuit is controlled by movement of brake adjusting ring 21 (foldout 15,B). When the brake is applied, the adjusting ring moves forward and uncovers the large port, allowing cooling oil to flood the cavity and cool the brake plates.

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

2-11. HYDRAULIC SYSTEM--TRT 2221 AND TRT 2421 MODELS (fig. 2-4 through 2-9)

a. Oil Pump, Filter Circuit. Refer to paragraph 2-10a (1).

b. Main-Pressure Regulator Valve, Converter-in Circuit. Refer to paragraph 2-10b.

c. Torque Converter. Refer to paragraph 2-10c.

d. Converter-out, Cooler, Lubrication Circuit. Refer to paragraph 2-10d.

e. Clutch Cutoff Valve Circuit (fig. 2-4, 2-6, 2-8). Refer to paragraph 2-10e.

f. Inching Control Valve Circuit (fig. 2-5, 2-7, 2-9). Refer to paragraph 2-10f. Not all -3 underdrive models (fig. 2-6) use the low-range clutch for inching. Some use the forward or reverse clutch as the slipping clutch. When one of these clutches is used, the clutch coolant circuit directs the coolant to the slipping clutch.

g. Manual Selector Valve Circuit

(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

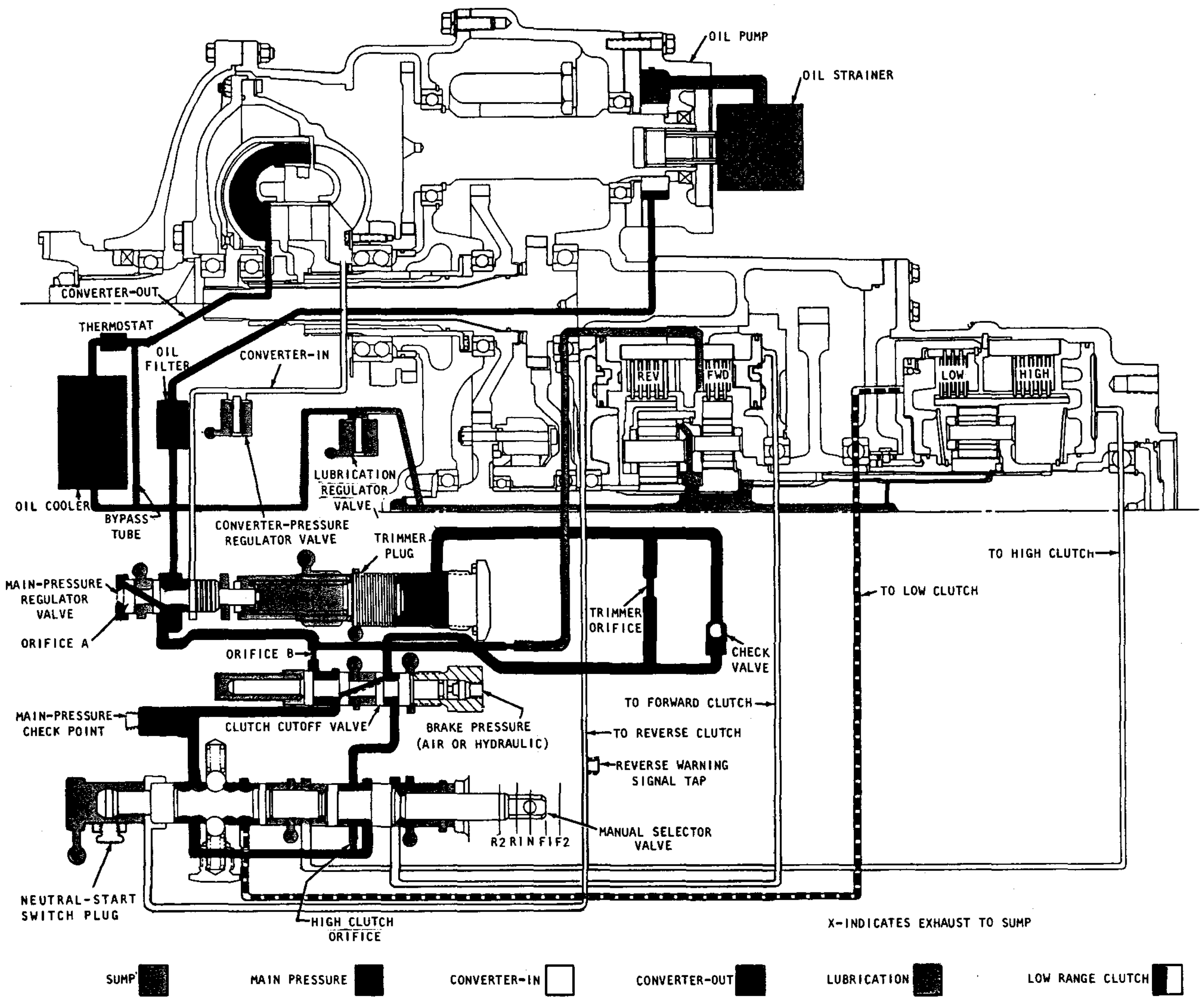


Fig. 2-4. TRT 2221-1, TRT 2421-1 hydraulic system with clutch cutoff control

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.

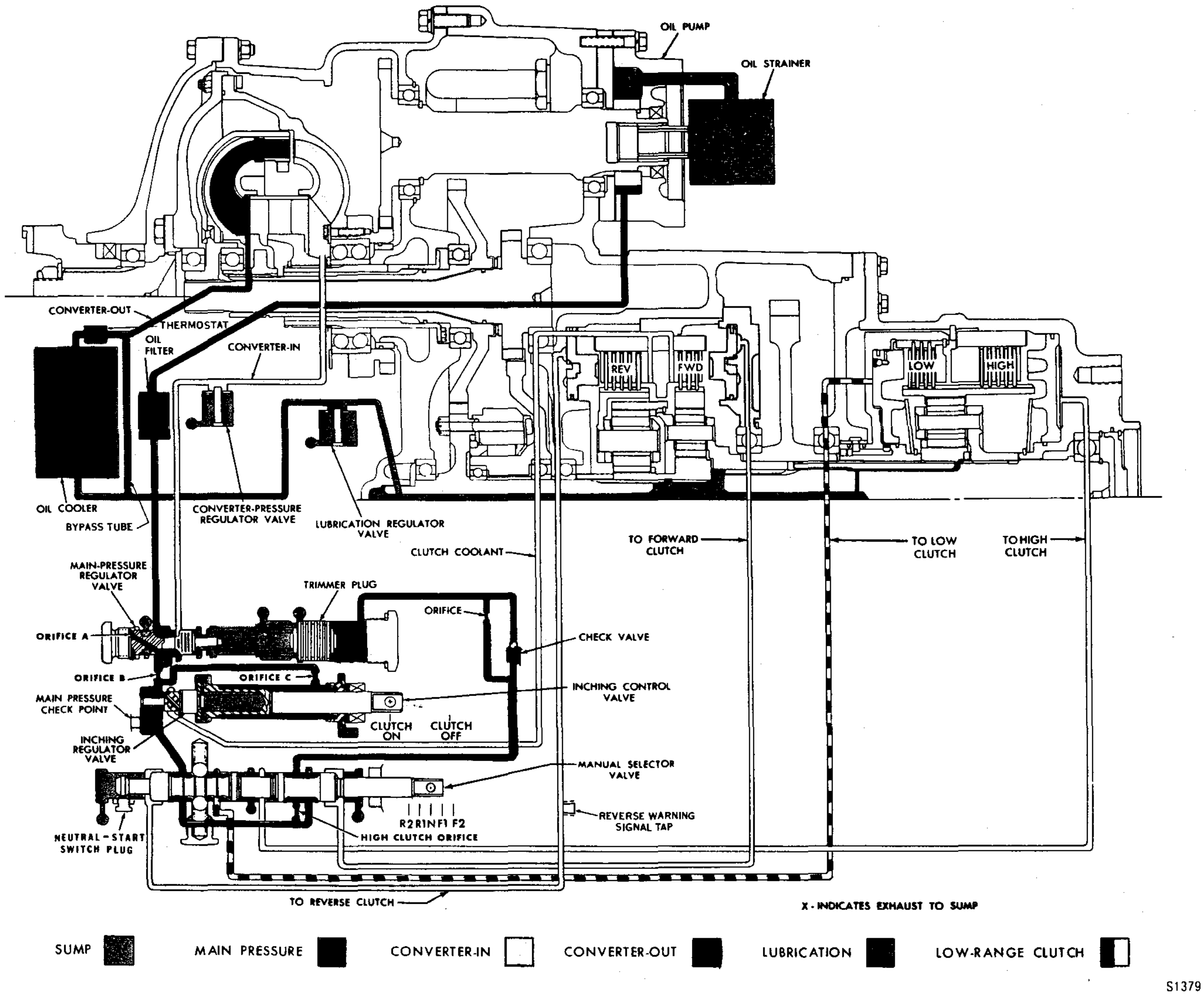


Fig. 2-5. TRT 2221-1, TRT 2421-1 hydraulic system with inching control

(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.

h. Trimmer Circuit. Refer to paragraph 2-10h.

2-12. HYDRAULIC SYSTEM—TRT 2211 AND TRT 2411 MODELS (fig. 2-10, 2-11)

a. Oil Pump, Filter Circuit. Refer to paragraph 2-10a (1).

b. Main-Pressure Regulator Valve, Converter-in Circuit. Refer to paragraph 6-10b.

c. Torque Converter. Refer to paragraph 6-10c.

d. Converter-out, Cooler, Lubrication Circuit. Refer to paragraph 2-10d.

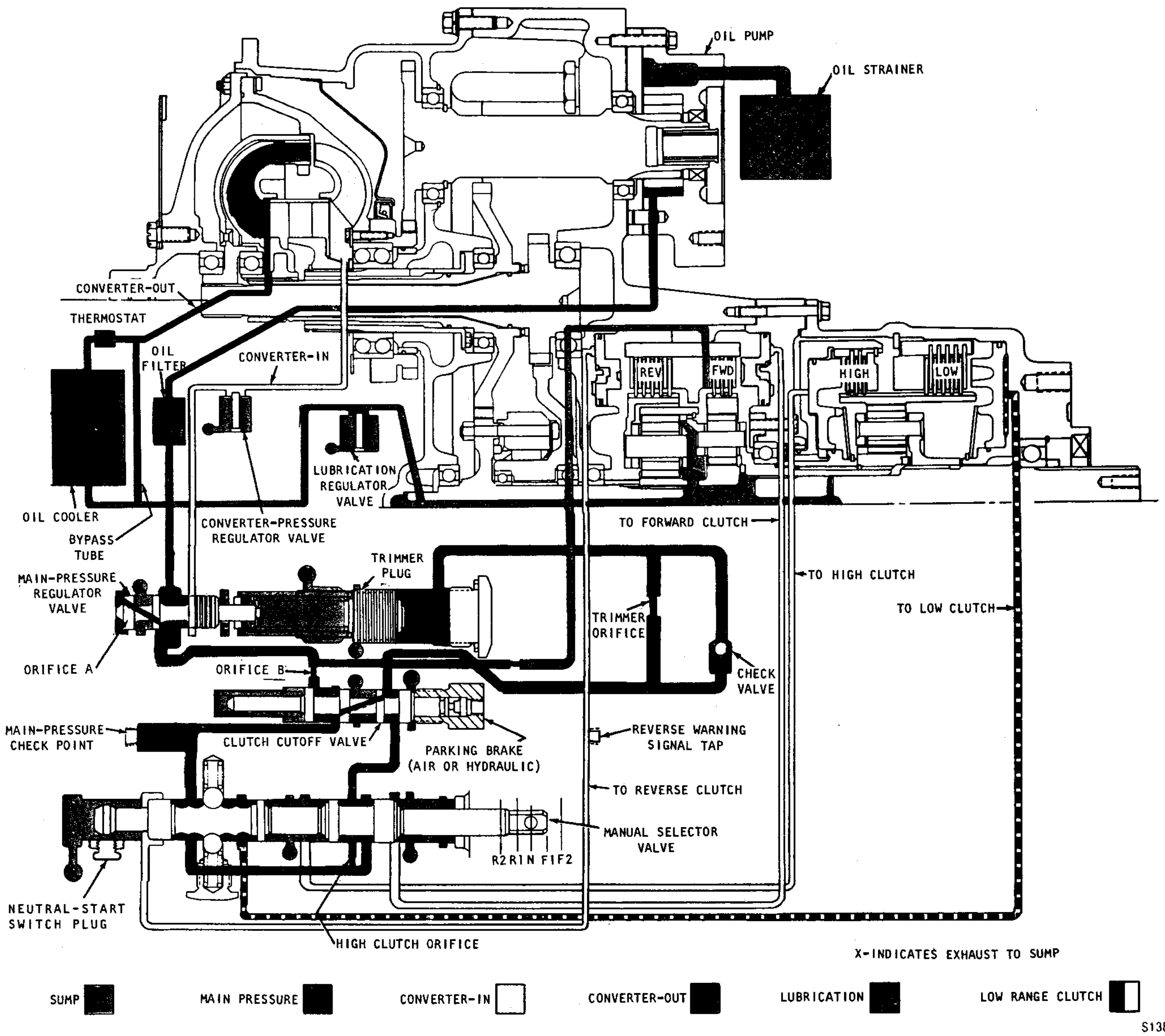


Fig. 2-6. TRT 2221-3, TRT 2421-3 hydraulic system for underdrive model with clutch cutoff

e. Clutch Cutoff Valve Circuit (fig. 2-10). Refer to paragraph 2-10e.

f. Inching Control Valve Circuit (fig. 2-11). Refer to paragraph 2-10f.

g. Manual Selector Valve Circuit

(1) Refer to paragraph 2-11g 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 reverse. Two valve stops limit the travel of the manual selector valve to these three positions.

h. Trimmer Circuit. Refer to paragraph 2-10h.

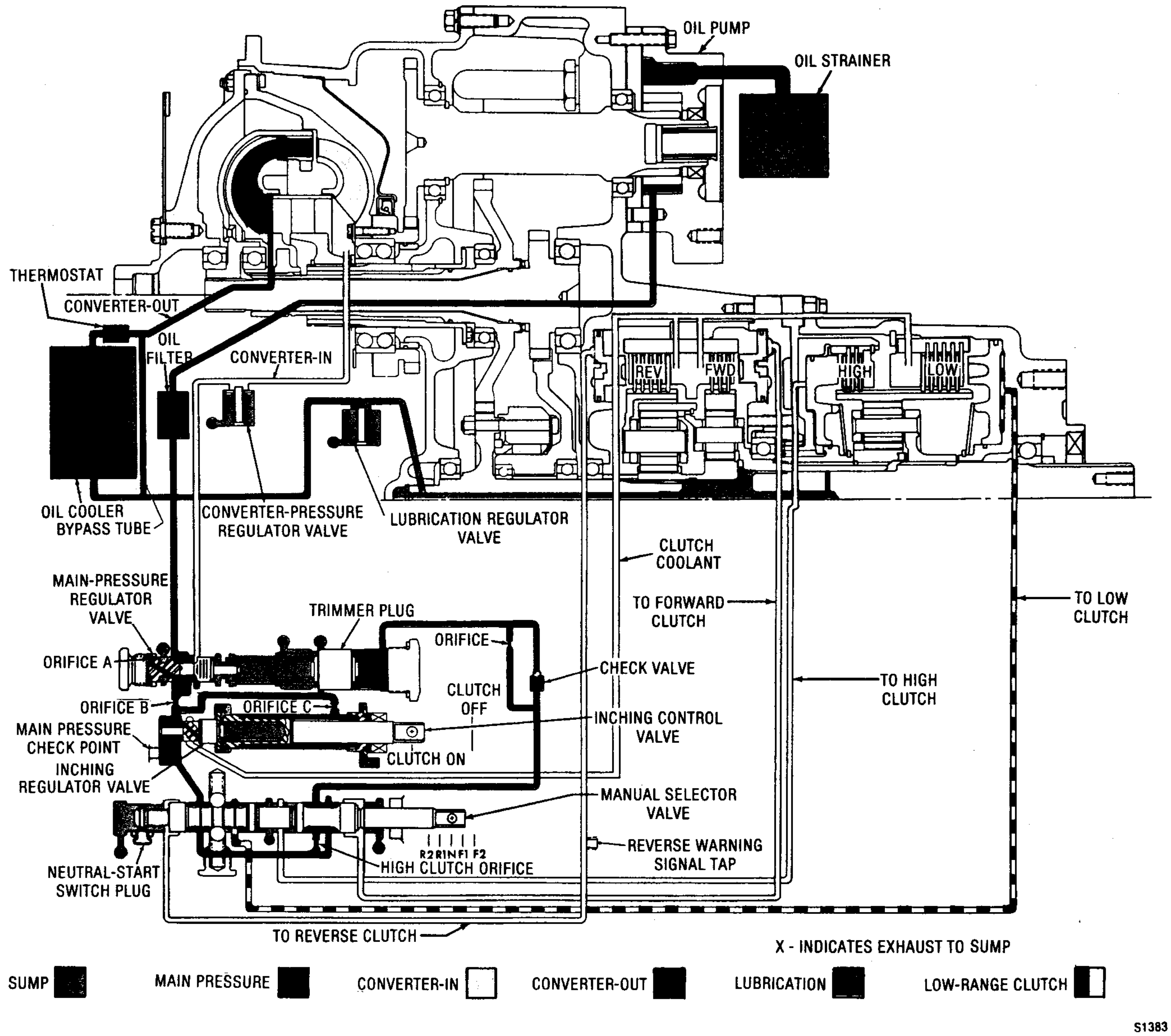


Fig. 2-7. TRT 2221-3, TRT 2421-3 hydraulic system for underdrive model with inching control

2-13. TRANSMISSION TORQUE PATHS

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

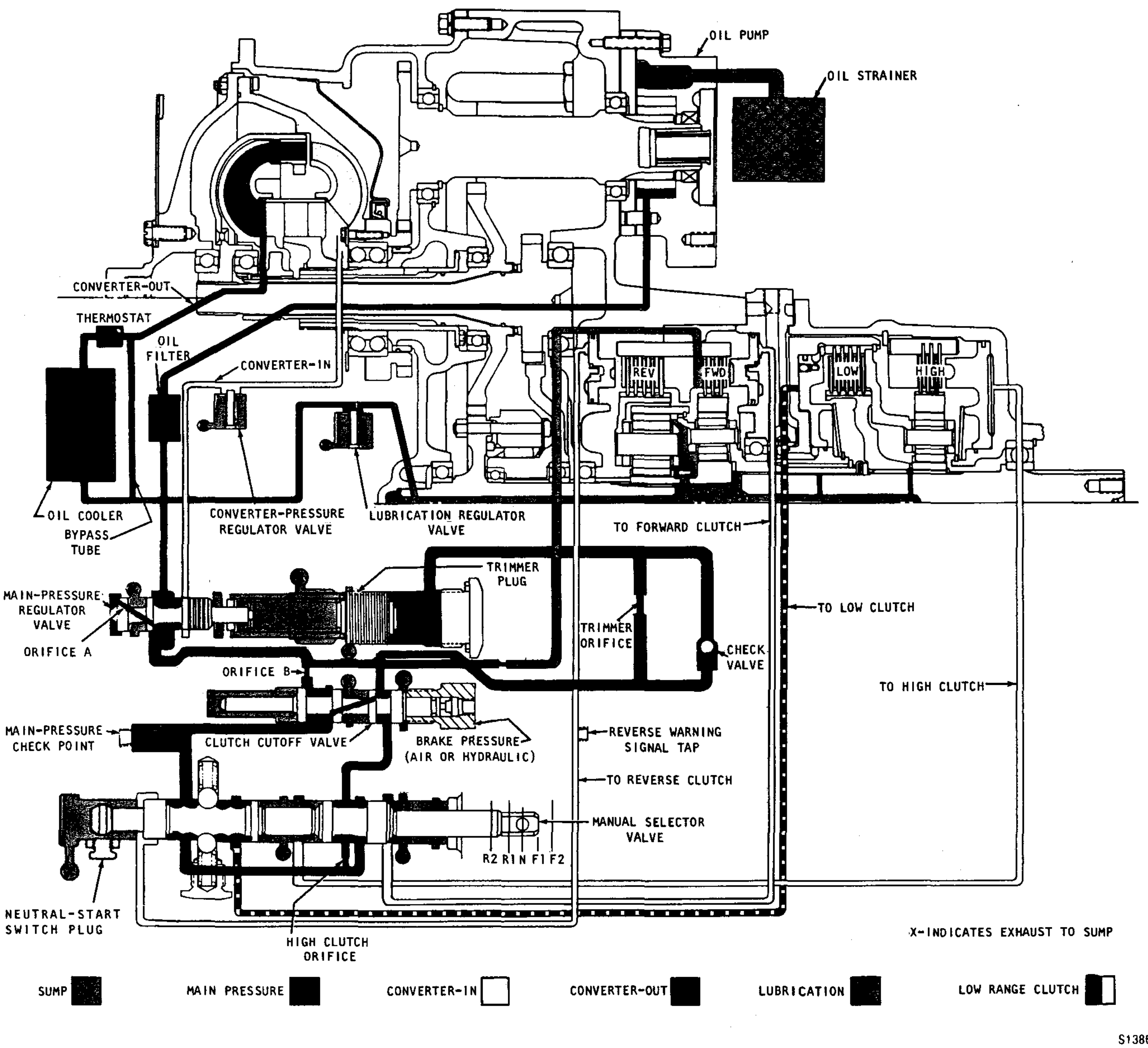


Fig. 2-8. TRT 2221-3, TRT 2421-3 hydraulic system for overdrive model with clutch cutoff

b. Cross-Section Illustrations

(1) Figure 2-12 is a cross-section view of the twin-turbine torque converter. Figures 2-13 through 2-25 illustrate the paths through which the power flows from the engine to the transmission outputs.

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

(3) All individual conditions for each transmission are not illustrated. However, the red torque paths and explanations for specific models can be applied to other

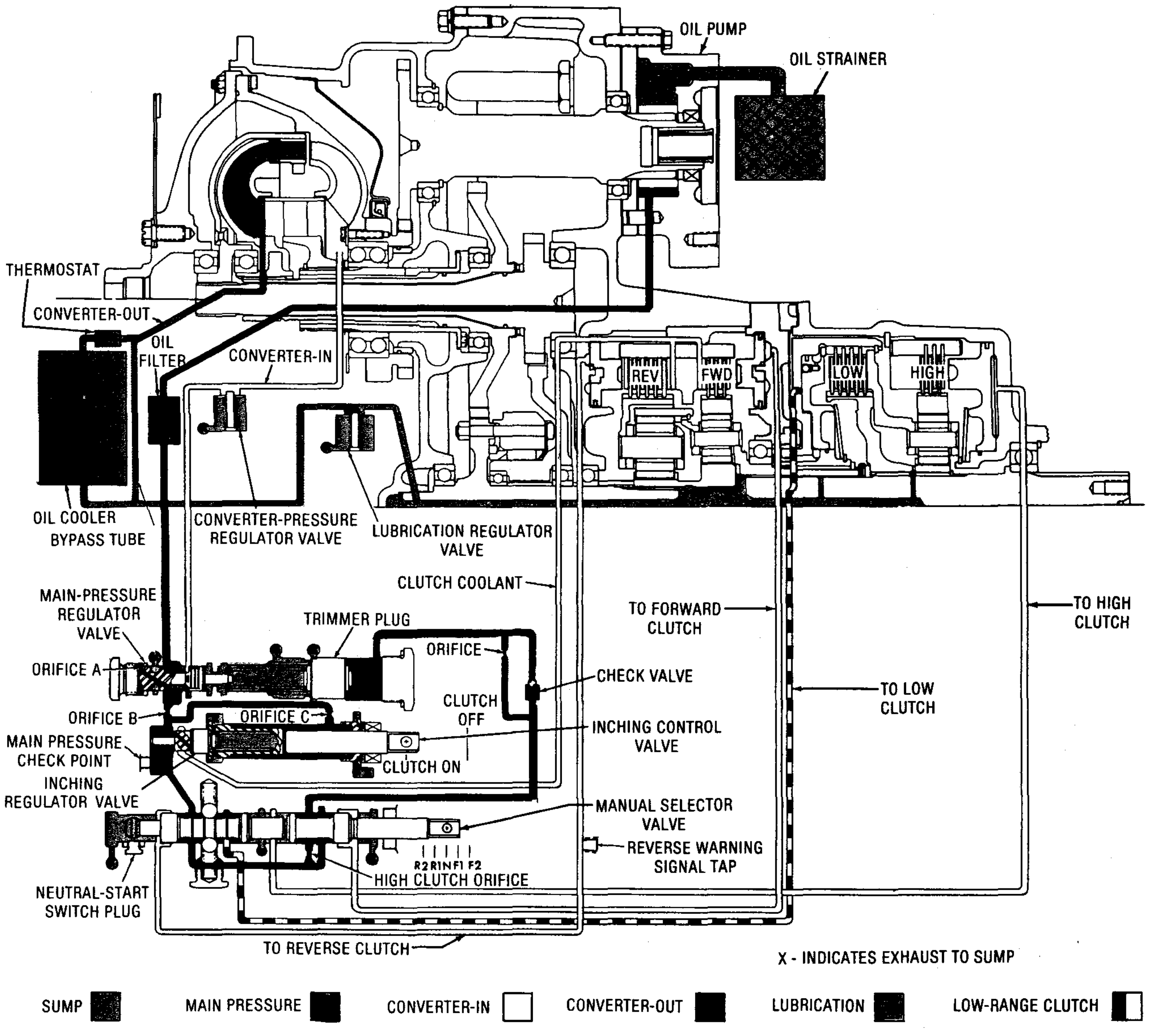


Fig. 2-9. TRT 2221-3, TRT 2421-3 hydraulic system for overdrive model with inching control

nodels. This will be done by referring, in some instances, to text and illustrations for one model when explaining another model.

c. Torque Converter, Freewheel Clutch (fig. 2-12)

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

(2) Speed and load determine whether the torque flows through the first- and second-turbine assemblies 3 and 4, or only through second-turbine assembly 4. At high-load demand and low speed, freewheel clutch 12 is engaged and first-turbine assembly 3 acts as the driving member. As speed in-

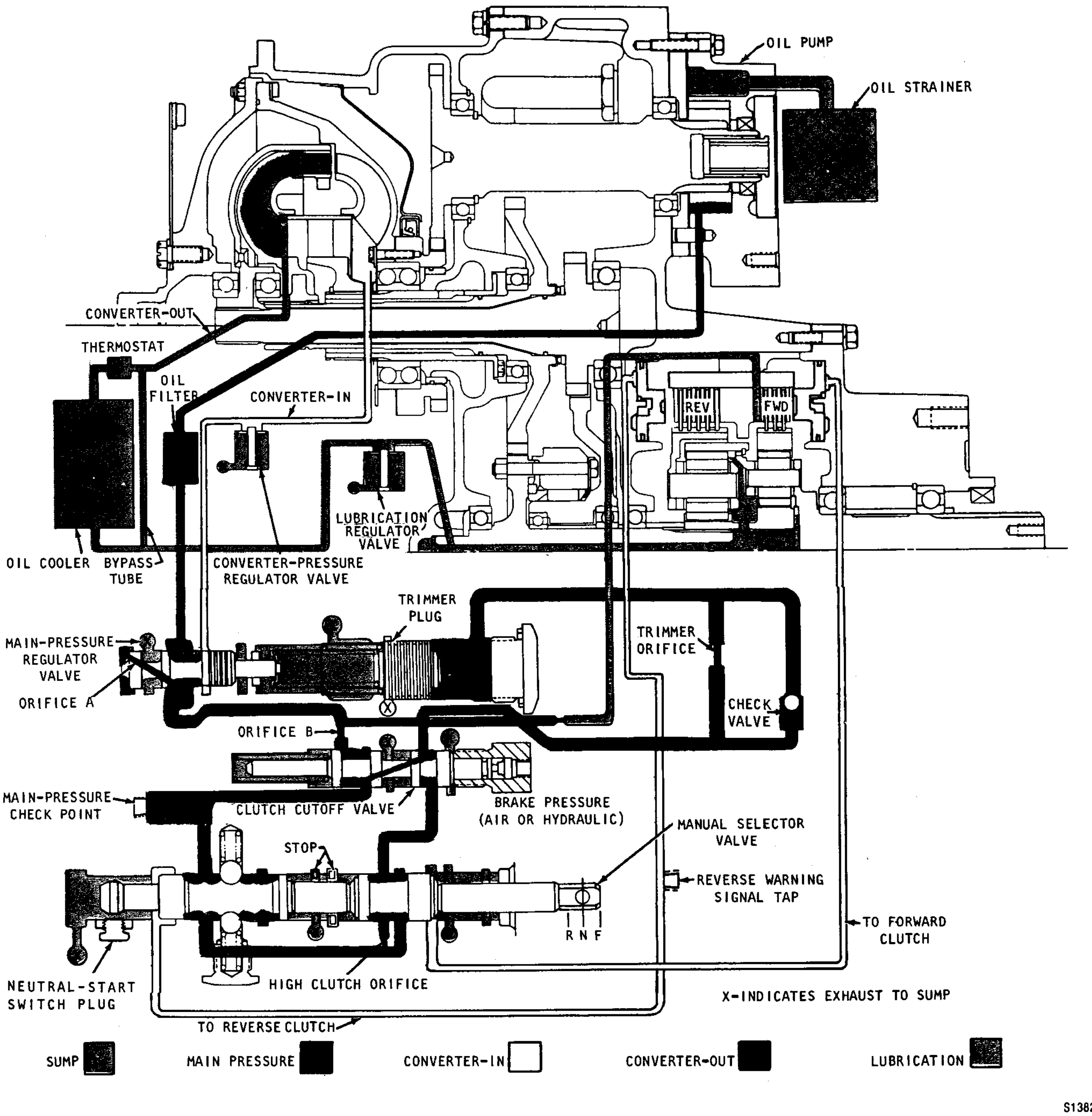


Fig. 2-10. TRT 2211-3, TRT 2411-3 hydraulic system with clutch cutoff control

creases and load demand decreases, freewheel clutch 12 disengages and second-turbine assembly 4 becomes the primary driving member. Thus, first-turbine operation is related to higher torque, and second-turbine operation to higher speed. The transition from the torque phase to the speed phase is entirely automatic, governed by the load and speed of the vehicle.

2-14. CONVERTER GEARING TO FORWARD-AND-REVERSE SUN GEAR—TORQUE PATH

a. First Turbine (fig. 2-12). Torque from converter pump assembly 6 is transmitted hydraulically to first-turbine assembly 3. The first turbine is splined to first-turbine drive gear 10 which meshes with first-tur-

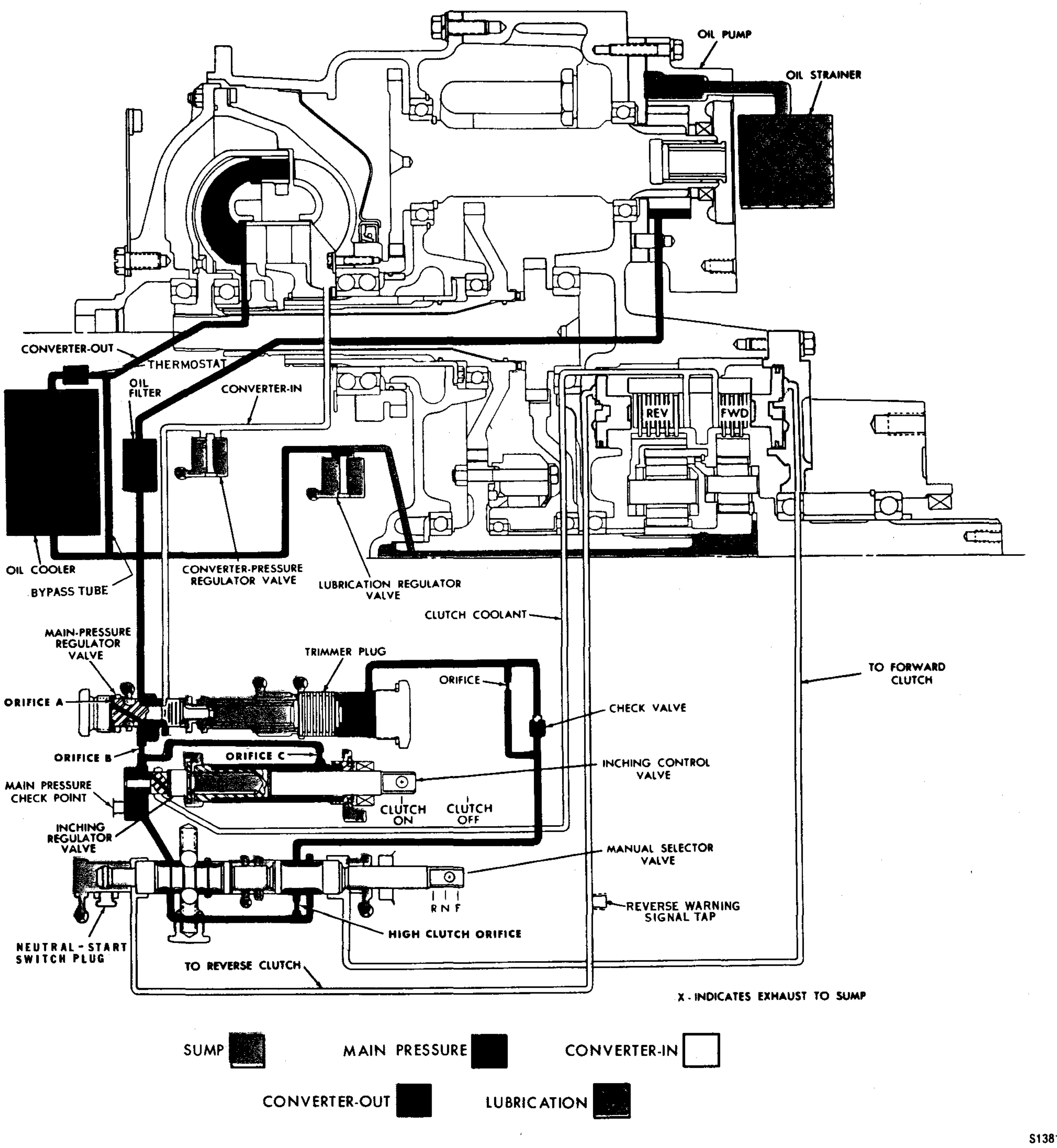


Fig. 2-11. TRT 2211-3, TRT 2411-3 hydraulic system with inching control

bine driven gear 11. The first-turbine driven gear is connected by freewheel clutch 12 to second-turbine driven gear 14. The second-turbine driven gear is integral with range gear input shaft 13. The forward-and-reverse sun gear is splined onto the shaft end. Thus, all these components rotate when the vehicle is operating in a high-load, low-speed condition. The hydraulic action in the converter and the interconnection of the turbine-driven gears (first and second) permit the second turbine to assist the first until the freewheel clutch disengages.

1- Input flange
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 engine-driven PTO
10- First-turbine drive gear
11- First-turbine driven gear
12- Freewheel clutch
13- Range gear input shaft
14- Second-turbine driven gear
15- Second-turbine drive gear
16- Input accessory drive gear
17- Torque converter housing
18- Converter drive cover
19- Transmission front cover
20- Second-turbine support bearing
21- Converter front support bearing

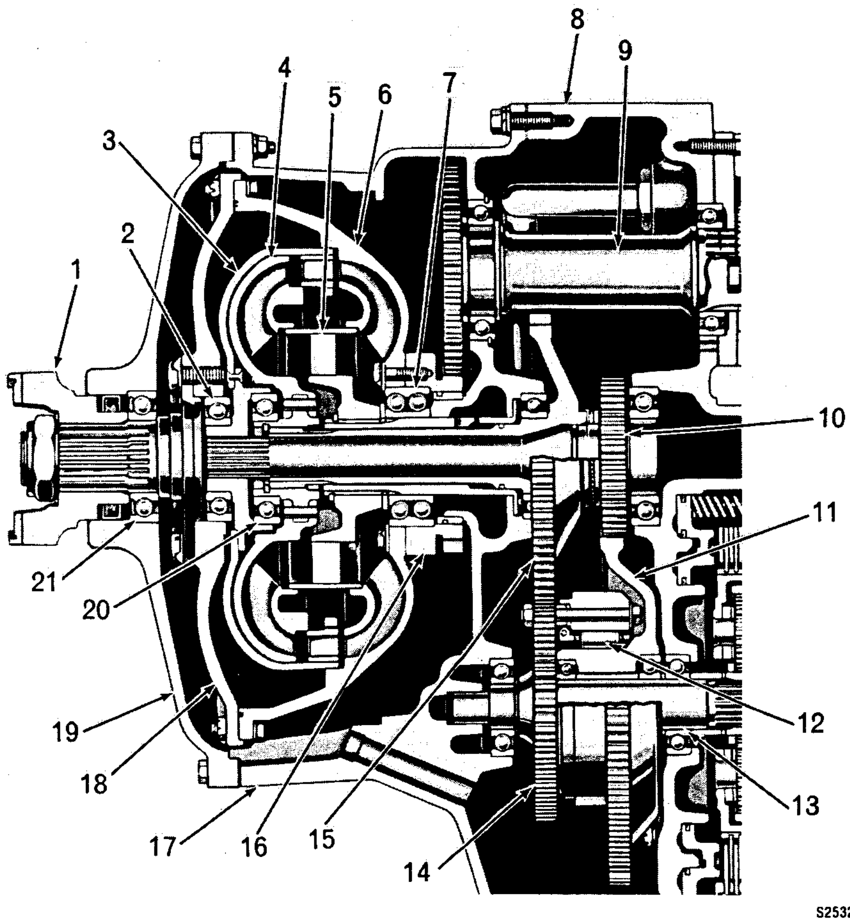


Fig. 2-12. Typical twin-turbine torque converter and converter gearing

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

2-15. TT, TTB 2221-1, 2421-1 TORQUE PATHS

a. Neutral and Power Takeoff (fig. 2-13)

(1) When the range selector is in neutral position, power is transmitted through

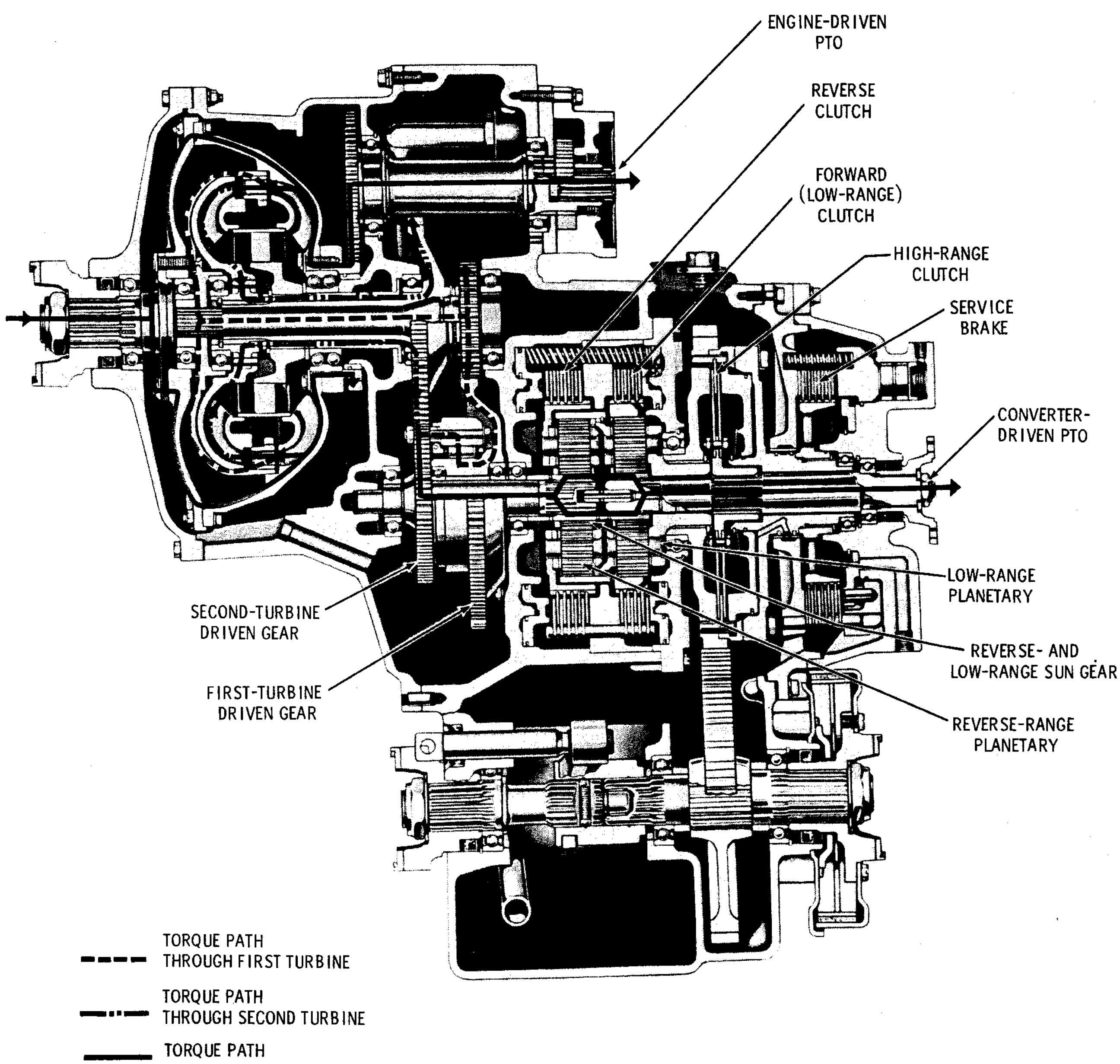


Fig. 2-13. Neutral torque path (TTB 2221-1, TTB 2421-1 with converter-driven PTO)

the torque converter to the forward-and-reverse sun gear as described in paragraph 2-14. No range clutches are engaged. Thus, rotation of the sun gear causes the planetary pinions to rotate freely, and no power flow occurs in the range gearing. However, on models equipped with a converter-driven PTO, rotation of the sun gear drives the PTO shaft any time the turbines are rotating.

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

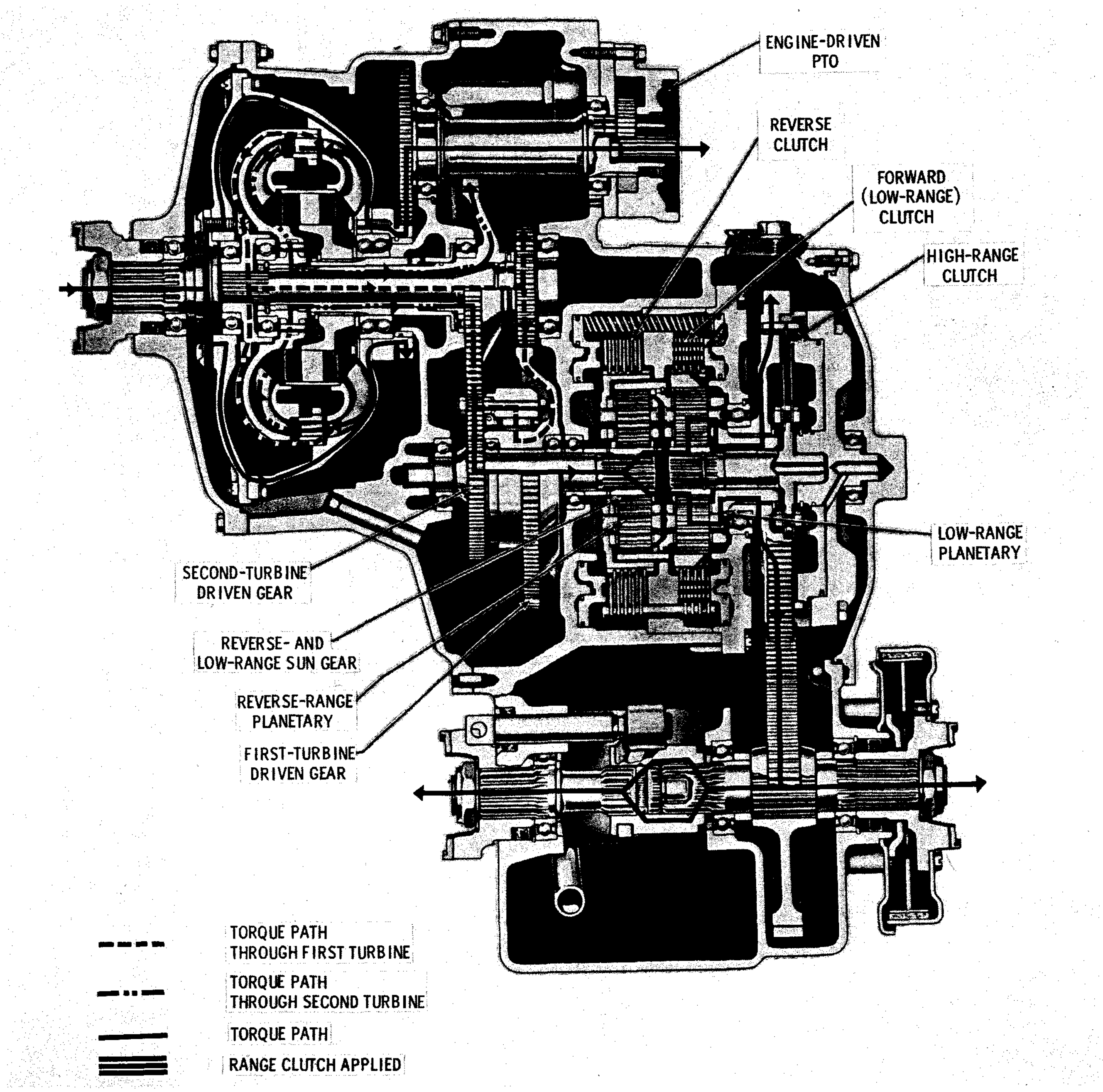


Fig. 2-14. Forward-1 (low-range) torque path (TT 2221-1, TT 2421-1 transmission)

b. Forward-1 (low-range) (fig. 2-14)

(1) In forward-1 (low-range) operation, torque is transmitted through the torque converter to the forward-and-reverse sun gear in the same manner as described in paragraph 2-14. When the range selector is moved from neutral to low range (F1), the forward clutch engages and holds the forward ring gear stationary.

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

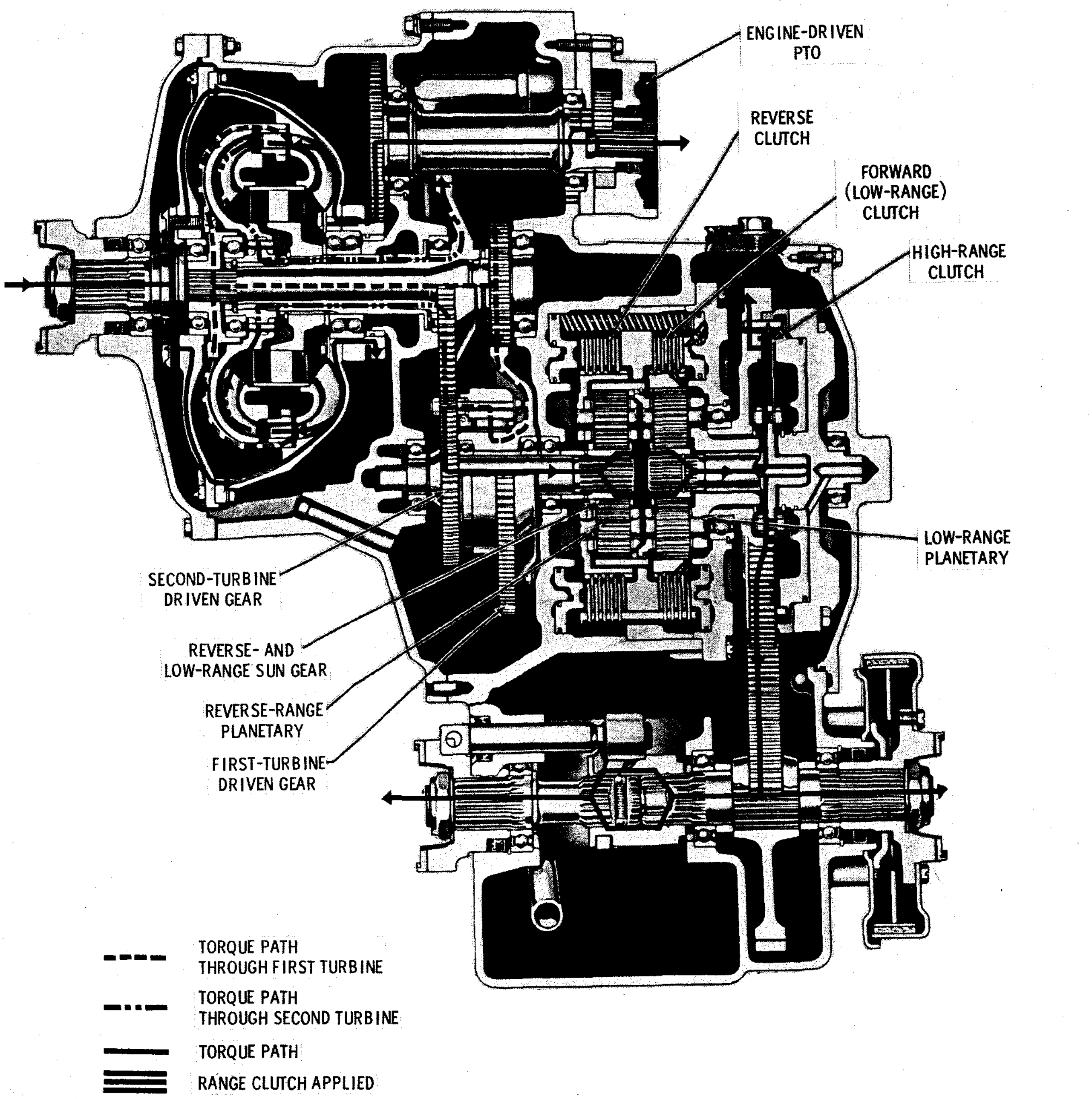


Fig. 2-15. Forward-2 (high-range) torque path (TT 2221-1, TT 2421-1 transmission)

c. Forward-2 (high-range) (fig. 2-15)

(1) In forward-2 (high-range) operation, torque is transmitted through the torque converter to the forward-and-reverse sun gear in the same manner as described in paragraph 2-14. When the range selector is moved from low range (F1) to high range (F2), the forward (low-range) clutch releases and the high-range clutch engages.

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

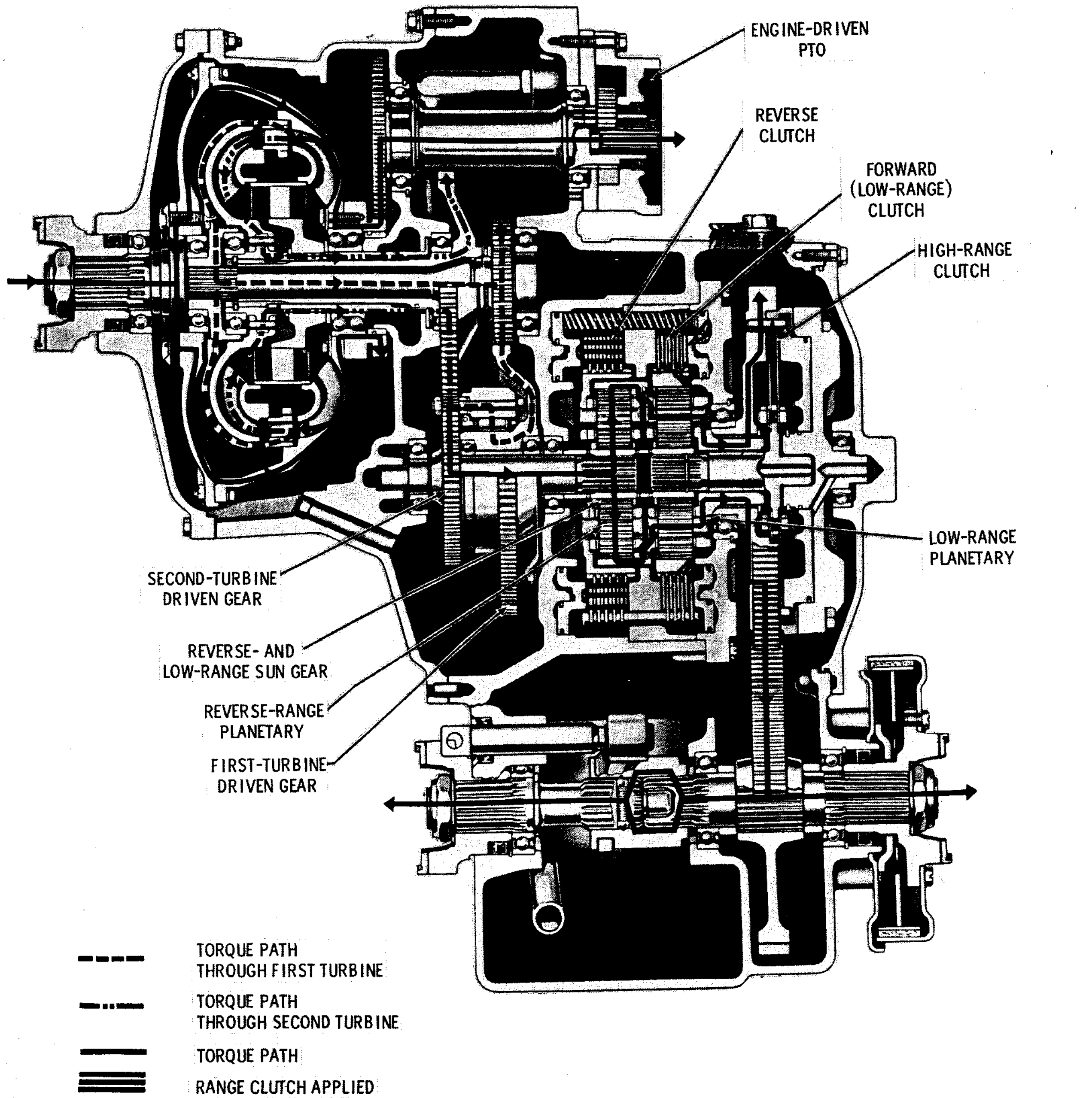


Fig. 2-16. Reverse-range torque path (TT 2221-1, TT 2421 transmission)

d. Reverse Range (fig. 2-16)

(1) In reverse-range operation, torque is transmitted through the torque converter to the forward-and-reverse sun gear in the same manner as described in paragraph 2-14. When the range selector is moved to reverse-range position, the forward-range clutches (F1 and F2) are exhausted and the reverse-range clutch engages and holds the reverse-range planetary hub (and carrier) stationary.

(2) The rotating forward-and-reverse sun gear drives the pinions which also are in mesh with the reverse-range ring gear. This causes the ring gear to rotate in a direction opposite to that of the sun gear. The ring gear is attached to the forward planetary carrier. Thus, the reverse torque is transmitted from the reverse-range ring gear through the forward planetary carrier to the transfer drive gear. The transfer drive gear meshes with the driven gear which in turn

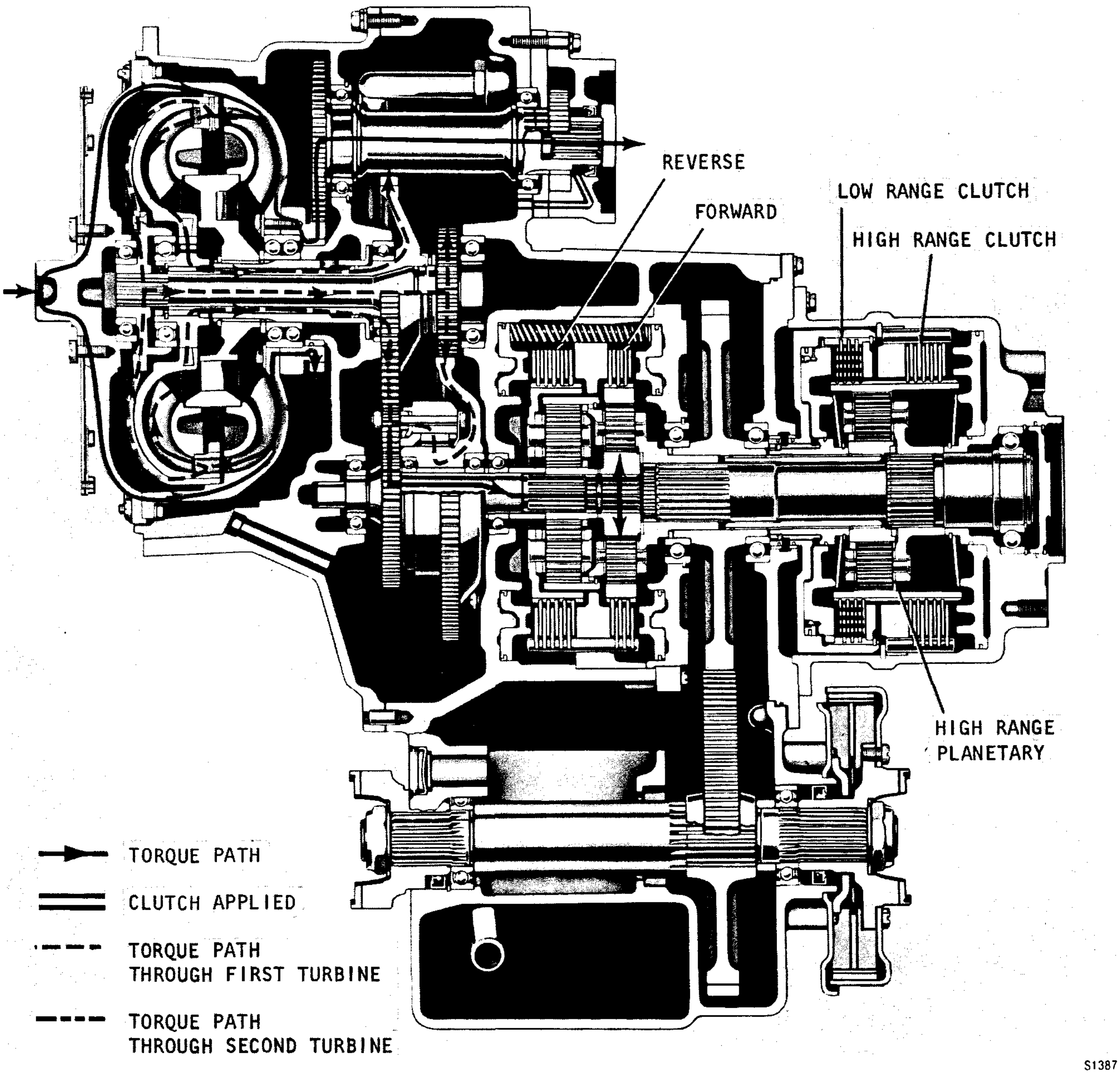


Fig. 2-17. Neutral torque path (TRT 2221-1, TRT 2421-1 transmission)

drives the transfer drive gear and output shaft in reverse. The manual-operated disconnect coupling, when moved forward, will interrupt the drive to the front output.

2-16. TRT 2221-1, 2421-1 TORQUE PATHS

a. Neutral and Power Takeoff (fig. 2-17)

(1) When the range selector is in Neutral position, power is transmitted through the torque converter to the forward-and-reverse sun gear as described in paragraph 2-14. 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) Refer to paragraph 2-15a (2).

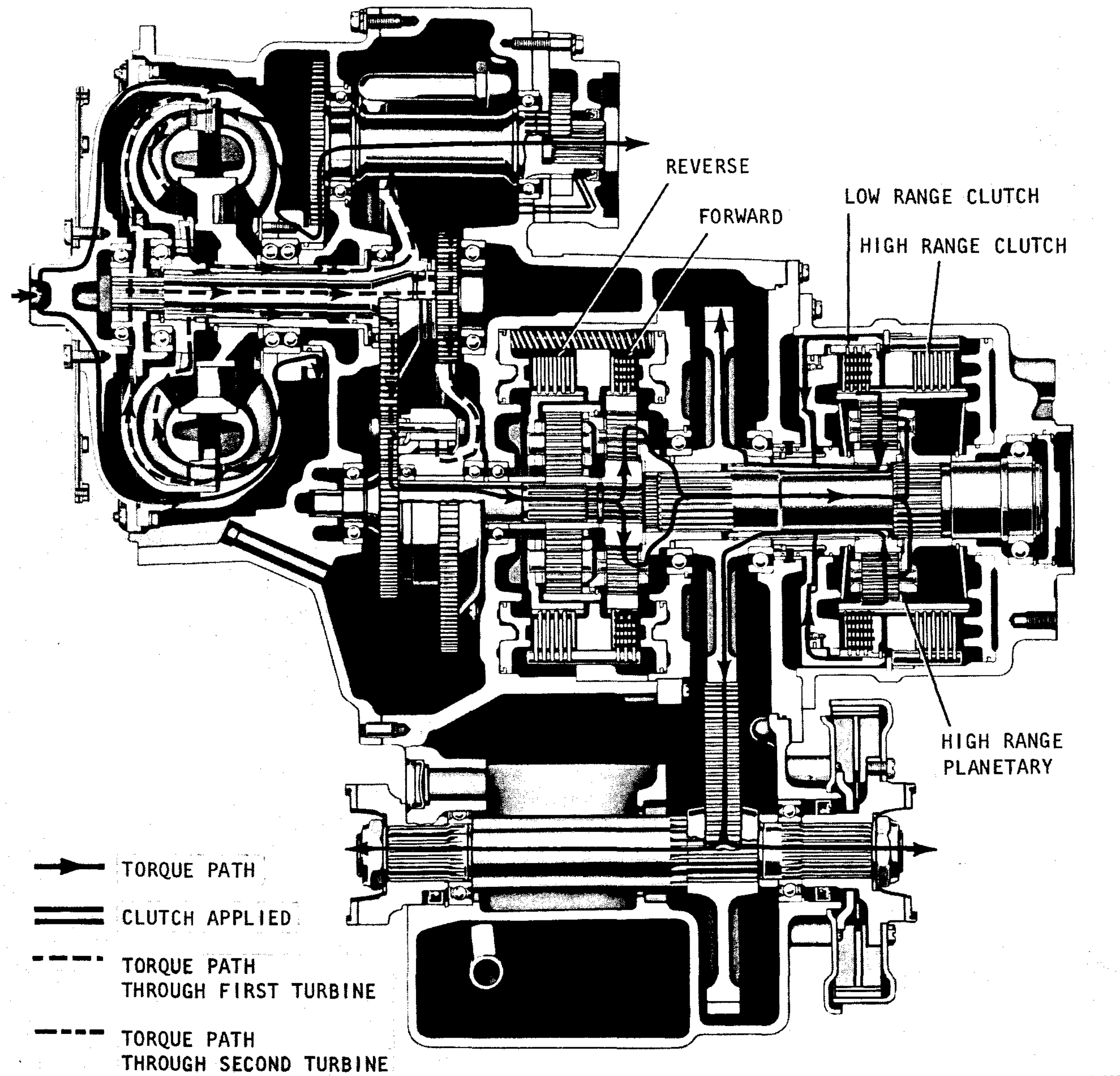


Fig. 2-18. Forward-1 torque path (TRT 2221-1, TRT 2421-1 transmission)

b. Forward-1 (fig. 2-18)

(1) When the range selector is in Forward-1 position, power is transmitted through the torque converter to the forward-and-reverse sun gear as described in paragraph 2-14.

(2) The low-range clutch remains engaged, which 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 transfer drive gear. The high-range ring gear is splined to the low-range clutch internal-splined plates. The low-range clutch exter-

nal-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 2-18 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 2 while studying the explanation of Forward-2 operation. Refer to paragraph 2-14 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 paragraph 2-16b (3).

(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 paragraph 2-16b (7) for explanation of the remainder of the torque path.

d. Reverse-1

(1) Refer to foldout 2 while studying the explanation of reverse-1 operation. Refer to paragraph 2-14 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 paragraph 2-16b (4) through (7) except that all rotations are reversed.

e. Reverse-2 (fig. 2-19)

(1) Refer to paragraph 2-14 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 engaged high-range clutch holds the high-range planetary ring gear stationary.

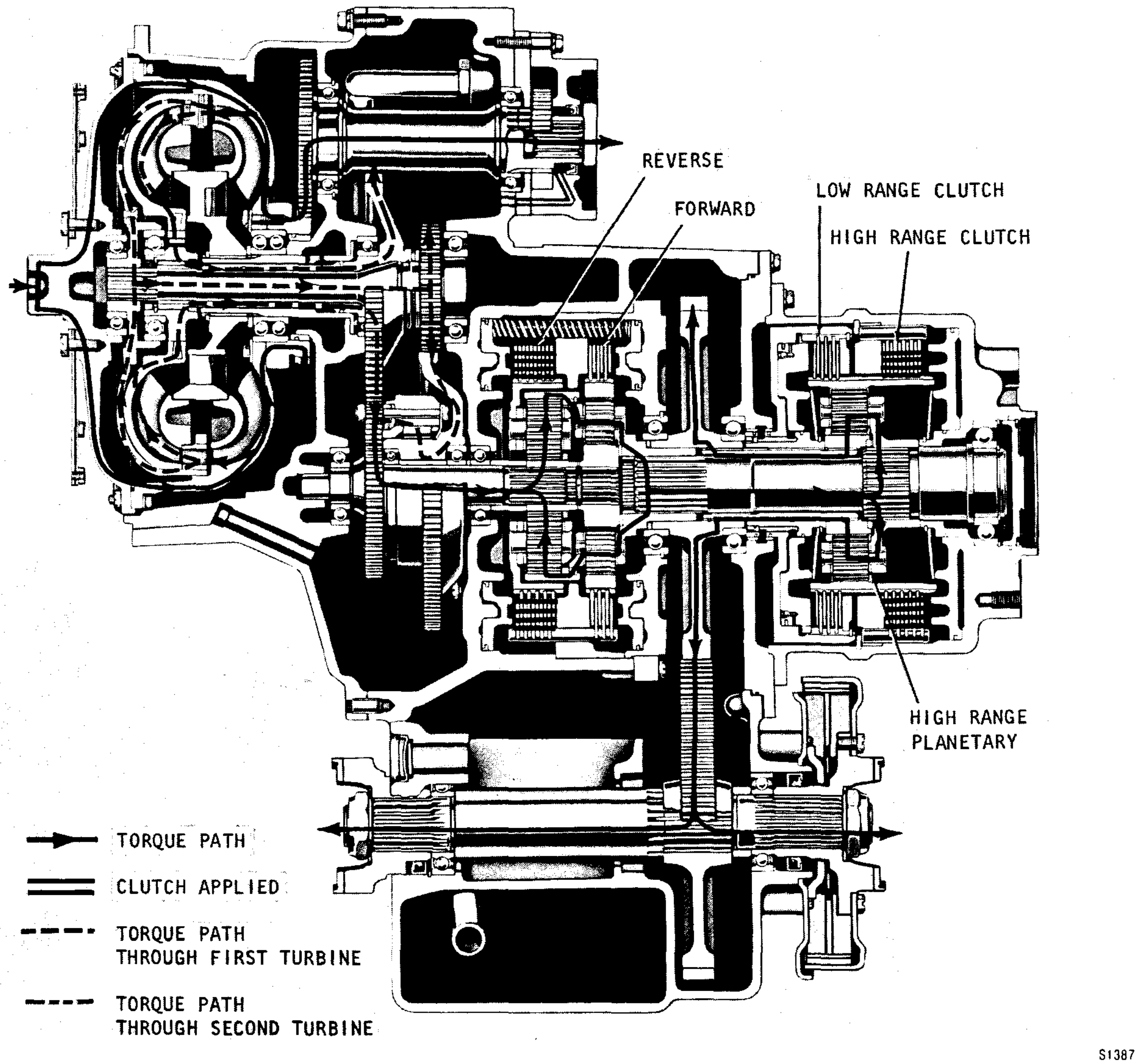


Fig. 2-19. Reverse-2 torque path (TRT 2221-1, TRT 2421-1 transmission)

(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 paragraph 2-16b (7) for explanation of the remainder of the torque path.

2-17. 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 2-14 for explanation of power

flow from the engine to the transmission gearing.

(2) In neutral, power is not transmitted beyond the forward-and-reverse 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 2-15a (2) and figure 2-16 for explanation of the power takeoff torque path.

b. Forward-1

(1) Refer to foldout 3 while studying the explanation of operation in forward-1. Refer to paragraph 2-14 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.

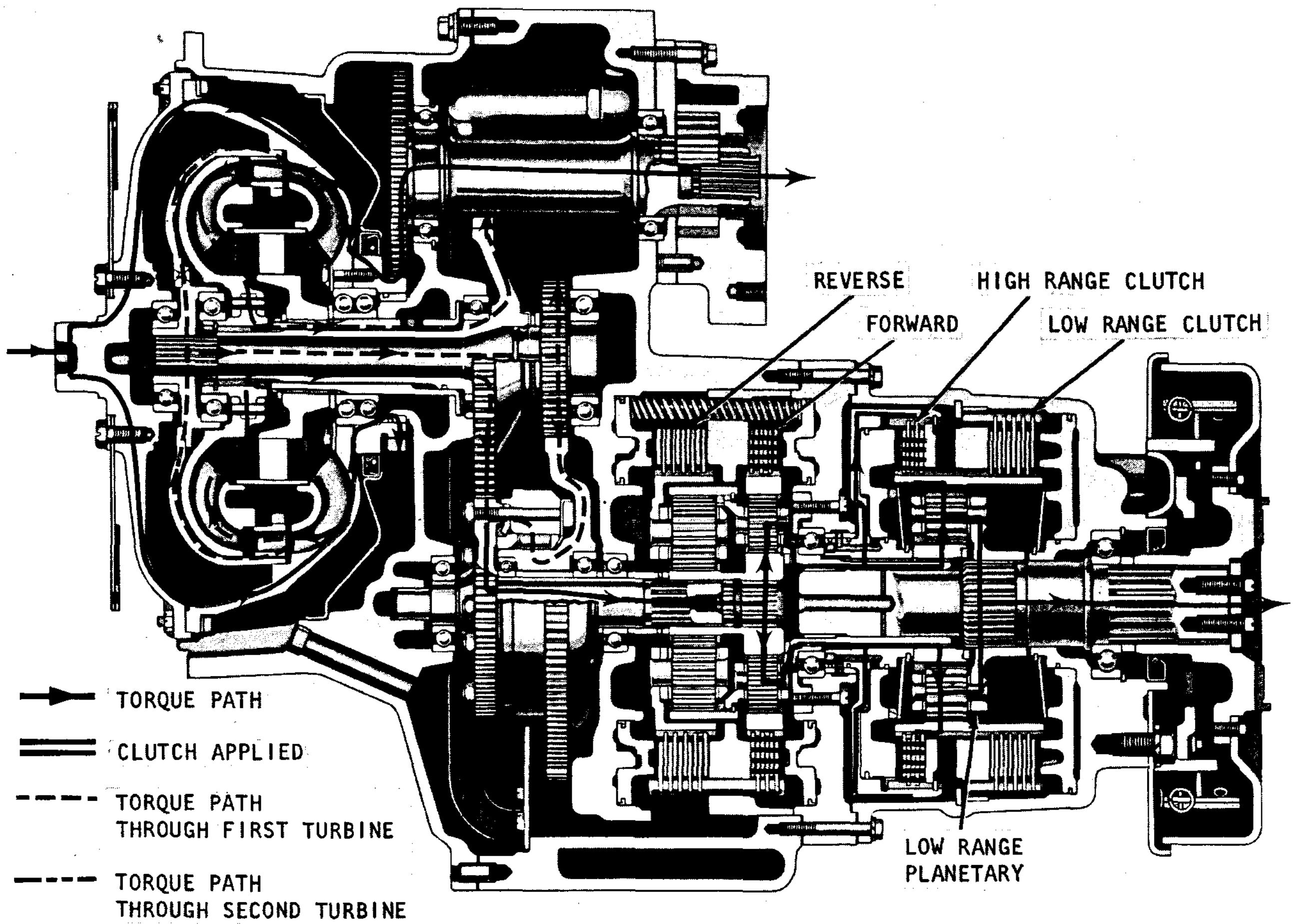


Fig. 2-20. Forward-2 torque path (TRT 2221-3, TRT 2421-3 underdrive transmission)

c. Forward-2 (fig. 2-20)

(1) Refer to paragraph 2-14 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, 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.

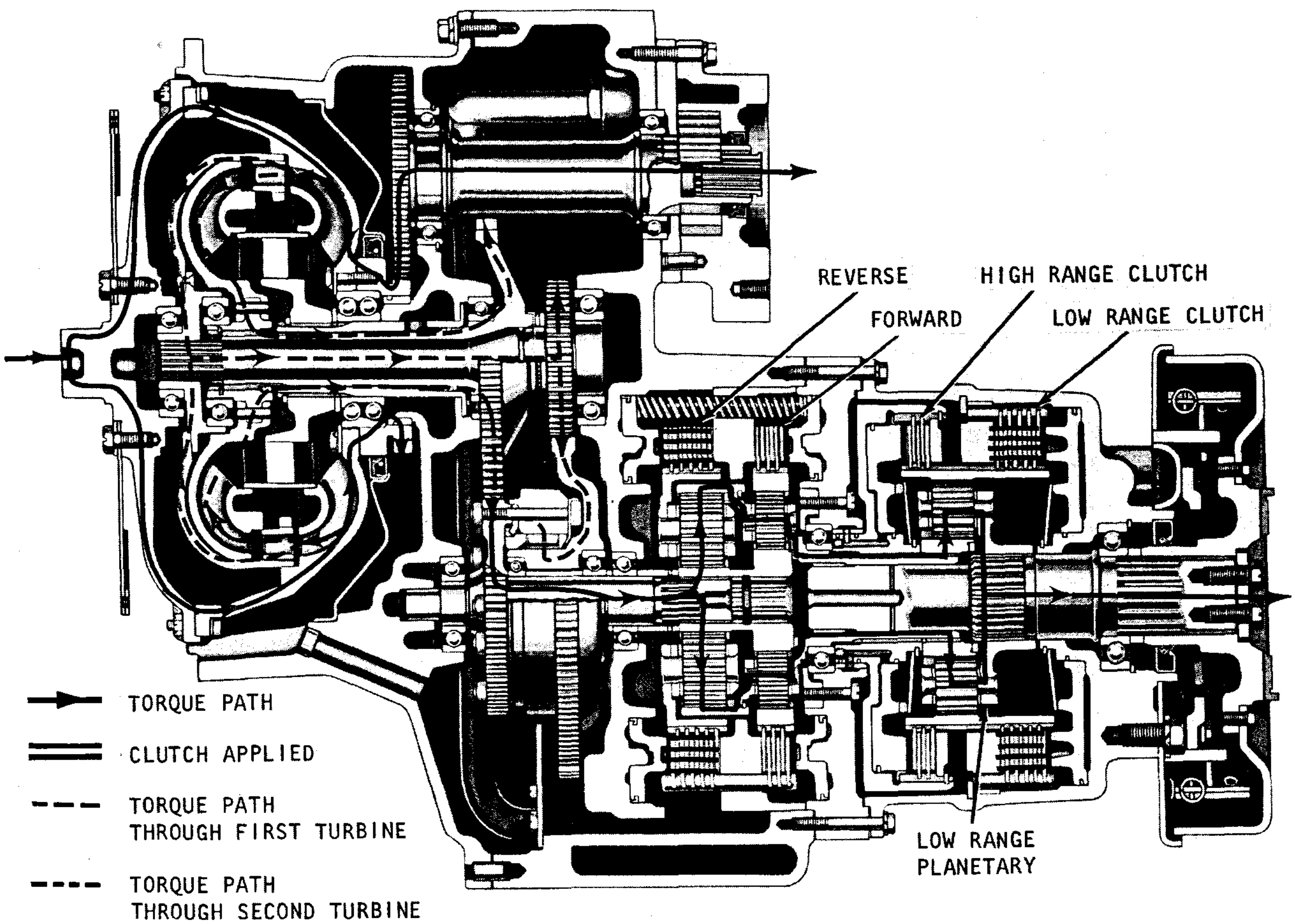


Fig. 2-21. Reverse-1 torque path (TRT 2221-3, TRT 2421-3 underdrive transmission)

d. Reverse-1 (fig. 2-21)

(1) Refer to paragraph 2-14 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 planetary 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).

e. Reverse-2

(1) Refer to foldout 3 while studying the power flow during operation in Reverse-2. Refer to paragraph 2-14 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).

2-18. 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 2-14 for explanation of power flow from the engine to the transmission gearing.

(2) Refer to paragraph 2-17a (2) and (3) for the remainder of the explanation of power flow in neutral.

b. Forward-1 (fig. 2-22)

(1) Refer to paragraph 2-14 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.

c. Forward-2

(1) Refer to foldout 4 while studying power flow during operation in Forward-2. Refer to paragraph 2-14 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 paragraph 2-18b (3) 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.

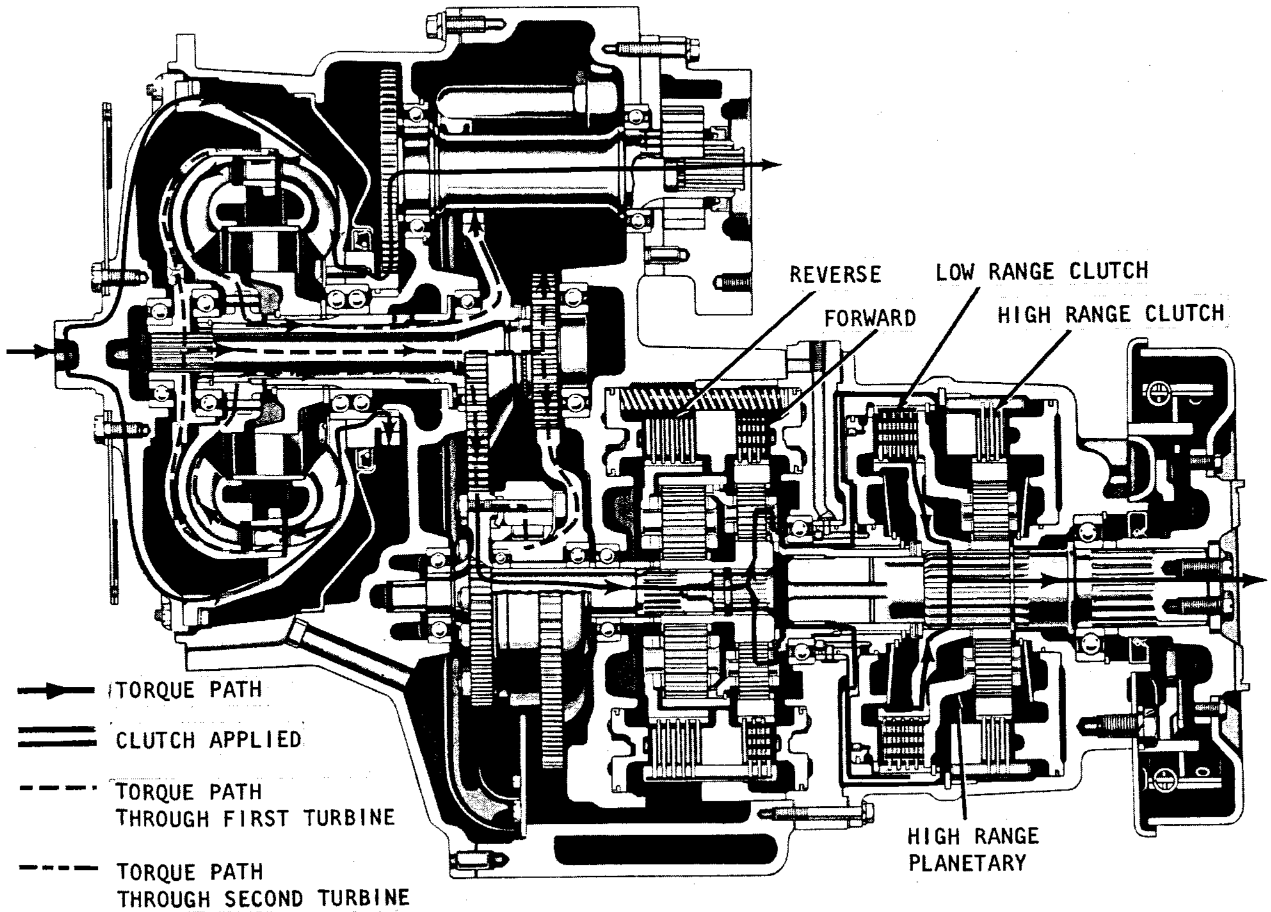


Fig. 2-22. Forward-1 torque path (TRT 2221-3, TRT 2421-3 overdrive transmission)

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 2-14 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.

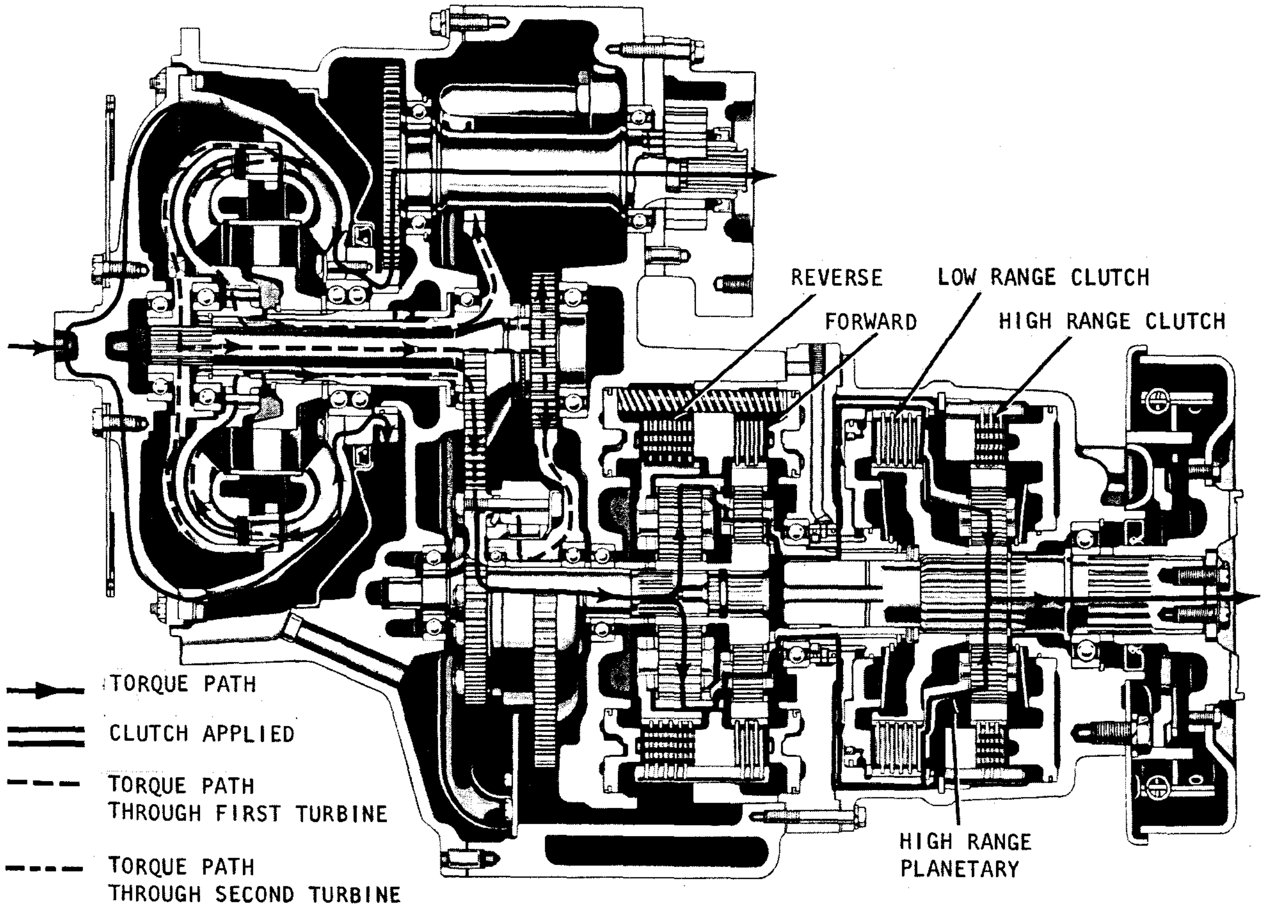


Fig. 2-23. Reverse-2 torque path (TRT 2221-3, TRT 2421-3 overdrive transmission)

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.

e. Reverse-2 (fig. 2-23)

(1) Refer to paragraph 2-14 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 remains engaged. The high-range clutch, engaged, holds the high-range planetary ring gear stationary.

(3) Refer to paragraph 2-18d (3) 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.

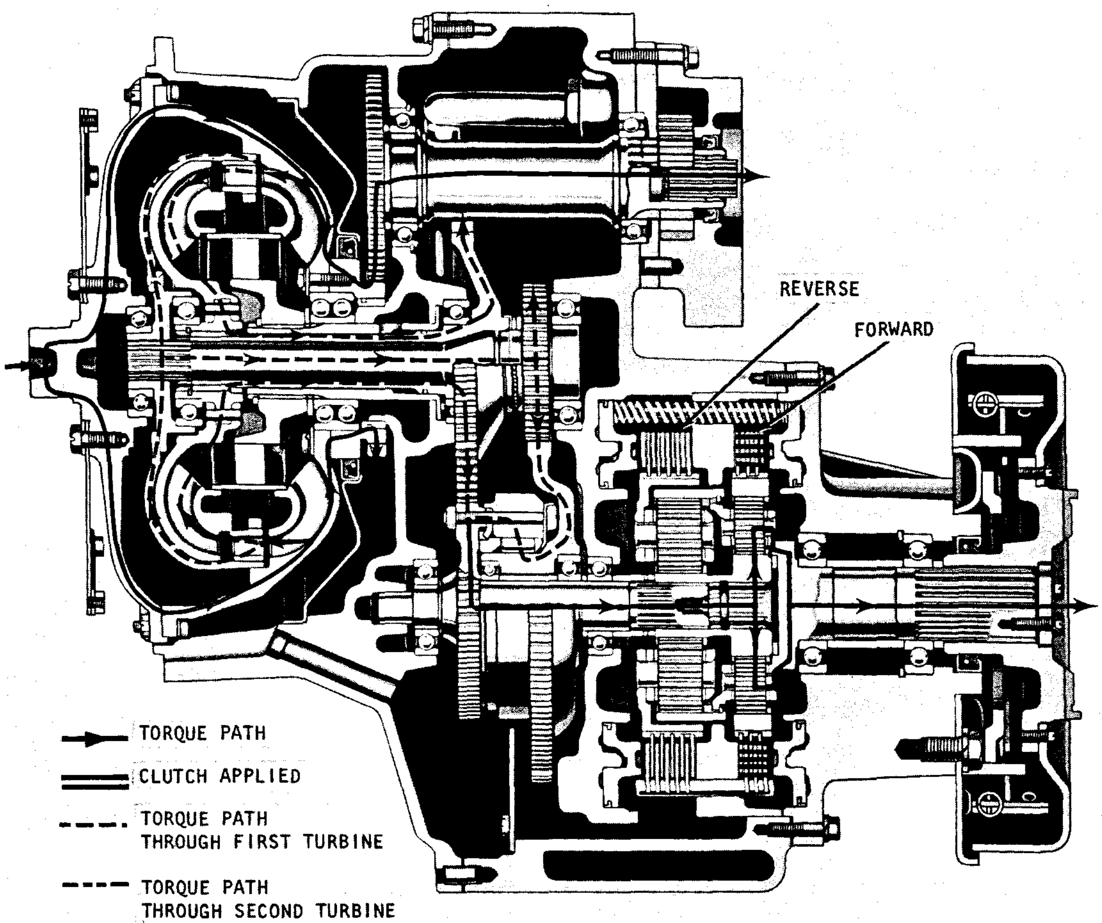


Fig. 2-24. Forward torque path (TRT 2211-3, TRT 2411-3 transmission)

2-19. TRT 2211-3, 2411-3 TORQUE PATHS

a. Neutral

(1) Refer to foldout 5 while studying the explanation of power flow in neutral. Refer to paragraph 2-14 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 2-15 and figure 2-16 for explanation of the power takeoff power flow.

b. Forward (fig. 2-24)

(1) Refer to paragraph 2-14 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.

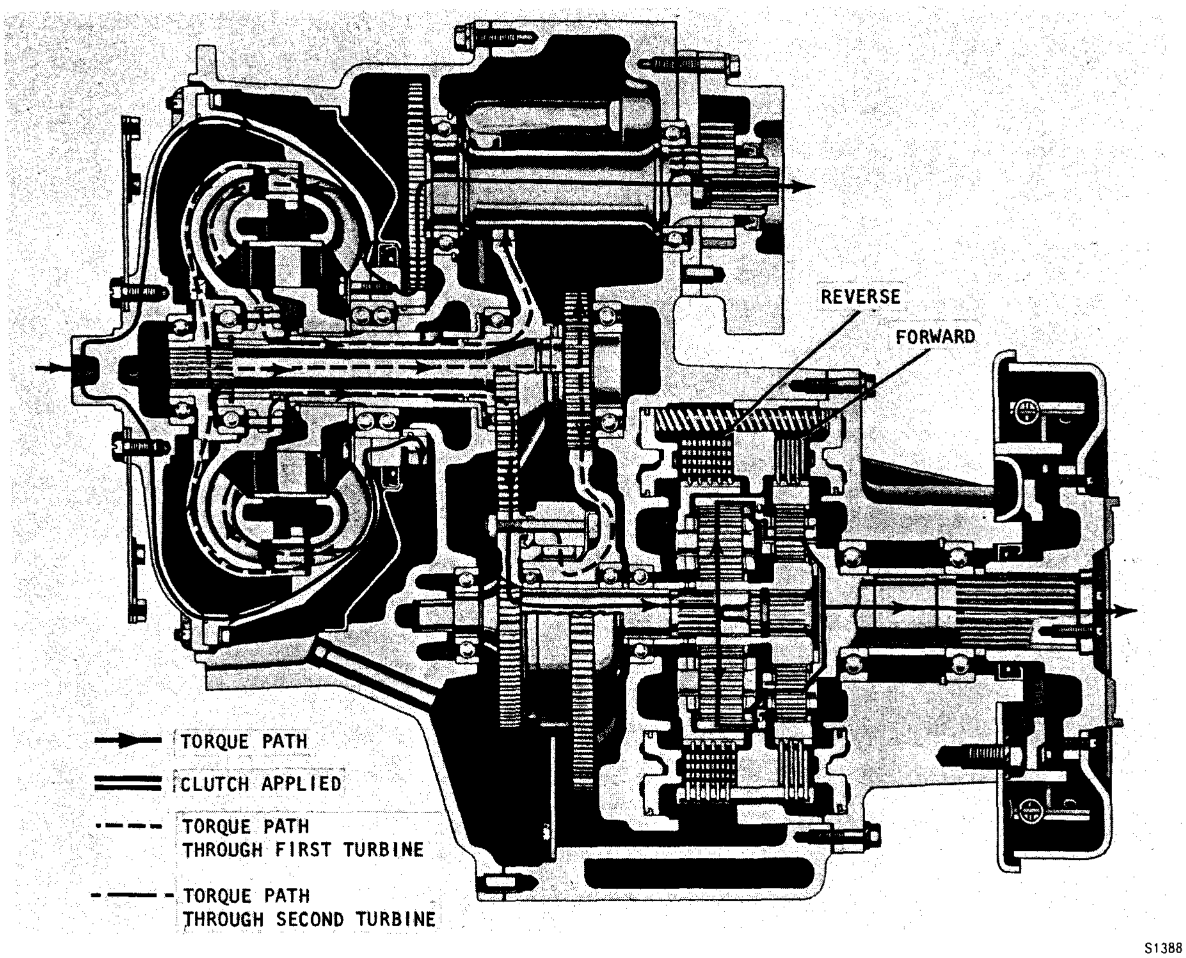


Fig. 2-25. Reverse torque path (TRT 2211-3, TRT 2411-3 transmission)

c. Reverse (fig. 2-25)

(1) Refer to paragraph 2-14 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.

Section 3. PREVENTIVE MAINTENANCE

3-1. SCOPE

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

3-2. PERIODIC INSPECTIONS, CLEANING

a. Inspecting Exterior

(1) The exterior of the transmission should be cleaned and inspected at regular intervals. The severity of service and operating environment will determine the frequency of such procedures.

(2) The transmission should be inspected for loose or missing bolts, oil leaks, linkage damage, and worn or frayed oil lines. Oil leaks require immediate attention. Refer to paragraph 3-12.

(3) Linkage must be clean, adjusted, and well lubricated.

b. Cleaning Breather. The prevalence of dust and dirt will determine the frequency at which the breather requires cleaning. Clean the area around the breather stem before removing the breather. Wash the breather thoroughly by agitating it in mineral spirits or cleaning solvent. Dry it thoroughly with compressed air after cleaning. Always use a wrench of the proper size to remove or replace the breather. Pliers or a pipe wrench will crush or damage it and produce metal chips which could enter the transmission.

3-3. OIL CONTAMINATION

a. Examine at Oil Change. At each oil change examine the oil which is drained for evidence of dirt or water. A normal amount of condensation will emulsify in the oil during operation of the transmission. However, if there is evidence of water, check the cooler (heat exchanger) for leakage between the water and oil areas. Oil in the water side of the cooler (or vehicle radiator) is another sign of leakage. This, however, may indicate leakage from the engine oil system. Any accumulation of sludge or soft dirt in the sump should be removed with flushing oil.

b. Coolant Leakage. If engine coolant leaks into the transmission oil system, immediate action must be taken to prevent malfunction and possible serious damage. Glycol solution will attack friction-faced clutch plates. The transmission must be completely disassembled, inspected, and cleaned. If glycol solution is present, all friction-faced clutch plates must be replaced. All traces of the coolant and varnish deposits, resulting from coolant contamination, must be removed. The cooler should be thoroughly cleaned or replaced prior to installation of the new or rebuilt transmission.

NOTE

A Gly-Tek test kit to detect glycol in transmission oil can be obtained from Nelco Company, 1047 McKnight Road South, St. Paul, Minnesota 55119. (Some transmission fluids may produce a positive reading due to "additives" that are not actually glycol. When test results are questionable, a test of an unused sample of the oil type or brand should be made to confirm test results.)

c. Metal Particles. Metal particles in the oil (except for the minute particles normally trapped in the oil filter) indicate damage has occurred in the transmission. When these particles are found in the sump or on the magnetic drain plug, the transmission must be disassembled and closely inspected to find the source. Metal contamination will require complete disassembly of the transmission and cleaning or replacement of all internal and external circuits, cooler, filter, and all other areas where the particles could lodge.

d. Auxiliary Filter

(1) After a transmission failure that introduces debris into the oil system, a complete clean-up of the oil cooler and lines is necessary.

(2) Repeated cleaning and flushing may not remove all debris. To prevent a repeated failure, caused by eventual movement of trapped debris, installation of an auxiliary filter in the cooler-out line (between cooler and transmission) is recommended. This recommendation applies whether the failed transmission is overhauled or replaced by a new or rebuilt unit.

(3) If any doubt exists about the clean-up of the oil cooler, replace the cooler.

(4) When an auxiliary filter is placed in the cooler-out line, converter regulator valve spring P/N 6773551 must be replaced with spring P/N 6880795 on S/N's before 92911.

(5) Refer to paragraph 6-8 for instructions for removal and replacement of the converter regulator valve, spring, and pin.

(6) The auxiliary filter should be an AC DM 13-5 P/N 5575224 or equivalent 40 micron filter. Pressure drop across the new filter can not exceed 5 psi (34 kPa) and the cooler circuit pressure differential can not exceed 40 psi (276 kPa) at full throttle stall.

(7) Auxiliary filter elements should be inspected for contamination after 500 and 1000 hours operation (depending on application), and changed at regular filter change intervals thereafter. Pressure drop across a dirty filter in excess of 15 psi (103 kPa) will cause the filter bypass valve to open and dirty oil will contaminate the system.

3-4. CHECKING OIL LEVEL

a. Cold Check (using oil level check plugs)

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

(2) Start the engine and operate at 1000 to 1500 rpm with the transmission in neutral. Operate for approximately 2 minutes. Then idle the engine and shift through all range positions slowly to charge the hydraulic system.

(3) While the engine is running, add oil as required to establish the oil level at the lower (Add) plug. Then proceed with the hot check (para 3-4b).

NOTE

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

b. Hot Check (using oil level check plugs)

(1) Start the engine and operate the vehicle until the transmission reaches the operating temperature of 180-220°F (82-104°C). Then idle the engine and shift through all range positions slowly. This will ensure that all parts of the system are filled with oil. Shift to neutral and run the engine at approximately 1200-1500 rpm.

(2) Remove the upper (Full) oil level check plug. Oil should be at the level of the plug opening. Add or drain oil to bring it to this level.

NOTE

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

c. Cold Check (using dipstick)

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

(2) Start the engine and let engine idle (500-750 rpm) with the transmission in neutral. Idle engine for approximately 2 minutes. Then shift through all range positions slowly to fully charge the hydraulic system.

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

(4) Then proceed with the hot check (para 3-4d).

d. Hot Check (using dipstick)

(1) Start the engine and operate the vehicle until the transmission reaches an operating temperature of 180-220°F (82-104°C). Idle the engine and shift through all range positions slowly to fully charge the hydraulic system. With the engine at idle speed and transmission in neutral range, the oil level should be within the OPERATING RANGE and not exceed the HOT (FULL) mark.

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

3-5. MAINTENANCE INTERVALS

a. Frequency. The severity of service and the environment in which the transmission operates will determine the frequency of some maintenance operations. Under very dusty or dirty operating conditions, the transmission oil should be changed more often. Oil should be changed immediately if it has been subjected to overheating. The breather will require more frequent cleaning when dirt and dust conditions are severe.

b. Oil and Filter Change. Generally the oil and filter should be changed after each 1200 hours of operation. For severe service, refer to paragraph 3-5a. Refer also to paragraph 3-3 before changing oil. Do not operate a transmission which is filled with preservative oil except for minimum necessary time and distance. Refer to paragraph 3-11e.

3-6. CHANGING OIL, FILTER

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

b. Refilling Oil System. Refer to Tables 3-1 and 3-2 and refill the oil system. Then conduct the hot check as described in paragraph 3-4b or d, adding oil as necessary to establish the correct oil level for operation.

3-7. BLEEDING INTERNAL BRAKE (TTB models)

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

b. To bleed the system, use a pressure bleeder inserted into either the master valve or plug. When manually bleeding the system, the reservoir must not be permitted to empty, or more air will be introduced. The bleeder valve, or plug 30 or 36 (foldout 15,B) is located directly opposite the point to which the tube from the master cylinder to the transmission is connected (left to right side).

Table 3-1. CHOICE OF PROPER C-3 OIL

Fluid viscosity and grade	Ambient temperature below which PREHEAT IS REQUIRED
SAE 30	32°F (0°C)
SAE 15W-40	32°F (0°C)
SAE 10W-30	10°F (-12°C)
SAE 10W	10°F (-12°C)
SAE 5W-20	-10°F (-23°C)

Table 3-2. OIL SYSTEM REFILL AMOUNTS

Initial fill (dry)

Model	Amount*
-3	6-1/2 U.S. gal (25 liters)
-1	8-1/2 U.S. gal (32 liters)

Refill (after drain)

Model	Amount*
-3	4-1/2 U.S. gal (17 liters)
-1	6-1/2 U.S. gal (25 liters)

* less external circuits

c. Flush fluid through the system with a pressure bleeder, or pump the brake pedal slowly through complete strokes, until no more air escapes at the bleeder valve or plug. If difficulty is experienced in obtaining a firm, solid feel when the brake is applied after bleeding, loosen one of the nuts at the upper ends of brake manifold 32 or 34 (foldout 15,B) and continue to purge air from the system. When the brake is bled manually, always close the bleeder valve or plug before the pedal upstroke.

3-8. PRESSURES, TEMPERATURES

Figure 3-1 illustrates the points where the transmission temperature and pressure may be measured. The vehicle may be equipped with a temperature gage and a pressure gage. If so, the temperature gage registers the con-

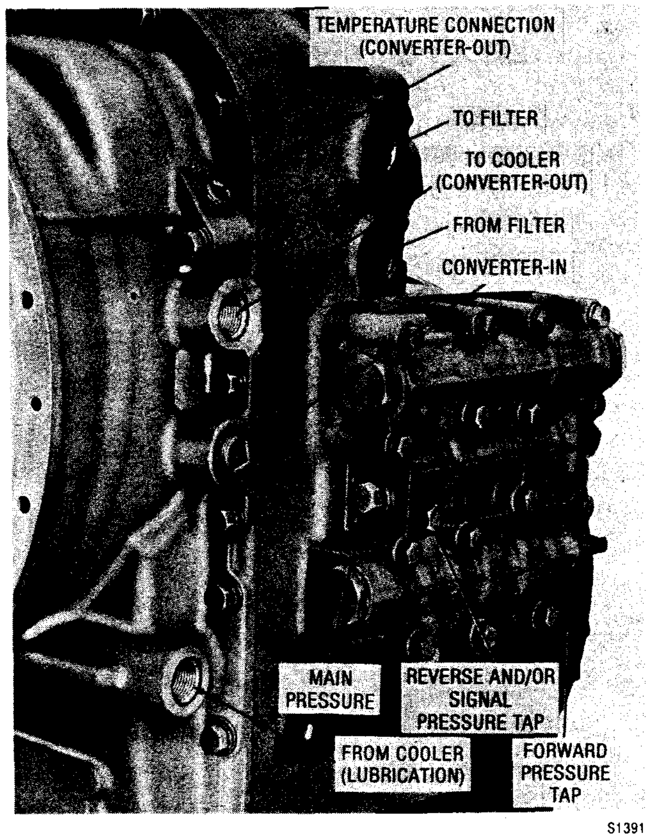


Fig. 3-1. Pressure and temperature check points

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

3-9. LINKAGE CHECKS, ADJUSTMENTS

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

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

c. Front Output Disconnect

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

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

d. Parking Brake (external, mechanical)

(1) Disconnect the brake linkage before adjustment. Adjust the brake shoes for proper drum clearance by inserting a screwdriver or adjusting tool into one of the openings at the rear of the brake drum and turning the starwheel. The starwheel should be rotated until 0.010 inch (0.254 mm) thickness gages are held snugly between the adjustment end of the shoes and the drum (use two gages simultaneously—one at each shoe).

(2) Hold the brake assembly actuating lever so that all slack is removed (without applying the brakes). Adjust the vehicle linkage by releasing the hand lever fully and adjusting the connecting rod so that it can be connected to the brake assembly actuating lever.

3-10. TRANSMISSION STALL TEST

NOTE

The engine stall speeds for all Detroit Diesel Allison approved engine/transmission applications may be obtained from the SCAAN Computerized Vehicle Performance program. Access to this program is available at Detroit Diesel Allison distributors and any Detroit Diesel Allison Regional Office.

a. Purpose

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

(2) A stall test is conducted with the transmission in F2 range, the engine running at full throttle, and the transmission outputs stalled. The data obtained from the test must be used in conjunction with engine-converter matched performance curves. These performance curves can be obtained from your equipment dealer or distributor.

b. Procedure

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

CAUTION

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

(2) Apply the parking brake, block the vehicle securely, and shift the selector control to high range. (The test may also be

conducted in F1 or reverse, if necessary. However, such tests must be made with extreme caution because of the high torque delivered at the transmission output shaft.)

CAUTION

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

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

NOTE

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

c. Results. Under stall test conditions, a comparison of actual engine speed with the established normal speed for such conditions will indicate if the engine or the transmission is malfunctioning.

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 ±150 rpm from the established normal value. When deviation can be attributed to such causes, the actual speed can be accepted as normal.

3-11. PRESERVATION, STORAGE

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

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

c. Storage, One Year — Without Oil

(1) Drain the oil and replace the oil filter element(s) (para 3-6).

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

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

(4) If the breather can be easily removed, spray one ounce (30 milliliters) of Motorstor® * (or equivalent) into the transmission through the breather hole. Also, spray one ounce (30 milliliters) through the fill tube hole. If the breather cannot be removed, spray two ounces (60 milliliters) of Motorstor (or equivalent) into the transmission through the fill tube hole.

(5) If additional storage time is required, repeat (3) and (4) at yearly intervals.

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

d. Storage, One Year — With Oil

(1) Drain the oil and replace the filter element(s) (para 3-6).

(2) Fill the transmission to operating level with a mixture of 30 parts Type C-3 oil to one part Motorstor rust preventative (or equivalent). Add 1/4 tsp of Biobor JF® * (or equivalent) for each 3 gallons (0.1 ml/liter) of oil in the system.

NOTE

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

(3) Shift through all selector positions to thoroughly distribute the oil. Then stop the vehicle and stall the transmission output until an oil temperature of 225°F (107°C) is obtained.

CAUTION

Do not allow the temperature to exceed 225°F (107°C). If the vehicle does not have a temperature gage, do not stall the transmission for more than 10 seconds.

(4) Stop the engine. As soon as the unit is cool enough to touch, seal all openings and breather with moisture-proof tape.

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

(6) If additional storage time is required, just add the prescribed mixture (para 3-11d (2)) of Motorstor and Biobor JF, or equivalents, and repeat (3) through (5) above, at yearly intervals. It is not necessary to drain the transmission each year.

e. Restoring Units to Service

(1) Remove the tape from openings and breather.

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

(3) If the transmission is new, drain the residual preservative oil. Refill the transmission to the proper level (para 3-4) with type C-3 oil.

(4) If the transmission was prepared for storage without oil, refill the transmission to the proper level (para 3-6) with type C-3 oil.

(5) If the transmission was prepared for storage with oil, check for proper oil level (para 3-6). Add or drain transmission oil as required to obtain the proper level.

NOTE

It is not necessary to drain and refill the transmission with new oil.

3-12. FLANGE RETAINER

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

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

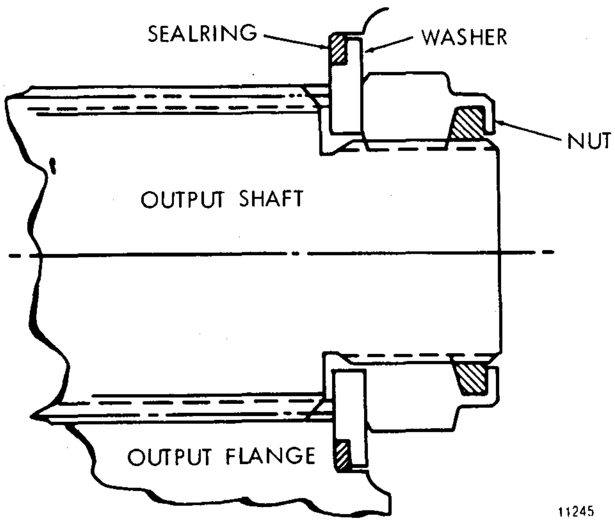


Fig. 3-2. Output shaft retainer washer and seal

3-13. TROUBLESHOOTING

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

b. Troubleshooting Table. Table 3-3 outlines the possible causes of and remedies for transmission troubles. Capital letters indicate the symptom; numerals following the symptom indicate several possible causes; numerals in the right column indicate remedies for the correspondingly numbered causes in the left column.

Table 3-3. TROUBLESHOOTING

Cause	Remedy
A LOW MAIN PRESSURE	
1. Low oil level	1. Add oil to correct level (para 3-4)
2. Clogged oil strainer	2. Clean strainer (para 3-6a)
3. Clogged oil filter	3. Replace filter element (para 3-6a)
4. Weak or broken main-pressure regulator valve spring	4. Replace spring (para 6-3)
5. Inching control adjustment not fully retracted	5. Check, adjust linkage (para 3-9)
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 (para 7-13b); check oil pickup tube nut (para 7-10c)
8. Internal oil leakage	8. Disassemble transmission; rebuild subassemblies as required
9. External oil leakage	9. Tighten bolts or replace gaskets
10. Brake hydraulic (or air) pressure applying clutch cutoff valve	10. Check brake residual pressure (brakes released); check brakes for full release
B OVERHEATING	
1. High oil level	1. Restore proper oil level (para 3-4)
2. Clutch failed	2. Rebuild transmission
3. Vehicle overloaded	3. Reduce load
4. Low main pressure	4. Refer to A
5. Engine water overheated	5. Correct engine overheating
6. Cooler oil or water line kinked or clogged	6. Clean or replace line

Table 3-3. TROUBLESHOOTING (cont)

Cause	Remedy
C LOW CLUTCH-APPLY PRESSURE	
1. Low main pressure	1. Refer to A
2. Clutch piston sealrings failed	2. Overhaul transmission
3. Clutch cutoff control valve sticking	3. Rebuild control valve assembly (para 6-3)
4. Inching control valve sticking	4. Rebuild control valve assembly (para 6-3)
5. Internal oil leakage	5. Overhaul transmission
D AERATED (foaming) OIL	
1. Incorrect type oil used	1. Change oil; use proper type. Refer to Table 3-1
2. High oil level	2. Restore proper oil level (para 3-4)
3. Low oil level	3. Restore proper oil level (para 3-4)
4. Air entering suction side of oil pump	4. Check oil pump bolts and gasket (para 7-13b); check oil pickup tube and nut (para 7-10c)
5. Air entering at clutch cutoff valve (air actuated)	5. Check plug seal and sealring of valve (para 6-3)
E VEHICLE WILL NOT TRAVEL	
1. Low main pressure	1. Refer to A
2. Low clutch-apply pressure	2. Refer to C
3. Selector linkage broken or disconnected	3. Repair or connect linkage (para 3-9)
4. Internal mechanical failure	4. Overhaul transmission
F VEHICLE TRAVELS IN NEUTRAL WHEN ENGINE IS ACCELERATED	
1. Selector linkage out of adjustment	1. Adjust linkage (para 3-9)
2. Clutch failed (won't release)	2. Overhaul transmission
G VEHICLE LACKS POWER AND ACCELERATION AT LOW SPEED	
1. Low clutch-apply pressure	1. Refer to C
2. Aerated oil	2. Refer to D
3. High oil viscosity	3. Preheat oil, or change to a lighter viscosity. Refer to Table 3-1.
4. Engine malfunction	4. Check engine; refer to engine service manual
5. Turbine freewheel clutch failed	5. Overhaul transmission
H STALL SPEED TOO HIGH (see para 3-10)	
1. Clutch slipping	1. Overhaul transmission
2. Low main pressure	2. Refer to A and C

Table 3-3. TROUBLESHOOTING (cont)

Cause	Remedy
I STALL SPEED TOO LOW (see para 3-10)	
1. Engine not producing full power	1. Tune or repair engine; refer to engine service manual
2. Torque converter failed	2. Rebuild converter
3. Loss of engine power through accessories attached to engine	3. Disconnect accessories which are absorbing power
J SERVICE BRAKE MALFUNCTIONS—TTB MODELS	
1. Brake slips when pedal is fully applied	1. Rebuild brake (para 6-16)
2. Spongy brake pedal	2. Bleed hydraulic brake lines (para 3-7)
3. Brake pedal bottoms when brake is applied	3. Check for leaks in hydraulic brake lines and for broken linkage. Bleed brake hydraulic system (para 3-7)
K CLUTCH CUTOFF VALVE INEFFECTIVE	
1. Valve or plug sticking	1. Rebuild control valve body assembly (para 6-3)
2. Brake-apply hydraulic pressure not reaching control valve	2. Check pressure at control valve (min-max limits — 100-2000 psi; 689-13 789 kPa)
3. Brake-apply air pressure not reaching air cylinder	3. Check at air cylinder for brake-apply pressure (35 lb (136 N) force required to stroke valve)
4. Plunger sticking in air cylinder	4. Check operation of air cylinder
5. Air entering at valve (air actuated)	5. Check operation of air cylinder (seals)

Section 4. GENERAL OVERHAUL INFORMATION

4-1. SCOPE

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

4-2. MODEL CHANGES

The release of new assemblies may require new or different overhaul procedures. Major changes in the transmission will be described in supplementary issues to this manual. Contact your dealer or distributor for the latest information. When requesting service information, be sure to give the model, assembly part number, and serial number as stamped on the transmission nameplate (refer to para 1-3a).

4-3. TOOLS, EQUIPMENT

a. Special Tools. Table 4-1, and figures 4-1 and 4-2 show special tools required for overhaul procedures.

b. Mechanic's Tools, Shop Equipment. The following tools, in addition to common tools, should be available:

CAUTION

Caustic cleaning compounds will damage some transmission parts. Use only mineral spirits such as PD 680-2 (or equivalent).

- Container of mineral spirits (for cleaning parts)
- Hoist (1/2-ton (450 kg) capacity, min)
- Press (for removal and installation of press-fit parts)
- Supply of wood blocks

Table 4-1. SPECIAL TOOLS

Tool No.*	Fig.	Item	Name	Ref. Para.
J-23547	4-1	1	Converter pump assembly puller	5-6a (4)
J-23723-6	4-1	2	Converter pump hub bearing driver	6-7b(2)
J-33080-1	4-1	3	Bridge	6-26
J-33080-2	4-1	4	Retriever	6-26
J-33080-3	4-1	5	Collet	6-26
J-33080-5	4-1	3	Collar	6-26
J-33080-8	4-1	6	Height gage	6-26
J-33080-13	4-1	3	Washer (two required)	6-26
**	4-1	7	Flange puller	4-9a
**	4-1	8	Cam bolt holding fixture	6-9b(6)
**	4-1	9	Suction tube nut wrench	5-7c, 7-7b(4)

* These tools are manufactured by Kent-Moore Tool Division, 29784 Little Mack, Roseville, Michigan 48066, and may be obtained through your local Detroit Diesel Allison dealer or distributor.

** Must be fabricated—not available from Kent-Moore.

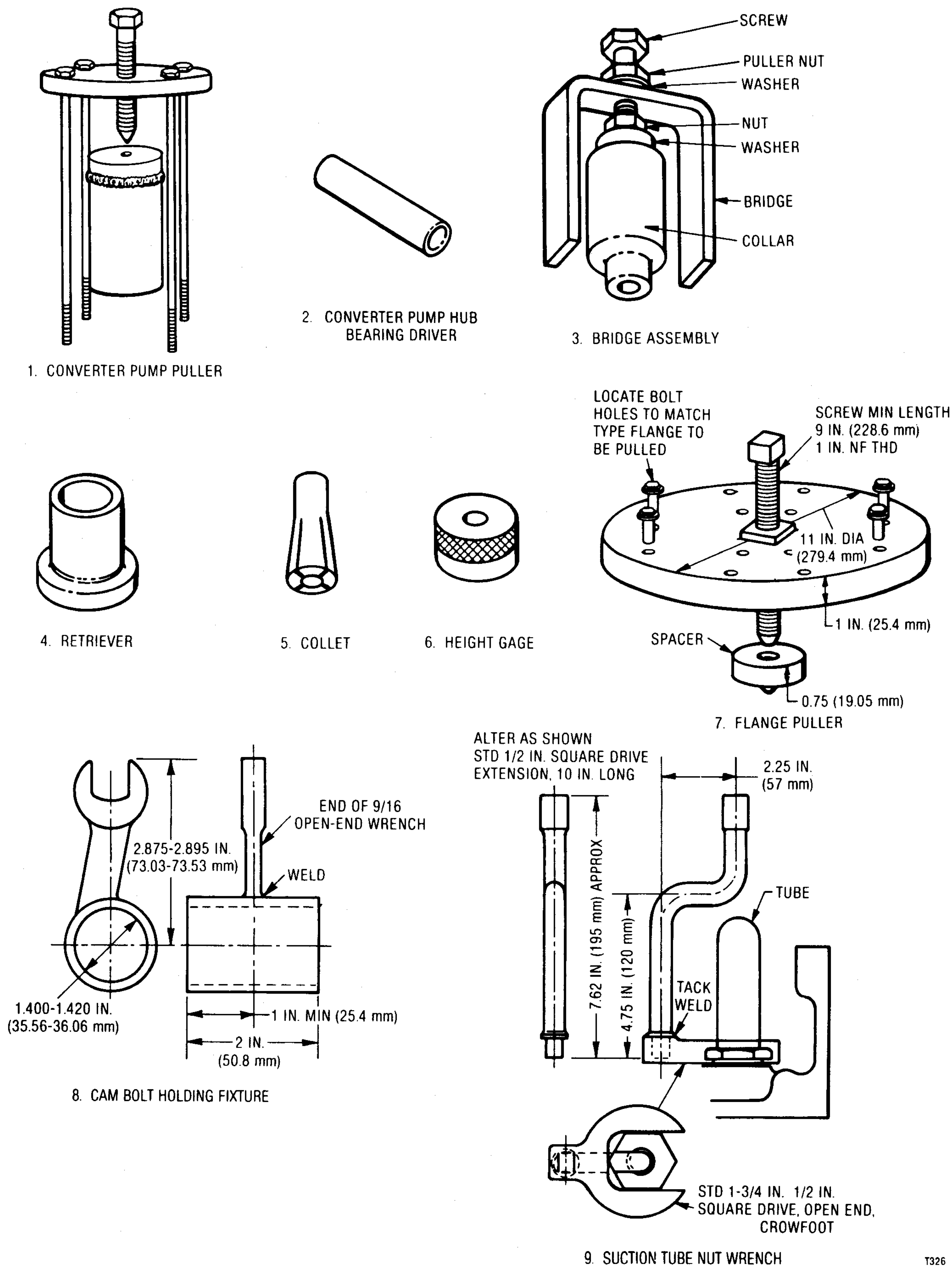


Fig. 4-1. Special tools

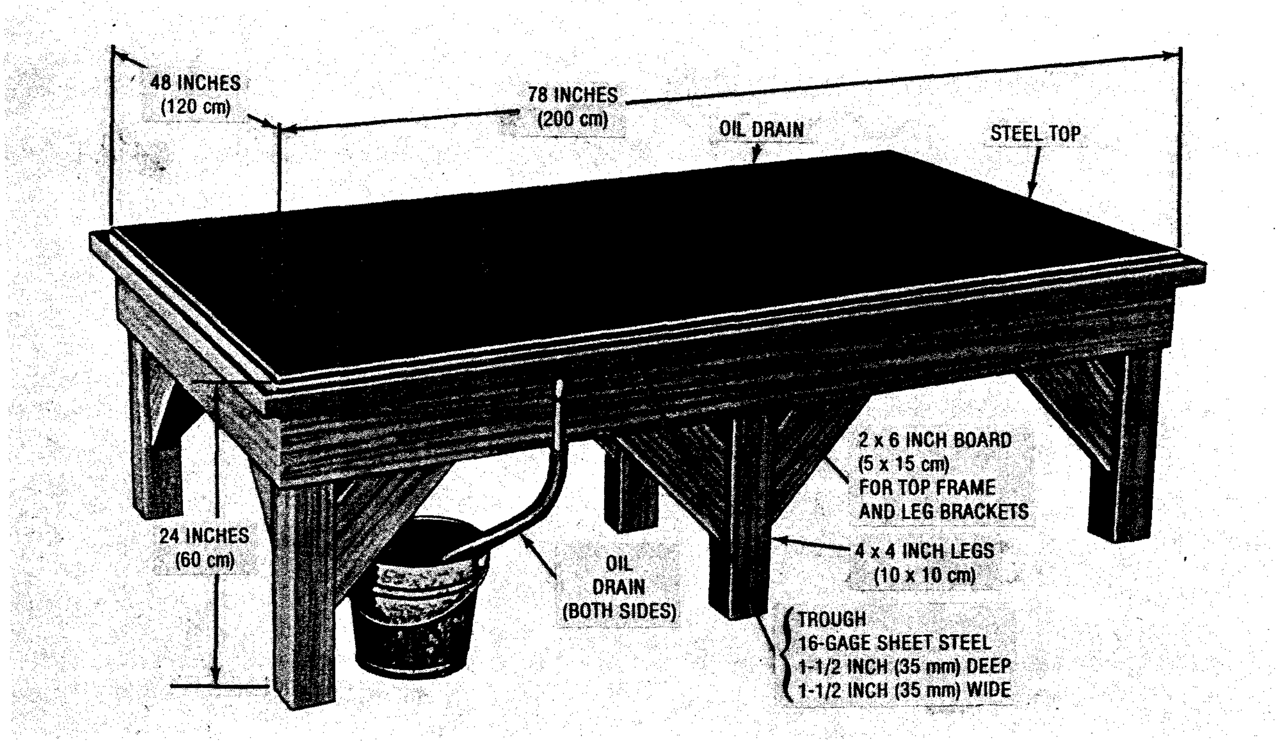


Fig. 4-2. Work table

- Clean lint-free shop cloths (do not use linty waste)
- Parts receptacles
- Cleaning equipment (brushes, solvents, etc.)
- Oil-soluble grease (petrolatum)
- Dry ice (for cooling interference-fit parts)
- Heating equipment or hot plate to provide oil at 300°F (150°C) (for heating interference-fit parts)
- Snapring pliers
- 3-leg lifting sling—1/2 ton (1200 kg) capacity--90 degree angle attaching plates
- Micrometer
- 100 inch-pound (11 N·m) torque wrench
- 100 foot-pound (136 N·m) torque wrench
- 1000 foot-pound (1356 N·m) torque wrench
- Nonhardening sealer, Permatex® * No. 2 or equivalent (for seals that are not precoated)
- Loctite® ** Pipe Sealant with Teflon or equivalent (for plugs that are not precoated)
- Loctite Sleeve Retainer 601 or equivalent (for sleeve-type bearings)
- High temperature grease, MIL-G-81322, Mobil Grease No. 28 (Mobil Oil Co.), Aeroshell Grease No. 22 (Shell Oil Co.) or equivalent (for lip-type oil seals—do not use inside transmission)
- High-quality molybdenum disulfide grease, Allison P/N 6769877 or equivalent (antiseize compound for input and output shaft threads—do not use inside transmission)

CAUTION

Use an antiseize compound that will not attack the Buna or Polyacrylate seal material. Mobile-Grease Special with molybdenum disulfide, or equivalent, is recommended.

* Permatex® is a registered trademark of Permatex Co. Inc., West Palm Beach, FL.
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4-4. REPLACEMENT PARTS

a. Ordering Information. Refer to paragraph 1-3 for information on ordering parts and service kits.

b. Parts Normally Replaced. The following parts are normally replaced during overhaul:

WARNING

Do not burn discarded Teflon seals. Toxic gases are produced by burning.

- Sealrings
- Oil seals (if removed)
- Gaskets
- Lockstrips
- Washers or snaprings damaged by removal

4-5. CAREFUL HANDLING

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

4-6. CLEANING, INSPECTION

a. Dirt-free Assembly. All parts must be clean to permit effective inspection. During assembly, it is very important that no dirt or foreign matter enters the transmission. Even minute particles can cause the malfunction of close-fitting parts.

b. Cleaning Parts

CAUTION

Use only mineral spirits for cleaning. Solvents such as trichloroethylene, Benzol, Acetone, and all aromatics are harmful to oil seals using polyacrylate rubber.

(1) Use only mineral spirits on friction-faced clutch plates and bearings. All other metallic parts of the transmission should be cleaned thoroughly with mineral spirits, or by steam-cleaning. Do not use a caustic soda solution for steam cleaning.

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

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

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

(5) Removal of minor defects with such items as crocus cloth, soft honing stones, and scrapers produces debris and residue. Cover adjacent parts, ports, and cavities before removing defects. Thoroughly reclean the affected areas after rework.

c. Cleaning Bearings

WARNING

Never dry bearings by spinning them with compressed air. A spinning bearing can disintegrate, allowing balls or rollers to become lethal flying projectiles. Also, spinning a bearing while it is not lubricated can damage the bearing.

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

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

(3) Before inspection, oil the bearings with type C-3 transmission oil.

d. Inspecting Bearings

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

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

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

CAUTION

Any bearing that has been subjected to metal contamination (para 3-3) must be closely inspected for metal particles. Metal particles will cause failure of the bearing.

e. Keeping Bearings Clean. The presence of dirt or grit in ball bearings is usually responsible for bearing failures. Keep bearings clean during installation and removal. Observance of the following rules will do much to ensure maximum bearing life.

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

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

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

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

f. Inspecting Cast Parts, Machined Surfaces

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

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

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

(4) Inspect threaded openings for damaged threads. Chase damaged threads with the correct size used tap (a new tap can cut oversize).

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

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

(7) Inspect piston bores in clutch housings for nicks, burrs, and displaced metal that could interfere with mating parts or damage piston sealrings. Remove these defects with crocus cloth or soft honing stone.

(8) Inspect sealring grooves in clutch pistons for nicks, burrs, dents, or displaced metal that could damage sealrings. Remove these defects with crocus cloth or soft honing stone.

g. Inspecting Bushings, Thrust Washers

(1) Inspect bushings for scores, roundness, burrs, sharp edges, and evidence of overheating. Remove scores with crocus cloth. Remove burrs and sharp edges with a scraper or knife blade. If the bushing is out-of-round, deeply scored, or excessively worn, replace it, using the proper size replacer tool. Whenever it is necessary to cut out a defective bushing, do not damage the bore into which the bushing fits.

(2) Inspect thrust washers for distortion, scores, burrs, and wear. Replace the thrust washer if it is defective or worn.

h. Inspecting Oil Seals, Gaskets

(1) Inspect piston sealrings for nicks, cuts, tears, splits, and pattern damage. This type damage on old sealrings can indicate defects in the piston grooves or in the piston housing bores. Locate and remove the defects. Refer to paragraphs 4-6 f, (7) and (8).

(2) Inspect metal-encased seals for cuts and hardness. Replace the seal if defects are found or if the seal is damaged by removal. Replace all sealrings (except hook-type) and composition gaskets.

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

(4) Install a new hook-type sealring if the ring shows any wear on the outside circumference or if there is excessive side wear. 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 to (50 micro-inches (1.27 μm)) and square with the axis of rotation within 0.002 inch (0.05 mm). If the sides of ring grooves have to be reworked (0.020 inch (0.51 mm) maximum side wear), install a new sealring.

i. Inspecting Gears

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

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

(3) Inspect the thrust faces of gears for scores, scratches, and burrs. Remove such defects with a soft honing stone.

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

k. Inspecting Clutch Plates

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

(2) Inspect steel plates for burrs, scoring, excessive wear, cone, distortions, imbedded metal, galling, cracks, breaks, and damaged tangs. Remove burrs 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. 4-3). Discard plates having excessive cone (refer to wear limits, Section 8).

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

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

n. Inspecting Springs. Inspect all the springs for signs of overheating, permanent set, or wear due to rubbing adjacent parts.

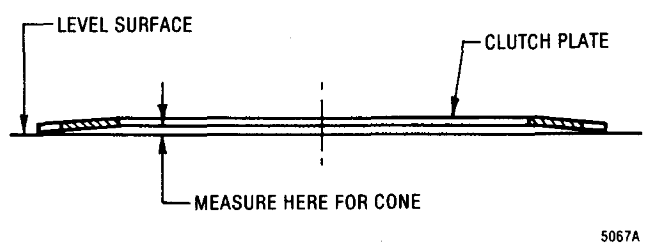

Fig. 4-3. Method for determining cone of clutch plate

Replace the spring if any one of these defects if found. Replace springs which do not meet the load-height specifications in the spring chart in Section 8.

o. Inspecting Seal Contact Surfaces. Inspect the surfaces that contact the sealing area or lip of any seal. Roughness, scoring, pitting, or wear that will permit oil leakage or cause damage to the seal must be corrected. The affected part must be replaced if defects cannot be corrected.

p. Inspecting Swaged, Interference-fit Parts. If there is evidence of looseness due to relative motion, the assembly should be replaced.

q. Inspecting Balls in Clutch Pistons. Inspect all balls in clutch pistons for free movement. Any restriction could prevent the ball from seating during clutch application.

r. Inspecting Pump Gears. Inspect pump gears for evidence of wear such as scoring or shiney areas due to rubbing of adjacent parts. Replace gears with any signs of wear.

4-7. ASSEMBLY PROCEDURES

a. Clutches, Pistons

(1) Soak each friction face clutch plate (two-minute minimum) in transmission fluid prior to final assembly.

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

(3) Assemble clutch plates so that the cone of each plate faces the same direction as the cone of the adjacent plates (fig. 4-3).

b. Parts Lubrication. During final assembly, lubricate all moving parts with transmission fluid. The lubricant will help protect the friction surfaces and ferrous metals until the unit is in service.

c. External Pipe Plugs, Hydraulic Fittings.

(1) New Precoated Plugs. New plugs that are precoated with Teflon need no preparation for assembly.

(2) Reused or Uncoated Plugs, Hydraulic Fittings. Prepare the threads with a small amount of nonhardening sealant, such as Loctite Pipe Sealant with Teflon, or equivalent. Do not use Teflon tape.

CAUTION

Inaccurate torque can cause leakage and cracked housings. Tighten all pipe plugs to the torque specified in the assembly step and on the exploded views.

d. Oil-soluble Grease. Use only oil-soluble grease with a low melting point, such as MIL-VV-P-236 or Amojell petrolatum (Amoco Oil Co.) or equivalent to temporarily retain parts, step-joint sealrings, scarf-cut sealrings, and hook-type sealrings during assembly with mating parts.

CAUTION

Do not use petrolatum to retain cork gaskets.

e. Sealing Compounds, Nonsoluble Greases. Do not use gasket-type sealing compounds, fibrous greases, or nonsoluble, vegetable-base cooking compounds any place inside the transmission. Do not use them any place where they could be flushed into the transmission hydraulic system.

f. Metal-Encased Oil Seals

(1) When replacing metal-encased oil seals, make sure the spring-loaded lip side is toward the oil to be sealed in (toward the inside of the unit). Coat the inside of the seal with high temperature grease, such as MIL-G-81322, Mobil Grease No. 28 (Mobil Oil Co.) or Aeroshell Grease No. 22 (Shell Oil Co.) or

equivalent to protect the seal during shaft installation and to provide lubrication during initial operation. Do not use high temperature grease on other internal transmission parts.

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

(3) Uncoated Seals. Prepare the circumference of uncoated seals with a nonhardening sealant such as Permatex No. 2 or equivalent before installation.

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

h. Sleeve-type Bearings. Loctite Sleeve Retainer 601, or equivalent, should be used to retain bushings and sleeve-type bearings that have press-fit tolerance.

i. Bearings (Ball or Roller)

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

NOTE

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

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

4-8. REMOVING, INSTALLING TRANSMISSION

a. Drain Oil. Drain the oil from the transmission. For better drainage, the transmission should be warm and allowed to drain overnight. Replace the drain plug.

b. Check Linkages, Lines. Make sure that all linkages, controls, cooler and filter lines, pressure and temperature lines, driveline couplings, and mounting bolts are disconnected before transmission removal. Carefully place oil lines clear of the removal path and cover all openings to keep out dirt.

c. Remove, Clean Transmission. Consult the vehicle service manual for specific instructions for removal and installation, as applications will differ. Clean the exterior of the transmission. If steam cleaning is used, the transmission should be disassembled and dried immediately as condensation of the the steam will rust the ferrous parts in the transmission.

d. Lifting. Two 3/4-10 tapped openings are provided at the top of the transmission housing. Bolts or eyebolts may be installed into the openings for lifting the transmission. assembly.

e. Reconnect at Installation

(1) At installation, reconnect all linkage and lines which were previously removed. Refer to the vehicle service manual and to paragraph 3-9 for proper adjustments of control linkage.

(2) Use Loctite Pipe Sealant with Teflon, or equivalent, for thread sealing on hydraulic, air, and other threaded fittings. Do not use Teflon tape. Loose slivers of tape can plug orifices, cause valves to stick, or may interfere with check ball operation.

(3) On the direct-mount transmissions equipped with torque converter drive cover 12 (foldout 6,B), make sure the counterbore in drive ring 8 is packed with high-quality molybdenum disulfide grease. (Refer to para 7-12b.)

4-9. TIGHT-FIT FLANGES

a. Removal of Flanges

(1) If present, flatten the corners of the lockstrip and remove two bolts, lockstrip, retainer washer, and shims (fig. 4-4).

(2) Some flanges are retained by a self-locking nut. Before removing the nut, check to see how many notches have been cut into the wrenching flats. If there are five notches, remove the nut and throw it away.

(3) If there are less than five notches, or none at all, remove all dirt and any burrs from the exposed shaft threads. Then, only loosen the nut until there is approximately 1/16-inch (1.59 mm) gap between the nut and flange.

(4) Check the running torque while removing the nut. The nut can be reused only if it meets the following requirements.

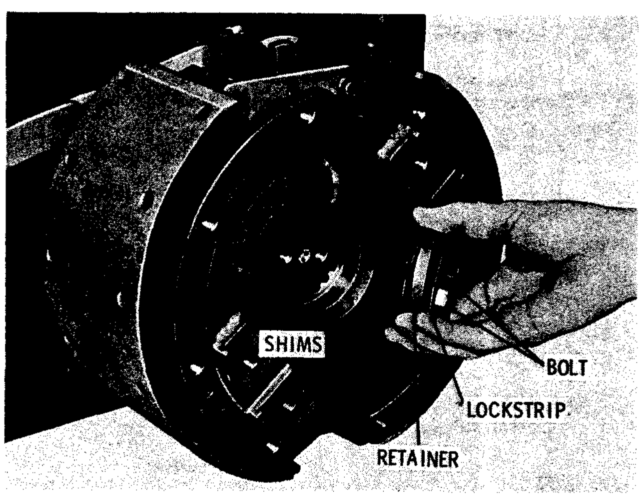

Fig. 4-4. Removing or installing output flange retaining parts

- The first time (no notches) the nut is removed, the running torque must be at least 400 lb in. (45 N·m).
- Each additional time (one to four notches) the nut is removed, the running torque must be at least 300 lb in. (34 N·m).

(5) Each time the nut is reused, deeply scribe a line onto one of the wrenching flats. This method of marking the nut will indicate how many times the nut has been reused. The nut must not be reused more than five times.

CAUTION

A puller placed on the outside diameter of the flange may deform the pilot diameter and mounting face.

(6) Install a suitable heavy-duty puller to the face of the flange. A typical puller is illustrated in figure 4-1. A Torqmatic coupling requires a puller that will engage the internal groove machined in the coupling hub.

(7) In order to protect the tapped holes in the end of the shaft, install a soft metal spacer between the puller jackscrew point and the end of the shaft.

(8) Provide a means for preventing flange rotation.

CAUTION

Do not use a pry bar or hammer to force the flange at disassembly.

(9) Remove the flange by tightening the puller screw against the spacer and shaft.

b. Installation of Flanges

(1) Coat the shaft splines and the lip of the oil seal with a thin layer of bearing grease.

(2) Heat the flange to approximately 300°F (149°C) prior to assembly. Either heat in a controlled temperature furnace for at least 45 minutes or submerge the flange in a container of oil and heat the oil. (If acetylene torch is used, heat the container of oil for 15 minutes.)

CAUTION

Do not let the flange cool prior to installation. If the flange cools and seizes to the shaft prior to its final assembly, it will be necessary to remove the flange and repeat the assembly procedure. Do not attempt to force the flange with a hammer.

(3) Immediately after heating, install the flange on the shaft, making sure that the flange is tight against its locating shoulder. The flange should slide freely to its assembled position.

(4) If an output nut is used, coat the threads of the nut with molybdenum disulfide grease and install the flange retaining washer and nut. (Do not reuse nut with five notches; refer to paragraph 4-9a.) Tighten the nut to 450-700 lb ft (611-949 N·m) (fig. 4-5).

(5) If washer and bolts are used, install washer and free running bolts to draw the flange down into final position. (Do not use lock bolts that will be used at final assembly.) Remove the bolts and install the lockstrip (and shim(s), if required—see fig. 4-6). Shims are available in thicknesses of 0.005 inch (0.13 mm) and 0.025 inch (0.63 mm). Use shims to allow 0.005-0.009 inch (0.12-0.22 mm) between surface A (fig. 4-6) and the surface of the shim pack. Install the lock bolts and tighten them to 41-49 lb ft (56-66 N·m).

(6) After the assembly has cooled, it is good practice to check the nuts or bolts for tightness and, if necessary, retighten them.

4-10. WEAR LIMITS, SPRING DATA

a. Wear Limits Inspection. When parts are being inspected, those listed in Section 8 should be measured for wear. Those parts

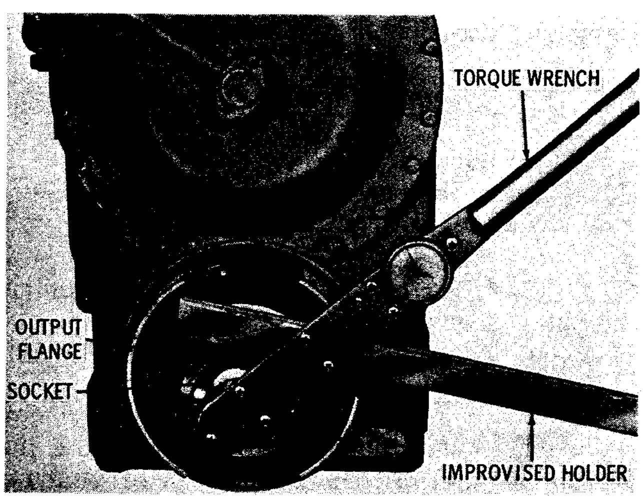

Fig. 4-5. Tightening rear output flange nut

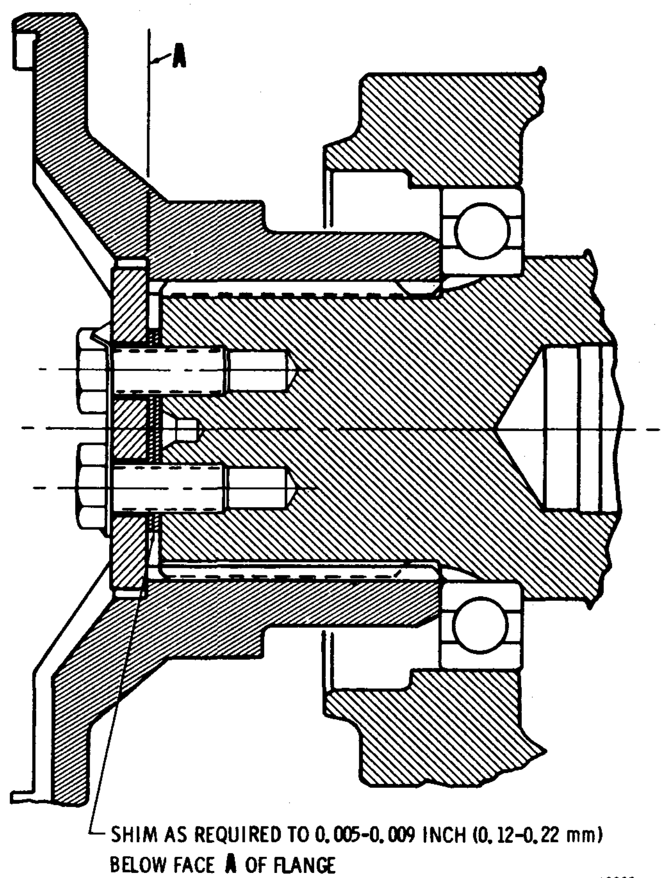

Fig. 4-6. Measurement to determine flange shim thickness

which have reached or exceeded the specified wear limit should be discarded and replaced. All wear limits data are tabulated in Section 8. The item numbers are keyed to the parts shown in the exploded views at the back of the book.

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

4-11. TORQUE SPECIFICATIONS

Torque specifications are given with each assembly procedure. Also, the exploded view foldouts state torque specifications for all threaded parts.

