RUTHZIL TRATOR COMERCIAL DE PEÇAS LTDA 11 97083-6812 ROLANDO CITRANGULO

930R 930T

OUTUBRO 2001

produtos: WHEEL LOADER
Modelo: 930R WHEEL LOADER 57Z
Configuração: 930T WHEEL LOADER 57Z04000-UP (MACHINE) POWERED BY 3304 ENGINE

Operação dos Sistemas
930R & 930T WHEEL LOADERS POWER TRAIN

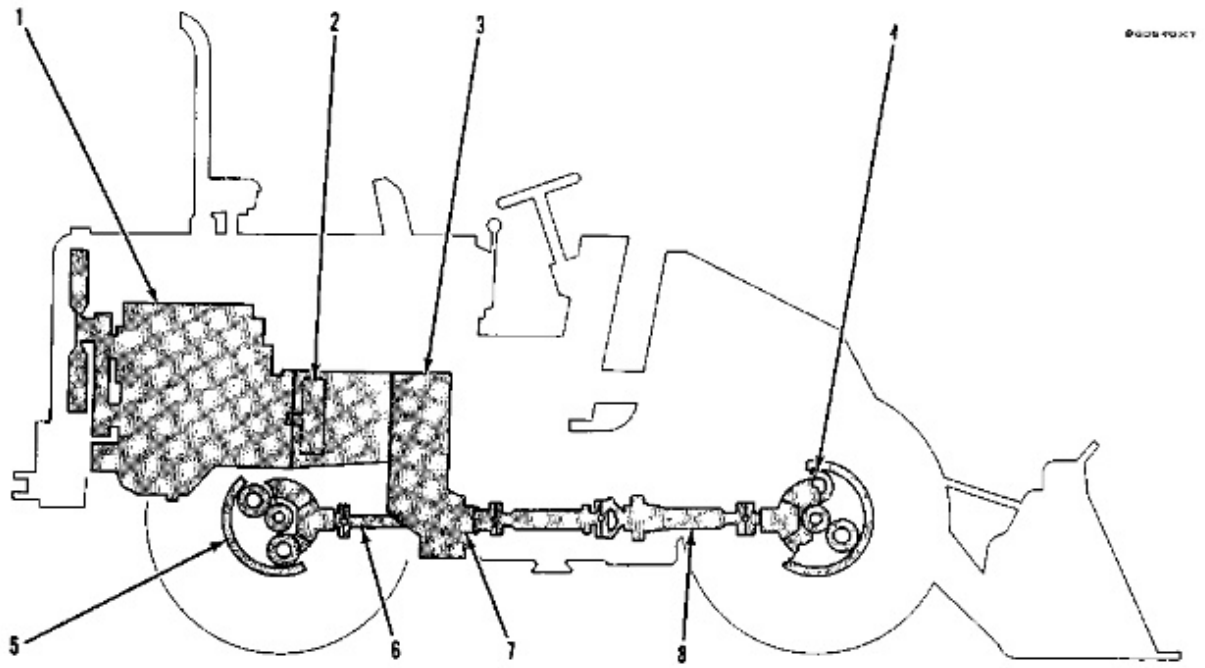
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Systems Operation

Introduction

NOTE: For Specifications with illustrations, make reference to SPECIFICATIONS FOR 930R WHEEL LOADER POWER TRAIN, Form No. SENR2431. If the Specifications in Form SENR2431 are not the same as in the Systems Operation and the Testing and Adjusting, look at the printing date on the back cover of each book. Use the Specifications given in the book with the latest date.

General Information



LOCATION OF POWER TRAIN COMPONENTS

1. Diesel engine.

2. Torque converter.

3. Transmission.

4. Front final drives.

5. Rear final drives.

6. Rear drive shaft.

7. Output transfer gears.

8. Front drive shaft.

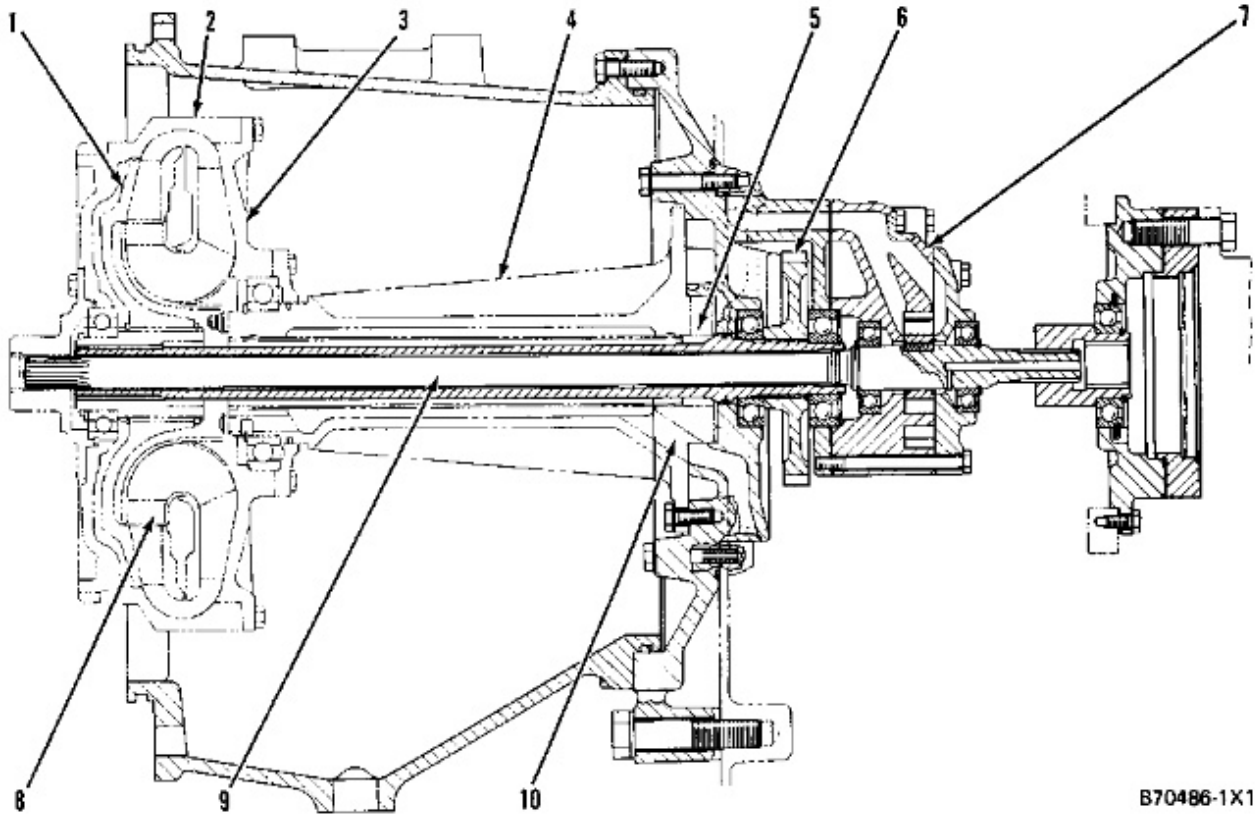
Power from diesel engine (1) is sent from the flywheel to torque converter (2). The torque converter output gear is connected to the transmission input gear.

Hydraulically activated clutches in transmission (3), give three forward speeds and three reverse speeds. Speed and direction selections are made manually.

The transmission output shaft is connected to a gear in the output transfer gear case by splines. Power is sent through the gear to the output gear. The output gear sends power through drive shaft (6) to the rear drive pinion. The output gear also sends power to the front drive pinion through drive shaft (8).

The pinions, bevel gears and gears of each differential turn their respective axles. The axles are connected to final drives (4) and (5). The final drives turn the wheels.

Torque Converter



TORQUE CONVERTER AND TRANSMISSION OIL PUMP

1. Turbine. 2. Rotating housing. 3. Impeller. 4. Stator carrier. 5. Inlet port. 6. Output gear. 7. Transmission oil pump. 8. Stator. 9. Transmission oil pump drive shaft. 10. Outlet port.

Oil for the operation of the converter is supplied by transmission oil pump (7). The maximum converter inlet oil pressure is controlled by the inlet relief valve. The valve is located in the converter mounting manifold.

The outlet oil pressure is controlled by a relief valve located in the converter outlet oil passage in the transmission housing.

The input flange, rotating housing, impeller, impeller hub, and the oil pump drive shaft rotate as a unit at engine speed.

Oil from the transmission hydraulic controls enters the torque converter through inlet port (5) in stator carrier (4). Oil is directed to the carrier by a passage in the converter housing.

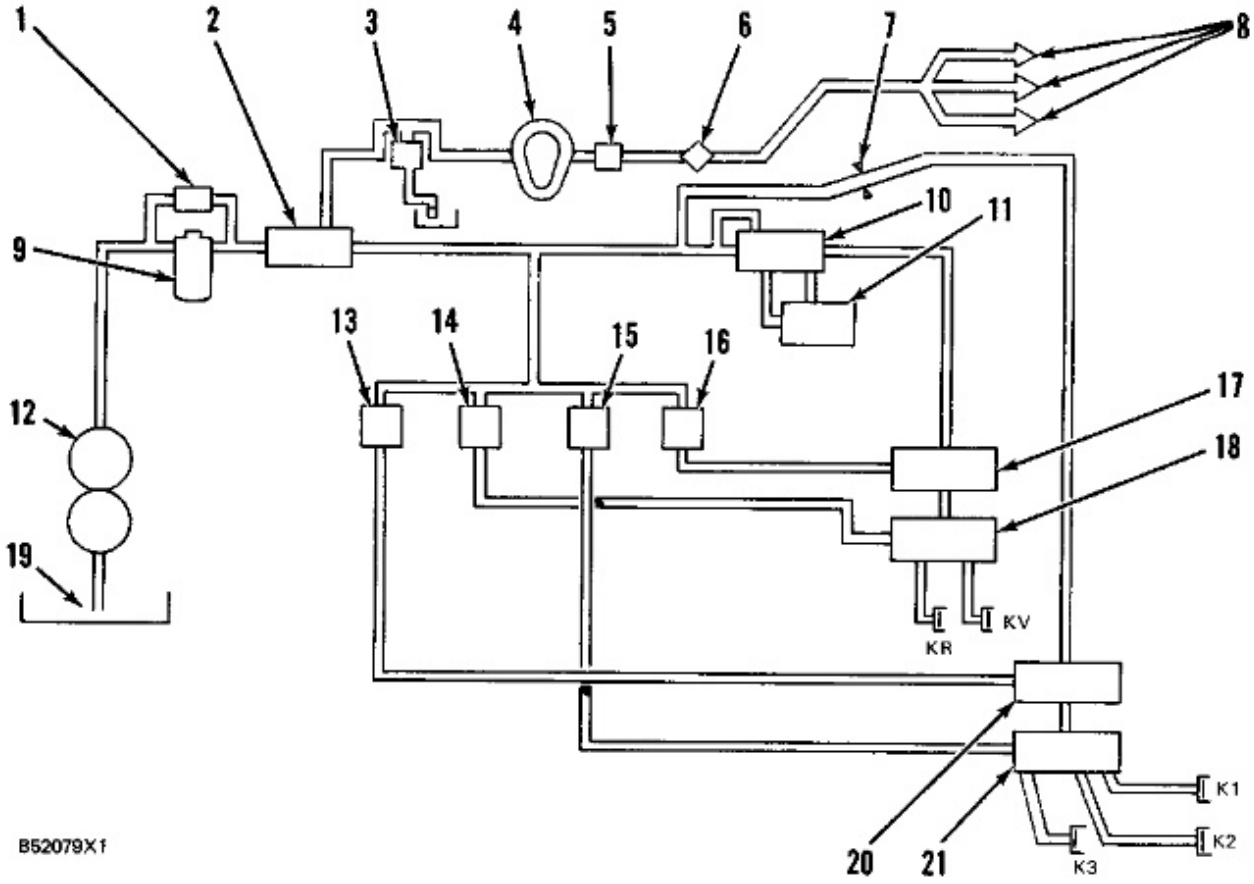
The impeller acts as a pump. As the impeller rotates, it directs oil to the rotating turbine. The turbine is splined to the output shaft. The turbine directs the oil to the stator which is bolted to the converter housing.

Oil leaves the converter through outlet port (10) in the carrier. The oil flows through an oil cooler and then to the transmission lubrication system.

The energy imparted to the oil by the impeller transmits torque to the turbine and the output shaft. Under normal operating conditions, the oil passes through the converter easily and quickly striking each blade at a very slight angle. When a load is encountered, the speed of the turbine is reduced, and the oil strikes the turbine blades at a sharper angle. This multiplies the torque delivered to the output shaft of the torque converter.

The output gear of the torque converter meshes with the input gears of the transmission which in turn transmit power into the transmission.

Transmission Hydraulic Controls



SCHEMATIC OF TRANSMISSION HYDRAULIC SYSTEM

1. Oil filter bypass valve.
2. Main relief valve.
3. Torque converter inlet relief valve.
4. Torque converter.
5. Torque converter outlet relief valve.
6. Oil cooler.
7. Orifice.
8. Transmission lubrication system.
9. Transmission oil filter.
10. Modulating reducing valve and load piston.
11. Reset valve.
12. Oil pump.
13. M-4 Solenoid.
14. M-3 Solenoid.
15. M-2 Solenoid.
16. M-1 solenoid.
17. No. 1 valve spool.

18. No. 3 valve spool.

19. Reservoir.

20. No. 4 valve spool.

21. No. 2 valve spool.

KR. Reverse clutch.
KV. Forward clutch.
K1. First speed clutch.
K2. Second speed clutch.
K3. Third speed clutch.

Transmission oil pump (12) pulls oil from reservoir (19) and sends it to filter (9). The filter has a bypass valve (1) that permits the oil to go around the filter when the oil is cold and thick, or should the filter become clogged.

Oil from the filter is sent to the valve group housing to main relief valve (2). The main relief valve limits the maximum oil pressure in the valve group housing and releases the remaining oil to torque converter (4) and lubrication system (8). Oil passes upstream of the main relief valve and is sent through a passage to modulating reducing valve and load piston (10). The modulating reducing valve and load piston directs oil to reset valve (11) and sends modulated oil to the direction valve spools. This oil goes to number 1 valve spool (17), where it goes around the number 1 valve spool to number 3 valve spool (18). The number 3 valve spool blocks the oil to the direction clutches. (KR reverse clutch, and KV forward clutch).

In the "at rest" position [directional spools (17) and (18) blocking oil to directional clutches KV and KR], pump pressure oil flows according to the position of "1", "2" or "3" of the speed control part of the electronic shift control. The speed control energizes the appropriate solenoids (13), (14), (15) and (16) according to speed selection.

A part of the oil that goes to the modulating reducing valve and load piston goes through a passage to the screen end of the four solenoids (13-14-15-16). Each of the four solenoids control pilot oil that moves each of the four valve spools in the valve group housing. When the direction and speed selector lever on the steering column is moved to a direction and a speed, certain of the four solenoids are energized. When a solenoid is energized, it opens the valve inside and sends pilot oil to the valve spool it controls and moves it for oil to pass to a direction or speed clutch causing it to engage.

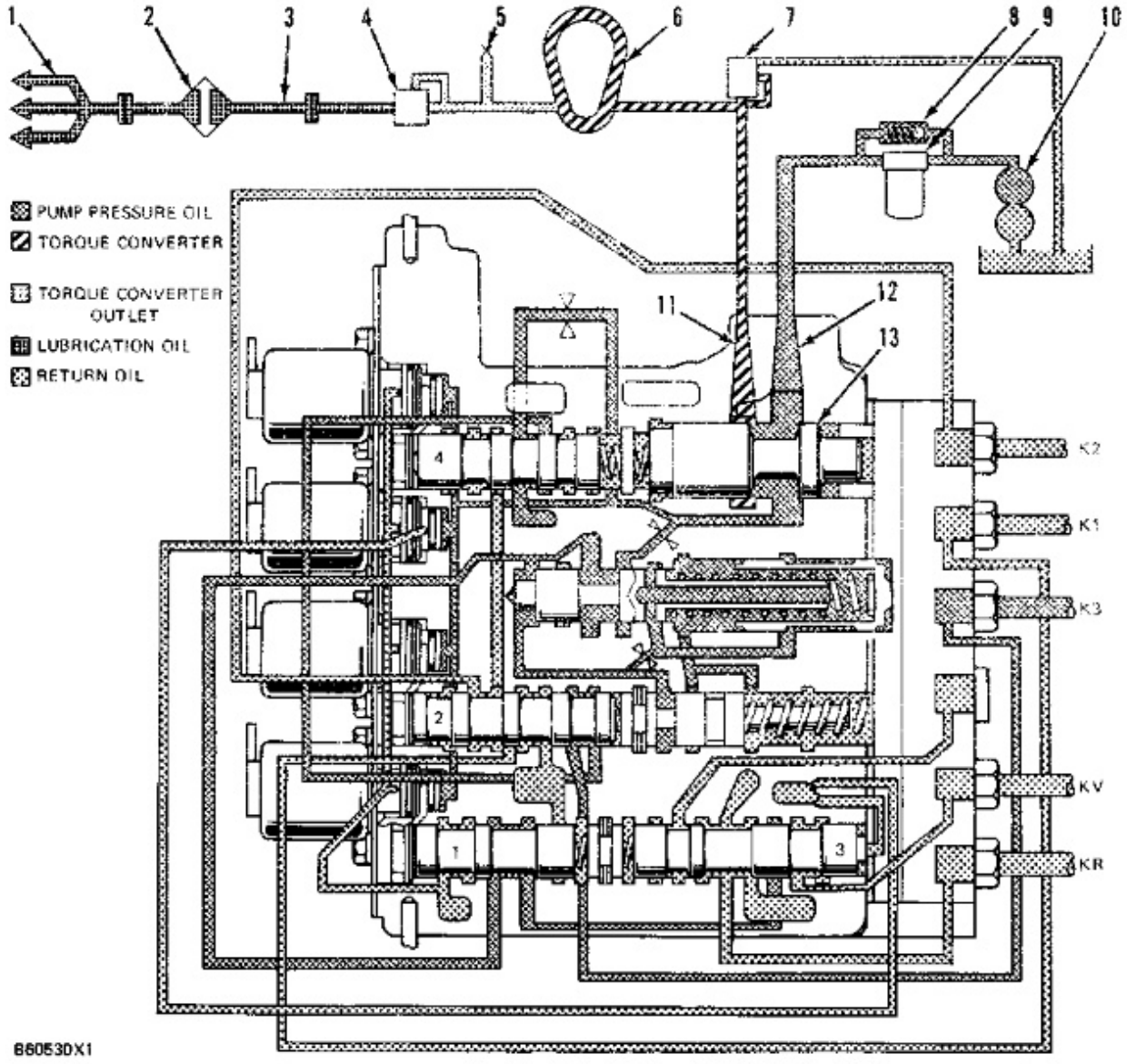
M-4 solenoid (13) controls pilot oil that moves number 4 valve spool (20) that directs pump pressure oil to the number 2 valve spool. M-2 solenoid (15) controls pilot oil that moves number 2 valve spool (21) and directs oil going to K1, K2 and K3. M-3 solenoid (14) controls pilot oil that moves number 3 valve spool (18) and directs oil to the KV forward and KR reverse direction clutch. M-1 solenoid (16) controls pilot oil that moves number 1 valve spool (17) and directs oil to the number 3 valve spool (18).

Main relief valve (2) limits the maximum oil pressure in the valve group housing and releases the remaining oil to the torque converter (4) and lubrication system (8) beyond the torque converter. When sufficient oil has passed through the main relief valve and the passages, chambers, and lines are filled, oil pressure starts to build and pushes on the main relief which pushes on the spring behind it. When the oil pressure is great enough to overcome the spring force, the main relief valve moves back and releases the oil to the passage to the torque converter.

The converter inlet pressure relief valve protects the torque converter from high oil pressure that could cause it damage and sends the oil back to the sump. Oil that does not go through the converter inlet pressure relief valve is sent to the torque converter housing and then to the torque converter

outlet pressure relief valve (5). The converter outlet pressure relief valve keeps the oil in the converter at a set pressure so the converter stays completely full of oil to prevent cavitation. Oil passes through the converter outlet pressure relief valve and goes to the oil cooler (7). From the cooler oil is sent to the lubrication circuits (8) for lubrication and cooling of the moving components inside the transmission.

Operation Of Transmission Control Valve



TRANSMISSION CONTROL SCHEMATIC (ENGINE RUNNING; DIRECTIONAL CONTROL IN NEUTRAL POSITION AND SPEED CONTROL TURNED TO THIRD SPEED)

1. Lubrication system.

2. Oil cooler.

3. Lubrication oil.

4. Torque converter outlet relief valve.

5. Torque converter temperature gauge connection.

6. Torque converter.

7. Torque converter inlet relief valve.

8. Oil filter bypass.

9. Oil filter.

10. Oil pump.

11. Pressure oil to converter.

12. Pressure oil to control valve group.

13. Main relief valve.

Pump (10) supplies oil from the sump to torque converter (6) and the shift control and clutches. The pump is located inside the transmission and is driven by the converter shaft.

Pump (10) pulls oil from the transmission oil reservoir (sump) through a screen in the suction tube.

Pressure oil from pump (10) is sent to oil filter (9) which is remote mounted on a bracket above the transmission. The filter base has a bypass valve (8) which operates with a pressure differential of 35 to 41 psi (242 to 283 kPa).

Pump oil is sent from the filter into the valve group housing to relief valve (13). Oil at pump pressure is directed through the valve and goes through the passages and chambers to the control valves in the valve group housing.

Main relief valve (13) limits the maximum system pressure in the valve group housing. Oil pressure must reach 160 to 218 psi (1100 to 1500 kPa) before it opens and releases oil to torque converter (6) and then to oil cooler (2) and lubrication system. Converter inlet pressure relief valve (7) in the supply passage to the converter protects the converter against abnormal (high) internal pressure such as might occur in a cold start. The converter inlet pressure relief valve has an opening pressure of 123 psi (850 kPa).

The pressure oil fills converter (6) completely with oil all the time in order to avoid cavitation. This is done with a converter outlet relief valve (4) which is in the line from the converter to oil cooler (2). The converter outlet pressure relief valve has an opening pressure of 40 psi (275 kPa).

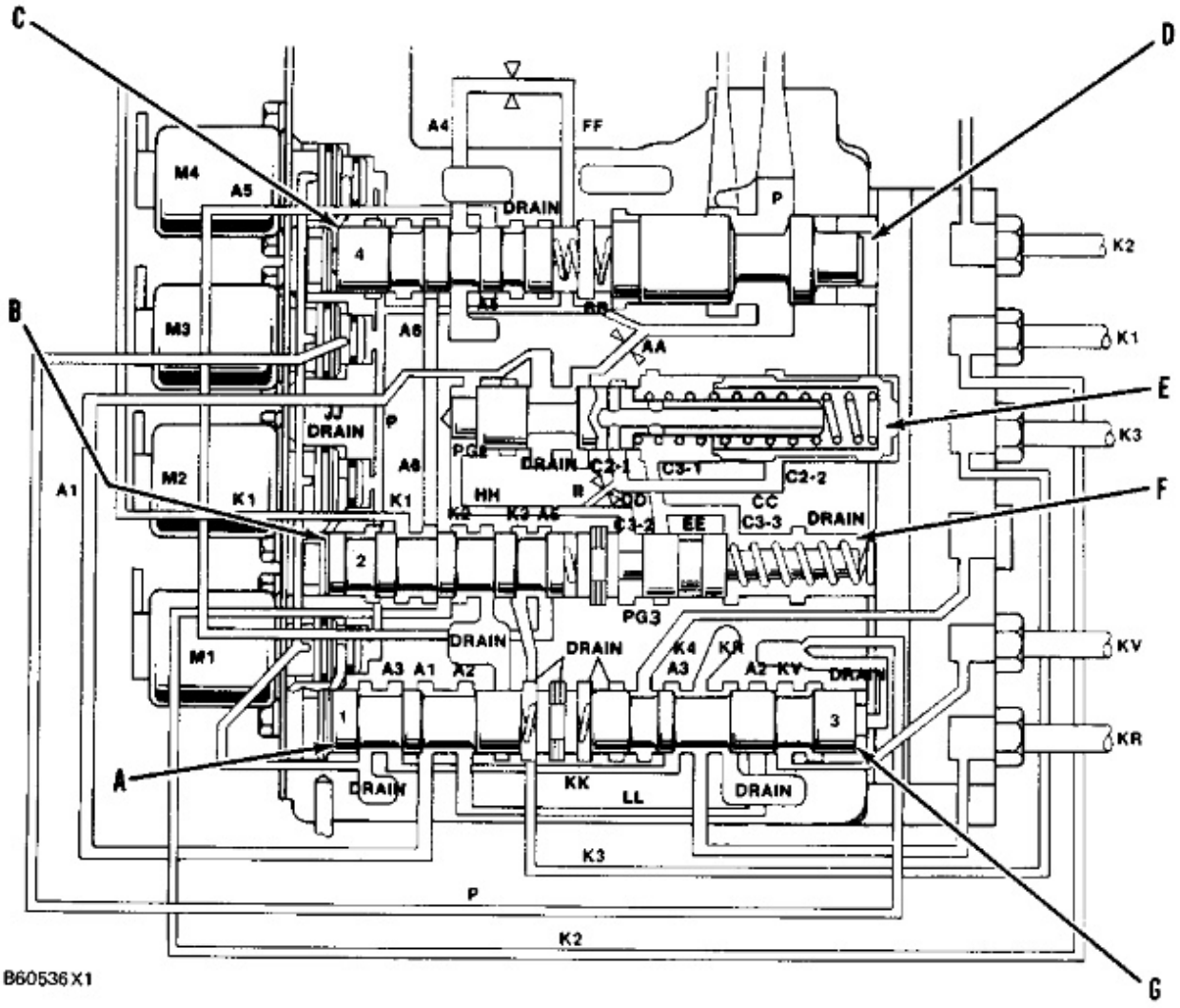
The oil coming from the converter through the converter outlet pressure relief valve is sent to oil cooler (2).

The temperature of the oil from the torque converter can be measured at the converter outlet temperature gauge connection (5).

After the oil goes through the cooler, it goes back into the transmission for lubrication of the moving components.

Anytime the engine is running and the direction and speed clutch control selector lever is in the neutral position, one speed clutch will remain engaged (depending on speed selector position) to prevent high speed gear rotation in the transmission.

Oil Flow Inside The Control Valve



CONTROL VALVE PASSAGES

While the pressure in the system is increasing, oil goes through the hole in the flange of the main relief valve and pushes against the sleeve. When the pressure is great enough to overcome the force of the spring, it will move the main relief valve to the left, sending oil to the torque converter, the oil cooler, and then to the lubrication circuits. All oil not required to maintain pressure in the valve housing and clutches, passes over the relief valve to the torque converter.

Pressure oil from the main relief valve chamber of bore D goes through passage AA and orifice to the chamber (P) in the middle of the modulation reduction valve and fills the PGI cavity. Oil from AA goes through passage FF to the A4 chamber of the number 4 valve spool and also through BB to the four solenoids.

Oil also goes from the PG1 cavity through passage GG and fills the PG2 cavity at the left end of the modulation reducing valve. Oil from PG2 goes through passage HH to PG3 at the left end of the reset valve. Oil in PG2 also goes through passage JJ to the A1 chamber of number 1 valve spool. With the number 1 valve spool in this "at rest" position, oil goes from the A1 to the A2 chamber and then through passage LL to the A2 chamber and around number 3 valve spool, where the oil is blocked.

Oil in passage HH also goes through passage II through the orifice and into and around the C2-1 chamber. Oil goes from the C2-1 chamber through passage CC to the C2-2 chamber.

With the modulation reducing valve held to the left by the spring, oil in the C2-1 chamber goes through the cross and long-drilled passages of the modulation reducing valve and into the C3-1 chamber between the modulation reducing valve and the load piston.

Oil in the C3-1 chamber, between the modulation reducing valve and the load piston, goes through passage DD to the C3-2 chamber around the reset valve. Oil in passage DD goes through passage EE to the C3-3 chamber around the reset valve and out to drain.

After oil fills PG-1, PG-2, PG-3, and the clutches, the modulation reducing valve moves to the right. When the modulation reducing valve moves far enough to the right, oil is blocked from going through C2-1 through the drilled passages of the modulation reducing valve to the C3-1 chamber. Oil can still flow through C2-1 through passage CC to C2-2 to the end of the load piston, moving it farther to the left.

The modulation reducing valve is moving to the right at the same time the load piston is moving to the left. Pressure on the right end of the load piston will move the load piston to the left, compress the spring, and move the modulation reducing valve to the left. Flow from the pump (P) will cause an increase in pressure in PG1, PG2, PG3 and move the modulation reducing valve and reset valve to the right. This left and right movement of the modulation reducing valve, along with the movement of the load piston, permits a gradual increase in system pressure (modulation). During modulation, the load piston moves smoothly to the left while the modulation reducing valve moves left and right. Pressure in the system will increase and move the reset valve farther to the right until oil can go through C3-2 and passage DD to C3-1 chamber between the modulation reducing valve and the load piston. This will spread the modulation reducing valve and the load piston. The modulation reducing valve will move to the left, and the load piston to the right. Pressure in the system will increase until there is equal pressures in P, PG1, PG2, PG3, C3-1 chamber and at the end of the load piston. This pressure will be between 182 to 210 psi (1255 to 1450 kPa). The reducing valve and load piston are now finished with the modulation cycle and are reset to their original position ready to respond and recycle when the next shift is made.

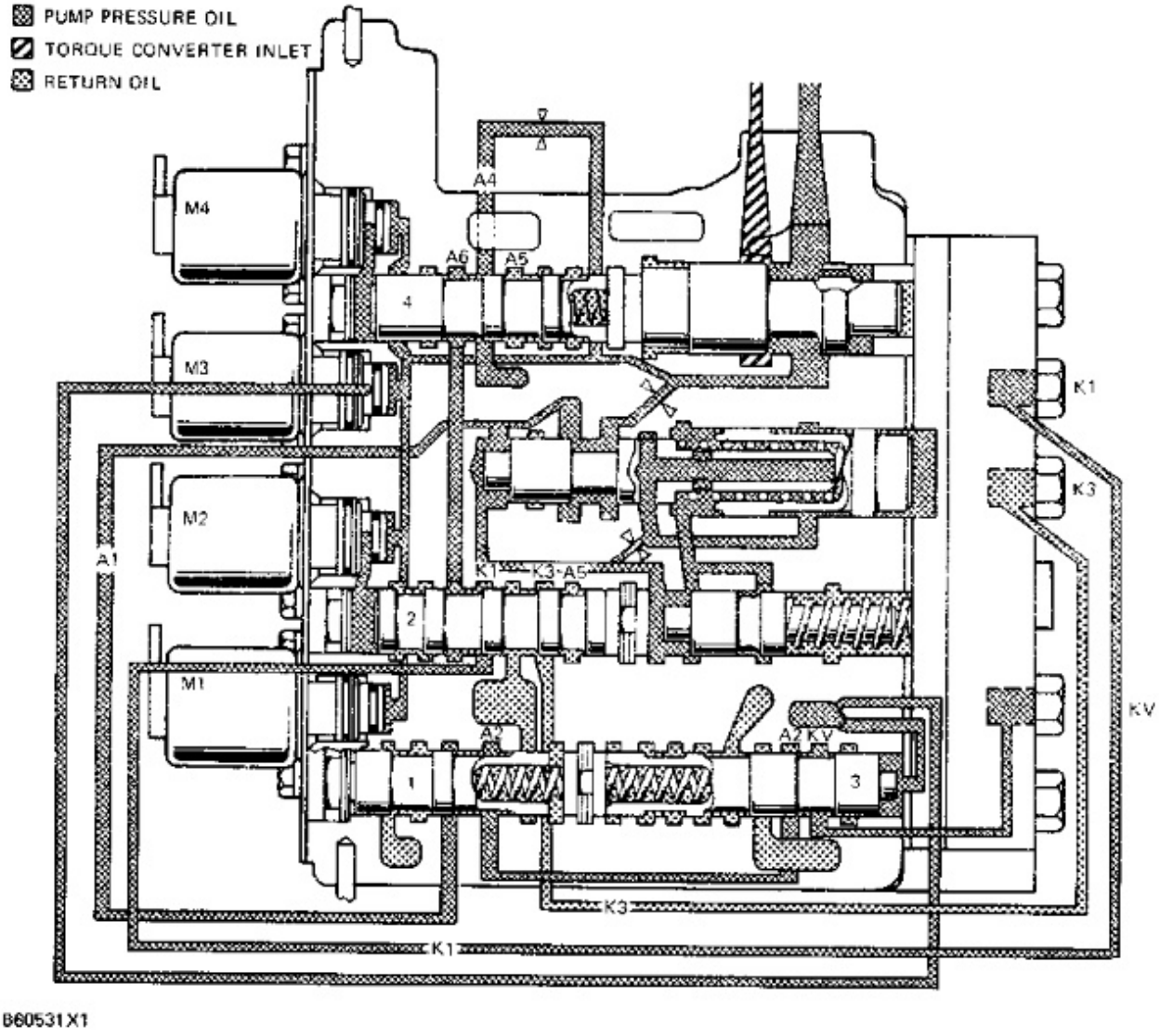
When A Shift Is Made

When the direction and speed selector lever is moved to a direction and a speed, the correct solenoids open and send pilot oil to the valve spools they control. The valve spools move and direct modulated oil to the selected clutches. The opening of the solenoids, movement of the valve spools, and draining of the clutches cause a decrease in oil pressure in PG1, PG2, and PG3. The reset valve moves to the left by spring pressure and blocks oil going from PG3 into C3-2, through passage DD to the C3-1 chamber between the modulation reducing valve and the load piston. When the reset valve moves far enough to the left, it opens the C3-3 chamber so the oil in the C3-1 chamber can go to drain.

As all passages begin to fill, pump oil from P starts to increase the pressure of the oil in PG1, PG2, and PG3. As the pressure increases in PG1, PG2 and PG3, the reset valve moves to the right and blocks the C3-3 chamber oil from going to drain. The reset valve, operating in this manner, controls the rate of oil pressure increase inside to the load piston.

As oil pressure increases in PG1, PG2, and PG3, the modulation reducing valve moves farther to the right, and the load piston moves to the left. Movement of the load piston is slower because of the orifice in passage II. The modulation reducing valve, the reset valve, and the load piston continue working as before as pressure in PG1, PG2, and PG3 increases to the point that the reset valve fully opens and resets the reducing and load piston. The relief valve begins sending the main flow of oil to the torque converter. These events take place each time the engine is started, or a shift is made. The time for these events to take place is approximately 1.0 to 1.5 seconds.

Forward-First Speed



TRANSMISSION CONTROLS (FORWARD-FIRST SPEED)

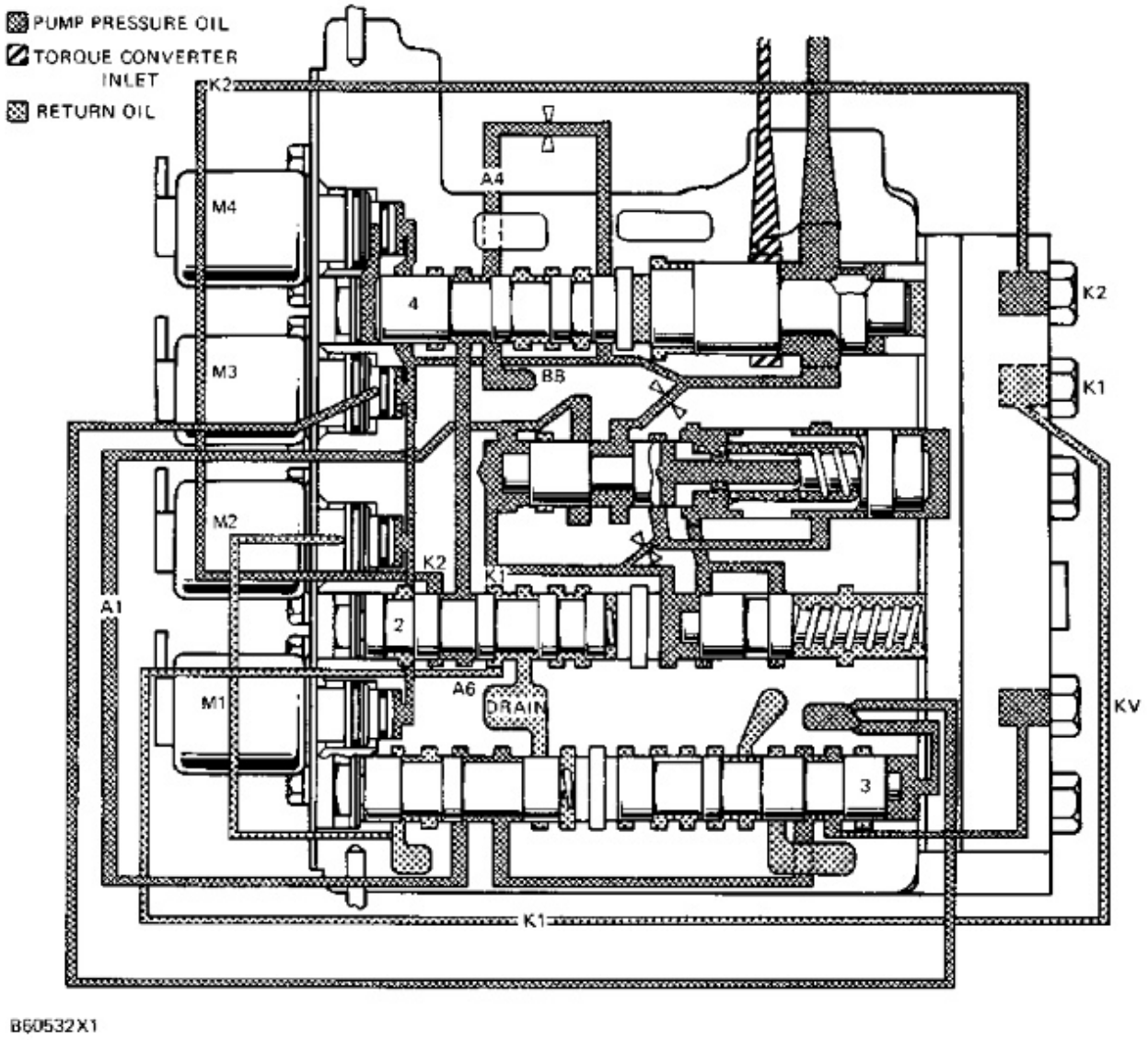
When the direction and speed control selector lever is moved to FORWARD - FIRST SPEED position, solenoids M-2, M-3, and M-4 are energized (open). Pump pressure oil from passage BB goes through the inlet ports of M-2, M-3, M-4 solenoids and pilot oil goes out the pressure port to the three valve spools they control.

The pilot oil from M-2 solenoid moves the number 2 valve spool to the right, and blocks the modulated oil in the A5 chamber from going into K3 to the K3 third speed clutch. Oil in the K3 chamber and the K3 third speed clutch goes to drain.

The pilot oil from the M-3 solenoid moves the number 3 valve spool to the left, sending modulated oil in the A2 chamber to the KV chamber and to the KV FORWARD direction clutch, causing it to engage.

The pilot oil from the M-4 solenoid moves the number 4 valve spool to the right, blocking oil from going from the A4 chamber to the A5 chamber. Pressure oil in the A4 chamber now goes to the A6 chamber, then through the passage to the A6 chamber of the number 2 valve spool. Because the number 2 valve spool is to the right, pressure oil can go from the A6 chamber to the K1 chamber to the K1 first speed clutch, causing it to fill.

Forward-Second Speed



TRANSMISSION CONTROLS (FORWARD-SECOND SPEED)

When the direction and speed control selector is moved to FORWARD-SECOND SPEED position, solenoids M-3 and M-4 remain energized. Pump pressure oil in passage BB continues through M-3 and M-4 solenoids to the two valve spools they control.

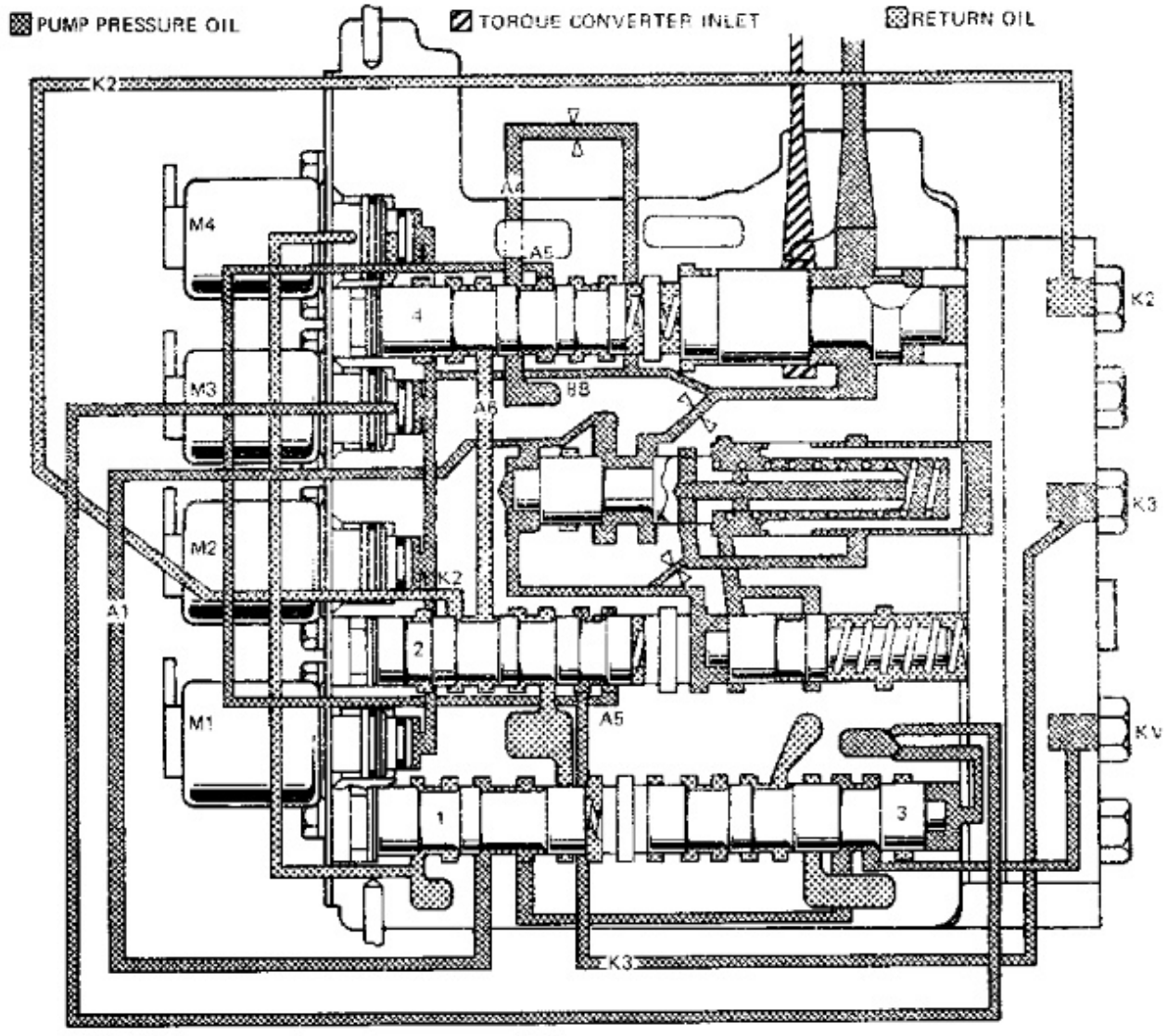
When a shift is made from FIRST to SECOND speed, M-2 is no longer energized. The inlet valve closes and stops pilot oil to the number 2 valve spool. As the M-2 solenoid inlet valve closes, the valve opens to drain. The spring behind the number 2 valve spool moves the valve to the left moving the pilot oil through the pressure port and out the drain port of the solenoid to the drain passage to drain.

With the number 2 valve spool to the left "at rest" position, pressure oil in the A6 chamber is blocked to the K1 chamber, but open to the K2 chamber to the K2 second speed clutch, causing it to fill. Oil in the K1 first speed clutch can now go back through the K1 chamber to drain.

NOTE: While the K2 clutch is filling, pressure in A4 and A6 chambers drops and the main relief valve closes. After K2 clutch has filled, pressure behind the main relief valve builds and resumes passing oil on to the converter. This drop and rebuild of pressure in the speed clutch circuit (A4 and

A6) is so fast (approximately .3 seconds) that the modulating reducing valve does not lose pressure. The directional clutch circuit (A1 and A2) remains fully pressurized so the modulating cycle does not occur on a speed shift.

Forward-Third Speed



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TRANSMISSION CONTROLS (FORWARD-THIRD SPEED)

When the direction and speed control selector is moved from FORWARD-SECOND SPEED to FORWARD-THIRD SPEED position, the M-3 solenoid remains energized (open). Pump pressure oil in passage BB continues through the M-3 solenoid to the number 3 valve spool.

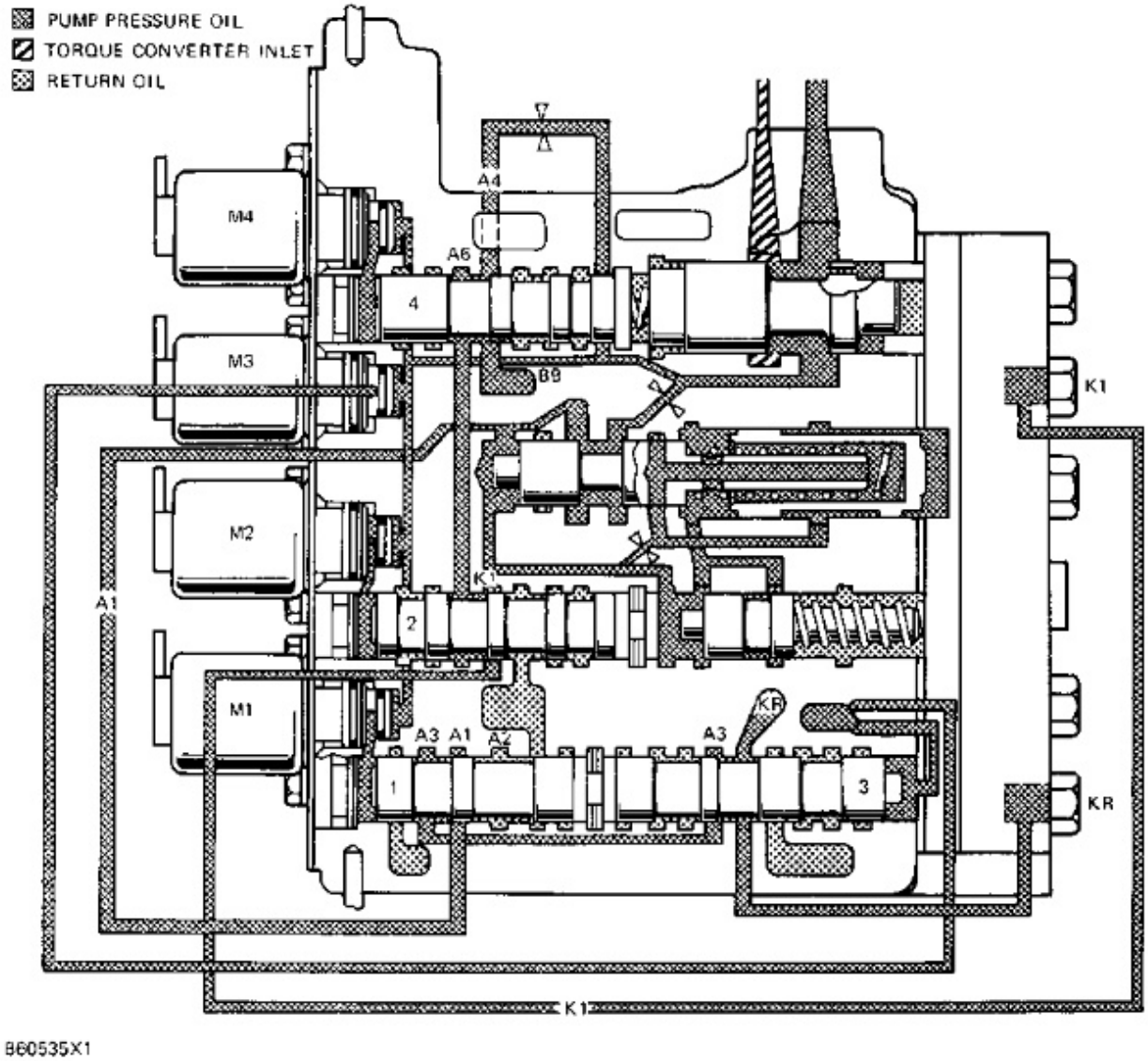
When the shift is made from SECOND to THIRD speed, the M-4 solenoid is no longer energized. The M-4 solenoid inlet valve closes and stops pilot oil to the number 4 valve spool. As the solenoid inlet valve closes, the valve opens to drain. The spring behind the number 4 valve spool moves the valve to the left, moving the pilot oil through the pressure port and out the drain port of the solenoid where it goes to drain.

With the number 2 valve spool to the left in the "at rest" position, pressure oil in the A4 chamber is blocked to the A6 chamber, but open to the A5 chamber. The A5 chamber of the number 4 valve

spool sends pressure oil to the A5 chamber of the number 2 valve spool. Oil in the A5 chamber can now go into the K3 chamber to the K3 third speed clutch, causing it to fill and engage. No change in pressure occurs in the directional clutch KV.

Oil in the K2 second speed clutch can now go back through the K2 chamber to the A6 chamber of the number 2 valve spool. Oil in the A6 chamber of the number 2 valve spool goes through the passage to the A6 chamber of the number 4 valve spool to drain.

Reverse - First Speed



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TRANSMISSION CONTROLS (REVERSE - FIRST SPEED)

When a machine is being operated in FORWARD - THIRD SPEED and the operator needs to go to REVERSE, the engine speed should be reduced. The speed control selector should be moved from THIRD speed to SECOND speed, then to FIRST speed. The direction selector is then moved from the FORWARD to REVERSE position.

When the direction and speed control selector is moved to the REVERSE - FIRST SPEED position, M-1, M-2, M-3, and M-4 are energized (open). Pump pressure oil from passage BB goes through the inlet ports of M-1, M-2, M-3, and M-4 solenoids and pilot oil goes out the pressure ports to the four valve spools they control.

The pilot oil from the M-1 solenoid moves number 1 valve spool to the right and blocks modulated oil in the A1 chamber from going to the A2 chamber and directs it into the A3 chamber. Modulated oil in the A3 chamber of the number 1 valve spool goes through the passage to the A3 chamber of the number 3 valve spool.

As soon as the pilot oil from the M-3 solenoid moves number 3 valve spool to the left, modulated oil in the A3 chamber goes into the KR chamber to the KR REVERSE direction clutch, causing it to engage.

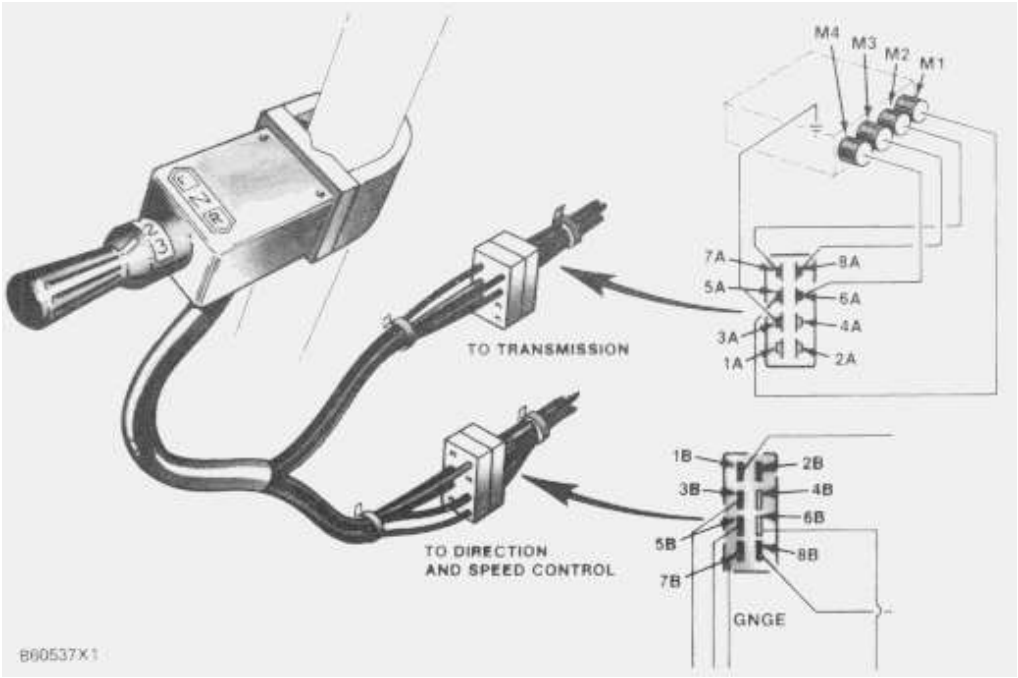
The pilot oil from the M-2 solenoid moves the number 2 valve spool to the right. The valve spool blocks the oil in the A5 chamber and the oil in the K3 third speed clutch now goes to drain.

The pilot oil from the M-4 solenoid moves number 4 valve spool to the right and blocks oil from the A4 chamber from going to the A5 chamber. Oil in the A4 chamber now goes to the A6 chamber, then through the passage to the A6 chamber of the number 2 valve spool. Because the number 2 valve spool is to the right, oil from the A6 chamber goes into the K1 chamber to the K1 speed clutch, causing it to engage.

Reverse - Second And Third Speed

Reverse SECOND and THIRD speed will not be explained as they operate in the same way as SECOND and THIRD speeds FORWARD, except for the REVERSE direction clutch being engaged.

Electric Shift Control Console



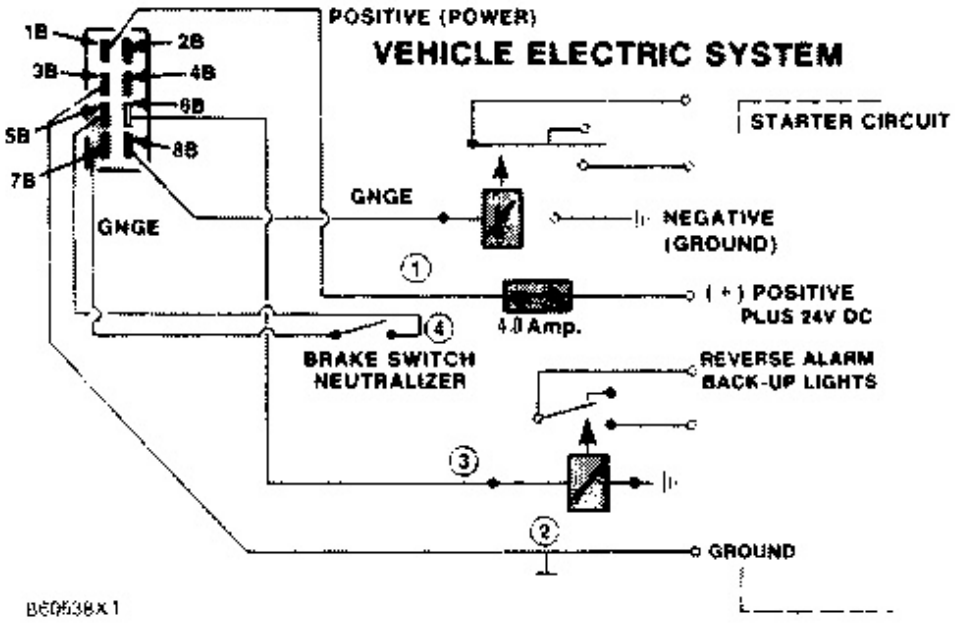
ELECTRONIC SHIFT CONSOLE

The source of current for the electric shift control console comes from the starting motor circuit of the vehicle electric system. From the starting circuit, the wiring harness goes to a connector, a blade and pancake-type socket and plug box. The socket (female) box connects to the plug (male) box and the harness continues to the direction and speed control console mounted on the left side of the steering column. Another wiring harness goes from the direction and speed control console to a

connector and then to a pin and socket circular connector (Cannon-type) on the transmission valve control group. A third wiring harness goes from the pin and socket connector to each of the four solenoids.

Current for the electric shift direction and speed control operation comes from the electric supply system positive terminal on the starter solenoid. From the positive terminal, current goes through a 40 amp manual circuit breaker (on dash) and then to the ammeter (not shown). Current from the ammeter goes to the transmission control box, through a 4.0 amp fuse and then to terminal 1B of the harness connector. From the connector terminal 1B, current goes to the direction and speed control. With the direction and speed control selector in the neutral position, current is sent back to the connector to terminal 8B. Terminal 8B sends current through the GNGE (GREEN/YELLOW) wire to the neutral safety relay which causes the neutral safety switch to close. The neutral safety switch is a normally open switch. When the direction and speed selector is in the NEUTRAL position, current is sent to terminal 8B. When the direction and speed selector is moved to a direction, forward or reverse, current is sent to terminal 8A.

When the HEAT-START switch on the dash is moved to START, the solenoid on the starting motor can energize and activate the starting motor and crank the engine. The neutral safety switch, when open, prevents the engine from being started when the direction and speed selector is in any position except neutral. When the neutral safety switch closes, it allows current to the starting motor solenoid, which is energized, closing the circuit for cranking the engine.



CONTROL CONSOLE ELECTRIC CONNECTIONS

1. Positive (24 volt DC) circuit to terminal 1B.

2. Ground (negative) circuit from terminal 3B.

3. Reverse alarm/back-up light circuit from terminal 6B.

4. Brake switch neutralizer circuit terminal 7B to 5B; and GNGE. Ground circuit for neutral safety switch from terminal 8B.

Selector Position	Trans. Terminals	Console Terminals	Solenoid
Neutral	3A	1B-3B-8B	*
Forward First	3A-6A 7A-8A	1B-3B 5B-7B	M2-M3-M4
Second	3A-6A-8A	1B-3B 5B-7B	M3-M4
Third	3A-8A	1B-3B 5B-7B	M3
Reverse First	3A-5A-6A 7A-8A	1B-6B-3B 5B-7B	M1-M2 M3-M4
Second	3A-5A 6A-8A	1B-6B-3B 5B-7B	M1-M3-M4
Third	3A-5A-8A	1B-6B-3B 5B-7B	M1-M3

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ELECTRIC SHIFT OPERATION CHART

*In NEUTRAL, the M2 and M4 solenoids (first speed), or M4 solenoid (second speed), or no solenoids (third speed) will be energized.

The chart shows:

- **direction and speed control console SELECTOR POSITION:**
- **connector TRANSMISSION TERMINALS charged in each selector position;**
- **connector CONSOLE TERMINALS charged in each selector position; and**
- **SOLENOIDS energized in each selector position.**

The chart can be used to trace current flow and for troubleshooting the electric shift control console (switches), wiring harness, connector terminals, and solenoids.

Forward - First Speed

With the direction and speed selector in FIRST SPEED FORWARD position, power terminal 1B sends current to the control console which sends current to terminals 7B, 5B, 6A and 7A. Terminal 7B sends current to the brake switch neutralizer and to terminal 5B. Terminal 5B from the brake switch neutralizer sends current to terminal 8A. Terminal 8A sends current to M-3 solenoid, opening it.

The control console also sends current to terminal 6A. Terminal 6A sends current to M-4 solenoid, opening it.

The control console also sends current to terminal 7A. Terminal 7A sends current to M-2 solenoid, opening it.

Second Speed

When the direction and speed selector is moved to the SECOND SPEED FORWARD position, power terminal 1B sends current to the control console which sends current terminal 7B. Terminal 7B sends current to the brake switch neutralizer and to terminal 5B. Terminal 5B from the brake switch neutralizer sends current to terminal 8A. Terminal 8A sends current to the M-3 solenoid, opening it.

The control console also sends current to terminal 6A. Terminal 6A sends current to the M-4 solenoid, opening it.

Terminals 3A and 3B provide connections for the return of current for the solenoids.

Third Speed

When the direction and speed selector is moved to the THIRD SPEED FORWARD position, power terminal 1B sends current through the control console to terminals 7B, 5B and 8A. Terminal 7B sends current to the brake switch neutralizer to terminal 5B. Terminal 5B from the brake switch neutralizer sends current to terminal 8A. Terminal 8A sends current to the M-3 solenoid, opening it.

Terminals 3A and 3B provide connections for the return of current from the solenoid.

Reversing Only In First Gear

While operating a machine in THIRD SPEED FORWARD or THIRD SPEED REVERSE at full throttle, it is necessary to move the speed selector to SECOND SPEED, then FIRST SPEED, and reduce the engine speed before moving the direction selector to the opposite position.

Reverse - First Speed

When the direction and speed selector is in the FIRST SPEED REVERSE position, power terminal 1B sends current through the control console to terminals 7B, 5B, 8A, 6A, 7A, 5A, and 6B. Terminal 7B sends current to the brake switch neutralizer and to terminal 5B. Terminal 5B from the brake switch neutralizer sends current to terminal 8A. Terminal 8A sends current to the M-3 solenoid, opening it.

The control console sends current to terminal 6A. Terminal 6A sends current to the M-4 solenoid, opening it.

The control console sends current to terminal 7A. Terminal 7A sends current to the M-2 solenoid, opening it.

The control console sends current to terminal 5A. Terminal 5A sends current to terminal 6B and the M-1 solenoid, opening it. (Terminal 6B is on the wire that is spliced into the wire that goes from terminal 5A to the M-1 solenoid).

When current is sent to the M-1 solenoid (direction selector is in reverse position), current is sent through the splice and wire to terminal 6B.

Terminal 6B sends current to the back-up relay, energizing it, which closes the switch and sends current to the reversing alarm.

Terminals 3A and 3B provide connections for the return of current for the solenoids.

Second Speed

When the direction and speed selector is moved to SECOND SPEED REVERSE position, power terminal 1B sends current to the control console which sends current to terminals 7B, 5B, 8A, 6A, 5A, 6B, 3A and 3B. Terminal 7B sends current to the brake switch neutralizer and to terminal 5B. Terminal 5B from the brake switch neutralizer sends current to terminal 8A. Terminal 8A sends current to the M-3 solenoid, opening it.

The control console sends current to terminal 5A. Terminal 5A sends current to terminal 6B and the M-1 solenoid, opening it.

Terminal 6B takes current sent to terminal 5A and sends it to the back-up relay, energizing it, which closes the switch in the relay and sends current to the reversing alarm.

Terminals 3A and 3B provide connections for the return of current for the solenoids.

Third Speed

When the direction and speed selector is moved to the THIRD SPEED REVERSE position, power terminal 1B sends current through the control console to terminals 7B, 5B, 8A, 5A and 6B. Terminal 7B sends current to the brake switch neutralizer and to terminal 5B. Terminal 5B from the brake switch neutralizer sends current to terminal 8A. Terminal 8A sends current to the M-3 solenoid, opening it.

The control console sends current to terminal 5A. Terminal 5A sends current to terminal 6B and the M-1 solenoid, opening it.

Terminal 6B sends current to the back-up relay, energizing it, which closes the switch in the relay and sends current to the reversing alarm.

Terminals 3A and 3B provide connections for the return of current for the solenoids.

Brake Switch Neutralizer

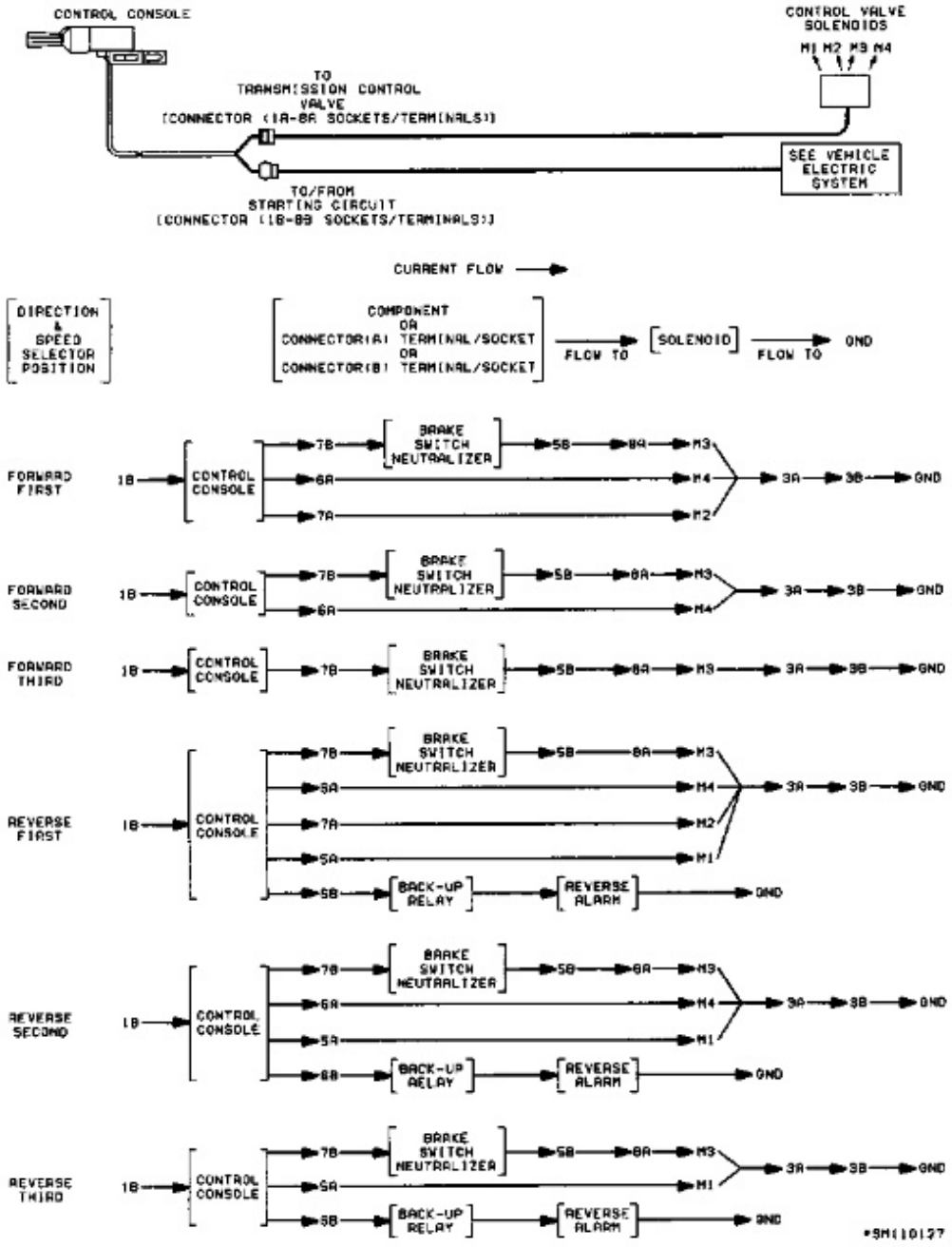
The brake switch neutralizer is operated by a pedal in the cab of the machine. When the operator pushes the pedal, the brake switch neutralizer opens and stops current flow from terminal 7B to 5B, which stops flow to terminal 8A. When current to terminal 8A is stopped, the M-3 solenoid closes and stops the pilot oil going to the number 3 valve spool. When the pilot oil stops and drains out, the number 3 valve spool moves to the "at rest" position and blocks oil to the direction clutch (FORWARD or REVERSE), causing it to disengage. All engine power is now available for the implement hydraulics.

When the pedal is released, the brake switch neutralizer closes and again current flows from terminal 7B to terminal 5B and to terminal 8A. Terminal 8A sends current to the M-3 solenoid, causing it to open and send pilot oil to number 3 valve spool. As number 3 valve spool moves back, oil is directed to the direction clutch, causing it to engage.

Terminals 3A and 3B

Terminal 3A is on the ground wire connected to the housing of the transmission. Terminal 3B is on the ground wire connected to the machine frame and the ground (negative) side of the vehicle electric system.

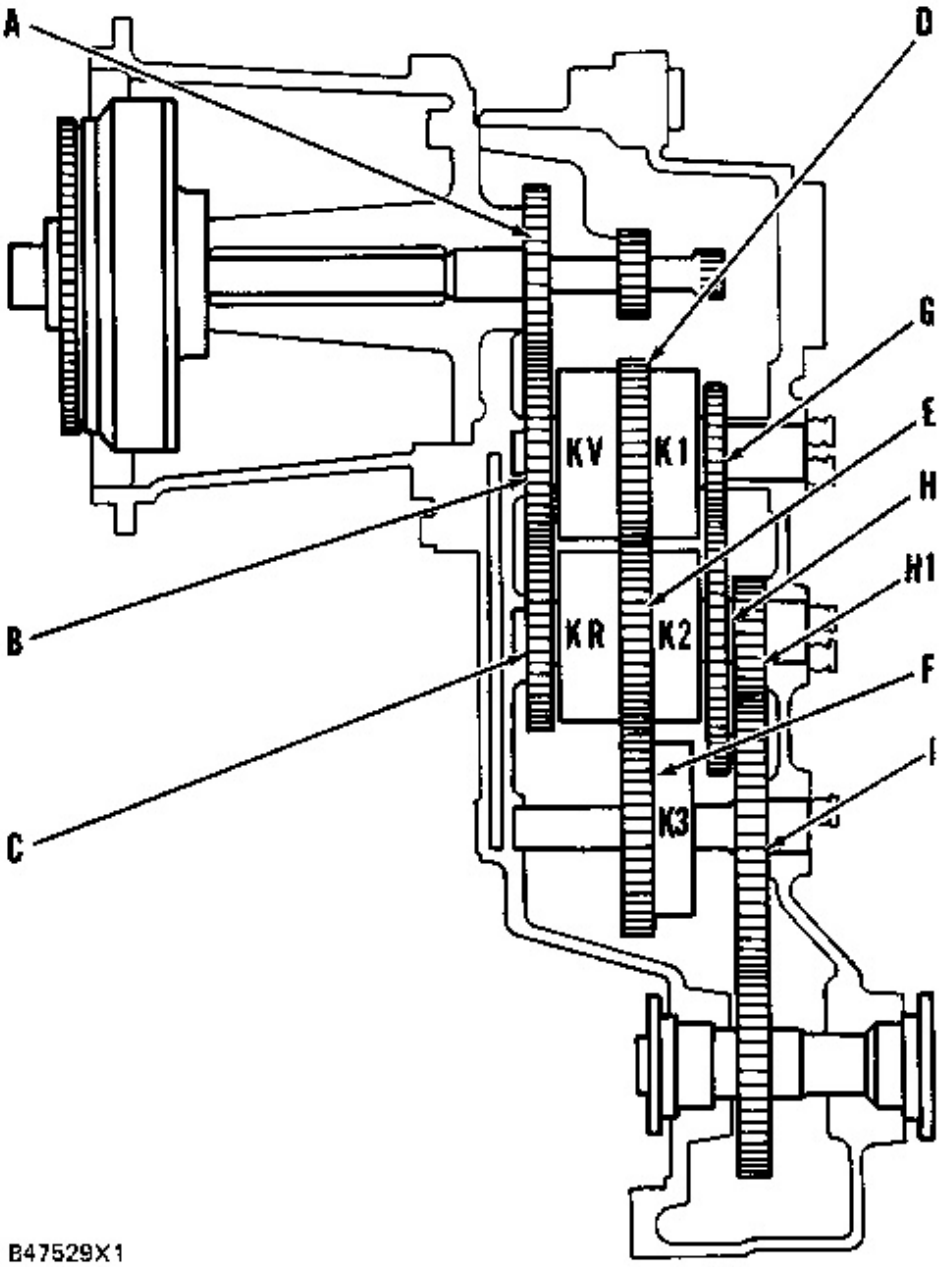
Terminals 3A and 3B provide connections for the circuit for the return of the of current for the solenoids in all shift positions. A poor connection or broken wire will cause the solenoids to operate erratically or not at all.



DIRECTION AND SPEED SELECTOR - CURRENT FLOW DIAGRAM

NOTE: In NEUTRAL, the M2 and M4 solenoids (first speed), or M4 solenoid (second speed), or no solenoids (third speed) will be energized.

Transmission



TRANSMISSION COMPONENTS
A through J. Gears. KV. FORWARD direction clutch. K1. FIRST SPEED clutch. KR. REVERSE direction clutch. K2. SECOND SPEED clutch. K3. THIRD SPEED clutch.

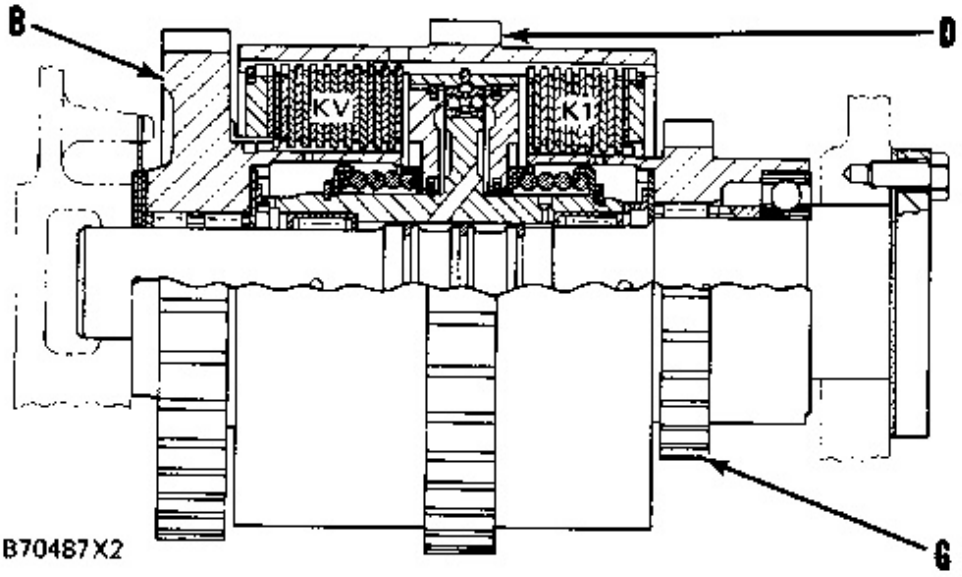
FUNCTION	CLUTCH
Forward	KV
Reverse	KR
First Speed	K1
Second Speed	K2
Third Speed	K3

Gear Trains and Clutches

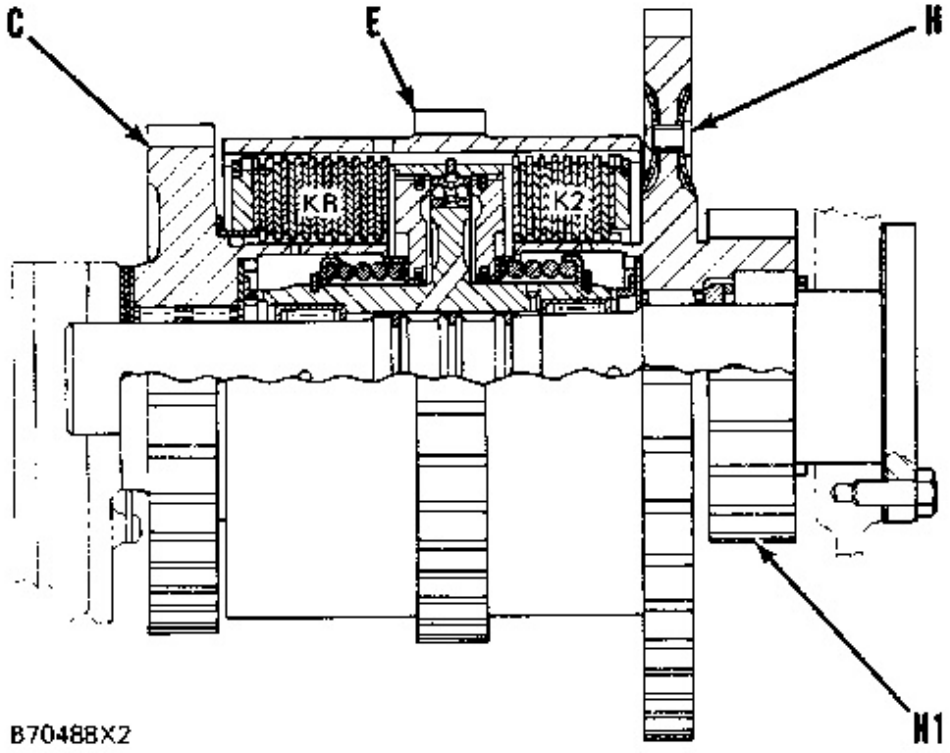
The transmission has three gear trains with constant mesh gears and five multi-disc clutches.

The first gear train is at the torque converter side of the transmission and brings power to the input side of the FORWARD and REVERSE clutches. The main drive gear (A) is on the turbine output shaft. Drive gear (B) is on the left side of and on the same shaft with the FORWARD and FIRST speed clutches. Drive gear (B) is positioned to the right side of the transmission and is driven by drive gear (A).

Drive gear (C) is on the left side of and on the same shaft with the REVERSE and SECOND speed clutches. It is positioned toward the left side of the transmission and is also driven by drive gear (A). Drive gears (A), (B), and (C) are arranged so that drive gears (B) and (C) are both driven by the main drive gear (A).

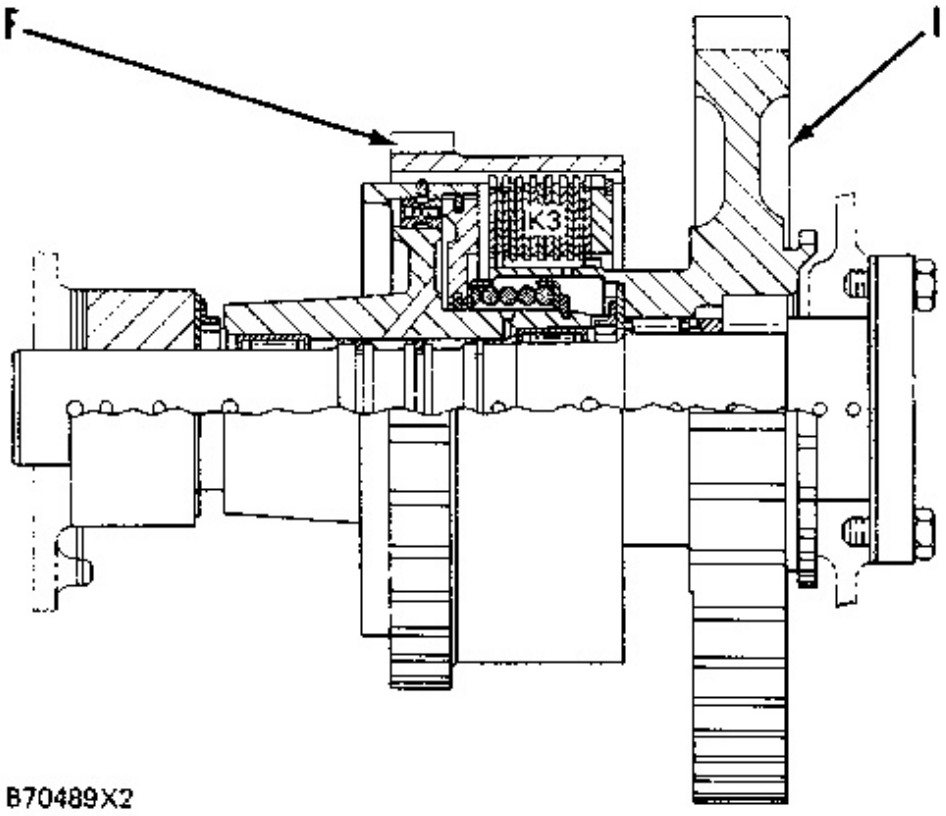


FORWARD AND FIRST SPEED CLUTCH ASSEMBLY



REVERSE AND SECOND SPEED CLUTCH ASSEMBLY

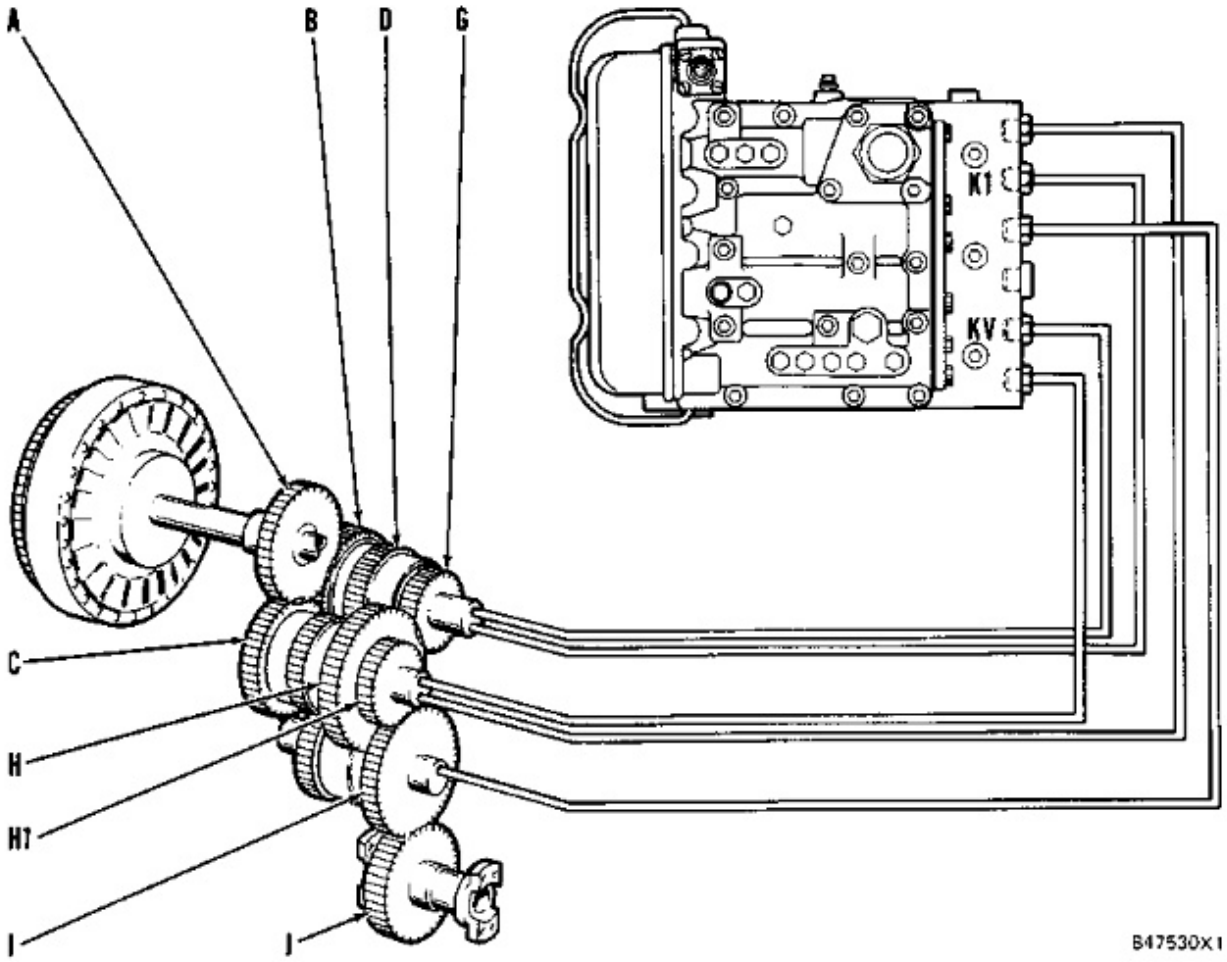
The second (center) gear train has gear (D), gear (E), and gear (F). Gear (D) is on the outside diameter of the FORWARD and FIRST speed clutch housing. Gear (D) meshes with gear (E) which is on the outside diameter of the REVERSE and SECOND speed clutch housing. Gear (E) drives gear (F) which is on the outside diameter of the THIRD speed clutch housing.



THIRD SPEED CLUTCH ASSEMBLY

The third gear train is at the rear of the transmission housing and consists of gear (G), gear (H) and (H-1). (H-1 is connected to, and a part of Gear H), gear (I) and gear (J). Drive gear (G) is to the right and on the same shaft with the FIRST speed clutch and drives gears (H) and (H-1). Drive gears (H) and (H-1) are to the right of and on the same shaft with the SECOND speed clutch. Drive gear (I) is to the right of and on the same shaft with the THIRD speed clutch and is drive by (H-1). Drive gear (I) drives gear (J) which is on the output shaft to the final drives (front and rear differentials).

First Speed Forward

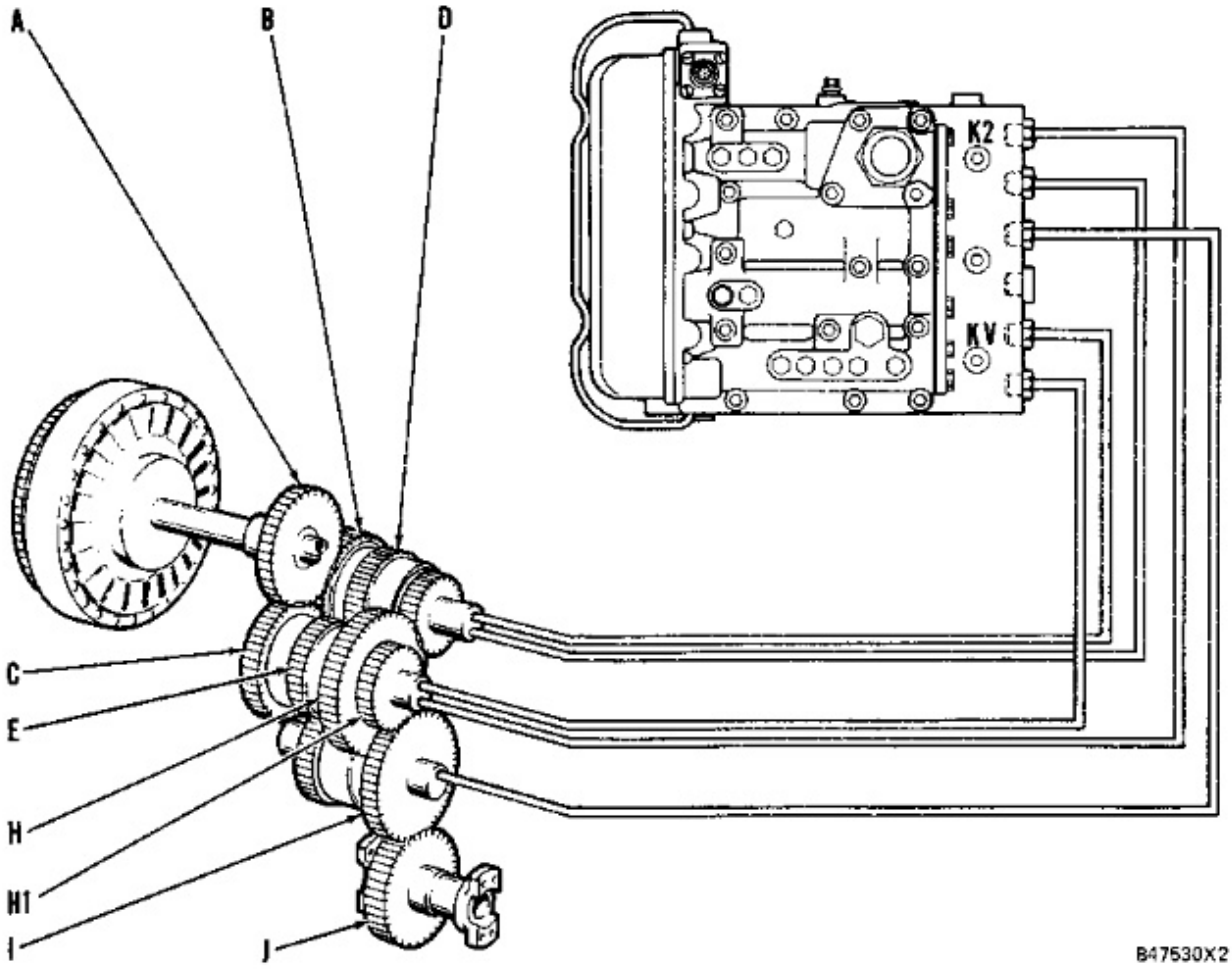


POWER FLOW FIRST SPEED FORWARD (KV and K1 Clutches Engaged)

Power from the torque converter turbine wheel turns the output shaft that drive gear (A) is mounted on. Drive gear (A) turns in the same direction of rotation as the flywheel (counterclockwise). Drive gear (A) turns drive gear (B) and (C) (clockwise). With the FORWARD clutch (KV) engaged, power turns drive gear (D) (CW) which is on the outside diameter of the clutch housing.

With the FIRST speed clutch (K1) engaged, the power from the FORWARD clutch goes through the FIRST speed clutch and turns drive gear (G) (CW). Drive gear (G) now turns drive gear (H) and (H-1) (CCW). Drive gear (H-1) turns drive gear (I) (CW). Drive gear (I) turns drive gear (J) (CCW) and power goes to the output shaft to the differentials.

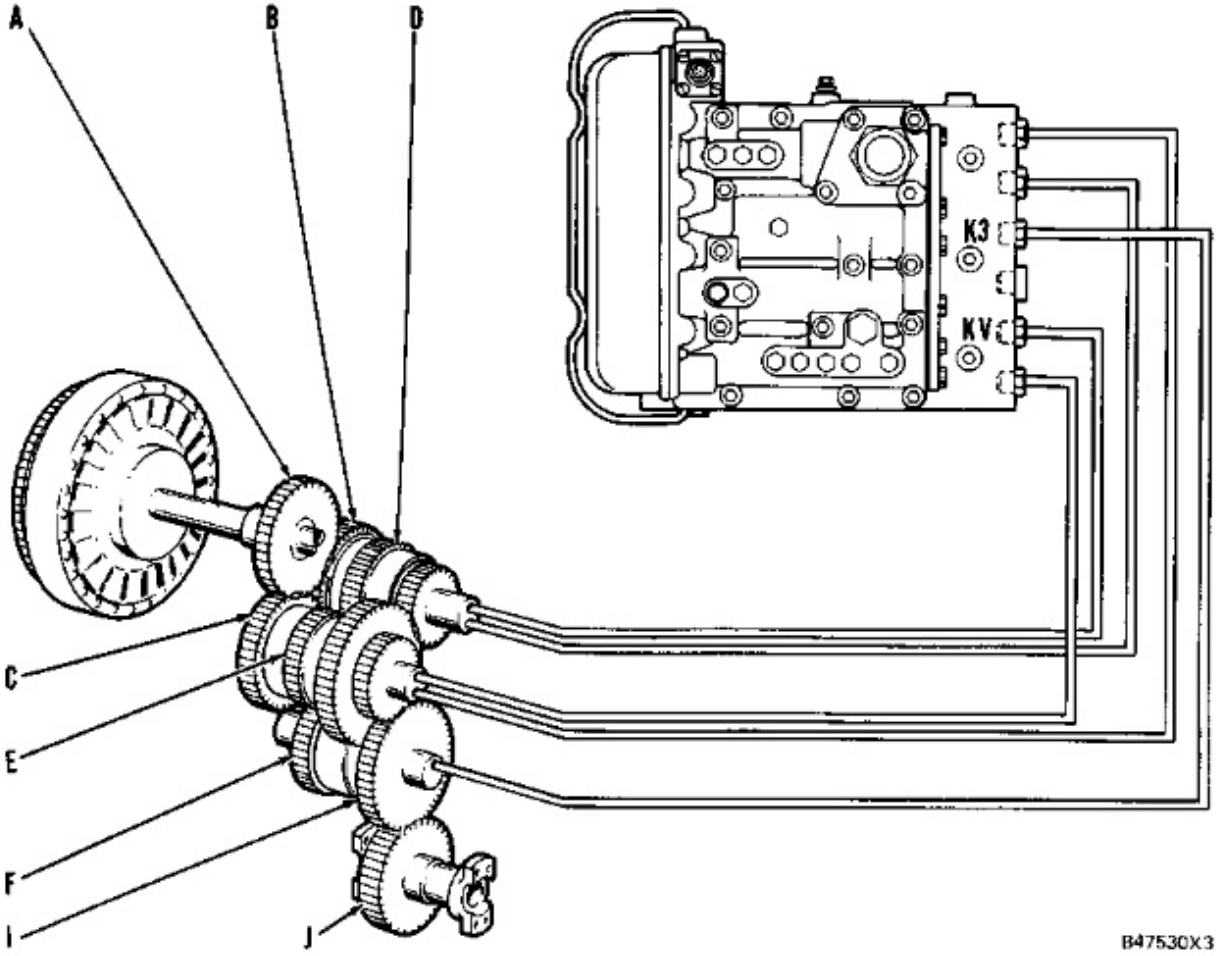
Second Speed Forward



POWER FLOW SECOND SPEED FORWARD (KV And K2 Clutches Engaged)

Power from the torque converter turbine wheel turns the output shaft and drive gear (A) (CCW). Drive gear (A) turns drive gear (B) (CW). With the FORWARD clutch (KV) engaged, the power turns drive gear (D) (CW) which is on the outside diameter of the FORWARD and FIRST speed clutch housing. Drive gear (D) is in constant mesh with and drives drive gear (E) (CCW) which is on the outside diameter of the REVERSE and second speed clutch housing. With drive gear (E) taking power from gear (D) and the SECOND speed clutch (K2) engaged, power turns drive gear (H) and (H-1) (CCW). Drive gear (H-1) turns drive gear (I) (CW). Drive gear (I) turns drive gear (J) (CCW) and the output shaft to the differentials.

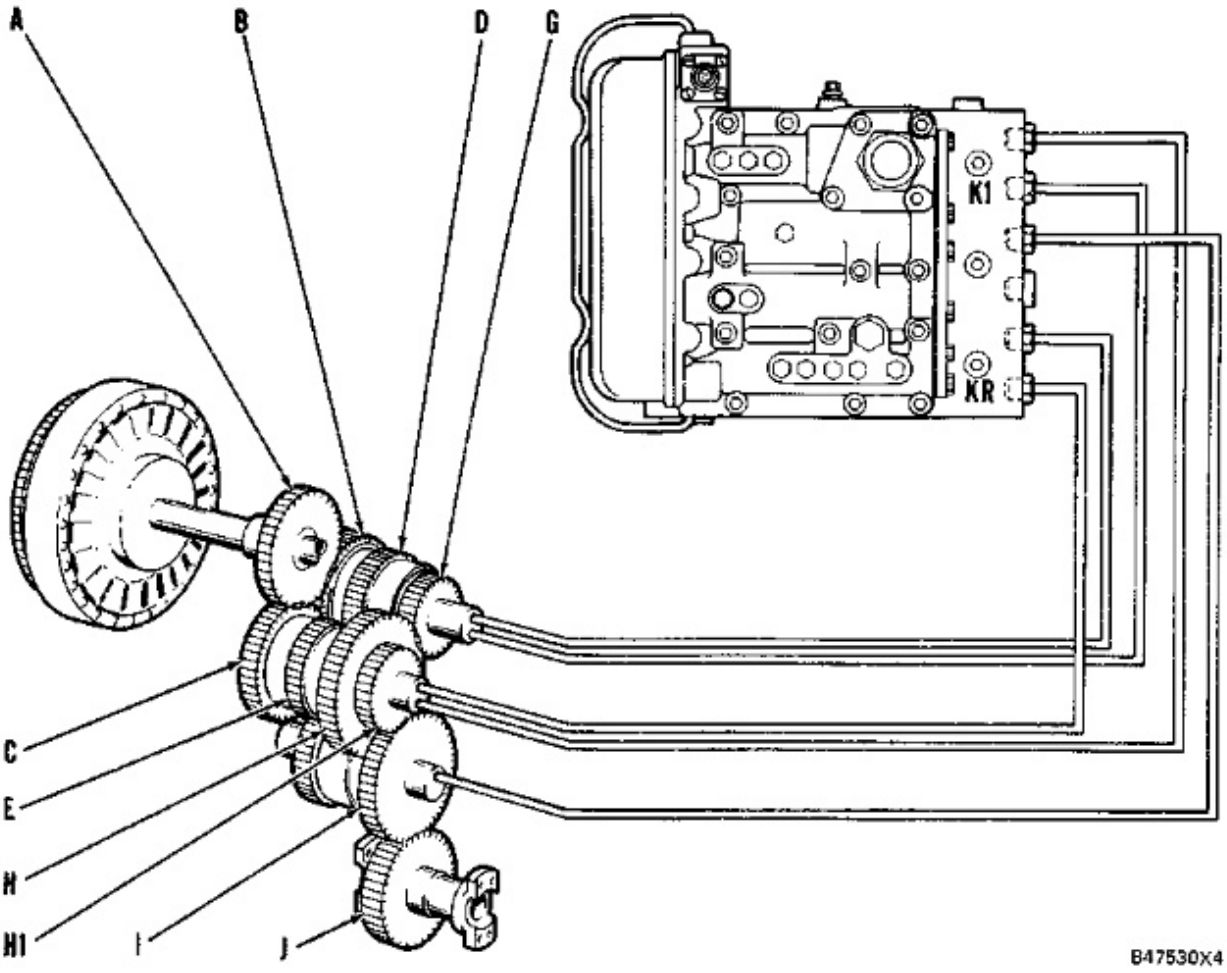
Third Speed Forward



POWER FLOW THIRD SPEED FORWARD (KV And K3 Clutches Engaged)

Power from the torque converter turbine wheel turns the output shaft drive gear (A) (CCW). Drive gear (A) turns drive gear (B) (CW). With the FORWARD clutch (KV) engaged, the power turns drive gear (D) (CW). Drive gear (D) turns drive gear (E) (CCW). Drive gear (E) turns drive gear (F) (CW) which is on the outside diameter of the third speed clutch housing. With the THIRD speed clutch (K3) engaged, power from gear (F) turns drive gear (I) (CW). Drive gear (I) turns drive gear (J) (CCW) and the output shaft to the differentials.

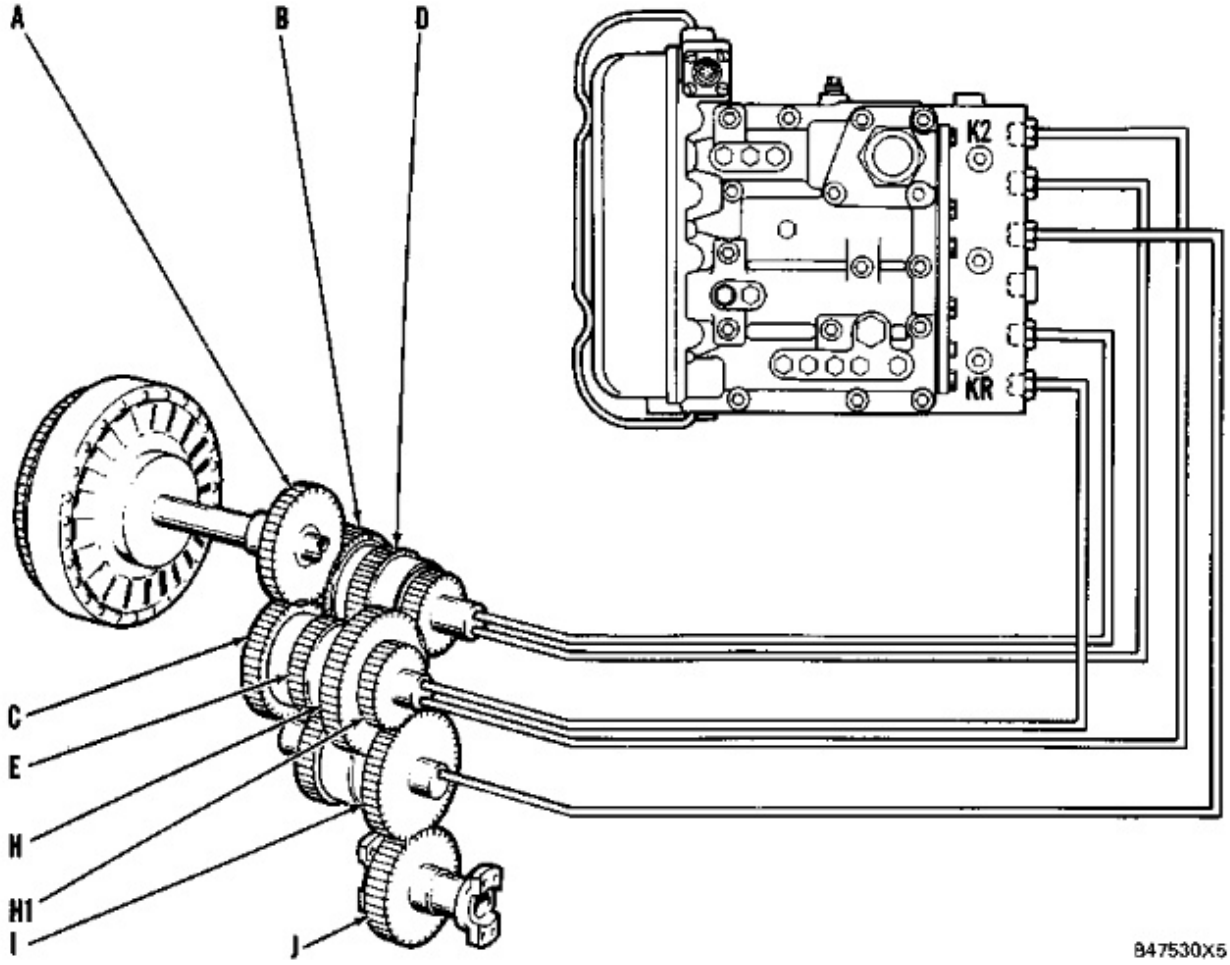
First Speed Reverse



POWER FLOW FIRST SPEED REVERSE (KR And K1 Clutches Engaged)

Power from the torque converter turbine wheel turns the output shaft drive gear (A) (CCW). Drive gear (A) turns drive gear (C) (CW). With the REVERSE clutch (KR) engaged, power turns drive gear (E) (CW) which is on the outside diameter of the REVERSE and SECOND speed clutch housing. Drive gear (E) which is in constant mesh with drive gear (D), turns drive gear (D) (CCW). With the FIRST speed clutch (K1) engaged, power from drive gear (D) goes through the FIRST speed clutch and turns drive gear (G) (CCW). Drive gear (G) turns drive gear (H) and (H-1) (CW). Drive gear (H-1) turns drive gear (I) (CCW). Drive gear (I) turns drive gear (J) (CW) and power goes to the output shaft to the differentials.

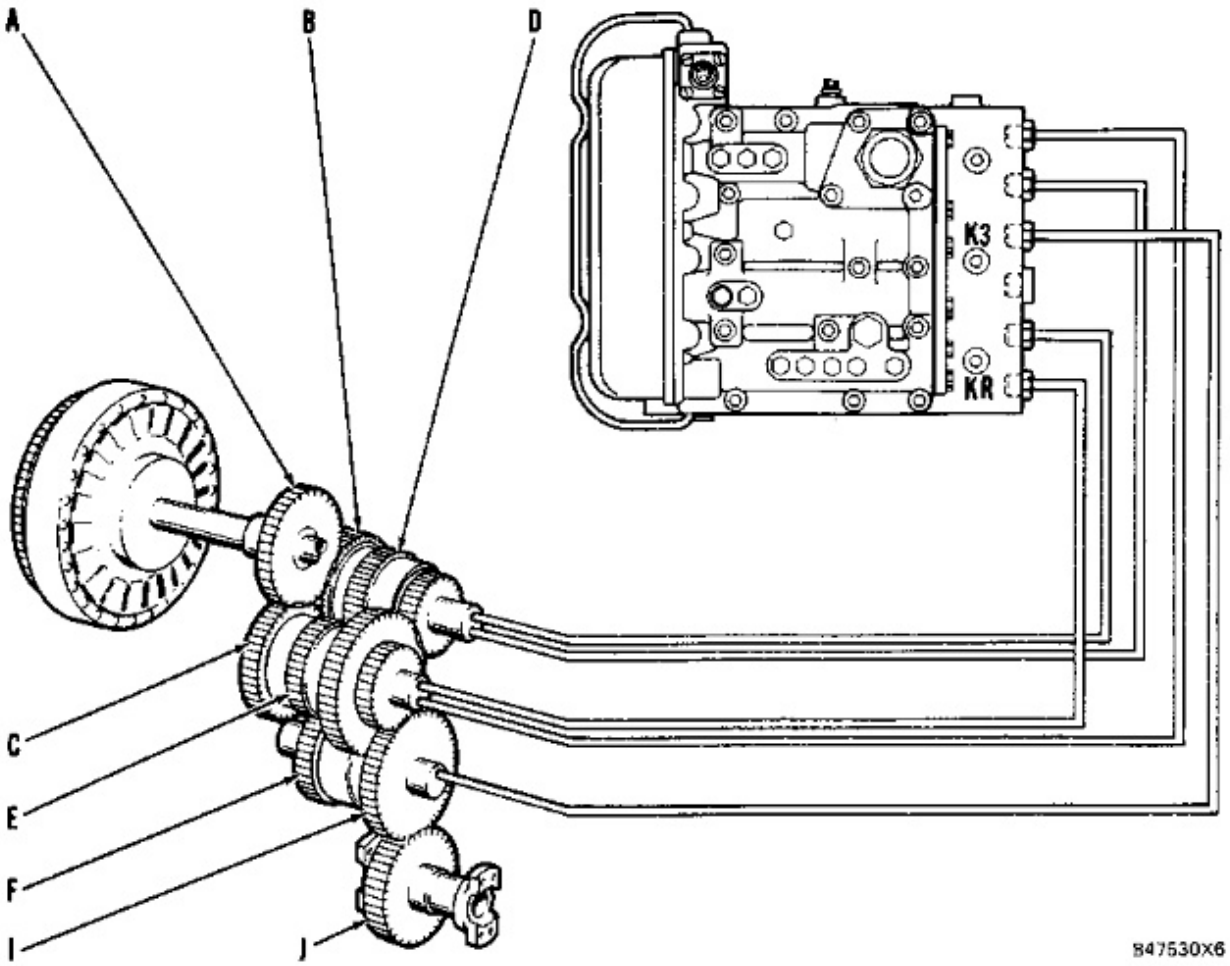
Second Speed Reverse



POWER FLOW SECOND SPEED REVERSE (KR And K2 Clutches Engaged)

Power from the torque converter turbine wheel turns the output shaft and drive gear (A) (CCW). Drive gear (A) turns drive gear (C) (CW). With the REVERSE clutch (KR) engaged, the power turns drive gear (E) (CW) which is on the outside diameter of the clutch housing. With the SECOND speed clutch (K2) engaged, the power from REVERSE clutch (KR) goes through the SECOND speed clutch and turns drive gear (H) (CW). Drive gear (H) now turns drive gear (H-1) (CW). Drive gear (H-1) turns drive gear (I) (CCW). Drive gear (I) turns drive gear (J) (CW) and power goes to the output shaft to the differentials.

Third Speed Reverse



POWER FLOW THIRD SPEED REVERSE (KR And K3 Clutches Engaged)

Power from the torque converter turbine wheel turns the output shaft drive gear (A) (CCW). Drive gear (A) turns drive gear (C) (CW). With the reverse clutch engaged, power turns drive gear (E) (CW) which is on the outside diameter of the REVERSE and SECOND speed clutch housing. Drive gear (E) turns drive gear (F) (CCW) which is on the outside diameter of the THIRD speed clutch housing. With the THIRD speed clutch engaged, power from gear (F) turns drive gear (I) (CCW). Drive gear (I) turns drive gear (J) (CW) and the output shaft to the differentials.

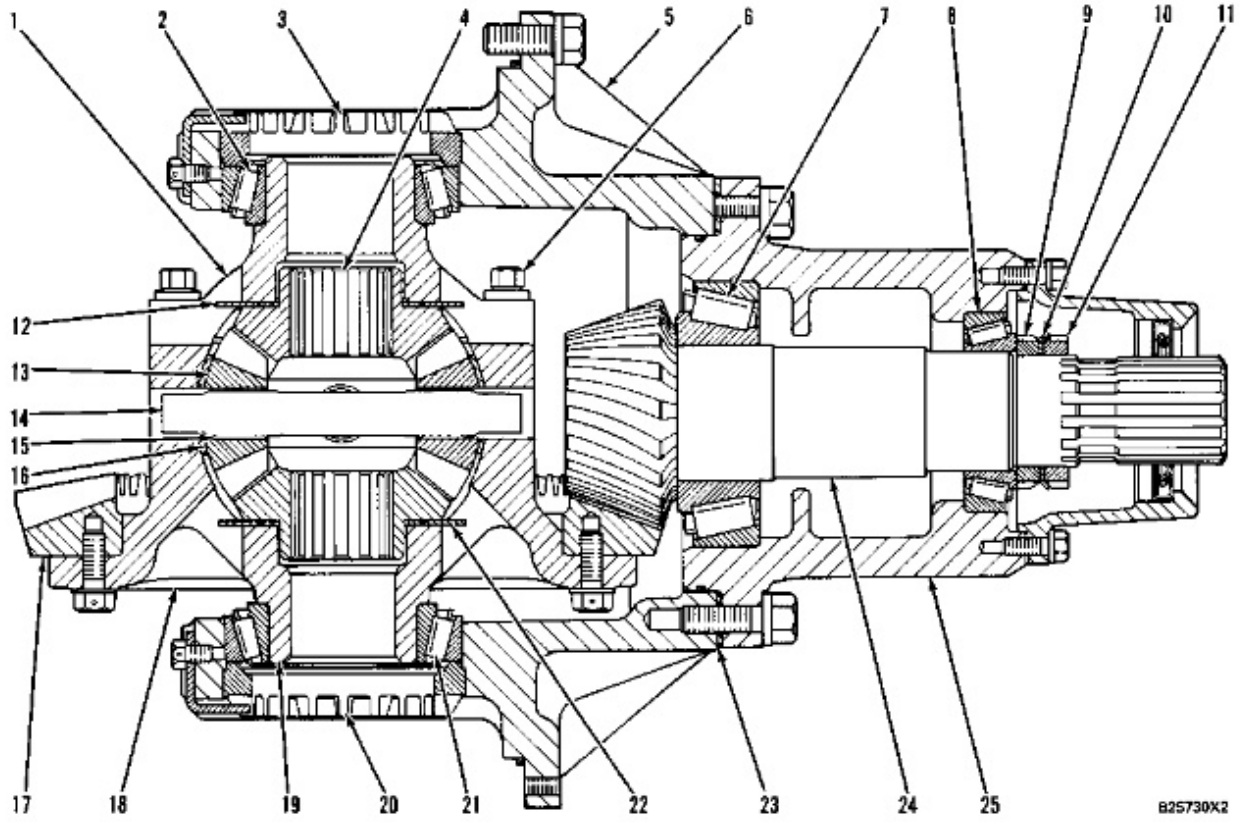
Neutral-Engine Running

Anytime the engine is running, the torque converter turbine wheel turns the output shaft where drive gear (A) is mounted. The output shaft and drive gear (A) turns in the same direction of rotation as the flywheel (CCW). Drive gear (A) turns drive gear (B) and (C) (CW). Even though gear (A) is turning gears (B) and (C), no power is sent to the second gear train until a forward or reverse clutch is engaged. Gears (B) and (C) are turning but transmitting no power. Because of the turning and some clutch drag (friction) in the FORWARD and REVERSE clutches, gear (B) will attempt to turn gear (D), gear (C) will attempt to turn gear (E) and gear (F). This drag turning would cause high speed gear rotation. To prevent gear free turning when the direction control is in NEUTRAL, the electronic shift console energizes the appropriate control valve solenoids based on the selected speed control position.

When a machine is standing still, the final drives hold the output shaft and gear (J) from turning. Gear (J) hold gears (I), (H-1), (H) and (G) from turning. With the above gears held from turning and one of the speed clutches selected, gears D, E and F are kept from turning. This leaves only three

gears (A), (B), and (C) in the first gear train turning when the direction and speed control is in NEUTRAL and the machine stopped.

Differentials



DIFFERENTIAL AND BEVEL GEAR GROUP (Top View Of Front Differential)

1. Case.
2. Bearing cup and cone.
3. Adjustment ring.
4. Side gear.
5. Carrier.
6. Bolts.
7. Bearing cup and cone.
8. Bearing cup and cone.
9. Nut.
10. Lock.
11. Nut.
12. Thrust washer.
13. Pinions.
14. Spider.

15. Bearing.

16. Washer.

17. Ring gear.

18. Case.

19. Side gear.

20. Adjustment ring.

21. Bearing cup and cone.

22. Thrust washer.

23. Shims.

24. Pinion.

25. Housing.

A differential divides or causes a balance of the power which is sent to the wheels. When one wheel turns slower than the other, as in a turn, the differential lets the inside wheel go slower in relation to the outside wheel. The differential still sends the same amount of torque to each wheel.

Bevel pinion (24) is connected to a yoke. The yoke assembly is connected to a universal joint from the output transfer gears. Pinion (24) is connected to the yoke assembly by splines. Pinion (24) is engaged with ring gear (17). Ring gear (17) is fastened to the differential group. Differential carrier (5) is fastened to the axle housing.

The differential group has a case (18). Ring gear (17) is fastened to case (18). Case (18) is fastened to case (1) by bolts (6). Inside the differential group is side gear (4), spider (14), four pinions (13) and side gear (19). Spider (14) is installed between the two cases. When the cases are turned, the spider turns. Pinions (13) are installed on the spider and are engaged with the teeth of side gears (4 and 19). The axle shafts are connected to the side gears by splines. Side gears (4 and 19) turn against thrust washers (12) and 22). Pinions (13) turn on bearings (15).

Nuts (9 and 11) and lock (10) are used to make an adjustment to the end play (bearing preload) of bearings (7 and 8) for pinion (24).

Shims (23) are used to make an adjustment to the tooth contact (wear pattern) between pinion (24) and ring gear (17).

Rings (3 and 20) are used to make an adjustment to the free movement (backlash) between pinion (24) and ring gear (17). Rings (3 and 20) are also used to make an adjustment to the bearing preload of bearings (2 and 21).

The inside components of the differential get their lubrication from oil thrown around inside the differential. Flat surfaces on spider (14) let oil go to bearings (15). The supply for lubrication oil is a reservoir in the axle housing.

Operation

Straight Forward or Reverse

When the machine moves in a straight direction with the same amount of traction under each drive wheel, the same amount of torque on each axle holds the pinions so they do not turn on the spider.

Pinion (24) turns ring gear (17). Ring gear (17) turns cases (1 and 18). Cases (1 and 18) turn spider (14). Spider (14) turns side gears (4 and 19) through pinions (13). Pinions (13) do not turn on the spider. The side gears turn the axle shafts. The same amount of torque is sent to each wheel.

This gives the same effect as if both drive wheels were on one axle shaft.

Forward or Reverse Turn

When the machine is in a turn, the inside wheel has more resistance to turn than the outside wheel. This resistance causes different torques on the opposite sides of the differential. It is easier for the outside wheel to turn than it is for the inside wheel. The outside wheel starts to turn faster than the inside wheel.

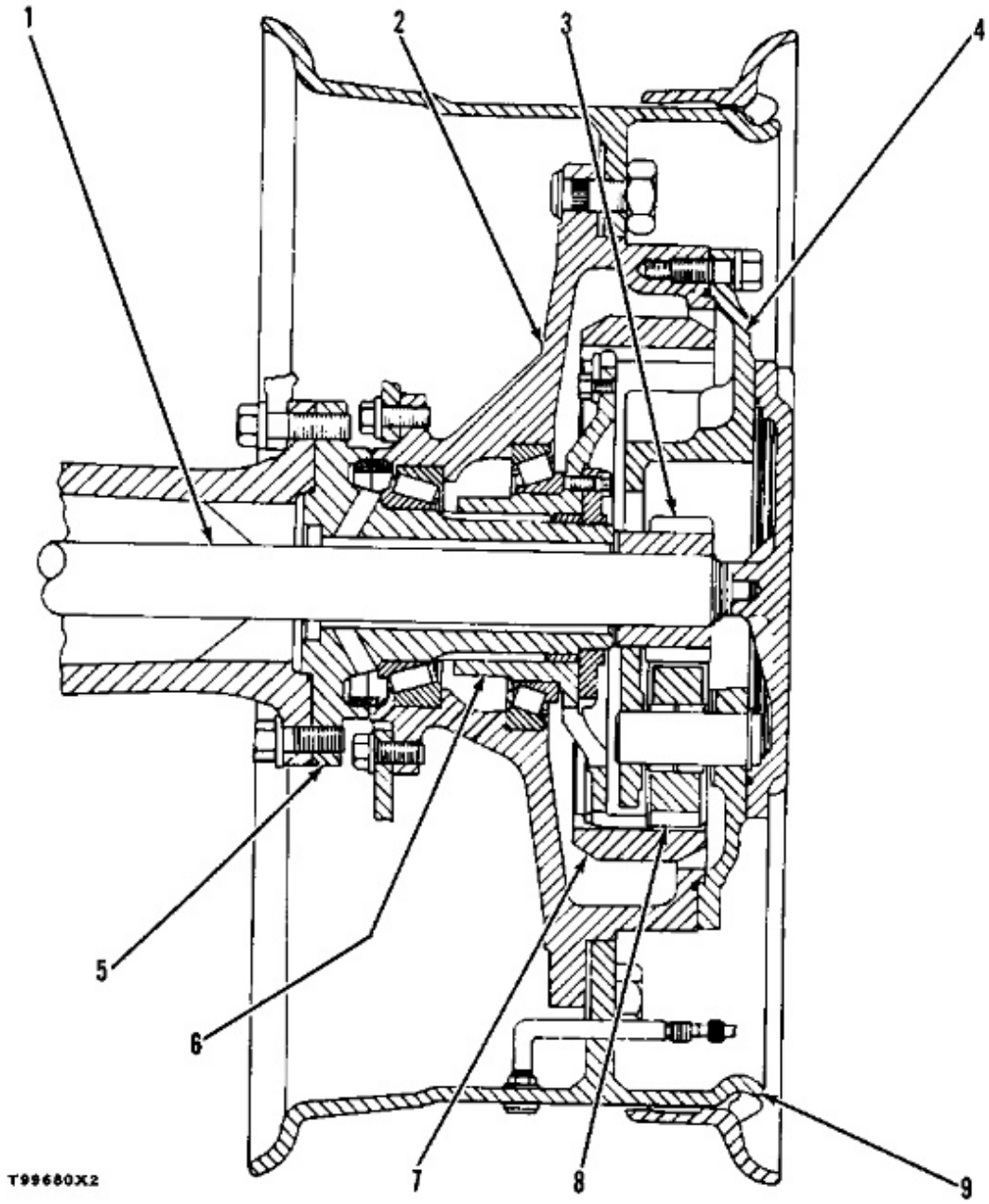
Pinion (24) turns ring gear (17). Ring gear (17) turns cases (1 and 18). Cases (1 and 18) turn spider (14). Spider (14) turns side gears (4 and 19) through pinions (13). Since it takes more force to turn one side gear then it does the other, pinions (13) turn around the spider. As the pinions turn, they move around the side gears. This lets the outside wheel turn faster than the inside wheel.

The same amount of torque is sent to both the inside and outside wheels. This torque is only equal to the amount needed to turn the outside wheel.

Loss of Traction (Wheel Slippage)

When one wheel has more traction than the other, the operation of the differential is the same as in a turn. The same amount of torque is sent to both wheels. This torque is only equal to the amount needed to turn the wheel with the least resistance.

Final Drive And Wheels



FINAL DRIVE

FINAL DRIVE

1. Axle. 2. Wheel assembly. 3. Sun gear. 4. Carrier. 5. Spindle. 6. Hub. 7. Ring gear. 8. Planet gears. 9. Rim assembly.

The final drive is a planetary gear system. Axle (1) is connected to the differential at one end and to the sun gear (3) at the other end with splines. The ring gear (7) of the planetary system is connected to the hub (6) with splines. The hub is connected to the spindle (5) with splines. The spindle is fastened to the axle housing.

When axle (1) is turned by the differential, the sun gear (3) turns the planet gears (8). Because the ring gear (7) is held by the axle housing, the planet gears (8) (turned by the sun gear) make the carrier (4) turn at a slower speed than the sun gear (3). The carrier (4) is connected to the wheel assembly (2) and rim assembly (9) and the power is sent to the ground.

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