



REN8482-15 (en-us)
May 2020



Systems Operation Troubleshooting Testing and Adjusting

14M, 16M Motor Graders Power Train

B9H 1-UP (Machine)
R9H 1-UP (Machine)
B9J 1-UP (Machine)
R9J 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

NOTICE

When replacement parts are required for this product Caterpillar recommends using original Caterpillar® replacement parts.

Other parts may not meet certain original equipment specifications.

When replacement parts are installed, the machine owner/user should ensure that the machine remains in compliance with all applicable requirements.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

Table of Contents

Systems Operation Section

Introduction	4
Location of Components	5
Parking Brake	14
Power Train Hydraulic System	19
Modulating Valve (Transmission Clutch).....	25
Relief Valve (Transmission Hydraulic Control)	30
Transmission Power Flow	32
Gear Pump (Transmission Charging and Scavenge)	89
Oil Filter (Power Train).....	89
Rear Axle	90
Differential and Bevel Gear	91
Final Drive and Tandem Drive	94
Wheel Group	96
Graphic Color Codes	96

Troubleshooting Section

Introduction

General Information	98
Machine Preparation for Troubleshooting	98
Visual Inspection.....	99
Operational Checks.....	99

Symptom Procedures

Power Train	100
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Testing and Adjusting Section

Testing and Adjusting

Parking Brake - Test	103
Fill Time for the Transmission Clutch - Calibrate ..	103
Power Train Charge System Pressure - Test and Adjust	107
Transmission Lubrication Oil Pressure - Test	109
Transmission Pressures - Test and Adjust.....	111
Tandem - Check.....	113
Drive Chain - Check	115
Differential Lock Pressure - Check.....	118
Final Drive Oscillation Joint End Play - Check.....	119

Index Section

Index.....	123
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Systems Operation Section

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Introduction

SMCS Code: 3000; 3100; 4000

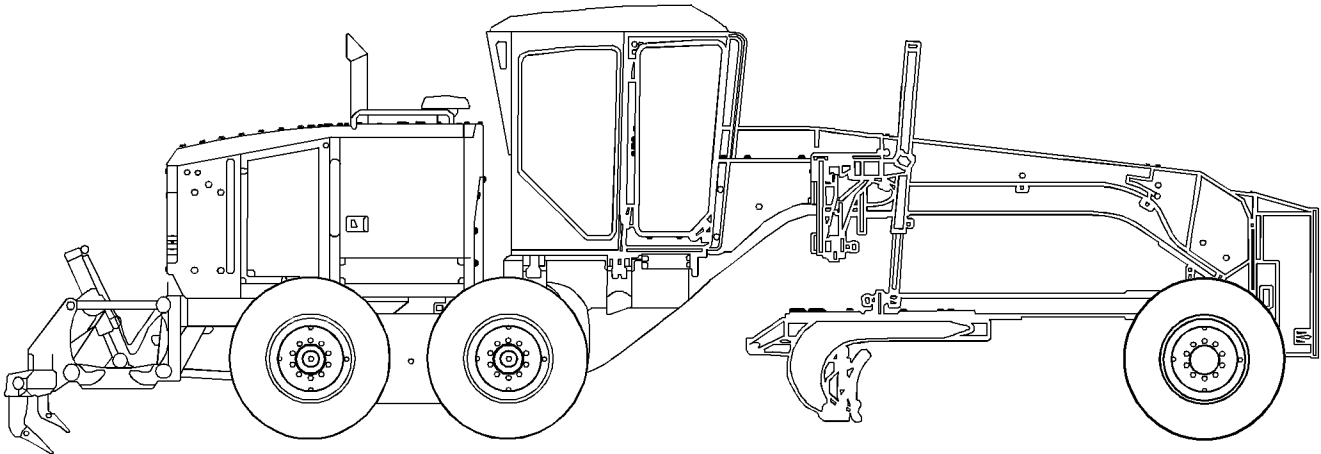


Illustration 1

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Power from the engine is transferred to the transmission. Power flows through the transmission directly to the differential and bevel gear. The differential and bevel gear transfers power to the final drives. The final drives transfer power to the chains. The chains drive the wheels. The following Motor Graders are covered in this module:

- 14M
- 16M

The Power Train system has the following main components:

- Transmission control valve
- Transmission
- Differential and bevel gear
- Final drive and tandem drive

Transmission Control Valve

The transmission control valve provides the proper flow and pressure in order to engage the desired transmission clutches. The transmission control valve contains the following major components:

- Main relief valve

- Modulating clutch valves
- Parking brake valve

Transmission

The Motor Graders that are covered in this manual are equipped with Electronic Clutch Pressure Control (ECPC). The ECPC controls the transmission. The transmission has eight forward speeds and six reverse speeds. The transmission is electronically controlled and hydraulically actuated.

Differential and Bevel Gear

The differential and bevel gear is used to transfer power from the transmission to the final drives. The differential allows the wheels to turn at different rates of speed when the machine is going through a turn. The differential can be locked by the differential lock valve.

Final Drive and Tandem Drive

The final drive is used to transfer power to the wheels. The wheels are connected to the final drive

by chains. The chains are located inside the tandem housing. The final drive is also used as the pivot point for the tandem housing.

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Location of Components

SMCS Code: 1400; 3000; 3100; 4000; 4250; 5050

Hydraulic Components

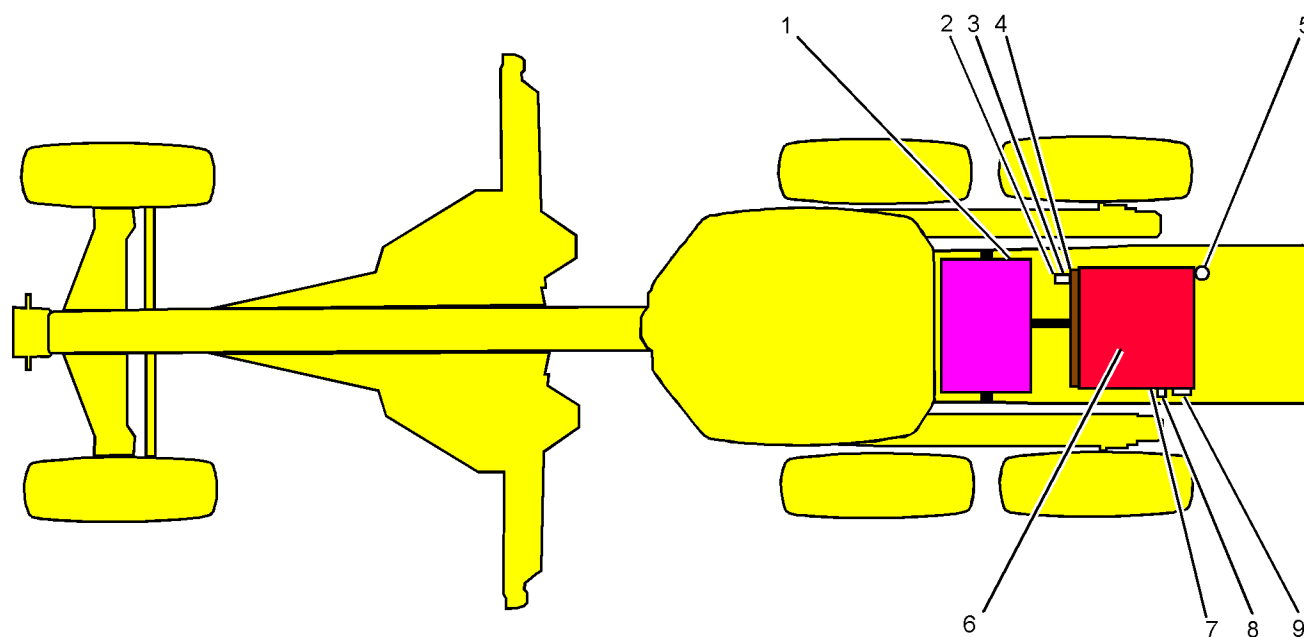


Illustration 2

g01288066

- (1) Transmission oil cooler
- (2) Magnetic screen (transmission charge pump section)
- (3) Transmission pump (transmission charge pump and scavenge pump)

- (4) Magnetic screen (transmission scavenge pump section)
- (5) Transmission oil filter
- (6) Transmission
- (7) Transmission lubrication relief valve

- (8) Transmission main relief valve
- (9) Transmission control valve

Transmission Oil Cooler

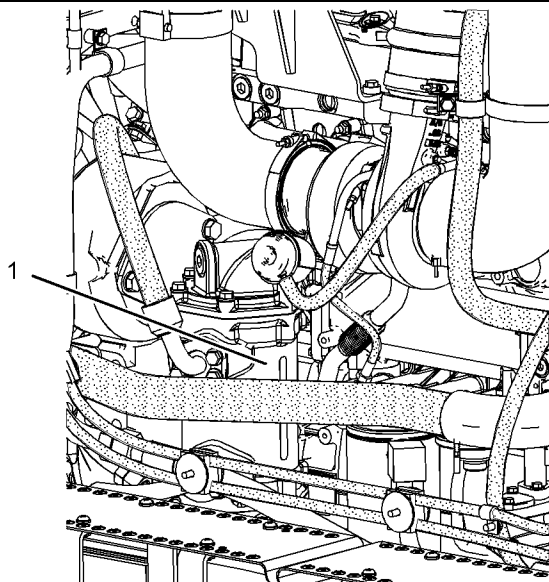


Illustration 3
g01462055
(1) Transmission oil cooler

Transmission oil cooler (1) is mounted next to the engine on the right side of the machine. Transmission oil cooler (1) uses engine coolant in order to cool the transmission oil. The cooled oil is used for the transmission lubrication.

Reference: See the Power Train Specifications, "Transmission Oil Cooler" for more information.

Screen and Magnetic Filter for the Transmission Charge Pump

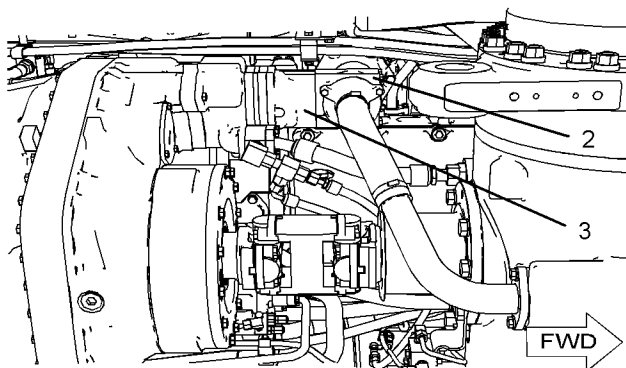


Illustration 4
g01281603
(2) Magnetic screen (transmission charge pump section)
(3) Transmission pump (transmission charging and scavenge)

The magnetic screen filter (2) for the transmission charge pump (3) is located on the end of the transmission pump. Filter (2) is used to filter the charge oil from the differential.

Reference: See the Power Train Specifications, "Magnetic Screen (Transmission)" for more information.

Transmission Pump

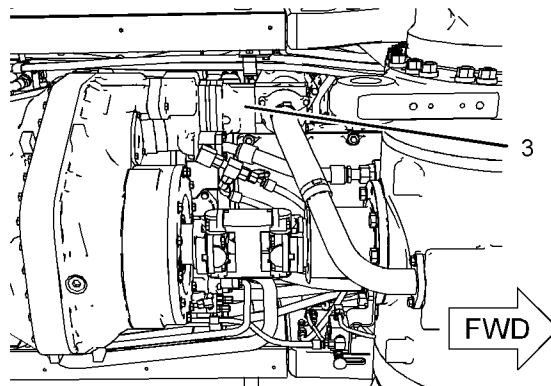


Illustration 5
g01281520
(3) Transmission pump (Transmission charging and scavenge)

Transmission pump (3) is located on the front of the transmission case. Transmission pump (3) is a two-section pump that contains a charging section and a scavenge section. The scavenge section transfers oil from the transmission sump to the differential for lubrication. The charging section transfers oil from the differential sump scavenge for use as pressure oil in the operation of the transmission.

Reference: See the Power Train Specifications, "Gear Pump (Transmission Charging and Scavenge)" for more information.

Screen and Magnetic Filter for the Transmission Scavenge Pump

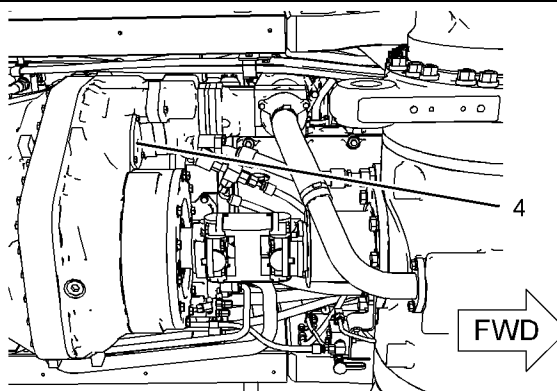


Illustration 6
g01281608
(4) Magnetic screen (transmission scavenge pump section)

The magnetic screen filter (4) for the transmission scavenge pump (3) is located just below the transmission pump. Filter (4) is used to filter the oil that is transferred to the differential.

Transmission Oil Filter

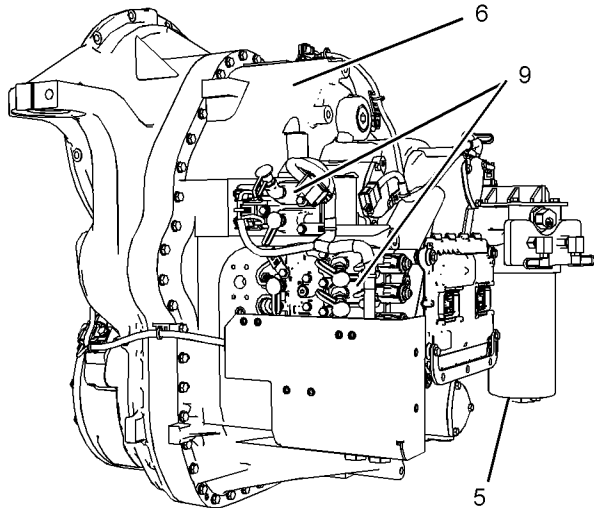


Illustration 7

g01288070

- (5) Transmission oil filter
- (6) Transmission
- (9) Transmission control valves

Transmission oil filter (5) is located in the rear right portion of the machine. Transmission oil filter (5) is used to filter the oil that flows from transmission pump (3) to transmission control valve (9).

Reference: See the Power Train Specifications, "Oil Filter (Transmission)" for more information.

Transmission Lubrication Relief Valve

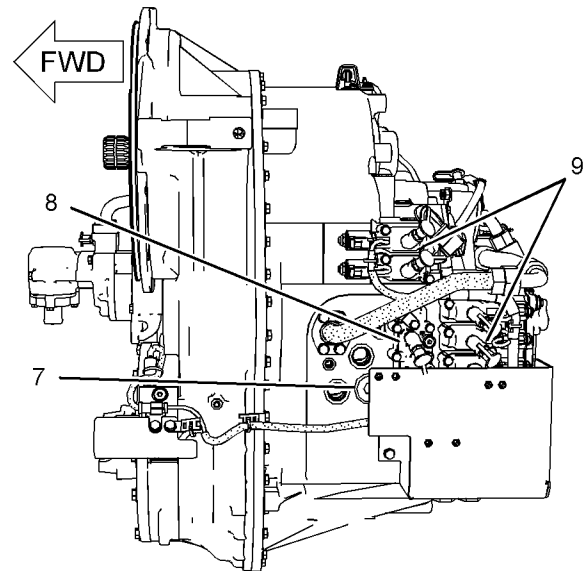


Illustration 8

g01462287

- (7) Transmission lubrication relief valve
- (8) Transmission main relief valve
- (9) Transmission control valves

The transmission lubrication relief valve (7) is located in the transmission case underneath a large plug to the left of the transmission relief valve. The transmission lubrication relief valve (7) is held in place by a retaining ring. When the pressure at the inlet for lube oil exceeds a specified pressure, the transmission lubrication relief valve allows the oil to flow into the transmission sump.

Reference: See the Power Train Specifications, "Transmission Lubrication Relief Valve" for more information about the cracking pressure.

Reference: See the Power Train Specifications, "Relief Valve (Drain (Clutch 7))" for more information.

Transmission Main Relief Valve

Transmission main relief valve (8) is located to the left of the transmission control valve on the left side of the transmission case. Transmission main relief valve (8) controls the maximum pressure of the clutches that are engaged.

Reference: See the Power Train Specifications, "Relief Valve (Main Relief)" for more information.

Transmission Control Valve

Transmission control valve (9) is located on the left side of the transmission case at the rear of the machine. Transmission control valve (9) provides oil flow at the correct pressure and at the proper time in order to engage the desired clutch packs. There are eight transmission control valves.

Reference: See the Systems Operation Testing and Adjusting, “Transmission Control Valve” for more information.

Reference: See the Power Train Specifications, “Modulating Valve (Transmission Hydraulic Control)” for more information.

Electrical Components

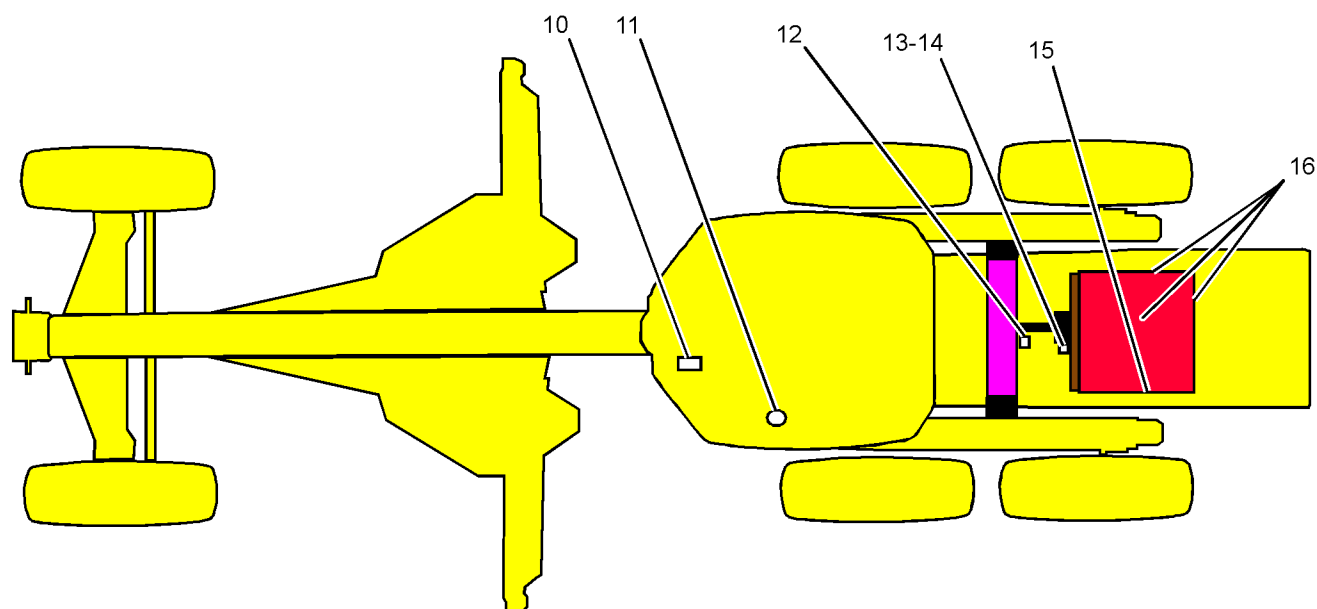


Illustration 9

g01462327

(10) Inching pedal
 (11) Joystick control
 (12) Differential lock valve

(13) Parking brake solenoid
 (14) Parking brake pressure switch
 (15) Temperature sensor

(16) Speed sensors

Inching Pedal

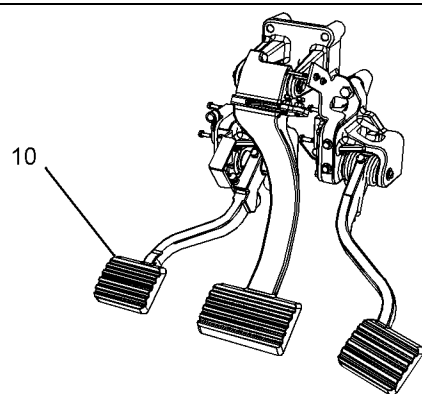


Illustration 10

g01487843

(10) Inching pedal

Inching pedal (10) is located in the operator compartment on the left. Inching pedal (10) is used to vary the power that is transmitted to the drive wheels.

Joystick Control

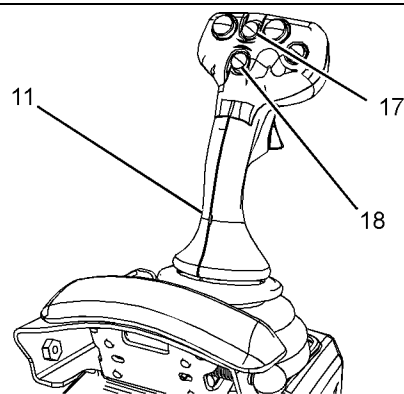


Illustration 11

g01462391

(11) Joystick control
 (17) Up shift control
 (18) Down shift control

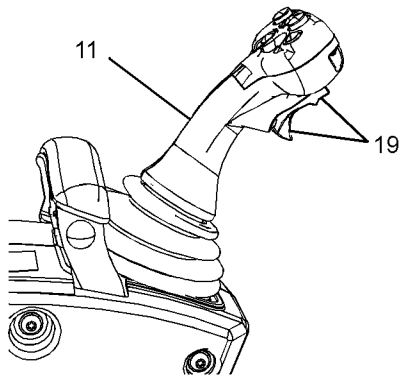


Illustration 12

g01462388

(11) Joystick control
(19) Direction control

The operator controls for the transmission are located on joystick control (11). Joystick control (11) is located on the left side of the operator in the operator compartment. Joystick control (11) is used to control the following transmission speeds and directions:

- PARK
- NEUTRAL
- FIRST SPEED FORWARD THROUGH EIGHTH SPEED FORWARD
- FIRST SPEED REVERSE THROUGH SIXTH SPEED REVERSE

Reference: See Operation and Maintenance Manual, "Transmission Control" for more information.

Differential Lock Valve

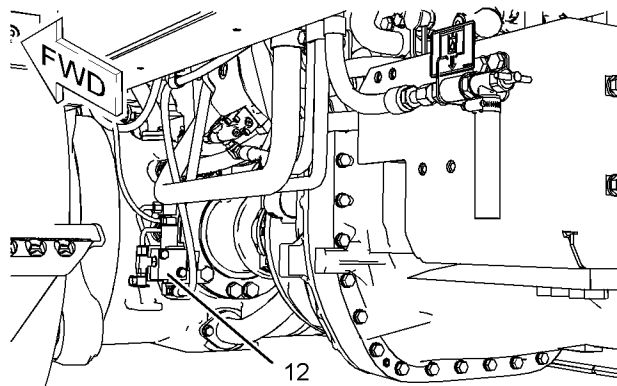


Illustration 13

g01284896

(12) Differential lock valve

Differential lock valve (12) is located on the pinion housing. Differential lock valve (12) is a solenoid activated hydraulic valve that directs power train oil to the differential lock.

Reference: See the Power Train Systems Operation, Testing and Adjusting, "Differential and Bevel Gear" for more information.

Parking Brake Solenoid and Parking Brake Pressure Switch

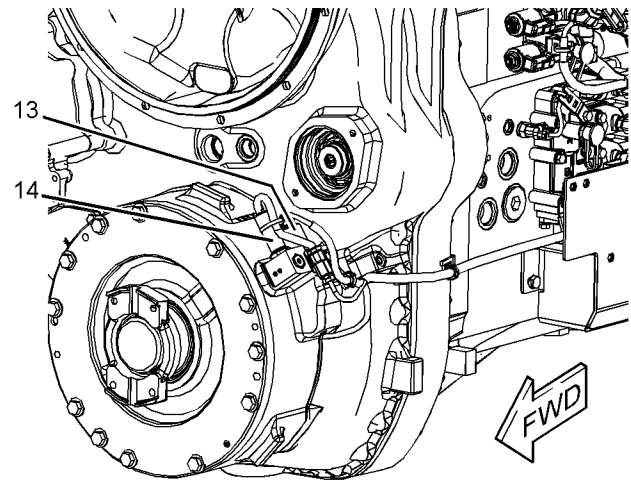


Illustration 14

g01461710

(13) Parking brake solenoid
(14) Parking brake pressure switch

Parking brake solenoid (13) is located on the parking brake. Parking brake pressure switch (14) is located on the parking brake. The parking brake is located on the front of the transmission.

Temperature Sensor

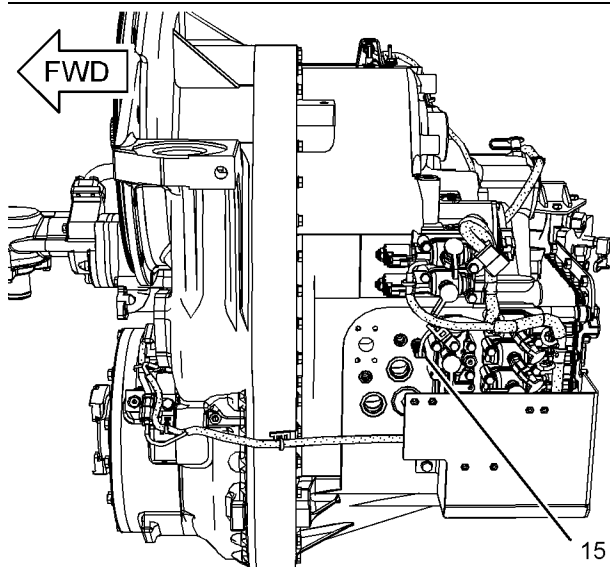


Illustration 15

g01463532

(15) Temperature sensor

Temperature sensor (15) is located on the left side of the transmission next to the main relief valve.

Speed Sensors

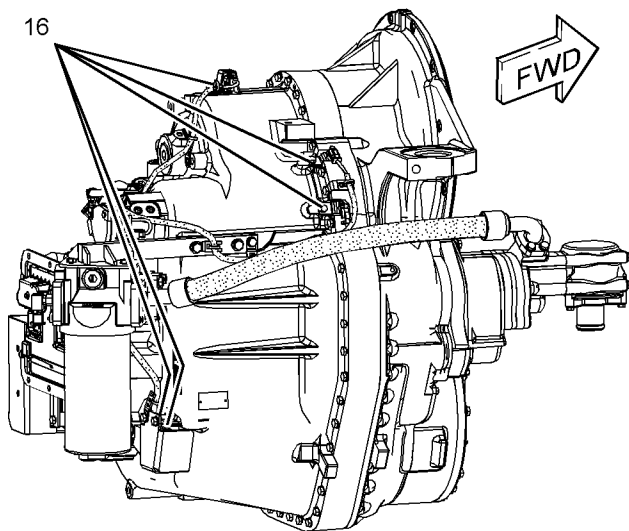


Illustration 16

g01463571

(16) Speed sensors

There is one speed sensor (16) that is located on the top of the transmission. There are two speed sensors (16) that are located on the upper right side of the transmission. There are two speed sensors (16) that are located on the lower right side of the transmission.

Lower Power Train Components

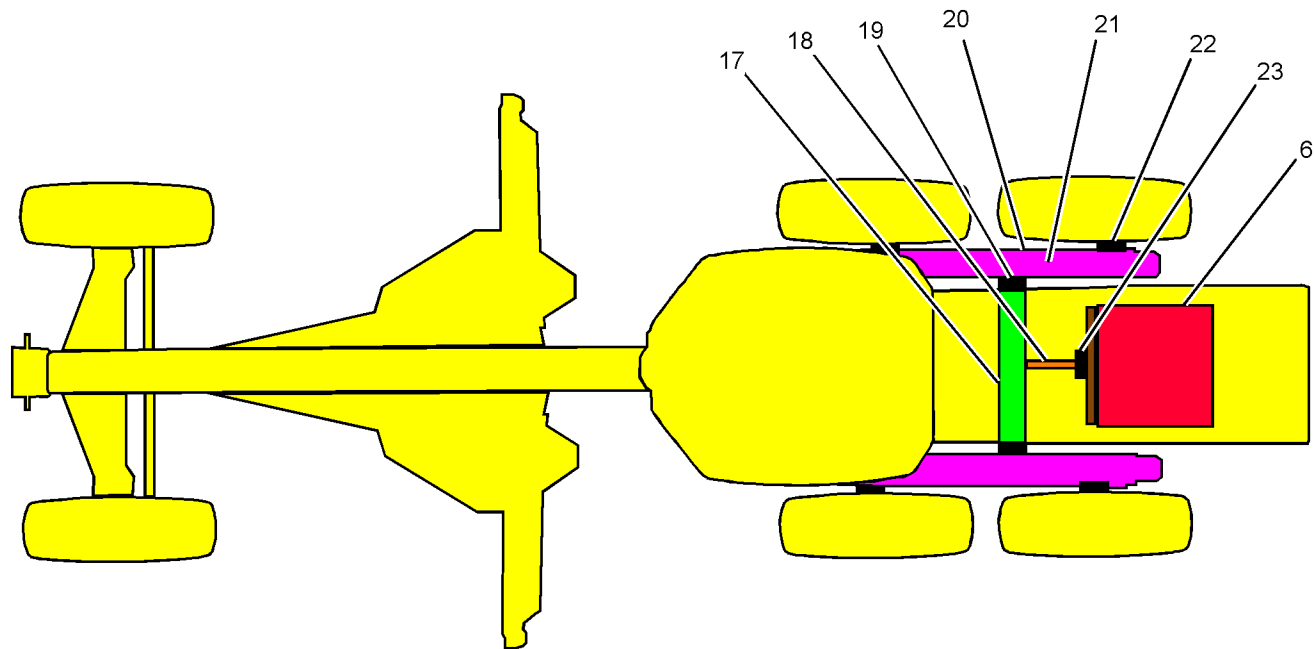


Illustration 17

g01463704

(6) Transmission
(17) Rear axle
(18) Drive shaft

(19) Final drives
(20) Tandem
(21) Chain assembly

(22) Wheel group
(23) Parking brake

Parking Brake

Reference: See the Power Train Systems Operations, "Parking Brake" for more information.

Drive Shaft

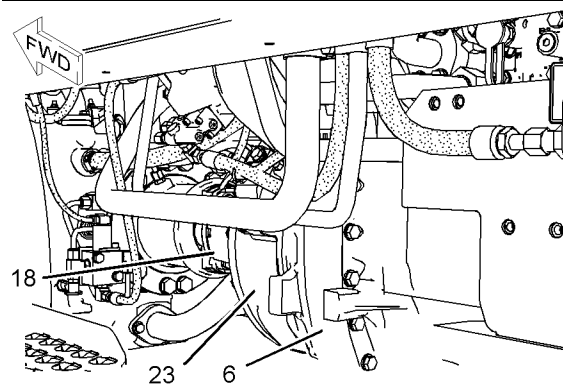


Illustration 18

g01463987

(6) Transmission
(18) Drive shaft
(23) Parking brake

Parking brake (23) is located on the output shaft of the transmission. Parking brake (23) is located between transmission (6) and drive shaft (18).

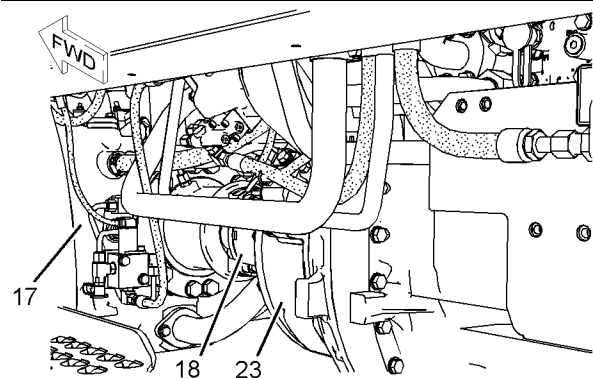


Illustration 19

g01463989

(23) Parking brake
(18) Drive shaft
(17) Rear axle

Drive shaft (18) is located between parking brake (23) and rear axle (17). Drive shaft (18) transfers power from the transmission output to the differential and bevel gear in the rear axle.

Rear Axle

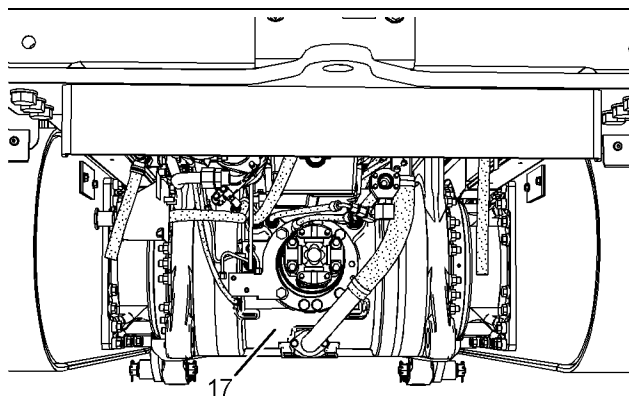


Illustration 20

g01466107

View of machine from the rear

The transmission has been removed for ease of viewing.

(17) Rear axle

Rear axle (17) is located in front of the transmission. The rear axle is composed of the bevel gear and the differential. The bevel gear and the differential transfer power to the final drives in order to be delivered to the wheels.

Reference: See the Power Train Systems Operations, "Rear Axle" for more information.

Reference: See the Power Train Systems Operations, "Differential and Bevel Gear" for more information.

Final Drives

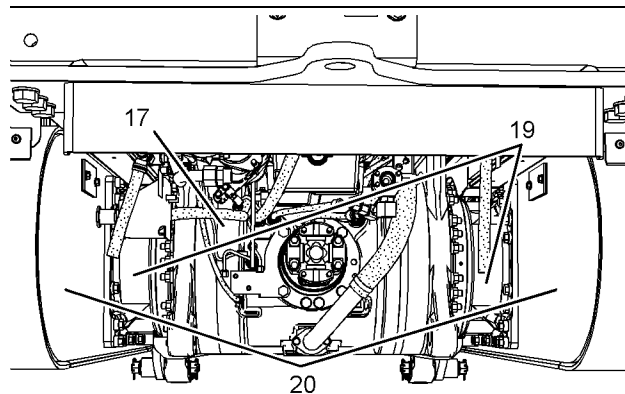


Illustration 21

g01466328

View of machine from the rear

The transmission has been removed for ease of viewing.

(19) Final drives

Final drives (19) are located between rear axle (17) and tandem (20). Final drives (19) transfer power from rear axle (17) to the wheels.

Reference: See the Power Train Systems Operations, "Final Drive and Tandem Drive" for more information.

Tandem

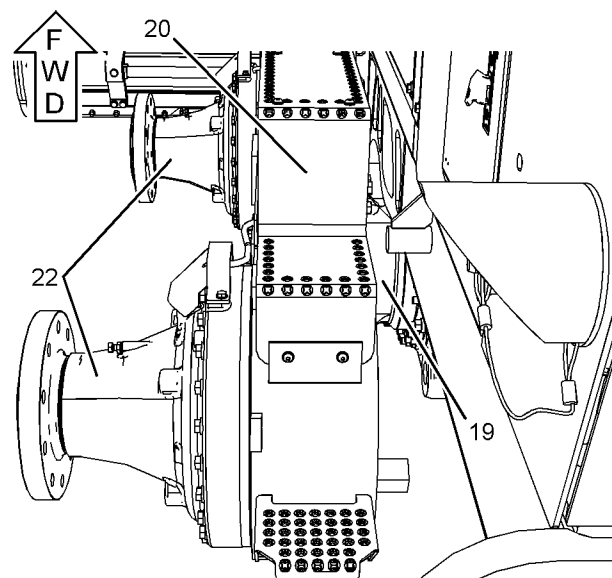


Illustration 22

g01466667

(19) Final drives

(20) Tandem

(22) Wheel group

Tandem (20) is located on the left side and located on the right side of the machine. The chain assembly is located inside tandem (20). The chain assembly transfers the power from final drive (19) to wheel groups (22). Chain assembly (21) is composed of two set of chains in each tandem. Final drives (19) are bolted to the inside of tandem (20). Wheel groups (22) are bolted to the outside of tandem (20).

Reference: See the Power Train Systems Operations, "Final Drive and Tandem Drive" for more information.

Wheel Group

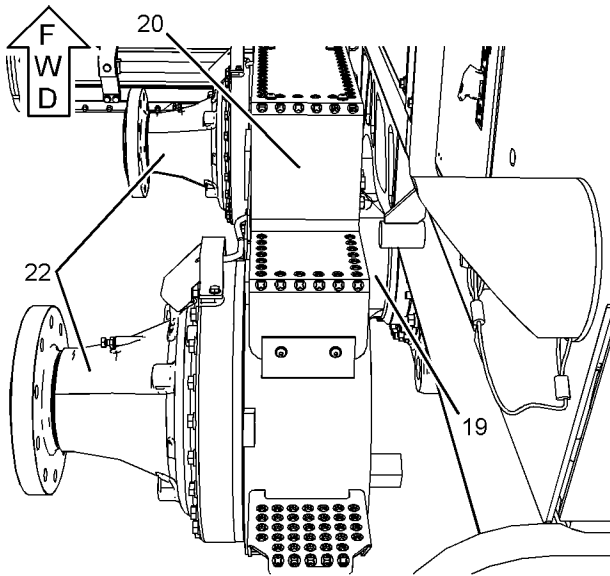


Illustration 23

g01466667

- (19) Final drives
- (20) Tandem
- (22) Wheel group

Wheel groups (22) are located on the outside of tandem (20). Wheel groups (22) transfer power to the wheels. There are four service brake assemblies on the machine.

Reference: See the Power Train Systems Operations, "Wheel groups and Brake" for more information.

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Parking Brake

SMCS Code: 4267

The parking brake is intended to hold the machine stationary after the machine has come to a complete stop. The parking brake is a disc type brake that is mounted to the output shaft of the transmission. The parking brake is applied by spring pressure. The parking brake is released by oil pressure.

Location of Components and Functions

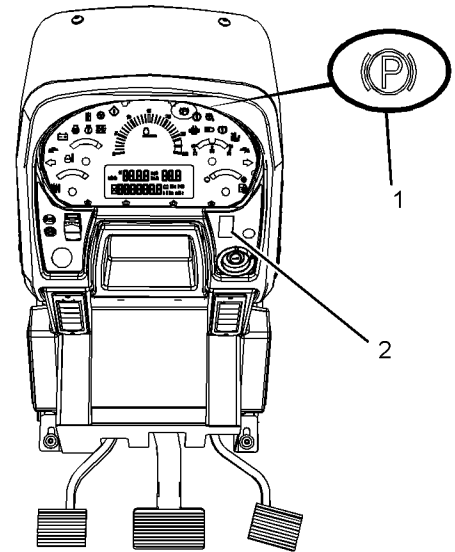


Illustration 24

g01336727

- (1) Parking brake indicator
- (2) Parking brake switch

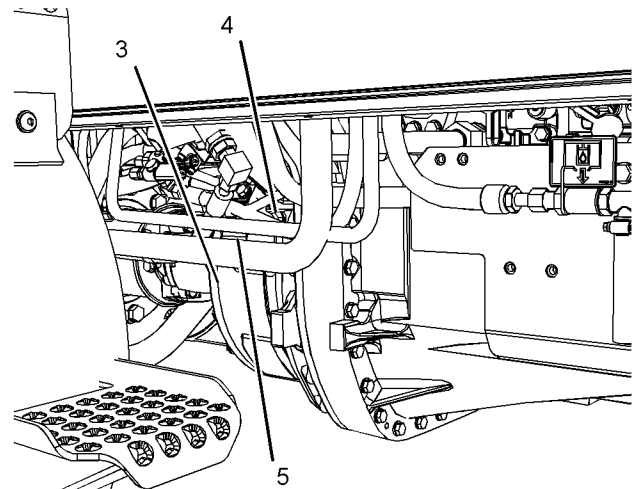


Illustration 25

g01336729

- (3) Parking brake
- (4) Parking brake solenoid
- (5) Pressure switch

The parking brake switch (2) allows the operator to turn the parking brake ON and OFF. The parking brake indicator (1) shows that the parking brake is engaged or disengaged. The parking brake (3) is connected to the output shaft of the transmission. The parking brake (3) locks the output shaft to apply the parking brake. The pressure switch (5) informs the Transmission Electronic Control Module (ECM) that the parking brake is either ON or OFF. The parking brake solenoid (4) controls the flow of oil to the parking brake and from the parking brake. The parking brake is OFF when the solenoid is energized. The parking brake is ON when the solenoid is de-energized.

Parking Brake Function

The parking brake will be engaged under the following conditions:

- An operator is not present in the seat.
- The ECM has been powered up for a minimum of 500 ms.
- The operator turns the parking brake switch to the ON position.
- The parking brake override is active.

The parking brake will be disengaged if all the following conditions occur:

- An operator is present in the seat.
- The operator turns the parking brake switch to the OFF position.
- The parking brake override is inactive.

Parking Brake Override

The parking brake override is a function that is used to prevent the operator from starting the machine while the parking brake switch is in the OFF position.

The parking brake override is active under the following conditions:

- The ECM has powered up.
- The position of the parking brake switch is unknown and the machine speed is less than 5 km/h (3 mph).

Diagnostics can be used to lock the parking brake. Diagnostics prevent the ECM from knowing the position of the parking brake switch. The parking brake override keeps the parking brake engaged when the diagnostics are completed. The operator must cycle the parking brake switch to deactivate the parking brake override.

The parking brake override is deactivated under the following conditions:

- The ECM has been powered up for a minimum of 500 ms and the parking brake switch is in the ON position.
- The engine has been running for at least 500 ms. The machine speed is more than 5 km/h (3 mph). The parking brake switch is in the OFF position.

Parking Brake Gear Limit Function

The operator can place the transmission into the desired gear when the pressure switch indicates that the parking brake is disengaged.

The operator can only shift the transmission into certain gears when the pressure switch indicates that the parking brake is engaged.

The transmission can be shifted into the following gears:

- NEUTRAL
- FIRST GEAR REVERSE
- FIRST GEAR FORWARD
- FIFTH GEAR FORWARD

The transmission can be shifted into FIFTH GEAR FORWARD to test the parking brake. To shift into FIFTH GEAR FORWARD, the parking brake switch must be in the ON position. After the operator shifts from NEUTRAL, no other shifts are allowed except back into NEUTRAL.

Parking Brake Operation

The Parking Brake Solenoid De-energized

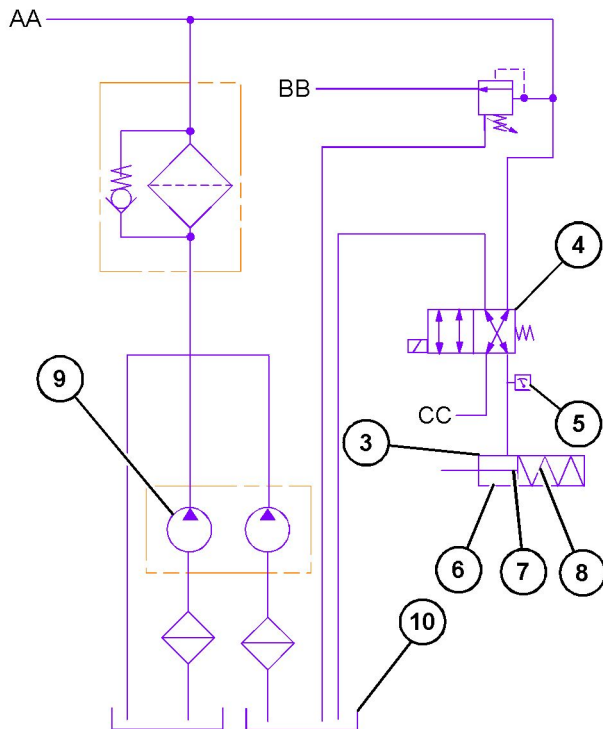


Illustration 26

g06231116

S/N: DZM Transmission

- (AA) Line to electronic clutch pressure controls
- (BB) Oil cooler
- (CC) Parking brake lubrication
- (3) Parking brake
- (4) Parking brake solenoid
- (5) Pressure switch
- (6) Cavity
- (7) Piston
- (8) Springs
- (9) Transmission charge pump
- (10) Transmission case

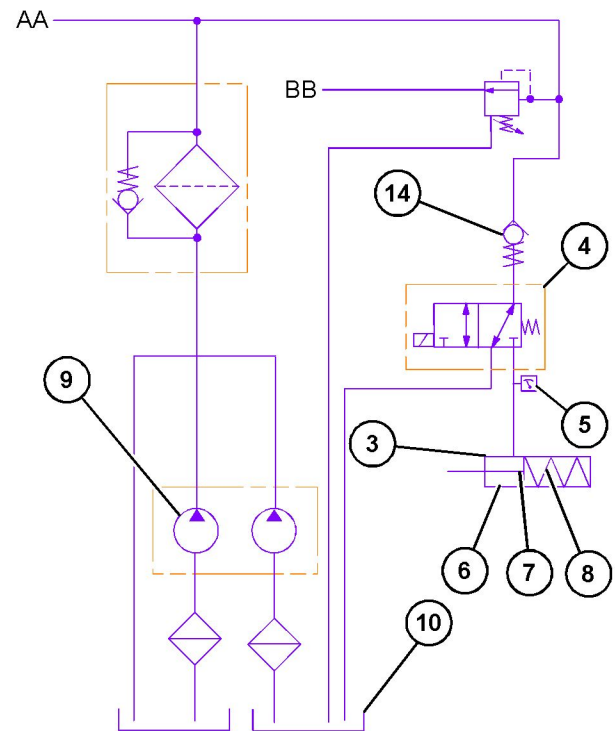


Illustration 27

g06231118

S/N: SLZ Transmission

- (AA) Line to transmission oil cooler
- (BB) Line to electronic clutch pressure controls
- (CC) Oil cooler
- (DD) Parking brake lubrication
- (3) Parking brake
- (4) Parking brake solenoid
- (5) Pressure switch
- (6) Cavity
- (7) Piston
- (8) Springs
- (9) Transmission charge pump
- (10) Transmission case
- (14) Park brake relief valve

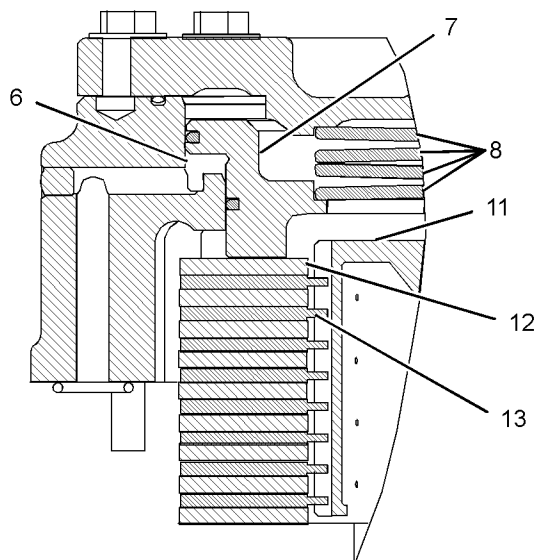


Illustration 28

g01459776

- (6) Cavity
- (7) Piston
- (8) Springs
- (11) Hub
- (12) Plate
- (13) Brake disc

When the engine is being started or when the parking brake switch (2) is in the ON position, the parking brake solenoid (4) is de-energized. When the parking brake solenoid is de-energized, oil is being drained from cavity (6). Pressure from spring (8) moves piston (7). The piston compresses the plates (12) and the brake discs (13). The brake discs (13) are splined to hub (11). The hub is splined to the output shaft. The output shaft of the transmission is locked when plates (12) and brake discs (13) are compressed. The rear wheels cannot turn when the output shaft is locked. The pressure switch (5) sends a signal to the ECM. The ECM turns on the parking brake indicator to inform the operator that the parking brake is engaged.

The Parking Brake Solenoid Energized

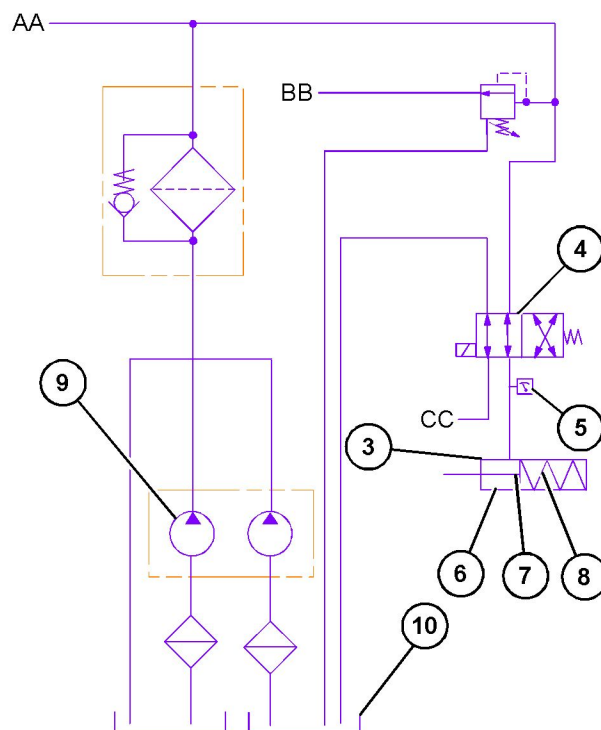


Illustration 29

g06231121

S/N: DZM Transmission

- (AA) Line to electronic clutch pressure controls
- (BB) Oil cooler
- (CC) Parking brake lubrication
- (3) Parking brake
- (4) Parking brake solenoid
- (5) Pressure switch
- (6) Cavity
- (7) Piston
- (8) Springs
- (9) Transmission charge pump
- (10) Transmission case

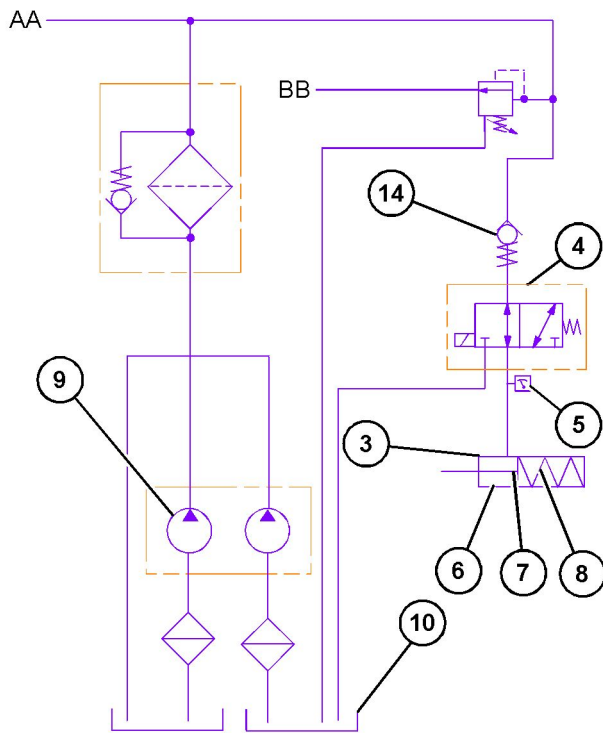


Illustration 30

g06231124

S/N: SLZ Transmission

- (AA) Line to electronic clutch pressure controls
- (BB) Oil cooler
- (3) Parking brake
- (4) Parking brake solenoid
- (5) Pressure switch
- (6) Cavity
- (7) Piston
- (8) Springs
- (9) Transmission charge pump
- (10) Transmission case
- (14) Park brake relief valve

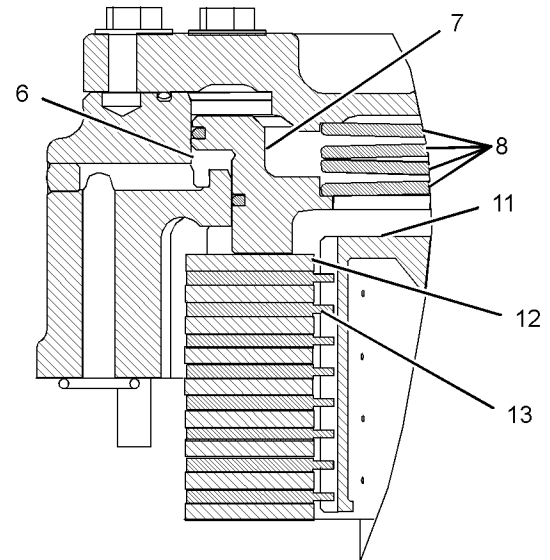


Illustration 31

g01459776

- (6) Cavity
- (7) Piston
- (8) Springs
- (11) Hub
- (12) Plate
- (13) Brake disc

When the parking brake switch (2) is in the OFF position, the parking brake solenoid (4) is energized. When the parking brake solenoid is energized, the solenoid shifts and the valve overcome spring pressure. Oil is sent into cavity (6) from the transmission charge pump (9). Oil pressure moves piston (7). The piston compresses the springs (8). The brake discs (13) are splined to hub (11). The hub is splined to the output shaft. The output shafts of the transmission and the brake discs (13) are free to turn when springs (8) are compressed. The rear wheels can turn freely when the output shaft is unlocked. The pressure switch (5) sends a signal to the ECM. The ECM turns off the parking brake indicator to inform the operator that the parking brake is disengaged.

i07124182

Power Train Hydraulic System

SMCS Code: 3000; 3100; 3101; 4000; 5050-PWT

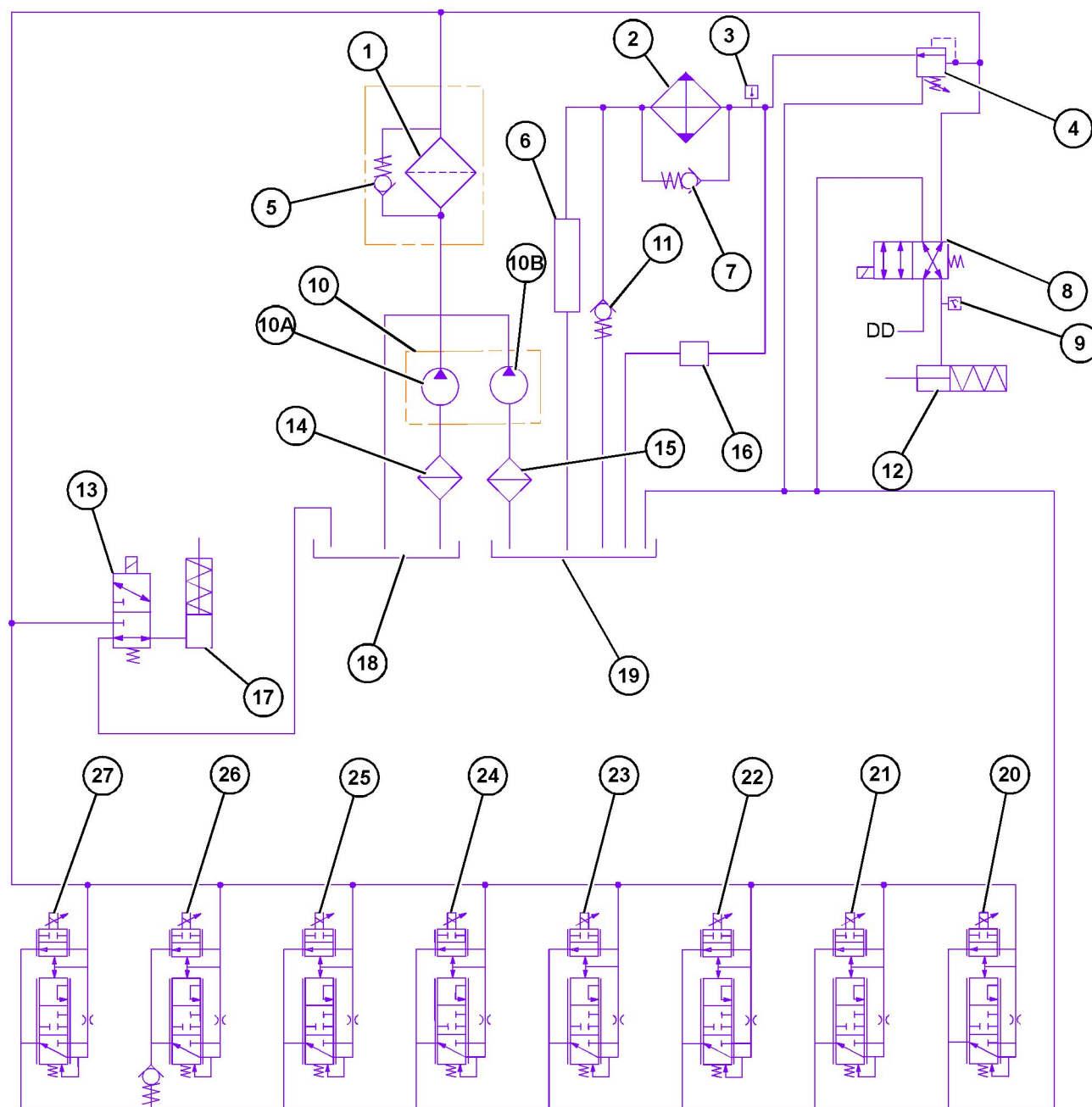


Illustration 32

g06230997

S/N: DZM Transmission Lubrication

- (1) Transmission oil filter
- (2) Oil cooler
- (3) Temperature sensor
- (4) Transmission main relief valve
- (5) Oil filter bypass valve (transmission)

- (6) Transmission lubrication
- (7) Oil cooler bypass valve
- (8) Parking brake solenoid
- (9) Pressure switch for the parking brake
- (10) Oil pump housing

- (10A) Transmission charging section
- (10B) Transmission scavenge section
- (11) Transmission lubrication relief valve
- (12) Parking brake
- (13) Differential lock valve

Systems Operation Section

(14) Magnetic screen (differential)
 (15) Magnetic filter (transmission)
 (16) Engine flywheel gear case
 (17) Differential lock
 (18) Differential case

(19) Transmission sump
 (20) Modulating valve for clutch 1
 (21) Modulating valve for clutch 2
 (22) Modulating valve for clutch 3
 (23) Modulating valve for clutch 4

(24) Modulating valve for clutch 5
 (25) Modulating valve for clutch 6
 (26) Modulating valve for clutch 7
 (27) Modulating valve for clutch 8
 (DD) Parking brake lubrication

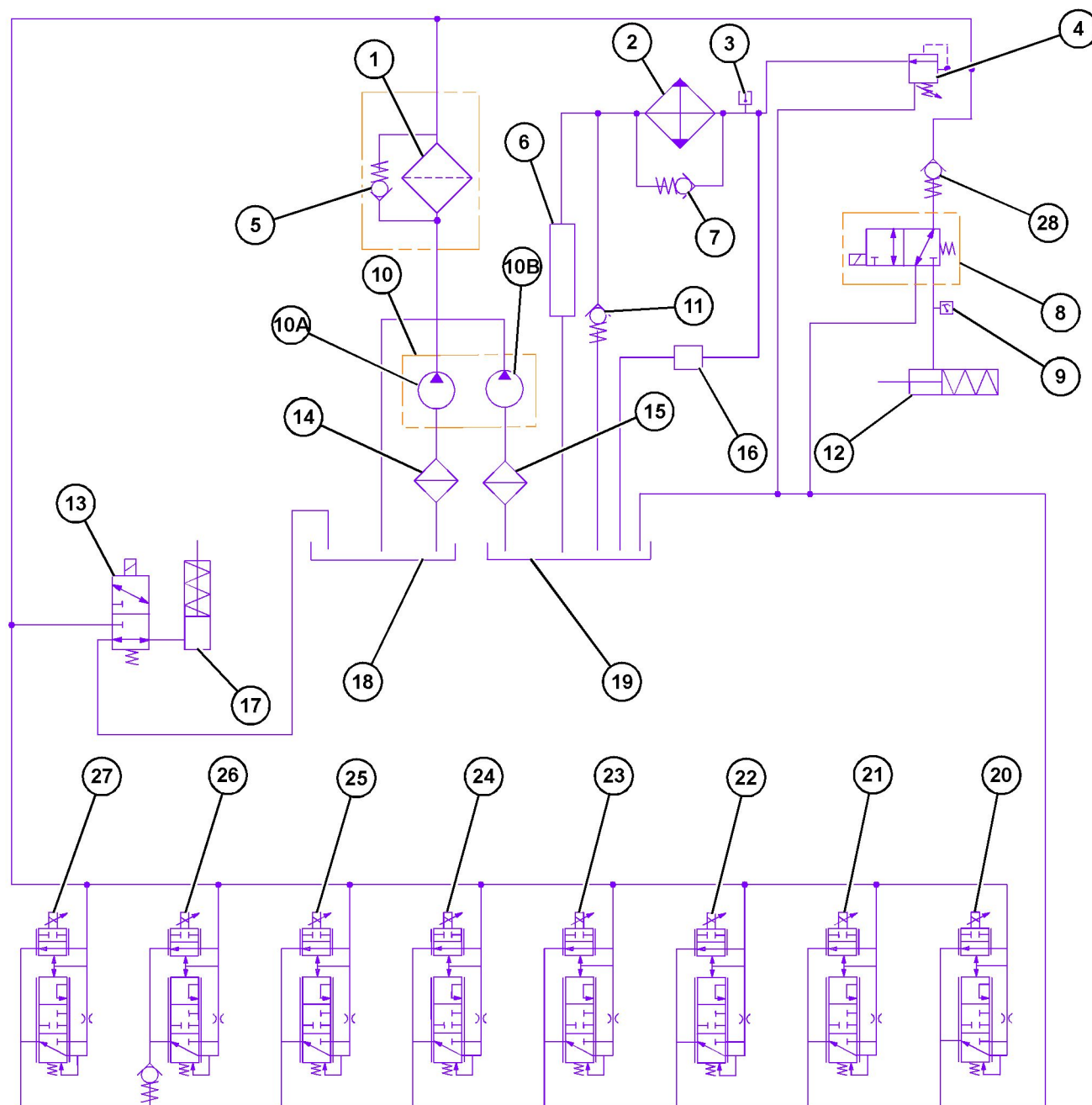


Illustration 33

g06231088

S/N: SLZ
Transmission Lubrication

(1) Transmission oil filter
 (2) Oil cooler
 (3) Temperature sensor
 (4) Transmission main relief valve
 (5) Oil filter bypass valve (transmission)
 (6) Transmission lubrication

(7) Oil cooler bypass valve
 (8) Parking brake solenoid
 (9) Pressure sensor for the parking brake
 (10) Oil pump housing
 (10A) Transmission charging section
 (10B) Transmission scavenge section

(11) Transmission lubrication relief valve	(18) Differential case	(25) Modulating valve for clutch 6
(12) Parking brake	(19) Transmission sump	(26) Modulating valve for clutch 7
(13) Differential lock valve	(20) Modulating valve for clutch 1	(27) Modulating valve for clutch 8
(14) Magnetic screen (differential)	(21) Modulating valve for clutch 2	(28) Park brake relief valve
(15) Magnetic filter (transmission)	(22) Modulating valve for clutch 3	(DD) Parking brake lubrication
(16) Engine flywheel gear case	(23) Modulating valve for clutch 4	
(17) Differential lock	(24) Modulating valve for clutch 5	

The oil that is used for the operation and the lubrication of the transmission is made available by gear pump (10). Pump (10) also provides oil for the lubrication of the differential and the lubrication of the engine flywheel. Pump (10) turns from power that is transferred to the transmission by the engine. The two main hydraulic reservoirs in the power train are differential case (18) and transmission sump (19).

Transmission charging section (10A) of gear pump (10) pulls oil from differential case (18) through magnetic screen (14). Pressure oil from transmission section (10A) of gear pump (10) is filtered by transmission filter (1) prior to being used to operate the following components:

- Eight modulating valves (Electronic Clutch Pressure Control)
- Differential lock valve (13)
- Transmission lubrication (6)
- Main relief valve (4)
- Parking brake (12)

Control of the transmission is achieved by electronically activated modulating valves that allow oil to fill the various clutches in the transmission. Differential lock valve (13) is used to control lockup clutch (17) in the differential. Differential lock valve (13) is on the outside housing of differential case. Pressure oil for the release of the parking brake is supplied by pump (10).

Reference: For more information on the parking brake, please refer to the Power Train Systems Operations, "Parking Brake".

Transmission scavenge section (10B) of pump (10) pulls oil from transmission sump (19) through magnetic screen (15) for the lubrication of the differential.

Transmission Lubrication

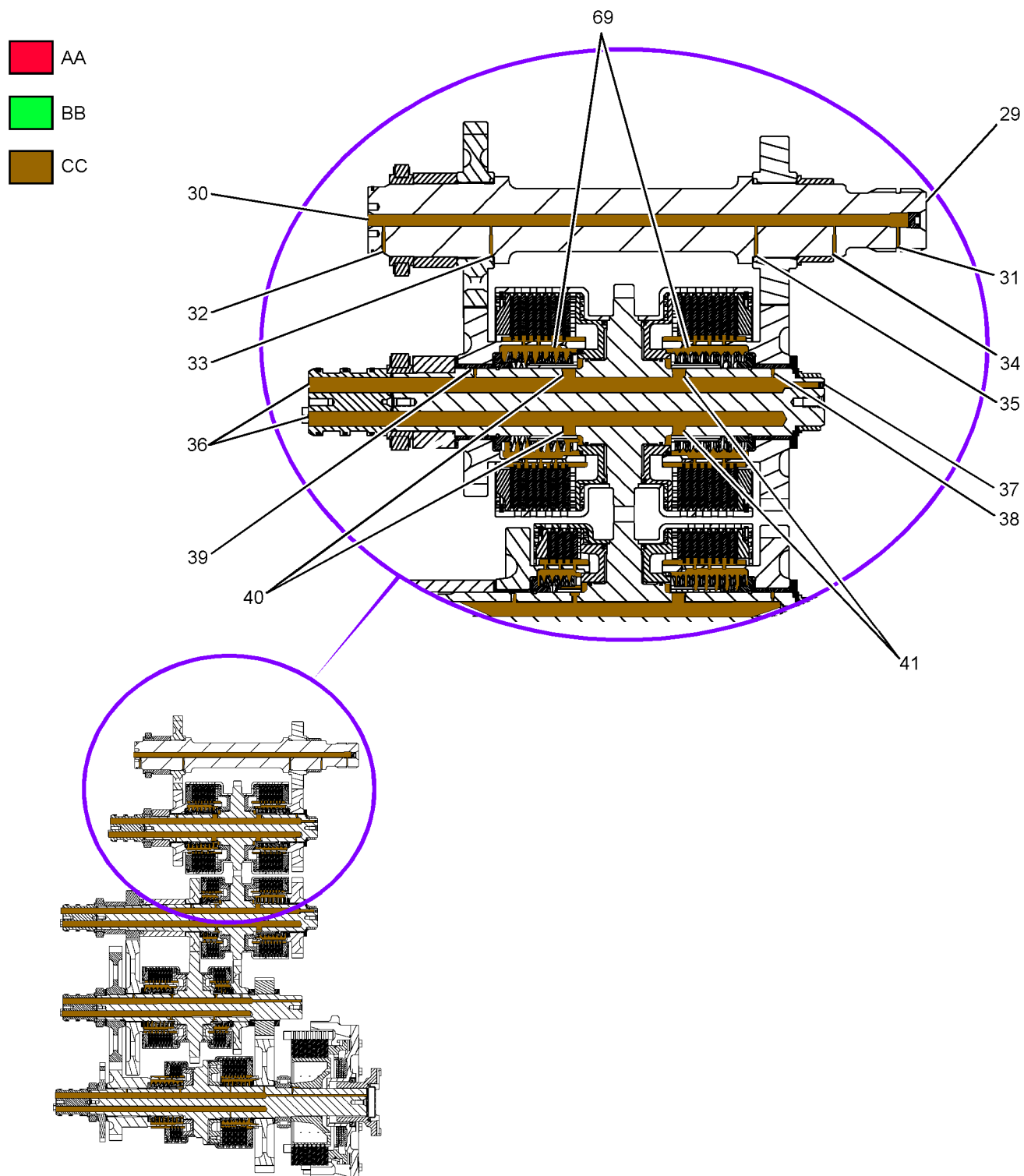


Illustration 34

g01457567

Lubrication of the input shaft and a clutch shaft

(29) Input shaft
(30) Passage for lubrication of the shaft
(31) Lubrication passage

(32) Lubrication passage
(33) Lubrication passage
(34) Lubrication passage

(35) Lubrication passage
(36) Passage for lubrication of the shaft
(37) Clutch shaft

(38) Lubrication passage
(39) Lubrication passage

(40) Lubrication passage
(41) Lubrication passage

(69) Slider
(CC) Lubrication oil

Input shaft (29) receives lubrication from oil cooler (2). The oil flows through the center of each shaft. There are five passages that are connected to the center passage of input shaft (29). Lubricating oil flows through passage (31) to lubricate the splines on input shaft (29). Lubricating oil flows through passage (33) and passage (35) to lubricate the gears that transfer power to the clutch shafts. Passage (32) provides lubricating oil to the inner bearing and passage (34) provides lubrication oil for the inner race.

Clutch shaft (37) receives lubrication from oil cooler (2). The oil flows through the center of each shaft. There are four passages that are connected to the center passage of the clutch shaft (37). Lubricating oil flows through passage (38) and passage (39) to lubricate the gears that transfer power from the input shaft. When a clutch is engaged, slider (69) shifts to allow lubrication oil (CC) to enter the clutch through passage (40) and passage (41). Passage (40) and passage (41) are used to send lubrication oil (CC) to the clutch plates for lubrication and cooling. When a clutch is not engaged, slider (69) blocks passage (40) and passage (41).

Additional lubrication is provided by splash lubrication and by leakage oil. The leakage oil will return to transmission sump (19).

Transmission Clutch Engagement

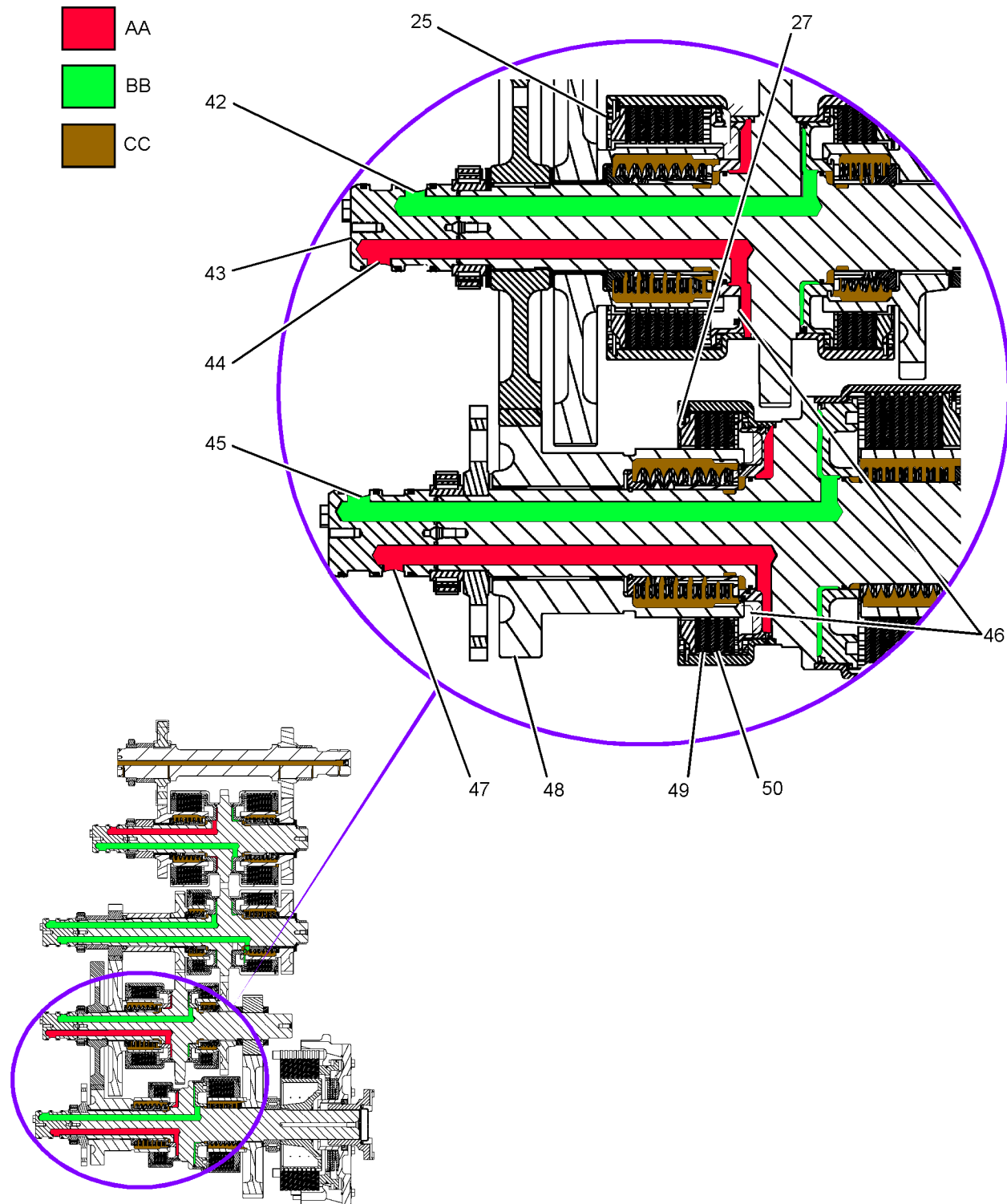


Illustration 35

g01457569

The transmission in FIFTH SPEED FORWARD with clutch 1, clutch 6, and clutch 8 engaged.

(25) Clutch 6
(27) Clutch 8
(42) Clutch oil passage

(43) Clutch shaft
(44) Clutch oil passage
(45) Clutch oil passage

(46) Clutch piston
(47) Clutch oil passage
(47) Clutch oil passage

(48) Gear
(49) Clutch friction discs

(50) Clutch plate
(AA) Pressure oil

(BB) Tank oil
(CC) Lubrication oil

Hydraulic fluid (AA) from the transmission charge pump section of the two-section gear pump travels through passage (44) and passage (47). The fluid exerts pressure upon clutch piston (46). Clutch piston (46) pushes clutch plates (50) and clutch friction discs (49) together. This creates a mechanical connection between clutch shaft (43) and gear (48).

The hydraulic oil in the clutches that are not engaged is sent back to the sump and the oil becomes tank oil (BB).

i02617313

Modulating Valve (Transmission Clutch)

SMCS Code: 3139-T3; 4800-JV

General Information

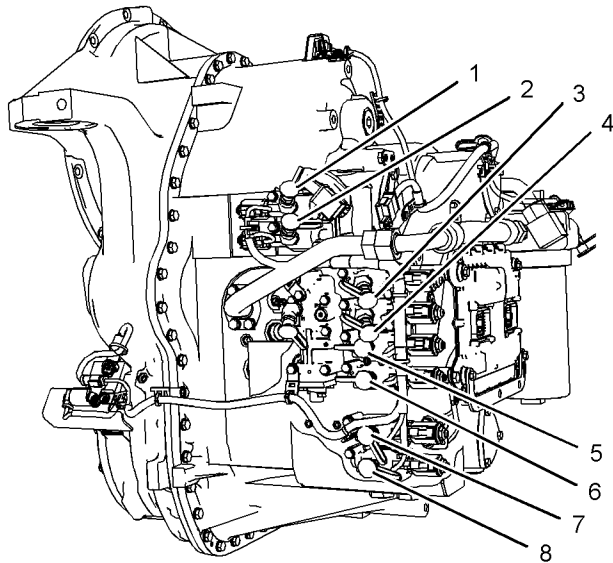


Illustration 36

g01310748

- (1) Modulating valve for clutch 1 (forward high)
- (2) Modulating valve for clutch 2 (forward low)
- (3) Modulating valve for clutch 3 (reverse)
- (4) Modulating valve for clutch 4 (second speed)
- (5) Modulating valve for clutch 5 (third speed)
- (6) Modulating valve for clutch 6 (first speed)
- (7) Modulating valve for clutch 7 (low range)
- (8) Modulating valve for clutch 8 (high range)

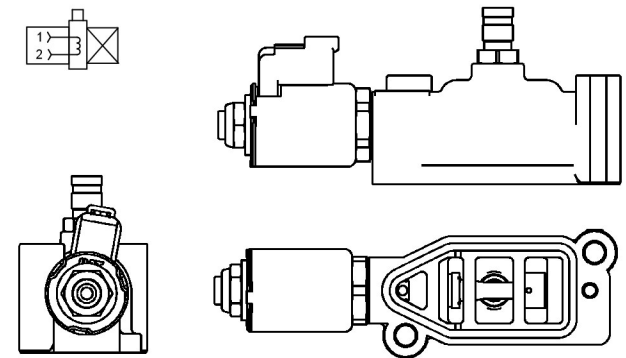


Illustration 37

g01113926

Modulating valve (transmission clutch)

The clutch modulating valves are mounted on the rear of the transmission on the left side of the machine. There is one modulating valve for each of the eight transmission clutches. Refer to Illustration 36 for the location of the following modulating valves:

- Modulating valve for clutch 1 (1) (forward high)
- Modulating valve for clutch 2 (2) (forward low)
- Modulating valve for clutch 3 (3) (reverse)
- Modulating valve for clutch 4 (4) (second speed)
- Modulating valve for clutch 5 (5) (third speed)
- Modulating valve for clutch 6 (6) (first speed)
- Modulating valve for clutch 7 (7) (low range)
- Modulating valve for clutch 8 (8) (high range)

Each of the modulating valves are controlled by a solenoid. The solenoids are controlled by the machine electronic control module (ECM). The modulating valves are used by the machine ECM to directly modulate the oil pressure that is sent to each individual clutch. When the operator selects a direction and a speed, the machine ECM sends a pulse width modulated signal (PWM) in order to vary the current to the solenoid on the modulating valve. The amount of current that is sent to the solenoid regulates the amount of oil pressure that is supplied to the selected clutch. When the machine ECM sends the maximum current to the solenoid, the oil pressure in the clutch is at the maximum. When no current is sent to the modulating valve, the clutch will receive no oil pressure from the modulating valve.

In order for the machine to move, one solenoid for a speed clutch, one solenoid for a direction clutch, and one solenoid for a range clutch must be energized.

Note: The solenoid coils are not designed to be operated at 24 DCV directly. The machine ECM sends a 24 Volt PWM signal at a duty cycle which provides an average voltage of about 12 Volts to the solenoid coils. **Do not energize the solenoid coils with 24 DCV (+battery).** The life of the solenoid coils will be drastically reduced if the solenoid coils are energized with 24 DCV (+battery). If the solenoid coils must be energized by a source that is different from the machine ECM, use 12 DCV to energize the solenoid coils.

No Signal

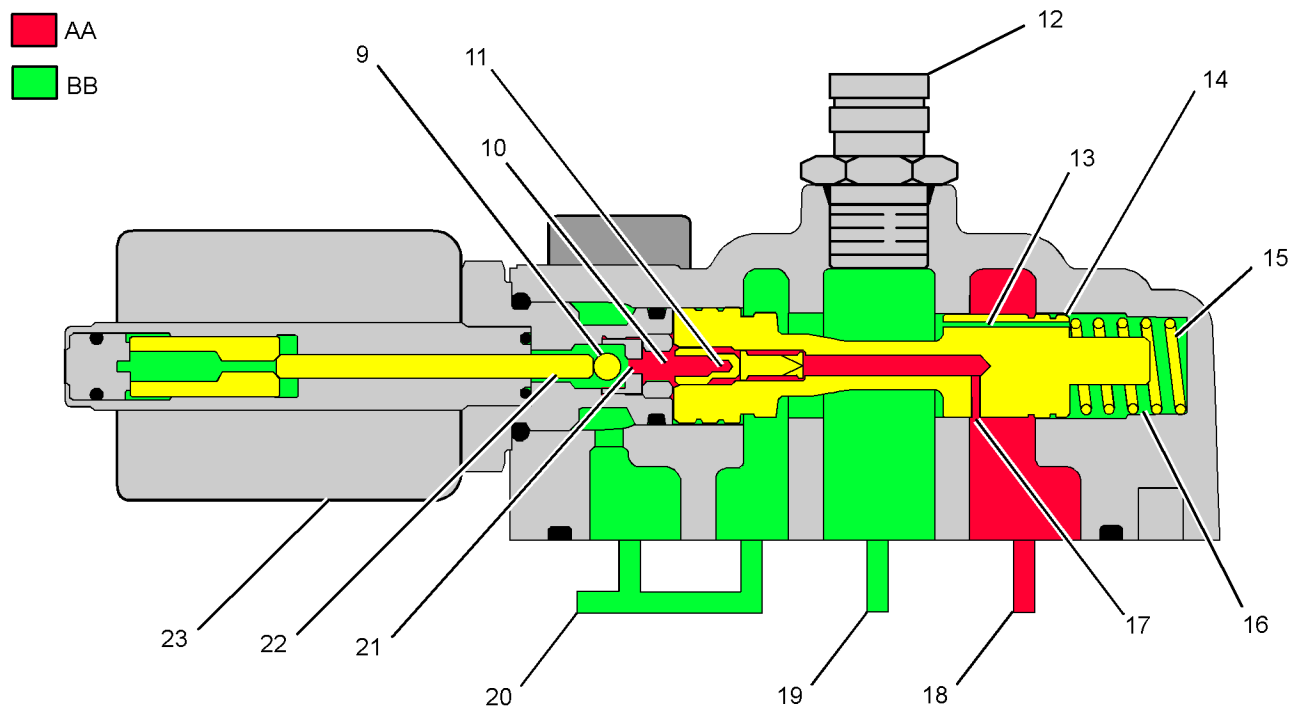


Illustration 38

g01338964

- | | | |
|------------------|----------------------------|--------------------|
| (9) Ball | (15) Spring | (21) Drain orifice |
| (10) Chamber | (16) Chamber | (22) Pin |
| (11) Orifice | (17) Passage | (23) Solenoid |
| (12) Test port | (18) Passage from the pump | (AA) Pump oil |
| (13) Passage | (19) Passage to the clutch | (BB) Return oil |
| (14) Valve spool | (20) Passage to the tank | |

When the machine ECM requires a clutch to be disengaged, there is no flow of electric current to solenoid (23).

Pump oil (AA) flows into the valve body from pump passage (18). Oil then flows into passage (17), through orifice (11) and into chamber (10). Since there is no signal that is sent to solenoid (23), pin (22) cannot hold ball (9) against orifice (21). The oil flows through orifice (21) past ball (9) to tank passage (20). The oil in tank passage (20) becomes return oil (BB).

Spring (15) holds valve spool (14) to the left. When valve spool (14) is shifted to the left, the oil in passage (19) flows to tank passage (20). When the oil in passage (19) is vented to the tank, the clutch cannot be engaged. The oil in pump passage (18) is blocked from entering passage (19).

Less Than Maximum Signal

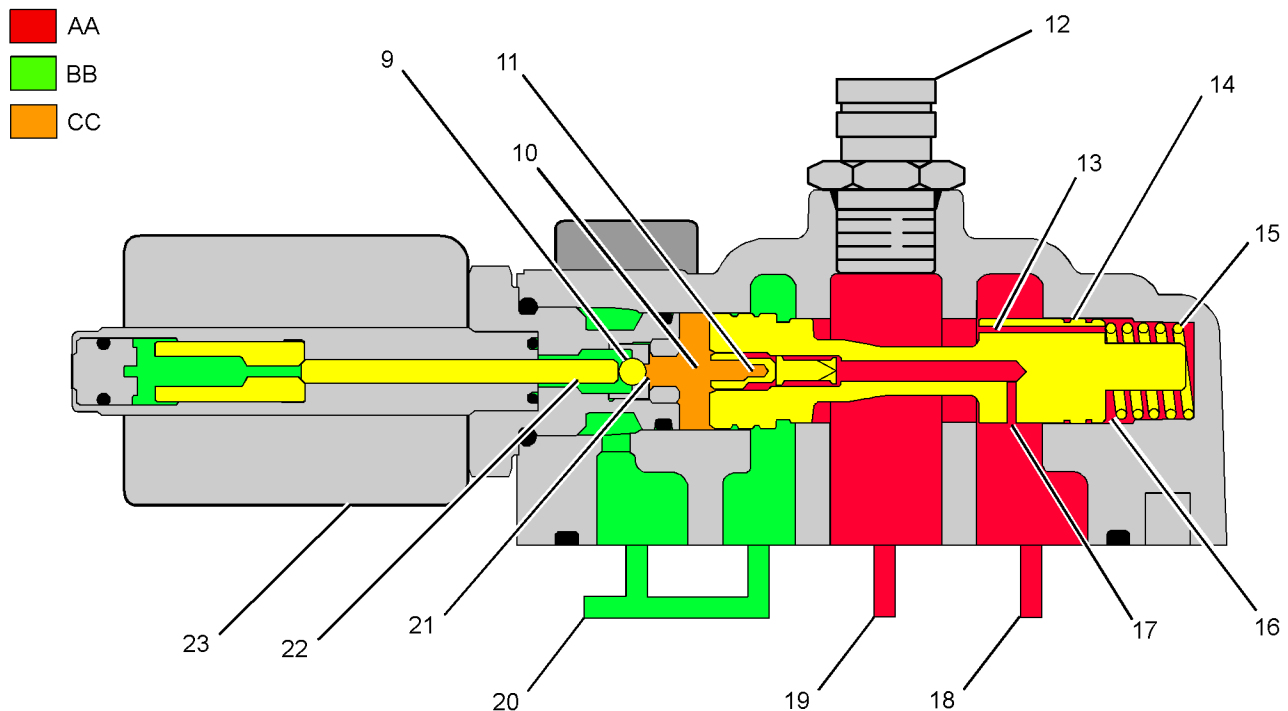


Illustration 39

g01338972

(9) Ball
(10) Chamber
(11) Orifice
(12) Test port
(13) Passage
(14) Valve spool

(15) Spring
(16) Chamber
(17) Passage
(18) Passage from the pump
(19) Passage to the clutch
(20) Passage to the tank

(21) Drain orifice
(22) Pin
(23) Solenoid
(AA) Pump oil
(BB) Return oil
(CC) Pilot oil

When the machine ECM requires a clutch to be engaged, a signal is sent to the solenoid (23). The strength of the signal is proportional to the desired clutch pressure.

When the signal is sent to the solenoid, pin (22) moves to the right and pin (22) forces ball (9) toward orifice (21). When ball (9) moves toward orifice (21), the flow of return oil (BB) into tank passage (20) is restricted. Pressure in chamber (10) increases and pump oil (AA) acts as pilot oil (CC). The pressure moves valve spool (14) to the right against the force of spring (15).

When valve spool (14) moves to the right, pump oil (AA) in pump passage (18) enters passage (19). The valve spool blocks the flow of oil from passage (19) to tank passage (20). The clutch pressure will increase due to the flow of pump oil (AA) into passage (19). The oil in passage (19) also flows through passage (13) into chamber (16).

Initially, the machine ECM sends a high signal to the solenoid in order to fill the clutch with oil quickly. Then, a reduced signal is sent to the solenoid in order to allow the clutch to engage smoothly.

Once the clutch engages, the machine ECM begins to increase the signal to solenoid (23) in order to further engage the clutch. When the signal to solenoid (23) increases, pin (22) moves to the right. Pin (22) pushes ball (9) toward orifice (21) and ball (9) restricts the flow of oil to tank passage (20). Oil pressure in chamber (10) will rise and valve spool (14) will move to the right. This causes the clutch pressure to increase.

Maximum Signal

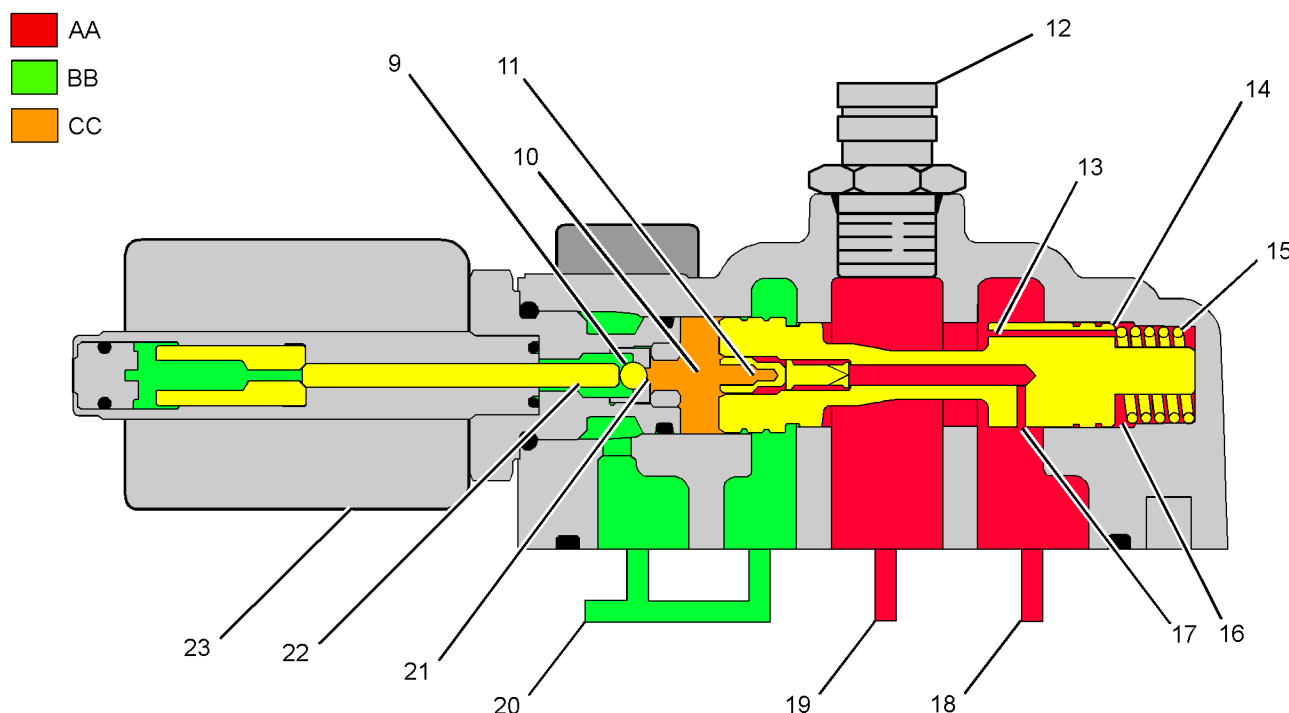


Illustration 40

g01338975

- | | | |
|------------------|----------------------------|--------------------|
| (9) Ball | (15) Spring | (21) Drain orifice |
| (10) Chamber | (16) Chamber | (22) Pin |
| (11) Orifice | (17) Passage | (23) Solenoid |
| (12) Test port | (18) Passage from the pump | (AA) Pump oil |
| (13) Passage | (19) Passage to the clutch | (BB) Return oil |
| (14) Valve spool | (20) Passage to the tank | (CC) Pilot oil |

When the clutch is fully engaged, the machine ECM sends the maximum specified signal to solenoid (23) in order to keep the clutch fully engaged.

The signal that is sent to solenoid (23) moves pin (22) and ball (9) to the right. This further restricts the flow of return oil (BB) from passage (19) to tank passage (20). The pressure in chamber (5) increases and pump oil (AA) becomes pilot oil (CC). The valve spool (14) moves further to the right. The pump oil (AA) from pump passage (18) flows to passage (19) and the clutch will fully engage.

Once the clutch is fully engaged, the pump oil (AA) in chamber (10) and the combined pressure of oil in chamber (16) and spring (15) will equalize. This will cause valve spool (14) to move slightly to the left to a balanced position.

In the balanced position, the flow of oil from pump passage (18) to passage (19) maintains the desired clutch pressure. In the balanced position, pump oil (AA) flows to the clutch in order to compensate for internal leakage in the clutch.

Note: The modulating valves control the engaging and the disengaging of the clutches. This valve is not a simple on/off valve. The machine ECM varies the strength of the signal that is sent to the solenoid. The signal that is sent to the solenoid is programmed into the machine ECM.

Note: Since the main relief valve will control the maximum amount of clutch pressure for all of the modulating valves, the main relief pressure and the clutch pressure will be equal when the clutch is fully engaged.

i02940422

Relief Valve (Transmission Hydraulic Control)

SMCS Code: 3167-PV; 3210

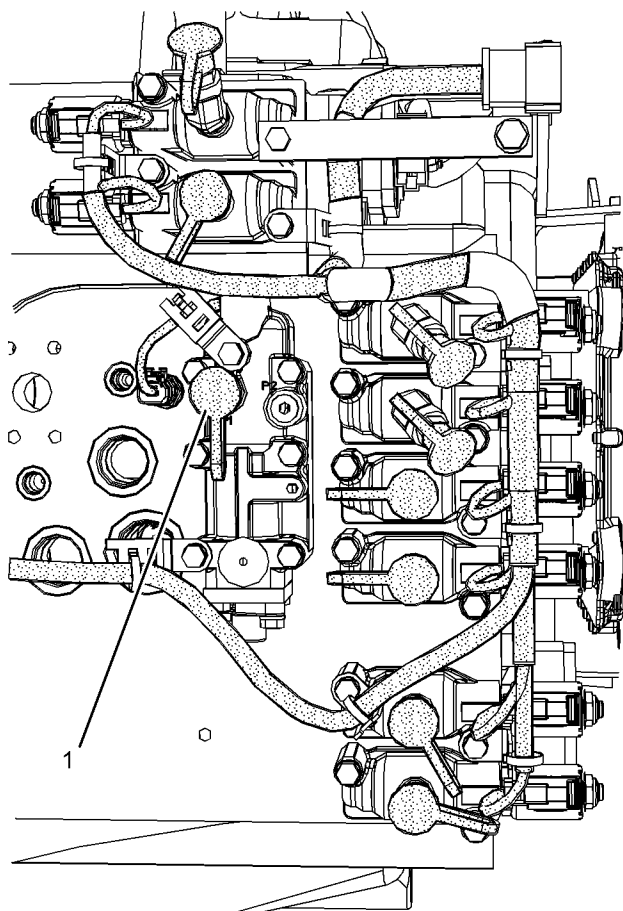


Illustration 41

g01457446

(1) Transmission main relief valve

Transmission main relief valve (1) is located on the transmission case next to the modulating valves.

The transmission main relief valve (1) controls the maximum pressure of the clutches that are engaged. The transmission main relief valve controls the flow of oil that enters the modulating valves and the transmission main relief valve directs the remaining oil to the transmission for lubrication. The controlled flow provides a constant fill time for the clutches through the entire engine speed range.

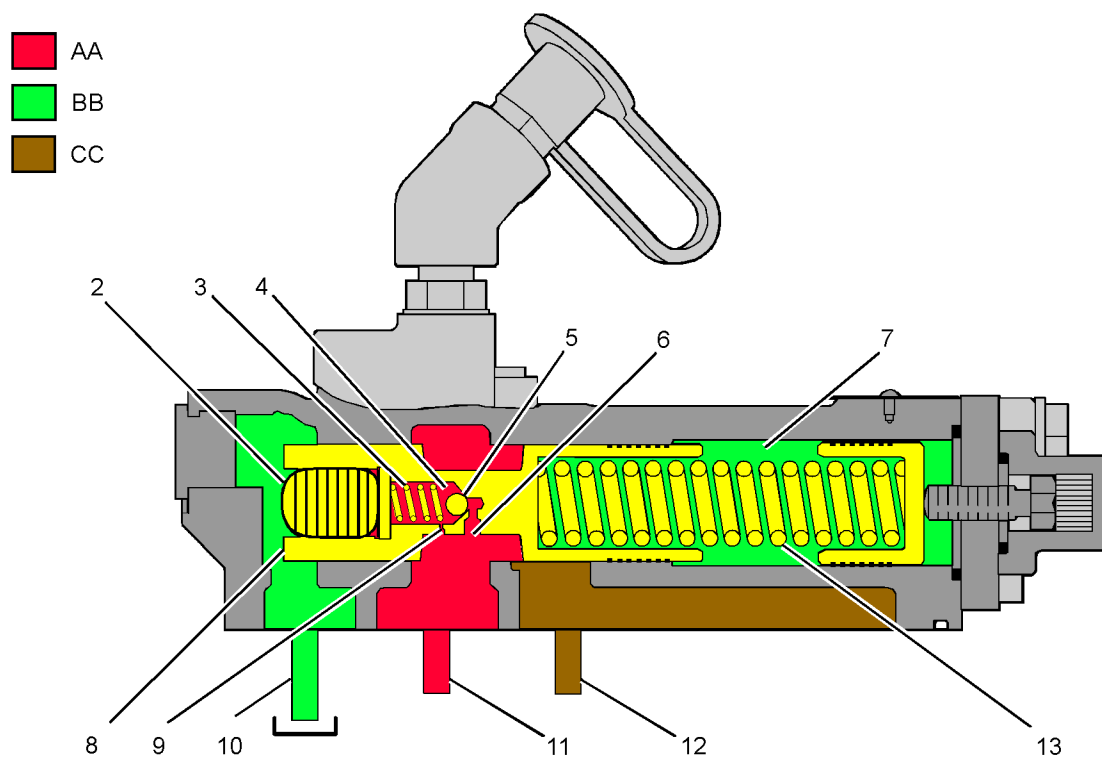


Illustration 42

g01457524

- (2) Slug
- (3) Spring
- (4) Chamber
- (5) Ball
- (6) Orifice

- (7) Chamber
- (8) Spool
- (9) Orifice
- (10) Port to tank
- (11) Pump port

- (12) Port to transmission lubrication
- (13) Spring
- (AA) Pump oil
- (BB) Tank oil
- (CC) Lubrication oil

Pump oil (AA) flows into pump port (11). Pump oil (AA) flows into orifice (6) and the pump oil unseats ball (5). When ball (5) unseats, spring (3) compresses against slug (2). The pump oil flows past ball (5) and into chamber (4). The pressure in chamber (4) moves spool (8) to the right against spring (13). When spool (8) moves to the right, pump oil (AA) in pump port (11) flows past the spool and into the port to transmission lubrication (12) as lubricating oil (CC). Oil in chamber (7) is vented to the port to tank (10) as return oil (BB).

The pressure in pump port (11) will vary slightly with the demand from the clutches. When the pressure changes, spool (8) will move in order to maintain the required engagement pressure to the clutches. Spool (8) will direct the unneeded flow to the port to transmission lubrication (12).

When the pressure in pump port (11) decreases, spring (13) will move spool (8) to the left. When the spool moves to the left, the flow of oil into the port to transmission lubrication (12) will be blocked. As the pressure drops further, spring (3) will push ball (5) to

the right. When ball (5) moves to the right, the flow of oil from pump port (11) into chamber (4) will be blocked. Oil in chamber (4) will drain back into pump port (11) through orifice (9) when ball (5) is moved to the right.

i02934569

Transmission Power Flow

SMCS Code: 3030; 3160

General Information

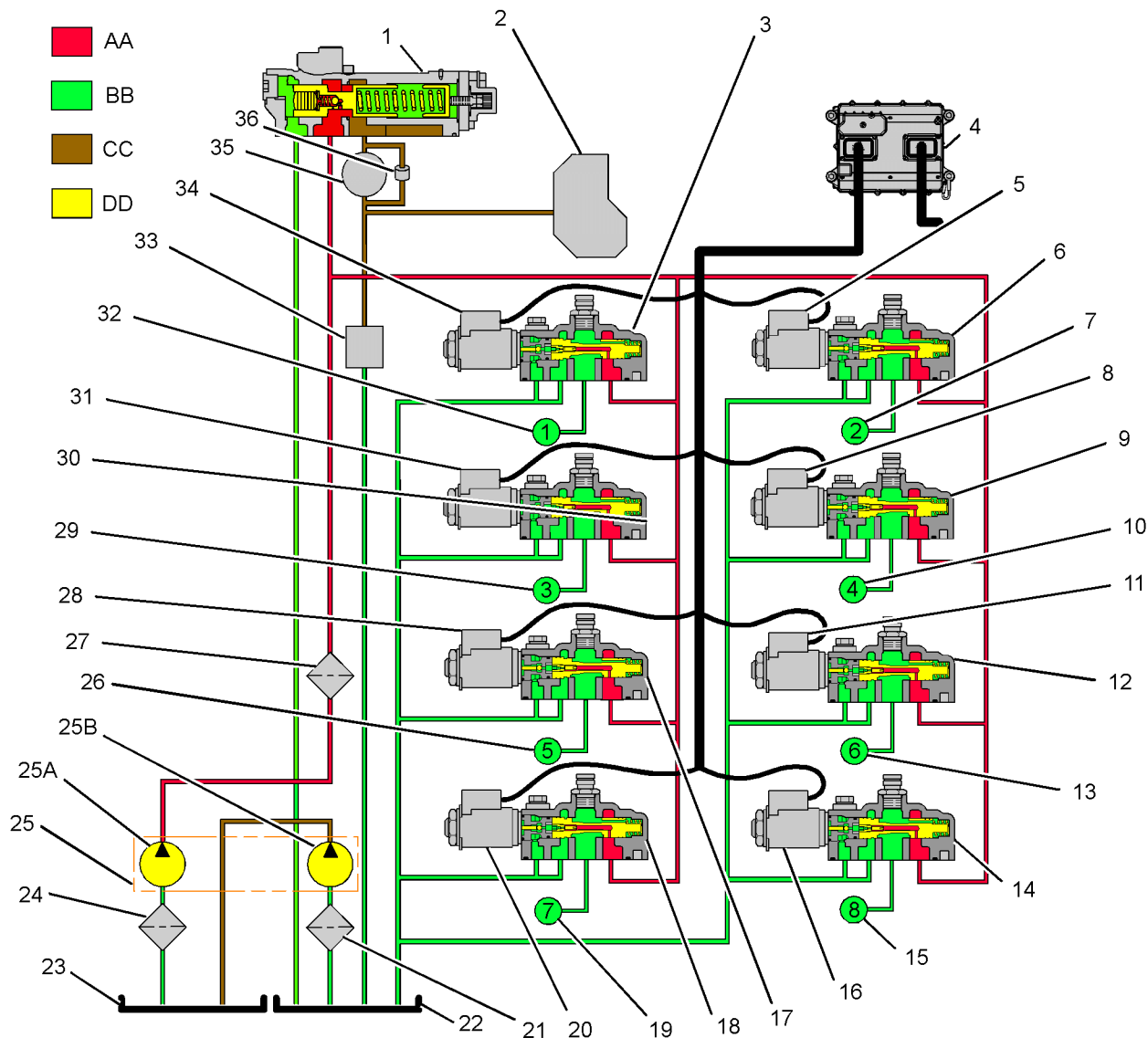


Illustration 43

g01455438

Transmission hydraulic control

The following components are part of the transmission hydraulic system:

- | | |
|--|--|
| (1) Transmission relief valve | (4) Transmission Electronic Control Module (ECM) |
| (2) Transmission (lubrication) | (5) Solenoid for clutch 2 (forward low) |
| (3) Modulating valve for clutch 1 (Forward high) | (6) Modulating valve for clutch 2 (forward low) |

(7) Clutch 2 (forward low)
 (8) Solenoid for clutch 4 (second speed)
 (9) Modulating valve for clutch 4 (second speed)
 (10) Clutch 4 (second speed)
 (11) Solenoid for clutch 6 (first speed)
 (12) Modulating valve for clutch 6 (first speed)
 (13) Clutch 6 (first speed)
 (14) Modulating valve for clutch 8 (high range)
 (15) Clutch 8 (high range)
 (16) Solenoid for clutch 8 (high range)

(17) Modulating valve for clutch 5 (third speed)
 (18) Modulating valve for clutch 7 (low range)
 (19) Clutch 7 (low range)
 (20) Solenoid for clutch 7 (low range)
 (21) Magnetic screen
 (22) Transmission sump
 (23) Differential case
 (24) Magnetic screen
 (25) Pump housing
 (25A) Transmission charging section
 (25B) Transmission scavenge section
 (26) Clutch 5 (third speed)

(27) Filter
 (28) Solenoid for clutch 5 (third speed)
 (29) Clutch 3 (reverse)
 (30) Modulating valve for clutch 3 (reverse)
 (31) Solenoid for clutch 3 (reverse)
 (32) Clutch 1 (forward high)
 (33) Transmission lubrication relief valve
 (34) Solenoid for clutch 1 (forward high)
 (35) Oil cooler
 (36) Cooler bypass valve
 (AA) Pressure oil
 (BB) Tank oil
 (CC) Lubrication oil
 (DD) Moving parts

When the engine is started, transmission scavenge section (25B) of pump (25) pulls oil from the transmission sump (22) through magnetic screen (21) in order to direct the oil to the differential as lubricating oil (CC).

When the engine is started, transmission charging section (25A) of pump (25) pulls oil from differential case (23) through magnetic screen (24).

Transmission charging section (25A) of pump (25) sends pressure oil (AA) through transmission oil filter (27). Pressure oil (AA) flows from the transmission oil filter (27) to the oil inlet in the transmission housing. The pressurized oil flows through an internal passage of transmission housing. The oil then flows to transmission relief valve (1). Transmission relief valve (1) controls the pressure of pump oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil through oil cooler (35) to the transmission (2) as lubrication oil (CC). After the oil cools, the oil flows through the lubrication system and to transmission sump (22). The pressurized oil flows out of transmission relief valve (1). The pressurized oil flows into the following modulating valves:

- Modulating valve for clutch 1 (3)
- Modulating valve for clutch 2 (6)
- Modulating valve for clutch 3 (30)
- Modulating valve for clutch 4 (9)
- Modulating valve for clutch 5 (17)
- Modulating valve for clutch 6 (12)
- Modulating valve for clutch 7 (18)
- Modulating valve for clutch 8 (14)

Transmission ECM (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM. Some of the inputs that are considered are machine speed, engine speed and operator inputs. A solenoid is located on each modulating valve. Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (5)

- Clutch solenoid (8)
- Clutch solenoid (11)
- Clutch solenoid (16)
- Clutch solenoid (20)
- Clutch solenoid (28)
- Clutch solenoid (31)
- Clutch solenoid (34)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve. There is a modulating valve for each clutch. The modulating valves regulate pressure oil (AA) that is sent to the following clutches:

- Clutch 2 (7)
- Clutch 4 (10)
- Clutch 6 (13)
- Clutch 8 (15)
- Clutch 7 (19)
- Clutch 5 (26)
- Clutch 3 (29)
- Clutch 1 (32)

The modulating valve directs pressure oil (AA) to the clutch in order to engage the clutch. The solenoid controls the modulating valve spool. Transmission ECM (4) controls the solenoids. The oil in the clutches that are not engaged is sent back to transmission sump (22) and the oil becomes return oil (BB).

Table 1 gives the combination of the clutches that are engaged for each forward speed, neutral, and each reverse speed.

Systems Operation Section

Table 1

	Clutch 1 (forward high)	Clutch 2 (forward low)	Clutch 3 (reverse)	Clutch 4 (second speed)	Clutch 5 (third speed)	Clutch 6 (first speed)	Clutch 7 (low range)	Clutch 8 (high range)
First Speed Forward	X					X	X	
Second Speed Forward		X		X			X	
Third Speed Forward		X			X		X	
Fourth Speed Forward	X				X		X	
Fifth Speed Forward	X					X		X
Sixth Speed Forward		X		X				X
Seventh Speed Forward	X			X				X
Eighth Speed Forward	X				X			X
Neutral					X			X
First Speed Reverse			X			X	X	
Second Speed Reverse			X	X			X	
Third Speed Reverse			X		X		X	
Fourth Speed Reverse			X			X		X
Fifth Speed Reverse			X	X				X
Sixth Speed Reverse			X		X			X

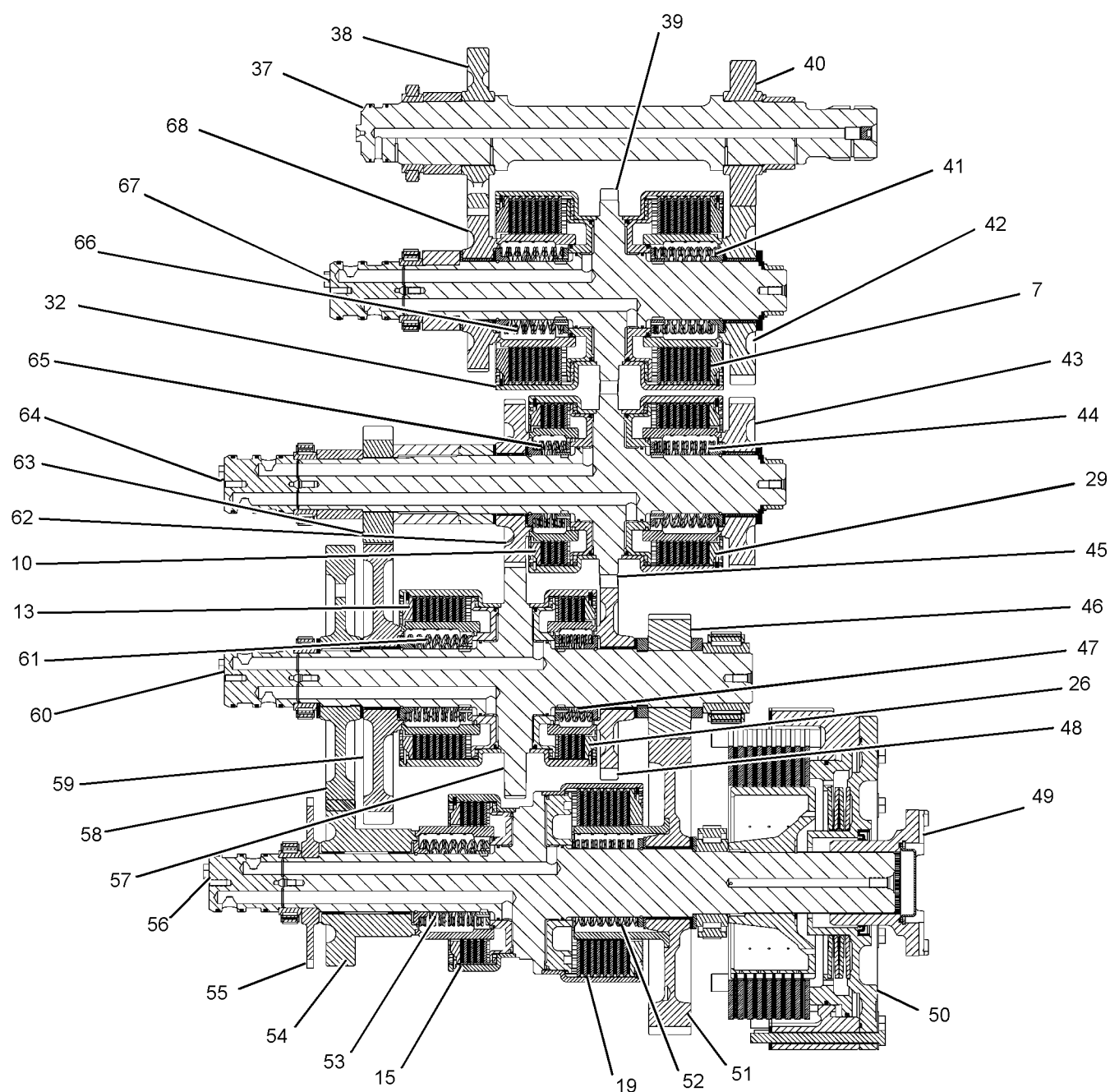


Illustration 44

g01455592

(7) Clutch 2 (forward low)
 (10) Clutch 4 (second speed)
 (13) Clutch 6 (first speed)
 (15) Clutch 8 (high range)
 (19) Clutch 7 (low range)
 (26) Clutch 5 (third speed)
 (29) Clutch 3 (reverse)
 (32) Clutch 1 (forward high)
 (37) Input shaft assembly
 (38) Gear
 (39) Gear
 (40) Gear
 (41) Wave spring
 (42) Gear

(43) Gear
 (44) Wave spring
 (45) Gear
 (46) Gear
 (47) Wave spring
 (48) Gear
 (49) Yoke
 (50) Parking brake assembly
 (51) Gear
 (52) Wave spring
 (53) Wave spring
 (54) Gear
 (55) Rotor
 (56) Shaft assembly

(57) Gear
 (58) Gear
 (59) Gear
 (60) Shaft assembly
 (61) Wave spring
 (62) Gear
 (63) Gear
 (64) Shaft assembly
 (65) Wave spring
 (66) Wave spring
 (67) Shaft assembly
 (68) Gear

The countershaft transmission has eight forward speeds and six reverse speeds that are controlled by electronic clutch pressure control. The transmission has eight clutches that are engaged hydraulically. The clutches are disengaged by the following:

- Wave Spring (41)
- Wave Spring (44)
- Wave Spring (47)
- Wave Spring (52)
- Wave Spring (53)
- Wave Spring (61)
- Wave Spring (65)
- Wave Spring (66)

When a clutch is not engaged, the force of the wave spring retracts the piston to the disengaged position.

The transmission has five shafts: Input shaft assembly (37), and four clutch shaft assemblies. Input shaft assembly (37) is driven by the engine. Shaft assembly (67) contains clutch 1 (32) (forward high) and clutch 2 (7) (forward low). Shaft assembly (64) contains clutch 3 (29) (reverse) and clutch 4 (10) (second speed). Shaft assembly (60) contains clutch 5 (26) (third speed) and clutch 6 (13) (first speed). Shaft assembly (56) contains clutch 7 (19) (low range) and clutch 8 (15) (high range).

Parking brake assembly (50) is mounted to the transmission case.

Reference: Refer to the Power Train Systems Operation, "Parking Brake" for information about the operation of the parking brake(50).

Input shaft assembly (37) has one internal passage for lubrication and cooling of the bearings and gears. Shaft assembly (67), shaft assembly (64), shaft assembly (60) and shaft assembly (56) have four internal passages for hydraulic oil. Two passages supply the oil for the lubrication and cooling of the clutches, bearings and gears. The other two passages supply pressure oil for the engagement of the clutches on each shaft.

In order to transfer power through the transmission, a speed clutch, a direction clutch, and a range clutch must be engaged.

During cold weather and spikes in the oil pressure in the lubrication circuit, transmission lubrication relief valve (33) limits the lubrication oil pressure in order to protect the bearings and seals in the transmission.

First Speed Forward

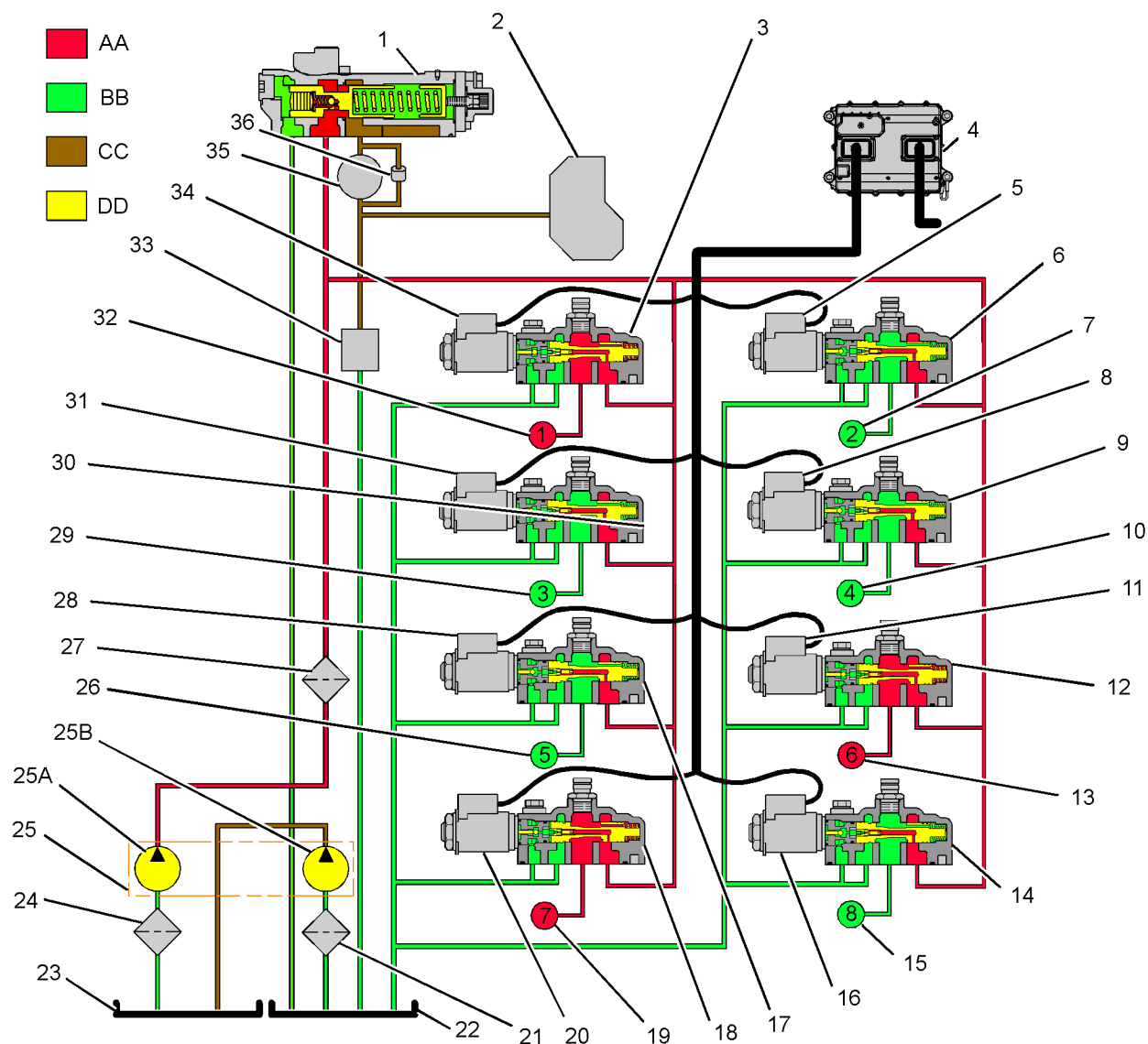


Illustration 45

g01455786

Transmission in FIRST SPEED FORWARD

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (34)
- Clutch solenoid (11)
- Clutch solenoid (20)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 1 (3)
- Modulating valve for clutch 6 (12)
- Modulating valve for clutch 7 (18)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in FIRST SPEED FORWARD, the solenoid on modulating valve (3) for clutch 1 (32) (forward high), the solenoid on modulating valve (12) for clutch 6 (13) (first speed), and the solenoid on modulating valve (18) for clutch 7 (19) (low range) are energized.

When solenoid (34) on modulating valve (3) is energized, valve (3) directs pump oil (AA) to clutch 1 (32) in order to engage the clutch.

When solenoid (11) on modulating valve (12) is energized, valve (12) directs pump oil (AA) to clutch 6 (13) in order to engage the clutch.

When solenoid (20) on modulating valve (18) is energized, valve (18) directs pump oil (AA) to clutch 7 (19) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

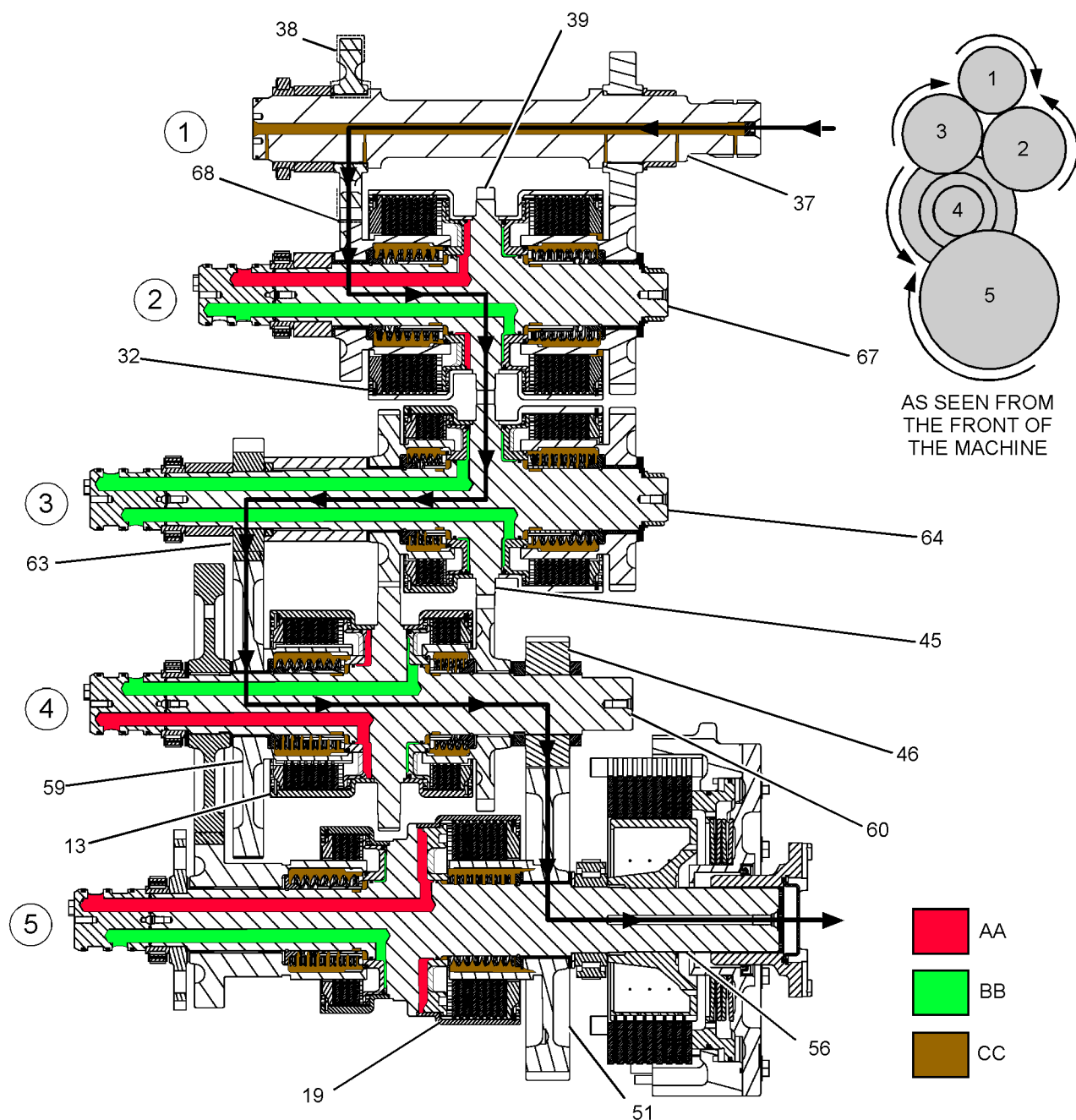


Illustration 46

g01455826

Transmission in FIRST SPEED FORWARD

When the transmission is in FIRST SPEED FORWARD, clutch 1 (32), clutch 6 (13), and clutch 7 (19) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (38) is splined to input shaft assembly (37). When clutch 1 (32) is engaged, torque is transferred from input shaft assembly (37) through gear (38) and gear (68) in order to turn shaft assembly (67).

Gear (39) is part of shaft assembly (67) which causes gear (39) to turn. Torque is transferred from shaft assembly (67) through gear (39) and gear (45) to shaft assembly (64).

When clutch 6 (13) is engaged, torque is transferred from shaft assembly (64) through gear (63) and gear (59) in order to turn shaft assembly (60).

When clutch 7 (19) is engaged, torque is transferred from shaft assembly (60) through gear (46) and gear (51) in order to turn shaft assembly (56).

Second Speed Forward

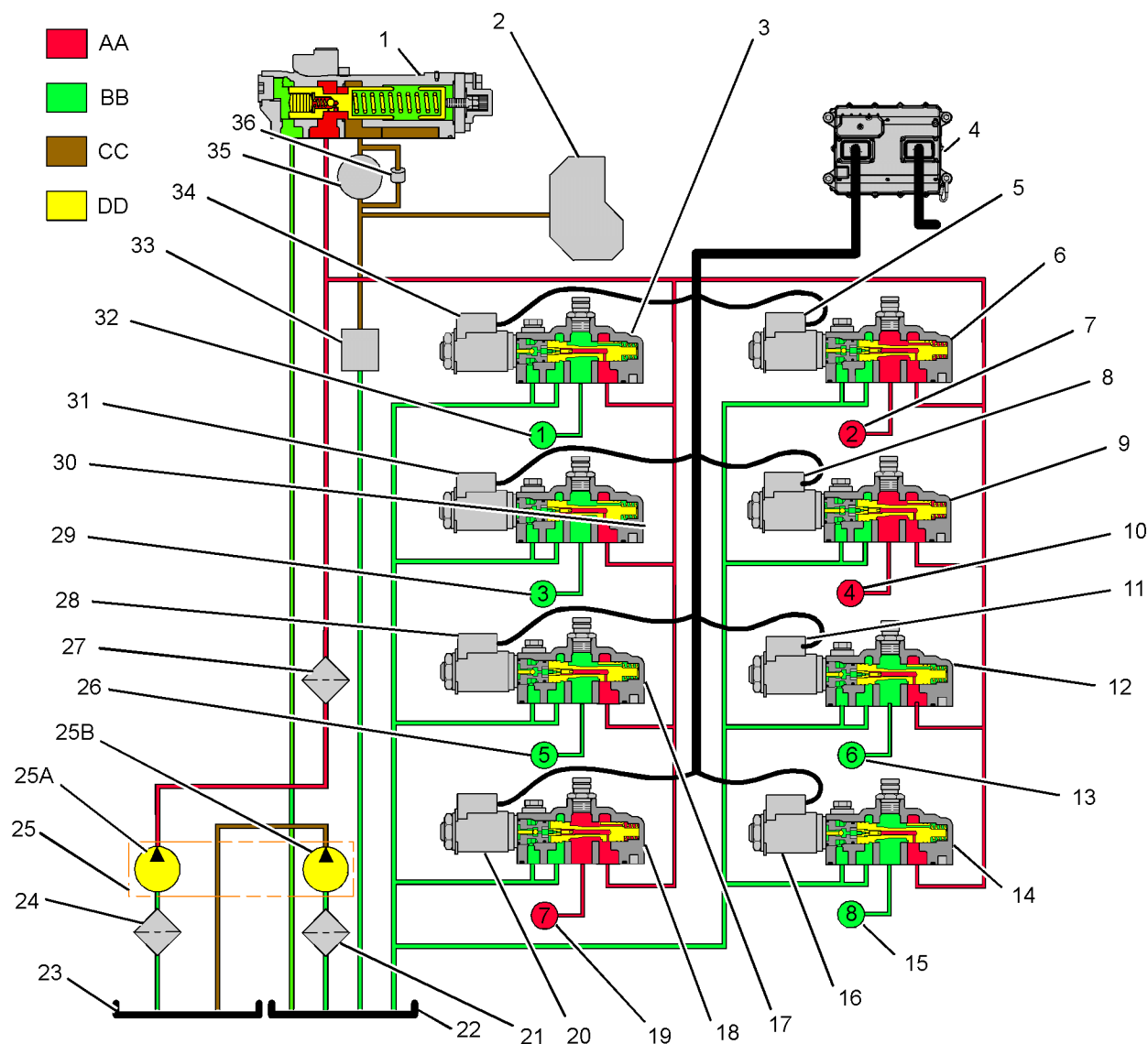


Illustration 47

g01455888

Transmission in SECOND SPEED FORWARD

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (5)
- Clutch solenoid (8)
- Clutch solenoid (20)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 2 (6)
- Modulating valve for clutch 4 (9)
- Modulating valve for clutch 7 (18)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in SECOND SPEED FORWARD, the solenoid on modulating valve (6) for clutch 2 (7) (forward low), the solenoid on modulating valve (9) for clutch 4 (10) (second speed), and the solenoid on modulating valve (18) for clutch 7 (19) (low range) are energized.

When solenoid (5) on modulating valve (6) is energized, valve (6) directs pump oil (AA) to clutch 2 (7) in order to engage the clutch.

When solenoid (8) on modulating valve (9) is energized, valve (9) directs pump oil (AA) to clutch 4 (10) in order to engage the clutch.

When solenoid (20) on modulating valve (18) is energized, valve (18) directs pump oil (AA) to clutch 7 (19) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil.

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

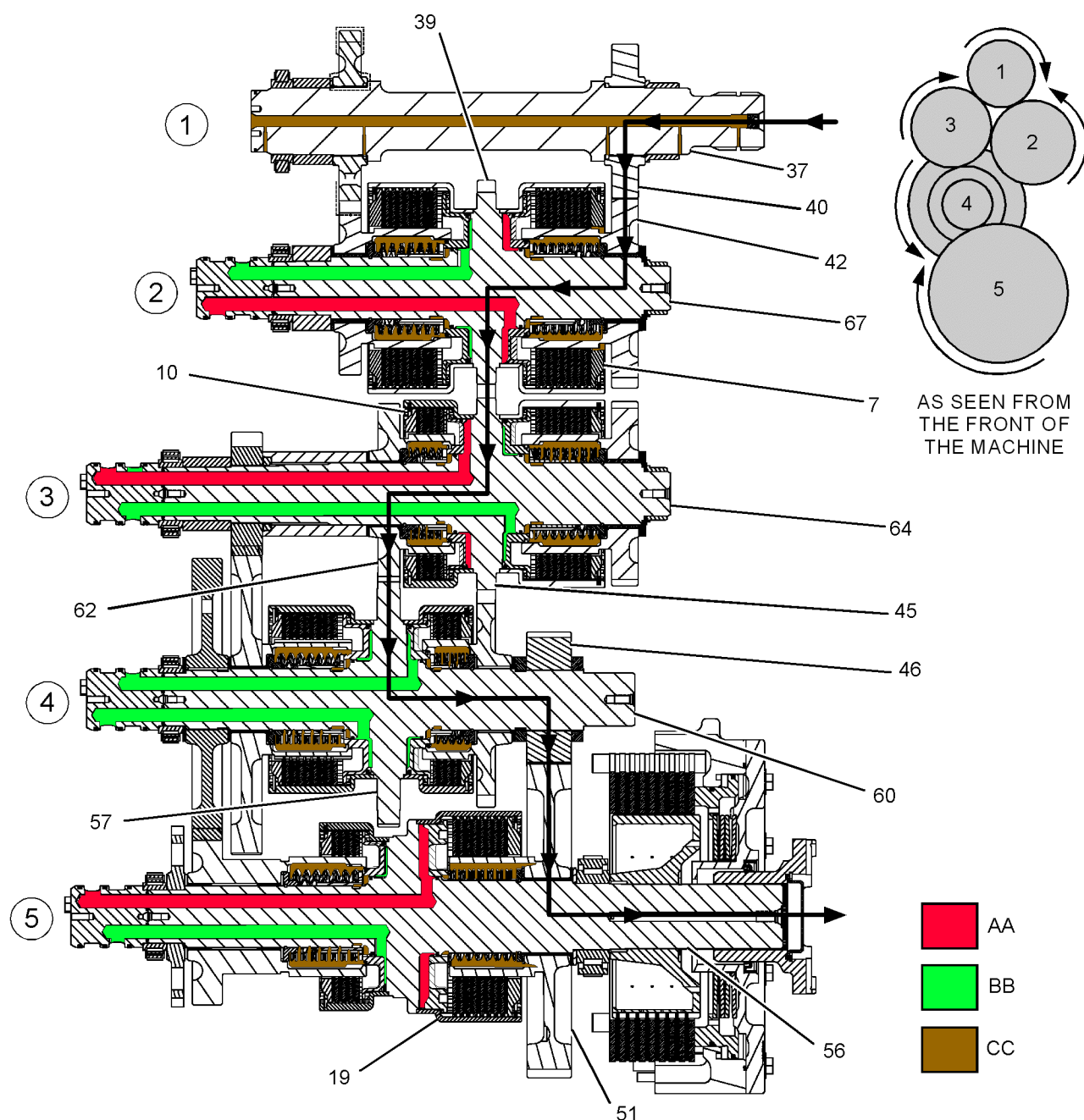


Illustration 48

g01455919

Transmission in SECOND SPEED FORWARD

When the transmission is in **SECOND SPEED FORWARD**, clutch 2 (7), clutch 4 (10), and clutch 7 (19) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (40) is splined to input shaft assembly (37). When clutch 2 (7) is engaged, torque is transferred from input shaft assembly (37) through gear (40) and gear (42) in order to turn shaft assembly (67).

Gear (39) is part of shaft assembly (67) which causes gear (39) to turn. Torque is transferred from shaft assembly (67) through gear (39) and gear (45) to shaft assembly (64).

When clutch 4 (10) is engaged, torque is transferred from shaft assembly (64) through gear (62) and gear (57) in order to turn shaft assembly (60).

When clutch 7 (19) is engaged, torque is transferred from shaft assembly (60) through gear (46) and gear (51) in order to turn shaft assembly (56).

Third Speed Forward

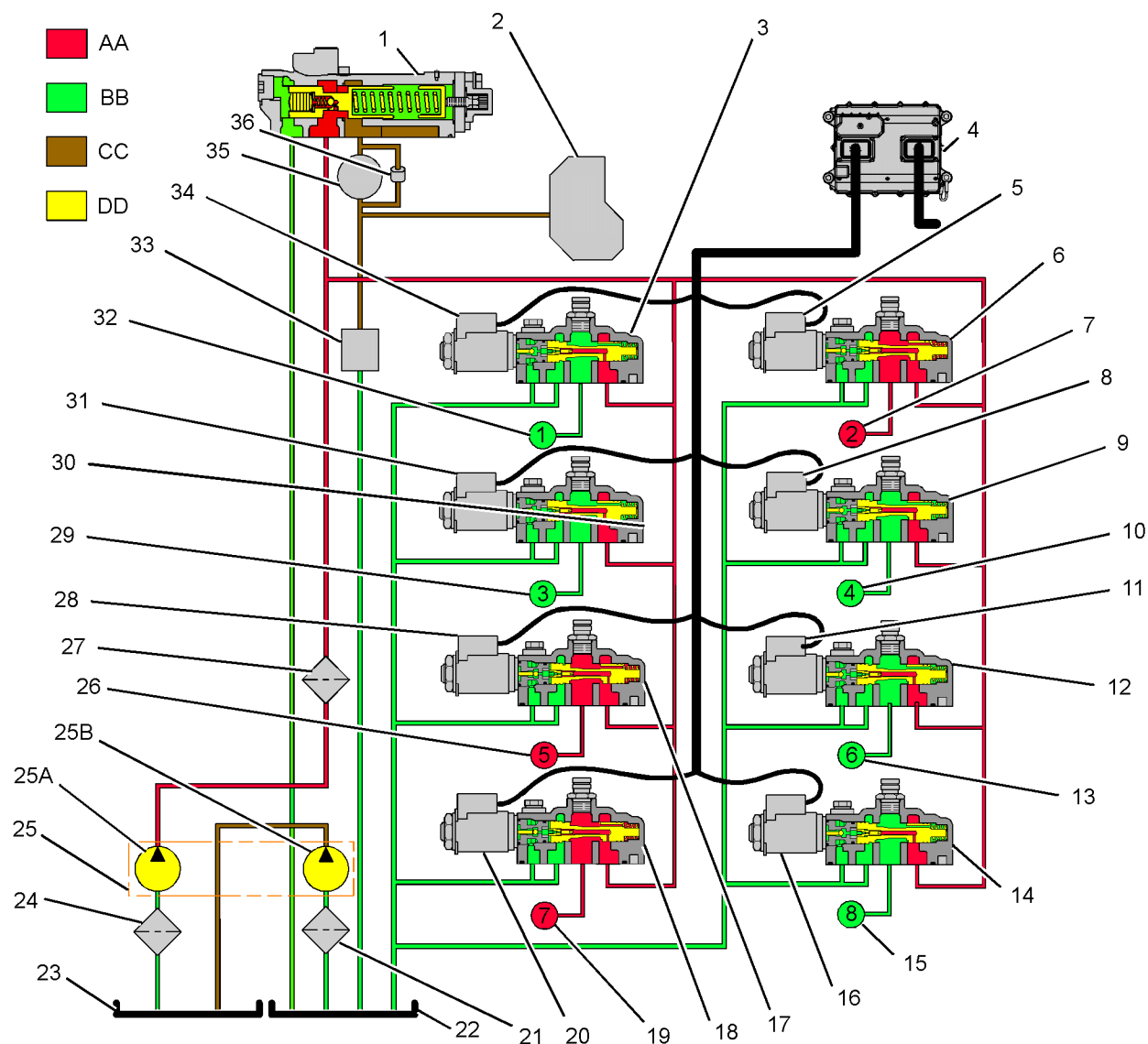


Illustration 49

g01455959

Transmission in THIRD SPEED FORWARD

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (5)
- Clutch solenoid (28)
- Clutch solenoid (20)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 2 (6)
- Modulating valve for clutch 5 (17)
- Modulating valve for clutch 7 (18)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in THIRD SPEED FORWARD, the solenoid on modulating valve (6) for clutch 2 (7) (forward low), the solenoid on modulating valve (17) for clutch 5 (26) (third speed), and the solenoid on modulating valve (18) for clutch 7 (19) (low range) are energized.

When solenoid (5) on modulating valve (6) is energized, valve (6) directs pump oil (AA) to clutch 2 (7) in order to engage the clutch.

When solenoid (28) on modulating valve (17) is energized, valve (17) directs pump oil (AA) to clutch 5 (26) in order to engage the clutch.

When solenoid (20) on modulating valve (18) is energized, valve (18) directs pump oil (AA) to clutch 7 (19) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

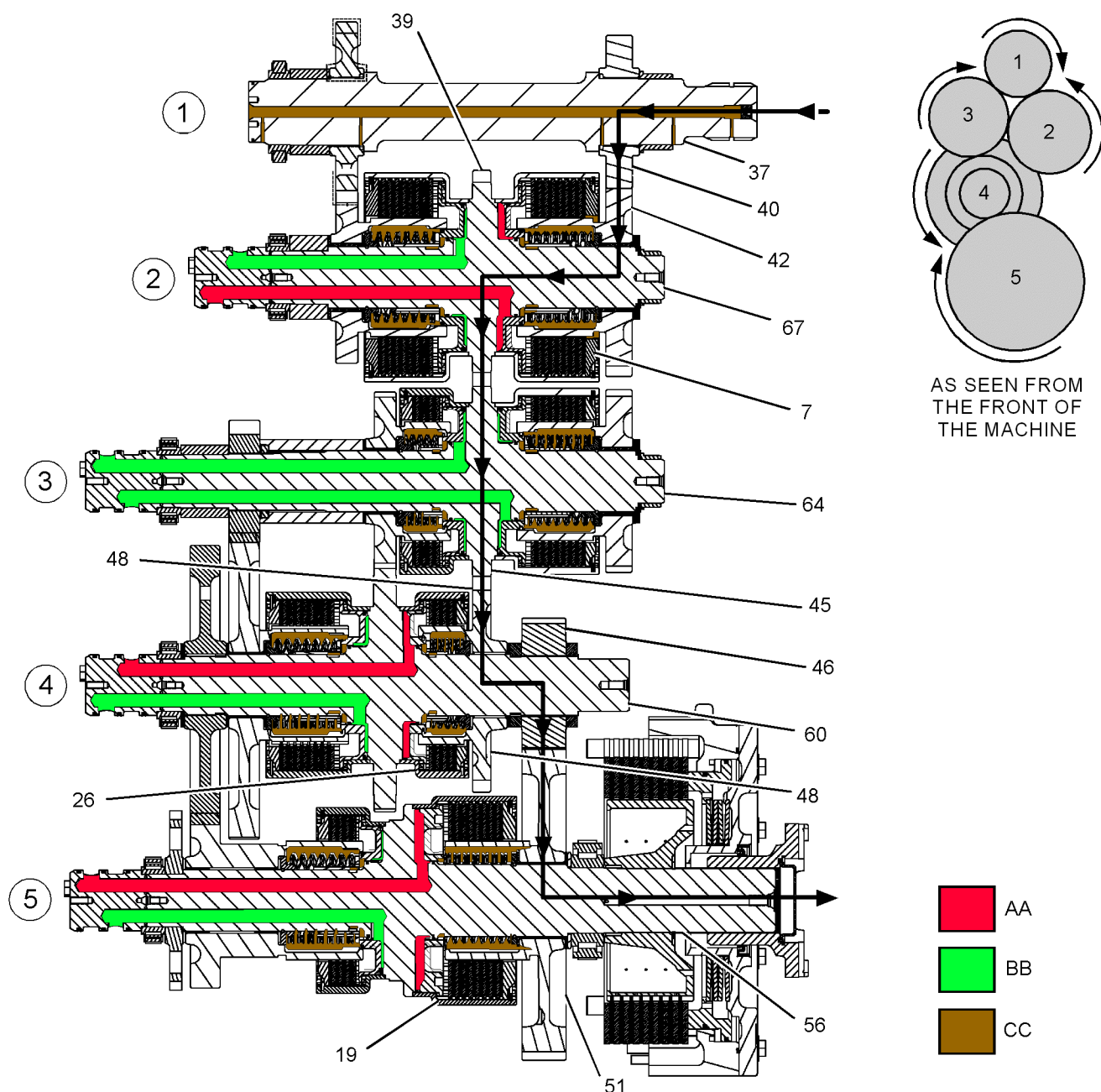


Illustration 50

g01455967

Transmission in THIRD SPEED FORWARD

When the transmission is in **THIRD SPEED FORWARD**, clutch 2 (7), clutch 5 (26), and clutch 7 (19) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (40) is splined to input shaft assembly (37). When clutch 2 (7) is engaged, torque is transferred from input shaft assembly (37) through gear (40) and gear (42) in order to turn shaft assembly (67).

Gear (39) is part of shaft assembly (67) which causes gear (39) to turn. Torque is transferred from shaft assembly (67) through gear (39) and gear (45) to shaft assembly (64).

When clutch 5 (26) is engaged, torque is transferred from shaft assembly (64) through gear (45) and gear (48) in order to turn shaft assembly (60).

When clutch 7 (19) is engaged, torque is transferred from shaft assembly (60) through gear (46) and gear (51) in order to turn shaft assembly (56).

Fourth Speed Forward

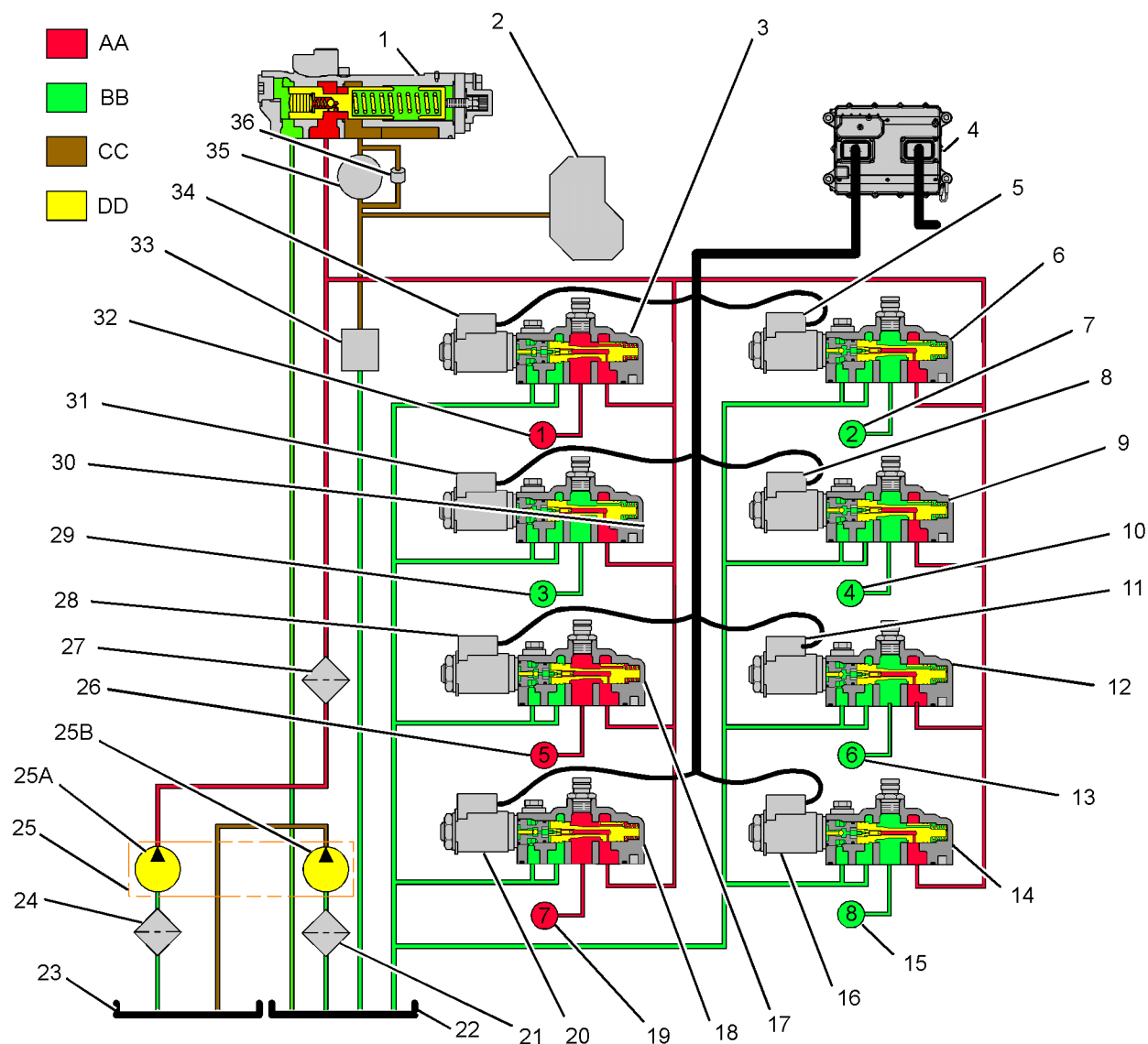


Illustration 51

g01456004

Transmission in FOURTH SPEED FORWARD

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (34)
- Clutch solenoid (28)
- Clutch solenoid (20)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 1 (3)
- Modulating valve for clutch 5 (17)
- Modulating valve for clutch 7 (18)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in FOURTH SPEED FORWARD, the solenoid on modulating valve (3) for clutch 1 (32) (forward high), the solenoid on modulating valve (17) for clutch 5 (26) (third speed), and the solenoid on modulating valve (18) for clutch 7 (19) (low range) are energized.

When solenoid (34) on modulating valve (3) is energized, valve (3) directs pump oil (AA) to clutch 1 (32) in order to engage the clutch.

When solenoid (28) on modulating valve (17) is energized, valve (17) directs pump oil (AA) to clutch 5 (26) in order to engage the clutch.

When solenoid (20) on modulating valve (18) is energized, valve (18) directs pump oil (AA) to clutch 7 (19) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

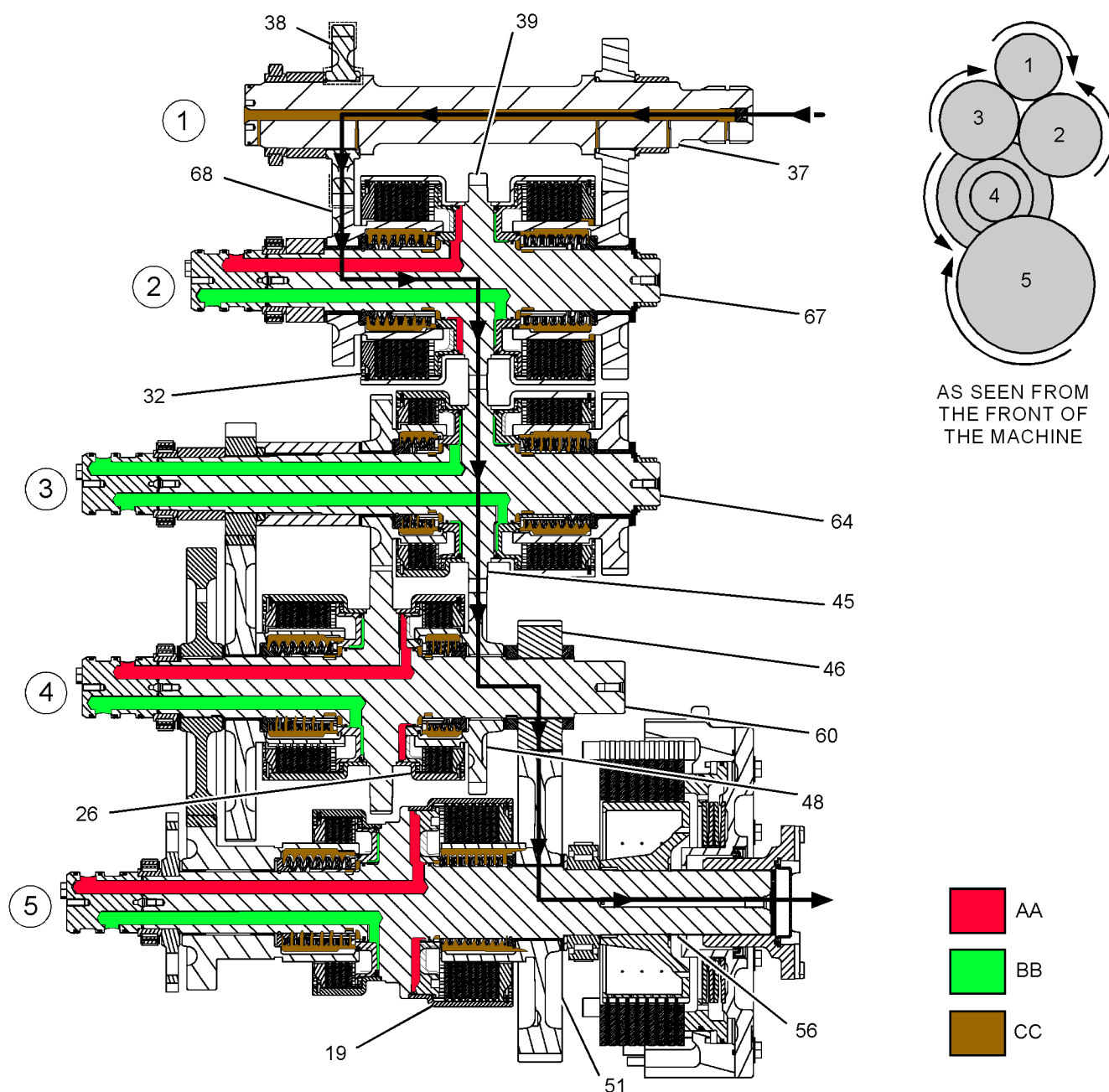


Illustration 52

g01456007

Transmission in FOURTH SPEED FORWARD

When the transmission is in **FOURTH SPEED FORWARD**, clutch 1 (32), clutch 5 (26), and clutch 7 (19) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (38) is splined to input shaft assembly (37). When clutch 1 (32) is engaged, torque is transferred from input shaft assembly (37) through gear (38) and gear (68) in order to turn shaft assembly (67).

Gear (39) is part of shaft assembly (67) which causes gear (39) to turn. Torque is transferred from shaft assembly (67) through gear (39) and gear (45) to shaft assembly (64).

When clutch 5 (26) is engaged, torque is transferred from shaft assembly (64) through gear (45) and gear (48) in order to turn shaft assembly (60).

When clutch 7 (19) is engaged, torque is transferred from shaft assembly (60) through gear (46) and gear (51) in order to turn shaft assembly (56).

Fifth Speed Forward

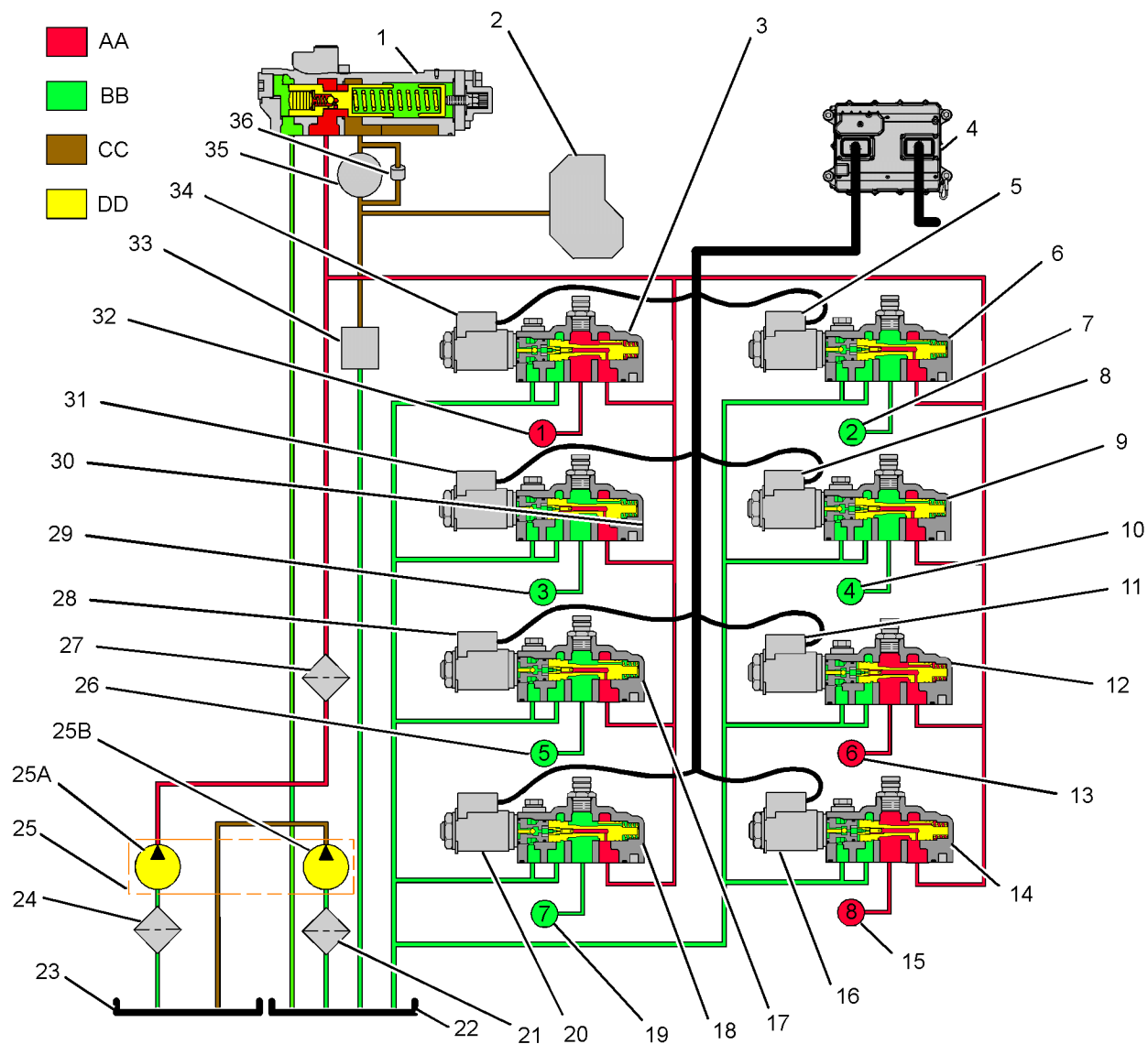


Illustration 53

g01456206

Transmission in FIFTH SPEED FORWARD

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (34)
- Clutch solenoid (11)
- Clutch solenoid (16)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 1 (3)
- Modulating valve for clutch 6 (12)
- Modulating valve for clutch 8 (14)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in FIFTH SPEED FORWARD, the solenoid on modulating valve (3) for clutch 1 (32) (forward high), the solenoid on modulating valve (12) for clutch 6 (13) (first speed), and the solenoid on modulating valve (14) for clutch 8 (15) (high range) are energized.

When solenoid (34) on modulating valve (3) is energized, valve (3) directs pump oil (AA) to clutch 1 (32) in order to engage the clutch.

When solenoid (11) on modulating valve (12) is energized, valve (12) directs pump oil (AA) to clutch 6 (13) in order to engage the clutch.

When solenoid (16) on modulating valve (14) is energized, valve (14) directs pump oil (AA) to clutch 8 (15) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

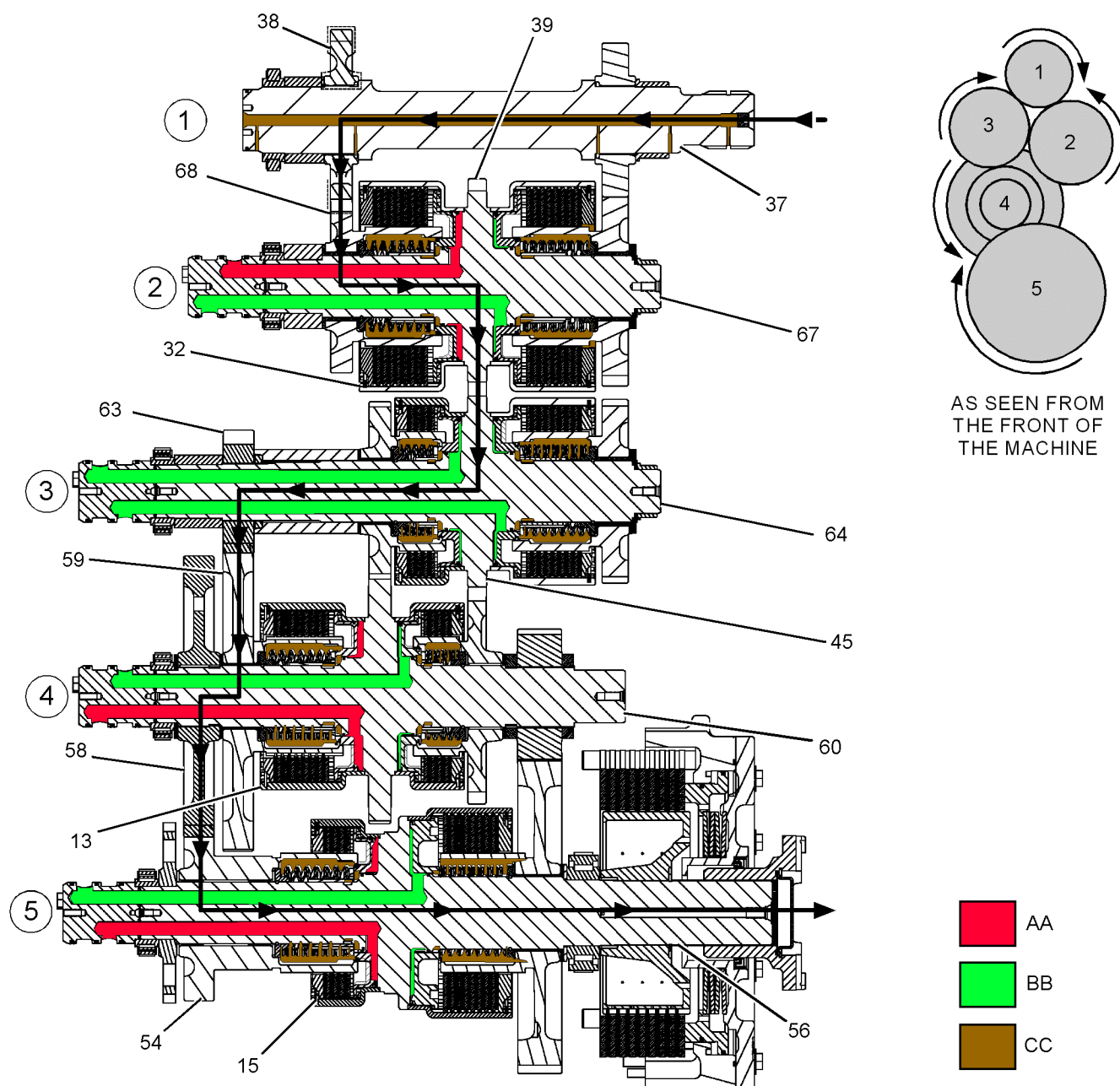


Illustration 54

g01456222

Transmission in FIFTH SPEED FORWARD

When the transmission is in FIFTH SPEED FORWARD, clutch 1 (32), clutch 6 (13), and clutch 8 (15) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (38) is splined to input shaft assembly (37). When clutch 1 (32) is engaged, torque is transferred from input shaft assembly (37) through gear (38) and gear (68) in order to turn shaft assembly (67).

Gear (39) is part of shaft assembly (67) which causes gear (39) to turn. Torque is transferred from shaft assembly (67) through gear (39) and gear (45) to shaft assembly (64).

When clutch 6 (13) is engaged, torque is transferred from shaft assembly (64) through gear (63) and gear (59) in order to turn shaft assembly (60).

When clutch 8 (15) is engaged, torque is transferred from shaft assembly (60) through gear (58) and gear (54) in order to turn shaft assembly (56).

Sixth Speed Forward

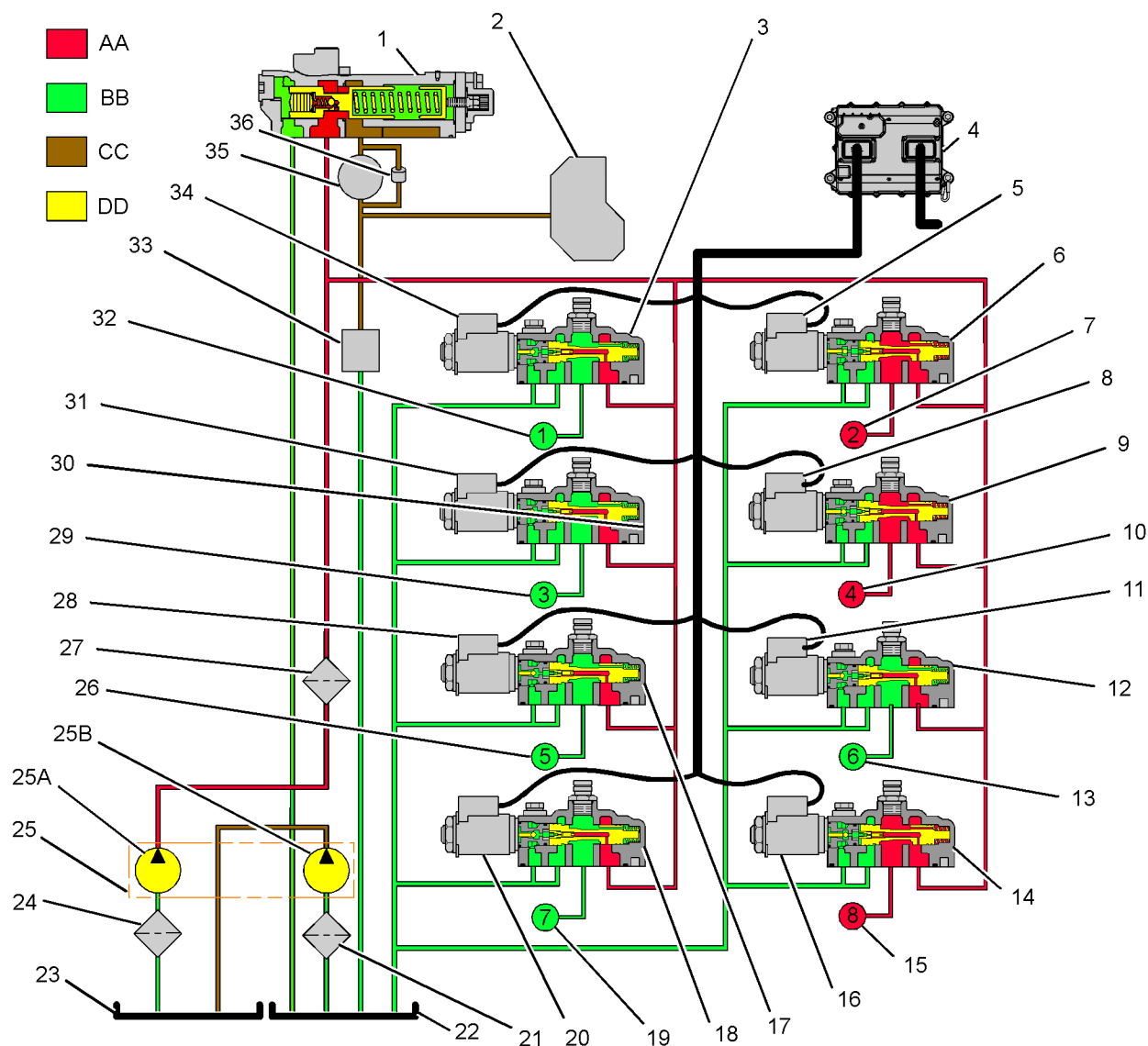


Illustration 55

g01456262

Transmission in SIXTH SPEED FORWARD

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (5)
- Clutch solenoid (8)
- Clutch solenoid (16)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 2 (6)
- Modulating valve for clutch 4 (9)
- Modulating valve for clutch 8 (14)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in SIXTH SPEED FORWARD, the solenoid on modulating valve (6) for clutch 2 (7) (forward low), the solenoid on modulating valve (9) for clutch 4 (10) (second speed), and the solenoid on modulating valve (14) for clutch 8 (15) (high range) are energized.

When solenoid (5) on modulating valve (6) is energized, valve (6) directs pump oil (AA) to clutch 2 (7) in order to engage the clutch.

When solenoid (8) on modulating valve (9) is energized, valve (9) directs pump oil (AA) to clutch 4 (10) in order to engage the clutch.

When solenoid (16) on modulating valve (14) is energized, valve (14) directs pump oil (AA) to clutch 8 (15) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

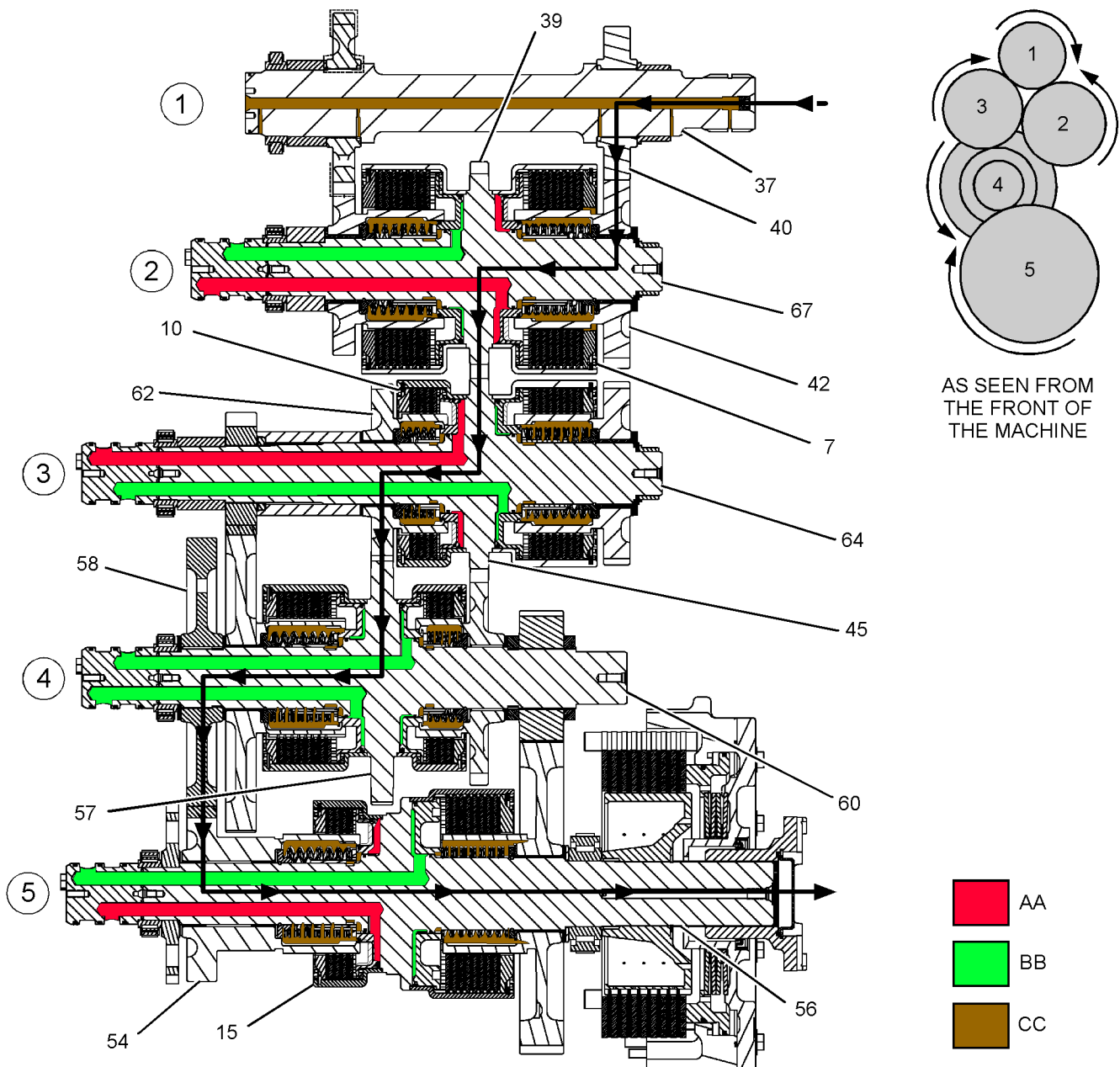


Illustration 56

g01456265

Transmission in SIXTH SPEED FORWARD

When the transmission is in **SIXTH SPEED FORWARD**, clutch 2 (7), clutch 4 (10), and clutch 8 (15) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (40) is splined to input shaft assembly (37). When clutch 2 (7) is engaged, torque is transferred from input shaft assembly (37) through gear (40) and gear (42) in order to turn shaft assembly (67).

Gear (39) is part of shaft assembly (67) which causes gear (39) to turn. Torque is transferred from shaft assembly (67) through gear (39) and gear (45) to shaft assembly (64).

When clutch 4 (10) is engaged, torque is transferred from shaft assembly (64) through gear (62) and gear (57) in order to turn shaft assembly (60).

When clutch 8 (15) is engaged, torque is transferred from shaft assembly (60) through gear (58) and gear (54) in order to turn shaft assembly (56).

Seventh Speed Forward

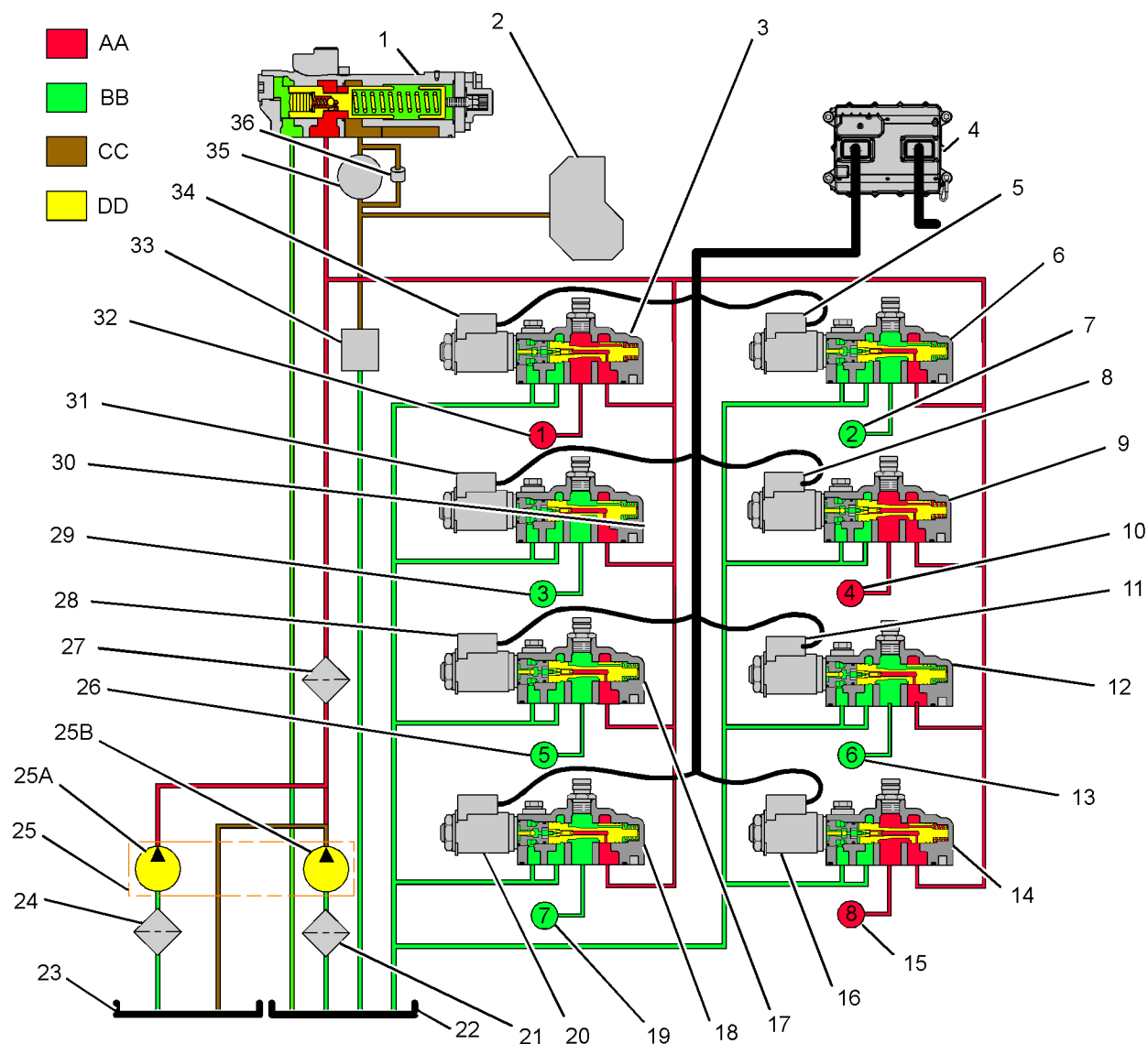


Illustration 57

g01456291

Transmission in SEVENTH SPEED FORWARD

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (34)
- Clutch solenoid (8)
- Clutch solenoid (16)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 1 (3)
- Modulating valve for clutch 4 (9)
- Modulating valve for clutch 8 (14)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in SEVENTH SPEED FORWARD, the solenoid on modulating valve (3) for clutch 1 (32) (forward high), the solenoid on modulating valve (9) for clutch 4 (10) (second speed), and the solenoid on modulating valve (14) for clutch 8 (15) (high range) are energized.

When solenoid (34) on modulating valve (3) is energized, valve (3) directs pump oil (AA) to clutch 1 (32) in order to engage the clutch.

When solenoid (8) on modulating valve (9) is energized, valve (9) directs pump oil (AA) to clutch 4 (10) in order to engage the clutch.

When solenoid (16) on modulating valve (14) is energized, valve (14) directs pump oil (AA) to clutch 8 (15) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

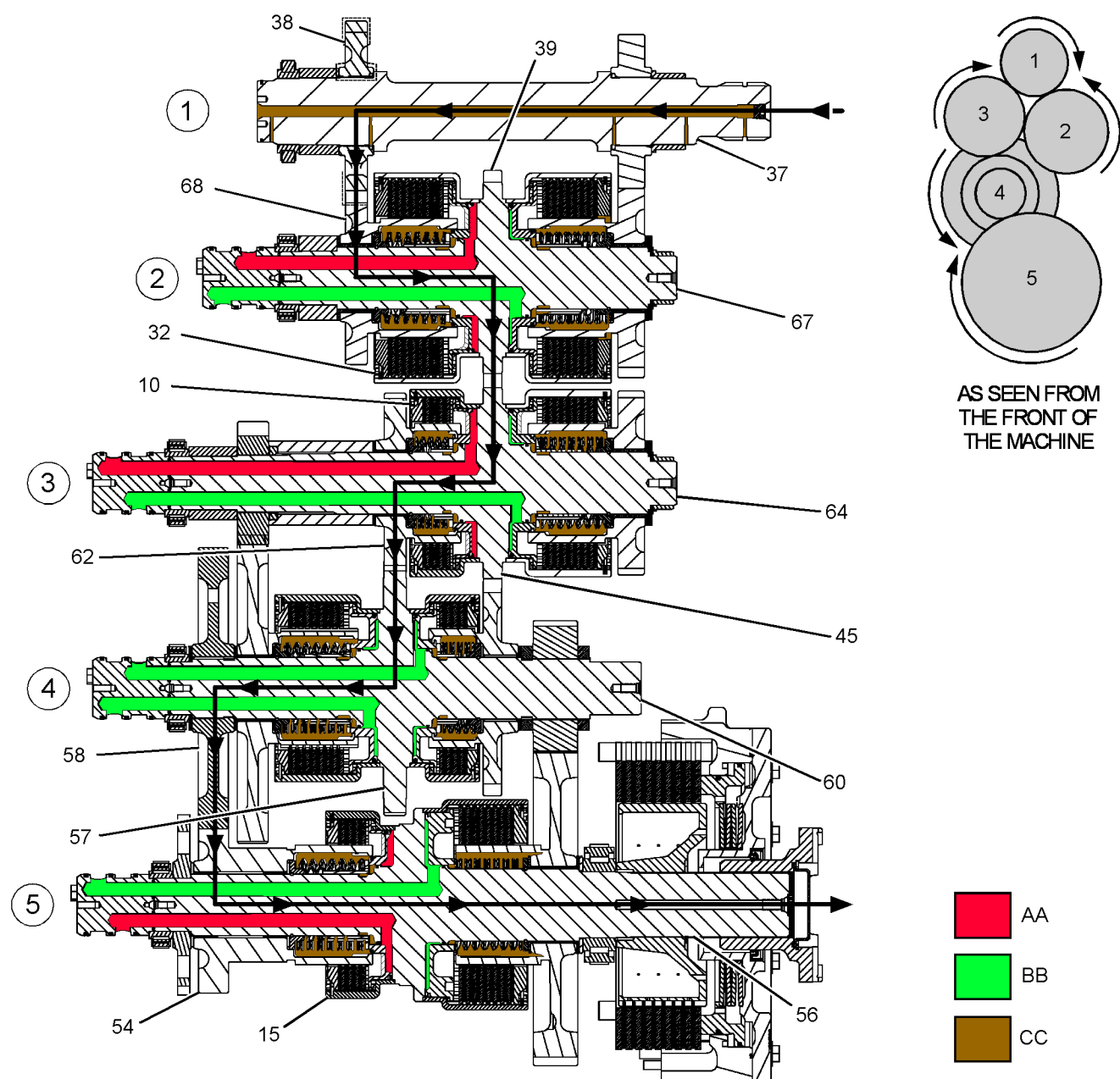


Illustration 58

g01456346

Transmission in SEVENTH SPEED FORWARD

When the transmission is in SEVENTH SPEED FORWARD, clutch 1 (32), clutch 4 (10), and clutch 8 (15) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (38) is splined to input shaft assembly (37). When clutch 1 (32) is engaged, torque is transferred from input shaft assembly (37) through gear (38) and gear (68) in order to turn shaft assembly (67).

Gear (39) is part of shaft assembly (67) which causes gear (39) to turn. Torque is transferred from shaft assembly (67) through gear (39) and gear (45) to shaft assembly (64).

When clutch 4 (10) is engaged, torque is transferred from shaft assembly (64) through gear (62) and gear (57) in order to turn shaft assembly (60).

When clutch 8 (15) is engaged, torque is transferred from shaft assembly (60) through gear (58) and gear (54) in order to turn shaft assembly (56).

Eighth Speed Forward

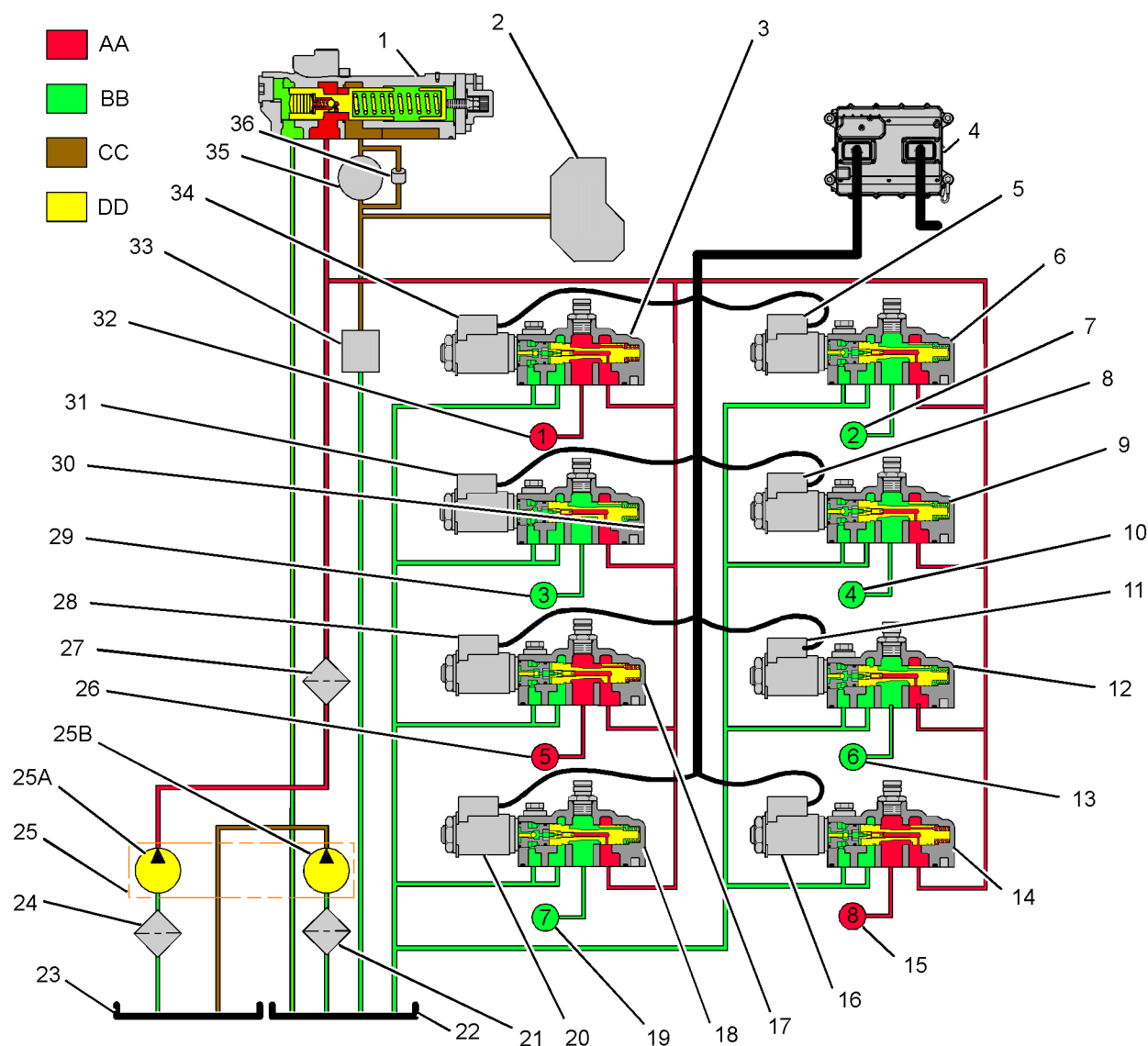


Illustration 59

g01456414

Transmission in EIGHTH SPEED FORWARD

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (34)
- Clutch solenoid (28)
- Clutch solenoid (16)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 1 (3)
- Modulating valve for clutch 5 (17)
- Modulating valve for clutch 8 (14)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in EIGHTH SPEED FORWARD, the solenoid on modulating valve (3) for clutch 1 (32) (forward high), the solenoid on modulating valve (17) for clutch 5 (26) (third speed), and the solenoid on modulating valve (14) for clutch 8 (15) (high range) are energized.

When solenoid (34) on modulating valve (3) is energized, valve (3) directs pump oil (AA) to clutch 1 (32) in order to engage the clutch.

When solenoid (28) on modulating valve (17) is energized, valve (17) directs pump oil (AA) to clutch 5 (26) in order to engage the clutch.

When solenoid (16) on modulating valve (14) is energized, valve (14) directs pump oil (AA) to clutch 8 (15) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

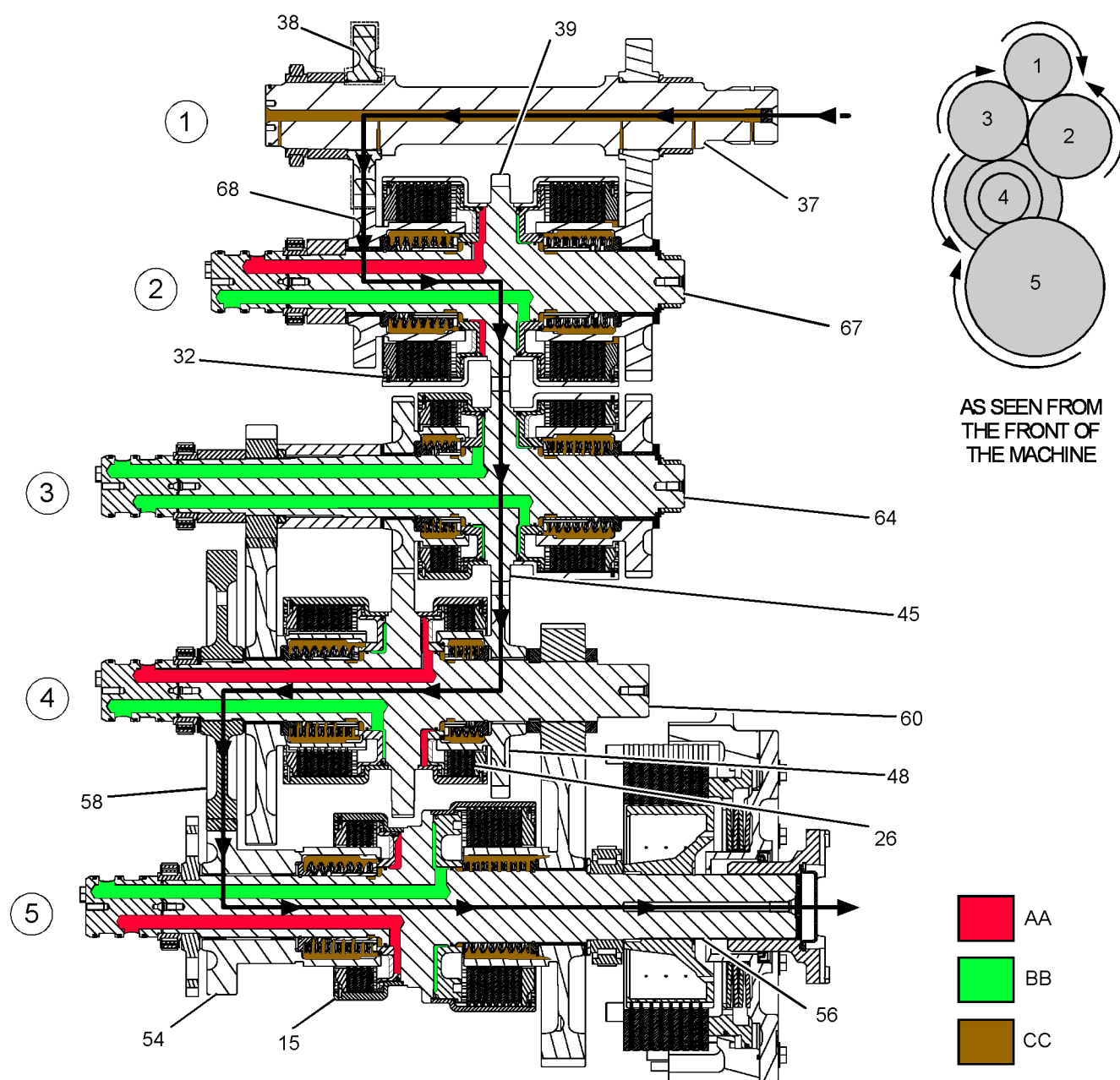


Illustration 60

g01456422

Transmission in EIGHTH SPEED FORWARD

When the transmission is in EIGHTH SPEED FORWARD, clutch 1 (32), clutch 5 (26), and clutch 8 (15) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (38) is splined to input shaft assembly (37). When clutch 1 (32) is engaged, torque is transferred from input shaft assembly (37) through gear (38) and gear (68) in order to turn shaft assembly (67).

Gear (39) is part of shaft assembly (67) which causes gear (39) to turn. Torque is transferred from shaft assembly (67) through gear (39) and gear (45) to shaft assembly (64).

When clutch 5 (26) is engaged, torque is transferred from shaft assembly (64) through gear (45) and gear (48) in order to turn shaft assembly (60).

When clutch 8 (15) is engaged, torque is transferred from shaft assembly (60) through gear (58) and gear (54) in order to turn shaft assembly (56).

Neutral

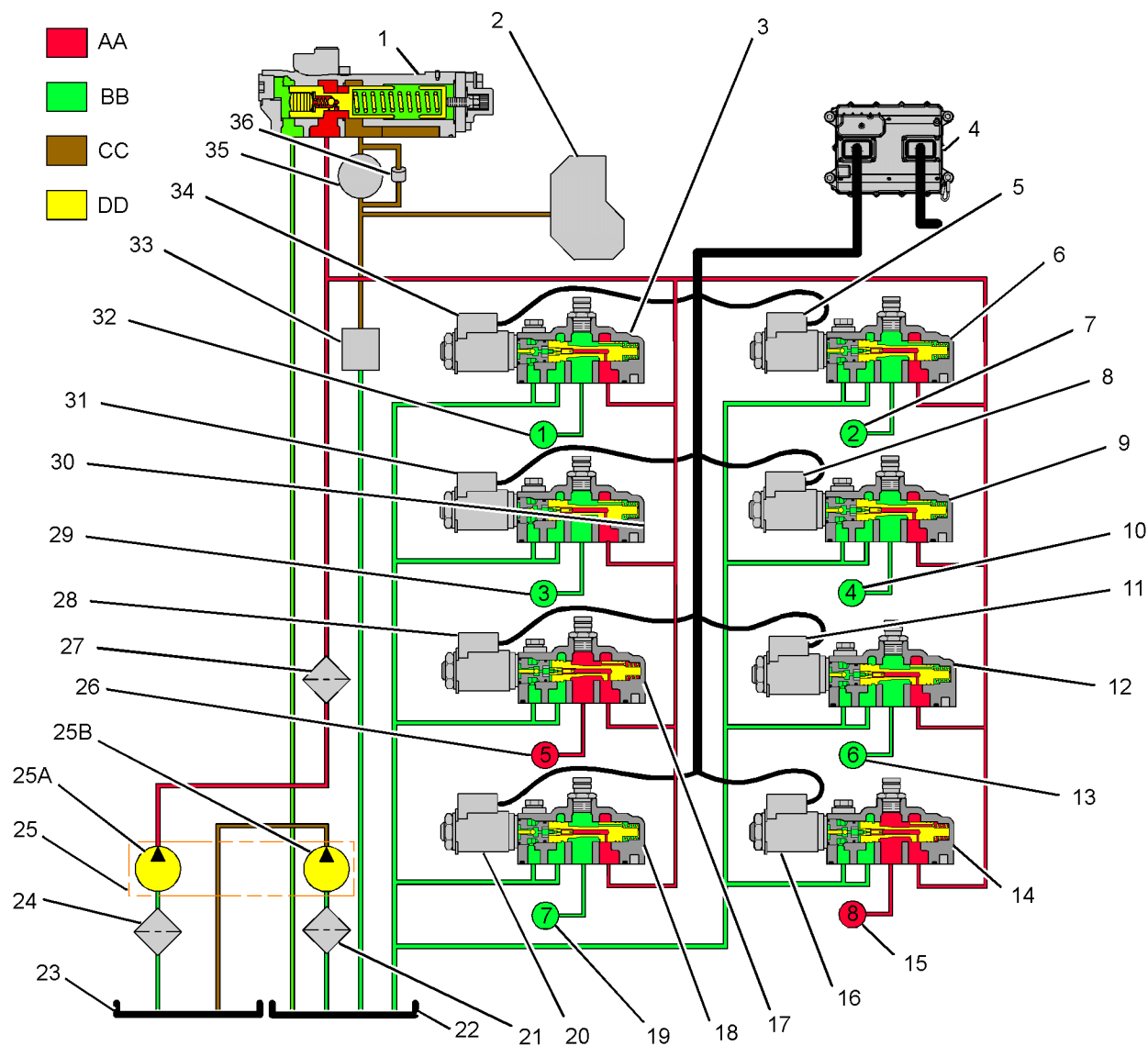


Illustration 61

g01456575

Transmission in NEUTRAL

When the transmission is in NEUTRAL, the solenoid on modulating valve (17) for clutch 5 (26) (Third speed), and the solenoid on modulating valve (14) for clutch 8 (15) (high range) are energized.

When solenoid (28) on modulating valve (17) is energized, valve (17) directs pump oil (AA) to clutch 5 (26) in order to engage the clutch.

When solenoid (16) on modulating valve (14) is energized, valve (14) directs pump oil (AA) to clutch 8 (15) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

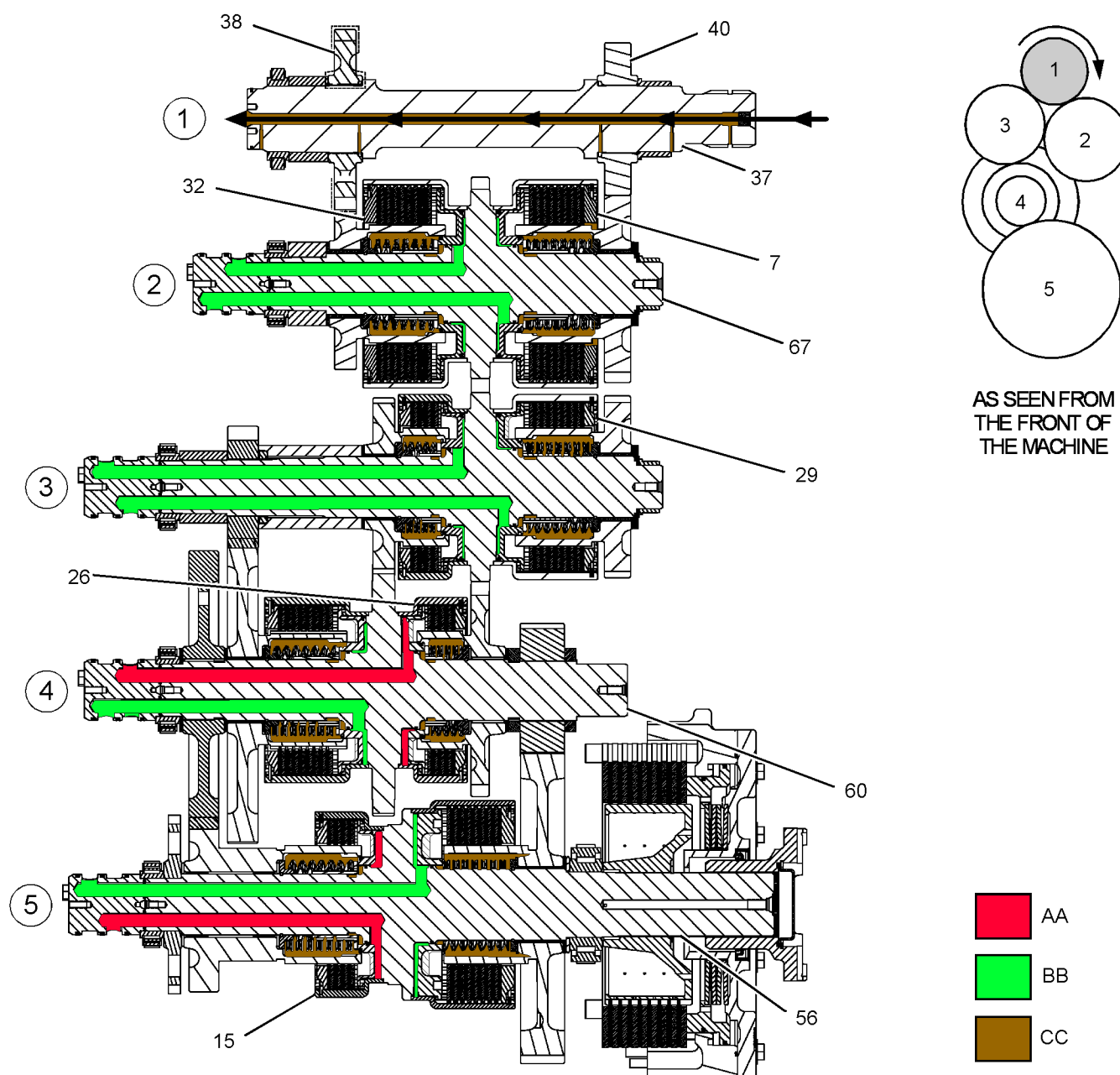


Illustration 62

g01456581

Transmission in NEUTRAL

When the transmission is in NEUTRAL, clutch 5 (26), and clutch 8 (15) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (38) is splined to input shaft assembly (37) and gear (40) is splined to input shaft assembly (37). Because clutch 1 (32), clutch 2 (7), or clutch 3 (29) is not engaged, power is not transferred from the input shaft through the transmission. Clutch 5 (26) and clutch 8 (15) are engaged when the transmission is in NEUTRAL.

First Speed Reverse

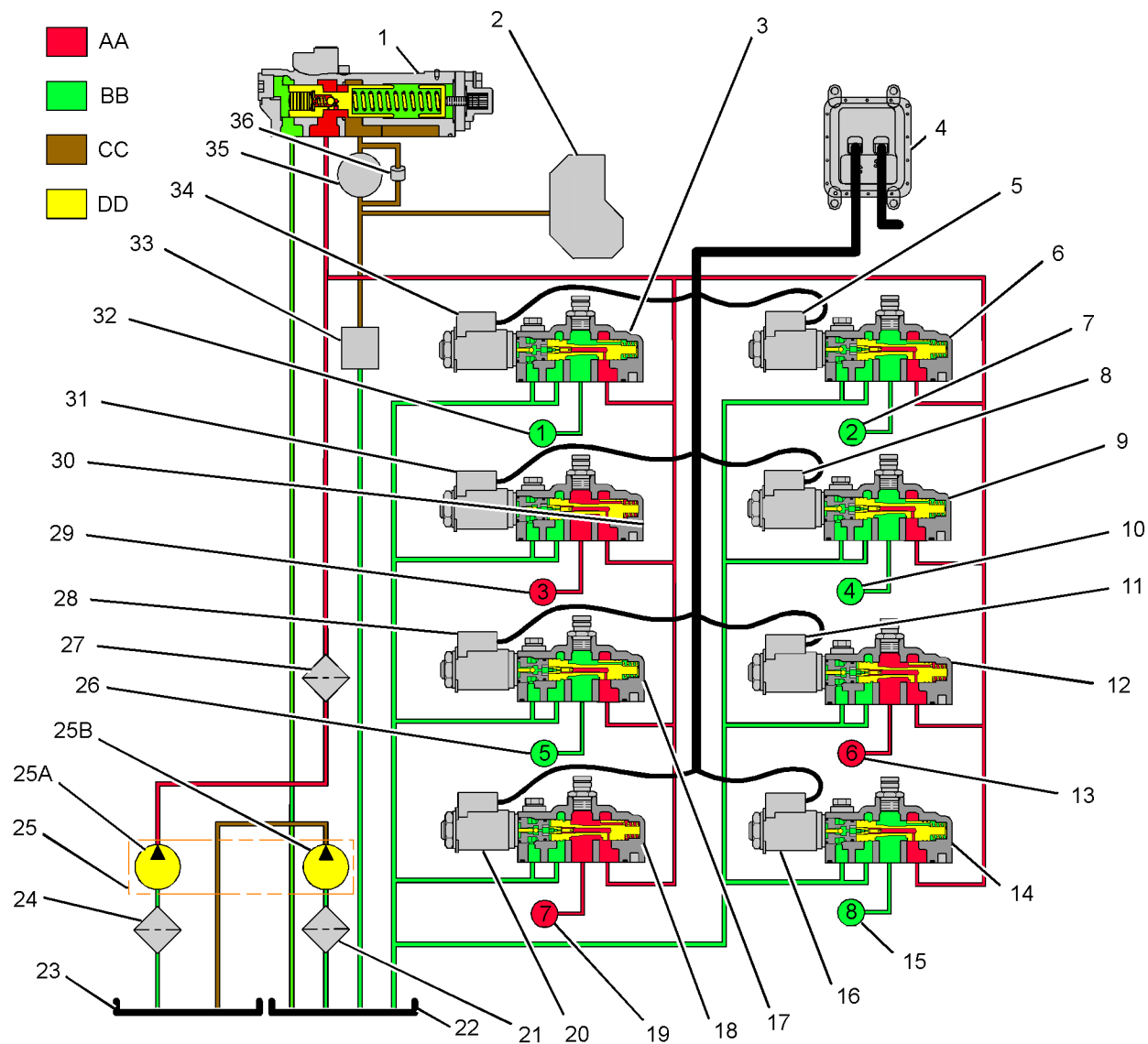


Illustration 63

g01456588

Transmission in FIRST SPEED REVERSE

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (31)
- Clutch solenoid (11)
- Clutch solenoid (20)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 3 (30)
- Modulating valve for clutch 6 (12)
- Modulating valve for clutch 7 (18)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in FIRST SPEED REVERSE, the solenoid on modulating valve (30) for clutch 3 (29) (reverse), the solenoid on modulating valve (12) for clutch 6 (13) (first speed), and the solenoid on modulating valve (18) for clutch 7 (19) (low range) are energized.

When solenoid (31) on modulating valve (30) is energized, valve (30) directs pump oil (AA) to clutch 3 (29) in order to engage the clutch.

When solenoid (11) on modulating valve (12) is energized, valve (12) directs pump oil (AA) to clutch 6 (13) in order to engage the clutch.

When solenoid (20) on modulating valve (18) is energized, valve (18) directs pump oil (AA) to clutch 7 (19) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

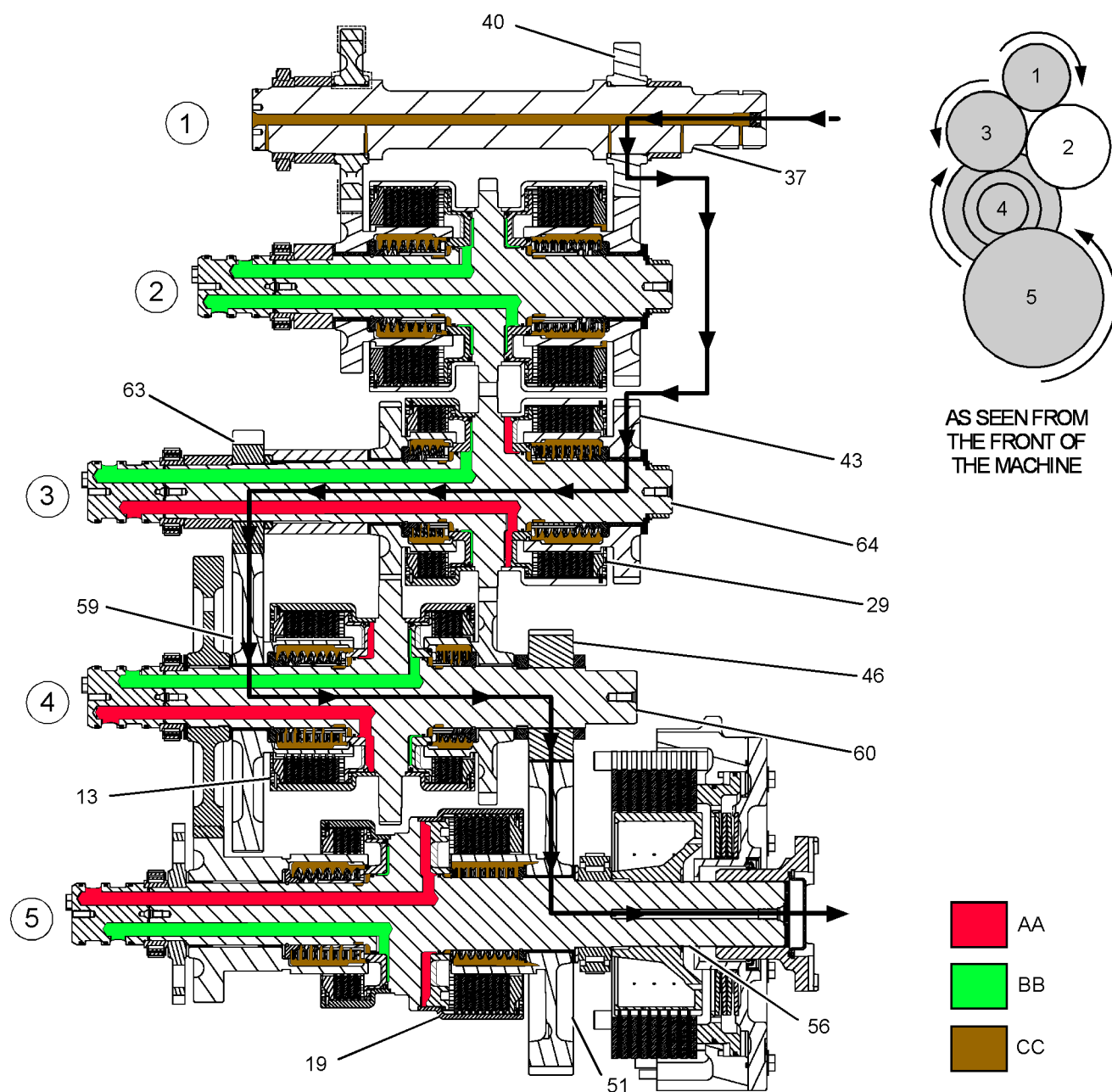


Illustration 64

g01456601

Transmission in FIRST SPEED REVERSE

When the transmission is in FIRST SPEED REVERSE, clutch 3 (29), clutch 6 (13), and clutch 7 (19) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (40) is splined to input shaft assembly (37). When clutch 3 (29) is engaged, torque is transferred from input shaft assembly (37) through gear (40) and gear (43) in order to turn shaft assembly (64).

When clutch 6 (13) is engaged, torque is transferred from shaft assembly (64) through gear (63) and gear (59) in order to turn shaft assembly (60).

When clutch 7 (19) is engaged, torque is transferred from shaft assembly (60) through gear (46) and gear (51) in order to turn shaft assembly (56).

Second Speed Reverse

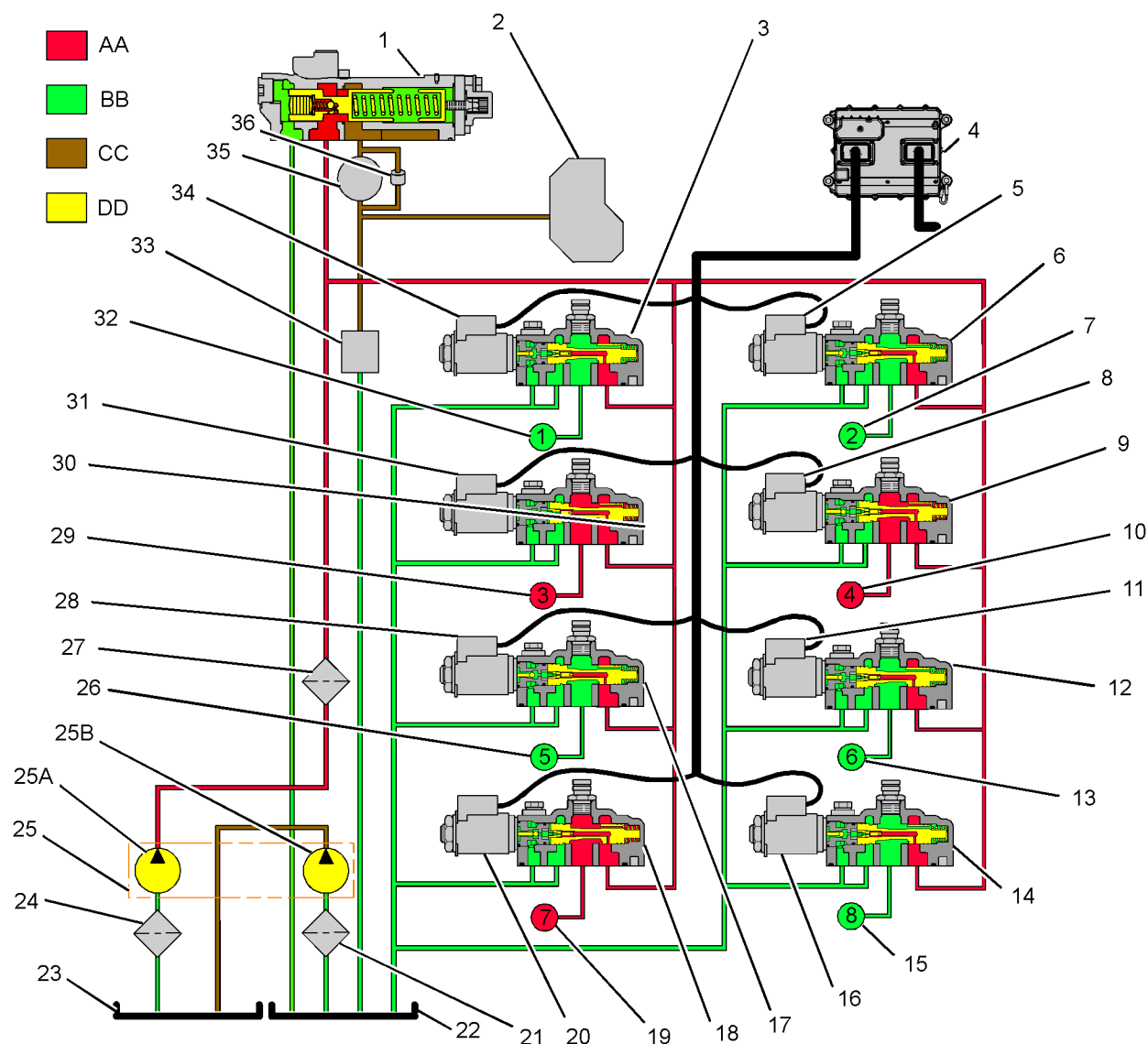


Illustration 65

g01456625

Transmission in SECOND SPEED REVERSE

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (31)
- Clutch solenoid (8)
- Clutch solenoid (20)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 3 (30)
- Modulating valve for clutch 4 (9)
- Modulating valve for clutch 7 (18)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in SECOND SPEED REVERSE, the solenoid on modulating valve (30) for clutch 3 (29) (reverse), the solenoid on modulating valve (9) for clutch 4 (10) (second speed), and the solenoid on modulating valve (18) for clutch 7 (19) (low range) are energized.

When solenoid (31) on modulating valve (30) is energized, valve (30) directs pump oil (AA) to clutch 3 (29) in order to engage the clutch.

When solenoid (8) on modulating valve (9) is energized, valve (9) directs pump oil (AA) to clutch 4 (10) in order to engage the clutch.

When solenoid (20) on modulating valve (18) is energized, valve (18) directs pump oil (AA) to clutch 7 (19) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

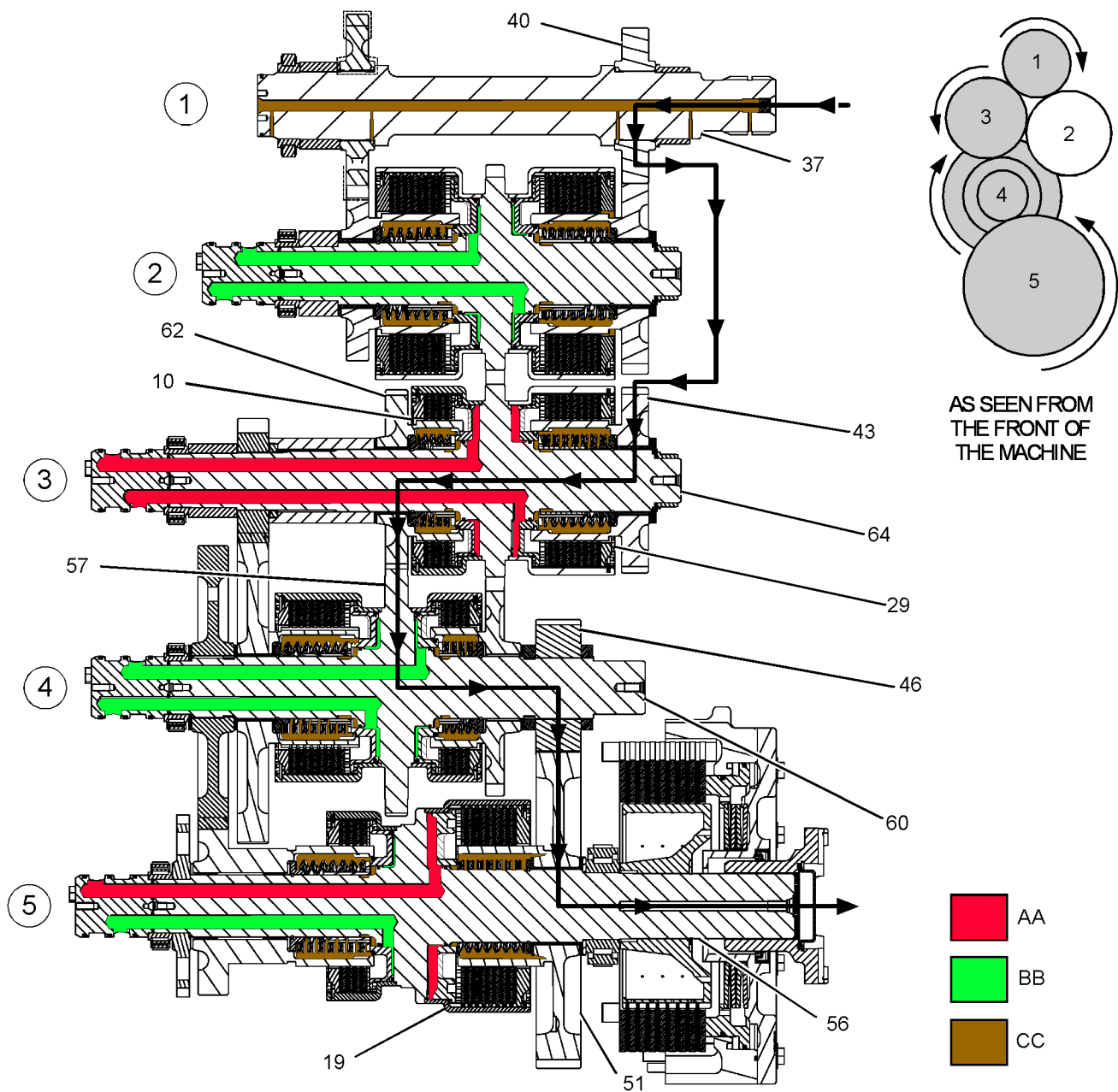


Illustration 66

g01456675

Transmission in SECOND SPEED REVERSE

When the transmission is in SECOND SPEED REVERSE, clutch 3 (29), clutch 4 (10), and clutch 7 (19) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (40) is splined to input shaft assembly (37). When clutch 3 (29) is engaged, torque is transferred from input shaft assembly (37) through gear (40) and gear (43) in order to turn shaft assembly (64).

When clutch 4 (10) is engaged, torque is transferred from shaft assembly (64) through gear (62) and gear (57) in order to turn shaft assembly (60).

When clutch 7 (19) is engaged, torque is transferred from shaft assembly (60) through gear (46) and gear (51) in order to turn shaft assembly (56).

Third Speed Reverse

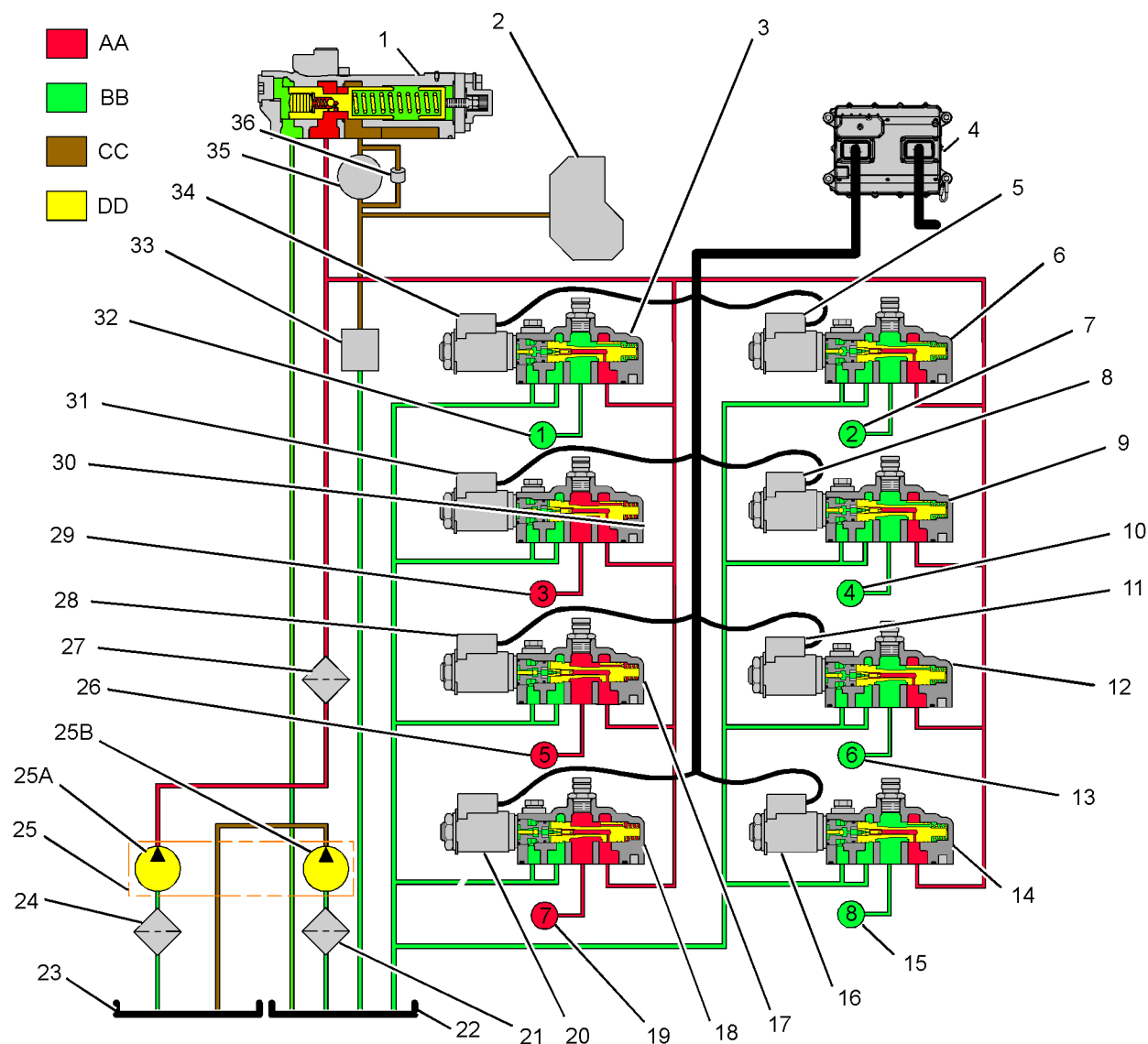


Illustration 67

g01456703

Transmission in THIRD SPEED REVERSE

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (31)
- Clutch solenoid (28)
- Clutch solenoid (20)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 3 (30)
- Modulating valve for clutch 5 (17)
- Modulating valve for clutch 7 (18)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in THIRD SPEED REVERSE, the solenoid on modulating valve (30) for clutch 3 (29) (reverse), the solenoid on modulating valve (17) for clutch 5 (26) (third speed), and the solenoid on modulating valve (18) for clutch 7 (19) (low range) are energized.

When solenoid (31) on modulating valve (30) is energized, valve (30) directs pump oil (AA) to clutch 3 (29) in order to engage the clutch.

When solenoid (28) on modulating valve (17) is energized, valve (17) directs pump oil (AA) to clutch 5 (26) in order to engage the clutch.

When solenoid (20) on modulating valve (18) is energized, valve (18) directs pump oil (AA) to clutch 7 (19) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to the sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

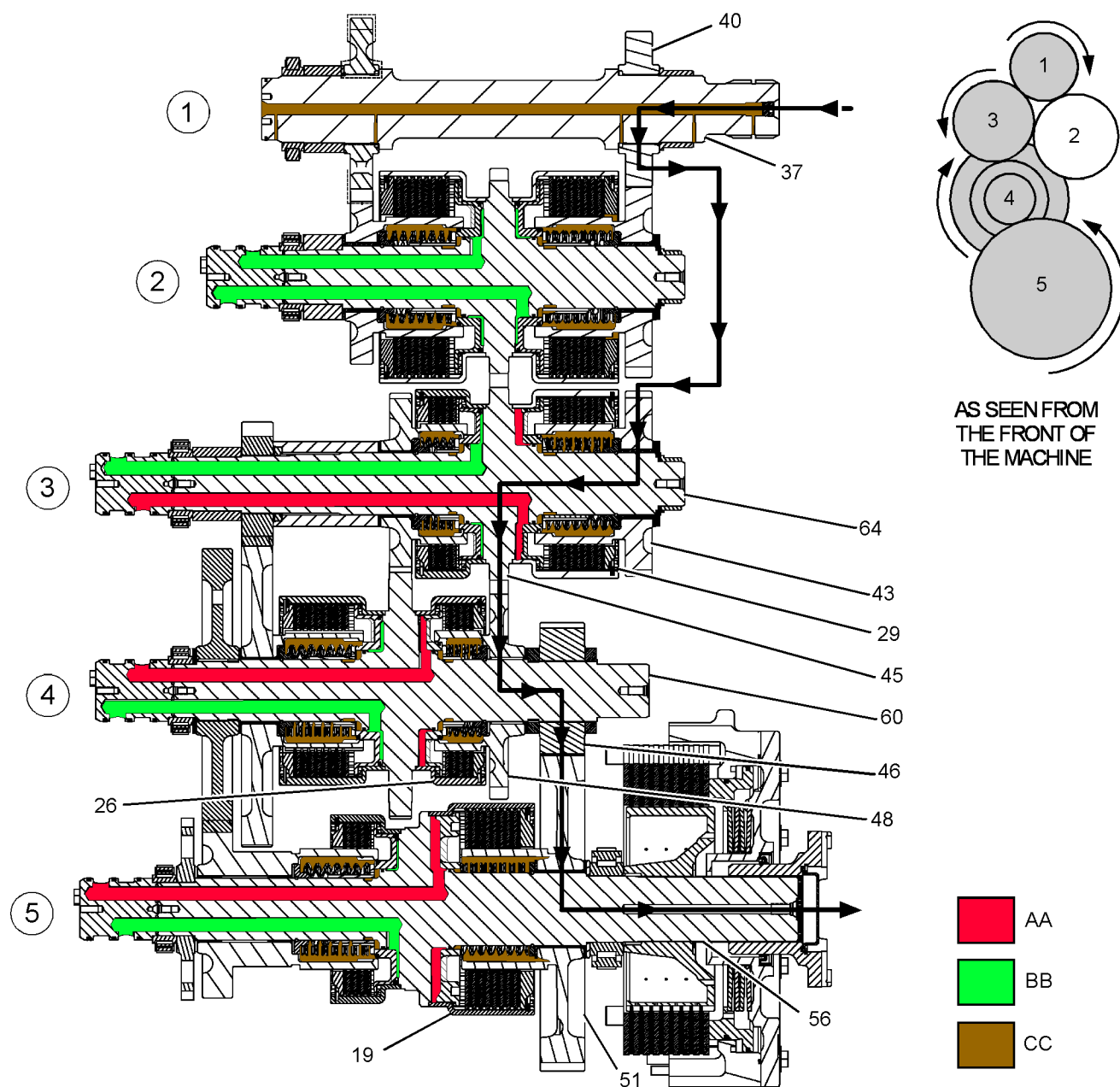


Illustration 68

g01456717

Transmission in THIRD SPEED REVERSE

When the transmission is in THIRD SPEED REVERSE, clutch 3 (29), clutch 5 (26), and clutch 7 (19) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (40) is splined to input shaft assembly (37). When clutch 3 (29) is engaged, torque is transferred from input shaft assembly (37) through gear (40) and gear (43) in order to turn shaft assembly (64).

When clutch 5 (26) is engaged, torque is transferred from shaft assembly (64) through gear (45) and gear (48) in order to turn shaft assembly (60).

When clutch 7 (19) is engaged, torque is transferred from shaft assembly (60) through gear (46) and gear (51) in order to turn shaft assembly (56).

Fourth Speed Reverse

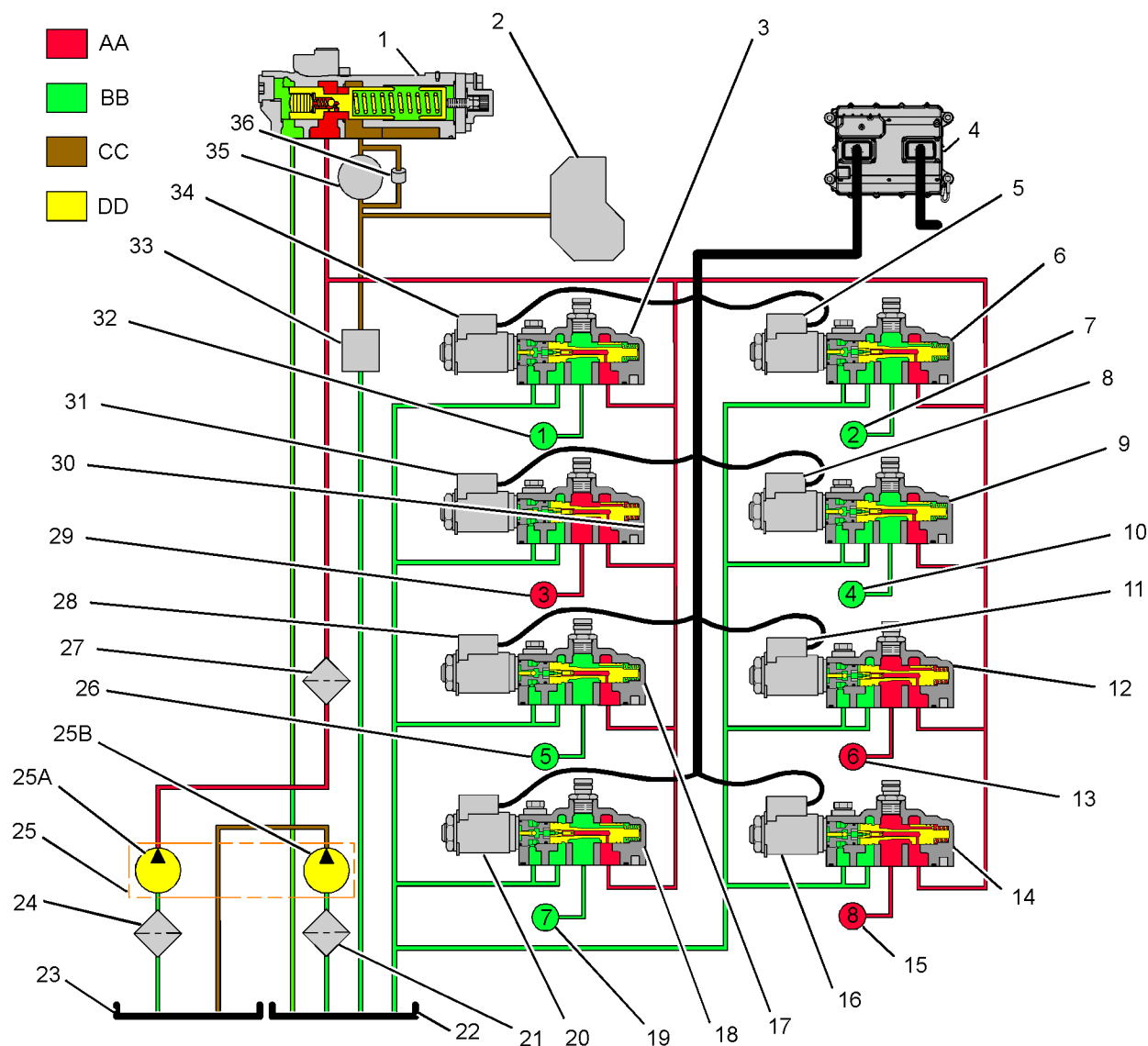


Illustration 69

g01456757

Transmission in FOURTH SPEED REVERSE

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (31)
- Clutch solenoid (11)
- Clutch solenoid (16)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 3 (30)
- Modulating valve for clutch 6 (12)
- Modulating valve for clutch 8 (14)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in FOURTH SPEED REVERSE, the solenoid on modulating valve (30) for clutch 3 (29) (reverse), the solenoid on modulating valve (12) for clutch 6 (13) (first speed), and the solenoid on modulating valve (14) for clutch 8 (15) (high range) are energized.

When solenoid (31) on modulating valve (30) is energized, valve (30) directs pump oil (AA) to clutch 3 (29) in order to engage the clutch.

When solenoid (11) on modulating valve (12) is energized, valve (12) directs pump oil (AA) to clutch 6 (13) in order to engage the clutch.

When solenoid (16) on modulating valve (14) is energized, valve (14) directs pump oil (AA) to clutch 8 (15) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

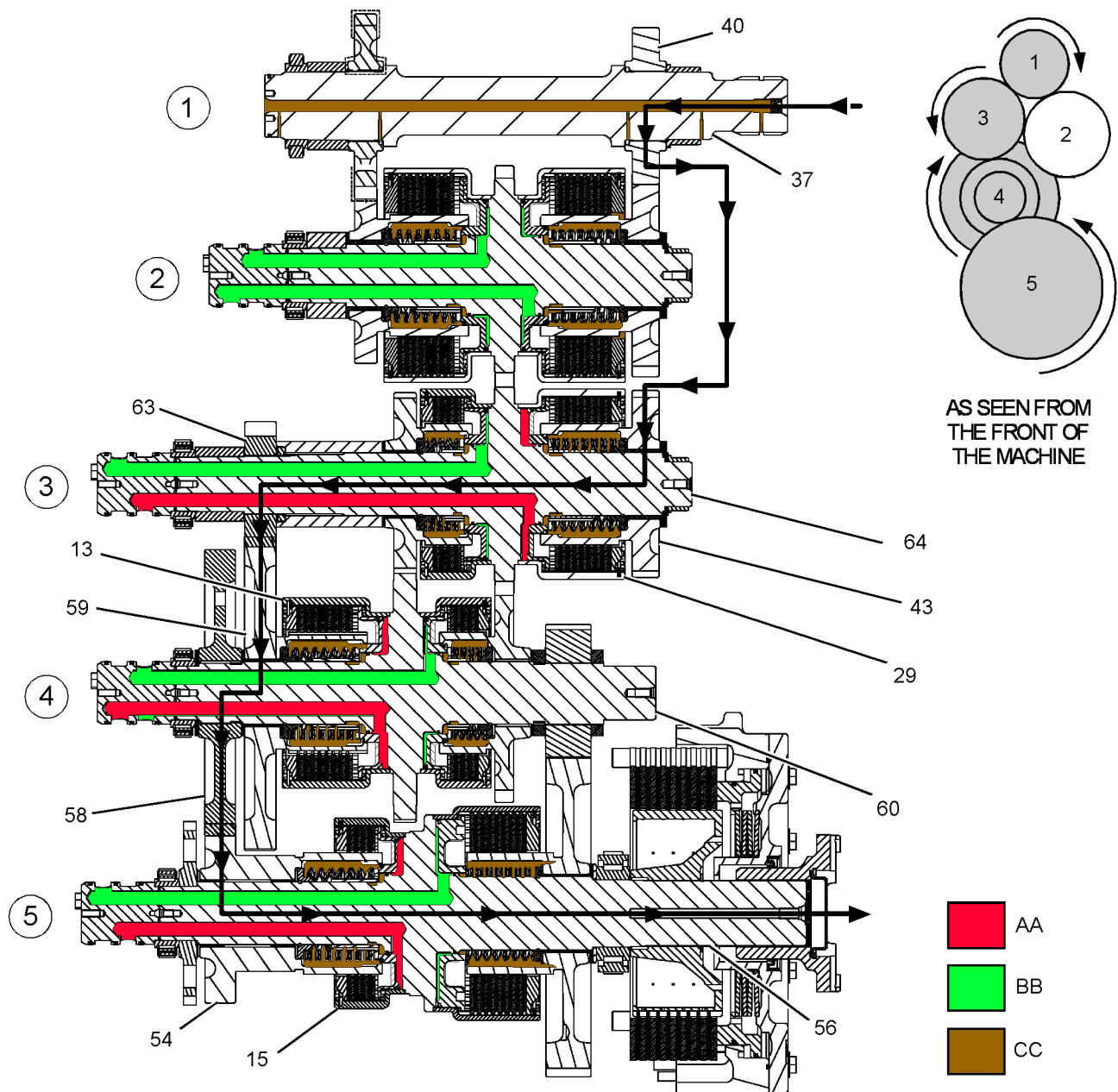


Illustration 70

g01456769

Transmission in FOURTH SPEED REVERSE

When the transmission is in **FOURTH SPEED REVERSE**, clutch 3 (29), clutch 6 (13), and clutch 8 (15) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (40) is splined to input shaft assembly (37). When clutch 3 (29) is engaged, torque is transferred from input shaft assembly (37) through gear (40) and gear (43) in order to turn shaft assembly (64).

When clutch 6 (13) is engaged, torque is transferred from shaft assembly (64) through gear (63) and gear (59) in order to turn shaft assembly (60).

When clutch 8 (15) is engaged, torque is transferred from shaft assembly (60) through gear (58) and gear (54) in order to turn shaft assembly (56).

Fifth Speed Reverse

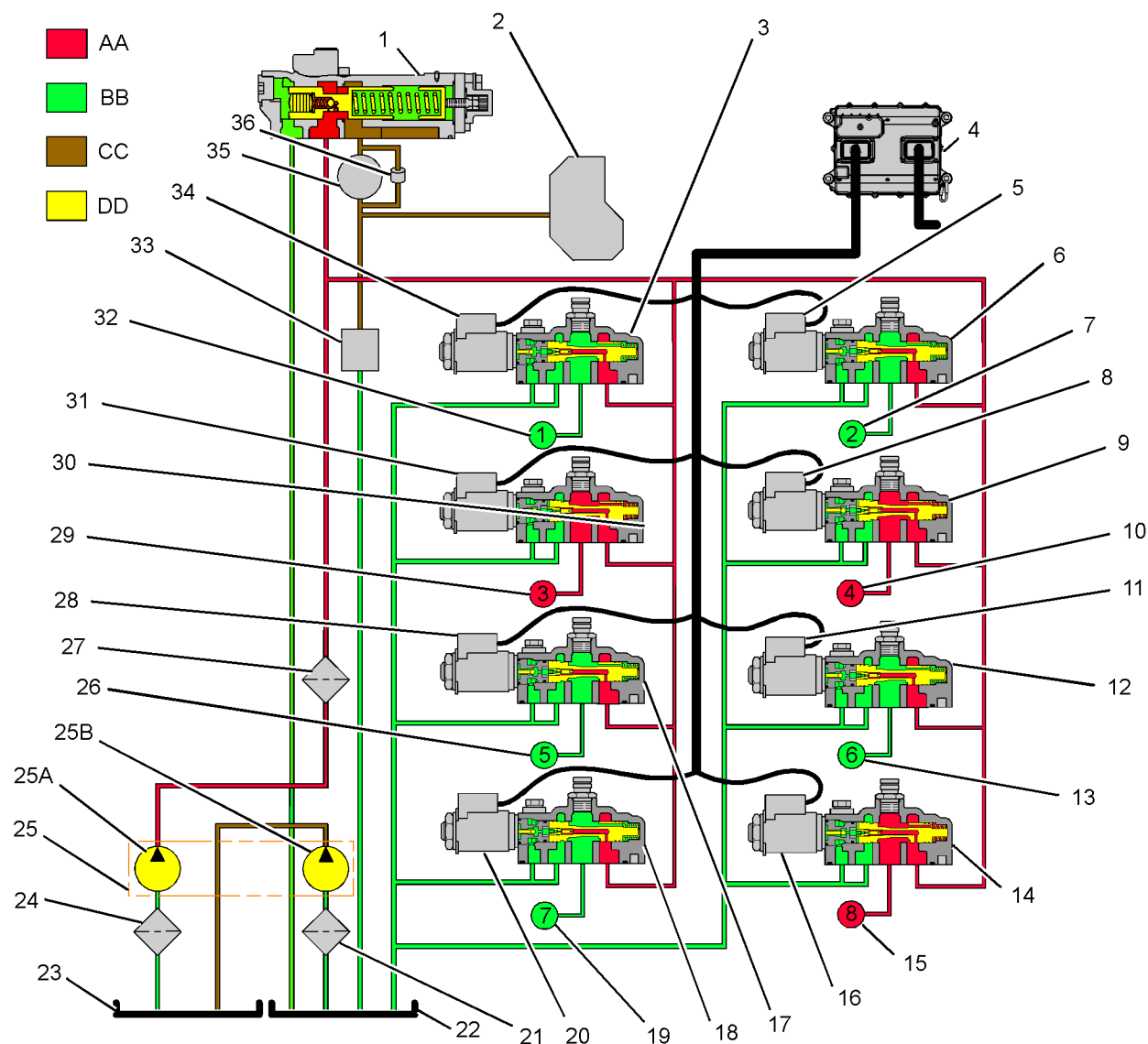


Illustration 71

g01456790

Transmission in FIFTH SPEED REVERSE

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (31)
- Clutch solenoid (8)
- Clutch solenoid (16)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 3 (30)
- Modulating valve for clutch 4 (9)
- Modulating valve for clutch 8 (14)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in FIFTH SPEED REVERSE, the solenoid on modulating valve (30) for clutch 3 (29) (reverse), the solenoid on modulating valve (9) for clutch 4 (10) (second speed), and the solenoid on modulating valve (14) for clutch 8 (15) (high range) are energized.

When solenoid (31) on modulating valve (30) is energized, valve (30) directs pump oil (AA) to clutch 3 (29) in order to engage the clutch.

When solenoid (8) on modulating valve (9) is energized, valve (9) directs pump oil (AA) to clutch 4 (10) in order to engage the clutch.

When solenoid (16) on modulating valve (14) is energized, valve (14) directs pump oil (AA) to clutch 8 (15) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

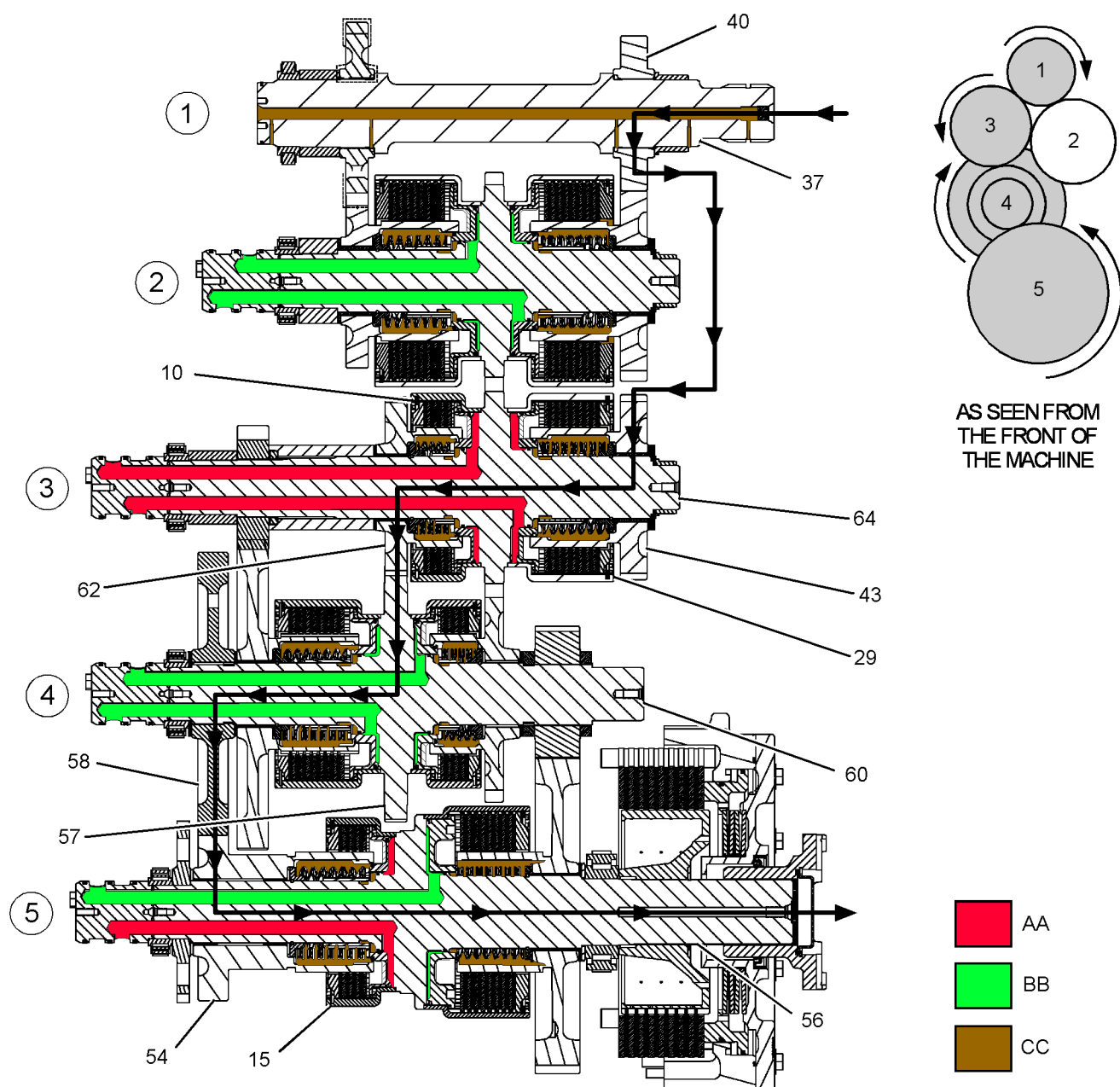


Illustration 72

g01456810

Transmission in FIFTH SPEED REVERSE

When the transmission is in FIFTH SPEED REVERSE, clutch 3 (29), clutch 4 (10), and clutch 8 (15) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (40) is splined to input shaft assembly (37). When clutch 3 (29) is engaged, torque is transferred from input shaft assembly (37) through gear (40) and gear (43) in order to turn shaft assembly (64).

When clutch 4 (10) is engaged, torque is transferred from shaft assembly (64) through gear (62) and gear (57) in order to turn shaft assembly (60).

When clutch 8 (15) is engaged, torque is transferred from shaft assembly (60) through gear (58) and gear (54) in order to turn shaft assembly (56).

Sixth Speed Reverse

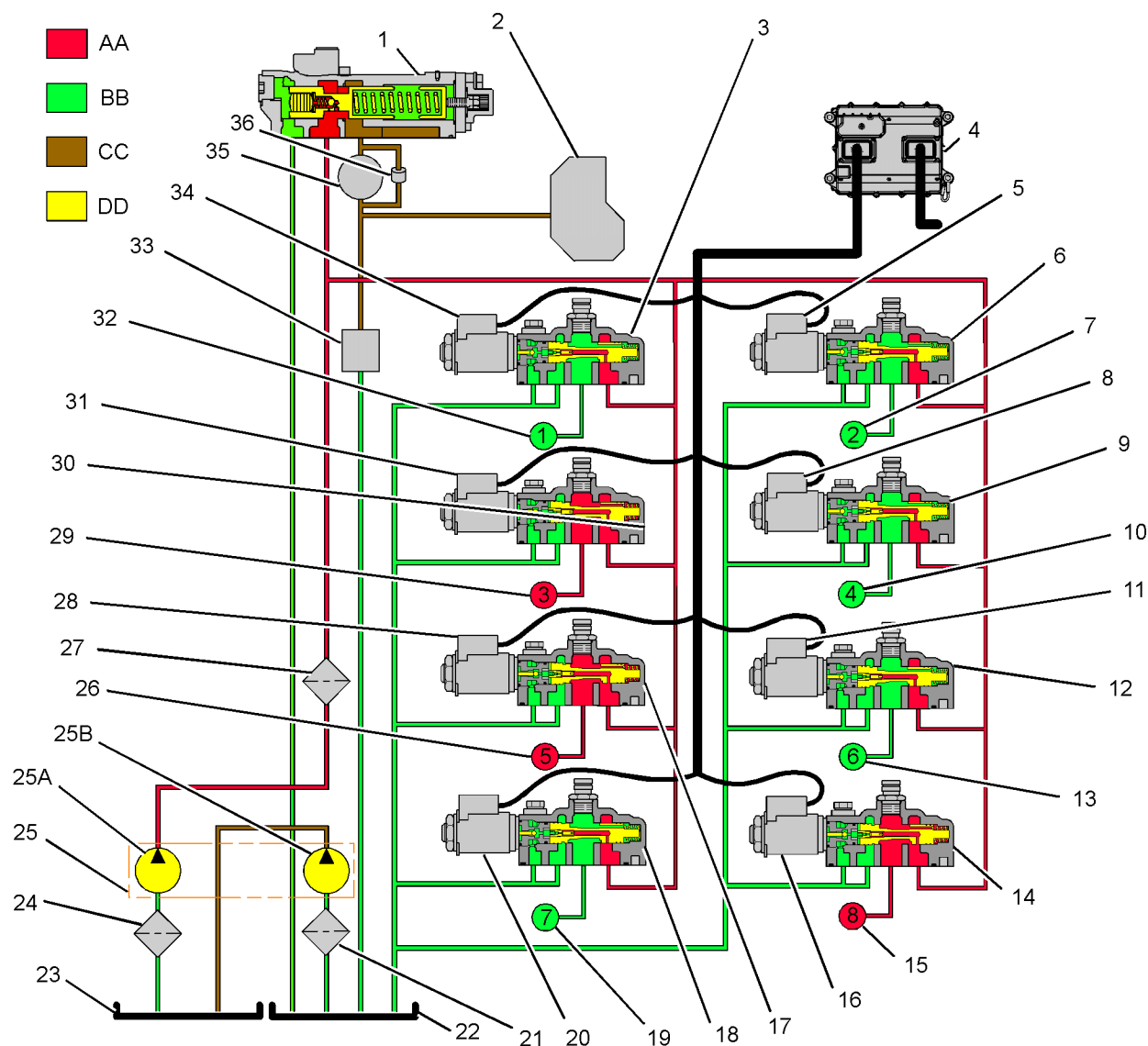


Illustration 73

g01456829

Transmission in SIXTH SPEED REVERSE

The transmission Electronic Control Module (ECM) (4) determines the proper clutches that need to be engaged. The proper clutch engagement is based on the inputs to the transmission ECM (4). Some of the inputs that are considered are machine speed, engine speed, and operator inputs.

Transmission ECM (4) modulates the electrical current that is sent to the following solenoids:

- Clutch solenoid (31)
- Clutch solenoid (28)
- Clutch solenoid (16)

The clutch solenoids are located on the following valves:

- Modulating valve for clutch 3 (30)
- Modulating valve for clutch 5 (17)
- Modulating valve for clutch 8 (14)

Modulating the current to the clutch solenoid controls the clutch pressure by shifting the spool in the modulating valve.

When the transmission is in SIXTH SPEED REVERSE, the solenoid on modulating valve (30) for clutch 3 (29) (reverse), the solenoid on modulating valve (17) for clutch 5 (26) (third speed), and the solenoid on modulating valve (14) for clutch 8 (15) (high range) are energized.

When solenoid (31) on modulating valve (30) is energized, valve (30) directs pump oil (AA) to clutch 3 (29) in order to engage the clutch.

When solenoid (28) on modulating valve (17) is energized, valve (17) directs pump oil (AA) to clutch 5 (26) in order to engage the clutch.

When solenoid (16) on modulating valve (14) is energized, valve (14) directs pump oil (AA) to clutch 8 (15) in order to engage the clutch.

The oil in the clutches that are not engaged is sent back to sump (22) and the oil becomes return oil (BB).

Transmission relief valve (1) controls the pressure of pressure oil (AA) that is supplied to the modulating valves. Transmission relief valve (1) directs the unneeded pump oil to oil cooler (35) as lubrication oil (CC) for transmission lubrication (2). The transmission is lubricated and the oil drains to sump (22). Transmission lubrication relief valve (33) limits the pressure in the lubrication circuit in order to protect the seals and bearings in the transmission. Unwanted oil returns to transmission sump (22) as return oil (BB).

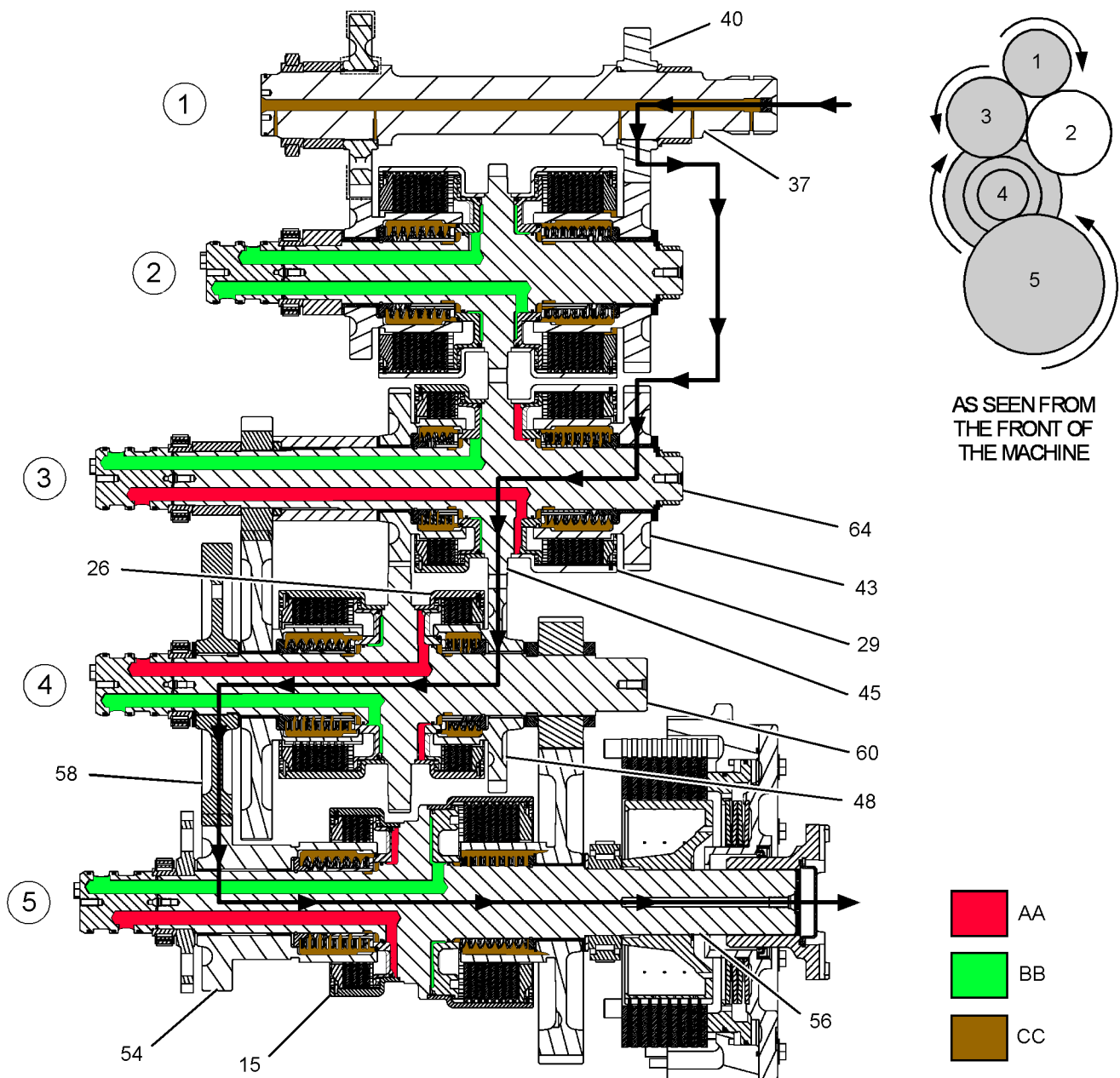


Illustration 74

g01456837

Transmission in SIXTH SPEED REVERSE

When the transmission is in **SIXTH SPEED REVERSE**, clutch 3 (29), clutch 5 (26), and clutch 8 (15) are engaged.

Torque from the engine is transferred to input shaft assembly (37). Gear (40) is splined to input shaft assembly (37). When clutch 3 (29) is engaged, torque is transferred from input shaft assembly (37) through gear (40) and gear (43) in order to turn shaft assembly (64).

When clutch 5 (26) is engaged, torque is transferred from shaft assembly (64) through gear (45) and gear (48) in order to turn shaft assembly (60).

When clutch 8 (15) is engaged, torque is transferred from shaft assembly (60) through gear (58) and gear (54) in order to turn shaft assembly (56).

i02566249

i02934531

Gear Pump (Transmission Charging and Scavenge)

SMCS Code: 5073

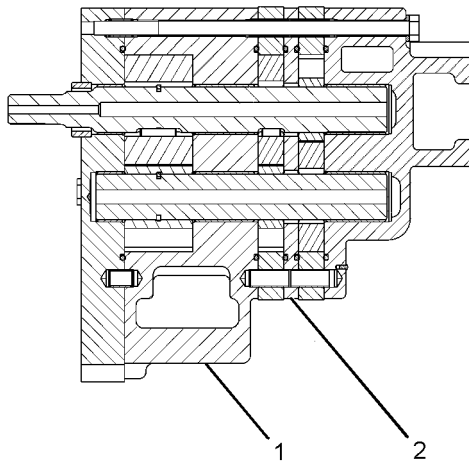


Illustration 75

g01114661

Gear pump (transmission charging and scavenge)

- (1) Transmission scavenge section
(2) Transmission charging section

The pump (transmission charging and scavenge) is a positive displacement type pump. The two-section gear pump is bolted to the transmission cover and driven by the transmission. Transmission scavenge section (1) draws hydraulic oil from the transmission sump in order to supply hydraulic oil to the differential for lubrication.

Transmission charging section (2) draws hydraulic oil from the differential case. The transmission charging section is composed of two pump gears that are out-of-phase. The pump gears are aligned so that the tooth of one gear is aligned with the root of the other gear. The phasing of the gears allows the smoothing of the pressure pulse that is created by the transmission charging section. Transmission charging section (2) supplies pressure oil for the following:

- Operation of the transmission
- Lubrication of the transmission
- Operation of the differential lock
- Release of the parking brake

Reference: Refer to the Power Train Specifications, "Gear Pump (Transmission Charging and Scavenge)" for test information.

Oil Filter (Power Train)

SMCS Code: 3004; 3067; 5068-PWT

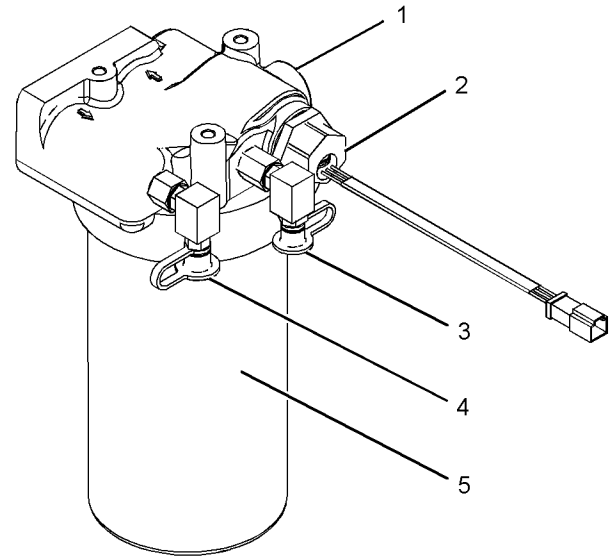


Illustration 76

g01145693

- (1) Bypass valve housing
(2) Pressure switch
(3) Pressure port
(4) Sampling port
(5) Filter element

The externally mounted oil filter has a bypass valve that is equipped with pressure switch (2). If there is a restriction in the oil filter or if the viscosity of the oil is very high, the bypass valve in bypass valve housing (1) will open.

If the inlet pressure to the oil filter is greater than the outlet pressure by a specified amount, the bypass valve will open.

Reference: See the Power Train Specifications, "Oil Filter (Power Train)" for more information.

When the oil does not go through filter element (5), the debris in the oil can cause damage to other components in the power train system.

Correct maintenance procedures must be followed in order to make sure that the element does not become full of debris. Debris could stop the flow of clean oil to the power train system. The filter is mounted to the transmission on the right, rear side of the machine.

i02966080

Rear Axle

SMCS Code: 3278-RE; 3282-RE; 4068

The rear axle contains the bevel gear and the differential. The rear axle housing is used as the storage location for the sump oil for the transmission. Sump oil is pulled from the rear axle housing by the charge section of the pump on the transmission.

Reference: See the Power Train Systems Operation, Testing and Adjusting, “Gear Pump (Transmission Charging and Scavenge)” for more information.

Reference: See the Power Train Systems Operation, Testing and Adjusting, “Differential and Bevel Gear” for more information.

i06179120

Differential and Bevel Gear

SMCS Code: 3256; 3258; 3264; 3270

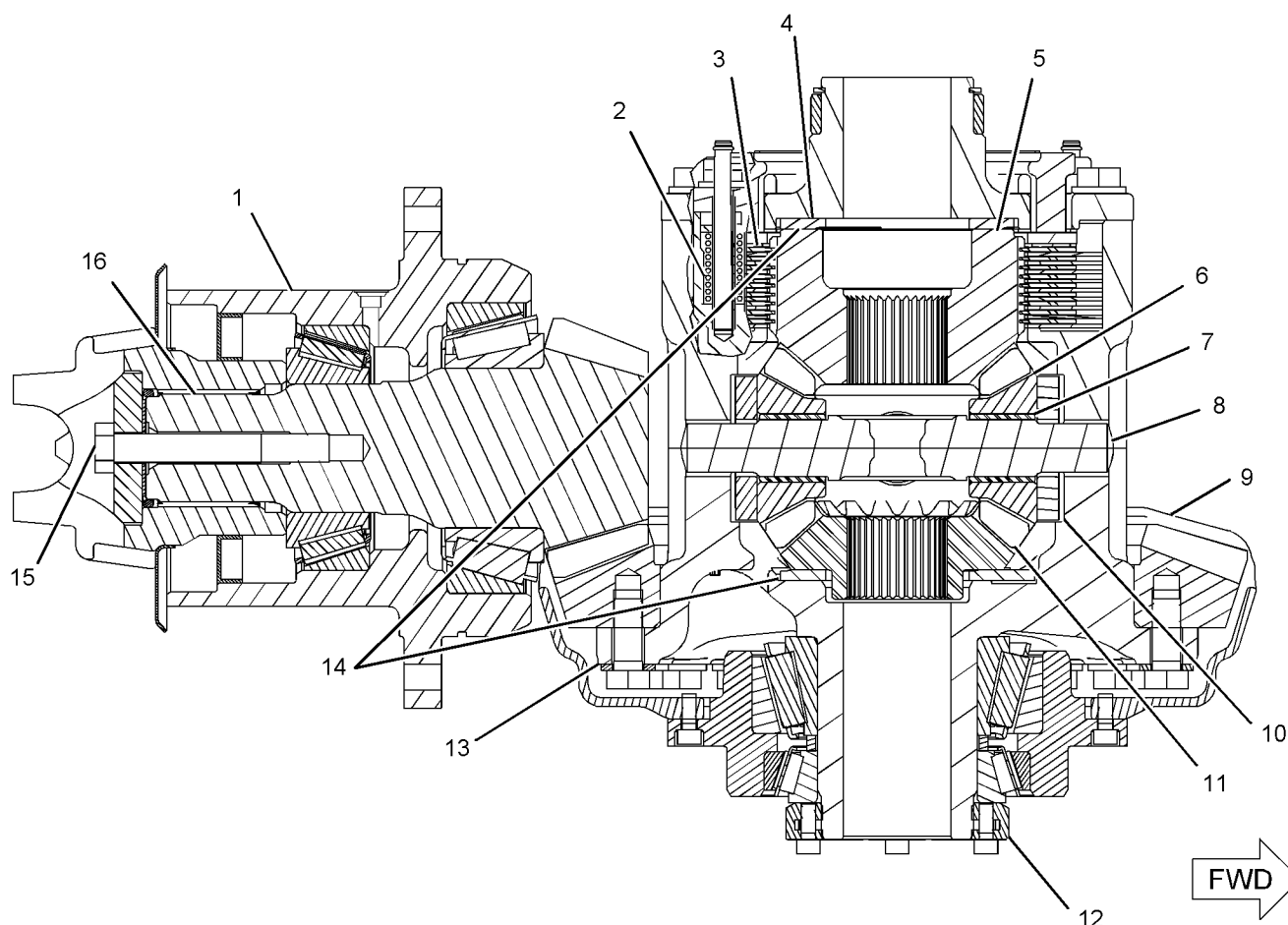


Illustration 77

g01322843

Typical Example of a Differential and Bevel Gear

- | | | |
|----------------------------------|----------------------------|-------------------------------|
| (1) Housing for the pinion shaft | (7) Bearing sleeve | (13) Differential case (gear) |
| (2) Spring | (8) Spider shaft | (14) Thrust Washers |
| (3) Clutch plates and discs | (9) Bevel gear | (15) Adjustment bolt (pinion) |
| (4) Thrust Washers | (10) Thrust washers | (16) Bevel pinion shaft |
| (5) Left side gear | (11) Right side gear | |
| (6) Pinions (spider pinions) | (12) Adjustment nut (gear) | |

The differential is used to transfer power from the transmission output shaft to the final drives. The final drives then transfer power to the wheels. The differential allows the rear wheels to turn at different rates of speed. When the machine is turned, the differential allows the inside wheels to turn at a slower rate of speed than the outside wheels. The differential can be unlocked or locked by the operator. The differential lock control button (17) is located in the cab on the right joystick control.

The output shaft of the transmission directly turns bevel pinion shaft (16). Bevel pinion shaft (16) turns bevel gear (9), which is fastened to differential case (gear) (13). The differential has spider shaft (8) for pinions (6). The differential has two side gears: left side gear (5) and right side gear (11). The connections between four pinions (6) and the two side gears are at right angles through a gear mesh. Left side gear (5) and right side gear (11) are connected to the shafts by splines which are connected to the final drives.

When the machine is moving straight in a forward direction and the differential is in the UNLOCK position, the same amount of torque is applied to the wheels on each side. The same amount of torque that is sent to each shaft for the final drive stops pinion (6) so the pinions cannot turn on spider shaft (8). This gives the same effect as if both tandem drives are being driven by the same shaft. When the machine is turned, different forces are applied to the opposite sides of the differential. This action will turn pinions (6). The rotation of pinions (6) allow the inside wheels to rotate at a slower rate of speed than the outside wheels. This moves the machine through the turn under full power.

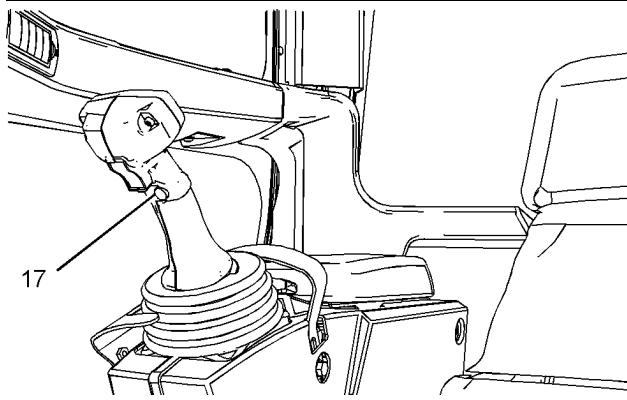


Illustration 78

g01146112

Right joystick control

(17) Differential lock control button

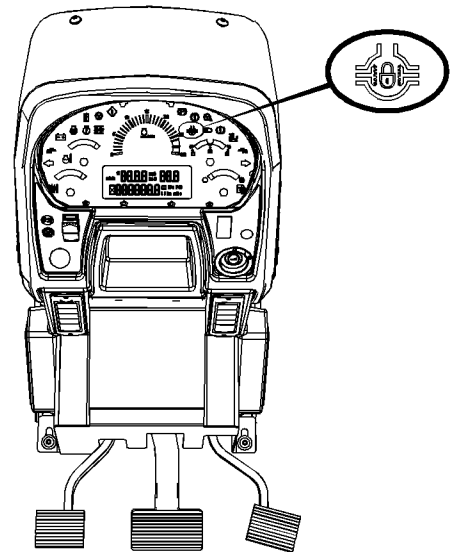


Illustration 79

g01322868

Location of dash panel differential lock indicator

The differential can be locked by pressing differential lock control button (17). This button is located on the right joystick control in the cab of the machine. Pressing differential lock control button (17) pressurizes oil behind the piston in the differential lock. Locking the clutch discs (3) together forces the shaft to each final drive to turn together at the same speed. Pressing differential lock control button (17) again releases the oil pressure behind the piston. The reduction in oil pressure releases the differential lock. This will allow the two output shafts to turn at different speeds.

The housing for the differential runs on tapered roller bearings. Pinions (6) turn on manganese bronze bushings. Pinions (6), left side gear (5), and right side gear (11) turn against thrust washers (10). Washers (10) take the end thrust against the differential housing.

The differential gets lubrication from oil that is thrown about inside the bevel gear housing. A flat surface on each side of spider shaft (8) allows lubrication to flow to pinions (6) and to washers (10).

Differential Lock Valve

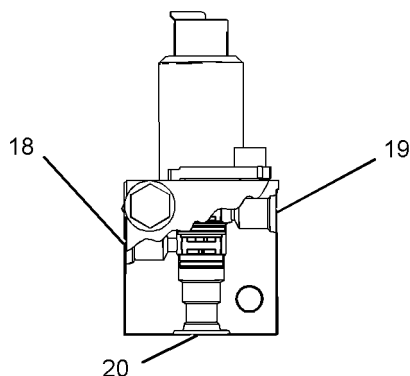


Illustration 80

g01146123

Differential Lock Valve

(18) Opening to the reservoir

(19) Opening to the clutch

(20) Inlet opening

Differential lock control button (17) controls a solenoid activated hydraulic valve that is located on the differential carrier. When button (17) is pressed and the differential is locked, differential lock lamp will be illuminated on the dash. To lock the differential, current flows to the solenoid coil and the solenoid will energize. The oil from the transmission relief valve flows through a hose to inlet opening (20). The internal passages of the solenoid valve act as an orifice.

Oil flows into inlet opening (20) and exits through opening (19) to the differential lock clutch. Then, the oil flows to the cavity of the differential bearing and piston housing. The force of the oil will overcome the force of spring (2). The force of the oil pushes the piston against clutch plates and discs (3) which causes left side gear (5) to turn with bevel gear (9). Pinions (6) do not turn on spider shaft (8). Pinions (6) turn with left side gear (5) and right side gear (11).

If the traction under the tandem wheels is different, the speed of the wheels will be equal.

When button (17) is pressed again and the differential is unlocked, differential lock lamp will not be illuminated on the dash. To unlock the differential, no current flows to the solenoid coil and the solenoid will not be energized. Spring force will return the valve to rest position. The oil in the differential flows through opening (19) and flows to the oil reservoir through opening (18). Oil that is flowing to inlet opening (20) is blocked by the valve spool. When traction varies under each wheel tandem, pinions (6), left side gear (5), and right side gear (11) can turn at different speeds.

Note: To prevent damage to the differential, do not engage the differential lock control at high speeds.

i02934250

Final Drive and Tandem Drive

SMCS Code: 4050; 4062; 4064

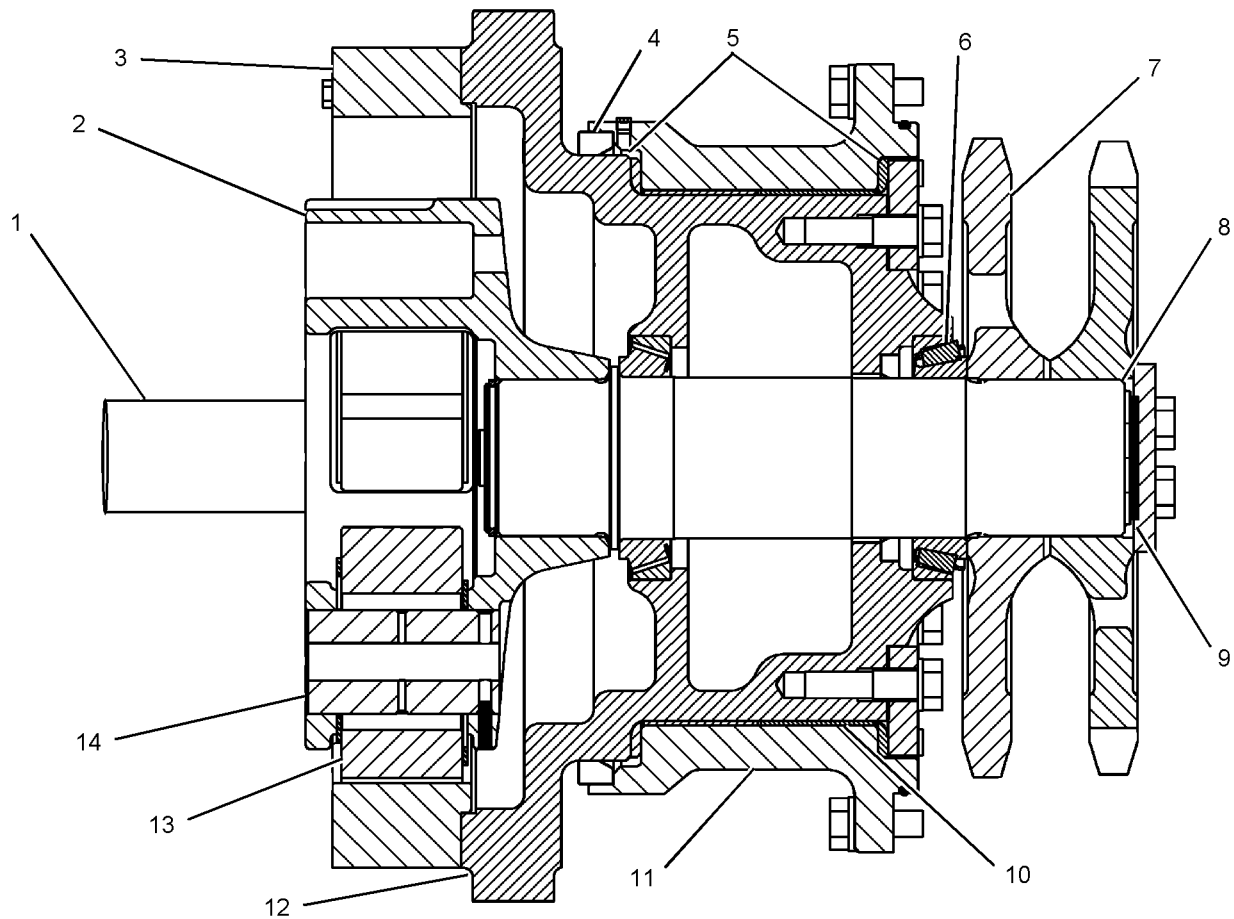


Illustration 81

g01108240

Final Drive

- (1) Sun gear and shaft
- (2) Carrier
- (3) Ring gear
- (4) Lip type seal
- (5) Thrust washer

- (6) Tapered roller bearing
- (7) Sprocket
- (8) Output shaft
- (9) Shims
- (10) Wear ring

- (11) Tandem pivot housing
- (12) Final drive housing
- (13) Planetary gear
- (14) Planetary shaft

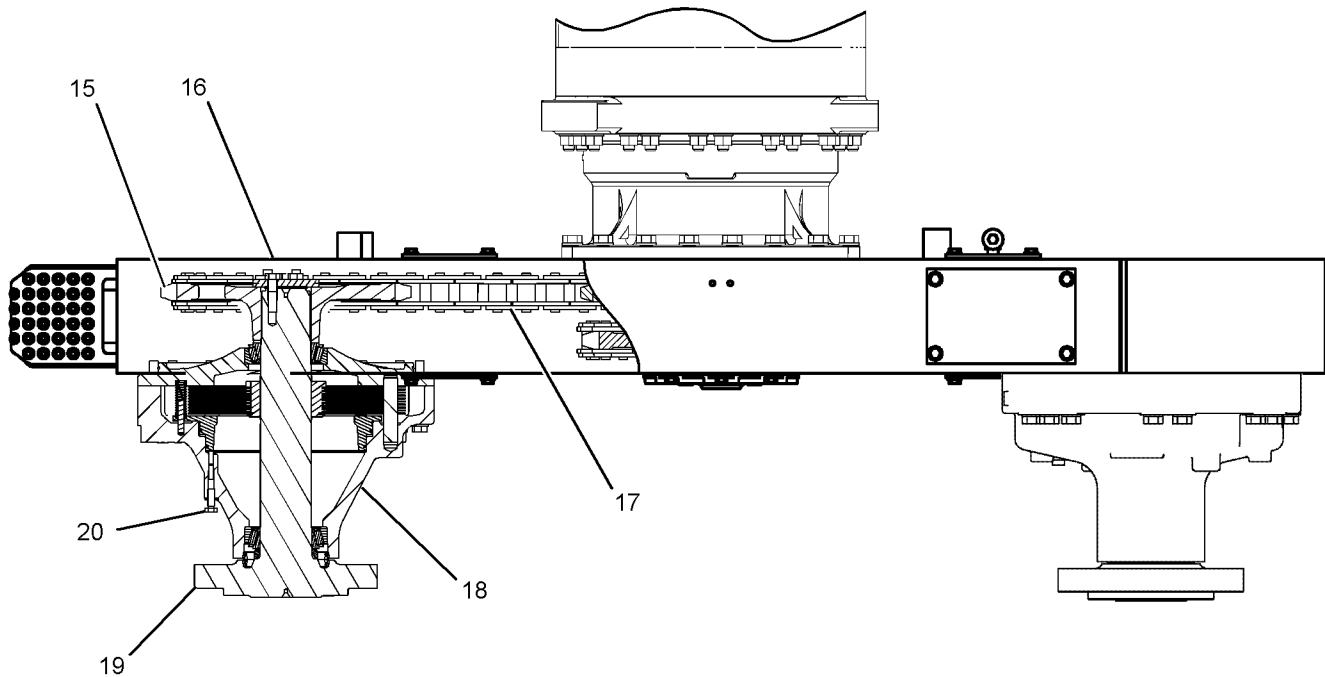


Illustration 82

g01280389

Tandem Housing

(15) Wheel sprocket
(16) Tandem housing

(17) Chain
(18) Spindle housing

(19) Wheel spindle
(20) Compensator

The final drive is a planetary gear system that increases the torque to the wheels, and the final drive transfers the torque to the wheels. Each wheel is driven by chain (17) that connects final drive sprocket (7) to wheel sprocket (15) on each wheel spindle (19). The final drive also provides the pivot point for each tandem wheel.

The differential drives sun gear and shaft (1). Planetary gear (13) is driven by sun gear (1). Planetary gear (13) rotates on the inside of ring gear (3). Planetary gear (13) drives carrier (2). Carrier (2) is splined to output shaft (8).

Two sprockets (7) are splined onto each output shaft (8) of the final drive. These sprockets (7) are in the center of the tandem drive between the wheels. Chain (17) that is between the center and wheel sprockets (15) drives each wheel on the tandem drive. Wheel spindle (19) is splined to wheel sprocket (15). Wheel sprocket (15) turns wheel spindle (19).

Tandem housing (16) is connected with bolts to pivot housing (11). Pivot housing (11) allows the wheels to oscillate tandem housing (16). Two wear rings (10), washers (5) and two seals (4) are between final drive housing (12) and pivot housing (11).

Wheel spindle housings (18) also contain the components for the service brakes. The brake components are lubricated and cooled by the oil in the tandem housing. This oil is circulated by the movement of the wheels. The compensator (20) can be used for checking the wear to brake components.

Reference: Refer to the Braking and Hydraulic Fan System System Operation, "Service Brakes" for additional information concerning the compensator.

Hydraulic Oil Additive

The service brakes on this machine are designed for operation with a hydraulic oil additive in the tandem oil. This additive reduces brake noise and the additive also reduces grabbing of the brakes.

Reference: Refer to the Operation and Maintenance Manual, “Capacities Refill” or the Operation and Maintenance Manual, “Lubricant Viscosities” for information regarding the addition of this Hydraulic Oil Additive.

i07244118

Graphic Color Codes

SMCS Code: 3000; 3100; 4000

i02572001

Wheel Group

SMCS Code: 4006; 4201; 4208

The wheel groups are located on the outside of the tandem housing. There are four wheel group assemblies on the machine. Power is transferred from the transmission through the differential and bevel gear to the final drives. The final drives transfer the power through the chain assemblies in the tandem to the sprocket of the wheel group. The sprocket is splined to the wheel spindle. Rotation of the wheel spindle transfers power to the wheels.

Reference: See the Power Train Systems Operation/ Testing and Adjusting, “Final Drive and Tandem Drive” for more information.

AA		KK	
BB		LL	
CC		MM	
DD		NN	
EE		PP	
FF		RR	
GG		SS	
HH		TT	
JJ		UU	

Illustration 83

g01861138

- (AA) Black. Mechanical connection or seal
- (BB) Dark Gray. Cutaway section
- (CC) Light Gray Surface of the part
- (DD) White Atmosphere or air (no pressure)
- (EE) Purple. Pneumatic pressure
- (FF) Yellow . . . Moving parts or activated components
- (GG) Green. Tank oil, suction oil, return oil, and case drain oil
- (HH) Brown. Lubricating oil
- (JJ) Green Stripes and White Stripes . . . Scavenge or suction oil
- (KK) Red. High pressure oil
- (LL) Red Stripes and White Stripes . . . Signal (First pressure reduction)

(MM) Red Crosshatch Signal (Second pressure reduction)

(NN) Pink Signal (Third pressure reduction)

(PP) Red and Pink Stripes . . . Secondary source of oil pressure

(RR) Orange Pilot, charge, or torque converter oil

(SS) Orange Stripes and White Stripes Reduced pilot, charge, or torque converter oil

(TT) Orange Crosshatch . . . Second reduction in pilot, charge, or torque converter oil

(UU) Blue Trapped oil

Troubleshooting Section

Introduction

i02798712

General Information

SMCS Code: 4800

Visual checks are the first steps in order to troubleshoot a problem. When the visual inspections are complete and the problem is not fully understood, perform operational checks. After visual inspections and operation checks are complete and the problem is not fully understood, perform test procedures. These procedures will help identify system problems. These procedures are located in the Testing and Adjusting module for your machine.

Reference: For the locations of your individual system components, refer to the Systems Operation module for your machine.

Reference: For more information on the electrical system, refer to the Electrical Schematic for your machine.

Reference: For more information on the hydraulic system, refer to the Hydraulic Schematic for your machine.

i02583823

Machine Preparation for Troubleshooting

SMCS Code: 3030-035

WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To help prevent possible injury, perform the procedure that follows before testing and adjusting the hydraulic and steering system:

WARNING

Check valves in the hydraulic system may allow pressure to exist in the hydraulic lines after the engine has been stopped. Pressure must be relieved prior to servicing the components of the hydraulic system. Failure to relieve pressure prior to servicing may result in personal injury.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

1. Move the machine to a smooth horizontal location. Move away from operating machines and move away from all personnel. Lower all implements to the ground. Place the joystick control for the blade lift control valve in the FLOAT position.
2. Install the wheel lean locking bolt in the front axle. Install the frame lock pin. Engage the parking brake and stop the engine.
3. Permit only one operator on the machine. Keep all other personnel away from the machine. Also, all personnel should be visible to the operator.
4. Place chocks in front of the wheels and behind the wheels.
5. Make sure that all hydraulic pressure is released before you perform any of the following procedures:
 - Loosen any fitting, any hose, or any component.
 - Tighten any fitting, any hose, or any component.
 - Remove any fitting, any hose, or any component.
 - Adjust any fitting, any hose, or any component.

6. After the pressure in the system has been released, carefully loosen fittings and remove lines or components.

i02196423

Visual Inspection

SMCS Code: 3030-035

The first step in the diagnosis of the power train is the performance of a visual inspection. A visual inspection must be performed prior to testing. Before you begin the checks, refer to Systems Operation, Testing and Adjusting, "Machine Preparation for Troubleshooting".

Perform the following visual checks:

1. Check the level of the differential oil sump. Check the oil for air or for water. If necessary, add oil to the differential. For the recommended oil grade and viscosity, refer to the appropriate Operation and Maintenance Manual for your machine.
2. Inspect the transmission oil for coolant on machines that use engine coolant to cool the transmission oil.
3. Inspect all oil lines, hoses, and connections for damage or leaks. Look for oil on the ground under the machine.
4. Remove the suction screen and clean the suction screen. Inspect the oil in the screen for foreign material. Remove the transmission oil filter and inspect the transmission oil filter for foreign material. Use a magnet in order to distinguish between any ferrous particles and any nonferrous particles.
5. The drive shafts and universal joints must be free to rotate except when cold oil causes a resistance.

Note: Make sure that the following conditions exist before you perform this test:

- The transmission must be in neutral.
- The wheels must be off the ground.
- The parking brake must be disengaged.

i02196433

Operational Checks

SMCS Code: 3030-035

The operational checks can help diagnose poor performance in the power train system.

1. Start the engine. Run the machine in all FORWARD gears and in all REVERSE gears.
2. Engage the differential lock while you are driving straight. Turn the machine slightly, and watch the rear wheels. The wheels should rotate at the same speed if the differential lock is working correctly. Disengage the differential lock.
3. Depress the clutch pedal while you operate the machine. The machine will slow down when the pedal is depressed further.
4. Stop the machine. Engage the parking brake.

Symptom Procedures

i05692091

Power Train

SMCS Code: 3030-035

Troubleshooting the Power Train

Problem: The transmission will not shift into any gear from the NEUTRAL position

Probable Causes

- Low Oil Level
- Low battery voltage
- Wiring harness connections
- Transmission control (shifter or forward, neutral, reverse toggle switch)
- Electrical problem with the clutch pedal
- Main relief valve
- Transmission oil pump
- Rotating seal leakage in the transmission
- Multiple ECPC valves are malfunctioning.
- The parking brake system is malfunctioning.

Problem: The transmission has lost a single gear

Probable Causes

- The wiring harness for the transmission control
- Transmission control (shifter or forward, neutral, reverse toggle switch)
- Electronic control module

Problem: The motor grader has lost multiple forward/reverse gear selections

Probable Causes

- Torsional coupling failure
- Wiring harness
- The ECPC valve is malfunctioning.

- Transmission control (shifter or forward, neutral, reverse toggle switch)
- Electronic control module
- Internal transmission problem

Note: Before performing test procedures that involve running the engine, check the magnetic screens in the transmission for bolts or metallic debris; this could indicate a torsional coupling failure.

Note: If the transmission will shift into FIRST SPEED FORWARD, FIFTH SPEED FORWARD, or FIRST SPEED REVERSE, the parking brake may be engaged or there is an electrical fault in the parking brake system.

Problem: The transmission slips

Probable Causes

- Low system pressure
- Differential lock valve
- The ECPC valve requires calibration.
- The ECPC valve is malfunctioning.
- Driver in the electronic control module
- Contamination
- Rotating shaft seal
- Rotating shaft O-ring
- Worn clutch
- Mechanical problem
- The calibration of the clutch pedal
- Clutch piston seal
- The sump has low oil level.
- The pump is causing aeration.

Problem: The motor grader creeps when the clutch pedal is fully depressed

Probable Causes

- Calibration for the clutch pedal
- The ECPC valve requires calibration.
- The ECPC valve is malfunctioning.
- Wiring harness for the ECPC valve
- Wiring harness for the transmission

- Contamination
- Driver in the electronic control module
- Internal clutch drag

Problem: When the transmission shifts a hesitation occurs

Probable Causes

- The ECPC valve requires calibration.
- The ECPC valve is malfunctioning.
- Contamination in the transmission control valve
- Oil temperature sensor
- Drivers in the electronic control module
- Speed sensors
- Internal seal leakage on the transmission
- Internal pump leakage
- Main relief valve
- Differential lock valve
- Communication link between engine and transmission
- The pump is causing aeration.

Problem: The transmission shifts are harsh

Probable Causes

- Transmission speed sensor
- Wiring harness for the transmission speed sensor
- Communication link between engine and transmission
- Oil temperature sensor
- The ECPC valve requires calibration.
- The ECPC valve is malfunctioning.
- Broken spring in the main relief valve
- A spool in the main relief valve sticks.
- The piston on a clutch sticks.

Problem: The transmission shifts are sluggish

Probable Causes

- Worn clutches
- The ECPC valve requires calibration.
- The ECPC valve is malfunctioning.
- Slow clutch disengagement
- The calibration of the proportional solenoid valve
- The parking brake system is malfunctioning.

Problem: The transmission shifts at the wrong point when the autoshift control is in the ON position

Probable Causes

- Transmission intermediate speed sensor
- Transmission input speed sensor
- Transmission output speed sensor
- The electronic control module has the wrong transmission configuration code.

Problem: The transmission does not shift into all the gears when the autoshift is in the ON position

Probable Causes

- Transmission intermediate speed sensor
- Transmission input speed sensor
- Transmission output speed sensor
- The top gear limit is set.
- The operator override is selected.

Problem: The transmission shifts into the wrong gear when the autoshift is in the ON position

Probable Causes

- Transmission intermediate speed sensor
- Transmission input speed sensor
- Transmission output speed sensor
- The wiring harness for the ECPC valve is bad.
- The wiring harness for the transmission ECM is bad.

Troubleshooting the Parking Brake System

Problem: The parking brake does not hold the machine stationary.

Probable Causes

- The brake linings for the parking brake are worn.
- There is grease or oil on the brake lining.
- The parking brake must be adjusted.

Problem: The parking brake does not engage when the parking brake switch is actuated.

Probable Causes

- The parking brake switch is faulty.
- The parking brake solenoid is not operating properly.
- The main relief valve setting for the transmission is incorrect.
- The piston seals are damaged or broken.

Testing And Adjusting Section

Testing and Adjusting

i05300588

Parking Brake - Test

SMCS Code: 4267-081

Note: Be sure that the machine has the **352-5716 Power Train Software Gp** or newer before performing this test.

Introduction

WARNING

Personal injury can result if the machine moves while testing the parking brake.

If the machine begins to move during the test, reduce the engine speed immediately and apply the service brakes.

The following test is used to determine if the parking brake is functional. This test is intended to measure the maximum brake holding effort. The brake holding effort that is required to prevent a machine from moving at a specific engine rpm varies depending on the machine. The variations are the differences in the engine setting, in the power train efficiency, and in the brake holding ability.

Machine Preparation

Note: Be sure that the machine has the correct software for the transmission for this test.

Check the area around the machine. Make sure that the machine is clear of personnel and clear of obstacles.

Test the parking brake on a dry, level surface.

Fasten the seat belt before testing the parking brake.

Test Procedure

1. Start the engine and set the throttle to the HIGH IDLE. Raise the implements slightly.
2. Ensure that the parking brake is engaged.
3. Depress the transmission modulator control (inching pedal).

Note: Do not apply the service brakes.

4. Depress the up shift control four times in order to select "5F". The display should read "5F".

Note: This step must be completed within 2 seconds.

5. Shift the transmission to the FORWARD direction.

Note: When, the transmission is shifted into "5F" and the parking brake is engaged a Warning Category 3 will occur.

6. With the engine at high idle, slowly release the pedal until the transmission automatically shifts to neutral. The engine speed will recover to the initial set point.

7. Shift the transmission to the NEUTRAL position. Run the engine at 1500 rpm for at least two minutes in order to cool the transmission oil.

Note: Do not shut down the engine until the oil is cooled properly. Do not repeat the test procedure until the oil is cooled down properly.

8. Lower the implements to the ground.

9. Stop the engine.

NOTICE

If the machine moved while testing the parking brake, inspect the parking brake components for wear or damage. Repair or replace the worn or damaged parking brake components as required before returning the machine to service.

i05737947

Fill Time for the Transmission Clutch - Calibrate

SMCS Code: 3155-524-FW

Introduction

The following procedure is used to calibrate the fill time for the transmission clutches.

Improper calibration of the transmission clutch fill will cause transmission shifting problems. The automatic calibration procedure for setting the transmission clutch fill will achieve greater consistency. The main relief valve must be calibrated.

Reference: Refer to Testing and Adjusting, "Power Train Charge System Pressure - Test and Adjust" for information about setting the relief valve.

Reference: Refer to the Troubleshooting manual for information about Cat ET error codes.

Note: Do not perform this procedure if software has just been uploaded into the Transmission/Chassis electronic control module. Cycle the power for the transmission/chassis electronic control module prior to performing this procedure.

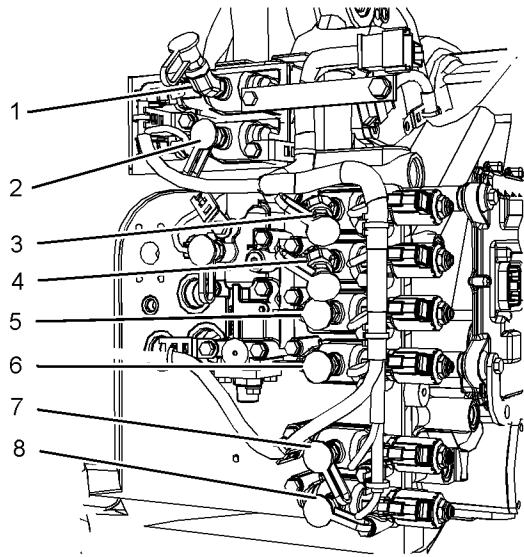


Illustration 84 g01285415

- (1) Modulating valve for clutch 1 (forward high)
- (2) Modulating valve for clutch 2 (forward low)
- (3) Modulating valve for clutch 3 (reverse)
- (4) Modulating valve for clutch 4 (second speed)
- (5) Modulating valve for clutch 5 (third speed)
- (6) Modulating valve for clutch 6 (first speed)
- (7) Modulating valve for clutch 7 (low range)
- (8) Modulating valve for clutch 8 (high range)

The modulating control valves are mounted on the rear of the transmission on the left side of the machine. There is one modulating valve for each of the eight transmission clutches. Illustration 84 shows the location of the modulating valves for the clutches. The machine is equipped with the following clutches:

- Modulating valve for clutch 1 (1) (forward high)
- Modulating valve for clutch 2 (2) (forward low)
- Modulating valve for clutch 3 (3) (reverse)
- Modulating valve for clutch 4 (4) (second speed)
- Modulating valve for clutch 5 (5) (third speed)
- Modulating valve for clutch 6 (6) (first speed)
- Modulating valve for clutch 7 (7) (low range)
- Modulating valve for clutch 8 (8) (high range)

Required Tools

Table 2

Required Tools		
Tool	Description	Qty
D	Caterpillar Electronic Technician (ET)	1

Machine Preparation

WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

NOTICE

Do not connect or disconnect hose fittings to or from the quick disconnect nipples when there is pressure in the system. This will prevent damage to the seals that are in the fitting.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

The following conditions must be met before calibration:

- The main relief valve must be calibrated.
- The machine speed must be zero.
- The engine must be running.
- The parking brake must be set.
- The implement lockout switch must be in the locked position.
- The transmission filter bypass must not be bypassing.
- The transmission oil temperature must be at an operating temperature of 80° ± 10°C (176° ± 18°F).

- The inching pedal must be fully released in order to allow the automatic calibration function to start.
- The service brake pedal must be fully released in order to allow the automatic calibration function to start.

Reference: Refer to Testing and Adjusting, “Power Train Charge System Pressure - Test and Adjust” for information about setting the relief valve.

Note: Bumping of the inching pedal or bumping of the service brake pedal during the automatic calibration function will cause the calibration procedure to be aborted.

Note: If a new modulating valve was installed, start the engine and shift the transmission for at least 12 times into a speed or a direction that uses the new clutch solenoid modulating valve. Refer to Table 3 in order to identify the clutches that are engaged for each direction and each gear.

Table 3

	Clutch 1 (forward high)	Clutch 2 (forward low)	Clutch 3 (reverse)	Clutch 4 (second speed)	Clutch 5 (third speed)	Clutch 6 (first speed)	Clutch 7 (low range)	Clutch 8 (high range)
First Speed Forward	X					X	X	
Second Speed Forward		X		X			X	
Third Speed Forward		X			X		X	
Fourth Speed Forward	X				X		X	
Fifth Speed Forward	X					X		X
Sixth Speed Forward		X		X				X
Seventh Speed Forward	X			X				X
Eighth Speed Forward	X				X			X
Neutral					X			X
First Speed Reverse			X			X	X	
Second Speed Reverse			X	X			X	
Third Speed Reverse			X		X		X	
Fourth Speed Reverse			X			X		X
Fifth Speed Reverse			X	X				X
Sixth Speed Reverse			X		X			X

Calibration Procedure

The Caterpillar Electronic Technician (ET) is used to access the calibration procedures. A message on Cat ET screen will give instructions that guide the user through the calibration procedure. Refer to the Manual that is provided with Cat ET for more information about Cat ET.

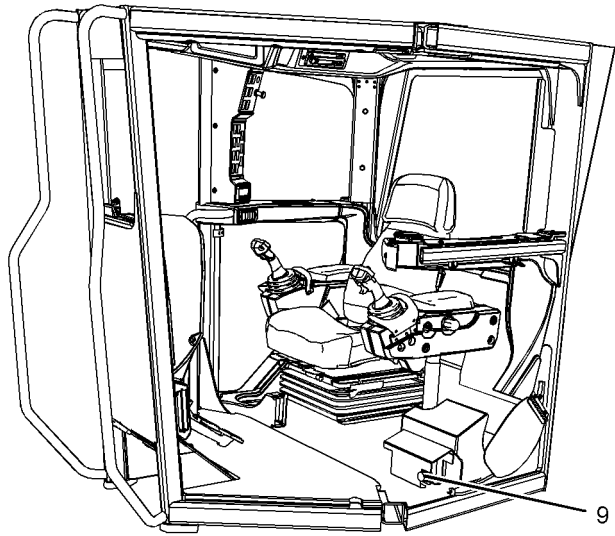


Illustration 85

g01133440

Cutaway view of the cab

(9) Service connector

1. Connect Cat ET to service connector (9).
2. Open Cat ET. Select the transmission Electronic Control Module (ECM) for the machine that is being calibrated.
3. If the conditions that are listed above in Preparation for Calibration Procedure are met, the display will inform the technician to press NEXT in order to advance to the next step.

Note: During the calibration of the transmission clutch fill, many transmission clutch fills are occurring. Remain seated. There will be some vibration and noise as the clutches are being calibrated. If any of the conditions for calibration are violated during the calibration, the calibration will be stopped. **Do not operate the air conditioning or hydraulics during the calibration of the solenoids. During the automatic calibration function, avoid performing steering movements.**

Note: At any time during the calibration, the user can abort the calibration by pressing the CANCEL button. Depressing the clutch pedal or depressing the service brake pedal will also abort the calibration.

4. The ECM will command the engine to run at 1,700 rpm.

Note: The engine must achieve the requested speed in a maximum of five seconds. If the engine does not reach the requested rpm in the given amount of time, the ECM will abort the calibration due to an incorrect engine speed.

5. The display will continuously display "Calibrating Clutch #8". The ECM will fill clutch 8 and the ECM will drain clutch eight several times. The ECM will formulate the optimal hold current and the optimal ramp levels for the solenoid that operates the modulating valve for clutch 8. When the ECM has completed calibrating this clutch, Cat ET automatically moves to the next step.
6. The display will continuously display "Calibrating Clutch #7". The ECM will fill clutch 7 and the ECM will drain clutch seven several times. The ECM will formulate the optimal hold current and the optimal ramp levels for the solenoid that operates the modulating valve for clutch 7. When the ECM has completed calibrating this clutch, Cat ET automatically moves to the next step.
7. The display will continuously display "Calibrating Clutch #6". The ECM will fill clutch 6 and the ECM will drain clutch six several times. The ECM will formulate the optimal hold current and the optimal ramp levels for the solenoid that operates the modulating valve for clutch 6. When the ECM has completed calibrating this clutch, Cat ET automatically moves to the next step.
8. The display will continuously display "Calibrating Clutch #5". The ECM will fill clutch 5 and the ECM will drain clutch five several times. The ECM will formulate the optimal hold current and the optimal ramp levels for the solenoid that operates the modulating valve for clutch 5. When the ECM has completed calibrating this clutch, Cat ET automatically moves to the next step.
9. The display will continuously display "Calibrating Clutch #4". The ECM will fill clutch 4 and the ECM will drain clutch four several times. The ECM will formulate the optimal hold current and the optimal ramp levels for the solenoid that operates the modulating valve for clutch 4. When the ECM has completed calibrating this clutch, Cat ET automatically moves to the next step.
10. The display will continuously display "Calibrating Clutch #3". The ECM will fill clutch 3 and the ECM will drain clutch three several times. The ECM will formulate the optimal hold current and the optimal ramp levels for the solenoid that operates the modulating valve for clutch 3. When the ECM has completed calibrating this clutch, Cat ET automatically moves to the next step.

- 11. The display will continuously display "Calibrating Clutch #2". The ECM will fill clutch 2 and the ECM will drain clutch two several times. The ECM will formulate the optimal hold current and the optimal ramp levels for the solenoid that operates the modulating valve for clutch 2. When the ECM has completed calibrating this clutch, Cat ET automatically moves to the next step.
- 12. The display will continuously display "Calibrating Clutch #1". The ECM will fill clutch 1 and the ECM will drain clutch one several times. The ECM will formulate the optimal hold current and the optimal ramp levels for the solenoid that operates the modulating valve for clutch 1. When the ECM has completed calibrating this clutch, Cat ET automatically moves to the next step.
- 13. The ECM will command the engine to resume normal operations.
- 14. Once the calibration has been completed successfully, the ECM will write the calibration data to memory.
- 15. Power cycle the key switch and operate the machinery in order to check the quality of transmission shift.

i06229080

Power Train Charge System Pressure - Test and Adjust

SMCS Code: 5117-025-PWT; 5117-081-PWT

Introduction

WARNING

When testing and adjusting the transmission and power train, move the machine to an area clear of obstructions, with safe exhaust ventilation for the exhausts. Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before testing and adjusting the transmission and power train.

WARNING

Personal injury can result from spring force released when removing cap screws.

Internal spring force will be released when cylinder assembly cap screws are removed causing injury.

Always restrain cover as cap screws are loosened.

Follow the established procedure in the Service Manual to service these parts.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

The following procedure is used in order to test the charge system for the power train.

Specifications

Table 4

Worksheet	
Target Pressure	Actual Pressure
2480 ± 35 kPa (360 ± 5 psi)	

Required Tools

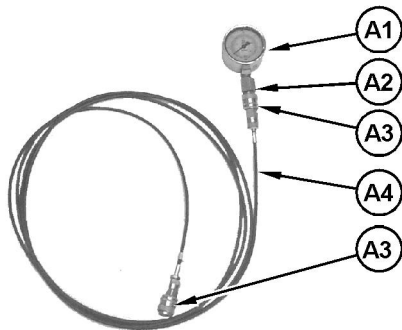


Illustration 86

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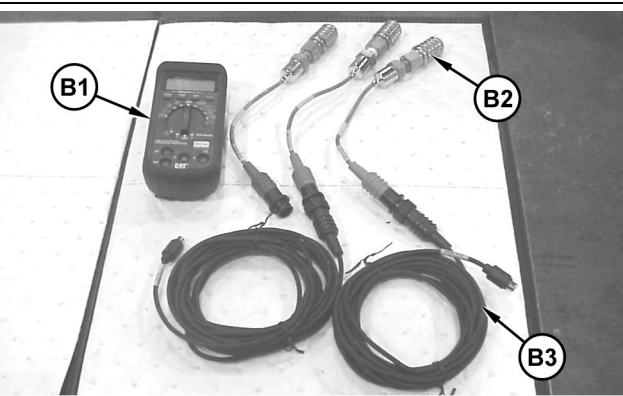


Illustration 87

g01623868

Table 5

Tool	Item	Part Number	Description	Qty
A	A1	8T-0855	Pressure Gauge (0 to 4,000 kPa (0 to 580 psi))	1
	A2	6V-3989	Fitting	1
	A3	6V-4143	Quick Connect Coupler	2
	A4	177-7860	Hose As (3.0 m (10 ft))	1
B		198-4240	Digital Pressure Indicator Gp	
	B1	198-4234	Digital Indicator	1
	B2	198-4237	Pressure Sensor Gp (0 to 3,445 kPa (0 to 500 psi))	1
	B3	198-4236	Adapter Cable As	1

Test Preparation

Reference: Before you perform this adjustment, refer to Testing and Adjusting, “Machine Preparation”.

1. Operate the machine until the transmission oil is at operating temperature range of 75 °C to 90 °C (167 °F to 194 °F).
2. Stop the machine on a hard level surface. Move the transmission control lever to the NEUTRAL position. Shut off the engine. Place blocks in front of the wheels and place blocks behind the wheels.
3. Engage the parking brake.

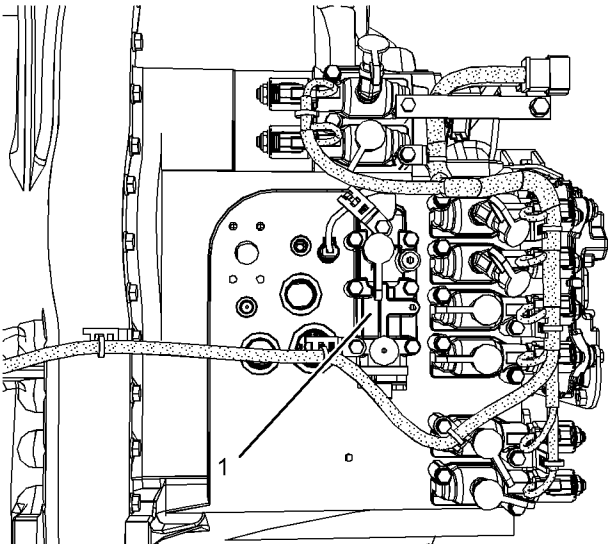


Illustration 88

g01488477

Left side view of the transmission

(1) Main relief valve

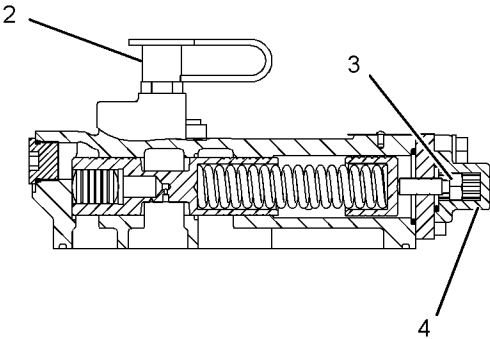


Illustration 89

g01302695

Main relief valve

- (2) Dust cap
(3) Adjustment screw
(4) Cover

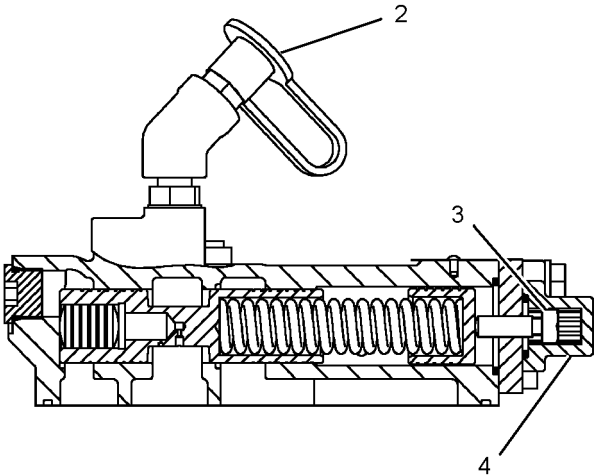


Illustration 90

g01127091

4. Remove dust cap (2). Attach Tooling (A) to the fitting.

Test Procedure

1. Be sure that the transmission control lever is in the NEUTRAL position. Start the engine and run the engine at high idle.
2. At high idle, the pressure should be 2480 ± 35 kPa (360 ± 5 psi).

Adjustment Procedure

1. If the pressure is more than 2480 ± 35 kPa (360 ± 5 psi), remove cover (4) and turn adjustment screw (3) counterclockwise until pressure reaches 2480 ± 35 kPa (360 ± 5 psi).
2. If the pressure is less than 2480 ± 35 kPa (360 ± 5 psi), remove cover (4) and turn adjustment screw (3) clockwise until pressure reaches 2480 ± 35 kPa (360 ± 5 psi).
3. Once the indicated pressure has been reached, release and engage the parking brake again. If the pressure reading has changed, repeat Step 1 or Step 2 until pressure reading reaches 2480 ± 35 kPa (360 ± 5 psi).
4. Replace the adjustment screw cover (4).

5. Turn off the engine and remove the test equipment. Install dust cap (2).

i06229082

Transmission Lubrication Oil Pressure - Test

SMCS Code: 3080-032-PX

Specifications

Table 6

Transmission Lubrication Pressure (Minimum)		
	Neutral	First Gear Forward
LOW Idle	14 kPa (2 psi)	6 kPa (1 psi)
HIGH Idle	275 kPa (40 psi)	135 kPa (20 psi)

Table 7

Transmission Lubrication Pressure Differential Lock in the "ON" Position		
	Neutral	First Gear Forward
LOW Idle		
HIGH Idle		
Transmission Lubrication Pressure Differential Lock in the "OFF" Position		
	Neutral	First Gear Forward
LOW Idle		
HIGH Idle		

Introduction

⚠ WARNING

When testing and adjusting the transmission and power train, move the machine to an area clear of obstructions, with safe exhaust ventilation for the exhausts. Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before testing and adjusting the transmission and power train.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

The following procedure is used to test the pressure of the transmission lubrication oil.

Required Tools

Table 8

Tool	Item	Part No	Description	Qty
A	A1	8T-0854	Pressure Gauge (0 to 1,000 kPa (0 to 145 psi))	1
	A2	6V-3989	Fitting	1
	A3	6V-4143	Quick Connect Coupler	2
	A4	177-7860	Hose As (3.0 m (10 ft))	1
D	D1	148-8309	Adapter As	1
	D2	164-5567	Quick Disconnect Coupler As	1

Test Preparation

Before you begin this procedure, refer to Testing and Adjusting, "Machine Preparation".

1. Operate the machine until the transmission oil is at operating temperature of 51 °C (124 °F).
2. Stop the machine on a hard level surface. Engage the parking brake. Turn off the engine.

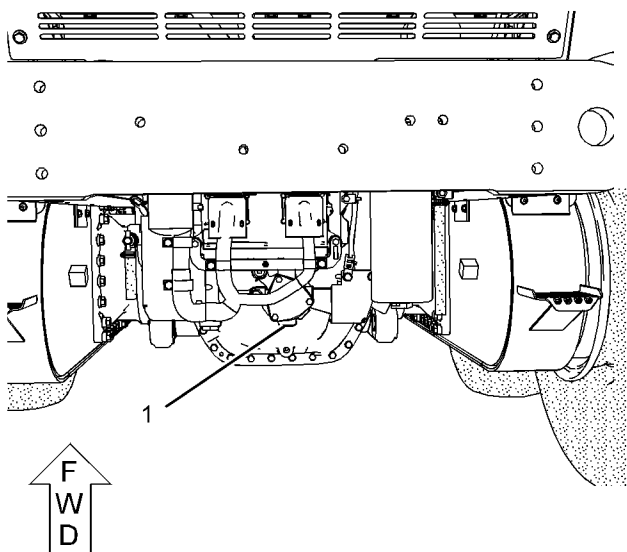


Illustration 91

g01378070

Rear view of the machine

(1) Plug

3. Remove plug (1) from the transmission case. Install Tooling (D) into the port. Attach Tooling (A) onto Tooling (D).

4. Place the machine on stands so that the rear wheels are off the ground.

Note: Make sure that the All Wheel Drive system is turned off.

Note: Support the tandem in order to prevent the tandem from torquing when the service brake is applied.

Test Procedure

1. Start the engine.
2. Apply the parking brake. Turn the differential lock to the "ON" position. Operate the machine in NEUTRAL at low idle. The pressure on the gauge should be a minimum of 14 kPa (2 psi). Record the gauge reading in Table 7 .
3. Operate the machine in NEUTRAL at high idle. The pressure on the gauge should be a minimum of 275 kPa (40 psi). Record the gauge reading in Table 7 .
4. Disengage the parking brake. Operate the machine in FIRST GEAR FORWARD at low idle. The gauge pressure should be a minimum 6 kPa (1 psi). Record the gauge reading in Table 7 .
5. Operate the machine in FIRST GEAR FORWARD at high idle. The gauge pressure should be a minimum 135 kPa (20 psi). Record the gauge reading in Table 7 .
6. Repeat Step 2 through Step 5 with the differential lock in the OFF position. Transmission lubrication pressures that vary with the differential lock in the ON position indicate leakage in the differential lock system.
7. Stop the machine.
8. Turn off the engine.
9. Remove the stands that were installed under the machine.
10. Remove the test equipment.

11. Install the plug that was removed in Step 3.

i07307438

Transmission Pressures - Test and Adjust

SMCS Code: 3030-081-PX; 3030-025-PX; 3073-025-PX; 3073-081-PX; 3074-081-PX; 3074-025-PX

Specifications

Table 9

Transmission Clutch Pressures				
Test Port	NEUTRAL	FIRST GEAR FORWARD	SECOND GEAR FORWARD	FIRST GEAR REVERSE
(1)				
(2)				
(3)				
(4)				
(5)				
(6)				
(7)				
(8)				

Table 10

Transmission Clutch Pressures				
Test Port	NEUTRAL	FIRST GEAR FORWARD	SECOND GEAR FORWARD	FIRST GEAR REVERSE
(1)	0.0 kPa (0.00 psi)	1925 ± 220 kPa (280 ± 32 psi)	0.0 kPa (0.00 psi)	0.0 kPa (0.00 psi)
(2)	0.0 kPa (0.00 psi)	0.0 kPa (0.00 psi)	1925 ± 220 kPa (280 ± 32 psi)	0.0 kPa (0.00 psi)
(3)	0.0 kPa (0.00 psi)	0.0 kPa (0.00 psi)	0.0 kPa (0.00 psi)	1925 ± 220 kPa (280 ± 32 psi)
(4)	0.0 kPa (0.00 psi)	0.0 kPa (0.00 psi)	2480 ± 70 kPa (360 ± 10 psi)	0.0 kPa (0.00 psi)
(5)	2480 ± 70 kPa (360 ± 10 psi)	0.0 kPa (0.00 psi)	0.0 kPa (0.00 psi)	0.0 kPa (0.00 psi)
(6)	0.0 kPa (0.00 psi)	2480 ± 70 kPa (360 ± 10 psi)	0.0 kPa (0.00 psi)	2480 ± 70 kPa (360 ± 10 psi)
(7)	0.0 kPa (0.00 psi)	2480 ± 70 kPa (360 ± 10 psi)	2480 ± 70 kPa (360 ± 10 psi)	2480 ± 70 kPa (360 ± 10 psi)
(8)	2480 ± 70 kPa (360 ± 10 psi)	0.0 kPa (0.00 psi)	0.0 kPa (0.00 psi)	0.0 kPa (0.00 psi)

Introduction

WARNING

When testing and adjusting the transmission and power train, move the machine to an area clear of obstructions, with safe exhaust ventilation for the exhausts. Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before testing and adjusting the transmission and power train.

WARNING

Personal injury can result from spring force released when removing cap screws.

Internal spring force will be released when cylinder assembly cap screws are removed causing injury.

Always restrain cover as cap screws are loosened.

Follow the established procedure in the Service Manual to service these parts.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

The following test is used to test the transmission pressures.

Required Tools

Table 11

Tool	Item	Part Number	Description	Qty
A	A1	8T-0855	Pressure Gauge (0 to 4,000 kPa (0 to 580 psi))	1
	A2	6V-3989	Fitting	1
	A3	6V-4143	Quick Connect Coupler	2
	A4	177-7860	Hose As (3.0 m (10 ft))	1
B		198-4240	Digital Pressure Indicator Gp	

(Table 11, contd)

Tool	Item	Part Number	Description	Qty
	B1	198-4234	Digital Indicator	1
	B2	198-4237	Pressure Sensor Gp (0 to 3,445 kPa (0 to 500 psi))	1
	B3	198-4236	Adapter Cable As	1
D	D1	326-8026	Transmission Test Cover	1

Test Preparation

Before you begin this procedure, refer to Testing and Adjusting, "Machine Preparation".

1. Operate the machine until the transmission oil is at operating temperature of 75 °C to 90 °C (167 °F to 194 °F).
2. Stop the machine on a hard level surface. Place the transmission in NEUTRAL. Turn off the engine. Place blocks in front of the wheels and place blocks behind the wheels.

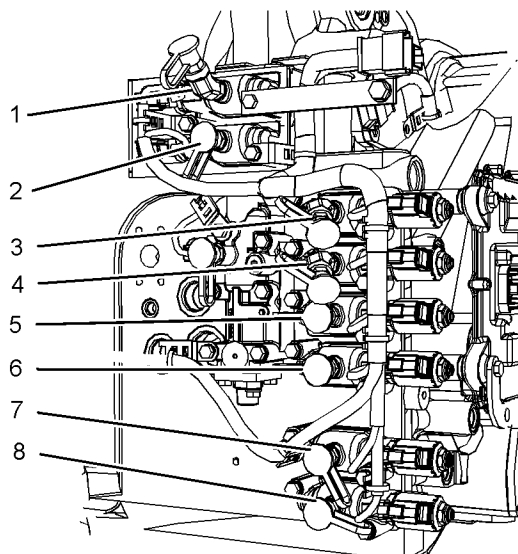


Illustration 92

g01285415

- (1) Test port for clutch 1 (forward high)
- (2) Test port for clutch 2 (forward low)
- (3) Test port for clutch 3 (reverse)
- (4) Test port for clutch 4 (second speed)
- (5) Test port for clutch 5 (third speed)
- (6) Test port for clutch 6 (first speed)
- (7) Test port for clutch 7 (low range)
- (8) Test port for clutch 8 (high range)

(continued)

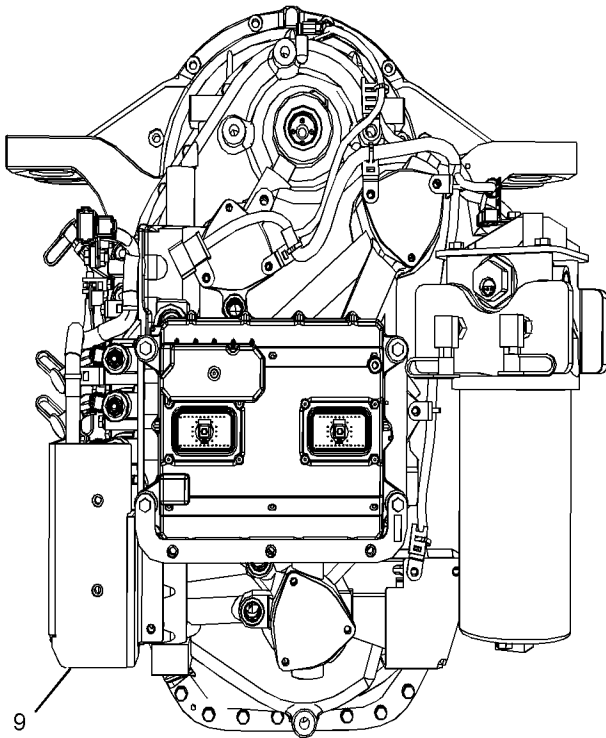


Illustration 93

g01285414

Rear view of the transmission

(9) Cover for the transmission control valve

3. Remove cover (9) from the transmission.
4. Remove the drive shaft guard.
5. Remove the differential drive shaft.
6. Assemble Tooling (D) with the 25.4 mm (1.00 inch) bumper.
7. Use the bolt holes for the drive shaft guard to attach Tooling (D) to the parking brake housing.

Test Procedure

1. Attach Tooling (A) or (B) to test ports (5) and (8). Operate the engine at high idle with the transmission in NEUTRAL. Tooling (A) or (B) should read 2480 ± 70 kPa (360 ± 10 psi). Record the pressure readings in Table 9 . Remove Tooling (A) or (B).
2. Attach Tooling (A) or (B) to test port (1), (6), and (7). Operate the engine at high idle with the transmission in FIRST GEAR FORWARD. Tooling (A) or (B) should read 1925 ± 220 kPa (280 ± 32 psi) for test port (1) and 2480 ± 70 kPa (360 ± 10 psi) for test ports (6) and (7). Record the pressure readings in Table 9 . Remove Tooling (A) or (B) from test port (1).

3. Attach Tooling (A) or (B) to test ports (3), (6), and (7). Operate the engine at high idle with the transmission in FIRST GEAR REVERSE. Tooling (A) or (B) should read 1925 ± 220 kPa (280 ± 32 psi) for test port (3) and 2480 ± 70 kPa (360 ± 10 psi) for test ports (6) and (7). Record the pressure readings in Table 9 . Remove Tooling (A) or (B) from test ports (3), and (6).
4. Attach Tooling (A) or (B) to test ports (2), (4), and (7). Operate the engine at high idle with the transmission in SECOND GEAR FORWARD. Tooling (A) or (B) should read 1925 ± 220 kPa (280 ± 32 psi) for test port (2) and 2480 ± 70 kPa (360 ± 10 psi) for test ports (4) and (7). Record the pressure readings in Table 9 . Remove tooling (A) or (B).
5. Stop the engine.
6. Install the cover (9) and the differential drive shaft.

Note: If all the pressure readings are not within the specified pressure ranges listed in Table 10 , the main relief valve may need to be adjusted. Refer to Testing and Adjusting, "Power Train Charge System Pressure - Test and Adjust" for information about adjusting the main relief valve. The Testing and Adjusting, "Fill Time for the Transmission Clutch - Calibrate" procedure will not affect the top pressure of the clutch.

Note: If some of the pressure readings are not within the specified pressure range that is listed in Table 10 , those modulating valves may need to be replaced.

i08066669

Tandem - Check

SMCS Code: 4064-535

Introduction

The following procedure is used to check the wear of the final drive thrust washer and check to ensure the oscillation joint was assembled correctly. For example, if the final drive lip seal is leaking, this procedure can be used to check if the oscillation joint integrity is contributing to a leaking lip seal.

Check Preparation

WARNING

Personal injury or death can result from improper lifting or blocking.

When a hoist or jack is used to lift any part or component, stand clear of the area. Be sure the hoist or jack has the correct capacity to lift a component. Install blocks or stands before performance of any work under a heavy component.

Approximate weights of the components are shown. Clean all surfaces where parts are to be installed.

WARNING

Personal injury or death can result from sudden machine movement.

Sudden movement of the machine can cause injury to persons on or near the machine.

Prevent possible injury by performing the procedure that follows before working on the machine.

1. Park the machine on a level surface.
2. Apply the service brake in order to stop the machine. Move the transmission control lever to the NEUTRAL position.
3. Move the speed control lever to the LOW IDLE position.
4. Engage the parking brake.
5. Stop the engine.
6. Turn the engine start switch to OFF position and remove the key.
7. Turn battery disconnect switch to the OFF position.

Check Procedure

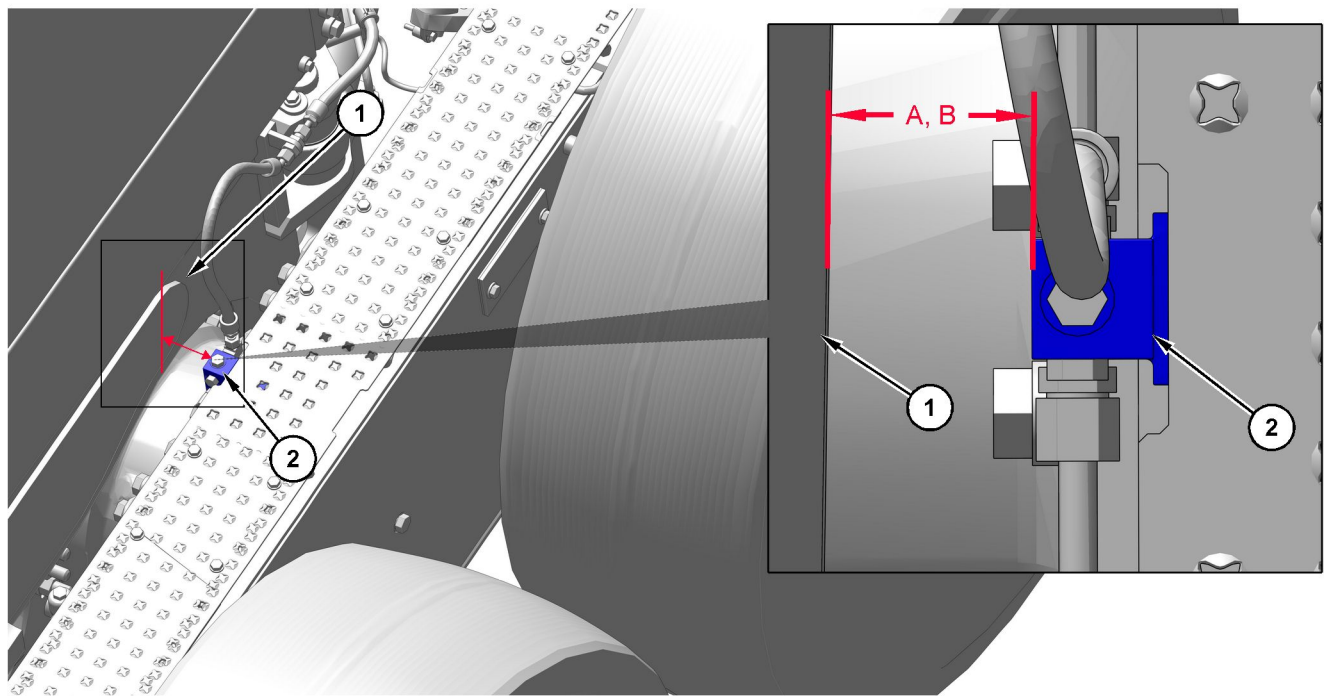


Illustration 94

g06528822

View of the space between the cat walk and the enclosure

(1) Engine Enclosure (2) Brake Junction Block

1. With the machine on level ground, record the distance from the engine enclosure (1) to the brake junction block (2) on top of the tandem case (A).

Note: Make sure that the implements are raised so that the machine weight is fully on the tires.

2. Raise the back of the machine into the air so all the machine weight is off the tires and oscillation joint hangs freely. If machine is equipped with ripper, this can be used to raise rear of machine. Using the same reference points on the enclosure and the brake junction block, record dimension (B).

3. Subtract the value found in Step 1 from the value found in Step 2, and record the difference. The difference is the tandem sag measurement.

4. If tandem sag measurement reaches the measurement provided in Table 12 , schedule an immediate rebuild to prevent square or top hat housing (oscillation joint) damage.

Table 12

Model	Tandem Sag
14M	6.7 mm (0.26 inch)
16M	6.4 mm (0.25 inch)

5. Repeat this process on the other side of the machine.

i08111971

Drive Chain - Check

SMCS Code: 3261; 4063

Introduction

The following procedure is used to check the elongation of the drive chains.

It is important to check the chains inside the tandem drives for wear. Normal operation will cause the pins, links, and rollers in the chains to wear. The chart lists the maximum limits of chain wear for a given number of chain links. Elongation of the chain due to wear is considered normal. Elongation of 3% is normal for all motor graders. The chain should be replaced when the chain reaches the maximum allowable wear. This action will prevent possible damage that could be caused by a broken chain.

Note: A broken chain can wedge in the tandem housing. A wedged chain can damage the following items: sprockets, spindles, and housings.

Machine Preparation

Reference: Refer to the Power Train Disassembly and Assembly, "Drive Chain - Remove".

1. Remove the Drive Chain from the motor grader.

Test Procedure

1. Inspect the chains. Replace the chains for the following conditions:

- Cracks
- Broken components
- Deformation

Note: If the chain does not pass the inspection, the entire chain must be replaced. Always replace both chains in a tandem housing at the same time. Do not splice a new section of chain on a worn section of chain. Worn chains will not engage the sprockets properly and increased damage to the sprocket may occur.

WARNING

Personal injury or death can result from improper lifting or blocking.

When a hoist or jack is used to lift any part or component, stand clear of the area. Be sure the hoist or jack has the correct capacity to lift a component. Install blocks or stands before performance of any work under a heavy component.

Approximate weights of the components are shown. Clean all surfaces where parts are to be installed.

2. Suspend the chain from the hoist.
3. Hang a suitable scale from the chain. The scale must be able to measure the chain tension that is listed in Table 13 .
4. Fix the free end of the scale to the motor grader.

Reference: Refer to the Operation and Maintenance Manual, "Lifting and Tying Down the Machine" for the proper lifting locations for a motor grader.

5. Apply the proper amount of chain tension. Refer to Table 13 . Ensure that all the slack is out of the chain before a measurement is taken.

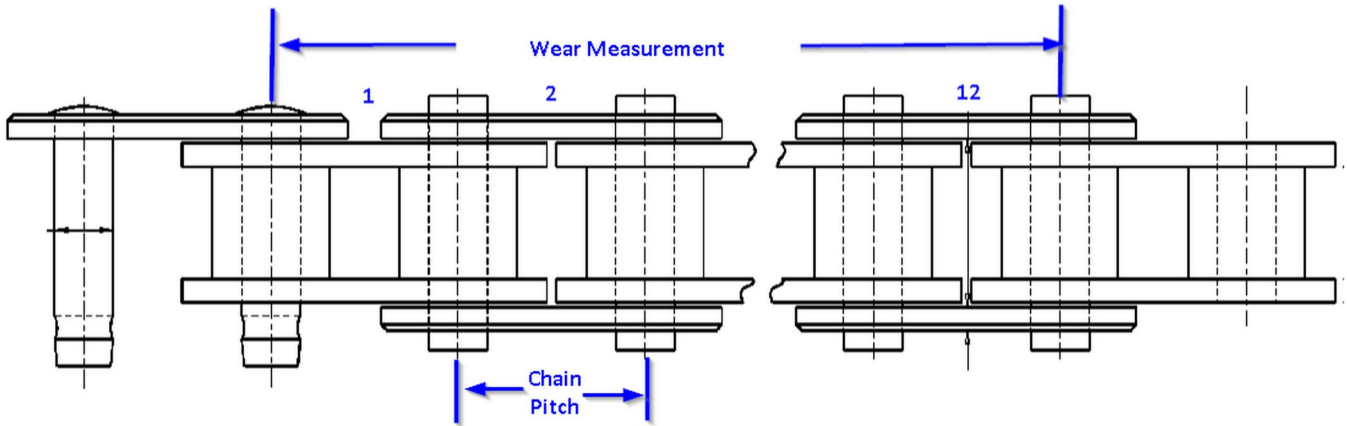


Illustration 95 g06549003

Example showing measurement of chain links

6. Measure the number of chain links that are listed in Table 13 .

Note: Measure the chain from link pin to link pin.

7. The elongation of the chain must be less than the specification in Table 13 .

Note: If the elongation of the chain is not within specifications, the chain must be replaced. Replace the entire chain. Always replace both chains in a tandem housing at the same time. Do not splice a new section of chain on a worn section of chain. Worn chains will not engage the sprockets properly and increased damage to the sprocket may occur.

8. You may reuse the old chain if the chain passed the checks for chain wear. Otherwise install a new chain.

Reference: Refer to the Power Train Disassembly and Assembly, “Drive Chain - Install”.

Refer to the following table for the limits for chain wear.

Table 13

Limits for Wear of the Chain					
Model	Chain Pitch	Number of Chain Links	New Measurement	Measurement of Maximum Wear	Chain Tension ⁽¹⁾
14M	57.2 mm (2.25 inch)	11	628.7 mm (24.75 inch)	647.7 mm (25.50 inch)	286 kg (630 lb)
16M	63.5 mm (2.50 inch)	10	635 mm (25 inch)	654.1 mm (25.75 inch)	354 kg (780 lb)

⁽¹⁾ The chain is put into tension to displace oil between the components of the chain. This will help to ensure metal-to-metal contact between the components. This will also ensure an accurate measurement.

i06229069

Differential Lock Pressure - Check

SMCS Code: 3272-535-PX

Specifications

Table 14

Worksheet	
Target Pressure	Actual Pressure
2480 ± 70 kPa (360 ± 10 psi)	

Introduction

WARNING

When testing and adjusting the transmission and power train, move the machine to an area clear of obstructions, with safe exhaust ventilation for the exhausts. Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before testing and adjusting the transmission and power train.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

The following procedure is used in order to test the operation of the differential lock.

Required Tools

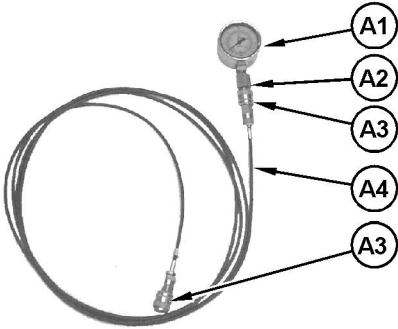


Illustration 96

g01089423

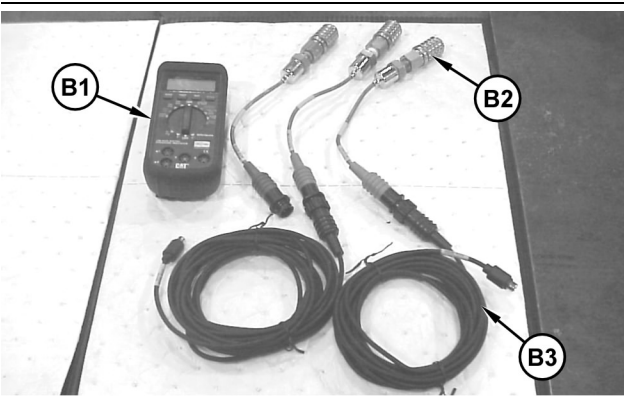


Illustration 97

g01623868

Table 15

Tool	Item	Part Number	Description	Qty
A	A1	8T-0855	Pressure Gauge (0 to 4,000 kPa (0 to 580 psi))	1
	A2	6V-3989	Fitting	1
	A3	6V-4143	Quick Connect Coupler	2
	A4	177-7860	Hose As (3.0 m (10 ft))	1
B		198-4240	Digital Pressure Indicator Gp	
	B1	198-4234	Digital Indicator	1
	B2	198-4237	Pressure Sensor Gp (0 to 3,445 kPa (0 to 500 psi))	1
	B3	198-4236	Adapter Cable As	1

Check Preparation

Reference: Before you perform this adjustment, refer to Testing and Adjusting, “Machine Preparation”.

- 1. Operate the machine until the transmission oil is at operating temperature of 75 °C to 90 °C (167 °F to 194 °F).
- 2. Stop the machine on a hard level surface. Engage the parking brake. Shut off the engine.

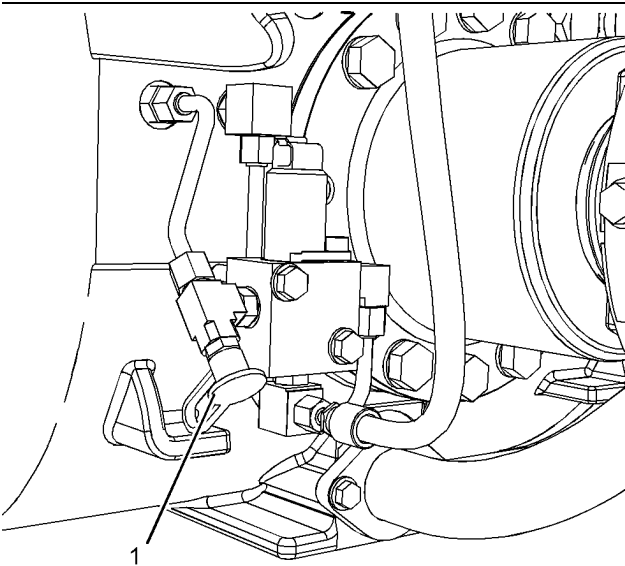


Illustration 98
Test port (1)

- 3. Remove the dust cap. Attach Tooling (A) or Tooling (B) to test port (1).

Test Procedure

- 1. Start the engine and run the engine at high idle.
- 2. Move the differential lock switch to the ON position.
- 3. The gauge should read 2480 ± 70 kPa (360 ± 10 psi). If the pressure reading is too high or if the pressure reading is too low, the transmission relief valve may need adjusted.

Reference: Refer to Testing and Adjusting, “Power Train Charge System Pressure - Test and Adjust” for more information about setting the transmission relief valve.

- 4. If the setting for the transmission relief valve is correct and the pressure reading is still incorrect, inspect the differential lock valve. If the differential lock valve appears to be working properly, the differential lock clutch may need serviced.

- 5. Shut off the engine. Remove the test equipment.

i07914968

Final Drive Oscillation Joint End Play - Check

SMCS Code: 4050-535

S/N: B9H1–Up

S/N: B9J1–Up

Introduction

The following procedure is used in order to check the end play of the final drives.

Required Tools

Table 16

Required Tools			
Item	Qty	Part Number	Description
1	2	5F - 7341	Adapter
2	2		Threaded Rod
3	4	1B - 4206	Nut
4	4	4B - 5275	Washer
5	1	8S - 2328	Dial Indicator Gp

Note: The threaded rod is 5/8 - 18. The threaded rod is 266.7 mm (10.5 inch) long.

Check Preparation

Before you begin this procedure, refer to Testing and Adjusting, “Machine Preparation”.

- 1. Remove the tandems from the machine.

Reference: Refer to the Power Train Disassembly and Assembly, “Housing (Tandem) - Remove and Install” for the proper procedures.

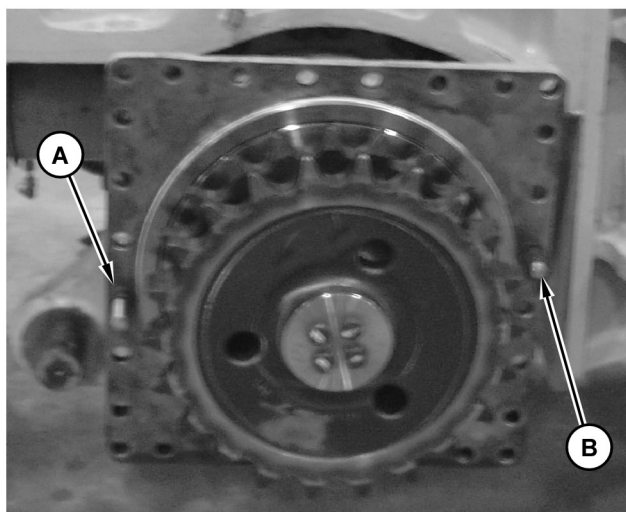


Illustration 99

g01453166

Right side of the machine is shown.

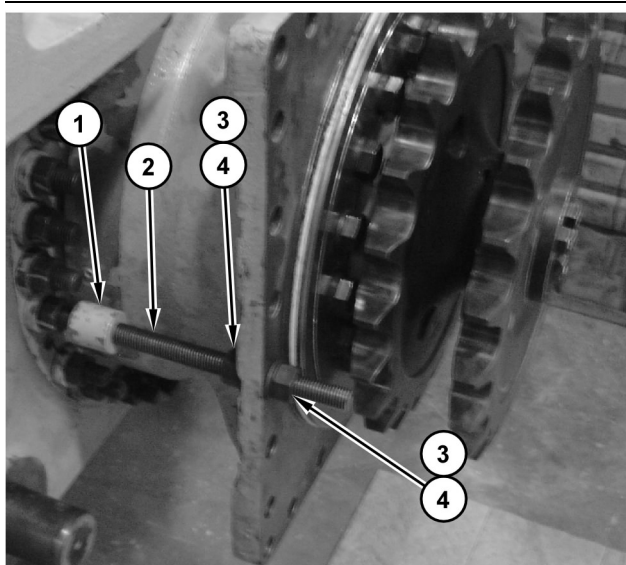


Illustration 100

g01453137

- (1) Adapter
- (2) Threaded rod
- (3) Nuts
- (4) Washers

2. Install the following tooling at Location (A) and Location (B) according to Illustration 99 :

- One adapter (1)
- One threaded rod (2)
- Two nuts (3)

- Two washers (4)

Test Procedure

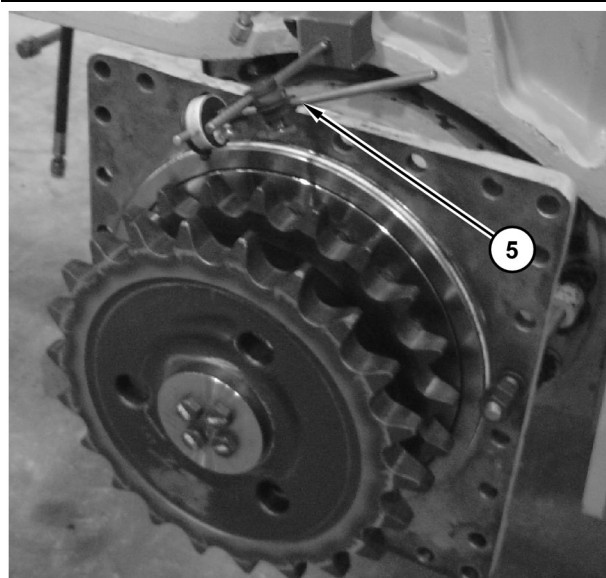


Illustration 101

g01453172

Right side of the machine is shown.

- (5) Dial indicator

1. Install dial indicator (5) according to Illustration 101 . Zero the dial indicator.

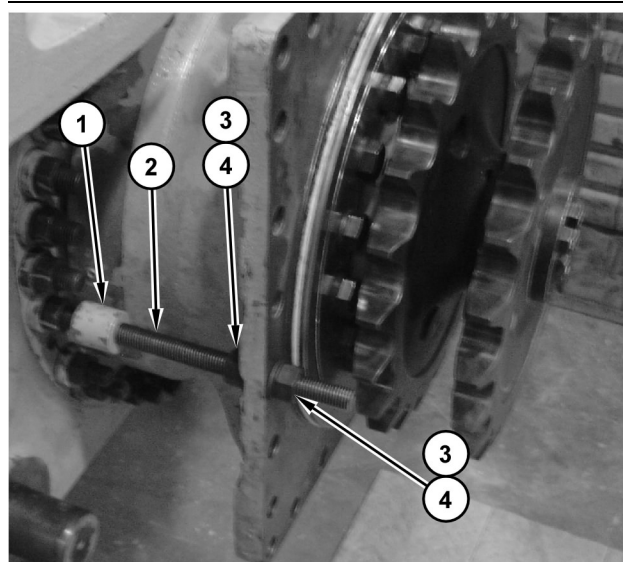


Illustration 102

g01453137

Right side of the machine is shown.

- (1) Adapter
- (2) Threaded rod
- (3) Nuts
- (4) Washers

2. Loosen both of the inside nuts away from the housing. Tighten both of the outside nuts evenly. This action will push the housing toward the machine. Loosen both of the nuts on the outside of the plate evenly. Move the outside nuts away from the housing.

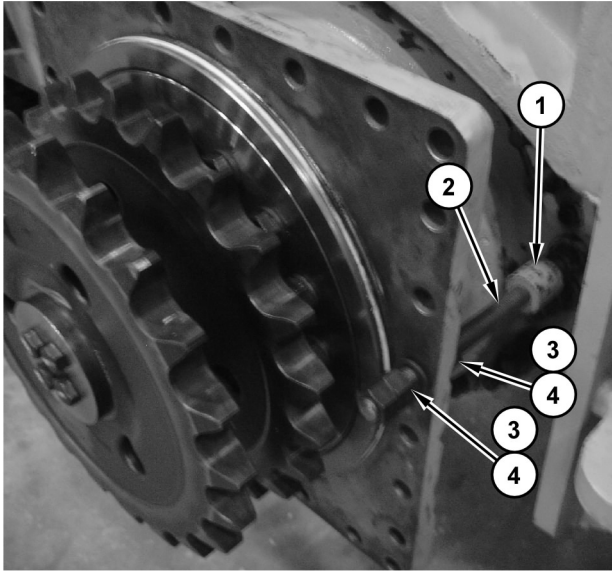


Illustration 103

g01453200

Right side of the machine is shown.

- (1) Adapter
- (2) Threaded rod
- (3) Nuts
- (4) Washers

3. Tighten both of the inside nuts evenly. This action will push the housing away from the machine. Loosen both of the inside nuts evenly.

4. The dial indicator (5) should read
0.00 to 0.051 mm (0.000 to 0.002 inch).

Reference: Refer to the Power Train Disassembly and Assembly, "Final Drives" if the reading in Step 4 is not correct.

5. If the reading in Step 4 is correct, remove all tooling.

6. Install the tandems on the machine.

Reference: Refer to the Power Train Disassembly and Assembly, "Housing (Tandem) - Remove and Install" for the proper procedures.

Index

D

Differential and Bevel Gear	91
Differential Lock Pressure - Check	118
Check Preparation	119
Introduction	118
Required Tools	118
Specifications	118
Test Procedure	119
Drive Chain - Check	115
Introduction	115
Machine Preparation	116
Test Procedure	116

F

Fill Time for the Transmission Clutch - Calibrate ..	103
Calibration Procedure	106
Introduction	103
Machine Preparation	104
Required Tools	104
Final Drive and Tandem Drive	94–95
Final Drive Oscillation Joint End Play - Check	119
Check Preparation	119
Introduction	119
Required Tools	119
Test Procedure	120

G

Gear Pump (Transmission Charging and Scavenge)	89
General Information	98
Graphic Color Codes	96

I

Important Safety Information	2
Introduction	4, 98
Differential and Bevel Gear	4
Final Drive and Tandem Drive	5
Transmission	4
Transmission Control Valve	4

L

Location of Components	5
Electrical Components	9
Hydraulic Components	5
Lower Power Train Components	12

M

Machine Preparation for Troubleshooting	98
Modulating Valve (Transmission Clutch)	25
General Information	25
Less Than Maximum Signal	28
Maximum Signal	29
No Signal	27

O

Oil Filter (Power Train)	89
Operational Checks	99

P

Parking Brake	14
Location of Components and Functions	14
Parking Brake Operation	16
Parking Brake - Test	103
Introduction	103
Machine Preparation	103
Test Procedure	103
Power Train	100
Troubleshooting the Parking Brake System	102
Troubleshooting the Power Train	100
Power Train Charge System Pressure - Test and Adjust	107
Adjustment Procedure	109
Introduction	107
Required Tools	108
Specifications	107
Test Preparation	108
Test Procedure	109
Power Train Hydraulic System	19
Transmission Clutch Engagement	24
Transmission Lubrication	22

R

Rear Axle	90
Relief Valve (Transmission Hydraulic Control)	30

S

Symptom Procedures	100
Systems Operation Section	4

T

Table of Contents	3
Tandem - Check	113
Check Preparation	114
Check Procedure	115
Introduction	113
Testing and Adjusting	103
Testing and Adjusting Section	103
Transmission Lubrication Oil Pressure - Test	109
Introduction	109
Required Tools	110
Specifications	109
Test Preparation	110
Test Procedure	110
Transmission Power Flow	32
Eighth Speed Forward	65
Fifth Speed Forward	53
Fifth Speed Reverse	83
First Speed Forward	37
First Speed Reverse	71
Fourth Speed Forward	49
Fourth Speed Reverse	80
General Information	32

Neutral 69

Second Speed Forward 41

Second Speed Reverse 74

Seventh Speed Forward 61

Sixth Speed Forward 57

Sixth Speed Reverse 86

Third Speed Forward 45

Third Speed Reverse 77

Transmission Pressures - Test and Adjust 111

 Introduction 112

 Required Tools 112

 Specifications 111

 Test Preparation 112

 Test Procedure 113

Troubleshooting Section 98

V

Visual Inspection 99

W

Wheel Group 96

