RENR8484-10 (en-us)
August 2020

Systems Operation
Troubleshooting
Testing and Adjusting

14M, 16M Motor Graders
Hydraulic and Steering System

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

i07966018

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.

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Systems Operation Section

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Introduction

SMCS Code: 4300; 5050

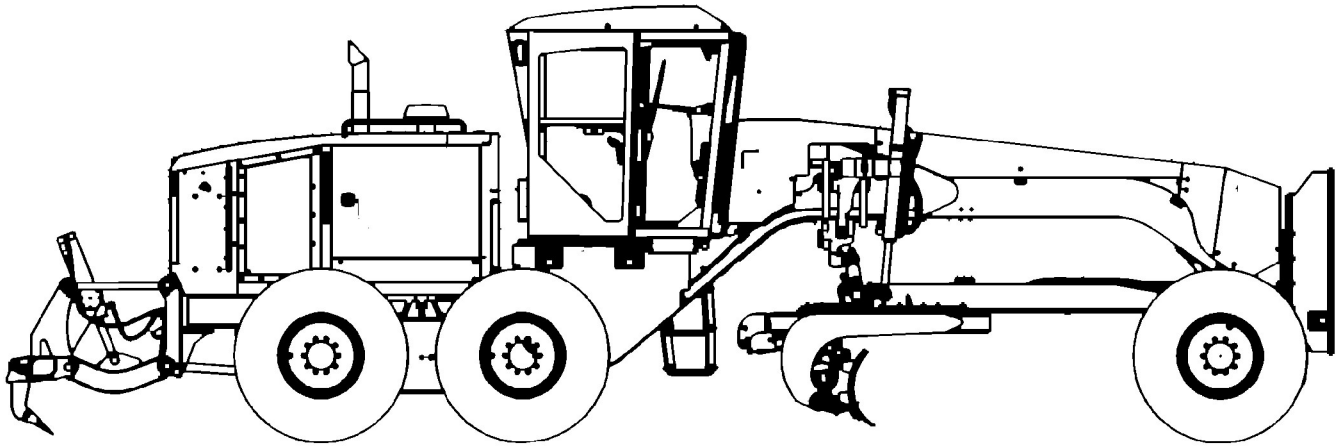

Illustration 1 g01346957

View of the 14M Motor Grader B9J1–Up

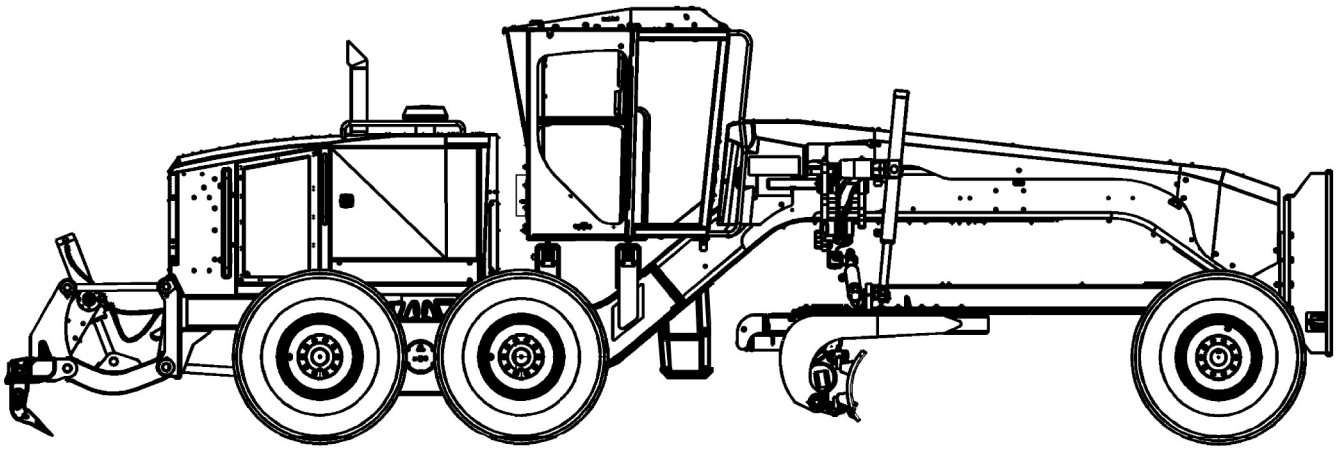

Illustration 2 g02185404

View of the 14M and 16M Motor Grader
S/N: B9H1–Up; R9H1–Up; R9J1–Up

This module discusses the features and operation of the implement and steering system. The following Motor Graders are covered in this module:

- 14M Motor Grader
- 16M Motor Grader

The hydraulic system is a proportional priority pressure compensated system. The PPPC system is a load sensing system. The PPPC system uses a load sensing pump for the implement and steering in order to perform the pressure compensation function. The implement control valves have an internal flow compensator. This flow compensator performs the proportional priority function.

The implement system and the steering system have the following main components:

- Implement control valves
- Control manifold (steering pilot oil backup)
- Implement pilot oil filter
- Control manifold
- Main relief valve
- Hydraulic tank
- Piston pump (implement and steering)
- Pump control valve
- Oil filter (hydraulic return)
- Joystick controls
- Steering control valve
- Centershift lock
- Implement control valves
- Variable blade float (if equipped)
- Blade accumulators (if equipped)

Implement Control Valves

The implement control valve regulates the operation of each implement. Each implement control valve contains a compensator valve. The compensator valve distributes the oil flow that is available. The implement control valve may contain a relief valve. The relief valve will protect the rod end of the cylinders from thermal cycle.

Control Manifold (Steering Pilot Oil Backup)

The steering pilot valve will direct pilot oil to the steering control valve when the primary steering solenoids have failed.

Implement Pilot Oil Filter

The pilot oil filter removes debris from the pilot oil for the implement solenoids.

Control Manifold

The pilot control manifold directs pilot oil to the solenoids of the implement system. The control manifold contains the following: a main relief valve, a pressure reducing valve, a solenoid for the implement lockout switch, a pressure port, and a pressure sensor.

Hydraulic Tank

The hydraulic tank stores oil for the hydraulic system.

Piston Pump (Implement and Steering)

The piston pump for the implement and steering is a variable displacement axial piston pump. When the engine is operating, the pump will produce flow in order to satisfy the following conditions:

- The demand of the steering system
- The margin pressure of the pump
- The demand of the hydraulic implements
- The internal lubrication of the pump components

Pump Control Valve

The pump control valve keeps the pump pressure and the pump flow at the level required by the implement and steering system.

Oil Filter (Hydraulic Return)

The return filter removes debris from the hydraulic system. The return filter prevents debris from entering the hydraulic tank.

Joystick Controls

The joystick controls send an electrical signal to the solenoids of the implement system and the steering system.

Steering Control Valve

The steering control valve directs the oil from the pump to the steering circuit and to the implement circuit.

Centershift Lock

The centershift lock is actuated by oil from the implement pilot system. The centershift lock receives pilot oil from the pilot control manifold. The centershift lock switch sends a signal to the solenoid for the centershift lock in order to actuate the centershift lock.

Variable Blade Float (If Equipped)

The variable blade float will enable for control of the pressure of the hydraulic fluid for the blade lift cylinders. The blade must be in the FLOAT position. The pressure is controlled by left variable blade float control and right variable blade float control. Continuous hydraulic flow over a variable relief valve provides lifting force on the drawbar, the circle, and mold bar. The weight to the ground of the drawbar, the circle, and mold bar will be reduced. The variable relief valve is electronically controlled through a dial in the cab.

Blade Accumulators (If Equipped)

The blade cushion accumulators dampen the shock that is made in the blade lift hydraulic circuit. Shock occurs when the blade contacts an object that will not move. The blade cushion accumulators have a nitrogen precharge pressure that provides the cushion.

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Location Of Components

SMCS Code: 4300; 5050

Implement and Steering System

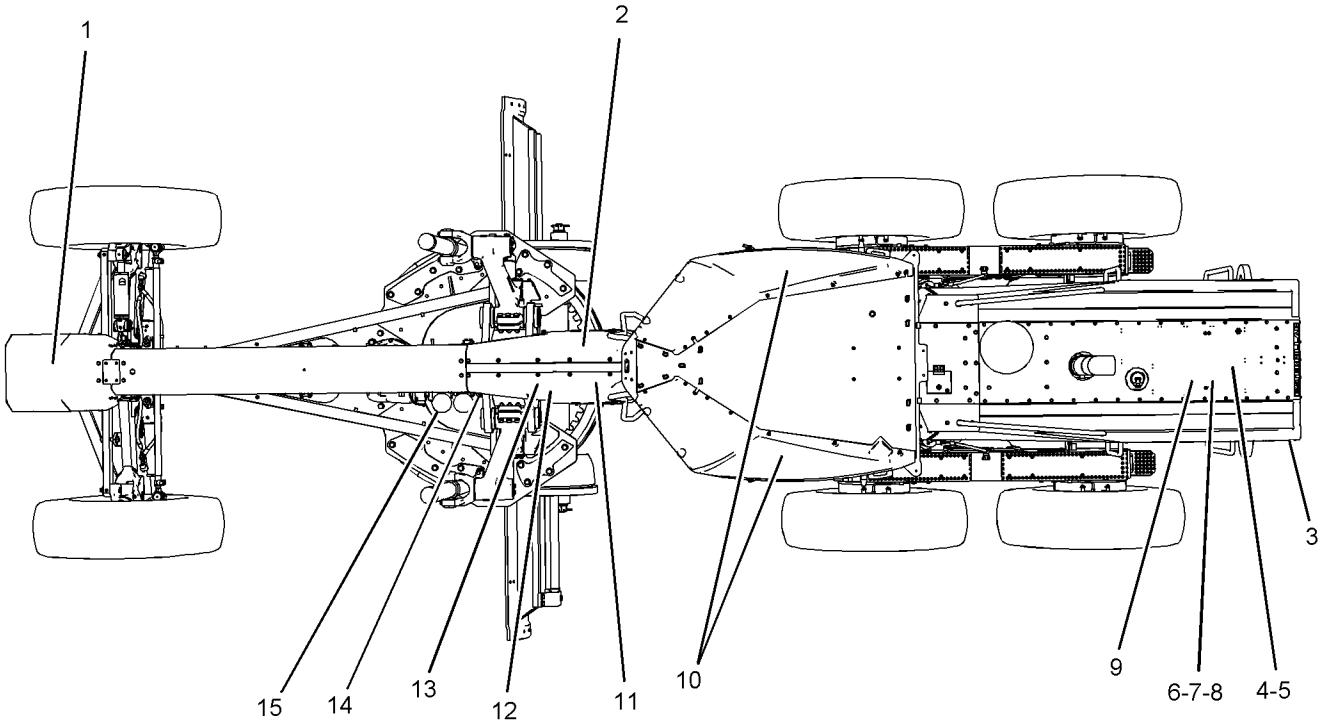

Illustration 3 g01324930

(1) Implement control valves
(2) Control manifold (steering pilot oil backup)
(3) Implement pilot oil filter
(4) Control manifold
(5) Main relief valve
(6) Hydraulic tank
(7) Piston pump (implement and steering)
(8) Pump control valve
(9) Oil filter (hydraulic return)
(10) Joystick controls
(11) Steering control valve
(12) Centershift lock
(13) Implement control valves
(14) Variable blade float (if equipped)
(15) Blade accumulators (if equipped)

Note: Some of the Motor Graders may have different implements. The number of control valves in each valve group may vary.

Implement Control Valves

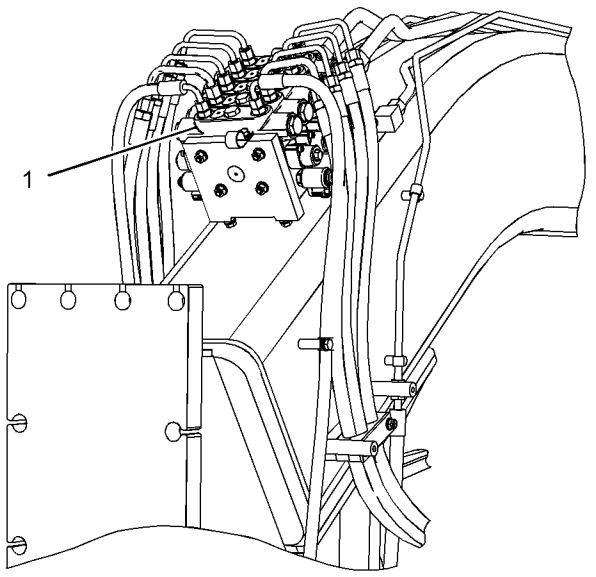

Illustration 4 g02202854

Control valves (1) are located at the front of the machine.

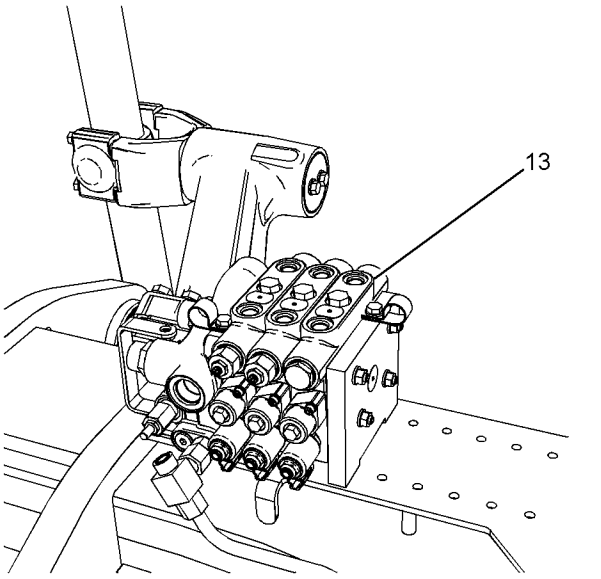

Illustration 5 g01330717

Control valves (13) are located on the frame in front of the cab.

There are eight implement control valves on each machine. There is a maximum of 14 implement control valves that can be installed on each machine. The implement control valves are mounted in two different locations. Valve bank (1) is mounted on the frame near the front of the machine. Valve bank (13) is mounted on the frame in front of the cab. The implement control valves direct oil to the corresponding implements.

Control Manifold (Steering Pilot Oil Backup)

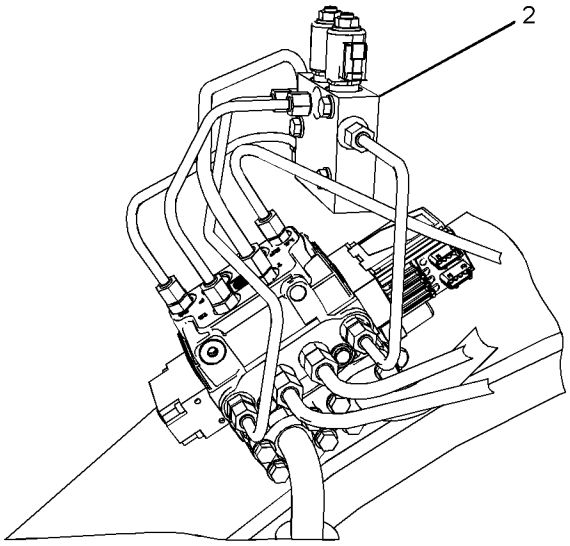

Illustration 6 g02202855

Steering pilot valve (2) is located in front of the cab. Valve (2) directs pilot oil to the steering control valve.

Implement Pilot Oil Filter

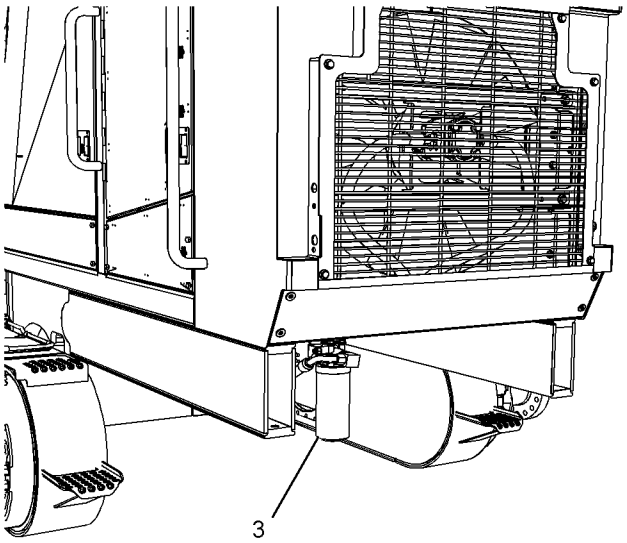

Illustration 7 g01330723

View of the 14M and 16M Motor Grader
S/N: B9H1–Up; B9J1–Up

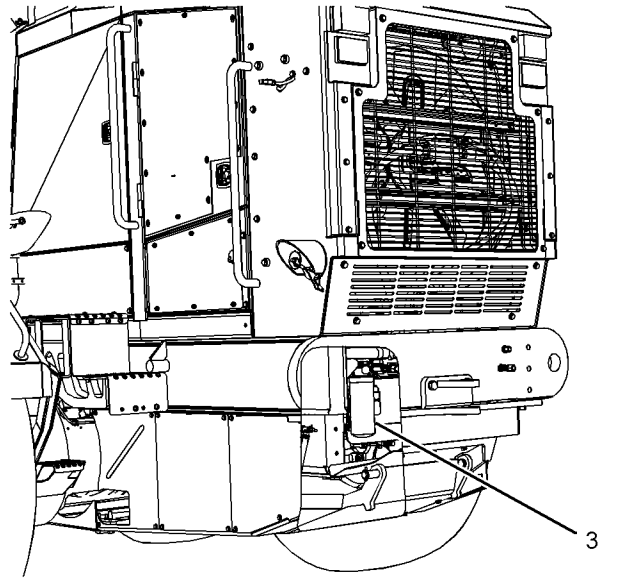

Illustration 8 g02189793

View of the 14M and 16M Motor Grader
S/N: R9H1–Up; R9J1–Up

Implement pilot oil filter (3) is located at the rear of the machine. The implement pilot oil filter removes debris from the pilot oil for the implement solenoids.

Control Manifold

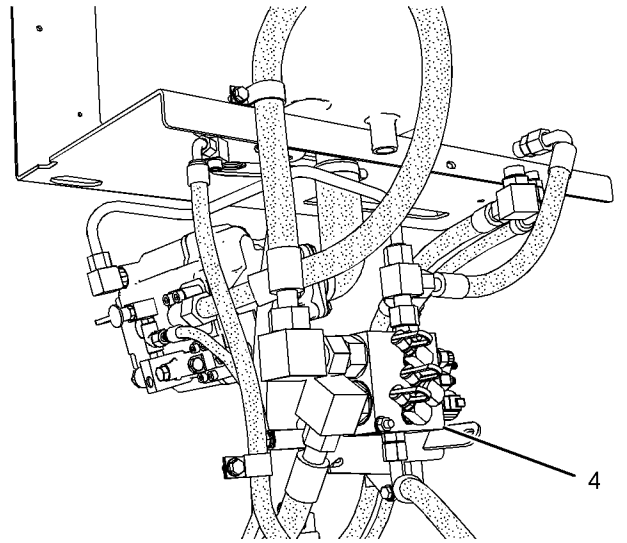

Illustration 9 g02202856

Control manifold (4) is located at the service center near the rear of the machine. Manifold (4) directs pilot oil to the implement control valves.

Hydraulic Tank

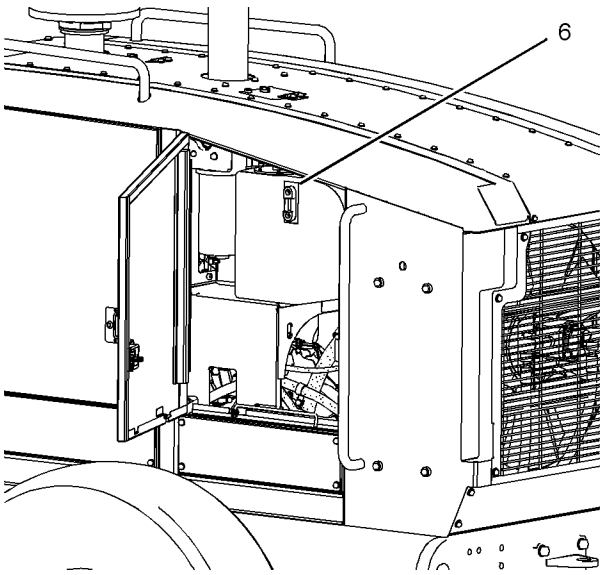

Illustration 10 g02204213

Hydraulic tank (6) is located between the engine and the radiator. Tank (6) stores oil.

Piston Pump (Implement and Steering)

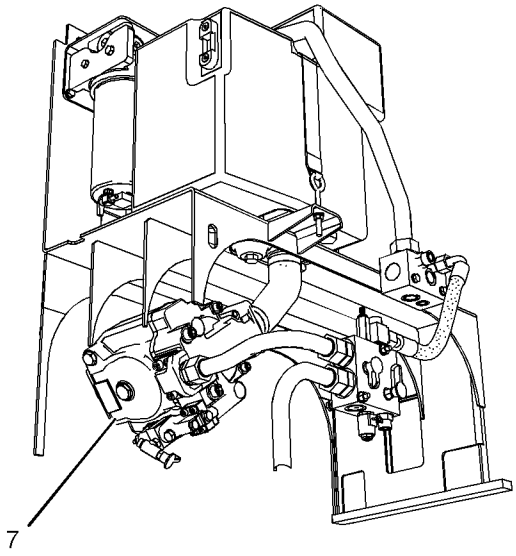

Illustration 11 g02202857

Pump (7) is located below the hydraulic tank. Pump (7) is a variable displacement axial piston pump.

Pump Control Valve

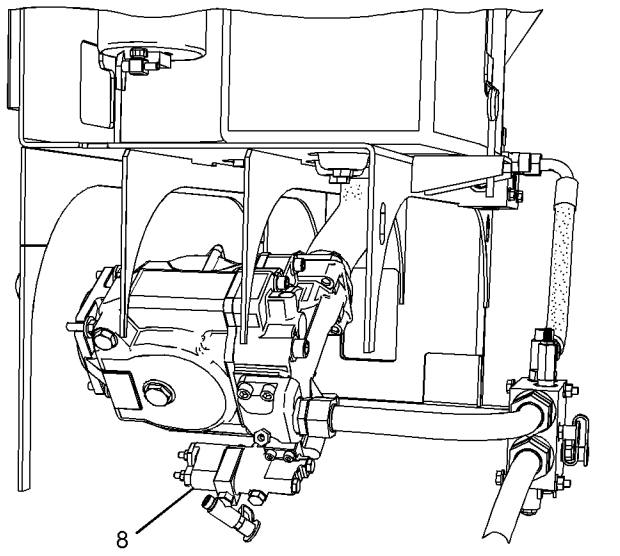

Illustration 12 g02202858

Pump control valve (8) is attached to the hydraulic and steering pump. Pump control valve (8) keeps pump flow at the level that is needed to fulfill the requirements of the hydraulic and steering system.

Oil Filter (Hydraulic Return)

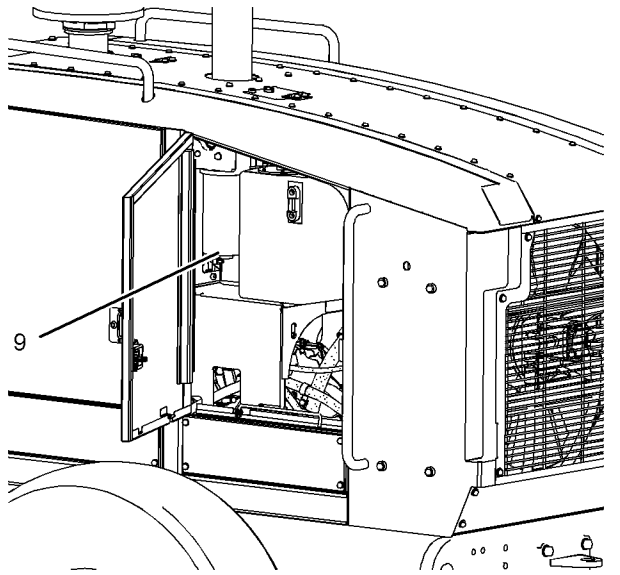

Illustration 13 g02202859

Hydraulic filter (9) is located in front of hydraulic tank (6). Filter (9) removes debris from the hydraulic system.

Joystick Controls

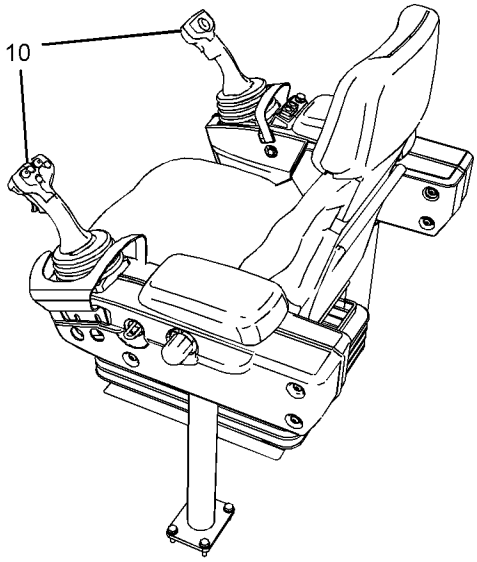

Illustration 14 g01330713

Controls (10) are located inside the cab. Controls (10) send an electrical signal to the solenoids of the hydraulic system.

Steering Control Valve

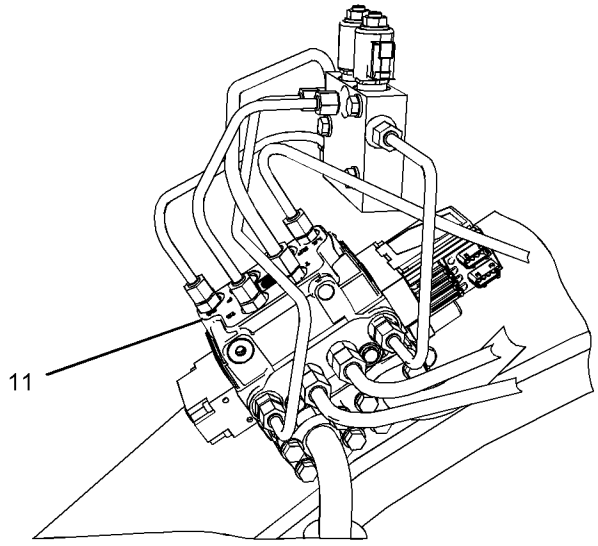

Illustration 15 g01330715

Steering control valve (11) is located in front of the cab. Valve (11) directs hydraulic fluid to the steering system and the implement system.

Centershift lock

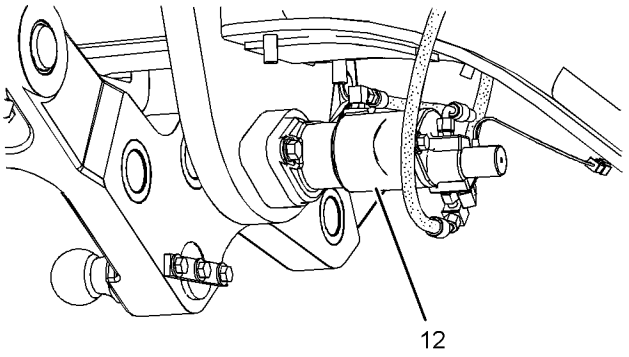

Illustration 16 g02234736

View of the 14M and 16M Motor Grader
S/N: B9H1–Up; B9J1–Up

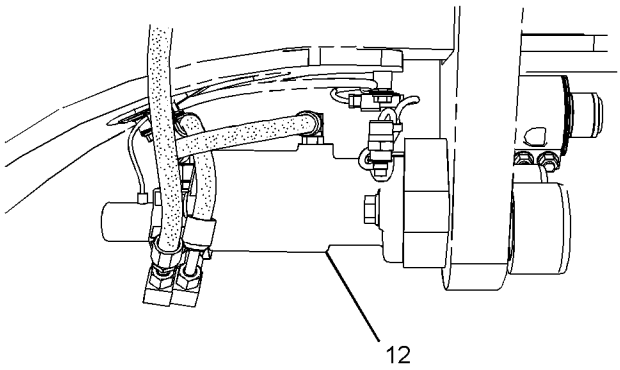

Illustration 17 g02189960

View of the 14M and 16M Motor Grader
S/N: R9H1–Up; R9J1–Up

Centershift lock (12) is located on the center of the link bar. The centershift lock prevents the circle from moving to either side of the machine when the centershift lock is engaged.

Variable Blade Float (If Equipped)

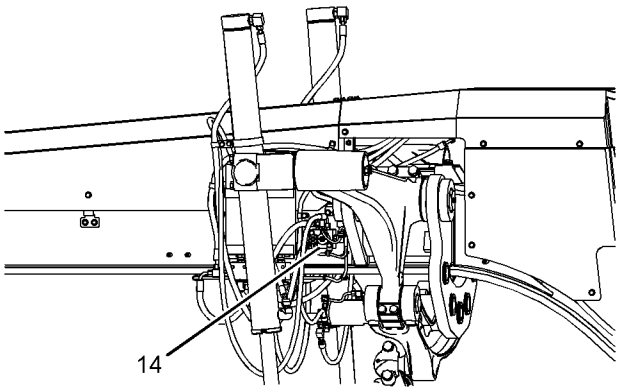

Illustration 18 g01324937

View of the 14M and 16M Motor Grader
S/N: B9H1–Up; B9J1–Up

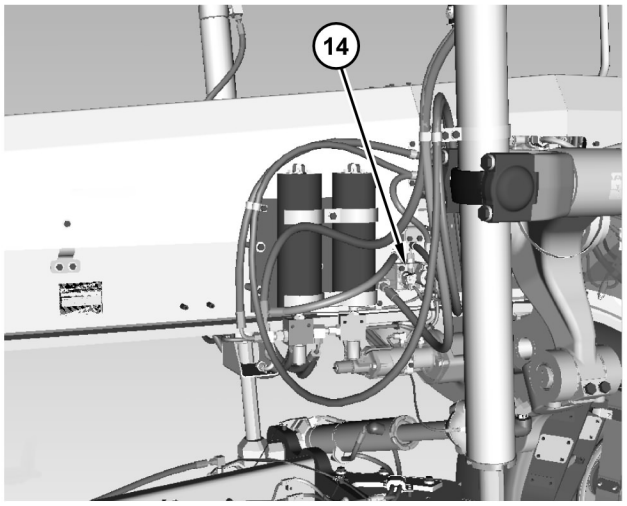

Illustration 19 g02190898

View of the 14M and 16M Motor Grader
S/N: R9H1–Up; R9J1–Up

The variable blade float (14) is mounted on the frame in back of the blade lift cylinders. Continuous hydraulic flow over a variable relief valve provides lifting force on the drawbar, the circle, and mold bar. The weight to the ground of the drawbar, the circle, and mold bar will be reduced.

Blade Accumulators (If Equipped)

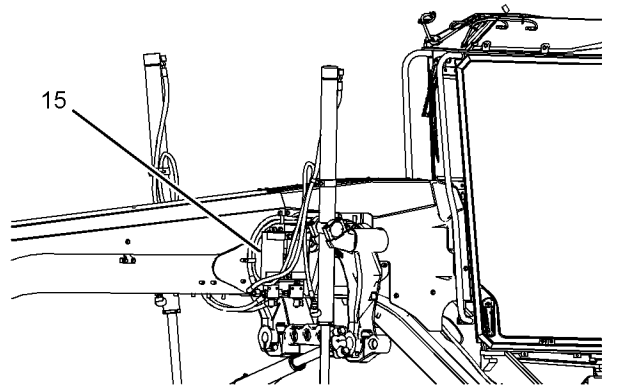

Illustration 20 g01330111

View of the 14M and 16M Motor Grader
S/N: B9H1–Up; B9J1–Up

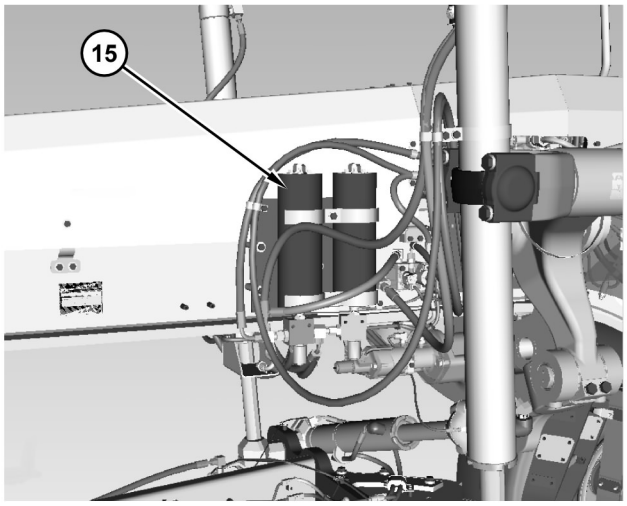

Illustration 21 g02190893

View of the 14M and 16M Motor Grader
S/N: R9H1–Up; R9J1–Up

Blade cushion accumulators (15) are mounted on the frame in front of the blade lift cylinders. Accumulators (15) cushion the head end of the cylinder from sudden rises in pressure.

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Implement and Steering System

SMCS Code: 4300; 5050-II

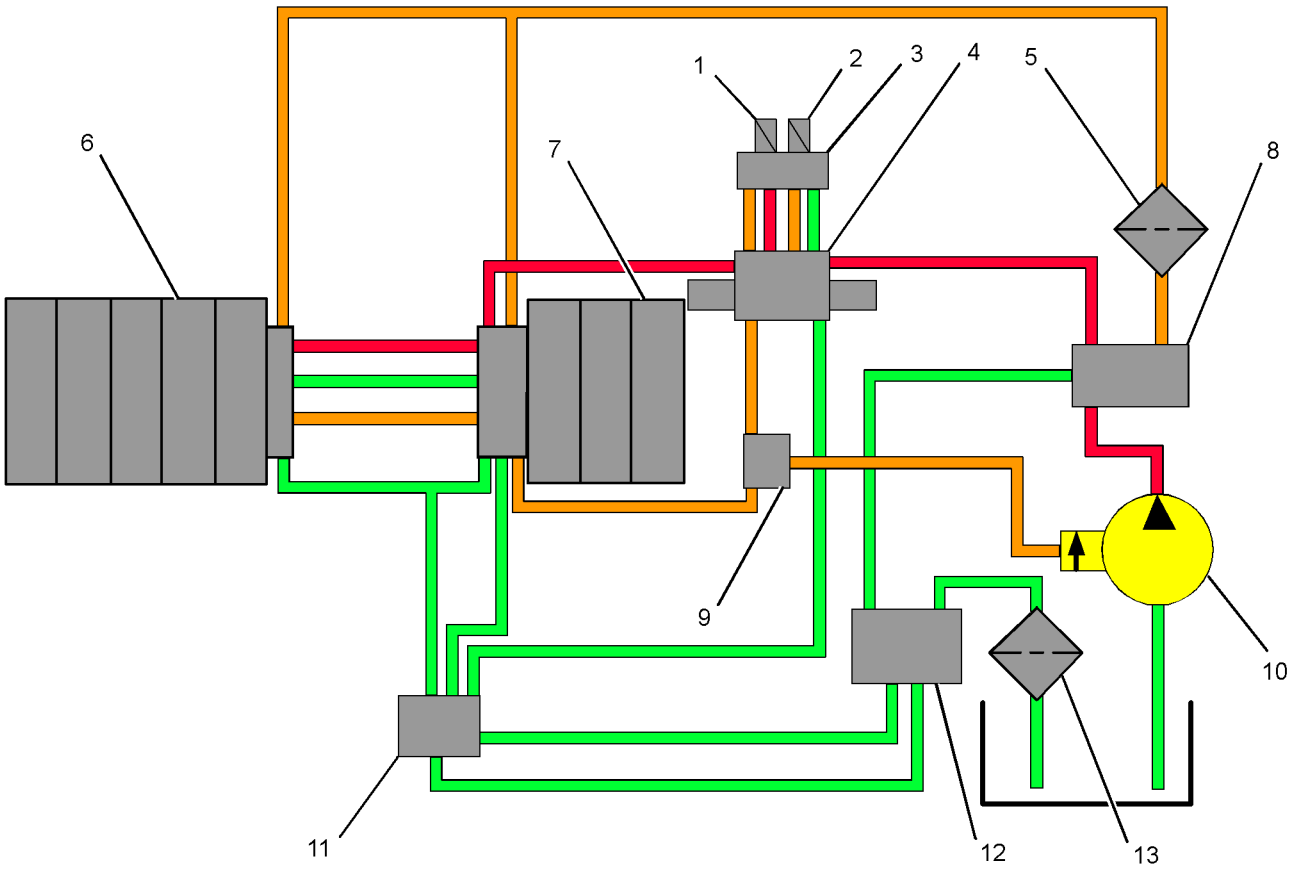

Illustration 22 g01108413

(1) Solenoid
(2) Solenoid
(3) Secondary steering pilot valve
(4) Steering control valve
(5) Pilot filter
(6) Implement control valve
(7) Implement control valve
(8) Pilot manifold
(9) Shuttle valve
(10) Piston pump
(11) Return manifold
(12) Return manifold
(13) Oil filter

At low pressure standby, the implement circuit and the steering circuit are not active. Piston pump (10) pumps oil to pilot manifold (8). Manifold (8) will direct pilot oil into the pilot system when the implement lockout switch is on. Pump (10) also pumps oil to steering control valve (4). After pump oil has satisfied the steering system, steering control valve (4) will direct pump oil to implement control valve (7) and implement control valve (6). When the requirements for the implement system and the steering system are met, pump (10) will destroke.

When the implement system or the steering system is used, signal oil will flow to shuttle valve (9). Shuttle valve (9) will shift. Shuttle valve (9) will direct the highest signal pressure to the pump. Signal oil will upstroke the pump.

Oil returns to the hydraulic tank through two manifolds. Manifold (11) and manifold (12) will direct all return oil to oil filter (13). Oil filter (13) will remove any debris in the oil before directing the oil to the hydraulic tank.

i02696020

Hydraulic Tank

SMCS Code: 5056

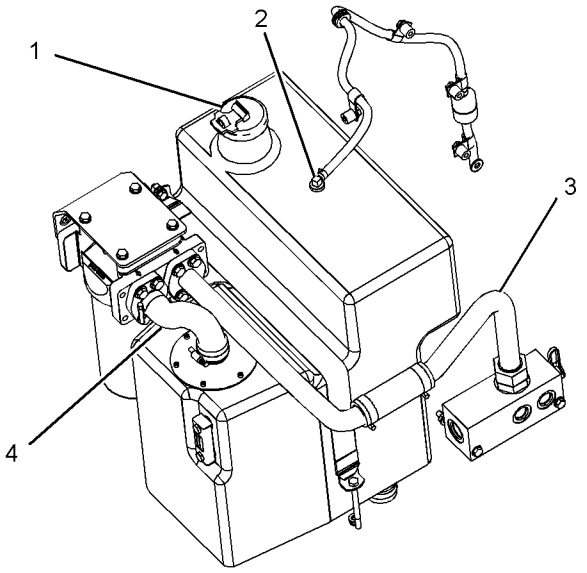

Illustration 23 g01352072

(1) Cap
(2) Vent
(3) Return oil to the hydraulic return oil filter
(4) Return oil from hydraulic return oil filter to tank

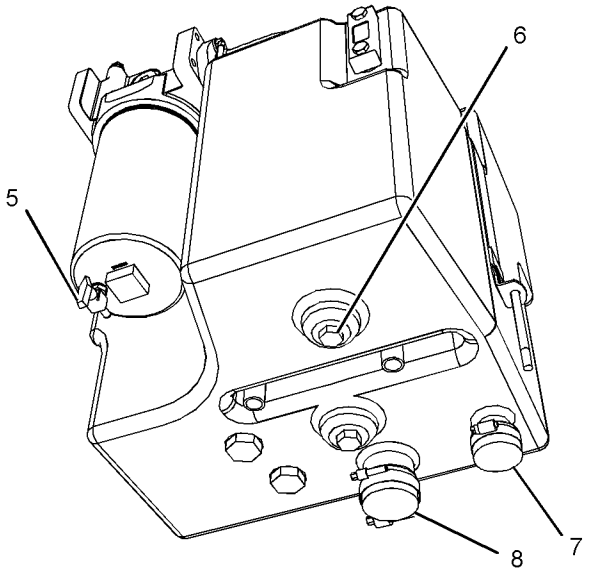

Illustration 24 g01352073

(5) Oil drain for the filter
(6) Supply for secondary steering
(7) Supply for piston pump (brake and hydraulic fan)
(8) Supply for implement and steering pump

Oil flows to the hydraulic return oil filter through line (3). After the oil is filtered, oil will flow to the hydraulic tank through line (4). Oil will flow out of the bottom of the hydraulic tank through several ports. Port (6) will supply oil to the secondary steering system. Port (8) will supply oil to the implement and the steering system. Port (7) will supply oil to the brake system and the fan system.

i02576067

Oil Filter (Hydraulic Return)

SMCS Code: 5068-RJ

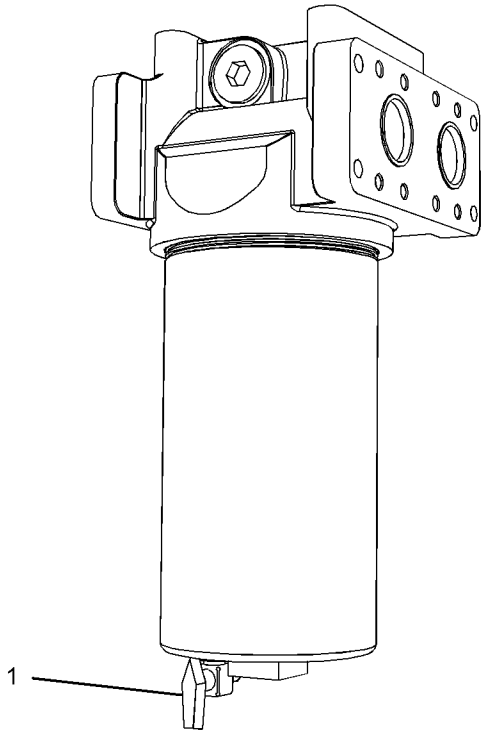

Illustration 25 g01290830

The hydraulic filter has a bypass valve. If the filter element becomes full of debris, oil cannot pass through the filter. The restriction to oil flow will cause a pressure increase. The increase in pressure will open the filter bypass. When oil bypasses the filter element, debris in the oil will cause damage to other system components. Correct maintenance must be used in order to make sure that the filter element remains clean. The filter is equipped with a drain (1). Drain (1) is used to drain the oil out of the filter before the filter element is changed.

i02816834

Oil Filter (Implement)

SMCS Code: 5068-II

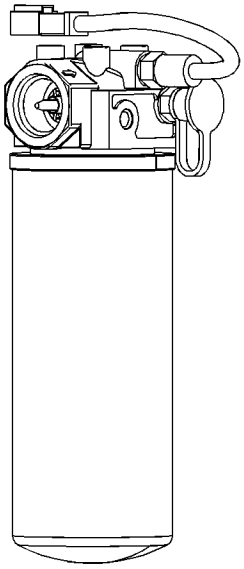

Illustration 26 g01404760

The filter for the implement pilot system has a bypass valve. If the filter element becomes full of debris, oil cannot pass through the filter. The restriction to oil flow will cause a pressure increase. The increase in pressure will open the filter bypass. When oil bypasses the filter element, debris in the oil will cause damage to other system components. Correct maintenance must be used in order to make sure that the filter element remains clean. The Scheduled Oil Sample port is located on the control manifold (implement and steering). The port is used to remove a small amount of oil for testing.

Reference: For more information on the Scheduled Oil Sample port, refer to Systems Operation, “Control Manifold (Implement, Steering)”.

The filter has a pressure switch (1) that monitors the oil pressure inside the filter. Switch (1) is a two-position switch. Switch (1) will send an input to the implement Electronic Control Module (ECM) when the filter is bypassing oil. The implement ECM will read inputs from switch (1) and the temperature sensor for the hydraulic oil in order to determine the status of the oil filter.

i04014429

Piston Pump (Implement and Steering)

SMCS Code: 5070-ZI

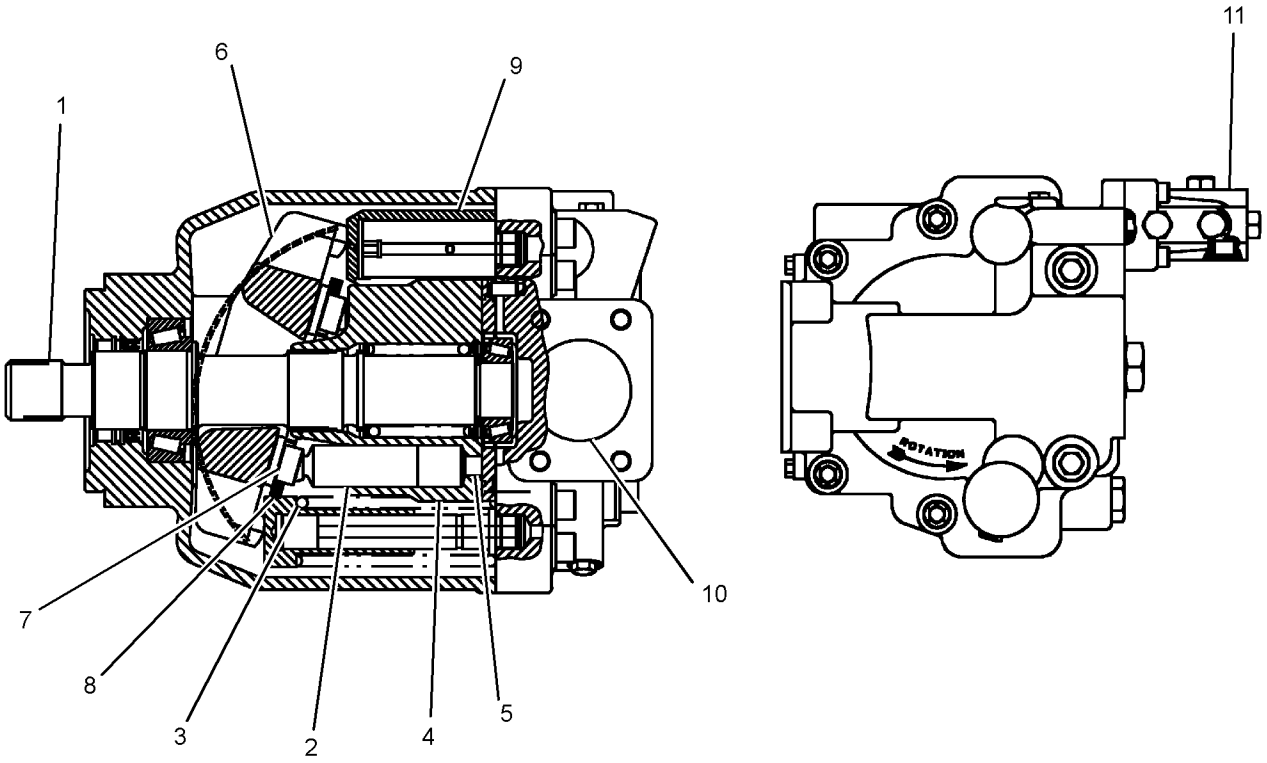

Illustration 27 g01288061

Typical hydraulic pump

(1) Pump drive shaft
(2) Pistons
(3) Bias spring
(4) Barrel
(5) Inlet opening from the hydraulic tank
(6) Swashplate
(7) Slipper
(8) Retraction plate
(9) Control piston
(10) Outlet opening to the combination valve
(11) Pump control valve

The implement and steering pump is a variable displacement axial piston pump.

The implement and steering pump has nine pistons (2). When drive shaft (1) turns, barrel (4), slippers (7) and retraction plate (8) turn. The piston ends connect to the slippers. Swashplate (6) does not turn. There is a bearing journal on each side of the swashplate. The two bearing journals are inside bearings which allow movement of the swashplate. Oil flow through the passages in the pistons lubricates the internal components of the pump.

When swashplate (6) is at the maximum angle and drive shaft (1) is turning, pistons (2) are moved in and out of barrel (4). As the pistons move out of the barrel, the pistons create a vacuum at inlet opening (5). The pressure in the hydraulic tank pushes the oil into the inlet opening. The oil passes through the inlet opening and into the piston bore in the barrel. As the barrel continues to turn, the pistons are pushed into the barrel as the slippers rotate up the angle of swashplate (6). The pistons push the oil from the piston bore through pump outlet opening (10) and into the combination valve.

When the engine is operating, the pump will produce flow in order to satisfy the following conditions:

- The demand of the steering system
- The margin pressure of the pump

- The demand of the hydraulic implements
- The internal lubrication of the pump components

i04014449

Pump Control Valve (Implement, Steering)

SMCS Code: 5455-ZI

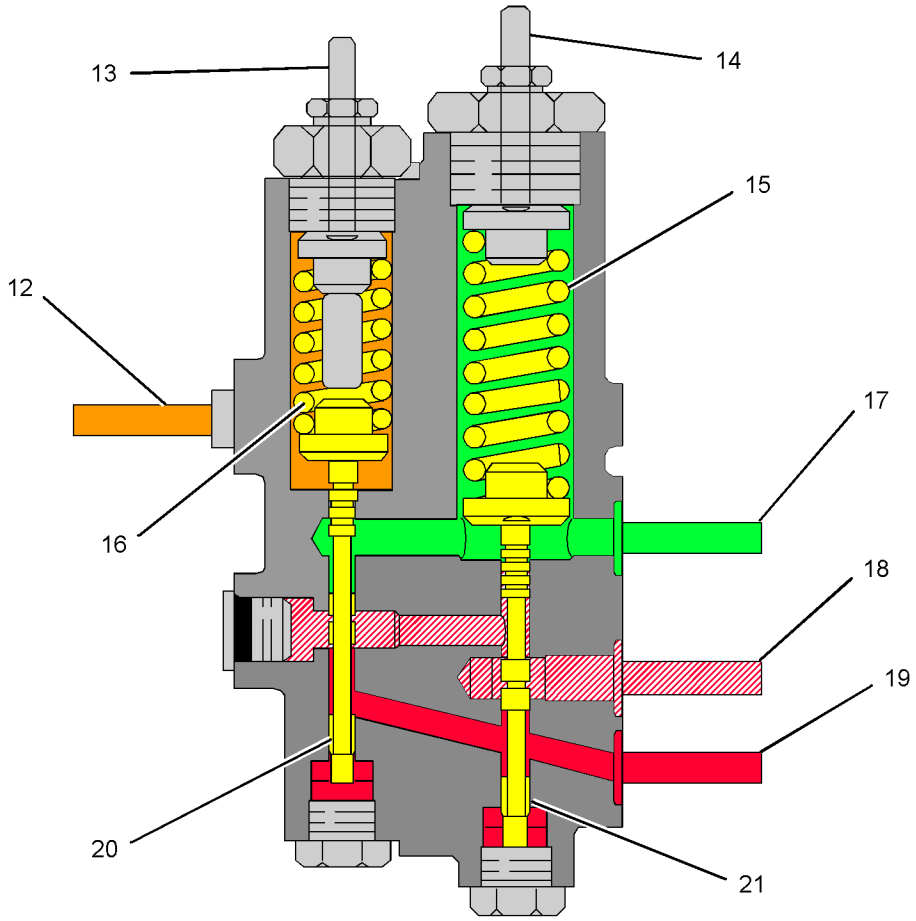

Illustration 28 g01402593

(12) Line for signal oil pressure
(13) Adjustment screw for the flow compensator
(14) Adjustment screw for the pressure compensator
(15) Spring (pressure compensator)
(16) Spring (flow compensator)
(17) Oil flow to the pump case
(18) Oil flow to the control piston
(19) Oil flow from the output port of the pump
(20) Spool (flow compensator)
(21) Spool (pressure compensator)

Pump control valve (11) contains a pressure compensator and a flow compensator. Control valve (11) keeps the pump pressure and the pump flow at the level that is required of the hydraulic and steering system. When the hydraulic circuits are not active, the pump is at low-pressure standby. However, if one or more circuits are active, the load signal resolver compares the signal pressure of the hydraulic implement and steering system. The highest resolved signal pressure is then routed to the pressure and flow compensator valve. The control valve (11) adjusts the swashplate angle of the pump in order to maintain flow and pressure requirements. The margin pressure is defined as the difference between the pump discharge pressure and signal pressure (12) with the force of spring (16).

The pump control valve (11) limits the pressure in order to prevent overloads of the hydraulic system.

When the system pressure exceeds the setting of the pump control valve (11), the pressure compensator will override the flow compensator. The output flow will be lowered. Lowering the output flow will protect the hydraulic system from damage due to high pressure.

Low Pressure Standby

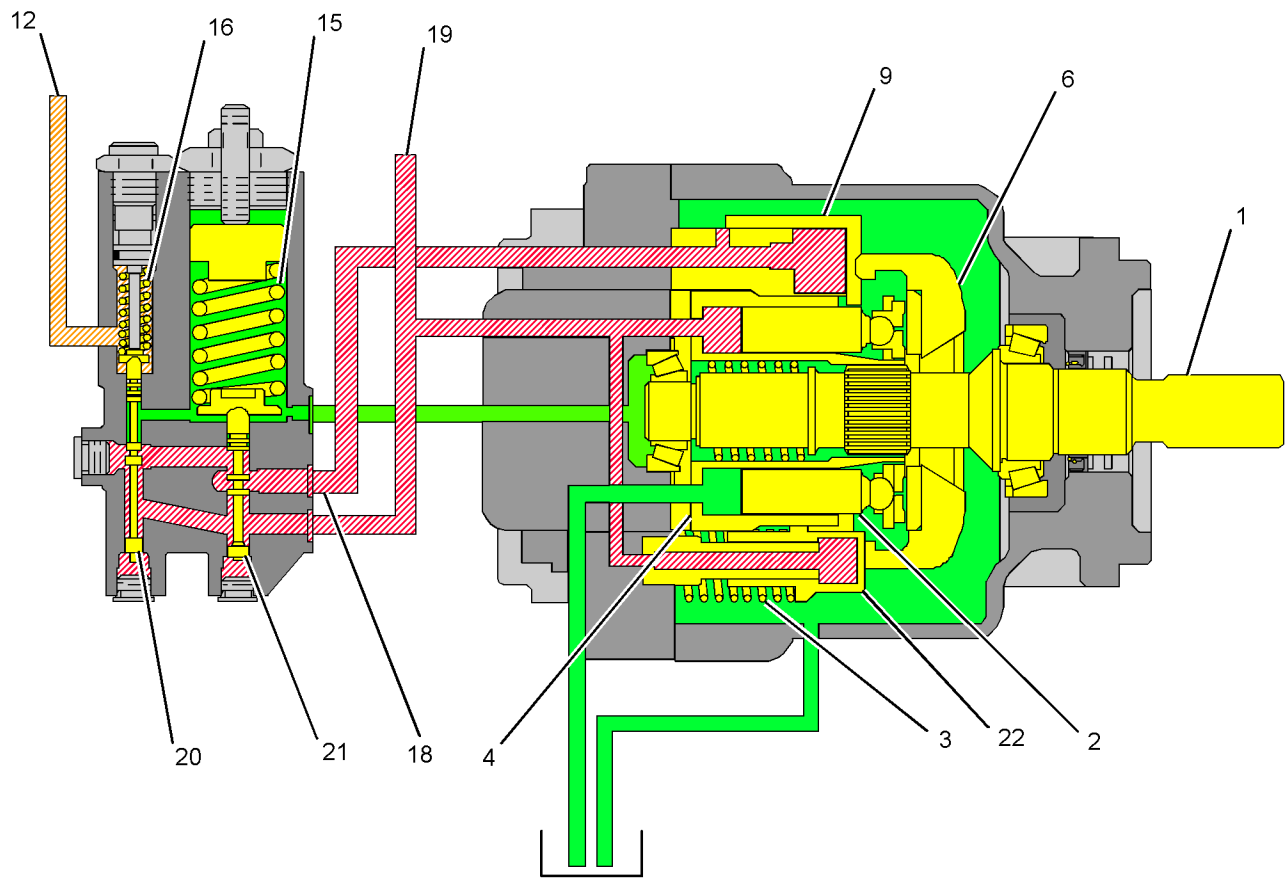

Illustration 29 g01402594

Typical example of a piston pump at low-pressure standby

(1) Pump drive shaft
(2) Pistons
(3) Bias spring
(4) Barrel
(6) Swashplate
(9) Control piston
(12) Signal oil
(15) Spring (pressure compensator)
(16) Spring (flow compensator)
(18) Oil passage to the control piston
(19) Oil flow from the output port of the pump
(20) Spool (flow compensator)
(21) Spool (pressure compensator)
(22) Bias piston

When the engine is off, spring (3) holds swashplate (6) at the maximum angle. When the engine is started, shaft (1) begins to rotate. Oil is drawn into the bore of pistons (2). Barrel (4) starts to rotate. Pistons (2) stroke. This forces hydraulic oil into the hydraulic system.

The pump is in low-pressure standby when the following conditions are met:

- The machine is operating.
- The implements are in the HOLD position.
- There is no demand on the steering.

As the pump produces flow, the system pressure begins to increase. The system pressure overcomes the spring force of spring (16) and the signal pressure in line (12).

Spool (20) moves up and oil flows into passage (18) to piston (9). The oil pressure inside piston (9) overcomes the spring force of spring (3) and the system pressure inside piston (22). Piston (9) moves the swashplate to the minimum angle. When the swashplate is moved to the minimum angle, the oil flows through the cross-drilled passage to the pump case. The system pressure is now at low-pressure standby.

When the pump is at low-pressure standby, the pump produces enough flow in order to compensate for internal leakage. Also, the pump produces enough flow in order to maintain sufficient system pressure. low-pressure standby is maintained in order to ensure instantaneous response under one of the following conditions:

- The steering is activated.
- An implement is activated.

low-pressure standby is higher than margin pressure. This characteristic is due to a higher back pressure that is created by the closed center valves that are in the HOLD position. The pump supply oil moves spool (20) upward. This compresses spring (16). Since spool (20) is moved upward, more of the pump supply oil is allowed to flow through passage (18). The oil will flow through passage (18) and flow out of the cross-drilled passage to the pump case.

Upstroke

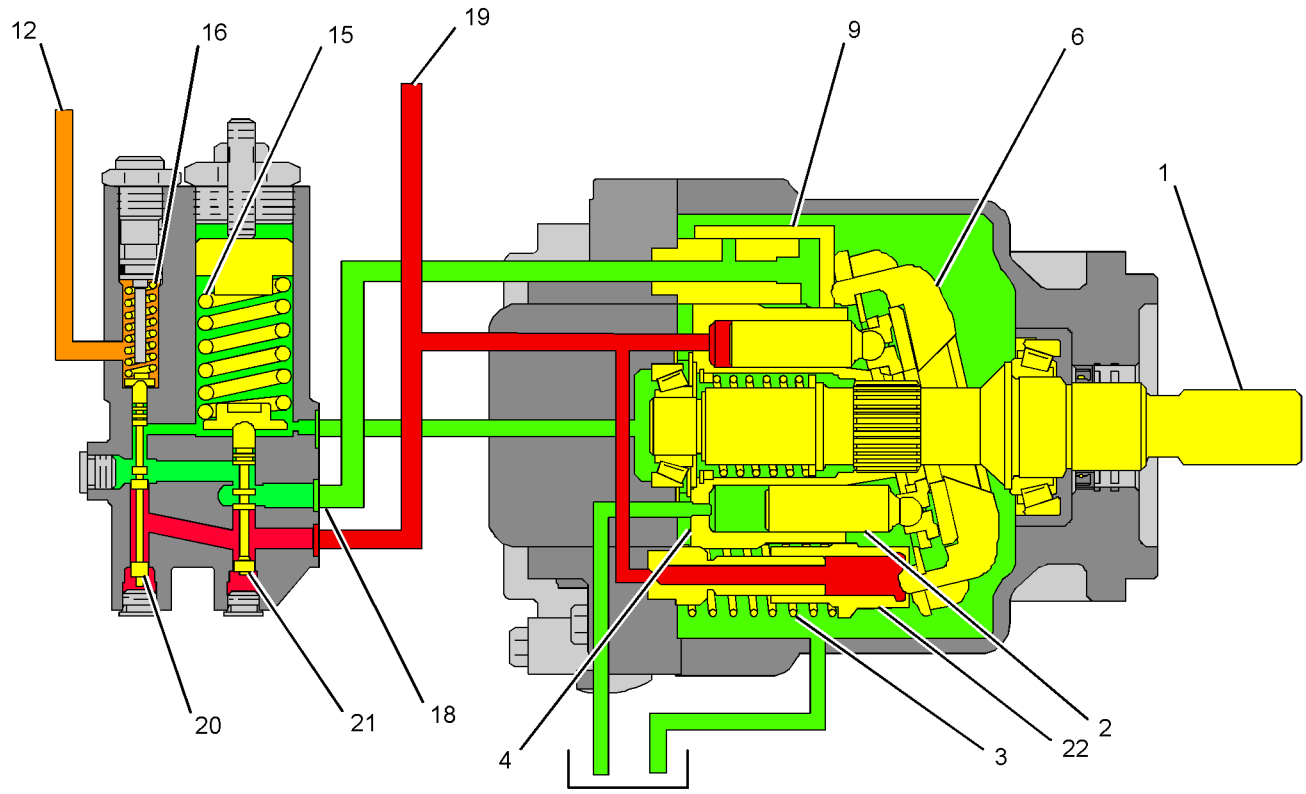

Illustration 30 g01123650

Typical example of a piston pump during upstroke

(1) Pump drive shaft
(2) Pistons
(3) Bias spring
(4) Barrel
(6) Swashplate
(9) Control piston
(12) Signal oil
(15) Spring (pressure compensator)
(16) Spring (flow compensator)
(18) Oil passage to the control piston
(19) Oil flow from the output port of the pump
(20) Spool (flow compensator)
(21) Spool (pressure compensator)
(22) Bias piston

When more oil flow is needed, the hydraulic pump upstrokes. Signal oil is sent to the pressure and flow compensator valve when increased oil flow is required by the steering system. Signal oil is sent to the pressure and flow compensator valve when increased oil flow is required by the implement and control valves. Both signal pressure in line (12) and the force of spring (16) cause spool (20) to block the oil flow into passage (18). With no oil flow to piston (9), spring (3) is now allowed to increase the swashplate angle. The hydraulic pump will produce more oil flow.

Constant Flow

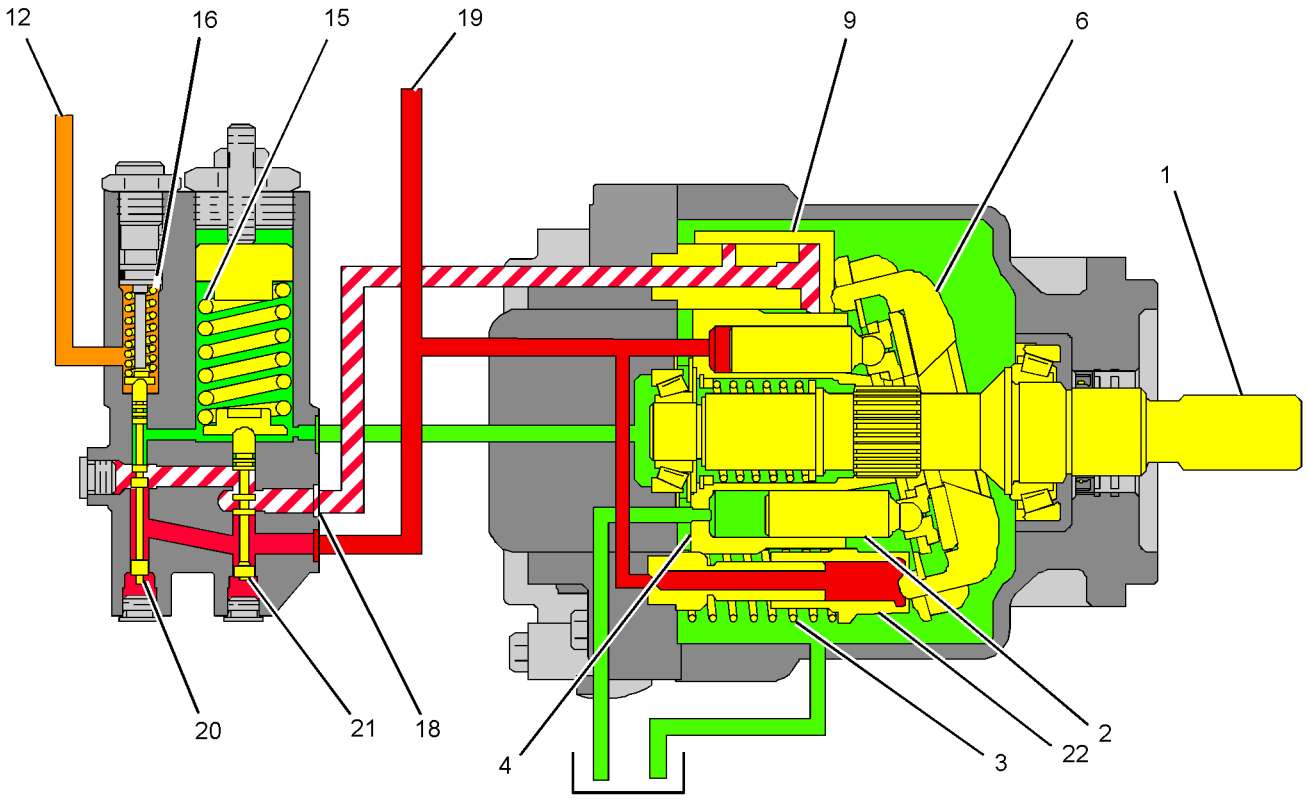

Illustration 31 g01144586

Typical example of a piston pump during constant flow

(1) Pump drive shaft
(2) Pistons
(3) Bias spring
(4) Barrel
(6) Swashplate
(9) Control piston
(12) Signal oil
(15) Spring (pressure compensator)
(16) Spring (flow compensator)
(18) Oil passage to the control piston
(19) Oil flow from the output port of the pump
(20) Spool (flow compensator)
(21) Spool (pressure compensator)
(22) Bias piston

As the pump flow increases, the pump supply pressure increases. Spool (20) moves to a metering position. Spool (20) moves when the pump supply pressure increases to the point of equaling the sum of signal pressure (12) and spring (16). The difference between signal pressure (12) and the pump supply pressure is the value of spring (16). The value of margin pressure is 2100 kPa (305 psi).

Destroke

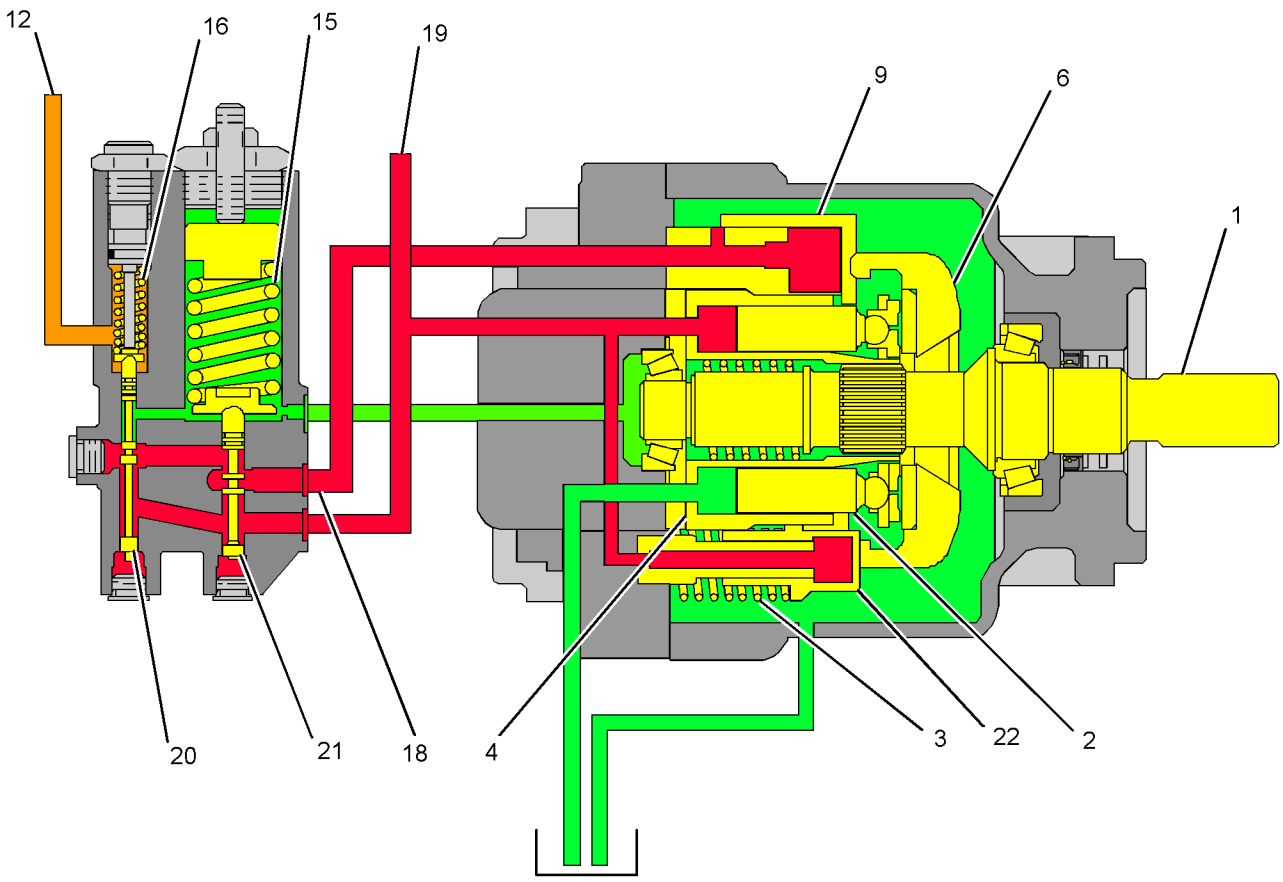

Illustration 32 g01402595

Typical example of a piston pump during destroke

(1) Pump drive shaft
(2) Pistons
(3) Bias spring
(4) Barrel
(6) Swashplate
(9) Control piston
(12) Signal oil
(15) Spring (pressure compensator)
(16) Spring (flow compensator)
(18) Oil passage to the control piston
(19) Oil flow from the output port of the pump
(20) Spool (flow compensator)
(21) Spool (pressure compensator)
(22) Bias piston

When less oil flow is required, the hydraulic pump destrokes. The pump destrokes when the force on the bottom of spool (20) is greater than the force of spring (16) and signal pressure (12) combined. Spool (20) moves upward. More oil is allowed to flow to piston (9). With increased oil pressure on piston (9), the swashplate angle decreases. The hydraulic pump will produce less oil.

The following conditions will cause the pump to destroke:

- All implement control valves are moved to the HOLD position. The pump returns to low-pressure standby.
- The directional stem on the control valve is moved in order to reduce flow.
- If the engine rpm increases, the pump speed increases. The pump will destroke in order to maintain the flow requirements of the system.
- No steering demand

High Pressure Stall

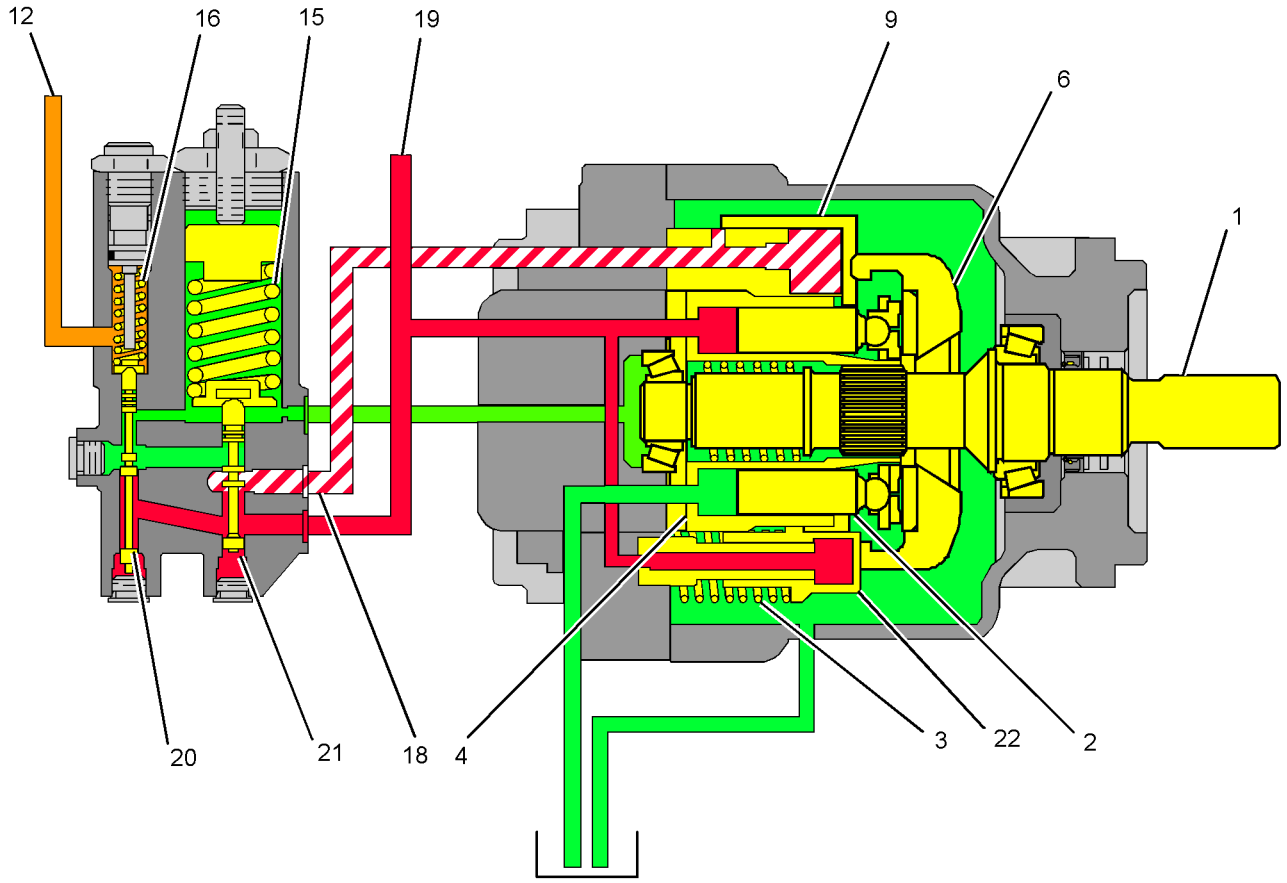

Illustration 33 g01402596

Typical example of a piston pump at high-pressure stall

(1) Pump drive shaft
(2) Pistons
(3) Bias spring
(4) Barrel
(6) Swashplate
(9) Control piston
(12) Signal oil
(15) Spring (pressure compensator)
(16) Spring (flow compensator)
(18) Oil passage to the control piston
(19) Oil flow from the output port of the pump
(20) Spool (flow compensator)
(21) Spool (pressure compensator)
(22) Bias piston

Note: The following description is for a single circuit that is in operation.

When signal pressure (12) and the spring force from spring (16) are equal to the output pressure in line (19), spool (20) moves downward. This blocks the pressure oil from piston (9). The angle of swashplate (6) increases. When the implement is stalled, the pressure in line (19) increases to the setting of spring (15). This causes spool (21) to move upward. The oil in the inlet passage now flows through passage (18) into piston (9). The flow of oil from passage (18) moves piston (9). The piston moves swashplate (6) toward the minimum angle. The pump output is decreased. The pump produces enough flow in order to compensate for internal leakage. Also, the pump produces enough flow in order to maintain system pressure.

When the system pressure decreases to a pressure that is less than the setting of spring (15), spool (21) moves downward. Spool (20) now controls the flow from the pump.

When several circuits are actuated in a stall condition, the pump will not destroke. The angle of swashplate (6) will decrease enough to supply oil to the remaining circuits that are not stalled.

The following conditions will cause the pump to stall at high pressure:

- Load sense relief too high.
- Not functioning properly
- Margin pressure is set too high.

i03772605

Control Manifold (Implement, Steering)

SMCS Code: 5051-ZI

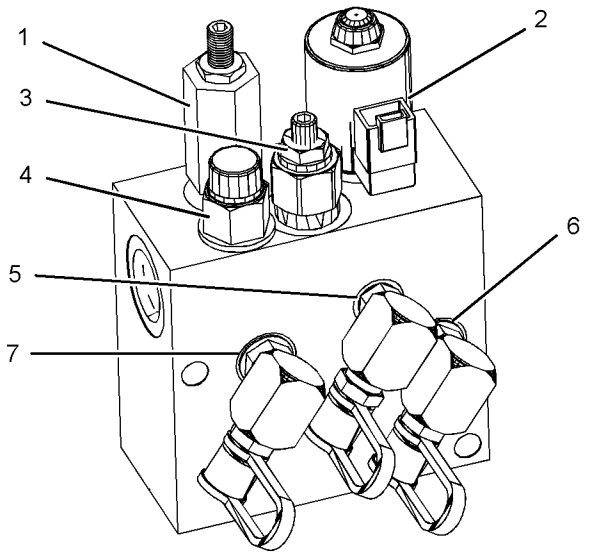

Illustration 34 g01341453

(1) Relief valve
(2) Solenoid for the implement lockout function
(3) Pressure reducing valve
(4) Pressure sensor
(5) Scheduled Oil Sampling port
(6) Pressure test port for pilot pressure
(7) Pressure test port for pump pressure

The control manifold for the pilot system will enable the pilot system for the machine. The control manifold for the pilot system will also disable the pilot system for the machine implements. The implements will not function when the pilot system is disabled. Solenoid (2) will shut off oil flow to the solenoids of the implement system. With no pilot oil, the implement control valves can not direct oil to the implement cylinders. Solenoid (2) is controlled by the implement lockout switch.

The control manifold contains two pressure test ports. Pressure test port (7) will indicate the oil pressure from the piston pump for the implement and steering. Pressure test port (6) will indicate the oil pressure in the pilot system for the implements. The control manifold contains one Scheduled Oil Sampling port (5).

The control manifold contains a pressure reducing valve (3). The pressure reducing valve limits the pilot system for the implements. When the pilot system reaches the pilot pressure the pressure reducing valve will close.

Reference: For information on the pilot pressure settings, refer to Testing and Adjusting, “Hydraulic System Pressure - Test and Adjust”.

The control manifold contains a relief valve (1) that will protect the system from a sudden rise in pressure. Relief valve (1) will limit the peak pressure in the circuit.

Reference: For more information on the relief valve settings, refer to Testing and Adjusting, “Hydraulic System Pressure - Test and Adjust”.

Operation of the Control Manifold

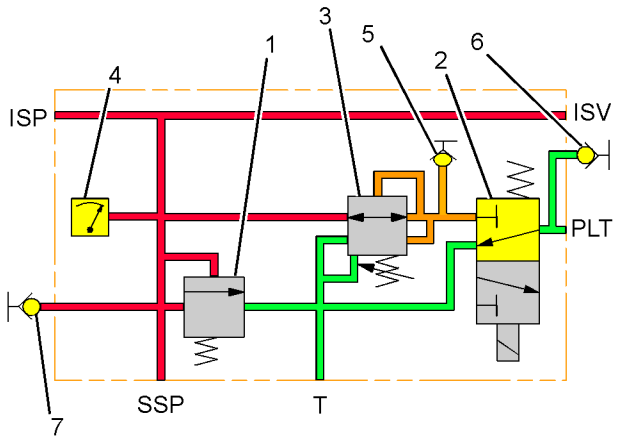

Illustration 35 g01174082

(1) Relief valve
(2) Solenoid for the implement lockout function
(3) Pressure reducing valve
(4) Pressure sensor
(5) Scheduled Oil Sample port
(6) Pressure test port for pilot pressure
(7) Pressure test port for pump pressure
(ISP) Inlet from implement and steering pump
(ISV) Outlet to steering control valve
(PLT) Outlet to the implement pilot system
(SSP) Inlet from secondary steering pump (if equipped)
(T) Outlet to the tank

Oil enters the manifold at port (ISP). Oil flows through an internal passage to pressure reducing valve (3). When the implement lockout switch is engaged, oil will be blocked by solenoid (2). Port (PLT) will be open to the hydraulic tank. Oil will also flow out of the manifold at port (ISV) to the steering control valve.

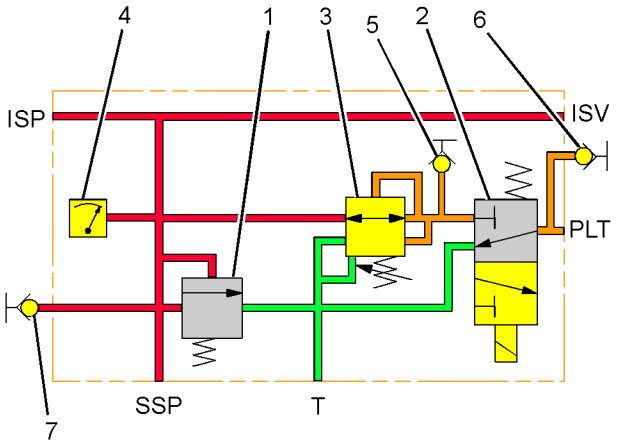

Illustration 36 g01354321

(1) Relief valve
(2) Solenoid for the implement lockout function
(3) Pressure reducing valve
(4) Pressure sensor
(5) Scheduled Oil Sampling port
(6) Pressure test port for pilot pressure
(7) Pressure test port for pump pressure
(ISP) Inlet from implement and steering pump
(ISV) Outlet to steering control valve
(PLT) Outlet to the implement pilot system
(SSP) Inlet from secondary steering pump (if equipped)
(T) Outlet to the tank

When the implement lockout switch is disengaged, oil will be directed by solenoid (2) to port (PLT). Port (PLT) will direct oil to the solenoids in the implement control valves. Pressure reducing valve (3) will close when the pilot circuit is up to operating pressure.

i03856110

Steering Control Valve (with Secondary Steering)

SMCS Code: 4307; 4307-SST; 4307-PV; 4307-CV; 4307-SE; 4322; 4343; 5067-ZH; 5453-ZH

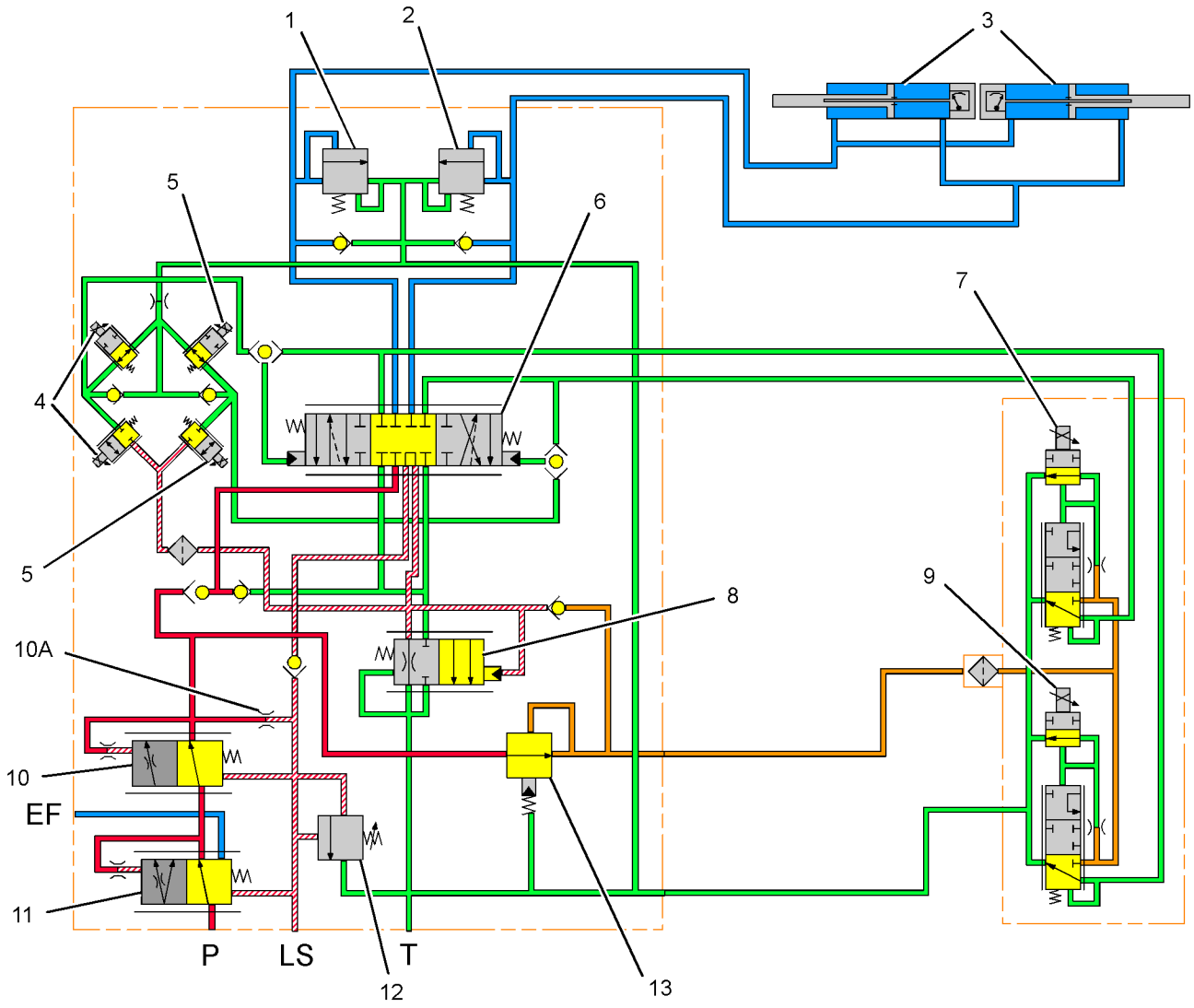

Illustration 37 g01336080

Engine on with the steering control valve in the neutral position

(1) Crossover relief valve
(2) Crossover relief valve
(3) Steering cylinders
(4) Solenoids
(5) Solenoids
(6) Spool
(7) Secondary steering solenoid
(8) Metering valve
(9) Secondary steering solenoid

(10) Compensator valve
(10A) Internal orifice for the compensator valve
(11) Priority valve
(12) Relief valve
(13) Pressure reducing valve
(EF) Port for implement supply
(LS) Port for signal oil to the pump
(T) Port to tank
(P) Supply oil from the pump

When the engine is first started, priority valve (11) will be held to the left by the spring. Pump flow will be directed to flow compensator valve (10). Compensator valve (10) is held to the left by the force of the spring. Pump flow will satisfy the steering system. When valve spool (6) is in the neutral position, pump flow will be blocked at the spool. Pump flow also travels to pressure reducing valve (13) for the pilot system. The pressure reducing valve will be held open by the spring until the pilot system reaches 3000 kPa (435 psi). When the steering system is satisfied, priority valve (11) will shift to the right. Pump flow will be directed to the implement system. The steering system will always have priority over the implement system.

Compensator valve (10) has an integrated orifice (10A) in the stem of the valve. Orifice (10A) will meter pump flow to an internal passage inside the steering control valve. The internal passage will direct oil flow to two locations. Oil flow will meter past spool (6). Oil will be directed to the hydraulic tank by metering valve (8). Oil will also flow to the control valve for the supply pump. The oil that flows to the pump is called signal oil. Signal oil will not be directed to the pump control valve when spool (6) is in the neutral position.

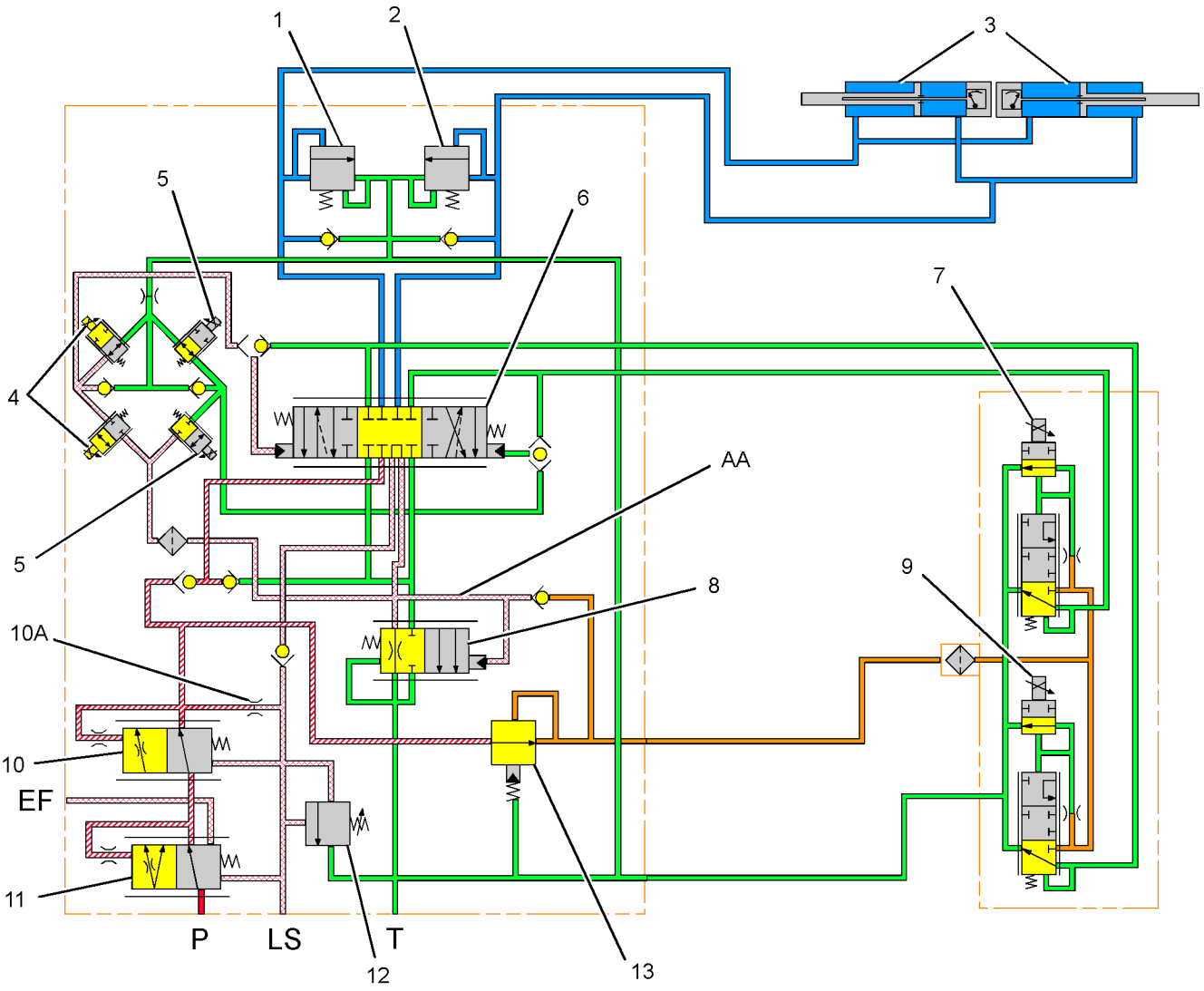

Illustration 38 g01338159

Engine on with the steering control valve in the left turn position

(1) Crossover relief valve
(2) Crossover relief valve
(3) Steering cylinders
(4) Solenoids
(5) Solenoids
(6) Spool
(7) Secondary steering solenoid
(8) Metering valve
(9) Secondary steering solenoid
(10) Compensator valve
(10A) Internal orifice for the compensator valve
(11) Priority valve
(12) Relief valve
(13) Pressure reducing valve
(AA) Internal passage
(EF) Port for implement supply
(LS) Port for signal oil to the pump
(T) Port to tank
(P) Supply oil from the pump

The implement Electronic Control Module (ECM) receives an input from the joystick control when the operator moves the control lever into the left turn position. The implement ECM will energize solenoids (4). Solenoids (4) will direct oil from passage (AA) to the left end of spool (6). As the pressure begins to increase, spool (6) will begin to shift.

Priority valve (11) will meter pump flow between the steering circuit and the implement circuit (EF). Reduced pump oil will travel past compensator valve (10) to spool (6).

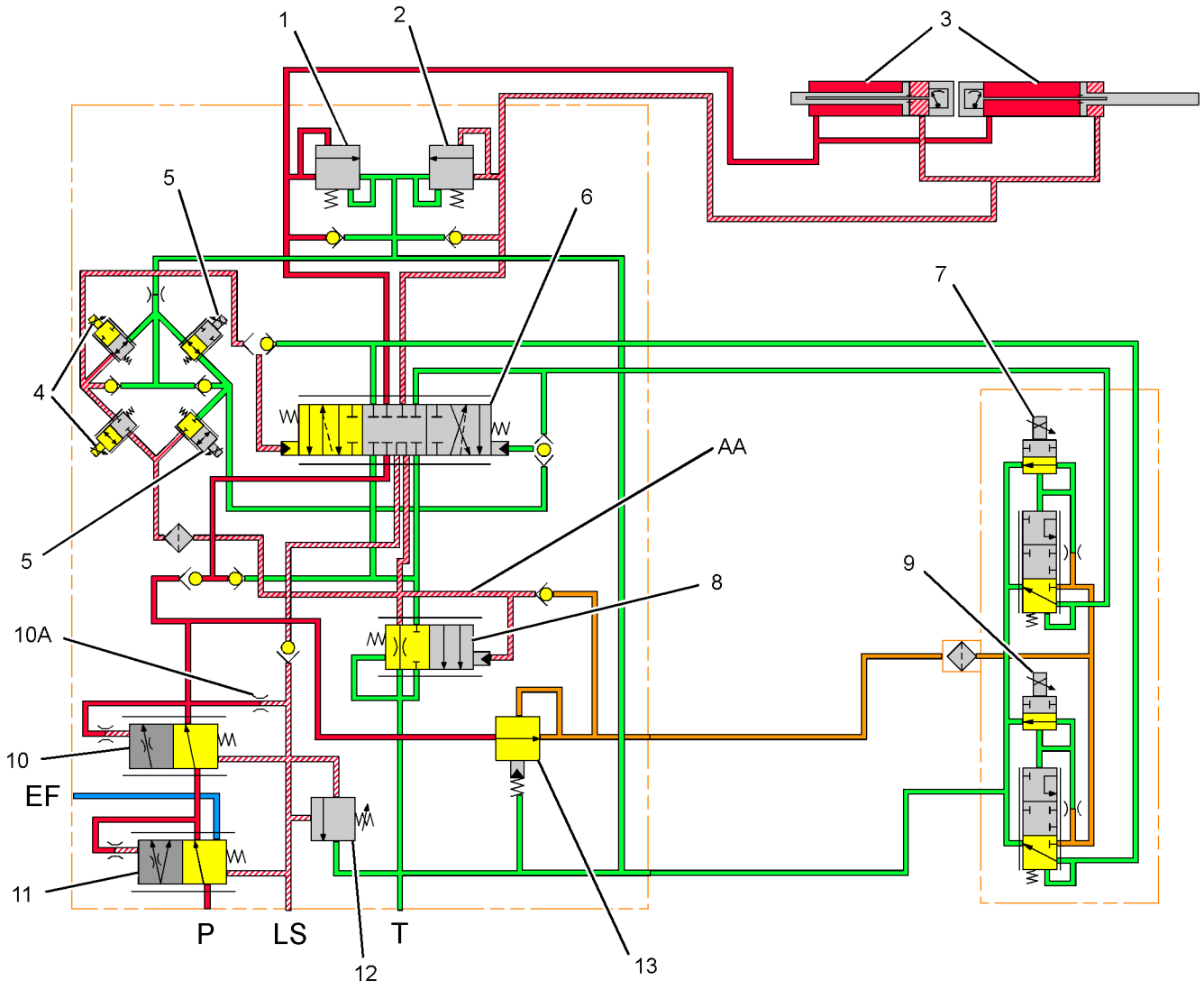

Illustration 39 g01338161

Steering control valve during a left turn

(1) Crossover relief valve
(2) Crossover relief valve
(3) Steering cylinders
(4) Solenoids
(5) Solenoids
(6) Spool
(7) Secondary steering solenoid
(8) Metering valve
(9) Secondary steering solenoid
(10) Compensator valve
(10A) Internal orifice for the compensator valve
(11) Priority valve
(12) Relief valve
(13) Pressure reducing valve
(AA) Internal passage
(EF) Port for implement supply
(LS) Port for signal oil to the pump
(T) Port to tank
(P) Supply oil from the pump

Once spool (6) has shifted to the left a passage will open for pump oil to travel to steering cylinders (3). Valve (10) and valve (11) will shift to the right. Pump oil will travel past spool (6). Pump oil will satisfy the steering cylinders. The rod end of the steering cylinders will move to the right. This will move the front wheels to the left.

As the steering cylinders move, oil will be forced out of the right end of the steering cylinders. Oil will flow across valve (6). Oil will fill passage (AA). Metering valve (8) will maintain around 1200 kPa (174 psi) in the internal passage (AA). Metering valve (8) will direct excess oil from the steering cylinders to the hydraulic tank.

Secondary Steering Function

The transmission/chassis ECM controls the secondary steering functions. A level 3 warning will be generated when the secondary steering system is turned on. The implement ECM will signal the transmission/chassis ECM to turn on the secondary steering system under the following conditions:

- An error code is received from the controller for the steering control valve.
- The main hydraulic pump has failed.
- A steering signal is detected with no input signal by the operator.
- A steering signal is not detected with an input signal by the operator.
- A steering signal is detected in the wrong direction from the operator input.

The transmission/chassis ECM will only turn on the parts of the secondary steering system that are necessary for continued machine operation. If the primary steering solenoids are not functioning correctly, only the secondary steering solenoids will be activated. If the supply pump for the steering fails, only the secondary steering pump will be activated. If the steering system does not function under an operator input, the following components will be activated:

- Secondary steering solenoids
- Secondary steering pump

The secondary steering system will turn on automatically when the machine is in motion. The secondary steering system will need to be manually turned on when the machine is not moving.

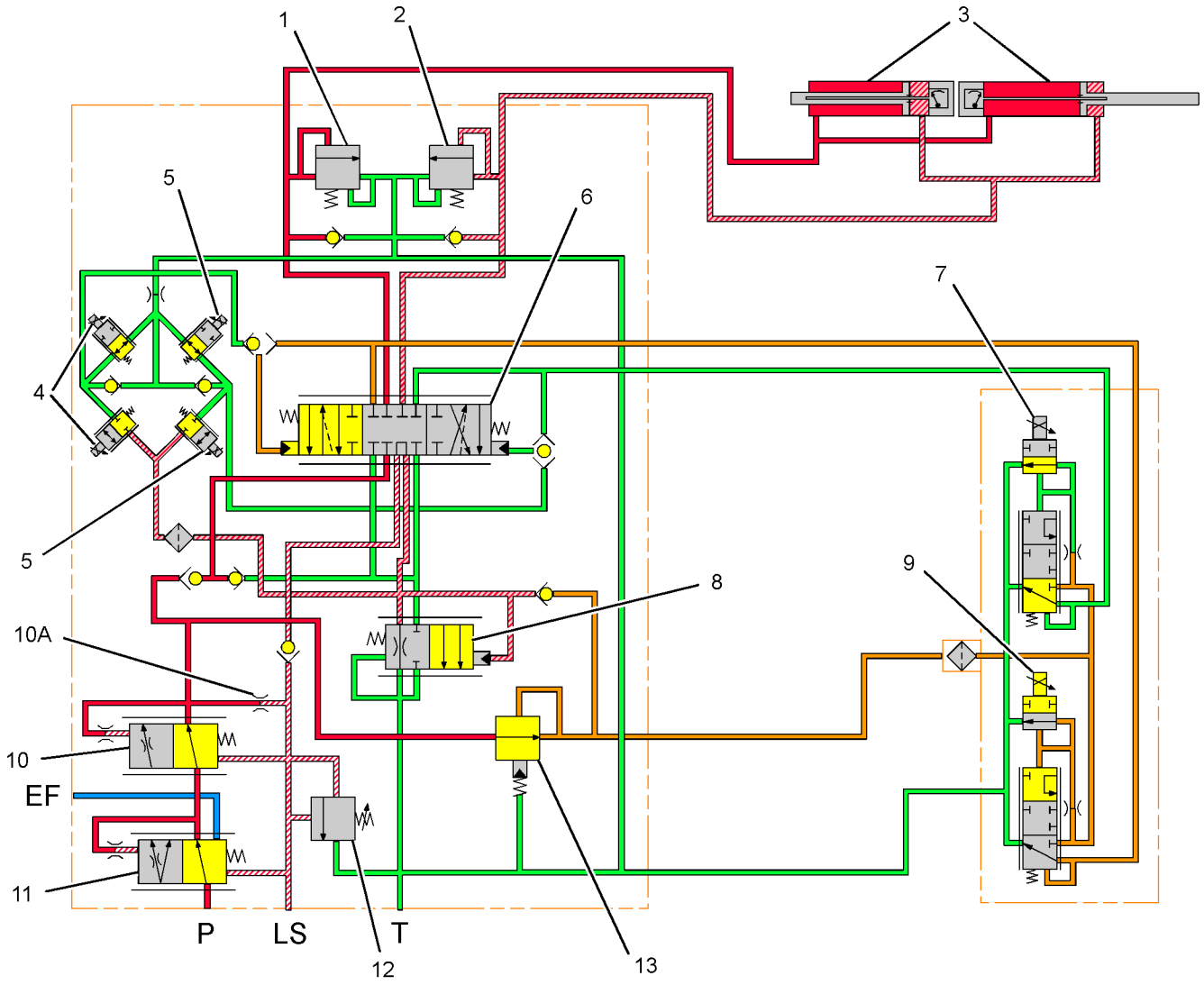

Illustration 40 g01338306

Secondary steering function

(1) Crossover relief valve
(2) Crossover relief valve
(3) Steering cylinders
(4) Solenoids
(5) Solenoids
(6) Spool
(7) Secondary steering solenoid
(8) Metering valve
(9) Secondary steering solenoid
(10) Compensator valve
(10A) Internal orifice for the compensator valve
(11) Priority valve
(12) Relief valve
(13) Pressure reducing valve
(EF) Port for implement supply
(LS) Port for signal oil to the pump
(T) Port to tank
(P) Supply oil from the pump

When solenoids (4) or (5) are not working properly, secondary steering solenoids (7) and (9) will be turned on by the transmission/chassis ECM.

Priority valve (11) will be held to the left by the spring. Pump flow will be directed to flow compensator valve (10). Compensator valve (10) is held to the left by the force of the spring. Pump flow will satisfy the steering system. Pump flow will travel to pressure reducing valve (13) for the pilot system. The pressure reducing valve will be held open by the spring until the pilot system pressure is 3000 kPa (435 psi).

The transmission/chassis ECM will energize solenoid (9) when the joystick control is moved to the left turn position by the operator. Solenoid (9) will shift downward. Solenoid (9) will direct pilot oil to the left side of spool (6). Spool (6) will shift to the right. Pump oil will be directed past spool (6) to the steering cylinders.

Crossover Relief Valve

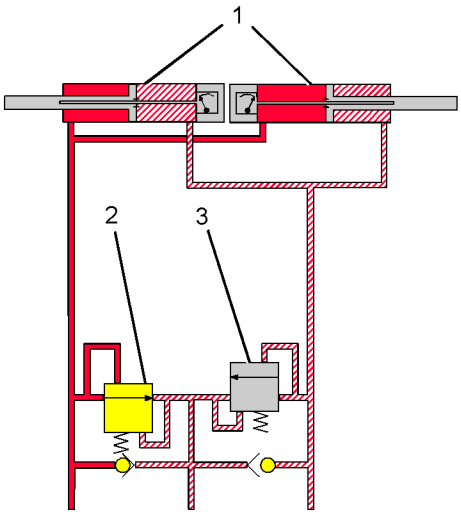

Illustration 41 g01344745

Crossover relief valve

(1) Steering cylinders
(2) Relief valve
(3) Relief valve

The crossover relief valves prevent damage from high pressure oil in the steering circuit when an outside force suddenly moves a steering cylinder rod. When the pressure of the oil in the cylinders rises to the setting of relief valve (2), the valve will open. Oil will flow from one side of the steering circuit to the other side of the steering circuit.

i06590230

Implement System

SMCS Code: 5050

The implement system is composed of the following components:

- Implement and steering pump
- Control manifold
- Steering control valve
- Implement control valve
- Cylinders and the circle drive
- Shuttle valve

The piston pump transfers oil from the tank to the control manifold. The control manifold will send some of the pump supply oil to the pilot system. The oil that is not used by the control manifold will flow to the steering control valve. The steering system has priority over the implement system. When the demands of the steering circuit are met, the steering control valve will direct oil to the implement circuit. Oil flows from the steering control valve to the implement control valves. The implement control valves will direct oil to the cylinders or circle drive.

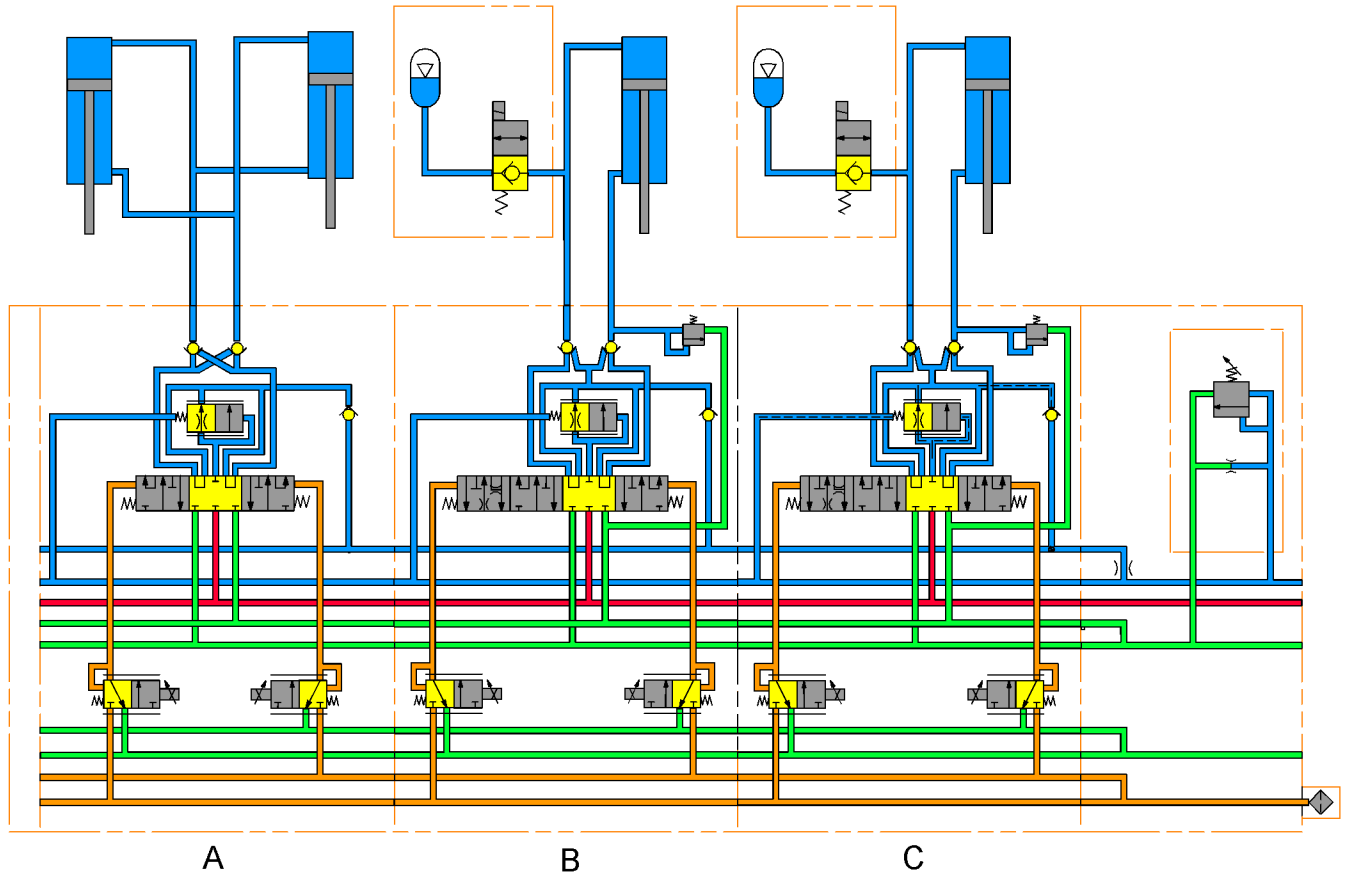

Illustration 42 g01334623

(A) Articulation (B) Blade lift (C) Blade lift

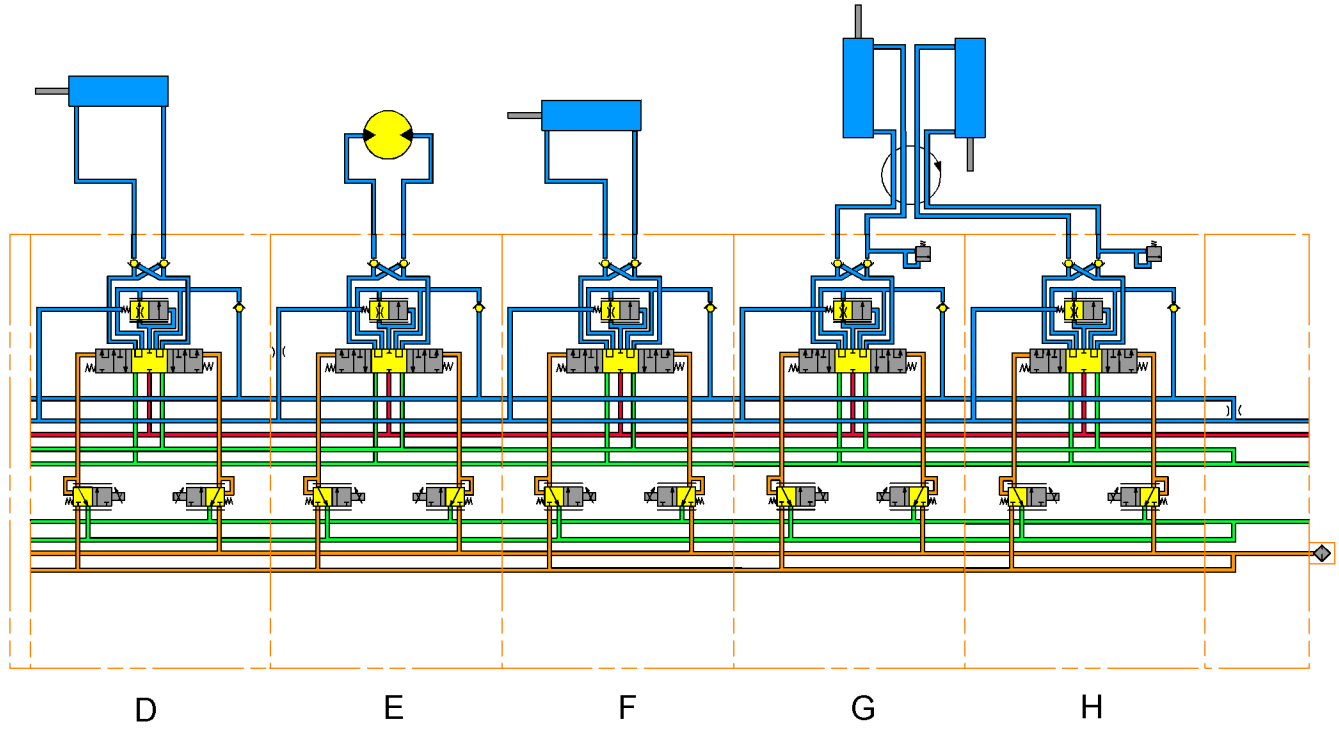

Illustration 43 g01334624

(D) Wheel lean
(E) Circle drive
(F) Centershift
(G) Side shift
(H) Blade tip

There are eight standard implement circuits on the machine. Seven control valves are for cylinder circuits and one control valve is for the motor that rotates the blade around the drawbar. The implement system can accommodate as many as 14 implement control valves. The individual control valves regulate the operation of each implement. When the operator moves the joystick control, an electrical signal is sent to a directional solenoid. When the solenoid is energized, pilot oil will be directed to one side of the valve spool. The valve spool will shift. Oil will be directed to the corresponding implement.

Some of the Motor Graders may have different implements. The number of the control valves in each valve group may vary. When an implement control valve is replaced, use the same part number. This will keep the control valve and the cylinder matched.

Reference: For additional information on the hydraulic system, refer to the hydraulic schematic for your machine.

i02808157

Signal Network

SMCS Code: 5050-X8

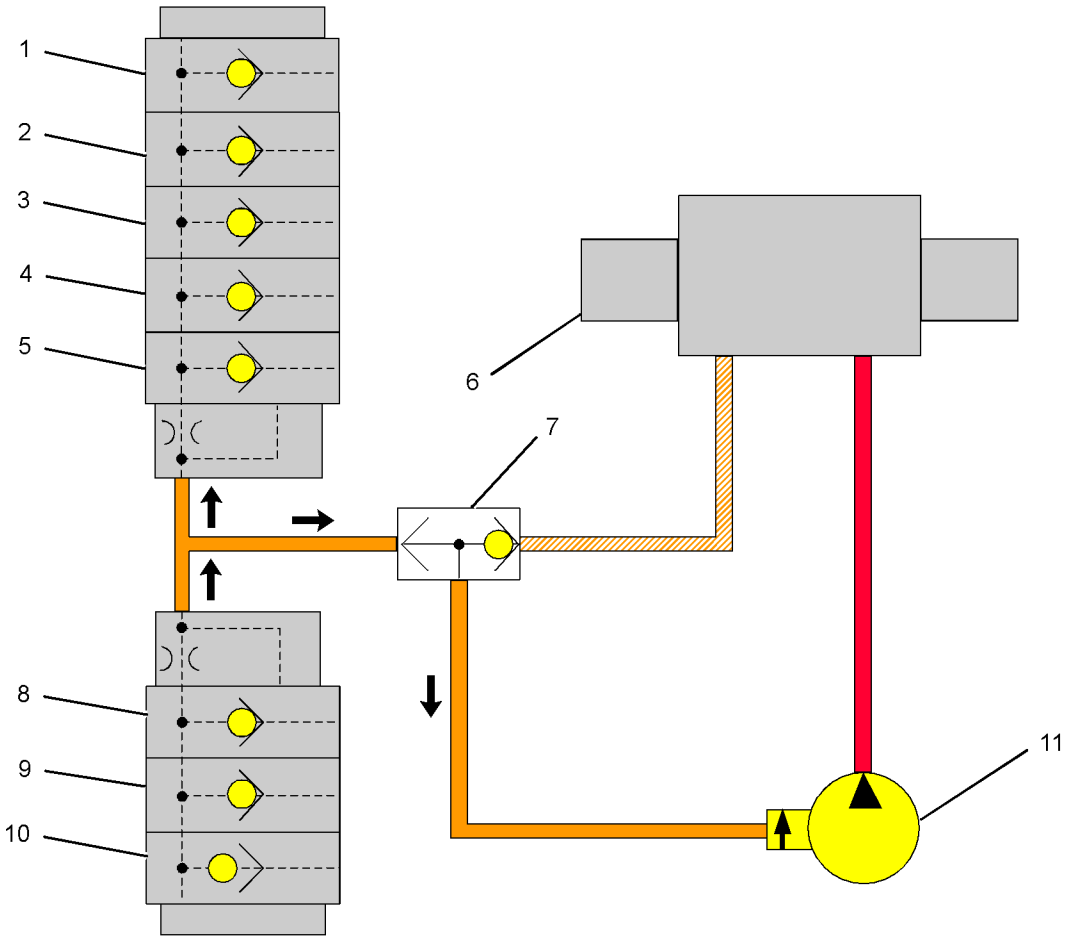

Illustration 44 g01400918

(1) Wheel lean
(2) Circle drive
(3) Centershift
(4) Side shift
(5) Blade tip
(6) Steering control valve
(7) Shuttle valve
(8) Blade lift
(9) Blade lift
(10) Articulation
(11) Piston pump

When the operator articulates the machine, oil unseats the signal check valve in the articulation implement control valve (10). The signal oil from the articulation circuit forces all the remaining signal check valves to be in the closed position. The signal oil from the articulation circuit also forces all the compensator valves that are in the implement control valves to be in the closed position. Even though there is steering signal oil pressure, the signal oil pressure is lower than the signal pressure from the articulation circuit. The ball in shuttle valve (7) moves in order to direct the signal oil from the articulation circuit to the control valve for piston pump (11). Pump (11) will upstroke in order to meet the demands of the articulation circuit.

i03776532

Control Valve (Implement)

SMCS Code: 5051

Implement Control Valve Without a Line Relief Valve

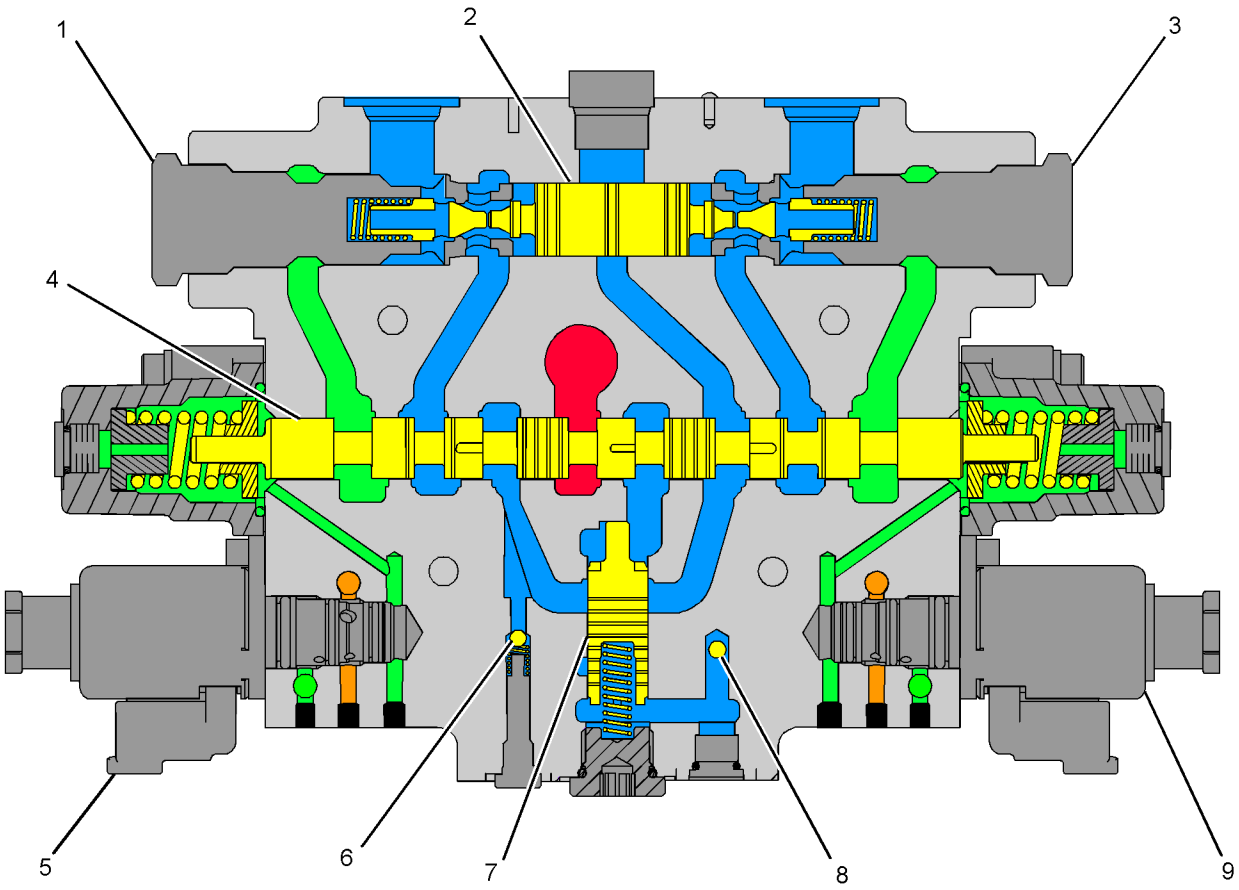

Illustration 45 g01400926

Typical implement control valve without a line relief valve in the HOLD position

(1) Check valve
(2) Piston
(3) Check valve
(4) Stem
(5) Solenoid
(6) Check valve for signal network
(7) Compensator spool
(8) Signal port
(9) Solenoid

The following implement circuits do not have line relief valves:

- Articulation
- Centershift
- Circle drive

- Wheel lean

Control stem (4) has metering holes and slots that are designed to match the flow requirements for each circuit. If the components become damaged or worn, the components in the control valves are replaceable.

Check valve (1) and check valve (3) are incorporated into the control valve body. A guided poppet is used in order to reduce leakage. The reduction in leakage reduces cylinder drift.

Piston (2) will shift when pressurized oil is directed to one side of the piston. Piston (2) will unseat one of check valves. Pressurized oil will open the other check valve.

When the total flow demand exceeds the maximum pump flow, compensator spool (7) distributes the hydraulic pump flow that is available. Compensator spool (7) creates an additional restriction in each circuit. This is done so a single circuit cannot use all of the available pump flow. Compensator spool (7) maintains an equal pressure drop across each opening. The oil flow from each implement control valve is proportional to the opening of stem (4).

Check valve (6) allows pressurized oil to travel out of the implement control valve through a passage and into the signal network. The check valve also prevents back pressure from the other control valves from acting on the control valve. The highest load pressure is the only pressure that passes through the signal check valve. All other signal check valves will remain seated. The signal oil also becomes the input signal to the back of compensator spool (7). The signal oil enters through port (8). Signal oil plus the force of the spring act on compensator spool (7). Compensator spool (7) regulates the flow of oil to the cylinders when multiple implement circuits are being used.

Solenoid (5) and solenoid (9) work independently of each other in order to shift control stem (4). When the operator moves the joystick, an electrical signal will cause one solenoid to energize. The energized solenoid will direct pilot oil to the end of control stem (4). The de-energized solenoid will have a passage open to the hydraulic tank. The pilot oil on one side of control stem (4) will shift control stem (4) against the spring on the opposite side. Solenoid (5) and solenoid (9) are variable.

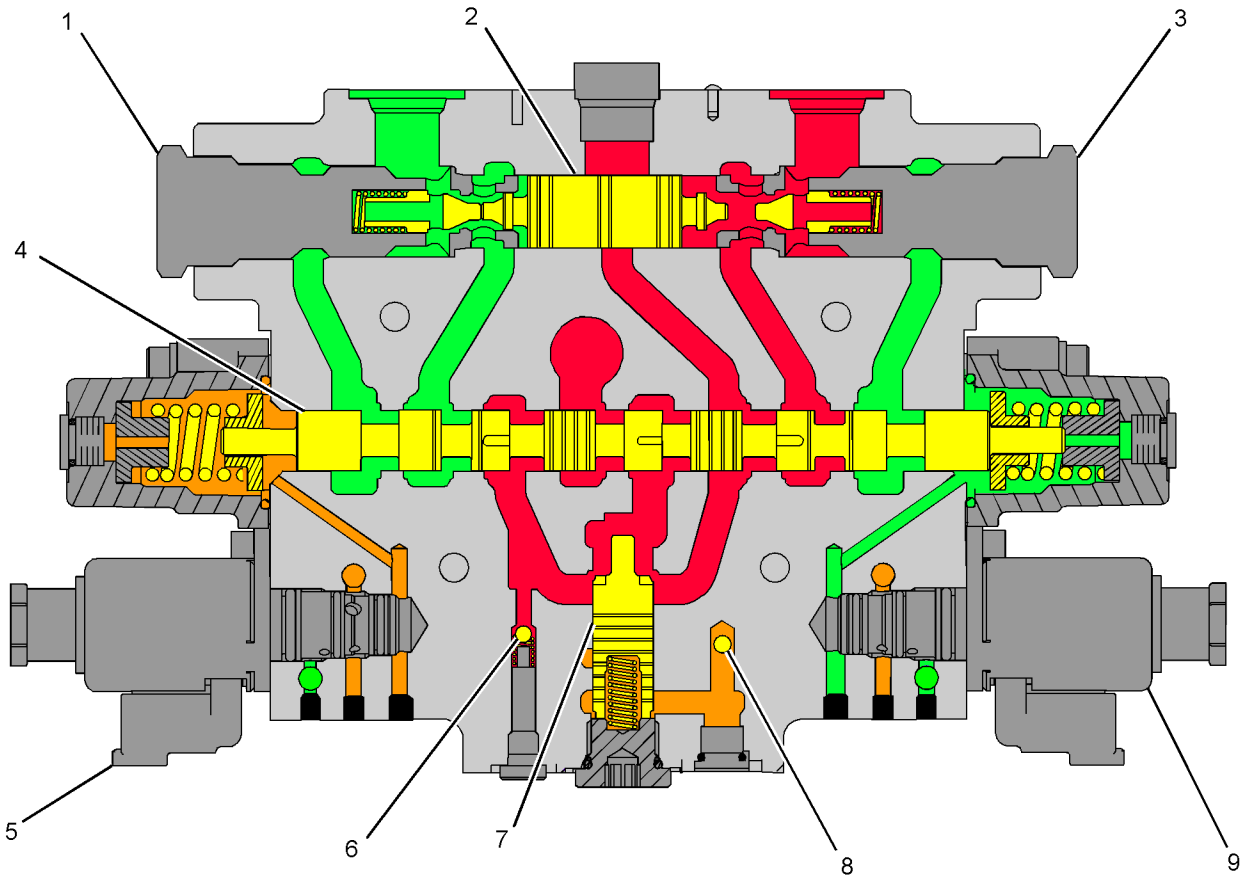

Illustration 46 g01404621

Typical implement control valve without a line relief valve in operation

(1) Check valve
(2) Piston
(3) Check valve
(4) Stem
(5) Solenoid
(6) Check valve for signal network
(7) Compensator spool
(8) Signal port
(9) Solenoid

When the operator moves the joystick, an electrical signal will cause one solenoid to energize. When solenoid (5) is energized, solenoid (5) will direct pilot oil to the end of control stem (4). When solenoid (9) is de-energized, solenoid (9) will have a passage open to the hydraulic tank. The pilot oil on one side of the control stem (4) will shift control stem (4). Pump supply oil will flow into the internal passages of the control valve. Pump supply oil will flow past compensator spool (7) and shift piston (2) to the left. Piston (2) will unseat check valve (1). Pump supply oil will flow past check valve (3) to the cylinder. The opposite end of the cylinder will be open to the hydraulic tank by check valve (1).

Pump supply oil will also unseat check valve (6). The oil that flows past check valve (6) will flow into the signal network. The signal network will send pilot oil to the implement piston pump in order to upstroke the pump. The implement piston pump will maintain oil flow in order to meet the system demands.

Implement Control Valve With a Line Relief Valve

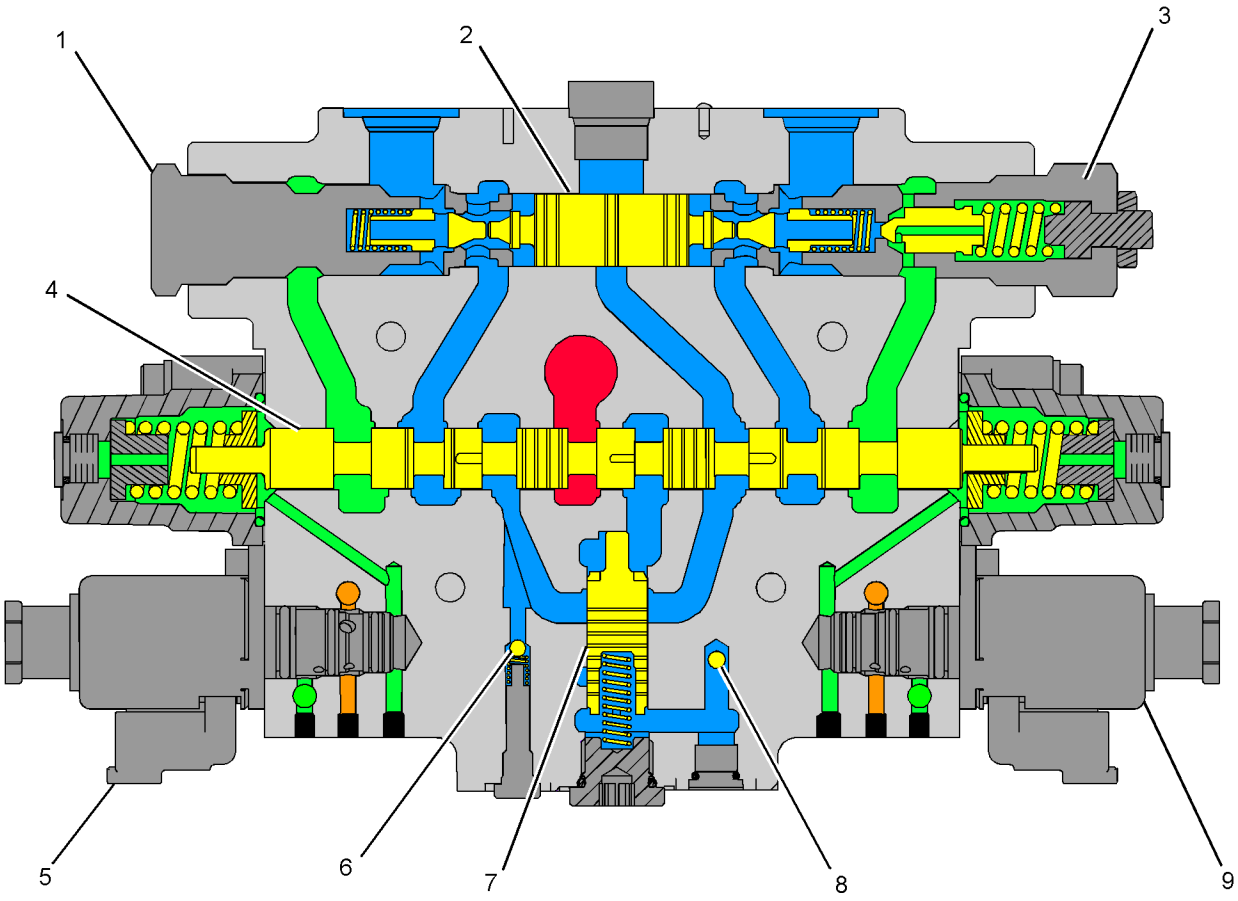

Illustration 47 g01400929

(1) Check valve
(2) Piston
(3) Check valve
(4) Stem
(5) Solenoid
(6) Check valve for signal network
(7) Compensator spool
(8) Signal port
(9) Solenoid

The following implement circuits include one line relief valve:

- Blade lift
- Blade tip
- Blade sideshift
- Ripper
- Scarifier
- Snow plow/dozer lift
- Snow plow/dozer angle

The following implement circuits include two line relief valves:

- Snow wing lift
- Snow wing tilt

Check valve (3) contains a check valve and a relief valve. The relief valve protects the rod end of the circuit from high pressures. If the pressure in the rod end of the circuit rises above the setting of the relief valve, the relief valve will open. The relief valve will drain the excessive pressure to the hydraulic tank.

Implement Control Valves with Blade Float

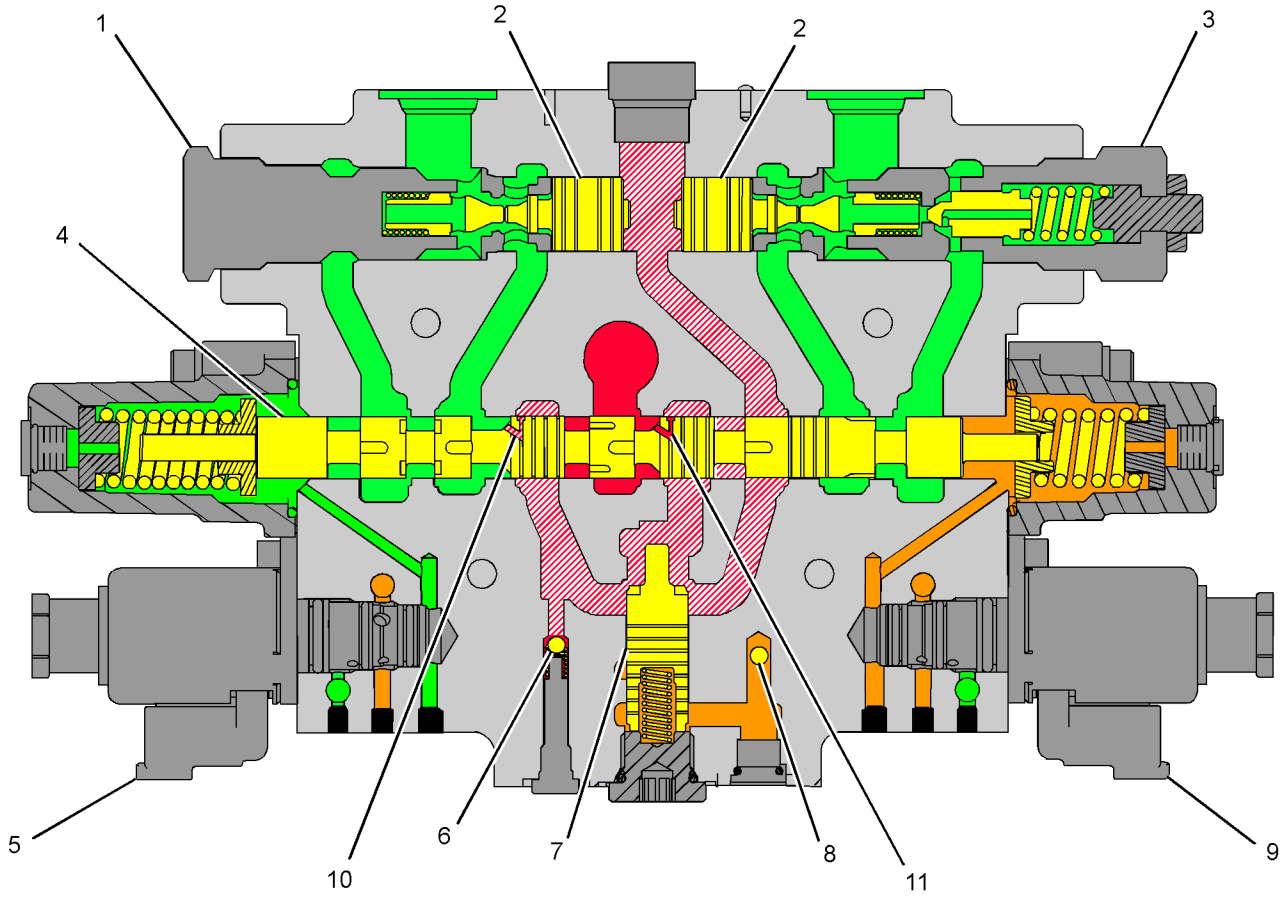

Illustration 48 g01404615

(1) Check valve
(2) Pistons
(3) Check valve
(4) Stem
(5) Solenoid
(6) Check valve for signal network
(7) Compensator spool
(8) Signal port
(9) Solenoid
(10) Orifice
(11) Orifice

The following implement valves have a blade float function:

- Blade lift
- Snow plow/dozer lift

Solenoid (9) is energized to the maximum of one amp in the float position. The solenoid directs pilot oil to the back of stem (4). Pilot oil shifts stem (4) all the way to the left. Orifice (11) meters pressurized oil from the pump supply port into the internal passages of the control valve. Pressurized oil flows through the internal passages in the control valve to pistons (2). Pressurized oil moves pistons (2) outward. Pistons (2) push check valve (1) and check valve (3) open. Orifice (10) and orifice (11) are different sizes. Orifice (10) is smaller. Orifice (10) will meter a small amount of pressurized oil to the hydraulic tank in order to limit the pressure of the oil inside the control valve. Orifice (10) maintains the pressure inside the control valve in order to keep pistons (2) shifted outward. In the float position, both cylinder ports are vented to the hydraulic tank.

Control Valve Operation

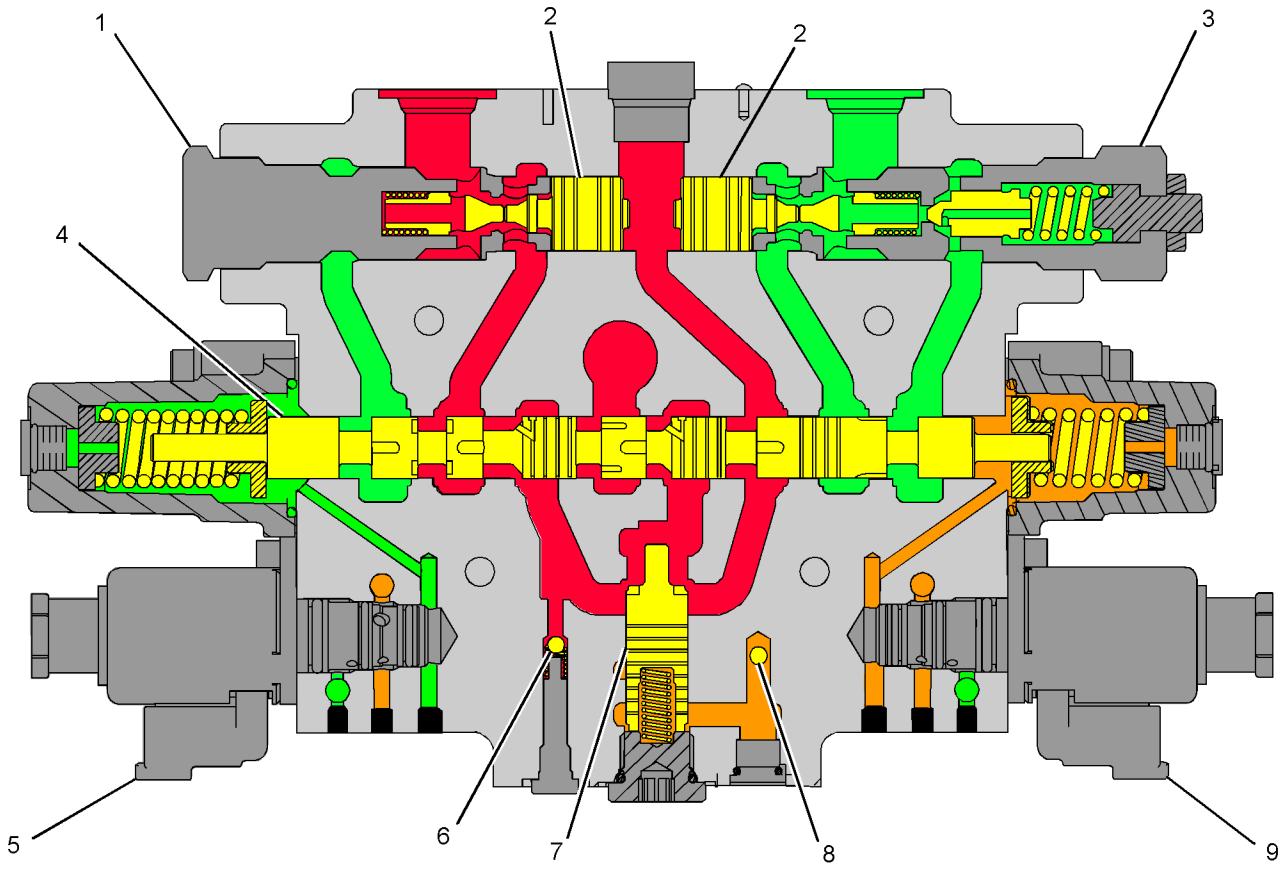

Illustration 49 g01400932

Blade control valve in the LOWERED position

(1) Check valve
(2) Pistons
(3) Check valve
(4) Stem
(5) Solenoid
(6) Check valve for signal network
(7) Compensator spool
(8) Signal port
(9) Solenoid

When the operator moves the joystick, an electrical signal will cause one solenoid to energize. Solenoid (9) is energized in the LOWERED position. Solenoid (9) will direct pilot oil to the end of control stem (4). The de-energized solenoid will have a passage open to the hydraulic tank. The pilot oil on one side of control stem (4) will shift control stem (4). Pump supply oil will flow into the internal passages of the control valve. Pump supply oil will flow past compensator spool (7) and shift pistons (2) outward. Pistons (2) will unseat check valve (1) and check valve (3). Pump supply oil will flow past check valve (1) to the head end of the cylinder. The rod end of the cylinder will be open to the hydraulic tank by check valve (3).

Pump supply oil will also unseat check valve (6). The oil that flows past check valve (6) will flow into the signal network. The signal network will send pilot oil to the implement piston pump in order to upstroke the pump. The implement piston pump will maintain oil flow in order to meet the system demands.

i02813017

Centershift Lock

SMCS Code: 5221

⚠ WARNING

Be sure to ground moldboard before retracting centershift lock pin. Failure to ground the moldboard can cause personal injury or death.

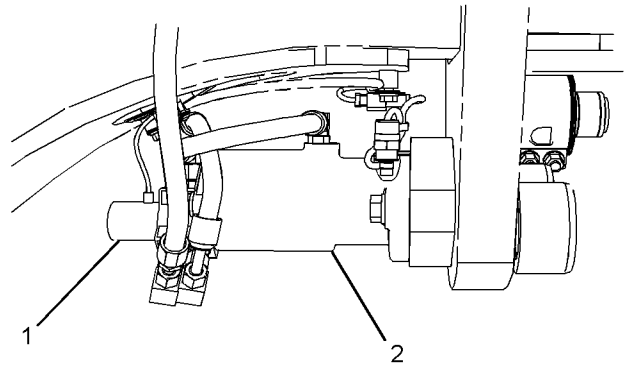

Illustration 50 g01292474

(1) Solenoid for the centershift lock
(2) Centershift lock cylinder

Centershift lock (2) is located on the rear of the link bar. When the centershift lock (2) is not engaged, the link bar and the circle can be moved in order to place the blade in the correct position. When the centershift lock (2) is engaged, the link bar and the circle will not move sideways.

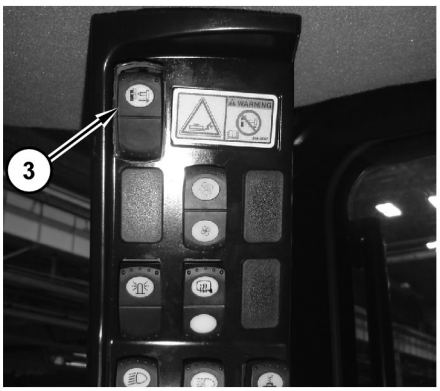

Illustration 51 g01294070

(3) Centershift lock switch

Centershift lock switch (3) is located on the console to the right of the operator. This switch sends an electrical signal to solenoid (1) for the centershift lock. Solenoid (1) will direct oil to either side of centershift lock cylinder (2). The machine is normally operated with the centershift lock pin in the LOCK position.

Reference: For more information on operation of the centershift lock switch, refer to Operation and Maintenance Manual, “Centershift Lock Switch”.

Since the centershift lock pin cannot be seen by the operator, a centershift indicator shows the operator when the lock pin is in alignment with the correct hole in the lock plate. the centershift lock indicator is located on the right side of the link bar.

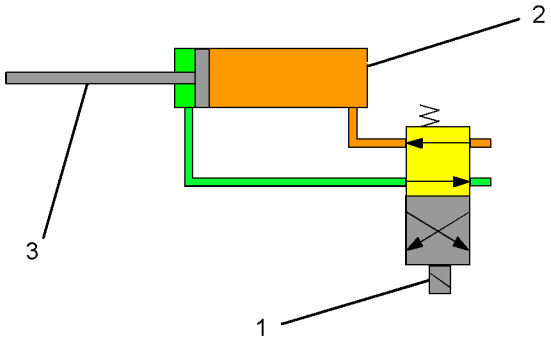

Illustration 52 g01291344

(1) Solenoid for the centershift lock
(2) Centershift lock cylinder
(3) Centershift lock pin

Implement pilot oil is directed to the centershift lock when the implement lockout switch is engaged. When solenoid (1) is de-energized, pilot oil will be directed to the head end of the centershift lock cylinder (2). Cylinder (2) will travel to the end of the stroke. The cylinder rod will hold the blade circle in position.

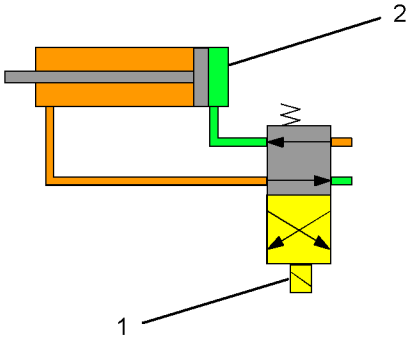

Illustration 53 g01118359

(1) Solenoid for the centershift lock
(2) Centershift lock cylinder

Implement pilot oil is directed to the centershift lock when the implement lockout switch is engaged. When solenoid (1) is energized, pilot oil will be directed to the rod end of the centershift lock cylinder (2). Cylinder (2) will travel to the end of the stroke. The retracted cylinder rod will release the blade circle from a fixed position.

i04907810

Blade Cushion
(If Equipped)

SMCS Code: 5077; 6151

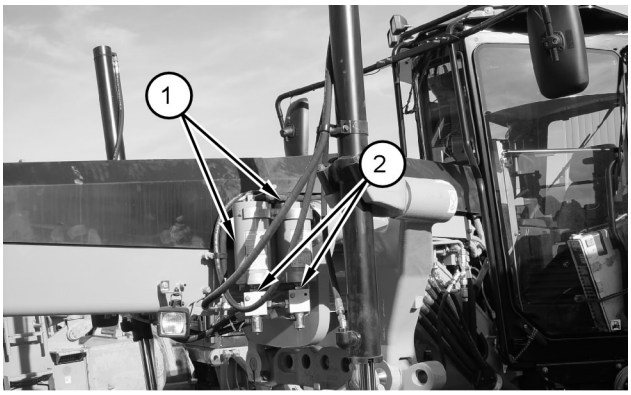

Illustration 54 g01139373

(1) Blade cushion accumulators
(2) Solenoid operated valves

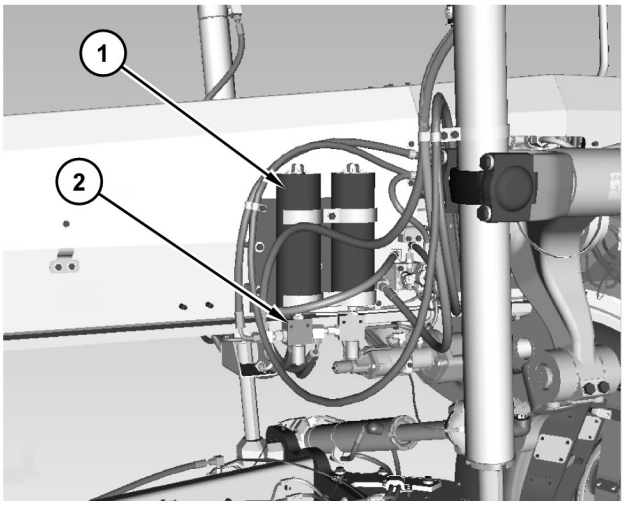

Illustration 55 g02190913

(1) Blade cushion accumulators
(2) Solenoid operated valves

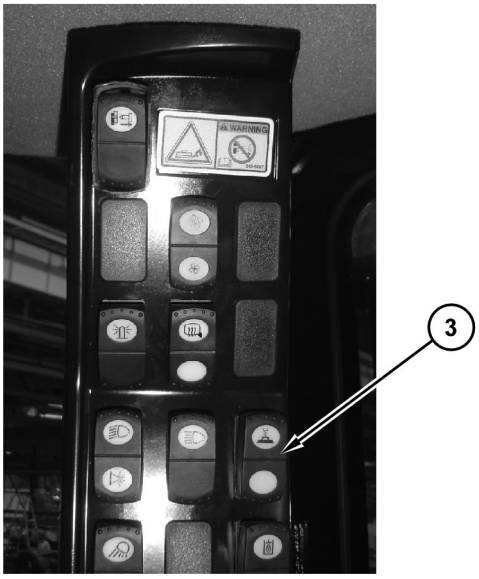

Illustration 56 g01302525

(3) Blade cushion switch

The blade cushion dampens the shocks that are made in the blade lift hydraulic circuit when the blade contacts an object that will not move. Blade cushion accumulators (1) have a nitrogen precharge pressure that provides the cushion.

The blade cushion is activated by blade cushion switch (3) on the right side of the operator on the shift console. Blade cushion switch (3) energizes the solenoids which control the check valves for the blade cushion. A manifold is located at the base of blade cushion accumulators (1). Each manifold contains an oil passage to the corresponding blade cushion accumulator (1). Solenoid operated valves (2) are mounted to the manifolds. Solenoid operated valves (2) regulate the flow of oil to blade cushion accumulators (1).

Blade Cushion that is Deactivated

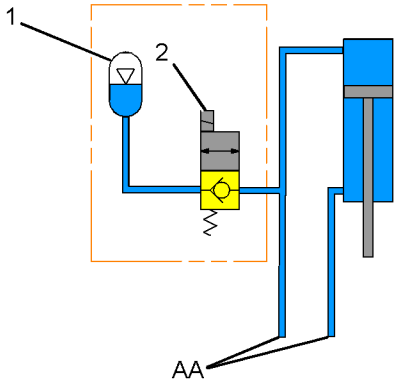

Illustration 57 g01401305

Blade cushion that is deactivated

(1) Blade cushion accumulator
(2) Solenoid operated valve
(AA) Hydraulic line to implement control valve

With blade cushion switch (3) in the OFF position, the solenoids are de-energized. Oil pressure from the lines cannot pass through the manifolds in order to enter blade cushion accumulators (1). The cartridge assemblies in the manifolds contain one-way check valves. The one-way check valves allow oil into the head of the blade lift cylinders. Oil is prevented from flowing back into blade cushion accumulators (1).

Blade Cushion that is Activated

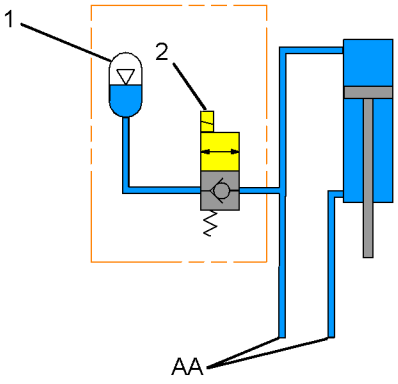

Illustration 58 g01401306

Blade cushion that is activated

(1) Blade cushion accumulator
(2) Solenoid operated valve
(AA) Hydraulic line to implement control valve

With blade cushion switch (3) in the ON position, the solenoids are energized. The cartridge assemblies are pulled back out of the manifolds. There is now an open passage from the hydraulic circuit to blade cushion accumulators (1).

When a shock occurs, oil pressure flows through the lines and the manifolds into blade cushion accumulators (1). Accumulators (1) cushion the force of the pressure oil in the hydraulic circuit. Once the shock has passed, pressure oil from blade cushion accumulators (1) re-enters the hydraulic circuit. Oil flows back into the head end of the blade lift cylinders. The blade is allowed to return to the original position.

i02957134

Hydraulic Schematic

SMCS Code: 4300; 5050

RENR8484-10-00-ALL

Page Range: 49-50

Foldouts: 1

11x17OR LESS

THROW THIS AWAY AFTER FOLDOUT \ WALLCHART ASSEMBLY COMPLETED

THROW THIS AWAY AFTER FOLDOUT \ WALLCHART ASSEMBLY COMPLETED

(1) Wheel lean cylinder
(2) Circle drive motor
(3) Centershift cylinder
(4) Sideshift cylinder
(5) Blade tip cylinder
(6) Blade cushion
(7) Blade lift cylinder
(8) Blade cushion
(9) Blade lift cylinder
(10) Articulation cylinders
(11) Wheel lean control valve
(12) Circle drive control valve
(13) Centershift control valve
(14) Blade sideshift control valve
(15) Swivel
(16) Blade tip control valve
(17) Inlet manifold
(18) Signal relief valve
(19) Inlet manifold
(20) Blade lift control valve
(21) Solenoid valve and manifold (variable blade float)
(22) Blade lift control valve
(23) Articulation control valve
(24) Screens
(25) Steering cylinders
(26) Hydraulic tank
(27) Centershift lock
(28) Steering control valve
(29) Implement and steering pump
(30) Pilot control manifold
(31) Secondary steering pilot valve
(32) Filter
(33) Secondary steering pump
(34) Check valve
(35) Pilot filter
(36) Screen
(37) Shuttle valve
(A) Test port for the pump signal
(B) Test port for pump supply pressure
(C) Test port for implement pilot circuit
(D) Oil sample port

i07244118

Graphic Color Codes

SMCS Code: 4300; 5050

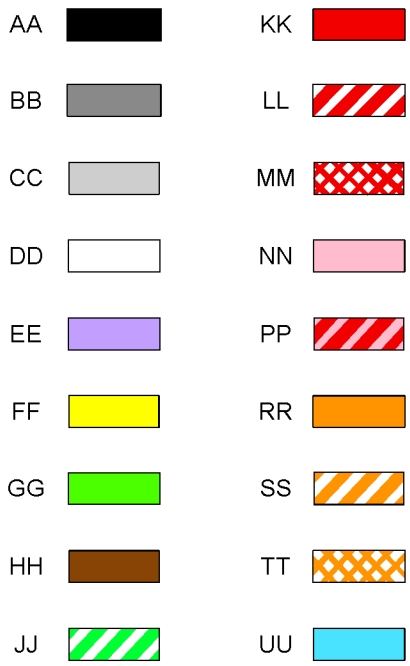

Illustration 60 g01861138

(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: 4300-035; 5050-035

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: 4300-035; 5050-035

⚠ 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, PERJ1017, “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.

i03780253

Visual Inspection

SMCS Code: 4300-035; 5050-035

⚠ WARNING

Always use a board or cardboard when checking for a leak. Escaping fluid under pressure, even a pin hole leak, can penetrate body tissue, causing serious injury and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this type of injury.

When you identify a problem, visually inspect the hydraulic system, the steering system and the different components. Lower the implements to the ground and then stop the engine. Make the following inspections:

1. Trace all of the hydraulic implement lines from the implement connections to the valve connections. Check the following components for damage and check the following components for leaks:
   - All of the hydraulic implement lines
   - All of the connections on the components
2. Check the control valves for leaks.
3. Check the following components for damage and check the following components for leaks:
   - The implement and steering pump
   - The connections on the components
4. Trace the lines from the implement and steering pump to the hydraulic tank. Also, trace the lines from the implement and steering pump to the valves. Check the following components for damage and check the following components for leaks:
   - The lines from the implement and steering pump to the hydraulic tank
   - The lines from the implement and steering pump to the valves
   - The hydraulic tank
   - The connections on the components
5. Check the hydraulic tank oil level.
6. For information on taking an oil sample, refer to the Operation and Maintenance Manual for your machine.
7. Remove the filter element and the strainer. Check for particles that have been removed from the oil by the filter element. A magnet will separate ferrous particles from nonferrous particles. Ferrous materials such as piston rings contain iron. If necessary, replace the filter and clean the strainer.

i03866254

Operational Checks

SMCS Code: 4300-035; 5050-035

⚠ WARNING

Personal injury or death can result from escaping fluid under pressure.

Escaping fluid under pressure, even a very small pin-hole size leak, can penetrate body tissue and cause serious injury and possible death. If fluid is injected into your skin, it must be treated by a doctor familiar with this type of injury.

Always use a board or cardboard when checking for a leak.

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, PERJ1017, “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.

Operational Checks (Steering System)

The operational checks can be used to find leakage in the steering system. Also, the operational checks can be used to find a failed valve or a failed implement and steering pump. Before you begin the checks, refer to Troubleshooting, “Machine Preparation for Troubleshooting”.

Reference: Before you start the engine, refer to Operation and Maintenance Manual, “Before Starting Engine”.

The oil in the steering system must be at an normal operating temperature.

Release the parking brake.

1. Release the service brakes. Move the joystick controls in both directions until the steering cylinders extend completely and the steering cylinders retract completely. The extension of the steering cylinders must be smooth and regular. The retraction of the steering cylinders must be smooth and regular.
2. Listen for noise from the pump for the implement and steering.
3. Inspect the steering system for leaks and damaged components.

Operational Checks (Hydraulic System)

The oil in the hydraulic system must be at an operating temperature of 60° ± 5°C (140° ± 9°F).

1. Move the implements in both directions until the implement cylinders extend completely and the implement cylinders retract completely. The extension of the implement cylinders must be smooth and regular. The retraction of the implement cylinders must be smooth and regular.
2. Listen for noise from the pump for the implement and steering.
3. Inspect the implement system for leaks and damaged components.

Symptom Procedures

i06840274

Hydraulic and Steering System

SMCS Code: 4300-035; 5050-035

Problem: The temperature of the oil is too hot.

Probable Cause

- The viscosity of the oil is incorrect.
- The signal relief valve is set too high. Refer to Testing and Adjusting, “Pump Control Valve (Implement, Steering) - Test and Adjust”.
- The implement relief valve is set too low. Refer to Testing and Adjusting, “Pump Control Valve (Implement, Steering) - Test and Adjust”.
- The implement and steering pump has too much wear (high leakage).
- There is a restriction in an oil passage.
- The load of the system is too high.
- The signal purge valve has malfunctioned. The signal purge valve is in the pump control valve. The signal purge valve should be in the CLOSED position.
- There is air in the oil.
- Outside air temperature is too hot.

Problem: The implement and steering pump makes unusual noise. The cylinder rods do not move evenly. Air bubbles are in the oil.

Probable Cause

- There is a leak in the oil line between the hydraulic tank and the implement and steering pump.
- There is a leak in the oil line between the hydraulic tank and the hydraulic fan pump.
- The hydraulic system was not purged correctly. The system may not have been purged correctly after assembly of the hydraulic system. The system may not have been purged correctly after inspection of the hydraulic system, or after testing of the hydraulic system. Refer to Testing and Adjusting, “Steering System - Purge”.
- The relief valve constantly cycles.
- There is leakage around the cylinder seals.
- The operator is using the blade float function in order to drop the blade.

Problem: The maximum pressure of the implement and steering pump is too low.

Probable Cause

- The signal relief valve is set too low.
- There is a leak in the signal network or there is a restriction in the signal network.
- The pump control valve is set incorrectly. Refer to Testing and Adjusting, “Pump Control Valve (Implement, Steering) - Test and Adjust”.
- The margin pressure is set too low.
- The implement and steering pump is not upstroking. The swashplate is blocked.

Problem: The pressure of the implement and steering pump is too high.

Probable Cause

- The signal relief valve is set too high. Refer to Testing and Adjusting, “Pump Control Valve (Implement, Steering) - Test and Adjust”.
- The margin pressure is set too high.
- The implement and steering pump is not destroking. The actuator piston is stuck or the swashplate is blocked.

Problem: The implement and steering pump has no pressure.

Probable Cause

- The hydraulic system is low on oil.

- The implement and steering pump has malfunctioned or the pump drive shaft has malfunctioned.
- The pump control valve is set incorrectly.
- The check valve at the pump discharge line is possible stuck.

Problem: The implement and steering pump remains at margin pressure. When the implements are used or the steering is used, the pump will not upstroke.

Probable Cause

- The implement and steering pump is not receiving a signal.
- The pump control valve is not working.
- The implement and steering pump is not upstroking. The swashplate is blocked.

Problem: The front wheels vibrate, when you steer the machine.

Probable Cause

- Air is in the steering cylinders and air is in the steering system. Refer to Testing and Adjusting, “Steering System - Purge”.
- Check the steering priority valve that is in the steering control valve.

Problem: The steering does not work but the implements do work.

Probable Cause

- The shuttle valve in the pump signal line is faulty.
- The steering priority valve is malfunctioning. The pressure from the implement and steering pump is blocked to the steering circuit.
- There is blockage or damage to the steering circuit or components.

Problem: The response of one implement is too slow.

Probable Cause

- The valve spool that is installed in the control valve is incorrect for the implement.
- The signal check valve in the signal network is functioning incorrectly.
- The implement control valve has failed.
- The implement relief valve is set too low.
- The signal relief valve is set too low.

Problem: The response of all the implements are too slow.

Probable Cause

- The check valve is leaking or the ball resolver in the signal network system is leaking.
- There is contamination in any of the control valves.
- Air is in the system.
- The signal purge valve is stuck open.
- The signal relief valve malfunctions.
- The flow compensator (margin pressure) is set improperly.
- The implement relief valve is set too low or the implement relief valve leaks.
- The steering priority valve has malfunctioned.

Problem: Implement circuits will not operate when one cylinder is stalled.

Probable Cause

- The pressure compensator (pressure cutoff) is set too low or the signal relief valve is set too high. Refer to Testing and Adjusting, “Pump Control Valve (Implement, Steering) - Test and Adjust”.

Problem: The performance of a single implement circuit is erratic.

Probable Cause

- The implement control valve is contaminated.

- The control valve stem is incorrect for this circuit.
- The flow compensator (margin pressure) is set incorrectly.

Problem: The performance of all the implement circuits are erratic.

Probable Cause

- The hydraulic oil in the hydraulic system has not reached normal operating temperature.
- The implement and steering pump has failed or the pump control valve has failed.
- Air is in the hydraulic system.

Problem: Any implement moves with the joystick in the HOLD position.

Probable Cause

- The cylinder piston seals have failed or the cylinder piston seals are worn. The steering line relief valve has failed or the steering line relief valve is worn.
- The lock check valve has failed or the port relief has failed.
- The implement relief valve is malfunctioning.

Problem: When the implement is first activated, the implement surges.

Probable Cause

- An incorrect control stem is installed in the implement control valve.
- Air is in the circuit.
- The flow compensator (margin pressure) is set too high.

Problem: The implements do not work but the steering does work.

Probable Cause

- The shuttle valve has a failed in the signal network.
- The steering priority valve is stuck. The flow of oil to the implements will be stopped.
- The signal relief valve has failed in the OPEN position or the pressure setting is set incorrectly.
- Implement lockout switch is active
- Implement solenoids are out of calibration

Problem: The response of the implements is too fast.

Probable Cause

- An incorrect control stem is installed in the implement control valve.
- The implement control valve has failed.
- The flow compensator (margin pressure) is set too high.
- Implement solenoids are out of calibration

Problem: The implement and steering pump does not return to the low margin pressure after the implement is used.

Probable Cause

- The joystick has interference. The joystick does not return to the HOLD position. The signal pressure is still sent to the pump control valve.
- The signal purge valve has malfunctioned in the CLOSED position.
- The implement and steering pump has failed or the pump control valve has failed.

Problem: When you steer the machine, the implements slow down or the implements stop.

Probable Cause

- The low margin pressure of the implement and steering pump is set low.
- The implement and steering pump has insufficient flow.

Problem: The blade float will not work.

Probable Cause

- The implement control valve has an incorrect control stem.

- There is leakage in the signal network.
- The implement control valve has an incorrect lock valve piston.
- The signal purge valve malfunctions.
- There is contamination in the control stem of the blade lift control valve.
- The viscosity of the oil is incorrect.
- The implement relief valve opens at low oil pressure.
- There is a loose oil line connection on the inlet side of the implement and steering pump. Oil aeration.
- The implement and steering pump has too much wear.
- The operator is using the blade float function in order to drop the blade.

Problem: One or more of the implement cylinders are drifting

Probable Cause

- There are contaminant particles in the hydraulic oil and on the lock and relief valves, preventing a complete seal.

Solution

- Flush hydraulic oil through the affected circuit by operating the implement at high idle for 30 to 60 seconds.
- Cycle the implement a few times during the exercise to dislodge and push any contaminants or particles away from relief valves. Make sure that the implement cylinders reach full extension and retraction during each cycle. The exercise should push particles and contaminants into the hydraulic oil filtration system.

Testing And Adjusting Section

Testing and Adjusting

i04167951

Calibration Procedures

SMCS Code: 5479-524; 5705-524

⚠ 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.

Introduction

The following will explain the calibration procedure for the implement solenoids and the articulation position sensor.

Required Tools

Table 1

Tool	Description	Qty
	Caterpillar Electronic Technician (ET)	1

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

Machine Preparation

1. Move the machine to a smooth horizontal location.

2. Chock the wheels.

3. Lower all of the implements.

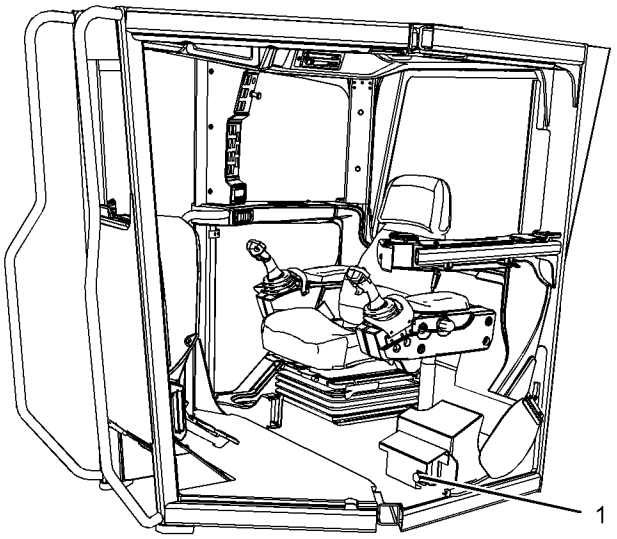

Illustration 61 g01127810

Cutaway view of the cab

(1) Service connector

4. Connect Cat ET to service connector (1).

Note: The following information is an example of the calibration procedure. The actual calibration screens may not be for your machine and the screens may vary as new versions of software are released.

Calibrate the Implement Solenoids

The calibration of the implement solenoids should be performed if any of the following items occur:

- The cylinder cycle time is slow.
- Drift of the implements.
- The implement solenoid is remounted.
- The implement solenoid is replaced.
- The machine Electronic Control Module (ECM) is replaced.

Note: The following information is an example of the calibration procedure. The actual calibration screens may vary as new versions of the software are released.

1. To start, select the Implement ECM.

2. To get to the calibration procedures for the implement solenoids, click the service menu.

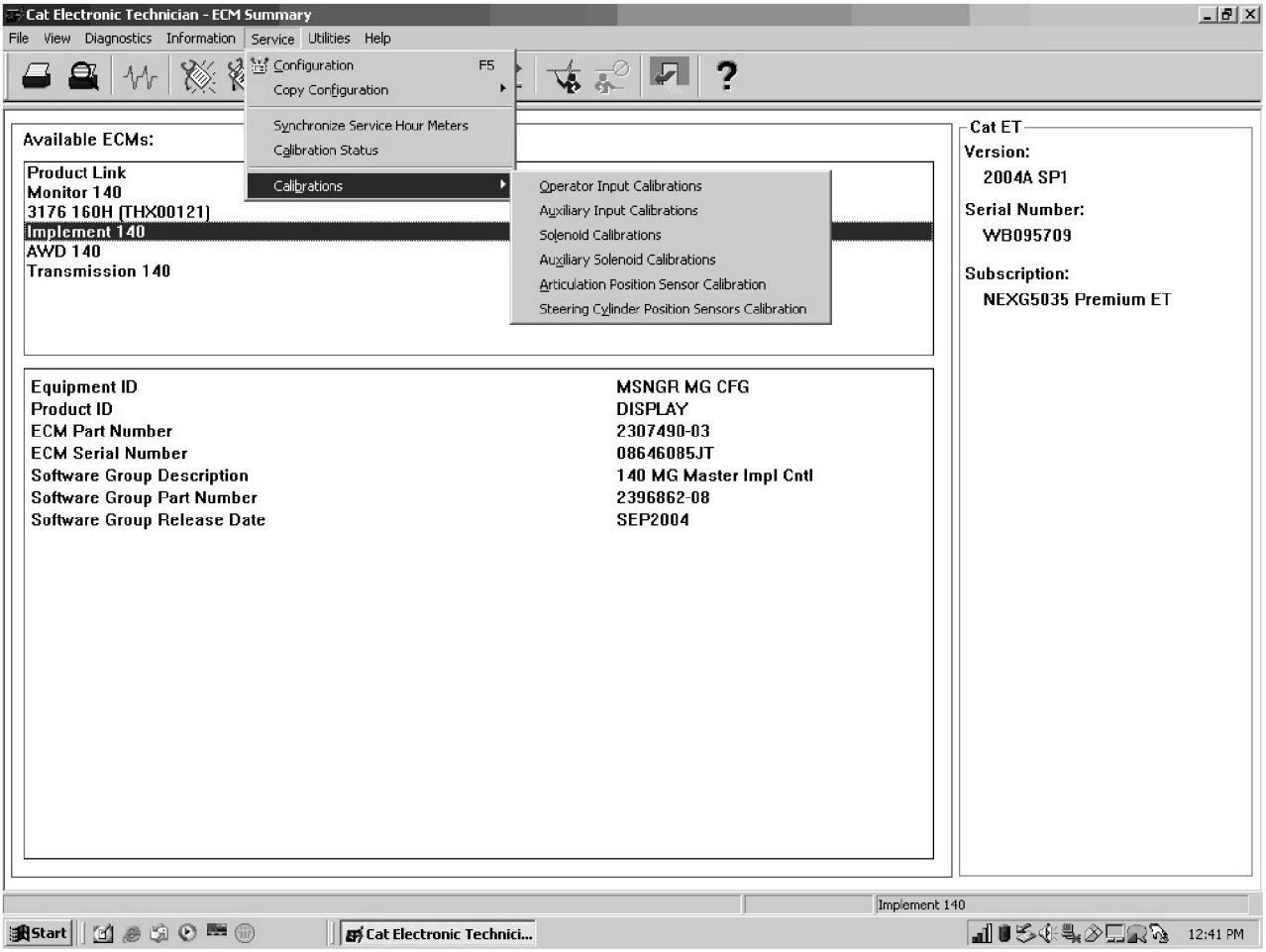

Illustration 62 g01131162

3. Click on Calibrations.

4. Click on “Solenoid Calibrations” .

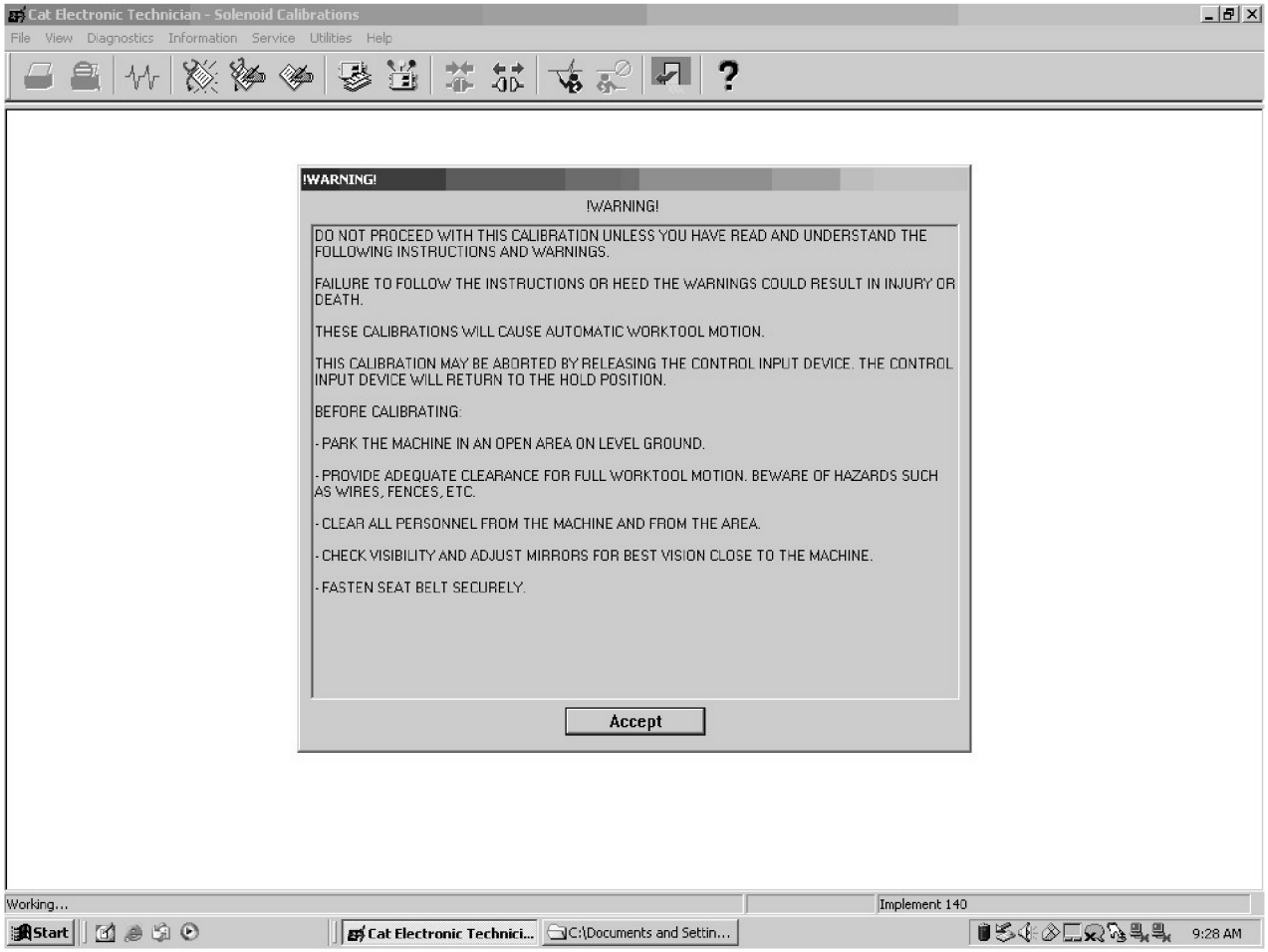

Illustration 63 g01128237

5. Read all warnings and understand all warnings.
Click on the “Accept” icon

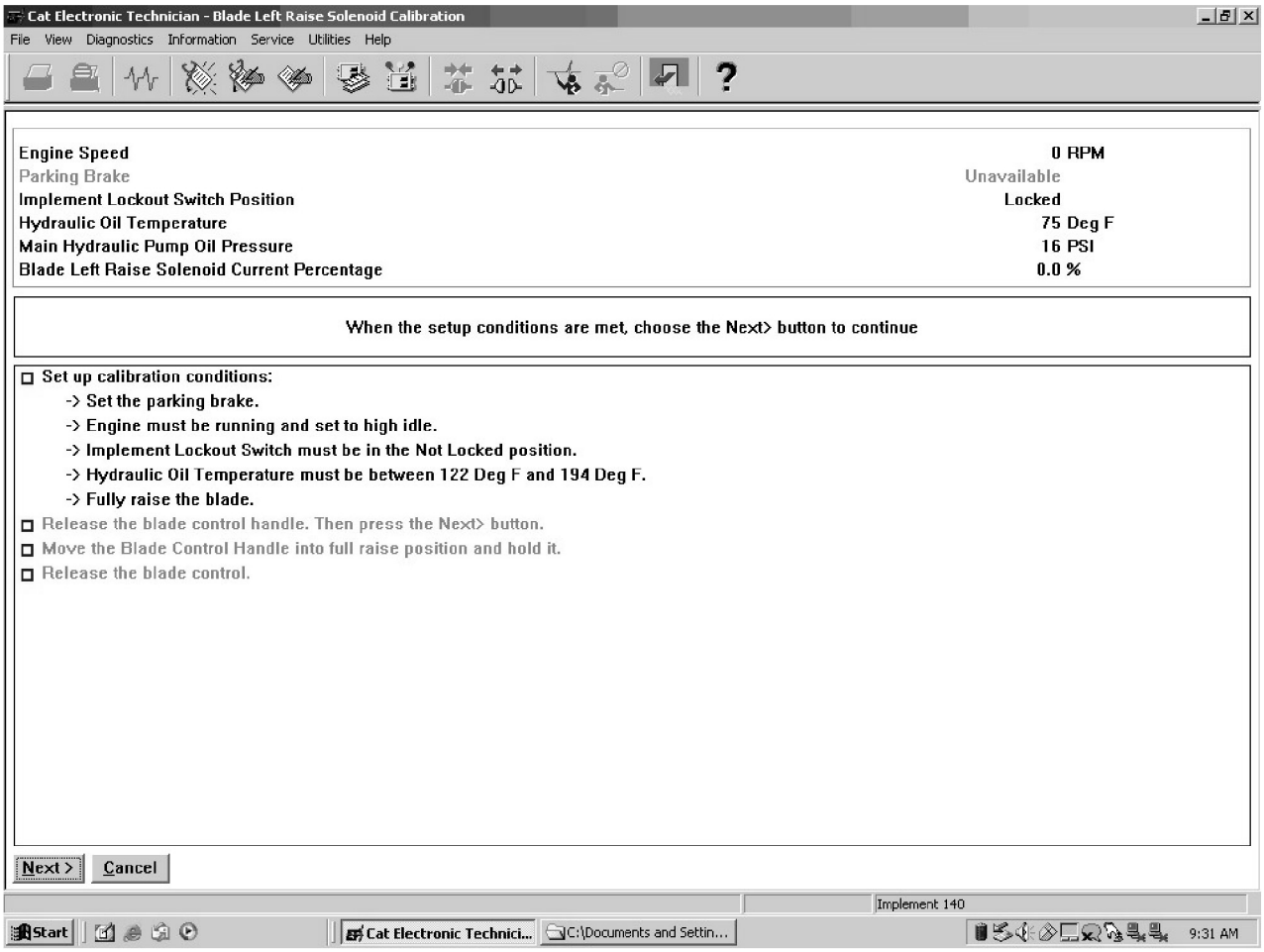

Illustration 64 g01128301

6. Follow the directions on the screen in order to complete the calibration procedure.

Note: All 18 solenoid calibrations for the implements are completed in the same manner.

Calibration for Articulation Position Sensor

The calibration of the articulation position sensor should be performed if any of the following items occur:

- The articulation position sensor is remounted.
- The articulation position sensor is replaced.
- The machine ECM is replaced.

Note: The following information is an example of the calibration procedure. The actual calibration screens may vary as new versions of the software are released.

1. To get to the calibration procedures for the articulation position sensor, click the service menu.

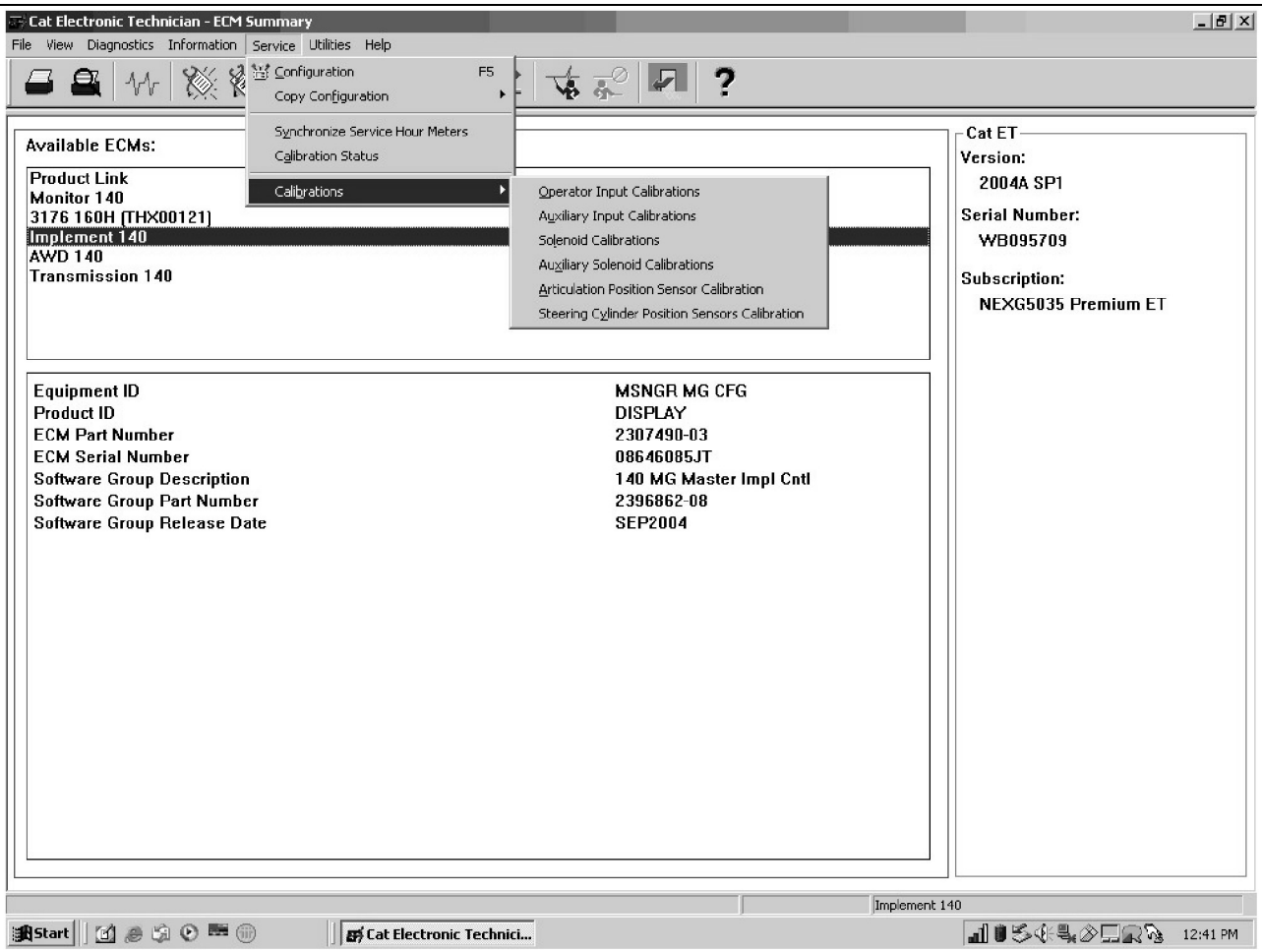

Illustration 65 g01131162

2. Click on Calibrations.

3. Click on “Articulation Position Sensor Calibration” .

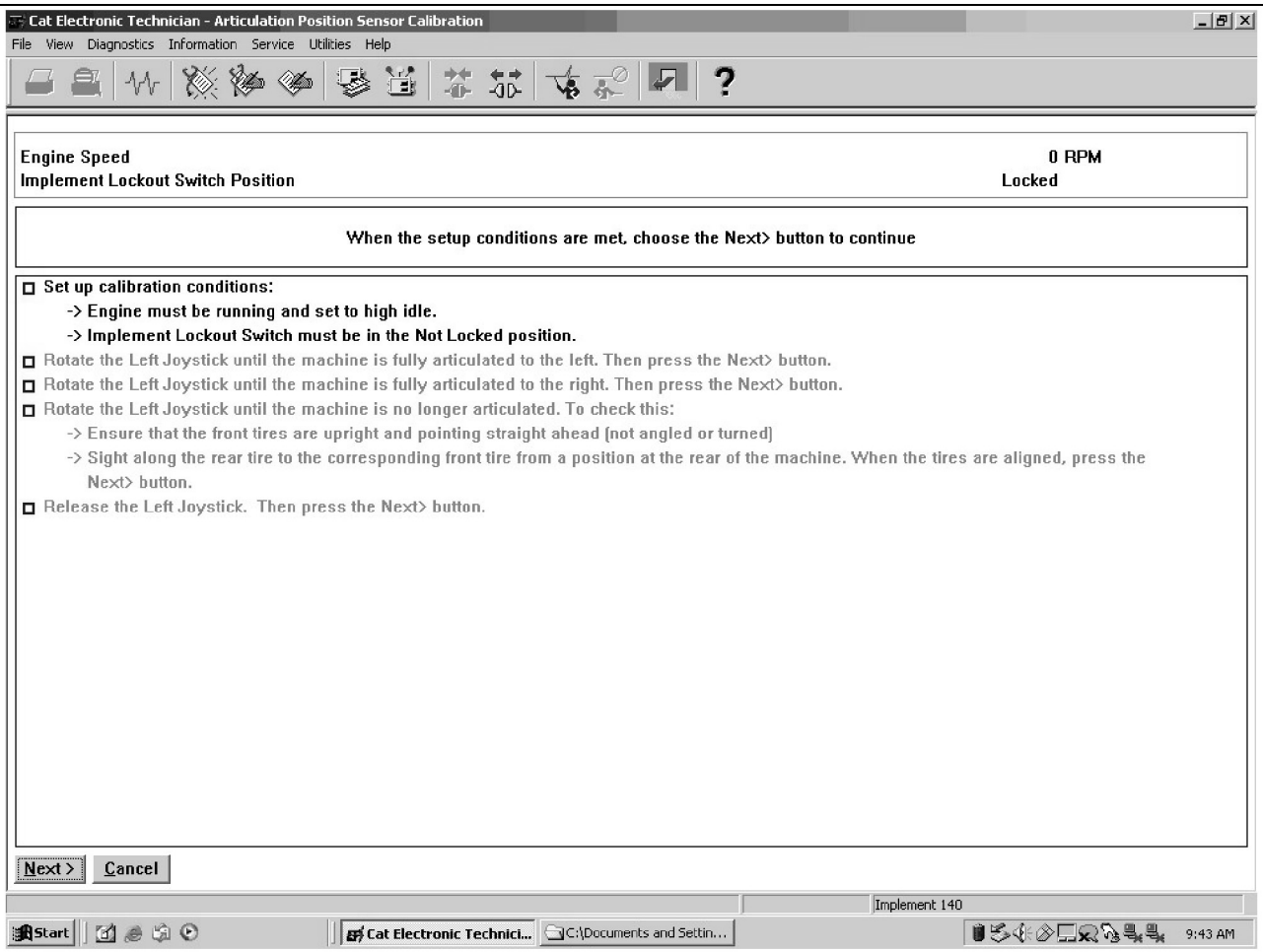

Illustration 66 g01131273

4. Follow the directions on the screen in order to complete the calibration procedure.

i04901913

Bearing End Play (Piston Pump) - Adjust

SMCS Code: 4306-025; 5070-025

Specifications

Table 2

Piston Pump End Play		
Date	**Equipment ID Code**	
Description	**Specification**	**Actual**
Shaft End Play	0.010 to 0.100 mm (0.0004 to 0.0039 inch)	

Introduction

The following will explain the procedure for shaft bearing end play adjustment.

Required Tools

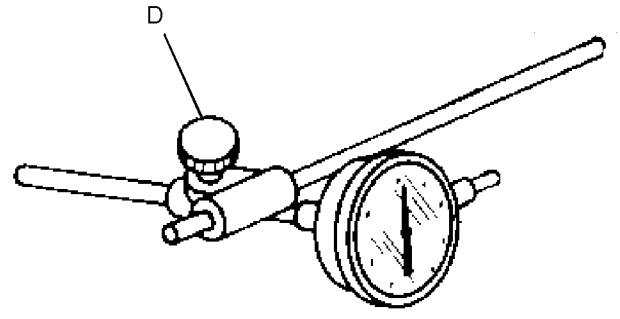

Illustration 67 g02110994

Dial indicator group (D)

Table 3

Tool	Part Number	Description	Qty
D	8T-5096	Dial Indicator Gp	1

Adjustment Procedure

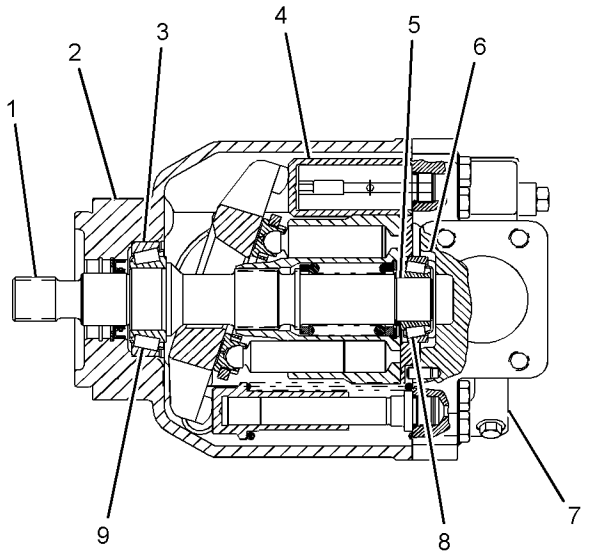

Illustration 68 g01335448

Piston pump (implement and steering)

(1) Shaft
(2) Housing
(3) Cone
(4) Pump rotating group
(5) Shims
(6) Cup
(7) Head
(8) Cone
(9) Cup

Perform the following procedure for shaft bearing end play adjustment when any of these components are replaced:

- Shaft (1)
- Housing (2)
- Cone (3) or (8)
- Cup (6) or (9)
- Head (7)

Note: Do not install pump rotating group (4) when you perform this procedure.

1. Refer to Disassembly and Assembly, “Piston Pump (Hydraulic and Steering) - Disassemble” for the correct procedure to disassemble this pump.

2. Position the pump so that the taper on shaft (1) is pointing upward.

3. Rotate the shaft backward and rotate the shaft forward several times in order to seat the cones properly.

4. Install an appropriate nut on the threaded end of the shaft.

5. Position dial indicator group (D) so that the contact point of the dial indicator is on the face of the threaded end of the shaft.

6. Position the dial indicator to zero.

7. Apply a suitable force to the nut in order to move the shaft upward. Read the dial indicator while the shaft is under an upward force.

8. Subtract desired shaft bearing end play of 0.010 to 0.100 mm (0.0004 to 0.0039 inch) from the dial indicator reading that is noted in Step 7. This is the thickness of shims (5) to use in order to achieve proper shaft bearing end play.

Table 4

EXAMPLE	
Shaft bearing end play reading from Step 8	1.016 mm (0.0400 inch)
Subtract desired shaft bearing end play.	0.010 to 0.100 mm (0.0004 to 0.0039 inch)
Required thickness of shims	1.006 to 0.916 mm (0.0396 to 0.0361 inch)

9. Refer to Disassembly and Assembly, “Piston Pump (Hydraulic and Steering) - Assemble” for the correct procedure to assemble this pump.

i04901114

Hydraulic System Pressure - Test and Adjust

SMCS Code: 5050-036-PX

Specifications

Table 5

Hydraulic System Pressure		
Date	**Equipment ID Code**	
Description	**Specification**	**Actual**
Relief Valve Pressure Range	27600 ± 400 kPa (4000 ± 60 psi) at a flow of 4.0 L/min (1.10 US gpm)	

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

Introduction

The following procedure is used in order to test the main relief valve.

Required Tools

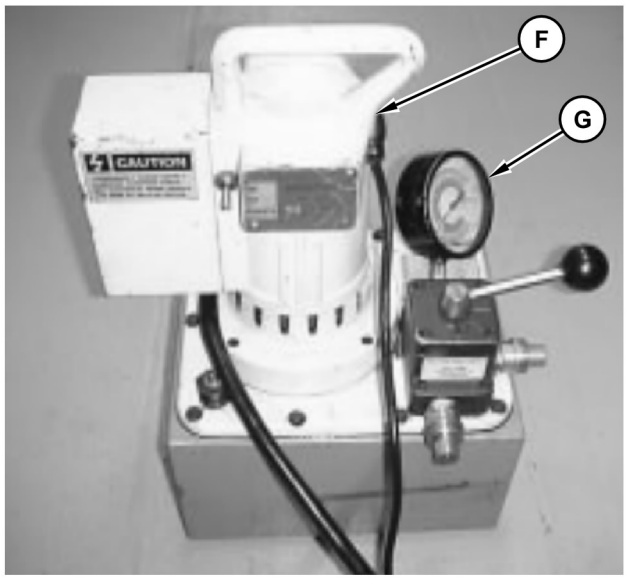

Illustration 69 g02110753

Typical electric hydraulic pump group (F) with pressure gauge (G).

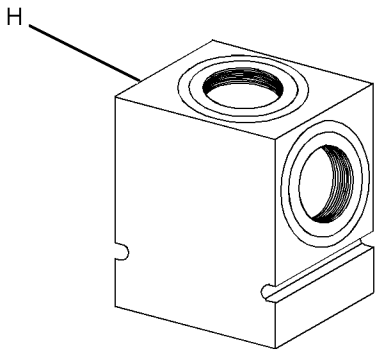

Illustration 70 g02110814

Test manifold block (H)

Table 6

Tool	Part Number	Description	Qty
F	3S-6224	Electric Hydraulic Pump Gp	1

(continued)

(Table 6, contd)

G	8T-0860	Pressure Gauge (0 to 40,000 kPa (0 to 5,800 psi))	1
H	257-5616	Test Manifold Block	2
J	5P-1838	Adapter	2
K	1P-2375	Quick Connect Coupler	2
L	1P-2376	Quick Connect Coupler	2
M	8F-0024	Hose As	2
N	3B-7722	Pipe Bushing	1
P	7J-8611	Pipe Elbow	2

Test Procedure

Note: The main relief valve should only be tested on a test bench. Use test manifold block (H) in order to test the main relief valve.

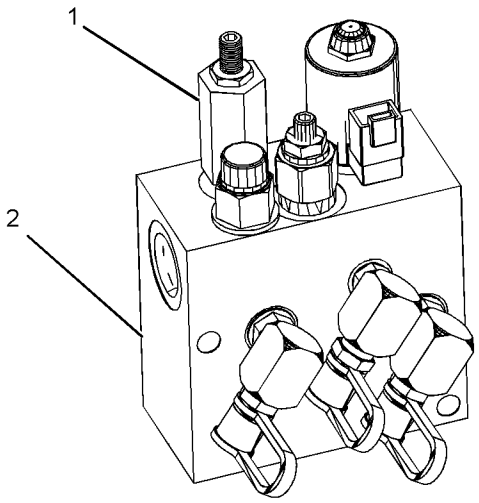

Illustration 71 g01352106

(1) Main relief valve
(2) Control manifold

1. Remove main relief valve (1) from the control manifold (2).
2. Secure test manifold block (H) in a suitable holding device.
3. Install two adapters (J) and two quick connect couplers (K) in test manifold block (H).
4. Attach two quick connect couplers (L) to two hose assemblies (M).

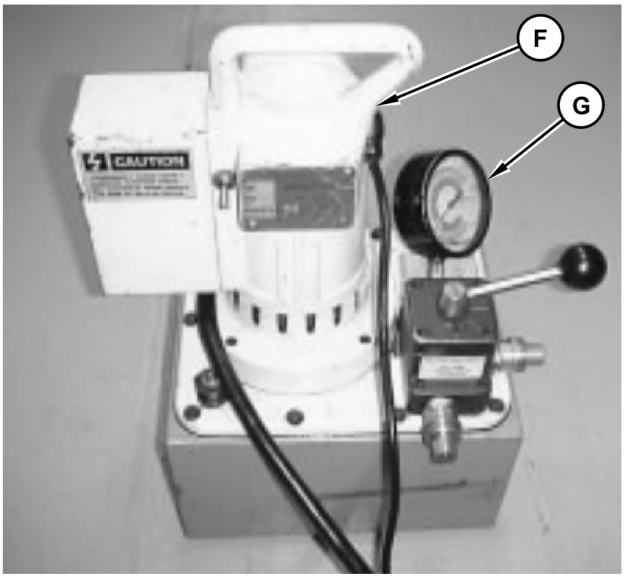

Illustration 72 g02110866

Typical electric hydraulic pump group (F) with pressure gauge (G).

5. Connect two hose assemblies (M), two pipe bushings (N), and pipe elbow (P) to electric hydraulic pump group (F).

6. Connect pressure gauge (G) to electric hydraulic pump group (F).

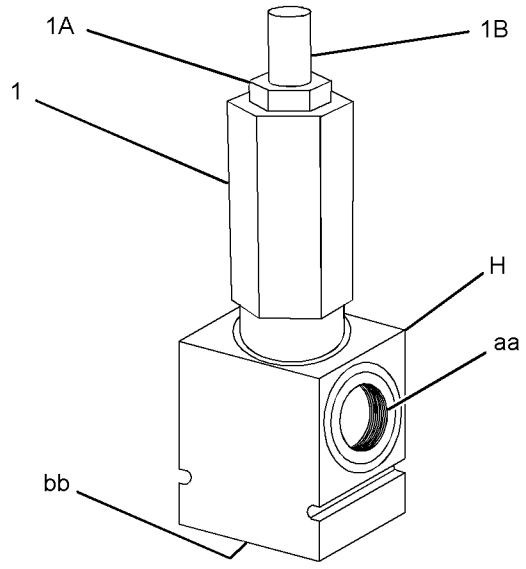

Illustration 73 g02110828

(1) Main relief valve
(1A) Nut
(1B) Retainer
(H) Test manifold block
(aa) Port for the return oil
(bb) Port for the pressure line from electric hydraulic pump group (F)

7. Install main relief valve (1) into test manifold block (H).

8. Install oil return line to port (aa).

9. Install the pressure oil line from electric hydraulic pump group (F) to port (bb).

Note: Ensure that the hose assemblies are connected to the proper test port. If the lines are not connected correctly, the relief valve setting will be incorrect.

10. Turn electric hydraulic pump group (F) into the ON position. Check for leaks at any of the connections.

NOTICE
The 3S-6224 Electric Hydraulic Pump only has a 7.6 L (2 US gal) reservoir. Pump damage may result if the pump is operated with an empty reservoir.

11. Slowly increase the pressure. Record the pressure when the main relief valve opens.

12. Shut off electric hydraulic pump group (F).

The correct pressure setting for main relief valve (1) is 27600 ± 400 kPa (4000 ± 60 psi) at a flow of 4.0 L/min (1.10 US gpm). **If the pressure setting is within the specified pressure range, install the main relief valve back into control manifold (2).**

Adjustment Procedure

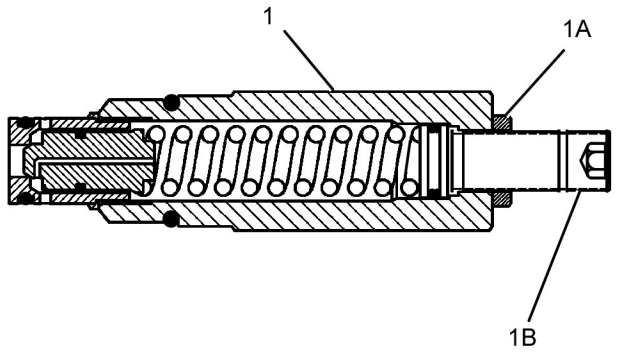

Illustration 74 g01352108

(1) Main relief valve
(1A) Nut
(1B) Retainer

1. If the pressure setting is not within the specified pressure range, loosen nut (1A) and turn retainer (1B) in order to adjust the pressure setting. Turning the retainer clockwise will increase the relief valve pressure setting. Turning the retainer counterclockwise will reduce the relief valve pressure setting.

Note: If the specified relief valve pressure setting cannot be achieved, the relief valve may need to be replaced.

2. Repeat Step 10 through Step 1 until the specified setting is reached.

3. Install main relief valve (1) back into control manifold (2).

i08193750

Pilot Pressure - Test and Adjust

SMCS Code: 5051-081; 5051-025; 5069-025; 5069-081; 5264-025; 5264-081; 5467-081; 5467-025; 5479-025-PS; 5479-081-PS

⚠ WARNING

Hydraulic oil pressure can remain in the hydraulic system on this machine after the engine and pump have been stopped. Serious injury can result if this pressure is not released before any service is done on the hydraulic system. In order to prevent possible injury, release the hydraulic system pressure before working on any fitting, hose, or hydraulic component.

Lower all work tools to the ground before service is started. If the hydraulic system must be serviced, tested, or adjusted with the work tool in the raised position, the work tool and lift cylinders must be supported properly.

Always move the machine to a location away from the travel of other machines. Be sure that other personnel are not near the machine when the engine is running and tests or adjustments are being made.

⚠ WARNING

Personal injury can result from removing hoses or fittings in a system under pressure.

Failure to relieve pressure can cause personal injury.

Do not remove or disconnect hoses or fittings until all pressure in the hydraulic system has been relieved.

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, PERJ1017, “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.

Note: To reduce the risk of injuries due to tests/adjusts performed on the equipment with the engine running, use a remote pressure reading with a wireless gauge or add long hoses/wires to keep all personnel away from the machine while the engine is running.

Reference: Refer to System Operation, “Machine Preparation for Troubleshooting” before you begin this procedure.

Specifications

Table 7

Pilot Pressure - Test and Adjust		
Date	**Equipment ID Code**	
Description	**Specification**	**Actual**
Pump Discharge Pressure	10,000 kPa (1450 psi)	
Pilot Pressure	4000 ± 200 kPa (580 ± 29 psi)	

Introduction

The following test procedure will verify whether the pressure setting for the pilot pressure is within the specified limit. The following adjustment procedure will explain the procedure for adjusting the pilot pressure.

Required Tools

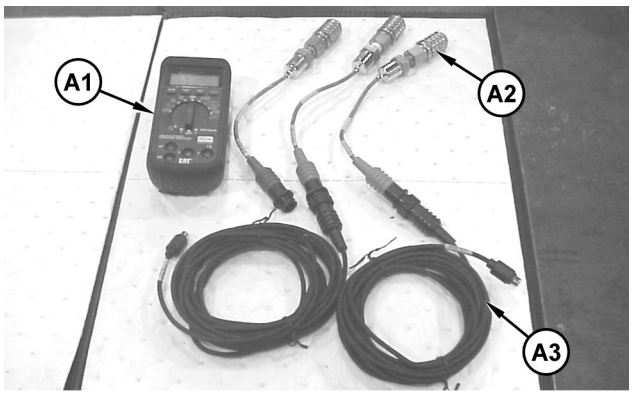

Illustration 75 g02571852

Tooling (A)

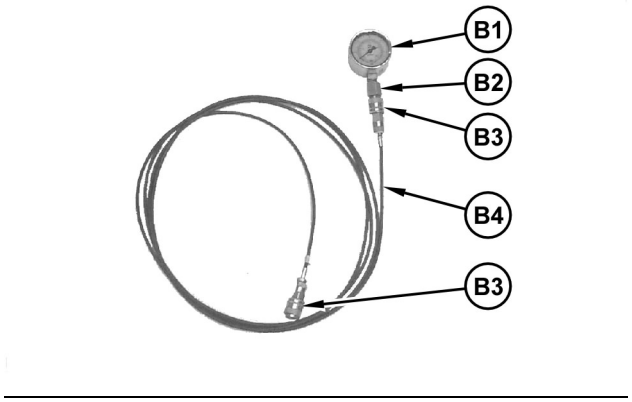

Illustration 76 g02726620

Tooling (B)

Table 8

Tool	Item	Part Number	Description	Qty
A		198-4240	Digital Pressure Indicator Gp	
	A1	198-4234	Digital Indicator	1
	A2	198-4239	Pressure Sensor Gp (0 to 41,368 kPa (0 to 6000 psi))	1
	A3	198-4236	Adapter Cable As	1
B	B1	8T-0855	Pressure Gauge (0 to 4,000 kPa (0 to 580 psi))	1
	B1	8T-0857	Pressure Gauge (0 to 10,000 kPa (0 to 1,450 psi))	1
	B2	6V-3989	Fitting	1

(continued)

(Table 8, contd)

Tool	Item	Part Number	Description	Qty
	B3	6V-4143	Quick Connect Coupler	2
	B4	177-7861	Hose As (4.3 m (14 ft))	1

Note: Tooling (A) or Tooling (B) may be used to perform these tests.

Machine Preparation

1. Move the machine to a smooth horizontal location.

2. Chock the wheels.

3. Lower all of the implements.

4. Stop the Engine.

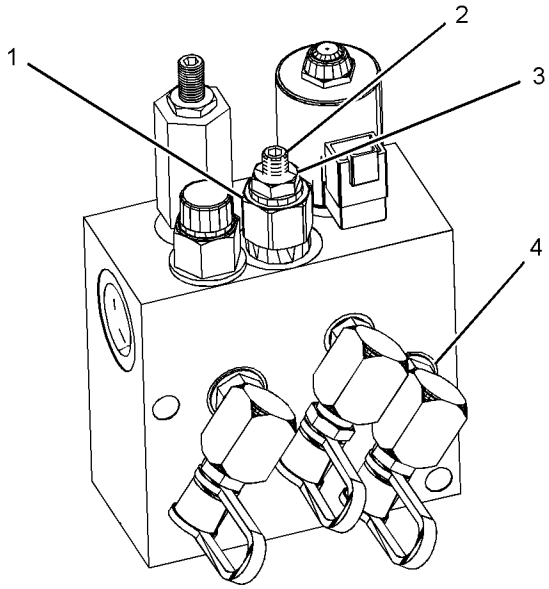

Illustration 77 g01487295

(1) Pressure reducing valve
(2) Adjustment screw for pressure reducing valve (pilot pressure)
(3) Locknut
(4) Pressure test port for pilot pressure

5. Remove the dust cap on test port (4).

6. Attach Tooling (A) to test port (4). Pressure test port (4) will indicate the oil pressure in the pilot system for the implements. Pressure reducing valve (1) limits the pilot system for the implements. When the pilot system reaches the pilot pressure, pressure reducing valve (1) will close.

Test Procedure

1. Start the engine.

2. In order to test the pilot pressure, run this test with hydraulic oil at 60° ± 5°C (140° ± 9°F).

3. Stall the blade tip cylinder.

4. Operate the engine at high idle. Throttle to 2150 rpm

5. Check that pump discharge pressure is 10,000 kPa (1450 psi) or higher.

6. Record the pilot pressure at test port (4). Pilot pressure should be 4000 ± 200 kPa (580 ± 29 psi).

7. If the pressure at Tooling (A) is within the specified limit, the test is complete.

Adjustment Procedure

1. In order to adjust the pilot pressure, run this test with hydraulic oil at 60° ± 5°C (140° ± 9°F).

2. If the pressure reading is incorrect, stop the engine.

3. Loosen locknut (3) on adjustment screw (2). Turn the adjustment screw clockwise in order to increase the setting. Turn the adjustment screw counterclockwise in order to decrease the setting.

4. Start the engine and check the pressure.

5. Repeat steps 3 and 4 until the pressure is within the limits.

6. Stop the engine.

7. When you tighten locknut (3) hold adjustment screw (2) secure.

8. Remove Tooling (A). Replace the dust cap on test port (4).

i08193776

Pump Control Valve (Implement, Steering) - Test and Adjust

SMCS Code: 5455-036

⚠ WARNING

Hydraulic oil pressure can remain in the hydraulic system on this machine after the engine and pump have been stopped. Serious injury can result if this pressure is not released before any service is done on the hydraulic system. In order to prevent possible injury, release the hydraulic system pressure before working on any fitting, hose, or hydraulic component.

Lower all work tools to the ground before service is started. If the hydraulic system must be serviced, tested, or adjusted with the work tool in the raised position, the work tool and lift cylinders must be supported properly.

Always move the machine to a location away from the travel of other machines. Be sure that other personnel are not near the machine when the engine is running and tests or adjustments are being made.

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.

Refer to Special Publication, NENG2500, “Caterpillar Tools and Shop Products Guide”, for tools and supplies suitable to collect and contain fluids.

Dispose of all fluids according to local regulations and mandates.

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

Note: To reduce the risk of injuries due to tests/adjusts performed on the equipment with the engine running, use a remote pressure reading with a wireless gauge or add long hoses/wires to keep all personnel away from the machine while the engine is running.

Specifications

Table 9

Pump Control Valve		
Date	**Equipment ID Code**	
Description	**Specification**	**Actual**
Margin Pressure Test	14.3 ± 1.9 seconds	
Margin Pressure Adjustment	2100 ± 100 kPa (305 ± 15 psi)	
Signal Pressure Adjustment	22050 ± 500 kPa (3198 ± 73 psi)	

References

Reference: Refer to the Operation and Maintenance Manual, “System Pressure Release” for the detailed procedure to release the system pressure.

Reference: Refer to Testing and Adjusting, “Steering System - Purge” for information on purging the steering system.

Introduction

The pump control valve for the hydraulic and steering system is attached to the pump for the implement and steering. The pump control valve keeps pump flow at the level that is needed to fulfill the requirements of the hydraulic and steering system.

Required Tools

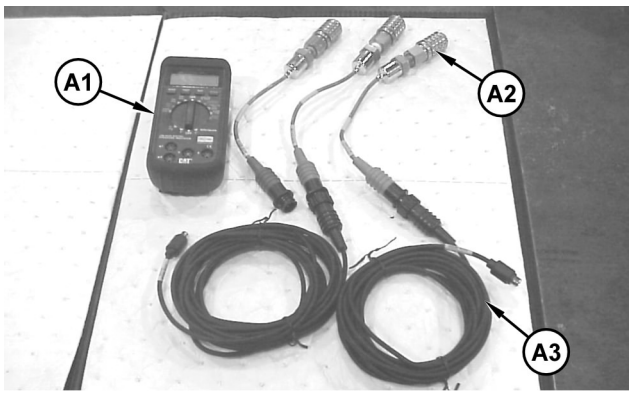

Illustration 78 g02571852

Tooling (A)

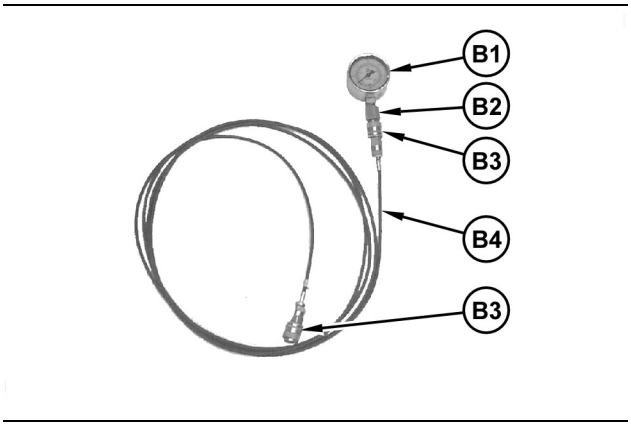

Illustration 79 g02726620

Tooling (B)

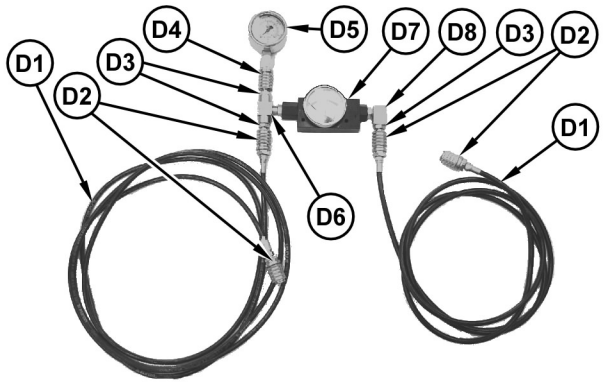

Illustration 80 g02111086

Tooling (D)

Table 10

Tool	Item	Part Number	Description	Qty
A		198-4240	Digital Pressure Indicator Gp	1
B	A1	198-4234	Digital Indicator	1
	A2	198-4238	Pressure Sensor Gp (0 to 3,440 kPa (0 to 5000 psi))	1
	A3	198-4236	Adapter Cable As	1
	B1	8T-0855	Pressure Gauge (0 to 4,000 kPa (0 to 580 psi))	1
	B1	8T-0858	Pressure Gauge (0 to 16,000 kPa (0 to 2,300 psi))	1
	B1	8T-0859	Pressure Gauge (0 to 25,000 kPa (0 to 3,600 psi))	1
	B2	6V-3989	Fitting	1

(continued)

(Table 10, contd)

	B3	6V-4143	Quick Connect Coupler	2
	B4	177-7862	Hose As (5.5 m (18 ft))	1
D		1U-5796	Pressure Differential Tool Gp	1
	D1	177-7862	Hose As (5.49 m (18 ft))	2
	D2	6V-4143	Quick Connect Coupler	4
	D3	6V-3965	Fitting	3
	D4	6V-4144	Quick Connect Coupler	1
	D5	8T-0861	Pressure Gauge (0 to 60,000 kPa (0 to 8,700 psi))	1
	D6	8C-8431	Tee	1
	D7	1U-5793	Oil Filter Pressure Differential Gauge Gp	1
	D8	6V-0484	O-Ring Adapter	1
F		6V-3668	Bolt	2
		5P-8245	Hard Washer	8

Note: Tooling (A) or Tooling (B) may be used to perform these tests.

Test Preparation - Margin Pressure

1. Move the machine to a smooth horizontal location.

2. Chock the wheels.

3. Start the engine.

4. Operate the engine at low idle. Operate the implement controls for 3 to 10 minutes to raise the hydraulic oil temperature to normal operating temperature range.

5. Stop the engine.

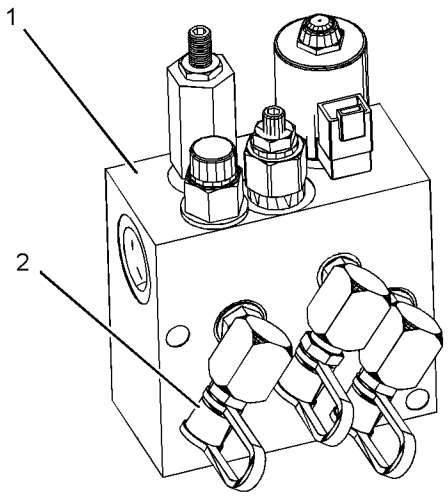

Illustration 81 g01341376

Control manifold for the pilot system

(1) Control manifold
(2) Pressure test port for the pump

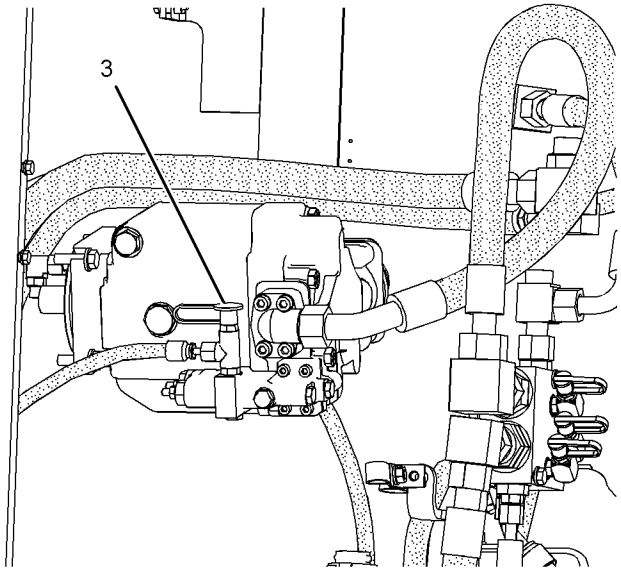

Illustration 82 g01432477

Pump control valve

(3) Test port

6. Connect the low side of Tooling (D) onto pressure test port (3).

7. Connect the high side of Tooling (D) onto pressure test port (2).

Test Procedure - Margin Pressure

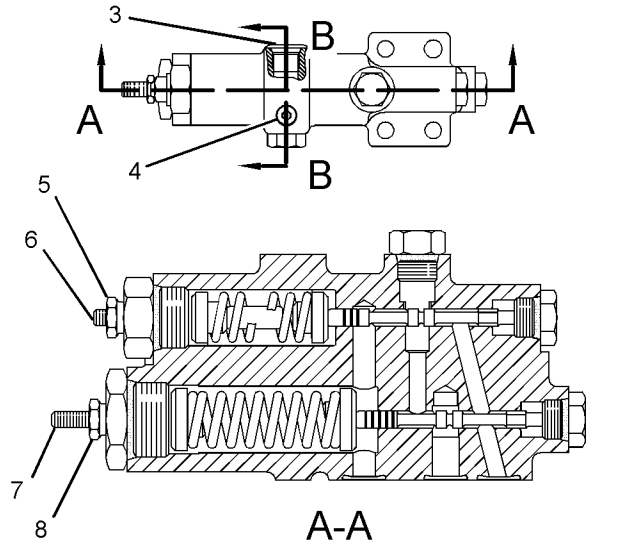

Illustration 83 g01349216

Pump control valve

(3) Test port
(4) Purge valve for the flow compensator
(5) Locknut
(6) Adjustment screw for the flow compensator (margin pressure)
(7) Adjustment screw for the pressure compensator (pressure cutoff)
(8) Locknut

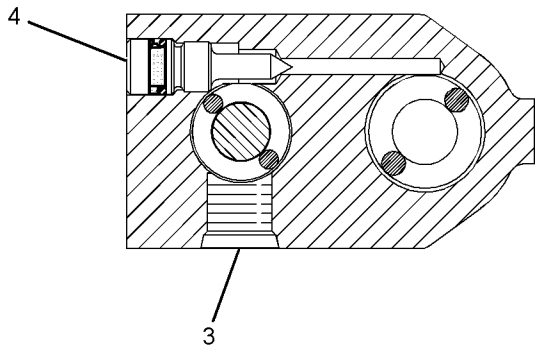

Illustration 84 g01349221

Section B-B of pump control valve

(3) Test port
(4) Purge valve for the flow compensator

1. Start the engine. Operate the engine at high idle.

2. Extend the side shift cylinder in one direction until STALL occurs.

3. Measure the amount of time required to extend the side shift cylinder from fully stalled in one direction to fully stalled in the opposite direction. The time from one stall to the other stall should be 14.3 ± 1.9 seconds.

4. If the time is within the specified limit, proceed to step 13. If the time is not within the specified limit, the signal network may require purging.

Reference: Refer to Testing and Adjusting, “Steering System - Purge” for information on purging the steering system.

5. Stop the engine.

6. Open purge valve (4) counterclockwise by one turn. A small amount of oil may leak by the purge valve during this procedure.

7. Start the engine.

8. Operate multiple implements for 1 to 2 minutes to purge the air.

9. Stop the engine.

10. Close purge valve (4) clockwise by one turn.

11. Start the engine.

12. Operate the engine at high idle.

13. Operate the circle drive and rotate the blade at full speed. The pressure reading at Tooling (D) while the circle drive is in motion should be 2100 ± 100 kPa (305 ± 15 psi).

14. Stop the engine.

Adjustment Procedure - Margin Pressure

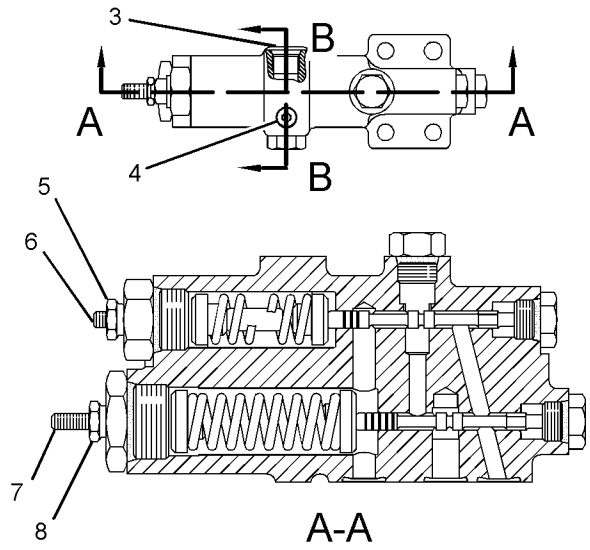

Illustration 85 g01349216

Pump control valve

(3) Test port
(4) Purge valve for the flow compensator
(5) Locknut
(6) Adjustment screw for the flow compensator (margin pressure)
(7) Adjustment screw for the pressure compensator (pressure cutoff)
(8) Locknut

1. If the pressure reading is incorrect, stop the engine.

2. Loosen locknut (5) on adjustment screw (6). Turn the adjustment screw clockwise to increase the setting. Turn the adjustment screw counterclockwise to decrease the setting.

3. Start the engine and check the pressure.

4. Repeat steps 1 through 3 until the pressure meets the requirement.

5. Stop the engine.

6. When tightening locknut (5), hold adjustment screw (6) secure.

7. After all adjustments are complete, remove Tooling (D). Replace the dust caps on test port (2) and test port (3).

Test Preparation - Signal Network

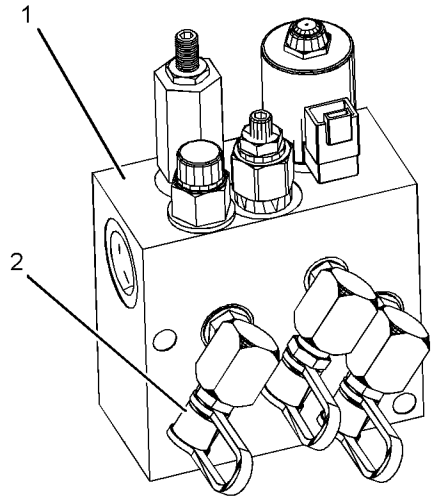

Illustration 86 g01341383

Control manifold for the pilot system

(1) Control manifold
(2) Pressure test port for the pump

1. With the engine off, remove the dust cover from pressure test port (2). Install Tooling (A) onto pressure test port (2).

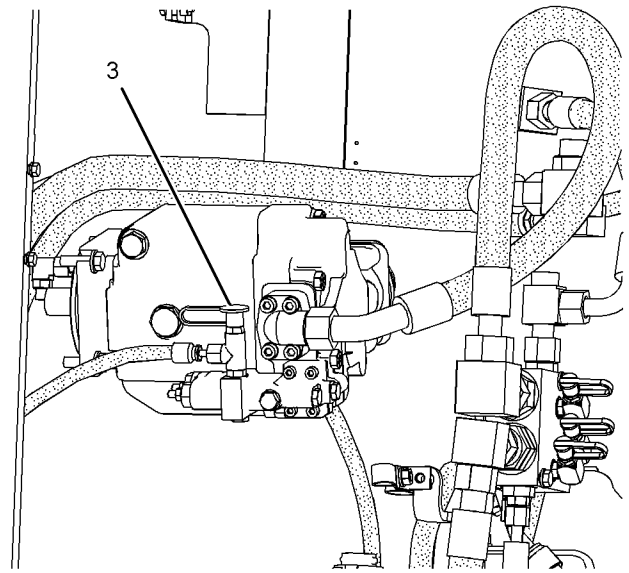

Illustration 87 g01432477

Pump control valve

(3) Test port

2. Remove the dust cover from pressure test port (3). Install Tooling (A) onto pressure test port (3).

Test Procedure - Signal Network

1. Start the engine. Operate the engine at low idle.

2. Operate the implement controls for 3 minutes to 10 minutes to raise the hydraulic oil temperature to the normal operating temperature range.

3. Move the joystick control to move the blade tip cylinder to the maximum stroke and stall. Read the pressure gauges. The pressure at test port (2) should increase. The pressure at test port (3) should increase.

4. If the pressure at test port (3) increases and the pressure at test port (2) does not increase, replace the pump control valve.

5. The pressure reading at test port (3) should be 22050 ± 500 kPa (3198 ± 73 psi).

Adjustment Procedure - Signal Network

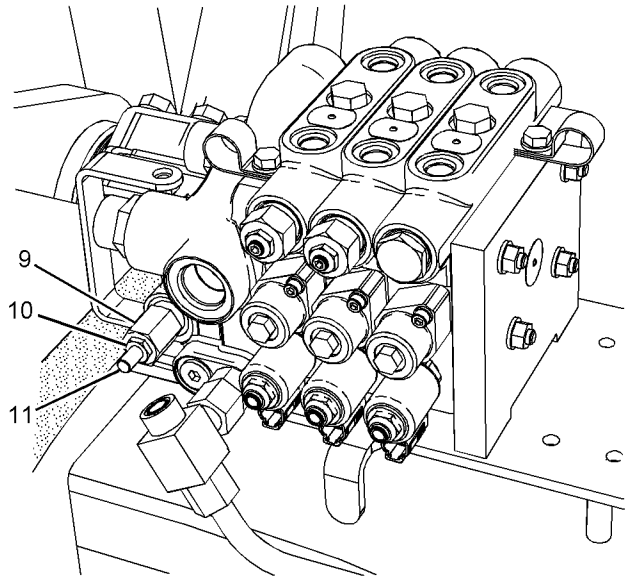

Illustration 88 g02204215

(9) Relief valve (signal)
(10) Locknut
(11) Adjustment screw for the relief valve (signal)

1. If the pressure reading is incorrect, stop the engine.

2. Loosen locknut (10) on adjustment screw (11). Turn the adjustment screw clockwise to increase the setting. Turn the adjustment screw counterclockwise to decrease the setting.

3. Start the engine and check the pressure.

4. Repeat steps 1 through 3 until the pressure meets the requirement.

5. Stop the engine.

6. When you tighten locknut (10), hold adjustment screw (11) secure.

7. After all adjustments are complete, remove Tooling (A). Replace the dust caps on test port (2) and test port (3).

Test Preparation - Signal Resolver

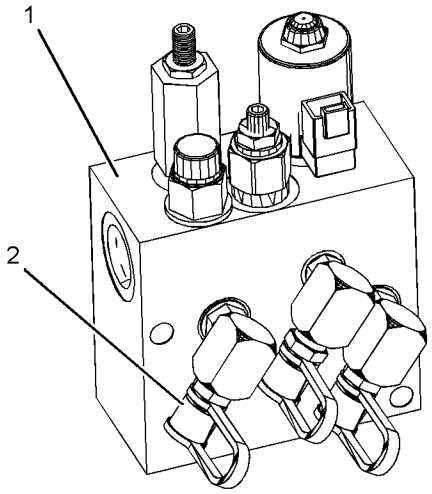

Illustration 89 g01341393

Control manifold for the pilot system

(1) Control manifold
(2) Pressure test port for the pump

1. With the engine off, remove the dust cover from pressure test port (2). Install Tooling (A) onto pressure test port (2).

Test Procedure - Signal Resolver

1. Start the engine and operate the engine at low idle.

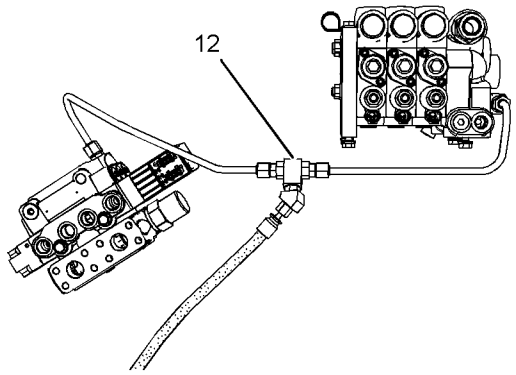

Illustration 90 g02203993

(12) Signal resolver

2. Move the wheel lean cylinder to the end of the stroke and stall the cylinder. The pressure at Tooling (A) should read 24000 ± 500 kPa (3481 ± 73 psi). Resolver (12) has shifted correctly to allow signal oil from the implement system to flow to the pump control valve.

3. Stop the engine.

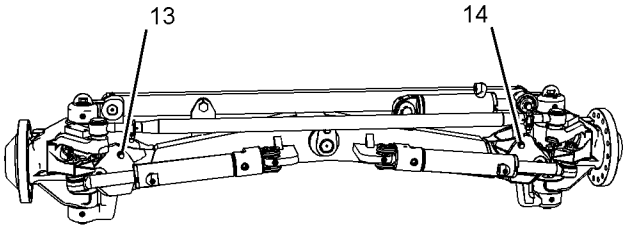

Illustration 91 g02416677

4. Install Tooling (F) into holes (13) and (14). Be sure **NOT** to use the wheel lean function. The wheel lean function may damage Tooling (F).

5. Start the engine and operate the engine at low idle.

6. Move the steering cylinder to the end of the stroke and stall the cylinder. The steering cylinders will stall out against Tooling (F) before the electronic control module automatically reduces steering pressure. The pressure gauge should read 18100 kPa (2625 psi) for the 14M and 21600 kPa (3133 psi) for the 16M. If Tooling (A) displays the correct pressure reading, resolver (12) has shifted correctly. Steering signal oil will be allowed to flow to the pump control valve.

7. If the pressure reading does not change between the two different systems, replace signal resolver (12).

8. After all adjustments are complete, stop the engine and remove Tooling (F).

i07506128

Accumulator (Blade Cushion) - Test and Charge

SMCS Code: 5077-081-BG

⚠ WARNING

Pressurized System!

Hydraulic accumulators contain gas and oil under high pressure. DO NOT disconnect lines or disassemble any component of a pressurized accumulator. All gas pre-charge must be removed from the accumulator as instructed by the service manual before servicing or disposing of the accumulator or any accumulator component.

Failure to follow the instructions and warnings could result in personal injury or death.

Only use dry nitrogen gas to recharge accumulators. See your Cat dealer for special equipment and detailed information for accumulator service and charging.

⚠ WARNING

Dry nitrogen is the only gas approved for use in the accumulators. The charging of oxygen gas in an accumulator will cause an explosion. An explosion can be eliminated by using nitrogen gas cylinders with standard CGA (Compressed Gas Association, Inc.) No. 580 connectors. When nitrogen gas is ordered, make sure to order the cylinders with CGA No. 580 connectors.

Do not rely on color codes or other methods of identification to tell the difference between nitrogen and oxygen cylinders. In any application, never use an adapter to connect your nitrogen charging group to a valve outlet used on both nitrogen, oxygen, or other gas cylinders. BE SURE YOU USE DRY NITROGEN (99.8% purity).

⚠ WARNING

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

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

⚠ WARNING

Cold ambient temperatures could result in the loss of secondary braking capability due to inadequate hydraulic accumulator nitrogen precharge. The loss of the secondary braking system as well as the main hydraulic pressure will result in little or no braking capability and a potential for injury or death.

It is recommended to perform a brake accumulator check anytime the machine has been idle for longer than two hours below −25 °C (−13 °F). Refer to Operation and Maintenance Manual before performing any check of the brake accumulator.

Reference: Refer to Testing and Adjusting, “Machine Preparation” before you begin the test.

Specifications

Table 11

Charging Pressure and Temperature Relationship for the 2758 kPa (400 psi) Accumulator	
Temperature	**Pressure**
-7°C (20°F)	2494 kPa (362 psi)
-1°C (30°F)	2550 kPa (370 psi)
4°C (40°F)	2597 kPa (377 psi)
10°C (50°F)	2653 kPa (385 psi)
16°C (60°F)	2709 kPa (393 psi)
21°C (70°F)	2756 kPa (400 psi)
27°C (80°F)	2812 kPa (408 psi)
32°C (90°F)	2859 kPa (415 psi)
38°C (100°F)	2915 kPa (423 psi)
43°C (110°F)	2962 kPa (430 psi)
49°C (120°F)	3018 kPa (438 psi)

Table 12

Allowable Tolerance on Nominal Pressure for the 2758 kPa (400 psi) Accumulator	
-7°C (20°F)	187 kPa (27 psi)
-1°C (30°F)	191 kPa (28 psi)
4°C (40°F)	195 kPa (28 psi)
10°C (50°F)	199 kPa (29 psi)
16°C (60°F)	203 kPa (29 psi)
21°C (70°F)	207 kPa (30 psi)
27°C (80°F)	211 kPa (31 psi)
32°C (90°F)	215 kPa (31 psi)
38°C (100°F)	219 kPa (32 psi)
43°C (110°F)	223 kPa (32 psi)
49°C (120°F)	226 kPa (33 psi)

Introduction

Blade cushion accumulators are mounted on the frame in front of the blade lift cylinders. The accumulators cushion the head end of the cylinder from sudden rises in pressure.

The following procedure will determine if the accumulator is charged to the appropriate pressure.

Lower the Piston in Blade Cushion Accumulators

1. Start the engine. Turn the blade cushion ON.
2. Move the joystick all the way forward into the detent position. The blade float will be activated.
3. Turn the blade cushion OFF. Deactivate the blade float. Stop the engine.

In order to charge the accumulator, the piston in the blade cushion accumulator must be on the bottom of the cylinder. The air temperature outside the accumulator is the ambient temperature. Before the dry nitrogen pressure in the accumulator can be accurately checked, the temperature of the accumulator must be equal to the ambient temperature. Before the accumulator may be correctly charged, the temperature of the accumulator must be equal to the ambient temperature.

Use table 11 in order to determine the correct charging pressure for the accumulator.

Accumulator Charge Procedure

1. Refer to Special Instruction, REHS5464, “Accumulator Discharging and Charging Procedures”.

Accumulator Charge Procedure for a Rebuilt Accumulator

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, PERJ1017, “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.

When the accumulator has been rebuilt, the air must be removed from the upper chamber of the accumulator. After the accumulator is rebuilt, put approximately 0.9 L (1 qt) of SAE 10W hydraulic oil in the nitrogen chamber of the accumulator. This oil will be used to help remove the air from the nitrogen chamber of the accumulator. This hydraulic oil also lubricates the top seal of the piston in the accumulator.

Install the rebuilt accumulator on the machine. Refer to Special Instruction, REHS5464, “Accumulator Discharging and Charging Procedures” to charge the rebuilt accumulator.

i06287670

Disc Pack Preload for Circle Drive - Adjust

SMCS Code: 5207-025-ZP

S/N: B9H1–Up

S/N: R9H1–Up

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

Specifications

Table 13

Disk Pack Preload		
Date:	**Equipment ID Code:**	
Description	**Specification**	**Actual**
Spring Deflection	2.54 ± 0.25 mm (0.10 ± 0.010 inch)	
Minimum thickness to reuse clutch disk	2.44 mm (0.096 inch)	
Minimum thickness for friction material	0.20 mm (0.008 inch)	

Introduction

The clutch may need set or adjusted to the specifications due to worn clutch discs. As clutch discs wear, they will lose material, therefore decrease in thickness, causing the spring deflection to decrease. This procedure will reset the clutch to the correct torque.

Note: An incorrect setting does not indicate incorrect factory setting. This system is subjected to wear during operation.

Required Tools

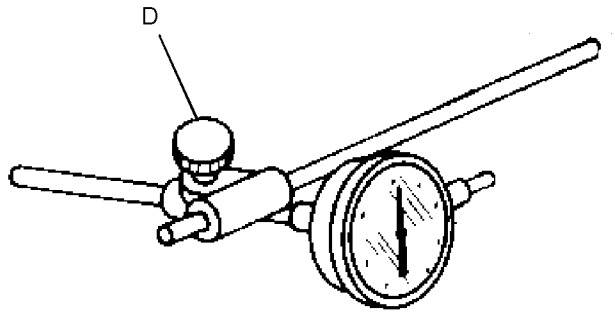

Illustration 92 g02115434
Tooling (D)

Table 14

Tool	Part Number	Description	Qty
D	8T-5096	Dial Indicator Gp	1

Adjustment Procedure

Note: Minimum reusable thickness for one clutch disk is 2.44 mm (0.096 inch). Minimum thickness for friction material on one side of the clutch disk is 0.20 mm (0.008 inch).

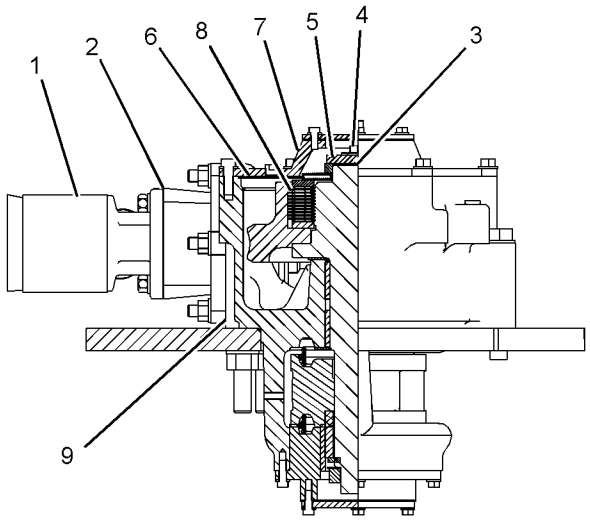

Illustration 93 g03519218

View of Circle Drive

(1) Motor
(2) Bracket
(3) Shims
(4) Bolts
(5) Plate
(6) Spacer
(7) Cover
(8) Spring
(9) Shims

1. Remove cover (7).

2. Remove three bolts (4) and plate (5).

3. Measure the distance from the top of spacer (6) to the top of shims (3). The top of spacer (6) must be above the top of shims (3). The distance between the spacer and the shims must be 2.54 ± 0.25 mm (0.10 ± 0.010 inch). Add shims or remove shims in order to achieve the correct deflection of spring (8).

4. Install plate (5) and bolts (4). Tighten the bolts to the proper torque. For the correct torque, refer to Specifications, “Circle Drive” for your machine.

5. Install cover (7).

i06287672

Disc Pack Preload for Circle Drive - Adjust

SMCS Code: 5207-025-ZP

S/N: B9J1–Up

S/N: R9J1–Up

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

Specifications

Table 15

Disk Pack Preload		
Date	**Equipment ID Code**	
Description	**Specification**	**Actual**
Spring Deflection	2.30 ± 0.25 mm (0.091 ± 0.010 inch)	
Minimum thickness to reuse clutch disk	2.44 mm (0.096 inch)	
Minimum thickness for friction material	0.20 mm (0.008 inch)	

Introduction

The clutch may need set or adjusted to the specifications due to worn clutch discs. As clutch discs wear, they will lose material, therefore decrease in thickness, causing the spring deflection to decrease. This procedure will reset the clutch to the correct torque.

Note: An incorrect setting does not indicate incorrect factory setting. This system is subjected to wear during operation.

Required Tools

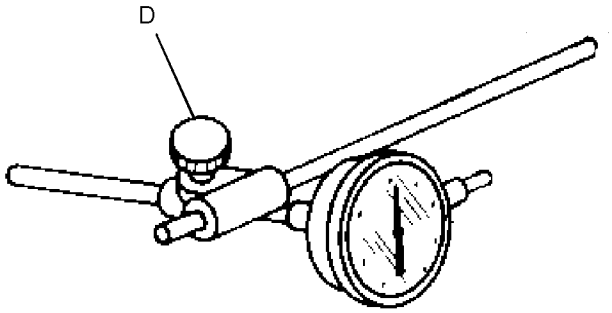

Illustration 94 g02115434

Tooling (D)

Table 16

Tool	Part Number	Description	Qty
D	8T-5096	Dial Indicator Gp	1

Adjustment Procedure

Note: Minimum reusable thickness for one clutch disk is 2.44 mm (0.096 inch). Minimum thickness for friction material on one side of the clutch disk is 0.20 mm (0.008 inch).

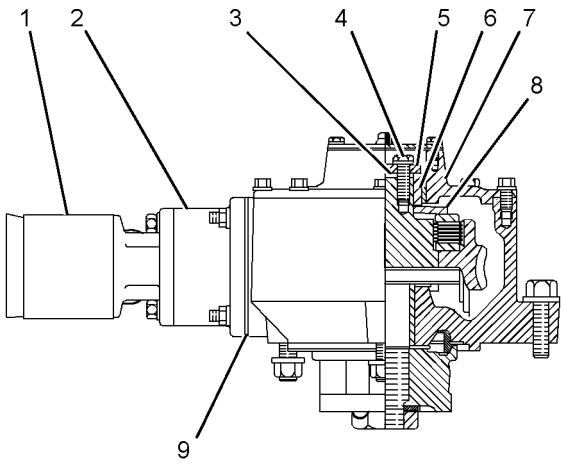

Illustration 95 g01116419

Circle drive

(1) Motor
(2) Bracket
(3) Shims
(4) Bolts
(5) Plate
(6) Spacer
(7) Cover
(8) Spring
(9) Shims

1. Remove cover (7).

2. Remove three bolts (4) and plate (5).

3. Measure the distance from the top of spacer (6) to the top of shims (3). The top of spacer (6) must be above the top of shims (3). The distance between the spacer and the shims must be 2.30 ± 0.25 mm (0.091 ± 0.010 inch). Add shims or remove shims in order to achieve the correct deflection of spring (8).

4. Install plate (5) and bolts (4). Tighten the bolts to the proper torque. For the correct torque, refer to Specifications, “Circle Drive” for your machine.

5. Install cover (7).

i08193834

Hydraulic Cylinder Drift - Check

SMCS Code: 7562-535-D9

WARNING

Hydraulic oil pressure can remain in the hydraulic system on this machine after the engine and pump have been stopped. Serious injury can result if this pressure is not released before any service is done on the hydraulic system. In order to prevent possible injury, release the hydraulic system pressure before working on any fitting, hose, or hydraulic component.

Lower all work tools to the ground before service is started. If the hydraulic system must be serviced, tested, or adjusted with the work tool in the raised position, the work tool and lift cylinders must be supported properly.

Always move the machine to a location away from the travel of other machines. Be sure that other personnel are not near the machine when the engine is running and tests or adjustments are being made.

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. Dispose of all fluids according to local regulations and mandates.

Specifications

Table 17

Cylinder Drift for Motor Graders						
Date		**Equipment ID Code**				
Implement	**Drift Time**	**Cylinder Drift Specification**				**Actual**
		12M 140 12M Series 2 12M Series 3 120M 120M Series 2 140M 140M Series 2 140M Series 3 150 160M 160M Series 2 160M Series 3160	**14M**	**16M 16M Series 3 18M Series 3**	**24M**	
Blade Lift	3 minutes	15 mm (0.59 inch)	11 mm (0.43 inch)	9 mm (0.35 inch)	6 mm (0.24 inch)	
Blade Tip	3 minutes	7 mm (0.28 inch)	4 mm (0.16 inch)	4 mm (0.16 inch)	3 mm (0.12 inch)	
Ripper	3 minutes	4 mm (0.16 inch)	2 mm (0.08 inch)	3 mm (0.12 inch)	4 mm (0.16 inch)	
Wheel Lean	3 minutes	4 mm (0.16 inch)	4 mm (0.16 inch)	3 mm (0.12 inch)	3 mm (0.12 inch)	
Scarifier	3 minutes	8 mm (0.32 inch)	N/A	N/A	N/A	
Snow Wing Lift	3 minutes	12 mm (0.48 inch)	12 mm (0.48 inch)	N/A	N/A	
Snow Wing Tilt	3 minutes	5 mm (0.20 inch)	5 mm (0.20 inch)	N/A	N/A	
Snow Plow Lift	3 minutes	5 mm (0.20 inch)	5 mm (0.20 inch)	N/A	N/A	

Reference: Before you perform this test, refer to Machine Preparation for Troubleshooting

Introduction

Hydraulic cylinder drift is any movement of the cylinder rod, when the cylinder rod is in the HOLD position. During normal operation, movement of the cylinder can have an effect on the performance of the machine.

Any of the following examples may cause cylinder drift:

- The cylinder piston seal is damaged.
- A scratch in the cylinder bore or a groove in the cylinder bore
- A scratch on the cylinder rod or a groove on the cylinder rod
- The cylinder head seal is damaged.
- Dirt in the lock valve or the lock valve is damaged in the implement control valve.
- Loose fittings or damaged hydraulic lines that have oil leaks.
- Dirt in the line relief valves or the line relief valves are damaged.

Required Tools

Table 18

Tool	Part Number	Description	Qty
D		A Stopwatch or Timer	1
F	1U-9366	Automatic Tape Measure	1

Test Preparation

1. Move the machine to a smooth horizontal location.

2. Chock the wheels.

3. Lower all of the implements.

Test Procedure

1. In order to test for cylinder drift, the oil temperature should be 38° to 50°C (100° to 122°F). Extend the cylinder rod halfway and put the cylinder rod in the HOLD position.

Note: The pressure should never exceed 42000 kPa (6090 psi).

2. Stop the engine.

3. Place a mark on the rod. Use ink in order to create all marks. Do not create marks by scratching or by scoring.

Note: Make sure that marks are visible from inside the cab or outside the machine live work envelope.

4. The piston shall not move more than the specified time in Table 17 for each function. Use the mark as a reference.

5. Inspect all welds and seals for leaks. Note any unusual noise from testing in order to determine damaged seals.

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Cylinder Cycle Time - Check

SMCS Code: 7562-535-VF

Table 19

Required Tools	
A Stopwatch or Timer	1

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

Use Table 20 in order to determine the correct cylinder cycle times. Choose the column that has the cycle times for your Motor Grader. Record the actual cycle times in the column that is on the right side of the table. The cycle times that are shown in Table 20 are in seconds.

For most cylinders, a test cycle is the full range of movement. For the following cylinders, a test cycle is movement through a 305 mm (12.0 inch) distance: blade lift cylinders and ripper cylinder. For the circle, a test cycle is 1/4 of one full rotation.

All of the checks of the implement cycle times must be performed at high idle. The hydraulic oil must be at normal operating temperature. Ensure that the cylinder bears no additional loads. The following causes will create additional loads: interference from other machine components, contact with foreign objects and contact with the ground.

Table 20

Implement Cycle Times for Motor Graders				
Implement	Action	Implement Cycle Times		Actual Implement Cycle Times
		14M	16M 16M Series 3 18M Series 3	
Blade Lift	Rod In(1) Rod Out(1)	3.0 ± 1.0 3.0 ± 1.0	3.0 ± 1.0 4.0 ± 1.0	
Centershift	Rod In(2) Rod Out(2)	5.5 ± 2.0 6.5 ± 2.0	5.5 ± 2.0 6.5 ± 2.0	
Wheel Lean	Rod In(2) Rod Out(2)	2.0 ± 0.5 2.5 ± 1.0	2.5 ± 1.0 2.5 ± 1.0	
Blade Tip	Rod In(2) Rod Out(2)	6.0 ± 2.0 5.5 ± 1.5	6.0 ± 2.0 5.5 ± 1.5	
Sideshift	Rod In(2) Rod Out(2)	16.0 ± 4.0 16.0 ± 4.0	16.0 ± 4.0 16.0 ± 4.0	
Ripper (If Equipped) B9J1–Up, B9H1–Up, R9J1–215, R9H1–201	Rod In(1) Rod Out(1)	4.5 ± 1.5 5.5 ± 1.5	4.5 ± 1.5 5.5 ± 1.5	
Ripper (If Equipped) R9J216–Up, R9H202–Up, N9Y1–Up, E9Y1–Up, N9A1–Up, E9W1–Up	Rod In(1) Rod Out(1)	3.5 ± 1.0 4.0 ± 1.5	3.5 ± 1.0 4.0 ± 1.5	
Articulation	Left(2) (3) Right(2) (3)	4.0 ± 1.0 4.0 ± 1.0	6.0 ± 1.5 6.0 ± 1.5	
Blade Circle	1/4 Rotation	13.0 ± 4.0	13.0 ± 4.0	

(1) Cycle times are for a “running distance” of 305 mm (12 inch).
(2) Cycle time is through full travel.
(3) When you check the cycle times for these cylinders, operate the machine at high idle and in the FIRST SPEED position. The differential must be unlocked.

Procedure To Check Blade Lift Cycle Times and Ripper (If Equipped) Cycle Times

Table 21

Required Tools	
A Stopwatch or Timer	1
1U-9366 Automatic Tape Measure	1

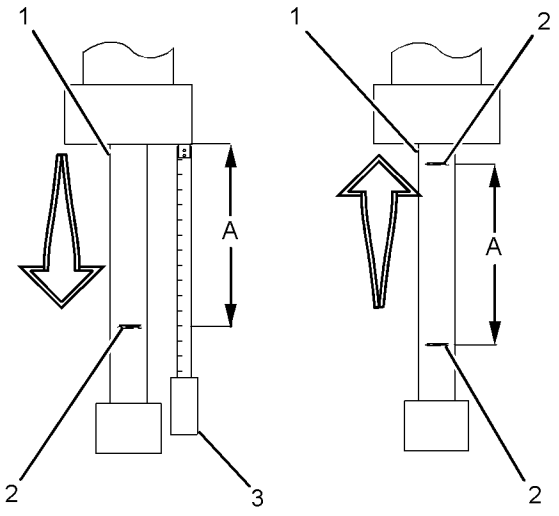

Illustration 96 g01373871

(1) Cylinder rod
(2) Marks
(3) Tape measure
(A) Running distance

1. Raise the implement that needs to be checked to the maximum height.

2. Stop the engine.

3. Place a mark on the rod. Place the mark just below the cylinder head. Use ink in order to create all marks. Do not create marks by scratching or by scoring.

Note: Make sure that marks are visible from inside the cab or outside the machine live work envelope.

4. Start the engine.

5. Use the stopwatch in order to determine the time that is required to lower the cylinder by 305 mm (12.0 inch). Use the tape measure in order to determine 305 mm (12.0 inch) of movement. Use the mark as a reference.

6. Position the implement just above the ground.

7. Stop the engine.

8. Place two marks on the rod. Place the marks 305 mm (12.0 inch) away from each other.

9. Start the engine.

10. Use the stopwatch in order to determine the time that is required to raise the cylinder by 305 mm (12.0 inch). Use the marks for reference.

i08194288

Steering System - Purge

SMCS Code: 4300-542; 4303-542; 4307-542

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

Introduction

The following will explain the procedure for purging the steering system.

Required Tools

Table 22

Tool	Part Number	Description	Qty
D	8T-2362	Adapter(1)	4
	7J-0204	O-Ring Seal	4
	6V-8628	Elbow	4
	3J-7354	O-Ring Seal	4
	4J-5477	O-Ring Seal	4
	9C-2394	Hose As	2
F	6V-3668	Bolt	2
	5P-8245	Hard Washer	8

(1) The adapter must be change 02. Exterior thread is 3/8 by 24. Interior threads are 7/16 by 20.

Machine Preparation

1. Move the machine to a smooth horizontal location.

2. Chock the wheels.

3. Lower all the implements.

4. Stop the engine.

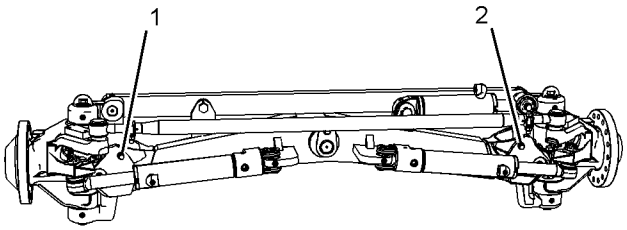

Illustration 97 g01459671

Steering cylinders

5. Install Tooling (F) into the locations (1) and (2) on the front axle body.

Note: Be careful **NOT** to engage the wheel lean. Activating the wheel lean function could damage Tooling (F).

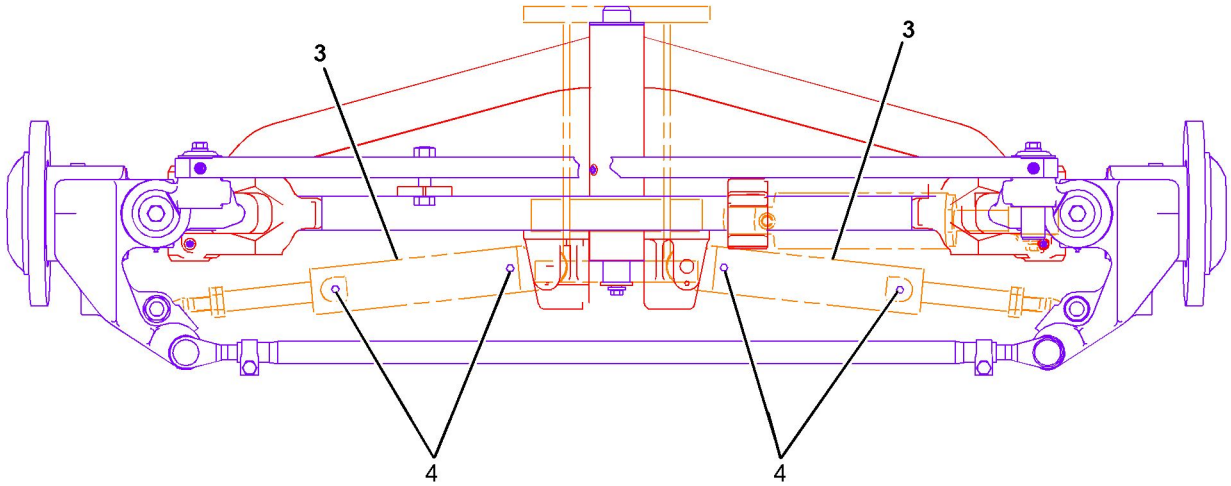

Illustration 98 g06395715

Typical top view of front axle

(3) Steering cylinders (4) Plugs

6. Remove plugs (4) from each steering cylinder (3).

7. Install Tooling (D) to connect the port of the rod end to the port of the head end. Perform this procedure for both of the cylinders.

Purge Procedure (Steering System)

1. Start the engine and operate the engine at low idle.

2. Align the left-hand joystick control so that the joystick control will match the steering angle of the front wheels.

3. Move the left-hand joystick control all the way to the left and hold for 30 seconds.

4. Move the left-hand joystick control all the way to the right and hold for 30 seconds.

5. Shut off the engine.

6. Remove all the Tooling from the machine.

7. Check the oil level in the hydraulic tank.

Purge Procedure (Signal Network)

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

Note: Perform the Steering System−Purge procedures before you perform the purge procedure for the signal network.

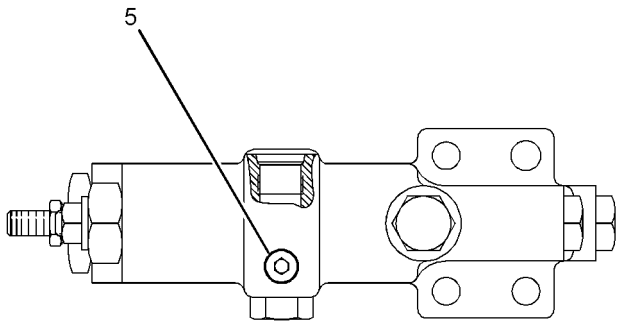

Illustration 99 g06395727

Pump control valve

(5) Purge valve for flow compensator

1. Use a hex wrench. Turn purge valve (5) counterclockwise by one turn to open the valve.

2. Start the engine and operate the engine at low idle. During this procedure, a small amount of oil may leak by the purge valve.

3. The implement lockout switch must be in the unlocked position.

4. Select an implement.

5. Move the joystick control to extend the implement cylinder. Hold the joystick control in this position for 10 seconds.

6. Move the joystick control to retract the implement cylinder. Hold the joystick control in this position for 10 seconds.

7. Repeat for each implement circuit on the machine.

8. Turn purge valve (5) clockwise to close the valve.

9. Stop the engine.

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