



Systems Operation Troubleshooting Testing and Adjusting

14M, 16M Motor Graders Braking and Hydraulic Fan System

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

Important Safety Information

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

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

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

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

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



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

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

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

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

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



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

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

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: 4250

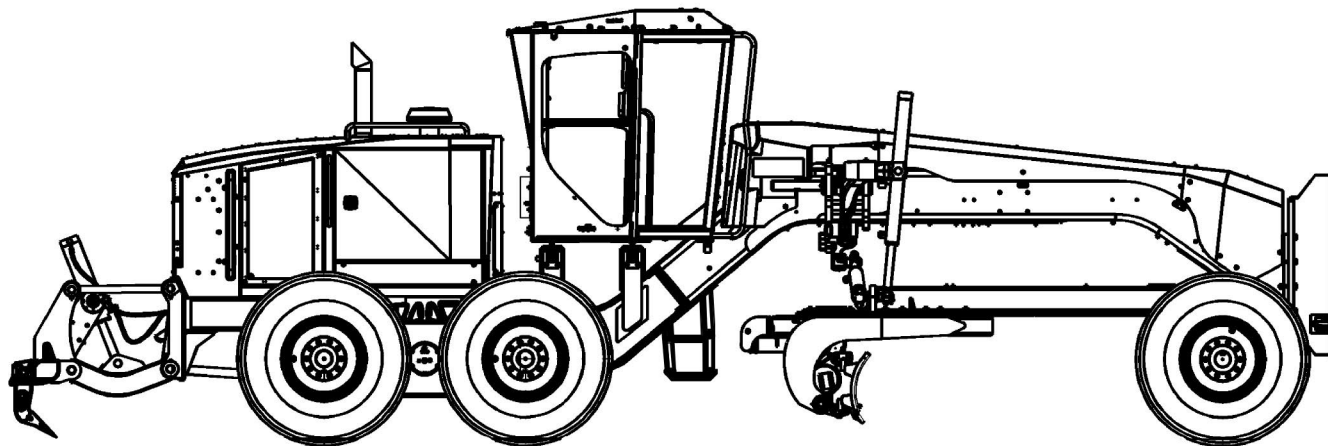


Illustration 1

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Typical of the R9J, B9H, and the R9H machines.

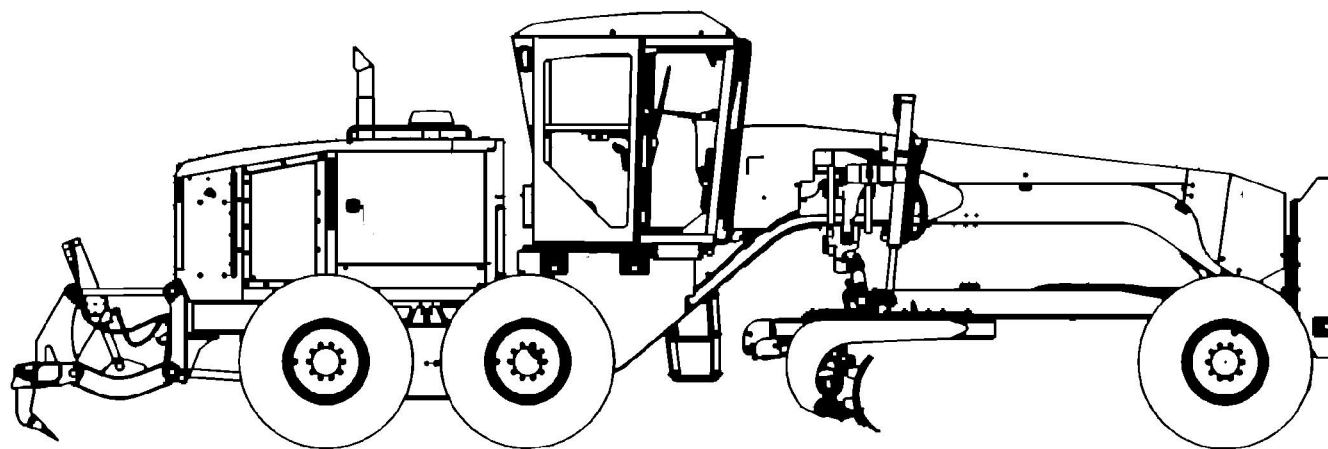


Illustration 2

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Typical of the B9J machines.

This module discusses the features and operation of the brake system and the hydraulic fan system. The following motor graders are covered in this module:

- 14M
- 16M

The brake system and the hydraulic fan system have the following main components:

- Monitoring system
- Piston pump (brake and hydraulic fan)
- Pump control valve
- Control manifold
- Brake accumulator
- Service brake control
- Wheel group
- Parking brake
- Parking brake solenoid
- Gear motor (hydraulic fan)
- Oil cooler (brake and hydraulic fan)

Monitoring System

The Caterpillar Monitoring System consists of an action alarm, action light, and a monitoring panel. The monitoring panel contains individual alert indicators for each machine system and two LCD display screens. The Caterpillar Monitoring System provides three warning categories. The first warning category requires only operator awareness. The second warning category needs operator response. The third warning category requires immediate shutdown of the machine systems.

Piston Pump (Brake and Hydraulic Fan)

The brake and hydraulic fan pump is a variable displacement axial piston pump. The piston pump is driven off the transmission. When the engine is operating, the pump will produce flow in order to satisfy the following conditions:

- The demand of the brake system
- The demand of the hydraulic fan system

The pump will produce flow until the following conditions are met:

- The pressure setting of the pressure compensator is reached.
- The brakes and the hydraulic fan are not being operated.

Pump Control Valve

The pump control valve is mounted on the piston pump (brake and hydraulic fan). The pump control valve has two functions. The pump control valve controls system pressure. The pump control valve is load sensing. The piston pump (brake and hydraulic fan) will only produce enough oil flow to satisfy the demand of the brake and the hydraulic fan system.

Control Manifold

The control manifold directs the oil from the brake and the hydraulic fan pump to the brake circuit and to the fan circuit.

Brake Accumulator

There are two brake accumulators in the brake system. The brake accumulators maintain brake system pressure when the brake and hydraulic fan pump is destroyed.

Service Brake Control

The service brake control valve for the service brakes provides the proper flow in order to engage the service brakes. The service brake control for the service brakes also balances the oil pressure between the left side brakes and the right side brakes.

Wheel Group

Service Brakes

The service brakes are located in wheel groups. The service brakes are actuated by oil pressure from the service brake control valve for the service brakes. The service brakes are activated when the brake pedal is depressed.

Parking Brake

Refer to the Power Train Systems Operation/Testing and Adjusting for information regarding the parking brake and parking brake components for your machine.

Parking Brake Solenoid

The parking brake solenoid controls the operation of the parking brake. The parking brake is applied when the parking brake solenoid is the de-energized state. When the parking brake solenoid is energized oil flows to the parking brake. The oil disengages the parking brake. Refer to the Power Train Systems Operation/Testing and Adjusting for information regarding the parking brake and parking brake components for your machine.

Gear Motor (Hydraulic Fan)

The gear motor (hydraulic fan) is located in the cooling group of the motor grader. The fan is attached to the gear motor. The gear motor converts hydraulic energy into mechanical energy in order to rotate the fan.

Oil Cooler (Brake and Hydraulic Fan)

The oil cooler (brake and hydraulic fan) is located behind the radiator group. Oil flows from the gear motor (hydraulic fan) through the cooler. The oil flows through the return filter and into the hydraulic tank.

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Location of Components

SMCS Code: 4250

Braking and Hydraulic Fan System

The brake and the hydraulic fan system consist of the following components:

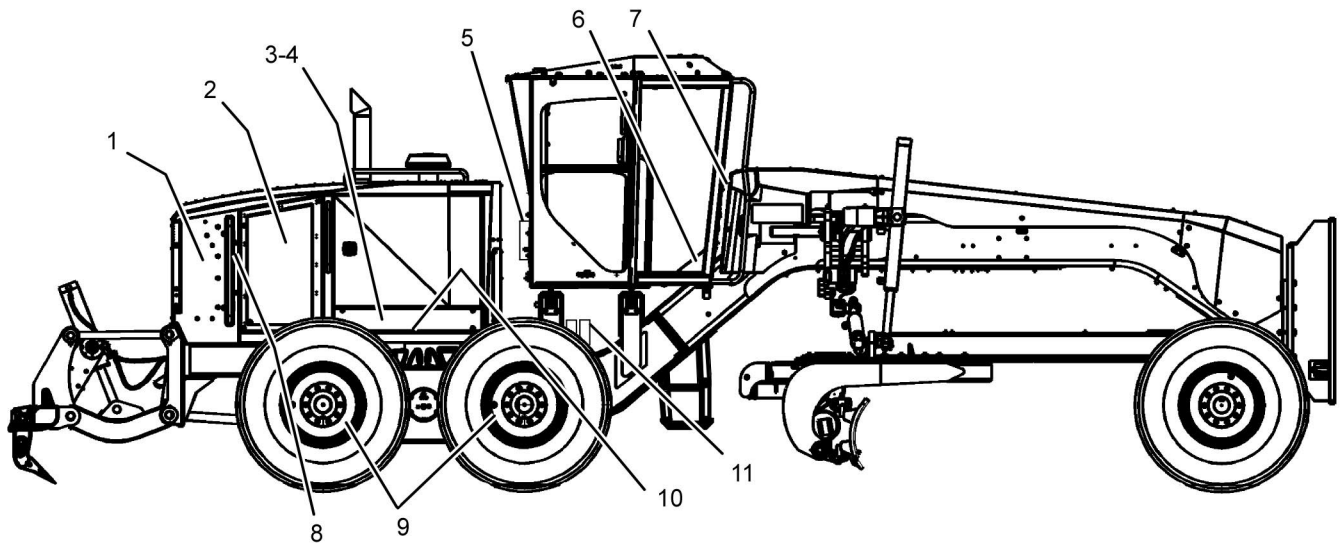


Illustration 3

g02232993

Typical of the B9H, R9H, and the R9J machines.

- (1) Gear motor (hydraulic fan)
- (2) Control manifold
- (3) Piston pump
- (4) Pump control valve

- (5) Brake accumulators for the 14M
- (6) Service brake control
- (7) Monitoring system
- (8) Oil Cooler (brake and hydraulic fan)

- (9) Service brakes
- (10) Parking Brake
- (11) Brake Accumulator for the 16M

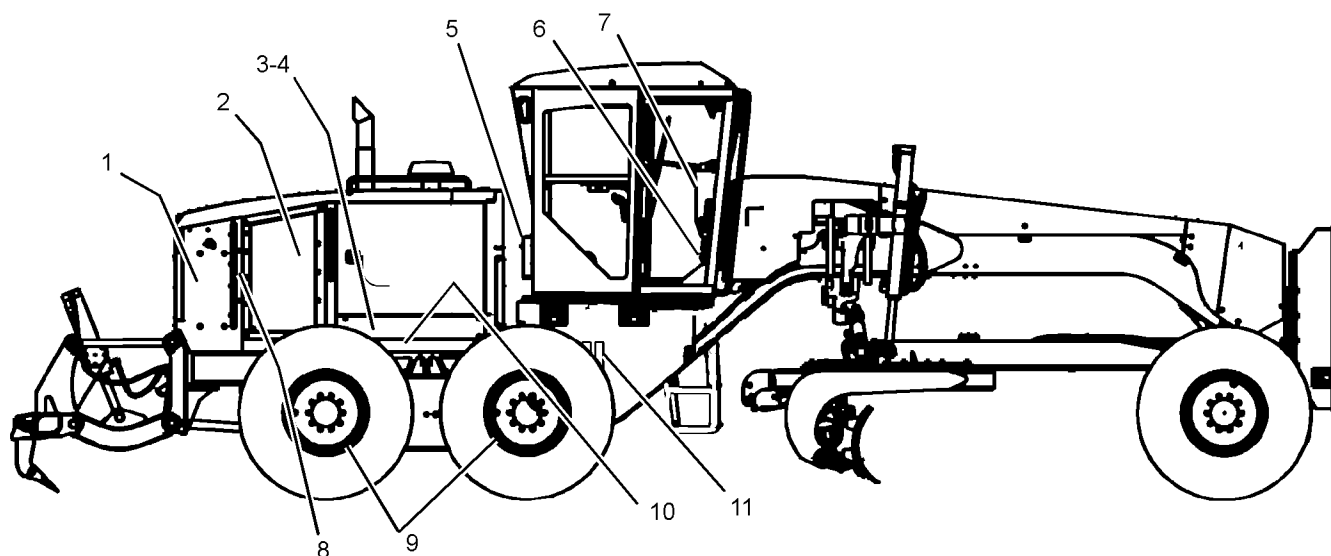


Illustration 4

g01329600

Typical of the B9J machines.

- (1) Gear motor (hydraulic fan)
- (2) Control manifold
- (3) Piston pump
- (4) Pump control valve

- (5) Brake accumulators for the 14M
- (6) Service brake control
- (7) Monitoring system
- (8) Oil Cooler (brake and hydraulic fan)

- (9) Service brakes
- (10) Parking Brake
- (11) Brake Accumulator for the 16M

Monitoring System

Piston Pump (Brake and Hydraulic Fan)



Illustration 5

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The monitoring system (7) is located in the operator console.

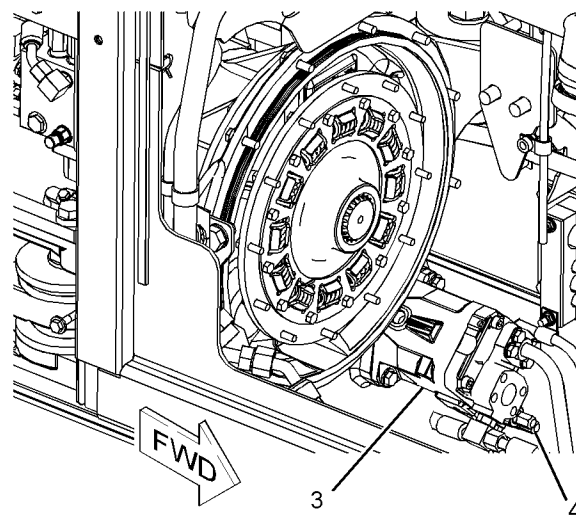


Illustration 6

g01330754

View of the engine compartment without the engine

Piston pump (3) is connected to an output shaft of the transmission.

Pump Control Valve

The pump control valve (4) is located on the bottom of the piston pump (3).

Control Manifold

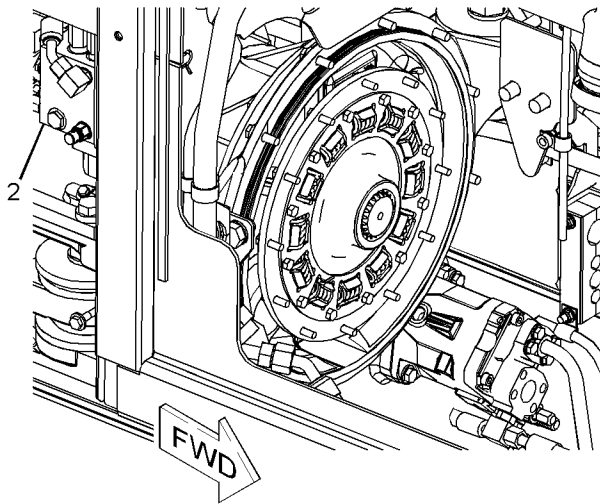


Illustration 7
View of the engine compartment without the engine

The control manifold (2) is located on the right side of the machine. The control manifold (2) is just above the frame rail.

Brake Accumulator

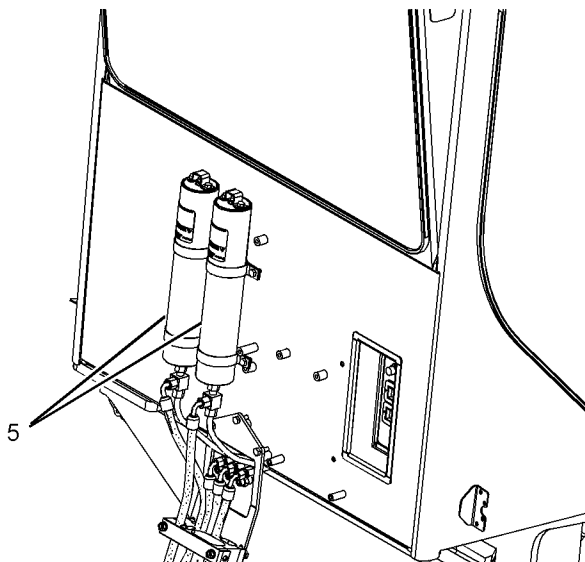


Illustration 8
View of 14M

The brake accumulators (5) are mounted on the back of the cab.

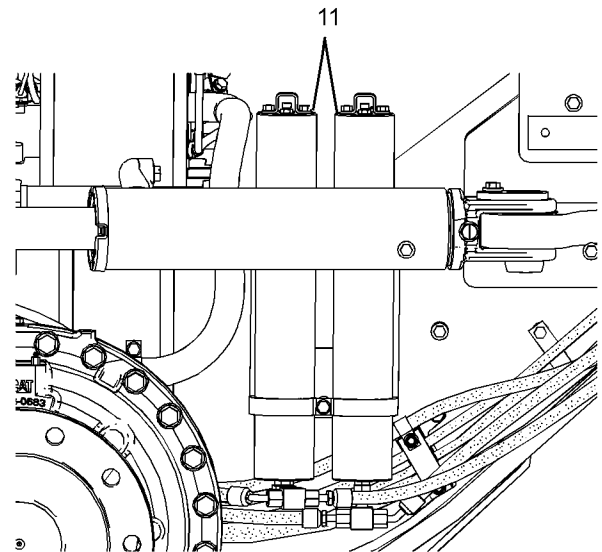


Illustration 9
View of 16M

The brake accumulators (11) are located on the right side of the frame and below the cab.

Service Brake Control

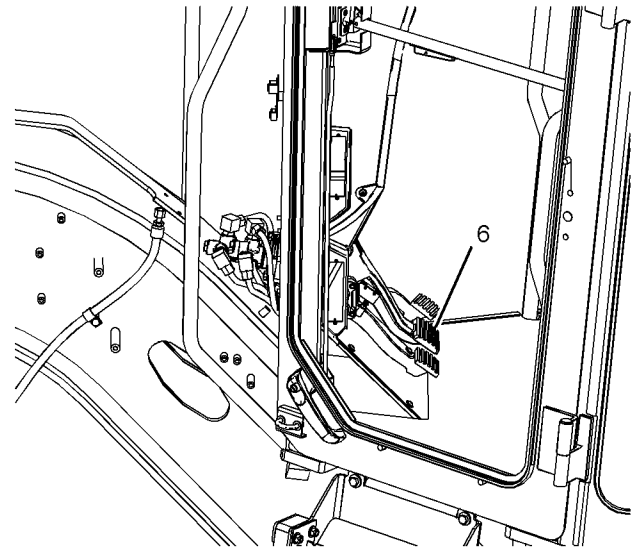


Illustration 10
Service brake

The service brake control (6) is located in the cab.

Service Brakes

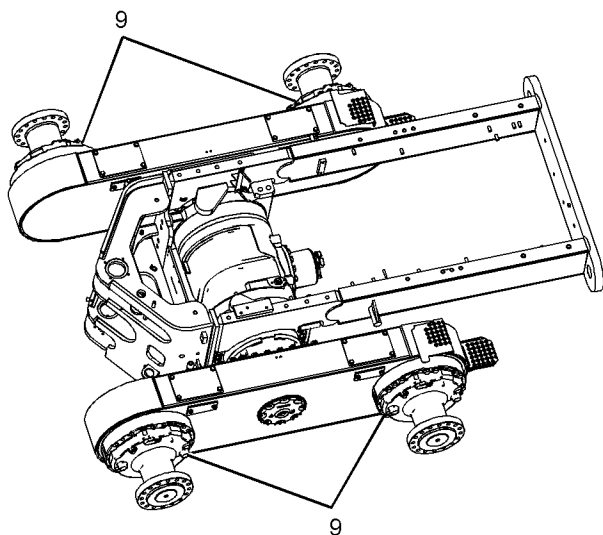


Illustration 11

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Wheel groups

There is a service brake (9) in each one of the four wheel-groups.

Parking Brake

Refer to the Power Train Systems Operation/Testing and Adjusting for information regarding the parking brake and parking brake components for your machine.

Gear Motor (Hydraulic Fan)

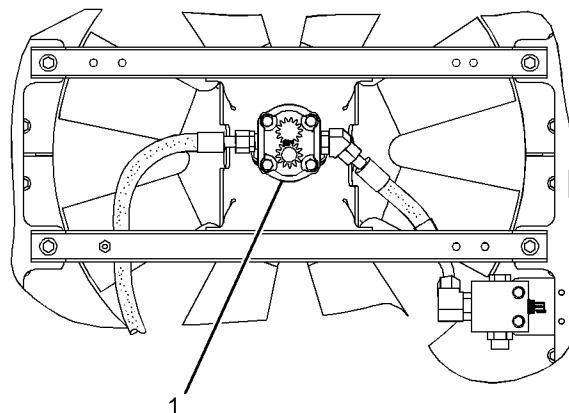


Illustration 12

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14M Gear motor (hydraulic fan) not equipped with a case drain

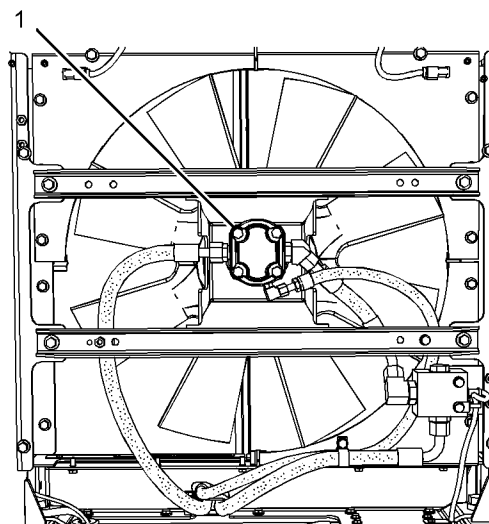


Illustration 13

g02215053

14M Gear motor (hydraulic fan) equipped with a case drain

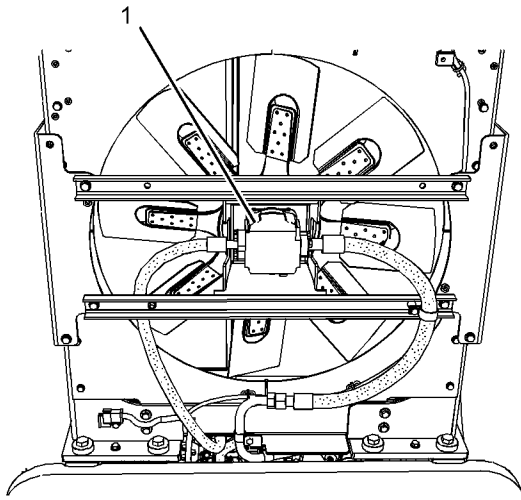


Illustration 14

g02233993

16M Gear motor (hydraulic fan) not equipped with a case drain

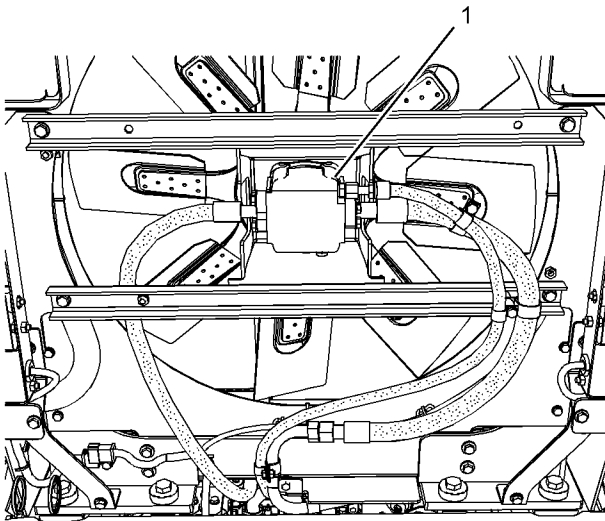


Illustration 15

g02214996

16M Gear motor (hydraulic fan) equipped with a case drain

The gear motor (hydraulic fan) (1) is part of the cooling group. The gear motor (hydraulic fan) (1) is located at the rear of the machine.

Oil Cooler (Brake and Hydraulic Fan)

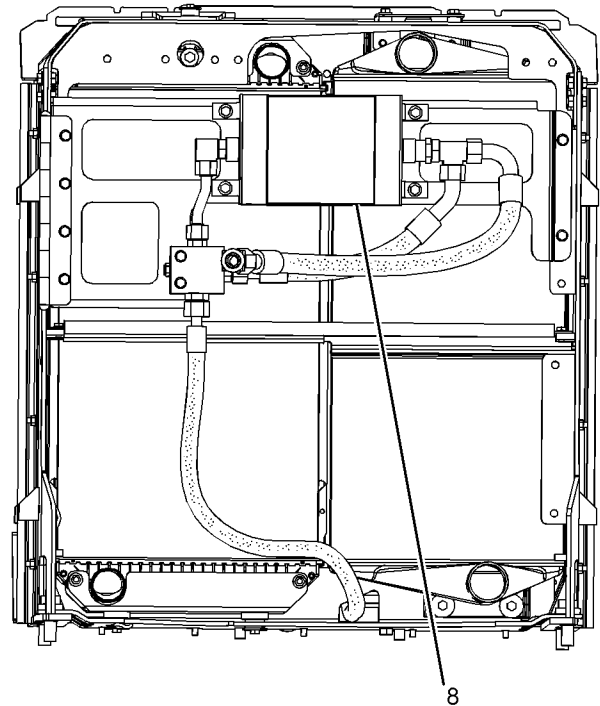


Illustration 16

g01389601

14M Oil cooler (brake and hydraulic fan)

The oil cooler (brake and hydraulic fan) (8) is located at the rear of the machine in front of the radiator.

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Hydraulic Fan System

SMCS Code: 1386-GT; 1387-GT

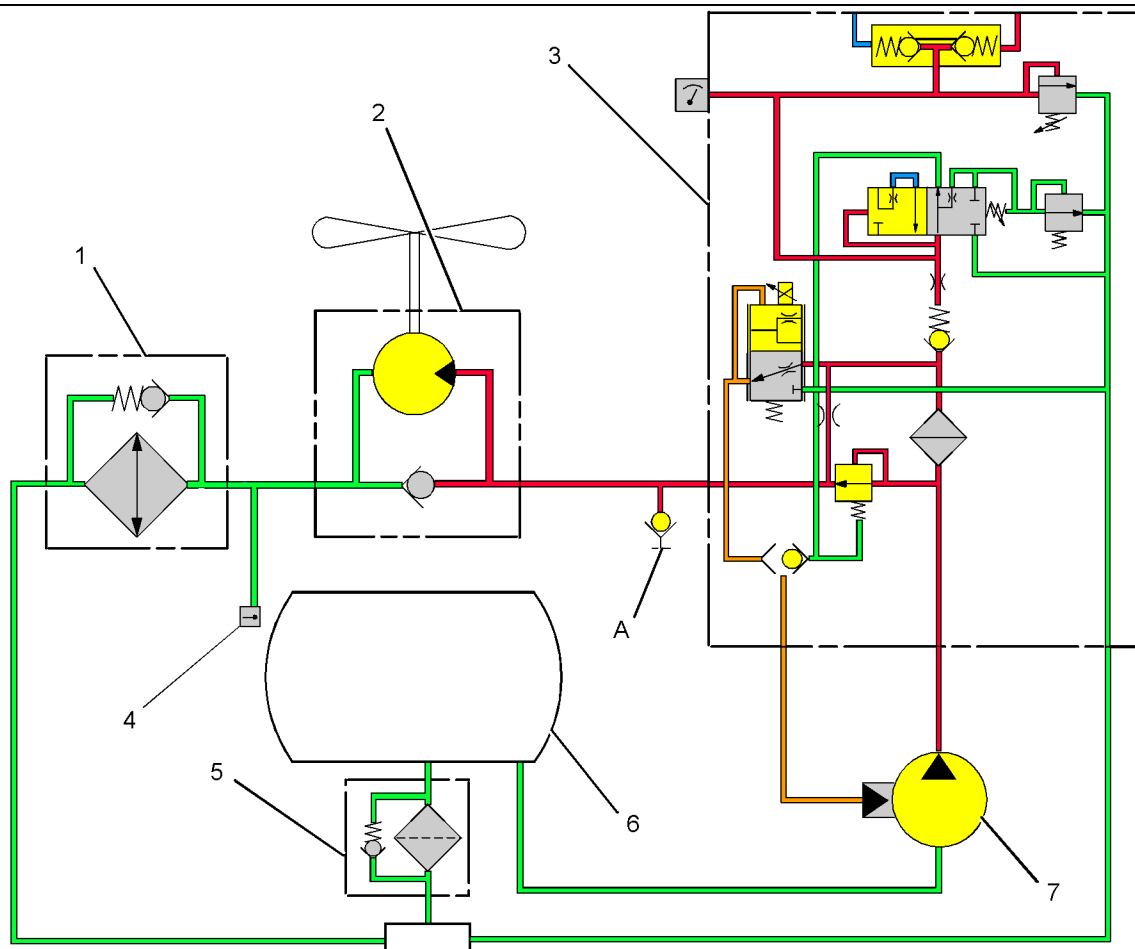


Illustration 17

g01521324

(1) Oil cooler
(2) Fan motor
(3) Control manifold

(4) Temperature sensor
(5) Oil filter
(6) Hydraulic tank

(7) Piston pump
(A) Test port

Piston pump (7) pumps oil to control manifold (3). Manifold (3) will direct oil into two systems. The first system is the braking system. The braking system has priority over the fan system, but the fan will not completely shut off. When the oil requirements for the braking system have been met, manifold (3) will direct oil to the fan system. Oil will flow from manifold (3) to fan motor (2). Pressurized oil will flow through the motor which will cause the fan to rotate. Oil that leaves motor (2) will flow to oil cooler (1). Cooler (1) will cool the hydraulic oil. Cooler (1) is equipped with temperature sensor (4). The Electronic Control Module (ECM) will use the signal from sensor (4) to monitor system temperature. Oil will flow from cooler (1) to oil filter (5). Filter (5) will remove debris from the oil. Oil will flow from filter (5) into hydraulic tank (6).

i04090709

Piston Pump (Brake, Hydraulic Fan)

SMCS Code: 1387-QP; 4268-QP; 5070-HFN; 5070-BRK

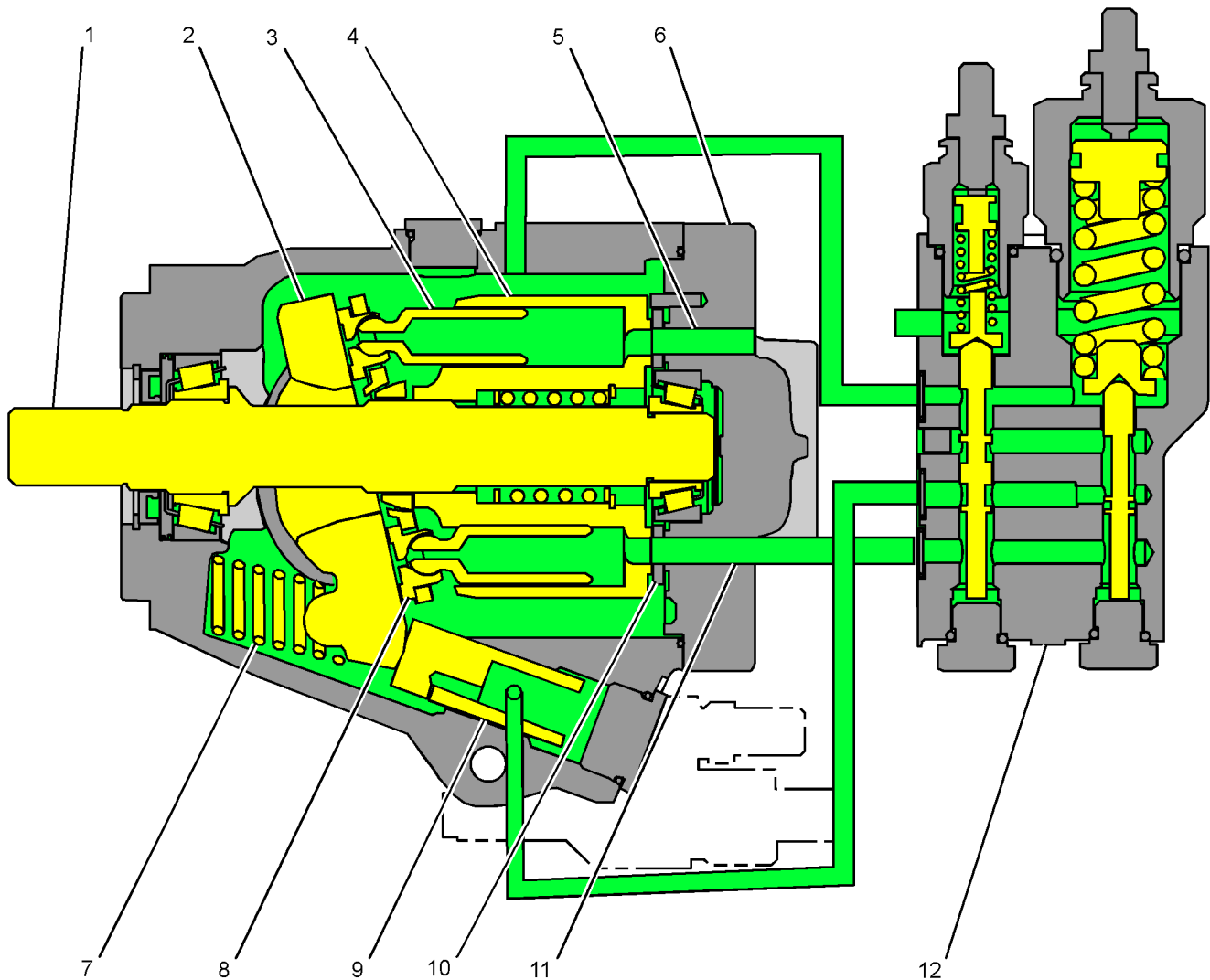


Illustration 18
Piston Pump

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- (1) Drive shaft
- (2) Swashplate
- (3) Piston assembly
- (4) Cylinder barrel

- (5) Pump inlet
- (6) Pump head
- (7) Bias spring
- (8) Slipper

- (9) Actuator piston
- (10) Valve plate
- (11) Pump pressure passage
- (12) Pump control valve

The brake and the hydraulic fan pump is a variable displacement piston pump. The axial piston type pump is used to supply oil flow to the hydraulic fan motor. The movement of piston assembly (3) in the pump creates an area of low pressure. Atmospheric pressures will push oil from the hydraulic tank into the pump. The oil is pumped to the fan motor in order to rotate the fan.

When the engine is in operation, drive shaft (1) is driven by shaft of the main hydraulic pump. The components that rotate are cylinder barrel (4), piston assemblies (3), and slipper (8). There are nine piston assemblies in cylinder barrel (4).

Oil from the hydraulic tank flows into pump head (6) through pump inlet (5). The oil then flows from pump inlet (5) through inlet passages in valve plate (10). When drive shaft (1) rotates, the openings of cylinder barrel (4) move toward the inlet passages of valve plate (10).

Each piston assembly (3) inside cylinder barrel (4) is held against swashplate (2) by slipper (8). Swashplate (2) can be at any angle between the maximum angle and the neutral angle.

The angle of swashplate (2) determines the amount of oil that is pushed out of each cylinder barrel (4). Swashplate (2) can be at any angle between the neutral angle and the maximum angle. The neutral angle is perpendicular with drive shaft (1). When swashplate (2) is at the neutral angle, piston assemblies (3) do not move in and out of rotating cylinder barrel (4). Therefore, no oil is drawn into the brake and the hydraulic fan pump and no oil is pushed out of the pump. The brake and hydraulic fan pump has zero displacement and zero flow.

When swashplate (2) is at the maximum angle, piston assemblies (3) move in and out of cylinder barrel (4). The movement of piston assemblies (3) will allow the maximum amount of oil to be drawn in to cylinder barrel (4). The pump will produce the maximum displacement.

The swashplate angle is controlled by actuator piston (9). The movement of the actuator piston (9) is regulated by oil pressure from pump control valve (12).

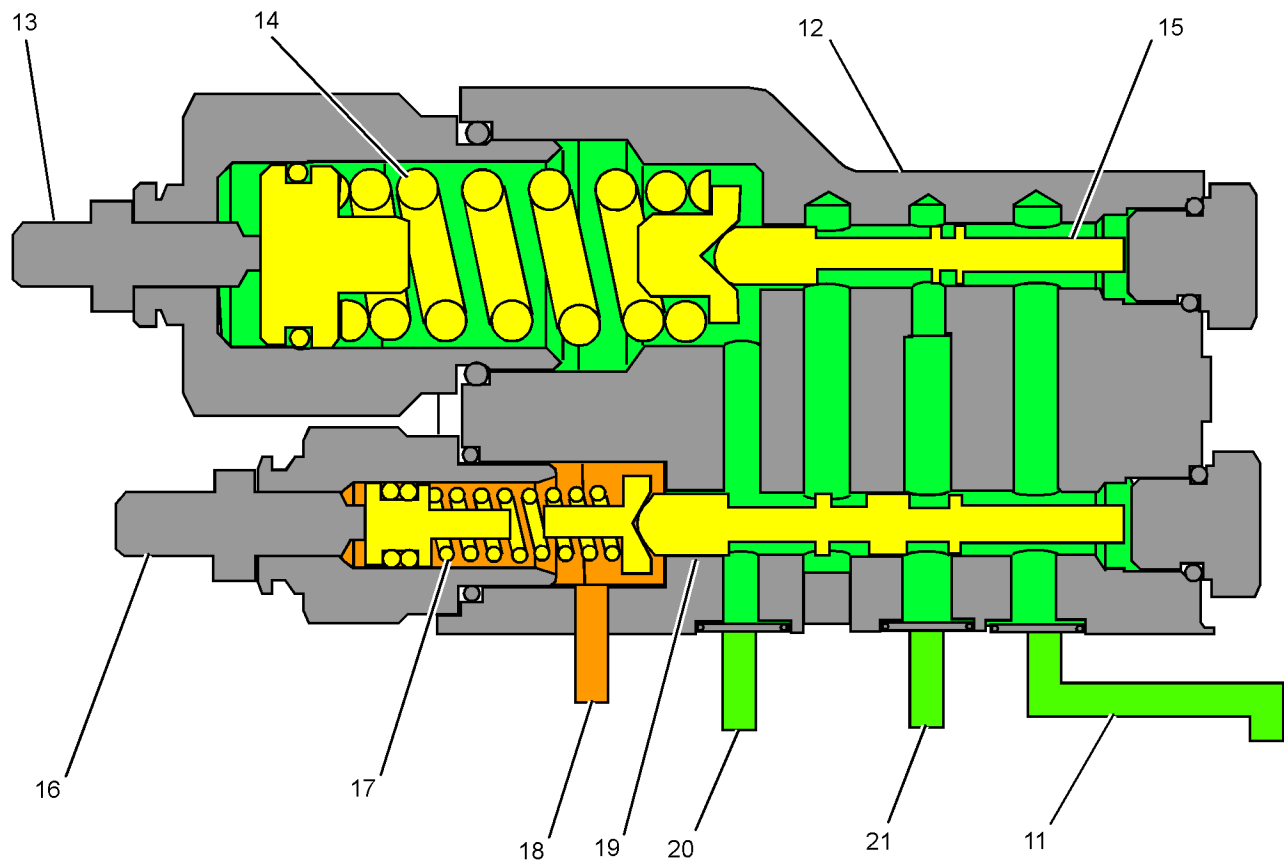


Illustration 19

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Pressure and Flow Compensator Valve

- | | | |
|------------------------------------|------------------------------|--|
| (11) Pump pressure passage | (15) Cutoff spool | (19) Margin spool |
| (12) Pump control valve | (16) Margin spool adjustment | (20) Case drain passage |
| (13) Cutoff valve adjustment screw | (17) Margin spring | (21) Signal passage to the actuator piston |
| (14) Cutoff spring | (18) Load sensing port | |

Pump control valve (12) is mounted to the brake and the hydraulic fan pump. Pump control valve (12) contains two spools. Margin spool (19) regulates the pump output flow in response to load sensing port (18). Cutoff spool (15) protects the pump for high pressures.

Pump control valve (12) maintains the correct pressure and correct oil flow. The pump is controlled by either sending pump oil to actuator piston (9) or by draining the pump oil from actuator piston (9).

Actuator piston (9) and bias spring (7) work together in order to adjust the angle of swashplate (2). Pump control valve (12) prevents overloading of the pump.

Pump Destroke

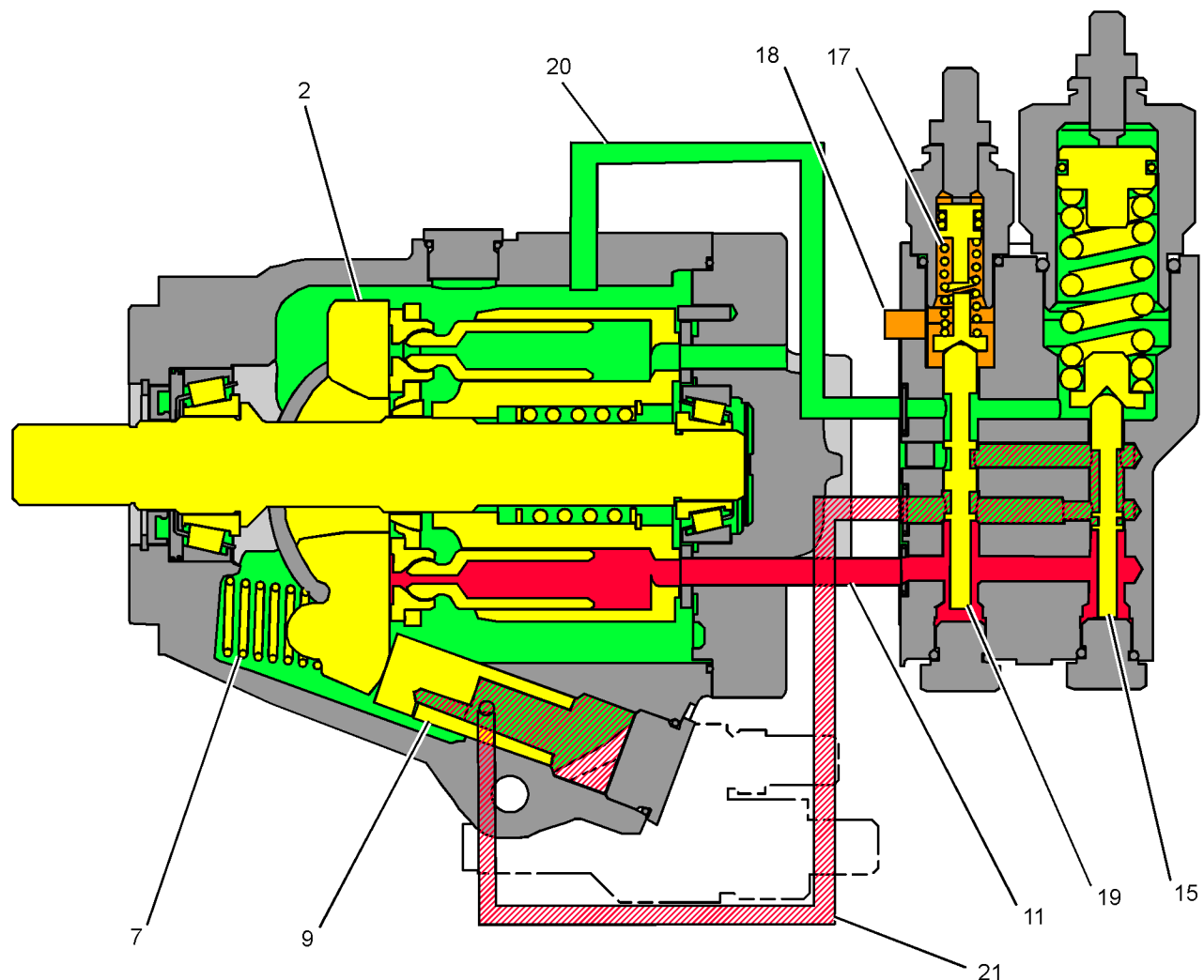


Illustration 20

g01332919

Piston Pump in Destroke

- | | | |
|----------------------------|------------------------|--|
| (2) Swashplate | (15) Cutoff spool | (20) Case drain passage |
| (7) Bias spring | (17) Margin spring | (21) Signal passage to the actuator piston |
| (9) Actuator piston | (18) Load sensing port | |
| (11) Pump pressure passage | (19) Margin spool | |

When the hydraulic system requires a reduction in flow, a reduced signal is sent to load sensing port (18).

High-pressure oil flows to margin spool (19) through pump pressure passage (11). When the pressure against spool (19) overcomes the force of both signal (18) and margin spring (17), spool (19) will begin to move.

The oil will flow around the spool (19). Oil will flow to actuator piston (9).

When the oil pressure behind actuator piston (9) is sufficient, the piston will start to move. The piston rod will push swashplate (2) against bias spring (7). Swashplate (2) will overcome bias spring (7). The swashplate (2) will move to a minimal angle. The piston pump will be destroke.

Pump Upstroke

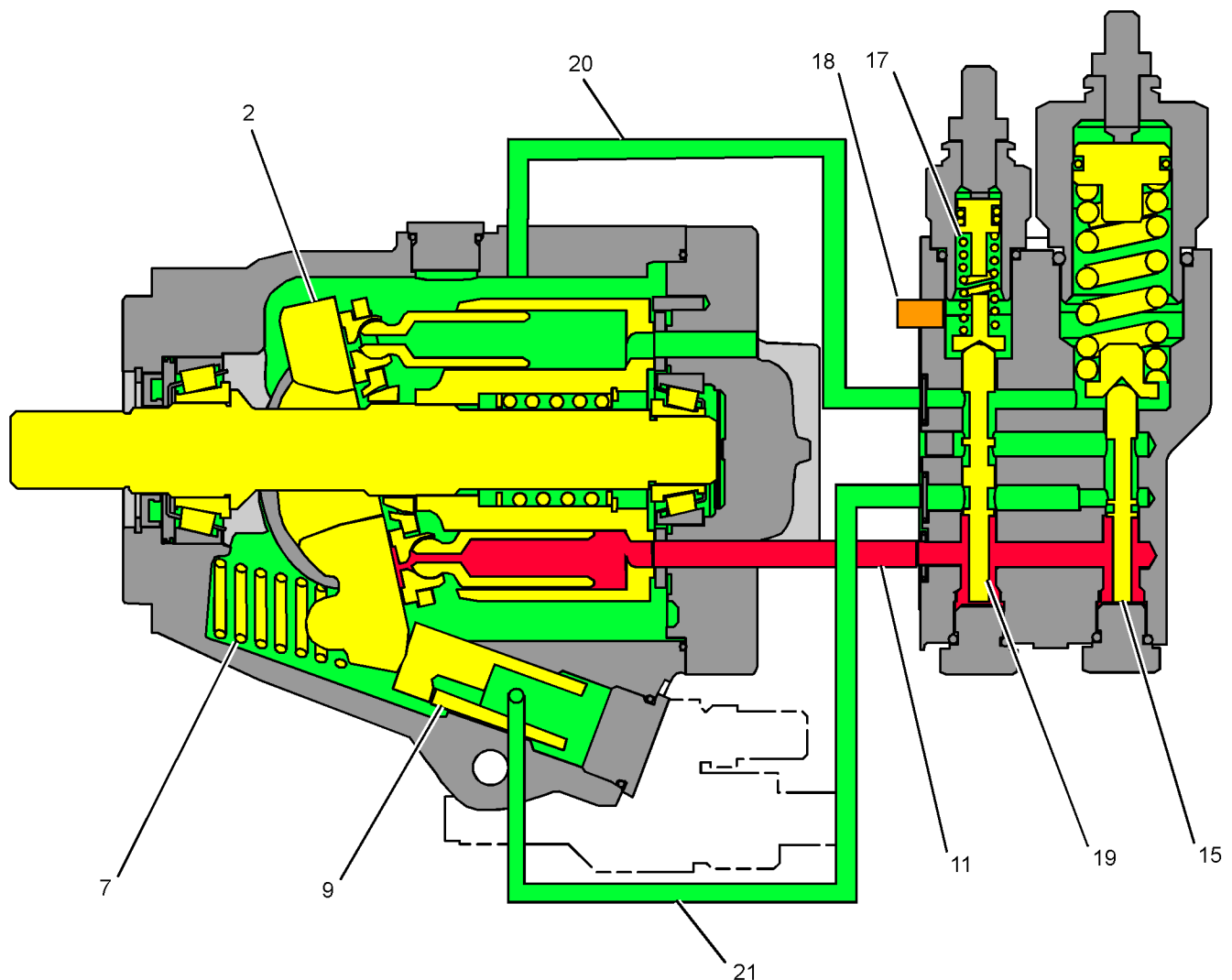


Illustration 21

g01332923

Pump Upstroke

- | | | |
|----------------------------|------------------------|--|
| (2) Swashplate | (15) Cutoff spool | (20) Case drain passage |
| (7) Bias spring | (17) Margin spring | (21) Signal passage to actuator piston |
| (9) Actuator piston | (18) Load sensing port | |
| (11) Pump pressure passage | (19) Margin spool | |

When the hydraulic system requires an increase in oil flow, a signal is sent to load sensing port (18). The pressure at the load sensing port (18) is increased. The combination of the force of margin spring (17) and the increase of pressure at load sensing port (18) will shift spool (19) downward. This shifting of the spool will allow the oil that is behind piston (9) to flow through signal passage (21). The oil will flow around spool (15). The oil will flow around the upper section of spool (19). The oil will flow through passage (20) to the case drain.

As the oil is metered out of the piston (9), the force of bias spring (7) overcomes the pressure behind piston (9). The angle of swashplate (2) begins to increase. As the angle of swashplate (2) increases, the piston pump will upstroke.

Constant Flow

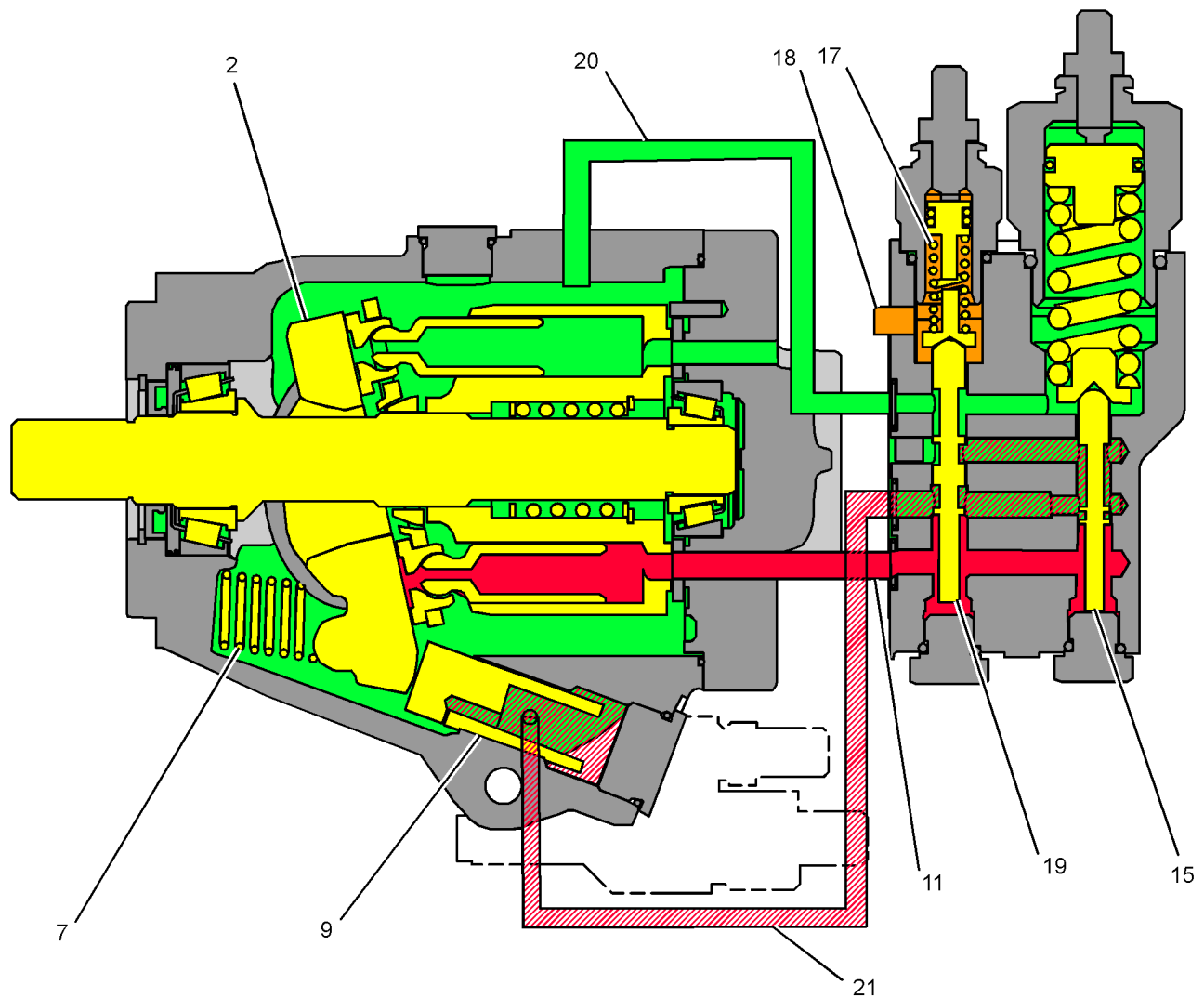


Illustration 22

g01332925

Pump at Constant Flow

Pump Upstroke

- | | | |
|----------------------------|------------------------|--|
| (2) Swashplate | (15) Cutoff spool | (20) Case drain passage |
| (7) Bias spring | (17) Margin spring | (21) Signal passage to actuator piston |
| (9) Actuator piston | (18) Load sensing port | |
| (11) Pump pressure passage | (19) Margin spool | |

The force from margin spring (17) and pressure from load sensing port (18) act on the end of spool (19).

The pump pressure in passage (11) will act on the opposite end of spool (19).

The pressures that are acting on the ends of margin spool (19) equalize. The margin spool (19) will then meter oil to actuator piston (9) through signal passage (21). The force behind actuator piston (9) will equalize with the force of bias spring (7). Swashplate (2) will be held at a relative constant angle in order to maintain the required oil flow. The flow of hydraulic oil to the system will stabilize.

When a constant flow of hydraulic oil is demanded by the hydraulic system, the supply oil pressure in the pump pressure passage (11) will be constant. The supply of oil will flow at a constant rate until the pressure at load sensing port (18) changes.

High Pressure Cutoff

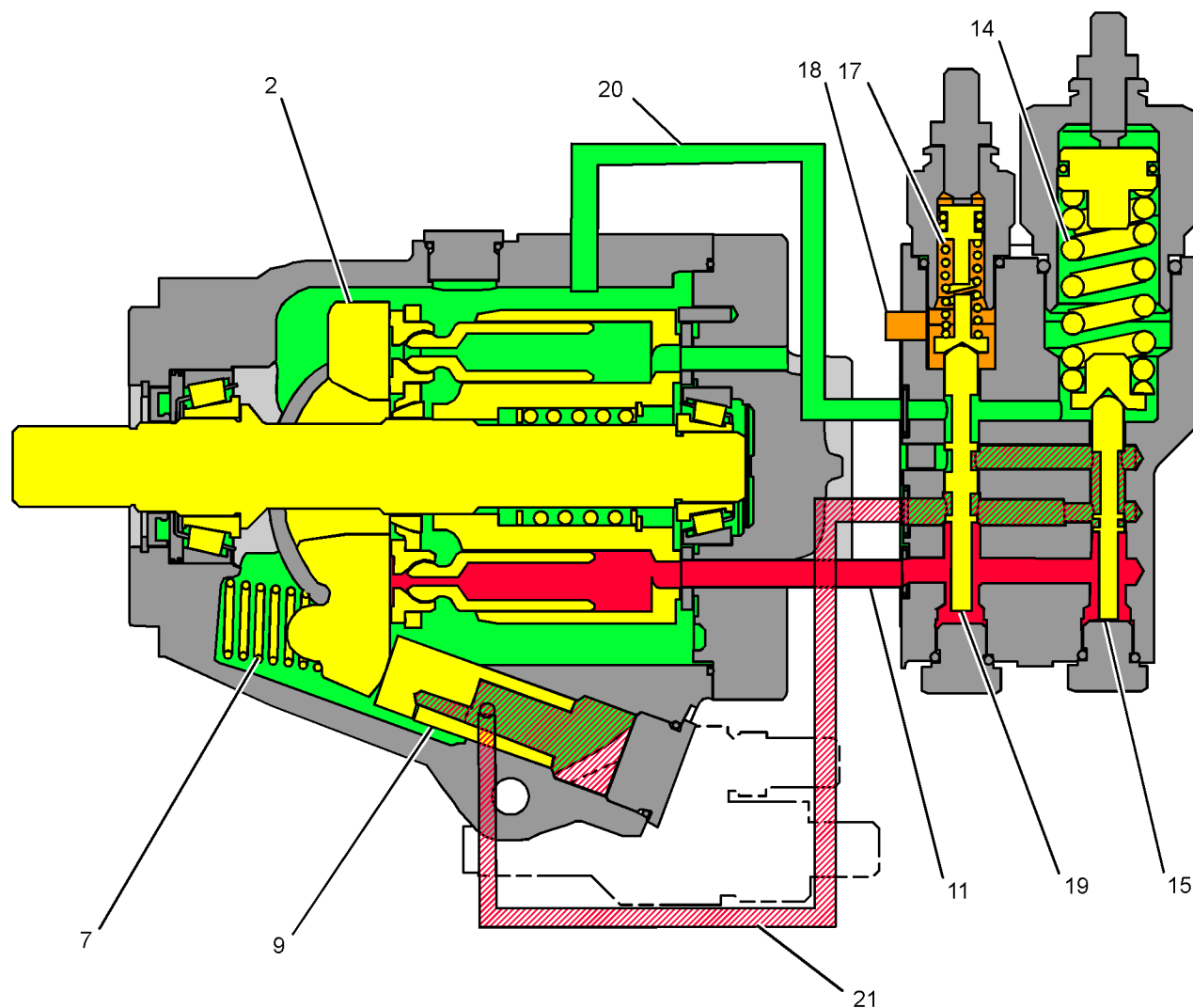


Illustration 23

g01332927

Pump at High Pressure Cutoff

Pump Upstroke

- | | | |
|----------------------------|------------------------|--|
| (2) Swashplate | (14) Cutoff spring | (19) Margin spool |
| (7) Bias spring | (15) Cutoff spool | (20) Case drain passage |
| (9) Actuator piston | (17) Margin spring | (21) Signal passage to actuator piston |
| (11) Pump pressure passage | (18) Load sensing port | |

High-pressure cutoff in a piston pump limits the maximum pressure at any pump displacement. During normal operation of a piston pump, cutoff spool (15) is forced down by spring (14).

As the pressure in passage (11) increases, oil forces cutoff spool (15) against spring (14). The pressure that is acting on spool (15) becomes greater than the force of spring (14). Spool (15) overrides spring (14) and the spool moves up. As cutoff spool (15) moves up, oil flows around spool (15). The oil will flow through pilot passage (21). This flow of oil will extend piston (9). The angle of swashplate (2) will be decreased and will cause the pump to maintain the cutoff pressure.

i04047457

Control Manifold (Brake, Hydraulic Fan)

SMCS Code: 5264-HFN; 5264-BRK

The control manifold controls the brake and the hydraulic fan system. The brake system has priority over the hydraulic fan system. The fan system is only used on demand.

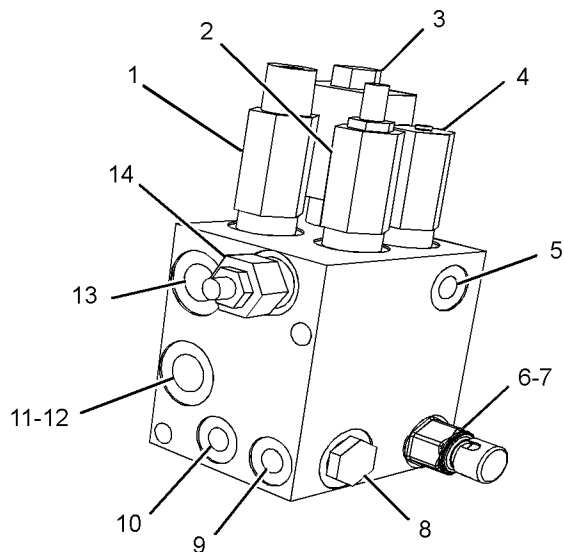


Illustration 24

g01374819

- (1) Priority valve
- (2) Cut in valve
- (3) Fan speed solenoid
- (4) Main relief valve
- (5) Tank return port
- (6) Brake pressure sensor
- (7) Orifice
- (8) Inverse shuttle valve
- (9) Brake accumulator port (left side brakes)
- (10) Brake accumulator port (right side brakes)
- (11) Screen
- (12) Pump supply port
- (13) Supply port for Fan motor
- (14) Cut out valve

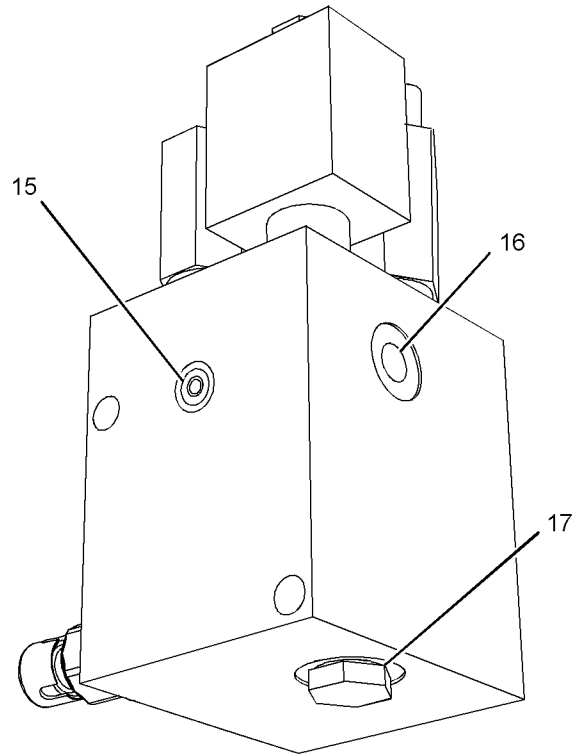


Illustration 25

g01333114

- (15) Shuttle valve
- (16) Load sensing port
- (17) Check valve

Service Brake Operation

Brake Operation Below Cut-In Pressure

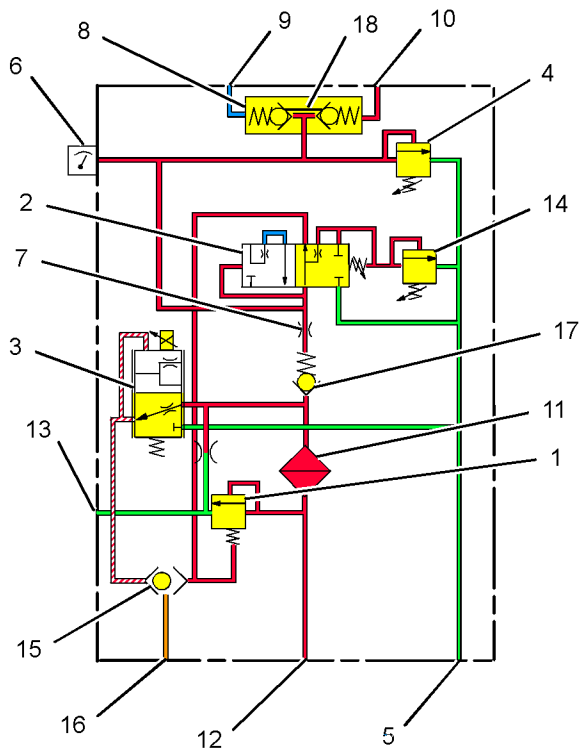


Illustration 26

g01374532

- (1) Priority valve
- (2) Cut in valve
- (3) Fan speed solenoid
- (4) Main relief valve
- (5) Tank return port
- (6) Brake pressure sensor
- (7) Orifice
- (8) Inverse shuttle valve
- (9) Brake accumulator port (left side brakes)
- (10) Brake accumulator port (right side brakes)
- (11) Screen
- (12) Pump supply port
- (13) Supply port for fan motor
- (14) Cut out valve
- (15) Shuttle valve
- (16) Load sensing port
- (17) Check valve
- (18) Rod

The cut in valve (2) controls the minimum pressure of the braking system. When the service brake pressure is below the cut in pressure, the cut in valve (2) allows pressurized oil to flow to shuttle valve (15). Shuttle valve (15) shifts to the left and shuttle valve (15) allows the pressurized oil to exit the load sensing port (16). This process will upstroke the pump. Pressurized oil and spring pressure hold the priority valve (1) closed. Maximum pump flow is directed to the brake section of the control manifold in order to satisfy the demand of the brake system. The excess flow that is not used by the brakes is diverted to the fan motor.

Pump flow enters the control manifold through the pump supply port (12). Pump flow goes through the following components: screen (11), check valve (17) and orifice (7). Pump flow goes to the inverse shuttle valve (8). The inverse shuttle valve (8) senses the brake accumulator port (9) or (10) that has the highest pressure. The accumulator port with the highest pressure seats the check valve. Rod (18) opens the check valve that has the lowest accumulator pressure. The brake accumulator can be charged with the check valve in the open position. Brake pressure sensor (6) senses pressure in the brake accumulators. When the pressure is low, the sensor activates a warning lamp on the monitoring system.

Brake Operation at Cut Out Pressure

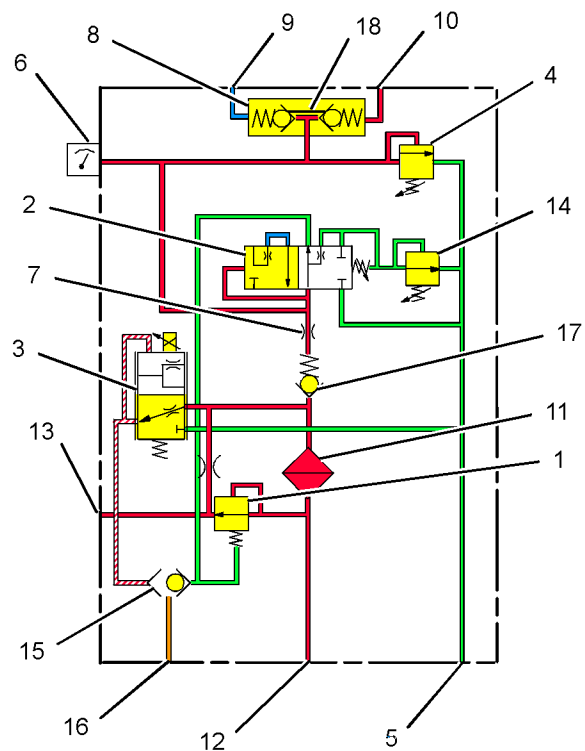


Illustration 27

g01374548

- (1) Priority valve
- (2) Cut in valve
- (3) Fan speed solenoid
- (4) Main relief valve
- (5) Tank return port
- (6) Brake pressure sensor
- (7) Orifice
- (8) Inverse shuttle valve
- (9) Brake accumulator port (left side brakes)
- (10) Brake accumulator port (right side brakes)
- (11) Screen
- (12) Pump supply port
- (13) Supply port for fan motor
- (14) Cut out valve
- (15) Shuttle valve
- (16) Load sensing port
- (17) Check valve
- (18) Rod

When brake system pressure reaches the cut out pressure, cut out valve (14) opens. Cut out valve (14) drains the spring side of cut in valve (2) to the tank return port (5). System pressure overcomes the spring pressure on the cut in valve (2). The cut in valve (2) shifts to the right. When the cut in valve (2) shifts to the right, pressurized oil from the right side of shuttle valve (15) and the spring side of the priority valve (1) is metered to the tank return port (5). System pressure overcomes the spring pressure on priority valve (1). Priority valve (1) opens and the priority valve allows pump flow to the fan system. At the same time, shuttle valve (15) shifts to the right. This allows the pump to sense the pressure requirements of the fan system. Check valve (17) closes and the check valve maintains brake system pressure.

Operation of the Hydraulic Fan System

Operation at the Brake Cut In Pressure

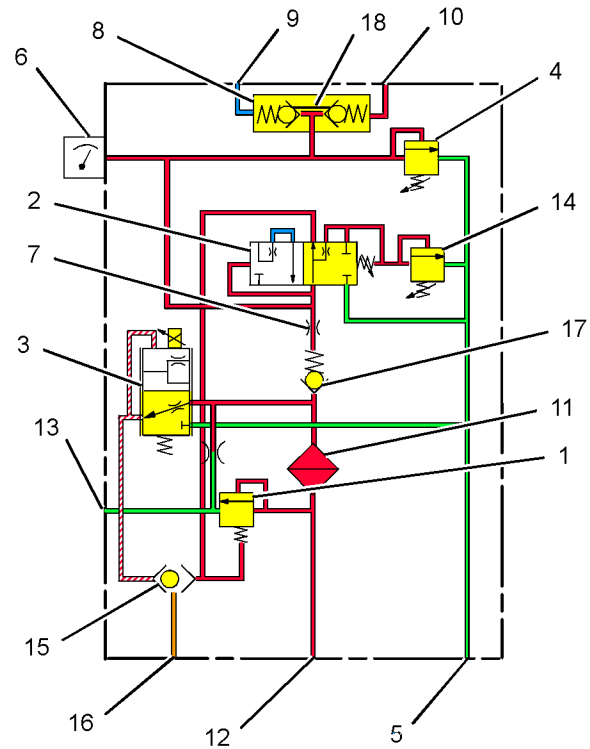


Illustration 28

g01374544

- (1) Priority valve
- (2) Cut in valve
- (3) Fan speed solenoid
- (4) Main relief valve
- (5) Tank return port
- (6) Brake pressure sensor
- (7) Orifice
- (8) Inverse shuttle valve
- (9) Brake accumulator port (left side brakes)
- (10) Brake accumulator port (right side brakes)
- (11) Screen
- (12) Pump supply port
- (13) Supply port for fan motor
- (14) Cut out valve
- (15) Shuttle valve
- (16) Load sensing port
- (17) Check valve
- (18) Rod

When the brake system pressure is below cut in pressure, the brake system receives a higher priority than the fan system. Priority valve (1) is closed. Pump flow to the fan motor is blocked when the priority valve is closed.

Operation with the Fan Speed Solenoid De-Energized

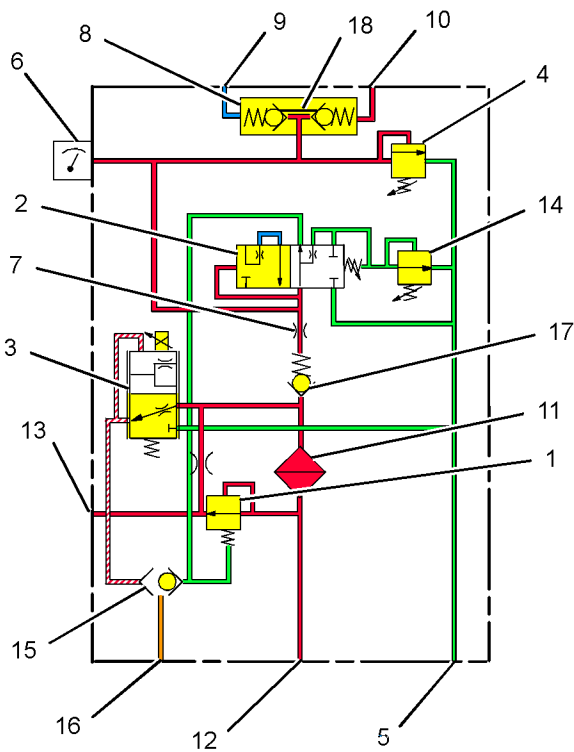


Illustration 29

g01374554

- (1) Priority valve
- (2) Cut in valve
- (3) Fan speed solenoid
- (4) Main relief valve
- (5) Tank return port
- (6) Brake pressure sensor
- (7) Orifice
- (8) Inverse shuttle valve
- (9) Brake accumulator port (left side brakes)
- (10) Brake accumulator port (right side brakes)
- (11) Screen
- (12) Pump supply port
- (13) Supply port for fan motor
- (14) Cut out valve
- (15) Shuttle valve
- (16) Load sensing port
- (17) Check valve
- (18) Rod

The fan system has priority when the brake system pressure is at the cut out pressure. Fan speed solenoid (3) controls the load sensing pressure for the pump when the brake system is fully charged. Fan speed solenoid (3) is a proportional solenoid. As current to the fan speed solenoid increases, the output pressure decreases. When fan speed solenoid (3) is de-energized, the output pressure to the load sensing port is maximum. The pump will be fully stroked and the pump will send maximum flow to the fan motor. Thus, the fan motor is turning at maximum speed.

Pump flow enters the control manifold through port (12). Oil flow from the pump flows through the priority valve (1). The oil flow exits the supply port for the fan motor (13). A small amount of pressurized oil flows through fan speed solenoid (3). Fan speed solenoid (3) is a pressure reducing valve. The solenoid assists in the pressure reducing function. If the fan system pressure is above the pressure reducing pressure of fan speed solenoid (3), then fan speed solenoid (3) shifts in order to meter output pressure to the tank return port (5). The output pressure of the fan speed solenoid is then reduced. Oil that is at a reduced pressure flows to shuttle valve (15). Shuttle valve (15) shifts to the right. Pressurized oil exits through the load sensing port (16) in order to upstroke the pump.

Operation with the Fan Speed Solenoid Energized

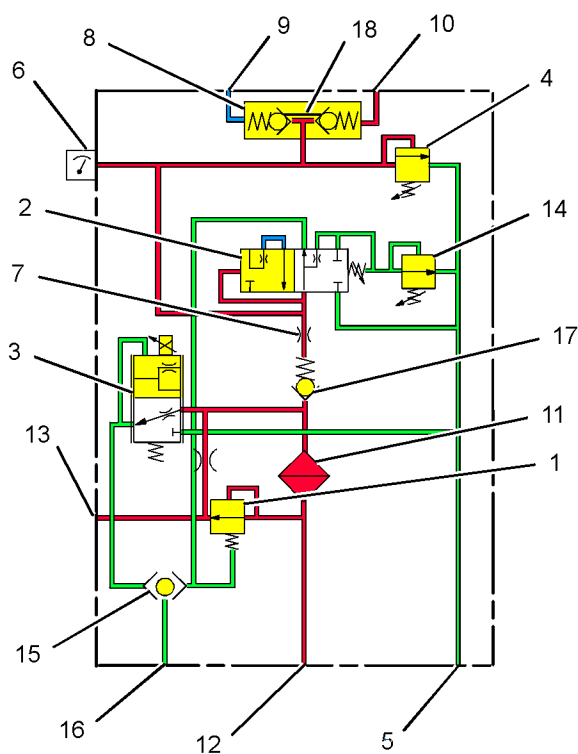


Illustration 30

g01374556

- (1) Priority valve
- (2) Cut in valve
- (3) Fan speed solenoid
- (4) Main relief valve
- (5) Tank return port
- (6) Brake pressure sensor
- (7) Orifice
- (8) Inverse shuttle valve
- (9) Brake accumulator port (left side brakes)
- (10) Brake accumulator port (right side brakes)
- (11) Screen
- (12) Pump supply port
- (13) Supply port for fan motor
- (14) Cut out valve
- (15) Shuttle valve
- (16) Load sensing port
- (17) Check valve
- (18) Rod

The fan system has priority when the brake system pressure is at the cut out pressure. The fan speed solenoid (3) controls the load sensing pressure for the pump when the brake system is fully charged. The fan speed solenoid (3) is a proportional solenoid. As current to the fan speed solenoid increases, the output pressure decreases. When the fan speed solenoid (3) is energized, the output pressure to the load sensing port on the pump is reduced. Thus, the fan motor is turning below maximum speed.

The amount of current that is applied to the fan speed solenoid is controlled by the engine Electronic Control Module (ECM). The engine ECM receives three inputs. The ECM receives the following inputs: hydraulic oil temperature sensor, temperature sensor for the inlet air manifold and engine coolant temperature sensor. If the engine ECM determines that the fan speed should be minimum, then the maximum current is sent to the fan speed solenoid (3). If one of the three sensors shows that there is a demand for more cooling, then the engine ECM will reduce the amount of current to the fan speed solenoid (3). By decreasing the current to the fan speed solenoid, the pump will upstroke in order to provide more cooling capacity.

Pump flow enters the control manifold through port (12). Oil flows through priority valve (1) to the fan motor. A small amount of pressurized oil flows through fan speed solenoid (3). Fan speed solenoid (3) is a pressure reducing valve. The solenoid assists in the pressure reducing function. If the fan system pressure is above the pressure reducing pressure of fan speed solenoid (3), then fan speed solenoid (3) shifts in order to meter output pressure to the tank return port (5). The engine ECM sends current to the fan speed solenoid (3) in order to reduce the output pressure further. The output pressure of the fan speed solenoid is then reduced. Oil that is at a reduced pressure flows to shuttle valve (15). Shuttle valve (15) shifts to the right. Pressurized oil exits through the load sensing port (16). The pressurized oil changes the output of the pump in order to meet system demands.

i04064649

i04035189

Shuttle Valve (Brake, Hydraulic Fan)

SMCS Code: 5079-HFN; 5079-BRK

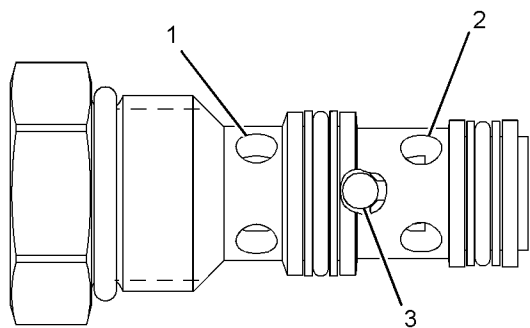


Illustration 31

g02278663

- (1) Passage
- (2) Passage
- (3) Check ball

The shuttle valve sends pressure in order to signal the pump to meet the pressure demand of the hydraulic fan and service brakes. When the service brake pressure is below the cut in pressure, the pressure in passage (2) is greater than the pressure in passage (1). The pressure forces check ball (3) to the left and pressurized oil to exit through passage (1). This signals the pump to upstroke. When the brake system reaches the cut out pressure, the signal pressure for the brake becomes zero. The check ball (3) moves to the right. This movement of the ball allows the pump to sense the requirement for the fan system.

Gear Motor (Hydraulic Fan)

SMCS Code: 1386-GT; 5061-HFN

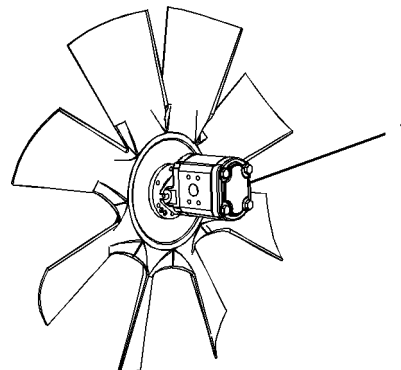


Illustration 32

g01125080

(1) Gear motor (hydraulic fan)

The fan is driven by a gear motor. Oil enters gear motor (1) and that oil causes the internal gears to rotate. The internal gears inside motor (1) are attached to the fan by a shaft. Fan speed depends on the amount of oil that is supplied to the motor (1).

The gear motor (1) has an internal makeup valve. The makeup valve allows the fan to stop gradually when the engine is shut down. When the fan is spinning and there is no supply oil, the makeup valve redirects the oil inside the motor. Oil will flow from the outlet side of the motor to the inlet side of the motor. The makeup valve prevents cavitation of the motor.

If your gear motor is equipped with a case drain, then the excess oil from the case will drain directly back to the hydraulic tank.

i04029490

Oil Cooler (Brake, Hydraulic Fan) (16M)

SMCS Code: 1386-HOC; 4250-HOC

S/N: B9H1-Up

S/N: R9H1-Up

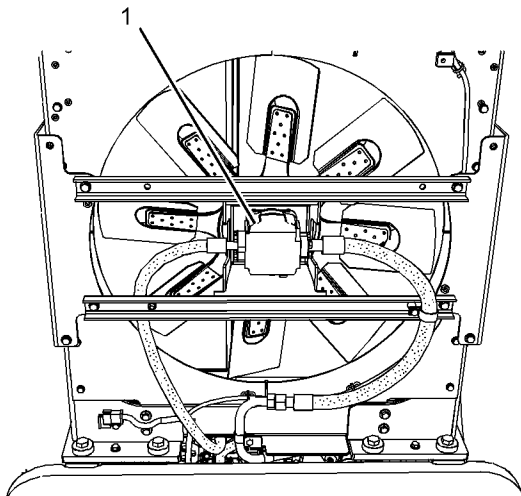


Illustration 33 g02233993

View of the gear motor (hydraulic fan) not equipped with a case drain

(1) Gear motor (hydraulic fan)

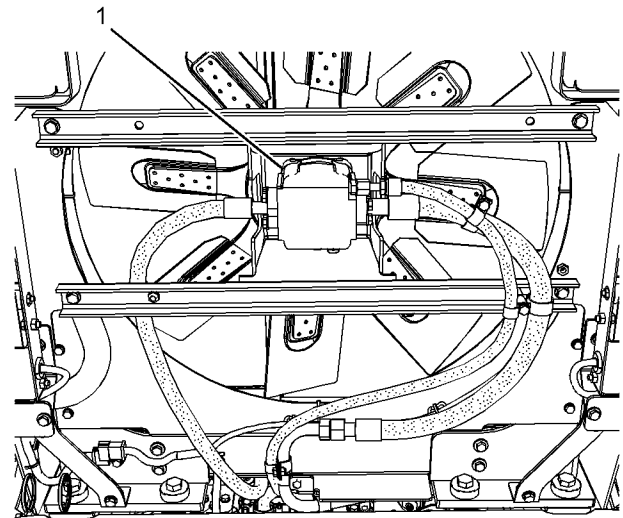


Illustration 34 g02215615

View of the gear motor (hydraulic fan) equipped with a case drain

(1) Gear motor (hydraulic fan)

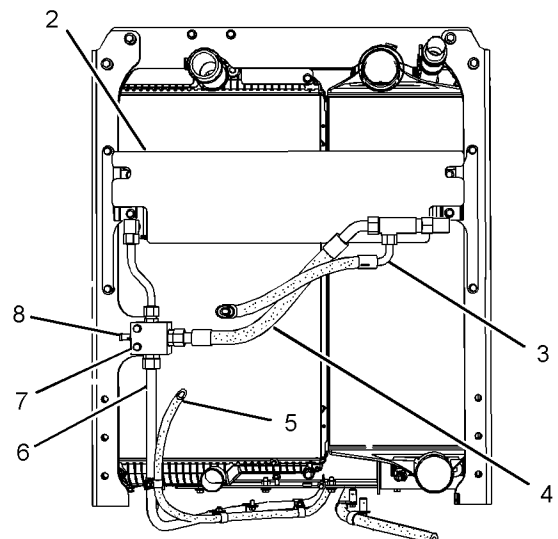


Illustration 35 g02216833

View of the front of the radiator

- (2) Oil cooler
- (3) Exit for oil to return to tank
- (4) By-pass hose
- (5) Case drain for the gear motor (hydraulic fan) (if equipped)
- (6) Inlet from gear motor (hydraulic fan)
- (7) Cooler bypass valve
- (8) Temperature sensor

i04328337

Oil from the gear motor (hydraulic fan) (1) enters the cooler system at tube (6). Oil flows from hose (3) through the return filter and into the hydraulic tank. Bypass valve (7) will open when the oil flow becomes too restrictive. Bypass valve (7) will direct oil around the cooler through hose (4). Hose (4) will then direct flow through hose (3) to the filter and the hydraulic tank. Excess oil from the motor will return directly to the hydraulic tank through the case drain hose (5).

Temperature sensor (8) sends a voltage signal to the engine Electronic Control Module (ECM). The engine ECM calculates the oil temperature by comparing the voltage signal to a predetermined set of values.

Some machines are equipped with a case drain (5) for the gear motor (hydraulic fan). The excess oil from the gear motor will return directly to the hydraulic tank through the case drain hose (5).

Oil Cooler (Brake, Hydraulic Fan) (14M)

SMCS Code: 1386-HOC; 4250-HOC

S/N: B9J1–Up

S/N: R9J1–Up

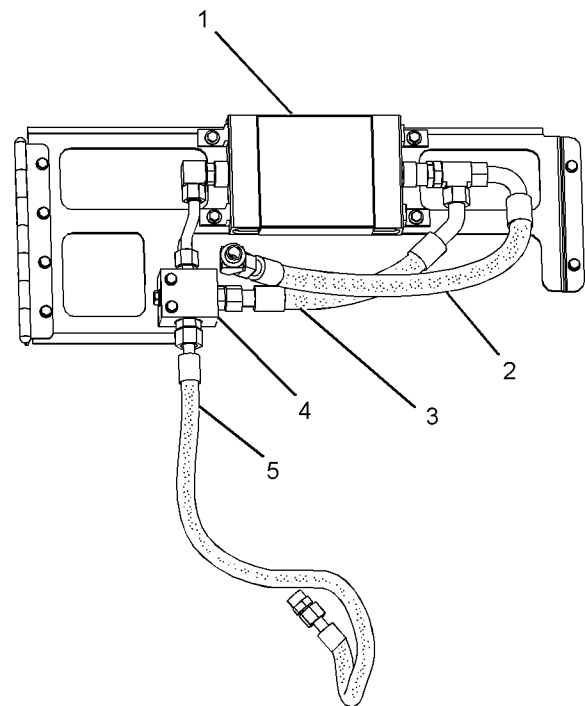


Illustration 36

g02217124

View of the front of the radiator

- (1) Oil cooler
- (2) Exit for oil to return to tank
- (3) Cooler bypass hose
- (4) Cooler bypass valve
- (5) Inlet from hydraulic fan

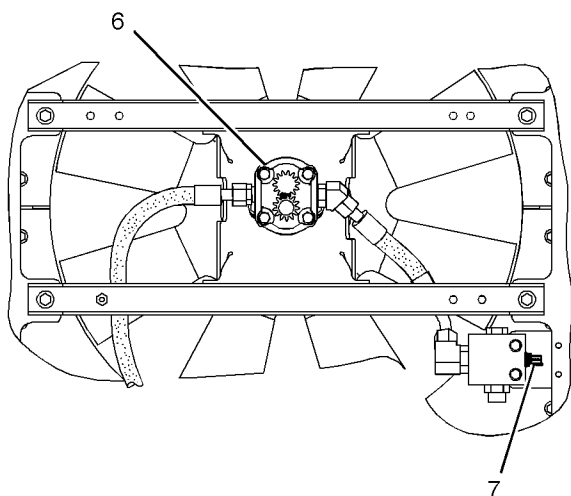


Illustration 37

g02217134

View of the rear of machine

- (6) Gear motor (hydraulic fan) not equipped with a case drain
 (7) Temperature sensor

Oil from the gear motor (hydraulic fan) (6) enters the cooler system at hose (5). Oil flows from hose (2) through the return filter and into the hydraulic tank. Bypass valve (4) will open when the oil flow becomes too restrictive. Bypass valve (4) will direct oil around the cooler through hose (3). Hose (3) will then direct flow through hose (2) to the filter and the hydraulic tank.

Temperature sensor (7) sends a voltage signal to the engine Electronic Control Module (ECM). The engine ECM calculates the oil temperature by comparing the voltage signal to a predetermined set of values.

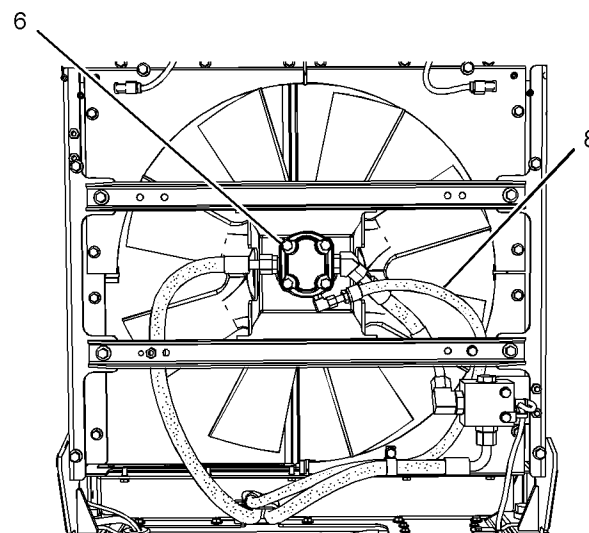


Illustration 38

g02226973

- (6) Gear motor (hydraulic fan) equipped with case drain (8)

Some machines are equipped with a case drain (8) for the gear motor (hydraulic fan). The excess oil from the gear motor will return directly to the hydraulic tank through the case drain hose.

i02654780

Brake Accumulator

SMCS Code: 4263

S/N: B9J1-Up

S/N: R9J1-Up

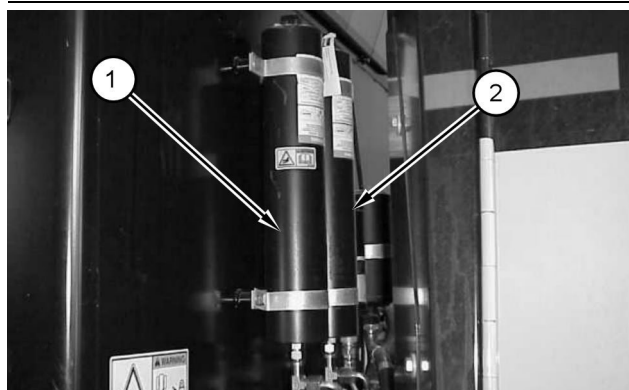


Illustration 39

g01109080

Location of the Brake Accumulators for the Service Brakes

- (1) Left brake accumulator
- (2) Right brake accumulator

The accumulators for both the left and the right service brakes are located between the cab and the rear enclosure of the machine. Both accumulators are in a vertical position.

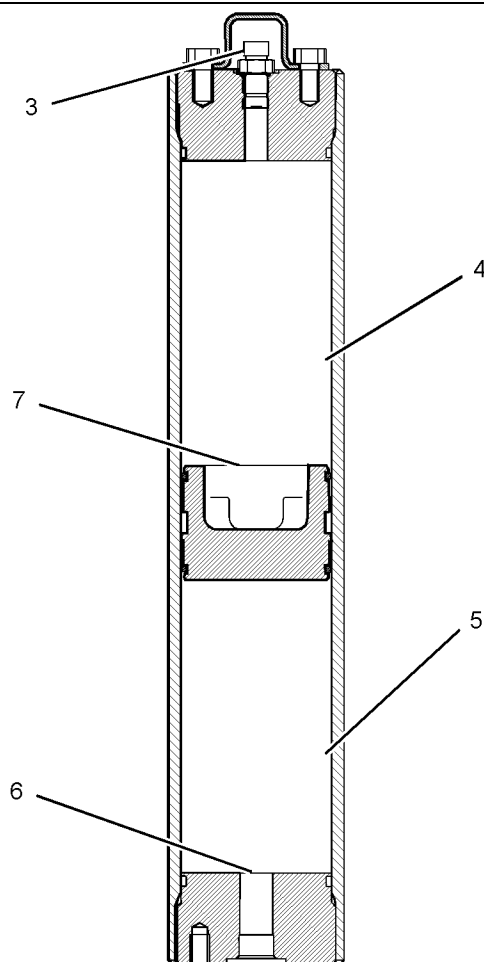


Illustration 40

g01333233

- (3) Nitrogen charging valve
- (4) Chamber for the nitrogen gas
- (5) Pressure oil chamber
- (6) Outlet to the service brake control valve
- (7) Piston

The two accumulators for the service brakes contain piston (7), which is sealed. The piston moves back and forth inside the bore of each accumulator. The chamber is charged to the proper precharge pressure through nitrogen charging valve (3).

Reference: Refer to The Testing and Adjusting Section for charging information.

Oil from the accumulator charging valve flows through outlet (6). The oil then enters pressure oil chamber (5). The oil then pushes piston (7). This causes the dry nitrogen gas to compress. When the pressure in the brake system reaches the cut out pressure, the supply of oil is stopped by the cut out valve.

When a brake pedal is depressed, oil from chamber (5) flows outward through outlet (6). This oil flows to the service brake control valve and the oil then applies the service brakes.

i02659653

Brake Accumulator

SMCS Code: 4263

S/N: B9H1-Up

S/N: R9H1-Up

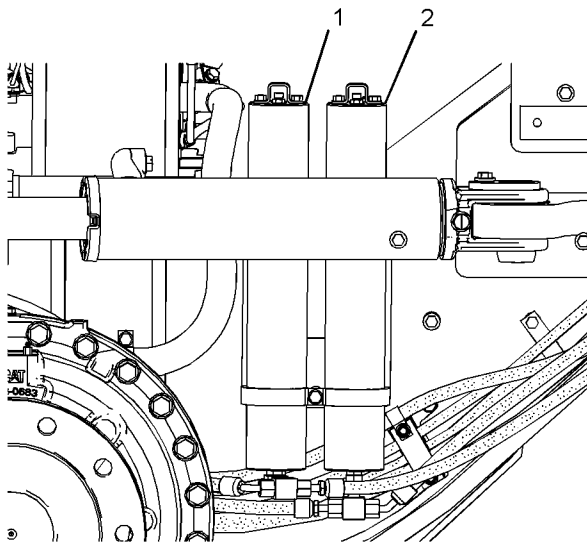


Illustration 41

g01329541

Location of the Brake Accumulators for the Service Brakes

- (1) Right brake accumulator
- (2) Left brake accumulator

The accumulators for both the left and the right service brakes are located on the right side of the frame and under the cab. Both accumulators are in a vertical position.

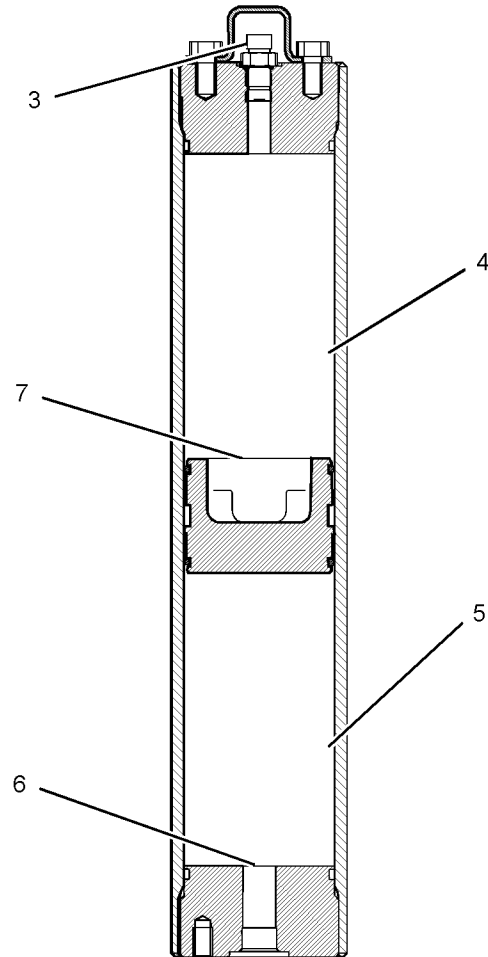


Illustration 42

g01333933

- (3) Nitrogen charging valve
- (4) Chamber for the nitrogen gas
- (5) Pressure oil chamber
- (6) Outlet to the service brake control valve
- (7) Piston

The two accumulators for the service brakes contain piston (7), which is sealed. The piston moves up and down inside the bore of each accumulator. The chamber is charged to the proper precharge pressure through nitrogen charging valve (3).

Reference: Refer to The Testing and Adjusting Section for charging information.

Oil from the accumulator charging valve flows through outlet (6). The oil then enters pressure oil chamber (5). The oil then pushes piston (7). This causes the dry nitrogen gas to compress. When the pressure in the brake system reaches the cut out pressure, the supply of oil is stopped by the cut out valve.

When a brake pedal is depressed, oil from chamber (5) flows outward through outlet (6). This oil flows to the service brake control valve and the oil then applies the service brakes.

i02431331

Shuttle Valve (Brake Accumulator)

SMCS Code: 4289-ZJ

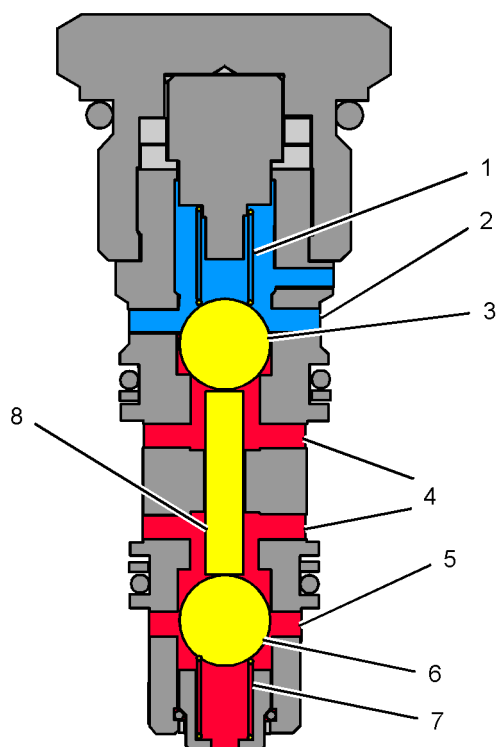


Illustration 43

g01109104

- (1) Spring
- (2) Passage
- (3) Check ball
- (4) Passage
- (5) Passage
- (6) Check ball
- (7) Spring
- (8) Rod

The inverse shuttle valve is used to charge the two brake accumulators. The check ball with highest accumulator pressure is closed. The check ball with the highest pressure pushes rod (8). Rod (8) opens the check valve with the lowest accumulator pressure.

Accumulator pressure acts on the back side of check ball (3) and check ball (6). The accumulator pressure enters the inverse shuttle valve through passage (2) and passage (5). Pressurized oil from the brake pump acts on the inner surface of ball (3) and ball (6). When the service brakes are applied, accumulator pressure drops. The brake accumulator with the highest pressure holds the check ball (3) closed. Rod (8) moves check ball (6) to the OPEN position. Pressurized oil from the brake pump exits the valve through passage (5). Pressurized oil from the brake pump charges the brake accumulator with the lower pressure until the two brake accumulators have the same pressure or the pressure in the opposite brake accumulator drops.

i02776460

Brake Control Valve (Service)

SMCS Code: 4265

The brake control valve (service) (2) controls the flow of pressurized oil. When the service brake pedal (1) is depressed, the rod (3) actuates the service brake control valve. The position of the brake pedal causes a specific pressure at the service brakes. As the position of the pedal changes, the pressure at the service brake also changes.

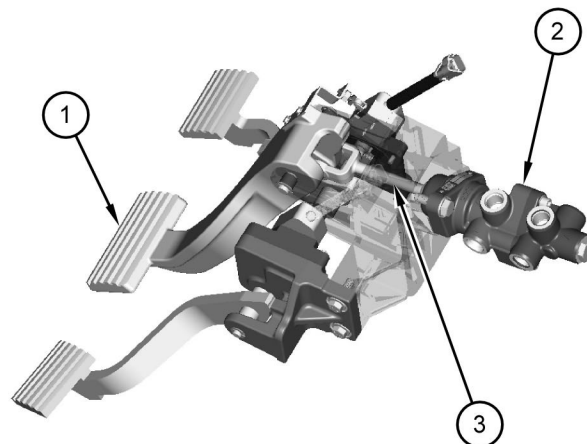


Illustration 44

g01333260

- (1) Service brake pedal
- (2) Brake control valve
- (3) Rod

Disengaged Position

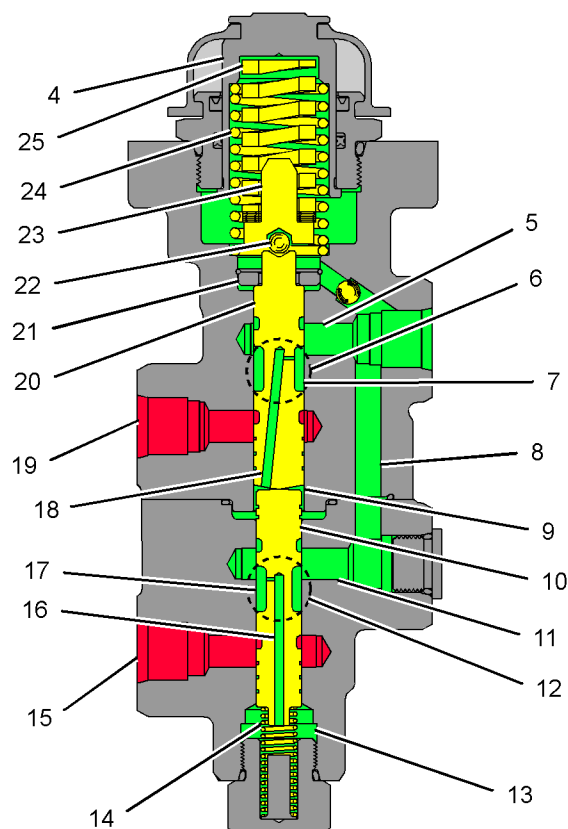


Illustration 45

g01333272

View from bottom of the machine

Service brake pedal in the DISENGAGED position

- | | | |
|-----------------------------------|-------------------------------------|------------------------|
| (4) Piston | (12) Outlet to right service brakes | (20) Upper valve spool |
| (5) Tank port | (13) Cavity | (21) Spacer |
| (6) Outlet to left service brakes | (14) Spring | (22) Ball |
| (7) Passage | (15) Supply for the right brakes | (23) Retainer |
| (8) Drain port | (16) Lower valve spool passage | (24) Spring |
| (9) Cavity | (17) Passage | (25) Spring |
| (10) Lower valve spool | (18) Upper valve spool passage | |
| (11) Tank port | (19) Supply for the left brakes | |

When the service brake pedal is in the disengaged position, the right and the left service brakes are drained to the tank. Oil flows from the service brakes through outlets (6) and (12). The oil flows through passages (7) and (17) into the tank return ports (5) and (11).

Partially Engaged Position

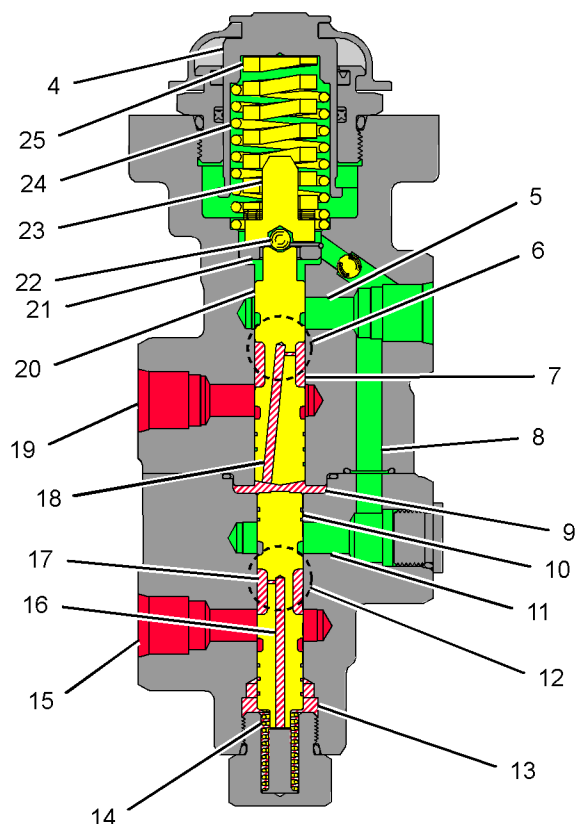


Illustration 46

g01333294

View from bottom of the machine

Service brake pedal in the PARTIALLY ENGAGED position

- | | | |
|-----------------------------------|-------------------------------------|------------------------|
| (4) Piston | (12) Outlet to right service brakes | (20) Upper valve spool |
| (5) Tank port | (13) Cavity | (21) Spacer |
| (6) Outlet to left service brakes | (14) Spring | (22) Ball |
| (7) Passage | (15) Supply for the right brakes | (23) Retainer |
| (8) Drain port | (16) Lower valve spool passage | (24) Spring |
| (9) Cavity | (17) Passage | (25) Spring |
| (10) Lower valve spool | (18) Upper valve spool passage | |
| (11) Tank port | (19) Supply for the left brakes | |

When the brake pedal is depressed, the rod on the pedal assembly pushes piston (4) downward. Piston (4) applies a force on springs (25) and (24). The force of springs (25) and (24) moves retainer (23) and ball (22). Movement of retainer (23) and ball (22) causes upper valve spool (20) to move away from the seat in spacer (21).

The movement of upper valve spool (20) causes the movement of lower valve spool (10) and the compression of spring (14). When valve spools (20) and (10) move, oil flow through passages (7) and (9) to tank return ports (5) and (11) is blocked.

This allows pressurized oil from the supply ports (19) and (15) to flow through passages (7), (18), (17) and (16). The oil then flows through passages (6) and (12) in order to engage the service brakes. At the same time, pressurized oil flows through passages (18) and (16) and into cavities (9) and (13). The oil pressure at the service brakes has the same pressure as the oil in cavities (9) and (13).

Oil pressure in cavity (13) and the force of spring (14) act to balance lower valve spool (10) against the force of the pressure in cavity (9). In the same manner, pressure in cavity (9) creates a force against the bottom of upper valve spool (20). The upper valve spool is balanced by the force of spring (25) at the top of spool (20).

The force of springs (25), (24) and (14) is balanced by the force that is applied to the pedal. Upward movement of valve spools (20) and (10) causes the supply ports (19) and (15) to be covered. The level of pressure in the valve sections (20) and (19) create a feedback force. The feedback force from the valve spools allows the operator to feel the amount of pressure that is applied to the service brakes.

Valve spools (20) and (10) balance between the tank ports and the ports for the service brakes. This is done in order to maintain the brake pressure until the position of the pedal changes. A change in the pedal position means that more brake pressure or less brake pressure is necessary.

If piston (4) is moved downward in order to apply more compression on springs (25) and (24), valve spools (20) and (10) will move. The valve spools move in order to allow more pressure oil to flow to outlets (6) and (12) to the service brakes. This results in a higher oil pressure in cavities (9) and (13). A higher oil pressure is necessary in order to maintain the balance of valve spools (20) and (10).

Fully Engaged Position

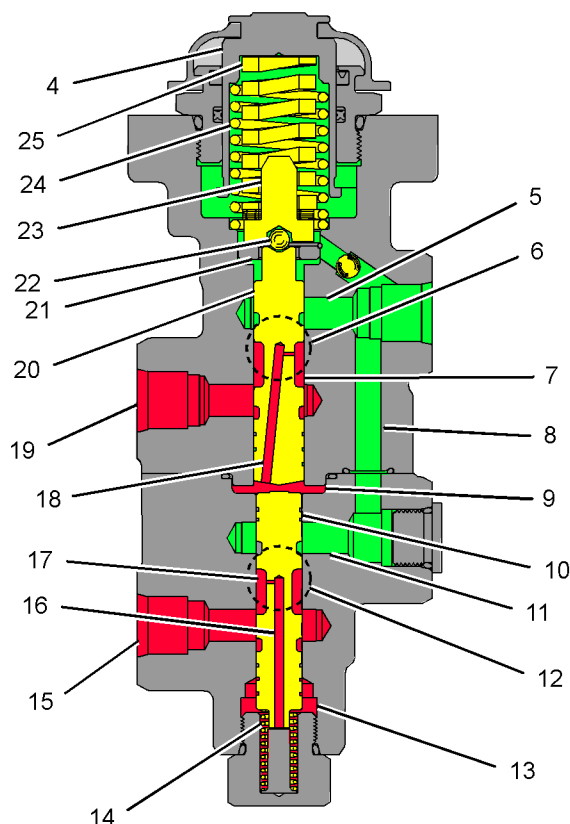


Illustration 47

g01333318

View from bottom of the machine

Service brake pedal in the FULLY ENGAGED position

- | | | |
|-----------------------------------|-------------------------------------|------------------------|
| (4) Piston | (12) Outlet to right service brakes | (20) Upper valve spool |
| (5) Tank port | (13) Cavity | (21) Spacer |
| (6) Outlet to left service brakes | (14) Spring | (22) Ball |
| (7) Passage | (15) Supply for the right brakes | (23) Retainer |
| (8) Drain port | (16) Lower valve spool passage | (24) Spring |
| (9) Cavity | (17) Passage | (25) Spring |
| (10) Lower valve spool | (18) Upper valve spool passage | |
| (11) Tank port | (19) Supply for the left brakes | |

When the brake pedal is depressed, the rod on the pedal assembly pushes piston (4) downward. Piston (4) applies a force on springs (25) and (24). The force of springs (25) and (24) moves retainer (23) and ball (22). Movement of retainer (23) and ball (22) causes upper valve spool (20) to move away from the seat in spacer (21).

The movement of upper valve spool (20) causes the movement of lower valve spool (10) and the compression of spring (14). When valve spools (20) and (10) move, oil flow through passages (7) and (17) to tank return ports (5) and (11) is blocked.

This allows pressurized oil from the supply ports (19) and (15) to flow through passages (7), (18), (17) and (16). The oil then flows through passages (6) and (12) in order to engage the service brakes. At the same time, pressurized oil flows through passages (18) and (16) and into cavities (9) and (13). The oil pressure at the service brakes has the same pressure as the oil in cavities (9) and (13).

Oil pressure in cavity (13) and the force of spring (14) act to balance lower valve spool (10) against the force of the pressure in cavity (9). In the same manner, pressure in cavity (9) creates a force against the bottom of upper valve spool (20). The upper valve spool is balanced by the force of spring (25) at the top of spool (20).

The force of springs (25), (24) and (14) is balanced by the force that is applied to the pedal. Upward movement of valve spools (20) and (10) causes the supply ports (19) and (15) to be covered. The level of pressure in the valve spools (20) and (10) create a feedback force. The feedback force allows the operator to feel the amount of pressure that is applied to the service brakes.

Valve spools (20) and (10) balance between the tank ports and the ports for the service brakes. This is done in order to maintain the brake pressure until the position of the pedal changes. A change in the pedal position means that less brake pressure is necessary.

i04029163

Service Brakes

SMCS Code: 4251

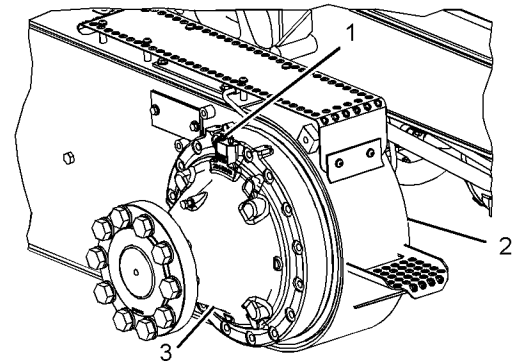


Illustration 48

g01285595

The guard has been removed for clarity.

- (1) Oil inlet port
- (2) Tandem housing
- (3) Wheel spindle housing

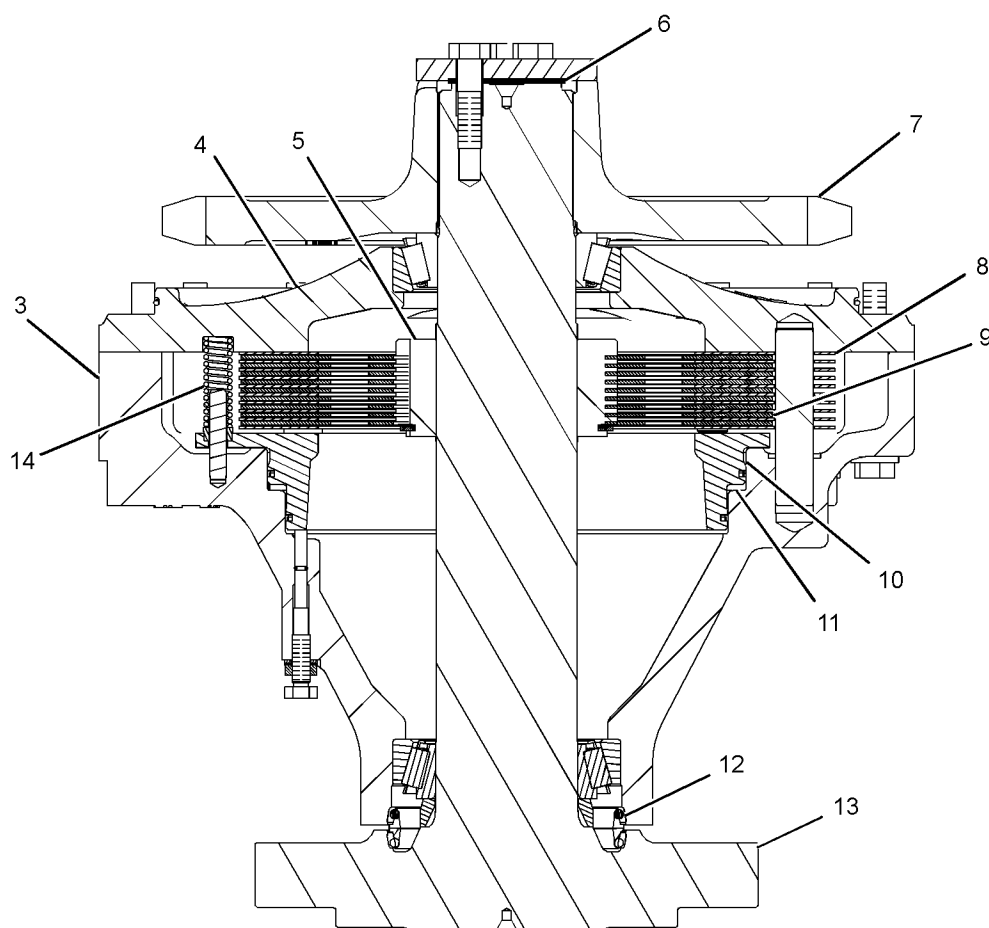


Illustration 49

g01333952

Typical Example Section View

(3) Wheel spindle housing
(4) Cover
(5) Brake hub
(6) Shims

(7) Sprocket
(8) Plates
(9) Brake discs
(10) Piston

(11) Oil compartment
(12) Duo-Cone seal
(13) Wheel spindle
(14) Spring

Power from the differential flows through the drive chain to sprocket (7). Inside wheel spindle housing (3), the sprocket turns wheel spindle (13), brake hub (5), and brake discs (9). The drive wheels are connected to the wheel spindle.

Plates (8) are held in the stationary position by dowels located in the wheel spindle housing (3). Brake discs (9) are splined onto brake hub (5). The brake hub is splined onto wheel spindle (13).

The four disc type brakes are used for the service brake system. There is one disc type brake in each wheel spindle housing (3). The brakes are cooled through the oil in tandem housing (2). The service brakes are activated by pressurized oil from the brake control valve. There is a Duo-Cone seal (12) that is located between the wheel spindle (13) and the wheel spindle housing (3). The Duo-Cone seal will seal in the oil. The Duo-Cone seal will also keep out the dirt, the water, and the other contaminants.



Illustration 50

g01334696

(15) Brake warning lamp

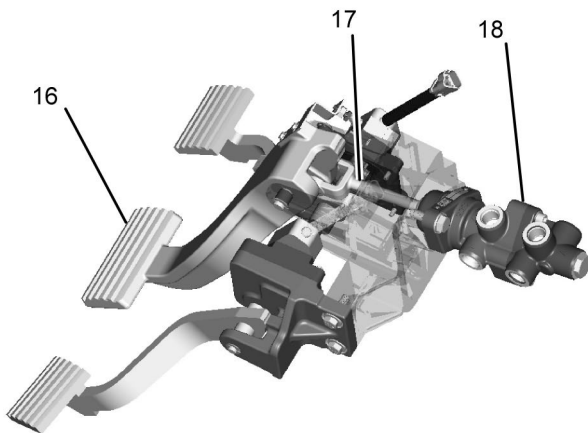


Illustration 51

g01334699

(16) Service brake pedal

(17) Rod

(18) Brake control valve

The braking and the hydraulic fan pump sends oil to the control manifold. The control manifold contains valves that control the pressure in the brake system. The control manifold contains a pressure sensor that sends an electronic signal to the monitoring system. When the brake pressure is low, the monitoring system turns on a brake warning lamp (15).

When you depress the service brake pedal (16), a rod (17) actuates brake control valve (18). Then, the brake control valve (18) for the service brakes will send pressurized oil from the brake accumulators to the service brakes. The position of the pedal regulates the amount of oil pressure to the brakes.

Pressurized oil flows through oil inlet port (1) into oil compartment (11). Oil then moves piston (10) against plates (8) and brake discs (9). The piston pushes the discs against wheel spindle housing (3). As oil pressure increases, the piston is forced against the discs. This movement of the piston will cause friction between the discs. As the friction increases, the brake discs (9), brake hub (5), and wheel spindle (13) will start to slow down. This slowing of motion is caused by plates (8) and wheel spindle housing (3) not being able to turn. The brakes are in BRAKE ON position, but the brakes are not fully engaged.

If the operator continues to depress the pedal downward, oil pressure will increase in oil compartment (11). The friction between the discs will then become great enough to stop the brake discs (9), the brake hub (5), and the wheel spindle (13). Oil pressure is held in the brakes in order to keep the brakes in the BRAKE ON position.

When the operator releases the pedal, oil pressure in oil compartment (11) is released through oil inlet port (1) to the brake control valve (18). Then, springs (14) force piston (10) back to the BRAKE OFF position. Brake discs (9) are again free to turn between plates (8).

Compensator

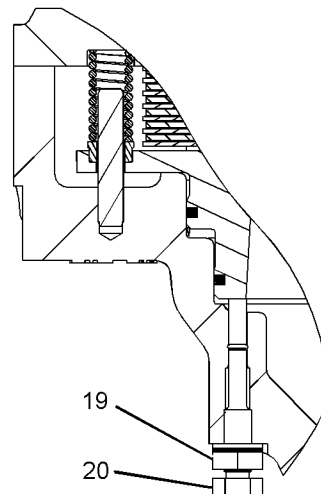


Illustration 52

g01370646

Cut away of a service brake

Compensator (20) serves two functions. Compensator (20) will compensate for brake wear by limiting the retract position of piston (10). Compensator (20) will also indicate the proper replacement interval for the brake. When compensator (20) bottoms out on nut (19), brake discs (9) are at the allowable minimum thickness and brake discs (9) need replacement. The compensation is accomplished by adjusting compensator (20) to a depth that will allow piston (10) to retract only a given distance. When compensator (20) is properly adjusted, piston (10) will retract against compensator (20). Piston (10) will stroke a shorter distance as brake discs (9) continue to wear.

Reference: Refer to the Testing and Adjusting , “Service Brake - Test (14M)”, and Testing and Adjusting , “Service Brake - Test (16M)” for additional information concerning the Compensator.

Hydraulic Oil Additive

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

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

i02566254

Parking Brake System

SMCS Code: 4267

Refer to the Power Train Systems Operation/Testing and Adjusting for information regarding the parking brake and parking brake components for your machine.

i04029157

Monitoring System

SMCS Code: 7400; 7402; 7450; 7451

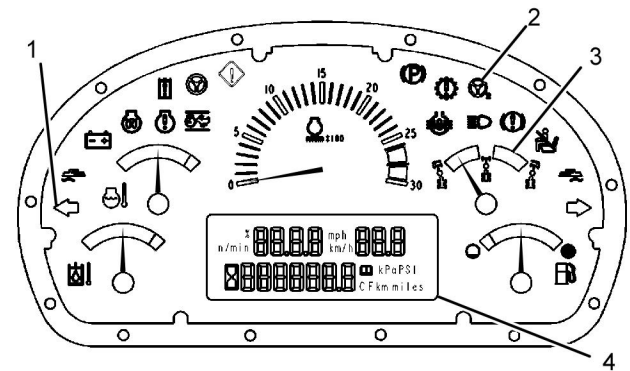


Illustration 53

g01333416

Dash

The Caterpillar Monitoring System includes the following components.

- (1) Indicator lamps
- (2) Indicator lamps
- (3) Gauges
- (4) Digital display windows

Also, the monitoring system includes an action alarm that is not shown.

The monitoring system is designed to alert the operator of a problem in one or more of the machine systems that are covered. The EMS-III module includes individual alert indicators for each machine system. The action lamp and individual alert indicators will light when a problem occurs. Also, the action alarm will sound when certain problems occur.

The monitoring system will perform a self test when the key start switch is turned from the OFF position to the ON position. This test verifies that the main display module and the display modules are operating properly. Refer to Service Manual, RENR9034, “Caterpillar Monitoring System” for more information.

Indicators

The main display module includes 16 alert indicator lamps (2) and two signal indicator lamps (1). The alert indicator lamps monitor machine systems of the motor grader. The main display module also contains one digital display window (4). Digital display window (4) will display important numeric readouts for different machine systems, and the machine's speed.

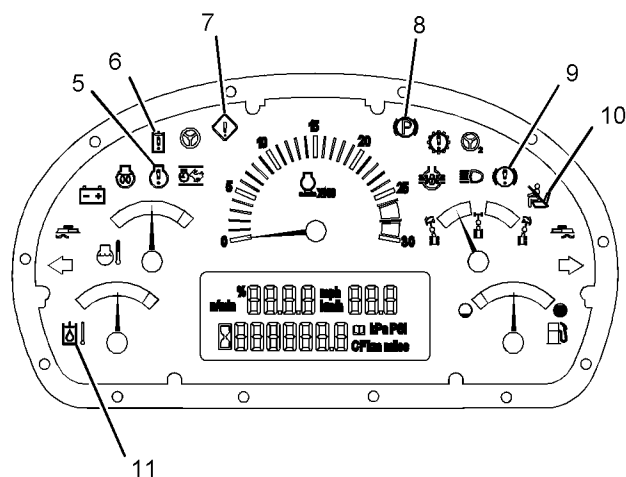


Illustration 54

g01313478

Dash

Warning Category 1

In this category, only the alert indicator comes on. This category alerts the operator that the machine system needs attention. The following alert indicators can be illuminated with Warning Category 1:

- Engine system (5)
- Implement system (6)
- Parking brake (8)
- Brake system (9)
- Hydraulic oil temperature (11)

Warning Category 2

In this category, the alert indicator and action light (7) comes on. This category requires a change in machine operation in order to reduce excessive temperature in one or more of the machine systems.

In this category, only the alert indicator comes on. This category alerts the operator that the machine system needs attention. The following alert indicator can be illuminated with Warning Category 2:

- The operator is not present indicator (10).

Warning Category 3

In this category, the alert indicator and the action light come on and the action alarm sounds. This category requires immediate shutdown of the machine in order to prevent injury or death. This category requires immediate shutdown of the machine in order to prevent severe damage to the machine. The following alert indicators can be illuminated with Warning Category 3:

- Engine system (5)
- Implement system (6)
- Parking brake (8)
- Brake system (9)

Note: Stop the machine immediately if all of the following conditions occur:

- The alert indicator turns on.
- The action light (7) turns on.
- The action alarm sounds.

Engage the parking brake and stop the engine. Investigate the cause of the problem.

Do not operate the machine until the cause of the problem has been corrected.

Gauges

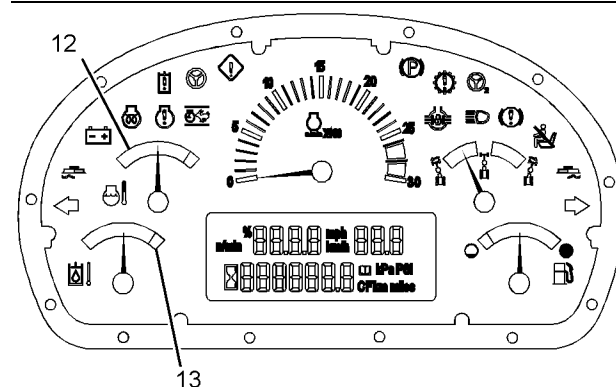


Illustration 55

g01313635

Dash

The engine coolant temperature is shown on gauge (12). The gauge receives a signal from the engine coolant temperature sensor (18). The hydraulic oil temperature is shown on gauge (13). The gauge receives a signal from the hydraulic oil temperature sensor (15).

Location of Solenoids, Switches, and Sensors

Solenoids, switches, and sensors are monitored by the monitoring system. This section shows the locations of the solenoids, switches, and sensors that are part of the braking and the hydraulic fan system.

Note: Refer to the Power Train Systems Operation/ Testing and Adjusting for information regarding the parking brake and parking brake components for your machine.

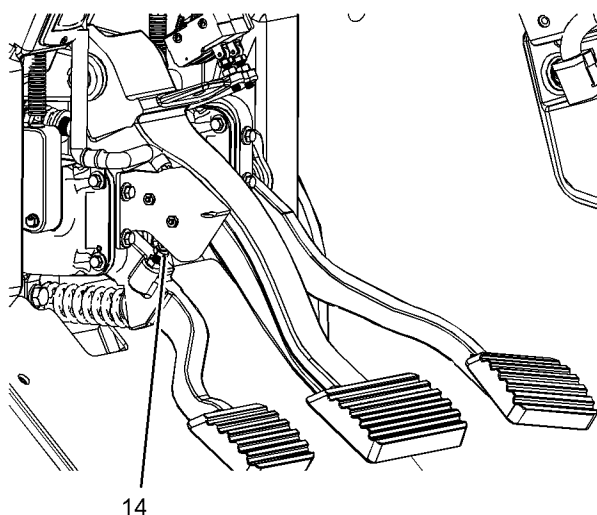


Illustration 56

g01287119

(14) Limit switch for the brake pedal

Limit switch (14) for the brake pedal is used to turn on the brake lights when the brake pedal is depressed.

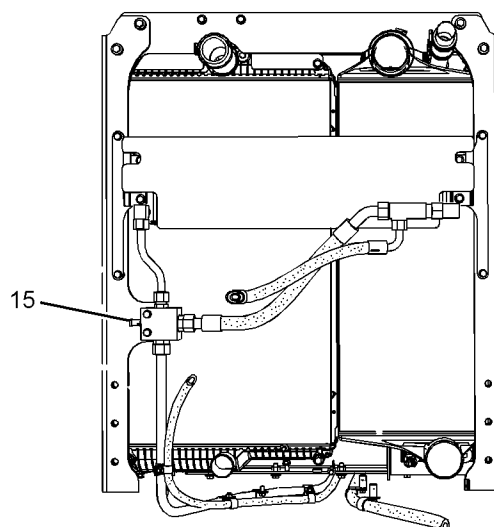


Illustration 57

g02228174

View of hydraulic oil temperature sensor (15) on the 16M

This gear motor (hydraulic fan) is equipped with a case drain.

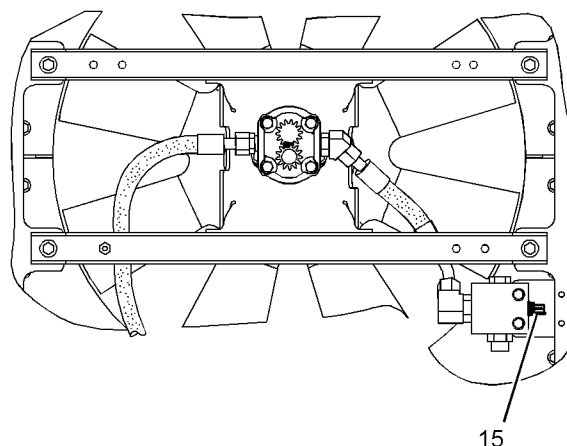


Illustration 58

g01292799

View of the rear side of the radiator on a 14M

This gear motor (hydraulic fan) is not equipped with a case drain.

(15) Hydraulic oil temperature sensor

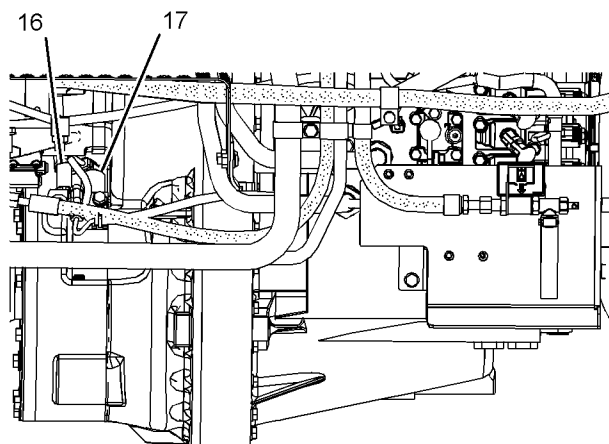


Illustration 59

g01295888

View from the left rear of machine

- (16) Pressure sensor
(17) Parking brake solenoid

The hydraulic oil temperature sensor (15) sends a signal to the engine Electronic Control Module (ECM). This signal controls the speed of the hydraulic fan. The pressure sensor (16) for the parking brake sends a signal that turns on the parking brake indicator (6). The parking brake solenoid (17) controls the flow of oil to the parking brake.

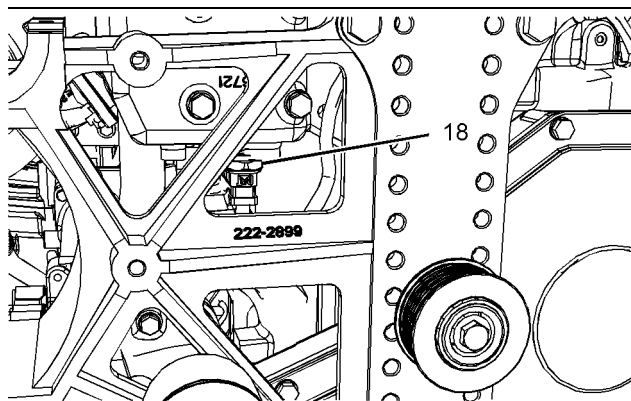


Illustration 60

g01112213

View from the front of the engine

- (18) Coolant temperature sensor

The engine coolant temperature sensor (18) sends a signal to the engine ECM in order to control the speed of the hydraulic fan.

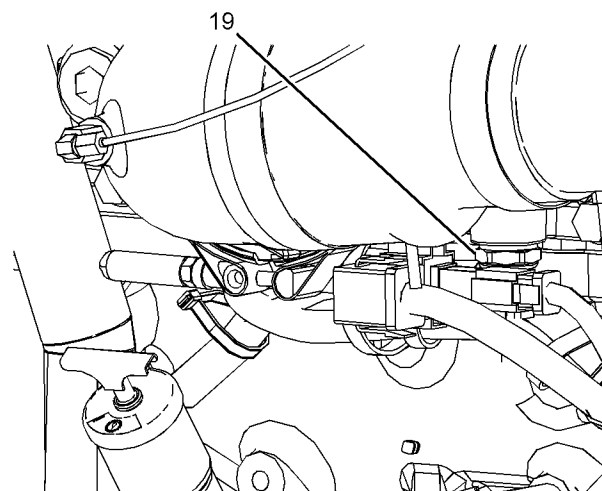


Illustration 61

g01295785

View of the left side of machine

- (19) Inlet air temperature sensor

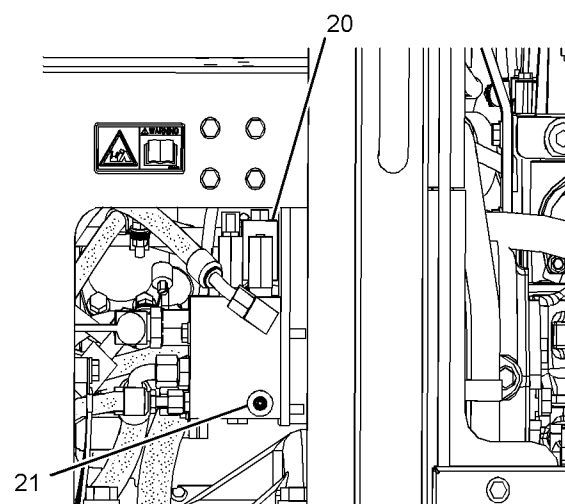


Illustration 62

g01295791

View of the right rear of the machine

- (20) Fan speed solenoid
(21) Pressure sensor for the brake accumulators

The inlet air temperature sensor (19) sends a signal to the engine ECM in order to control the speed of the hydraulic fan. The fan speed solenoid (20) controls the displacement of the braking and the hydraulic fan pump. The fan speed solenoid (20) receives a signal from the engine ECM. The pressure sensor (21) for the brake accumulators sends a signal that turns on the indicator (7) for the brake system. The indicator for the brake system will illuminate when the brake accumulator pressure is low.

Refer to Operation and Maintenance Manual,
“Monitoring System” for your machine for more

information.

i02742851

Schematics (Brake, Hydraulic Fan)

SMCS Code: 4250-HFN; 4250

Braking and Hydraulic Fan System

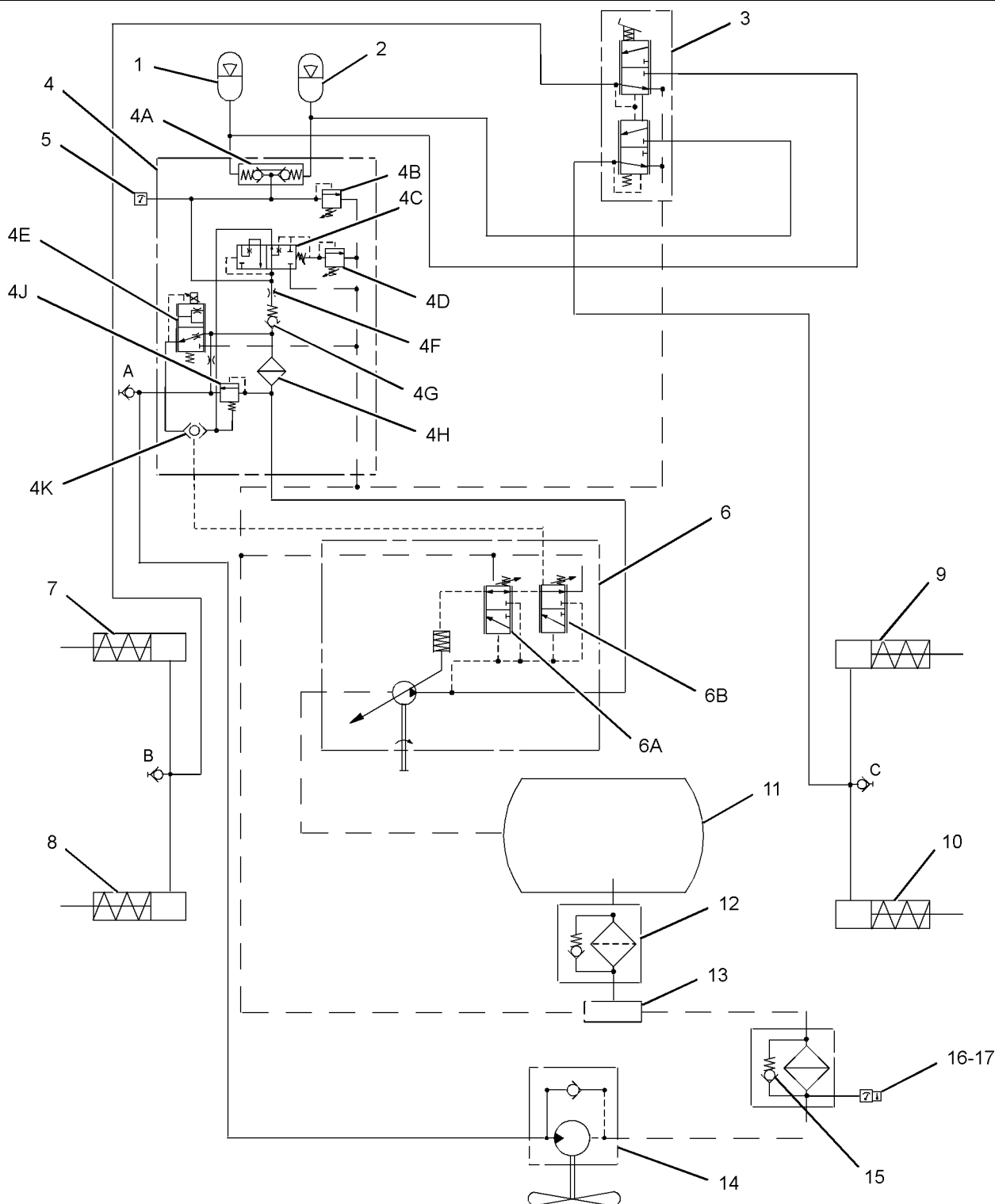


Illustration 63

g01374724

(A) Pressure tap for the hydraulic fan
 (B) Left brake pressure tap
 (C) Right brake pressure tap
 (1) Brake accumulator for the left brakes
 (2) Brake accumulator for the right brakes
 (3) Brake control valve
 (4) Control manifold

(4A) Shuttle valve
 (4B) Main relief valve
 (4C) Diverter valve
 (4D) Relief valve
 (4E) Fan speed solenoid
 (4F) Orifice
 (4G) Check valve

(4H) Screen
 (4J) Priority valve
 (4K) Shuttle valve
 (5) Pressure sensor for the brake accumulators
 (6) Piston pump (brake and fan)
 (6A) Cutoff pressure

(6B) Margin pressure
(7) Service brake (left front)
(8) Service brake (left rear)
(9) Service brake (right front)

(10) Service brake (right rear)
(11) Hydraulic tank
(12) Return filter
(13) Junction block

(14) Fan motor
(15) Oil cooler bypass valve
(16) Pressure sensor for the oil cooler
(17) Temperature sensor for the oil cooler

Parking Brake System

Refer to the Power Train Systems Operation/Testing and Adjusting for information regarding the parking brake and parking brake components for your machine.

Troubleshooting Section

Introduction

i02202212

General Information

SMCS Code: 4250-035; 5050-035-HFN

Visual inspections 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 operational 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.

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

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

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

i02583119

Machine Preparation for Troubleshooting

SMCS Code: 4250-035; 5050-035-HFN

WARNING

Personal injury or death can result from sudden machine movement.

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

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

WARNING

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

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

1. Move the machine to a smooth horizontal location. Move away from operating machines and move away from all personnel. Lower all implements to the ground.
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. Depress the brake pedal repeatedly. This will relieve any pressure that may be present in the brake hydraulic system.

i02583128

Visual Inspection

SMCS Code: 4250-035; 5050-035-HFN

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 braking system, the hydraulic fan system and the different components. Stop the engine and lower the implements to the ground. Move the sideshift cylinder to the right in order to reduce pressure in the hydraulic tank. Also, move the sideshift cylinder to the right in order to reduce the oil level in the hydraulic tank. Make the following inspections:

1. Trace all of the brake lines from the connections on the service brakes to the connections on the service brake control valve. Check the following components for damage and check the following components for leaks:
 - All of the brake lines
 - All of the connections on the components
2. Trace all of the hydraulic lines for the fan drive from the hydraulic fan pump to the hydraulic fan motor. Check the following components for damage and check the following components for leaks:
 - All of the lines for the hydraulic fan drive
 - The brake and the hydraulic fan pump
 - The hydraulic fan motor
 - The control manifold
 - All of the connections on the components
3. Check the control valves for leaks.
4. Check the following components for damage and check the following components for leaks:
 - The brake and the hydraulic fan pump
 - Control manifold
 - The connections on the components
5. Trace the lines from the brake and the hydraulic fan pump to the hydraulic tank. Also, trace the lines from the brake and the hydraulic fan pump to the control manifold. Check the following components for damage and check the following components for leaks:
 - The lines from the brake and the hydraulic fan pump to the hydraulic tank
 - The lines from the brake and the hydraulic fan pump to the control manifold
 - The hydraulic tank
 - The connections on the components
6. Check the hydraulic tank oil level.
7. Immediately after the machine has stopped, use a clean, clear bottle or use a clean, clear container in order to obtain an oil sample from the hydraulic tank. Check for air bubbles in the oil sample.
8. Remove the filter element. 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.
9. Locate the mesh screen that is located in the line to the diverter valve. Remove the mesh screen and check the mesh screen for debris. A magnet will separate ferrous particles from nonferrous particles. Ferrous materials such as piston rings contain iron. Clean the screen and reinstall the screen.

i02583157

Operational Checks (Brake, Hydraulic Fan System)

SMCS Code: 4250-035; 5050-035-HFN

WARNING

Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pin hole leaks.

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

When you diagnose a problem in the braking and hydraulic fan system, a visual inspection of the system is the first step. Before any tests are performed, visually inspect the entire braking and hydraulic fan system for oil leaks and for damaged parts.

Bring the machine to a stop and engage the parking brake. Then lower the implements to the ground and stop the engine. Perform the following inspections:

1. Check the oil level in the sight gauge.
2. Check all oil lines and all connections for damage and for leaks.
3. Inspect the braking and the hydraulic fan pump for damage and inspect the hydraulic fan motor for damage.
4. Start the engine.
5. Use a clear container to obtain a sample of the oil. Look for air bubbles in the oil that is in the container.
6. Ensure that the fan is operating.
7. Raise the implements from the ground.
8. Release the parking brake and activate the service brakes while the machine is moving in both directions. Listen for any unusual noises. Ensure that the brakes stop the machine within an acceptable distance.
9. Lower the implements and stop the engine.

Symptom Procedures

i05692217

Brake and Hydraulic Fan System

SMCS Code: 4250-035; 5050-035-HFN

Troubleshooting the Braking and Hydraulic Fan System

Problem: Fan will not spin, or the fan will spin when machine first turned on but stops spinning shortly thereafter

Probable Causes

- The pump is not being driven. Damage internal to the transmission or damage to the torsional coupling could prevent the pump from spinning. Refer to Troubleshooting, RENR8482, "The transmission will not shift into any gear from the Neutral position" for further troubleshooting.
- The margin pressure setting of the pump is too low. Inadequate margin pressure can cause the priority valve to close. When the priority valve is closed, most oil that flows to the fan motor will be blocked. Adjust the margin to the specified value. Refer to the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) Margin Pressure - Test and Adjust (14M)" and the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) Margin Pressure - Test and Adjust (16M)" to set the margin pressure of the pump.

Problem: Fan spins when machine is cold, but stops when machine gets warm or gets hot

Probable Causes

- The margin pressure setting of the pump is incorrect. The margin pressure can change slightly as the hydraulic oil warms up. Adjust all margin pressure settings with warm oil $62.5^{\circ} \pm 2.5^{\circ}\text{C}$ ($145^{\circ} \pm 5^{\circ}\text{F}$). There is not much allowance in this system between the margin pressure and the priority valve. Therefore the margin pressure setting of the pump must be fairly accurate. Refer to the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) Margin Pressure - Test and Adjust (14M)" and the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) Margin Pressure - Test and Adjust (16M)" to set the margin pressure of the pump.

Problem: Fan spins at or near maximum fan speed when maximum speed is not required

Probable Causes

- The fan speed solenoid failed or the fan speed solenoid is not getting current.
- The brake circuit stuck in constant charging. Refer to section "Problem: When the engine is idling and the brakes are not applied, the brake accumulators seem to drain down. The pump enters the charge cycle at a rate of less than one minute per cycle" for probable causes.
- The high-pressure cutoff setting of the pump is too low. If the high-pressure cutoff setting is below the cutout setting of the charging valve, the brakes will never reach the cutout pressure. The priority valve will never shift flow back to the fan. Adjust high-pressure cutoff to the specified value. Refer to the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) High Pressure Stall - Test and Adjust (14M)" and the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) High Pressure Stall - Test and Adjust (16M)" to set the high-pressure cutoff of the pump.

Problem: The calibration in Caterpillar Electronic Technician (ET) cannot achieve minimum desired fan speed, the lowest fan speed possible is higher than 550 ± 50 rpm

Probable Causes

- The pump margin pressure setting is too high. Cat ET is used to set the actual current value to the fan solenoid in order to achieve the desired fan speed. The margin and the high-pressure cutoff settings need to be properly set to allow Cat ET to achieve the range of desired fan speeds. Refer to the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) Margin Pressure - Test and Adjust (14M)" and the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) Margin Pressure - Test and Adjust (16M)" to set the margin pressure of the pump. Refer to the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) High Pressure Stall - Test and Adjust (14M)" and Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) High Pressure Stall - Test and Adjust (16M)" to set the high-pressure cutoff of the pump. Refer to the Testing and Adjusting, "Hydraulic Fan Speed - Calibrate and Adjust" to set the fan speed.

Problem: Maximum fan speed is not attainable

Probable Causes

- The fan speed solenoid is not operating properly.
- Pump cutoff pressure is too low. Refer to the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) High Pressure Stall - Test and Adjust (14M)" and the Testing and Adjusting, "Piston Pump (Brake, Hydraulic Fan) High Pressure Stall - Test and Adjust (16M)" to set the high-pressure cutoff of the pump.
- The piston pump is damaged or worn.

Problem: Fan makes noise, especially when the brakes are charging

Probable Causes

- The motor is operating incorrectly or the motor is damaged.

Problem: Only get one or two applications of brake pedal between brake valve cut out and brake valve cut in

Probable Causes

- The cut out valve is not set correctly.
- The cut-in valve is not set correctly.
- The pre-charge of the brake accumulator is incorrect. Refer to Testing and Adjusting, "Brake Accumulator (Service) - Test and Charge" for the procedure to set the pre-charge of the brake accumulator.

- The seals on the brake piston have failed.

Problem: When the engine is idling and the brakes are not applied, the brake accumulators seem to drain down. The pump enters the charge cycle at a rate of less than one minute per cycle

Probable Causes

- The cut out valve is not set correctly.
- Check the service brake control valve for leakage. Refer to Testing and Adjusting, "Brake Control Valve (Service) - Check" in order to check the internal leakage of the brake control valve.
- Check for leaks around fan and brake block
- Check for leaks around brake accumulators.

Problem: The wheels rotate, the engine does not stall, and the brake circuit has no leakage during the service brake test

Probable Causes

- The brake linings for the service brakes are worn. Refer Testing and Adjusting, "Brake Disk Wear - Check"
- Piston seals are damaged or broken.

Problem: The service brakes are noisy when stopping the machine

- Hydraulic Oil Additive was not added to the tandems during the refill. Refer to the Operation and Maintenance Manual, "Capacities Refill" or the Operation and Maintenance Manual, "Lubricant Viscosities" for information regarding the addition of this Hydraulic Oil Additive.
- Service brakes are worn or damaged.

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

Refer to the Power Train Systems Operation/Testing and Adjusting for information regarding the parking brake and parking brake components for your machine.

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

Refer to the Power Train Systems Operation/Testing and Adjusting for information regarding the parking brake and parking brake components for your machine.

Testing And Adjusting Section

Testing and Adjusting

i03780370

System Pressure - Release

SMCS Code: 4250-553-PX; 5050-553-PX

Braking and Hydraulic Fan System

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

To relieve the pressure from the braking and hydraulic fan system, turn off the machine. Pump the brakes at least 110 times. Do not assume that all of the pressure is removed from the system because the brake pedal does not have resistance. Remove the pressure when you work on any part of the braking and hydraulic fan system.

i04001001

Piston Pump (Brake, Hydraulic Fan) High Pressure Stall - Test and Adjust (14M)

SMCS Code: 5070-081-HFN; 5070-081-BRK; 5086-025

S/N: B9J1-Up

S/N: R9J1-Up

WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move during test, reduce the engine speed immediately and engage the parking brake.

WARNING

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

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

Introduction

This procedure will test the setting of the cut out pressure of the piston pump against a dead head load.

NOTICE

During this test procedure operation of the engine for more than 1 minute durations can damage the pump.

Required Tools

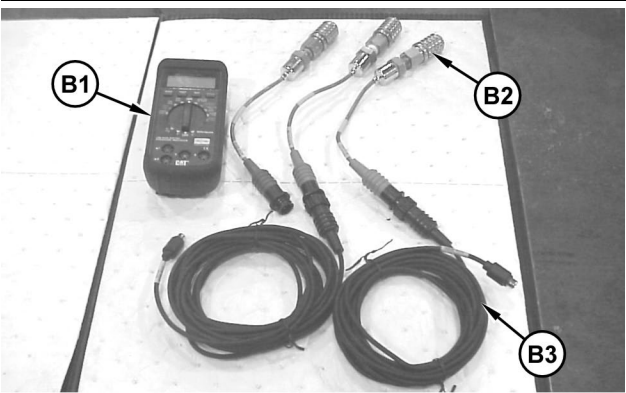


Illustration 64

g01623868

Tooling B

Table 1

Tool	Item	Part Number	Description	Qty
	B	198 - 4240	Digital Pressure Indicator Gp	
	B1	198 - 4234	Digital Indicator	1

(continued)

(Table 1, contd)

Tool	Item	Part Number	Description	Qty
	B2	198 - 4239	Pressure Sensor Gp (0 to 41,369 kPa (0 to 6,000 psi))	1
	B3	198 - 4236	Adapter Cable As	1
	F	6V - 9511 6V - 9746	Plug O-Ring Seal	1
	G	5P - 9436 3D - 2824	Plug O-Ring Seal	1

Machine Preparation

1. Run the machine in order to reach the normal operating temperature.
2. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control lever in the NEUTRAL position. Engage the parking brake. Lower the work tools to the ground. Stop the engine and put chocks in front of the wheels and behind the wheels.
3. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.
4. Remove the grill.

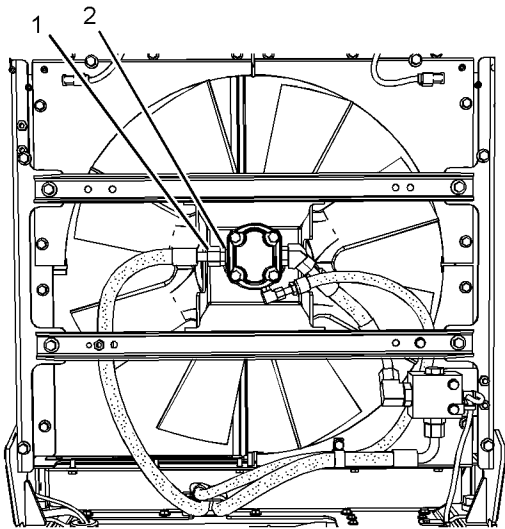


Illustration 65 g02227835
Gear motor (hydraulic fan) equipped with a case drain

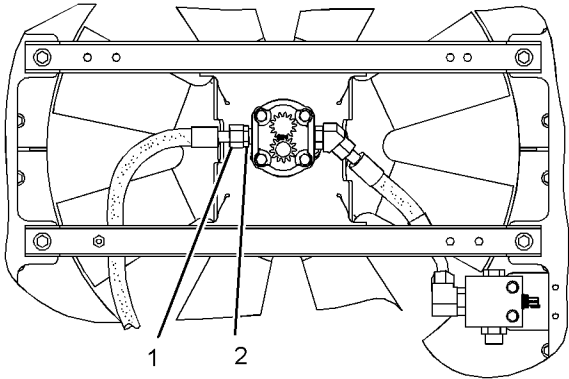


Illustration 66 g01296286
Gear motor (hydraulic fan) not equipped with a case drain

5. Remove hydraulic oil inlet line (1) from the adapter on the fan motor. Add tooling (F) to the supply hose.
6. Remove adapter (2) from the fan motor. Add tooling (G) to the motor.

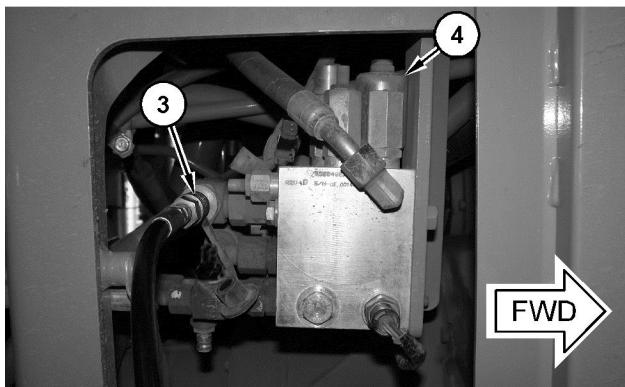


Illustration 67

g01458770

View of the control manifold

7. Remove the cap from test port (3). Install tooling (B) onto test port (3).
8. Disconnect the wire connector from the fan speed solenoid (4).

Perform the Test

NOTICE

During this test procedure operation of the engine for more than 1 minute durations can damage the pump.

1. Start the engine. Set the engine speed to high idle.
2. Check the pressure on the gauge. The high-pressure cutoff setting should be 21500 ± 200 kPa (3120 ± 30 psi).

Note: If the high-pressure cutoff setting is incorrect, then the pressure compensator must be adjusted. Refer to Step 3.

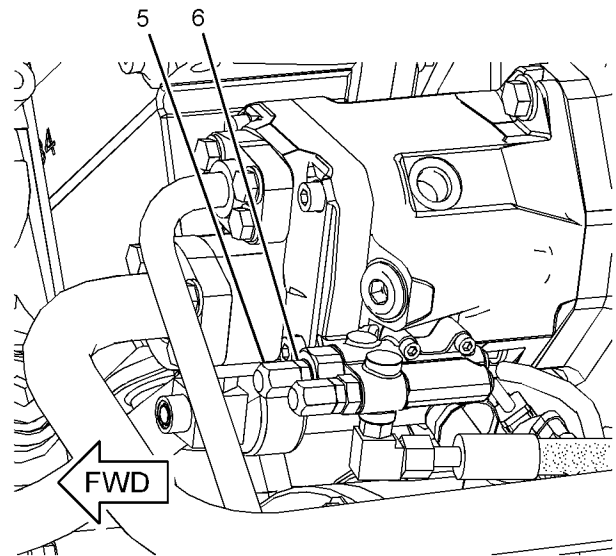


Illustration 68

g01458778

View of bottom left of the 14M engine compartment

3. Perform the following operations in order to adjust the high-pressure cutoff setting:
 - a. Remove cap (5) and loosen locknut (6).
 - b. Turn the adjustment screw clockwise in order to increase the high-pressure cutoff setting.
Turn the adjustment screw counterclockwise in order to decrease the high-pressure cutoff setting.
 - c. Tighten locknut (6) and reinstall cap (5).
Perform Steps 1 through 3c until the high-pressure cutoff setting is correct.
4. Remove tooling (B) from test port (3) and reinstall the cap.
5. Connect the wire connector to the fan speed solenoid (4).
6. Remove tooling (G) and add adapter (2) to the fan motor.
7. Remove tooling (F) and connect hydraulic oil inlet line (1) to adapter (2) on the fan motor.

8. Install the grill.

i04002112

Piston Pump (Brake, Hydraulic Fan) High Pressure Stall - Test and Adjust (16M)

SMCS Code: 5070-081-HFN; 5070-081-BRK; 5086-025

S/N: B9H1-Up

S/N: R9H1-Up

! WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move during test, reduce the engine speed immediately and engage the parking brake.

! WARNING

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

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

Introduction

This procedure will test the setting of the cut out pressure of the piston pump against a dead head load.

NOTICE

During this test procedure operation of the engine for more than 1 minute durations can damage the pump.

Required Tools

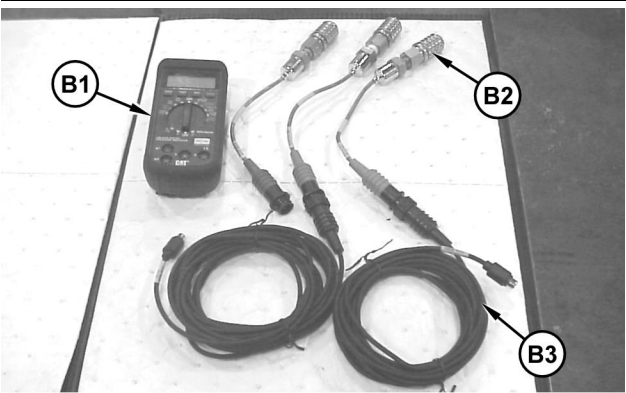


Illustration 69

g01623868

Tooling B

Table 2

Tool	Item	Part Number	Description	Qty
B		198 - 4240	Digital Pressure Indicator Gp	
	B1	198 - 4234	Digital Indicator	1
	B2	198 - 4239	Pressure Sensor Gp (0 to 41,369 kPa (0 to 6,000 psi))	1
	B3	198 - 4236	Adapter Cable As	1
F		6V - 9511 6V - 9746	Plug O-Ring Seal	1
G		6V - 9832 6V - 9746	Cap As O-Ring Seal	1

Machine Preparation

1. Run the machine in order to reach the normal operating temperature.
2. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control lever in the NEUTRAL position. Engage the parking brake. Lower the work tools to the ground. Stop the engine and put chocks in front of the wheels and behind the wheels.
3. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.

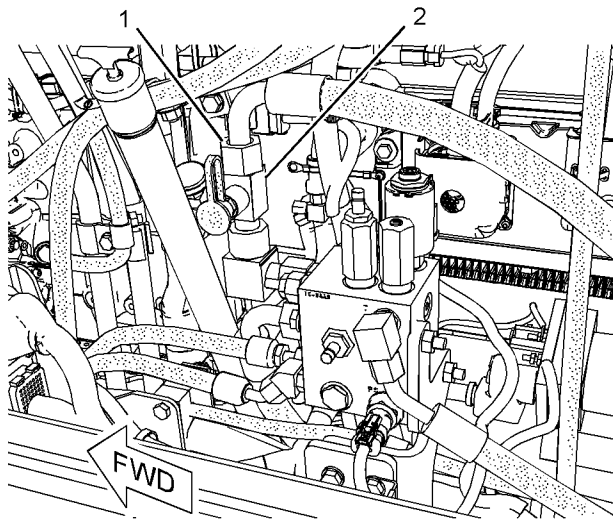


Illustration 70

g02234097

View of the brake and hydraulic fan control manifold

4. Remove hydraulic oil line (1) from the Tee (2) and add tooling (F) to the supply hose (1). Add tooling (G) to tee (2).

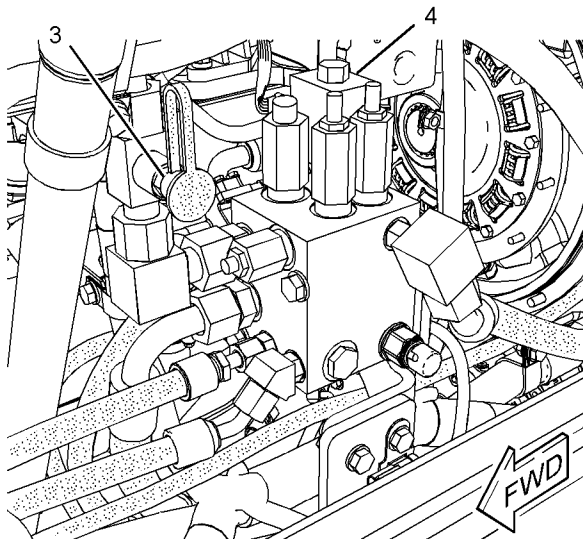


Illustration 71

g01452429

View of the brake and hydraulic fan control manifold

5. Remove the cap from test port (3). Install tooling (B) onto test port (3).
6. Disconnect the wire connector from the fan speed solenoid (4).

Perform the Test

NOTICE

During this test procedure operation of the engine for more than 1 minute durations can damage the pump.

1. Start the engine. Set the engine speed to high idle.
2. Check the pressure on the gauge. The high-pressure cutoff setting should be 21500 ± 200 kPa (3120 ± 30 psi).

Note: If the high-pressure cutoff setting is incorrect, then the pressure compensator must be adjusted. Refer to Step 3.

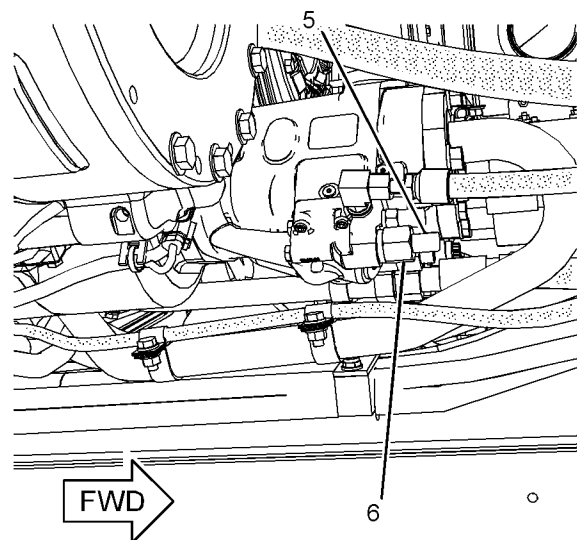


Illustration 72

g01458753

View of bottom left of the 16M engine compartment

3. Perform the following operations in order to adjust the high-pressure cutoff setting:
 - a. Remove cap (5) and loosen locknut (6).
 - b. Turn the adjustment screw clockwise in order to increase the high-pressure cutoff setting.
Turn the adjustment screw counterclockwise in order to decrease the high-pressure cutoff setting.
 - c. Tighten locknut (6) and reinstall cap (5). Perform Steps 1 through 3c until the high-pressure cutoff setting is correct.
4. Remove tooling (B) from test port (3) and reinstall the cap.
5. Connect the wire connector to the fan speed solenoid (4).

- 6. Remove tooling (G) and add adapter (2) to the fan motor.
- 7. Remove tooling (F) and connect hydraulic oil inlet line (1) to adapter (2) on the fan motor.
- 8. Install the grill.

i04001032

Piston Pump (Brake, Hydraulic Fan) Margin Pressure - Test and Adjust (14M)

SMCS Code: 5070-081-PX; 5086-081-BRK

S/N: B9J1–Up

S/N: R9J1–Up

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

Introduction

This test procedure is intended to measure the margin pressure of the braking and the hydraulic fan pump.

Note: Do not adjust margin pressure in order to control fan speed unless the calibration for fan speed in Caterpillar Electronic Technician (ET) cannot achieve the minimum desired fan speed or the lowest possible fan speed is within 550 ± 50 rpm.

Required Tools

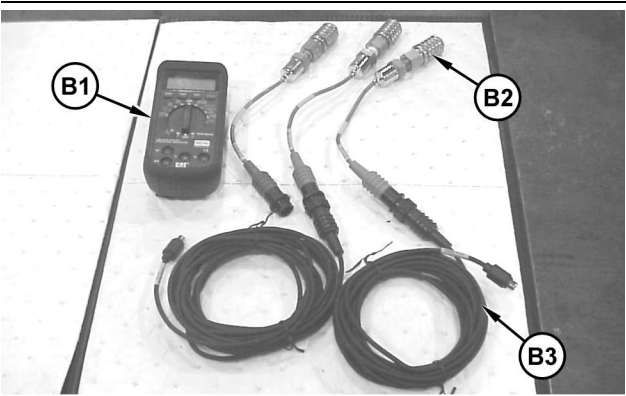


Illustration 73

g01623868

Tooling B

Table 3

To-ol	Item	Part Number	Description	Qty
B		198 - 4240	Digital Pressure Indicator Gp	
	B1	198 - 4234	Digital Indicator	1
	B2	198 - 4239	Pressure Sensor Gp (0 to 41,369 kPa (0 to 6,000 psi))	2
	B3	198 - 4236	Adapter Cable As	2
F		8T - 8902	Tee	1
G		6V - 3965	Fitting (TEST)	1
H		153 - 4906	O-Ring Seal	1

Optional Tooling

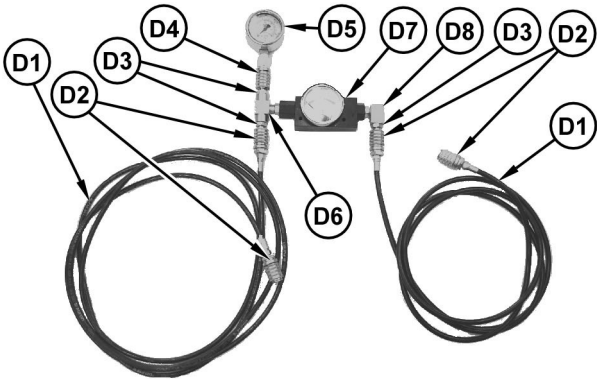


Illustration 74
Tooling D

Table 4

To-ol	Item	Part No	Description	Qt-y
D		1U-5796	Pressure Differential Tool Gp	
	D1	177-7861	Hose As (4.3 M (14 FT))	2
	D2	6V-4143	Quick Connect Coupler	4
	D3	6V-3965	Fittings (TEST)	3
	D4	6V-4144	Quick Connect Coupler	1
	D5	8T-0859	Pressure Gauge (0 to 25,000 kPa (0 to 3,600 psi))	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		8T-8902	Tee	1
G		6V-3965	Fitting (TEST)	1
H		153-4906	O-Ring Seal	1

Machine Preparation

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control switch in the NEUTRAL position. Engage the parking brake. Lower the work tools to the ground. Stop the engine and put chocks in front of the wheels and behind the wheels.
2. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.
3. Assemble tool (H) onto tool (G).

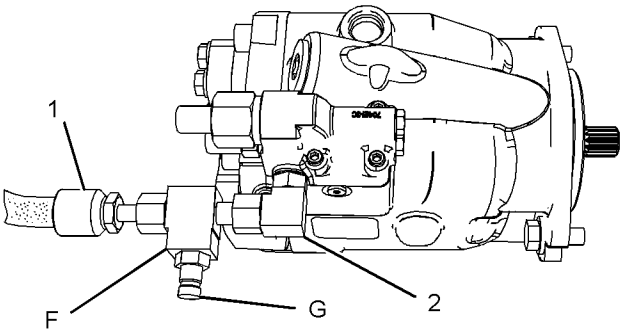


Illustration 75
Piston pump for the brake and hydraulic fan

4. Install tool (F) between line (1) and fitting (2). Install tool (G) into tool (F).

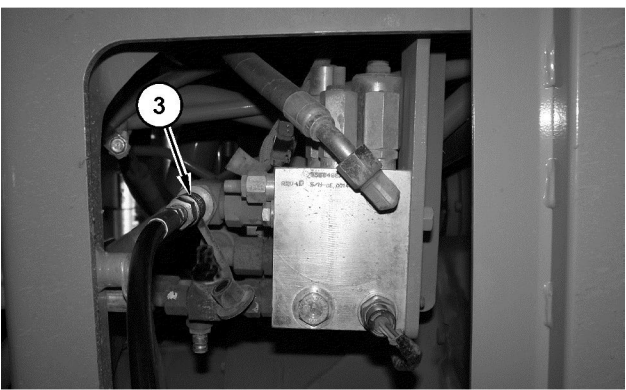


Illustration 76
View of the brake and hydraulic fan control manifold that is located on the right side of the machine.

5. Remove the cap from test port (3). Install tooling (B) onto pressure test port (3).
6. Install tooling (B) onto test port (G).
7. Use Cat ET to set the fan speed at 50% of the maximum rpm.
 - a. Connect Cat ET to the machine.
 - b. Open Cat ET and check for active diagnostic codes. If there is an active diagnostic code, the calibration procedure will be stopped until the condition that caused the diagnostic code is corrected.
 - c. Once any active diagnostic codes are corrected, select the engine Electronic Control Module (ECM) from the available ECM list.

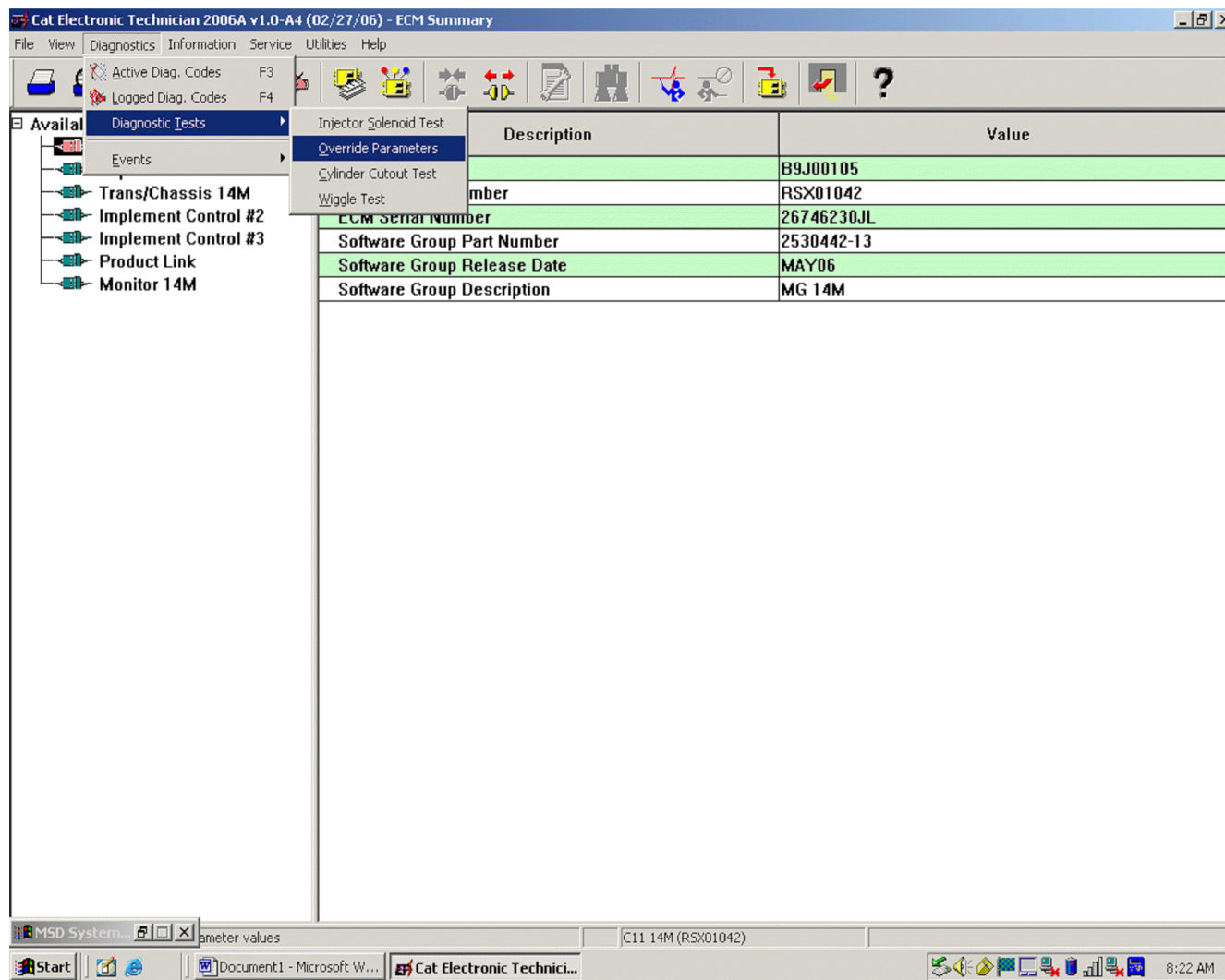


Illustration 77

g01297743

Typical example

- d. Then select "Diagnostic Tests". A second menu will be displayed. Select "Override Parameters" from the second menu.

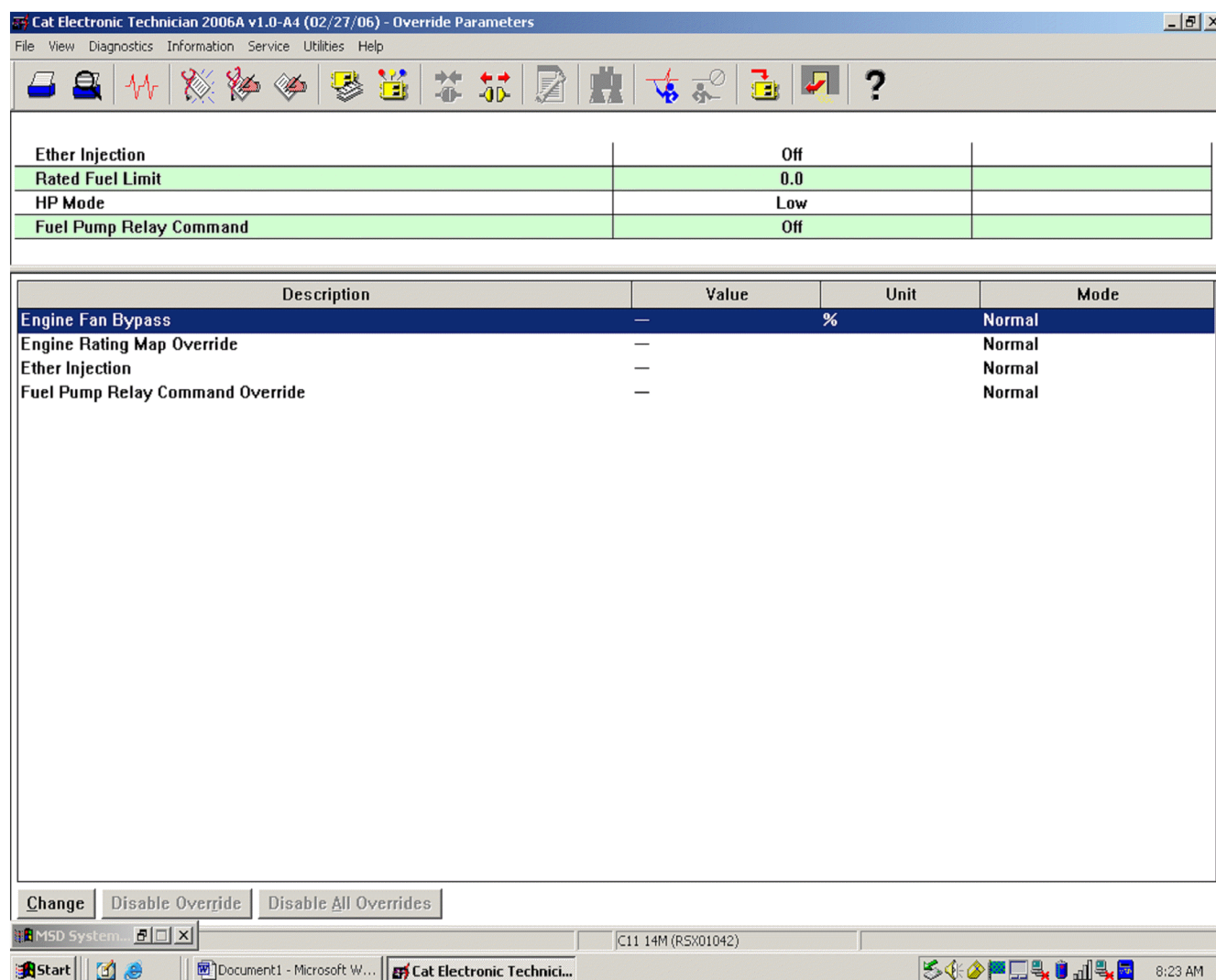


Illustration 78

g01297795

Typical example

- e. The "Override Parameters" screen will appear. Select the "Engine Fan Bypass" line and place the number 50 in the "value column". Then select the "Change" button.

Perform the Test

1. Start the engine. Operate the machine until the brake system and hydraulic fan system is at the normal operating temperature. The normal operating temperature of the machine is $60^{\circ} \pm 5^{\circ}\text{C}$ ($140^{\circ} \pm 9^{\circ}\text{F}$).

Note: Monitor the system temperature throughout the entire test. Keep the temperature within the $60^{\circ} \pm 5^{\circ}\text{C}$ ($140^{\circ} \pm 9^{\circ}\text{F}$) normal operating temperature range.

2. Operate the engine at high idle.
3. Record the pump discharge pressure from test port (3). Record the signal pressure from test port (G).

Note: If you are using optional Differential Pressure Gauge (D), connect the high-pressure side of the Differential Pressure Gauge to port (3). Then connect the low-pressure side of the Differential Pressure Gauge to port (G).

The difference between the pressure at test port (3) and the pressure at test port (G) is margin pressure. The correct margin pressure is 1800 kPa (260 psi).

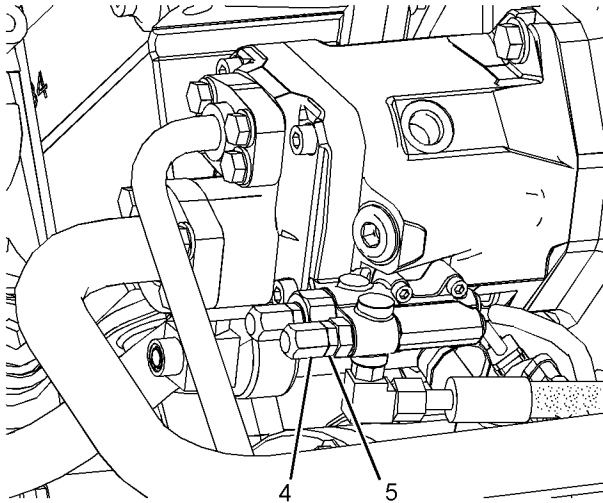


Illustration 79

g01295404

View of bottom left of the 14M engine compartment

4. If the margin pressure is incorrect, remove cap (4) and loose locknut (5).
5. Turn the adjustment screw clockwise in order to increase the margin pressure setting.
Turn the adjustment screw counterclockwise in order to decrease the margin pressure setting.
6. Tighten the locknut (5) and reinstall the cap (4). Perform Steps 3 through 6 until the margin pressure setting is correct.
7. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.
8. Remove all test equipment.

i04002542

Piston Pump (Brake, Hydraulic Fan) Margin Pressure - Test and Adjust (16M)

SMCS Code: 5070-081-PX; 5086-081-BRK

S/N: B9H1-Up

S/N: R9H1-Up

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

Introduction

This test procedure is intended to measure the margin pressure of the braking and the hydraulic fan pump.

Note: Do not adjust margin pressure in order to control fan speed unless the calibration for fan speed in Caterpillar Electronic Technician (ET) cannot achieve the minimum desired fan speed or the lowest possible fan speed is within 550 ± 50 rpm.

Required Tools

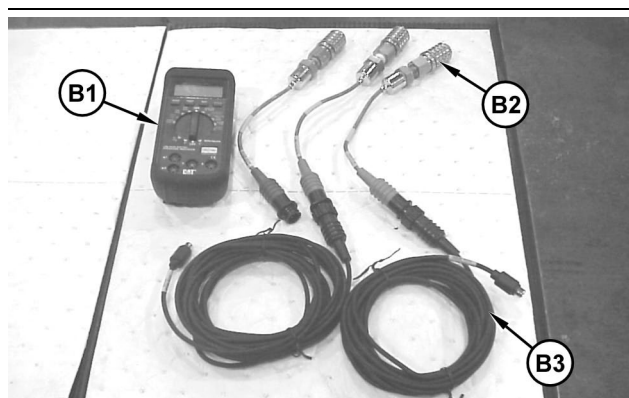


Illustration 80

g01623868

Tooling B

Table 5

Tool	Item	Part Number	Description	Qty
B		198-4240	Digital Pressure Indicator Gp	
	B1	198-4234	Digital Indicator	1
	B2	198-4239	Pressure Sensor Gp (0 to 41,369 kPa (0 to 6,000 psi))	2
	B3	198-4236	Adapter Cable As	2
F		8T-8902	Tee	1
G		6V-3965	Fitting (TEST)	1
H		153-4906	O-Ring Seal	1

Optional Tooling

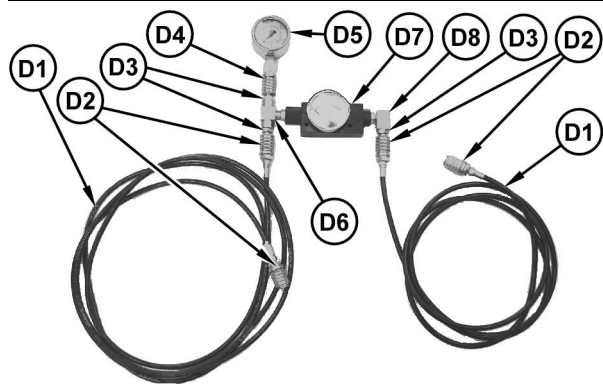


Illustration 81

g01879273

Tooling D

Table 6

Tool	Item	Part No	Description	Qty
D		1U-5796	Pressure Differential Tool Gp	
	D1	177-7861	Hose As (4.3 M (14 FT))	2
	D2	6V-4143	Quick Connect Coupler	4
	D3	6V-3965	Fitting (TEST)	3
	D4	6V-4144	Quick Connect Coupler	1
	D5	8T-0859	Pressure Gauge (0 to 25,000 kPa (0 to 3,600 psi))	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		8T-8902	Tee	1
G		6V-3965	Fitting (TEST)	1
H		153-4906	O-Ring Seal	1

Machine Preparation

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control switch in the NEUTRAL position. Engage the parking brake. Lower the work tools to the ground. Stop the engine and put chocks in front of the wheels and behind the wheels.
2. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.
3. Assemble tooling (H) onto tooling (G).

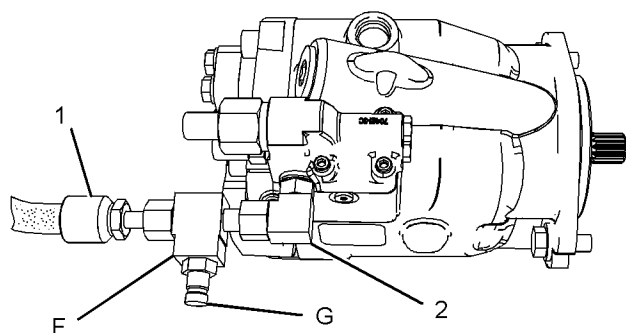


Illustration 82

g02230215

Piston pump for the brake and hydraulic fan

4. Install Tool (F) between line (1) and fitting (2).
Install Tool (G) into Tool (F).
5. Install Tooling (B) onto test port (G).

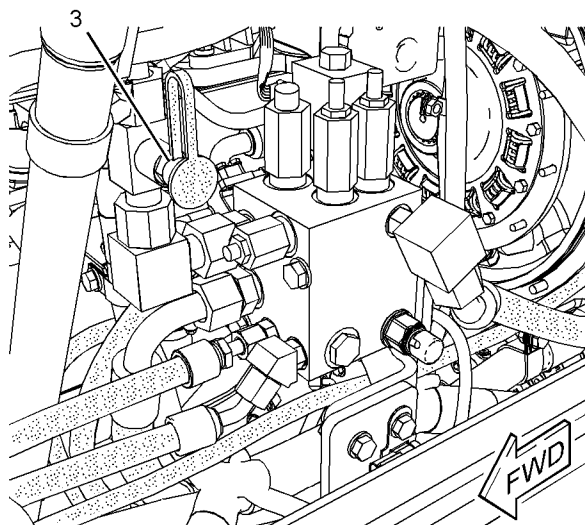


Illustration 83

g01452437

Left side of the engine compartment

6. Remove the cap from test port (3). Install Tooling (B) onto pressure test port (3).
7. Use Cat ET to set the fan speed at 50% of the maximum rpm.
 - a. Connect Cat ET to the machine.
 - b. Open Cat ET and check for active diagnostic codes. If there is an active diagnostic code, then the calibration procedure will be stopped until the condition that caused the diagnostic code is corrected.

- c. Once any active diagnostic codes are corrected, select the engine Electronic Control Module (ECM) from the available ECM list.

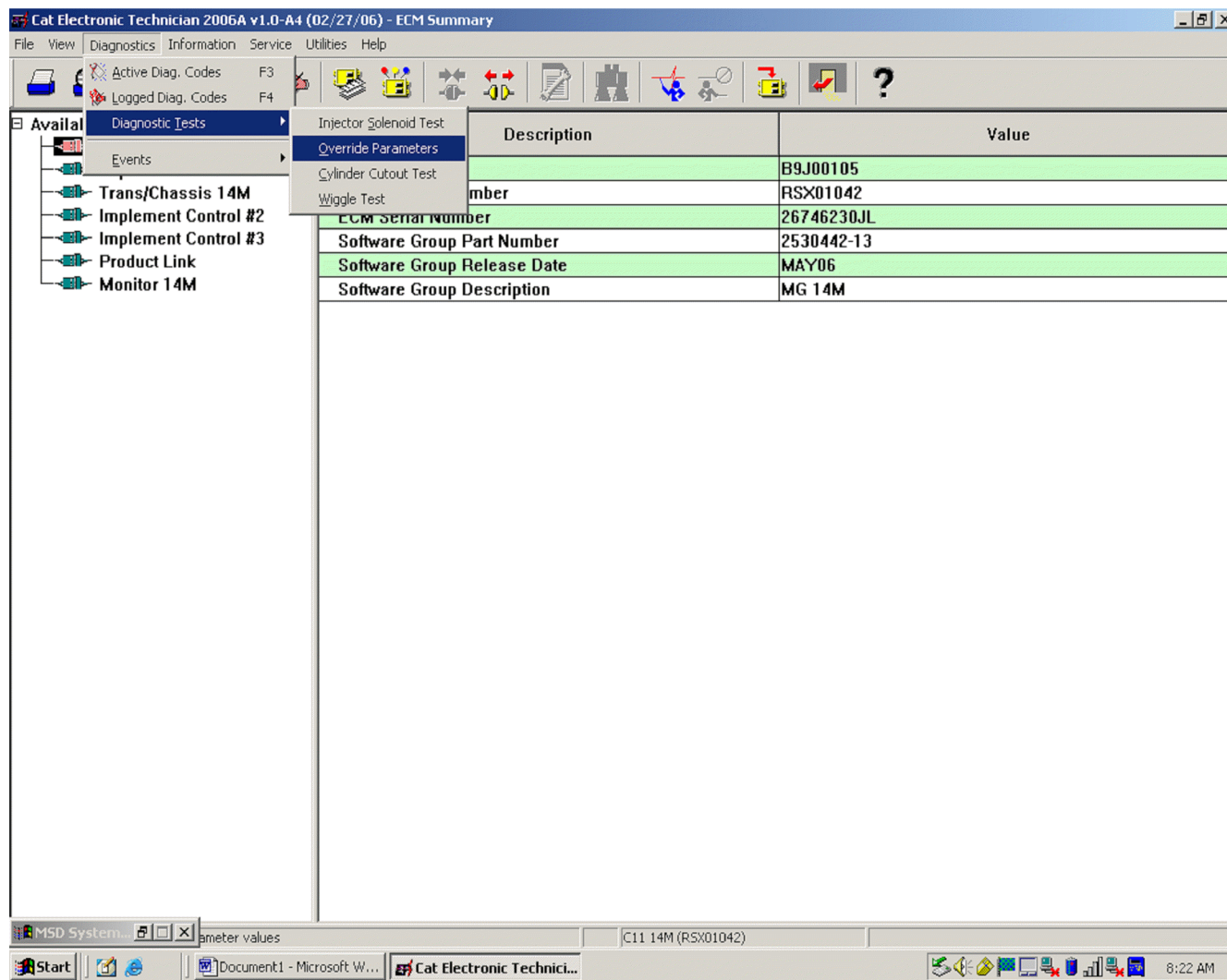


Illustration 84

g01297743

Typical example

- d. Then select "Diagnostic Tests". A second menu will be displayed. Select "Override Parameters" from the second menu.

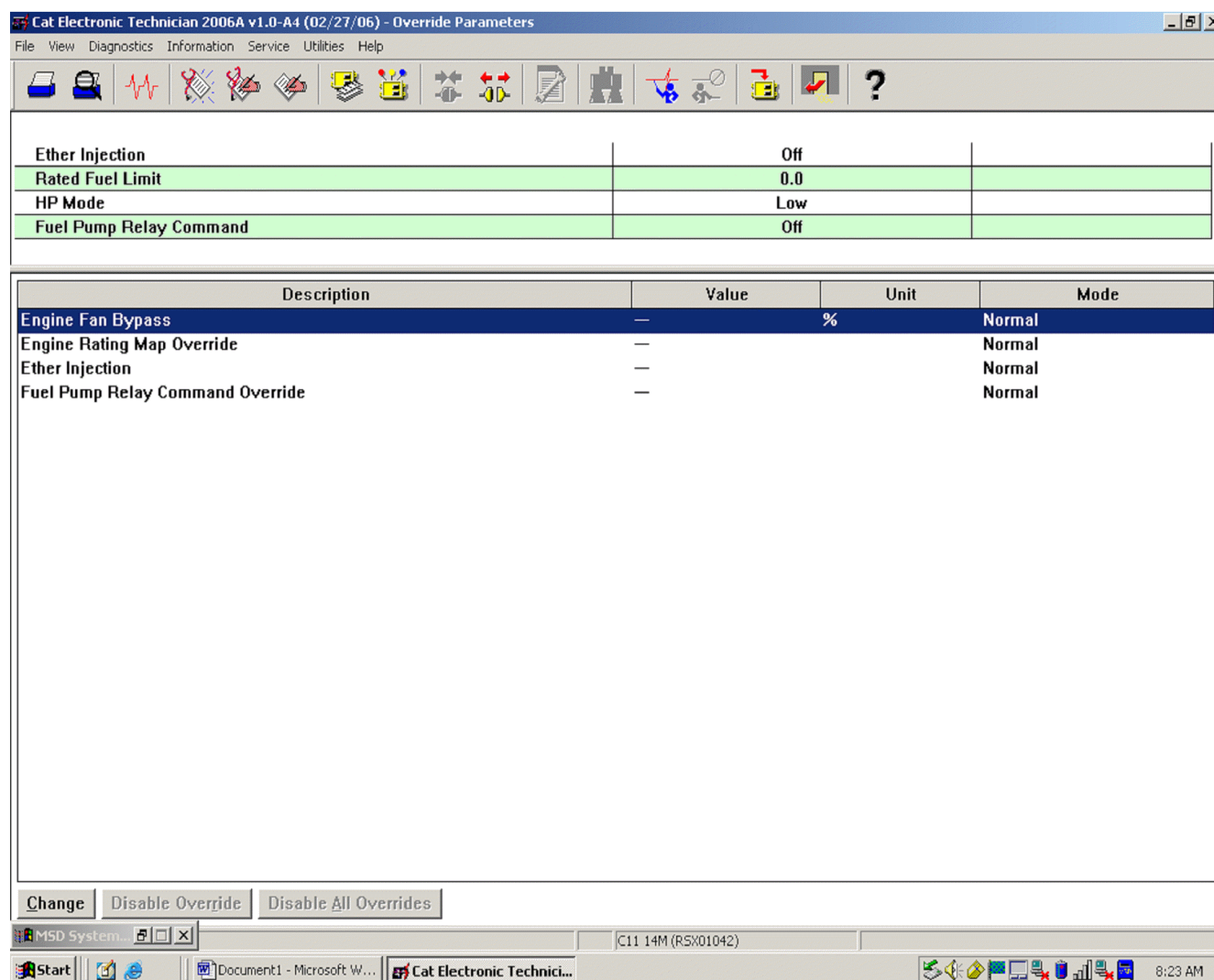


Illustration 85

g01297795

Typical example

- e. The "Override Parameters" screen will appear. Select the "Engine Fan Bypass" line and place the number 50 in the "value column". Then select the "Change" button.

Perform the Test

1. Start the engine. Operate the machine until the brake and hydraulic fan system is at the normal operating temperature. The normal operating temperature of the brake and hydraulic fan system is $60^{\circ} \pm 5^{\circ}\text{C}$ ($140^{\circ} \pm 9^{\circ}\text{F}$).

Note: Monitor the system temperature throughout the entire test. Keep the temperature within the $60^{\circ} \pm 5^{\circ}\text{C}$ ($140^{\circ} \pm 9^{\circ}\text{F}$) normal operating temperature range.

2. Operate the engine at high idle.
3. Record the pump discharge pressure from test port (3). Record the signal pressure from test port (G).

Note: When using optional Differential Pressure Gauge (D) connect the high-pressure side of the Differential Pressure Gauge to port (3). Then connect the low-pressure side of the Differential Pressure Gauge to port (G).

The difference between the pressure at test port (3) and the pressure at test port (G) is margin pressure. The correct margin pressure is 1800 kPa (260 psi).

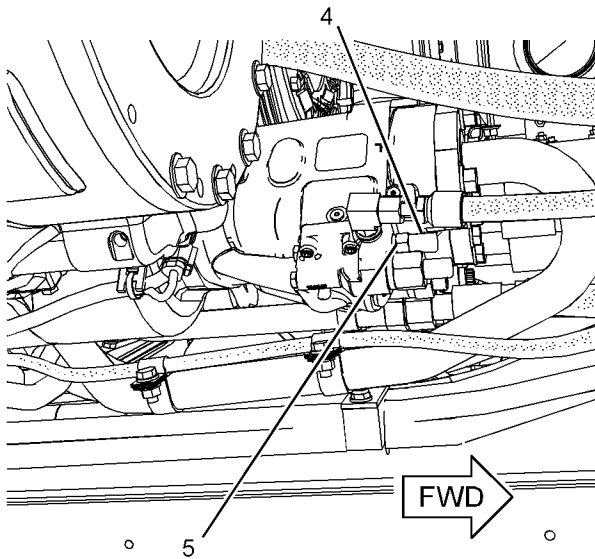


Illustration 86

g01458801

View of bottom left of engine compartment

4. If the margin pressure is incorrect, remove cap (4) and loose locknut (5).
5. Turn the adjustment screw clockwise in order to increase the margin pressure setting.
Turn the adjustment screw counterclockwise in order to decrease the margin pressure setting.
6. Tighten the locknut (5) and reinstall the cap (4). Perform Steps 3 through 6 until the margin pressure setting is correct.
7. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.

8. Remove all test equipment.

i06293068

Hydraulic Fan Speed - Test

SMCS Code: 1386-081-VF; 1387-081-PX

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

WARNING

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

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

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

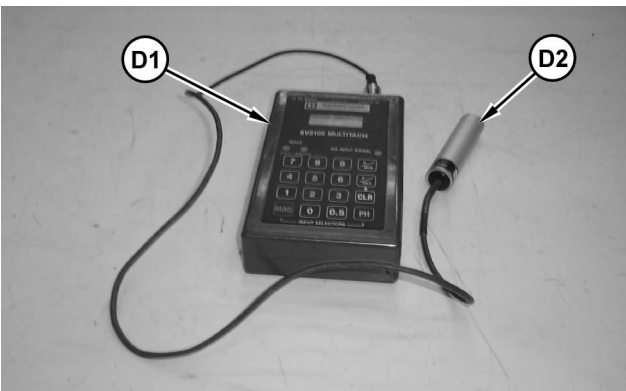


Illustration 87
Tooling (D) 9U - 7400 Multitach Tool Gp g02145526

Table 7

Tool	Item	Part No	Description	Qty
	D	9U - 7400	Multitach Tool Gp	
	D1	9U - 7401	Multitach Tool Gp	1
	D2	9U - 5140	Photo Pickup	1

Introduction

This test procedure is intended to determine the maximum and the minimum hydraulic fan speed.

Preparation for Fan Speed Tests

1. Move the machine to a smooth, horizontal location.
Move the machine away from other operating machines and away from personnel. Place the transmission direction control switch in the NEUTRAL position.
2. Engage the parking brake. Lower the work tools to the ground. Stop the engine and put chocks in front of the wheels and behind the wheels.
3. Inspect the hoses for the fan drive for damage.
Inspect all of the connectors for the fan drive for damage. Inspect all of the components for the fan drive for damage.
4. Check the cooling fan for a piece of reflective tape on one of the fan blades.

Note: If a piece of reflective tape is already visible on one of the fan blades, proceed to Step 5. If no reflective tape is visible on one of the fan blades, use the following procedure:

- a. Turn the engine start switch to the OFF position.
- b. Ensure that the engine start switch is in the OFF position.

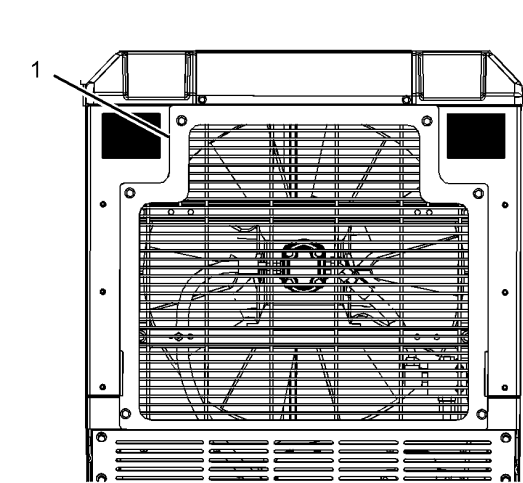


Illustration 88
View of the rear of the machine g01295807

- c. Remove the rear grill (1).
 - d. Clean a small area on the surface of one fan blade near the edge. Position the tape so that the tape is visible. Place the tape near the edge of the blade.
 - e. Install the grill assembly (1).
5. Install Tool (D) on the grill assembly (1).

Test for Minimum Fan Speed

1. Start the engine and run the engine at high idle.
Use the throttle lock in order to maintain high idle.

Note: To ensure the proper operation of the cooling system, the doors for the engine enclosure should be closed while the test procedures are conducted.

2. Engage the parking brake.
3. Allow the brake accumulators to charge fully.
4. Measure the fan speed before the engine reaches normal operating temperature.
5. The minimum fan speed is 550 ± 50 rpm. If the minimum fan speed is incorrect refer to the Testing and Adjusting, "Hydraulic Fan Speed - Calibrate and Adjust".

Test for Maximum Fan Speed

Note: You may not be able to reach maximum fan speed because of the inability of getting the engine and the hydraulic systems hot enough.

1. Start the engine and run the engine at high idle.
Use the throttle lock in order to maintain high idle.

Note: To ensure the proper operation of the cooling system, the doors for the engine enclosure should be closed while the test procedures are conducted.

- 2. Engage the parking brake.
- 3. Allow the brake accumulators to charge fully.
- 4. With the engine at normal operating temperature, measure the speed of the fan.
- 5. Check Table 8 for the maximum fan speed of your machine. If the maximum fan speed is incorrect refer to the Testing and Adjusting, "Hydraulic Fan Speed - Calibrate and Adjust".

Table 8

Fan Speeds		
Maximum		
Sales Model	Standard	High Ambient
14M	1450 ± 50 rpm	1650 ± 50 rpm
16M	1450 ± 50 rpm	1650 ± 50 rpm

i07275097

Hydraulic Fan Speed - Calibrate and Adjust

SMCS Code: 1386-025-VF; 1386-524-VF; 1387-025-PX; 7610-MCH

WARNING

Personal injury can result from hydraulic oil pressure and hot oil.

Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.

Make sure all of the work tools have been lowered to the ground, and the oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.

WARNING

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

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

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

Introduction

This procedure is used to set the minimum and the maximum fan speed for your machine.

Required Tools

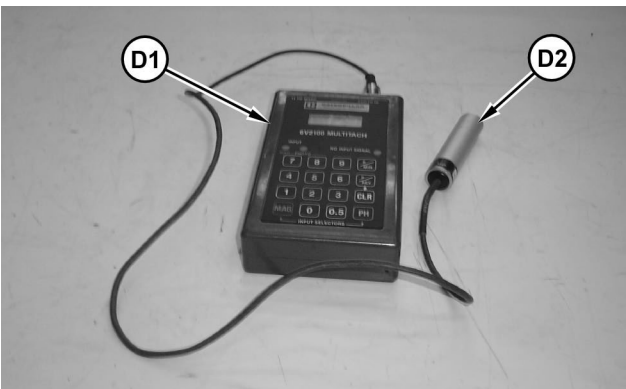


Illustration 89

g02145526

Tooling D

Table 9

Tool	Item	Part No	Description	Qty
D		9U - 7400	Multitach Tool Gp	
	D1	9U - 7401	Multitach Tool Gp	1
	D2	9U - 5140	Photo Pickup	1

Preparation for Calibration

- 1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control switch in the NEUTRAL position.
- 2. Engage the parking brake. Lower the work tools to the ground. Stop the engine and place chocks in front of the wheels and behind the wheels.

3. Inspect the hoses for the fan drive for damage. Inspect all of the connectors for the fan drive for damage. Inspect all of the components for the fan drive for damage.
4. Check the cooling fan for a piece of reflective tape on one of the fan blades.

Note: If a piece of reflective tape is already visible on one of the fan blades, proceed to Step 5. If no reflective tape is visible on one of the fan blades, use the following procedure:

- a. **Turn the engine start switch to the OFF position.**
- b. Ensure that the engine start switch is in the OFF position.

8. Open Cat ET and check for active diagnostic codes. If there is an active diagnostic code, the calibration procedure will be stopped until the condition that caused the diagnostic code is corrected.
9. Once any active diagnostic codes are corrected, select the engine Electronic Control Module (ECM) from the available ECM list.

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.

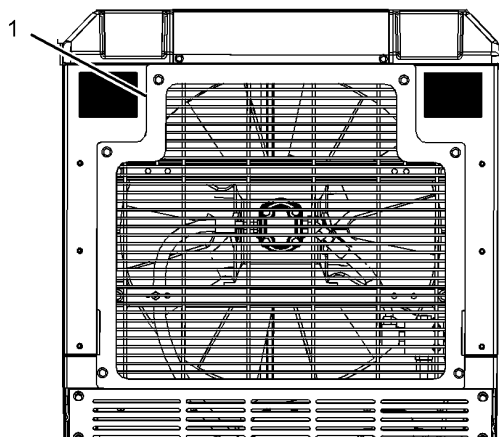


Illustration 90

g01295807

View of the rear grill

- c. Remove the rear grill (1).
 - d. Clean a small area on the surface of one fan blade near the edge. Position the tape so that the tape is visible. Place the tape near the edge of the blade.
 - e. Install the grill assembly (1).
5. Install Tool (D) on the grill assembly (1).
 6. Start the engine and run the engine at low idle.
- Note:** To ensure the proper operation of the cooling system, the doors for the engine enclosure should be closed while the test procedures are conducted.
7. Connect Caterpillar Electronic Technician (ET) to the machine.

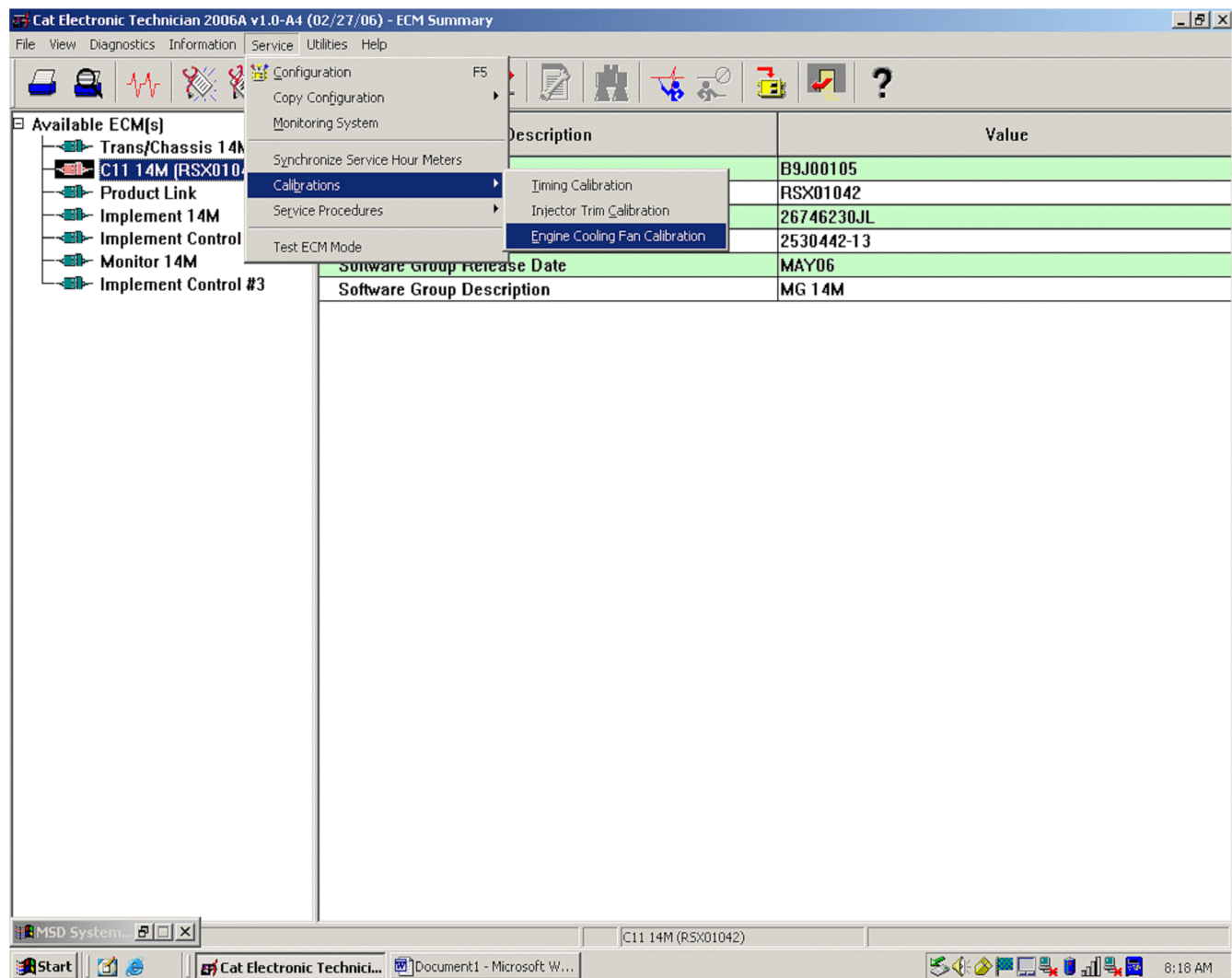


Illustration 91

g01297189

Typical example

10. Select the "Service" menu in order to begin the calibration procedure. Then select "Calibrations". A second menu will be displayed. Select "Engine Cooling Fan Calibration" from the second menu.

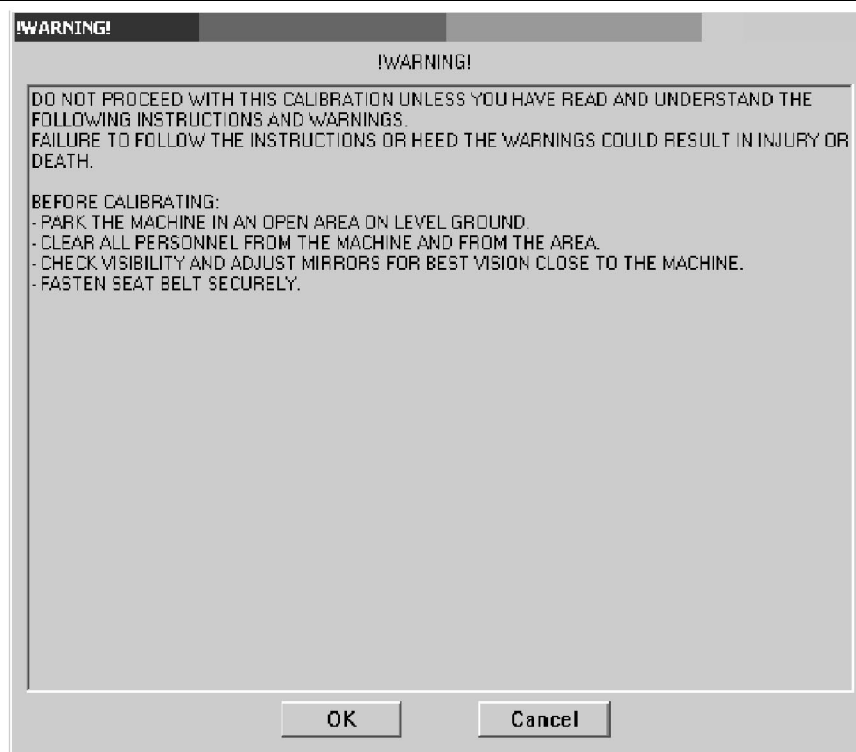


Illustration 92

g01113270

Typical example

11. Read the warning and select "OK" when you are ready to proceed.

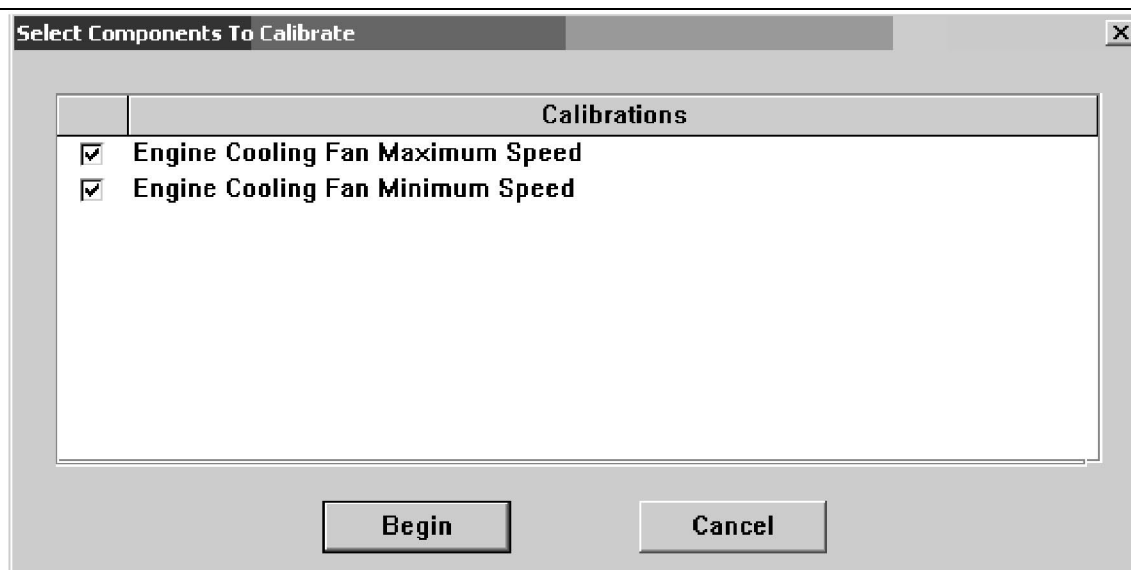


Illustration 93

g01113271

Typical example

12. The next screen allows you to unselect the tests that are not required. Select the box next to the test that is not desired. The check in the check box will disappear when the test is unselected. The test for the nominal fan speed should not be performed. The test for the nominal fan speed is used for testing purposes only. The test for the maximum fan speed and the test for the minimum fan speed are the only tests that should be used. Once the desired tests have been selected, select **"Begin"**.
13. Proceed to "Calibration for Maximum Fan Speed" if the test for the maximum fan speed was selected.
14. Proceed to "Calibration for Minimum Fan Speed" if the test for the minimum fan speed was selected.

Calibration for Fan Speed Solenoid

Calibration for Maximum Fan Speed

Caterpillar Electronic Technician 2010A v1.0 - Engine Cooling Fan Minimum Speed

File View Diagnostics Information Service Utilities Help

Description	Value	Unit
Engine Speed	802	RPM
Parking Brake	Engaged	
Engine Cooling Fan Solenoid Current	1.600	Amps

When the setup conditions are met, click the Next> button to continue

☐ Set up calibration conditions:

- > Set the parking brake.
- > Set Engine Speed to high idle.

☐ To abort the calibration, click the Cancel button.

- > Use the increment and decrement buttons to adjust the current until the fan speed is 600 RPM.
- > When the measured fan speed is within 50 RPM of 600 RPM, click the Next> button to continue.
- > PLEASE NOTE: Increasing the solenoid current will decrease the fan speed. Decreasing the solenoid current will increase the fan speed.

0.099 Engine Cooling Fan Solenoid Current [Amps]: 1.600 1.799

Next> Cancel

<< < > >>

Active Codes [0] Active Events [2] Status Flags [0]

C11.14M/PSY03812

1. The next screen is the initial calibration screen. The screen displays the instructions for calibration. The top display area displays status parameters that are monitored during the calibration. The middle display area displays information about the status of the calibration. The display area on the bottom will display the conditions for the setup and the instructions for the calibration.

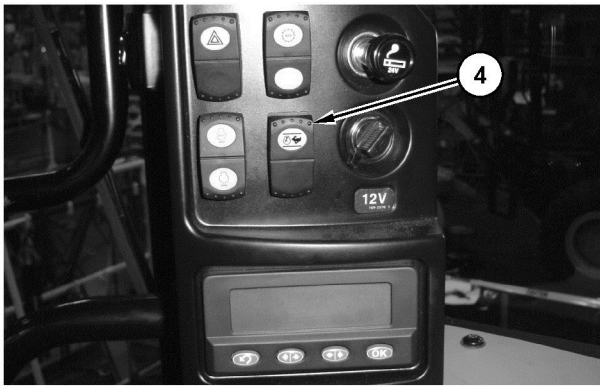


Illustration 95

g01286217

Throttle lock

2. The display area will show the following conditions for the setup:
 - Set the parking brake.
 - Operate the engine at high idle. Use the throttle lock (4) in order to operate the engine at high idle.
 - Ensure that the hydraulic oil temperature exceeds 55 °C (131 °F).
3. Perform the following procedures in order to satisfy the conditions for setup.
 - a. Ensure that the parking brake is engaged.
 - b. Run the engine at high idle with the throttle lock.
 - c. Monitor the hydraulic oil temperature with the Cat ET screen and stall a hydraulic function in order to increase the hydraulic oil temperature. Stall a hydraulic function by moving the function to the end of travel.
4. When the conditions for setup are satisfied, press the **"Next>"** button in order to start the calibration. If the conditions for the setup are not correct, the condition that is not correct will be display in the middle display area. The calibration will not start. When the conditions are correct, press the **"Next>"** button in order to start the calibration of the fan speed.

Note: When the maximum fan speed is calibrated, the minimum signal will be sent to the hydraulic demand fan solenoid. This minimum signal will obtain the maximum fan speed.

Note: You can cancel the calibration at any time by pressing the **"Cancel"** button.

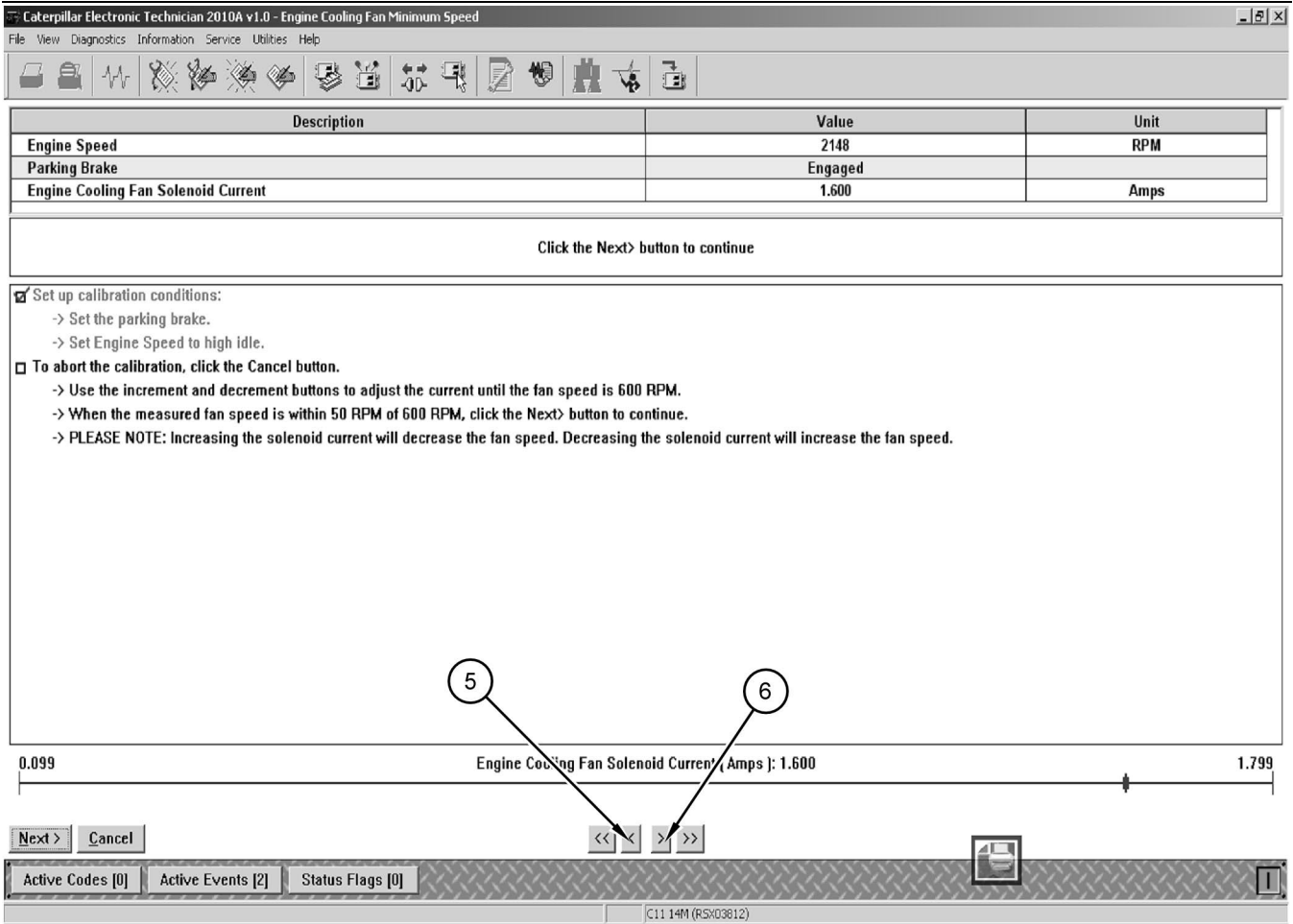


Illustration 96 g02262853

Typical example

5. Record the fan speed. The maximum fan speed for your machine is shown in Table 10 . Press button (5) or press button (6) at the bottom of the screen until the fan speed is approximately 1000 rpm. Then, press the button (5) at the bottom of the screen until the fan speed is correct.

Note: When button (6) is pressed, the signal to the hydraulic demand fan solenoid will be increased. When the signal is increased, the fan speed will decrease. When button (5) is pressed, the signal to the hydraulic demand fan solenoid will be decreased. When the signal is decreased, the fan speed will increase.

Note: When adjusting the maximum fan speed, if the maximum fan speed is exceeded, then decrease the fan speed to 1000 rpm. Repeat the process of increasing the fan speed to the maximum fan speed in Table 10 . This procedure will allow the fan speed to be properly set.

Table 10

Fan Speeds			
Maximum			
Sales Model	Standard	AWD	High Ambient
14M	1450 ± 50 rpm	NA	1650 ± 50 rpm
16M	1400 ± 50 rpm	NA	1650 ± 50 rpm

6. The calibration procedure could be stopped for several reasons. Refer to the following table for the error codes that can be displayed by Cat ET. Correct the condition that caused the error code and restart the calibration.

Table 11

Error Codes for the Calibration of the Fan Speed Solenoid		
Error Code	Description	Procedure
0002	Active diagnostic present	There is an active diagnostic code. Exit the calibration and correct the condition that caused the diagnostic code.
0006	Calibration aborted by tool/monitor	The calibration has been stopped by Cat ET. Restart the calibration procedure.
0009	Calibration aborted by ECM	The calibration has been stopped by the ECM. Restart the calibration procedure.
1010	Engine stopped	The engine has stopped. Restart the engine and set the engine to high idle.
1012	Engine rpm incorrect	The engine rpm is not correct. Set the engine rpm to high idle.
1018	Parking brake not engaged	The parking brake is not engaged. Set the parking brake.
1020	Transmission gear incorrect	The transmission gear is not correct. The transmission must be in NEUTRAL.
1048	Hydraulic oil temperature too low	The hydraulic oil temperature is too low. Repeat the procedure to increase the hydraulic oil temperature.
1054	Hydraulic oil temperature too high	The hydraulic oil temperature is too high. Decrease engine speed and ensure that the doors for the engine enclosure are closed.
1074	Engine rpm too low	The engine rpm is too low. Set the engine rpm to high idle.

7. Once the maximum fan speed is correct, press the **"Next>"** button in order to complete the test.

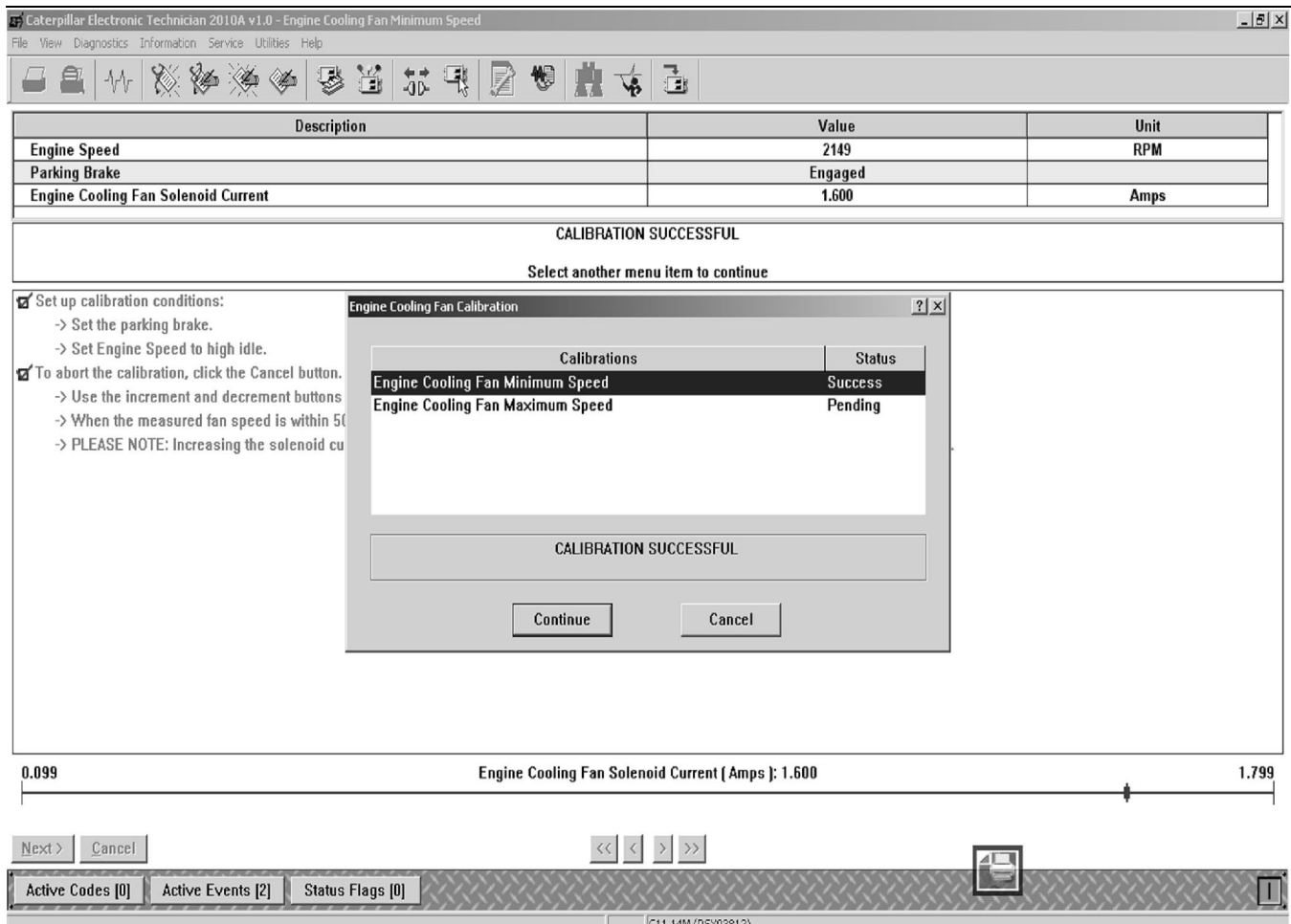


Illustration 97

g02262874

Typical example

8. The next screen will show that the test was successful. Select **"Continue"** in order to proceed.
9. If the test for the minimum fan speed was selected, proceed to "Calibration for Minimum Fan Speed". If the test for the minimum fan speed was not selected, disengage the throttle lock and stop the engine.
10. Remove the test equipment unless proceeding to the "Calibration for Minimum Fan Speed" steps.

Calibration for Minimum Fan Speed

Description	Value	Unit
Engine Speed	2152	RPM
Parking Brake	Engaged	
Engine Cooling Fan Solenoid Current	1.471	Amps

When the setup conditions are met, click the Next> button to continue.

☐ Set up calibration conditions:

- > Set the parking brake.
- > Set Engine Speed to high idle.

☐ To abort the calibration, click the Cancel button.

- > Use the increment and decrement buttons to adjust the current until the fan speed is 1550 RPM.
- > When the measured fan speed is within 50 RPM of 1550 RPM, click the Next> button to continue.
- > PLEASE NOTE: Increasing the solenoid current will decrease the fan speed. Decreasing the solenoid current will increase the fan speed.

0.099 Engine Cooling Fan Solenoid Current [Amps]: 1.471 1.799

Next > Cancel << < > >>

Active Codes [0] Active Events [2] Status Flags [0]

ET11.14M (R5003812)

Illustration 98

g02262876

Typical example

1. The next screen is the initial calibration screen.
The screen displays the instructions for calibration. The top display area displays status parameters that are monitored during the calibration. The middle display area displays information about the status of the calibration. The display area on the bottom will display the conditions for the setup and the instructions for the calibration.

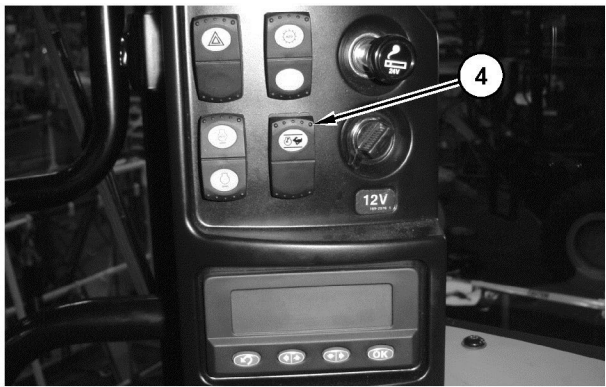


Illustration 99

g01286217

Throttle Lock

2. The display area will show the following conditions for the setup:

- Set the parking brake.
 - Operate the engine at high idle. Use the throttle lock (4) in order to operate the engine at high idle.
 - Ensure that the hydraulic oil temperature exceeds 55 °C (131 °F).
3. Perform the following procedures in order to satisfy the conditions for setup.
- a. Ensure that the parking brake is engaged.
 - b. Run the engine at high idle with the throttle lock.
 - c. Monitor the hydraulic oil temperature with the Cat ET screen and stall a hydraulic function in order to increase the hydraulic oil temperature. Stall a hydraulic function by moving the function to the end of travel.
4. When the conditions for setup are satisfied, press the “**Next>**” button in order to start the calibration. If the conditions for the setup are not correct, the condition that is not correct will be display in the middle display area. The calibration will not start. When the conditions are correct, press the “**Next>**” button in order to start the calibration of the fan speed.

Note: When the minimum fan speed is being calibrated, the maximum signal will be sent to the hydraulic demand fan solenoid. This maximum signal will obtain the minimum fan speed.

Note: You can cancel the calibration at any time by pressing the “**Cancel**” button.

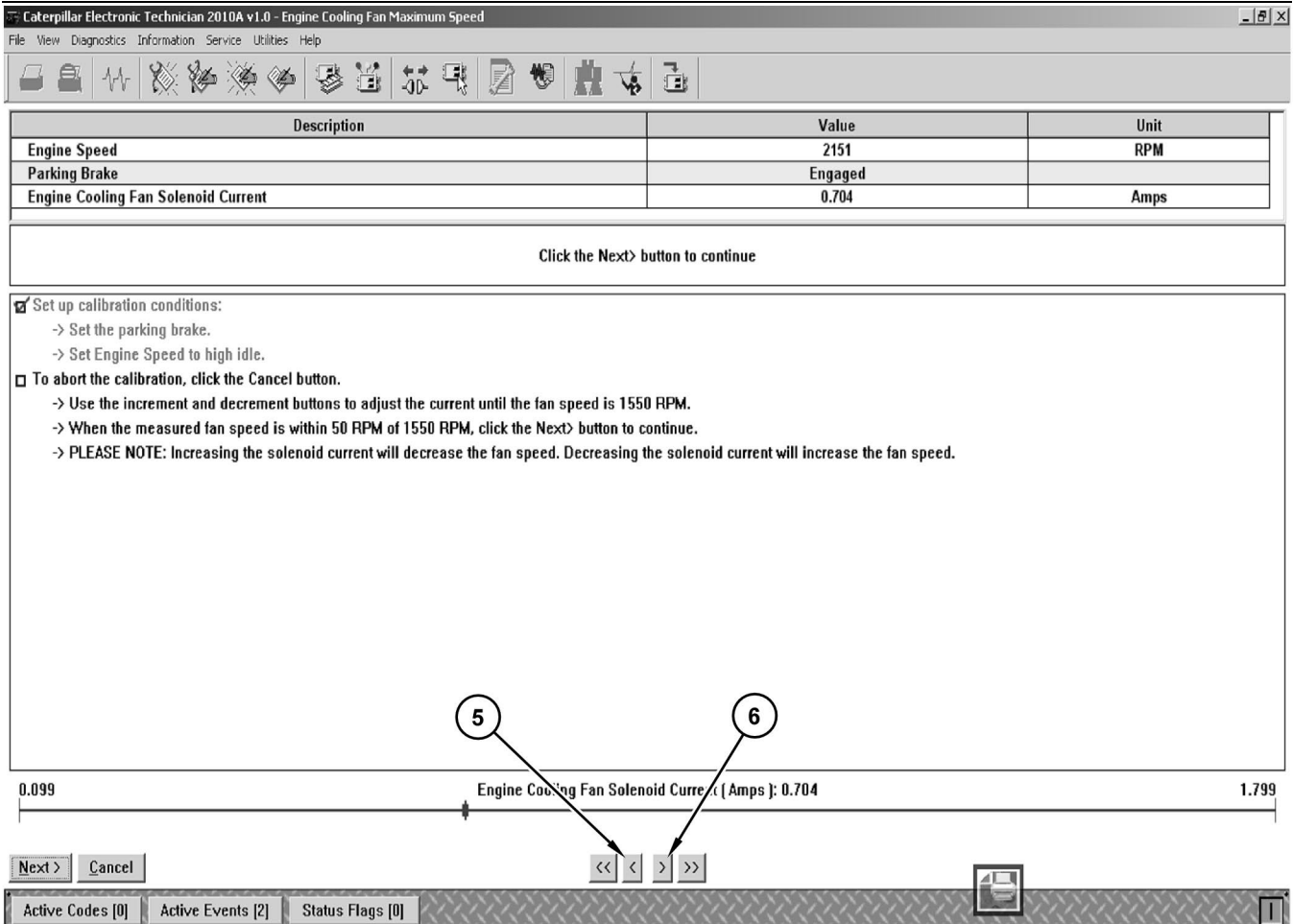


Illustration 100

g02263115

Typical example

5. Record the fan speed. Press button (5) or press button (6) at the bottom of the screen until the fan speed is approximately 1000 rpm. Then, press the button (6) at the bottom of the screen until the fan speed is correct. The minimum fan speed is 550 ± 50 rpm.

Note: When button (6) is pressed, the signal to the hydraulic demand fan solenoid will be increased. When the signal is increased, the fan speed will decrease. When button (5) is pressed, the signal to the hydraulic demand fan solenoid will be decreased. When the signal is decreased, the fan speed will increase.

Note: When adjusting the minimum fan speed, if the minimum speed is exceeded, then increase the speed of the fan to 1000 rpm. Repeat the process of decreasing the speed of the fan to 550 ± 50 rpm. This procedure will allow the fan speed to be properly set.

6. The calibration procedure could be stopped for several reasons. Refer to the following table for the error codes that can be displayed by Cat ET. Correct the condition that caused the error code and restart the calibration.

Table 12

Error Codes for the Calibration of the Fan Speed Solenoid		
Error Code	Description	Procedure
0002	Active diagnostic present	There is an active diagnostic code. Exit the calibration and correct the condition that caused the diagnostic code.
0006	Calibration aborted by tool/monitor	The calibration has been stopped by Cat ET. Restart the calibration procedure.
0009	Calibration aborted by ECM	The calibration has been stopped by the ECM. Restart the calibration procedure.
1010	Engine stopped	The engine has stopped. Restart the engine and set the engine to high idle.
1012	Engine rpm incorrect	The engine rpm is not correct. Set the engine rpm to high idle.
1018	Parking brake not engaged	The parking brake is not engaged. Set the parking brake.
1020	Transmission gear incorrect	The transmission gear is not correct. The transmission must be in NEUTRAL.
1048	Hydraulic oil temperature too low	The hydraulic oil temperature is too low. Repeat the procedure to increase the hydraulic oil temperature.
1054	Hydraulic oil temperature too high	The hydraulic oil temperature is too high. Decrease engine speed and ensure that the doors for the engine enclosure are closed.
1074	Engine rpm too low	The engine rpm is too low. Set the engine rpm to high idle.

7. Once the minimum fan speed is correct, press the **"Next>"** button in order to end the calibration of the fan speed.

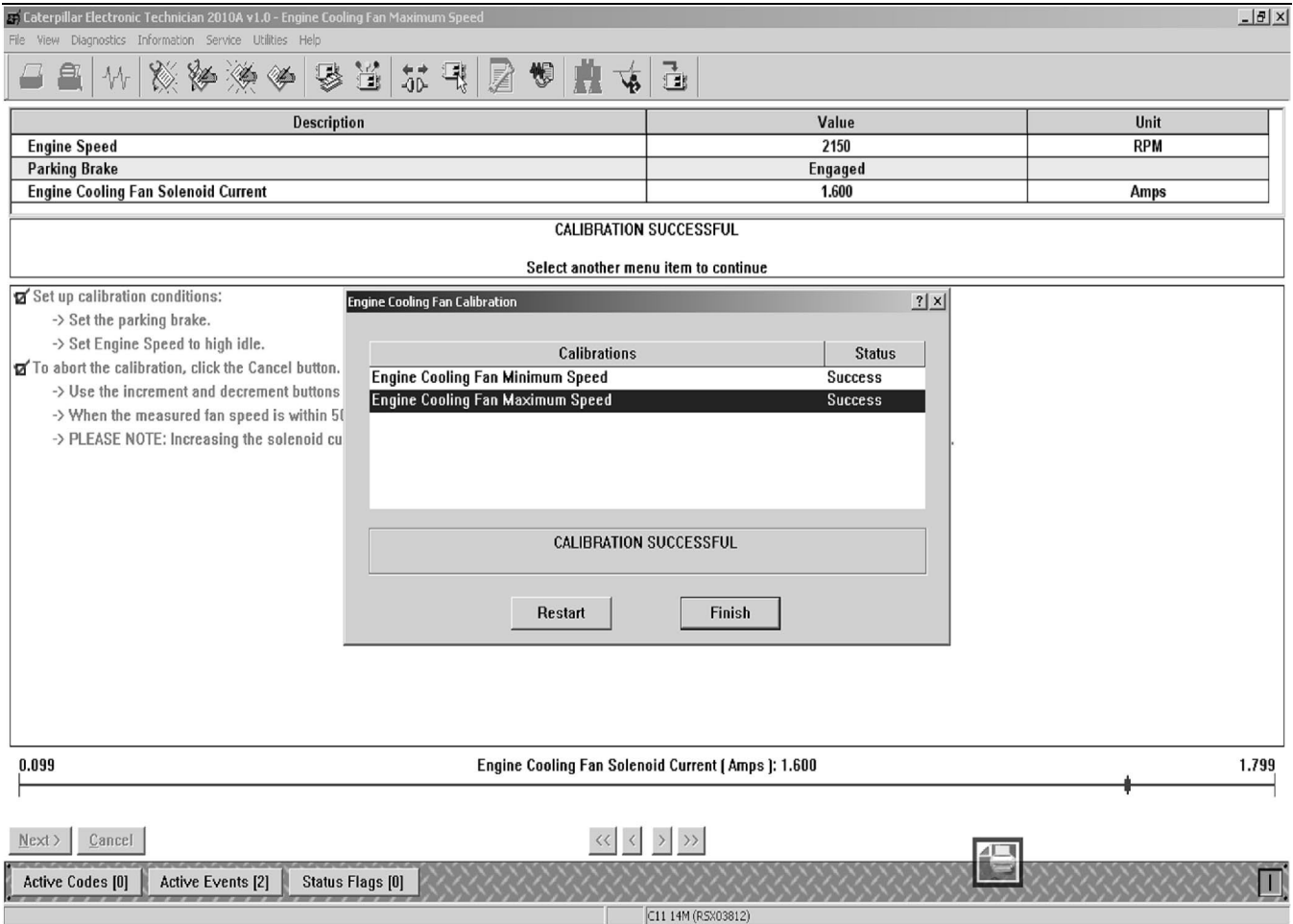


Illustration 101 g02263120

Typical example

8. The next screen will show that the test was successful. Select **“Continue”** in order to proceed.
9. Disengage the throttle lock and stop the engine.
10. Remove the test equipment.

i05203342

Brake Accumulator Charging Valve - Test and Adjust (14M)

SMCS Code: 4264-036

S/N: B9J1–Up

S/N: R9J1–Up

WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move during test, reduce the engine speed immediately and engage the parking brake.

WARNING

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

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

Introduction

This test provides information on the testing and the adjusting of the accumulator charging valve.

Required Tools

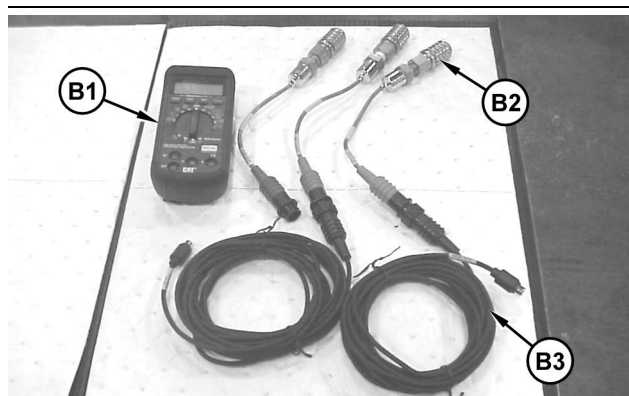


Illustration 102

g01623868

Tooling (B)

Table 13

Tool	Item	Part Number	Description	Qty
B		198 - 4240	Digital Pressure Indicator Gp	
	B1	198 - 4234	Digital Indicator	1
	B2	198 - 4238	Pressure Sensor Gp (0 to 34,450 kPa (0 TO 5,000 psi))	2
	B3	198 - 4236	Adapter Cable As	2
F		5P - 1318	Adapter	1
G		1J - 9671	O-Ring Seal	1
H		6V - 3965	Fitting (TEST)	1
J		153 - 4906	O-Ring Seal	1

Machine Preparation

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control lever in the NEUTRAL position. Engage the parking brake. Lower the work tools to the ground. Stop the engine and put chocks in front of the wheels and behind the wheels.
2. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.

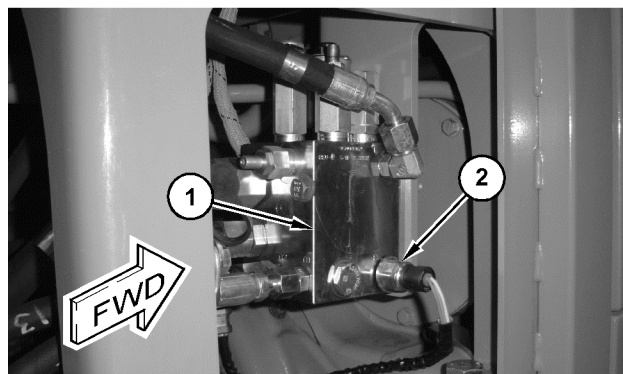


Illustration 103

g01446247

The control manifold prior to the installation of the adapter and the quick disconnect coupler

3. Remove sensor (2) from manifold (1). Install (G) onto adapter (F). Then install adapter (F) into the port that held sensor (2).
4. Install (J) onto (H). Then install (H) onto (F). Next install (B) onto (H).

Note: Performing this procedure will produce a Warning Category 3, because sensor (1) has been removed.

Perform the Procedure

1. Start the engine and run the engine with the transmission in neutral and the parking brake engaged. Allow the hydraulic oil to reach normal operating temperature.

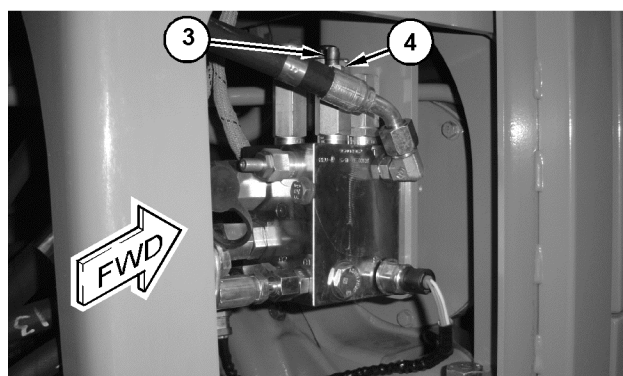


Illustration 104

g01448786

The control manifold prior to the installation of the adapter and the quick disconnect coupler

Note: The cut in pressure must be adjusted first, because changing the cut in pressure will also change the cut out pressure.

2. Pump the service brake pedal. The minimum pressure on the gauges is the cut in pressure. The cut in pressure should be 9650 ± 661 kPa (1400 ± 96 psi).

Loosen locknut (4) and turn setscrew (3) in order to adjust the cut in pressure. Pump the service brake pedal. Turn the setscrew clockwise in order to increase the cut in pressure. Turn the setscrew counterclockwise in order to decrease the cut in pressure. Perform this operation until the correct cut in pressure is achieved. Then tighten locknut (4).

3. Pump the service brake pedal until the pressure in the brake system decreases to the cut in pressure. The system will recharge and the pump will cut out at maximum pressure.

The maximum pressure on the gauges is the cut out pressure. The cut out pressure should be 15858 ± 661 kPa (2300 ± 96 psi).

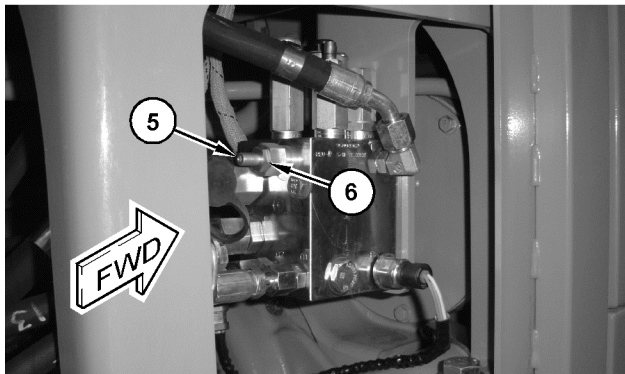


Illustration 105

g01458671

The control manifold prior to the installation of the adapter and the quick disconnect coupler

4. If the cut out pressure is incorrect, loosen locknut (6). Turn setscrew (5) clockwise in order to increase the cut out pressure. Turn setscrew (5) counterclockwise in order to decrease the cut out pressure. Adjust the setscrew until the cut out valve is at the correct pressure setting. Then tighten locknut (6).
5. Stop the engine. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.

6. Remove the test equipment and reinstall sensor (2) into manifold (1).

i05203350

Brake Accumulator Charging Valve - Test and Adjust (16M)

SMCS Code: 4264-036

S/N: B9H1-Up

S/N: R9H1-Up

WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move during test, reduce the engine speed immediately and engage the parking brake.

WARNING

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

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

Introduction

This test provides information on the testing and the adjusting of the accumulator charging valve.

Required Tools

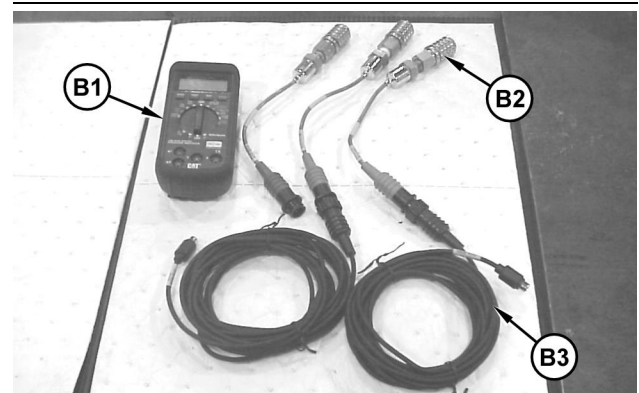


Illustration 106

g01623868

Tooling (B)

Table 14

Tool	Item	Part Number	Description	Qty
B		198-4240	Digital Pressure Indicator Gp	
	B1	198-4234	Digital Indicator	1
	B2	198-4238	Pressure Sensor Gp (0 to 34,450 kPa (0 TO 5,000 psi))	2
	B3	198-4236	Adapter Cable As	2
F		5P-1318	Adapter	1
G		1J-9671	O-Ring Seal	1
H		6V-3965	Fitting (TEST)	1
J		153-4906	O-Ring Seal	1

Machine Preparation

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control lever in the NEUTRAL position. Engage the parking brake. Lower the work tools to the ground. Stop the engine and put chocks in front of the wheels and behind the wheels.
2. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.

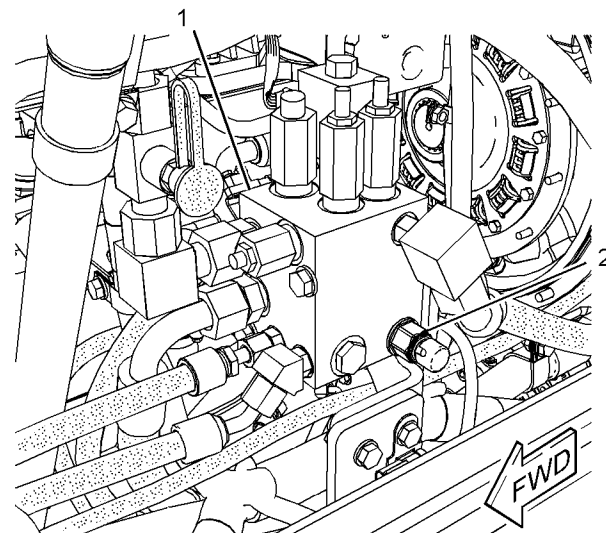


Illustration 107

g01446465

The control manifold prior to the installation of the adapter and the quick disconnect coupler

3. Remove sensor (2) from manifold (1). Install (G) onto adapter (F). Then install adapter (F) into the port that held sensor (2).
4. Install (J) onto (H). Then install onto (H) onto (F). Next install (B) onto (H).

Note: Performing this procedure will produce a Warning Category 3, because sensor (1) has been removed.

Perform the Test

1. Start the engine and run the engine with the transmission in neutral and the parking brake engaged. Allow the hydraulic oil to reach normal operating temperature.

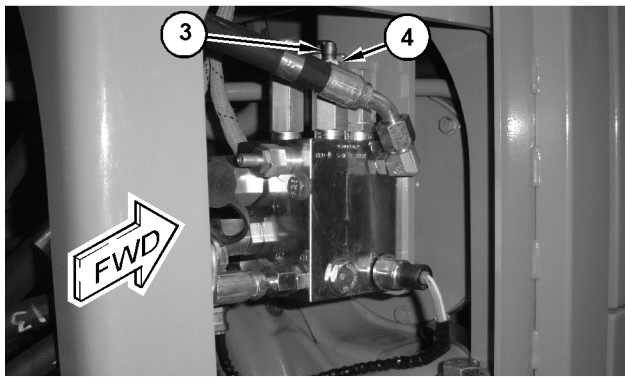


Illustration 108

g01448786

The control manifold prior to the installation of the adapter and the quick disconnect coupler

Note: The cut in pressure must be adjusted first, because changing the cut in pressure will also change the cut out pressure.

2. Pump the service brake pedal. The minimum pressure on the gauges is the cut in pressure. The cut in pressure should be 9650 ± 661 kPa (1400 ± 96 psi).

Loosen locknut (4) and turn setscrew (3) in order to adjust the cut in pressure. Pump the service brake pedal. Turn the setscrew clockwise in order to increase the cut in pressure. Turn the setscrew counterclockwise in order to decrease the cut in pressure. Perform this operation until the correct cut in pressure is achieved. Then tighten locknut (4).

3. Pump the service brake pedal until the pressure in the brake system decreases to the cut in pressure. The system will recharge and the pump will cut out at maximum pressure.

The maximum pressure on the gauges is the cut out pressure. The cut out pressure should be 15858 ± 661 kPa (2300 ± 96 psi).

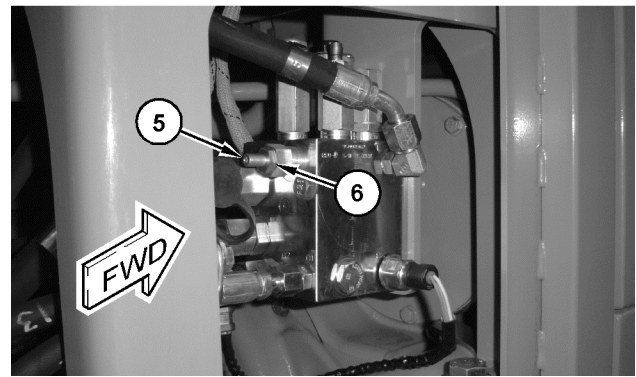


Illustration 109

g01458671

The control manifold prior to the installation of the adapter and the quick disconnect coupler

4. If the cut out pressure is incorrect, loosen locknut (6). Turn setscrew (5) clockwise in order to increase the cut out pressure. Turn setscrew (5) counterclockwise in order to decrease the cut out pressure. Adjust the setscrew until the cut out valve is at the correct pressure setting. Then tighten locknut (6).
5. Stop the engine. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.

6. Remove the test equipment and reinstall sensor (2) into manifold (1).

i05166909

Brake Accumulator (Service) - Test and Charge

SMCS Code: 4263-535; 4263-045; 4263-081

⚠ WARNING

Personal injury or death can result from improper accumulator charging.

Dry nitrogen is the only gas approved for use in the accumulator. Charging the accumulator with oxygen gas will cause an explosion. This danger will not happen if nitrogen cylinders with standard CGA Compressed Gas Association, Inc. Number 580 connections are used.

When ordering nitrogen gas, be sure that the cylinders are equipped with CGA Number 580 Connections. Do not use color codes or other methods of identification to tell the difference between nitrogen and oxygen cylinders.

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 pre-charge. 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 for Troubleshooting” before you begin the test.

Specification

Table 15

Accumulator Precharge Pressure/Temperature Relationship for a Typical 4138 kPa (600 psi) Brake Accumulator	
Temperature	Pressure ⁽¹⁾
-10°C (14°F)	3701 kPa (536 psi)
-5°C (23°F)	3771 kPa (547 psi)
0°C (32°F)	3841 kPa (557 psi)
5°C (41°F)	3911 kPa (567 psi)
10°C (50°F)	3982 kPa (577 psi)
15°C (59°F)	4052 kPa (587 psi)
20°C (68°F)	4122 kPa (597 psi)
25°C (77°F)	4193 kPa (608 psi)
30°C (86°F)	4263 kPa (618 psi)
35°C (95°F)	4333 kPa (628 psi)
40°C (104°F)	4404 kPa (638 psi)
45°C (113°F)	4474 kPa (648 psi)
50°C (122°F)	4544 kPa (659 psi)

⁽¹⁾ The tolerance on the nominal pressure is 206 kPa (30 psi).

Introduction

The brake accumulators are mounted behind the cab. The purpose of the accumulator is to store pressure. The stored pressure allows the machine operator to bring the machine to a stop in the event of an interruption of pressure from the brake pump.

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

Machine Preparation

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel.
2. Place the transmission direction control switch in the NEUTRAL position. Engage the parking brake.
3. Lower the work tools to the ground. Stop the engine and place chocks in front of the wheels and behind the wheels.

Lowering the Piston in Brake Accumulators

1. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.

In order to charge the accumulator, the piston in the brake 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 15 in order to determine the correct charging pressure for the 249-3860 Brake Accumulator Gp.

Accumulator Charging 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, NENG2500, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat® products.

Dispose of all fluids according to local regulations and mandates.

Remove all of the air from 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.

1. Install the 175-5507 Nitrogen Charging Group.

i04954698

Brake System Air - Purge

SMCS Code: 4250-542-AI

WARNING

Personal injury or death can result if two persons are not used in the following procedure.

NOTICE

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

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

Dispose of all fluids according to local regulations and mandates.

Specifications

There are no specifications for this procedure.

Introduction

This procedure will remove air from the brake system.

Required Tools

Table 16

Required Tool		
Item	Description	Qty
F	Transparent tube 6.4 mm (0.25 inch) in diameter	4
	Suitable containers	4

Machine Preparation

1. Prepare the machine for testing by completing the procedure that is specified in the Service Manual module Troubleshooting, "Machine Preparation for Troubleshooting" for the machine that is being serviced.

2. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control switch in the NEUTRAL position. Engage the parking brake. Lower the work tools to the ground. Stop the engine and place chocks in front of the wheels and behind the wheels.
3. Check the hydraulic tank oil level. Make sure that you maintain the correct oil level in the hydraulic oil tank throughout the air removal procedure.

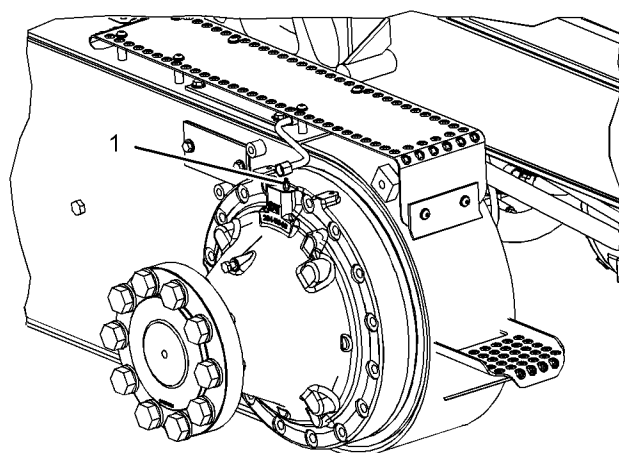


Illustration 110

g01292758

(1) Air purge screw. The guard has been removed for clarity. The four air purge screws (1) for the service brakes are located on the top of the corresponding wheel group.

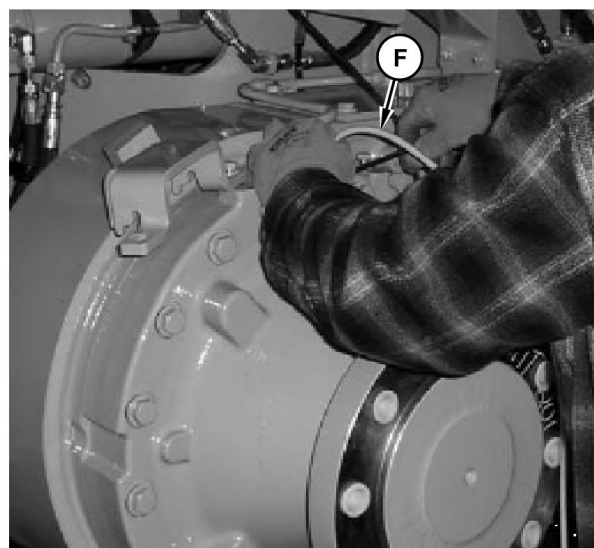


Illustration 111

g02150060

(1) Air purge screw with the drain hose (F) attached. The air purge screw is not in sight.

4. Fasten one end of a transparent tube (F) to each air purge screw. Place the other end of the tube into a suitable container for collecting the hydraulic oil.

Procedure to Purge the Air From the Brake System

1. Hold the end of the tubing (F) in suitable containers and open all four purge screws.
2. Start the engine. Allow the oil pressure to increase to the cutout pressure. Stop the engine.
3. The operator should slowly depress the brake pedal until the accumulators are fully discharged.
4. Release the pedal.
5. Fill the hydraulic oil tank if necessary.
6. While the purge screws still open Repeat Step 2 through Step 5 at least four times. Repeat Step 2 through Step 5 until no air bubbles are visible.
7. While the air purge screws still open, start the engine and depress the pedal slightly until the oil is flowing from the tubes. Allow oil to flow from the tubes for a minimum of one minute. Allow oil to flow from the tubes until no air bubbles are visible. Make sure that the hydraulic tank oil level is maintained during this procedure.
8. Stop the engine.

9. Tighten all of the air purge screws. Remove tubes (F).

i06049626

Service Brake System Pressure - Test

SMCS Code: 4250-032-PX

WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move during test, reduce the engine speed immediately and engage the parking brake.

WARNING

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

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

Specifications

Table 17

Service Brake System Pressures		
System pressure prior to starting the engine	0 kPa (0 psi)	
Both Left and Right Service Brake Pressures at normal operating temperature	5860 ± 345 kPa (850 ± 50 psi) ⁽¹⁾⁽²⁾	

⁽¹⁾ If your machine has 308 - 9523 Brake Control Valve Gp installed, the maximum bias pressure will be around 207 kPa (30 psi).
⁽²⁾ If your machine has 355 - 7411 Brake Control Valve Gp installed, the maximum bias pressure will be around 55 kPa (8 psi).

Introduction

This test will check the service brake pressure at the tandem units.

Required Tools

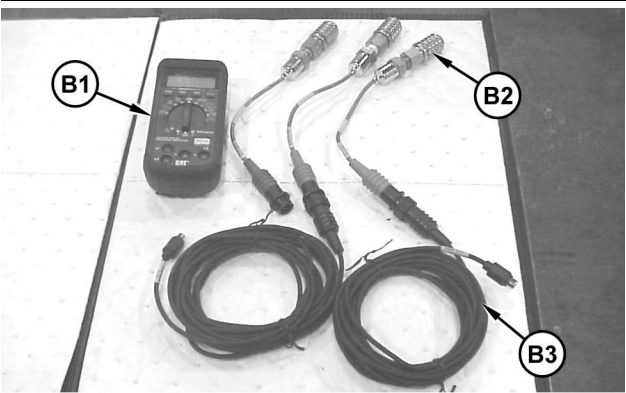


Illustration 112

g01623868

Tooling (B)

Table 18

Tool	Item	Part Number	Description	Qty
B		198 - 4240	Digital Pressure Indicator Gp	
	B1	198 - 4234	Digital Indicator	1
	B2	251 - 9600	Pressure Sensor Gp (0 to 68,900 kPa (0 to 10,000 psi))	1
	B3	198 - 4236	Adapter Cable As	1
G		6V - 3965	Fitting (TEST)	2
H		153 - 4906	O-Ring Seal	2

Test Preparation

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control switch in the NEUTRAL position. Engage the parking brake. Lower the work tools to the ground. Stop the engine and put chocks in front of the wheels and behind the wheels.
2. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.
3. Assemble each (G) to each (H).

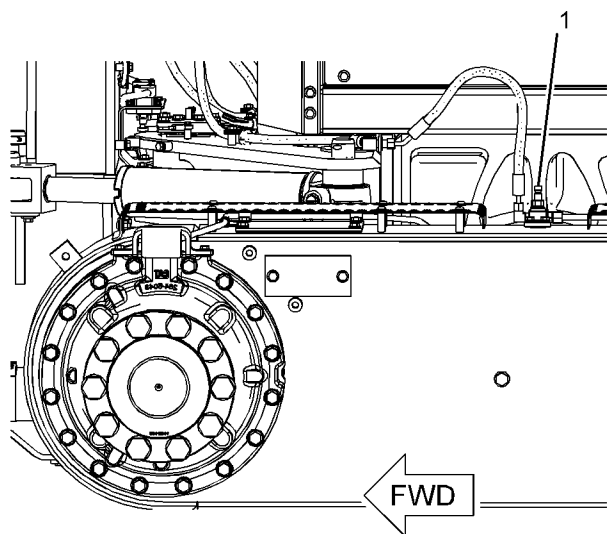


Illustration 113

g01294188

Left side service brake

4. Remove the plug from the test port (1) for the left service brakes. Install fitting (G) and tooling (B) onto test port (1).

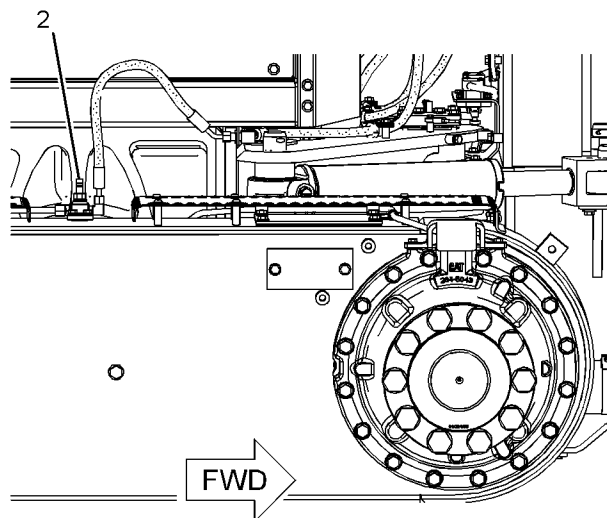


Illustration 114

g01294167

Right side service brake

5. Remove the plug from the test port (2) for the right service brakes. Install fitting (G) and tooling (B) onto test port (2).

Test Procedure

1. Look at the pressure gauges. Before you start the engine, the hydraulic oil pressure should be 0 kPa (0 psi).
2. Start the engine. Allow the hydraulic oil to reach normal operating temperature.
3. Depress the brake pedal. Do not permit the brake pedal to come up. Both the left service brake and the right service brake pressures must be within 5860 ± 345 kPa (850 $\pm$ 50 psi). If your machine has 308 - 9523 Brake Control Valve Gp installed, the maximum bias pressure will be around 207 kPa (30 psi). If your machine has 355 - 7411 Brake Control Valve Gp installed, the maximum bias pressure will be around 55 kPa (8 psi).
4. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.
5. Remove all test equipment and reinstall the plugs.

Adjustment Procedure

If the service brake pressures are not correct refer to the Testing and Adjusting, "Brake Accumulator Charging Valve - Test and Adjust".

i07694713

Service Brakes - Test

SMCS Code: 4251-081

Perform as described in Operation and Maintenance Manual, "14M Motor Grader" SEBU7883, "Braking System - Test" Service Brake Holding Ability Test or Operation and Maintenance Manual, "16M Motor Grader" SEBU7884, "Braking System - Test" Service Brake Holding Ability Test.

i04955670

Brake Control Valve (Service) - Check

SMCS Code: 4265-535

WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move during test, reduce the engine speed immediately and engage the parking brake.

WARNING

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

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

Specifications

Table 19

Maximum Amount That The Service Brake Pressure Can Drop After Two Minutes	
140 kPa (20 psi)	

Introduction

The brake control valve (service) controls the flow of pressurized oil.

Required Tools

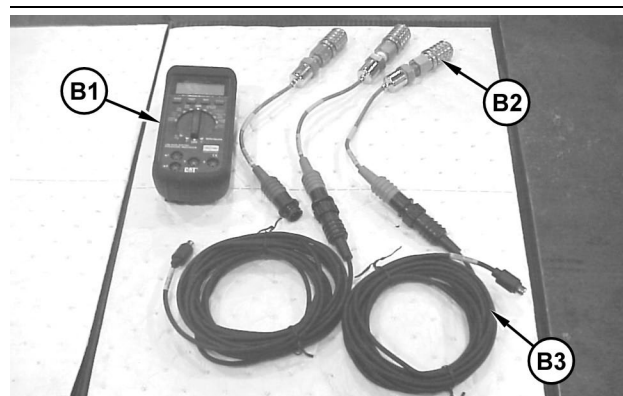


Illustration 115

g01623868

Tooling (B)

Table 20

Tool	Item	Part Number	Description	Qty
B		198 - 4240	Digital Pressure Indicator Gp	
	B1	198 - 4234	Digital Indicator	1
	B2	198 - 4239	Pressure Sensor Gp (0 to 41,369 kPa (0 to 6,000 psi))	2
	B3	198 - 4236	Adapter Cable As	2
G		6V - 3965	Fitting (TEST)	2
H		153 - 4906	O-Ring Seal	2

Test Preparation

1. Move the machine to a smooth, horizontal location. Move the machine away from other operating machines and away from personnel. Place the transmission direction control switch in the NEUTRAL position. Engage the parking brake. Lower the work tools to the ground. Stop the engine and put chocks in front of the wheels and behind the wheels.
2. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance.
3. Assemble each (G) to each (H).

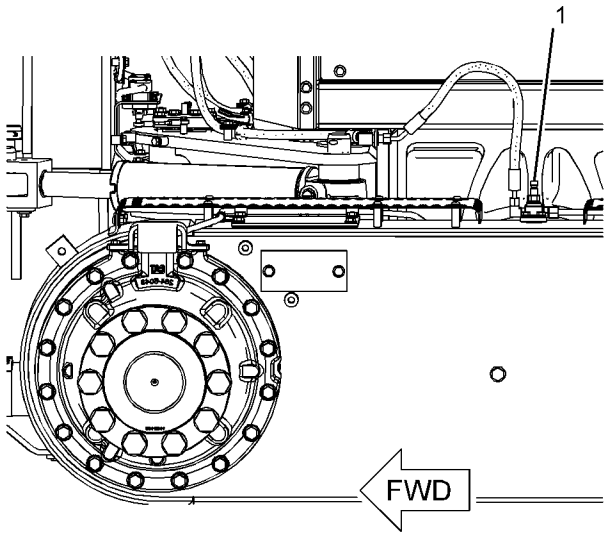


Illustration 116
Left side service brake

4. Remove the plug from the test port (1) for the left service brakes. Install fitting (G) and Tooling (B) onto the test port (1).

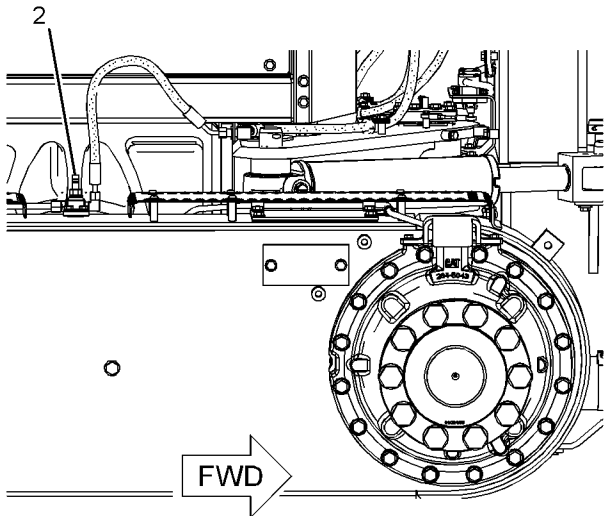


Illustration 117
Right side service brake

5. Remove the plug from the test port (2) for the right service brakes. Install fitting (G) and Tooling (B) onto the test port (2).
6. Look at the pressure gauges. Before you start the engine, the hydraulic oil pressure should be 0 kPa (0 psi).

Test Procedure for the Brake Control Valve

1. Start the engine. Allow the hydraulic oil to reach normal operating temperature. Normal operating is $60^{\circ} \pm 5^{\circ}\text{C}$ ($140^{\circ} \pm 9^{\circ}\text{F}$).
2. Depress the brake pedal. Do not permit the brake pedal to come up. Shut off the engine. Look at the pressure gauges.
3. If the service brake pressure drops more than 140 kPa (20 psi) after two minutes, the brake control valve must be inspected for the cause of leakage.
4. Remove the pressure from the brake system by pumping the service brake pedal at a rate of one second ON and one second OFF. Continue to pump the brakes until a minimum of 110 applications have been completed. Do not assume that the pressure is removed from the circuit if the brake pedal has no resistance. Remove all test equipment and reinstall the plugs.

i07263065

Brake Disc Wear - Check

SMCS Code: 4255-535

Specification

Table 21

Compensator Settings		
Machine	Number of turns out	Tolerance ⁽¹⁾
14M	2.75 Turns + 60°	± 30 °
16M	4 Turns + 60°	± 30 °

⁽¹⁾ Tolerance is measured in degrees of rotation of the adjustment knob

Introduction

This test determines the amount of wear to the brake discs, which determines if the brake pack needs to be replaced. The adjustment keeps piston travel to a minimum.

Reference: Refer to the Systems Operation, “Service Brakes” for additional information concerning the Compensator.

Compensator (4) is preset at the factory. The factory setting will allow compensator (4) to travel a predetermined amount prior to hitting nut (3).

Note: This test is only valid when piston (2) is fully compressed against brake pack (1).

Required Tooling

Tooling is not required for this procedure.

Check Preparation

1. Lower all implements to the ground, set the parking brake, shut off the engine, and chock the rear wheels.

Perform the Check Procedure

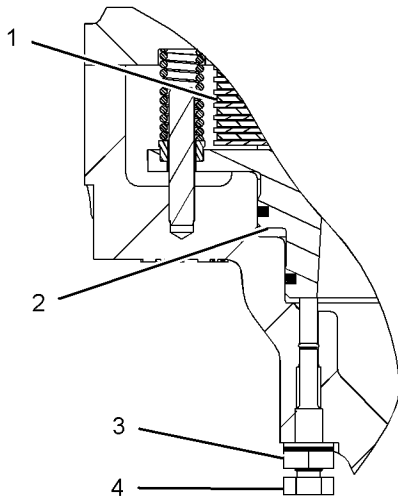


Illustration 118

g03321593

Cut-away of the brakes

- (1) Brake pack
- (2) Piston
- (3) Nut
- (4) Compensator

1. Depress the brake pedal in order to compress piston (2) fully against brake pack (1).
2. Loosen nut (3) completely, until the nut contacts the head of compensator (4).
3. Turn compensator (4) in by hand until the compensator (4) contacts piston (2).

Note: If compensator (4) can be turned in completely and does not contact piston (2), then brake pack (1) must be replaced. If compensator (4) contacts piston (2), proceed to the Testing and Adjusting, "Adjustment Procedure" in this article.

Adjustment Procedure

1. Back off compensator (4) according to the specifications that are reflected in the table. Refer to Table 21 .
2. Hold compensator (4) in position from Step 1 and tighten nut to $50 \pm 10 \text{ N}\cdot\text{m}$ ($37 \pm 7 \text{ lb ft}$).

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