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RENR9614-02

Systems Operation

303.5C CR and 303C CR Mini Hydraulic Excavators Hydraulic System

S/N: DMY1-UP

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i04677649

General Information

SMCS - 4000; 4250; 4265; 4284; 4300; 4801; 5050

ReferenceFor Testing and Adjusting of the hydraulic system, refer to Testing and Adjusting, "Hydraulic System".

ReferenceFor more information on specifications, refer to Specifications, "Machine System Specifications".

ReferenceFor more information on the hydraulic schematics, refer to Schematic, "Hydraulic System".

ReferenceFor more information on electrical schematics, refer to Schematic, " Electrical System".

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303.5C CR and 303C CR Mini Hydraulic Excavators Hydraulic System
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i02676714

Main Hydraulic System

SMCS - 5050; 5051; 5069; 5117; 5472

Schematic of Main Hydraulic System

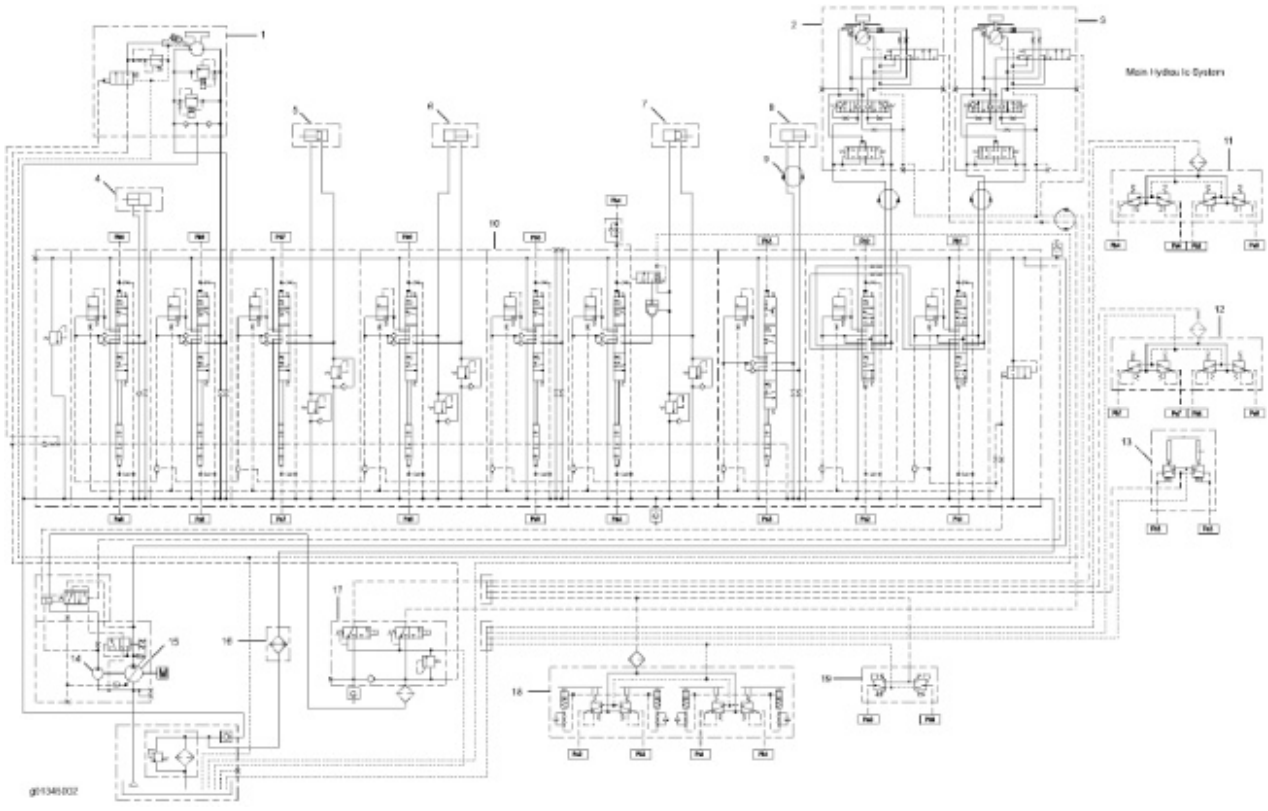

Illustration 1 g01345002

(1) Swing motor

(2) Travel motor (Left)

(3) Travel motor (Right)

(4) Swing boom cylinder

(5) Stick cylinder

(6) Bucket cylinder

(7) Boom cylinder

(8) Blade cylinder

(9) Swivel

(10) Main control valve

(11) Pilot control valve (Boom and Bucket)

(12) Pilot control valve (Swing and Stick)

(13) Pilot control valve (Blade)

(14) Pilot pump

(15) Main pump

(16) Oil cooler

(17) Pilot manifold

(18) Pilot Control Valve (Travel)

(19) Pilot control valve (Swing boom)

(20) Hydraulic tank

(21) Oil filter

Pump Flow and Pressure Control System

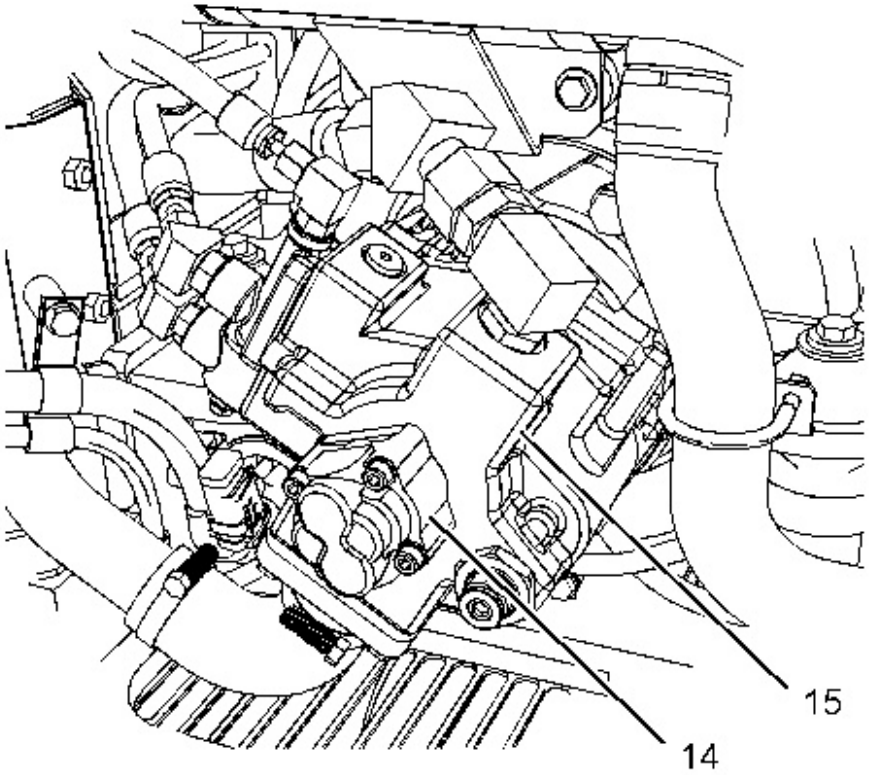

Illustration 2 g01210074

Pump compartment

(14) Pilot pump

(15) Main pump

This machine is driven and controlled by the following systems:

- The main hydraulic system provides oil to the boom cylinders, the stick cylinder, and the bucket cylinder. The main hydraulic system also provides oil to the travel motors and the swing motor.
- The pilot hydraulic system provides oil to the control circuit.

Main pump (15) is directly connected to the engine through a coupling. The main pump is constructed as a single body with one main outlet.

The pump is a variable displacement piston pump. The pistons are arranged in a common cylinder block. The main pump supplies oil to the main control valve.

When an operation is being performed, the main control valve directs pump oil to the respective cylinders (boom, stick, and bucket) and/or motors (swing and travel). The main control valve contains numerous valve stems, passages, check valves, relief valves, and orifices in order to carry out a single operation or a combined operation. The working pressure of the main hydraulic system is restricted by the main relief valve.

ReferenceFor more information on the main control valve, see Systems Operation, "Main Control Valve".

The output flow of the main pump is maximized at no load. As the load pressure increases during working conditions, and the oil delivery pressure increases and the oil flow rate decreases. The hydraulic horsepower remains constant even though the delivery pressure and the flow rates change. The hydraulic horsepower is approximately identical to the engine horsepower.

When there is no load on the machine, pump oil flows through the main control valve to the hydraulic tank. When a load is applied to the machine, pump oil is divided at the main control valve. The oil is sent to the travel motor, the swing motor, and the cylinders.

ReferenceFor more information on the main pump, see Systems Operation, "Main Hydraulic Pump".

The pilot pump (14) is a gear type pump that is connected to the rear of the main pump.

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Media Number -RENR9614-02 **Publication Date -01/01/2007** **Date Updated -24/01/2007**

i02676755

Pilot Hydraulic System

SMCS - 5050-PS

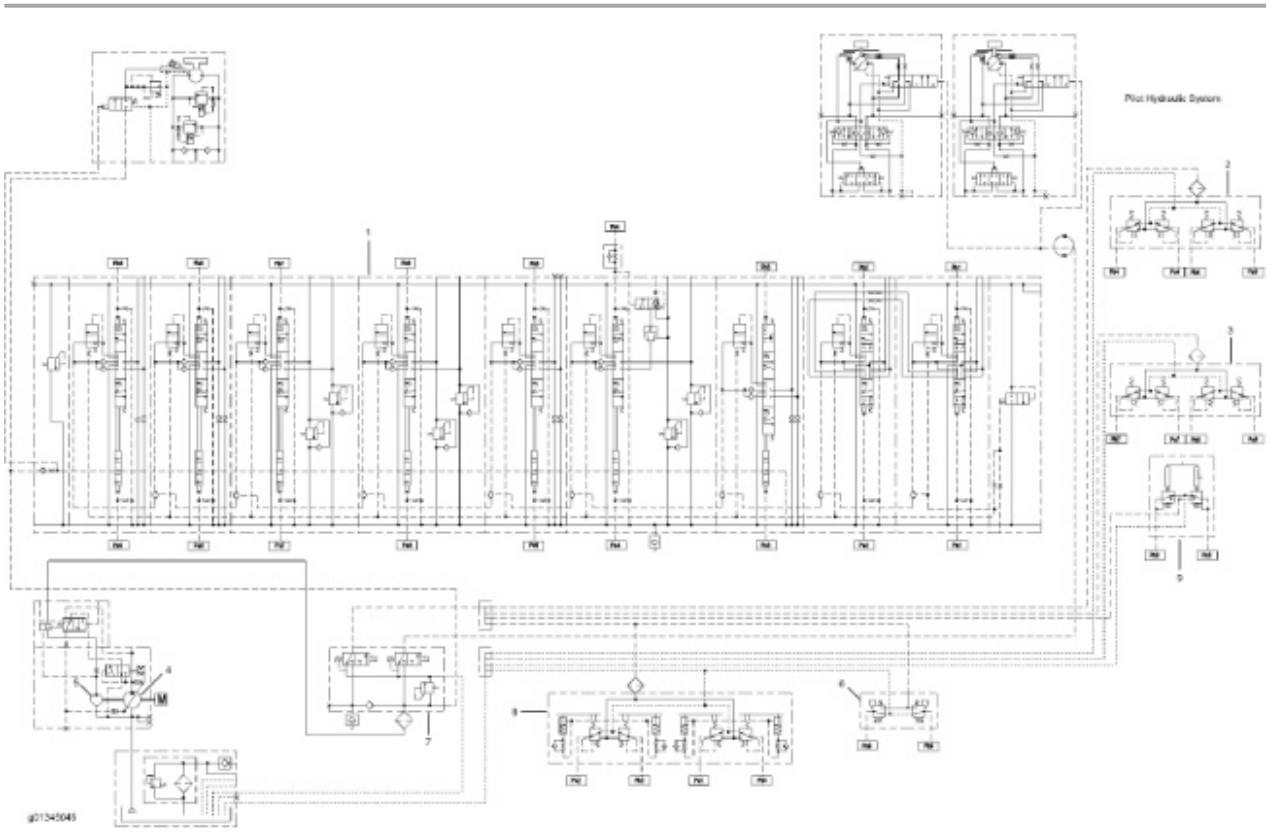

Illustration 1 g01345045

Partial hydraulic schematic

(1) Main control valve

(2) Pilot control valve (Boom and Bucket)

(3) Pilot control valve (Stick and Swing)

(4) Main hydraulic pump

(5) Pilot pump

(6) Pilot control valve (Swing Boom)

(7) Pilot manifold

(8) Pilot control valve (Travel)

(9) Pilot control valve (Blade)

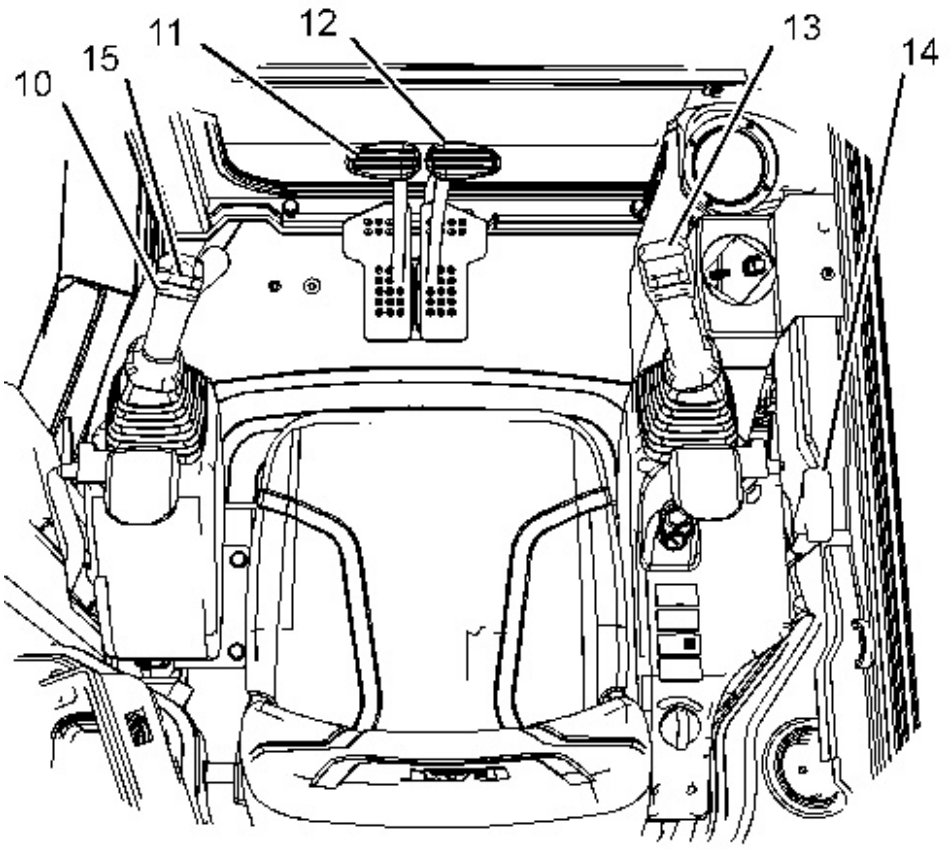

Illustration 2 g01210126

Operator's compartment

(10) Left joystick (Stick and Swing)

(11) Left travel lever

(12) Right travel lever

(13) Right joystick (Boom and Bucket)

(14) Blade control lever

(15) Joystick slide control for the swing boom

The flow rate of the pilot pump does not vary as the pump directs oil under pressure to the main control valve. The pressure of the pilot system is regulated by the pilot relief valve.

Pilot oil has the following functions:

Operation of the main control valve - When joysticks (2) and (3) are operated, pilot oil is sent to main control valve (1) via pilot control valves (2) , and (3) . See Illustration 1. The boom swing is activated by joystick slide control for the swing boom (13) .

Generation of signal pressure - The following operations are carried out by the signal pressure that is generated in the pilot circuit:

- The swing parking brake is released.

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Systems Operation
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Media Number -RENR9614-02 **Publication Date -01/01/2007** **Date Updated -24/01/2007**

i02556488

Relief Valve (Pilot)

SMCS - 5072

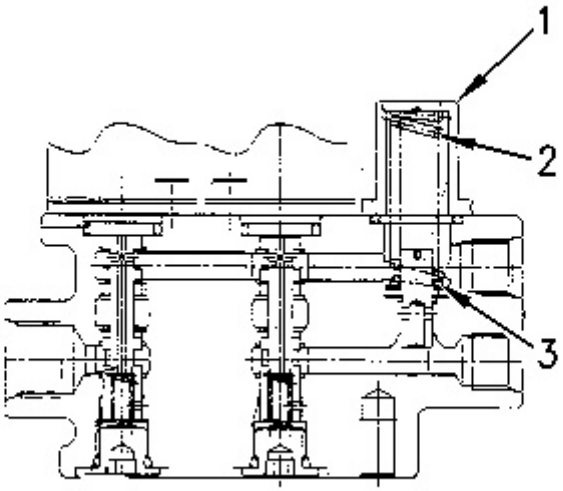

Illustration 1 g00843356

Pilot relief valve

(1) Relief valve

(2) Spring

(3) Shim

The pilot relief valve is located inside the pilot and travel speed manifold. The pilot relief valve protects the pilot system from damage that could occur if the pressure in the system was too high.

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Systems Operation
303.5C CR and 303C CR Mini Hydraulic Excavators Hydraulic System
Media Number -RENR9614-02 **Publication Date -01/01/2007** **Date Updated -24/01/2007**

i02436859

Accumulator (Pilot)

SMCS - 5077

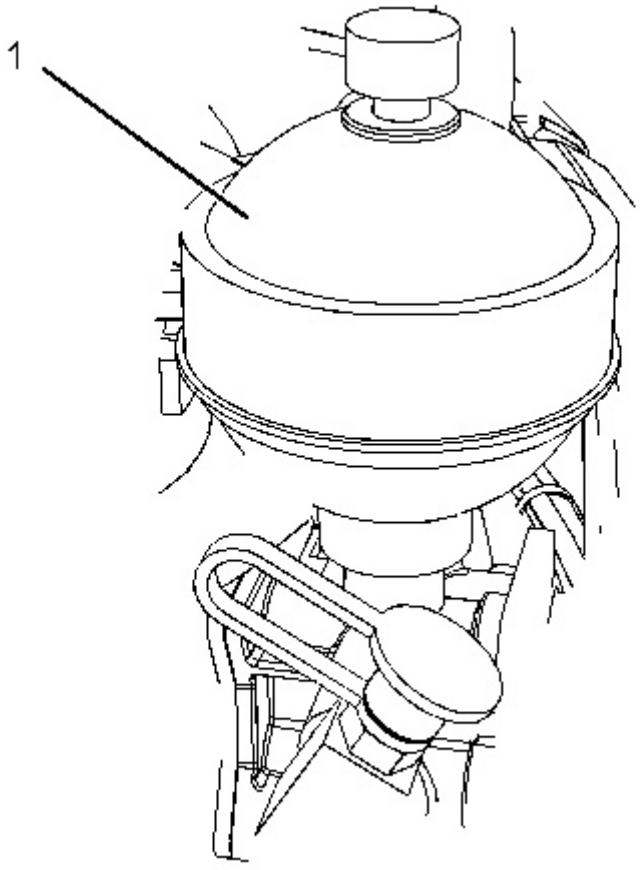

Illustration 1 g01217387

(1) Accumulator

Accumulator (1) maintains a residual pressure in the pilot system. The residual pressure helps to eliminate erratic movement of the hydraulic controls during combined operations. Also, the residual pressure allows the implements to be lowered when the engine is not running.

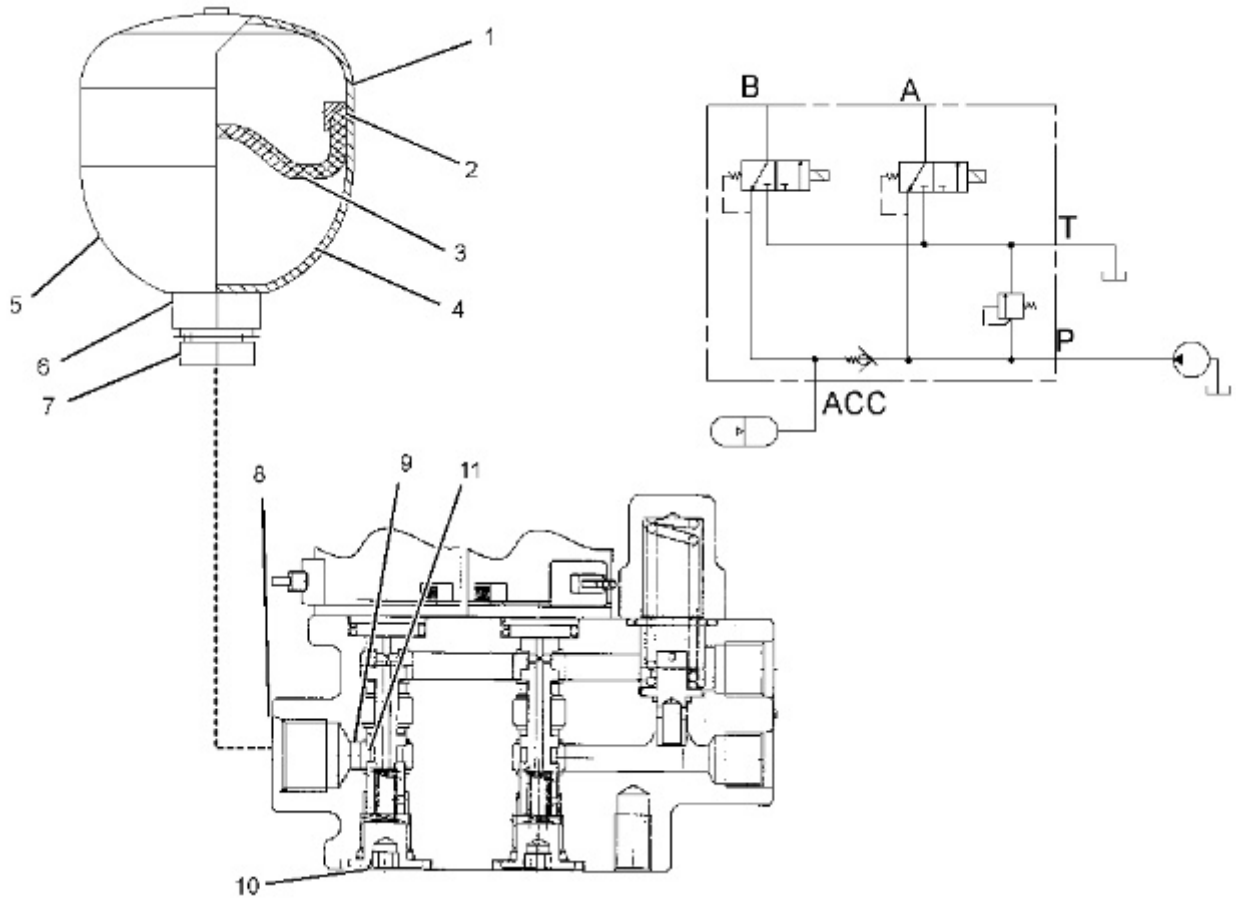

Illustration 2 g012173

Accumulator

(1) Gas chamber

(2) Bladder

(3) Vessel

(4) Pressure oil chamber

(5) Accumulator

(6) Inlet port

(7) Adapter As

(8) ACC Accumulator Port

(9) Passage

(10) Check valve

(11) Passage

(A) Port for two-speed travel

(B) Port for the swing brake

(ACC) Accumulator Port

(P) Inlet port (pilot oil manifold)

(T) Tank port

Pilot oil from the pilot filter enters inlet port (P) of the pilot oil manifold. Pilot oil flows through passage (11) and opens check valve (10). Pilot oil now flows through passages (A) and (B) to the pilot control valves (joysticks and travel levers/pedals).

The pilot oil also flows through passage (9) to adapter (7) for accumulator (5). The pilot oil now flows through inlet port (6) into pressure oil chamber (4). The pilot oil acts against bladder (2) and the nitrogen gas in gas chamber (1) is compressed. Check valve (10) prevents a backflow of the stored oil in the accumulator.

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Systems Operation
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Media Number -RENR9614-02 **Publication Date -01/01/2007** **Date Updated -24/01/2007**

i02421705

Implements and Swing Controls Alternate Patterns

SMCS - 5065-PS

Two-Way Valve

WARNING

WHENEVER A CHANGE IS MADE TO THE MACHINES CONTROL PATTERN ALSO EXCHANGE THE PATTERN CARD IN THE CAB TO MATCH THE NEW PATTERN. FOLLOW THE CORRECT PROCEDURE IN THE OPERATOR AND MAINTENANCE MANUAL.

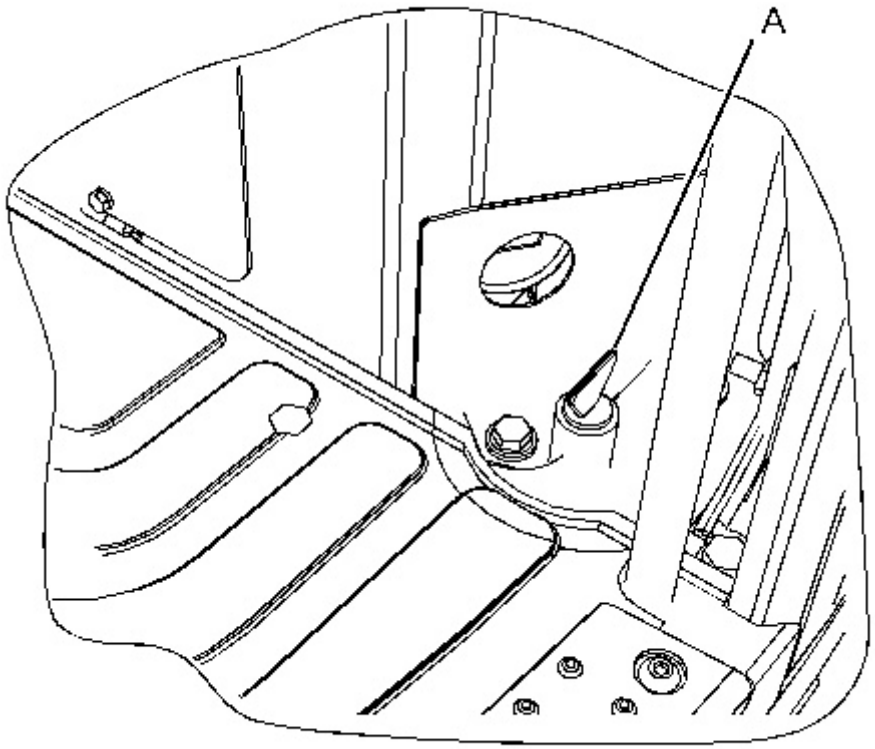

Illustration 1 g01210030

The joystick control selector is located under the seat.

(A) Lever

The machine control pattern can easily be changed to the SAE system or to the standard backhoe loader hydraulic system (BHL) by changing the position of the two-way valve.

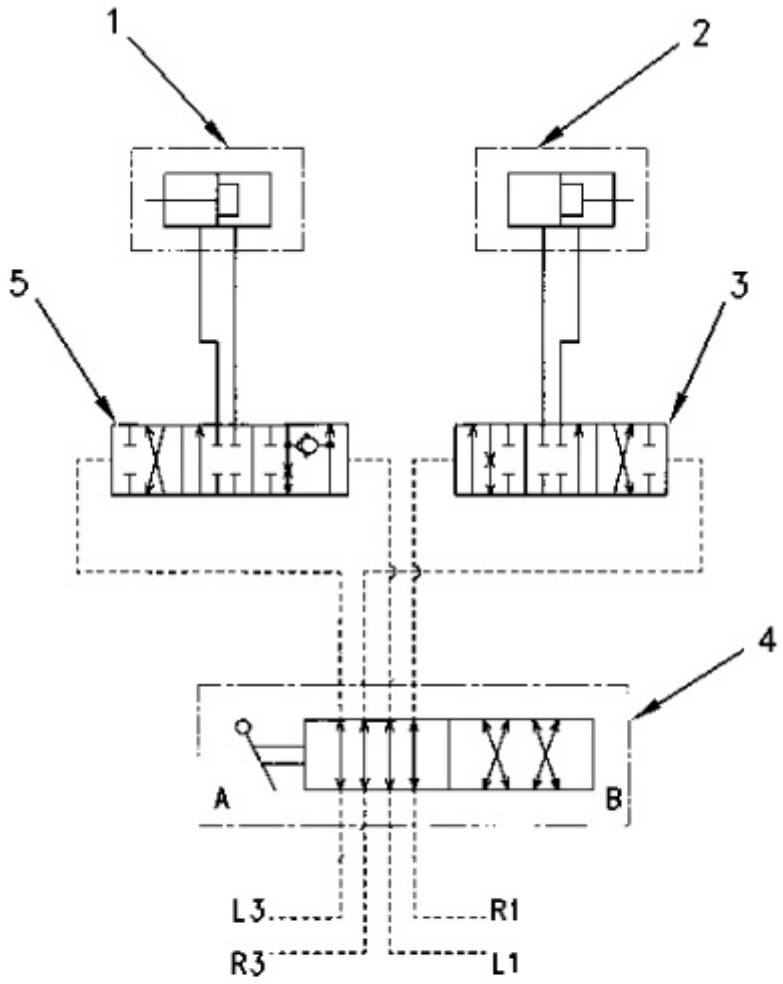

Illustration 2 g00840184

(1) Stick cylinder

(2) Boom cylinder

(3) Boom control valve

(4) Joystick control selector

(5) Stick control valve

(A) Standard position (SAE)

(B) Alternate position (standard backhoe loader hydraulic system (BHL))

(R1, R3) Pilot supply from the right side pilot control valve (joystick)

(L1, L3) Pilot supply from the left side pilot control valve (joystick).

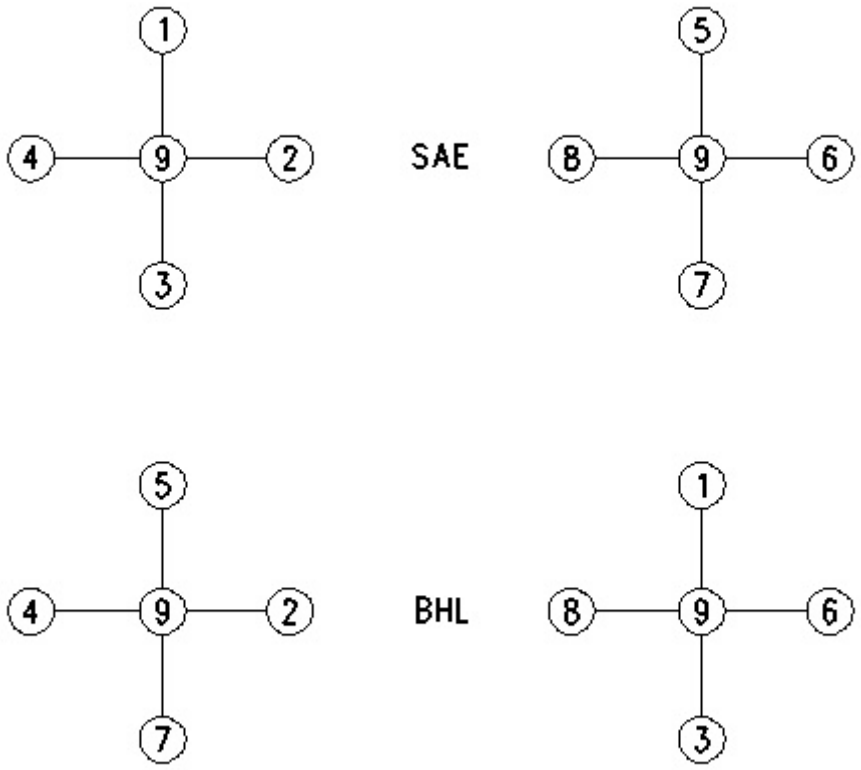

Illustration 3 g00842464

The patterns on the left side of Illustration 3 show the possible configurations for the left control lever. The patterns on the right side of the illustration show the possible configurations for the right control lever.

Stick Out (1) - Move the control lever to this position in order to move the stick outward.

Swing Right (2) - Move the control lever to this position in order to swing the upper structure to the right.

Stick In (3) - Move the control lever to this position in order to move the stick inward.

Swing Left (4) - Move the control lever to this position in order to swing the upper structure to the left.

Boom Lower (5) - Move the control lever to this position in order to lower the boom.

Bucket Dump (6) - Move the control lever to this position in order to dump the bucket.

Boom Raise (7) - Move the control lever to this position in order to raise the boom.

Bucket Close (8) - Move the control lever to this position in order to close the bucket.

HOLD (9) - When the control lever is released from any position, the control lever will return to the HOLD position. Movement of the upper structure will stop.

Two functions may be performed at the same time by moving a control lever diagonally.

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Media Number -RENR9614-02 **Publication Date -01/01/2007** **Date Updated -24/01/2007**

i04019174

Main Hydraulic Pump

SMCS - 5070-MV

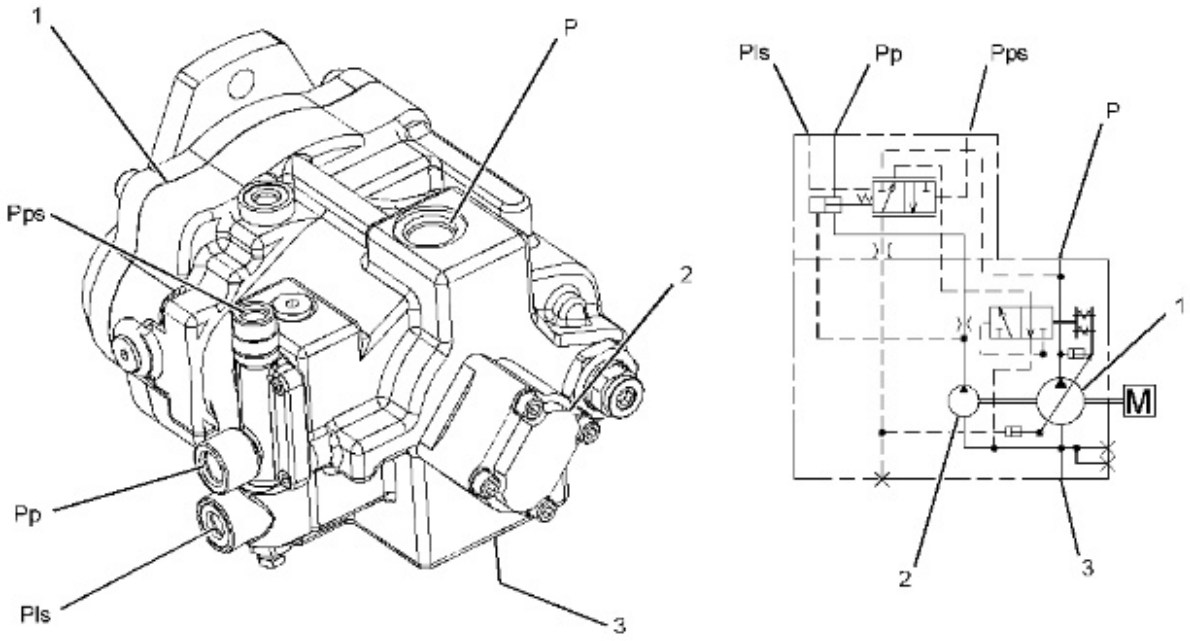

Illustration 1 g02192314

Main hydraulic pump

(1) Main Pump

(2) Pilot Pump

(3) Suction port

(P) Outlet port (Main Pump)

(Pls) Load sensing signal

(Pp) Outlet port (pilot pump)

(Pps) Pump pressure signal

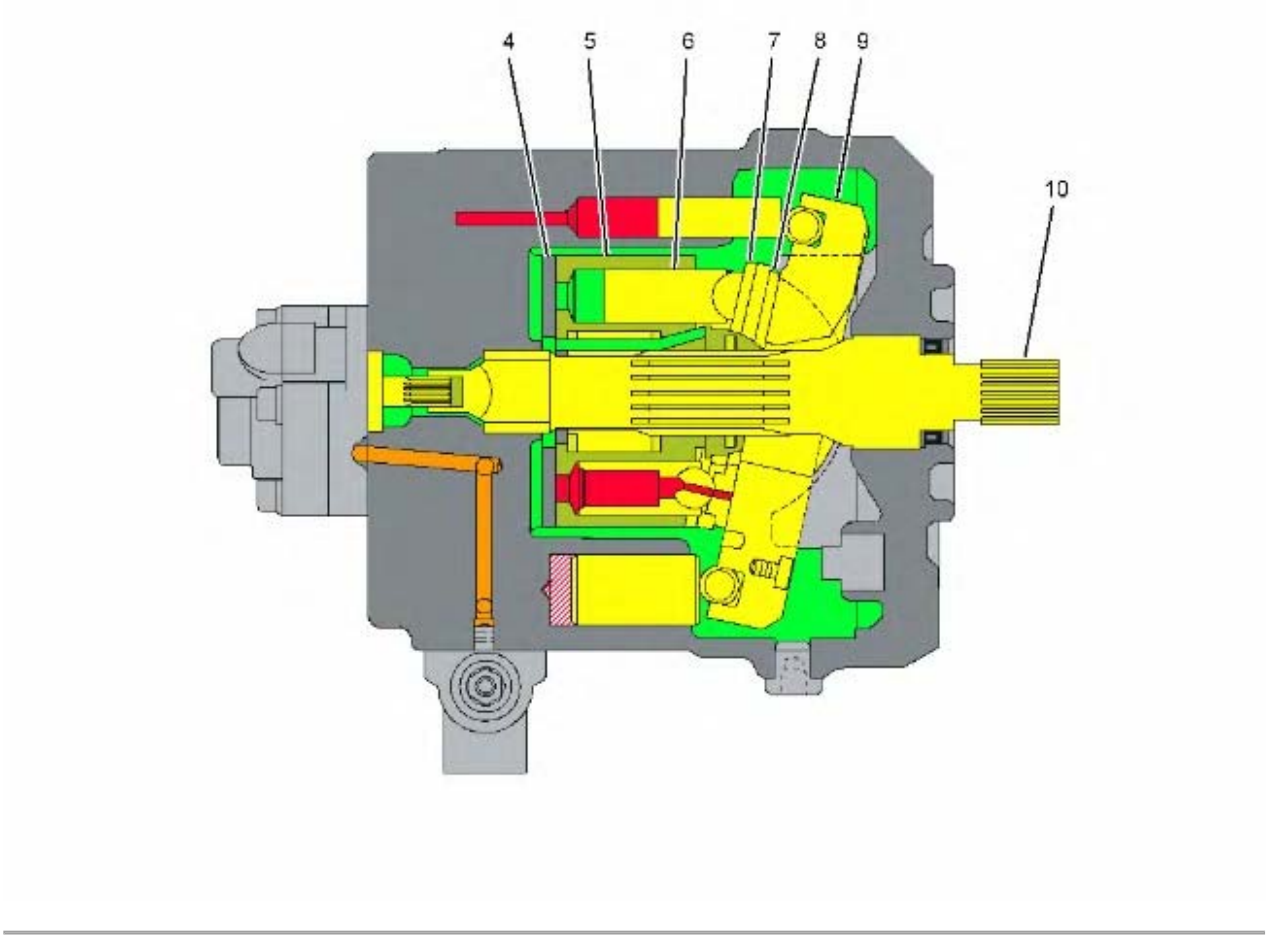

Illustration 2 g02192496

Rotating group

(4) Valve plate

(5) Barrel

(6) Piston

(7) Retainers

(8) Shoe

(9) Swashplate

(10) Shaft

The main pump is constructed as a single body with one outlet. The main pump is a variable displacement piston pump. The pump consists of barrel (5) , pistons (6) , and swashplate (9) in the pump housing.

Oil from the hydraulic tank enters the pump through suction port (3) . Then, the oil is drawn through the inlet passage into the pilot pump. The pilot pump is directly connected to the main pump.

Shaft (10) is directly connected to the engine. Barrel (5) is splined to the shaft. When the shaft rotates, the barrel rotates. As a result, pistons (6) , shoes (8) , and retainers (7) rotate.

The shoes are connected to the pistons. When the shaft rotates, retainers (7) push the shoes against swashplate (9) . At the same time pistons (6) rotate on the inclined plane of the swashplate. As the shoes ride up on the inclined plane, oil is pushed out of the pistons. At the end of this stroke the shoes follow the inclined plane of the swashplate. This action creates a suction which draws oil into the pistons.

Oil from the hydraulic tank enters the pump through suction port (3) and the oil is drawn through the inlet passages in valve plate (4) . Oil that is pushed out of pistons (6) flows to outlet port (P) . The oil is directed to the main control valve.

The pump regulator changes the angle of the swashplate according to the flow that is required for a machine operation. As the angle of the inclined surface of the swashplate changes, the stroke of pistons (6) changes and the pump output increases or decreases.

ReferenceFor additional information on the pump regulator, see Systems Operation, "Pump Control (Main Hydraulic)".

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Systems Operation
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i04020786

Pump Control (Main Hydraulic)

SMCS - 3222; 5070; 5086

Standby

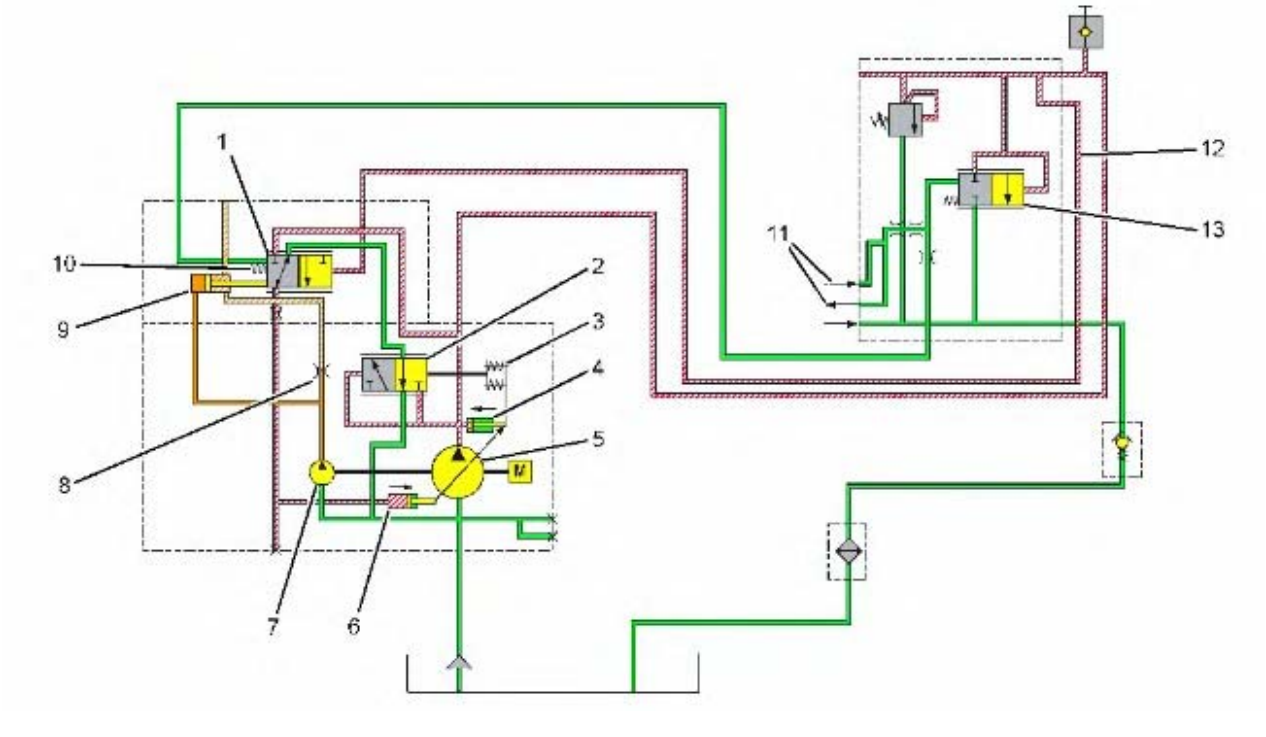

Illustration 1 g02197433

Regulation of pump flow (standby)

(1) Flow compensator spool

(2) Torque control spool

(3) Torque control springs

(4) Small actuator

(5) Main hydraulic pump

(6) Large actuator

(7) Pilot pump

(8) Orifice

(9) Margin boost cylinder

(10) Flow compensator spring

(11) Load signal (LS)

(12) Supply pressure

(13) Unload valve (margin relief)

Main hydraulic pump (5) is a variable displacement piston pump. The main hydraulic pump is controlled by torque control spool (2) and flow compensator spool (1) in order to control the amount of oil flow.

Torque control spool (2) will reduce the maximum pump flow available as the system pressure increases to prevent engine stall. Maximum hydraulic horsepower is controlled without excessively lugging the engine. Torque control spool (2) has priority control over flow compensator spool (1) . Torque control spool (2) will destroke the pump in a stall condition.

Whenever torque control spool (2) is not controlling the pump, flow compensator spool (1) controls the upstroking and destroking of the pump. This action maintains the desired flow to the implements. Flow compensator spool (1) compares load signal pressure (11) from the implements and supply pressure (12) . The flow compensator spool shifts to maintain a pressure differential between the two by signaling the pump to adjust the flow.

Margin boost cylinder (9) works with flow compensator spool (1) and against the pump supply pressure on the right side of the flow compensator spool. Pressure oil from the pilot pump supplies the margin boost cylinder.

As engine speed varies, the pilot flow will vary. Due to the flow through orifice (8) , the pressure differential across the orifice will vary. At higher engine speeds the pressure differential is greater and margin boost cylinder (9) will move more to the right to assist flow compensator spring (10) , which will make the system more responsive.

At lower engine speeds the pressure differential across orifice (8) is less, which will result in a less responsive system. With less response the system will provide more precise control of the implements.

Unload valve (margin relief) (13) is used to unload the pump at standby or when the pump flow is reduced rapidly.

Due to the leakage to tank across unload valve (13) , the pump will be slightly upstroked. This extra stroking of the pump will allow for faster response when the system state changes from NEUTRAL to an activated state. The unload valve also reduces pressure spikes in the system.

Upstroke

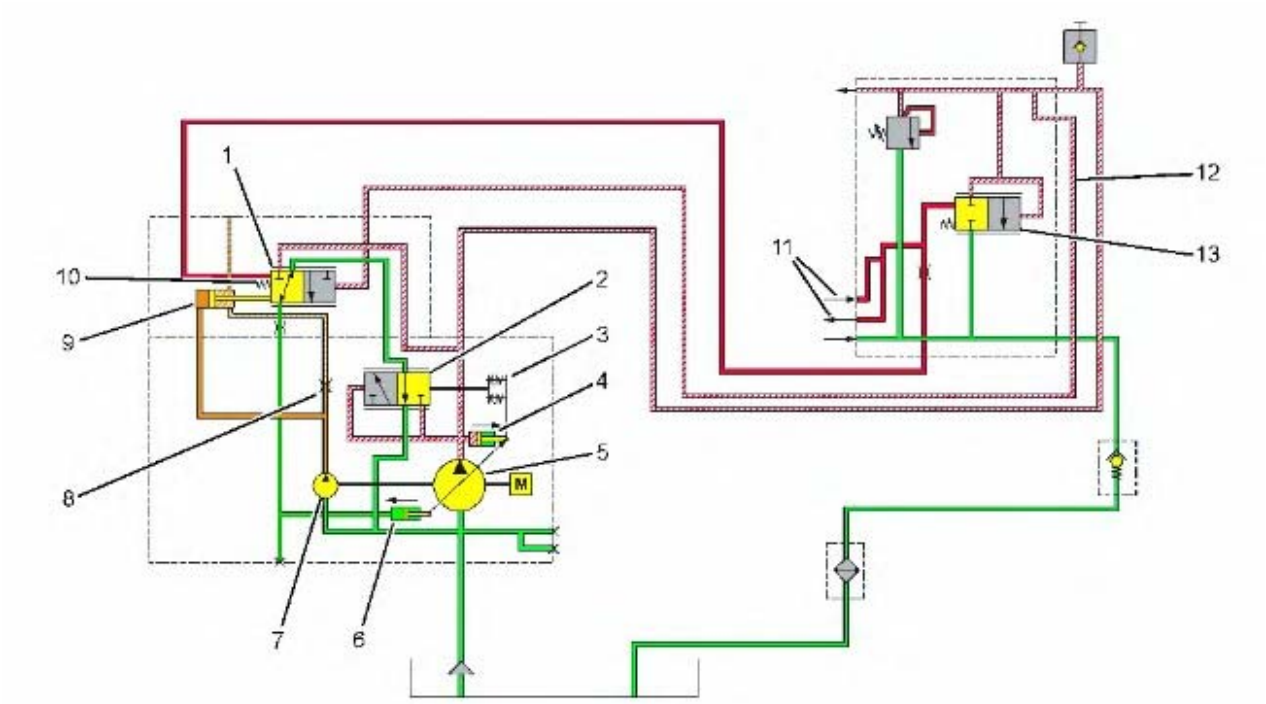

Illustration 2 g02199075

Regulation of pump flow (upstroke)

(1) Flow compensator spool

(2) Torque control spool

(3) Torque control springs

(4) Small actuator

(5) Main hydraulic pump

(6) Large actuator

(7) Pilot pump

(8) Orifice

(9) Margin boost cylinder

(10) Flow compensator spring

(11) Load signal (LS)

(12) Supply pressure

(13) Unload valve (margin relief)

When a circuit is activated, load signal (LS) (11) is directed to the pump. The LS signal results in an imbalance of forces working on flow compensator spool (1) due to the need for increased flow.

Flow compensator spool (1) moves to the right to drain oil from large actuator (6) . Since torque control springs (3) continue to hold torque control spool (2) to the left, the return oil flows through the torque control spool to the tank.

Supply pressure in small actuator (4) causes the pump swashplate to shift and the pump upstrokes.

At the same time LS signal (11) moves unload valve (13) to the right to block supply oil from flowing to the tank.

Constant Flow Control

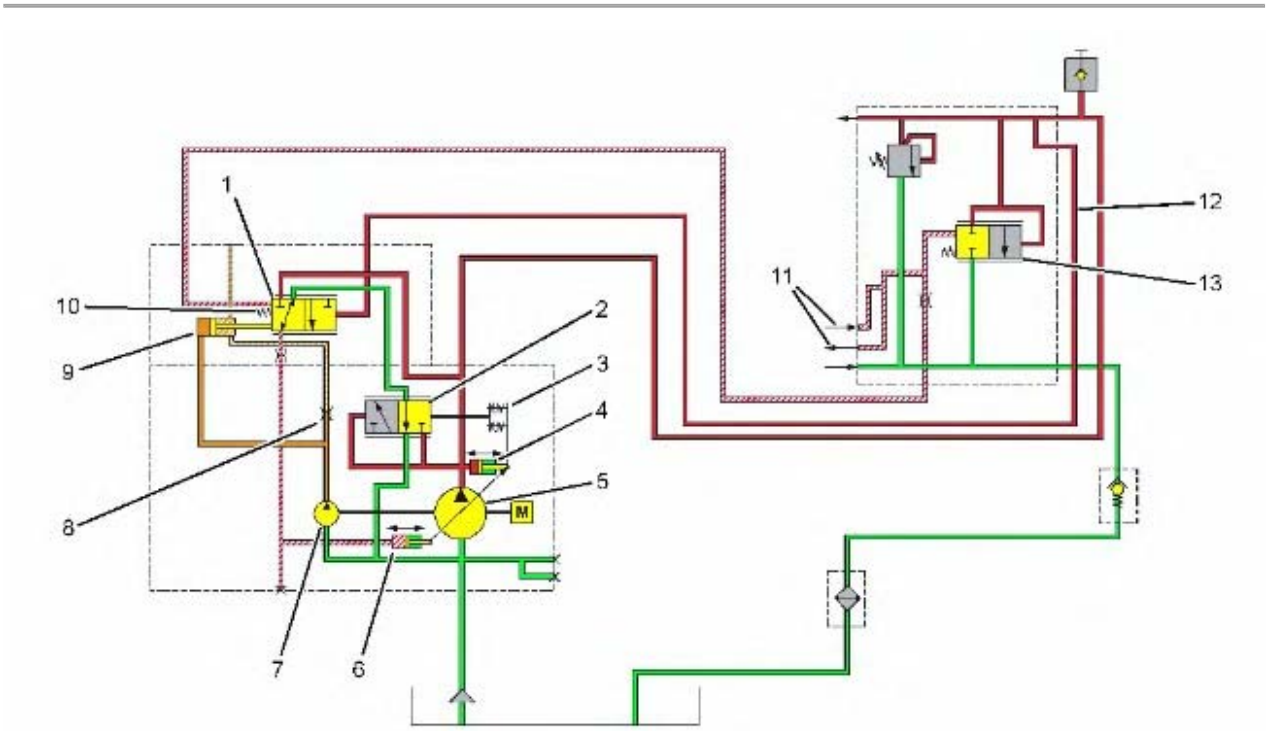

Illustration 3 g02197235

Regulation of pump flow (constant flow)

(1) Flow compensator spool

(2) Torque control spool

(3) Torque control springs

(4) Small actuator

(5) Main hydraulic pump

(6) Large actuator

(7) Pilot pump

(8) Orifice

(9) Margin boost cylinder

(10) Flow compensator spring

(11) Load signal (LS)

(12) Supply pressure

(13) Unload valve (margin relief)

As the pump flow increases, the supply pressure increases. As the supply pressure increases flow compensator spool (1) will move back to the left until forces on both sides of the compensator are in balance.

When the forces are balanced, the pump will produce relatively constant flow until the flow demand changes.

The difference between the supply pressure (12) and load signal pressure (11) is called margin pressure.

Torque control springs (3) continue to hold torque control spool (2) to the left.

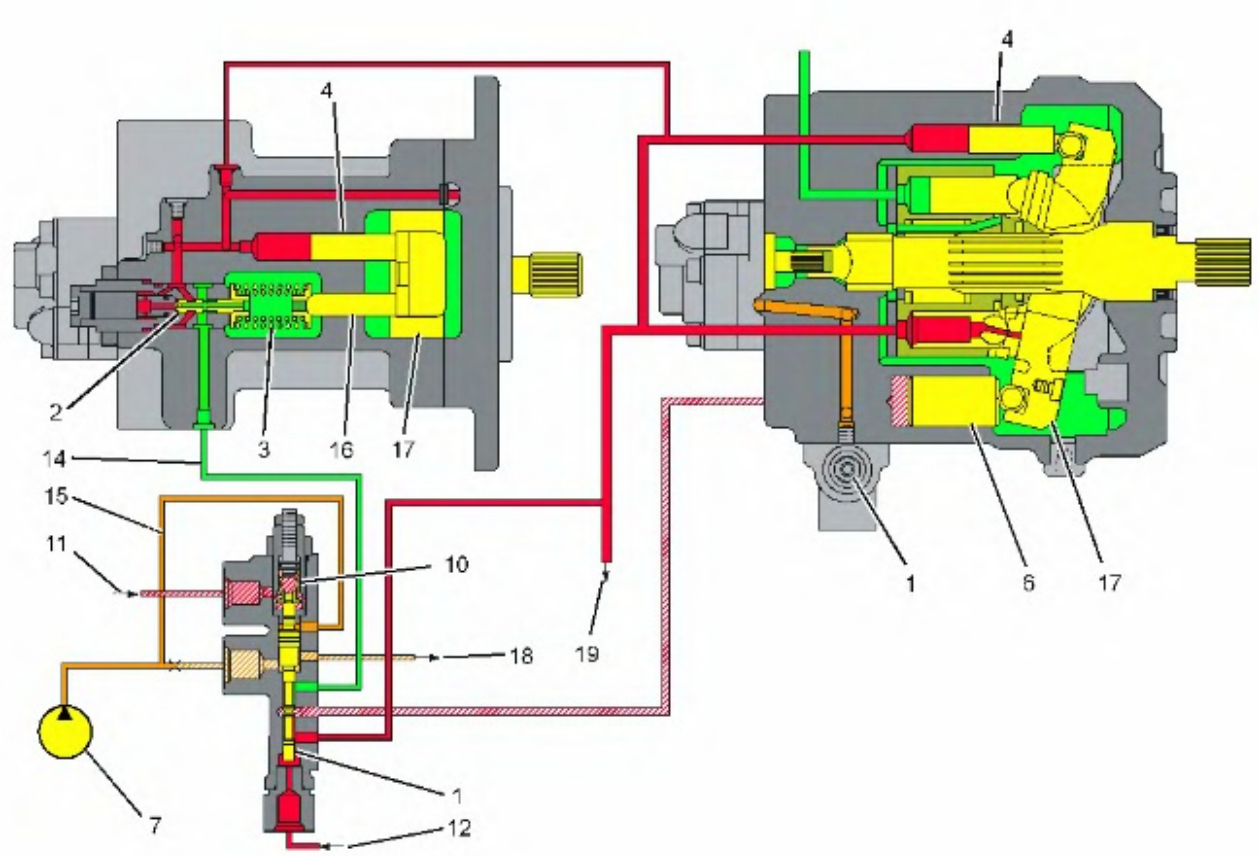

Illustration 4 g02195658

Cutaway view of main hydraulic pump (constant flow)

(1) Flow compensator spool

(2) Torque control spool

(3) Torque control springs

(4) Small actuator

(6) Large actuator

(7) Pilot pump

(10) Flow compensator spring

(11) Load signal (LS)

(12) Supply pressure

(14) Drain passage

(15) Margin boost pressure

(16) Piston

(17) Swashplate

(18) Pilot oil to pilot manifold

(19) Pump supply to main control valve

In this constant flow cutaway view of the pump, flow compensator spool (1) is metering some pump supply oil to large actuator (6) to control the angle of swashplate (17) .

Supply pressure (12) is being sensed below compensator spool (1) and works against load signal pressure (11) , margin boost pressure (15) , and flow compensator spring (10) .

Pilot pump (7) provides the oil to create margin boost pressure (15) . The margin boost pressure will change with the speed of the engine. The higher the engine speed the greater the boost pressure.

Drain passage (14) from flow compensator spool (1) is directed to the tank through torque control spool (2) .

Torque control springs (3) change tension with the angle of swashplate (17) . The greater the swashplate angle the less spring tension there is.

Destroke

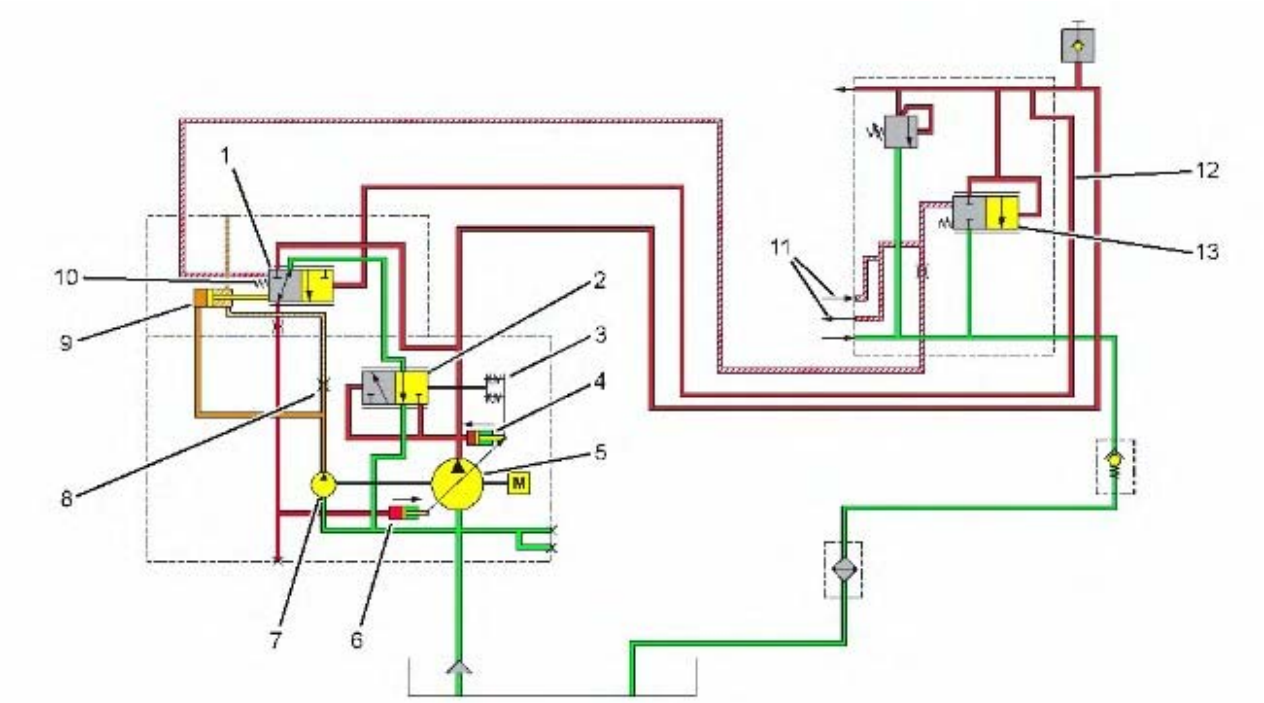

Illustration 5 g02199093

Regulation of pump flow (destroke)

(1) Flow compensator spool

(2) Torque control spool

(3) Torque control springs

(4) Small actuator

(5) Main hydraulic pump

(6) Large actuator

(7) Pilot pump

(8) Orifice

(9) Margin boost cylinder

(10) Flow compensator spring

(11) Load signal (LS)

(12) Supply pressure

(13) Unload valve (margin relief)

When less flow is needed, an imbalance of forces occurs on flow compensator spool (1) . The flow compensator spool moves to the left to direct supply oil to large actuator (6) to destroke the pump.

Unload valve (13) also moves to the left to unload some of the pump flow to the tank. This action helps the system respond faster to the reduction in the flow needed.

As the pump flow is reduced the forces on each side of flow compensator spool (1) start to balance and the pump once again produces only the flow needed to meet the demand.

Torque control springs (3) continue to hold torque control spool (2) to the left.

Torque Control

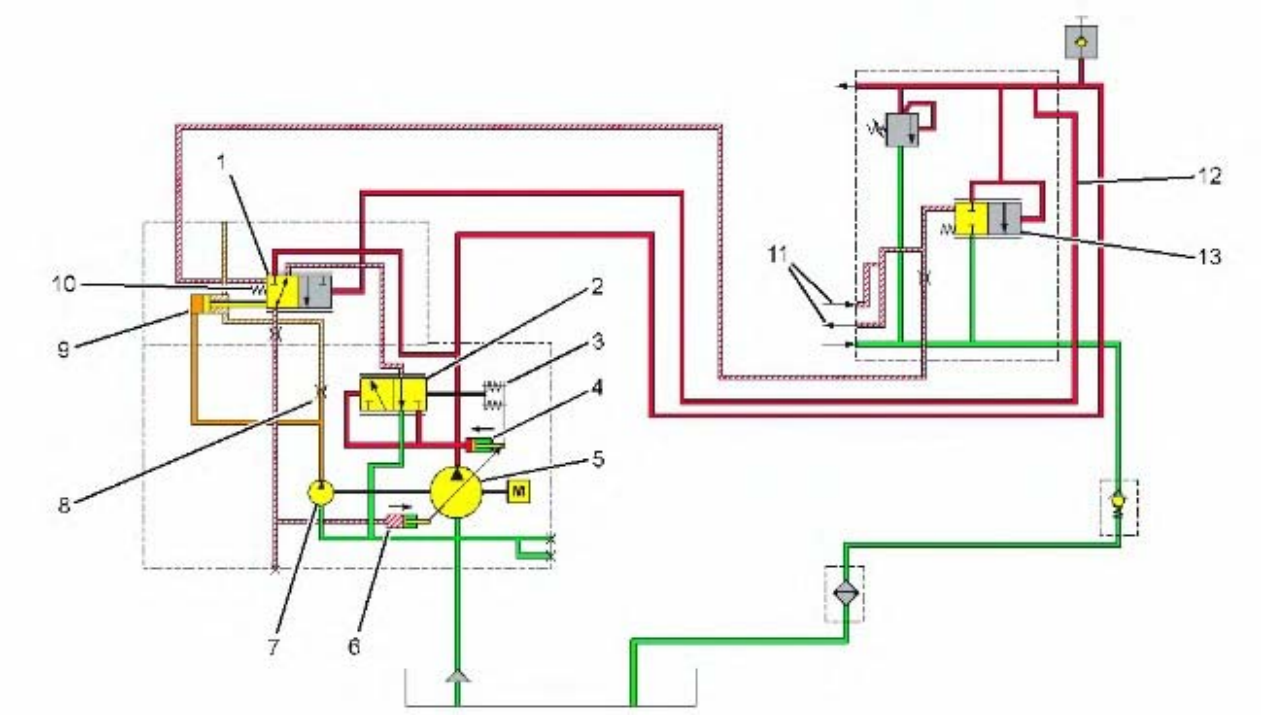

Illustration 6 g02197317

Regulation of pump flow (torque control)

(1) Flow compensator spool

(2) Torque control spool

(3) Torque control springs

(4) Small actuator

(5) Main hydraulic pump

(6) Large actuator

(7) Pilot pump

(8) Orifice

(9) Margin boost cylinder

(10) Flow compensator spring

(11) Load signal (LS)

(12) Supply pressure

(13) Unload valve (margin relief)

Torque control springs (3) are affected by the angle of swashplate (17) . The higher the swashplate angle the less resistance the springs have to the supply pressure working on the left end of torque control spool (2) .

When the supply pressure overcomes the force of torque control springs (3) torque control spool (2) shifts to direct some pump supply to flow compensator spool (1) . At the flow compensator spool, pump supply oil is directed to large actuator (6) to destroke the pump as needed.

Maximum hydraulic horsepower is maintained, but the pump produces less flow.

Since the flow needs are no longer met due to torque control spool (2) taking over control of the pump, flow compensator spool (1) will shift to the right.

Torque control spool (2) will maintain control of the pump. The pump flow provided will follow the torque curve of the pump as LS signal pressure (11) varies.

If the LS signal pressure (11) or the flow needs are reduced to a point below the torque curve, torque control springs (3) will move torque control spool (2) fully to the left and return flow control of the pump to flow compensator spool (1) .

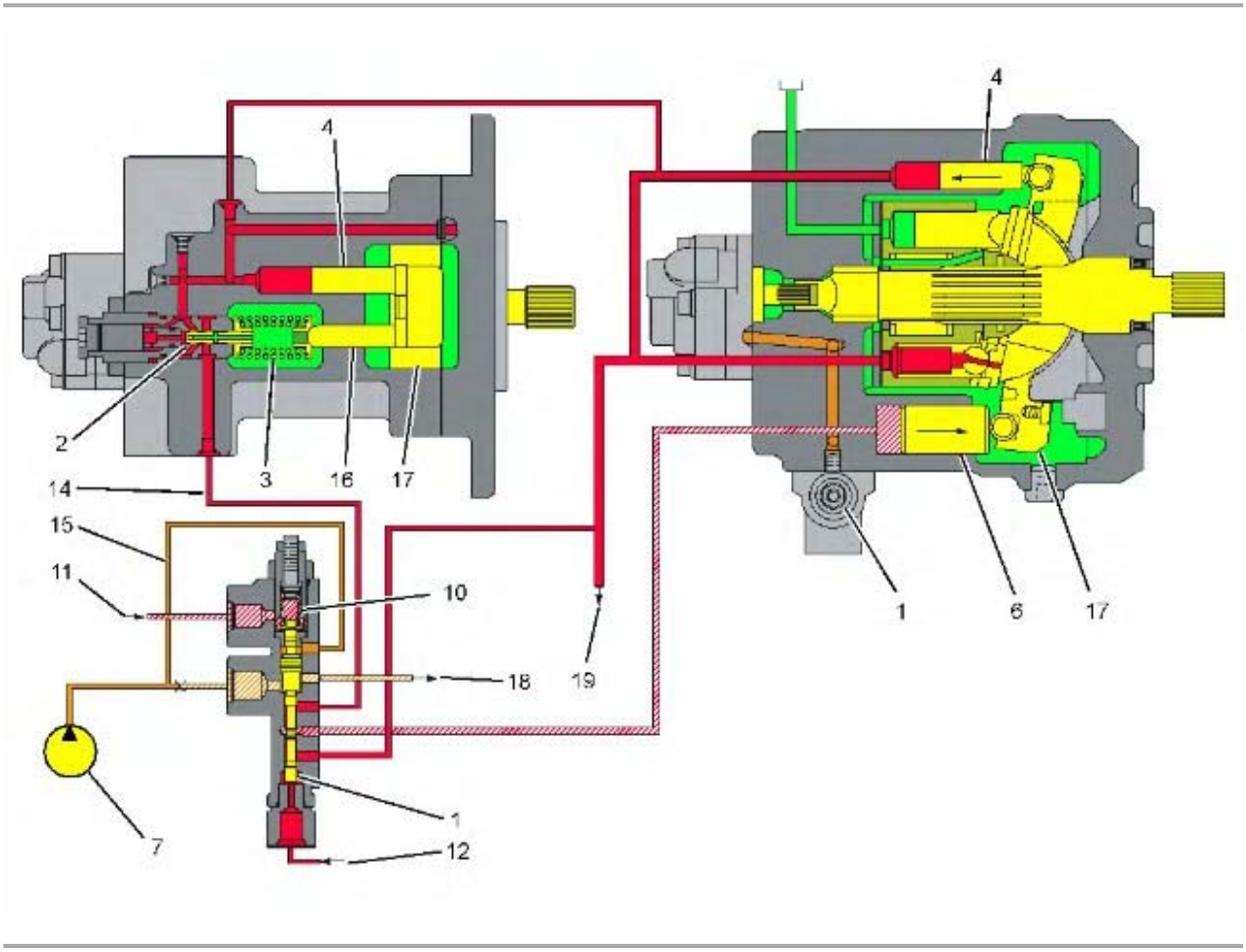

Illustration 7 g02196962

Cutaway view of main hydraulic pump (torque control)

(1) Flow compensator spool

(2) Torque control spool

(3) Torque control springs

(4) Small actuator

(6) Large actuator

(7) Pilot pump

(10) Flow compensator spring

(11) Load signal (LS)

(12) Supply pressure

(14) Drain passage

(15) Margin boost pressure

(16) Piston

(17) Swashplate

(18) Pilot oil to pilot manifold

(19) Pump supply to main control valve

When the pump supply pressure increases to move torque control spool (2) to the left, drain passage (14) from flow compensator spool (1) is blocked from being connected to tank. Pump supply oil from torque control spool (2) is directed to flow compensator spool (1) through drain passage (14) .

Supply pressure from passage (14) causes flow compensator spool (1) to move down. Pump supply oil is now sent from torque control spool (2) to larger actuator (6) in order to destroke the pump. This action prevents the engine from excessive lugging.

Pressure/Flow Characteristic Curves

Diesel Engines

ABS	Agco-Sisu
Akasaka	Baudouin
BMW	Bukh
Caterpillar	CHN 25/34
Cummins	Daihatsu
Detroit	Deutz
Doosan-Daewoo	Fiat
Ford	GE
Grenaa	Guascor
Hanshin	Hatz
Hino	Honda
Hyundai	Isotta
Isuzu	Iveco
John-Deere	Kelvin
Kioti	Komatsu
Kubota	Liebherr
Lister	Lombardini
MAK	MAN B&W
Mercedes	Mercruiser
Mirrlees BS	Mitsubishi
MTU	MWM
Niigata	Paxman
Perkins	Pielstick
Rolls / Bergen	Ruggerini
Ruston	Scania
Shibaura	Sisu-Valmet
SKL	Smit-Bolnes
Sole	Stork
VM-Motori	Volvo
Volvo Penta	Westerbeke
Wichmann	Yanmar

Machinery

ABG	Airman
Akerman	Ammann
Astra	Atlas Copco
Atlas Weyha.	Atlet
Bell	Bendi
Bigjoe	Bobcat
Bomag	BT
Carelift	Case
Caterpillar	Cesab
Challenger	Champion
Claas	Clark
Combilift	Crown
Daewoo-Doosan	Demag
Deutz-Fahr	Dressta

Machinery

Drott	Dynapack
Extec	Faun
Fendt	Fiat
Fiatallis	Flexicoil
Furukawa	Gehl
Genie	Grove-gmk
Halla	Hamm
Hangcha	Hanix
Hanomag	Hartl
Haulpack	Hiab
Hidromek	Hino truck
Hitachi	Hyster
Hyundai	IHI
Ingersoll-rand	JCB
JLG	John-Deere
Jungheinrich	Kalmar
Kato	Kioti
Kleeman	Kobelco
Komatsu	Kramer
Kubota	Lamborghini
Landini	Liebherr
Linde	Link-belt
Manitou	Massey-Ferg.
Mccormick	MDI-Yutani
Mitsubishi	Moxy
Mustang	Neusson
New-Holland	Nichiyu
Nissan	OK
OM-Pimespo	others-tech
Pel-Job	PH-mining
Poclain	Powerscreen
Same	Samsung
Sandvik	Scania
Schaefer	Schramm
Sennebogen	Shangli
Shibaura	Steiger
Steinbock	Steyr
Still	Sumitomo
Super-pac	Tadano
Takeuchi	TCM
Terex	Toyota
Valpadana	Venieri
Versatile	Vogele
Volvo	Weidemann
Wirtgen	Yale
YAM	Yanmar