PART NO. TO1JK-E-00

HITACHI

Technical Manual
Operational Principle

ZX 400R-3 400LCH-3
Hydraulic Excavator

Service Manual consists of the following separate Part No.

Technical Manual (Operational Principle)	: Vol. No.TO1JK-E
Technical Manual (Troubleshooting)	: Vol. No.TT1JK-E
Workshop Manual	: Vol. No.W1JK-E

ZX400R-3 · 400LCH-3 HYDRAULIC EXCAVATOR TECHNICAL MANUAL OPERATIONAL PRINCIPLE

Hitachi Construction Machinery
URL:http://www.hitachi-c-m.com

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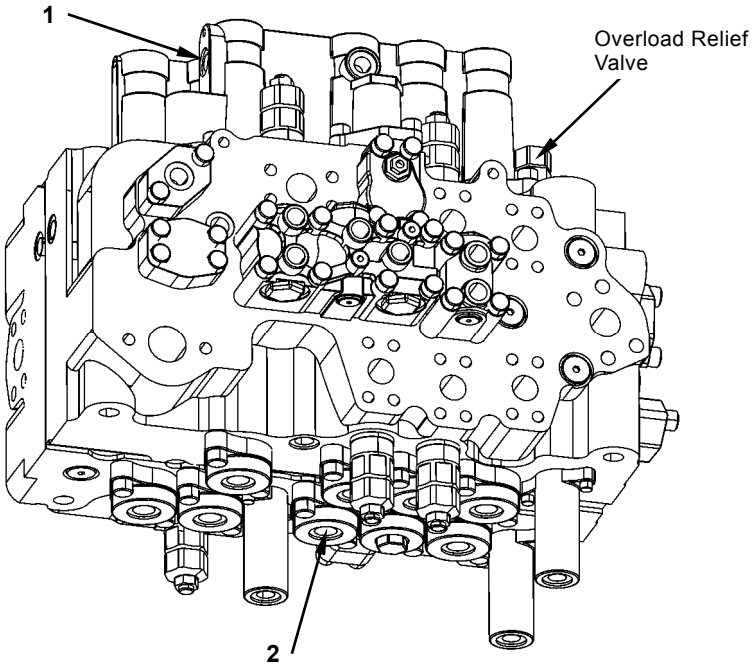
BUCKET TYPES AND APPLICATIONS

Bucket	Bucket Capacity m3 (yd3)		Bucket Width (in)		No. of Bucket Teeth	Weight kg (lb)	Front-End Attachment	
							ZAXIS 400R-3	ZAXIS400LCH-3
	PCSA (Heaped)	CECE (Heaped)	With Side Cutter	Without Side Cutter			R Boom 6.4m (20′12″)	R Boom 6.4m (20′12″)
							R arm 3.2 m (10′6″)	H Arm 3.2 m (10′6″)
Rock Bucket	1.6 (2.09)	1.4 (1.83)	1490 (59″)	1250 (60″)	5	1650 (3640)	-	■
Reinforced Rock Bucket	1.5 (1.96)				5	1720 (3800)	■	-

NOTE: Symbols in the above table have the following meanings.
■: Rock digging
-: Not applicable (not warrantable)

IMPORTANT: Using inapplicable buckets may cause serious damage to the front structure such as boom, arm and hydraulic cylinders.

CONTROL VALVE



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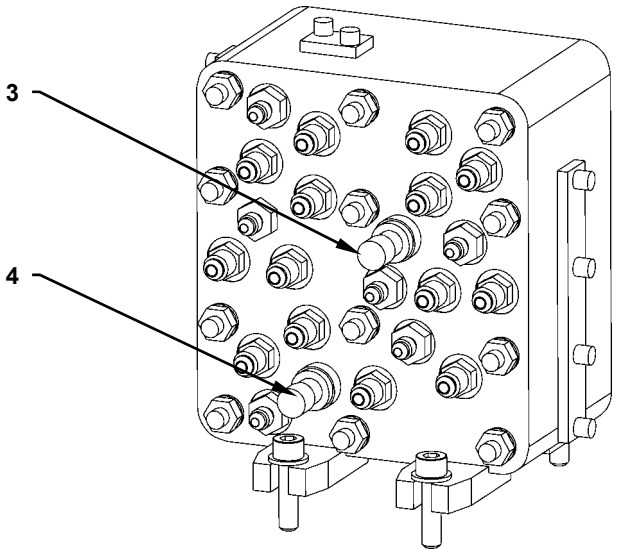
SIGNAL CONTROL VALVE



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1 - Pressure Sensor (Arm Roll-In)
2 - Pressure Sensor (Boom Raise)
3 - Pressure Sensor (Swing)
4 - Pressure Sensor (Travel)

FRONT ATTACHMENT PILOT VALVE
- Model HVP06J-040-101
- Plunger Stroke ..... Ports 1, 3: 6.5 mm (0.26 in), Ports 2, 4: 8.0 mm (0.32 in)

TRAVEL PILOT VALVE
- Model HVP05S-040-101
- Plunger Stroke ..... Ports 1, 2, 3, 4: 4.6 mm (0.18 in)

SOLENOID VALVE UNIT
- Type ..... 4-Spool Proportional Solenoid valve
- Rated Voltage ..... DC 24 V

SIGNAL CONTROL VALVE
- Model KVSS-10-H
- Rated Pressure ..... 3.72 MPa (38 kgf/cm^2, 540 psi)

PILOT SHUT-OFF VALVE
- Type ..... ON/OFF Solenoid Valve
- Rated Voltage ..... DC 24 V

OIL COOLER BYPASS CHECK VALVE
- Cracking Pressure ..... 392 kPa (4 kgf/cm^2) at 5 L/min (1.3 US gpm)

MC: MAIN CONTROLLER

Function Outline
Engine Control

• Engine Control Dial Control

MC sends the signal to ECM according to the idle position of engine control dial and controls the engine speed.
When all control levers are in neutral with the engine control dial at fast idle position, MC sends the signal to ECM and reduces engine speed by 100 min $^{-1}$ from the fast idle speed.

• HP Mode Control

Average Delivery Pressure of Pumps 1 and 2: High
Engine Control Dial: Engine Speed 1500 min^{-1} or faster
Power Mode Switch: HP Mode Position
When operating boom raise and arm roll-in on conditions above, MC sends the signal to ECM and increases engine speed beyond the set speed of engine control dial in order to increase engine power.

• Travel HP Mode Control

Average Delivery Pressure of Pumps 1 and 2: High
Engine Control Dial: Fast Idle Position
Travel Mode Switch: Fast
When operating travel on conditions above, MC sends the signal to ECM and increases engine speed beyond the set speed of engine control dial in order to increase travel speed.
When operating the front attachment at the same time, this control becomes ineffective.

• E Mode Control

Condition:
Pump Control Pressure and Pump Average Delivery Pressure: Both Low Pressure
Pump Control Pressure and Pump Average Delivery Pressure: Both High Pressure
Pump Control Pressure: Low Pressure and Pump Average Delivery Pressure: High Pressure
Engine Control Dial: Engine Speed 1600 min^{-1} or faster
Power Mode Switch: E Mode Position

On conditions above, MC sends the signal to ECM and decreases engine speed below the set speed of engine control dial.
Pump Control Pressure: High Pressure and Pump Average Delivery Pressure: Low Pressure
On conditions above, MC sends the signal to ECM and increases engine speed 100 min^{-1} beyond the set speed of engine control dial.

• HSB Breaker Control (Optional)

As for the machine equipped with HSB breaker, when breaker 1 is selected on the monitor unit or is set by Dr. ZX, MC drives the selector valve control solenoid valve and the secondary pilot relief pressure control solenoid valve.

Pilot pressure from the selector valve control solenoid valve shifts the selector valve and connects the return circuit in breaker to hydraulic oil tank.

Pilot pressure from the secondary pilot relief pressure control solenoid valve shifts the secondary pilot relief pressure control valve and reduces relief set pressure in the breaker circuit.

• NPK Breaker Control (Optional)

As for the machine equipped with NPK breaker, when breaker 2 is selected on the monitor unit or is set by Dr. ZX, MC drives the selector valve control solenoid valve and the accumulator control solenoid valve.

Pilot pressure from the selector valve control solenoid valve shifts the selector valve and connects the return circuit in breaker to hydraulic oil tank.

Pilot pressure from the accumulator control solenoid valve shifts the accumulator control valve, connects the accumulator to the circuits in breaker cylinder bottom side and rod side, reduces shock of oil pressure, and buffers vibration when the breaker is used.

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- Overload Alarm
  (Only machines equipped with optional parts)

IMPORTANT: When using overload alarm, make overload alarm available by using Dr. ZX.

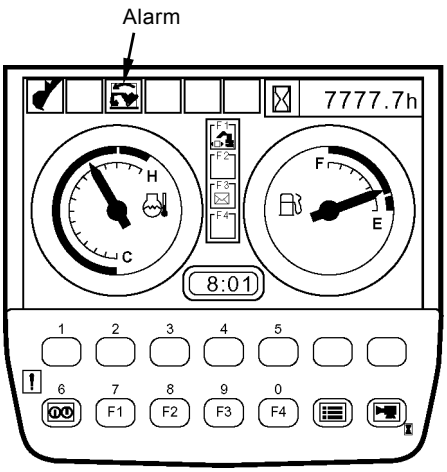
The system measures load of the suspended load from bottom pressure of the boom cylinder. An alarm message is displayed and a buzzer is rung, if overload is detected.

1. If load of the suspended load becomes overloaded, the boom bottom pressure sensor (optional) sends a signal to MC.

2. If the overload alarm ON/OFF switch (optional) is turned ON, the monitor unit displays an alarm message and rings a buzzer according to the signal from MC by using CAN.

3. If overload of the suspended load is dissolved, the alarm message disappears and the buzzer stops ringing.

NOTE: Even if the work is done while displaying a screen except the primary screen, when an overload condition is reached, the screen of monitor unit is switched to the primary screen, an alarm message is displayed, and a buzzer is rung.
Even after the overload alarm is dissolved, the monitor unit keeps on displaying the primary screen without returning to the screen while the work is done.



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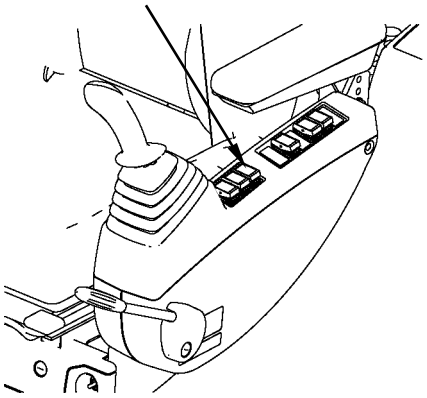
Primary Screen

Overload Alarm ON/OFF Switch (Optional)



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Travel HP Mode Control

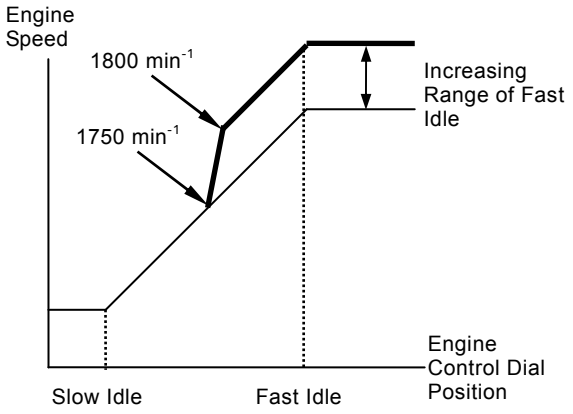
Purpose: Increases the engine speed and travels faster during travel single operation.

Operation:

1. When the travel mode switch is in fast idle and all the following conditions exist, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication.
2. ECM increases the engine speed by 100 min^{-1} from the speed set by the engine control dial and travels faster.

Condition:

1. Engine Control Dial: Set the engine speed in the fast idle speed position.
2. Travel Operation: Operated
3. Front Attachment Operation: Not Operated (When starting traveling)
4. Delivery Pressure of Pumps 1 and 2: Delivery pressure of either pump is high.
   (Reference: 15 MPa (153 kgf/cm^2, 2180 psi))



Heater Control

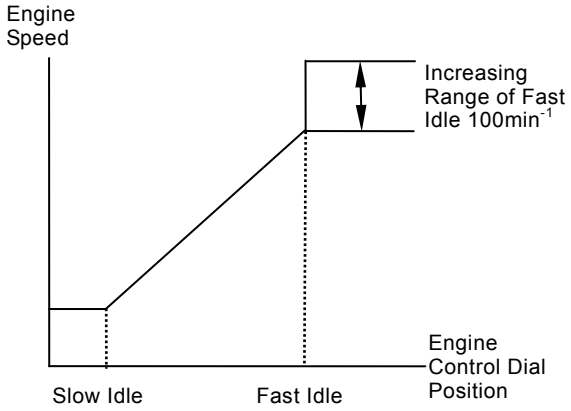
Purpose: Increases the rising temperature speed of the heater in cab while increasing the engine speed at the low temperature.

Operation:

1. When the following conditions exist and the engine starts, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication.
2. ECM increases the engine speed beyond fast idle speed.

Condition:

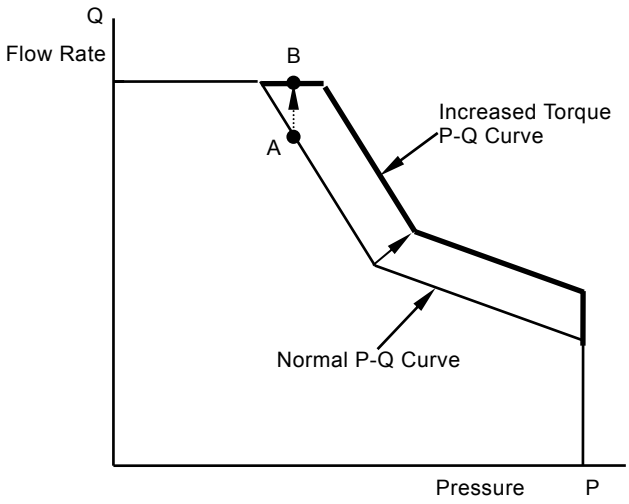
- Engine Control Dial: Set the engine speed at fast idle speed position.
- Front Attachment Operation: Not Operated
- Travel Operation: Not Operated
- Coolant Temperature: Less than 5 °C (41 °F).
- Pumps 1, 2 Control Pressure Sensors: Both pump control pressures: 0.5 MPa (5.1 kgf/cm^2, 73 psi) or less.



Travel Torque-Up Control

Purpose: Effectively controls during single travel operation. Allows the machine to travel at the maximum pump flow rate when the engine is running at slow speed. When travel operation is made with the engine running at slow speed, normally, the hydraulic pump delivers pressure oil at the flow rate corresponding to point A on the P-Q curve illustrated to the right. Therefore, if any difference exists between pump 1 and pump 2 flow rate, the machine will mistrack. In order to prevent mistracking, the pump P-Q curve is raised so that, when traveling the machine with the engine running at slow speed, the pump delivers pressure oil at the flow rate corresponding to point B (maximum flow rate).

When travel operation is made with the engine running at fast speed, the pump P-Q curve is raised in order to improve travel function.



Operation:

1. When the engine speed set by the engine control dial is slow, MC processes signals from the travel pressure sensor, and pump 1 and 2 delivery pressure sensors, and sends the signals to torque control solenoid valve.
2. The torque control solenoid valve delivers pilot pressure corresponding to the received signals to the regulator and increases pump flow rate.

VALVE CONTROL

The valve control system functions as follows:

- Power Digging Control
- Auto-Power Lift Control
- Arm Regenerative Control
- Digging Regenerative Control
- Travel Motor Swash Angle Control
- *HSB Breaker Control
- *NPK Breaker Control
- *Secondary Crusher Control
- *Hydraulic Crusher Control

*NOTE: *This control is for only the machine equipped with the optional parts.*

Travel Motor Swash Angle Control

Purpose: Controls the travel mode.

Operation:

- Slow
  When the travel mode switch is in the SLOW position, the travel motor swash angle is kept in the maximum angle so that the travel speed is slow.
- Fast

1. When the travel mode switch is in the HIGH position and MC receives the signals from travel pressure sensor, pump 1 and 2 delivery pressure sensors and pump 1 and 2 control pressure sensors under the following conditions, MC shifts solenoid valve unit (SI).
2. When solenoid valve unit (SI) is shifted, pilot pressure acts on the travel motor swash angle control valve and reduces the swash angle to the minimum, so that the travel speed increases.

Condition:

- Travel Pressure Sensor: Outputting signal.
- Front Attachment Pressure Sensor: OFF
- Pump 1, 2 Delivery Pressure Sensors: Delivery pressure of either pump is low. (Reference: 24 MPa (245 kgf/cm^2, 3490 psi) or less)
- Pumps 1, 2 Control Pressure Sensors: Either pump control pressure is high. (Reference: 2.2 MPa (22 kgf/cm^2, 320 psi) or more)

NOTE: When one side track is raise off the ground and is rotated, the one side pump control pressure increases, so that the raised track rotates at fast speed.
When the machine is traveling in the fast speed and even if the front attachment is operated (the front attachment pressure sensor: ON), the travel mode is kept in the fast speed.

OTHER CONTROLS

Rear View Image Selection Control

Purpose: Changes the display of monitor unit into the image of rearview monitor.

Operation:

1. When the signal from travel pressure sensor or rear view switch (optional) is sent to MC, MC sends the signal to select the display to the monitor unit by using CAN communication.
2. Monitor unit changes the display into the image of rearview monitor.
3. Push the rearview monitor selection switch on monitor unit and change the image of rearview monitor.

NOTE: The function of image selection on monitor unit can be turned OFF in the setting menu.

Fuel Injection Pressure Control

Purpose: Controls fuel injection pressure according to fuel pressure in the common rail.

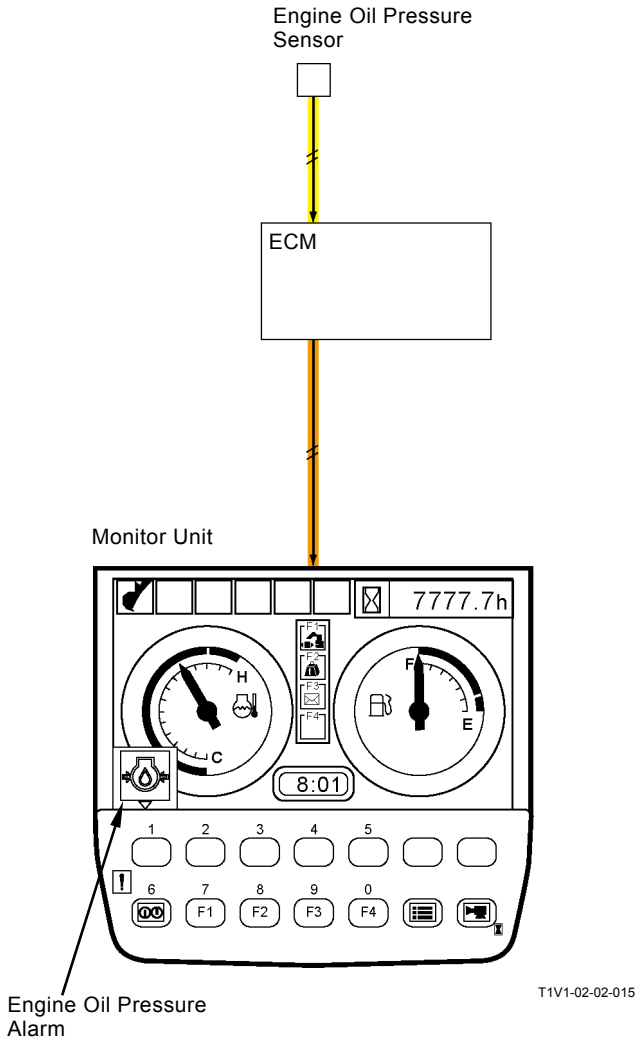
Operation:

1. ECM calculates fuel injection amount according to the engine speed and the signals from MC by using CAN communication. (Refer to the page on Fuel Injection Amount Control.)
2. The common rail pressure sensor sends the signals according to pressure in the common rail to ECM.
3. ECM calculates the best fuel pressure in common rail according to the engine speed, fuel injection amount and the signals of common rail pressure. ECM drives the suction control valve in supply pump and supplies the best amount of fuel to the common rail.
4. Fuel according to fuel pressure in the common rail is supplied to the injector from the common rail so that fuel injection pressure is controlled.

ENGINE STOP CONTROL

Operation:

1. When turning the engine stop switch ON, electrical current from the battery flows to the terminal #1-47 in ECM through ECM main relay.
2. ECM stops injection of the injector and stops the engine.
3. ECM is turned OFF after turning ECM main relay OFF.



Valve Control Circuit (Refer to the Control Valve section in COMPONENT OPERATION.)

- Pilot pressure from the pilot valve, solenoid valve units (SC, SF, SG), flow combiner valve control spool (2) in the signal control valve, bucket flow control valve control spool (3) and arm flow control valve control spool (1) controls the valves below.

  - Boom Lower Pilot Pressure: Boom Anti-Drift Valve (8)
  - Arm Roll-In Pilot Pressure: Arm Anti-Drift Valve (16)
  - Auxiliary Pilot Pressure: Auxiliary Flow Combining Valve (20), Bypass Shut-Out Valve (10) (When the auxiliary spool is used.)
  - Solenoid Valve Unit SC: Arm Regenerative Valve (12), Arm Flow Control Valve (Arm 2) (9)
  - Solenoid Valve Unit SF: Digging Regenerative Valve (13)
  - Solenoid Valve Unit SG: Main Relief Valve (18) (increasing the set-pressure)
  - Auxiliary Flow Combining Selection Solenoid Valve: Boom, Arm and Bucket Pilot Pressure
  - Flow Combiner Valve Control Spool: Flow Combiner Valve (4)
  - Bucket Flow Control Valve Control Spool: Bucket Flow Control Valve (5)
  - Arm Flow Control Valve Control Spool: Arm Flow Control Valve (Arm 1) (14)
  - Bypass Shut-Out Valve (10), Hose Rupture Valve (Optional) (15)
  - Bypass Shut-Out Valve (10)

- Boom lower meter-in cut valve (7) controls boom flow control valve (6). (Refer to the Boom Lower Meter-In Cut.)

- Travel and Arm Roll-In Operation

  - When the arm is rolled in while traveling, pilot pressure shifts the spools of travel, arms 1 and 2.
  - At the same time, pilot pressure shifts the flow combiner valve spool in signal control valve. Pressure oil from the flow combiner valve spool flows to the flow combiner valve and shifts the flow combiner valve.
  - Pressure oil from pump1 drives the right travel motor through right travel spool.
  - At the same time, pressure oil drives the left travel motor through flow combiner valve and left travel spool.
  - Pressure oil from pump 2 flows to the arm cylinder through the arm 1 spool and moves the arm.
  - Consequently, pressure oil pump 2 is used for the arm. Pressure oil from pump 1 is equally supplied to both left and right travel motors and the machine can travel straight.

NOTE: As the right travel circuit is a tandem circuit, pressure oil from pump 1 does not flow to the arm 2 spool.

MAIN CIRCUIT

The major functions and circuits in the main circuit are as follows.

- Electric Power Circuit: Supplies all electric power to all electrical systems on this machine. [Key Switch, Batteries, Fuses (Fuse Boxes, Fusible Links), Battery Relay]

- Accessory Circuit
  Becomes operative when the key switch is turned to the ACC position.

- Starting Circuit
  Starts the engine. [Key Switch, Starter, Starter Relay 2]

- Charging Circuit
  Charges the batteries. [Alternator, (Regulator)]

- Serge Voltage Prevention Circuit
  Prevents the occurrence of serge voltage developed when stopping the engine. [Load Damp Relay]

- Pilot Shut-Off Circuit (Key Switch: ON)
- Supplies pressure oil to the pilot valve from the pilot pump by the pilot shut-off solenoid valve.

- Security Lock Circuit
  Cut electrical current for starting from the key switch according to the signals from external alarm system or monitor unit.

- Engine Stop Circuit (Key Switch: OFF)
  Stops the engine by using ECM. (MC, ECM)

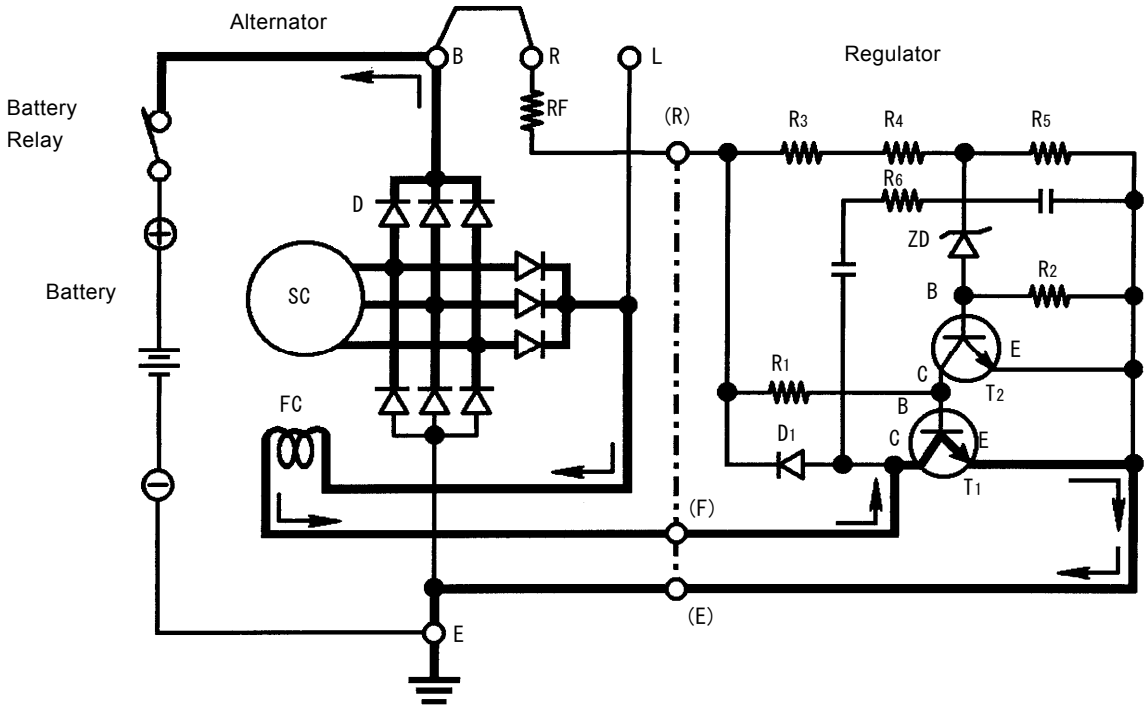
- Security Horn Circuit
  Operate the security horn according to the signals from external alarm system or monitor unit.

- Working Light Circuit
  Turn on the work light and cab light.

- Wiper Circuit
  Operate the intermittent operation of wiper and the washer.

Alternator Operation

- The alternator consists of field coil FC, stator coil SC and diode D. The regulator consists of transistors (T1 and T2), Zener diode ZD and resistances (R1 and R2).
- Alternator terminal B is connected to base B of transistor T1 through the circuit [B → R → RF → (R) → (R1)].
- When the battery relay is ON, the battery voltage is applied to base B of transistor T1 so that collector C is connected to emitter E. Therefore, field coil FC is grounded through transistor T1.
- At the beginning, no current is flowing through field coil FC. When the rotor starts rotating, alternate current is generated in stator coil SC by the rotor remanent magnetism.
- When current flows through field coil FC, the rotor is further magnetized so that the generating voltage increases. Thereby, current flowing through field coil FC increases. Therefore, generating voltage increases further and the batteries start charging.



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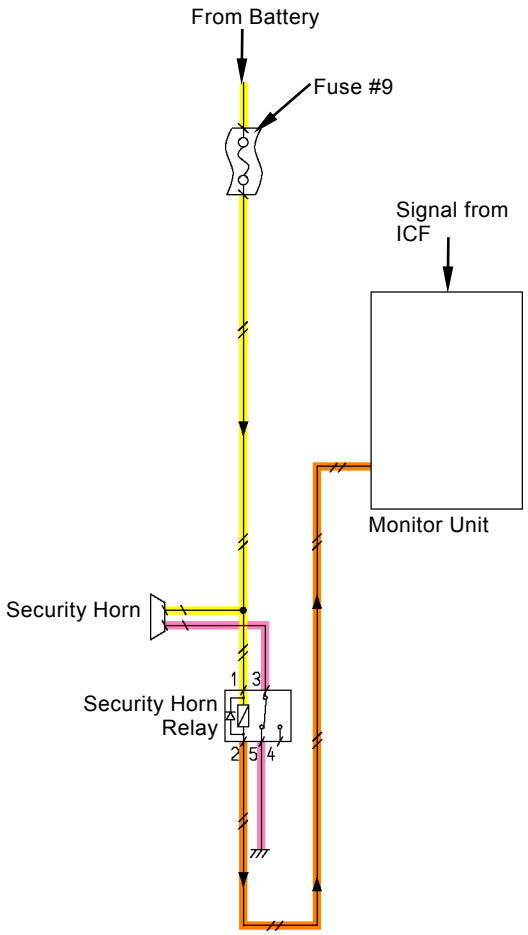
SECURITY HORN CIRCUIT

1. The monitor unit connects the ground circuit of security horn relay according to the external warning signal from ICF or the password input error so that the security horn relay is turned ON.
2. When the security horn relay is turned ON, current from fuse #9 operates the security horn.



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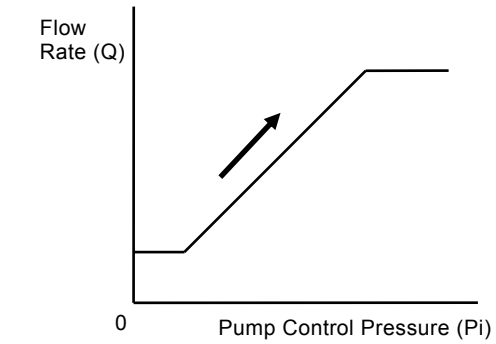
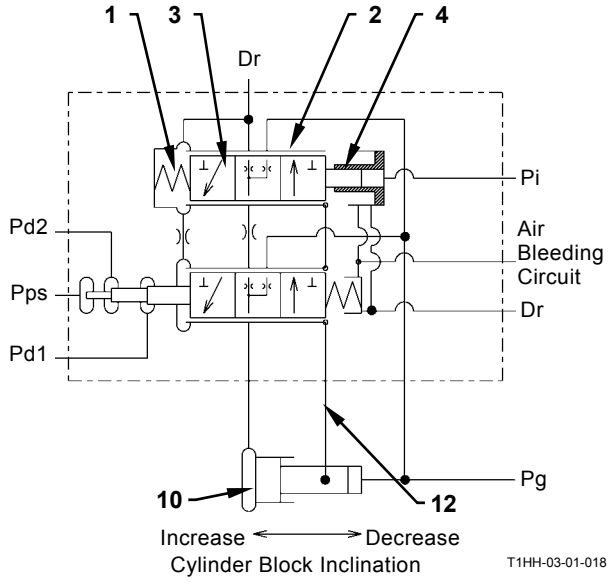
Control by Pump Control Pressure

- Increasing Flow Rate
  1. When a control lever is operated, the flow rate control valve in signal control valve is shifted and pump control pressure Pi increases.
  2. Piston (4) pushes spool A (3) and spring (1) so that spool A (3) is moved toward direction of the arrow.
  3. The circuit from the large chamber of servo piston (10) is opened to the hydraulic oil tank.
  4. As pilot pressure is always routed into the small chamber of servo piston (10), servo piston (10) is moved toward direction of the arrow. Then, the cylinder block rotated in the maximum inclination direction and the pump delivery flow rate increases.
  5. The movement of the cylinder block is transmitted to sleeve A (2) via link (12). Sleeve A (2) is moved in the same direction as spool A (3).
  6. When sleeve A (2) is moved by the same stroke as spool A (3), the open part between spool A (3) and sleeve A (2) is closed and the circuit from the large chamber of servo piston (10) to the hydraulic oil tank is closed. Therefore, servo piston (10) is stopped and the flow rate increase operation is completed.



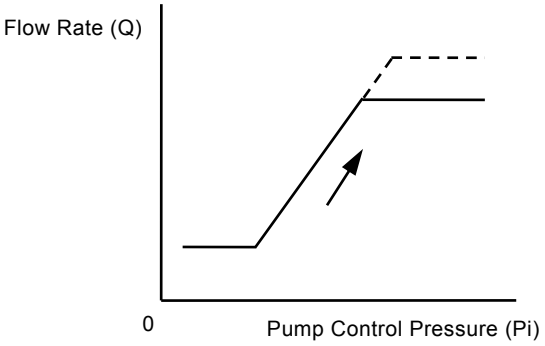


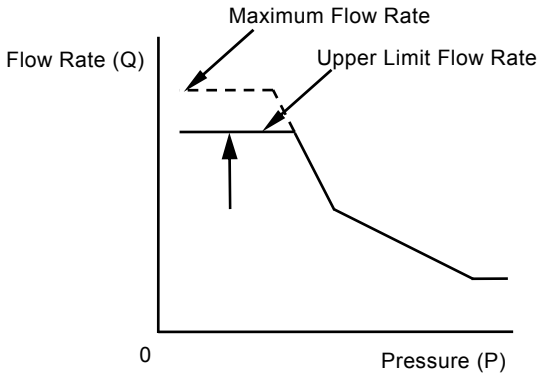
1 - Spring
2 - Sleeve A
3 - Spool A
4 - Piston
10 - Servo Piston
12 - Link

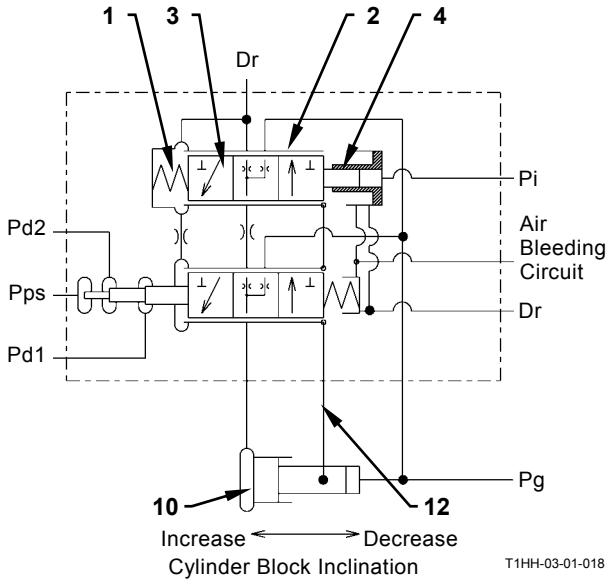
Pd1 - Pump 1 Delivery Pressure
Pd2 - Pump 2 Delivery Pressure
Dr - Returning to Hydraulic Oil Tank
Pi - Pump Control Pressure
Pps - Torque Control Pressure
Pg - Primary Pilot Pressure (From Pilot Pump)

Control by Pilot Pressure from Flow Rate Control Solenoid Valve

- Upper Limit Flow Rate Control (Pump 2 Only)
  1. The maximum pump flow rate control solenoid valve in pump control pressure Pi circuit is activated by the signals from the main controller (MC).
  2. The maximum pump flow rate control solenoid valve functions as a reducing valve and pump control pressure Pi decreases.
  3. Piston (4) is moved toward direction of the arrow by reduced pump control pressure Pi.
  4. Piston (4) pushes spool A (3) and spring (1), until the force acting on piston (4) by pump control pressure Pi becomes balanced with the spring (1) force, spool A (3) moves toward direction of the arrow.
  5. As pump control pressure Pi has been reduced, spool A (3) is moved in a shorter distance than usual.
  6. Due to the movement of spool A (3), the circuit from the large chamber of servo piston (10) is opened to the hydraulic oil tank.
  7. As pilot pressure is constantly routed into the small chamber of servo piston (10), servo piston (10) is moved toward direction of the arrow. Therefore, the cylinder block is rotated in the maximum inclination direction and the pump delivery flow rate increases.
  8. The movement of cylinder block is transmitted to sleeve A (2) via link (12). Sleeve A (2) is moved in the same direction as spool A (3).
  9. When sleeve A (2) is moved by the same stroke as spool A (3), the open part between spool A (3) and sleeve A (2) is closed and pilot pressure to the large chamber of servo piston (10) is blocked.
  10. Therefore, servo piston (10) is stopped and the flow rate increase operation is completed.
  11. Accordingly, pump control pressure Pi increases in proportion to the stroke of control lever and the pump delivery flow rate increases. However, as pump control pressure Pi is regulated, the strokes of spool A (3) and servo piston (10) are reduced so that the maximum flow rate becomes less than usual.







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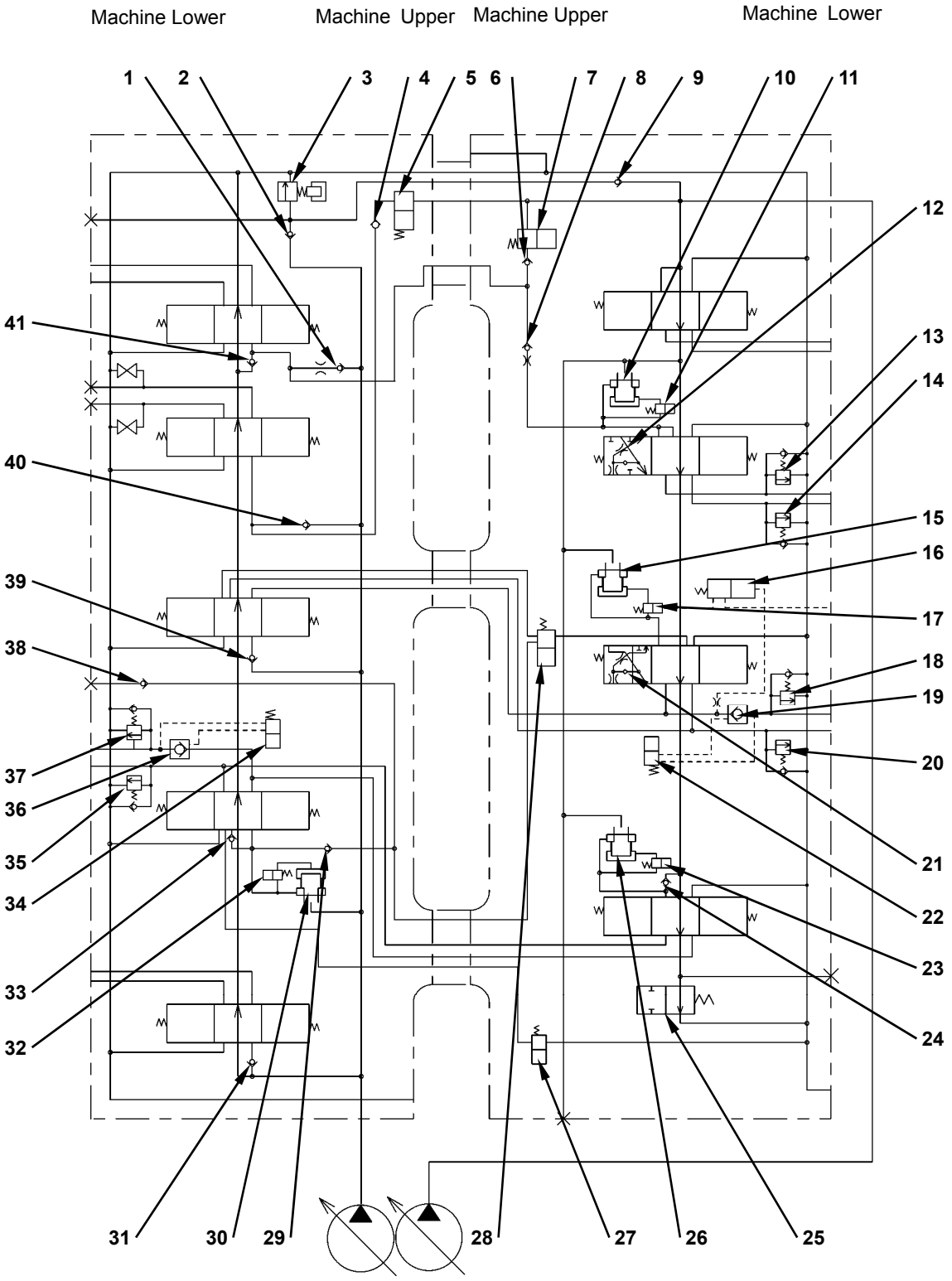

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Pilot Control Circuit

Pressure oil (indicated with numbers) from the pilot valve acts to the spool in control valve in order to move the spool.

In the following operations, pressure oil moves the spool and acts to the switch valves as follows.

- During arm roll-in (4) operation, pressure oil moves the arm spool and shifts the spool in switch valve of arm anti-drift valve.
- During boom lower (2) operation, pressure oil moves the boom 1 and 2 spools and shifts the spool in switch valve of boom anti-drift valve.
- During boom lower (2) operation, divided pressure oil passes through the boom lower meter-in cut valve and shifts the bypass shut-out valve.
- During auxiliary open (13) or close (14) operation, pressure oil moves the auxiliary spool and shifts the bypass shut-out valve.
  (Only the machine equipped with the optional auxiliary flow combining system)

The air bleed circuit is located on the upper section of control valve and bleeds any air trapped inside automatically.

External Pilot Pressure Circuit

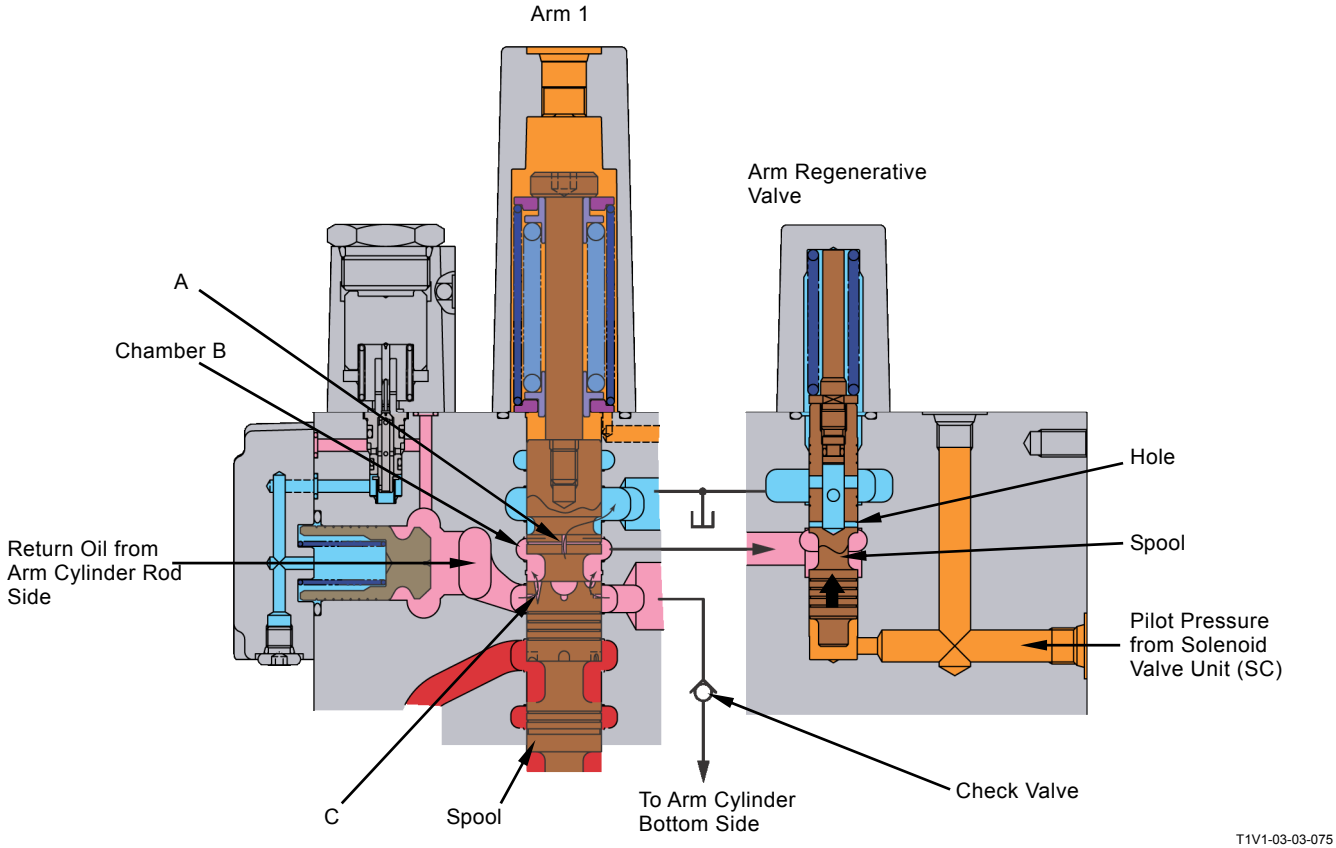
- Pressure in the main relief valve is increased by pilot pressure from solenoid valve (SG).
- The arm regenerative valve and arm 2 flow rate control valve are shifted by pilot pressure from solenoid valve unit (SC).
- The digging regenerative valve is shifted by pilot pressure from rate solenoid valve unit (SF).
- The arm 1 flow rate control valve is shifted by pilot pressure from the arm flow rate control valve spool in signal control valve.
- The flow combiner valve is shifted by pilot pressure from the flow rate combiner valve spool in signal control valve.
- The bucket flow rate control valve is shifted by pressure oil from the bucket flow rate control valve spool in signal control valve.

ARM REGENERATIVE VALVE

- During Normal Operation:
  1. During normal arm roll-in operation, return oil from the cylinder rod side flows to chamber B through notch (C) on the arm 1 spool.
  2. Return oil is divided from chamber B. One flows to the hydraulic oil tank through notch (A) on the arm 1 spool. The other flows to the hydraulic oil tank through the hole (orifice) on the spool in arm regenerative valve.
  3. As pressure in the cylinder bottom side is larger than that in the cylinder rod side, the check valve is kept closed.
  4. Consequently, as pressure oil in the cylinder rod side does not flow to the cylinder bottom side, the regenerative operation is not operated.

- During Regenerative Operation:
  1. When solenoid valve unit (SC) is activated by the signal from the main controller (MC), pilot pressure shifts the spool in arm regenerative valve. (Refer to Control System/ SYSTEM.)
  2. Pressure oil from chamber B (the cylinder rod side) is blocked by the spool in arm regenerative valve.
  3. As pressure oil flows to the hydraulic oil tank from chamber B by only the circuit through notch (A) on the arm 1 spool, pressure in chamber B increases.
  4. Pressure in the cylinder rod side becomes larger than that in the cylinder bottom side.
  5. Consequently, pressure oil in the cylinder rod side opens the check valve, is combined with pressure oil from pump 2 together, and flows to the cylinder bottom side.
  6. The regenerative operation is operated in the procedures above and speed of cylinder increases.

During Regenerative Operation:

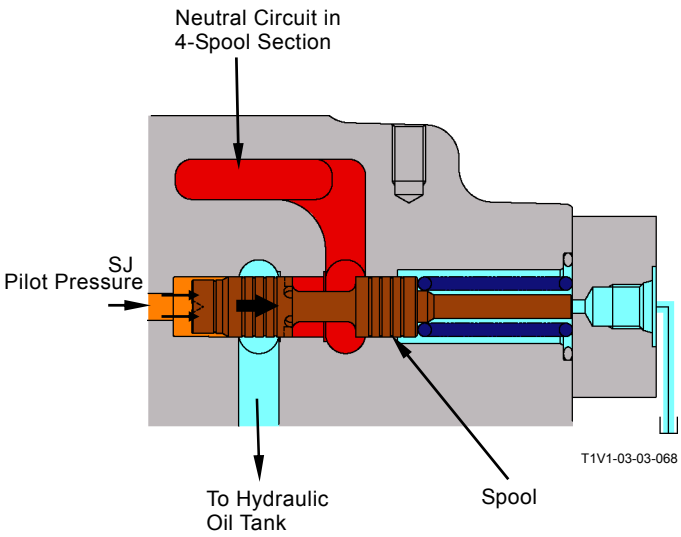


BYPASS SHUT-OUT VALVE

The bypass shut-out valve is provided in the rear of 4-spool section circuit.
The bypass shut-out valve is operated when operating boom lower, auxiliary and positioning. When the neutral circuit in 4-spool section is blocked, pressure oil in the pump 1 side is supplied to the pump 2 side or other actuators.

Operation

1. When operating boom lower, auxiliary and positioning, pilot pressure acts on port SJ and shifts the spool in bypass shut-put valve.
2. When the spool in bypass shut-put valve is shifted, the neutral circuit in 4-spool section is blocked.
3. Therefore, pressure oil in pump 1 is supplied to pump 2 or other actuator.



- Auxiliary / Positioning Pilot Valve

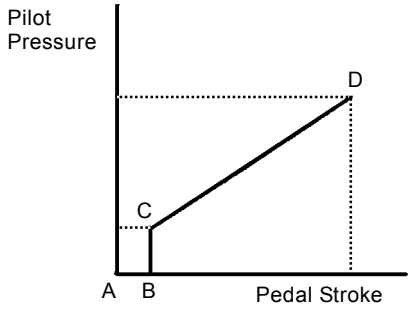
In Neutral (Output Curve: A to B)

1. When the control pedal is in neutral, spool (7) completely blocks pressure oil from port P.
2. As the output port is connected to port T through the passage in spool (7), pressure in the output port is equal to that in the hydraulic oil tank.
3. When slightly depressing the control pedal and moving cam (1), pusher (2) compresses return spring (6) downward with spring guide (4) together.
4. At this time, spool (7) is pushed by balance spring (5) and moved downward until dimension (A) becomes zero (port P is aligned with the hole).
5. During this movement, the output port is connected to port T so that pressure oil is not supplied to the output port.

NOTE: The pedal stroke while pressure at dimension (A) becomes zero is play.

During Metering or Decompressing (Output Curve: C to D)

1. When the control pedal is depressed further, the hole on spool (7) is connected to the notch.
2. Pressure oil in port P flows into the output port through the notch and the hole on spool (7), and pressure in the output port increases.
3. Pressure in the output port acts on the bottom surface of spool (7) and spool (7) is moved upward.
4. When the force to move spool (7) upward is smaller than balance spring (5), balance spring (5) is not compressed.
5. Therefore, as port P is kept connected to the output port, pressure in the output port continues to increase.
6. When pressure in the output port increases further, the force to move spool (7) upward increases.
7. When this force becomes larger than balance spring (5), spool (7) compresses balance spring (5) and moves upward.
8. When spool (7) moves upward, the notch is closed. As pressure oil from port P does not flow to the output port, pressure in the output port stop increasing.
9. As spool (7) is moved downward and balance spring (5) is compressed, pressure acting on the bottom surface of spool (7) increases until pressure balances with the increasing spring force. This increasing pressure becomes pressure at the output port.



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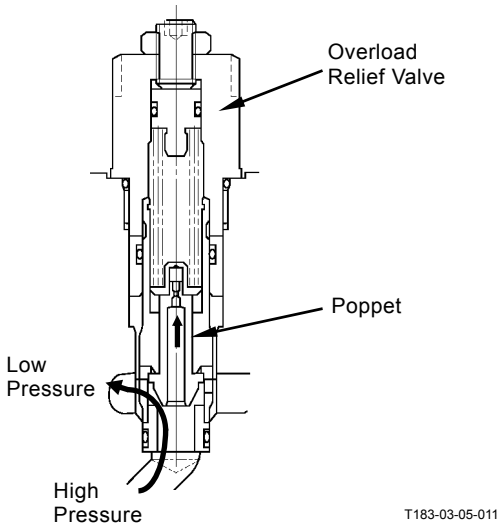
Overload Relief Valve

Circuit Protection Operation:

1. When pressure in the circuit increases over the set-pressure of overload relief valve, the poppet is opened and high pressure oil relieves to the low pressure side, so that the travel motor is protected from being overloaded.
2. In addition, the overload relief valve relieves the shock loads developed due to inertia force when stopping the travel motor.



Control Valve Side

Port Name	Connecting to	Remark
Port 1	Control Valve	Boom Raise Pilot Pressure
Port 2	Control Valve	Boom Lower Pilot Pressure
Port 3	Control Valve	Arm Roll-Out Pilot Pressure
Port 4	Control Valve	Arm Roll-In Pilot Pressure
Port 5	Control Valve	Left Swing Pilot Pressure
Port 6	Control Valve	Right Swing Pilot Pressure
Port 7	Control Valve	Bucket Roll-In Pilot Pressure
Port 8	Control Valve	Bucket Roll-Out Pilot Pressure
Port 9	Control Valve	Left Travel Forward Pilot Pressure
Port 10	Control Valve	Left Travel Reverse Pilot Pressure
Port 11	Control Valve	Right Travel Forward Pilot Pressure
Port 12	Control Valve	Right Travel Reverse Pilot Pressure
Port 13	Control Valve	Auxiliary Open Pilot Pressure
Port 14	Control Valve	Auxiliary Close Pilot Pressure
Port SE	Control Valve	Arm 1 Flow Rate Control Valve Control Pressure
Port SM	Hydraulic Oil Tank	Returning to Hydraulic Oil Tank
Port SN	-	Plug
Port SP	Hydraulic Oil Tank	Returning to Hydraulic Oil Tank
Port SL	Control Valve	Flow Combiner Valve Control Pressure
Port SK	Control Valve	Bucket Flow Rate Control Valve Control Pressure

Machine with Front Attachment (Secondary Crushers 1 to 5 and Hydraulic Crushers 1 to 5) attached.

Port SM	Auxiliary Flow Rate Combining Solenoid Valve	Bypass Shut-Out Valve Control Pressure
Port SP	Auxiliary Flow Rate Combining Solenoid Valve	Pump 1 Control Pressure

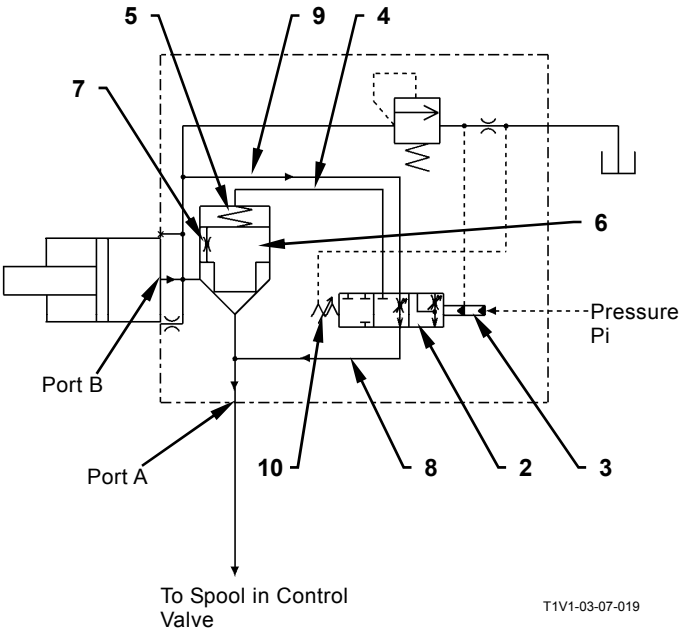
PUMP 1 AND PUMP 2 FLOW RATE CONTROL VALVES

The pump flow rate control valve delivers pump control pressure Pi to the pump regulator in response to pilot pressure from the pilot valve.

1. Pilot pressure from the pilot valve acts on the chamber A side in either the pump 1 or pump 2 flow rate control valve after being selected by the shuttle valves in signal control valve.
2. The spool is moved to the left and primary pilot pressure flows in either port SA or SB.
3. Therefore, pressure in port SA or SB increases.
4. Pressure oil in port SA or SB acts on the spring chamber. Thus, the spool is moved back until pressure force balances with pilot pressure force in the chamber A side so that pressure in port SA or SB stops increasing.

NOTE: The pump 1 flow rate control valve operates when the boom (raise or lower), arm (roll-in or out), bucket (roll-in or out), auxiliary (machine with front attachment (secondary crushers 1 to 5, hydraulic crushers 1 to 5) attached) travel (right) and positioning functions are operated. The pump 2 flow rate control valve operates when the boom (raise), arm (roll-in or out), swing (right or left), travel (left) and auxiliary functions are operated.

- During Boom Lowering Operation (Control Lever Stroke: Less than Half-Stroke)
  1. When the boom is lowered, pilot pressure Pi acts on piston (3).
  2. When the boom lower control lever is less than half-stroke, piston (3) restricts spool (2) and pushes spool (2) to the position where orifice (11) is opened.
  3. Pressure oil in the spring (5) chamber is blocked by spool (2) and poppet (6) is pushed downward.
  4. Pressure oil from port B flows to the spool in control valve through passage C (9), orifice (11) and passage B (8) and lowers the boom.
  5. As oil flow rate through the spool in control valve is reduced by orifice (11), the boom is lowered slowly.



2 - Spool
3 - Piston
4 - Passage A
5 - Spring
6 - Poppet
7 - Orifice
8 - Passage B
9 - Passage C
10 - Spring