TTLA-0721-ZX

HITACHI

Training Text

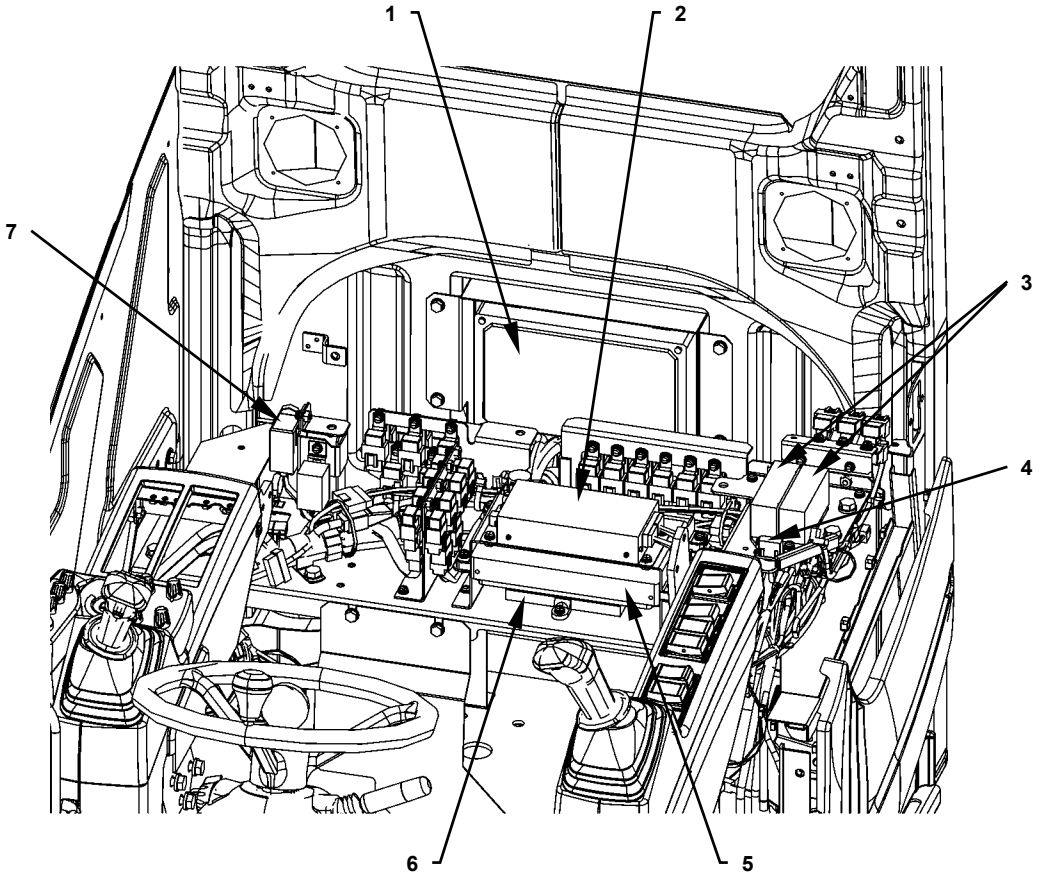
ZAXIS

170W-3
190W-3

OPERATIONAL PRINCIPLE

Technical Training Center

ELECTRICAL COMPONENT LAYOUT (CONTROLLERS AND RELAYS)



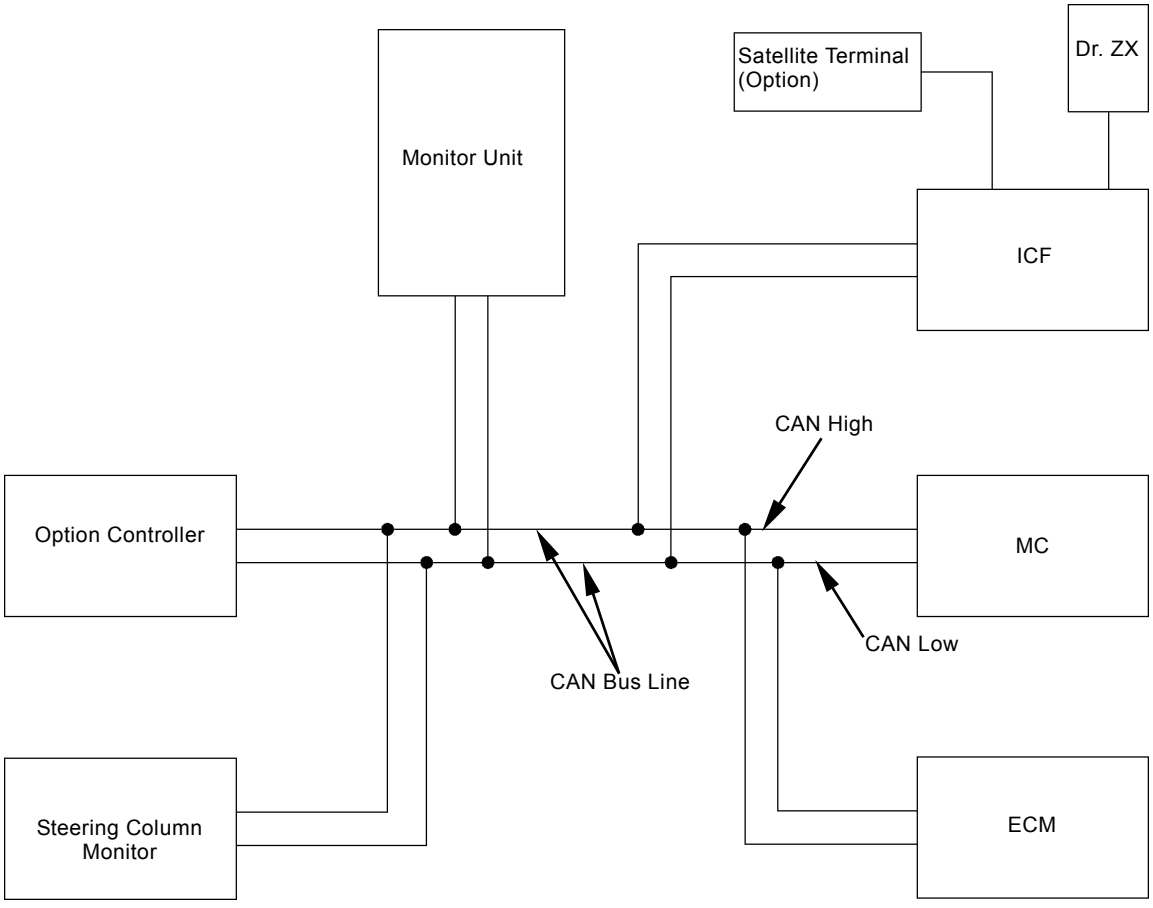
TCJB-01-02-015

1 - MC (Main Controller)
2 - Satellite Communication Terminal (Optional)
3 - Fuse Box
4 - Dr.ZX Connector (Use as Download Connector)
5 - Option Controller
6 - ICF (Information Controller)
7 - Flasher

CAN: Controller Area Network (NETWORK PROVIDED FOR MACHINE)

MC, ECM, ICF, monitor unit, option controller and steering column monitor are connected by using CAN bus line and communicate the signal and data each other.

CAN bus line consists of two wires, CAN High and CAN Low.
Each controller judges the CAN bus line level due to potential difference between CAN High and CAN Low.
Each Controller arranges the CAN bus line level and sends the signal and data to other controllers.



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ECM: ENGINE CONTROL MODULE

Function Outline
ECM (Engine Control Module) receives the signals from sensors and MC
ECM processes and drives the two-way valve, suction control valve and EGR (Exhaust Gas Recirculation) motor in order to control the supply pump, injector pump and EGR valve.

ECM has the controls as follows.

- Fuel Injection Control
  ECM detects the engine operating condition according to the signals from each sensor and MC and controls the fuel injection.

- Fuel Injection Amount Correction
  ECM adjusts fuel injection amount according to the signal of atmospheric pressure sensor.

- Preheating Control
  ECM controls time for continuity of electrical current for the glow plug according to coolant temperature and improves the starting of engine.

- EGR Control
  ECM decides EGR gas amount according to engine speed, fuel flow rate, coolant temperature, atmospheric pressure and intake-air temperature.
  ECM opens EGR valve and re-circulates exhaust gas, amount of which is equal to EGR gas amount, in the intake manifold. EGR gas is combined with intake-air so that combustion temperature is lowered and NOx is reduced.

- Engine Stop Control
  When the emergency stop switch is turned to the ON position, ECM stops the fuel injection of injector and stops the engine.

NOTE: As for details on each control, refer to the SYSTEM / ECM System group.

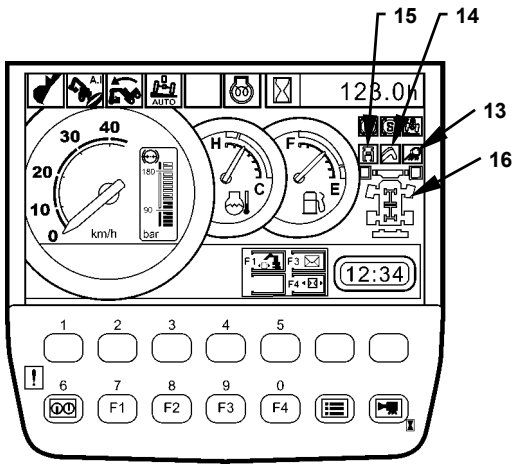
- Work Light Display (13)
  The work light switch is turned ON, the green indicator lights.

- Auxiliary 2 (Positioning) Selection Display (14)
  When the auxiliary/positioning selection switch is in the Positioning position, the green indicator lights.

- Auxiliary 1 (Attachment) Selection Display (15)
  When the auxiliary/positioning selection switch is in the Auxiliary (Attachment) position, the green indicator lights.

- Blade/Outrigger Setup and Brake Mode Display (16)
  The combination data of blade/outrigger is displayed. When the parking brake, work brake or blade/outrigger is operated, the green indicator related to the operated function lights.

NOTE: The illustration shows the screen on the front outrigger and rear blade specification.



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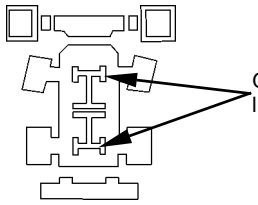
When applying parking brake



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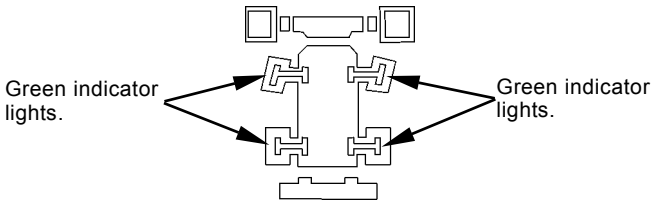
When applying work brake



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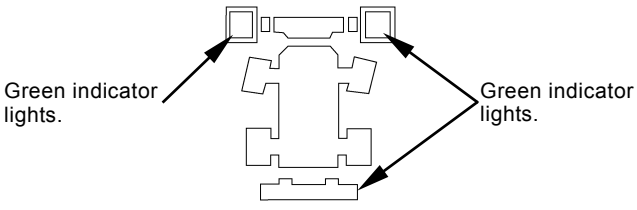
When operating blade/outrigger



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- Auxiliary and Positioning Control
  Selects each function by using the auxiliary and positioning selection switch and activates the related solenoid valve according to operation.

- Blade/Outrigger Control
  Activates the blade/outrigger solenoid valve according to electric lever operation.

- Assist Control
  Activates the assist solenoid valve according to assist switch operation.

- Auxiliary and Blade/Outrigger Output Monitoring Control
  The option controller compares electric lever operation with the detected value of pressure sensor. If the option controller recognizes abnormality, the auxiliary and blade/outrigger stop.

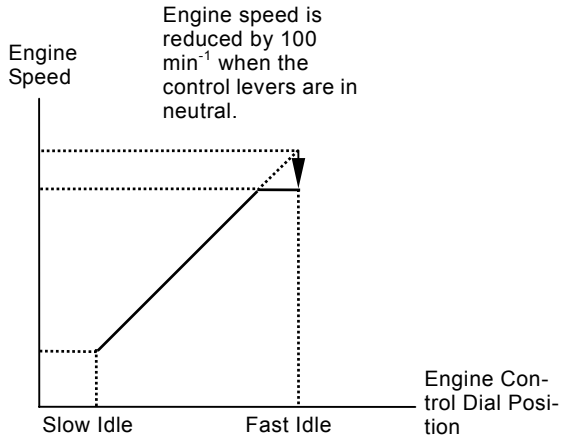
- Positioning and Assist Output Monitoring Control
  The option controller compares electric lever operation with the detected value of pressure sensor. If the option controller recognizes abnormality, the positioning and assist stop.

- Electric Lever Pilot Cut Control
  The option controller compares electric lever operation with the detected value of pressure sensor. If the option controller recognizes abnormality, all the solenoid valves stop.

- Overload Alarm Control (Optional)
  Rings the buzzer and displays the overload alarm when boom raise operation like as suspending is overloaded.

Engine Control Dial Control

Purpose: Controls the engine speed according to the rotation angle of engine control dial.
Reduces the engine speed by 100 min^{-1} from fast idle speed in order to reduce fuel consumption and noise level when all the control levers are in neutral.



Operation:

1. MC sends the signals equivalent to target engine speed to ECM by using CAN communication according to rotation angle of the engine control dial.
2. ECM controls the engine speed according to CAN communication.
3. When the following conditions exist and all the control levers are turned to the neutral position (pressure sensors (travel forward/reverse, front attachment): OFF), MC sends the signal to ECM by using CAN communication after one second.
4. ECM reduces the engine speed by 100 min^{-1} from fast idle speed (P mode engine speed).

Condition:

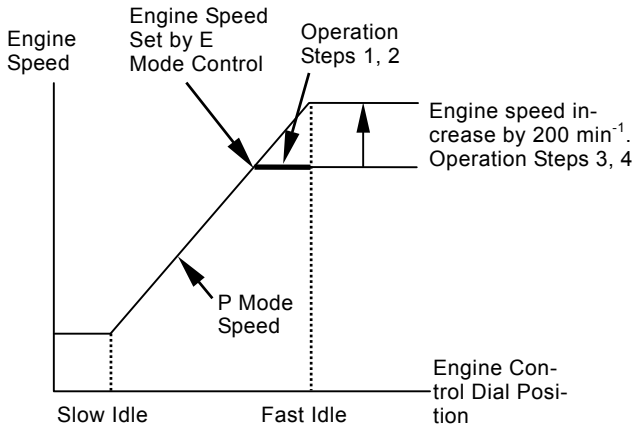
- Engine Control Dial: P-90 min^{-1} or more
- Engine Speed Control Mode Selection Switch: Dial mode or Creeper mode
- Power Mode Switch: HP or P

NOTE: When the engine speed set by the engine control dial is already slower than the fast speed idle by 100 min^{-1}, the engine speed does not change.
This control is done regardless of whether the auto-idle control is done or not.
The fast idle speed (P mode engine speed) of engine can be corrected by Dr. ZX.

IMPORTANT: The control in operation steps 3, 4 is deactivated by Dr. ZX temporarily or permanently.

E Mode Control

Purpose: Reduces the engine speed set by the engine control dial according to the pump control pressure (lever operation) and the average pump delivery pressure in order to reduce fuel consumption.



Operation:

1. When the required engine speed by the engine control dial is faster than the engine speed set by E mode control and the power mode switch is in the E mode position, and if the pump control pressure and the average pump delivery pressure are within the following conditions, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication.
2. ECM reduces the engine speed from the required engine speed set by the engine control dial.
3. If the pump control pressure is high and the average pump delivery pressure is low, MC sends the signal equivalent to the target engine speed to ECM by using CAN communication.
4. ECM increases the engine speed by 200 min^{-1}.

Condition:

- Engine speed is reduced lower than the required engine speed by the engine control dial:
  Control Pressure of Pump 1 or 2: Low of either (Reference: 3 MPa (31 kgf/cm^2, 436 psi) or less) and Average Pump Delivery Pressure: High (Reference: 9.8 MPa (100 kgf/cm^2, 1425 psi))

- Engine speed is increased to P mode speed
  Control Pressure of Pump 1 or 2: High of either (Reference: 3 MPa (31 kgf/cm^2, 436 psi) or more) and Average Pump Delivery Pressure: Low (Reference: Less than 9.8 MPa (100 kgf/cm^2, 1425 psi))

Heater Control

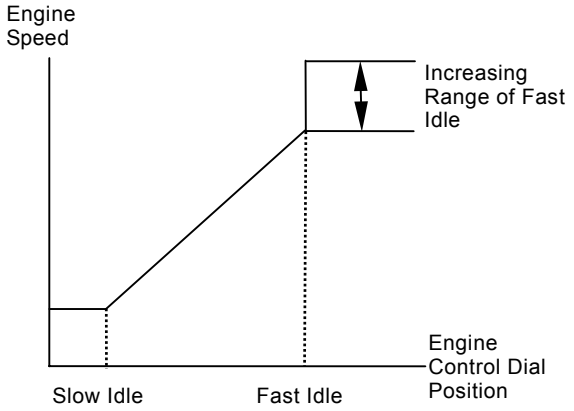
Purpose: Increases the rising temperature speed of the heater in cab while increasing the engine speed at the low temperature.

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.
- Coolant Temperature: Less than 5 °C (41 °F).
- Control Lever: Neutral (Front Attachment/Travel)
- Pilot Shut-Off Switch: OFF
  (Pilot Shut-Off Lever: Lock position
- Brake Switch: P (Parking Brake) position



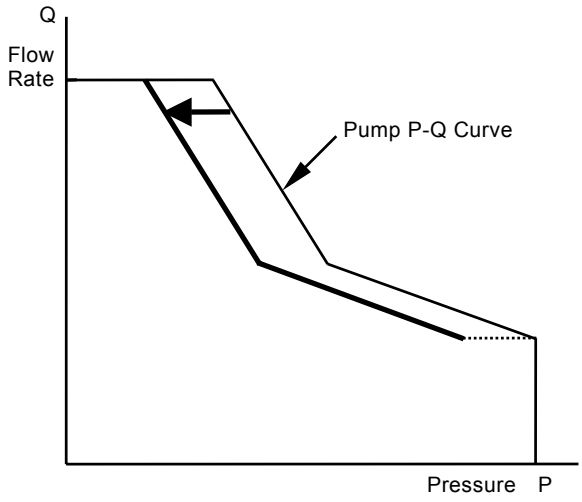
Model	Increasing Range of Fast Idle Speed
ZAXIS170W-3	400 min^{-1}
ZAXIS190W-3	500 min^{-1}

Travel Speed Sensing Control

Function: The pump flow rate is controlled in response to variations in engine speed due to travel load changes in order to use the engine power effectively.

Operation:

1. MC determines the engine target running speed corresponding to sensing signals detected by the engine control dial or the pressure sensor (travel forward or reverse).
2. When the following conditions exist, MC calculates the difference between the target engine speed and actual engine speed detected by ECM by using CAN communication and sends the signals to the torque control solenoid valve.
3. In response to the signals from MC, the torque control solenoid valve sends pilot pressure to the pump regulators in order to control the pump flow rate.
4. When the actual engine speed becomes slower than the target engine speed as the load to the engine increases, the pump displacement angle is reduced in order to reduce the delivery flow rate. Therefore, the load to the engine is reduced and the engine is prevented from stalling.
5. If the actual engine speed becomes faster than the target engine speed, the pump displacement angle is increased in order to effectively utilize the engine power.

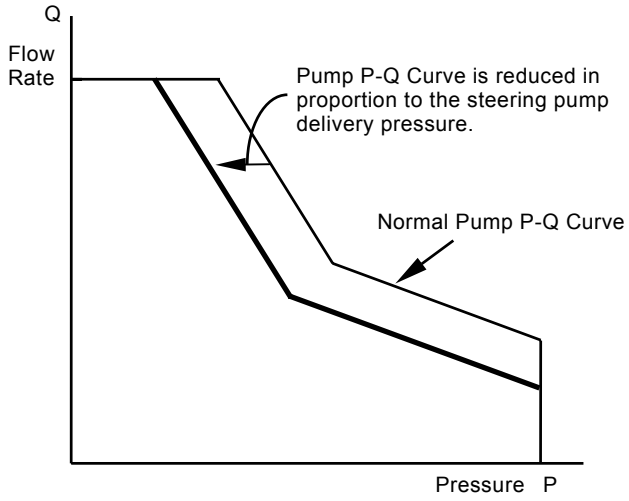


Condition:

- Travel Forward or Reverse Operation
- Brake Switch: Axle Lock, Auto Axle Lock or OFF position
- Work Brake: Inoperable

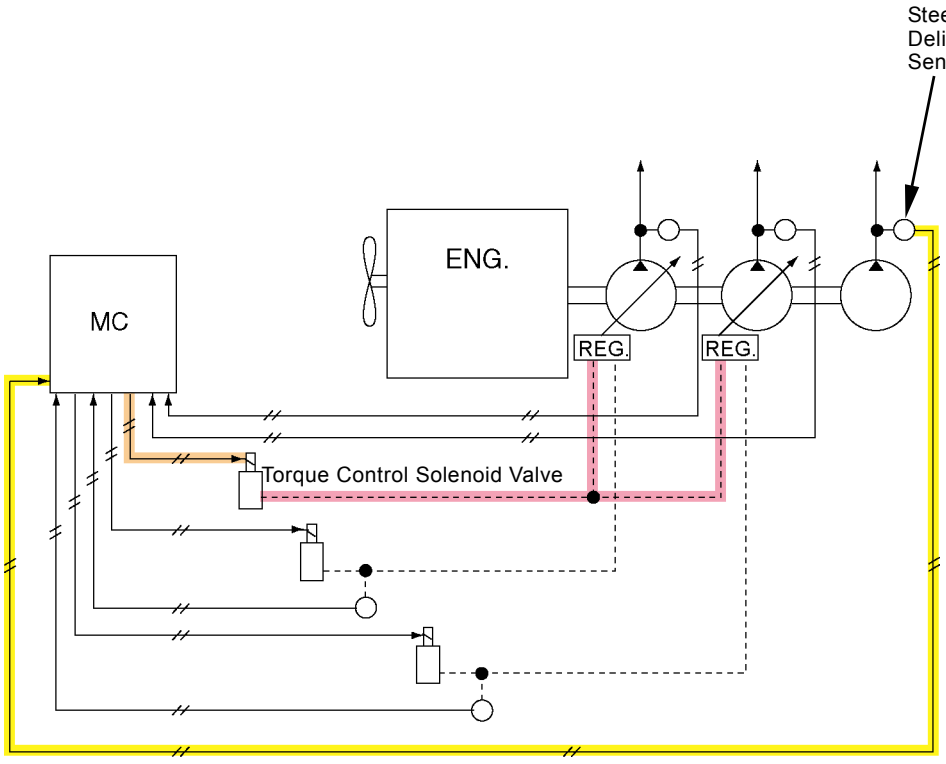
Steering Pump Torque Reduction Control (ZAXIS190W-3)

Function: When load to the steering pump increases, loads to pump 1 and 2 are reduced so that engine stall is prevented and the engine power is used efficiently.



Operation:

1. When the MC receives the signals from the steering pump delivery pressure sensor, MC activates the torque control solenoid valve so that the pumps 1 and 2 delivery flow rate is reduced.
2. Accordingly, the total driving power of pumps 1, 2 and the steering pump is controlled in order not to exceed the engine output power. Therefore, the engine power can be used efficiently.



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Work Brake Control

Purpose: The front and rear brakes are applied during excavation work in order to stabilize the machine vehicle.

Operation:

1. When the following conditions exist and the brake pedal is depressed, the work brake release switch is activated so that MC shifts solenoid valve unit (SF).
2. When solenoid valve unit (SF) is shifted, pilot pressure shifts the brake valve.
3. When the brake valve is shifted, pressure oil from the brake valve flows to the front and rear brakes and the brakes are applied.

Condition:

- Brake Switch: Axle Lock or Auto Axle Lock position
- Engine: Running
- Travel Speed: 3 km/h or less
- Brake Pressure : 6.6 MPa or more

NOTE: A slight time-lag will occur due to difference in operation start time of solenoid valves when the brake switch is shifted to the P (parking brake) position. MC activates the work brake control for four seconds after the brake switch has been shifted to the parking brake position.
Therefore, the machine is prevented from descending the slope when the machine stops on the slope.

NOTE: When the brake pedal is depressed once and released, the work brake switch is turned OFF and the work brake is applied. When the brake pedal is depressed again, the work brake switch is turned ON and the work brake is released.

Pulverizer Control (Optional)

IMPORTANT: Pulverizer 1 is set at pulverizer 1 of attachment mode in monitor unit when the machine is carried out. When pulverizer 2 to 5 is used, set the setting by using Dr. ZX.

Purpose: Increases operating speed of the pulverizer. Reduces flow rate through the auxiliary spool and improve arm, boom, swing or travel operation during combined operation of arm roll-out, arm roll-out+ boom raise, swing or travel and secondary crusher.

Operation:

1. When selecting pulverizer 1 in the monitor unit, MC drives the auxiliary flow combiner control solenoid valve.
2. When operating the pulverizer, pressure oil from the auxiliary solenoid valve flows through the auxiliary flow combiner control solenoid valve and shifts the bypass shut-out valve and auxiliary flow combiner valve.
3. As the neutral circuit in 4-spool side is blocked by the bypass shut-out valve, pressure oil from pump 1 through the auxiliary flow combiner valve is combined with pressure oil from pump 2 so that combined pressure oil is supplied to the auxiliary spool. Therefore, operating speed of the pulverizer increases.
4. Flow rate of the auxiliary flow rate control solenoid valve can be adjusted finely in the monitor unit.

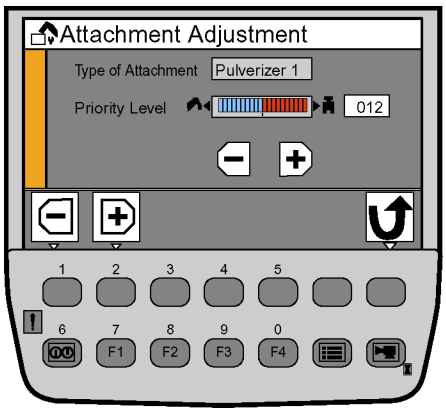
During Combined Operation

Operation:

1. When the following conditions exist, MC drives the auxiliary flow rate control solenoid valve MC controls restricted flow rate of the auxiliary flow rate control solenoid valve and reduces pressure oil which flows to the pulverizer through the auxiliary spool from pump 2.
2. As pressure oil which flows to arm roll-out, arm roll-out+ boom raise, swing or travel from pump 2 increases, arm roll-out, arm roll-out+ boom raise, swing or travel operation is improved.

Condition:

- Auxiliary Pressure Sensor: Output ting signal
  Arm Roll-Out Pressure Sensor: Outputting signal
- Auxiliary Pressure Sensor: Outputting signal
  Arm Roll-Out and Boom Raise Pressure Sensors: Outputting signal
- Auxiliary Pressure Sensor: Outputting signal
  Swing Pressure Sensor: Outputting signal
- Auxiliary Pressure Sensor: Putputting signal
  Travel Pressure Seonsor: Outputting signal



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Travel Mode Selection Control

Purpose: Selects the travel mode selector solenoid valve by shifting the travel speed mode switch and shifts fast/slow of the transmission. In addition, lights the indicator in steering column monitor.

Operation:

- Travel Speed Mode Switch: Fast

1. When the travel speed mode switch is turned into fast position, MC grounds to terminal #A26 in MC.
2. Therefore, the fast speed selection relay is magnetized.
3. Current from fuse #28 flows to the travel mode selector solenoid valve in transmission changeover solenoid valve through the fast speed selection relay and the travel mode selector solenoid valve is shifted.
4. Pressure oil from the pilot pump flows to the fast side port in transmission through the pressure reducing valve and travel mode selector solenoid valve in transmission changeover solenoid valve.
5. The disc brake side in transmission is released by pressure oil and the transmission is shifted to the fast side.
6. When the travel speed mode switch is in the fast position, MC sends the signal to the steering column monitor by using CAN communication.
7. The steering column monitor turns the travel slow speed indicator off.

Rear View Image Selection Control

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

Operation:

1. When the FNR switch is turned into the R (reverse) position with rear view monitor auto selection ON, MC sends the signal to shift the display to the monitor unit by using CAN communication.
2. The monitor unit changes the image of rearview monitor.
3. When the FNR switch is turned into the F (forward) or N (neutral) position, the image of rearview is displayed for three seconds and then the primary screen is automatically displayed.

NOTE: The function rear view monitor auto selection on monitor unit is set OFF when the machine is delivered.

NOTE: Although the FNR switch is turned into the F (forward) or N (neutral) position after the image of rearview is displayed on the monitor unit, the image of rearview is displayed for three seconds.
When the following operations are done within three seconds after the image of rearview is displayed, the image of rearview is not displayed on the monitor unit.
1. Change the image of rearview into the primary screen.
2. Turn the FNR switch into the R (reverse) position.
(If the FNR is kept in the R (reverse) position, the image of rearview is not displayed. If step 1 above is done, the image of rearview is displayed in three seconds or longer.

(Blank)

Positioning and Assist Output Monitoring Control

Purpose: The option controller compares positioning pedal and assist switch operations with the detected value of pressure sensor. If the optional controller recognizes abnormality, the positioning and assist stop.

Operation:

1. Positioning pedal, assist switch operations and the detected value of pressure sensor (positioning) are input to the option controller.
2. When the option controller compares the input signals and detects error beyond 0.5 MPa in 200 ms (0.2 seconds), the option controller blocks current to the positioning, assist and swing parking brake release solenoid valve.
3. Therefore, as the positioning and assist solenoid valves are turned OFF and pressure oil from the pilot pump is blocked by the solenoid valves, the actuators stop.

NOTE: If hydraulic oil temperature is low, the required time when the option controller detects the signal is 0.2 second longer.

Pilot Cut Control

Purpose: Prevents the front attachment and swing operations from operating while the machine travels by turning the blade/outrigger selector switch to the pilot cut position when the machine travels with the pilot shut-off lever in the UNLOCK position.

Operation:

1. When the pilot shut-off lever is in the UNLOCK position, the pilot shut-off relay is magnetized and current from fuse #4 flows to the ground through the pilot shut-off solenoid valve, pilot shut-off relay and security relay.
2. Therefore, the pilot shut-off solenoid valve is shifted and the front attachment and swing operations can be operated.
   (Refer to the SYSTEM / Electrical System group.)
3. At this time, when the blade/outrigger selector switch is in the pilot cut position, current from fuse #4 magnetizes the security relay and turns on the lock indicator in steering column console.
4. As the security relay is turned ON, current from the pilot shut-off relay is blocked.
5. Therefore, as the pilot shut-off solenoid valve is not shifted, pressure oil from the pilot pump is blocked by the pilot shut-off solenoid valve.
6. Consequently, although the front attachment and swing operations are operated, these operations are inoperable.
7. When the blade/outrigger selector switch is in the pilot cut position, terminals #2 in blade/outrigger relays (front) and (rear) are grounded.
8. Therefore, although the blade/outrigger selector switch and blade/outrigger main relay 1 becomes faulty and current from fuse #29 flows into, the blade/outrigger operation is prevented.

Fuel Injection Timing Control

Purpose: Calculates the best fuel injection timing.

Operation:
1. ECM calculates the fuel injection timing according to engine speed and fuel injection amount.
2. ECM controls the two-way valve in injector by turning ON/OFF according to fuel injection timing.

Fuel Injection Rate Control

Purpose: Improves combustion in the engine cylinder.

Operation:
1. The injector injects small amount of fuel (pilot injection) first and ignites.
2. After igniting, the injector injects fuel (main injection).
3. ECM controls fuel injection timing and fuel injection amount by turning the two-way valve in injector ON/OFF.

- Fuel Injection Operation

1. The nozzle in injector is always pressured.
2. When the two-way valve is turned ON, high-pressure fuel in the control chamber flows through orifice 1.
3. Therefore, the hydraulic pressure piston is raised and the nozzle opens so that the injection starts.
4. When the two-way valve is turned OFF, high-pressure fuel from the common rail flows to the control chamber through orifice 2.
5. Therefore, when high-pressure flows to the control chamber, the hydraulic pressure piston is lowered.
6. Consequently, the nozzle is closed and injection stops.

PILOT CIRCUIT

Outline:

Pressure oil from the pilot pump is used as operation pressure as follows.

- Operation Circuit (Front Attachment, Travel, Blade/Outrigger)
- Swing Parking Brake Release Circuit
- Valve Control Circuit
- Hydraulic Oil Heat Circuit
- Work Brake Circuit
- Axle Lock Circuit
- Travel Mode Selector Circuit
- Blade/Outrigger Circuit
- Pump Control Circuit
- Front Attachment Operation Circuit
- Positioning Control Circuit

Pump Control Circuit (Refer to the COMPONENT OPERATION/Pump Device group.)

- Pump Delivery Flow Rate Control by Flow Rate Control Pressure Pi
  - Pilot pressure from the control valve is selected by the shuttle valve in signal control valve and the pump 1 flow rate control valve or pump 2 flow rate control valve in signal control valve is shifted.
  - Pilot pressure from the positioning is selected by the external shuttle valve and the pump 1 flow rate control valve in signal control valve is shifted.
  - Pilot pressure oil from the pilot pump is supplied to main pump 1 or 2 through the max. pump 1 and 2 flow rate limit control valves as flow rate control pressure Pi by shifting the pump 1 flow rate control valve or pump 2 flow rate control valve.

NOTE: When operating boom raise/lower, arm roll-out/in, bucket roll-in/out, travel (forward/reverse) and positioning, flow rate control pressure Pi is supplied to main pump 1.
When operating boom raise, arm roll-out/in, swing (right/left), blade/outrigger and auxiliary, flow rate control pressure Pi is supplied to main pump 2.

- Pump Control by Torque Control Solenoid Valve
  - Pilot pressure from the pilot pump is controlled by the torque control solenoid valve and supplied to main pumps 1 and 2 as torque control pressure Pps.

Neutral Circuit

- When the control lever is in neutral, pressure oil from the main pump passes through the control valve and returns to the hydraulic oil tank.
- The parallel circuit is located in the 4-spool section and 5-spool section respectively so that combined operation is possible.

Single Operation Circuit

- Pressure oil from main pump 1 is routed to the 4-spool control valve and is further routed to each spool of travel, bucket, boom 1 and arm 2.
- Pressure oil from main pump 2 is routed to the 5-spool control valve and is further routed to each spool of swing, arm 1, boom 2, auxiliary and blade/outrigger.
- The boom and arm are actuated by pressure oil from two main pumps. Pressure oil from each main pump is combined and supplied together.

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]

- 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. Turns the pilot shut-off solenoid valve OFF and blocks the pilot circuit.

- 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.

Brake Switch: OFF, Auto Axle Lock or Axle Lock Position

- Starting Safety Circuit
  1. When the key switch is turned to the START position, current from key switch terminal ST flows to the starter cut relay.
  2. At this time, if the brake switch is in the OFF, auto axle lock or axle lock position, current from terminal ST excites the starter cut relay and is grounded from the brake switch.
  3. When the starter cut relay is turned ON, the circuit between key switch terminal ST and starter relay terminal S is blocked. Therefore, although the key switch is turned to the START position, the engine does not start.

SECURITY LOCK CIRCUIT

1. When the external alarm signal or password input error signal from ICF is input to the monitor unit, terminal #A4 is connected to the ground inside the monitor unit.
2. Therefore, the security relay and starter cut relay are excited.
3. When the security relay is excited, the ground circuit in pilot shut-off solenoid valve is blocked and the pilot shut-off solenoid valve is turned OFF.
4. Therefore, pressure oil which flows to the pilot valve from the pilot pump is blocked by the pilot shut-off solenoid valve.
5. When the starter cut relay is excited, the circuit between terminal ST in the key switch and terminal S in starter relay is blocked.
6. Therefore, when the key switch is turned to the START position, the engine does not start.

Head Light Circuit

NOTE: The operation with the dimmer switch in the LOW position is explained here.

1. When the light switch is turned to position 2, terminal #3 is connected to terminal #4 in the light switch.
2. When the dimmer switch is turned to the LOW position, terminal #5 is connected to terminal #6 in the dimmer switch.
3. Current from fuses #22 and #32 flows to the ground through the dimmer switch and light switch.
4. Therefore, head light relays (right) and (left) are excited.
5. Current from fuses #22 and #32 flows to the head light and the head light is turned on.

NOTE: When the light switch is in position 2, terminals #1 and #2 are connected in the light switch. Therefore, head light, clearance lights (right), (left) and tail light are turned on.

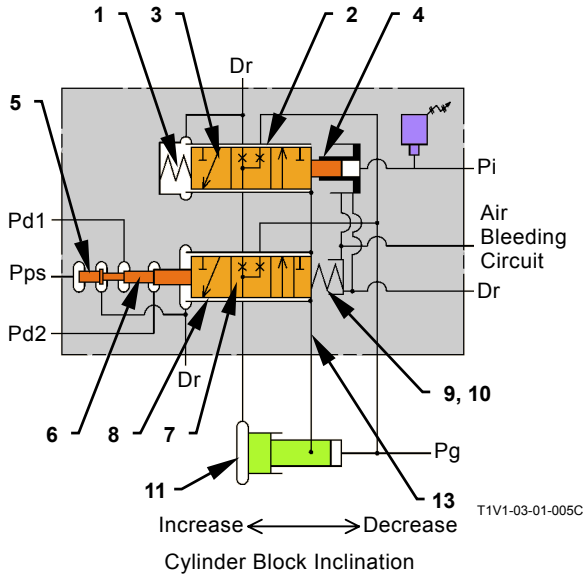
Stop Light Circuit

1. When the brake pedal is depressed, the stop light switch is turned ON.
2. Current from fuses #25 flows to the ground through the stop light switch.
3. Therefore, the stop light relay is excited.
4. Current from fuses #25 flows to the stop light and the stop light is turned on.

REGULATOR

The regulator controls the main pump flow rate in response to the various command signal pressures so that the pump driving power does not exceed the engine power. Pump 1 and pump 2 are provided with one regulator for each. The major parts of regulator are spring (1), sleeve A (2), sleeve B (8), spool A (3), spool B (7), piston (4), load piston 1 (5), load piston 2 (6), inner spring (9) and outer spring (10). According to the various command signal pressures, the regulator opens or closes the circuit to servo piston (11), the inclination of cylinder block (12) is changed and the pump flow rate is controlled.

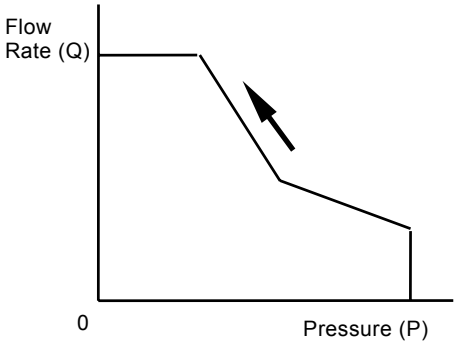
NOTE: Pilot oil pressure is constantly supplied in the smaller chamber side of servo piston (11).

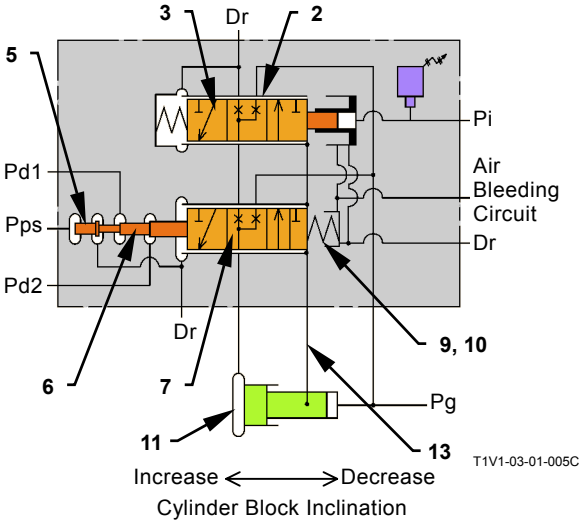


Pd1 -Pump 1 Delivery Pressure
Pd2 -Pump 2 Delivery Pressure
Dr - Returning to Hydraulic Oil Tank
Pi - Pump Control Pressure
Pps -Torque Control Pressure
Pg - Primary Pilot Pressure (From Pilot Pump)

1 - Spring
2 - Sleeve A
3 - Spool A
4 - Piston
5 - Load Piston 1
6 - Load Piston 2
7 - Spool B
8 - Sleeve B
9 - Inner Spring
10 - Outer Spring
11 - Servo Piston
12 - Cylinder Block
13 - Link

- Increasing Flow Rate
  1. When the pump load is reduced, either pump 1 delivery pressure Pd1 or pump 2 delivery pressure Pd2 decreases. (During operation, pump control pressure Pi is kept increased.)
  2. Load piston 1 (5), load piston 2 (6) and spool B (7) are pushed by inner spring (9) and outer spring (10). Spool B (7) moves toward direction of the arrow.
  3. Due to the movement of spool B (7), the circuit from the large chamber of servo piston (11) is opened to the hydraulic oil tank.
  4. As pilot pressure is constantly routed in the small chamber of servo piston (11), servo piston (11) is moved toward direction of the arrow. The cylinder block is rotated in the maximum inclination direction and the pump delivery flow rate increases.
  5. The movement of cylinder block is transmitted to sleeve A (2) via link (13). 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 pilot pressure to servo piston (11) is blocked. Therefore, servo piston (11) is stopped and the flow rate increasing operation is completed.



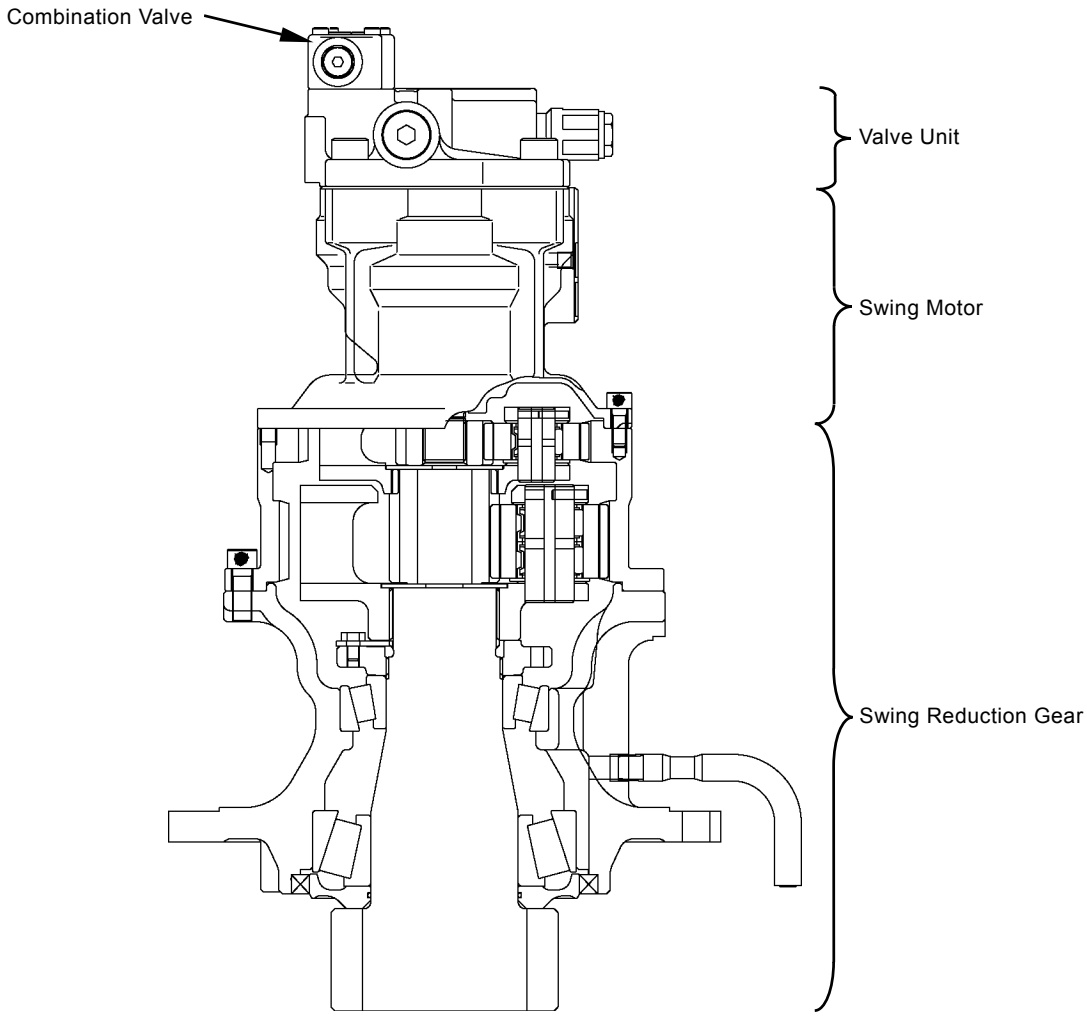


2 - Sleeve A
3 - Spool A
5 - Load Piston 1
6 - Load Piston 2
7 - Spool B
9 - Inner Spring
10 - Outer Spring
11 - Servo Piston
13 - Link

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)

OUTLINE

The swing device consists of the valve unit, the swing motor and the swing reduction gear.
The valve unit prevents the cavitation and overloads in the swing circuit.
The swing motor is a swash-plate type axial plunger motor (with built-in swing parking brake), which is driven by pressure oil from the pump, and the rotation is transmitted to the swing reduction gear.
The swing reduction gear turns the swing motor with large torque at the slow speed and swings the upperstructure.
The combination valve is provided for the main circuit in swing motor.
The combination valve reduces shock when the swing brake is applied and also prevents aftershock.



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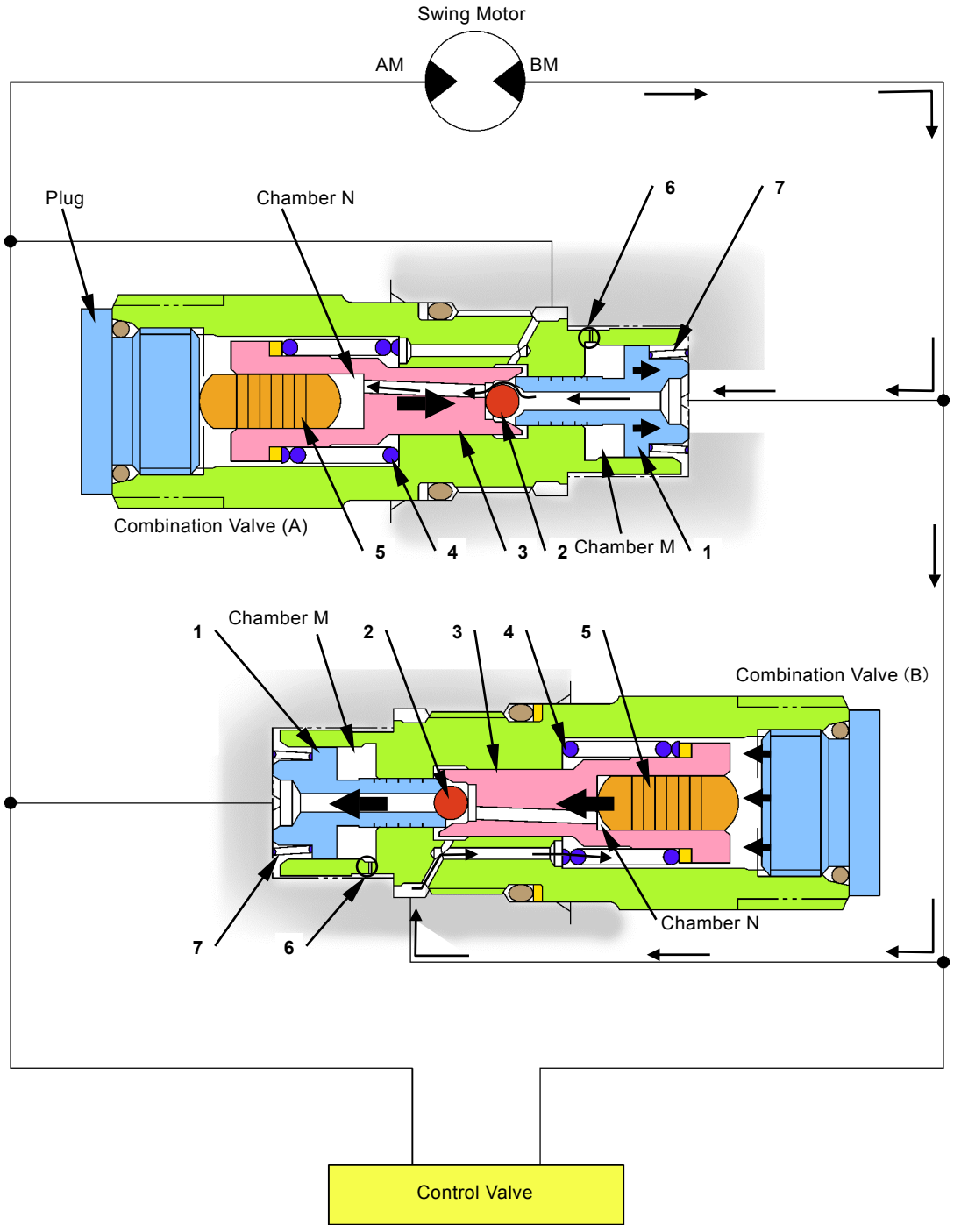
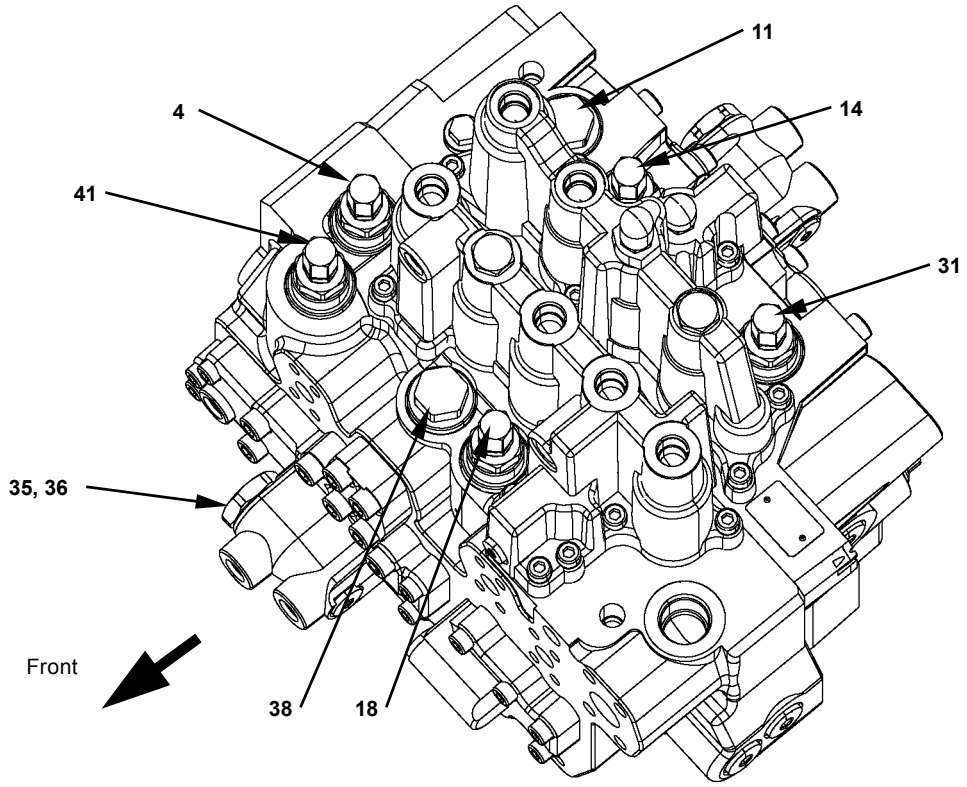


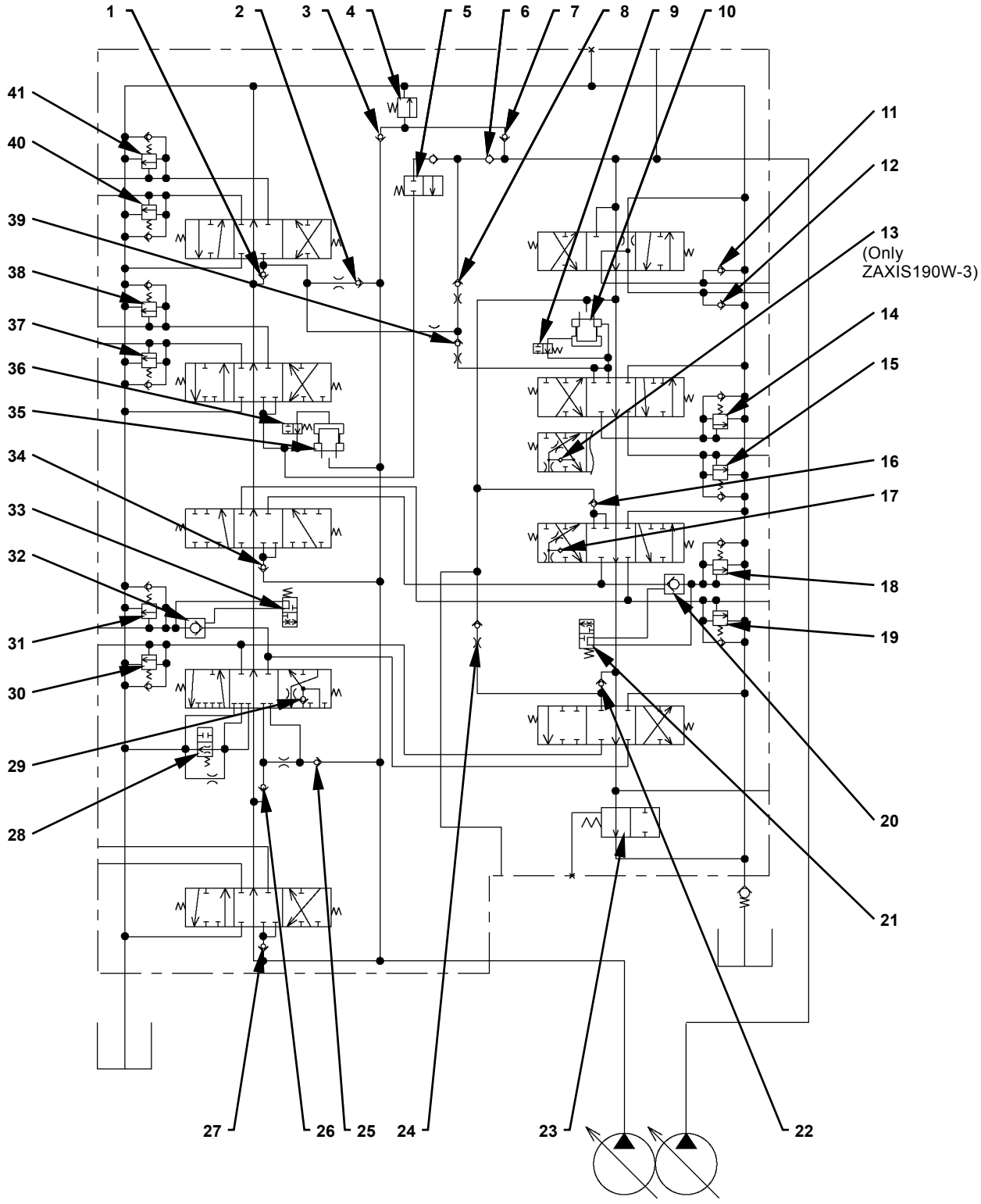
T1V1-03-02-013C

1 - Poppet
2 - Ball
3 - Plunger
4 - Spring
5 - Piston
6 - Orifice
7 - Spring



T16W-03-03-030

1 - Load Check Valve (Blade/Outrigger Tandem Circuit)
2 - Load Check Valve (Blade/Outrigger Parallel Circuit)
3 - Check Valve (Main Relief Circuit)
4 - Main Relief Valve
5 - Auxiliary Flow Combiner Valve
6 - Check Valve (Auxiliary Flow Combiner Circuit)
7 - Check Valve (Main Relief Circuit)
8 - Check Valve (Flow Combiner Circuit)
9 - Bucket Flow Rate Control Valve (Selector Valve)
10 - Bucket Flow Rate Control Valve (Poppet Valve)
11 - Make-Up Valve (Travel Reverse Side)
12 - Make-Up Valve (Travel Forward Side)
13 - Bucket Regenerative Circuit (Only ZAXIS190W-3)
14 - Overload Relief Valve (Bucket Rod Side)
15 - Overload Relief Valve (Bucket Bottom Side)
16 - Load Check Valve (Boom 1 Parallel Circuit)
17 - Boom Regenerative Circuit
18 - Overload Relief Valve (Boom Bottom Side)
19 - Overload Relief Valve (Boom Rod Side)
20 - Boom Anti-Drift Valve (Check Valve)
21 - Boom Anti-Drift Valve (Selector Valve)
22 - Load Check Valve (Arm 2 Tandem Circuit)
23 - Bypass Shut-Out Valve
24 - Check Valve (Orifice) (Arm 2 Parallel Circuit)
25 - Load Check Valve (Arm 1 Parallel Circuit)
26 - Load Check Valve (Arm 1 Tandem Circuit)
27 - Load Check Valve (Swing Circuit)
28 - Arm Regenerative Valve (Selector Valve)
29 - Arm Regenerative Circuit
30 - Overload Relief Valve (Arm Bottom Side)
31 - Overload Relief Valve (Arm Rod Side)
32 - Arm Anti-Drift Valve (Check Valve)
33 - Arm Anti-Drift Valve (Selector Valve)
34 - Load Check Valve (Boom 2 Parallel Circuit)
35 - Aux. Flow Rate Control Valve (Poppet Valve)
36 - Aux. Flow Rate Control Valve (Selector Valve)
37 - Overload Relief Valve (Auxiliary)
38 - Overload Relief Valve (Auxiliary)
39 - Load Check Valve (Bucket Parallel Circuit)
40 - Overload Relief Valve (Blade/Outrigger Rod Side)
41 - Overload Relief Valve (Blade/Outrigger Bottom Side)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ZAXIS190W-3)
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TCGB-03-03-001

Pilot Control Circuit (2-Piece Boom)

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 switch valve in arm anti-drift valve and the spool in hose rupture valve (arm).
- During boom lower (2) operation, pressure oil moves the boom spool and shifts the switch valve in boom anti-drift valve and the spool in hose rupture valve (boom).
- During positioning raise (31) or lower (32) operation, pressure oil moves the positioning spool and shifts the bypass shut-out valve.
- During positioning lower (32) operation, pressure oil moves the spool in hose rupture valve (positioning).

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

External Pilot Pressure Circuit (2-Piece Boom)

- The arm regenerative valve is shifted by pilot pressure from solenoid valve unit (SC).
- The bucket flow rate control valve is shifted by pilot pressure from the bucket flow rate control valve spool in signal control valve.
- The auxiliary flow combiner valve and bypass shut-out valve are shifted by pressure oil from the auxiliary flow combiner control solenoid valve. (Only the machine equipped with the optional parts)
- The auxiliary flow rate control valve is shifted by pilot pressure from the auxiliary flow rate control solenoid valve (optional). (Only the machine equipped with the optional parts)

NOTE: In general, the auxiliary flow combiner valve and auxiliary flow rate control valve are routed to the drain circuit.
The auxiliary flow rate control solenoid valve is installed to only the machine equipped with the optional parts.

REGENERATIVE VALVE

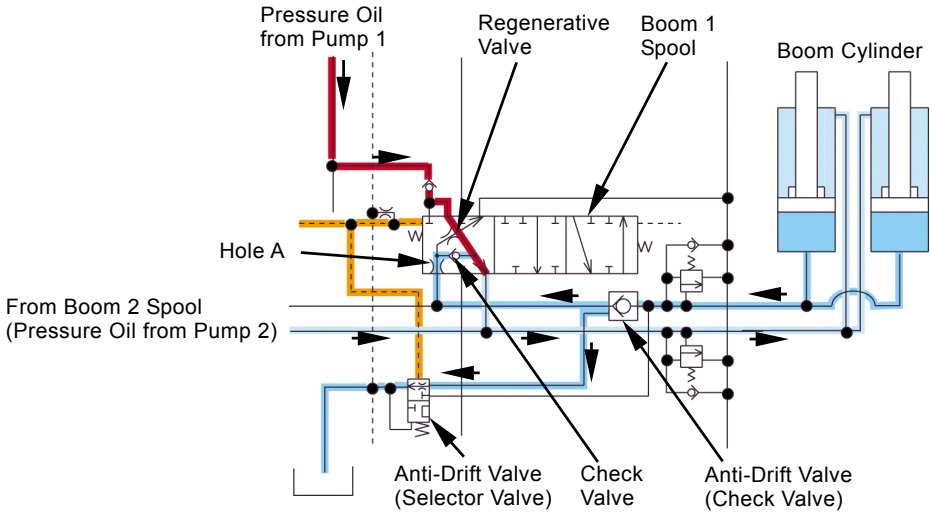
The regenerative valves are located in the boom lower, arm roll-in and bucket roll-in (ZAXIS190W-3 only) accelerating the cylinder operating speeds, preventing the cylinders from making a pose in movement, and improving machine controllability.

NOTE: Operational principles of each regenerative valve are almost identical. Therefore, the boom regenerative valve is used as an example.

Operation

1. When the boom is lowered, the return oil from the cylinder bottom side (the rod side in case of the arm cylinder) is routed the check valve via anti-drift valve and hole A on the spool. (Refer to T3-3-30 as for the operation of the anti-drift valve.)
2. At this moment, when the pressure oil in the cylinder rod side (the bottom side in case of the arm cylinder) is lower than the bottom side, the check valve is unseated.
3. Then, the return oil from the cylinder bottom side flows into the rod side so that the return pressure oil is regenerated, increasing the cylinder operating speed.
4. When the cylinder is fully stroked or digging loads increase, the oil pressure in the cylinder bottom circuit decreases more than the rod side, causing the check valve to seat so that regeneration is stopped.

NOTE: Arm Regenerative Valve (Selector Valve) Operation
The arm regenerative valve (selector Valve) is shifted by the pilot pressure oil from solenoid valve unit (SC) so that the return oil circuit from the cylinder rod side to the hydraulic oil tank is blocked. (Refer to the SYSTEM / Control system group.)



T1F3-03-03-022

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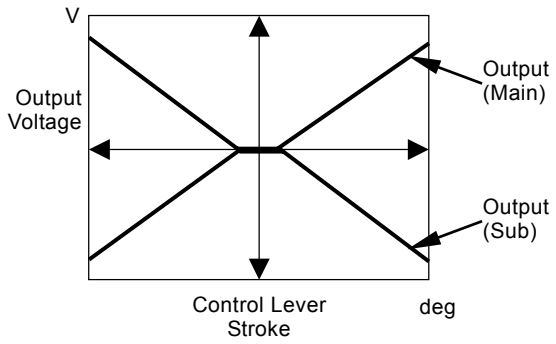
OPERATION

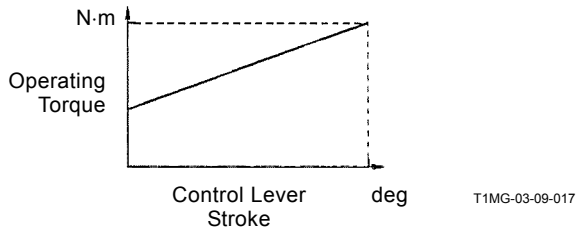
1. When the electric lever is operated, cam (5) and arm (4) are tilted.
2. The arm (4) movement is transmitted to potentiometer (1) through pin (3) in arm (4) and support (2) in potentiometer (1).
3. Potentiometer (1) outputs the signal according to the support (2) tilt to the option controller.

NOTE: Potentiometer (1) outputs the main and sub signals.
If one signal is faulty, the machine can operate due to the other.



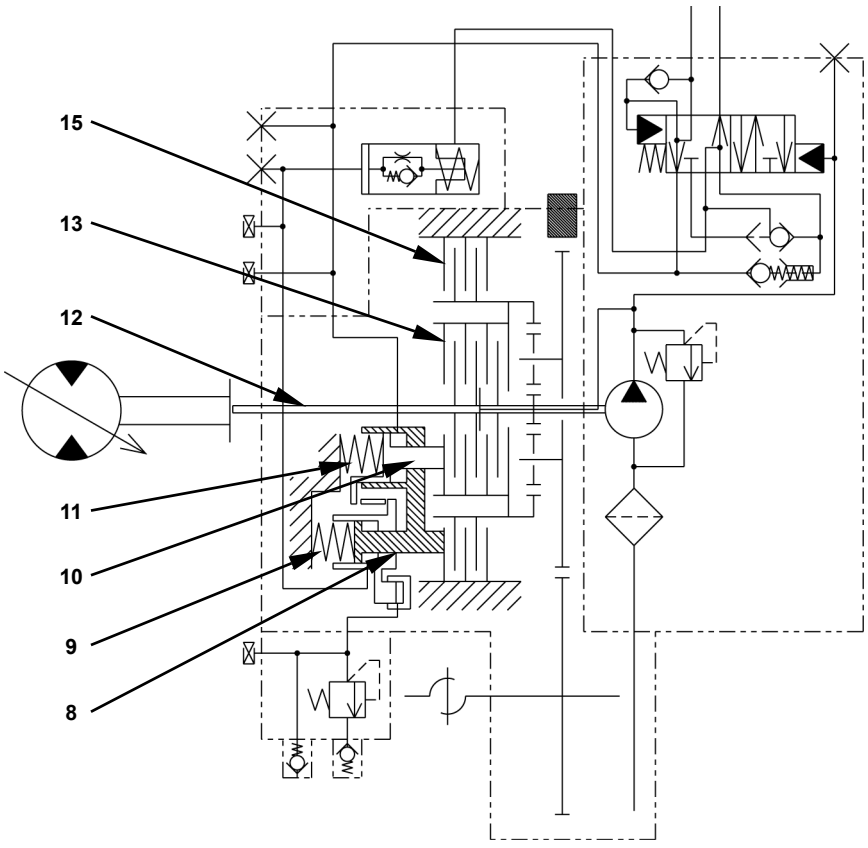
Operating Torque:

1. When the electric lever is operated, cam (5) is tilted and pusher (6) is pushed down.
2. Pusher (6) compresses spring (7).
3. Therefore, torque when operating the electric lever is obtained.



Parking Brake

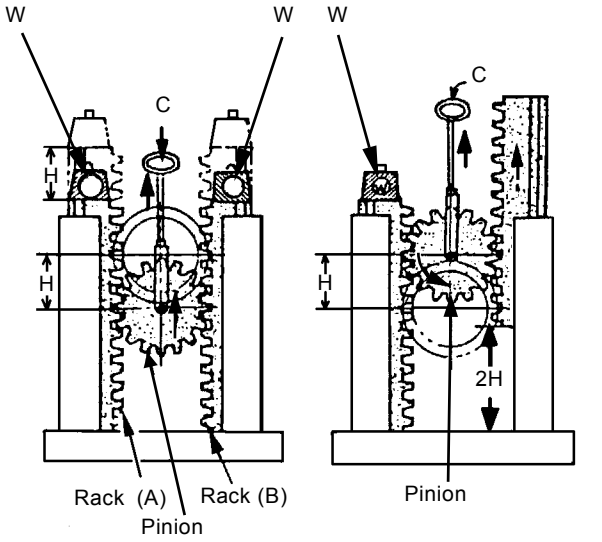
1. When the brake switch is turned to the P (parking brake) position, the transmission changeover solenoid valve blocks pressure oil from the pilot pump. (Refer to the COMPONENT OPERATION / Others (Upperstructure) group.)
2. Pressure oil acting on the clutch piston (10) and brake piston (8) is routed to the hydraulic oil tank.
3. Therefore, clutch piston (10) and brake piston (8) are moved by disc springs (11, 9) force to the right so that disc clutch (13) is engaged and disc brake (15) is applied.
4. Consequently, all gears are locked and shaft (12) stops rotating.



T21W-03-05-001

- Basic Operational Principle of Differential Gear
  The operational principle of differential gear is explained by using a pair of racks and a pinion gear.

1. When handle (C) is moved upward by distance (H) while applying equal loads (W) onto both racks (A and B) respectively, both racks (A and B) move by distance (H) together with the pinion gear.
2. When handle (C) is moved upward without applying load (W) onto rack (B), the pinion gear is moved upward while rotating along rack (A) to which load (W) is kept applied.
3. Rack (B) to which no load is applied is moved upward as the pinion gear rotates.
4. At this time, the moving distance of rack (B) is longer than the moving distance of the pinion gear that rotates along rack (A).
5. The moving distance of rack (B) can be obtained as H + H = 2H. This is equal to the operational principle of the differential gear.

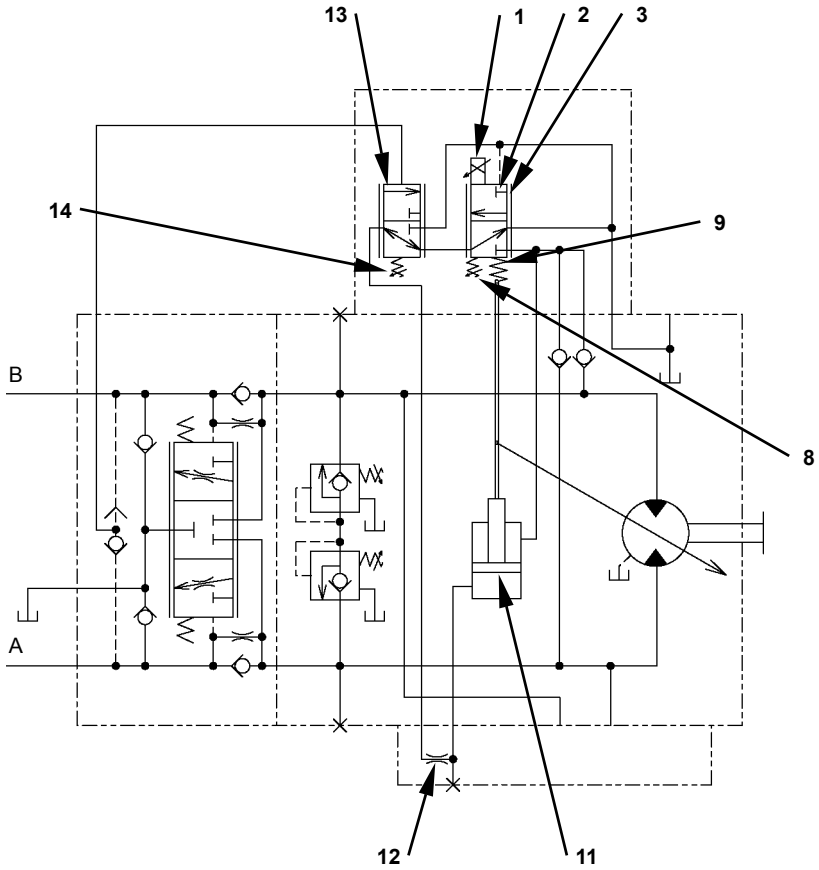


T202-03-05-006

REGULATOR

The major components of regulator are travel motor displacement control solenoid valve (1), spool (2), sleeve (3), piston (4), spring (5), bushing (6), collar (7), return spring (8), balance spring (9), pin (10), servo piston (11), orifice (12) and pilot piston (13). Corresponding to various signal pressures delivered to the regulator, the regulator opens or closes the circuit to servo piston (11) so that the tilt angle of rotor is adjusted and the travel motor rotation is controlled.

NOTE: The motor circuit pressure is constantly routed into the small chamber of servo piston (11).



TCJB-03-08-001

Port A: Travel Reverse Side Port B: Travel Forward Side

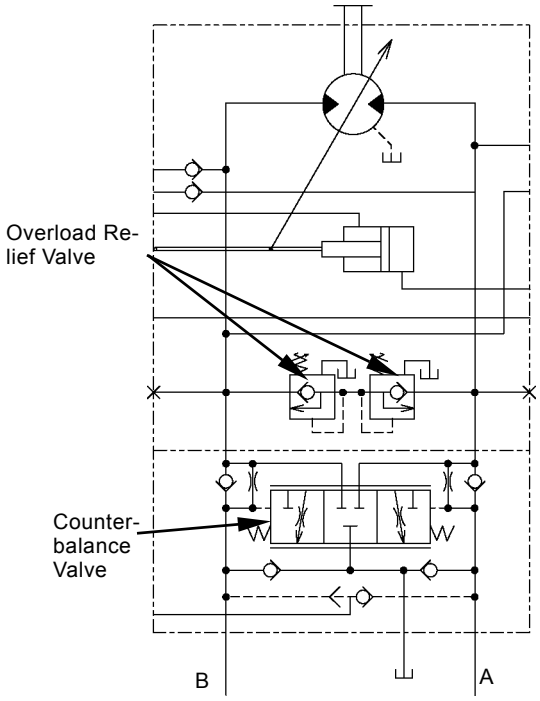
OVERLOAD RELIEF VALVE

The motor is equipped with the overload relief valves that prevents surge pressure from occurring in the motor circuit.

Circuit Protection

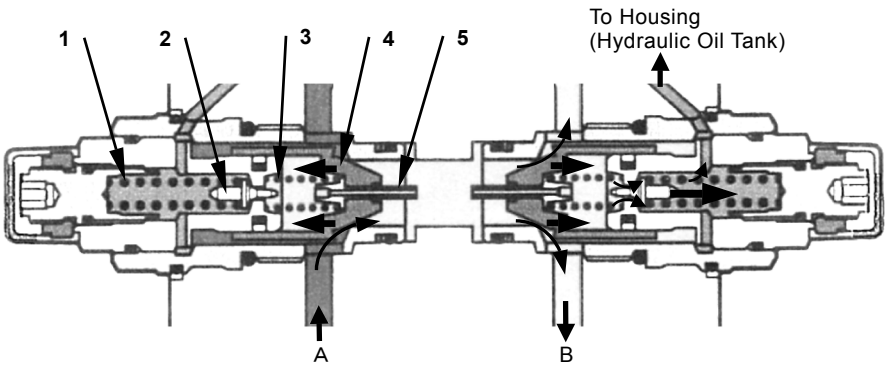
1. When the circuit oil pressure increases to higher than the set-pressure of overload relief valve, the overload relief valve opens, surge pressure is relieved to the lower pressure side so that the travel motor is protected from being overloaded.

NOTE: When the motor runs faster than the oil volume supplied from the pump, the counterbalance valve is closed, and pressure in the returning oil pressure from the motor increases.



TCJB-03-08-005

When Relieving:



T1F3-03-05-035

1 - Spring
2 - Poppet
3 - Spring
4 - Check Valve
5 - Piston

SHUTTLE VALVE

The shuttle valve selects pilot pressure to perform each operation and routes pilot pressure to the corresponding flow rate control valves and/or control valve spools. The flow rate control valves and/or control valve spools corresponding to each operation are as follows:

	Pump 1 Flow Rate Control Valve	Pump 2 Flow Rate Control Valve	Bucket Flow Rate Control Valve Control Spool	Swing Parking Brake Release Spool
Boom Raise	○	○	-	○
Boom Lower	○	-	-	○
Arm Roll- Out	○	○	-	○
Arm Roll- In	○	○	○	○
Bucket Roll-In	○	-	-	○
Bucket Roll-Out	○	-	-	○
Right Swing	-	○	-	○
Left Swing	-	○	-	○
Travel	○	-	-	-
Blade/Outrigger	-	○	-	○
Auxiliary	*○	○	-	○
Positioning (2-Piece Boom Only)	○	-	-	-

*NOTE: *As for the machine with the front attachment (pulverizer 1 to 5 and crusher 1 to 5) attached, the pump 1 flow rate control valve is operated by pressure from the auxiliary solenoid valve.*

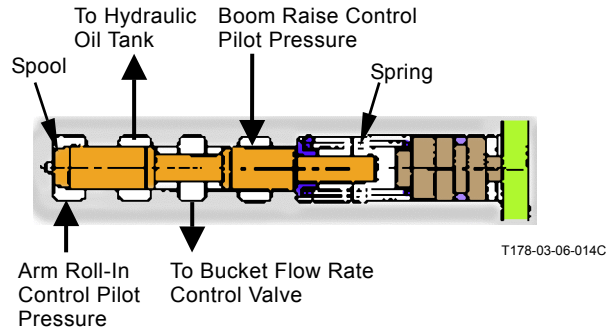
BUCKET FLOW RATE CONTROL VALVE CONTROL SPOOL, SWING PARKING BRAKE RELEASE SPOOL

NOTE: The spools above are identical in operational principle.

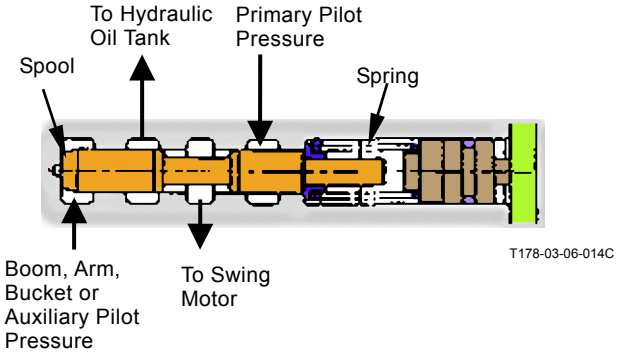
1. The bucket flow rate control valve control spool is shifted by arm roll-in control pilot pressure and supplies boom raise control pilot pressure to the bucket flow rate control valve in control valve.

2. The swing parking brake release spool is shifted by the boom, arm, bucket, swing or auxiliary control pilot pressure and supplies primary pilot pressure to the swing motor.

Bucket Flow Rate Control Valve Control Spool:



Swing Parking Brake Release Spool:



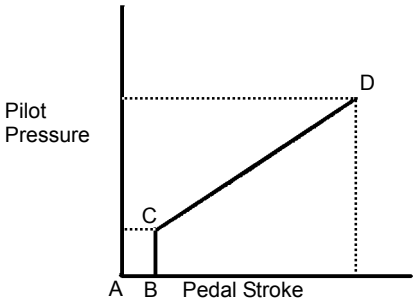
OPERATION

When steering is in neutral:

1. Pressure oil from the steering pump flows to the steering valve through chamber A, port P and the outer circumference in spool (9).
2. When the steering valve is in neutral (the steering wheel is not operated), pressure oil which flows to the steering valve from chamber A is blocked by the steering valve so that pressure in chamber A increases.
3. Pressure oil from port P is divided into two direction through the inner passage in spool (9).
4. One pressure oil flows to chamber B through orifice (8).
5. The other pressure oil flows to the steering valve through orifice (13) and spring (12).
6. As pressure oil in spring (12) flows to the hydraulic oil tank through the steering valve, the pressure difference occurs due to orifice (13).
7. Therefore, pressure in spring (12) is lower than that in chamber B.
8. When the pressure difference increases beyond the force of spring (12), spool (9) moves to the left by compressing spring (12)
9. Consequently, when the steering valve is in neutral, pressure oil from the steering pump always flows to the accumulator charging valve through port EF.

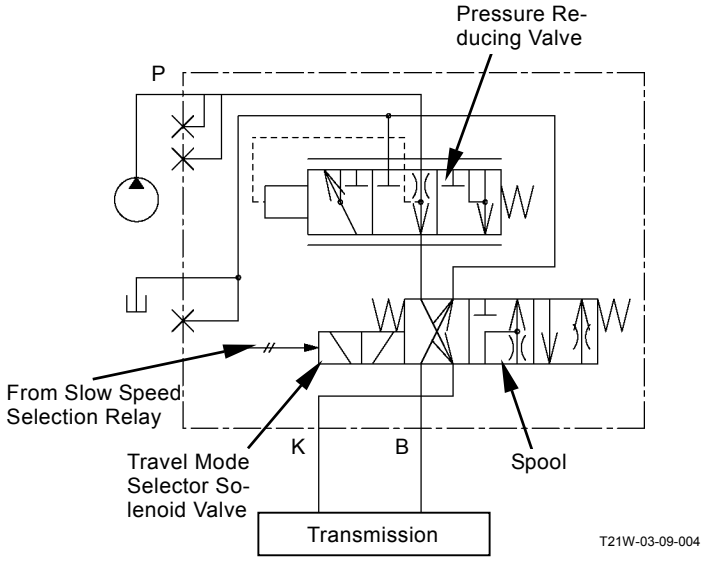
Output Diagram: Range C to D

1. When brake pedal (1) is further stepped on and push rod (2) and pilot piston (3) are pushed, the notches on spools (7, 10) are connected to ports BA and BB respectively and pressure oil from ports PA and PB flow to port BA and BB.
2. Oil pressure in ports BA and BB is routed into the inside of spools (7, 10) through each spool hole so that spools (7, 10) are pushed to the left.
3. When the force pushing spools (7, 10) to the left is smaller than the balance spring (6) force, balance spring (6) is not compressed. Therefore, spools (7, 10) do not move so that oil pressure in port BA and BB continues to increase.
4. When oil pressure in ports BA and BB increases further, the force pushing spools (7, 10) to the left increases. When this force overcomes the balance spring (6) force, spools (7, 10) compresses balance spring (6) and move to the left.
5. When spools (7, 10) move to the left, the notches are closed, no pressure oil flows to ports BA and BB from ports PA and PB. Thereby, oil pressure in ports BA and BB stops increasing.
6. As described above, balance spring (6) is compressed by the stroke of spools (7, 10). During this operation, spring force increases in proportion to force to push spools (7, 10). Oil pressure creating this force is equal to the oil pressure in ports BA and BB.

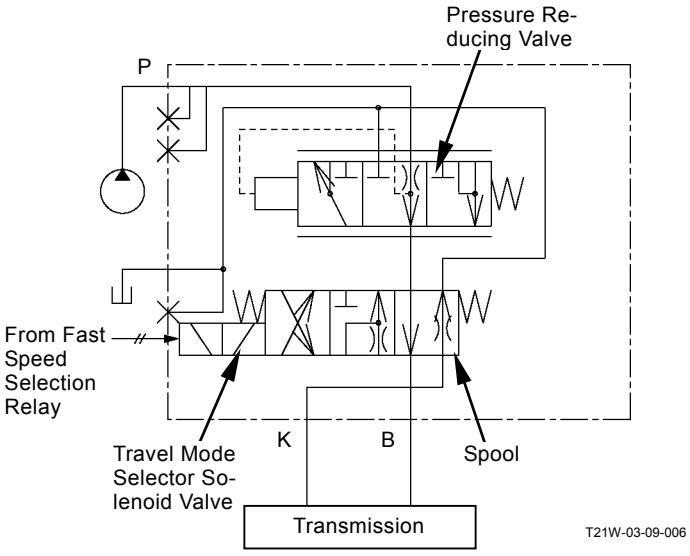


T1F3-03-09-004

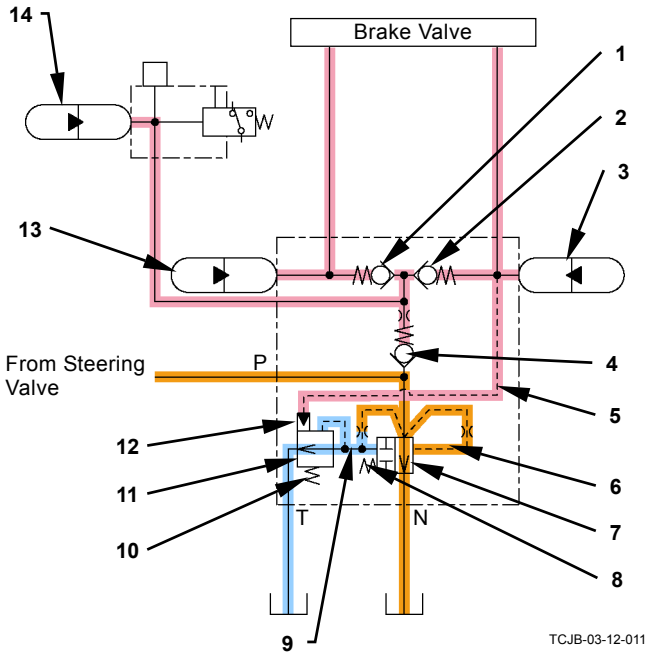
- Slow speed selection
  1. Pressure oil from port P flows to the travel mode selector solenoid valve spool through the pressure reducing valve.
  2. When the travel speed mode switch is turned to the slow position, current from the slow speed selection relay activates the solenoid valve and shifts the spool.
     (Refer to the SYSTEM / Control System group.)
  3. Therefore, port P is connected to port K so that pressure oil from port P flows to the slow side in transmission through port K.
  4. Consequently, travel speed is selected into the slow speed.



- Fast speed selection
  1. Pressure oil from port P flows to the travel mode selector solenoid valve spool through the pressure reducing valve.
  2. When the travel speed mode switch is turned to the fast position, current from the fast speed selection relay activates the solenoid valve and shifts the spool.
     (Refer to the SYSTEM / Control System group.)
  3. Therefore, port P is connected to port B so that pressure oil from port P flows to the fast side in transmission through port B.
  4. Consequently, travel speed is selected into the fast speed.



- After pressure charging finish
  1. Pressure in passage (5) acts on piston (12).
  2. Pressure in accumulators (3, 13, 14) is blocked and kept by check valves (2, 1, 4) respectively.
  3. When the accumulator becomes saturated (cut-out pressure), piston (12) moves upward due to pressure in passage (5) (downward as illustrated in the circuit diagram).
  4. As passage (9) is connected to port T (hydraulic oil tank), pressure in passage (9) decreases.
  5. Therefore, as pressure in chamber A (6) is larger than pressure in passage (9) + spring (8) force, spool (7) moves upward (to the left as illustrated in the circuit diagram).
  6. Consequently, pressure oil in port P flows to port N (hydraulic oil tank).
  7. These procedures are continued until the service brake is applied (pressure in the brake circuit decreases).



1 -	Check Valve	8 -	Spring
2 -	Check Valve	9 -	Passage
3 -	Accumulator	10 -	Spring
4 -	Check Valve	11 -	Pilot Piston
5 -	Passage	12 -	Piston
6 -	Chamber A	13 -	Accumulator
7 -	Spool	14 -	Accumulator

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