

Technical Manual

Operational Principle

ZAXIS

160LC-3

180LC-3

180LCN-3

Hydraulic Excavator

ZAXIS160LC-3 • 180LC-3 • 180LCN-3
HYDRAULIC EXCAVATOR TECHNICAL MANUAL OPERATIONAL PRINCIPLE

 **Hitachi Construction Machinery Co., Ltd.**
URL:<http://www.hitachi-c-m.com>

Service Manual consists of the following separate Part No;
Technical Manual (Operational Principle) : Vol. No.TO1T1-E
Technical Manual (Troubleshooting) : Vol. No.TT1T1-E
Workshop Manual : Vol. No.W1T1-E
Engine Manual : Vol. No.KM-4JJ1-E

INTRODUCTION

TO THE READER

- This manual is written for an experienced technician to provide technical information needed to maintain and repair this machine.
- Be sure to thoroughly read this manual for correct product information and service procedures.
- If you have any questions or comments, at if you found any errors regarding the contents of this manual, please contact using “Service Manual Revision Request Form” at the end of this manual. (Note: Do not tear off the form. Copy it for usage.):
Publications Marketing & Product Support
Hitachi Construction Machinery Co. Ltd.
TEL: 81-298-32-7173
FAX: 81-298-31-1162

ADDITIONAL REFERENCES

- Please refer to the materials listed below in addition to this manual.
 - The Operator’s Manual
 - The Parts Catalog
 - Operation Manual of the Engine
 - Parts Catalog of the Engine
 - Hitachi Training Material

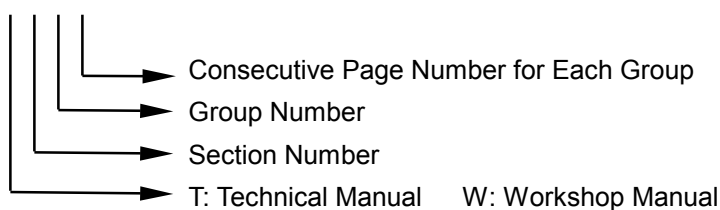
MANUAL COMPOSITION

- This manual consists of three portions: the Technical Manual (Operational Principle), the Technical Manual (Troubleshooting) and the Workshop Manual.
- Information included in the Technical Manual (Operational Principle):
technical information needed for redelivery and delivery, operation and activation of all devices and systems.
- Information included in the Technical Manual (Troubleshooting):
technical information needed for operational performance tests, and troubleshooting procedures.
- Information included in the Workshop Manual:
technical information needed for maintenance and repair of the machine, tools and devices needed for maintenance and repair, maintenance standards, and removal/installation and assemble/disassemble procedures.

PAGE NUMBER

- Each page has a number, located on the center lower part of the page, and each number contains the following information:


Example : T 1-3-5



INTRODUCTION


SAFETY ALERT SYMBOL AND HEADLINE NOTATIONS

In this manual, the following safety alert symbol and signal words are used to alert the reader to the potential for personal injury or machine damage.


 This is the safety alert symbol. When you see this symbol, be alert to the potential for personal injury. Never fail to follow the safety instructions prescribed along with the safety alert symbol.

The safety alert symbol is also used to draw attention to component/part weights.

To avoid injury and damage, be sure to use appropriate lifting techniques and equipment when lifting heavy parts.

-  **CAUTION:**
Indicated potentially hazardous situation which could, if not avoided, result in personal injury or death.

- **IMPORTANT:**
Indicates a situation which, if not conformed to the instructions, could result in damage to the machine.

-  **NOTE:**
Indicates supplementary technical information or know-how.

UNITS USED

- SI Units (International System of Units) are used in this manual.
MKSA system units and English units are also indicated in parentheses just behind SI units.

Example : 24.5 MPa (250 kgf/cm², 3560 psi)

A table for conversion from SI units to other system units is shown below for reference purposes.

Quantity	To Convert From	Into	Multiply By	Quantity	To Convert From	Into	Multiply By
Length	mm	in	0.03937	Pressure	MPa	kgf/cm ²	10.197
	mm	ft	0.003281		MPa	psi	145.0
Volume	L	US gal	0.2642	Power	kW	PS	1.360
	L	US qt	1.057		kW	HP	1.341
	m ³	yd ³	1.308	Temperature	°C	°F	°C×1.8+32
Weight	kg	lb	2.205	Velocity	km/h	mph	0.6214
Force	N	kgf	0.10197		min ⁻¹	rpm	1.0
	N	lbf	0.2248	Flow rate	L/min	US gpm	0.2642
Torque	N·m	kgf·m	1.0197		mL/rev	cc/rev	1.0
	N·m	lbf·ft	0.7375				

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All information, illustrations and specifications in this manual are based on the latest product information available at the time of publication. The right is reserved to make changes at any time without notice.

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- Group 8 Pilot Shut-Off Solenoid Valve
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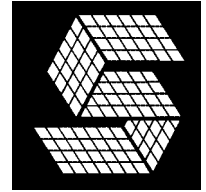
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-

SECTION 1 GENERAL



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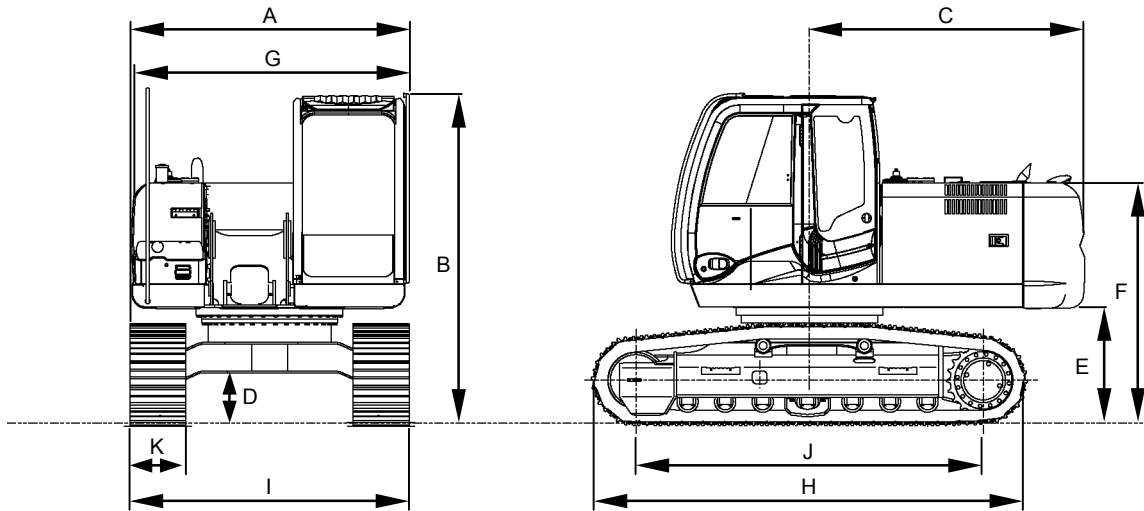
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GENERAL / Specifications

SPECIFICATIONS

ZAXIS160LC-3



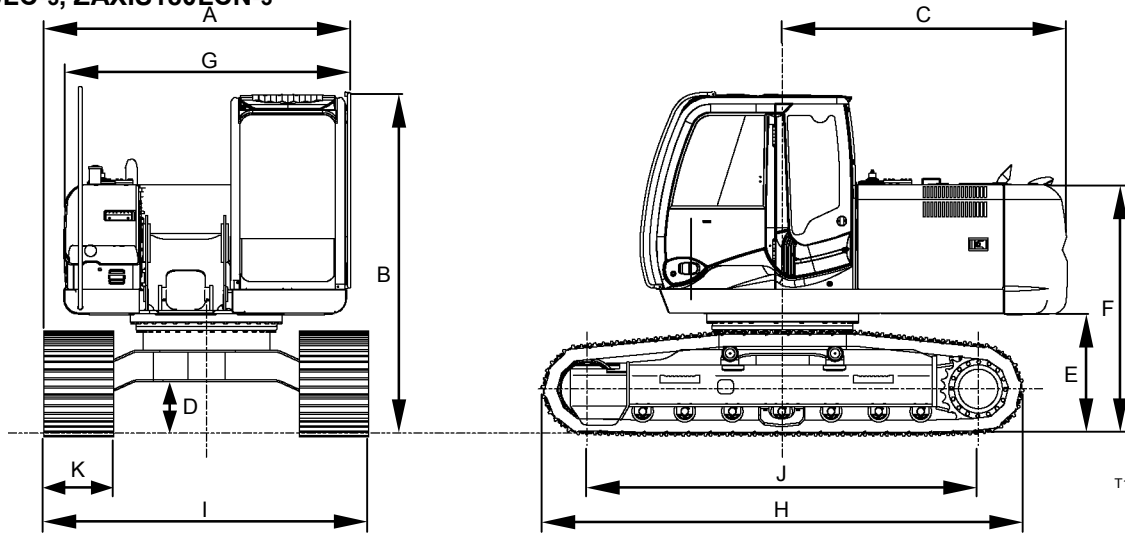
T1T1-01-01-001

Model	ZAXIS160LC-3
Type of Front-End Attachment	2.58 m (8 ft 6 in) Arm
Bucket Capacity (Heaped)	PCSA 0.6 m ³ (0.76 yd ³), CECE 0.55 m ³
Operating Weight	16500 kg (36380 lb)
Basic Machine Weight	13000 kg (28660 lb)
Engine	Isuzu AH-4JJ1XYSA-01 90.2 kW/2200 min ⁻¹ (123 PS/2200 rpm) (HP Mode)
A: Overall Width (Excluding back mirrors)	2500 mm (8 ft 2 in)
B: Cab Height	2950 mm (9 ft 8 in)
C: Rear End Swing Radius	2490 mm (8 ft 2 in)
D: Minimum Ground Clearance	* 470 mm (19 in)
E: Counterweight Clearance	* 1030 mm (3 ft 5 in)
F: Engine Cover Height	* 2140 mm (8 ft 0 in)
G: Overall Width of Upperstructure	2480 mm (8 ft 2 in)
H: Undercarriage Length	3920 mm (12 ft 10 in)
I: Undercarriage Width	2490 mm (8 ft 2 in)
J: Sprocket Center to Idler Center	3100 mm (10 ft 2 in)
K: Track Shoe Width	500 mm (20 in) (Grouser shoe)
Ground Pressure	48 kPa (0.49 kgf/cm ² , 7.0 psi)
Swing Speed	13.3 min ⁻¹ (rpm)
Travel Speed (fast/slow)	5.3/3.4 km/h (3.4/2.1 mph)
Gradeability	35° (tan θ = 0.70)

NOTE: “*” The dimensions do not include height of the shoe lug.

GENERAL / Specifications

ZAXIS180LC-3, ZAXIS180LCN-3



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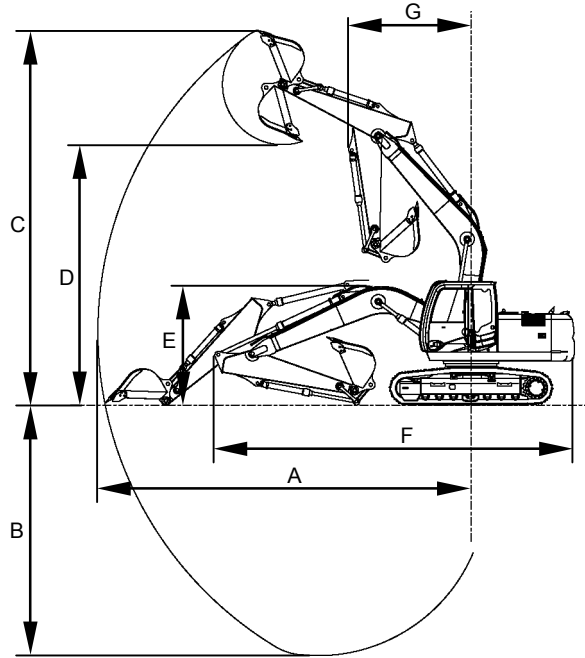
Model	ZAXIS180LC-3	ZAXIS180LCN-3
Type of Front-End Attachment	2.71 m (8 ft 11 in) Arm	
Bucket Capacity (Heaped)	PCSA 0.7 m ³ (0.92 yd ³), CECE 0.6 m ³	
Operating Weight	18300 kg (40340 lb)	18000 kg (39680 lb)
Basic Machine Weight	14400 kg (31750 lb)	14100 kg (31090 lb)
Engine	Isuzu AH-4JJ1XYSA-01 90.2 kW/2200 min ⁻¹ (123 PS/2200 rpm)	
A: Overall Width (Excluding back mirrors)	2800 mm (9 ft 2 in)	2500 mm (8 ft 3 in)
B: Cab Height	2950 mm (9 ft 8 in)	
C: Rear End Swing Radius	2490 mm (9 ft 8 in)	
D: Minimum Ground Clearance	* 450 mm (18 in)	
E: Counterweight Clearance	* 1030 mm (3 ft 5 in)	
F: Engine Cover Height	* 2140 mm (7 ft 0 in)	
G: Overall Width of Upperstructure	2480 mm (8 ft 2 in)	
H: Undercarriage Length	4170 mm (13 ft 8 in)	
I: Undercarriage Width	2800 mm (9 ft 2 in)	2490 mm (8 ft 2 in)
J: Sprocket Center to Idler Center	3370 mm (11 ft 1 in)	
K: Track Shoe Width	600 mm (24 in) (Grouser shoe)	500 mm (20 in)
Ground Pressure	41 kPa (0.42 kgf/cm ² , 5.9 psi)	48 kPa (0.49 kgf/cm ² , 7.0 psi)
Swing Speed	14.1 min ⁻¹ (rpm)	
Travel Speed (fast/slow)	5.3/3.4 km/h (3.4/2.1 mph)	
Gradeability	35° (tan θ = 0.70)	

NOTE: "*" The dimensions do not include height of the shoe lug.

GENERAL / Specifications


WORKING RANGES

ZAXIS160LC-3 (Machine with Mono Boom)



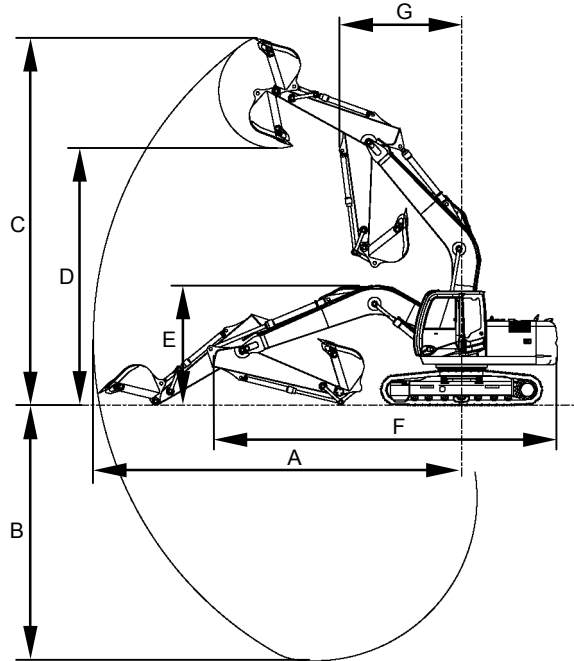
T1T1-01-01-003

Model		ZAXIS160LC-3					
Item	Category	2.22 m (7 ft 4 in) Arm		2.58 m (8 ft 6 in) Arm		3.08 m (10 ft 2 in) Arm	
		mm	ft·in	mm	ft·in	mm	ft·in
A:	Maximum Digging Reach	8520	27'12"	8870	29'2"	9330	30'8"
B:	Maximum Digging Depth	5620	18'6"	5980	19'8"	6490	21'4"
C:	Maximum Cutting Height	8620	28'4"	8890	29'2"	9130	29'12"
D:	Maximum Dumping Height	5940	19'6"	6170	20'3"	6400	20'12"
E:	Transport Height	3190	10'6"	3010	9'5"	3110	10'3"
F:	Overall Transport Length	8650	28'5"	8550	28'1"	8580	28'2"
G:	Minimum Swing Radius	3290	10'10"	2910	9'7"	2920	9'7"

 **NOTE:** The dimensions do not include height of the shoe lug (except Item E).

GENERAL / Specifications

ZAXIS180LC-3, ZAXIS180LCN-3 (Machine with Mono Boom)



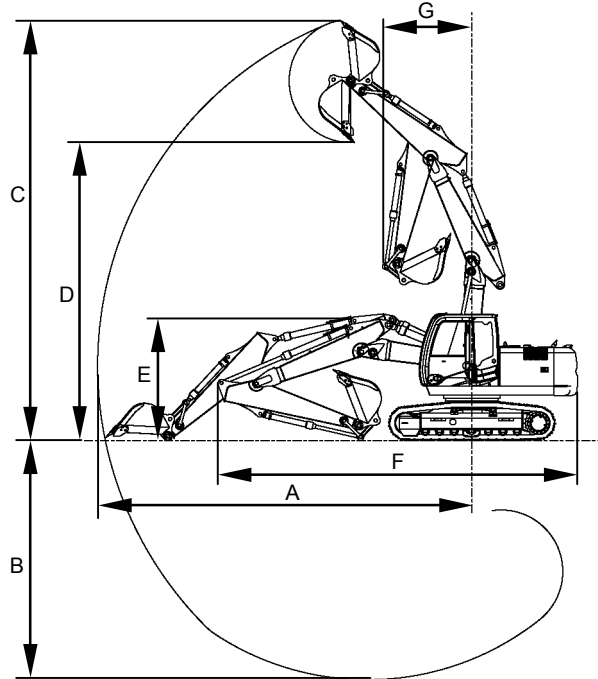
T1T1-01-01-004

Model	ZAXIS180LC-3, ZAXIS180LCN-3					
Category	2.26 m (7 ft 5 in) Arm		2.71 m (8 ft 11 in) Arm		3.21 m (10 ft 7 in) Arm	
Item	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	9070	29'10"	9430	30'12"	9940	32'8"
B: Maximum Digging Depth	6120	20'1"	6570	21'7"	7070	23'3"
C: Maximum Cutting Height	9290	30'6"	9400	30'11"	10090	23'2"
D: Maximum Dumping Height	6450	21'2"	6570	21'7"	7210	23'8"
E: Transport Height	3100	10'2"	3080	10'2"	3390	11'2"
F: Overall Transport Length	9000	29'7"	8970	29'6"	8970	29'6"
G: Minimum Swing Radius	3140	10'4"	3130	10'4"	2880	9'6"

NOTE: The dimensions do not include height of the shoe lug (except Item E).

GENERAL / Specifications

ZAXIS160LC-3 (Machine with 2-Piece Boom)



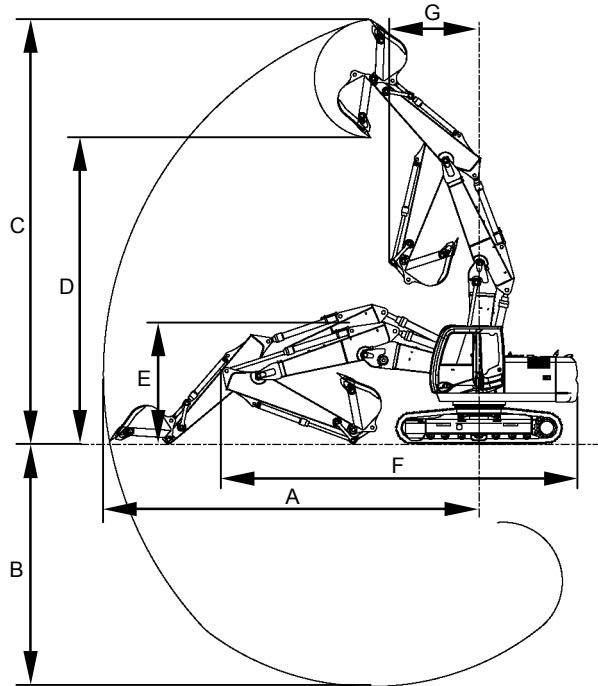
T1T1-01-01-005

Item	Model Category	ZAXIS160LC-3					
		2.22 m (7 ft 4 in) Arm		2.58 m (8 ft 6 in) Arm		3.08 m (10 ft 2 in) Arm	
		mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach		8330	27'4"	8690	28'7"	9150	30'1"
B: Maximum Digging Depth		5210	17'2"	5580	18'4"	6080	19'12"
C: Maximum Cutting Height		9420	30'11"	9740	31'12"	10090	33'2"
D: Maximum Dumping Height		6600	21'8"	6900	22'8"	7250	23'10"
E: Transport Height		3090	10'2"	3010	9'11"	3060	10'1"
F: Overall Transport Length		8450	27'9"	8350	27'5"	8370	27'6"
G: Minimum Swing Radius		2580	8'7"	2070	6'10"	2280	7'6"

NOTE: The dimensions do not include height of the shoe lug (except Item E).

GENERAL / Specifications

ZAXIS180LC-3, ZAXIS180LCN-3 (Machine with 2-Piece Boom)



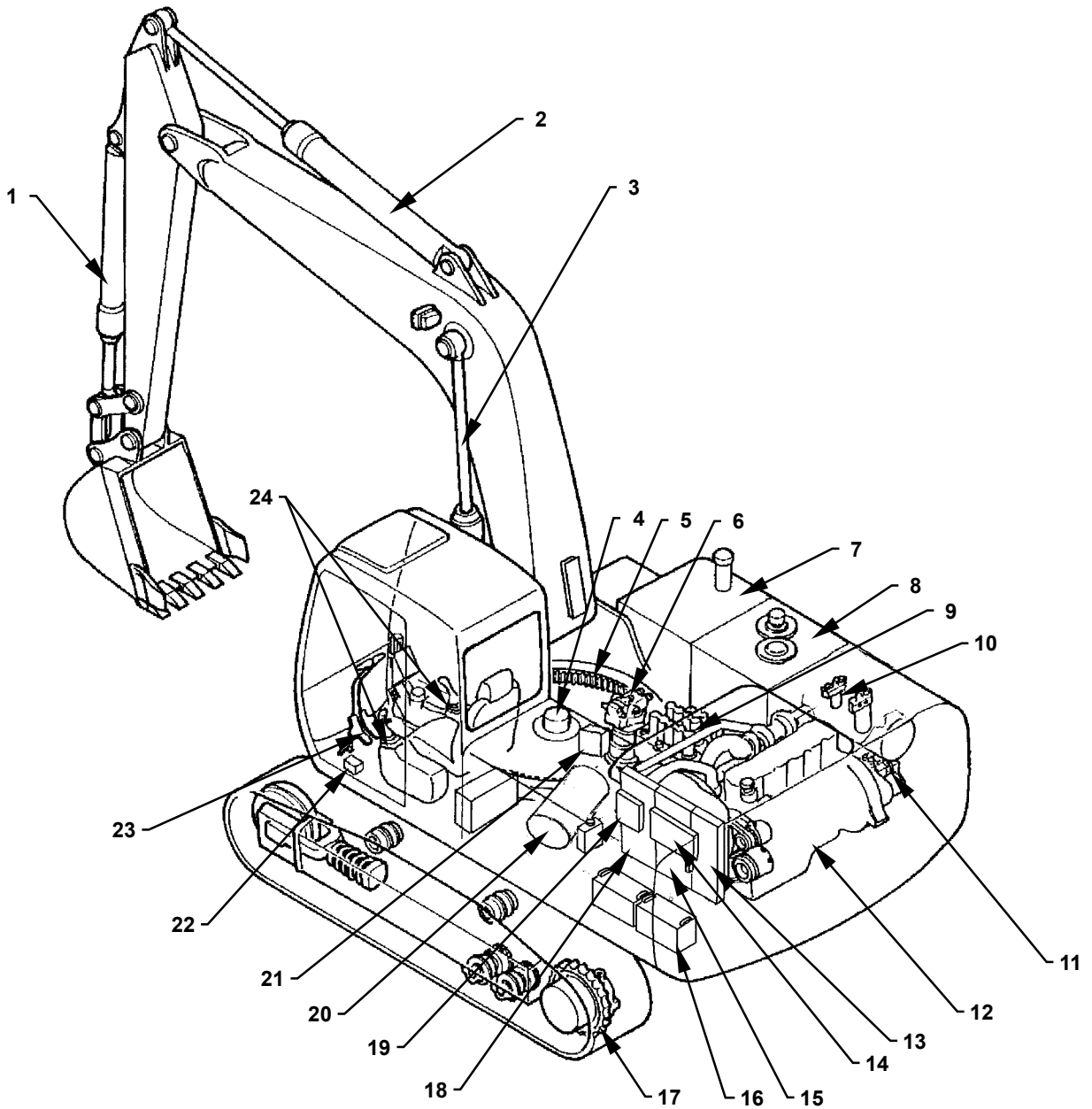
T1T1-01-01-006

Model	ZAXIS180LC-3, ZAXIS180LCN-3					
	2.26 m (7 ft 5 in) Arm		2.71 m (8 ft 11 in) Arm		3.21 m (10 ft 7 in) Arm	
Category	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	8980	29'6"	9350	30'9"	9860	32'5"
B: Maximum Digging Depth	5640	18'6"	6050	19'11"	6570	21'7"
C: Maximum Cutting Height	10260	33'8"	10530	34'7"	10990	36'1"
D: Maximum Dumping Height	7320	24'1"	7590	24'11"	8060	26'6"
E: Transport Height	3030	9'12"	3030	9'12"	3330	10'12"
F: Overall Transport Length	8850	29'1"	8840	29'0"	8780	28'10"
G: Minimum Swing Radius	2280	7'6"	2230	7'4"	2550	8'5"

NOTE: The dimensions do not include height of the shoe lug (except Item E).

GENERAL / Component Layout

MAIN COMPONENTS

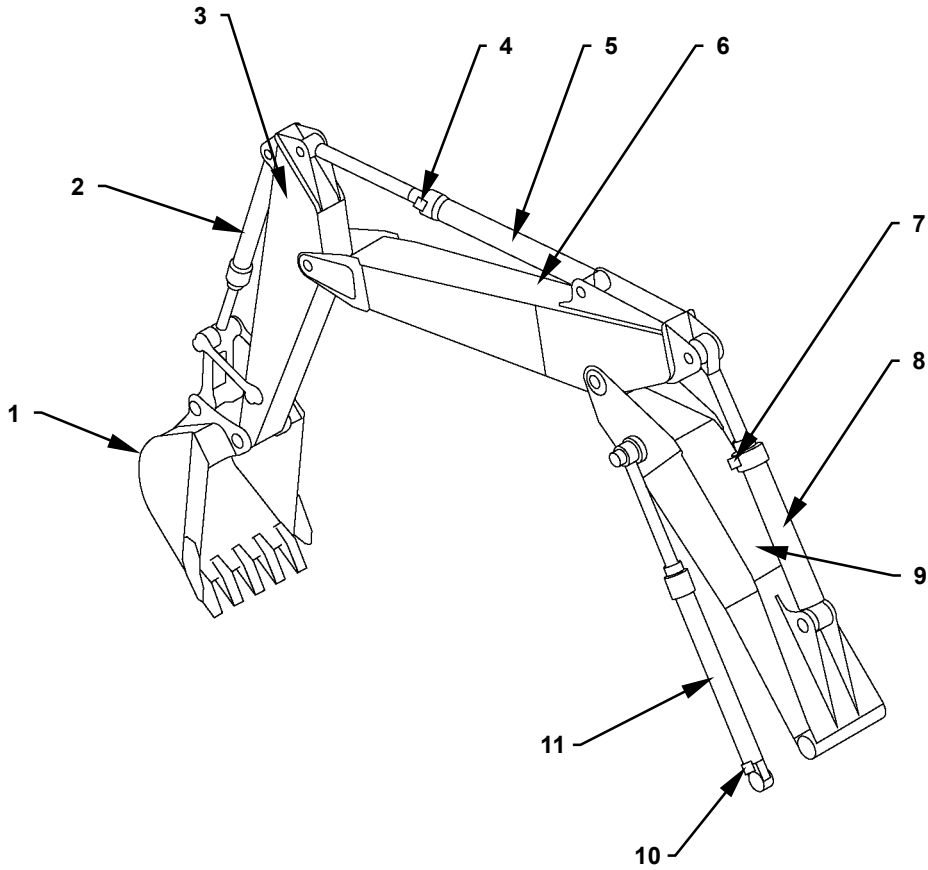


T1T1-01-02-010

- | | | | |
|---------------------|---------------------------------------|--------------------------------|---|
| 1 - Bucket Cylinder | 7 - Fuel Tank | 13 - Intercooler | 19 - Fuel Cooler |
| 2 - Arm Cylinder | 8 - Hydraulic Oil Tank | 14 - Air Conditioner Condenser | 20 - Air Cleaner |
| 3 - Boom Cylinder | 9 - Control Valve | 15 - Radiator | 21 - Signal Control Valve |
| 4 - Center Joint | 10 - Pilot Filter/ Pilot Relief Valve | 16 - Battery | 22 - Pilot Shut-Off Solenoid Valve |
| 5 - Swing Bearing | 11 - Pump Device | 17 - Travel Device | 23 - Travel Pilot Valve |
| 6 - Swing Device | 12 - Engine | 18 - Oil Cooler | 24 - Front Attachment / Swing Pilot Valve |

GENERAL / Component Layout

Front Attachment (2-Piece Boom)

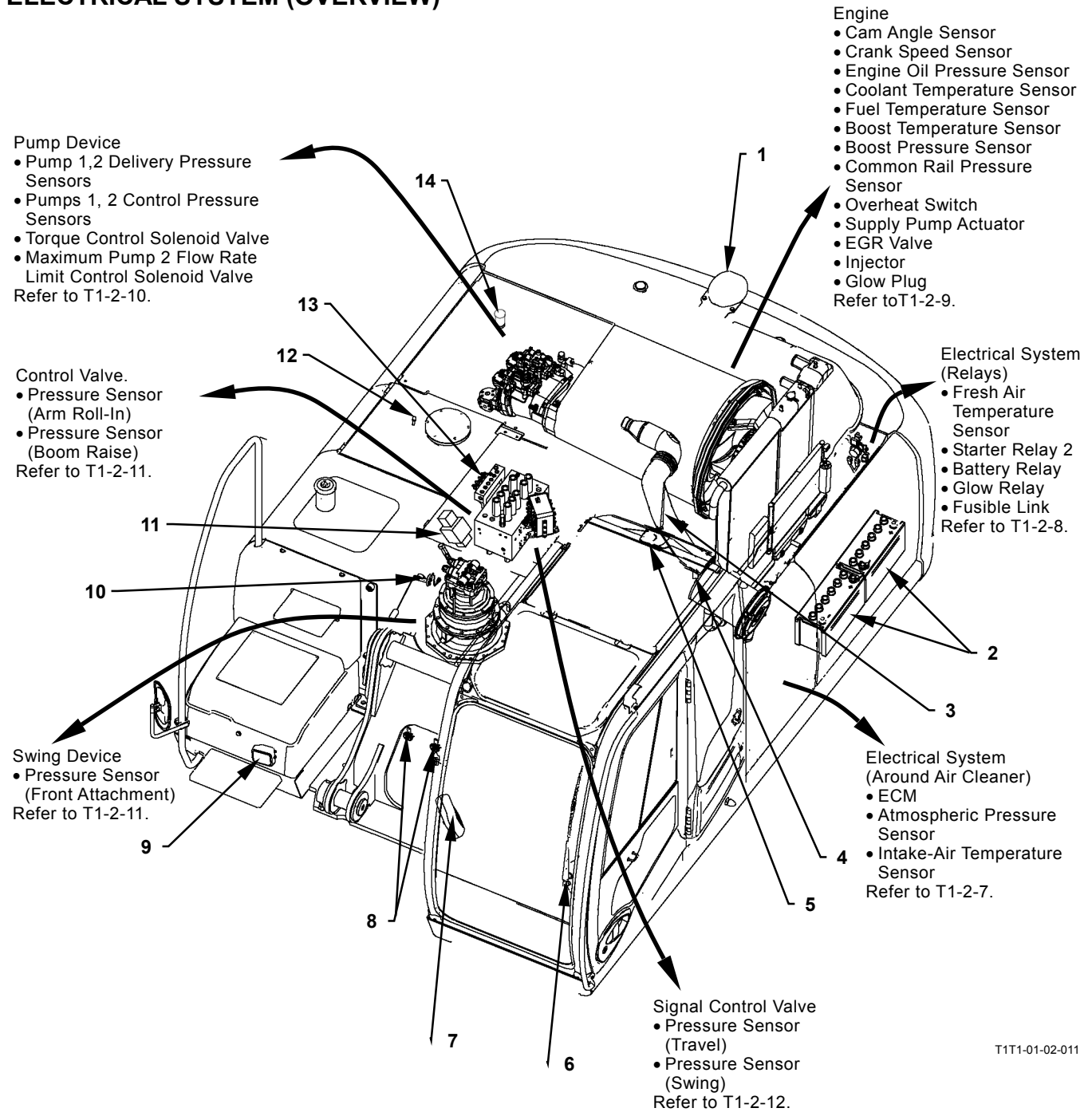


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- | | | | |
|---------------------|---------------------------------------|---|---|
| 1 - Bucket | 4 - Hose Rupture Valve (Arm Cylinder) | 7 - Hose Rupture Valve (Positioning Cylinder) | 10 - Hose Rupture Valve (Boom Cylinder) |
| 2 - Bucket Cylinder | 5 - Arm Cylinder | 8 - Positioning Cylinder | 11 - Boom Cylinder |
| 3 - Arm | 6 - Upper Boom | 9 - Bottom Boom | |

GENERAL / Component Layout

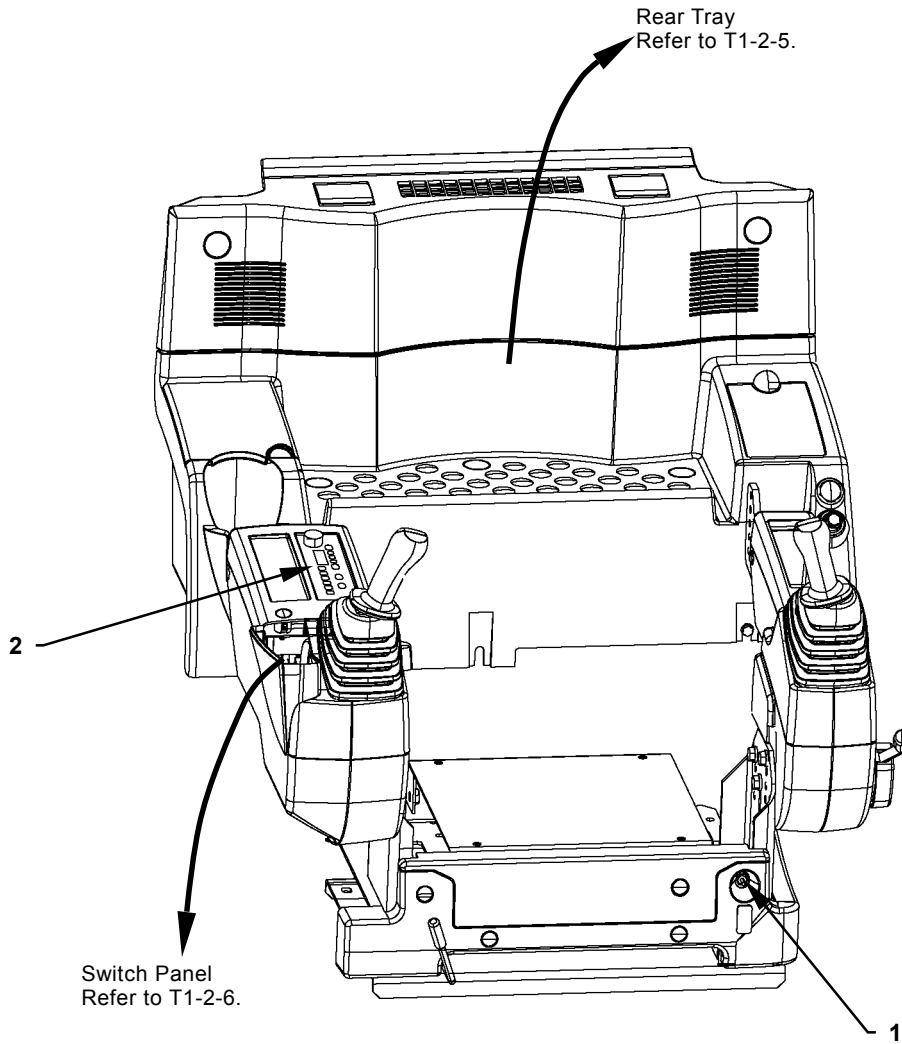
ELECTRICAL SYSTEM (OVERVIEW)



- | | | | |
|-----------------------------------|--|--|---------------------------------------|
| 1 - Rear View Camera | 5 - GPS (Global Positioning System) Aerial | 9 - Working Light | 12 - Hydraulic Oil Temperature Sensor |
| 2 - Battery | 6 - Wiper Motor | 10 - Fuel Sensor | 13 - Solenoid Valve Unit |
| 3 - Communication Aerial | 7 - Monitor Unit | 11 - Positioning Control Valve (2-Piece Boom Machine Only) | 14 - Solenoid Pump |
| 4 - Air Filter Restriction Switch | 8 - Horn | | |

GENERAL / Component Layout

ELECTRICAL SYSTEM (IN CAB)

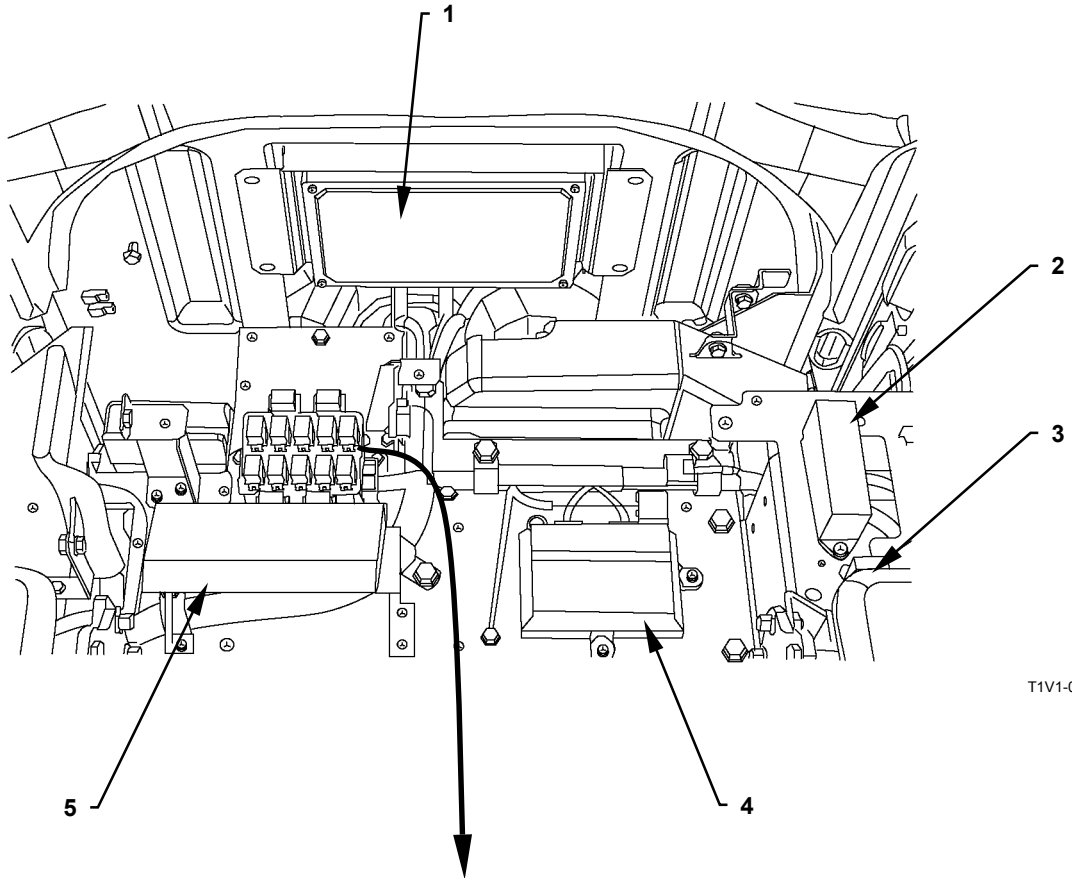


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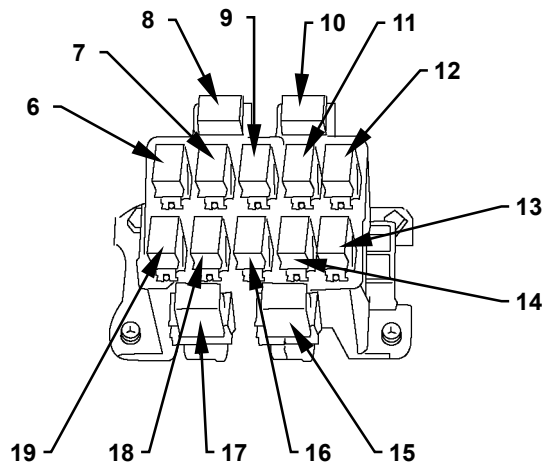
- 1 - Engine Stop Switch 2 - Radio

GENERAL / Component Layout

ELECTRICAL SYSTEM (REAR TRAY)



T1V1-01-02-007

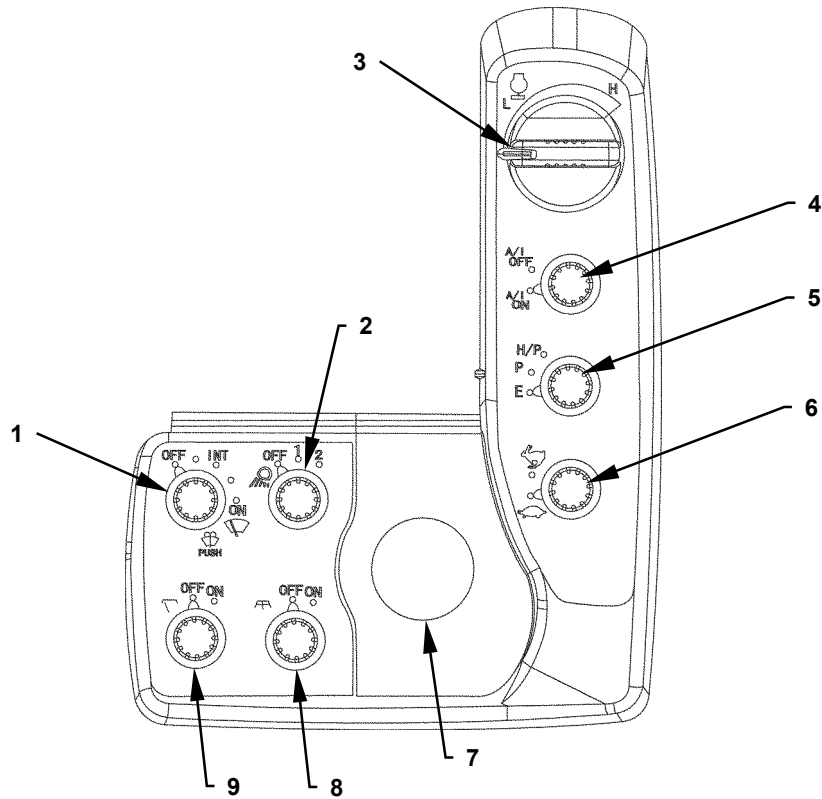


T1V1-01-02-009

- | | | | |
|--|---------------------------------------|---|---|
| 1 - MC (Main Controller) | 6 - Starter Relay 2 (R5) | 11 - Pilot Shut-Off Relay (R12) | 16 - Light Relay 2 (R8) |
| 2 - Fuse Box | 7 - Starter Cut Relay (R4) | 12 - Load Damp Relay (R1) | 17 - ECM (Engine Control Module) Main Relay (R14) |
| 3 - Dr. ZX Connector (Download Connector Using Combinedly) | 8 - OFF Relay (Air Conditioner) (R12) | 13 - Wiper Relay (R6) | 18 - Washer Relay (R9) |
| 4 - ICF (Information Controller) | 9 - Security Horn Relay (R3) | 14 - Light Relay 1 (R7) | 19 - Horn Relay (R10) |
| 5 - Satellite Communication Terminal (Optional) | 10 - Air Conditioner Relay (R11) | 15 - MAX HI Relay (Air Conditioner) (R13) | |

GENERAL / Component Layout

ELECTRICAL SYSTEM (SWITCH PANEL)

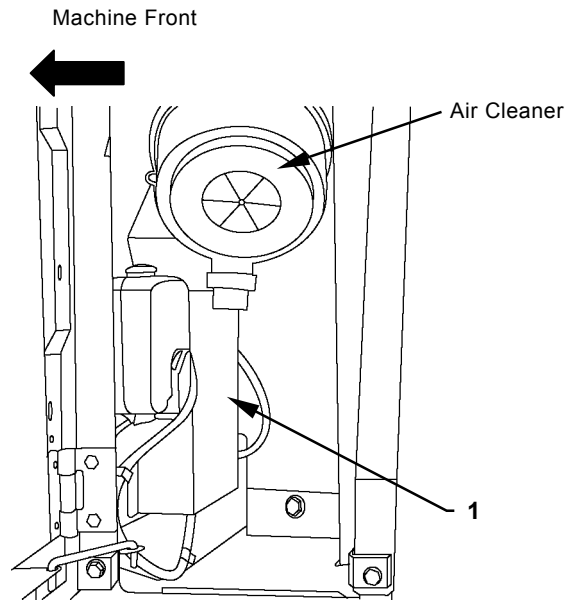


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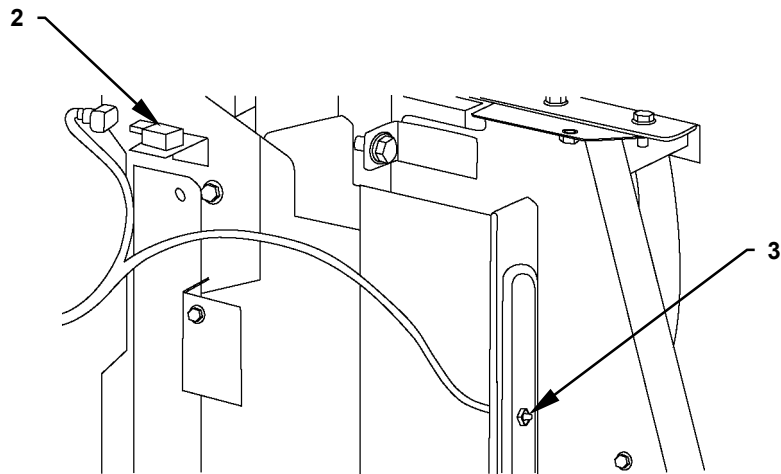
- | | | | |
|---------------------------|-----------------------|------------------------|--|
| 1 - Wiper / Washer Switch | 4 - Auto-Idle Switch | 6 - Travel Mode Switch | 8 - Overhead Window Washer Switch (Optional) |
| 2 - Working Light Switch | 5 - Power Mode Switch | 7 - Key Switch | 9 - Overhead Window Wiper Switch (Optional) |
| 3 - Engine Control Dial | | | |

GENERAL / Component Layout

ELECTRICAL SYSTEM (AROUND AIR CLEANER)



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T1T1-01-02-008

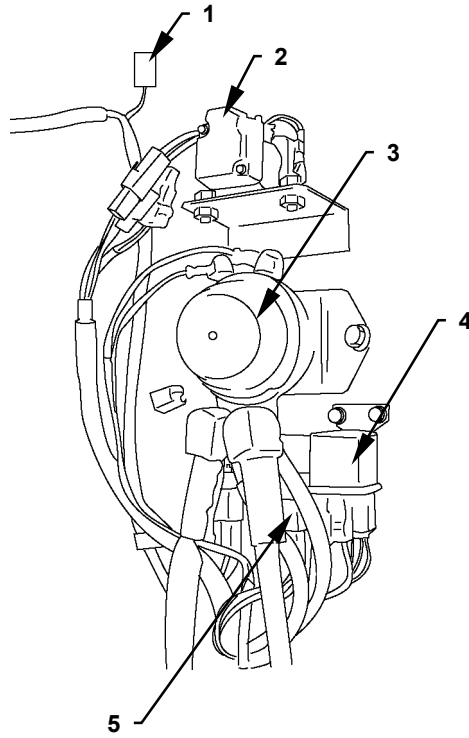
1 - ECM (Engine Control Module)

2 - Atmospheric Pressure Sensor

3 - Intake-Air Temperature Sensor

GENERAL / Component Layout

ELECTRICAL SYSTEM (RELAYS)



T1V1-01-02-018

1 - Fresh Air Temperature
Sensor
2 - Starter Relay 2

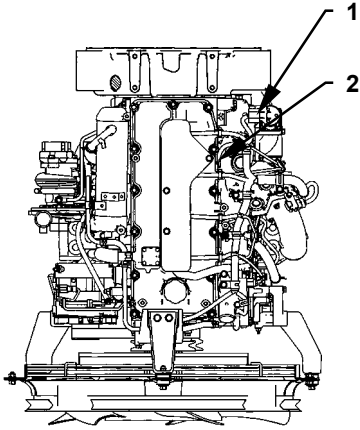
3 - Battery Relay

4 - Glow Relay

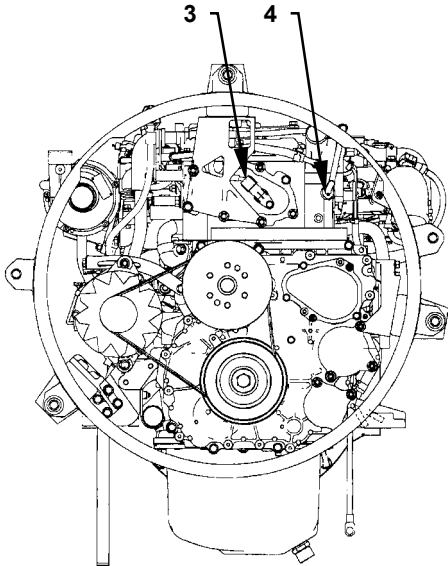
5 - Fusible Link

GENERAL / Component Layout

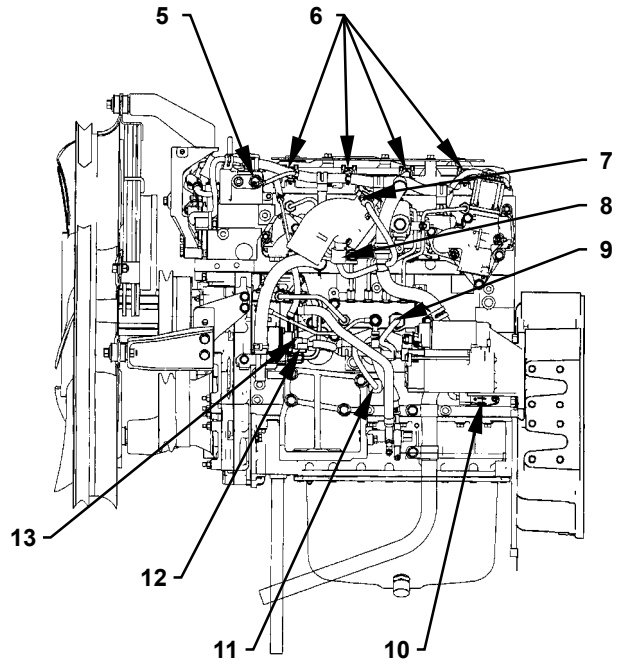
ENGINE



T1T1-01-02-005



T1T1-01-02-003



T1T1-01-02-004

- 1 - EGR (Exhaust Gas Recirculation) Valve
- 2 - Glow Plug
- 3 - Cam Angle Sensor
- 4 - Coolant temperature sensor

- 5 - Overheat Switch
- 6 - Injector
- 7 - Boost Pressure Sensor

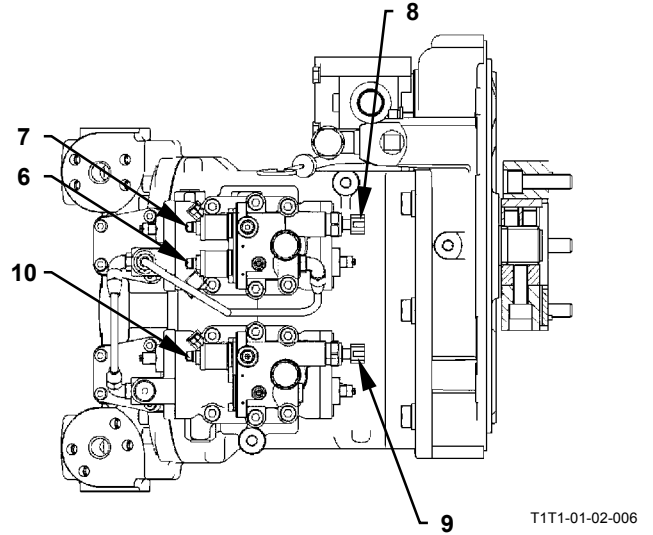
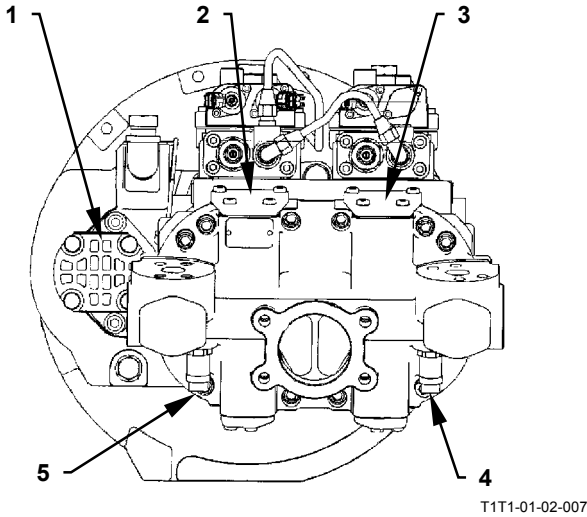
- 8 - Boost Temperature Sensor
- 9 - Common Rail Pressure Sensor
- 10 - Crank Speed Sensor

- 11 - Hydraulic Oil Pressure Sensor
- 12 - Fuel Temperature Sensor
- 13 - Supply Pump Actuator

GENERAL / Component Layout

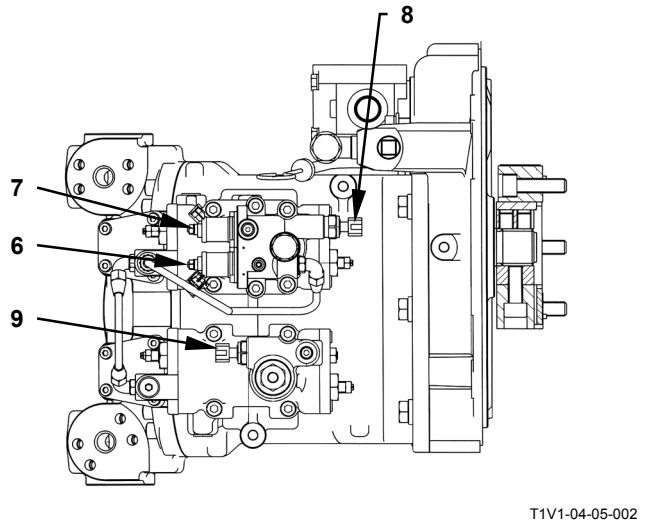
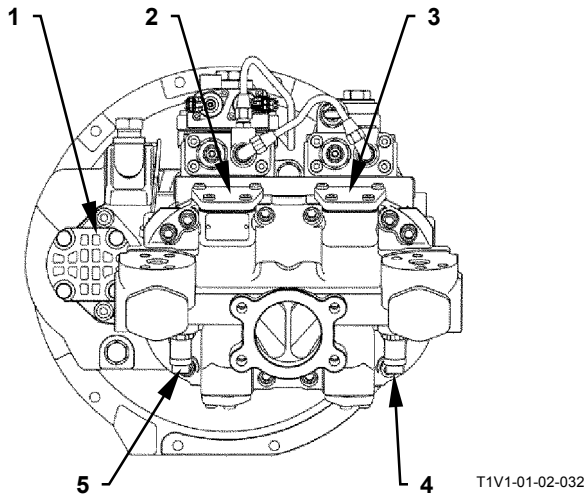
PUMP DEVICE

ZX160-3 class



AROUND PUMP DEVICE

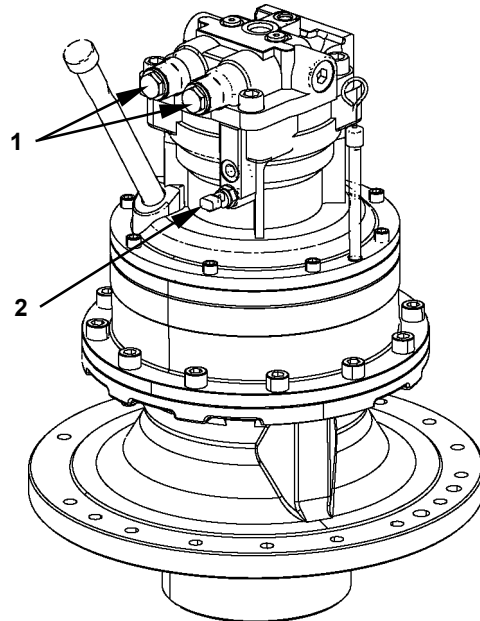
ZX180-3 class



- | | | | |
|----------------|-------------------------------------|---|--|
| 1 - Pilot Pump | 4 - Pump 1 Delivery Pressure Sensor | 7 - Maximum Pump 2 Flow Rate Limit Control Solenoid Valve | 9 - Pump 1 Control Pressure Sensor |
| 2 - Pump 2 | 5 - Pump 2 Delivery Pressure Sensor | 8 - Pump 2 Control Pressure Sensor | 10 - Maximum Pump 1 Flow Rate Limit Control Solenoid Valve |
| 3 - Pump 1 | 6 - Torque Control Solenoid Valve | | |

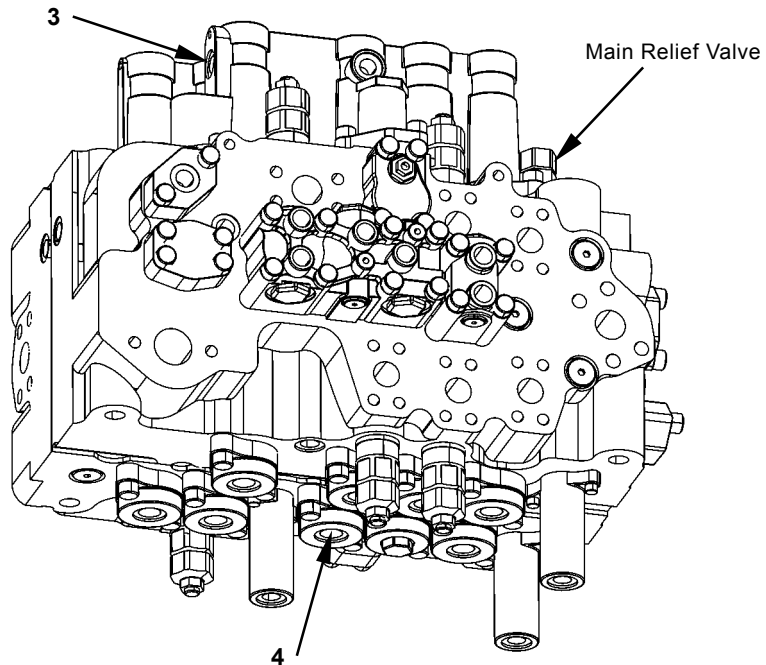
GENERAL / Component Layout

SWING DEVICE



T1V1-01-02-005

CONTROL VALVE



T1V1-03-03-073

1 - Swing Relief Valve

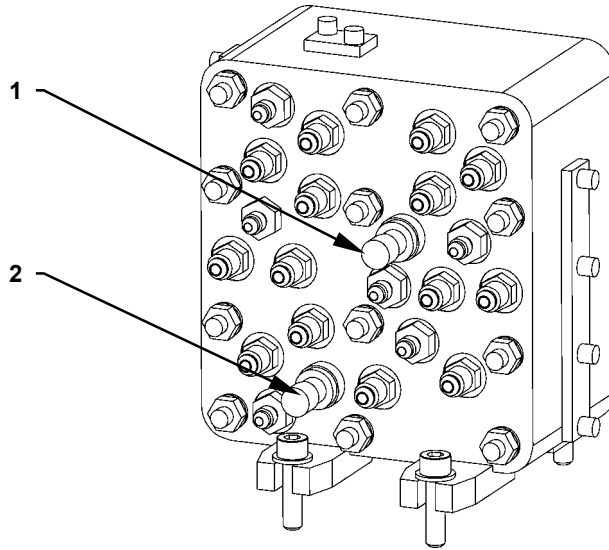
2 - Pressure Sensor (Front Attachment)

3 - Pressure Sensor (Arm Roll-In)

4 - Pressure Sensor (Boom Raise)

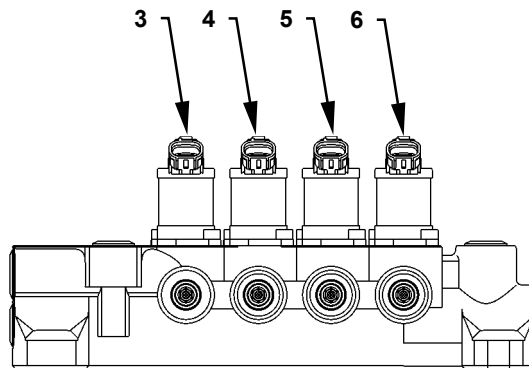
GENERAL / Component Layout

SIGNAL CONTROL VALVE



T1V1-01-02-014

SOLENOID VALVE UNIT



T1V1-03-07-007

1 - Pressure Sensor (Swing)
2 - Pressure Sensor (Travel)

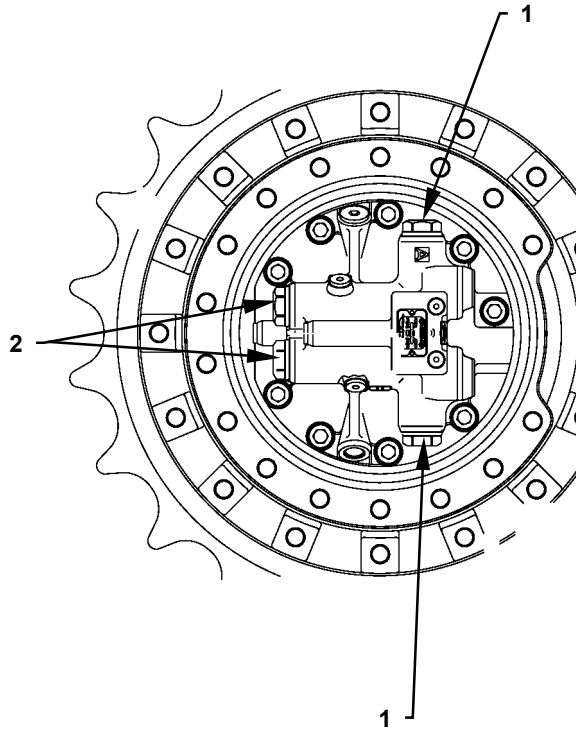
3 - Solenoid Valve Unit SC
4 - Solenoid Valve Unit SF

5 - Solenoid Valve Unit SI

6 - Solenoid Valve Unit SG

GENERAL / Component Layout

TRAVEL DEVICE



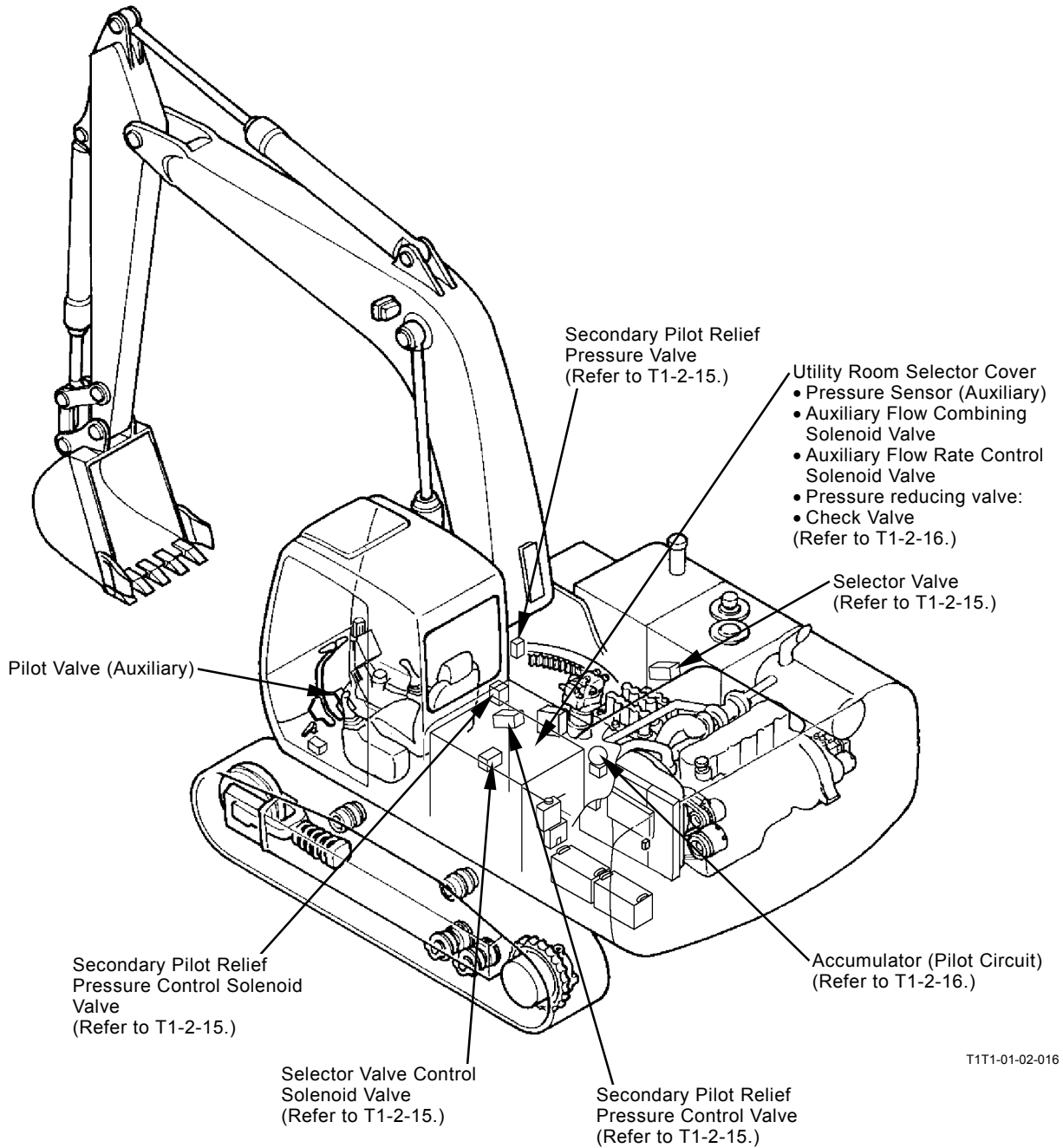
T1HD-01-02-001

1 - Counterbalance Valve

2 - Travel Relief Valve

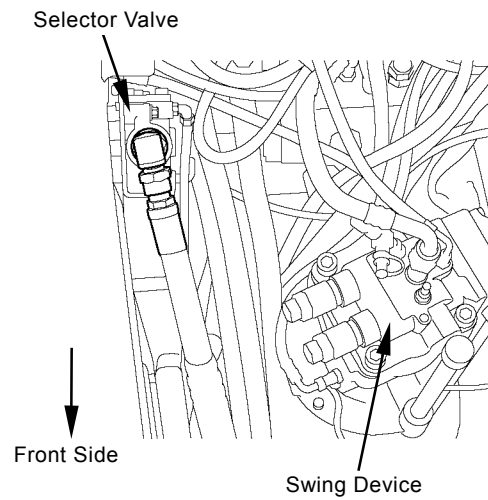
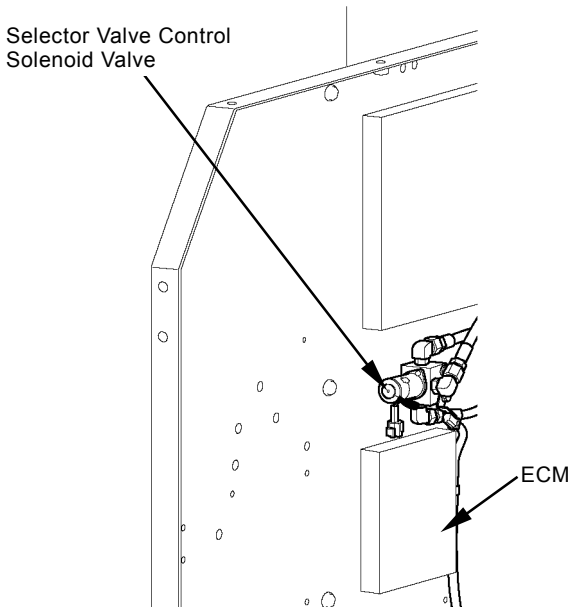
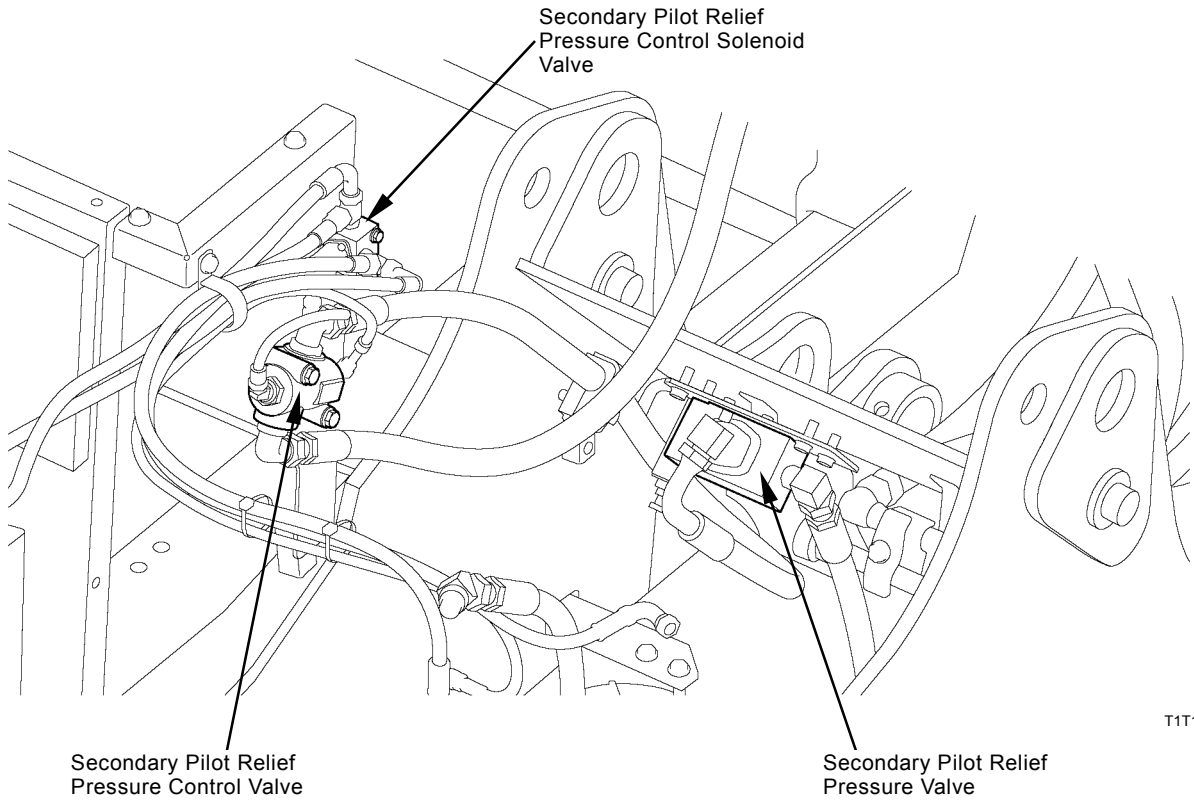
GENERAL / Component Layout

LAYOUT OF ATTACHMENT SPEC. PARTS



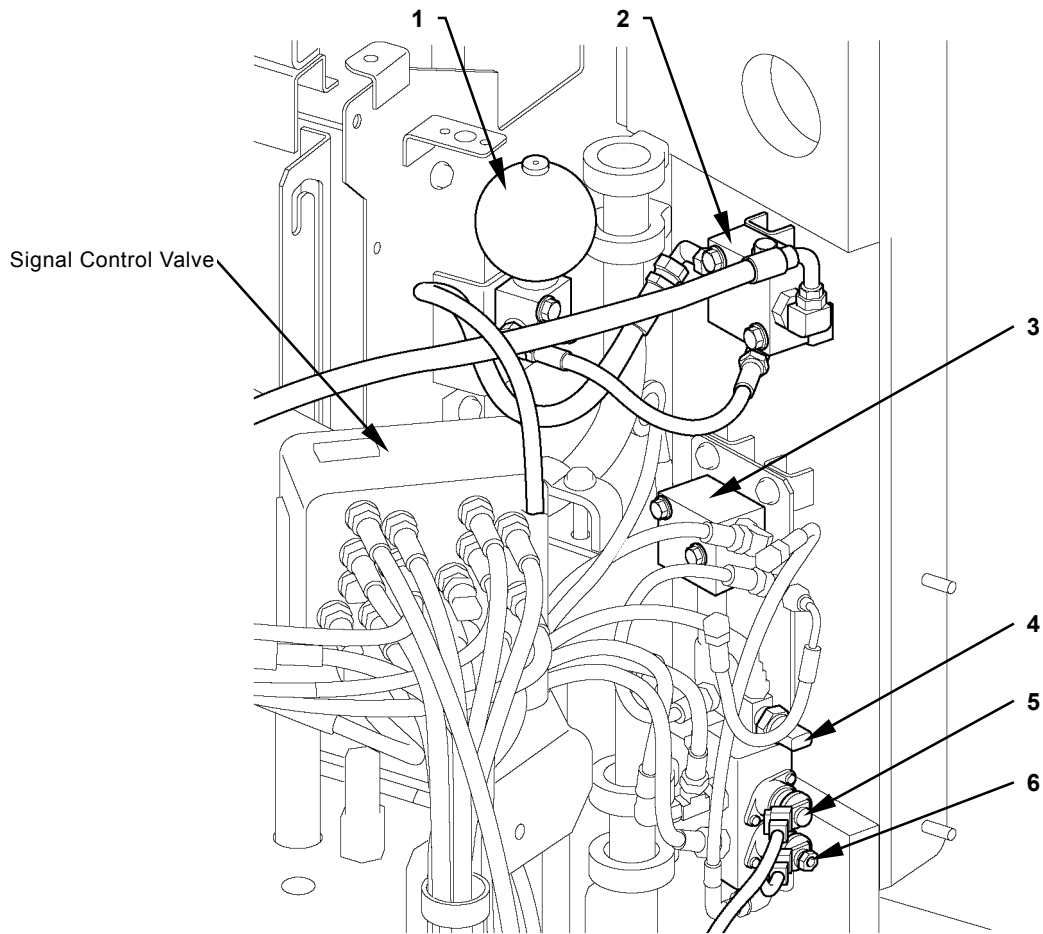
T1T1-01-02-016

GENERAL / Component Layout



GENERAL / Component Layout

Utility Room Selector Cover



T1T1-01-02-015

- | | | | |
|---------------------------------|---------------------------------|---|--|
| 1 - Accumulator (Pilot Circuit) | 3 - Pressure Reducing Valve | 5 - Auxiliary Flow Combining Solenoid Valve | 6 - Auxiliary Flow Rate Control Solenoid Valve |
| 2 - Check Valve | 4 - Pressure Sensor (Auxiliary) | | |

GENERAL / Component Specifications

ENGINE

Manufacturer	ISUZU
Model	4JJ1XYSA-01
Type	Diesel, 4-Cycle, Water-cooled, Over Head Valve Direct Injection Type, Exhaust Turbo Charged Type
Cyl. No.- Bore × Stroke	4-95.4 mm×104.9 mm (3.76 in×4.13 in)
Piston Displacement	2.999 cm ³ (183 in ³)
Rated Output.....	83±3.3 kW/2000 min ⁻¹ (113±4.49 PS/2000 rpm) HP Mode: 90.2 ^{+1.5} _{-3.9} kW / 2200 min ⁻¹ (123 ⁺² _{-5.3} PS / 2000 rpm)
Compression Ratio	17.5
Dry Weight	320 kg (705 lb)
Firing Order	1-3-4-2
Rotation Direction.....	Clockwise (Viewed from fan side)

COOLING SYSTEM

Cooling Fan	Dia. 650 mm (25.6 in), 5 Blades, Draw-in Type, Synthetic Resin, with Fan Ring and Safety Net
Fan Pulley Ratio	Belt Driven Rotation Ratio: 0.87
Thermostat.....	Cracking Temperature at Atmospheric Pressure: 85 °C (185 °F)
Water Pump	Centrifugal Type

LUBRICATION SYSTEM

Lubrication Pump Type	Gear Pump
Oil Filter.....	Full-Flow Paper Element Type with Bypass
Oil Cooler	Water Cooled Integral Type

STARTING SYSTEM

Motor.....	Magnetic Pinion Shift Reduction Type
Voltage / Output	24 V / 4 kW

PREHEAT SYSTEM

Preheating Method.....	Glow Plug (24V, QOS II Type)
------------------------	------------------------------

ENGINE STOP SYSTEM

Stop Method	Fuel Shut-Off (Electronic Control)
-------------------	------------------------------------

GENERAL / Component Specifications

ALTERNATOR

Type Regulator Integrated AC Type, Brushless
Voltage / Output 24 V / 50 A (Brushless)

SUPERCHARGING SYSTEM

Type Exhaust-Turbocharger Type RHF5 Type without Weight Gate

FUEL SYSTEM

Type Common Rail Type HP3 Type
Governor Electronic All Speed Control
Injection Nozzle Electrical Multi-Hole Injector

PERFORMANCE

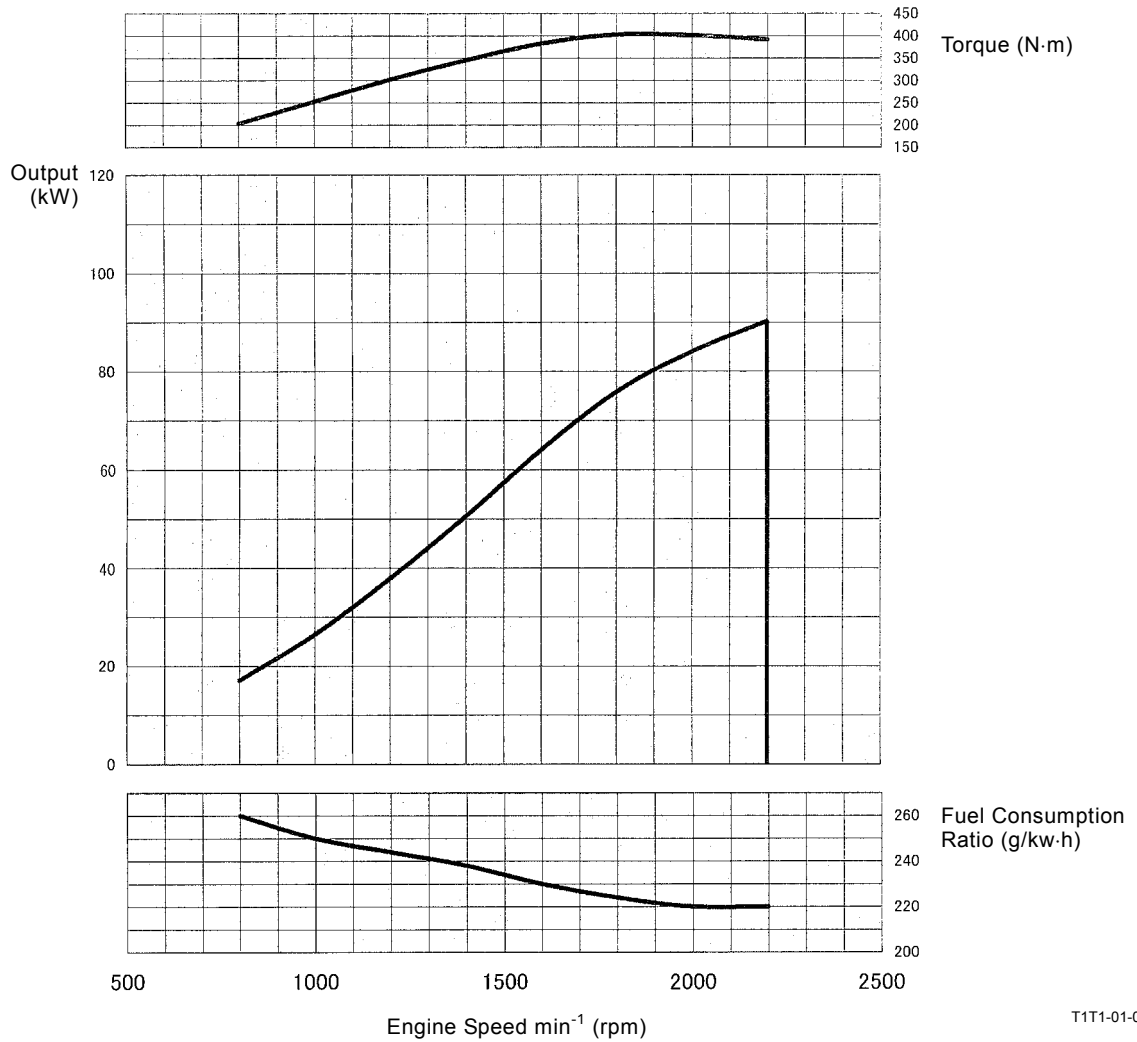
IMPORTANT: This list shows design specifications, which are not servicing standards.

Fuel Consumption Ratio..... 220 ± 10 g/kW/h (299 ± 13.5 g/PS·h) at $90.2^{+1.5}_{-3.9}$ kW /
(at Full Load: 2200 min^{-1})
 220 ± 10 g/kW/h (299 ± 13.5 g/PS·h) at 83 ± 3.3 kW /
(at Working Load: 2000 min^{-1})
Maximum Output Torque..... 402 ± 20 N·m (41 ± 2 kgf·m) at approx. 1800 min^{-1}
Compression Pressure 3 MPa (31 kgf/cm^2) at 200 min^{-1}
Valve Clearance (Inlet / Exhaust)..... 0.15 / 0.15 mm (when cool)
No Load Speed Slow: (at Full Load: $800 \pm 20 \text{ min}^{-1}$)
Fast: (at Full Load: $2200 \pm 20 \text{ min}^{-1}$)
(at Working Load: $2000 \pm 20 \text{ min}^{-1}$)

GENERAL / Component Specifications

Engine Performance Curve (4JJ1XYSA-01)

- Test Condition: 1. In conformity with JIS D1005 (Performance Test Method for Diesel Engine Used for Construction Machinery) under standard atmospheric pressure.
2. Equipped with the fan and alternator.



T1T1-01-03-001

GENERAL / Component Specifications

ENGINE ACCESSORIES

RADIATOR ASSEMBLY

Type Parallel Type
Weight..... 52 kg (115 lb)

	Radiator	Oil Cooler
Capacity	6.1 L (1.6 US gal)	8.4 L (2.2 US gal)
Air-Tight Test Pressure.....	100 kPa (1.0 kgf/cm ² , 14.5 psi)	1500 kPa (15 kgf/cm ² , 218 psi)
Cap Opening Pressure.....	49 kPa (0.5 kgf/cm ² , 7 psi)	—

	Intercooler
Capacity	7.5 L (2.0 US gal)
Air-Tight Test Pressure.....	250 kPa (2.6 kgf/cm ² , 37 psi)
Cap Opening Pressure.....	—

FUEL COOLER

Weight..... 0.7 kg (1.5 lb)
Core Type..... Wavy Fin
Capacity

0.2 L (0.05 US gal.)

BATTERY

Type 115D31R
Capacity 70 Ah (5-Hour Rate)
Voltage 12 V
Weight..... 21.0 kg (46 lb)×2

Solenoid Pump

Manufacture Product No. B6952B-00-00
Rated Voltage..... DC24V

GENERAL / Component Specifications

HYDRAULIC COMPONENT

PUMP DEVICE

Drive Gear Ratio Main Pump: 1, Pilot Pump: 1

MAIN PUMP

Type Bent-Axis Type Variable Displacement Axial Plunger Pump

Maximum Flow Rate 174 L/min (45.9 US gpm)×2

HP Mode: 191 L/min (50.4 US gpm) ×2

Maximum Flow Rate (Theoretical Value) 86.8 L/min (22.9 US gpm)×2

Rated Pressure 34.3 MPa

REGULATOR

Type Hydraulic Pressure Operated Type

PILOT PUMP

Type FS 11/16.8

Model Fixed Displacement Type Gear Pump

Maximum Flow (Theoretical Value) 33.6 L/min (8.87 US gpm)

HP Mode: 37.0 L/min (9.76 US gpm)

CONTROL VALVE

Type Pilot Pressure Operated Type (4-Spools + 5-Spools)

Main Relief Set-Pressure Normal: 34.3 MPa (350 kgf/cm², 4980 psi) at
80 L/min (21.1 US gpm)

Power Digging: 36.3 MPa (370 kgf/cm²) at
80 L/min (21.1 US gpm)

Overload Relief Set-Pressure 37.2 MPa (380 kgf/cm², 5410 psi) at 50 L/min (13.2 US gpm)
(Boom Lower, Arm Roll-In, Bucket Roll-In)

39.2 MPa (400 kgf/cm², 5690 psi) at 50 L/min (13.2 US gpm)
(Boom Raise, Arm Roll-Out, Bucket Roll-Out)

SWING DEVICE

Type Two-Stage Reduction Planetary Gear

Reduction Gear Ratio 17.53

SWING MOTOR

ZX160-3 class:

Model M5X130CHB-10A-48A/300-92

Type Swash-Plate Type, Fixed Displacement Axial Plunger Motor

ZX180-3 class:

Model M5X130CHB-10A-47A-330-99

Type Swash-Plate Type, Fixed Displacement Axial Plunger Motor

GENERAL / Component Specifications

VALVE UNIT

ZX160-3 class:

Type Non Counterbalance Valve Type
Relief Set-Pressure 29.3 MPa (299 kgf/cm², 4250 psi) at 110 L/min

ZX180-3 class:

Type Non Counterbalance Valve Type
Relief Set-Pressure 32.4 MPa (330 kgf/cm², 4710 psi) at 110 L/min

SWING PARKING BRAKE

Type Multi-Disc-Wet Negative Type
Release Pressure 1.9 to 2.8 MPa (20 to 28.6 kgf/cm², 284 to 410 psi)

TRAVEL DEVICE

ZX160-3 class, ZAXIS180LCN-3:

Type Three-Stage Reduction Planetary Gear
Reduction Gear Ratio 53.234

ZAXIS180LC-3:

Type Three-Stage Reduction Planetary Gear
Reduction Gear Ratio 53.289

TRAVEL MOTOR

ZX160-3 class, ZAXIS180LCN-3:

Type Swash-Plate Type Variable Displacement Axial Plunger Motor
Maximum Flow (Theoretical Value)
(Fast/Slow) 79/122.5 L/min (20.8/32.3 US gpm)

ZAXIS180LC-3:

Type Swash-Plate Type Variable Displacement Axial Plunger Motor
Maximum Flow (Theoretical Value)
(Fast/Slow) 79/122.5 L/min (20.8/32.3 US gpm)

TRAVEL BRAKE VALVE

ZX160-3 class, ZAXIS180LCN-3:

Type Counterbalance Valve Type
Relief Set Pressure 34.3 MPa (350 kgf/cm², 4987 psi)

ZAXIS180LC-3:

Type Counterbalance Valve Type
Relief Set Pressure 34.3 MPa (350 kgf/cm², 4987 psi)

TRAVEL PARKING BRAKE

Type Multi-Disc-Wet Negative Type
Release Starting Pressure 0.95 to 1.02 MPa (9.7 to 10.4 kgf/cm², 138 to 148 psi)

GENERAL / Component Specifications

CYLINDER (MONO BOOM MACHINE)

ZAXIS160LC-3:

	Boom	Arm
Rod Diameter	80 mm (3.15")	90 mm (3.54")
Cylinder Bore.....	110 mm (4.33")	120 mm (4.72")
Stroke	1110 mm (3'8")	1365 mm (4'6")
Fully Retracted Length	1655 mm (5'5")	1905 mm (6'3")
Plating Thickness	30 µm (1.18 µm)	30 µm (1.18 µm)

Bucket

Rod Diameter	75 mm (2.95")
Cylinder Bore.....	105 mm (4.13")
Stroke	935 mm (3'1")
Fully Retracted Length	1460 mm (4'10")
Plating Thickness	30 µm (1.18 µm)

ZAXIS180LC-3, ZAXIS180LCN-3:

	Boom	Arm
Rod Diameter	85 mm (3.35")	90 mm (3.54")
Cylinder Bore.....	120 mm (4.72")	125 mm (4.92")
Stroke	1123 mm (3'8")	1371 mm (4'6")
Fully Retracted Length	1723 mm (5'8")	1901 mm (6'3")
Plating Thickness	30 µm (1.18 µm)	30 µm (1.18 µm)

Bucket

Rod Diameter	75 mm (2.95")
Cylinder Bore.....	105 mm (4.13")
Stroke	1060 mm (3'6")
Fully Retracted Length	1565 mm (5'2")
Plating Thickness	30 µm (1.18 µm)

GENERAL / Component Specifications

CYLINDER (2-PIECE BOOM MACHINE)

ZAXIS160LC-3:

	Boom	Arm
Rod Diameter	80 mm (3.15")	90 mm (3.54")
Cylinder Bore.....	110 mm (4.33")	120 mm (4.72")
Stroke	1110 mm (3'8")	1365 mm (4'6")
Fully Retracted Length	1655 mm (5'5")	1905 mm (6'3")
Plating Thickness	30 µm (1.18 µm)	30 µm (1.18 µm)

	Bucket	Positioning
Rod Diameter	75 mm (2.95")	95 mm (3.74")
Cylinder Bore.....	105 mm (4.13")	140 mm (5.51")
Stroke	935 mm (3'1")	1022 mm (3'4")
Fully Retracted Length	1460 mm (4'10")	1632 mm (5'4")
Plating Thickness	30 µm (1.18 µm)	30 µm (1.18 µm)

ZAXIS180LC-3, ZAXIS180LCN-3:

	Boom	Arm
Rod Diameter	85 mm (3.35")	90 mm (3.5")
Cylinder Bore.....	120 mm (4.72")	125 mm (4.92")
Stroke	1123 mm (3'8")	1371 mm (4'6")
Fully Retracted Length	1723 mm (5'8")	1901 mm (7'5")
Plating Thickness	30 µm (1.18 µm)	30 µm (1.18 µm)

	Bucket	Positioning
Rod Diameter	75 mm (3.5")	100 mm (3.94")
Cylinder Bore.....	105 mm (4.13")	150 mm (5.91")
Stroke	1060 mm (3'6")	1142 mm (3'9")
Fully Retracted Length	1565 mm (5'2")	1763 mm (5'9")
Plating Thickness	30 µm (1.18 µm)	30 µm (1.18 µm)

HOSE RUPTURE VALVE

Relief Set Pressure	39.2 MPa (400 kgf/cm ² , 5700 psi)
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GENERAL / Component Specifications

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/cm², 540 psi)

PILOT SHUT-OFF VALVE

Type ON/OFF Solenoid Valve
Rated Voltage..... DC 24 V

OIL COOLER BYPASS CHECK VALVE

Cracking Pressure 490 kPa (5 kgf/cm²) at 5 L/min
Rated Voltage..... DC 24 V

FILTER

Engine Oil Filter..... ISUZU 8973243861
Fuel Filter ISUZU 8980139861

Filtration

Air Cleaner -
Full-Flow Filter..... $\beta_{10} \geq 2.0$
Suction Filter 177 μm (80 mesh)
Pilot Filter $\beta_{10} \geq 1.4$

GENERAL / Component Specifications

ELECTRICAL COMPONENT

BATTERY RELAY

Parts No. ISUZU 8943795431
Voltage / Current 24 V / 100 A

STARTER RELAY 2

Parts No. ISUZU 1825530391
Voltage 24 V

GLOW RELAY

Parts No. ISUZU 8944607060
Voltage 24 V

HYDRAULIC OIL TEMPERATURE SENSOR

Operating Temperature -30 to 120 °C (-22 to 248 °F)

AIR CLEARNER RESTRICTION SWITCH

Operating Pressure 6.2±0.60 kPa

HORN

Voltage / Current 24 V·2.5±0.5 A
Sound Pressure 113±5 dB (A) @2 m

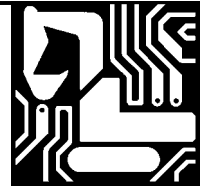
ILLUMINATION

Specifications Working Light: Halogen 24 V, 70 W / 60 W
Cab Light: 24 V, 10 W

AIR CONDITIONER

Refrigerant 134 a
Cooling Ability 19.3 MJ/h (4600 kcal/h)
Cool Air Volume 550 m³/h or More
Heating Ability 21.0 MJ/h (5000 kcal/h) or More
Warm Air Volume 500 m³/h or More
Temperature Adjusting System Electronic Type
Refrigerant Quantity 850±50 g
Compressor Oil Quantity 210 cm³

SECTION 2 SYSTEM



—CONTENTS—

Group 1 Controller

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Can (Network Provided for Machine)	T2-1-2
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ECM: Engine Control Module	T2-1-20
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Charging Circuit (Key Switch: ON).....	T2-5-12
Serge Voltage Prevention Circuit	T2-5-16
Pilot Shut-Off Circuit (Key Switch: ON) ...	T2-5-18
Security Lock Circuit.....	T2-5-20
Engine Stop Circuit (Key Switch: OFF) ...	T2-5-22
Security Horn Circuit.....	T2-5-24
Working Light Circuit	T2-5-26
Wiper Circuit	T2-5-28

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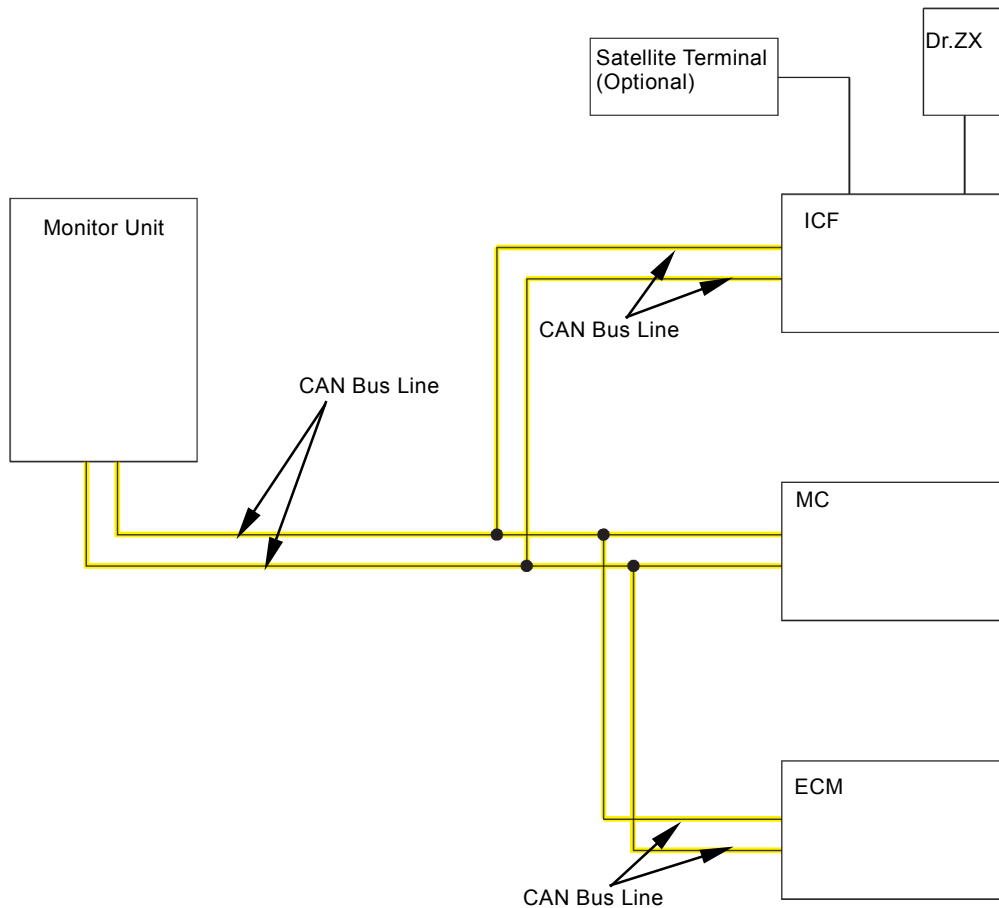
SYSTEM / Controller

OUTLINE


The controllers are provided for each control respectively.

Each controller is connected by using CAN (network provided for machine) in order to display on the monitor unit in cab or the monitoring of machine overall condition including the engine.

- MC : Main Controller
- ECM : Engine Control Module
- ICF : Information Controller
- Monitor Unit



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 NOTE: CAN (CAN Bus Line)

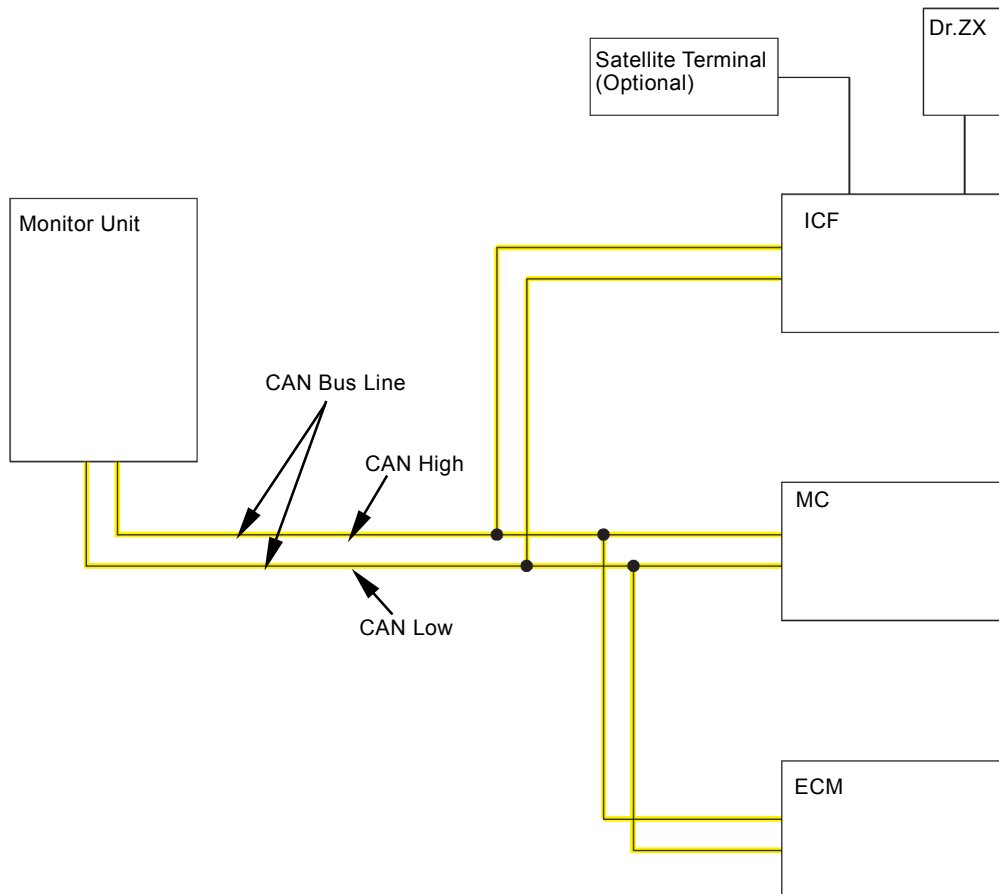
SYSTEM / Controller

CAN (NETWORK PROVIDED FOR MACHINE)

MC, ECM, ICF and the monitor unit 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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SYSTEM / Controller

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SYSTEM / Controller

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 1700 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 by engine control dial in order to increase engine power.

- Travel HP Mode Control

Engine Control Dial: Fast Idle Position

When operating travel on conditions above, MC sends the signal to ECM and increases engine speed beyond the set speed by 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 1850 min^{-1} or faster

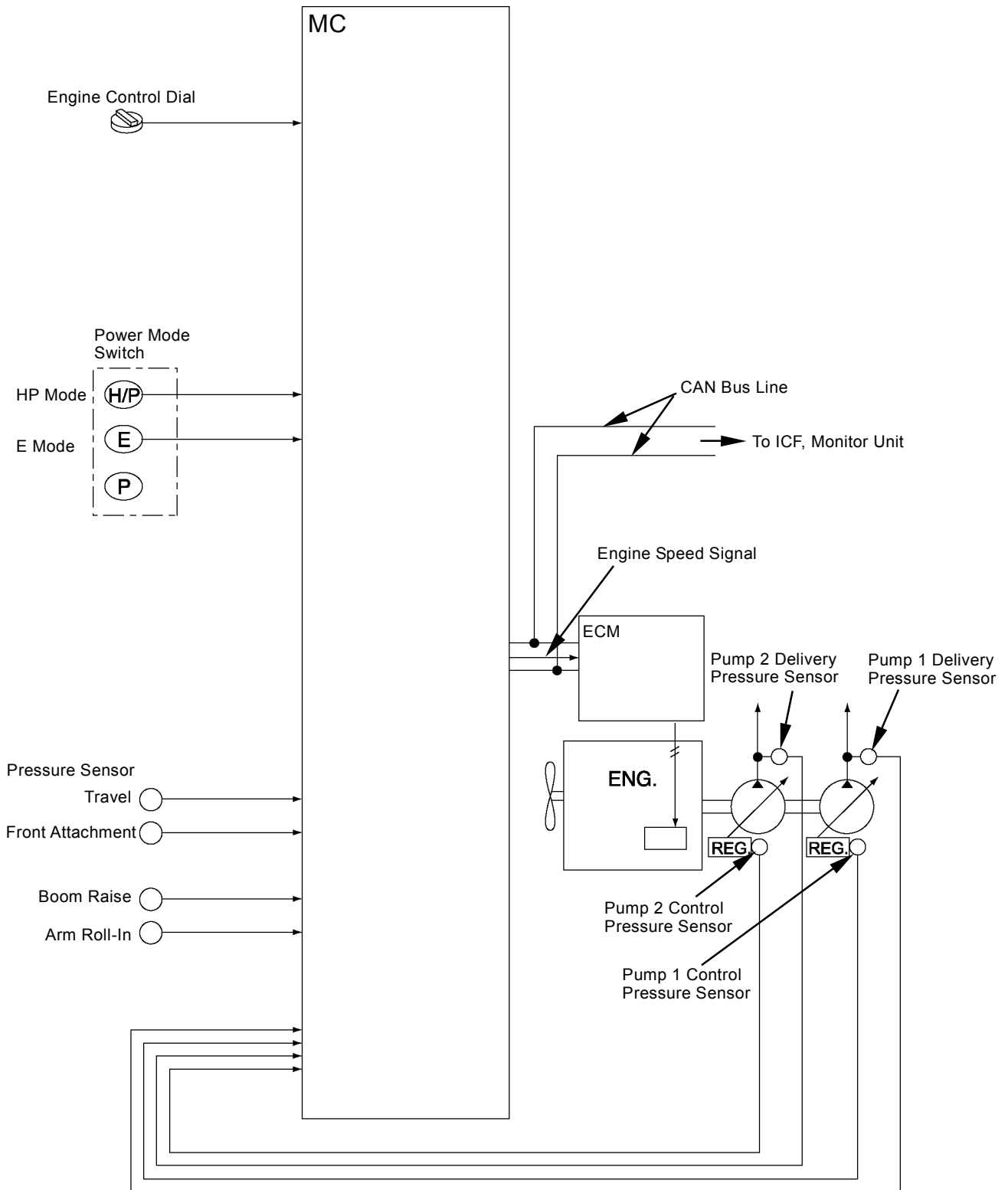
Power Mode Switch: E Mode Position

On conditions above, MC sends the signal to ECM and decreases engine speed below the set speed by 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 150 min^{-1} beyond the set speed by engine control dial.

SYSTEM / Controller



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SYSTEM / Controller

- Auto-Idle Control

All Control Levers: Neutral Position

Auto-Idle Switch: ON

On conditions above, MC sends the signal to ECM and set engine speed to auto-idle speed.

When operating the engine control dial, shifting the power mode switch (E mode to P mode or P mode to E mode) or operating front attachment/travel, auto-idle control is released.

- Hydraulic Oil Temperature Auto-Warming Up Control

When hydraulic oil temperature is below 0 °C (32 °F) for 12 minutes after starting the engine, MC sends the signal to ECM in response to the signal from key switch and hydraulic oil temperature sensor, and increases engine speed to hydraulic oil temperature auto warming up speed.

- Radiator Coolant Temperature Auto-Warming Up Control

After the engine starts, ECM sends the signals equivalent to radiator coolant temperature to MC.

MC sends the signal to ECM and increases engine speed to radiator coolant temperature auto warming up speed.

- Idle Speed-Up Control

Engine Speed: Between Slow Idle and Idle Speed-Up Speed

When operating front attachment or travel on condition above, MC sends the signal to ECM and increases engine speed to idle speed-up speed.

- Attachment Operation Speed Increase Control (Optional)

Set attachment operation speed to increase (+) in the service mode of Dr. ZX.

Engine Control Dial: Fast Idle Position

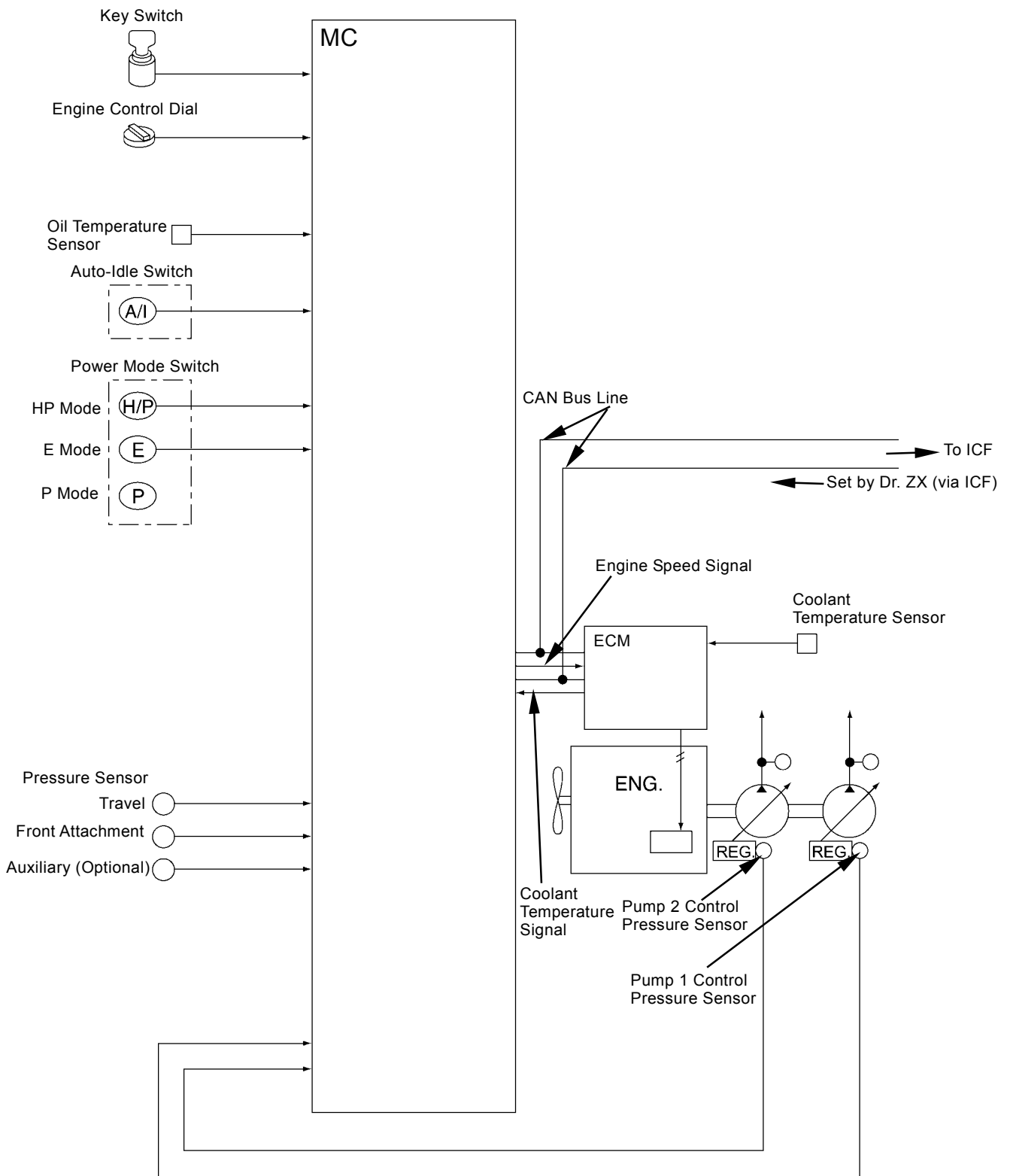
Power Mode Switch: HP Mode Position

When operating attachment on conditions above, MC sends the signal to ECM and increases engine speed to attachment operating speed set by Dr. ZX beyond fast idle.

- Attachment Operation Speed Limit Control (Optional)

Set attachment operation speed to decrease (-) in the service mode of Dr. ZX. When operating attachment, MC sends the signal to ECM and decreases engine speed to the attachment operating speed set by Dr. ZX below fast idle.

SYSTEM / Controller



T1V5-02-01-008

SYSTEM / Controller

Pump Control

- Speed Sensing Control

MC calculates difference between engine speed set by the engine control dial and actual engine speed detected by ECM. MC sends the signal to the torque control solenoid valve in order to control pilot pressure oil to the pump regulator. The pump delivery flow rate is changed due to engine speed so that engine power can be used effectively.

- Travel Torque-Up Control

When engine speed set by the engine control dial is slow, MC calculates by using the signals from travel pressure sensor and pump 1, 2 delivery pressure sensors. MC sends the signal to the torque control solenoid valve in order to control pilot pressure oil to the pump regulator. As one pump delivery flow rate increases, both pumps delivery flow rates become equal. Consequently, mistrack is prevented during single travel operation.

- Pump 1 Flow Rate Limit Control (Optional)

When the attachment (mainly a vibrating hammer) is used with the travel control lever in neutral, MC drives the maximum pump 1 flow rate limit control solenoid valve according to the signal from pressure sensor (auxiliary) and decreases maximum flow rate of pump 1.

- Pump 1 Flow Rate Control Valve at Travel (ZX160-3 Class Only)

When travel is operated during work mode “digging”, MC drives the maximum pump 1 flow rate limit control solenoid valve according to the signal from pressure sensor (travel) and decreases maximum flow rate of pump 1.

- Pump 2 Flow Rate Limit Control (Optional)

When the attachment (mainly a breaker) is used, MC drives the maximum pump 2 flow rate limit control solenoid valve according to the signal from pressure sensor (auxiliary) and decreases maximum flow rate of pump 2.

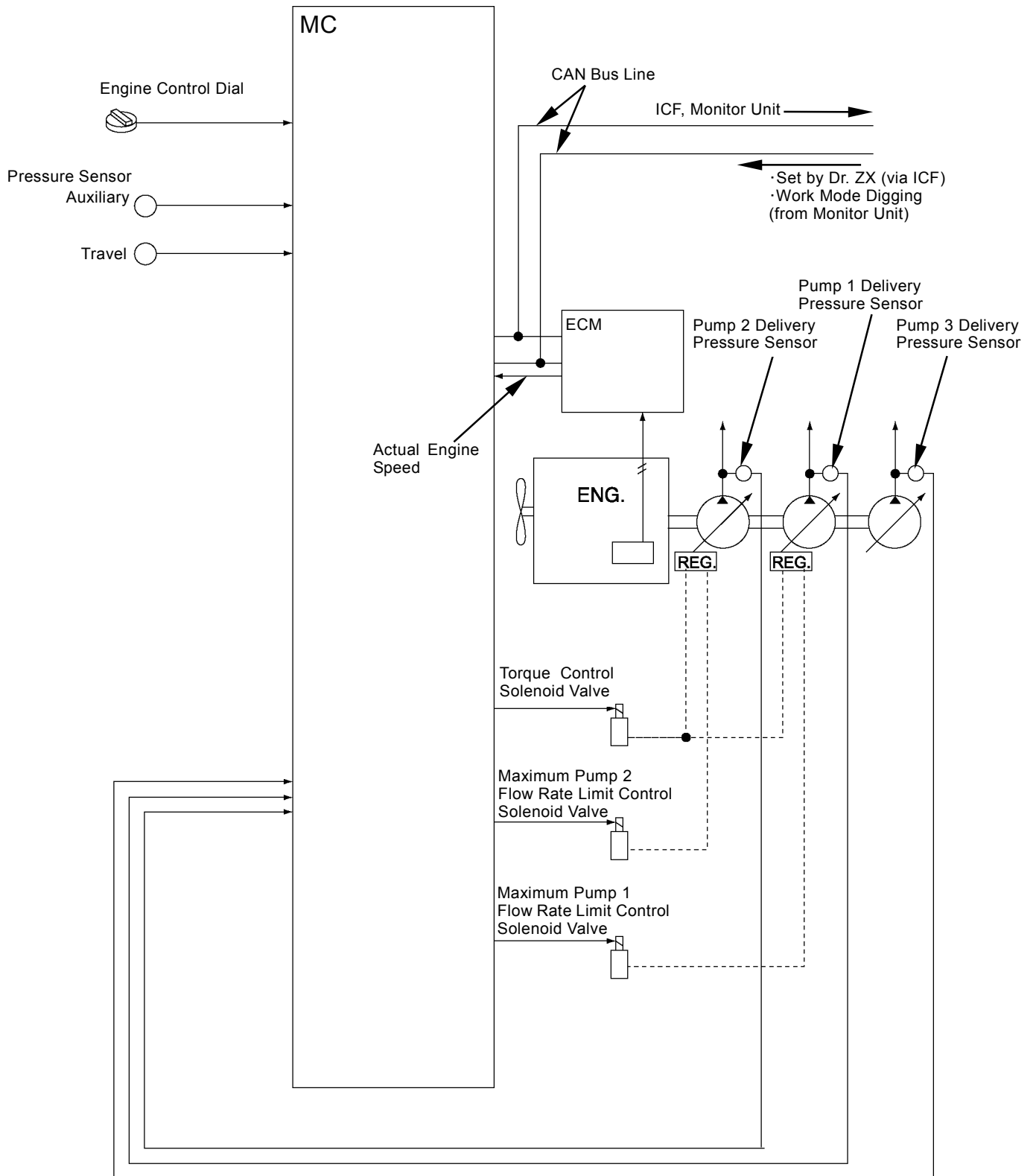
- Pump 2 Flow Rate Control Valve at Travel (ZX160-3 Class Only)

When travel is operated during work mode “digging”, MC drives the maximum pump 2 flow rate limit control solenoid valve according to the signal from pressure sensor (travel) and decreases maximum flow rate of pump 2.

- Pump 3 Flow Rate Limit Control (Optional)

As for the machine equipped with pump 3, MC drives the torque control solenoid valve according to the signal from pump 3 delivery pressure sensor, decreases delivery flow rate of pumps 1, 2, and controls pump 1, 2, 3 absorption power (pump torque) in order not to exceed engine power.

SYSTEM / Controller



T1V1-02-01-041

SYSTEM / Controller

Valve Control

- Power Digging Control

While the power digging switch is turned ON, MC drives solenoid valve unit (SG) and increases relief pressure of the main relief valve in control valve.

- Auto-Power Lift Control

When operating boom raise with pump 1 delivery pressure in high, MC drives solenoid valve unit (SG) according to the signals from pressure sensor (boom raise) and pump 1 delivery pressure sensor and increases relief pressure of the main relief valve in control valve.

- Arm Regenerative Control

Condition:

Pump 1, 2 Delivery Pressure: Either Low

Combined Operation of Swing or Boom Raise and Arm Roll-In

On conditions above, MC drives solenoid valve unit (SC) according to the signals from pump 1, 2 delivery pressure sensors and pressure sensors (swing, arm roll-in and boom raise), outputs pilot pressure, and shifts the arm regenerative valve and the arm flow rate control valve.

The arm regenerative valve closed the return circuit to hydraulic oil tank from arm cylinder rod side and supplies pressure oil to the arm cylinder bottom side. Consequently, speed of arm roll-in increases and hesitation during arm roll-in operation is prevented.

The arm flow rate control valve controls pressure oil to the arm 2 parallel circuit, supplies pressure oil to the boom 1 spool, and keeps boom raise speed.

(Refer to the Control System group in SYSTEM.)

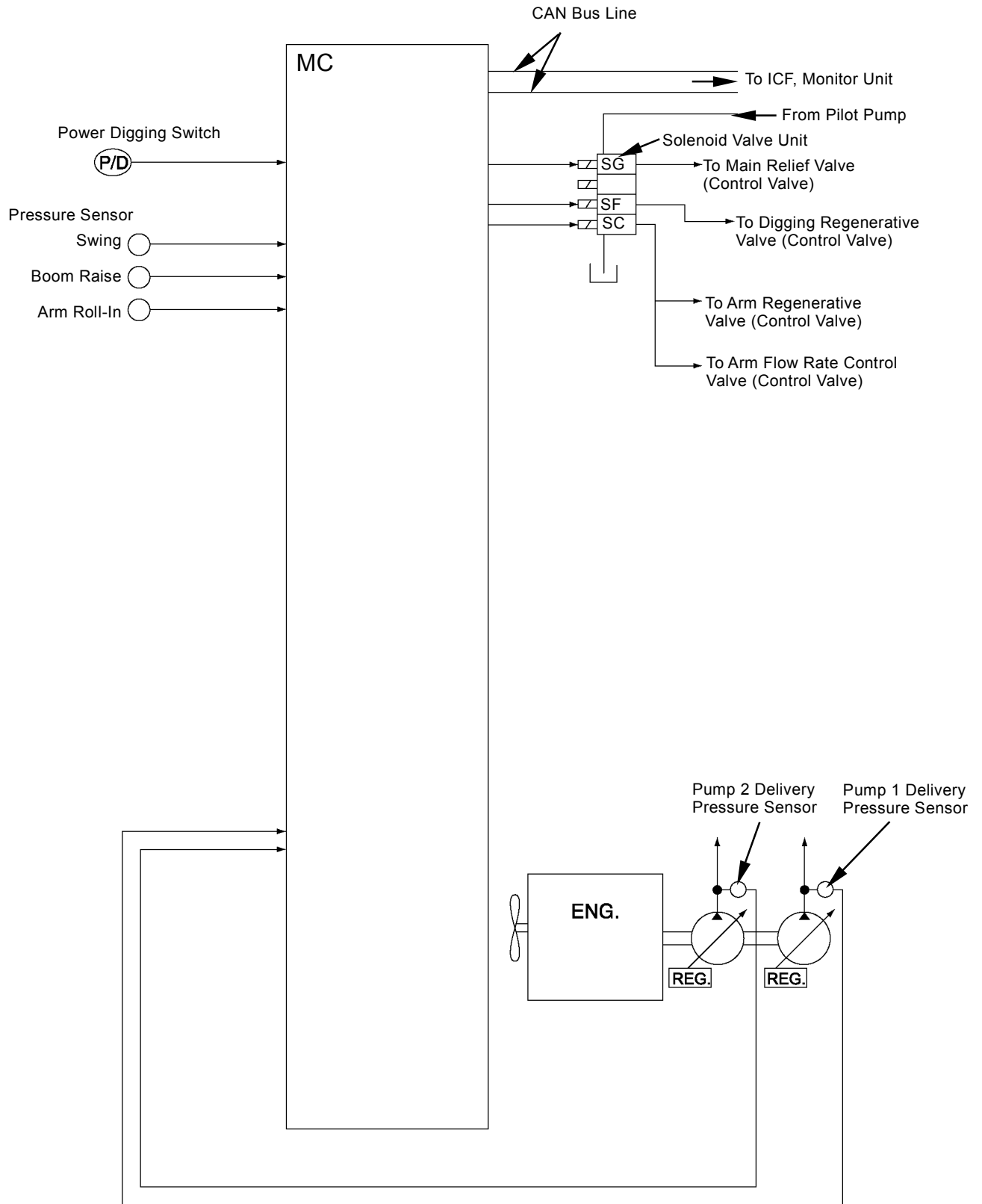
- Digging Regenerative Control

When operating digging with pump 1, 2 delivery pressure in high, MC drives solenoid valve unit (SF) according to the signals from pumps 1, 2 delivery pressure sensors and pressure sensor (arm roll-in, boom raise), outputs pilot pressure, and shifts the digging regenerative valve.

As pressure oil from pumps 1, 2 and the boom cylinder rod side flows to the arm cylinder bottom side through the digging regenerative valve, speed of arm roll-in increases.

(Refer to the Control System group in SYSTEM.)

SYSTEM / Controller



T1V1-02-01-042

SYSTEM / Controller

- Travel Motor Displacement Angle Selection Control

Condition:

Pump 1, 2 Delivery Pressure: Either Low

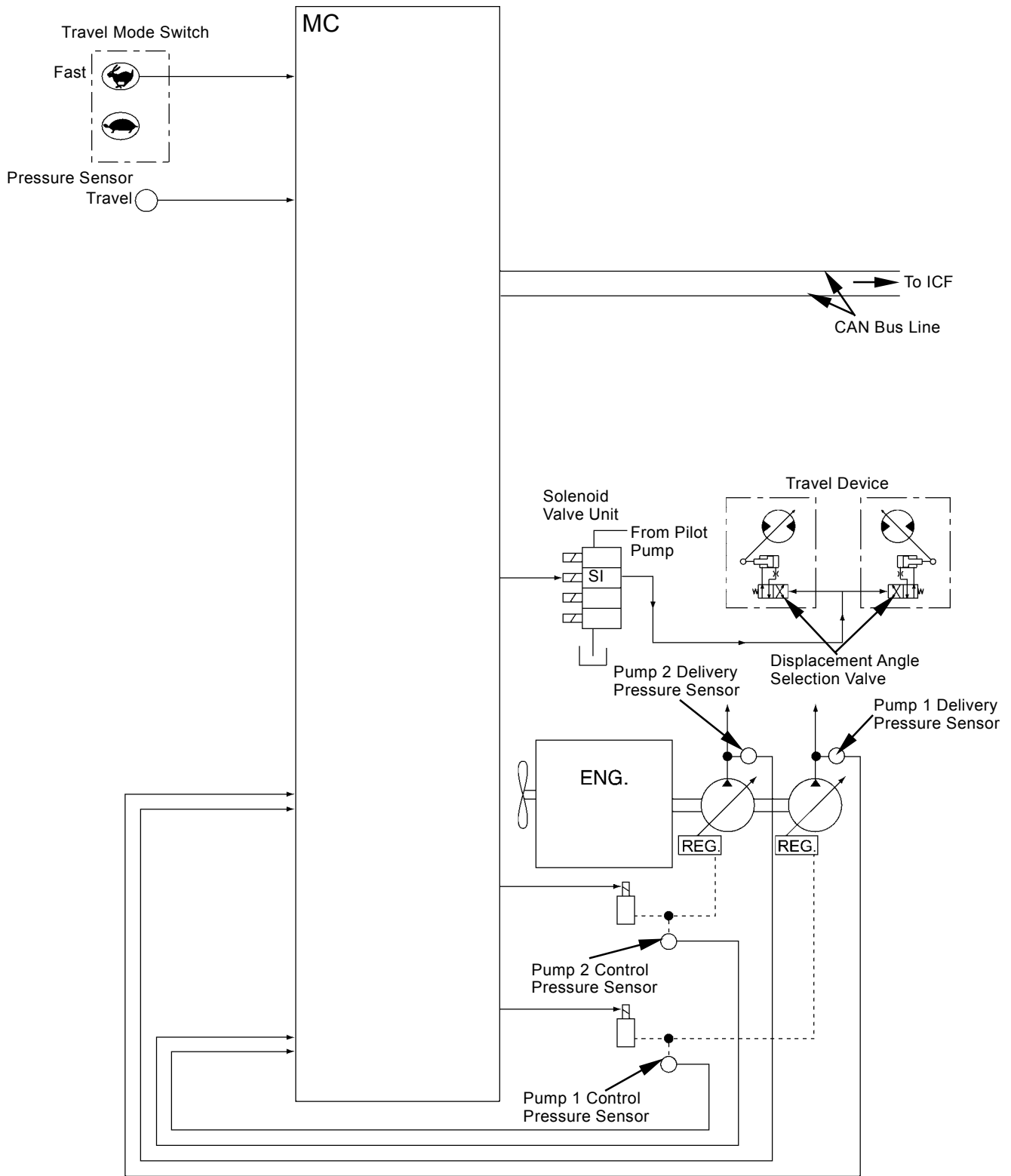
Pump 1, 2 Control Pressure: Either High

Travel Mode Switch: Fast

When operating travel on conditions above, MC drives solenoid valve unit (SI) according to the signals from pressure sensor (travel), pump 1, 2 delivery pressure sensors and pump 1, 2 control pressure sensors.

When pilot pressure from solenoid valve unit (SI) acts on the travel motor displacement angle selection valve, reduces displacement angle of the travel motor, and increases travel speed.

SYSTEM / Controller



T1V5-02-01-009

SYSTEM / Controller

- 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.

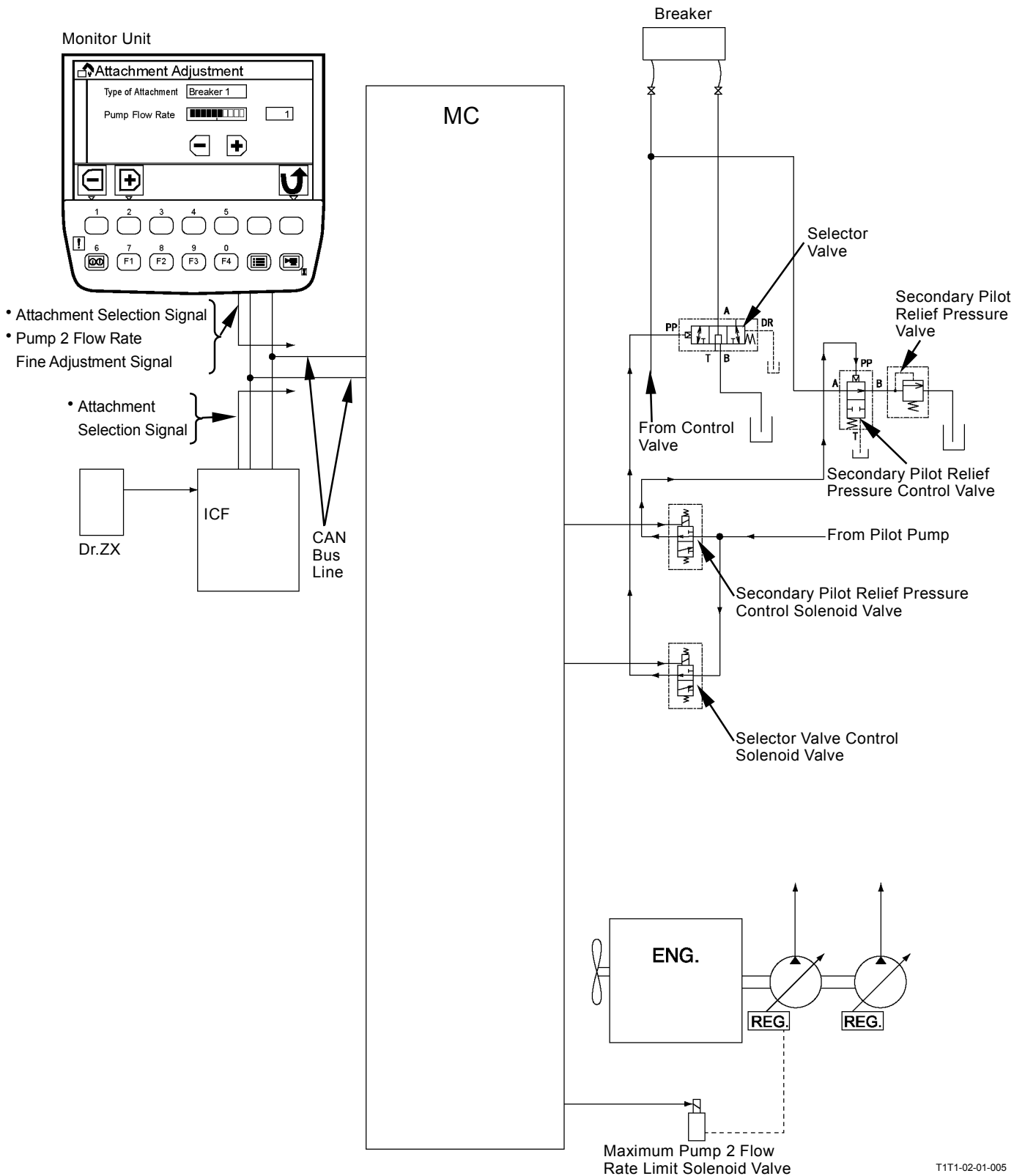
Pilot pressure from the secondary pilot relief pressure control solenoid valve shifts the secondary pilot relief pressure control valve and reduces relief set pressure in the breaker circuit.

- 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.

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

SYSTEM / Controller



NOTE: Flow rate of maximum pump 2 flow rate limit solenoid valve can be adjusted finely on the monitor unit.

SYSTEM / Controller

- Secondary Crusher Control (Optional)

As for the machine equipped with the secondary crusher, when secondary crusher 1 is selected on the monitor unit or is set by Dr. ZX, MC drives the auxiliary flow combining solenoid valve.

When operating the secondary crusher, pilot pressure from the attachment pilot valve shifts the bypass shut-out valve and the auxiliary flow combining valve through the auxiliary flow combining solenoid valve. When pressure oil from pump 1 is combined with pressure oil from pump 2 through the auxiliary flow combining valve. Therefore, combined pressure oil flows to the auxiliary spool and speed operating the secondary crusher increases.

When operating combined operation of arm roll-out, arm roll-out + boom raise, swing or travel and secondary crusher, MC drives the auxiliary flow rate control solenoid valve according to the signals from pressure sensors (auxiliary, arm roll-out, boom raise, swing or travel) so that pressure oil to the secondary crusher is restricted.

- Primary Crusher Control (Optional)

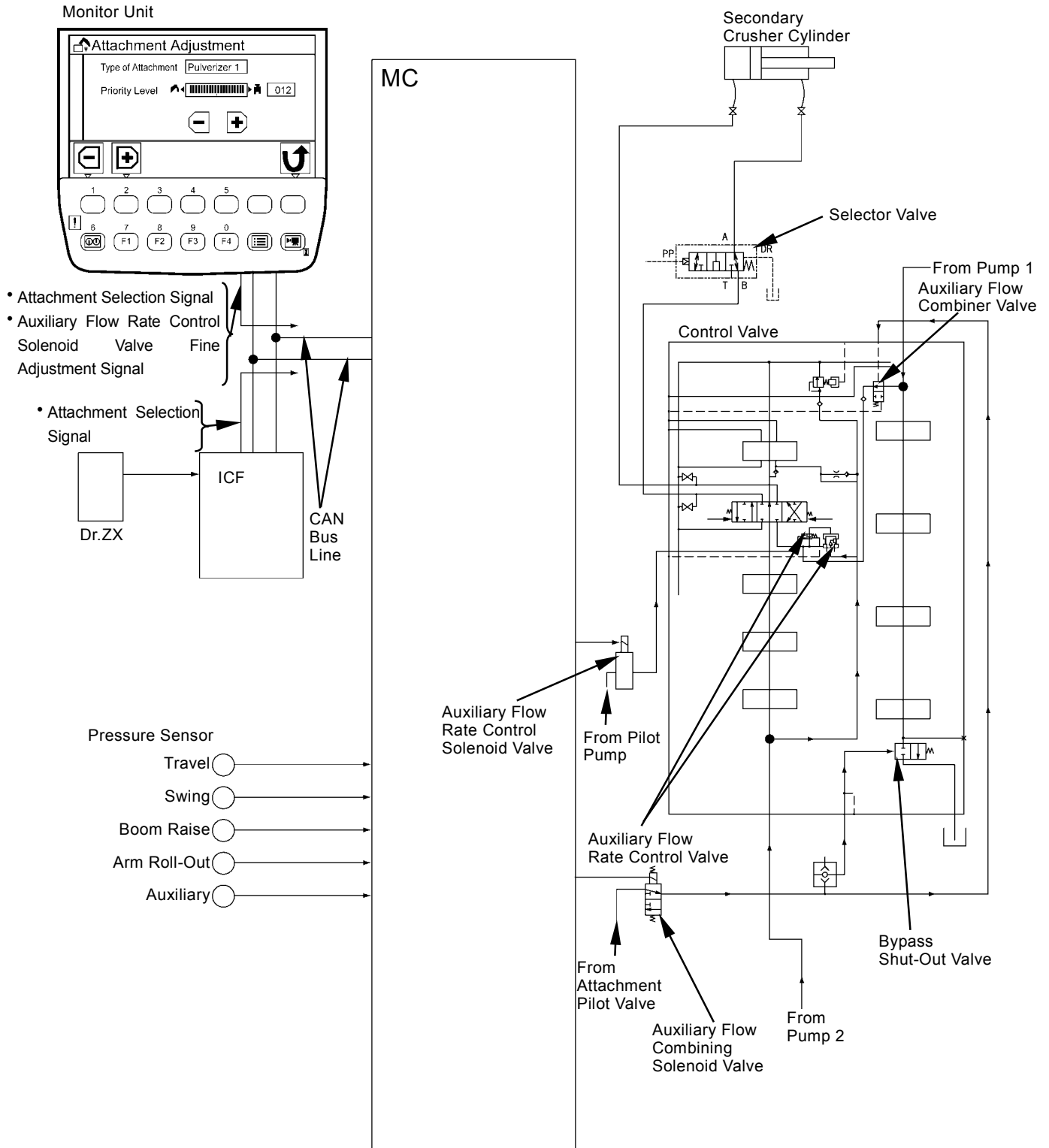
As for the machine equipped with the primary crusher, when primary crusher 1 is selected on the monitor unit or is set by Dr. ZX, MC drives the auxiliary flow combining solenoid valve.

When operating the primary crusher, pilot pressure from the attachment pilot valve shifts the bypass shut-out valve and the auxiliary flow combining valve through the auxiliary flow combining solenoid valve. When pressure oil from pump 1 is combined with pressure oil from pump 2 through the auxiliary flow combining valve. Therefore, combined pressure oil flows to the auxiliary spool and speed operating the primary crusher increases.

When operating combined operation of arm roll-out, arm roll-out + boom raise, swing or travel and primary crusher, MC drives the auxiliary flow rate control solenoid valve according to the signals from pressure sensors (auxiliary, arm roll-out, boom raise, swing or travel) so that pressure oil to the primary crusher is restricted.

As the primary crusher is heavier than the secondary crusher, when operating combined operation of arm roll-out or arm roll-out + boom raise and primary crusher, MC restricts flow rate of the auxiliary flow rate control solenoid valve further, and gives priority to operation of arm roll-out or arm roll-out + boom raise.

SYSTEM / Controller



T1V5-02-01-004

NOTE: The illustration shows the circuit of secondary crusher 1.

SYSTEM / Controller

Other Controls

- Rear Monitoring Display Selection Control

MC shifts the monitor unit into the back-screen display according to the signal from pressure sensor (travel).

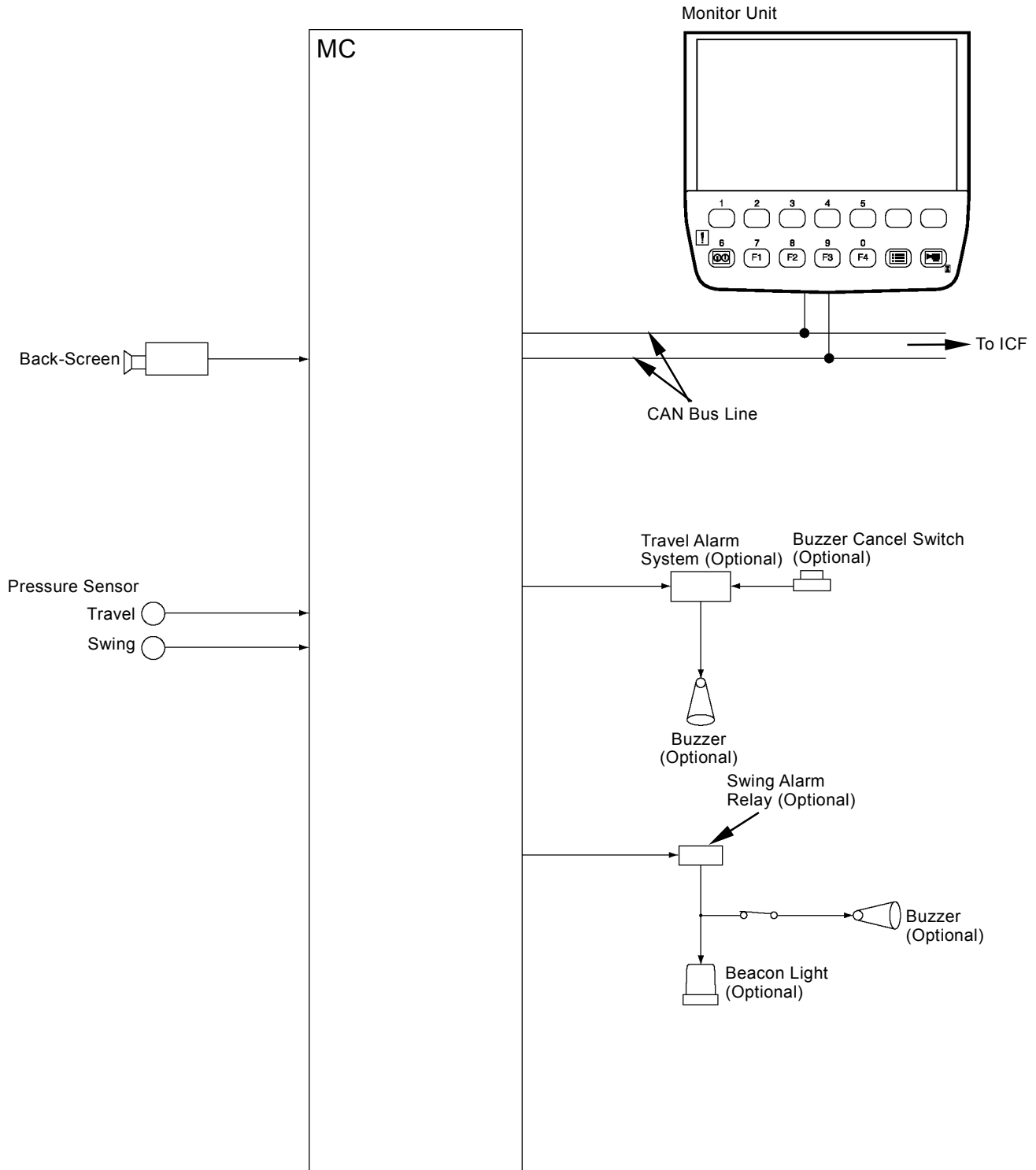
- Travel Alarm Control (Optional)

While MC receives the signal from pressure sensor (travel), MC outputs the signal to the travel alarm system and rings the buzzer.

- Swing Alarm Control (Optional)

While MC receives the signal from pressure sensor (swing), MC outputs the signal to the swing alarm system, rings the buzzer, and turns on the beacon light.

SYSTEM / Controller



T1T1-02-01-003

SYSTEM / Controller

ECM: ENGINE CONTROL MODULE

Function Outline

- Fuel Injection Control

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

- Engine Start 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.

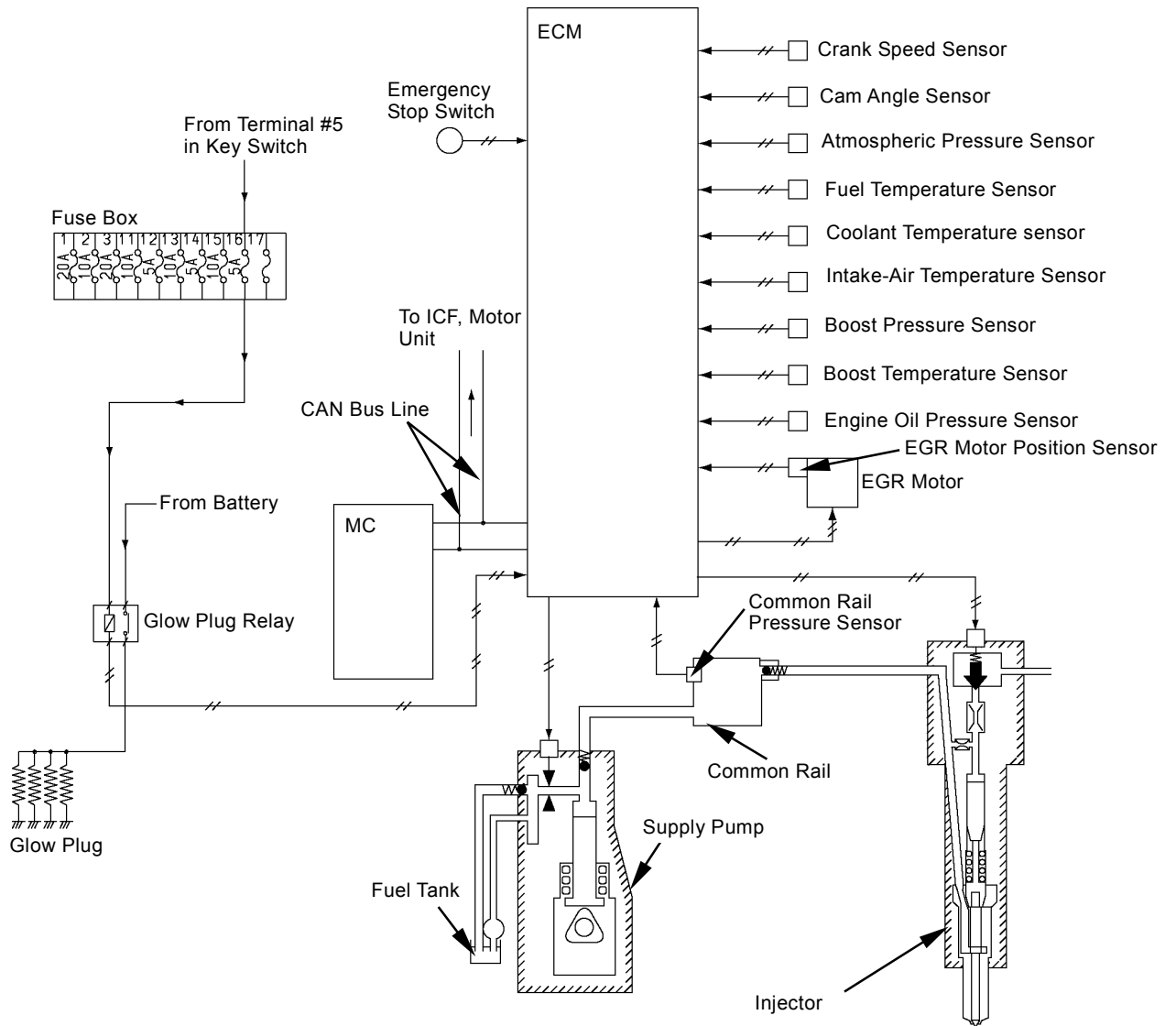
- Fuel Injection Amount Correction

ECM adjusts fuel injection amount according to the signal of atmospheric pressure sensor.

- 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.

SYSTEM / Controller



T1V1-02-01-047

SYSTEM / Controller

ICF: INFORMATION CONTROLLER

Function Outline

- Operating Hours Management

The built-in clock is provided for ICF.

ICF sends data of built-in clock to the monitor unit by using CAN bus line.

- Alarm, Fault Code Memory

ICF memorizes the alarm and fault code from each controller by using CAN bus line in the time series.

The memorized alarm and fault code are sent to the center server by the satellite terminal (optional).

Engine oil pressure alarm and overheat alarm are sent to the center server whenever these occur. Other alarm and fault code are sent to the center server once a day.

- Fault Code Display

ICF displays the fault code sent from each controller by using CAN bus line on Dr. ZX.

- Maintenance History

When the maintenance key is pushed on the monitor unit, time is recorded.

- Daily Report Data Making

ICF records operating hours, fuel level and fuel amount of use during daily operation, and makes the daily report data.

The daily report data can be sent to the center server by using the satellite terminal (optional).

- Frequency Distribution Data Making

ICF makes the frequency distribution data every 100 hours.

The frequency distribution data can be sent to the center server by using the satellite terminal (optional).

- Cumulative Operating Hours Record

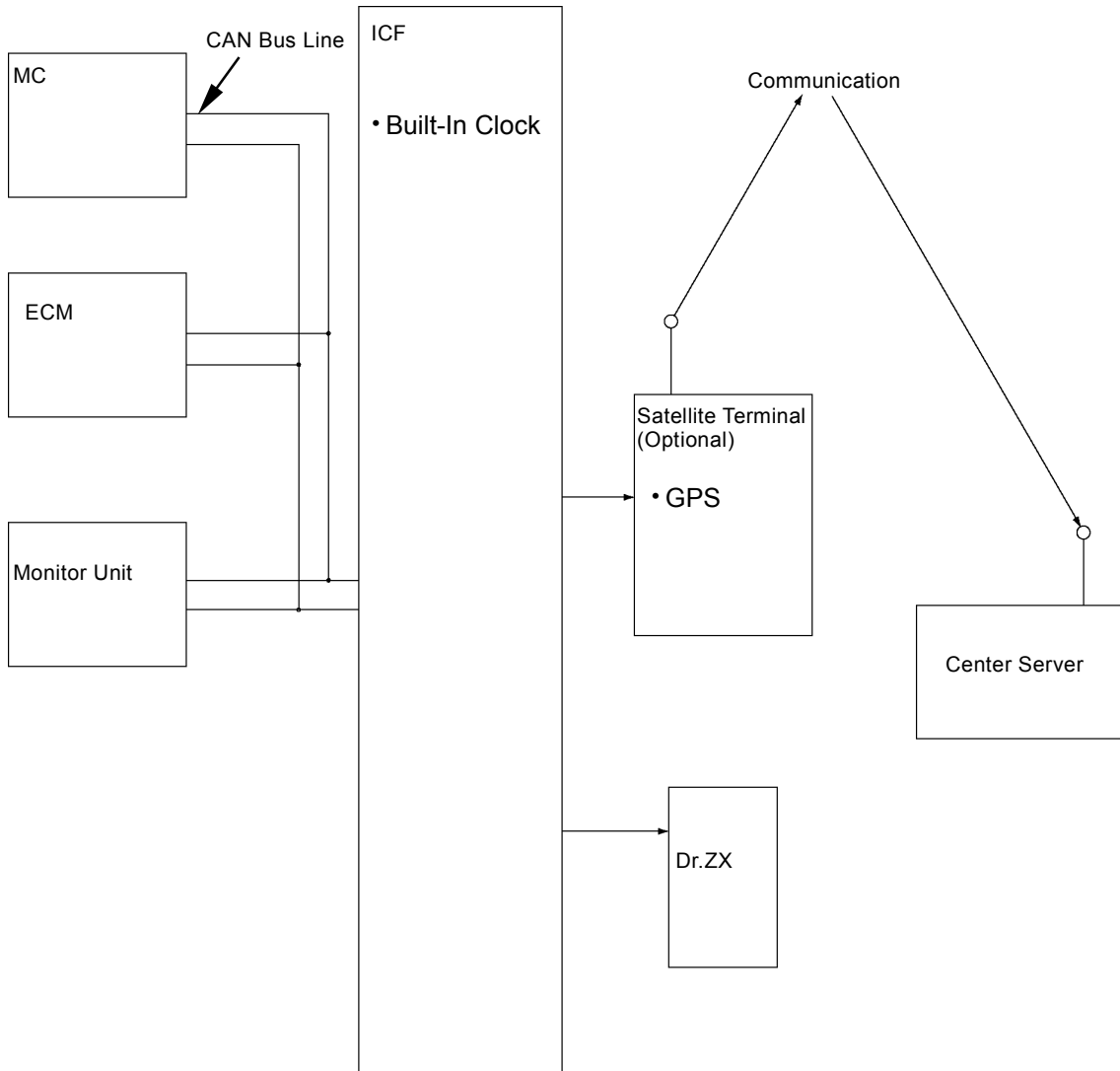
ICF records all hours when the machine is operated.

The cumulative operating hours can be downloaded to Dr. ZX.

- Mail Data Making (Optional)

ICF records the mails sent from the monitor unit and sends them to the center server by the satellite terminal.

SYSTEM / Controller



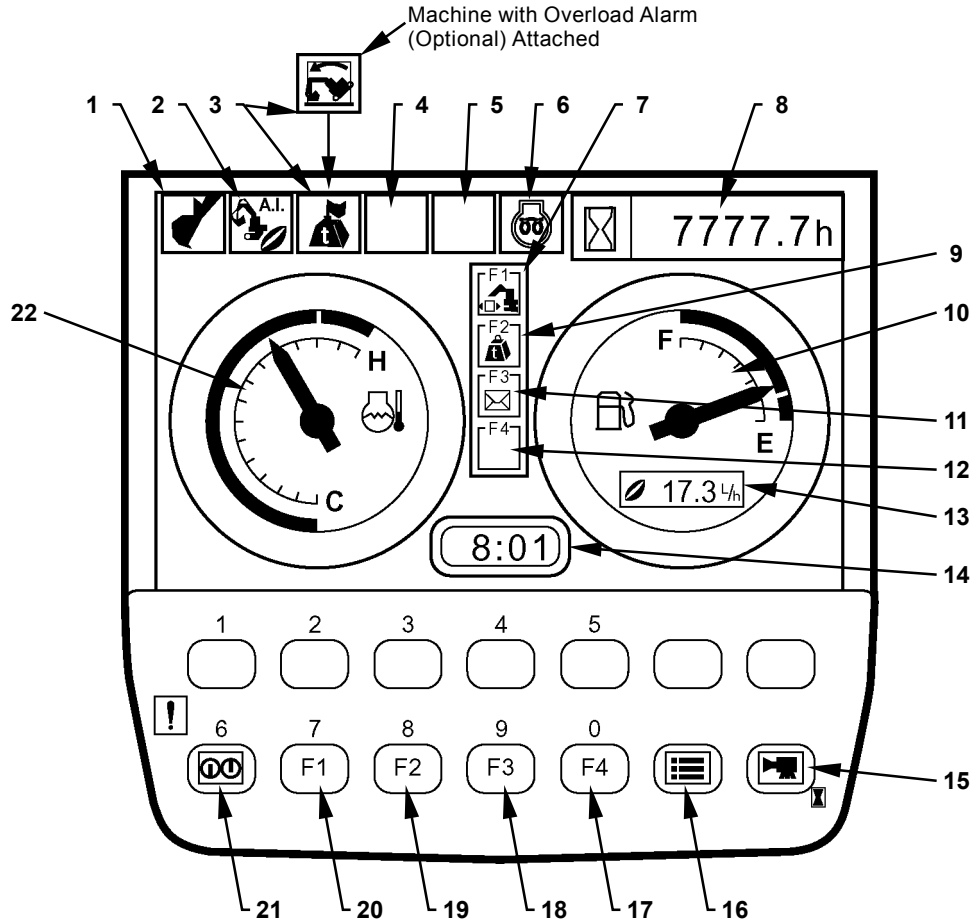
T1V1-02-01-049

SYSTEM / Controller

(Blank)

SYSTEM / Controller

MONITOR UNIT Function Outline Primary Screen



T1V1-05-01-094

- | | | | |
|--|----------------------------------|-----------------------------|-------------------------------------|
| 1 - Work Mode Display | 7 - Work Mode Display | 13 - Fuel Consumption Gauge | 18 - Mail Selection (Optional) |
| 2 - Auto-Idle Display | 8 - Hour Meter | 14 - Clock | 19 - *ML Crane Selection (Optional) |
| 3 - *ML Crane Display or Overload Alarm Display (Optional) | 9 - *ML Crane Display (Optional) | 15 - Back-Screen Selection | 20 - Work Mode Selection |
| 4 - Auxiliary | 10 - Fuel Gauge | 16 - Menu | 21 - Return to Primary Screen |
| 5 - Auxiliary | 11 - Mail Display (Optional) | 17 - Auxiliary Selection | 22 - Coolant Temperature Gauge |
| 6 - Glow Display | 12 - Auxiliary | | |

NOTE: *ML crane display and ML crane selection is only available in Japanese domestic marked.

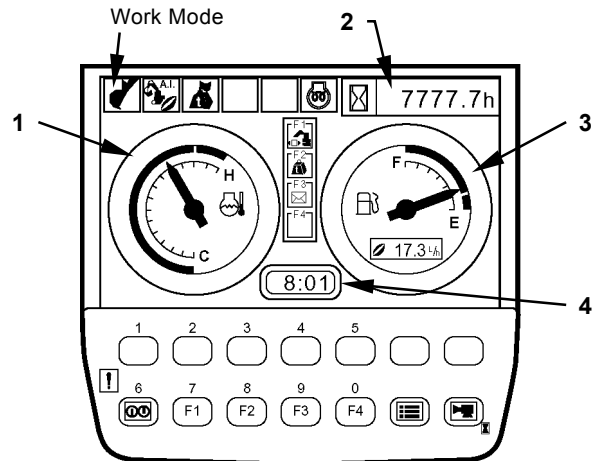
SYSTEM / Controller

- Display of Meters

Data to be displayed on each meter from are displayed on the monitor unit according to the input signal from sensor, the signal received by using CAN and the internal data of monitor unit.

Items to be displayed

1. Coolant Temperature Gauge (Input signal from the coolant temperature sensor)
2. Hour Meter (Internal data of the monitor unit)
3. Fuel Consumption Gauge (Input signal from the fuel sensor)
4. Clock (Signal received from ICF by using CAN)



T1V1-05-01-008

- Work Mode Display

The attachments being used are displayed according to the signals received from MC by using CAN.

Digging Mode



T1V1-05-01-108

Attachment Mode

Breaker



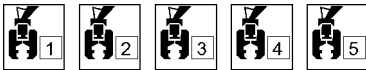
T1V1-05-01-104

Pulverizer



T1V1-05-01-105

Crusher



T1V1-05-01-106

Vibrating Hammer



T1V1-05-01-107

Others

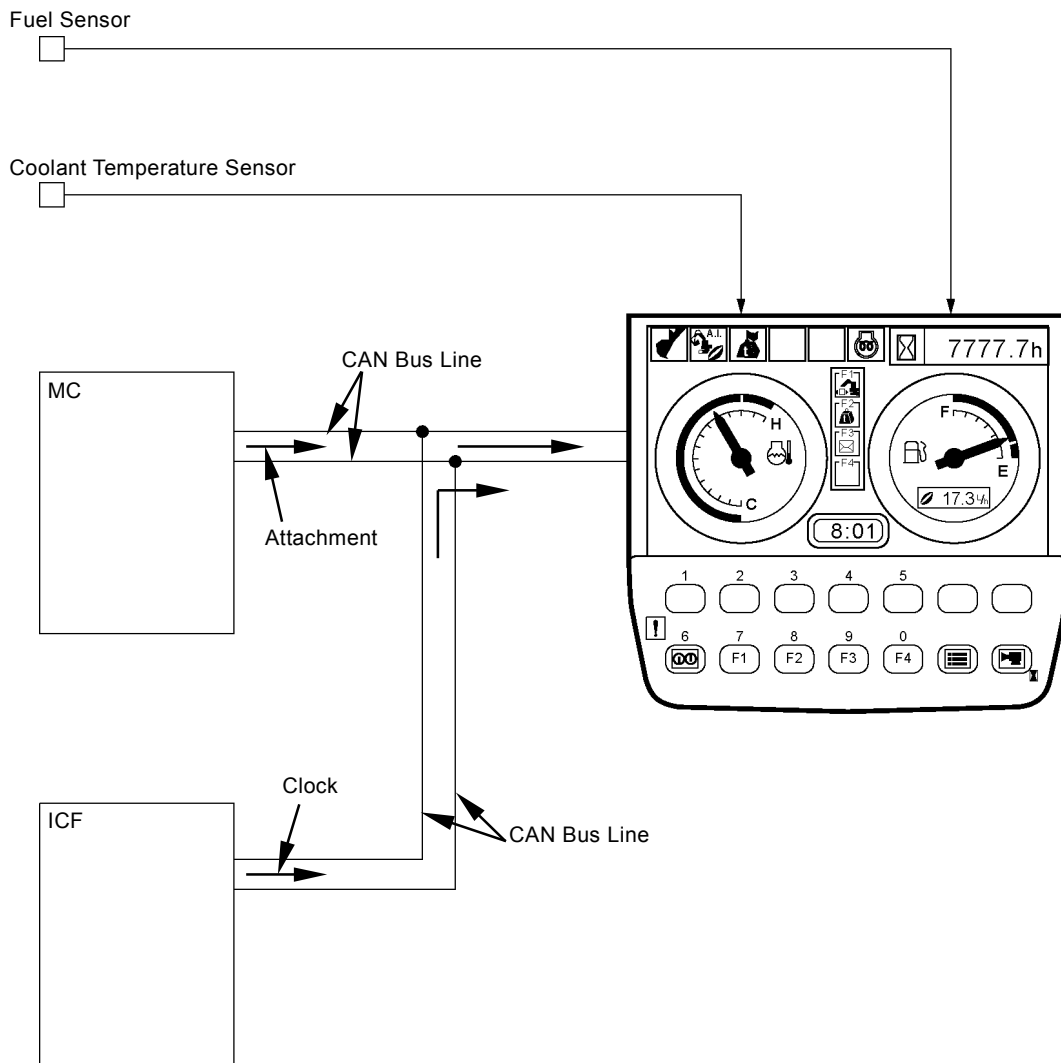


T1V1-05-02-003

NOTE: The items on monitor unit and HITACHI pattern are same.

Monitor Unit	HITACHI pattern
Breaker1	Hydraulic Breaker1
Breaker2	Hydraulic Breaker2
Pulverizer1	Secondary Crusher1
Crusher1	Primary Crusher1

SYSTEM / Controller

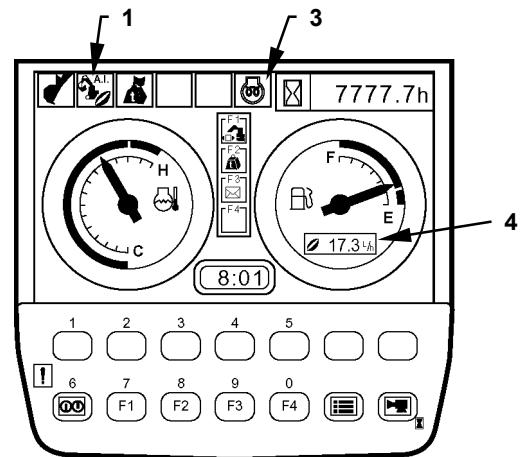


T1V1-02-01-053

SYSTEM / Controller

- Auto-Idle Display (1)

When the switch is turned ON, the data is displayed.
When the key switch is turned ON with the auto-idle switch ON, the data blinks for 10 seconds.



T1V1-05-01-008

- Overload Alarm (2)



T1V1-05-02-002

The system measures the load of suspended load from the bottom pressure of boom cylinder. When overload is detected, an alarm is displayed.
(Refer to T2-1-44.)

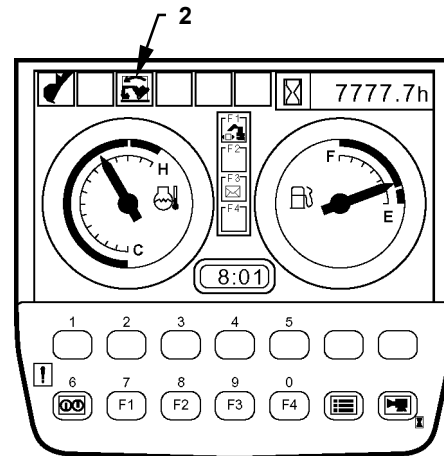
- Glow Display (3)

While ECM is supplying current to the glow plug, the date is displayed according to the signal from ECM.

- Fuel Consumption Gauge Display (4)

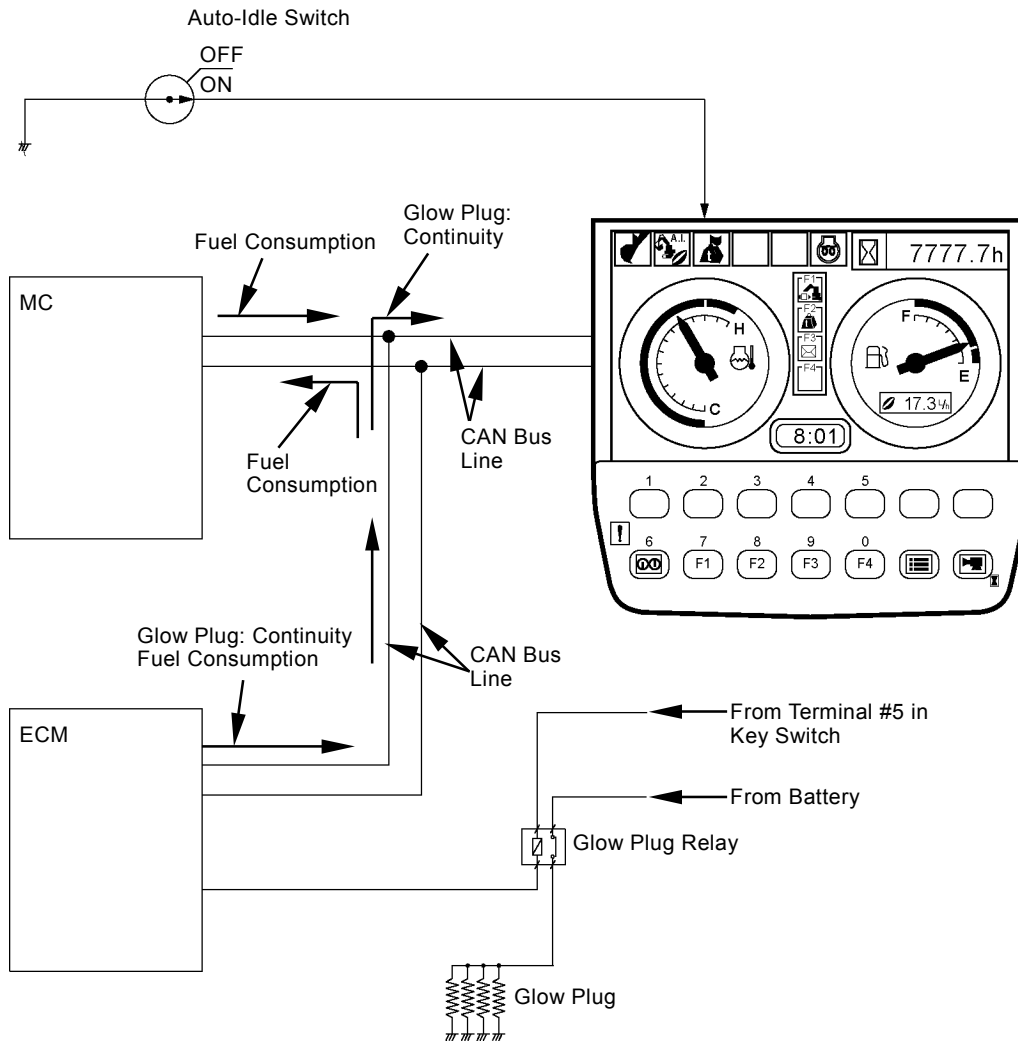
IMPORTANT: The values on fuel gauge are references and different from the measured values.

Fuel consumption is displayed according to the signal from ECM, which is received through MC by using CAN bus line.



T1V1-05-01-128

SYSTEM / Controller



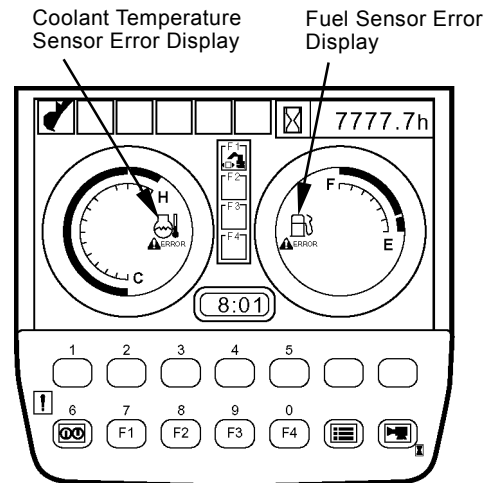
T1V1-02-01-054

SYSTEM / Controller

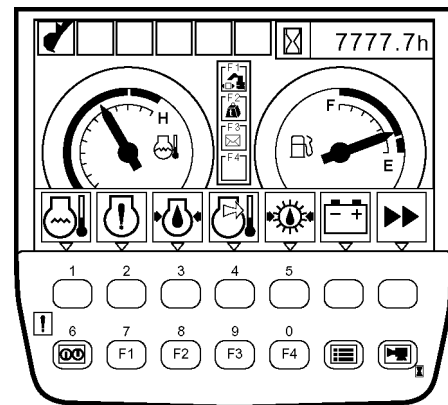
- **Fuel Sensor Error Display**
 When the fuel sensor is faulty or if the harness between fuel sensor and monitor unit is open circuit, the data is displayed on the fuel gauge.

- **Coolant Temperature Sensor Error Display**
 When the coolant temperature sensor is faulty, the data is displayed on the coolant temperature gauge.

- **Alarm and Remedy Displays against Alarm**
 Alarm marks are displayed on bottom of the screen according to the alarm signals from pilot shut-off lever, overheat switch, fuel sensor, hydraulic oil filter alarm switch (optional), air cleaner restriction switch, alternator, battery system and ECM and the alarm signals received by using CAN bus line. The remedy for each alarm is displayed by key operation.

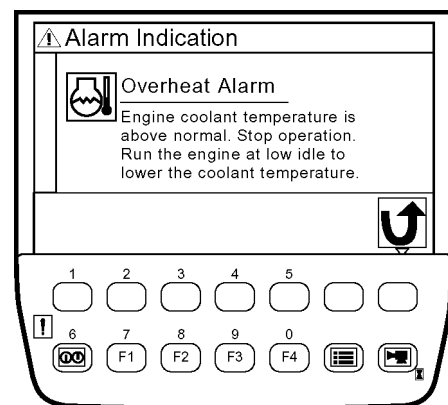


T1V1-05-02-005



Alarm Display

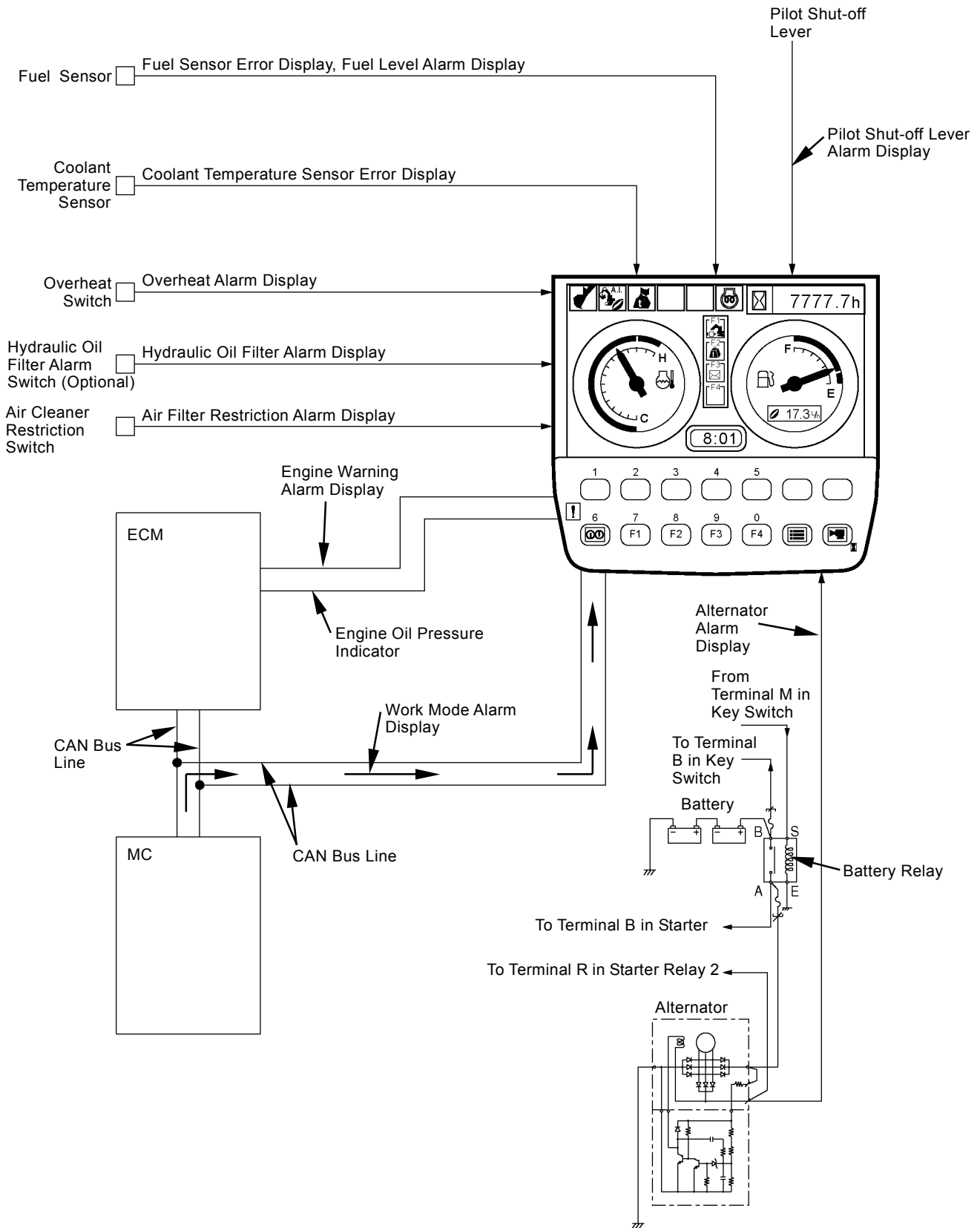
T1V1-05-01-096



Remedy Display against Alarm

T1V5-05-01-013

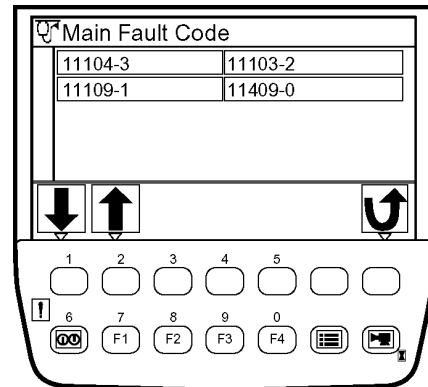
SYSTEM / Controller



SYSTEM / Controller

- Troubleshooting

This screen displays the fault codes according to the signals received from each controller by using CAN bus line.



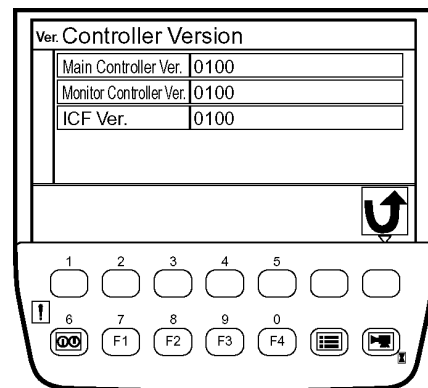
Fault Code Display

T1V5-05-01-097

- Controller Version

This screen displays the version on controller received from MC, ICF by using CAN bus line and the version of monitor unit.

NOTE: The version of ECM is not displayed.

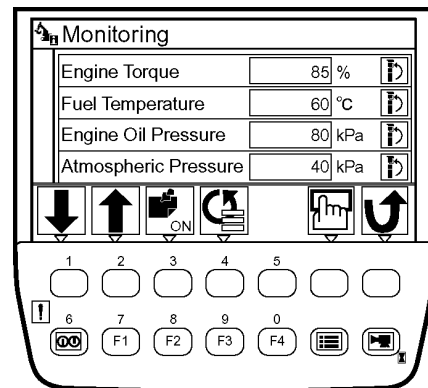


Controller Version Display

T1V5-05-01-122

- Monitoring

This screen displays temperature and pressure data received from each controller by using CAN bus line. By key operation, the displayed data is hold.

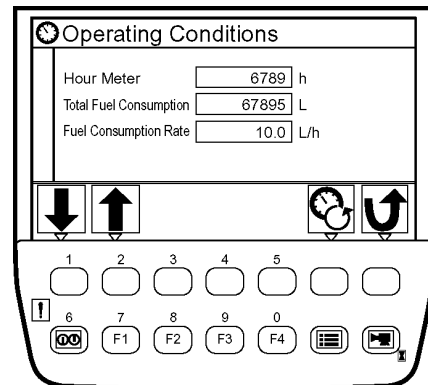


Monitoring Screen

T1V5-05-01-087

- Operating Conditions

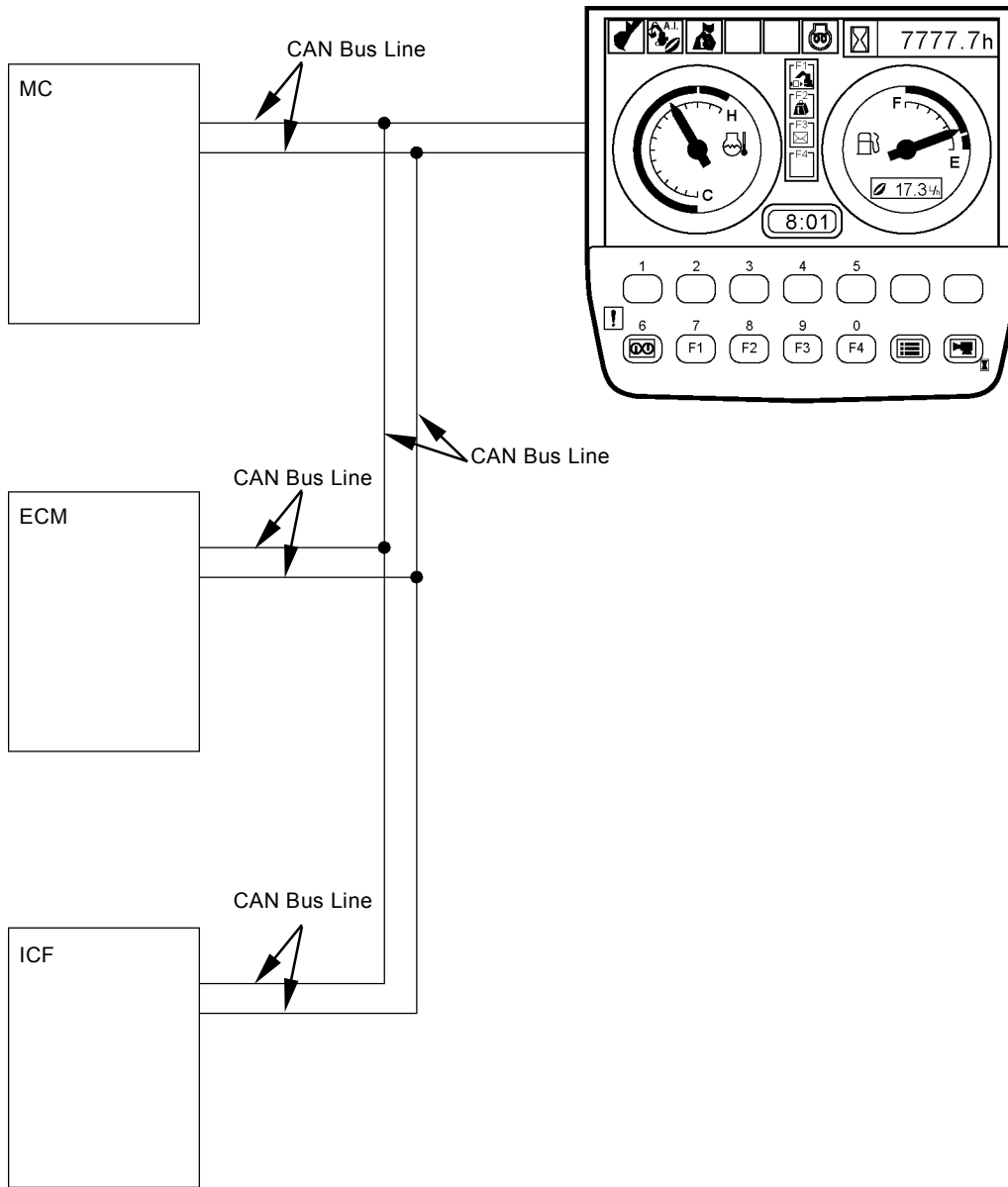
This screen displays the fuel consumption rate calculated by the monitor unit from machine operating hour, registered by the monitor unit fuel usage and machine operating hour received from ECM by using CAN bus line.



Operating Conditions Screen

T1V5-05-01-025

SYSTEM / Controller



T1V1-02-01-061

SYSTEM / Controller

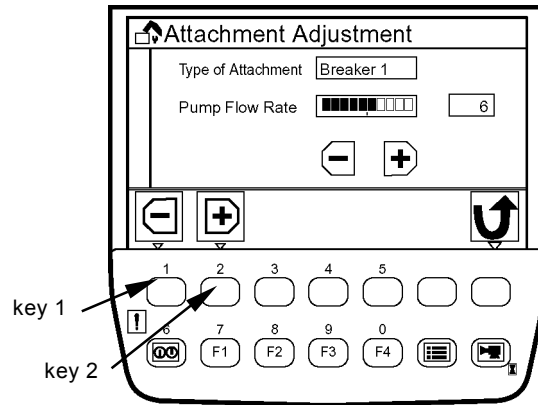
- Pump 2 Flow Rate Adjustment

(Only machines equipped with optional parts)

When using the attachments, fine adjust flow rate of pump 2 by keys 1 and 2 operation.

The signals from the monitoring unit are sent to MC by using CAN bus line.

When breaker 1 or 2 is used, MC adjusts flow rate of pump 2 while controlling maximum pump 2 flow rate limit control solenoid valve. When pulverizer 1 or crusher 1 is used, MC adjusts flow rate of pressure oil that flows from pump 2 to pulverizer or crusher while controlling the auxiliary flow rate control solenoid valve. (Refer to "Control Systems.")

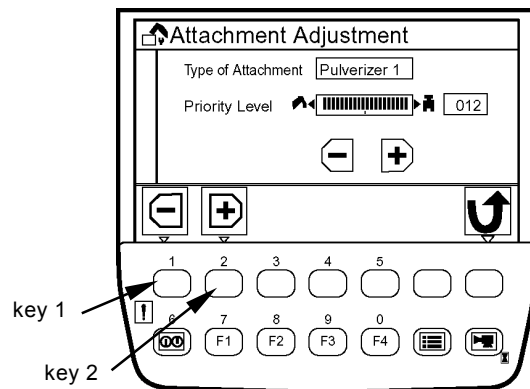


When using Breaker 1

T1V5-05-01-111

NOTE: When the 2-speed selector circuit is OFF, flow rate of pump 2 can be adjusted while controlling the maximum pump 2 flow rate limit control solenoid valve. When the 2-speed selector circuit is ON, flow rate of pressure oil that flows from pump 2 to the attachments can be adjusted while controlling the auxiliary flow rate control solenoid valve.

The table below is the setting of various factors at the time of shipment from the factory.



When using Pulverizer 1

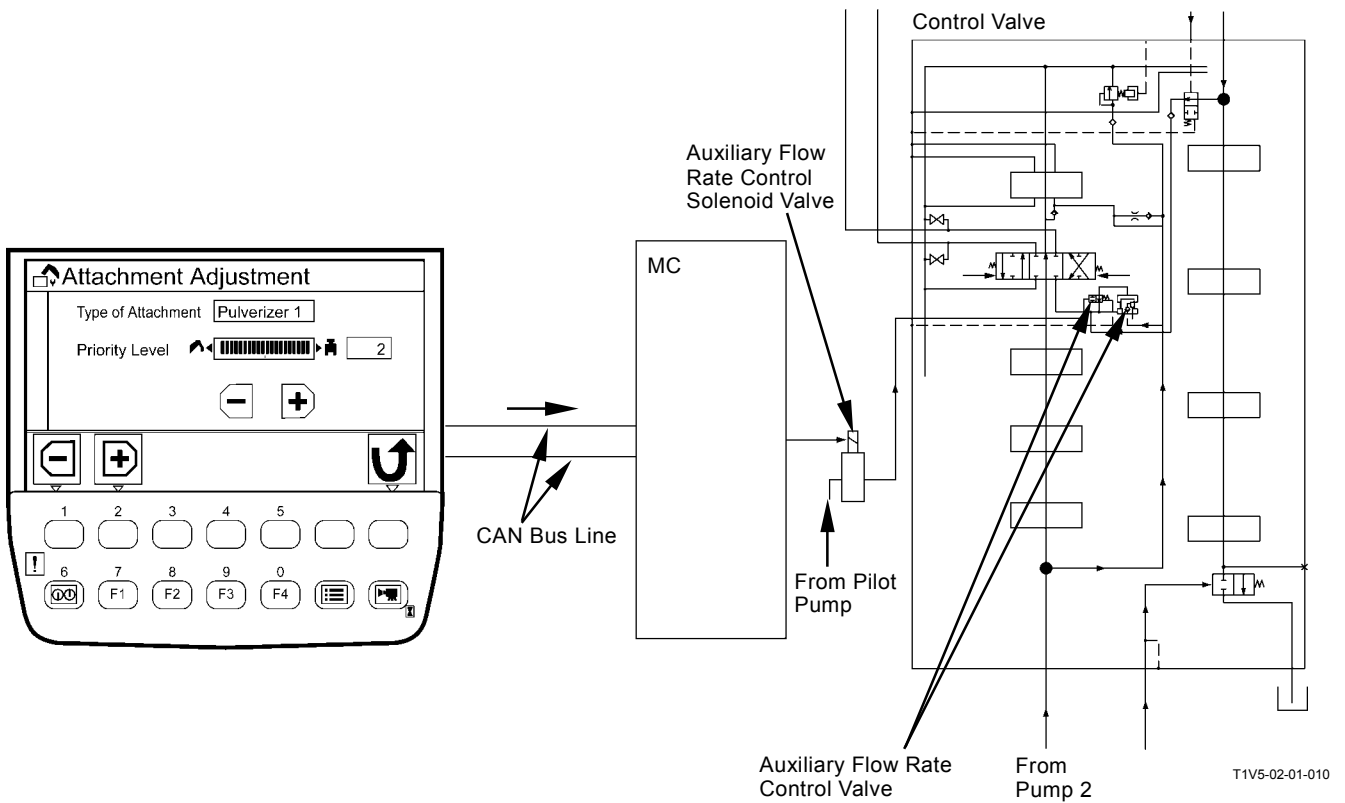
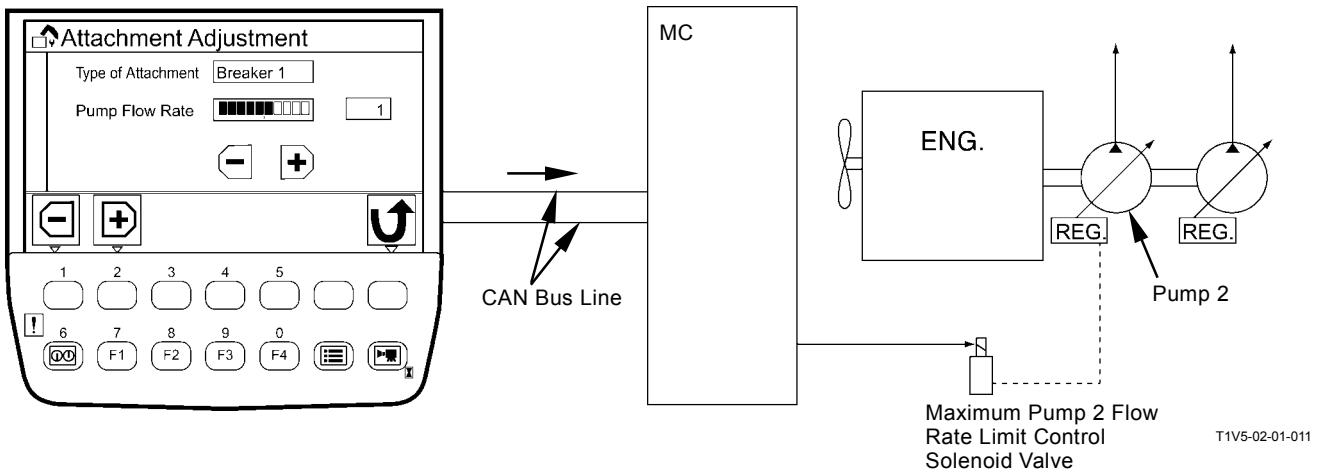
T1V5-05-01-024

Type of Attachments	2-Speed Selector Circuit	Valve Selector Circuit	Accumulator Circuit	Secondary Hydraulic Relief Selector Circuit	Pump 2 Flow Rate Control	Auxiliary Flow Rate Control
Breaker 1	OFF	to Hydraulic Oil Tank	OFF	ON	ON	OFF
Breaker 2	OFF	to Hydraulic Oil Tank	OFF	OFF	ON	OFF
Pulverizer 1	ON	to Control Valve	OFF	OFF	OFF	ON
Crusher 1	ON	to Control Valve	OFF	OFF	OFF	ON

NOTE: The items on monitor unit and HITACHI pattern are same.

Monitor Unit	HITACHI pattern
Breaker1	Hydraulic Breaker1
Breaker2	Hydraulic Breaker2
Pulverizer1	Secondary Crusher1
Crusher1	Primary Crusher1

SYSTEM / Controller



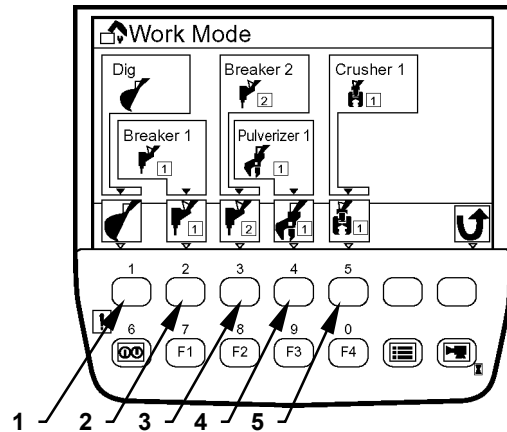
SYSTEM / Controller

- Attachment Selection
(Only machines equipped with optional parts)
Select digging mode and attachment mode set by Dr. ZX on this screen.

When the attachment mode is selected, the monitor unit sends the signal to MC by using CAN bus line. MC drives the solenoid valve set by the attachment mode.

NOTE: In attachment mode, the following five modes are set at the time of shipping from the factory.

- 1 - Digging
- 2 - Breaker 1 (HSB Breaker)
- 3 - Breaker 2 (NPK Breaker)
- 4 - Pulverizer 1
- 5 - Crusher 1



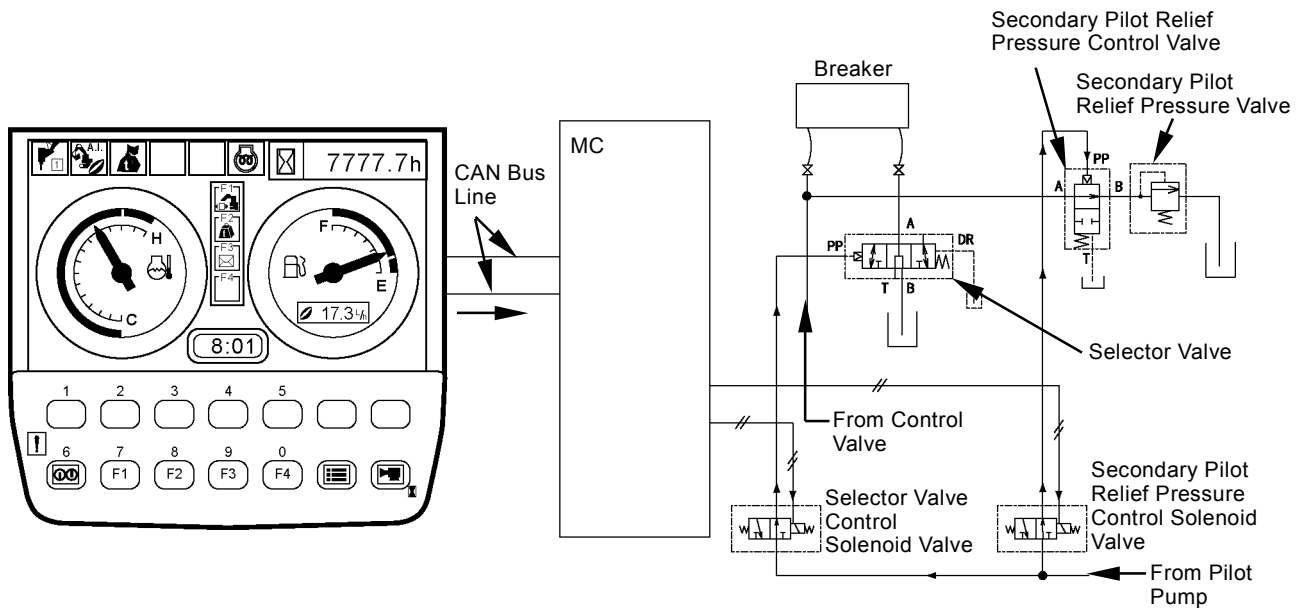
Attachment Selection Screen

T1V5-05-01-109

NOTE: The items on monitor unit and HITACHI pattern are same.

Monitor Unit	HITACHI pattern
Breaker1	Hydraulic Breaker1
Breaker2	Hydraulic Breaker2
Pulverizer1	Secondary Crusher1
Crusher1	Primary Crusher1

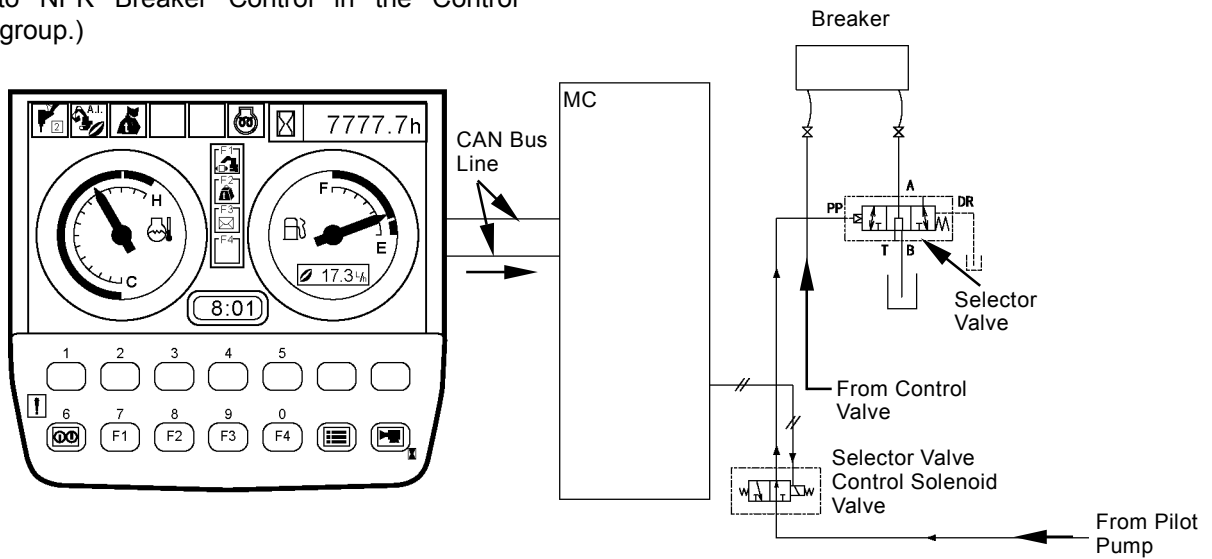
- When breaker 1 (HSB breaker) is selected:
(Refer to HSB Breaker Control in the Control System group.)



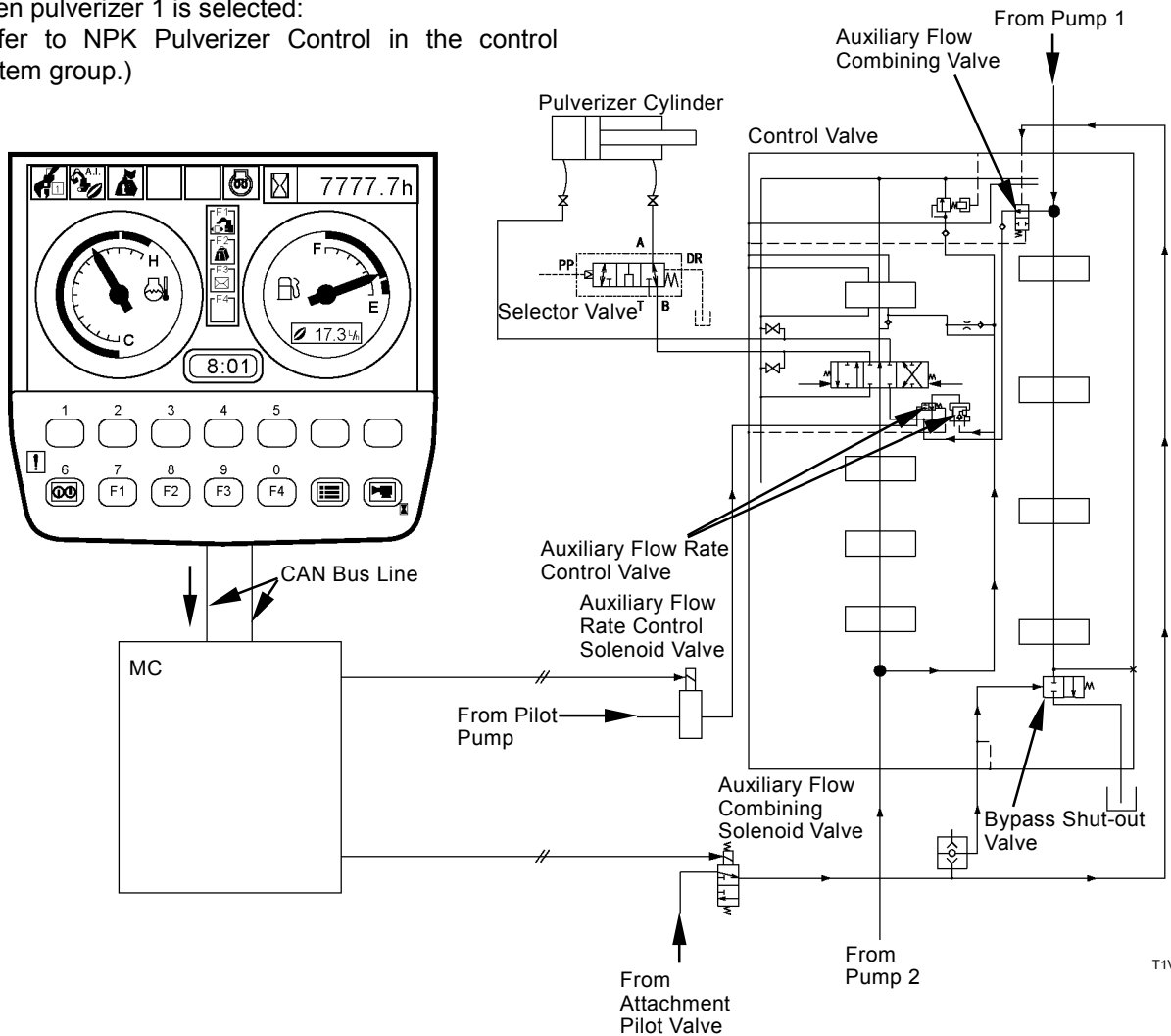
T1V1-02-01-063

SYSTEM / Controller

- When breaker 2 (NPK breaker) is selected:
(Refer to NPK Breaker Control in the Control System group.)

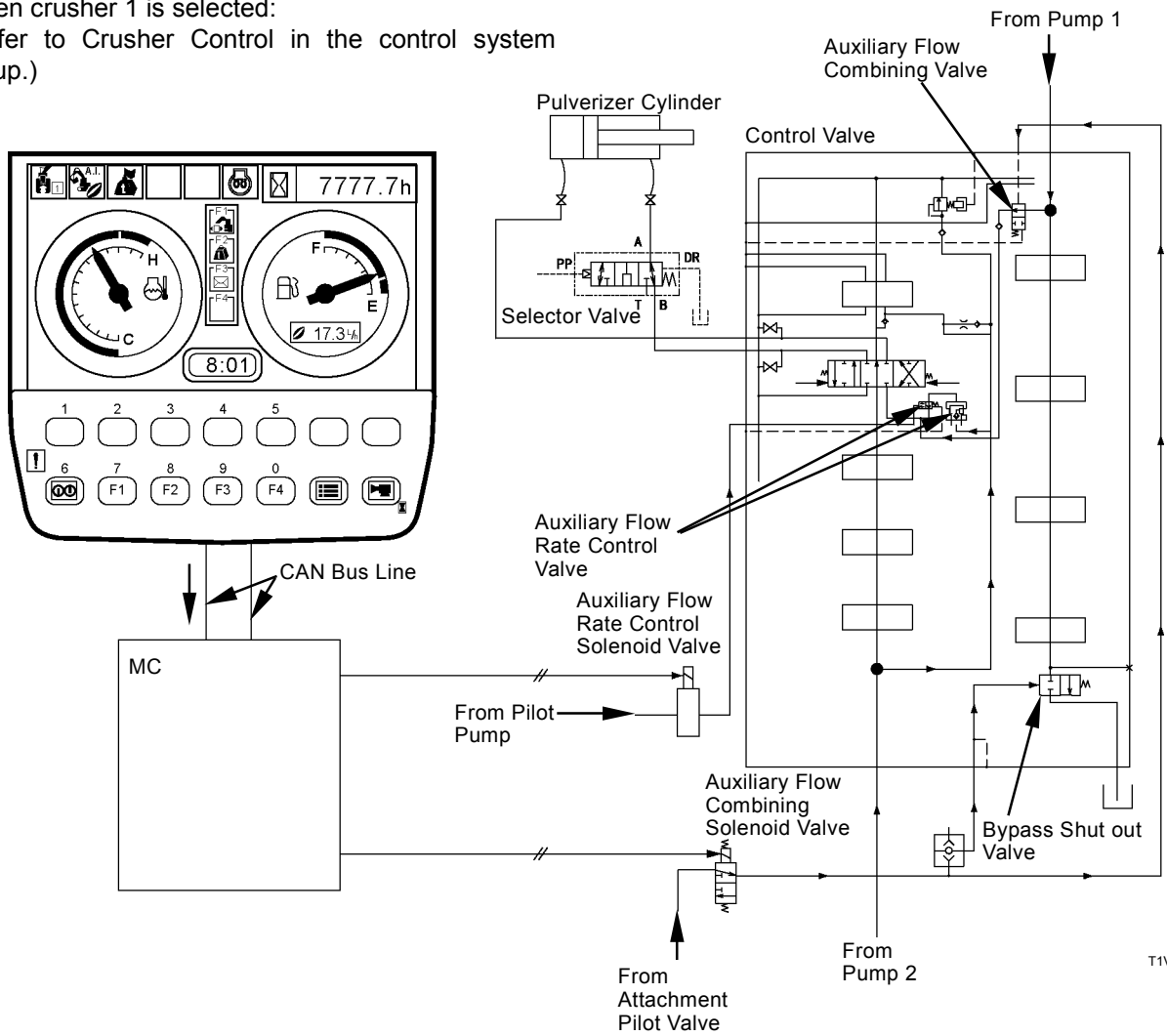


- When pulverizer 1 is selected:
(Refer to NPK Pulverizer Control in the control System group.)



SYSTEM / Controller

- When crusher 1 is selected:
(Refer to Crusher Control in the control system group.)



T1V1-02-01-066

SYSTEM / Controller

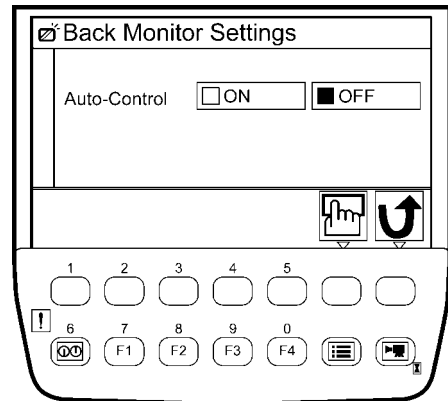
(Blank)

SYSTEM / Controller

- Back Monitor Settings

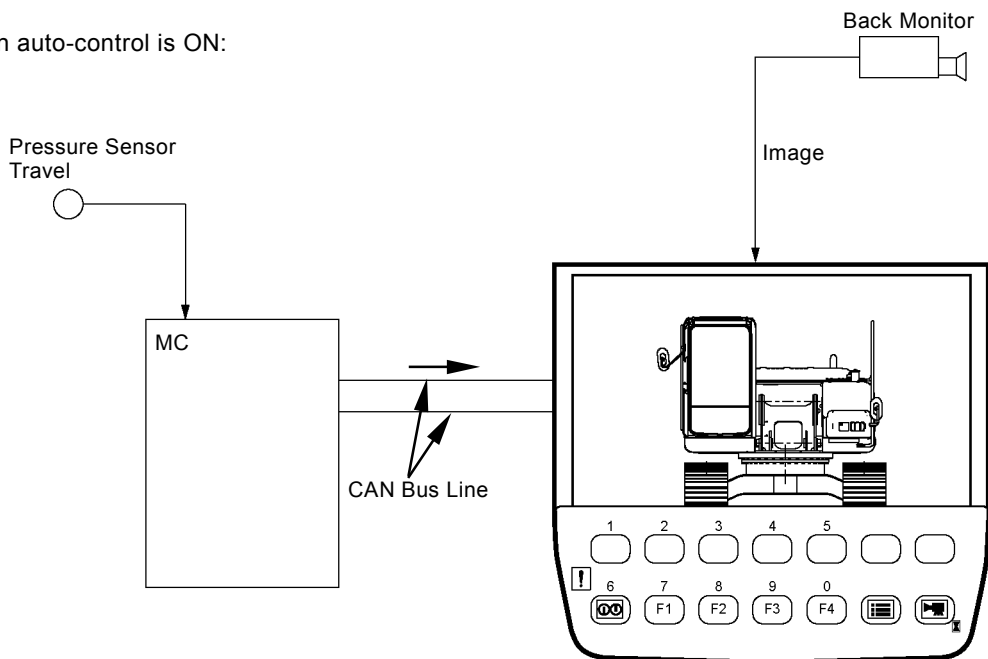
By key operation, image display ON and OFF of Auto-Control for switching image of the back monitor while traveling can be set.

IMPORTANT: The rearview camera is set in mirror image mode.



T1V5-05-01-173

When auto-control is ON:



T1V1-02-01-056

SYSTEM / Controller

(Blank)

SYSTEM / Controller

- Maintenance Settings

The data, the remaining hours until the next replacement is received from ICF by using CAN bus line.

This screen displays the remaining hours until the next replacement.

As the items to be replaced are displayed in a list, record performed replacement by selecting an item from the list.

- Interval ON/OFF Settings

Set change interval for each item to be replaced.

- Items included in Maintenance Settings

Engine Oil
 Engine Oil Filter
 Hydraulic Oil
 Hydraulic Oil Pilot Filter
 Hydraulic Oil Full-Flow Filter
 Pump Transmission Oil
 Travel Device Oil
 Swing Device Oil
 Swing Bearing Grease
 Air Cleaner Filter
 Engine/Air Conditioner V-belt
 Fuel Filter
 Air Conditioner Filter

- Language Settings

Select a language to be used in screens from among preset languages, according to work environment.

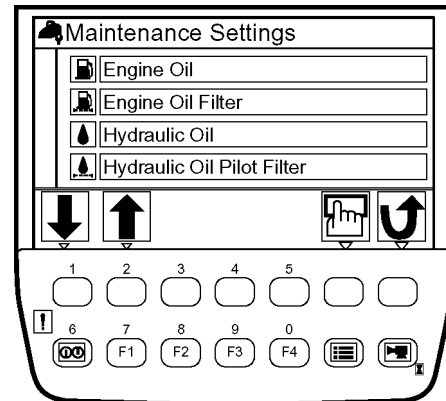
- Mail

(Optional Function)

Send requests such as general, fuel replenishment, service maintenance and forwarding requests in the mail switch screen.

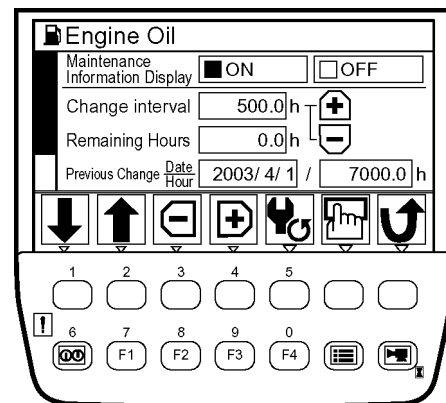
Contents of mails are registered in ICF, and are sent to the central server by a satellite terminal.

(Refer to ICF: Information Controller.)



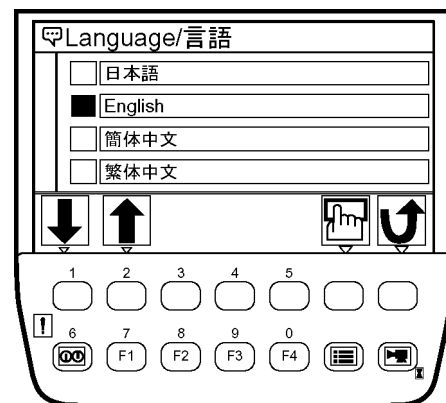
Maintenance Setup Screen

T1V5-05-01-049



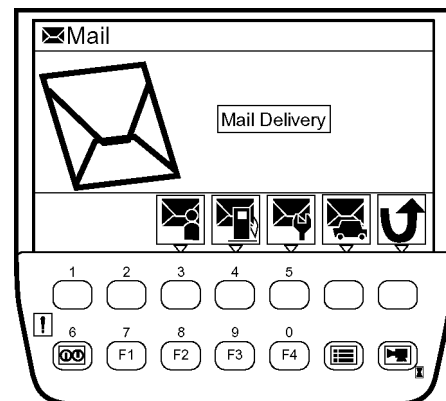
Interval ON/OFF Setup Screen

T1V5-05-01-052



Language Setup Screen

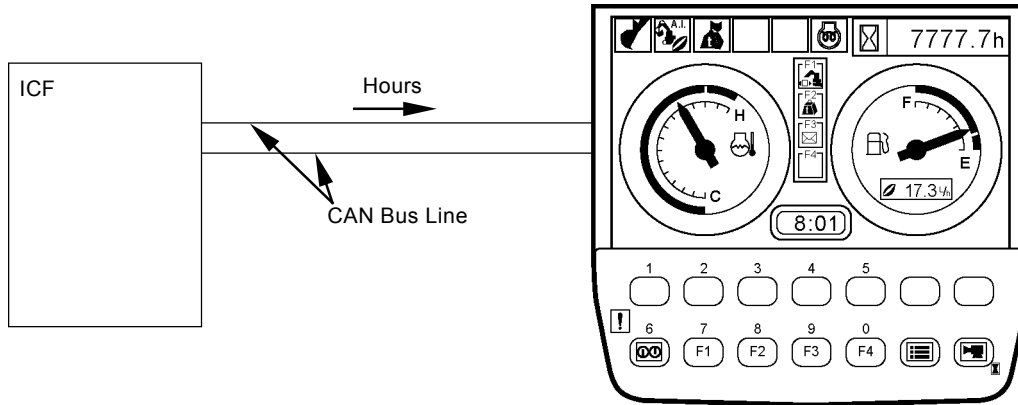
T1V1-05-01-137



Mail Switch Screen

T1V5-05-01-037

SYSTEM / Controller



T1V1-02-01-062


SYSTEM / Controller

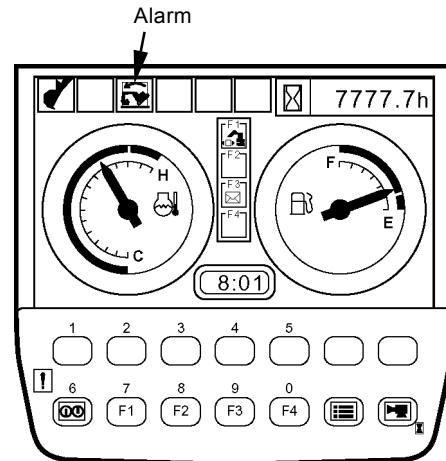
- Overload Alarm
(Only machines equipped with optional parts)

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

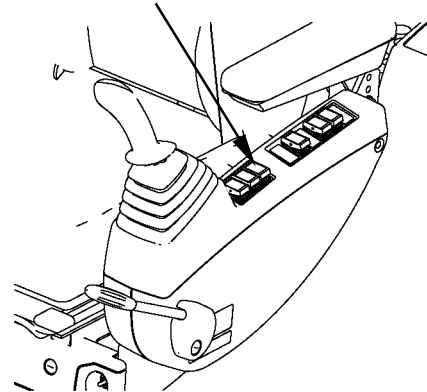
 **NOTE:** Even if the work is done while displaying a screen except the primary screen, when an overload condition is reached, the screen of monitor unit is switched to the primary screen, an alarm message is displayed, and a buzzer is rung. Even after the overload alarm is dissolved, the monitor unit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



Primary Screen

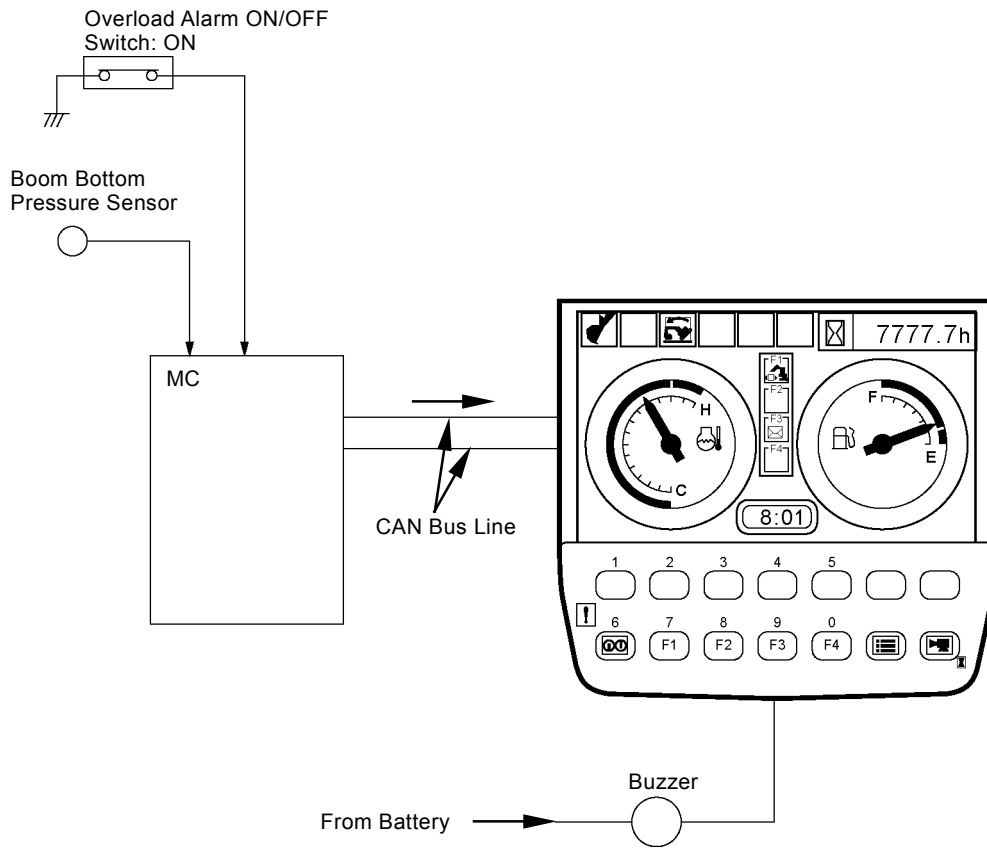
T1V1-05-01-128

Overload Alarm ON/OFF Switch
(Optional)



T1V1-05-02-004

SYSTEM / Controller



T1V1-02-01-057

SYSTEM / Controller

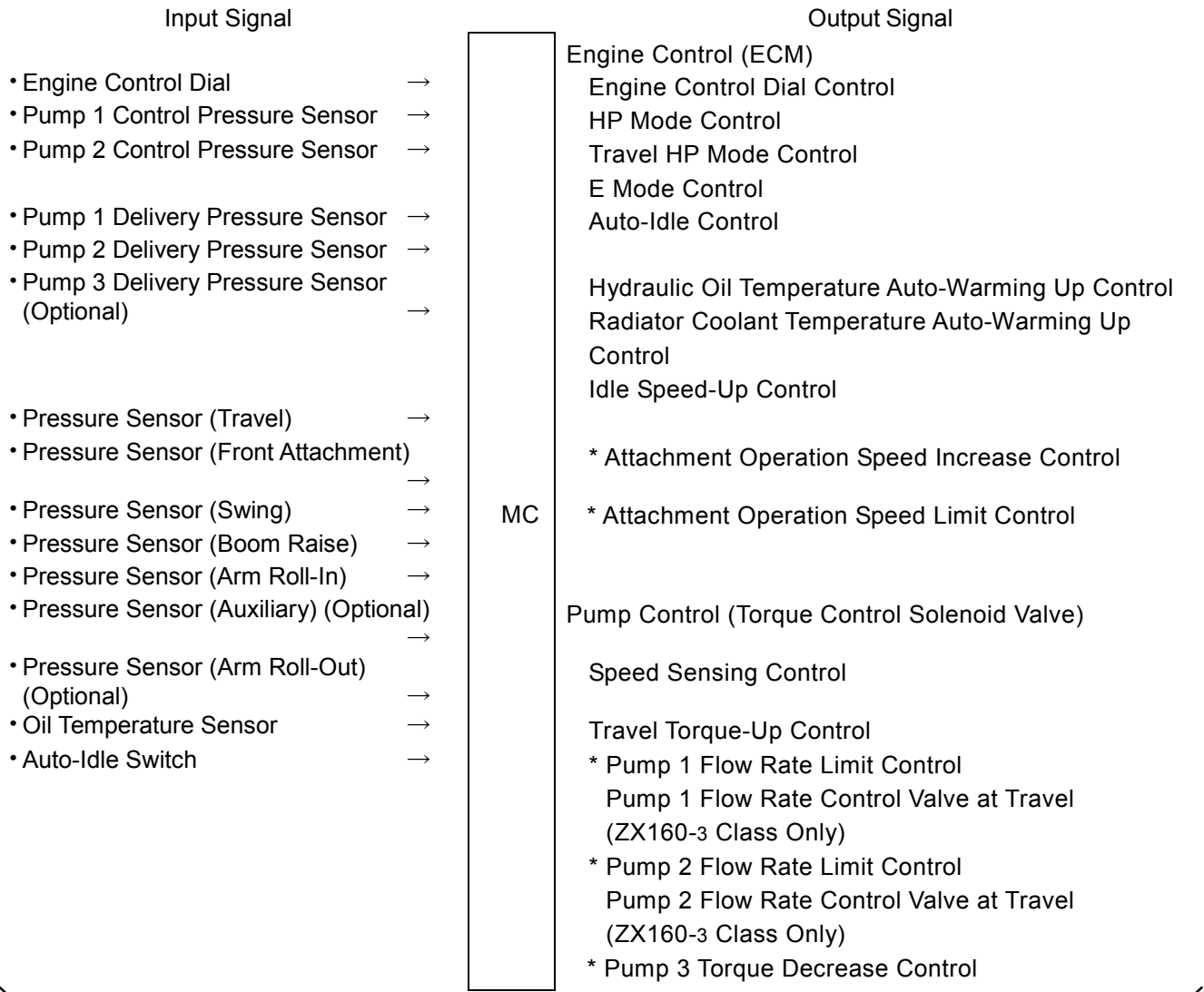
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SYSTEM / Control System

OUTLINE

MC (Main Controller) is used to control the machine operations. The signals from engine control dial, various sensors and switches are sent to MC and processed in the logic circuit.

MC sends the signals equivalent to the target engine speed to ECM (Engine Control Module) by using CAN communication in order to control the engine. (Refer to ECM System/ SYSTEM.) MC drives the solenoid valve unit and torque control solenoid valve in order to control the pump and valve.

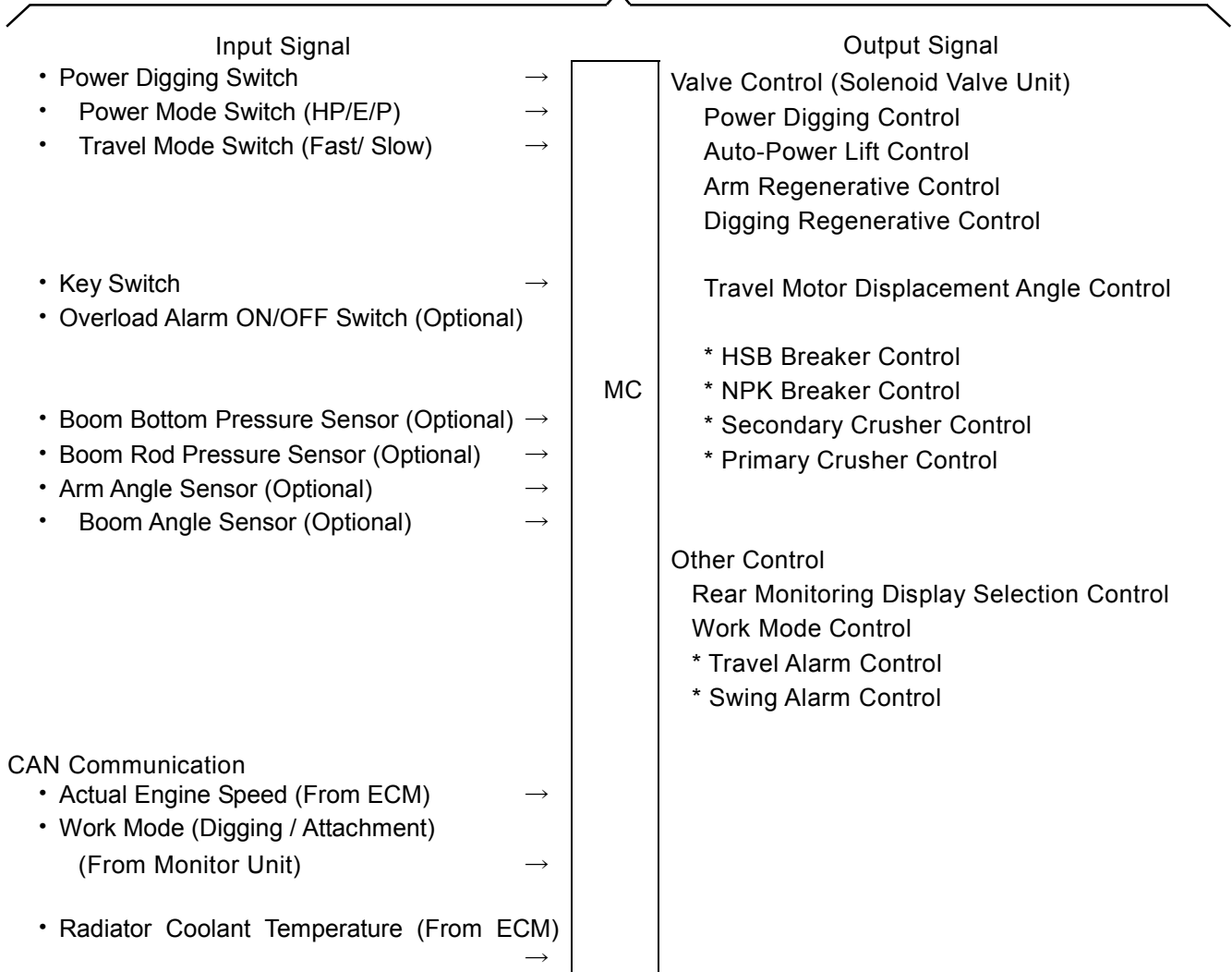


Continued to T2-2-2

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

SYSTEM / Control System

Continued from T2-2-1



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

SYSTEM / Control System

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SYSTEM / Control System

ENGINE CONTROL

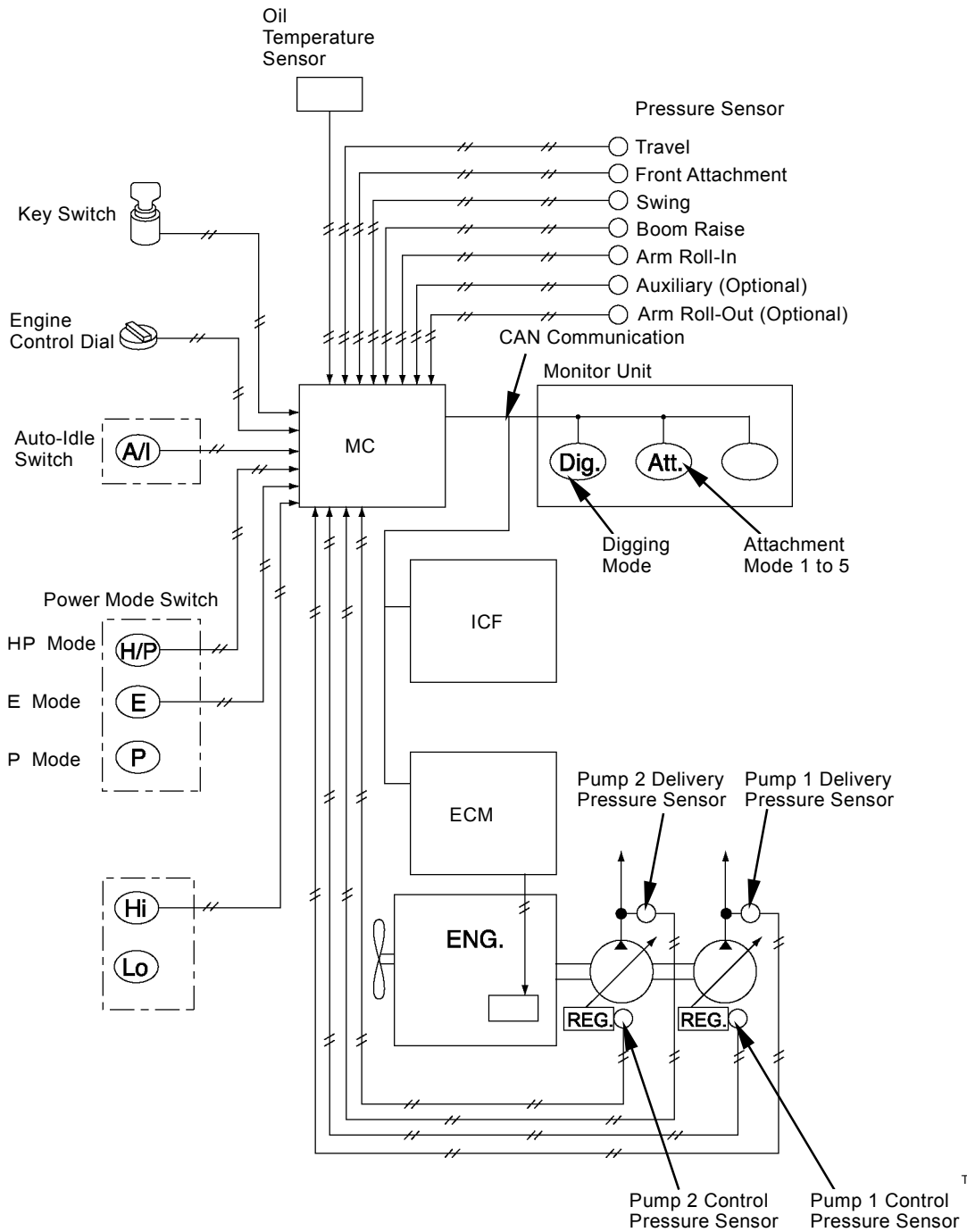
The engine control consists of the following functions.

- Engine Control Dial Control
- HP Mode Control
- Travel HP Mode Control
- E Mode Control
- Auto-Idle Control
- Hydraulic Oil Temperature Auto-Warming Up Control
- Radiator Coolant Temperature Auto-Warming Up Control
- Idle Speed-Up Control
- * Attachment Operation Speed Increase Control
- * Attachment Operation Speed Limit Control

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

SYSTEM / Control System

Engine Control System Layout



T1V1-02-01-002


SYSTEM / Control System

Engine Control Dial Control

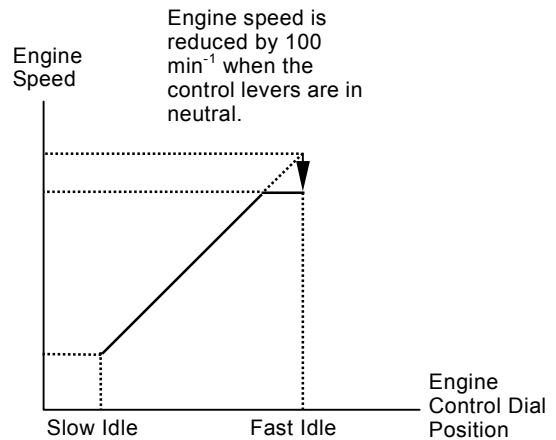
Purpose: Controls the engine speed according to the rotation angle of engine control dial.
Reduces the engine speed by 100 min^{-1} in order to reduce fuel consumption and noise level when all the control levers are in neutral.

Operation:

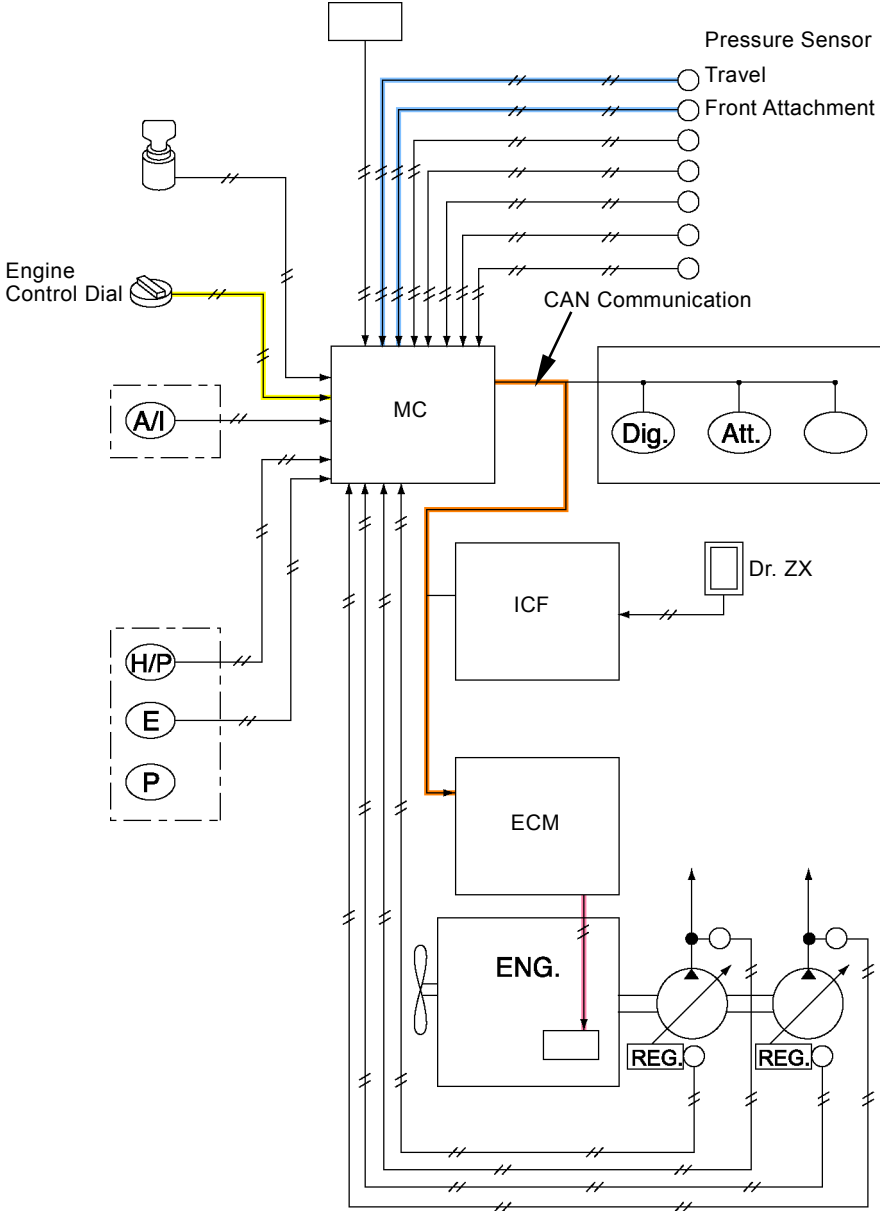
1. MC sends the signals equivalent to target engine speed to ECM by using CAN communication according to rotation angle of the engine control dial.
2. ECM controls the engine speed according to CAN communication.
3. When the engine control dial is in the fast idle speed position and all the control levers are turned to the neutral position (pressure sensors (travel, 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).

 **NOTE:** The engine speed is reduced from the fast idle speed (P mode engine speed) by 100 min^{-1} . For example, 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. EX.

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



SYSTEM / Control System



T1V1-02-01-005

SYSTEM / Control System

HP Mode Control


Purpose: Slightly increases digging power such as arm roll-in operation while excavating deeply.

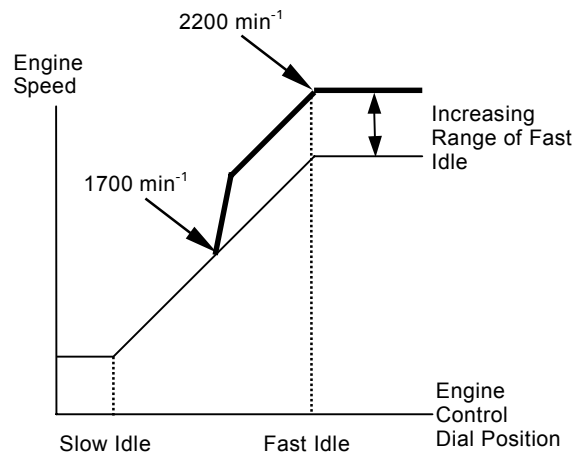
Operation:

1. When the power mode switch is in the HP mode position and all the following conditions exist, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication.
2. ECM slightly increases the engine speed set by the engine control dial in order to increase engine power.

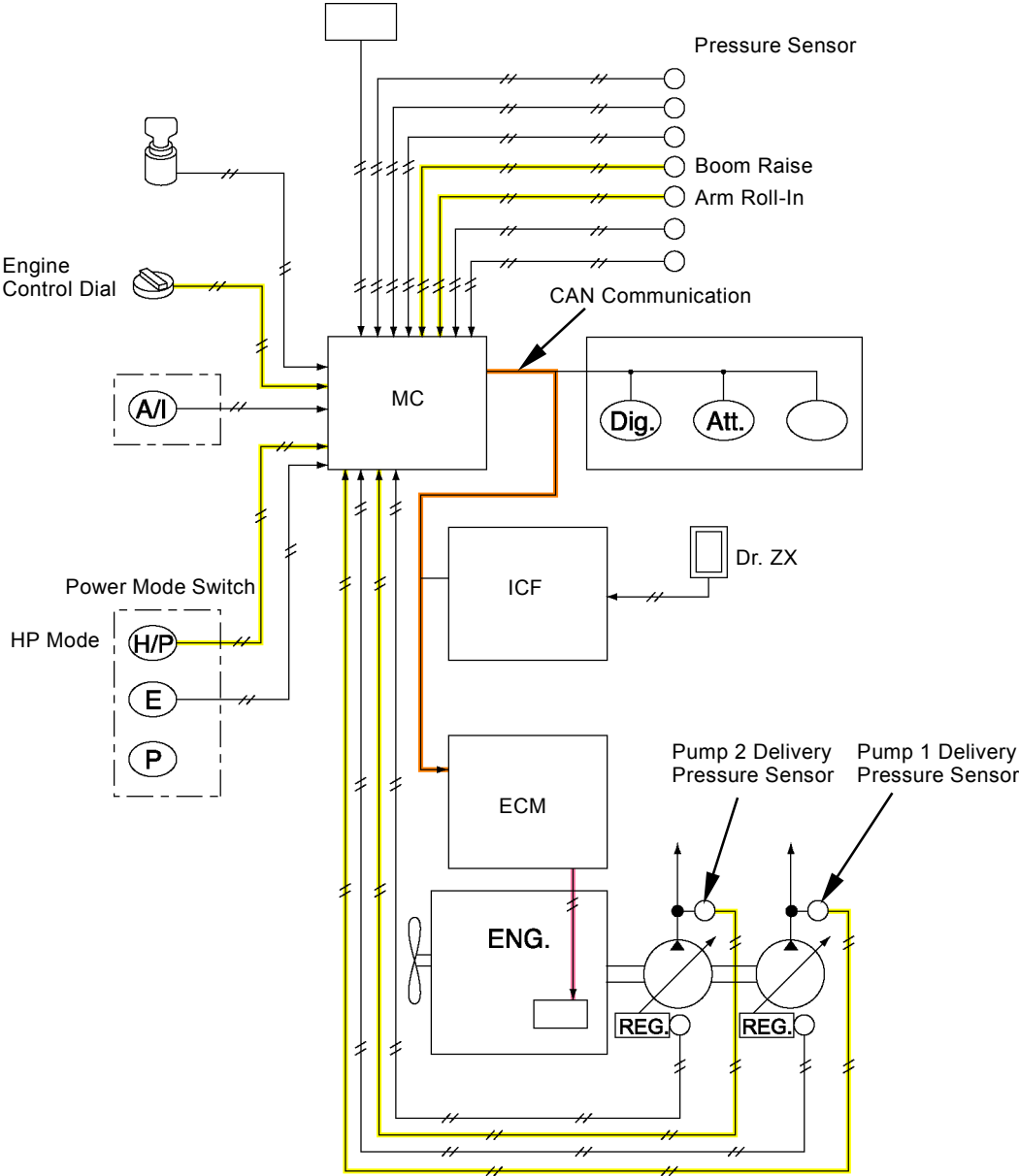
Condition:

- Engine Control Dial: Set at 1700 min^{-1} or faster.
- Boom Raise or Arm Roll-In Operation: Operated
- Average Delivery Pressure of Pumps 1 and 2: High
(Reference: 25 MPa, (255 kgf/cm², 3635 psi))

 **NOTE:** HP control can be made operable or inoperable by Dr. ZX. Although the key is turned OFF, the setting is kept.



SYSTEM / Control System



T1V1-02-01-006

SYSTEM / Control System

Travel HP Mode Control

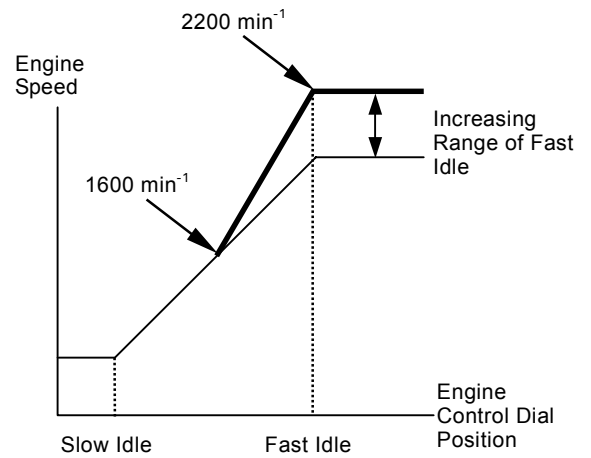
Purpose: Increases the engine speed and travels faster during travel single operation.

Operation:

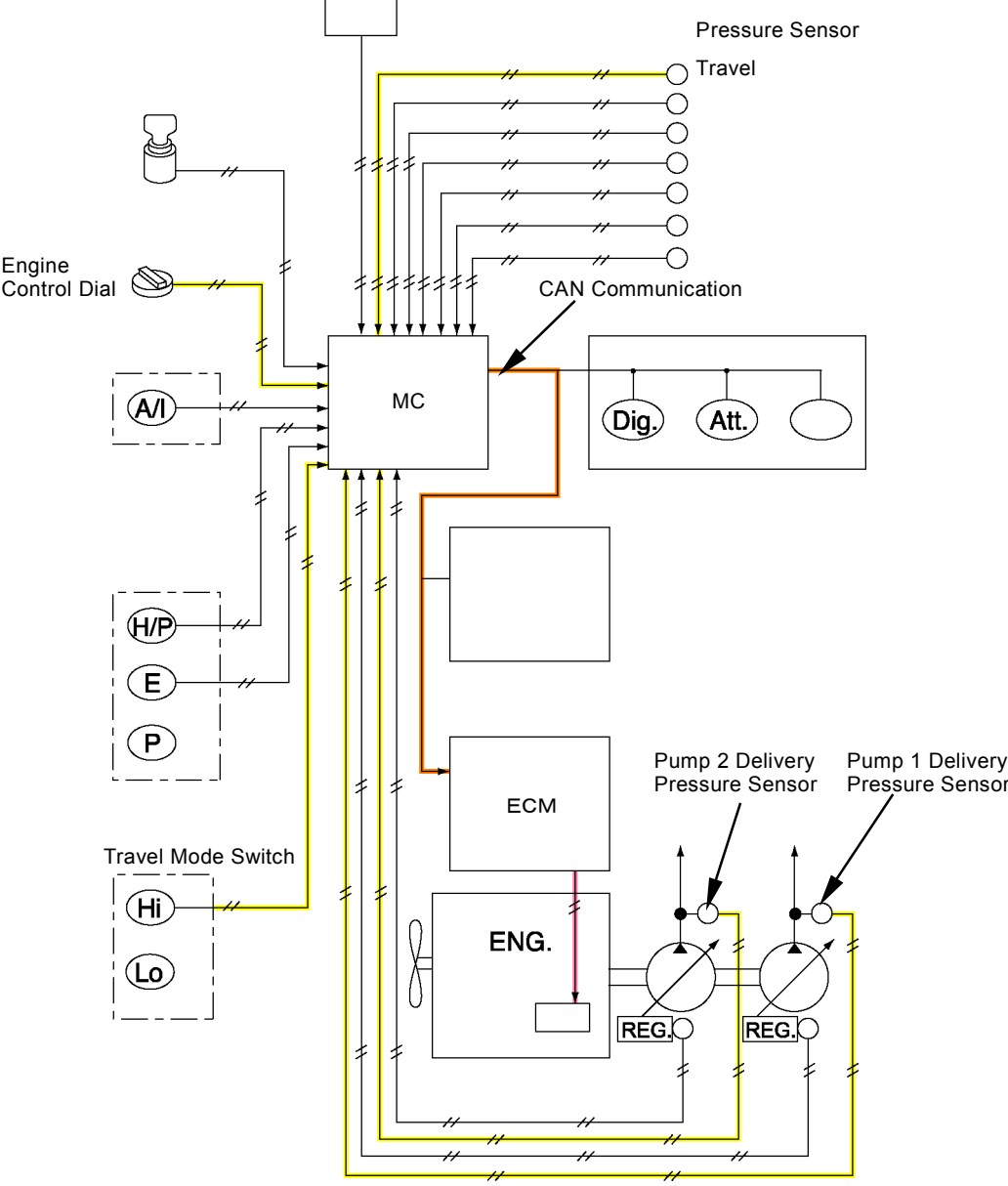
1. When the travel mode switch is in fast idle and all the following conditions exist, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication.
2. ECM increases the engine speed by 200 min^{-1} from the speed set by the engine control dial and travels faster.

Condition:

1. Engine Control Dial: Set the engine speed in the fast idle speed position.
2. Travel Operation: Operated



SYSTEM / Control System



T1V1-02-01-014

SYSTEM / Control System

E Mode Control

Purpose: Reduces the engine speed set by the engine control dial according to the pump control pressure 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 1850 min^{-1} or faster 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 150 min^{-1} .

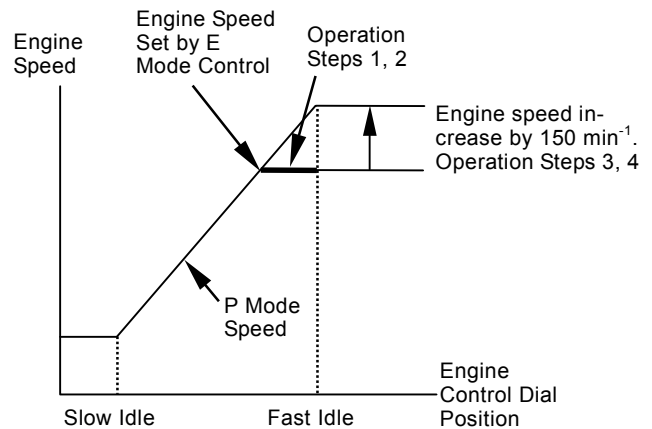
Condition:

- 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))

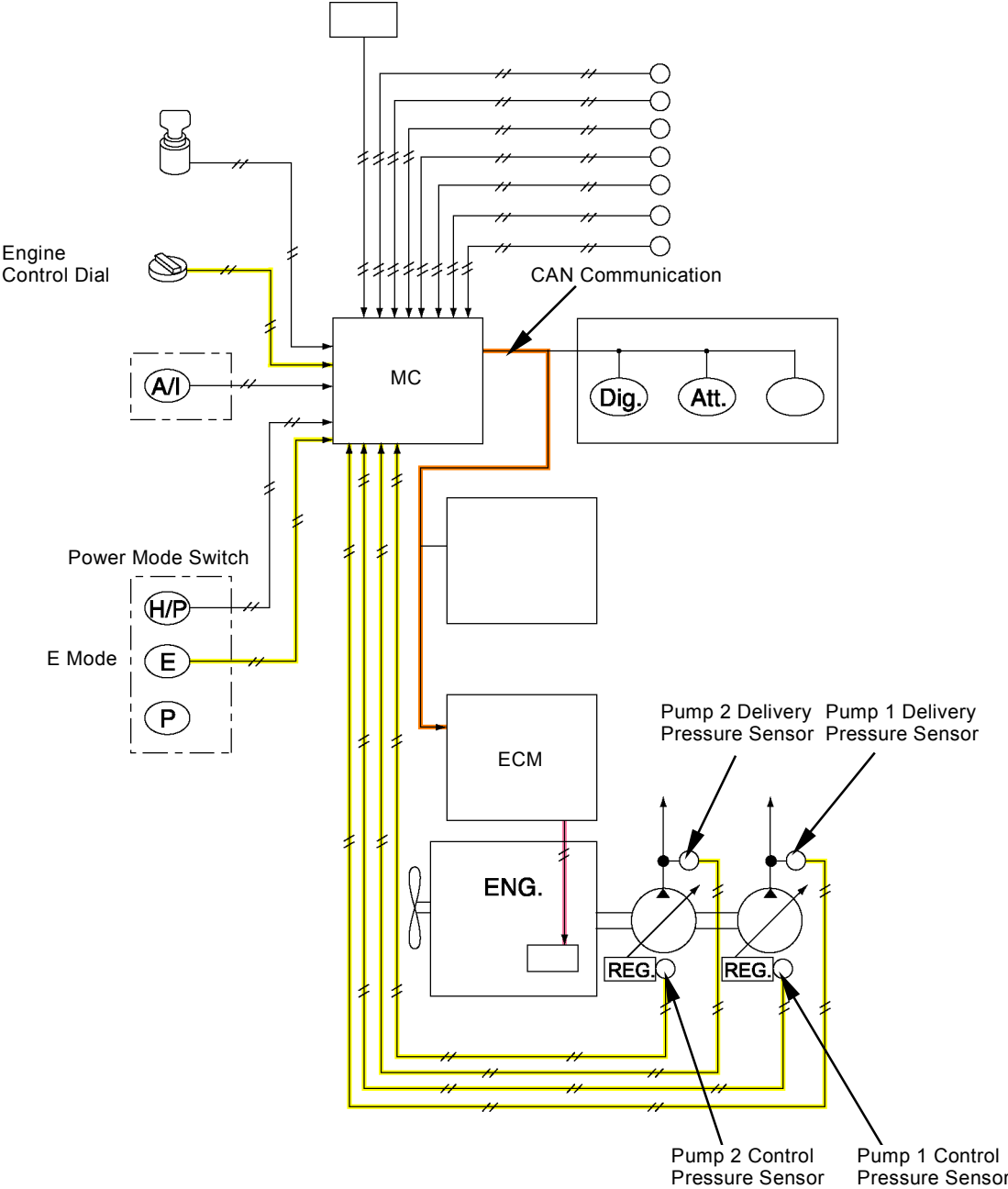
Control Pressure of Pump 1 or 2: Low of either (Reference: 3 MPa (31 kgf/cm^2 , 436 psi) or less) and Average Pump Delivery Pressure: Low (Reference: Less than 9.8 MPa (100 kgf/cm^2 , 1425 psi))

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: 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))



SYSTEM / Control System



T1V1-02-01-007

SYSTEM / Control System

Auto-Idle Control

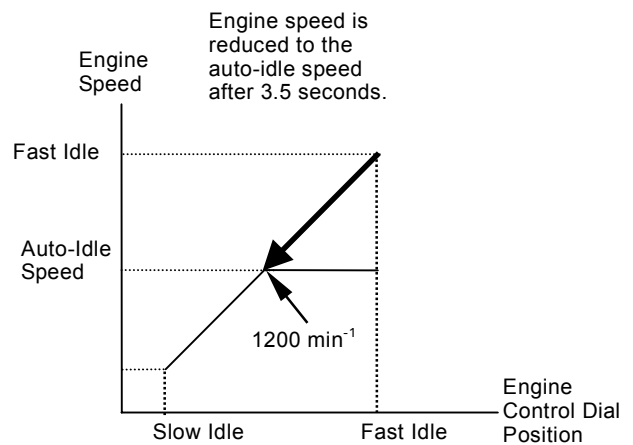
Purpose: Reduces the engine speed when all the control levers are in neutral in order to reduce fuel consumption and noise level.


Operation:

1. Approx. 3.5 seconds after the control lever is turned to neutral with the auto-idle switch ON, MC sends the signals equivalent to the auto-idle speed to ECM by using CAN communication.
2. ECM changes the engine speed into the auto-idle speed.
3. As soon as either control lever is moved (pressure sensors (travel, front attachment): ON), MC returns the signals sending to ECM into those equivalent to the target engine speed set by the engine control dial.
4. ECM returns the engine speed into the original engine speed.

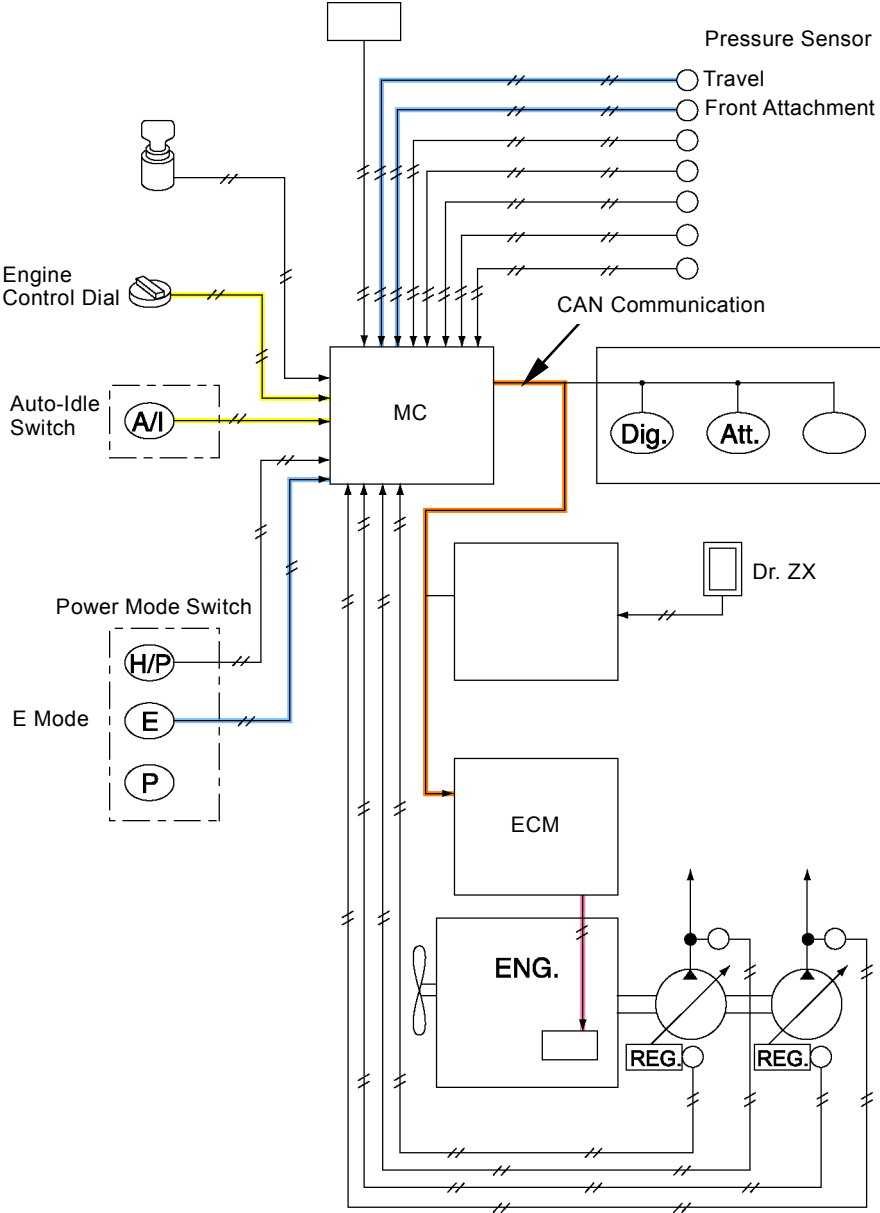
Auto-Idle Deactivation Requirements:

- Control Lever: Operated (pressure sensor (travel or front attachment): ON)
- Power Mode Switch: When the E mode is changed to P mode or P mode is changed to E mode
- Engine Control Dial: When the engine speed is changed



 NOTE: Auto-idle speed can be adjusted by Dr. ZX.

SYSTEM / Control System



T1V1-02-01-008

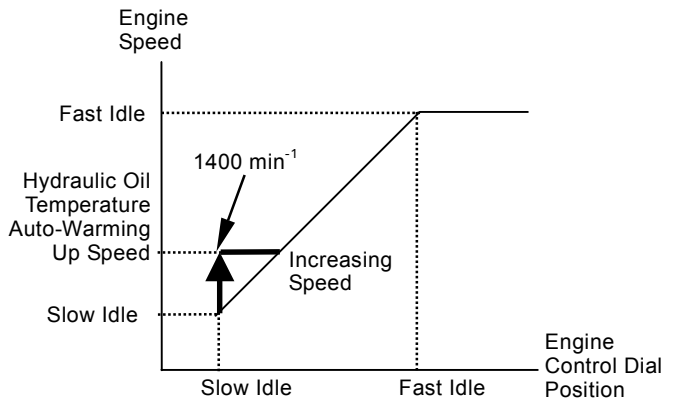
SYSTEM / Control System

Hydraulic Oil Temperature Auto-Warming Up Control

Purpose: Automatically warms up the hydraulic system.
(similar to the auto choke on automobiles)

Operation:

1. For 12 minutes after the engine starts or when hydraulic oil temperature is below 0 °C, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication according to the signals from key switch and hydraulic oil temperature sensor.
2. ECM increases the engine speed to the hydraulic oil temperature auto-warming up speed.



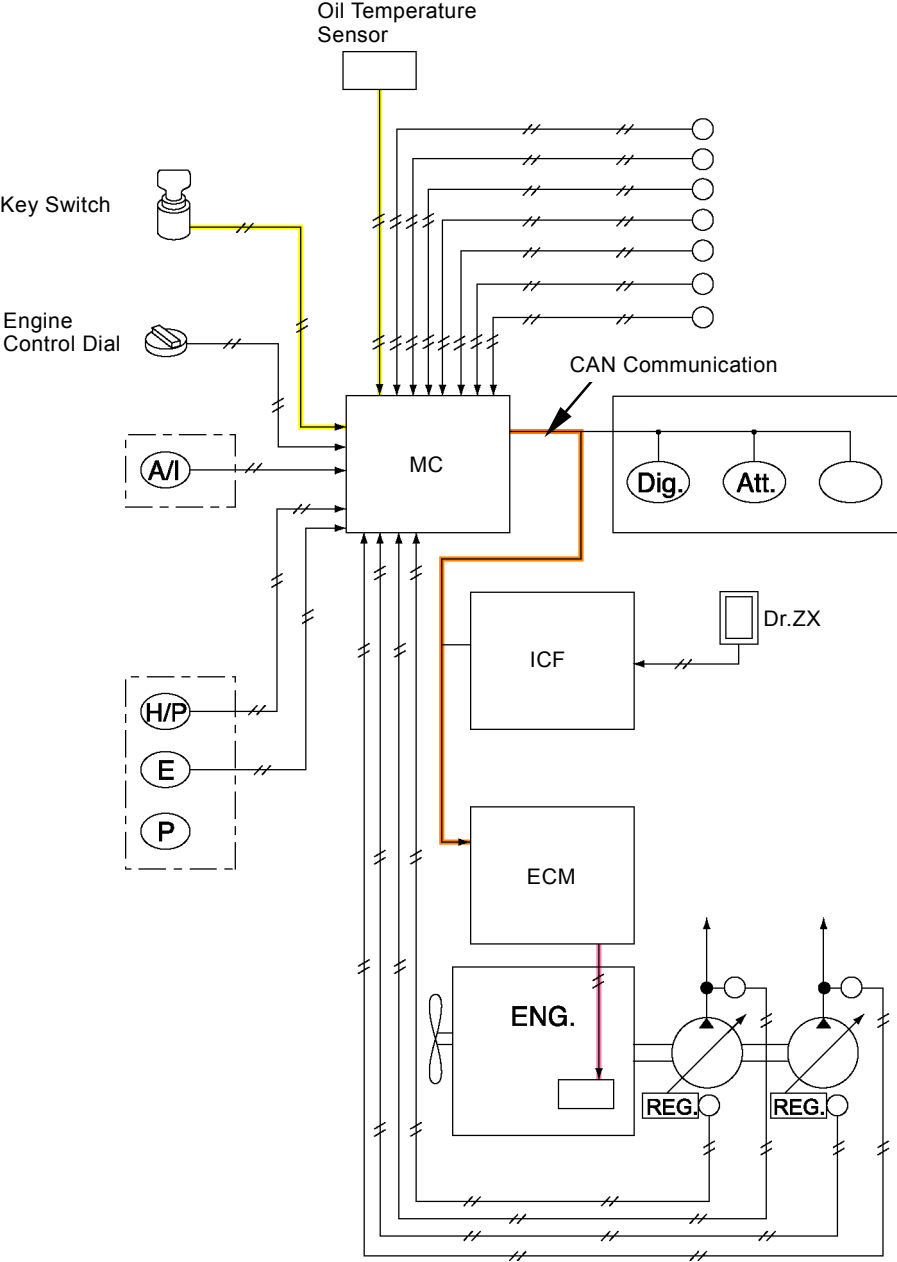
IMPORTANT: MC selects the higher target engine speed control; hydraulic oil temperature auto-warming up control or radiator coolant temperature auto-warming up control. MC sends the signal to ECM by using CAN communication.

IMPORTANT: When adjusting the auto-idle speed, deactivate the hydraulic oil temperature auto-warming up control by using Dr. ZX. Wait for adjustment until hydraulic oil temperature becomes beyond 2 °C and radiator coolant temperature becomes beyond 50 °C after the engine is completely warmed up.

The hydraulic oil temperature auto-warming up control can be deactivated temporarily by Dr. ZX. Once the key is turned OFF, the hydraulic oil temperature auto-warming up control is effective again.

IMPORTANT: Hydraulic oil temperature auto-warming up speed can be adjusted by Dr. ZX.

SYSTEM / Control System



T1V1-02-01-009

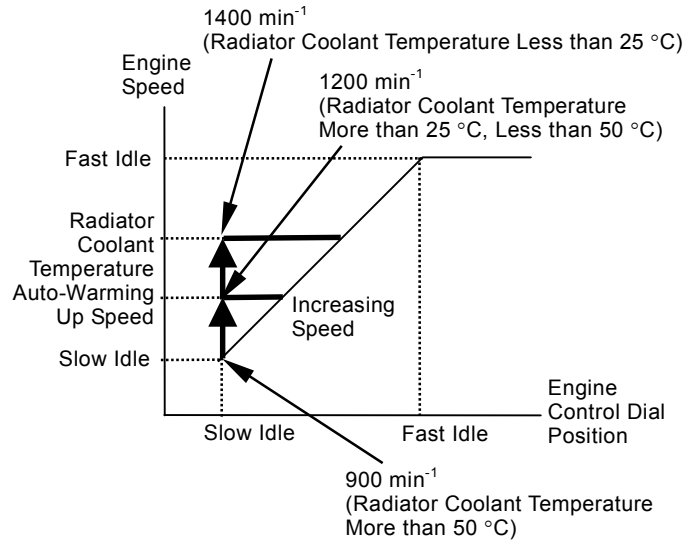
SYSTEM / Control System

Radiator Coolant Temperature Auto-Warming Up Control

Purpose: Automatically warms up the engine.

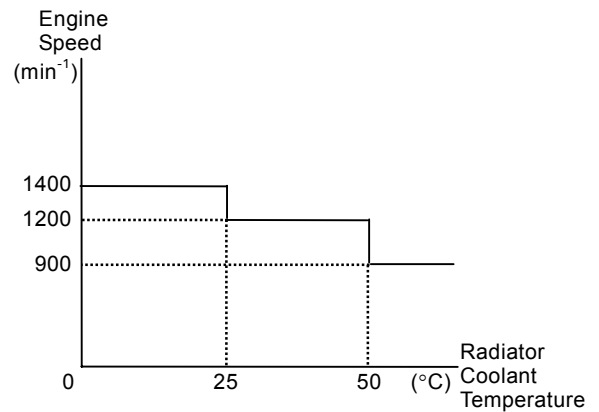
Operation:

1. After the engine starts, ECM send the signals equivalent to radiator coolant temperature to MC.
2. MC sends the signals equivalent to target engine speed to ECM by using CAN communication according to the CAN signal of radiator coolant temperature from ECM.
3. ECM increases the engine speed to the radiator coolant temperature auto-warming up speed.



IMPORTANT: MC selects the higher target engine speed control; hydraulic oil temperature auto-warming up control or radiator coolant temperature auto-warming up control. MC sends the signal to ECM by using CAN communication.

IMPORTANT: The radiator coolant temperature auto-warming up speed is changed due to radiator coolant temperature. Although the engine is set at slow idle speed with radiator coolant temperature beyond 50 °C and when radiator coolant temperature decreases, the engine speed increases again.

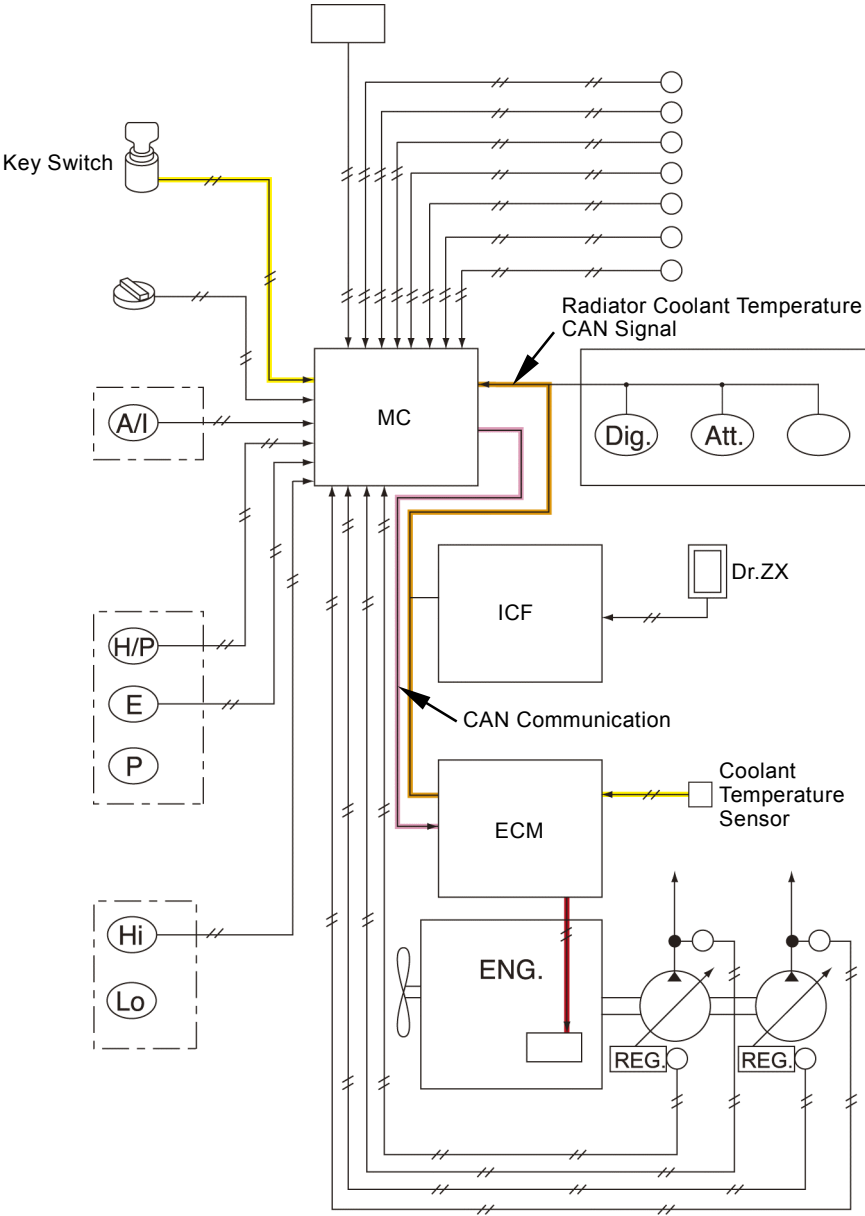


IMPORTANT: The radiator coolant temperature auto-warming up control can be deactivated temporarily by Dr.ZX.

When the radiator coolant temperature auto-warming up control is deactivated, contact with the service manager.

When the hydraulic oil temperature auto-warming up control is deactivated temporarily, the radiator coolant temperature auto-warming up control is deactivated at the same time. Once the key switch is turned OFF, the hydraulic oil temperature auto-warming up control and the radiator coolant temperature auto-warming up control are operable again.

SYSTEM / Control System



T1T1-02-02-002

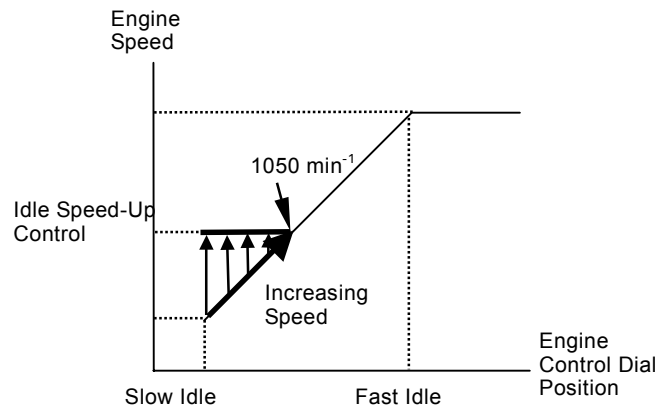
SYSTEM / Control System

Idle Speed-Up Control

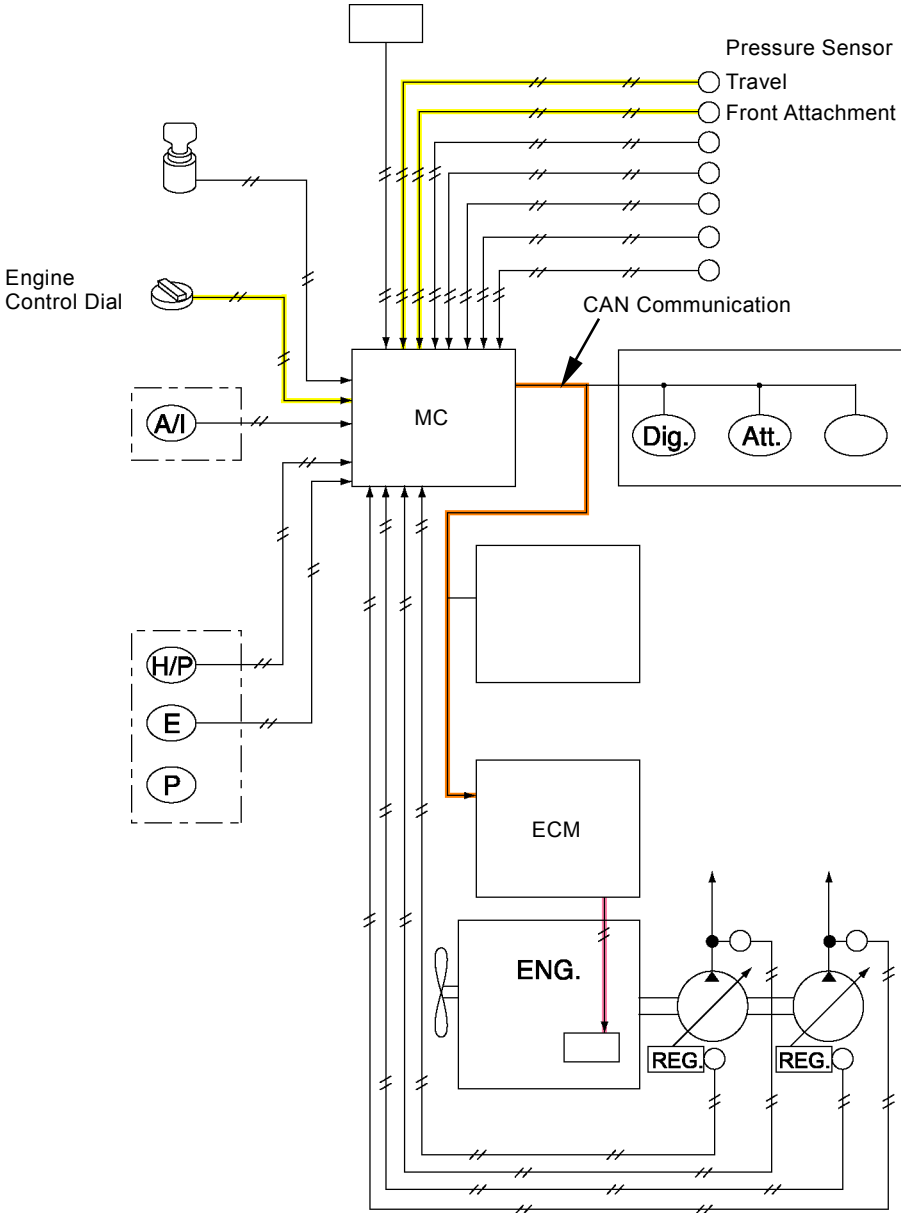
Purpose: Prevents the engine from hunting when the engine runs at slow speed.

Operation:

1. When the travel or front attachment is operated while the engine is running at a speed between slow idle and idle speed-up speed, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication.
2. ECM increases the engine speed to the idle speed-up speed.



SYSTEM / Control System



T1V1-02-01-010

SYSTEM / Control System

Attachment Operation Speed Increase Control (Only Machine Equipped with Attachment Parts)

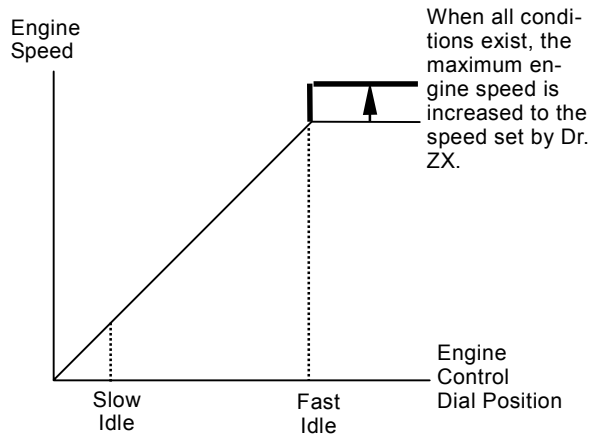
Purpose: Increases the maximum engine speed to the attachment (hydraulic breaker, secondary crusher, primary crusher or vibrating hammer) operating engine speed set by Dr. ZX when the attachment is operated.


Operation:

1. When the following conditions exist and the attachment is operated, MC sends the signals equivalent to the target engine speed set by Dr. ZX to ECM by using CAN communication.
2. ECM increases engine speed to the attachment operating speed set by Dr. ZX.

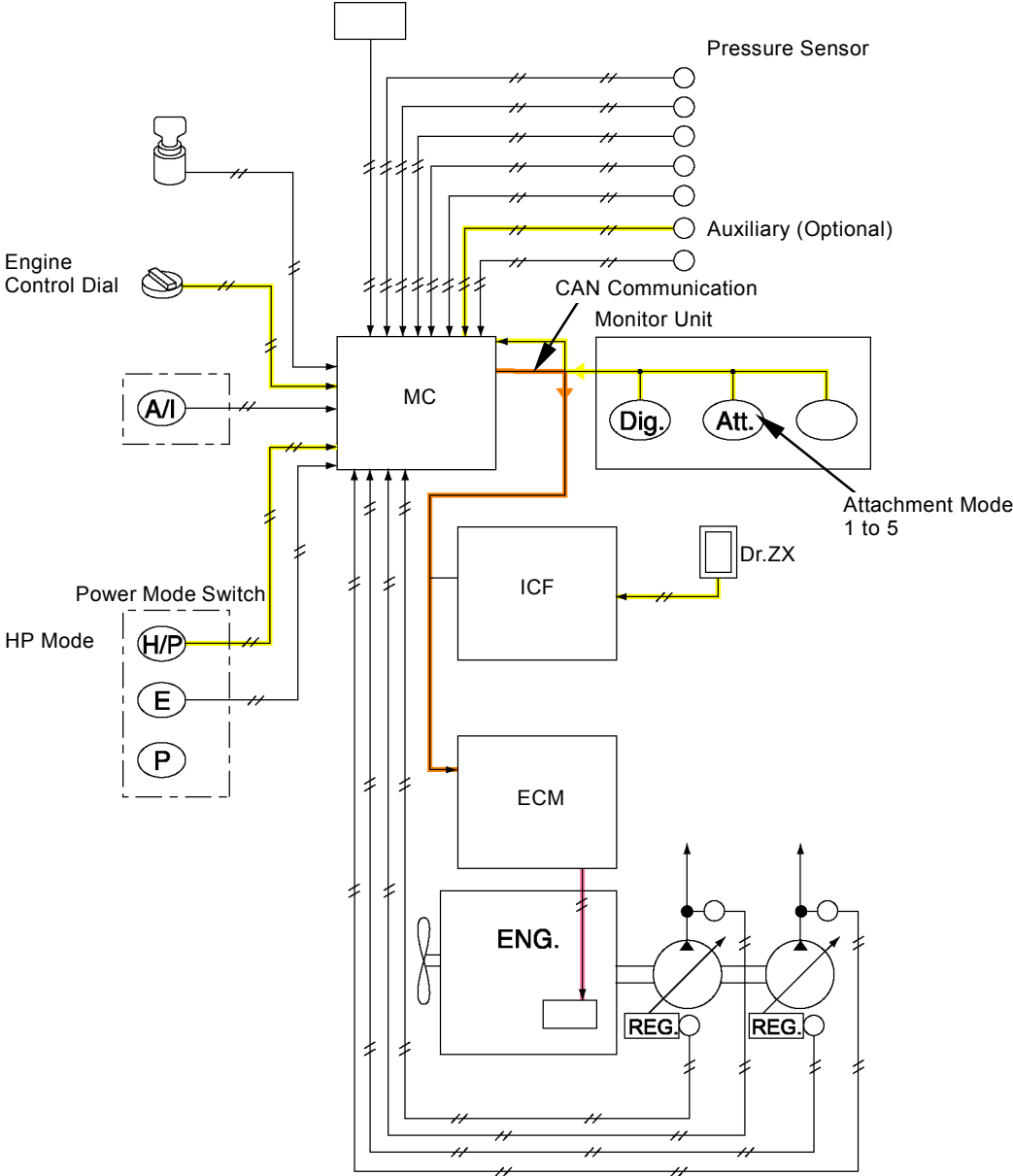
Conditions:

- Dr. ZX: Resets the maximum engine speed to a faster (+) attachment (hydraulic breaker, secondary crusher, primary crusher or vibrating hammer) operating speed in the service mode.
- Engine Control Dial: Fast Idle Speed Position
- Power Mode Switch: HP Mode
- Auxiliary: Operated
- Work Mode: Attachment selected by using the attachment mode monitor unit is set (+) by Dr. ZX.



 **NOTE:** When P mode engine speed is preset to a slower speed in Dr. ZX service mode, the maximum engine speed will not be increased when operating the attachment.

SYSTEM / Control System



T1V1-02-01-011

SYSTEM / Control System

Attachment Operation Speed Limit Control (Only Machine Equipped with Attachment Parts)

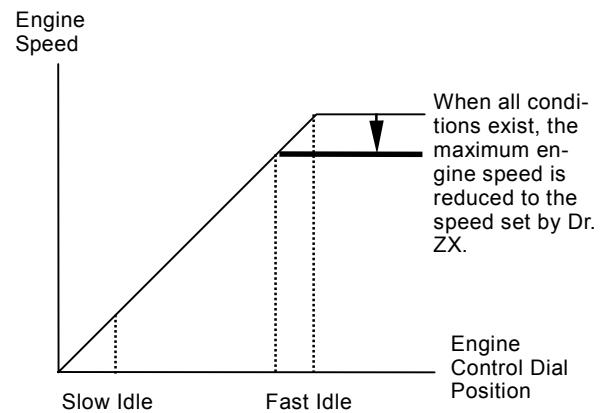
Purpose: Decreases the maximum engine speed to the attachment (hydraulic breaker, secondary crusher, primary crusher or vibrating hammer) operating engine speed set by Dr. ZX when the attachment mode is selected.

Operation:

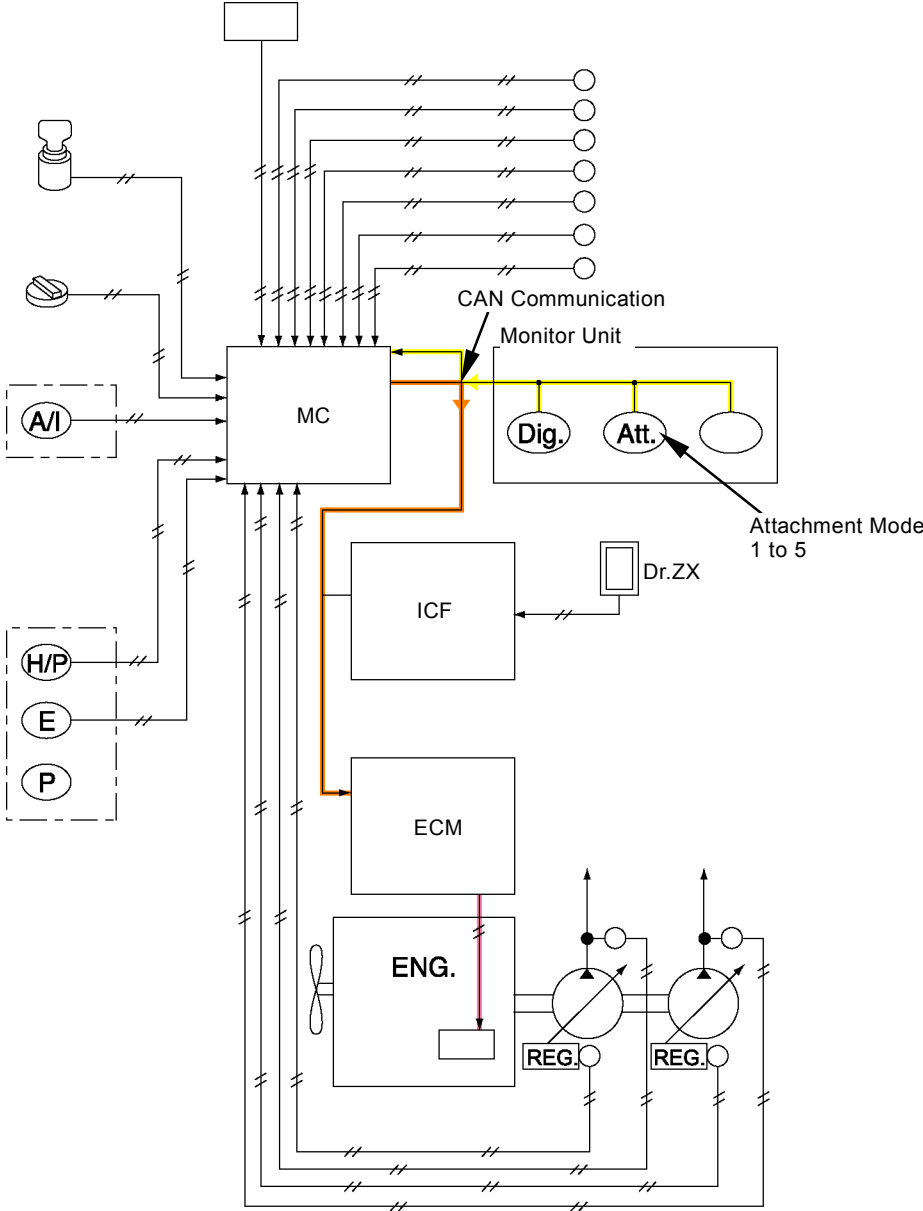
1. When the following conditions exist and the attachment is operated, MC sends the signals equivalent to the target engine speed set by Dr. ZX to ECM by using CAN communication.
2. ECM increases engine speed to the attachment operating speed set by Dr. ZX.

Conditions:

- Dr. ZX: Resets the maximum engine speed to a slower (–) attachment (hydraulic breaker, secondary crusher, primary crusher or vibrating hammer) operating speed in the service mode.
- Work Mode: Attachment Mode
- Auxiliary Mode: Attachment mode Attachment selected by using the monitor unit is set (–) by Dr. ZX



SYSTEM / Control System




T1V1-02-01-012

SYSTEM / Control System

PUMP CONTROL

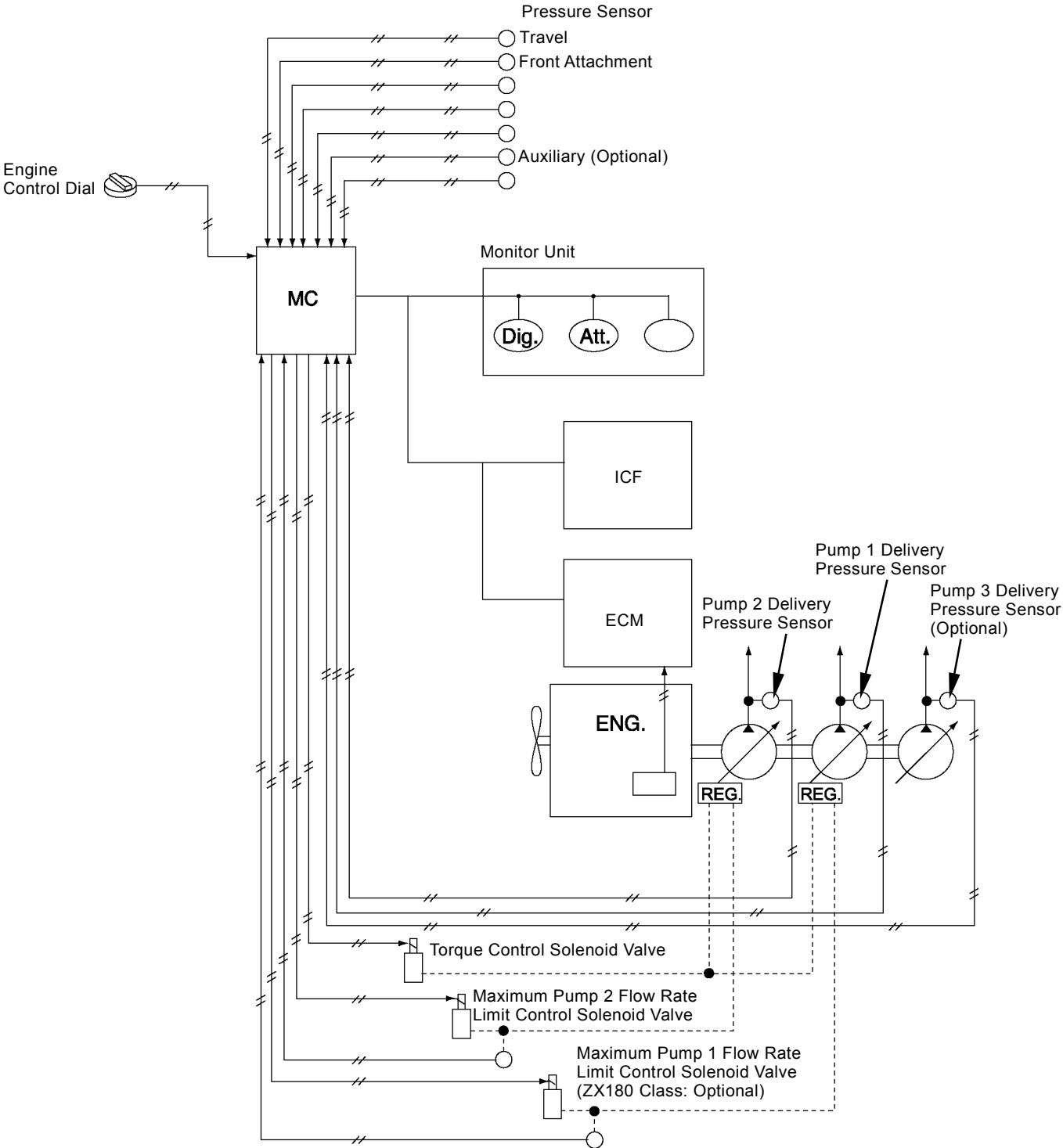
The pump control system has the following functions:

- Speed Sensing Control
- Travel Torque-Up Control
- *Pump 1 Flow Rate Control Valve at Travel
Pump 1 Flow Rate Control Valve at Travel
(ZX160-3 Class Only)
- *Pump 2 Flow Rate Control
Pump 2 Flow Rate Control Valve at Travel
(ZX160-3 Class Only)
- *Pump 3 Torque Decrease Control

 **NOTE:** **Only the machine equipped with the optional parts.*

SYSTEM / Control System

Pump Control System Layout



T1V1-02-01-003

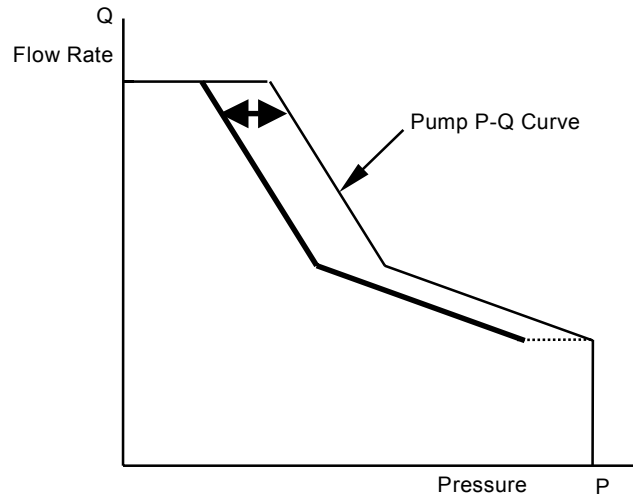
SYSTEM / Control System

Speed Sensing Control

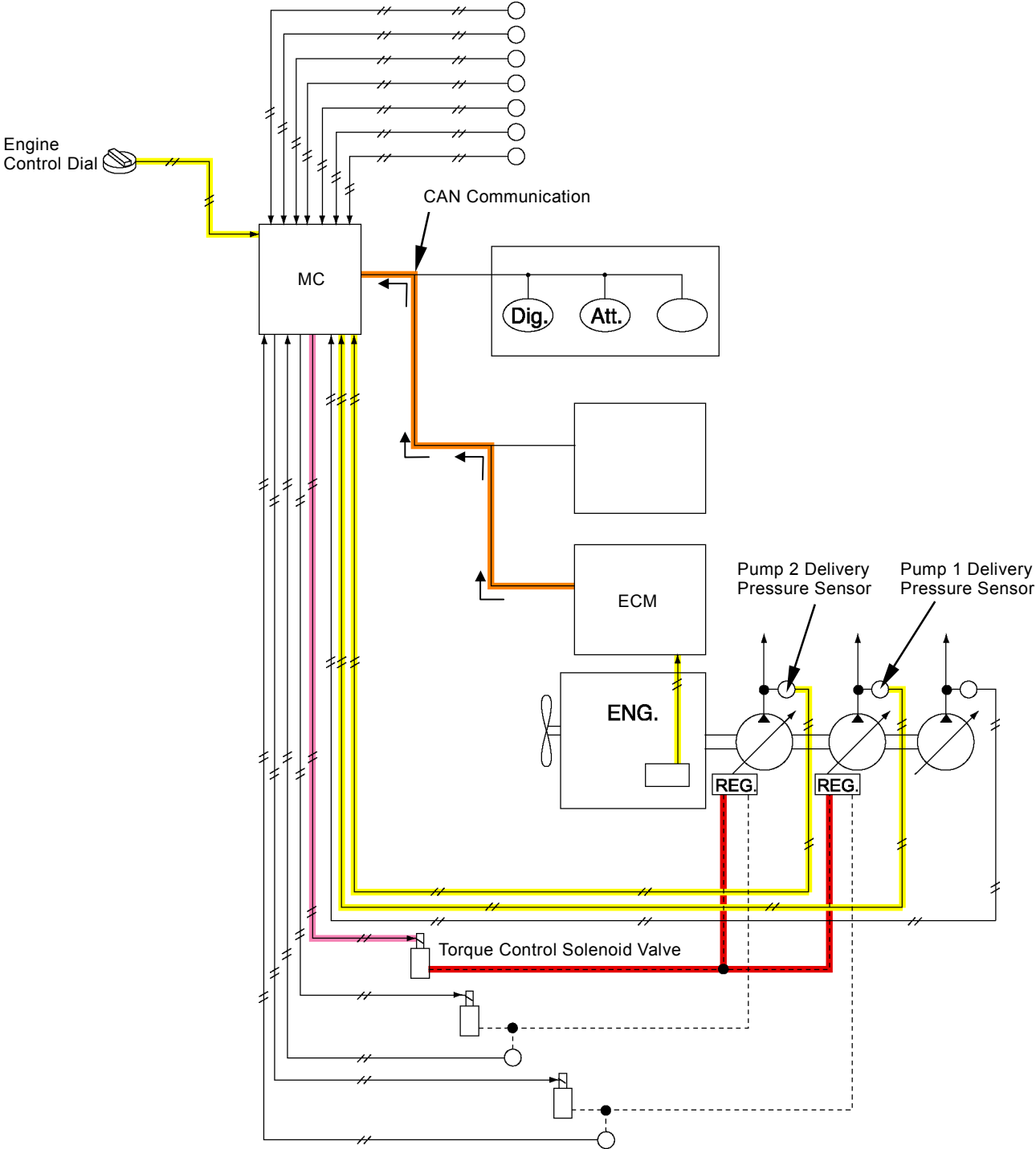
Purpose: Controls the pump delivery flow rate in response to engine speed changes due to variations in load so that the engine output power can be utilized more efficiently. Engine stall is prevented when the machine operates under adverse conditions such as operating at high altitude.

Operation:

1. The target engine operating speed is set by controlling the engine control dial.
2. MC calculates the difference in speed between the target engine speed and the actual engine speed monitored by CAN communication from ECM. Then, MC sends the signals to the torque control solenoid valve.
3. The torque control solenoid valve delivers pilot pressure in response to the received signals to the pump regulator and controls the pump delivery flow rate.
4. If the engine load increases and the actual engine speed becomes slower than the target engine speed, the pump swash angle is reduced so that pump flow rate will be reduced. Therefore, the engine load is reduced and engine stall is prevented.
5. If the actual engine speed becomes faster than the target engine speed, the pump swash angle is increased so that pump delivery flow rate will increase. Therefore, the engine output power can be utilized more efficiently.



SYSTEM / Control System



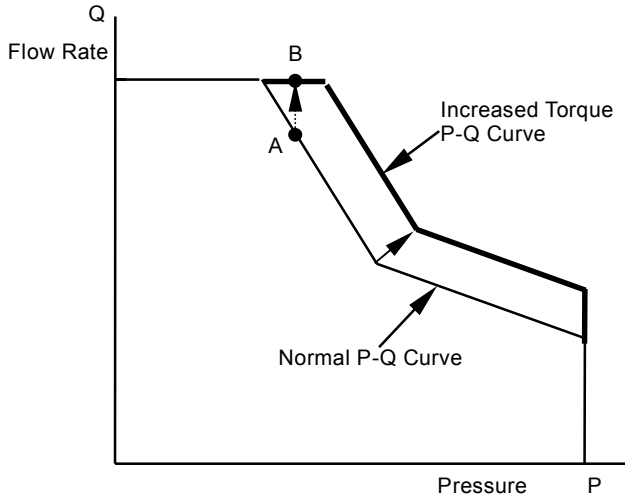
T1V1-02-01-016

SYSTEM / Control System

Travel Torque-Up Control

Purpose: Effectively controls during single travel operation. 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).

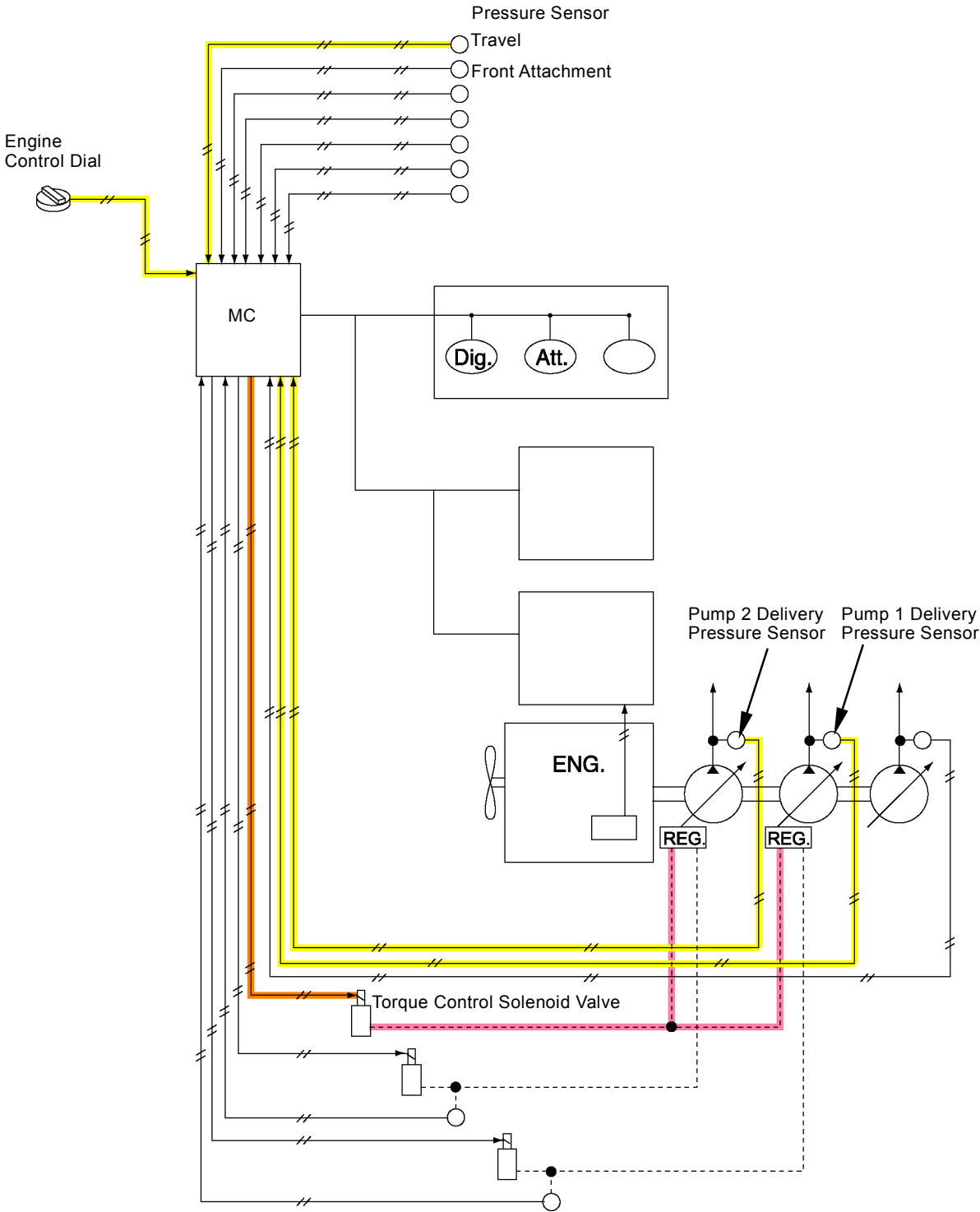
When travel operation is made with the engine running at fast speed, the pump P-Q curve is raised in order to improve travel function.



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 delivery flow rate.

SYSTEM / Control System



T1V1-02-01-018

SYSTEM / Control System


Pump 1 Flow Rate Limit Control (Only Machine Equipped with Attachment)

IMPORTANT: The maximum pump 1 flow rate limit control solenoid valve has come equipped for ZX160-3 class and is optional for ZX180-3 Class.

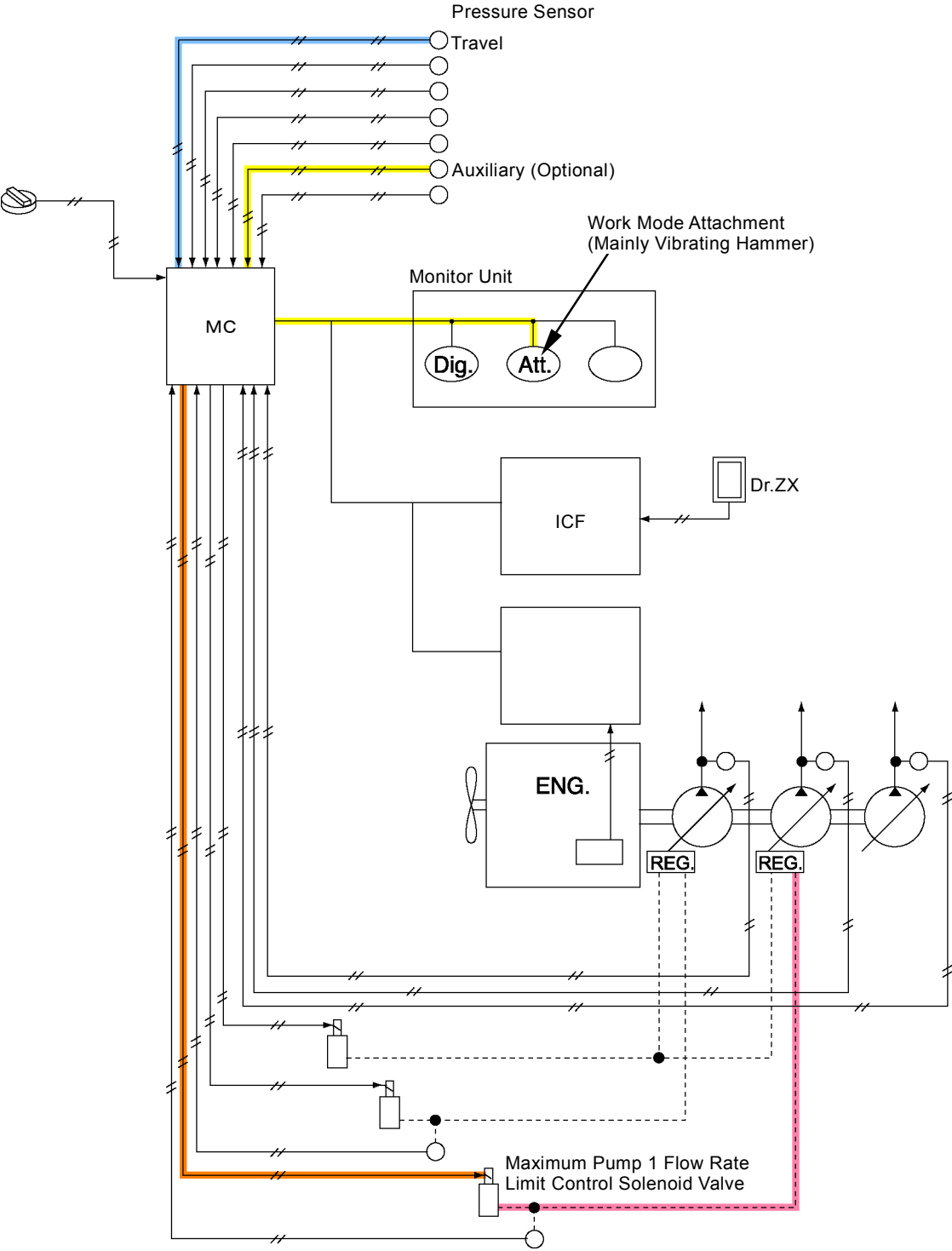
Purpose: Limits pump 1 flow rate in order to make up for pump flow rate for attachment operation when attachment (mainly a vibrating hammer) is used and pump 2 flow rate is lack.

Operation:

1. When the attachment is used with the travel control lever in neutral, MC receives the signals from pressure sensor (auxiliary) (optional).
2. In response to attachment control operation, MC drives the maximum pump 1 flow rate limit control solenoid valve and controls pump 1 flow rate.

 **NOTE:** *The minimum pump swash set-angle on monitor unit for a attachment (hydraulic breaker 1 to 5, secondary crusher 1 to 5, primary crusher 1 to 5 or vibrating hammer 1 to 5) can be set in the service mode of Dr. ZX.*

SYSTEM / Control System



T1V1-02-01-019

SYSTEM / Control System

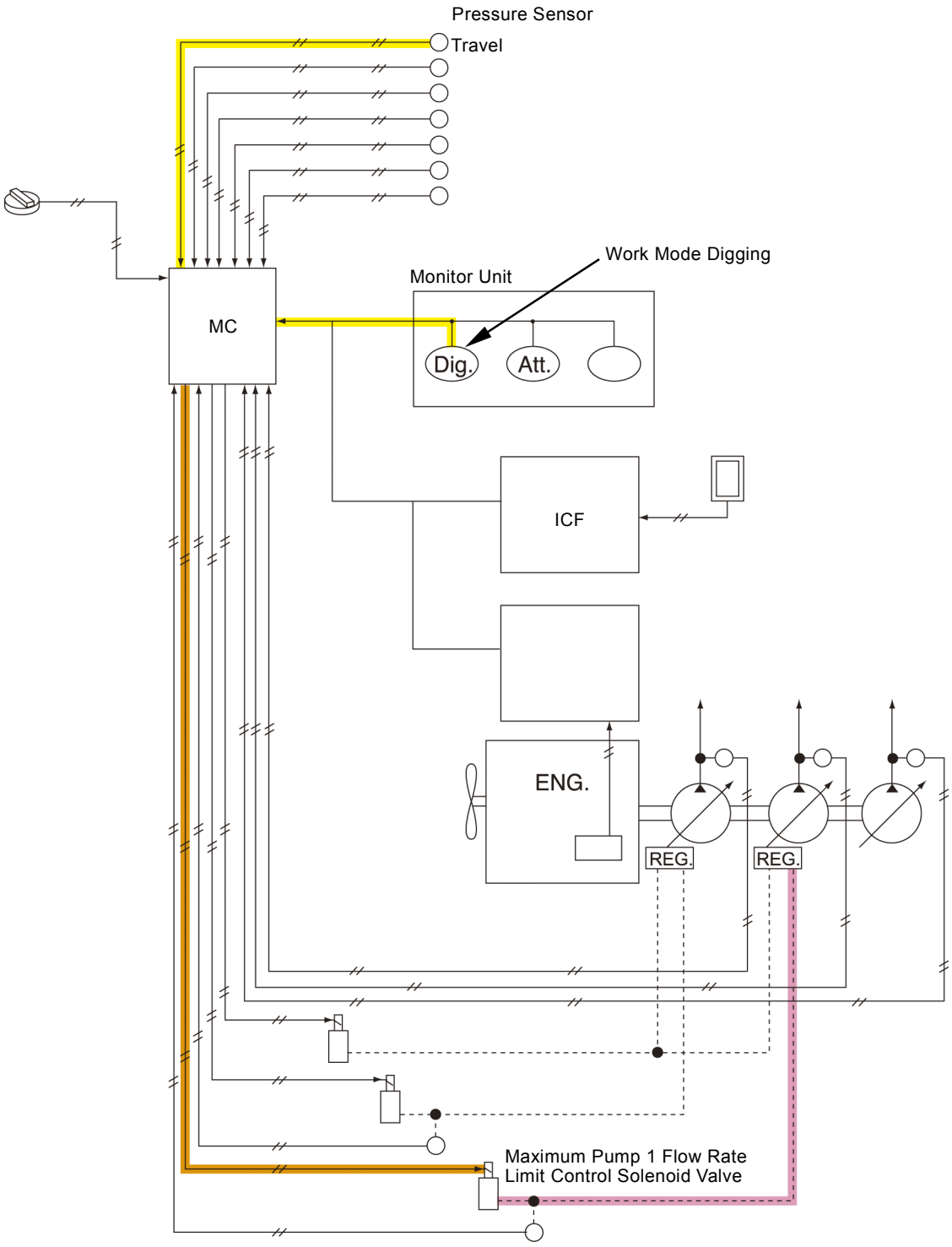
Pump 1 Flow Rate Control Valve at Travel (ZX160-3 Class Only)

Purpose: Control flow rate of pump 1 when traveling.

Operation:

1. When travel is operated during work mode “digging”, MC receives the signal from the pressure sensor (travel)
2. In response to travel control operation, MC drives the maximum pump 1 flow rate limit control solenoid valve and controls pump 1 flow rate.

SYSTEM / Control System



T1T1-02-02-004


SYSTEM / Control System

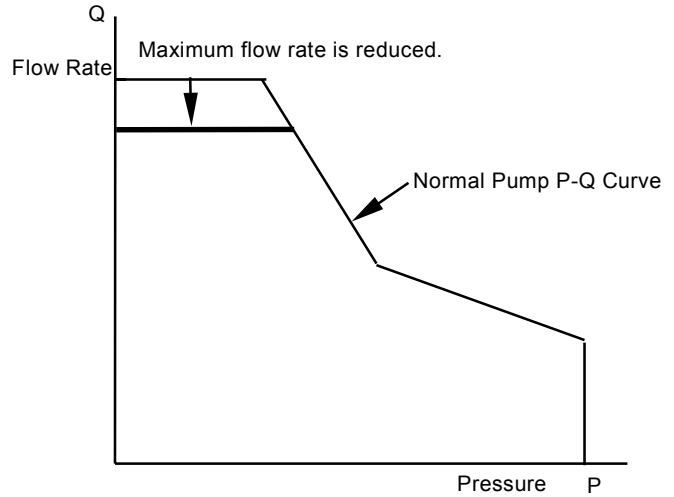
Pump 2 Flow Rate Limit Control (Only Machine Equipped with Attachment)

Purpose: Limits maximum pump 2 flow rate when a attachment (mainly a hydraulic breaker) is used.

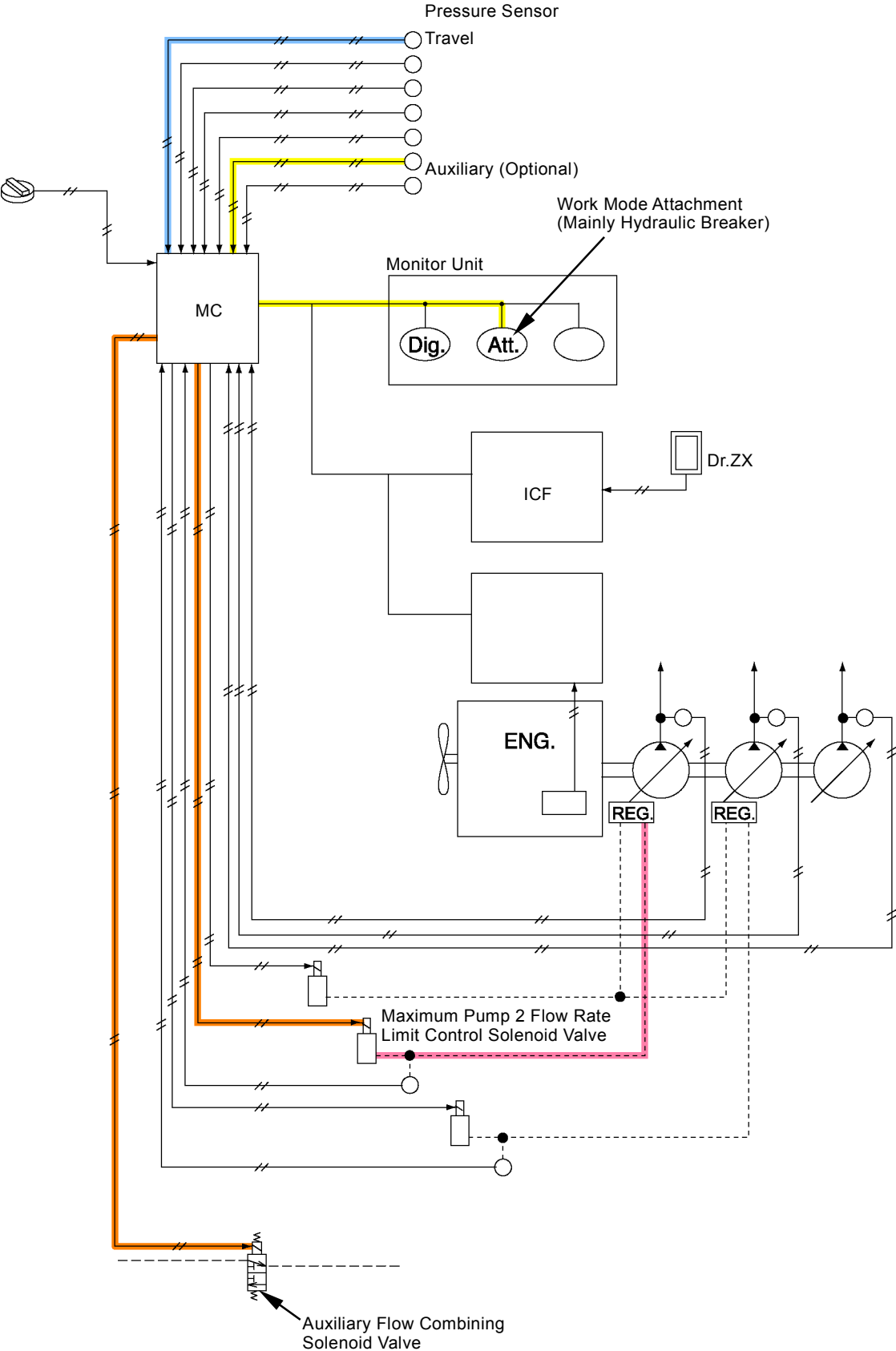
Operation:

1. When attachment is used with the travel control lever in neutral, MC receives the signals from pressure sensor (auxiliary) (optional).
2. In response to attachment control operation, MC drives the maximum pump 2 flow rate limit control solenoid valve and reduces maximum pump flow rate.
3. When the auxiliary flow combining solenoid valve stops, pump 2 flow rate can be adjusted finely by the monitor unit.

 **NOTE:** *In proportion to the attachment control operation, maximum pump flow rated is reduced. The minimum pump swash set-angle on monitor unit for a attachment (hydraulic breaker 1 to 5, secondary crusher 1 to 5, primary crusher 1 to 5 or vibrating hammer 1 to 5) can be set in the service mode of Dr. ZX.*



SYSTEM / Control System



T1V1-02-01-020

SYSTEM / Control System

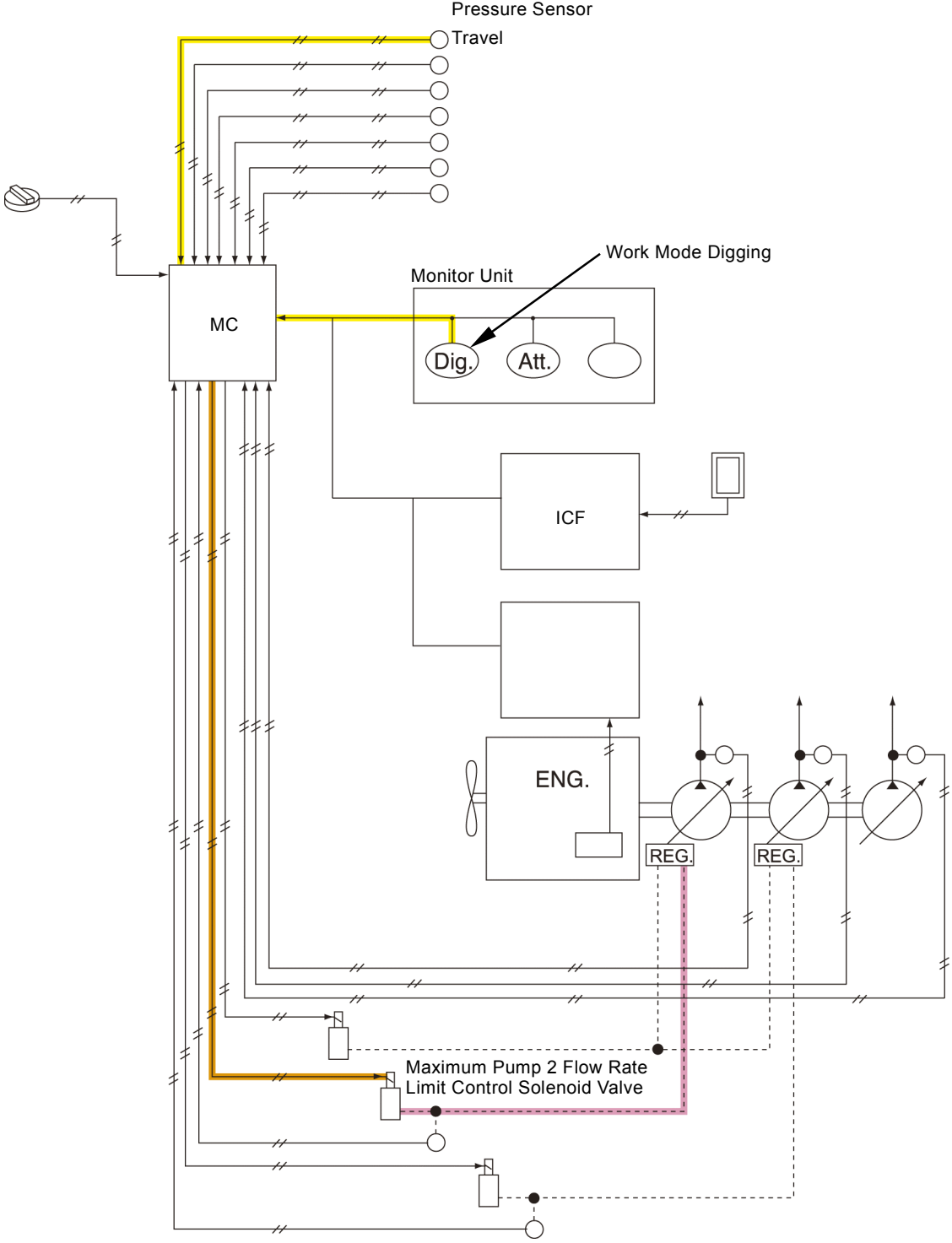
Pump 2 Flow Rate Control Valve at Travel (ZX160-3 Class Only)

Purpose: Control flow rate of pump 2 when traveling.

Operation:

1. When travel is operated during work mode “digging”, MC receives the signal from the pressure sensor (travel)
2. In response to travel control operation, MC drives the maximum pump 2 flow rate limit control solenoid valve and controls pump 2 flow rate.

SYSTEM / Control System



T1T1-02-02-003

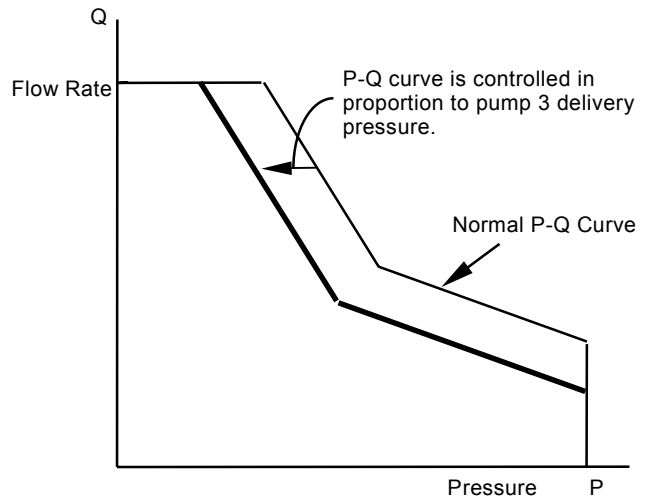
SYSTEM / Control System

Pump 3 Torque Decrease Control (Only Machine Equipped with Optional Parts)

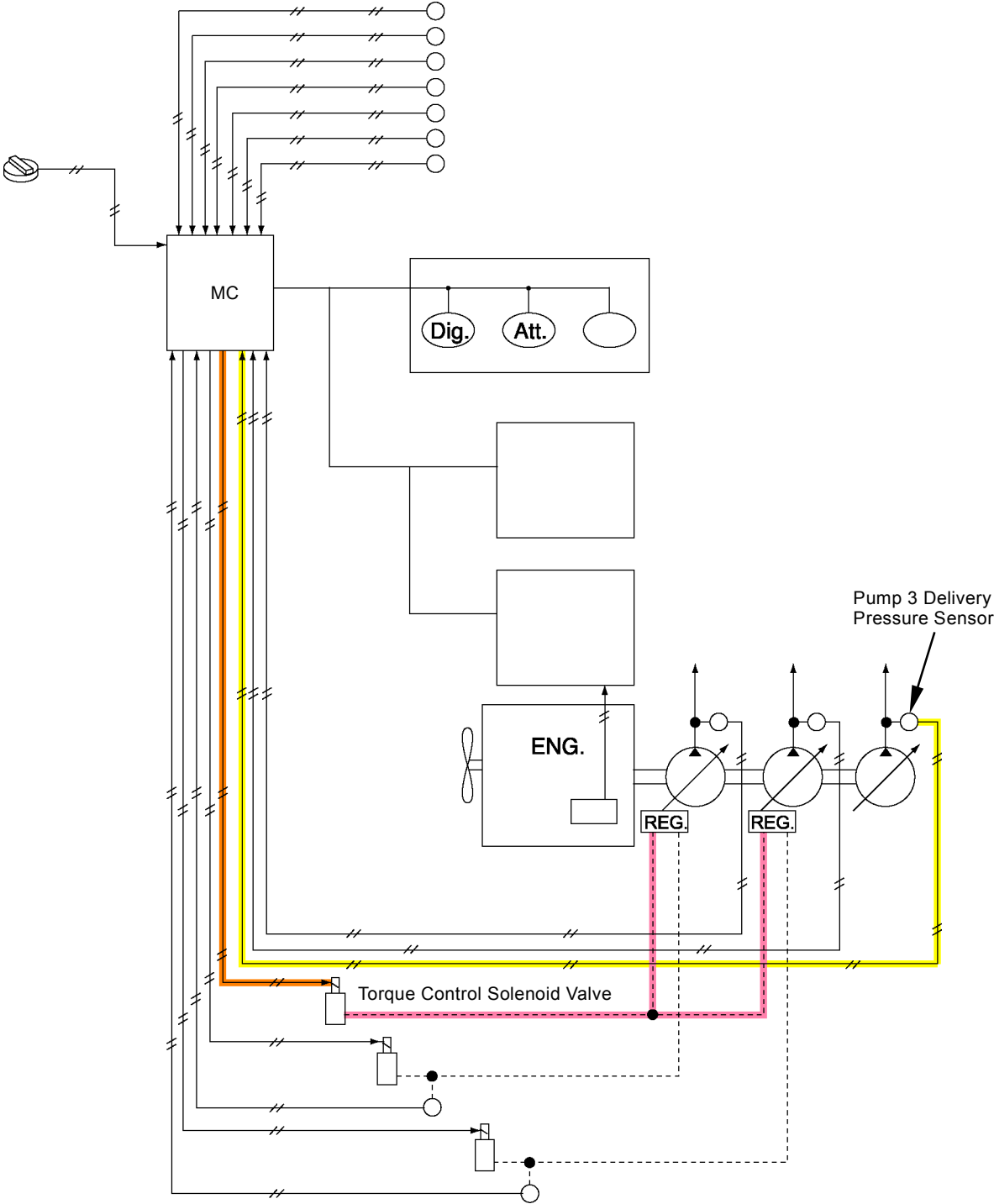
Purpose: Reduces pumps 1, 2 driving torque in order to prevent the engine from stalling and utilize the engine output power efficiently when the pump 3 (optional) driving torque increases as for the machine equipped with pump 3 (optional).

Operation:

1. When MC receives the signals from pump 3 delivery pressure sensor (optional), MC drives the torque control solenoid valve.
2. The torque control solenoid valve reduces pumps 1, 2 flow rates.
3. Thereby, the total pump 1, 2 and 3 driving torque (pump torque) is maintained not to exceed the engine output power and the engine output power is utilized efficiently.



SYSTEM / Control System




T1V1-02-01-021

SYSTEM / Control System

VALVE CONTROL

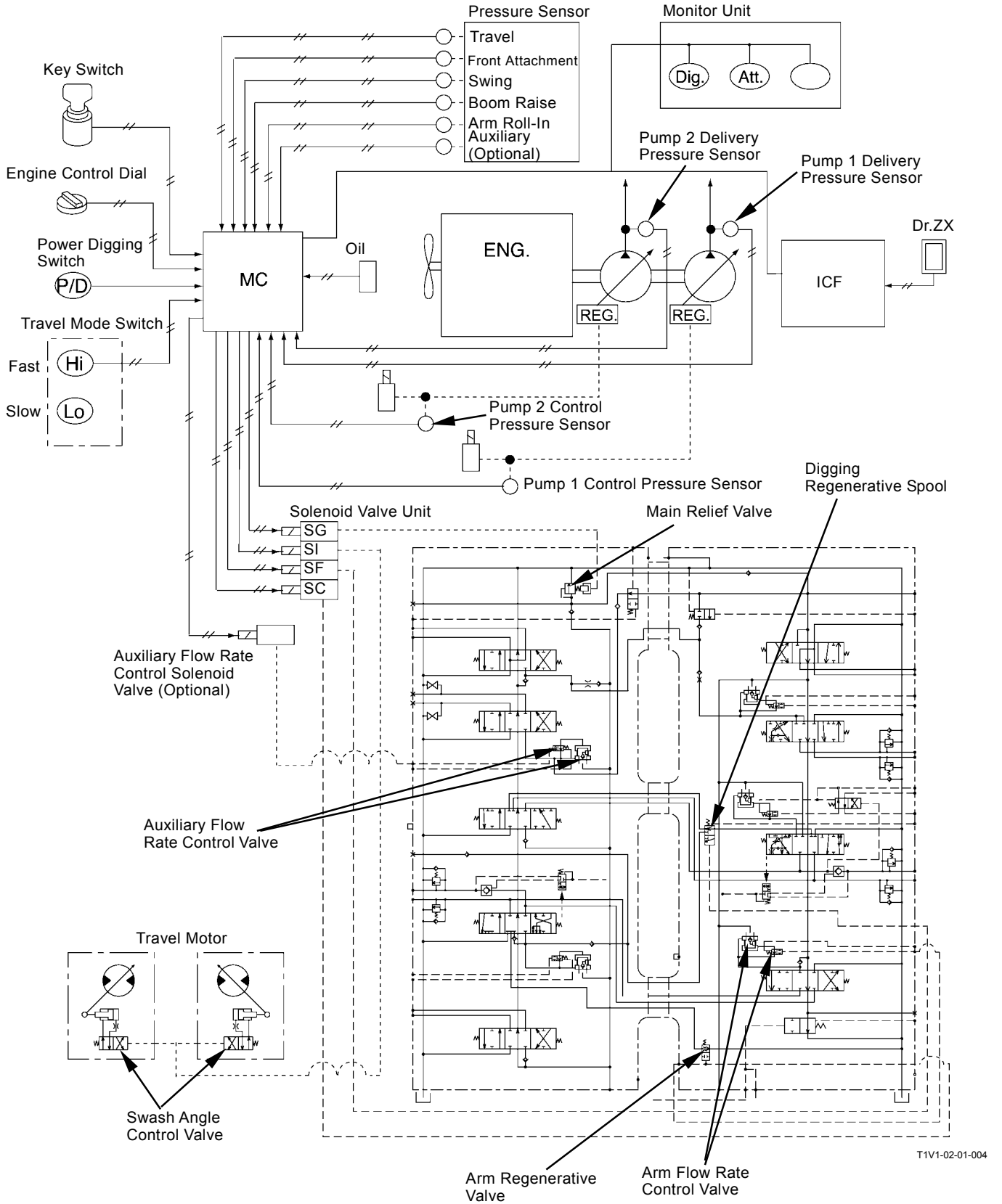
The valve control system functions as follows:

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

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

SYSTEM / Control System

Valve Control System Layout



SYSTEM / Control System

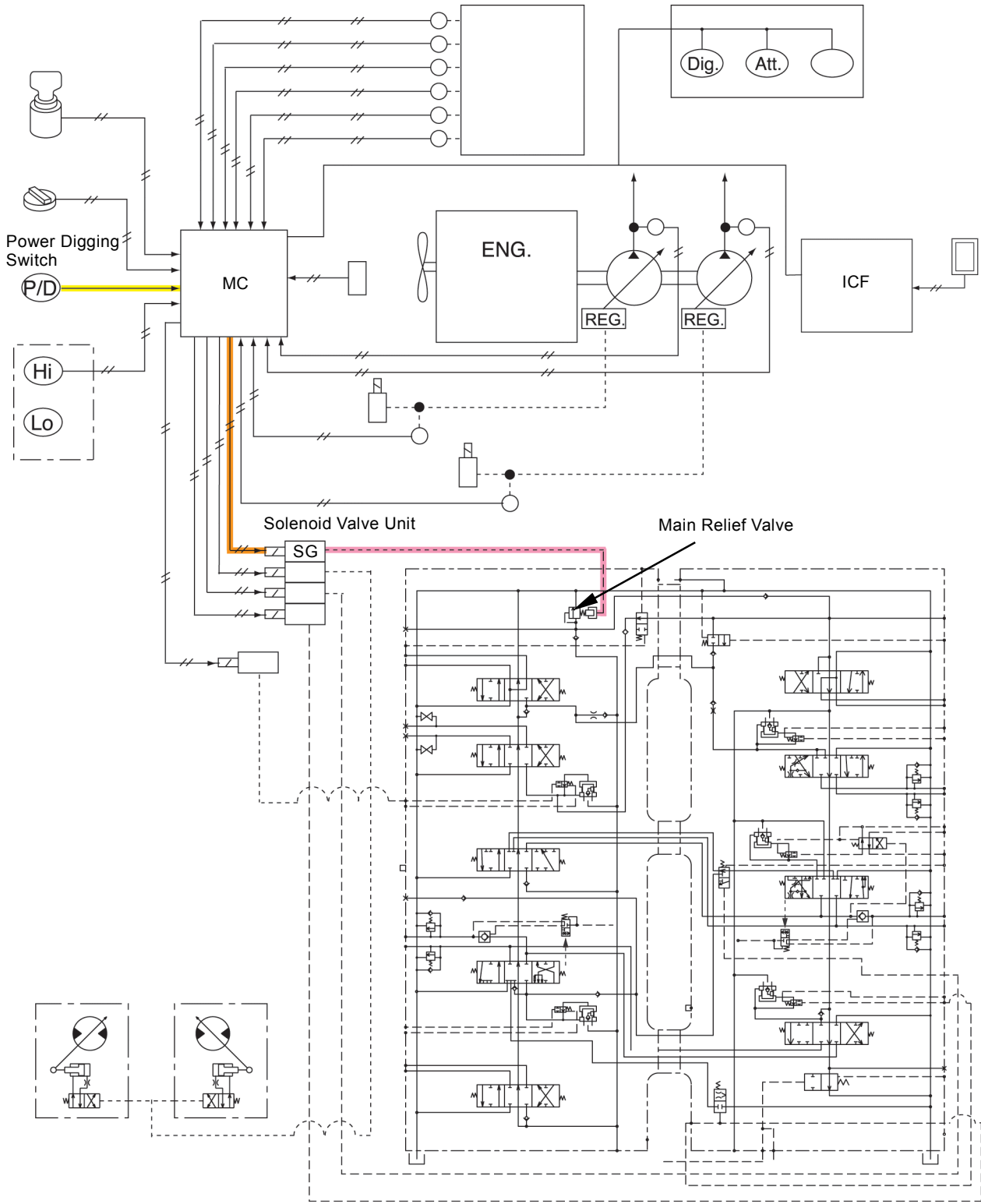
Power Digging Control

Purpose: Increases digging force by temporarily increasing relief pressure.

Operation:

1. For maximum 8 seconds after the power digging switch is turned ON, MC continuously activates solenoid valve unit (SG).
2. Solenoid valve unit (SG) delivers pilot pressure to the main relief valve in control valve and increases relief pressure. (Refer to Control Valve / COMPONENT OPERATION.)

SYSTEM / Control System



T1V1-02-01-024

SYSTEM / Control System

Auto-Power Lift Control


Purpose: Increases pressure when raising the boom.

Operation:

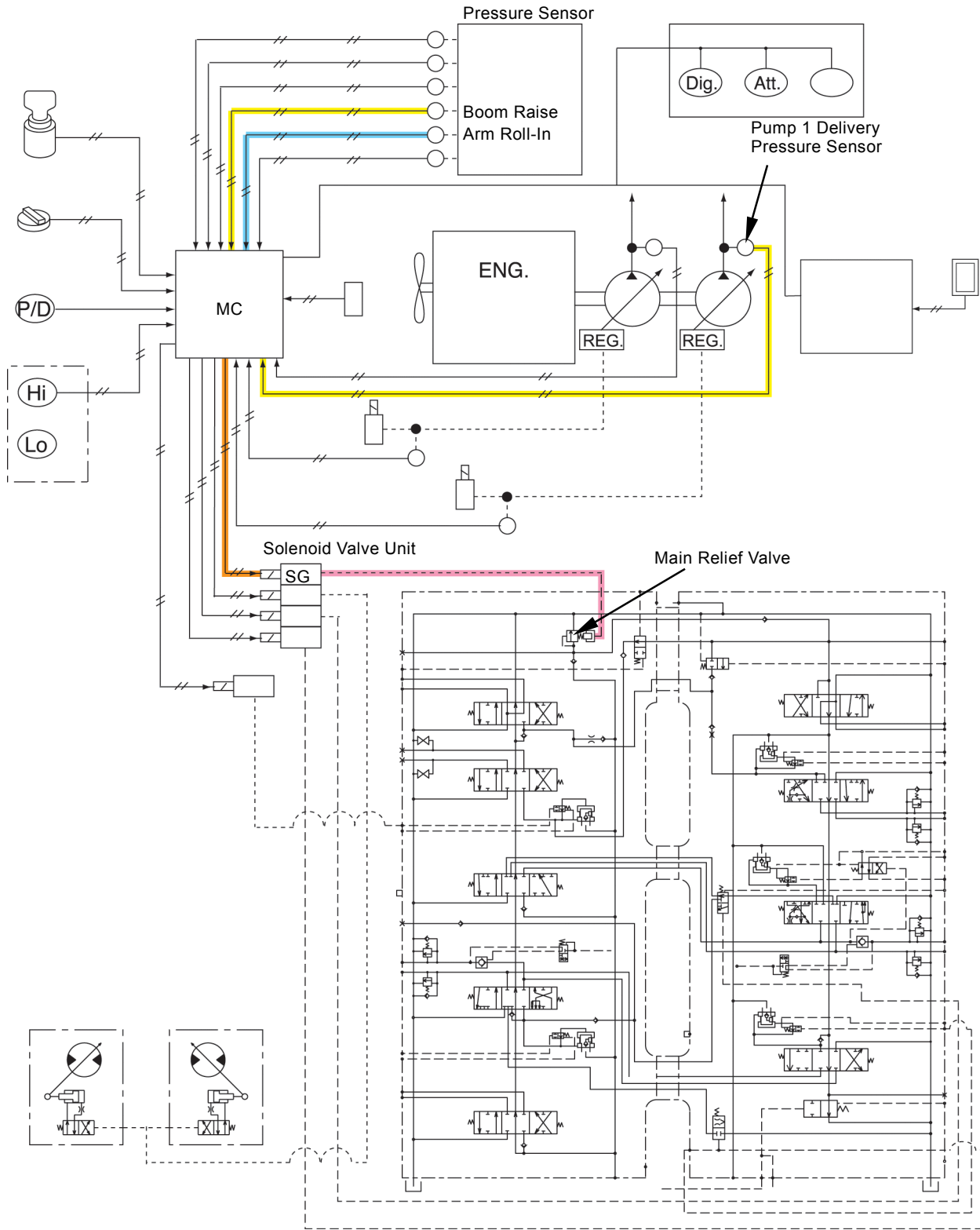
1. MC activates solenoid valve unit (SG) when the signals from pressure sensor (boom raise) and pump 1 delivery pressure sensor meet the following conditions.
2. Solenoid valve unit (SG) delivers pilot pressure to the main relief valve in control valve and increases relief pressure. (Refer to Control Valve/ COMPONENT OPERATION.)

Conditions:

- Boom Raise Pressure Sensor: Outputting signals (The boom must be raised to a certain extent.) (Reference: 1.7 MPa (17 kgf/cm², 247 psi))
- Pump 1 Delivery Pressure Sensor: High pressure (Reference: 31.3 MPa (320 kgf/cm², 4550 psi))
- Arm Roll-In Pressure Sensor: No output (The control lever is in neutral.)

 **NOTE:** *This control system is activated during combined operations (except for the arm roll-in combined operation).*

SYSTEM / Control System



T1V1-02-01-025

SYSTEM / Control System

Arm Regenerative Control

Purpose: Accelerates the arm roll-in speed in order to prevent arm hesitation during arm roll-in operation.

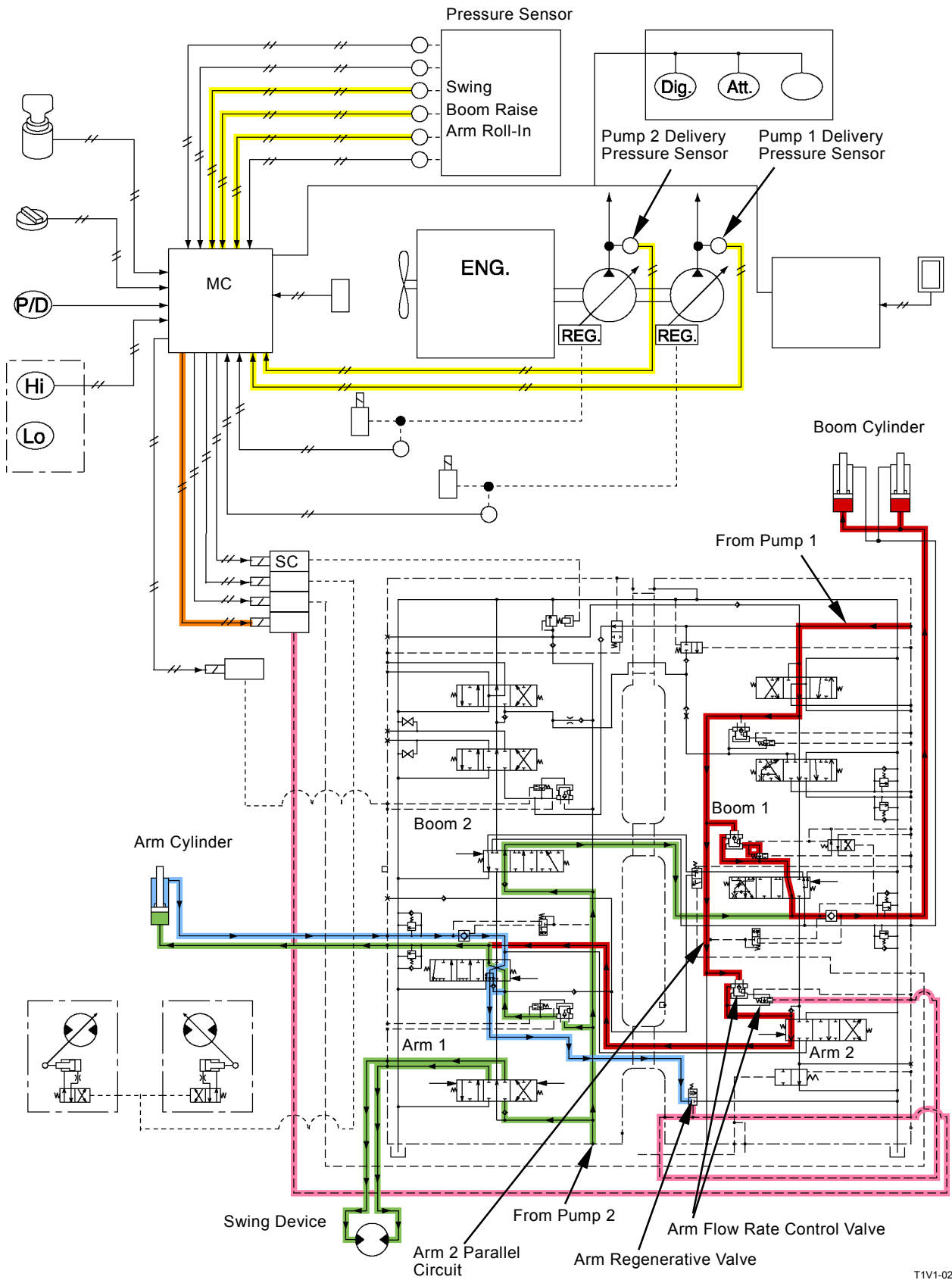
Operation:

1. MC activates solenoid valve unit (SC) so that solenoid valve unit (SC) delivers pilot pressure when the signals from pump 1, 2 delivery pressure sensors, swing pressure sensor, arm roll-in pressure sensor and boom raise pressure sensor meet the following conditions.
2. This pilot pressure shifts the arm regenerative valve and the return circuit from arm cylinder rod side to the hydraulic oil tank is closed.
3. Then, return oil from the arm cylinder rod side is combined with pressure oil from the pump and is routed to the cylinder bottom side so that arm roll-in speed increases and prevents arm hesitation. (Refer to Control Valve/ COMPONENT OPERATION.)
4. At the same time, pilot pressure from solenoid valve unit (SC) shifts the arm flow rate control valve in arm 2 parallel circuit.
5. Therefore, as pressure oil through arm 2 parallel circuit is controlled and delivered to boom 1, so that boom raise speed is kept.

Conditions:

- Pump 1 and 2 Delivery Pressure Sensors:
Either pump 1 or 2 delivery pressure is low. (The arm does not need much power to operate.) (Reference: 16.5 MPa (168 kgf/cm², 2400 psi) or less)
- Arm Roll-In Pressure Sensor: High output. (The arm control lever stroke is large.) (Reference: 0.5 MPa (5.1 kgf/cm², 73 psi) or more)
- Swing or Boom Raise Pressure Sensor:
Outputting signal.

SYSTEM / Control System



T1V1-02-01-022

SYSTEM / Control System

Digging Regenerative Control

Purpose: Increases arm roll-in speed when operating digging (boom raise, arm roll-in and bucket roll-in).

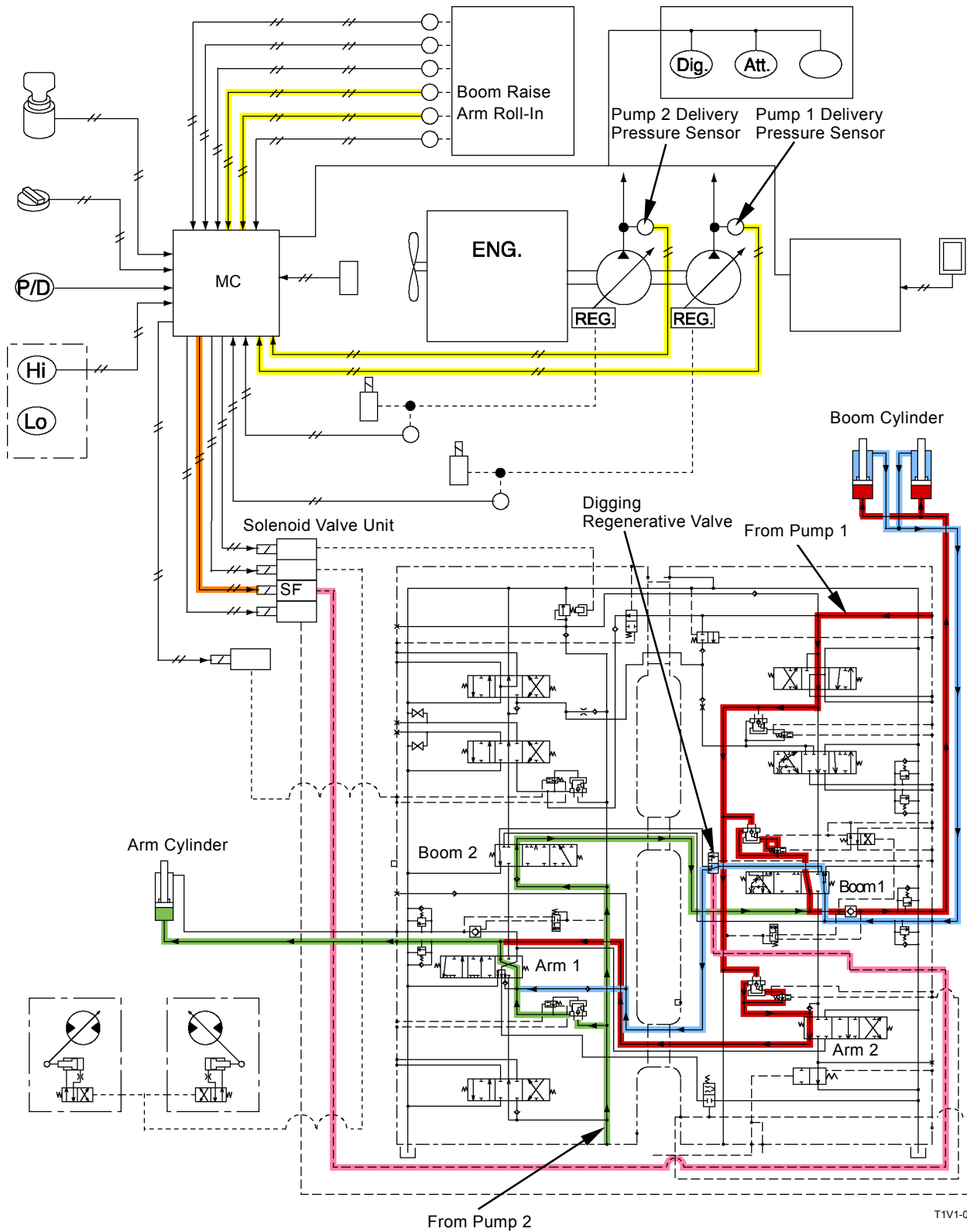
Operation:

1. MC activates solenoid valve unit (SF) when the signals from pump 1, 2 delivery pressure sensors, arm roll-in pressure sensor and boom raise pressure sensor meet the following conditions.
2. When solenoid valve unit (SF) is activated, pilot pressure shifts the digging regenerative valve.
3. Pressure oil in boom cylinder rod side is combined with that from pump 2 and flows to the arm 1 spool.
4. Pressure oil from the arm 1 spool is combined with that from the arm 2 spool and flows to the arm cylinder bottom side. Therefore, arm roll-in speed increases.

Condition:

- Pump 1, 2 Delivery Pressure Sensors: High pressure (Reference: 22 MPa (224 kgf/cm², 3200 psi) or more)
- Arm Roll-In Pressure Sensor: Specified pressure or higher (Reference: 2.7 MPa (28 kgf/cm², 393 psi) or more)

SYSTEM / Control System



SYSTEM / Control System

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.

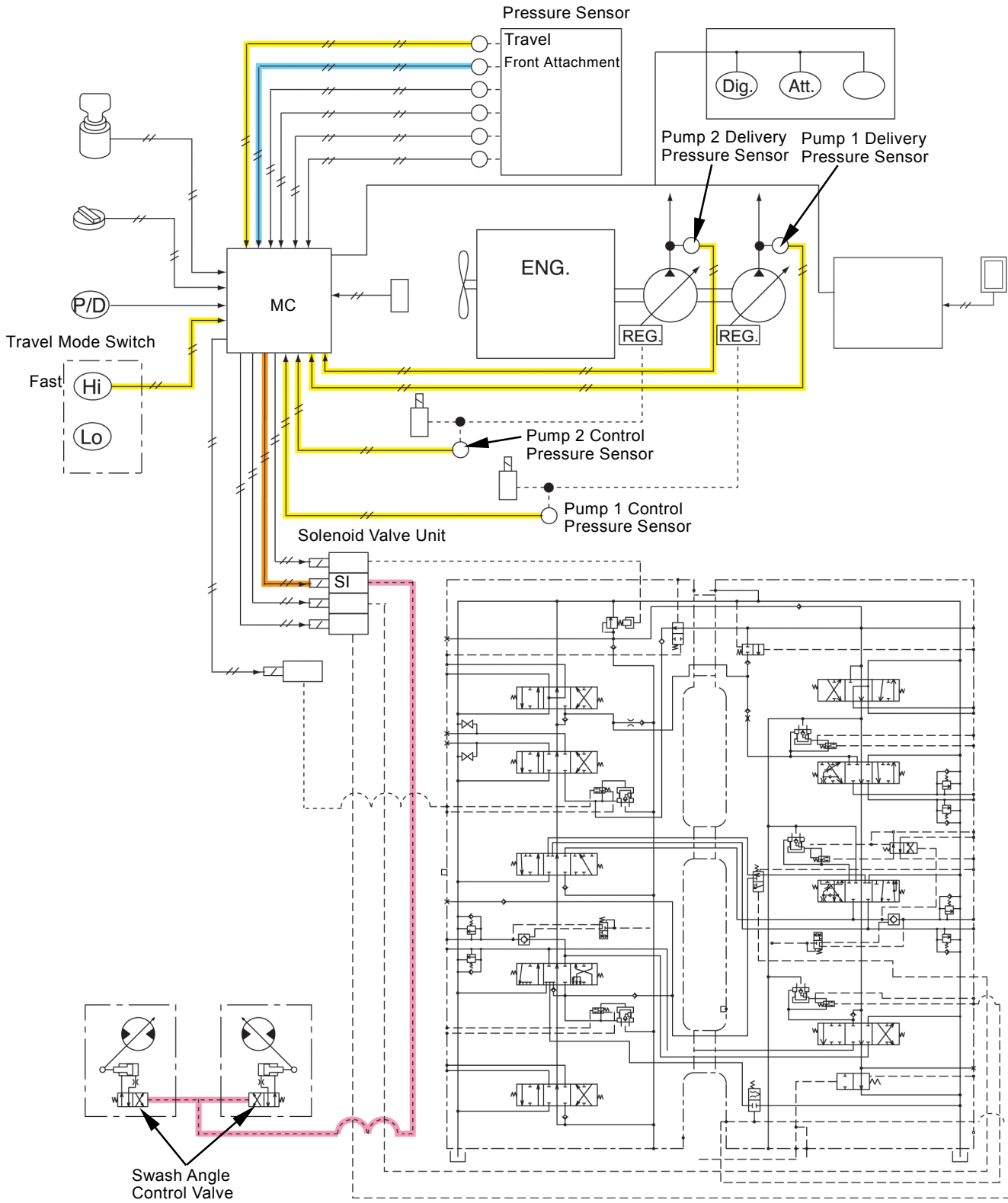
Condition:

- 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/cm², 3490 psi) or less)
- Pumps 1, 2 Control Pressure Sensors: Either pump control pressure is high. (Reference: 2.2 MPa (22 kgf/cm², 320 psi) or more)

 **NOTE:** *When one side track is raised 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.

SYSTEM / Control System



T1V1-02-01-027

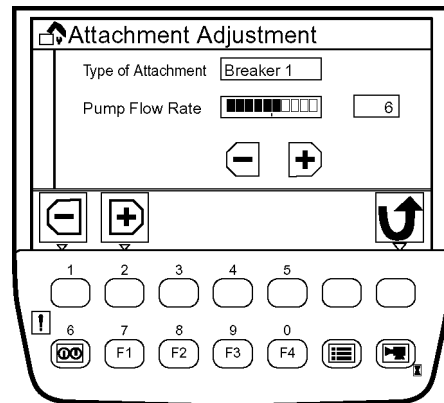
SYSTEM / Control System

HSB Breaker Control (Optional)

IMPORTANT: HSB breaker is set at breaker 1 of attachment mode in monitor unit when the machine is carried out. When breaker 3 to 5 is used, set the setting by using Dr. ZX.

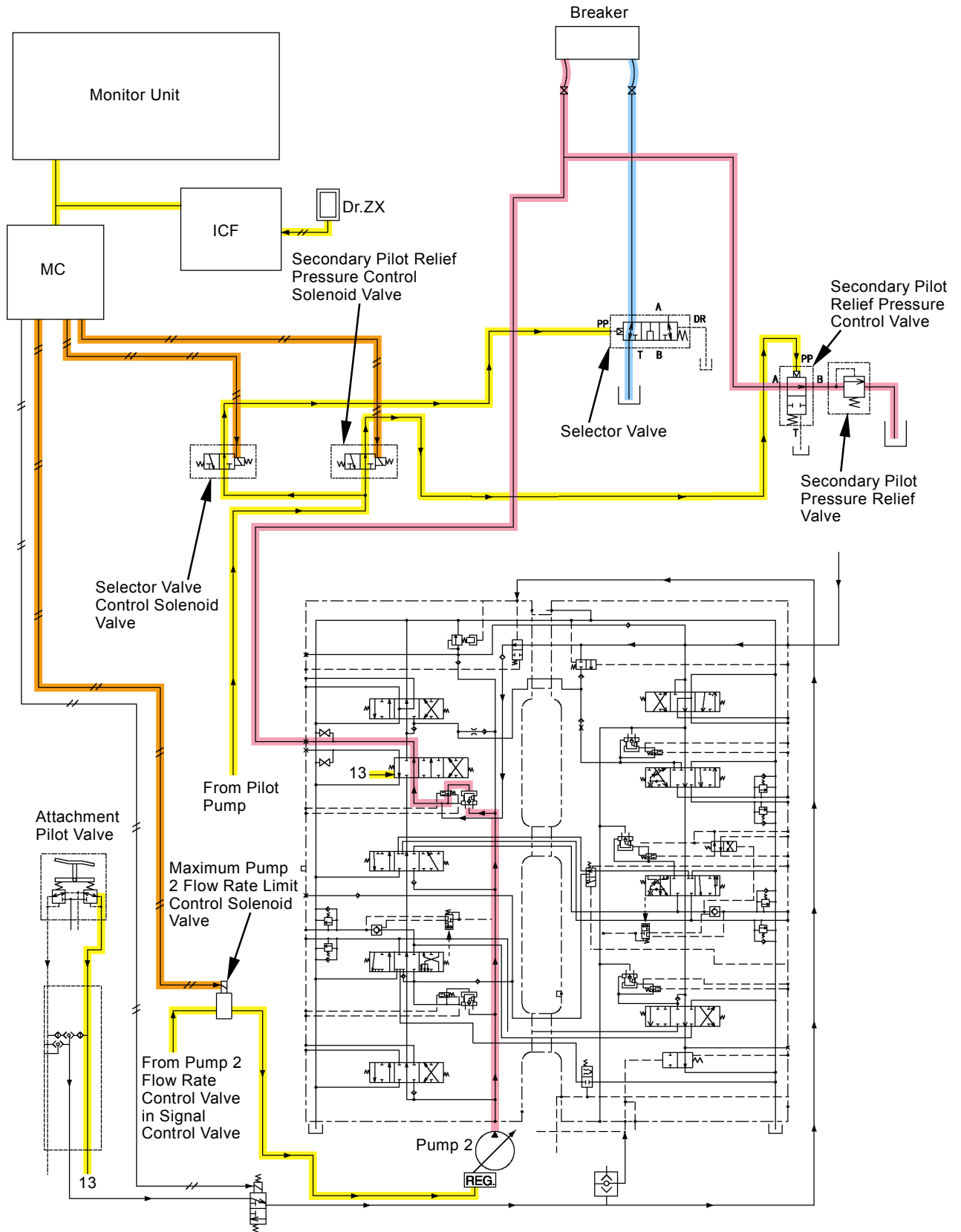
Operation:

1. When selecting breaker 1 in monitor unit, MC drives the selector valve control solenoid valve.
2. Pressure oil from the pilot pump flows through the selector valve control solenoid valve, shifts the selector valve, and the return circuit in breaker is connected to the hydraulic oil tank.
3. At the same time, MC drives the secondary relief control solenoid valve.
4. Pressure oil from the pilot pump flows the secondary pilot relief pressure control solenoid valve, shifts the secondary pilot relief pressure control valve, and reduces relief set pressure in breaker circuit.
5. When the maximum pump 2 flow rate limit control solenoid valve is driven in the monitor unit, pump 2 flow rate can be adjusted finely.



T1V5-05-01-111

SYSTEM / Control System



T1V1-02-01-068

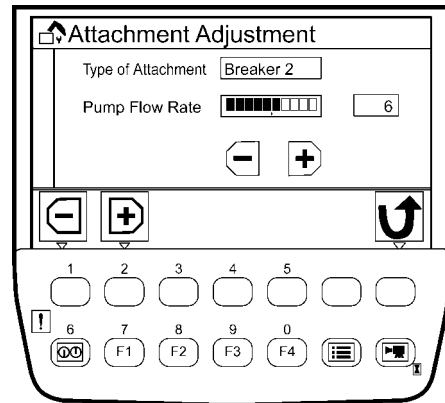
SYSTEM / Control System

NPK Breaker Control (Optional)

IMPORTANT: NPK breaker is set at breaker 2 of attachment mode in monitor unit when the machine is carried out. When breaker 3 to 5 is used, set the setting by using Dr. ZX.

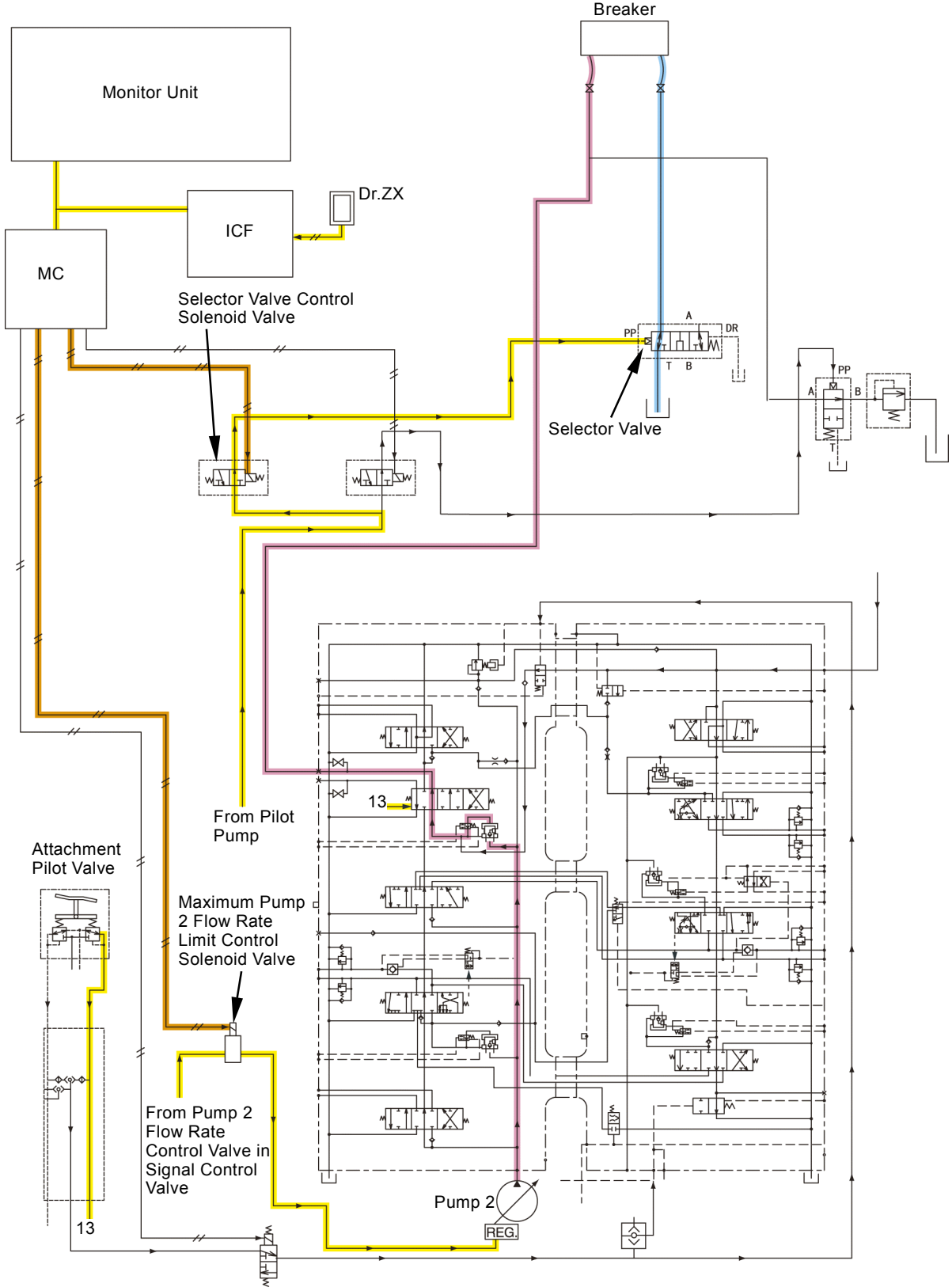
Operation:

1. When selecting breaker 2 in monitor unit, MC drives the selector valve control solenoid valve.
2. Pressure oil from the pilot pump flows through the selector valve control solenoid valve, shifts the selector valve, and the return circuit in breaker is connected to the hydraulic oil tank.
3. When the maximum pump 2 flow rate limit control solenoid valve is driven in the monitor unit, pump 2 flow rate can be adjusted finely.



T1V5-05-01-112

SYSTEM / Control System



T1T1-02-02-001

SYSTEM / Control System

Secondary Crusher Control (Optional)

IMPORTANT: Secondary crusher 1 is set at secondary crusher 1 of attachment mode in monitor unit when the machine is carried out.

When secondary crusher 2 to 5 is used, set the setting by using Dr. ZX.

Purpose: Increases operating speed of the secondary crusher.

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 secondary crusher 1 in the monitor unit, MC drives the auxiliary flow combining solenoid valve.
2. When operating the secondary crusher, pressure oil from the pilot valve flows through the auxiliary flow combining 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 secondary crusher increases.
4. Flow rate of the auxiliary flow rate control solenoid valve can be adjusted finely in the monitor unit.

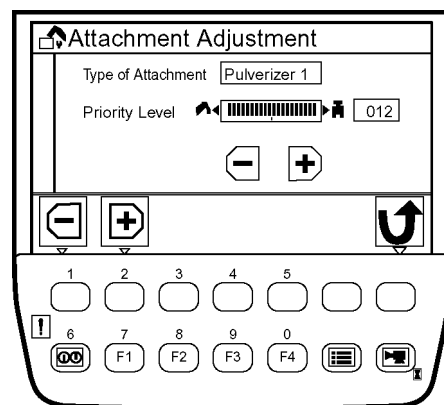
During Combined Operation

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 secondary crusher 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.

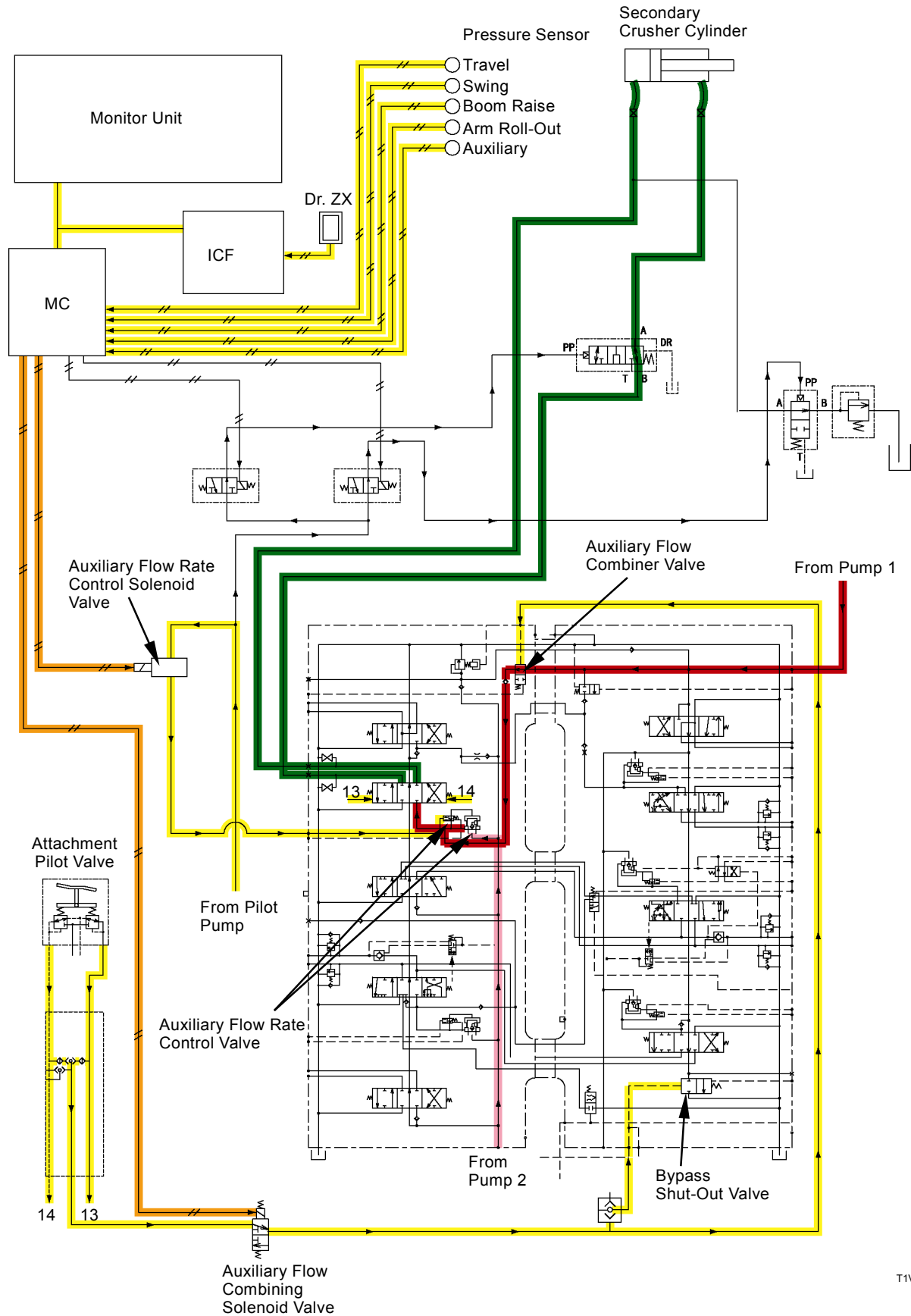
Condition:

- Auxiliary Pressure Sensor: Outputting 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: Outputting signal
- Travel Pressure Sensor: Outputting signal



T1V5-05-01-024

SYSTEM / Control System



T1V1-02-01-069

SYSTEM / Control System

Primary Crusher Control (Optional)

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

Purpose: Increases operating speed of the primary crusher.

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 primary crusher.

Operation:

1. When selecting crusher 1 in the monitor unit, MC drives the auxiliary flow combining solenoid valve.
2. When operating the primary crusher, pressure oil from the pilot valve flows through the auxiliary flow combining 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 primary crusher increases.
4. Flow rate of the auxiliary flow rate control solenoid valve can be adjusted finely in the monitor unit.

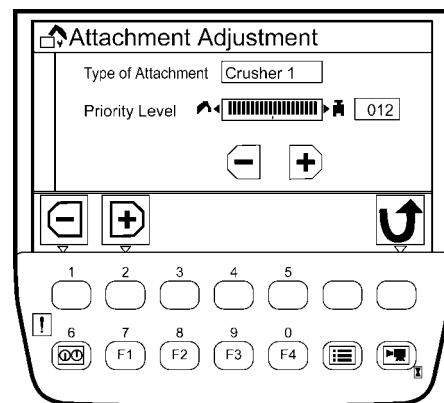
During Combined Operation

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 primary crusher through the auxiliary spool from pump 2.
2. As the primary crusher is heavier than the secondary crusher, restricted flow rate increases of the auxiliary flow rate control valve and gives priority to arm roll-out or arm roll-out+ boom raise during combined operation of arm roll-out or arm roll-out+ boom raise and primary crusher.

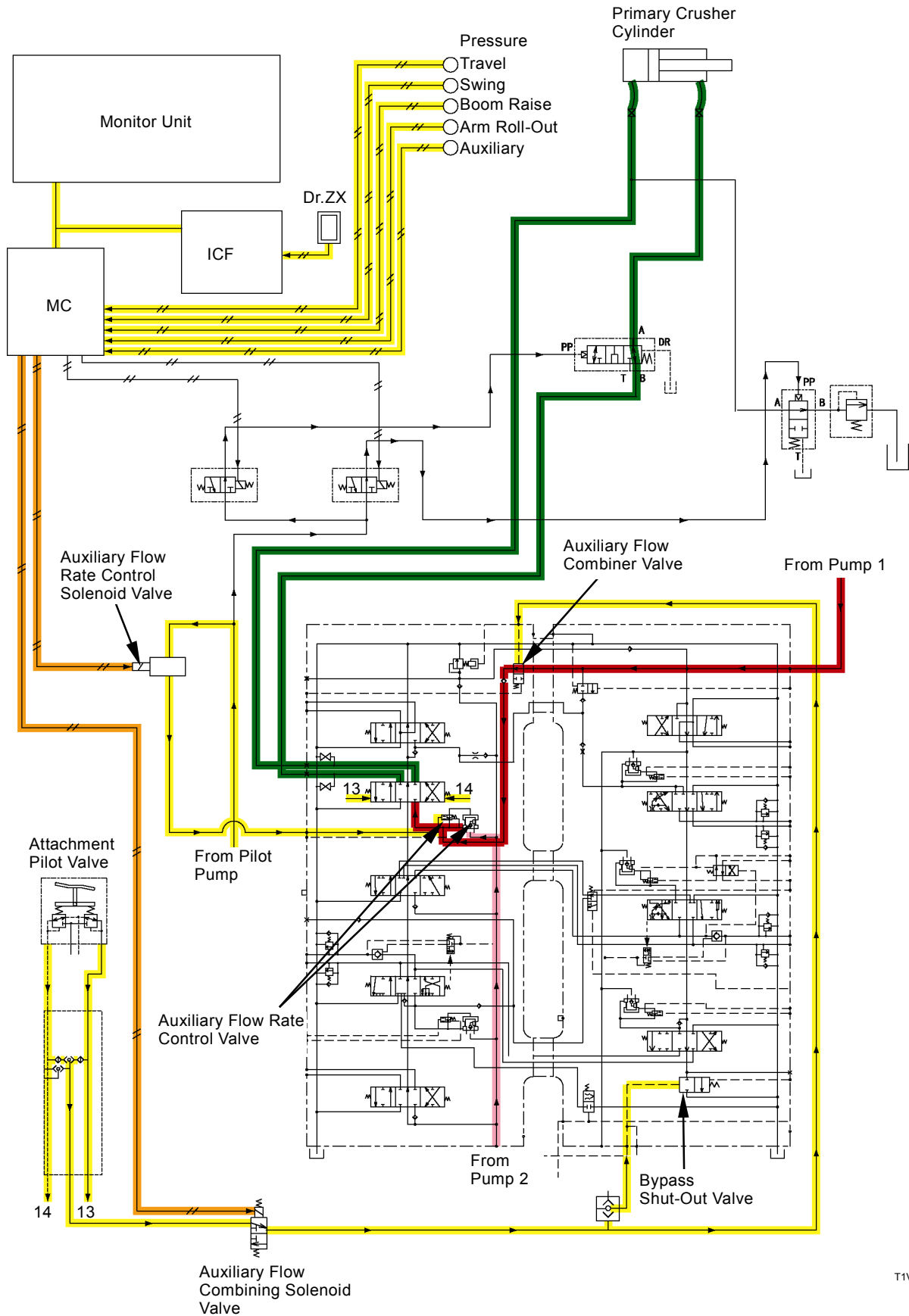
Condition:

- Auxiliary Pressure Sensor: Outputting 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: Outputting signal
- Travel Pressure Seonsor: Outputting signal



T1V5-05-01-113

SYSTEM / Control System



T1V1-02-01-069

SYSTEM / Control System


OTHER CONTROLS

Rear View Image Selection Control

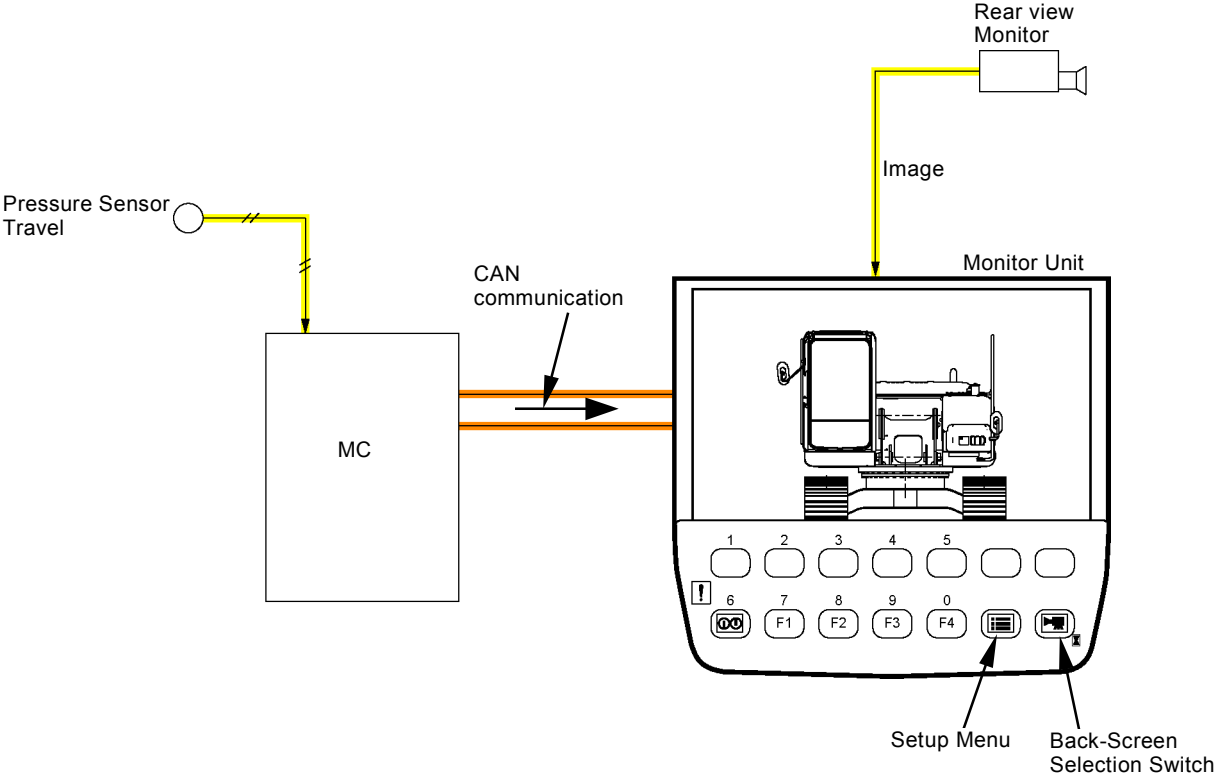
Purpose: Changes the display of monitor unit into the image of rearview monitor.

Operation:

1. When the back-screen selection switch on monitor unit is pushed, the display is changed into the image of rearview monitor.
2. When MC receives the signal from travel pressure sensor with rear view monitor auto selection ON, MC sends the signal to shift the display to the monitor unit by using CAN communication.
3. The monitor unit changes the image of rearview monitor.

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

SYSTEM / Control System




SYSTEM / Control System

Work Mode Control

The work modes include digging and front attachment 1 to 5 and are selected by the work mode on monitor unit.

- Digging Mode:
Normal control is performed.
- Front Attachment Mode:
Functions only when the attachment in the optional kit is operated.
In response to attachment control operation, increasing or decreasing of engine speed (refer to T2-2-22, 24.), increasing or decreasing pump flow rate (refer to T2-2-32, 36.) and valve selection (refer to T2-2-54 to 61) are controlled.
The engine speed and pump flow rate control settings are made by using Dr. ZX.


 **NOTE:** *As the attachment mode, one to five attachment modes can be selected from breaker 1 to 5, secondary crusher 1 to 5, crusher 1 to 5 and vibrating hammer 1 to 5 by using Dr. ZX*

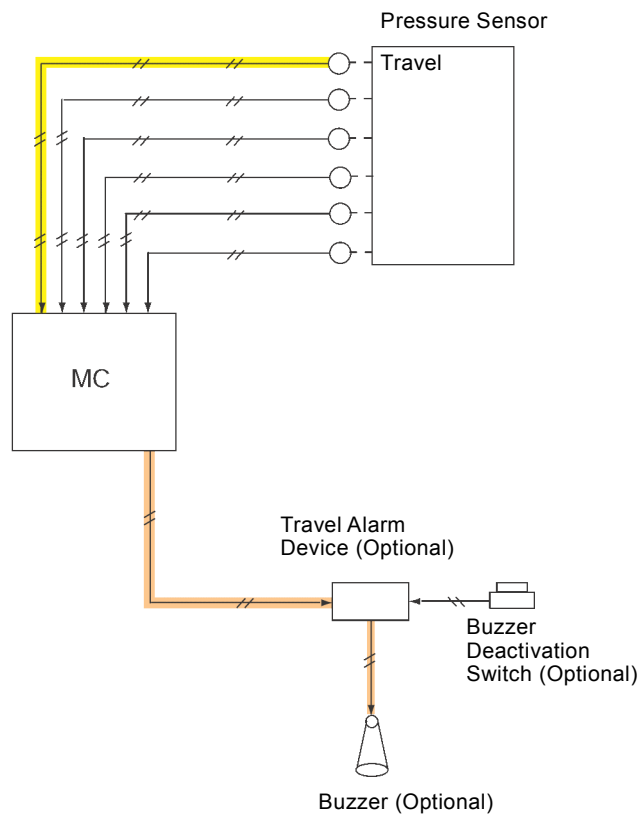
SYSTEM / Control System

Travel Alarm Control (Only Machine Equipped with Optional Parts)

Purpose: Sounds the buzzer (optional) while traveling.

Operation: MC receives the signals from travel pressure sensor when travel operation is made. As long as MC receives this signal, MC sends the signals to the travel alarm device and sounds the buzzer (optional).

 **NOTE:** After traveling continuously for more than 13 seconds, the buzzer (optional) can be stopped by using the buzzer deactivation switch (optional).




T178-02-01-025

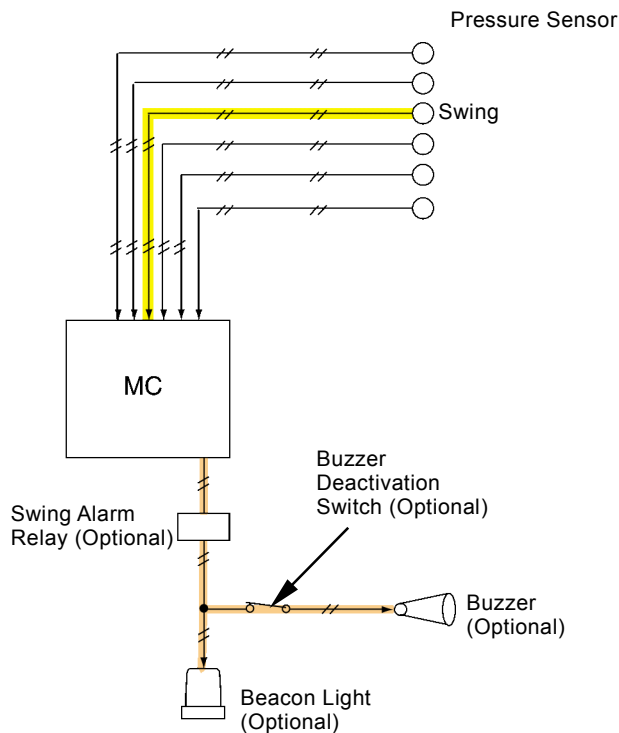
SYSTEM / Control System

Swing Alarm Control (Only Machines Equipped with Optional Parts)

Purpose: Sounds the buzzer (optional) and turn on the beacon light during swing operation.

Operation: MC receives the signals from swing pressure sensor when swing operation is made. As long as MC receives this signal, MC sends the signals to the swing alarm device, sounds the buzzer (optional) and turn on the beacon light.

 **NOTE:** The buzzer (optional) can be stopped by using the buzzer deactivation switch (optional).



T178-02-01-026

SYSTEM / ECM System

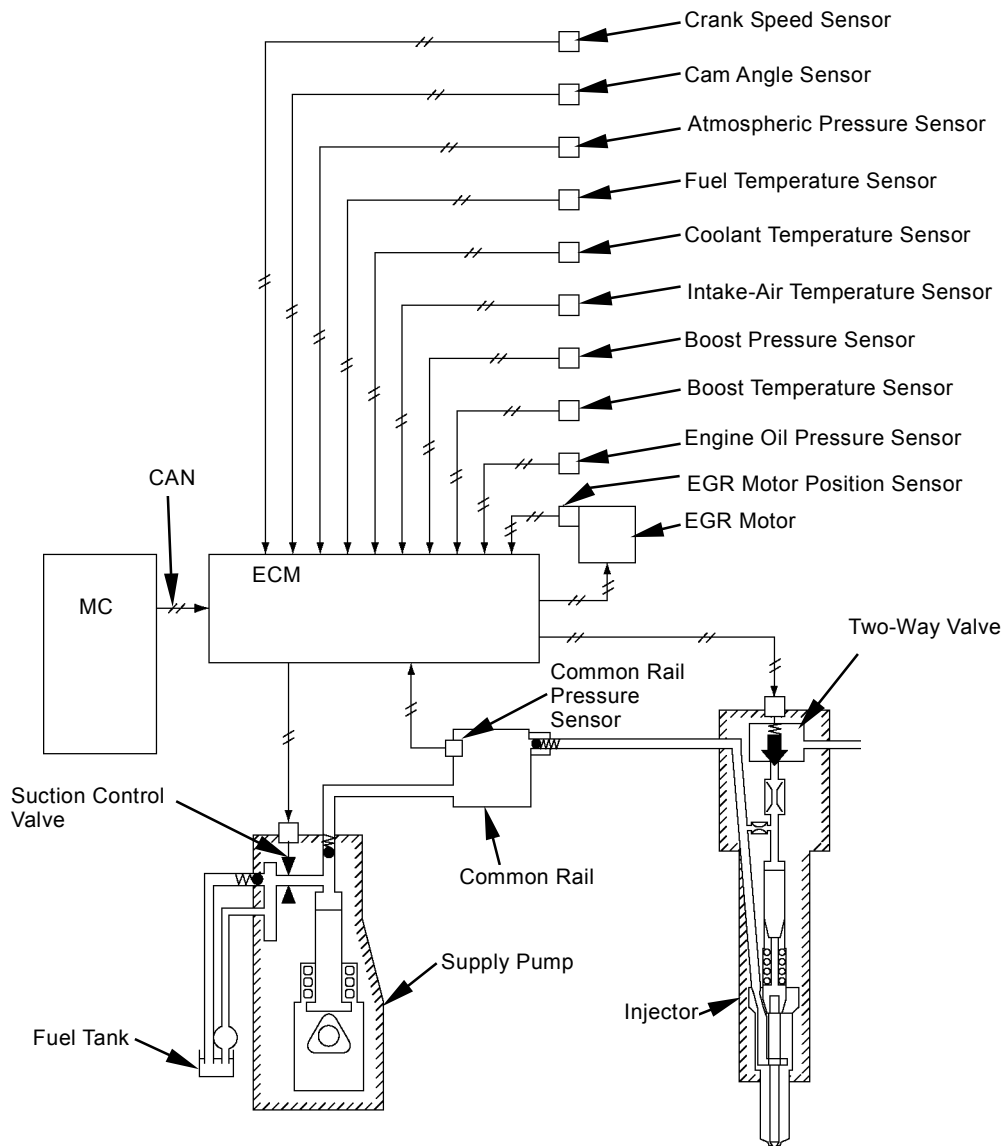
OUTLINE

ECM (Engine Control Module) receives the signals from sensors and MC

ECM processes and drives the two-way valve, suction control valve and EGR motor in order to control the supply pump, injector pump and EGR (Exhaust Gas Recirculation) valve.

- Fuel Injection Control
- Engine Start Control
- EGR Control
- Fuel Injection Amount Correction
- Engine Stop Control

- The supply pump is driven by the engine and produces high-pressure fuel.
- The common rail distributes high-pressure fuel produced by the supply pump to the injector in each engine cylinder.
- The injector injects high-pressure from the common rail.



T1GR-02-02-001

SYSTEM / ECM System

FUEL INJECTION CONTROL

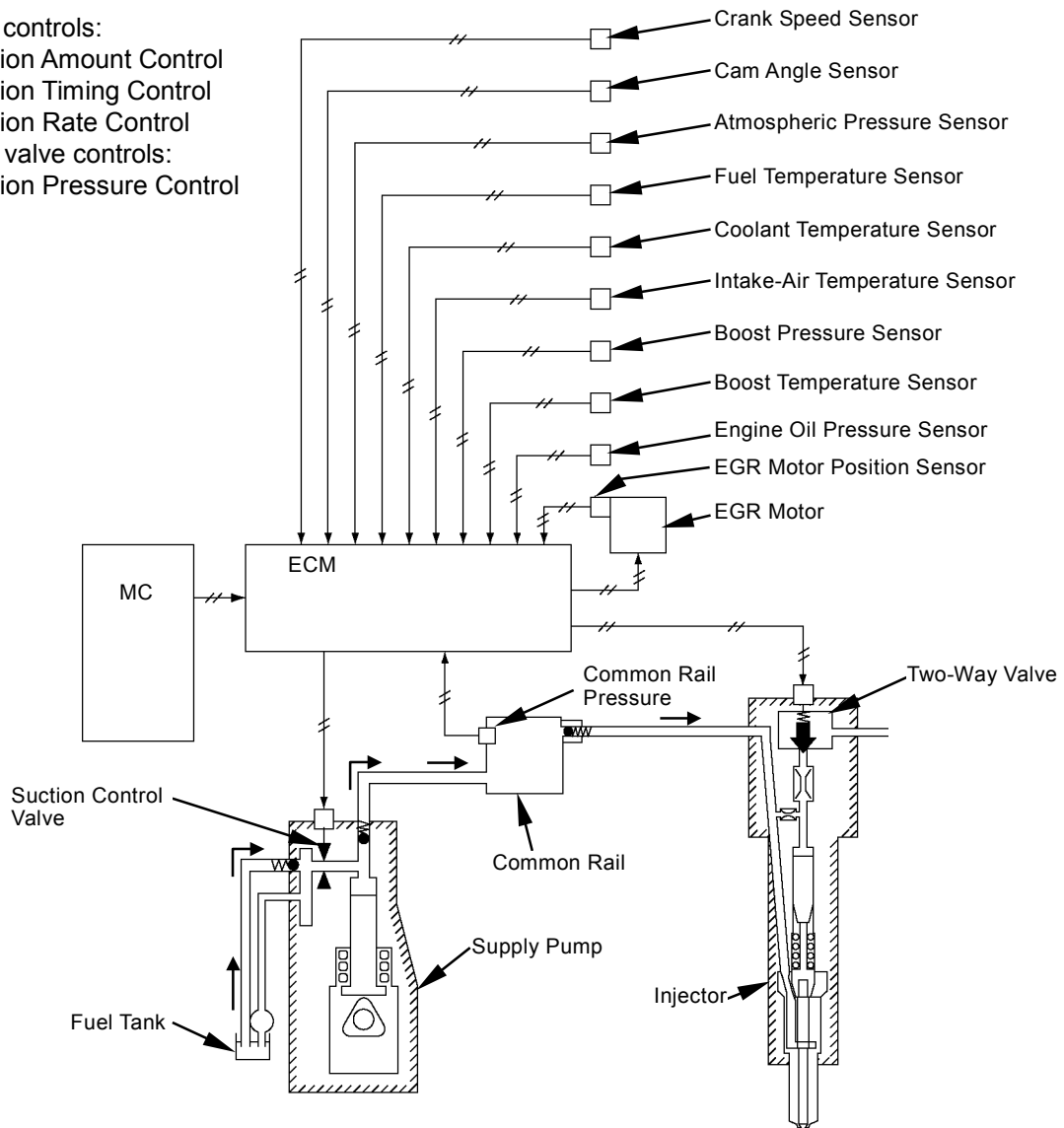
ECM detects the engine running condition according to the signals from each sensor and MC and controls fuel injection amount, injection pressure, injection timing and injection rate.

Two-way valve controls:

- Fuel Injection Amount Control
- Fuel Injection Timing Control
- Fuel Injection Rate Control

Suction control valve controls:

- Fuel Injection Pressure Control



T1GR-02-02-001

SYSTEM / ECM System

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SYSTEM / ECM System

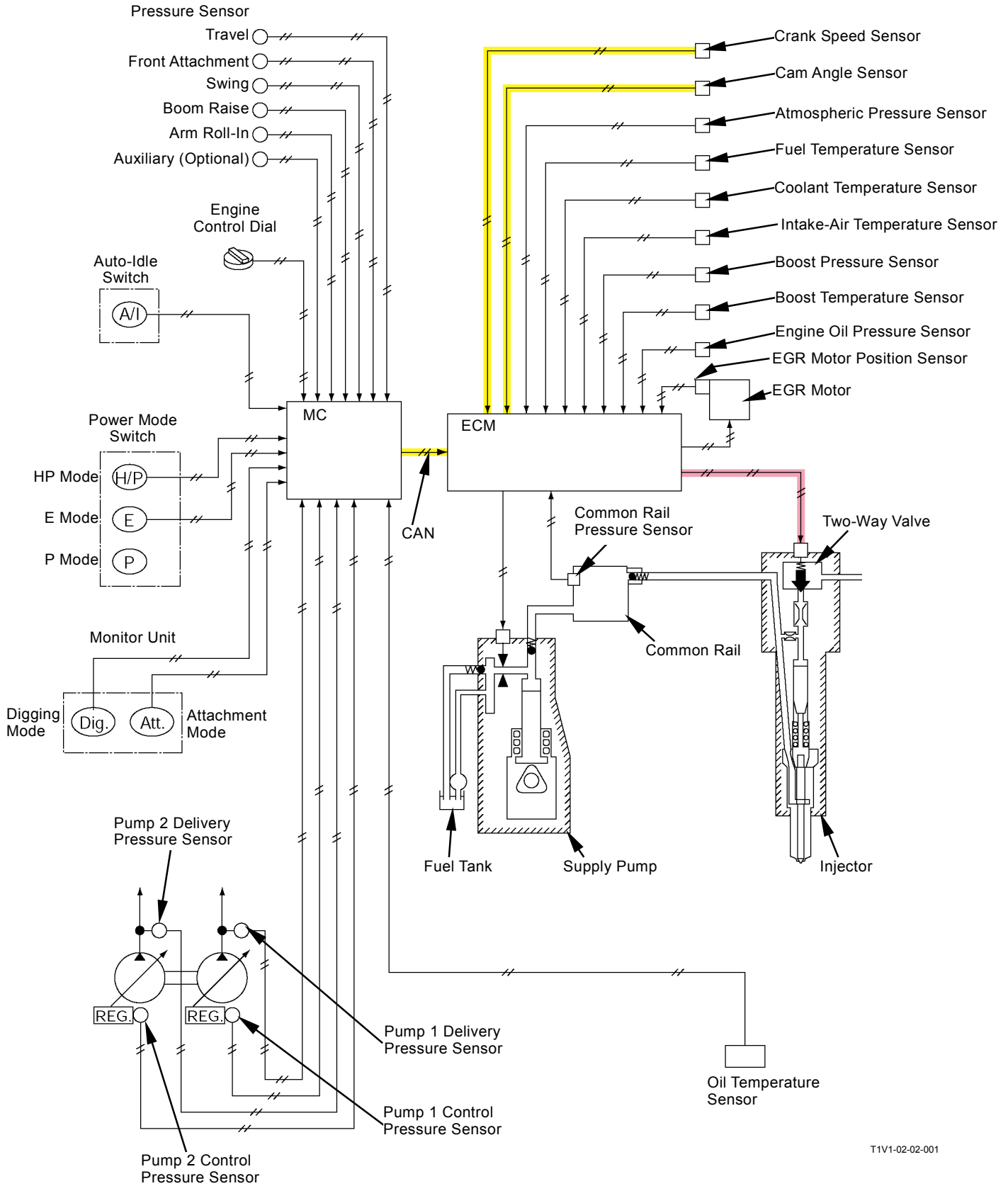
Fuel Injection Amount Control

Purpose: Controls the best fuel injection amount.

Operation:

1. ECM detects the engine speed according to the signals from the crank speed sensor and cam angle sensor.
2. MC calculate the target engine speed according to the signals from the engine control dial, sensors and switches and sends the signals to ECM by using CAN communication.
(Refer to SYSTEM / Control System.)
3. ECM mainly controls fuel injection amount by turning ON/OFF for two-way valve in injector according to the engine speed and the signals from MC.

SYSTEM / ECM System



T1V1-02-02-001

SYSTEM / ECM System

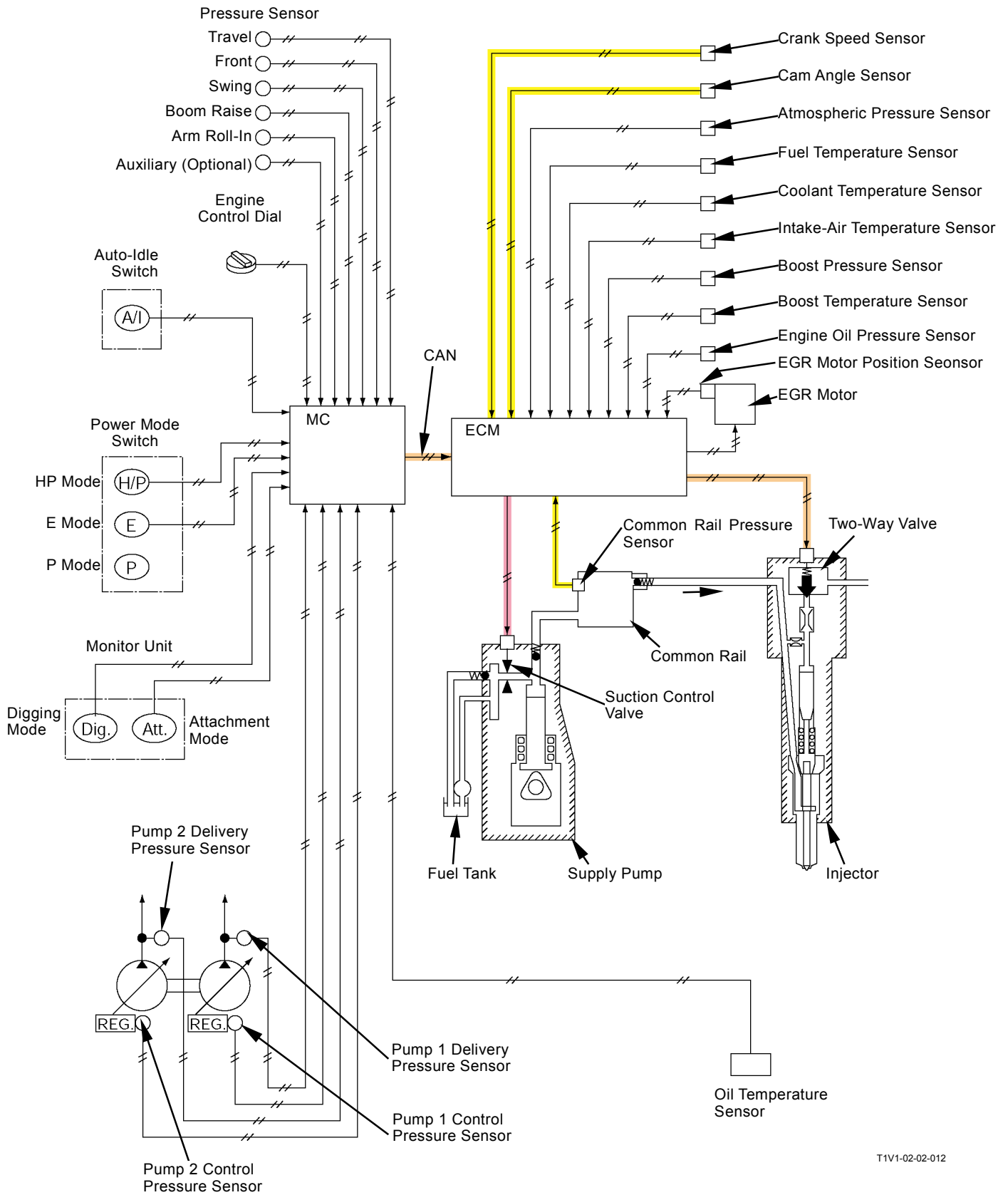
Fuel Injection Pressure Control

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.

SYSTEM / ECM System



T1V1-02-02-012

SYSTEM / ECM System

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:

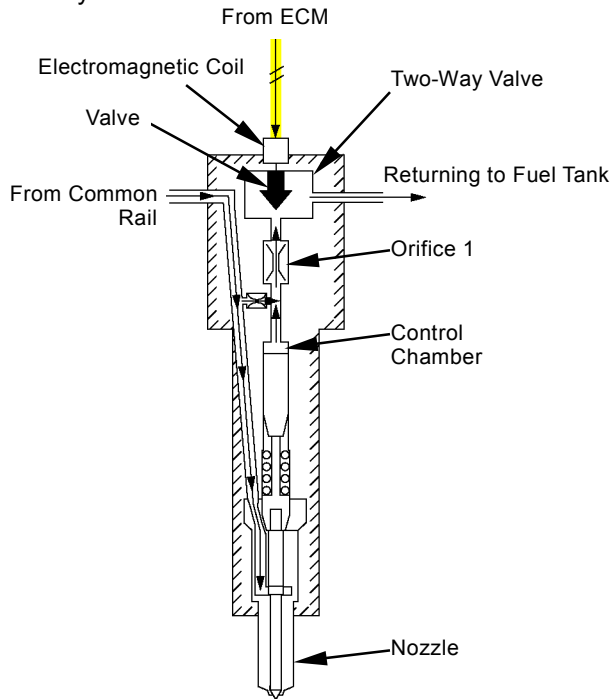
1. The injector injects small amount of fuel (pilot injection) first and ignites.
2. After igniting, the injector injects fuel (main injection). ECM controls fuel injection timing and fuel injection amount by turning the two-way valve in injector ON/OFF.

Fuel Injection

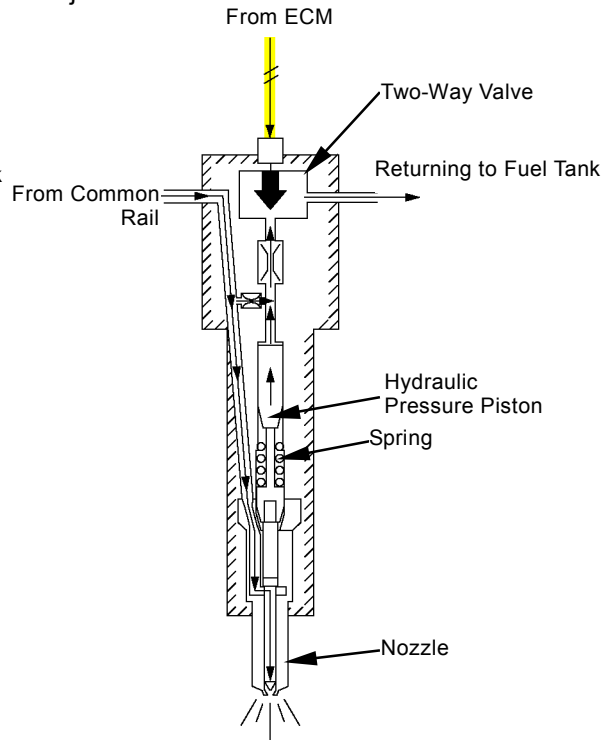
1. The nozzle in injector is always pressured.
2. When turning the electromagnetic coil in two-way valve ON, high-pressure fuel in the control chamber returns to the fuel tank through orifice 1.
3. Therefore, the hydraulic pressure piston is raised and the nozzle opens so that the injection starts.
4. When turning the electromagnetic coil in two-way valve OFF, the valve is closed and the circuit to fuel tank is closed. 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 by pressure difference of movement of hydraulic pressure piston so that injection stops.

SYSTEM / ECM System

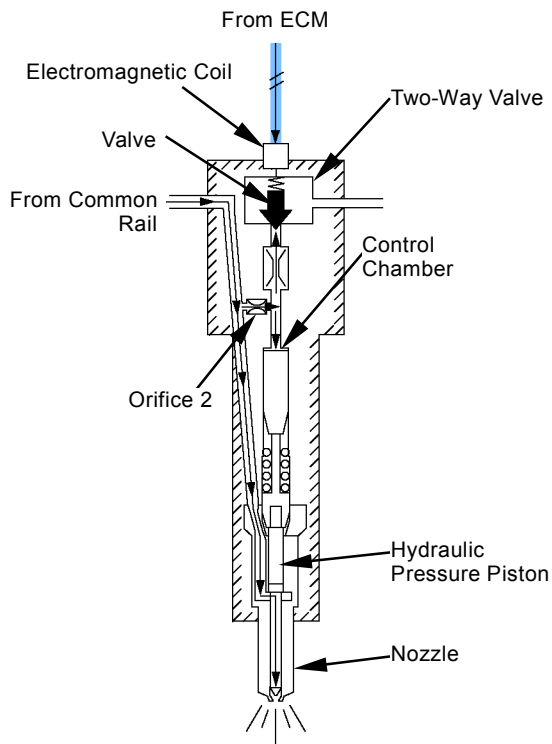
1. Two-Way Valve: ON



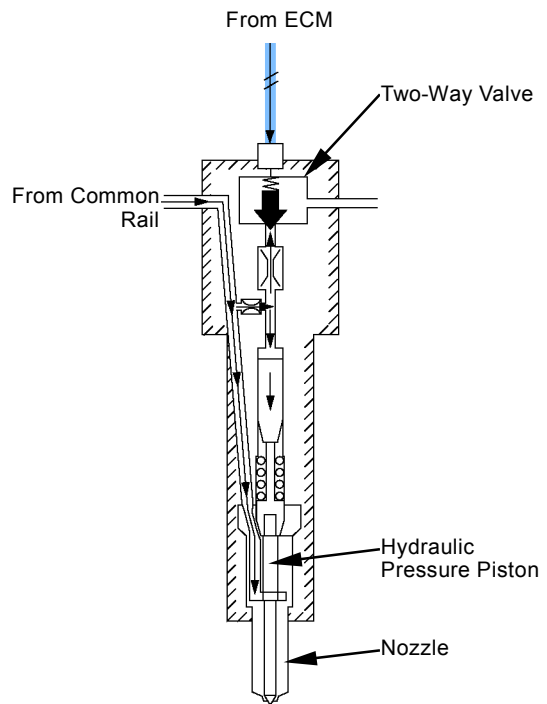
2. Injection Start



3. Two-Way Valve: OFF



4. Injection Stop



T1GR-02-02-012

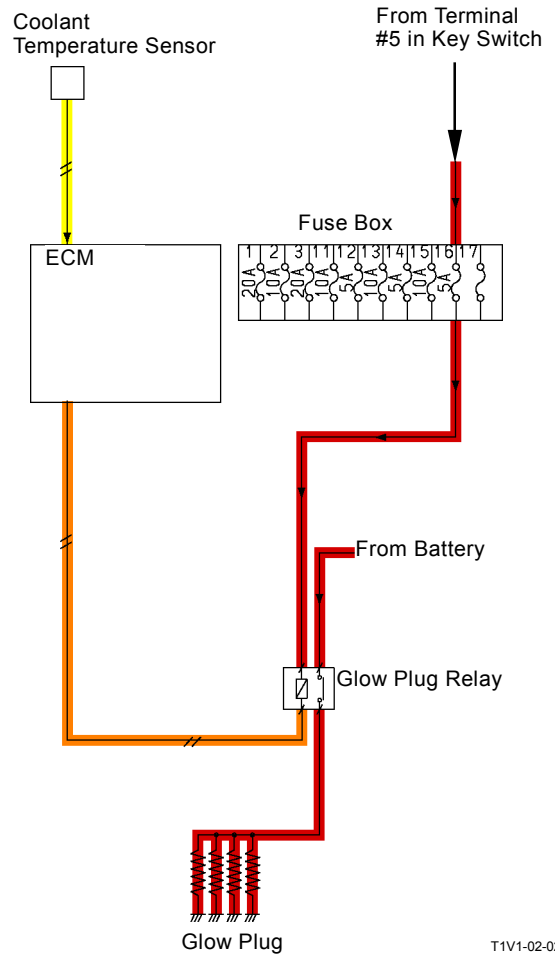
SYSTEM / ECM System

ENGINE START CONTROL

Purpose: Controls time for continuity of electrical current for the glow plug according to coolant temperature and improves the starting of engine.

Operation:

1. The coolant temperature sensor sends the signals according to coolant temperature to ECM.
2. ECM connects the ground circuit of glow plug relay according to the signals and controls time for continuity of electrical current for the glow plug.



T1V1-02-02-003

SYSTEM / ECM System

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SYSTEM / ECM System

EGR (EXHAUST GAS RECIRCULATION) CONTROL

Purpose: Re-circulates a part of exhaust gas in the intake manifold and combines it with intake-air. Therefore, combustion temperature is lowered and generation of oxide of nitrogen (NOx) is controlled.

Operation:

- EGR Gas Amount Control

1. ECM decides EGR gas amount according to engine speed, fuel flow rate, coolant temperature, atmospheric pressure and intake-air temperature.
2. ECM drives EGR motor, opens EGR valve and sends EGR gas to the intake manifold in response to engine condition so that EGR gas is combined with intake-air.
3. At the same time, ECM detects the opening amount of EGR valve by using EGR motor position sensor.

- EGR Gas Cooling

EGR gas is cooled by the cooling system in EGR gas passage.

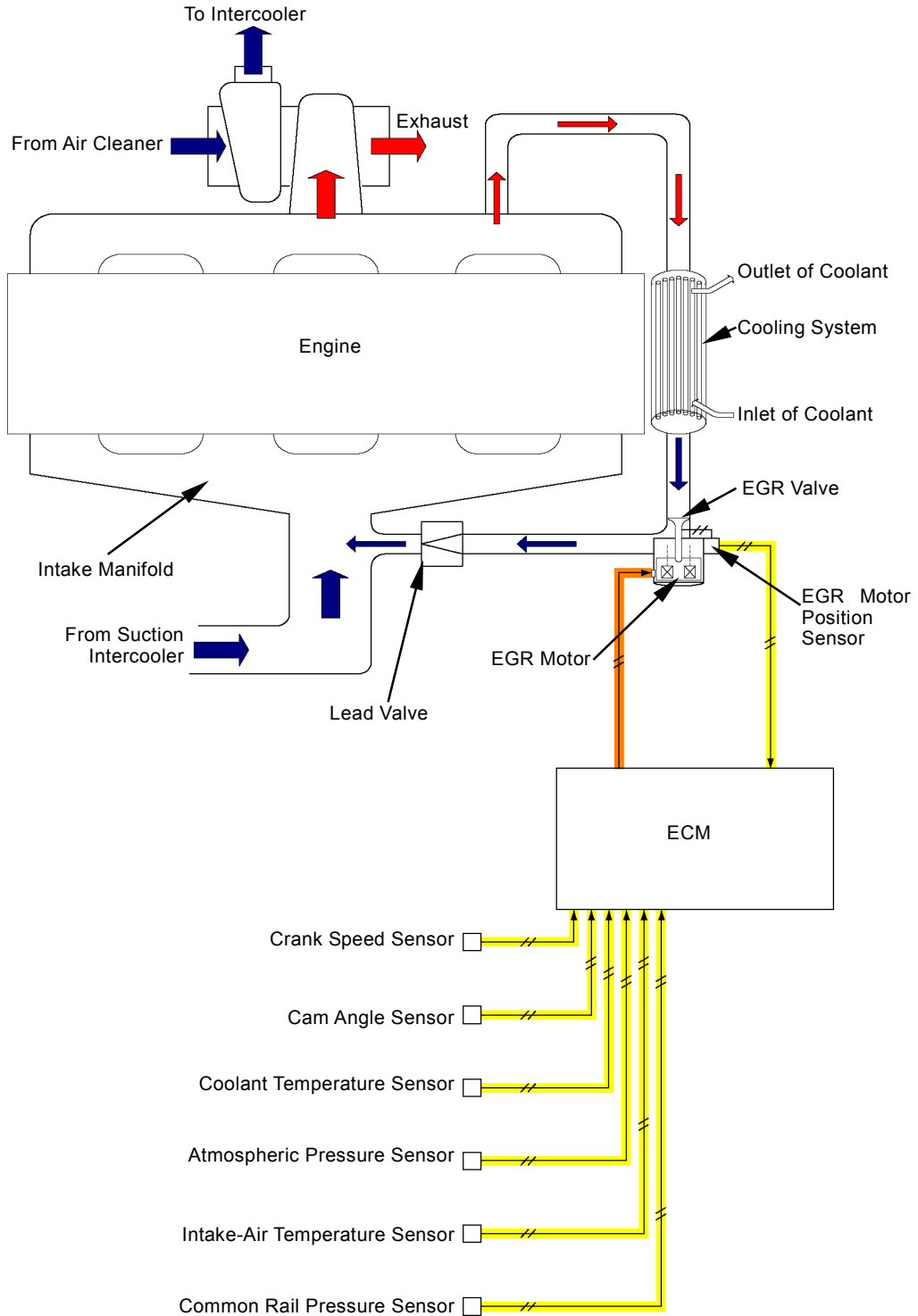
Cooled EGR gas is combined with intake-air so that combustion temperature is lowered and NOx is generated lower than normal EGR gas.

- Lead Valve

Lead valve prevents fresh air from entering into the EGR gas passage and EGR gas from flowing in reverse direction.

Therefore, EGR gas flows to one direction and EGR gas amount increases.

SYSTEM / ECM System



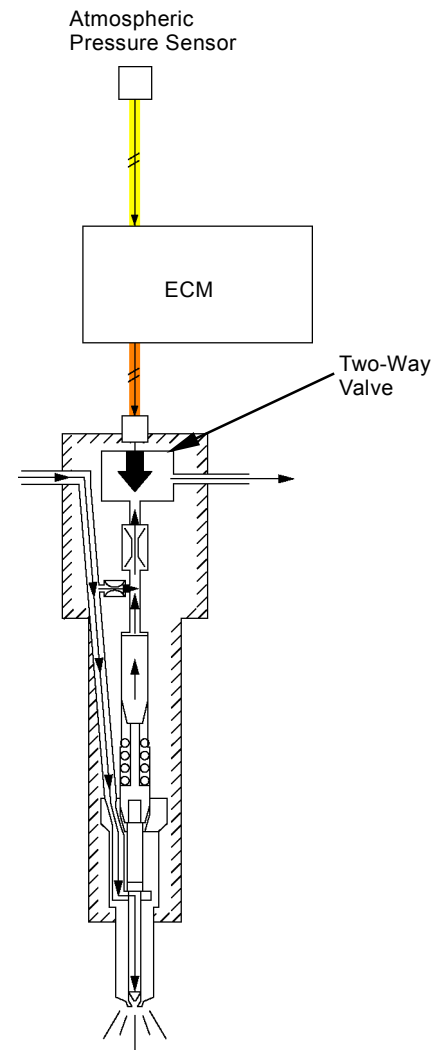
T1V1-02-02-007

SYSTEM / ECM System

FUEL INJECTION AMOUNT CORRECTION

Operation:

1. The atmospheric pressure sensor sends the signals according to atmospheric condition to ECM.
2. ECM calculates atmospheric pressure according to the signals, controls the two-way valve in injector and corrects fuel injection amount.



T1GR-02-02-002

SYSTEM / ECM System

(Blank)

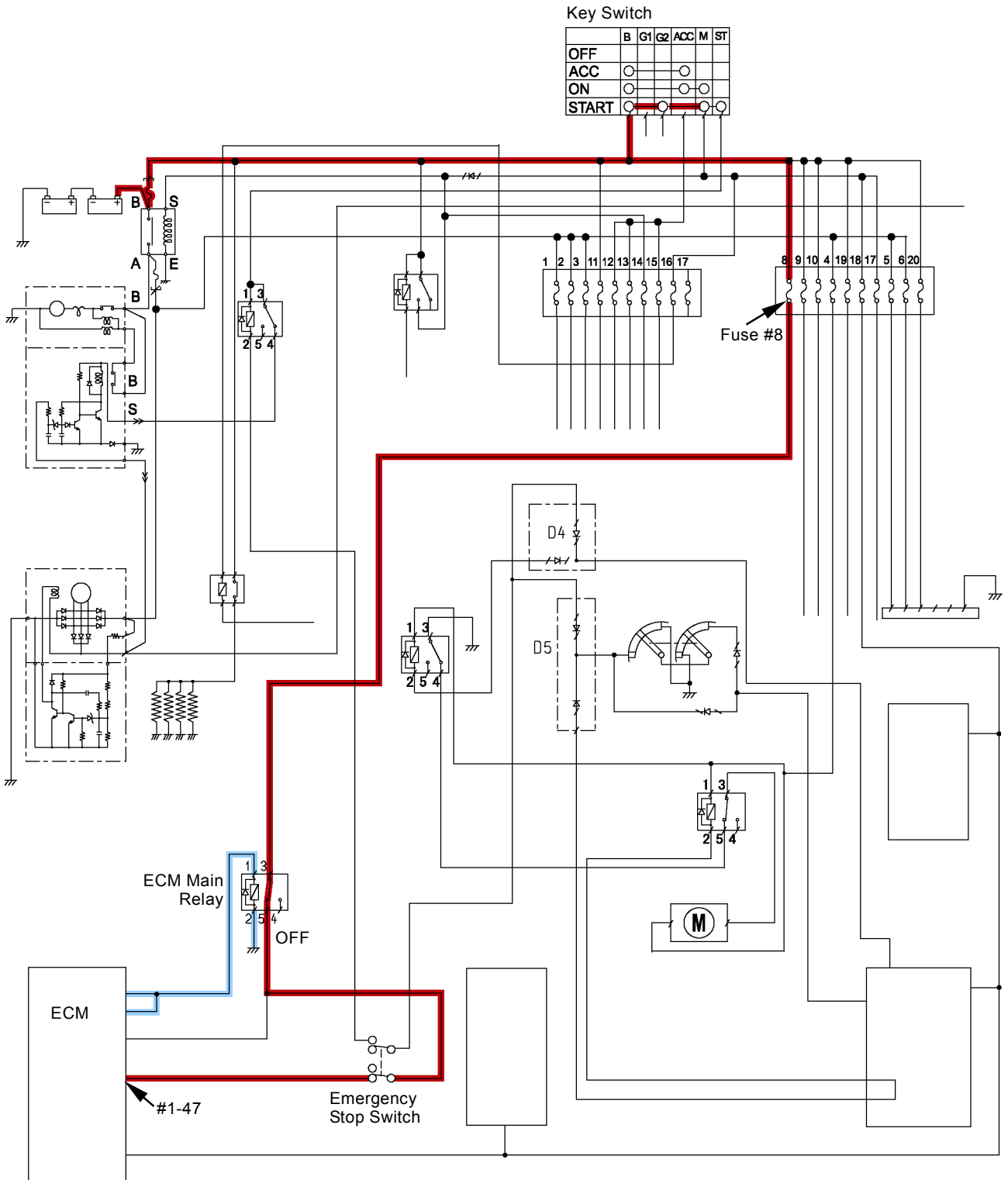
SYSTEM / ECM System

ENGINE STOP CONTROL

Operation:

1. When turning the emergency stop switch ON, electrical current from the battery flows to the terminal #1-47 in ECM through fuse #8 and 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.

SYSTEM / ECM System



T1V1-02-05-010

SYSTEM / ECM System

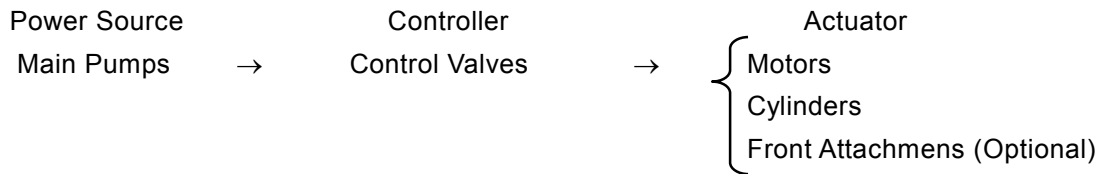
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SYSTEM / Hydraulic System

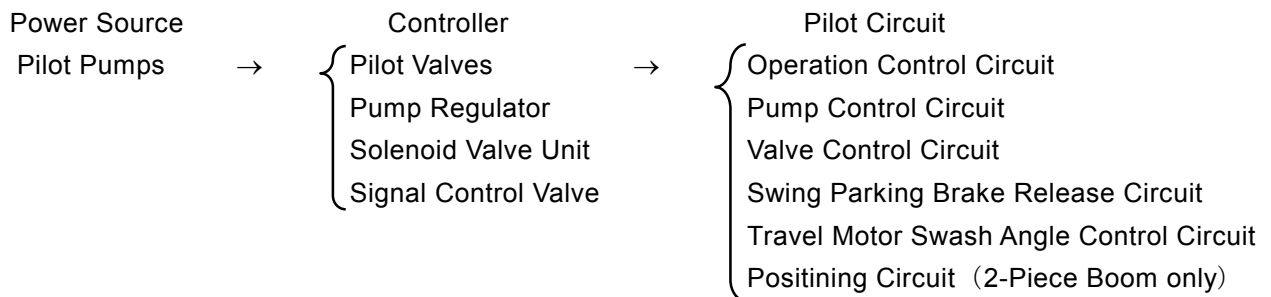
OUTLINE

The hydraulic system mainly consists of main circuit and pilot circuit.

Main Circuit:



Pilot Circuit:



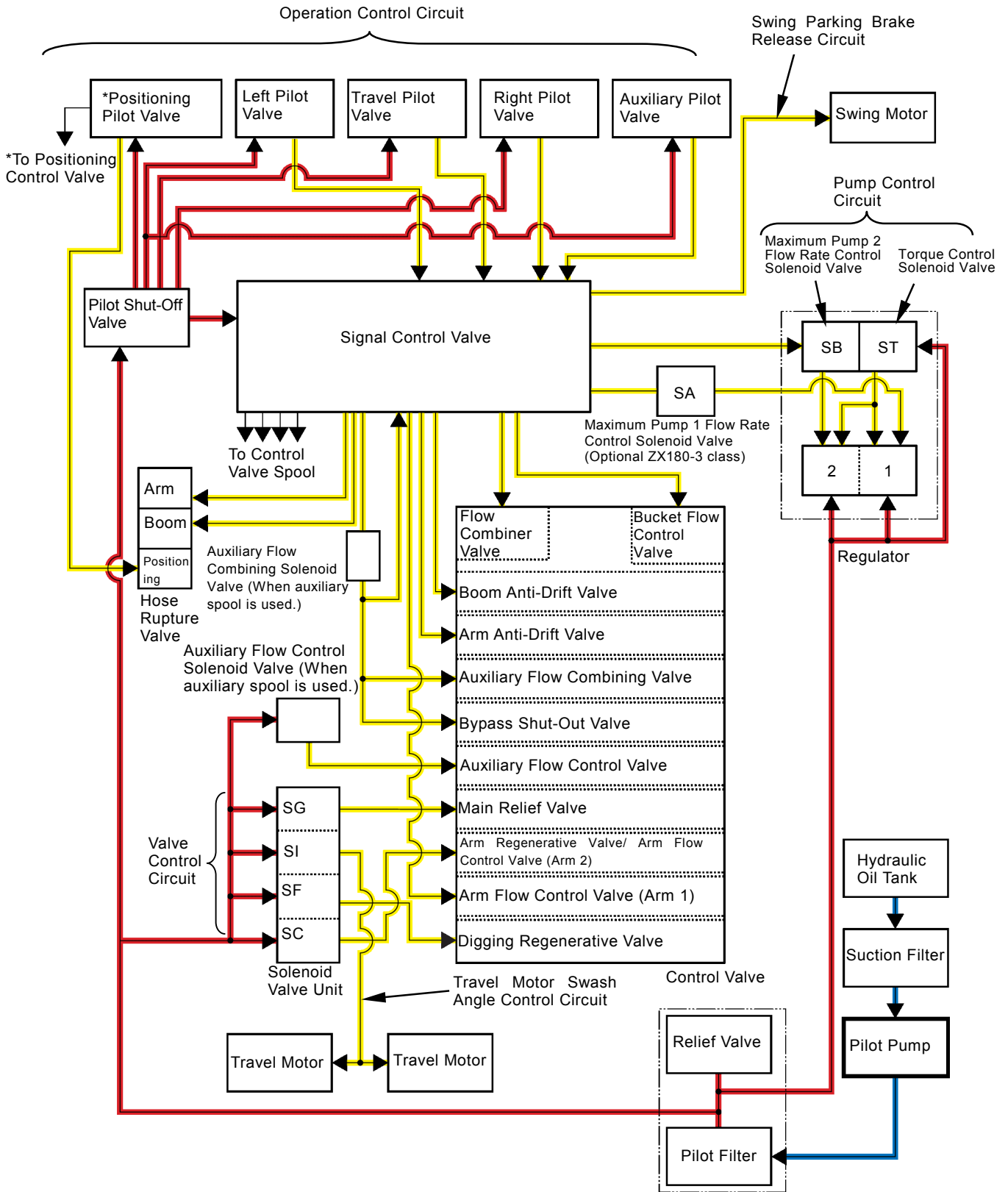
SYSTEM / Hydraulic System

PILOT CIRCUIT

Outline:

- Pressure oil from the pilot pump is used in order to the operation control circuit, pump control circuit, valve control circuit, swing parking brake release circuit, travel motor swash angle control circuit and positioning circuit (optional).

SYSTEM / Hydraulic System



T1V1-02-03-104

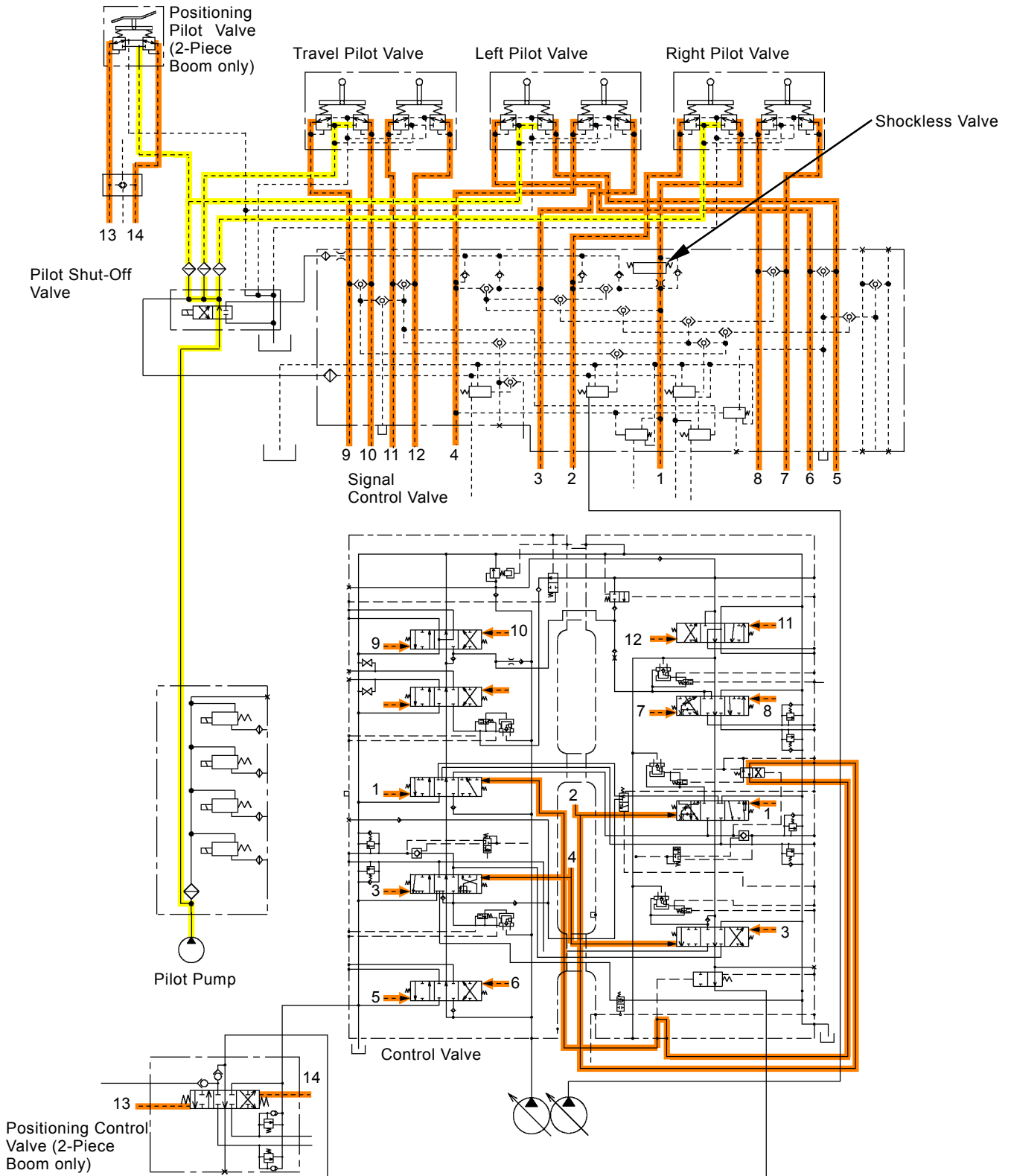
NOTE: *2 (2-Piece boom only)

SYSTEM / Hydraulic System

Operation Control Circuit

- The pilot valve controls pressure oil from the pilot pump and moves the spool in control valve.
- The signal control valve is provided between pilot valve and control valve. The shockless valve (boom lower circuit) built in the signal control valve dampens quick spool movement in the control valve. (Refer to the Signal Control Valve in COMPONENT OPERATION.)

SYSTEM / Hydraulic System




T1V1-02-03-011

- | | | | |
|------------------|---------------------|---------------------------|---------------------------|
| 1 - Boom Raise | 5 - Left Swing | 9 - Left Travel Forward | 12 - Right Travel Reverse |
| 2 - Boom Lower | 6 - Right Swing | 10 - Left Travel Reverse | 13 - Positioning Lower |
| 3 - Arm Roll-Out | 7 - Bucket Roll-In | 11 - Right Travel Forward | 14 - Positioning Raise |
| 4 - Arm Roll-In | 8 - Bucket Roll-Out | | |

SYSTEM / Hydraulic System

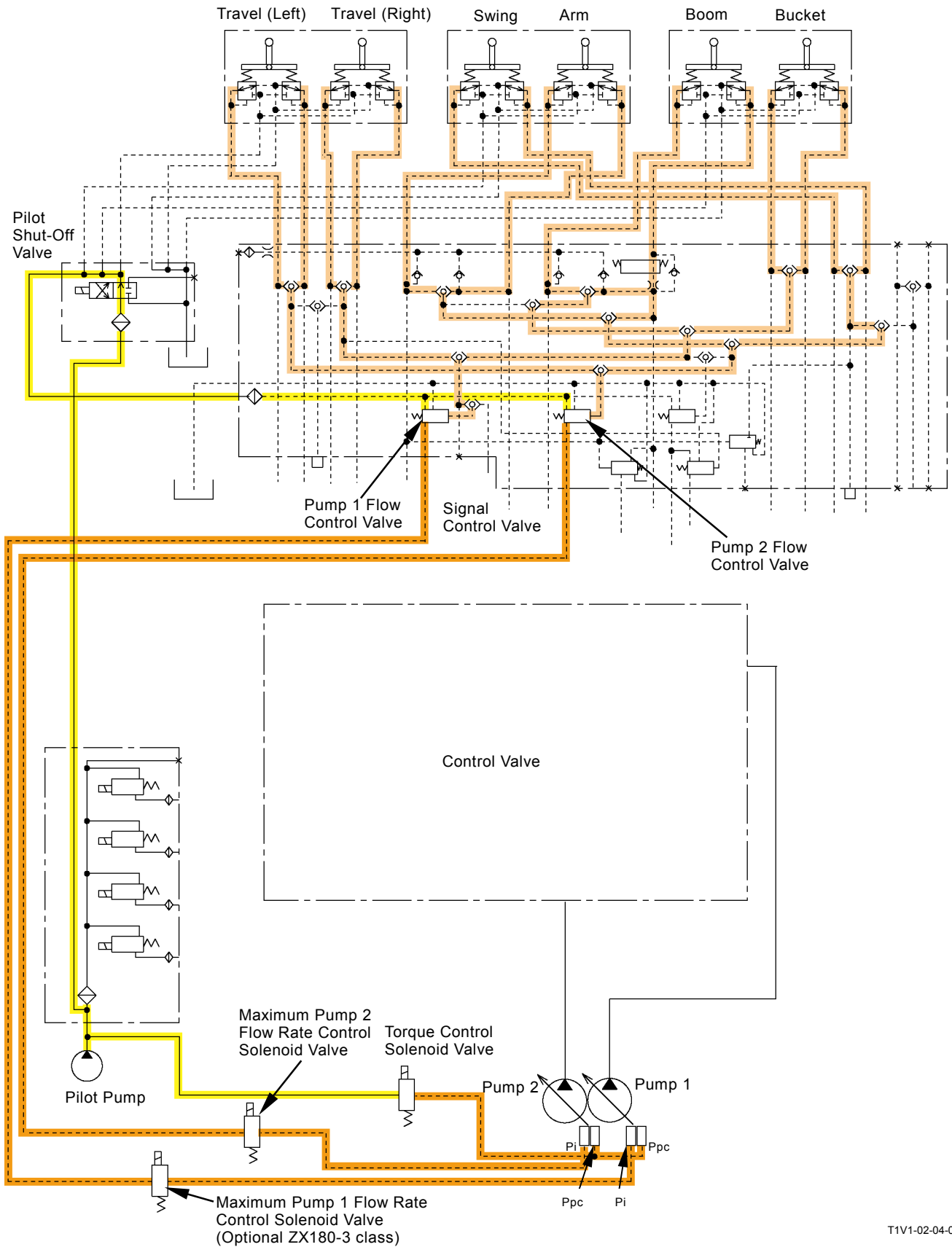
Pump Control Circuit (Refer to the Pump Device section in COMPONENT OPERATION.)

- Pump Delivery Flow Rate Control by Flow Rate Control Pressure P_i
 - The pilot pressure from control valve is selected by the shuttle valve in signal control valve so that the pump 1 flow control valve or pump 2 flow control valve in the signal control valve is shifted.
 - Pilot pressure from the pilot pump is supplied to the regulator in pump 1 or pump 2 as flow rate control pressure P_i by shifting the pump 1 flow control valve or pump 2 flow control valve.

 **NOTE:** *When operating boom raise/ lower, arm roll-out/in, bucket roll-in/out and travel (right), flow rate control pressure P_i is supplied to main pump1.
When operating boom raise, arm roll-out/in, swing right/left, auxiliary and travel (left), flow rate control pressure P_i is supplied to main pump 2.*

- Pump Control (Speed Sensing) by Torque Control Solenoid Valve
 - Pilot pressure from the pilot pump is controlled by the torque control solenoid valve and supplied to the regulator in pumps 1 and 2 as speed sensing pressure P_{pc} .

SYSTEM / Hydraulic System



T1V1-02-04-001

SYSTEM / Hydraulic System

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 (19) (increasing the set-pressure)
 - Auxiliary Flow Control Solenoid Valve: Auxiliary Flow Control Valve (18) (When the auxiliary spool is used.)
 - 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)
 - Positioning Lower Pilot Pressure (2-Piece Boom), Bypass Shut-Out Valve (10), Hose Rupture Valve (Optional) (15)
 - Positioning Raise Pilot Pressure (2-Piece Boom), 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.)

SYSTEM / Hydraulic System

Swing Parking Brake Release Circuit (Refer to the Swing Device in COMPONENT OPERATION.)

- When operating the front attachment or swing, pilot pressure SH is selected by the shuttle valve in signal control valve and shifts the swing parking brake release spool.
- As a result, the release signal pressure is supplied to the swing motor and the swing parking brake is released.

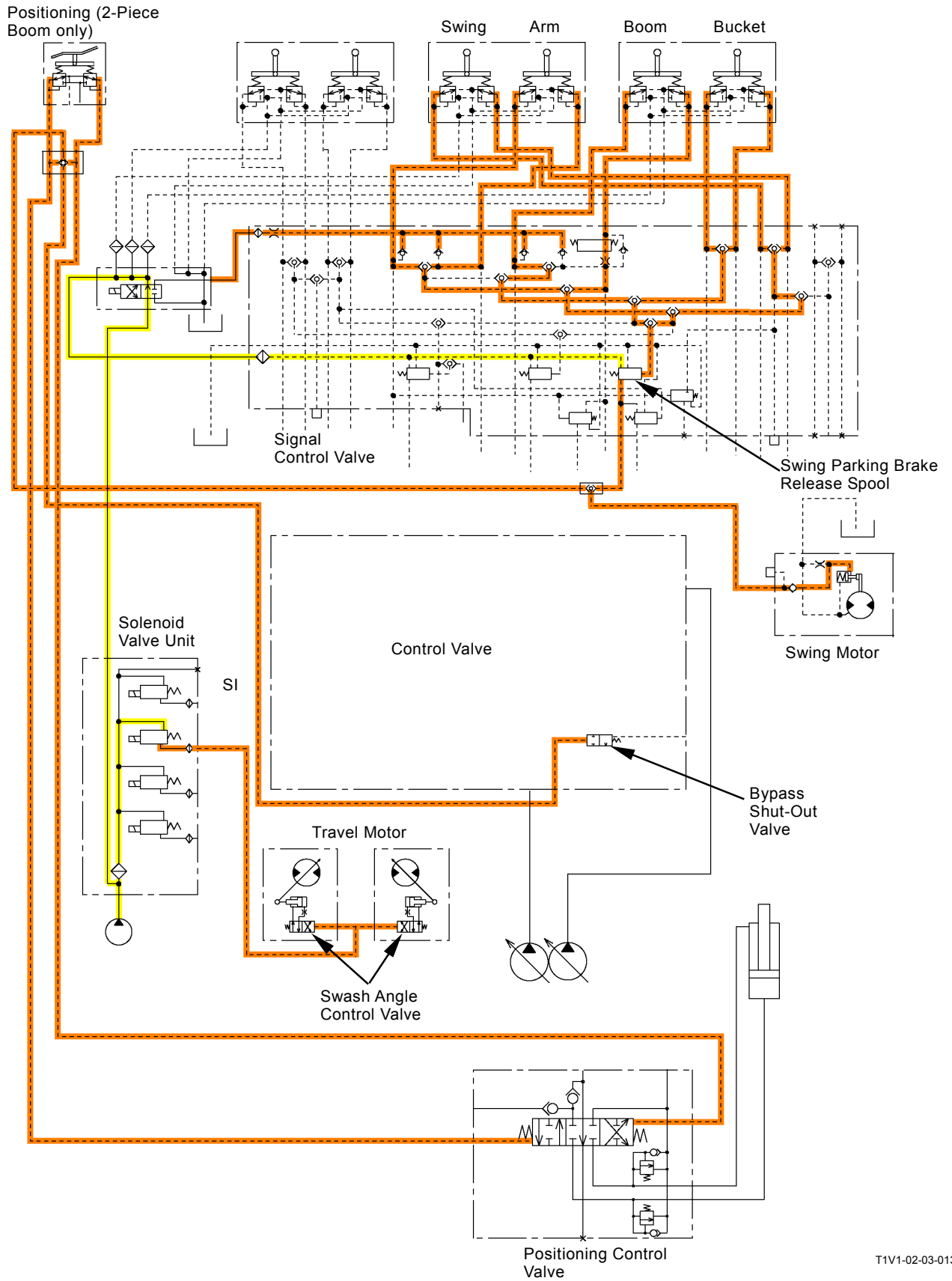
Travel Motor Swash Angle Control Circuit (Refer to the Travel Device in COMPONENT OPERATION.)

- Pilot pressure from solenoid valve unit SI controls the travel motor swash angle control valve.

Positioning Circuit (2-Piece Boom Only) (Refer to the Control Valve in COMPONENT OPERATION.)

- When operating the positioning pedal, pilot pressure from the positioning pilot valve shifts the bypass shut-put valve and the spool in positioning control valve.
- At the same time, the release signal pressure is supplied to the swing motor and the swing parking brake is released.

SYSTEM / Hydraulic System



T1V1-02-03-013

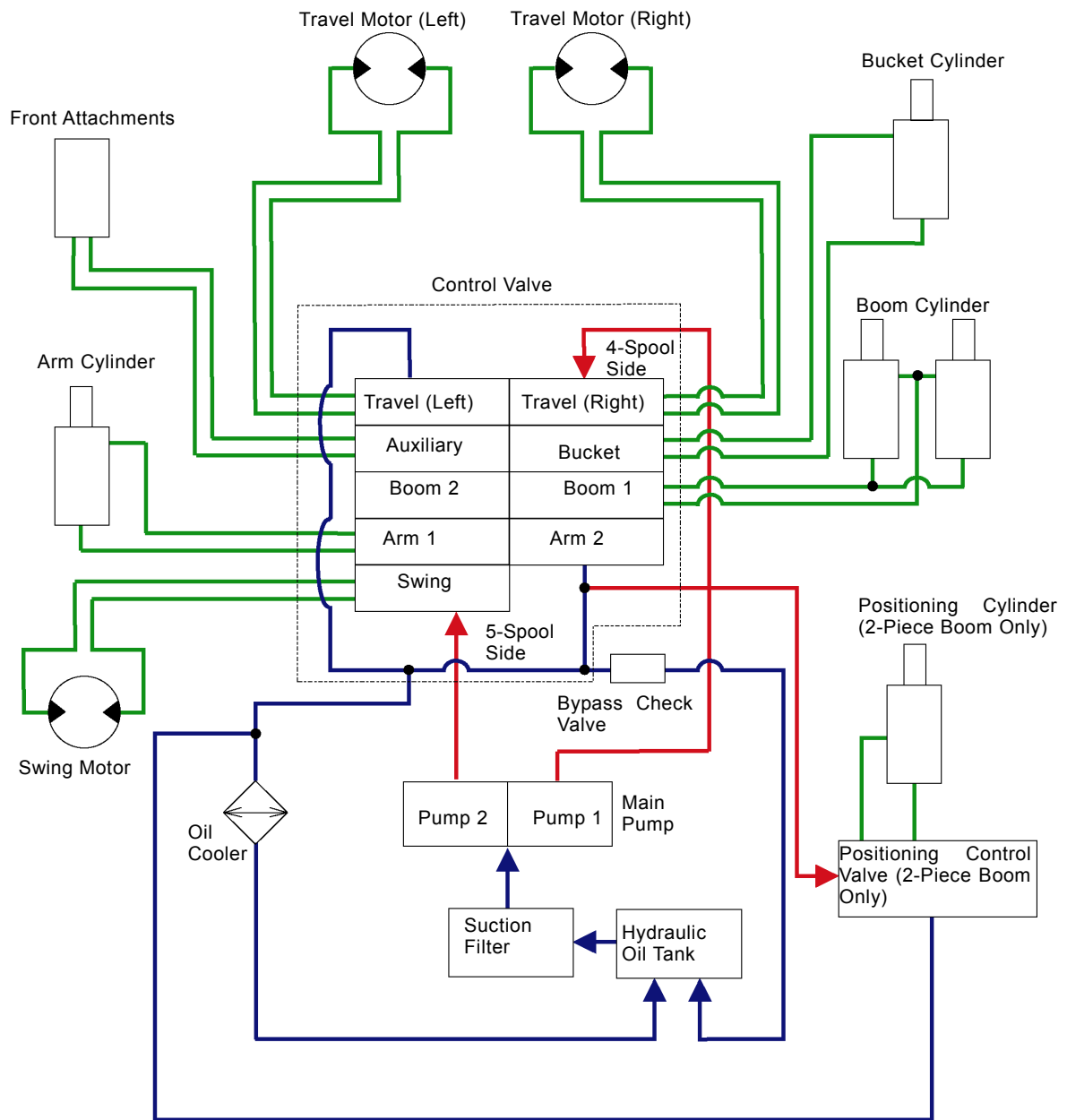
SYSTEM / Hydraulic System

MAIN CIRCUIT

Outline:

- The main pump (pumps 1 and 2) draws hydraulic oil from the hydraulic oil tank. Pump 1 delivers pressure oil to the 4-spool side in control valve and the positioning control valve (2-piece boom only). Pump 2 delivers pressure oil to the 5-spool side in control valve.
- Delivered pressure oil is supplied to the motor and cylinder according to operation of the spool in control valve.
- Return oil from the motor or cylinder returns to the hydraulic oil tank through the control valve and oil cooler.
- If oil temperature is low (with high viscosity), and flow resistance is large in the oil cooler, the bypass check valve opens and hydraulic oil directly returns to the hydraulic oil tank.

SYSTEM / Hydraulic System



T1V1-02-03-103

SYSTEM / Hydraulic System

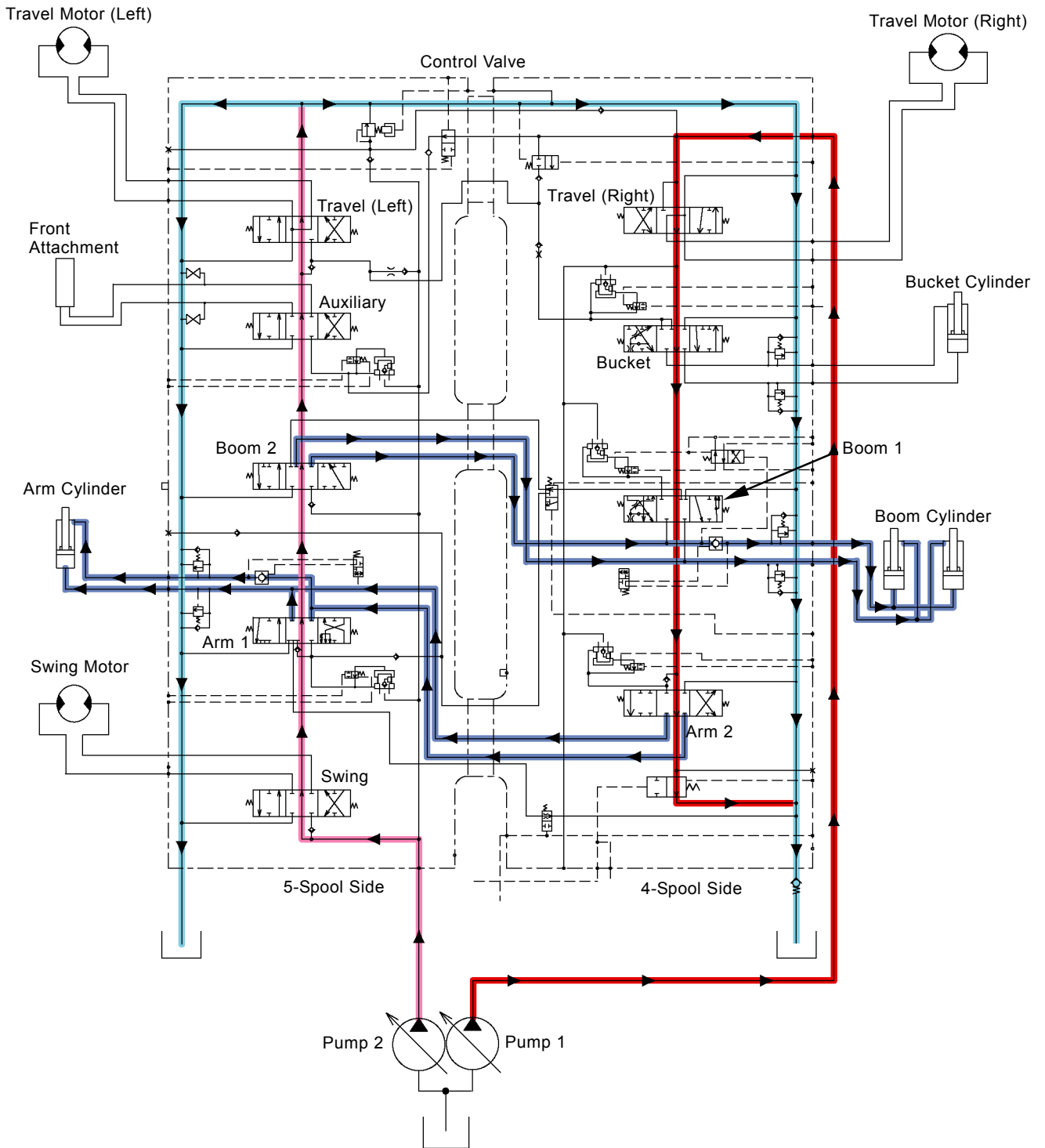
Neutral Circuit

- When the control lever is in neutral, pressure oil from pumps 1 and 2 returns to the hydraulic oil tank through the control valve.

Single Operation Circuit

- Pressure oil from pump 1 flows to each spool of right travel, bucket, boom 1 and arm 2 through the 4-spool control valve.
- Pressure oil from pump 2 flows to each spool of swing, arm 1, boom 2, auxiliary and left travel through the 5-spool control valve.
- The boom and arm are actuated by pressure oil from two pumps and pressure oil from each pump is combined and supplied together.

SYSTEM / Hydraulic System



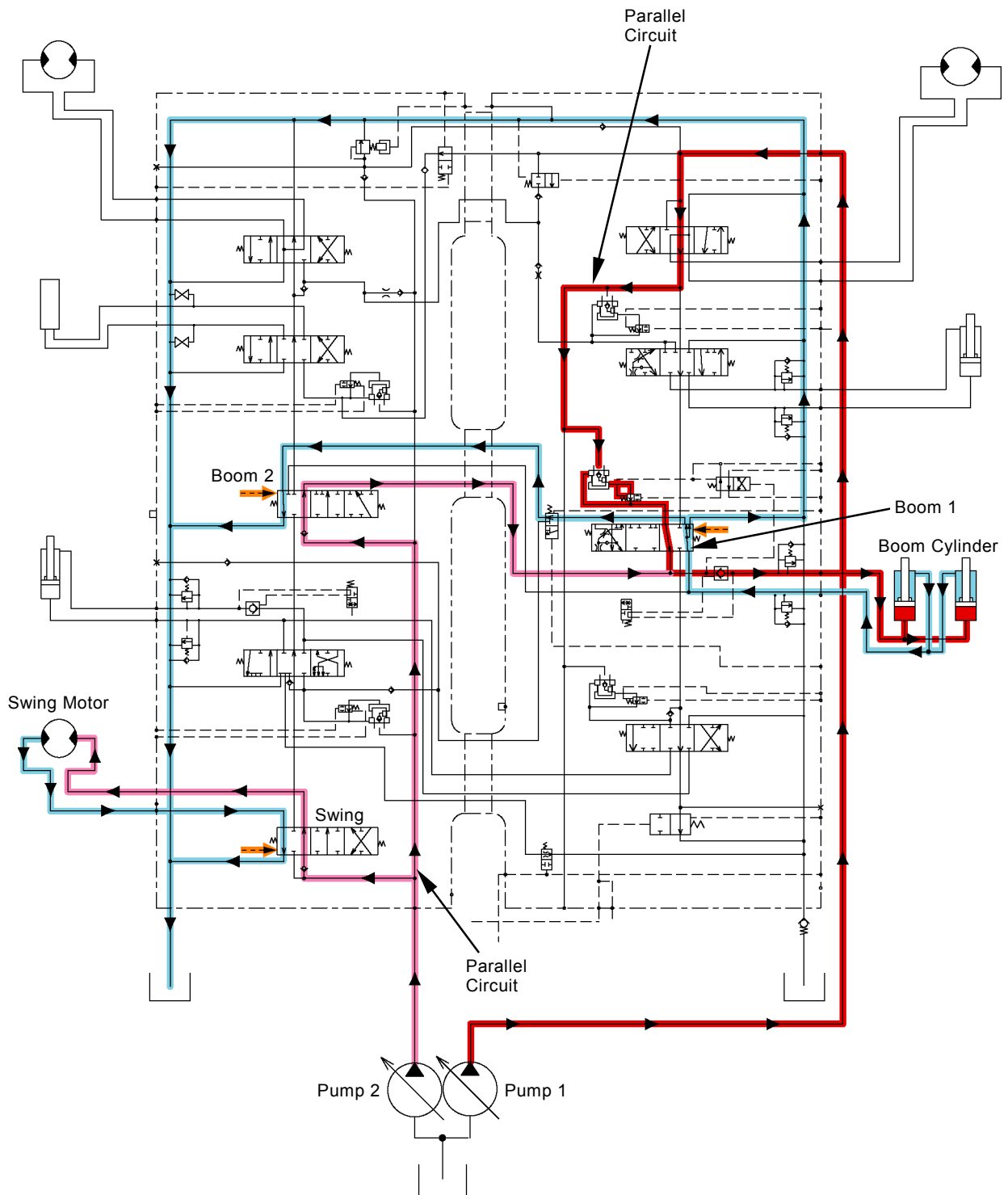
T1V1-02-03-001

SYSTEM / Hydraulic System

Combined Operation Circuit

- Swing and Boom Raise Operation
 - When the boom is raised while swinging, pilot pressure shifts the spools of swing, booms 1 and 2.
 - Pressure oil from pump 1 flows to the boom cylinder from the boom 1 spool through the parallel circuit and raises the boom.
 - Pressure oil from pump 2 flows to the swing motor through the swing spool and swings.
 - At the same time, pressure oil flows to the boom cylinder from the boom 2 spool through the parallel circuit, combines with pressure oil from pump 1 and raises the boom.


SYSTEM / Hydraulic System



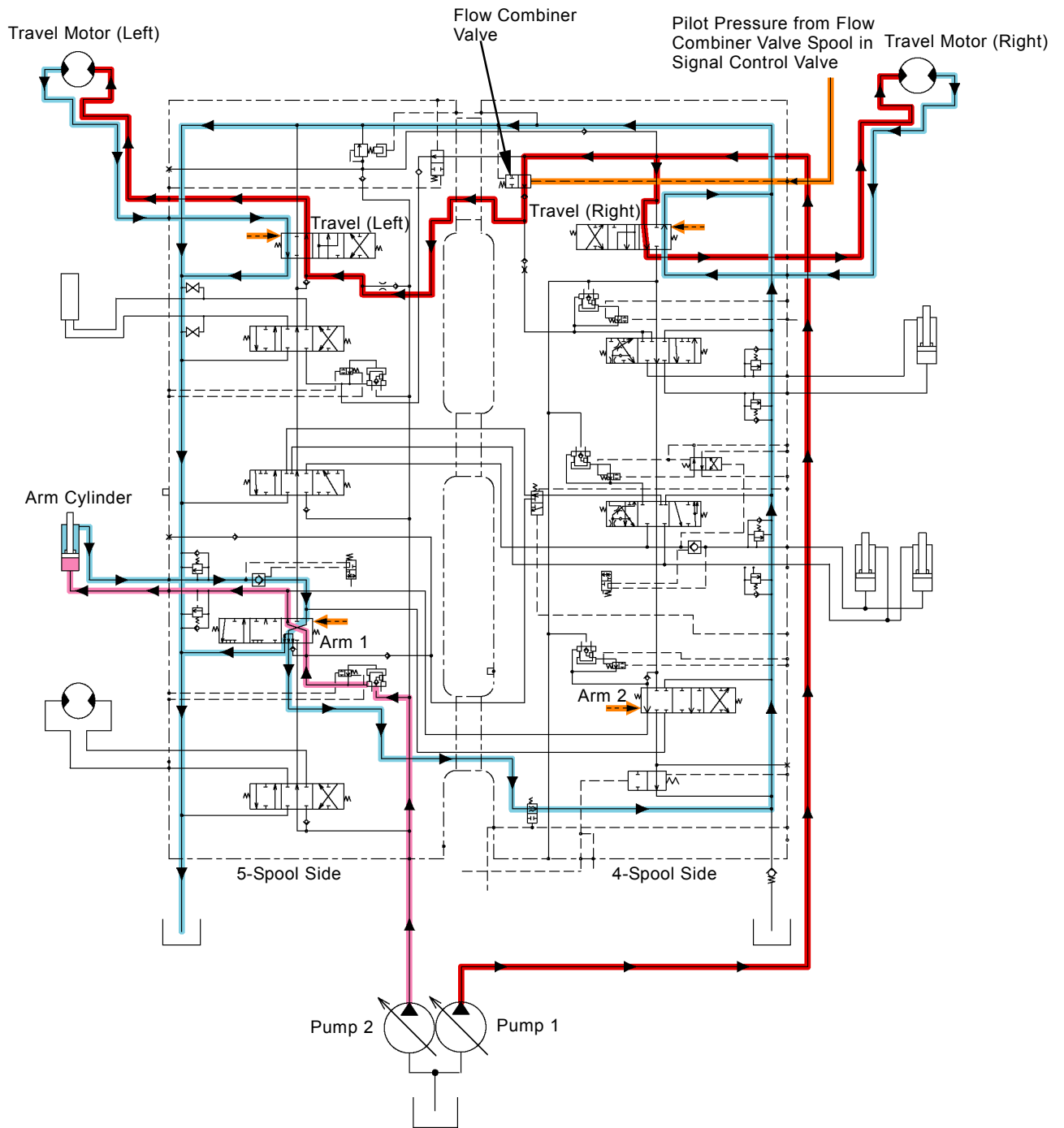
T1V1-02-03-002

SYSTEM / Hydraulic System

- 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.*

SYSTEM / Hydraulic System



T1V1-02-03-003

SYSTEM / Hydraulic System

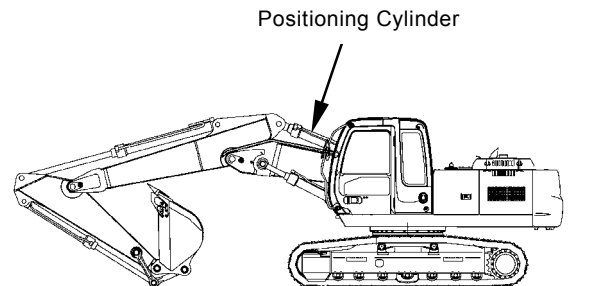
Positioning Circuit (2-Piece Boom Only)

Neutral Circuit

- When the positioning lever is in neutral, pressure oil from pump 1 returns to the hydraulic oil tank through the control valve.

Single Operation Circuit

- During positioning operation, the spools of bypass shut-out valve and positioning control valve are shifted.
- Pressure oil from pump 1 flows to the spool in positioning control valve and moves the positioning cylinder.

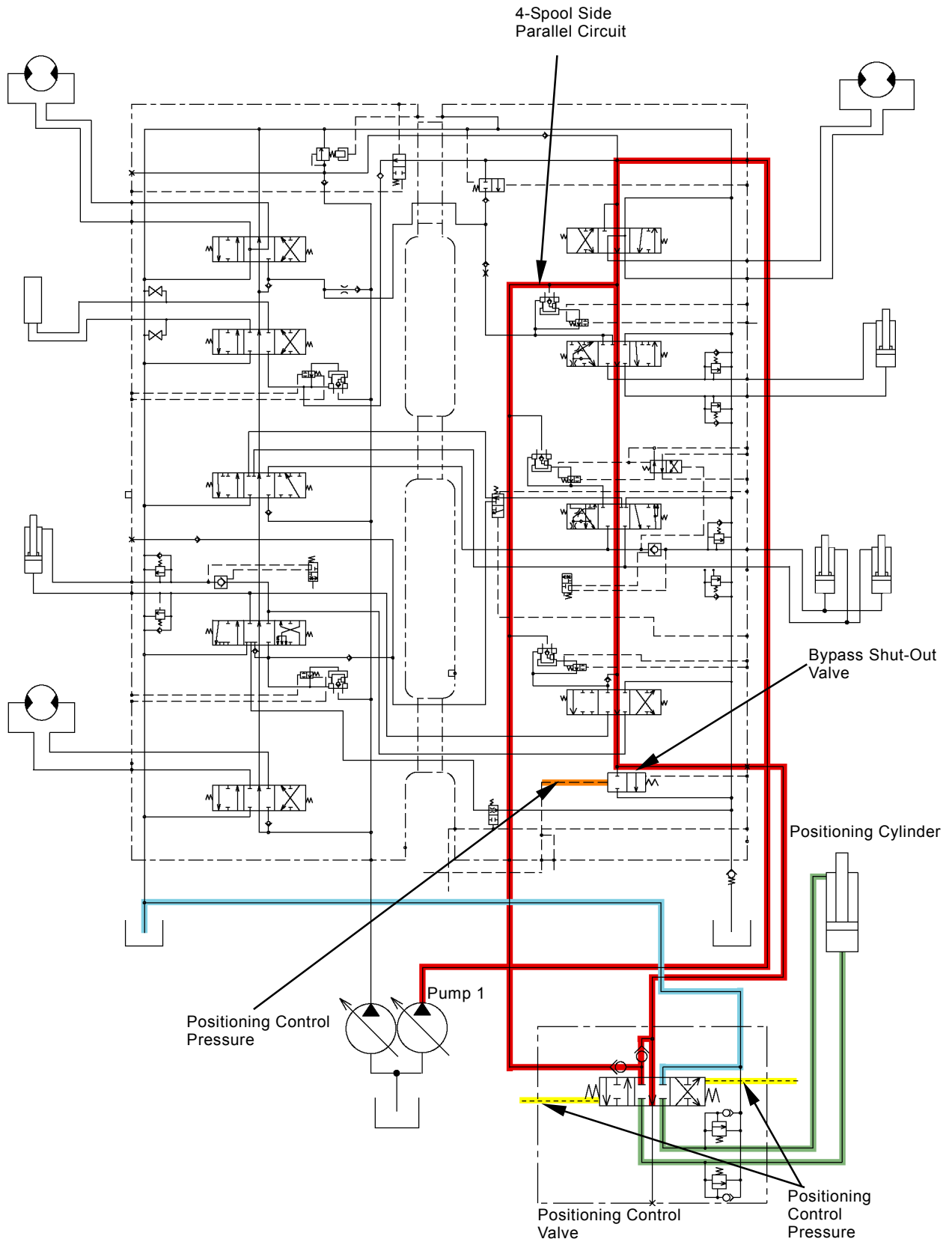


T178-02-02-014

Combined Operation Circuit

- During combined operation of positioning and boom, arm or bucket, pressure oil from pump 1 flows to the positioning cylinder through the 4-spool side parallel circuit in control valve and the spool in positioning control valve.

SYSTEM / Hydraulic System




T1V1-02-03-014

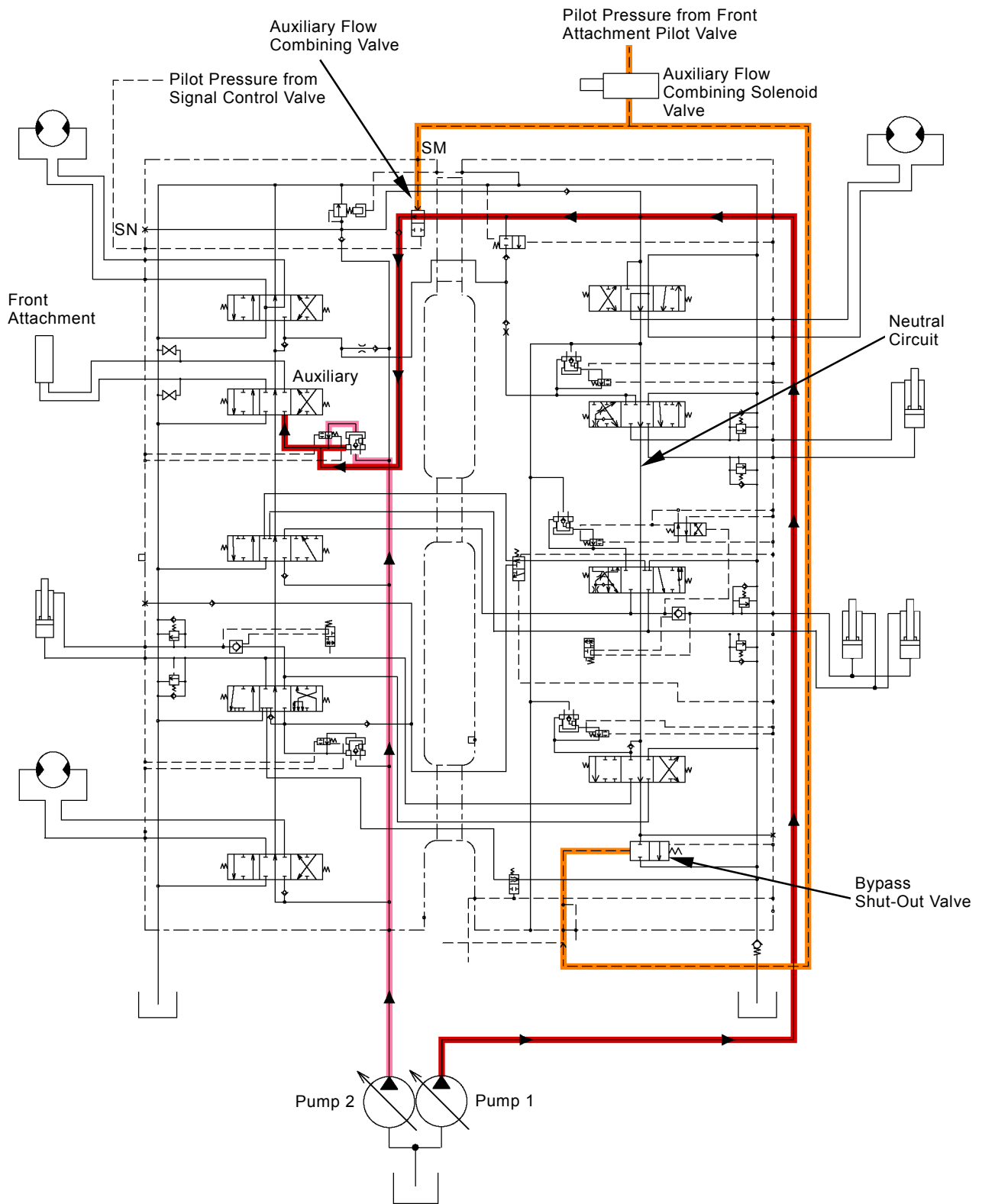
SYSTEM / Hydraulic System

Auxiliary Circuit

- When the front attachment as a hydraulic breaker is operated, pilot pressure from the pilot valve for front attachment shifts the auxiliary flow combining valve and bypass shut-out valve.
- Consequently, the neutral circuit in 4-spool side is blocked. Pressure oil from pump 1 through the auxiliary flow combining valve is combined with pressure oil from pump 2 so that combined pressure oil is supplied to the auxiliary spool.

 **NOTE:** *During operation of boom raise/lower, arm roll-in/out, bucket roll-in/out and right /left travel, pilot pressure from the signal control valve is supplied to port SN and the auxiliary flow combining valve is not shifted. (Refer to the Control System in SYSTEM.)*

SYSTEM / Hydraulic System



T1V1-02-03-004

SYSTEM / Hydraulic System

BOOM LOWER METER-IN CUT CONTROL


Purpose: During combined operation of boom lower and arm, bucket, swing or travel with the front attachment above the ground, pressure oil to the boom cylinder from the pump is cut, the boom falls due to own weight by using the regenerative circuit, pressure oil is used for other actuators and the control speed increases.

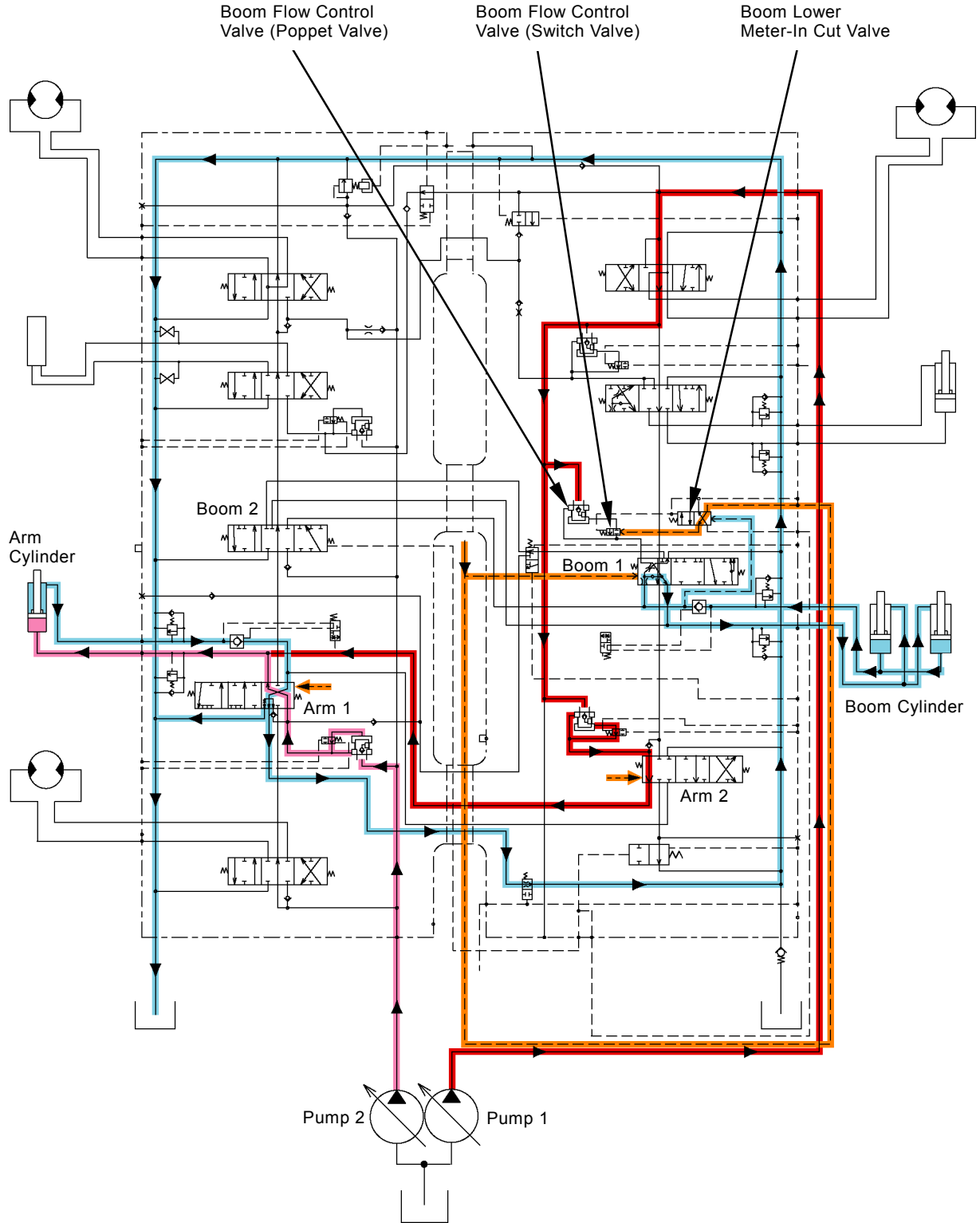
Operation:

Boom Cylinder Bottom Pressure: High Pressure (with the front attachment above the ground)

1. During combined operation of boom lower and other actuators with the boom raised, the boom lower meter-in cut valve is shifted by the boom cylinder bottom pressure. As boom lower pilot pressure does not act due to the boom lower meter-in cut valve, the boom 2 spool does not move.
2. The boom flow control valve (switch valve) is closed by boom lower pilot pressure.
3. Back pressure in the boom flow control valve (poppet valve) increases and the boom flow control valve (poppet valve) is closed.
4. Pressure oil to the boom 1 spool from pump 1 is cut by the boom flow control valve (poppet valve).
5. Pressure oil in the boom cylinder bottom side flows to the boom cylinder rod side through the boom 1 spool due to boom own weight.
6. As all pressure oil from pumps 1 and 2 is used for actuators except the boom, the control speed increases.

SYSTEM / Hydraulic System

 NOTE: The illustration shows combined operation of boom lower and arm roll-in.



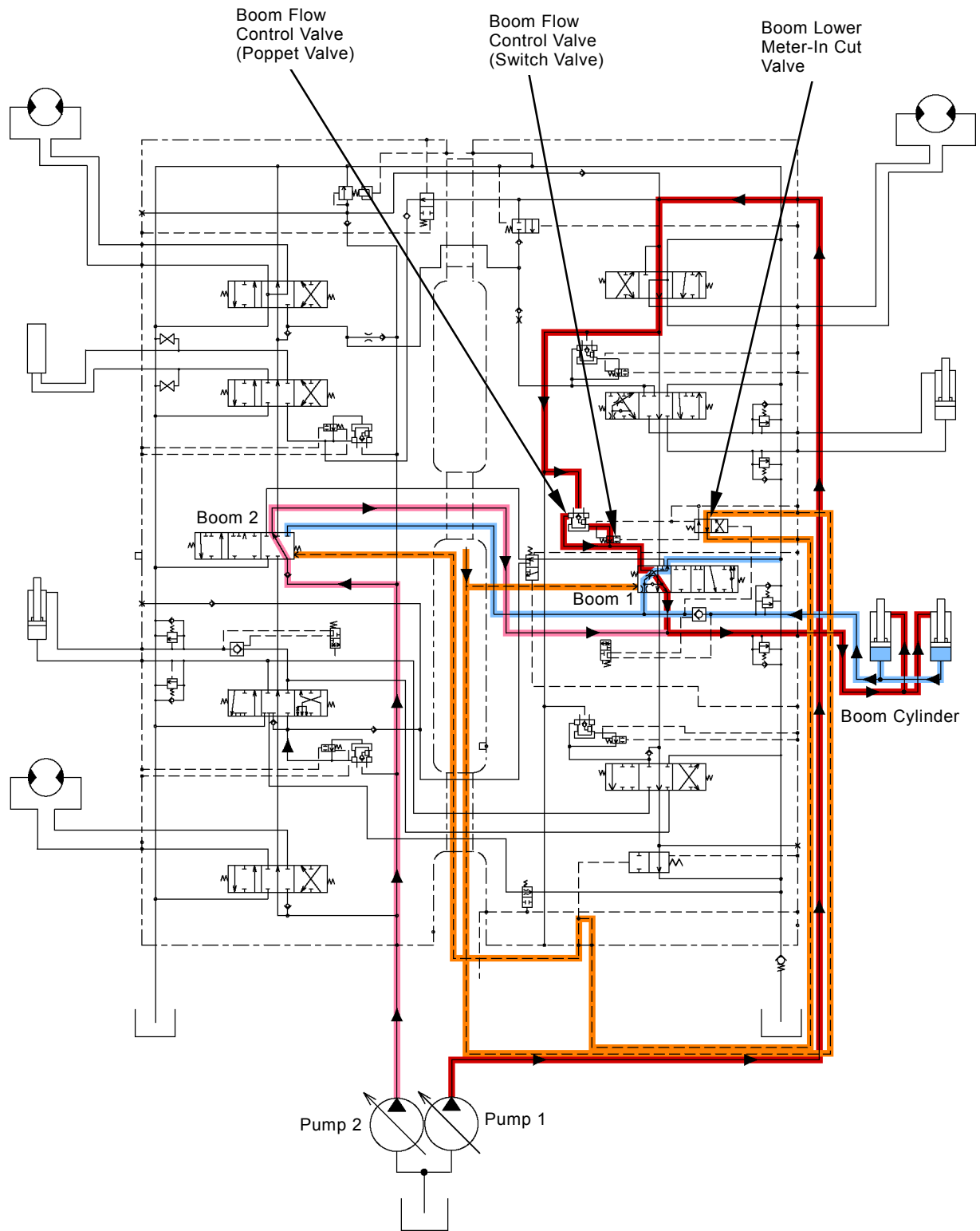
T1V1-02-03-005

SYSTEM / Hydraulic System

Boom Cylinder Bottom Pressure: Low Pressure (Jack-Up)

1. During boom lower operation with the angle between boom and arm at 90 to 110 ° and the bucket on the ground, the boom cylinder bottom pressure becomes low and the boom lower meter-in cut valve is shifted.
2. As boom lower pilot pressure is released, the boom flow control valve (switch valve) and boom flow control valve (poppet valve) are opened. Boom lower pilot pressure moves the boom 2 spool.
3. Pressure oil from pump 1 passes through the boom 1 spool. Pressure oil from pump 2 through the boom 2 spool is combined with pressure oil from the boom 1 spool and combined pressure oil flows to the boom cylinder rod side.

SYSTEM / Hydraulic System



T1V1-02-03-006

SYSTEM / Hydraulic System

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SYSTEM / Electrical System

OUTLINE

The electrical circuit is broadly divided into the main circuit, monitor circuit and control circuit.

- Main Circuit
The engine and accessory operation related circuit.
- Monitor Circuit
The electrical circuit group consists of the monitors, sensors and switches, and displays the machine operation status.
- Control Circuit (Refer to Control System / SYSTEM.)
The control circuit is categorized into the engine, pump and valve control circuits. Each circuit consists of the actuators such as solenoid valves, MC (main controller), ECM (engine control module), switch boxes, sensors and pressure switches.

SYSTEM / Electrical System

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)]
- Surge Voltage Prevention Circuit
Prevents the occurrence of surge 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.

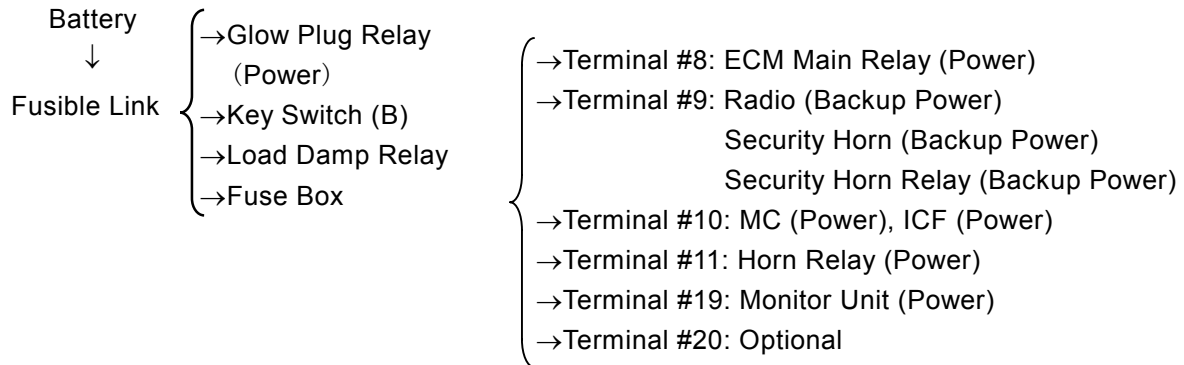
SYSTEM / Electrical System

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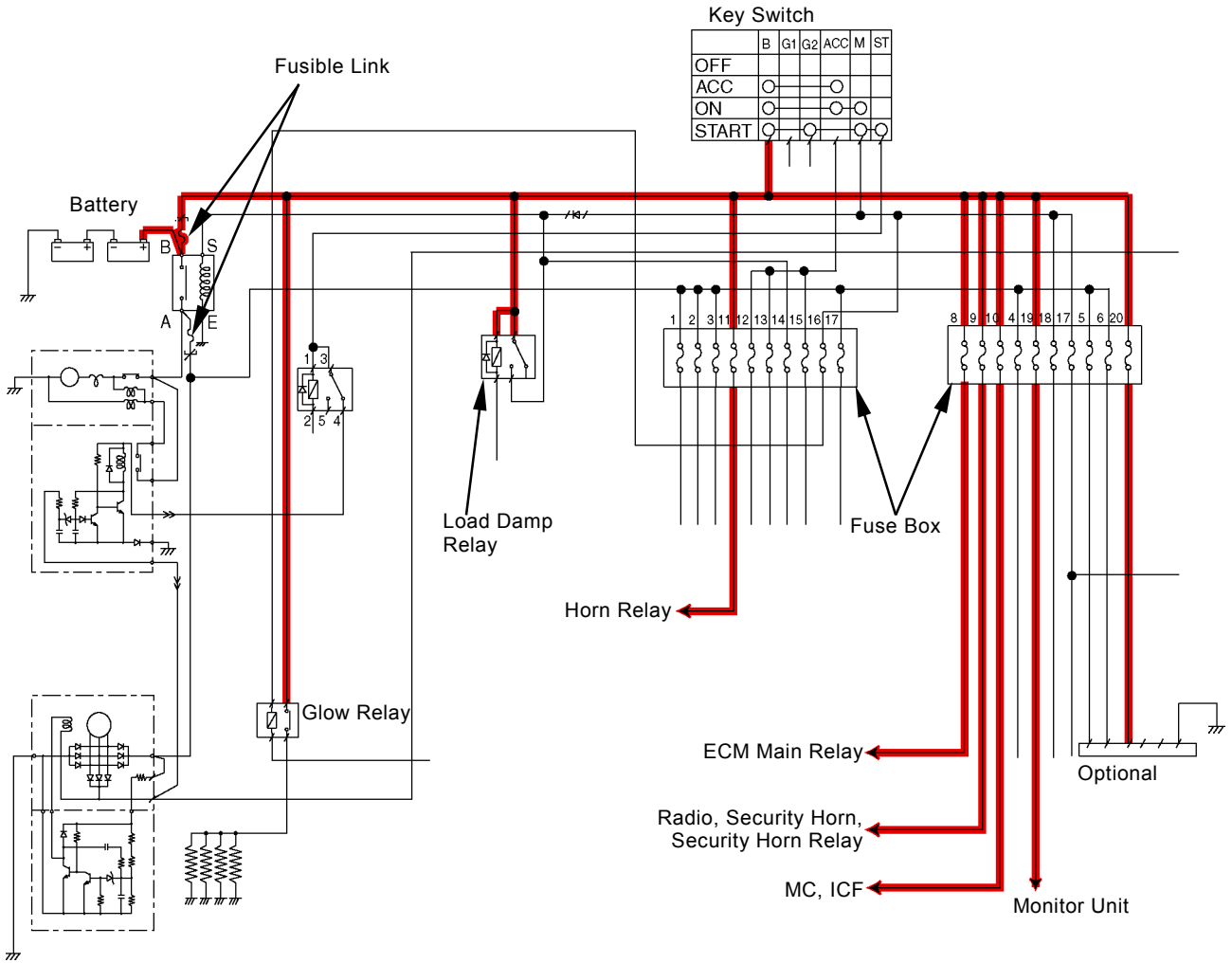
SYSTEM / Electrical System

ELECTRIC POWER CIRCUIT (KEY SWITCH: OFF)

The battery ground terminal is connected to the vehicle frame. Current from the battery plus terminal flows as shown below when the key switch is turned OFF.



SYSTEM / Electrical System



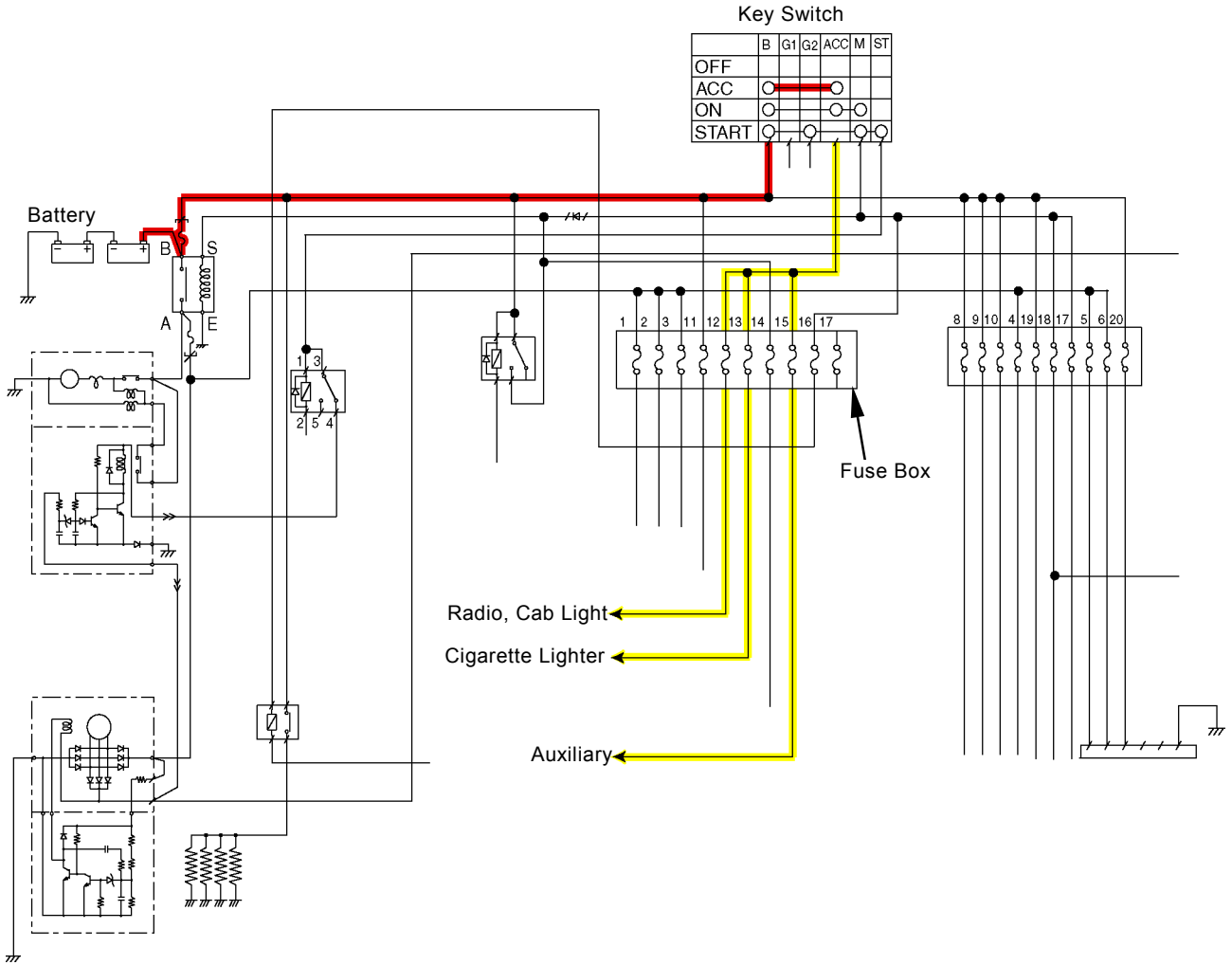
T1V1-02-05-001

SYSTEM / Electrical System

ACCESSORY CIRCUIT

- When the key switch is turned to the ACC position, terminal B is connected to terminal ACC in the key switch.
- Current from key switch terminal ACC flows to radio (#12), cab light (#12), lighter (#13) and auxiliary (#15) through the fuse box and makes each accessory operable.

SYSTEM / Electrical System



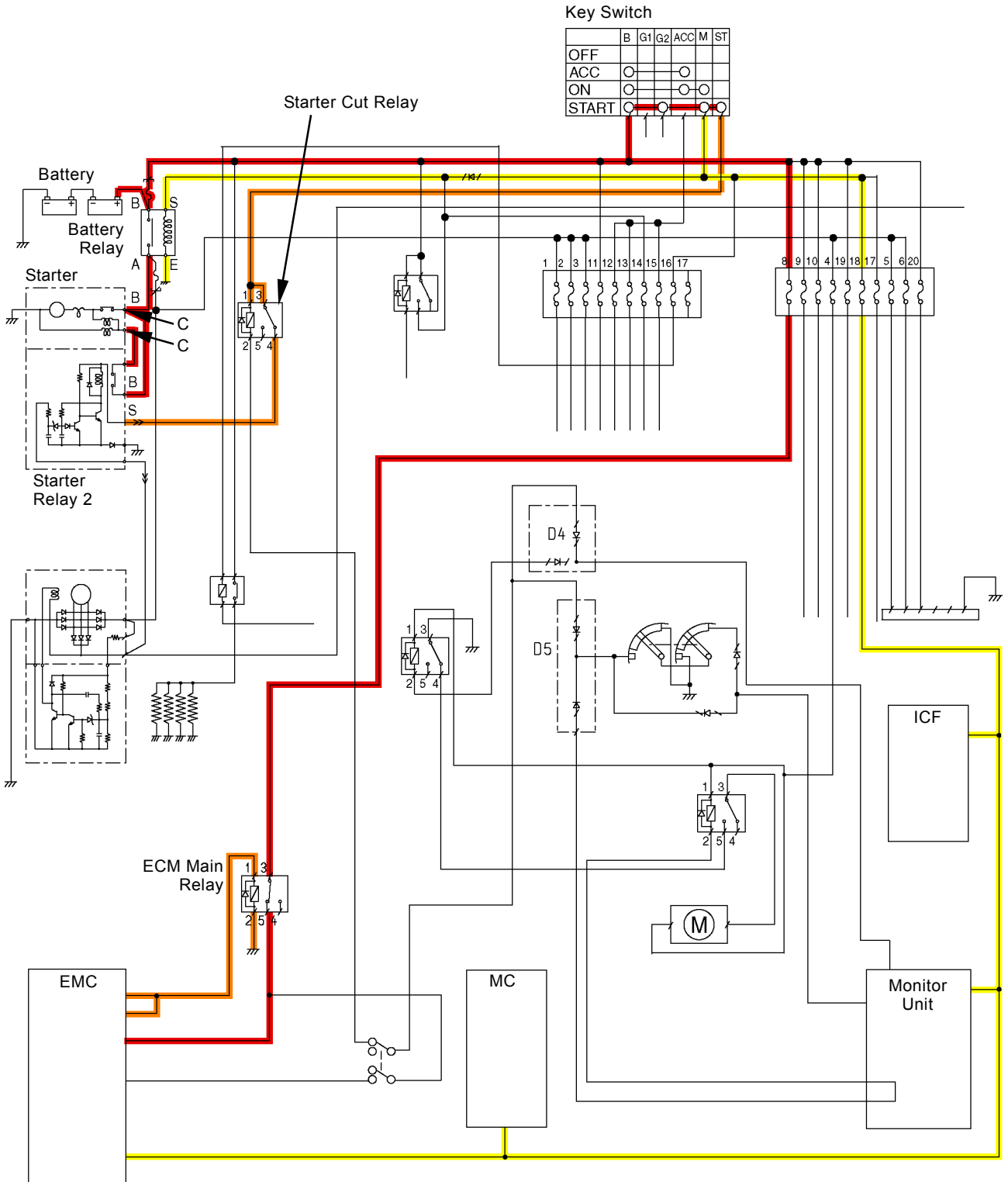
T1V1-02-05-002

SYSTEM / Electrical System

STARTING CIRCUIT (KEY SWITCH: START)

1. When the key switch is turned to the START position, terminal B is connected to terminals M and ST in the key switch.
2. As current from terminal M excites the battery relay, battery current is routed to starter terminal B and starter relay 2 terminal B through the battery relay.
3. Current from terminal ST flows to starter relay 2 terminal S through the starter cut relay.
4. Current flows to the starter relay 2 coil and starter relay 2 is turned ON.
5. Current flows to starter terminal C from starter relay 2 terminal C.
6. Consequently, the relay in starter is turned ON so that the starter begins rotating.
7. On the other hand, current from key switch terminal M flows to MC, ICF, the monitor unit and ECM through fuse #18 as a signal indicating that the key switch is in the ON or START position.
8. As soon as ECM receives this signal, ECM turns the ECM main relay ON.
9. Current from the battery flows to ECM through fuse #8 and the ECM main relay and the main power is turned ON.
10. ECM makes the engine starting condition.

SYSTEM / Electrical System



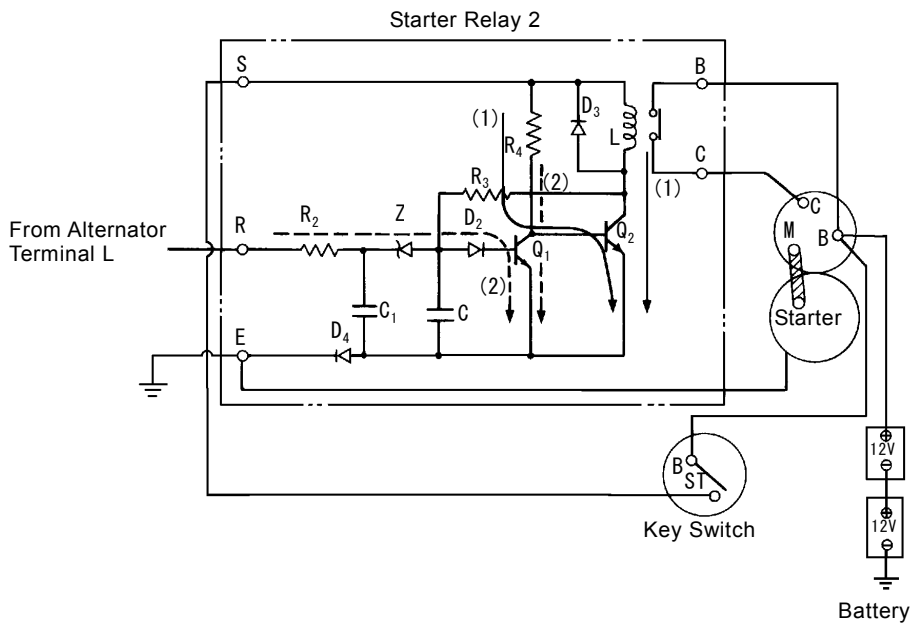
T1V1-02-05-007

SYSTEM / Electrical System

Starter Relay 2 Operation

1. When the key switch is turned to the START position, key switch terminal B is connected to terminal ST. Current is routed to the base in transistor (Q2) through resistance R4 in starter relay 2. Then, transistor (Q2) is turned ON and current flows to coil (L) in starter relay 2. Therefore, starter terminal B is connected to terminal C and the starter is operated.
2. After the engine starts, the alternator starts generating electricity and voltage at starter relay 2 terminal R increases.
3. When this voltage increases up to 21 to 22 V, Zener diode (Z) is turned ON. Consequently, transistor (Q1) is turned ON. Then, current to the base of transistor (Q2) does not flow and transistor (Q2) is turned OFF. At this moment, starter terminal B is disconnected from terminal C and the starter is turned OFF.

Condenser C1 is used to stabilize the operating voltage. Diode D4 protects the circuit in case the battery terminals are reversely connected.



T107-04-04-003


SYSTEM / Electrical System

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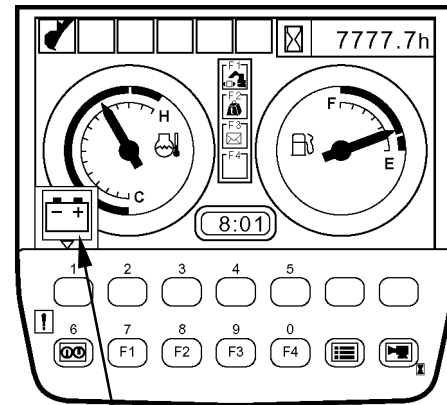
SYSTEM / Electrical System

CHARGING CIRCUIT (KEY SWITCH: ON)

1. After the engine starts and the key switch is released, the key switch moves to the ON position.
2. Key switch terminal B is connected to terminals ACC and M in the key switch with the key switch ON.
3. The alternator starts generating electricity with the engine running. Current from alternator terminal B flows to the batteries through the battery relay and charges the batteries.
4. Current from alternator terminal L flows to the monitor unit, turns the alternator alarm OFF and flows to ICF.

 **NOTE:** Monitor unit detects the alternator charging according to power from the alternator and turns the alternator alarm OFF.

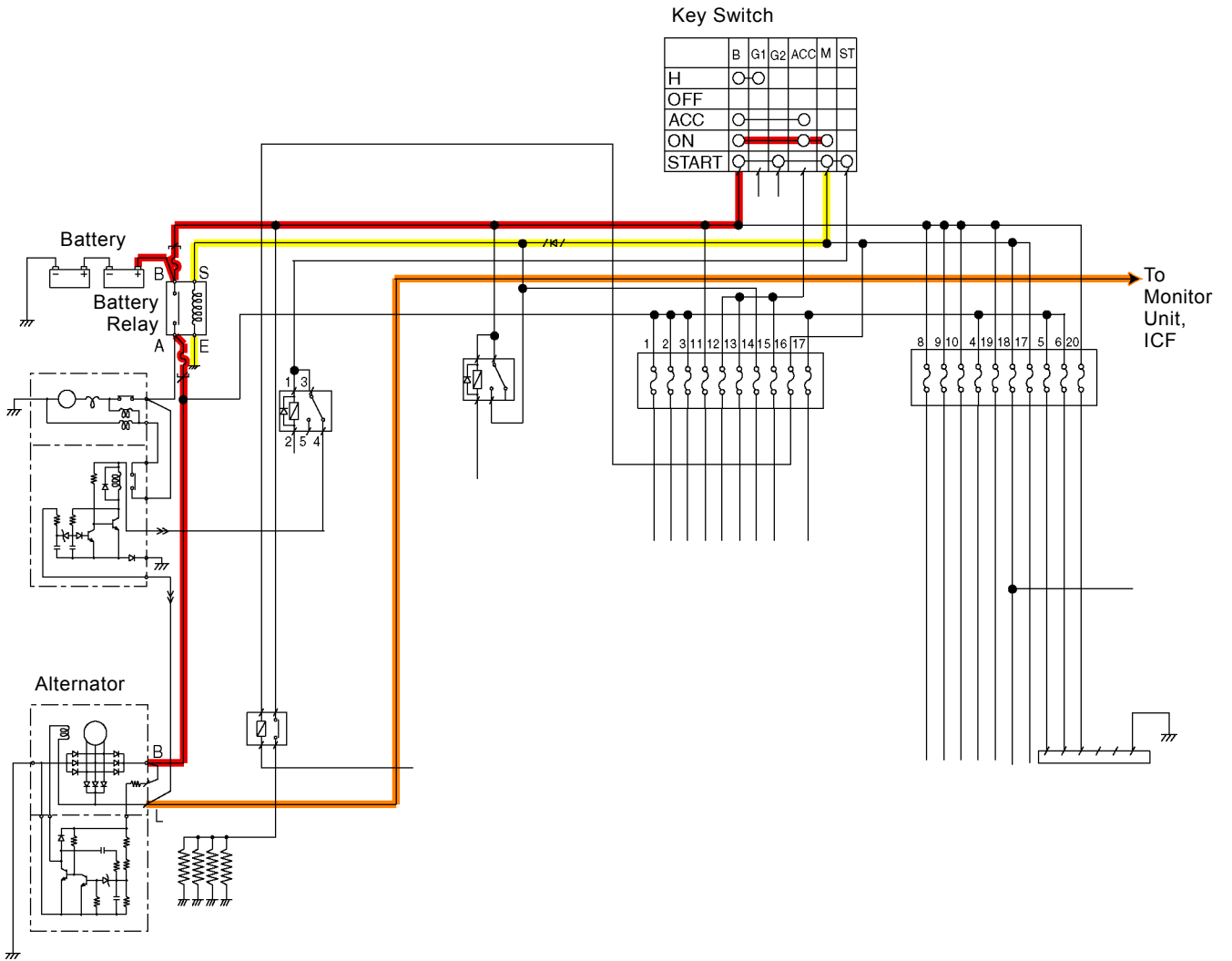
Monitor Unit



Alternator Alarm

T1V1-05-01-117

SYSTEM / Electrical System

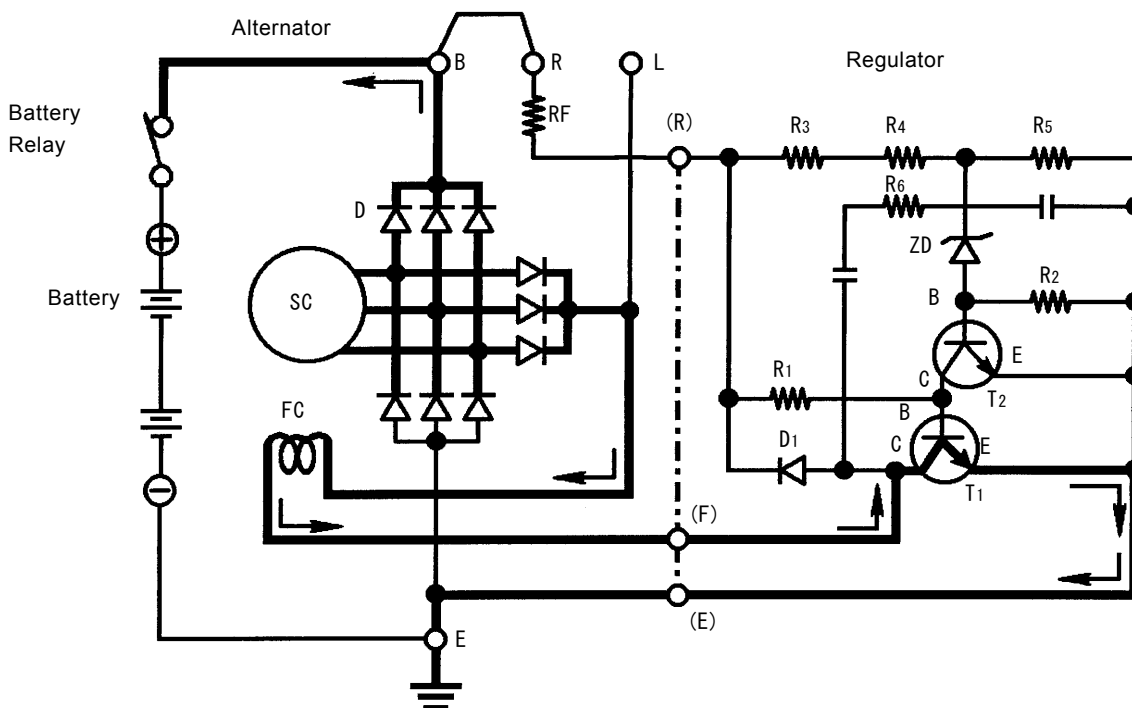


T1V1-02-05-003

SYSTEM / Electrical System

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).
- 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.
- 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.

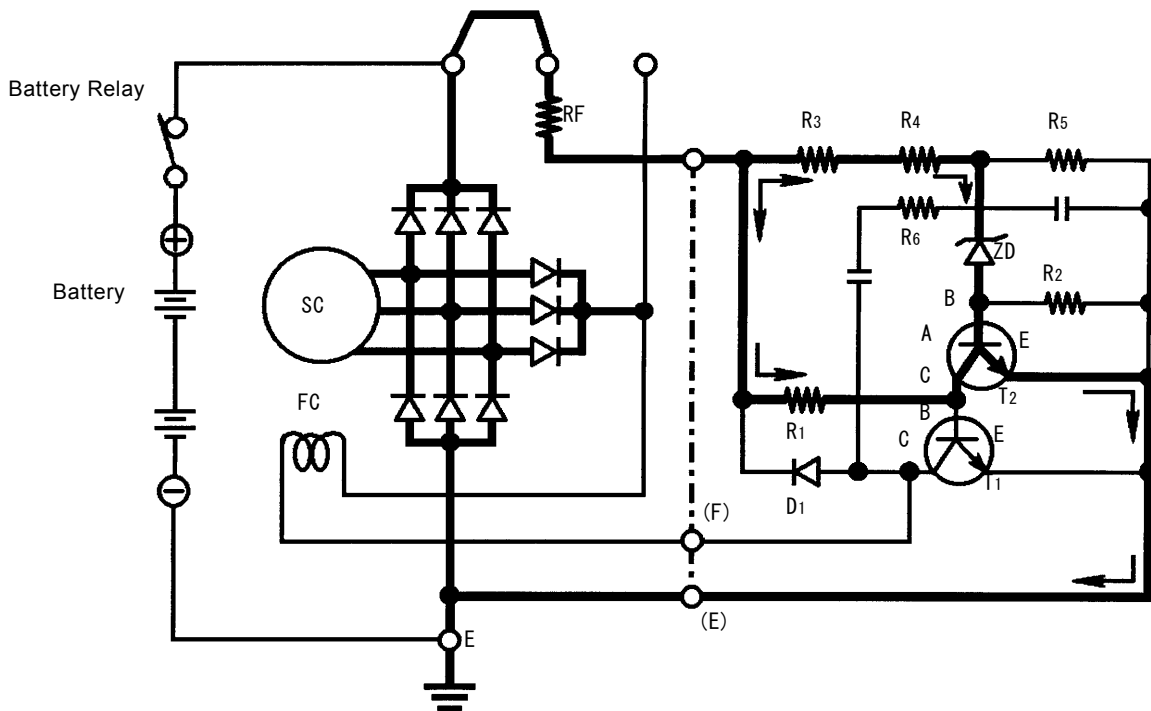


T157-04-02-008

SYSTEM / Electrical System

Regulator Operation

- When generating voltage increases more than the set-voltage of Zener diode ZD, current flows to base B of transistor T2 and collector C is connected to emitter E.
- Current which was routed to base B of transistor T1 disappears due to transistor T2 operation so that transistor T1 is turned OFF.
- No current flows through field coil FC and generating voltage at stator coil SC decreases.
- When generating voltage decreases lower than the set-voltage of Zener diode ZD, transistor T2 is turned OFF and transistor T1 is turned ON again.
- Current flows through field coil FC and generating voltage at stator coil SC increases. The above operation is repeated so that the alternator generating voltage is kept constant.



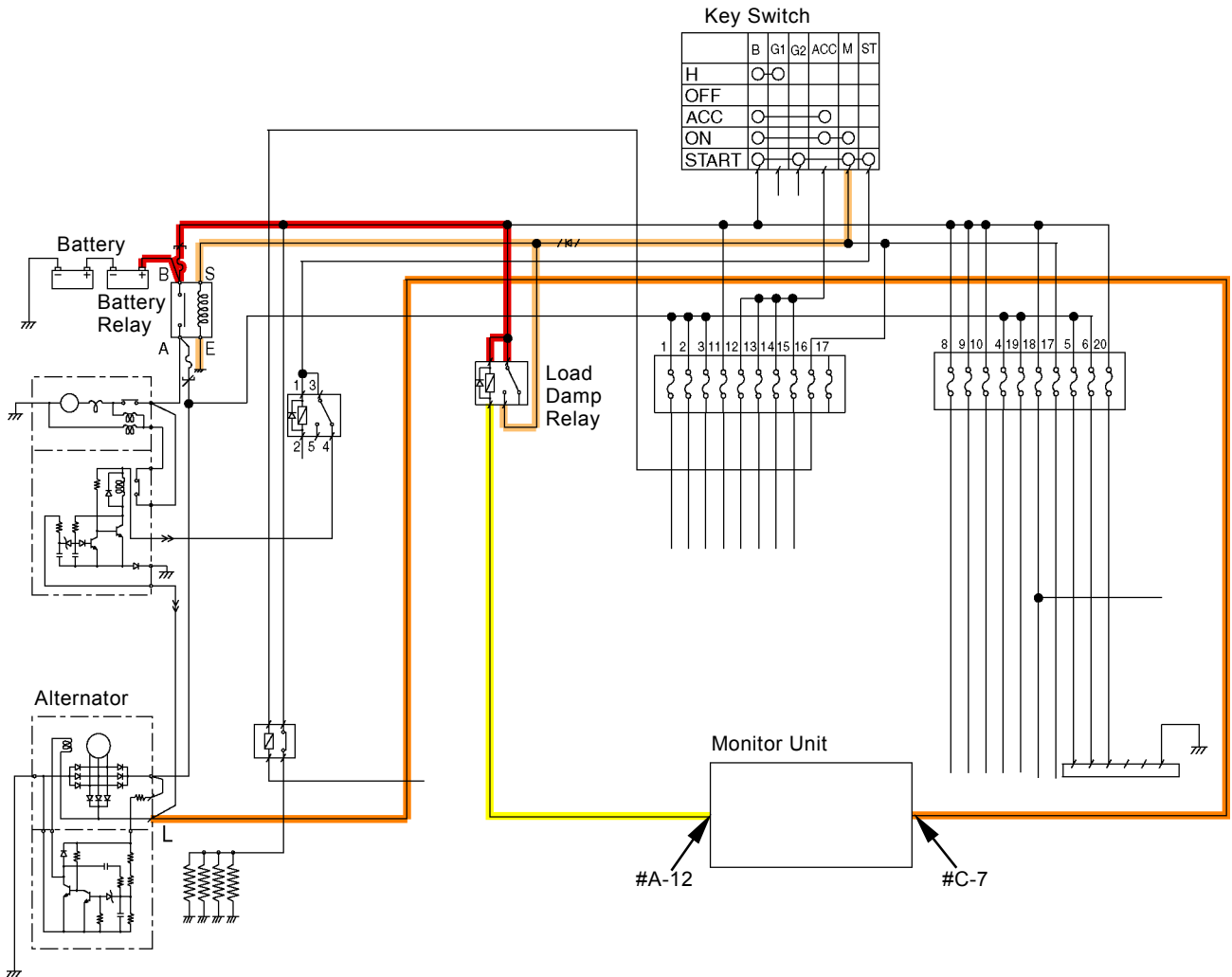
T157-04-02-009

SYSTEM / Electrical System

SERGE VOLTAGE PREVENTION CIRCUIT

1. When the engine is stopped (key switch: OFF), current from key switch terminal M is disconnected and the battery relay is turned OFF.
2. The engine continues to rotate due to inertia force just after the key switch is turned OFF so that the alternator continues to generate electricity.
3. As the generating current cannot flow to the battery, surge voltage arises in the circuit and failures of the electronic components, such as the controller, possibly cause. In order to prevent the occurrence of surge voltage, the surge voltage prevention circuit is provided.
4. When the alternator is generating electricity, generating current from alternator terminal L flows to monitor unit terminal #C-7. The monitor unit connects terminal #A-12 to ground.
5. Current flows through the load damp relay exciting circuit and the load damp relay is turned ON.
6. Accordingly, even if the key switch is turned OFF while the engine is rotating, battery current continues to excite the battery relay through the load damp relay. Until the alternator stops generating, the battery relay is kept ON.

SYSTEM / Electrical System



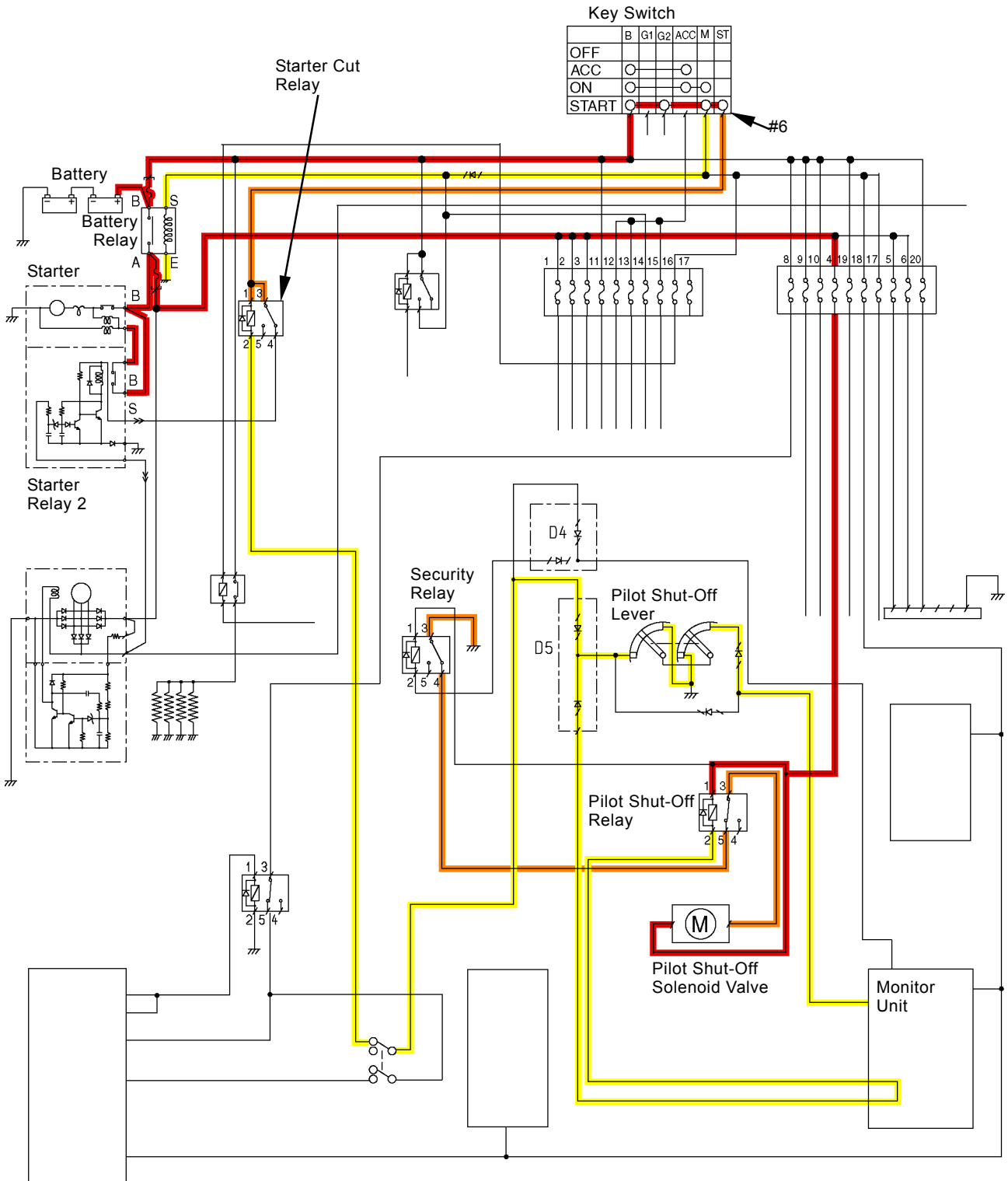
T1V1-02-05-004

SYSTEM / Electrical System

PILOT SHUT-OFF CIRCUIT (KEY SWITCH: ON)

1. When the pilot shut-off lever is turned ON, the monitor unit connects the ground circuit of pilot shut-off relay and starter cut relay so that the pilot shut-off relay and starter cut relay are turned ON.
2. When the pilot shut-off relay is turned ON, the ground circuit of pilot shut-off solenoid valve is connected, current from fuse #4 turns the pilot shut-off solenoid valve ON and pressure oil from the pilot pump is supplied to the pilot valve.
3. When the starter cut relay is turned ON, key switch terminal ST is disconnected from starter relay 2 terminal S. Therefore, although the key switch moves to the START position, the engine does not start.

SYSTEM / Electrical System



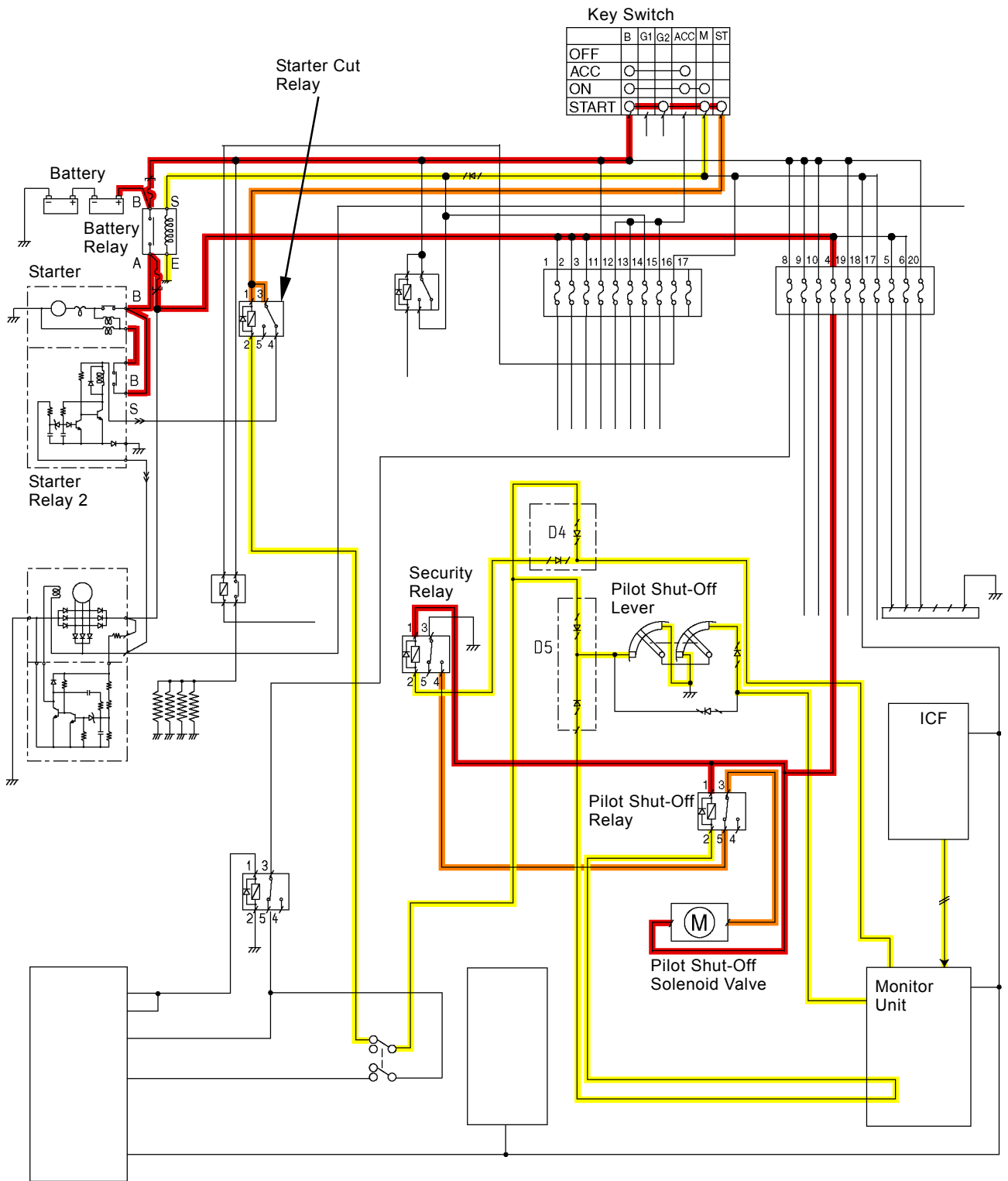
T1V1-02-05-008

SYSTEM / Electrical System

SECURITY LOCK CIRCUIT

1. The monitor unit connects the ground circuit of security relay and starter cut relay according to the external warning signal or password input error and the security relay and starter cut relay are turned ON.
2. When the security relay is turned ON, as the ground circuit of pilot shut-off solenoid valve is disconnected, the pilot shut-off solenoid valve is turned OFF so that pressure oil to the pilot valve from the pilot pump is blocked.
3. When the starter cut relay is turned ON, key switch terminal ST is disconnected from starter relay 2 terminal S. Therefore, although the key switch moves to the START position, the engine does not start.

SYSTEM / Electrical System



Key Switch

	B	G1	G2	ACC	M	ST
OFF						
ACC	○			○		
ON	○			○	○	
START	○	○	○	○	○	○

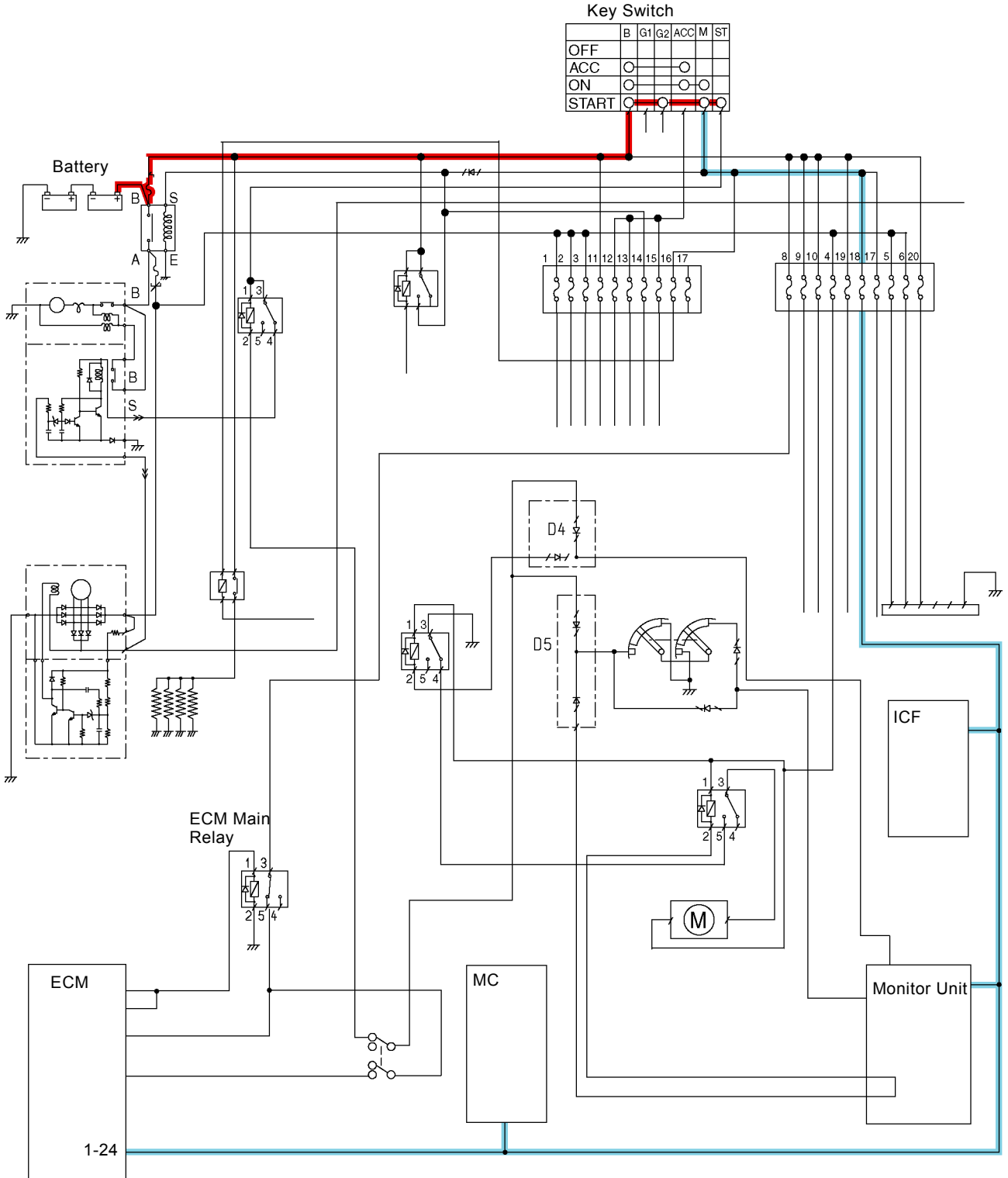
T1V1-02-05-009

SYSTEM / Electrical System

ENGINE STOP CIRCUIT (KEY SWITCH: OFF)

1. When the key switch is turned from the ON position to the OFF position, the signal current indicating that the key switch is ON stops flowing from terminal M to ECM terminal #1-24.
2. ECM stops injection of injector and the engine stops.
3. When the engine stops, ECM turns the ECM main relay OFF.

SYSTEM / Electrical System

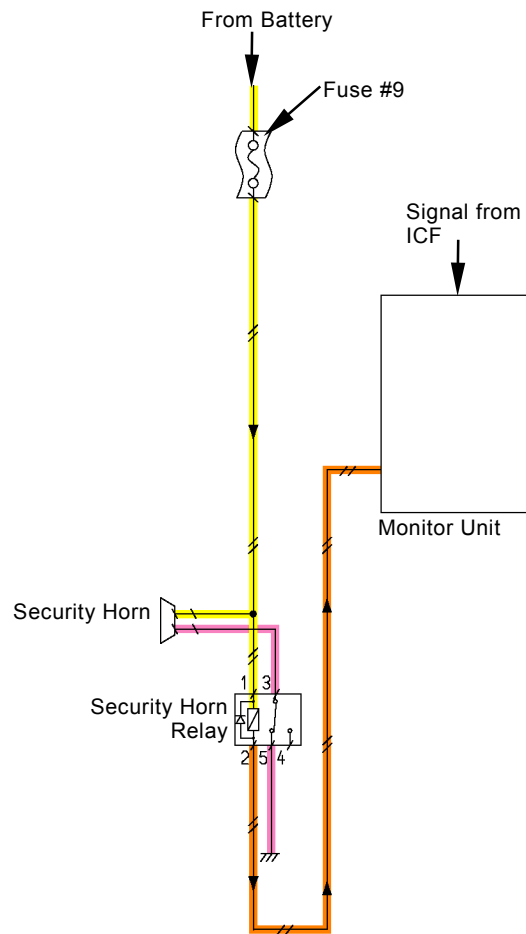


T1V1-02-05-011

SYSTEM / Electrical System

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.



T1V1-02-05-006

SYSTEM / Electrical System

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SYSTEM / Electrical System

WORKING LIGHT CIRCUIT

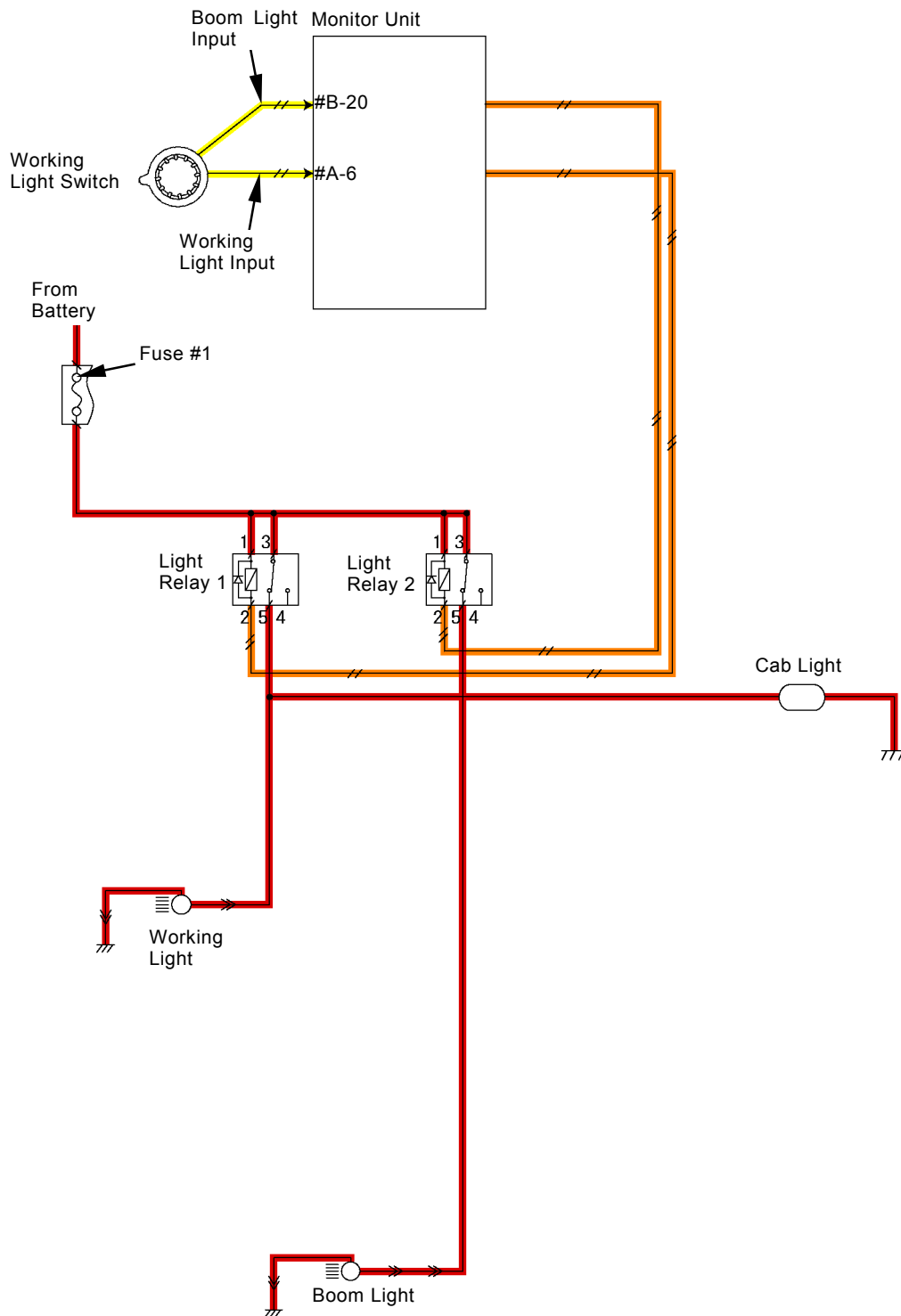
Working Light and Cab Light Circuit

1. When the working light switch moves to position 1, monitor unit terminal #B-20 receives the signal.
2. The monitor unit connects the ground circuit of light relay 1.
3. Current from fuse #1 turns light relay 1 ON and turns on the working light and cab light.

Boom Light Circuit

1. When the working light switch moves to position 2, monitor unit terminal #A-6 receives the signal.
2. The monitor unit connects the ground circuit of light relay 2.
3. Current from fuse #1 turns light relay 2 ON and turns on the boom light.

SYSTEM / Electrical System



T1V1-02-05-012

SYSTEM / Electrical System

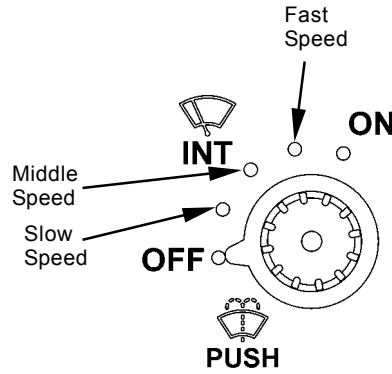
WIPER CIRCUIT

Intermittent Operation

Purpose: Operates the wiper at the intervals set by the wiper / washer switch.

Operation:

1. The wiper / washer switch sends the electrical signal on position the INT. in response to the set intervals to the monitor unit.
2. The monitor unit connects the ground circuit at the intervals set by the wiper / washer switch and the wiper relay is turned ON.
3. When the wiper relay is turned ON, the ground circuit of wiper motor is connected.
4. Current from fuse #2 operates the wiper motor and the wiper moves.



M178-01-016

Washer Operation

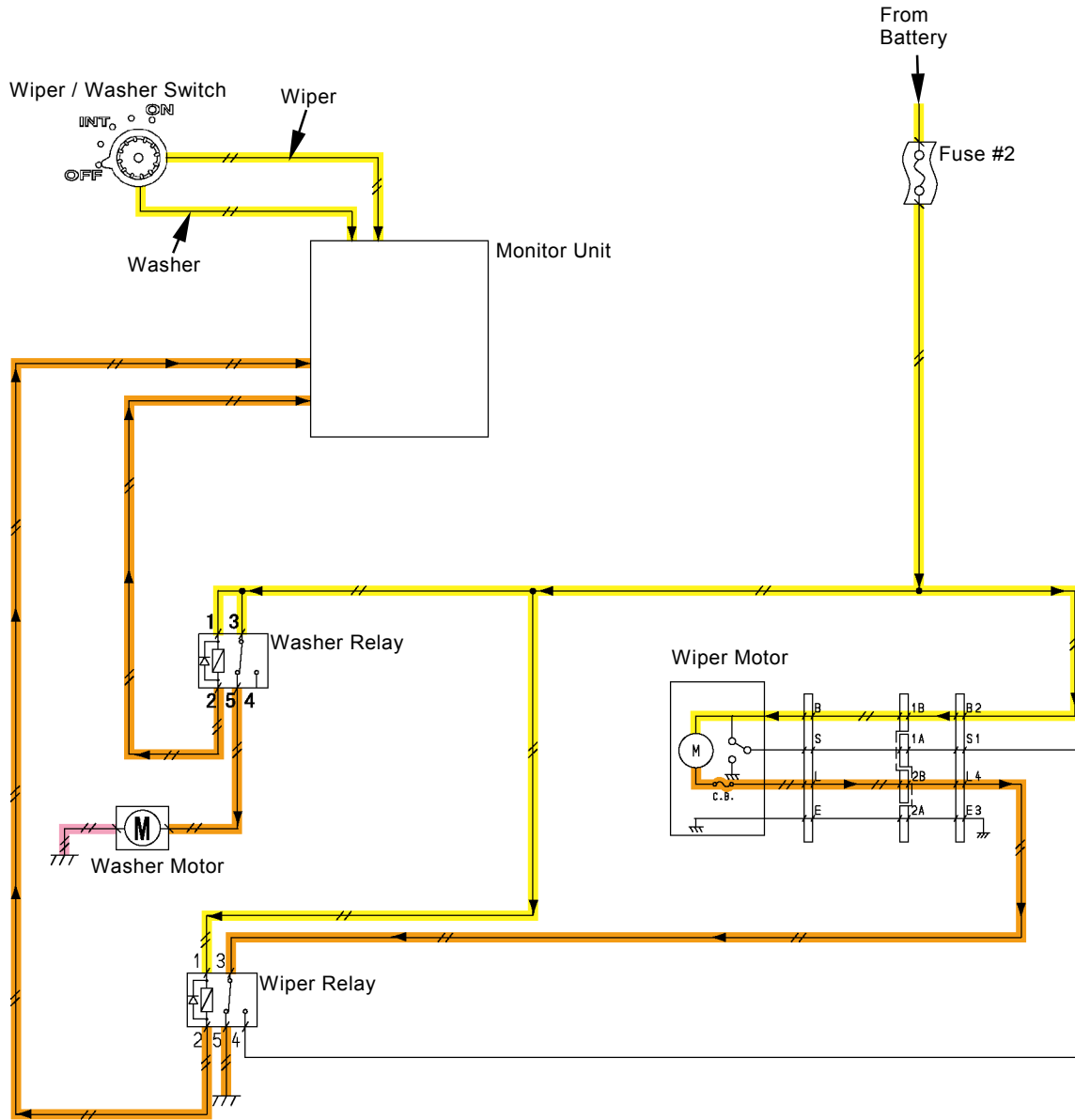
Purpose: Operates the washer.

Operation:

1. While pushing the wiper/washer switch, the monitor unit receives the electrical signal from the wiper/washer switch.
2. The monitor unit connects the ground circuit of washer relay and the washer relay is turned ON.
3. When the washer relay is turned ON, current from fuse #2 operates the washer motor and washer liquid jets.

Position INT.	Set Time
Slow	8 seconds
Middle	6 seconds
Fast	3 seconds

SYSTEM / Electrical System

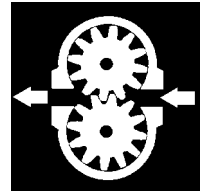


T1V1-02-05-005

SYSTEM / Electrical System

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SECTION 3 COMPONENT OPERATION



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COMPONENT OPERATION / Pump Device

OUTLINE

The pump device consists of transmission (11), main pump (pump 1 (1), pump 2 (2)) and pilot pump (3).

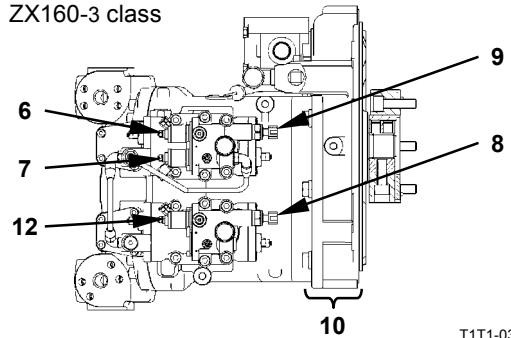
The engine output is transmitted to transmission (11) via coupling (12). After being distributed by the gear, the engine power drives pump 1 (1), 2 (2) and pilot pump (3). Both reduction gear ratios of the main pump and pilot pump (3) are 1:1. Transmission (11) is lubricated with engine oil.

The main pump is a bent-axis type variable displacement axial plunger pump. Pump 1 (1) and pump 2 (2) are integrated as two units in one housing. Pilot pump (3) is a gear pump.

Pump delivery pressure sensors (4, 5) and pump control pressure sensors (8, 9) are installed in order to control the pump and valve.

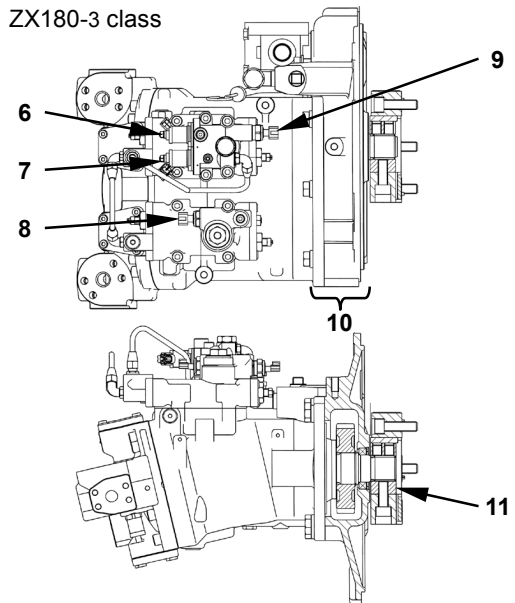
(Refer to the Control System group in SYSTEM.)

ZX160-3 class



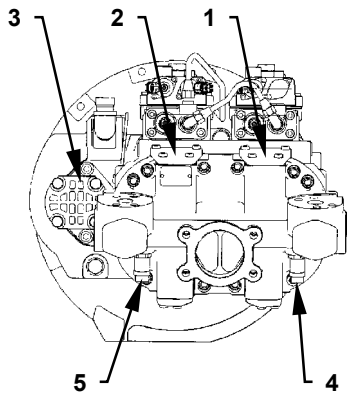
T1T1-03-01-001

ZX180-3 class

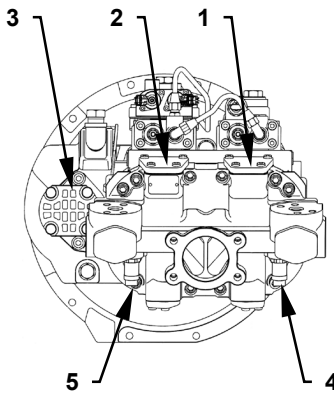


T1V1-03-01-006

ZX160-3 class



ZX180-3 class



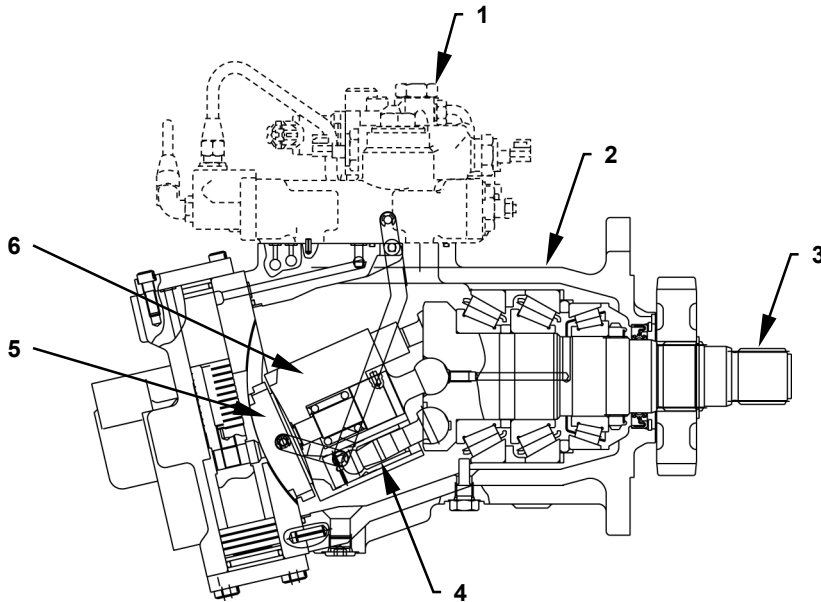
T1T1-03-01-002

- | | | | |
|----------------|---|------------------------------------|--|
| 1 - Pump 1 | 4 - Pump 1 Delivery Pressure Sensor | 7 - Torque Control Solenoid Valve | 10 - Transmission |
| 2 - Pump 2 | 5 - Pump 2 Delivery Pressure Sensor | 8 - Pump 1 Control Pressure Sensor | 11 - Coupling |
| 3 - Pilot Pump | 6 - Maximum Pump 2 Flow Rate Control Solenoid Valve | 9 - Pump 2 Control Pressure Sensor | 12 - Maximum Pump 1 Flow Rate Control Solenoid Valve |

COMPONENT OPERATION / Pump Device

MAIN PUMP

The main pump supplies pressure oil to actuate the hydraulic components such as motors or cylinders. The main pump consists of pump 1 and pump 2. Shaft (3) is connected to each pump cylinder block (6) via seven plungers (4). When shaft (3) is rotated with cylinder block (6) together, plunger (4) oscillates in cylinder block (6) and hydraulic oil is drawn and delivered. Each main pump is equipped with a regulator which controls the flow rate.



T1V1-03-01-007

1 - Regulator
2 - Housing

3 - Shaft
4 - Plunger

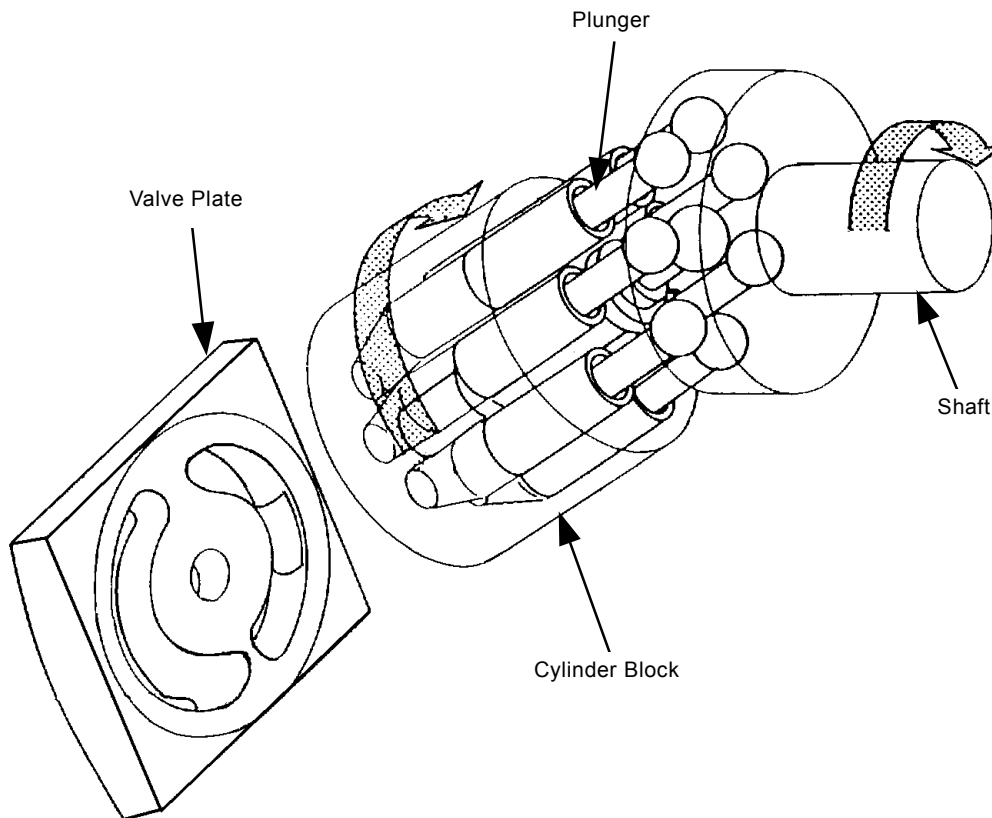
5 - Valve Plate

6 - Cylinder Block

COMPONENT OPERATION / Pump Device

Operational Principle

Engine torque is transferred to the shaft and the seven plungers, causes the cylinder block to rotate while sliding along the valve plate surface. The plunger oscillates in the cylinder block bores and alternately hydraulic oil is drawn and delivered.



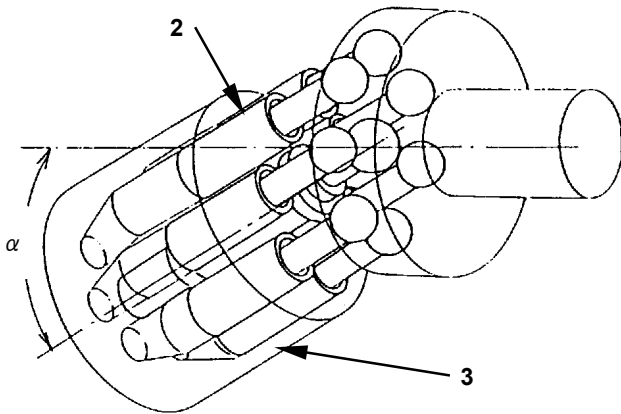
T105-02-03-002

COMPONENT OPERATION / Pump Device

Increasing and Decreasing Flow Rate

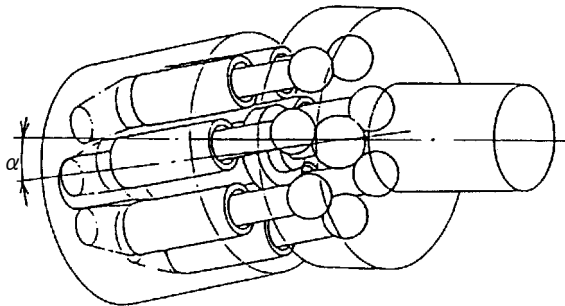
Changing inclination of cylinder block (3) causes the plunger (2) stroke to increase or decrease depending on the slant angle in order to control the main pump flow rate. Up-down movement of servo piston (6) changes inclination of cylinder block (3). Servo piston (6) is interlocked with valve plate (4) via pin (5). The one end of cylinder block (3) is kept in contact with the surface of valve plate (4) and slides along it.

Maximum Displacement Angle:

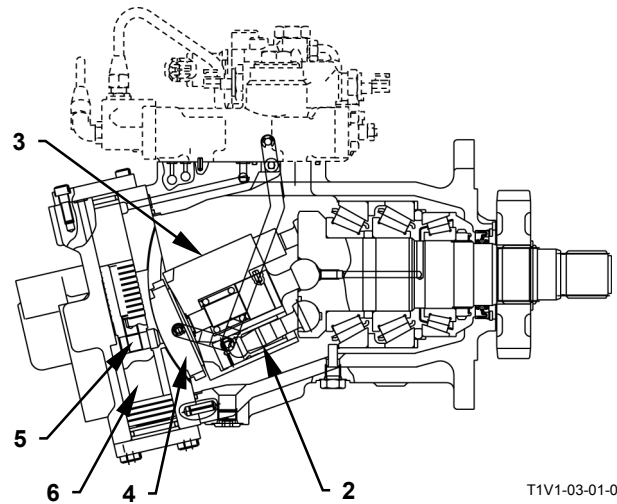


T105-02-03-021

Minimum Displacement Angle (Operable Limit Angle):



T105-02-03-022



T1V1-03-01-008

2 - Plunger
3 - Cylinder Block

4 - Valve Plate

5 - Pin

6 - Servo Piston


COMPONENT OPERATION / Pump Device

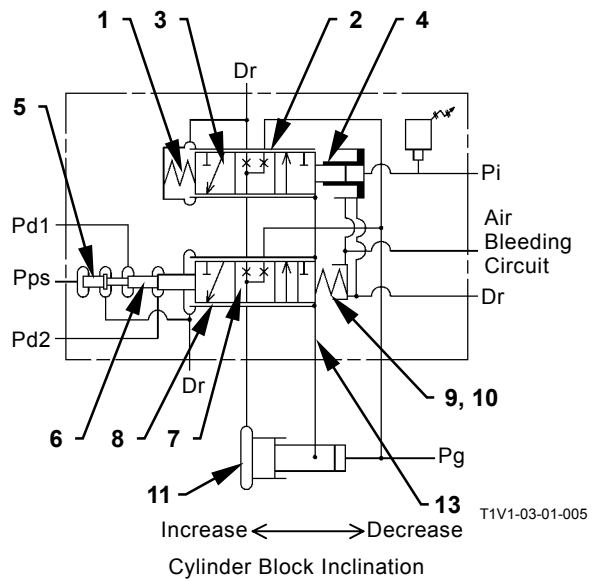
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COMPONENT OPERATION / Pump Device

REGULATOR

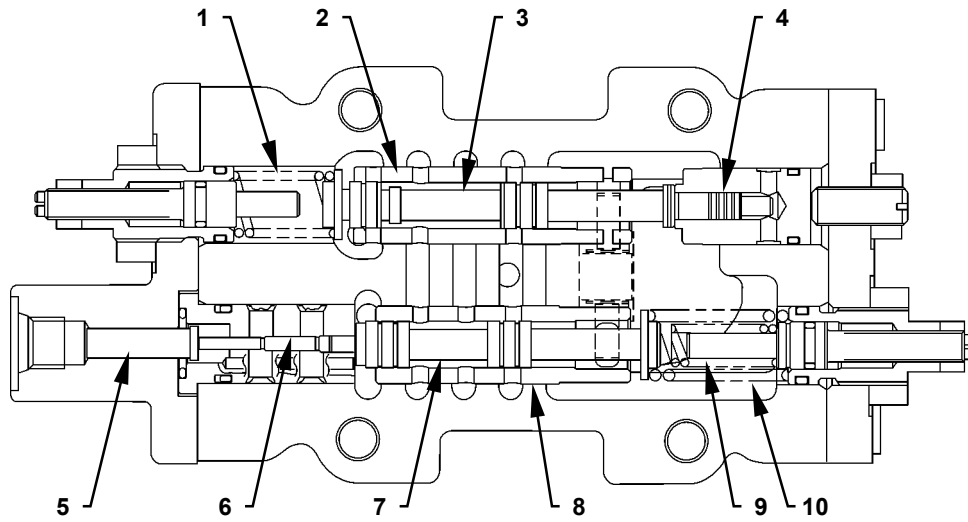
The regulator controls the main pump flow rate in response to the various command signal pressures so that the pump driving power does not exceed the engine power. Pump 1 and pump 2 are provided with one regulator for each. The major parts of regulator are spring (1), sleeve A (2), sleeve B (8), spool 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).

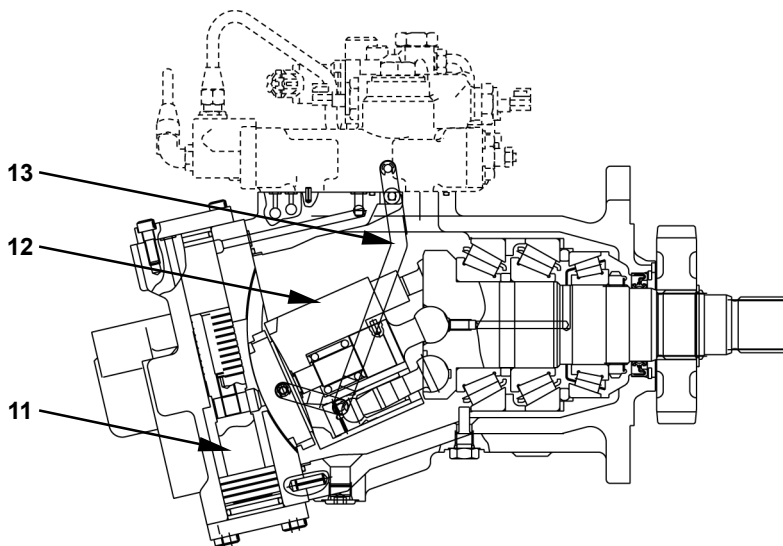


- | | |
|--------------------------------------|---|
| Pd1 - Pump 1 Delivery Pressure | Pi - Pump Control Pressure |
| Pd2 - Pump 2 Delivery Pressure | Pps - Torque Control Pressure |
| Dr - Returning to Hydraulic Oil Tank | Pg - Primary Pilot Pressure (From Pilot Pump) |
| 1 - Spring | 8 - Sleeve B |
| 2 - Sleeve A | 9 - Inner Spring |
| 3 - Spool A | 10 - Outer Spring |
| 4 - Piston | 11 - Servo Piston |
| 5 - Load Piston 1 | 12 - Cylinder Block |
| 6 - Load Piston 2 | 13 - Link |
| 7 - Spool B | |

COMPONENT OPERATION / Pump Device



T1V1-03-01-009



T1V1-03-01-007

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

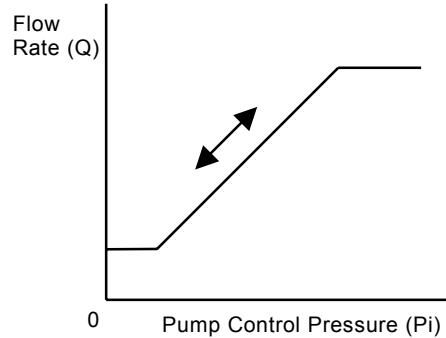
COMPONENT OPERATION / Pump Device

Regulator Control Function

The regulator has the following four control functions.

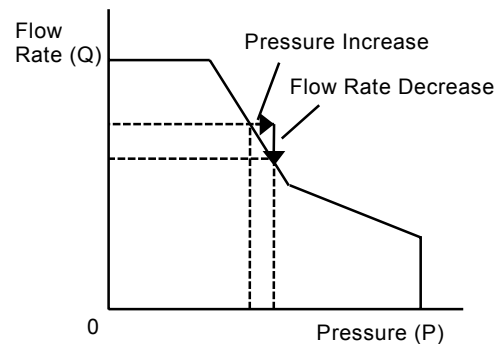
- Control by Pump Control Pressure

When a control lever is operated, the pump flow rate control valve in signal control valve regulates pump control pressure P_i in response to the lever stroke. When the regulator receives pump control pressure P_i , the regulator controls the pump delivery flow rate in proportion to pump control pressure P_i . When a control lever is operated, pump control pressure P_i increases and the regulator increases the pump delivery flow rate. When the control lever is returned to neutral, pump control pressure P_i decreases and the regulator decreases the pump delivery flow rate.



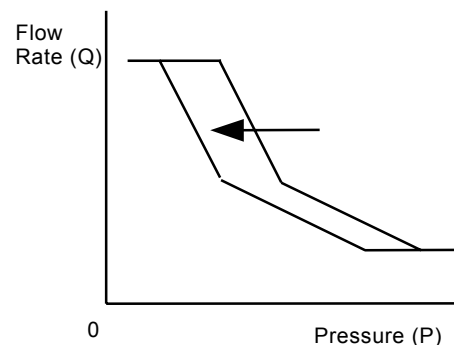
- Control by Own or Opponent Pump Delivery Pressure

The regulator receives own pump delivery pressure P_{d1} and opponent pump delivery pressure P_{d2} as control signal pressures. If the two average pressures increase over the set P-Q line, the regulator reduces both pump delivery flow rates and the total pump output is returned to the set P-Q line. Thereby, the engine is protected from being overloaded. As the P-Q line has been designated in order to jointly regulate both pump operations, both pump delivery flow rates are regulated almost equally to each other. Accordingly, although the higher-pressure side pump is loaded more than the lower-pressure side pump, the total pump output matches with the engine output. (Total Output Control)



- Control by Pilot Pressure from Torque Control Solenoid Valve

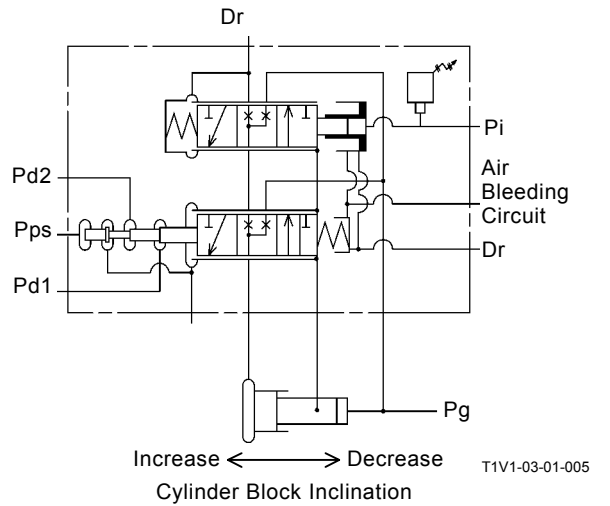
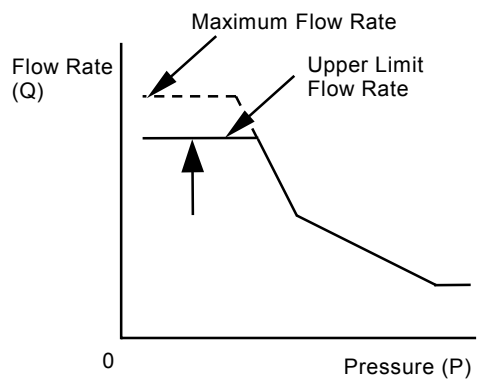
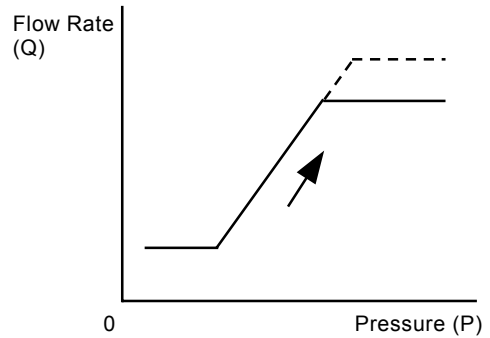
The main controller (MC) operates based on both the engine target speed input data and actual speed information signals and outputs the signals to the torque control solenoid valve. In response to the signals from MC, the torque control solenoid valve delivers torque control pilot pressure P_{ps} to the regulator. When receiving pilot pressure P_{ps} , the regulator reduces the pump delivery flow rate. (Speed Sensing Power Decrease Control: Slow Speed Torque Increase Control)
(Refer to the Control System group.)



COMPONENT OPERATION / Pump Device

- Control by Pilot Pressure from Maximum Pump Flow Rate Limit Control Solenoid Valve
 (ZX160-3 class : Pump 1 and Pump 2)
 (ZX180-3 class : Pump 2 Only)

When the main controller (MC) receives the signals from the work mode switch, pressure sensor [auxiliary] or attachment mode switch (optional), MC sends the signals to the maximum pump flow rate limit control solenoid valve. In response to the signals from MC, the maximum pump flow rate limit control solenoid valve reduces pump control pressure P_i . Therefore, the upper limit pump delivery flow rate is limited. (Pump Flow Rate Limit Control)
 (Refer to the Control System group.)



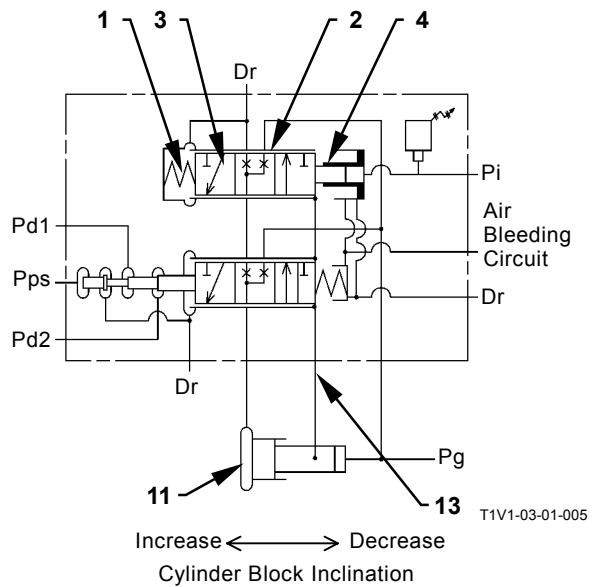
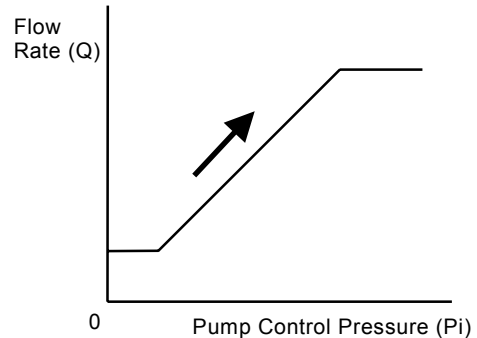
- | | |
|--|--|
| P_{d1} - Pump 1 Delivery Pressure | P_i - Pump Control Pressure |
| P_{d2} - Pump 2 Delivery Pressure | P_{ps} - Torque Control Pressure |
| Dr - Returning to Hydraulic Oil Tank | P_g - Primary Pilot Pressure (From Pilot Pump) |

COMPONENT OPERATION / Pump Device

Control by Pump Control Pressure

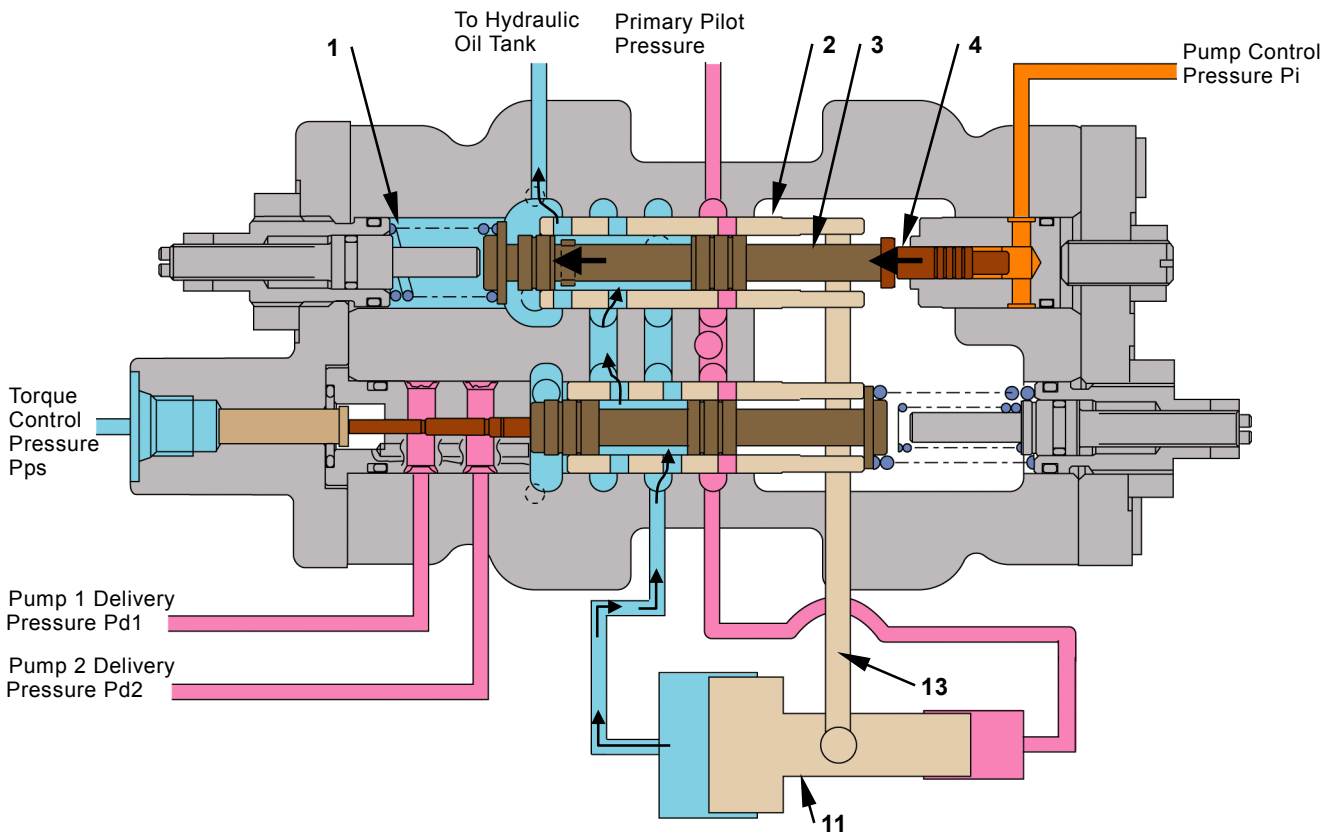
• Increasing Flow Rate

1. When a control lever is operated, the flow rate control valve in signal control valve is shifted and pump control pressure P_i increases.
2. Piston (4) pushes spool A (3) and spring (1) so that spool A (3) is moved toward direction of the arrow.
3. By this movement, the circuit from the large chamber of servo piston (11) is opened to the hydraulic oil tank.
4. As pilot pressure is always routed into the small chamber of servo piston (11), servo piston (11) is moved toward direction of the arrow. Then, 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 the circuit from large chamber of servo piston (11) to the hydraulic oil tank is closed. Therefore, servo piston (11) is stopped and the flow rate increasing operation is completed.

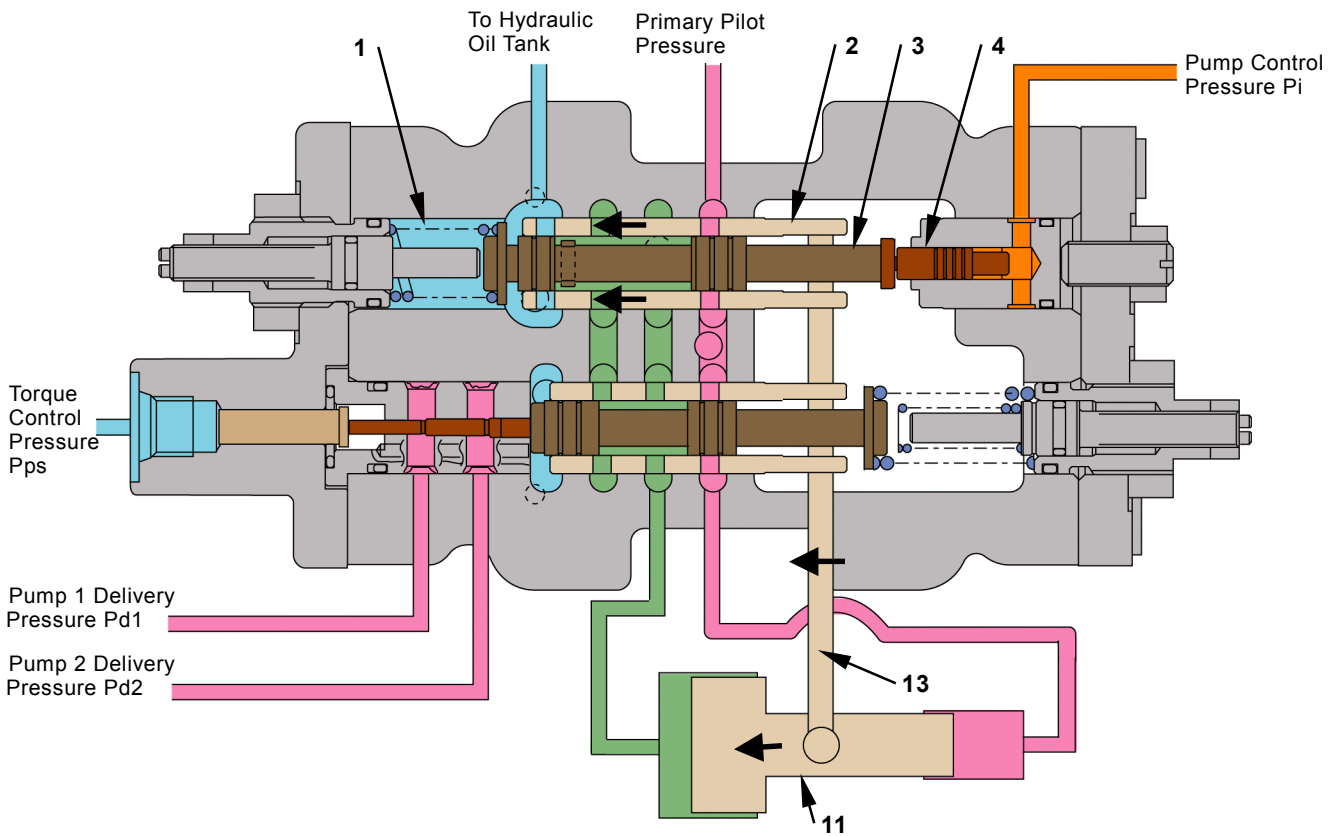


- | | |
|--------------|-------------------|
| 1 - Spring | 4 - Piston |
| 2 - Sleeve A | 11 - Servo Piston |
| 3 - Spool A | 13 - Link |
-
- | | |
|--------------------------------------|---|
| Pd1 - Pump 1 Delivery Pressure | Pi - Pump Control Pressure |
| Pd2 - Pump 2 Delivery Pressure | Pps - Torque Control Pressure |
| Dr - Returning to Hydraulic Oil Tank | Pg - Primary Pilot Pressure (From Pilot Pump) |

COMPONENT OPERATION / Pump Device



T1V1-03-01-010



T1V1-03-01-011

1 - Spring
2 - Sleeve A

3 - Spool A
4 - Piston

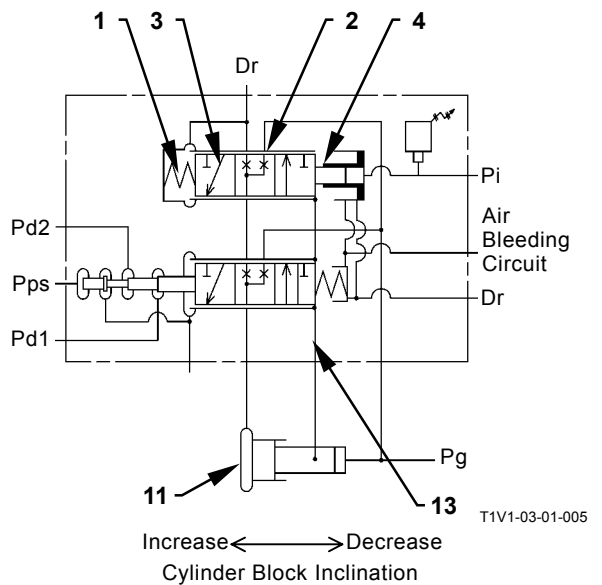
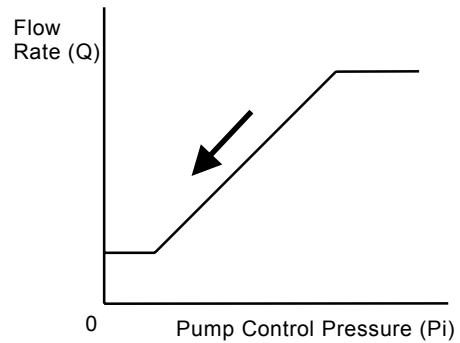
11 - Servo Piston

13 - Link

COMPONENT OPERATION / Pump Device

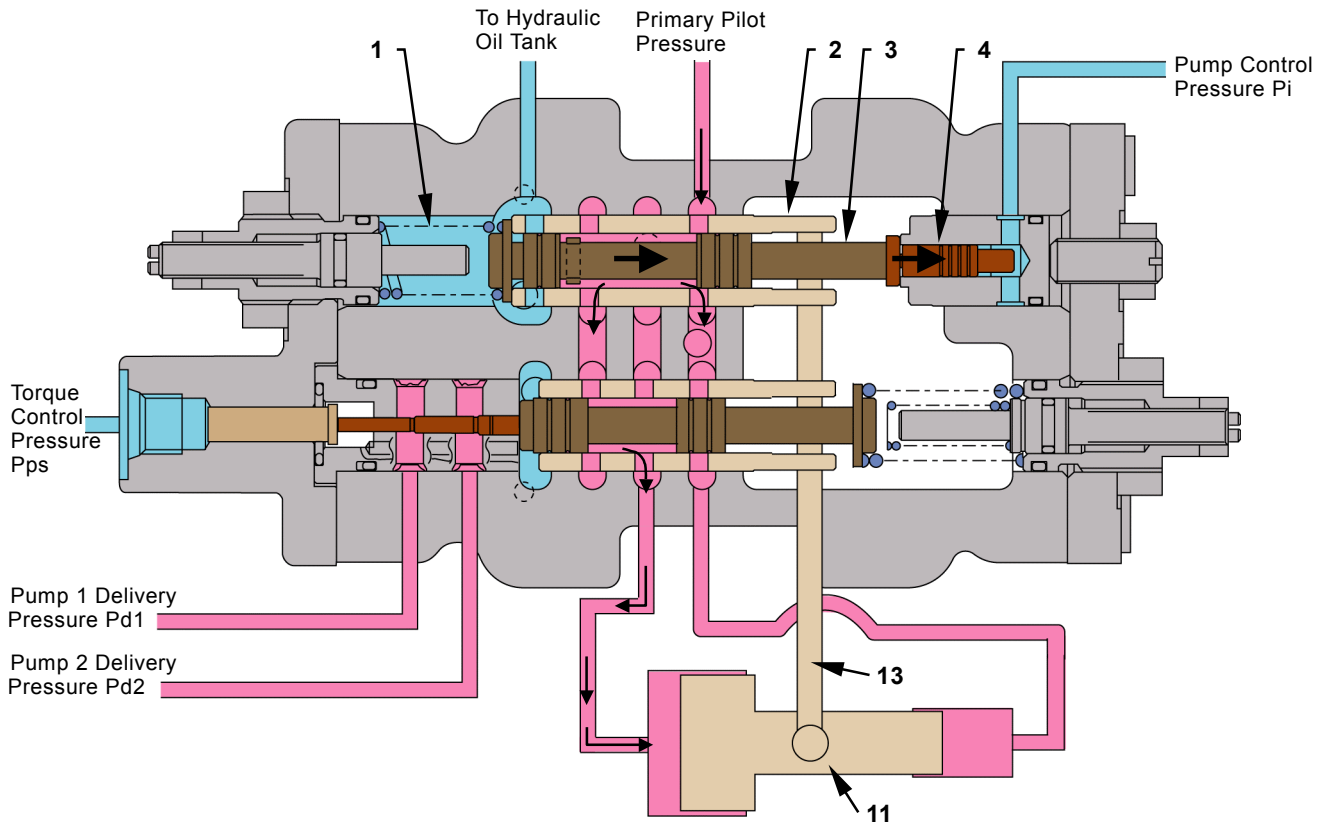
• Decreasing Flow Rate

1. When a control lever is returned, the flow rate control valve in signal control valve is returned and pump control pressure P_i decreases.
2. Piston (4) and spool A (3) are pushed by spring (1) so that spool A (3) is moved toward direction of the arrow.
3. Pilot pressure is also routed to the large chamber of servo piston (11).
4. Due to the difference in diameter between the large and small chambers, servo piston (11) is moved toward direction of the arrow. Therefore, the cylinder block is rotated in the minimum inclination direction and the pump delivery flow rate decreases.
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 sleeve A (2) and spool A (3) is closed and pilot pressure to servo piston (11) is blocked. Therefore, servo piston (11) is stopped and the flow rate decreasing operation is completed.

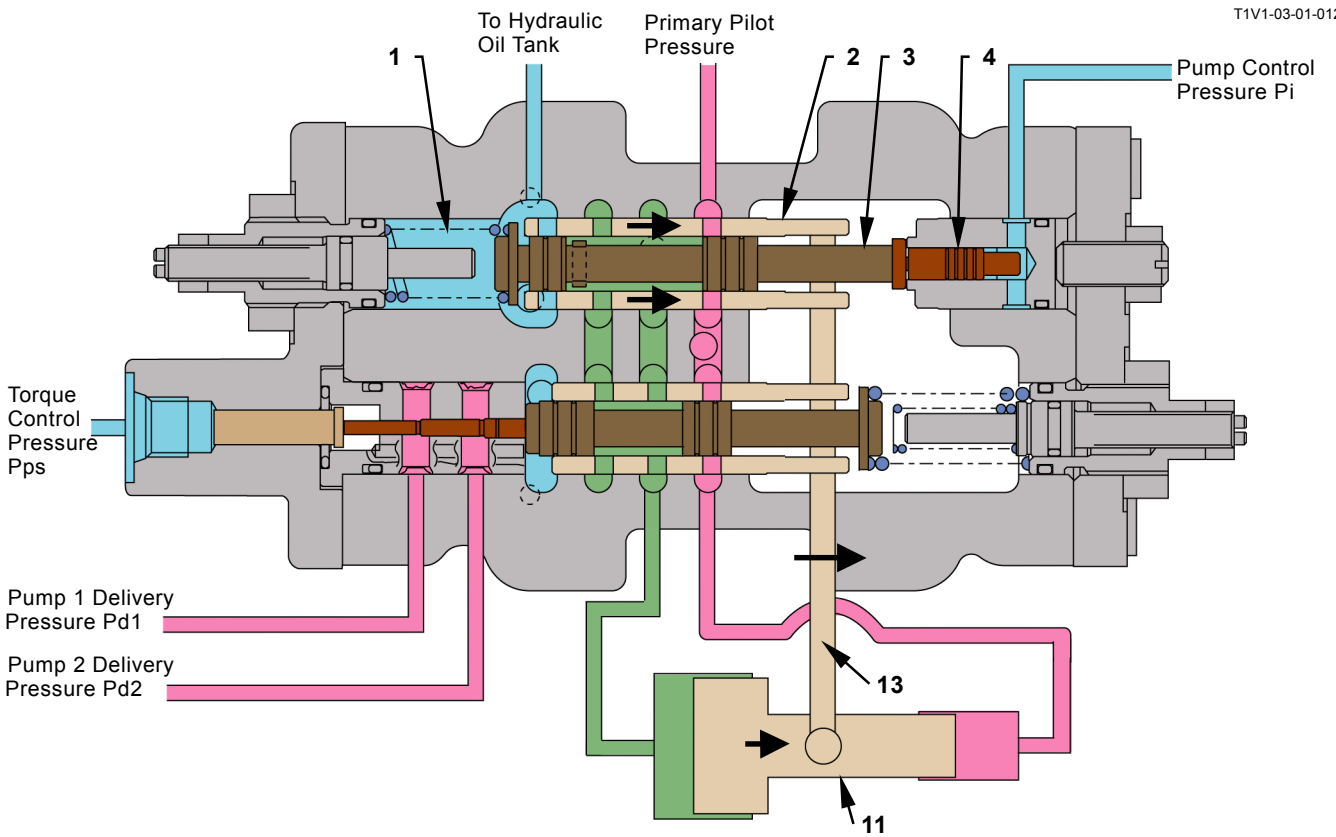


- | | |
|--------------------------------------|---|
| 1 - Spring | 4 - Piston |
| 2 - Sleeve A | 11 - Servo Piston |
| 3 - Spool A | 13 - Link |
| | |
| Pd1 - Pump 1 Delivery Pressure | Pi - Pump Control Pressure |
| Pd2 - Pump 2 Delivery Pressure | Pps - Torque Control Pressure |
| Dr - Returning to Hydraulic Oil Tank | Pg - Primary Pilot Pressure (From Pilot Pump) |

COMPONENT OPERATION / Pump Device



T1V1-03-01-012



T1V1-03-01-013

1 - Spring
2 - Sleeve A

3 - Spool A
4 - Piston

11 - Servo Piston

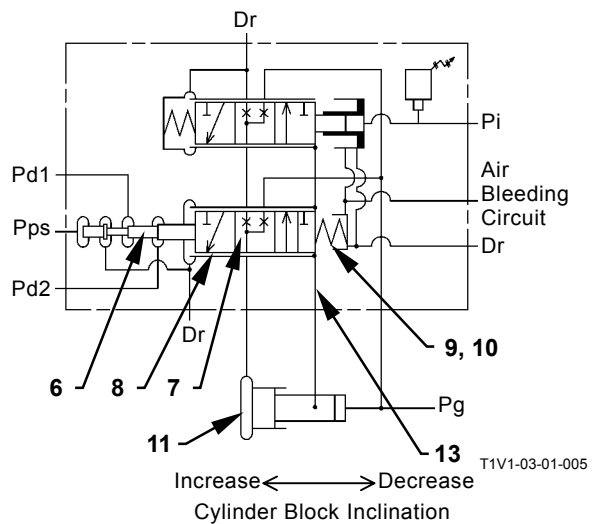
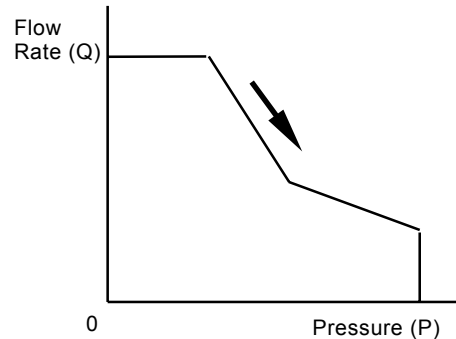
13 - Link

COMPONENT OPERATION / Pump Device

Control by Own or Opponent Pump Delivery Pressure

- Decreasing Flow Rate

- When the pump is loaded by operating any of the control levers, either pump 1 delivery pressure Pd1 or pump 2 delivery pressure Pd2 increases. (During operation, pump control pressure Pi is kept increased.)
- Load piston 2 (6) pushes spool B (7), inner spring (9) and outer spring (10). Spool B (7) moves toward direction of the arrow.
- Due to the movement of spool B (7), pilot pressure is routed to the large chamber of servo piston (11).
- Due to the difference in diameter between the large and small chambers, servo piston (11) moves toward direction of the arrow. The cylinder block is rotated in the minimum inclination direction and the pump delivery flow rate decreases.
- The movement of cylinder block is transmitted to sleeve B (8) via link (13). Sleeve B (8) is moved in the same direction as spool B (7).
- When sleeve B (8) is moved by the same stroke as spool B (7), the open part between sleeve B (8) and Spool B (7) is close and pilot pressure to servo piston (11) is blocked. Therefore, servo piston (11) is stopped and the flow rate decreasing operation is completed.



- 6 - Load Piston 2
- 7 - Spool B
- 8 - Sleeve B
- 9 - Inner Spring

- 10- Outer Spring
- 11 - Servo Piston
- 13- Link

Pd1 - Pump 1 Delivery Pressure

Pi - Pump Control Pressure

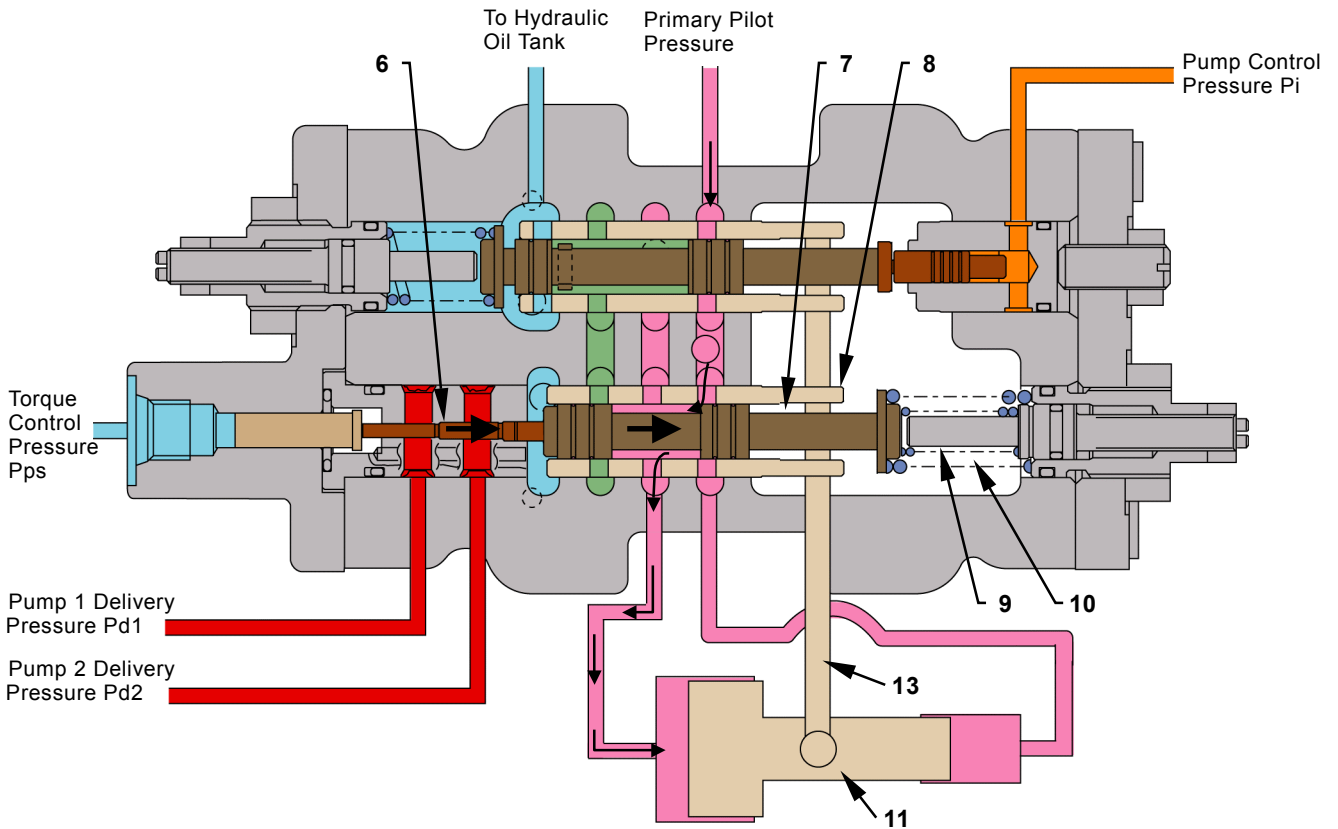
Pd2 - Pump 2 Delivery Pressure

Pps -Torque Control Pressure

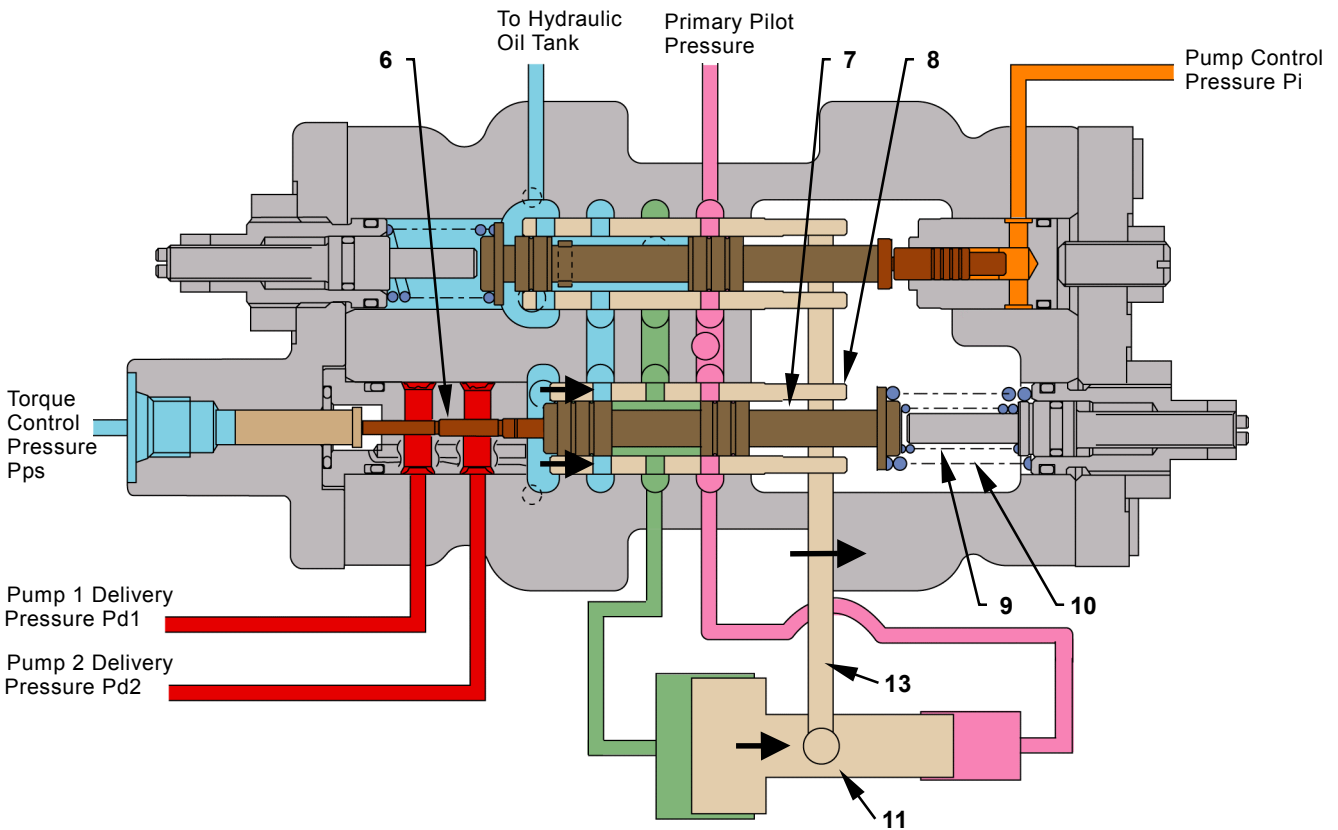
Dr - Returning to Hydraulic Oil Tank

Pg - Primary Pilot Pressure (From Pilot Pump)

COMPONENT OPERATION / Pump Device



T1V1-03-01-014



T1V1-03-01-015

6 - Load Piston2
7 - Spool B

8 - Sleeve B
9 - Inner Spring

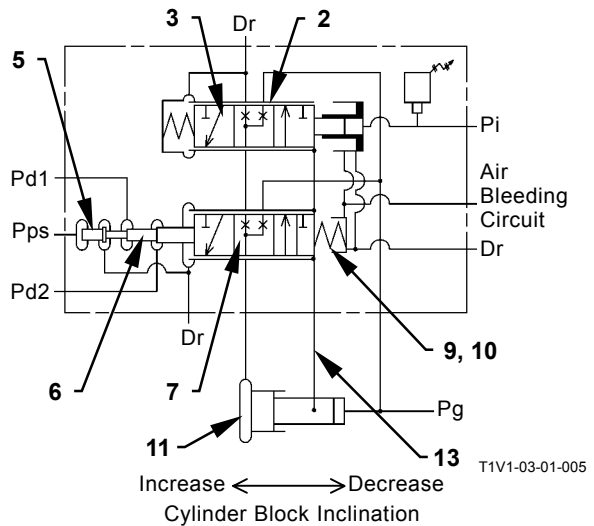
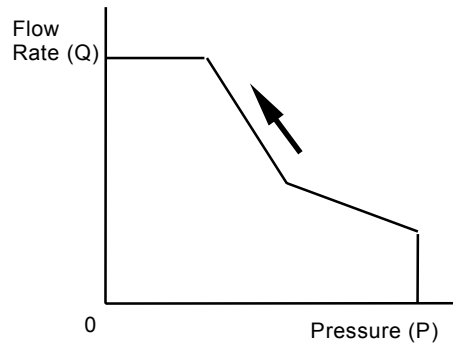
10 - Outer Spring
11 - Servo Piston

13 - Link

COMPONENT OPERATION / Pump Device

• Increasing Flow Rate

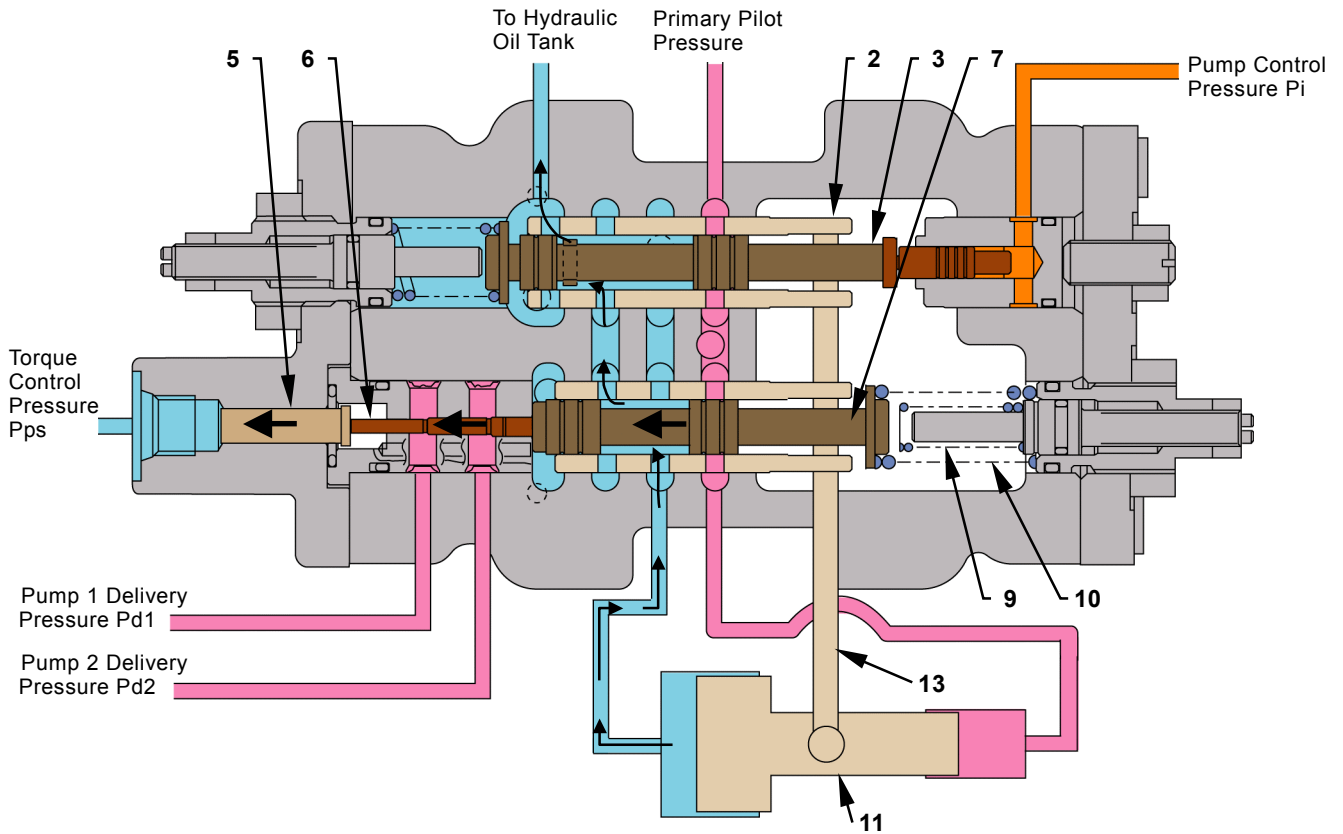
1. When the pump load is reduced, either pump 1 delivery pressure Pd1 or pump 2 delivery pressure Pd2 decreases. (During operation, pump control pressure Pi is kept increased.)
2. Load piston 1 (5), load piston 2 (6) and spool B (7) are pushed by inner spring (9) and outer spring (10). Spool B (7) moves 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.



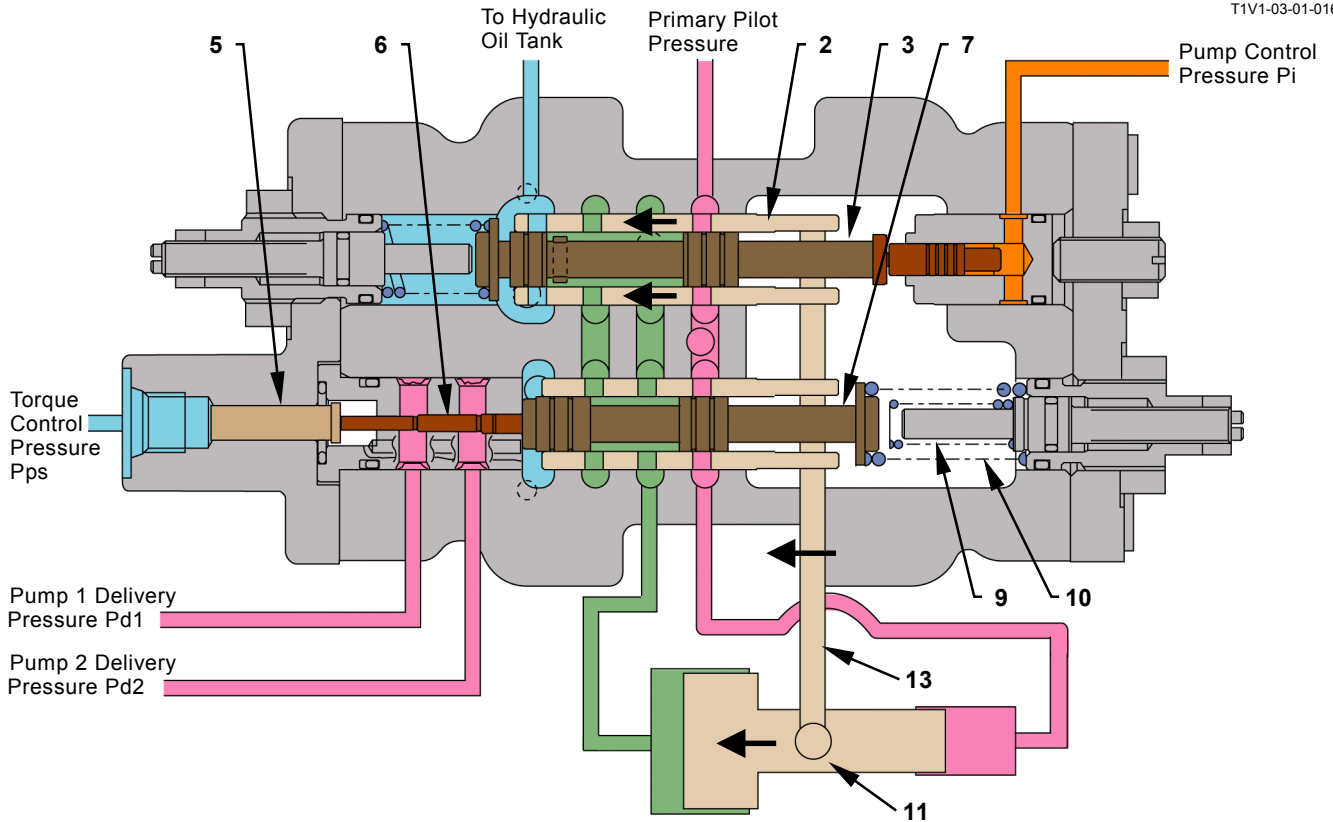
T1V1-03-01-005

- | | |
|-------------------|-------------------|
| 2 - Sleeve A | 9 - Inner Spring |
| 3 - Spool A | 10 - Outer Spring |
| 5 - Load Piston 1 | 11 - Servo Piston |
| 6 - Load Piston 2 | 13 - Link |
| 7 - Spool B | |
-
- | | |
|--------------------------------------|---|
| Pd1 - Pump 1 Delivery Pressure | Pi - Pump Control Pressure |
| Pd2 - Pump 2 Delivery Pressure | Pps - Torque Control Pressure |
| Dr - Returning to Hydraulic Oil Tank | Pg - Primary Pilot Pressure (From Pilot Pump) |

COMPONENT OPERATION / Pump Device



T1V1-03-01-016



T1V1-03-01-017

2 - Sleeve A
3 - Spool A

6 - Load Piston 2
7 - Spool B

9 - Inner Spring
10 - Outer Spring

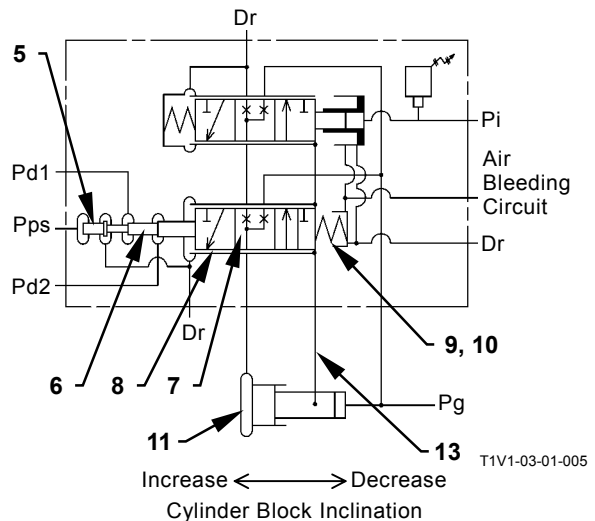
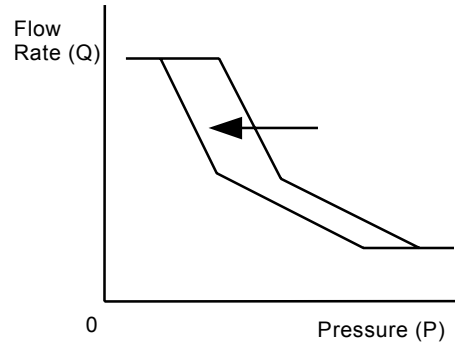
11 - Servo Piston
13 - Link

COMPONENT OPERATION / Pump Device

Control by Pilot Pressure from Torque Control Solenoid Valve

- Decreasing Flow Rate

- When the torque control solenoid valve is activated by the signals from the main controller (MC), torque control pressure P_{ps} increases.
- Torque control pressure P_{ps} and either pump 1 delivery pressure P_{d1} or pump 2 delivery pressure P_{d2} are combined and applied to load piston 1 (5).
- Load piston 1 (5) pushes load piston 2 (6), spool B (7) and inner spring (9) and outer spring (10). Spool B (7) moves toward direction of the arrow.
- Due to the movement of spool B (7), pilot pressure is routed into the large chamber of servo piston (11).
- Due to the difference in diameter between the large and small chambers, servo piston (11) is moved toward direction of the arrow. Therefore, the cylinder block is rotated in the minimum inclination direction and the pump delivery flow rate decreases.
- The movement of cylinder block is transmitted to sleeve B (8) via link (13). Sleeve B (8) is moved in the same direction as spool B (7).
- When sleeve B (8) is moved by the same stroke as spool B (7), the open part between sleeve B (8) and spool B (7) is closed and pilot pressure to the large chamber of servo piston (11) is blocked. Therefore, servo piston (11) is stopped and the flow rate decreasing operation is completed.



- 5 - Load Piston 1
- 6 - Load Piston 2
- 7 - Spool B
- 8 - Sleeve B
- 9 - Inner Spring

- 10 - Outer Spring
- 11 - Servo Piston
- 13 - Link

Pd1 - Pump 1 Delivery Pressure

Pd2 - Pump 2 Delivery Pressure

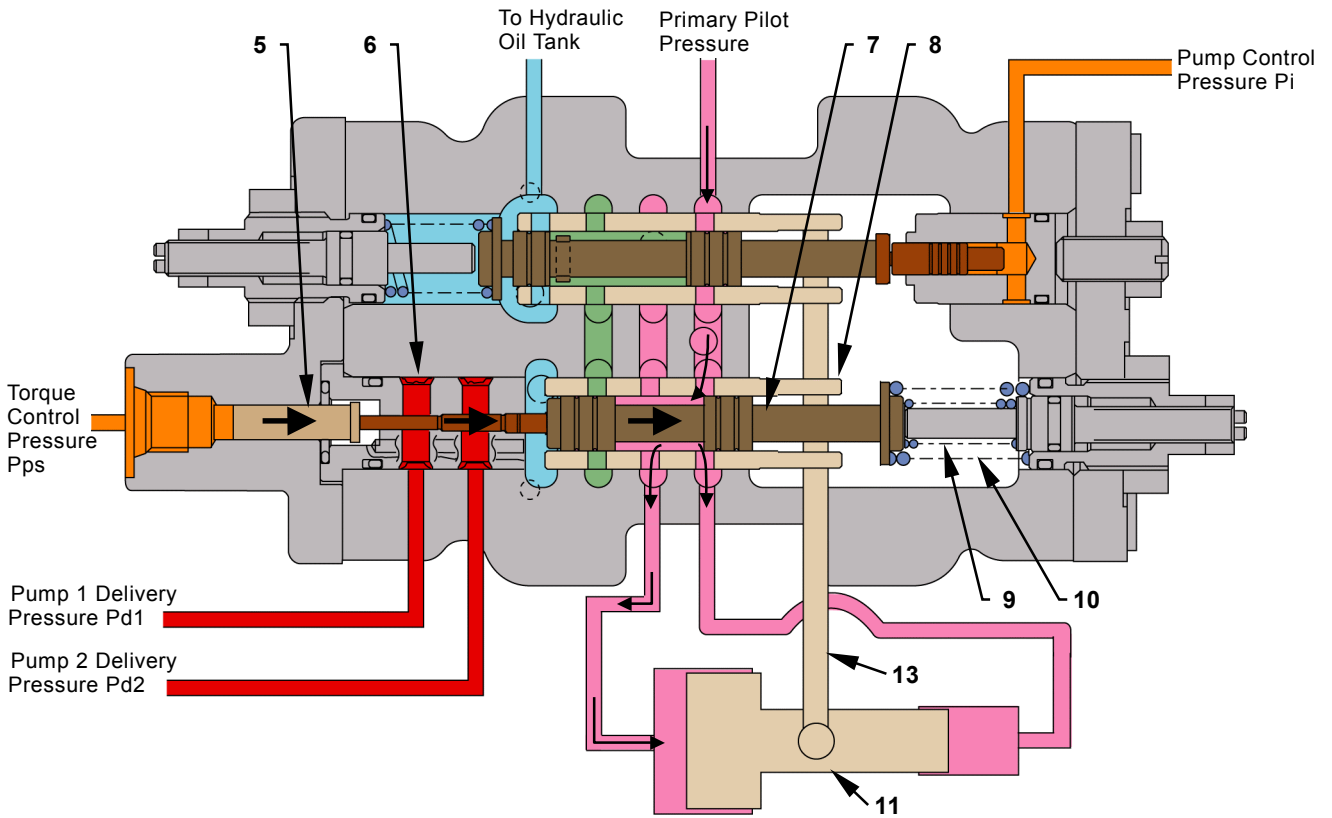
Dr - Returning to Hydraulic Oil Tank

Pi - Pump Control Pressure

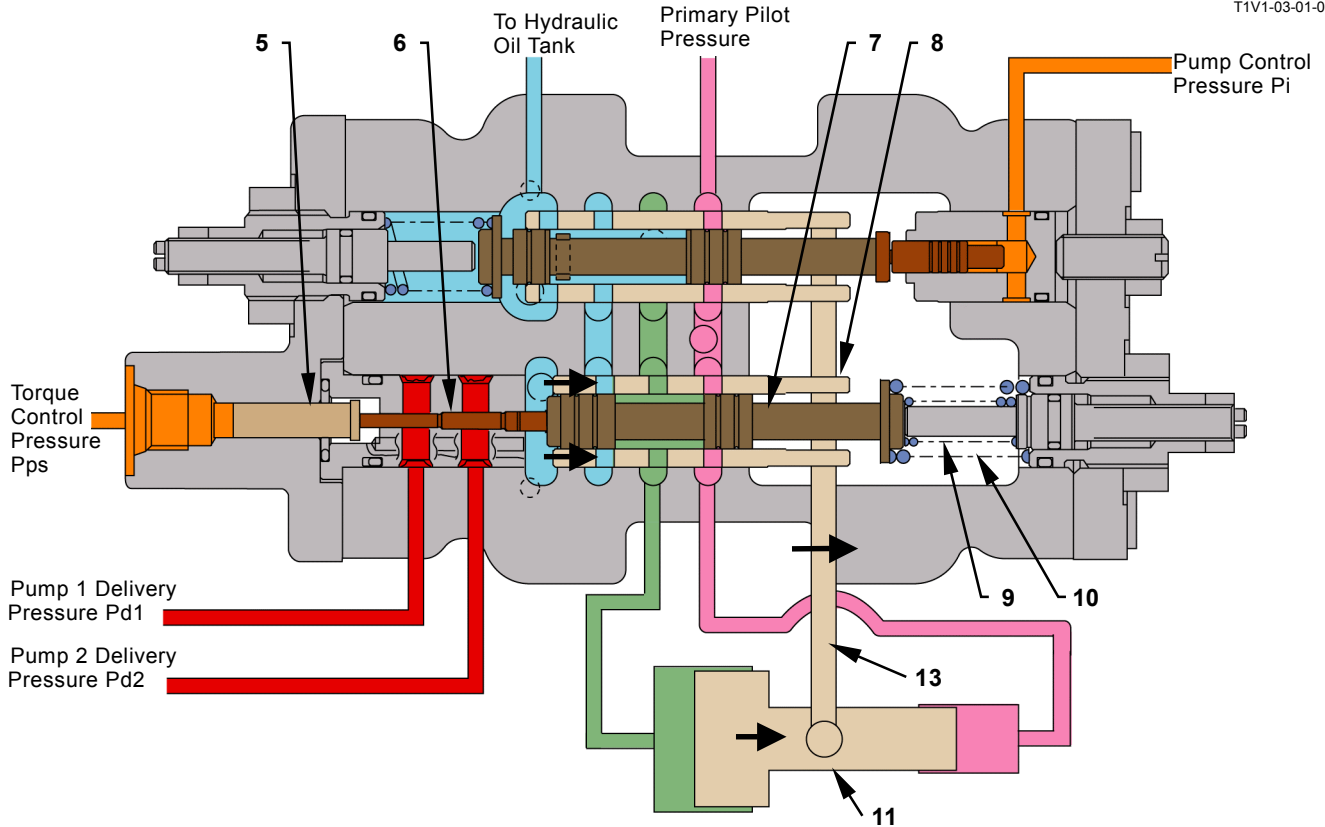
Pps - Torque Control Pressure

Pg - Primary Pilot Pressure (From Pilot Pump)

COMPONENT OPERATION / Pump Device



T1V1-03-01-018



T1V1-03-01-019

5 - Load Piston 1
6 - Load Piston 2

7 - Spool B
8 - Sleeve B

9 - Inner Spring
10 - Outer Spring

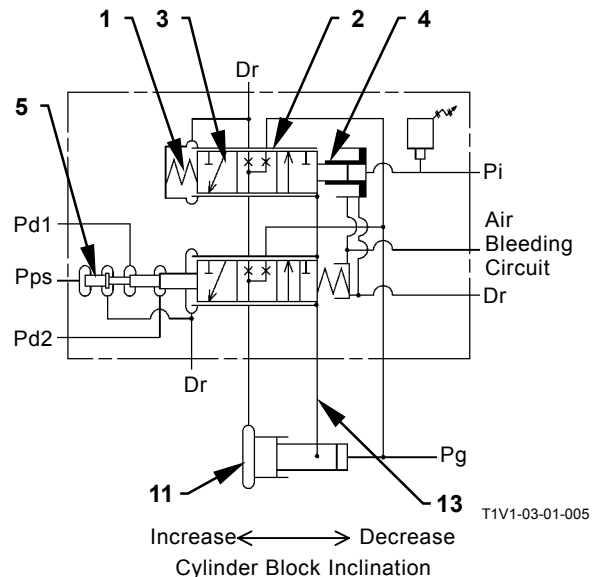
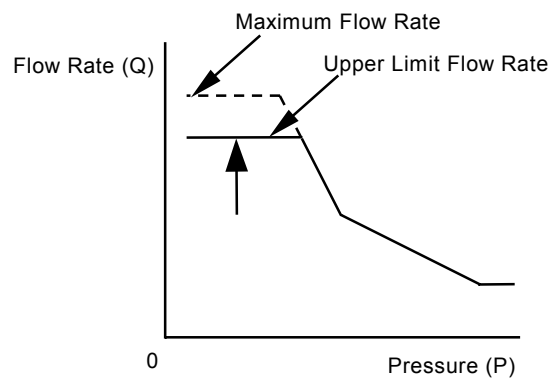
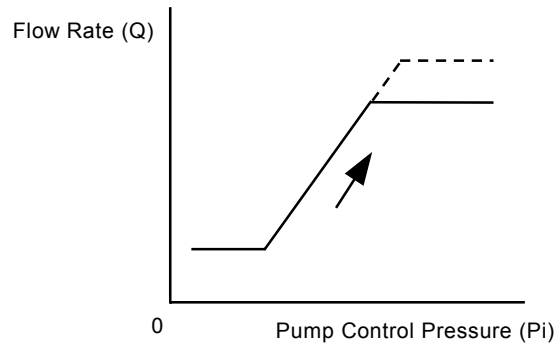
11 - Servo Piston
13 - Link

COMPONENT OPERATION / Pump Device

Control by Pilot Pressure from Flow Rate Control Solenoid Valve

ZX160-3 class : Pump 1 and Pump 2
 ZX180-3 class : Pump 2 Only

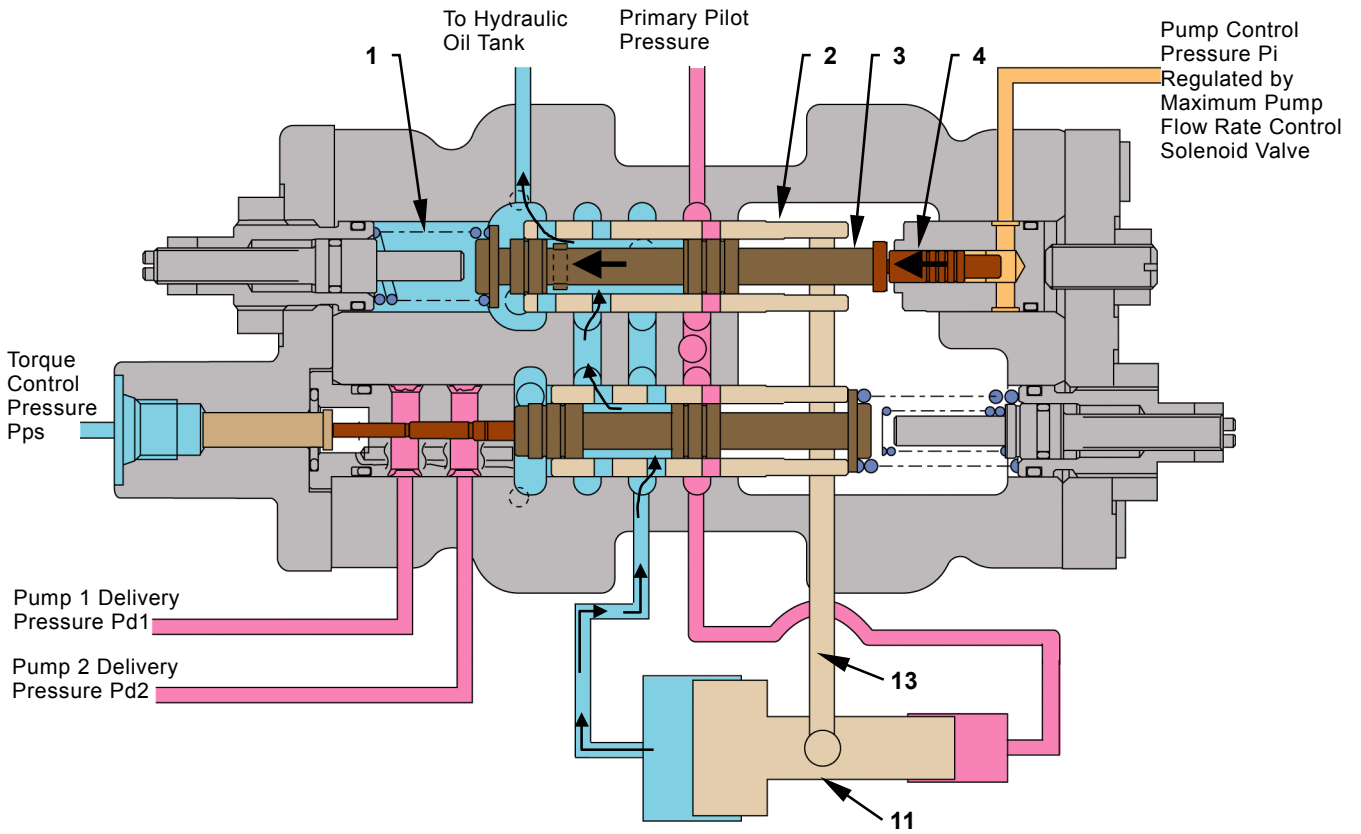
- Upper Limit Flow Rate Control
 1. The maximum pump flow rate control solenoid valve in pump control pressure P_i circuit is activated by the signals from the main controller (MC).
 2. The maximum pump flow rate control solenoid valve functions as a pressure reducing valve and pump control pressure P_i decreases.
 3. Piston (4) is moved toward direction of the arrow by reduced pump control pressure P_i .
 4. Piston (4) pushes spool A (3) and spring (1), until the force acting on piston (4) by pump control pressure P_i becomes balanced with the spring (1) force, spool A (3) moves toward direction of the arrow.
 5. As pump control pressure P_i 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 the small chamber of servo piston (11), servo piston (11) 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 (13). 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 (11) is blocked.
 10. Therefore, servo piston (11) is stopped and the flow rate increasing operation is completed.
 11. Accordingly, pump control pressure P_i increases in proportion to the stroke of control lever and the pump delivery flow rate increases. However, as pump control pressure P_i is regulated, the strokes of spool A (3) and servo piston (11) are reduced so that the maximum flow rate becomes less than usual.



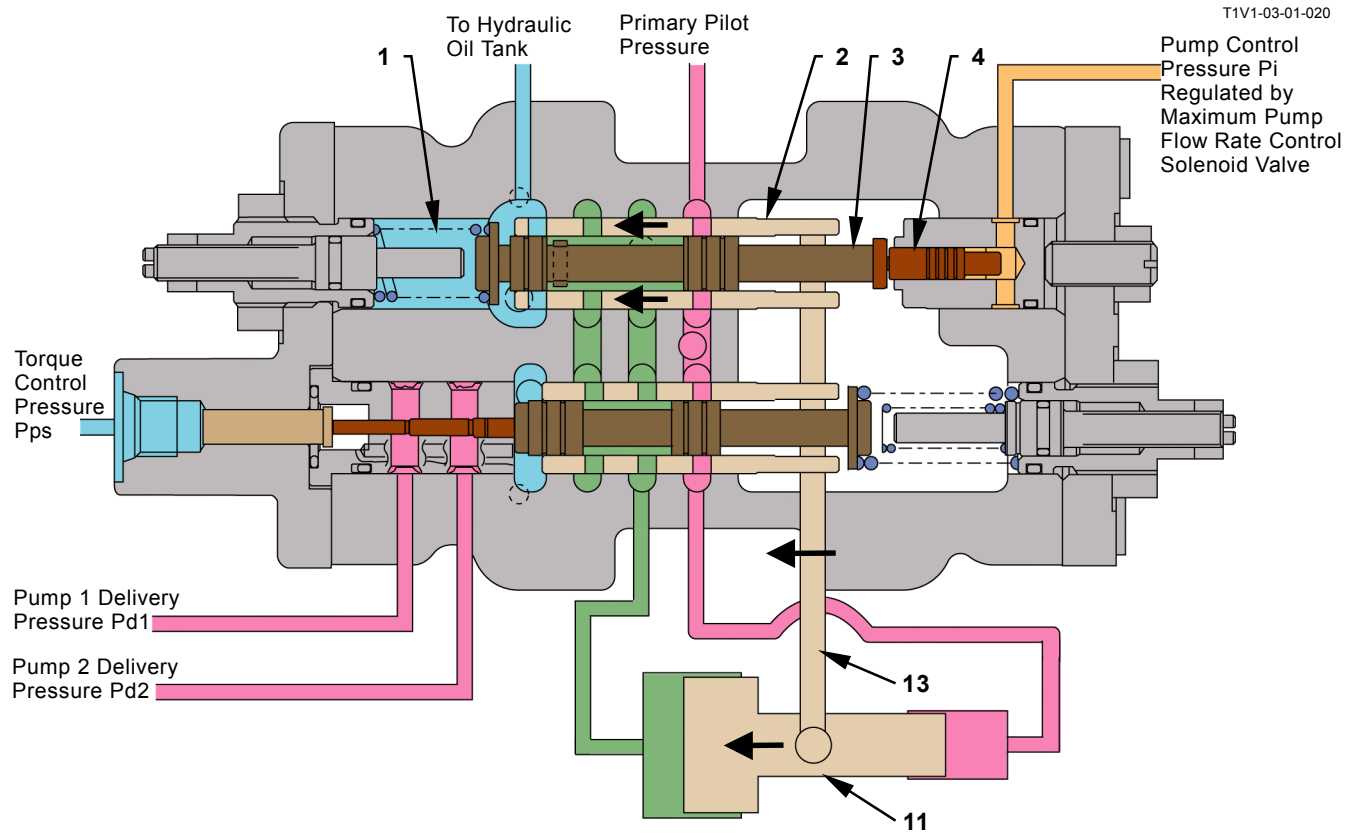
T1V1-03-01-005

- | | |
|--------------------------------------|---|
| 1 - Spring | 4 - Piston |
| 2 - Sleeve A | 11 - Servo Piston |
| 3 - Spool A | 13 - Link |
| Pd1 - Pump 1 Delivery Pressure | Pi - Pump Control Pressure |
| Pd2 - Pump 2 Delivery Pressure | Pps - Torque Control Pressure |
| Dr - Returning to Hydraulic Oil Tank | Pg - Primary Pilot Pressure (From Pilot Pump) |

COMPONENT OPERATION / Pump Device



T1V1-03-01-020



T1V1-03-01-021

1 - Spring
2 - Sleeve A

3 - Spool A
4 - Piston

11 - Servo Piston

13 - Link

COMPONENT OPERATION / Pump Device

SOLENOID VALVE

The torque control solenoid valve and the pump 2 flow rate limit solenoid valve are provided on the pump 2 regulator. The torque control solenoid valve supplies the torque control pressure Pps to both the pump 1 and pump 2 regulators to reduce the pump flow rate. The pump 2 flow rate limit solenoid valve reduces the pump control pressure to the pump 2 regulator so that the maximum pump flow rate is limited.

The pump 1 flow rate limit solenoid valve is provided on the pump 1 regulator. The pump 1 flow rate limit solenoid valve reduces the pump control pressure to the pump 1 regulator so that the maximum pump flow rate is limited.

Operation

1. When neutral, port P is connected to the output port through the notch on the spool.
2. When the current flows to the solenoid from the MC, the solenoid is magnetized, pushing spring 1.
3. Then, spring 1 pushes the spool so that the output port is connected to port T through the notch on the spool.
4. Thereby, pressure at the output port begins to decrease.
5. Left side spool diameter (A) at the notch is larger than right side diameter (B).
6. Accordingly, until the oil pressure at the output port disappears, the external force applied onto the spool is expressed as $P1 \times B + S1 > P1 \times A + S2$. Then, the spool is move toward the right side.
7. When the oil pressure at the output port disappears so that when $P1 \times B + S1$ becomes equal to $P1 \times A + S2$ ($P1 \times B + S1 = P1 \times A + S2$), the spool stops moving.

P1 : Oil pressure at the output port

A and B: Pressure receiving area on the spool

S1 : Spring 1 force

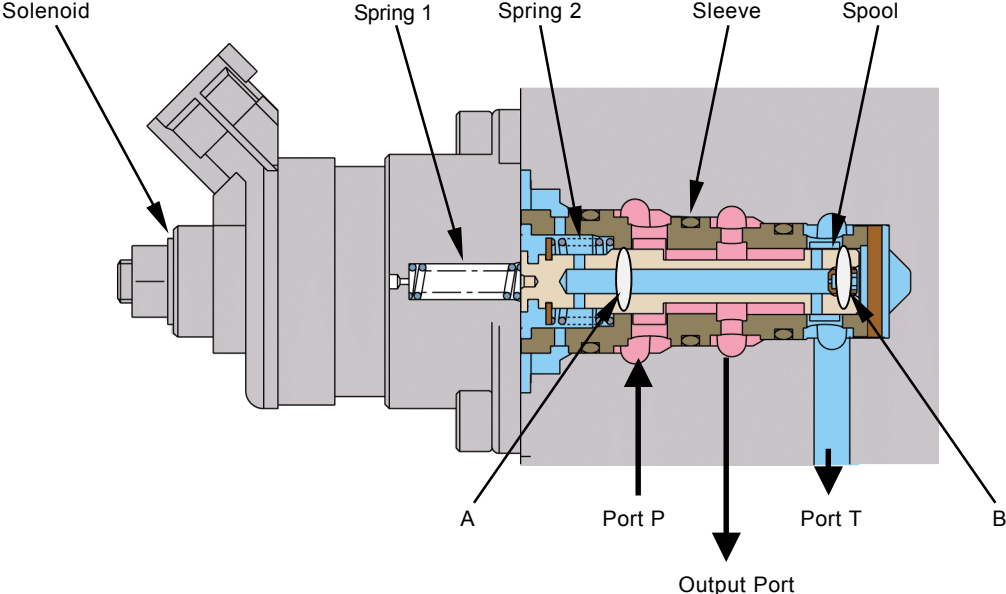
(pushing the spool toward the right side)

S2 : Spring 2 force

(pushing the spool toward the left side)

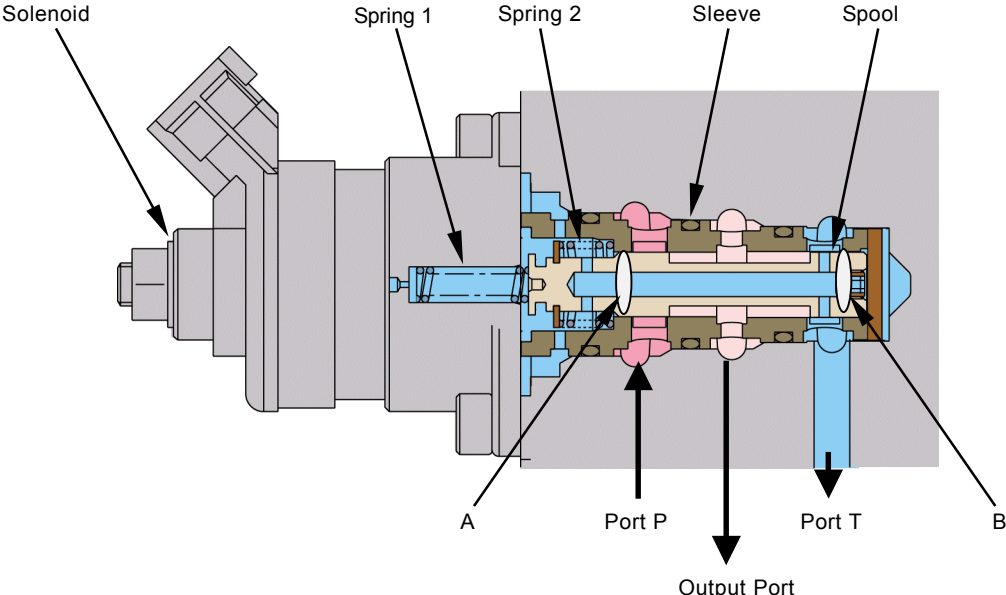
COMPONENT OPERATION / Pump Device

When Neutral:



T176-03-01-030

When in Operation:



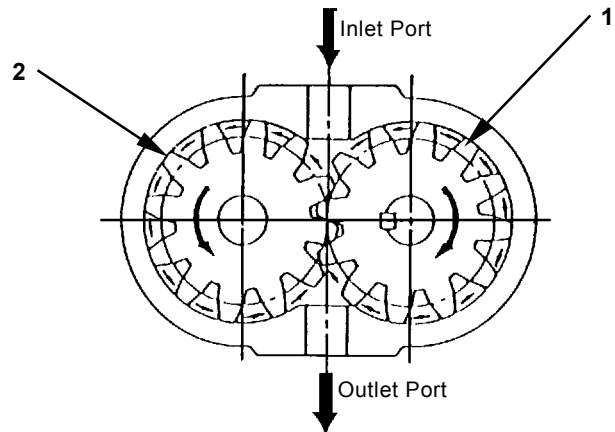
T176-03-01-031

COMPONENT OPERATION / Pump Device

PILOT PUMP

Drive gear (1) is driven by the engine via the transmission which in turn rotates driven gear (2) as they are meshed together.

- 1 - Drive Gear
- 2 - Driven Gear

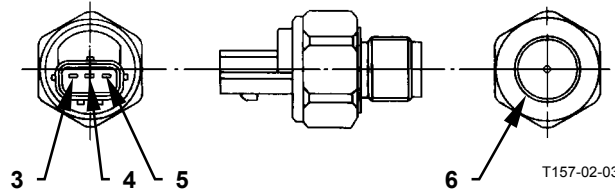


T137-02-03-005

PUMP DELIVERY PRESSURE SENSOR

This sensor detects the pump delivery pressures, which are used in order to control various operations. When oil pressure is applied to diaphragm (6), diaphragm (6) is deformed. The deformation of diaphragm (6) is detected as electrical signals.

- 3 - Ground
- 4 - Output
- 5 - Power Source (5V)
- 6 - Pressure Receiving Area (Diaphragm)

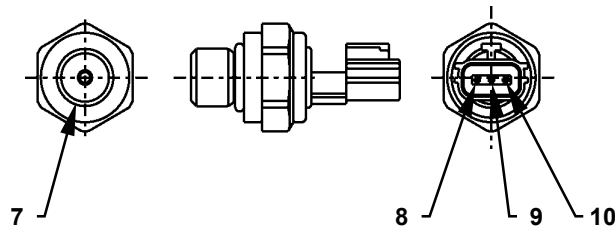


T157-02-03-010

PUMP CONTROL PRESSURE SENSOR

This sensor detects the pump control pressures, which are used in order to control various operations. When oil pressure is applied to diaphragm (7), diaphragm (7) is deformed. The deformation of diaphragm (7) is detected as electrical signals.

- 7 - Pressure Receiving Area (Diaphragm)
- 8 - Ground
- 9 - Output
- 10 - Power Source (5V)



T176-03-01-023

COMPONENT OPERATION / Swing Device

OUTLINE

The swing device consists of the valve unit, the swing motor and the swing reduction gear.

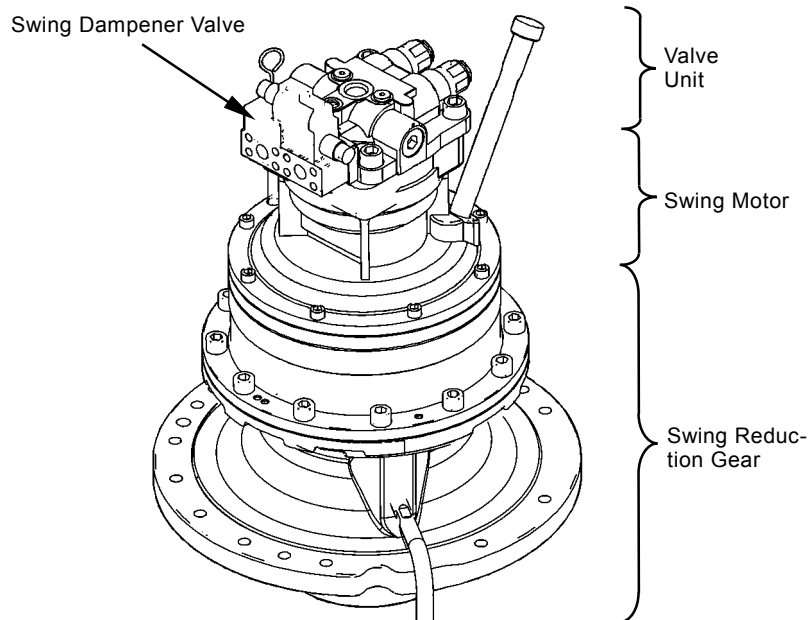
The valve unit prevents the cavitation and overloads in the swing circuit.

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 a low speed and swings the upper-structure.

The swing dampener valve is provided for the main circuit in swing motor.

The swing dampener valve reduces shock when the swing brake is applied and also prevents aftershock.



T1V1-03-02-003

COMPONENT OPERATION / Swing Device

SWING REDUCTION GEAR

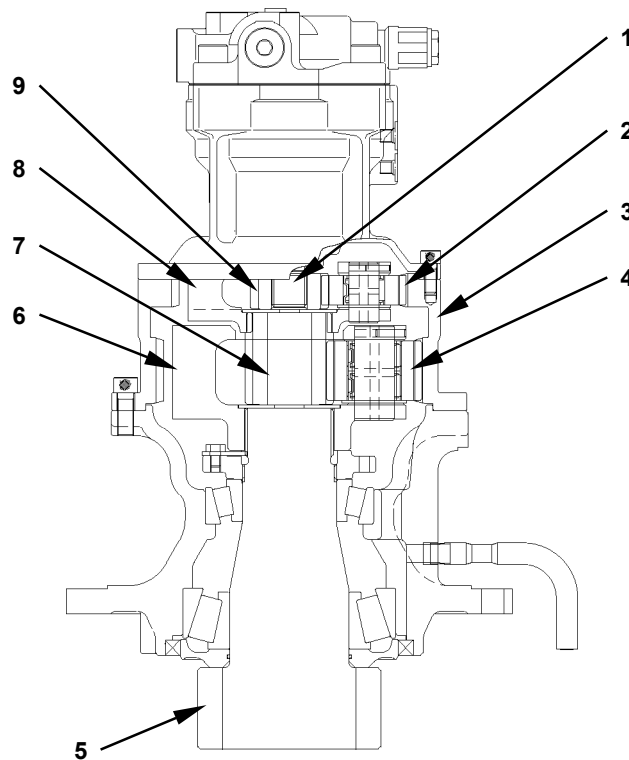
The swing reduction gear is a two-stage planetary reduction gear.

Ring gear (3) is monolithically built with the housing bolted to the upperstructure and does not allow to rotate.

Shaft (1) of the swing motor turns first stage sun gear (9), whose turning torque is transmitted to second stage sun gear (7) through first stage planetary gear (2) and first stage carrier (8).

Second stage sun gear (7) turns shaft (5) through second stage planetary gear (4) and second stage carrier (6).

Shaft (5) is engaged with the internal gear of swing bearing fixed to the undercarriage in order to swing the upperstructure.



T1V1-03-02-018

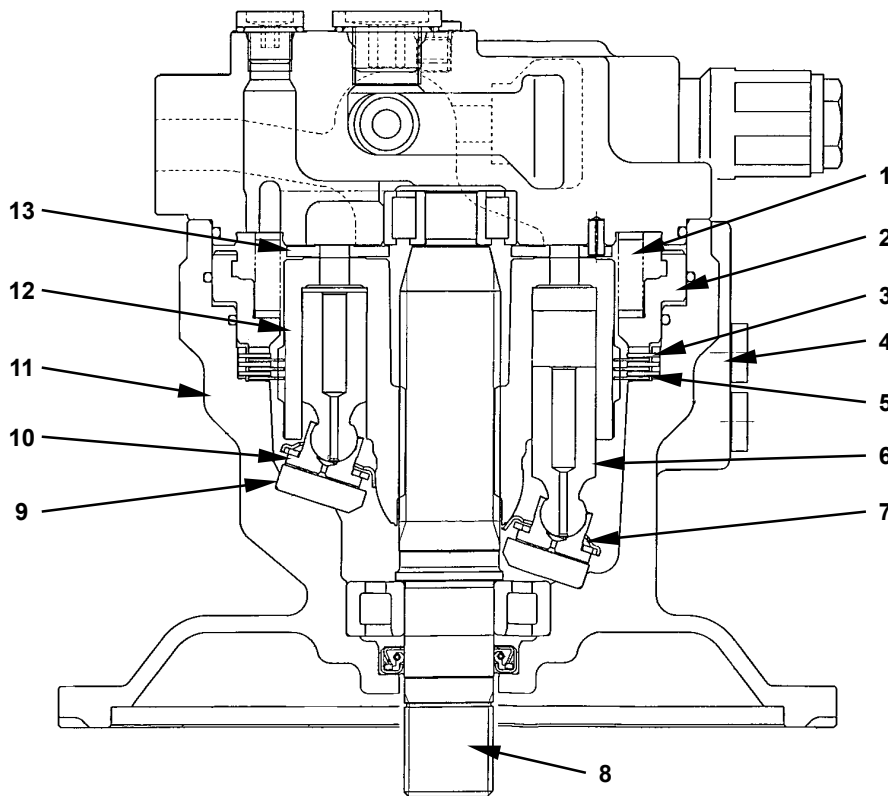
- | | | |
|--------------------------------|---------------------------------|---------------------------|
| 1 - Shaft (Swing Motor) | 4 - Second Stage Planetary Gear | 7 - Second Stage Sun Gear |
| 2 - First Stage Planetary Gear | 5 - Shaft | 8 - First Stage Carrier |
| 3 - Ring Gear | 6 - Second Stage Carrier | 9 - First Stage Sun Gear |

COMPONENT OPERATION / Swing Device

SWING MOTOR

The swing motor consists of swash plate (9), rotor (12), valve plate (13), housing (11) and swing parking brake (springs (1), brake pistons (2), plate (3), friction plate (5) and swing parking brake selection valve (4)). Shaft (8) is splined to rotor (12) into which plunger (6) is inserted.

When pressure oil is supplied from the pump, plunger (6) is pushed. Shoe (10) at the top of plunger (6) slides over swash plate (9) so that rotor (12) rotates. The top of shaft (8) is splined to the first stage sun gear of swing reduction gear. Therefore, the rotation of shaft (8) is transmitted to the swing reduction gear.



T1V1-03-02-008

- | | | | |
|---|--------------------|-----------------|------------------|
| 1 - Spring | 5 - Friction Plate | 8 - Shaft | 11 - Housing |
| 2 - Brake Piston | 6 - Plunger | 9 - Swash Plate | 12 - Rotor |
| 3 - Plate | 7 - Retainer | 10 - Shoe | 13 - Valve Plate |
| 4 - Swing Parking Brake Selection Valve | | | |

COMPONENT OPERATION / Swing Device

SWING PARKING BRAKE

The swing parking brake is a wet type multi-plate disc brake and a negative mechanism that releases the brake when brake release pressure acts on the brake piston chamber.

The brake release pressure is supplied from the pilot pump only when either swing or front attachment is operated.

In other cases (including engine stopping), the brake release pressure returns to the hydraulic oil tank, so that the brake is applied automatically by the spring.

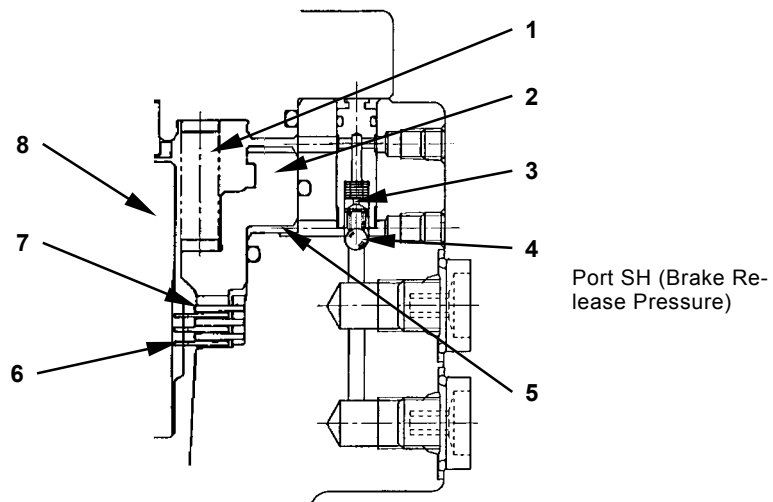
When Brake is Released

1. The swing or front attachment control lever is operated, the swing parking brake release spool in signal control valve is shifted. Then, pilot pressure from the pilot pump is applied to port SH.
2. Pilot pressure to port SH pushes to open check valve (4) and acts on brake piston chamber (5).
3. As a result, as brake piston (2) is pushed upward, plate (7) and friction plate (6) are freed and the brake is released.

When Brake is Applied

1. When the swing or front attachment control lever is returned to neutral, the swing parking brake release spool in signal control valve is returned to neutral and pilot pressure to port SH disappears.
2. Check valve (4) is closed and the brake release pressure through orifice (3) is released to the swing motor housing.
3. As a result, the force of spring (1) acts on friction plate (6), which is engaged with the external circumference of rotor (8), and on plate (7), which is engaged with the inside of motor housing through brake piston (2). Thus, the external circumference of rotor (8) is secured with friction force.
When the engine stops, the brake is applied automatically as pressure is not applied to port SH.

COMPONENT OPERATION / Swing Device



T178-03-02-003

1 - Spring
2 - Brake Piston

3 - Orifice
4 - Check Valve

5 - Brake Piston Chamber
6 - Friction Plate

7 - Plate
8 - Rotor

COMPONENT OPERATION / Swing Device

VALVE UNIT

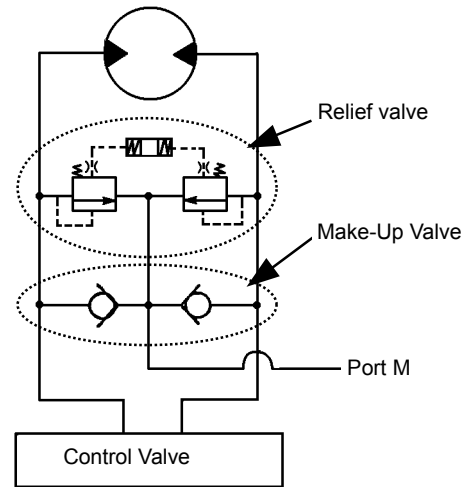
The valve unit consists of make-up valve and relief valve.

The make-up valve prevents cavitation in the circuit and the relief valve prevents surge pressure and overloads in the circuit.

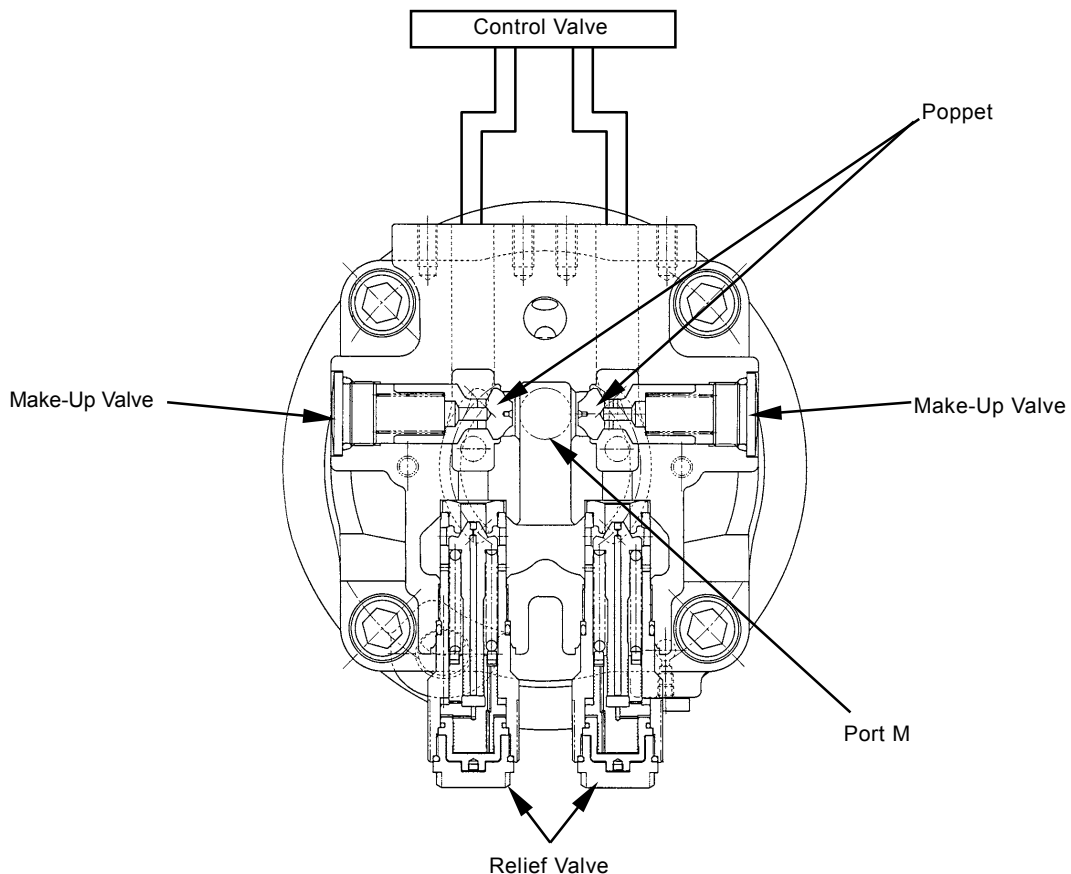
Make-Up Valve

During swing stopping operation, the swing motor is driven by the inertial force of swing frame. The swing motor is turned forcibly in excess of oil pressure from the pump, so that cavitation may be generated in the motor.

In order to avoid this cavitation, when pressure in the swing circuit becomes lower than that in the return circuit (port M), the poppet opens to draw hydraulic oil and compensates the lack of oil feed.



T107-02-04-013



T1V1-03-02-011

COMPONENT OPERATION / Swing Device

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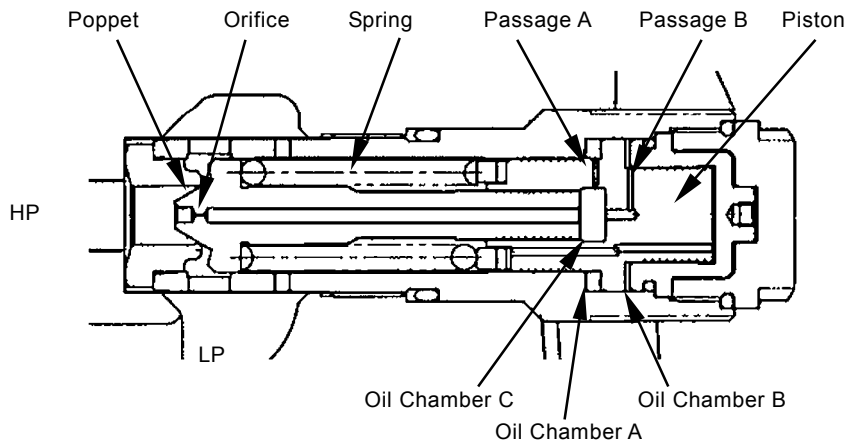
COMPONENT OPERATION / Swing Device

Relief Valve

During starting or stopping swing operation, oil pressure in the swing circuit becomes high. The relief valve prevents the circuit pressure from rising higher than the set-pressure.

ZX160-3 class

- Low Pressure Relief Operation (Shockless Function):
 1. Pressure at port HP (swing circuit) is routed to oil chamber C through the poppet orifice.
 2. Pressure oil in oil chamber C is further routed to oil chambers A and B via passages A and B respectively.
 3. The pressure receiving area in oil chamber B is larger than oil chamber A so that the piston moves to the left.
 4. As long as the piston keeps moving, a pressure difference is developed between the front and the rear of poppet. When this pressure difference is increased more than spring force, the poppet is unseated, pressure oil flows to port LP.
 5. When the piston is moved to full stroke, the pressure difference between the front and the rear of poppet disappears and the poppet is seated.
- High Pressure Relief Operation (Overload Prevention):
 1. After the piston is moved to full stroke, the spring is compressed so that the circuit pressure becomes the set-pressure.
 2. If pressure at port HP increases more than the spring set-pressure, the poppet is unseated and pressure oil flows to port LP.
 3. When pressure at port HP is reduced to the specified level, the poppet is seated by the spring force.

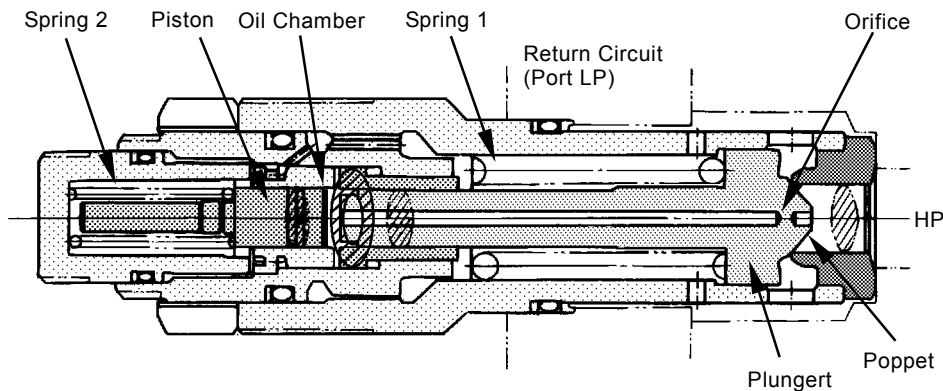


T178-03-02-005


COMPONENT OPERATION / Swing Device

ZX180-3 class

- Low Pressure Relief Operation (Shockless Function):
 1. Pressure at port HP (swing circuit) is routed to oil chamber through the poppet orifice.
 2. When pressure in the oil chamber is increased more than the force of spring 2, the piston moves to the left.
 3. As long as the piston keeps moving, a pressure difference is developed between the front and the rear of poppet. When this pressure difference is increased more than spring force, the poppet is unseated and pressure oil flows to port LP.
 4. When the piston is moved to full stroke, the pressure difference between the front and the rear of poppet disappears and the poppet is seated.
- High Pressure Relief Operation (Overload Prevention):
 1. After the piston is moved to full stroke, the circuit pressure becomes the relief set-pressure.
 2. If pressure at port HP increases more than the spring 1 set-pressure, the poppet is unseated pressure oil flows to port LP.
 3. When pressure at port HP is reduced to the specified level, the poppet is seated by the spring 1 force.



T107-02-04-020

 NOTE: Although the structure of relief valve is different, the operational principle is same.

COMPONENT OPERATION / Swing Device

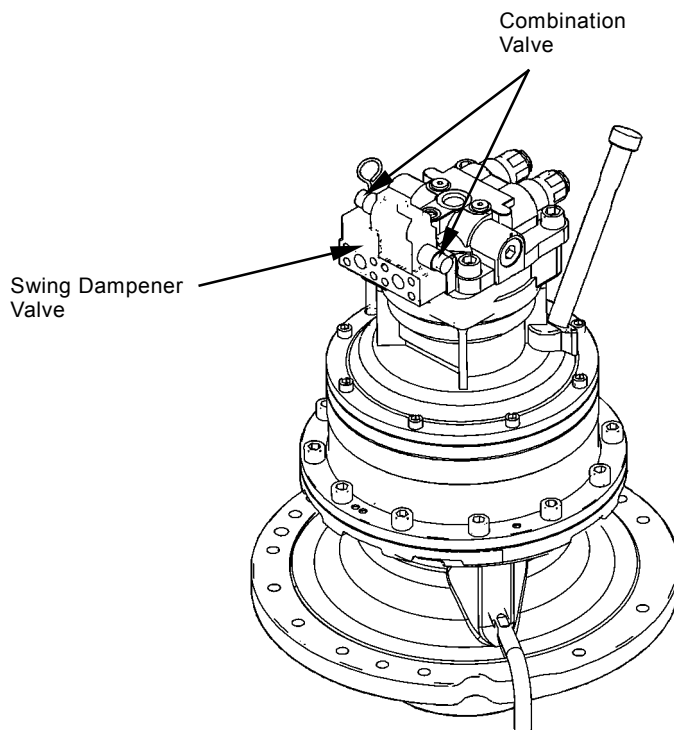
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COMPONENT OPERATION / Swing Device

SWING DAMPENER VALVE

The swing dampener valve is provided for the main circuit in swing motor.

The swing dampener valve consists of two combination valves. As the dampener valve relieves swing brake pressure (aftershock pressure) with the control lever released to the circuit in opposite side (low-pressure side), the dampener valve reduces the shock when applying the swing brake and prevents the aftershock.



T1V1-03-02-003

COMPONENT OPERATION / Swing Device

Operation

- Output Curve: Between A and B (When relieving)

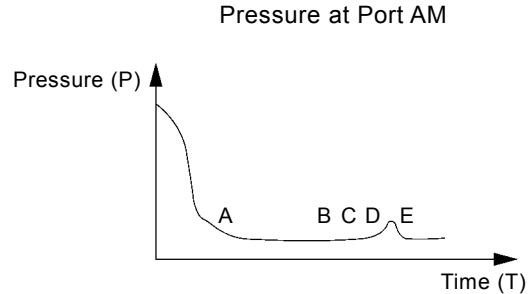
1. When releasing the control lever, the spool in control valve moves to the neutral position. As the swing motor rotates due to the inertia force of machine, pressure in the circuit at port BM (return side) increases momentarily and operates the swing relief valve.
2. Pressure oil from port BM acts on combination valves (A, B) respectively.

- Operation of Combination Valve (A):

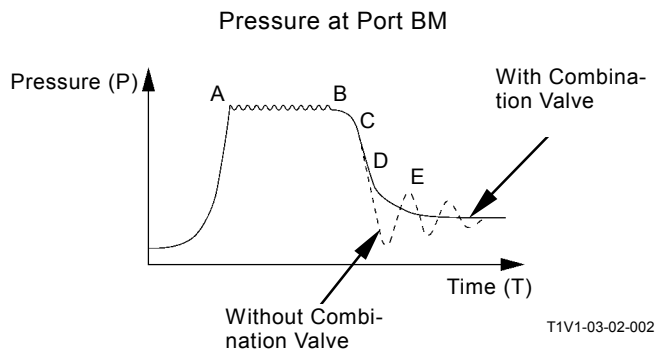
3. Pressure oil acting on combination valve (A) opens ball (2) and flows to chamber N through poppet (1).
4. When pressure in chamber N is larger than spring (4) force and spring (7) force (pressure in chamber N > spring (4) force + spring (7) force), piston (5) tries to move to the left. However, piston (5) is blocked by the plug and cannot move.
5. Plunger (3) and poppet (1) pushes springs (4, 7) and move to the right in union.
This state continues until pressure at port BM begins to decrease (output curve: between B and C).

- Operation of Combination Valve (B):

6. Pressure oil acting on combination valve (B) flows to the spring (4) chamber through the inner passage.
7. When pressure in spring (4) chamber is larger than spring (4) force and spring (7) force (pressure in spring (4) chamber > spring (4) force + spring (7) force), plunger (3), piston (5) and poppet (1) compress springs (4, 7) and move to the left in union.
This state continues until pressure at port BM decreases (output curve: between C and D).

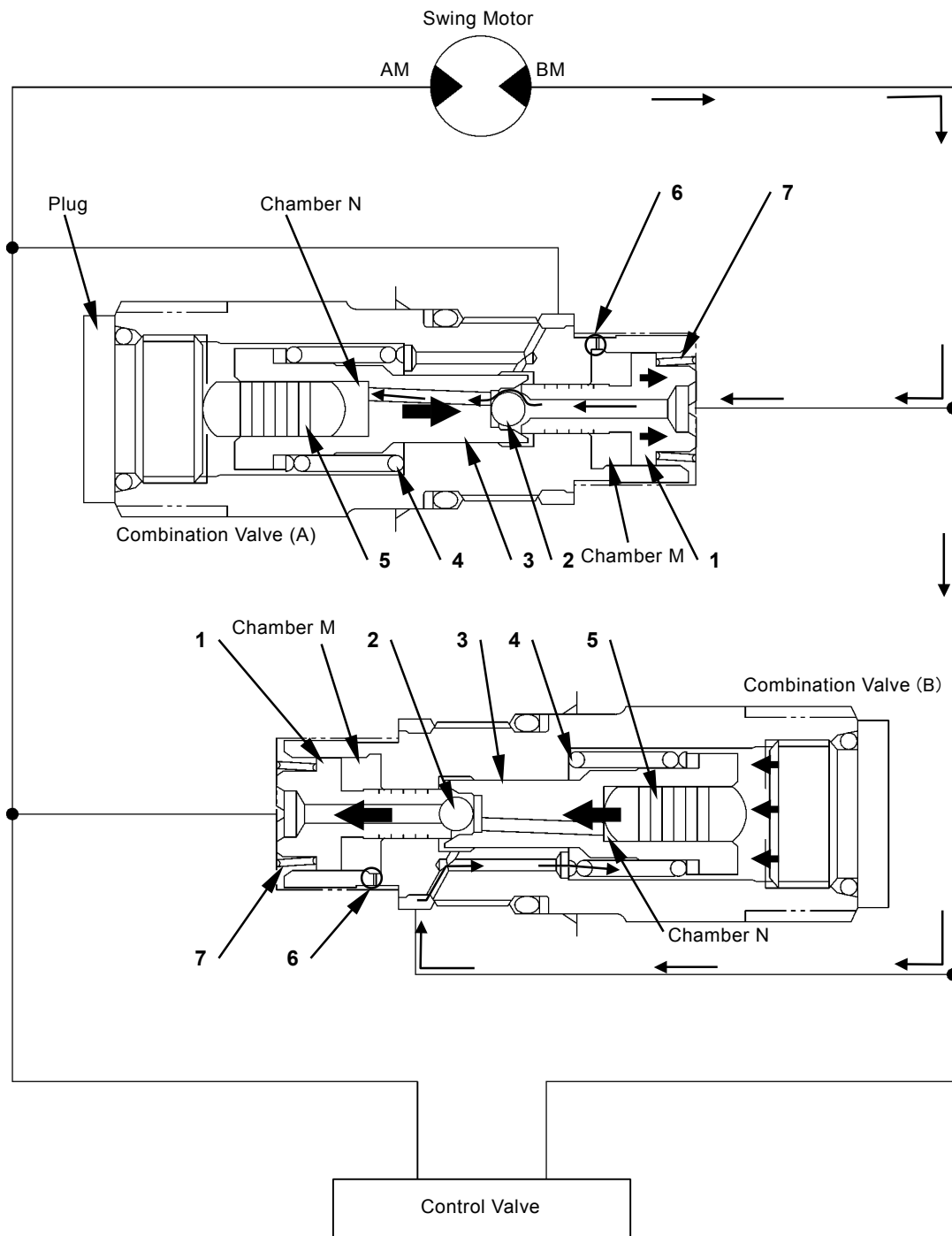


T1V1-03-02-001



T1V1-03-02-002

COMPONENT OPERATION / Swing Device



T1V1-03-02-013

1 - Poppet
2 - Ball

3 - Plunger
4 - Spring

5 - Piston
6 - Orifice

7 - Spring

COMPONENT OPERATION / Swing Device

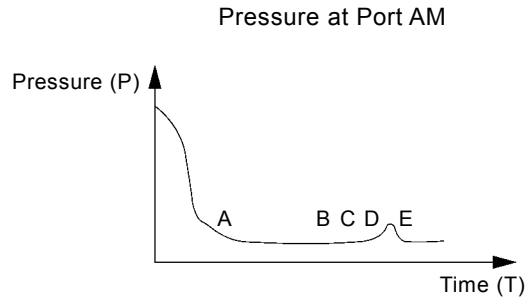
- Output Curve: Between B and C (Pressure begins to decrease)

When the swing motor rotation due to the inertia force of machine is reduced, pressure at port BM decreases. At this time, combination valve (A) functions as the following.

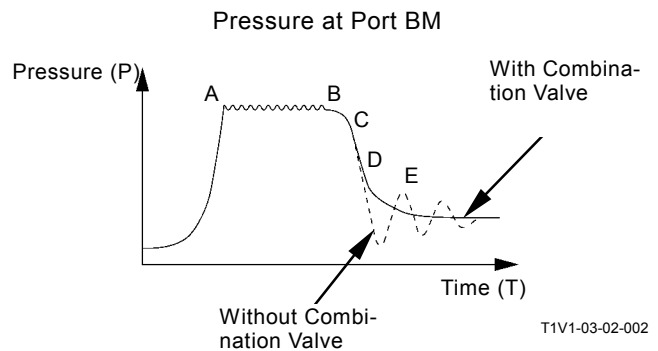
- Operation of Combination Valve (A):

1. When pressure at port BM decreases, pressure acting to chamber N also decreases.
2. When pressure in chamber N becomes smaller than the spring (4) force, the spring (4) force moves plunger (3) to the left.
3. At the same time, poppet (1) is pushed to the left by the spring (7) force.
4. As the pressure difference due to orifice (6) appears, pressure in chamber M increases.
5. Therefore, poppet (1) moves to the left more slowly.
6. Consequently, the clearance between poppet (1) and plunger (3) appears. Pressure oil from port BM flows to port AM through the clearance between poppet (1) and plunger (3).
7. As combination valve (A) makes pressure oil in port BM (high-pressure) flow to port AM (low-pressure), pressure increase at the high-pressure side is controlled and aftershock pressure is reduced.

This state continues until aftershock pressure at port AM appears (output curve: between D and E).

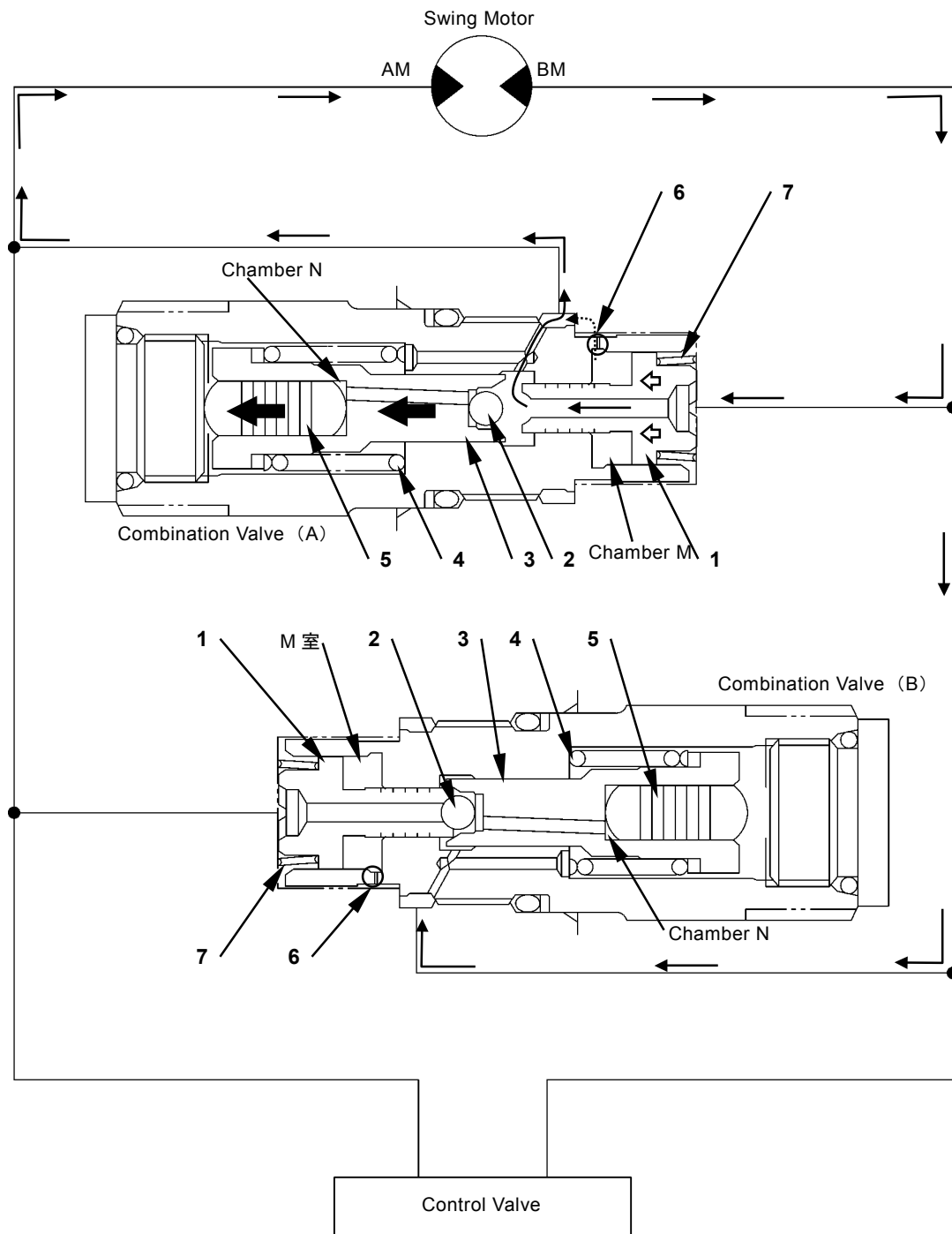


T1V1-03-02-001



T1V1-03-02-002

COMPONENT OPERATION / Swing Device



T1V1-03-02-014

1 - Poppet
2 - Ball

3 - Plunger
4 - Spring

5 - Piston
6 - Orifice

7 - Spring

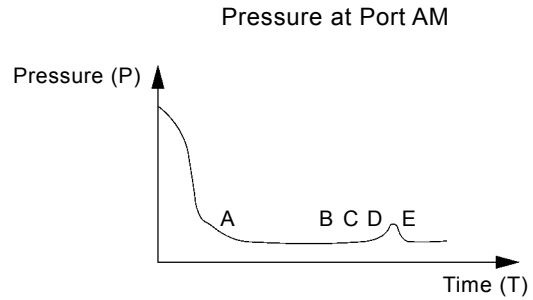
COMPONENT OPERATION / Swing Device

- Output Curve: Between C and D (Pressure at port BM decreases)

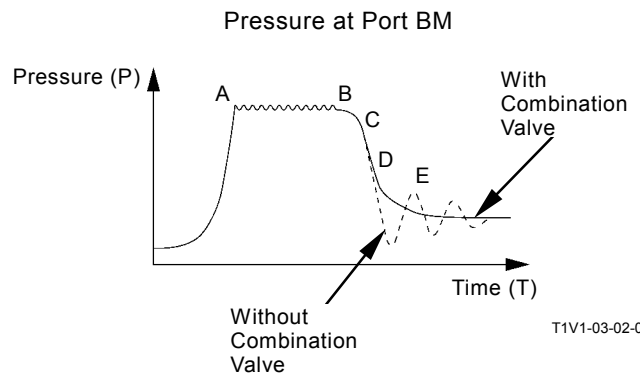
When the swing motor rotation is reduced more, pressure at port BM decreases more. At this time, combination valve (B) functions as the following.

- Operation of Combination Valve (B):

1. When pressure at port BM decreases more, pressure acting on the spring (4) chamber in combination valve (B) also decreases.
 2. When pressure in the spring (4) chamber becomes smaller than the spring (4) force, the spring (4) force moves plunger (3) to the right.
 3. At the same time, poppet (1) is pushed to the right by the spring (7) force.
 4. As the pressure difference due to orifice (6) appears, pressure in chamber M increases.
 5. Therefore, poppet (1) moves to the right more slowly.
 6. Consequently, the clearance between poppet (1) and plunger (3) appears. Pressure oil from port BM acts on poppet (1) and ball (2).
 7. Therefore, ball (2) is pushed by poppet (1). Pop-pet (1) and ball (2) compress spring (7) and move to the left in union.
 8. As combination valve (B) functions like this, and when aftershock pressure appears pressure is relieved promptly.
- This state continues until aftershock pressure at port AM appears (output curve: between D and E).

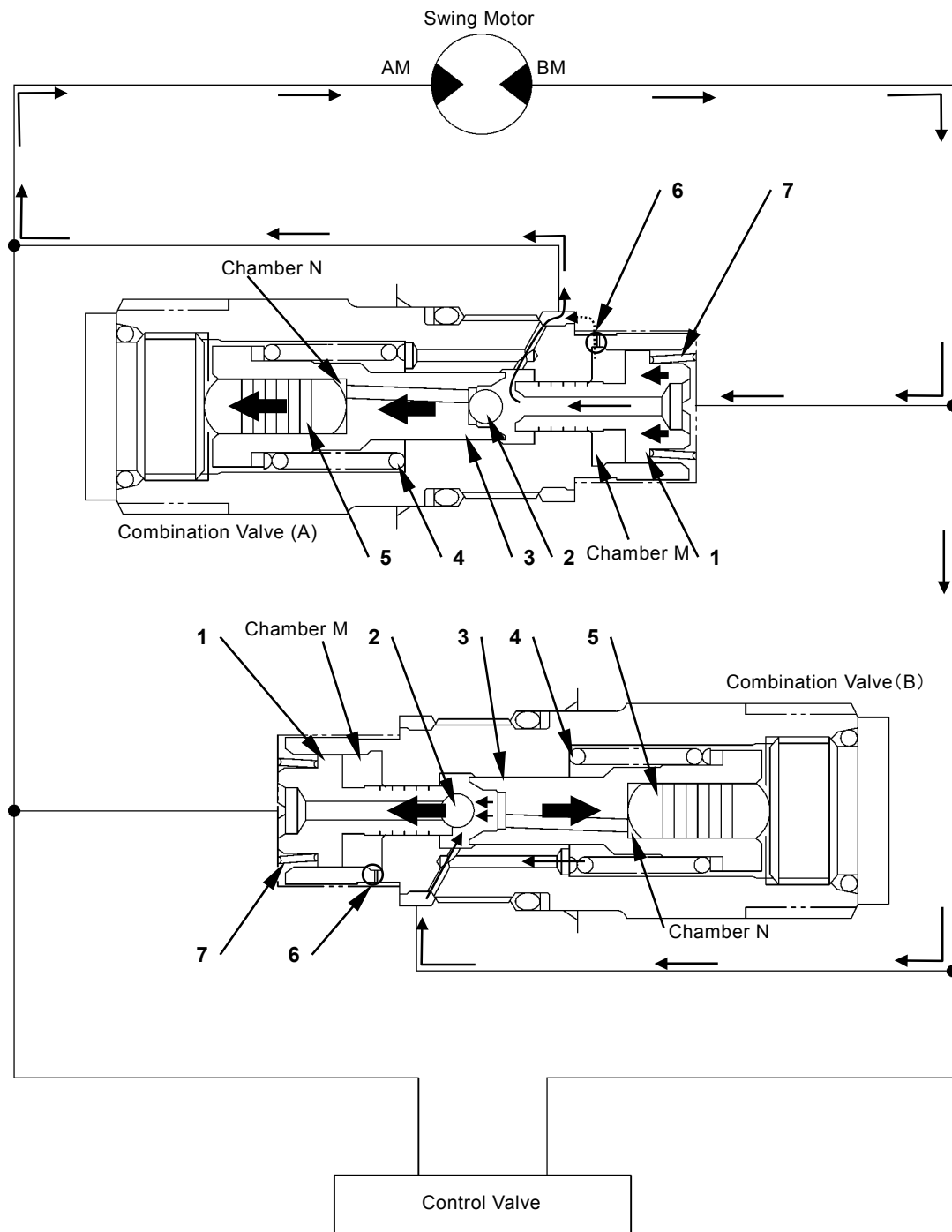


T1V1-03-02-001



T1V1-03-02-002

COMPONENT OPERATION / Swing Device



T1V1-03-02-015

1 - Poppet
2 - Ball

3 - Plunger
4 - Spring

5 - Piston
6 - Orifice

7 - Spring

COMPONENT OPERATION / Swing Device

• **Output Curve: Between D and E (During aftershock)**
When the swing motor stops rotating, aftershock pressure appears at port AM and pressure at port AM increases. (Port AM: High Pressure, Port BM: Low Pressure)

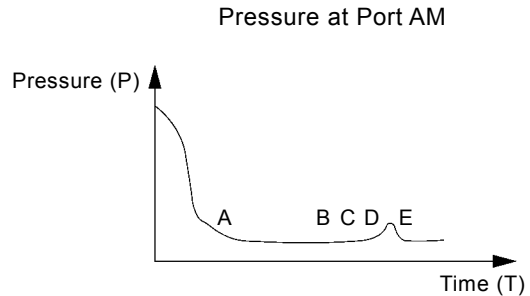
At this time, combination valves (A, B) function as the following.

• **Operation of Combination Valve (A):**

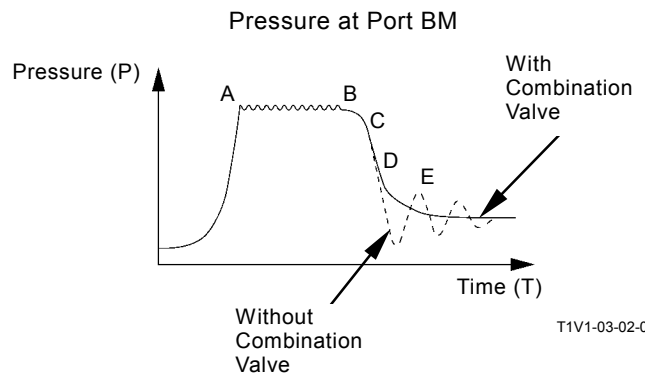
1. Pressure oil from port AM acts on ball (2) and poppet (1) through the inner passage.
2. Therefore, ball (2) and poppet (1) move to the right.
3. As combination valve (A) functions like this, and when aftershock pressure appears, pressure is relieved promptly.

• **Operation of Combination Valve (B):**

4. Pressure oil from port AM opens ball (2) and flows to port BM through poppet (1).
5. As combination valve (B) makes pressure oil from port AM (high-pressure) flow to port BM (low-pressure), pressure increase at high-pressure side is controlled and aftershock pressure is reduced.
6. Combination valves (A, B) repeat these procedures and prevent aftershock of the machine. When pressures at ports AM and BM decrease completely, the combination valve stops functioning.

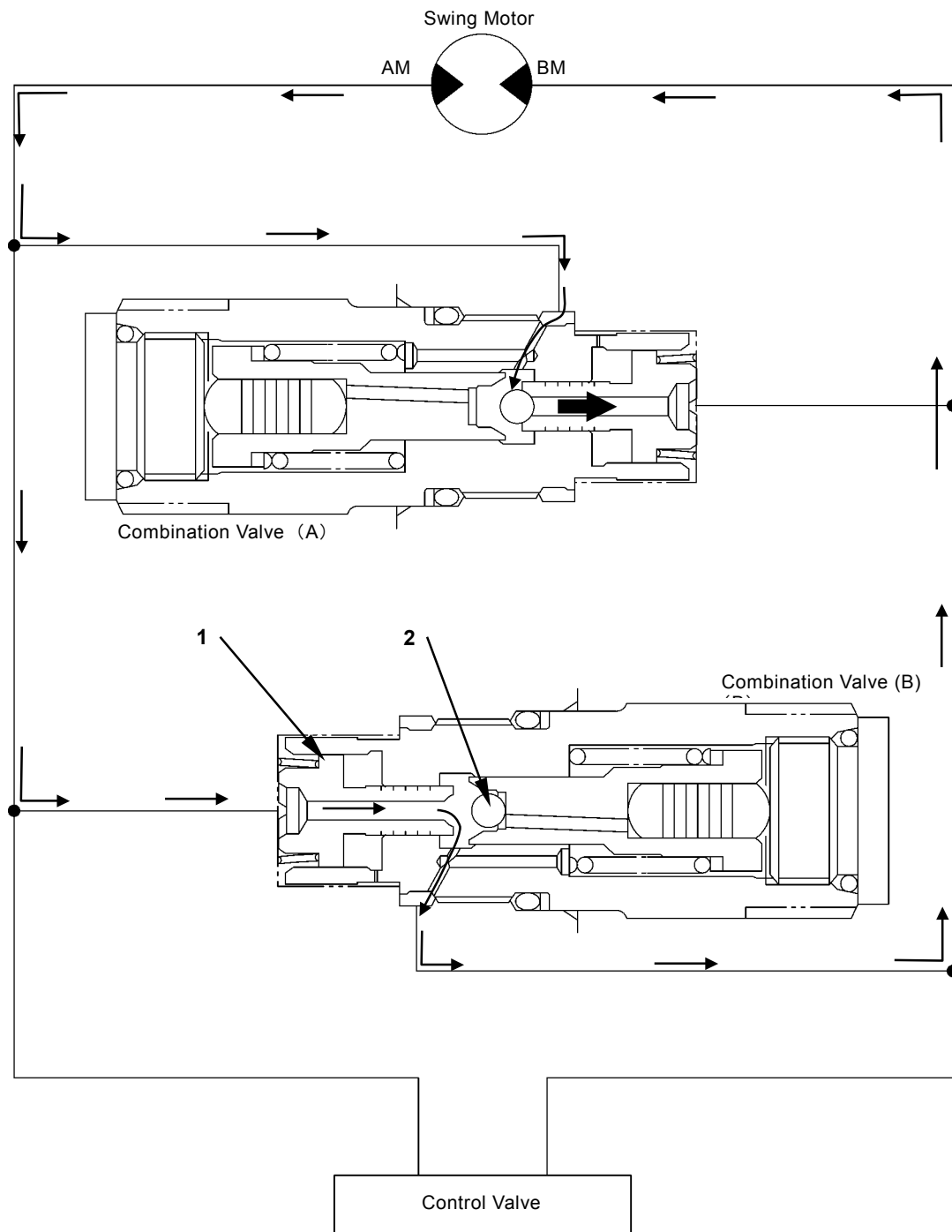


T1V1-03-02-001



T1V1-03-02-002

COMPONENT OPERATION / Swing Device



T1V1-03-02-016

1 - Poppet

2 - Ball

COMPONENT OPERATION / Swing Device

(Blank)

COMPONENT OPERATION / Control Valve

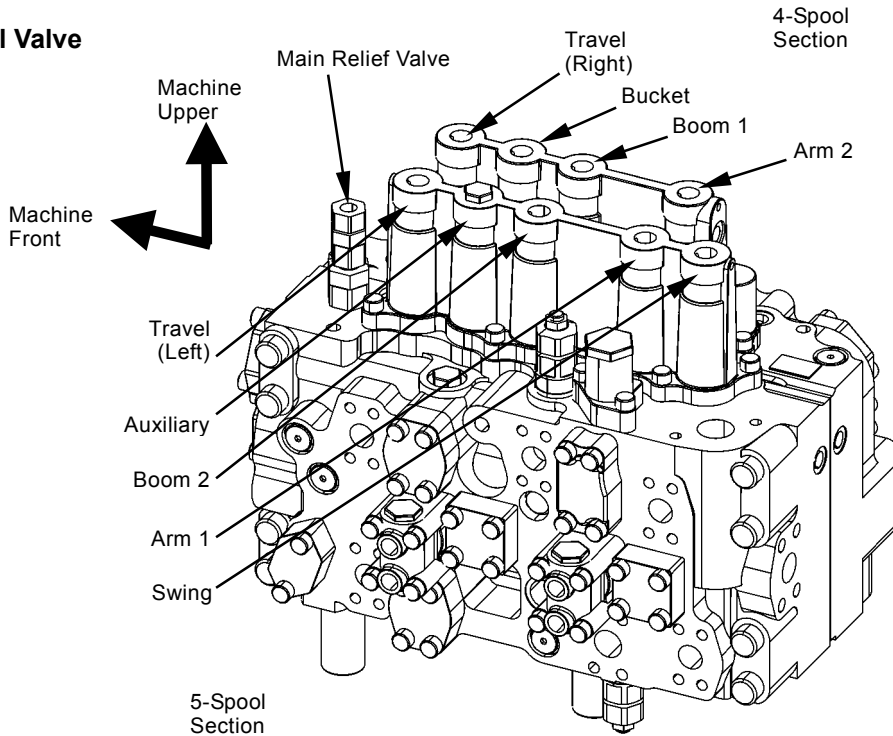
OUTLINE

The control valve controls the pressure, flow rate, and flow direction in the hydraulic circuit.

The major parts are main relief valve, overload relief valve, flow combiner valve, anti-drift valve, flow control valve, regenerative valve, digging regenerative valve, boom lower meter-in cut valve, auxiliary combining valve, bypass shut-out valve and spools. The spools are operated by pilot oil pressure.

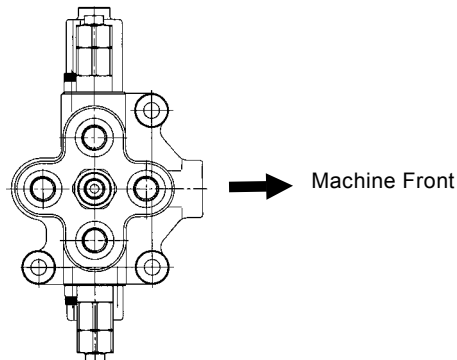
As for the spools, in the 4-spool section, right travel, bucket, boom 1 and arm 2 are arranged in that order as viewed from the machine front. In the 5-spool section, left travel, auxiliary, boom 2, arm 1 and swing are arranged in that order as viewed from the machine front.

Control Valve



T1V1-03-03-072

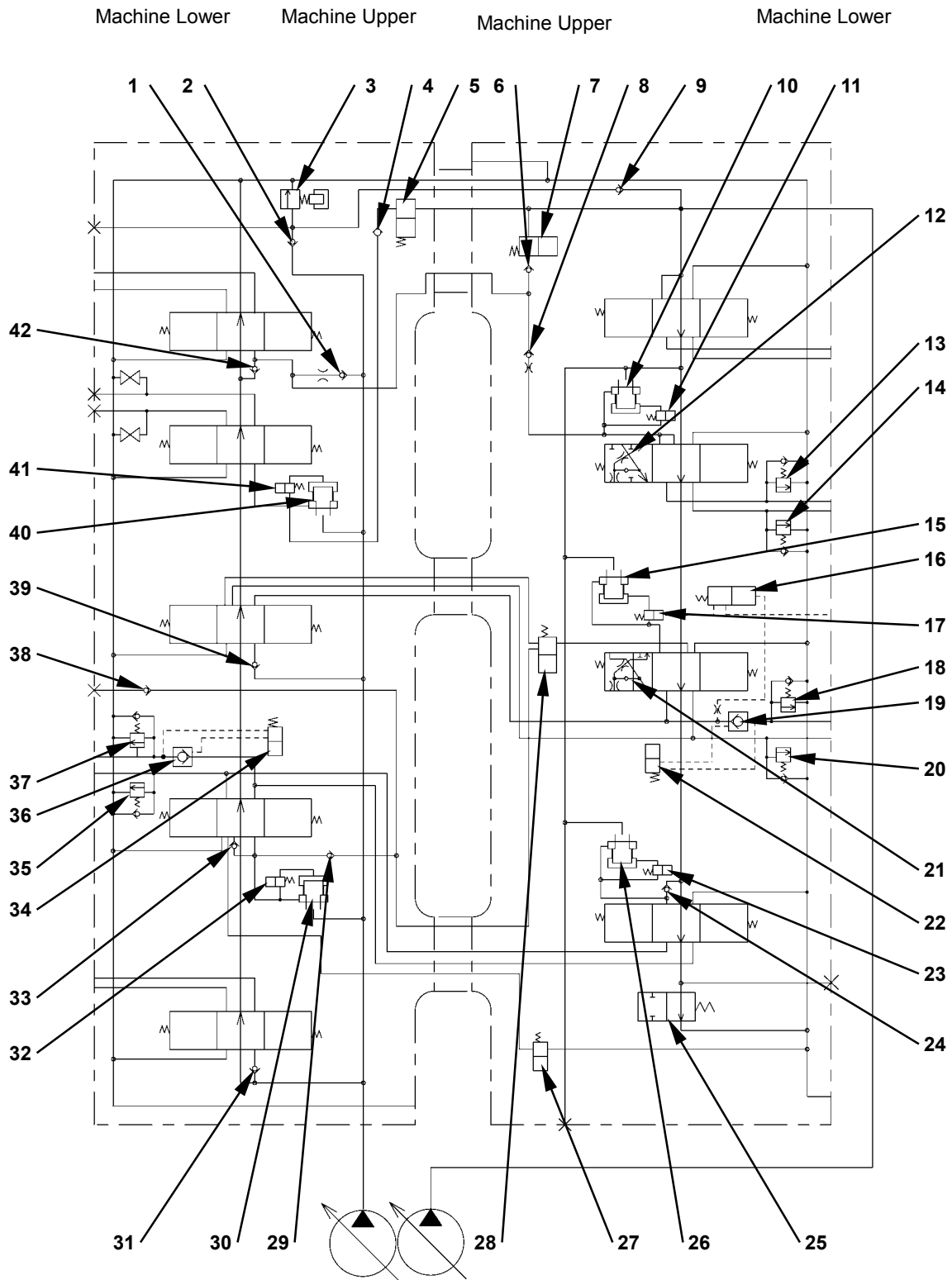
Positioning Control Valve (2-Piece Boom Only)



T178-03-03-370

COMPONENT OPERATION / Control Valve

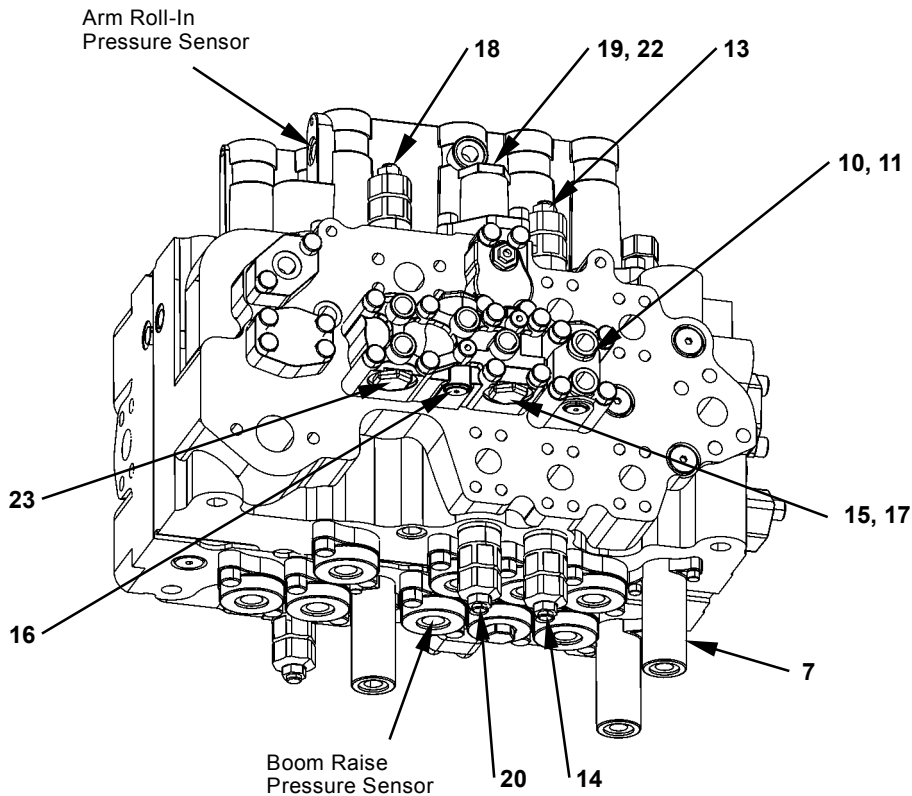
Layout of Control Valve



T1V1-03-03-021

COMPONENT OPERATION / Control Valve

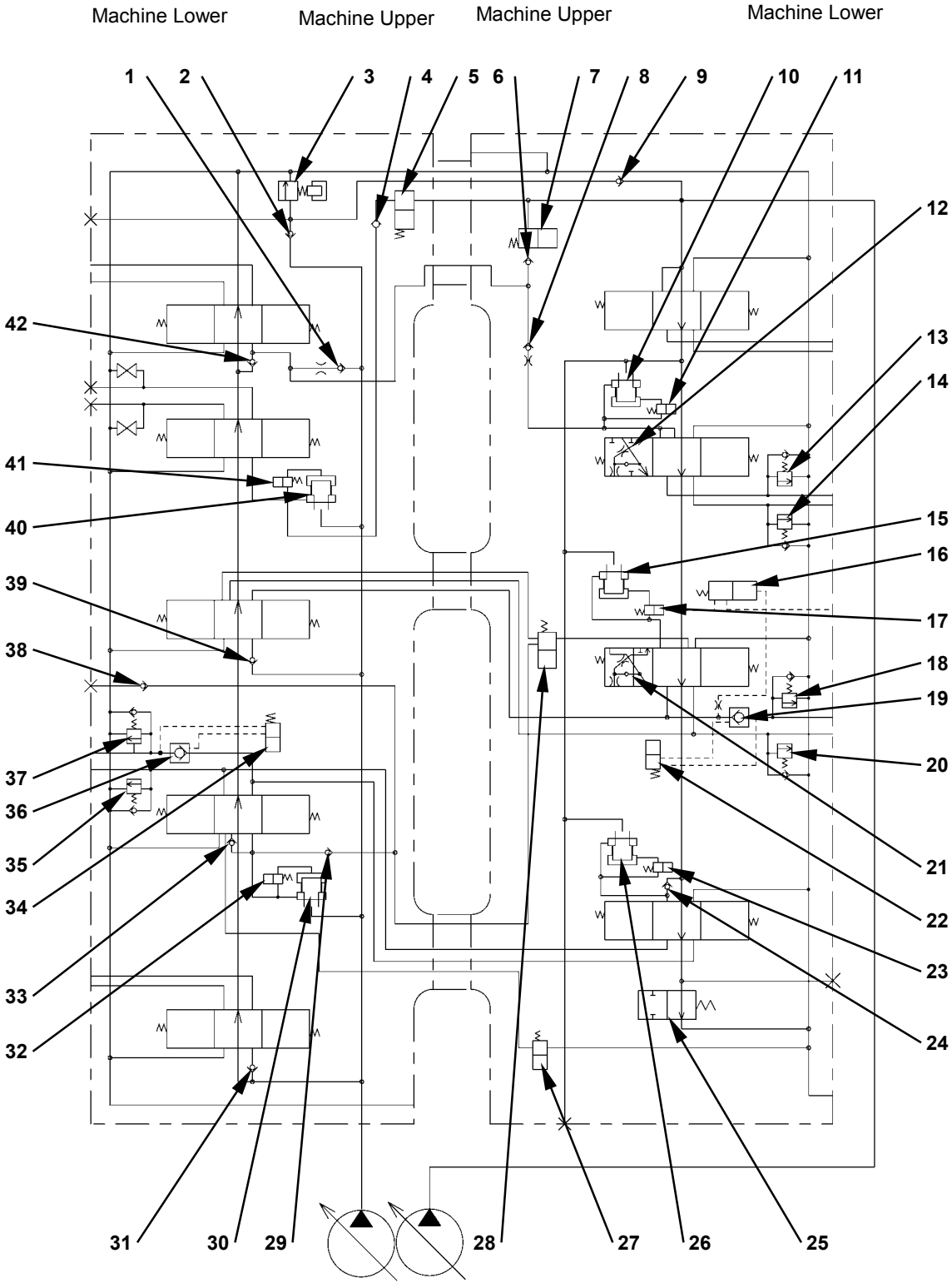
4-Spool Section



T1V1-03-03-073

- | | | | |
|---|--|--|---|
| 1 - Load Check Valve (Left Travel Parallel Circuit) | 12 - Bucket Regenerative Valve | 23 - Arm 2 Flow Rate Control Valve (Switch Valve) | 34 - Arm Anti-Drift Valve (Switch Valve) |
| 2 - Check Valve (Main Relief Circuit) | 13 - Overload Relief Valve (Bucket: Rod Side) | 24 - Load Check Valve (Arm 2 Tandem Circuit) | 35 - Overload Relief Valve (Arm: Bottom Side) |
| 3 - Main Relief Valve | 14 - Overload Relief Valve (Bucket: Bottom Side) | 25 - Bypass Shut-Out Valve | 36 - Arm Anti-Drift Valve (Check Valve) |
| 4 - Check Valve (Auxiliary Combining Valve Circuit) | 15 - Boom Flow Control Valve (Poppet Valve) | 26 - Arm 2 Flow Rate Control Valve (Poppet Valve) | 37 - Overload Relief Valve (Arm: Rod Side) |
| 5 - Auxiliary Flow Combiner Valve | 16 - Boom Lower Meter-In Cut Valve | 27 - Arm Regenerative Valve | 38 - Check Valve (Digging Regenerative Circuit) |
| 6 - Check Valve (Flow Combiner Valve Circuit) | 17 - Boom Flow Rate Control Valve (Switch Valve) | 28 - Digging Regenerative Valve | 39 - Load Check Valve (Boom 2 Parallel Circuit) |
| 7 - Flow Combiner Valve | 18 - Overload Relief Valve (Boom: Bottom Side) | 29 - Load Check Valve (Digging Regenerative Circuit) | 40 - Auxiliary Flow Rate Control Valve (Poppet Valve) |
| 8 - Load Check Valve (Orifice) (Bucket) | 19 - Boom Anti-Drift Valve (Check Valve) | 30 - Arm 1 Flow Rate Control Valve (Poppet Valve) | 41 - Auxiliary Flow Rate Control Valve (Switch Valve) |
| 9 - Check Valve (Main Relief Circuit) | 20 - Overload Relief Valve (Boom: Rod Side) | 31 - Load Check Valve (Swing Circuit) | 42 - Load Check Valve (Left Travel Tandem Circuit) |
| 10 - Bucket Flow Rate Control Valve (Poppet Valve) | 21 - Boom Regenerative Valve | 32 - Arm 1 Flow Rate Control Valve (Switch Valve) | |
| 11 - Bucket Flow Rate Control Valve (Switch Valve) | 22 - Boom Anti-Drift Valve (Switch Valve) | 33 - Load Check Valve (Arm Regenerative Circuit) | |

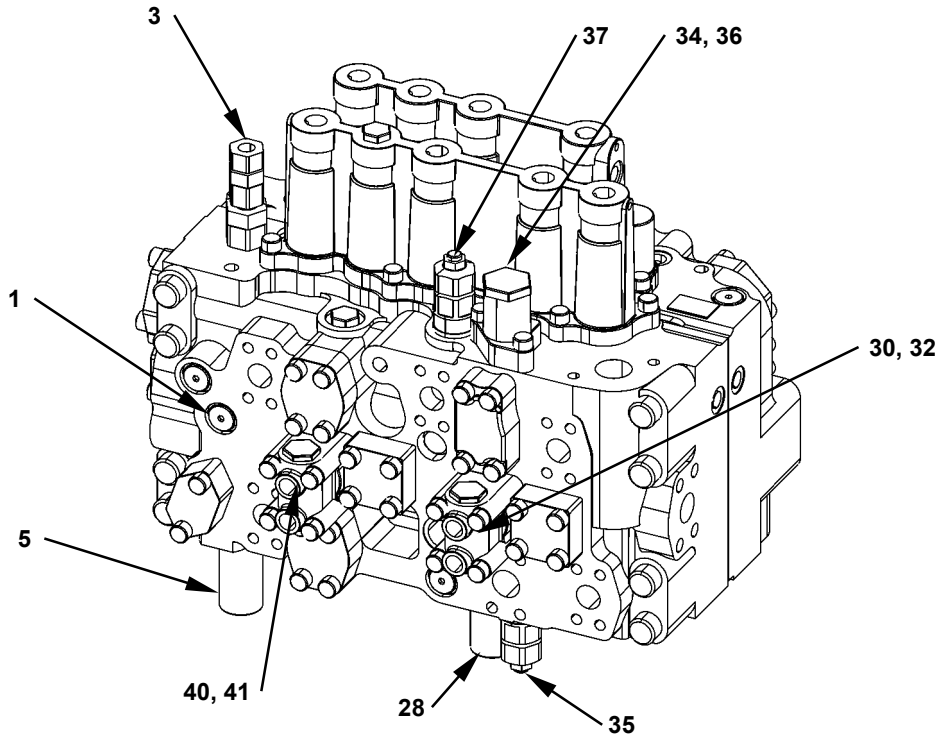
COMPONENT OPERATION / Control Valve



T1V1-03-03-021

COMPONENT OPERATION / Control Valve

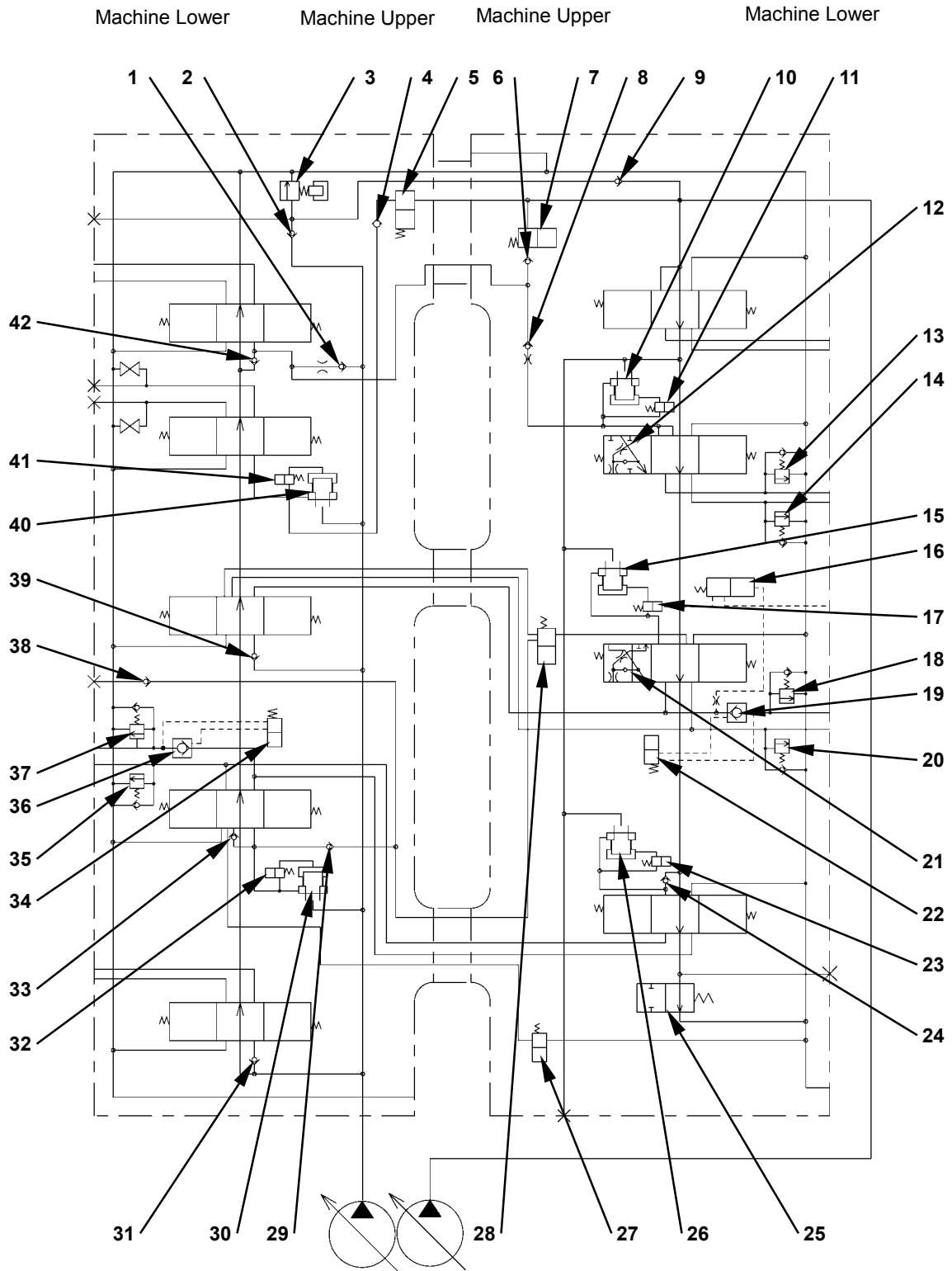
5-Spool Section



T1V1-03-03-072

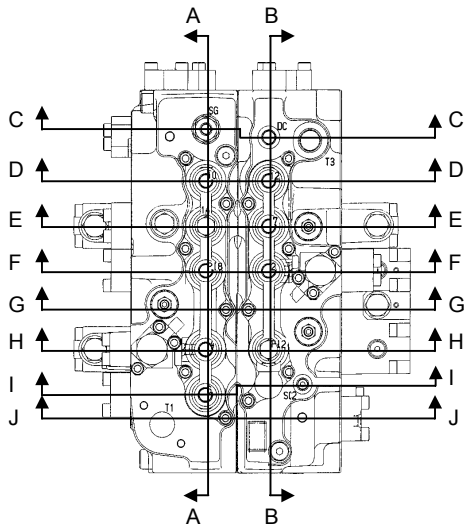
- | | | | |
|---|--|--|---|
| 1 - Load Check Valve (Left Travel Parallel Circuit) | 12 - Bucket Regenerative Valve | 23 - Arm 2 Flow Rate Control Valve (Switch Valve) | 34 - Arm Anti-Drift Valve (Switch Valve) |
| 2 - Check Valve (Main Relief Circuit) | 13 - Overload Relief Valve (Bucket: Rod Side) | 24 - Load Check Valve (Arm 2 Tandem Circuit) | 35 - Overload Relief Valve (Arm: Bottom Side) |
| 3 - Main Relief Valve | 14 - Overload Relief Valve (Bucket: Bottom Side) | 25 - Bypass Shut-Out Valve | 36 - Arm Anti-Drift Valve (Check Valve) |
| 4 - Check Valve (Auxiliary Combining Valve Circuit) | 15 - Boom Flow Control Valve (Poppet Valve) | 26 - Arm 2 Flow Rate Control Valve (Poppet Valve) | 37 - Overload Relief Valve (Arm: Rod Side) |
| 5 - Auxiliary Flow Combiner Valve | 16 - Boom Lower Meter-In Cut Valve | 27 - Arm Regenerative Valve | 38 - Check Valve (Digging Regenerative Circuit) |
| 6 - Check Valve (Flow Combiner Valve Circuit) | 17 - Boom Flow Rate Control Valve (Switch Valve) | 28 - Digging Regenerative Valve | 39 - Load Check Valve (Boom 2 Parallel Circuit) |
| 7 - Flow Combiner Valve | 18 - Overload Relief Valve (Boom: Bottom Side) | 29 - Load Check Valve (Digging Regenerative Circuit) | 40 - Auxiliary Flow Rate Control Valve (Poppet Valve) |
| 8 - Load Check Valve (Orifice) (Bucket) | 19 - Boom Anti-Drift Valve (Check Valve) | 30 - Arm 1 Flow Rate Control Valve (Poppet Valve) | 41 - Auxiliary Flow Rate Control Valve (Switch Valve) |
| 9 - Check Valve (Main Relief Circuit) | 20 - Overload Relief Valve (Boom: Rod Side) | 31 - Load Check Valve (Swing Circuit) | 42 - Load Check Valve (Left Travel Tandem Circuit) |
| 10 - Bucket Flow Rate Control Valve (Poppet Valve) | 21 - Boom Regenerative Valve | 32 - Arm 1 Flow Rate Control Valve (Switch Valve) | |
| 11 - Bucket Flow Rate Control Valve (Switch Valve) | 22 - Boom Anti-Drift Valve (Switch Valve) | 33 - Load Check Valve (Arm Regenerative Circuit) | |

COMPONENT OPERATION / Control Valve

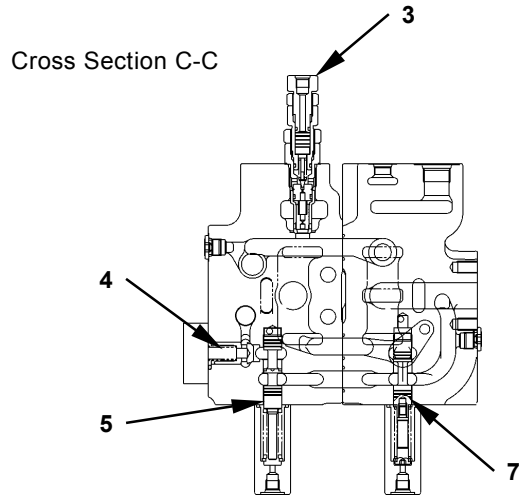


T1V1-03-03-021

COMPONENT OPERATION / Control Valve

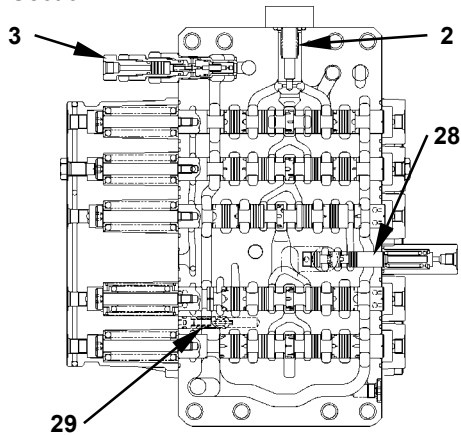


T1V1-03-03-026



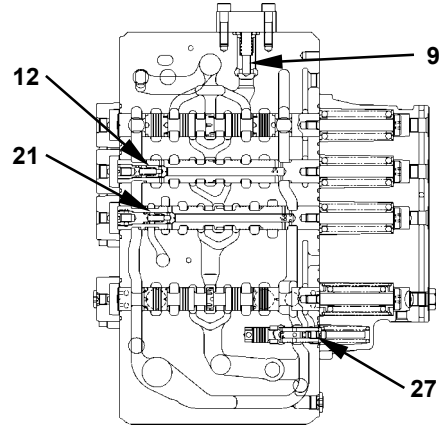
T1V1-03-03-003

Cross Section A-A



T1V1-03-03-001

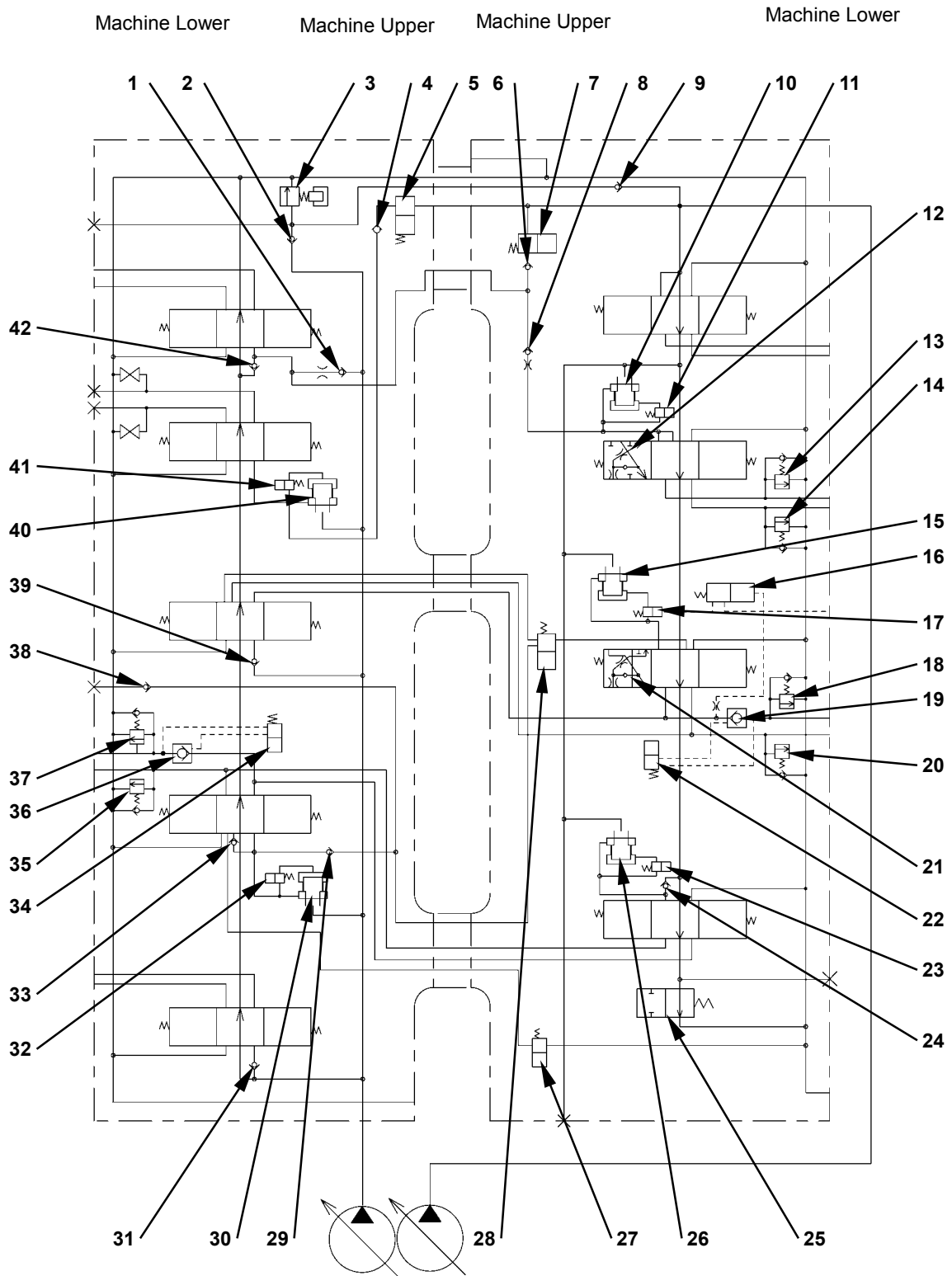
Cross Section B-B



T1V1-03-03-002

- | | | | |
|---|--|--|---|
| 1 - Load Check Valve (Left Travel Parallel Circuit) | 12 - Bucket Regenerative Valve | 23 - Arm 2 Flow Rate Control Valve (Switch Valve) | 34 - Arm Anti-Drift Valve (Switch Valve) |
| 2 - Check Valve (Main Relief Circuit) | 13 - Overload Relief Valve (Bucket: Rod Side) | 24 - Load Check Valve (Arm 2 Tandem Circuit) | 35 - Overload Relief Valve (Arm: Bottom Side) |
| 3 - Main Relief Valve | 14 - Overload Relief Valve (Bucket: Bottom Side) | 25 - Bypass Shut-Out Valve | 36 - Arm Anti-Drift Valve (Check Valve) |
| 4 - Check Valve (Auxiliary Combining Valve Circuit) | 15 - Boom Flow Control Valve (Poppet Valve) | 26 - Arm 2 Flow Rate Control Valve (Poppet Valve) | 37 - Overload Relief Valve (Arm: Rod Side) |
| 5 - Auxiliary Flow Combiner Valve | 16 - Boom Lower Meter-In Cut Valve | 27 - Arm Regenerative Valve | 38 - Check Valve (Digging Regenerative Circuit) |
| 6 - Check Valve (Flow Combiner Valve Circuit) | 17 - Boom Flow Rate Control Valve (Switch Valve) | 28 - Digging Regenerative Valve | 39 - Load Check Valve (Boom 2 Parallel Circuit) |
| 7 - Flow Combiner Valve | 18 - Overload Relief Valve (Boom: Bottom Side) | 29 - Load Check Valve (Digging Regenerative Circuit) | 40 - Auxiliary Flow Rate Control Valve (Poppet Valve) |
| 8 - Load Check Valve (Orifice) (Bucket) | 19 - Boom Anti-Drift Valve (Check Valve) | 30 - Arm 1 Flow Rate Control Valve (Poppet Valve) | 41 - Auxiliary Flow Rate Control Valve (Switch Valve) |
| 9 - Check Valve (Main Relief Circuit) | 20 - Overload Relief Valve (Boom: Rod Side) | 31 - Load Check Valve (Swing Circuit) | 42 - Load Check Valve (Left Travel Tandem Circuit) |
| 10 - Bucket Flow Rate Control Valve (Poppet Valve) | 21 - Boom Regenerative Valve | 32 - Arm 1 Flow Rate Control Valve (Switch Valve) | |
| 11 - Bucket Flow Rate Control Valve (Switch Valve) | 22 - Boom Anti-Drift Valve (Switch Valve) | 33 - Load Check Valve (Arm Regenerative Circuit) | |

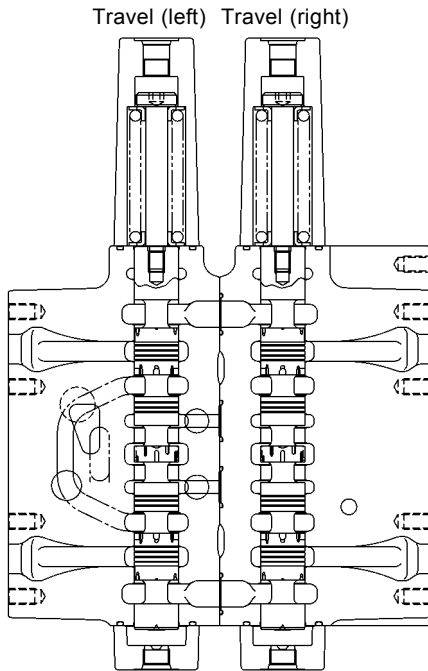
COMPONENT OPERATION / Control Valve



T1V1-03-03-021

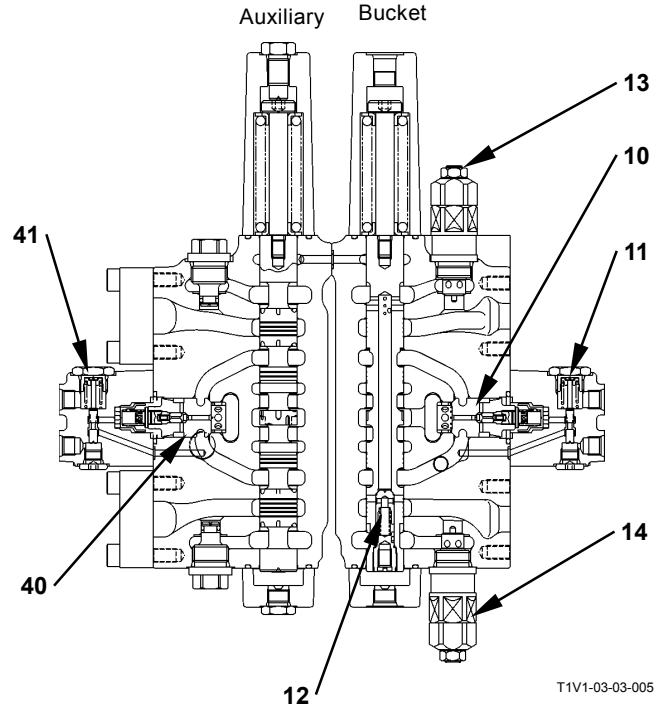
COMPONENT OPERATION / Control Valve

Cross Section D-D



T1V1-03-03-004

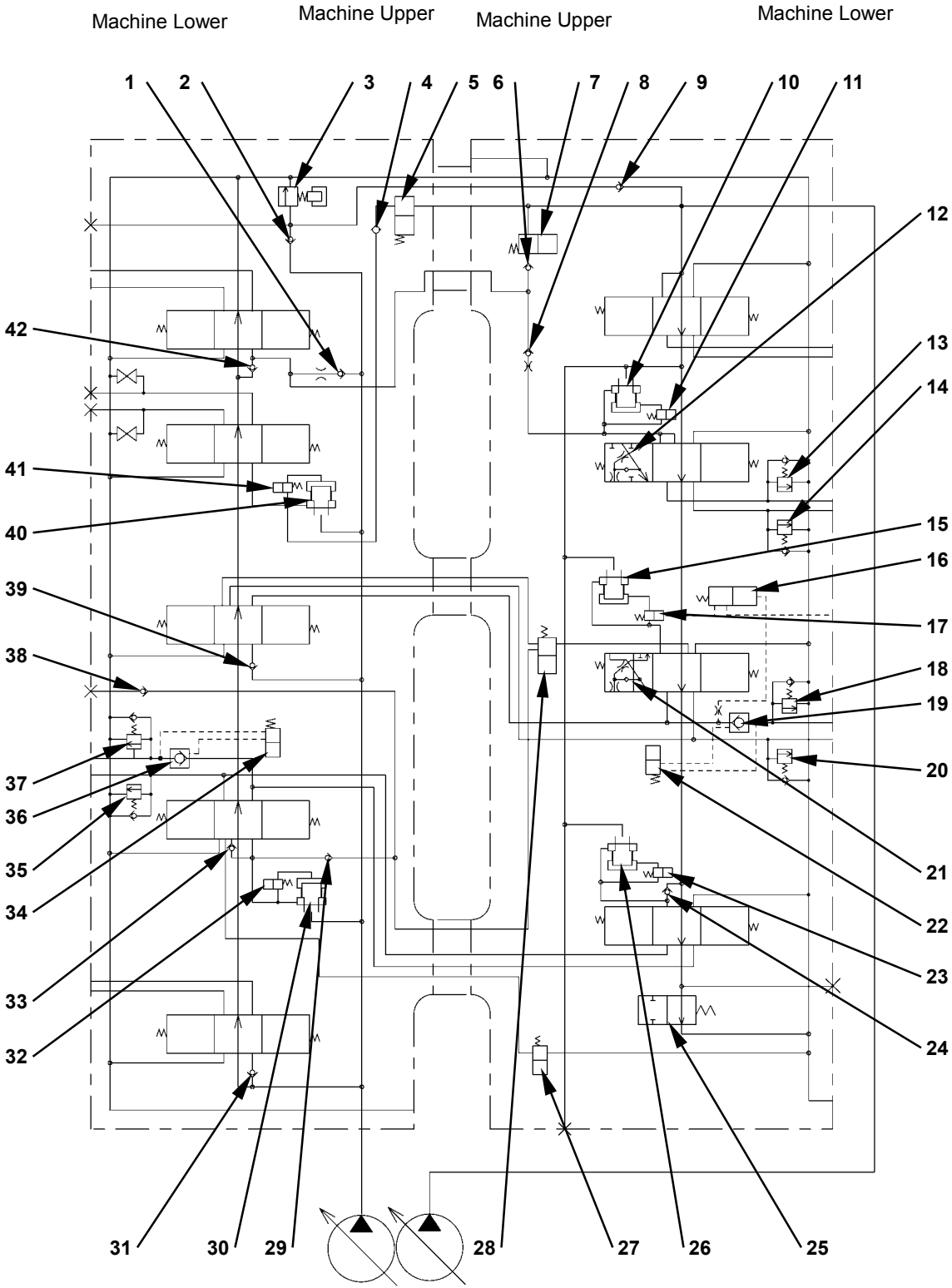
Cross Section E-E



T1V1-03-03-005

- | | | | |
|---|--|--|---|
| 1 - Load Check Valve (Left Travel Parallel Circuit) | 12 - Bucket Regenerative Valve | 23 - Arm 2 Flow Rate Control Valve (Switch Valve) | 34 - Arm Anti-Drift Valve (Switch Valve) |
| 2 - Check Valve (Main Relief Circuit) | 13 - Overload Relief Valve (Bucket: Rod Side) | 24 - Load Check Valve (Arm 2 Tandem Circuit) | 35 - Overload Relief Valve (Arm: Bottom Side) |
| 3 - Main Relief Valve | 14 - Overload Relief Valve (Bucket: Bottom Side) | 25 - Bypass Shut-Out Valve | 36 - Arm Anti-Drift Valve (Check Valve) |
| 4 - Check Valve (Auxiliary Combining Valve Circuit) | 15 - Boom Flow Control Valve (Poppet Valve) | 26 - Arm 2 Flow Rate Control Valve (Poppet Valve) | 37 - Overload Relief Valve (Arm: Rod Side) |
| 5 - Auxiliary Flow Combiner Valve | 16 - Boom Lower Meter-In Cut Valve | 27 - Arm Regenerative Valve | 38 - Check Valve (Digging Regenerative Circuit) |
| 6 - Check Valve (Flow Combiner Valve Circuit) | 17 - Boom Flow Rate Control Valve (Switch Valve) | 28 - Digging Regenerative Valve | 39 - Load Check Valve (Boom 2 Parallel Circuit) |
| 7 - Flow Combiner Valve | 18 - Overload Relief Valve (Boom: Bottom Side) | 29 - Load Check Valve (Digging Regenerative Circuit) | 40 - Auxiliary Flow Rate Control Valve (Poppet Valve) |
| 8 - Load Check Valve (Orifice) (Bucket) | 19 - Boom Anti-Drift Valve (Check Valve) | 30 - Arm 1 Flow Rate Control Valve (Poppet Valve) | 41 - Auxiliary Flow Rate Control Valve (Switch Valve) |
| 9 - Check Valve (Main Relief Circuit) | 20 - Overload Relief Valve (Boom: Rod Side) | 31 - Load Check Valve (Swing Circuit) | 42 - Load Check Valve (Left Travel Tandem Circuit) |
| 10 - Bucket Flow Rate Control Valve (Poppet Valve) | 21 - Boom Regenerative Valve | 32 - Arm 1 Flow Rate Control Valve (Switch Valve) | |
| 11 - Bucket Flow Rate Control Valve (Switch Valve) | 22 - Boom Anti-Drift Valve (Switch Valve) | 33 - Load Check Valve (Arm Regenerative Circuit) | |

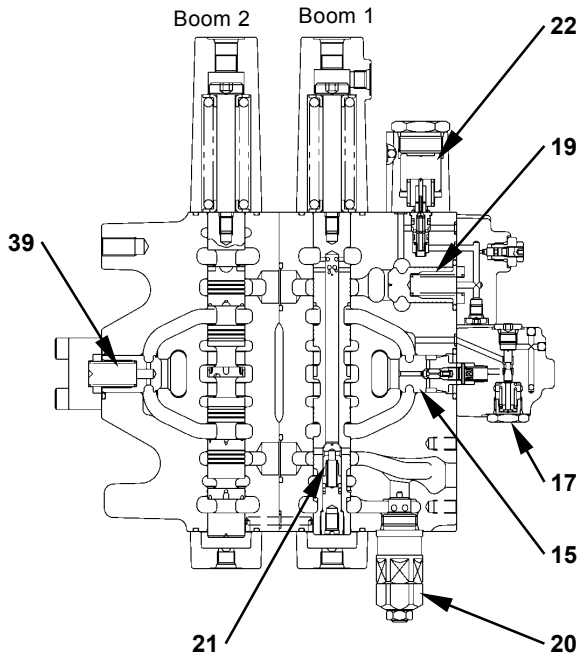
COMPONENT OPERATION / Control Valve



T1V1-03-03-021

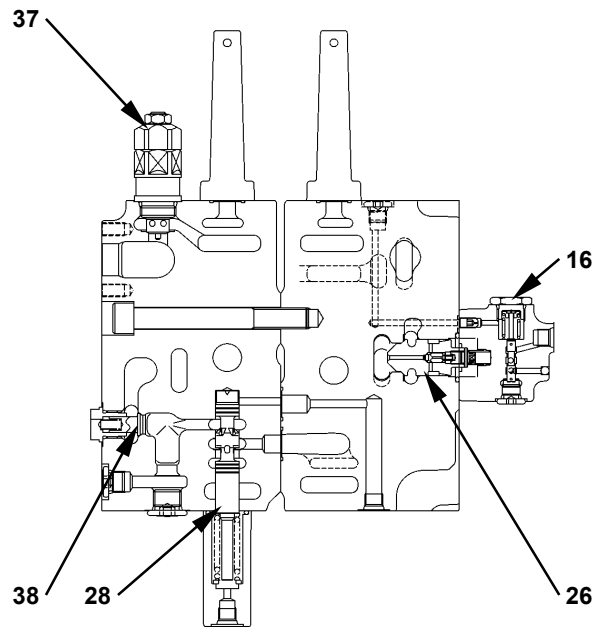
COMPONENT OPERATION / Control Valve

Cross Section F-F



T1V1-03-03-006

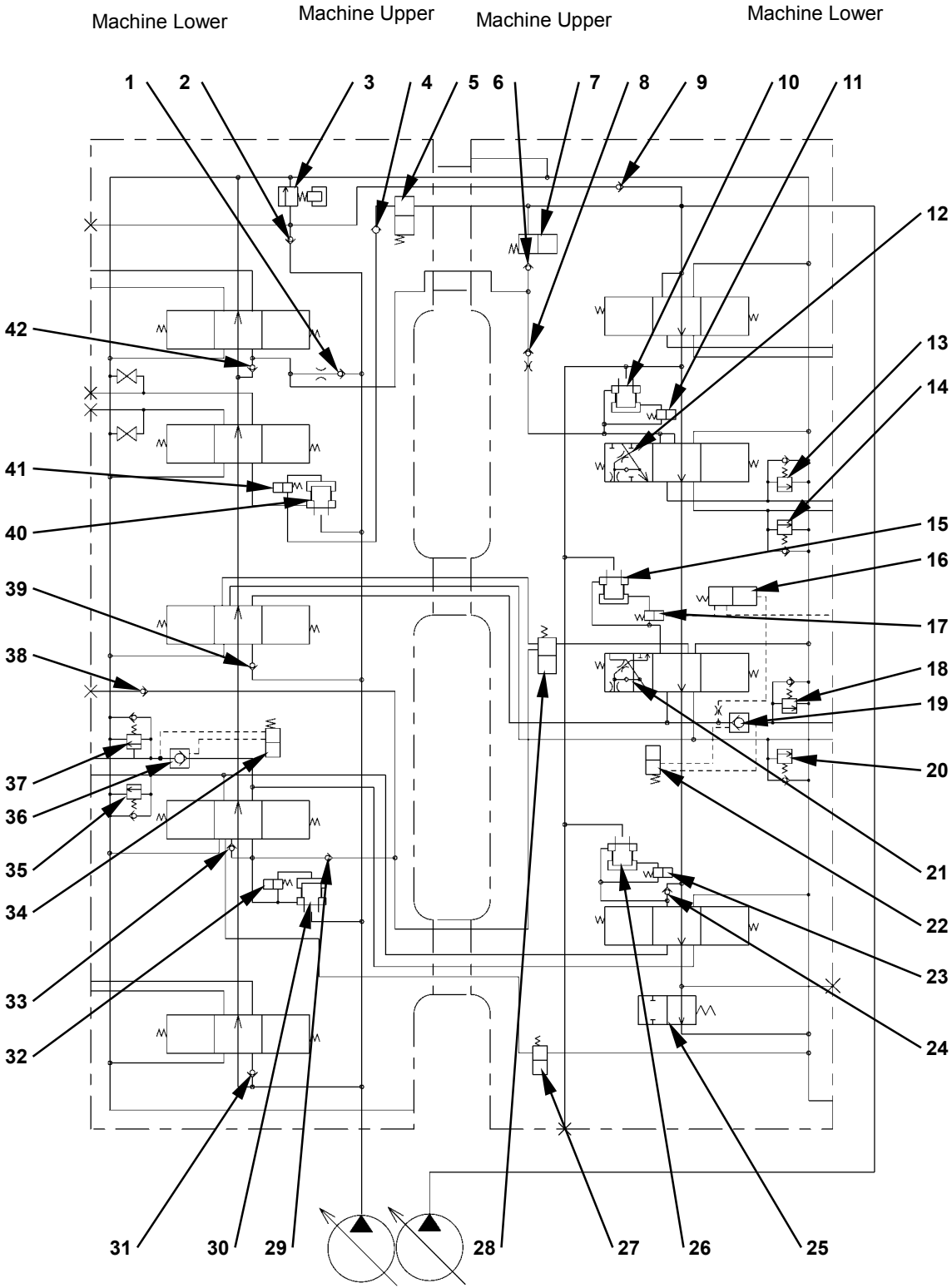
Cross Section G-G



T1V1-03-03-007

- | | | | |
|---|--|--|---|
| 1 - Load Check Valve (Left Travel Parallel Circuit) | 12 - Bucket Regenerative Valve | 23 - Arm 2 Flow Rate Control Valve (Switch Valve) | 34 - Arm Anti-Drift Valve (Switch Valve) |
| 2 - Check Valve (Main Relief Circuit) | 13 - Overload Relief Valve (Bucket: Rod Side) | 24 - Load Check Valve (Arm 2 Tandem Circuit) | 35 - Overload Relief Valve (Arm: Bottom Side) |
| 3 - Main Relief Valve | 14 - Overload Relief Valve (Bucket: Bottom Side) | 25 - Bypass Shut-Out Valve | 36 - Arm Anti-Drift Valve (Check Valve) |
| 4 - Check Valve (Auxiliary Combiner Valve Circuit) | 15 - Boom Flow Control Valve (Poppet Valve) | 26 - Arm 2 Flow Rate Control Valve (Poppet Valve) | 37 - Overload Relief Valve (Arm: Rod Side) |
| 5 - Auxiliary Flow Combiner Valve | 16 - Boom Lower Meter-In Cut Valve | 27 - Arm Regenerative Valve | 38 - Check Valve (Digging Regenerative Circuit) |
| 6 - Check Valve (Flow Combiner Valve Circuit) | 17 - Boom Flow Rate Control Valve (Switch Valve) | 28 - Digging Regenerative Valve | 39 - Load Check Valve (Boom 2 Parallel Circuit) |
| 7 - Flow Combiner Valve | 18 - Overload Relief Valve (Boom: Bottom Side) | 29 - Load Check Valve (Digging Regenerative Circuit) | 40 - Auxiliary Flow Rate Control Valve (Poppet Valve) |
| 8 - Load Check Valve (Orifice) (Bucket) | 19 - Boom Anti-Drift Valve (Check Valve) | 30 - Arm 1 Flow Rate Control Valve (Poppet Valve) | 41 - Auxiliary Flow Rate Control Valve (Switch Valve) |
| 9 - Check Valve (Main Relief Circuit) | 20 - Overload Relief Valve (Boom: Rod Side) | 31 - Load Check Valve (Swing Circuit) | 42 - Load Check Valve (Left Travel Tandem Circuit) |
| 10 - Bucket Flow Rate Control Valve (Poppet Valve) | 21 - Boom Regenerative Valve | 32 - Arm 1 Flow Rate Control Valve (Switch Valve) | |
| 11 - Bucket Flow Rate Control Valve (Switch Valve) | 22 - Boom Anti-Drift Valve (Switch Valve) | 33 - Load Check Valve (Arm Regenerative Circuit) | |

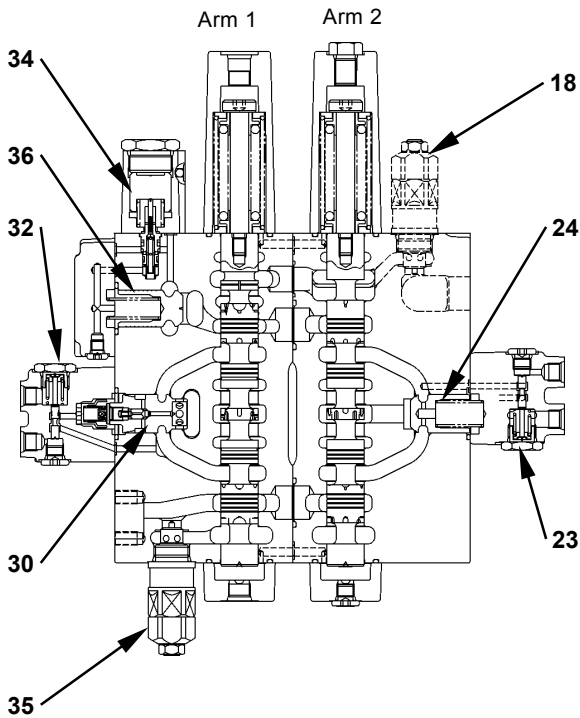
COMPONENT OPERATION / Control Valve



T1V1-03-03-021

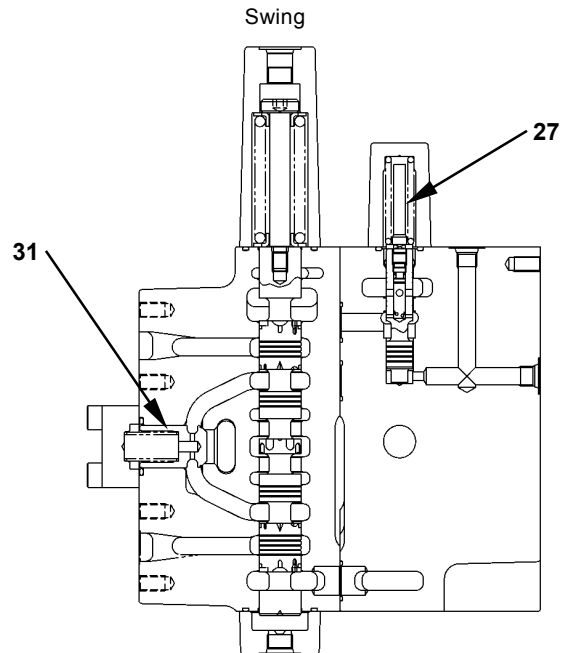
COMPONENT OPERATION / Control Valve

Cross Section H-H



T1V1-03-03-008

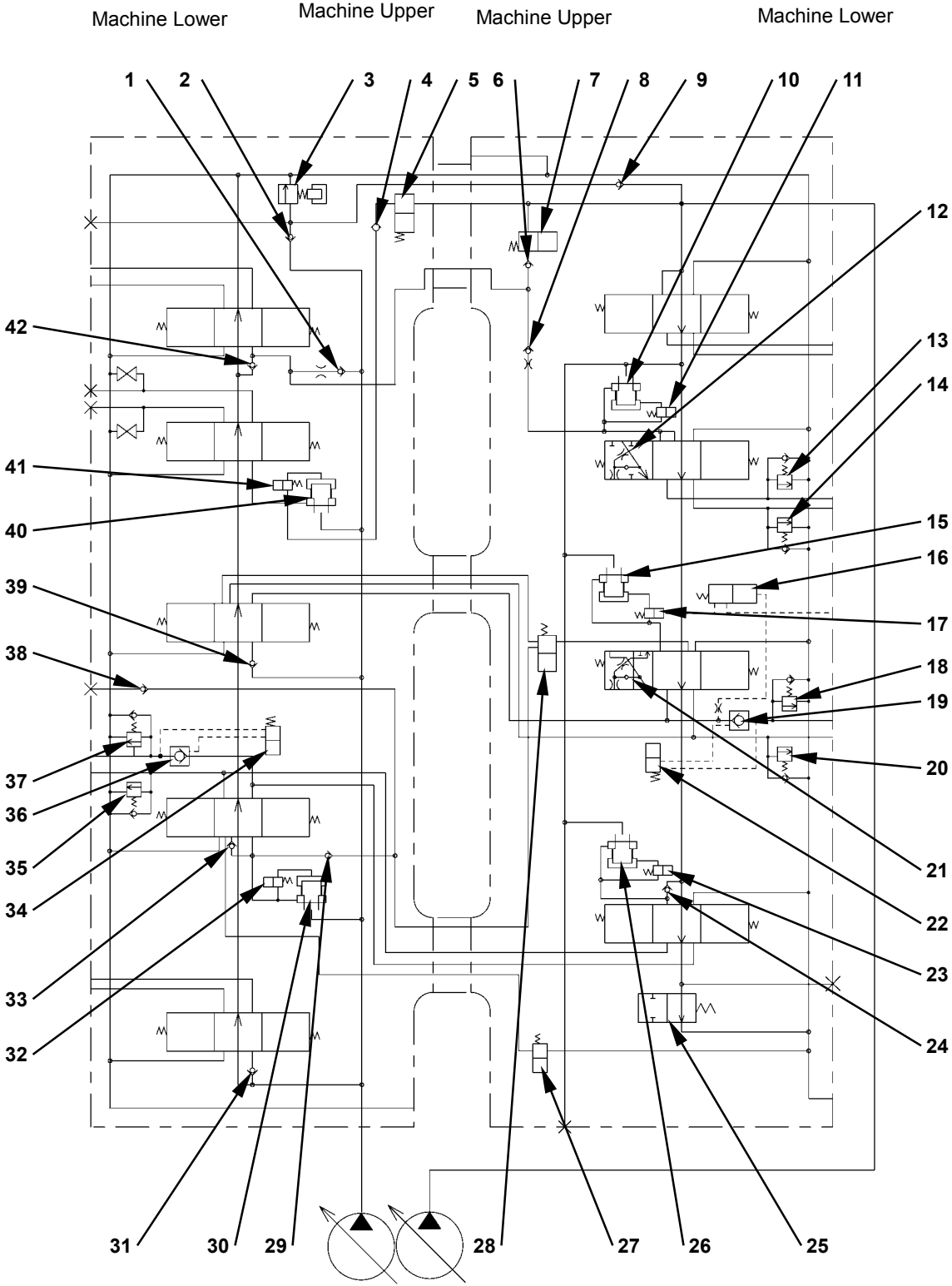
Cross Section I-I



T1V1-03-03-009

- | | | | |
|---|--|--|---|
| 1 - Load Check Valve (Left Travel Parallel Circuit) | 12 - Bucket Regenerative Valve | 23 - Arm 2 Flow Rate Control Valve (Switch Valve) | 34 - Arm Anti-Drift Valve (Switch Valve) |
| 2 - Check Valve (Main Relief Circuit) | 13 - Overload Relief Valve (Bucket: Rod Side) | 24 - Load Check Valve (Arm 2 Tandem Circuit) | 35 - Overload Relief Valve (Arm: Bottom Side) |
| 3 - Main Relief Valve | 14 - Overload Relief Valve (Bucket: Bottom Side) | 25 - Bypass Shut-Out Valve | 36 - Arm Anti-Drift Valve (Check Valve) |
| 4 - Check Valve (Auxiliary Combining Valve Circuit) | 15 - Boom Flow Control Valve (Poppet Valve) | 26 - Arm 2 Flow Rate Control Valve (Poppet Valve) | 37 - Overload Relief Valve (Arm: Rod Side) |
| 5 - Auxiliary Flow Combiner Valve | 16 - Boom Lower Meter-In Cut Valve | 27 - Arm Regenerative Valve | 38 - Check Valve (Digging Regenerative Circuit) |
| 6 - Check Valve (Flow Combiner Valve Circuit) | 17 - Boom Flow Rate Control Valve (Switch Valve) | 28 - Digging Regenerative Valve | 39 - Load Check Valve (Boom 2 Parallel Circuit) |
| 7 - Flow Combiner Valve | 18 - Overload Relief Valve (Boom: Bottom Side) | 29 - Load Check Valve (Digging Regenerative Circuit) | 40 - Auxiliary Flow Rate Control Valve (Poppet Valve) |
| 8 - Load Check Valve (Orifice) (Bucket) | 19 - Boom Anti-Drift Valve (Check Valve) | 30 - Arm 1 Flow Rate Control Valve (Poppet Valve) | 41 - Auxiliary Flow Rate Control Valve (Switch Valve) |
| 9 - Check Valve (Main Relief Circuit) | 20 - Overload Relief Valve (Boom: Rod Side) | 31 - Load Check Valve (Swing Circuit) | 42 - Load Check Valve (Left Travel Tandem Circuit) |
| 10 - Bucket Flow Rate Control Valve (Poppet Valve) | 21 - Boom Regenerative Valve | 32 - Arm 1 Flow Rate Control Valve (Switch Valve) | |
| 11 - Bucket Flow Rate Control Valve (Switch Valve) | 22 - Boom Anti-Drift Valve (Switch Valve) | 33 - Load Check Valve (Arm Regenerative Circuit) | |

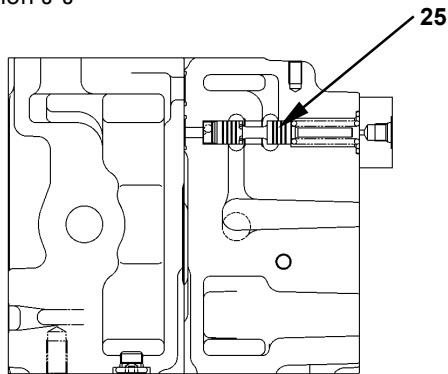
COMPONENT OPERATION / Control Valve



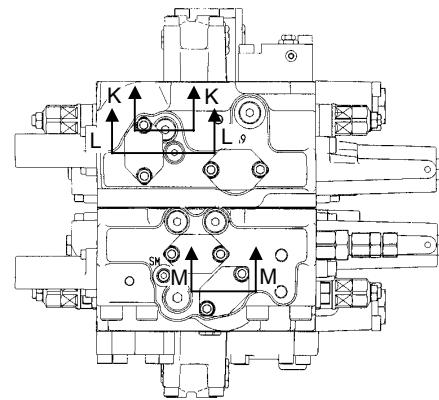
T1V1-03-03-021

COMPONENT OPERATION / Control Valve

Cross Section J-J

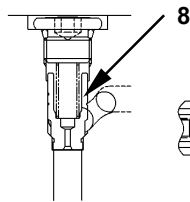


T1V1-03-03-010

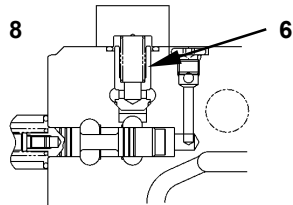


T1V1-03-03-027

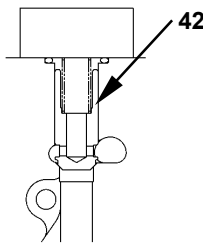
Cross Section K-K



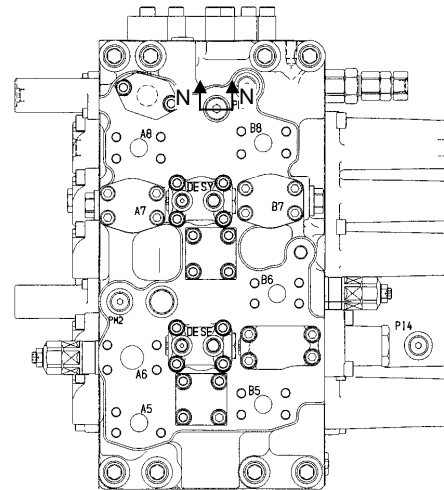
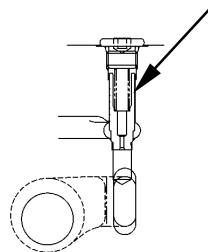
Cross Section L-L



Cross Section M-M



Cross Section N-N



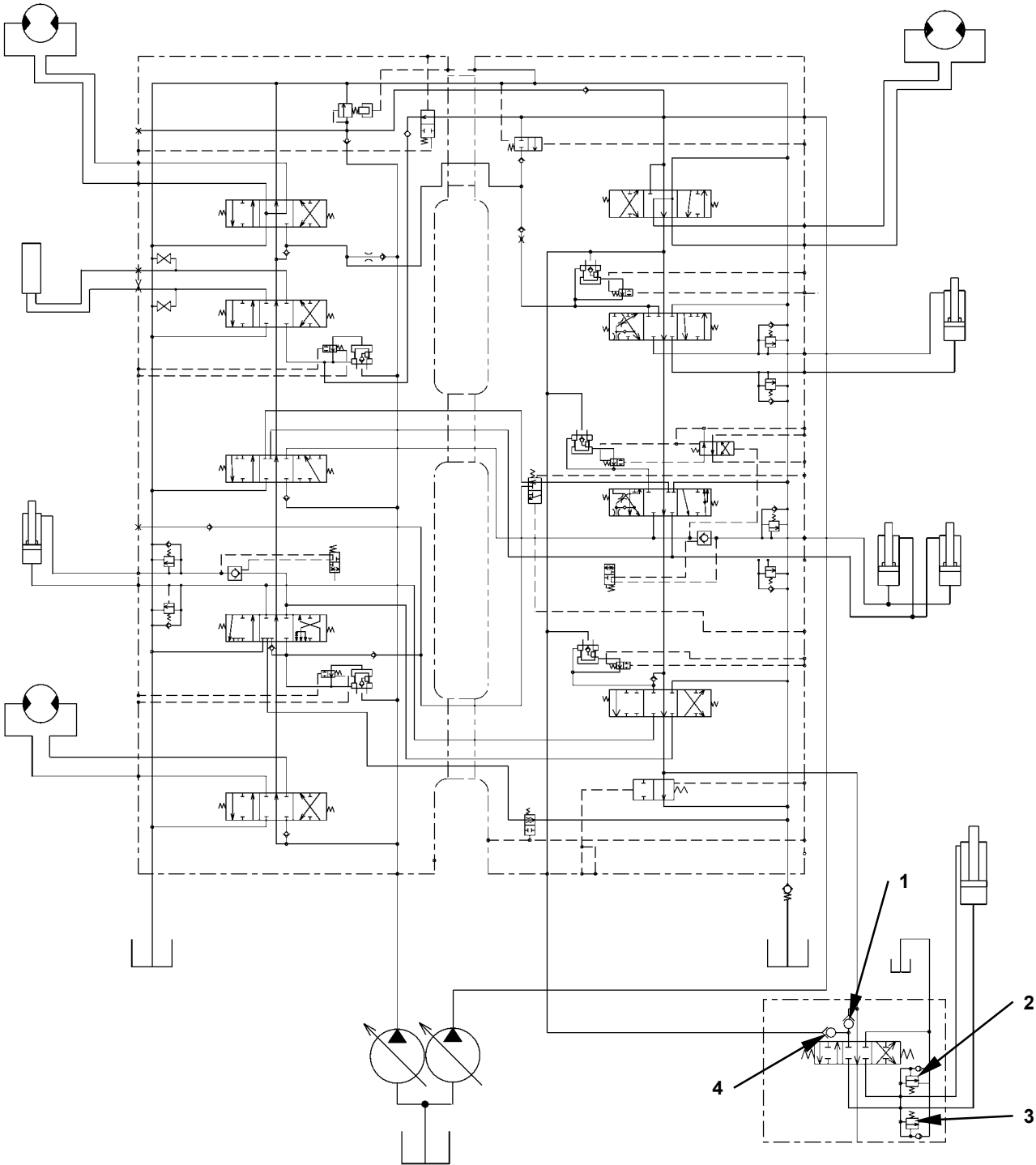
T1V1-03-03-028

T1V1-03-03-022

- | | | | |
|---|--|--|---|
| 1 - Load Check Valve (Left Travel Parallel Circuit) | 12 - Bucket Regenerative Valve | 23 - Arm 2 Flow Rate Control Valve (Switch Valve) | 34 - Arm Anti-Drift Valve (Switch Valve) |
| 2 - Check Valve (Main Relief Circuit) | 13 - Overload Relief Valve (Bucket: Rod Side) | 24 - Load Check Valve (Arm 2 Tandem Circuit) | 35 - Overload Relief Valve (Arm: Bottom Side) |
| 3 - Main Relief Valve | 14 - Overload Relief Valve (Bucket: Bottom Side) | 25 - Bypass Shut-Out Valve | 36 - Arm Anti-Drift Valve (Check Valve) |
| 4 - Check Valve (Auxiliary Combiner Valve Circuit) | 15 - Boom Flow Control Valve (Poppet Valve) | 26 - Arm 2 Flow Rate Control Valve (Poppet Valve) | 37 - Overload Relief Valve (Arm: Rod Side) |
| 5 - Auxiliary Flow Combiner Valve | 16 - Boom Lower Meter-In Cut Valve | 27 - Arm Regenerative Valve | 38 - Check Valve (Digging Regenerative Circuit) |
| 6 - Check Valve (Flow Combiner Valve Circuit) | 17 - Boom Flow Control Valve (Switch Valve) | 28 - Digging Generative Valve | 39 - Load Check Valve (Boom 2 Parallel Circuit) |
| 7 - Flow Combiner Valve | 18 - Overload Relief Valve (Boom: Bottom Side) | 29 - Load Check Valve (Digging Regenerative Circuit) | 40 - Auxiliary Flow Rate Control Valve (Poppet Valve) |
| 8 - Load Check Valve (Orifice) (Bucket) | 19 - Boom Anti-Drift Valve (Check Valve) | 30 - Arm 1 Flow Rate Control Valve (Poppet Valve) | 41 - Auxiliary Flow Rate Control Valve (Switch Valve) |
| 9 - Check Valve (Main Relief Circuit) | 20 - Overload Relief Valve (Boom: Rod Side) | 31 - Load Check Valve (Swing Circuit) | 42 - Load Check Valve (Left Travel Tandem Circuit) |
| 10 - Bucket Flow Rate Control Valve (Poppet Valve) | 21 - Boom Regenerative Valve | 32 - Arm 1 Flow Rate Control Valve (Switch Valve) | |
| 11 - Bucket Flow Rate Control Valve (Switch Valve) | 22 - Boom Anti-Drift Valve (Switch Valve) | 33 - Load Check Valve (Arm Regenerative Circuit) | |

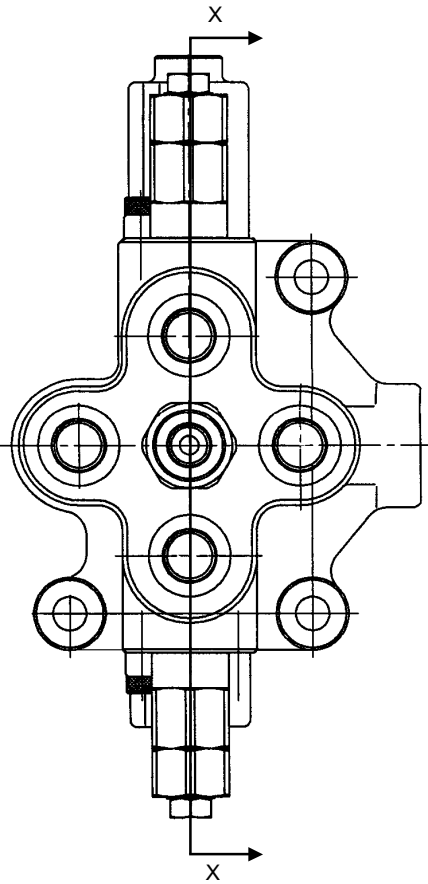
COMPONENT OPERATION / Control Valve

Layout of Positioning Control Valve (2-Piece Boom)



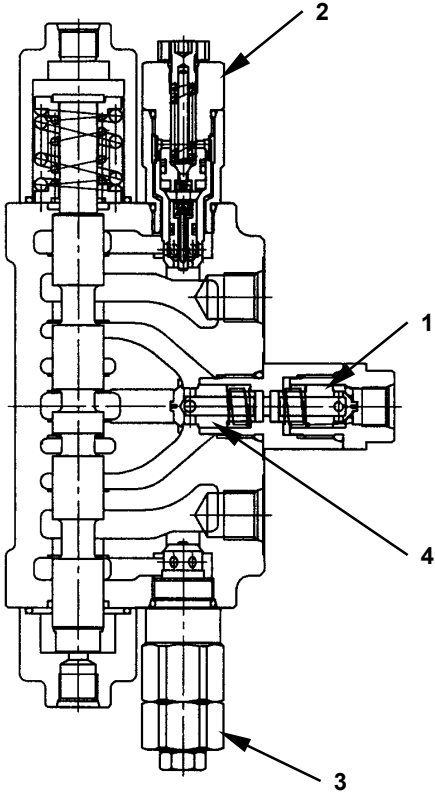
T1V1-03-03-019

COMPONENT OPERATION / Control Valve



T178-03-03-070

Cross Section X-X



T198-03-03-003

- 1 - Load Check Valve
(Positioning Tandem Circuit)
- 2 - Overload Relief Valve
(Positioning: Rod Side)
- 3 - Overload Relief Valve
(Positioning: Bottom Side)
- 4 - Load Check Valve
(Positioning Parallel Circuit)

COMPONENT OPERATION / Control Valve

HYDRAULIC CIRCUIT

Main Circuit

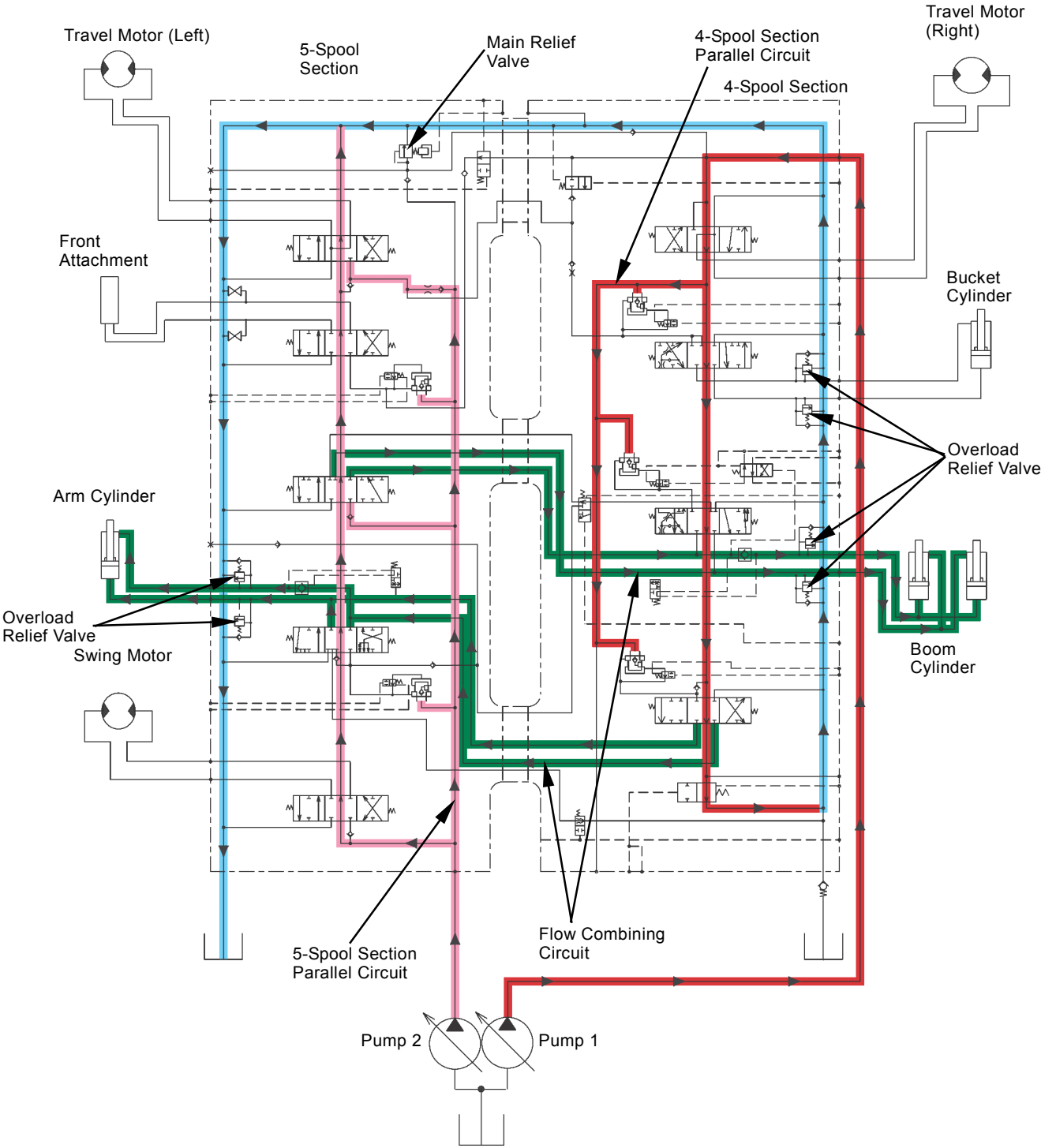
Pressure oils from pump 1 and pump 2 flow to the 4-spool section and 5-spool section of the control valve respectively.

The parallel circuit is provided in both right and left main circuits and makes the combined operation possible. The flow combining circuit is provided in both boom and arm circuits so that pressure oils from pump 1 and pump 2 are combined during a single operation.

The main relief valve is provided in the main circuit (between pump and actuator). The main relief valve works so that pressure in the main circuit does not exceed the set pressure when the spool is in operation (or when the control lever is in operation).

The overload relief valve is provided in the actuator circuits (between control valve and actuator) of boom, arm and bucket. The overload relief valve prevents surge pressure caused by external force in the actuator circuit does not exceed the set pressure when the spool is in neutral (with the control lever in neutral).

COMPONENT OPERATION / Control Valve



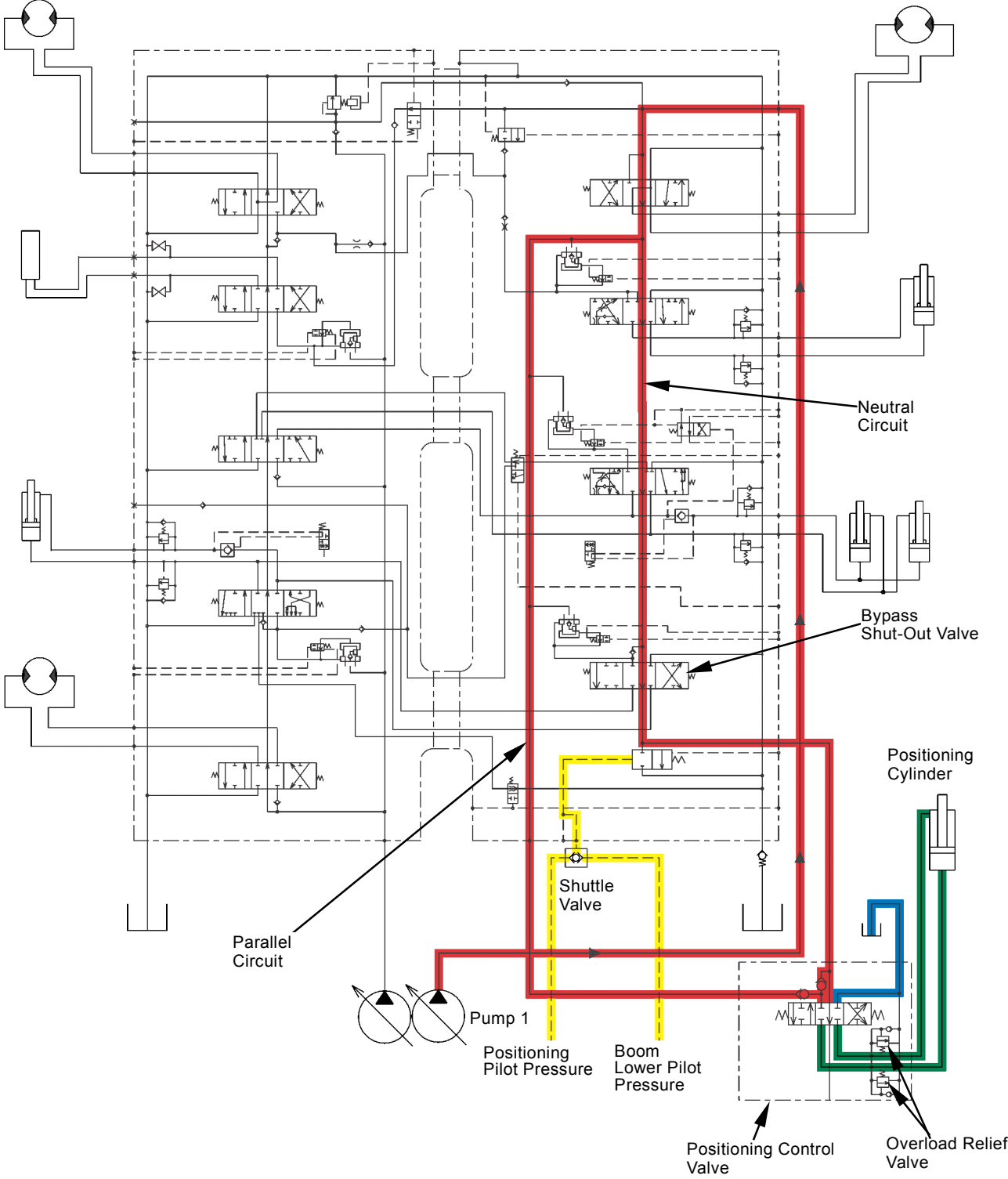
T1V1-03-03-018

COMPONENT OPERATION / Control Valve

Positioning Circuit (2-Piece Boom)

- When operating boom lower and positioning, pressure oil from each pilot valve flows to the bypass shut-out valve through the shuttle valve. Therefore, the bypass shut-out valve is switched.
- During Single Operation:
As the bypass shut-out valve is switched, the neutral circuit in 4-spool section of control valve is blocked and pressure oil from pump 1 is supplied to the positioning control valve.
- During Combined Operation:
When operating combined operation of boom, arm or bucket and positioning, the neutral circuit in 4-spool is blocked by each spool. Pressure oil from pump1 is supplied to the positioning control valve through the 4-spool section parallel circuit.
- The overload relief valve is provided in the actuator circuit (between positioning control valve and actuator) of positioning. The overload relief valve prevents surge pressure caused by external force in the actuator circuit does not exceed the set pressure when the spool is in neutral (with the control lever in neutral).

COMPONENT OPERATION / Control Valve



T1V1-03-03-020

COMPONENT OPERATION / Control Valve

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 spool 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 and boom 2 spool.
- During auxiliary open (13) or close (14) operation, pressure oil moves the auxiliary spool and shifts the auxiliary flow combiner valve.
(Only the machine equipped with the optional auxiliary flow combining system)

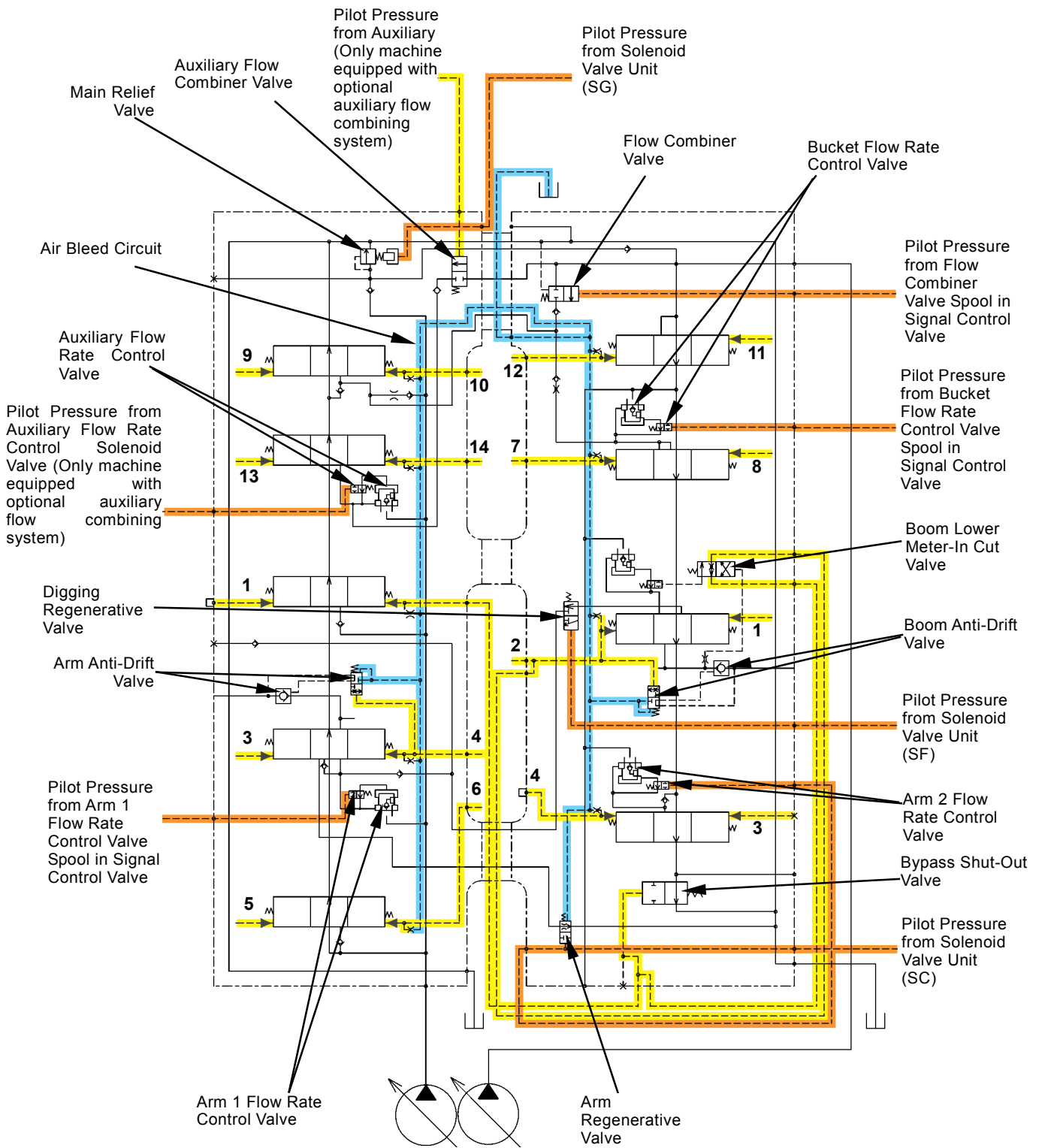
The air bleed circuit is located on the upper section of control valve and bleeds any air trapped inside automatically.

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 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 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.
- 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 auxiliary flow combining system)

 **NOTE:** *In general, the auxiliary flow combiner valve and auxiliary flow rate control valve are routed to the drain circuit.*

COMPONENT OPERATION / Control Valve



- | | | | |
|------------------|---------------------|-----------------------------|------------------------|
| 1 - Boom Raise | 5 - Left Swing | 9 - Travel (Left Forward) | 13 - Auxiliary (Open) |
| 2 - Boom Lower | 6 - Right Swing | 10 - Travel (Left Reverse) | 14 - Auxiliary (Close) |
| 3 - Arm Roll-Out | 7 - Bucket Roll-In | 11 - Travel (Right Forward) | |
| 4 - Arm Roll-In | 8 - Bucket Roll-Out | 12 - Travel (Right Reverse) | |

T1V1-03-03-023

NOTE: Yellow line: Pilot control circuit
Orange line: External pilot pressure circuit

COMPONENT OPERATION / Control Valve

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

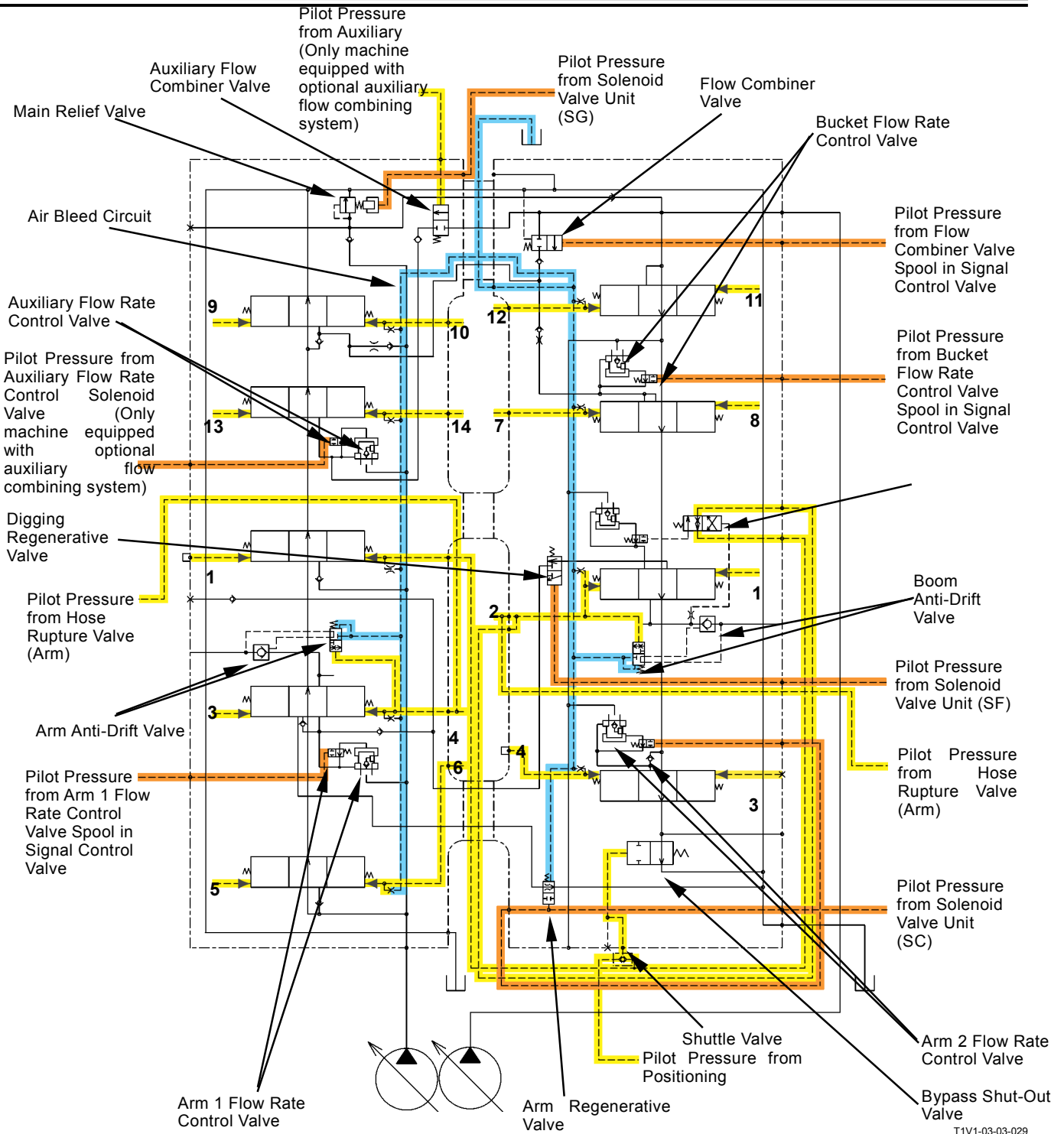
The air bleed circuit is located on the upper section of control valve and bleeds any air trapped inside automatically.

External Pilot Pressure Circuit (2-Piece Boom)

- 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 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 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.
- 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 auxiliary flow combining system)

 **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 auxiliary flow combining system.*

COMPONENT OPERATION / Control Valve



- | | | | |
|------------------|---------------------|-----------------------------|------------------------|
| 1 - Boom Raise | 5 - Left Swing | 9 - Travel (Left Forward) | 13 - Auxiliary (Open) |
| 2 - Boom Lower | 6 - Right Swing | 10 - Travel (Left Reverse) | 14 - Auxiliary (Close) |
| 3 - Arm Roll-Out | 7 - Bucket Roll-In | 11 - Travel (Right Forward) | |
| 4 - Arm Roll-In | 8 - Bucket Roll-Out | 12 - Travel (Right Reverse) | |

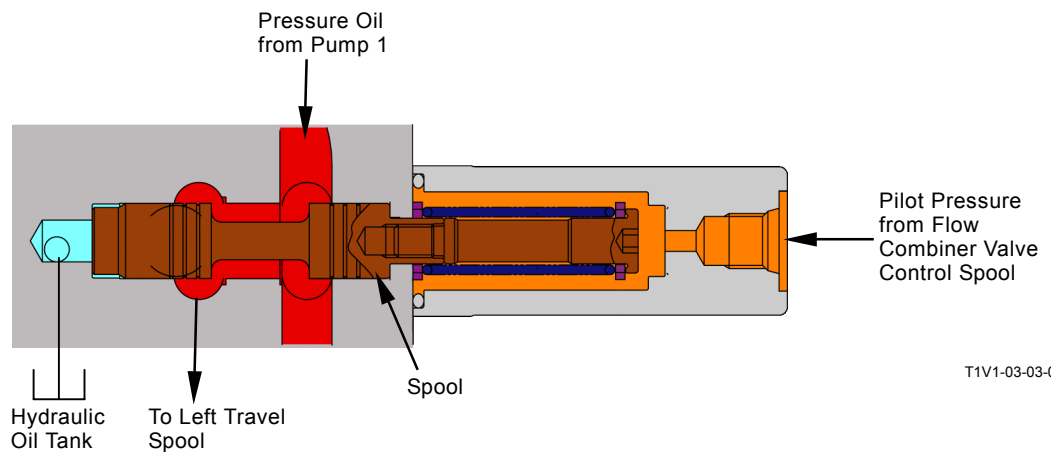
NOTE: Yellow line: Pilot control circuit
 Orange line: External pilot pressure circuit

T1V1-03-03-029

COMPONENT OPERATION / Control Valve

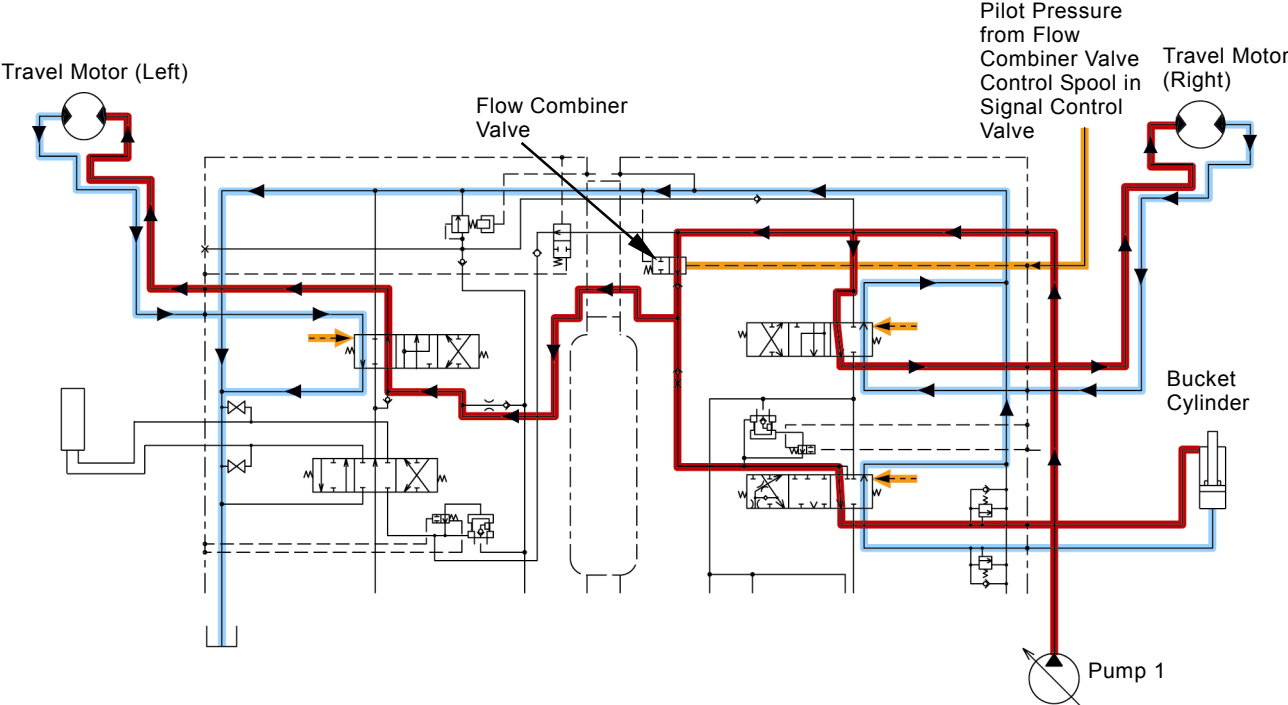
FLOW COMBINER VALVE

1. During combined operation of front attachment and travel, the flow combiner valve control spool in signal control valve is shifted and pilot pressure shifts the spool in flow combiner valve.
2. When the spool in flow combiner valve is shifted, pressure oil from pump 1 flows to the spools in left travel and bucket through the flow combiner valve.
3. Therefore, pressure oil from pump 1 is routed to both right travel and left travel spools.
4. Pressure oil from pump 2 is routed to the swing. Consequently, during combined operation of travel, front attachment and swing, the machine can travel straight.



T1V1-03-03-056

COMPONENT OPERATION / Control Valve



T1V1-03-03-046

COMPONENT OPERATION / Control Valve

MAIN RELIEF VALVE

The main relief valve serves so that pressure in the main circuit does not exceed the set pressure when the actuator such as motor or cylinder is in operation. Thus, oil leak from hose and pipe joints and breakage of the actuator are prevented.

Relief Operation

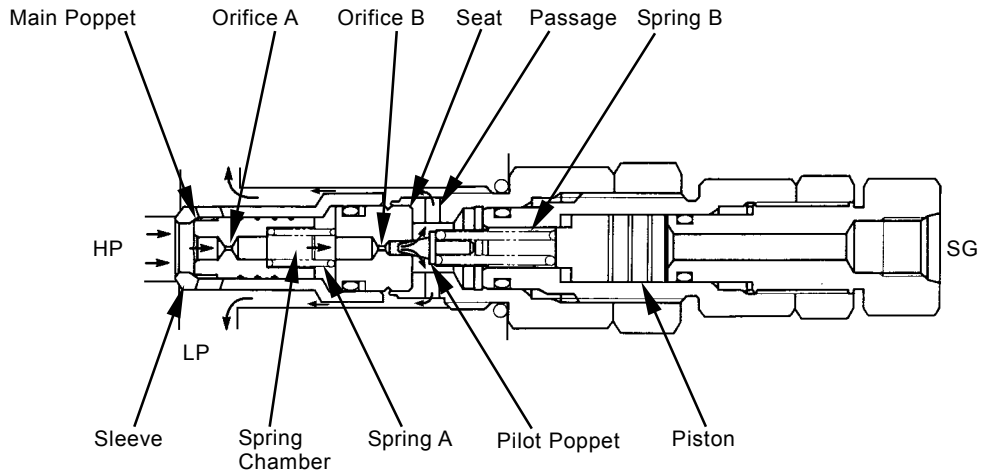
1. Pressure in port HP (main circuit) acts to the pilot poppet through orifice A in the main poppet and orifice B in the seat.
2. When pressure in port HP reaches the set pressure by spring B, the pilot poppet opens, pressure oil from passage A flows along the external circumference of sleeve and flows to port LP (hydraulic oil tank).
3. At this time, a pressure difference is caused between port HP and spring chamber due to orifice A.
4. When this pressure difference reaches the set pressure by spring A, the main poppet opens and pressure oil from port HP flows to port LP.
5. As a result, the pressure in main circuit decreases.
6. When pressure in the main circuit decreases to the specified level, the main poppet is closed by the force of spring A.

Set Pressure Increasing Operation

1. When pilot pressure from solenoid valve unit (SG) acts to port SG, spring B is compressed by the piston.
2. Therefore, the force of spring B becomes strong.
3. Consequently, as pressure required in order to open the pilot poppet is increased, the relief set pressure is increased.

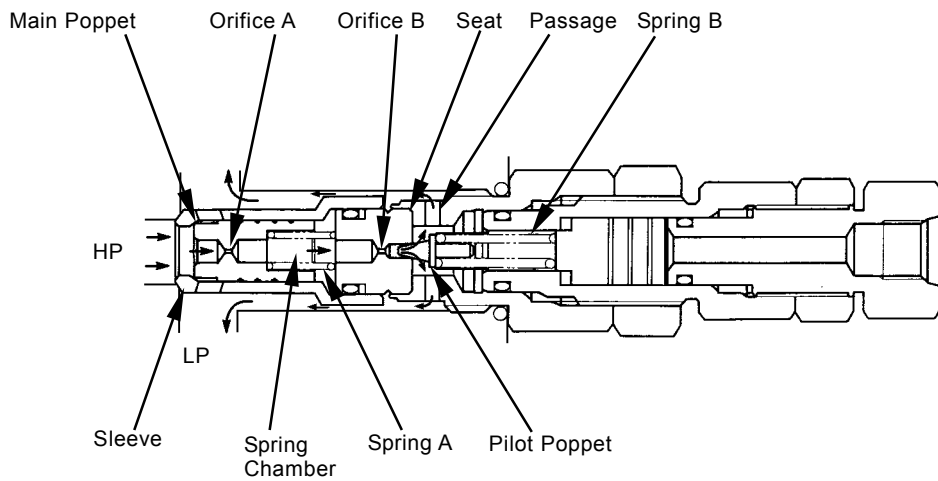
COMPONENT OPERATION / Control Valve

During Normal Operation:



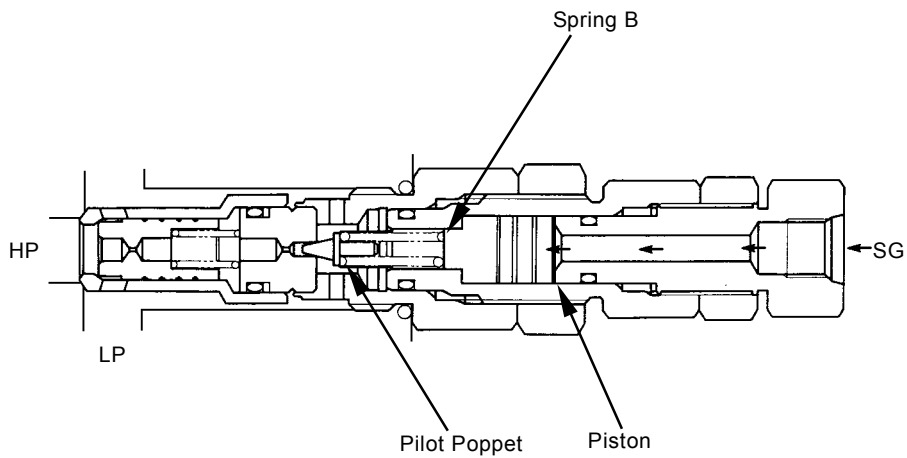
T157-02-05-003

During Relief Operation:



T157-02-05-003

During Set Pressure Increasing Operation:




T157-02-05-004

COMPONENT OPERATION / Control Valve

OVERLOAD RELIEF VALVE (with Make-Up Function)

The overload relief valves are located in the boom, arm, bucket and positioning control valve circuits. The overload relief valve prevents each actuator circuit pressure from rising excessively when the actuators are moved by external loads. In addition, when the actuator circuit pressure is reduced, the overload relief valve draws the hydraulic oil from the hydraulic oil tank and prevents the occurrence of cavitation (make-up function).

 **NOTE:** The operations of overload relief valves in boom, arm, bucket and positioning control valve are same. Therefore, the operation for boom, arm and bucket is shown here.

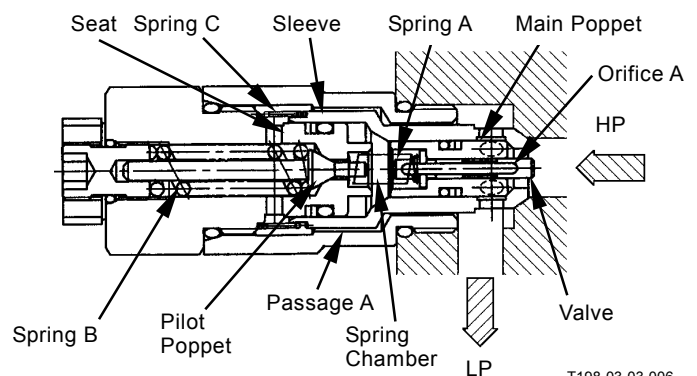
Relief Operation

1. Pressure in port HP (actuator circuit) acts on the pilot poppet through an orifice in the piston.
2. When pressure in port HP increases more than set-force of spring B, the pilot poppet is unseated and pressure oil flows to port LP (hydraulic oil tank) through passage A and clearance around the sleeve.
3. At this time, a pressure difference arises between port HP and the spring chamber due to the orifice.
4. If this pressure difference increases more than set-force of spring A, the main poppet is unseated so that pressure oil in port HP flows to port LP.
5. Thereby, the actuator circuit pressure decreases.
6. When the actuator circuit pressure decreases to the specified level, the piston and main poppet are seated by the force of spring A.

Make-Up Operation

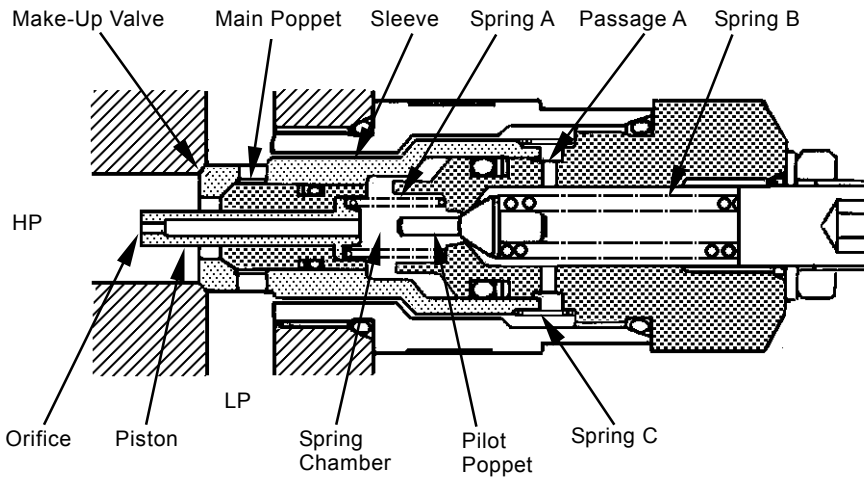
1. When pressure in port HP (actuator circuit) decreases lower than port LP (hydraulic oil tank), the sleeve moves to the right.
2. Hydraulic oil flows in port HP from port LP and cavitation is prevented.
3. When pressure in port HP increases more than the specified pressure, the sleeve is closed by the force of spring C.

For Positioning Control Valve



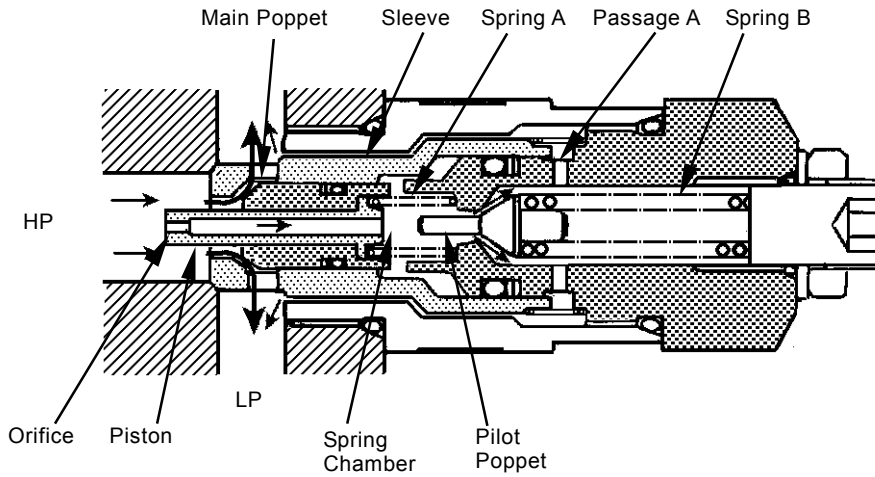
COMPONENT OPERATION / Control Valve

During Normal Operation:



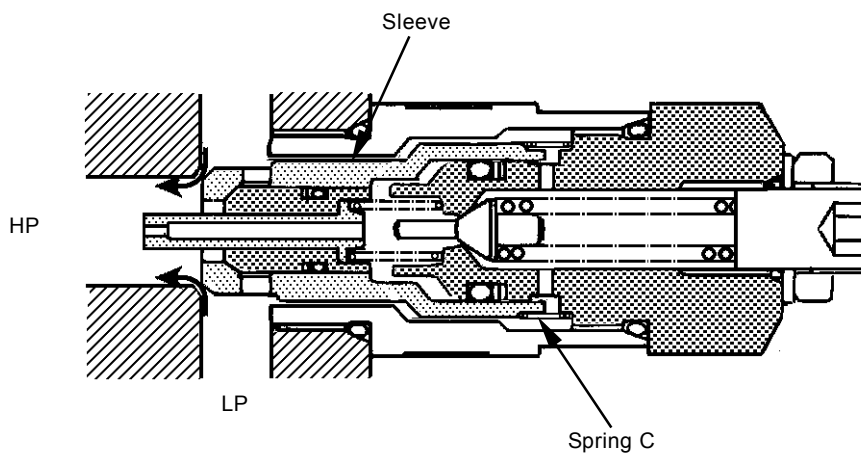
T107-02-05-019

During Relief Operation:



T178-03-03-049

During Make-Up Operation:




T178-03-03-050

COMPONENT OPERATION / Control Valve

REGENERATIVE VALVE

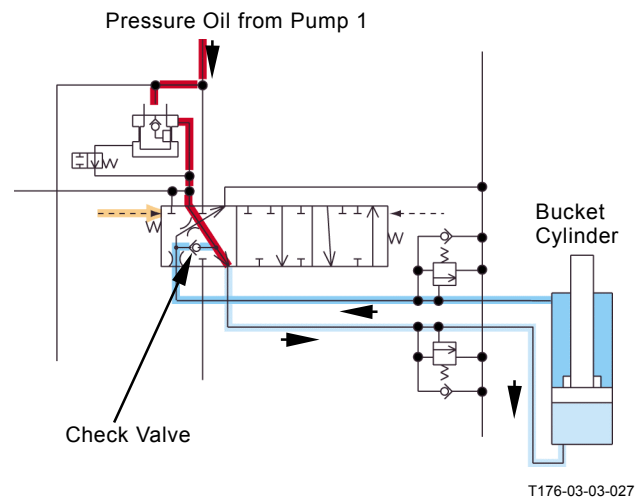
The regenerative valves are provided in the boom lower, arm roll-in and bucket roll-in circuits. The regenerative valve increases cylinder speeds in order to prevent cylinder hesitation, and improves machine controllability.

Boom Regenerative Valve and Bucket Regenerative Valve

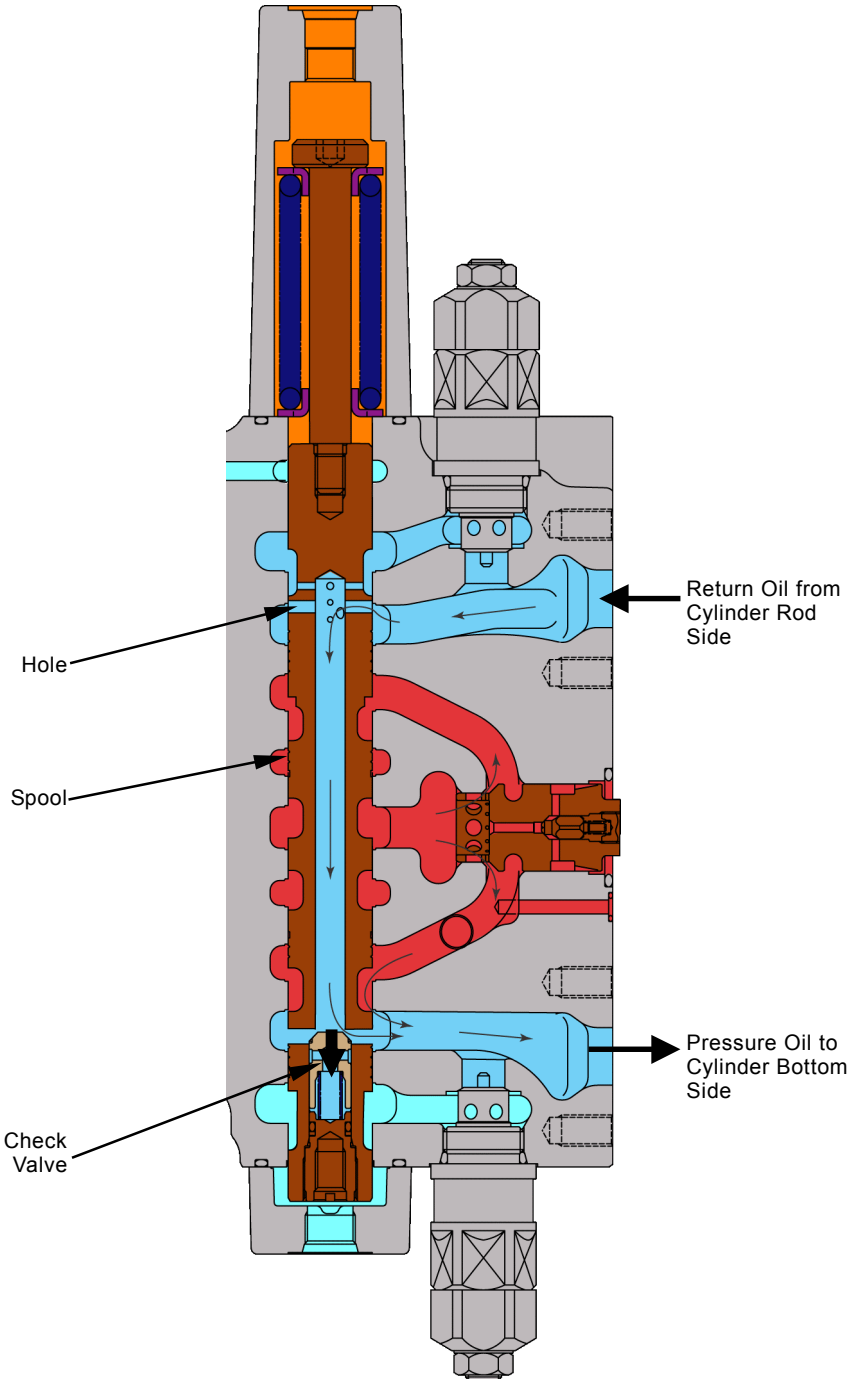
 **NOTE:** Operational principle of the boom regenerative valve is identical to that of the bucket regenerative valve. Therefore, the bucket regenerative valve is explained as an example.

Operation

1. When the bucket is rolled in, the return oil from the cylinder rod side (bottom side of the boom cylinder) enters hole in the spool and acts on the check valve.
2. At this time, if pressure in the cylinder bottom side (rod side of the boom cylinder) is lower than the rod side, the check valve is opened.
3. Then, return oil from the cylinder rod side flows into the bottom side together with oil delivered from the pump and the cylinder speed increases.
4. When the cylinder is moved full stroke or the digging load increases, pressure in the cylinder bottom side circuit increases more than the rod side. Therefore, the check valve is closed and regenerative operation stops.



COMPONENT OPERATION / Control Valve



T1V1-03-03-057

COMPONENT OPERATION / Control Valve

ARM REGENERATIVE VALVE

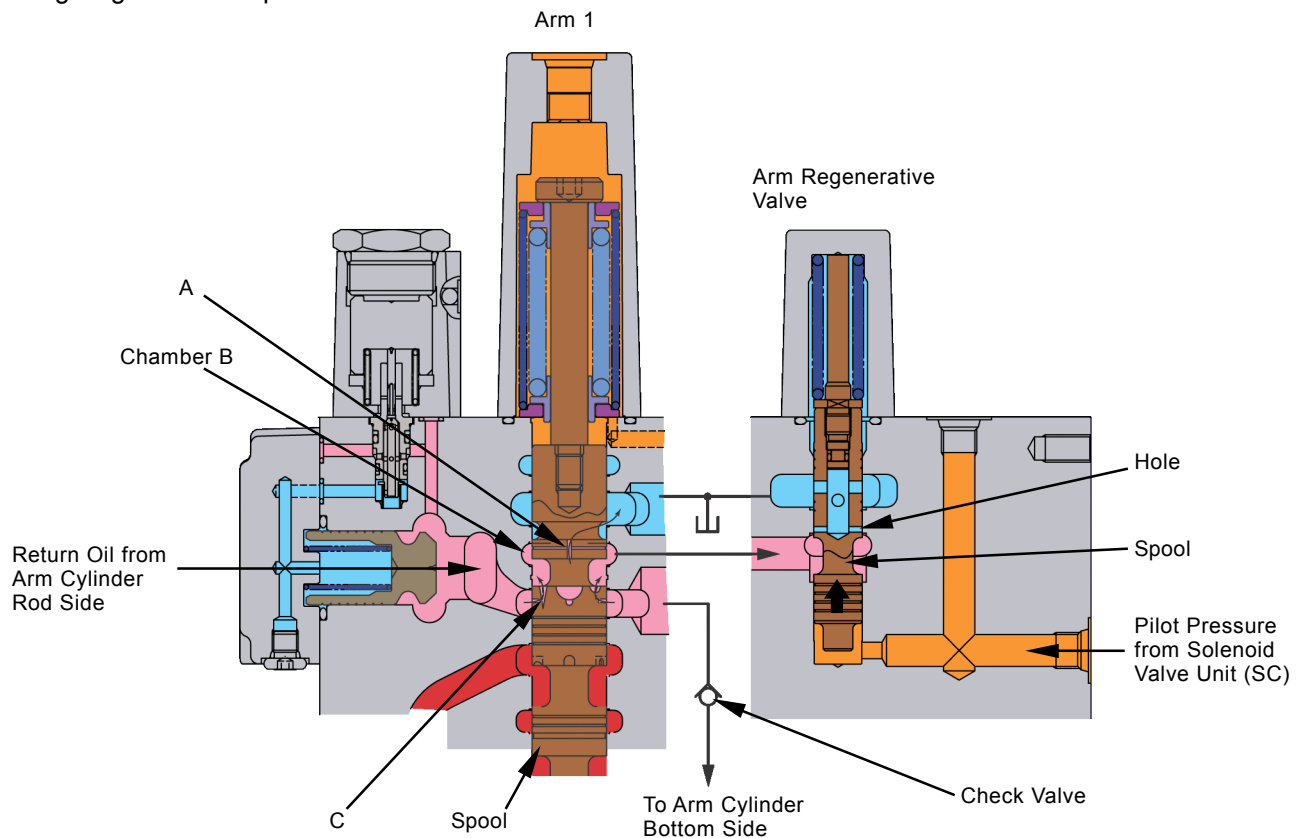
- During Normal Operation:

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 at the cylinder bottom side is larger than that at the cylinder rod side, the check valve is kept closed.
4. Consequently, as pressure oil at 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 at the cylinder rod side becomes larger than that at the cylinder bottom side.
5. Consequently, pressure at 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.

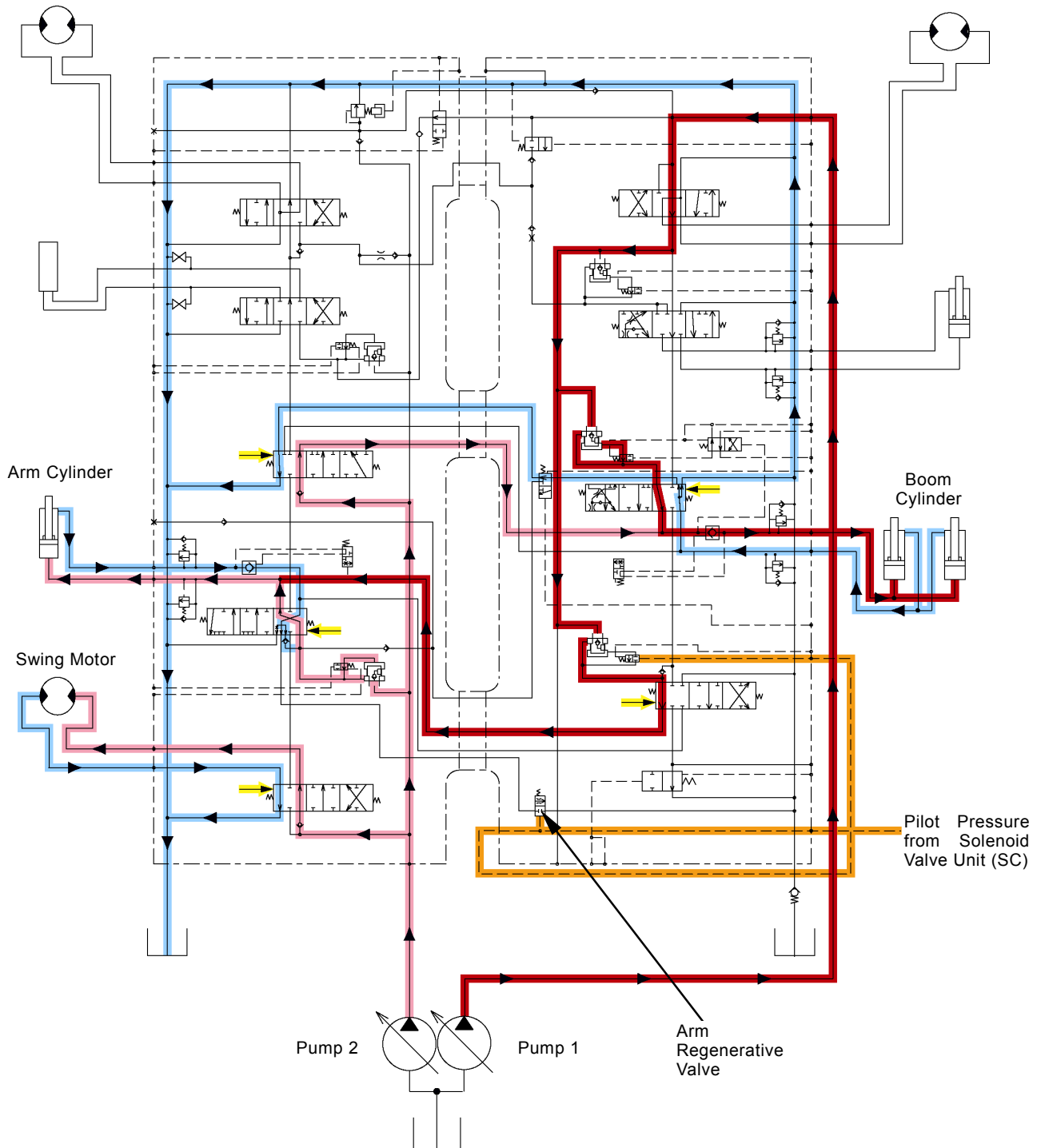
During Regenerative Operation:



T1V1-03-03-075

COMPONENT OPERATION / Control Valve

During Regenerative Operation:




T1V1-03-03-052

COMPONENT OPERATION / Control Valve

ANTI-DRIFT VALVE

The anti-drift valve is provided in the circuits of boom cylinder bottom side and arm cylinder rod side and prevents the cylinders from drifting.

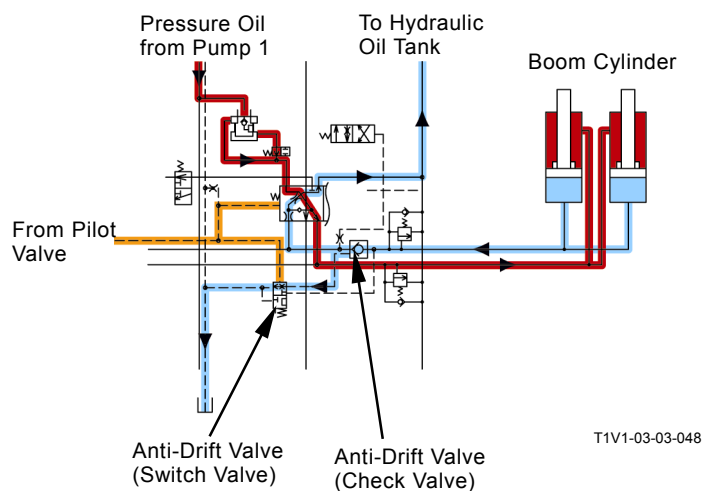
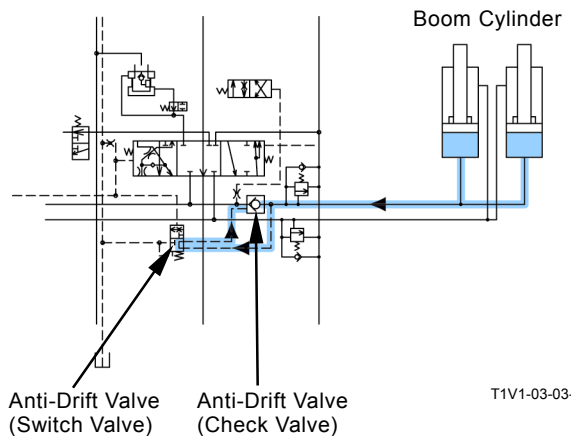
 **NOTE:** Both boom and arm anti-drift valves are identical in construction.

Holding Operation

1. When the control lever is in neutral (neutral spool position), the switch valve in anti-drift valve is not shifted.
2. Pressure at the boom cylinder bottom side (arm cylinder rod side) passes through the switch valve and acts to the check valve in anti-drift valve.
3. Consequently, as the check valve is pushed and the return circuit from cylinder is blocked, the cylinder drift is reduced.

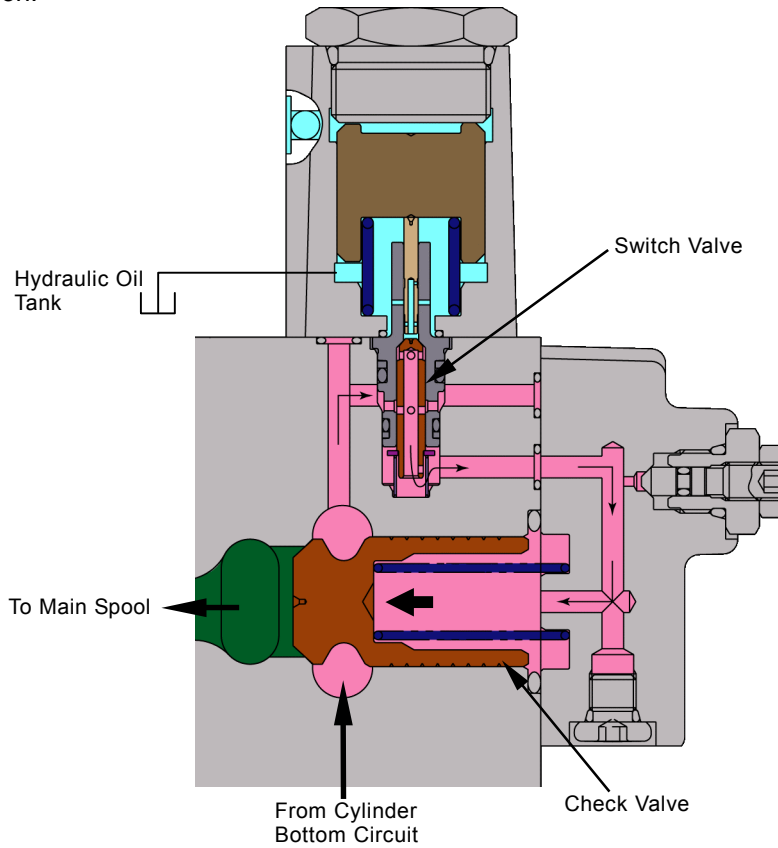
Releasing Operation

1. When the arm is rolled in or the boom is lowered, pressure oil from the pilot valve pushes the piston in anti-drift valve and shifts the switch valve.
 2. Oil in the spring chamber of check valve flows back to the hydraulic oil tank through the passage in switch valve.
 3. When pressure in the spring chamber decreases and pressure oil from the cylinder bottom side is larger than pressure in the spring chamber and spring force, the check valve moves to the right due to a area difference.
 4. Consequently, return oil from the boom cylinder bottom side (arm cylinder rod side) flows to the spool.
- As pressure decrease in the spring chamber is reduced by the orifice in switch valve, the check valve is prevented from rapidly moving and the shock is reduced during boom lower operation.



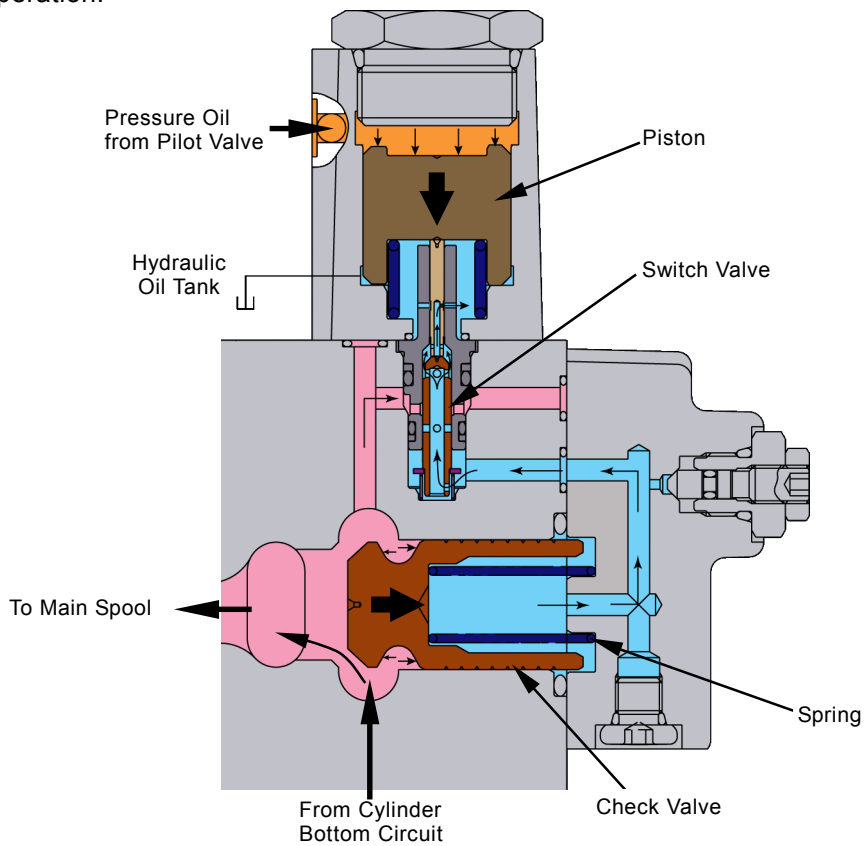
COMPONENT OPERATION / Control Valve

Holding Operation:



T1V1-03-03-060

Releasing Operation:



T1V1-03-03-061


COMPONENT OPERATION / Control Valve

FLOW RATE CONTROL VALVE

The flow rate control valve is provided in boom, arm, bucket and auxiliary circuits, restricts oil flow rate in the circuit during combined operation and gives priority to other actuators.

Each flow rate control valve is operated during combined operation as shown below.

Flow Control Valve	Combined Operation
Boom	Boom Lower (operation with the front attachment above ground (high pressure at bottom side))
Arm 1	Swing and Arm Roll-In
Arm 2	Swing, Boom Raise and Arm Roll-In
Bucket	Boom Raise and Arm Roll-In
Auxiliary	Front Attachment and Auxiliary

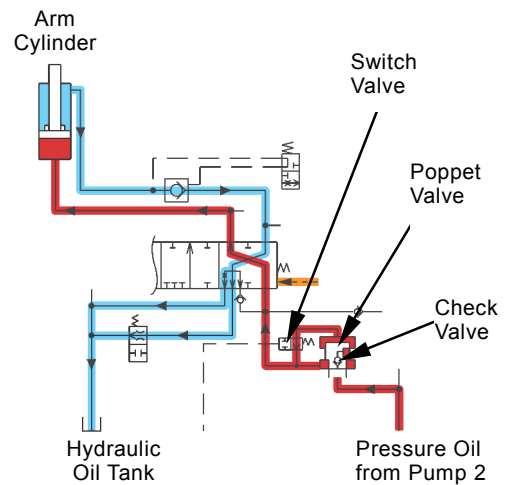
 **NOTE:** The arm 1 flow rate control valve is explained here.

Normal Operation

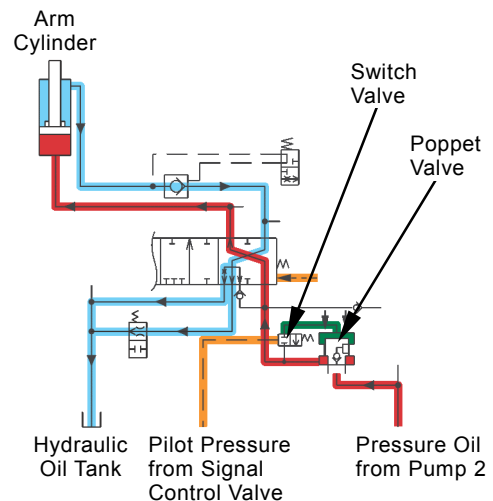
1. Pressure oil from pump 2 acts to the check valve in poppet valve.
2. As the switch valve is usually kept opened, pressure oil from pump 2 opens the check valve flows to the arm 1 spool.
3. If load at the actuator side is high, the poppet valve is open and pressure oil from pump 2 flows to the arm 1 spool.
4. Therefore, flow rate through the arm 1 spool increases and speed of arm increases.

Flow Rate Control Operation

1. The switch valve in arm 1 flow rate control valve is shifted by pilot pressure from the arm 1 flow rate control valve spool in signal control valve.
2. Therefore, back pressure in the poppet valve increases and the force to close the poppet valve appears.
3. Consequently, the poppet valve restricts flow rate to the arm 1 spool and pressure oil is supplied to the swing side which load pressure is higher at.

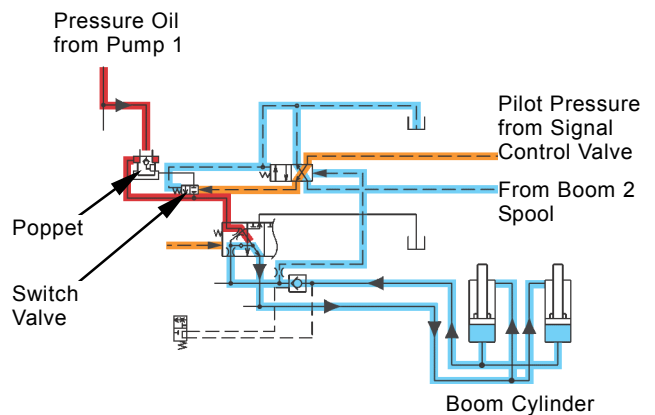


T1V1-03-03-049



T1V1-03-03-050

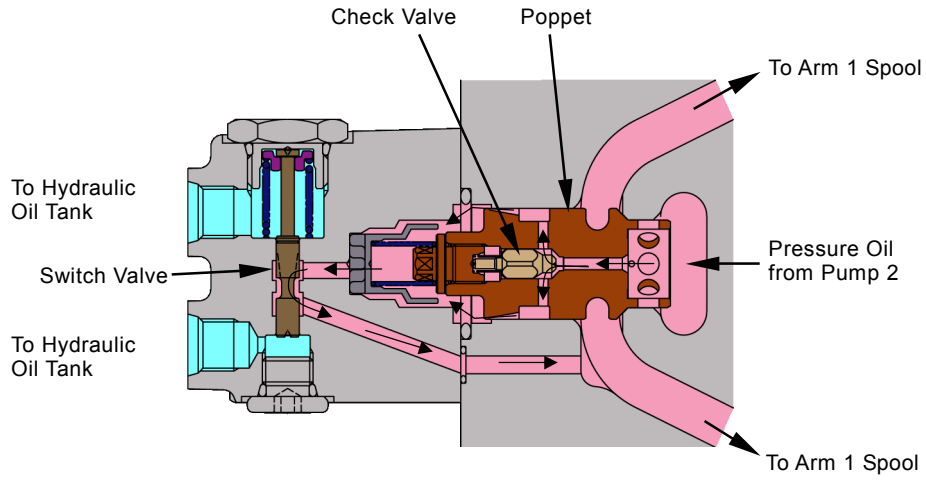
Boom Flow Rate Control Valve



T1V1-03-03-076

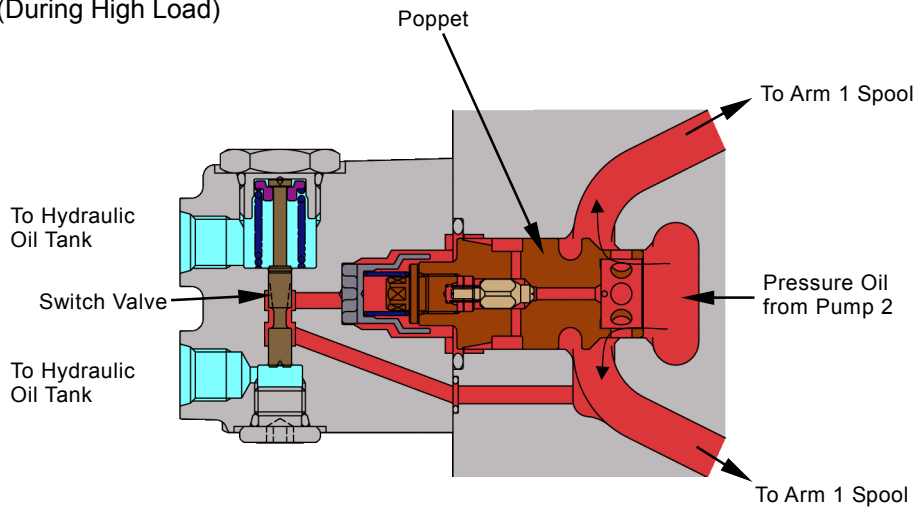
COMPONENT OPERATION / Control Valve

Normal Operation (During Low Load)



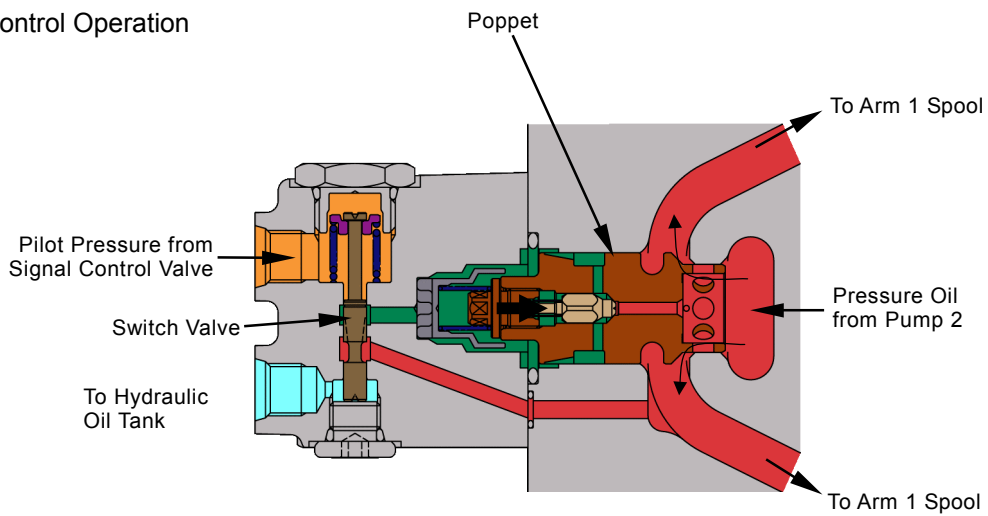
T1V1-03-03-062

Normal Operation (During High Load)



T1V1-03-03-063

Flow Rate Control Operation



T1V1-03-03-064

COMPONENT OPERATION / Control Valve

DIGGING REGENERATIVE VALVE

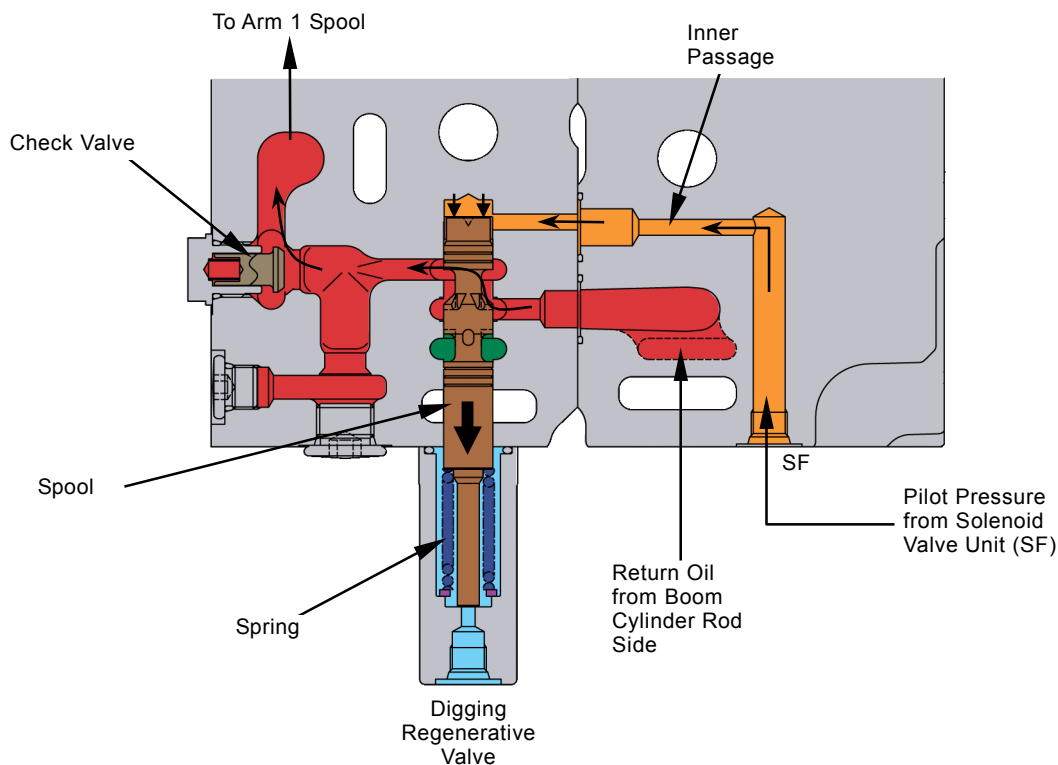
The digging regenerative valve is provided in the return circuit of boom lower and functions during combined operation of boom raise and arm roll-in.

When the digging regenerative valve is shifted, pressure oil from the boom cylinder rod side (return side) through the digging regenerative valve is combined with pressure oil from pump 2 and flows to the arm 1 spool. Therefore, speed of arm roll-in increases.

(Refer to Section "Control System"/ SYSTEM.)

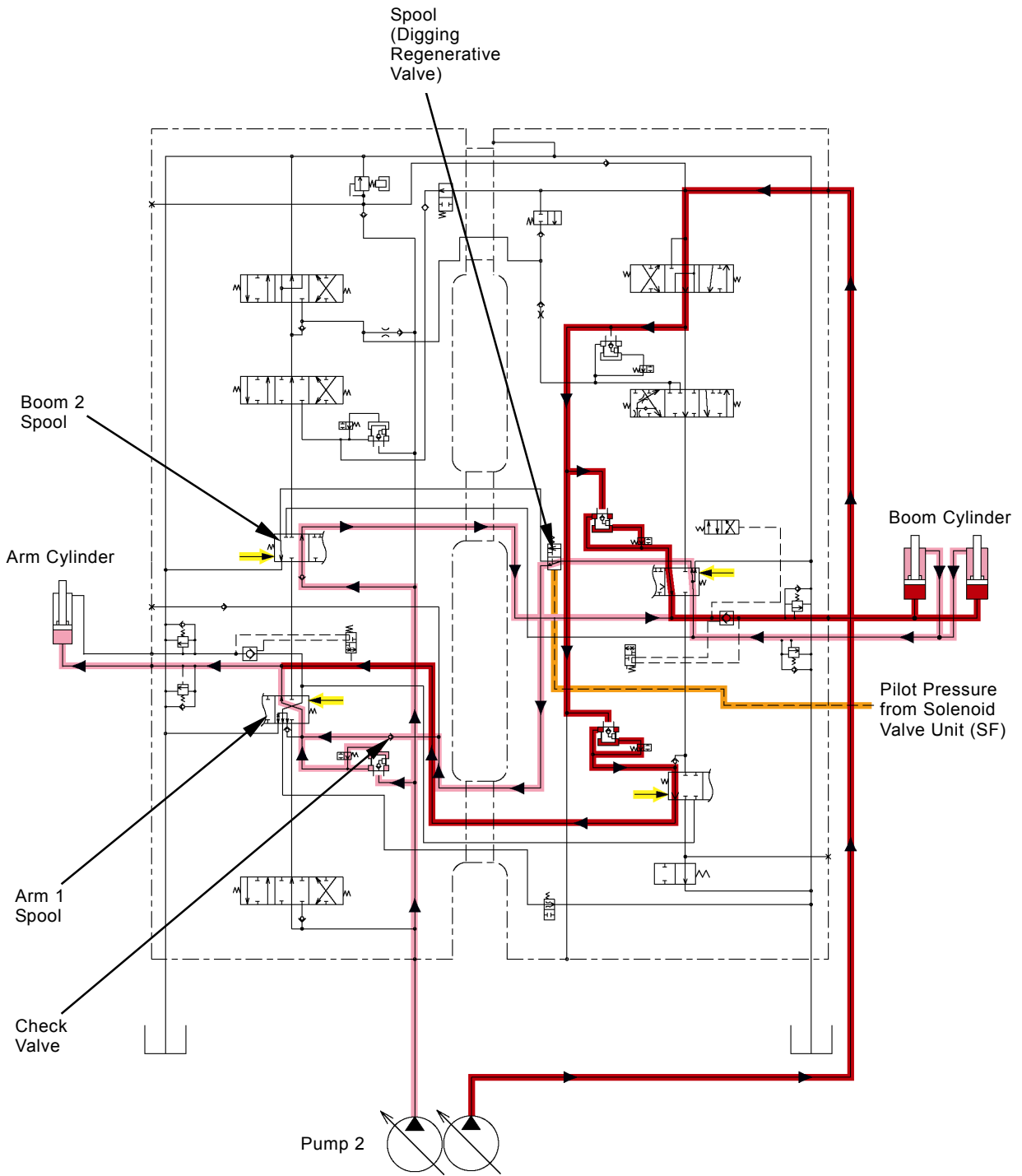
Operation

1. When solenoid valve unit (SF) is driven by the signal from main controller (MC), pressure oil from the pilot pump flows to port SF through solenoid valve unit (SF).
2. Pressure oil from port SF acts to the end of spool through the inner passage.
3. The spool moves downward by compressing the spring.
4. Therefore, pressure oil from the boom cylinder rod side (return side) opens the check valve, is combined with pressure oil from pump 2 and flows to the arm 1 spool.
5. Consequently, as oil flow rate to the arm cylinder increases, speed of arm roll-in increases.



T1V1-03-03-069

COMPONENT OPERATION / Control Valve



T1V1-03-03-053

COMPONENT OPERATION / Control Valve

BOOM LOWER METER-IN CUT VALVE

The boom lower meter-in cut valve is provided in the boom lower circuit and functions with the boom flow control valve together.

During boom lower operation with the front attachment above the ground, the boom flow rate control valve restricts pressure oil which flows to the boom 1 spool from pump 1 and blocks pilot pressure to the arm 2 spool.

Therefore, during operation of boom lower and other actuator, the boom falls due to own weight by the regenerative circuit and uses pressure oil from the pump for other actuator so that speed of other actuator increases. (Refer to "Hydraulic System"/ SYSTEM.)

Operation (Boom Lower with Front Attachment above Ground)

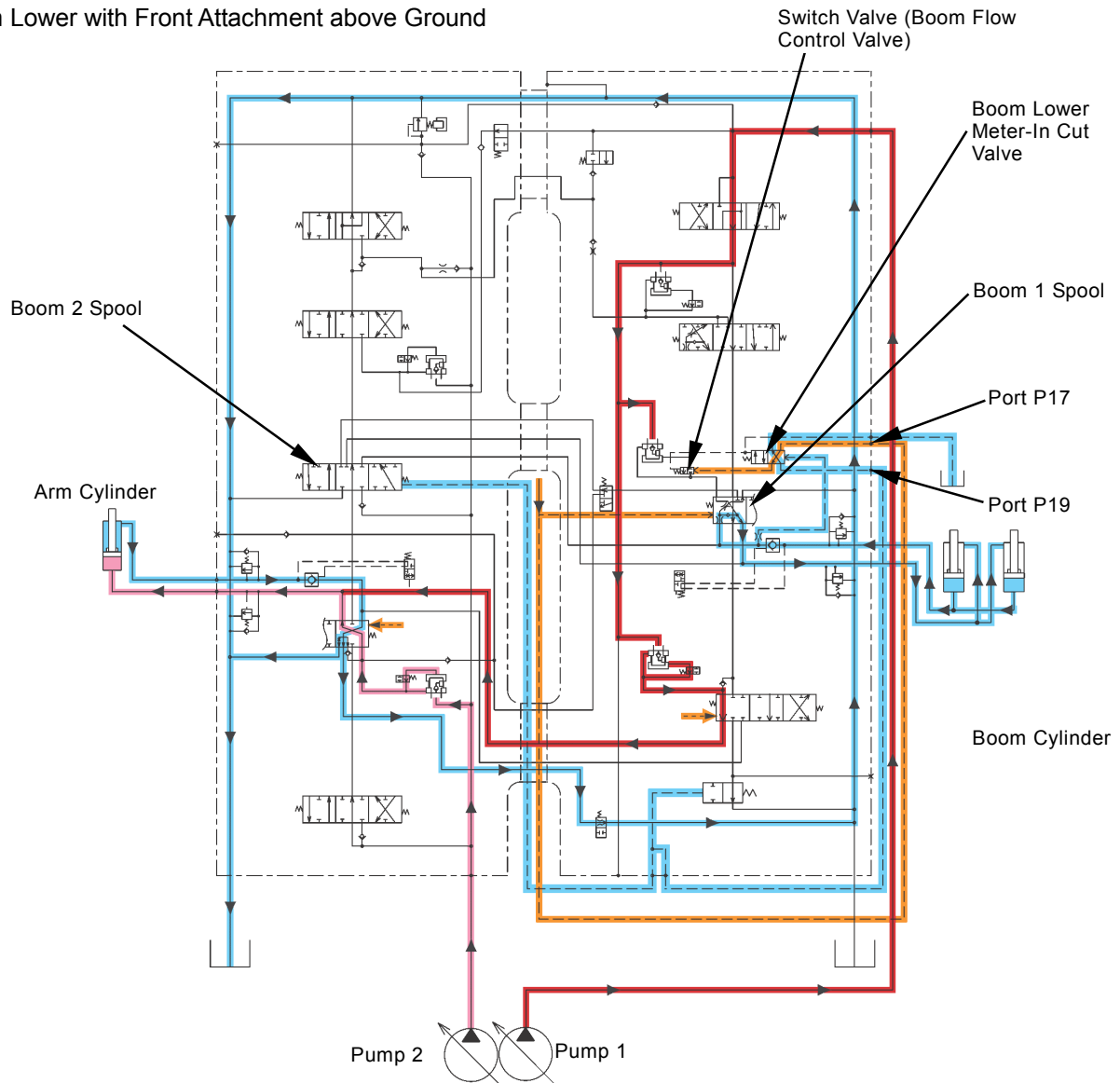
1. During boom lower operation, pressure oil from the pilot pump flows to the boom 2 spool from port P19 through port P17 and boom lower meter-in cut valve.
2. Pressure oil (return oil) from the boom cylinder bottom side flows to the spring chamber in boom lower meter-in cut valve through the orifice.
3. When pressure in the spring chamber becomes larger than the spring force, the boom lower meter-in cut valve compresses the spring moves to the left.
4. Therefore, as port P19 is connected to the hydraulic oil tank through the boom lower meter-in cut valve, the boom 2 spool is returned to the neutral position.
5. Pressure oil from port P17 flows to the switch valve in boom flow rate control valve through the spool.
6. The switch valve in boom flow rate control valve is shifted and pressure oil which flows to the boom 1 spool from pump 1 is reduced. (Refer to "Flow Control Valve".)
7. Consequently, during combined operation of boom lower and other actuator, more pressure oil is supplied to other actuator and speed of actuator increases.

Operation (Jack-Up)

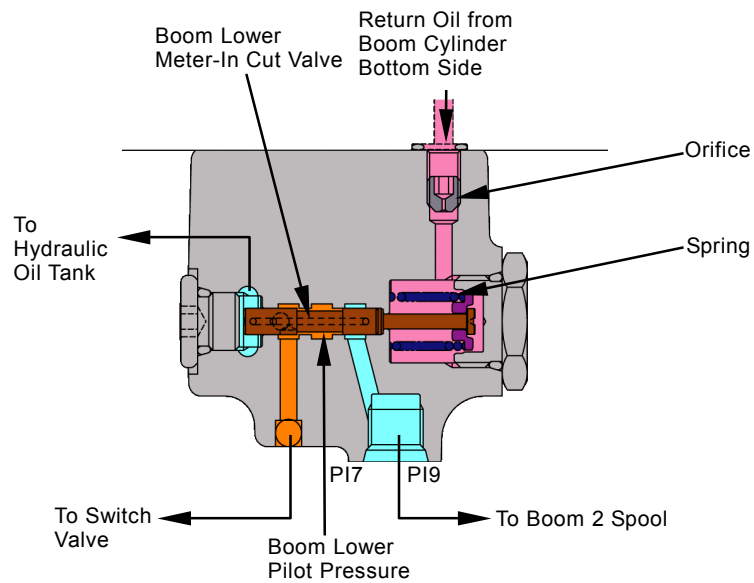
1. During jack-up operation, as pressure at the boom cylinder bottom side decreases, pressure in the spring chamber decreases.
2. When pressure in spring chamber becomes lower than the spring force, the boom lower meter-in cut valve moves to the right due to the spring force.
3. Therefore, as pressure oil which acts to the switch valve in boom flow rate control valve from port P17 flows to the hydraulic oil tank through the boom lower meter-in cut valve, the switch valve is returned to the original position.
4. Pressure oil from port P17 flows to the boom 2 spool from port P 19 through the boom lower meter-in cut valve.
5. Therefore, during jack-up operation, the boom lower meter-in cut control is not operated. (Refer to "Hydraulic System"/ SYSTEM.)

COMPONENT OPERATION / Control Valve

Boom Lower with Front Attachment above Ground



T1V1-03-03-051



T1V1-03-03-074

COMPONENT OPERATION / Control Valve

AUXILIARY FLOW COMBINER VALVE AND BYPASS SHUT-OUT VALVE


The auxiliary flow combiner valve and the bypass shut-out valve are provided in the 5-spool section circuit and the rear of 4-spool section circuit respectively.

These valve functions differ depending on whether only the front attachment is single-operated or combined-operated.

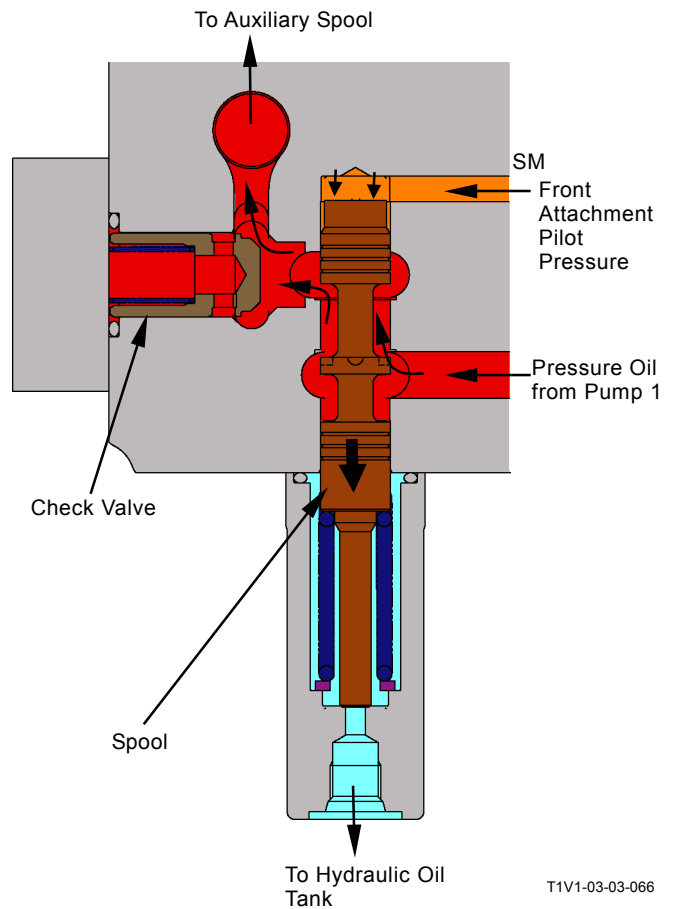
During Single Operation

When the front attachment is single operated, pressure oil from both pumps 1 and 2 is combined. Therefore, operating speed of front attachment increases.

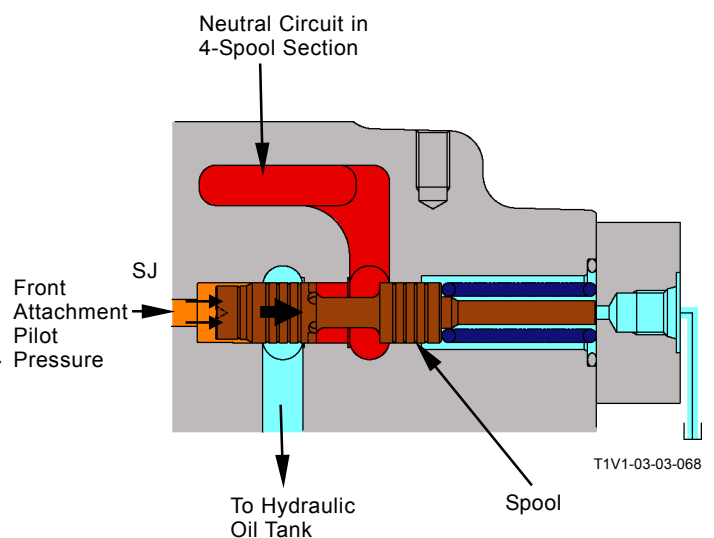
1. When the front attachment is single operated, front attachment pilot pressure acts to ports SM and SJ and the spools in auxiliary flow combiner valve and bypass shut-out valve are shifted.
2. When the spool in bypass shut-out valve is shifted, the neutral circuit in 4-spool section is blocked.
3. At this time, as the spool in auxiliary flow combiner valve is shifted, pressure oil in 4-spool section (pump 1) flows to the auxiliary spool through the auxiliary flow combining valve.
4. Consequently, pressure oil in pumps 1 and 2 is combined so that operating speed of front attachment increases.

 **NOTE:** The external shuttle valve is installed to the machine equipped with the optional auxiliary flow combining system. During front attachment operation, front attachment pilot pressure shifts the pump 1 flow rate control valve in signal control valve through the external shuttle valve. Therefore, swash angle of pump 1 becomes maximum and delivery flow rate increases. (Refer to "Pump Device" and "Signal Control Valve"/ COMPONENT OPERATION.)

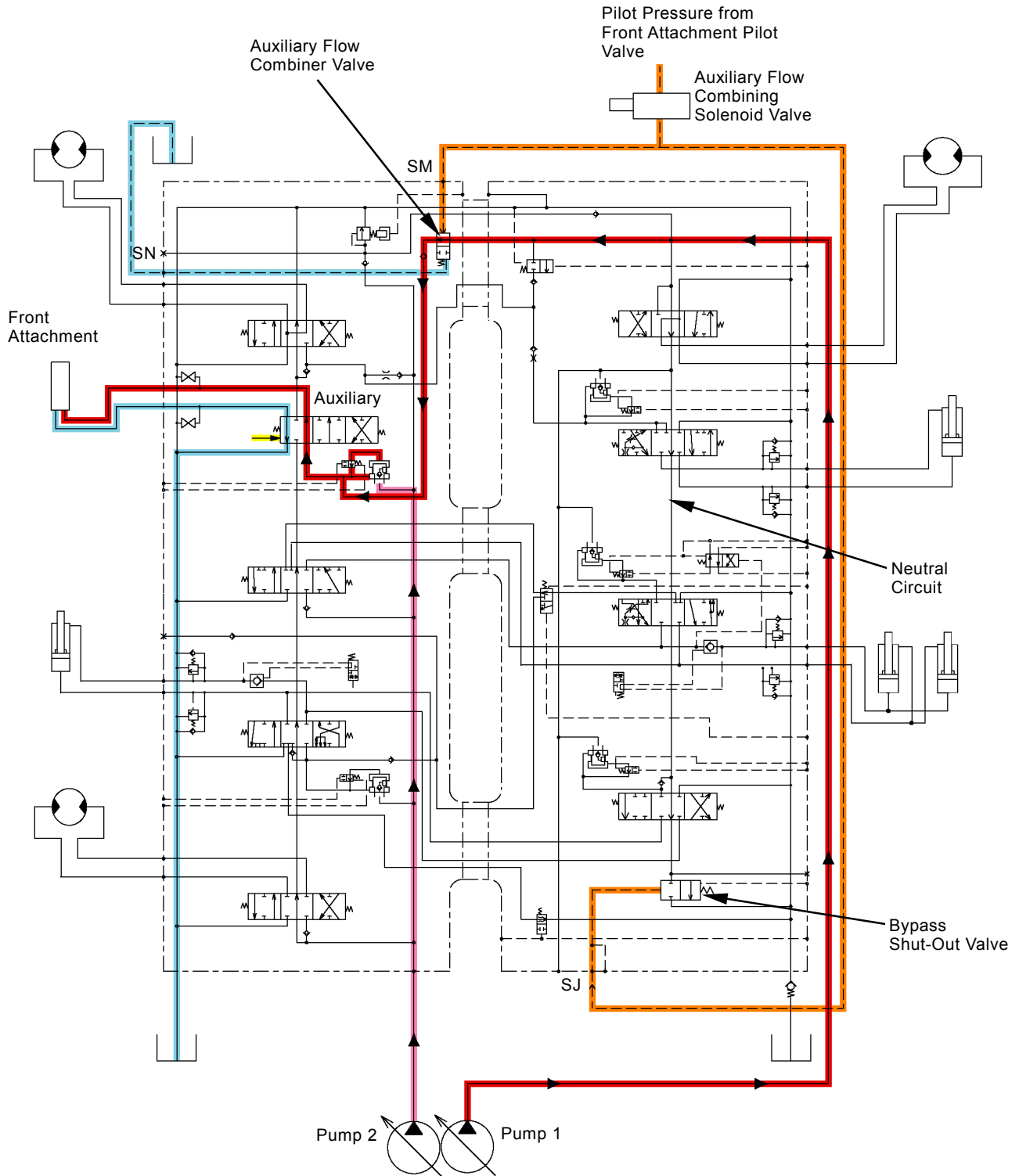
Auxiliary Flow Combiner Valve




Bypass Shut-Out Valve



COMPONENT OPERATION / Control Valve



T1V1-03-03-054

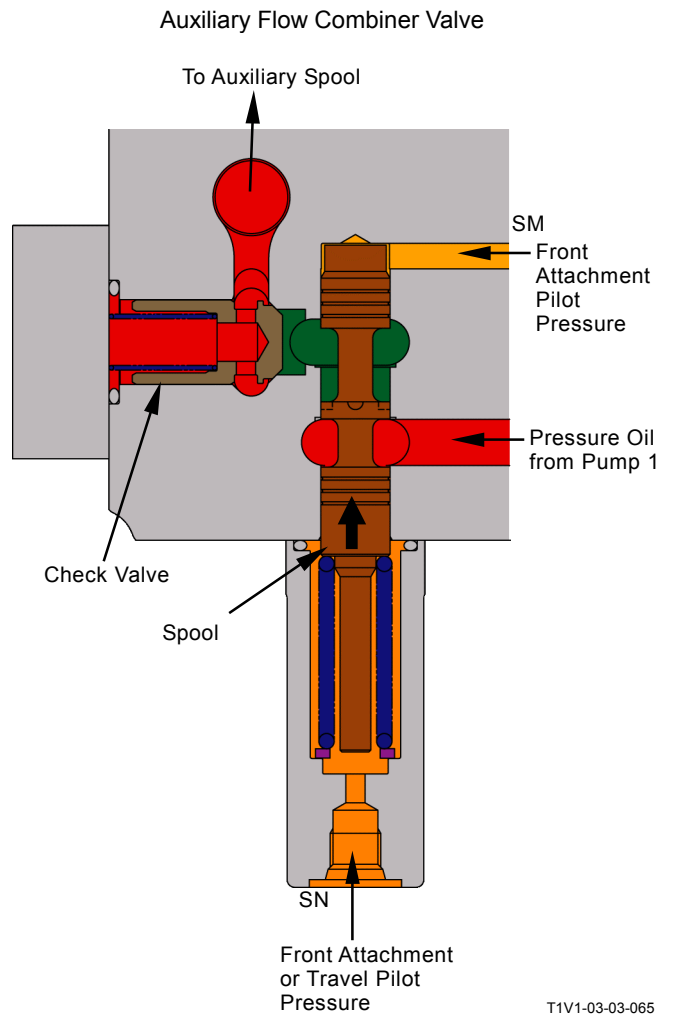
 **NOTE:** The illustration shows auxiliary (open) operation.

COMPONENT OPERATION / Control Valve

During Combined Operation

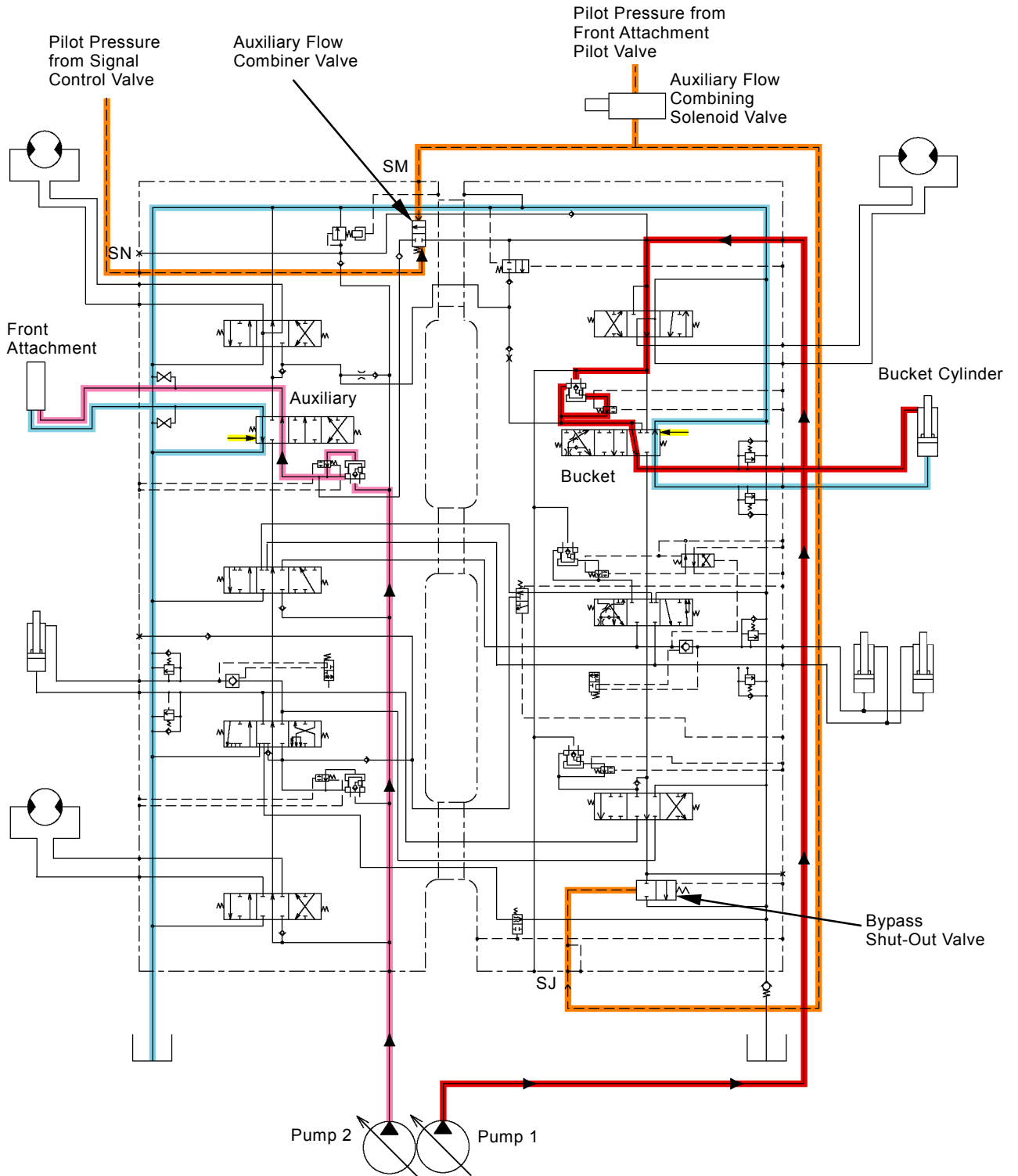
During combined operation of front attachment and boom, arm, bucket or travel, do not shift the auxiliary flow combiner valve. Therefore, operating speed of boom, arm, bucket and travel is maintained.

1. When the front attachment is operated, attachment pilot pressure acts to port SM in auxiliary flow combiner valve.
2. When the boom, arm, bucket or travel is operated at the same time, pilot pressure from signal control valve acts to port SN.
3. Pressure oil from port SM acts to the spool open direction and pressure oil from port SN and the spring force act to the spool close direction in auxiliary flow combiner valve.
4. As the force for spool close is larger, the spool is kept closed.
5. Consequently, pressure oil from pumps 1 and 2 is not combined and operating speed of boom, arm, bucket or travel is maintained.




T1V1-03-03-065

COMPONENT OPERATION / Control Valve



T1V1-03-03-055

 **NOTE:** The illustration shows auxiliary (open) / bucket roll-out operation.

COMPONENT OPERATION / Control Valve

(Blank)


COMPONENT OPERATION / Pilot Valve

OUTLINE

The pilot valve controls pilot pressure oil in order to move the spool in control valve. The pilot valve outputs pressure according to the control lever stroke by PPC (Pressure Proportional Control Valve) function and moves the spool in control valve.

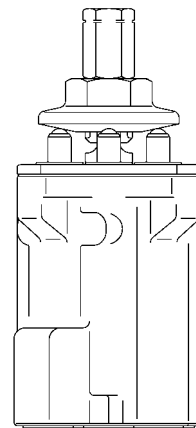
The 4-port pilot valves for front attachment/swing and for travel are standard.

The 2-port pilot valve is for auxiliary (optional) and for positioning (2-piece boom only).

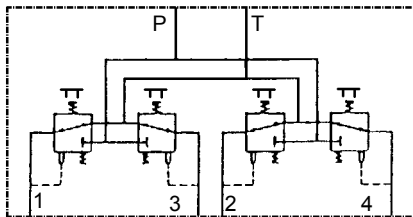
 **NOTE:** As for the pilot valves for front attachment/swing and for travel, the structure of cam to push in the pusher is different and that of pressure-reducing valve is same.

• Front Attachment / Swing Pilot Valve

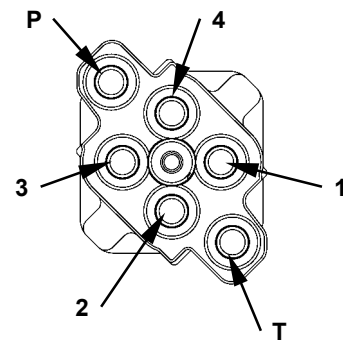
	Port No.	ISO Control Pattern	Hitachi Pattern
Right	1	Bucket Roll-Out	←
	2	Boom Lower	←
	3	Bucket Roll-In	←
	4	Boom Raise	←
Left	1	Right Swing	Arm Roll-In
	2	Arm Roll-Out	Right Swing
	3	Left Swing	Arm Roll-Out
	4	Arm Roll-In	Left Swing



Hydraulic Symbol



T105-02-07-020



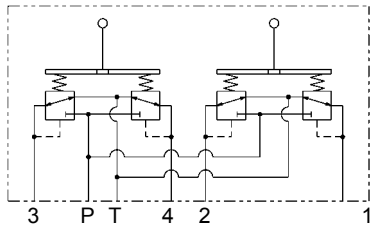
T1V1-03-04-001

COMPONENT OPERATION / Pilot Valve

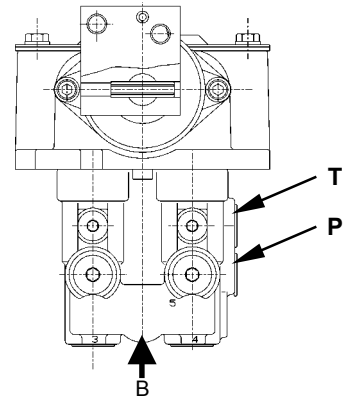
• Travel Pilot Valve

Port No.	
1	Travel (Right Reverse)
2	Travel (Right Forward)
3	Travel (Left Forward)
4	Travel (Left Reverse)

Hydraulic Symbol

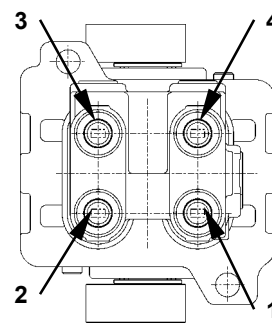


T178-03-04-017



T1M9-03-05-004

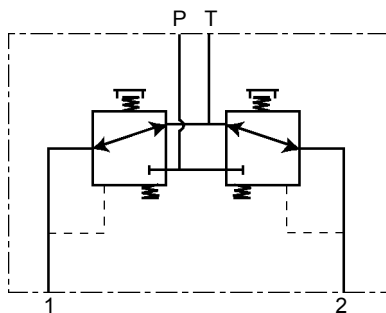
View B



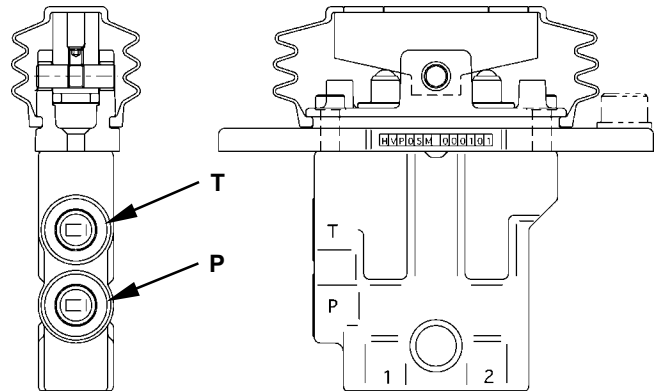
T1M9-03-05-005

• Auxiliary / Positioning Pilot Valve

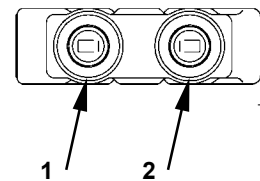
	Port No.	
Auxiliary	1	Open
	2	Close
Positioning	1	Lower
	2	Raise



T1CF-03-04-001



T1CF-03-04-002



COMPONENT OPERATION / Pilot Valve

(Blank)

COMPONENT OPERATION / Pilot Valve

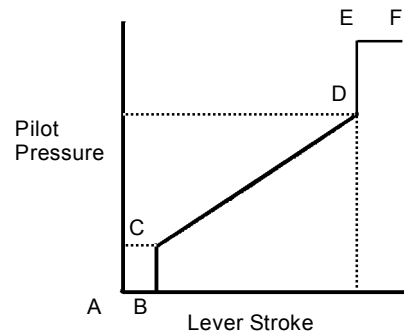
OPERATION

- Front Attachment / Swing and Travel Pilot Valves

Spool (6) head comes in contact with the upper surface of spring guide (3) which is kept raised by return spring (5).

Neutral (Output Curve: A to B):

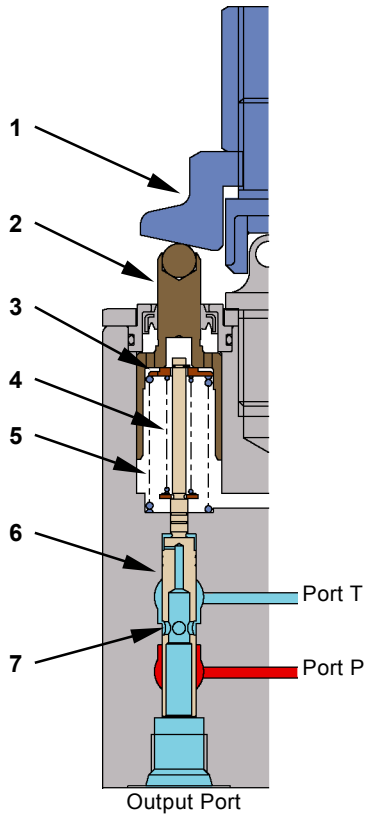
1. When in neutral, spool (6) totally blocks pressure oil from port P (the pilot pump). The output port is opened to port T (hydraulic oil tank) through the inner passage in spool (6).
2. Therefore, pressure in the output port is equal to that in port T.
3. When the control lever is slightly tilted, cam (1) is tilted and pusher (2) is downward. Pusher (2) compress return spring (5) along with spring guide (3) together.
4. At this time, as pressure in the output port is equal to that in port T, spool (6) moves downward while keeping the lower surface of the spool (6) head in contact with spring guide (3).
5. This status continues until hole (7) on spool (6) is opened to port P.



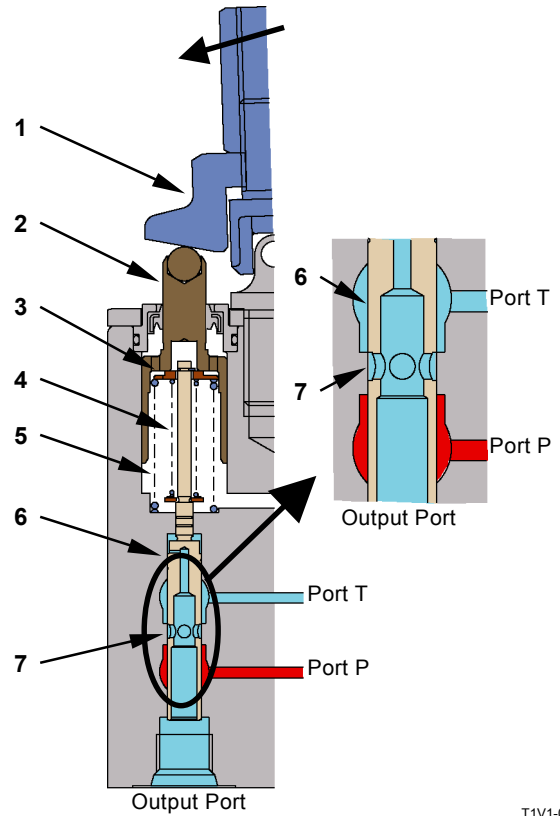
T523-02-05-001

COMPONENT OPERATION / Pilot Valve

Front Attachment / Swing Pilot Valve

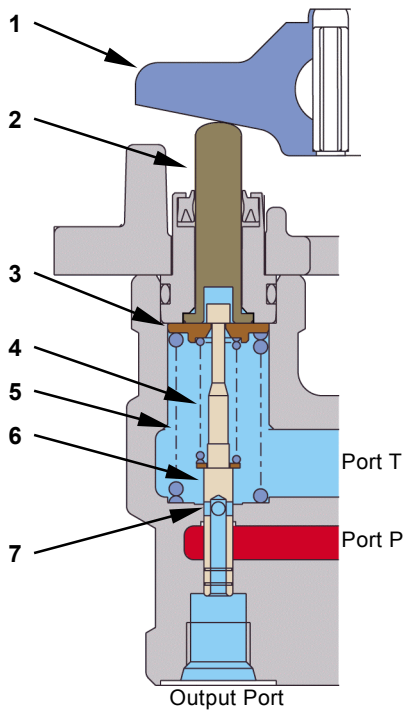


T1V1-03-04-007

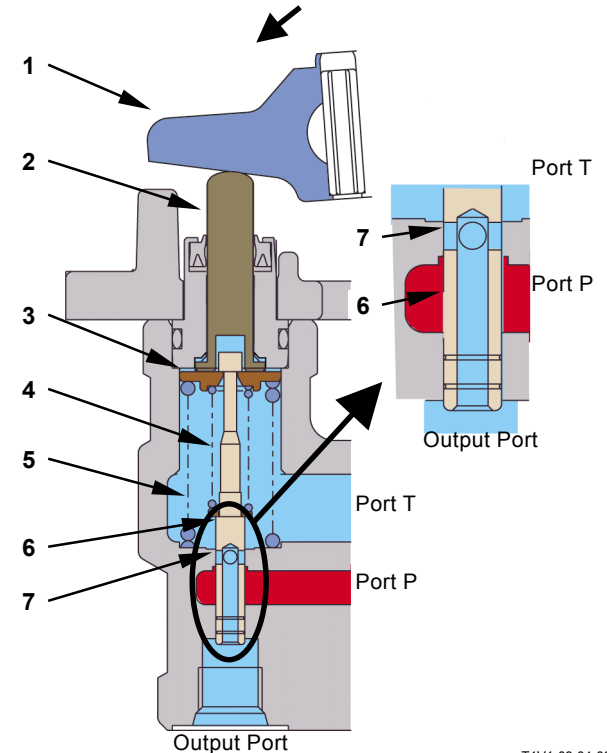


T1V1-03-04-008

Travel Pilot Valve



T1V1-03-04-002



T1V1-03-04-003

1 - Cam
2 - Pusher

3 - Spring Guide
4 - Balance Spring

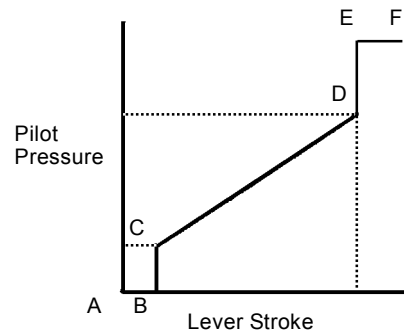
5 - Return Spring
6 - Spool

7 - Hole

COMPONENT OPERATION / Pilot Valve

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

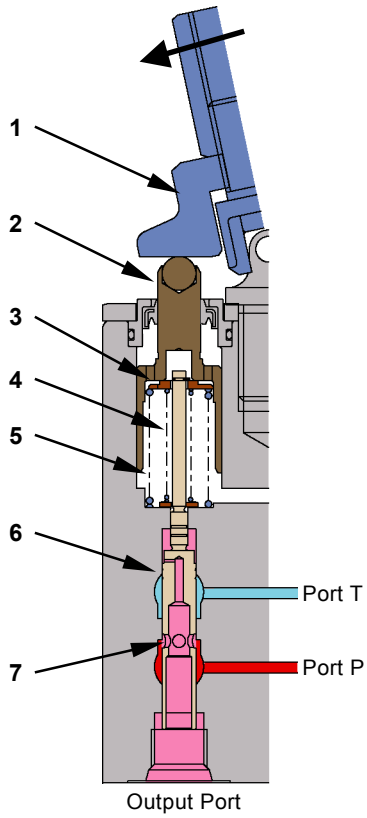
1. When the control lever is further tilted in order to move pusher (2) downward more, hole (7) on spool (6) is opened to port P and pressure oil in port P flows into the output port.
2. Pressure in the output port acts on the bottom surface of spool (6) so that spool (6) is pushed upward.
3. Until upward force acting on the bottom surface of spool (6) overcomes the balance spring (4) force, balance spring (4) is not compressed so that spool (6) is not raised and pressure in the output port increases.
4. As pressure in the output port increases, the force to push spool (6) upward increases. When this force overcomes the balance spring (4) force, balance spring (4) is compressed so that spool (6) is moved upward.
5. As spool (6) is moved upward, hole (7) is closed so that pressure oil from port P stops flowing into the output port and pressure in the output port stops increasing.
6. As spool (6) is moved downward and balance spring (4) is compressed, the pressure acting on the bottom surface of spool (6) increases until the pressure balances with the increasing spring force. This increasing pressure becomes pressure at the output port.



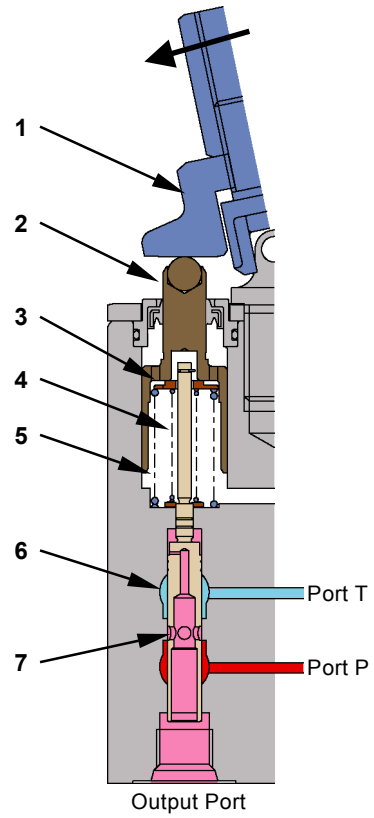
T523-02-05-001

COMPONENT OPERATION / Pilot Valve

Front Attachment / Swing Pilot Valve

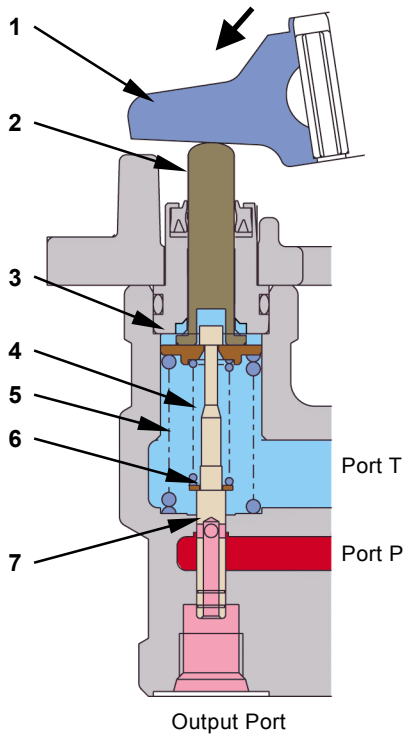


T1V1-03-04-009

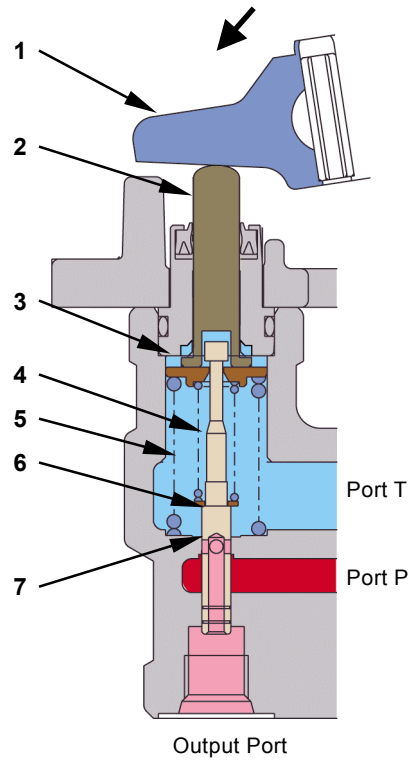


T1V1-03-04-010

Travel Pilot Valve



T1V1-03-04-004



T1V1-03-04-005

1 - Cam
2 - Pusher

3 - Spring Guide
4 - Balance Spring

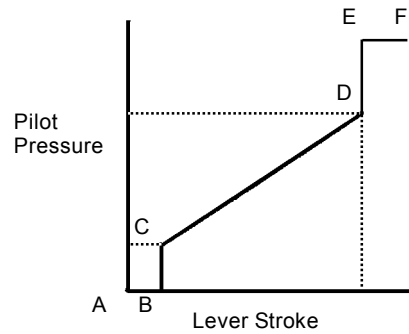
5 - Return Spring
6 - Spool

7 - Hole


COMPONENT OPERATION / Pilot Valve

Full Stroke (Output Curve: E to F)

1. When the control lever is fully stroked, pusher (2) is moved downward until pusher (2) on the front attachment / swing pilot valve comes in contact with the casing shoulder, or cam (1) on the travel pilot valve comes in contact with the casing.
2. At this time, the bottom surface of pusher (2) directly pushes spool (6). Therefore, even if pressure in the output port increases further, hole (7) on spool (6) is kept open.
3. Consequently, pressure in the output port is equal to that in port P.

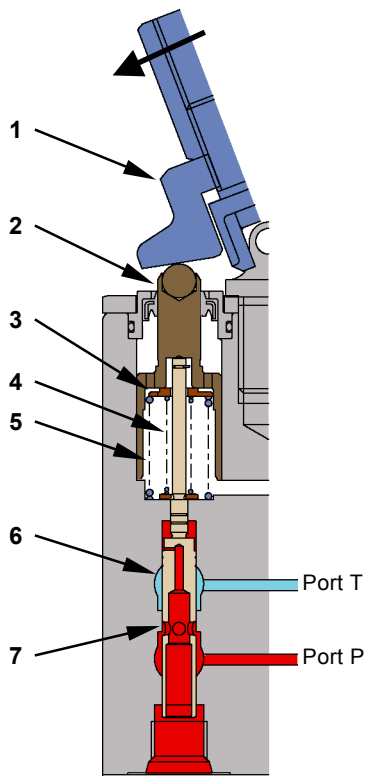


T523-02-05-001

 **NOTE:** Total lever strokes for front attachment and swing controls are determined by stroke dimension (E) of pusher (2). Total lever stroke for travel control is determined by stroke dimension (E) of cam (1).

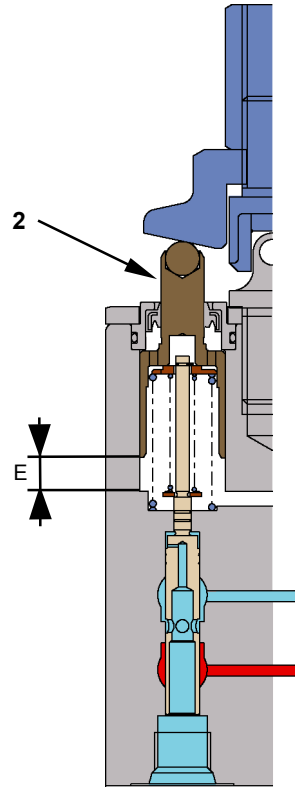
COMPONENT OPERATION / Pilot Valve

Front Attachment / Swing Pilot Valve



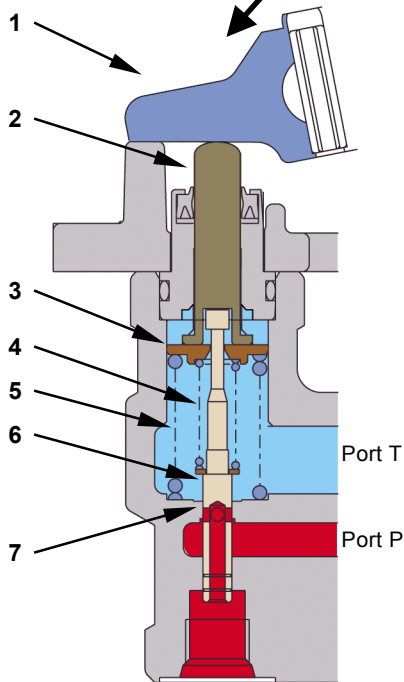
Output Port

T1V1-03-04-011



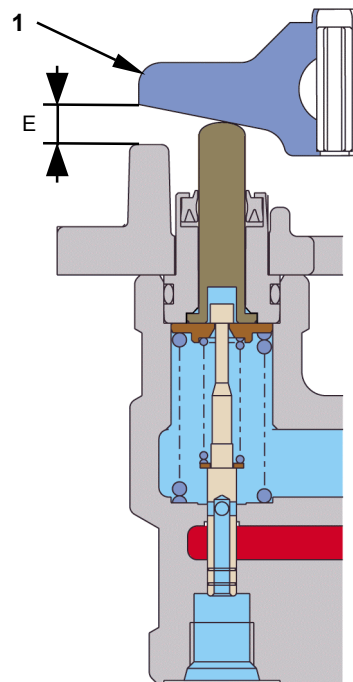
T1V1-03-04-007

Travel Pilot Valve



Output Port

T1V1-03-04-006



T1V1-03-04-002

1 - Cam
2 - Pusher

3 - Spring Guide
4 - Balance Spring

5 - Return Spring
6 - Spool


7 - Hole

COMPONENT OPERATION / Pilot Valve

• Auxiliary / Positioning Pilot Valve

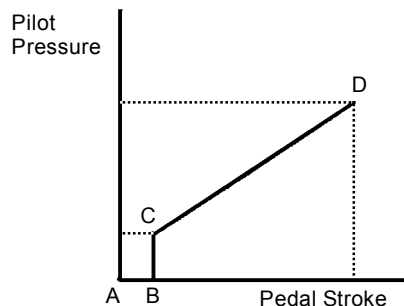
In Neutral (Output Curve: A to B)

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)

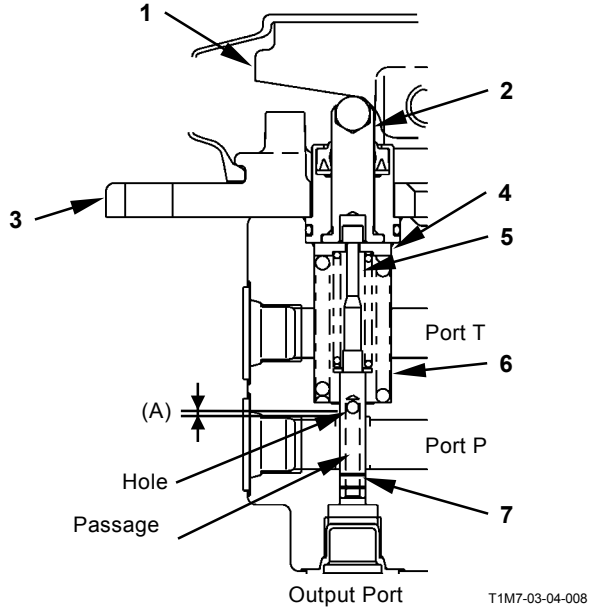
1. When the control pedal is depressed further, the hole on spool (7) is connected to the notch.
2. Pressure oil in port P flows into the output port through the notch and the hole on spool (7), and pressure in the output port increases.
3. Pressure in the output port acts on the bottom surface of spool (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.



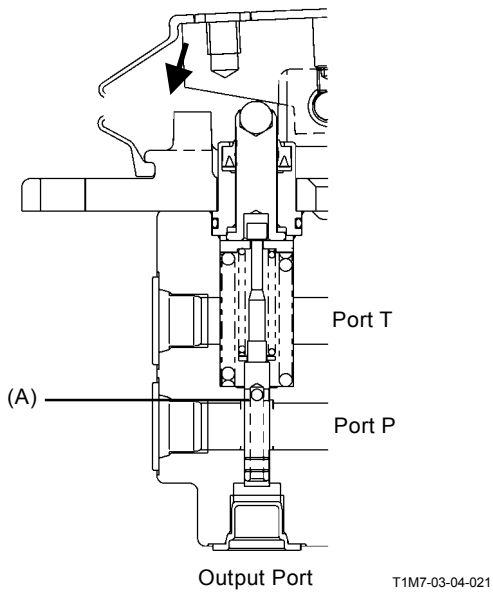
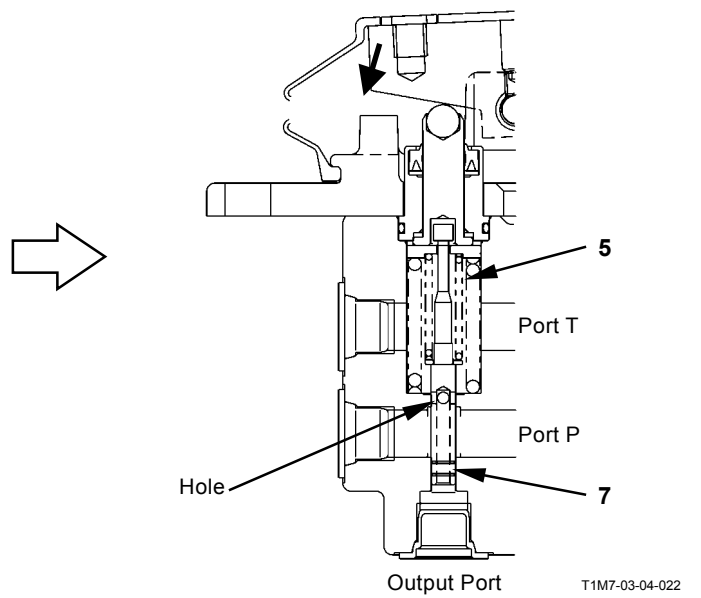
T1F3-03-09-004

COMPONENT OPERATION / Pilot Valve

In Neutral (Output Curve: A to B)



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



1 - Cam
2 - Pusher

3 - Plate
4 - Spring Guide

5 - Balance Spring
6 - Return Spring

7 - Spool

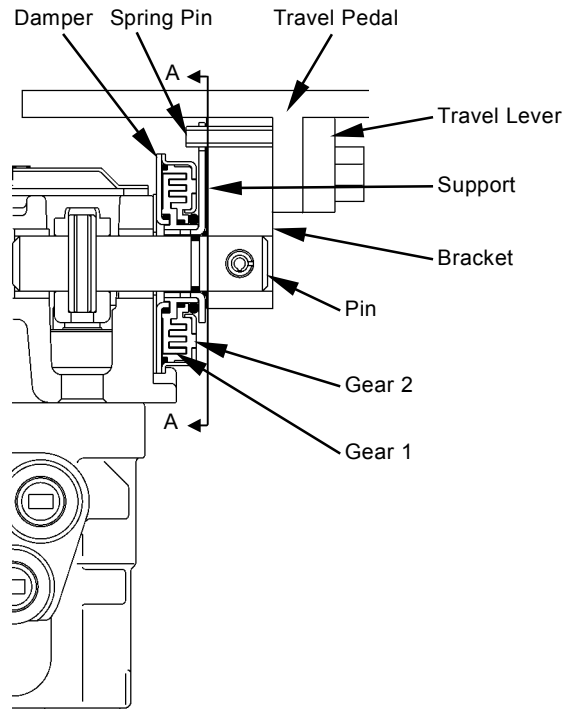
COMPONENT OPERATION / Pilot Valve

SHOCKLESS FUNCTION (ONLY FOR TRAVEL PILOT VALVE)

The travel pilot valve has the damper enabling damping of the speed change shock by the travel lever. The damper is composed of support, gears 1 and 2 and others. Gear 1 is connected with the support. The support is secure to the bracket by using a spring pin. The travel lever and travel pedal are secure to the bracket. Therefore, the support swings transversely around the pin in line with movement of the travel lever.

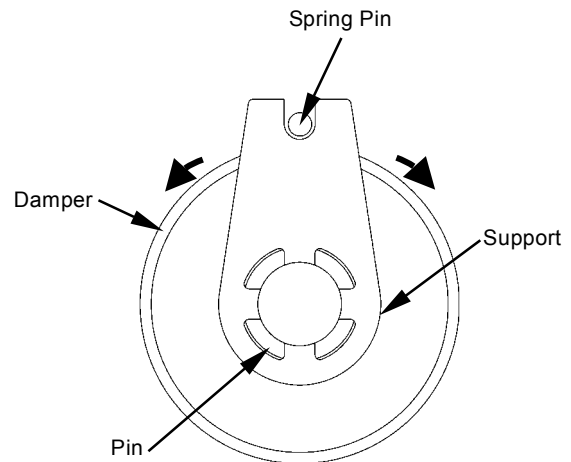
Operation

1. If the travel lever is released from the hand during traveling, spring force of the return spring returns the travel lever to the neutral position.
2. At this time, gears 1 and 2 inside the damper receive opposing force due to friction.
3. Therefore, as the travel lever gradually returns to the neutral position, the extent of sudden stop at the time of abrupt release of the travel lever is damped down.



T1M7-03-04-002

Section A-A



T1M7-03-04-003

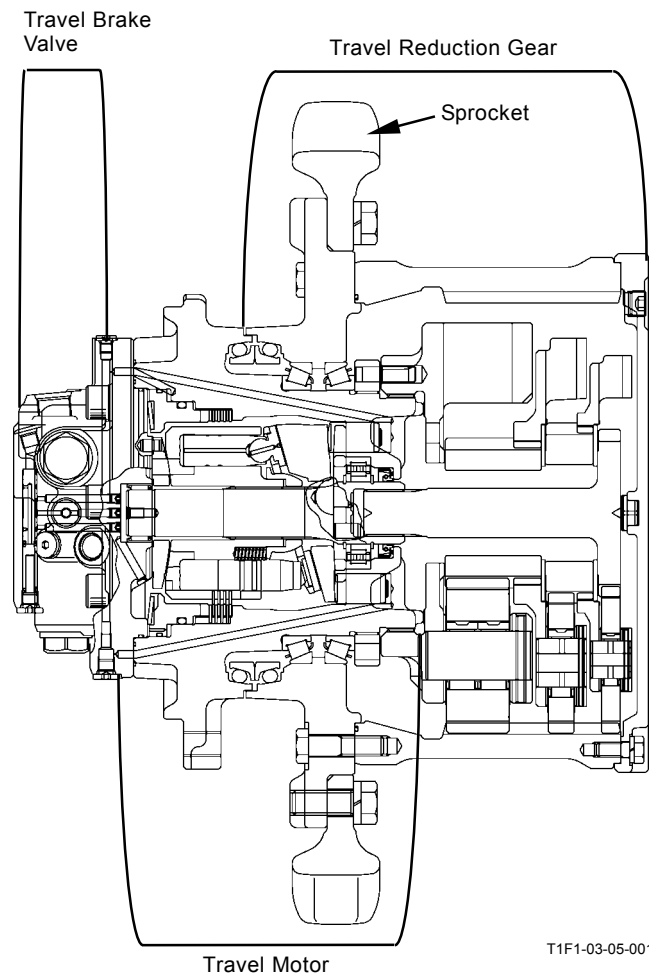
COMPONENT OPERATION / Travel Device

OUTLINE

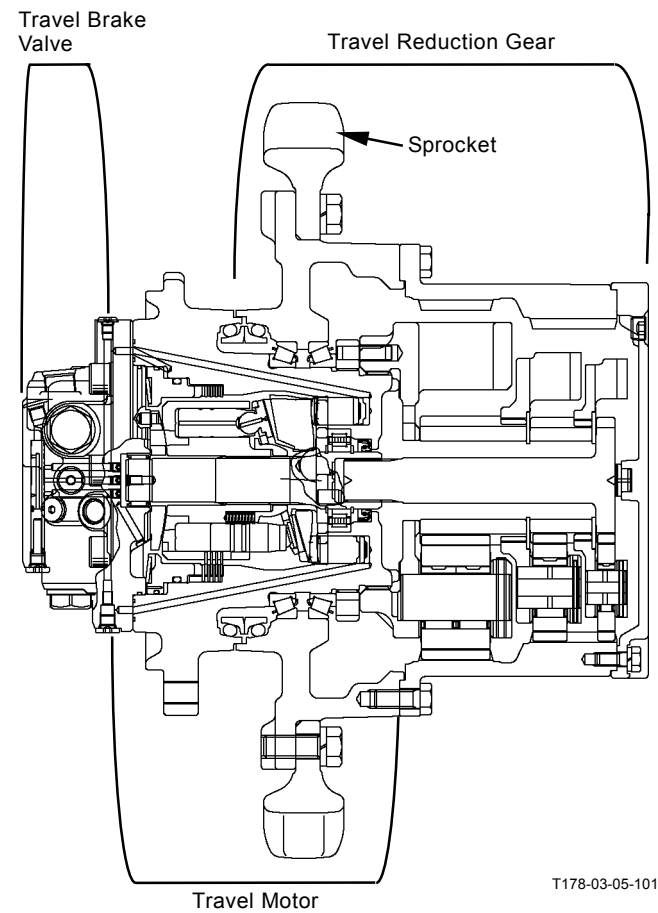
The travel device consists of the travel motor, travel reduction gear and travel brake valve. The travel motor is a swash plate type variable displacement axial plunger motor and equipped with the parking brake (wet-type negative multi-disc brake). The travel motor is driven by pressure oil from the pump and transmits its rotary power to the travel reduction gear.

The travel reduction gear is a three stage reduction planetary gear type, converts rotary power transmitted from the travel motor to slow large torque and rotates the sprocket and track. The travel brake valve protects the travel circuit from being overloaded and prevents the occurrence of cavitation.

ZAXIS160LC-3, ZAXIS180LCN-3



ZAXIS180LC-3



COMPONENT OPERATION / Travel Device

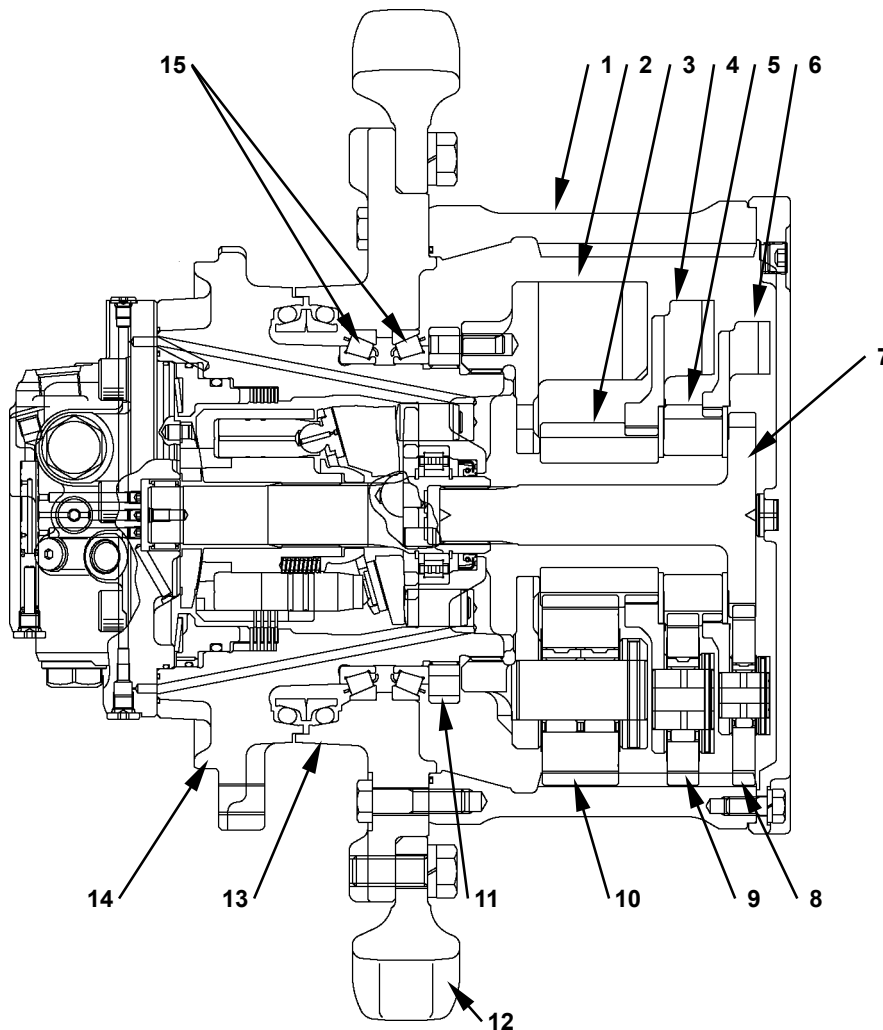
TRAVEL REDUCTION GEAR

The travel reduction gear is a three-stage reduction planetary gear type.

The travel motor rotates propeller shaft (7). This rotation is transmitted to ring gear (1) via first stage planetary gear (8), first stage carrier (6), second stage sun gear (5), second stage planetary gear (9), second stage carrier (4), third stage sun gear (3) and third stage planetary gear (10).

Housing (14) in the travel motor is bolted to the track frame and is secured to drum (13) via bearing (15) by bearing nut (11). Housing (14) is also splined to third stage carrier (2). Ring gear (1) is bolted to drum (13) and sprocket (12). Accordingly, when ring gear (1) is rotated, drum (13) and sprocket (12) are also rotated.

ZAXIS160LC-3, ZAXIS180LCN-3

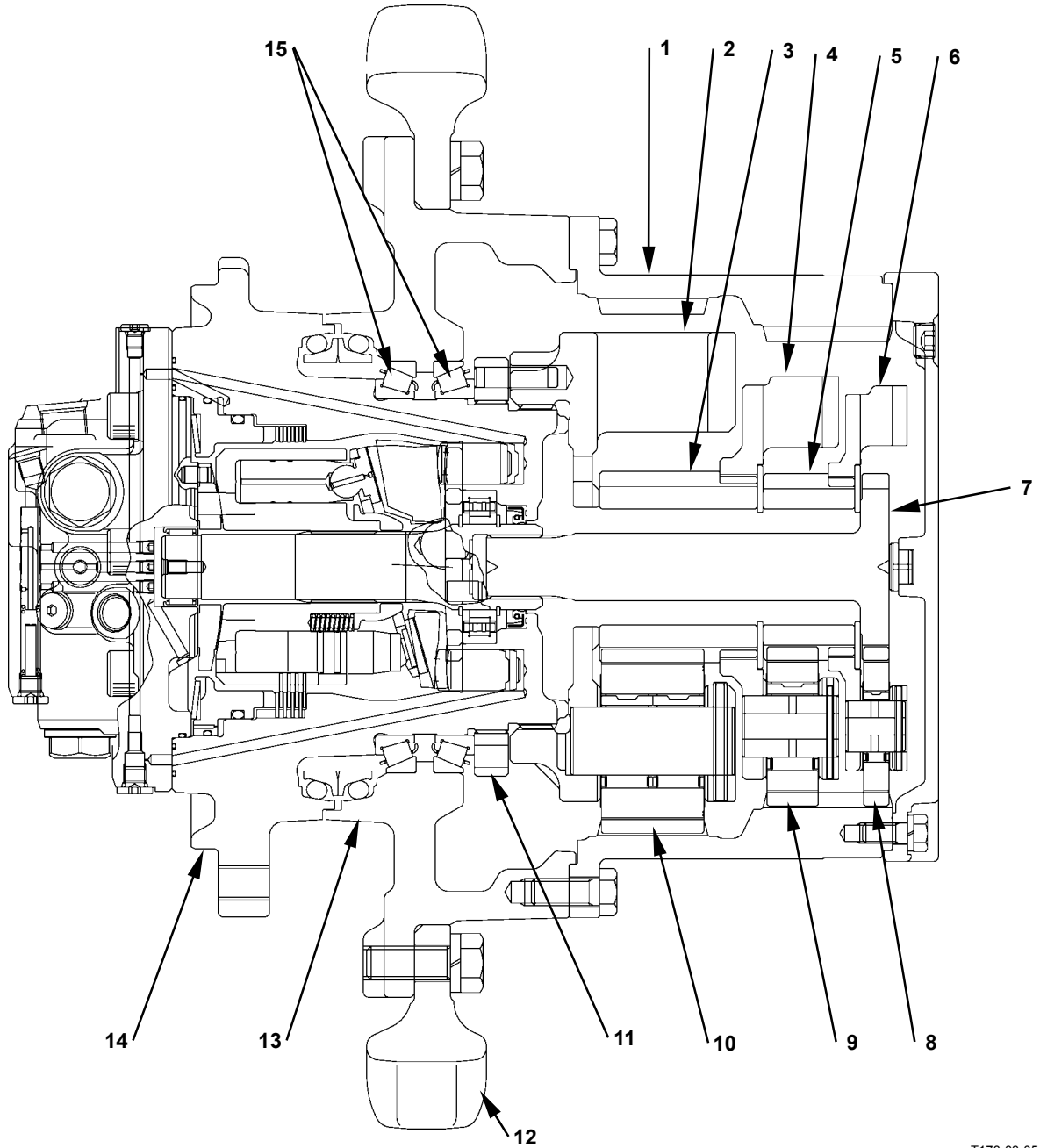


T1F1-03-05-101

- | | | | |
|--------------------------|--------------------------------|---------------------------------|--------------|
| 1 - Ring Gear | 5 - Second Stage Sun Gear | 9 - Second Stage Planetary Gear | 13 - Drum |
| 2 - Third Stage Carrier | 6 - First Stage Carrier | 10 - Third Stage Planetary Gear | 14 - Housing |
| 3 - Third Stage Sun Gear | 7 - Propeller Shaft | 11 - Bearing Nut | 15 - Bearing |
| 4 - Second Stage Carrier | 8 - First Stage Planetary Gear | 12 - Sprocket | |

COMPONENT OPERATION / Travel Device

ZAXIS180LC-3



T178-03-05-001

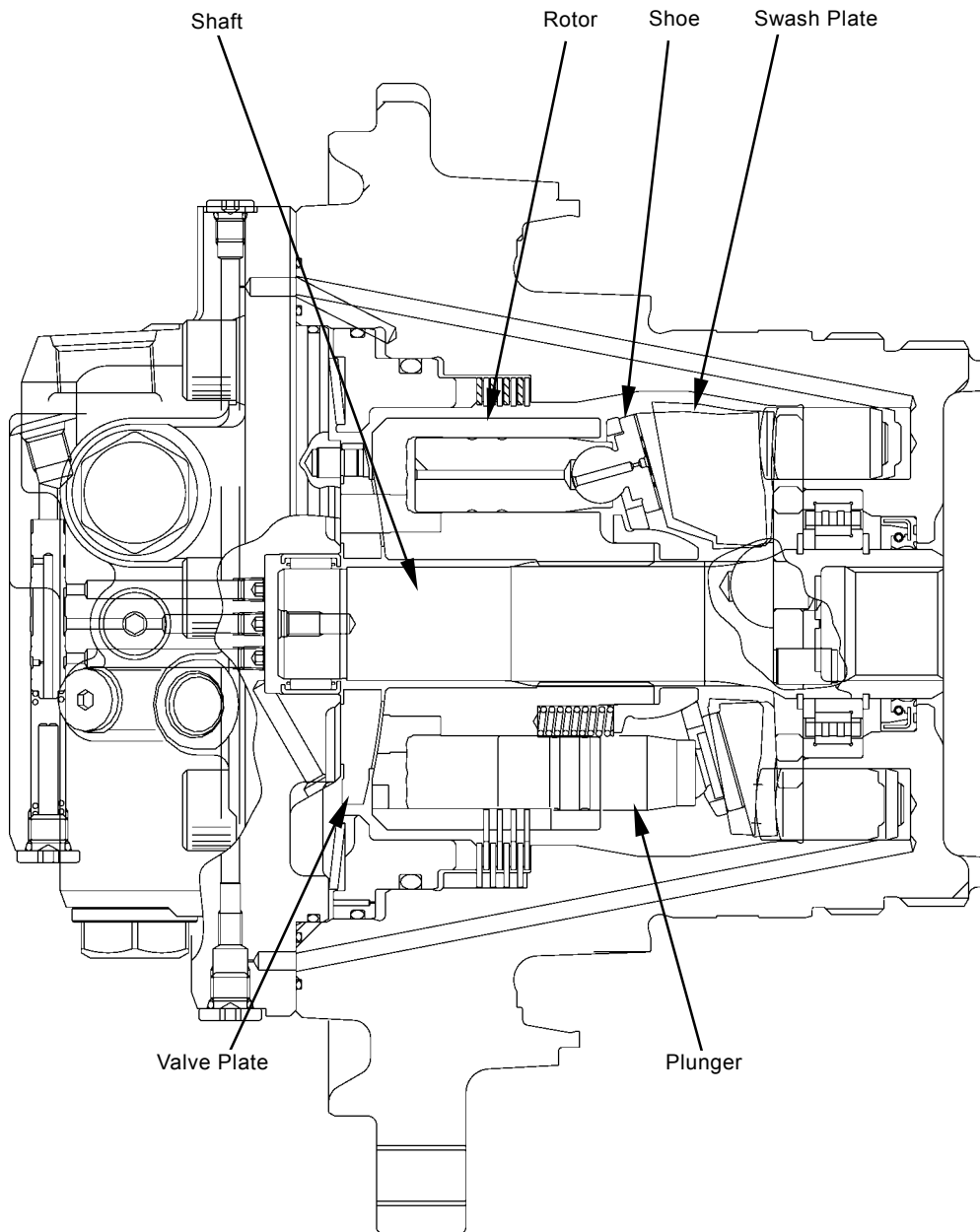
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|--------------------------|--------------------------------|---------------------------------|--------------|
| 1 - Ring Gear | 5 - Second Stage Sun Gear | 9 - Second Stage Planetary Gear | 13 - Drum |
| 2 - Third Stage Carrier | 6 - First Stage Carrier | 10 - Third Stage Planetary Gear | 14 - Housing |
| 3 - Third Stage Sun Gear | 7 - Propeller Shaft | 11 - Bearing Nut | 15 - Bearing |
| 4 - Second Stage Carrier | 8 - First Stage Planetary Gear | 12 - Sprocket | |

COMPONENT OPERATION / Travel Device

TRAVEL MOTOR

The travel motor is a swash plate type variable displacement axial plunger motor and consists of valve plate, swash plate, rotor, plunger and shaft. The shaft is splined to the rotor, in which the plungers are inserted. When pressure oil is supplied from the pump, the plungers are pushed.

The shoes on top of plungers slide along the swash plate surface due to inclination of the swash plate and the rotor rotates.



T178-03-05-002

COMPONENT OPERATION / Travel Device

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COMPONENT OPERATION / Travel Device

PARKING BRAKE

The parking brake is a wet-type multi disc brake. The brake is a negative type so that it is released only when the brake release pressure oil is routed into the brake piston chamber. The parking brake is automatically applied unless the travel function is operated. The friction plates and plates are splined to the housing in travel motor and rotor respectively.

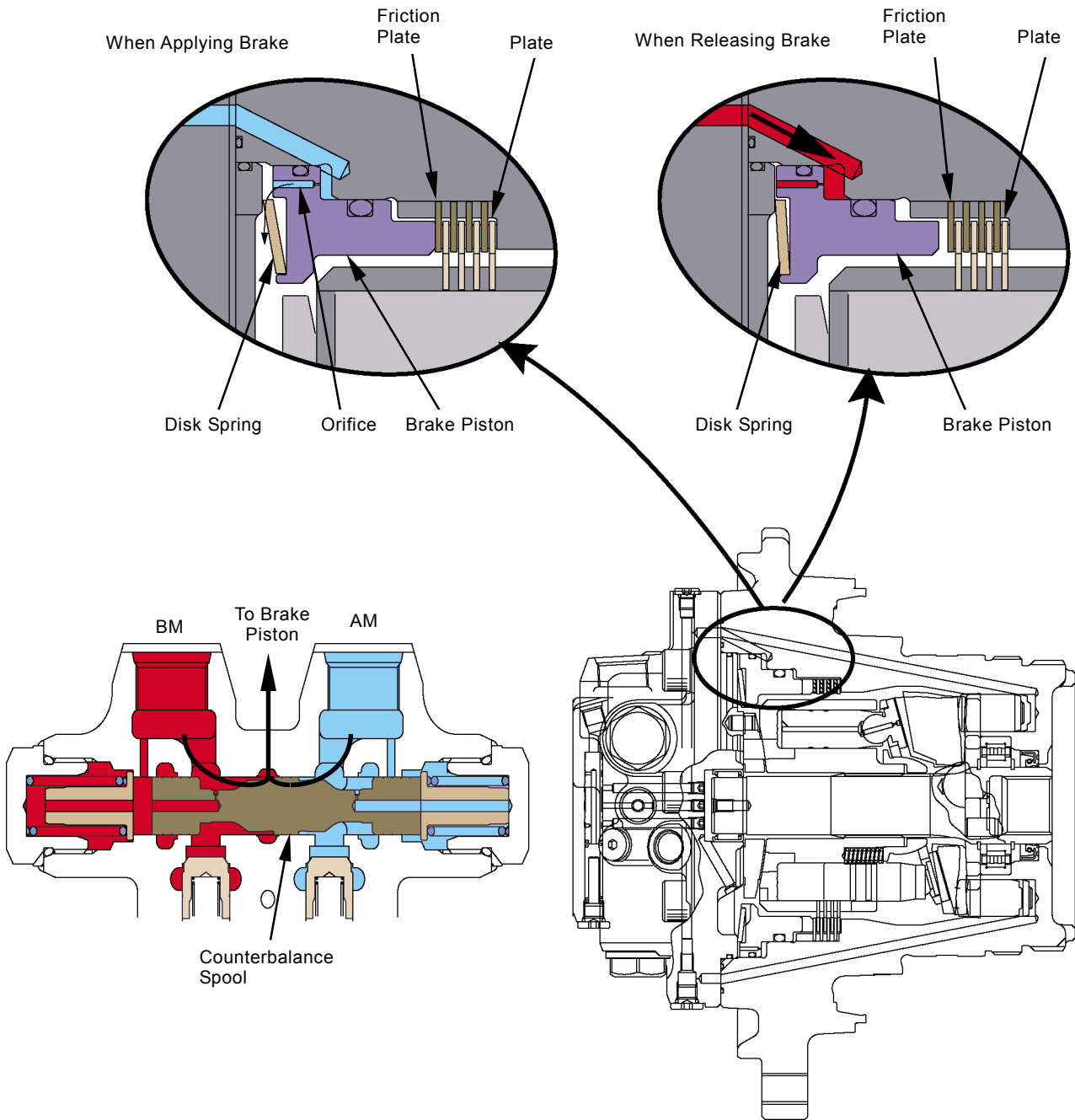
Releasing Brake

1. When the travel lever is operated, pressure oil from the main pump is routed to port AM or BM in the travel motor through the control valve.
2. This pressure oil shifts the counterbalance valve spool in travel brake valve and acts on the brake piston through the notch on spool.
3. Consequently, as the brake piston is pushed, the plates and friction plates become free each other so that the brake is released.

Applying Brake

1. When the travel lever is returned to neutral, the counterbalance valve spool in the travel brake valve is returned to neutral.
2. As pressure oil acting on the brake piston is returned to the drain circuit from the orifice of brake piston, the brake piston is slowly pushed back by the disc spring.
3. Consequently, spring force is applied to the plates engaging on the outer diameter of rotor and the friction plates engaging on the inner diameter of motor housing via the brake piston, and the rotor outer diameter is secured by friction force.

COMPONENT OPERATION / Travel Device




T178-03-05-008

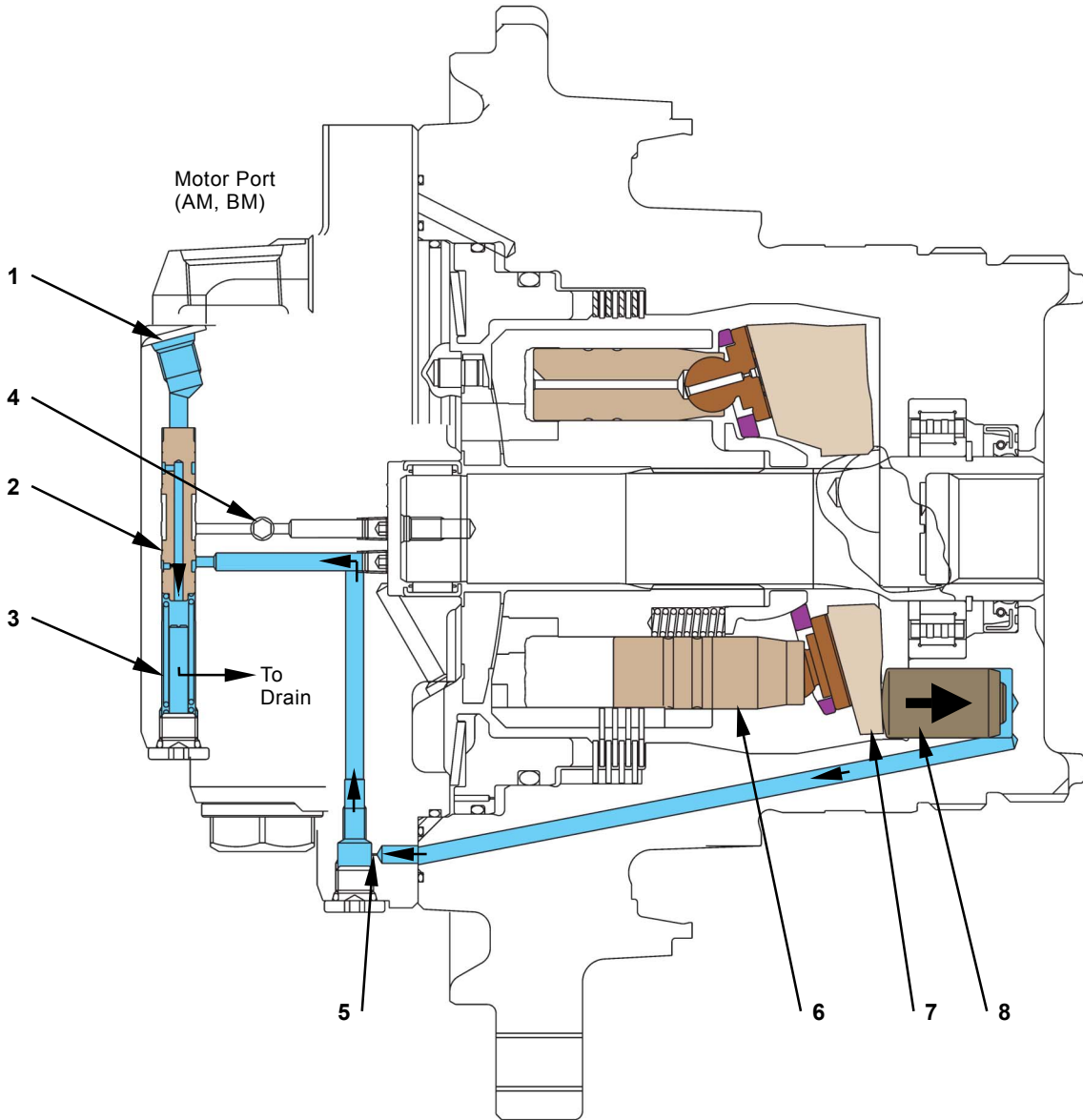
COMPONENT OPERATION / Travel Device

TRAVEL MODE CHANGE

The tilt angle of swash plate (7) is changed by piston (8) movement in order to select the travel mode.

- Slow Speed Mode 
 1. When the travel mode switch is in the SLOW position, MC (main controller) does not send the signals to solenoid valve unit (SI) so that pilot pressure is not routed to pilot port (1). Spool (2) is kept raised by spring (3).
 2. Therefore, piston (8) is not acted by pressure oil and secured at the maximum swash angle.
 3. Thereby, the plunger (6) stroke is increased and the travel motor rotates at slow speed.


COMPONENT OPERATION / Travel Device



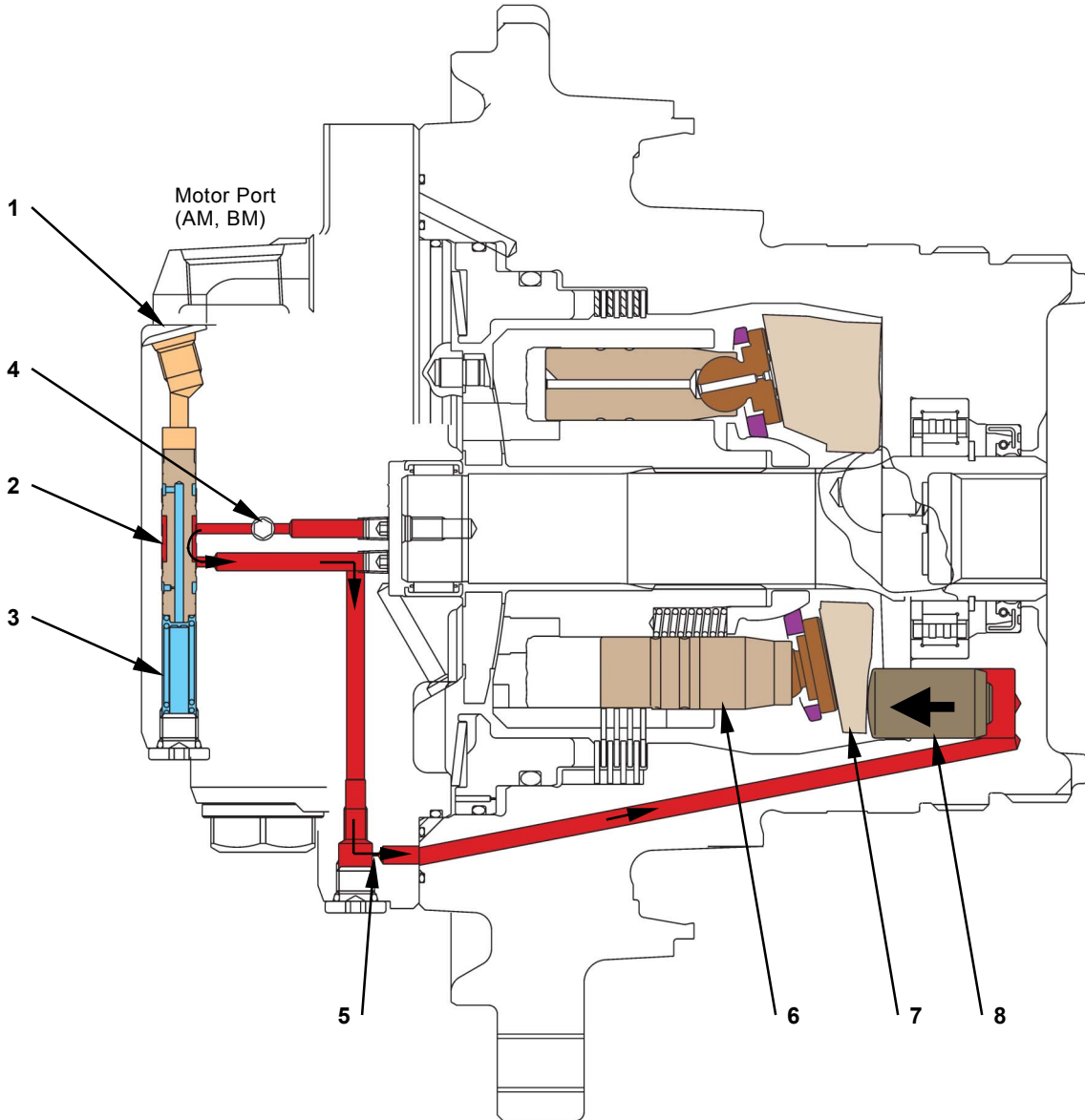
T178-03-05-010

- | | | | |
|----------------|--|-------------------------------------|-----------------|
| 1 - Pilot Port | 3 - Spring | 5 - Orifice (for Fast / Slow Speed) | 7 - Swash Plate |
| 2 - Spool | 4 - Shuttle Valve for Piston Operation | 6 - Plunger | 8 - Piston |

COMPONENT OPERATION / Travel Device

- Fast Speed Mode 
 1. When the travel mode switch is in the FAST position, MC sends the signals to solenoid valve unit (SI) in response to travel loads. (Refer to "Travel Motor Swash Angle Control" / SYSTEM / Control System.)
 2. Pilot pressure is routed from pilot port (1) and moves spool (2) downward.
 3. Pressure oil in high-pressure motor port (AM or BM) acts on piston (8) through orifice (5).
 4. Piston (8) pushes swash plate (7) so that the swash angle of swash plate (7) is reduced. Thereby, as the plunger (6) stroke is reduced, the travel motor rotates at fast speed.

COMPONENT OPERATION / Travel Device



T178-03-05-011

- | | | | |
|----------------|--|-----------------------------------|-----------------|
| 1 - Pilot Port | 3 - Spring | 5 - Orifice (for Fast/Slow Speed) | 7 - Swash Plate |
| 2 - Spool | 4 - Shuttle Valve for Piston Operation | 6 - Plunger | 8 - Piston |

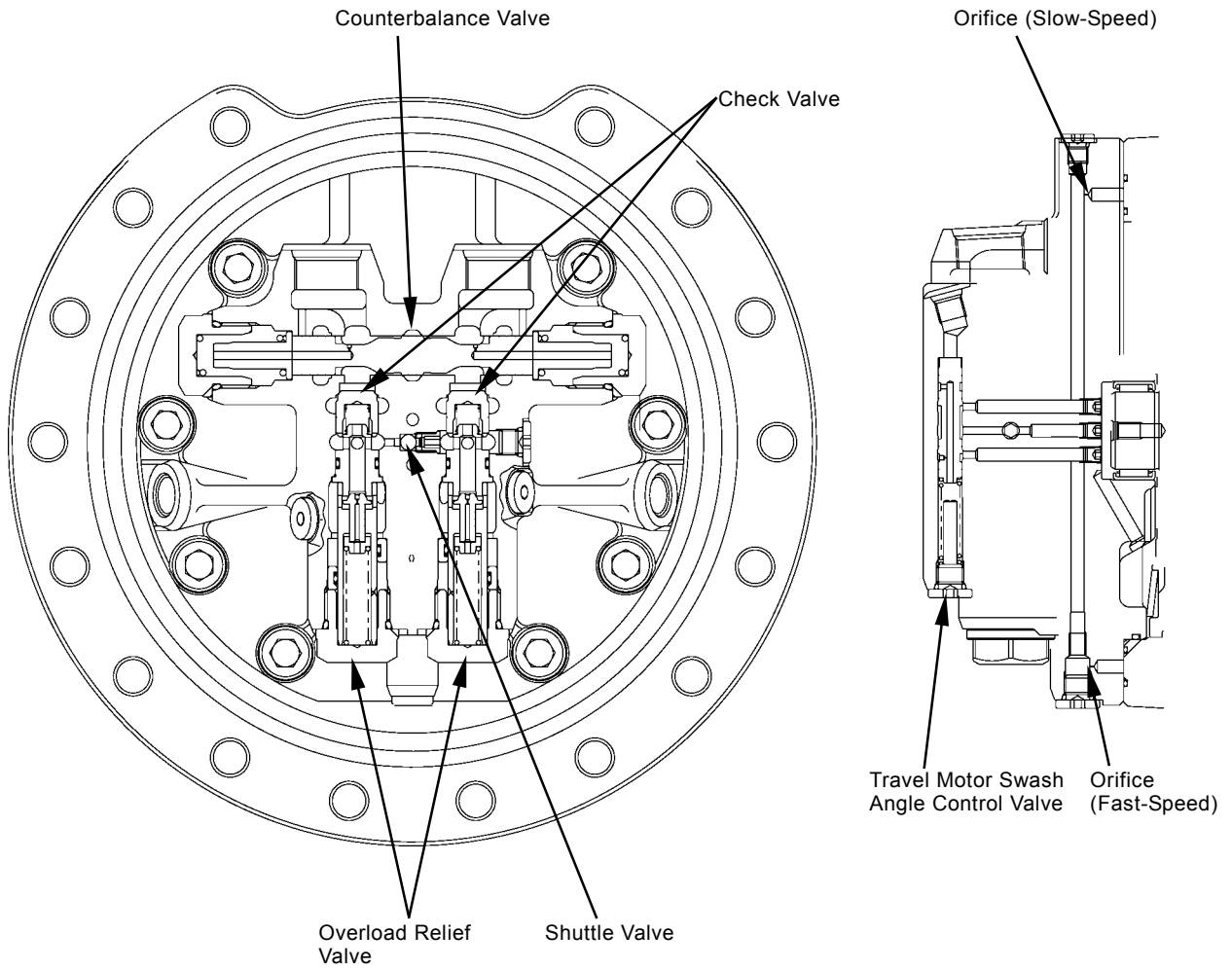
COMPONENT OPERATION / Travel Device

TRAVEL BRAKE VALVE

The travel brake valve is located on the travel motor head and consists of the following valves.

- Counterbalance Valve:
Makes starting and stopping travel operations smooth and prevents the machine from running away while descending slopes. Routes the travel motor operating pressure oil in high pressure port (AV or BV) to the parking brake.
- Check Valve:
Assists the counterbalance valve operation and prevents cavitation in the motor circuit.
- Overload Relief Valve:
Prevents the occurrence of overload and surge pressure in the motor circuit and reduces shock loads developed when stopping travel operation.
- Shuttle Valve:
Routes the travel motor operating high pressure oil in high pressure port (AM or BM) to the slow or fast side piston so that the piston is controlled.
- Travel Motor Swash Angle Control Valve:
Delivers pressure oil routed by the shuttle valve for piston operation to the piston through the orifice (for slow / fast speed).
- Orifice:
Makes the travel mode change (swash plate angle control) smooth.

COMPONENT OPERATION / Travel Device



T178-03-05-003

COMPONENT OPERATION / Travel Device

While Traveling:

1. When pressure oil from the control valve flows to port BV (8), pressure oil flows around the outer diameter of spool (9), unseats check valve BC (7) and flows further to motor port BM (6).
2. On the other hand, return oil from the travel motor is routed to motor port AM (4). However, its passage is blocked by check valve AC (3) and spool (9).
3. When pressure in port BV (8) increases further, pressure oil is routed into chamber B (10) through orifice (f) in spool (9) and moves spool (9) to the right.
4. Consequently, return oil from the travel motor flows to port AV (1) through notch (h) on spool (9). Then, pressure oil is allowed to flow so that the travel motor starts rotating.
5. When the travel lever is returned to neutral, spool (9) is returned to the original position by spring force and blocks the oil passage so that the travel motor rotation is stopped.

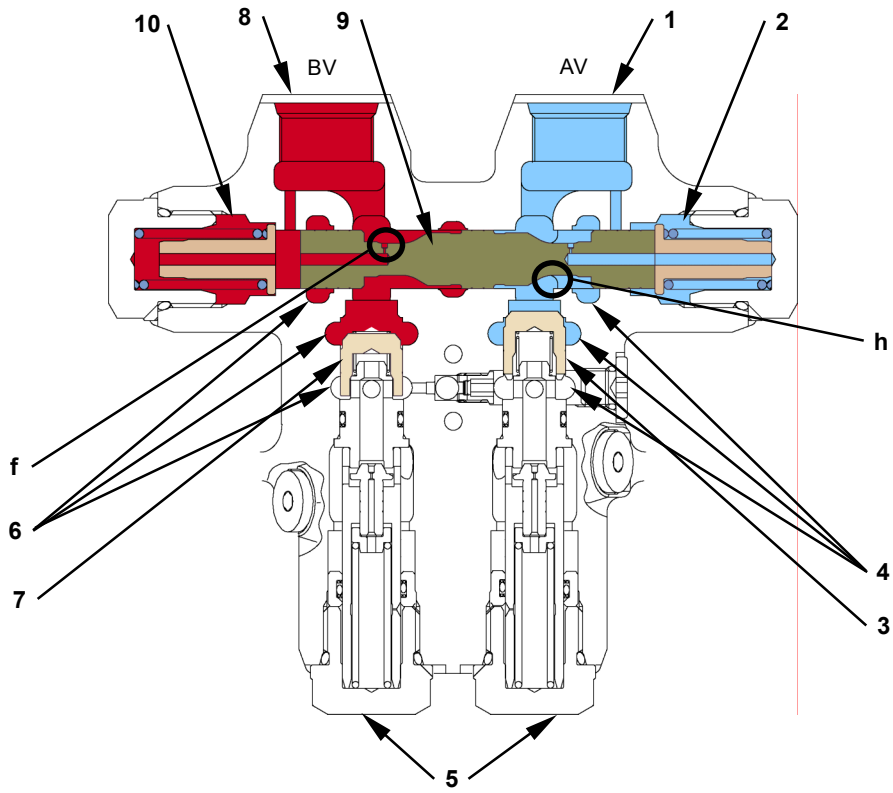
While Descending:

1. While descending a slope, the travel motor is forcibly rotated by the machine weight so that the motor operates like a pump.
2. If the travel motor draws oil, oil pressure in port BV (8) and chamber B (10) decrease, spool (9) moves to the left so that return oil from the travel motor is restricted.
3. Therefore, pressure in motor port AM (4) increases and brakes the travel motor.
4. Once pressure oil is restricted, pressure in motor port BV (8) increases again and moves spool (9) to the right. As this operation (hydraulic braking operation) is repeated, the machine is prevented from running away.

Circuit Protection Operation:

1. When pressure in the circuit increases over the set-pressure of overload relief valve (5), overload relief valve (5) 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, overload relief valve (5) relieves the shock loads developed due to inertia force when stopping the travel motor.
3. If the travel motor draws oil like a pump, check valve BC (7) is unseated (make-up operation) so that cavitation is prevented.

COMPONENT OPERATION / Travel Device



T178-03-05-006

- | | | | |
|--------------------|---------------------------|--------------------|----------------------------------|
| 1 - Port AV | 4 - Motor Port AM | 7 - Check Valve BC | 9 - Spool (Counterbalance Valve) |
| 2 - Chamber A | 5 - Overload Relief Valve | 8 - Port BV | 10 - Chamber B |
| 3 - Check Valve AC | 6 - Motor Port BM | | |

COMPONENT OPERATION / Travel Device

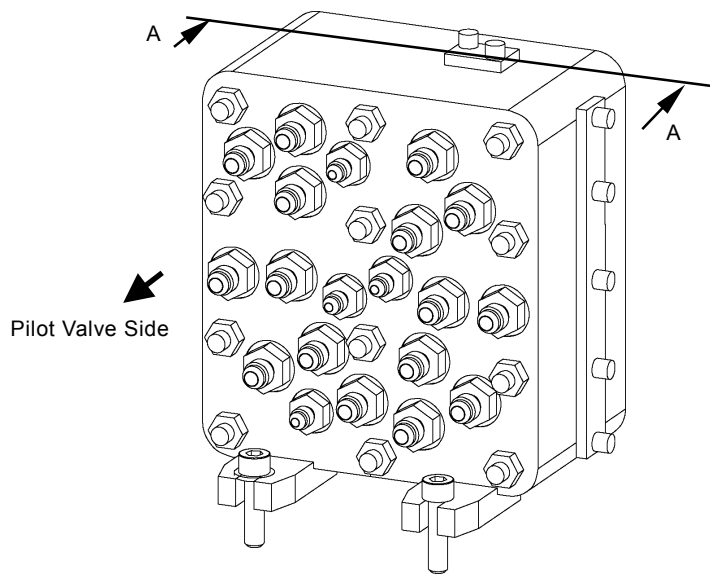
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COMPONENT OPERATION / Signal Control Valve

OUTLINE

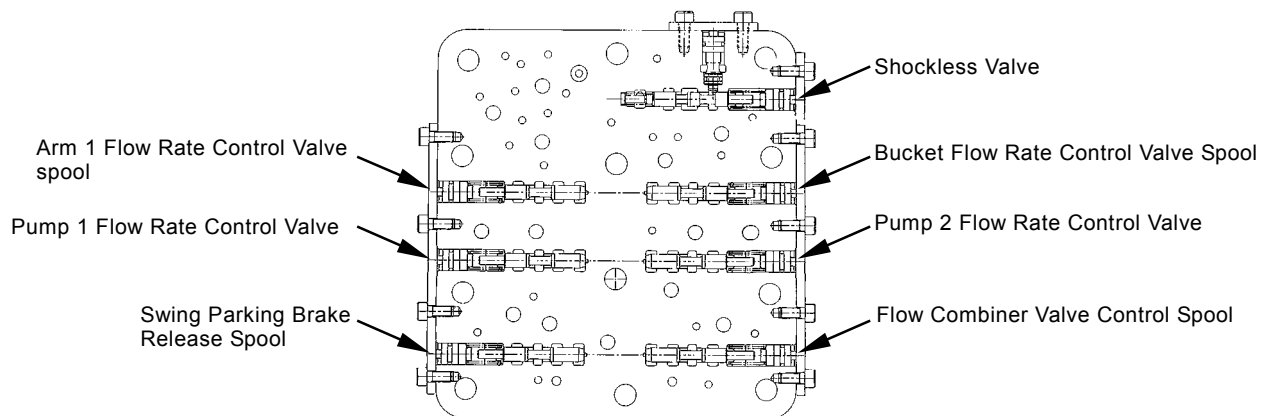
The signal control valve is provided in the pilot circuit between the pilot valve and control valve, and controls pilot signal pressure to regulate the pumps and various kinds of valves.

The major components of signal control valve are shuttle valve, shockless valve, pump 1 flow rate control valve, pump 2 flow rate control valve, flow combiner valve spool, bucket flow rate control valve spool, swing parking brake release spool and arm 1 flow rate control valve spool.



T178-03-06-016

Cross Section A-A



T178-03-06-002

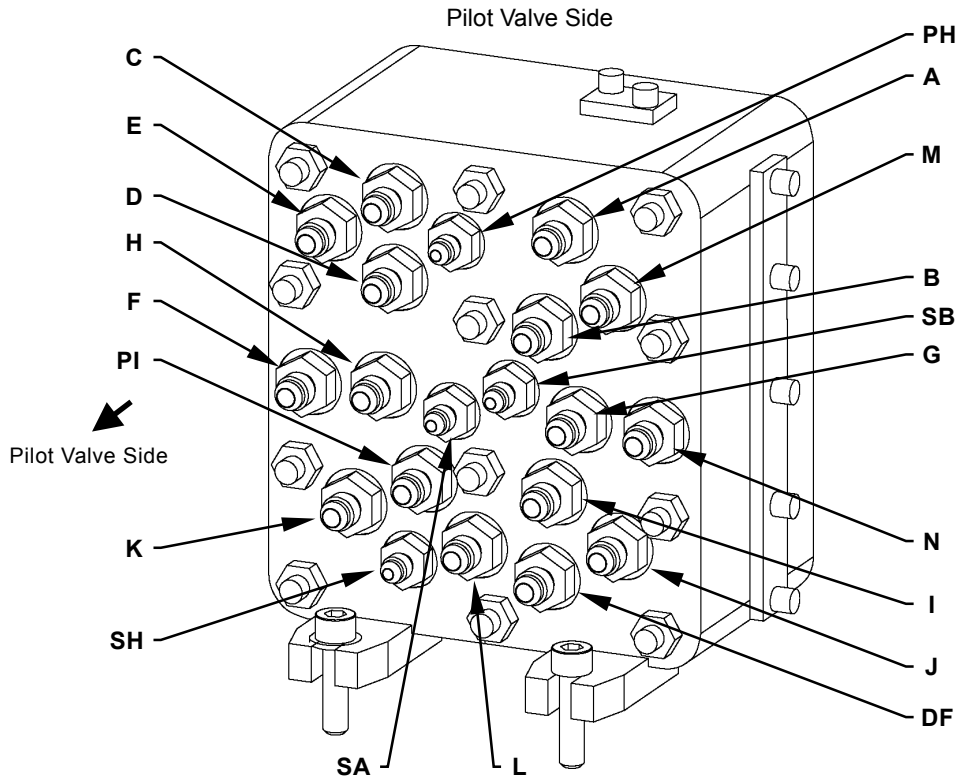
COMPONENT OPERATION / Signal Control Valve

PILOT PORT

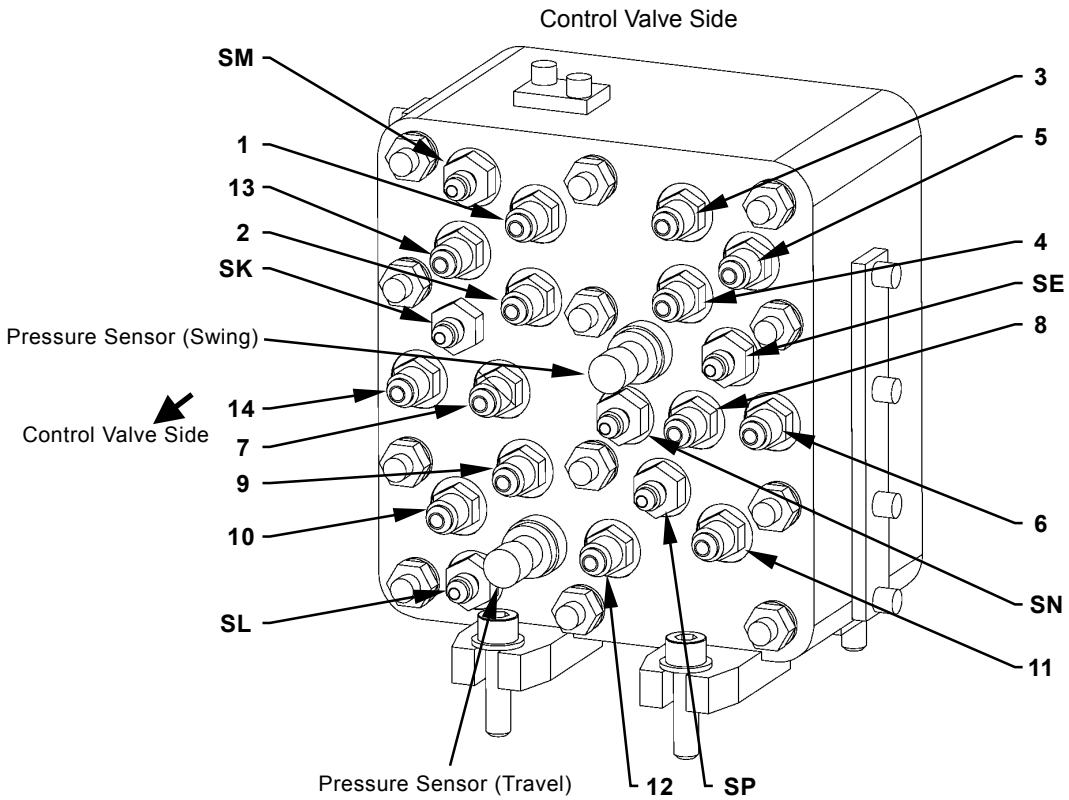
Pilot Valve Side

Port Name	Connecting to	Remark
Port A	Right Pilot Valve	Boom Raise Pilot Pressure
Port B	Right Pilot Valve	Boom Lower Pilot Pressure
Port C	Left Pilot Valve	Arm Roll-Out Pilot Pressure
Port D	Left Pilot Valve	Arm Roll-In Pilot Pressure
Port E	Left Pilot Valve	Left Swing Pilot Pressure
Port F	Left Pilot Valve	Right Swing Pilot Pressure
Port G	Right Pilot Valve	Bucket Roll-In Pilot Pressure
Port H	Right Pilot Valve	Bucket Roll-Out Pilot Pressure
Port I	Travel Pilot Valve	Left Travel Forward Pilot Pressure
Port J	Travel Pilot Valve	Left Travel Reverse Pilot Pressure
Port K	Travel Pilot Valve	Right Travel Forward Pilot Pressure
Port L	Travel Pilot Valve	Right Travel Reverse Pilot Pressure
Port M	Auxiliary Pilot Valve	Auxiliary Open Pilot Pressure
Port N	Auxiliary Pilot Valve	Auxiliary Close Pilot Pressure
Port SA	Pump 1 Regulator	Pump 1 Control Pressure
Port SB	Pump 2 Regulator	Pump 2 Control Pressure
Port PI	Pilot Shut-Off Valve	Primary Pilot Pressure
Port PH	-	Plug
Port SH	Swing Parking Brake	Brake Release Pressure
Port DF	Hydraulic Oil Tank	Returning to Hydraulic Oil Tank

COMPONENT OPERATION / Signal Control Valve



T178-03-06-016



T178-03-06-015

COMPONENT OPERATION / Signal Control Valve

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

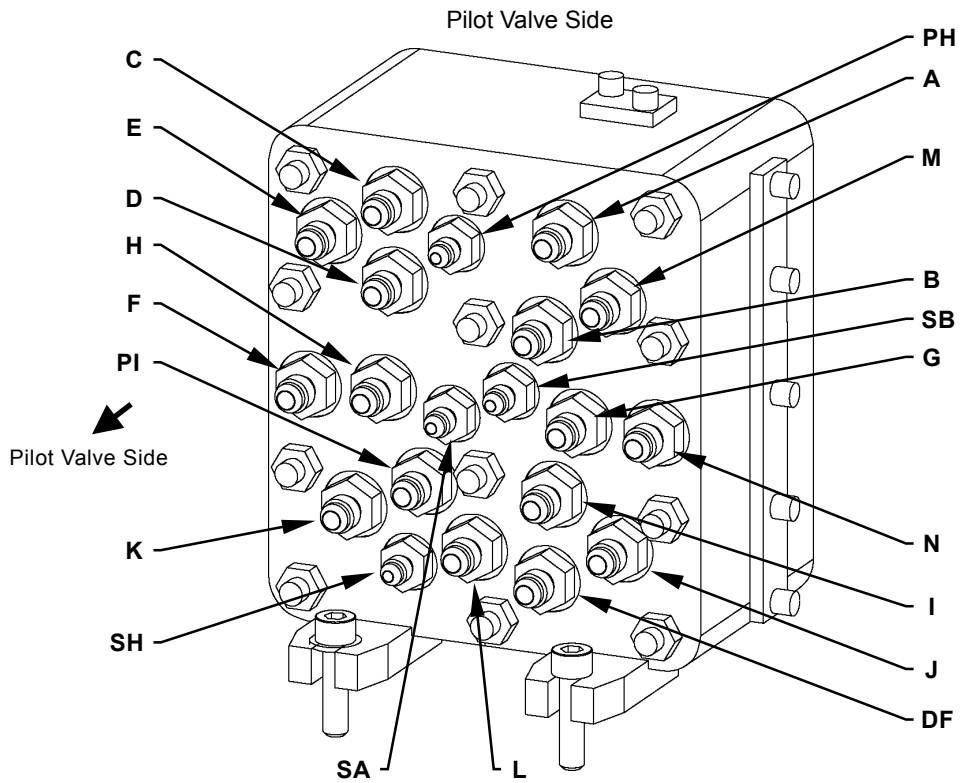
2-Piece Boom Specification Machine

Port SP	Positioning Pilot Valve	Secondary Pilot Pressure
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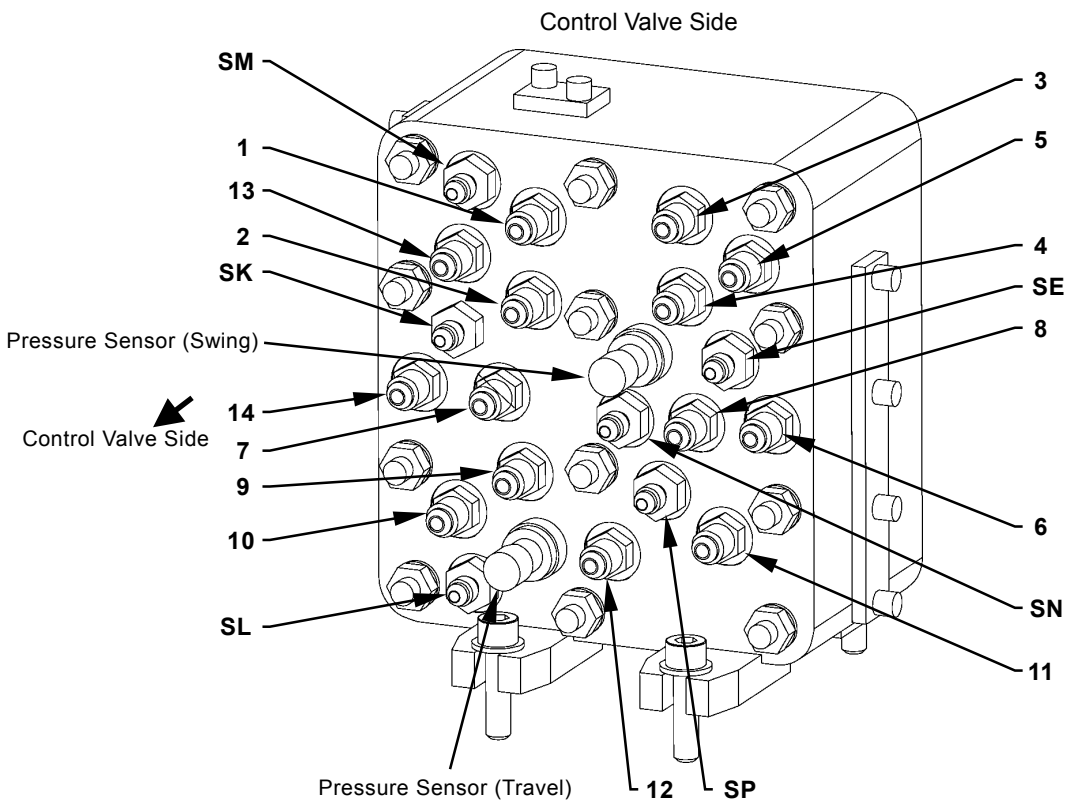
Machine with Front Attachment (Secondary Crushers 1 to 5 and Hydraulic Crushers 1 to 5) attached.

Port SM	Auxiliary Flow Rate Combiner Solenoid Valve	Auxiliary Flow Rate Combiner Valve Control Pressure
Port SN	Auxiliary Flow Rate Combiner Control Valve	Auxiliary Flow Rate Combiner Valve Control Pressure
Port SP	Auxiliary Flow Rate Combiner Solenoid Valve	Pump 1 Control Pressure

COMPONENT OPERATION / Signal Control Valve



T178-03-06-016




T178-03-06-015

COMPONENT OPERATION / Signal Control Valve

SHUTTLE VALVE

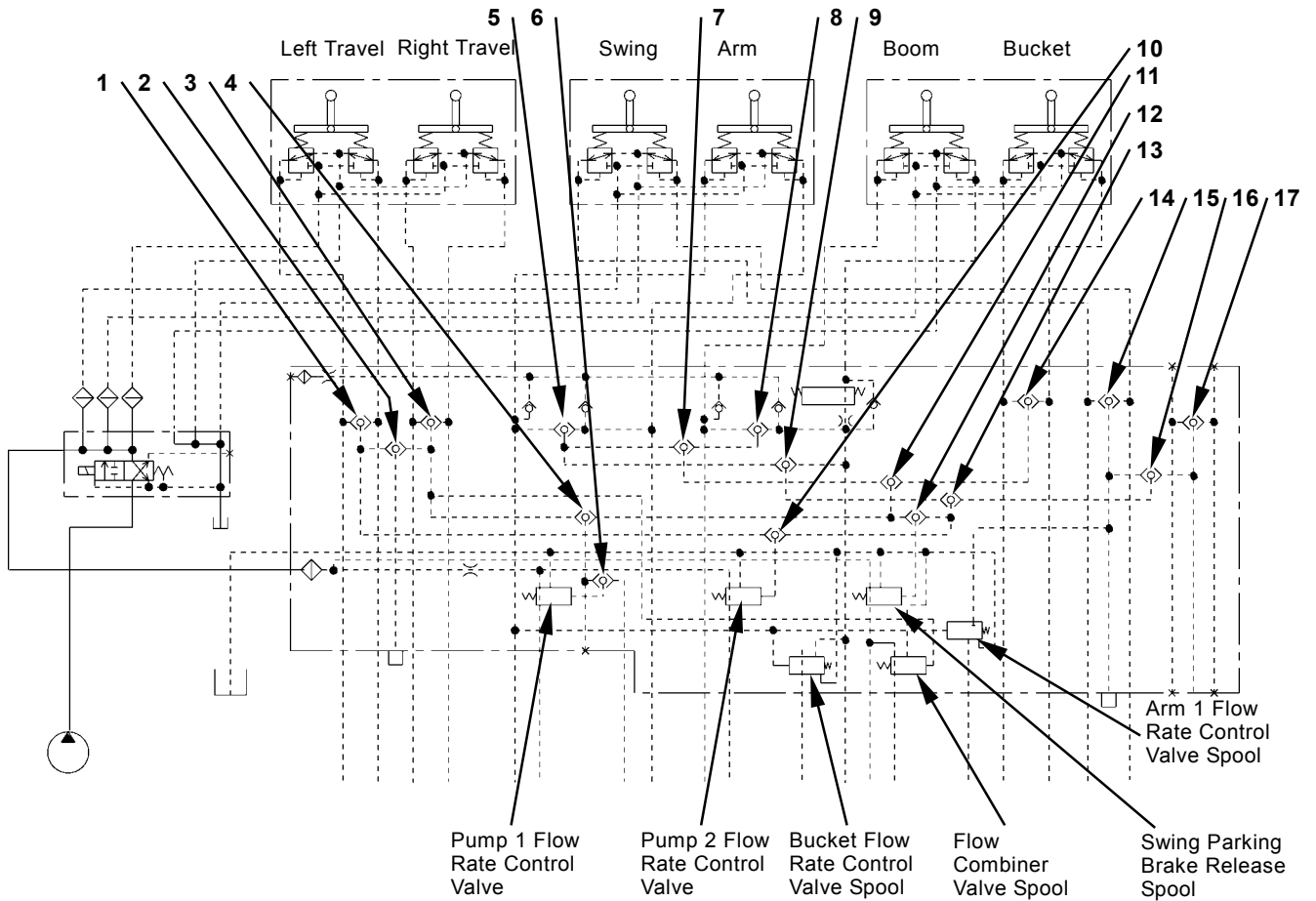
The shuttle valve selects pilot pressure oil to perform each operation and routes pilot pressure to the corresponding flow rate control valves and/or switch valve spools. The flow rate control valves and/or switch valve spools corresponding to each operation are as follows:

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

 **NOTE:** *As for the match with front attachment (secondary crushers 1 to 5 and hydraulic crushers 1 to 5) attached, the pump 1 flow rate control valve is operated by pressure from the auxiliary pilot valve.

COMPONENT OPERATION / Signal Control Valve

Monoblock Boom / STD Specification

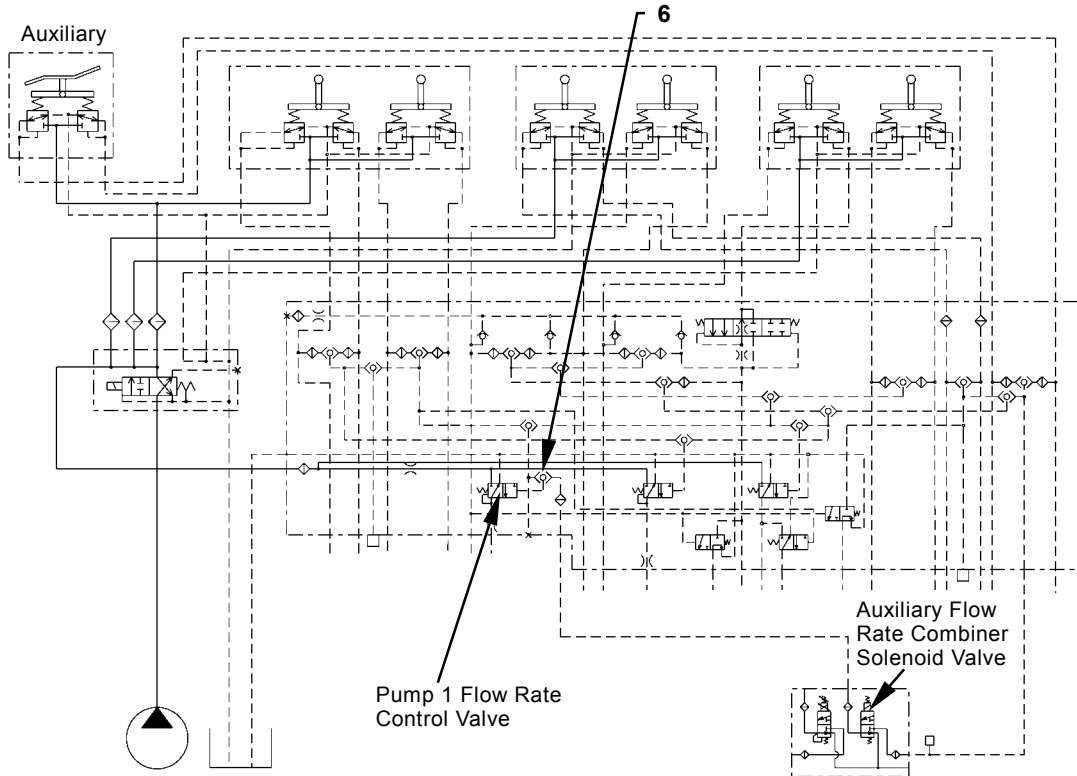


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- | | | | |
|--|--|--|------------------------|
| 1 - Left Travel | 6 - Boom / Arm / Bucket / Right Travel / Auxiliary / Positioning | 11 - Boom / Arm / Bucket | 16 - Swing / Auxiliary |
| 2 - Left Travel/Right Travel | 7 - Boom / Arm | 12 - Boom / Arm / Bucket / Swing / Auxiliary | 17 - Auxiliary |
| 3 - Right Travel | 8 - Boom | 13 - Arm / Boom Raise / Swing / Auxiliary | |
| 4 - Boom / Arm / Bucket / Right Travel | 9 - Arm / Boom Raise | 14 - Bucket | |
| 5 - Arm | 10 - Boom Raise / Arm / Left Travel / Swing | 15 - Swing | |

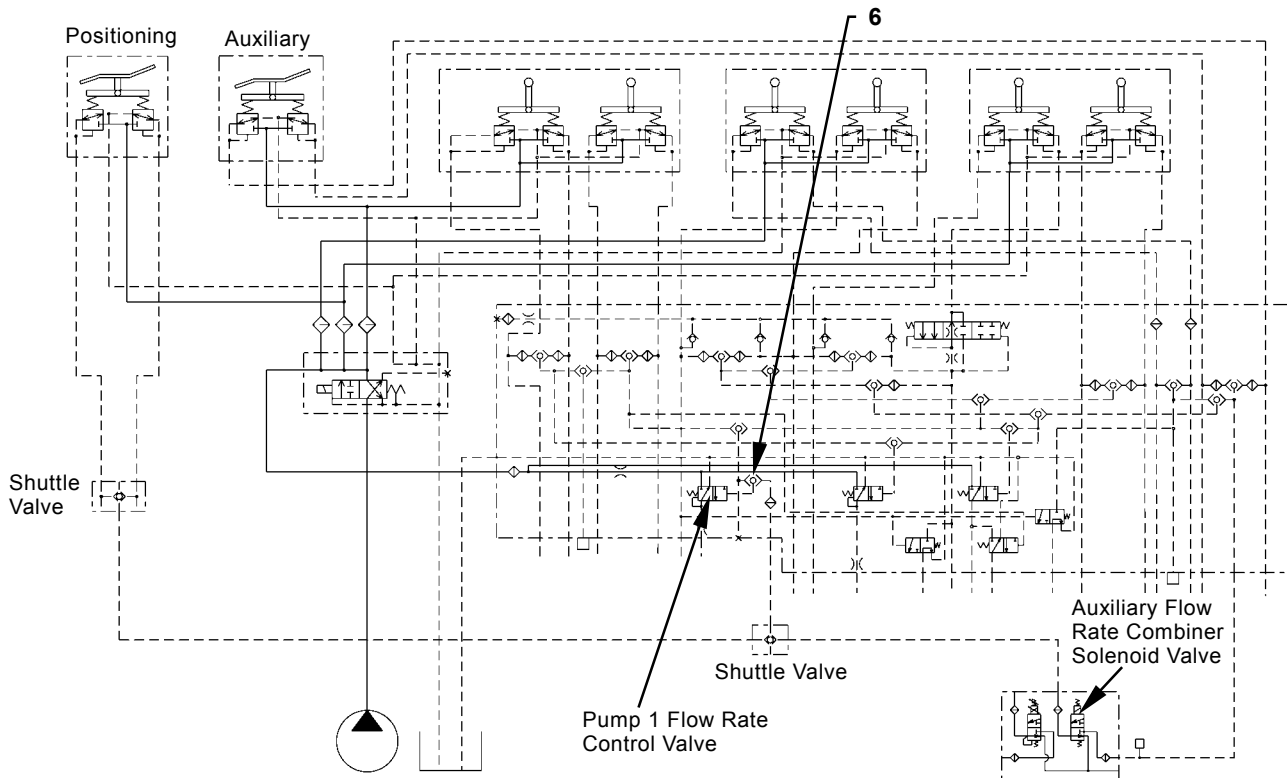
COMPONENT OPERATION / Signal Control Valve

Machine with Monoblock Boom and Auxiliary Flow Combining Attached (Optional)



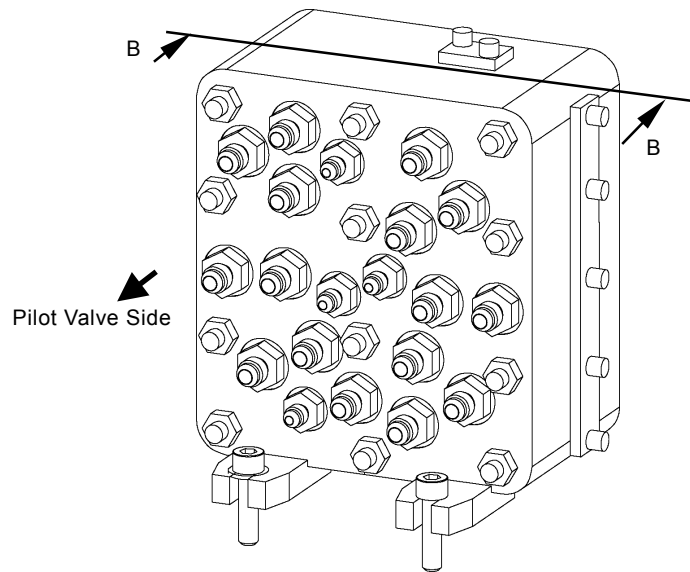
T1V1-03-06-007

Machine with 2-Piece Boom and Auxiliary Combining Attached (Optional)



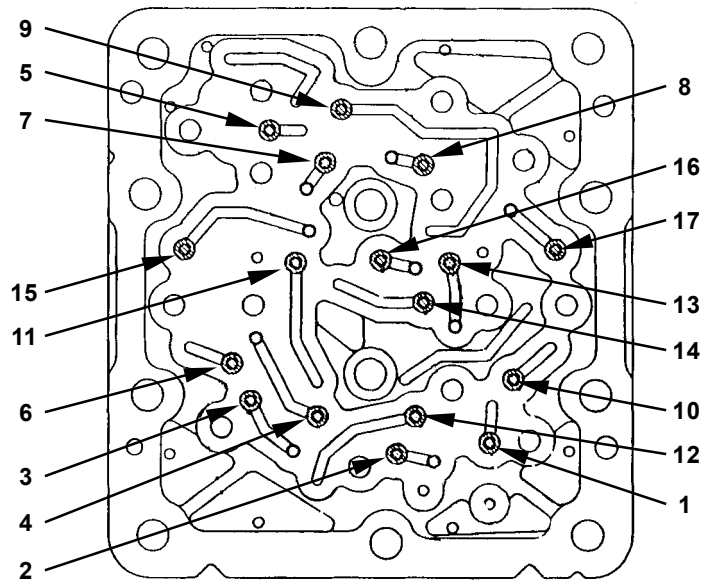
T1V1-03-06-006

COMPONENT OPERATION / Signal Control Valve



T178-03-06-016

Cross Section B-B



T178-03-06-009

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|--|--|--|------------------------|
| 1 - Left Travel | 6 - Boom / Arm / Bucket / Right Travel / Auxiliary / Positioning | 11 - Boom / Arm / Bucket | 16 - Swing / Auxiliary |
| 2 - Left Travel/Right Travel | 7 - Boom / Arm | 12 - Boom / Arm / Bucket / Swing / Auxiliary | 17 - Auxiliary |
| 3 - Right Travel | 8 - Boom | 13 - Arm / Boom Raise / Swing / Auxiliary | |
| 4 - Boom / Arm / Bucket / Right Travel | 9 - Arm / Boom Raise | 14 - Bucket | |
| 5 - Arm | 10 - Boom Raise / Arm / Left Travel / Swing | 15 - Swing | |

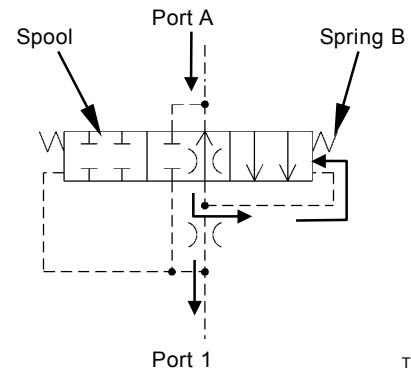
COMPONENT OPERATION / Signal Control Valve

SHOCKLESS VALVE

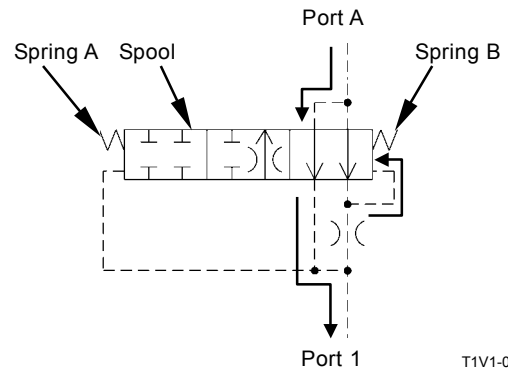
The shockless valve is provided in the boom raise circuit and functions during boom lowering operation.

During Boom Raising Operation:

1. Boom raise pilot pressure oil is routed into port A and acts on the spool.
2. Immediately after operation is started, low pilot pressure oil flows into the spring B chamber through clearance between spool and housing. At the same time, pilot pressure oil flows to port 1 through inner passage 2.
3. When pilot pressure increases, pressure in the spring B chamber increases, and the spool pushes spring A and moves to the left.
4. As the spool is moved, port A is connected to port 1 and pressure in port 1 increase so that the spool in control valve is moved.



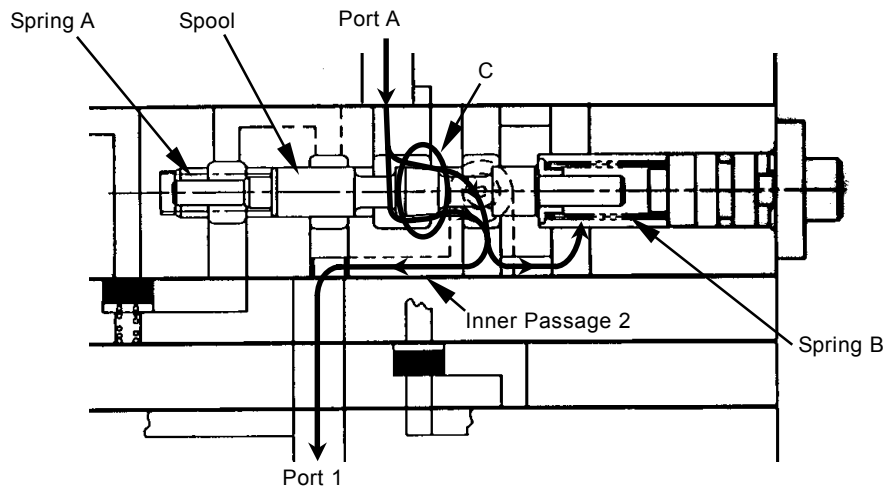
T1V1-03-06-003



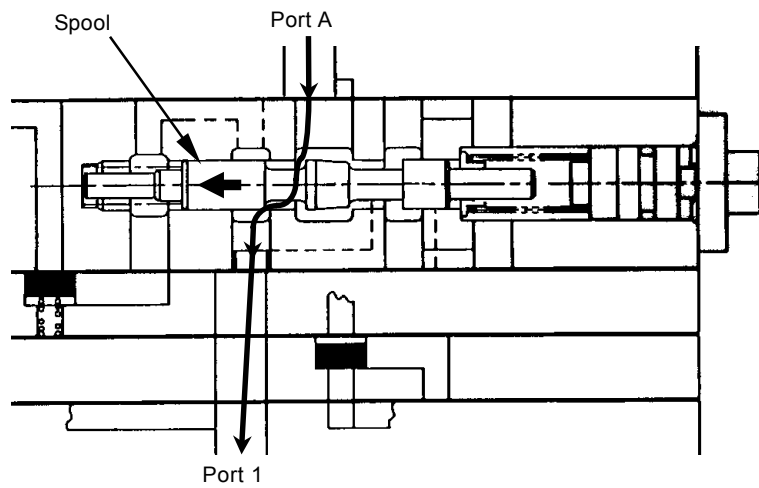
T1V1-03-06-002

COMPONENT OPERATION / Signal Control Valve

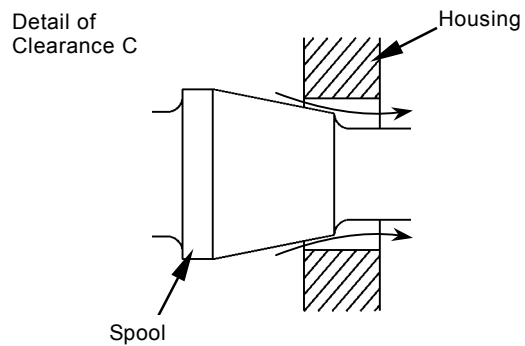
During Boom Raising Operation



T183-03-06-003



T183-03-06-004

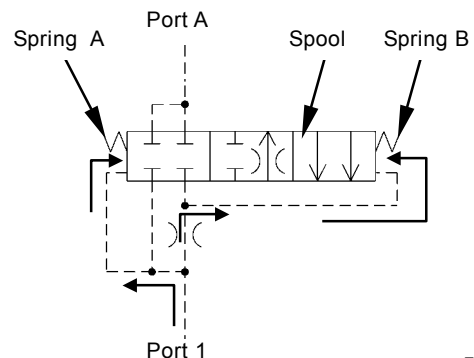


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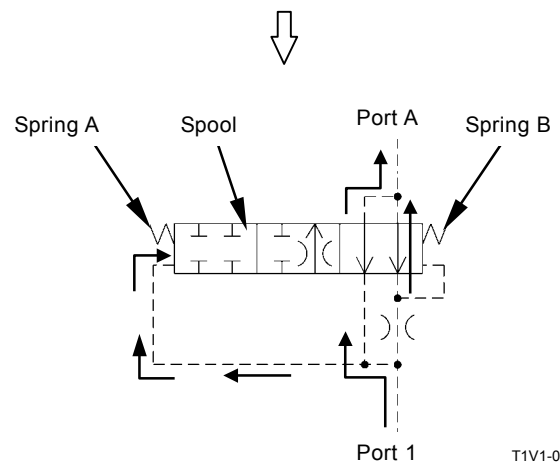
COMPONENT OPERATION / Signal Control Valve

During Boom Lowering Operation (Shock Reducing Operation)

1. When the boom is lowered, the return oil from the boom raise spool in the control valve is routed to port 1.
2. As the spool blocks the oil passage between port 1 and port A, return oil cannot flow directly to port A.
3. Port 1 is connected to the spring A side in spool via inner passage 1 and to the oil chamber via inner passage 2.
4. Pressure oil in the oil chamber flows from clearance C between spool and housing and pressure in the oil chamber decreases. The spool is moved to the right by pressure acting on the spring A side. Thereby, clearance C between the spool and housing is closed and pressure oil is blocked.
5. When clearance C is closed, pressure in the oil chamber increases and the spool moves to the left. Therefore, clearance C is opened again and pressure oil flows to port A.
6. As operations in steps (4 and 5) are repeated, pressure oil is gradually returned to port A so that the control spool returns slowly.



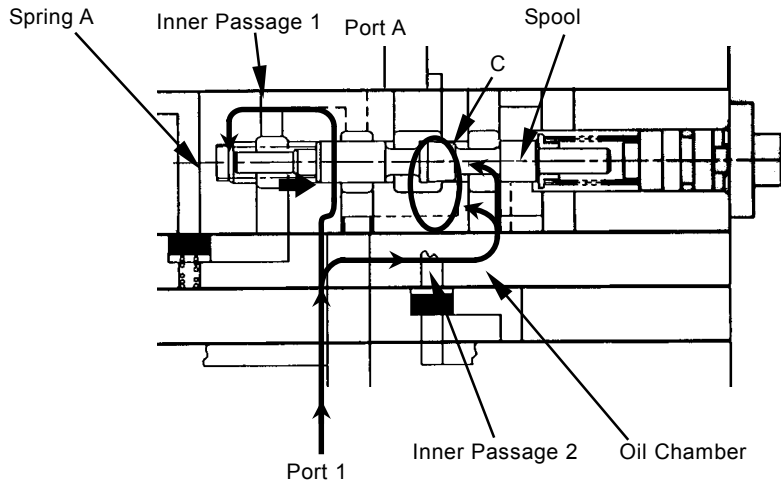
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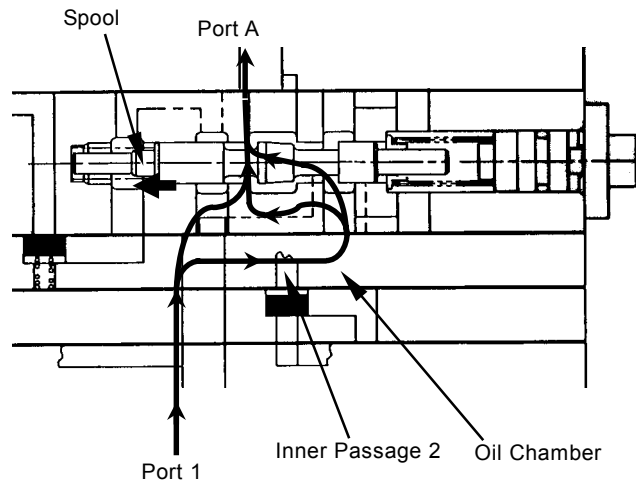
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COMPONENT OPERATION / Signal Control Valve

During Boom Lowering Operation (Shockless Operation)

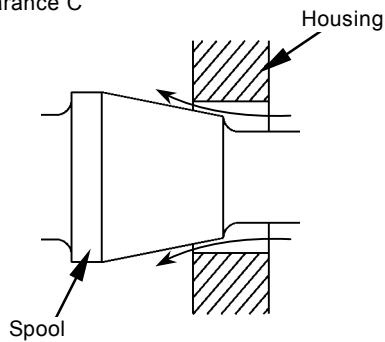


T183-03-06-005



T183-03-06-004

Detail of Clearance C




T1V1-03-06-008

COMPONENT OPERATION / Signal Control Valve

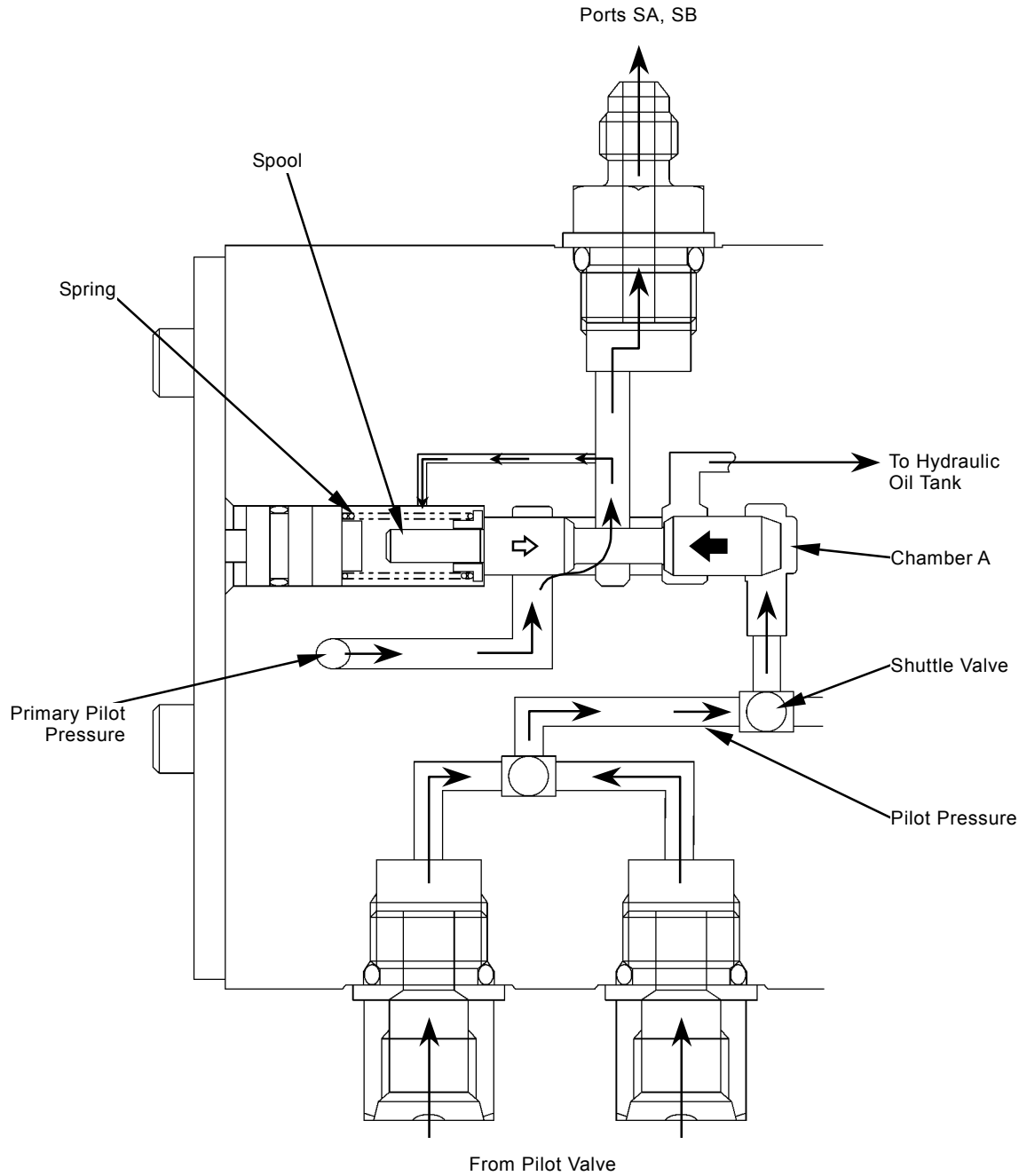
PUMP 1 AND PUMP 2 FLOW RATE CONTROL VALVES

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

1. Pilot oil pressure from the pilot valve is routed into 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.*


COMPONENT OPERATION / Signal Control Valve



T1V1-03-06-005

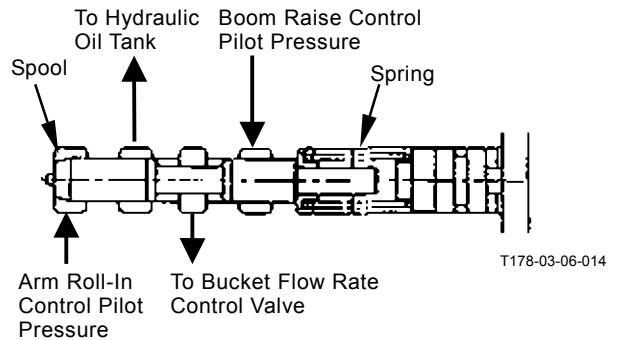
COMPONENT OPERATION / Signal Control Valve

BUCKET FLOW RATE CONTROL VALVE CONTROL SPOOL, FLOW COMBINER VALVE CONTROL SPOOL, SWING PARKING BRAKE RELEASE SPOOL, ARM 1 FLOW RATE CONTROL VALVE CONTROL SPOOL

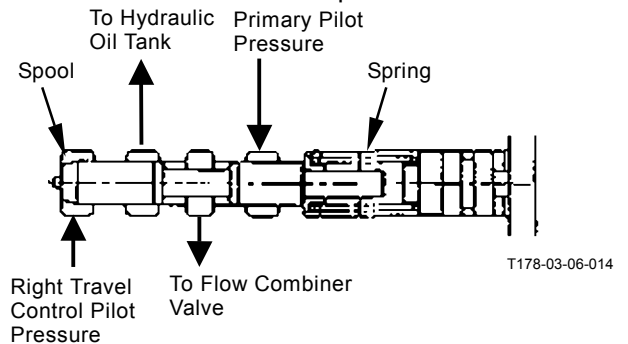
 **NOTE:** The spools above are identical in operational principle.

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 flow combiner valve control spool is shifted by right travel control pilot pressure and supplies primary pilot pressure to the flow combiner valve in control valve.
3. 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.
4. The arm flow rate control valve control spool is shifted and by arm roll-in control pilot pressure and supplies swing control pilot pressure to the arm 1 flow rate control valve in control valve.

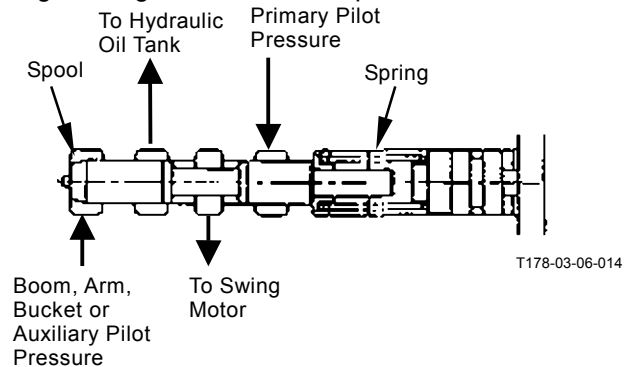
Bucket Flow Rate Control Valve Control Spool:



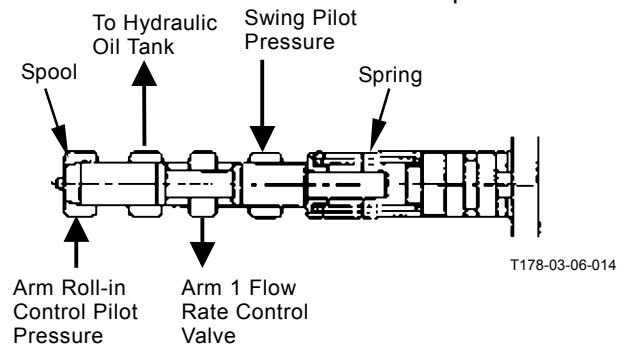
Flow Combiner Valve Control Spool:



Swing Parking Brake Release Spool:



Arm 1 Flow Rate Control Valve Control Spool:

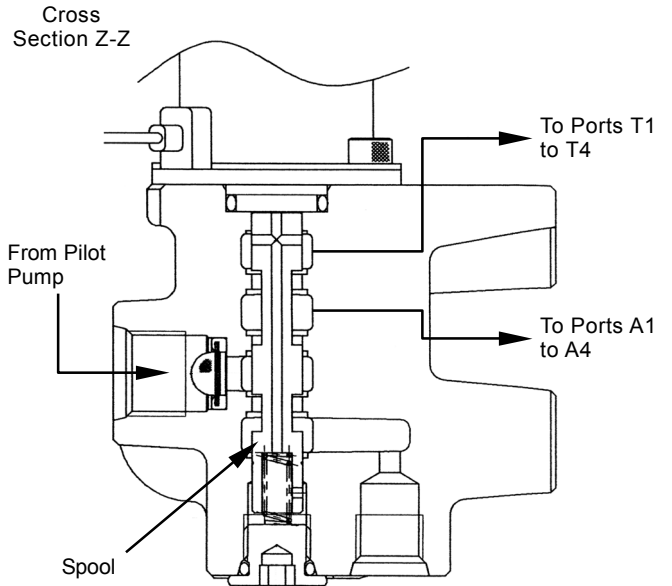


COMPONENT OPERATION / Others (Upperstructure)

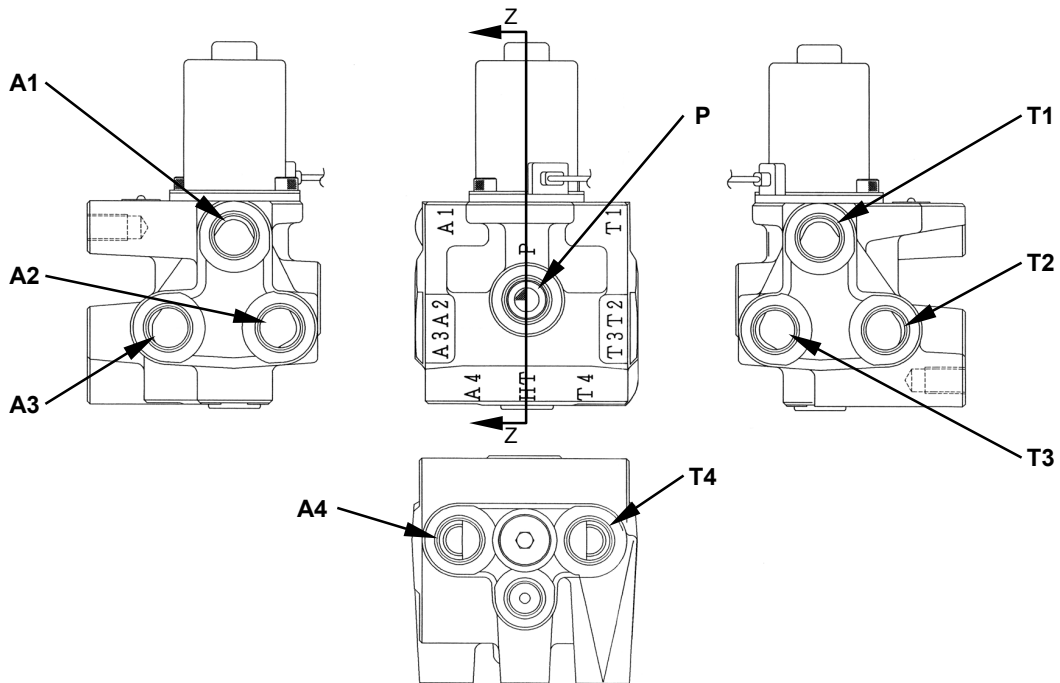
PILOT SHUT-OFF SOLENOID VALVE

The pilot shut-off solenoid valve is a solenoid valve-operated switch valve.

The spool in pilot shut-off solenoid valve is shifted by the pilot shut-off lever and turns on or off pilot pressure oil to the pilot valve and signal control valve.



T1V1-03-07-012



T1V1-03-07-011

A1 - Travel / Auxiliary Pilot Valve
 A2 - Right / Positioning Pilot Valve
 A3 - Left Pilot Valve

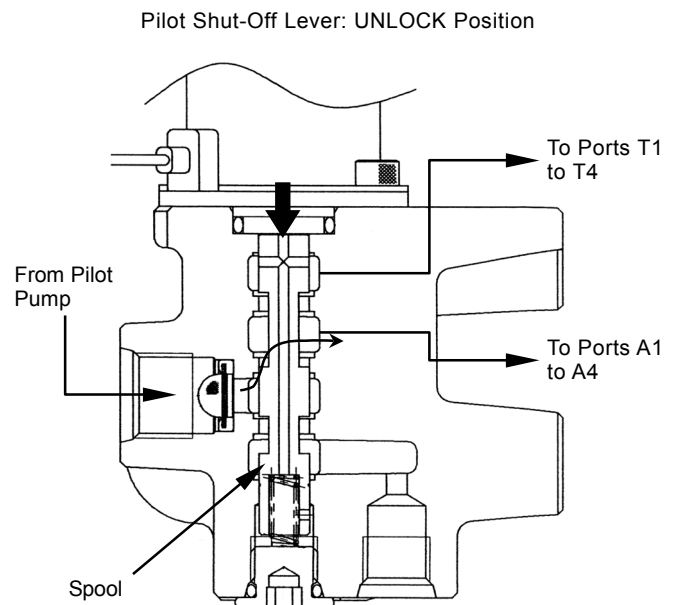
A4 - Signal Control Valve (Port PI)
 P - Primary Pilot Pressure

T1 - Travel / Auxiliary Pilot Valve
 T2 - Right / Positioning Pilot Valve

T3 - Left Pilot Valve
 T4 - Hydraulic Oil Tank

COMPONENT OPERATION / Others (Upperstructure)

- Pilot Shut-Off Lever: LOCK Position
 1. When the pilot shut-off lever is in the LOCK position, the pilot shut-off relay is turned OFF and the pilot shut-off solenoid valve is turned OFF. (Refer to Electrical System/ SYSTEM.)
 2. Pressure oil from the pilot pump is blocked by the spool in pilot shut-off solenoid valve.
 3. Oil to the pilot valve and signal control valve sides flow to the hydraulic oil tank.
 4. Therefore, although the control/travel lever is operated, the pilot valve is not operated.
- Pilot Shut-Off Lever: UNLOCK Position
 1. When the pilot shut-off lever is in the UNLOCK position, the pilot shut-off relay is turned ON and the pilot shut-off solenoid valve is activated.
 2. Therefore, the drain circuit is blocked by the spool in pilot shut-off valve.
 3. Pressure oil from the pilot pump flows to the pilot valve and signal control valve.
 4. Consequently, when the control/travel lever is operated, the pilot valve is operated.



T1V1-03-07-012

COMPONENT OPERATION / Others (Upperstructure)

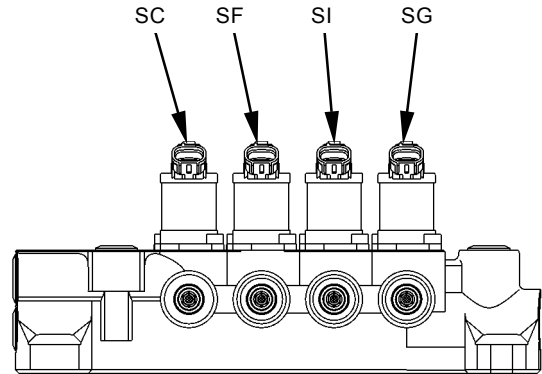
SOLENOID VALVE

The solenoid valve consists of the solenoid valve unit for pump and valve 4-spool control and the 2-spool solenoid valve unit (optional) for auxiliary flow rate control.

4-Spool Solenoid Valve Unit

Controls the control valve and the valve in travel motor by the signal from MC (main controller). (Refer to Control System / SYSTEM.) The 4-spool solenoid valve unit consists of proportional solenoid valves (SC, SF, SI and SG).

- SC: Control the arm regenerative valve and arm 2 flow rate control valve (switch valve) in control valve
- SF: Control the digging regenerative valve in control valve
- SI: Control the travel motor swash angle control valve
- SG: Increase pressure of the main relief valve in control valve



T1V1-03-07-007

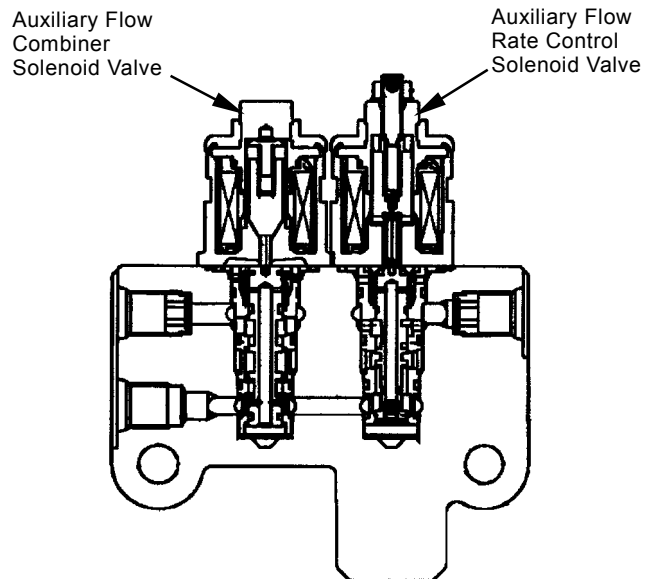
2-Spool Solenoid Valve Unit (Optional)

The 2-spool solenoid valve unit consists of the auxiliary flow combiner valve and auxiliary flow rate control solenoid valve.

The auxiliary flow combiner solenoid valve is an ON / OFF solenoid valve. When the front attachment is selected by using the monitor unit, the auxiliary flow combiner solenoid valve is turned ON and shifts the auxiliary flow combiner valve in control valve.

(Refer to Control System / SYSTEM.)

The auxiliary flow rate control solenoid valve is a proportional solenoid valve. The auxiliary flow rate control valve (switch valve) in control valve is shifted by the signal from MC.



T1GL-03-10-002

COMPONENT OPERATION / Others (Upperstructure)

Proportional Solenoid Valve

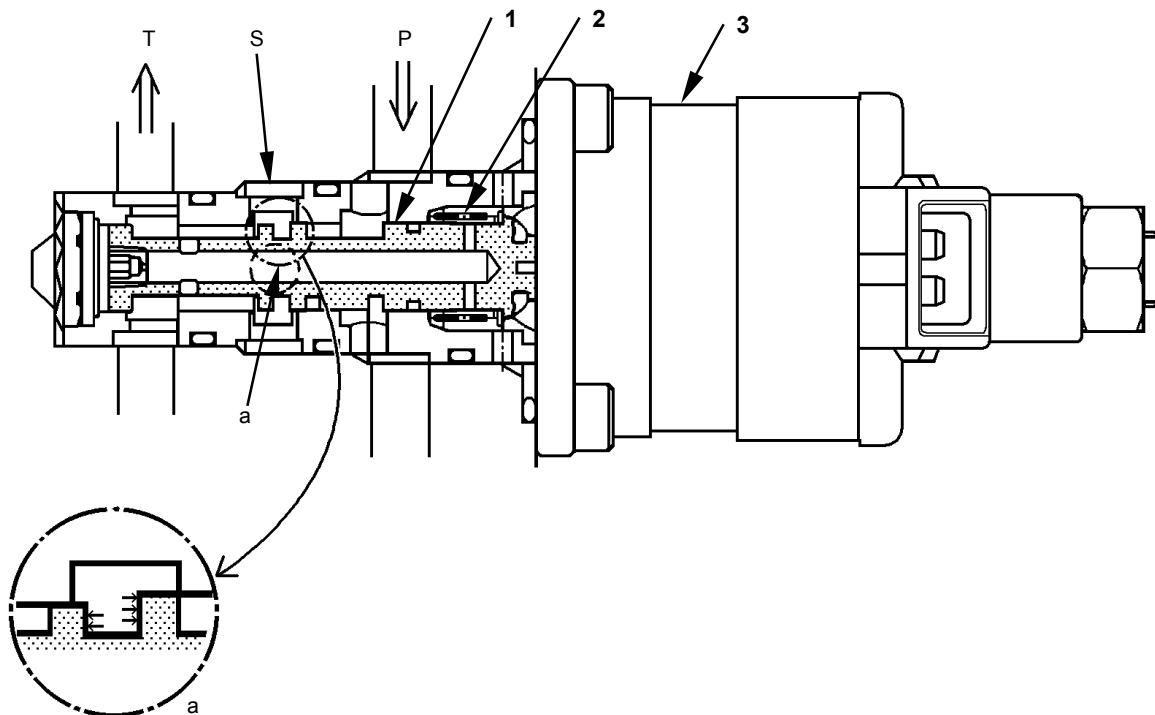
Controls by an electric current signal from MC and outputs pressure in proportional to degree of the electric current.

- When not energized (In neutral):

1. Spring (2) pushes spool (1) to the right and output port S is connected to tank port T.

- When energized:

1. Solenoid (3) pushes spool (1) to the left due to force in proportional to the electric current flowing through solenoid (3).
2. Pilot oil pressure from port P flows into output port S and pressure at output port S increases.
3. Pressure at output port S acts on step part a on spool (1).
Because of difference in the pressure receiving area between step part a, spool (1) is pushed to the right.
4. When pressure at port S increases and the force to push spool (1) to the right overcomes the force to push spool (1) to the left by solenoid (3), spool (1) moves back to the right side and the passage between output port S and port P is closed. As a result, pressure increase at port S stops.



1 - Spool

2 - Spring

3 - Solenoid

T107-02-07-005

COMPONENT OPERATION / Others (Upperstructure)

ON / OFF Solenoid Valve

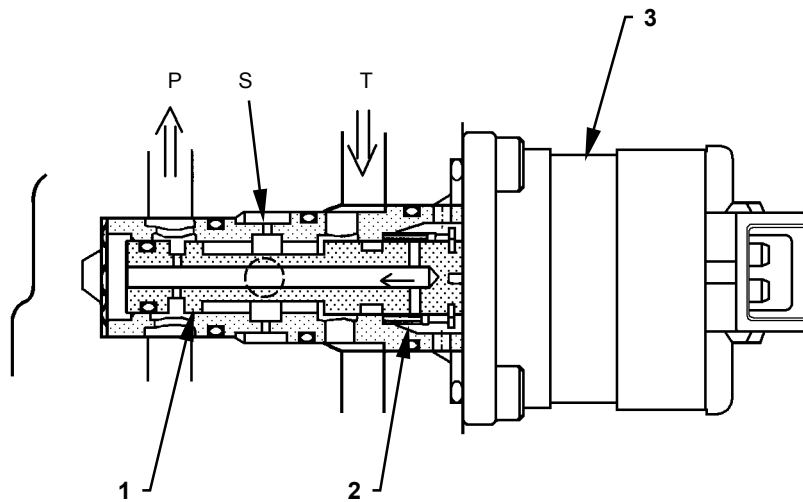
The ON / OFF solenoid valve shifts the brake switch and each control switch in order to shift pilot pressure.

- In Neutral State

Spool (1) is pushed to the right by spring (2).
Output port (S) is connected to tank port (T).

- In Operation

As solenoid (3) is activated, spool (1) moves to the left.
Pilot port (P) is connected to output port (S) and tank port (T) is blocked.



T105-02-11-010

1 - Spool


2 - Spring

3 - Solenoid

COMPONENT OPERATION / Others (Upperstructure)

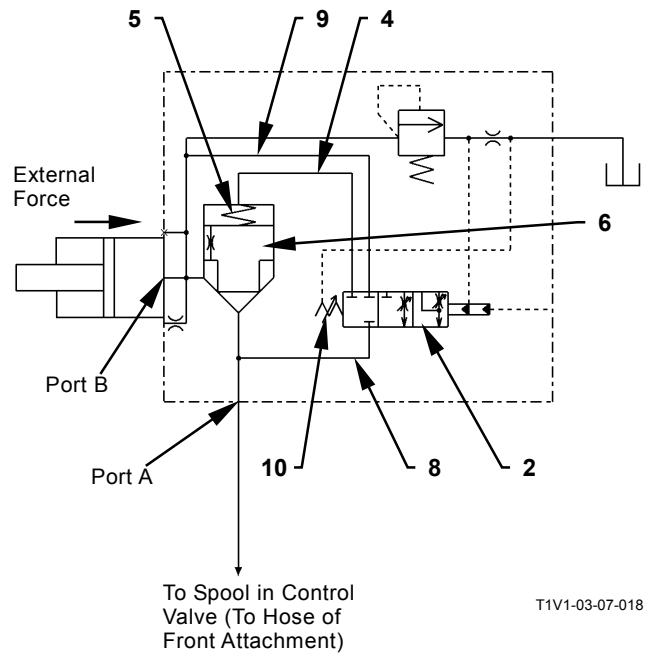
HOSE RUPTURE VALVE

The hose rupture valve is installed to boom cylinder (bottom side circuit), arm cylinder (rod side circuit) and positioning cylinder (2-piece boom) (rod side circuit). When the hose of front attachment is damaged, the hose rupture valve holds the front attachment and prevents the front attachment from falling.

 **NOTE:** The hose rupture valve in boom cylinder is explained here.

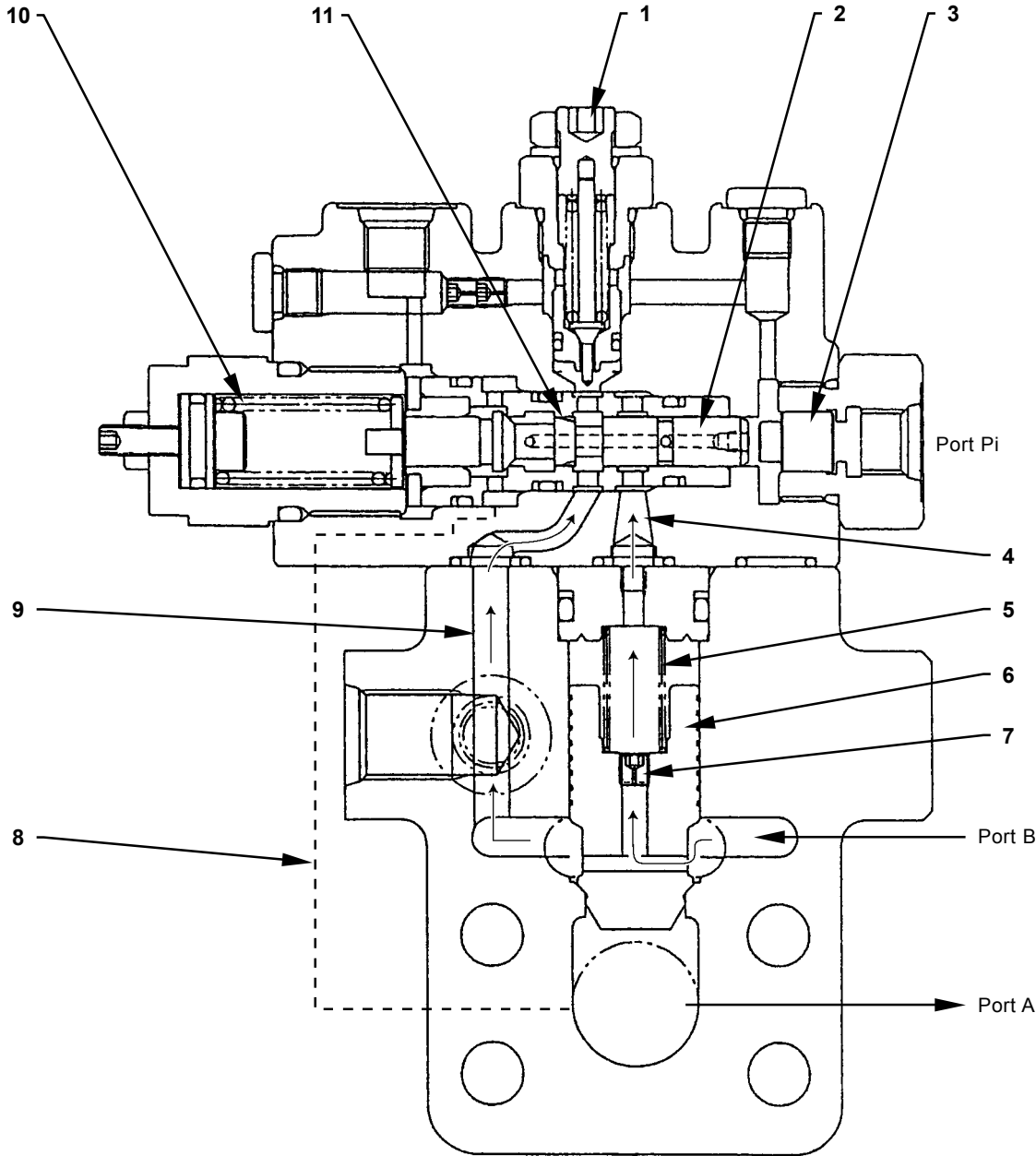
- Control Lever: In Neutral

1. As pilot pressure P_i does not act on spool (2), spool (2) is pushed to the right by the spring (10) force.
2. One holding pressure of cylinder at port B acts on poppet (6) and the other acts on spool (2) through passage C (9).
3. Holding pressure through passage C (9) is blocked by spool (2). Although pressure oil in the spring (5) chamber also acts on spool (2) through passage A (4), pressure oil is blocked by spool (2) and does not flow to passage B (8).
4. Therefore, poppet (6) is pushed downward by force (pressure of the spring (5) chamber + spring (5)).
5. Consequently, as holding pressure at port B is blocked completely, the front attachment is held and prevented from falling when the hose of front attachment is damaged.



- | | |
|---------------|---------------|
| 2 - Spool | 8 - Passage B |
| 4 - Passage A | 9 - Passage C |
| 5 - Spring | 10 - Spring |
| 6 - Poppet | |

COMPONENT OPERATION / Others (Upperstructure)

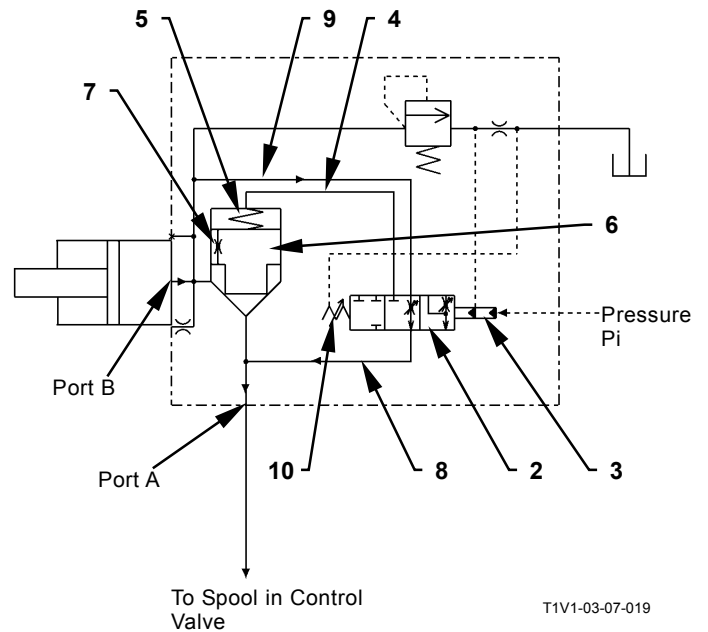


T1V1-03-07-017

- | | | | |
|------------------|---------------|---------------|--------------|
| 1 - Relief Valve | 4 - Passage A | 7 - Orifice | 10 - Spring |
| 2 - Spool | 5 - Spring | 8 - Passage B | 11 - Orifice |
| 3 - Piston | 6 - Poppet | 9 - Passage C | |

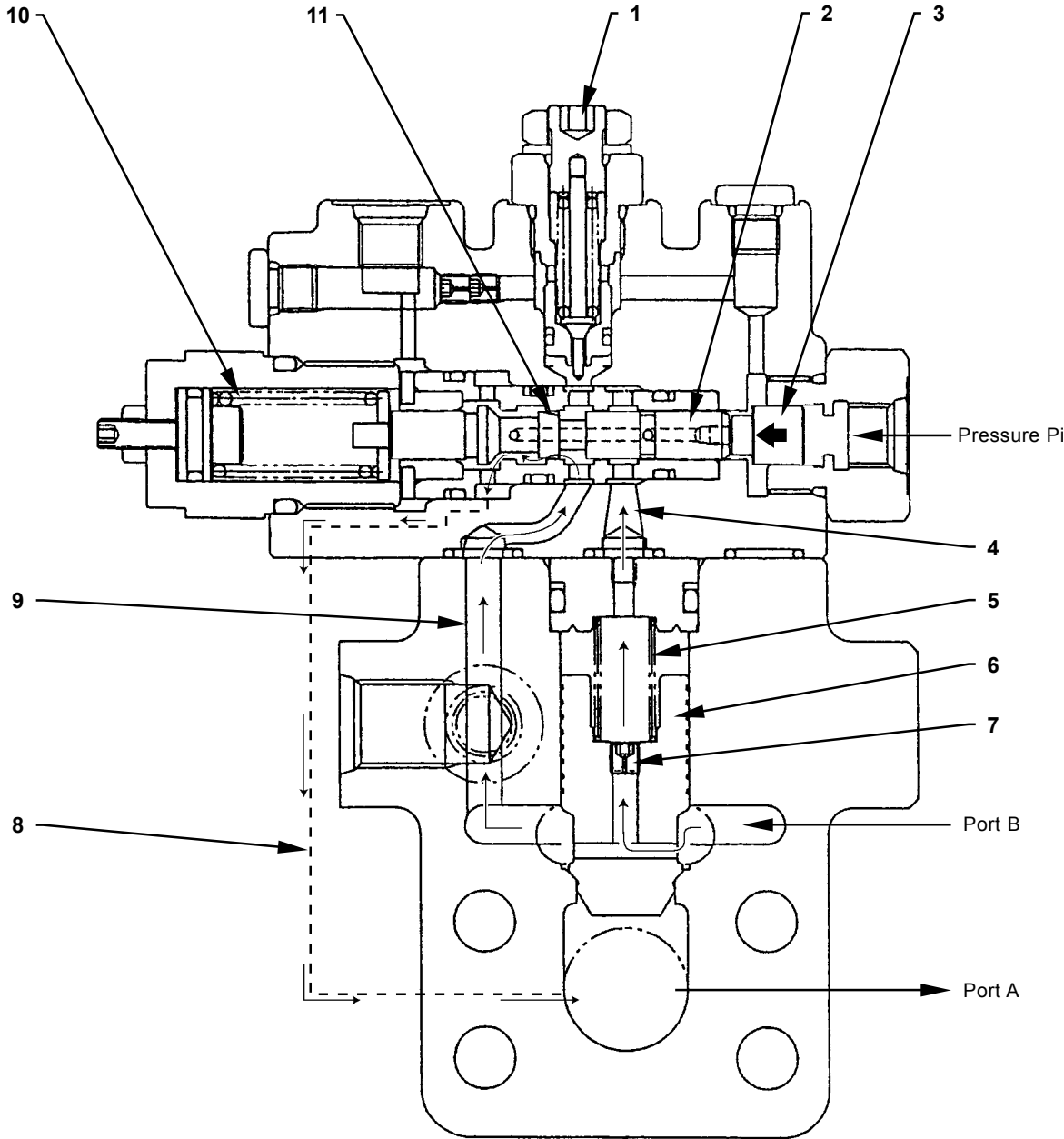
COMPONENT OPERATION / Others (Upperstructure)

- During Boom Lowering Operation (Control Lever Stroke: Less than Half-Stroke)
 1. When the boom is lowered, pilot pressure P_i 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 | 7 - Orifice |
| 3 - Piston | 8 - Passage B |
| 4 - Passage A | 9 - Passage C |
| 5 - Spring | 10 - Spring |
| 6 - Poppet | |

COMPONENT OPERATION / Others (Upperstructure)

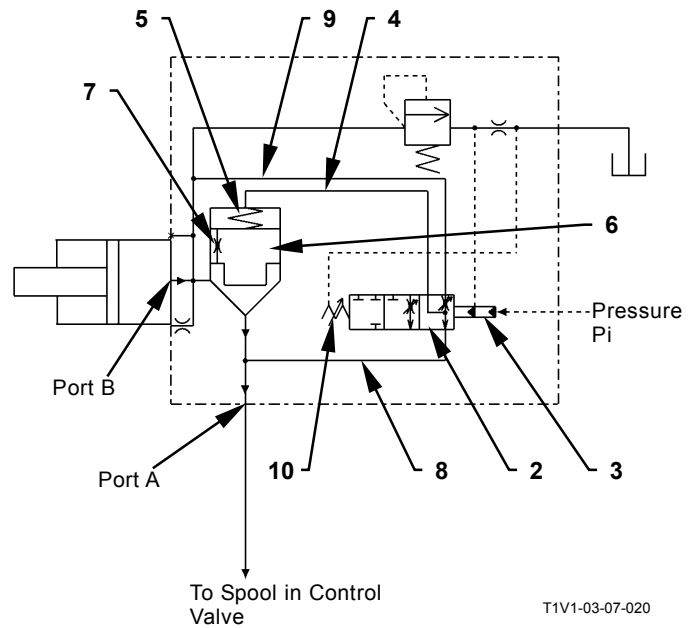


T1V1-03-07-015

- | | | | |
|-------------------|---------------|---------------|--------------|
| 1 - Relief valve: | 4 - Passage A | 7 - Orifice | 10 - Spring |
| 2 - Spool | 5 - Spring | 8 - Passage B | 11 - Orifice |
| 3 - Piston | 6 - Poppet | 9 - Passage C | |

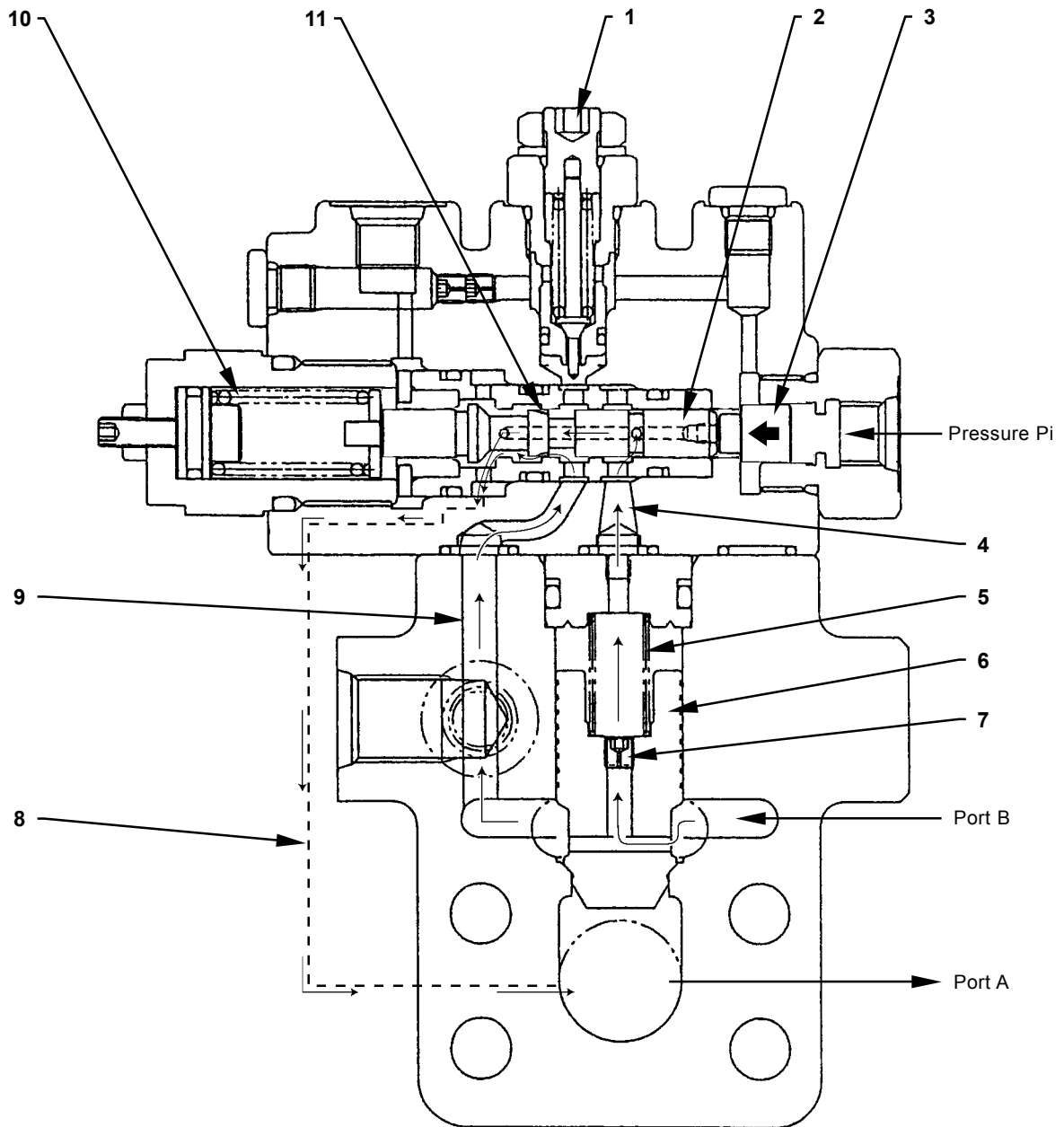
COMPONENT OPERATION / Others (Upperstructure)

- During Boom Lowering Operation (Control Lever Stroke: More than Half-Stroke)
 1. When the boom lower control lever is more than half-stroke, piston (3) pushes spool (2) to the position where passage (4) is connected to the hole on spool (2).
 2. Therefore, pressure oil in the spring (5) chamber flows to passage B through spool (2) from the hole on spool (2).
 3. Pressure in passage C (9) flows to passage B (8) through orifice (11).
 4. At this time, a pressure difference between port B and the spring (5) chamber appears due to orifice (7) and poppet (6) moves upward.
 5. Consequently, return oil from port B flows to the spool in control valve through poppet (6) from port A and lowers the boom.
 6. As pressure oil in port B flows to port A directly, oil flow rate through the spool in control valve increases and boom lowering speed becomes fast.



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

COMPONENT OPERATION / Others (Upperstructure)



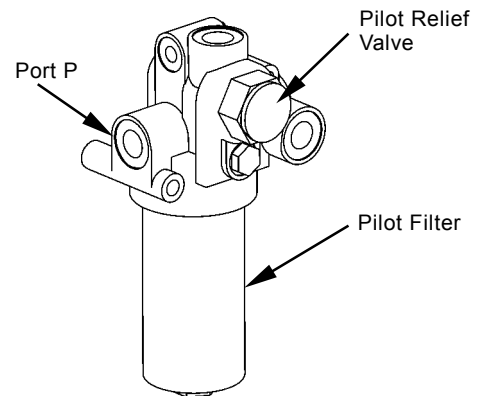
T1V1-03-07-016

- | | | | |
|-------------------|---------------|---------------|--------------|
| 1 - Relief valve: | 4 - Passage A | 7 - Orifice | 10 - Spring |
| 2 - Spool | 5 - Spring | 8 - Passage B | 11 - Orifice |
| 3 - Piston | 6 - Poppet | 9 - Passage C | |

COMPONENT OPERATION / Others (Upperstructure)

PILOT RELIEF VALVE

The pilot relief valve has a pilot filter incorporated.
The pilot relief valve functions to regulate pilot pump pressure oil routed to port P to a set constant pressure.



T178-03-07-001

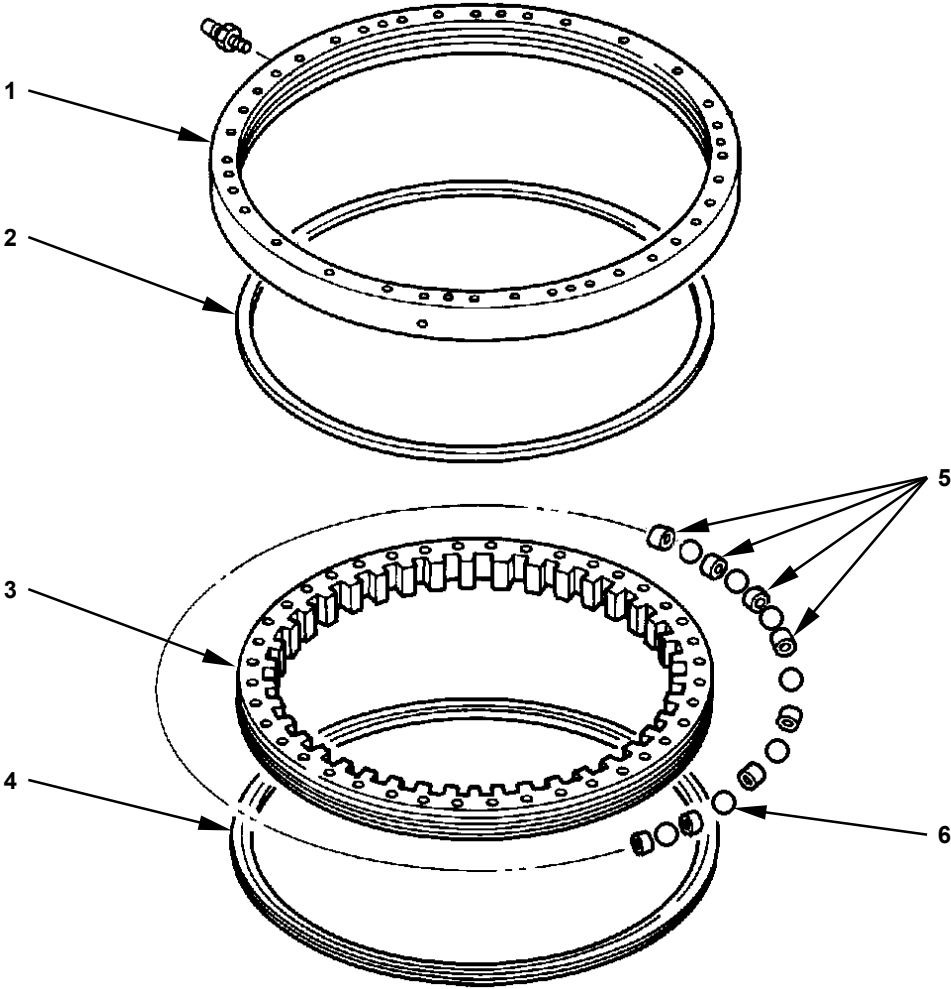
COMPONENT OPERATION / Others (Undercarriage)

SWING BEARING

The swing bearing sustains self weight of the upper structure and makes smooth swing.

This bearing is a single row type ball bearing and consists of outer race (1), inner race (3), ball (6), support (5) and seals (2, 4).

Outer race (1) is bolted to the upper structure and inner race (3) is bolted to the undercarriage. The internal teeth of inner race (3) are enmeshed with output shaft of swing reduction gear.



T135-03-02-001

1 - Outer Race
2 - Seal

3 - Inner Race
4 - Seal

5 - Support

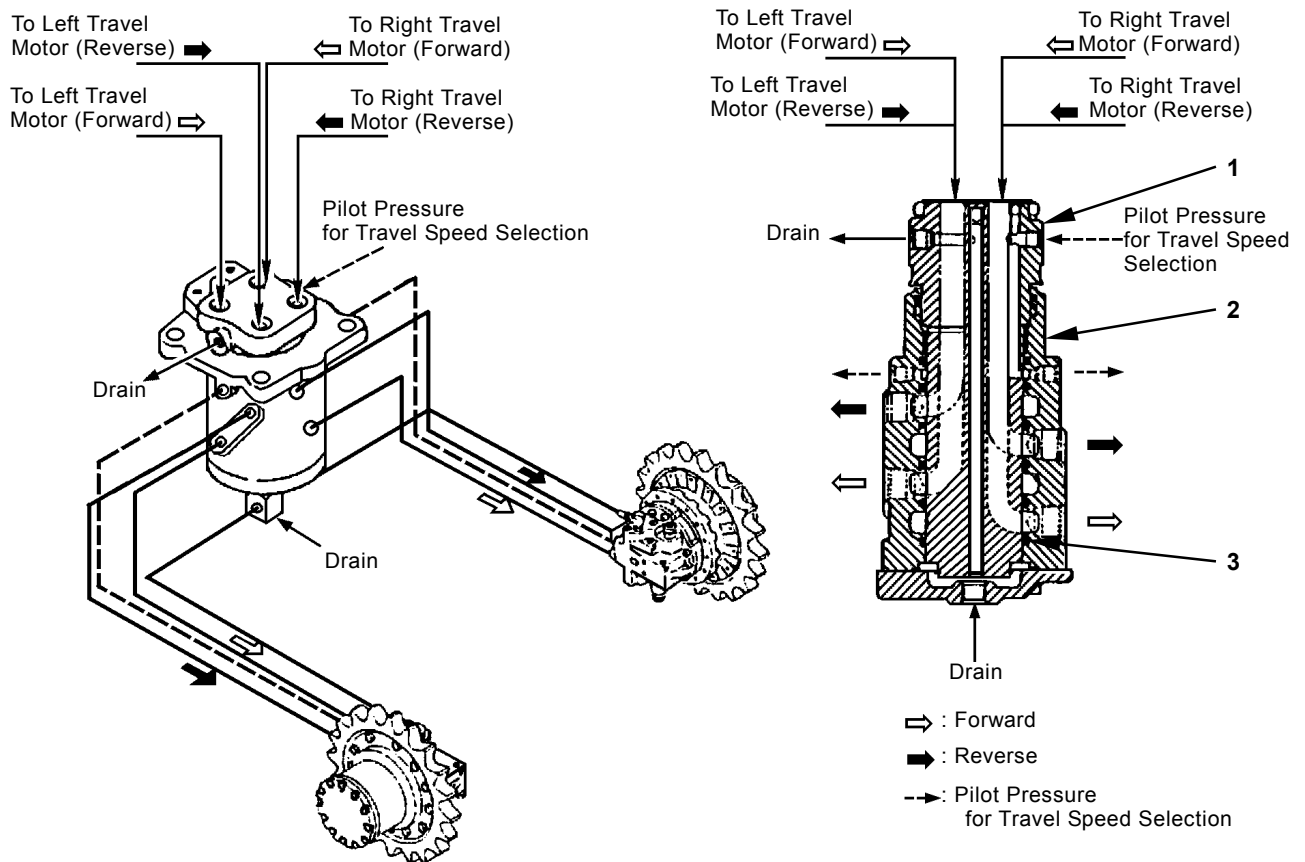
6 - Ball

COMPONENT OPERATION / Others (Undercarriage)

CENTER JOINT

The center joint is a 360° rotating joint. When the upperstructure is rotated, the center joint avoids twisting of hoses and allows hydraulic oil to flow smoothly to or from the travel motors. Spindle (1) is attached to the main frame, and body (2) is bolted to the swing center of the undercarriage.

Hydraulic oil flows to the right and left travel motors via spindle (1) and the oil ports of body (2). Seals (3) prevent oil leaks between spindle (1) and body (2) into adjacent passages.



1 - Spindle

2 - Body

3 - Seal

T157-03-02-004

COMPONENT OPERATION / Others (Undercarriage)

TRACK ADJUSTER

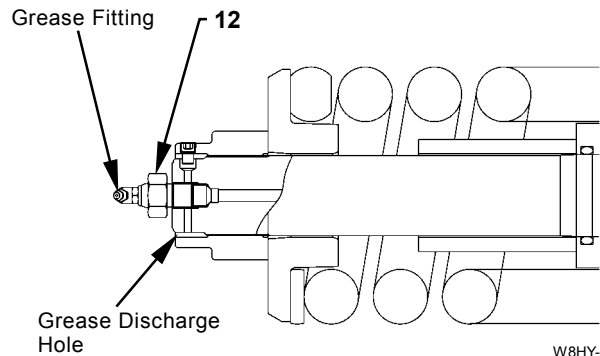
The track adjuster located on the side frame is composed of spring (7) and adjuster cylinder (5). Spring (7) absorbs loads applied to the front idler. Adjuster cylinder (5) adjusts track sag.

- Grease is applied through grease fitting into chamber A of adjuster cylinder (5), pushes piston rod (2) out and decreases track sag.
- Loosen valve (12) 1 to 1.5 turns counterclockwise and release grease in order to increase track sag.

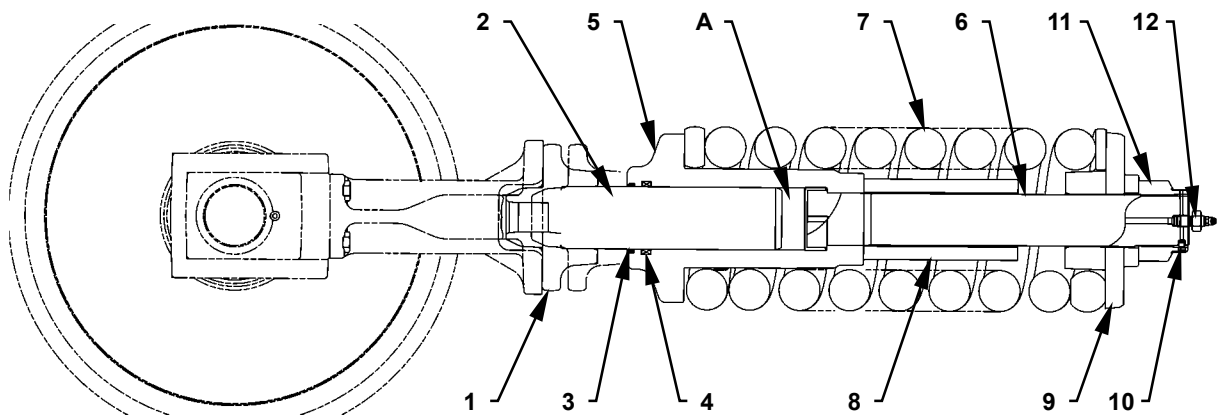


CAUTION: Do not loosen valve (12) quickly or loosen too much as high-pressure grease in adjusting cylinder (5) may spout out.

Loosen valve (12) carefully while keeping body parts and face away from valve (12). Do not loosen the grease fitting.



W8HY-04-03-001



W1V7-03-04-002

- | | | | |
|----------------|-----------------------|------------|------------|
| 1 - Holder | 4 - U-Ring | 7 - Spring | 10 - Plug |
| 2 - Piston Rod | 5 - Adjuster Cylinder | 8 - Spacer | 11 - Nut |
| 3 - Dust Seal | 6 - Rod | 9 - Washer | 12 - Valve |

COMPONENT OPERATION / Others (Undercarriage)

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