PART NO. TO1V7-E-00

HITACHI

Technical Manual

Operational Principle

ZAXIS

330-3 class

330-3・330LC-3

350H-3・350LCH-3

350LCK-3

350LC-3・350LCN-3

Hydraulic Excavator

Service Manual consists of the following separate Part No;	
Technical Manual (Operational Principle)	: Vol. No.TO1V7-E
Technical Manual (Troubleshooting)	: Vol. No.TT1V7-E
Workshop Manual	: Vol. No.W1V7-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

  5 → Consecutive Page Number for Each Group
  3 → Group Number
  1 → Section Number
  T → T: Technical Manual W: Workshop Manual

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 of 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 parenthheses just behind SI units.

Example : 24.5 MPa (250 kgf/cm^2, 3560 psi)

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

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				

SECTION AND GROUP CONTENTS

TECHNICAL MANUAL

(Operational Principle)

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.

WORKSHOP MANUAL

SECTION 1
GENERAL

—CONTENTS—

Group 1 Specifications

Group 2 Component Layout

Group 3 Component Specifications

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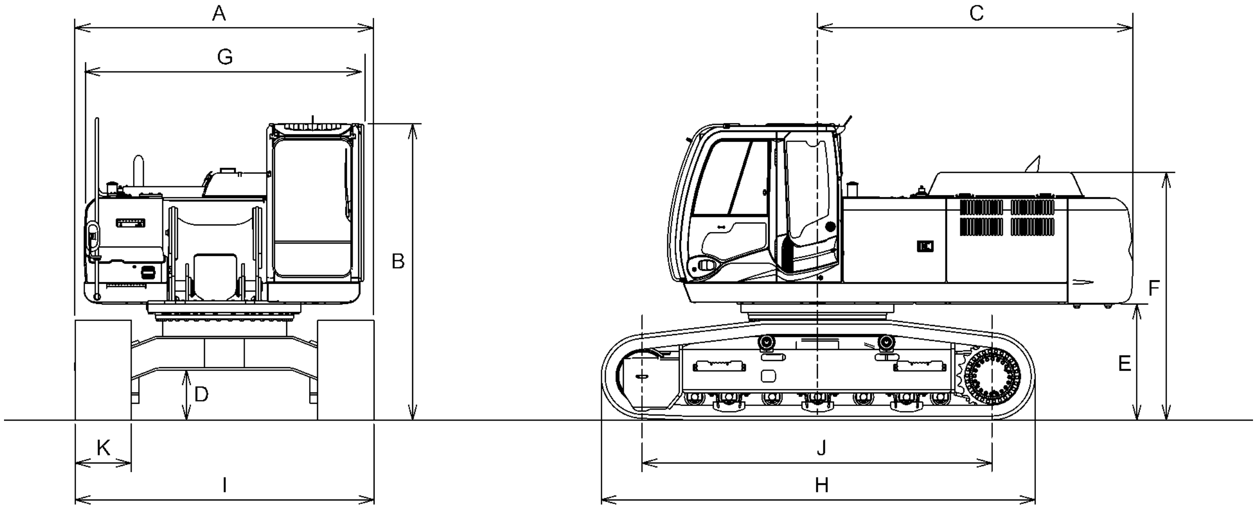
SPECIFICATIONS

ZAXIS330-3



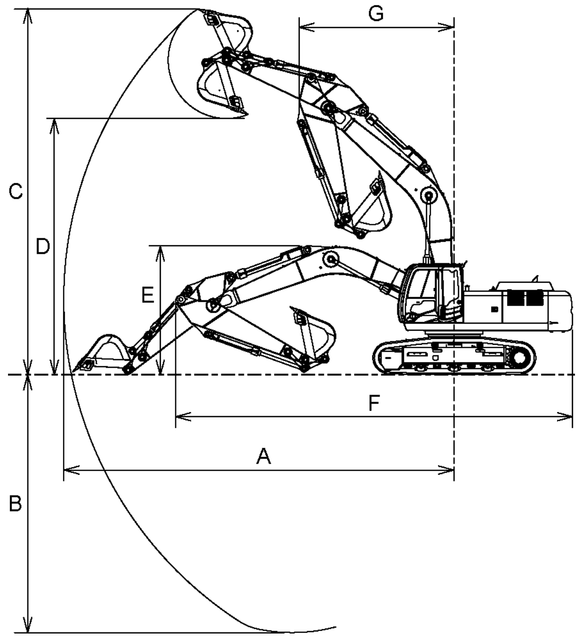
T1V7-01-01-001

Model	ZAXIS330-3
Type of Front-End Attachment	3.2 m (10 ft 6 in) Arm
Bucket Capacity (Heaped)	PCSA 1.40 m^3 (1.20 yd^3), CECE 1.2 m^3 (1.57 yd^3)
Operating Weight	31600 kg (69700 lb)
Basic Machine Weight	24100 kg (53100 lb)
Engine	Isuzu AH-6HK1XYSA-01 202 kW/1900 min^{-1} (275 PS/1900 rpm) (HP Mode)
A: Overall Width (Excluding back mirrors)	3190 mm (10 ft 6 in)
B: Cab Height	3160 mm (10 ft 4 in)
C: Rear End Swing Radius	3370 mm (11 ft 1 in)
D: Minimum Ground Clearance	* 500 mm (19.7 in)
E: Counterweight Clearance	* 1160 mm (3 ft 10 in)
F: Engine Cover Height	* 2590 mm (8 ft 6 in)
G: Overall Width of Upperstructure	2990 mm (9 ft 10 in)
H: Undercarriage Length	4640 mm (15 ft 3 in)
I: Undercarriage Width	3190 mm (10 ft 6 in)
J: Sprocket Center to Idler Center	3730 mm (12 ft 3 in)
K: Track Shoe Width	600 mm (24 in) (Grouser shoe)
Ground Pressure	64 kPa (0.65 kgf/cm^2, 9.3 psi)
Swing Speed	10.7 min^{-1} (rpm)
Travel Speed (fast/slow)	5.5/3.2 km/h (3.4/2.0 mph)
Gradeability	35° ($\tan\theta$ = 0.70)

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

WORKING RANGES

ZAXIS330-3 (Mono Boom)



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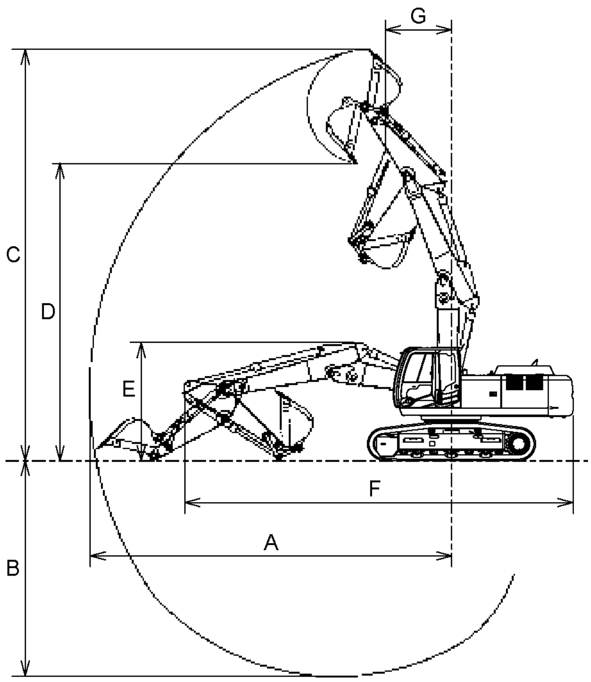
Model	ZAXIS330-3							
Category / Item	2.33 m (7 ft 8 in) Arm		2.67 m (8 ft 9 in) Arm		3.2 m (10 ft 6 in) Arm		4.0 m (13 ft 1 in) Arm	
	mm	ft·in	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	10310	33’10”	10570	34’8”	11100	36’5”	11860	38’11”
B: Maximum Digging Depth	6500	32’4”	6840	22’5”	7380	24’3”	8180	26’10”
C: Maximum Cutting Height	9980	32’9”	9990	32’9”	10360	33’12”	10750	35’3”
D: Maximum Dumping Height	6900	22’8”	6940	22’9”	7240	23’9”	7630	25’0”
E: Transport Height	3510	11’6”	3470	11’5”	3270	10’9”	3600	11’10”
F: Overall Transport Length	11170	36’8”	11130	36’6”	11000	36’1”	11090	36’5”
G: Minimum Swing Radius	4460	22’8”	4610	15’2”	4460	14’8”	4470	14’8”

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

ZAXIS330-3 (2-Piece Boom)



T1V7-01-01-003

Model	ZAXIS330-3							
Item / Category	2.33 m (7 ft 8 in) Arm		2.67 m (8 ft 9 in) Arm		3.2 m (10 ft 6 in) Arm		4.0 m (13 ft 1 in) Arm	
	mm	ft·in	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	10390	34’1”	10680	35’1”	11220	36’10”	12000	39’4”
B: Maximum Digging Depth	10170	33’4”	6360	20’10”	6900	22’8”	7700	25’3”
C: Maximum Cutting Height	11870	38’11”	12060	39’7”	12550	41’2”	13210	43’4”
D: Maximum Dumping Height	8550	28’	8750	28’9”	9240	30’4”	9910	32’6”
E: Transport Height	3380	11’1”	3370	11’1”	3310	10’10”	3690	12’1”
F: Overall Transport Length	11150	36’7”	11110	36’5”	11070	36’4”	11020	36’2”
G: Minimum Swing Radius	3250	10’8”	3120	10’3”	2890	9’6”	3230	10’7”

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

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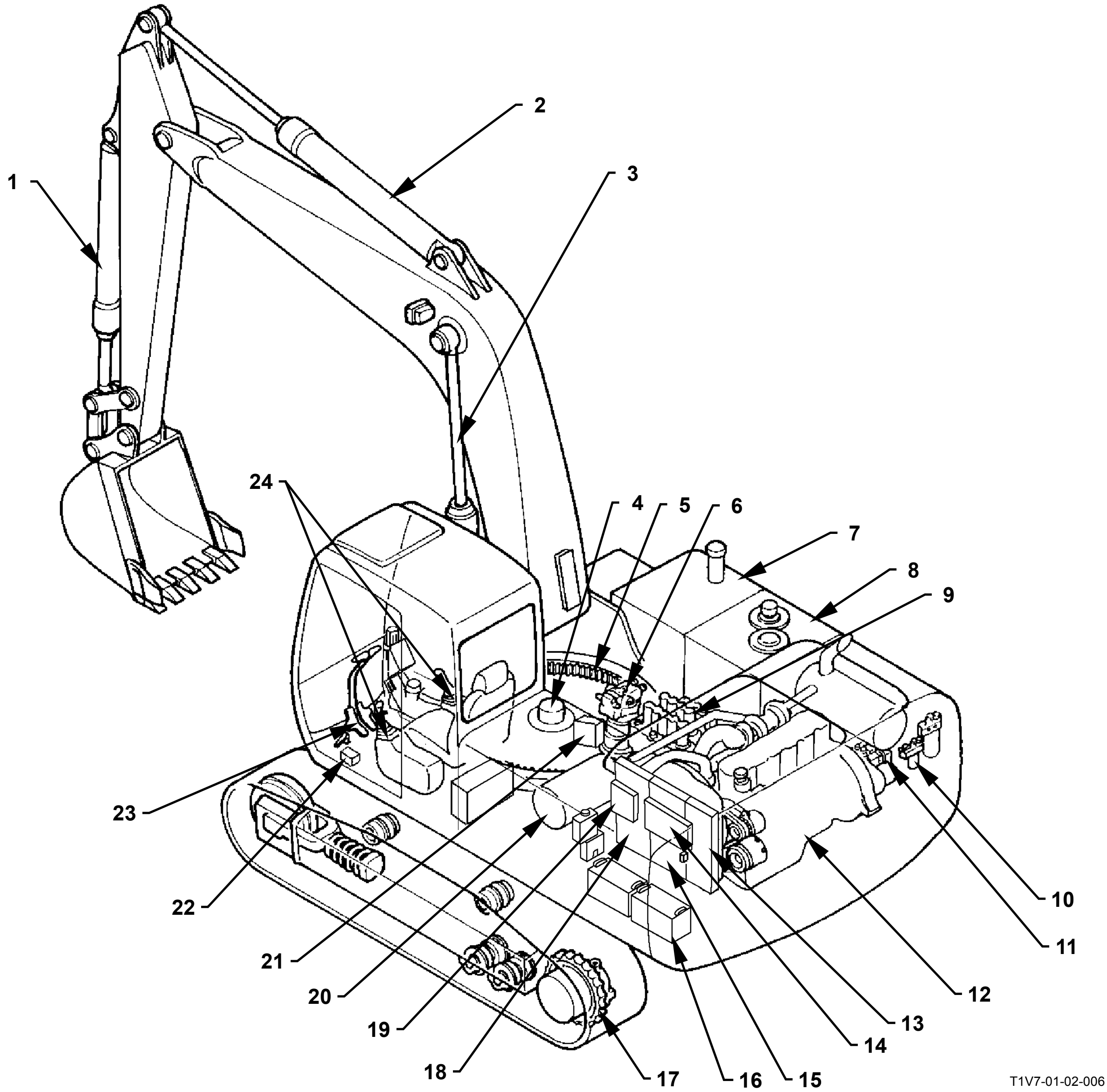
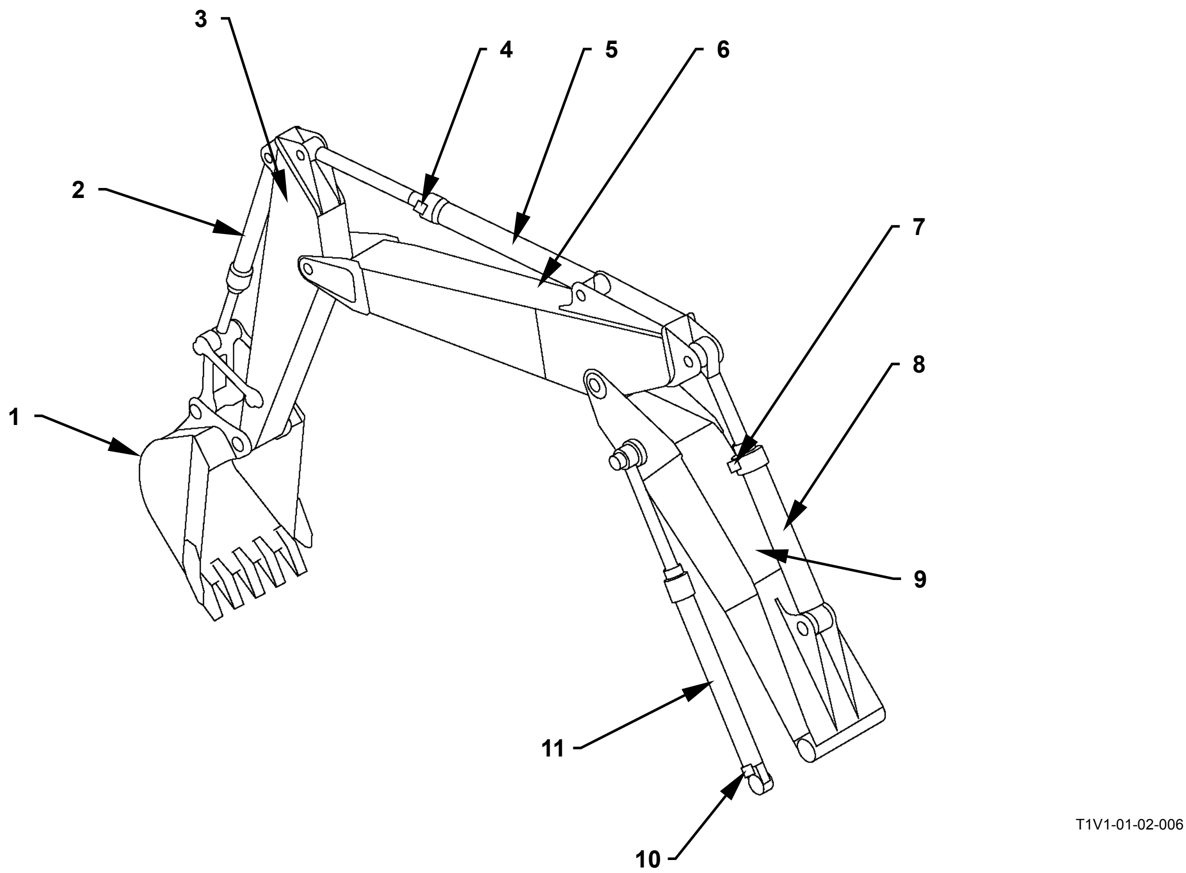
MAIN COMPONENTS



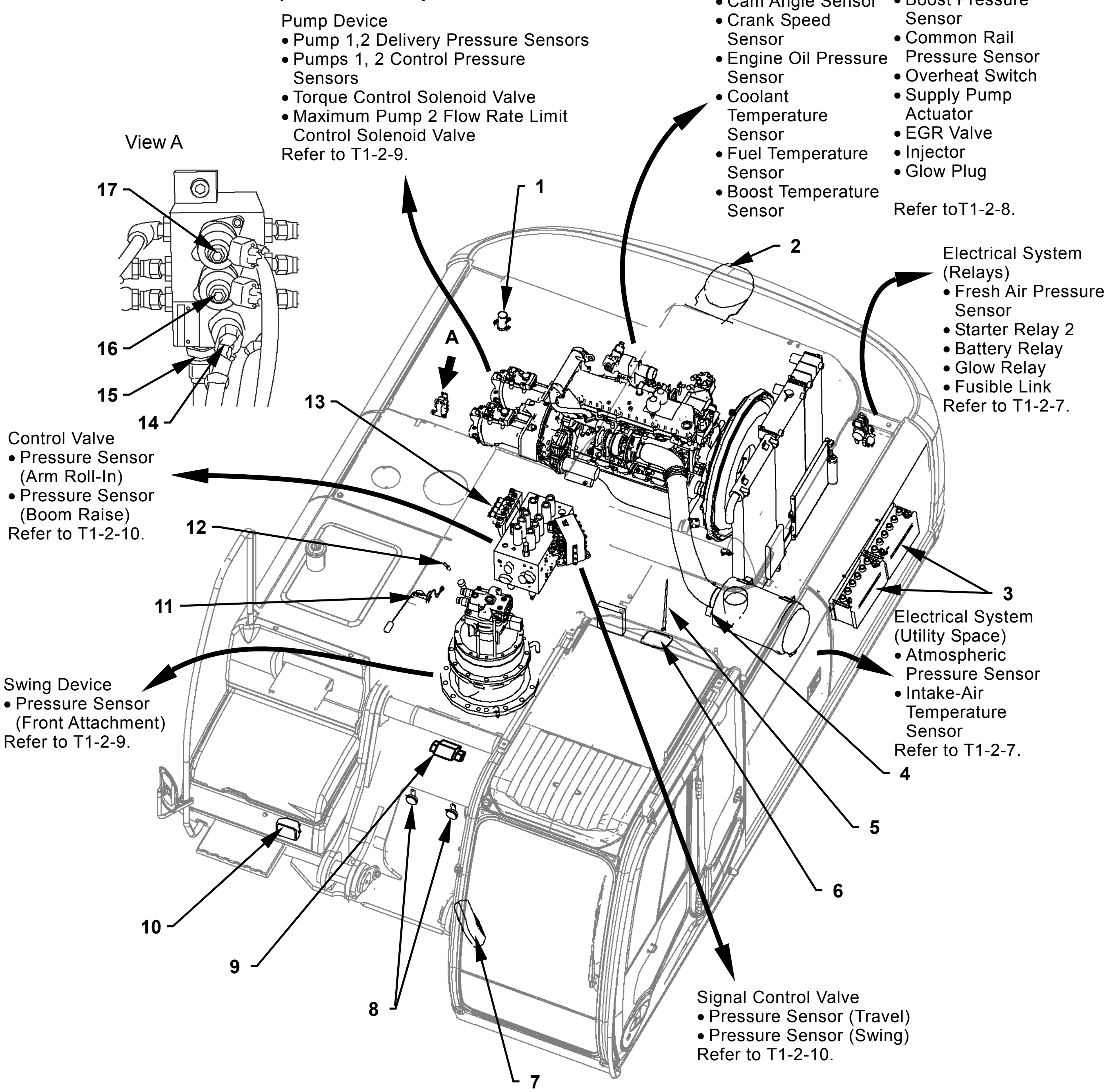
1 -	Bucket Cylinder	7 -	Fuel Tank	13 -	Intercooler	19 -	Fuel Cooler
2 -	Arm Cylinder	8 -	Hydraulic Oil Tank	14 -	Air Conditioner Condenser	20 -	Air Cleaner
3 -	Boom Cylinder	9 -	Control Valve	15 -	Radiator	21 -	Signal Control Valve
4 -	Center Joint	10 -	Pilot Filter/ Pilot Relief Valve	16 -	Battery	22 -	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

Front Attachment (2-Piece Boom)



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	

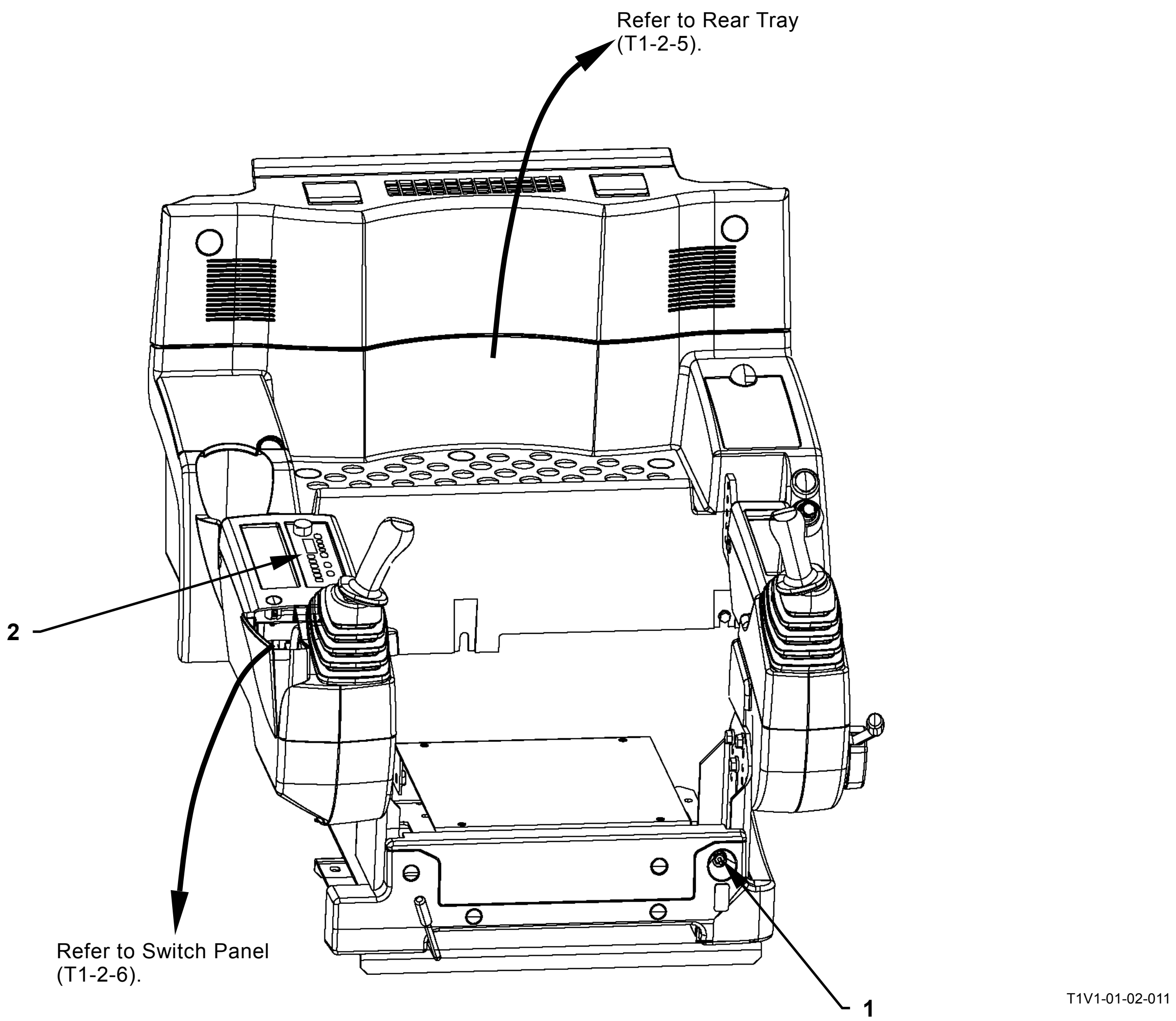
ELECTRICAL SYSTEM (OVERVIEW)



T1V7-01-02-010

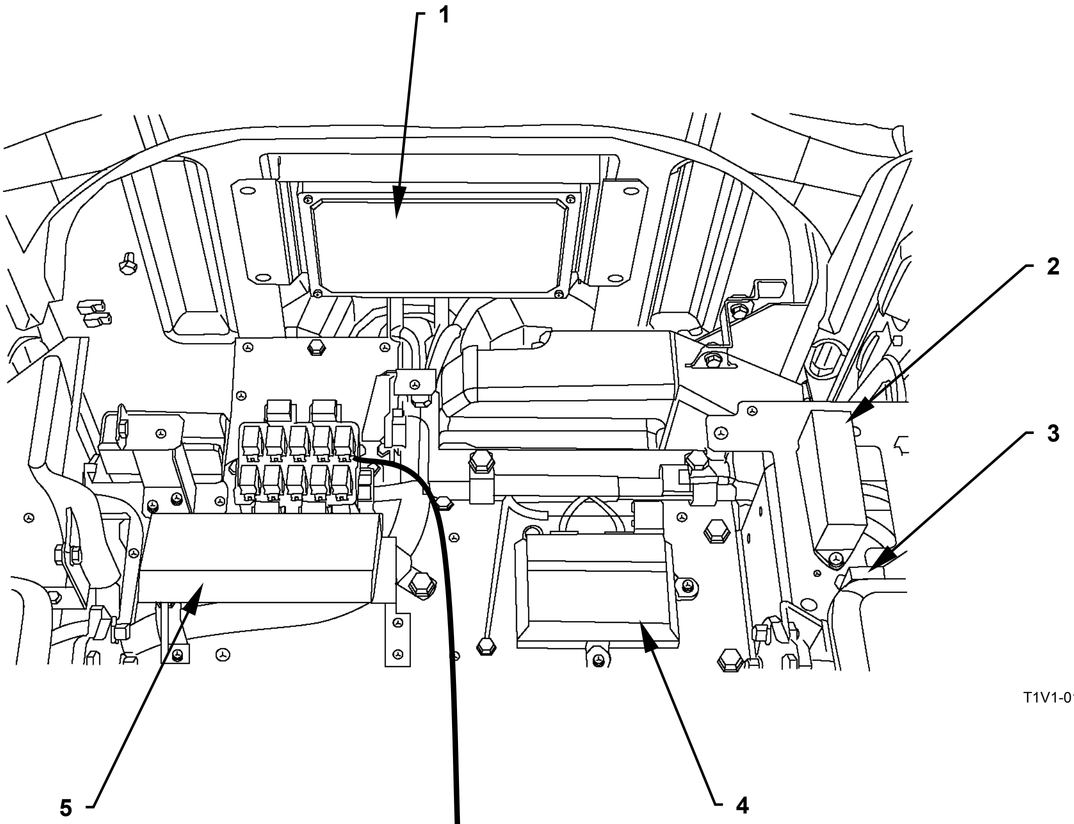
1 - Solenoid Pump
2 - Rear View Camera
3 - Battery
4 - Air Filter Restriction Switch
5 - Sending / Receiving Aerial
6 - GPS (Global Positioning System)
7 - Monitor Unit
8 - Horn
9 - Positioning Control Valve (2-Piece Boom Machine Only)
10 - Working Light
11 - Fuel Sensor
12 - Hydraulic Oil Temperature Sensor
13 - Solenoid Valve Unit
14 - Pump 2 Control Pressure Sensor
15 - Pump 1 Control Pressure Sensor
16 - Maximum Pump 2 Flow Rate Limit Control Solenoid Valve
17 - Torque Control Solenoid Valve

Electrical System (In Cab)



1 - Engine Stop Switch 2 - Radio

Electrical System (Rear Tray)



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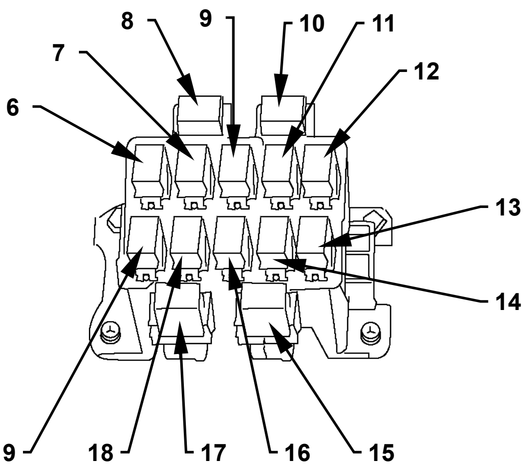
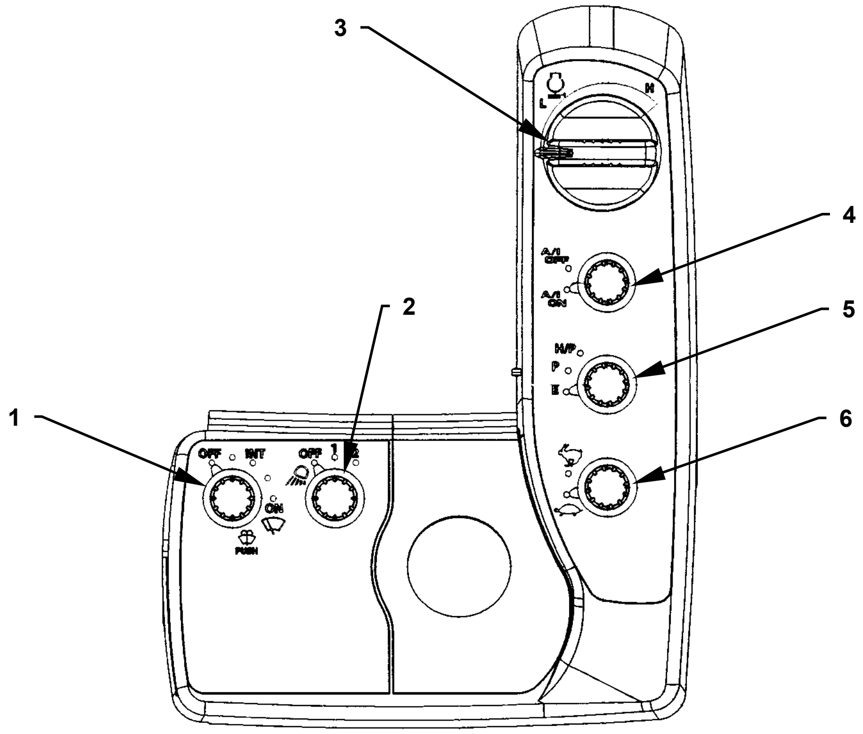


T1V1-01-02-009

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

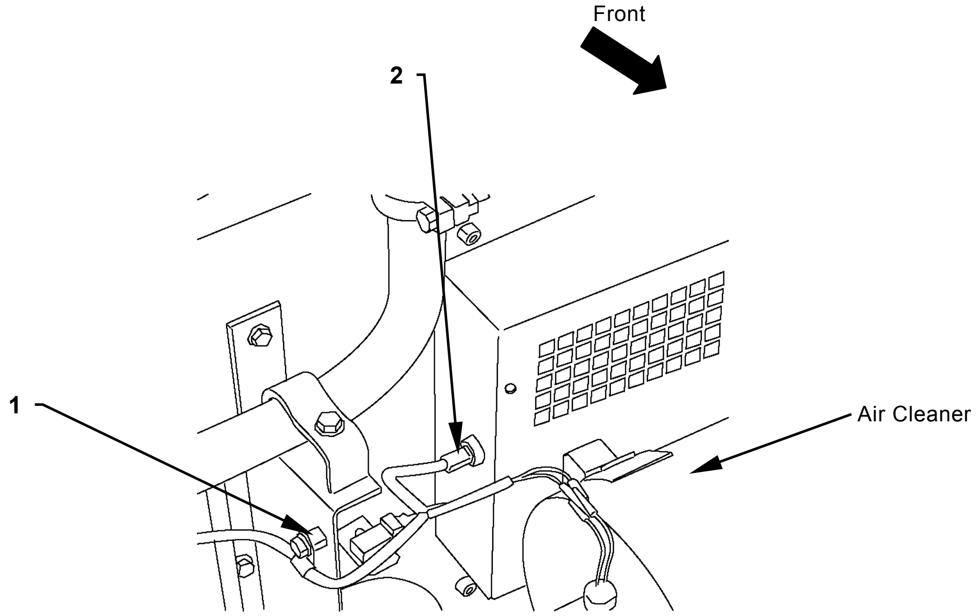
Electrical System (Switch Panel)



T1V1-04-02-001

1 - Wiper / Washer Switch	3 - Engine Control Dial	5 - Power Mode Switch	6 - Travel Mode Switch
2 - Working Light Switch	4 - Auto-Idle Switch		

Electrical System (Utility Space)



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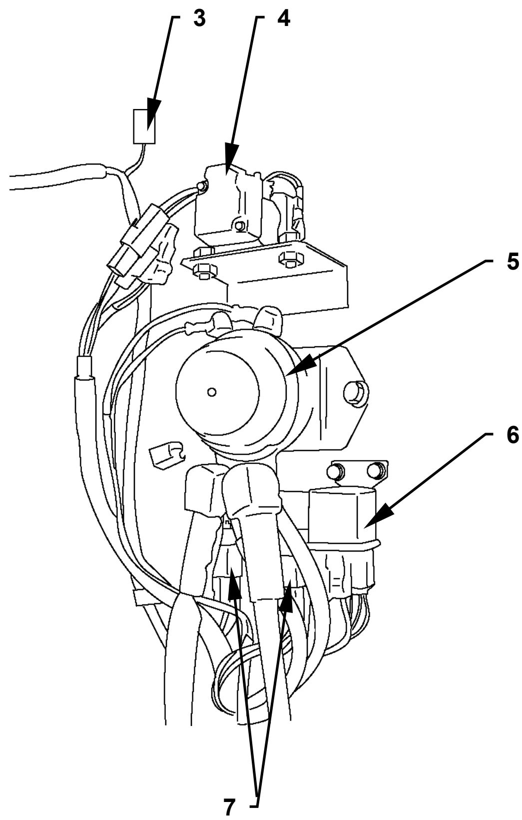
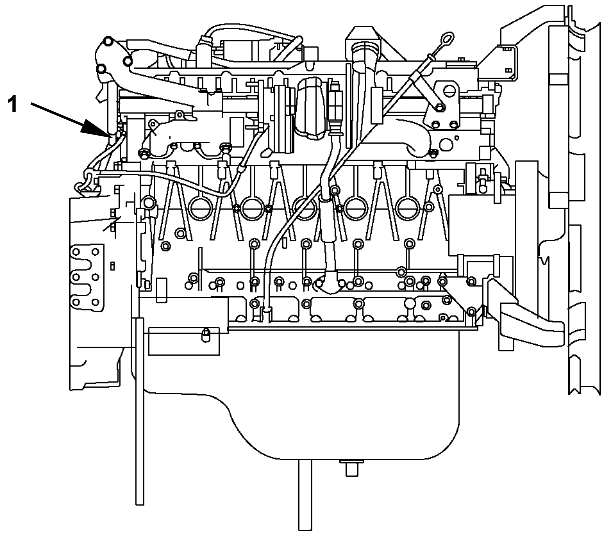
Electrical System (Relays)



T1V1-01-02-018

1 - Atmospheric Pressure Sensor
2 - Intake-Air Temperature Sensor
3 - Fresh Air Pressure Sensor
4 - Starter Relay 2
5 - Battery Relay
6 - Glow Relay
7 - Fusible Link

ENGINE



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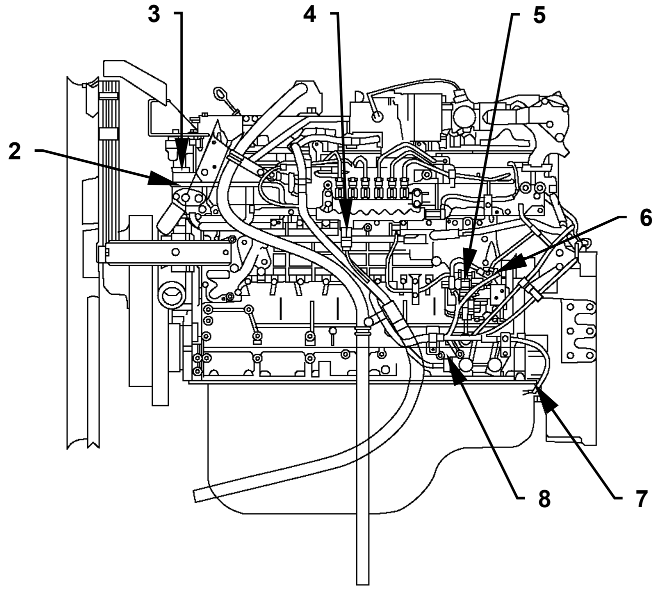

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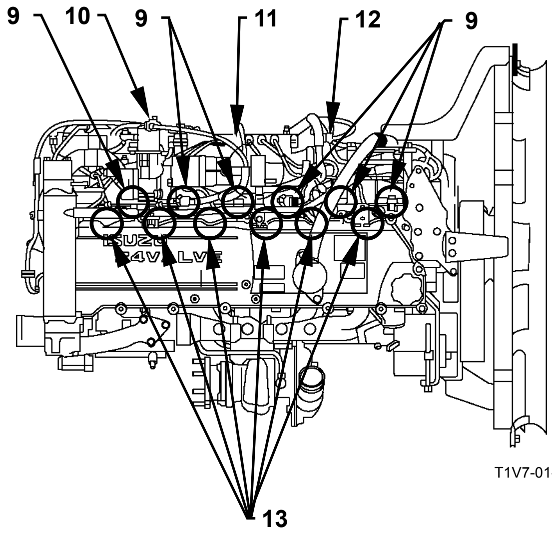


T1V7-01-02-001

1 - Cam Angle Sensor

2 - Coolant Temperature Sensor

3 - Overheat Switch

4 - Common Rail Pressure Sensor

5 - Supply Pump Actuator

6 - Fuel Temperature Sensor

7 - Crank Speed Sensor

8 - Hydraulic Oil Pressure Sensor

9 - Injector

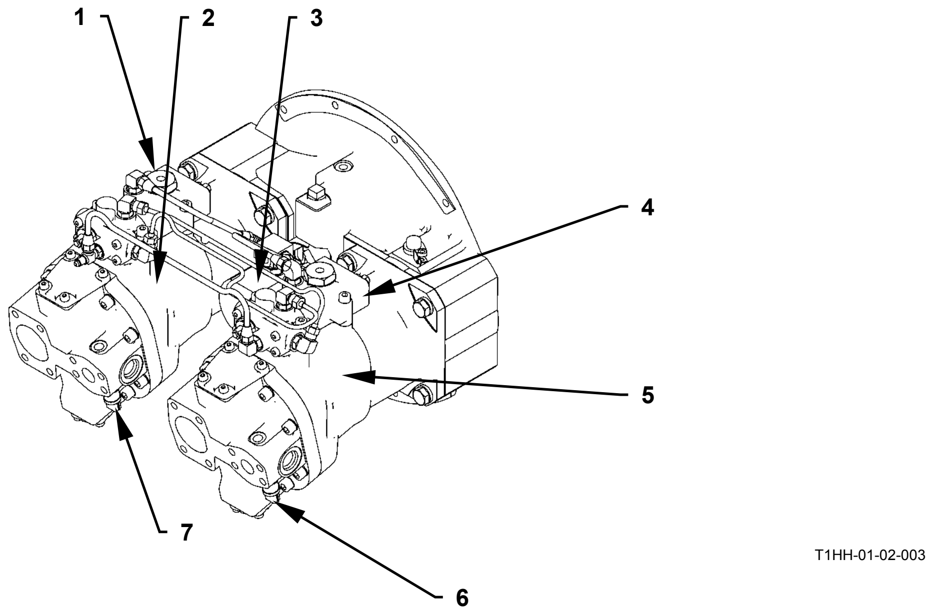
10 - EGR (Exhaust Gas Recirculation) Valve

11 - Boost Temperature Sensor

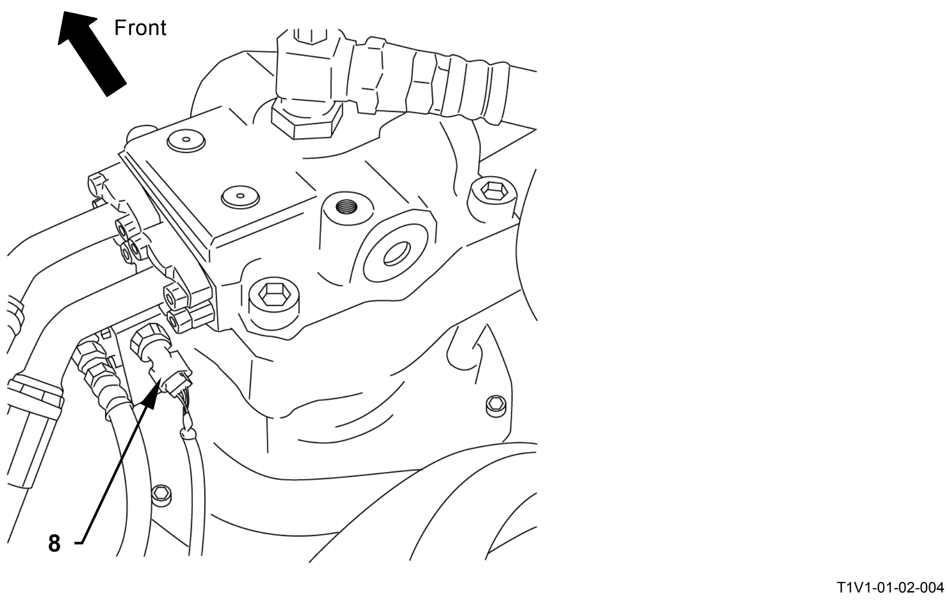
12 - Boost Pressure Sensor

13 - Glow Plug

PUMP DEVICE

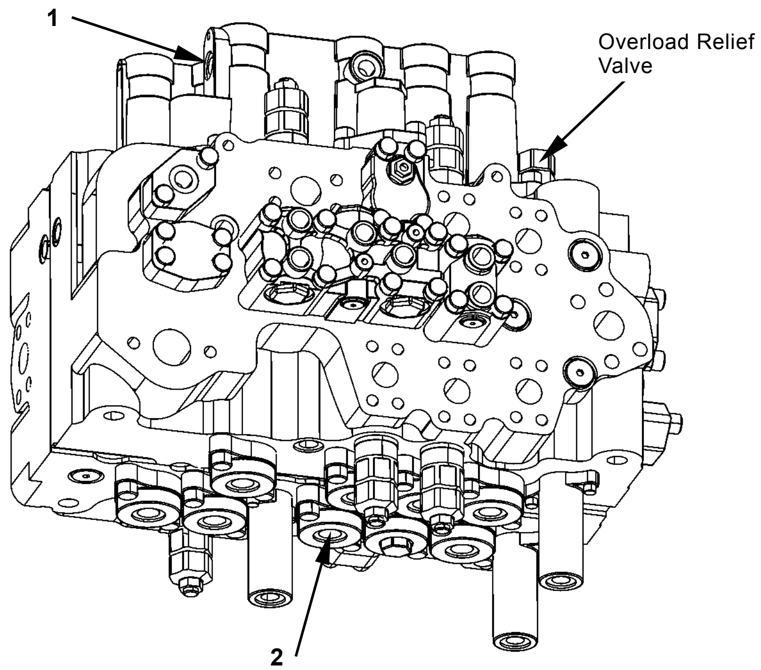


SWING DEVICE



1 - Regulator (Pump 2)
2 - Pump 2
3 - Pilot Pump
4 - Regulator (Pump 1)
5 - Pump 1
6 - Pump 1 Delivery Pressure Sensor
7 - Pump 2 Delivery Pressure Sensor
8 - Pressure Sensor (Front Attachment)

CONTROL VALVE



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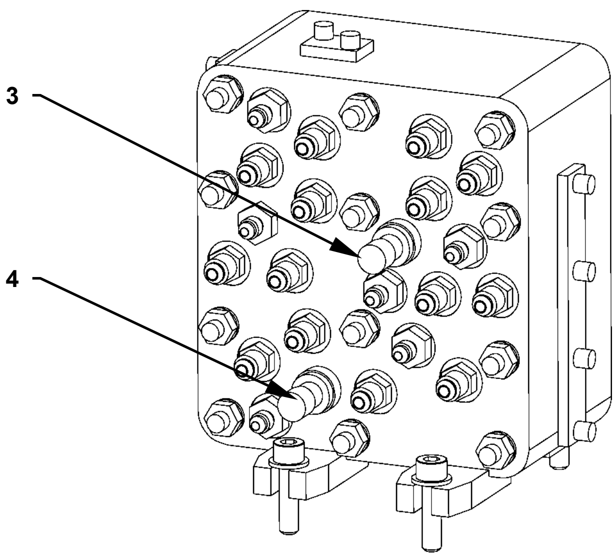
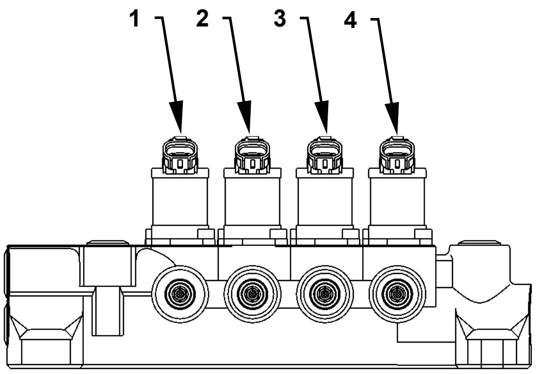
SIGNAL CONTROL VALVE



T1V1-01-02-014

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

SOLENOID VALVE UNIT



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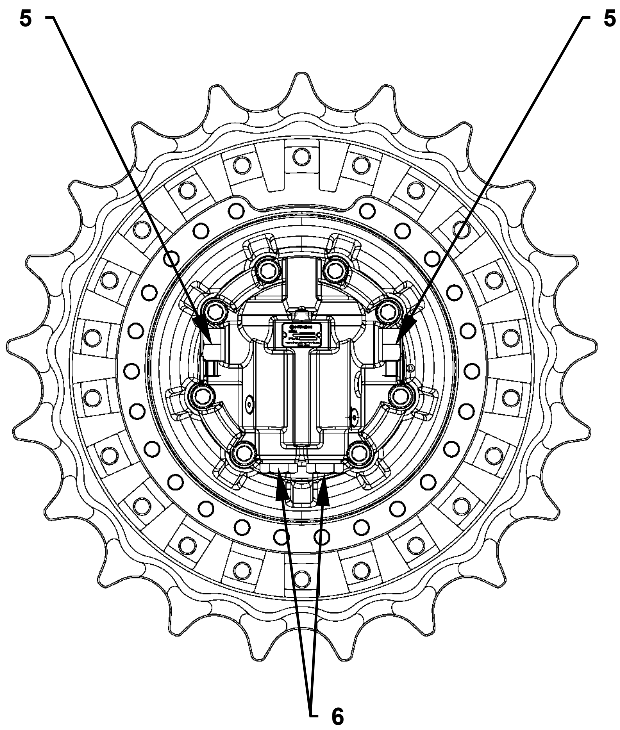
TRAVEL DEVICE



T1V7-01-02-004

1 − Solenoid Valve Unit SC	3 - Solenoid Valve Unit SI	5 - Counterbalance Valve	6 − Travel Relief Valve
2 − Solenoid Valve Unit SF	4 - Solenoid Valve Unit SG		

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ENGINE

Manufacturer	ISUZU
Model	6HK1XYSA-01
Type	Diesel, 4-Cycle, Water-cooled, Direct Injection Type, Exhaust Turbo Charged Type
Cyl. No.- Bore × Stroke	6-115 mm×125 mm (4.5 in×4.92 in)
Piston Displacement	7790 cm^3 (475 in^3)
Rated Output	165 kW/1750 min^{-1} (224 PS/1750 rpm) HP Mode: 202 kW / 1900 min^{-1} (274 PS / 1900 rpm)
Compression Ratio	17.5
Dry Weight	640 kg (1410 lb)
Firing Order	1-5-3-6-2-4
Rotation Direction	Clockwise (Viewed from fan side)

COOLING SYSTEM

Cooling Fan	Dia. 850 mm (33.5 in), 6 Blades, HF Hybrid (N6G Blade+ Iron Center), Draw-in Type, with Fan Ring and Safety Net
Fan Pulley Ratio	Belt Driven Rotation Ratio: 0.85
Thermostat	Cracking Temperature at Atmospheric Pressure: 82 °C (180 °F) Full Open (Stroke: 10 mm or more) Temperature: 95 °C (203 °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 5-Stage Type

STARTING SYSTEM

Motor	Magnetic Pinion Shift Reduction Type
Voltage / Output	24 V / 5.0 kW

PREHEAT SYSTEM

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

ENGINE STOP SYSTEM

Stop Method	Fuel Shut-Off (Electronic Control)

ALTERNATOR

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

SUPERCHARGING SYSTEM

Type	Exhaust-Turbocharger Type, RHG6 Type

FUEL SYSTEM

Type	Common Rail Type HP4 Type
Governor	Electronic All Speed Control
Injection Nozzle	Electrical Multi-Hole Injector

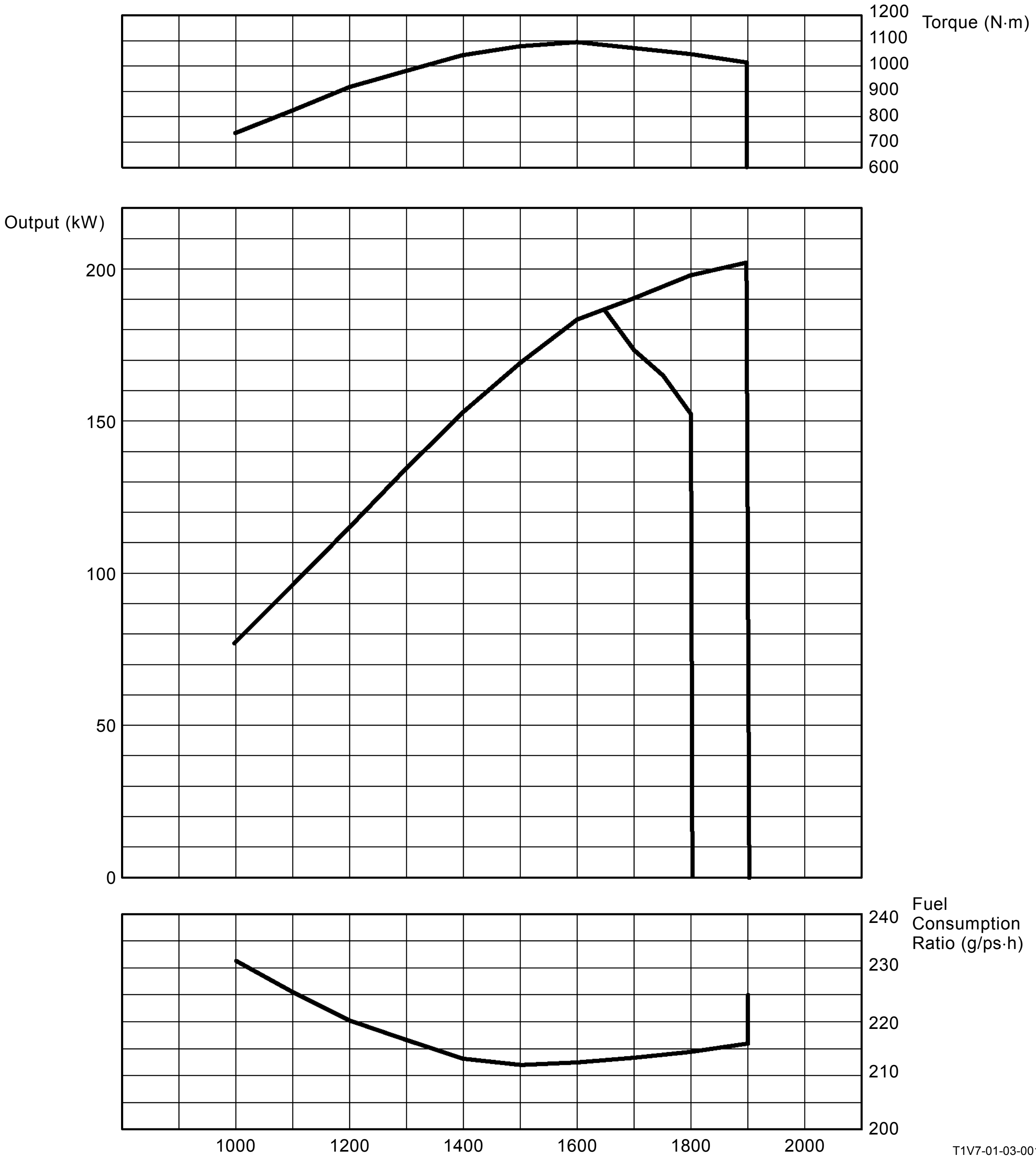
PERFORMANCE

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

Fuel Consumption Ratio	216 g/kW/h (294 g/PS·h) at 202 kW / (at Full Load: 1900 min^{-1}) 210 g/kW/h (285 g/PS·h) at 165 kW / (at Working Load: 1750 min^{-1})
Maximum Output Torque	1080 N·m (110 kgf·m) at approx. 1500 min^{-1}
Compression Pressure	3.04 MPa (31 kgf/cm^2) at 200 min^{-1}
Valve Clearance (Inlet / Exhaust)	0.4 / 0.4 mm (when cool)
No Load Speed	Slow: (at Full Load: 800±20 min^{-1}) Fast: (at Full Load: 1900±20 min^{-1}) (at Working Load: 1800±20 min^{-1})

Engine Performance Curve (6HK1XYSA-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.



T1V7-01-03-001

Engine Speed min^{-1}(rpm)

ENGINE ACCESSORIES

RADIATOR ASSEMBLY

Type	Parallel Type	
Weight	74.5 kg (164 lb)	
	Radiator	Oil Cooler
Capacity	11.4 L (3.0 US gal)	14.02 L (3.7 US gal)
Air-Tight Test Pressure	100 kPa (1.02 kgf/cm^2, 14.5 psi)	1500 kPa (15.3 kgf/cm^2, 218 psi)
Cap Opening Pressure	50 kPa (0.5 kgf/cm^2, 7 psi)	–
	Intercooler	
Capacity	10.2 L (2.7 US gal)	
Air-Tight Test Pressure	150 kPa (1.53 kgf/cm^2, 21.8 psi)	
Cap Opening Pressure	–	

FUEL COOLER

Weight .... 1.1 kg (2.4 lb)
Core Type .... Wavy Fin
Capacity .... 0.44 L (0.01 US gal.)

BATTERY

Capacity .... 128 Ah (5-Hour Rate)
Voltage .... 12 V
Weight .... 45 kg (99 lb)

Solenoid Pump

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

HYDRAULIC COMPONENT

PUMP DEVICE
- Drive Gear Ratio .... Main Pump: 1, Pilot Pump: 1

MAIN PUMP
- Type .... Bent-Axis Type Variable Displacement Axial Plunger Pump
- Model HPV145FW
- Maximum Flow Rate (Theoretical Value) .... 288 L/min (76 US gpm)×2
- Maximum Flow (Theoretical Value) .... 145.5 L/min (38.4 US gpm)×2
- Rated Pressure .... 34.3 MPa (350 kgf/cm^2, 4990 psi)

REGULATOR
- Type .... Hydraulic Pressure Operated Type

PILOT PUMP
- Model .... HY/ZFS 11/16.8
- Type .... Fixed Displacement Type Gear Pump
- Maximum Flow (Theoretical Value) .... 31.9 L/min (8.4 US gpm)

CONTROL VALVE
- Type .... Pilot Pressure Operated Type (4-Spools + 5-Spools)
  KVMG-270-HF
- Main Relief Set-Pressure .... Normal: 34.3 MPa (350 kgf/cm^2, 4980 psi) at
  260 L/min (69 US gpm)
  Power Digging: 36.3 MPa (370 kgf/cm^2) at
  260 L/min (69 US gpm)
- Overload Relief Set-Pressure .... 37.2 MPa (380 kgf/cm^2, 5410 psi) at 50 L/min (13.2 US gpm)
  (Boom Lower, Arm Roll-In, Bucket Roll-In)
  39.2 MPa (400 kgf/cm^2, 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.................................... 23.445

SWING MOTOR
- Model M5X180CHB-10A-46A
- Type .... Swash-Plate Type, Fixed Displacement Axial Plunger Motor

VALVE UNIT
- Type .... Non Counterbalance Valve Type
- Relief Set-Pressure....................................... 34.3^{+1}_{0} MPa (350^{+10}_{0} kgf/cm^2, 4990 psi) at 280 L/min (73.9 US gpm)

SWING PARKING BRAKE
- Type .... Multi-Disc-Wet Negative Type
- Release Pressure .... 3.3 MPa (34 kgf/cm^2, 480 psi)

SWING DAMPENER VALVE
- Model 2KR6P72/280-722
- Release Pressure .... 32.4 MPa (330 kgf/cm^2, 4710 psi)

TRAVEL DEVICE
- Type .... Three-Stage Reduction Planetary Gear
- Reduction Gear Ratio.................................... 76.066

TRAVEL MOTOR
- Type .... Swash-Plate Type Variable Displacement Axial Plunger Motor
- Model HMK160AF-3UB
- Maximum Flow (Theoretical Value) (Fast/Slow) .... 94.0/160.0 L/min (24.8/42.2 US gpm)

TRAVEL BRAKE VALVE
- Type .... Counterbalance Valve Type
- Relief Set Pressure .... 34.8 MPa (355 kgf/cm^2, 5050 psi)

TRAVEL PARKING BRAKE
- Type .... Multi-Disc-Wet Negative Type
- Release Starting Pressure .... 1.07 to 1.23 MPa (10.9 to 12.5 kgf/cm^2, 156 to 179 psi)

CYLINDER (MONO BOOM MACHINE)

	Boom	Arm
Rod Diameter	100 mm (3'9")	115 mm (4'5")
Cylinder Bore	145 mm (5'7")	170 mm (6'7")
Stroke	1520 mm (4'11")	1740 mm (5'8")
Fully Retracted Length	2145 mm (7'0")	2425 mm (7'11")
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

	Bucket
Rod Diameter	95 mm (3'7")
Cylinder Bore	140 mm (5'5")
Stroke	1250 mm (4'1")
Fully Retracted Length	1818 mm (5'11")
Plating Thickness	30 μm (1.18 μm)

CYLINDER (2-PIECE BOOM MACHINE)

	Boom	Arm
Rod Diameter	100 mm (3'9")	115 mm (4'5")
Cylinder Bore	145 mm (5'7")	170 mm (6'7")
Stroke	1520 mm (4'11")	1740 mm (5'8")
Fully Retracted Length	2145 mm (7'0")	2425 mm (7'11")
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

	Bucket	Positioning
Rod Diameter	95 mm (3'7")	110 mm (4'3")
Cylinder Bore	140 mm (5'5")	170 mm (6'7")
Stroke	1250 mm (4'1")	1498 mm (4'11")
Fully Retracted Length	1818 mm (5'11")	2138 mm (7'0")
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)

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

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

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

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

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

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

FILTER

Engine Oil Filter... ISUZU 8973243860
Fuel Filter .... ISUZU 8973759081

	Filtration
Air Cleaner	-
Full-Flow Filter..	12 μm
Suction Filter	177 μm
Pilot Filter	10 μm

ELECTRICAL COMPONENT

BATTERY RELAY
Voltage / Current .... 24 V / 100 A (continuousness), 1000A (30 seconds)

STARTER RELAY 2
Voltage .... 24 V

GLOW RELAY
Voltage .... 24 V

HYDRAULIC OIL TEMPERATURE SENSOR
Operating Temperature .... -30 to 120 °C (-22 to 248 °F)

AIR CLEARNER RESTRICTION SWITCH
Operating Pressure....................................... 62.2±0.57 kPa (0.6±0.006, 8.5±0.085 psi)

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

ILLUMINATION
Specifications .... Working Light: Halogen 24V, 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 m^3/h or More
Heating Ability.. 21.0 MJ/h (5000 kcal/h) or More
Warm Air Volume .... 500 m^3/h or More
Temperature Adjusting System .... Electronic Type
Refrigerant Quantity .... 1100±50 g
Compressor Oil Quantity............................... 210 cm^3

MEMO

MEMO

SECTION 2
SYSTEM

—CONTENTS—

Group 1 Controller

Group 2 Control System

Group 3 ECM System

Group 4 Hydraulic System

Group 5 Electrical System

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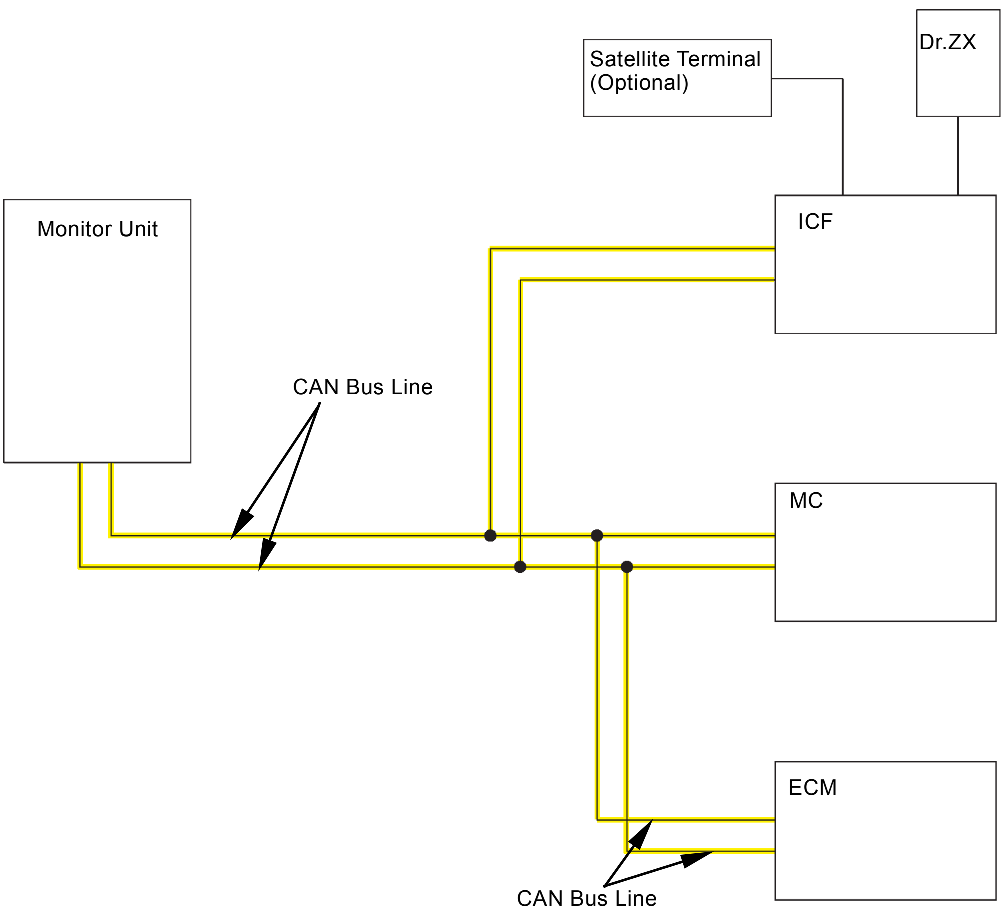
OUTLINE

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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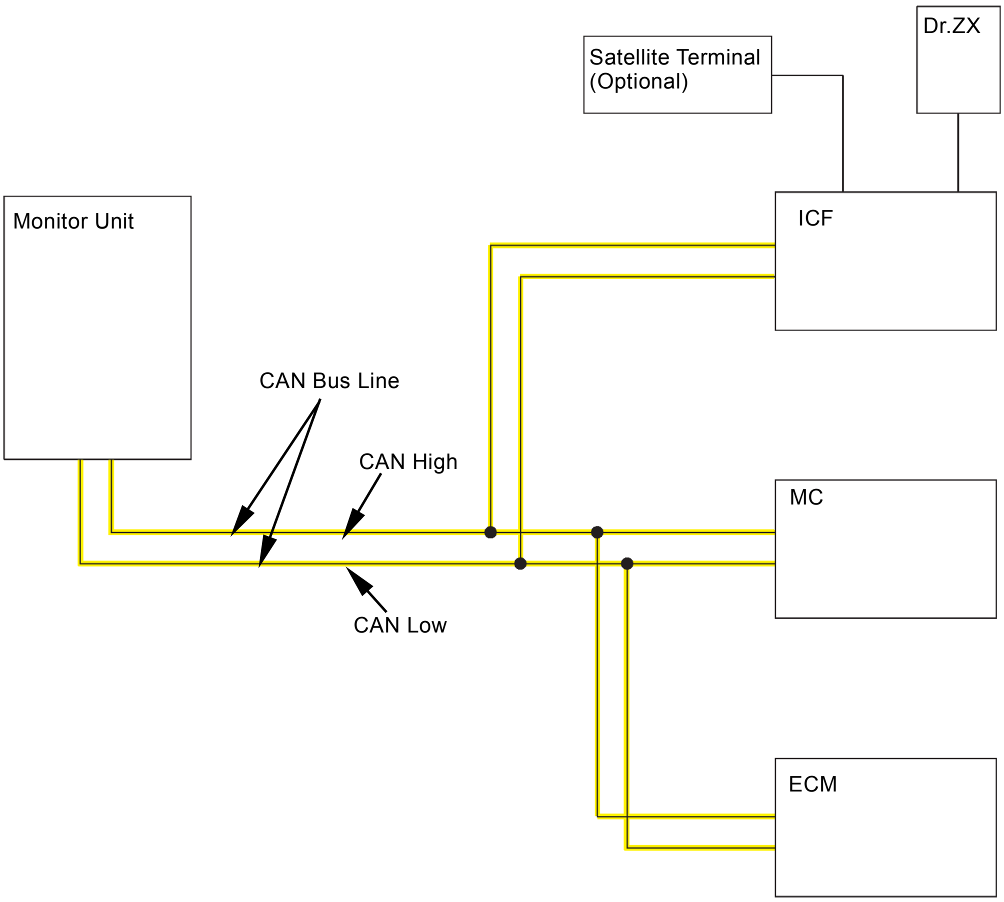
NOTE: CAN (CAN Bus Line)

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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MC: MAIN CONTROLLER

Function Outline

Engine Control

・Engine Control Dial Control

MC sends the signal to ECM according to the idle position of engine control dial and controls the engine speed.

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

・HP Mode Control

Average Delivery Pressure of Pumps 1 and 2: High
Engine Control Dial: Engine Speed 1500 min^{-1} or faster
Power Mode Switch: HP Mode Position

When operating boom raise and arm roll-in on conditions above, MC sends the signal to ECM and increases engine speed beyond the set speed of engine control dial in order to increase engine power.

・Travel HP Mode Control

Average Delivery Pressure of Pumps 1 and 2: High
Engine Control Dial: Fast Idle Position
Travel Mode Switch: Fast

When operating travel on conditions above, MC sends the signal to ECM and increases engine speed beyond the set speed of engine control dial in order to increase travel speed.

When operating the front attachment at the same time, this control becomes ineffective.

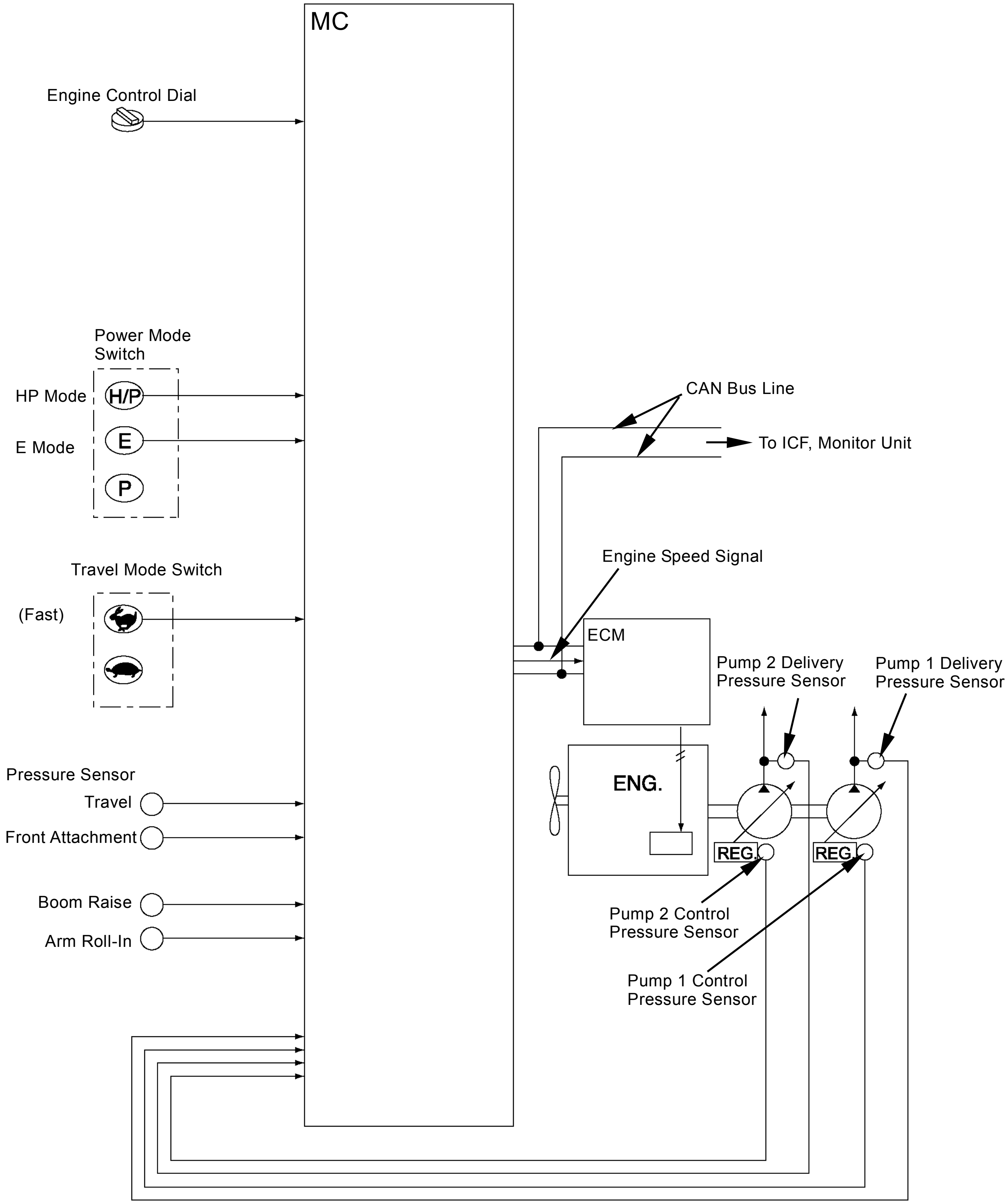
・E Mode Control

Condition:
Pump Control Pressure and Pump Average Delivery Pressure: Both Low Pressure
Pump Control Pressure and Pump Average Delivery Pressure: Both High Pressure
Pump Control Pressure: Low Pressure and Pump Average Delivery Pressure: High Pressure
Engine Control Dial: Engine Speed 1800 min^{-1} or faster
Power Mode Switch: E Mode Position

On conditions above, MC sends the signal to ECM and decreases engine speed below the set speed of engine control dial.

Pump Control Pressure: High Pressure and Pump Average Delivery Pressure: Low Pressure

On conditions above, MC sends the signal to ECM and increases engine speed 200 min^{-1} beyond the set speed of engine control dial.



T1V1-02-01-039

- 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 travel, auto-idle control is released.

- Auto-Warming Up Control

When the hydraulic oil temperature is below 0 °C (32 °F) for 15 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 auto warm-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.

- Heater Control

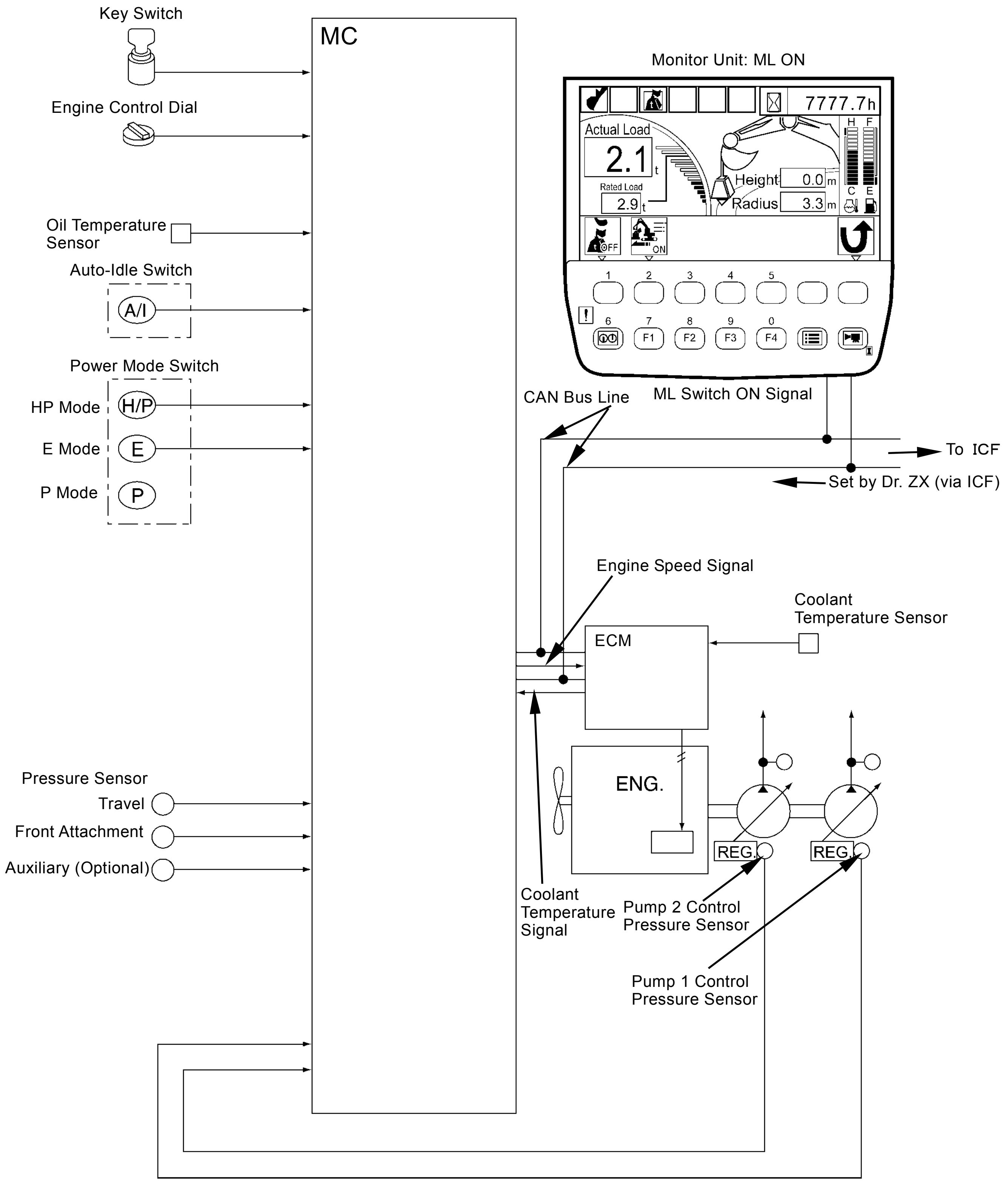
Coolant Temperature: Less than 5 °C (41 °F)
Pump Control Pressure of Pumps 1 and 2: 0.5 Mpa (5.1 kgf/cm^2, 37 psi) or less
Engine Control Dial: Fast Idle Position
When the engine starts on conditions above, MC send the signal to ECM and increases engine speed beyond fast idle speed.

- Attachment Operation Speed Increase Control (Optional)

Set attachment operation speed to increase (+) with Dr. ZX in the service mode.
Engine Control Dial: Fast Idle Position
Power Mode Switch: HP Mode Position
When operating attachment on condition above, MC sends the signal to ECM and increases engine speed to the attachment operating speed set by Dr. ZX beyond fast idle.

- Attachment Operation Speed Limit Control (Optional)

Set attachment operation speed to decrease (-) with Dr. ZX in the service mode. 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.



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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 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 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.

・Attachment Pump Torque Decrease Control (Optional)

When attachment pump torque control is effective on Dr. ZX, the attachment (secondary crusher or primary crusher) is operated and pump average delivery pressure becomes high, MC drives the torque control solenoid valve according to the signal from the pump 1, 2 delivery pressure sensors. Pilot pressure from the torque control solenoid valve decreases pump 1, 2 delivery flow rate and controls pump 1, 2 absorption power (pump torque) in order not to exceed engine power. This control prevents hydraulic from increasing temperature when the attachment is used.

・Pump 1 Flow Rate Limit Control (Optional)

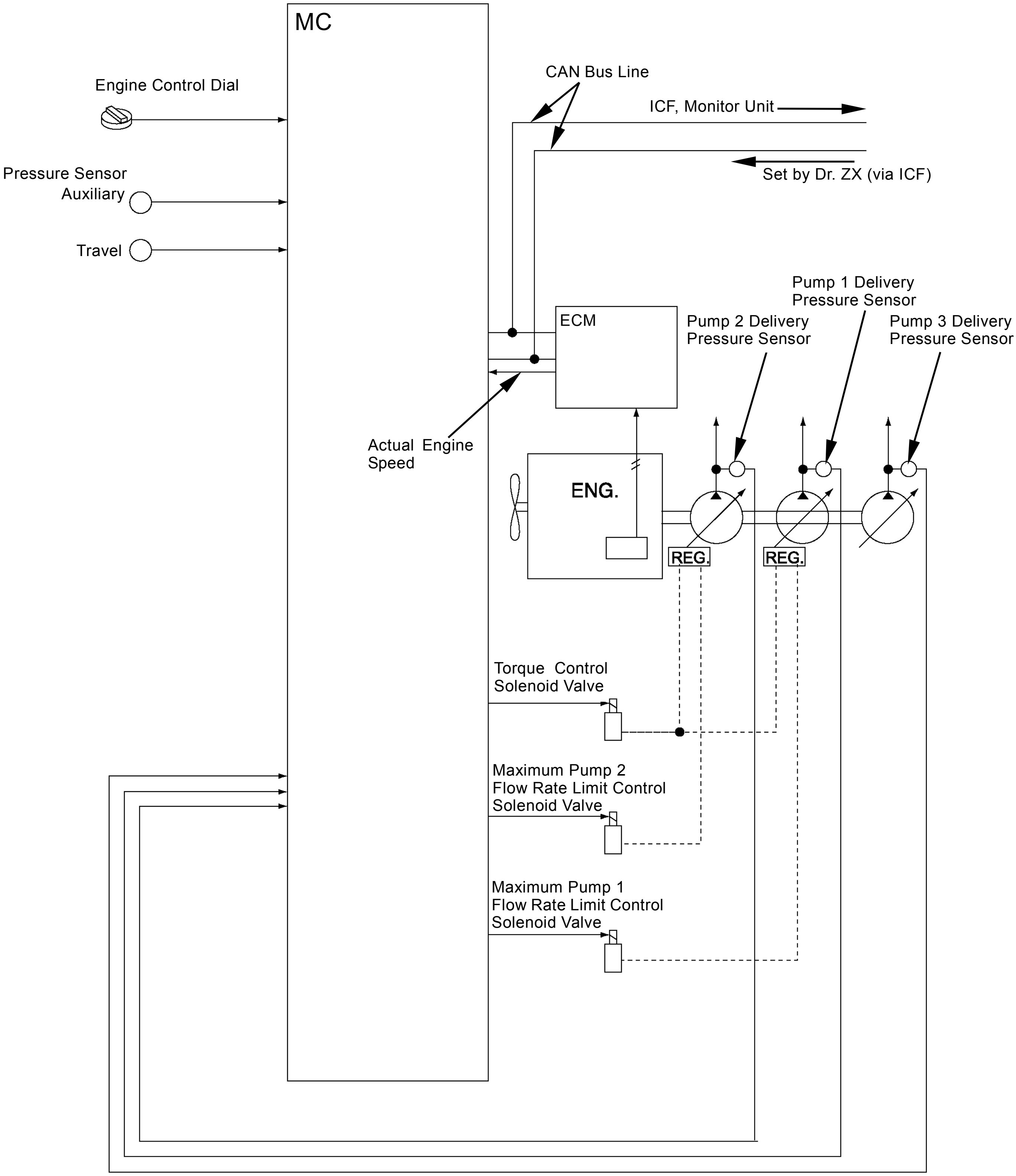
When the attachment (mainly a vibrating hammer) is used with the travel control lever in neutral, MC drives the maximum pump 1 flow rate limit control solenoid valve according to the signal from pressure sensor (auxiliary) and decreases maximum flow rate of pump 1.

・Pump 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 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.



T1V1-02-01-041

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 pimp 1 delivery pressure sensor and increases relief pressure of the main relief valve in control valve.

- Arm Regenerative Control

  Condition:

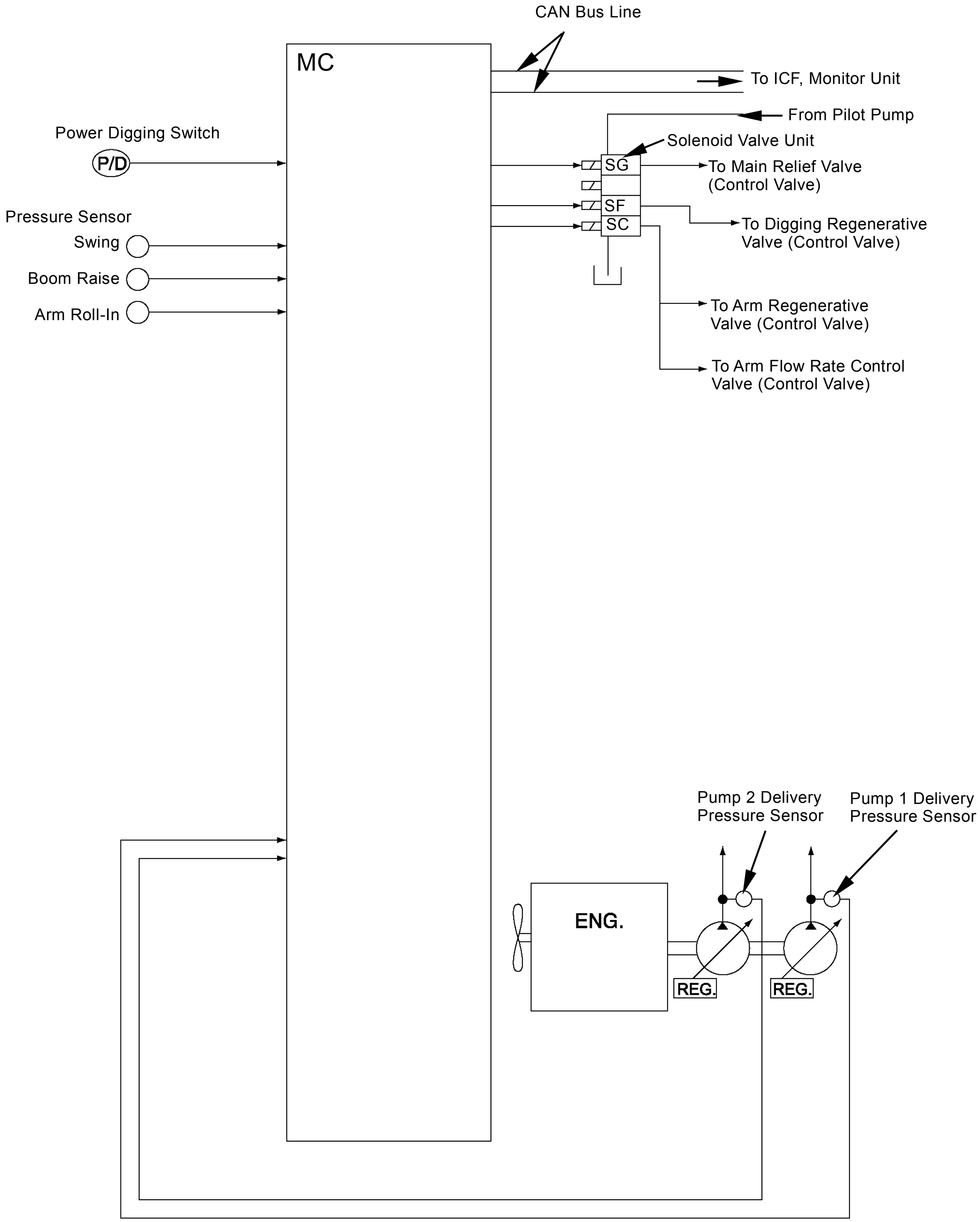
  Pump 1, 2 Delivery Pressure: Either Low

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

On conditions above, MC drives solenoid valve unit (SG) 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 section in SYSTEM.)

- Digging Regenerative Control

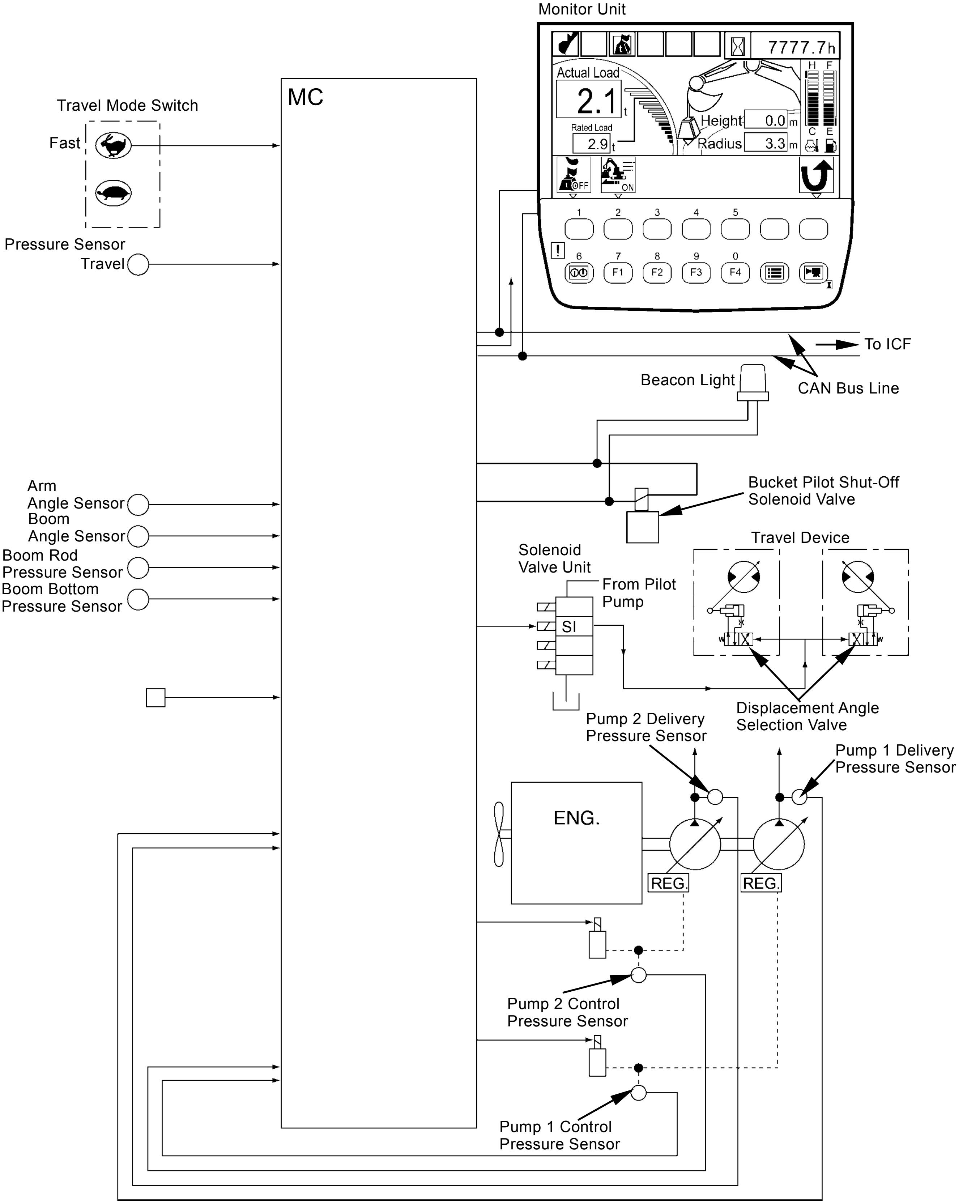
When operating digging with pump 1, 2 delivery pressure in high, MC drives solenoid valve unit (SF) according to the signals from pumps 1, 2 delivery pressure sensors and pressure sensor (arm roll-in, boom raise), outputs pilot pressure, and shifts the digging regenerative valve.
As pressure oil from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



T1V1-02-01-042

- 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.



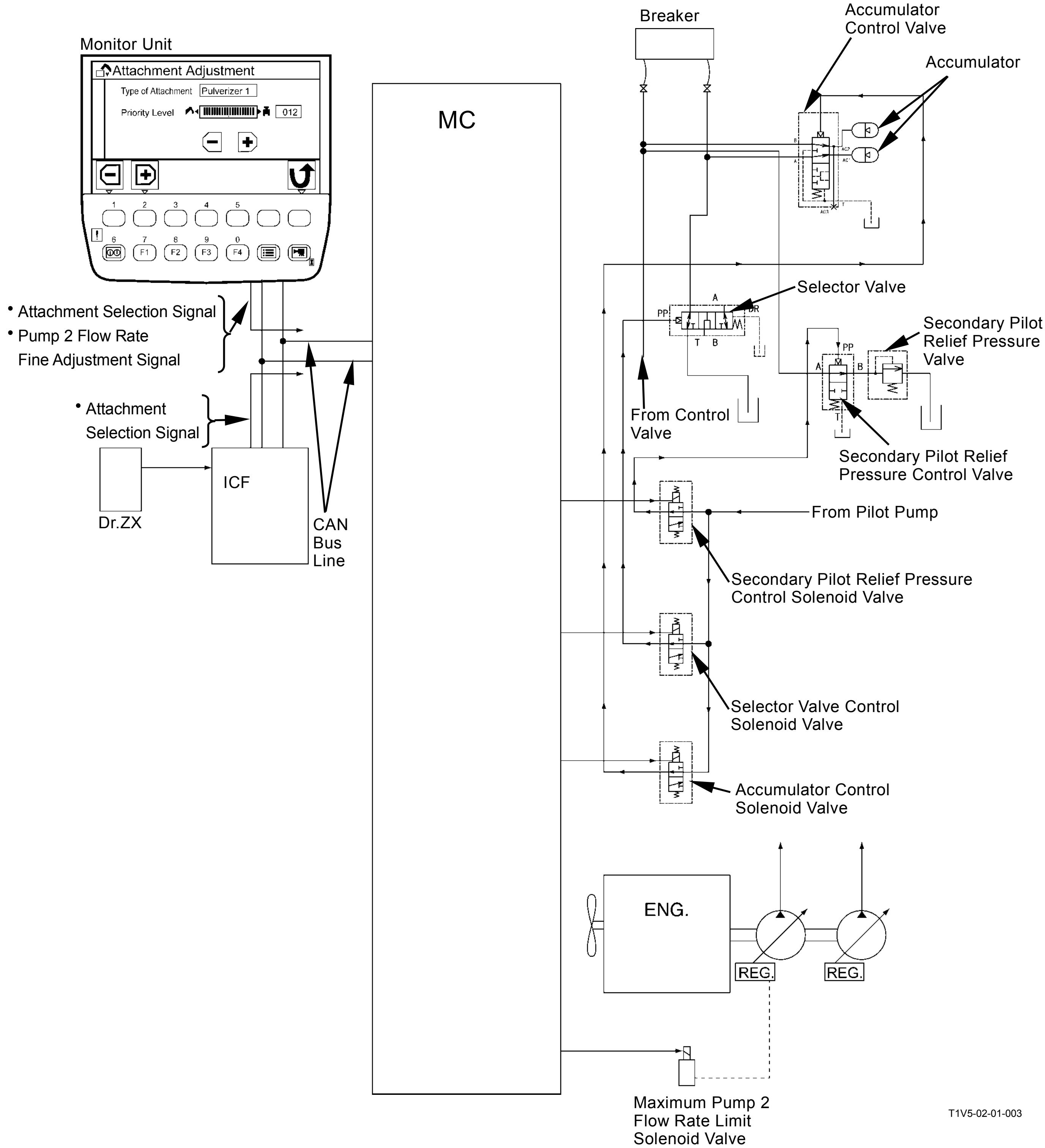
T1V5-02-01-002

- HSB Breaker Control (Optional)

As for the machine equipped with HSB breaker, when breaker 1 is selected on the monitor unit or is set by Dr. ZX, MC drives the selector valve control solenoid valve and the secondary pilot relief pressure control solenoid valve.
Pilot pressure from the selector valve control solenoid valve shifts the selector valve and connects the return circuit in breaker to hydraulic oil tank.
Pilot pressure from the secondary pilot relief pressure control solenoid valve shifts the secondary pilot relief pressure control valve and reduces relief set pressure in the breaker circuit.

- NPK Breaker Control (Optional)

As for the machine equipped with NPK breaker, when breaker 2 is selected on the monitor unit or is set by Dr. ZX, MC drives the selector valve control solenoid valve and the accumulator control solenoid valve.
Pilot pressure from the selector valve control solenoid valve shifts the selector valve and connects the return circuit in breaker to hydraulic oil tank.
Pilot pressure from the accumulator control solenoid valve shifts the accumulator control valve, connects the accumulator to the circuits in breaker cylinder bottom side and rod side, reduces shock of oil pressure, and buffers vibration when the breaker is used.



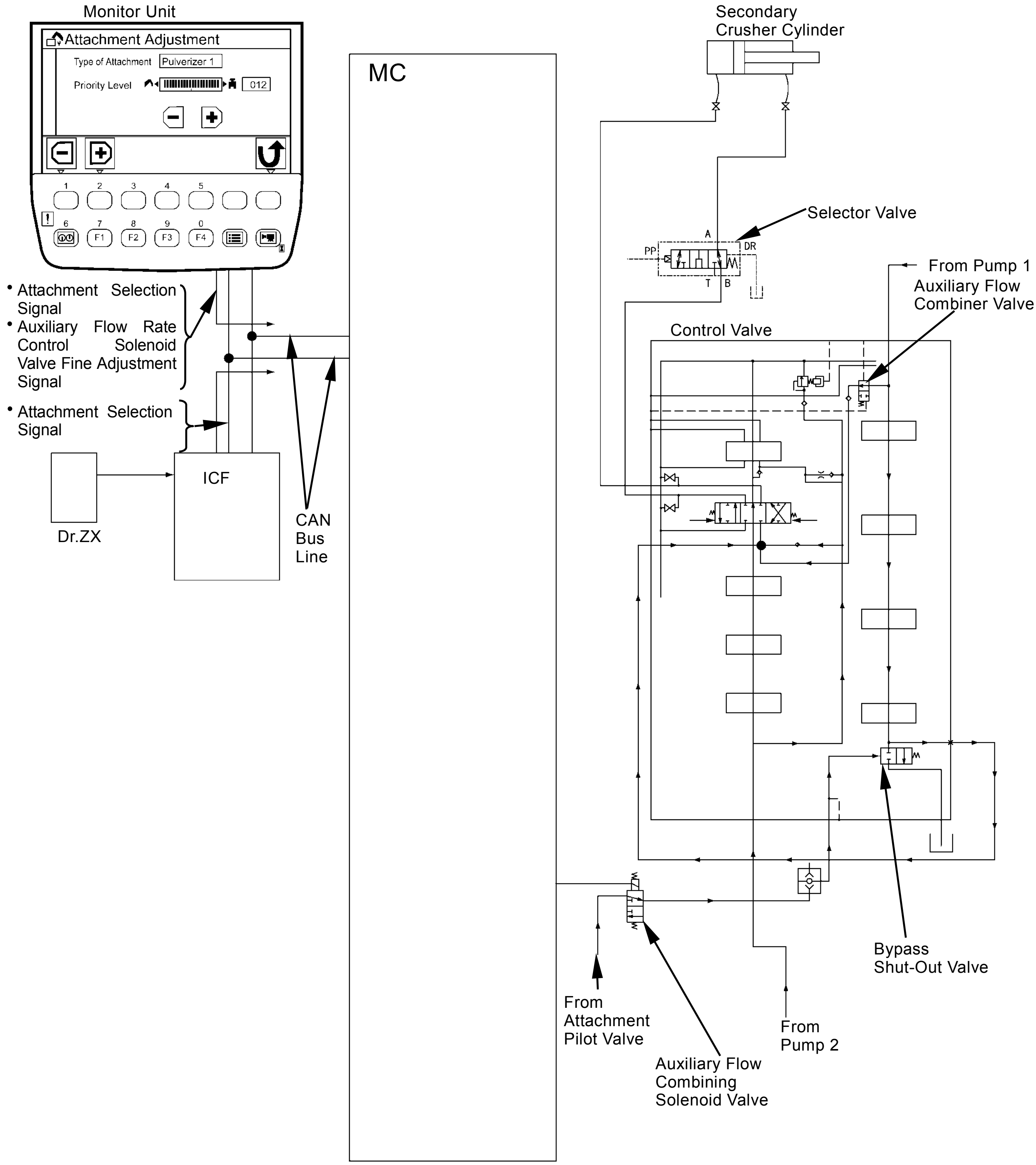
NOTE: Flow rate of maximum pump 2 flow rate limit solenoid valve can be adjusted finely on the monitor unit.

- 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.

- 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.



T1V7-02-01-003

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

Other Controls

- Rear Monitoring Display Selection Control

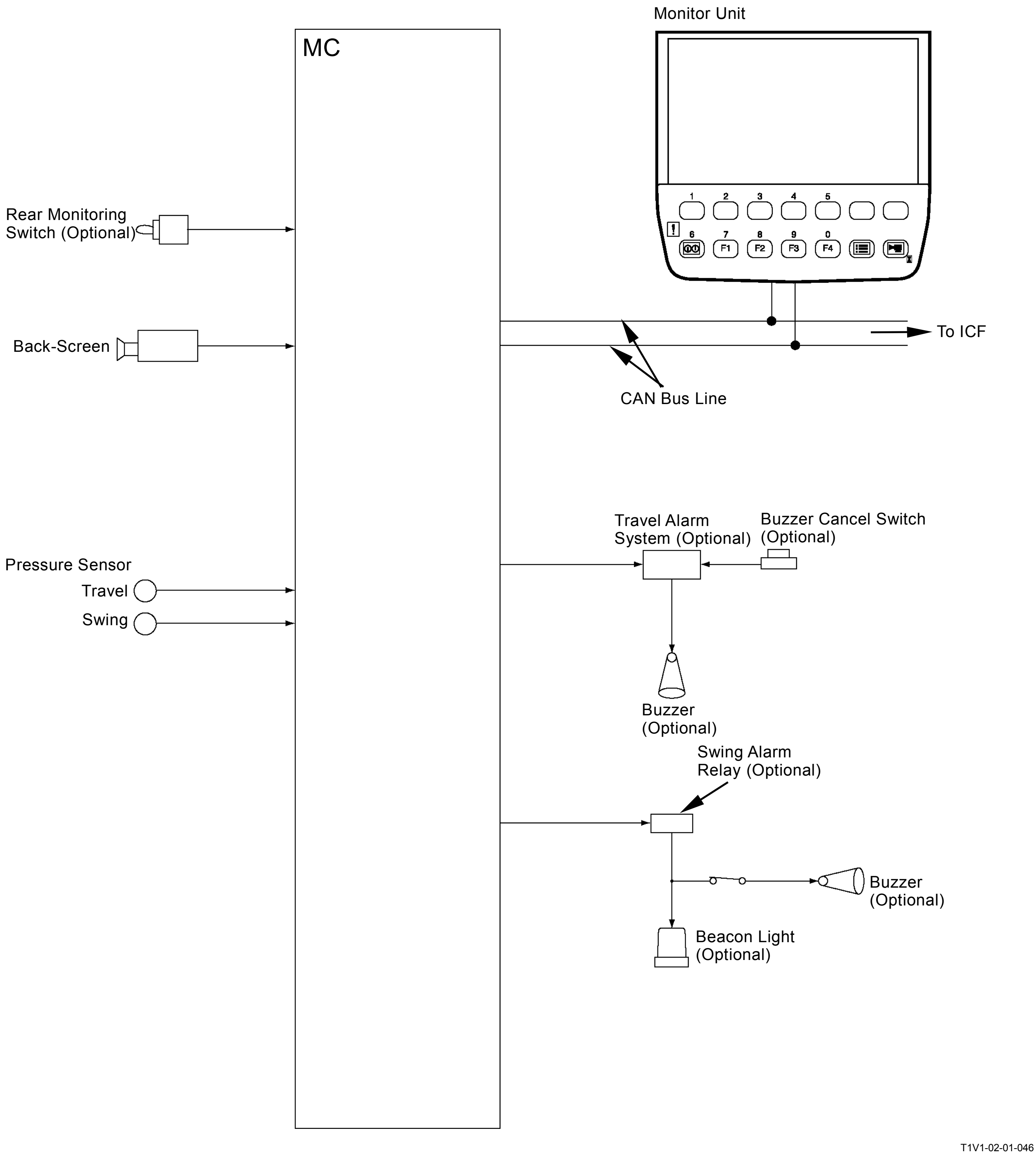
MC shifts the monitor unit into the back-screen display according to the signal from pressure sensor (travel) or rear monitoring switch (optional).

- 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.


Monitor Unit
MC
Rear Monitoring Switch (Optional)
Back-Screen
To ICF
CAN Bus Line
Travel Alarm System (Optional)
Buzzer Cancel Switch (Optional)
Pressure Sensor
Travel
Swing
Buzzer (Optional)
Swing Alarm Relay (Optional)
Buzzer (Optional)
Beacon Light (Optional)
T1V1-02-01-046

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

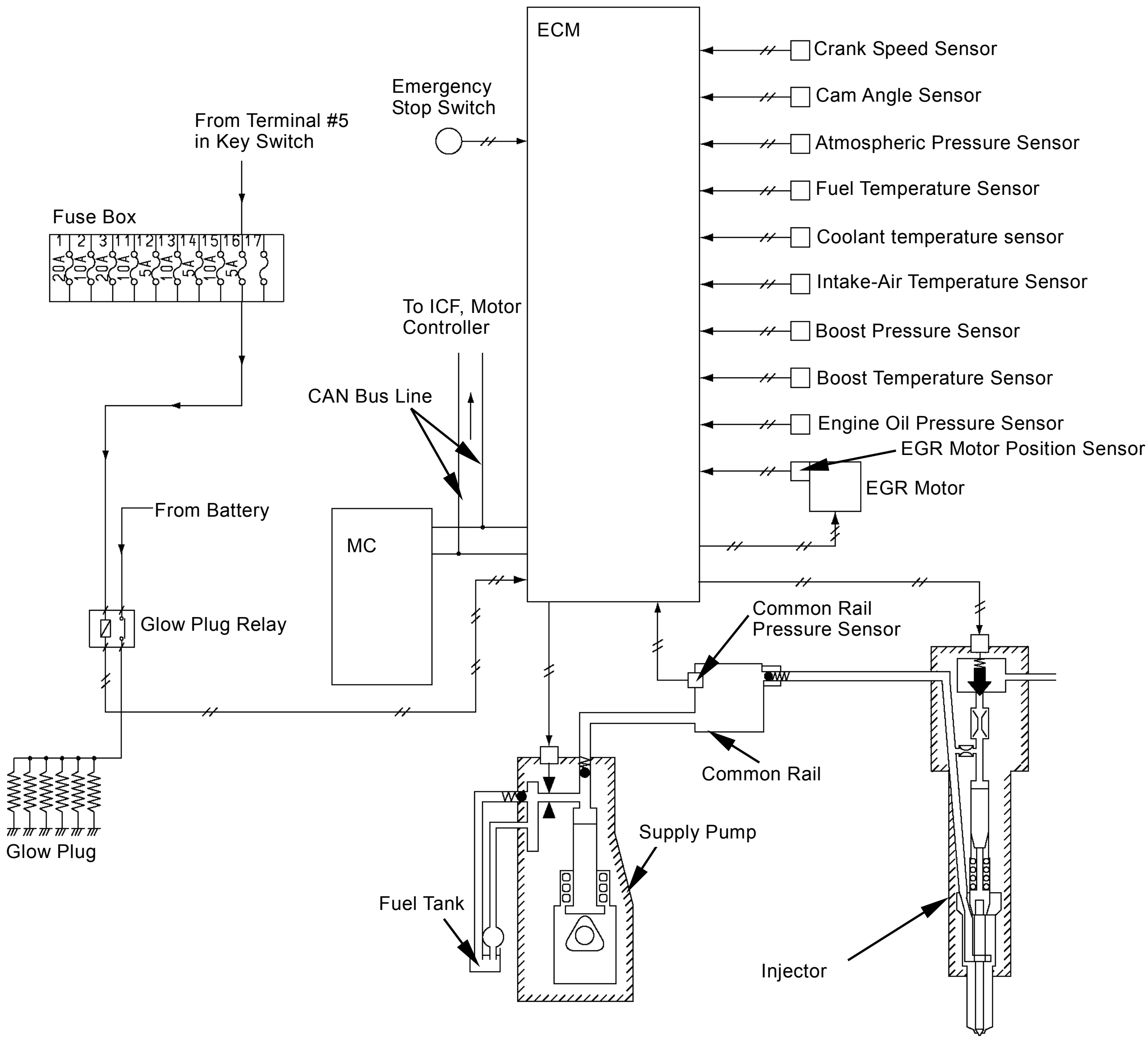
ECM decides EGR gas amount according to engine speed, fuel flow rate, coolant temperature, atmospheric pressure and intake-air temperature.
ECM opens EGR valve and re-circulates exhaust gas, amount of which is equal to EGR gas amount, in the intake manifold. EGR gas is combined with intake-air so that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



T1V7-02-01-002

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

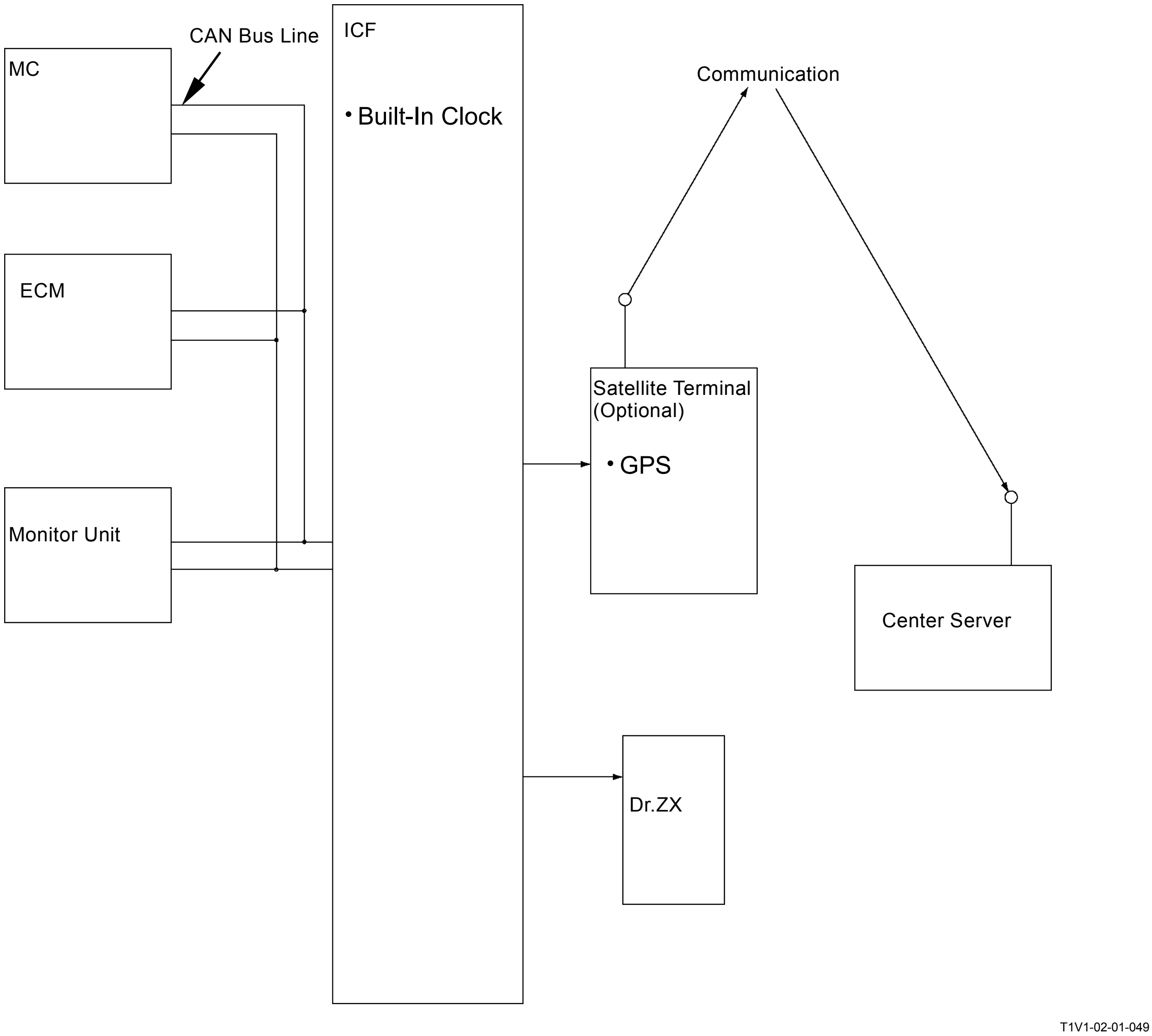
ICF makes the frequency distribution data every 100 hours.
The frequency distribution data can be sent to the center server by using the satellite terminal (optional).

- 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.


CAN Bus Line
ICF
• Built-In Clock
MC
ECM
Monitor Unit
Communication
Satellite Terminal
(Optional)
• GPS
Center Server
Dr.ZX
T1V1-02-01-049

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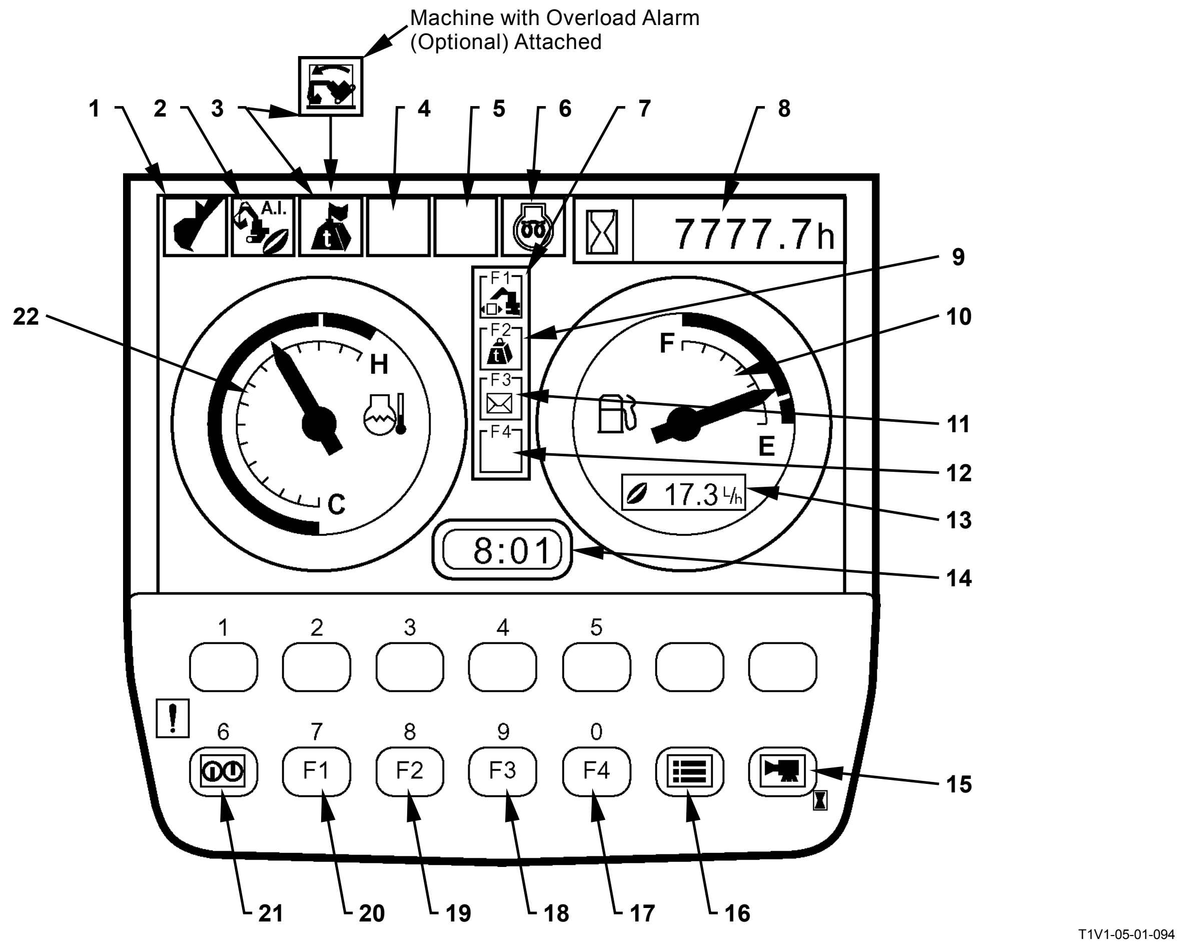
OUTLINE

Function Outline

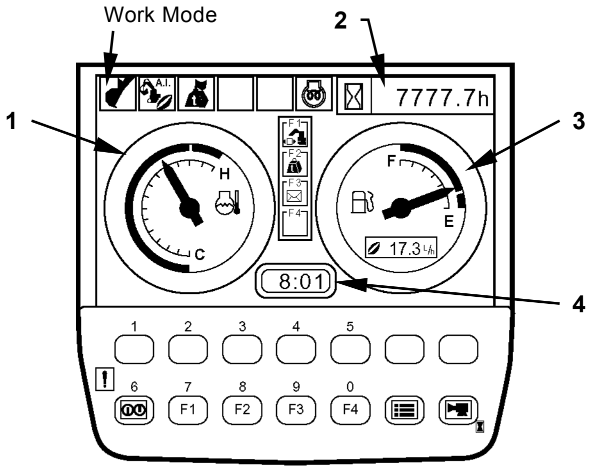
Primary Screen



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		

- Display of Meters
  Data to be displayed on each meter are received from other controllers (MC, ICF and ECM) by using CAN, and are displayed on the monitor unit.

  Items to be displayed
  1. Coolant Temperature Gauge
  2. Hour Meter
  3. Fuel Gauge
  4. Clock



T1V1-05-01-008

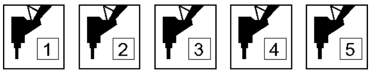
- Work Mode Display
  The attachments being used are displayed according to the signals received from MC by using CAN.

Digging Mode


T1V1-05-01-108

Attachment Mode

Breaker

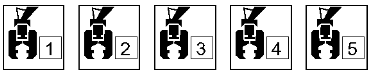


T1V1-05-01-104

Pulverizer

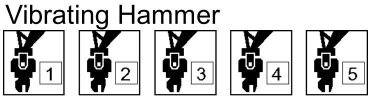
T1V1-05-01-105

Crusher



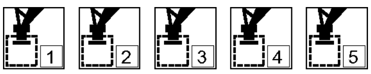
T1V1-05-01-106

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
Breaker 1	Hydraulic Breaker 1
Breaker 2	Hydraulic Breaker 2
Pulverizer 1	Secondary Crusher 1
Crusher 1	Primary Crusher 1

- Auto-Idle Display(1)
  When selecting auto-idle from the switch panel, the data according to the signals received from MC by using CAN is displayed.
  When the key is turned ON, the data blinks for 10 seconds.

- ML Crane or Overload Alarm Display (2) (optional)
  ML Crane

T1V1-05-02-001

When ML crane mode switch or travel suspended load mode switch is turned ON on the ML crane display, the data will be displayed.

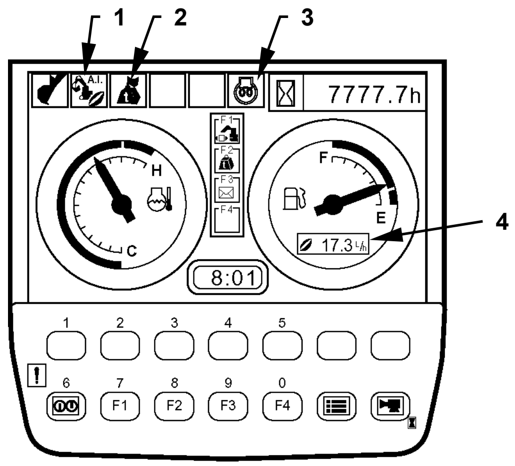
Overload Alarm Display

T1V1-05-02-002

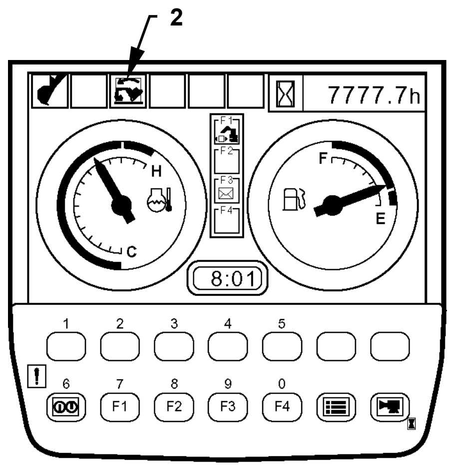
The system measures the load of suspended load from the bottom pressure of boom cylinder. When overload is detected, an alarm is displayed.
(Refer to T2-1-34.)

- Glow Display (3)
  While ECM is supplying current to the glow plug, the data is displayed according to the signal from ECM.

- Fuel Consumption Gauge Display (4)
  Fuel consumption is displayed according to the signal from ECM, which is received through MC by using CAN.



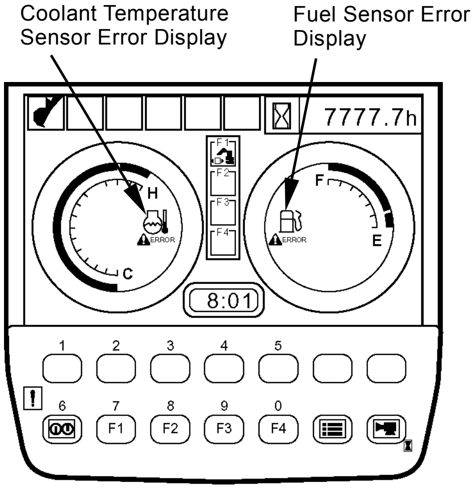
T1V1-05-01-008



T1V1-05-01-128

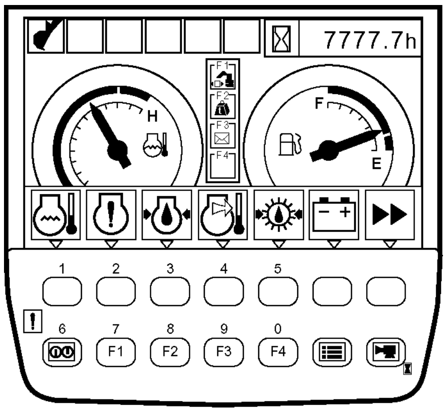
- Fuel Sensor Error Display
  When the fuel sensor is faulty or if the harness between fuel sensor and monitor unit is broken, the data is displayed on the fuel gauge.

- Coolant Temperature Sensor Error Display
  When the coolant temperature sensor is faulty or if the harness between coolant temperature sensor and monitor unit is broken, the data is displayed on the coolant temperature gauge.

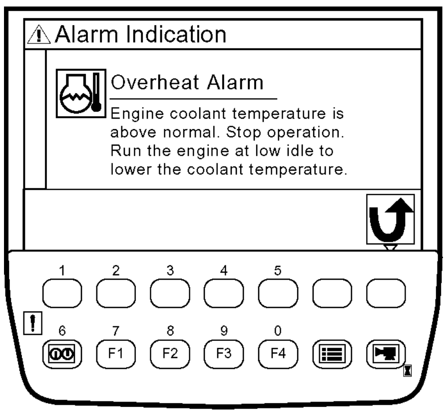


T1V1-05-02-005

- Alarm and Remedy Displays against Alarm
  Alarm marks are displayed on the lower part of screen according to the alarm signals received from each controller by using CAN. The remedy for each alarm is displayed by key operation.

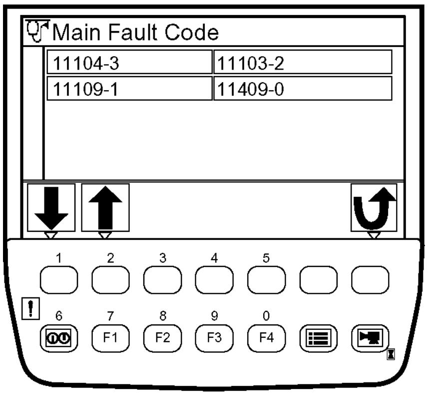


Alarm Display T1V1-05-01-096



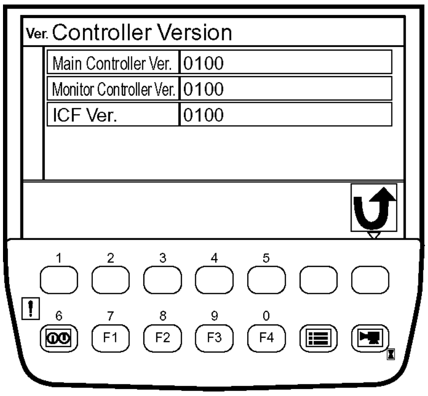
Remedy Display against Alarm T1V5-05-01-013

- Troubleshooting
  This screen displays fault codes according to the signals received from ICF by using CAN.



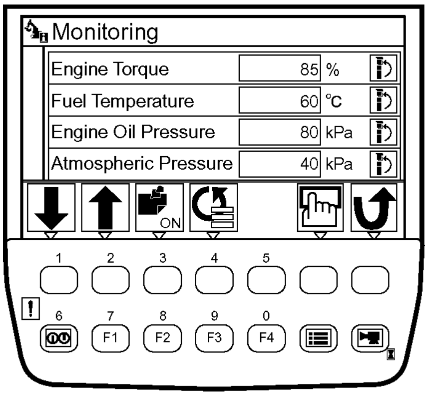
Fault Code Display T1V5-05-01-097

- Controller Version
  This screen displays the version of controller.



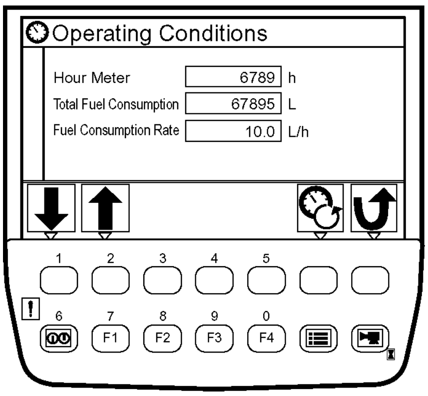
Controller Version Display T1V5-05-01-122

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



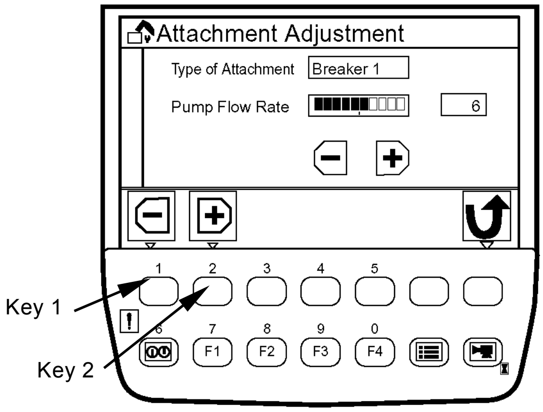
Monitoring Screen T1V5-05-01-087

- Operating Conditions
  This screen displays machine hour, fuel usage and fuel consumption rate registered by the monitor unit.



Operating Conditions Screen T1V5-05-01-025

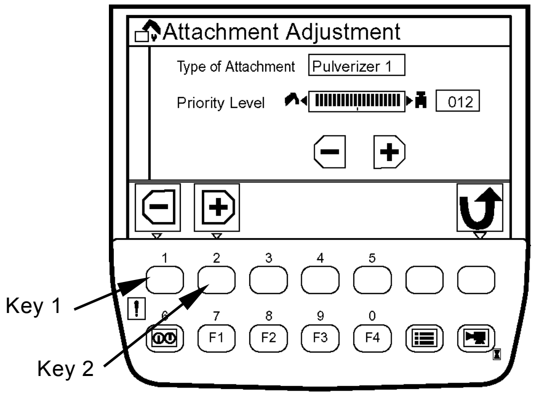
- Pump 2 Flow Rate Adjustment
  (Only machines equipped with optional parts)
  When using the attachments, fine adjust flow rate of pump 2 by keys 1 and 2 operation.
  The signals from the monitoring unit are sent to MC by using CAN.
  When breaker 1 or 2 is used, MC adjusts flow rate of pump 2 while controlling maximum pump 2 flow rate limit control solenoid valve. When using pulverizer 1 or crusher 1, 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 blow 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 Pilot Relief Pressure 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	ON	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
Breaker 1	Hydraulic Breaker 1
Breaker 2	Hydraulic Breaker 2
Pulverizer 1	Secondary Crusher 1
Crusher1	Primary Crusher 1

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

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

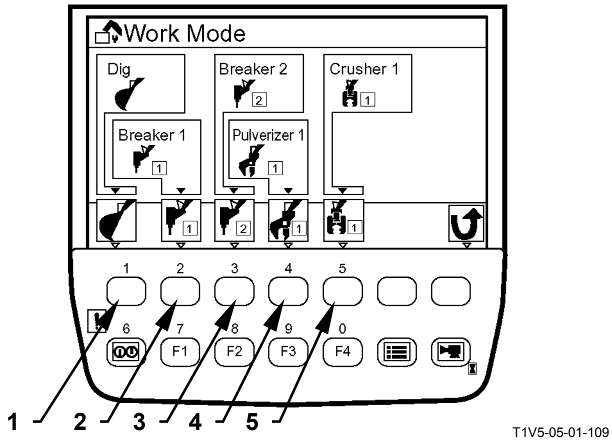
1 - Digging

2 - Breaker 1

3 - Breaker 2

4 - Pulverizer 1

5 - Crusher 1



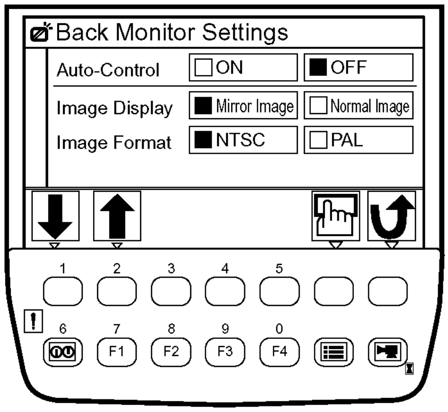
Attachment Selection Screen

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

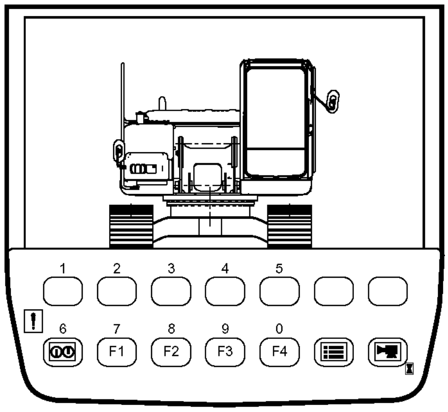
Monitor Unit	HITACHI pattern
Breaker 1	Hydraulic Breaker 1
Breaker 2	Hydraulic Breaker 2
Pulverizer 1	Secondary Crusher 1
Crusher 1	Primary Crusher 1

- Back Monitor Settings
  By key operation, image display ON and OFF of Auto-Control for switching image of the back monitor while traveling pilot time and display format on the screen of the rear view camera can be set.

IMPORTANT: the rear view camera is set in mirror image mode. Therefore, if image display is set as mirror image, normal image is displayed on the screen of monitor unit.
If image display is set as normal image, mirror image is displayed on the screen of monitor unit.

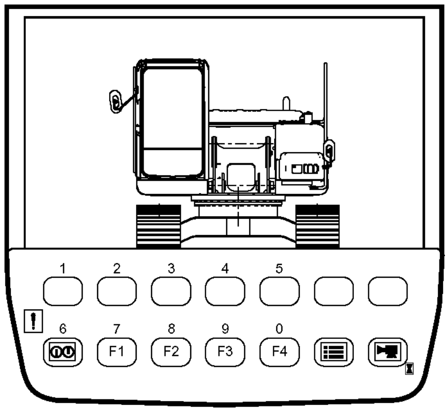


T1V5-05-01-134



T1V1-05-01-126

Normal Image Screen



T1V1-05-01-127

Mirror Image Screen

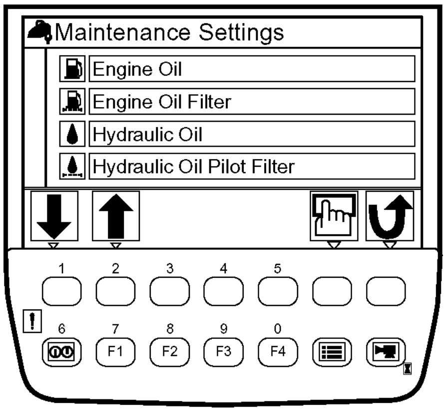
- Maintenance Settings
  This screen displays the hour meter reading at replacement time and the remaining hours until the next replacement.
  As the items to be replaced are displayed in a list, record performed replacement by selecting an item from the list.

  - Interval ON/OFF Settings
    Set change interval for each item to be replaced.

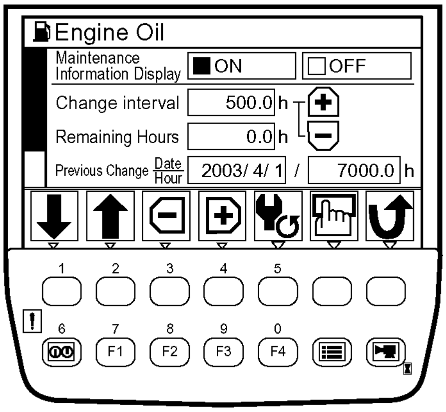
  - Items included in Maintenance Settings
    Engine Oil
    Engine Oil Filter
    Hydraulic Oil
    Hydraulic Oil Pilot Filter
    Hydraulic Oil Full-Flow Filter
    Pump Transmission Oil
    Travel Device Oil
    Swing Device Oil
    Swing Bearing Grease
    Air Cleaner Filter
    Engine/Air Conditioner 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.

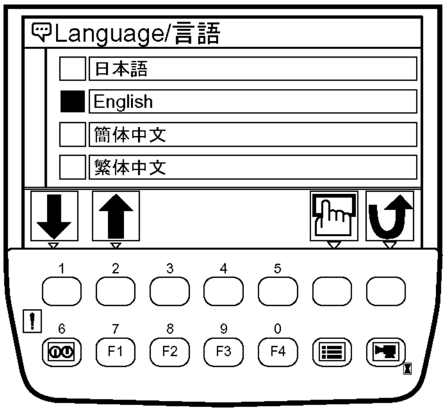
- Mail
  (Optional Function)
  Send requests such as general, fuel replenishment, service maintenance, and forwarding requests in the mail switch screen.
  Contents of mails are registered in ICF, and are sent to the central server by a satellite terminal.



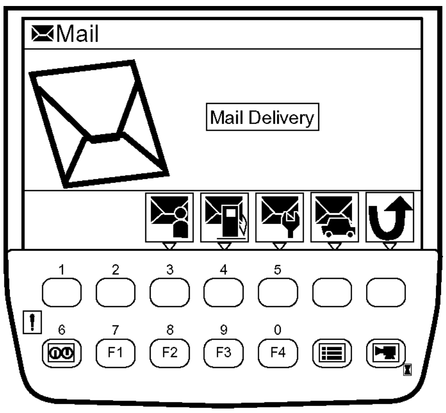
Maintenance Setting Screen T1V5-05-01-049



Interval ON/OFF Setting Screen T1V5-05-01-052



Language Settings Screen T1V1-05-01-137



Mail Switch Screen T1V5-05-01-037

- Overload Alarm
  (Only machines equipped with optional parts)

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

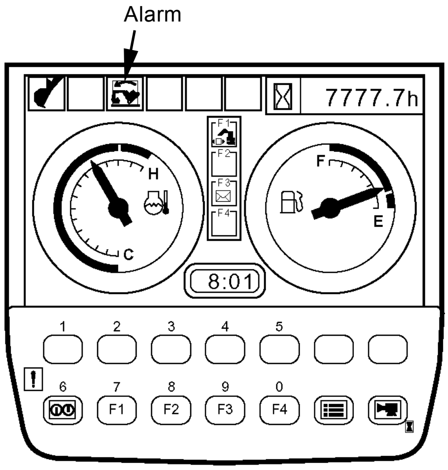
The system measures load of the suspended load from bottom pressure of the boom cylinder. An alarm message is displayed and a buzzer is rung, if overload is detected.

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

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

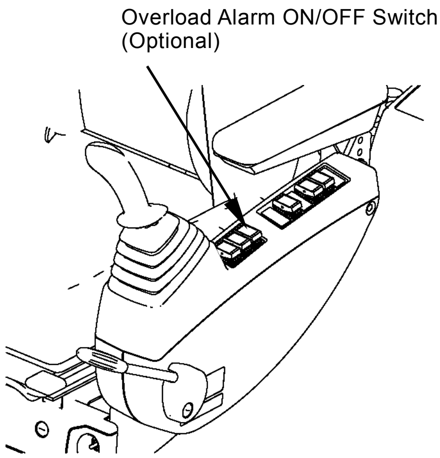
3. If overload of the suspended load is dissolved, the alarm message disappears and the buzzer stops ringing.

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



T1V1-05-01-128

Primary Screen



T1V1-05-02-004

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 CAM 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.

Input Signal

- Engine Control Dial →
- Pump 1 Control Pressure Sensor →
- Pump 2 Control Pressure Sensor →
- Pump 1 Delivery Pressure Sensor →
- Pump 2 Delivery Pressure Sensor →
- Pump 3 Delivery Pressure Sensor (Optional) →
- Pressure Sensor (Travel) →
- Pressure Sensor (Front Attachment) →
- Pressure Sensor (Swing) →
- Pressure Sensor (Boom Raise) →
- Pressure Sensor (Arm Roll-In) →
- Pressure Sensor (Auxiliary) (Optional) →
- Pressure Sensor (Arm Roll-Out) (Optional) →
- Oil Temperature Sensor →
- Auto-Idle Switch →

MC

Output Signal

Engine Control (ECM)
- Engine Control Dial Control
- HP Mode Control
- Travel HP Mode Control
- E Mode Control
- Auto-Idle Control
- Auto-Warming Up Control
- Idle Speed-Up Control
- Heater Control
- * Attachment Operation Speed Increase Control
- * Attachment Operation Speed Limit Control

Pump Control (Torque Control Solenoid Valve)
- Speed Sensing Control
- Travel Torque-Up Control
- * Attachment Pump Torque Decrease Control
- * Pump 1 Flow Rate Limit Control
- * Pump 2 Flow Rate Limit Control
- * Pump 3 Torque Decrease Control

Continued to T2-2-2

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

Continued from T2-2-1

Input Signal		Output Signal
• Power Digging Switch →	MC	Valve Control (Solenoid Valve Unit)
• Power Mode Switch (HP/E/P) →		Power Digging Control
• Travel Mode Switch (Fast/ Slow) →		Auto-Power Lift Control
		Arm Regenerative Control
		Digging Regenerative Control
• Key Switch →		Travel Motor Swash Angle Control
• Overload Alarm ON/OFF Switch (Optional)		
• Rear View Switch (Optional)		* HSB Breaker Control
		* NPK Breaker Control
• Boom Bottom Pressure Sensor (Optional) →		* Secondary Crusher Control
• Boom Rod Pressure Sensor (Optional) →		* Hydraulic Crusher Control
• Arm Angle Sensor (Optional) →		
• Boom Angle Sensor (Optional) →		
		Other Control
		Rear Monitoring Display Selection Control
		Work Mode Control
		* Travel Alarm Control
		* Swing Alarm Control
CAN Communication		
• Actual Engine Speed (From ECM) →		
• Work Mode (Digging / Attachment) (From Monitor Unit) →		
• Radiator Coolant Temperature (From ECM) →		

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

(Blank)

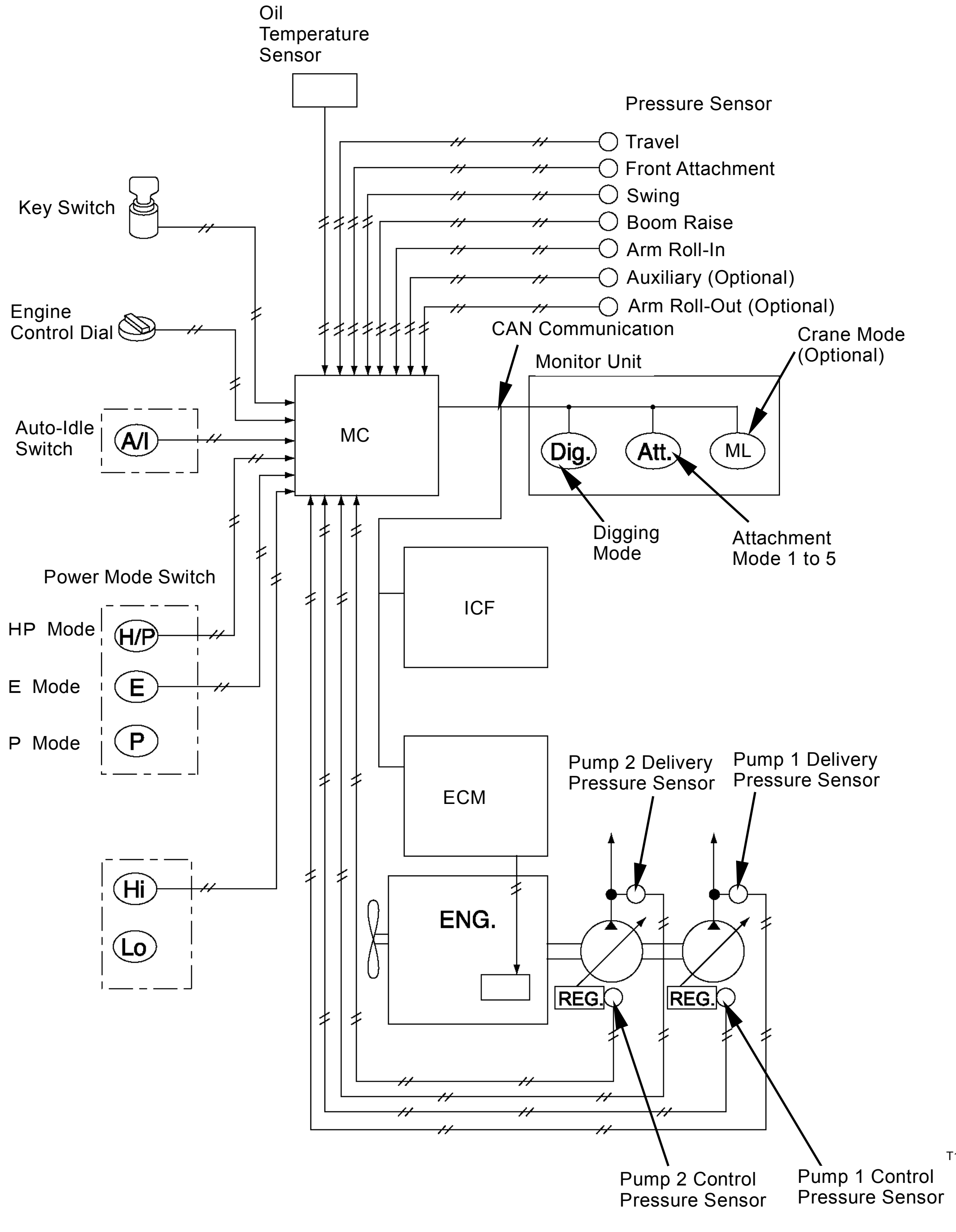
ENGINE CONTROL

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
- Auto-Warming Up Control
- Idle Speed-Up Control
- Heater Control
- * Attachment Operation Speed Increase Control
- * Attachment Operation Speed Limit Control

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

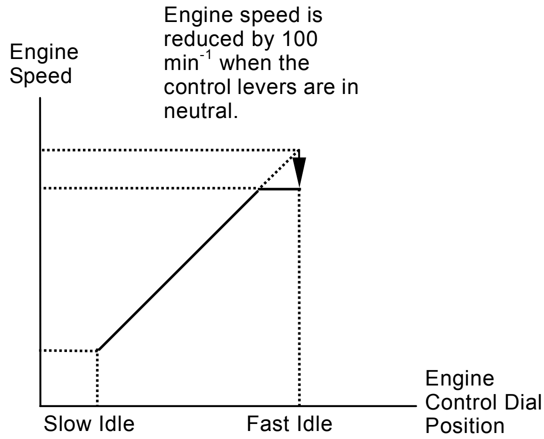
Engine Control System Layout



T1V1-02-01-002

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.

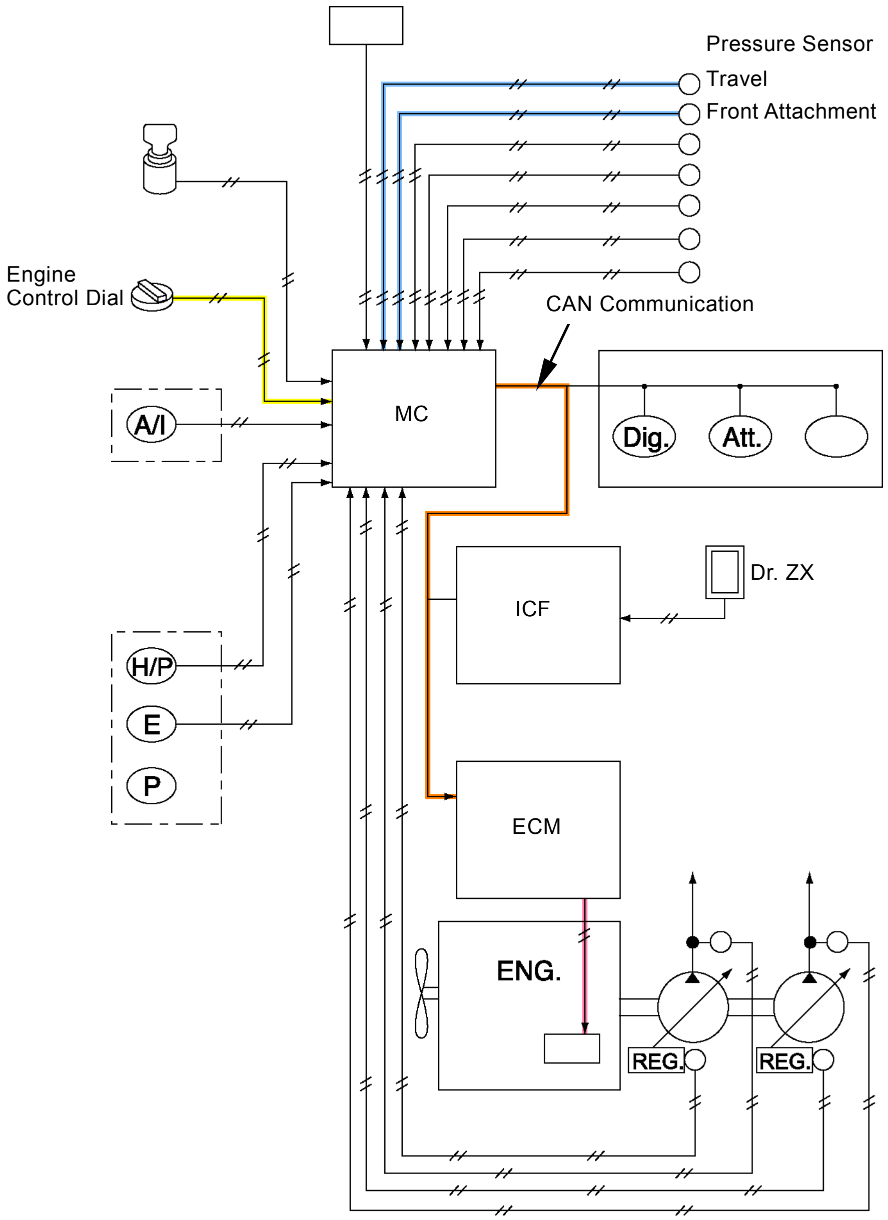


Operation:

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.



T1V1-02-01-005

HP Mode Control

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

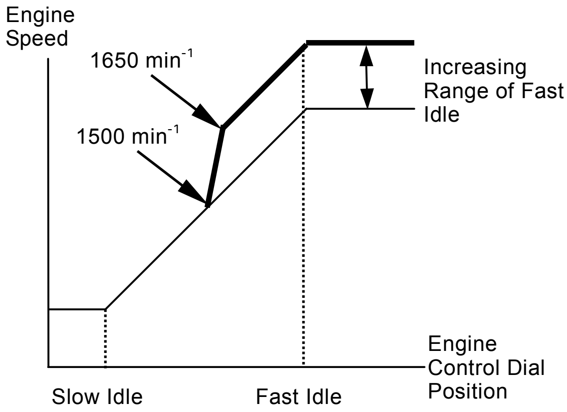
Operation:

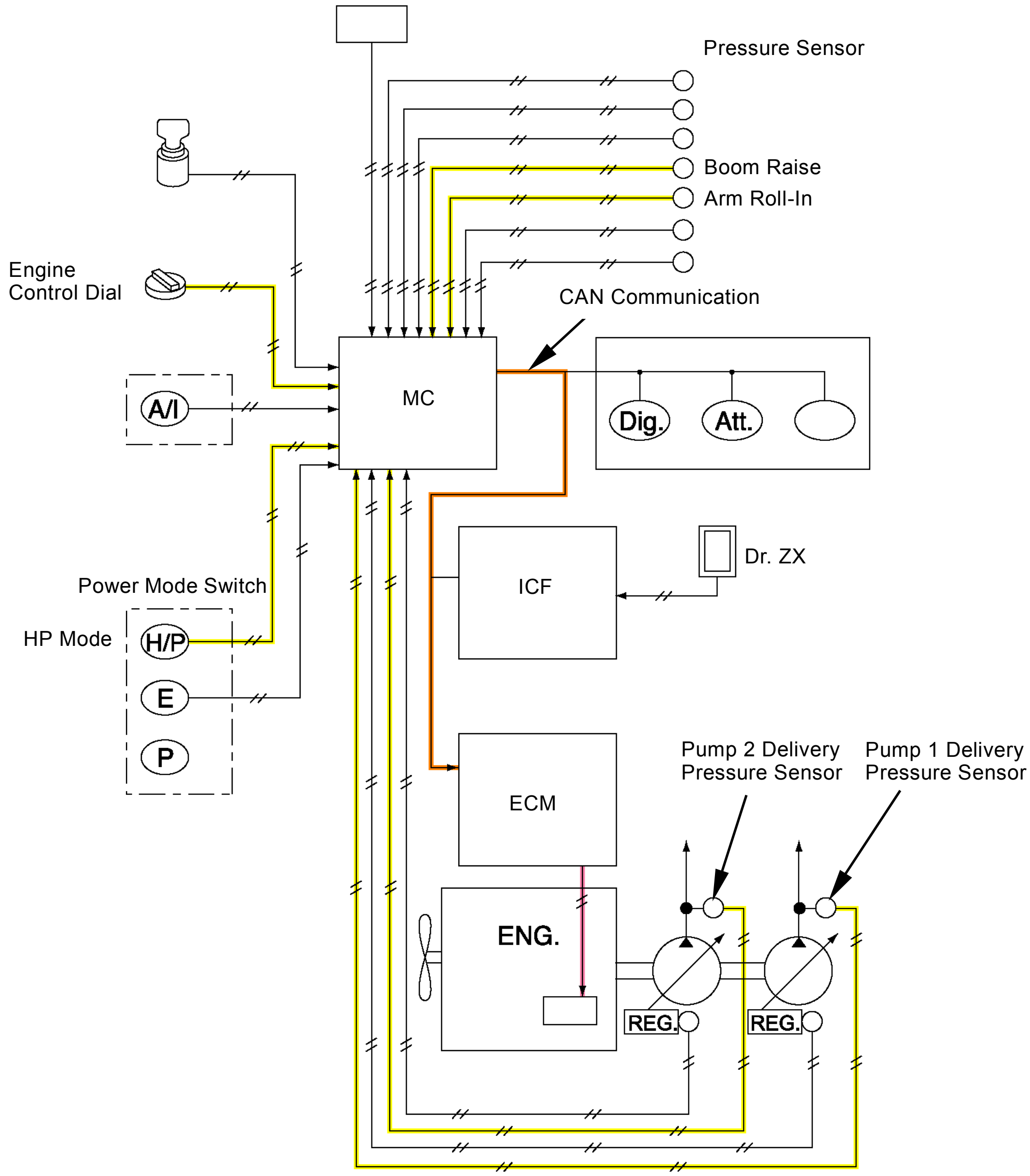
1. When the power mode switch is in the HP mode position and all the following conditions exist, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication.
2. ECM slightly increases the engine speed set by the engine control dial.

Condition:

- Engine Control Dial: Set at 1500 min^{-1} or faster.
- Boom Raise or Arm Roll-In Operation: Operated
- Average Delivery Pressure of Pumps 1 and 2: High
  (Reference: 20 MPa, (205 kgf/cm^2, 2910 psi))

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





T1V1-02-01-006

Travel HP Mode Control

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

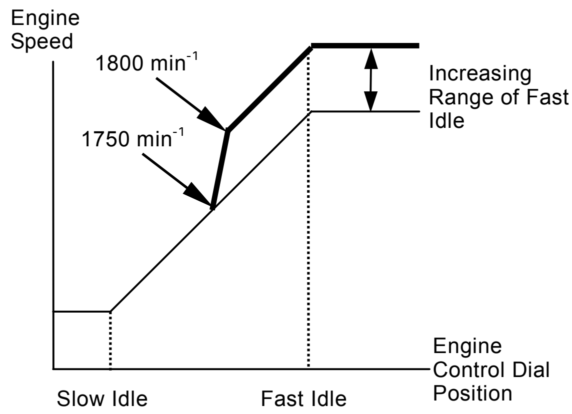
ZAXIS200-3, ZAXIS240-3

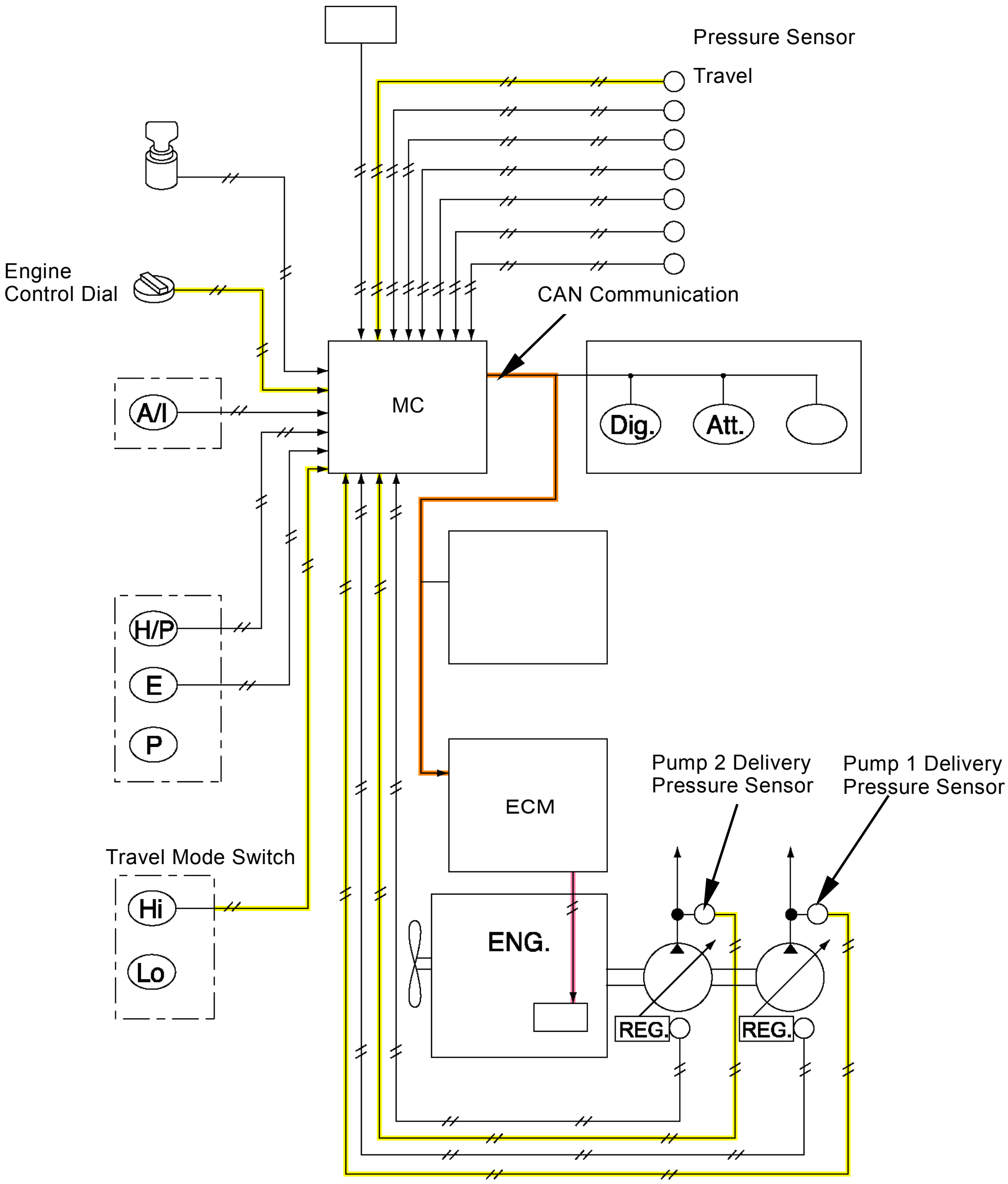
Operation:

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

Condition:

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

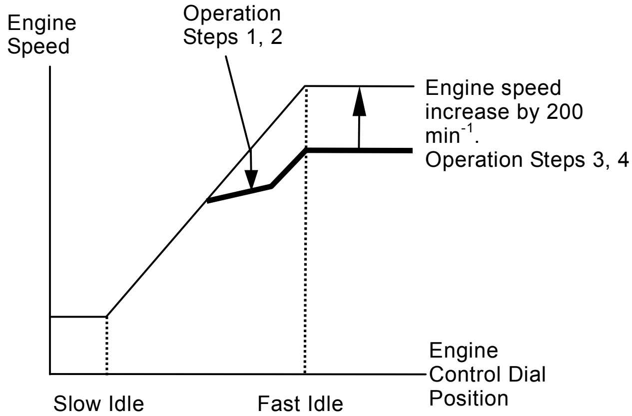




T1V1-02-01-014

E Mode Control

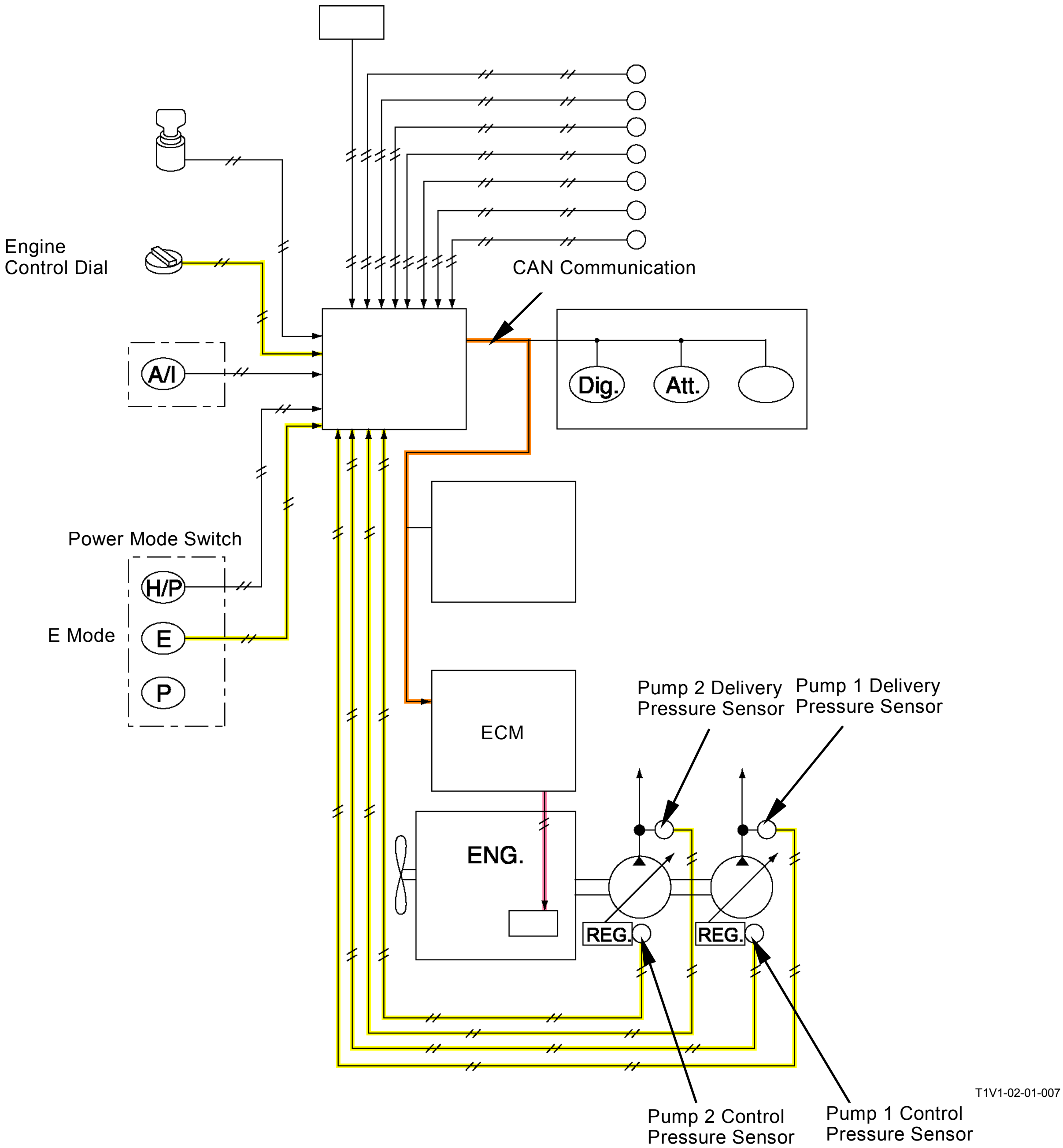
Purpose: Reduces the engine speed set by the engine control dial according to the pump control pressure and the average pump delivery pressure in order to reduce fuel consumption and noise level.



Operation:

1. When the required engine speed by the engine control dial is 1800 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 200 min^{-1}.

Condition: Pump Control Pressure: Low (Reference: 3 MPa (31 kgf/cm^2, 436 psi) or less) or Average Pump Delivery Pressure: High (Reference: 17 MPa (173 kgf/cm^2, 2471 psi))

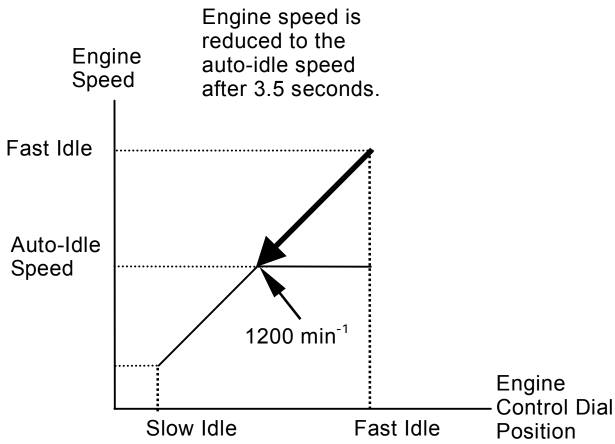

Engine
Control Dial
CAN Communication
A/I
Dig.
Att.
Power Mode Switch
H/P
E Mode
E
P
ECM
ENG.
REG.
REG.
Pump 2 Delivery
Pressure Sensor
Pump 1 Delivery
Pressure Sensor
Pump 2 Control
Pressure Sensor
Pump 1 Control
Pressure Sensor
T1V1-02-01-007

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:

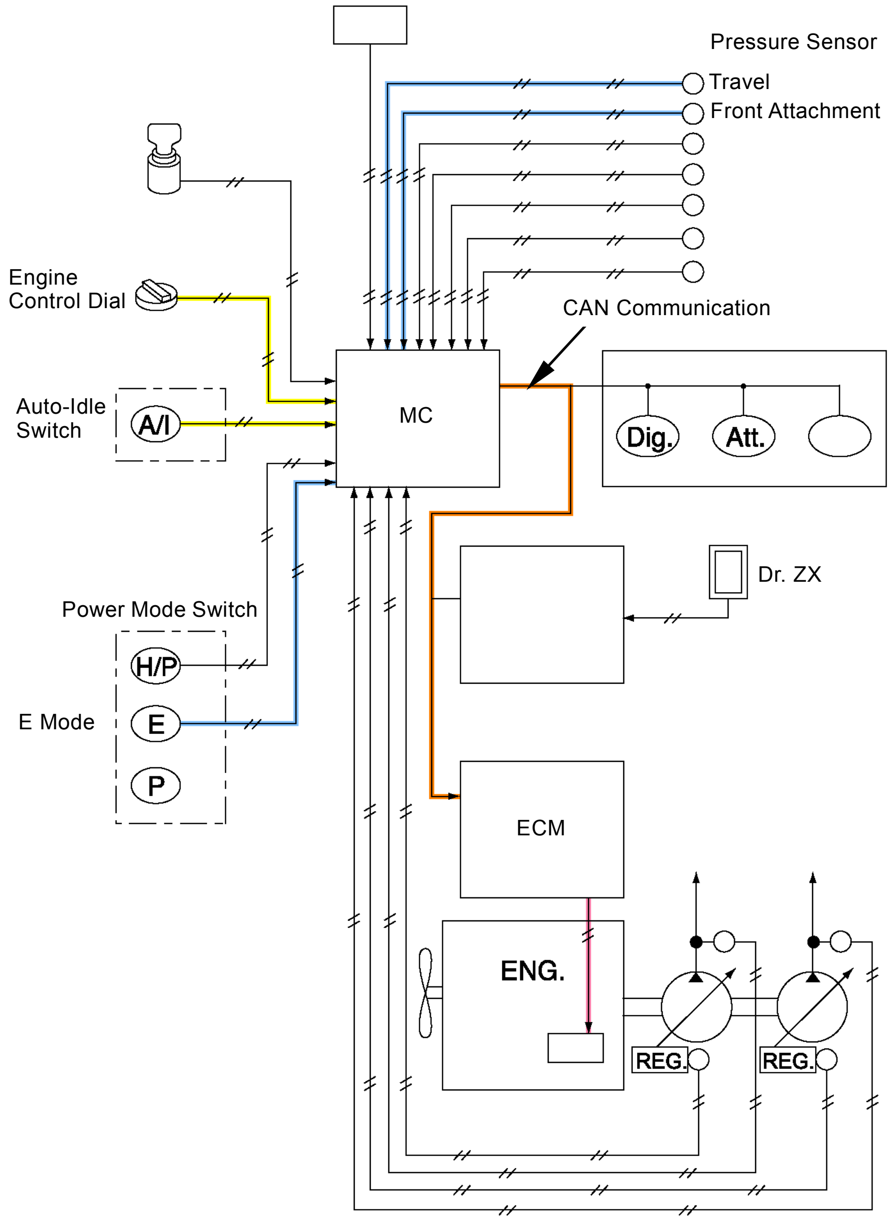
1. Approx. 3.5 seconds after the control lever is turned to neutral with the auto-idle switch ON, MC sends the signals equivalent to the auto-idle speed to ECM by using CAN communication.
2. ECM changes the engine speed into the auto-idle speed.
3. As soon as either control lever is moved (pressure sensors (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.



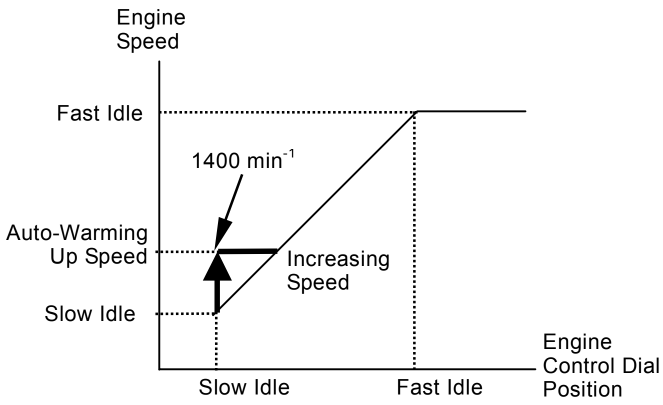
T1V1-02-01-008

Auto-Warming Up Control

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

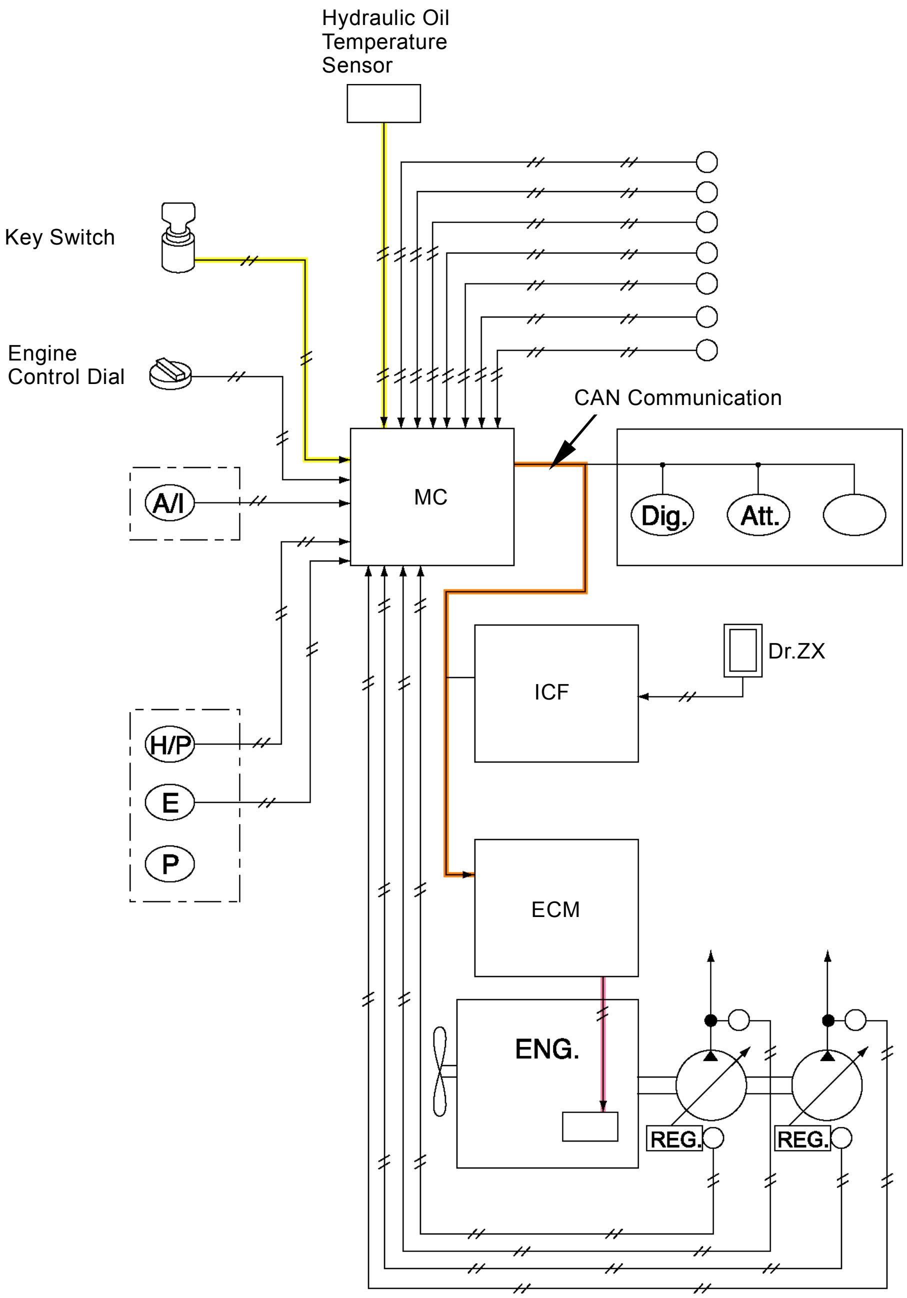
Operation:

1. For 15 minutes after the engine starts or when hydraulic oil temperature is below 0℃, 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 auto warming up speed.



IMPORTANT: When adjusting the auto-idle speed, deactivate the auto-warming up control by using Dr. ZX. Wait adjustment until 15 minutes after the engine starts.
Auto-warming up control can be deactivated temporarily by Dr. ZX.
Once the key is turned OFF, auto-warming up control is operable again.

IMPORTANT: Auto-warming up speed can be adjusted by Dr. ZX.



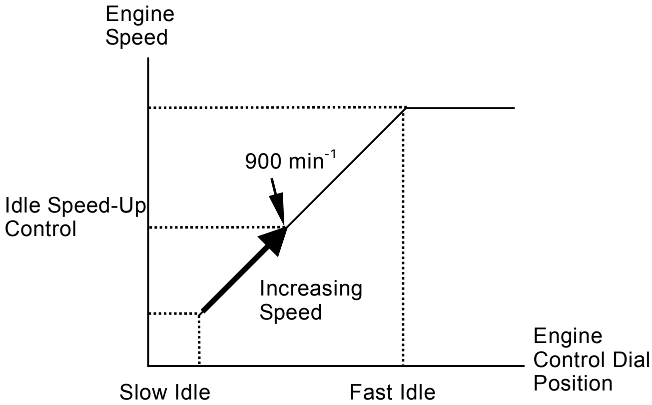
T1V1-02-01-009

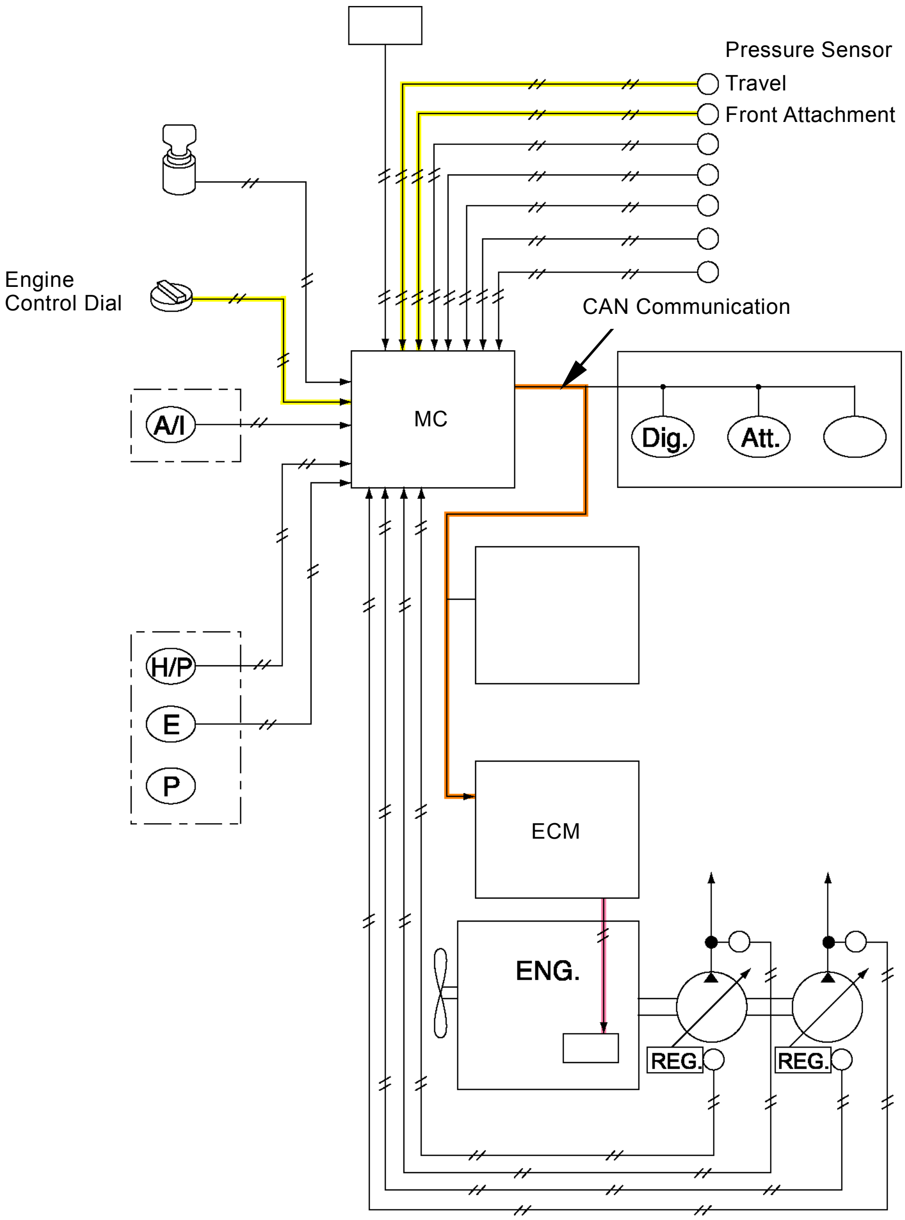
Idle Speed-Up Control

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

Operation:

1. When the travel or front attachment functions 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.





T1V1-02-01-010

Heater Control

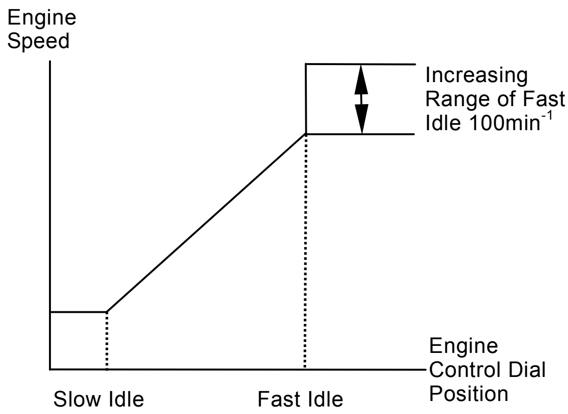
Purpose: Increases the rising temperature speed of the heater in cab while increasing the engine speed at the low temperature.

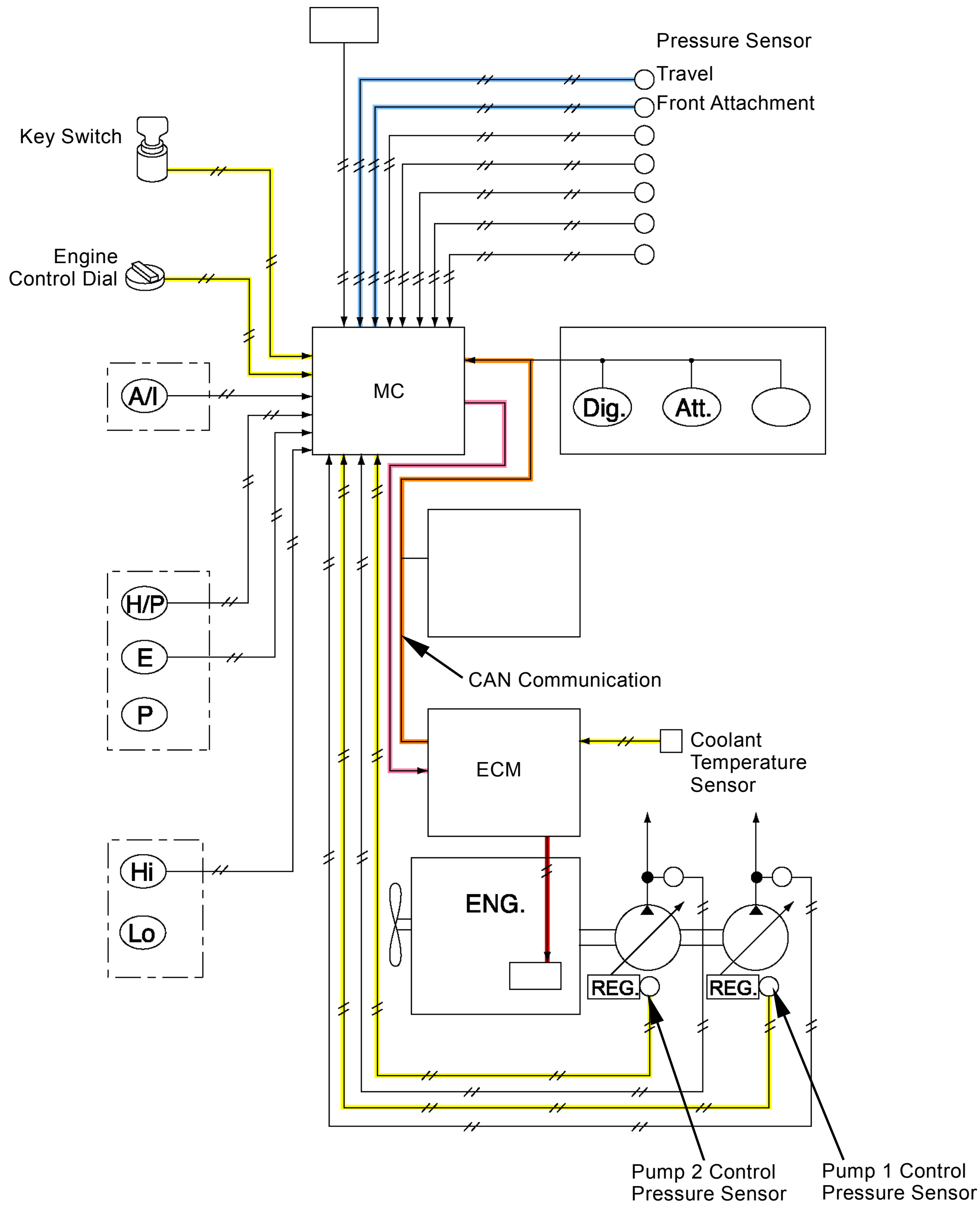
Operation:

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

Condition:

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

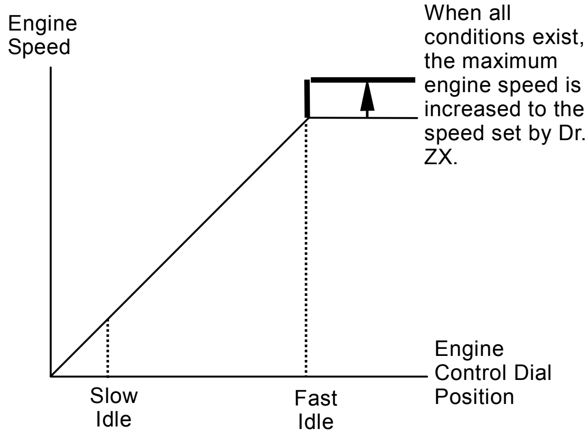




T1V1-02-01-035

Attachment Operation Speed Increase Control (Only Machine Equipped with Front 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.



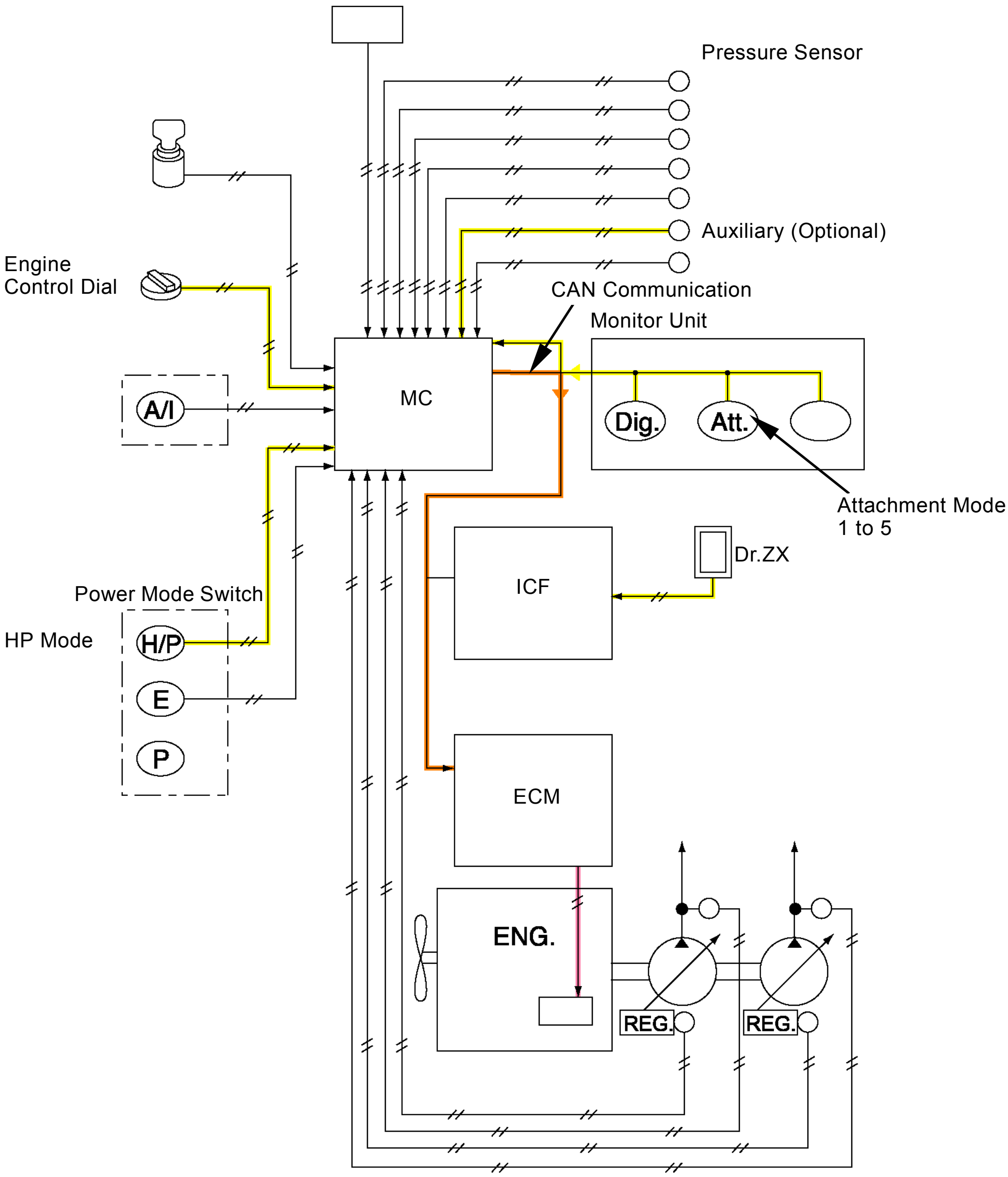
Operation:

1. When the following conditions exist and the front attachment is operated, the 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, hydraulic 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 Switch: Attachment selected by using the attachment mode monitor is reset by Dr. ZX.

NOTE: When the 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.



T1V1-02-01-011

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

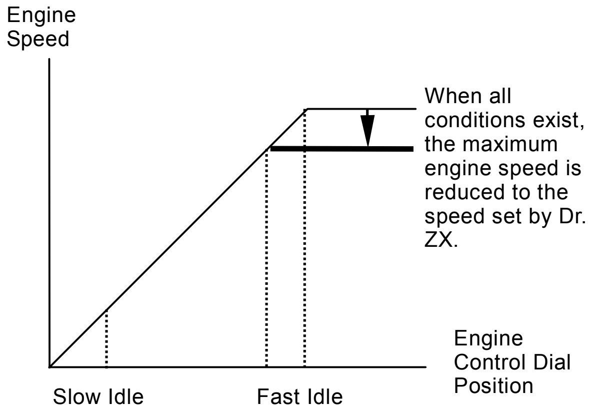
Purpose: Decreases the maximum engine speed to the attachment (hydraulic breaker, secondary crusher, primary crusher or vibrating hammer) operating engine speed set by Dr. ZX when the attachment mode is selected.

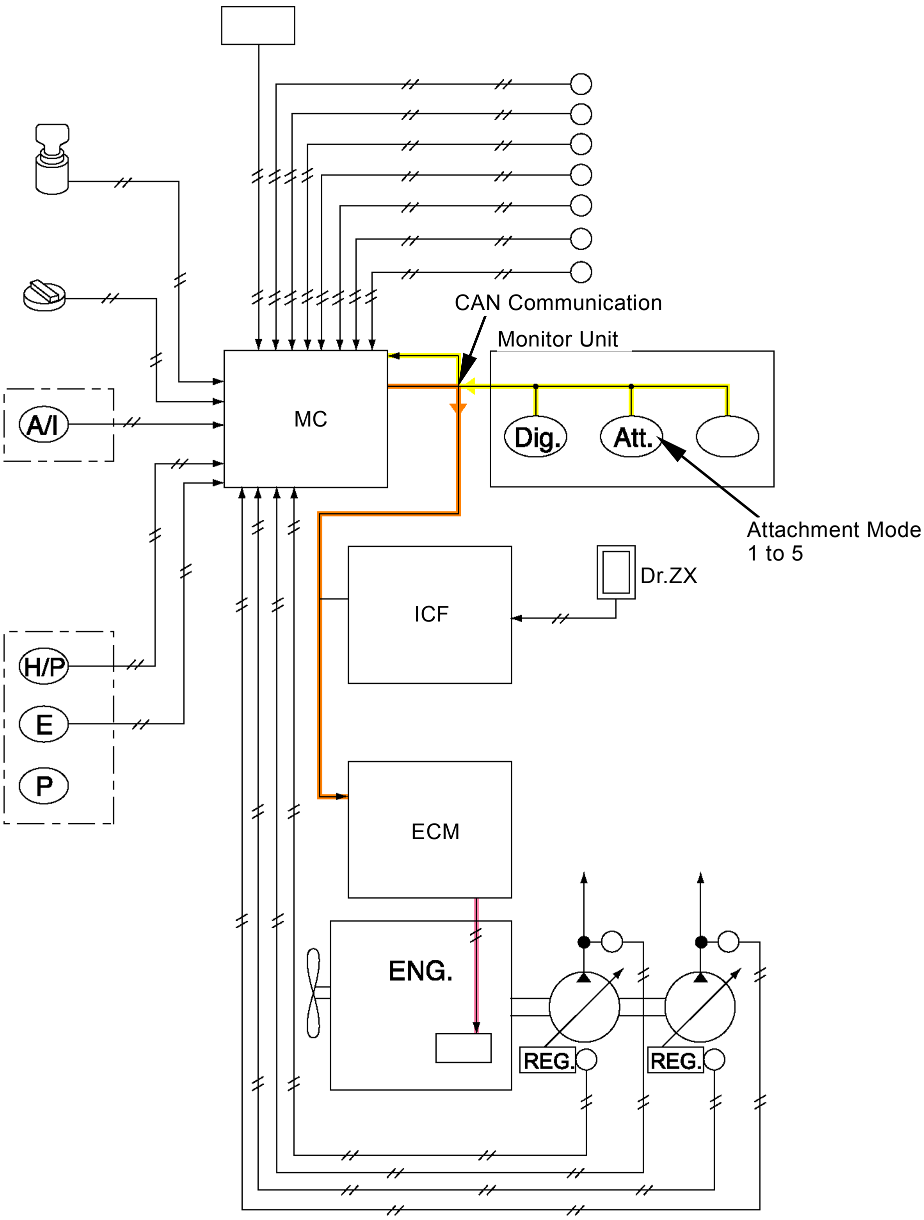
Operation:

1. When the following conditions exist and the front 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, hydraulic crusher or vibrating hammer) operating speed in the service mode.
- Work Mode: Attachment Mode
- Auxiliary Mode Switch (Optional): Attachment position Attachment selected by using the attachment mode monitor is reset by Dr. ZX





T1V1-02-01-012

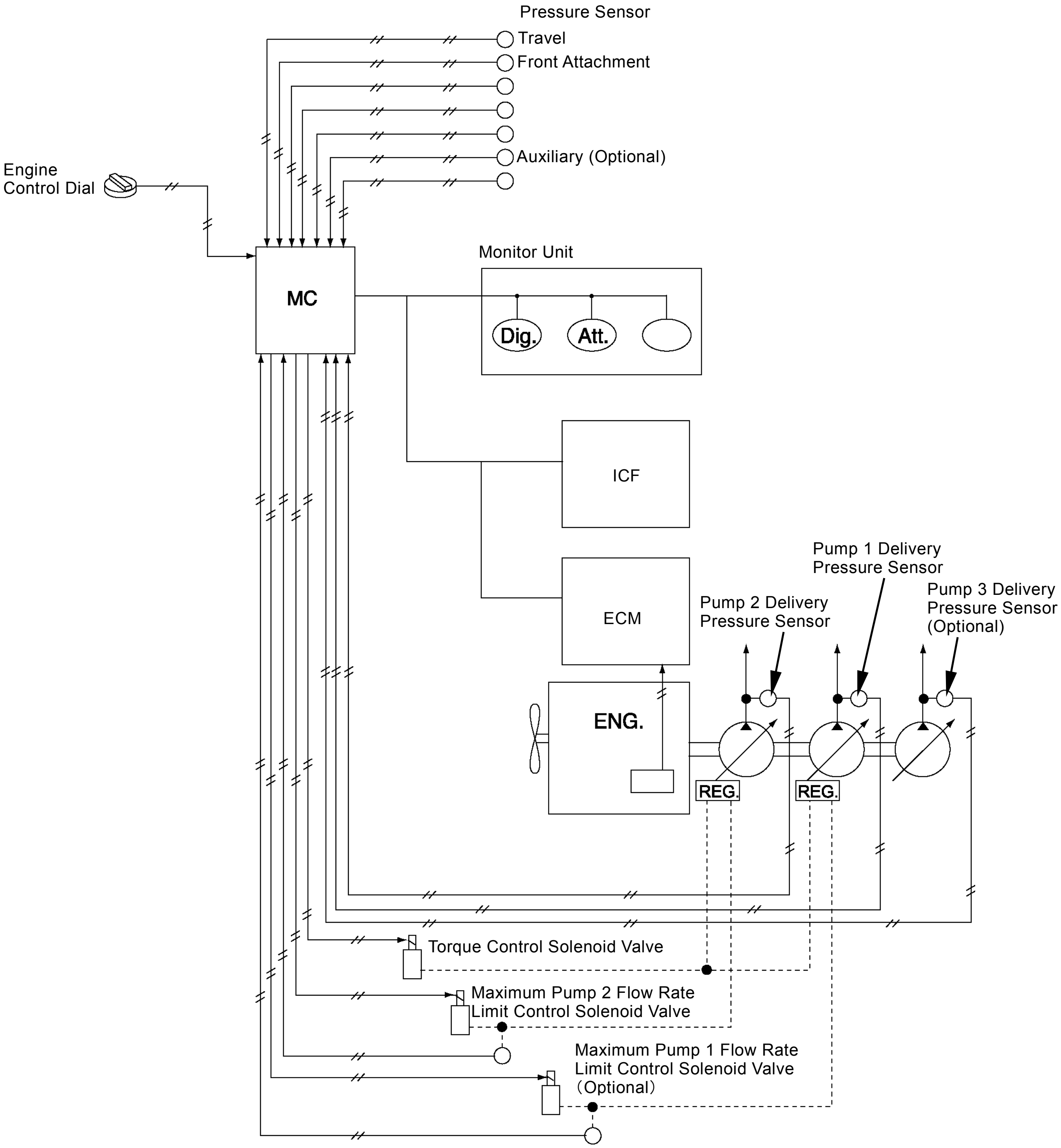
PUMP CONTROL

The pump control system has the following functions:

- Speed Sensing Control
- Travel Torque-Up Control
- *Attachment Pump Torque Decrease Control
- *Pump 1 Flow Rate Limit Control
- *Pump 2 Flow Rate Limit Control
- *Pump 3 Torque Decrease Control

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

Pump Control System Layout



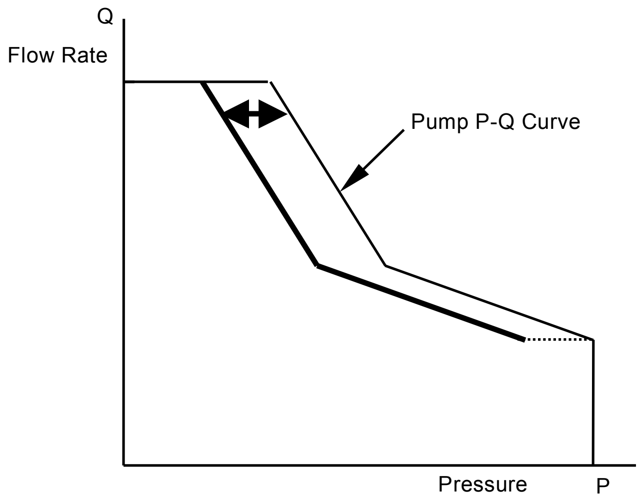
T1V1-02-01-003

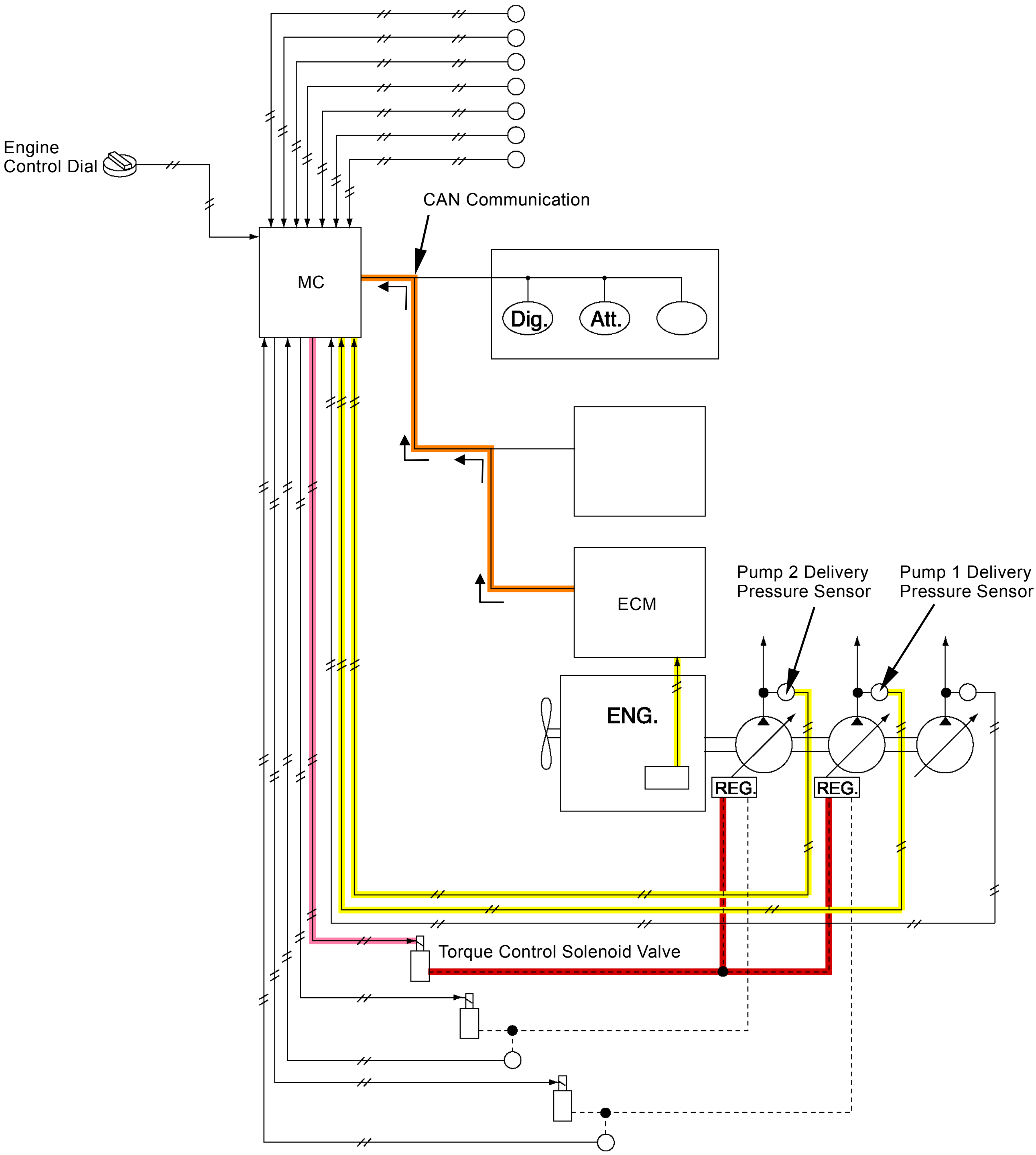
Speed Sensing Control

Purpose: Controls the pump flow rate in response to engine speed changes due to variations in load so that the engine output 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 signals to the torque control solenoid valve.
3. The torque control solenoid valve delivers pilot pressure oil 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 flow rate will increase. Therefore, the engine output can be utilized more efficiently.



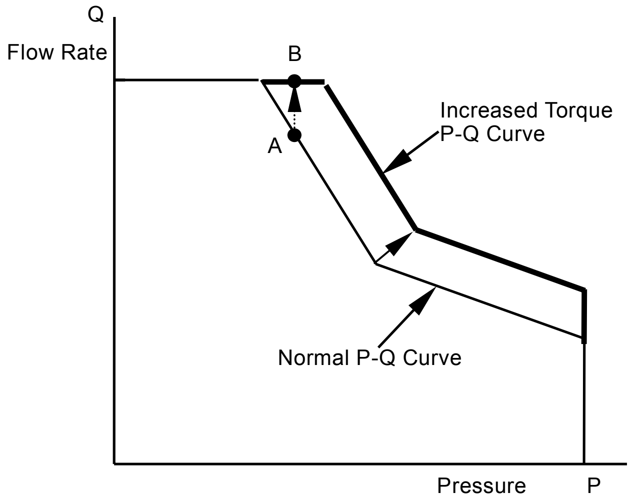


T1V1-02-01-016

Travel Torque-Up Control

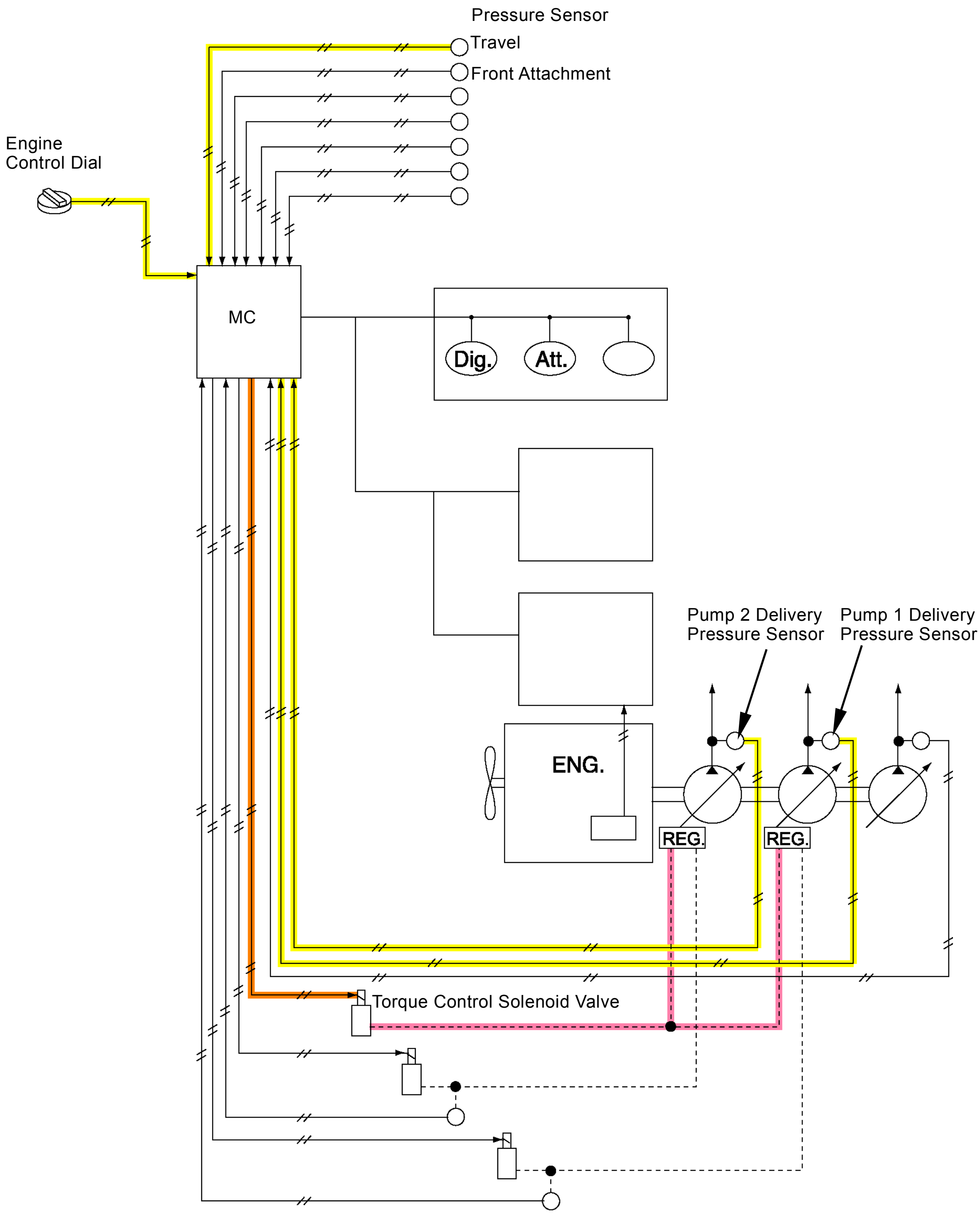
Purpose: Effectively controls during single travel operation. Allows the machine to travel at the maximum pump flow rate when the engine is running at slow speed. When travel operation is made with the engine running at slow speed, normally, the hydraulic pump delivers pressure oil at the flow rate corresponding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

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



Operation:

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



T1V1-02-01-018

Attachment Pump Torque Decrease Control (Only Machine Equipped with Front Attachment)

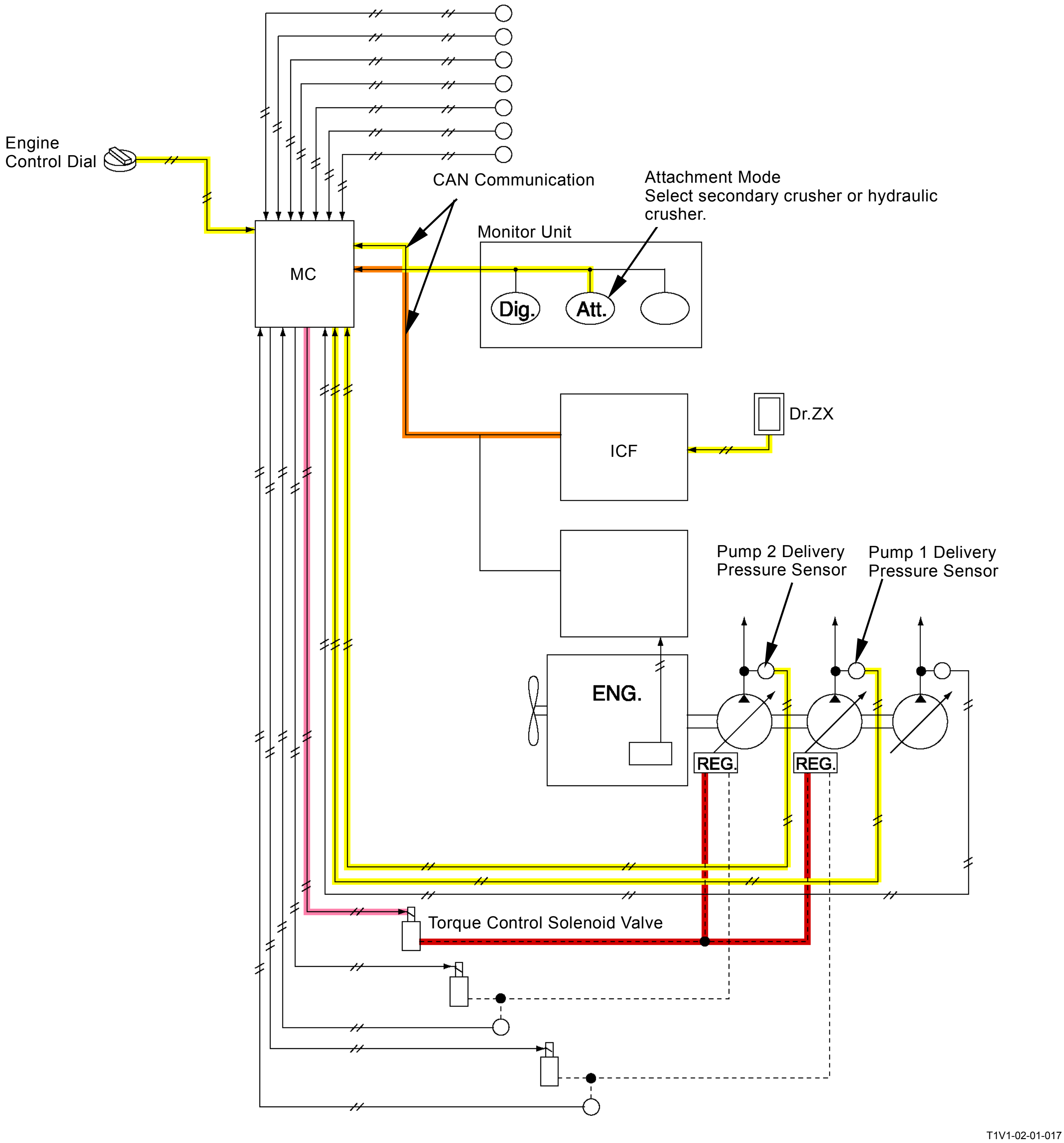
Purpose: When average pump delivery pressure becomes high while operating the front attachment (secondary crusher or hydraulic crusher), driving torque of pumps 1, 2 is decreased and pump delivery pressure is reduced in order to prevent hydraulic oil temperature from rising while operating the front attachment.

Operation:

1. When the following conditions exist and average pump delivery pressure becomes high, the pumps 1, 2 delivery pressure sensors output the signal to MC.
2. MC drives the torque control solenoid valve and reduces delivery flow rate of pumps 1, 2.
3. Therefore, driving torque (pump torque) of pumps 1, 2 is controlled not to exceed the engine output and hydraulic temperature is prevented from rising while operating the front attachment.

Condition:

- Work Mode: Select secondary crushers 1 to 5 or hydraulic crushers 1 to 5 at attachment mode.
- Attachment pump torque control is effective by Dr. ZX.


Engine
Control Dial
CAN Communication
Attachment Mode
Select secondary crusher or hydraulic crusher.
Monitor Unit
MC
Dig.
Att.
ICF
Dr.ZX
Pump 2 Delivery
Pressure Sensor
Pump 1 Delivery
Pressure Sensor
ENG.
REG.
REG.
Torque Control Solenoid Valve
T1V1-02-01-017

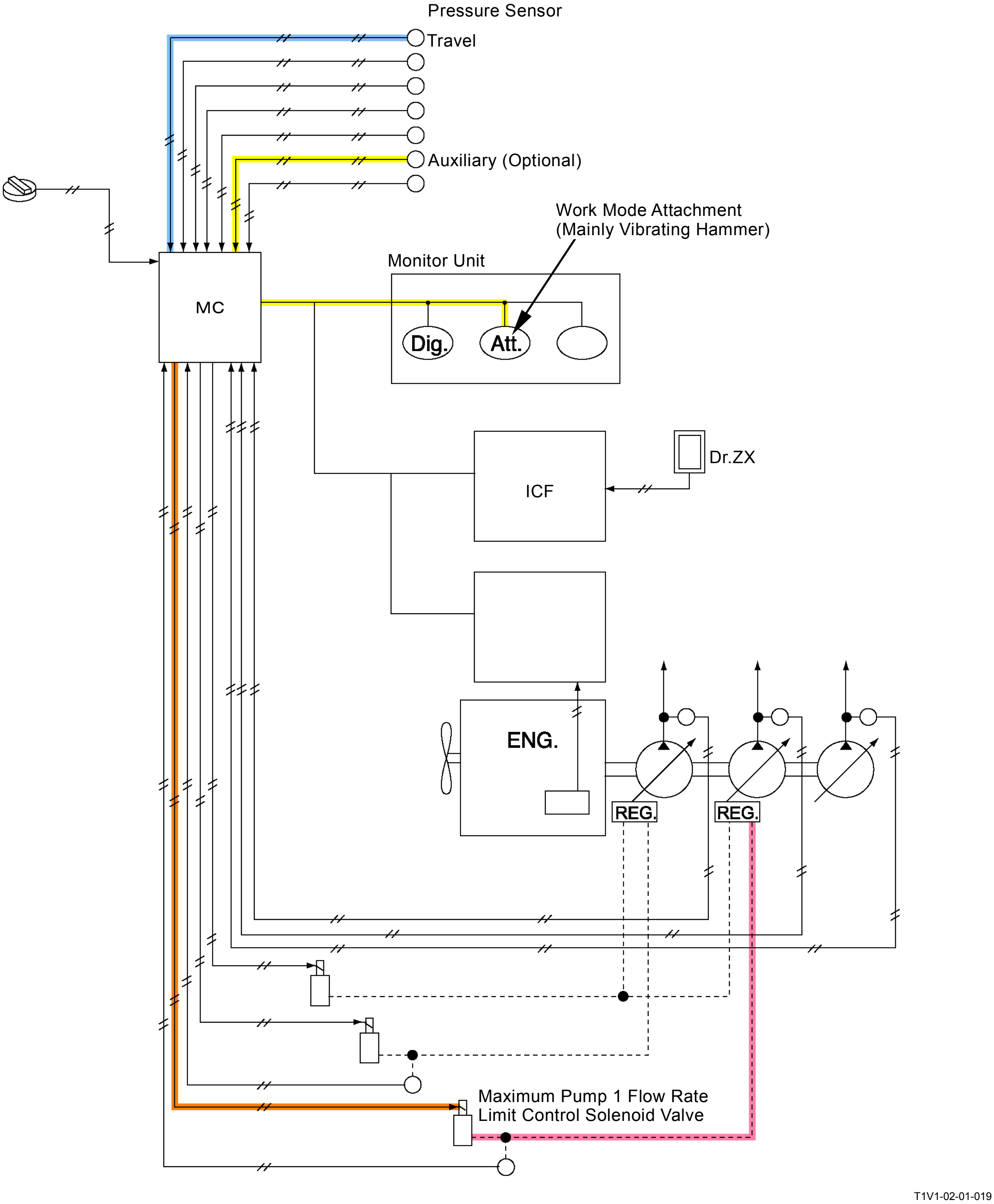
Pump 1 Flow Rate Limit Control (Only Machine Equipped with Front Attachment)

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

Operation:

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

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


Pressure Sensor
Travel
Auxiliary (Optional)
Work Mode Attachment
(Mainly Vibrating Hammer)
Monitor Unit
MC
Dig.
Att.
ICF
Dr.ZX
ENG.
REG.
REG.
Maximum Pump 1 Flow Rate
Limit Control Solenoid Valve
T1V1-02-01-019

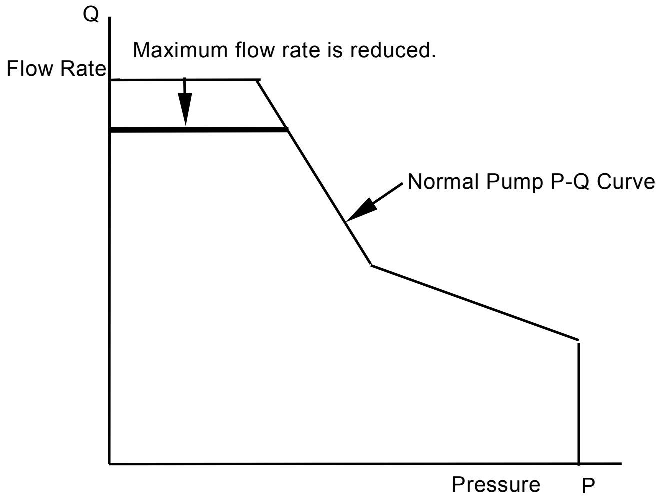
Pump 2 Flow Rate Limit Control (Only Machine Equipped with Front Attachment)

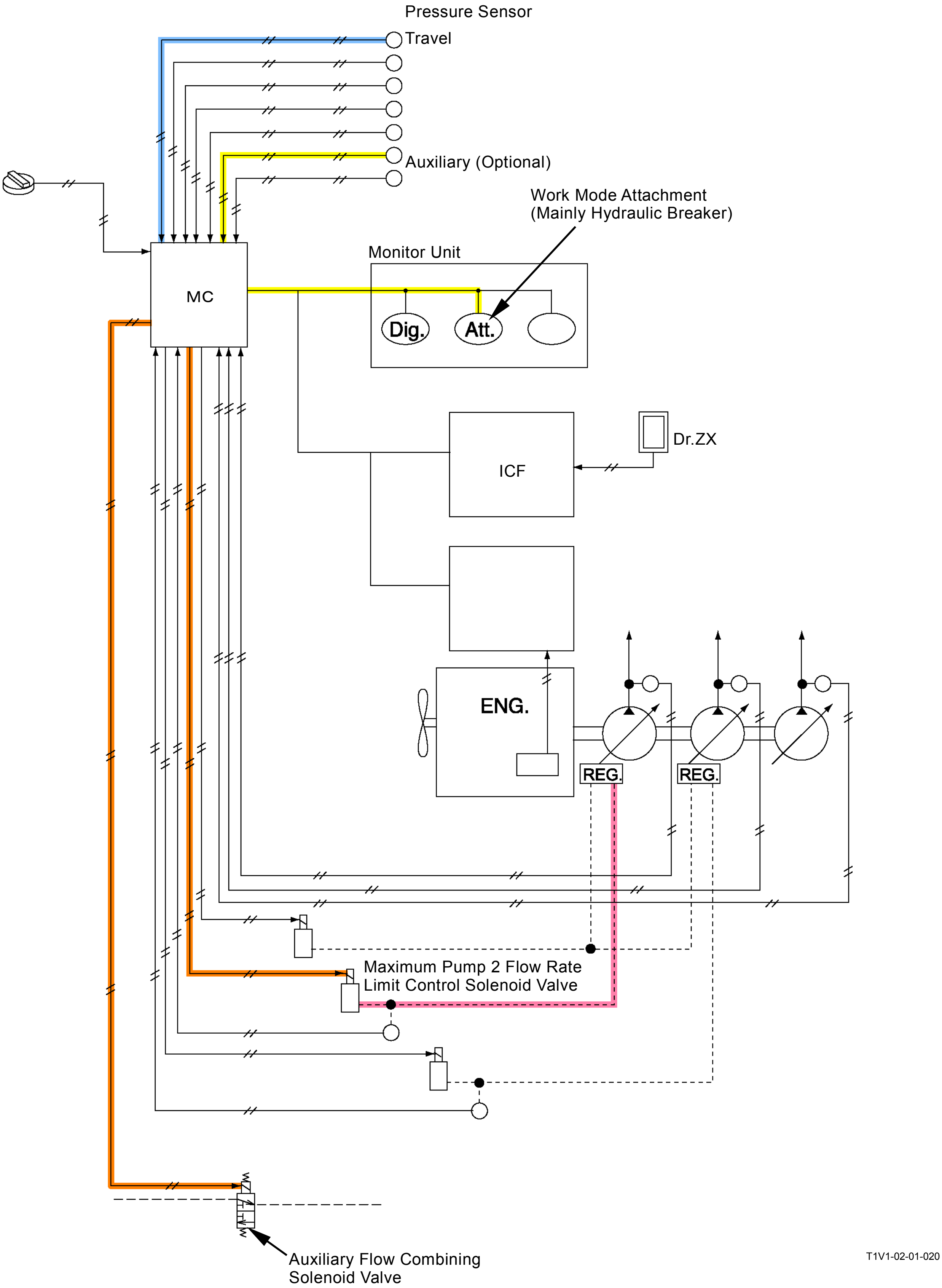
Purpose: Limits maximum pump 2 flow rate when a front attachment (mainly a hydraulic breaker) is used.

Operation:

1. When a front attachment is used, MC receives the signals from pressure sensor (auxiliary) (optional).
2. In response to front 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 front attachment (hydraulic breaker 1 to 5, secondary crusher 1 to 5, hydraulic crusher 1 to 5 or vibrating hammer 1 to 5) can be set in the service mode of Dr. ZX.





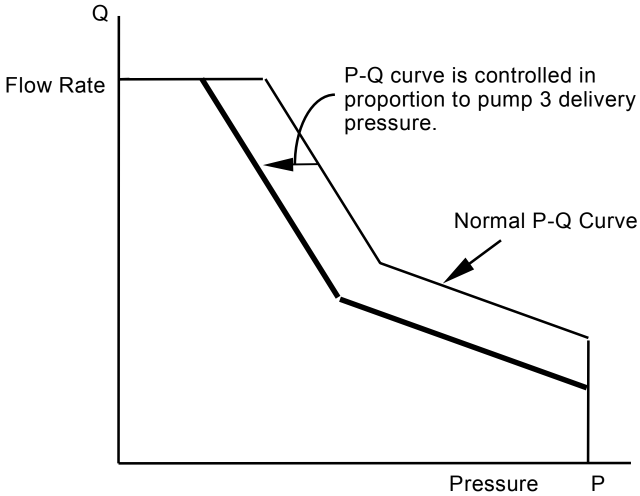
Pressure Sensor
Travel
Auxiliary (Optional)
Work Mode Attachment
(Mainly Hydraulic Breaker)
Monitor Unit
MC
Dig.
Att.
Dr.ZX
ICF
ENG.
REG.
REG.
Maximum Pump 2 Flow Rate
Limit Control Solenoid Valve
Auxiliary Flow Combining
Solenoid Valve
T1V1-02-01-020

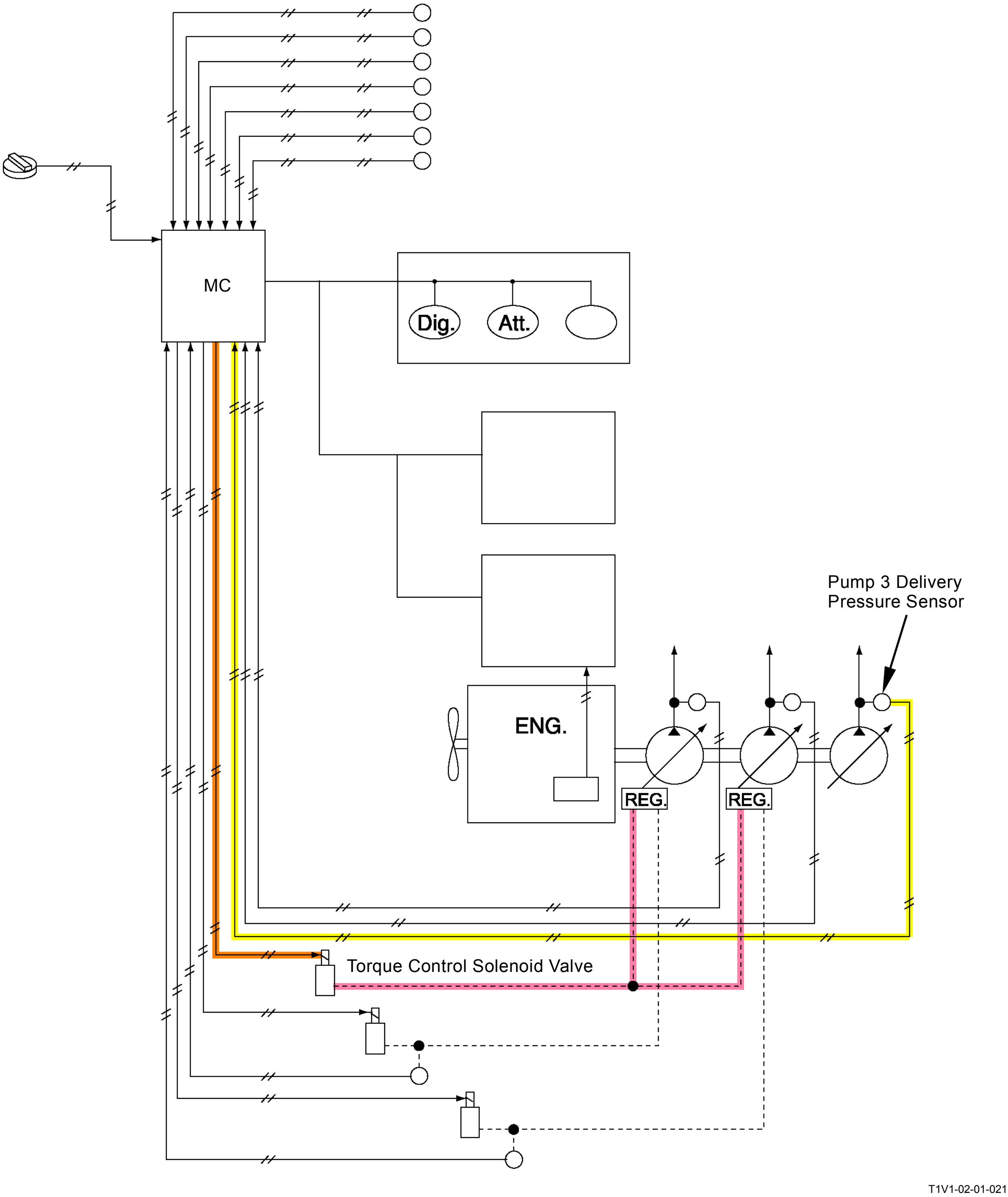
Pump 3 Torque Decrease Control (Only Machine Equipped with Optional Parts)

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

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 and the engine output is utilized efficiently.




MC
Dig.
Att.
ENG.
REG.
REG.
Pump 3 Delivery Pressure Sensor
Torque Control Solenoid Valve
T1V1-02-01-021

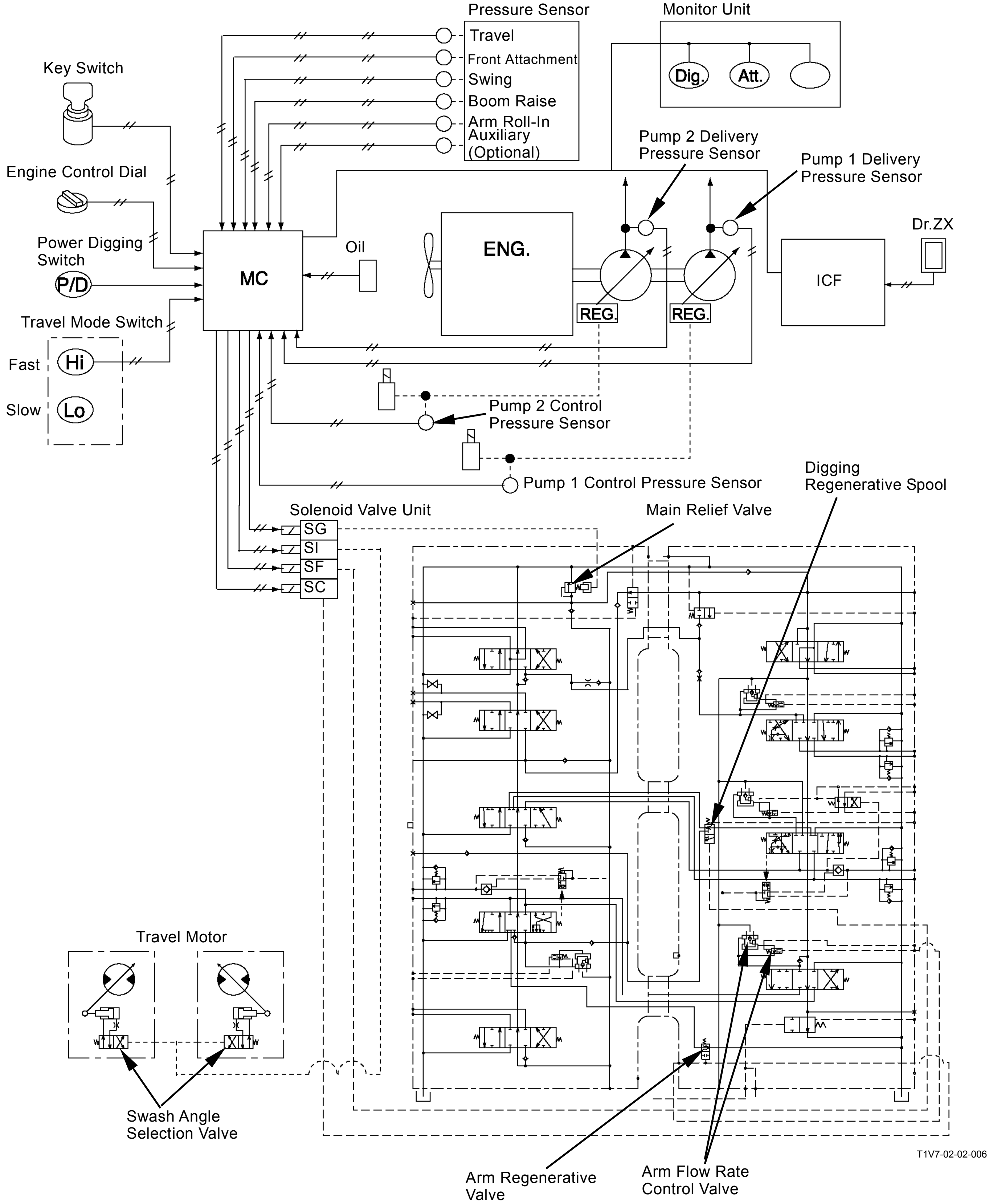
VALVE CONTROL

The valve control system functions as follows:

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

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

Valve Control System Layout

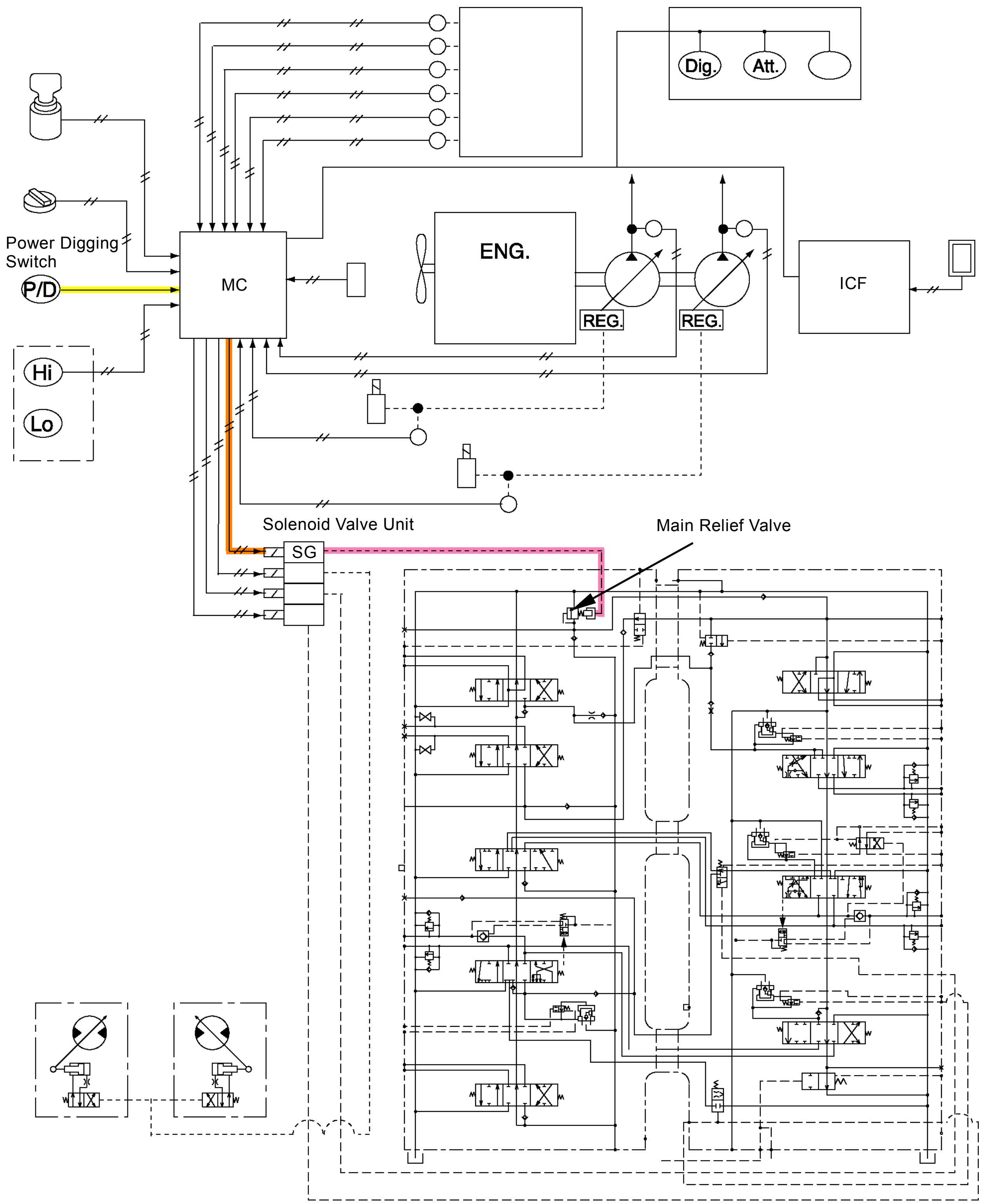


Power Digging Control

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.)



T1V7-02-02-009

Auto-Power Lift Control

Purpose: Increases pressure when raising the boom.

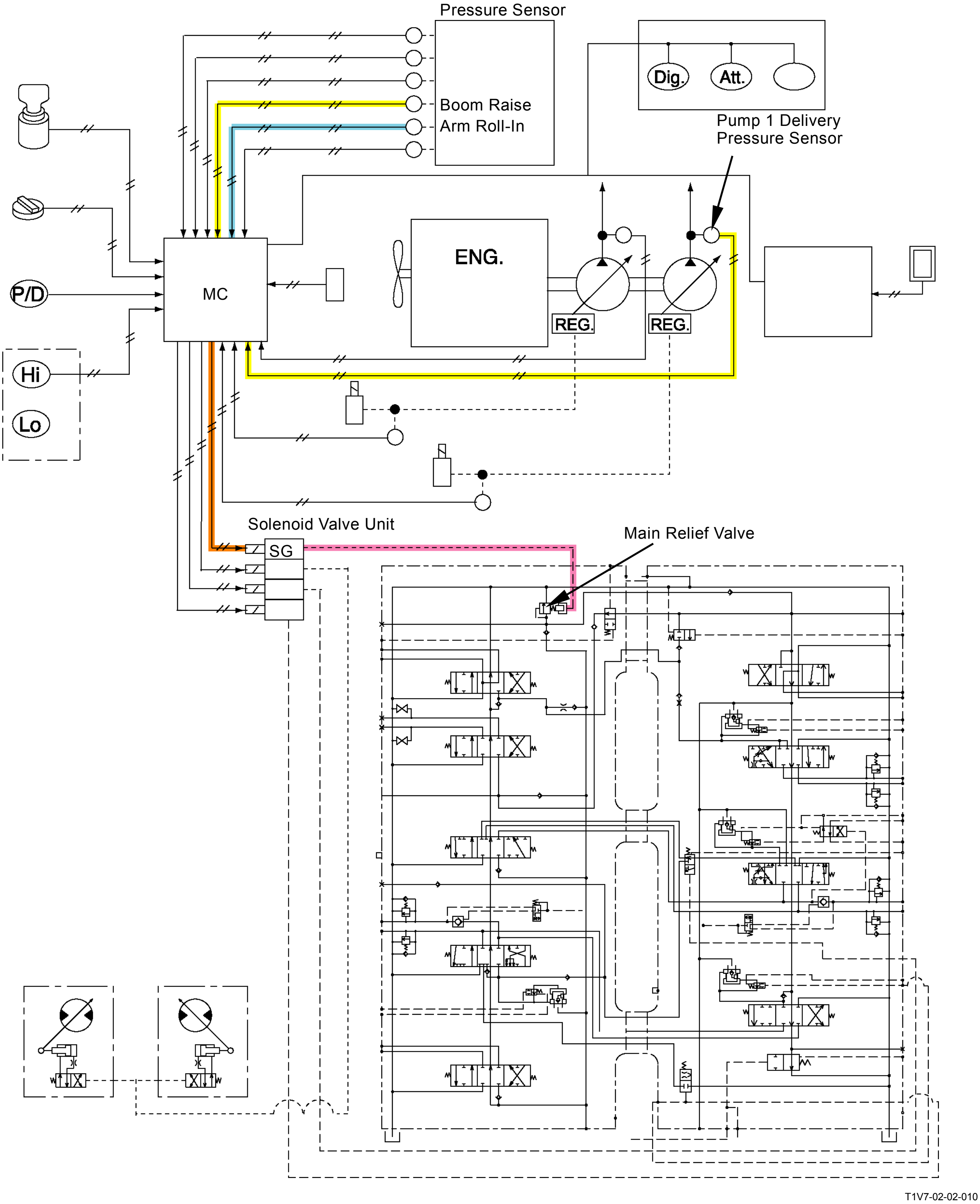
Operation:

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/cm^2, 247 psi))
- Pump 1 delivery Pressure Sensor: High pressure. (Reference: 31.3 MPa (320 kgf/cm^2, 4550 psi))
- Arm Roll-In Pressure Sensor: Output zero. (The control lever is in neutral.)

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


Pressure Sensor
Boom Raise
Arm Roll-In
Dig.
Att.
Pump 1 Delivery
Pressure Sensor
P/D
MC
ENG.
REG.
REG.
Hi
Lo
Solenoid Valve Unit
SG
Main Relief Valve
T1V7-02-02-010

Arm Regenerative Control

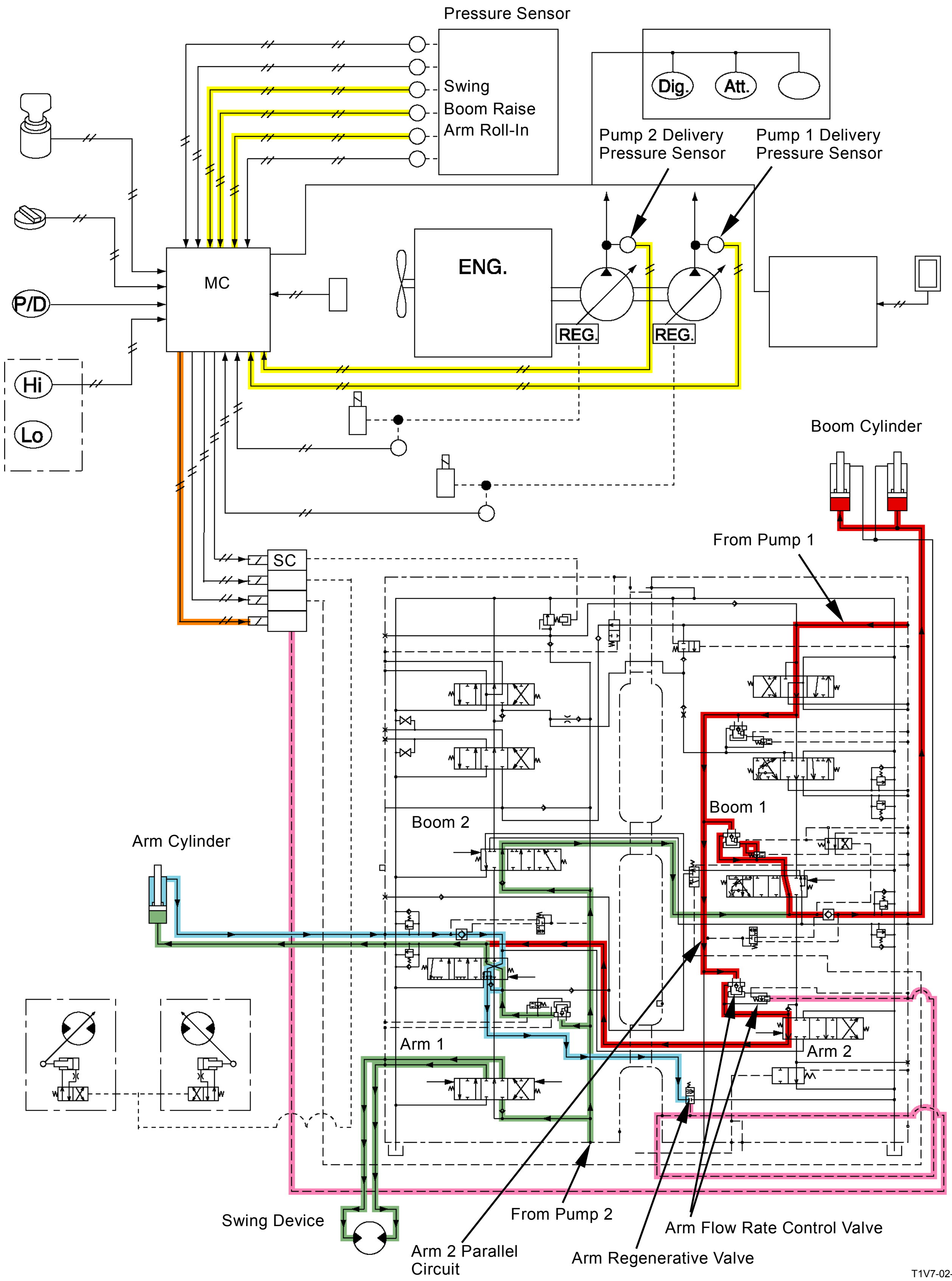
Purpose: Accelerates the arm roll-in speed in order to prevent arm hesitation during arm roll-in operation.

Operation:

1. MC activates solenoid valve unit (SC) so that solenoid valve unit (SG) delivers pilot pressure when the signals from pump 2 delivery pressure sensor, 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 (SG) 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, 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/cm^2, 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/cm^2, 73 psi) or more)
- Swing or Boom Raise Pressure Sensor: Outputting signal.



T1V7-02-02-007

Digging Regenerative Control

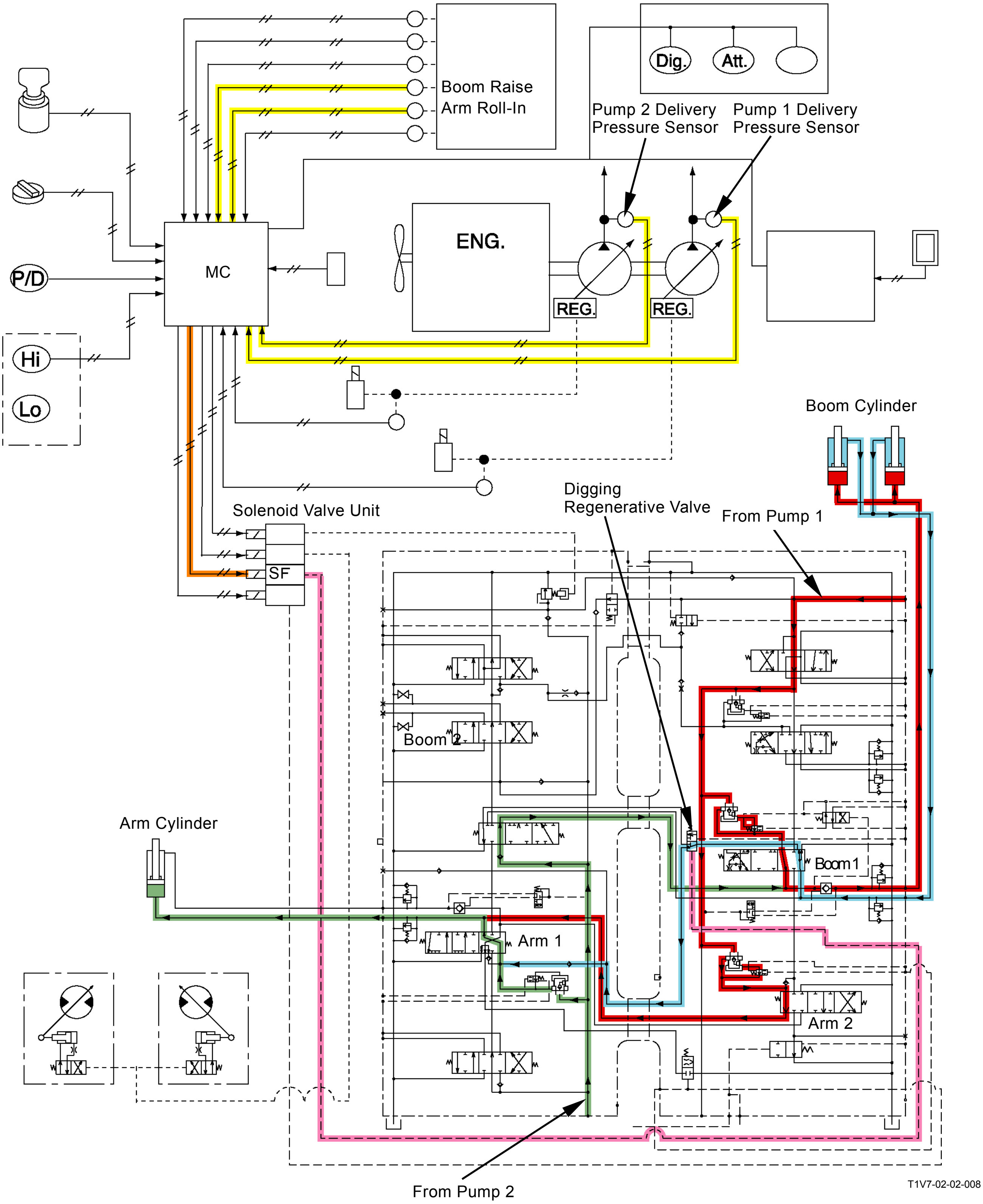
Purpose: Increases arm roll-in speed when operating digging (boom raise, arm roll-in and bucket roll-in).

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/cm^2, 3200 psi) or more)
- Arm Roll-In Pressure Sensor: Specified pressure or higher (Reference: 2.7 MPa (28 kgf/cm^2, 393 psi) or more)


Boom Raise
Arm Roll-In
Dig.
Att.
Pump 2 Delivery Pressure Sensor
Pump 1 Delivery Pressure Sensor
MC
ENG.
REG.
REG.
P/D
Hi
Lo
Boom Cylinder
Digging Regenerative Valve
From Pump 1
Solenoid Valve Unit
SF
Boom 2
Arm Cylinder
Boom 1
Arm 1
Arm 2
From Pump 2
T1V7-02-02-008

Travel Motor Swash Angle Control

Purpose: Controls the travel mode.

Operation:

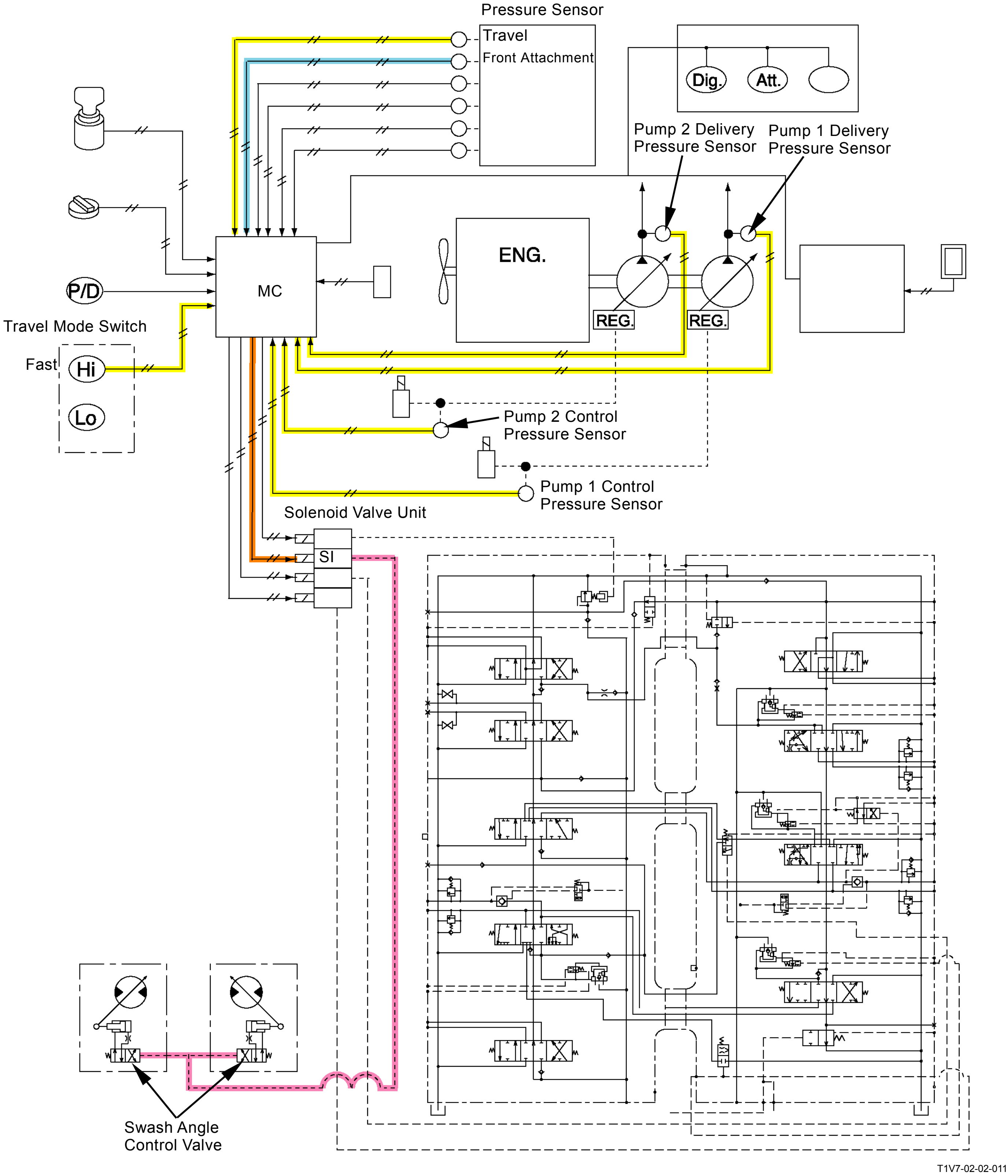
- Slow
  When the travel mode switch is in the SLOW position, the travel motor swash angle is kept in the maximum angle so that the travel speed is slow.
- Fast

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

Condition:

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

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

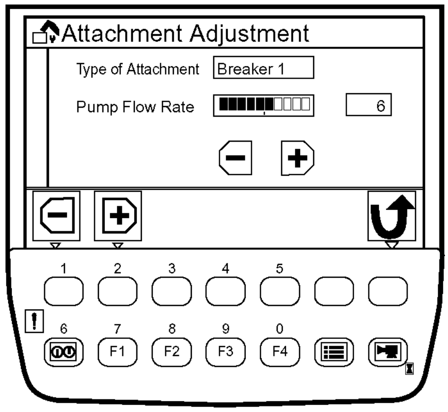

Pressure Sensor
Travel
Front Attachment
Dig.
Att.
Pump 2 Delivery Pressure Sensor
Pump 1 Delivery Pressure Sensor
ENG.
MC
P/D
Travel Mode Switch
Fast
Hi
Lo
REG.
REG.
Pump 2 Control Pressure Sensor
Pump 1 Control Pressure Sensor
Solenoid Valve Unit
SI
Swash Angle Control Valve
T1V7-02-02-011

HSB Breaker Control (Optional)

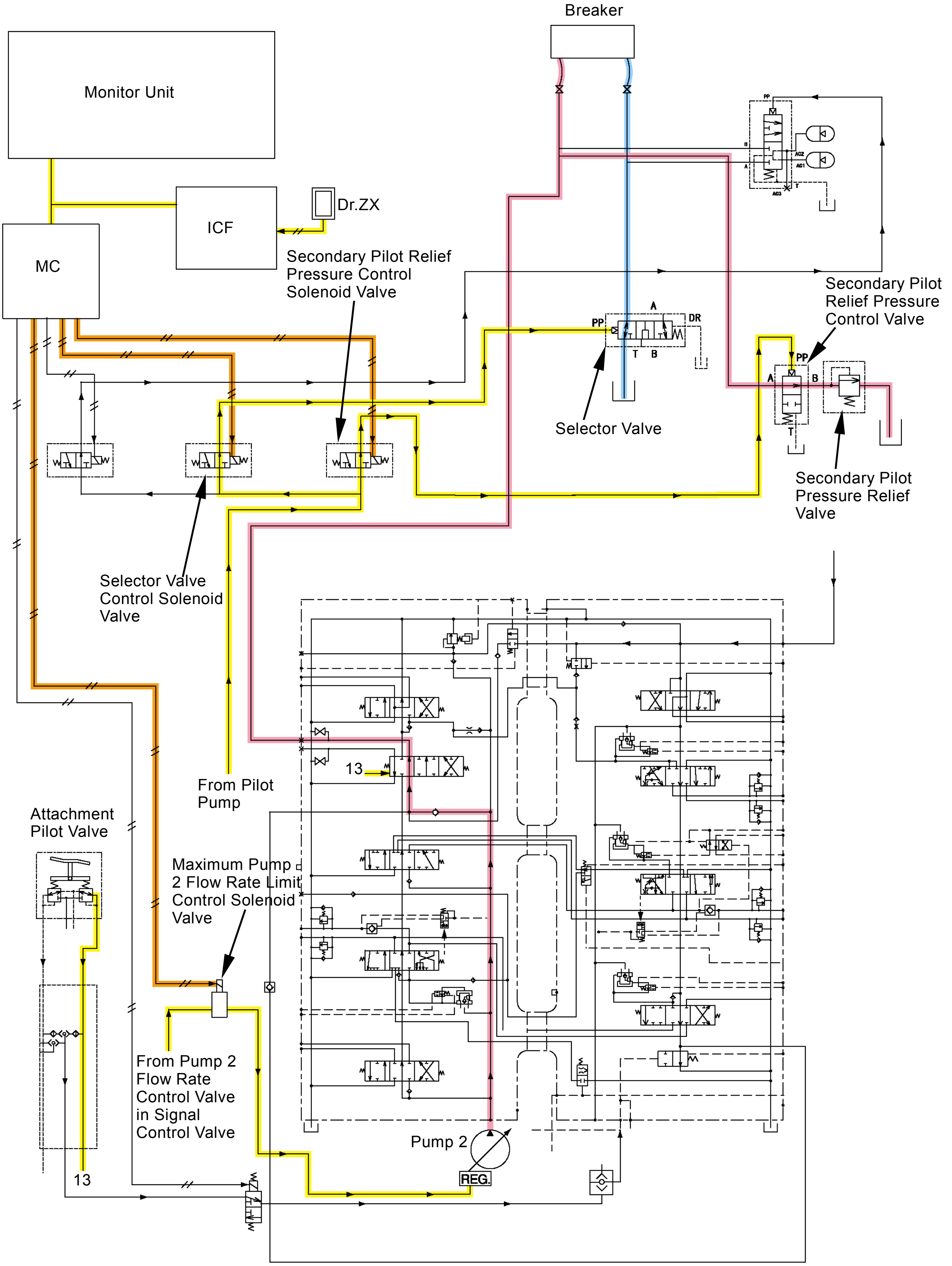
IMPORTANT: HSB breaker is set at breaker 1 of attachment mode in monitor unit when the machine is carried out. When using breaker 3 to 5, set the setting by using Dr. ZX.

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



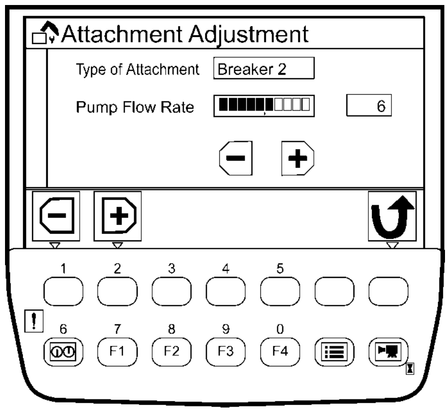
T1V7-02-02-005

NPK Breaker Control (Optional)

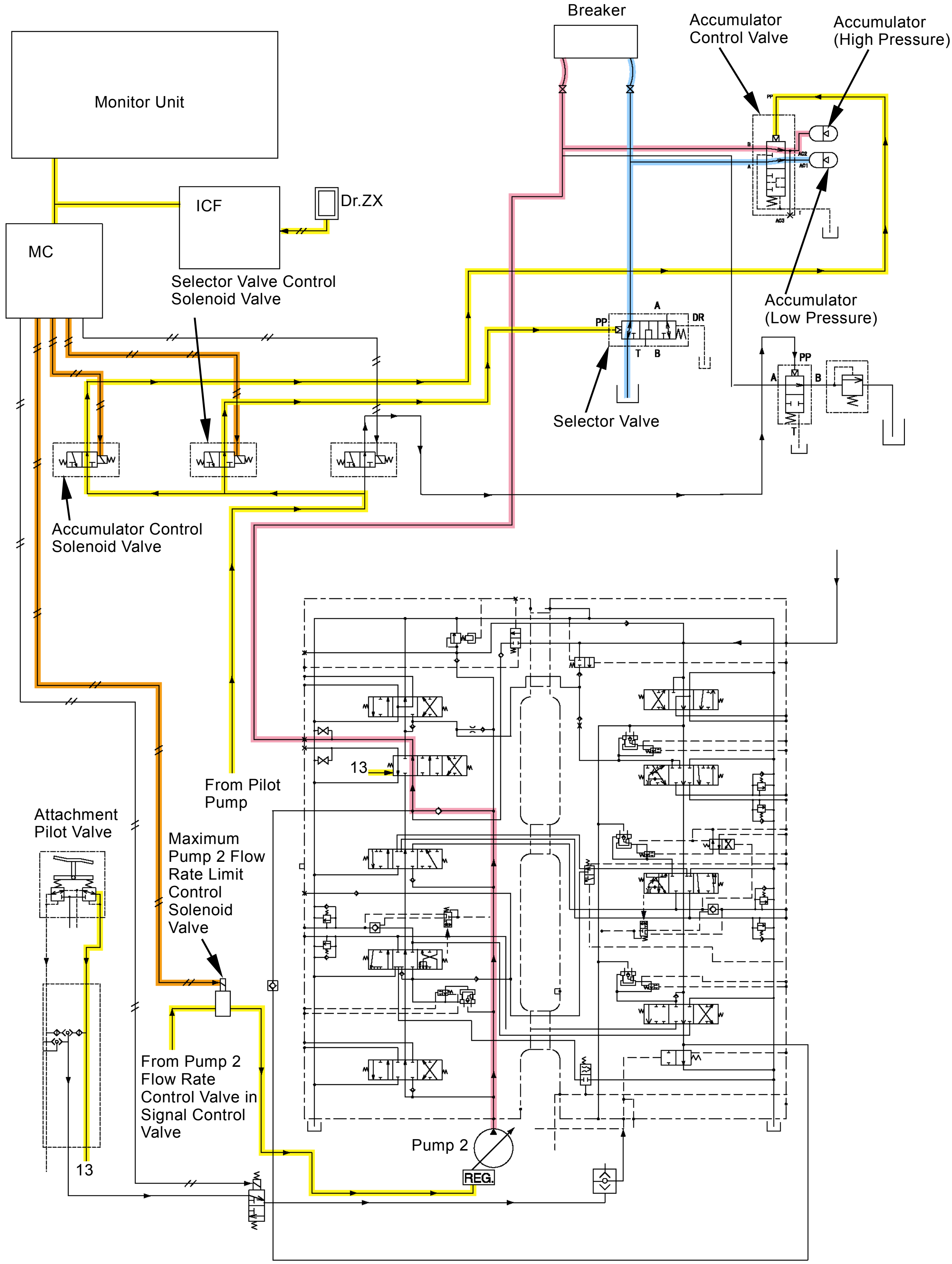
IMPORTANT: NPK breaker is set at breaker 2 of attachment mode in monitor unit when the machine is carried out. When using breaker 3 to 5, set the setting by using Dr. ZX.

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. At the same time, MC drives the accumulator control solenoid valve.
4. Pressure oil from the pilot pump flows the accumulator control solenoid valve and shifts the accumulator control valve.
5. The accumulator is connected to either high pressure side or low pressure side in breaker and reduces shock of oil pressure while using the breaker.
6. 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



T1V7-02-02-004

Secondary Crusher Control (Optional)

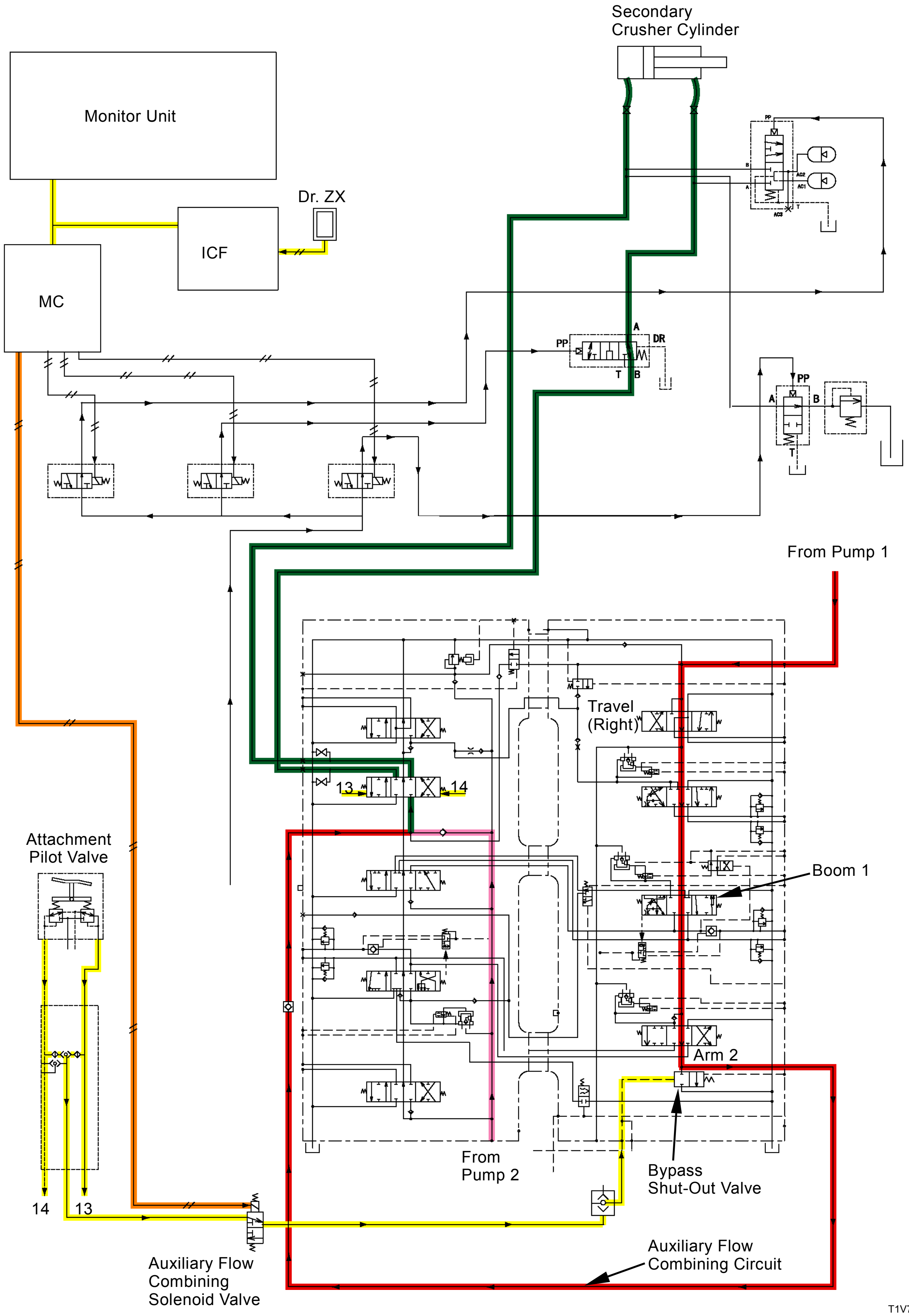
**IMPORTANT: Secondary crusher 1 is set at secondary crusher 1 of attachment mode in monitor unit when the machine is carried out.
When using secondary crusher 2 to 5, set the setting by using Dr. ZX.**

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 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.

During Combined Operation

Operation:
1. During combined operation of boom raise, arm or travel secondary crusher, as pressure oil which flows to the auxiliary flow combining circuit from pump 1 is blocked by boom 1, arm 2 or right travel spool, pressure oil to the secondary crusher is restricted.
2. As pressure oil which flows to boom raise, arm or travel from pump 1 increases, operation of boom raise, arm or travel improves.



T1V7-02-02-003

Hydraulic Crusher Control (Optional)

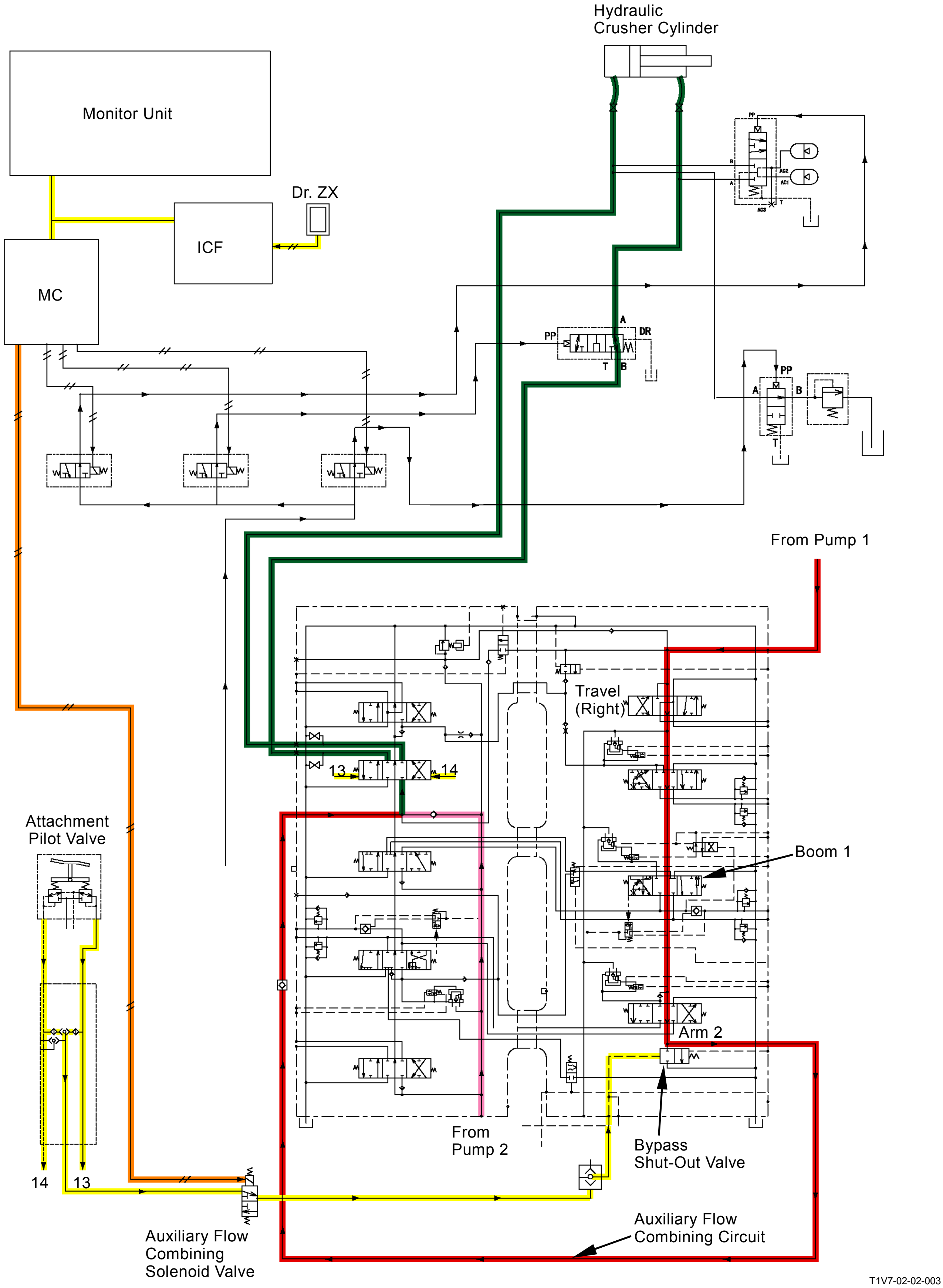
IMPORTANT: Hydraulic crusher 1 is set at hydraulic crusher 1 of attachment mode in monitor unit when the machine is carried out.
When using hydraulic crusher 2 to 5, set the setting by using Dr. ZX.

Purpose: Increases operating speed of the hydraulic 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 hydraulic crusher.

Operation:
1. When selecting hydraulic crusher 1 in the monitor unit, MC drives the auxiliary flow combining solenoid valve.
2. When operating the hydraulic 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 is combined with pressure oil from pump 2 so that combined pressure oil is supplied to the auxiliary spool. Therefore, operating speed of the hydraulic crusher increases.

During Combined Operation

Operation:
1. During combined operation of boom raise, arm or travel and hydraulic crusher, as pressure oil which flows to the auxiliary flow combining circuit from pump 1 is blocked by boom 1, arm 2 or right travel spool, pressure oil to the hydraulic crusher is restricted.
2. As pressure oil which flows to boom raise, arm or travel pump 1 increases, operation of boom raise, arm or travel improves.



Hydraulic Crusher Cylinder
Monitor Unit
Dr. ZX
ICF
MC
From Pump 1
Travel (Right)
13
14
Attachment Pilot Valve
Boom 1
Arm 2
From Pump 2
Bypass Shut-Out Valve
14
13
Auxiliary Flow Combining Solenoid Valve
Auxiliary Flow Combining Circuit
T1V7-02-02-003

OTHER CONTROLS

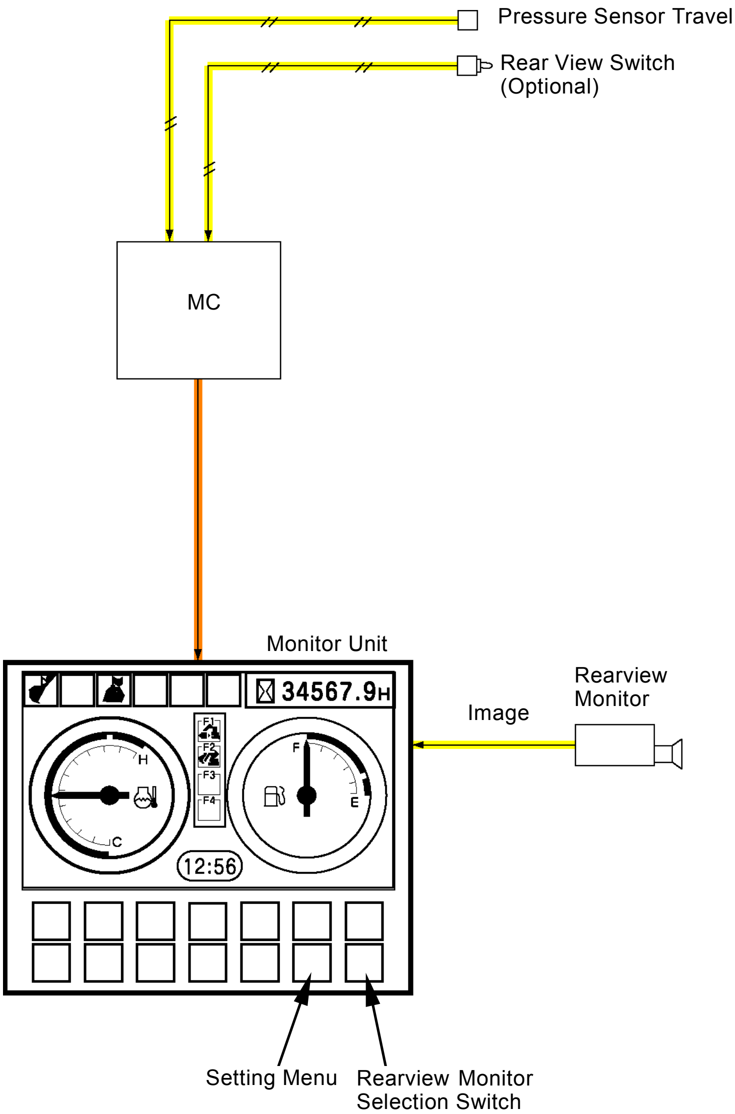
Rear View Image Selection Control

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

Operation:

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

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



T1V1-02-01-031

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 a front attachment in the optional kit is operated.
  In response to operation of front attachment, increasing or decreasing of engine speed (refer to T2-2-22, 24.), increasing or decreasing pump flow rate (refer to T2-2-32, 34, 36.) and valve selection (refer to T2-2-54 to 59) are controlled.
  The engine speed and pump flow rate control settings are made by using Dr. ZX.

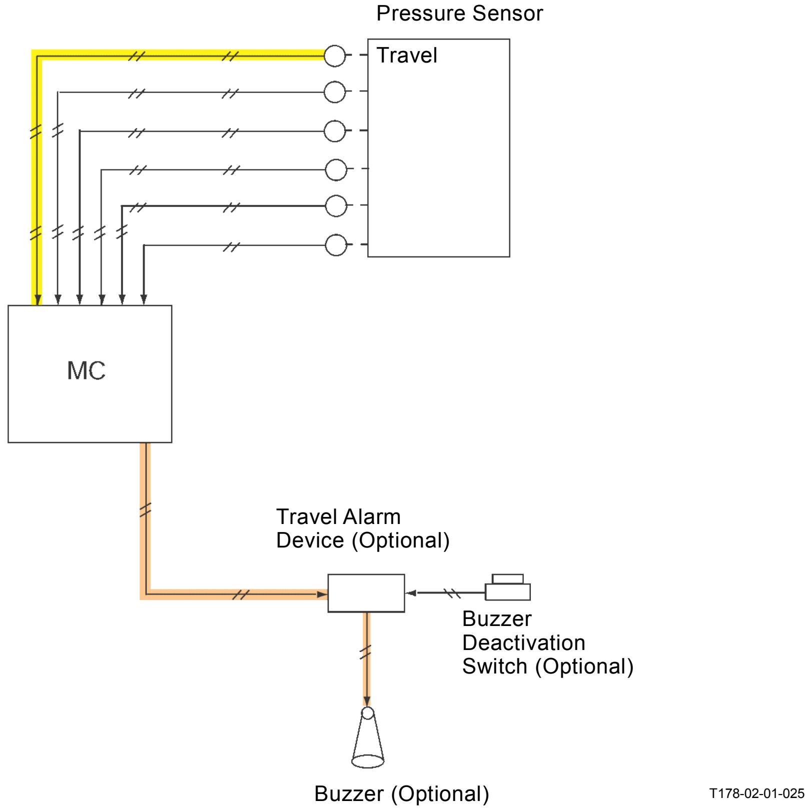
NOTE: As the attachment mode, one to five attachment modes can be selected from breaker 1 to 5, secondary crusher 1 to 5, hydraulic crusher 1 to 5 and vibrating hammer 1 to 5 by using Dr. ZX

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).

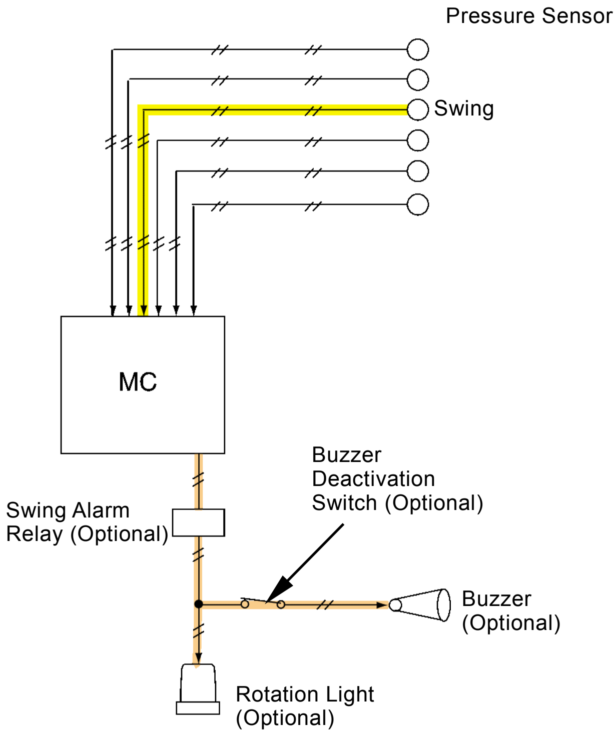


Swing Alarm Control (Only Machines Equipped with Optional Parts)

Purpose: Sounds the buzzer (optional) and turn on the rotation 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 rotation light.

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



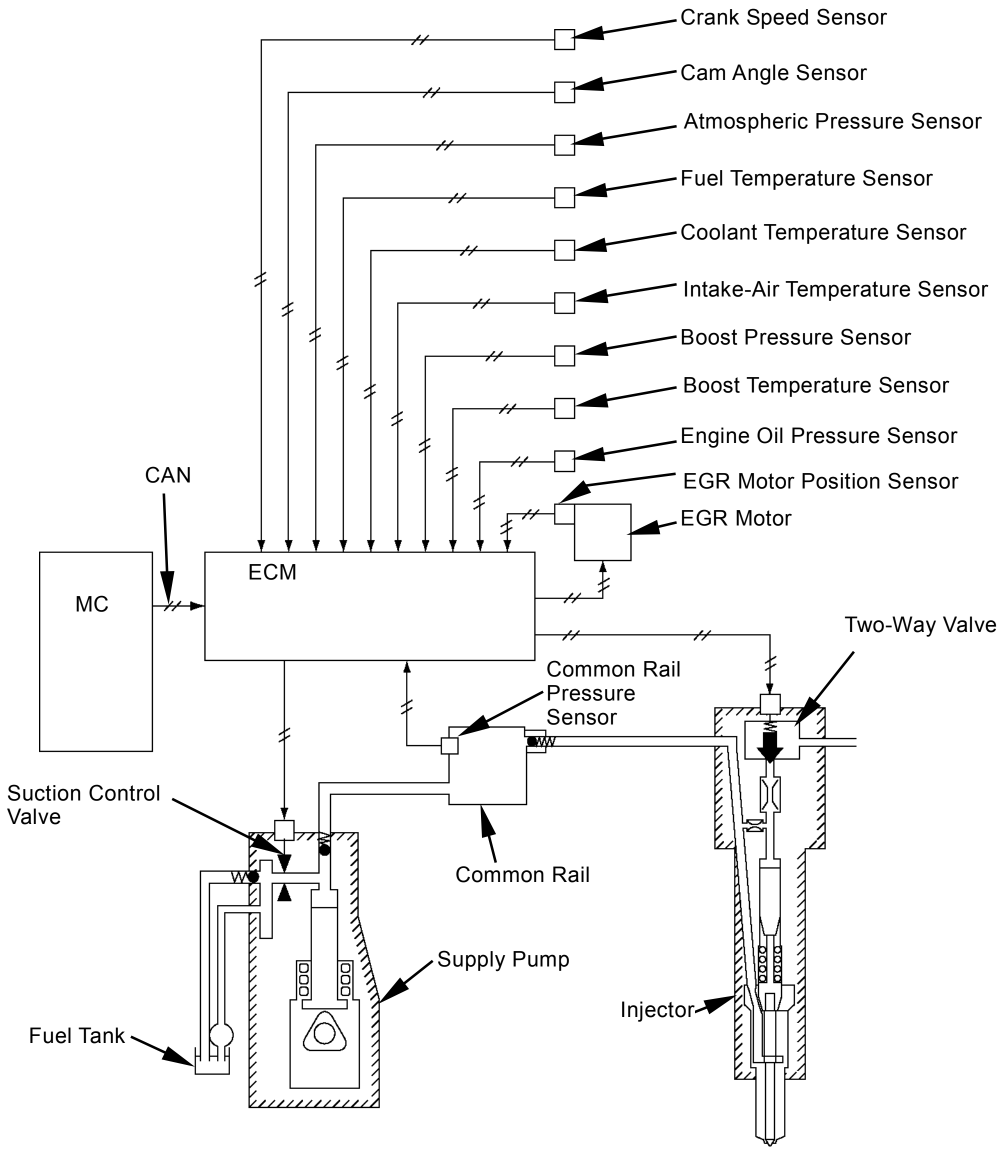
T178-02-01-026

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.



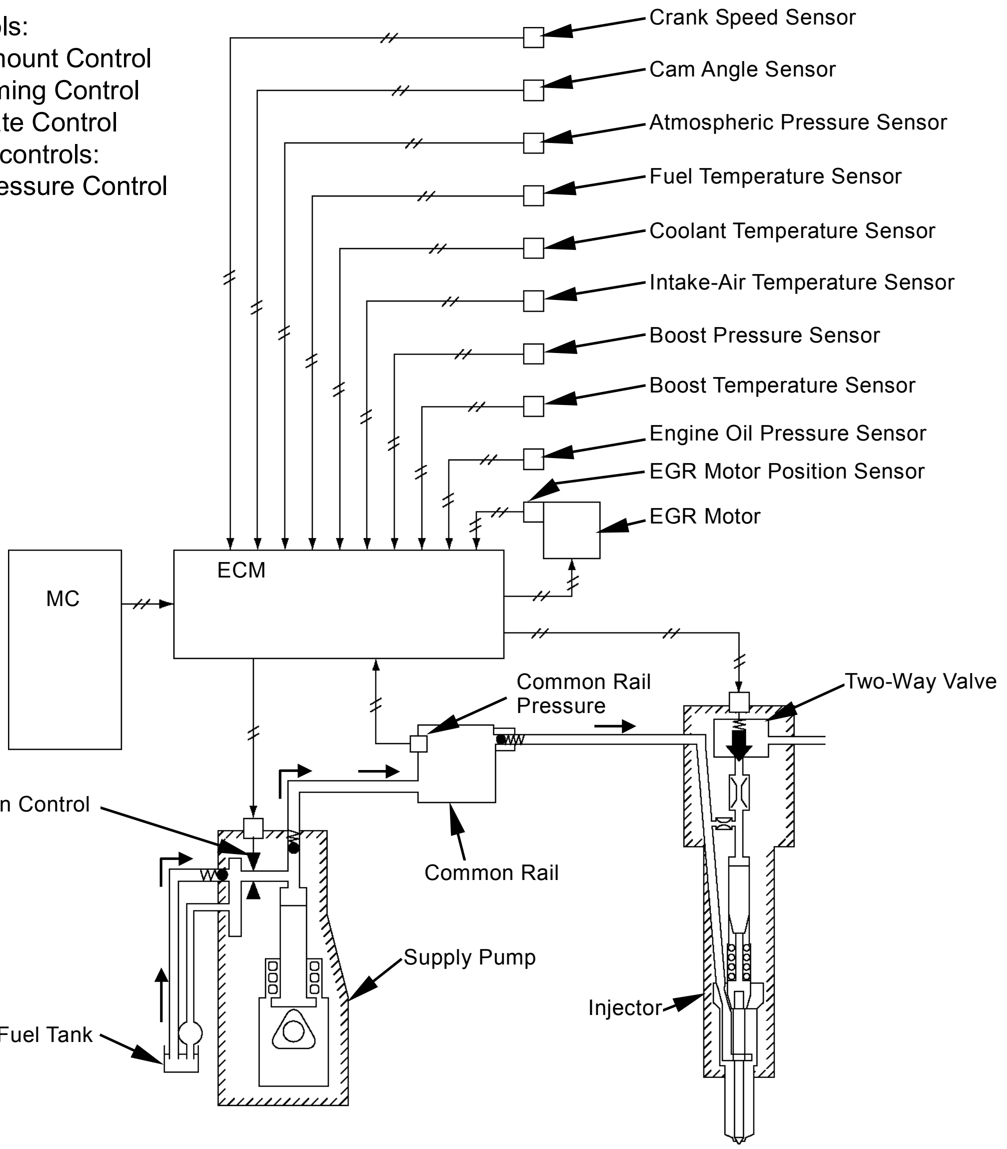
T1GR-02-02-001

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

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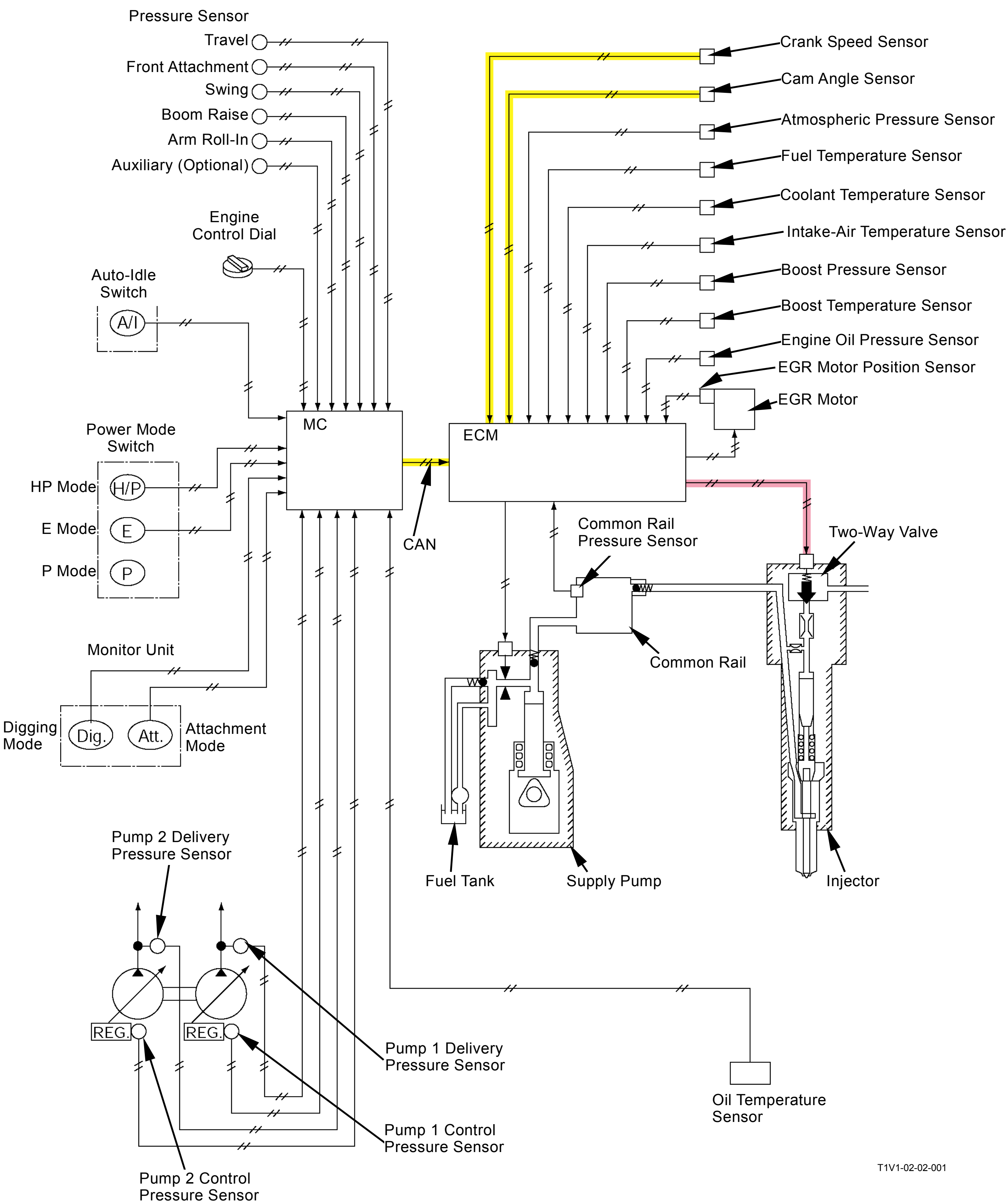
Fuel Injection Amount Control

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.



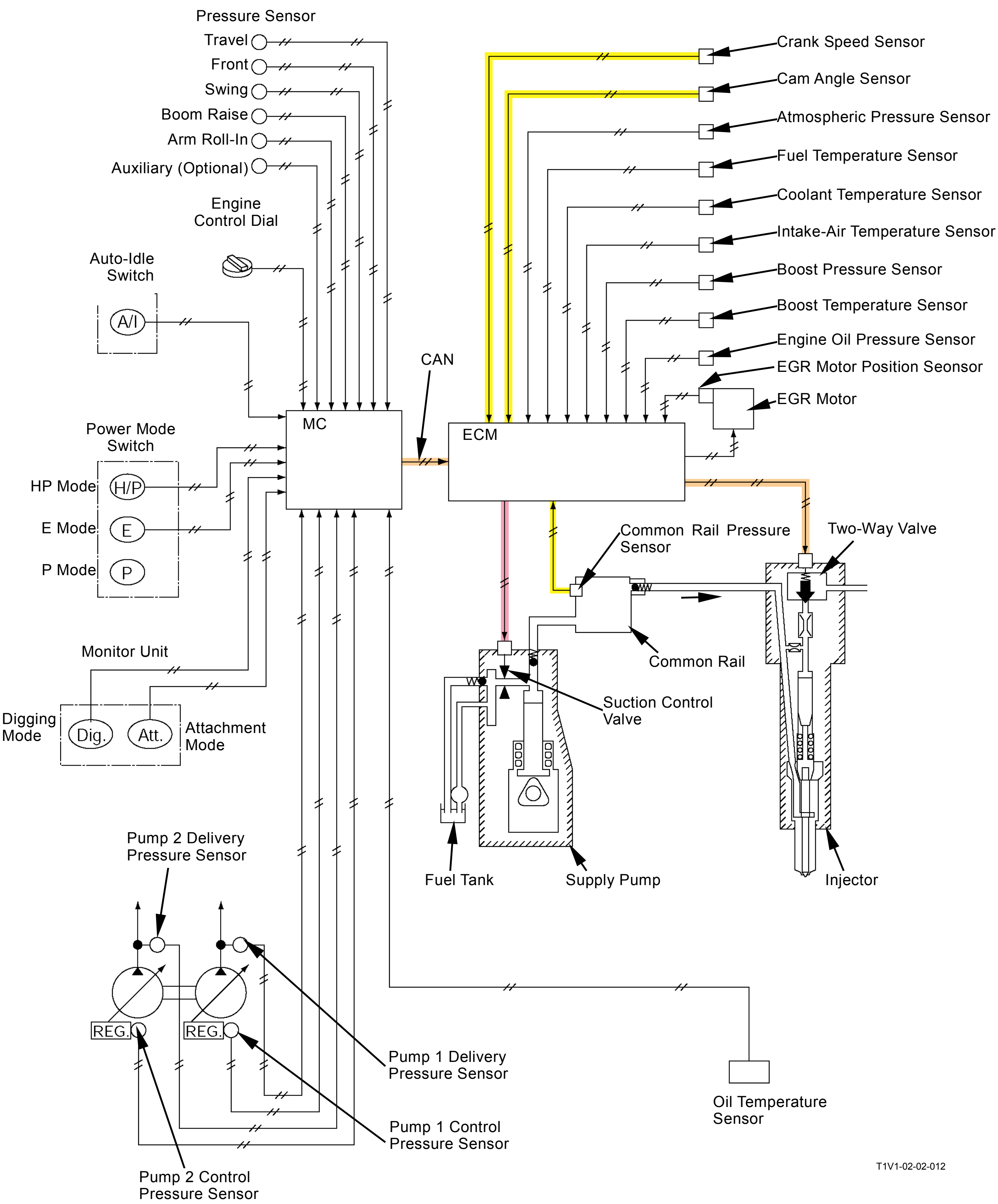
T1V1-02-02-001

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.



T1V1-02-02-012

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.

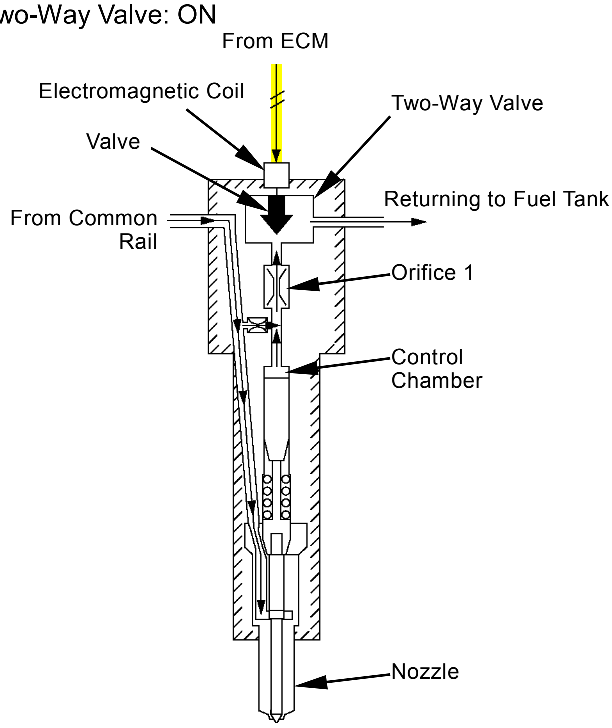
Fuel Injection Rate Control

Purpose: Improves combustion in the engine cylinder.

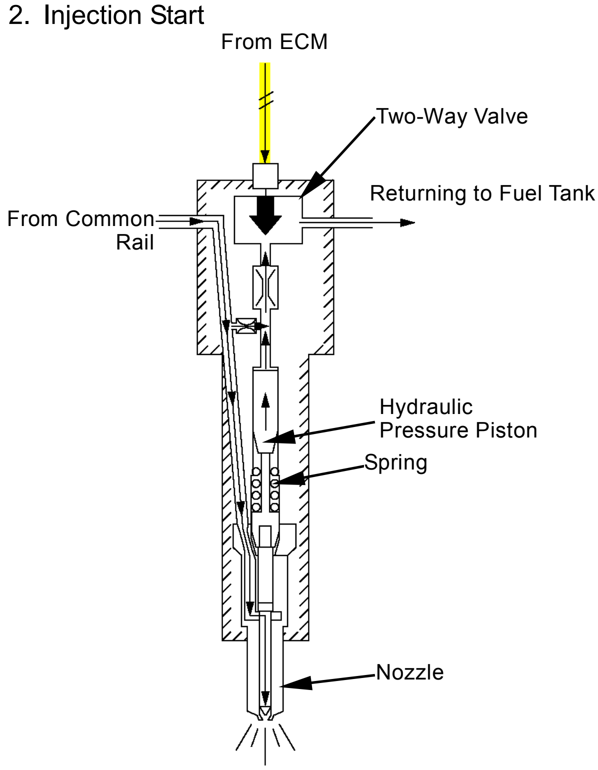
Operation:
1. The injector injects small amount of fuel (pilot injection) first and ignites.
2. After igniting, the injector injects fuel (main injection). ECM controls fuel injection timing and fuel injection amount by turning the two-way valve in injector ON/OFF.

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.

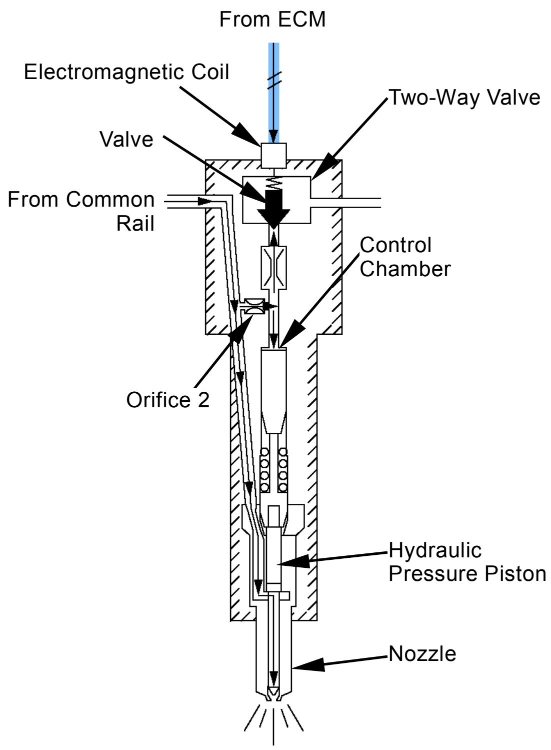
1. Two-Way Valve: ON



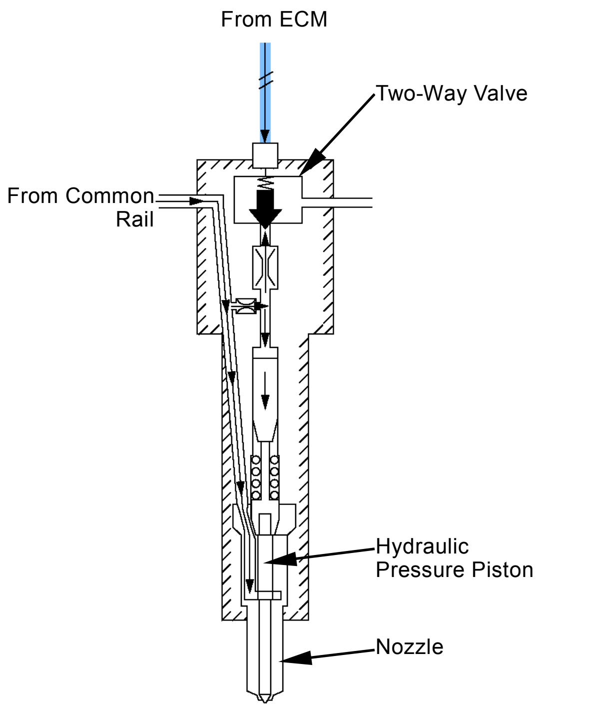
2. Injection Start



3. Two-Way Valve: OFF



4. Injection Stop



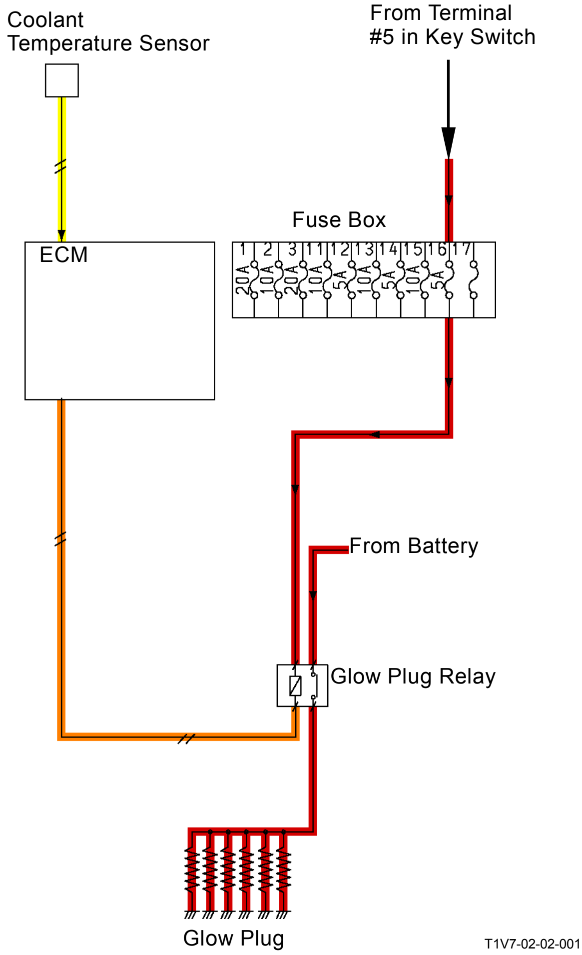
T1GR-02-02-012

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.



T1V7-02-02-001

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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

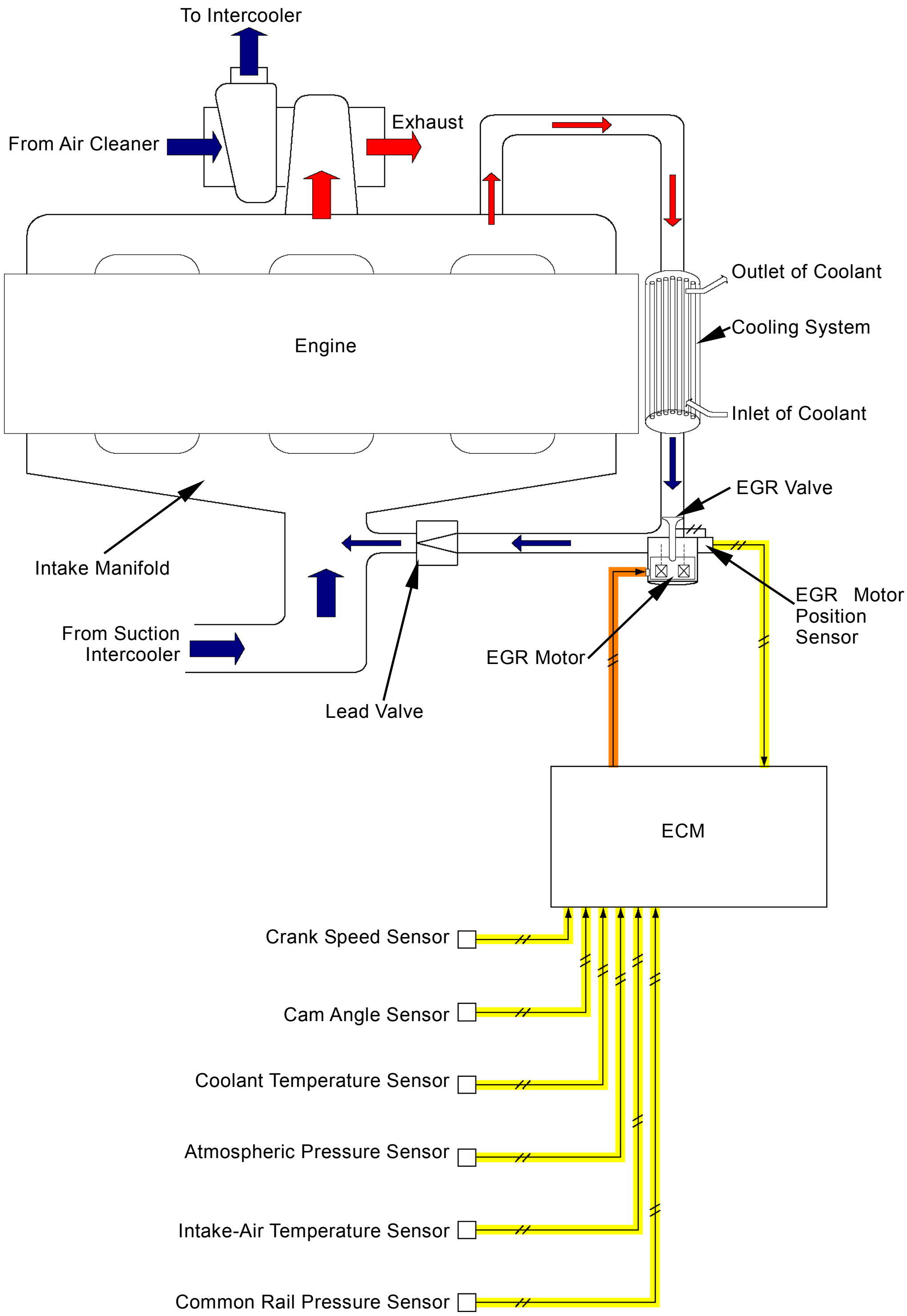
1. ECM decides EGR gas amount according to engine speed, fuel flow rate, coolant temperature, atmospheric pressure and intake-air temperature.
2. ECM drives EGR motor, opens EGR valve and sends EGR gas to the intake manifold in response to engine condition so that EGR gas is combined with intake-air.
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.

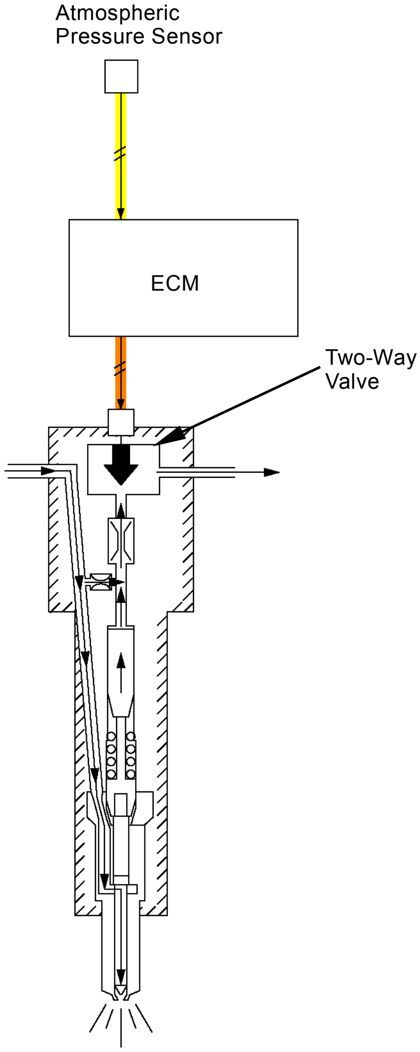


T1V1-02-02-007

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

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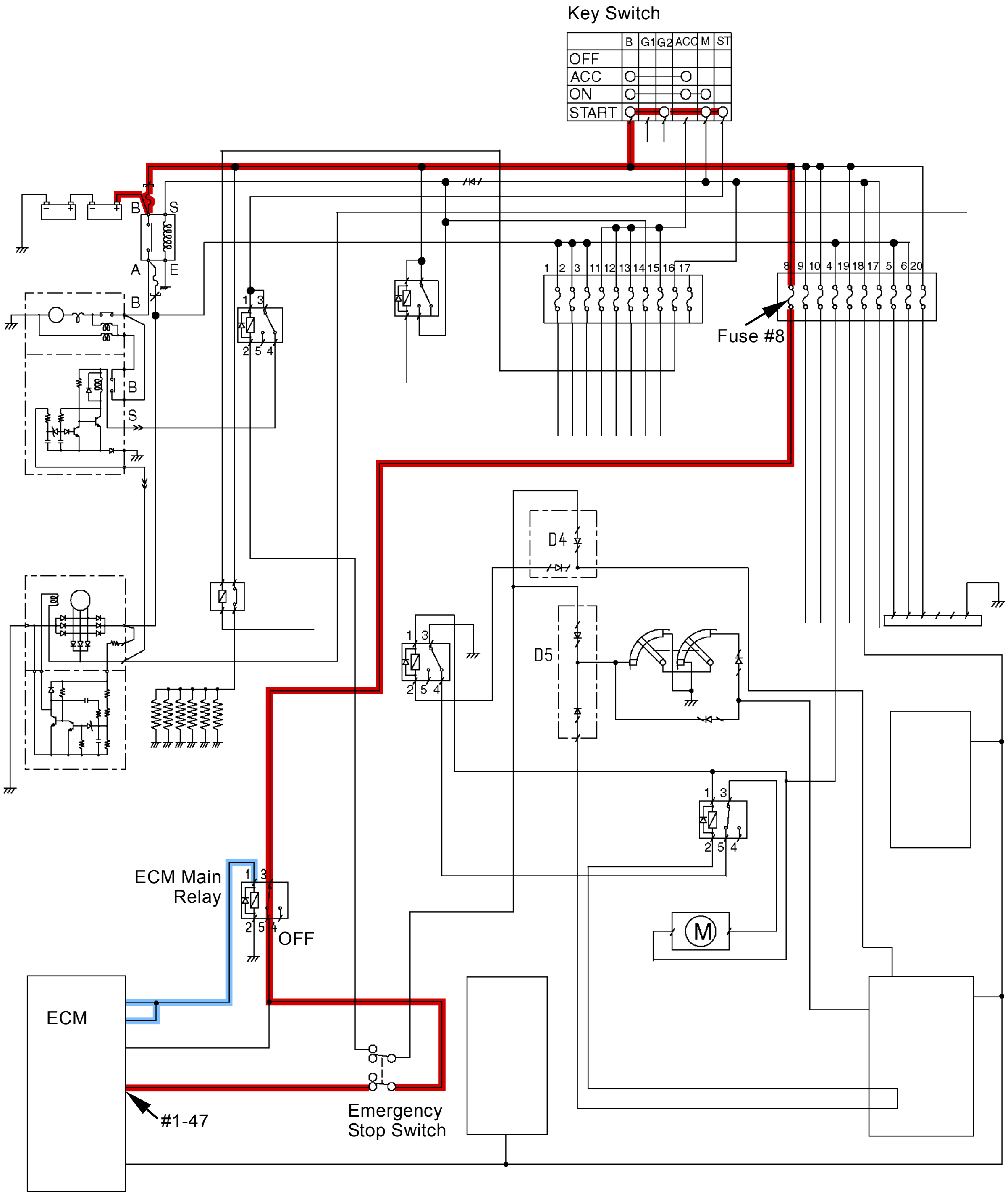
ENGINE STOP CONTROL

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.



T1V7-02-02-002

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OUTLINE

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

Main Circuit:

Power Source		Controller		Actuator
Main Pumps	→	Control Valves	→	Motors
				Cylinders
				Front Attachmens (Optional)

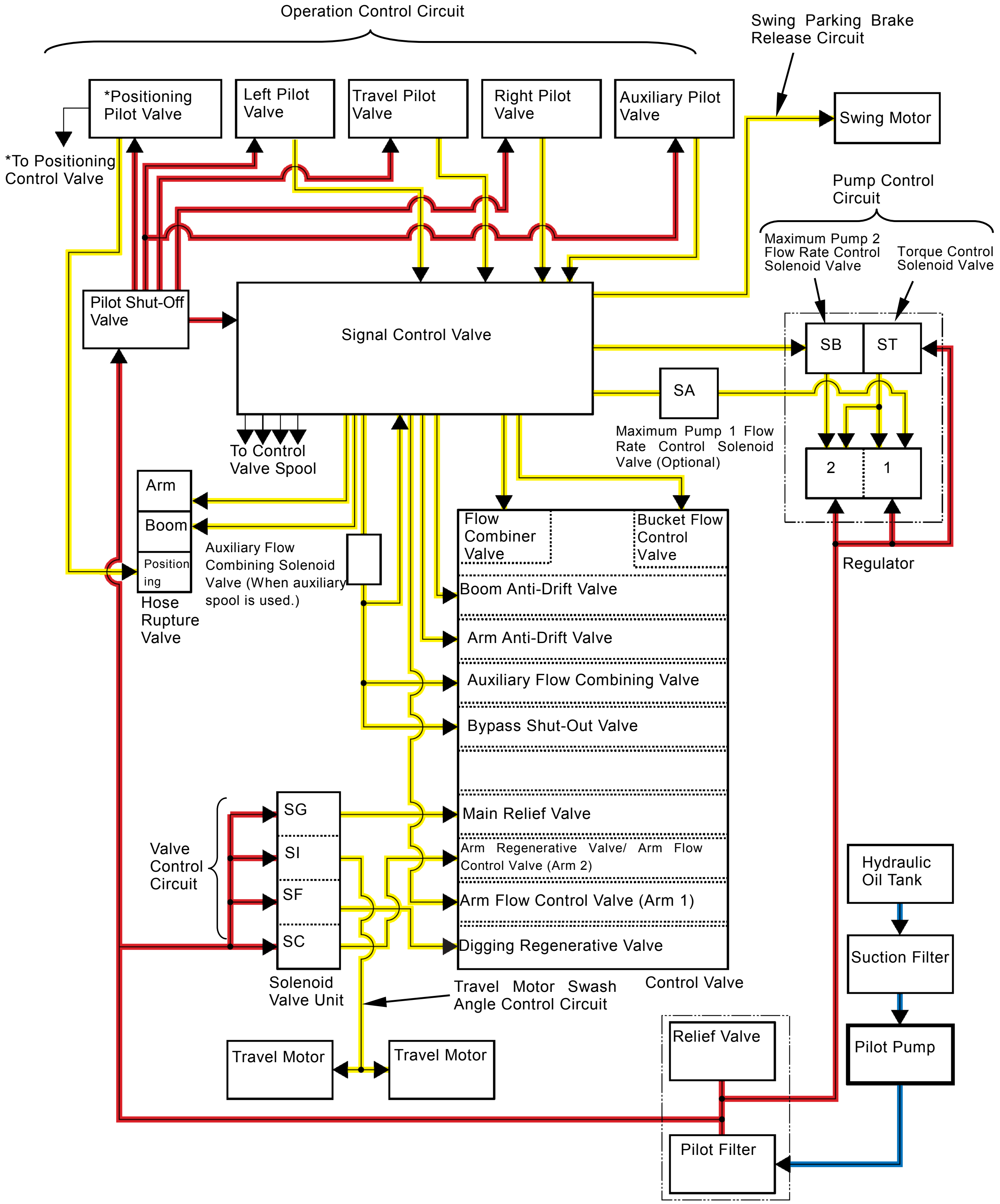
Pilot Circuit:

Power Source		Controller		Pilot Circuit
Pilot Pumps	→	Pilot Valves	→	Operation Control Circuit
		Pump Regulator		Pump Control Circuit
		Solenoid Valve Unit		Valve Control Circuit
		Signal Control Valve		Swing Parking Brake Release Circuit
				Travel Motor Swash Angle Control Circuit
				Positining Circuit（2-Piece Boom only）

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).

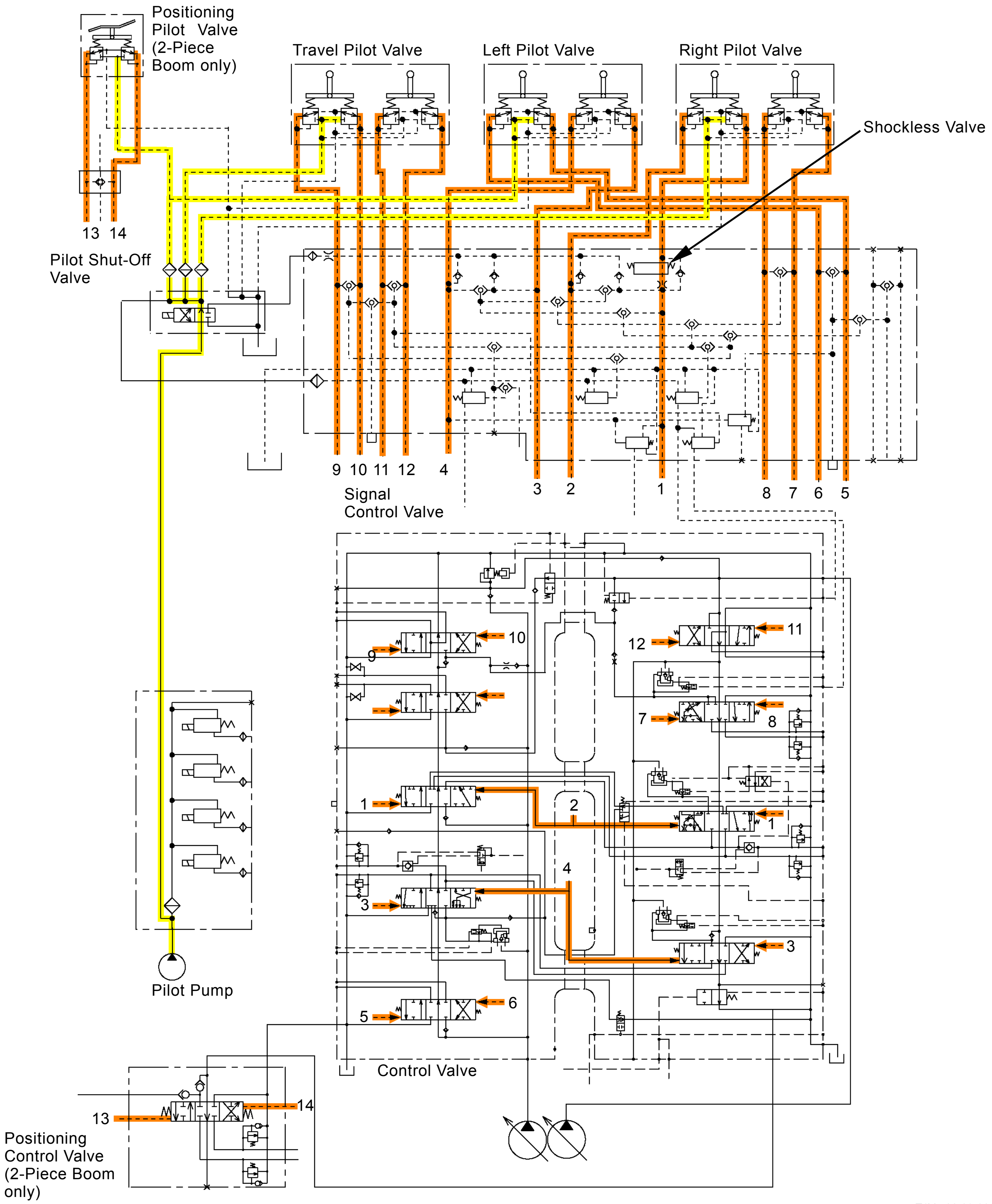


T1V7-02-03-013

NOTE:*2 (2-Piece boom only)

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.)



T1V7-02-03-009

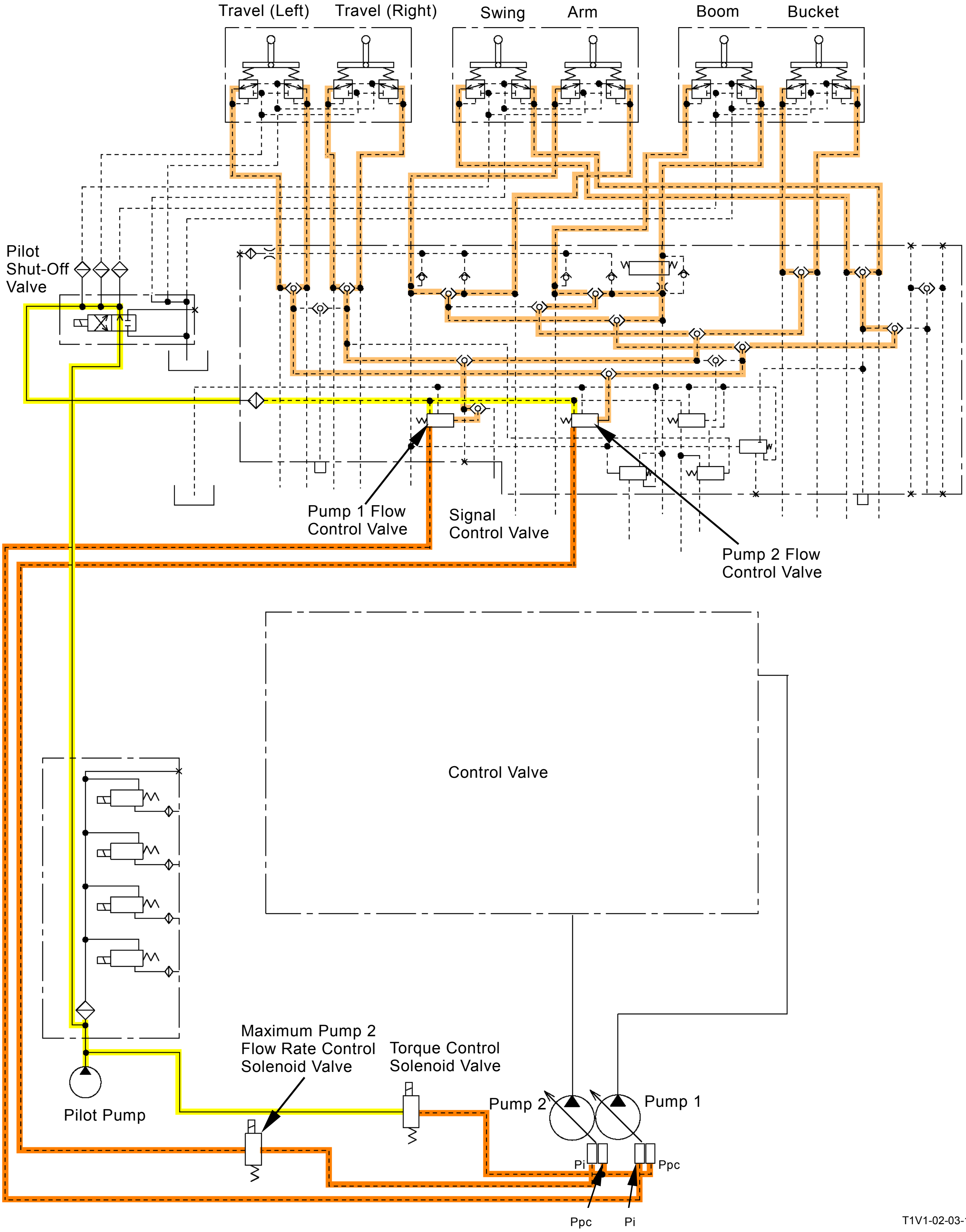
- 1 – Boom Raise
- 2 – Boom Lower
- 3 – Arm Roll-Out
- 4 – Arm Roll-In
- 5 - Left Swing
- 6 - Right Swing
- 7 - Bucket Roll-In
- 8 - Bucket Roll-Out
- 9 - Left Travel Forward
- 10 - Left Travel Reverse
- 11 - Right Travel Forward
- 12 - Right Travel Reverse
- 13 - Positioning Lower
- 14 - Positioning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

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

- Pump Delivery Flow Rate Control by Flow Rate Control Pressure Pi
  - 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 Pi 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, auxiliary and travel (right), flow rate control pressure Pi is supplied to main pump1.
When operating boom raise/ lower, arm roll-out/in, swing right/left and travel (left), flow rate control pressure Pi 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 Ppc.



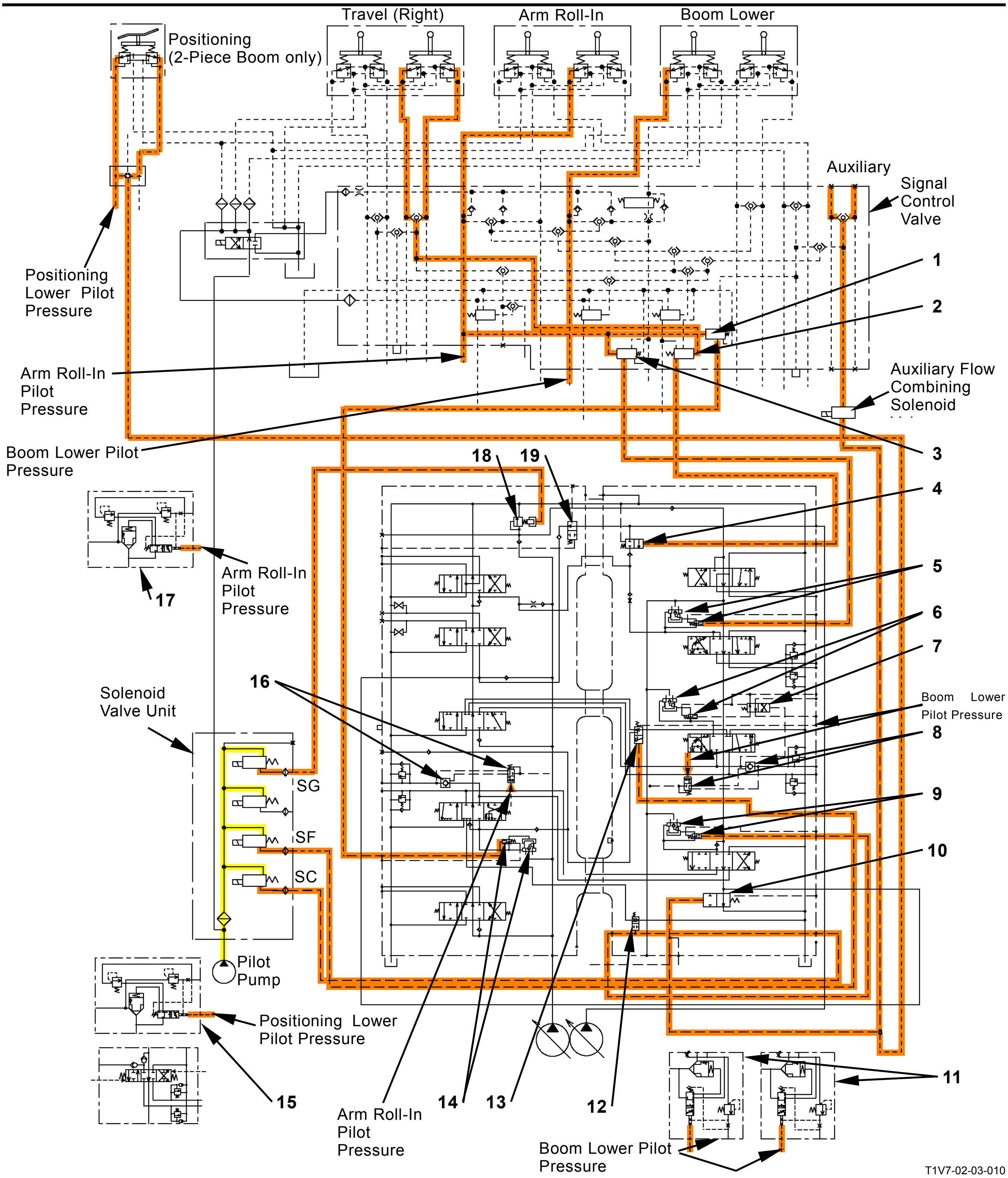
T1V1-02-03-100

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

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

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



1 – Arm Flow Control Valve Control Spool
2 – Flow Combiner Valve Control Spool
3 – Bucket Flow Control Valve Control Spool
4 – Flow Combiner Valve
5 – Bucket Flow Control Valve
6 - Boom Flow Control Valve
7 - Boom Lower Meter-In Cut Valve
8 - Boom Anti-Drift Valve
9 - Arm Flow Control Valve (Arm 2)
10 - Bypass Shut-Out Valve
11 - Hose Rupture Valve (Boom) (Optional)
12 - Arm Regenerative Valve
13 - Digging Regenerative Valve
14 - Arm Flow Control Valve (Arm 1)
15 - Hose Rupture Valve (Positioning) (Optional)
16 - Arm Anti-Drift Valve
17 - Hose Rupture Valve (Arm) (Optional)
18 - Main Relief Valve
19 - Auxiliary Flow Combining Valve

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

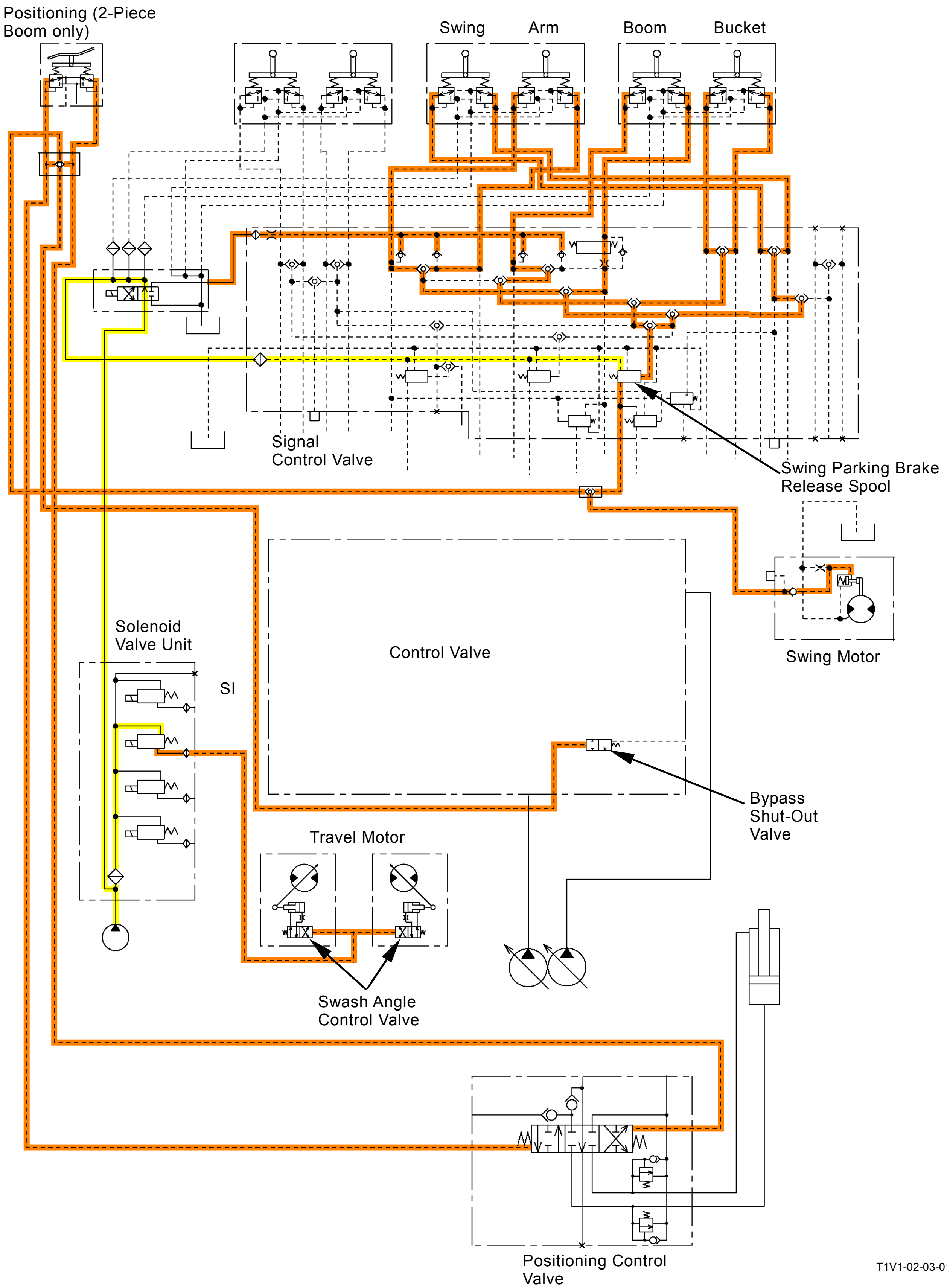
- When operating the front attachment or swing, pilot pressure SH is selected by the shuttle valve in signal control valve and shifts the swing parking brake release spool.
- As a result, the release signal pressure is supplied to the swing motor and the swing parking brake is released.

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.

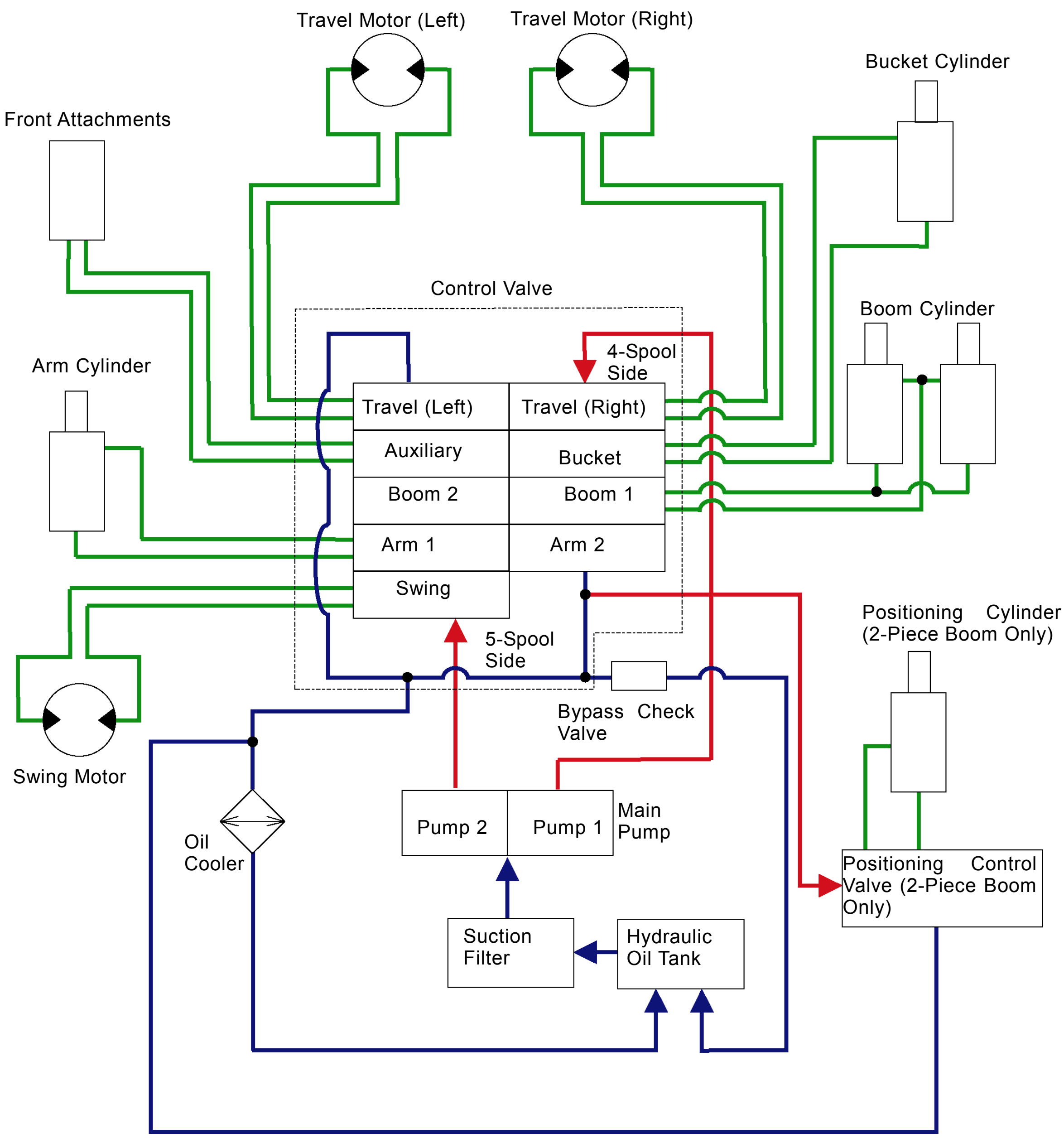


T1V1-02-03-013

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.



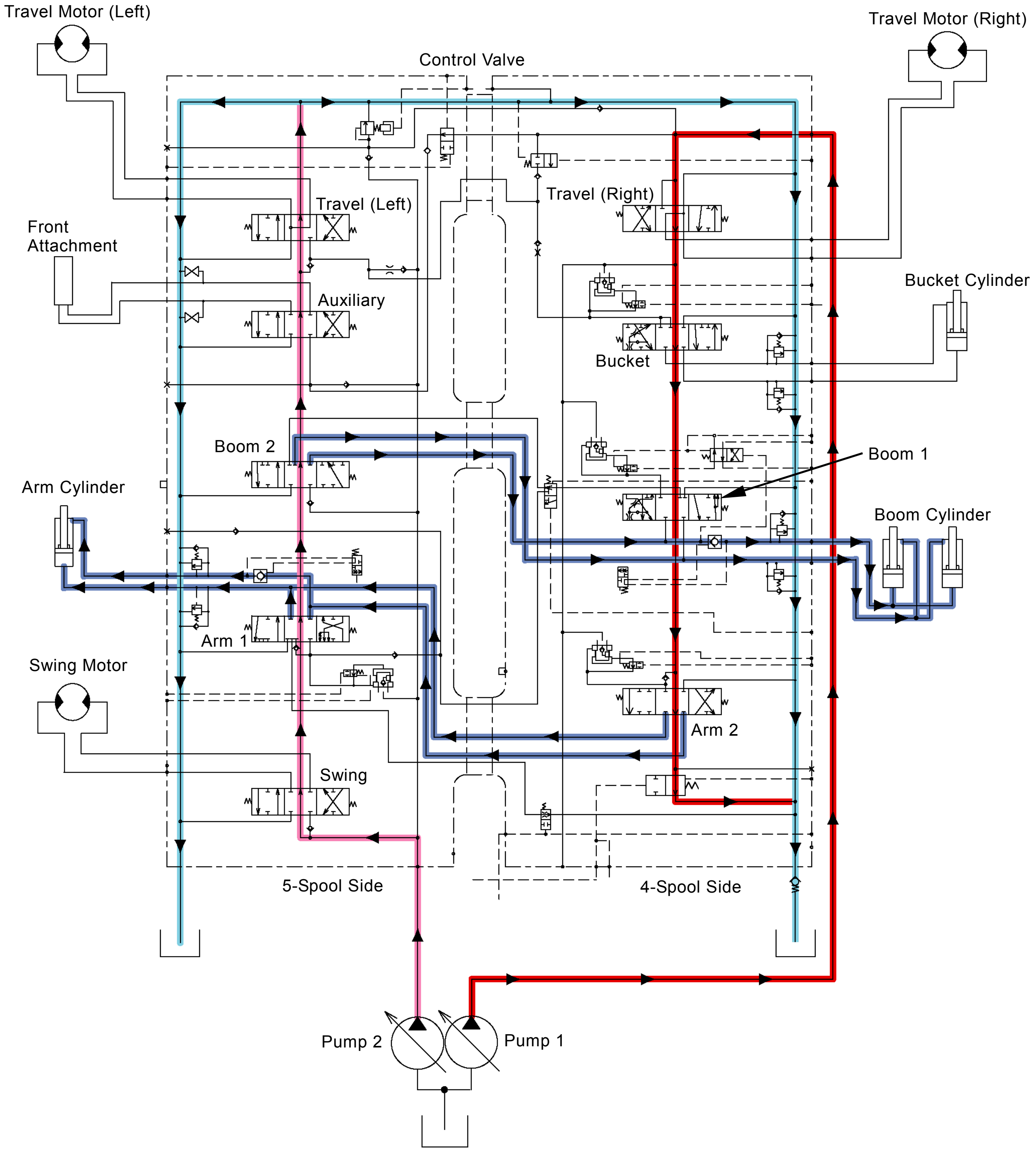
T1V1-02-03-103

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

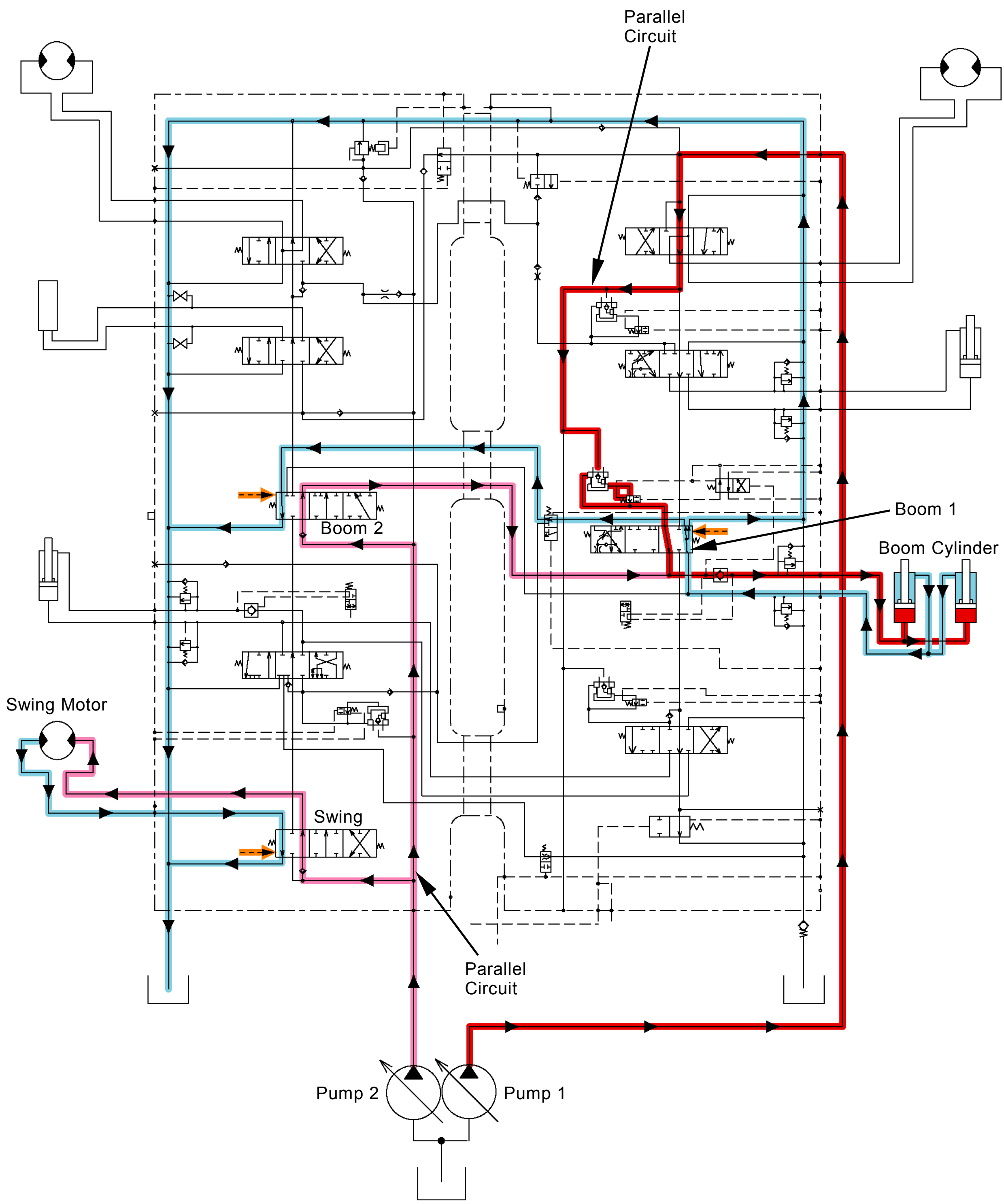
- Pressure oil from pump 1 flows to each spool of right travel, bucket, boom 1 and arm 2 through the 4-spool control valve.
- Pressure oil from pump 2 flows to each spool of swing, arm 1, boom 2, auxiliary and left travel through the 5-spool control valve.
- The boom and arm are actuated by pressure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



T1V7-02-03-003

Combined Operation Circuit

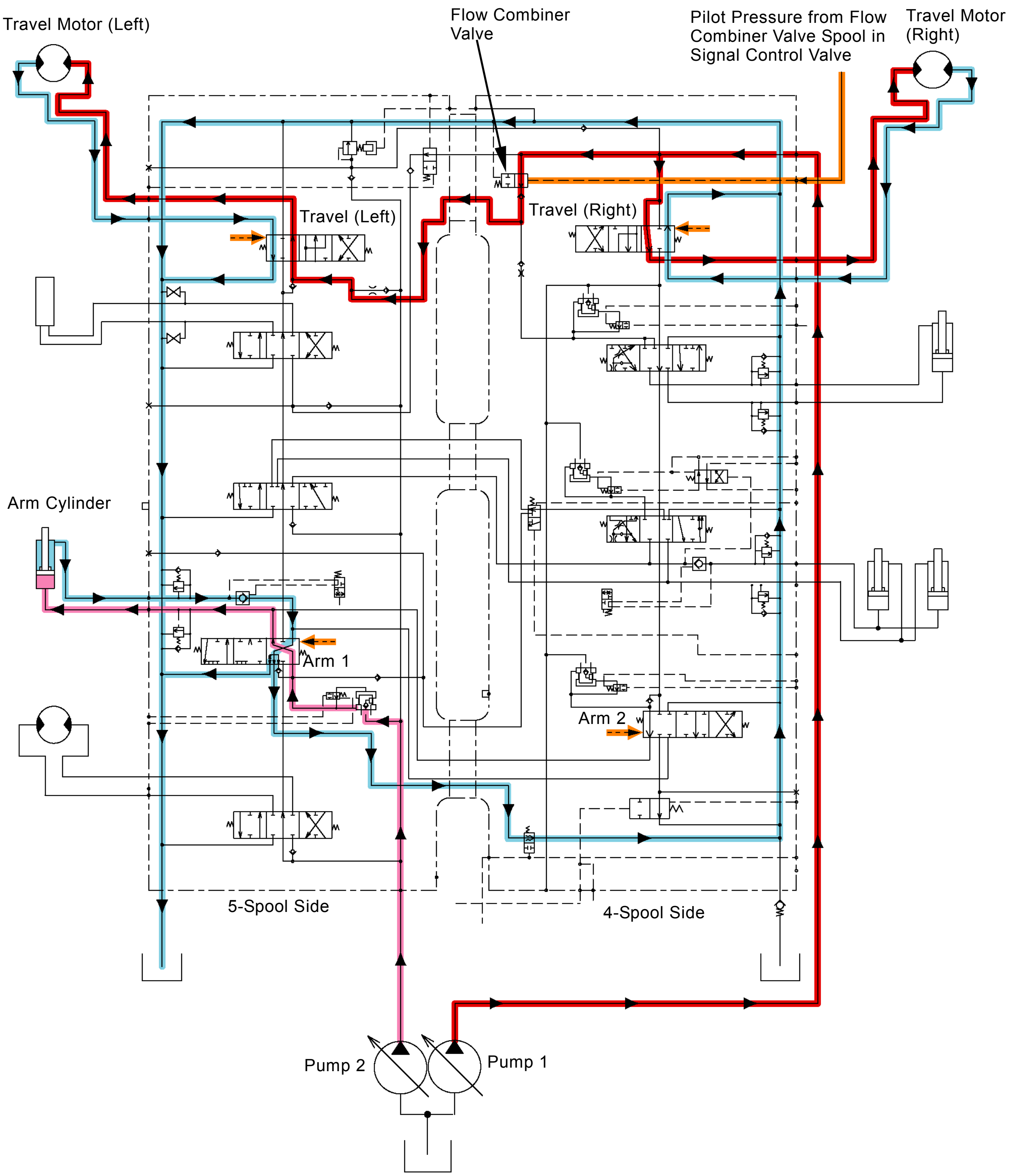
- Swing and Boom Raise Operation
  - When the boom is raised while swinging, pilot pressure shifts the spools of swing, booms 1 and 2.
  - Pressure oil from pump 1 flows to the boom cylinder from the boom 1 spool through the parallel circuit and raises the boom.
  - Pressure oil from pump 2 flows to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



T1V7-02-03-004

- 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.



T1V7-02-03-005

Positioning Circuit (2-Piece Boom Only)

Neutral Circuit

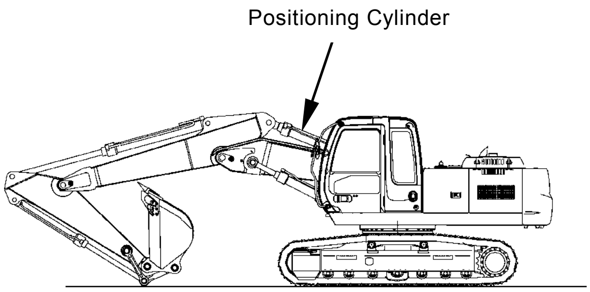
- When the positioning lever is in neutral, pressure oil from pump 1 returns to the hydraulic oil tank through the control valve.

Single Operation Circuit

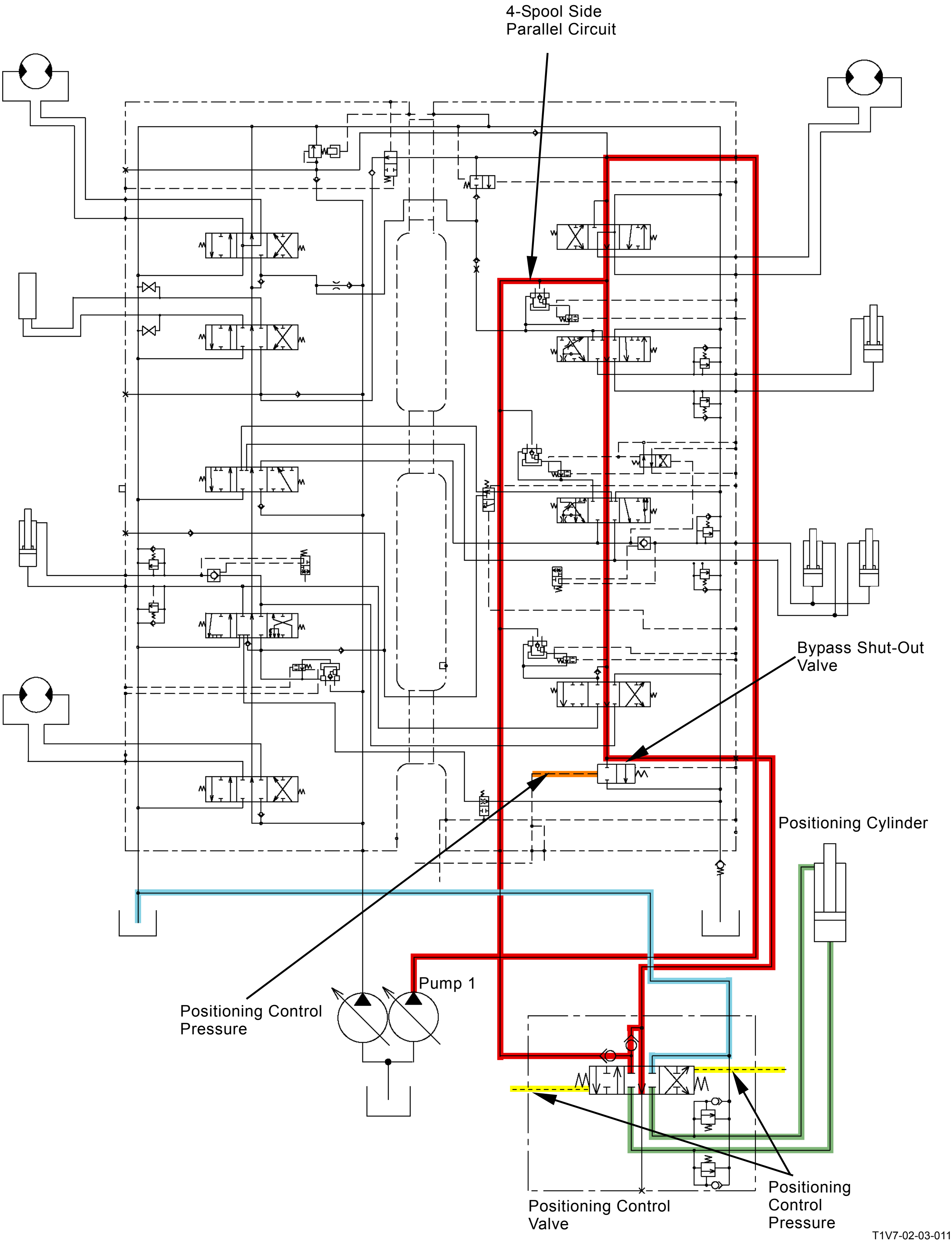
- During positioning operation, the spools of bypass shut-out valve and positioning control valve are shifted.
- Pressure oil from pump 1 flows to the spool in positioning control valve and moves the positioning cylinder.

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.



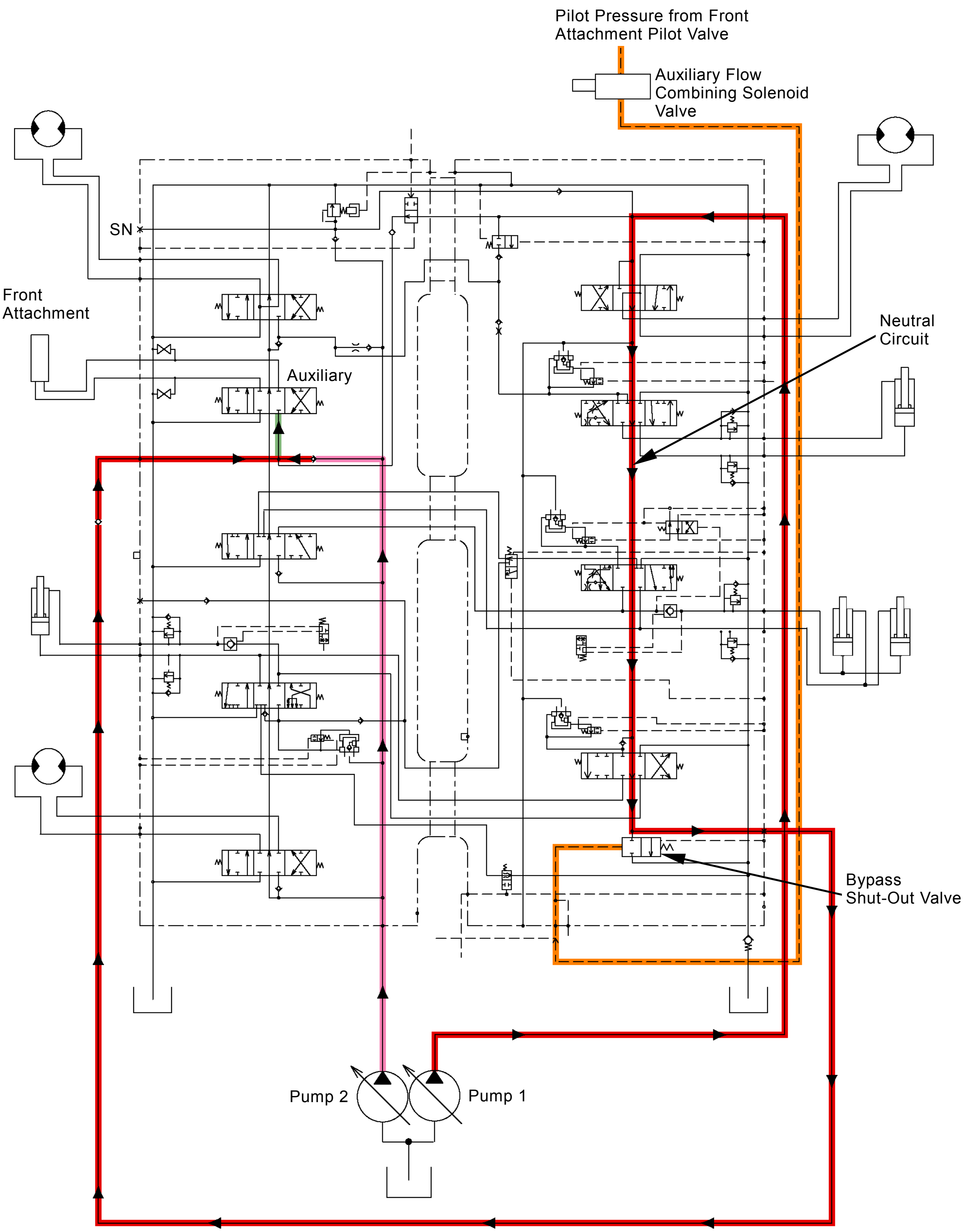
T178-02-02-014



4-Spool Side
Parallel Circuit
Bypass Shut-Out
Valve
Positioning Cylinder
Pump 1
Positioning Control
Pressure
Positioning
Control
Pressure
Positioning Control
Valve
T1V7-02-03-011

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.



T1V7-02-03-006

BOOM LOWER METER-IN CUT CONTROL

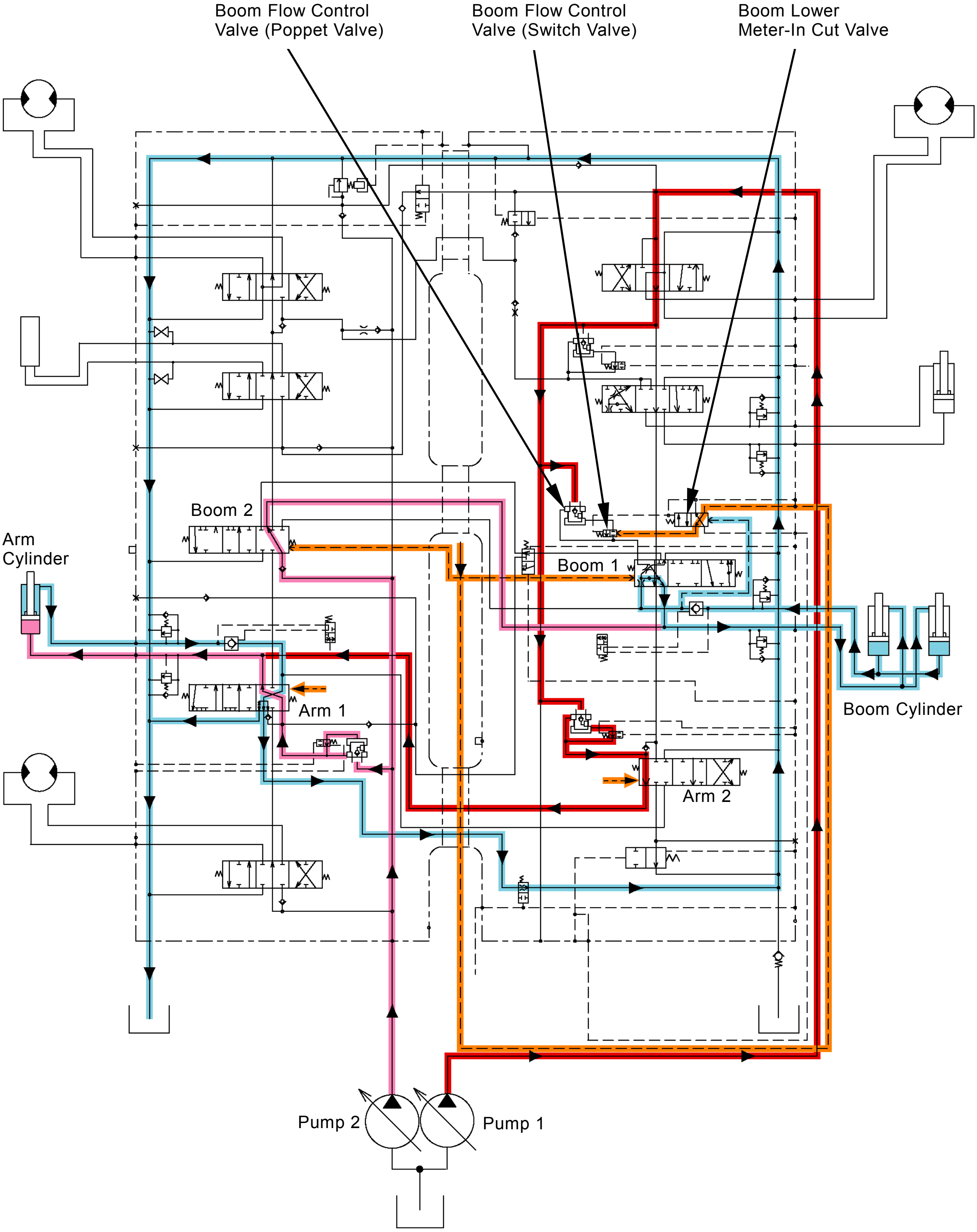
Purpose: During combined operation of boom lower and arm, bucket, swing or travel with the front attachment above the ground, pressure oil to the boom cylinder from the pump is cut, the boom falls due to own weight by using the regenerative circuit, pressure oil is used for other actuators and the control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

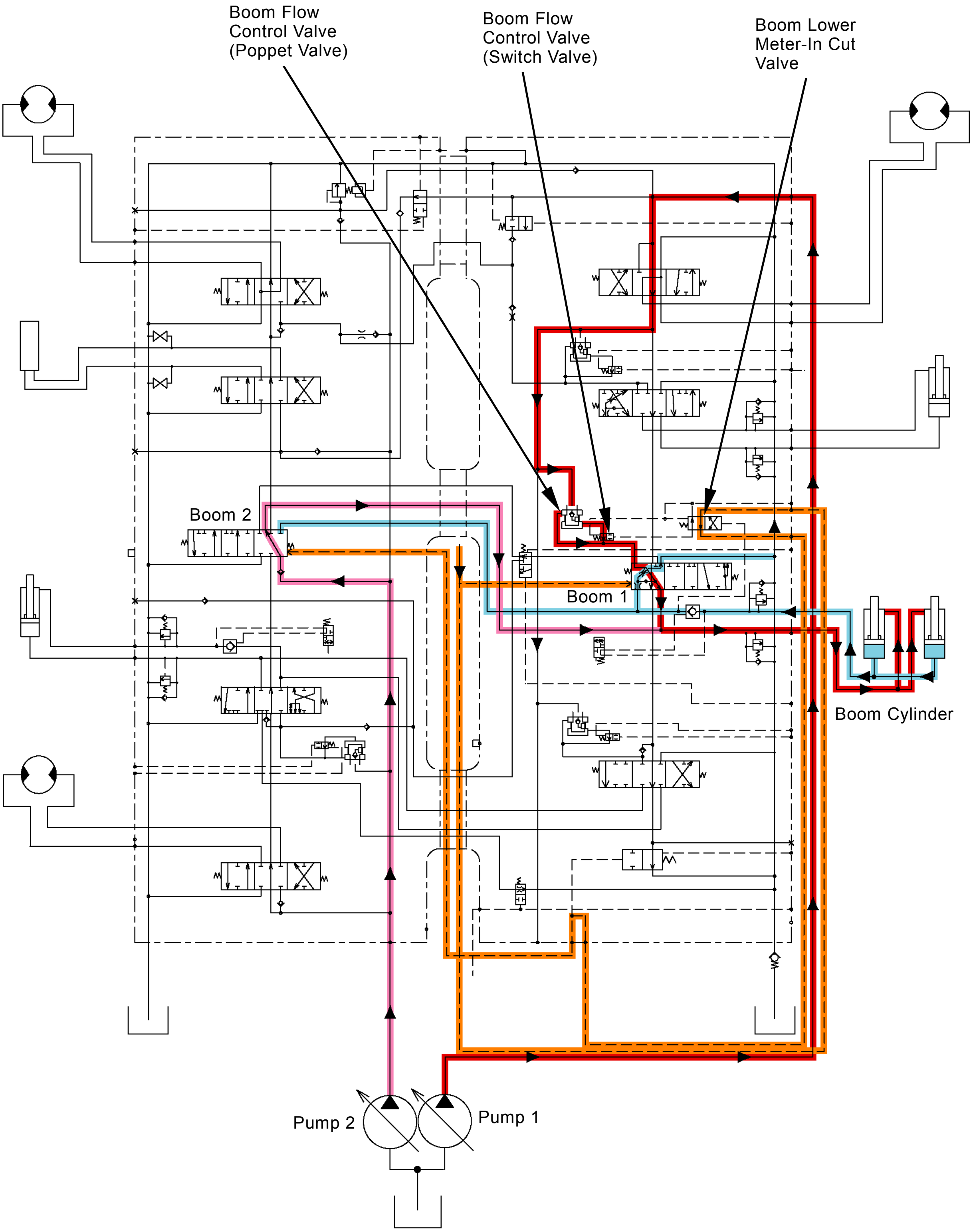
NOTE: The illustration shows combined operation of boom lower and arm roll-in.



T1V7-02-03-007

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.



T1V7-02-03-008

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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.

MAIN CIRCUIT

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

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

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

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

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

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

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

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

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

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

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

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

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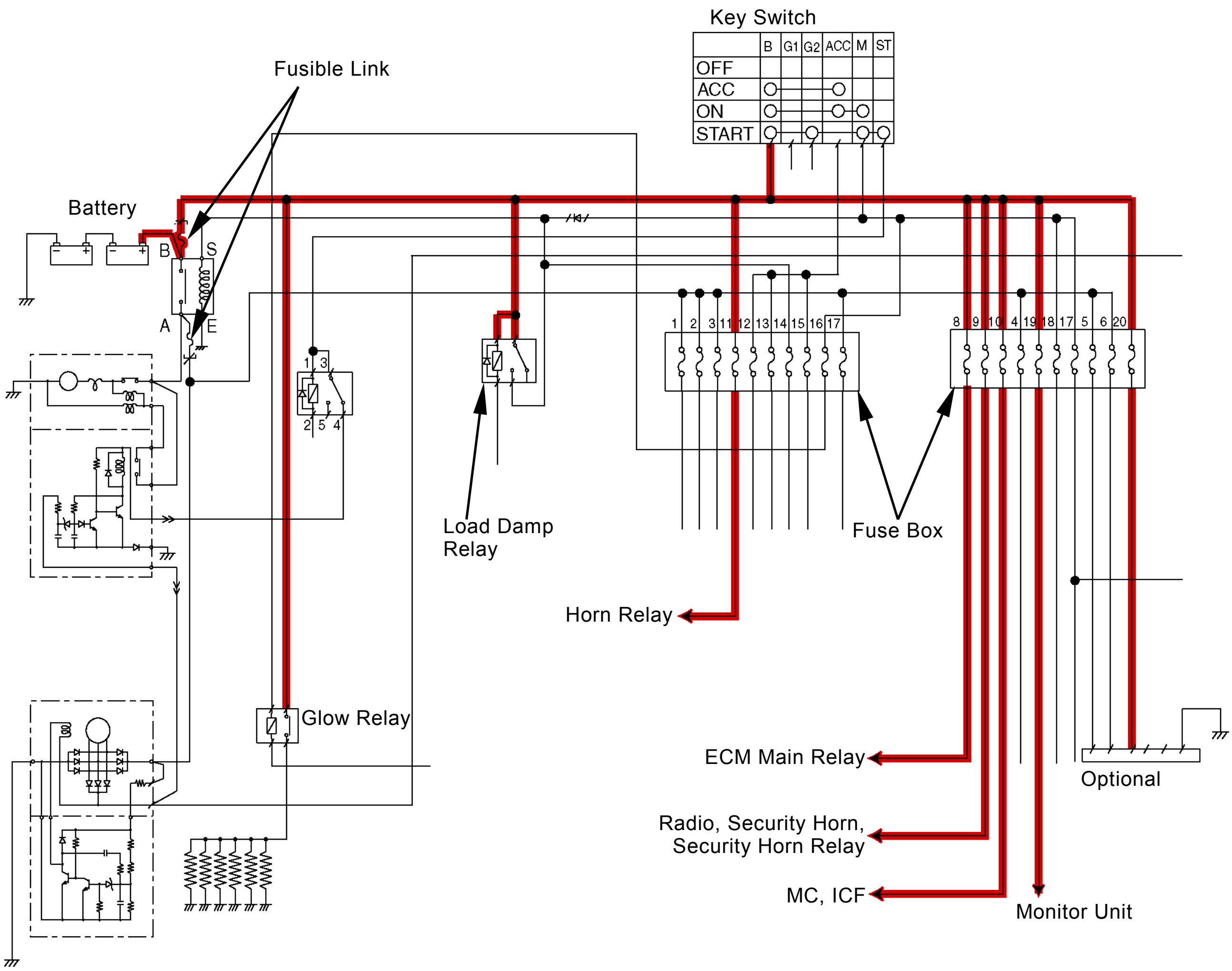
ELECTRIC POWER CIRCUIT (KEY SWITCH: OFF)

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.

Battery
↓
Fusible Link

- →Glow Plug Relay (Power)
- →Key Switch (B)
- →Load Damp Relay
- →Fuse Box
  - →Terminal #8: ECM Main Relay (Power)
  - →Terminal #9: Radio (Backup Power)
    Security Horn (Backup Power)
    Security Horn Relay (Backup Power)
  - →Terminal #10: MC (Power), ICF (Power)
  - →Terminal #11: Horn Relay (Power)
  - →Terminal #19: Monitor Unit (Power)
  - →Terminal #20: Optional

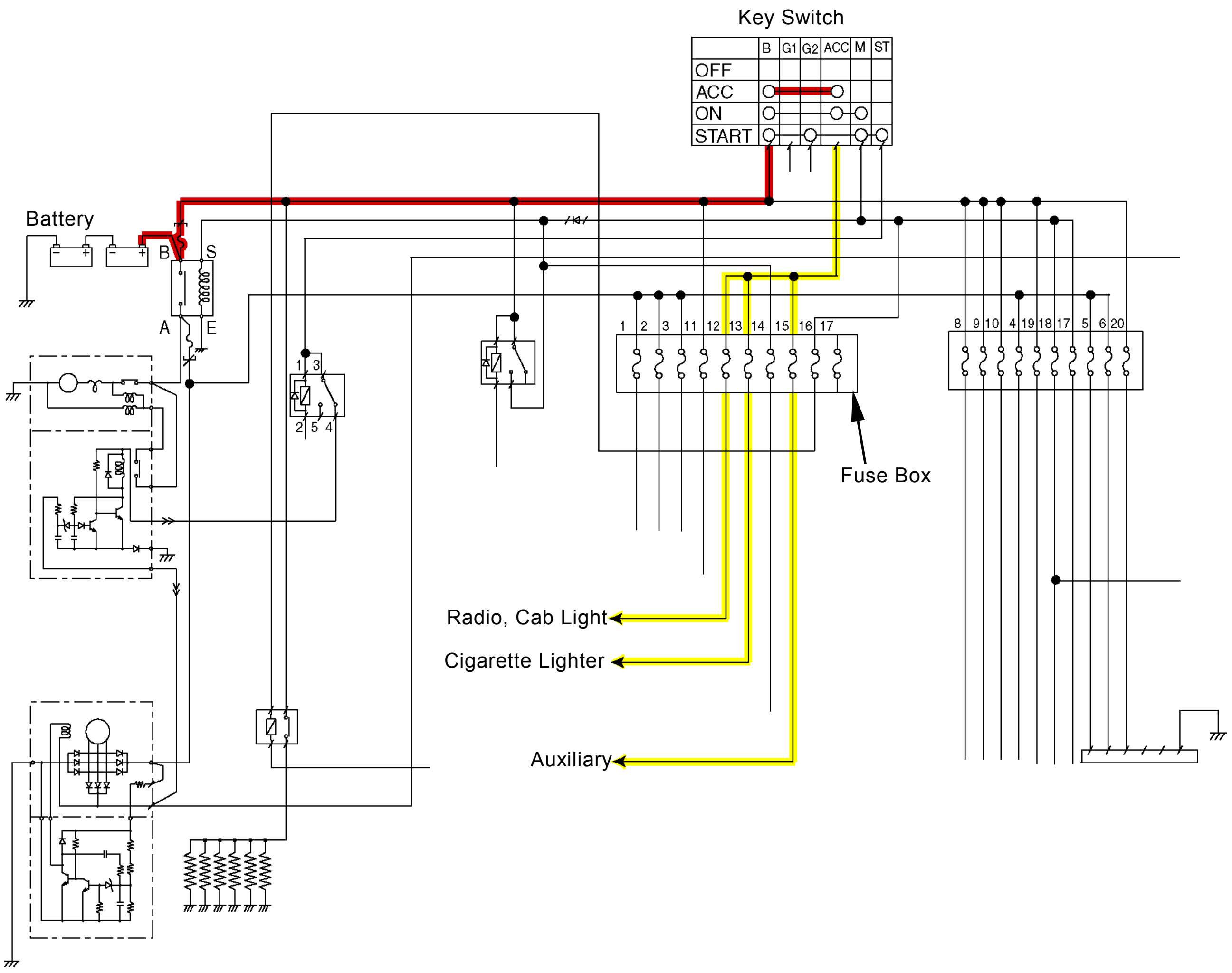


T1V7-02-05-001

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.



T1V7-02-05-002

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.

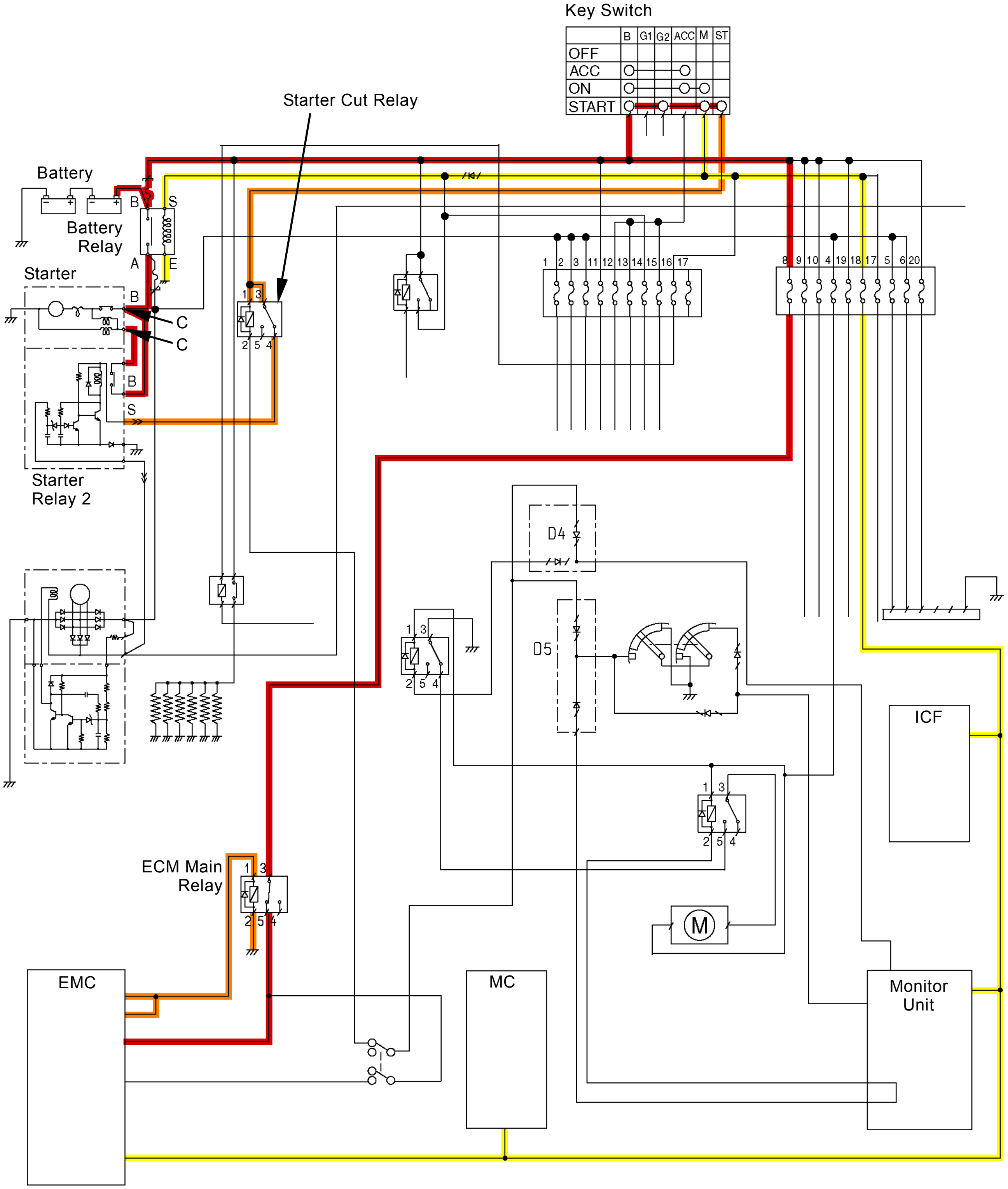
6. Consequently, the relay in starter is turned ON so that the starter begins rotating.

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.



T1V7-02-05-003

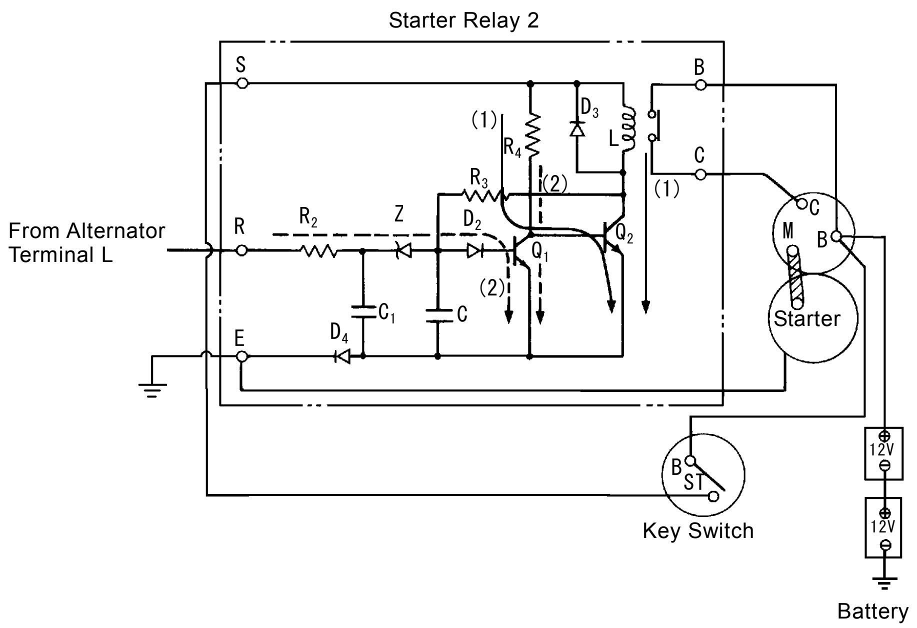
Starter Relay 2 Operation

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

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CHARGING CIRCUIT (KEY SWITCH: ON)

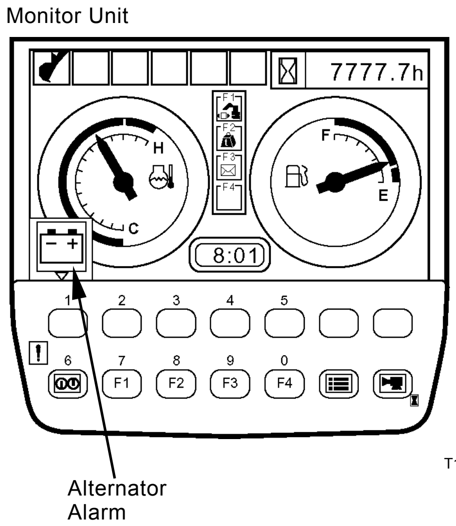
1. After the engine starts and the key switch is released, the key switch moves to the ON position.

2. Key switch terminal B is connected to terminals ACC and M in the key switch with the key switch ON.

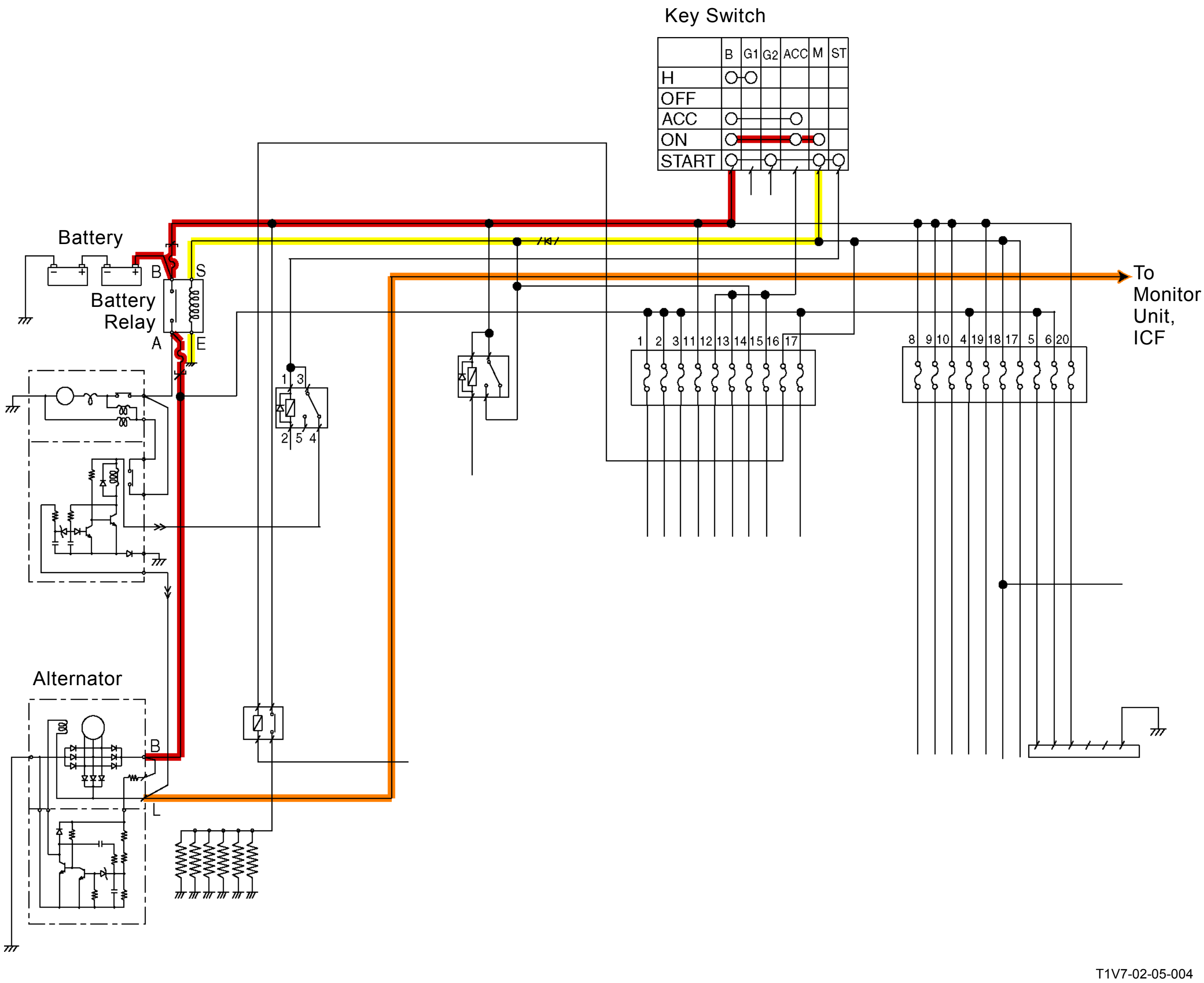
3. The alternator starts generating electricity with the engine running. Current from alternator terminal B flows to the batteries through the battery relay and charges the batteries.

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.



T1V1-05-01-117


Key Switch
B
G1
G2
ACC
M
ST
H
OFF
ACC
ON
START
Battery
B
S
Battery Relay
A
E
To Monitor Unit, ICF
1
2
3
11
12
13
14
15
16
17
8
9
10
4
19
18
17
5
6
20
1
3
2
5
4
Alternator
B
L
T1V7-02-05-004

Alternator Operation

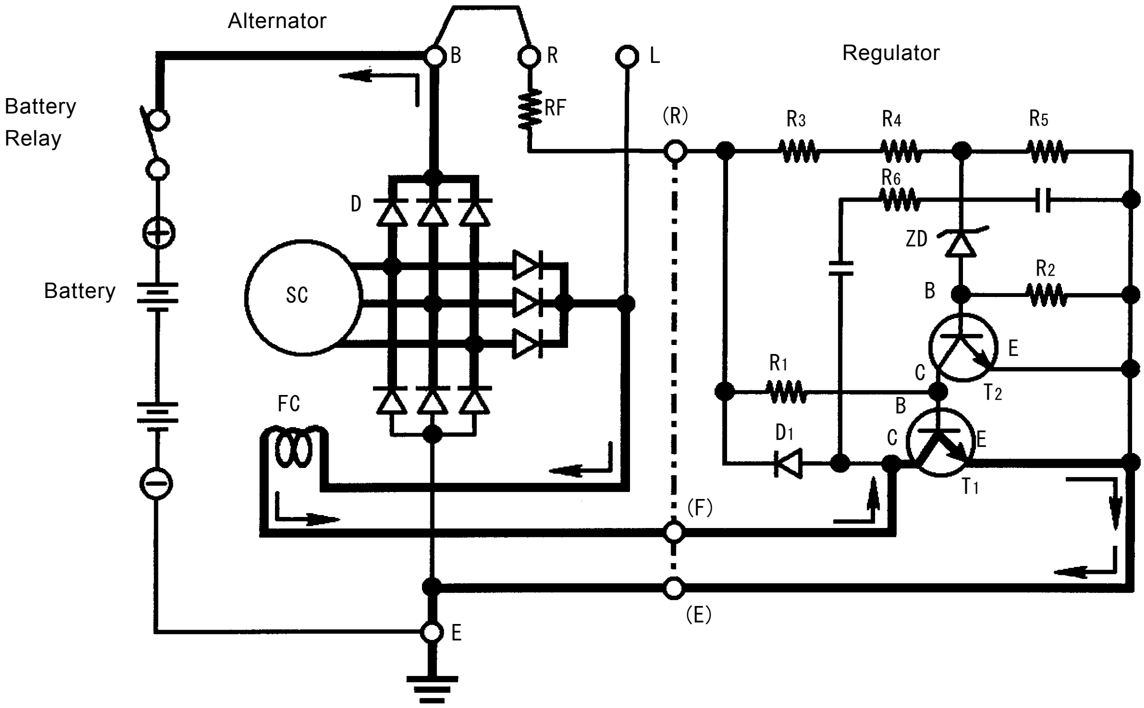
- The alternator consists of field coil FC, stator coil SC and diode D. The regulator consists of transistors (T1 and T2), Zener diode ZD and resistances (R1 and R2).

- Alternator terminal B is connected to base B of transistor T1 through the circuit [B → R → RF → (R) → (R1)].

- When the battery relay is ON, the battery voltage is applied to base B of transistor T1 so that collector C is connected to emitter E. Therefore, field coil FC is grounded through transistor T1.

- At the beginning, no current is flowing through field coil FC. When the rotor starts rotating, alternate current is generated in stator coil SC by the rotor remanent magnetism.

- When current flows through field coil FC, the rotor is further magnetized so that the generating voltage increases. Thereby, current flowing through field coil FC increases. Therefore, generating voltage increases further and the batteries start charging.



T157-04-02-008

Regulator Operation

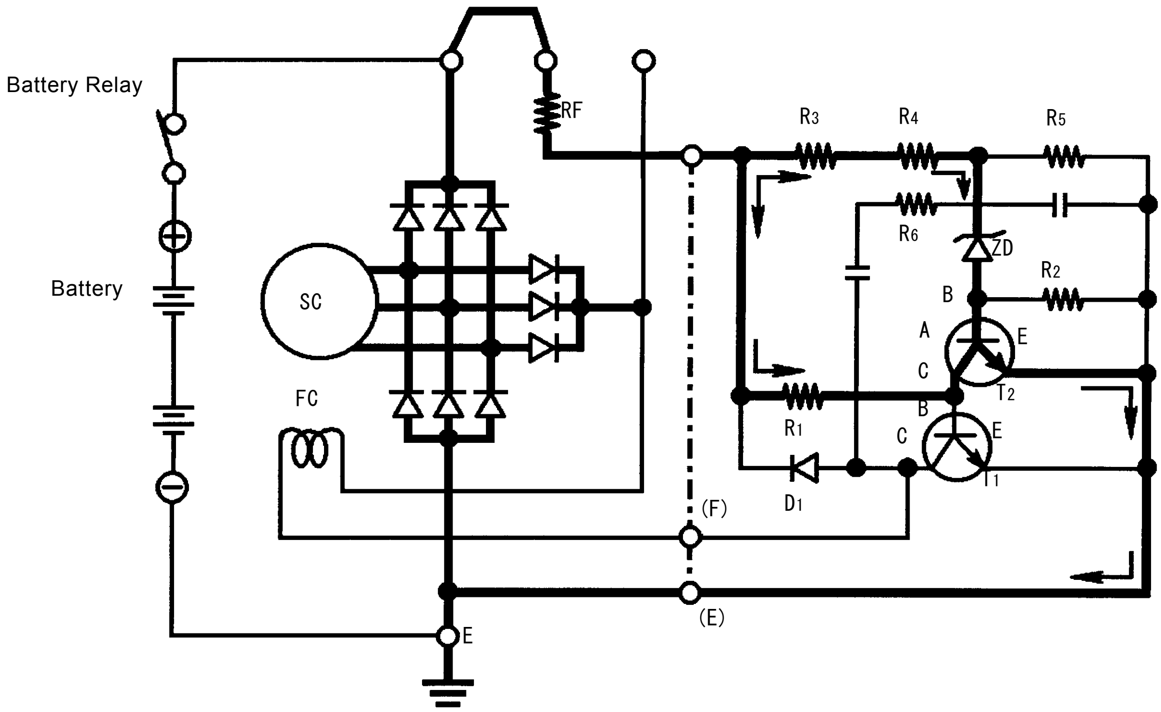
- When generating voltage increases more than the set-voltage of Zener diode ZD, current flows to base B of transistor T2 and collector C is connected to emitter E.

- 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 filed 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

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.

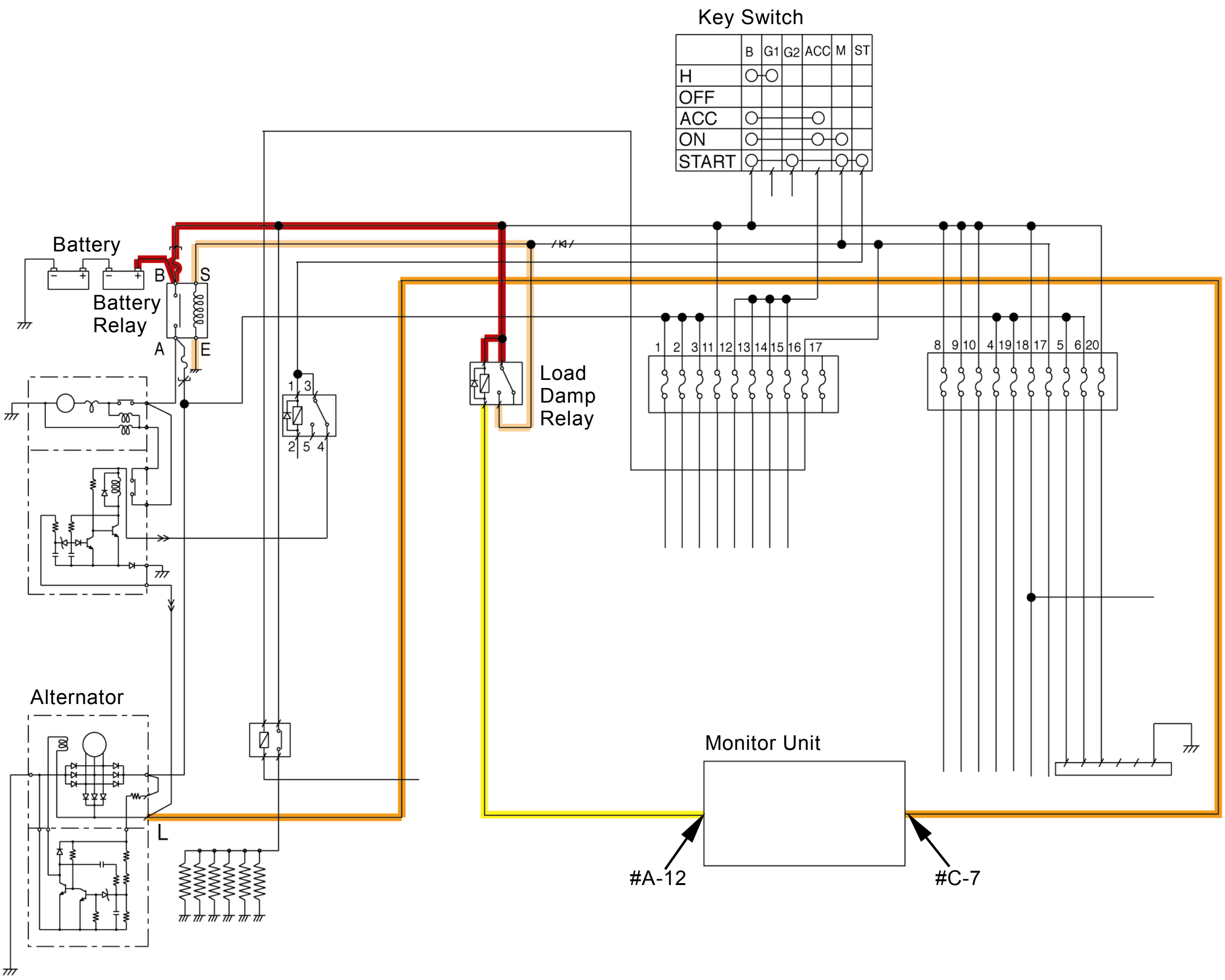
2. The engine continues to rotate due to inertia force just after the key switch is turned OFF so that the alternator continues to generate electricity.

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.

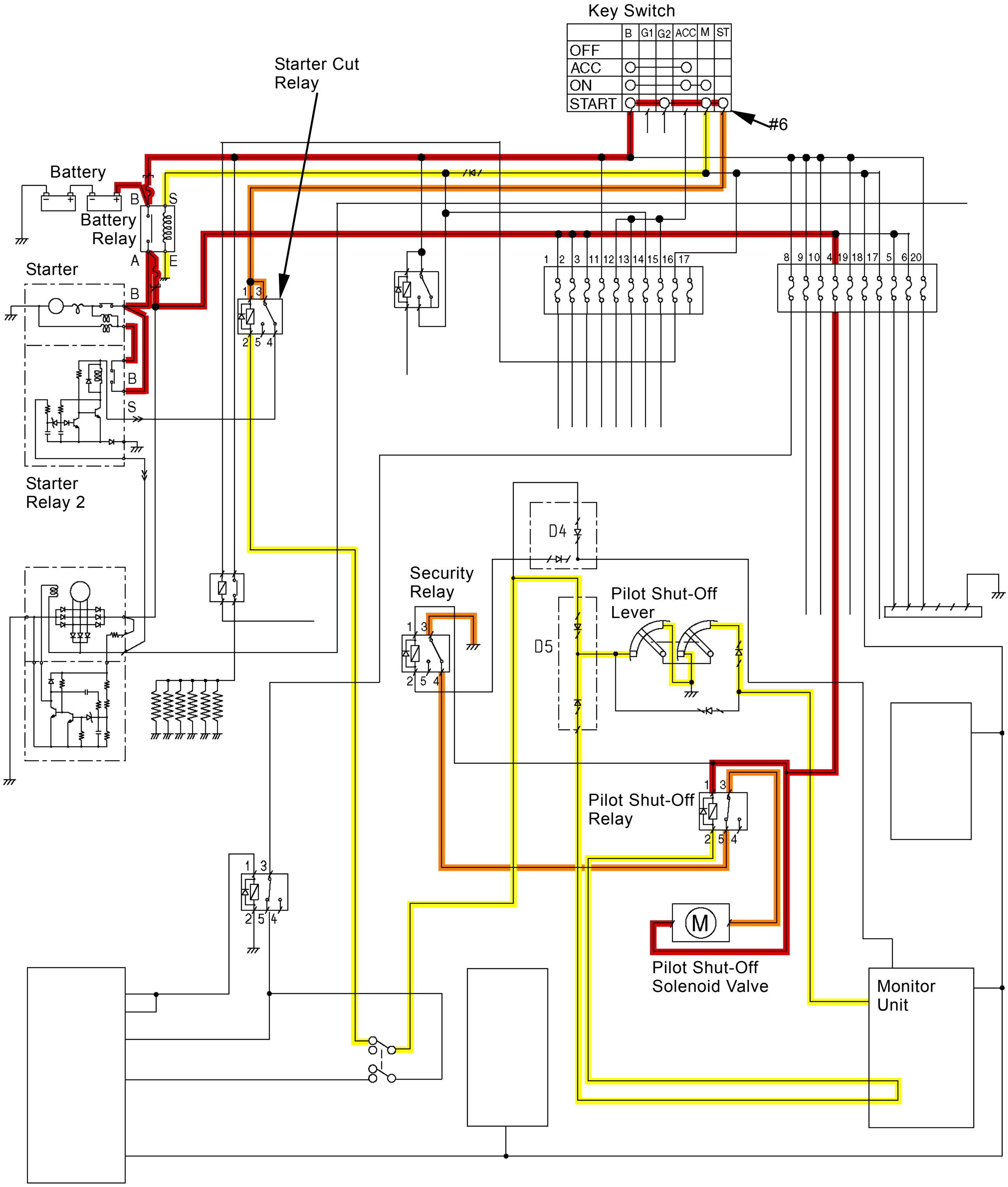
6. Accordingly, even if the key switch is turned OFF while the engine is rotating, battery current continues to excite the battery relay through the load damp relay. Until the alternator stops generating, the battery relay is kept ON.



T1V7-02-05-005

PILOT SHUT-OFF CIRCUIT (KEY SWITCH: ON)

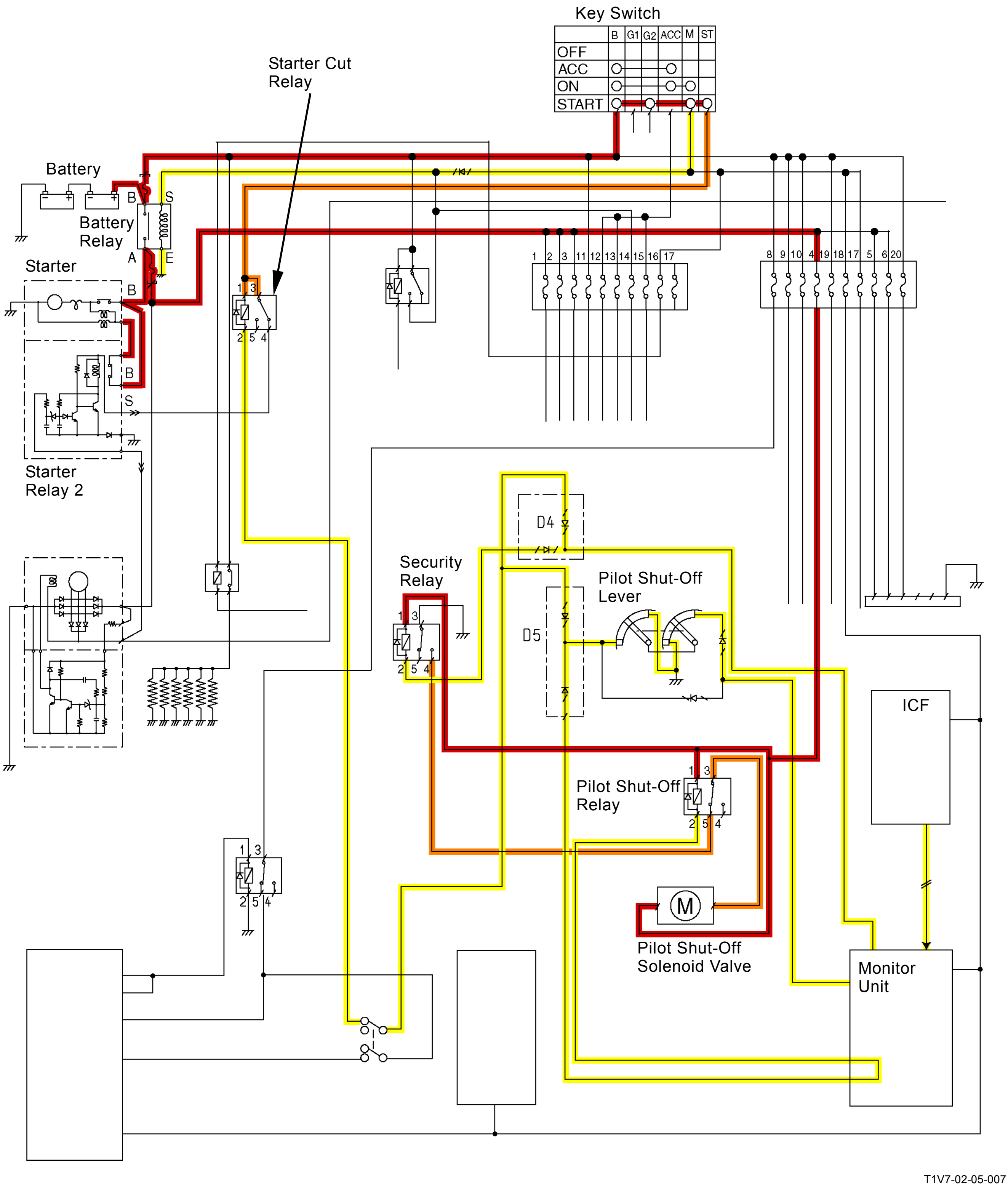
1. When the pilot shut-off lever is turned ON, the monitor unit connects the ground circuit of pilot shut-off relay and starter cut relay so that the pilot shut-off relay and starter cut relay are turned ON.
2. When the pilot shut-off relay is turned ON, the ground circuit of pilot shut-off solenoid 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.



T1V7-02-05-006

SEUCURITY 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.

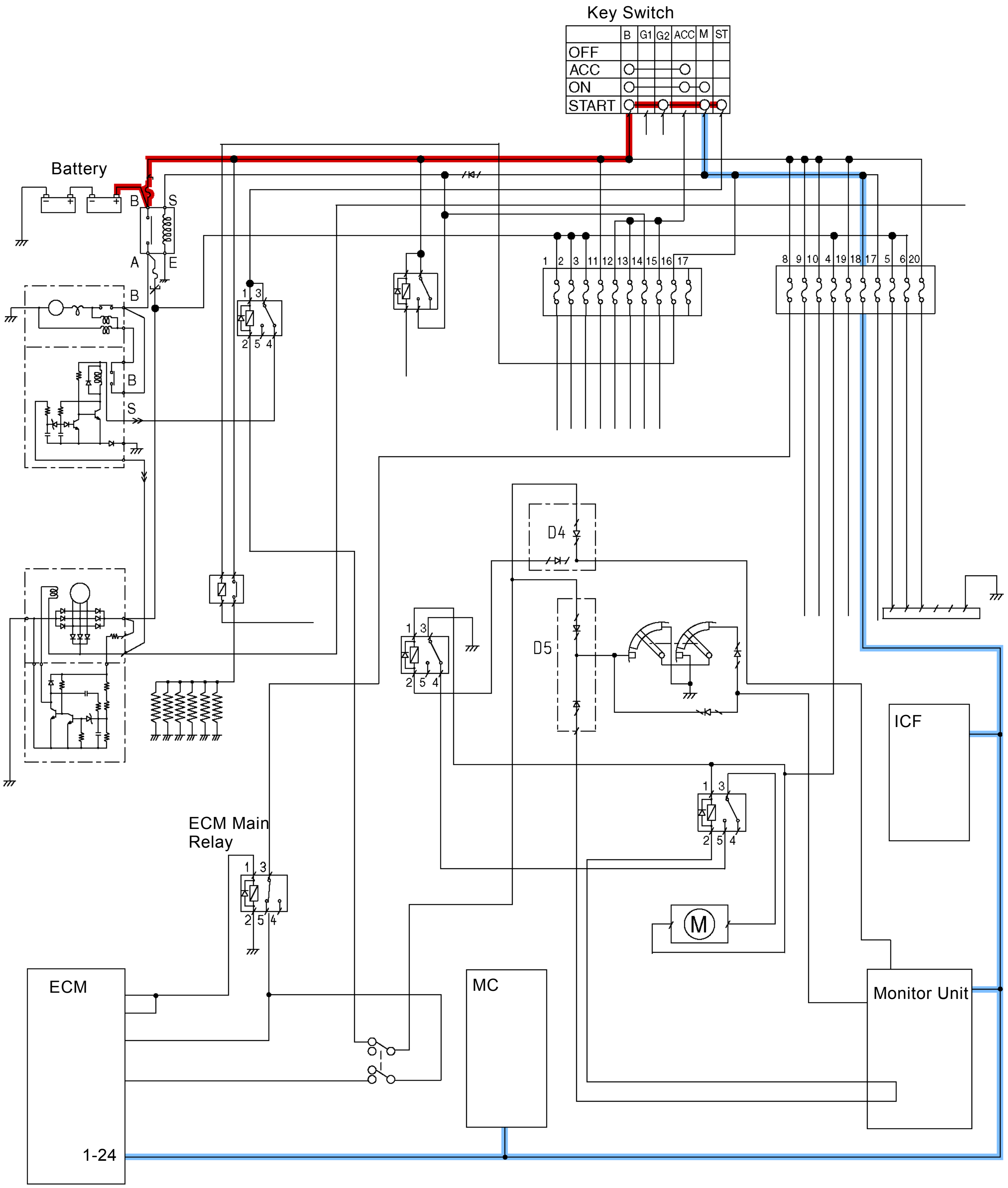

Key Switch
B
G1
G2
ACC
M
ST
OFF
ACC
ON
START
Starter Cut Relay
Battery
B
S
Battery Relay
A
E
Starter
B
B
S
Starter Relay 2
1
3
2
5
4
1
2
3
11
12
13
14
15
16
17
8
9
10
4
19
18
17
5
6
20
D4
D5
Security Relay
Pilot Shut-Off Lever
Pilot Shut-Off Relay
M
Pilot Shut-Off Solenoid Valve
ICF
Monitor Unit
T1V7-02-05-007

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.

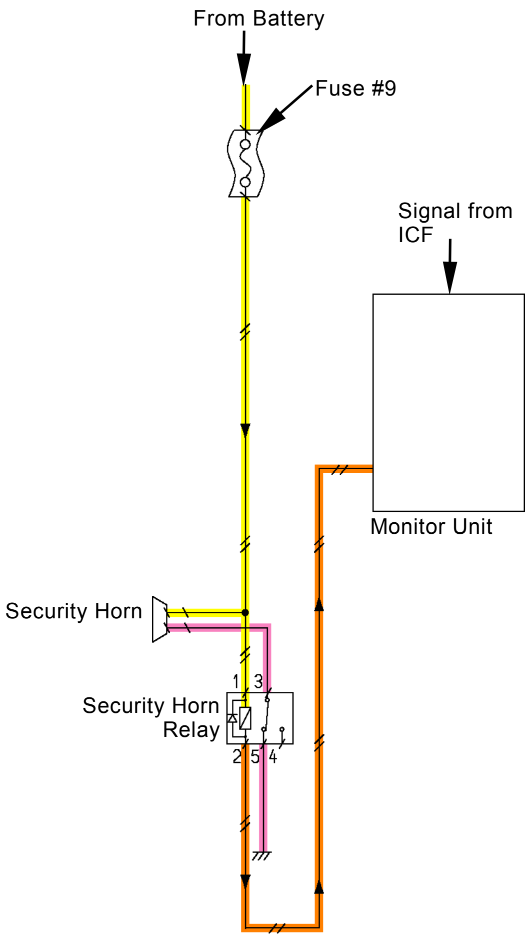
3. When the engine stops, ECM turns the ECM main relay OFF.



T1V7-02-05-008

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

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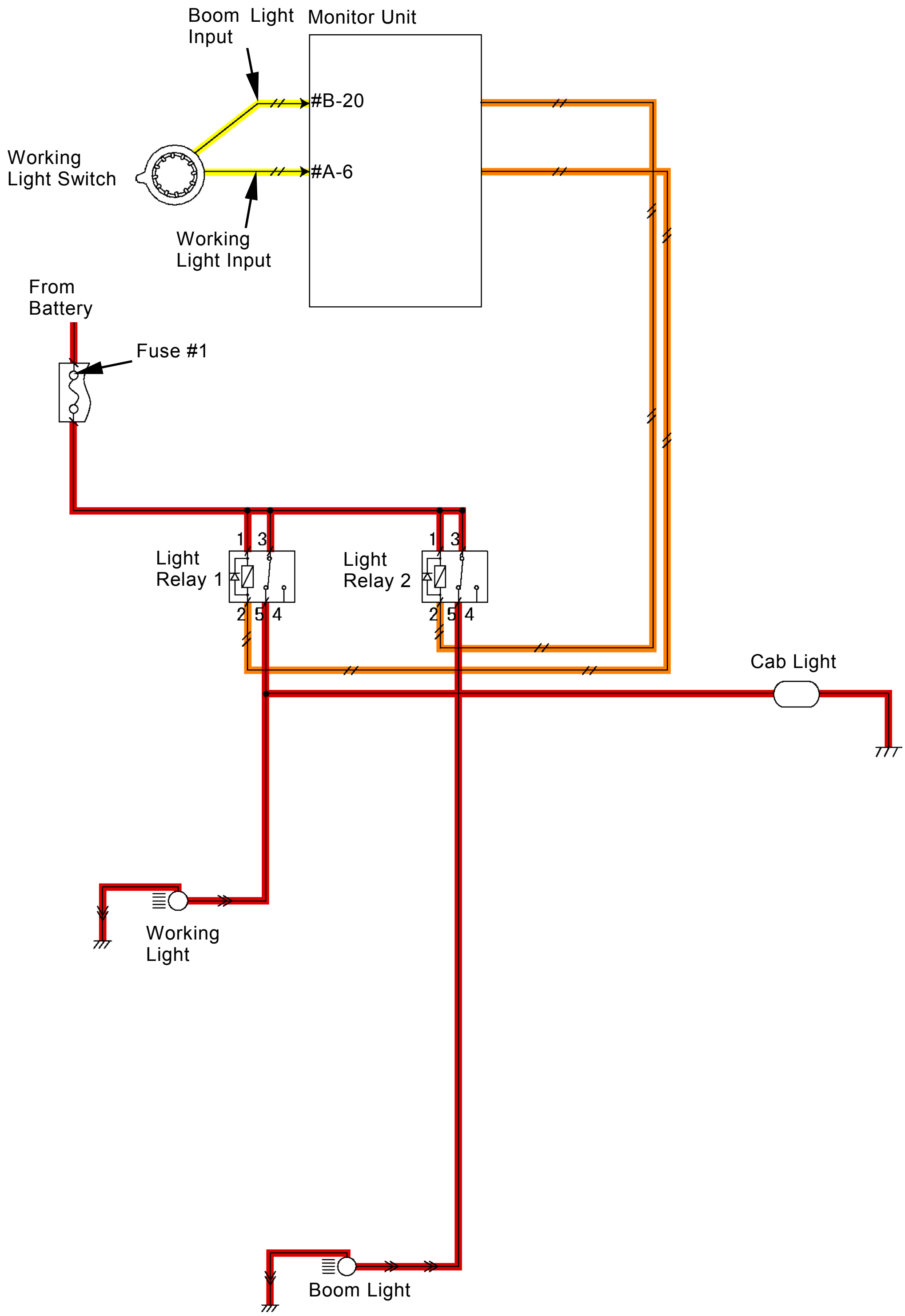
WORKING LIGHT CIRCUIT

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.



T1V1-02-05-012

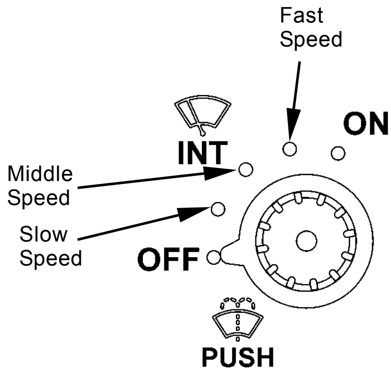
WIPER CIRCUIT

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

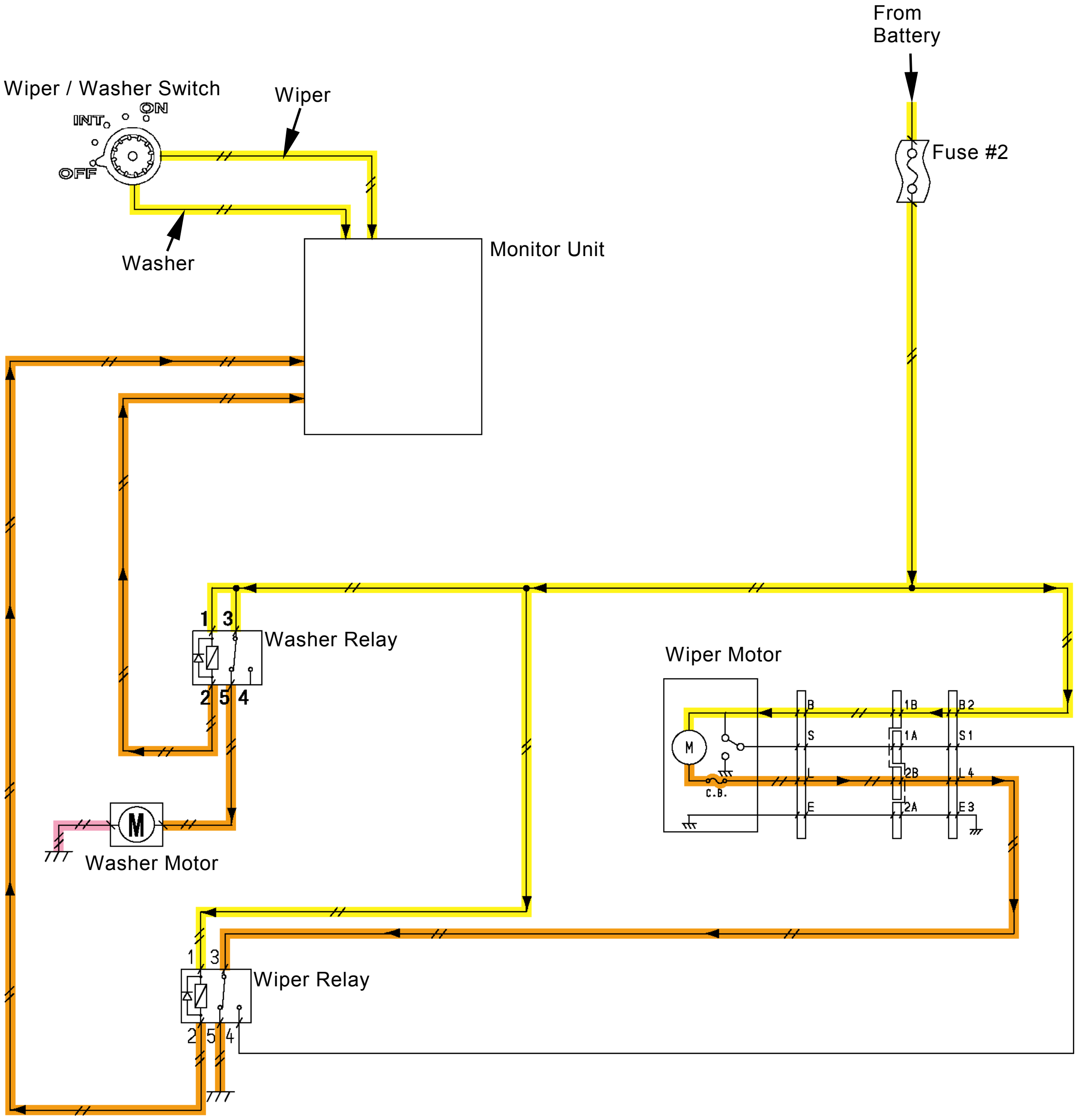
Position ITN.	Set Time
Slow	8 seconds
Middle	6 seconds
Fast	3 seconds

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.



T1V1-02-05-005

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MEMO

MEMO

SECTION 3
COMPONENT OPERATION

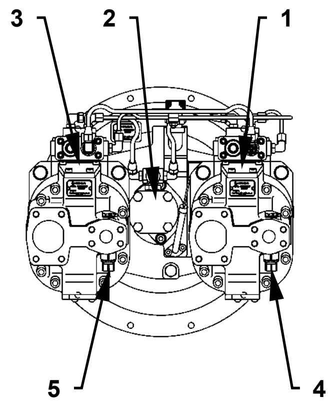
CONTENTS

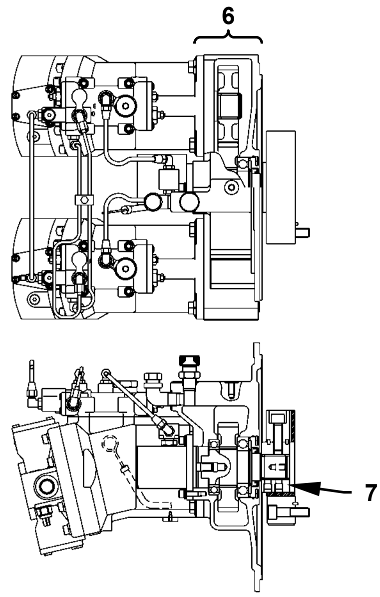
Group 7 Others (Upperstructure)

Group 8 Others (Undercarriage)

OUTLINE

The pump device consists of transmission (6), main pumps (1, 3) and pilot pump (2).
The engine output is transmitted to transmission (6) via coupling (8). After being distributed by the gear, the engine power drives main pumps (1, 3) and pilot pump (2). Both reduction gear ratios of engine and main pumps (1, 3) are 1:1.108, engine and pilot pump (2) is 1:1.
Main pumps (1, 3) are bent-axis type variable displacement axial plunger pumps.
Pilot pump (2) is a gear pump.
Pump delivery pressure sensors (4, 5) are installed in order to control the pump and valve.
(Refer to the Control System / SYSTEM.)



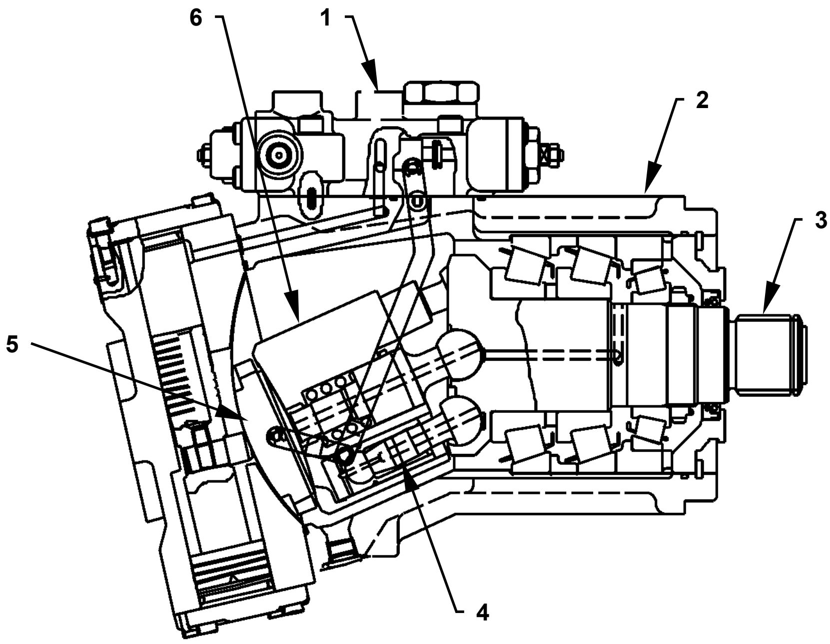


T1V7-03-01-001

1 - Main Pump 1
2 - Pilot Pump
3 - Main Pump 2
4 - Pump 1 Delivery Pressure Sensor
5 - Pump 2 Delivery Pressure Sensor
6 - Transmission
7 - Coupling

MAIN PUMPS 1, 2

The main pump supplies pressure oil to the hydraulic actuators such as motors and cylinders. Shaft (3) is connected to each pump cylinder block (6) via 7 plungers (4) so that the shaft and the cylinder block rotate together. When cylinder block (6) is rotated, plunders (4) reciprocate in cylinder block (6) hydraulic oil is drawn and delivered. Each pump is equipped with regulator (1) to control the delivery oil flow rate.

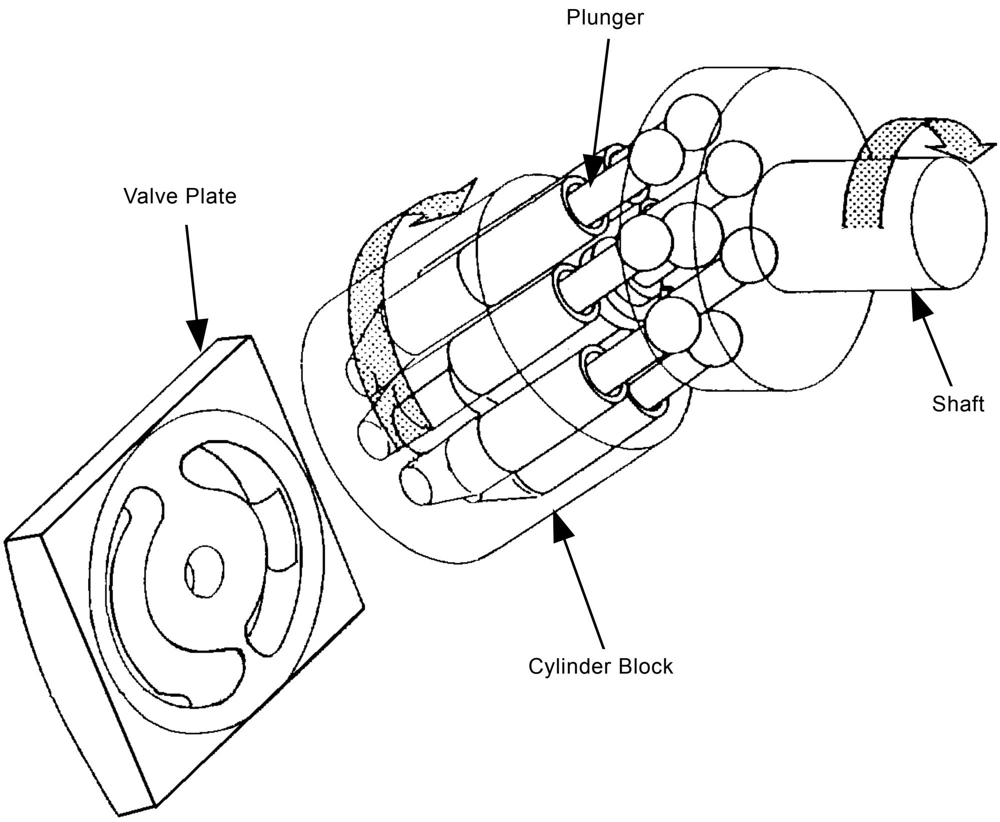


T173-03-01-004

1 - Regulator	3 - Shaft	5 - Valve Plate	6 - Cylinder Block
2 - Housing	4 - Plunger		

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.

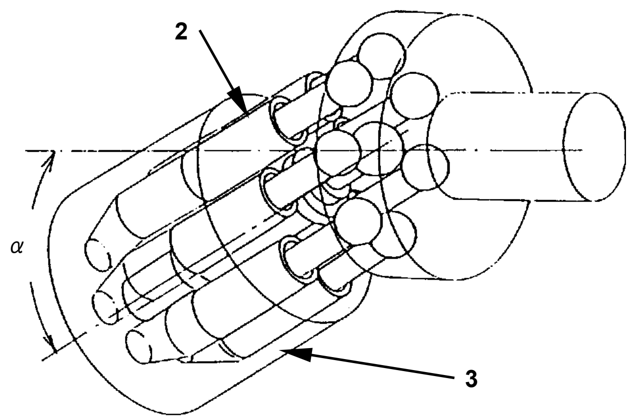


T105-02-03-002

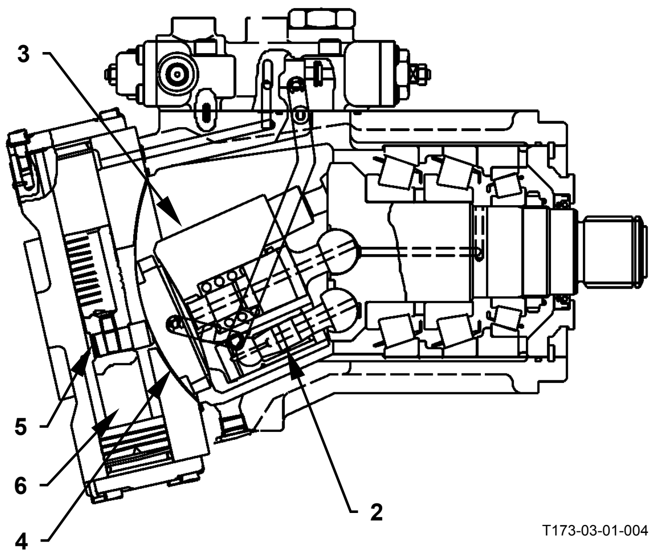
Increasing and Decreasing Flow Rate

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:

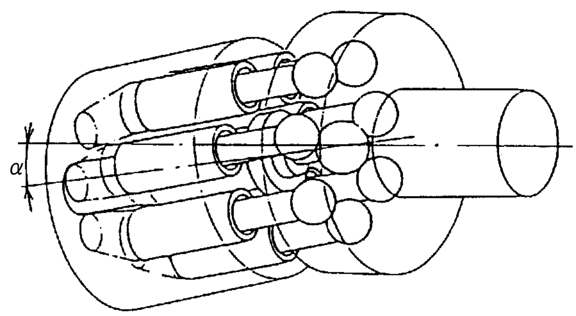


T105-02-03-021



T173-03-01-004

Minimum Displacement Angle (Operable Limit Angle):



T105-02-03-022

2 - Plunger
3 - Cylinder Block
4 - Valve Plate
5 - Pin
6 - Servo Piston

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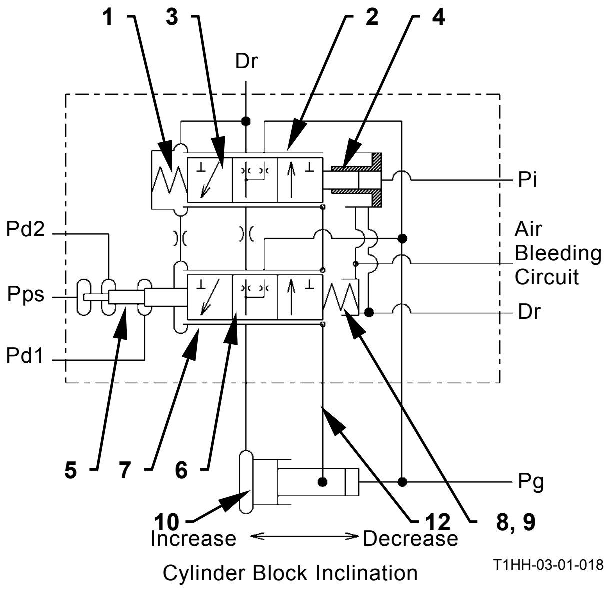
REGULATOR

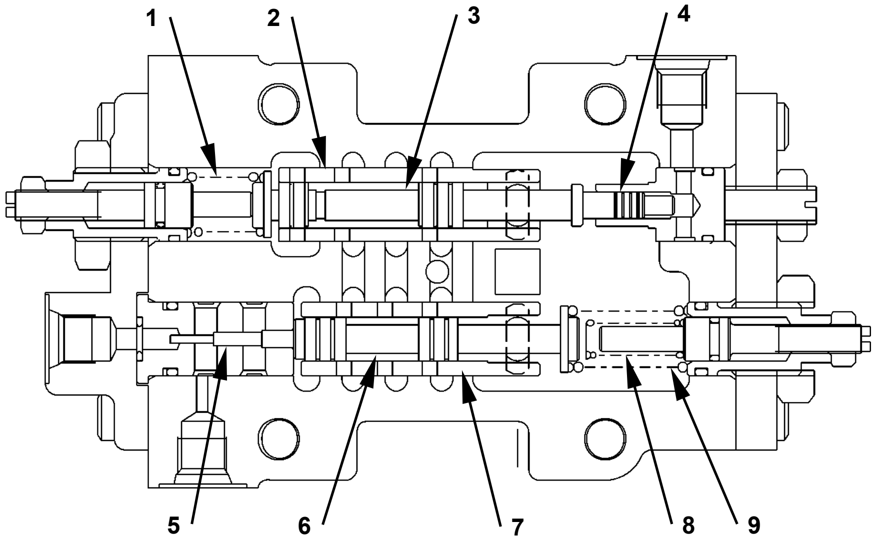
The regulator controls the main pump flow rate in response to the various command signal pressures so that the pump driving power does not exceed the engine power. Pump 1 and pump 2 are provided with one regulator for each. The major parts of regulator are spring (1), sleeve A (2), sleeve B (7), spool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

NOTE: Pilot oil pressure is constantly supplied in the smaller chamber side of servo piston (10).

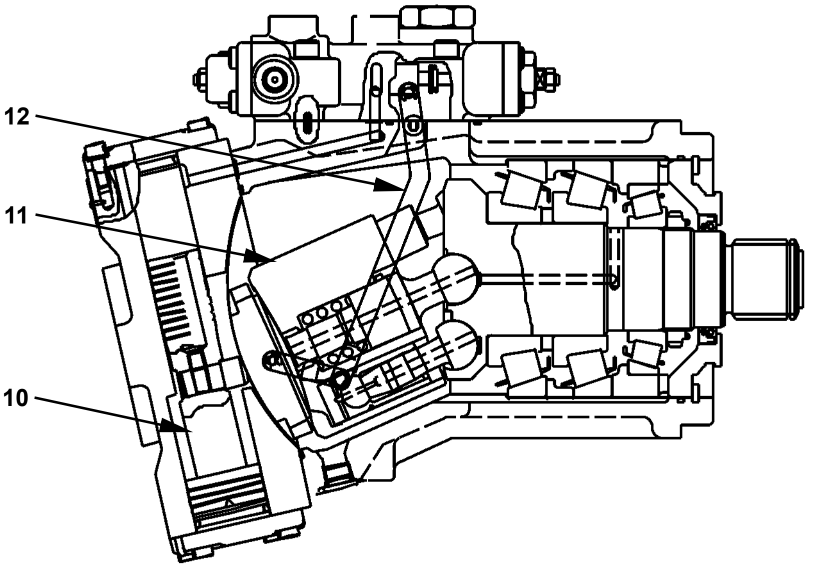


Pd1 -Pump 1 Delivery Pressure	Pi - Pump Control Pressure
Pd2 -Pump 2 Delivery Pressure	Pps -Torque Control Pressure
Dr - Returning to Hydraulic Oil Tank	Pg - Primary Pilot Pressure (From Pilot Pump)

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



T1HH-03-01-002



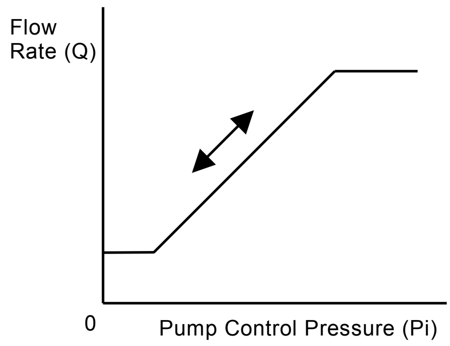
T173-03-01-004

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

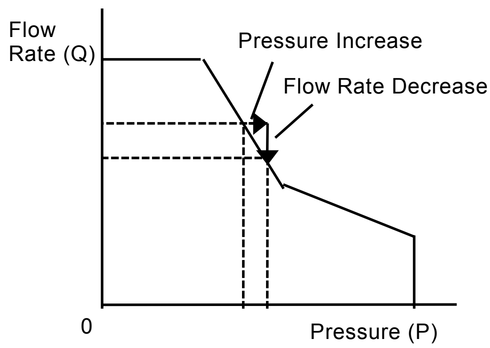
Regulator Control Function

The regulator has the following four control functions.

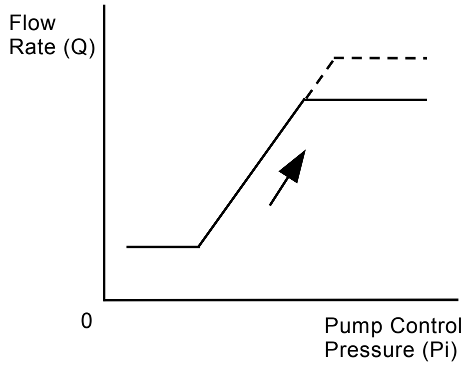
- Control by Pump Control Pressure
  When a control lever is operated, the pump flow rate control valve in signal control valve regulates pump control pressure Pi in response to the lever stroke. When the regulator receives pump control pressure Pi, the regulator controls the pump delivery flow rate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



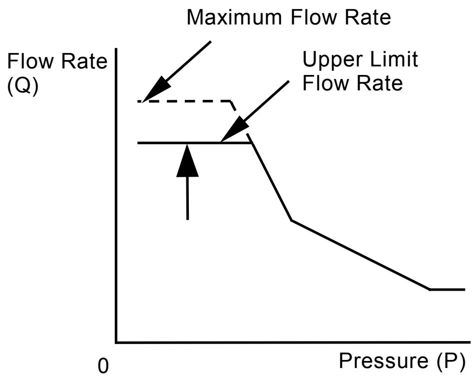
- Control by Own or Opponent Pump Delivery Pressure
  The regulator receives own pump delivery pressure Pd1 and opponent pump delivery pressure Pd2 as control signal pressures. If the two average pressures increase over the set P-Q line, the regulator reduces both pump delivery flow rates and the total 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 Pps to the regulator. When receiving pilot pressure Pps, the regulator reduces the pump delivery flow rate. (Speed Sensing Power Decrease Control, Slow Speed Torque Increase Control)
  (Refer to the Control System section.)



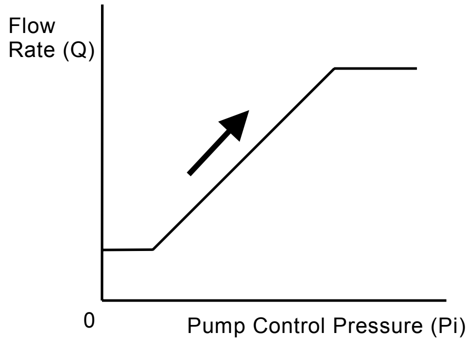
- Control by Pilot Pressure from Maximum Pump Flow Rate Limit Control Solenoid Valve
  (Pump 2 Side Only)
  When the main controller (MC) receives the signals from work mode switch, pressure sensor [auxiliary] or attachment mode switch (optional), MC sends the signals to the maximum pump flow rate limit control solenoid valve. In response to the signals from MC, the maximum pump flow rate limit control solenoid valve reduces pump control pressure Pi. Therefore, the upper pump delivery flow rate is limited. (Pump Flow Rate Limit Control)
  (Refer to the Control System section.)

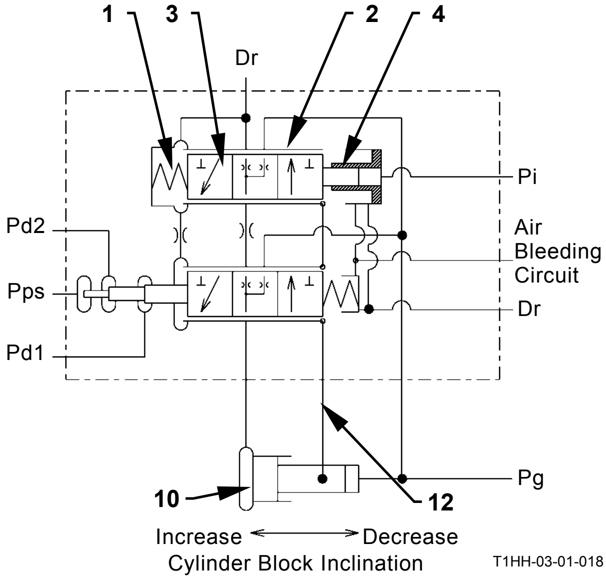


Control by Pump Control Pressure

- Increasing Flow Rate

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

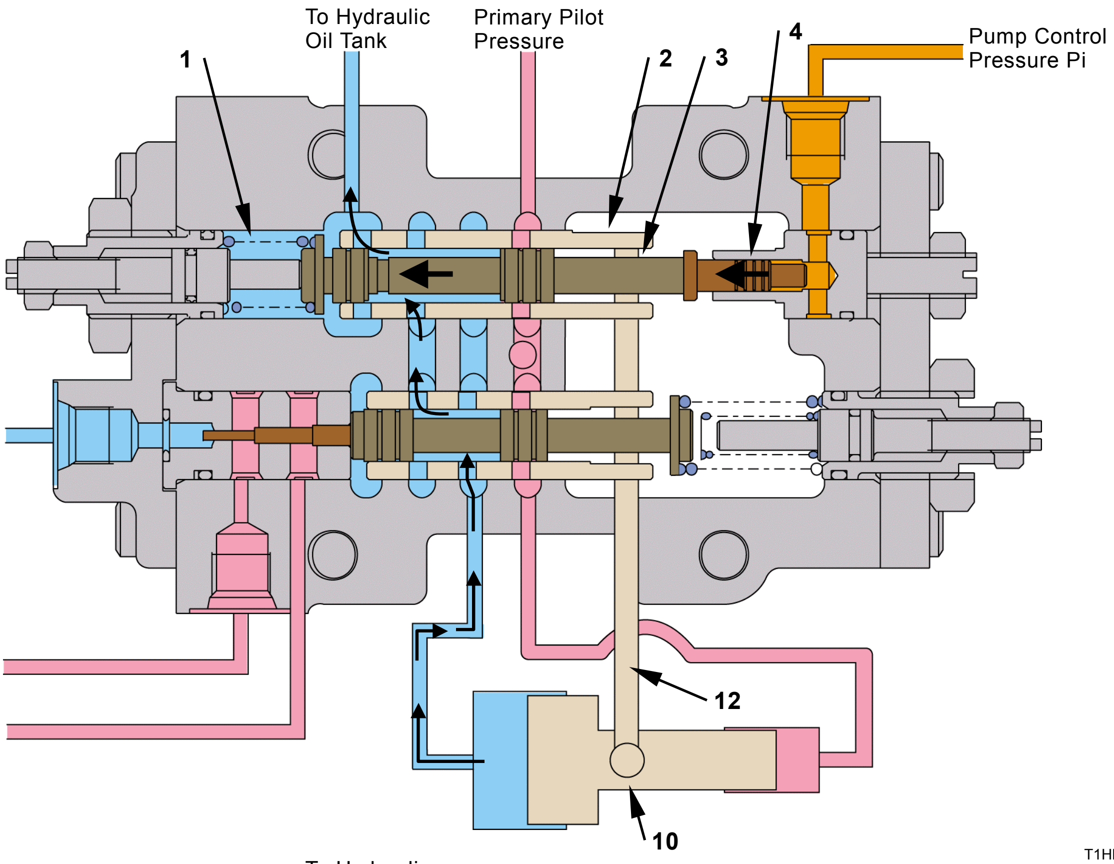




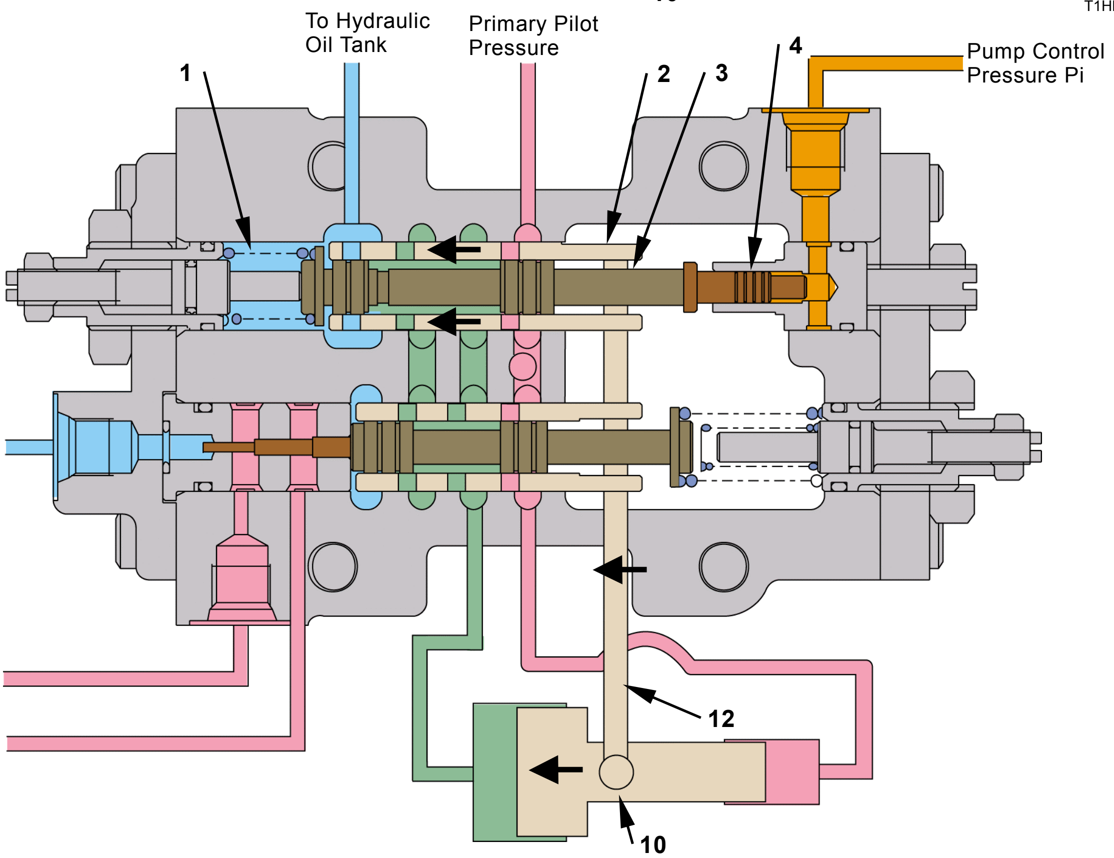
T1HH-03-01-018

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



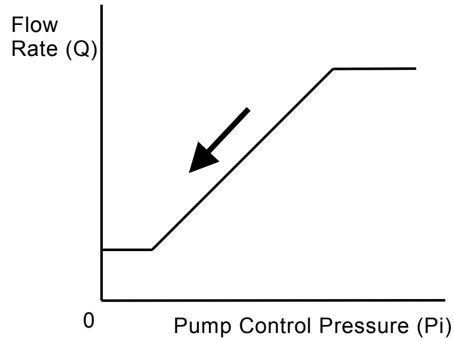
T1HH-03-01-004

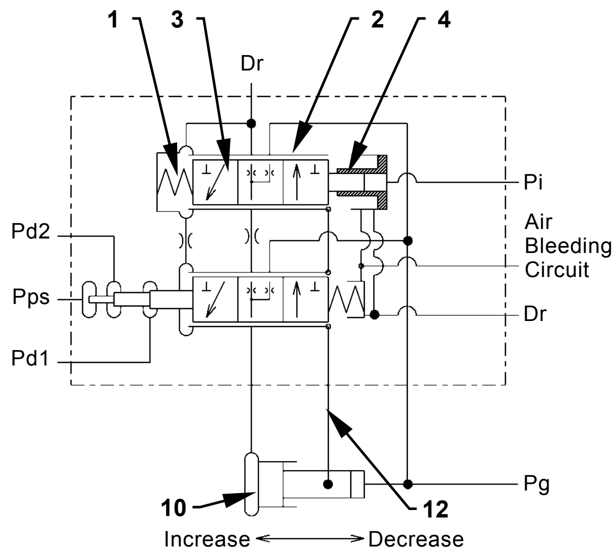


T1HH-03-01-005

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

- 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 Pi 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 onto the large chamber of servo piston (10).
  4. Due to the difference in diameter between the large and small chambers, servo piston (10) is moved toward direction of the arrow. Therefore, the cylinder block is rotated in the minimum inclination direction and the pump flow rate decreases.
  5. The movement of cylinder block is transmitted to sleeve A (2) via link (12). Sleeve A (2) is moved in the same direction as spool A (3).
  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 (10) is blocked. Therefore, servo piston (10) is stopped and the flow rate decrease operation is completed.

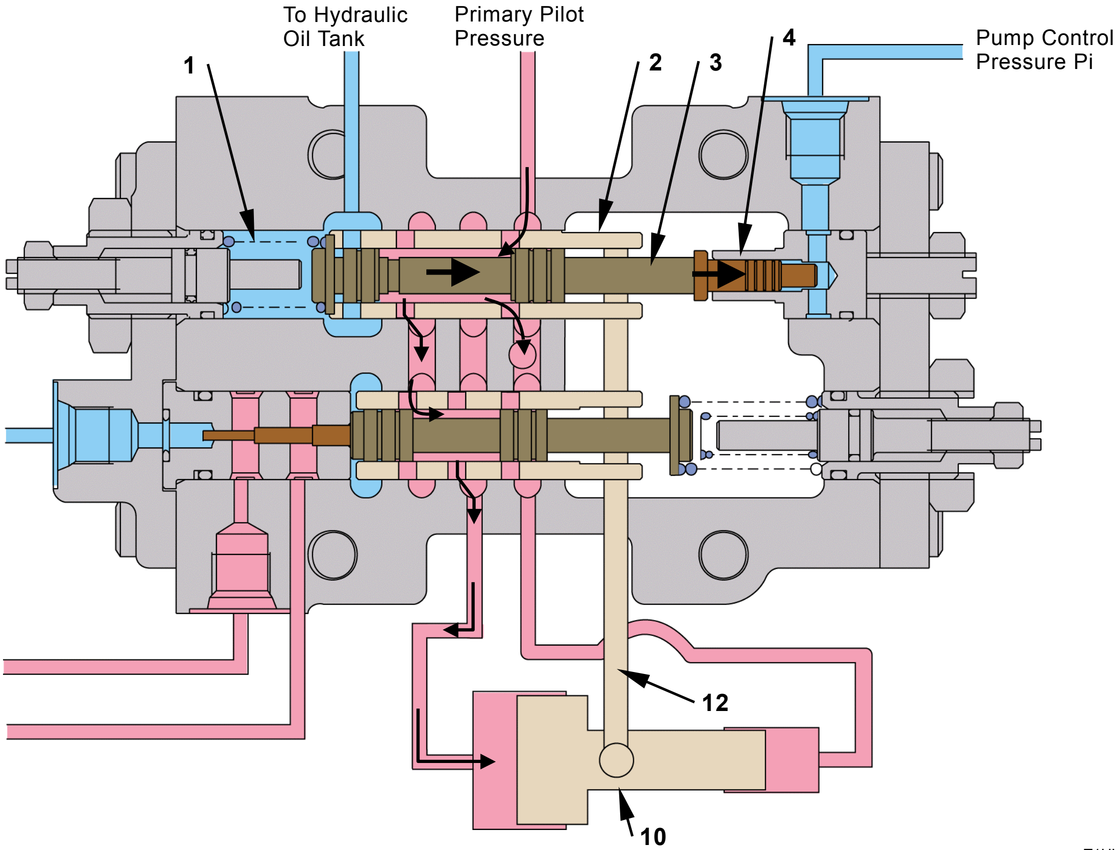




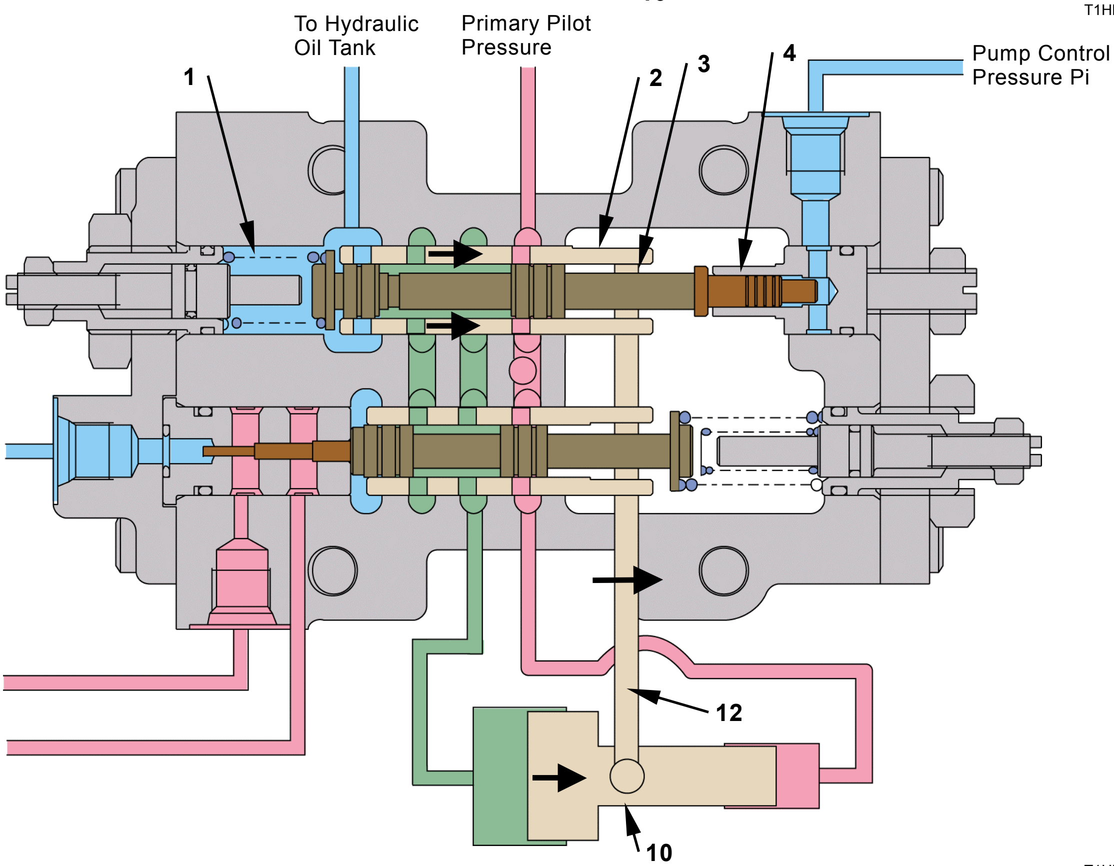
T1HH-03-01-018

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

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



T1HH-03-01-006



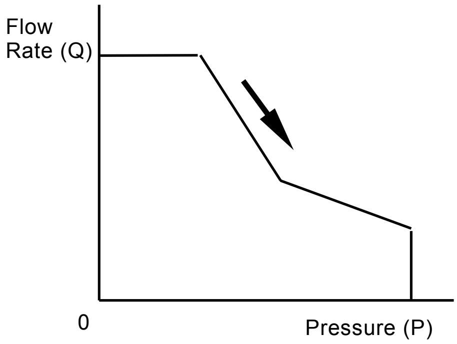
T1HH-03-01-007

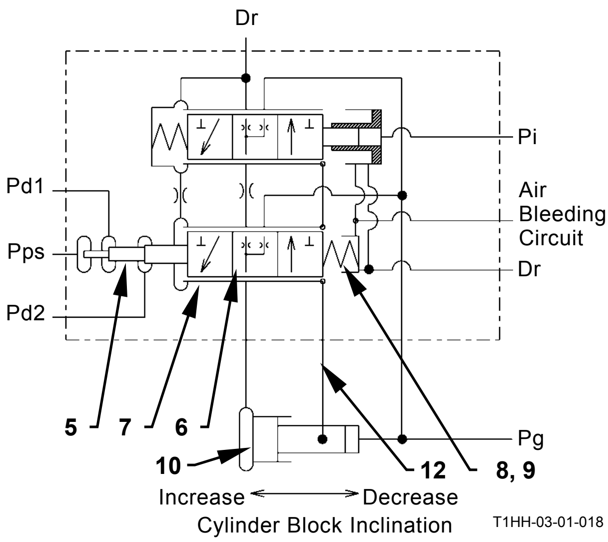
1 - Spring
2 - Sleeve A
3 - Spool A
4 - Piston
10 - Servo Piston
12 - Link

Control by Own or Opponent Pump Delivery Pressure

- Decreasing Flow Rate

1. 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.)
2. Load piston (5) pushes spool B (6), inner spring (8), outer spring (9) and spool B (6) moves toward direction of the arrow.
3. Due to the movement of spool B (6), the pilot oil pressure is routed into the large chamber of servo piston (10).
4. Due to the difference in diameter between the large and small chambers, servo piston (10) moves toward direction of the arrow. 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 B (7) via link (12). Sleeve B (7) is moved in the same direction as spool B (6).
6. When sleeve B (7) is moved by the same stroke as spool B (6), the open part between sleeve B (7) and Spool B (6) is close and the pilot pressure to servo piston (10) is blocked. Therefore, servo piston (10) is stopped and the flow rate decrease operation is completed.

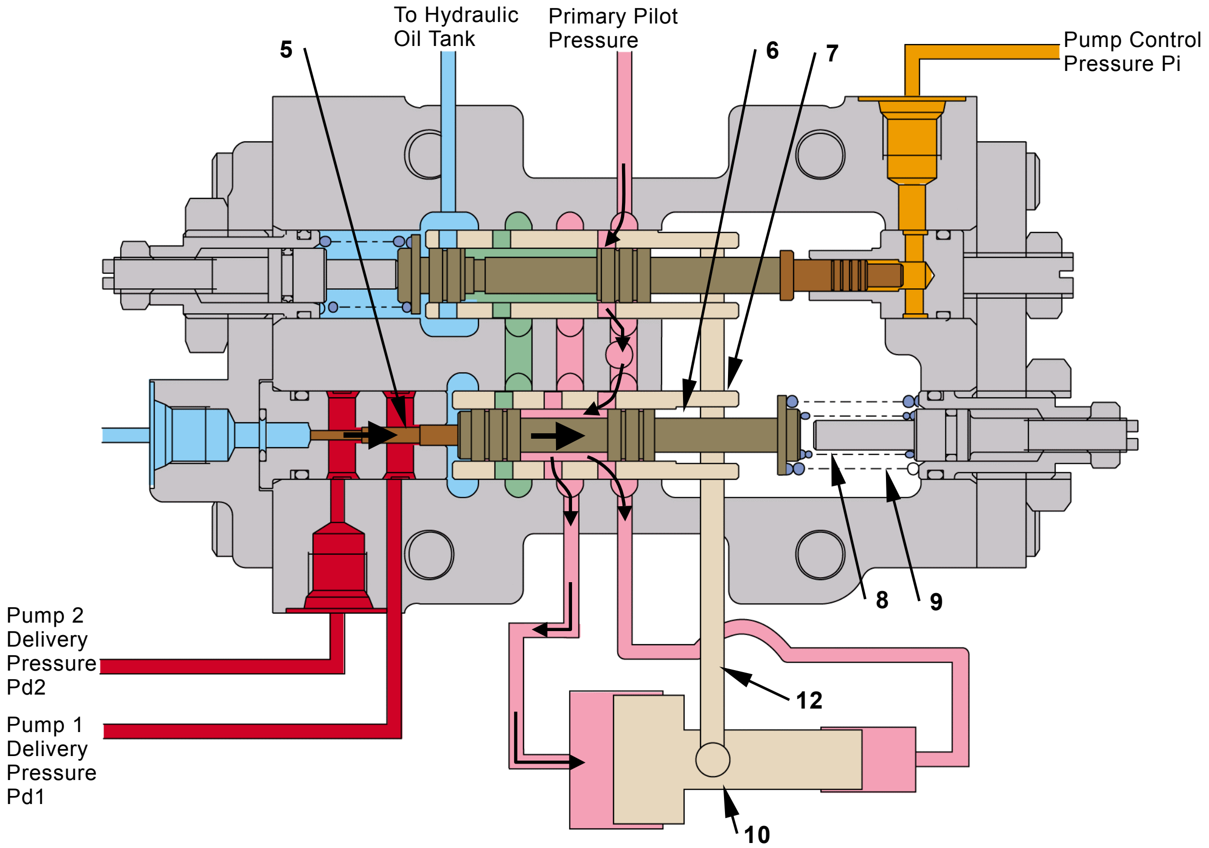




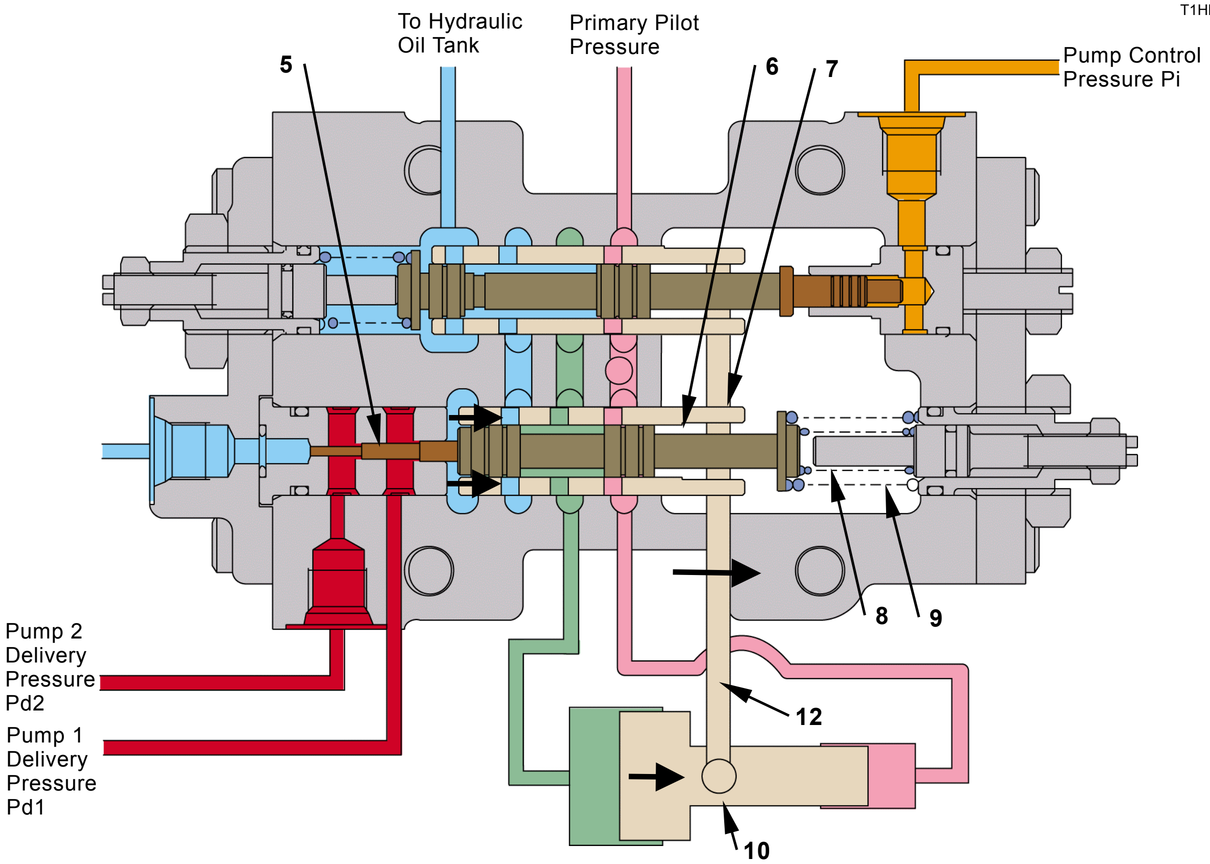
T1HH-03-01-018

5 - Load Piston
6 - Spool B
7 - Sleeve B
8 - Inner Spring
9 - Outer Spring
10 - Servo Piston
12 - Link

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



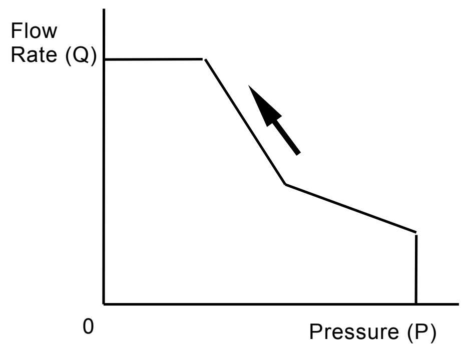
T1HH-03-01-008

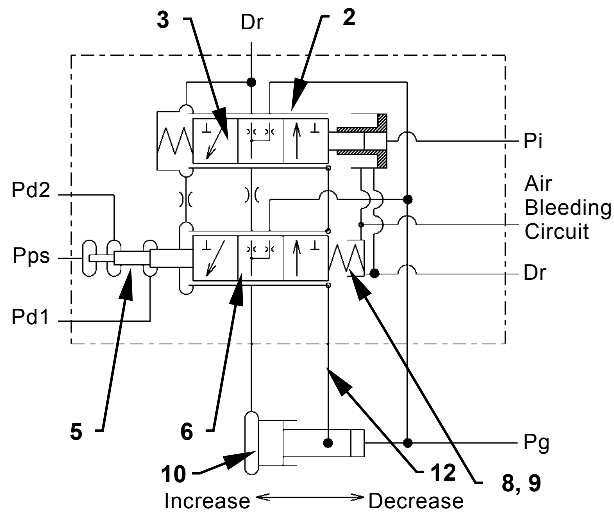


T1HH-03-01-009

5 - Load Piston
6 - Spool B
7 - Sleeve B
8 - Inner Spring
9 - Outer Spring
10 - Servo Piston
12 - Link

- Increasing Flow Rate
  1. When the pump load is reduced, either pump 1 delivery pressure Pd1 or pump 2 delivery pressure Pd2 decreases. (During operation, pump control pressure Pi is kept increased.)
  2. Load piston (5) and spool B (6) are pushed by inner spring (8) and outer spring (9) and moved toward direction of the arrow.
  3. Due to the movement of spool B (6), the circuit from the large chamber of servo piston (10) is opened to the hydraulic oil tank.
  4. As pilot pressure is constantly routed in the small chamber of servo piston (10), servo piston (10) 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 (12). Sleeve A (2) is moved in the same direction as spool A (3).
  6. When sleeve A (2) is moved by the same stroke as spool A (3), the open part between spool A(3) and sleeve A (2) is closed and pilot pressure to servo piston (10) is blocked. Therefore, servo piston (10) is stopped and the flow rate increase operation is completed.

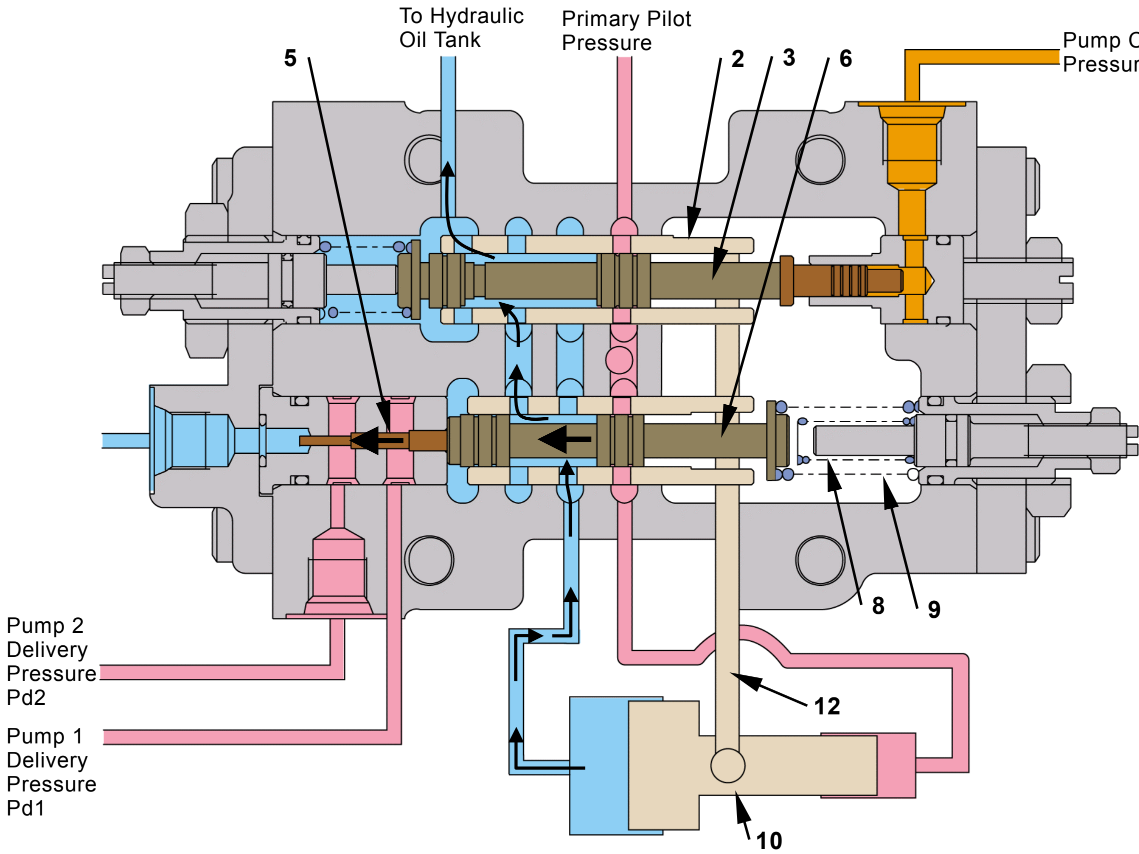




T1HH-03-01-018

2 - Sleeve A	8 - Inner Spring
3 - Spool A	9 - Outer Spring
5 - Load Piston	10 - Servo Piston
6 - Spool B	12 - 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)



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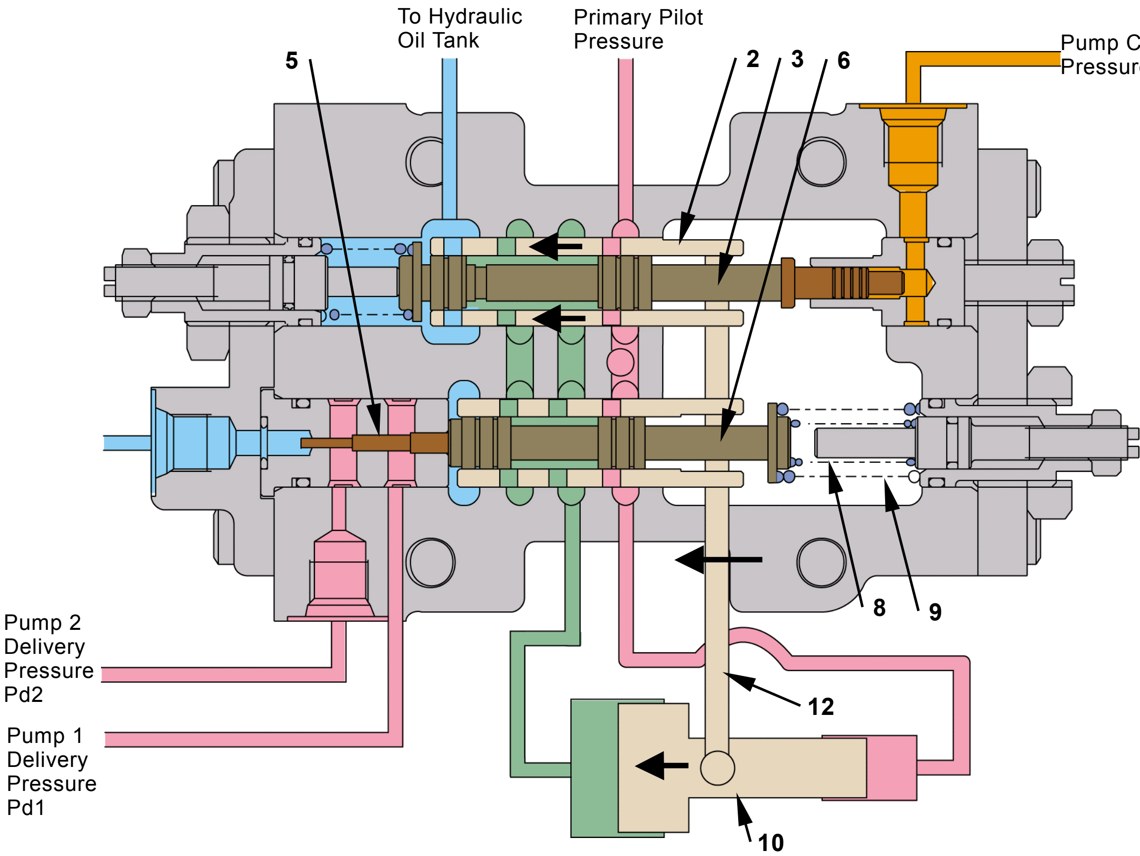


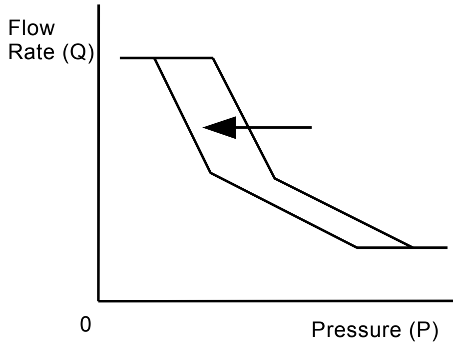
T1HH-03-01-011

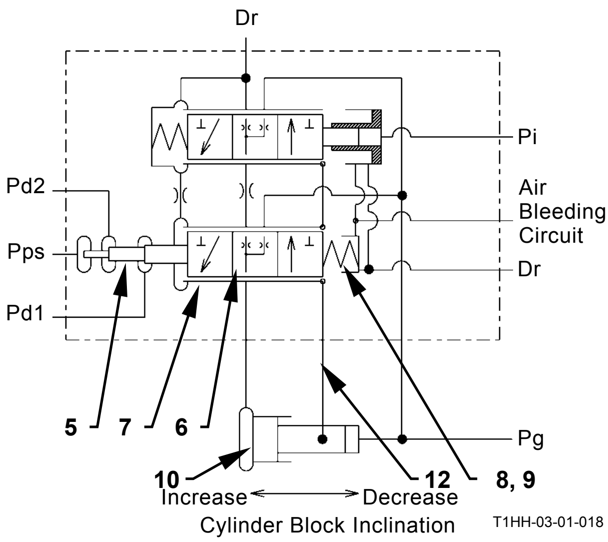
2 - Sleeve A
3 - Spool A
5 - Load Piston
6 - Spool B
8 - Inner Spring
9 - Outer Spring
10 - Servo Piston
12 - Link

Control by Pilot Pressure from Torque Control Solenoid Valve

- Decreasing Flow Rate

1. When the torque control solenoid valve is activated by the signals from the main controller (MC), torque control pressure Pps increases.
2. Torque control pressure Pps and either pump / delivery pressure Pd1 or pump 2 delivery pressure Pd2 are combined and applied to load piston (5).
3. Load piston (5) pushes spool B (6) and inner spring (8) and outer spring (9) and spool B (6) moves toward direction of the arrow.
4. Due to the movement of spool B (6), the pilot pressure is routed into the large chamber of servo piston (10).
5. Due to the difference in diameter between the large and small chambers, servo piston (10) 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.
6. The movement of cylinder block is transmitted to sleeve B (7) via link (12). Sleeve B (7) is moved in the same direction as spool B (6).
7. When sleeve B (7) is moved by the same stroke as spool B (6), the open part between sleeve B (7) and spool B (6) is closed and pilot pressure to the large chamber of servo piston (10) is blocked. Therefore, servo piston (10) is stopped and the flow rate decrease operation is completed.

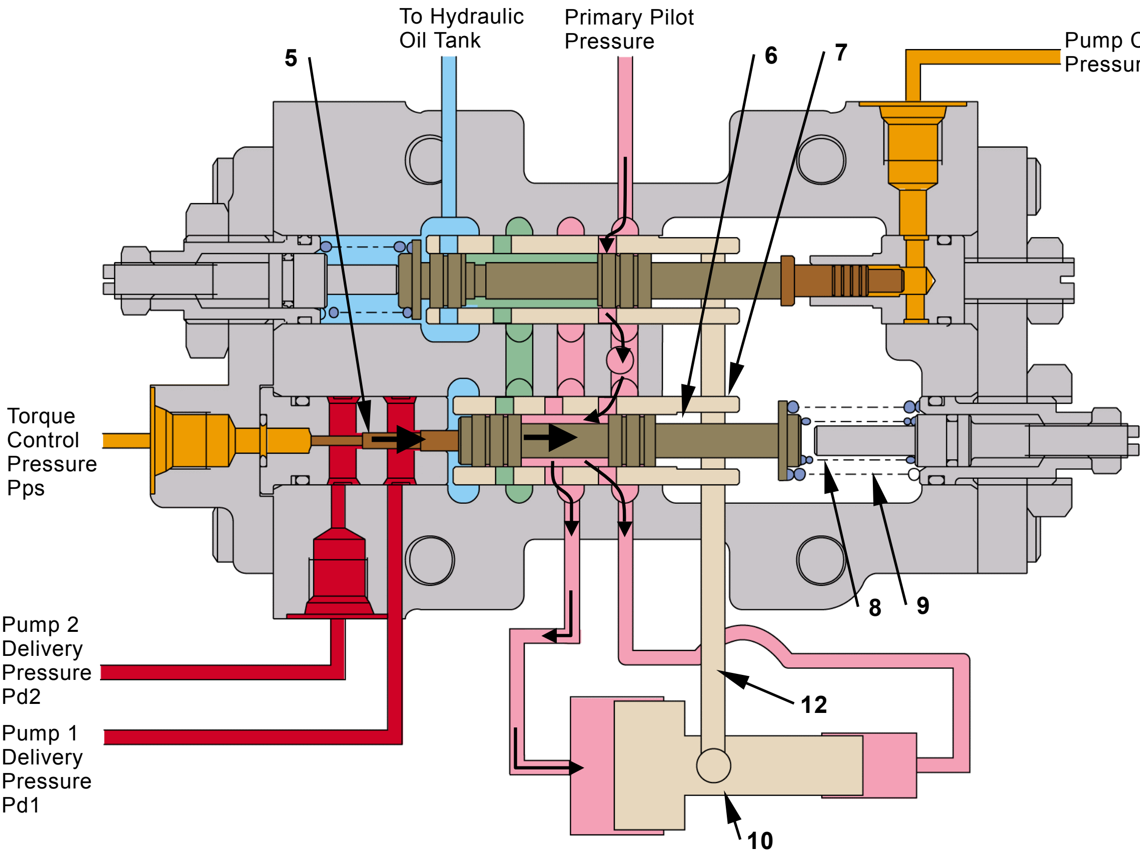




T1HH-03-01-018

5 - Load Piston
6 - Spool B
7 - Sleeve B
8 - Inner Spring
9 - Outer Spring
10 - Servo Piston
12 - Link

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



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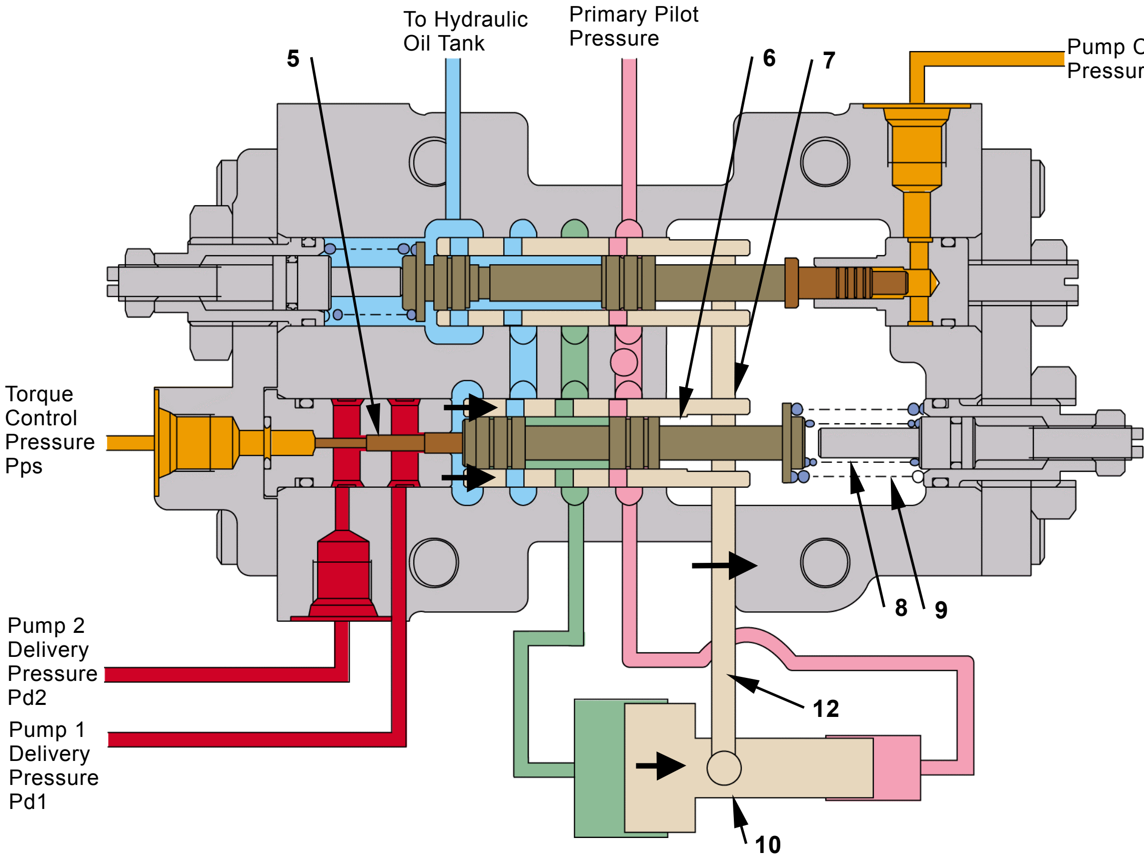


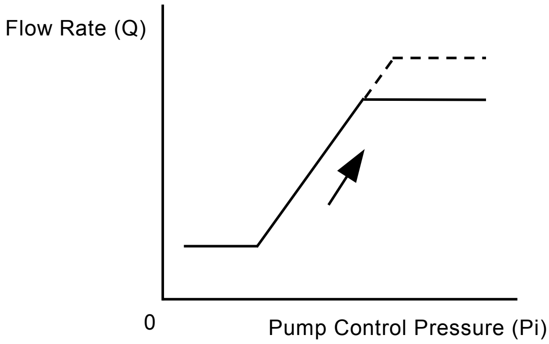
T1HH-03-01-013

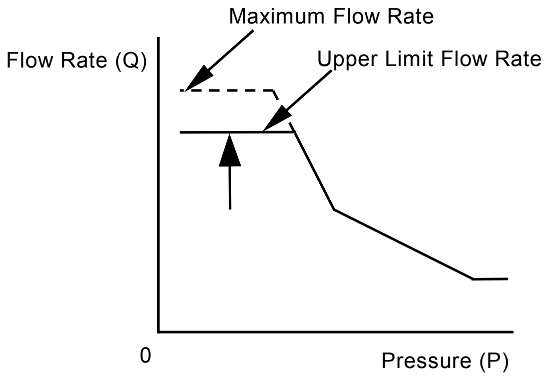
5 - Load Piston
6 - Spool B
7 - Sleeve B
8 - Inner Spring
9 - Outer Spring
10 - Servo Piston
12 - Link

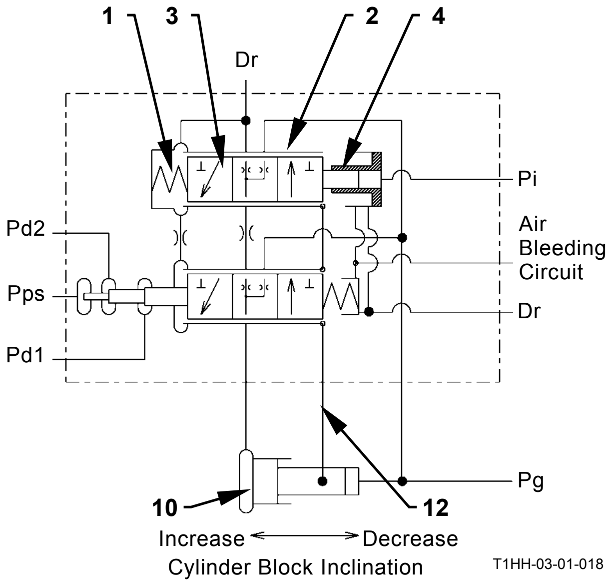
Control by Pilot Pressure from Flow Rate Control Solenoid Valve

- Upper Limit Flow Rate Control (Pump 2 Only)

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



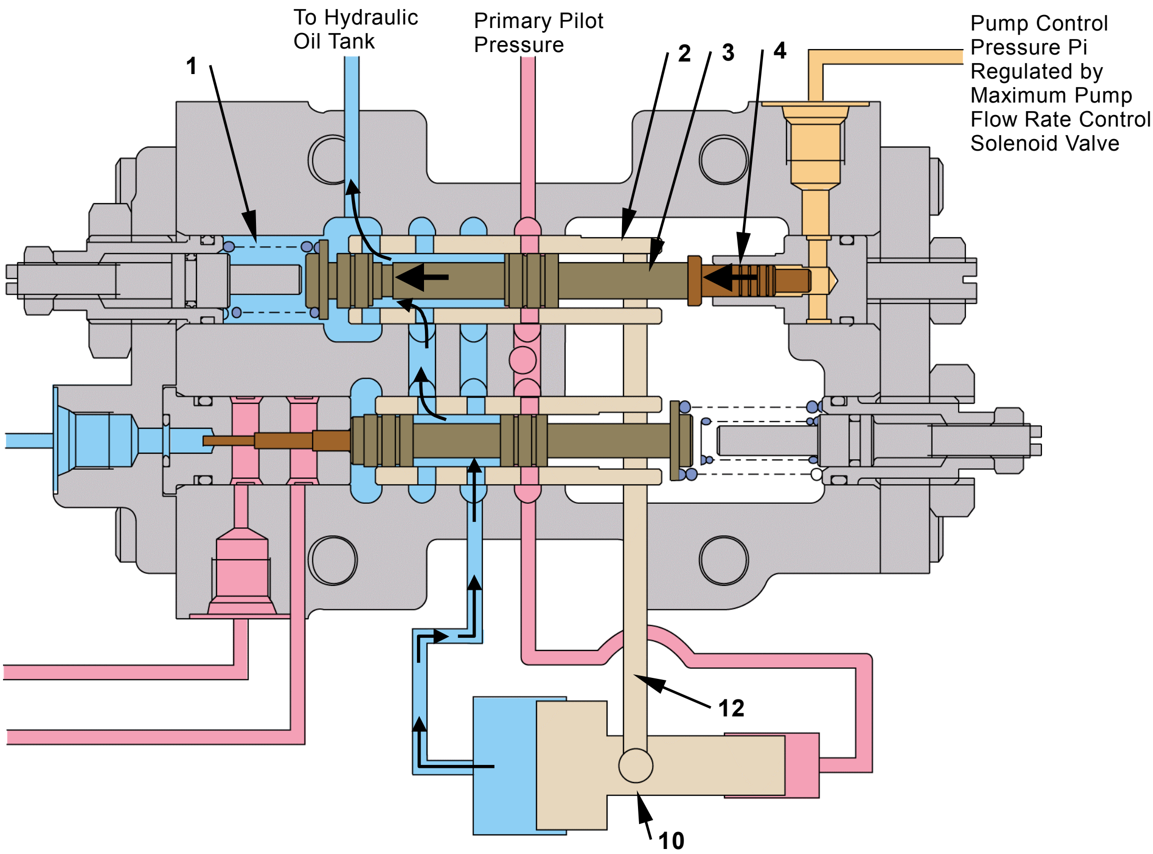




T1HH-03-01-018

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

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



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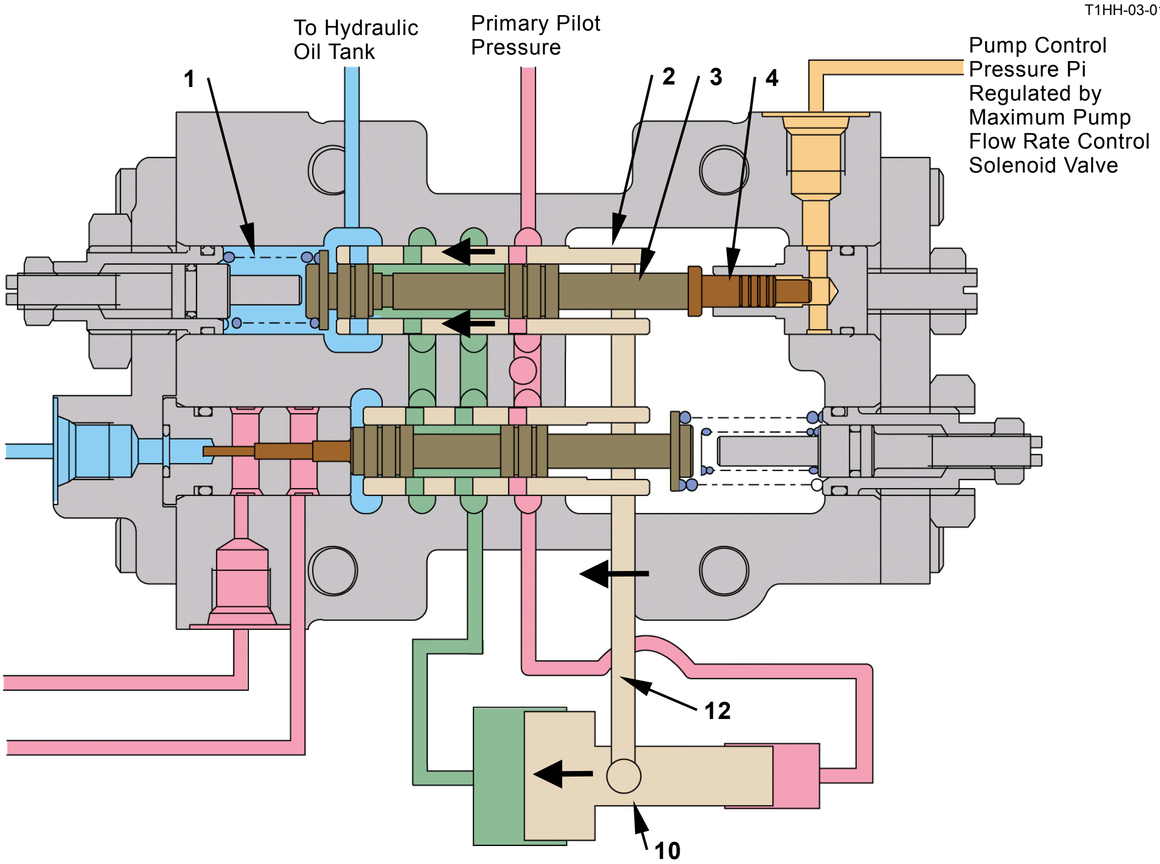


T1HH-03-01-015

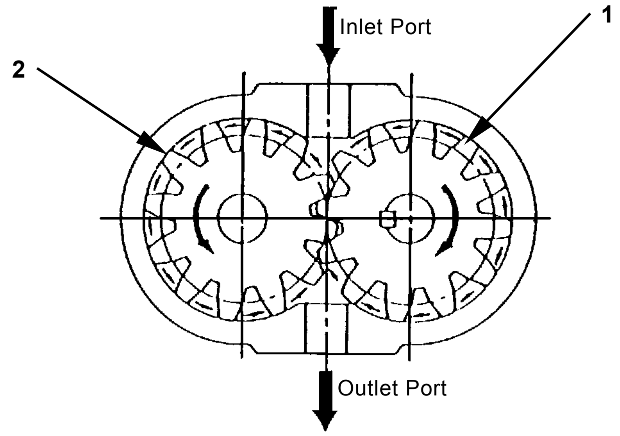
1 - Spring
2 - Sleeve A
3 - Spool A
4 - Piston
10 - Servo Piston
12 - Link

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

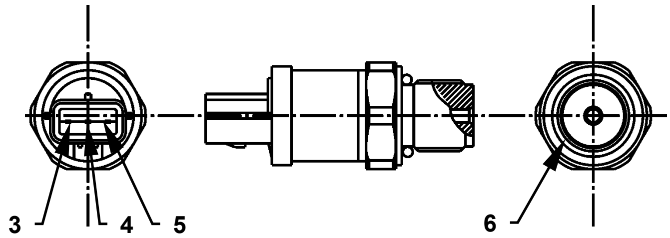
This sensor detects the pump delivery pressures, which are used in order to control various operations. When oil pressure is applied onto diaphragm (6), diaphragm (6) is deformed. The deformation of diaphragm (6) is detected as electrical signals.

3 - Ground

4 - Output

5 - Power Source (5V)

6 - Pressure Receiving Area (Diaphragm)

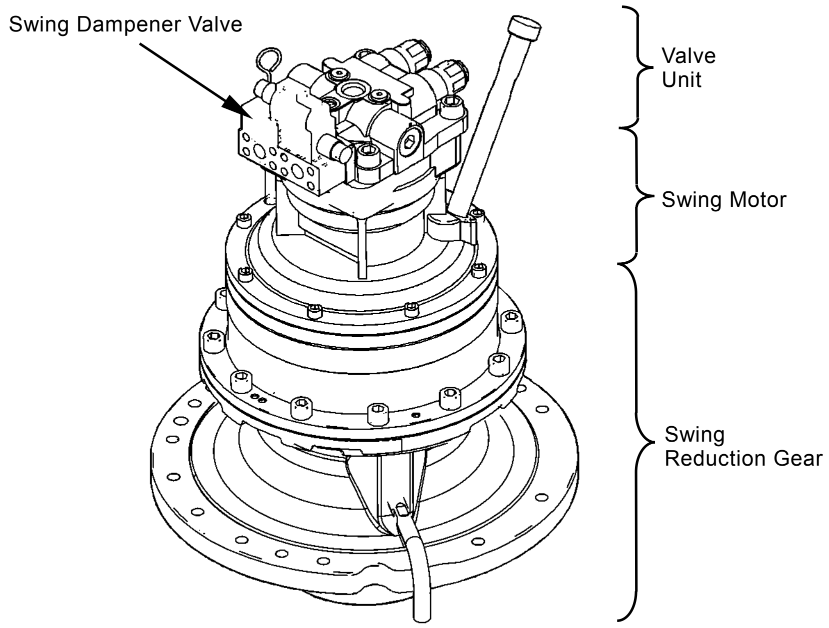


T1HH-03-01-017

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 is provided with the swing reduction gear.
The swing reduction gear turns the swing motor with large torque at a low speed and swings the upperstructure.

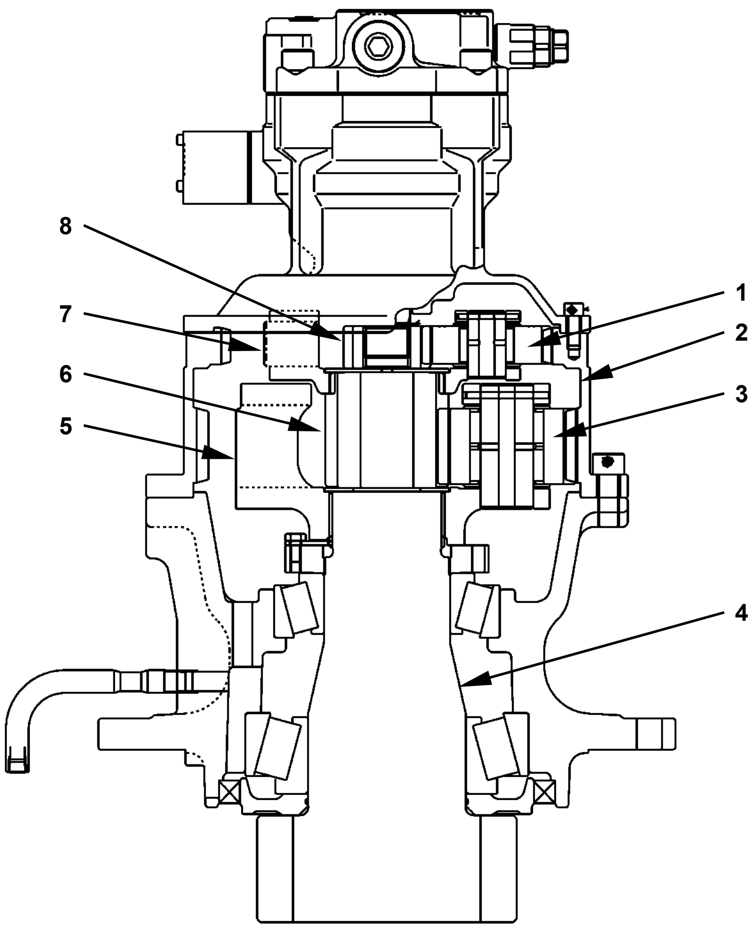
The swing dampener valve is provided for the main circuit in swing motor.
The swing dampener valve reduces shock when the swing brake is applied and also prevents aftershock.



T1V1-03-02-003

SWING REDUCTION GEAR

The swing reduction gear is a two-stage planetary gear type.
Ring gear (2) is provided on the inside of the housing, is fixed, and does not rotate.
The motor output shaft of swing motor drives first stage sun gear (8).
Then, rotary power is transmitted to second stage sun gear (6) via first stage planetary gear (1) and first stage carrier (7). Second stage sun gear (6) rotates shaft (output shaft)(4) via second stage planetary gear (3) and second stage carrier (5).
As shaft (4) meshes with the internal gear of swing bearing bolted to the undercarriage, the upperstructure is rotated.



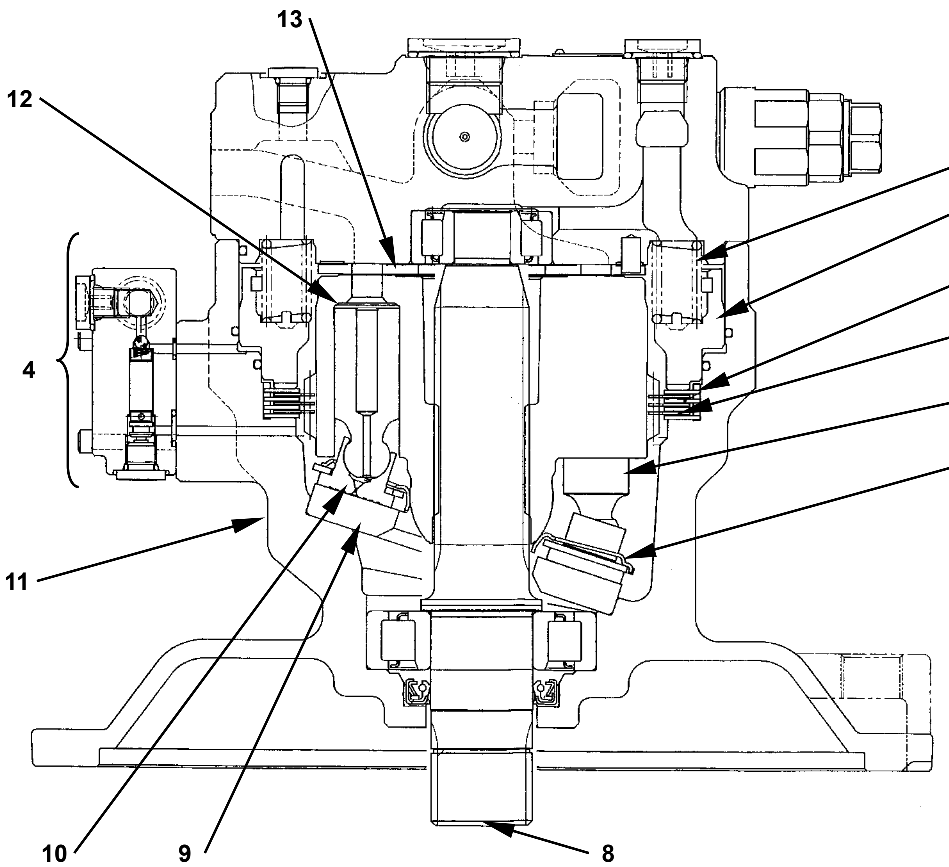
T1HH-03-02-001

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

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.



T1V7-03-02-001

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			

SWING PARKING BRAKE

The swing parking brake is a wet type multiplate disc brake and a negative mechanism that releases the brake when brake release pressure acts in 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.

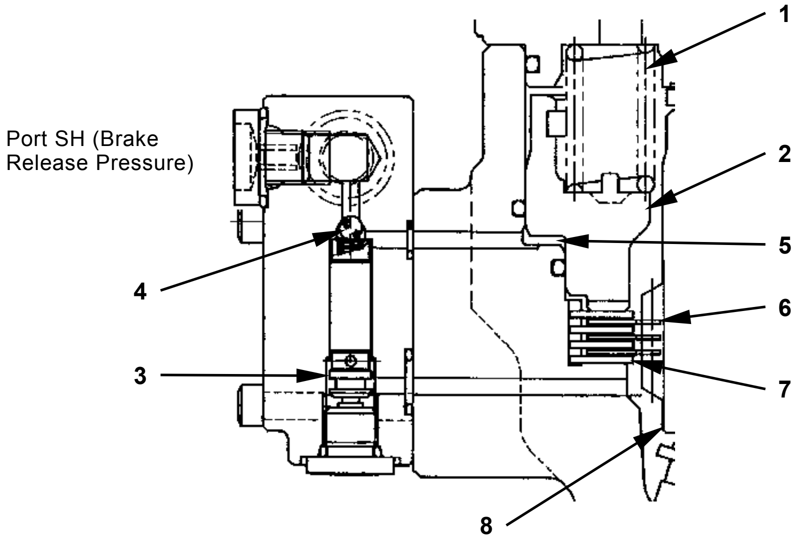
When Brake is Released

1. When 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 to 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.

Port SH (Brake
Release Pressure)



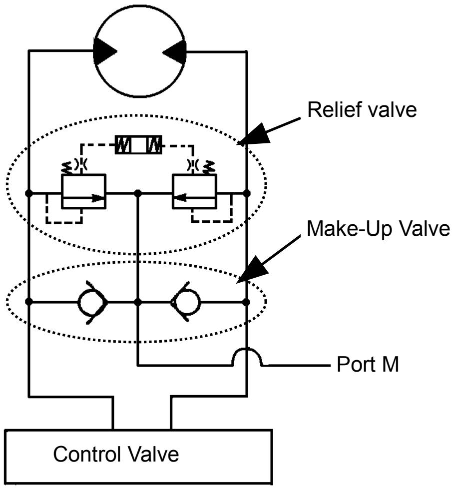
T1V7-03-02-002

1 - Spring	3 - Orifice	5 - Brake Piston Chamber	7 - Plate
2 - Brake Piston	4 - Check Valve	6 - Friction Plate	8 - Rotor

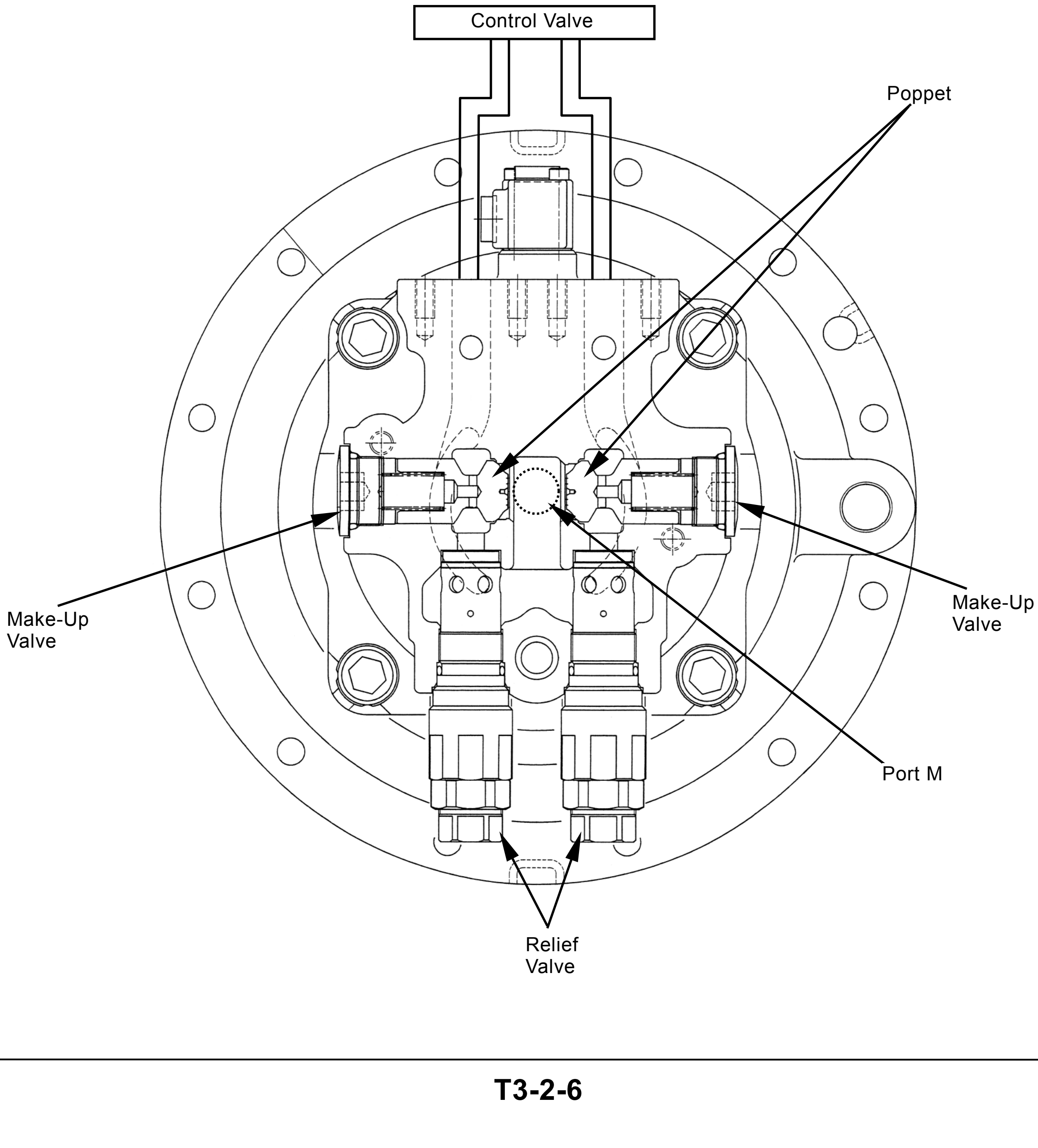
VALVE UNIT

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



T1V7-03-02-003

Relief Valve

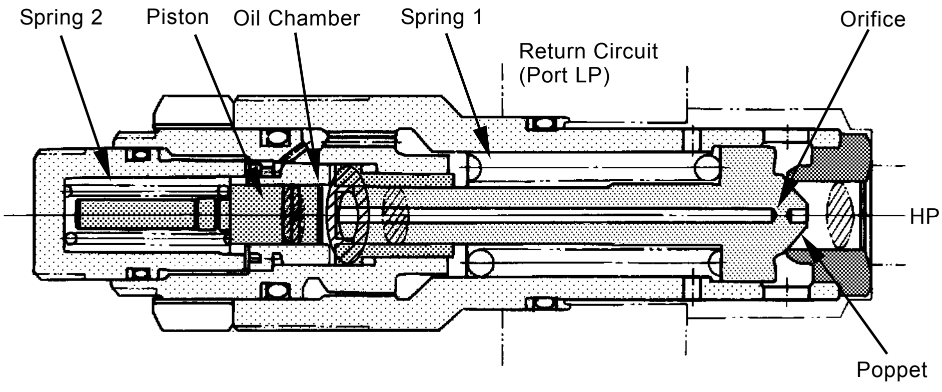
During starting or stopping swing operation, pressure in the swing circuit becomes high. The relief valve prevents the circuit pressure from rising higher than the set-pressure.

Low Pressure Relief Operation (Shockless Function):

1. Pressure at port HP (swing circuit) is routed into 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 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 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 HP.
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.

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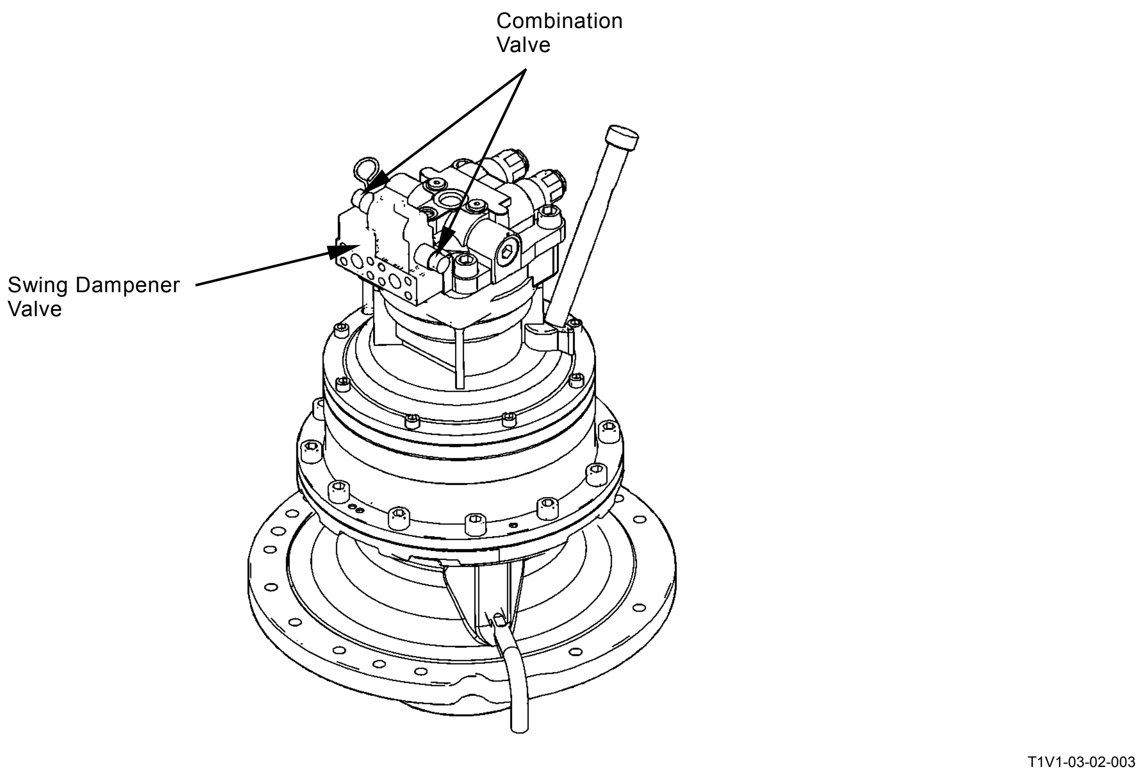
SWING DAMPENER VALVE

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.



Operation

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

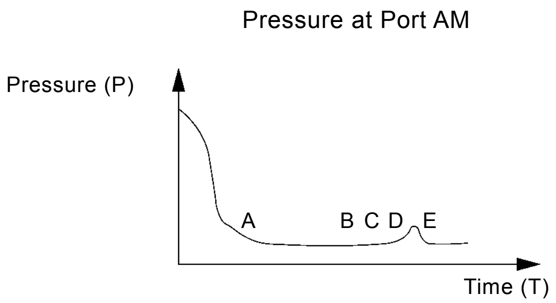
1. When releasing the control lever, the spool in control valve moves to the neutral position. As the swing motor rotates due to the inertia force of machine, pressure in the circuit at port BM (return side) increases momentarily and operates the swing relief valve.
2. Pressure oil from port BM acts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

- Operation of Combination Valve (A):

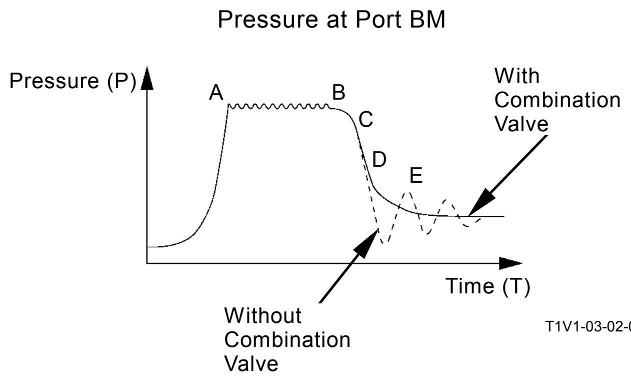
3. Pressure oil acting to combination valve (A) opens ball (2) and flows to chamber N through poppet (1).
4. When pressure in chamber N is larger than spring (4) force and spring (7) force (pressure in chamber N > spring (4) force + spring (7) force), piston (5) tries to move to the left. However, piston (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):

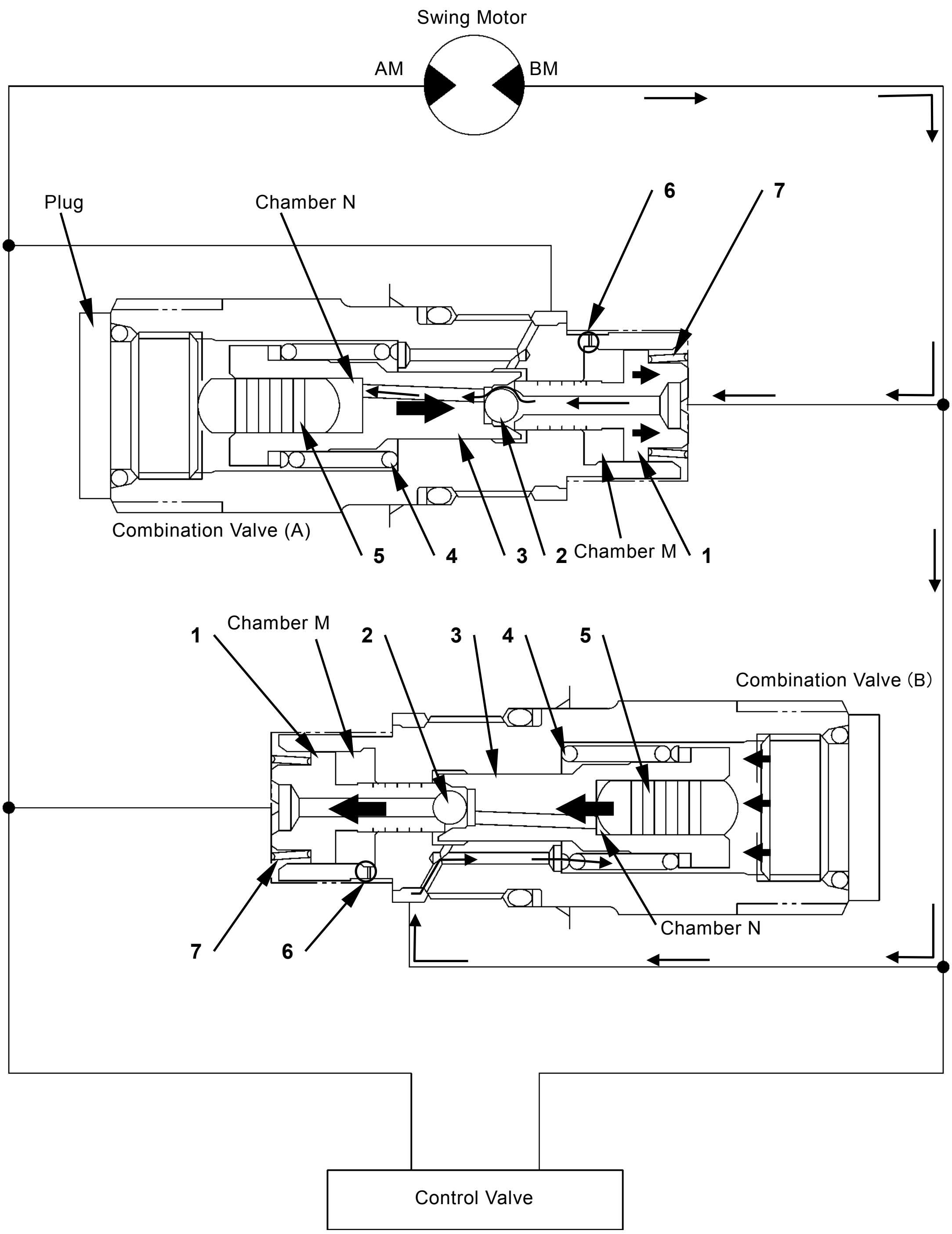
6. Pressure oil acting to combination valve (B) flows to the spring (4) chamber through the inner passage.
7. When pressure in spring (4) chamber is larger than spring (4) force and spring (7) force (pressure in spring (4) chamber > spring (4) force + spring (7) force), plunger (3), piston (5) and poppet (1) pushes 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



T1V1-03-02-013

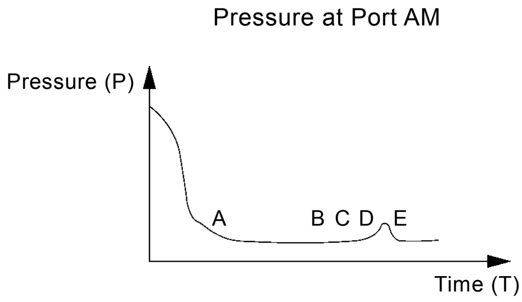
1 -	Poppet	3 -	Plunger	5 -	Piston	7 -	Spring
2 -	Ball	4 -	Spring	6 -	Orifice		

- 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).



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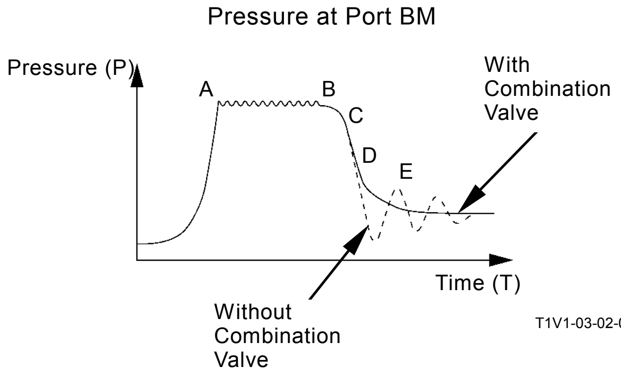

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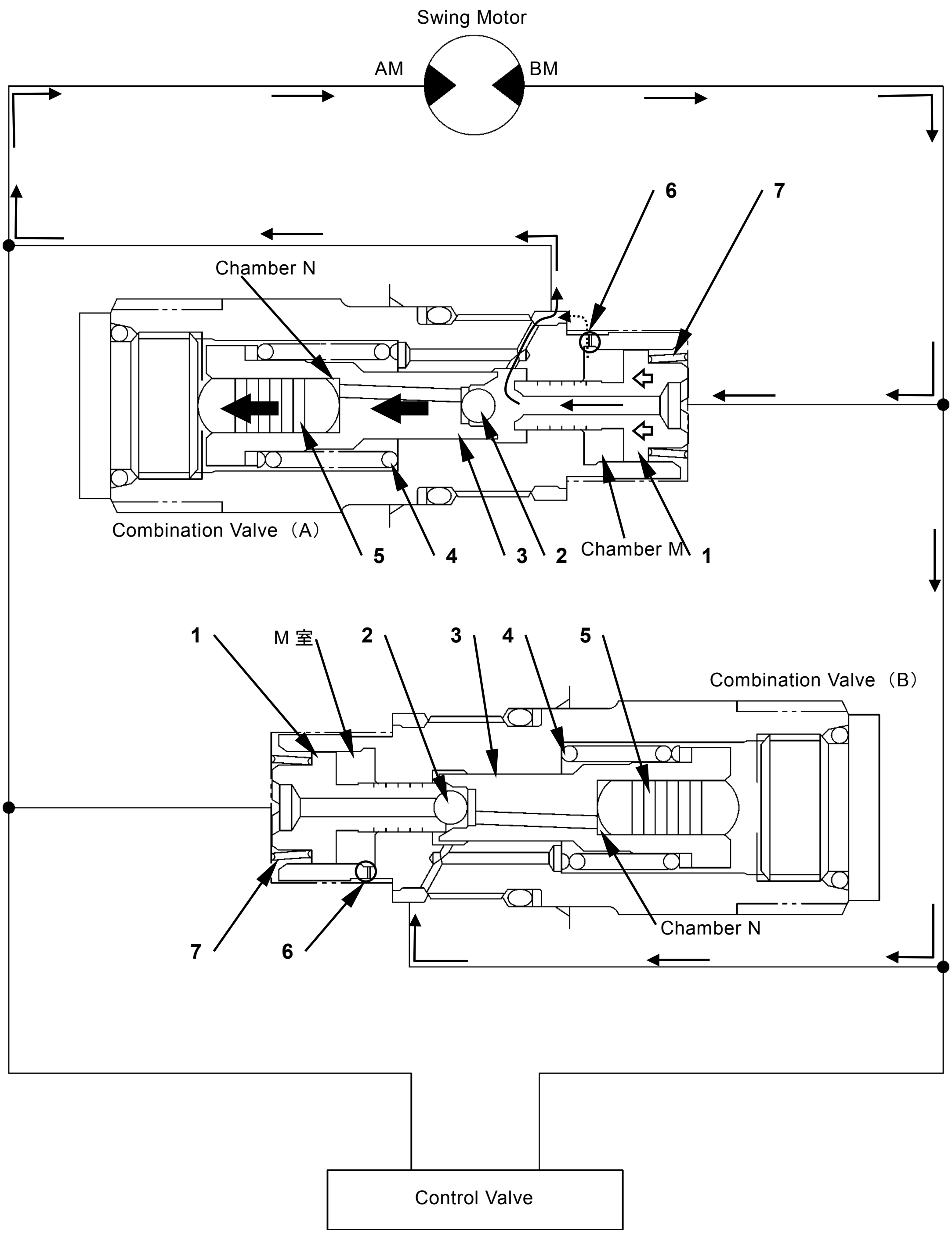


T1V1-03-02-014

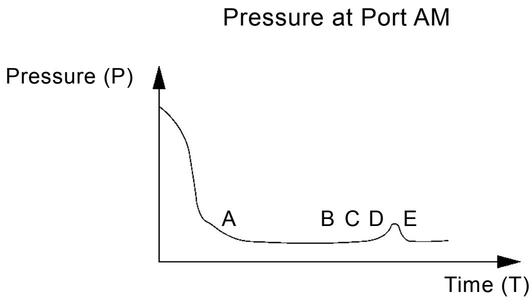
1 - Poppet
2 - Ball
3 - Plunger
4 - Spring
5 - Piston
6 - Orifice
7 - Spring

- 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 to spring (4) chamber in combination valve (B) also decreases.
2. When pressure in 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 to poppet (1) and ball (2).
7. Therefore, ball (2) is pushed by poppet (1). Poppet (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).



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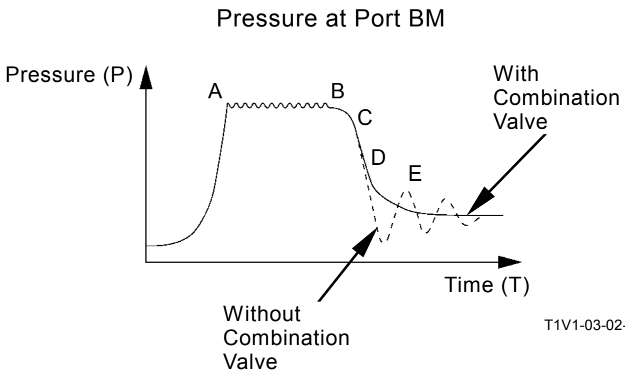

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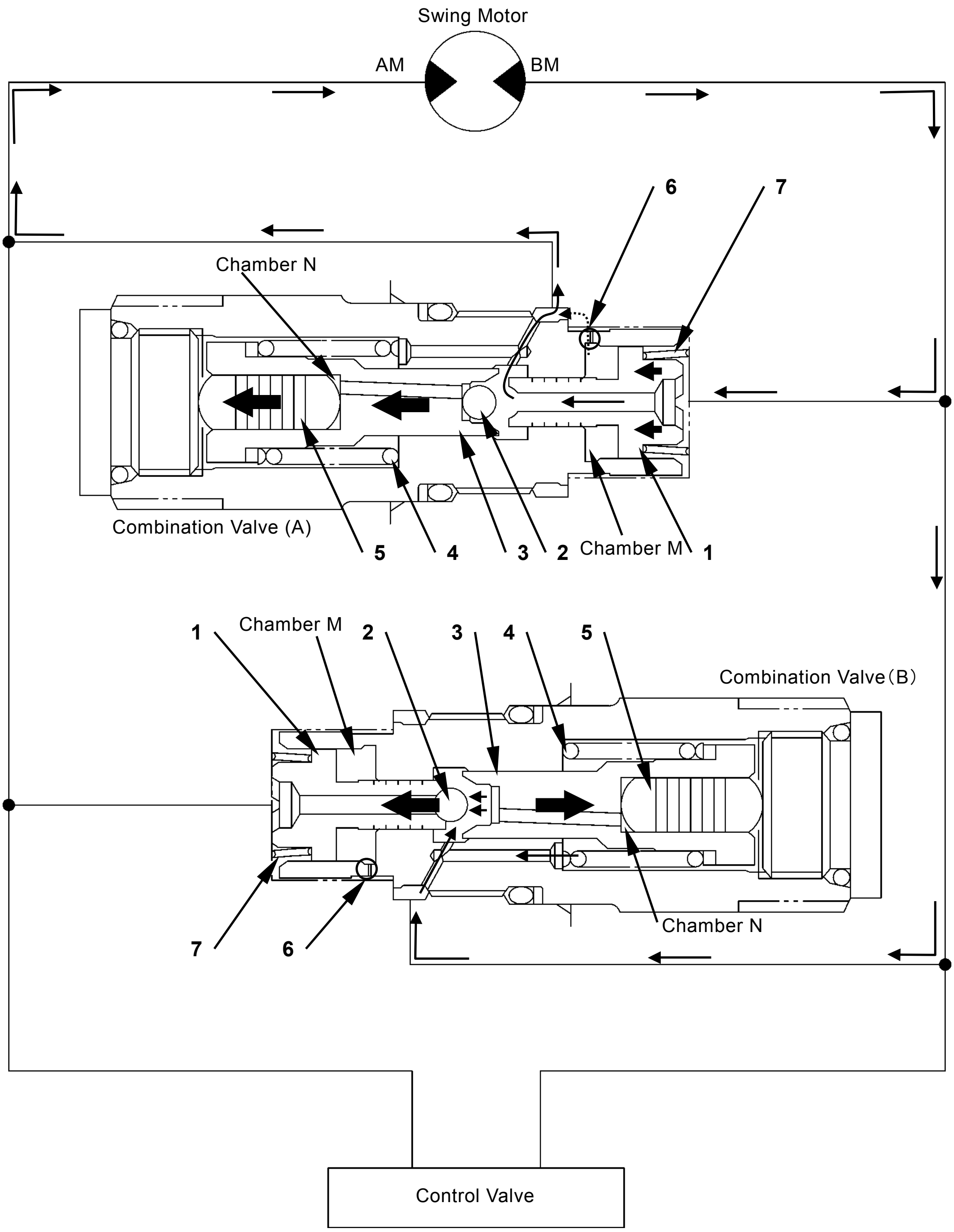


T1V1-03-02-015

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

- 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.

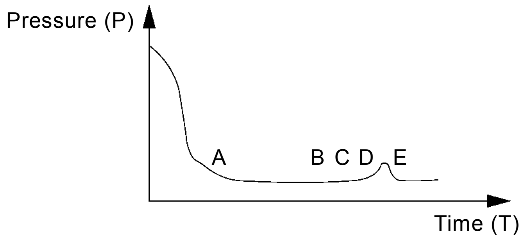
- Operation of Combination Valve (A):

1. Pressure oil from port AM acts to 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):

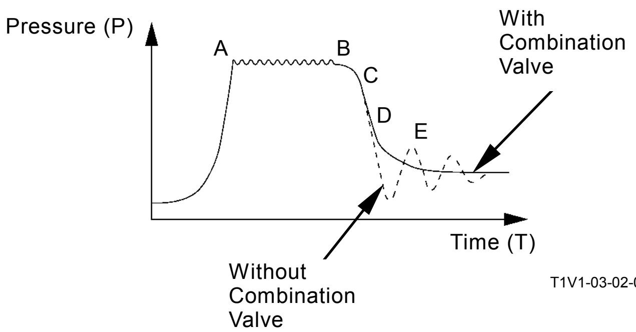
4. Pressure oil from port AM opens ball (2) and flows to port BM through poppet (1).
5. As combination valve (B) makes pressure oil from port AM (high-pressure) flow to port BM (low-pressure), pressure increase at high-pressure side is controlled and aftershock pressure is reduced.
6. Combination valves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

Pressure at Port AM



T1V1-03-02-001

Pressure at Port BM



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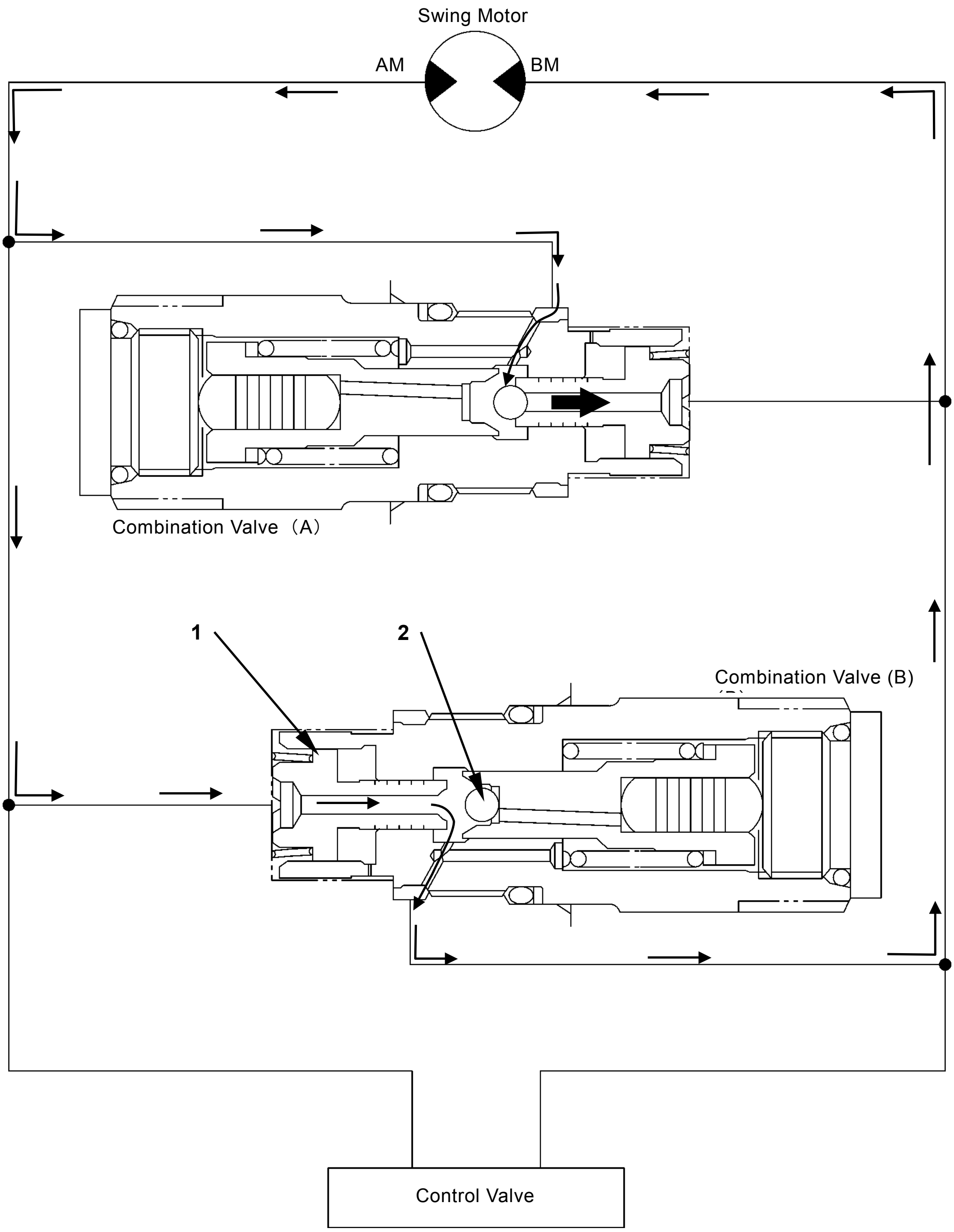

T1V1-03-02-016

1 - Poppet
2 - Ball

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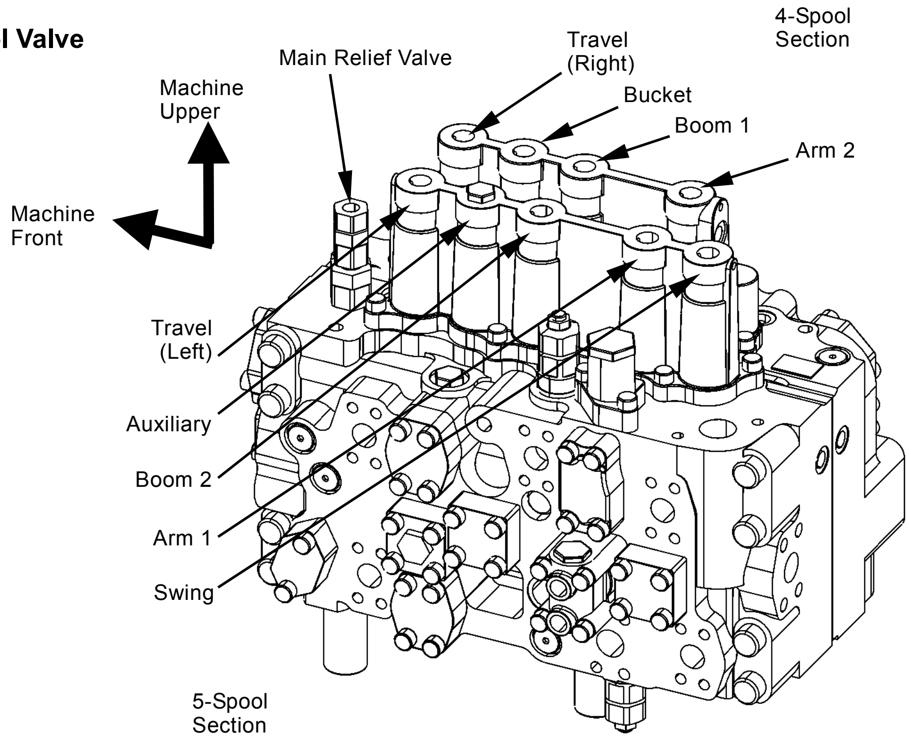
OUTLINE

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 rate control valve, regenerative valve, digging regenerative valve, boom lower meter-in cut valve, bypass shut-out valve and spools. The spools are operated by pilot oil pressure.

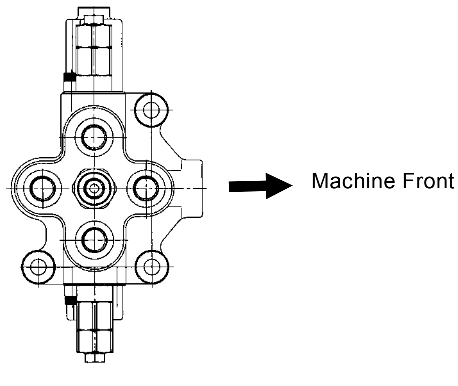
As for the spools, in the 4-spool section, right travel, bucket, boom 1 and arm 2 are arranged in that order as viewed from the machine front. In the 5-spool section, left travel, auxiliary, boom 2, arm 1 and swing are arranged in that order as viewed from the machine front.

Control Valve



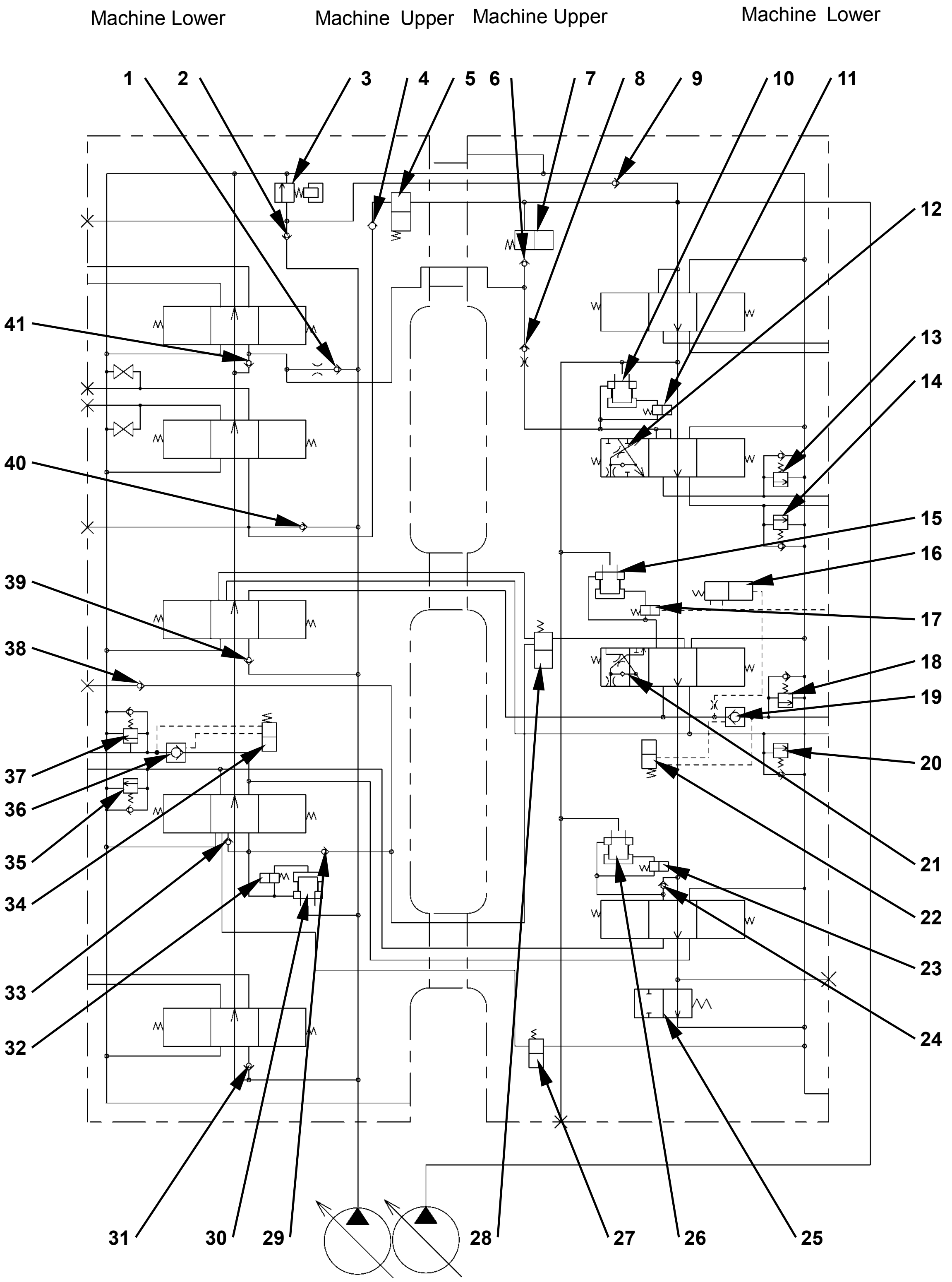
T1V7-03-03-002

Positioning Control Valve (2-Piece Boom Only)



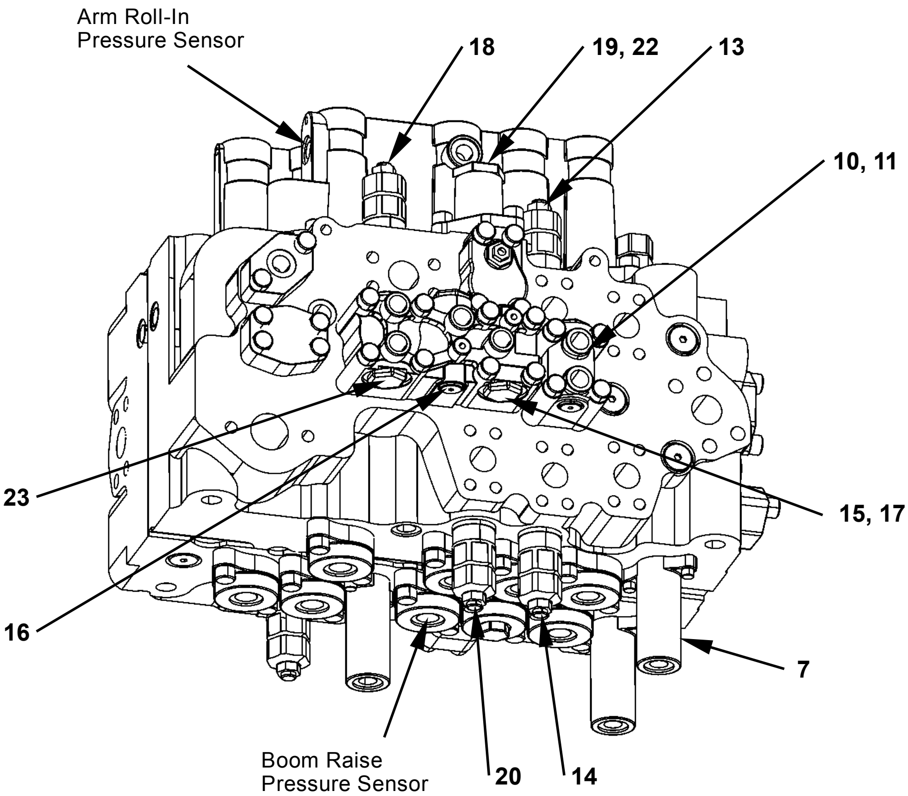
T178-03-03-370

Layout of Control Valve



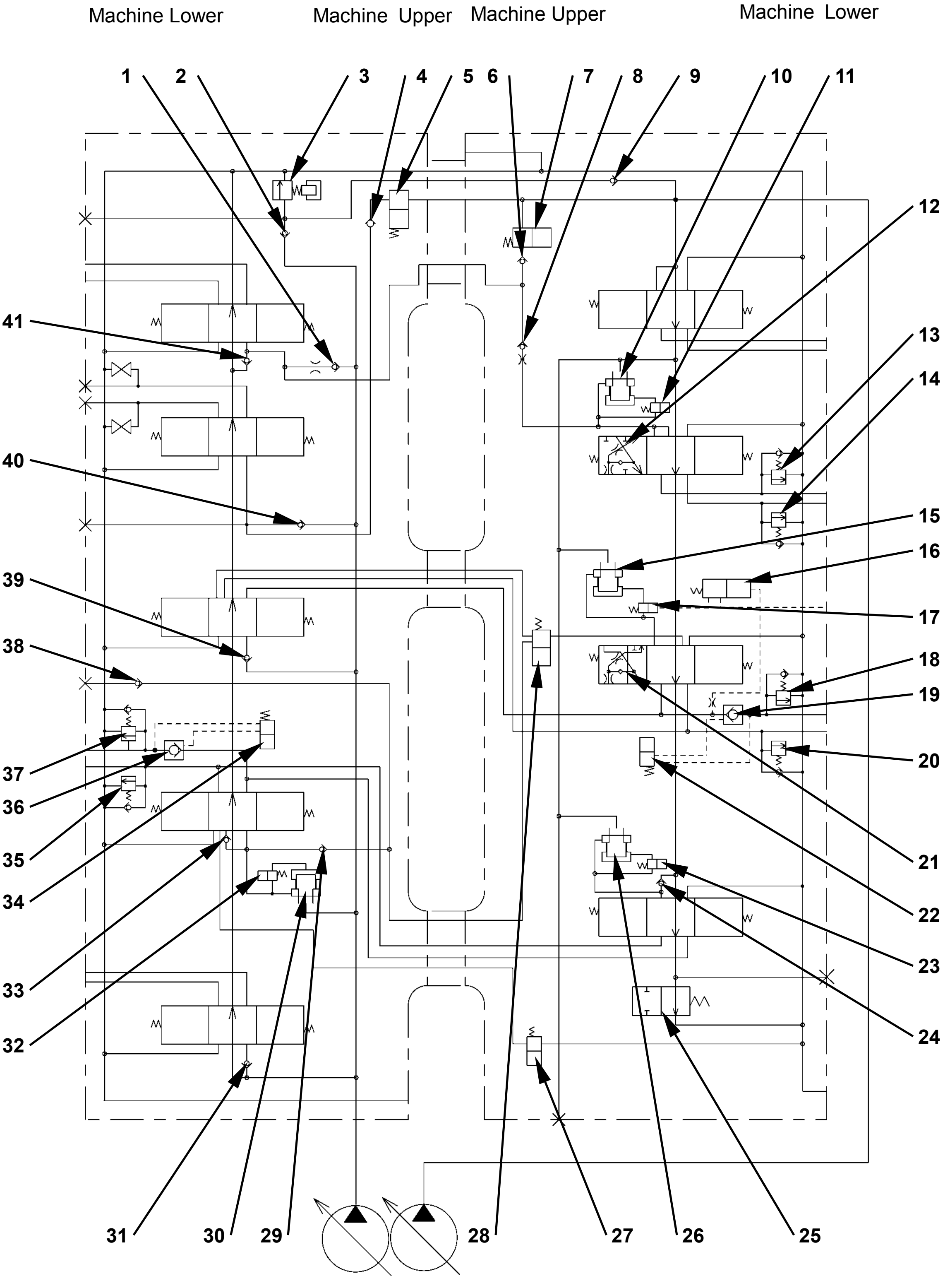
T1V7-03-03-003

4-Spool Section



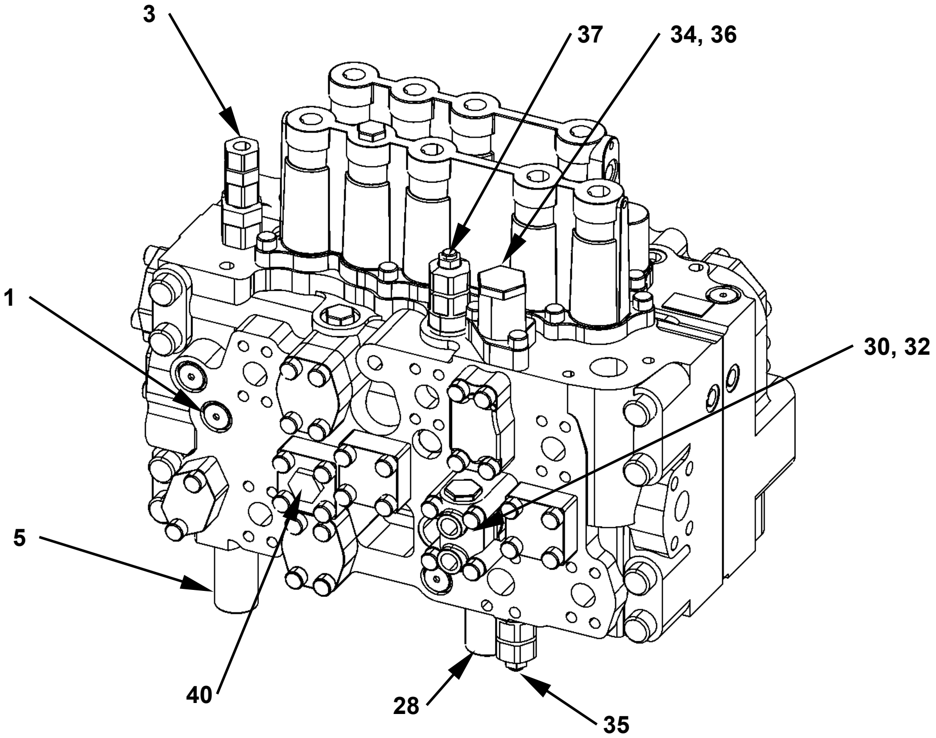
T1V1-03-03-073

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



T1V7-03-03-003

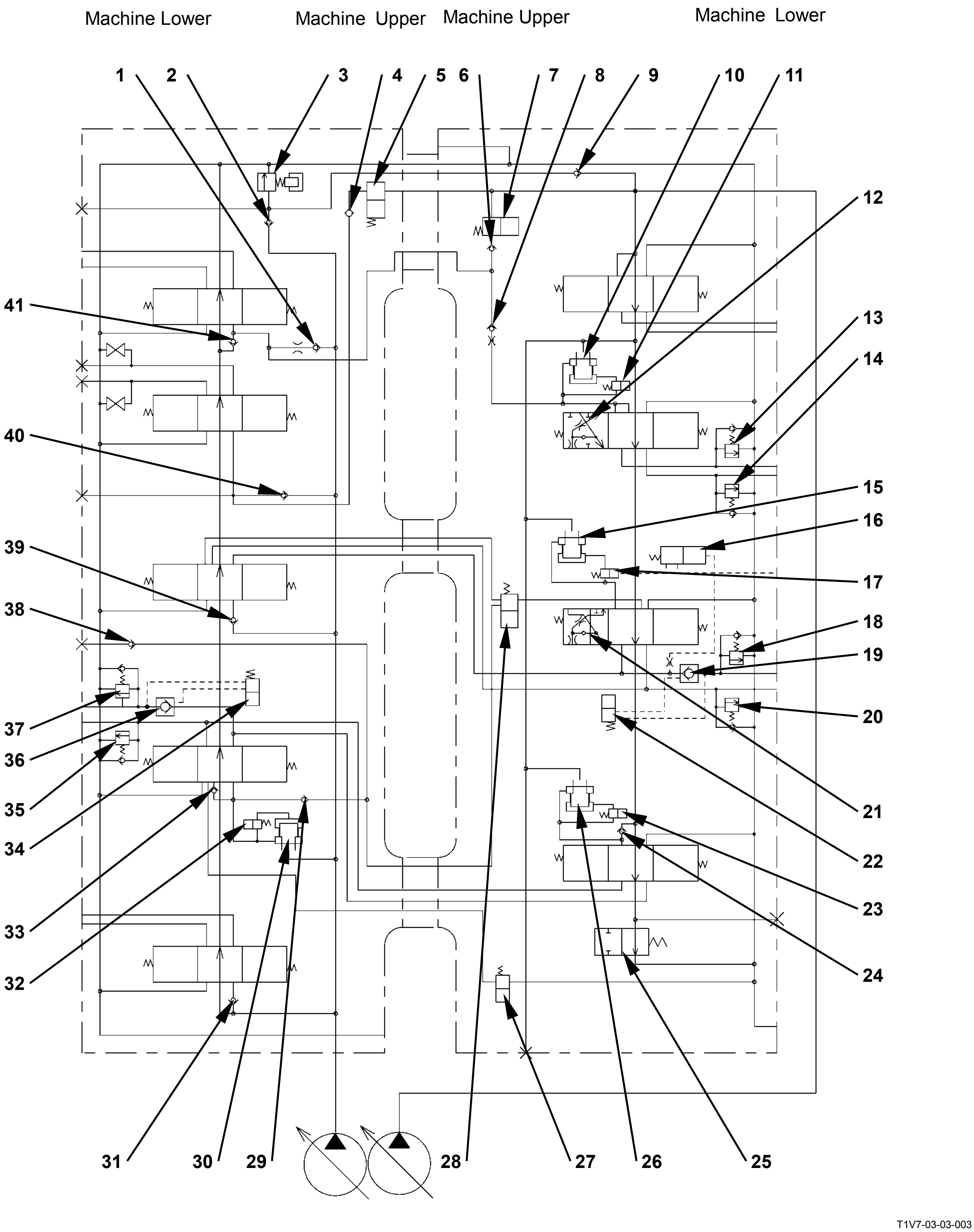
5-Spool Section



T1V7-03-03-002

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

NOTE: Auxiliary flow combiner valve (5) equipped in the control valve is not used for the machine control.


Machine Lower
Machine Upper
Machine Upper
Machine Lower
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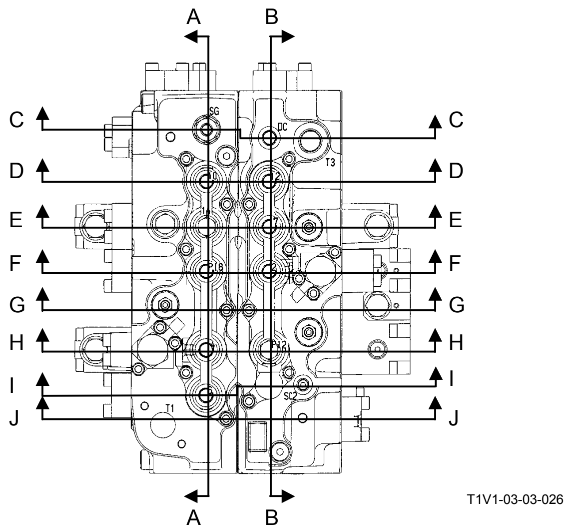
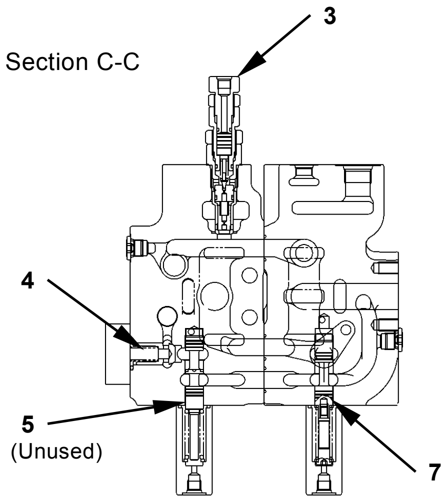
T1V7-03-03-003



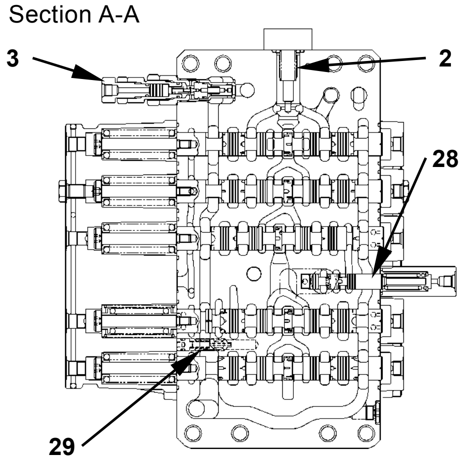
T1V1-03-03-026

Cross Section C-C



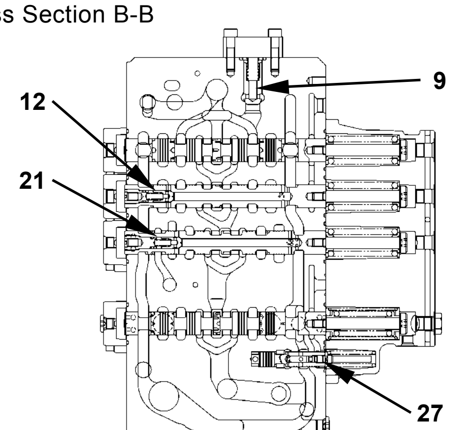
T1V1-03-03-003

Cross Section A-A



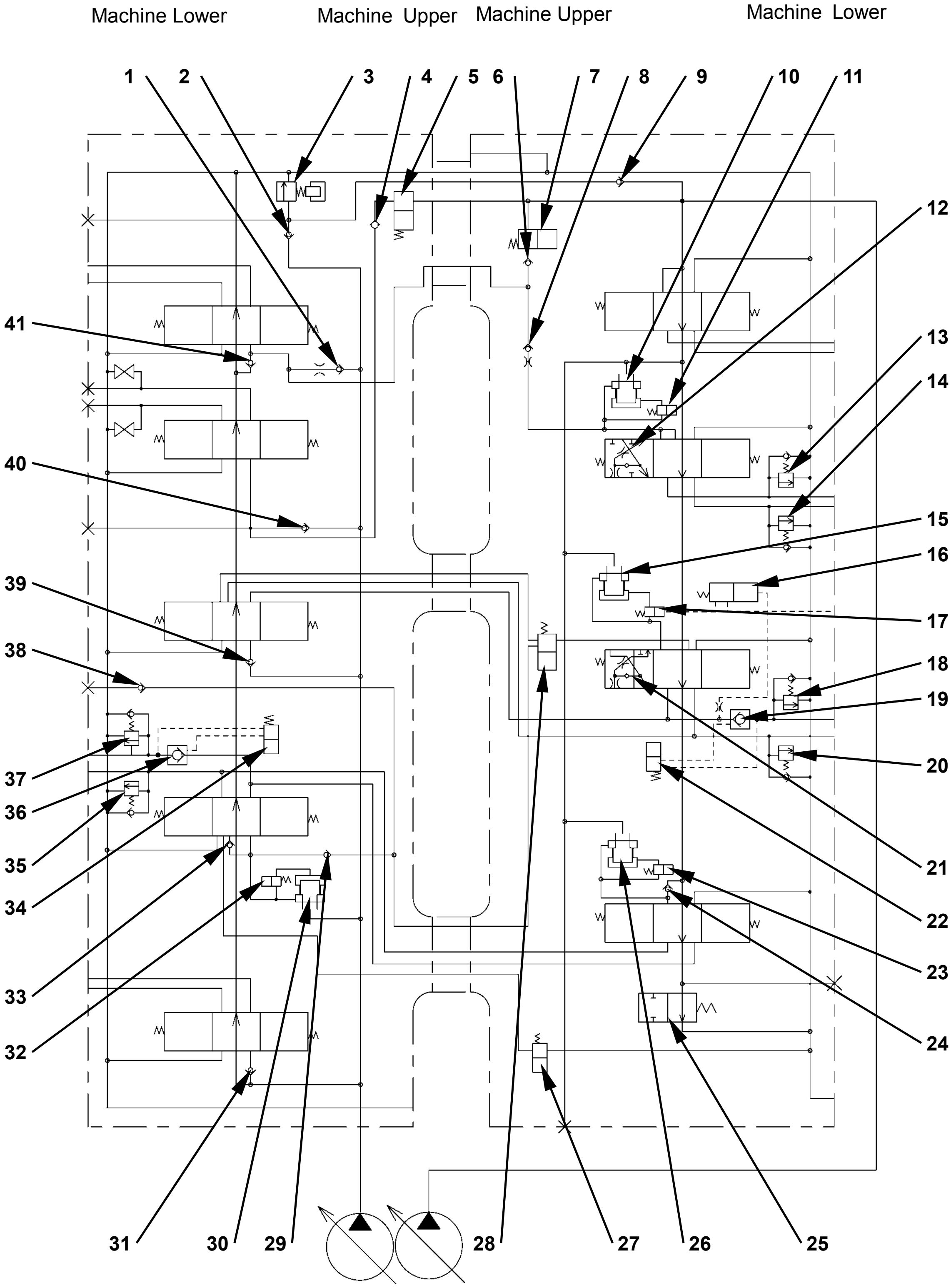
T1V1-03-03-001

Cross Section B-B



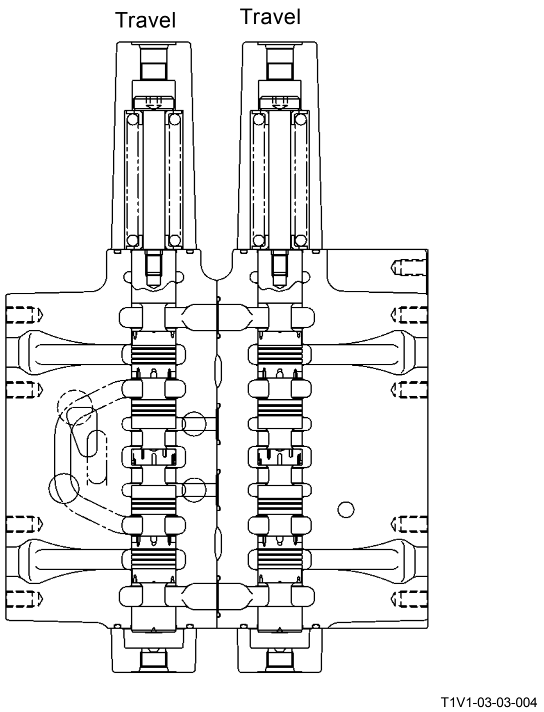
T1V1-03-03-002

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

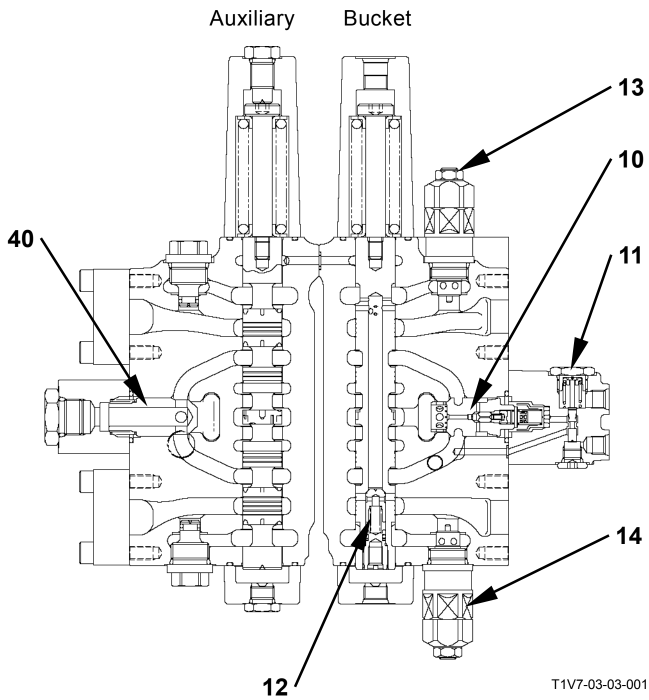


T1V7-03-03-003

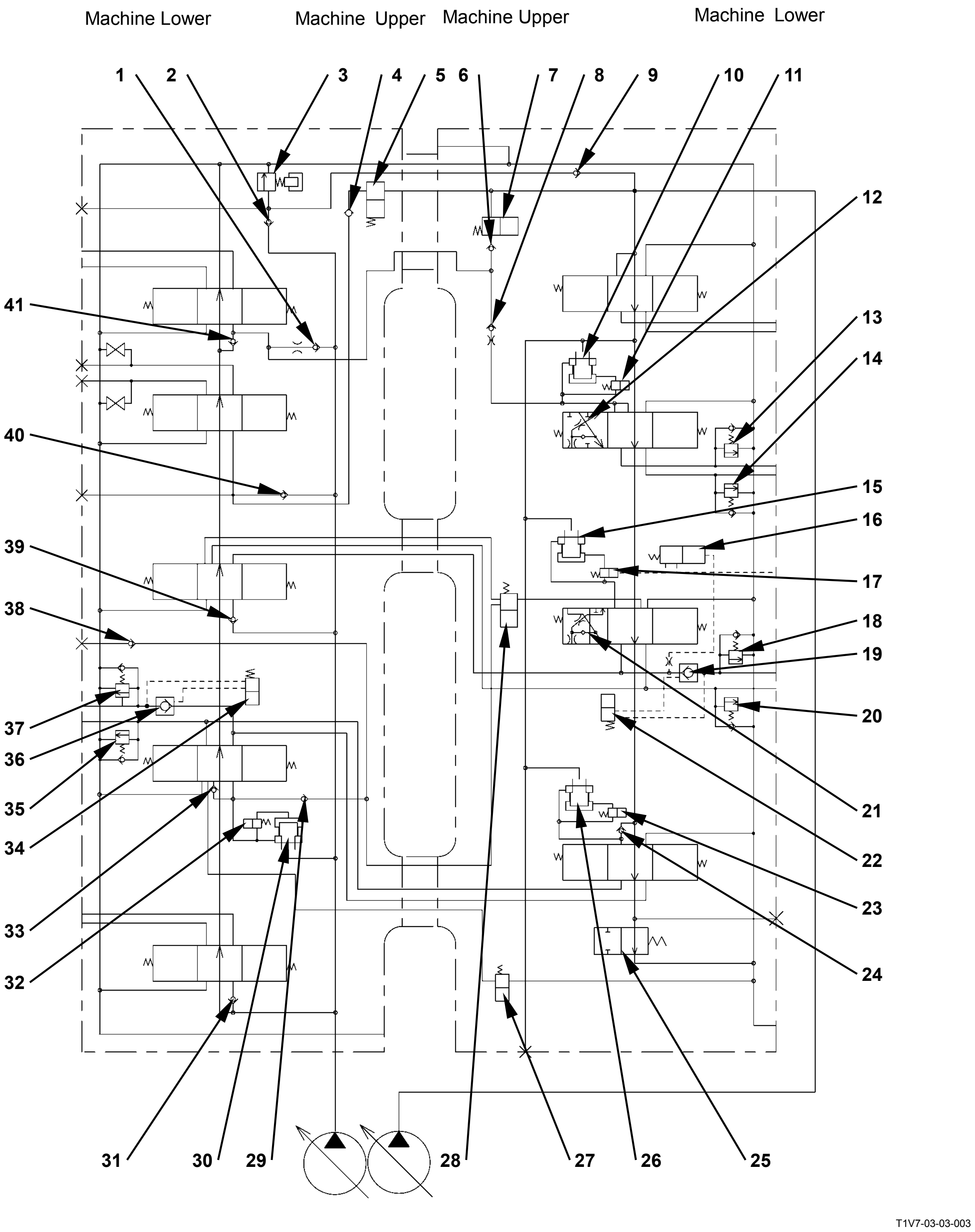
Cross Section D-D



Cross Section E-E



1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Flow Combiner Valve Circuit)
5 - Auxiliary Flow Combiner Valve
6 - Check Valve (Flow Combiner Valve Circuit)
7 - Flow Combiner Valve
8 - Load Check Valve (Orifice) (Bucket)
9 - Check Valve (Main Relief Circuit)
10 - Bucket Flow Rate Control Valve (Poppet Valve)
11 - Bucket Flow Rate Control Valve (Switch Valve)
12 - Bucket Regenerative Valve
13 - Overload Relief Valve (Bucket: Rod Side)
14 - Overload Relief Valve (Bucket: Bottom Side)
15 - Boom Flow Control Valve (Poppet Valve)
16 - Boom Lower Meter-In Cut Valve
17 - Boom Flow Rate Control Valve (Switch Valve)
18 - Overload Relief Valve (Boom: Bottom Side)
19 - Boom Anti-Drift Valve (Check Valve)
20 - Overload Relief Valve (Boom: Rod Side)
21 - Boom Regenerative Valve
22 - Boom Anti-Drift Valve (Switch Valve)
23 - Arm 2 Flow Rate Control Valve (Switch Valve)
24 - Load Check Valve (Arm 2 Tandem Circuit)
25 - Bypass Shut-Out Valve
26 - Arm 2 Flow Rate Control Valve (Poppet Valve)
27 - Arm Regenerative Valve
28 - Digging Regenerative Valve
29 - Load Check Valve (Digging Regenerative Circuit)
30 - Arm 1 Flow Rate Control Valve (Poppet Valve)
31 - Load Check Valve (Swing Circuit)
32 - Arm 1 Flow Rate Control Valve (Switch Valve)
33 - Load Check Valve (Arm Regenerative Circuit)
34 - Arm Anti-Drift Valve (Switch Valve)
35 - Overload Relief Valve (Arm: Bottom Side)
36 - Arm Anti-Drift Valve (Check Valve)
37 - Overload Relief Valve (Arm: Rod Side)
38 - Check Valve (Digging Regenerative Circuit)
39 - Load Check Valve (Boom 2 Parallel Circuit)
40 - Load Check valve (Auxiliary Parallel / Flow Combining Circuit)
41 - Load Check Valve (Left Travel Tandem Circuit)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Machine Upper
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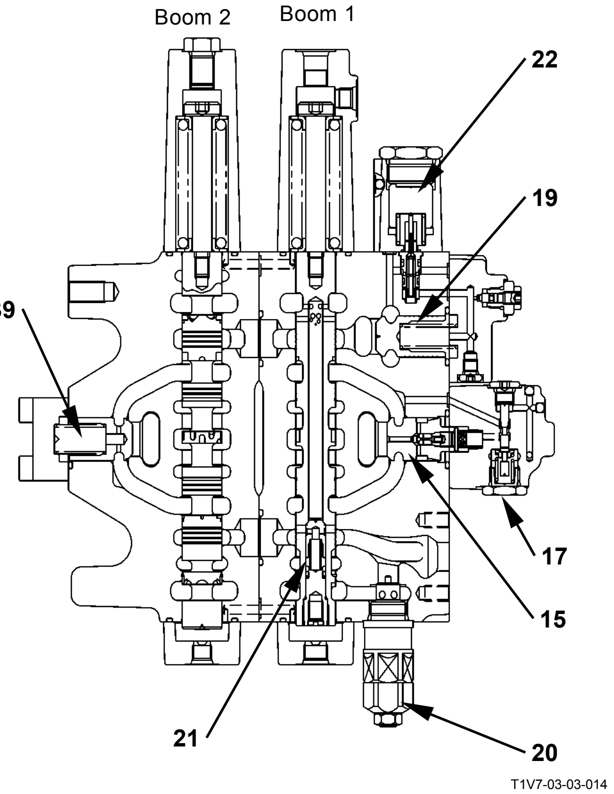
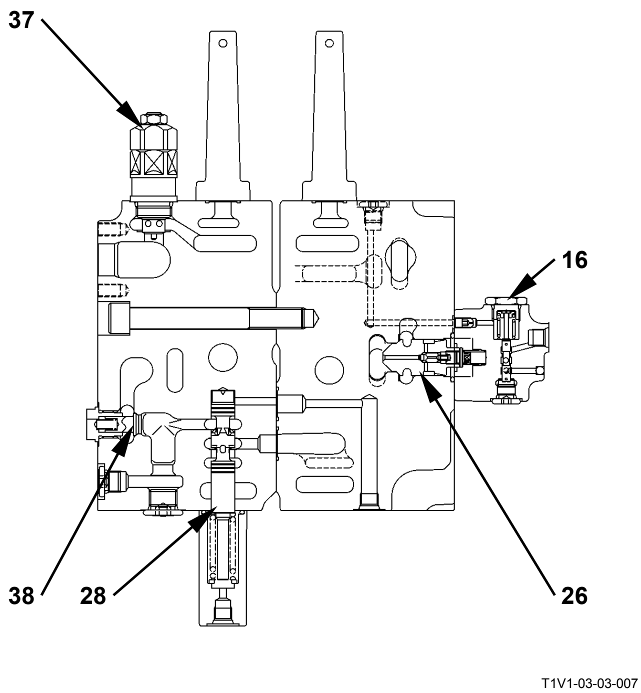
T1V7-03-03-003

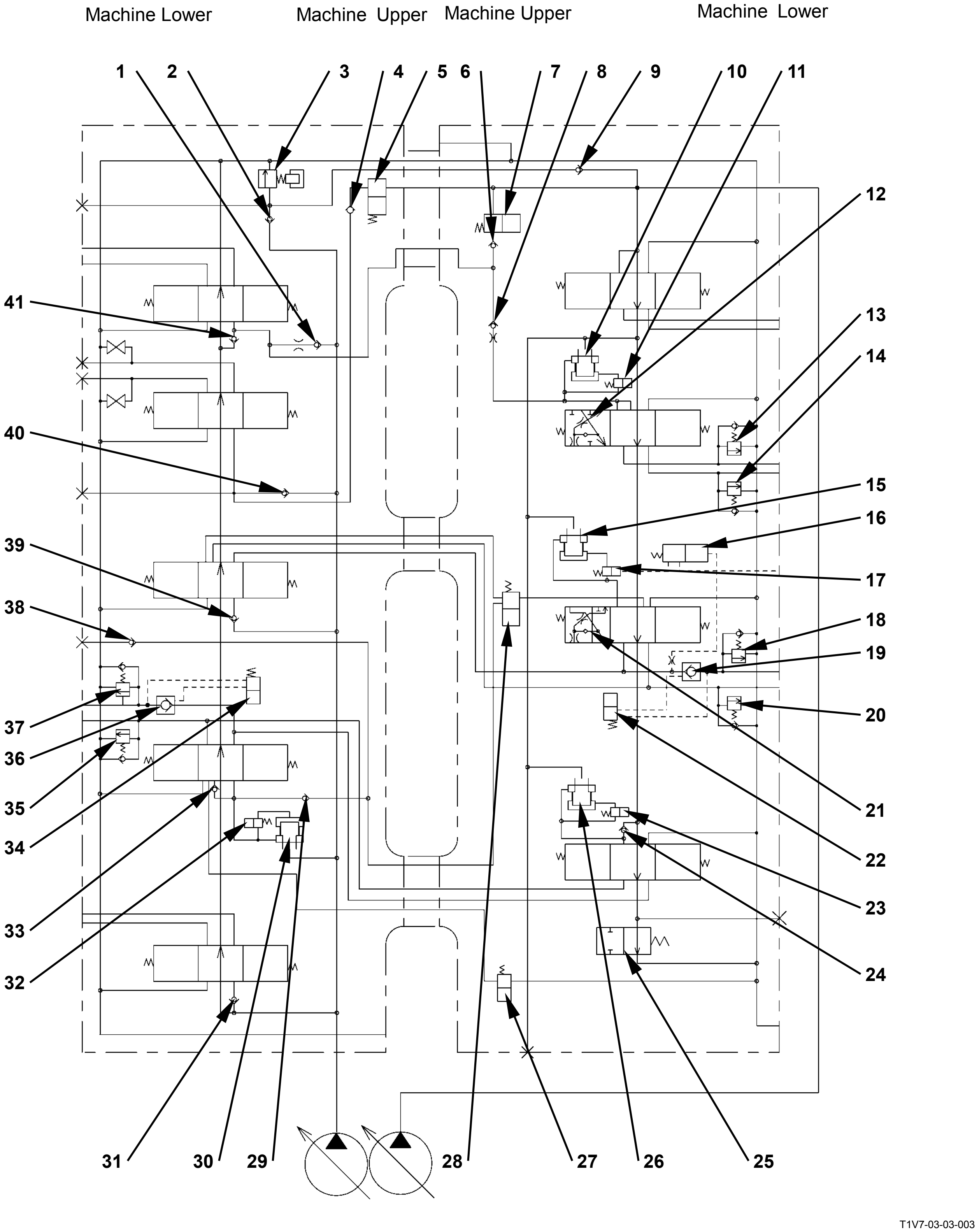
Cross Section F-F



Cross Section G-G



1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Flow Combiner Valve Circuit)
5 - Auxiliary Flow Combiner Valve
6 - Check Valve (Flow Combiner Valve Circuit)
7 - Flow Combiner Valve
8 - Load Check Valve (Orifice) (Bucket)
9 - Check Valve (Main Relief Circuit)
10 - Bucket Flow Rate Control Valve (Poppet Valve)
11 - Bucket Flow Rate Control Valve (Switch Valve)
12 - Bucket Regenerative Valve
13 - Overload Relief Valve (Bucket: Rod Side)
14 - Overload Relief Valve (Bucket: Bottom Side)
15 - Boom Flow Control Valve (Poppet Valve)
16 - Boom Lower Meter-In Cut Valve
17 - Boom Flow Rate Control Valve (Switch Valve)
18 - Overload Relief Valve (Boom: Bottom Side)
19 - Boom Anti-Drift Valve (Check Valve)
20 - Overload Relief Valve (Boom: Rod Side)
21 - Boom Regenerative Valve
22 - Boom Anti-Drift Valve (Switch Valve)
23 - Arm 2 Flow Rate Control Valve (Switch Valve)
24 - Load Check Valve (Arm 2 Tandem Circuit)
25 - Bypass Shut-Out Valve
26 - Arm 2 Flow Rate Control Valve (Poppet Valve)
27 - Arm Regenerative Valve
28 - Digging Regenerative Valve
29 - Load Check Valve (Digging Regenerative Circuit)
30 - Arm 1 Flow Rate Control Valve (Poppet Valve)
31 - Load Check Valve (Swing Circuit)
32 - Arm 1 Flow Rate Control Valve (Switch Valve)
33 - Load Check Valve (Arm Regenerative Circuit)
34 - Arm Anti-Drift Valve (Switch Valve)
35 - Overload Relief Valve (Arm: Bottom Side)
36 - Arm Anti-Drift Valve (Check Valve)
37 - Overload Relief Valve (Arm: Rod Side)
38 - Check Valve (Digging Regenerative Circuit)
39 - Load Check Valve (Boom 2 Parallel Circuit)
40 - Load Check valve (Auxiliary Parallel / Flow Combining Circuit)
41 - Load Check Valve (Left Travel Tandem Circuit)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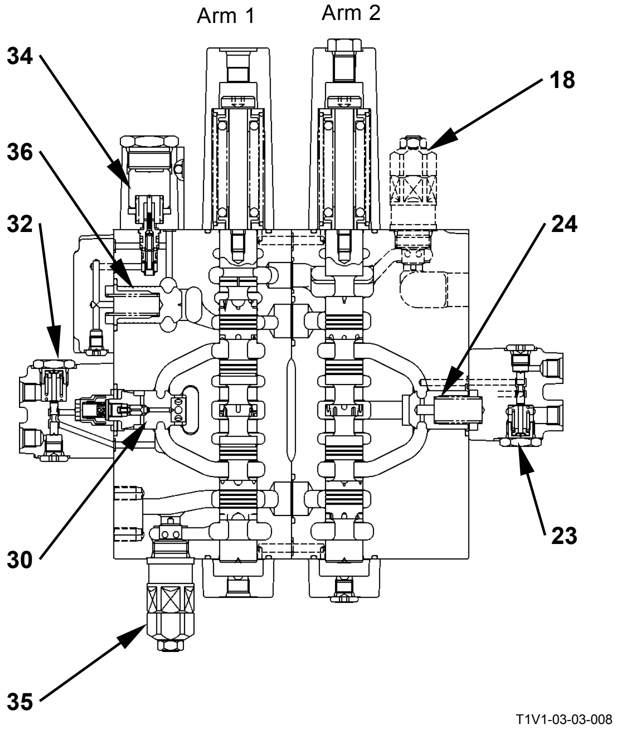
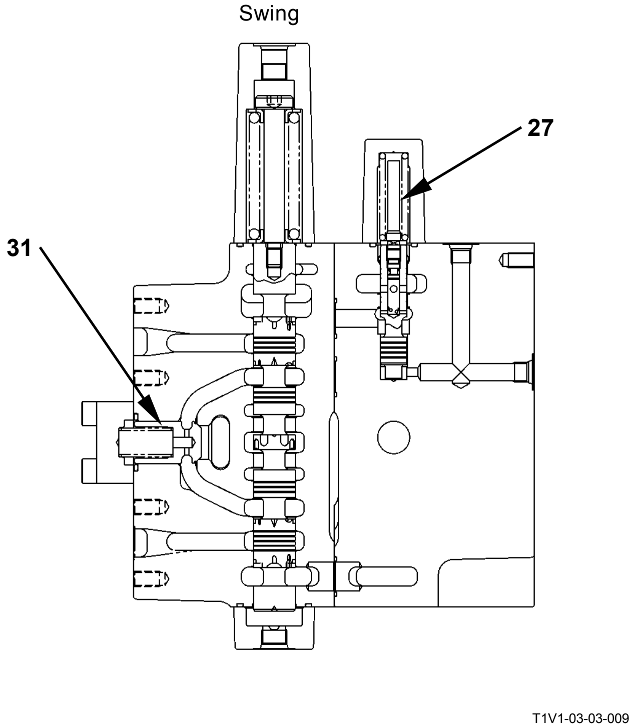
T1V7-03-03-003

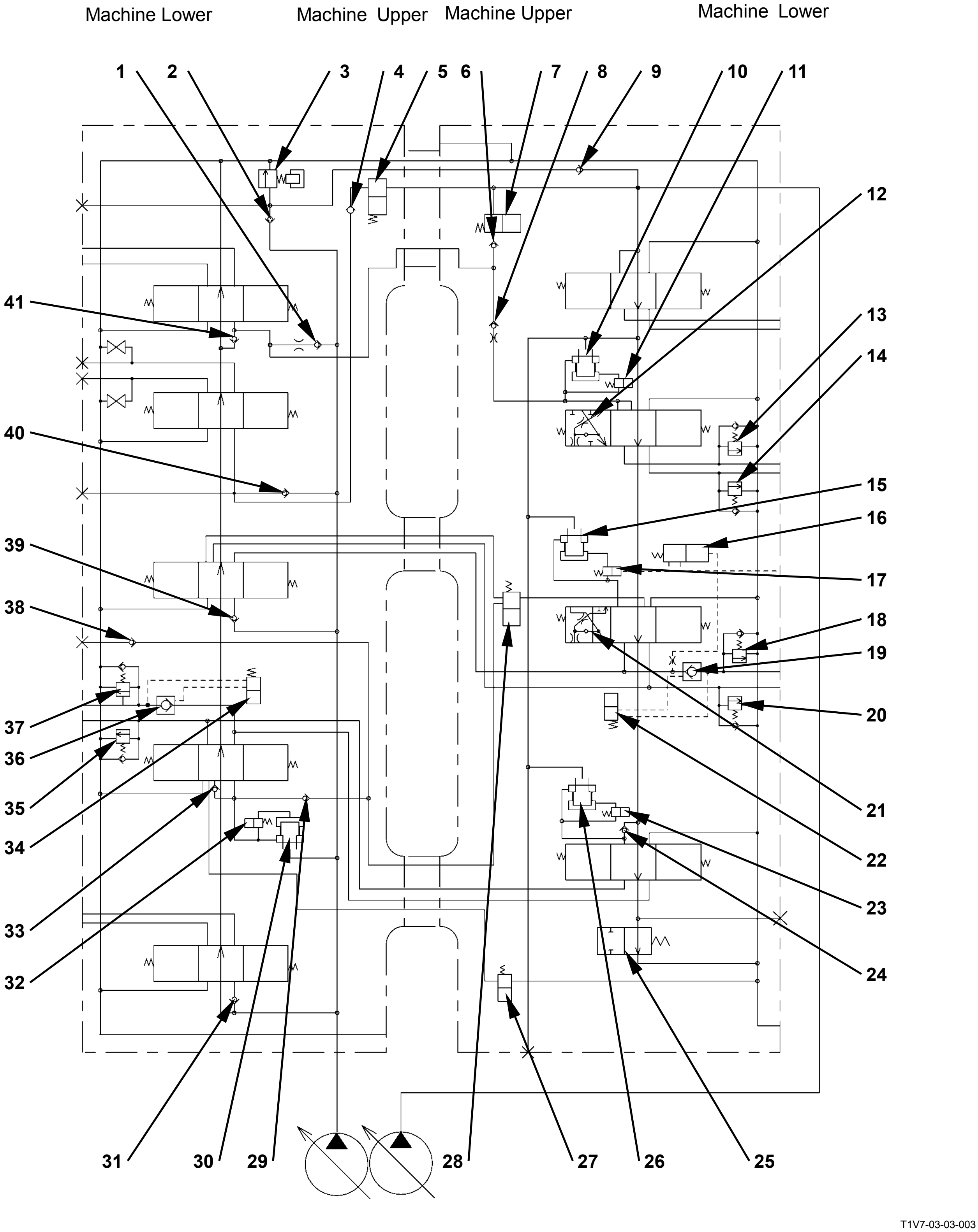
Cross Section H-H



Cross Section I-I



1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Flow Combiner Valve Circuit)
5 - Auxiliary Flow Combiner Valve
6 - Check Valve (Flow Combiner Valve Circuit)
7 - Flow Combiner Valve
8 - Load Check Valve (Orifice) (Bucket)
9 - Check Valve (Main Relief Circuit)
10 - Bucket Flow Rate Control Valve (Poppet Valve)
11 - Bucket Flow Rate Control Valve (Switch Valve)
12 - Bucket Regenerative Valve
13 - Overload Relief Valve (Bucket: Rod Side)
14 - Overload Relief Valve (Bucket: Bottom Side)
15 - Boom Flow Control Valve (Poppet Valve)
16 - Boom Lower Meter-In Cut Valve
17 - Boom Flow Rate Control Valve (Switch Valve)
18 - Overload Relief Valve (Boom: Bottom Side)
19 - Boom Anti-Drift Valve (Check Valve)
20 - Overload Relief Valve (Boom: Rod Side)
21 - Boom Regenerative Valve
22 - Boom Anti-Drift Valve (Switch Valve)
23 - Arm 2 Flow Rate Control Valve (Switch Valve)
24 - Load Check Valve (Arm 2 Tandem Circuit)
25 - Bypass Shut-Out Valve
26 - Arm 2 Flow Rate Control Valve (Poppet Valve)
27 - Arm Regenerative Valve
28 - Digging Regenerative Valve
29 - Load Check Valve (Digging Regenerative Circuit)
30 - Arm 1 Flow Rate Control Valve (Poppet Valve)
31 - Load Check Valve (Swing Circuit)
32 - Arm 1 Flow Rate Control Valve (Switch Valve)
33 - Load Check Valve (Arm Regenerative Circuit)
34 - Arm Anti-Drift Valve (Switch Valve)
35 - Overload Relief Valve (Arm: Bottom Side)
36 - Arm Anti-Drift Valve (Check Valve)
37 - Overload Relief Valve (Arm: Rod Side)
38 - Check Valve (Digging Regenerative Circuit)
39 - Load Check Valve (Boom 2 Parallel Circuit)
40 - Load Check valve (Auxiliary Parallel / Flow Combining Circuit)
41 - Load Check Valve (Left Travel Tandem Circuit)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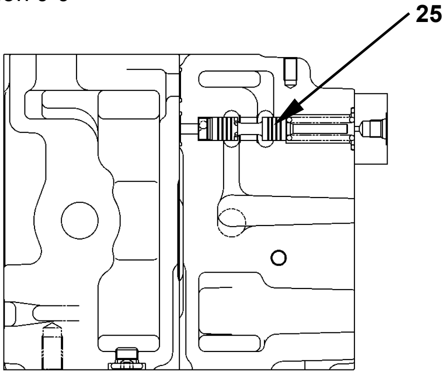
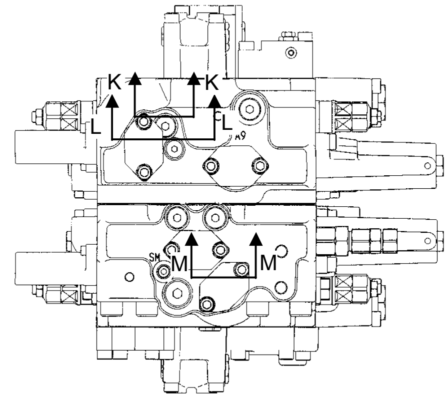
T1V7-03-03-003

Cross Section J-J

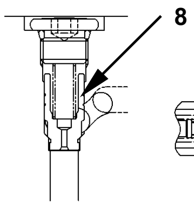


T1V1-03-03-010

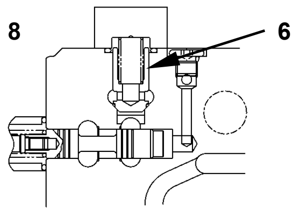


T1V1-03-03-027

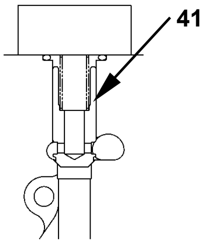
Cross Section K-K



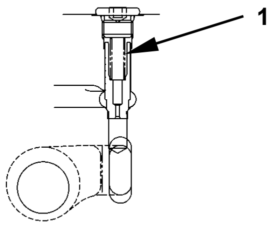
Cross Section L-L



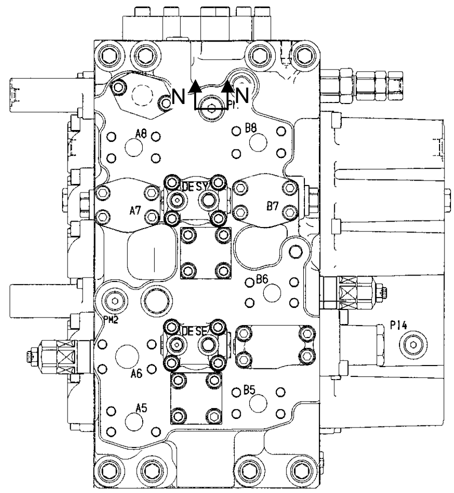
Cross Section M-M



Cross Section N-N



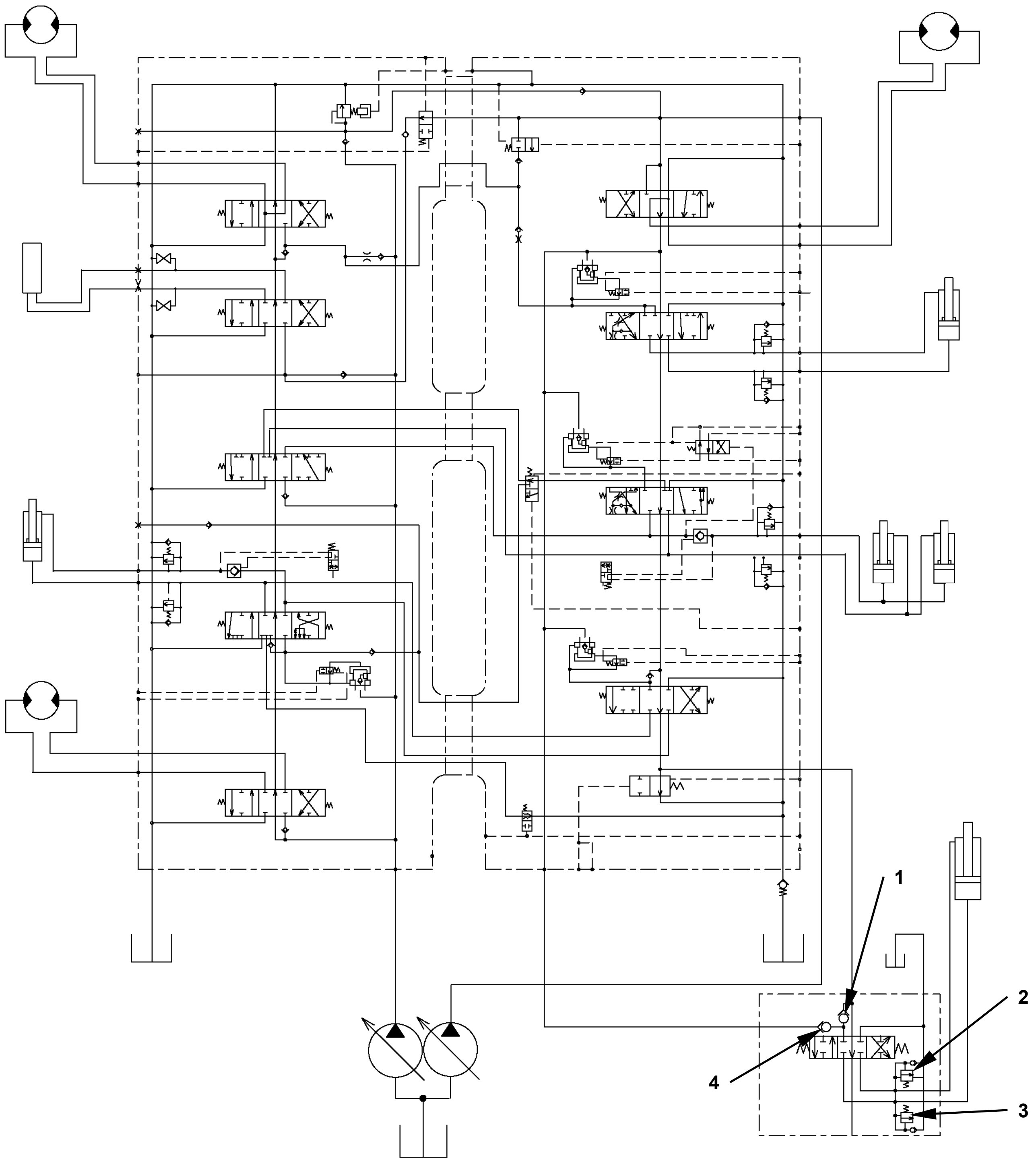
T1V1-03-03-022

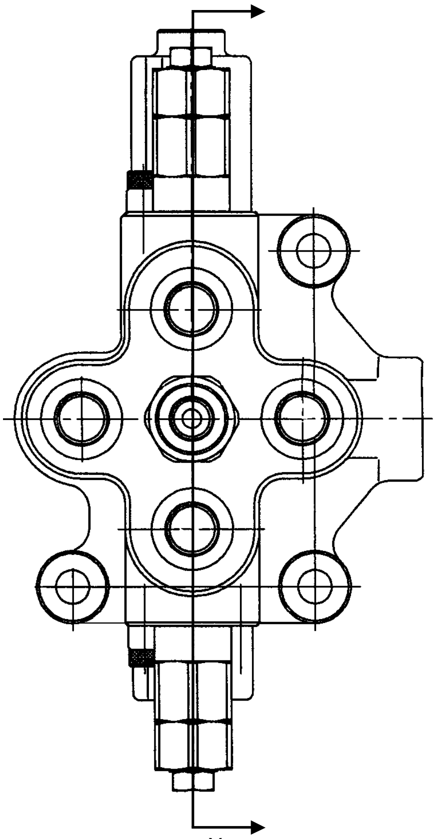


T1V1-03-03-028

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

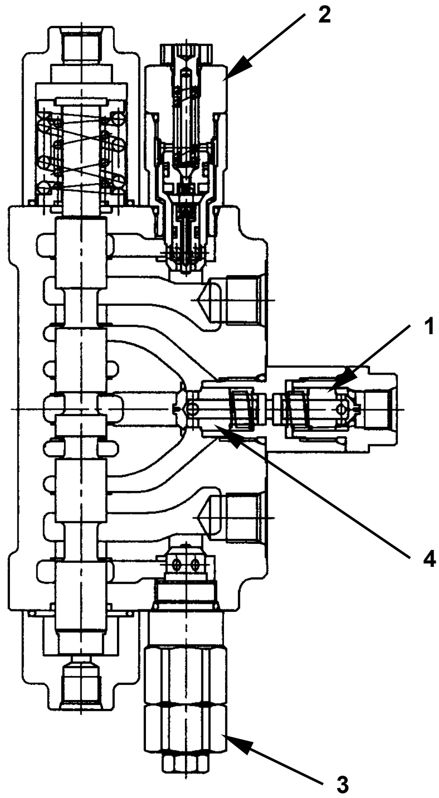
Layout of Positioning Control Valve (2-Piece Boom)





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)

HYDRAULIC CIRCUIT

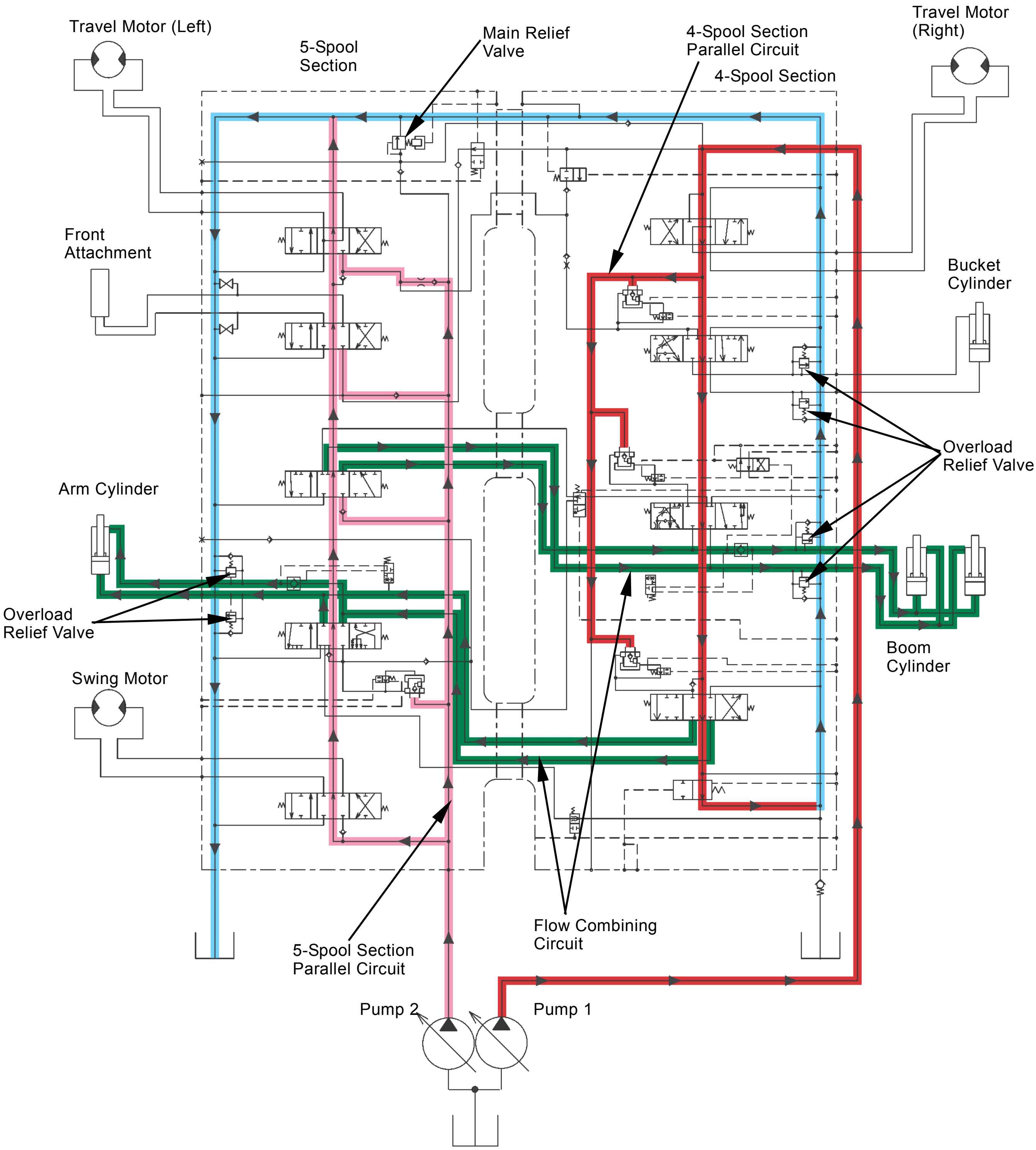
Main Circuit

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).

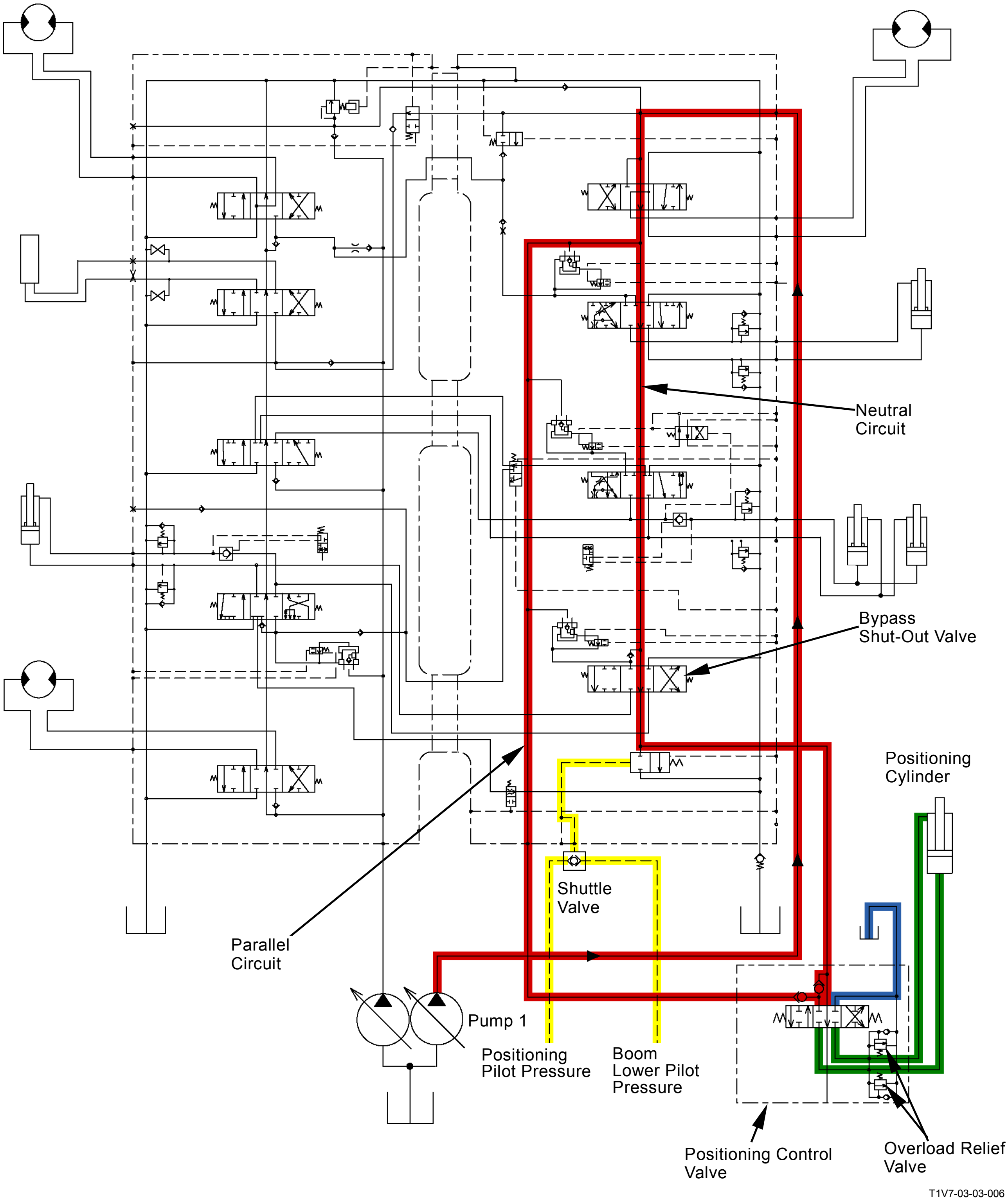
The overload relief valve is provided in the actuator circuits (between control valve and actuator) of boom, arm and bucket. The overload relief valve prevents surge pressure caused by external force in the actuator circuit does not exceed the set pressure when the spool is in neutral (with the control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



T1V7-03-03-005

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).



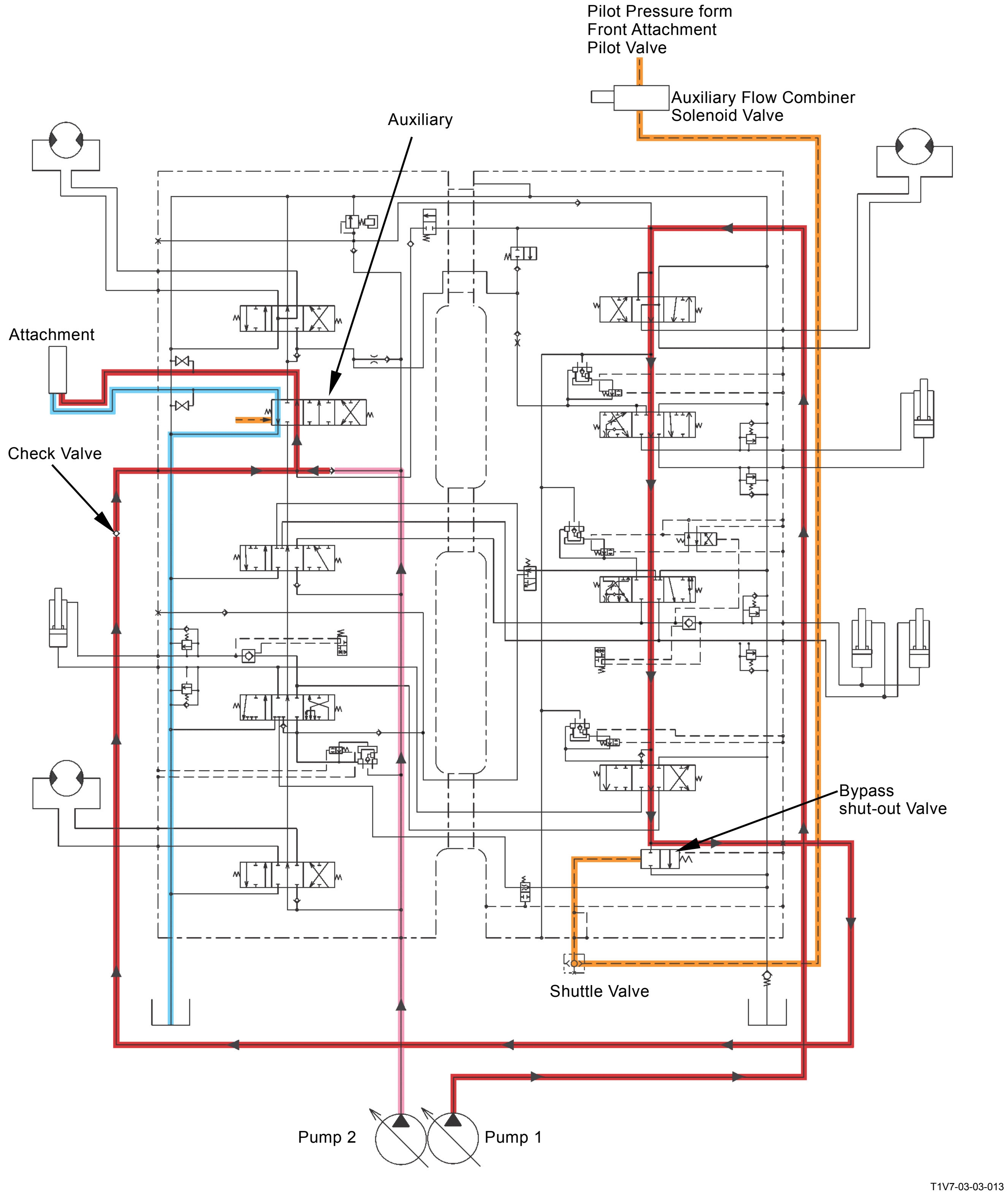
Neutral
Circuit
Bypass
Shut-Out Valve
Positioning
Cylinder
Shuttle
Valve
Parallel
Circuit
Pump 1
Positioning
Pilot Pressure
Boom
Lower Pilot
Pressure
Positioning Control
Valve
Overload Relief
Valve
T1V7-03-03-006

Auxiliary Flow Combining Circuit (Only the machines equipped with the optional auxiliary flow combining system)

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

- When operating front attachment, pressure oil from the pilot valve flows to the bypass shut-out valve through the auxiliary flow combiner solenoid valve and shuttle valve. Therefore, the bypass shut-out valve is switched.
- 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 auxiliary spool through the check valve.
- 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 Single Control Valve / COMPONENT OPERATION.)


Pilot Pressure form
Front Attachment
Pilot Valve
Auxiliary Flow Combiner
Solenoid Valve
Auxiliary
Attachment
Check Valve
Bypass
shut-out Valve
Shuttle Valve
Pump 2
Pump 1
T1V7-03-03-013

Pilot Control Circuit

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

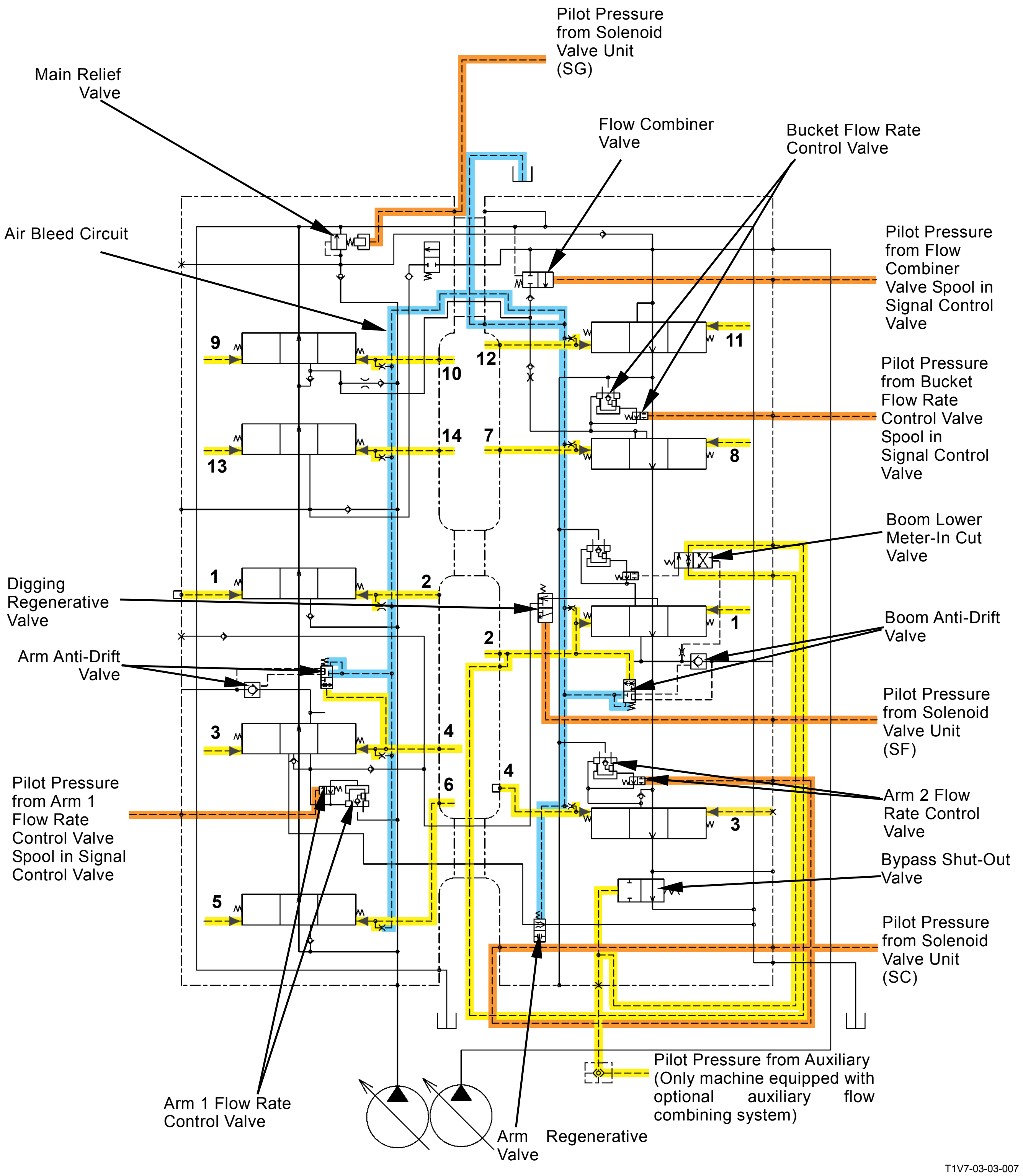
In the following operations, pressure oil moves the spool and acts to the switch valves as follows.

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

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

External Pilot Pressure Circuit

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



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

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.

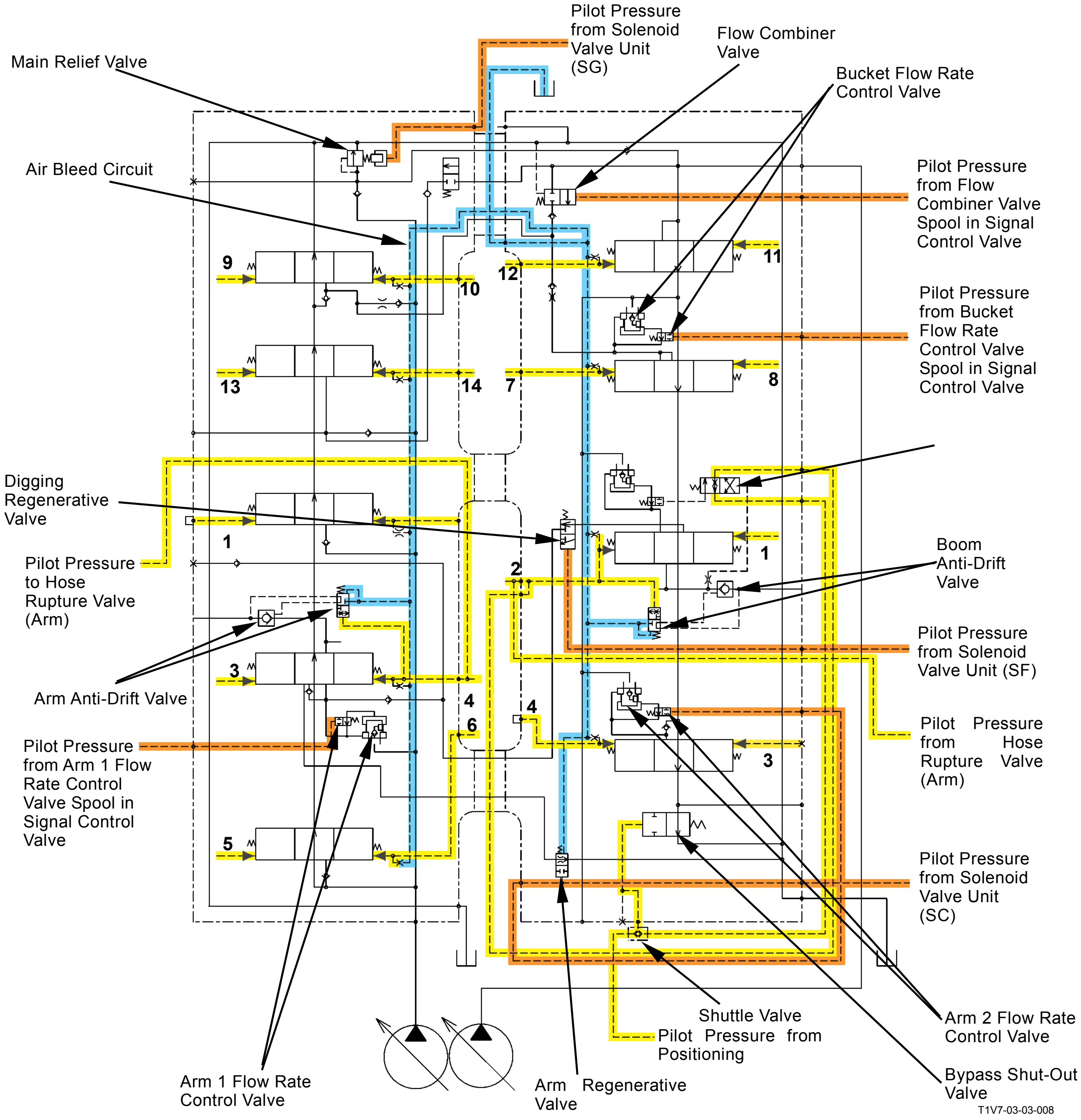
In the following operations, pressure oil moves the spool and acts to the switch valves as follows.

- 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 and 2 spools 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.
- During auxiliary open (13) or close (14) operation, pressure oil moves the auxiliary spool and shifts the bypass shut-put valve.
  (Only the machine equipped with the optional auxiliary flow combing 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.

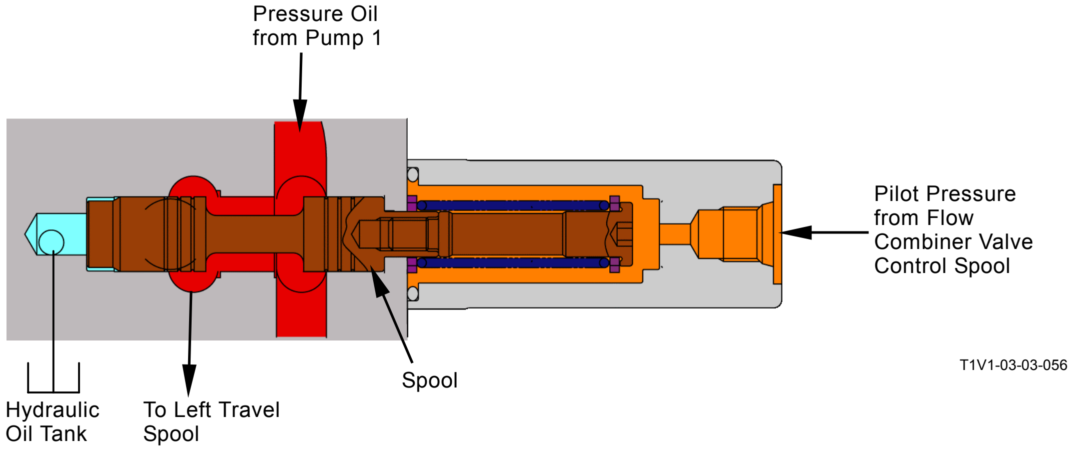


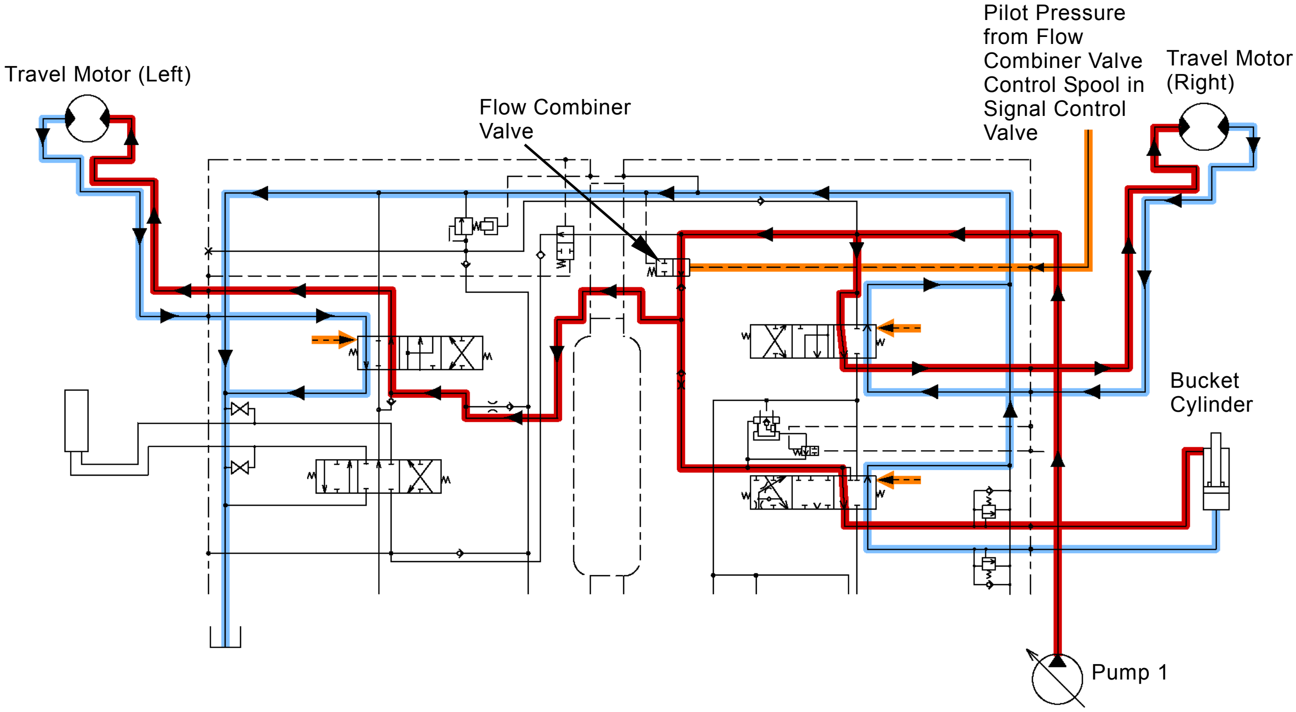
1 - Boom Raise
2 - Boom Lower
3 - Arm Roll-Out
4 - Arm Roll-In
5 - Left Swing
6 - Right Swing
7 - Bucket Roll-In
8 - Bucket Roll-Out
9 - Travel (Left Forward)
10 - Travel (Left Reverse)
11 - Travel (Right Forward)
12 - Travel (Right Reverse)
13 - Auxiliary (Open)
14 - Auxiliary (Close)

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

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.





T1V7-03-03-009

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.

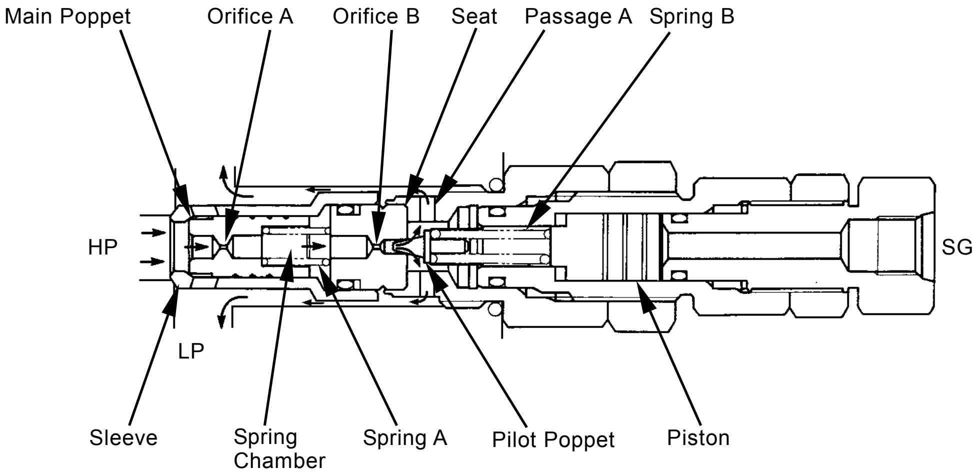
Relief Operation

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 in port HP flows to port LP.
5. As a result, pressure in the 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

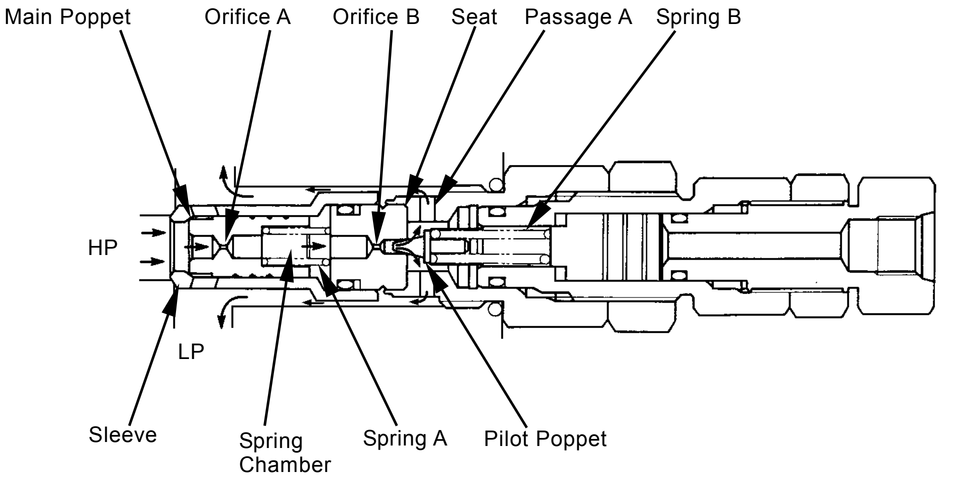
1. When pilot pressure from solenoid valve unit (SG) acts to port SG, spring B is compressed by the piston.
2. Therefore, the force of spring B becomes strong.
3. Consequently, as pressure required in order to open the pilot poppet is increased, the relief set pressure is increased.

During Normal Operation:



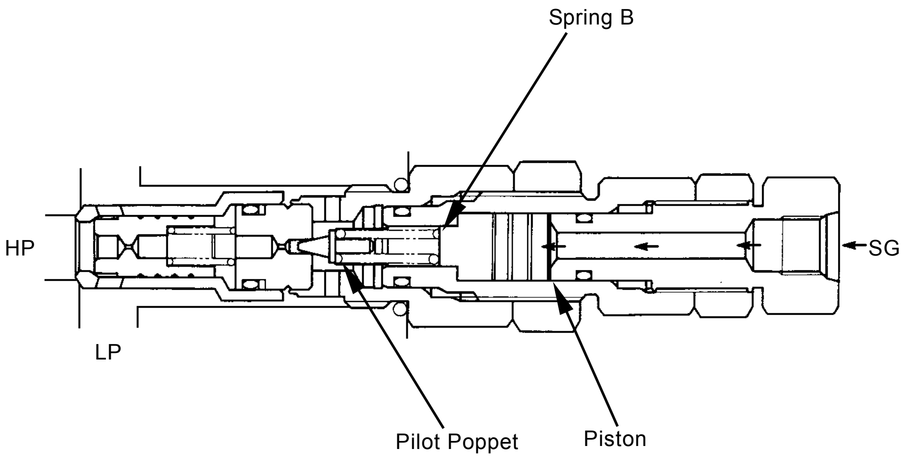
T157-02-05-003

During Relief Operation:



T157-02-05-003

During Set Pressure Increasing Operation:



T157-02-05-004

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.

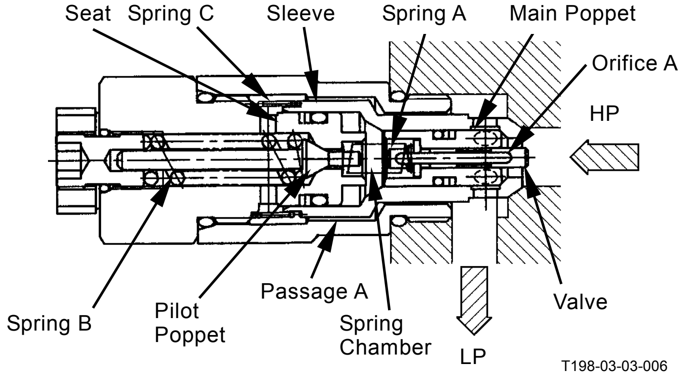
Relief Operation

1. Pressure in port HP (actuator circuit) acts on the pilot poppet through an orifice in the piston.
2. When pressure in port HP reaches the set-force of spring B, the pilot poppet opens and pressure oil flows to port LP (hydraulic oil tank) through passage A and external circumference of the sleeve.
3. At this time, a pressure difference is caused between port HP and spring chamber due to the orifice.
4. When this pressure difference reaches the set-force of spring A, the main poppet opens and 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.

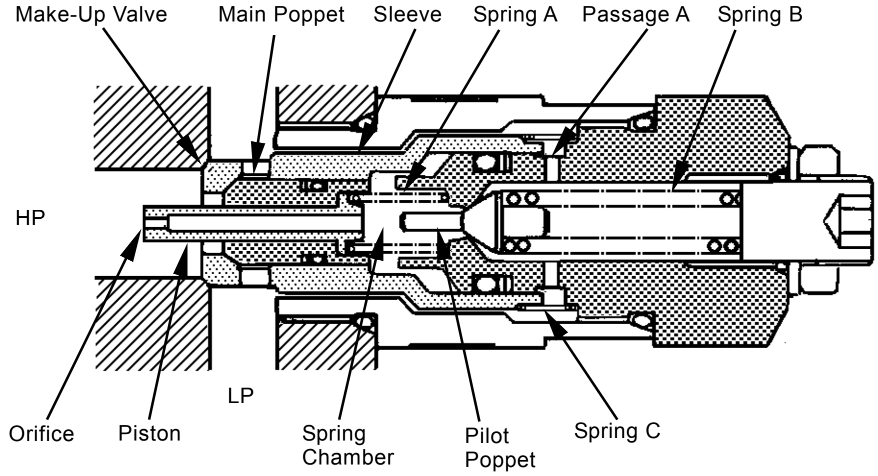
Make-Up Operation

1. When pressure in port HP (actuator circuit) decreases lower than that in 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

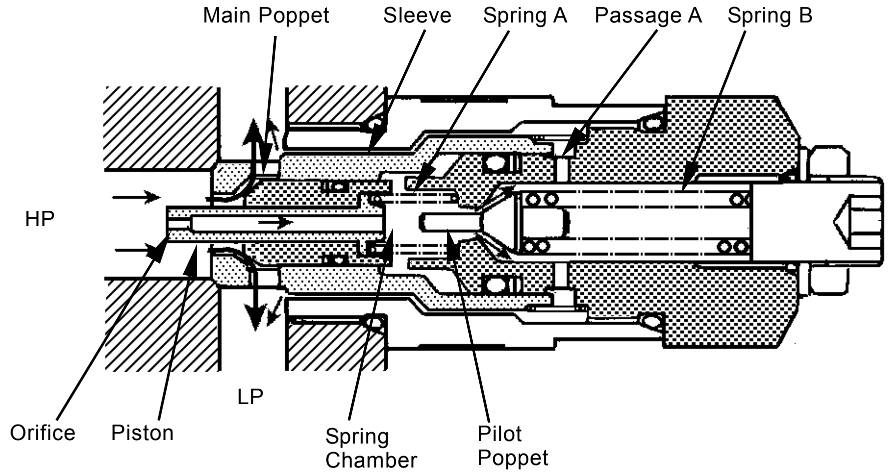


During Normal Operation:



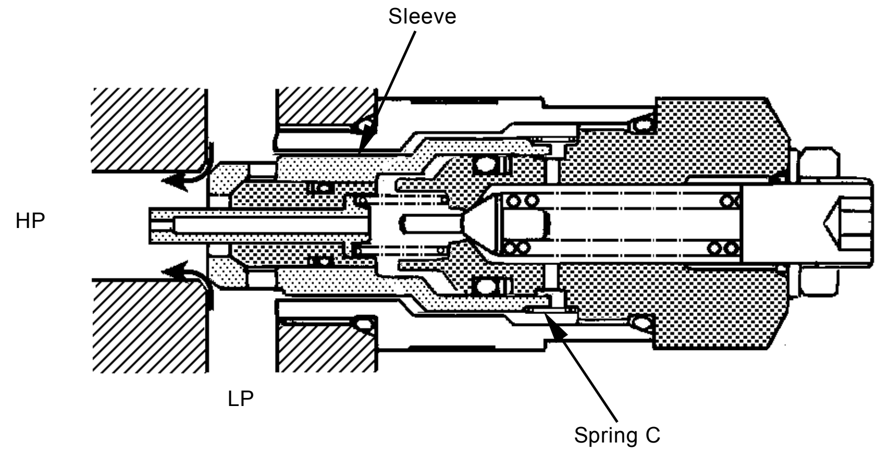
T107-02-05-019

During Relief Operation:



T178-03-03-049

During Make-Up Operation:



T178-03-03-050

REGENERATIVE VALVE

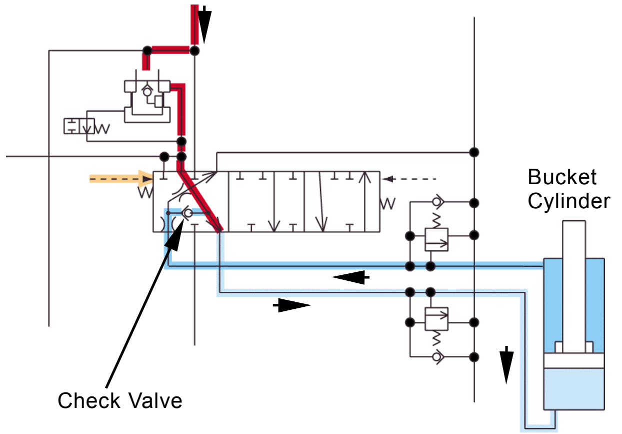
The regenerative valves are provided in the boom lower, arm roll-in and bucket roll-in circuits. The regenerative valve increases cylinder speeds in order to cylinder hesitation, and improve machine controllability.

Boom Regenerative Valve and Bucket Regenerative Valve

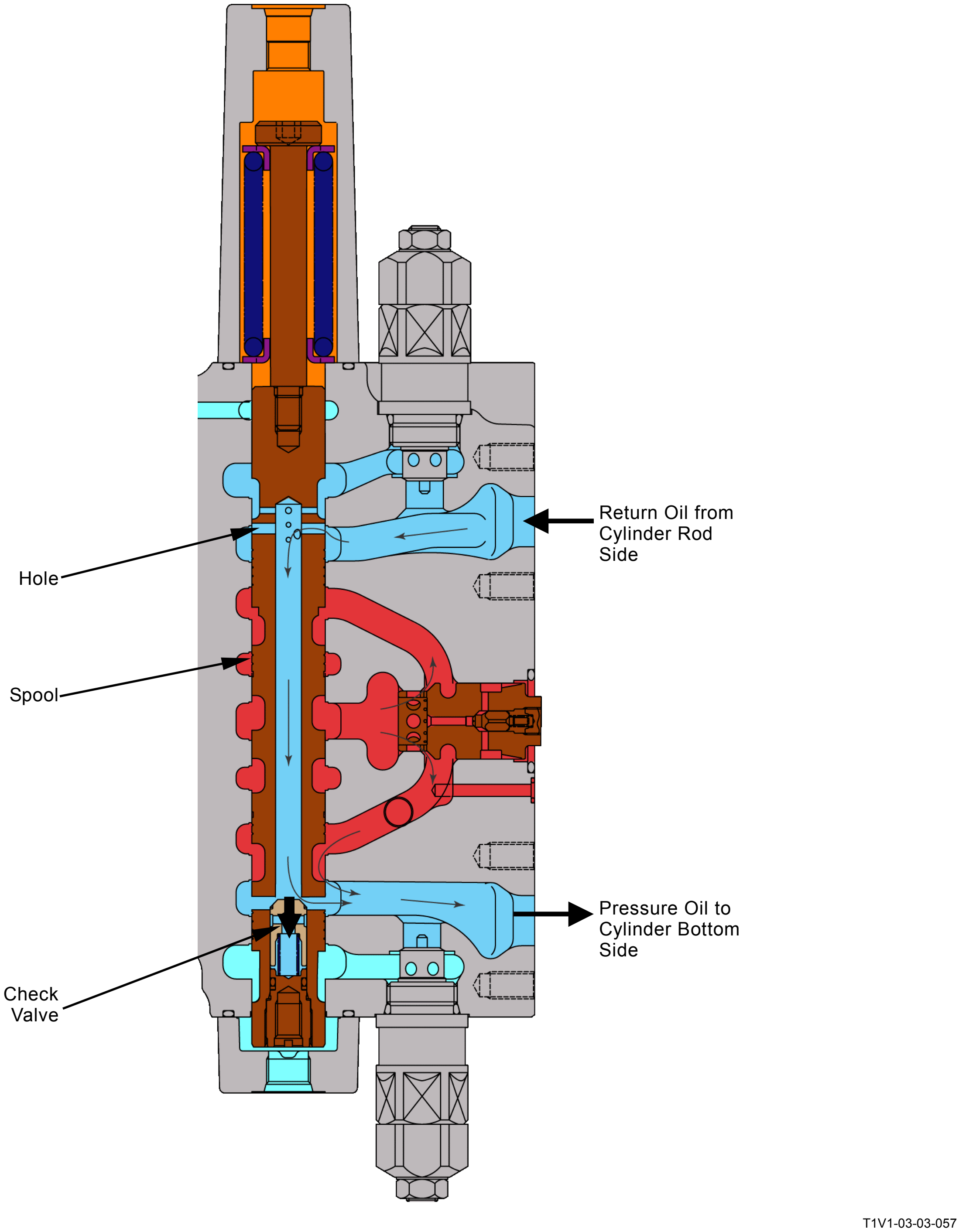
NOTE: *Operational principle of the boom regenerative valve is identical to that of the bucket regenerative valve. Therefore, the bucket generative valve is explained as an example.*

Operation

1. When the bucket is rolled in, 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 the regenerative operation stops.



T176-03-03-027


Return Oil from Cylinder Rod Side
Hole
Spool
Pressure Oil to Cylinder Bottom Side
Check Valve
T1V1-03-03-057

ARM REGENERATIVE VALVE

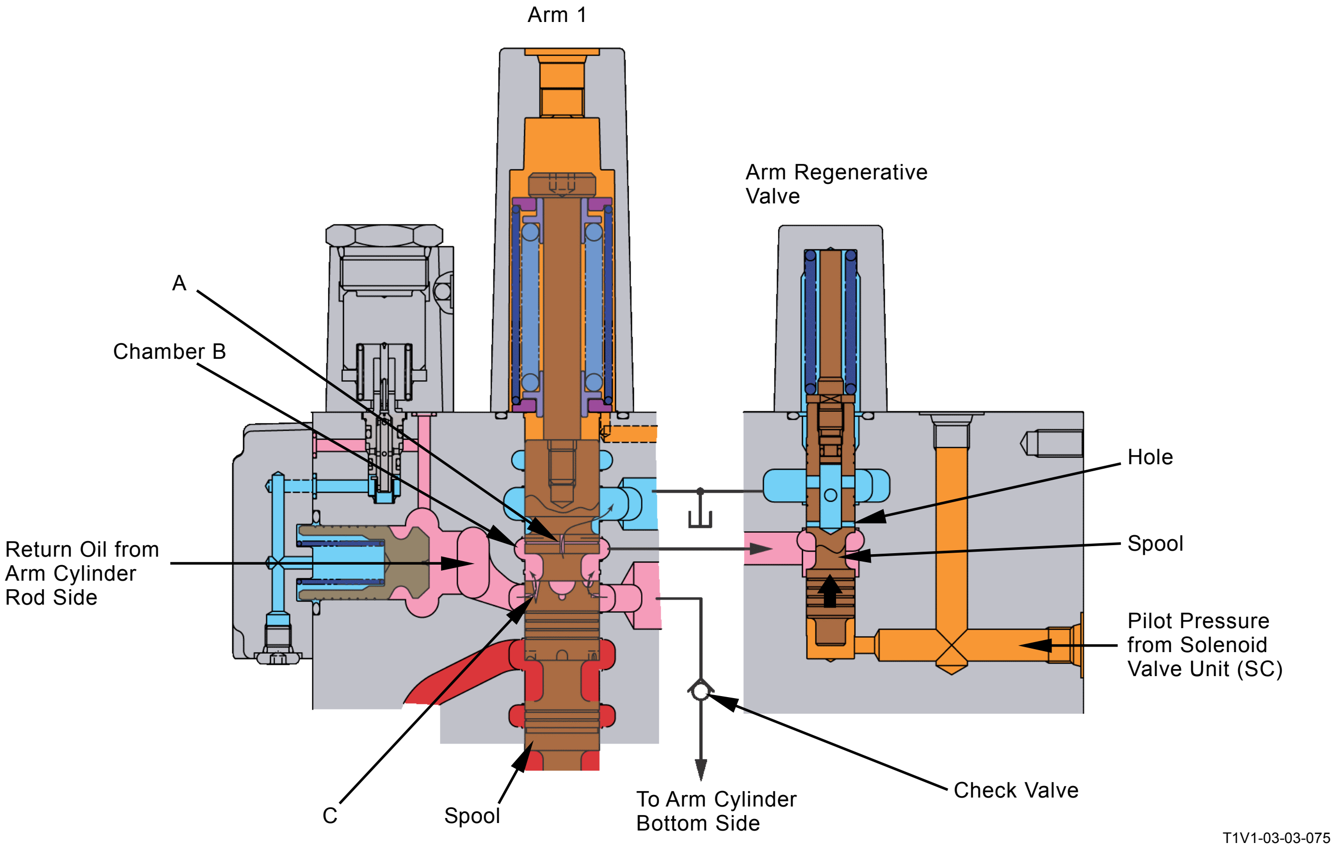
- During Normal Operation:

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

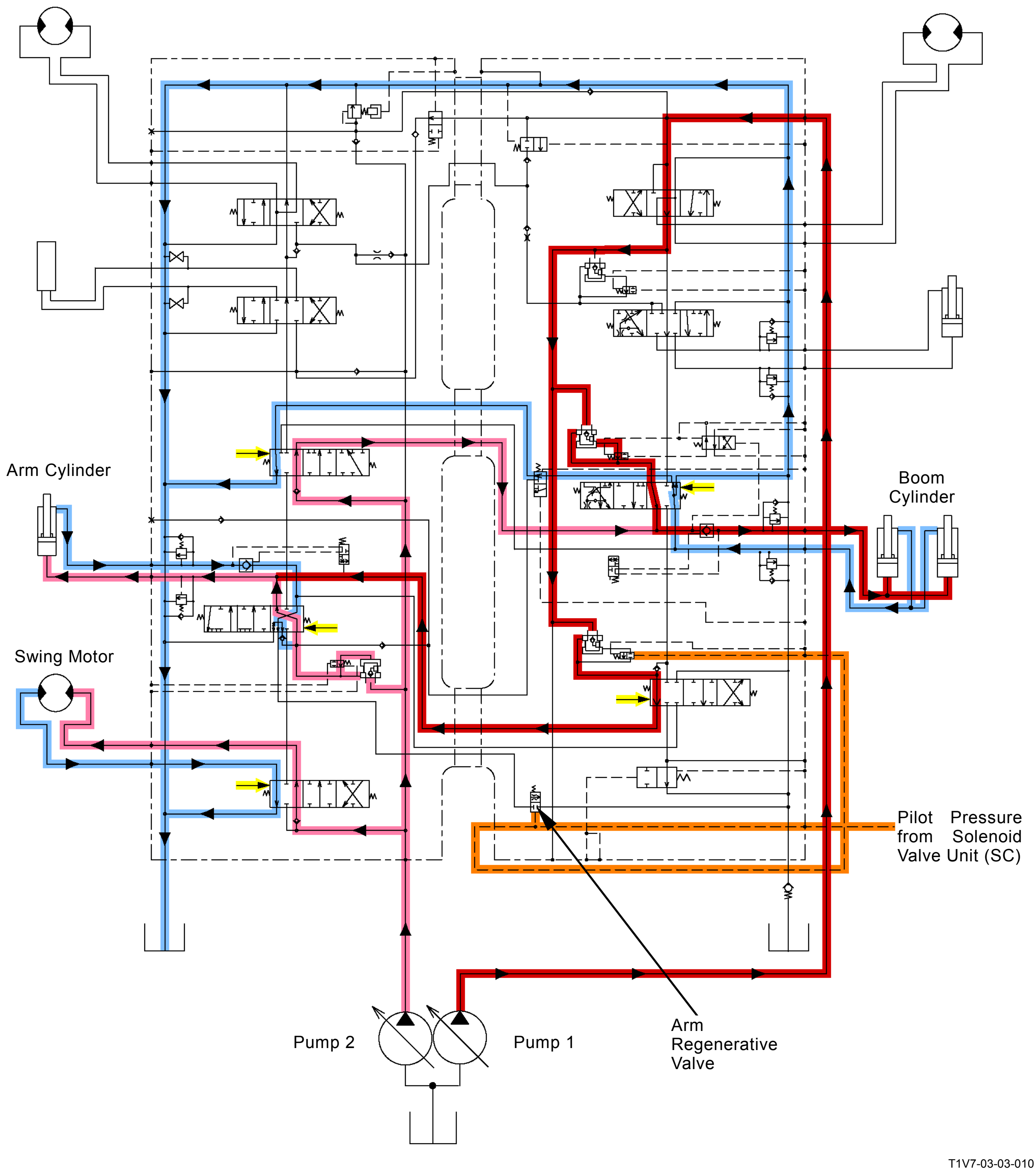
- During Regenerative Operation:

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

During Regenerative Operation:



During Regenerative Operation:



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.

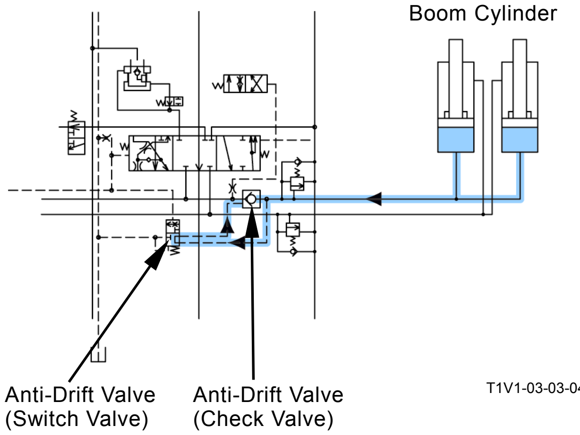
NOTE: Both boom and arm anti-drift valves are identical in construction.

Holding Operation

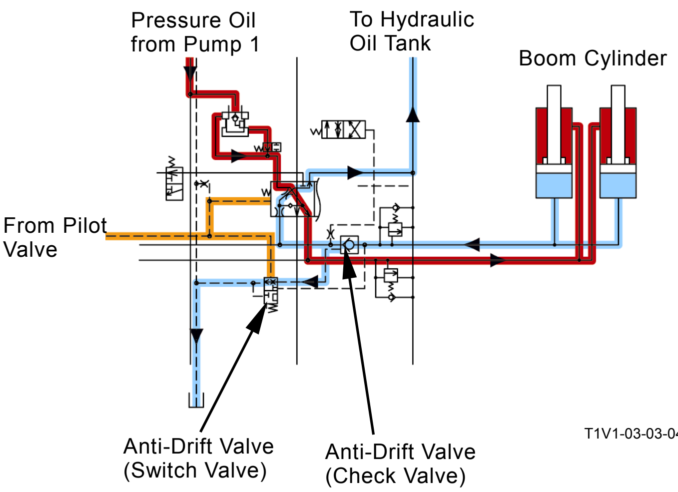
1. When the control lever is in neutral (neutral spool position), the switch valve in anti-drift valve is not shifted.
2. Pressure in the boom cylinder bottom side (arm cylinder rod side) passes through the switch valve and acts to the check valve (spring side) in anti-drift valve.
3. Consequently, as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

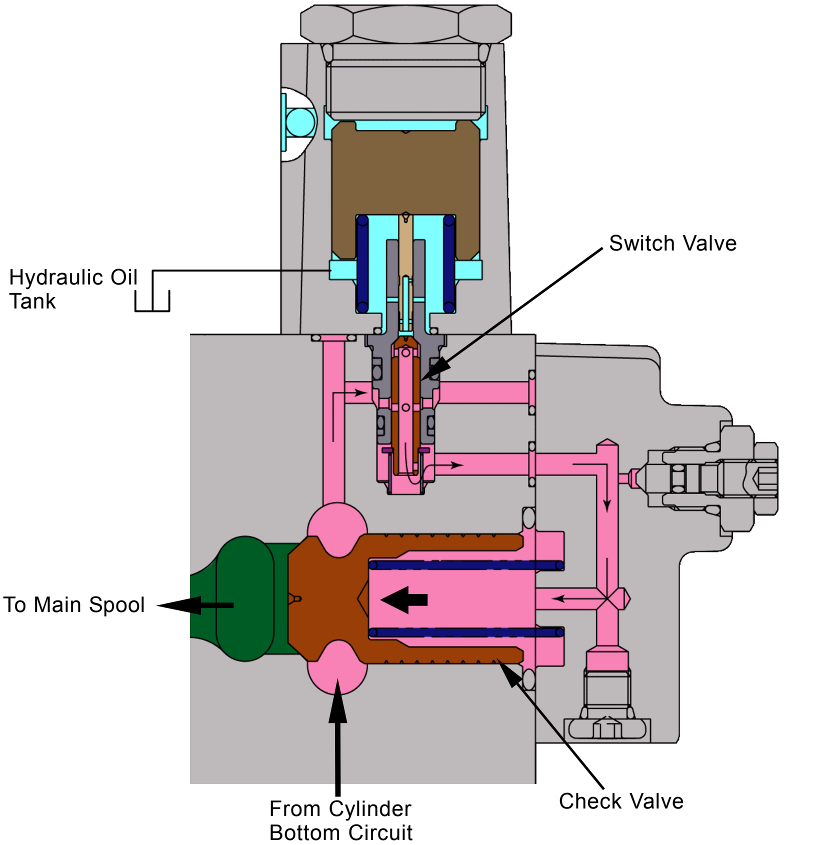


T1V1-03-03-047



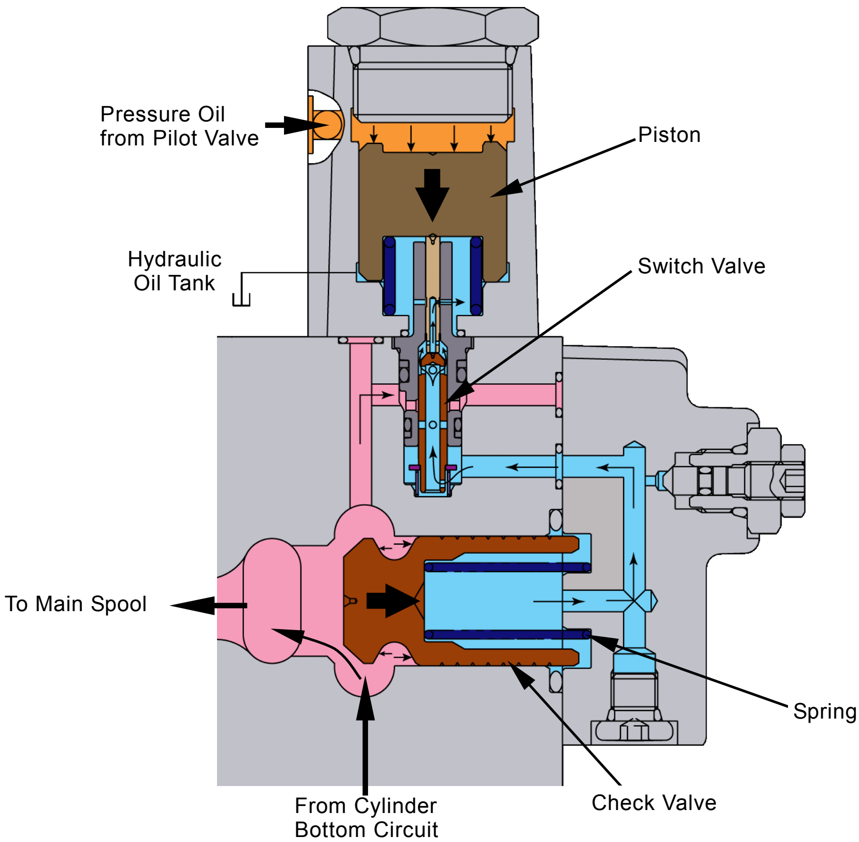
T1V1-03-03-048

Holding Operation:



T1V1-03-03-060

Releasing Operation:



T1V1-03-03-061

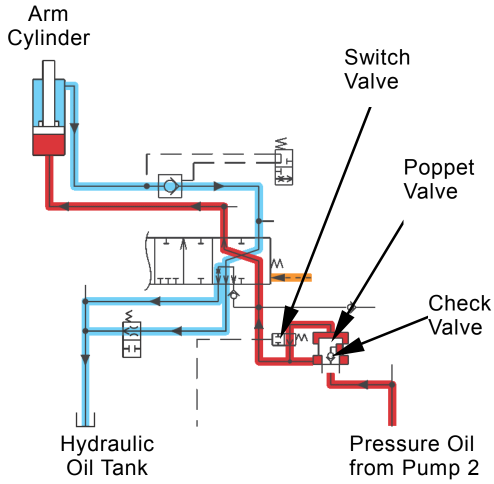
FLOW RATE CONTROL VALVE

The flow rate control valve is provided in boom, arm and bucket 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 Rate 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 Roll-In

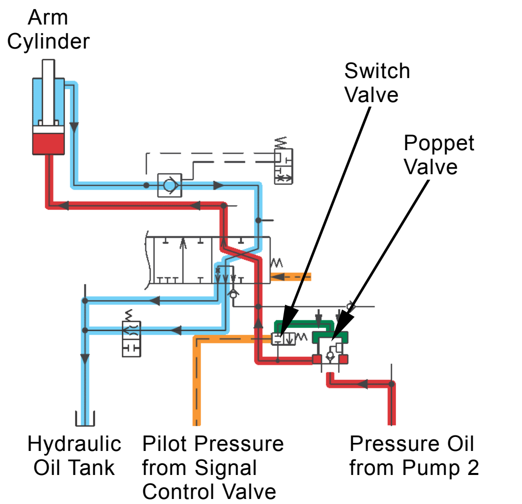
NOTE: The arm 1 flow rate control valve is explained here.



T1V1-03-03-049

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.

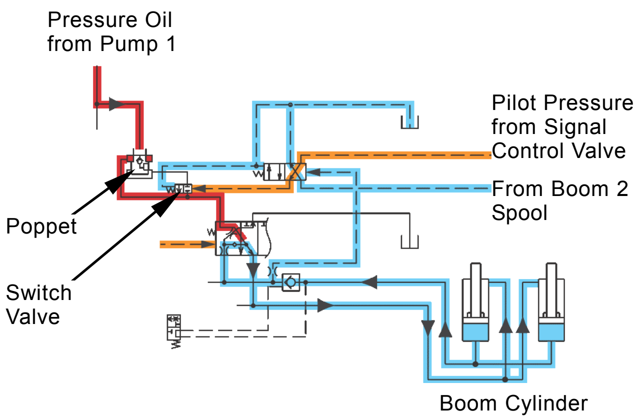


T1V1-03-03-050

Flow Rate Control Operation

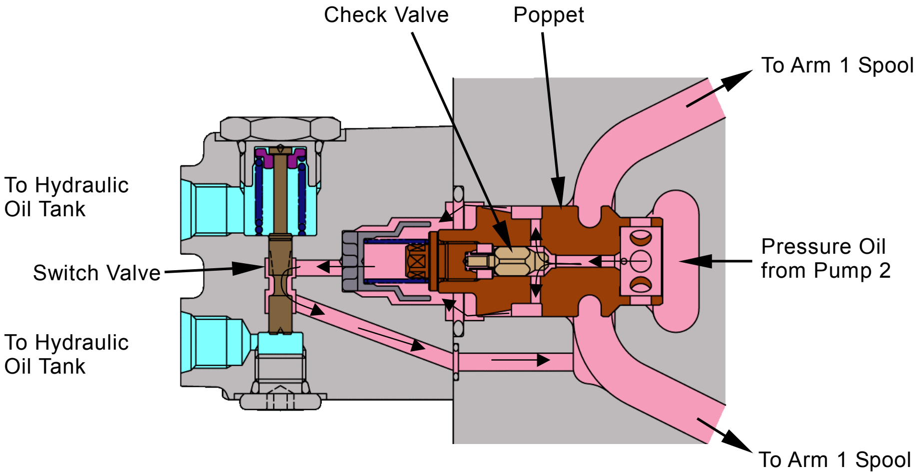
1. The switch valve in arm 1 flow rate control valve is shifted by pilot pressure from the arm 1 flow rate control valve spool in signal control valve.
2. Therefore, back pressure in the poppet valve increases and the force to close the poppet valve appears.
3. Consequently, the poppet valve restricts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

Boom Flow Rate Control Valve



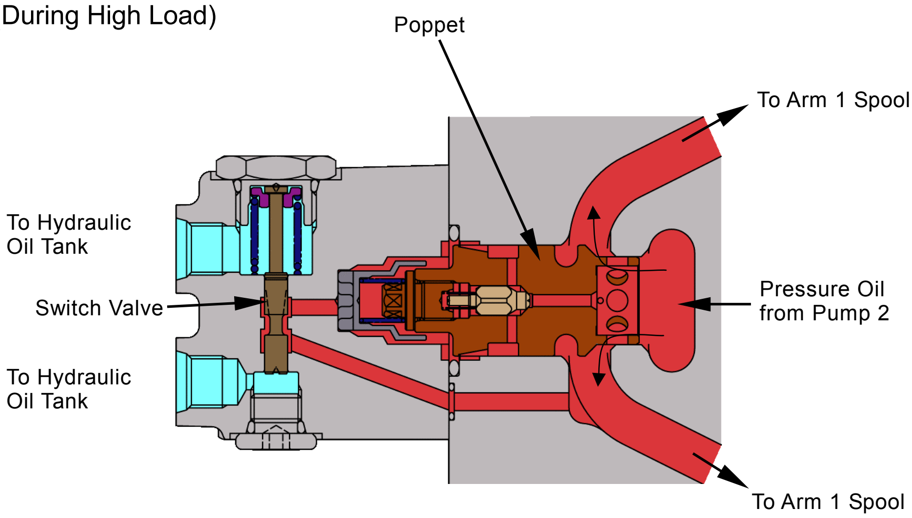
T1V1-03-03-076

Normal Operation (During Low Load)



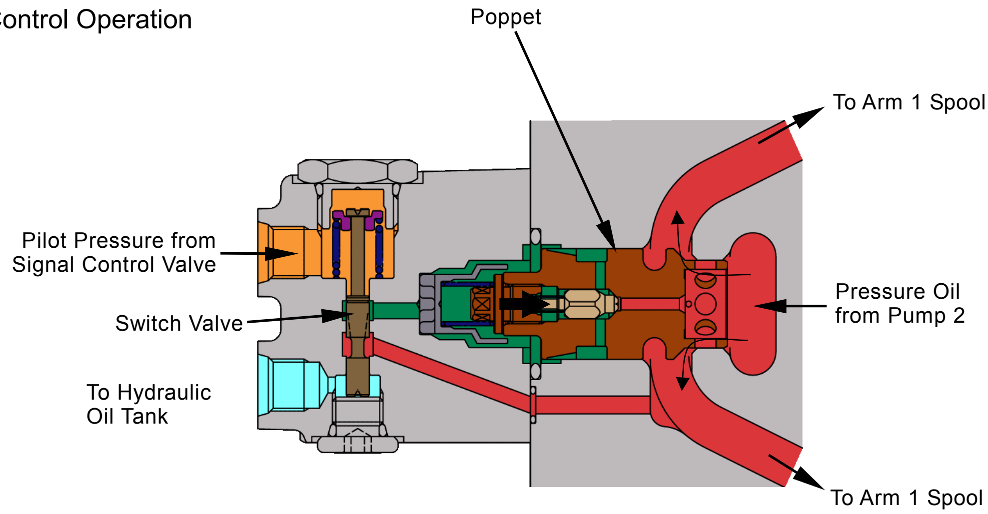
T1V1-03-03-062

Normal Operation (During High Load)



T1V1-03-03-063

Flow Rate Control Operation



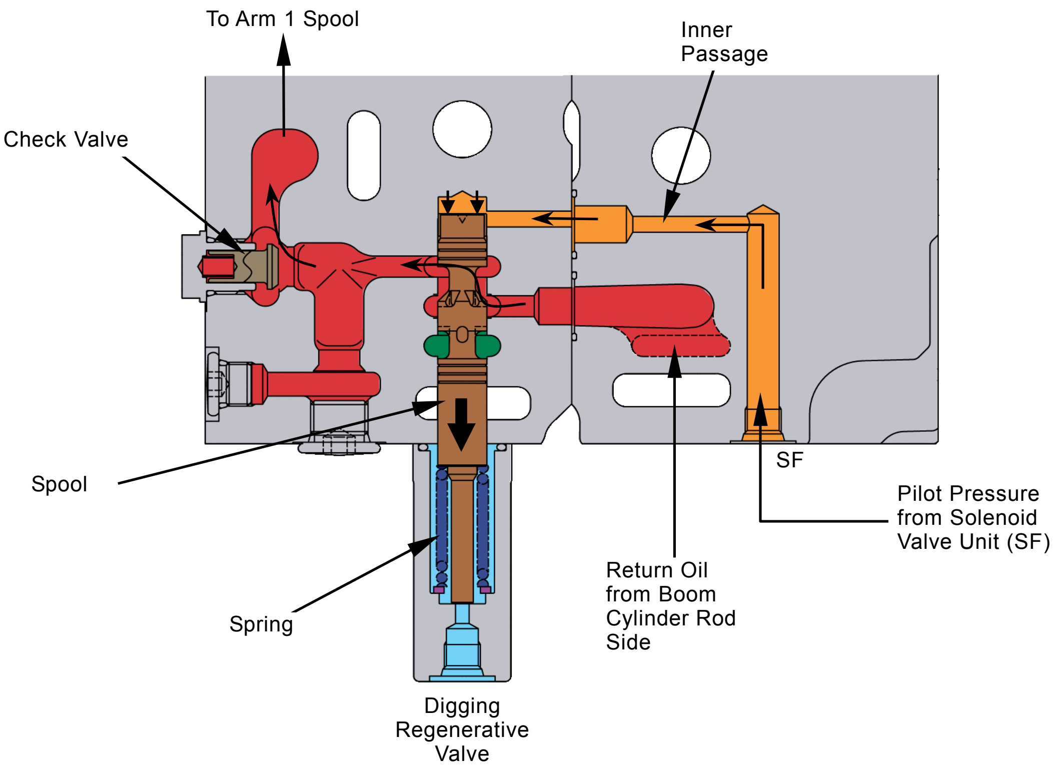
T1V1-03-03-064

DIGGING REGENERATIVE VALVE

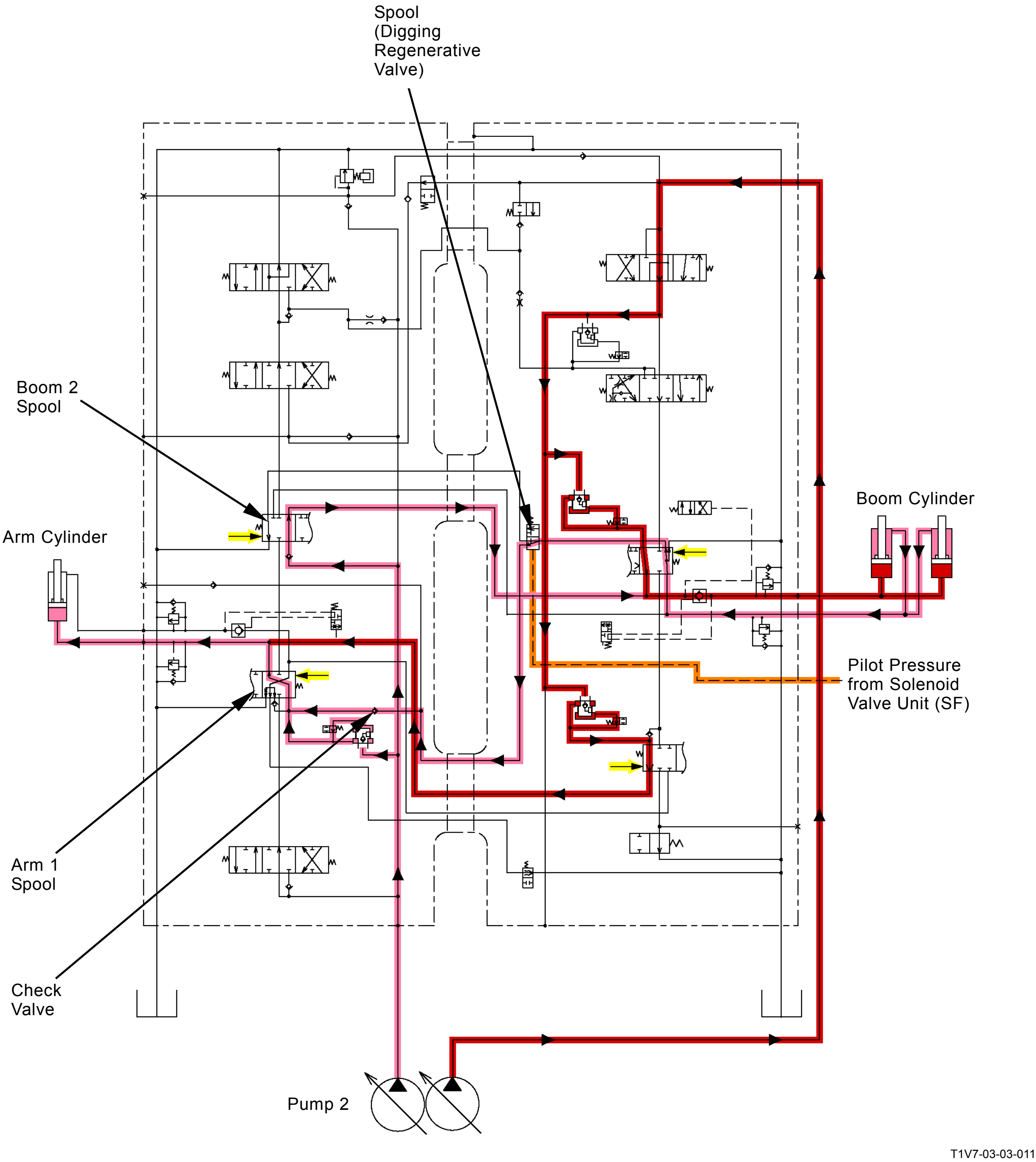
The digging regenerative valve is provided in the return circuit of boom raise and functions during combined operation of boom raise and arm roll-in.
When the digging regenerative valve is shifted, pressure oil from the boom cylinder rod side (return side) through the digging regenerative valve is combined 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


Spool
(Digging
Regenerative
Valve)
Boom 2
Spool
Arm Cylinder
Boom Cylinder
Pilot Pressure
from Solenoid
Valve Unit (SF)
Arm 1
Spool
Check
Valve
Pump 2
T1V7-03-03-011

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 rate 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.
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.)

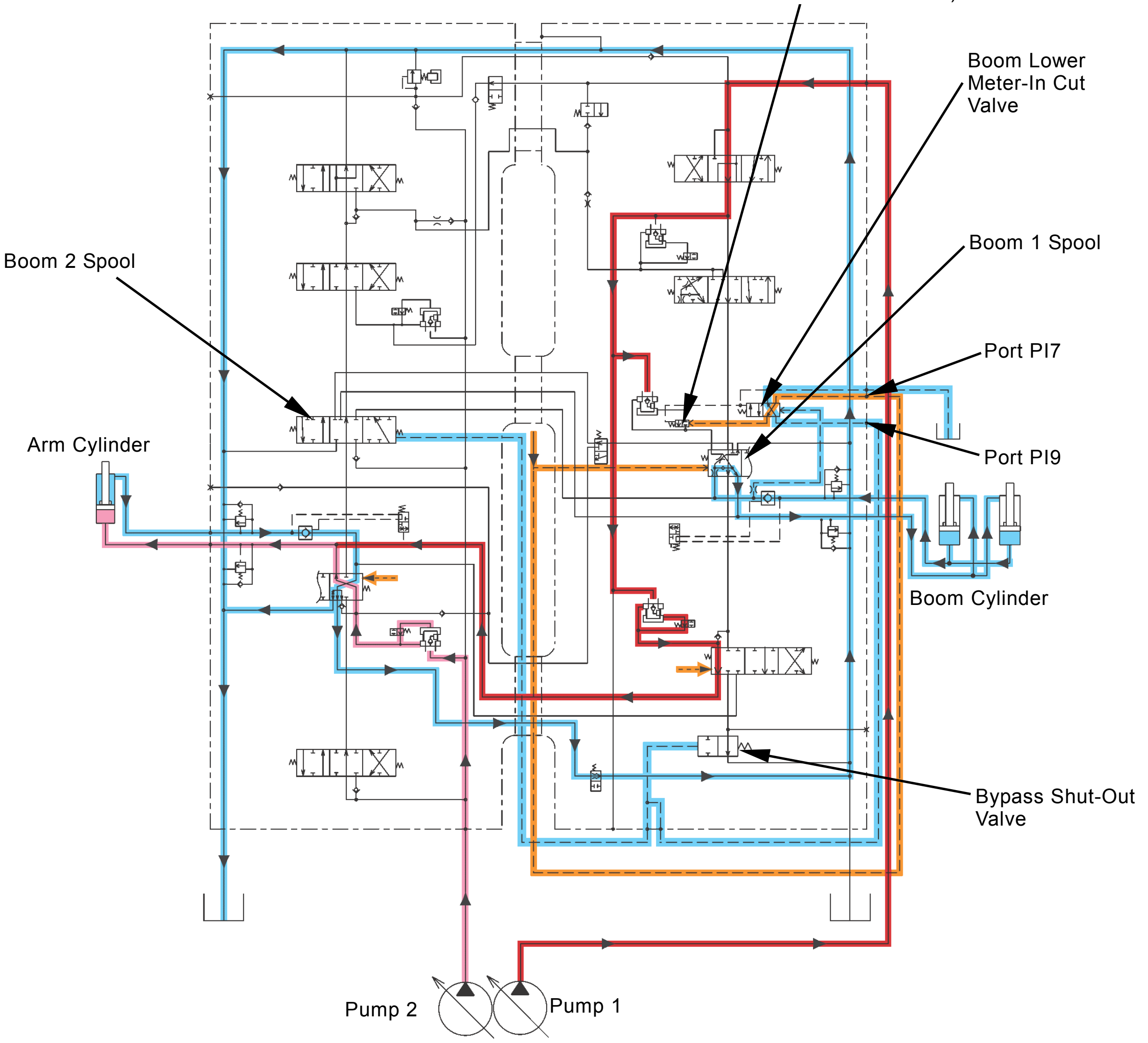
Operation (Boom Lower with Front Attachment above Ground)

1. During boom lower operation, pressure oil from the pilot pump flows to the bypass shut-put valve from port PI9 through port PI7 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 and moves to the left.
4. Therefore, as port PI9 is connected to the hydraulic oil tank through the boom lower meter-in cut valve, the bypass shut-out valve is returned to the neutral position.
5. Pressure oil from port PI7 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 restricted. (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.

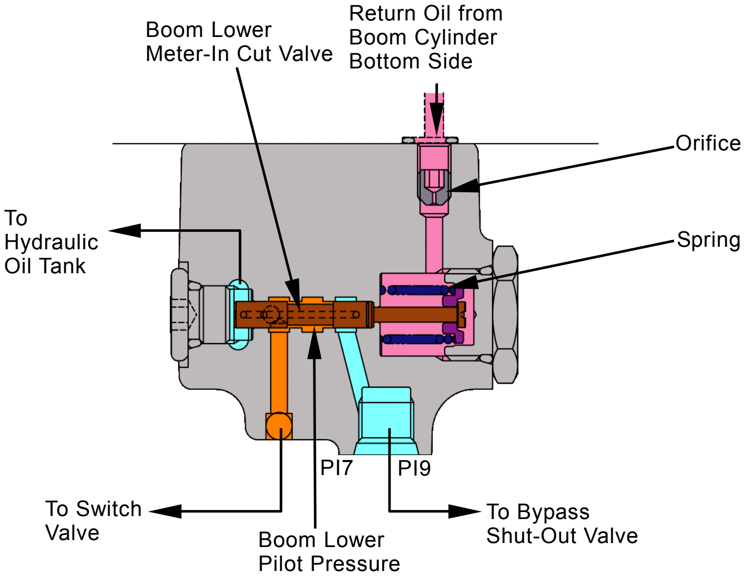
Operation (Jack-Up)

1. During jack-up operation, as pressure in 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 PI7 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 PI7 flows to the bypass shut-out valve from port PI9 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.)

Boom Lower with Front Attachment above Ground



T1V1-03-03-051



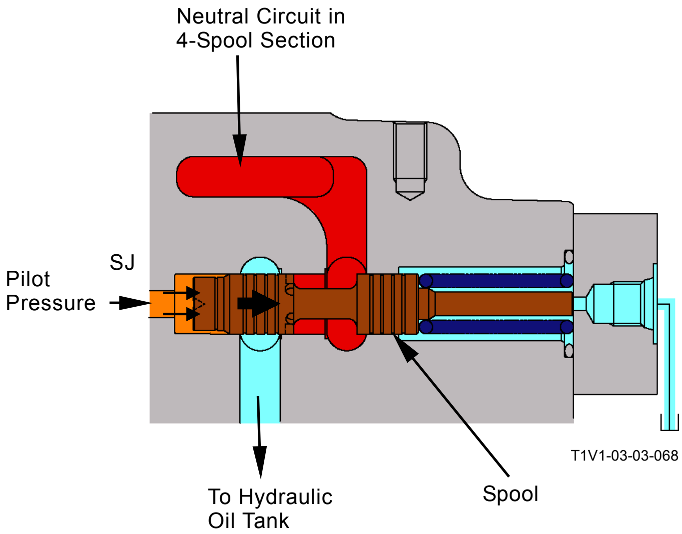
T1V1-03-03-074

BYPASS SHUT-OUT VALVE

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

Operation

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



OUTLINE

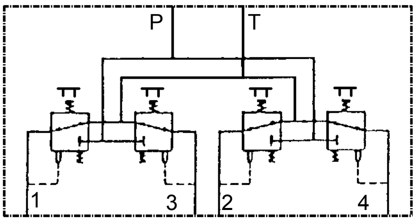
The pilot valve controls pilot pressure oil in order to move the spool in control valve. The pilot valve outputs pressure according to the control lever stroke by PPC (Pressure Proportional Control Valve) function and moves the spool in control valve.
The 4-port pilot valves for front attachment/swing 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.

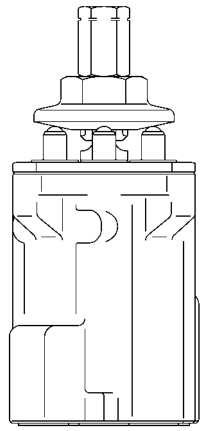
● Front Attachment / Swing Pilot Valve

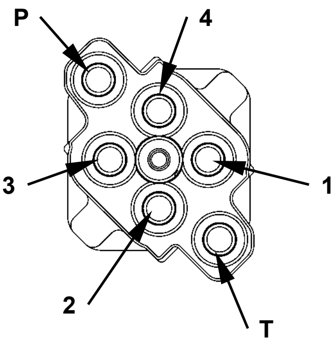
	Port No.	ISO Control Pattern	Hitachi Pattern
Right	1	Bucket Roll-Out	←
	2	Boom Lower	←
	3	Bucket Roll-In	←
	4	Boom Raise	←
Left	1	Right Swing	Arm Roll-In
	2	Arm Roll-Out	Right Swing
	3	Left Swing	Arm Roll-Out
	4	Arm Roll-In	Left Swing

Hydraulic Symbol



T105-02-07-020

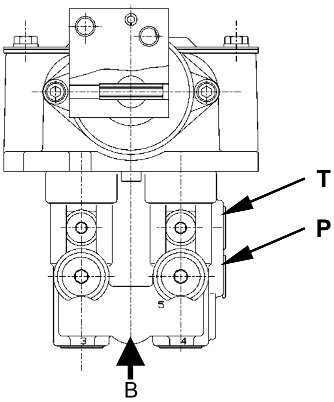




T1V1-03-04-001

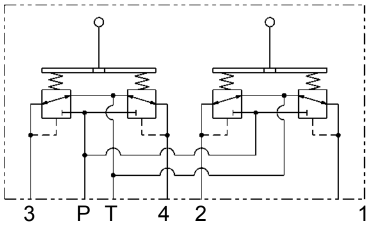
- Travel Pilot Valve

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



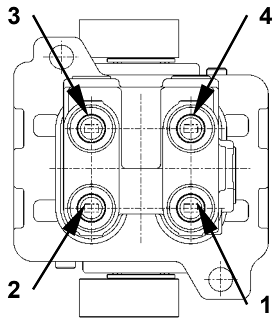
T1M9-03-05-004

Hydraulic Symbol



T178-03-04-017

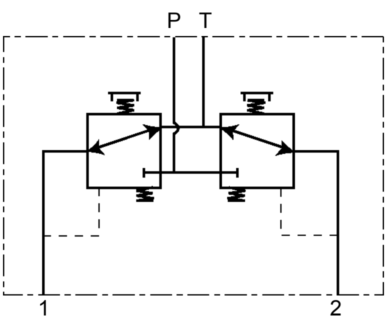
View B



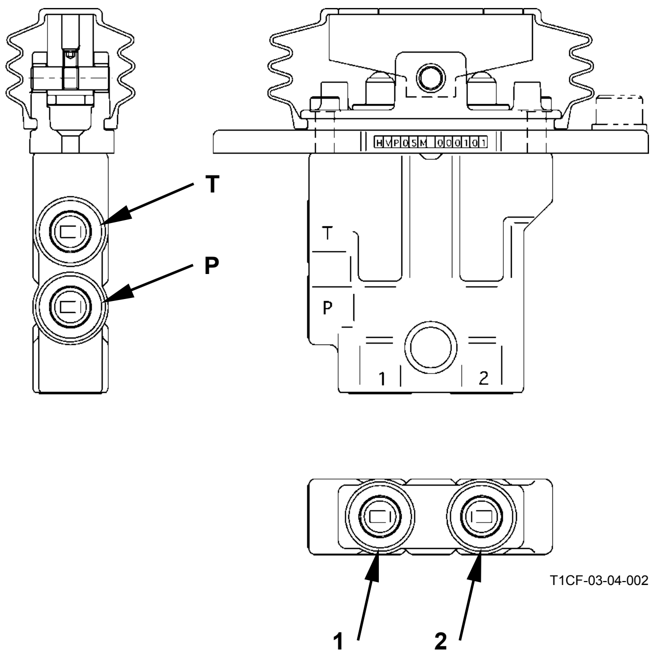
T1M9-03-05-005

- Auxiliary / Positioning Pilot Valve

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



T1CF-03-04-001



T1CF-03-04-002

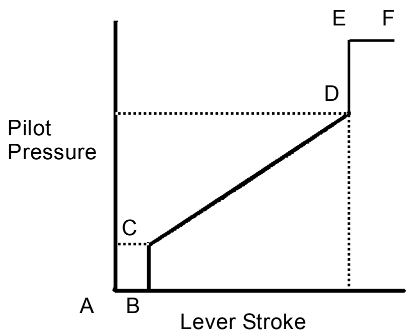
(Blank)

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).

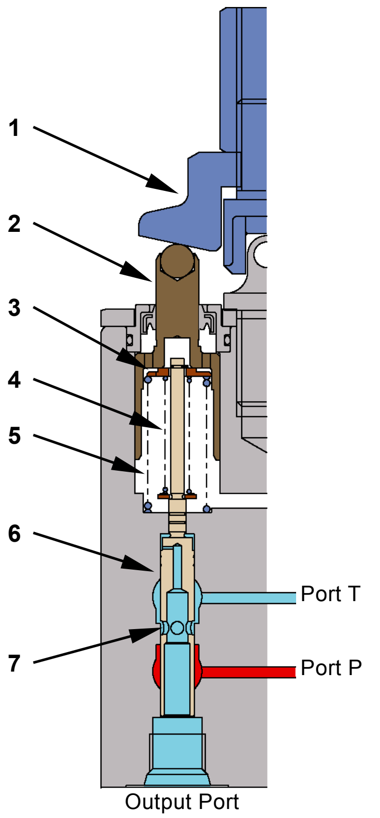
Neutral (Output Curve: A to B):

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.

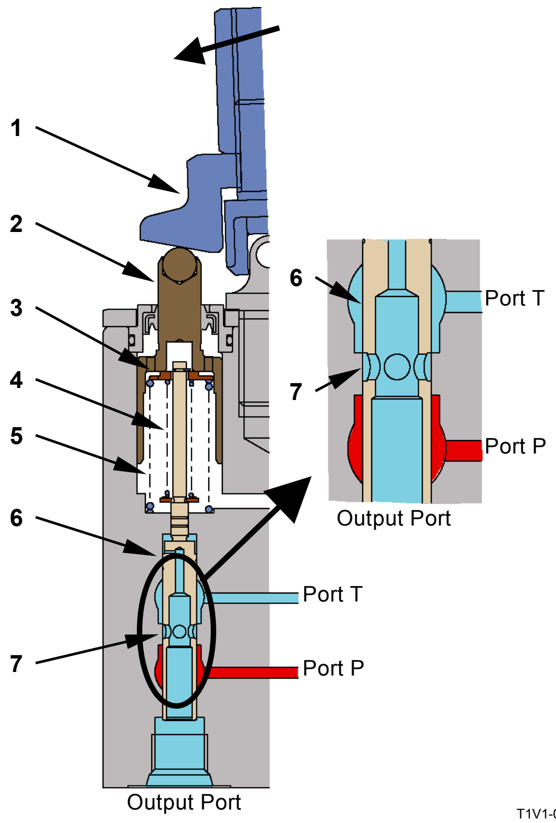


T523-02-05-001

Front Attachment / Swing Pilot Valve

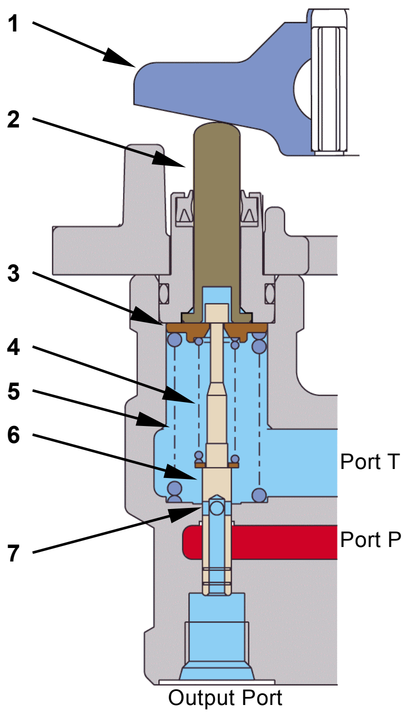


T1V1-03-04-007

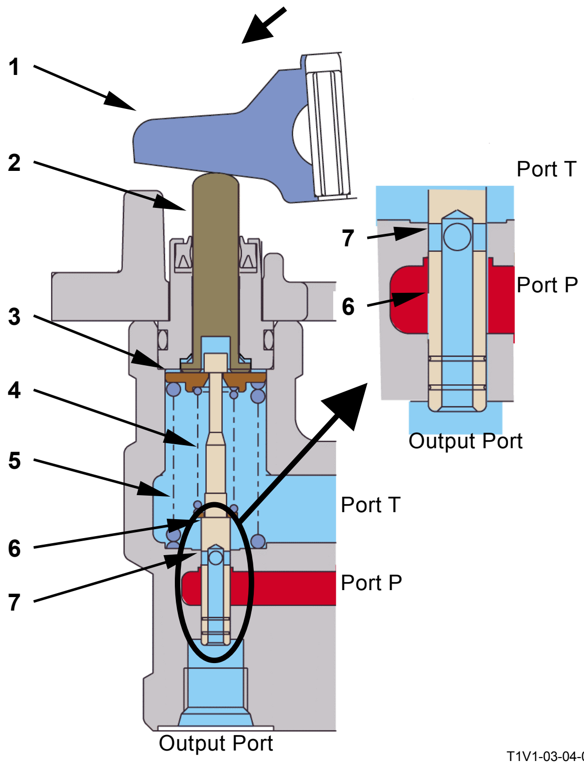


T1V1-03-04-008

Travel Pilot Valve



T1V1-03-04-002

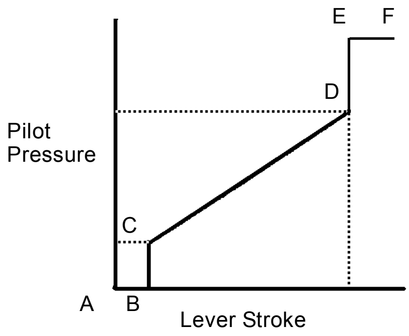


T1V1-03-04-003

1 - Cam
2 - Pusher
3 - Spring Guide
4 - Balance Spring
5 - Return Spring
6 - Spool
7 - Hole

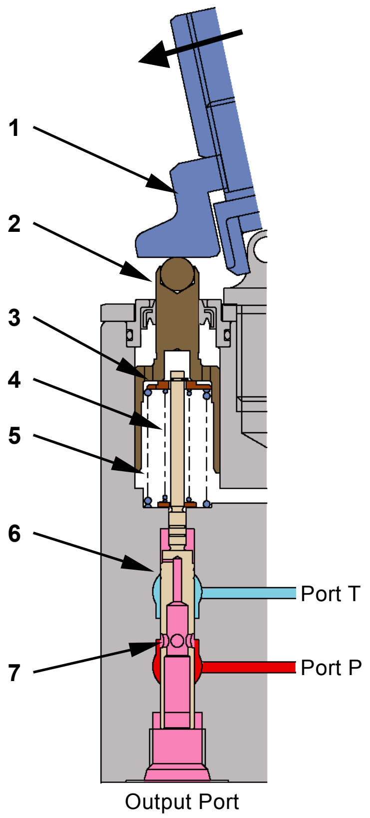
During Metering or Decompressing
(Output Curve: C to D)

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.

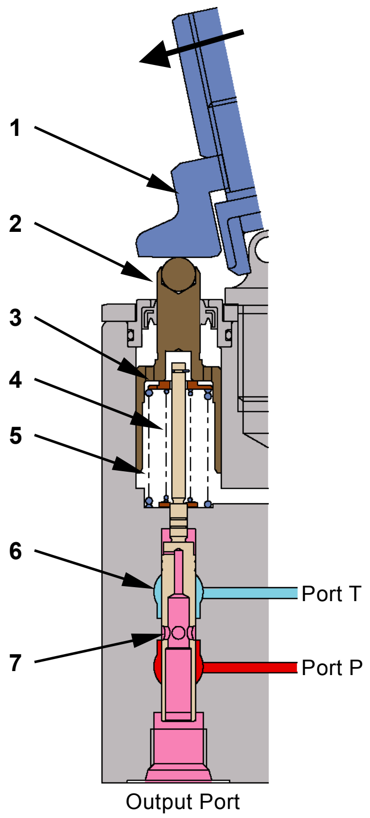


T523-02-05-001

Front Attachment / Swing Pilot Valve

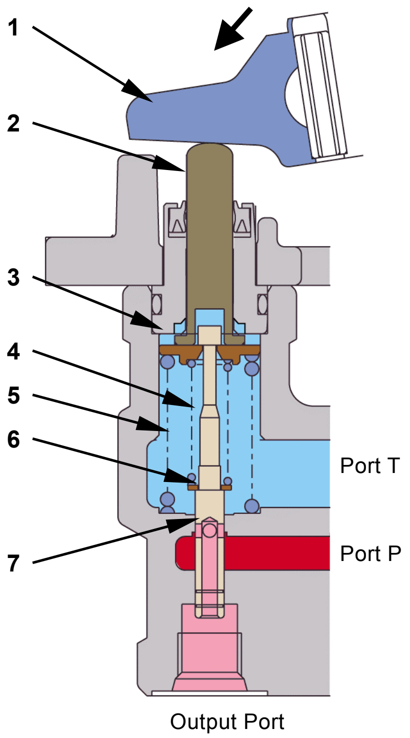


T1V1-03-04-009

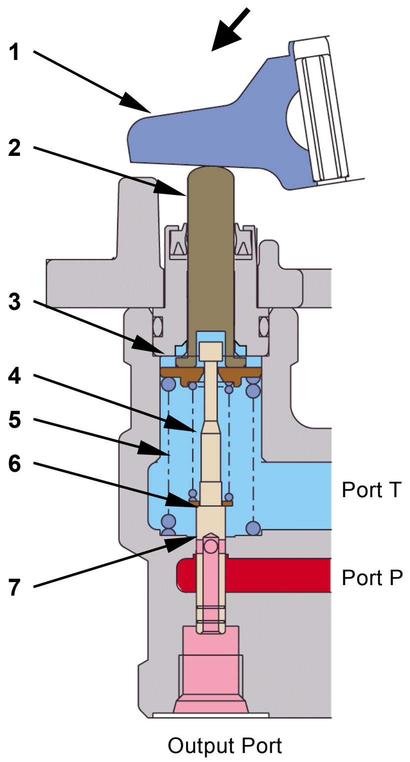


T1V1-03-04-010

Travel Pilot Valve



T1V1-03-04-004



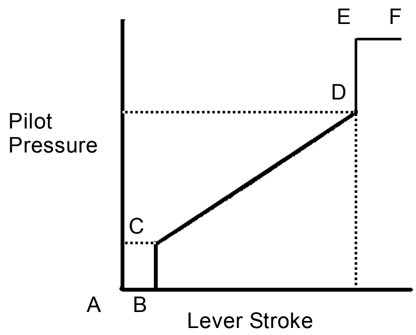
T1V1-03-04-005

1 - Cam
2 - Pusher
3 - Spring Guide
4 - Balance Spring
5 - Return Spring
6 - Spool
7 - Hole

Full Stroke (Output Curve: E to F)

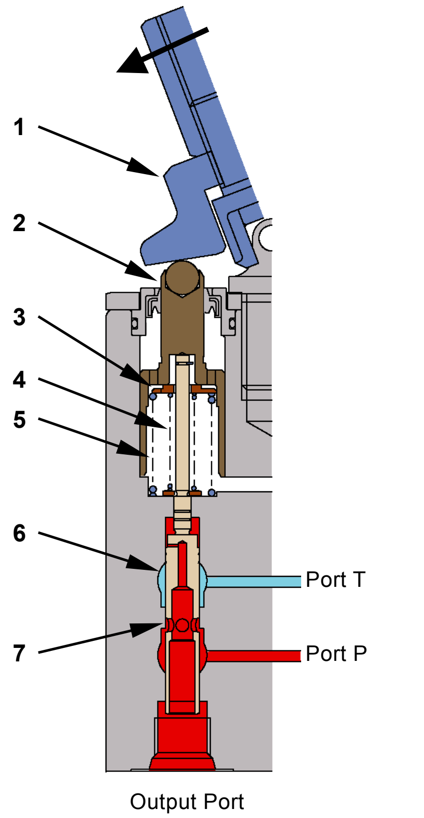
1. When the control lever is fully stroked, pusher (2) is moved downward until pusher (2) on the front attachment / swing pilot valve comes in contact with the casing shoulder, or cam (1) on the travel pilot valve comes in contact with the casing.
2. At this time, the bottom surface of pusher (2) directly 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.

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).

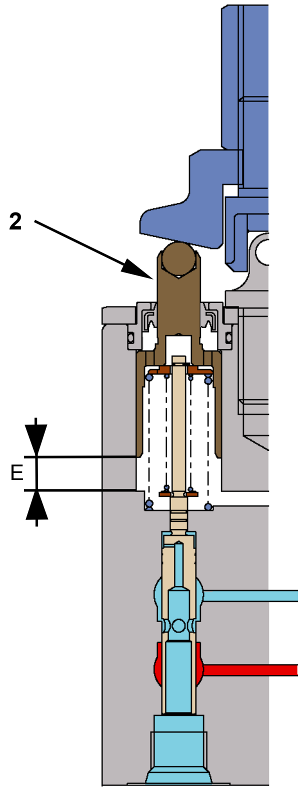


T523-02-05-001

Front Attachment / Swing Pilot Valve

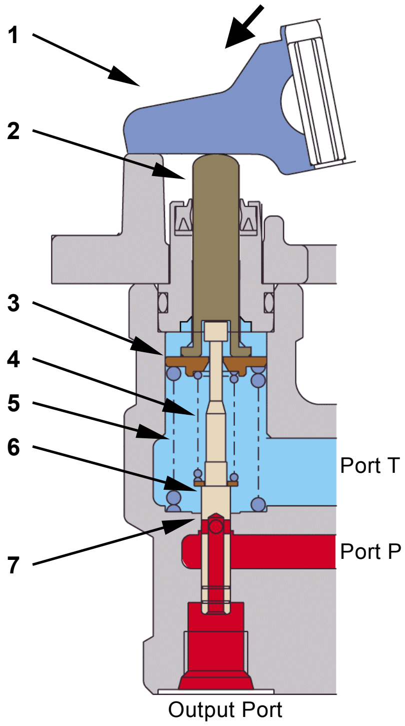


T1V1-03-04-011

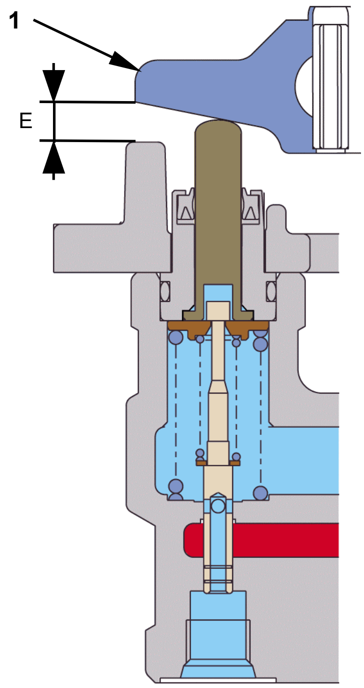


T1V1-03-04-007

Travel Pilot Valve



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

- Auxiliary / Positioning Pilot Valve

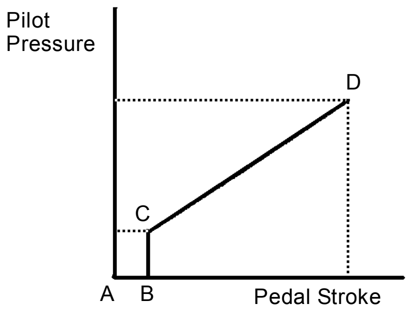
In Neutral (Output Curve: A to B)

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.

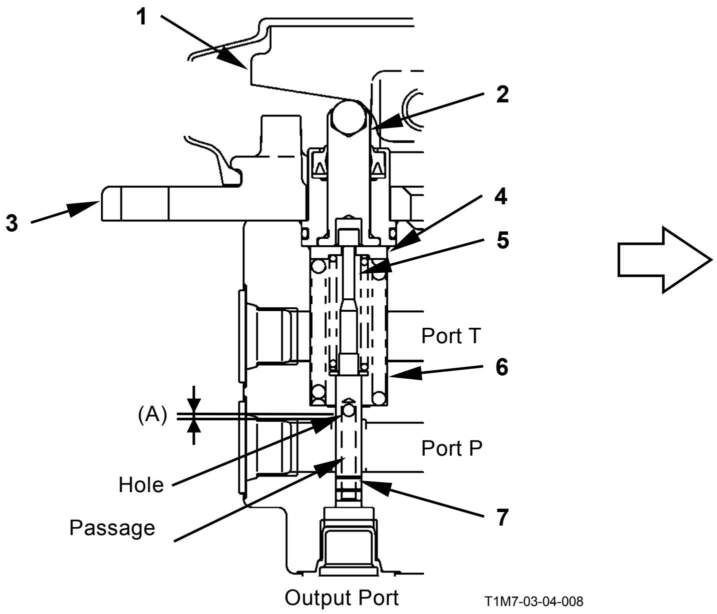
During Metering or Decompressing (Output Curve: C to D)

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.

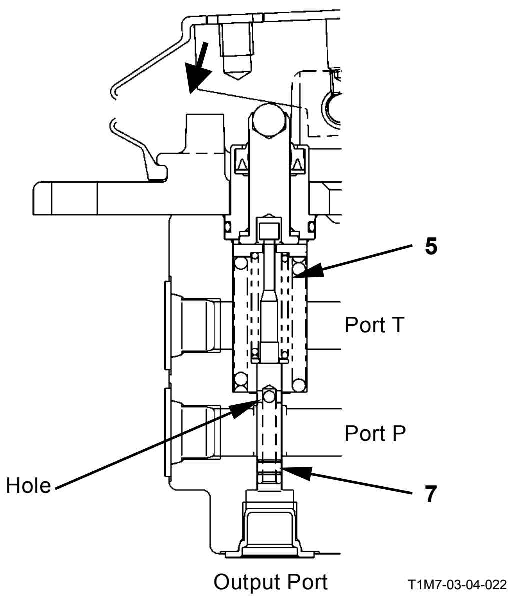


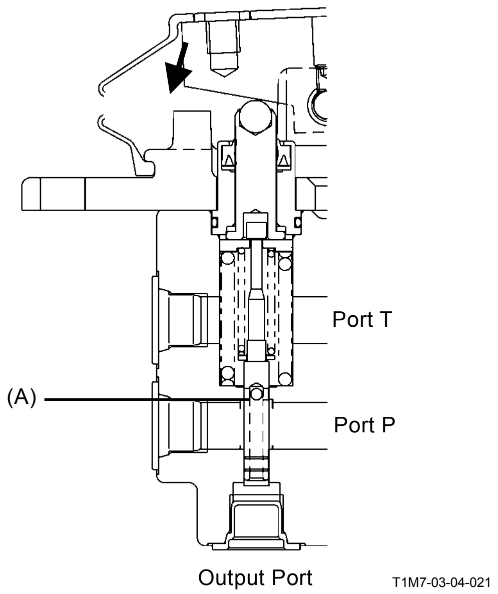
T1F3-03-09-004

In Neutral (Output Curve: A to B)



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





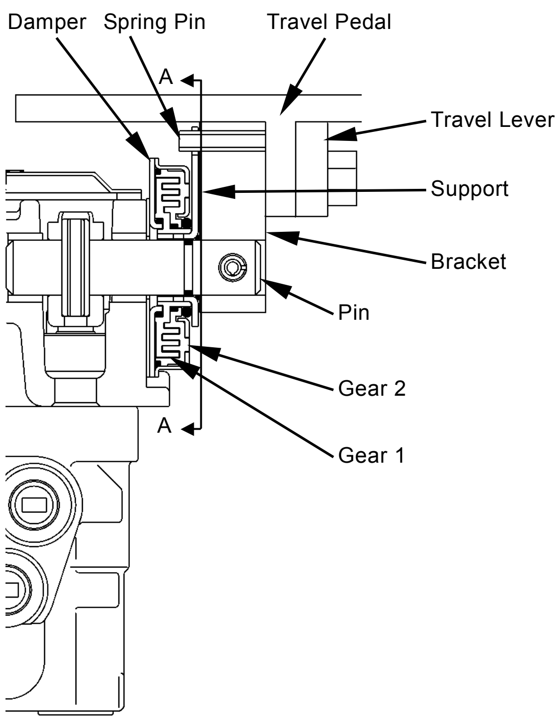
1 - Cam	3 - Plate	5 - Balance Spring	7 - Spool
2 - Pusher	4 - Spring Guide	6 - Return Spring	

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.

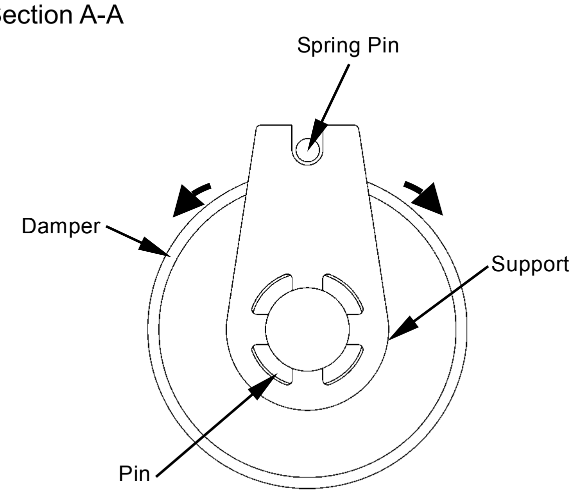
Operation

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

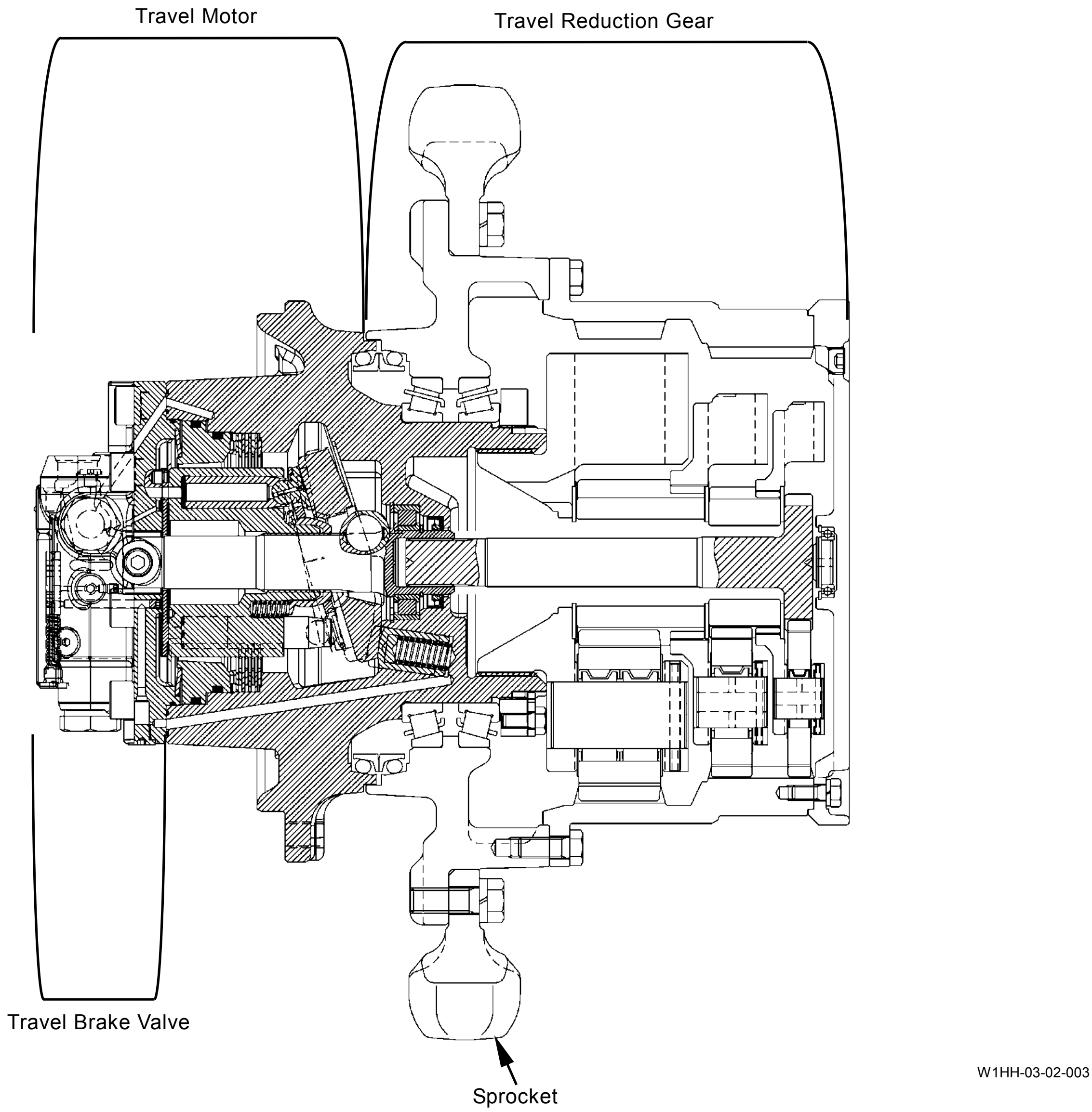


T1M7-03-04-003

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.

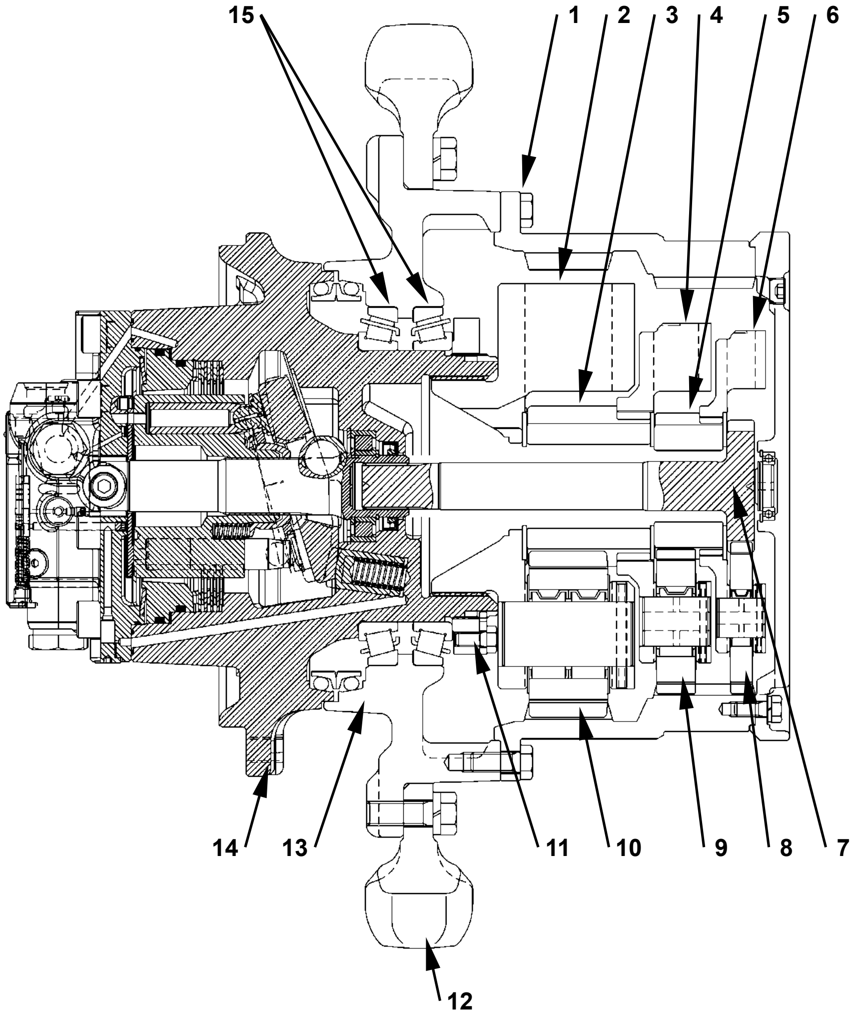


TRAVEL REDUCTION GEAR

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), third stage planetary gear (9), second stage carrier (4), third stage sun gear (3), 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 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.



W1HH-03-02-003

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 (Travel Motor)
3 - Third Stage Sun Gear	7 - Propeller Shaft (First Stage Sun Gear)	11 - Nut	15 - Bearing
4 - Second Stage Carrier	8 - First Stage Planetary Gear	12 - Sprocket	

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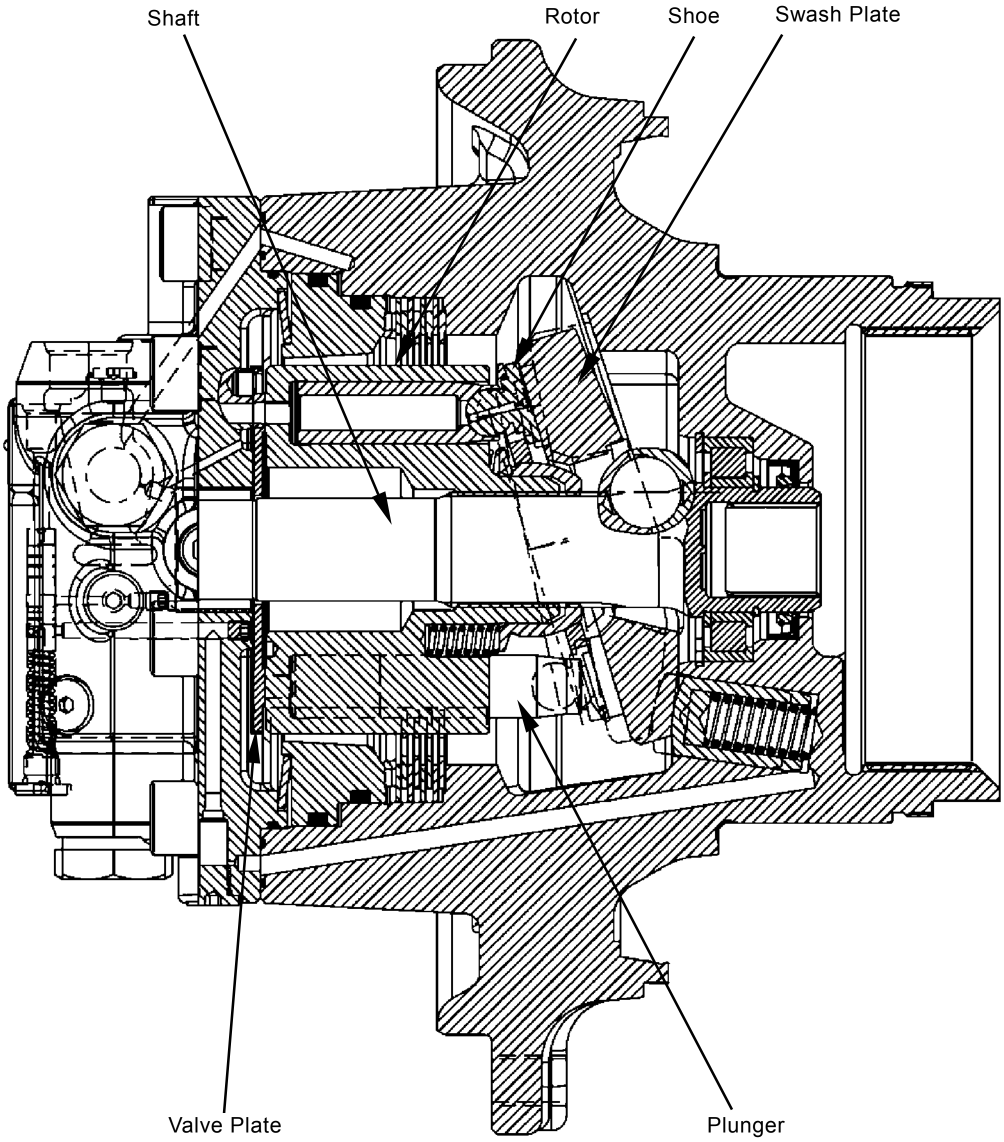
TRAVEL MOTOR

The travel motor consists of valve plate, swash plate, rotor, plungers 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.

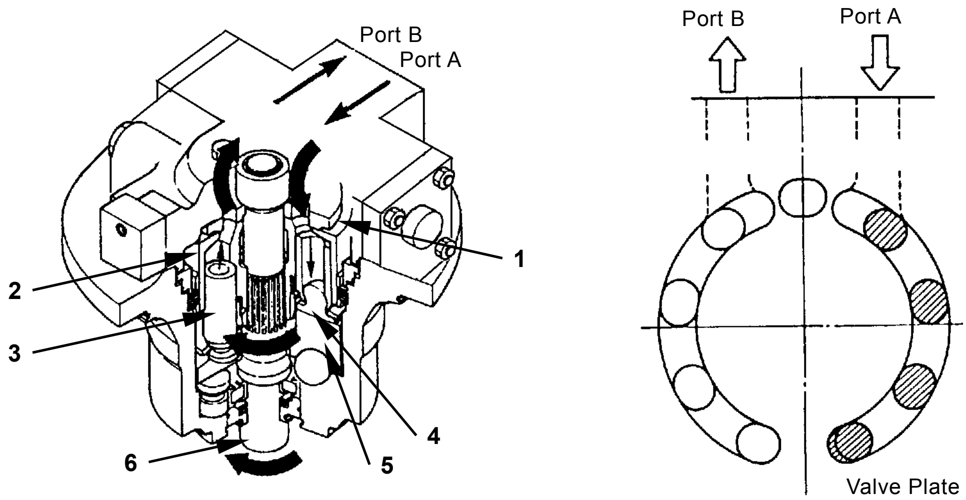
The shoes on top of plungers slide along the swash plate surface due to inclination of the swash plate and the rotor rotates.



W1HH-03-02-006

Operation

1. Pressure oil to port A of valve plate (1) enters into one-side in rotor (2) and pushes plunger (3).
2. This force and inclination of swash plate (5) make shoe (4) slide on swash plate (5) in order to rotate rotor (2) and output shaft (6).
3. As rotor (2) rotates, when plungers (3) reach port B, oil is routed to the hydraulic oil tank.
4. Whether pressure oil is supplied to port A or port B determines the travel direction.



T183-03-05-009

1 - Valve Plate
2 - Rotor
3 - Plunger
4 - Shoe
5 - Swash Plate
6 - Output Shaft

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.

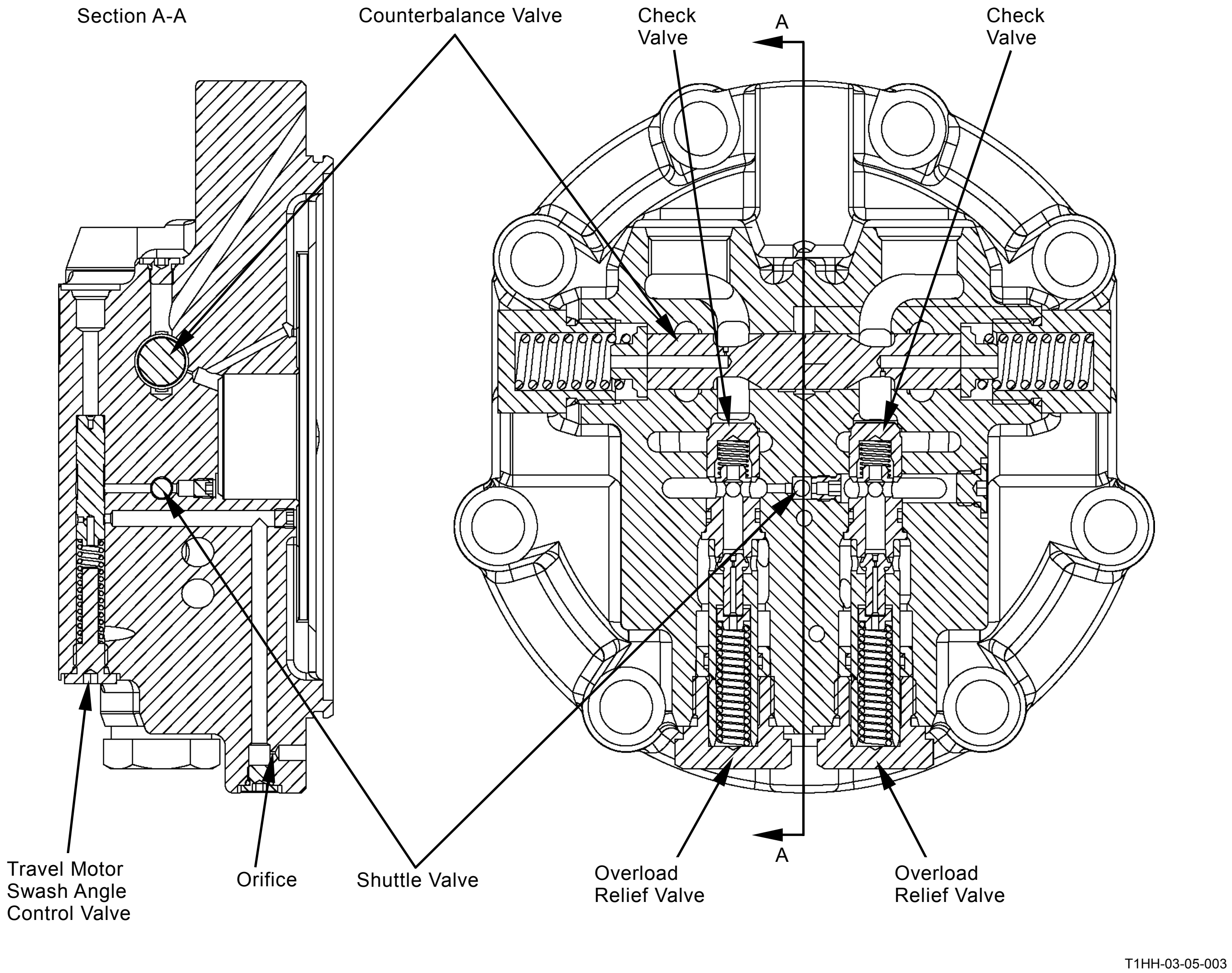
- Check Valve:
  Assists the counterbalance valve operation and prevents cavitation in the motor circuit.

- 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 travel motor swash angle control valve.

- Travel Motor Swash Angle Control Valve:
  Delivers pressure oil from the shuttle valve to the piston for travel speed control as pilot pressure from solenoid valve unit SI shifts the travel motor swash angle control valve.

- Orifice:
  Makes the travel mode change (swash plate angle control) smooth.


Section A-A
Counterbalance Valve
Check Valve
A
Check Valve
Travel Motor Swash Angle Control Valve
Orifice
Shuttle Valve
Overload Relief Valve
A
Overload Relief Valve
T1HH-03-05-003

While Traveling:

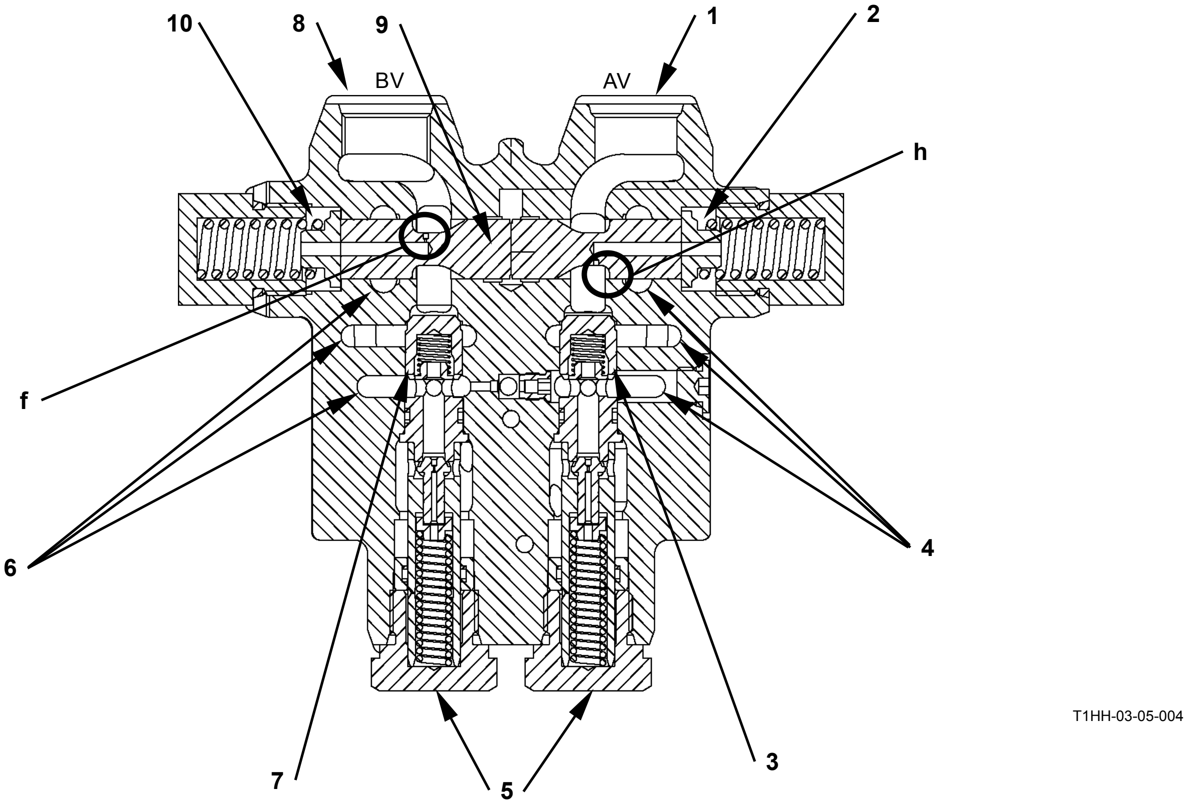
1. When pressure oil from the control valve flows to port BV (8), pressure oil flows around the outer diameter of spool (9), unseats check valve BC (7) and flows further to motor port BM (6).
2. On the other hand, return oil from the travel motor is routed to motor port AM (4). However, its passage is 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 and 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.

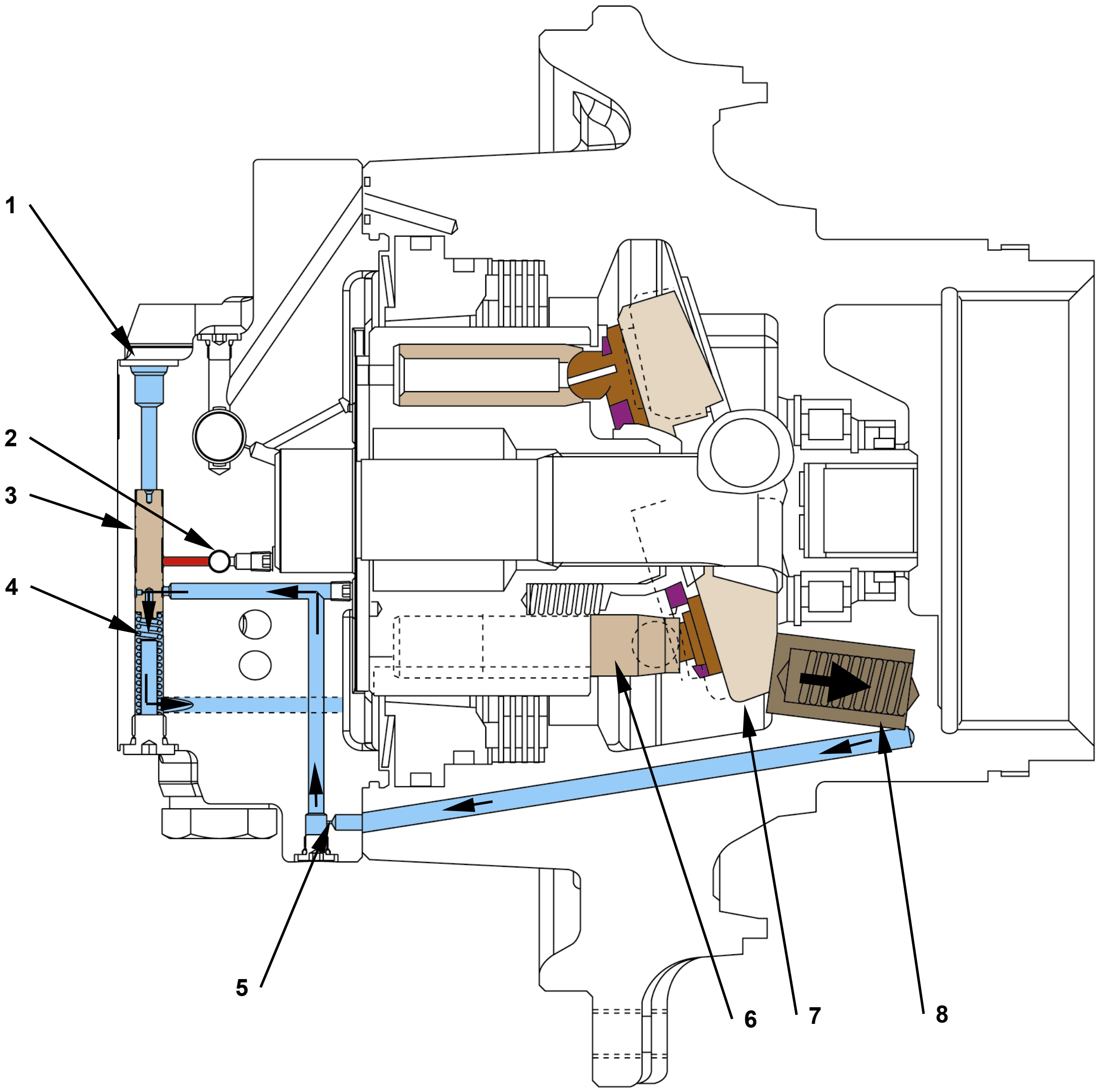


1 - Port AV	4 - Motor Port AM	7 - Check Valve BC	9 - Spool (Counterbalance Valve)
2 - Chamber A	5 - Overload Relief Valve	8 - Port BV	10 - Chamber B
3 - Check Valve AC	6 - Motor Port BM		

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 (3) is kept raised by spring (4).
  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.

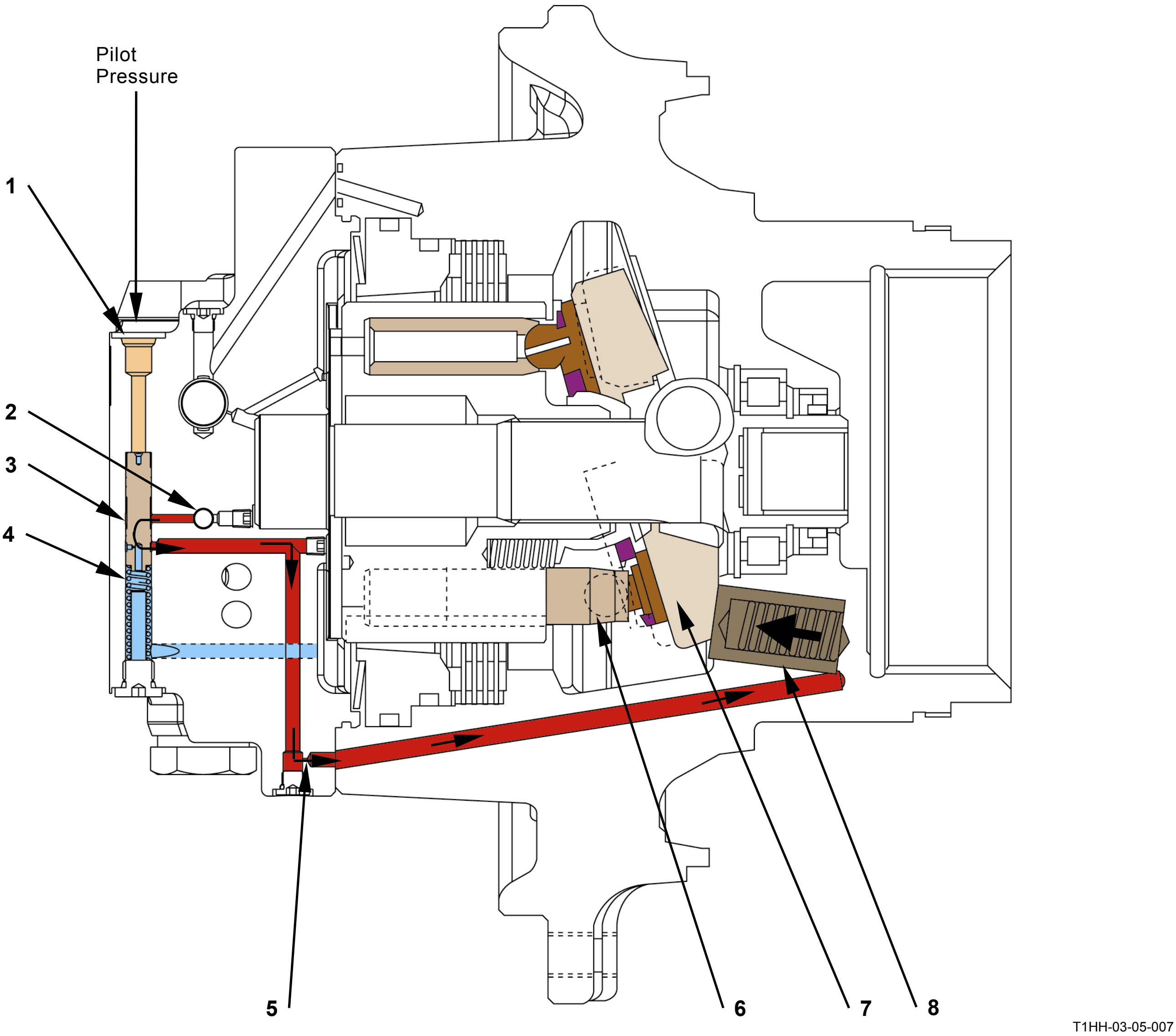


T1HH-03-05-005

1 - Pilot Port
2 - Piston Control Shuttle Valve
3 - Spool
4 - Spring
5 - Orifice
6 - Plunger
7 - Swash Plate
8 - Piston

- 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 (3) downward.
3. Pressure oil in high pressure motor port (AM or BM) acts on piston (8) through shuttle valve (2), spool (3) and 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.



1 - Pilot Port
2 - Piston Control Shuttle Valve
3 - Spool
4 - Spring
5 - Orifice
6 - Plunger
7 - Swash Plate
8 - Piston

PARKING BRAKE

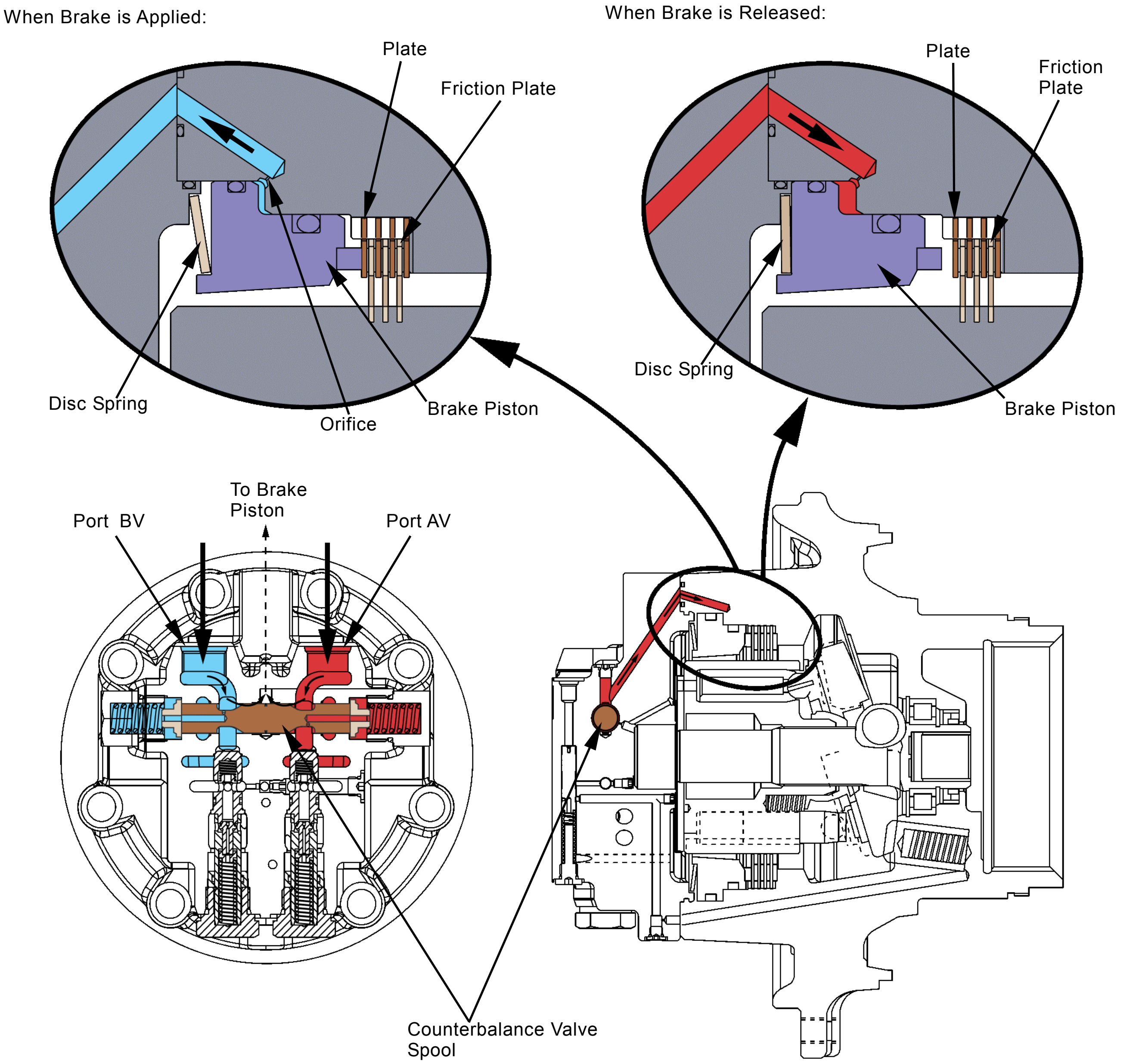
The parking brake is a wet-type multi disc brake. The brake is a negative type so that it is released only when the brake release pressure oil is routed into the brake piston chamber. The parking brake is automatically applied unless the travel function is operated. The friction plates and plates are 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 AV or BV 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 spool in 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, 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.



T1V7-03-05-001

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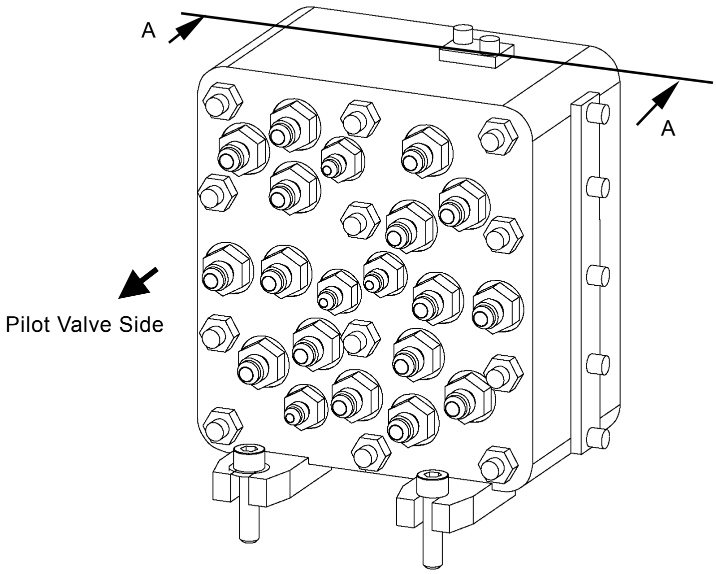
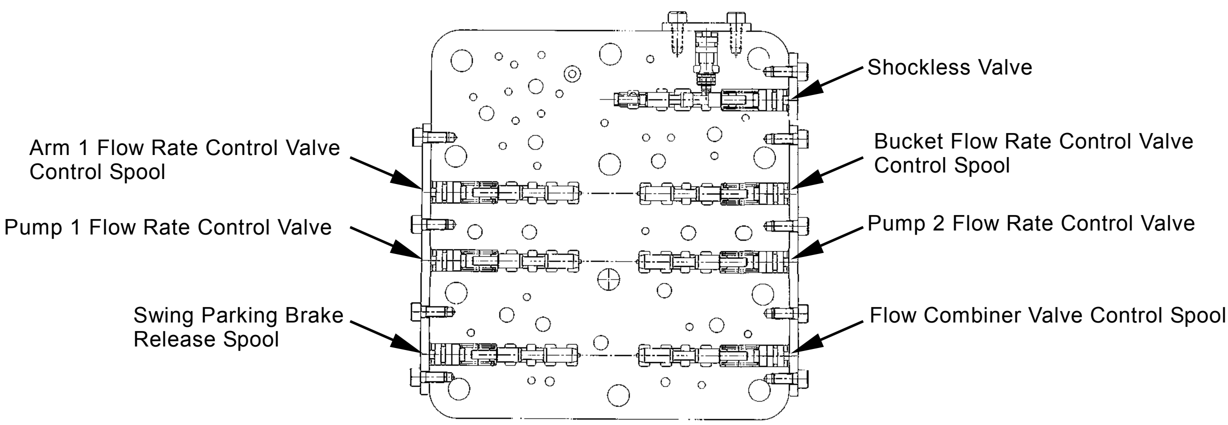
OUTLINE

The signal control valve is provided in the pilot circuit between 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 control spool, bucket flow rate control valve control spool, swing parking brake release spool and arm 1 flow rate control valve control spool.



T178-03-06-016

Cross Section A-A

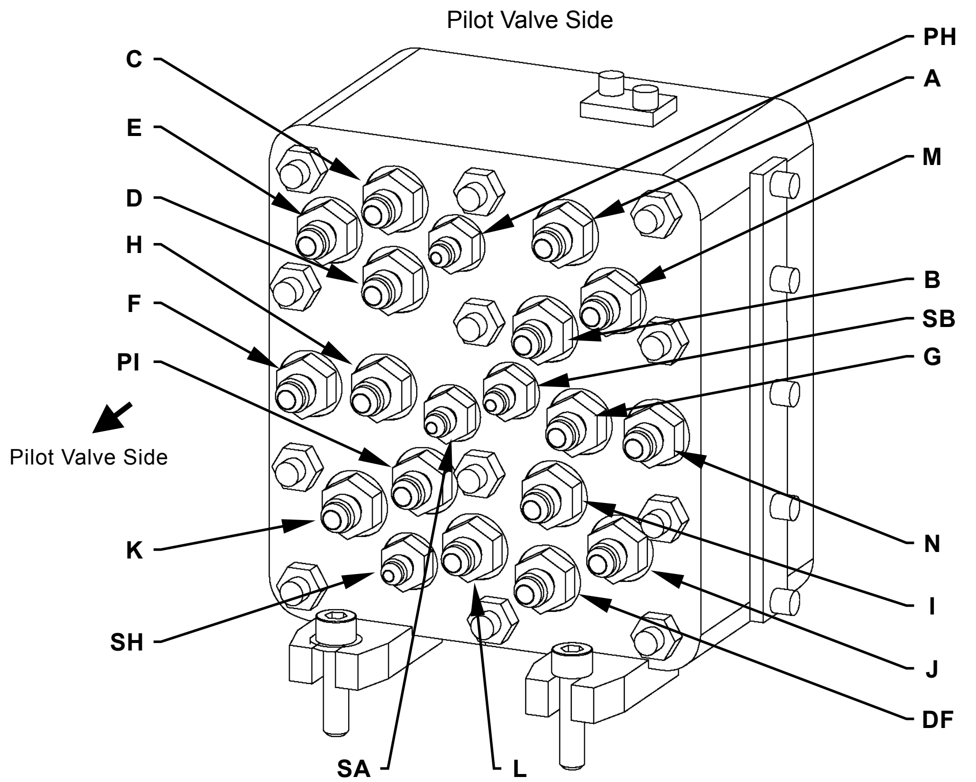


T178-03-06-002

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



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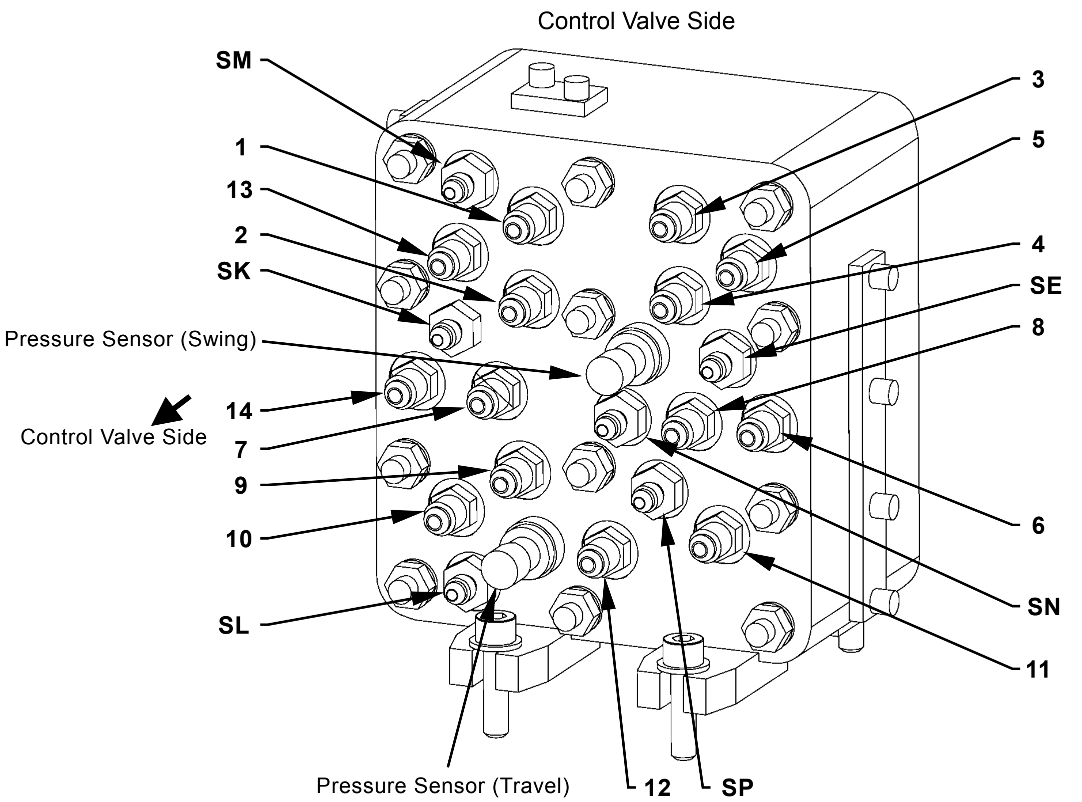


T178-03-06-015

Control Valve Side

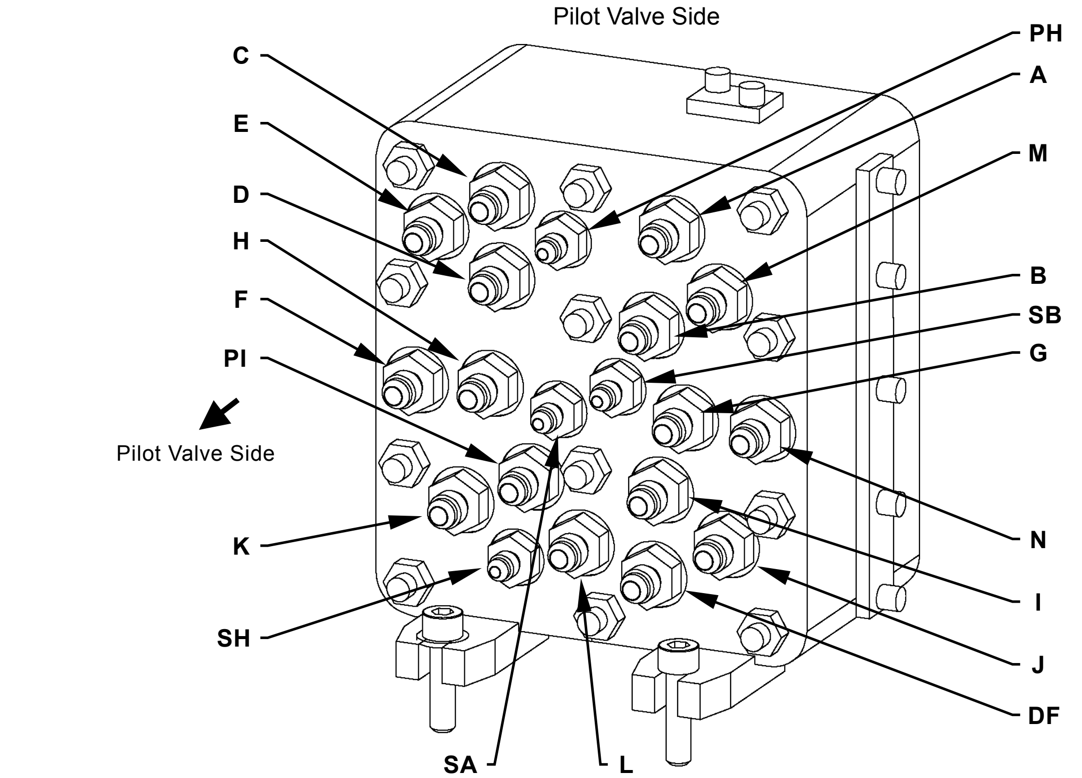
Port Name	Connecting to	Remark
Port 1	Control Valve	Boom Raise Pilot Pressure
Port 2	Control Valve	Boom Lower Pilot Pressure
Port 3	Control Valve	Arm Roll-Out Pilot Pressure
Port 4	Control Valve	Arm Roll-In Pilot Pressure
Port 5	Control Valve	Left Swing Pilot Pressure
Port 6	Control Valve	Right Swing 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

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

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



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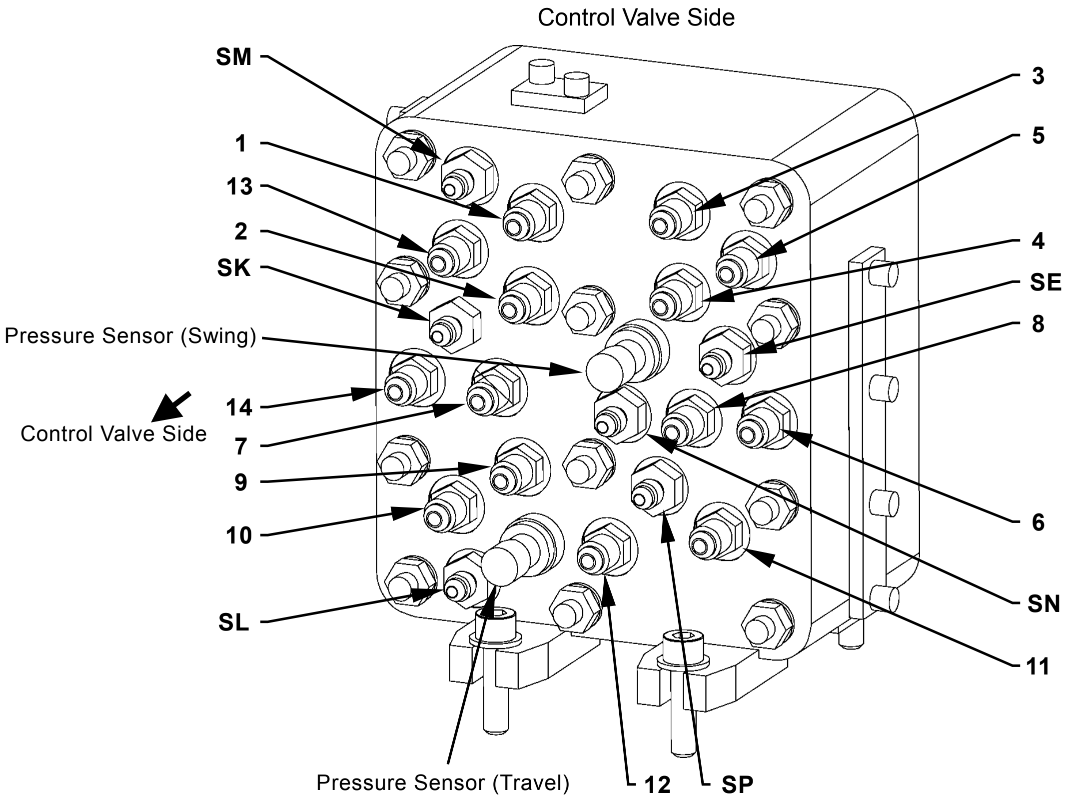


T178-03-06-015

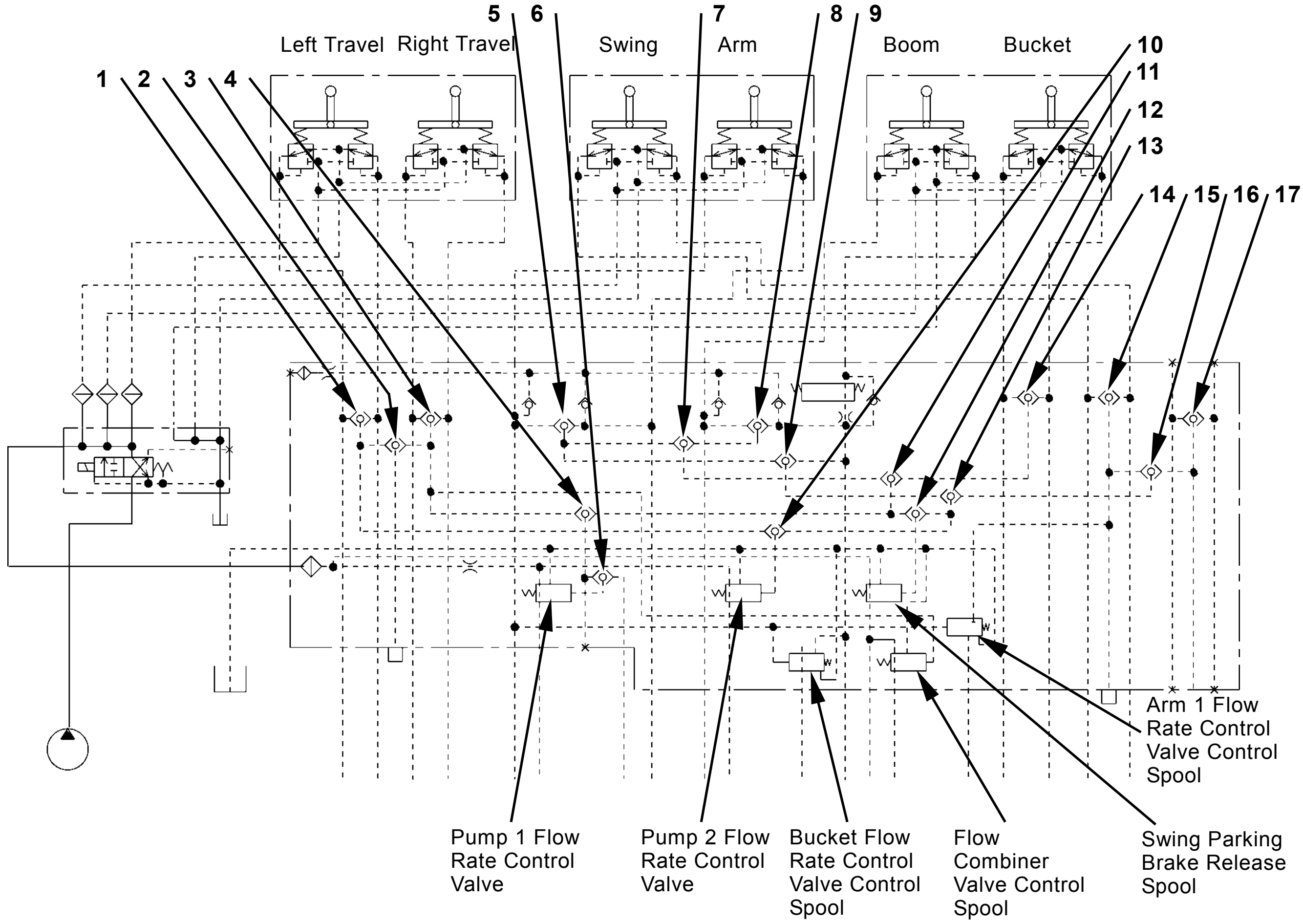
SHUTTLE VALVE

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 machine 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.*

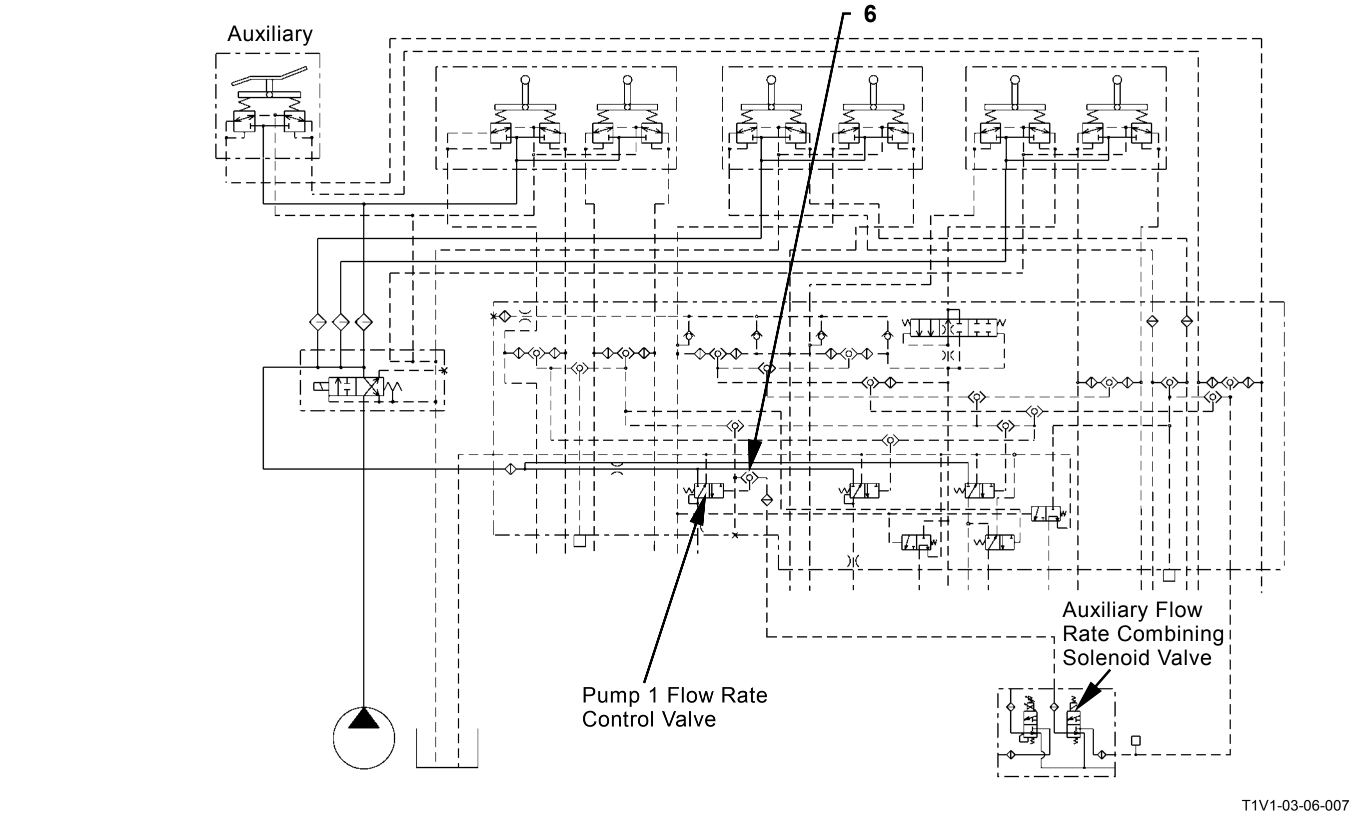
Monoblock Boom / STD Specification



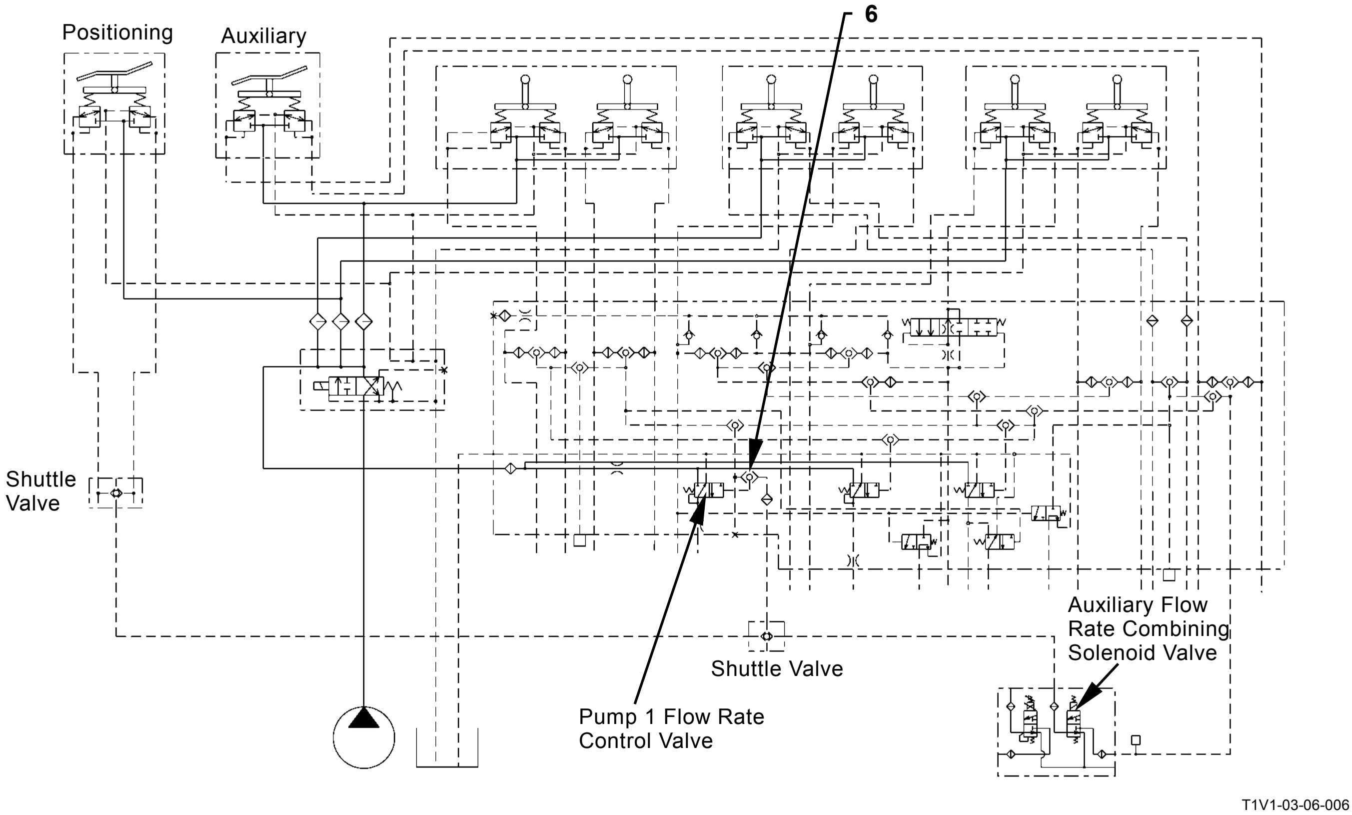
T1V1-03-06-001

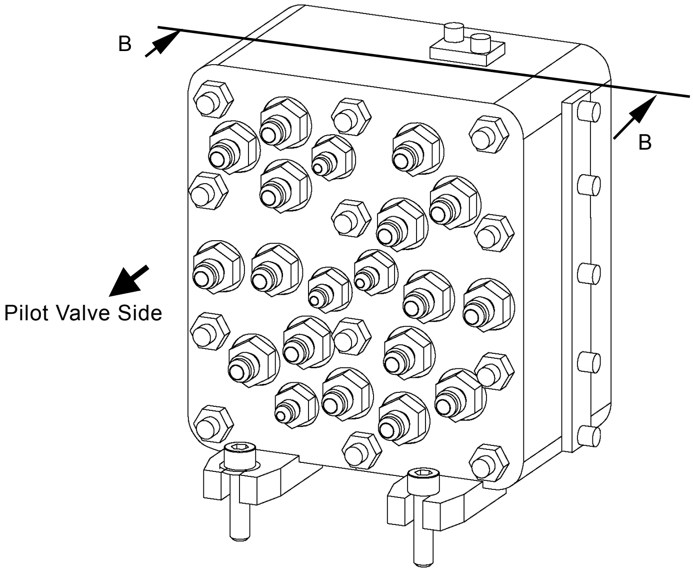
1 - Left Travel
2 - Left Travel/Right Travel
3 - Right Travel
4 - Boom / Arm / Bucket / Right Travel
5 - Arm
6 - Boom / Arm / Bucket / Right Travel / Auxiliary / Positioning
7 - Boom / Arm
8 - Boom
9 - Arm / Boom Raise
10 - Boom Raise / Arm / Left Travel / Swing
11 - Boom / Arm / Bucket
12 - Boom / Arm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

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



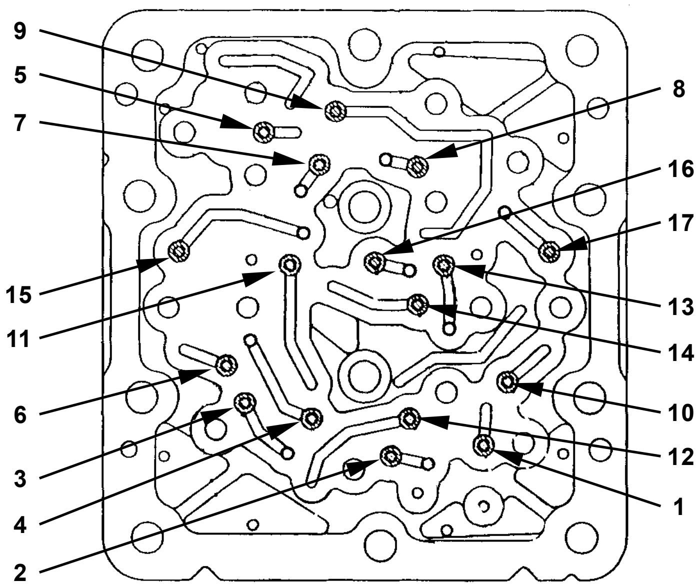
Machine with 2-Piece Boom and Auxiliary Combining Attached (Optional)





T178-03-06-016

Cross Section B-B



T178-03-06-009

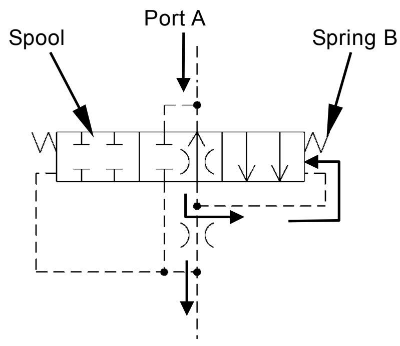
1 - Left Travel
2 - Left Travel/Right Travel
3 - Right Travel
4 - Boom / Arm / Bucket / Right Travel
5 - Arm
6 - Boom / Arm / Bucket / Right Travel / Auxiliary / Positioning
7 - Boom / Arm
8 - Boom
9 - Arm / Boom Raise
10 - Boom Raise / Arm / Left Travel / Swing
11 - Boom / Arm / Bucket
12 - Boom / Arm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

SHOCKLESS VALVE

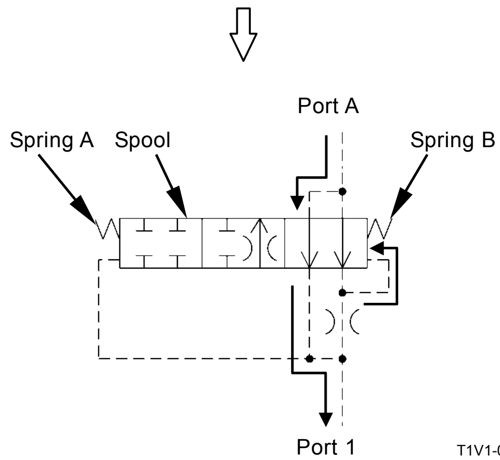
The shockless valve is provided in the boom raise circuit and functions during boom lowering operation.

During Boom Raising Operation:

1. Boom raise pilot pressure is routed into port A and acts on the spool.
2. Immediately after operation is started, low pilot pressure flows into the spring B chamber through clearance between spool and housing. At the same time, pilot pressure 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.

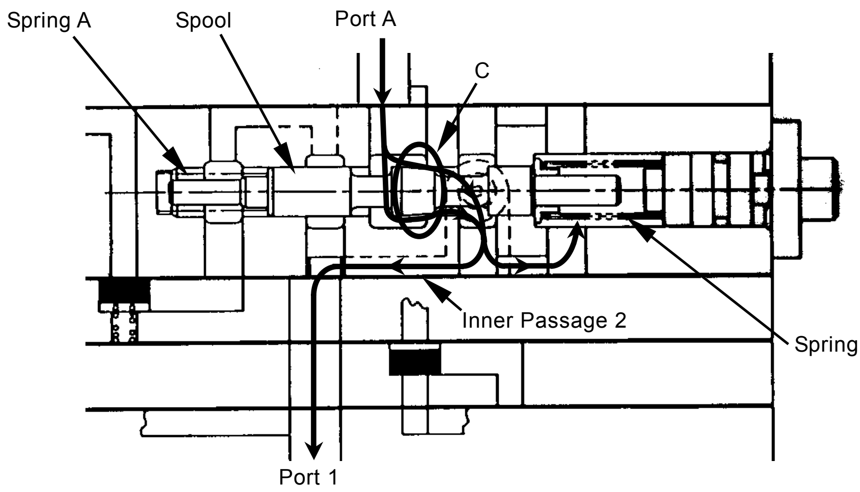


T1V1-03-06-003

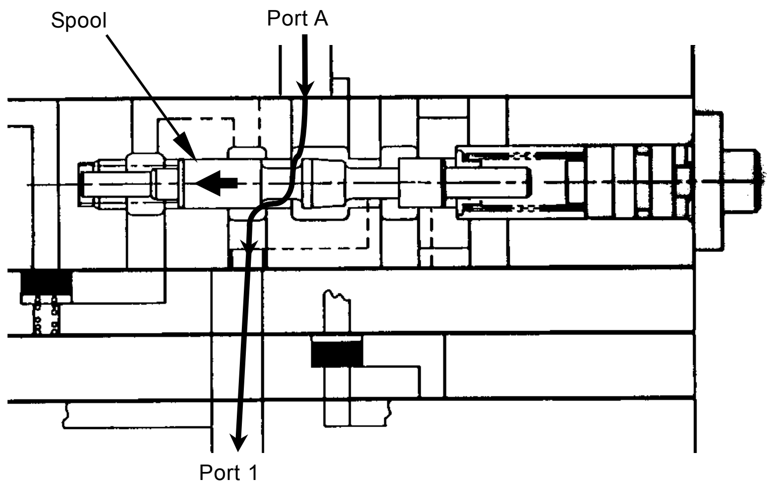


T1V1-03-06-002

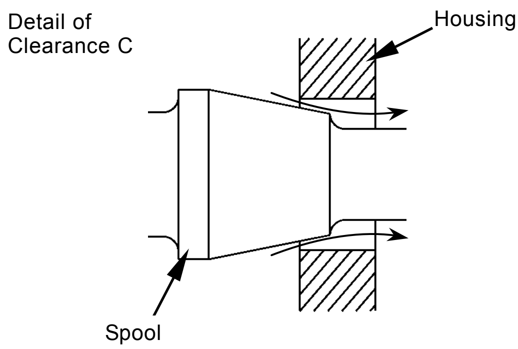
During boom raising operation



T183-03-06-003



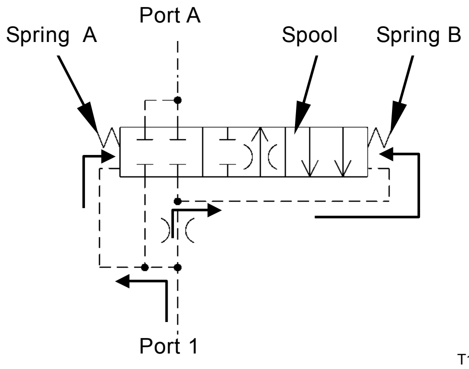
T183-03-06-004



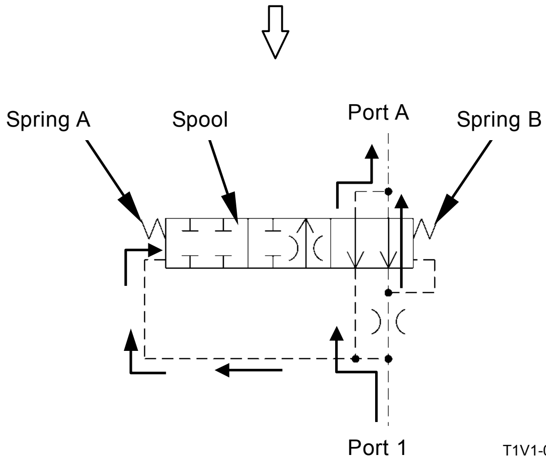
T1V1-03-06-008

During Boom Lowering Operation (Shockless Operation)

1. When the boom is lowered, return oil from the boom raise spool in the control valve acts 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 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 valve spool returns slowly.

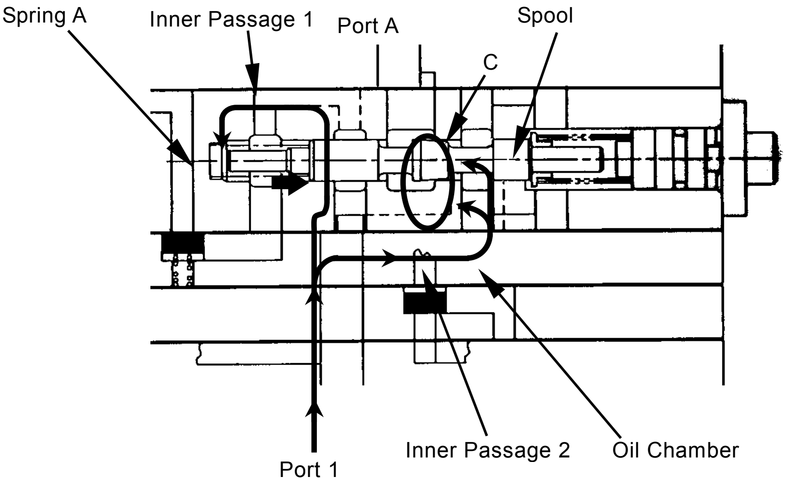


T1V1-03-06-004

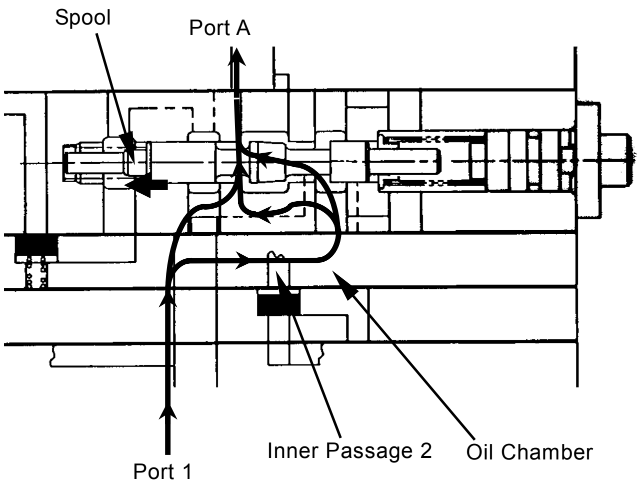


T1V1-03-06-002

During boom lowering operation (Shockless operation)

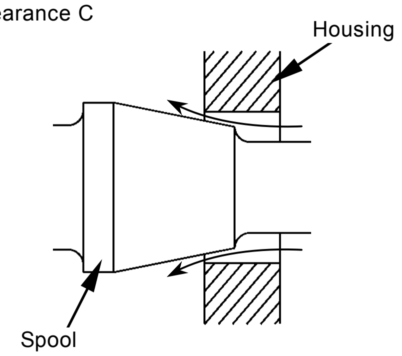


T183-03-06-005



T183-03-06-004

Detail of Clearance C



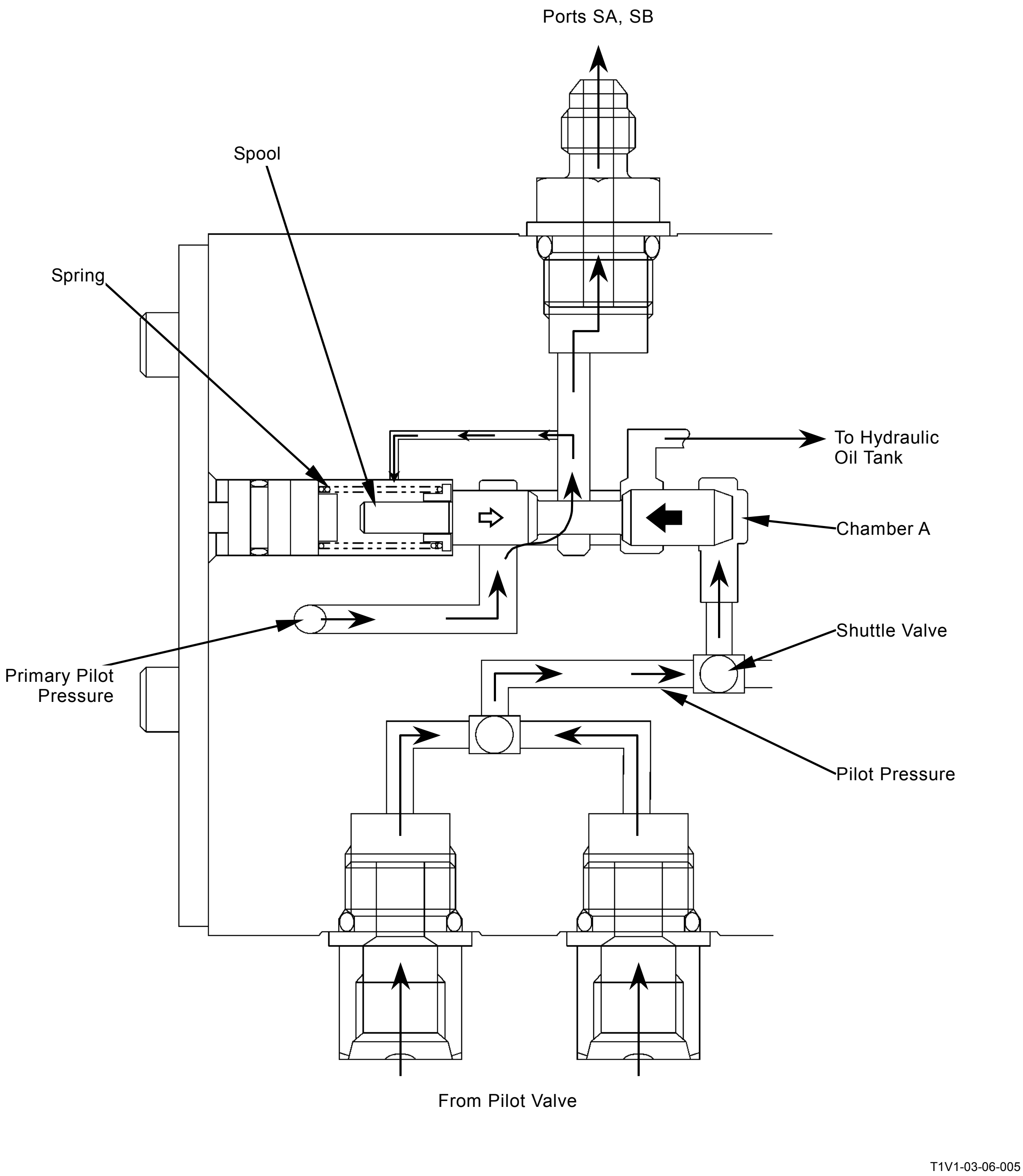
T1V1-03-06-008

PUMP 1 AND PUMP 2 FLOW RATE CONTROL VALVES

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

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

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

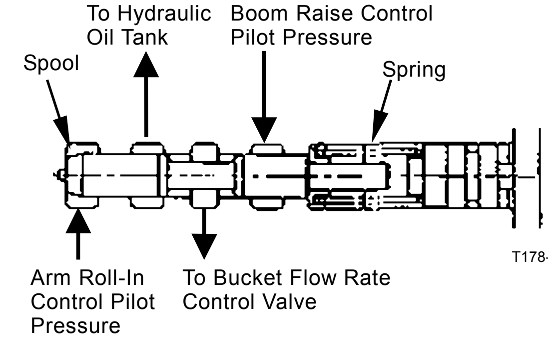

Ports SA, SB
Spool
Spring
To Hydraulic Oil Tank
Chamber A
Shuttle Valve
Primary Pilot Pressure
Pilot Pressure
From Pilot Valve
T1V1-03-06-005

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.

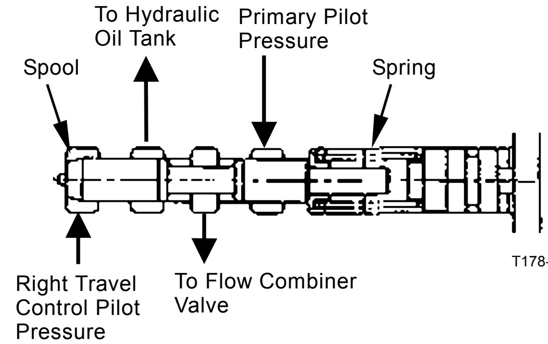
1. The bucket flow rate control valve control spool is shifted by arm roll-in control pilot pressure and supplies boom raise control pilot pressure to the bucket flow rate control valve in control valve.
2. The flow combiner valve control spool is shifted by right travel control pilot pressure and supplies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



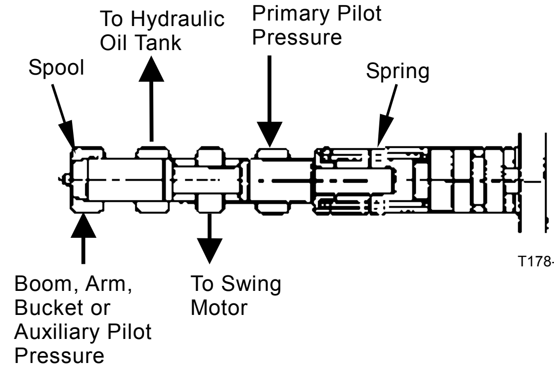
T178-03-06-014

Flow Combiner Valve Control Spool:



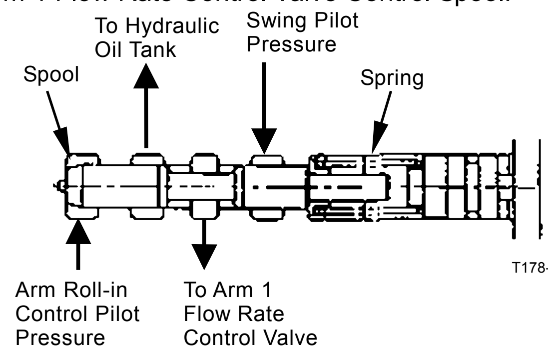
T178-03-06-014

Swing Parking Brake Release Spool:



T178-03-06-014

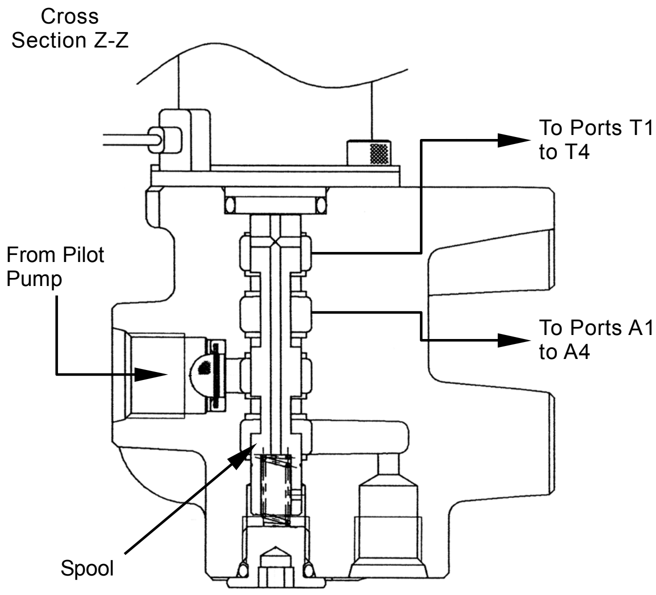
Arm 1 Flow Rate Control Valve Control Spool:



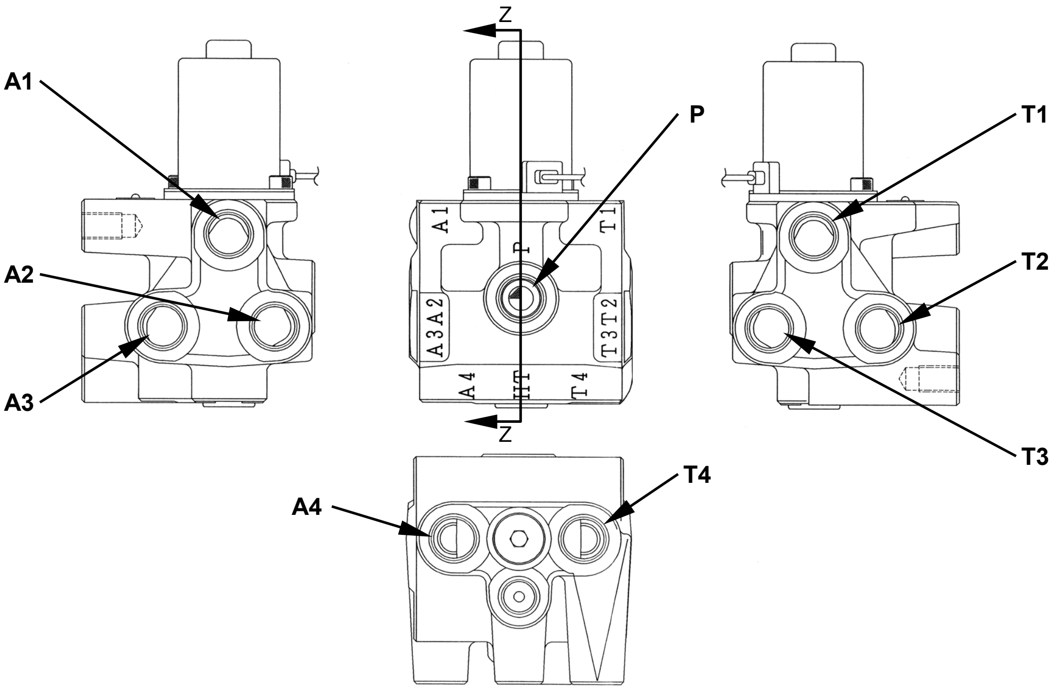
T178-03-06-014

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



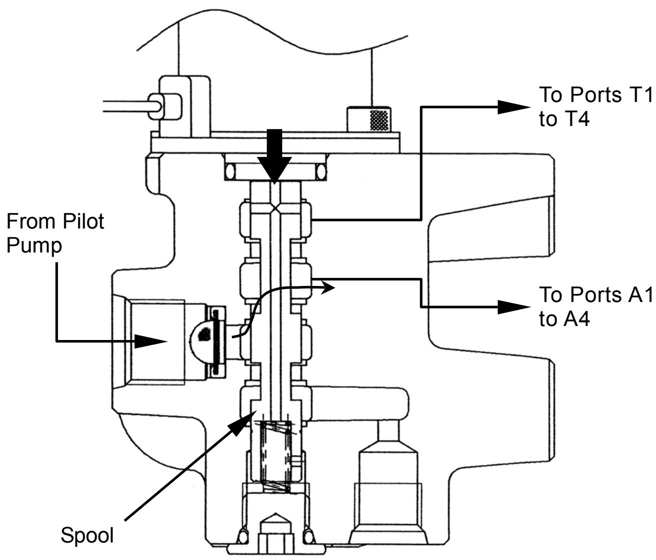
T1V1-03-07-011

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

- 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 UNLOCK position, the pilot shut-off relay is turned ON and the pilot shut-off solenoid valve is activated. (Refer to Electrical System / SYSTEM.)
  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.

Pilot Shut-Off Lever: UNLOCK Position



T1V1-03-07-012

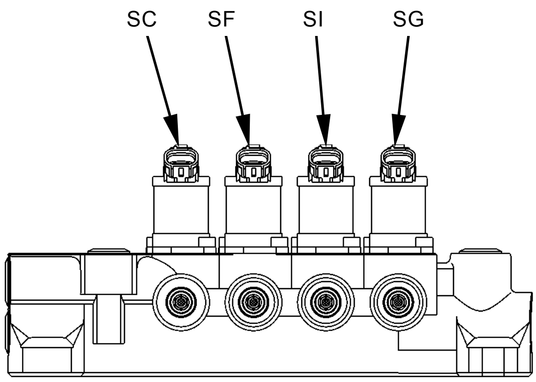
SOLENOID VALVE

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).

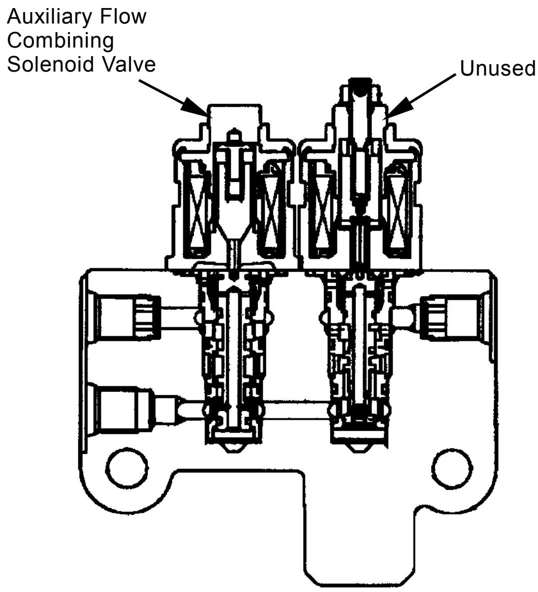
- SC: Control the arm regenerative valve and arm 2 flow rate control valve (switch valve) in control valve
- SF: Control the digging regenerative valve in control valve
- SI: Control the travel motor swash angle control valve
- SG: Increase pressure of the main relief valve in control valve



T1V1-03-07-007

2-Spool Solenoid Valve Unit (Optional)

The 2-spool solenoid valve unit consists of the auxiliary flow combining solenoid valve.
The auxiliary flow combining solenoid valve is an ON / OFF solenoid valve. When the front attachment is selected by using the monitor unit, the auxiliary flow combining solenoid valve is turned ON and shifts the bypass shut-out valve in control valve and pump 1 flow rate control valve in signal control valve.
(Refer to Control System / SYSTEM.)



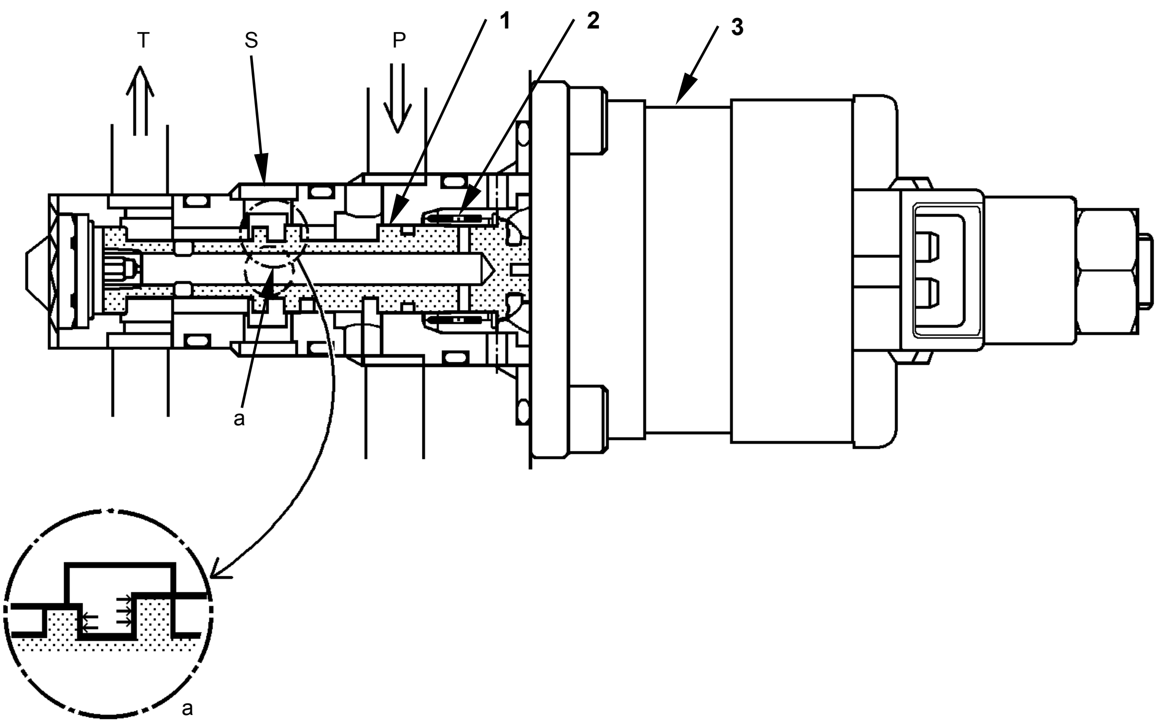
T1GL-03-10-002

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 to output port S and pressure at output port S increases.
  3. Pressure at port S acts on step part a on spool (1).
  4. Because of the pressure receiving area difference between step part a, spool (1) is pushed to the right.
  5. 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.



T107-02-07-005

1 - Spool　　2 - Spring　　3 - Solenoid

ON / OFF Solenoid Valve

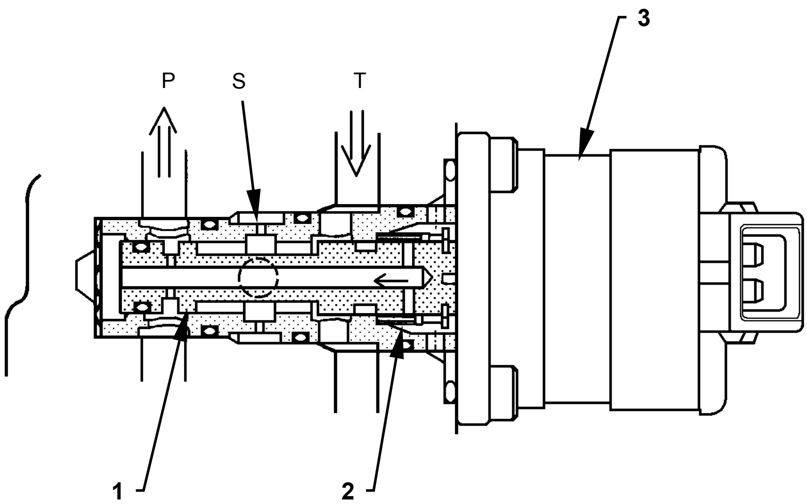
The ON / OFF solenoid valve shifts the brake switch and each control switch in order to shift pilot pressure.

- 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

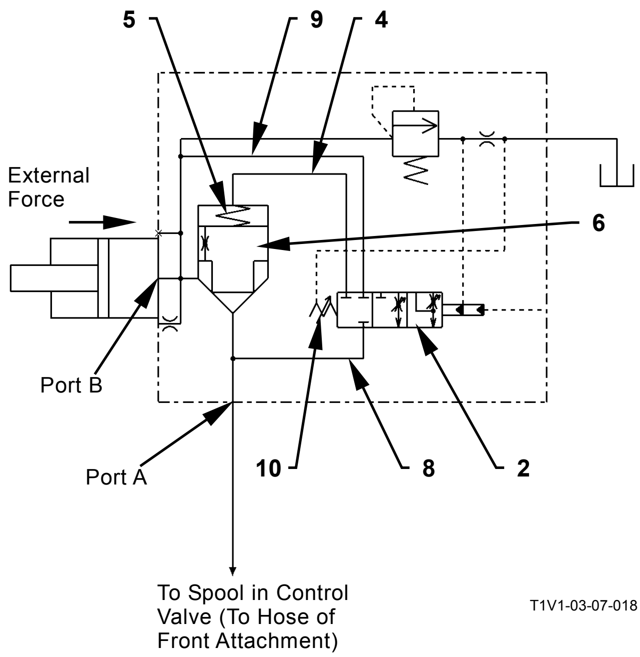
1 - Spool   2 - Spring   3 - Solenoid

HOSE RUPTURE VALVE

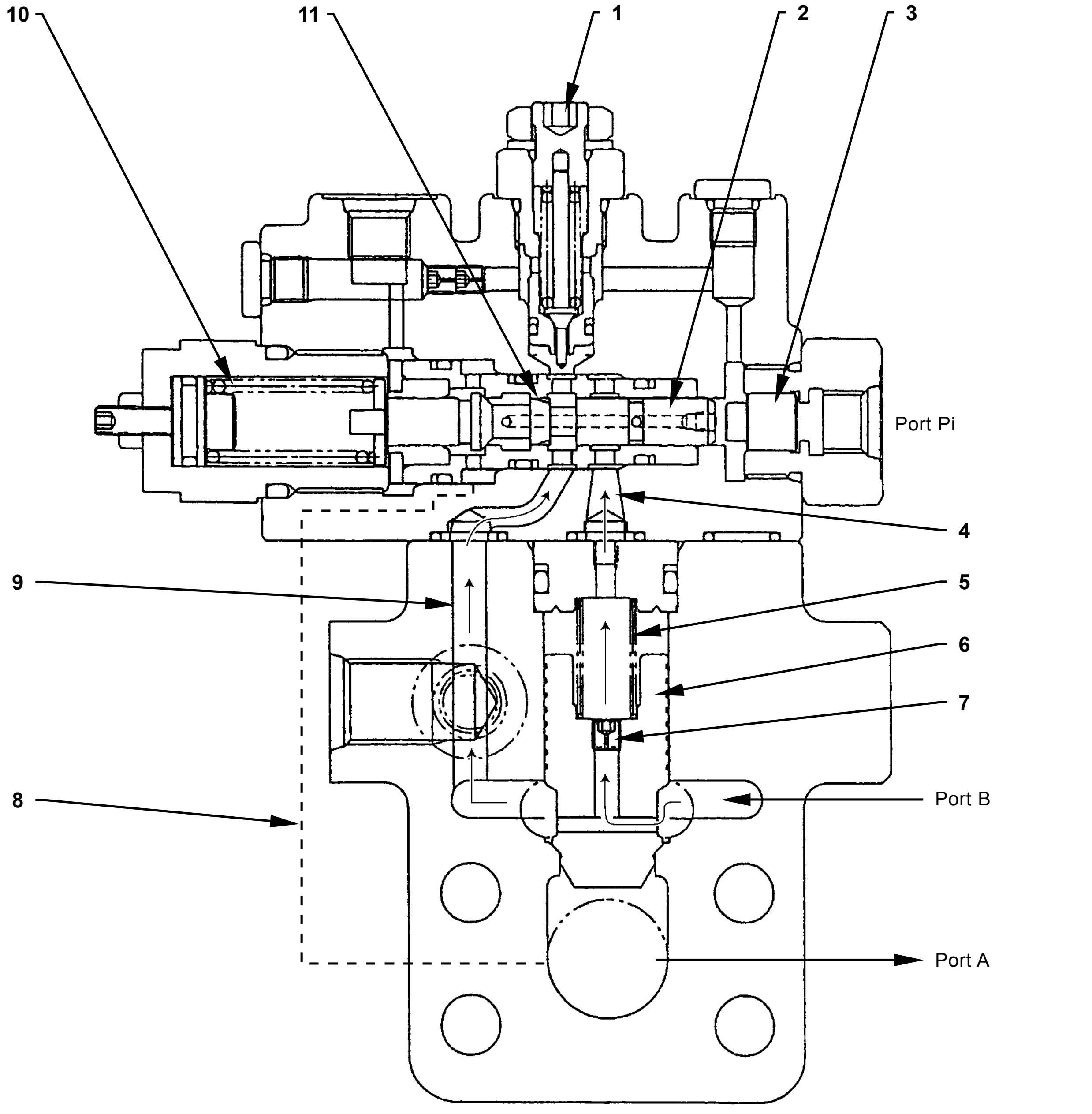
The hose rupture valve is installed to boom cylinder (bottom side circuit), arm cylinder (rod side circuit) and positioning cylinder (2-piece boom) (rod side circuit).
When the hose of front attachment is damaged, the hose rupture valve holds the front attachment and prevents the front attachment from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

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

- Control Lever: In Neutral
  1. As pilot pressure Pi 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.

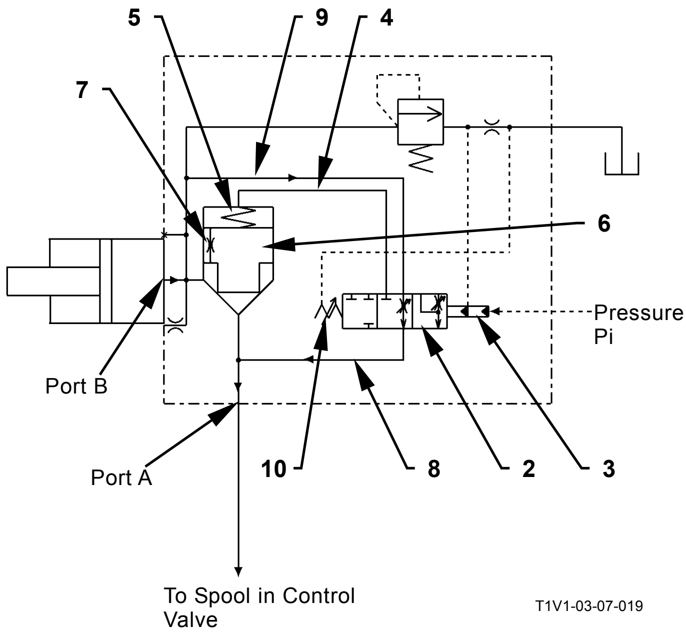


2 - Spool
4 - Passage A
5 - Spring
6 - Poppet
8 - Passage B
9 - Passage C
10 - Spring

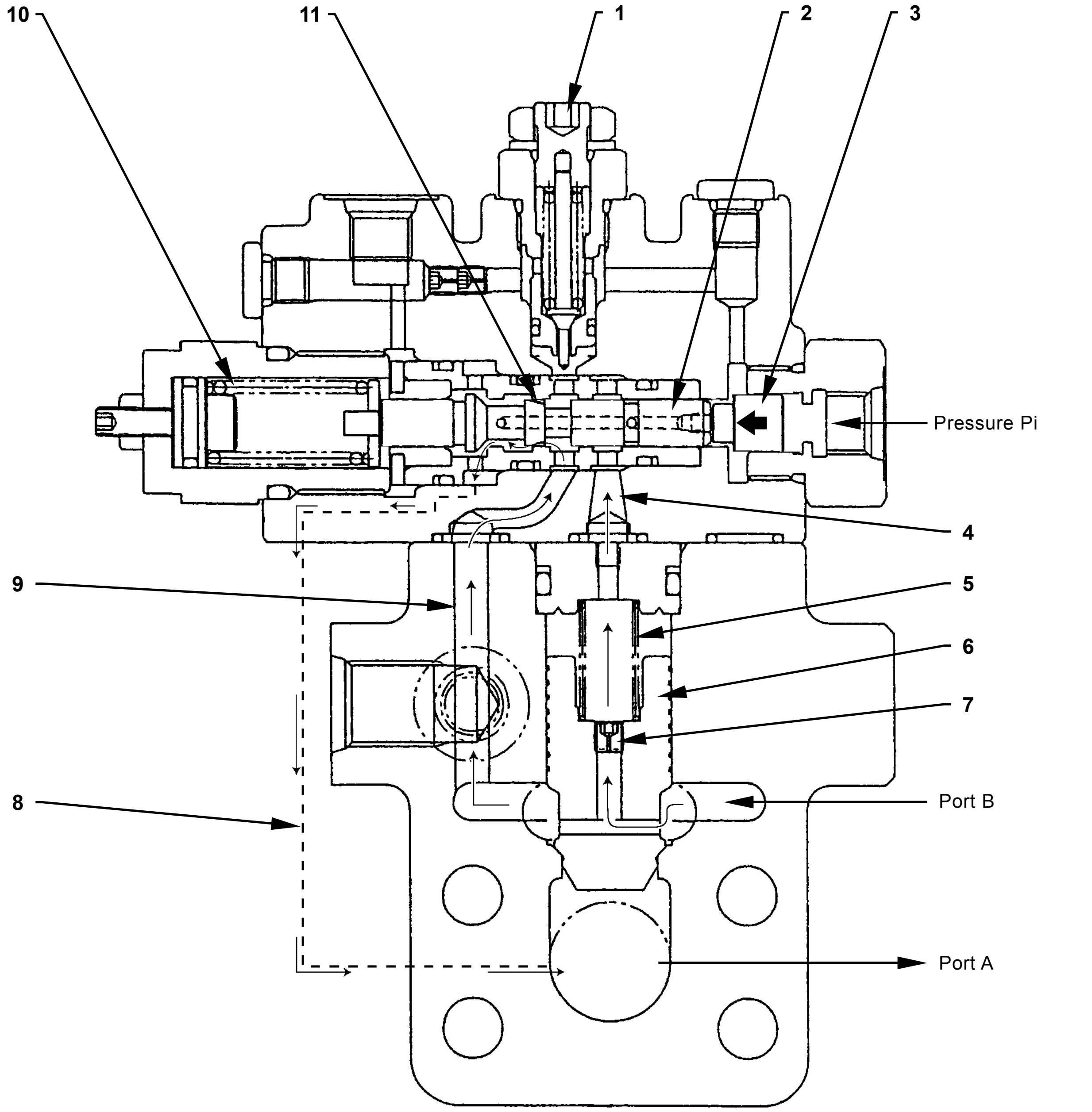


1 - Relief Valve	4 - Passage A	7 - Orifice	10 - Spring
2 - Spool	5 - Spring	8 - Passage B	11 - Orifice
3 - Piston	6 - Poppet	9 - Passage C	

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

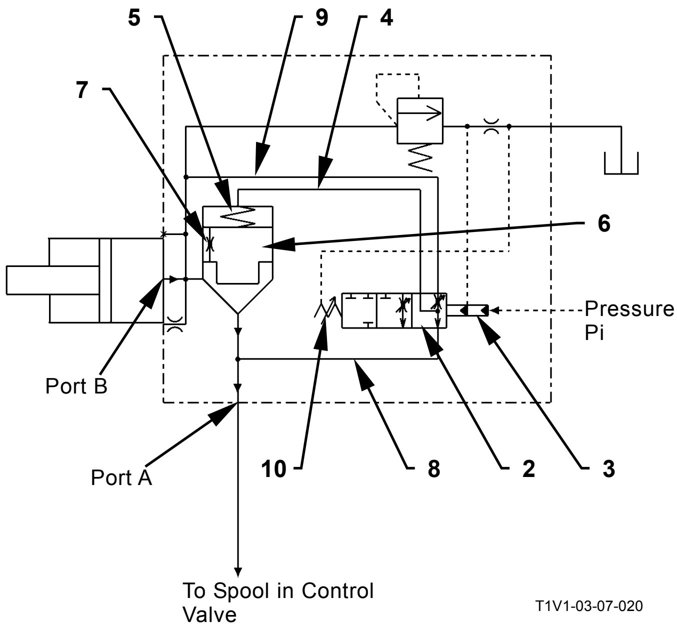


2 - Spool
3 - Piston
4 - Passage A
5 - Spring
6 - Poppet
7 - Orifice
8 - Passage B
9 - Passage C
10 - Spring



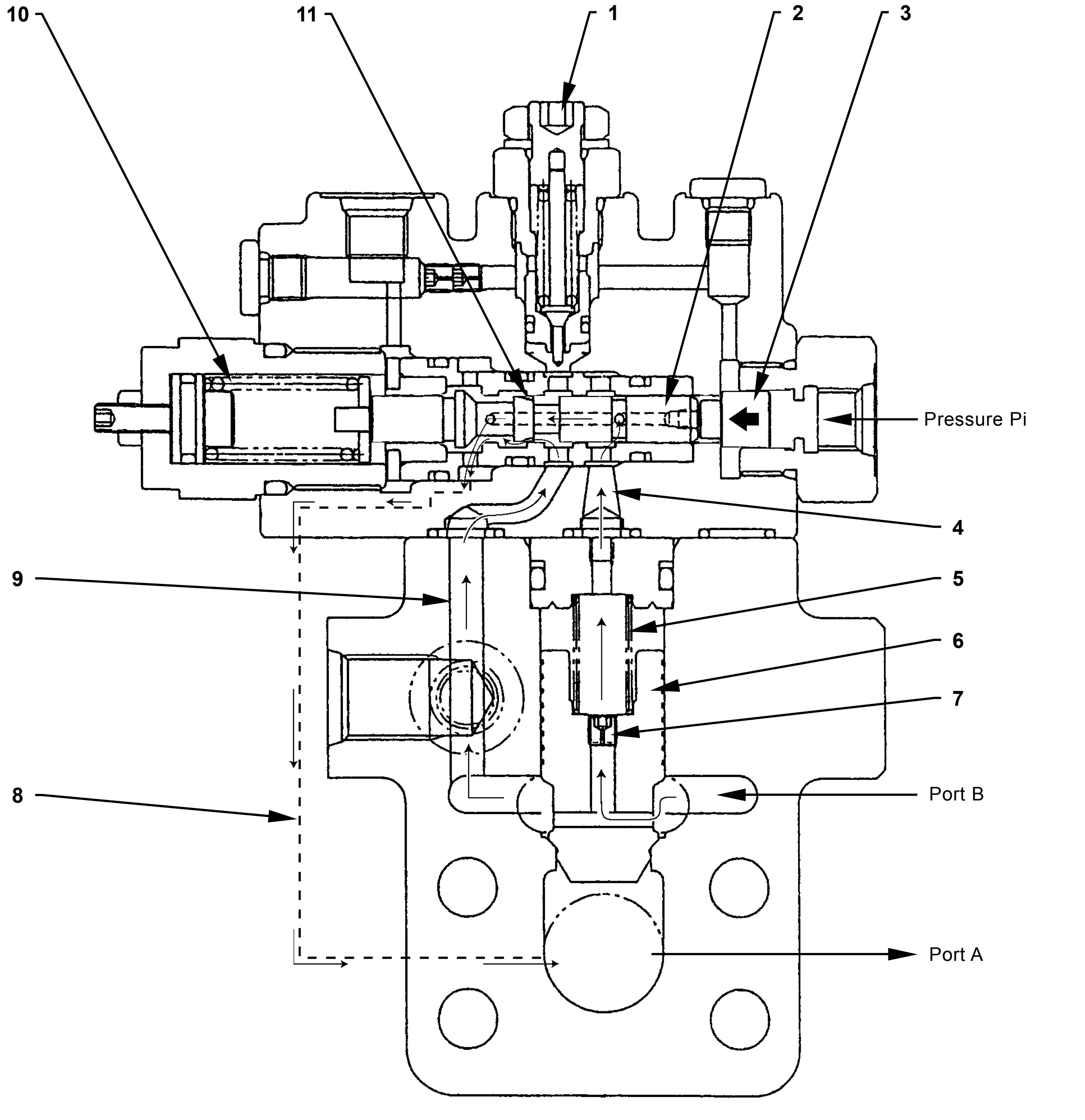
1 - Relief valve:	4 - Passage A	7 - Orifice	10 - Spring
2 - Spool	5 - Spring	8 - Passage B	11 - Orifice
3 - Piston	6 - Poppet	9 - Passage C	

- 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.



T1V1-03-07-020

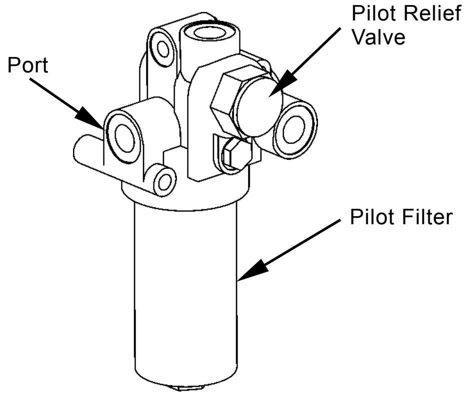
2 - Spool
3 - Piston
4 - Passage A
5 - Spring
6 - Poppet
7 - Orifice
8 - Passage B
9 - Passage C
10 - Spring



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	

PILOT RELIEF VALVE

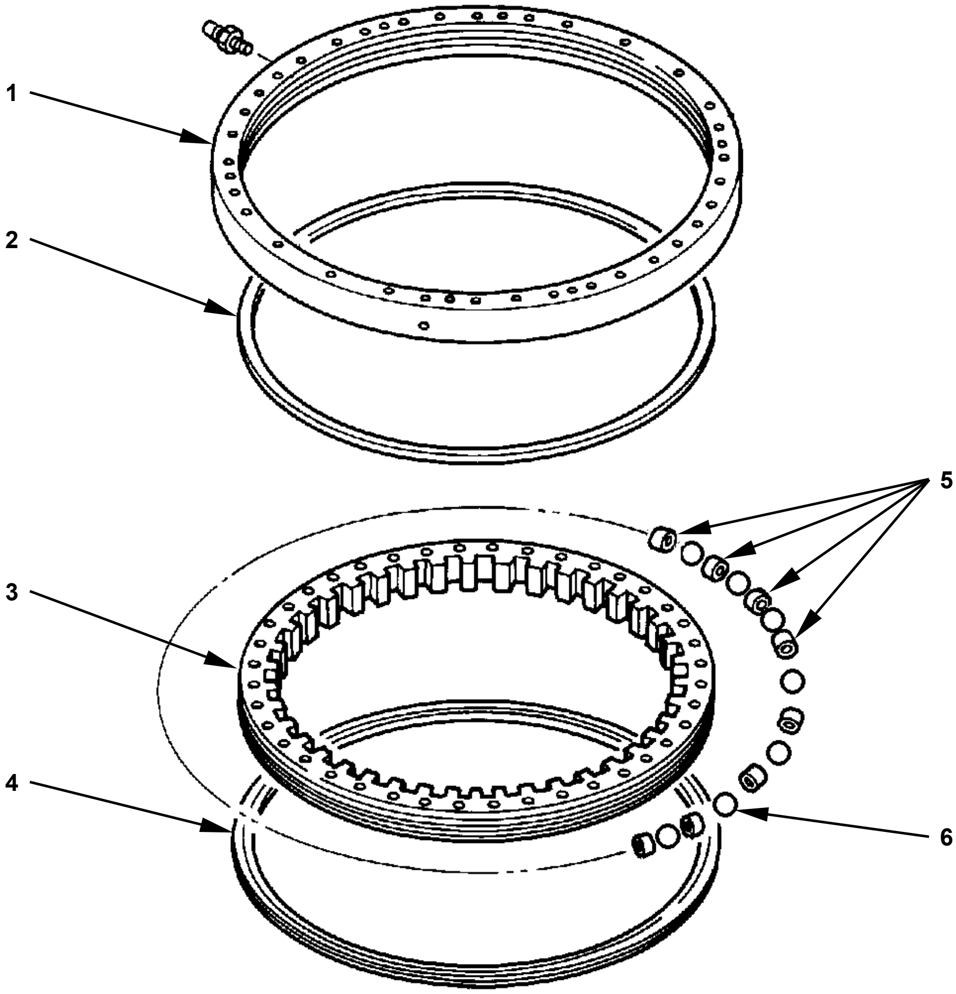
The pilot relief valve has a pilot filter incorporated.
The pilot relief valve functions to regulate pilot pump pressure oil routed to port P to a set constant pressure.



T178-03-07-001

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.

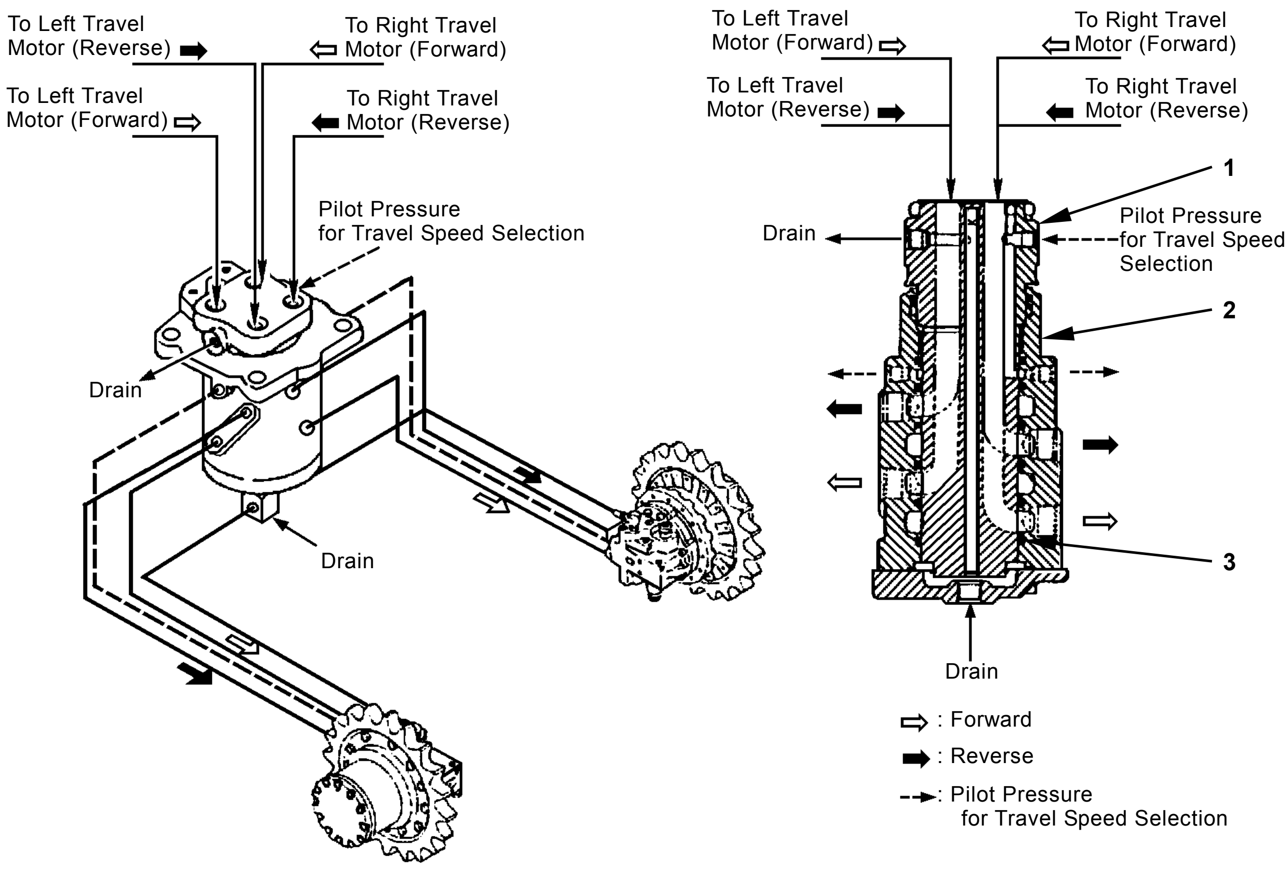


1 - Outer Race
2 - Seal
3 - Inner Race
4 - Seal
5 - Support
6 - Ball

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.



T157-03-02-004

1 - Spindle
2 - Body
3 - Seal

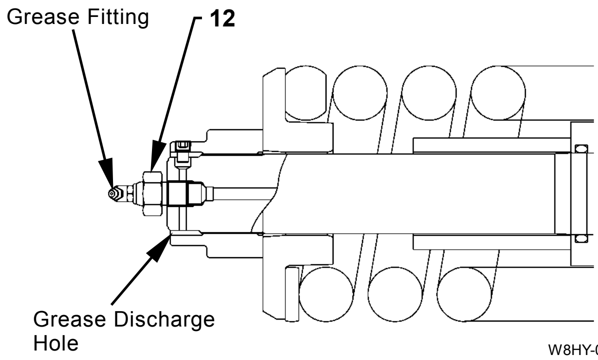
TRACK ADJUSTER

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.



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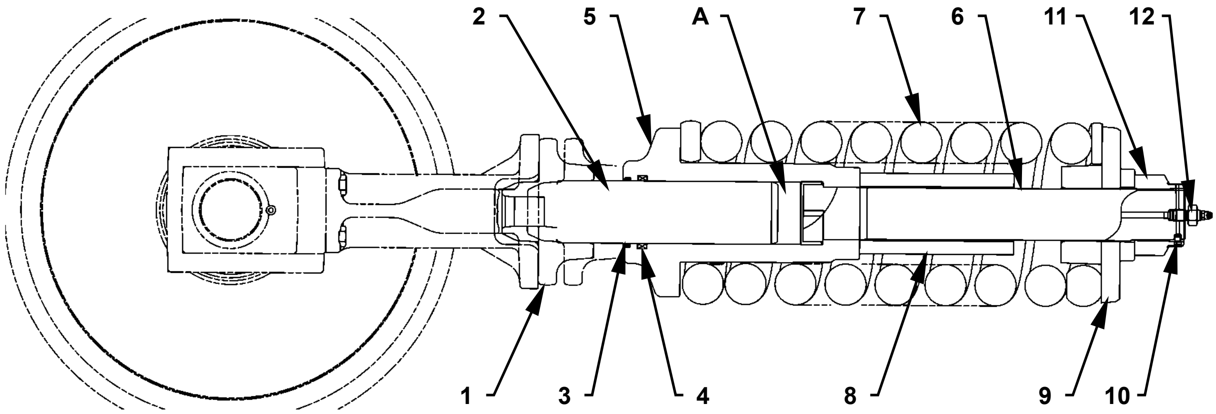

W1V7-03-04-002

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

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