PART NO. TO1V1-E-01

HITACHI

Technical Manual

Operational Principle

ZAXIS

200-3 class

200-3•200LC-3•210H-3•210LCH-3•210K-3•210LCK-3•210-3•210LC-3•
210LCN-3•240N-3

225US-3 class

225US-3•225USLC-3

225USR-3 class

225USR-3•225USRLC-3•225USRK-3•225USRLCK-3

240-3 class

240-3•240LC-3•250H-3•250LC-3•250LCN-3•250LCH-3•250K-3•250LCK-3

270-3 class

270-3•270LC-3•280LC-3•280LCN-3

Hydraulic Excavator

Service Manual consists of the following separate Part No;

Technical Manual (Operational Principle)	: Vol. No. TO1V1-E
Technical Manual (Troubleshooting)	: Vol. No. TT1V1-E
Workshop Manual	: Vol. No. W1V1-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.):

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Hitachi Construction Machinery Co. Ltd.
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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

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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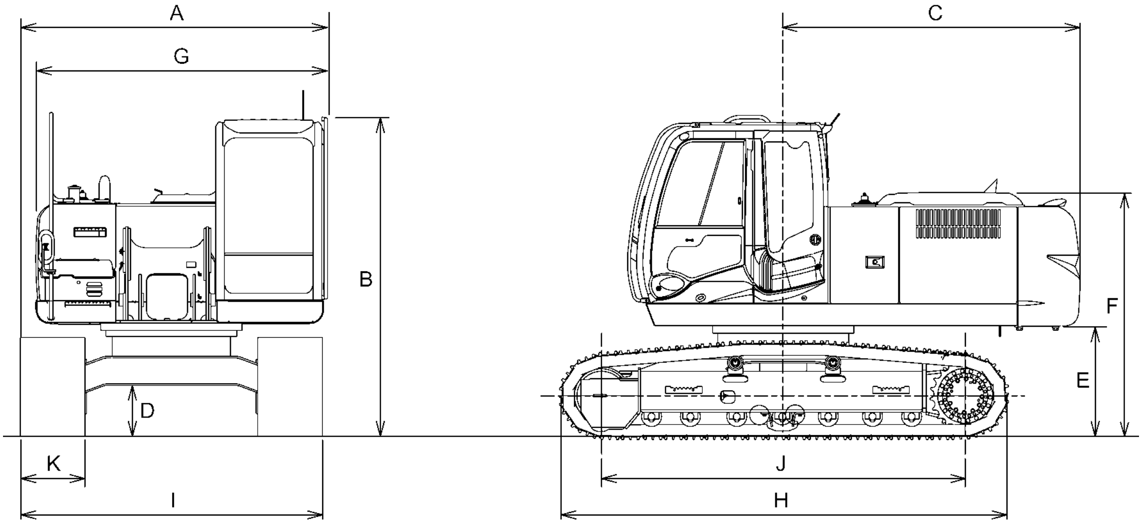
SPECIFICATIONS

ZAXIS200-3, ZAXIS200LC-3, ZAXIS210H-3, ZAXIS210LCH-3



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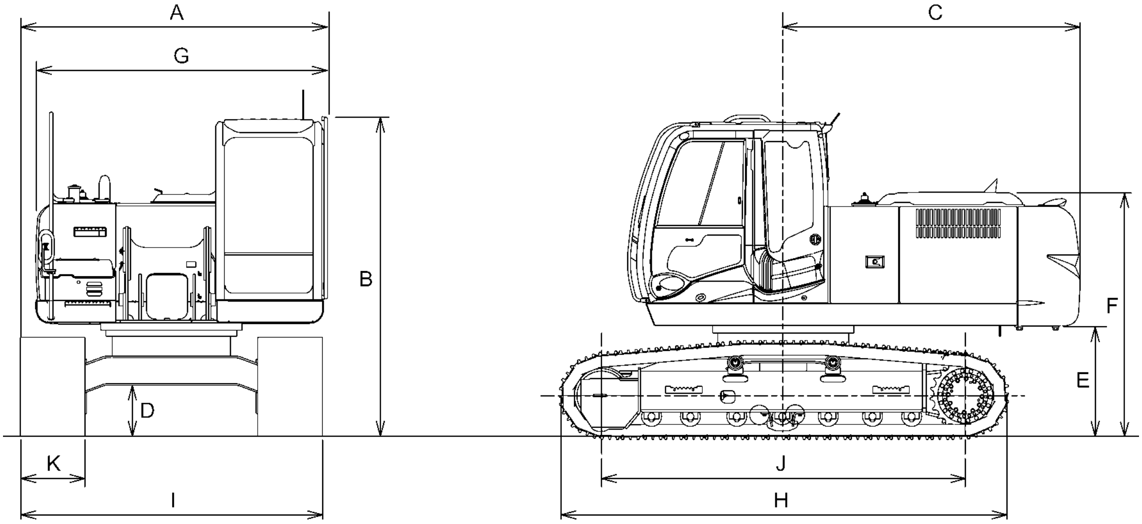
Model	ZAXIS200-3	ZAXIS200LC-3	ZAXIS210H-3	ZAXIS210LCH-3
Type of Front-End Attachment	2.91 m (9 ft 7 in) Arm		2.91 m (9 ft 7 in) H Arm	
Bucket Capacity (Heaped)	PCSA 0.8 m^3 (1.05 yd^3), CECE 0.7 m^3			
Operating Weight	19800 kg (43700 lb)	20400 kg (44974 lb)	21000 kg (46297 lb)	21500 kg (47399 lb)
Basic Machine Weight	15400 kg (34000 lb)	16000 kg (35274 lb)	16400 kg (36155 lb)	16800 kg (37037 lb)
Engine	ISUZU AI-4HK1XYSA-02 122 kW/2000 min^{-1} (166 PS/2000 rpm)			
A: Overall Width (Excluding back mirrors)	2860 mm (9 ft 5 in)	2990 (9 ft 10 in)	2860 (9 ft 5 in)	2990 (9 ft 10 in)
B: Cab Height	2950 mm (9 ft 8 in)			
C: Rear End Swing Radius	2750 mm (9 ft 0 in)			
D: Minimum Ground Clearance	* 450 mm (18 in)			
E: Counterweight Clearance	* 1030 mm (3 ft 5 in)			
F: Engine Cover Height	* 2270 mm (7 ft 5 in)			
G: Overall Width of Upperstructure	2710 mm (8 ft 11 in)			
H: Undercarriage Length	4170 mm (13 ft 8 in)	4470 mm (14 ft 8 in)	4170 mm (13 ft 8 in)	4470 mm (14 ft 8 in)
I: Undercarriage Width	2800 mm (9 ft 2 in)	2990 mm (9 ft 10 in)	2800 mm (9 ft 2 in)	2990 mm (9 ft 10 in)
J: Sprocket Center to Idler Center	3370 mm (11 ft 1 in)	3660 mm (12 ft 0 in)	3370 mm (11 ft 1 in)	3660 mm (12 ft 0 in)
K: Track Shoe Width	600 mm (24 in) (Grouser shoe)		600 mm (24 in) (Enhanced grouser shoe)	
Ground Pressure	44 kPa (0.45 kgf/cm^2, 6.4 psi)	42 kPa (0.43 kgf/cm^2, 6.1 psi)	47 kPa (0.48 kgf/cm^2, 6.8 psi)	44 kPa (0.45 kgf/cm^2, 6.4 psi)
Swing Speed	13.3 min^{-1} (rpm)			
Travel Speed (fast/slow)	5.5/3.5 km/h (3.4/2.2 mph)			
Gradeability	35° (tanθ = 0.70)			

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

ZAXIS210K-3, 210LCK-3



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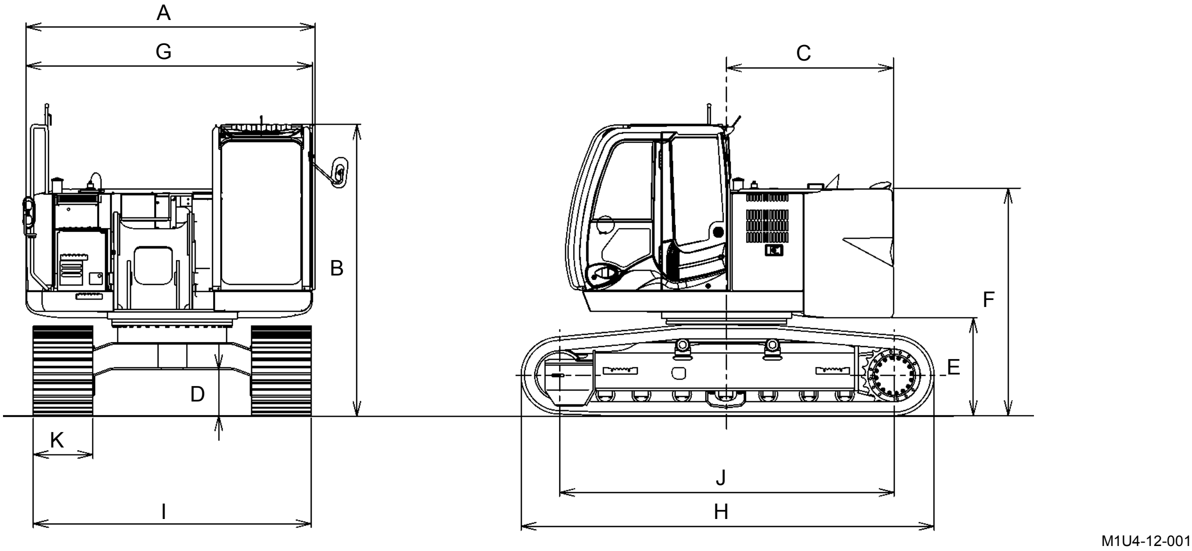
Model	ZAXIS210K-3		ZAXIS210LCK-3	
	Standard	High-Grade	Standard	High-Grade
Type of Front-End Attachment	2.91 m (9 ft 7 in) K Arm			
Bucket Capacity (Heaped)	PCSA 0.8 m^3 (1.05 yd^3), CECE 0.7 m^3			
Operating Weight	21100 kg (46517 lb)	21900 kg (48218 lb)	21600 kg (47619 lb)	22300 kg (19163 lb)
Basic Machine Weight	16400 kg (36155 lb)	17100 kg (37699 lb)	16800 kg (37037 lb)	17500 kg (38581 lb)
Engine	ISUZU AI-4HK1XYSA-02 122 kW/2000 min^{-1} (166 PS/2000 rpm)			
A: Overall Width (Excluding back mirrors)	2860 mm (9 ft 5 in)		2990 mm (9 ft 10 in)	
B: Cab Height	2950 mm (9 ft 8 in)	3080 mm (10 ft 1 in)	2950 mm (9 ft 8 in)	3080 mm (10 ft 1 in)
C: Rear End Swing Radius	2750 mm (9 ft 0 in)			
D: Minimum Ground Clearance	* 450 mm (18 in)			
E: Counterweight Clearance	* 1030 mm (3 ft 5 in)			
F: Engine Cover Height	* 2270 mm (7 ft 5 in)			
G: Overall Width of Upperstructure	2710 mm (8 ft 11 in)			
H: Undercarriage Length	4170 mm (13 ft 8 in)		4470 mm (14 ft 8 in)	
I: Undercarriage Width	2800 mm (9 ft 2 in)		2990 mm (9 ft 10 in)	
J: Sprocket Center to Idler Center	3370 mm (11 ft 1 in)		3660 mm (12 ft 0 in)	
K: Track Shoe Width	600 mm (24 in) (Enhanced grouser shoe)			
Ground Pressure	47 kPa (0.48 kgf/cm^2, 6.8 psi)	49 kPa (0.50 kgf/cm^2, 7.1 psi)	45 kPa (0.46, kgf/cm^2, 6.5 psi)	46 kPa (0.47 kgf/cm^2, 6.7 psi)
Swing Speed	13.3 min^{-1} (rpm)			
Travel Speed (fast/slow)	5.5/3.5 km/h (3.4/2.2 mph)			
Gradeability	35° (tanθ = 0.70)			

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

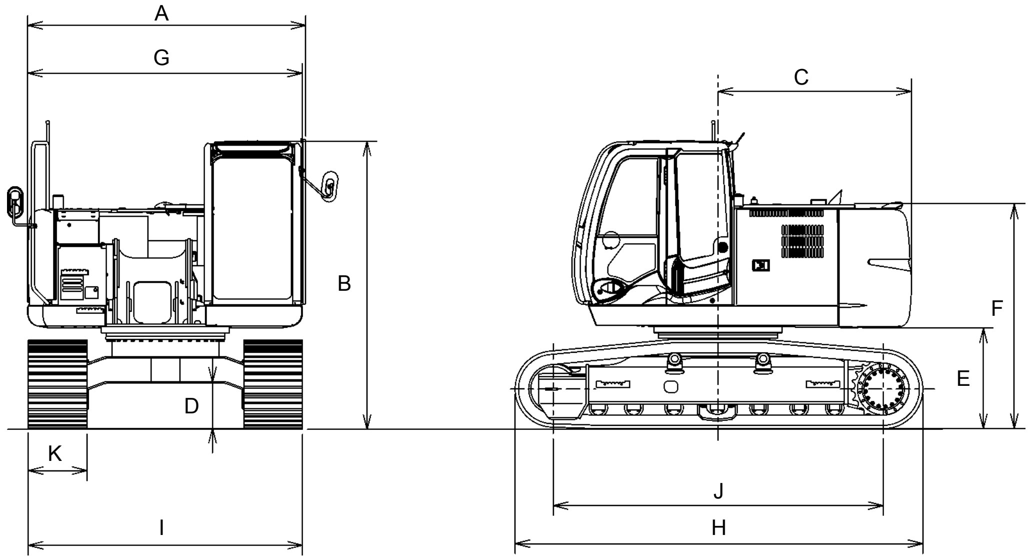
ZAXIS225US-3, 225USLC-3



Model	ZAXIS225US-3	ZAXIS225USLC-3
Type of Front-End Attachment	2.91 m (9 ft 7 in) Arm	
Bucket Capacity (Heaped)	PCSA 0.8 m^3 (1.05 yd^3), CECE 0.7 m^3	
Operating Weight	23200 kg (51147 lb)	23600 kg (52029 lb)
Basic Machine Weight	19000 kg (41887 lb)	19400 kg (42769 lb)
Engine	ISUZU AI-4HK1XYSA-02 122 kW/2000 min^{-1} (166 PS/2000 rpm)	
A: Overall Width (Excluding back mirrors)	2940 mm (9 ft 8 in)	2990 mm (9 ft 10 in)
B: Cab Height	2950 mm (9 ft 8 in)	
C: Rear End Swing Radius	1680 mm (5 ft 6 in)	
D: Minimum Ground Clearance	* 450 mm (18 in)	
E: Counterweight Clearance	* 975 mm (3 ft 2 in)	
F: Engine Cover Height	* 2300 mm (7 ft 7 in)	
G: Overall Width of Upperstructure	2870 mm (9 ft 5 in)	
H: Undercarriage Length	4170 mm (13 ft 8 in)	4460 mm (14 ft 8 in)
I: Undercarriage Width	2800 mm (9 ft 2 in)	2990 mm (9 ft 10 in)
J: Sprocket Center to Idler Center	3370 mm (11 ft 1 in)	3660 mm (12 ft 0 in)
K: Track Shoe Width	600 mm (24 in) (Grouser shoe)	
Ground Pressure	52 kPa (0.53 kgf/cm^2, 7.6 psi)	49 kPa (0.50 kgf/cm^2, 7.1 psi))
Swing Speed	13.3 min^{-1} (rpm)	
Travel Speed (fast/slow)	5.5/3.5 km/h (3.4/2.2 mph)	
Gradeability	35° (tanθ = 0.70)	

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

ZAXIS225USR-3, 225USRLC-3, 225USRK-3, 225USRLCK-3



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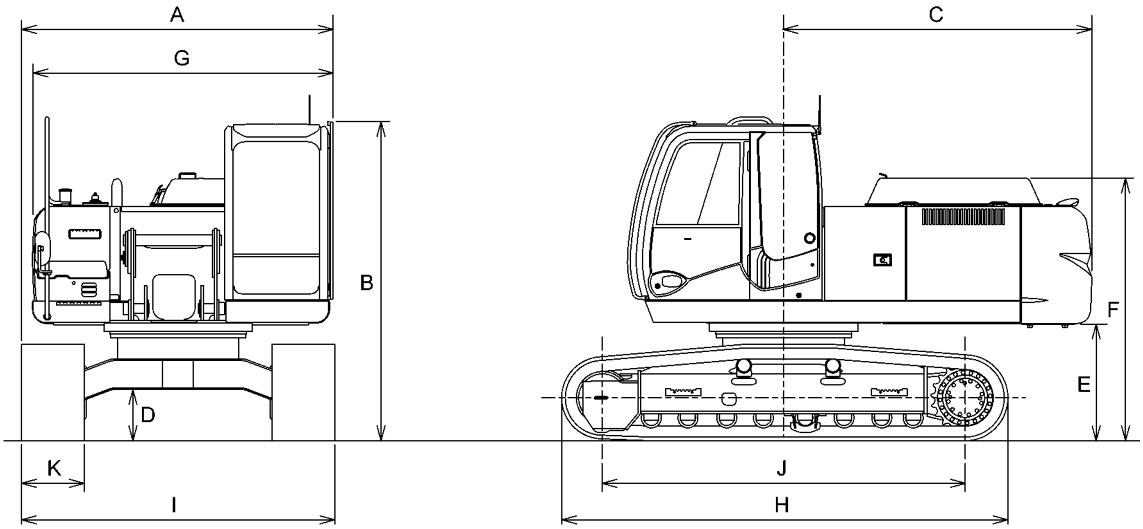
Model	ZAXIS225USR-3	ZAXIS225USRLC-3	ZAXIS225USRK-3	ZAXIS225USRLCK-3
Type of Front-End Attachment	2.91 m (9 ft 7 in) Arm		2.91 m (9 ft 7 in) H Arm	
Bucket Capacity (Heaped)	PCSA 0.8 m^3 (1.05 yd^3), CECE 0.7 m^3			
Operating Weight	22300 kg (49163 lb)	22700 kg (50044 lb)	23400 kg (51588 lb)	23900 kg (52690 lb)
Basic Machine Weight	18000 kg (39683 lb)	18400 kg (40565 lb)	18800 kg (41447 lb)	19200 kg (42328 lb)
Engine	ISUZU AI-4HK1XYSA-02 122 kW/2000 min^{-1} (166 PS/2000 rpm)			
A: Overall Width (Excluding back mirrors)	2860 mm (9 ft 5 in)	2990 (9 ft 10 in)	2860 (9 ft 5 in)	2990 (9 ft 10 in)
B: Cab Height	2950 mm (9 ft 8 in)		3080 mm (ft in)	
C: Rear End Swing Radius	1990 mm (6 ft 6 in)			
D: Minimum Ground Clearance	* 450 mm (18 in)			
E: Counterweight Clearance	* 1010 mm (3 ft 4 in)			
F: Engine Cover Height	* 2300 mm (7 ft 7 in)			
G: Overall Width of Upperstructure	2790 mm (9 ft 2 in)			
H: Undercarriage Length	4170 mm (13 ft 8 in)	4460 mm (14 ft 8 in)	4170 mm (13 ft 8 in)	4460 mm (14 ft 8 in)
I: Undercarriage Width	2800 mm (9 ft 2 in)	2990 mm (9 ft 10 in)	2800 mm (9 ft 2 in)	2990 mm (9 ft 10 in)
J: Sprocket Center to Idler Center	3370 mm (11 ft 1 in)	3660 mm (12 ft 0 in)	3370 mm (11 ft 1 in)	3660 mm (12 ft 0 in)
K: Track Shoe Width	600 mm (24 in) (Grouser shoe)		600 mm (24 in) (Enhanced grouser shoe)	
Ground Pressure	50 kPa (0.51 kgf/cm^2, 7.3 psi)	47 kPa (0.48 kgf/cm^2, 6.8 psi)	52 kPa (0.53 kgf/cm^2, 7.6 psi)	50 kPa (0.51 kgf/cm^2, 7.3 psi)
Swing Speed	13.3 min^{-1} (rpm)			
Travel Speed (fast/slow)	5.5/3.5 km/h (3.4/2.2 mph)			
Gradeability	35° ($\tan\theta = 0.70$)			

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

ZAXIS240-3, ZAXIS240LC-3, ZAXIS250H-3, ZAXIS250LCH-3



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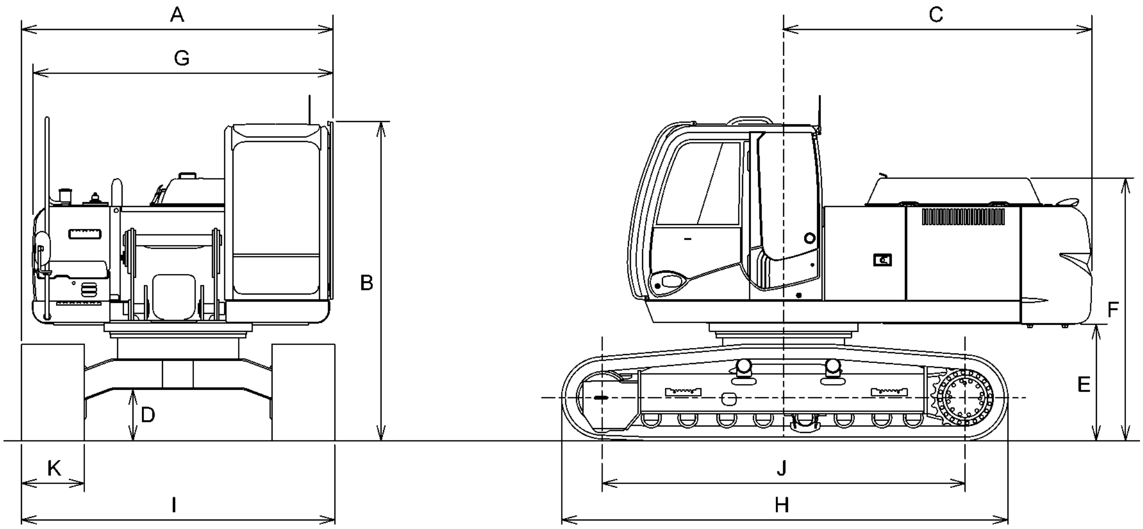
Model	ZAXIS240-3	ZAXIS240LC-3	ZAXIS250H-3	ZAXIS250LCH-3
Type of Front-End Attachment	2.96 m (9 ft 9 in) Arm		2.96 m (9 ft 9 in) H Arm	
Bucket Capacity (Heaped)	PCSA 1.0 m^3 (1.3 yd^3), CECE 0.9 m^3			
Operating Weight	23400 kg (51600 lb)	23900 kg (52690 lb)	24700 kg (54454 lb)	25300 kg (55776 lb)
Basic Machine Weight	17800 kg (39200 lb)	18400 kg (40565 lb)	18900 kg (41667 lb)	19500 kg (42990 lb)
Engine	ISUZU AH-4HK1XYSA-01 132kW/2000 min^{-1} (180 PS/2000 rpm)			
A: Overall Width (Excluding back mirrors)	2990 mm (9 ft 10 in)	3190 (10 ft 6 in)	2990 mm (9 ft 10 in)	3190 (10 ft 6 in)
B: Cab Height	3010 mm (9 ft 11 in)			
C: Rear End Swing Radius	2940 mm (9 ft 8 in)			
D: Minimum Ground Clearance	* 460 mm (18 in)			
E: Counterweight Clearance	* 1090 mm (3 ft 7 in)			
F: Engine Cover Height	* 2425 mm (7 ft 12 in)			
G: Overall Width of Upperstructure	2890 mm (9 ft 6 in)			
H: Undercarriage Length	4260 mm (13 ft 12 in)	4640 mm (15 ft 3 in)	4260 mm (13 ft 12 in)	4640 mm (15 ft 3 in)
I: Undercarriage Width	2990 mm (9 ft 10 in)	3190 mm (10 ft 6 in)	2990 mm (9 ft 10 in)	3190 mm (10 ft 6 in)
J: Sprocket Center to Idler Center	3463 mm (11 ft 4 in)	3845 mm (12 ft 7 in)	3463 mm (11 ft 4 in)	3845 mm (12 ft 7 in)
K: Track Shoe Width	600 mm (24 in) (Grouser shoe)		600 mm (24 in) (Enhanced grouser shoe)	
Ground Pressure	51 kPa (0.52 kgf/cm^2, 7.4 psi)	47 kPa (0.48 kgf/cm^2, 6.8 psi)	54 kPa (0.55 kgf/cm^2, 7.6 psi)	50 kPa (0.51 kgf/cm^2, 7.3 psi)
Swing Speed	13.5 min^{-1} (rpm)			
Travel Speed (fast/slow)	5.5/3.4 km/h (3.4/2.1 mph)			
Gradeability	35° ($\tan\theta = 0.70$)			

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

ZAXIS250K-3, 250LCK-3



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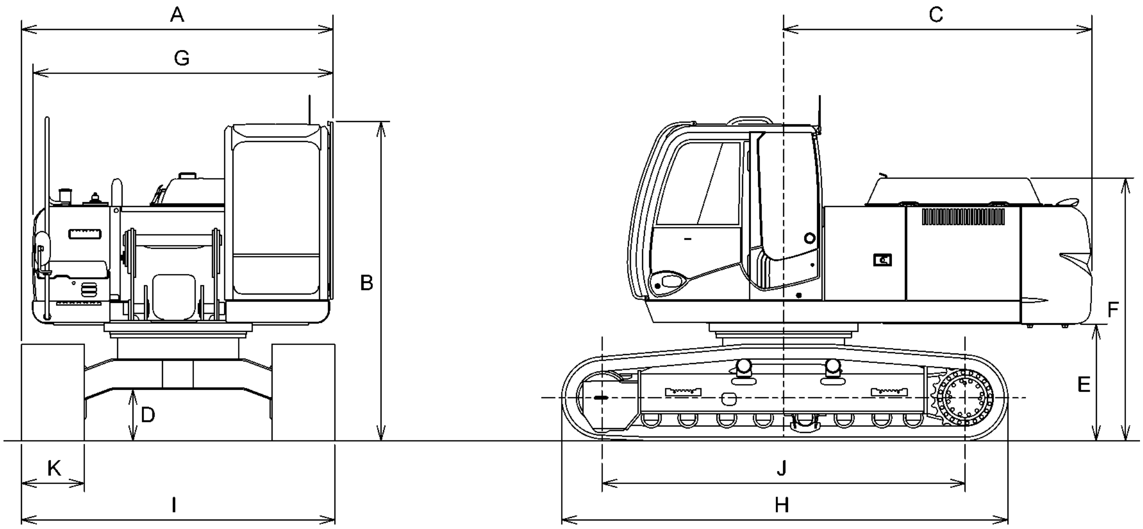
Model	ZAXIS250K-3	ZAXIS250LCK-3
Type of Front-End Attachment	2.96 m (9 ft 9 in) K Arm	
Bucket Capacity (Heaped)	PCSA 1.0 m^3 (1.3 yd^3), CECE 0.9 m^3	
Operating Weight	25400 kg (55997 lb)	26000 kg (57320 lb)
Basic Machine Weight	19500 kg (42990 lb)	20100 kg (44312 lb)
Engine	ISUZU AH-4HK1XYSA-01 132 kW/2000 min^{-1} (180 PS/2000 rpm)	
A: Overall Width (Excluding back mirrors)	2990 mm (9 ft 10 in)	3190 mm (ft in)
B: Cab Height	3140 mm (10 ft 4 in)	
C: Rear End Swing Radius	2940 mm (9 ft 8 in)	
D: Minimum Ground Clearance	* 460 mm (18 in)	
E: Counterweight Clearance	* 1090 mm (3 ft 7 in)	
F: Engine Cover Height	* 2425 mm (7 ft 12 in)	
G: Overall Width of Upperstructure	2890 mm (9 ft 6 in)	
H: Undercarriage Length	4260 mm (13 ft 12 in)	4460 mm (14 ft 8 in)
I: Undercarriage Width	2990 mm (9 ft 10 in)	3190 mm (10 ft 6 in)
J: Sprocket Center to Idler Center	3463 mm (11 ft 4 in)	3845 mm (12 ft 7 in)
K: Track Shoe Width	600 mm (24 in) (Enhanced grouser shoe)	
Ground Pressure	56 kPa (0.57 kgf/cm^2, 8.1 psi)	42 kPa (0.43 kgf/cm^2, 6.1 psi))
Swing Speed	13.5 min^{-1} (rpm)	
Travel Speed (fast/slow)	5.5/3.4 km/h (3.4/2.1 mph)	
Gradeability	35° ($\tan\theta = 0.70$)	

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

ZAXIS270-3, ZAXIS270LC-3



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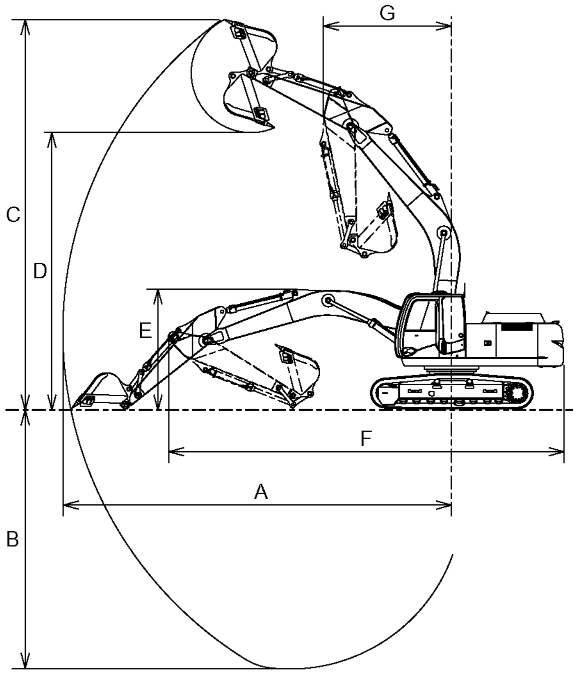
Model	ZAXIS270-3	ZAXIS270LC-3
Type of Front-End Attachment	3.11 m (10 ft 2 in) Arm	
Bucket Capacity (Heaped)	PCSA 1.1 m^3 (1.44 yd^3), CECE 1.0 m^3	
Operating Weight	27300 kg (60200 lb)	27800 kg (61288 lb)
Basic Machine Weight	21300 kg (47000 lb)	21800 kg (48060 lb)
Engine	ISUZU AH-4HK1XSA-03 140 kW/2100 min^{-1} (190 PS/2100 rpm)	
A: Overall Width (Excluding back mirrors)	3190 mm (10 ft 6 in)	
B: Cab Height	3100 mm (10 ft 2 in)	
C: Rear End Swing Radius	2940 mm (9 ft 8 in)	
D: Minimum Ground Clearance	* 510 mm (20 in)	
E: Counterweight Clearance	* 1180 mm (3 ft 11 in)	
F: Engine Cover Height	* 2515 mm (8 ft 3 in)	
G: Overall Width of Upperstructure	2890 mm (9 ft 6 in)	
H: Undercarriage Length	4670 mm (15 ft 4 in)	4940 mm (16 ft 2 in)
I: Undercarriage Width	3190 mm (10 ft 6 in)	
J: Sprocket Center to Idler Center	3720 mm (12 ft 3 in)	4052 mm (13 ft 4 in)
K: Track Shoe Width	600 mm (24 in) (Grouser shoe)	
Ground Pressure	55 kPa (0.56 kgf/cm^2, 8.0 psi)	52 kPa (0.53 kgf/cm^2, 7.6 psi))
Swing Speed	12.6 min^{-1} (rpm)	
Travel Speed (fast/slow)	5.5/3.3 km/h (3.4/2.1 mph)	
Gradeability	35° ($\tan\theta$ = 0.70)	

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

WORKING RANGES

ZAXIS200-3, ZAXIS200LC-3, ZAXIS210H-3, ZAXIS210LCH-3
(Grouser Shoe)



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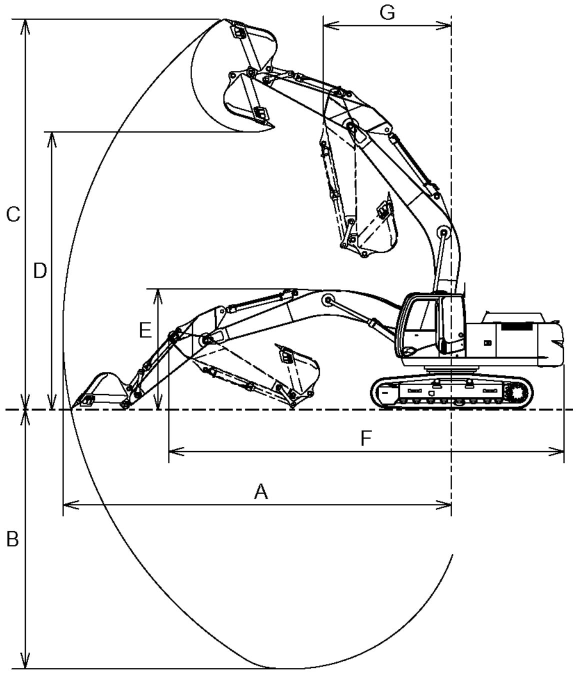
Model	ZAXIS200-3, 200LC-3				ZAXIS210H-3, 210LCH-3	
Category	2.42 m (7 ft 11in) Arm		2.91 m (9 ft 7 in) Arm		2.91 m (9 ft 7 in) H Arm	
	Backhoe		Backhoe		Backhoe	
Item	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	9430	30’11”	9920	32’7”	9920	32’7”
B: Maximum Digging Depth	6180	20’3”	6670	21’11”	6670	21’11”
C: Maximum Cutting Height	9670	31’9”	10040	32’11”	10040	32’11”
D: Maximum Dumping Height	6830	22’5”	7180	23’7”	7180	23’7”
E: Transport Height	3180	10’5”	3010	9’11”	3010	9’11”
F: Overall Transport Length	9605	31’6”	9520	31’3”	9520	31’3”
G: Minimum Swing Radius	3280	10’9”	3180	10’5”	3180	10’5”

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

ZAXIS210K-3, 210LCK-3
(Grouser Shoe)



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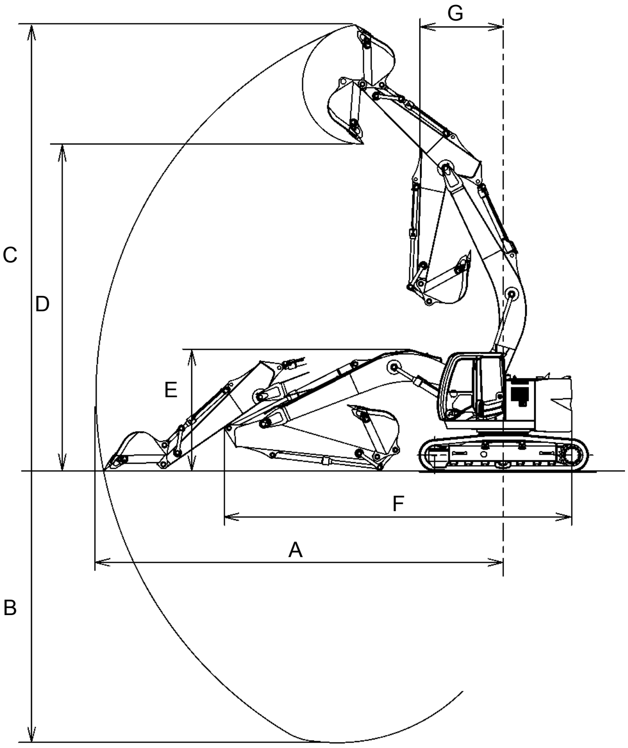
Model / Item \ Category	ZAXIS210H-3, 210LCH-3	
	2.91 m (9 ft 7 in) K Arm	
	Backhoe	
	mm	ft·in
A: Maximum Digging Reach	9920	32'7"
B: Maximum Digging Depth	6670	21'11"
C: Maximum Cutting Height	10040	32'11"
D: Maximum Dumping Height	7180	23'7"
E: Transport Height	3010 (Standard) 3080 (High-grade)	9'11" 10'1"
F: Overall Transport Length	9520	31'3"
G: Minimum Swing Radius	3180	10'5"

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

ZAXIS225US-3, 225USLC-3
(Grouser Shoe)



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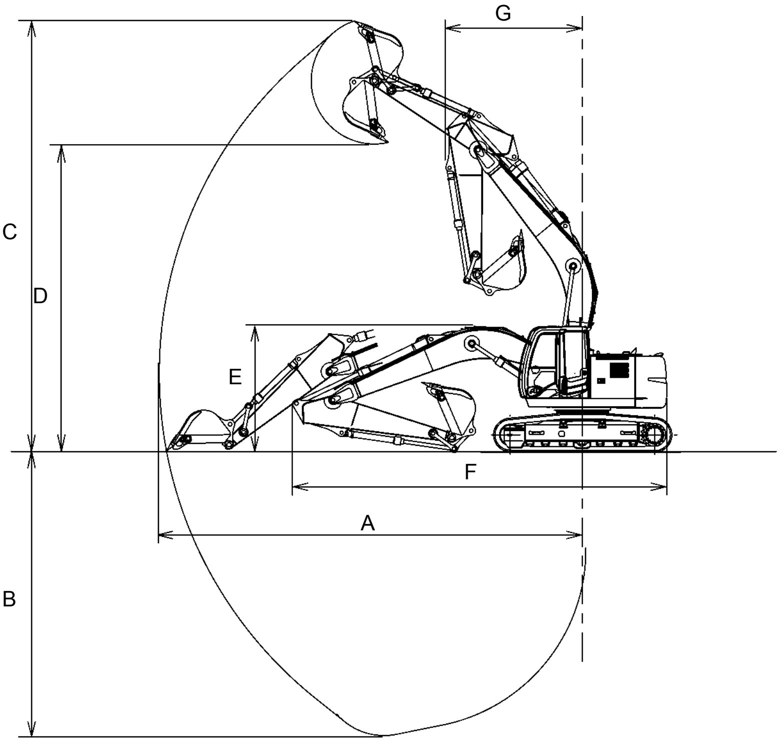
Item \ Model / Category	ZAXIS225US-3, 225USLC-3			
	2.42 m (7 ft 11in) Arm		2.91 m (9 ft 7 in) Arm	
	Backhoe		Backhoe	
	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	9520	31’3”	10010	32’10”
B: Maximum Digging Depth	6210	20’4”	6700	21’12”
C: Maximum Cutting Height	10560	34’8”	10980	36’0”
D: Maximum Dumping Height	7640	25’1”	8050	26’5”
E: Transport Height	3200	10’6”	2980	9’9”
F: Overall Transport Length	9040	29’8”	8920	29’3”
G: Minimum Swing Radius	2740	8’12”	2370	7’9”

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

ZAXIS225USR-3, 225USRLC-3, 225USRK-3, 225USRLCK-3
(Grouser Shoe)

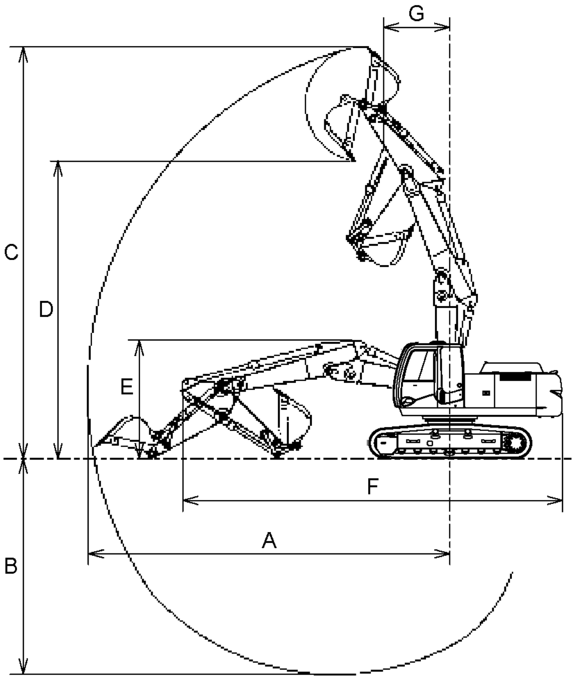


M1U4-12-004

Item \ Category / Model	ZAXIS225USR-3, 225USRLC-3				ZAXIS225USRK-3, 225USRLCK-3	
	2.42 m (7 ft 11in) Arm		2.91 m (9 ft 7 in) Arm		2.91 m (9 ft 7 in) H Arm	
	Backhoe		Backhoe		Backhoe	
	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	9430	30’11”	9920	32’7”	9920	32’7”
B: Maximum Digging Depth	6180	20’3”	6670	21’11”	6670	21’11”
C: Maximum Cutting Height	9670	31’9”	10040	32’11”	10040	32’11”
D: Maximum Dumping Height	6830	22’5”	7180	23’7”	7180	23’7”
E: Transport Height	3180	10’5”	3010	9’11”	2950	9’8”
F: Overall Transport Length	8940	29’4”	9520	31’3”	8850	29’0”
G: Minimum Swing Radius	3280	10’9”	3180	10’5”	3180	10’5”

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

ZAXIS240-3 (Machine with 2-Piece Boom)

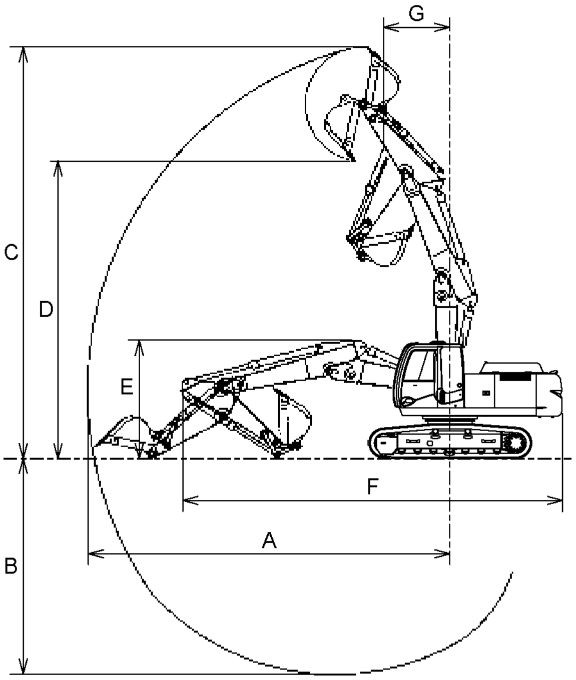


T1V1-01-01-005

Item	Model: ZAXIS240-3 / Category: 2.19 m (7 ft 3 in) Arm		2.5 m (8 ft 2 in) Arm		2.96 m (9 ft 9 in) Arm		3.61 m (11 ft 10 in) Arm	
	mm	ft·in	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	9770	32’1”	10010	32’10”	10430	34’3”	11070	36’4”
B: Maximum Digging Depth	5810	19’1”	6080	19’11”	6530	21’5”	7190	23’7”
C: Maximum Cutting Height	11300	37’1”	11470	37’8”	11840	38’10”	12420	40’9”
D: Maximum Dumping Height	8210	27’1”	8350	27’5”	8720	28’7”	9300	30’6”
E: Transport Height	3150	10’4”	3200	10’6”	3090	10’2”	3340	10’12”
F: Overall Transport Length	10230	33’7”	10250	33’8”	10220	33’6”	10190	33’5”
G: Minimum Swing Radius	2500	8’2”	2560	8’5”	2310	7’7”	2610	8’7”

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

ZAXIS270-3 (Machine with 2-Piece Boom)

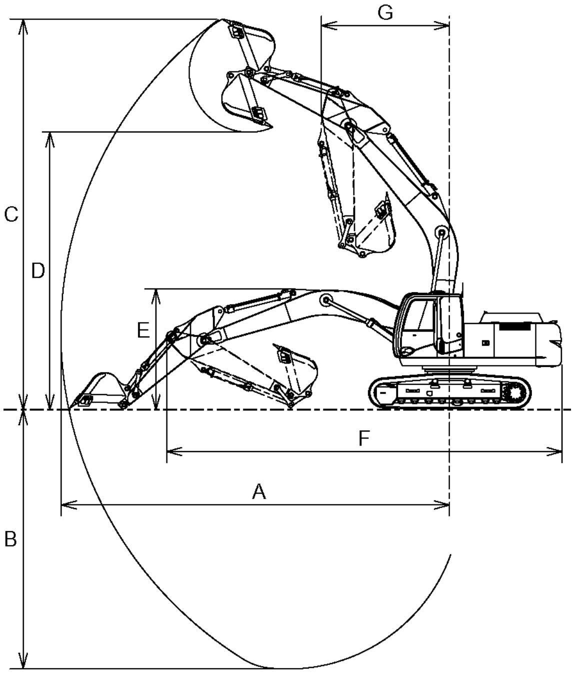


T1V1-01-01-005

Item \ Category / Model	ZAXIS270-3					
	2.42 m (7 ft11 in) Arm		3.11 m (10 ft 2 in) Arm		3.76 m (12 ft 4 in) Arm	
	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	10070	36’4”	10740	35’3”	11330	37’2”
B: Maximum Digging Depth	6020	19’9”	6690	21’11”	7330	24’1”
C: Maximum Cutting Height	11500	37’9”	12080	39’8”	12550	41’2”
D: Maximum Dumping Height	8390	27’6”	8960	29’5”	9430	30’11”
E: Transport Height	3220	10’7”	3150	10’4”	3380	11’1”
F: Overall Transport Length	10330	33’10”	10300	33’10”	10310	33’9”
G: Minimum Swing Radius	2820	9’3”	2580	8’6”	2740	8’12”

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

ZAXIS240-3, ZAXIS240LC-3
(Grouser Shoe)

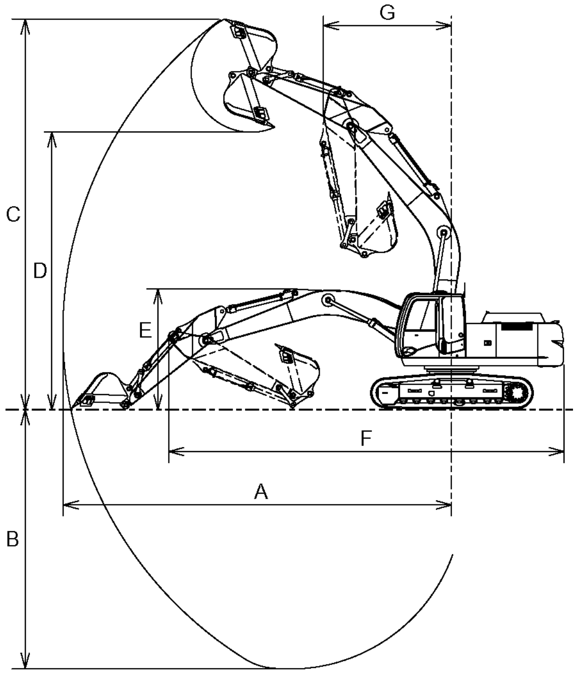


T1V1-01-01-002

Item \ Category / Model	ZAXIS240-3, 240LC-3					
	2.5 m (8 ft 2 in) Arm		2.96 m (9 ft 9 in) Arm		3.61 m (11 ft 10 in) Arm	
	Backhoe		Backhoe		Backhoe	
	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	9880	32’5”	10290	33’9”	10910	35’10”
B: Maximum Digging Depth	6500	21’4”	6960	22’10”	7610	24’12”
C: Maximum Cutting Height	9950	32’8”	10160	33’4”	10560	34’8”
D: Maximum Dumping Height	6990	22’11”	7200	23’8”	7580	24’10”
E: Transport Height	3370	11’1”	3070	10’1”	3320	10’11”
F: Overall Transport Length	10270	33’8”	10150	33’4”	10200	33’6”
G: Minimum Swing Radius	3480	11’5”	3440	11’3”	3430	11’3”

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

ZAXIS250H-3, ZAXIS250LCH-3, ZAXIS250K-3, ZAXIS250LCK-3
(Grouser Shoe)

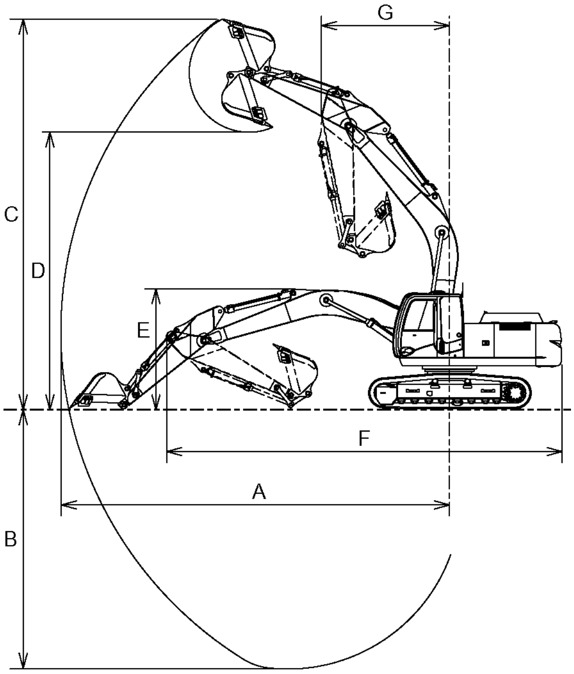


T1V1-01-01-002

Model / Category / Item	ZAXIS250H-3, 250LCH-3		ZAXIS250K-3, 250LCK-3	
	2.96 m (9 ft 9 in) H Arm		2.96 m (9 ft 9 in) K Arm	
	Backhoe		Backhoe	
	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	10290	33'9"	10290	33'9"
B: Maximum Digging Depth	6960	22'10"	6960	22'10"
C: Maximum Cutting Height	10160	33'4"	10160	33'4"
D: Maximum Dumping Height	7200	23'8"	7200	23'8"
E: Transport Height	3070	10'1"	3070	10'1"
F: Overall Transport Length	10150	33'4"	10150	33'4"
G: Minimum Swing Radius	3440	11'3"	3440	11'3"

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

ZAXIS270-3, ZAXIS270LC-3
(Grouser Shoe)



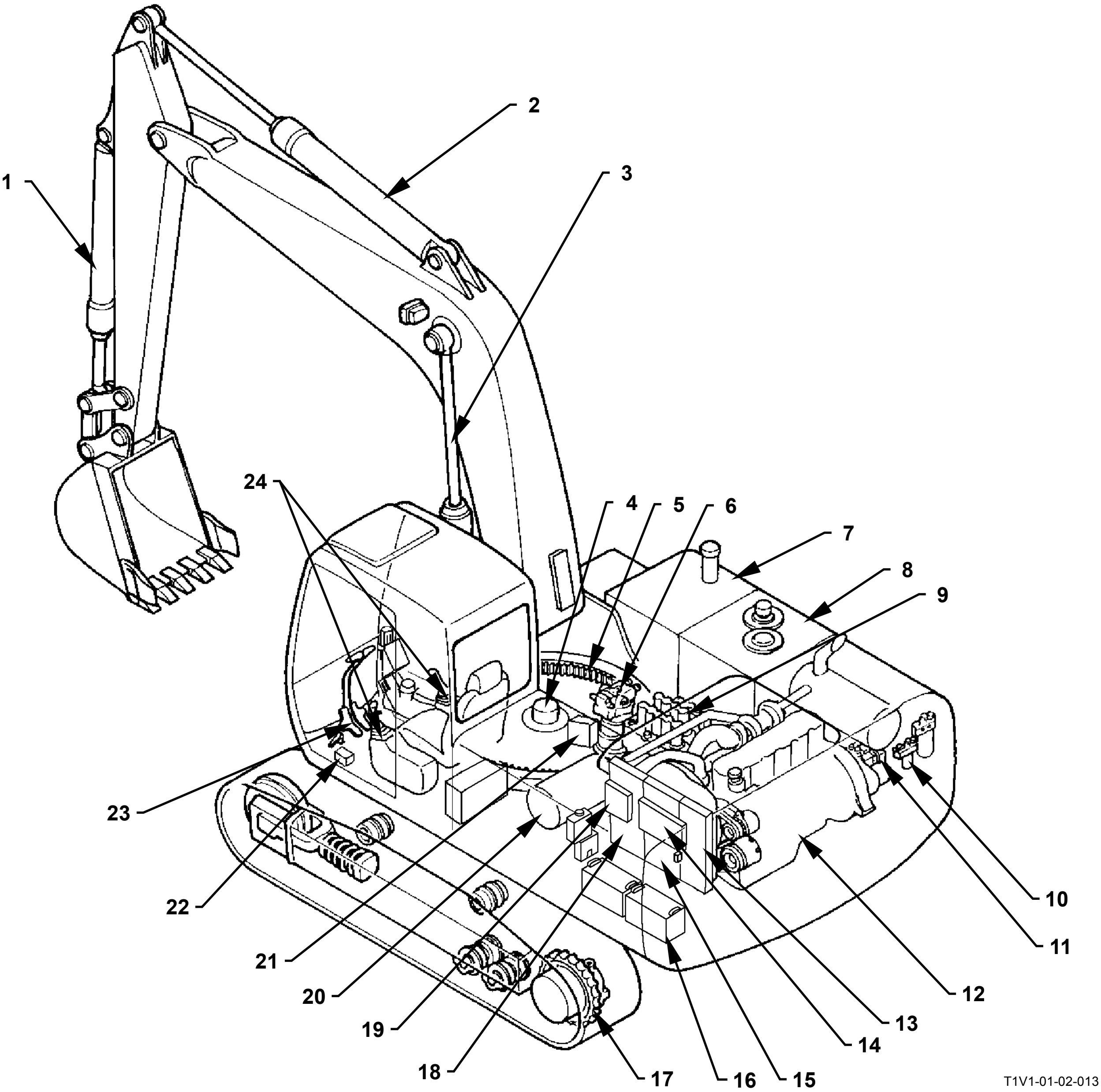
T1V1-01-01-002

Item \ Category / Model	ZAXIS270-3, 270LC-3					
	2.42 m (7 ft 11 in) Arm		3.11 m (7 ft 2 in) Arm		3.76 m (12 ft 4 in) Arm	
	Backhoe		Backhoe		Backhoe	
	mm	ft·in	mm	ft·in	mm	ft·in
A: Maximum Digging Reach	10060	33'0"	10710	35'2"	10270	33'8"
B: Maximum Digging Depth	6540	21'5"	7230	23'9"	7880	25'10"
C: Maximum Cutting Height	9890	32'5"	10260	33'8"	10460	34'4"
D: Maximum Dumping Height	6970	22'10"	7310	23'12"	7520	24'8"
E: Transport Height	3410	11'2"	3170	10'5"	3310	10'10"
F: Overall Transport Length	10440	34'3"	10340	33'11"	10390	34'1"
G: Minimum Swing Radius	4070	13'4"	3910	12'10"	3900	12'10"

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

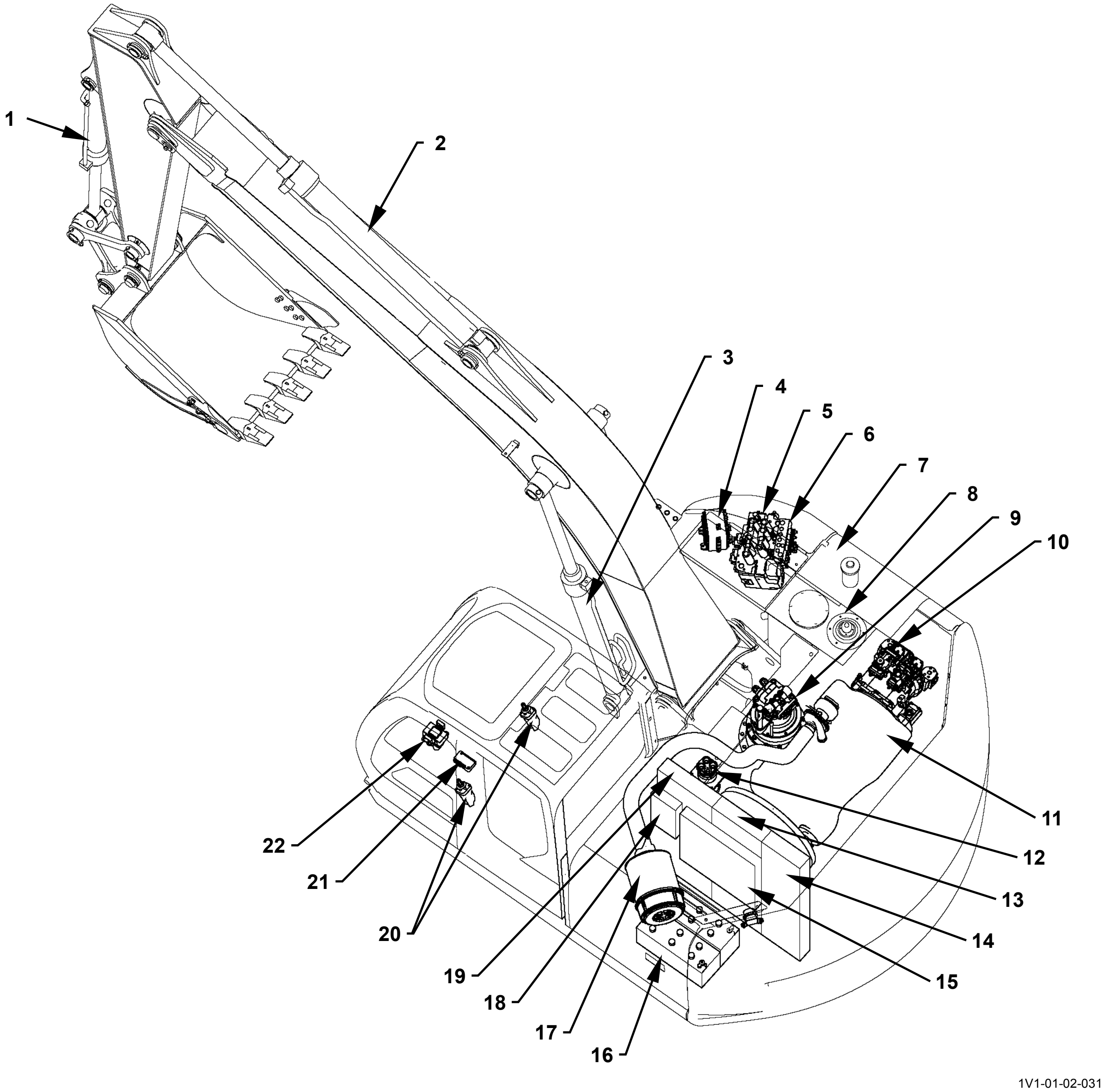
MAIN COMPONENTS

ZX200-3 class, ZX240-3 class, ZX270-3 class



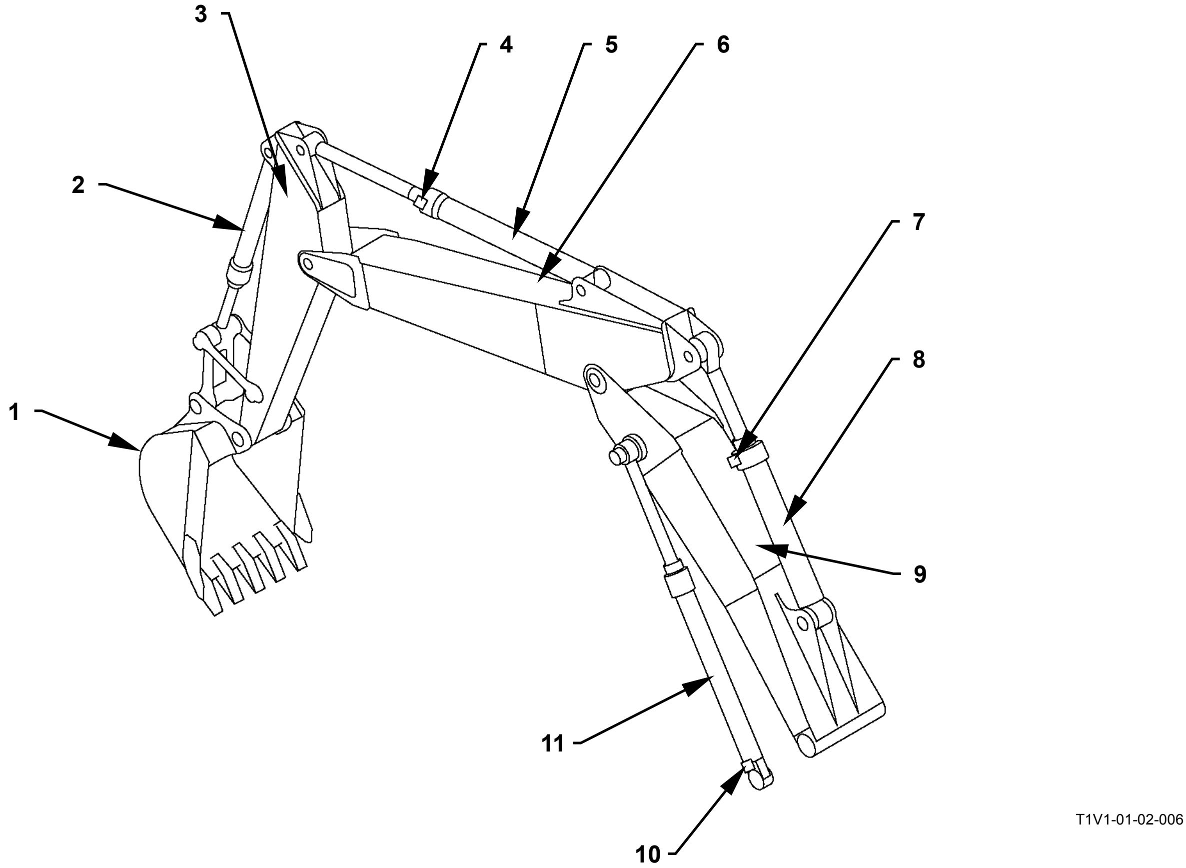
1 - Bucket Cylinder	7 - Fuel Tank	13 - Intercooler	19 - Fuel Cooler
2 - Arm Cylinder	8 - Hydraulic Oil Tank	14 - Air Conditioner Condenser	20 - Air Cleaner
3 - Boom Cylinder	9 - Control Valve	15 - Radiator	21 - Signal Control Valve
4 - Center Joint	10 - Pilot Filter/ Pilot Relief Valve	16 - Battery	22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

ZX225US-3class, ZX225USR-3 class



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

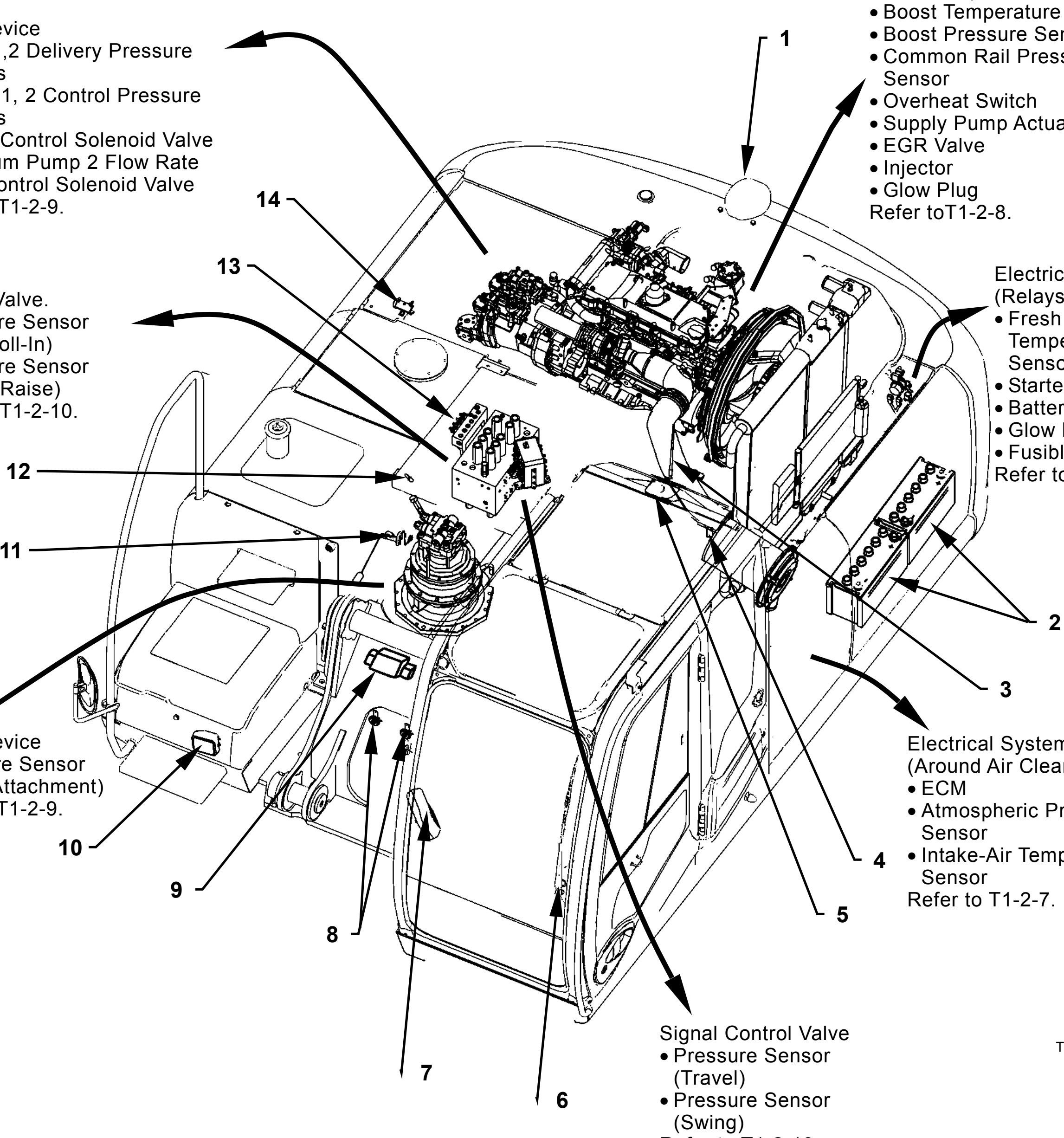
Front Attachment (2-Piece Boom)



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

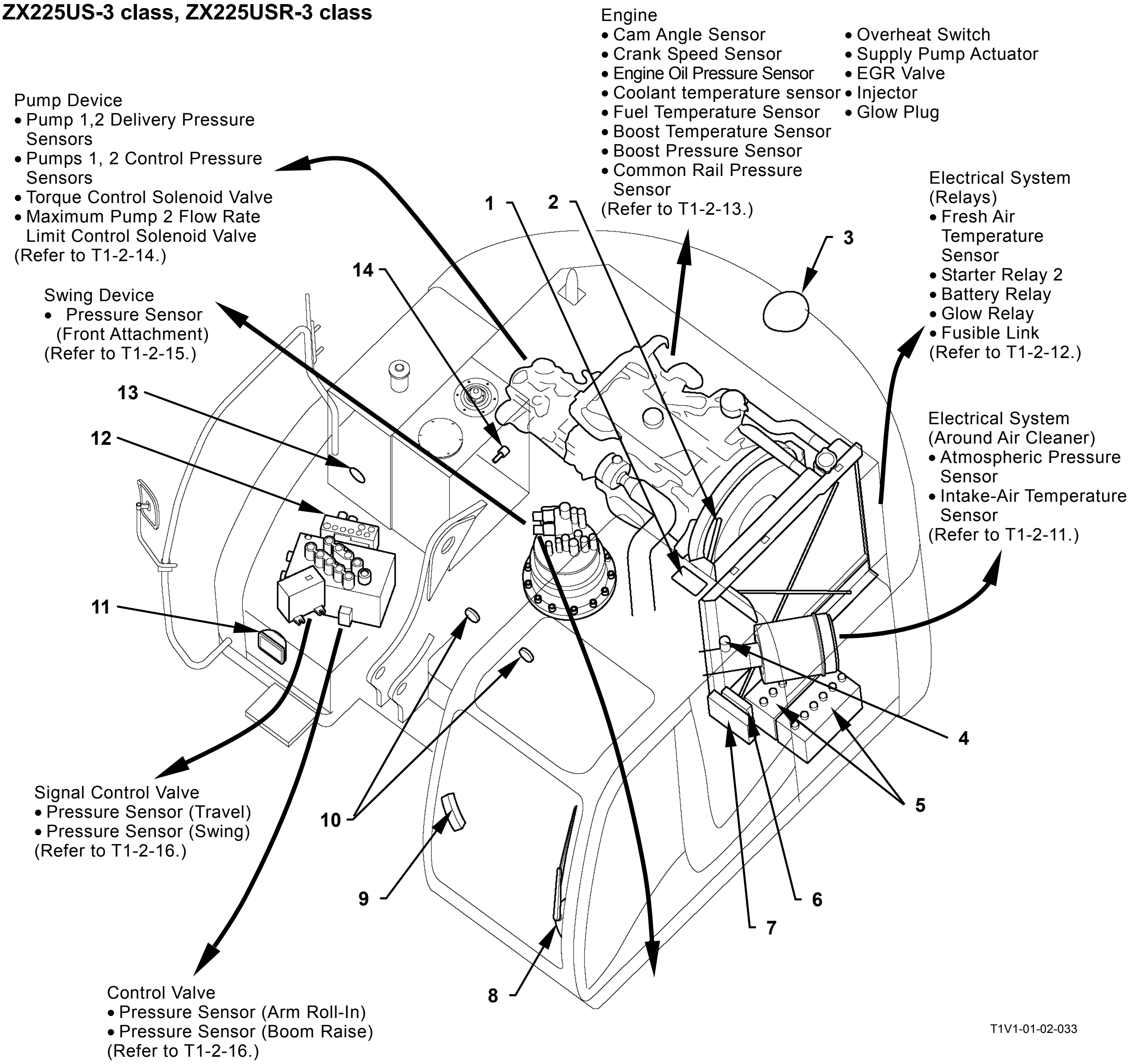
ELECTRICAL SYSTEM (OVERVIEW)

ZX200-3 class, ZX240-3 class, ZX270-3 class



- 1 - Rear View Camera
- 2 - Battery
- 3 - Communication Aerial
- 4 - Air Filter Restriction Switch
- 5 - GPS (Global Positioning System) Aerial
- 6 - Wiper Motor
- 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 - Solenoid Pump

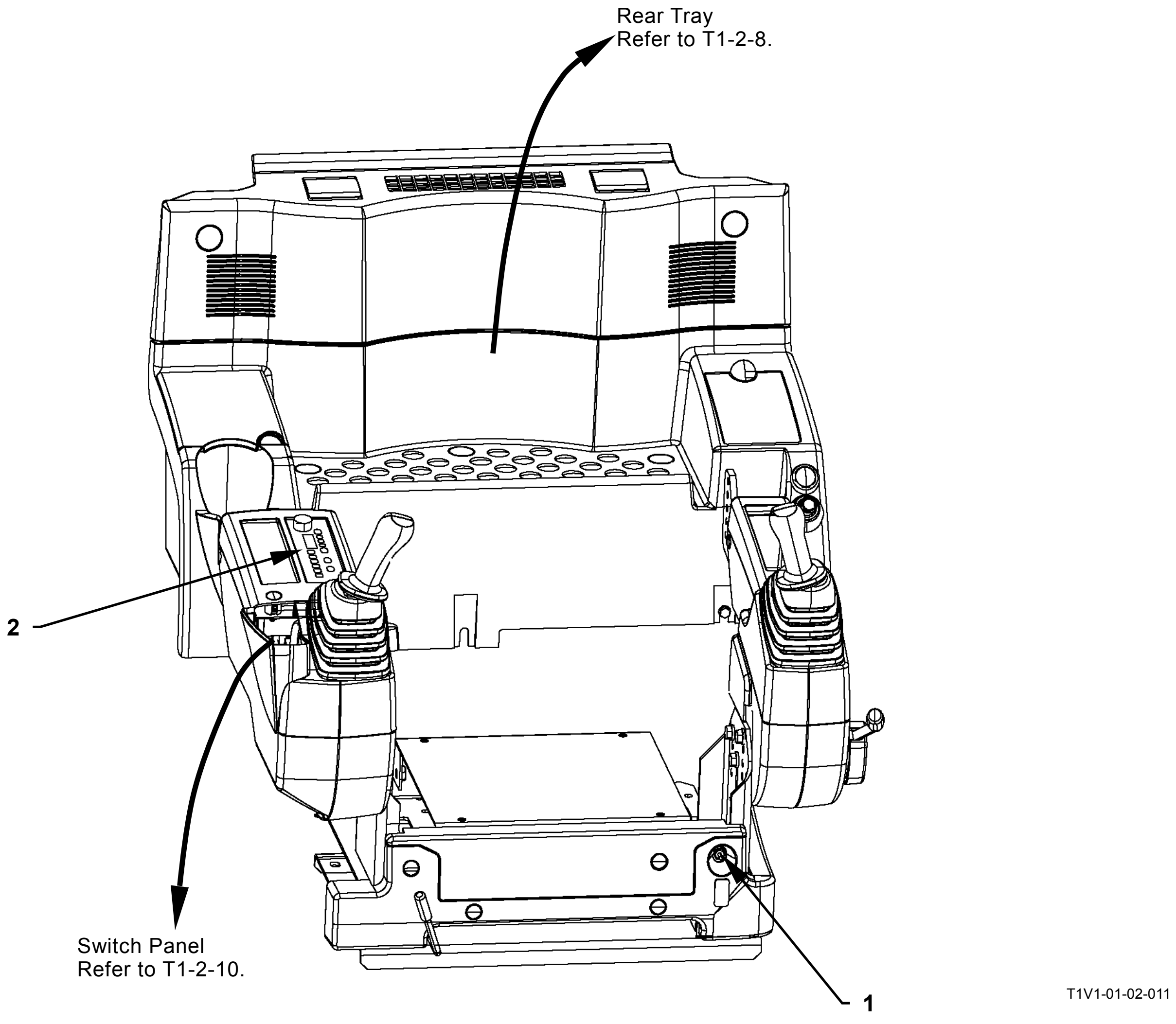
ZX225US-3 class, ZX225USR-3 class



1 - GPS (Global Positioning System) Aerial
2 - Communication Aerial
3 - Rear View Camera
4 - Air Filter Restriction Switch
5 - Battery
6 - ECM (Engine Control Module)
7 - MC (Main Controller)
8 - Wiper Motor
9 - Monitor Unit
10 - Horn
11 - Working Light
12 - Solenoid Valve Unit
13 - Fuel Sensor
14 - Hydraulic Oil Temperature Sensor

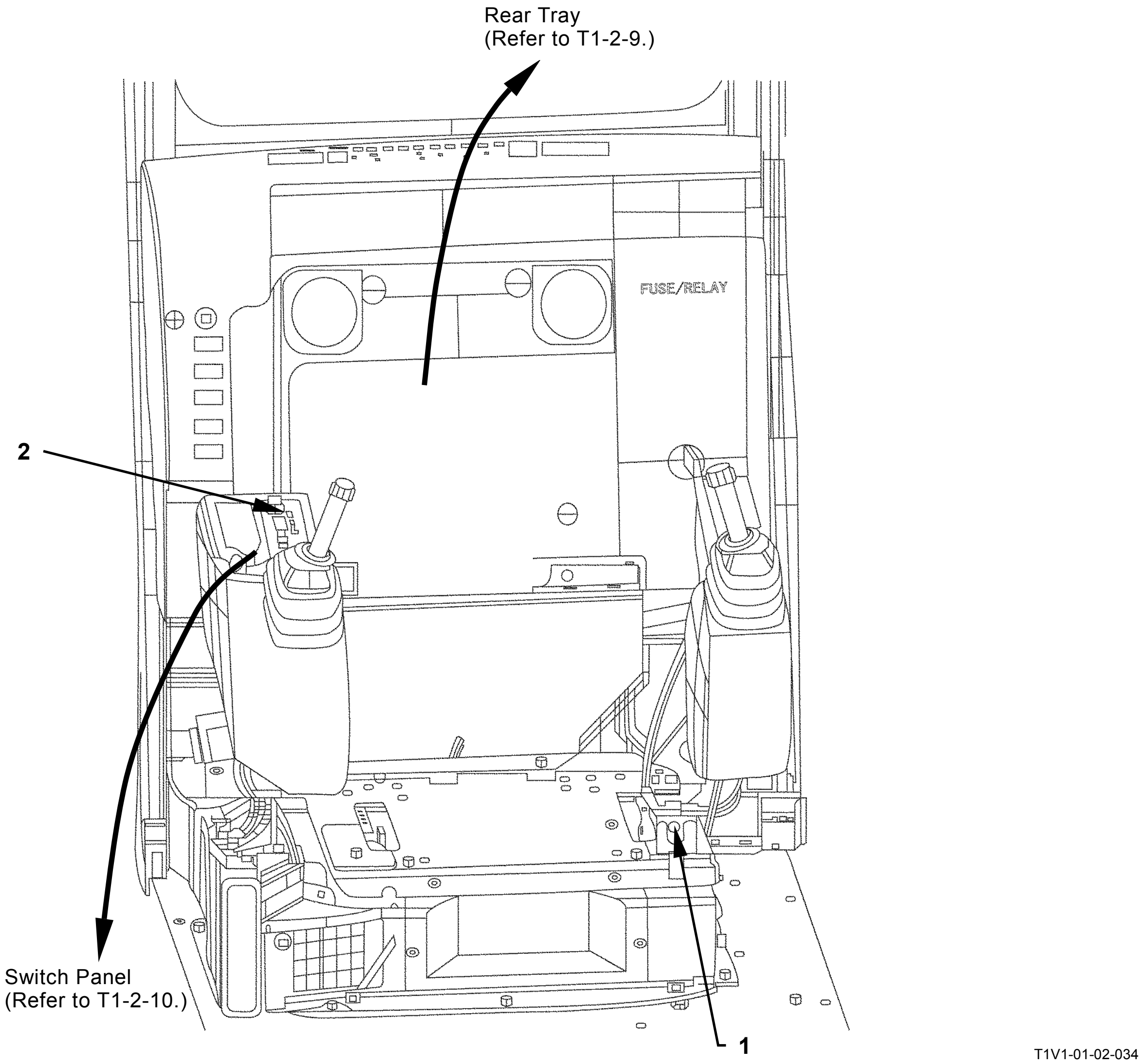
ELECTRICAL SYSTEM (IN CAB)

ZX200-3 class, ZX240-3 class, ZX270-3 class



1 - Engine Stop Switch
2 - Radio

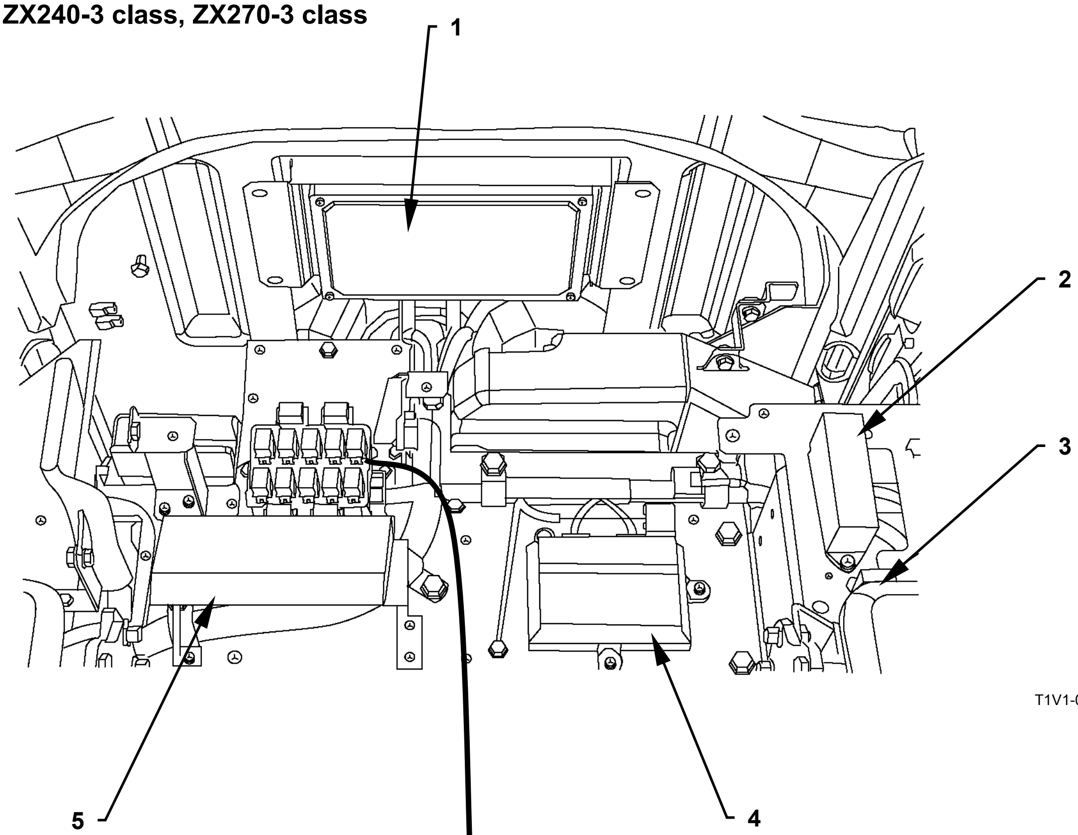
ZX225US-3 class, ZX225USR-3 class



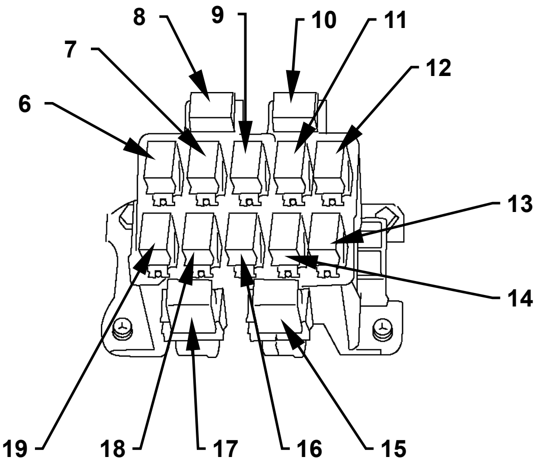
1 − Engine Stop Switch
2 - Radio

ELECTRICAL SYSTEM (REAR TRAY)

ZX200-3 class, ZX240-3 class, ZX270-3 class



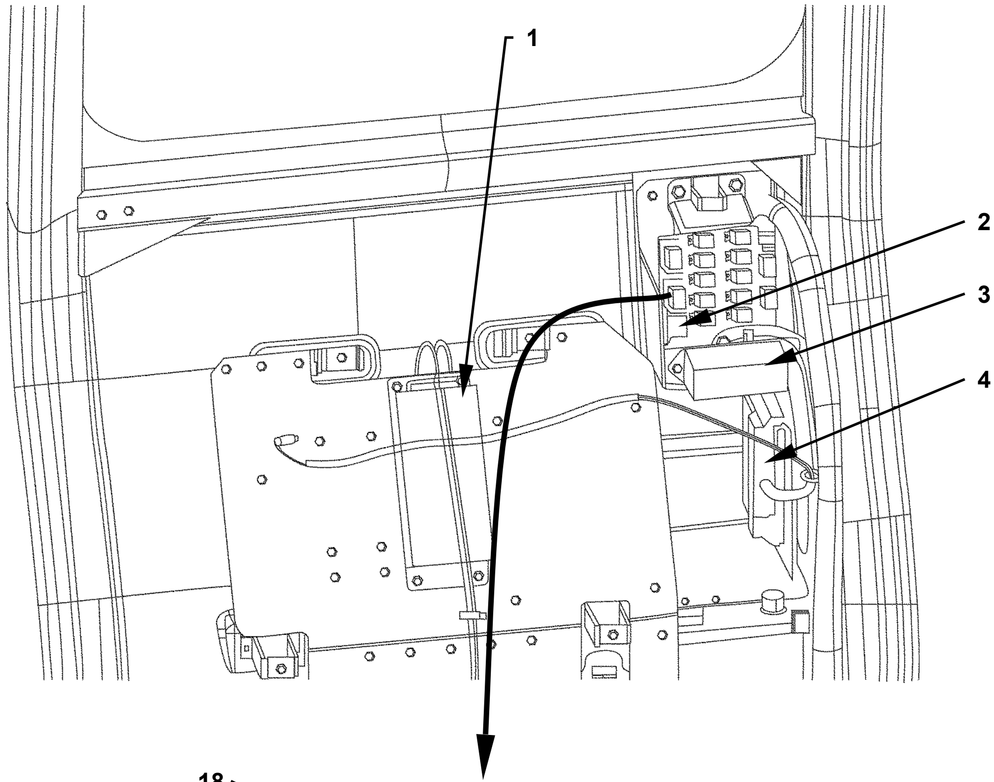
T1V1-01-02-007



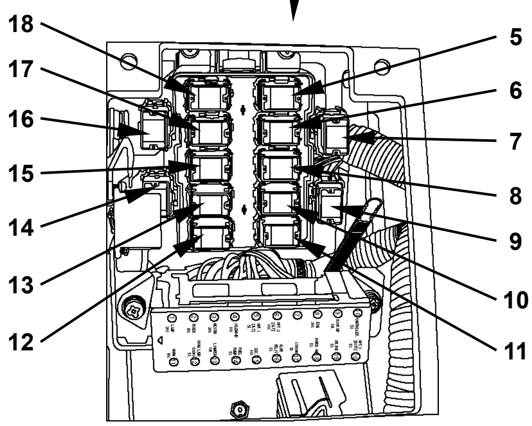
T1V1-01-02-009

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)

ZX225US-3 class, ZX225USR-3 class



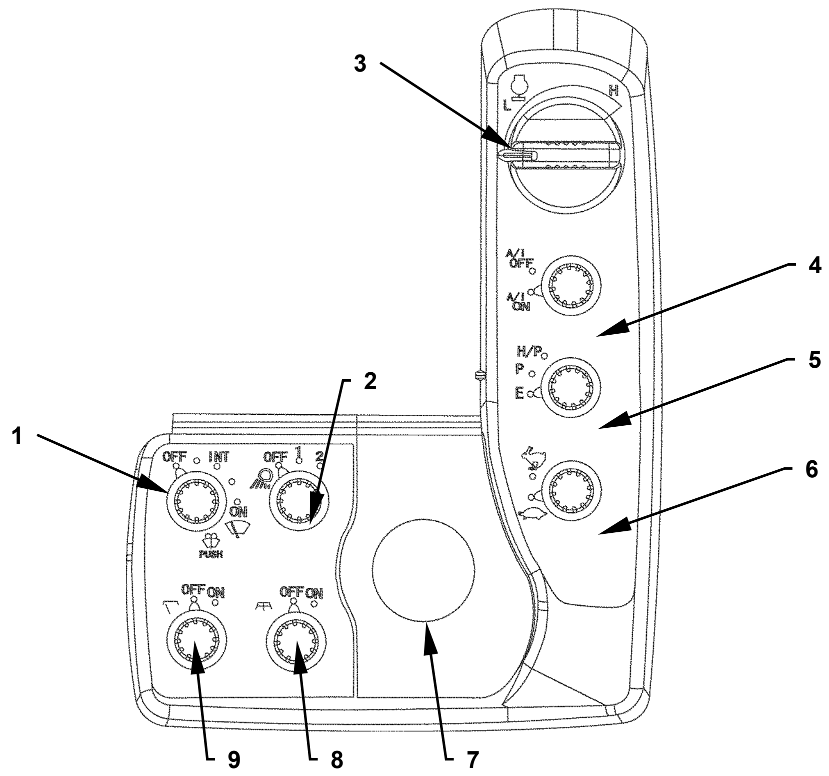
T1V1-01-02-035



T1V1-01-02-036

1 - Satellite Communication Terminal (Optional)	6 - Light Relay 1 (R7)	11 - Horn Relay (R10)	15 - Security Horn Relay (R3)
2 - Dr. ZX Connector (Download Connector Using Combinedly)	7 - MAX HI Relay (Air Conditioner) (R13)	12 - Starter Relay 2 (R5)	16 - Air Conditioner Relay (R11)
3 - Fuse Box	8 - Light Relay 2 (R8)	13 - Starter Cut Relay (R4)	17 - Pilot Shut-Off Relay (R2)
4 - ICF (Information Controller)	9 - ECM (Engine Control Module) Main Relay (R14)	14 - OFF Relay (Air Conditioner) (R12)	18 - Load Damp Relay (R1)
5 - Wiper Relay (R6)	10 - Washer Relay (R9)		

ELECTRICAL SYSTEM (SWITCH PANEL)

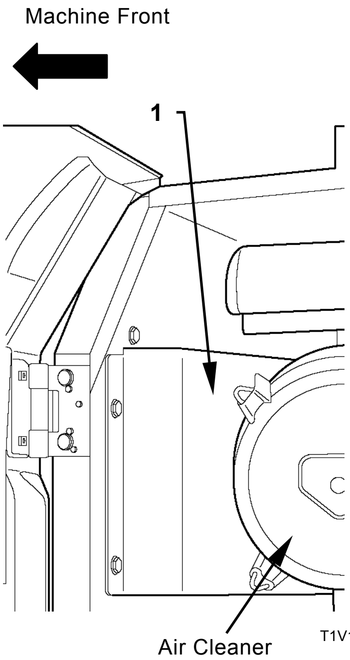


T1V1-01-02-037

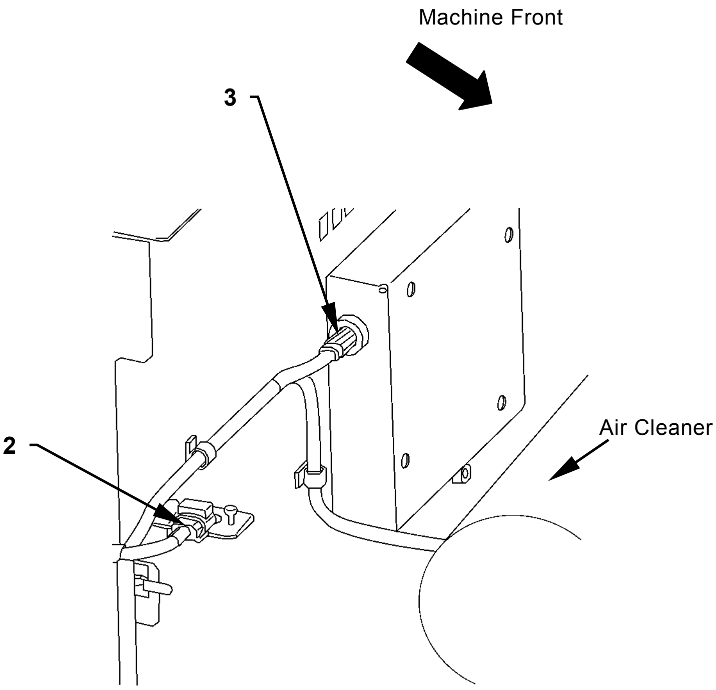
1 − Wiper / Washer Switch
2 − Working Light Switch
3 − Engine Control Dial
4 - Auto-Idle Switch
5 - Power Mode Switch
6 - Travel Mode Switch
7 - Key Switch
8 - Overhead Window Washer Switch (Optional)
9 - Overhead Window Wiper Switch (Optional)

ELECTRICAL SYSTEM (AROUND AIR CLEANER)

ZX200-3 class, ZX240-3 class, ZX270-3 class

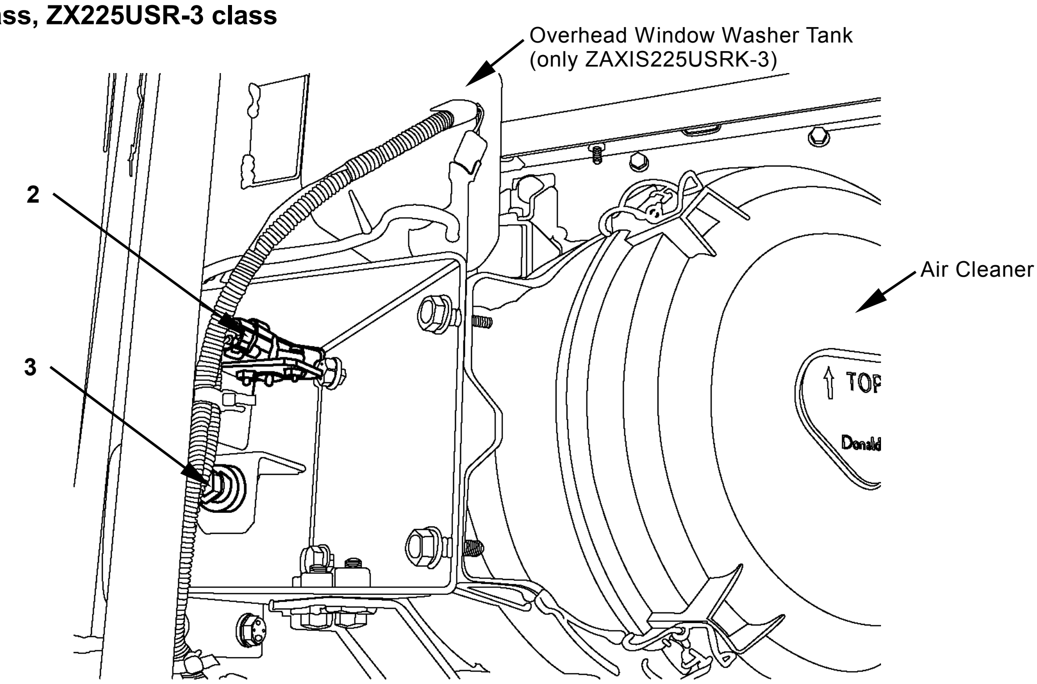


T1V1-01-02-023



T1V1-01-02-012

ZX225US-3 class, ZX225USR-3 class



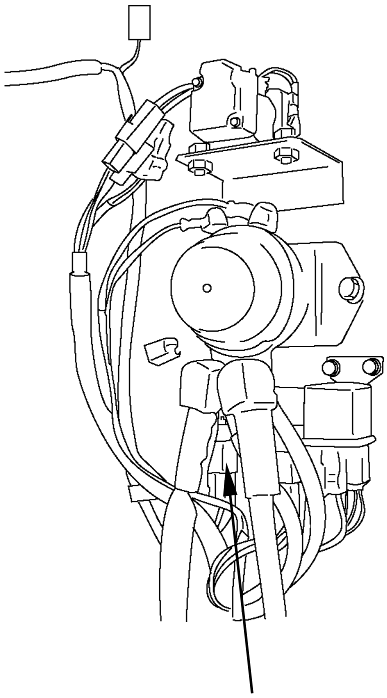
T1V1-01-02-038

1 - ECM (Engine Control Module)

2 - Atmospheric Pressure Sensor

3 - Intake-Air Temperature Sensor

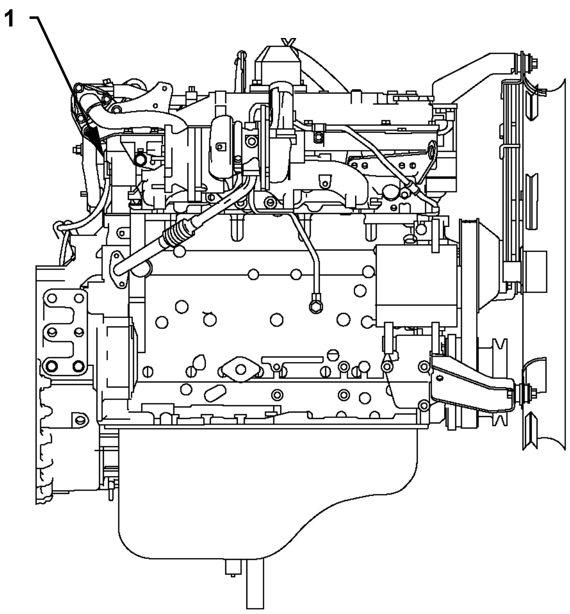
ELECTRICAL SYSTEM (RELAYS)



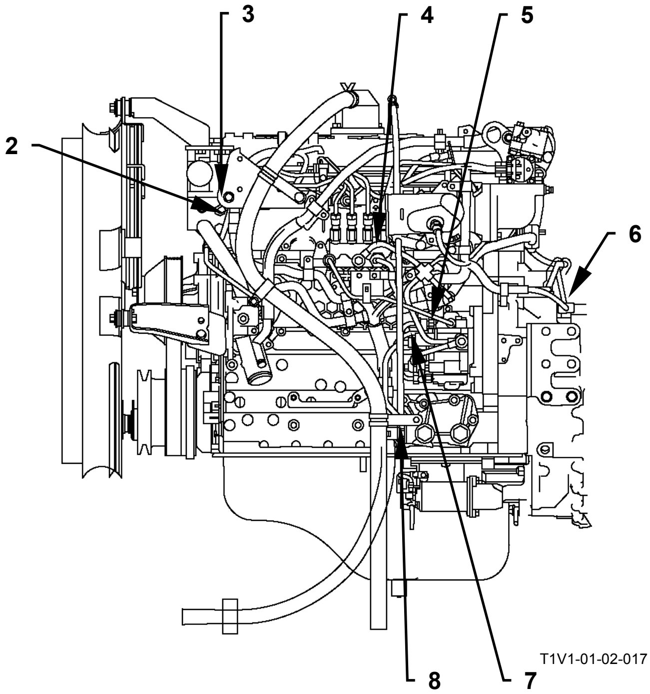
T1V1-01-02-018

1 - Fresh Air Temperature Sensor
2 - Starter Relay 2
3 - Battery Relay
4 - Glow Relay
5 - Fusible Link

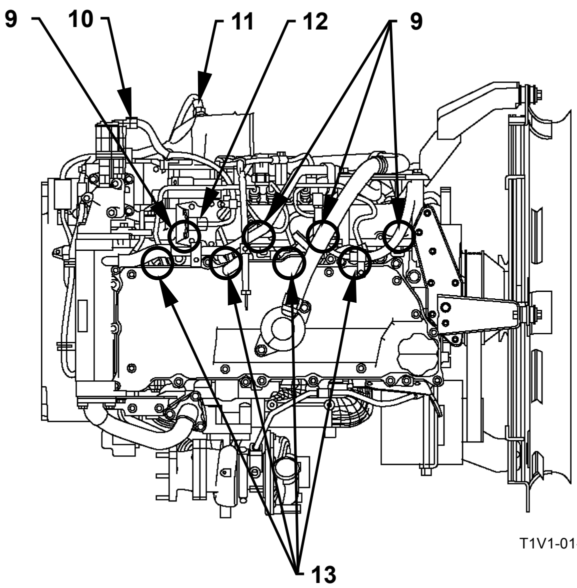
ENGINE



T1V1-01-02-016



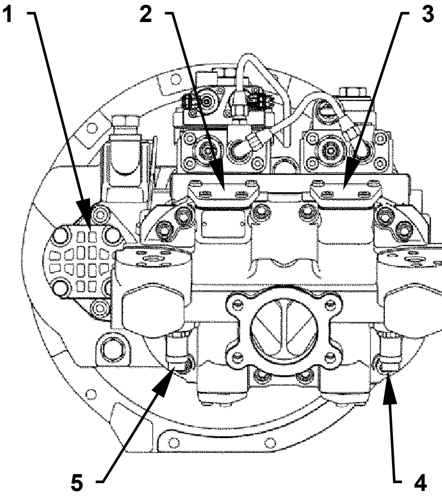
T1V1-01-02-017



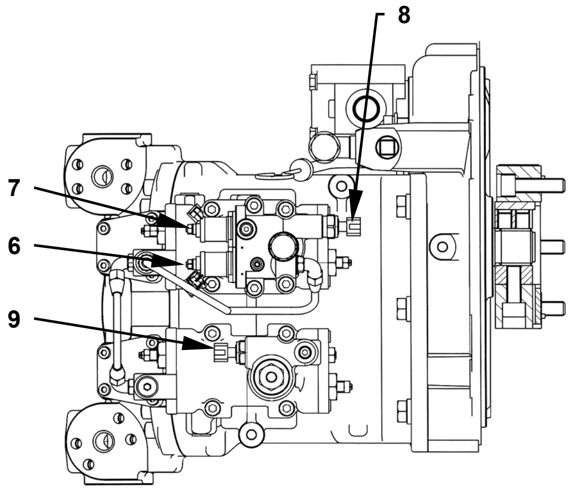
T1V1-01-02-015

1 - Cam Angle Sensor
2 - Overheat Switch
3 - Coolant temperature sensor
4 - Common Rail Pressure Sensor
5 - Fuel Temperature Sensor
6 - Crank Speed Sensor
7 - Supply Pump Actuator
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



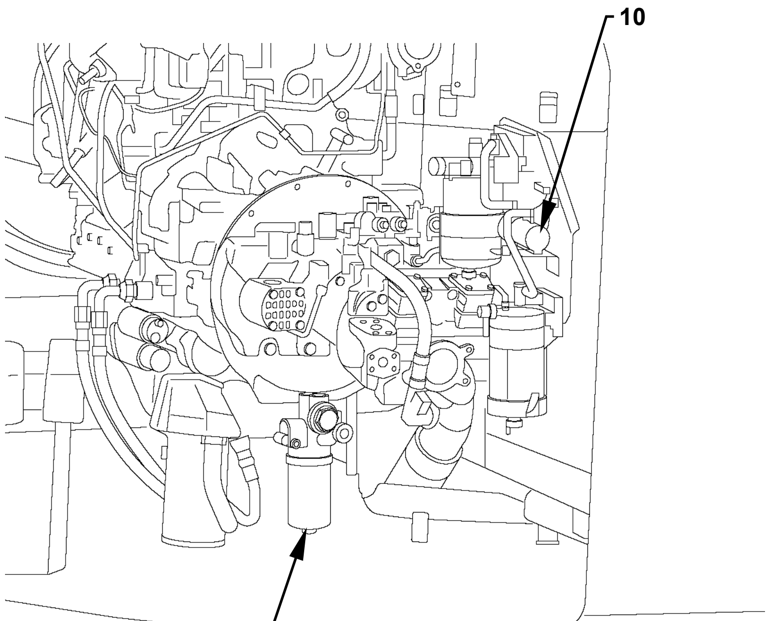
T1V1-01-02-032



T1V1-04-05-002

AROUND PUMP DEVICE

(ZX225US-3 class, ZX225USR-3 class)

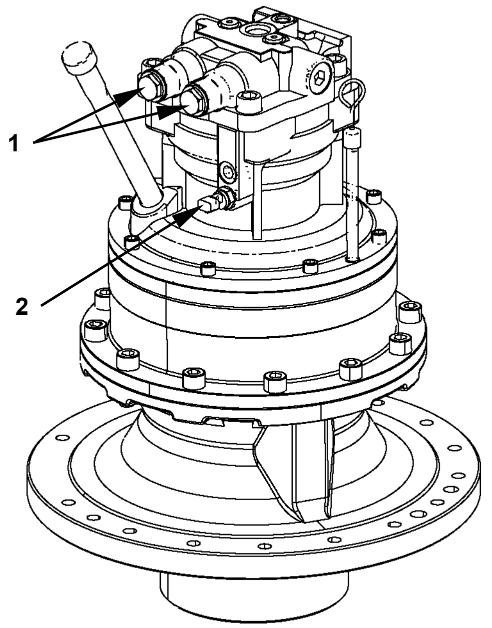


T1V1-01-02-039

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

SWING DEVICE

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class

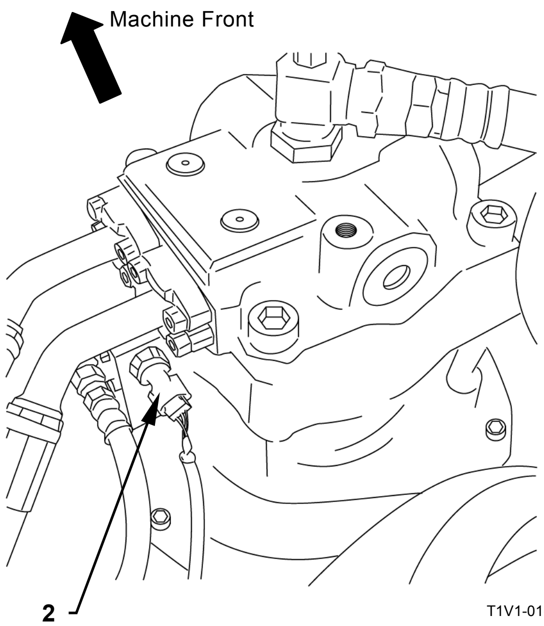


T1V1-01-02-005

1 − Swing Relief Valve

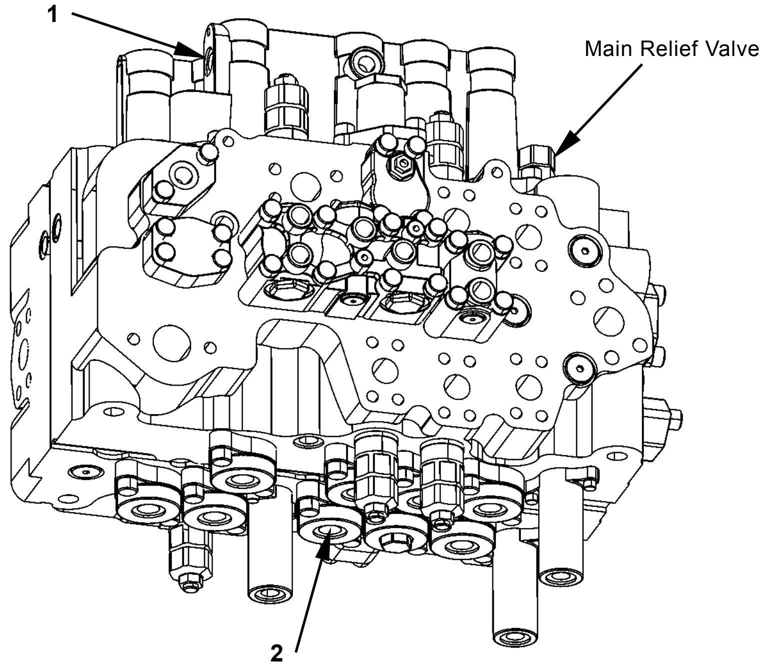
2 - Pressure Sensor (Front Attachment)

ZX270-3 class



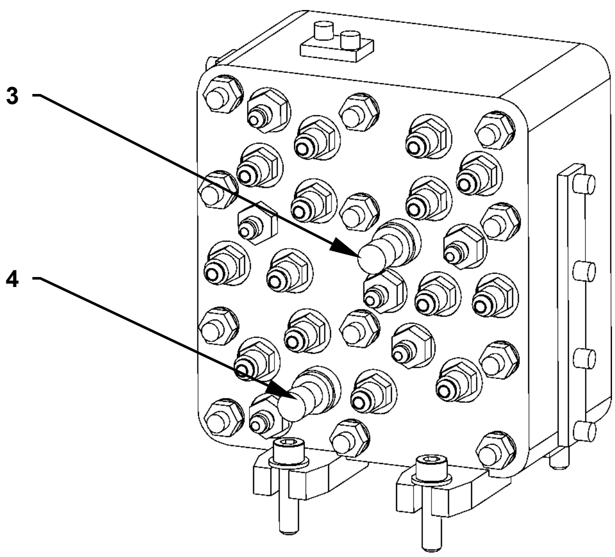
T1V1-01-02-004

CONTROL VALVE



T1V1-03-03-073

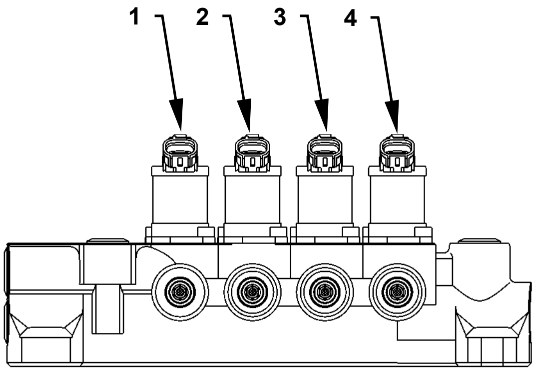
SIGNAL CONTROL VALVE



T1V1-01-02-014

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

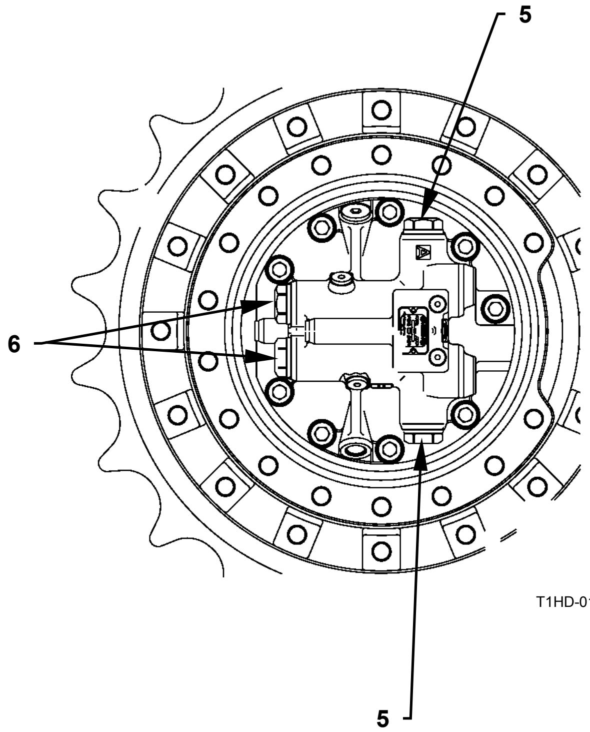
SOLENOID VALVE UNIT



T1V1-03-07-007

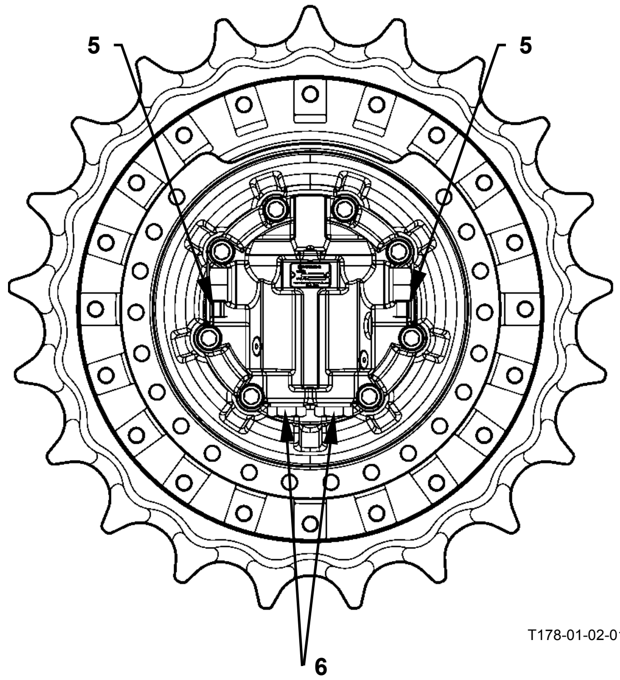
TRAVEL DEVICE

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class



T1HD-01-02-001

ZX270-3 class

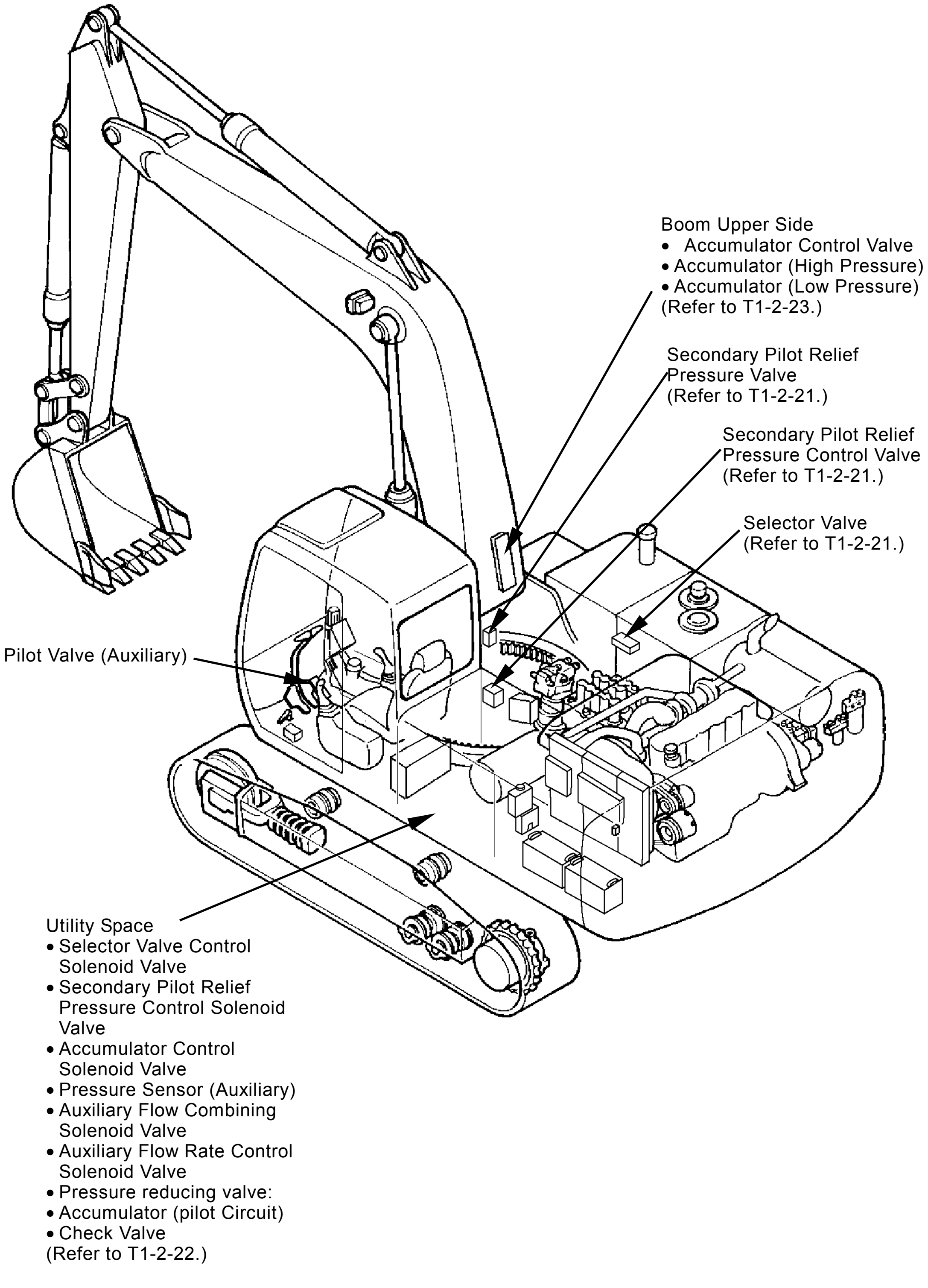


T178-01-02-014

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		

LAYOUT OF ATTACHMENT SPEC. PARTS

ZX200-3 class, ZX240-3 class, ZX270-3 class



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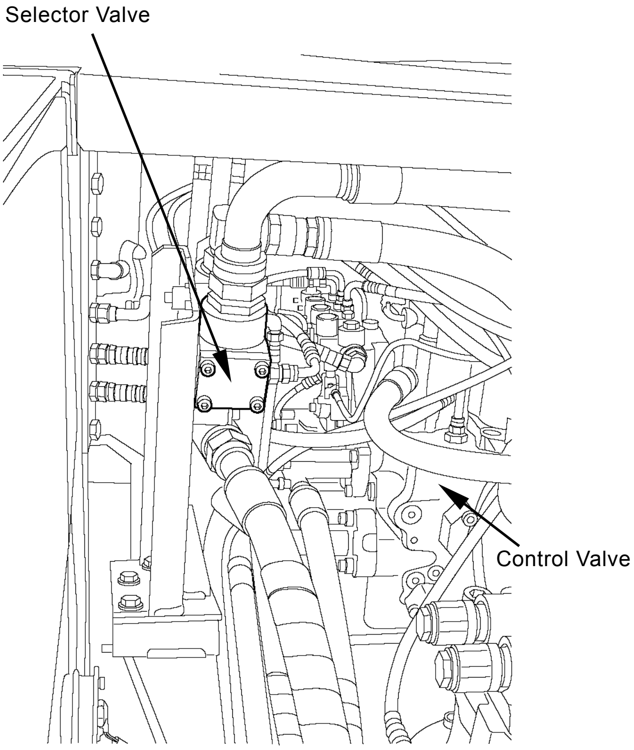

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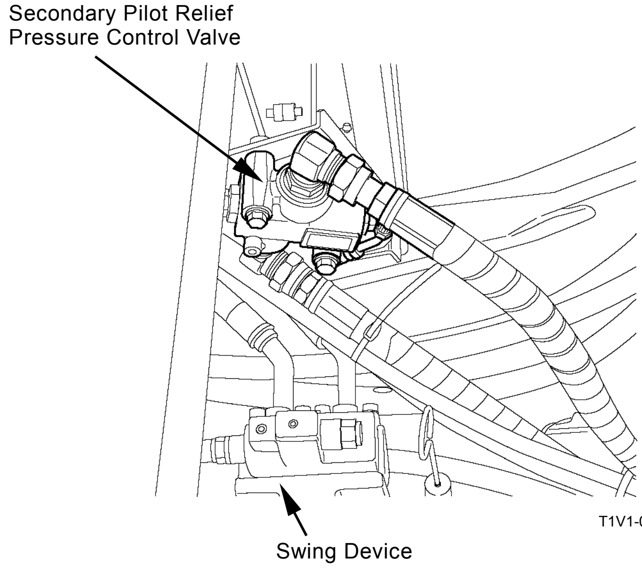

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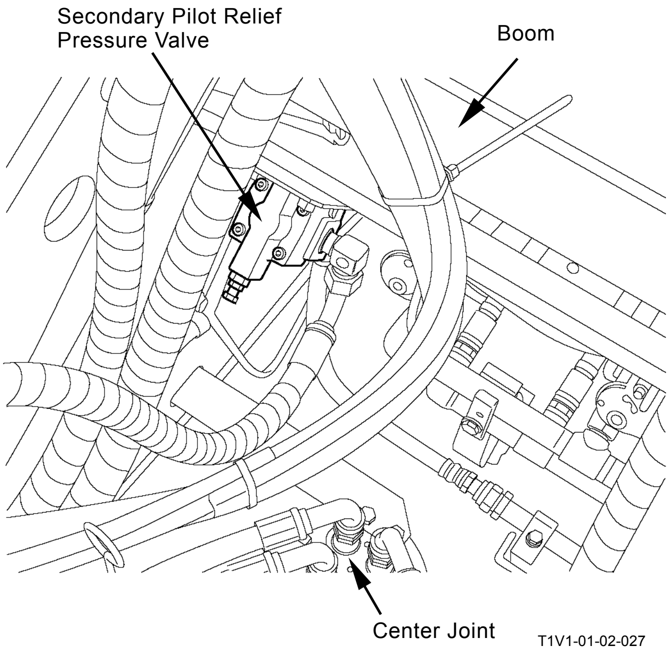
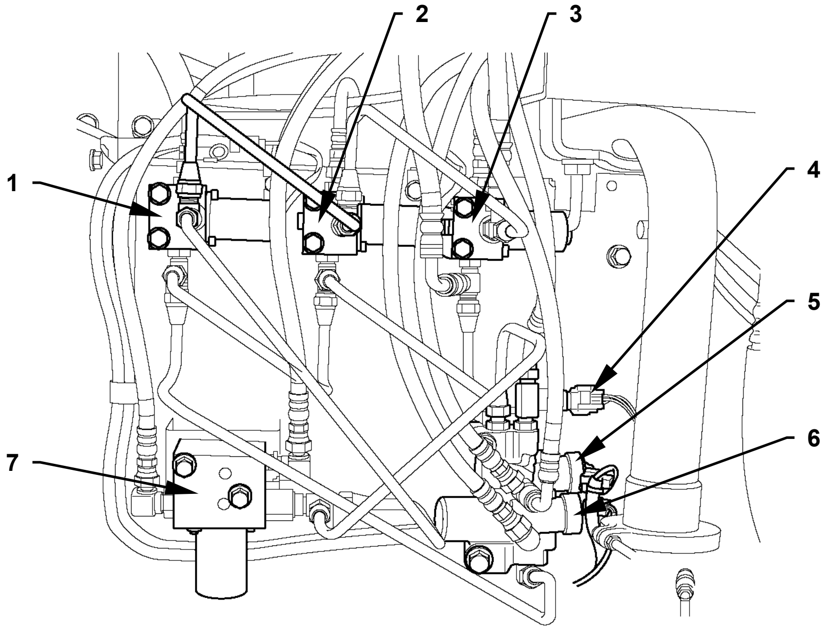
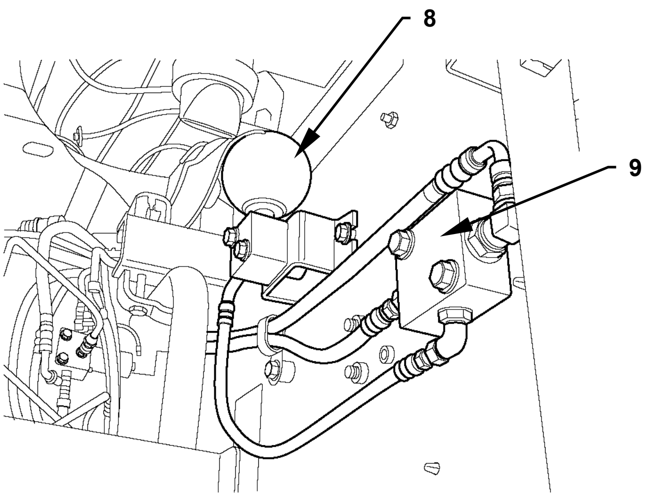


T1V1-01-02-027

Utility Space



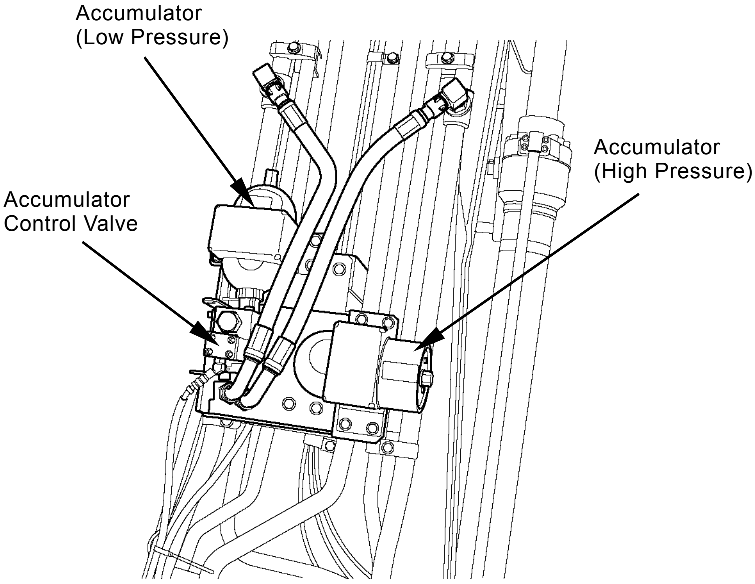
T1V1-01-02-028



T1V1-01-02-029

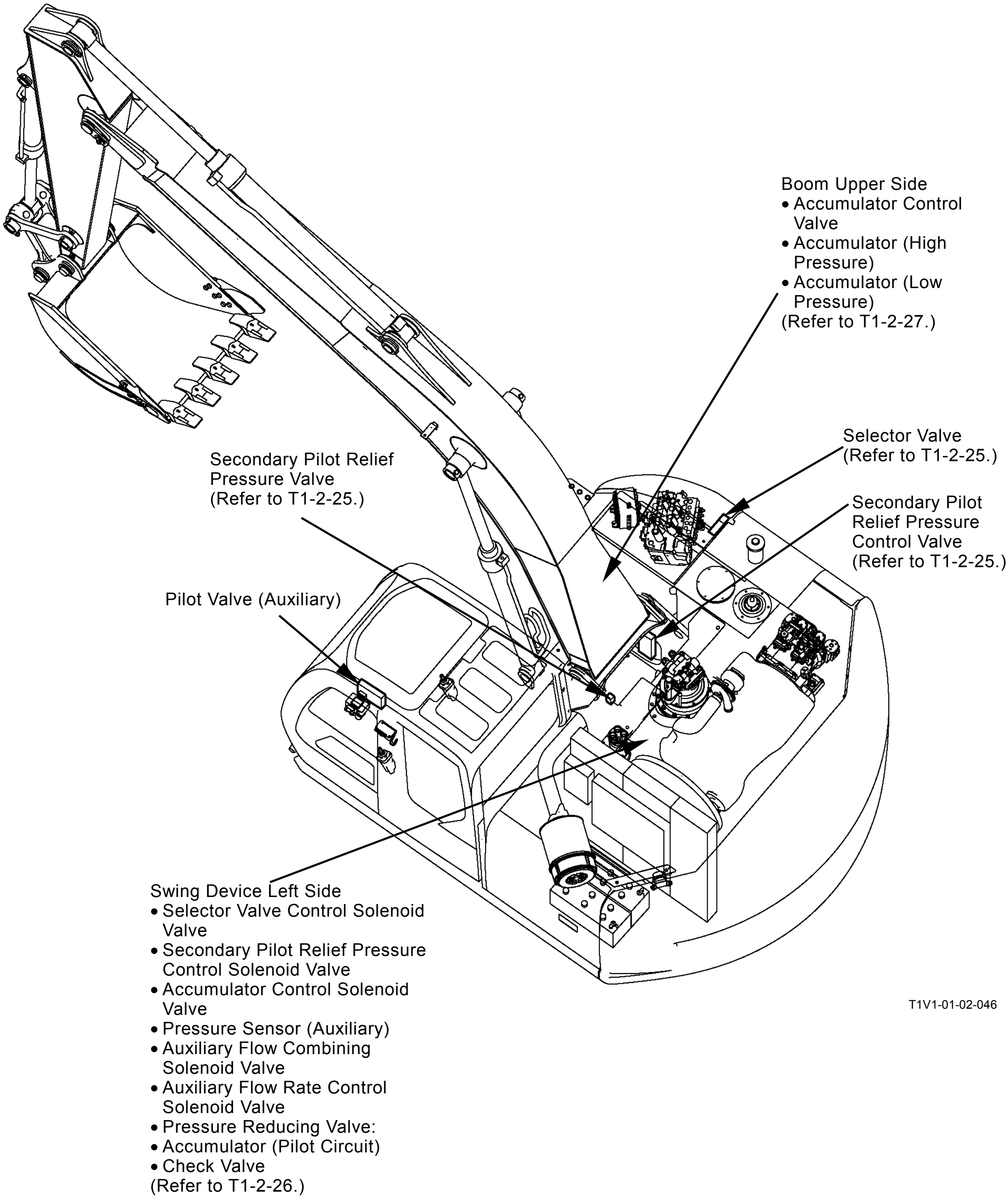
1 - Selector Valve Control Solenoid Valve
2 - Secondary Pilot Relief Pressure Control Solenoid Valve
3 - Accumulator Control Solenoid Valve
4 - Pressure Sensor (Auxiliary)
5 - Auxiliary Flow Combining Solenoid Valve
6 - Auxiliary Flow Rate Control Solenoid Valve
7 - Pressure Reducing Valve:
8 - Accumulator (Pilot Circuit)
9 - Check Valve

Boom Upper Side



T1V1-01-02-030

ZX225US-3 class, ZX225USR-3 class



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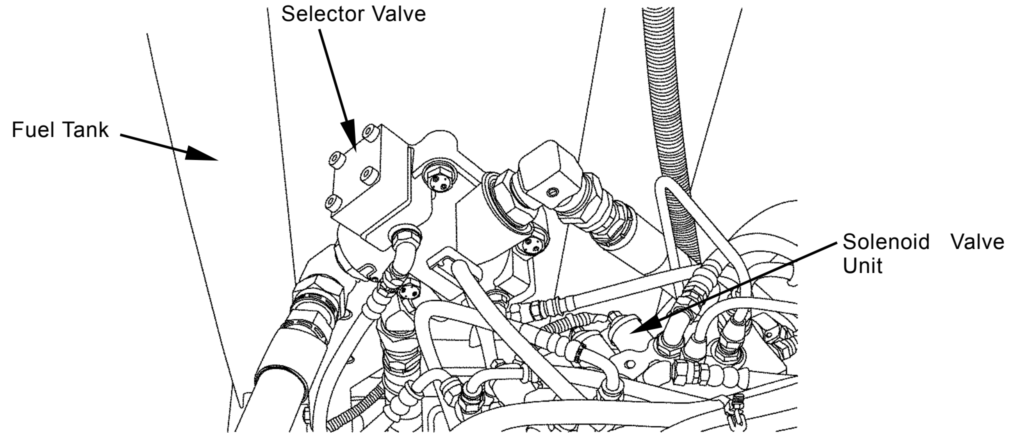
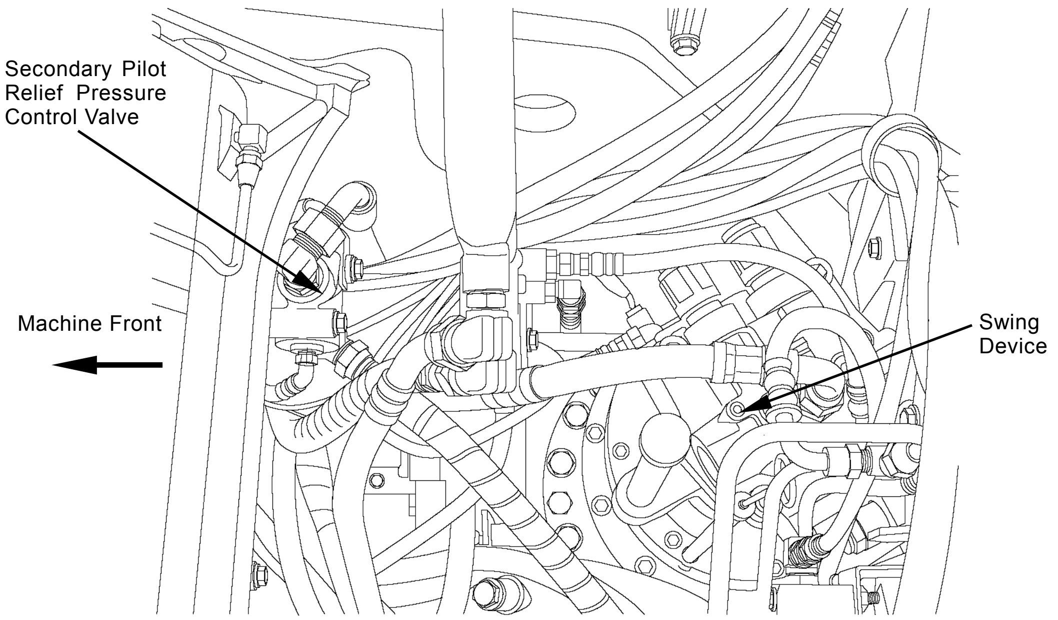
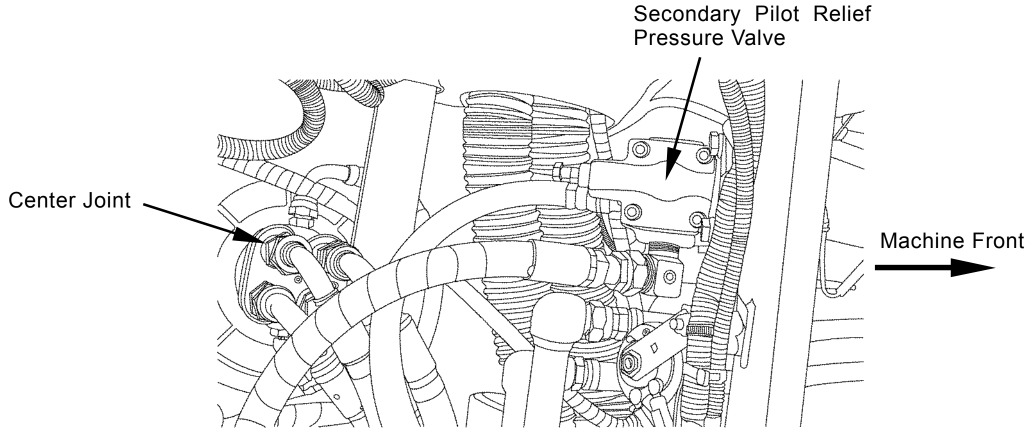


T1V1-01-02-040

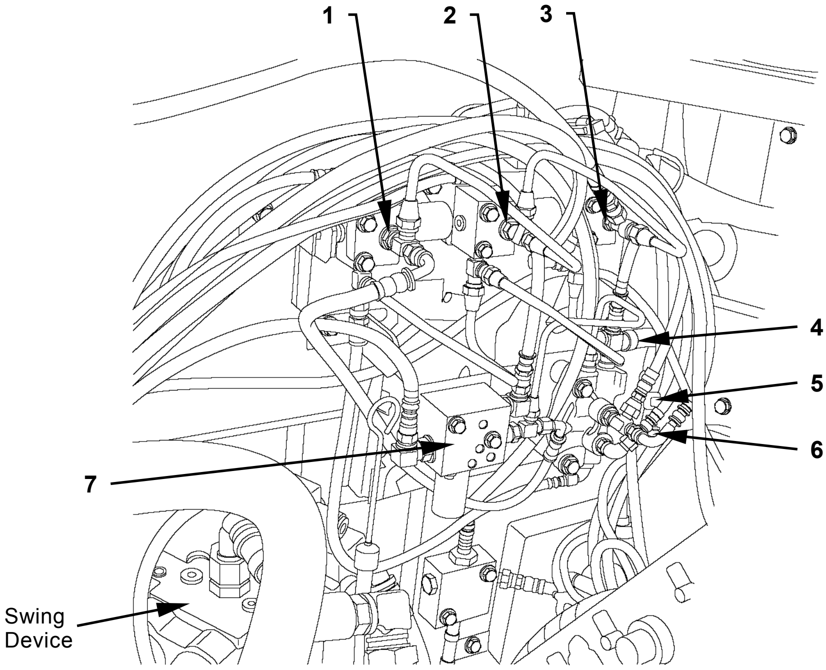


T1V1-01-02-042

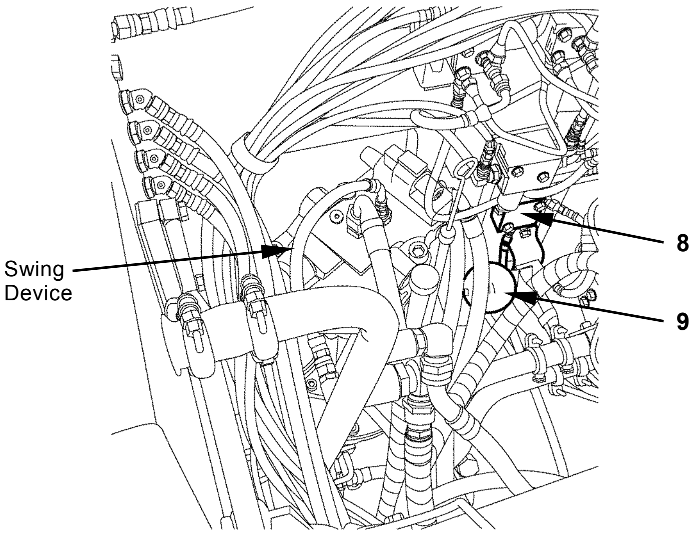


T1V1-01-02-041

Swing Device Left Side



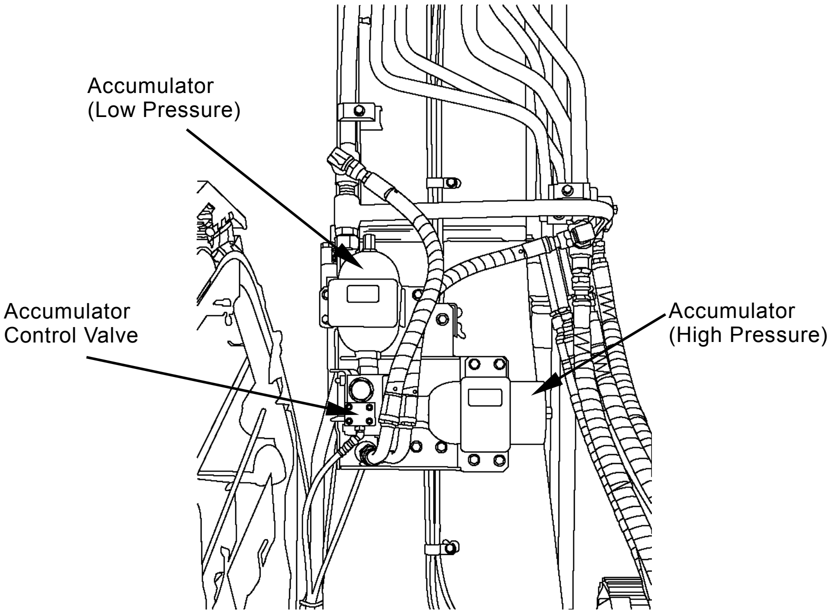
T1V1-01-02-043



T1V1-01-02-044

1 - Selector Valve Control Solenoid Valve
2 - Secondary Pilot Relief Pressure Control Solenoid Valve
3 - Accumulator Control Solenoid Valve
4 - Pressure Sensor (Auxiliary)
5 - Auxiliary Flow Combining Solenoid Valve
6 - Auxiliary Flow Rate Control Solenoid Valve
7 - Pressure reducing valve:
8 - Check Valve
9 - Accumulator (Pilot Circuit)

Boom Upper Side



T1V1-01-02-045

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ENGINE

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class:

Manufacturer	ISUZU
Model	4HK1XYSA-02
Type	Diesel, 4-Cycle, Water-cooled, Direct Injection Type, Exhaust Turbo Charged Type
Cyl. No.- Bore × Stroke	4-115 mm×125 mm (4.5 in×4.92 in)
Piston Displacement	5193 cm^3 (317 in^3)
Rated Output	114 kW/1800 min^{-1} (155 PS/1800 rpm) HP Mode: 122 kW / 2000 min^{-1} (166 PS / 2000 rpm)
Compression Ratio	17.5
Dry Weight	478 kg (1055 lb)
Firing Order	1-3-4-2
Rotation Direction	Clockwise (Viewed from fan side)

ZX240-3 class:

Manufacturer	ISUZU
Model	4HK1XYSA-01
Type	Diesel, 4-Cycle, Water-cooled, Direct Injection Type, Exhaust Turbo Charged Type
Cyl. No.- Bore × Stroke	4-115 mm×125 mm (4.5 in×4.92 in)
Piston Displacement	5193 cm^3 (317 in^3)
Rated Output	127 kW/1900 min^{-1} (173 PS/1900 rpm) HP Mode: 132 kW / 2000 min^{-1} (180 PS / 2000 rpm)
Compression Ratio	17.5
Dry Weight	478 kg (1055 lb)
Firing Order	1-3-4-2
Rotation Direction	Clockwise (Viewed from fan side)

ZX270-3 class:

Manufacturer	ISUZU
Model	4HK1XYSA-03
Type	Diesel, 4-Cycle, Water-cooled, Direct Injection Type, Exhaust Turbo Charged Type
Cyl. No.- Bore × Stroke	4-115 mm×125 mm (4.5 in×4.92 in)
Piston Displacement	5193 cm^3 (317 in^3)
Rated Output	136 kW/2000 min^{-1} (185 PS/2000 rpm) HP Mode: 140 kW / 2100 min^{-1} (190 PS / 2100 rpm)
Compression Ratio	17.5
Dry Weight	478 kg (1055 lb)
Firing Order	1-3-4-2
Rotation Direction	Clockwise (Viewed from fan side)

COOLING SYSTEM

Cooling Fan .... Dia. 650 mm (25.6 in), 5 Blades, Draw-in Type, Synthetic Resin, with Fan Ring and Safety Net

Fan Pulley Ratio .... Belt Driven Rotation Ratio : 0.95 (ZX200-3 class, ZX225US-3 class, ZX225USR-3 class)
: 1.01 (ZX240-3 class, ZX270-3 class)

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 4-Stage Type

STARTING SYSTEM

Motor .... Magnetic Pinion Shift Reduction Type

Voltage / Output .... 24 V / 5 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 (Brushless)

SUPERCHARGING SYSTEM

Type .... Exhaust-Turbocharger Type RHF55 Type with Weight Gate

FUEL SYSTEM

Type .... Common Rail Type HP3 Type

Governor .... Electronic All Speed Control

Injection Nozzle .... Electrical Multi-Hole Injector

PERFORMANCE

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

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class:

Fuel Consumption Ratio................................ 224 g/kW/h (304 g/PS·h) at 122 kW / (at Full Load: 2000 min^{-1})
219 g/kW/h (298 g/PS·h) at 114 kW / (at Working Load: 1800 min^{-1})

Maximum Output Torque................................ 655±60 N·m (67±6 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: 2000±20 min^{-1})
(at Working Load: 1800±20 min^{-1})

ZX240-3 class:

Fuel Consumption Ratio................................ 221 g/kW/h (300 g/PS·h) at 132 kW / (at Full Load: 2000 min^{-1})
216 g/kW/h (293 g/PS·h) at 127 kW / (at Working Load: 1900 min^{-1})

Maximum Output Torque................................ 673 N·m (69 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: 2000±20 min^{-1})
(at Working Load: 1900±20 min^{-1})

ZX270-3 class:

Fuel Consumption Ratio................................ 221 g/kW/h (300 g/PS·h) at 140 kW / (at Full Load: 2100 min^{-1})
216 g/kW/h (293 g/PS·h) at 136 kW / (at Working Load: 2000 min^{-1})

Maximum Output Torque................................ 676 N·m (65 kgf·m) at approx. 1500 min^{-1}

Compression Pressure .... 3.04 MPa (31 kgf/cm^2) at 200 min^{-1}

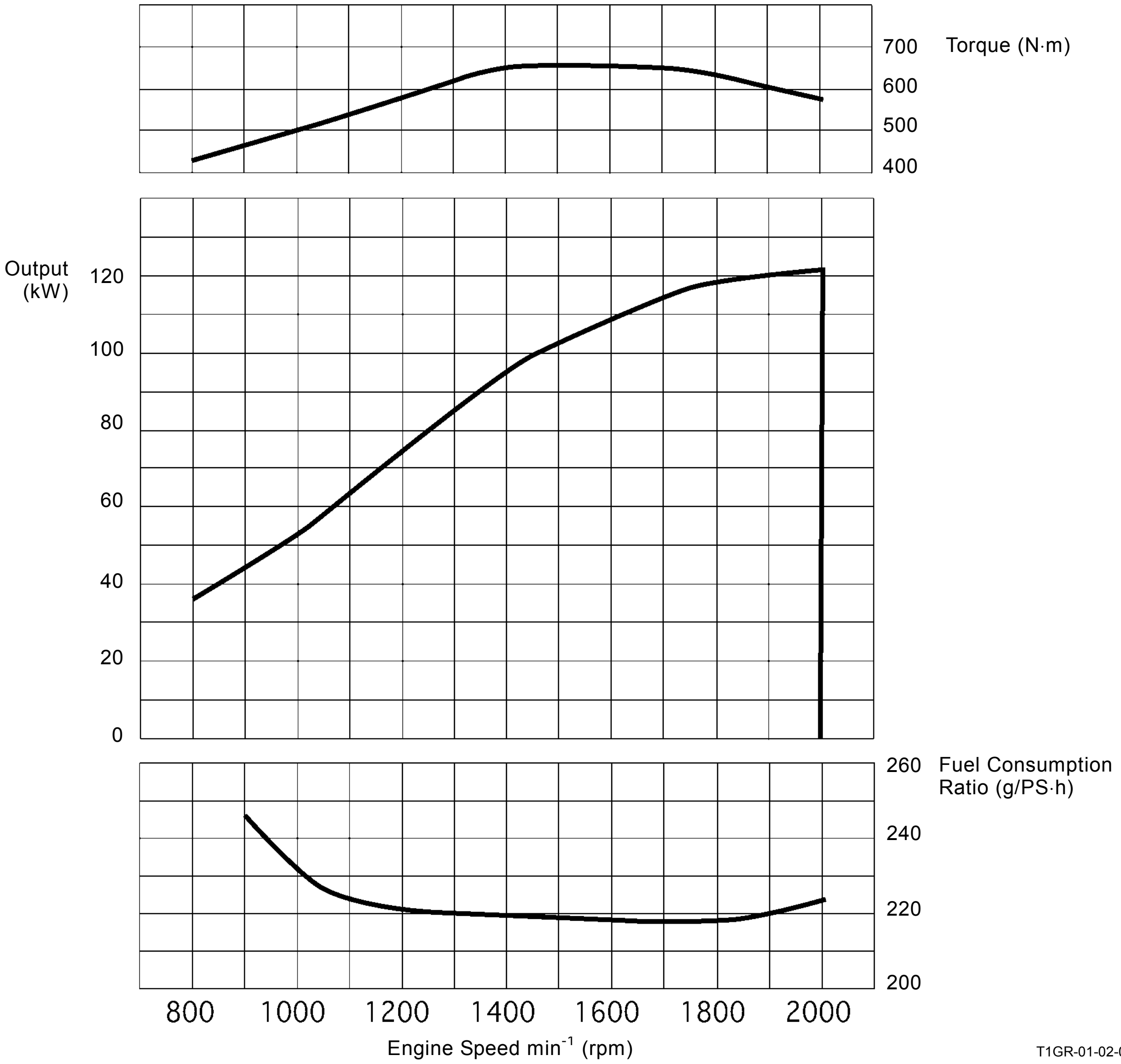
Valve Clearance (Inlet / Exhaust)................... 0.4 / 0.4 mm (when cool)

No Load Speed .... Slow: (at Full Load: 800±20 min^{-1})
Fast: (at Full Load: 2100±20 min^{-1})
(at Working Load: 2000±20 min^{-1})

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class:

Engine Performance Curve (4HK1XYSA-02)

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.

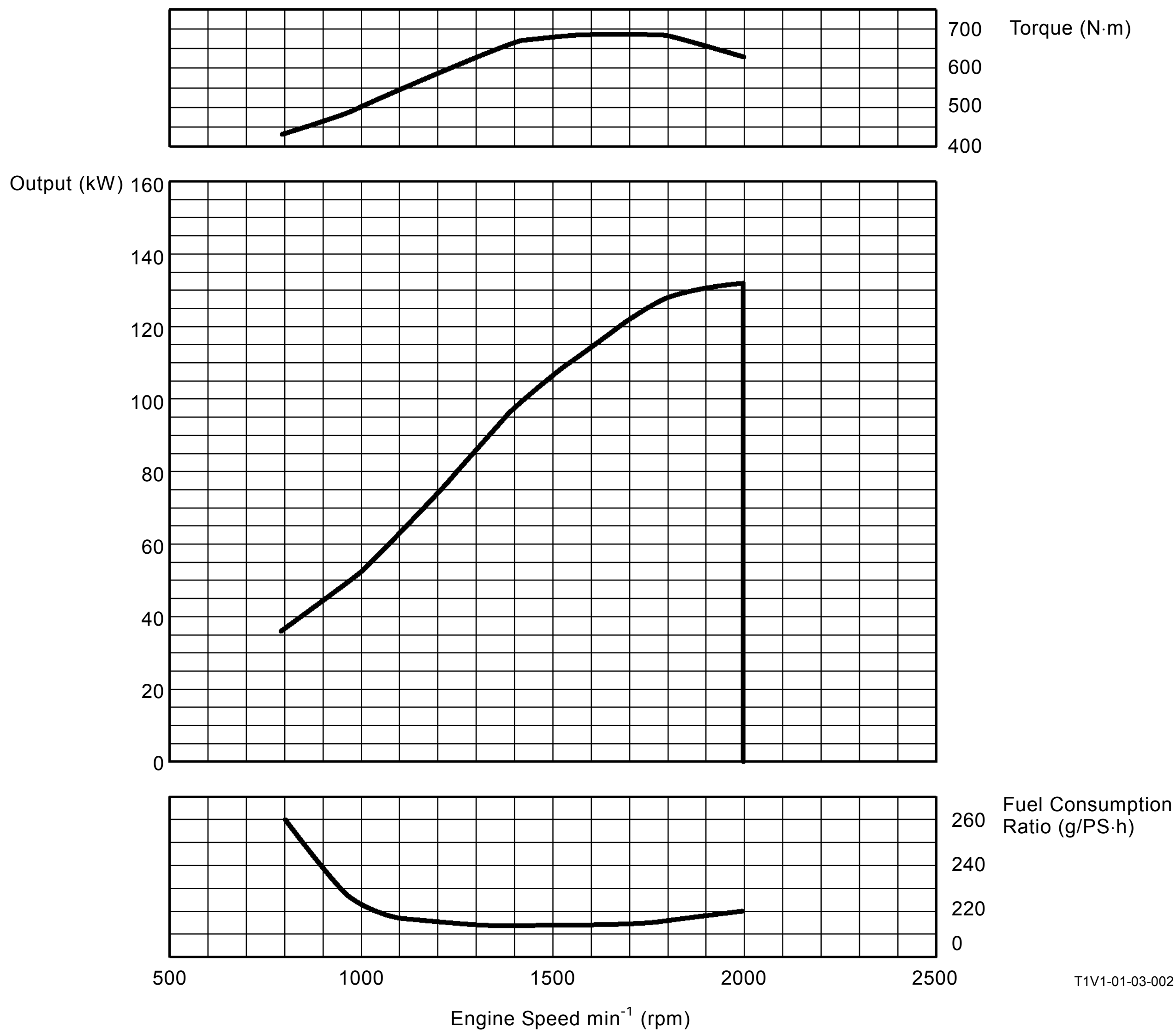


T1GR-01-02-002

ZX240-3 class:

Engine Performance Curve (4HK1XYSA-01)

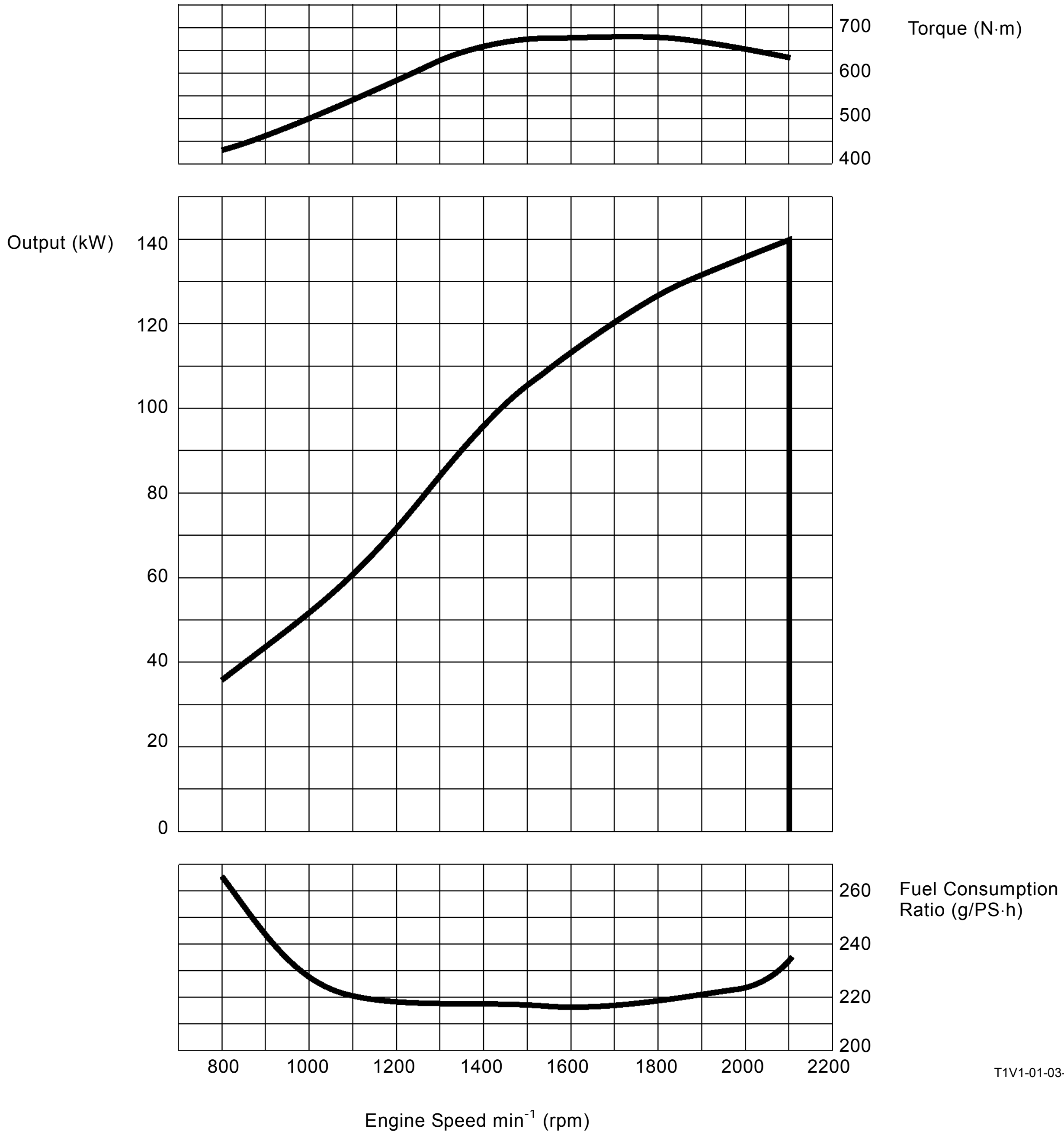
Test Condition: 1. In conformity with JIS D1005 (Performance Test Method for Diesel Engine Used for Construction Machinery) under standard atmospheric pressure.
2. Equipped with the fan and alternator.



ZX270-3 class:

Engine Performance Curve (4HK1XYSA-03)

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.



T1V1-01-03-003

ENGINE ACCESSORIES

RADIATOR ASSEMBLY

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class:

Type .... Parallel Type
Weight .... 59 kg (130 lb)

	Radiator	Oil Cooler
Capacity	6.3 L (1.7 US gal)	10 L (2.6 US gal)
Air-Tight Test Pressure	98 kPa (1.0 kgf/cm^2, 14 psi)	1470 kPa (15 kgf/cm^2, 213 psi)
Cap Opening Pressure	49 kPa (0.5 kgf/cm^2, 7 psi)	–

	Intercooler
Capacity	8.0 L (2.1 US gal)
Air-Tight Test Pressure	245 kPa (2.5 kgf/cm^2, 36 psi)
Cap Opening Pressure	–

ZX240-3 class, ZX270-3 class:

Type .... Parallel Type
Weight .... 63 kg (140 lb)

	Radiator	Oil Cooler
Capacity	6.6 L (1.74 US gal)	10.5 L (2.8 US gal)
Air-Tight Test Pressure	98 kPa (1.0 kgf/cm^2, 14 psi)	1470 kPa (15 kgf/cm^2, 213 psi)
Cap Opening Pressure	49 kPa (0.5 kgf/cm^2, 7 psi)	–

	Intercooler
Capacity	8.5 L (2.2 US gal)
Air-Tight Test Pressure	245 kPa (2.5 kgf/cm^2, 36 psi)
Cap Opening Pressure	–

FUEL COOLER

Weight .... 0.7 kg (1.5 lb)
Core Type .... Wavy Fin
Capacity .... 0.2 L (0.05 US gal.)

BATTERY

Type 115E41L
Capacity .... 88 Ah (5-Hour Rate)
Voltage .... 12 V
Weight .... 27.5 kg (61 lb)×2

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

Maximum Flow Rate .... 212 L/min (56 US gpm)×2 (ZX200-3 class, ZX225US-3 class, ZX225USR-3 class)
216 L/min (57 US gpm)×2 (ZX240-3 class)
227 L/min (59.9 US gpm)×2 (ZX270-3 class)

Maximum Flow Rate (Theoretical Value) .... 118 L/min (31.1 US gpm)×2

Rated Pressure .... 34.3 MPa

REGULATOR

Type .... Hydraulic Pressure Operated Type

PILOT PUMP

Type .... FS 11/16.8

Model .... Fixed Displacement Type Gear Pump

Maximum Flow (Theoretical Value)................ 31.9 L/min (8.4 US gpm)
HP Mode: 35.3 L/min (9.3 US gpm) } ZX200-3 class, ZX225US-3 class, ZX225USR-3 class

33.6 L/min (8.88 US gpm)
HP Mode: 35.28 L/min (9.32 US gpm) } ZX240-3 class

34.44 L/min (9.10 US gpm)
HP Mode: 36.12 L/min (9.54 US gpm) } ZX270-3 class

CONTROL VALVE

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

Main Relief Set-Pressure .... Normal: 34.3 MPa (350 kgf/cm^2, 4980 psi) at 150 L/min (39.6 US gpm)
Power Digging: 36.3 MPa (370 kgf/cm^2) at 150 L/min (39.6 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

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class:

Type .... Two-Stage Reduction Planetary Gear
Reduction Gear Ratio..................................... 17.53

ZX240-3 class:

Type .... Two-Stage Reduction Planetary Gear
Reduction Gear Ratio..................................... 21.75

ZX270-3 class:

Type .... Two-Stage Reduction Planetary Gear
Reduction Gear Ratio..................................... 17.513

SWING MOTOR

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class:

Model M5X130CHB-10A-29B
Type .... Swash-Plate Type, Fixed Displacement Axial Plunger Motor

ZX240-3 class:

Model M5X130CHB-10A-45A
Type .... Swash-Plate Type, Fixed Displacement Axial Plunger Motor

ZX270-3 class:

Model M5X180-10A-65A
Type .... Swash-Plate Type, Fixed Displacement Axial Plunger Motor

VALVE UNIT

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class:

Type .... Non Counterbalance Valve Type

Relief Set-Pressure .... 32.4 MPa (330 kgf/cm^2, 4710 psi) at 170 L/min

ZX240-3 class:

Type .... Non Counterbalance Valve Type

Relief Set-Pressure .... 32.4 MPa (330 kgf/cm^2, 4710 psi) at 180 L/min

ZX270-3 class:

Type .... Non Counterbalance Valve Type

Relief Set-Pressure .... 32.4 MPa (330 kgf/cm^2, 4710 psi) at 190 L/min

SWING PARKING BRAKE

Type .... Multi-Disc-Wet Negative Type

Release Pressure .... 1.9 to 2.8 MPa (20 to 28.6 kgf/cm^2, 284 to 410 psi)

TRAVEL DEVICE

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class:

Type .... Three-Stage Reduction Planetary Gear

Reduction Gear Ratio..................................... 58.702

ZX240-3 class:

Type .... Three-Stage Reduction Planetary Gear

Reduction Gear Ratio..................................... 64.863

ZX270-3 class:

Type .... Three-Stage Reduction Planetary Gear

Reduction Gear Ratio..................................... 70.842

TRAVEL MOTOR

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class:

Type .... Swash-Plate Type Variable Displacement Axial Plunger Motor

Maximum Flow (Theoretical Value)
(Fast/Slow) .... 79/122.5 L/min (20.8/32.3 US gpm)

ZX240-3 class:

Type .... Swash-Plate Type Variable Displacement Axial Plunger Motor

Maximum Flow (Theoretical Value)
(Fast/Slow) .... 75.7/122.5 L/min (20/32.3 US gpm)

ZX270-3 class:

Type .... Swash-Plate Type Variable Displacement Axial Plunger Motor

Maximum Flow (Theoretical Value)
(Fast/Slow) .... 86.5/145.5 L/min (22.8/38.4 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 .... 0.97±0.07 MPa (9.9±0.7 kgf/cm^2, 141±10 psi)
(ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class)

Release Starting Pressure .... 1.07 to 1.23 MPa (10.9 to 12.5 kgf/cm^2, 156 to 179 psi)
(ZX270-3 class)

CYLINDER (MONO BOOM MACHINE)

ZAXIS200-3, ZX225USR-3 class:

	Boom	Arm
Rod Diameter	85 mm (3.35”)	95 mm (3.74”)
Cylinder Bore	120 mm (4.72”)	135 mm (5.31”)
Stroke	1260 mm (4’2”)	1475 mm (4’10”)
Fully Retracted Length	1855 mm (6’1”)	2007 mm (6’7”)
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

	Bucket
Rod Diameter	80 mm (3.15”)
Cylinder Bore	115 mm (4.53”)
Stroke	1060 mm (3’6”)
Fully Retracted Length	1590 mm (5’3”)
Plating Thickness	30 μm (1.18 μm)

ZX225US-3 class:

	Boom	Arm
Rod Diameter	85 mm (3.35”)	95 mm (3.74”)
Cylinder Bore	120 mm (4.72”)	135 mm (5.31”)
Stroke	1325 mm (4’4”)	1475 mm (4’10”)
Fully Retracted Length	1843 mm (6’0”)	2007 mm (6’7”)
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

	Bucket
Rod Diameter	80 mm (3.15”)
Cylinder Bore	115 mm (4.53”)
Stroke	1060 mm (3’6”)
Fully Retracted Length	1590 mm (5’3”)
Plating Thickness	30 μm (1.18 μm)

ZAXIS240-3:

	Boom	Arm
Rod Diameter	90 mm (3.54”)	100 mm (3.94”)
Cylinder Bore	125 mm (4.92”)	140 mm (5.51”)
Stroke	1390 mm (4’6”)	1610 mm (5’3”)
Fully Retracted Length	1990 mm (6’6”)	2177 mm (7’1”)
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

	Bucket
Rod Diameter	90 mm (3.54”)
Cylinder Bore	130 mm (5.12”)
Stroke	1075 mm (3’6”)
Fully Retracted Length	1632 mm (5!4”)
Plating Thickness	30 μm (1.18 μm)

ZAXIS270-3:

	Boom	Arm
Rod Diameter	95 mm (3.74”)	105 mm (4’1”)
Cylinder Bore	135 mm (5.32”)	150 mm (5’9”)
Stroke	1360 mm (4’5”)	1615 mm (5’6”)
Fully Retracted Length	1940 mm (6’4”)	2259 mm (7’4”)
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

	Bucket
Rod Diameter	90 mm (3.5”)
Cylinder Bore	135 mm (5.32”)
Stroke	1070 mm (3’6”)
Fully Retracted Length	1660 mm (5’5”)
Plating Thickness	30 μm (1.18 μm)

CYLINDER (2-PIECE BOOM MACHINE)

ZAXIS240-3:

	Boom	Arm
Rod Diameter	90 mm (3.5”)	100 mm (3.94”)
Cylinder Bore	125 mm (4.92”)	140 mm (5.51”)
Stroke	1390 mm (4’6”)	1610 mm (5’3”)
Fully Retracted Length	1990 mm (6’6”)	2177 mm (7’1”)
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

	Bucket	Positioning
Rod Diameter	90 mm (3.5”)	100 mm (3.94”)
Cylinder Bore	130 mm (5.12”)	150 mm (5.91”)
Stroke	1075 mm (3’6”)	1327 mm (4’4”)
Fully Retracted Length	1632 mm (5’4”)	1910 mm (6’3”)
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

ZAXIS270-3:

	Boom	Arm
Rod Diameter	95 mm (3.7”)	105 mm (4.1”)
Cylinder Bore	135 mm (5.3”)	150 mm (5.9”)
Stroke	1360 mm (4’6”)	1659 mm (5’5”)
Fully Retracted Length	1940 mm (6’4”)	2259 mm (7’5”)
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

	Bucket	Positioning
Rod Diameter	90 mm (3.5”)	100 mm (3.94”)
Cylinder Bore	135 mm (5.32”)	150 mm (5.91”)
Stroke	1070 mm (3’6”)	1327 mm (4’4”)
Fully Retracted Length	1660 mm (5’5”)	1910 mm (6’3”)
Plating Thickness	30 μm (1.18 μm)	30 μm (1.18 μm)

HOSE RUPTURE VALVE

ZX240-3 class, ZX270-3 class:

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 24V

OIL COOLER BYPASS CHECK VALVE
Cracking Pressure .... 490 kPa (5 kgf/cm^2) at 5 L/min
Rated Voltage.. DC 24 V

FILTER
Engine Oil Filter... ISUZU 8973243860
Fuel Filter .... ISUZU 8973759081
Filtration
Air Cleaner .... -
Full-Flow Filter....................................... β 10≥2.0
Suction Filter .... 177 μm (80 mesh)
Pilot Filter .... 10≥1.4

ELECTRICAL COMPONENT

BATTERY RELAY

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

STARTER RELAY 2

Parts No. .... ISUZU 1825530391
Voltage .... 24 V

GLOW RELAY

Parts No. .... ISUZU 8944607060
Voltage .... 24 V

HYDRAULIC OIL TEMPERATURE SENSOR

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

AIR CLEARNER RESTRICTION SWITCH

Operating Pressure .... 62.2±0.60 kPa (ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class)
.... 62.2±0.57 kPa (ZX270-3 class)

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

ZX200-3 class, ZX240-3 class, ZX270-3 class:

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....................................... 850±50 g
Compressor Oil Quantity................................ 210 cm^3

ZX225US-3 class, ZX225USR-3 class:

Refrigerant .... 134 a
Cooling Ability... 16.0 MJ/h (3830 kcal/h)
Cool Air Volume... 395 m^3/h or More
Heating Ability... 14.9 MJ/h (3570 kcal/h) or More
Warm Air Volume .... 365 m^3/h or More
Temperature Adjusting System .... Electronic Type
Refrigerant Quantity....................................... 900±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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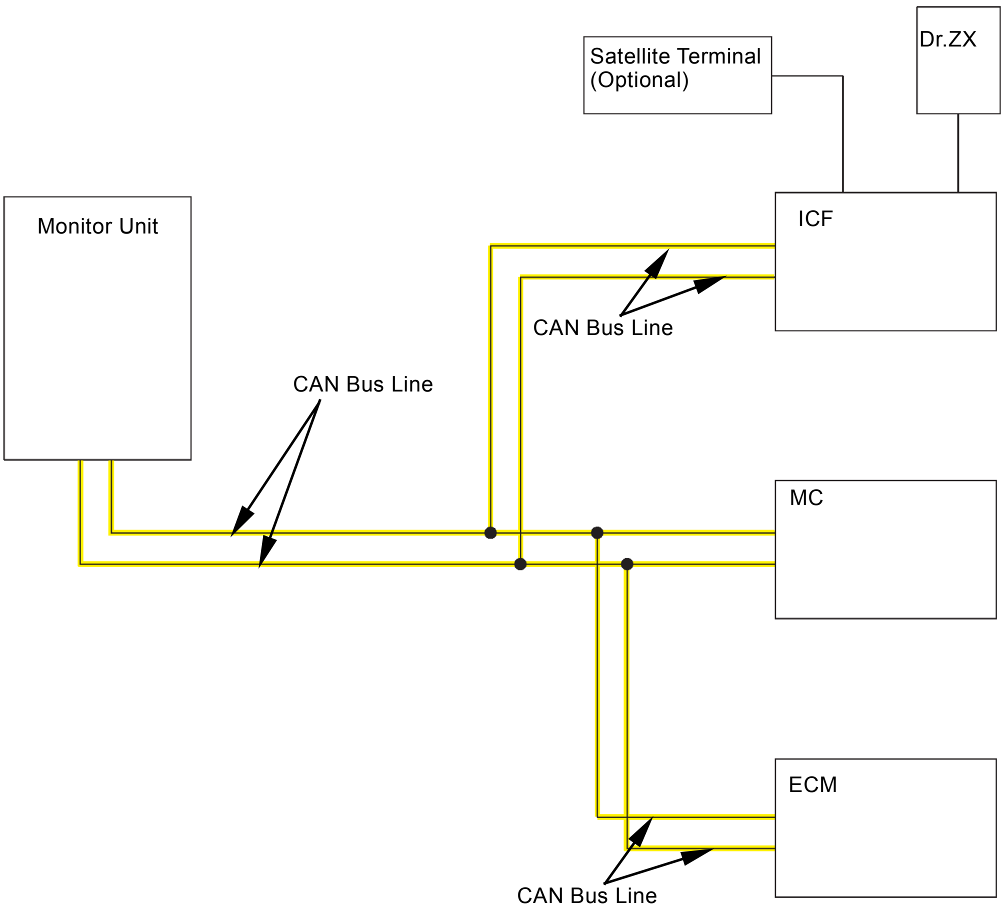
OUTLINE

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



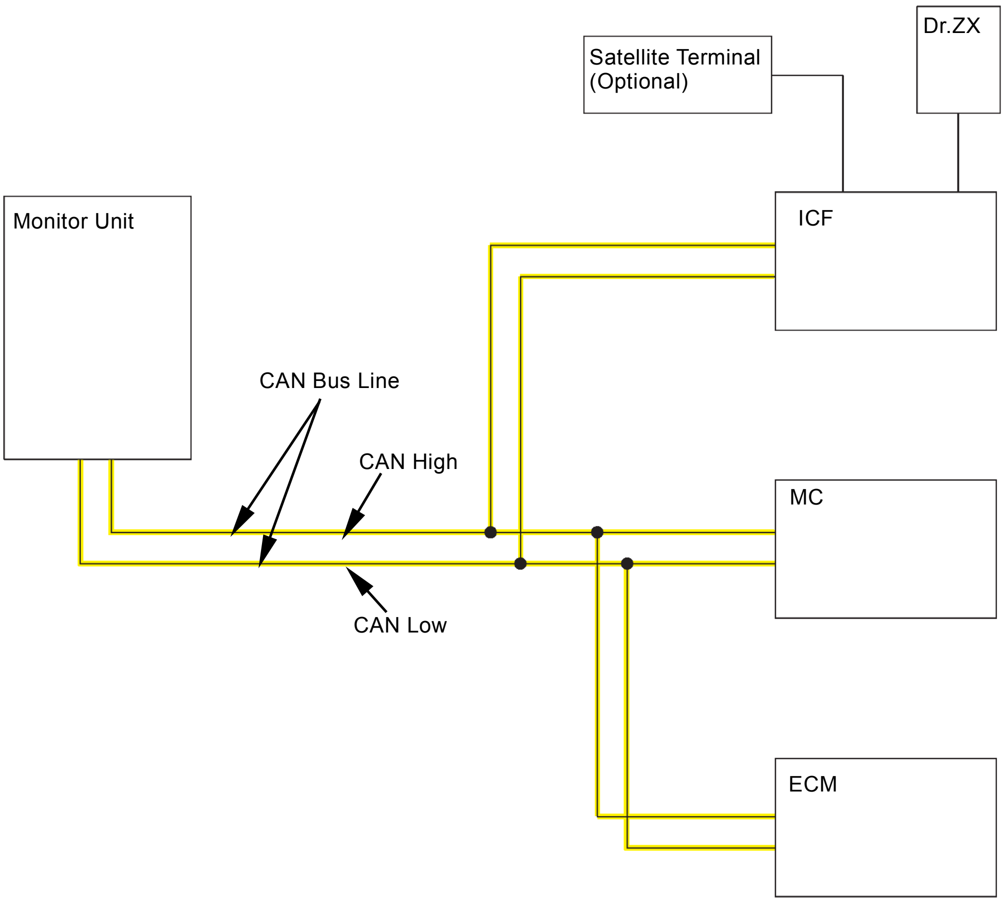
T1V1-02-01-050

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 by engine control dial in order to increase engine power.

・Travel HP Mode Control

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class

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 by engine control dial in order to increase travel speed.

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

ZX270-3 class

Engine Control Dial: Fast Idle Position

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

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

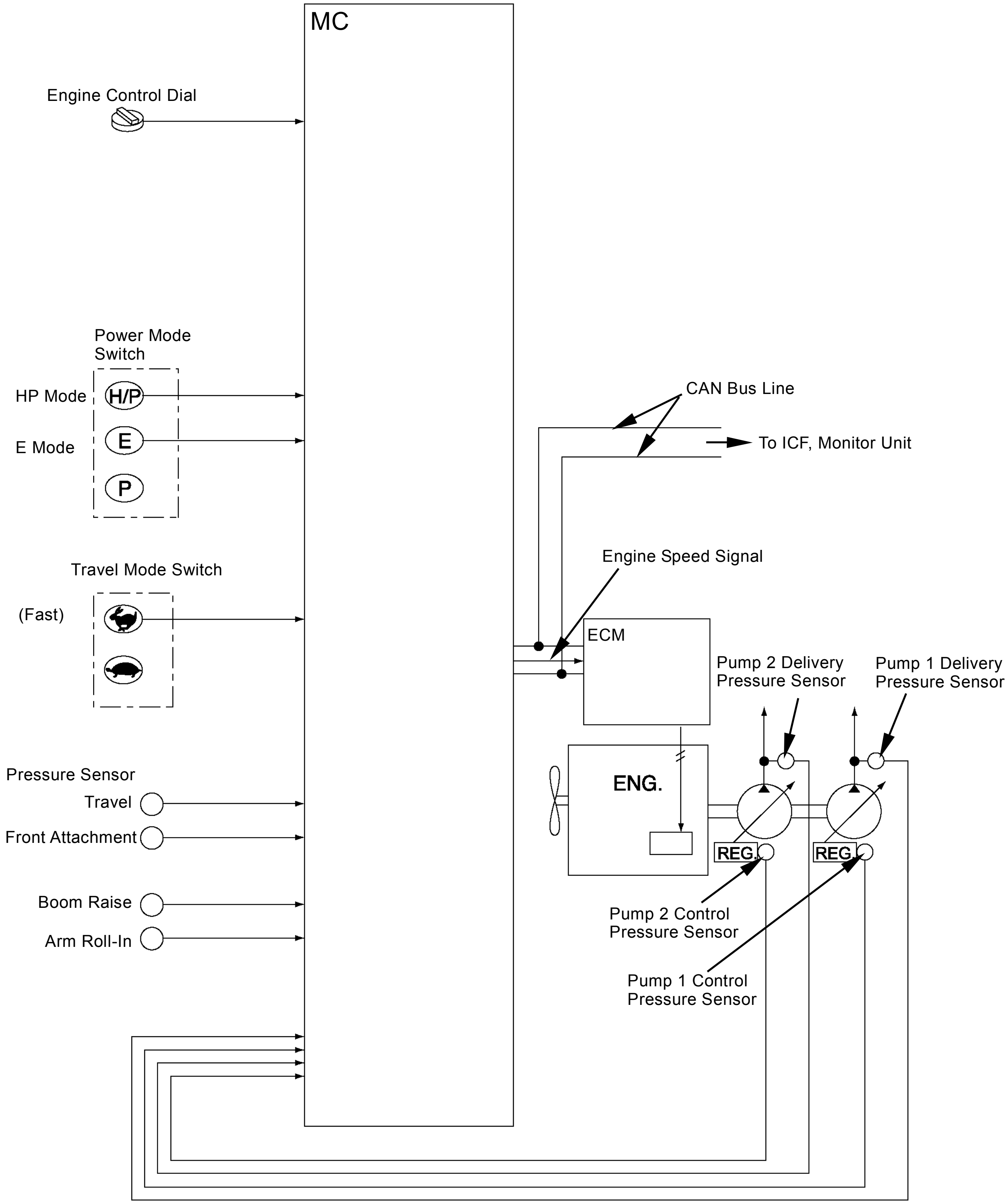
・E Mode Control

Condition:
Pump Control Pressure and Pump Average Delivery Pressure: Both Low Pressure
Pump Control Pressure and Pump Average Delivery Pressure: Both High Pressure
Pump Control Pressure: Low Pressure and Pump Average Delivery Pressure: High Pressure
Engine Control Dial: Engine Speed 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 by engine control dial.

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

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



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- Auto-Idle Control

All Control Levers: Neutral Position
Auto-Idle Switch: ON
On conditions above, MC sends the signal to ECM and set engine speed to auto-idle speed.
When operating the engine control dial, shifting the power mode switch (E mode to P mode or P mode to E mode) or operating front attachment/travel, auto-idle control is released.

- Auto-Warming Up Control

When 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

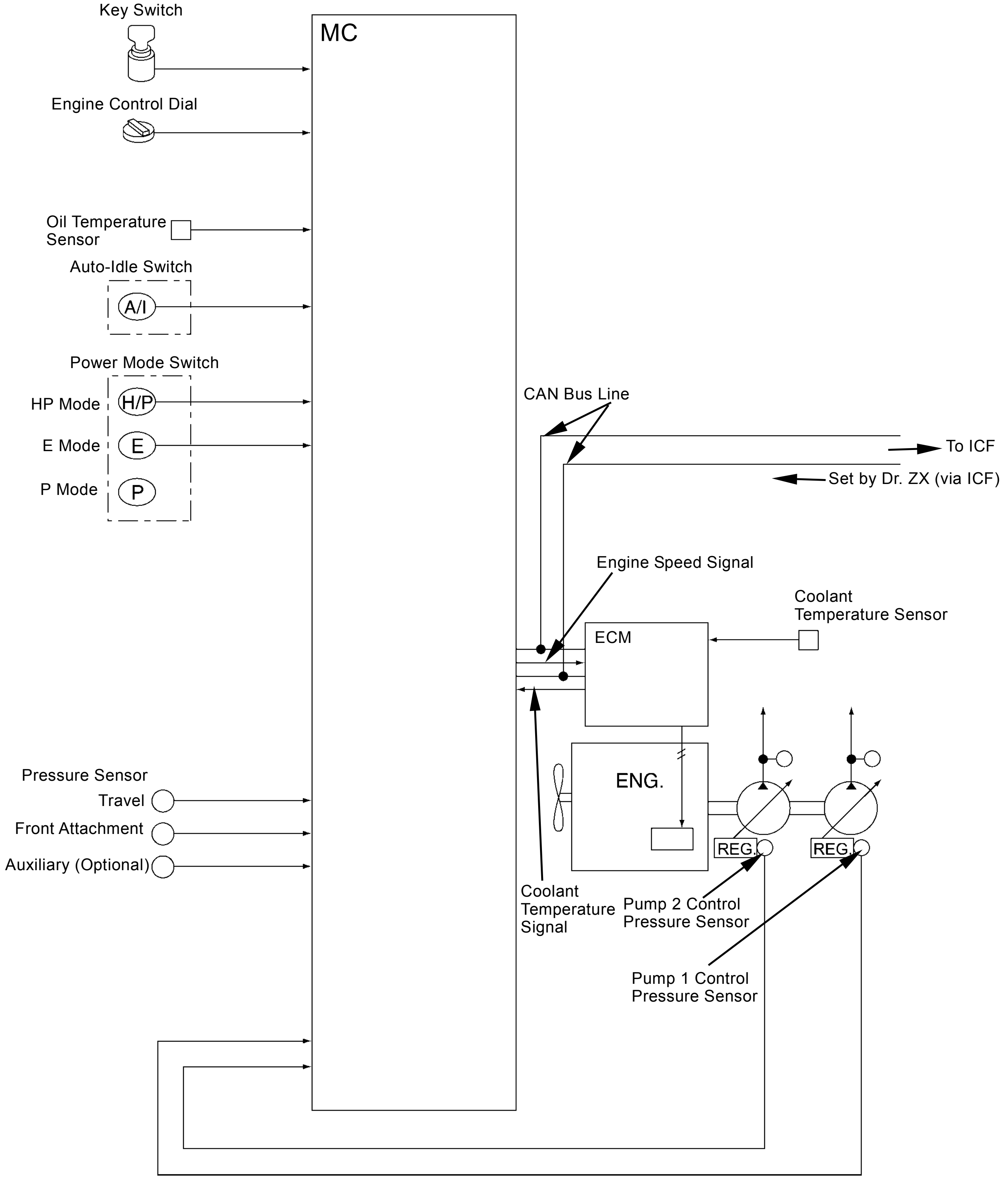
Coolant Temperature: Less than 5 °C (41 °F)
Pump Control Pressure of Pumps 1 and 2: 0.5 Mpa (5.1 kgf/cm^2, 37 psi) or less
Engine Control Dial: Fast Idle Position
When the engine starts on conditions above, MC sends the signal to ECM and increases engine speed beyond fast idle speed.

- Attachment Operation Speed Increase Control (Optional)

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

- Attachment Operation Speed Limit Control (Optional)

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



T1V5-02-01-008

Pump Control

・Speed Sensing Control

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

・Travel Torque-Up Control

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

・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)

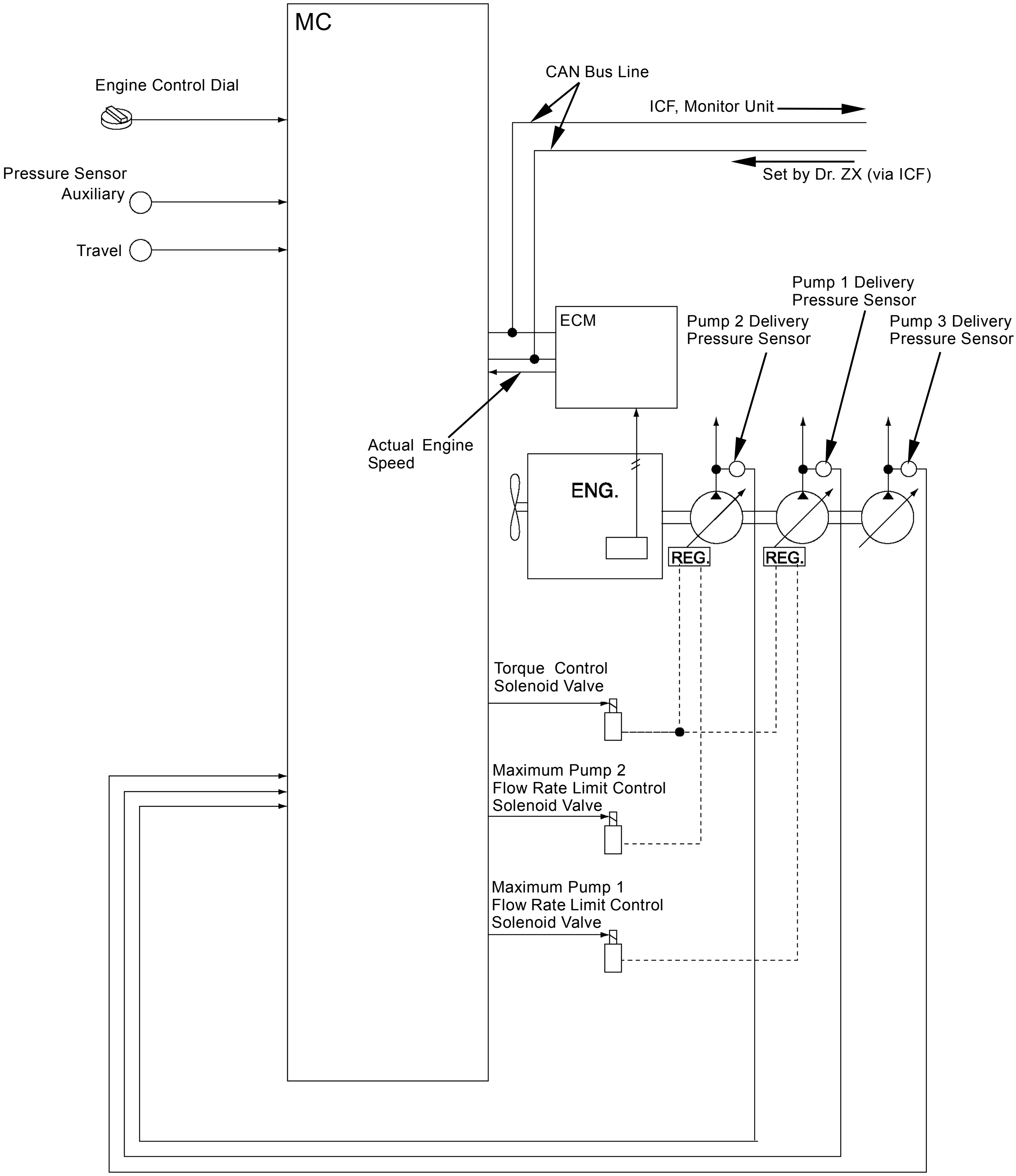
When the attachment (mainly a vibrating hammer) is used with the travel control lever in neutral, MC drives the maximum pump 1 flow rate limit control solenoid valve according to the signal from pressure sensor (auxiliary) and decreases maximum flow rate of pump 1.

・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.

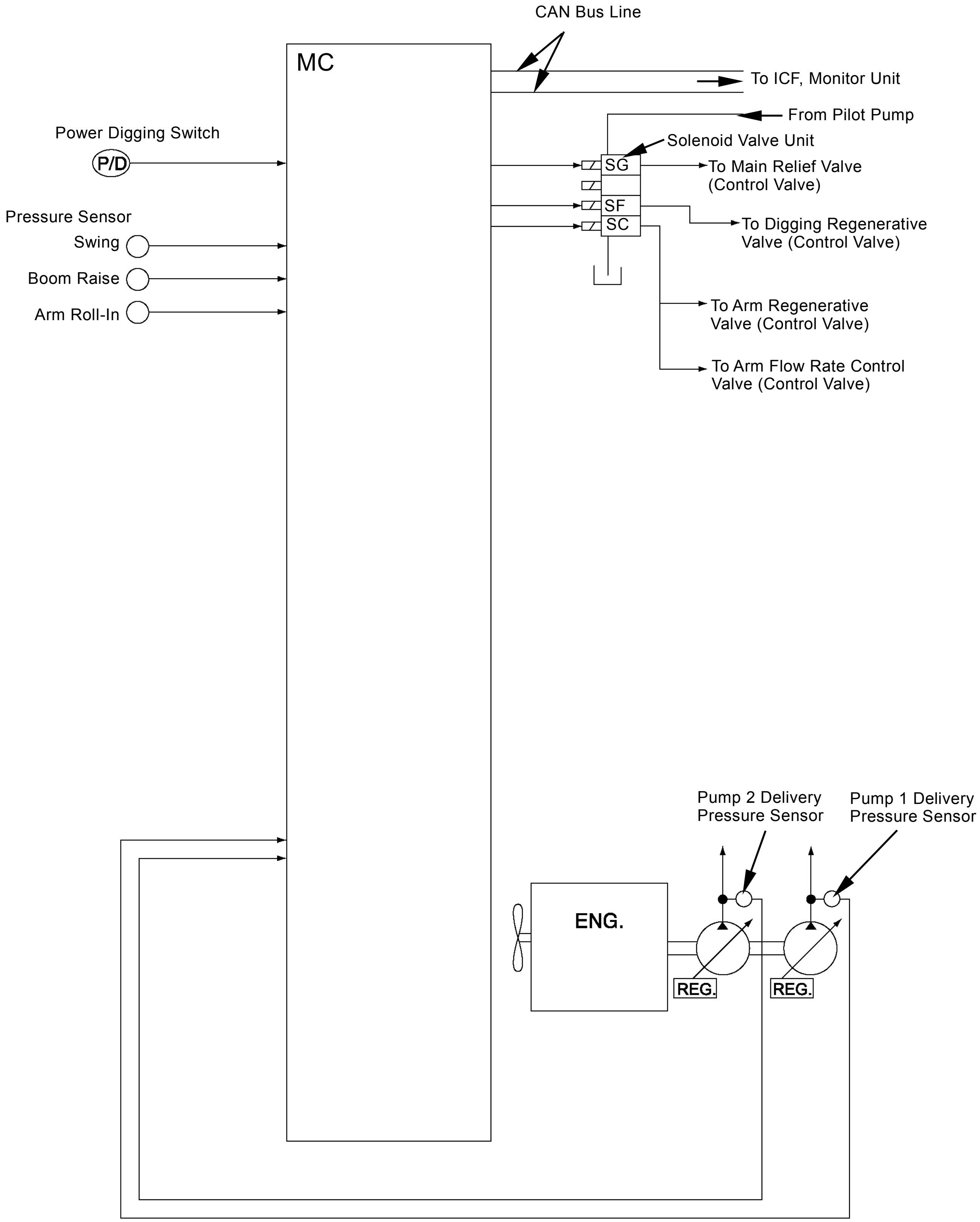
・Arm Regenerative Control

Condition:
Pump 1, 2 Delivery Pressure: Either Low
Combined Operation of Swing or Boom Raise and Arm Roll-In

On conditions above, MC drives solenoid valve unit (SC) according to the signals from pump 1, 2 delivery pressure sensors and pressure sensors (swing, arm roll-in and boom raise), outputs pilot pressure, and shifts the arm regenerative valve and the arm flow rate control valve.
The arm regenerative valve closed the return circuit to hydraulic oil tank from arm cylinder rod side and supplies pressure oil to the arm cylinder bottom side. Consequently, speed of arm roll-in increases and hesitation during arm roll-in operation is prevented.
The arm flow rate control valve controls pressure oil to the arm 2 parallel circuit, supplies pressure oil to the boom 1 spool, and keeps boom raise speed.
(Refer to the Control System group in SYSTEM.)

・Digging Regenerative Control

When operating digging with pump 1, 2 delivery pressure in high, MC drives solenoid valve unit (SF) according to the signals from pumps 1, 2 delivery pressure sensors and pressure sensor (arm roll-in, boom raise), outputs pilot pressure, and shifts the digging regenerative valve.
As pressure oil from pumps 1, 2 and the boom cylinder rod side flows to the arm cylinder bottom side through the digging regenerative valve, speed of arm roll-in increases.
(Refer to the Control System group in SYSTEM.)



T1V1-02-01-042

- Travel Motor Displacement Angle Selection Control
  ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class
  Condition:
  Pump 1, 2 Delivery Pressure: Either Low
  Pump 1, 2 Control Pressure: Either High
  Travel Mode Switch: Fast

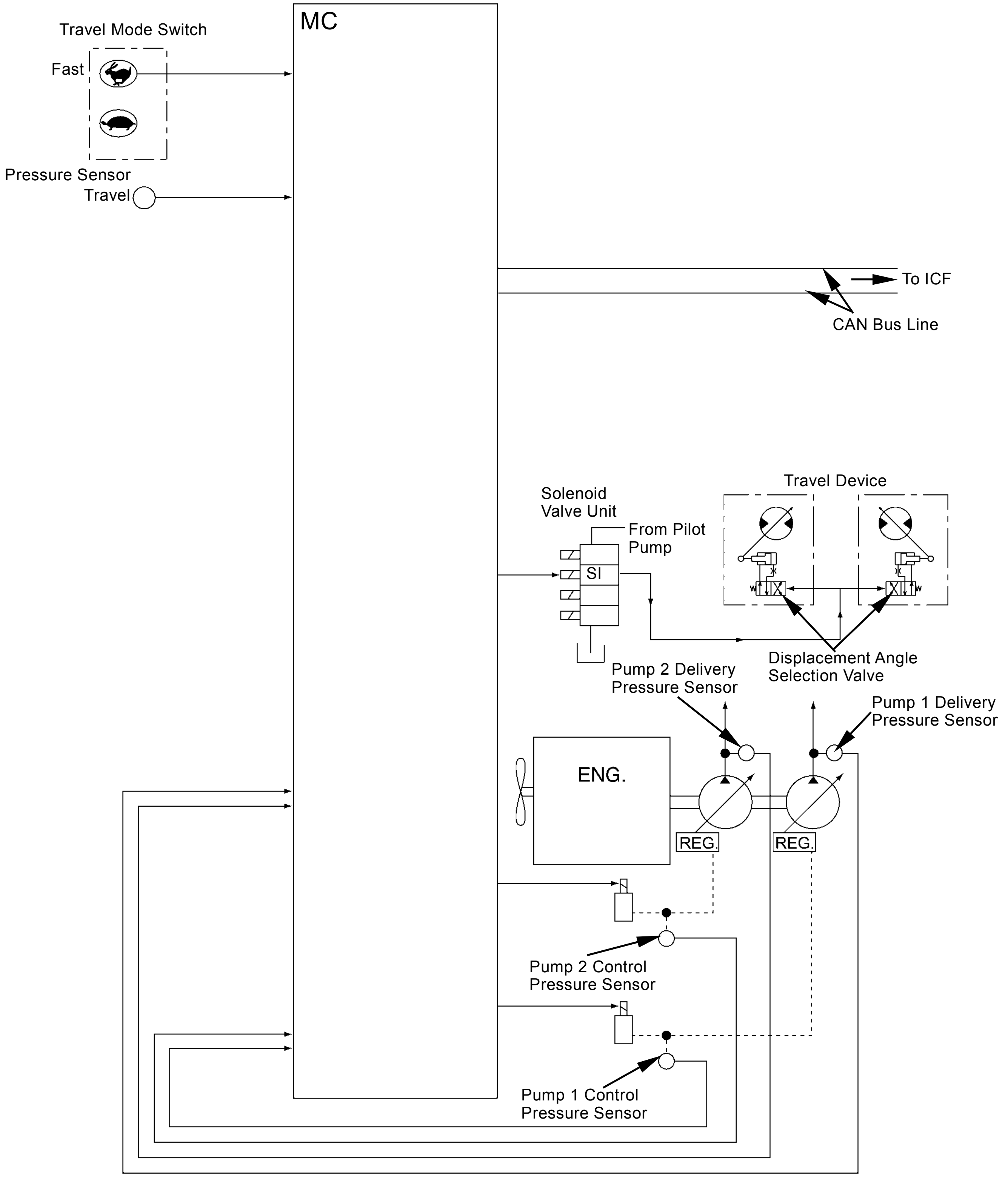
When operating travel on conditions above, MC drives solenoid valve unit (SI) according to the signals from pressure sensor (travel), pump 1, 2 delivery pressure sensors and pump 1, 2 control pressure sensors.

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.

ZX270-3 class
Condition:
Pump 1,2 Delivery Pressure: Low
Pump 1, 2 Control Pressure: 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.



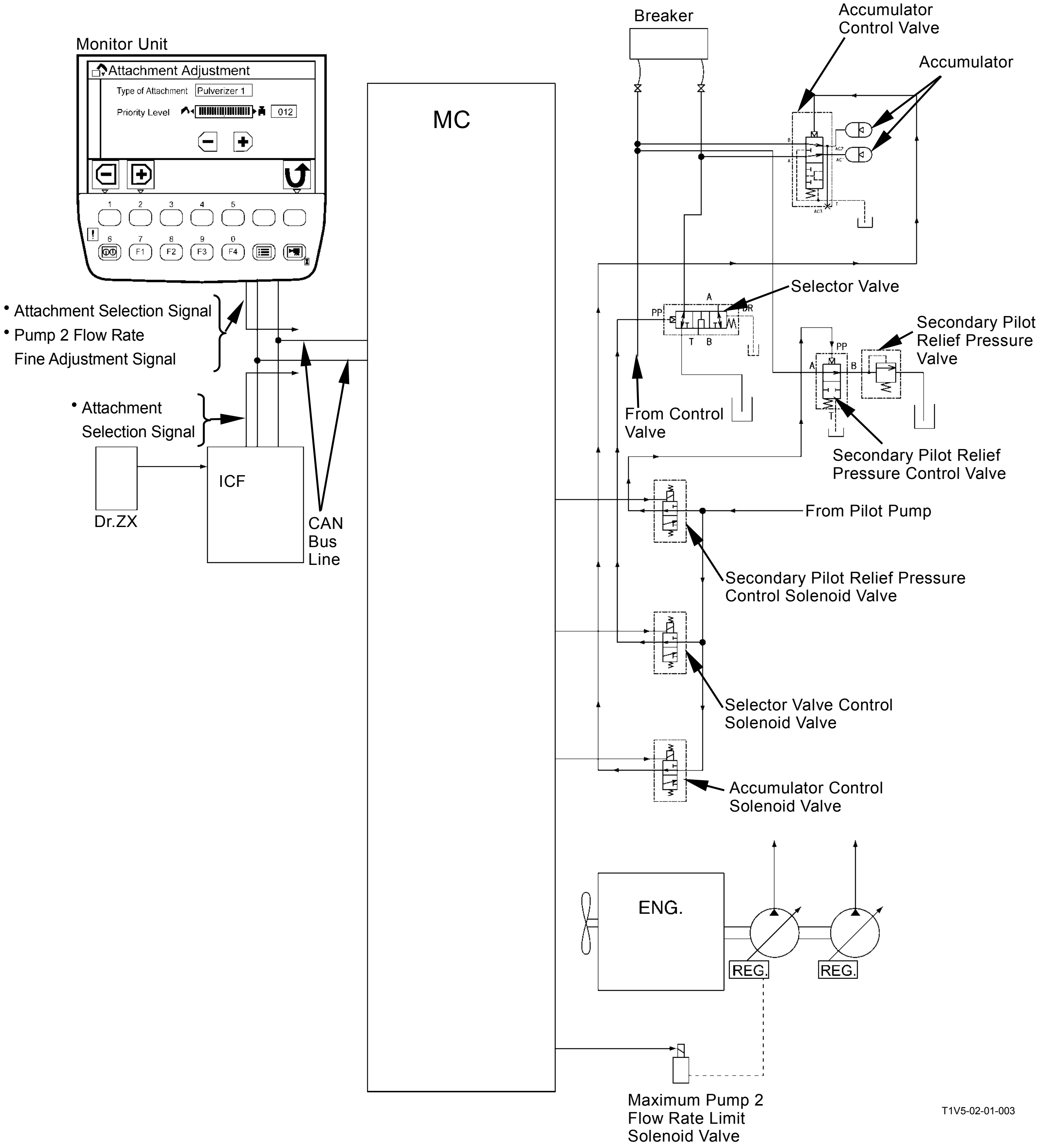
T1V5-02-01-009

- 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.



T1V5-02-01-003

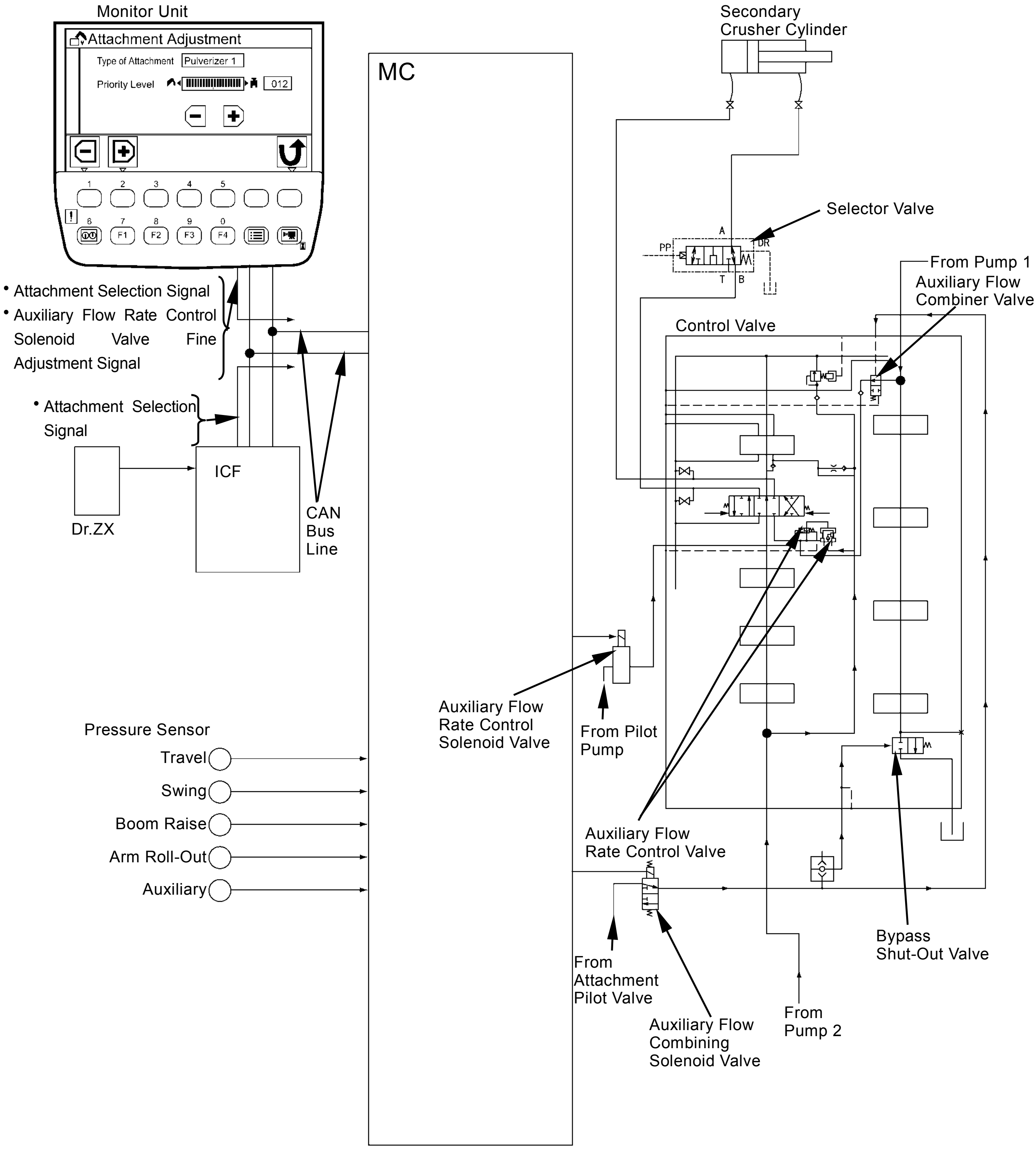
NOTE: Flow rate of maximum pump 2 flow rate limit solenoid valve can be adjusted finely on the monitor unit.

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

- Primary Crusher Control (Optional)

As for the machine equipped with the primary crusher, when primary crusher 1 is selected on the monitor unit or is set by Dr. ZX, MC drives the auxiliary flow combining solenoid valve.
When operating the primary crusher, pilot pressure from the attachment pilot valve shifts the bypass shut-out valve and the auxiliary flow combining valve through the auxiliary flow combining solenoid valve. When pressure oil from pump 1 is combined with pressure oil from pump 2 through the auxiliary flow combining valve. Therefore, combined pressure oil flows to the auxiliary spool and speed operating the primary crusher increases.
When operating combined operation of arm roll-out, arm roll-out + boom raise, swing or travel and primary crusher, MC drives the auxiliary flow rate control solenoid valve according to the signals from pressure sensors (auxiliary, arm roll-out, boom raise, swing or travel) so that pressure oil to the primary crusher is restricted.
As the primary crusher is heavier than the secondary crusher, when operating combined operation of arm roll-out or arm roll-out + boom raise and primary crusher, MC restricts flow rate of the auxiliary flow rate control solenoid valve further, and gives priority to operation of arm roll-out or arm roll-out + boom raise.



T1V5-02-01-004

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

Other Controls

- Rear Monitoring Display Selection Control

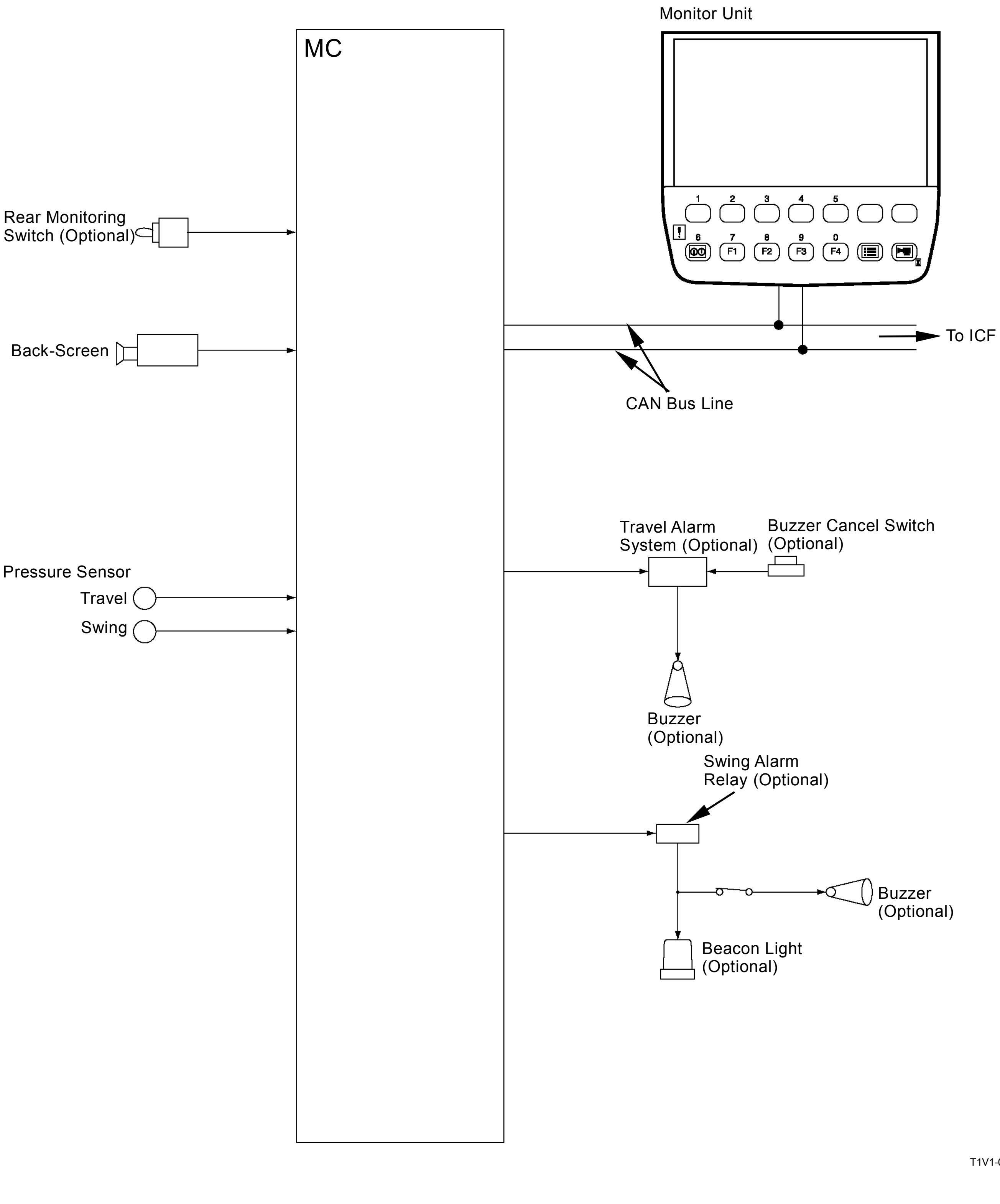
MC shifts the monitor unit into the back-screen display according to the signal from pressure sensor (travel) or rear monitoring switch (optional).

- 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.



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

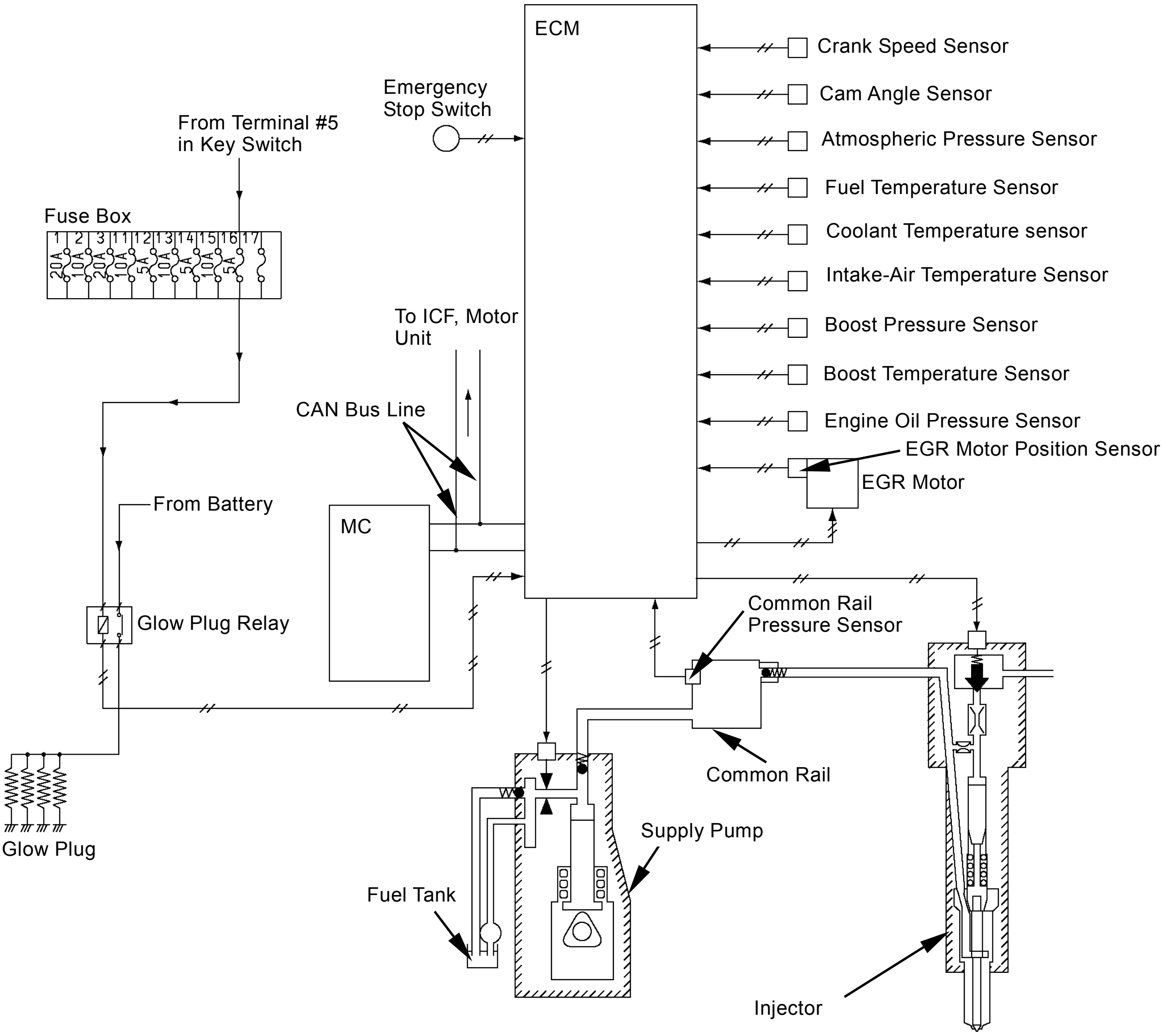
ECM decides EGR gas amount according to engine speed, fuel flow rate, coolant temperature, atmospheric pressure and intake-air temperature.
ECM opens EGR valve and re-circulates exhaust gas, amount of which is equal to EGR gas amount, in the intake manifold. EGR gas is combined with intake-air so that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



T1V1-02-01-047

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

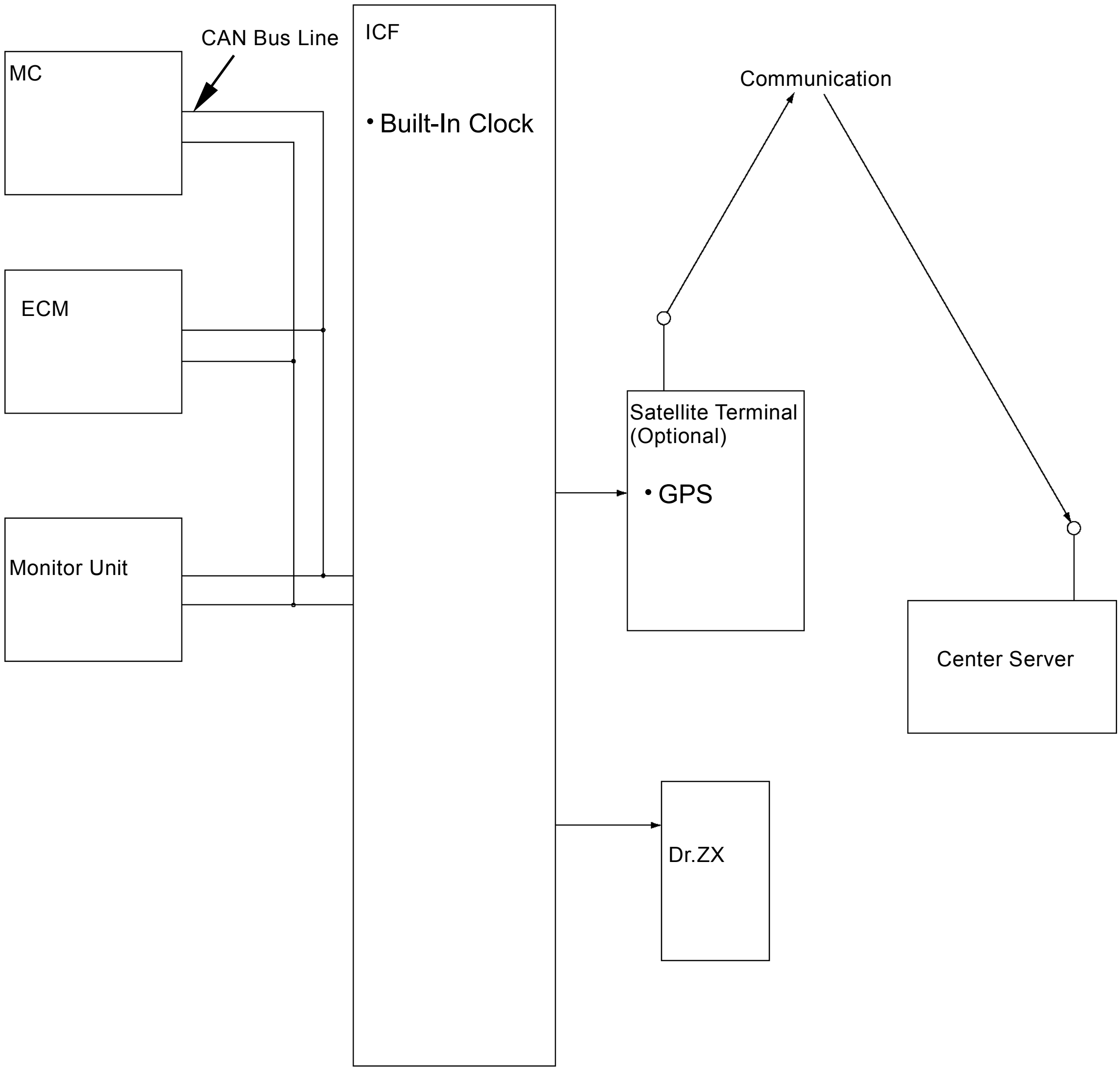
ICF makes the frequency distribution data every 100 hours.
The frequency distribution data can be sent to the center server by using the satellite terminal (optional).

- 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.



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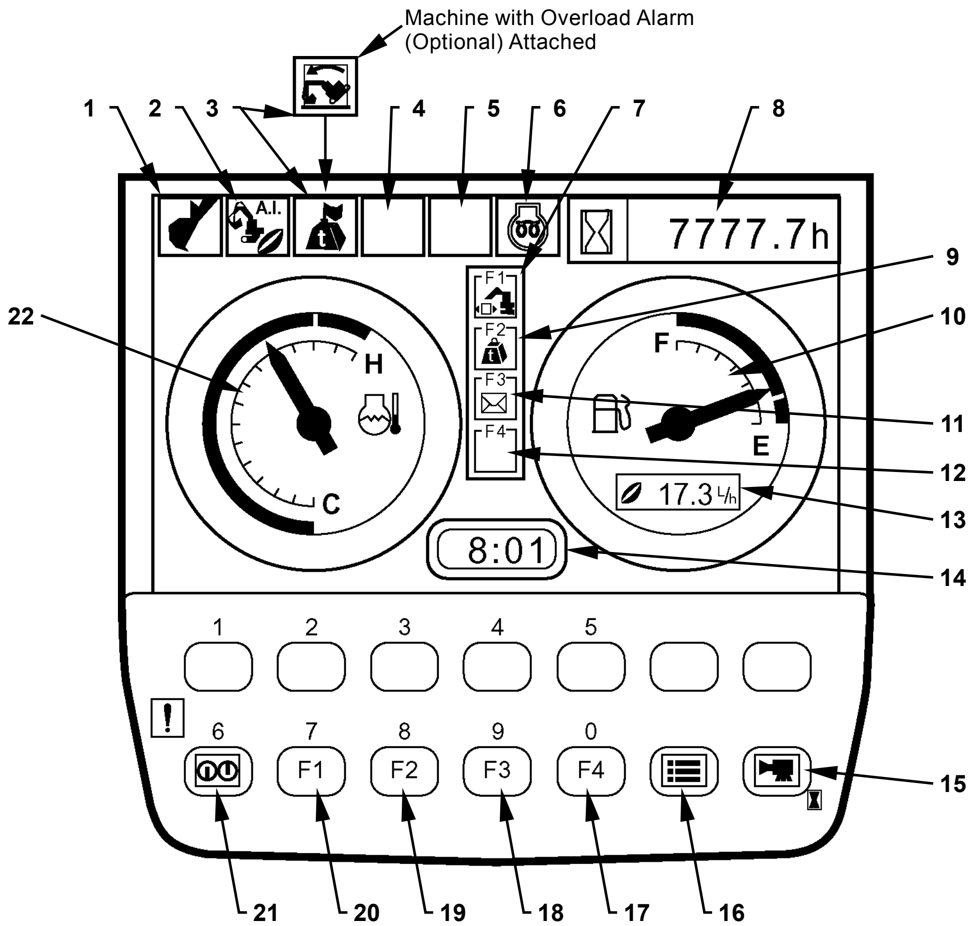
OUTLINE

Function Outline

Primary Screen



T1V1-05-01-094

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

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

- Display of Meters

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

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

- Work Mode Display

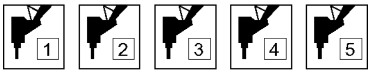
  The attachments being used are displayed according to the signals received from MC by using CAN.

Digging Mode

T1V1-05-01-108

Attachment Mode

Breaker

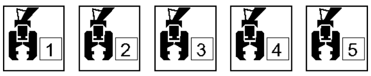


T1V1-05-01-104

Pulverizer

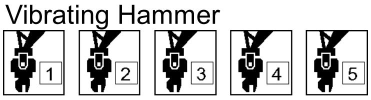
T1V1-05-01-105

Crusher



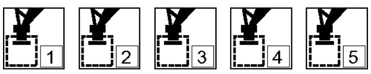
T1V1-05-01-106

Vibrating Hammer



T1V1-05-01-107

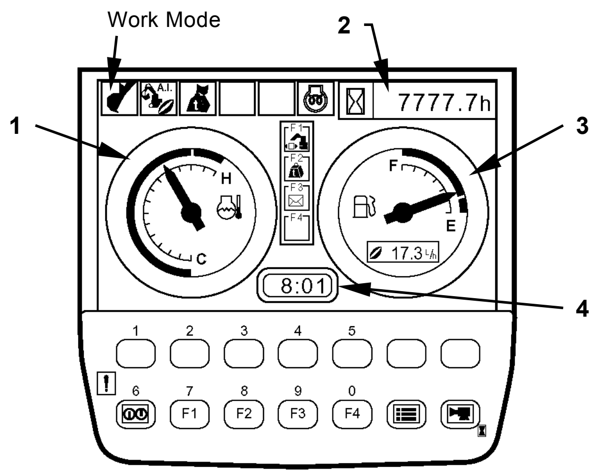
Others



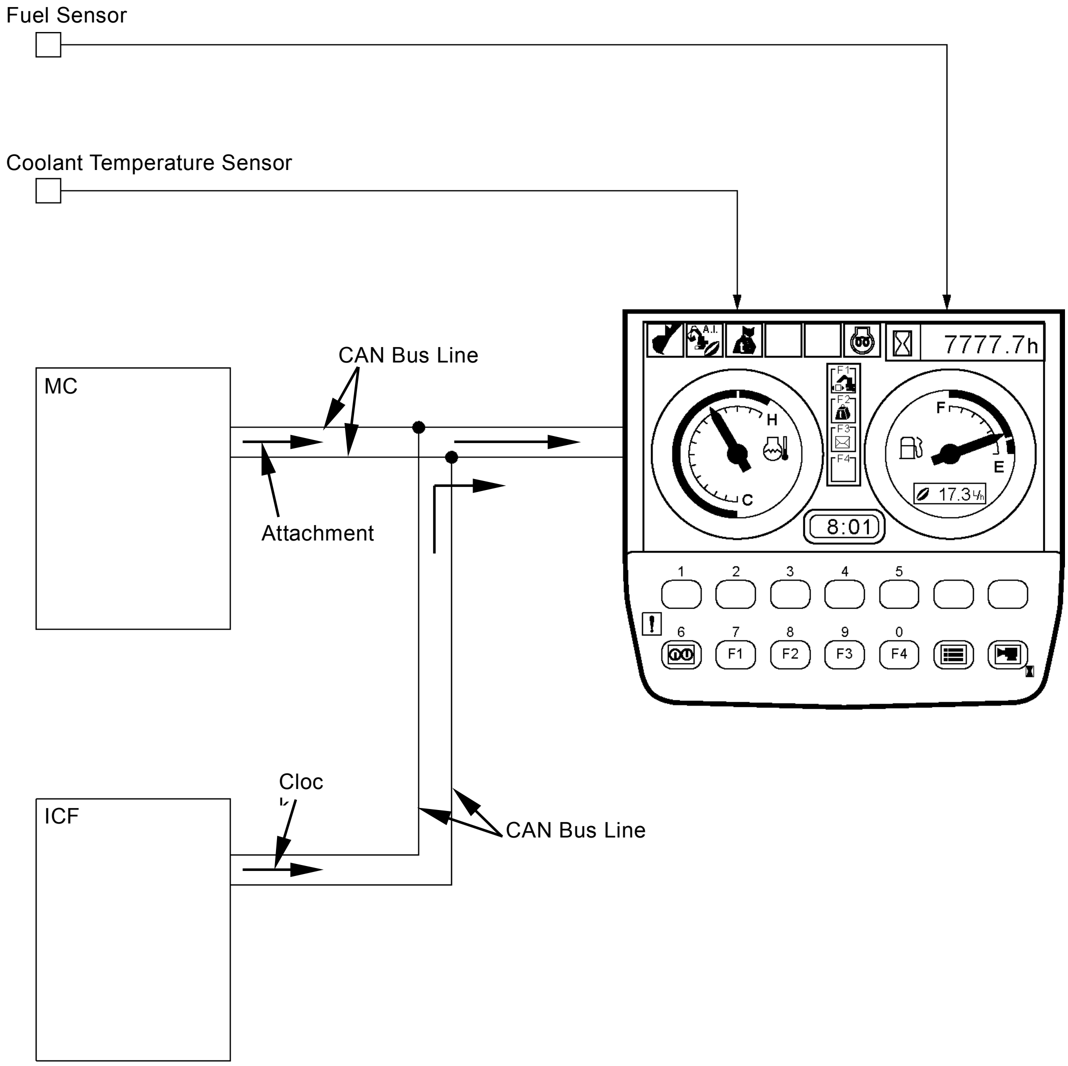
T1V1-05-02-003

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

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

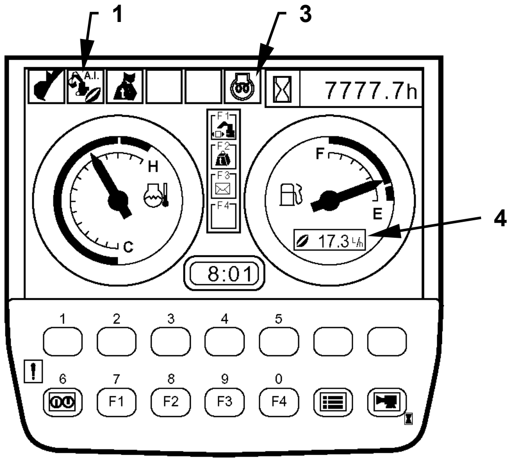


T1V1-05-01-008



T1V1-02-01-053

- Auto-Idle Display (1)
  When the switch is turned ON, the data is displayed. When the key switch is turned ON with the auto-idle switch ON, the data blinks for 10 seconds.

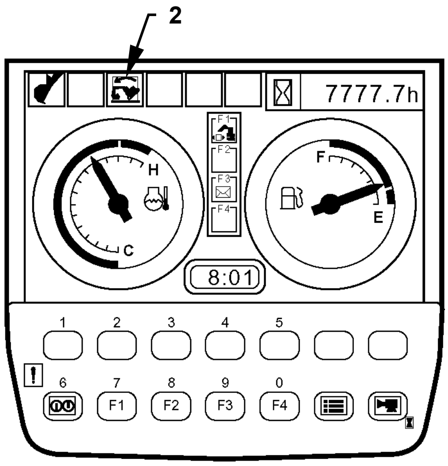


T1V1-05-01-008

Overload Alarm (2)

T1V1-05-02-002

The system measures the load of suspended load from the bottom pressure of boom cylinder. When overload is detected, an alarm is displayed.
(Refer to T5-2-10.)



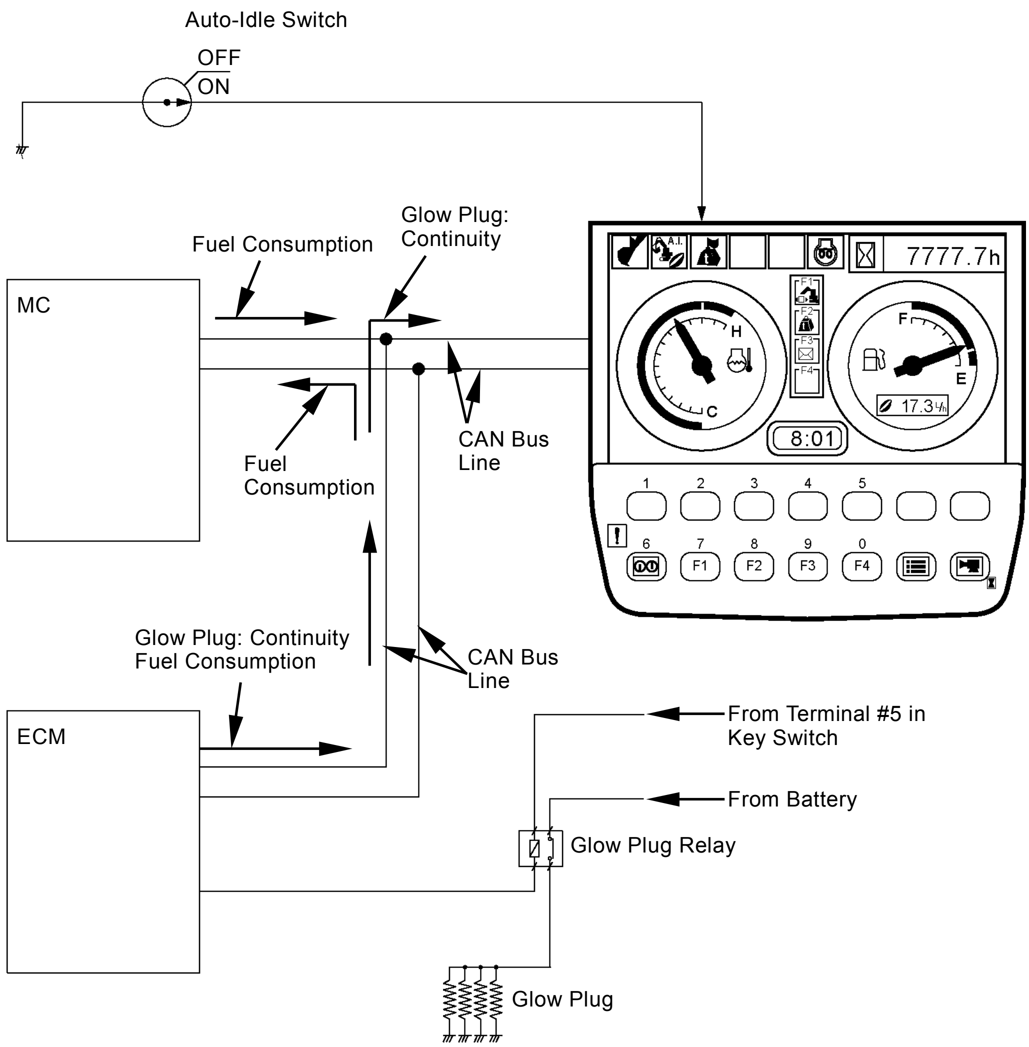
T1V1-05-01-128

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

- Fuel Consumption Gauge Display (4)

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

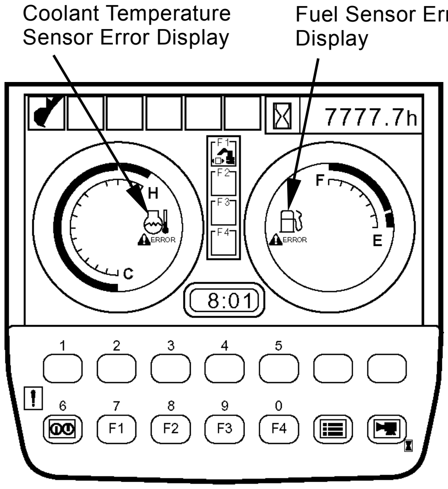
Fuel consumption is displayed according to the signal from ECM, which is received through MC by using CAN bus line.



T1V1-02-01-054

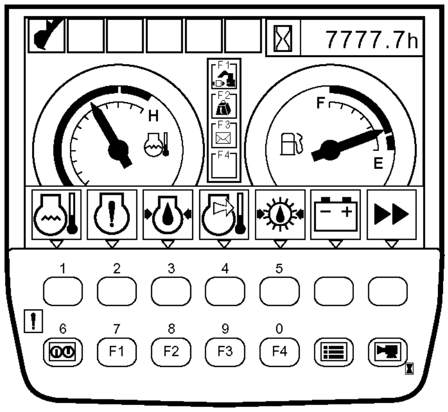
- Fuel Sensor Error Display
  When the fuel sensor is faulty or if the harness between fuel sensor and monitor unit is open circuit, the data is displayed on the fuel gauge.

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



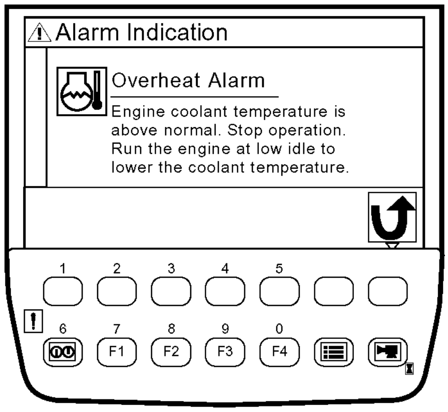
T1V1-05-02-005

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



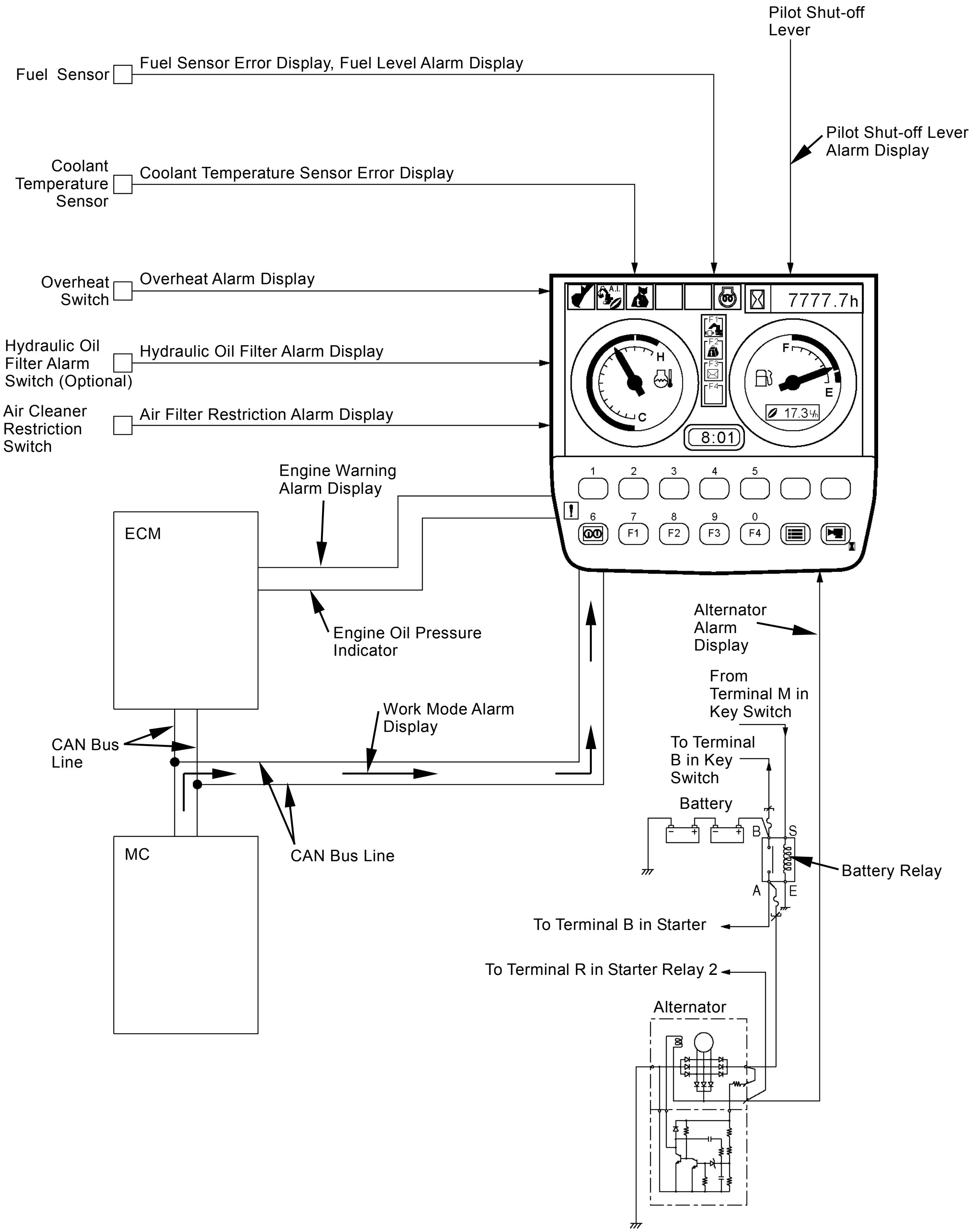
Alarm Display

T1V1-05-01-096



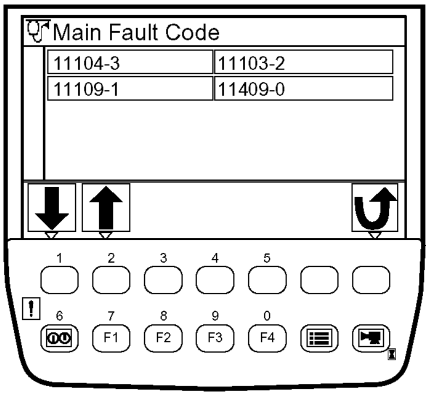
Remedy Display against Alarm

T1V5-05-01-013



T1V1-02-01-060

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

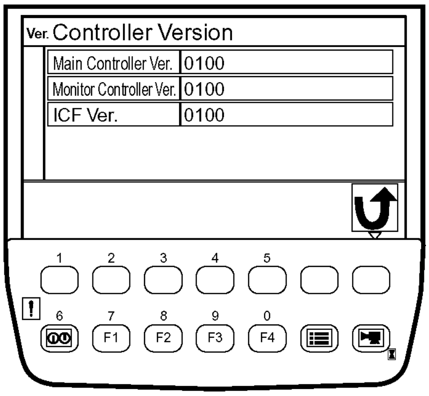


Fault Code Display

T1V5-05-01-097

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

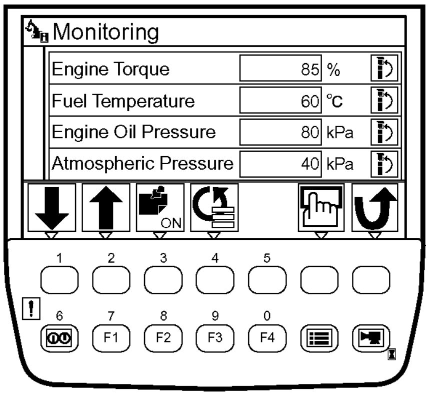
NOTE: The version of ECM is not displayed.



Controller Version Display

T1V5-05-01-122

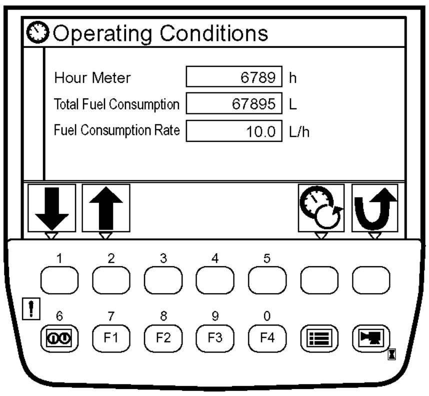
- Monitoring
  This screen displays temperature and pressure data received from each controller by using CAN bus line. By key operation, the displayed data is hold.



Monitoring Screen

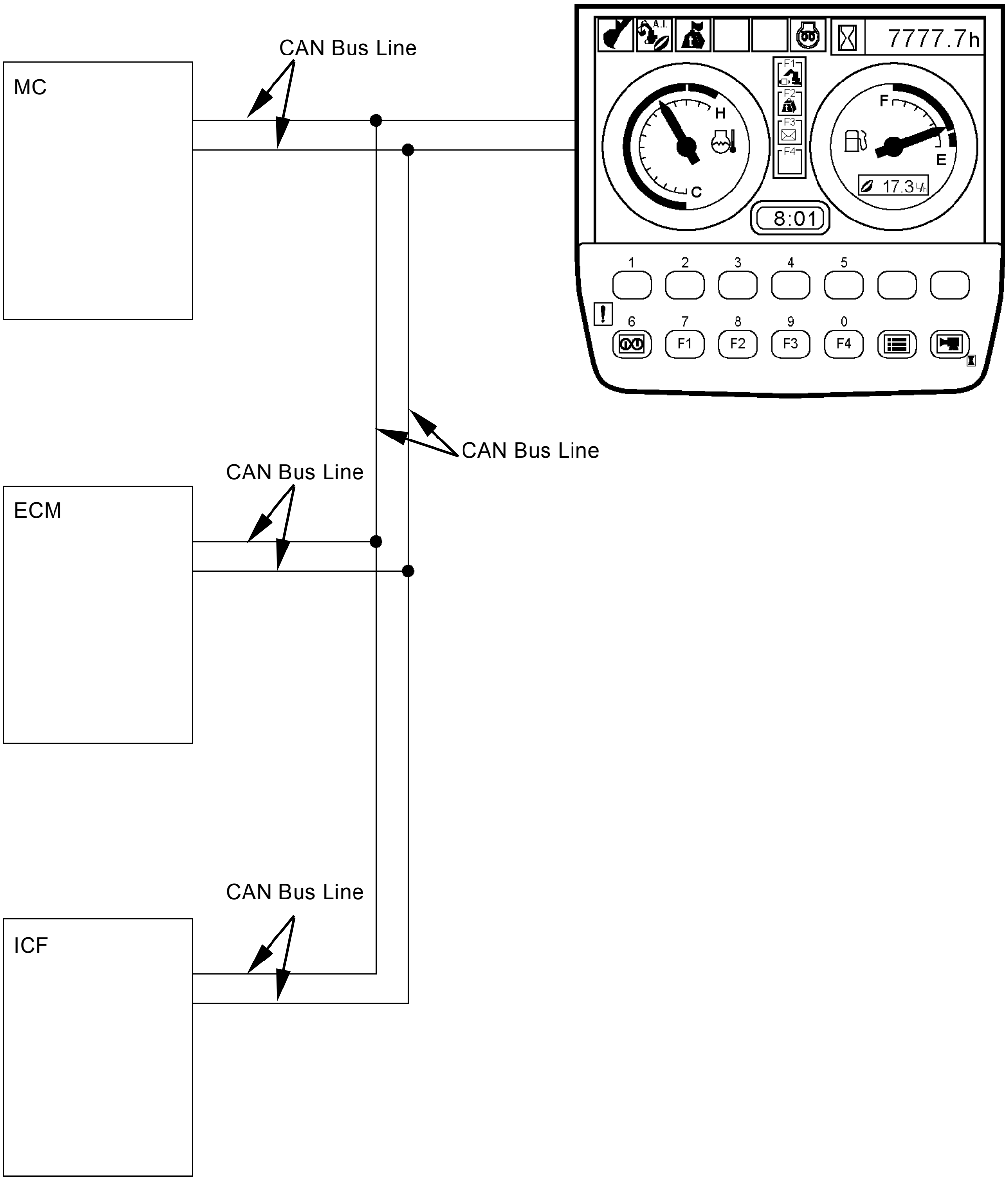
T1V5-05-01-087

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



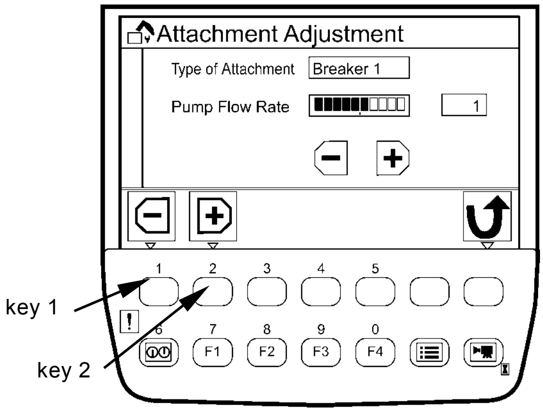
Operating Conditions Screen

T1V5-05-01-025



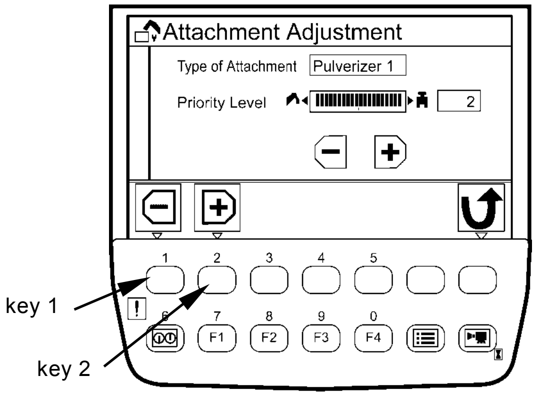
T1V1-02-01-061

- Pump 2 Flow Rate Adjustment
  (Only machines equipped with optional parts)
  When using the attachments, fine adjust flow rate of pump 2 by keys 1 and 2 operation.
  The signals from the monitoring unit are sent to MC by using CAN bus line.
  When breaker 1 or 2 is used, MC adjusts flow rate of pump 2 while controlling maximum pump 2 flow rate limit control solenoid valve. When pulverizer 1 or crusher 1 is used, MC adjusts flow rate of pressure oil that flows from pump 2 to pulverizer or crusher while controlling the auxiliary flow rate control solenoid valve. (Refer to "Control Systems.")



When using Breaker 1

T1V5-05-01-111



When using Pulverizer 1

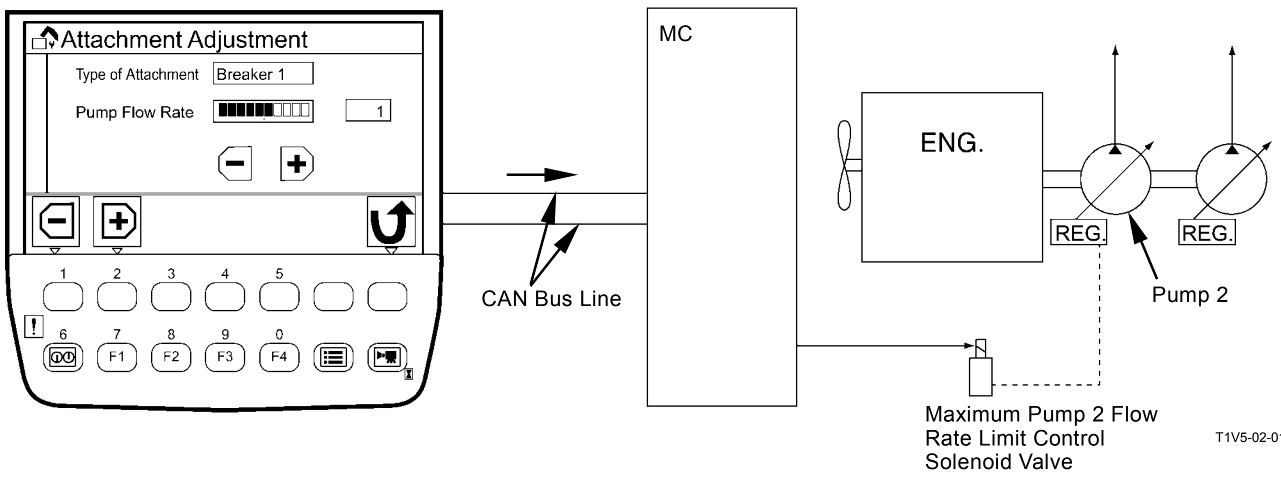
T1V5-05-01-024

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.

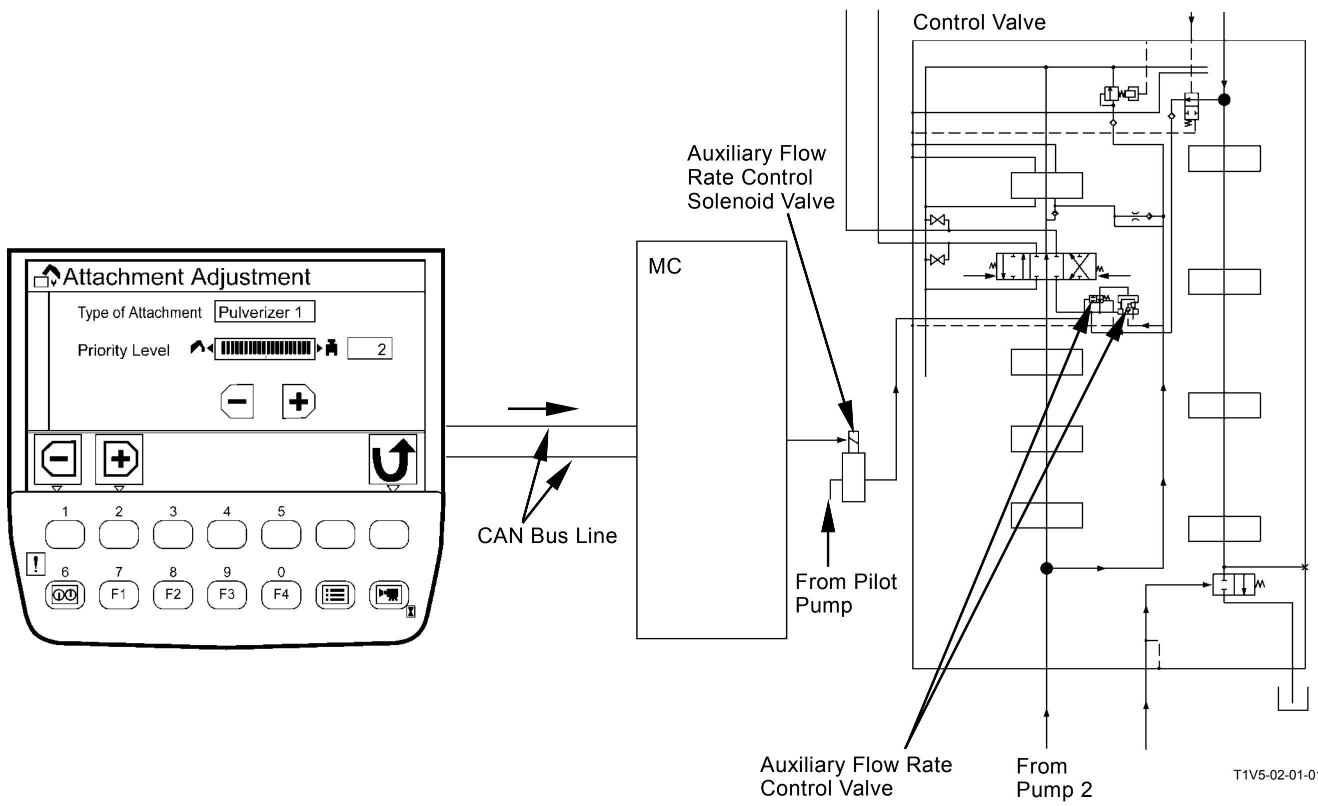
Type of Attachments	2-Speed Selector Circuit	Valve Selector Circuit	Accumulator Circuit	Secondary Hydraulic Relief Selector Circuit	Pump 2 Flow Rate Control	Auxiliary Flow Rate Control
Breaker 1	OFF	to Hydraulic Oil Tank	OFF	ON	ON	OFF
Breaker 2	OFF	to Hydraulic Oil Tank	ON	OFF	ON	OFF
Pulverizer 1	ON	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
Breaker1	Hydraulic Breaker1
Breaker2	Hydraulic Breaker2
Pulverizer1	Secondary Crusher1
Crusher1	Primary Crusher1



T1V5-02-01-011



T1V5-02-01-010

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

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

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

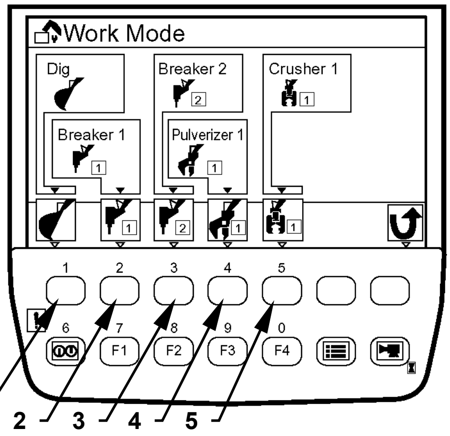
1 - Digging

2 - Breaker 1 (HSB Breaker)

3 - Breaker 2 (NPK Breaker)

4 - Pulverizer 1

5 - Crusher 1



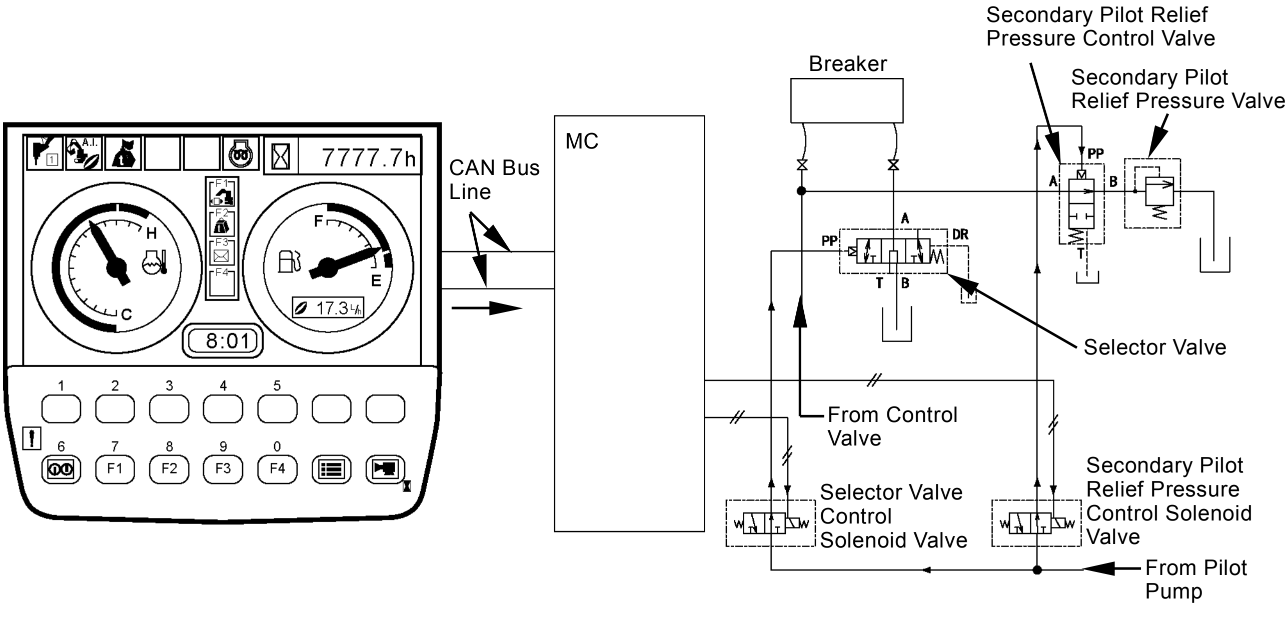
T1V5-05-01-109

Attachment Selection Screen

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

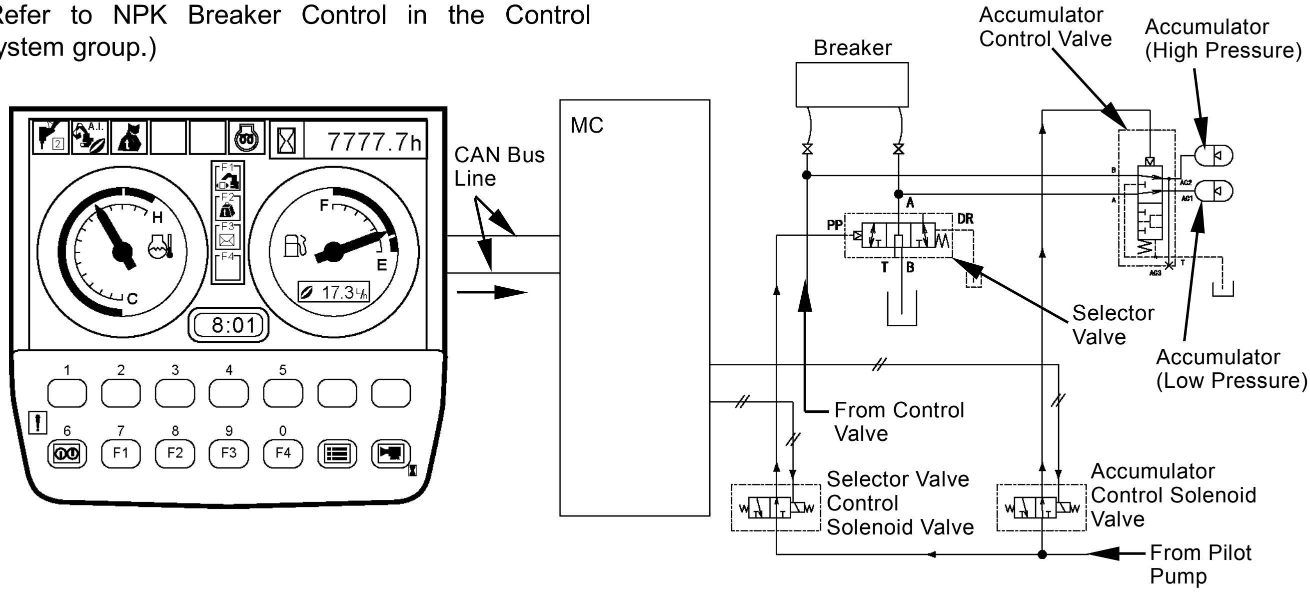
Monitor Unit	HITACHI pattern
Breaker1	Hydraulic Breaker1
Breaker2	Hydraulic Breaker2
Pulverizer1	Secondary Crusher1
Crusher1	Primary Crusher1

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



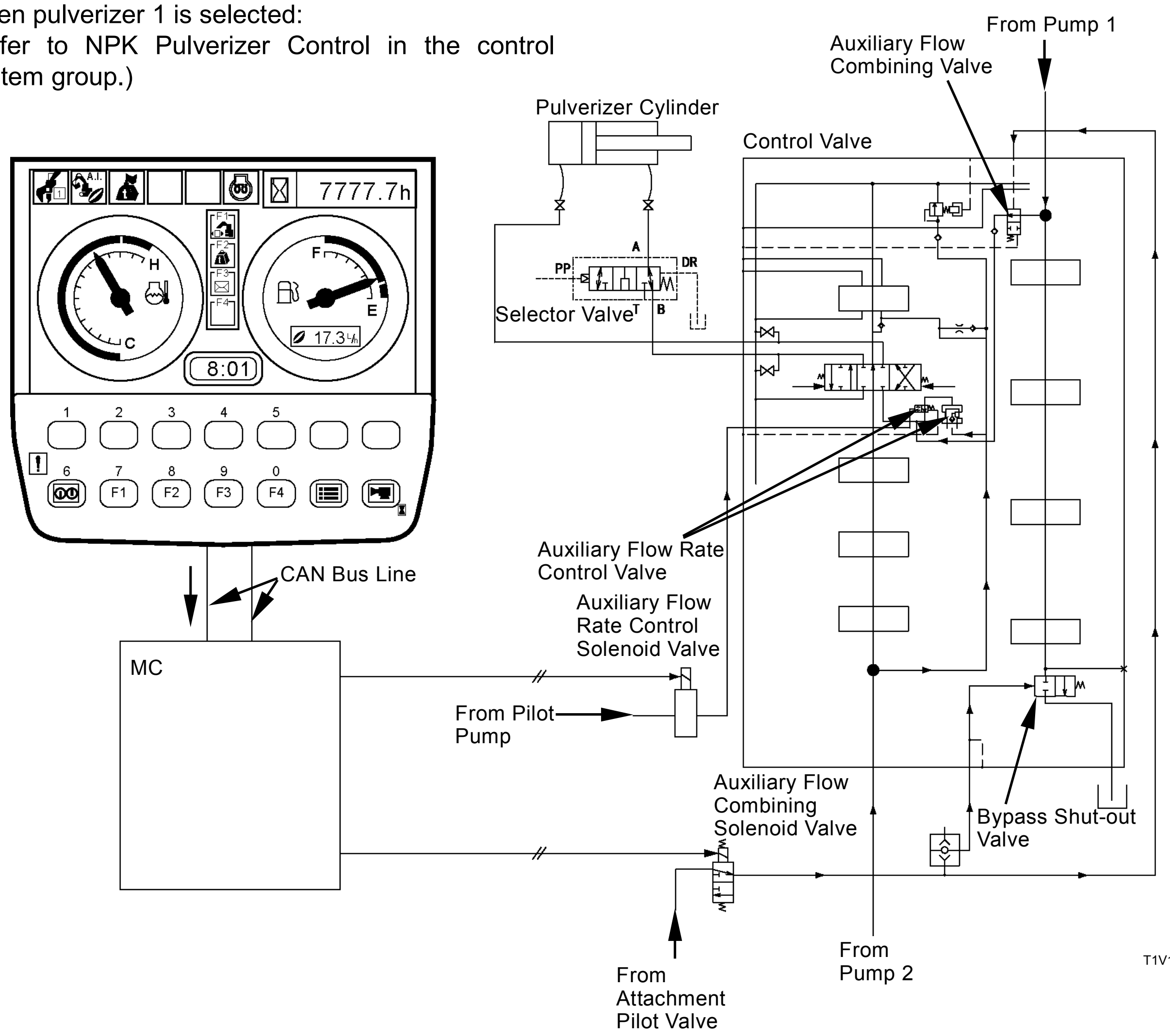
T1V1-02-01-063

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



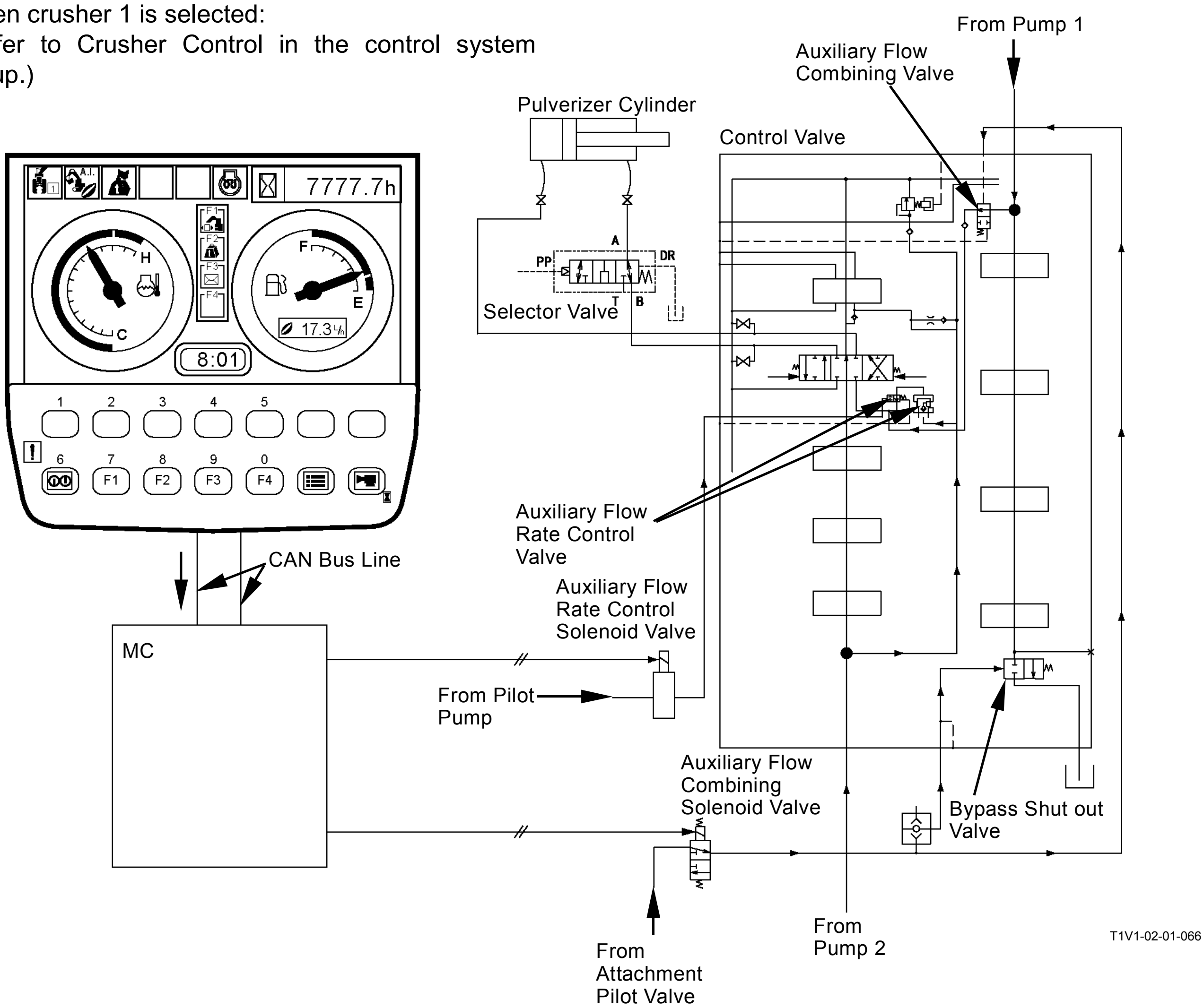
T1V1-02-01-064

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



T1V1-02-01-065

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

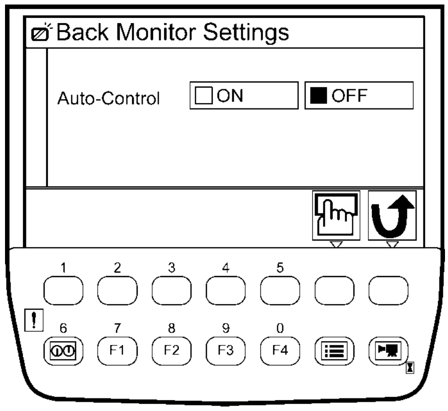


T1V1-02-01-066

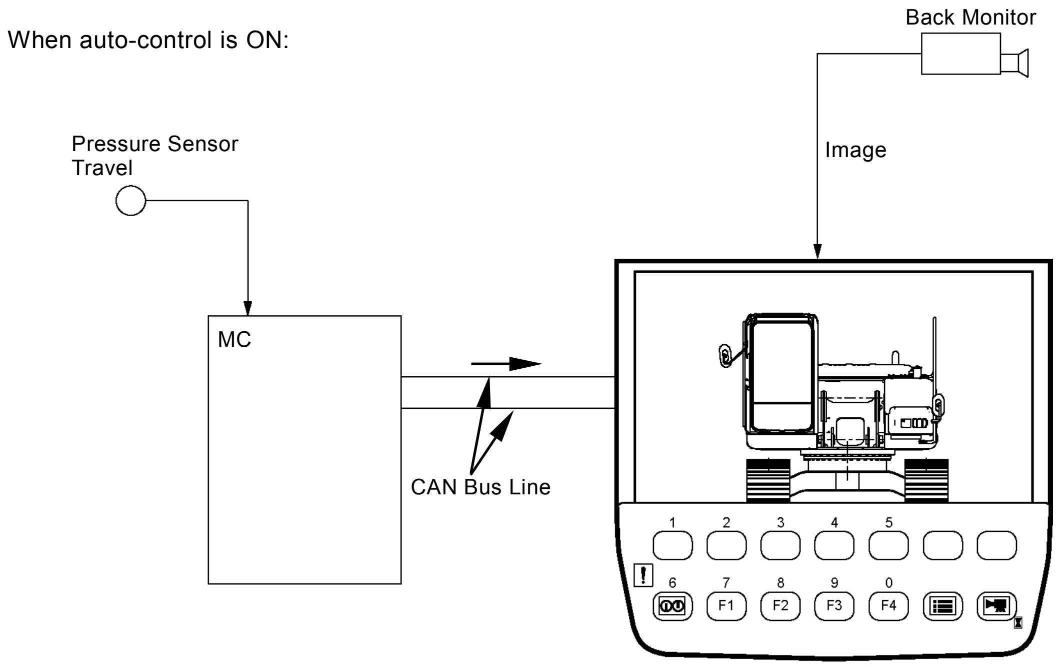
(Blank)

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

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



T1V5-05-01-173



T1V1-02-01-056

(Blank)

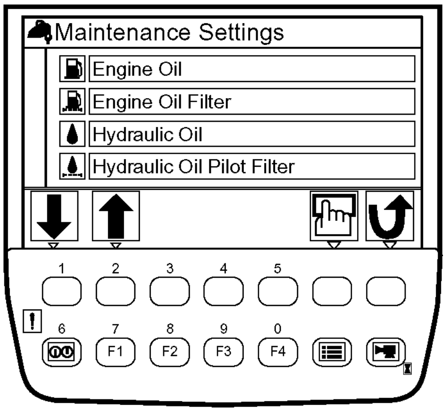
- Maintenance Settings
  The data, the remaining hours until the next replacement is received from ICF by using CAN bus line.
  This screen displays the remaining hours until the next replacement.
  As the items to be replaced are displayed in a list, record performed replacement by selecting an item from the list.

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

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

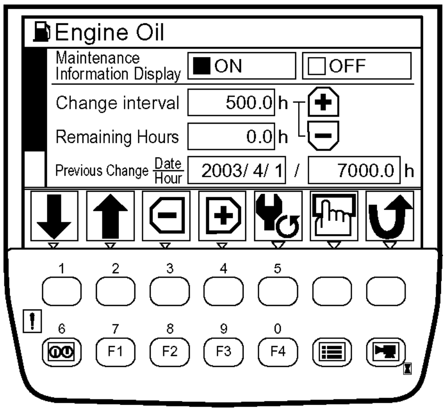
- Language Settings
  Select a language to be used in screens from among preset languages, according to work environment.

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



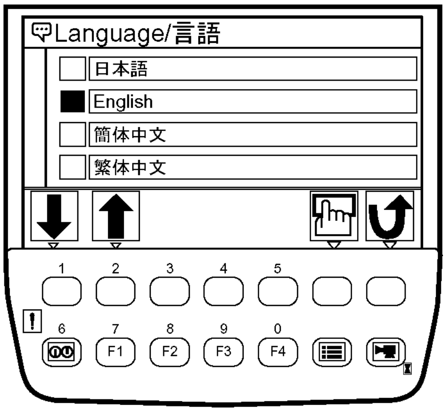
Maintenance Setup Screen

T1V5-05-01-049



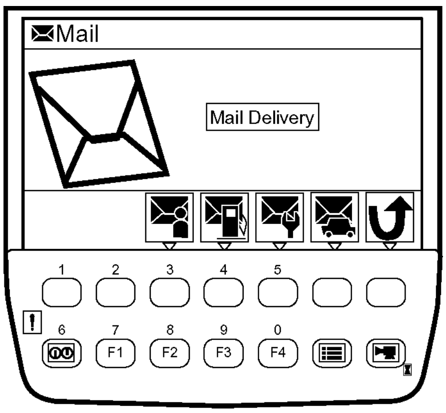
Interval ON/OFF Setup Screen

T1V5-05-01-052



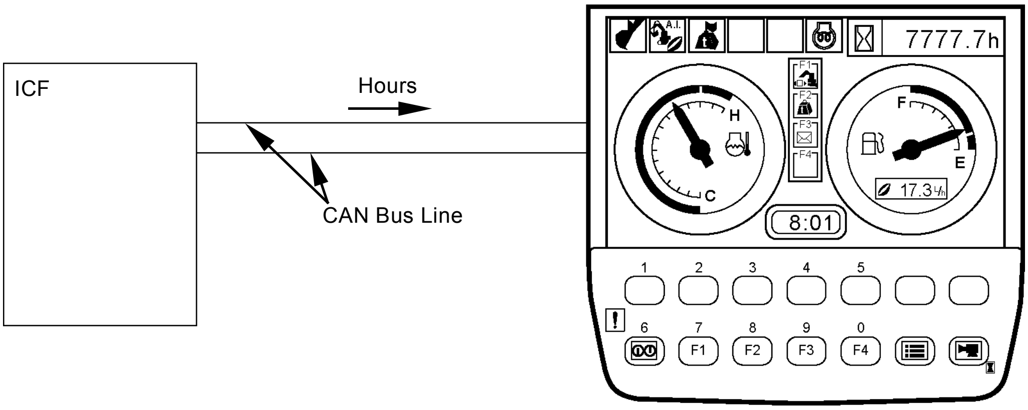
Language Setup Screen

T1V1-05-01-137



Mail Switch Screen

T1V5-05-01-037



T1V1-02-01-062

- Overload Alarm
  (Only machines equipped with optional parts)

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

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

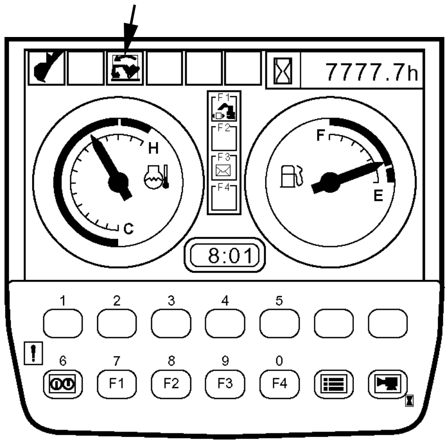
1. If load of the suspended load becomes overloaded, the boom bottom pressure sensor (optional) sends a signal to MC.

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

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

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

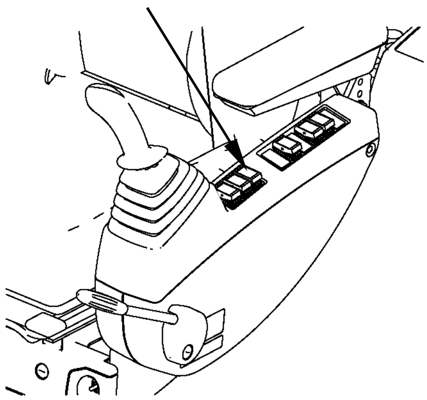
Alarm



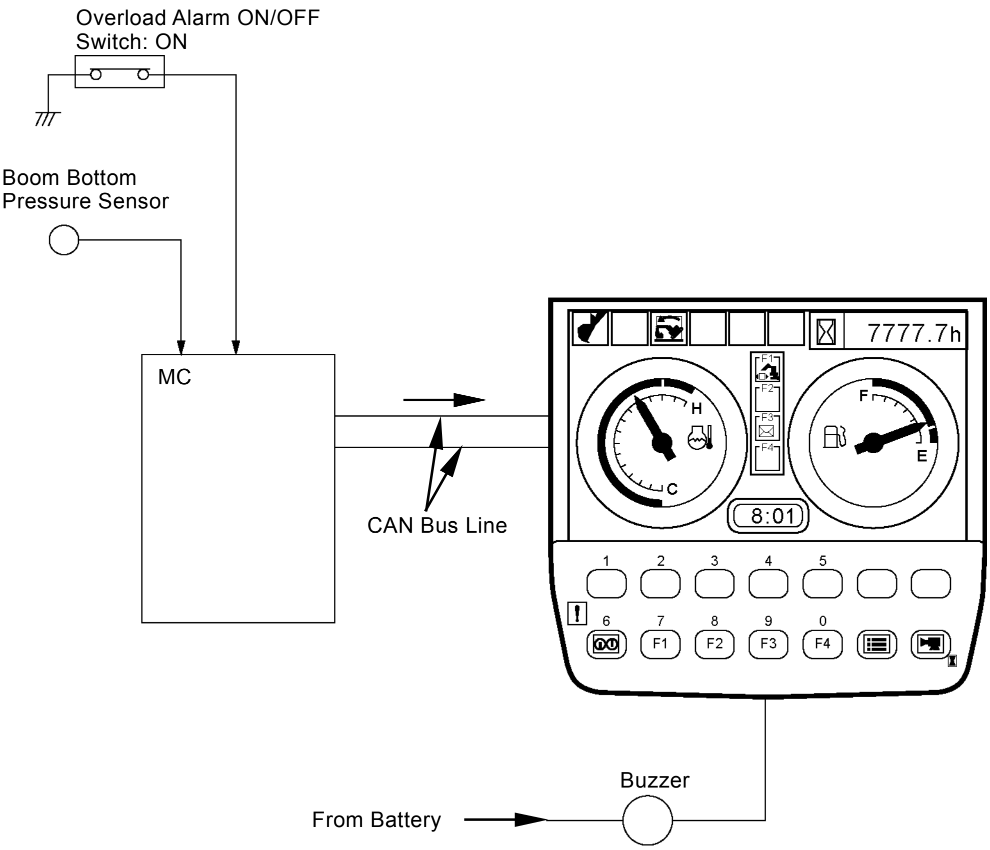
T1V1-05-01-128

Primary Screen

Overload Alarm ON/OFF Switch (Optional)



T1V1-05-02-004



T1V1-02-01-057

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OUTLINE

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

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

Input Signal		Output Signal
• Engine Control Dial →	MC	Engine Control (ECM)
• Pump 1 Control Pressure Sensor →		Engine Control Dial Control
• Pump 2 Control Pressure Sensor →		HP Mode Control
• Pump 1 Delivery Pressure Sensor →		Travel HP Mode Control
• Pump 2 Delivery Pressure Sensor →		E Mode Control
• Pump 3 Delivery Pressure Sensor (Optional) →		Auto-Idle Control
• Pressure Sensor (Travel) →		Auto-Warming Up Control
• Pressure Sensor (Front Attachment) →		Idle Speed-Up Control
• Pressure Sensor (Swing) →		Heater Control
• Pressure Sensor (Boom Raise) →		* Attachment Operation Speed Increase Control
• Pressure Sensor (Arm Roll-In) →		* Attachment Operation Speed Limit Control
• Pressure Sensor (Auxiliary) (Optional) →		Pump Control (Torque Control Solenoid Valve)
• Pressure Sensor (Arm Roll-Out) (Optional) →		Speed Sensing Control
• Oil Temperature Sensor →		Travel Torque-Up Control
• Auto-Idle Switch →		* 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

- Power Digging Switch →
- Power Mode Switch (HP/E/P) →
- Travel Mode Switch (Fast/ Slow) →

- Key Switch →
- Overload Alarm ON/OFF Switch (Optional)

- Boom Bottom Pressure Sensor (Optional) →
- Boom Rod Pressure Sensor (Optional) →
- Arm Angle Sensor (Optional) →
- Boom Angle Sensor (Optional) →

CAN Communication

- Actual Engine Speed (From ECM) →
- Work Mode (Digging / Attachment) (From Monitor Unit) →
- Radiator Coolant Temperature (From ECM) →

MC

Output Signal

Valve Control (Solenoid Valve Unit)

Power Digging Control
Auto-Power Lift Control
Arm Regenerative Control
Digging Regenerative Control

Travel Motor Displacement Angle Control

* HSB Breaker Control
* NPK Breaker Control
* Secondary Crusher Control
* Primary Crusher Control

Other Control

Rear Monitoring Display Selection Control
Work Mode Control
* Travel Alarm Control
* Swing Alarm Control

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

(Blank)

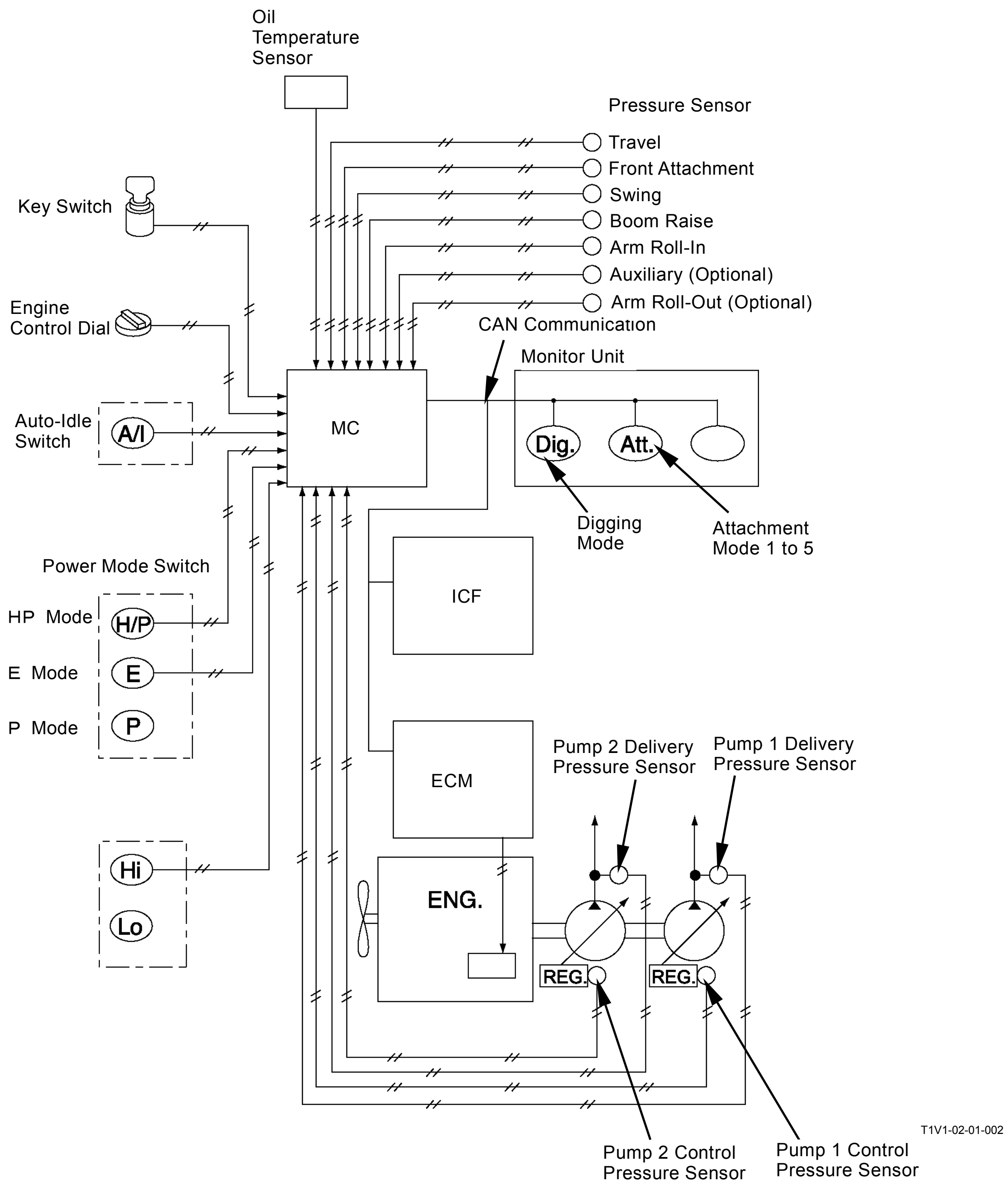
ENGINE CONTROL

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



Engine Control Dial Control

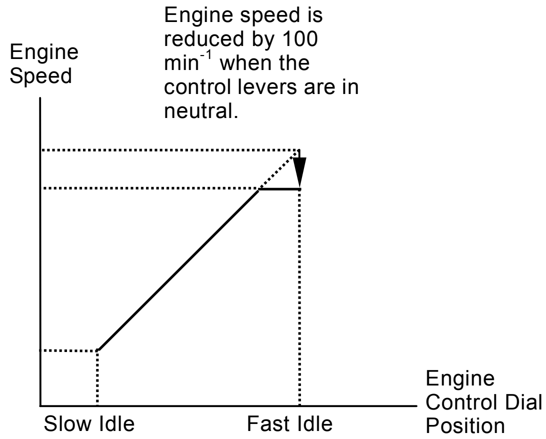
Purpose: Controls the engine speed according to the rotation angle of engine control dial.
Reduces the engine speed by 100 min^{-1} in order to reduce fuel consumption and noise level when all the control levers are in neutral.

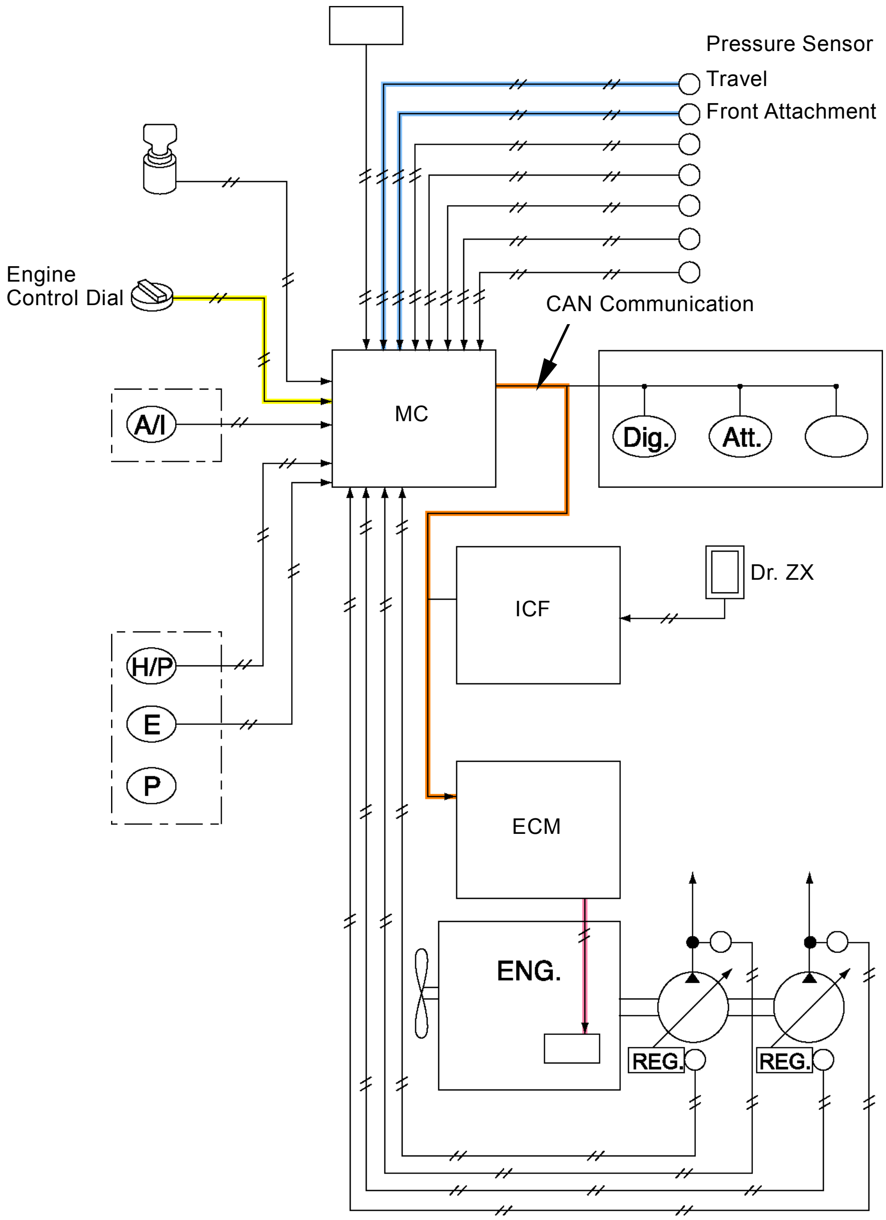
Operation:

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.

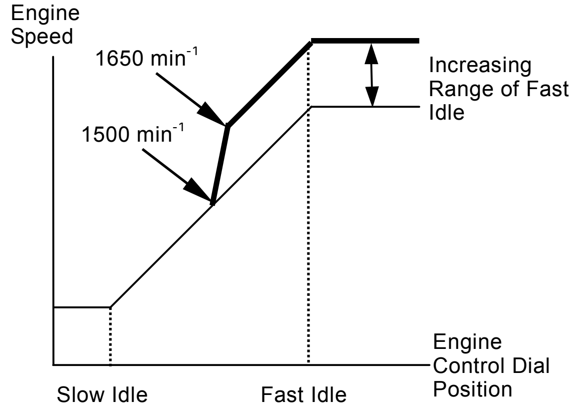
Operation:

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 in order to increase engine power.

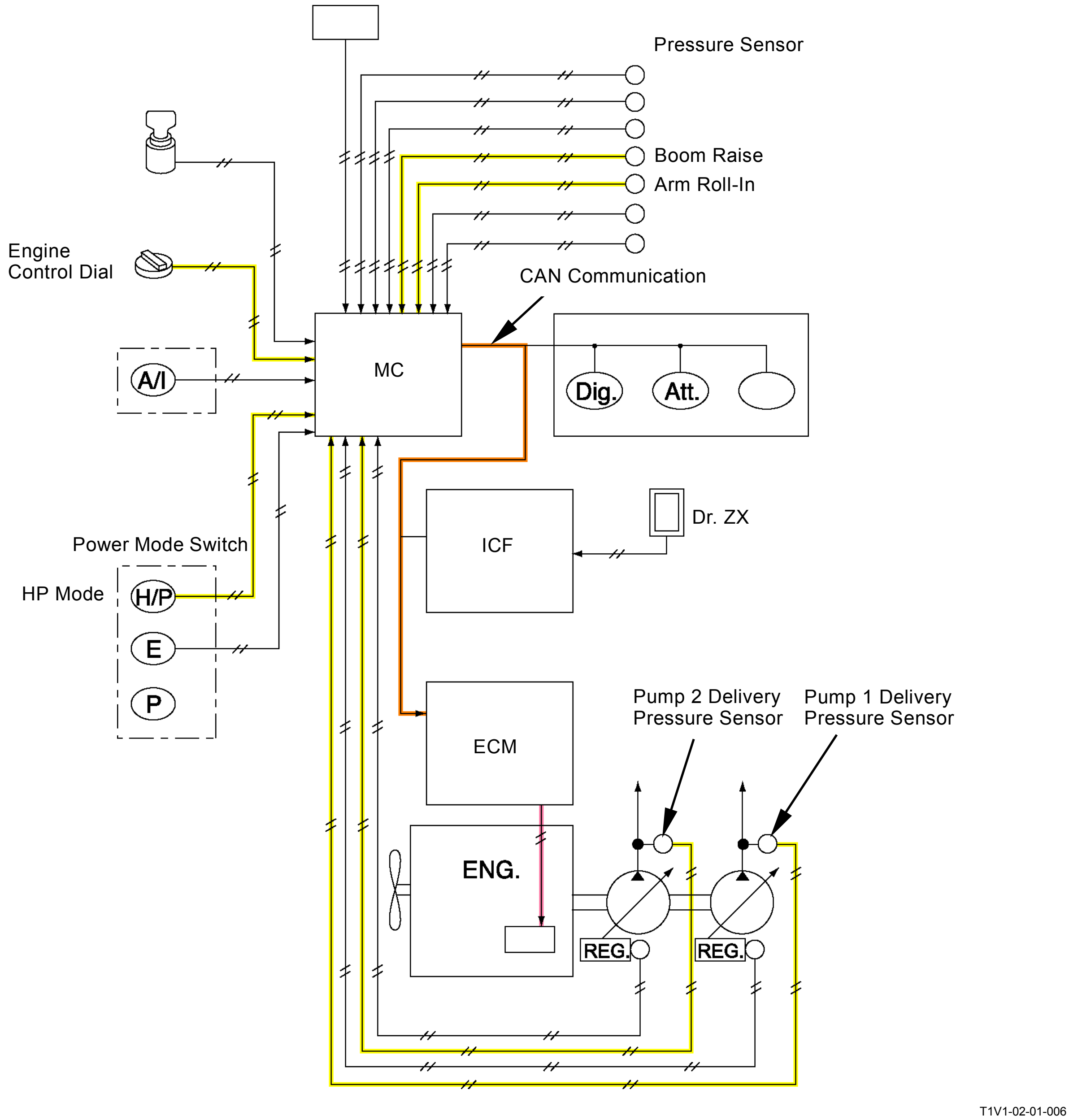
Condition:

- 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: ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class: 25 MPa, (255 kgf/cm^2, 3635 psi)
  ZX270-3 class: 20 MPa, (205 kgf/cm^2, 2910 psi))

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

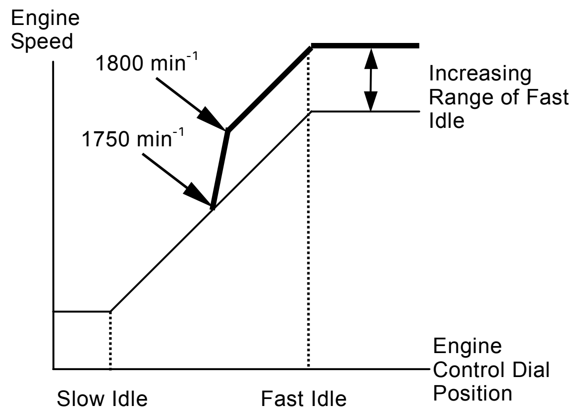


Model	Increasing Range of Fast Idle Speed
ZX200-3 class ZX225US-3 class ZX225USR-3 class	200 min^{-1}
ZX240-3 class	100 min^{-1}
ZX270-3 class	100 min^{-1}


Pressure Sensor
Boom Raise
Arm Roll-In
Engine Control Dial
CAN Communication
MC
A/I
Dig.
Att.
ICF
Dr. ZX
Power Mode Switch
HP Mode
H/P
E
P
ECM
Pump 2 Delivery Pressure Sensor
Pump 1 Delivery Pressure Sensor
ENG.
REG.
REG.
T1V1-02-01-006

Travel HP Mode Control

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



ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class

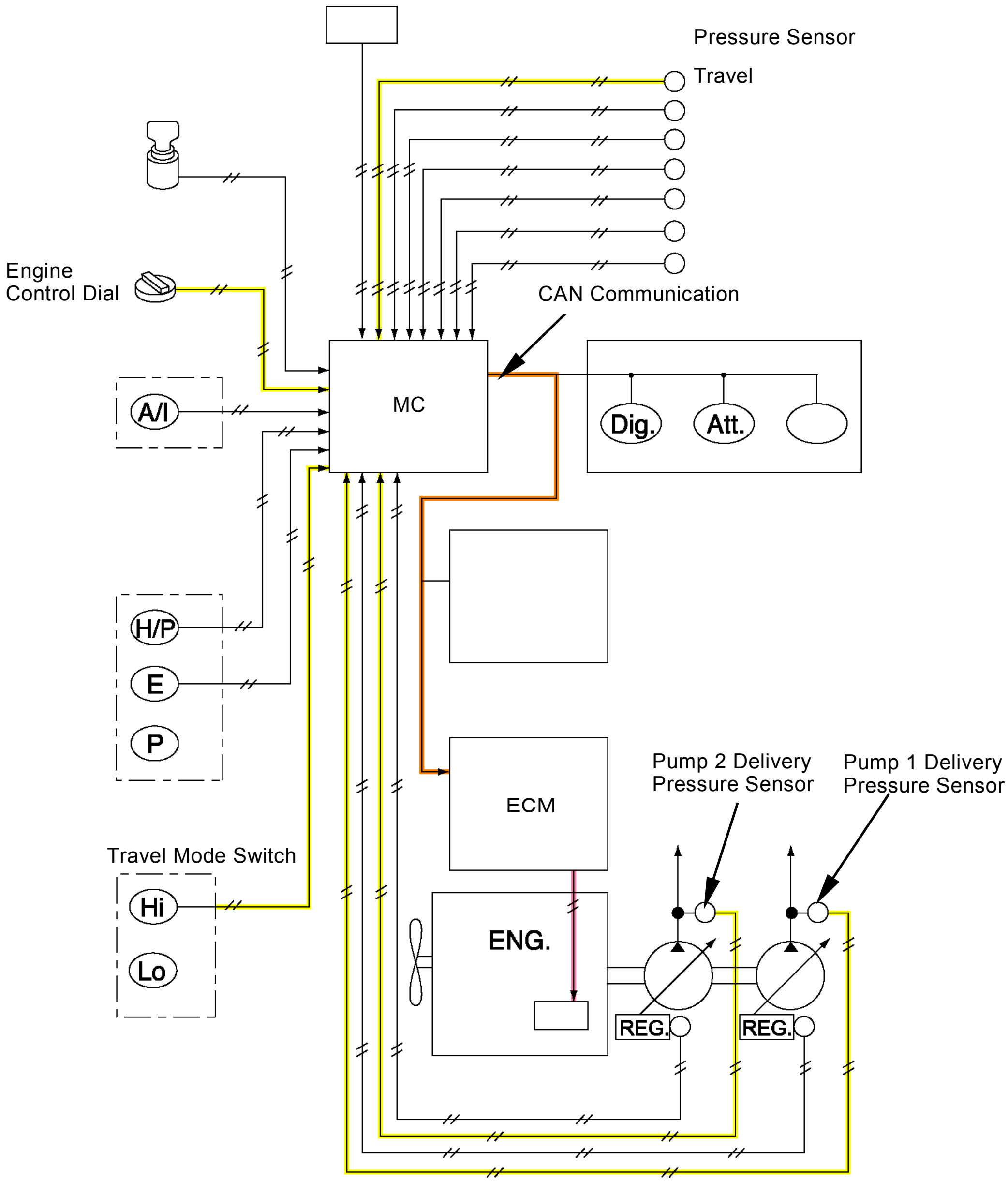
Operation:

1. When the travel mode switch is in fast idle and all the following conditions exist, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication.
2. ECM increases the engine speed by 200 min^{-1} (ZX240-3 class: 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: ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class: 19 MPa, (195 kgf/cm^2, 2760 psi)
   ZX240-3 class: 15 MPa (153 kgf/cm^2, 2180 psi))

Model	Increasing Range of Fast Idle Speed
ZX200-3 class ZX225US-3 class ZX225USR-3 class	200 min^{-1}
ZX240-3 class	100 min^{-1}



T1V1-02-01-014

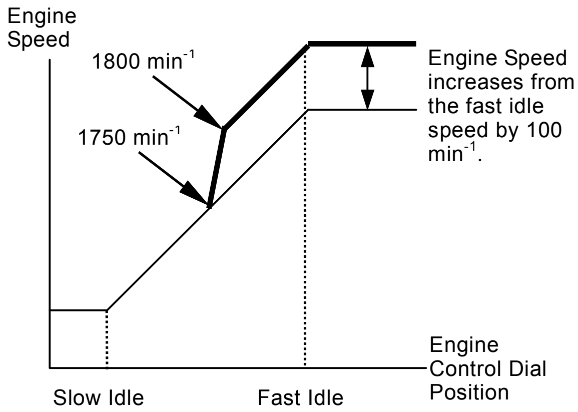
ZX270-3 class

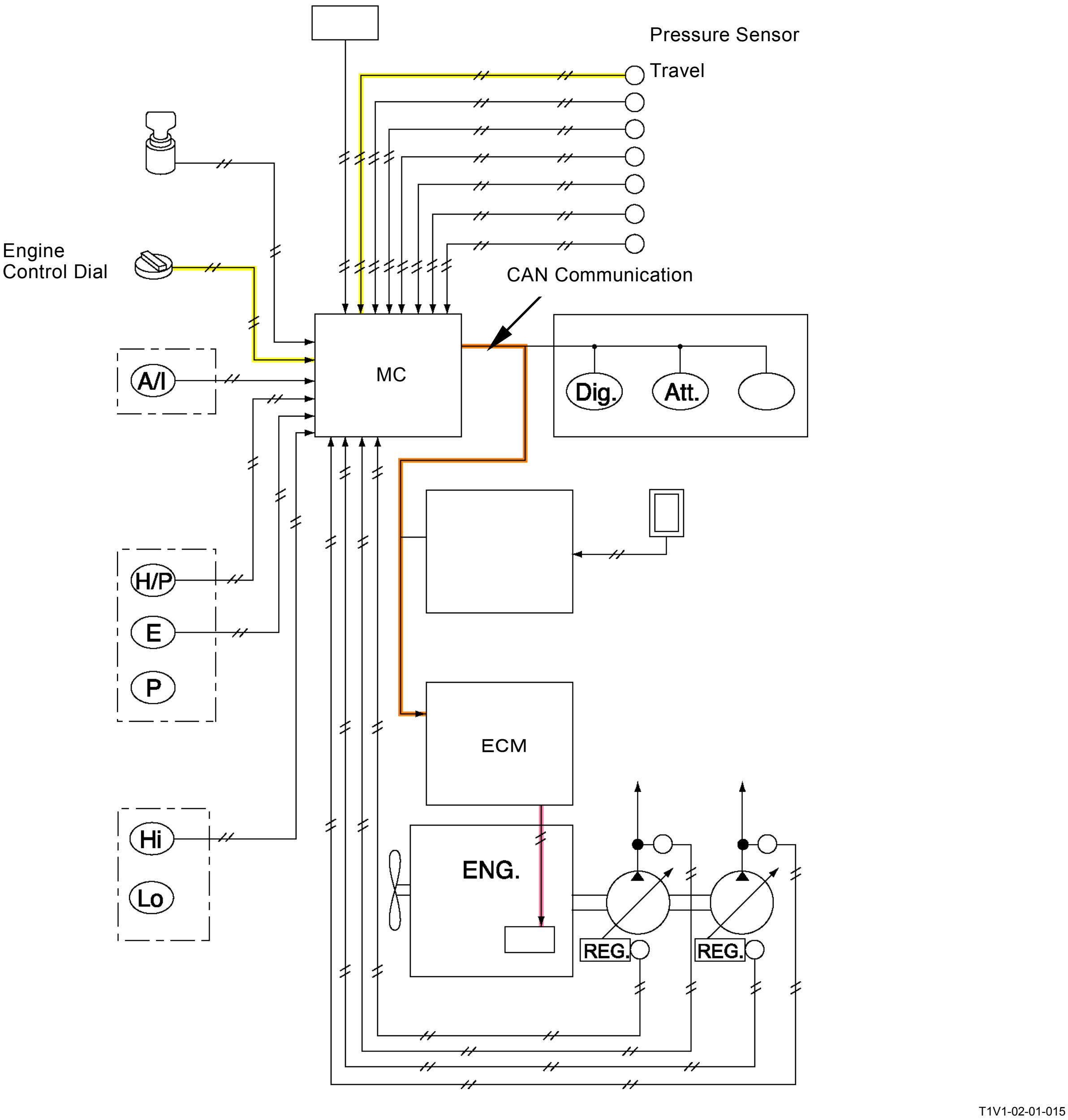
Operation:

1. When all the conditions exist, MC sends the signals equivalent to the target engine speed according to the travel control 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:

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




Pressure Sensor
Travel
Engine
Control Dial
CAN Communication
MC
A/I
Dig.
Att.
H/P
E
P
ECM
Hi
Lo
ENG.
REG.
REG.
T1V1-02-01-015

E Mode Control

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

Operation:

1. When the required engine speed by the engine control dial is faster than the engine speed set by E mode control and the power mode switch is in the E mode position, and if the pump control pressure and the average pump delivery pressure are within the following conditions, MC sends the signals equivalent to the target engine speed to ECM by using CAN communication.
2. ECM reduces the engine speed from the required engine speed set by the engine control dial.
3. If the pump control pressure is high and the average pump delivery pressure is low, MC sends the signal equivalent to the target engine speed to ECM by using CAN communication.
4. ECM increases the engine speed by 150 min^{-1}.

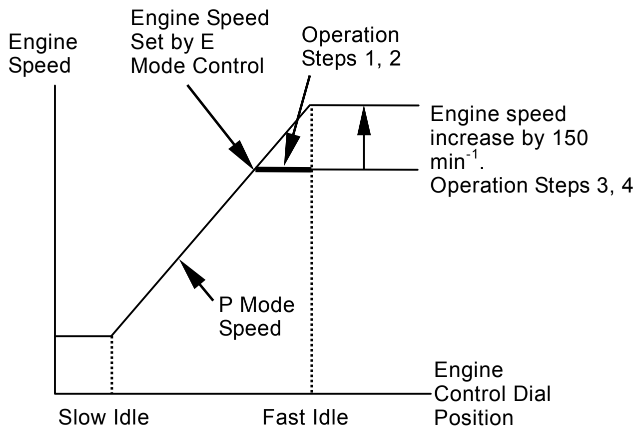
Condition:

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

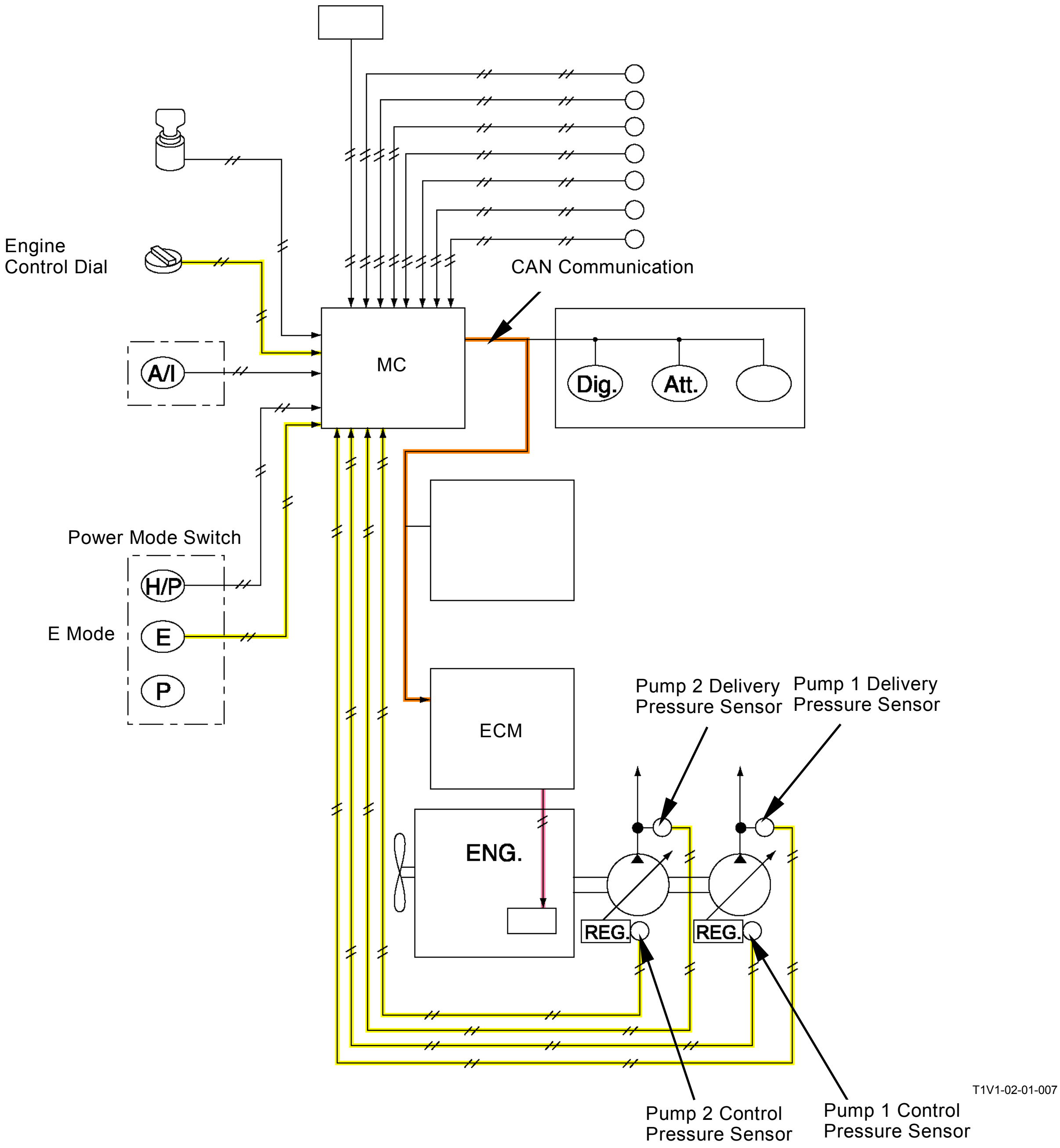
  Control Pressure of Pump 1 or 2: Low of either (Reference: 3 MPa (31 kgf/cm^2, 436 psi) or less) and Average Pump Delivery Pressure: Low (Reference: Less than 9.8 MPa (100 kgf/cm^2, 1425 psi))

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

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



Model	Engine Speed Set by E Mode Control	P Mode Speed
ZX200-3 class ZX225US-3 class ZX225USR-3 class	1650 min^{-1}	1800 min^{-1}
ZX240-3 class	1750 min^{-1}	1900 min^{-1}
ZX270-3 class	1850 min^{-1}	2000 min^{-1}

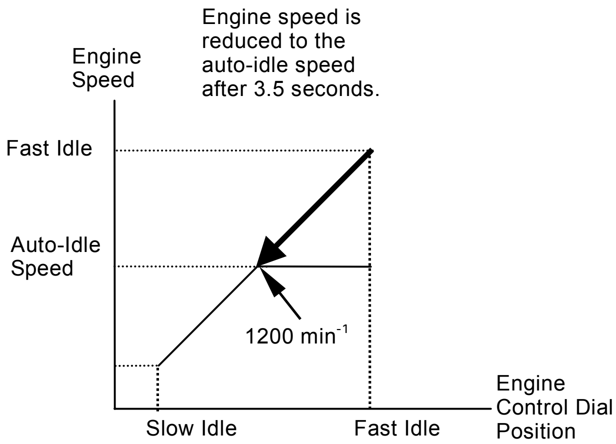

Engine Control Dial
A/I
Power Mode Switch
H/P
E Mode
E
P
MC
CAN Communication
Dig.
Att.
ECM
ENG.
REG.
REG.
Pump 2 Delivery Pressure Sensor
Pump 1 Delivery Pressure Sensor
Pump 2 Control Pressure Sensor
Pump 1 Control Pressure Sensor
T1V1-02-01-007

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:

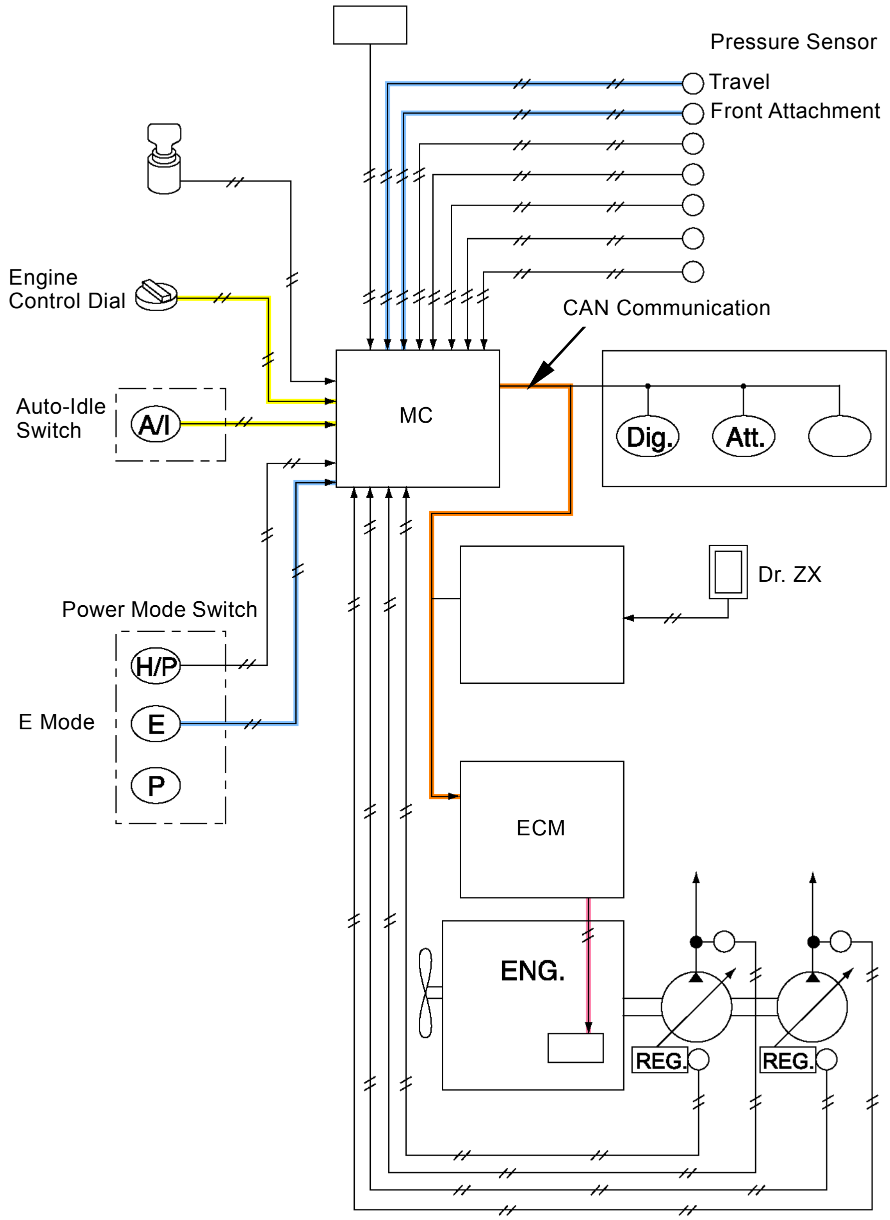
1. Approx. 3.5 seconds after the control lever is turned to neutral with the auto-idle switch ON, MC sends the signals equivalent to the auto-idle speed to ECM by using CAN communication.
2. ECM changes the engine speed into the auto-idle speed.
3. As soon as either control lever is moved (pressure sensors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



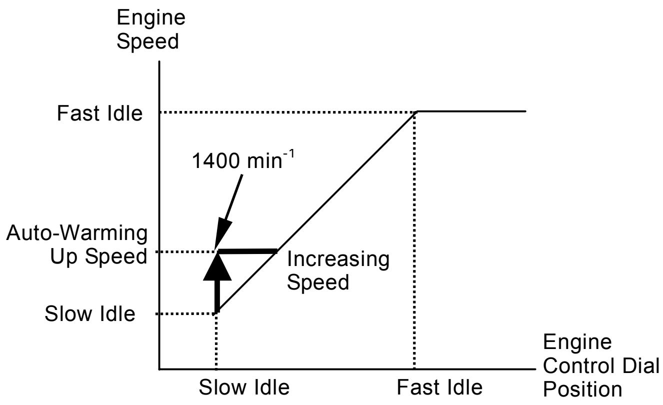
T1V1-02-01-008

Auto-Warming Up Control

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

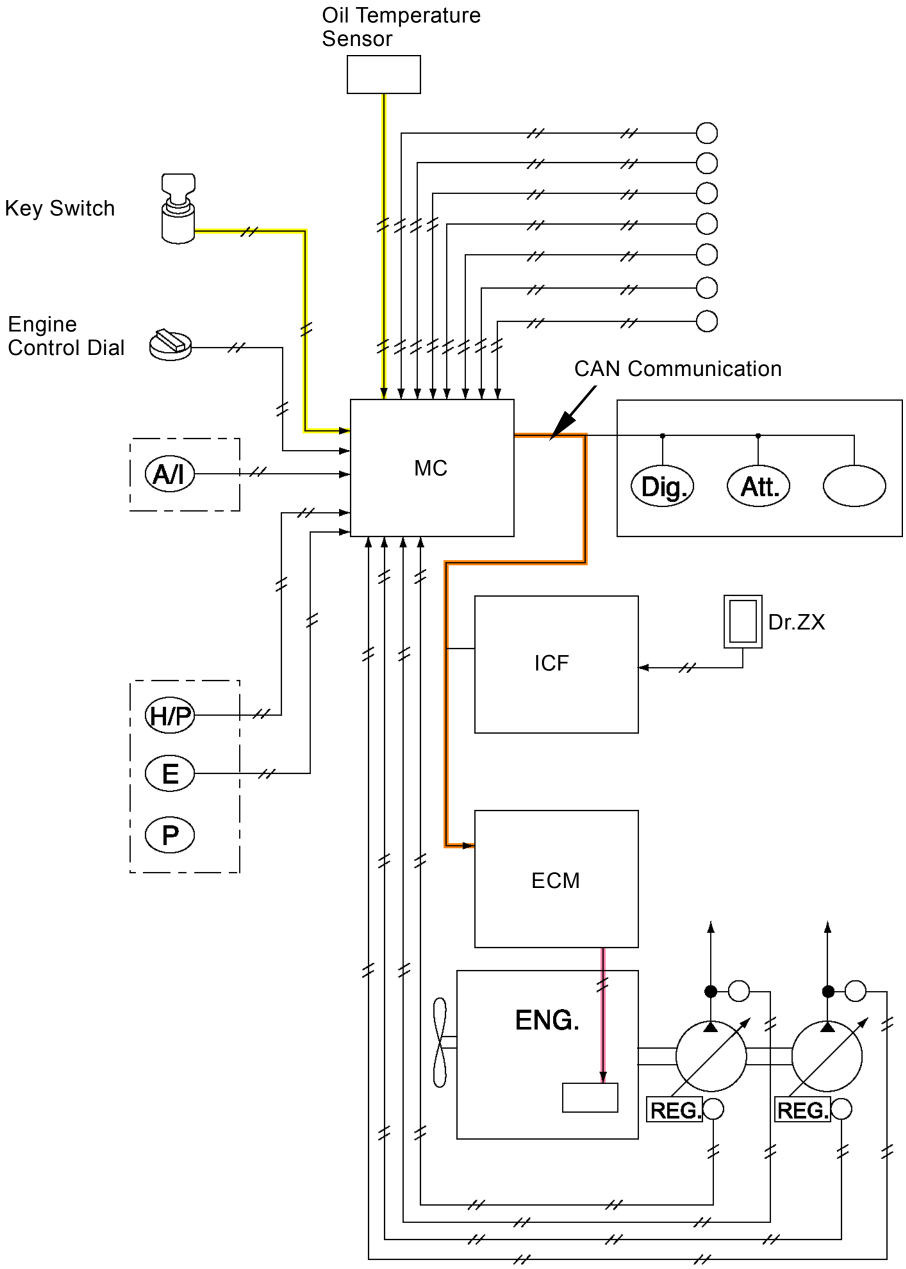
Operation:

1. For 12 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 12 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 effective again.

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



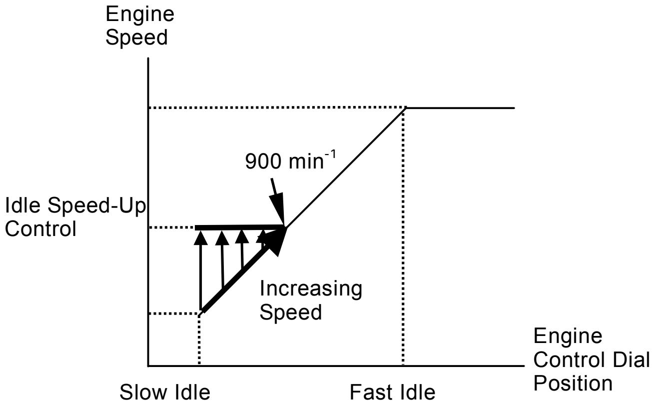
T1V1-02-01-009

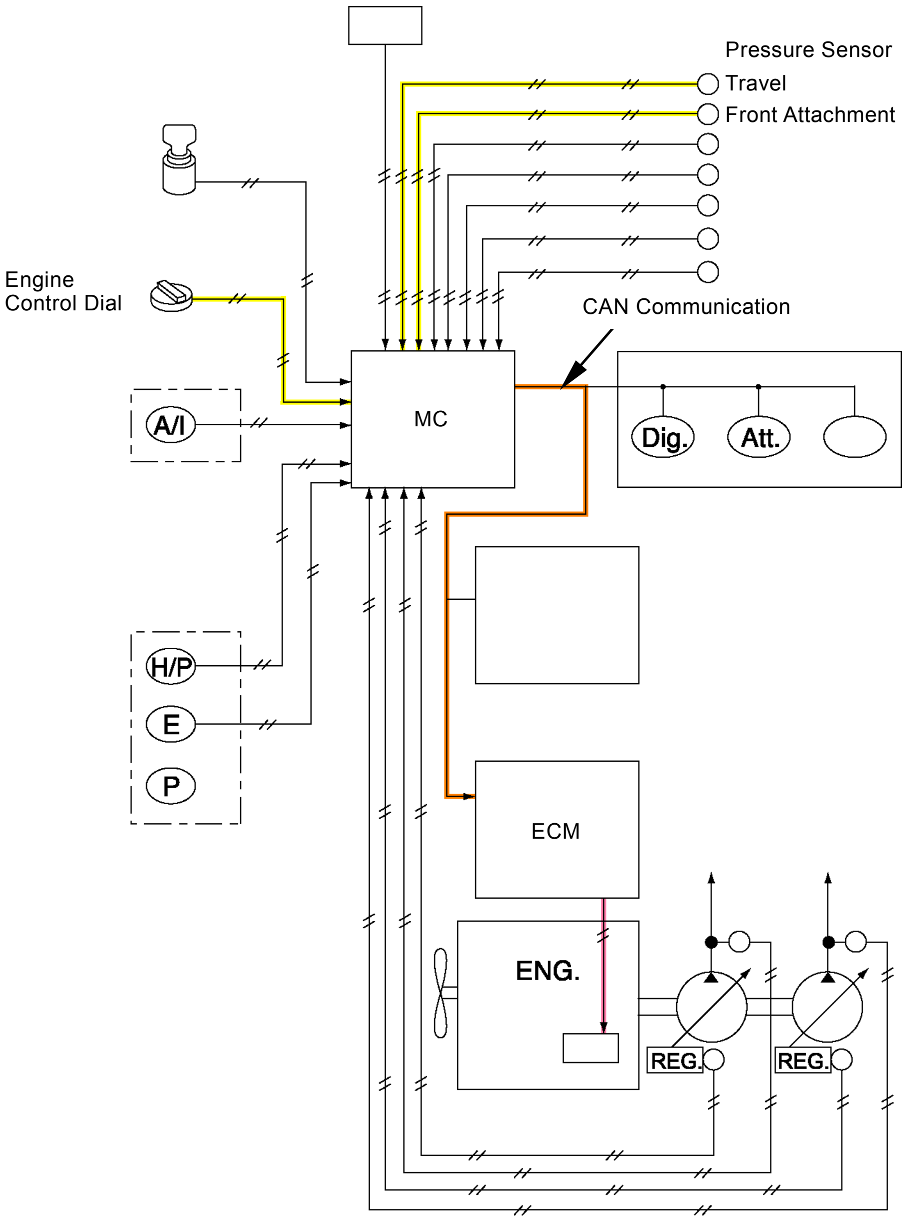
Idle Speed-Up Control

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

Operation:

1. When the travel or front attachment 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.

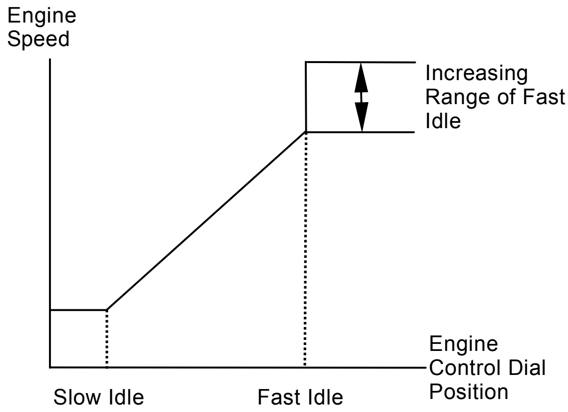




T1V1-02-01-010

Heater Control

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



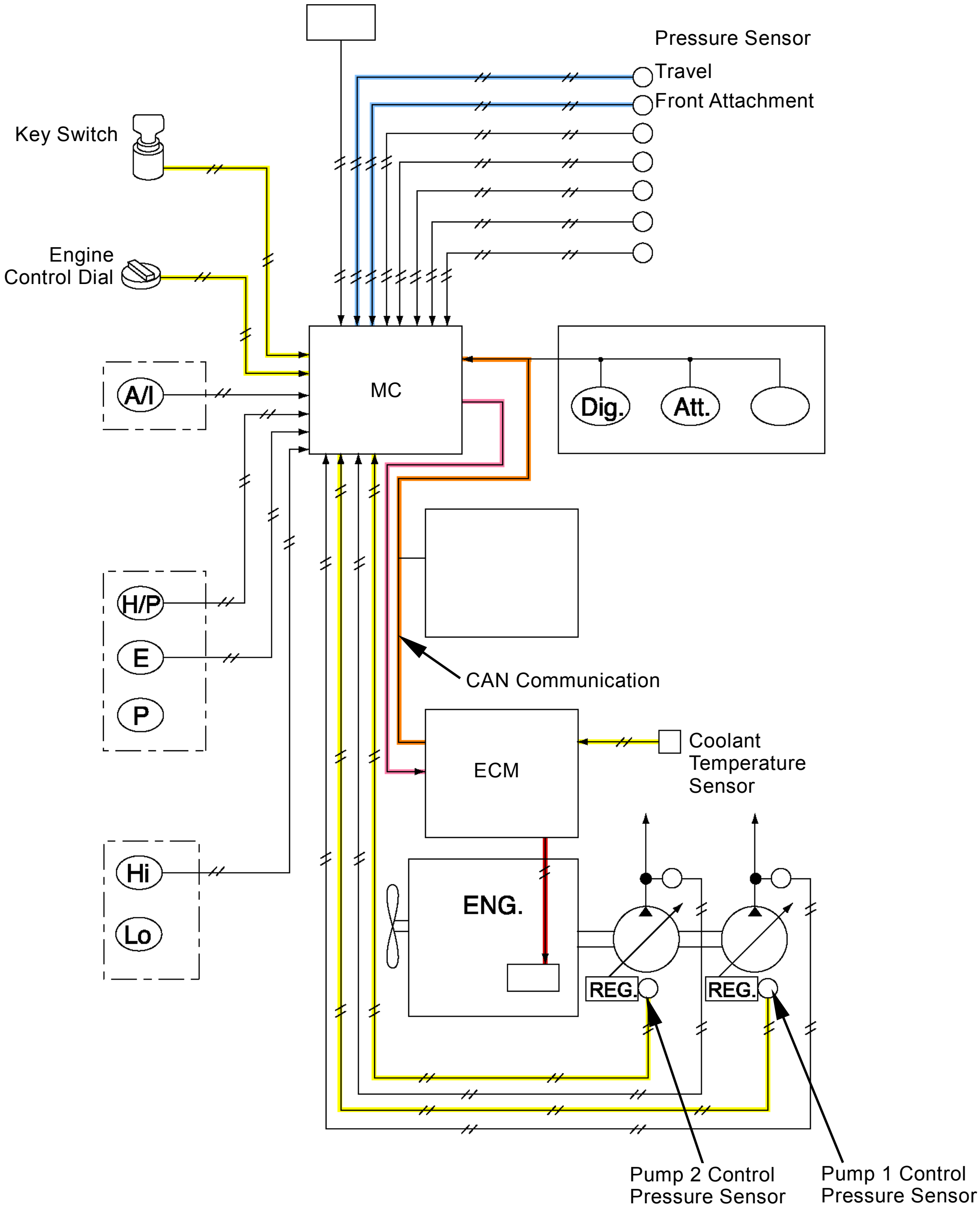
Operation:

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.
- 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.
- Pilot Shut-off Lever: Up
  (Pilot Shut-off Solenoid Valve: OFF)

Model	Increasing Range of Fast Idle Speed
ZX200-3 class	100 min^{-1}
ZX225US-3 class ZX225USR-3 class	200 min^{-1}
ZX240-3 class ZX270-3 class	100 min^{-1} (HP mode engine speed)



T1V1-02-01-035

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

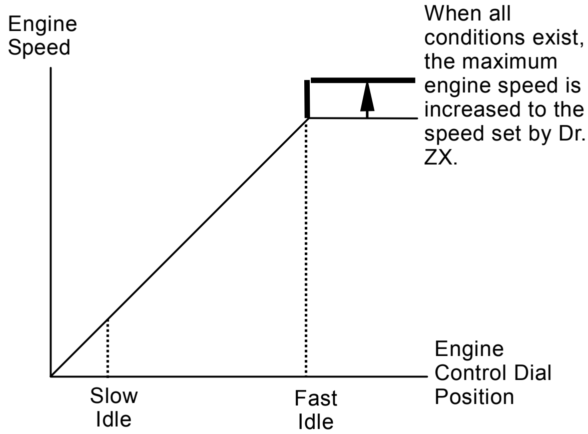
Purpose: Increases the maximum engine speed to the attachment (hydraulic breaker, secondary crusher, primary crusher or vibrating hammer) operating engine speed set by Dr. ZX when the attachment is operated.

Operation:

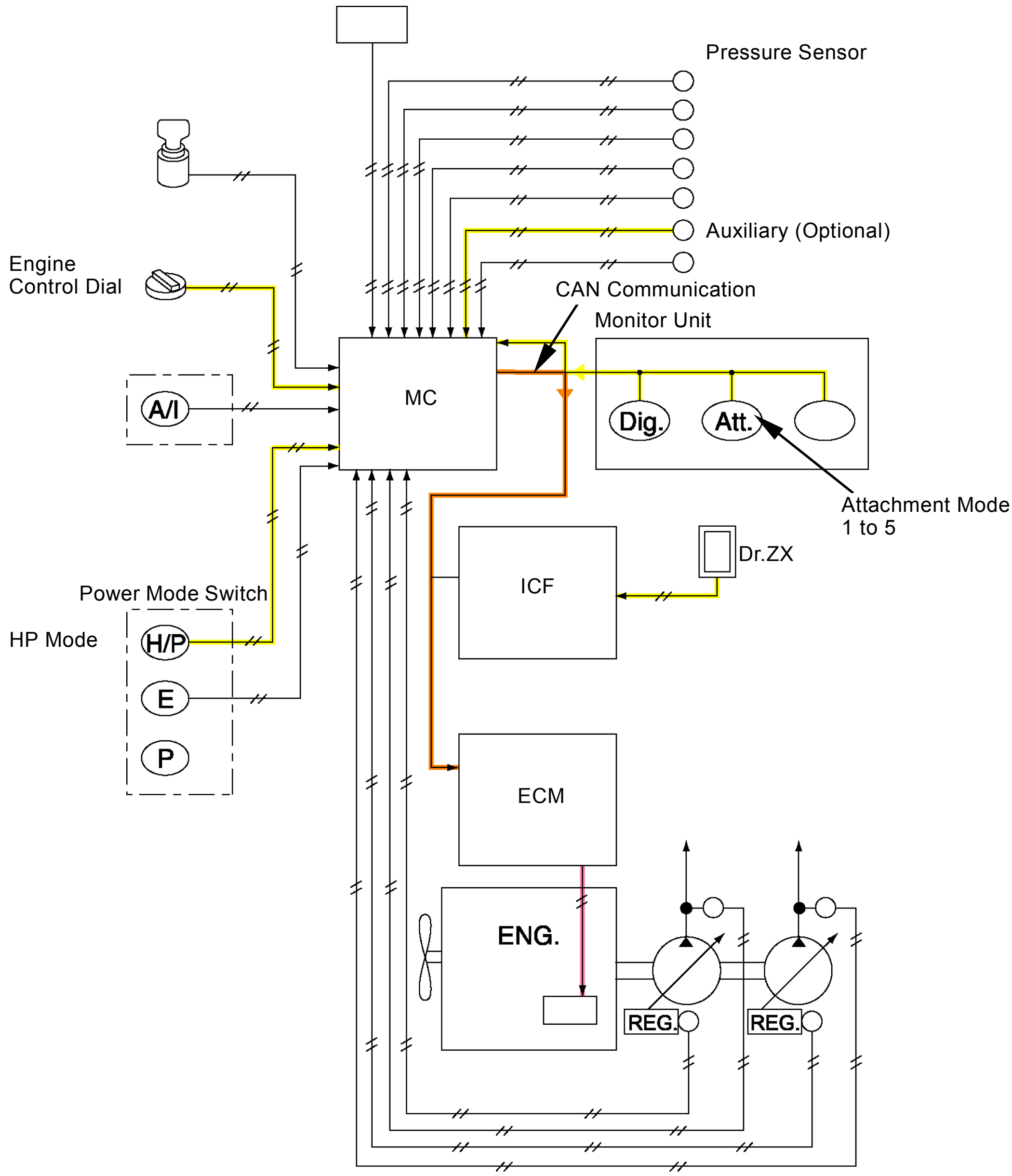
1. When the following conditions exist and the attachment is operated, MC sends the signals equivalent to the target engine speed set by Dr. ZX to ECM by using CAN communication.
2. ECM increases engine speed to the attachment operating speed set by Dr. ZX.

Conditions:

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



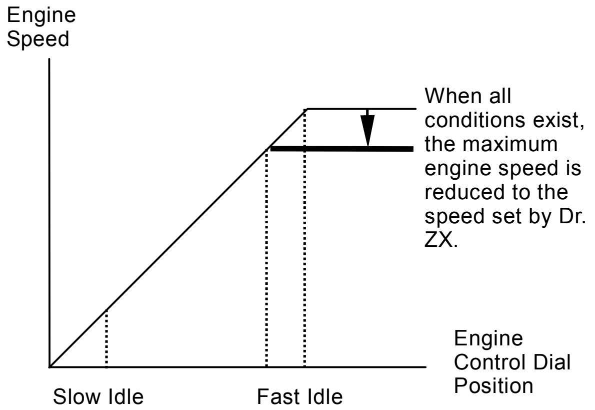
NOTE: *When P mode engine speed is preset to a slower speed in Dr. ZX service mode, the maximum engine speed will not be increased when operating the attachment.*



T1V1-02-01-011

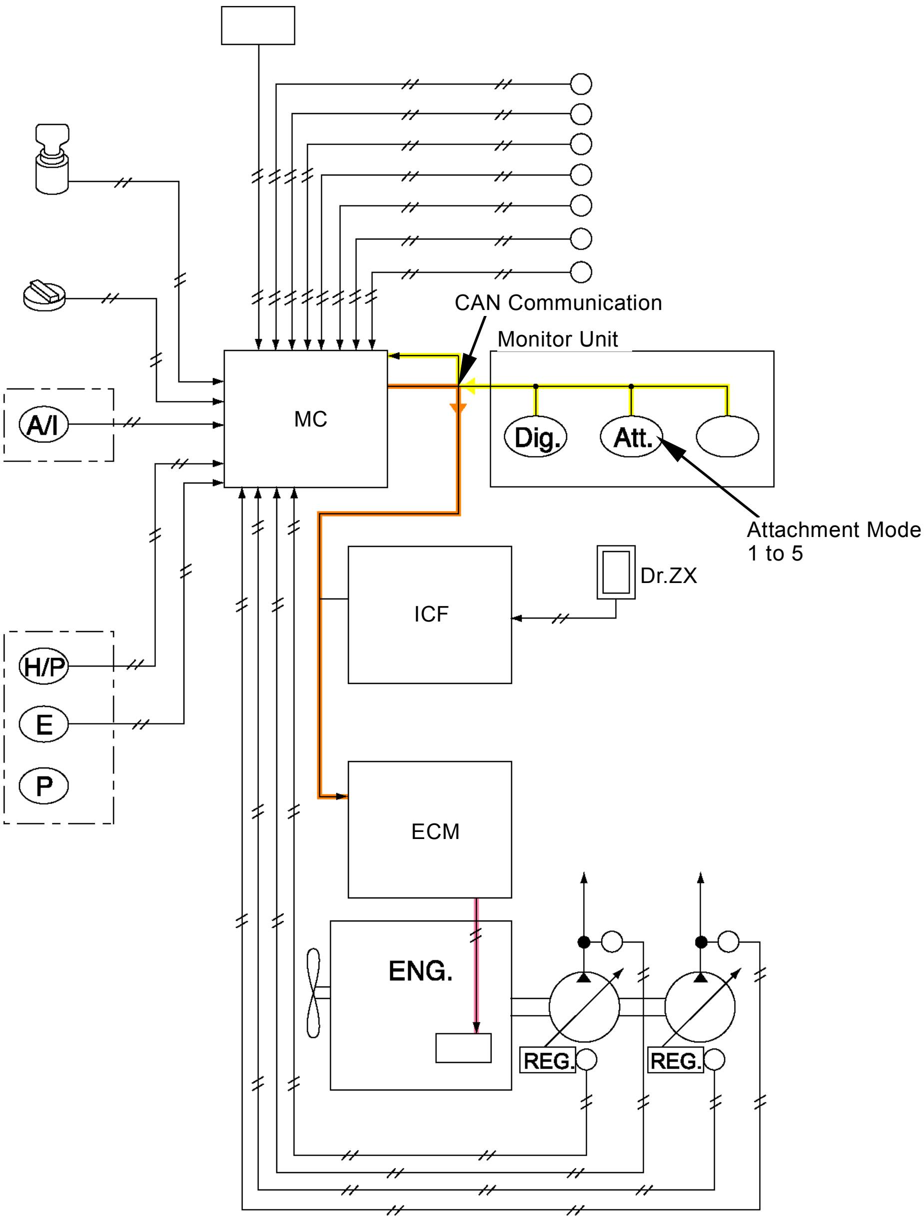
Attachment Operation Speed Limit Control (Only Machine Equipped with Attachment Parts)

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



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

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



T1V1-02-01-012

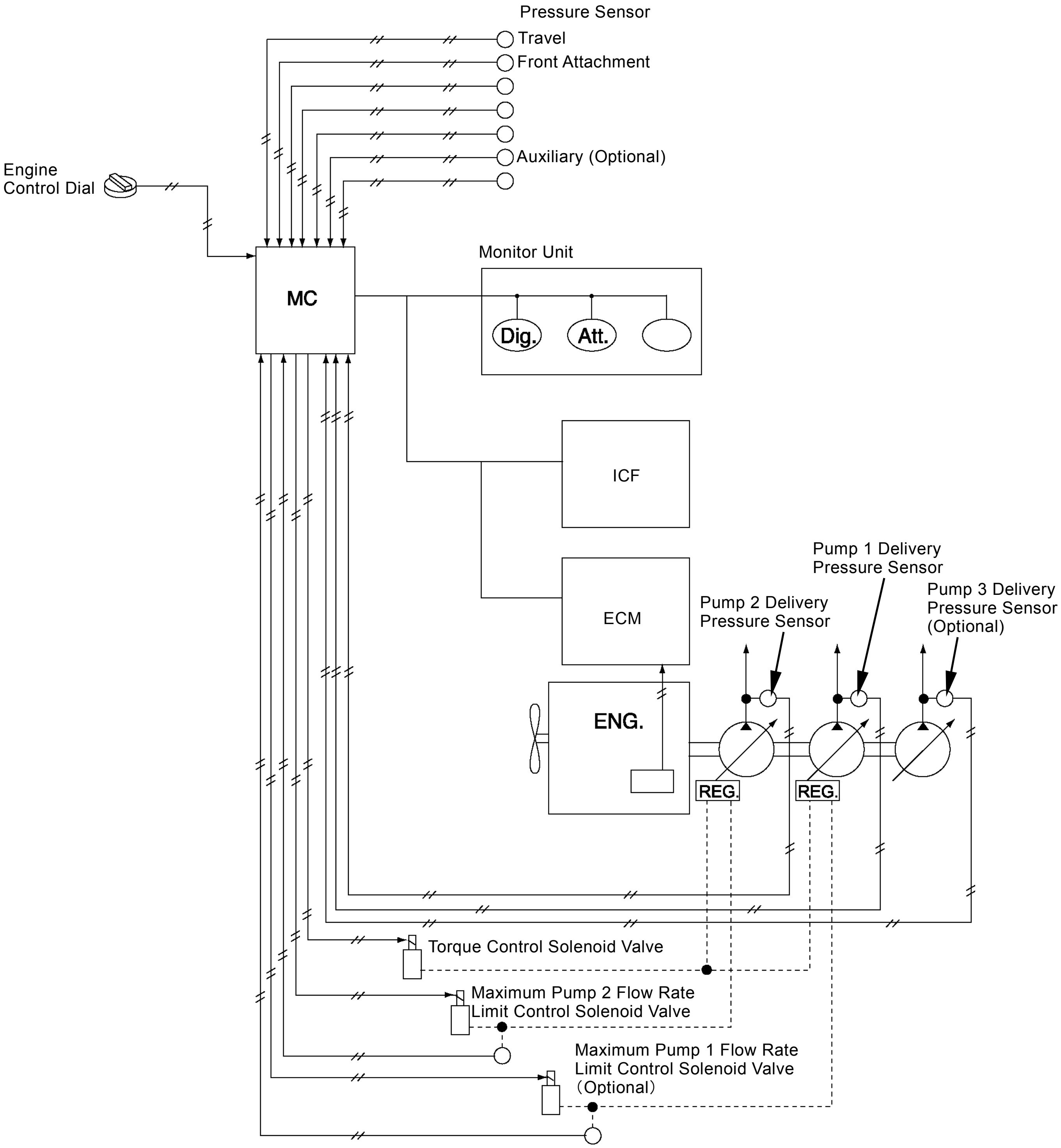
PUMP CONTROL

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



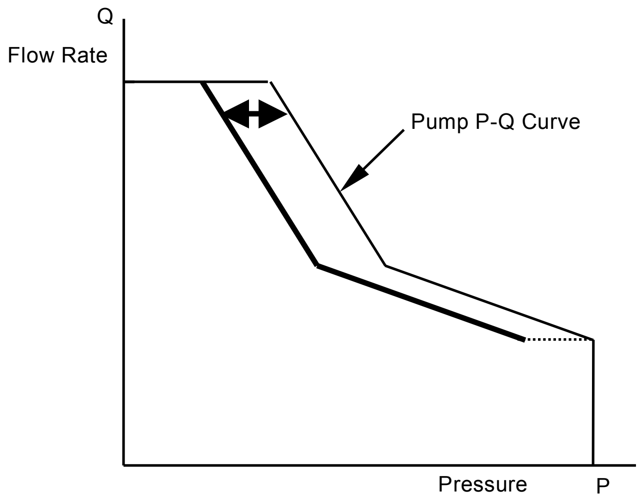
T1V1-02-01-003

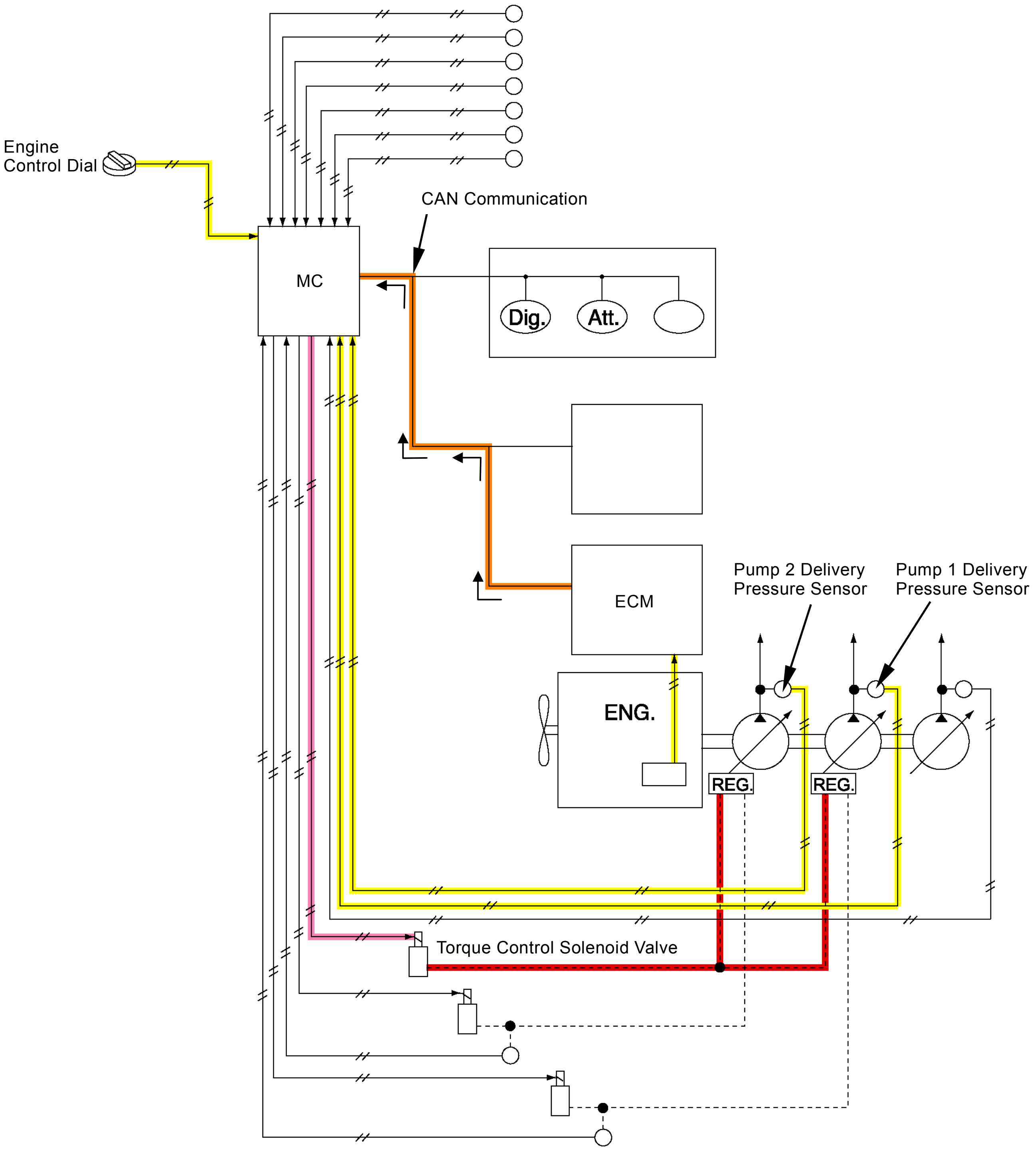
Speed Sensing Control

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

Operation:

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



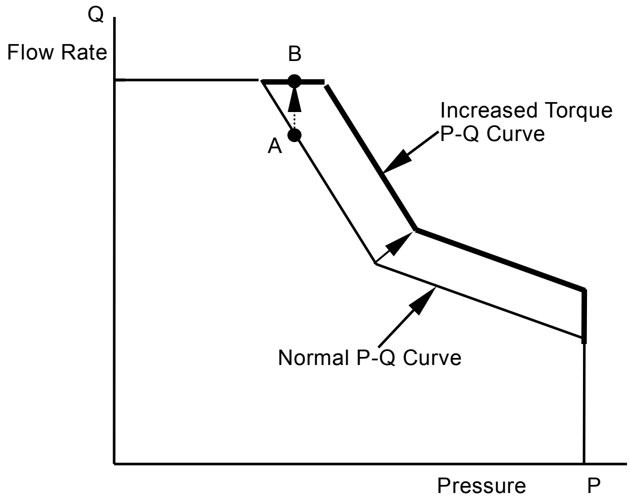


T1V1-02-01-016

Travel Torque-Up Control

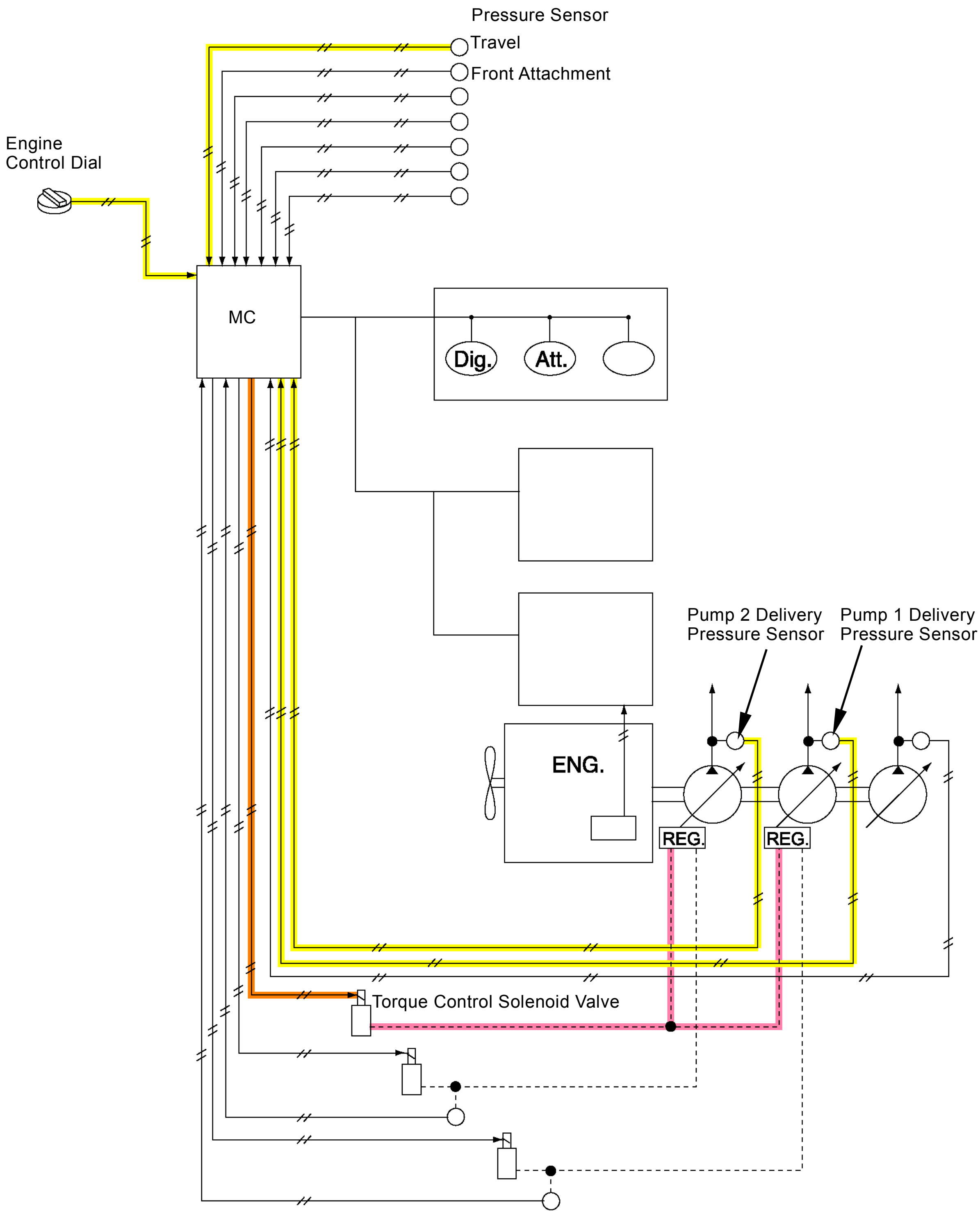
Purpose: Effectively controls during single travel operation. When travel operation is made with the engine running at slow speed, normally, the hydraulic pump delivers pressure oil at the flow rate corresponding to point A on the P-Q curve illustrated to the right. Therefore, if any difference exists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

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



Operation:

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



T1V1-02-01-018

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

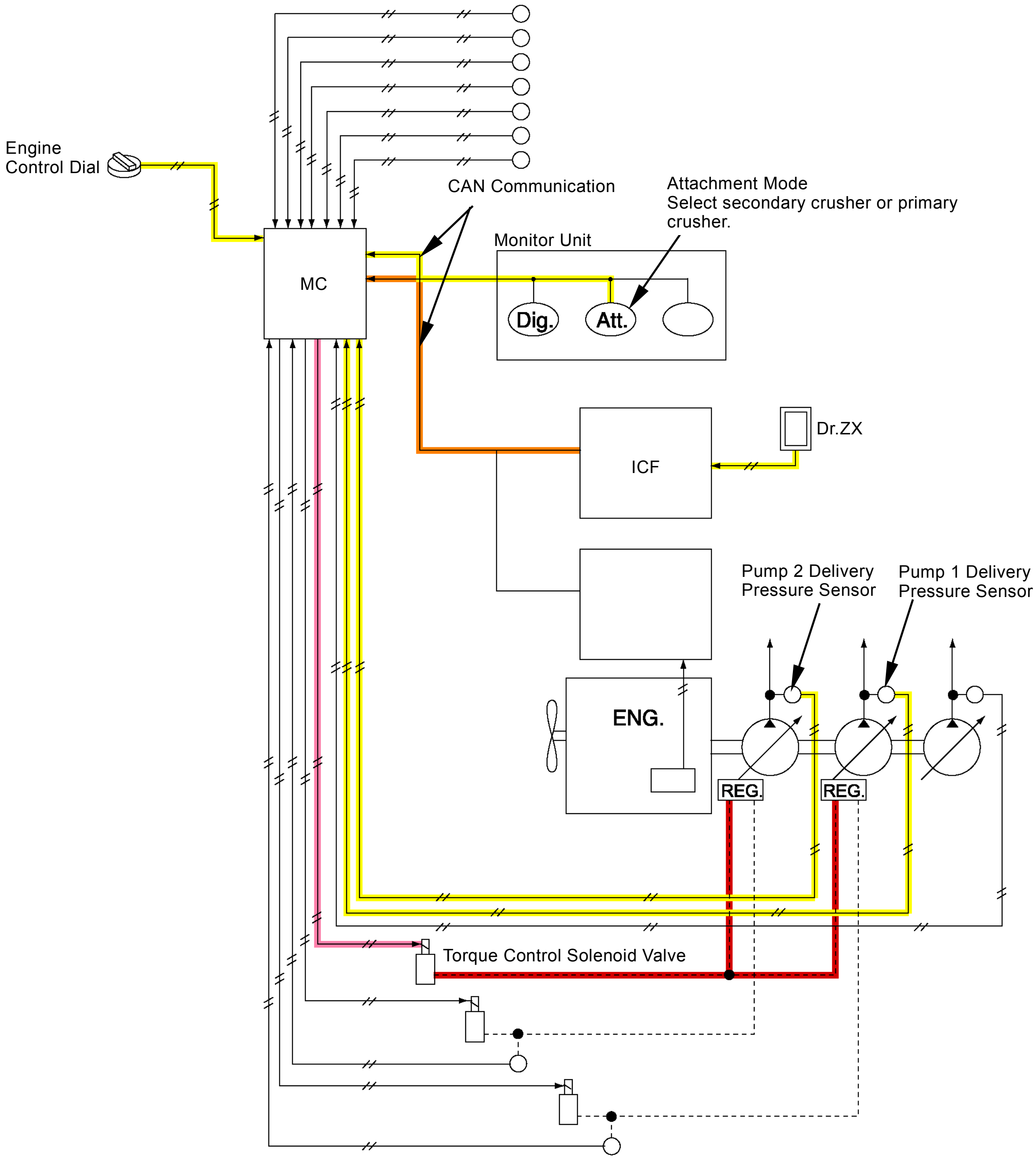
Purpose: When average pump delivery pressure becomes high while operating the attachment (secondary crusher or primary crusher), driving torque of pumps 1, 2 is decreased and pump delivery pressure is reduced in order to prevent hydraulic oil temperature from rising while operating the attachment.

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 power and hydraulic temperature is prevented from rising while operating the attachment.

Condition:

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



T1V1-02-01-017

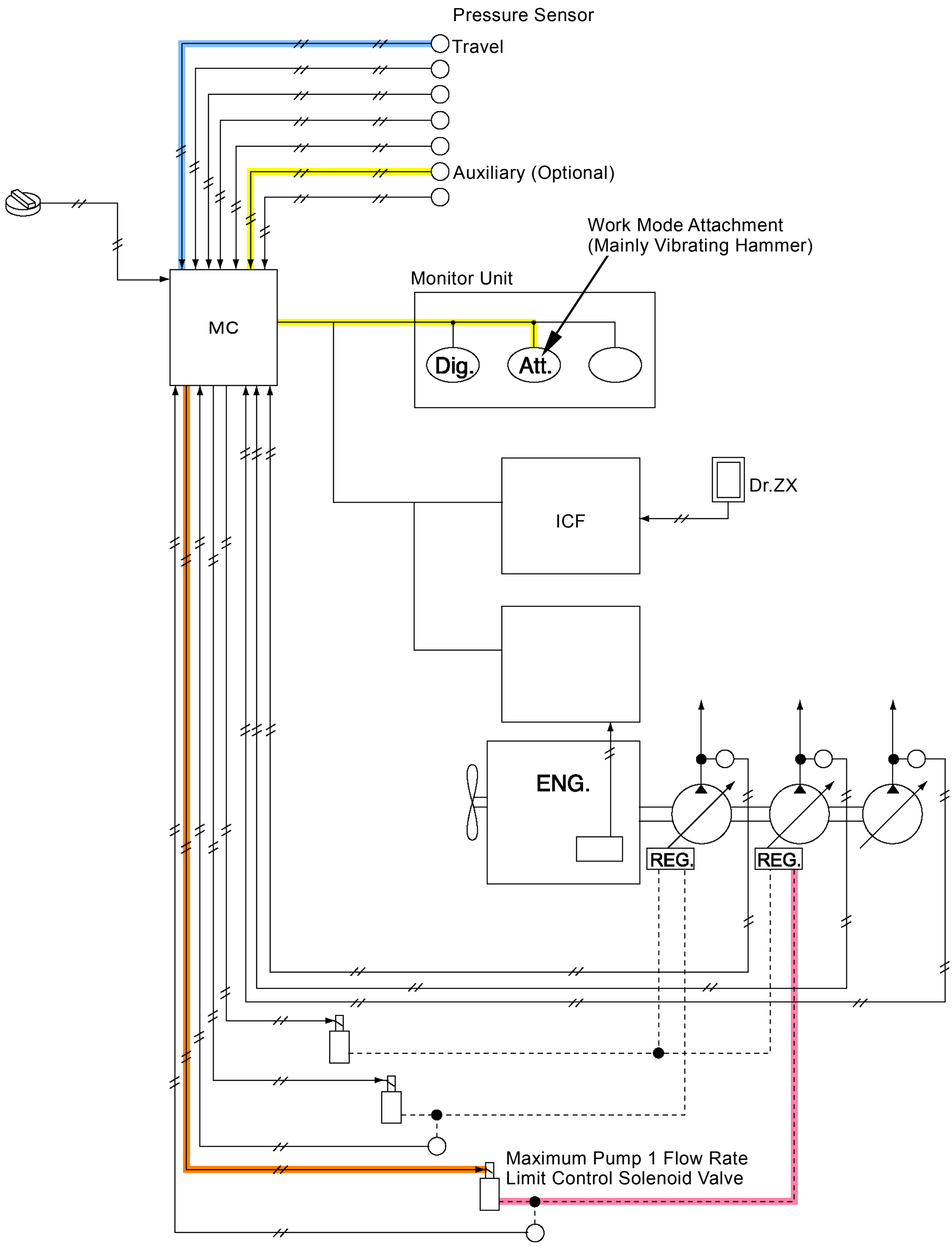
Pump 1 Flow Rate Limit Control (Only Machine Equipped with Attachment)

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

Operation:

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

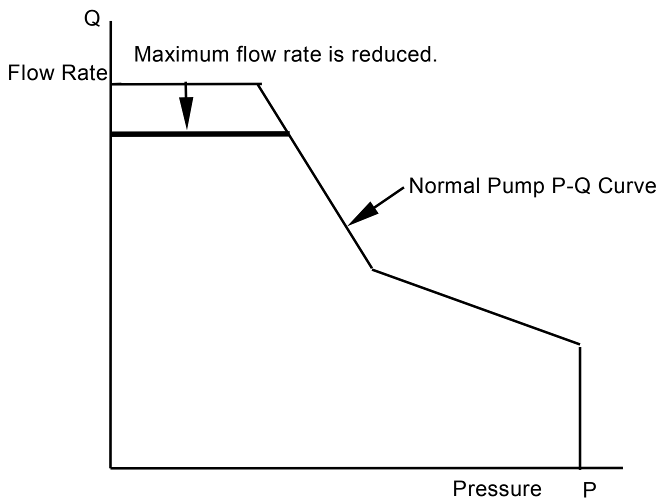
NOTE: The minimum pump swash set-angle on monitor unit for a attachment (hydraulic breaker 1 to 5, secondary crusher 1 to 5, primary crusher 1 to 5 or vibrating hammer 1 to 5) can be set in the service mode of Dr. ZX.



T1V1-02-01-019

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

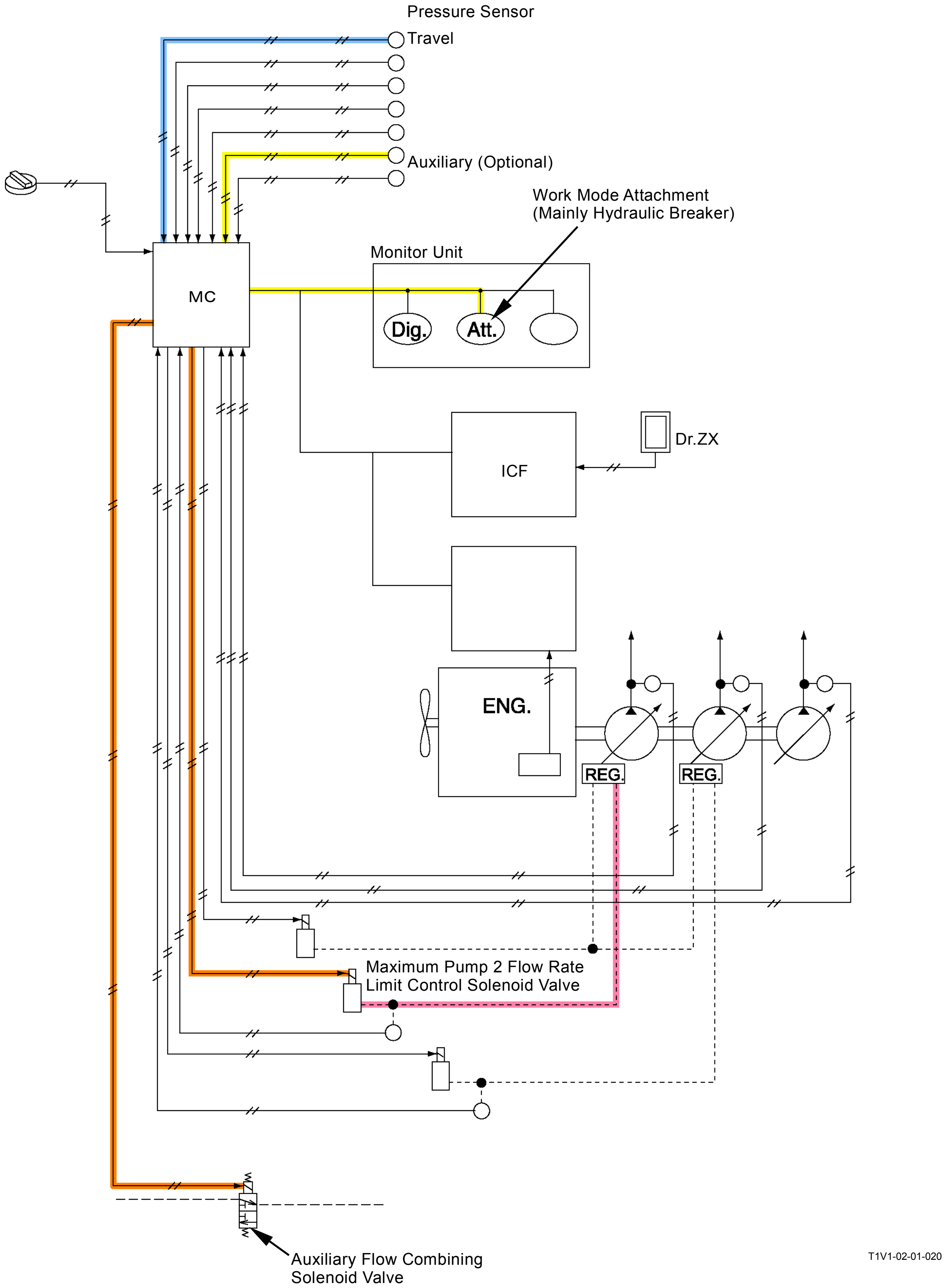
Purpose: Limits maximum pump 2 flow rate when a attachment (mainly a hydraulic breaker) is used.



Operation:

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

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

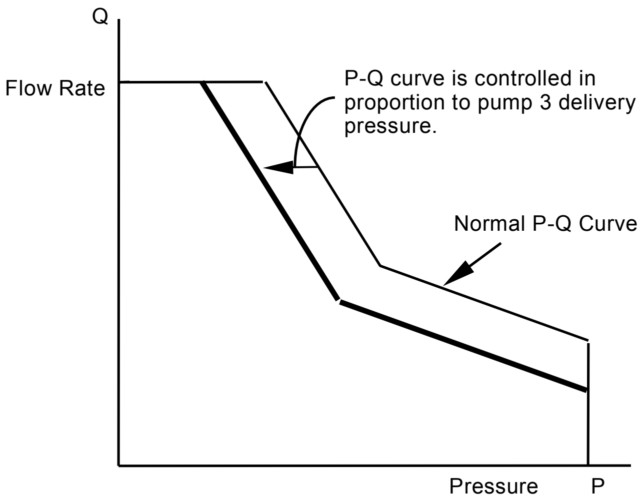

Pressure Sensor
Travel
Auxiliary (Optional)
Work Mode Attachment
(Mainly Hydraulic Breaker)
Monitor Unit
MC
Dig.
Att.
ICF
Dr.ZX
ENG.
REG.
REG.
Maximum Pump 2 Flow Rate
Limit Control Solenoid Valve
Auxiliary Flow Combining
Solenoid Valve
T1V1-02-01-020

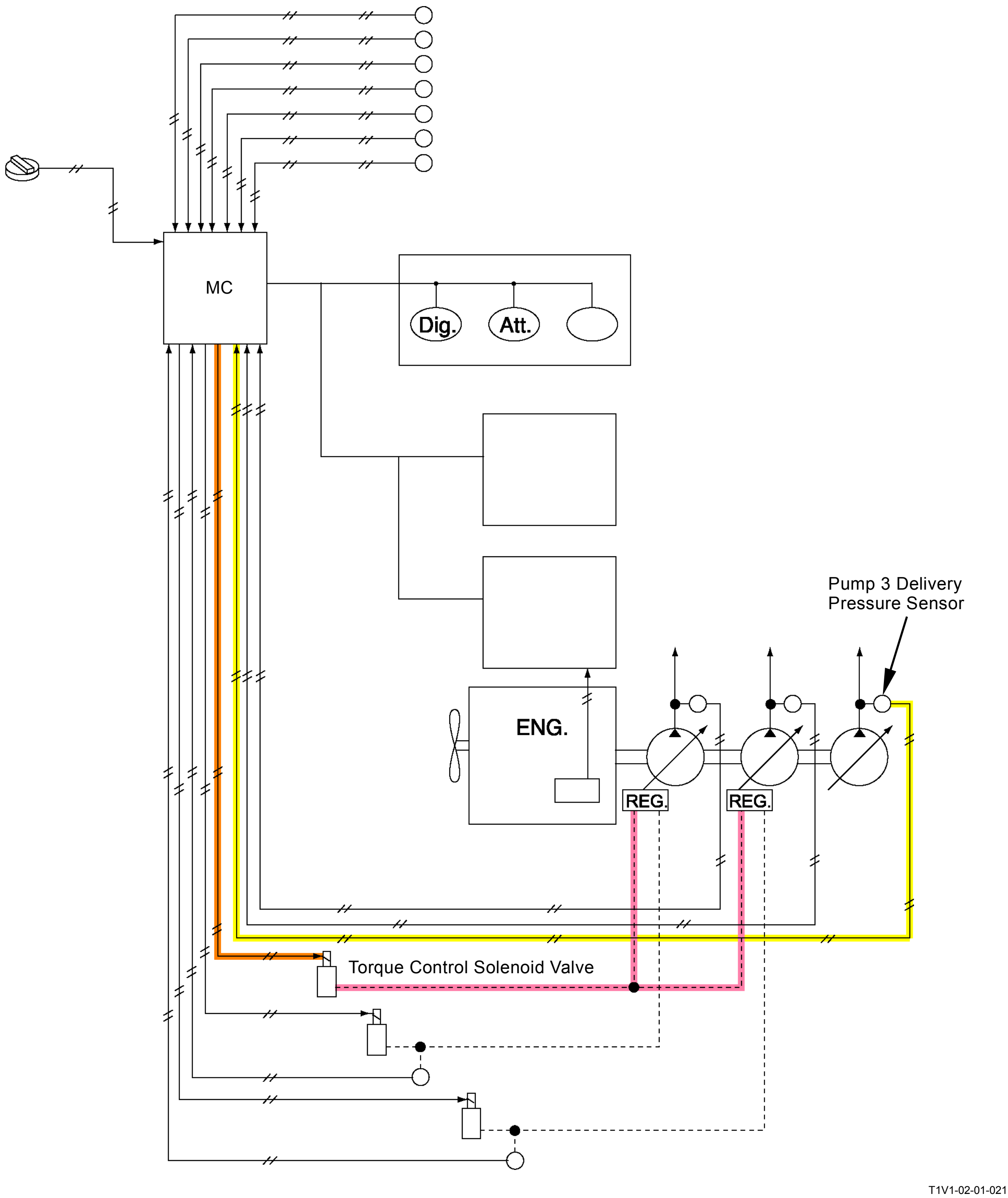
Pump 3 Torque Decrease Control (Only Machine Equipped with Optional Parts)

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

Operation:

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





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

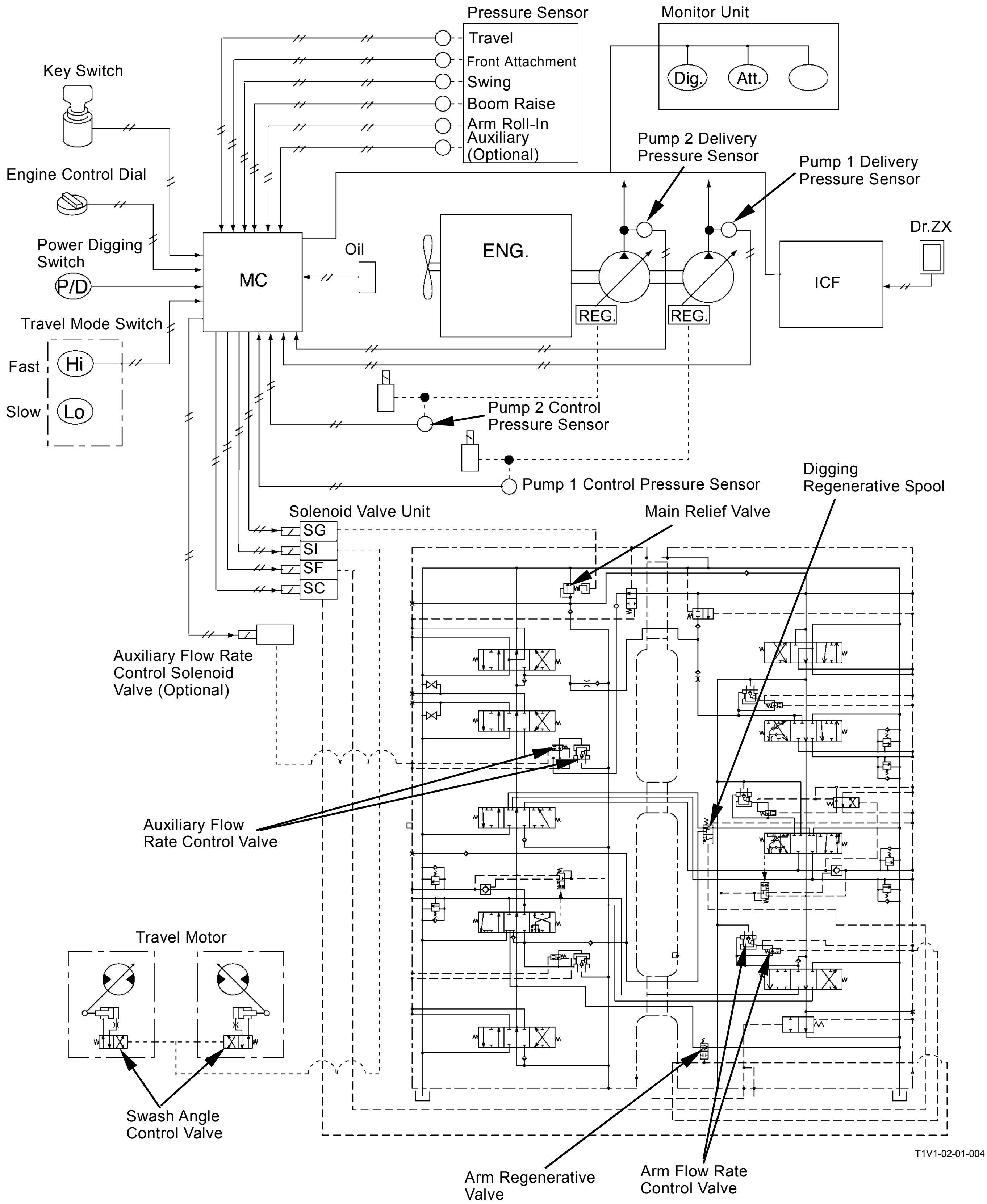
VALVE CONTROL

The valve control system functions as follows:

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

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

Valve Control System Layout

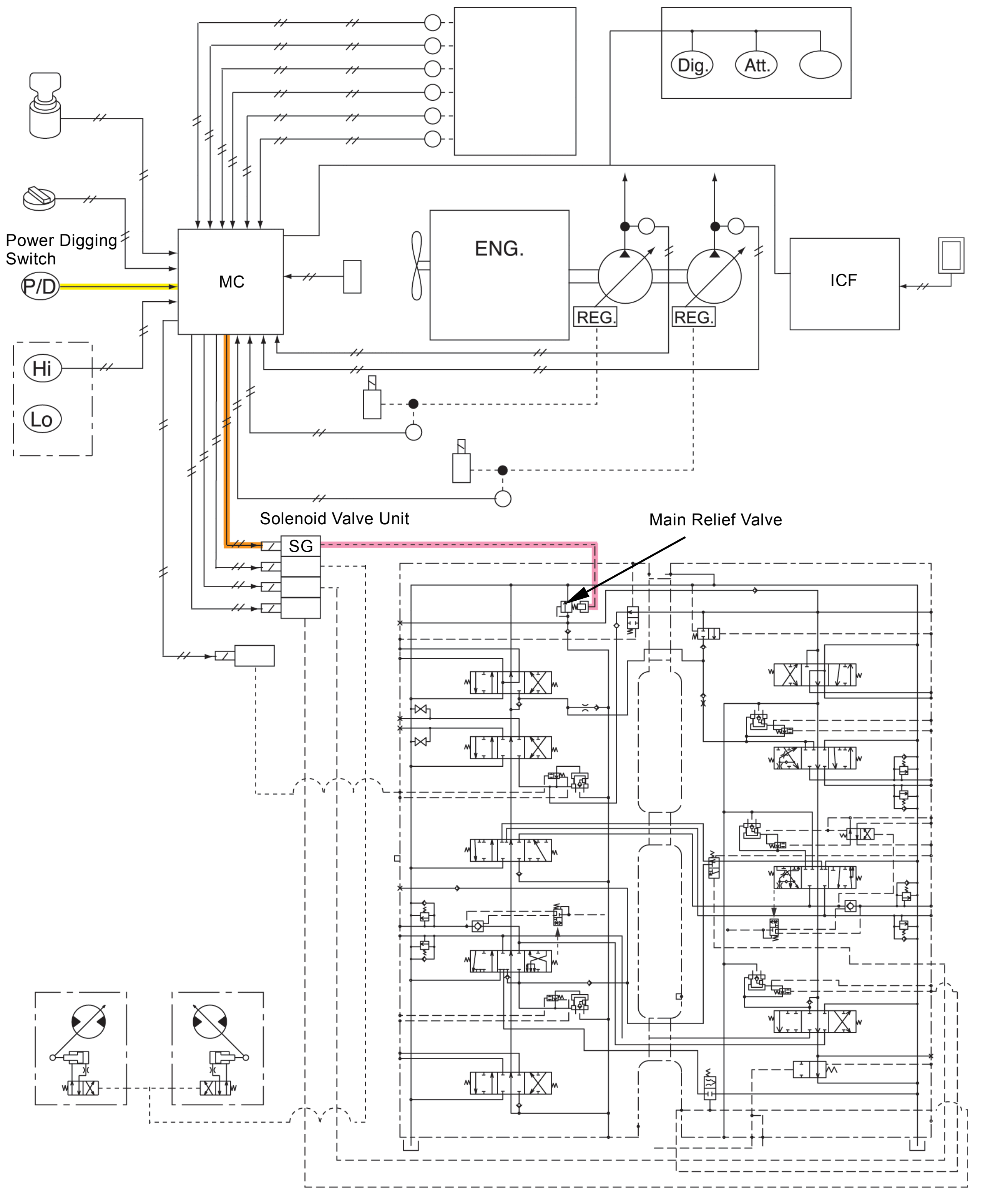


Power Digging Control

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.)



Power Digging Switch
P/D
Hi
Lo
MC
ENG.
REG.
REG.
Dig.
Att.
ICF
Solenoid Valve Unit
SG
Main Relief Valve
T1V1-02-01-024

Auto-Power Lift Control

Purpose: Increases pressure when raising the boom.

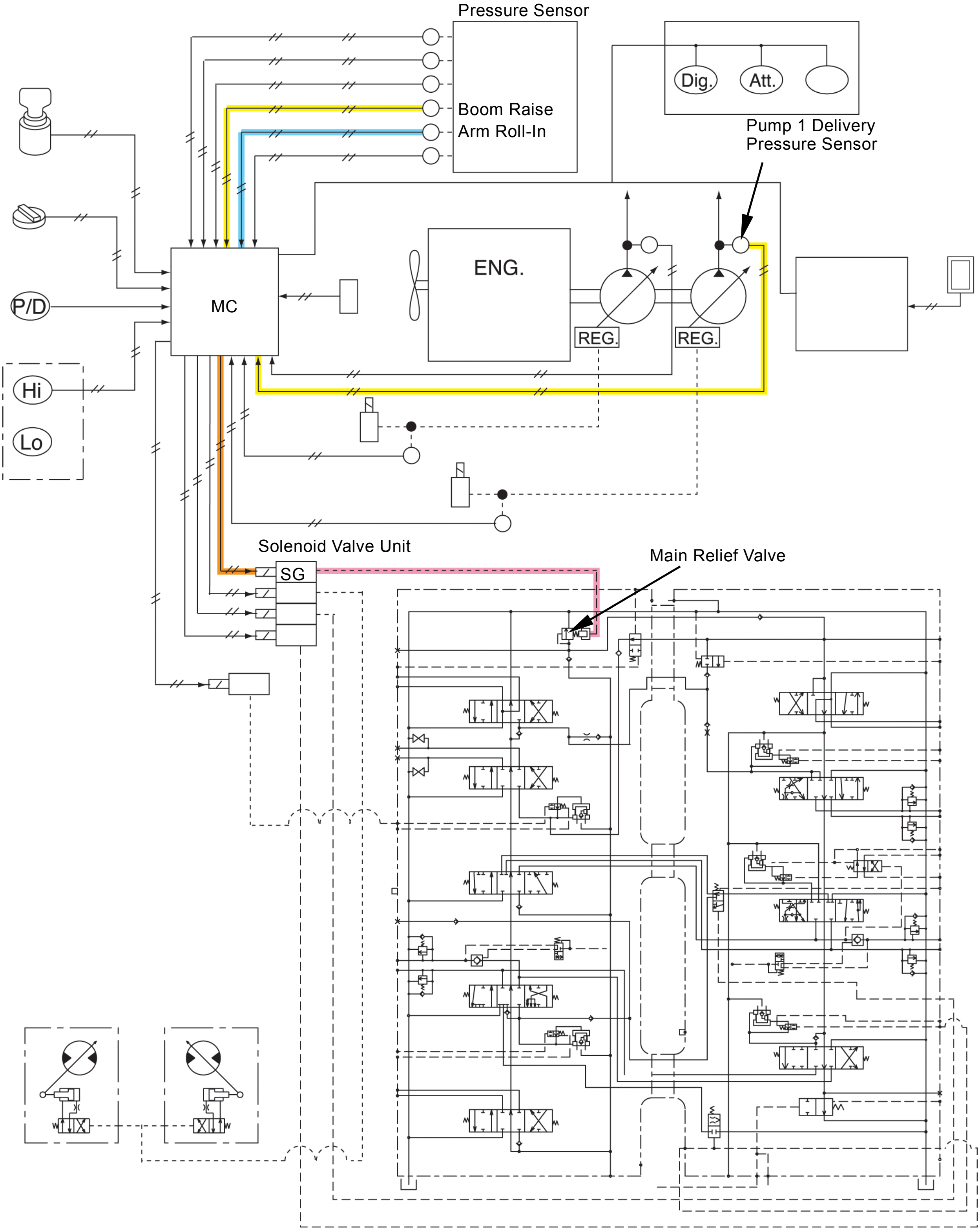
Operation:

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: No output (The control lever is in neutral.)

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



T1V1-02-01-025

Arm Regenerative Control

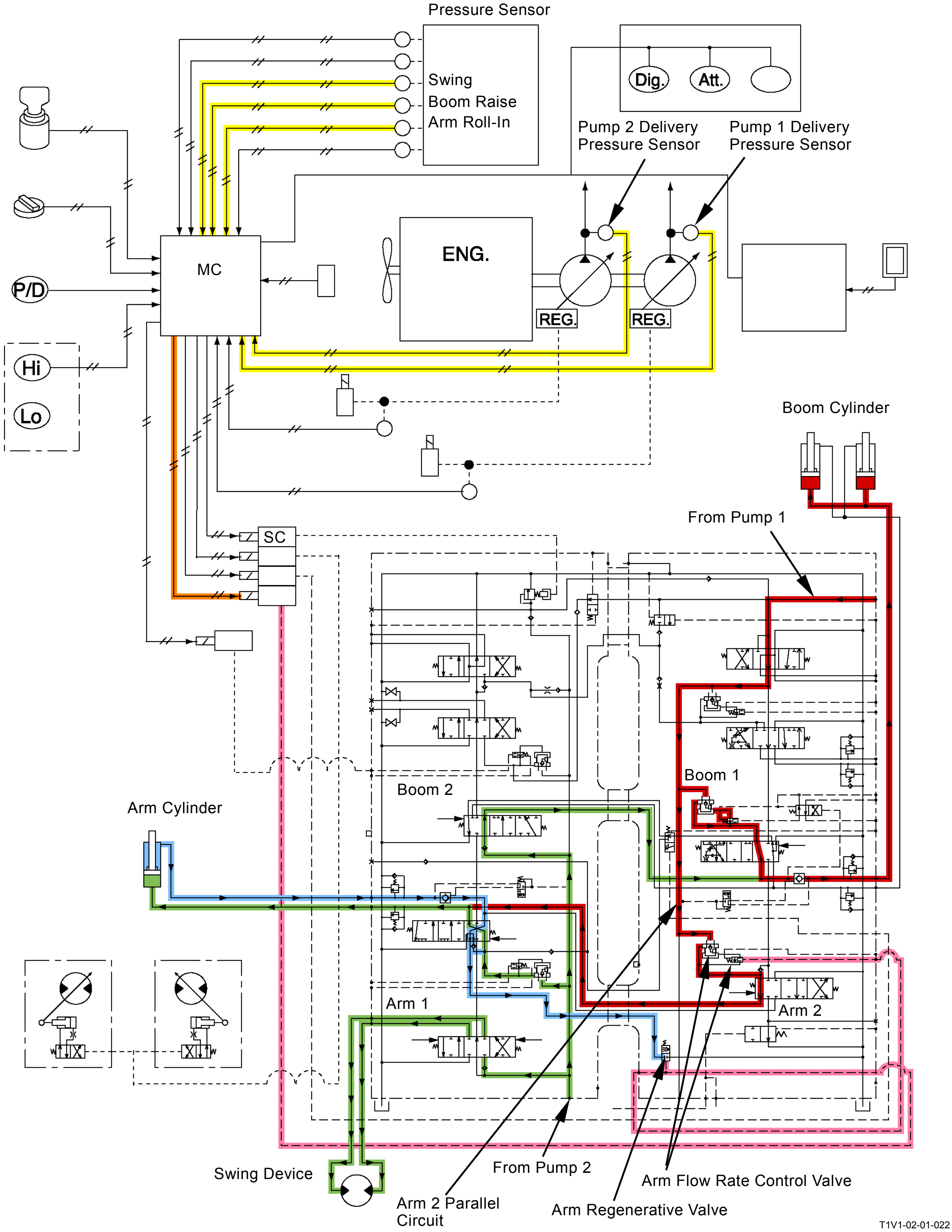
Purpose: Accelerates the arm roll-in speed in order to prevent arm hesitation during arm roll-in operation.

Operation:

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

Conditions:

- Pump 1 and 2 Delivery Pressure Sensors:
  Either pump 1 or 2 delivery pressure is low. (The arm does not need much power to operate.) (Reference: 16.5 MPa (168 kgf/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.


Pressure Sensor
Swing
Boom Raise
Arm Roll-In
Dig.
Att.
Pump 2 Delivery Pressure Sensor
Pump 1 Delivery Pressure Sensor
MC
P/D
Hi
Lo
ENG.
REG.
REG.
Boom Cylinder
From Pump 1
SC
Boom 1
Boom 2
Arm Cylinder
Arm 1
Arm 2
Swing Device
From Pump 2
Arm 2 Parallel Circuit
Arm Regenerative Valve
Arm Flow Rate Control Valve
T1V1-02-01-022

Digging Regenerative Control

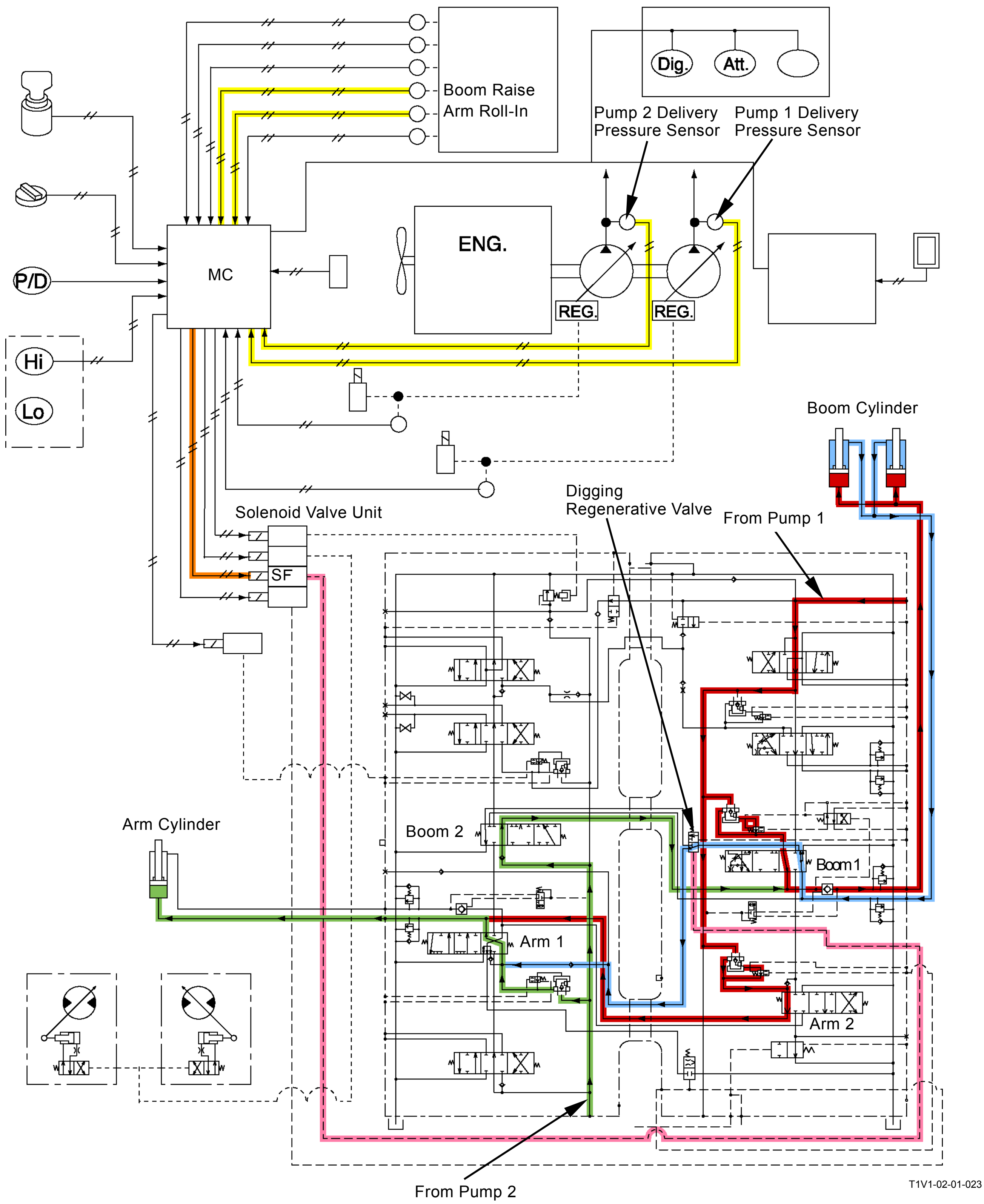
Purpose: Increases arm roll-in speed when operating digging (boom raise, arm roll-in and bucket roll-in).

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.
P/D
REG.
REG.
Hi
Lo
Boom Cylinder
Digging Regenerative Valve
Solenoid Valve Unit
SF
From Pump 1
Arm Cylinder
Boom 2
Boom 1
Arm 1
Arm 2
From Pump 2
T1V1-02-01-023

Travel Motor Swash Angle Control

Purpose: Controls the travel mode.

ZXIS200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class

Operation:

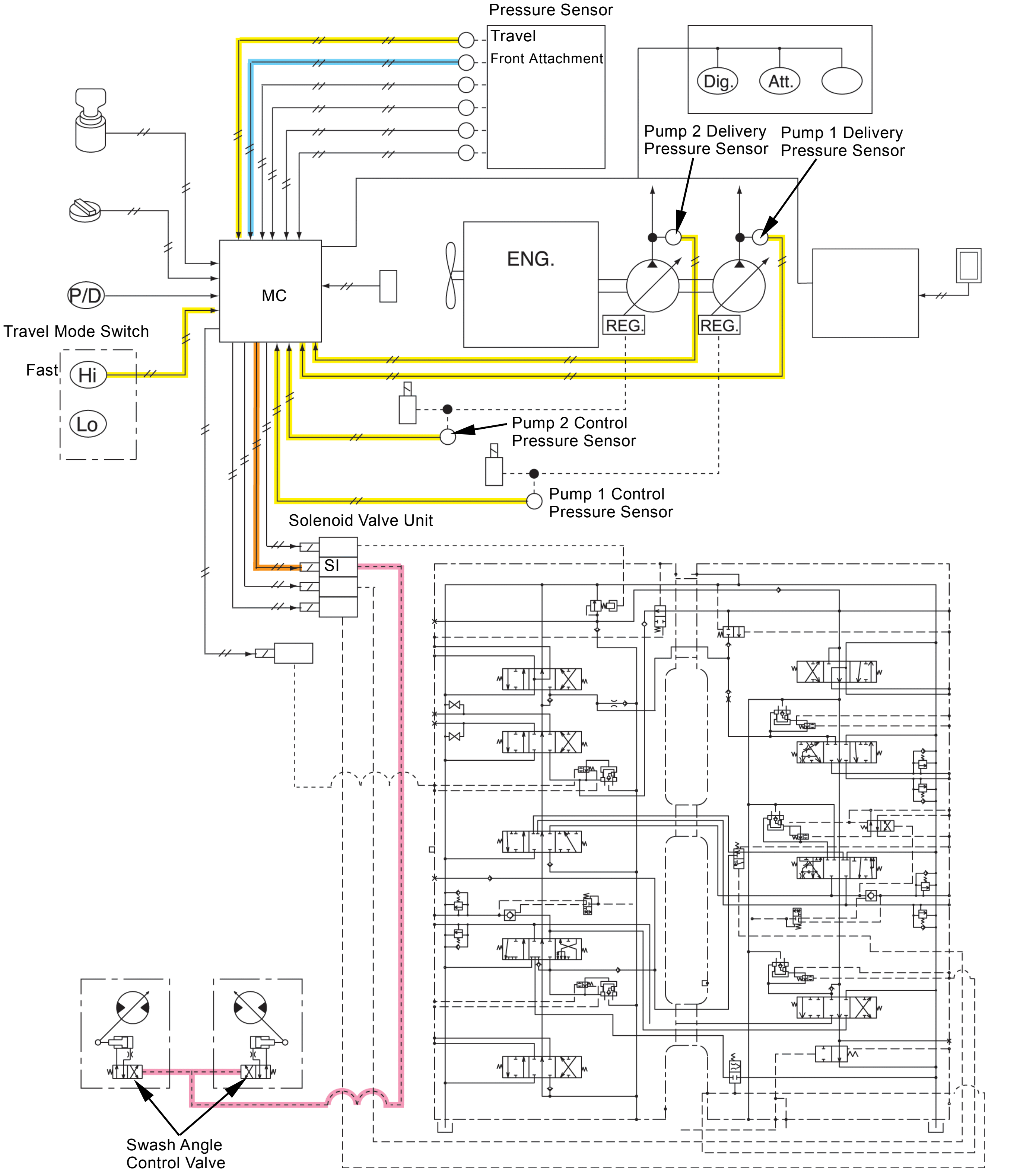
- Slow
  When the travel mode switch is in the SLOW position, the travel motor swash angle is kept in the maximum angle so that the travel speed is slow.
- Fast

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.



T1V1-02-01-027

ZX270-3 class

Operation:

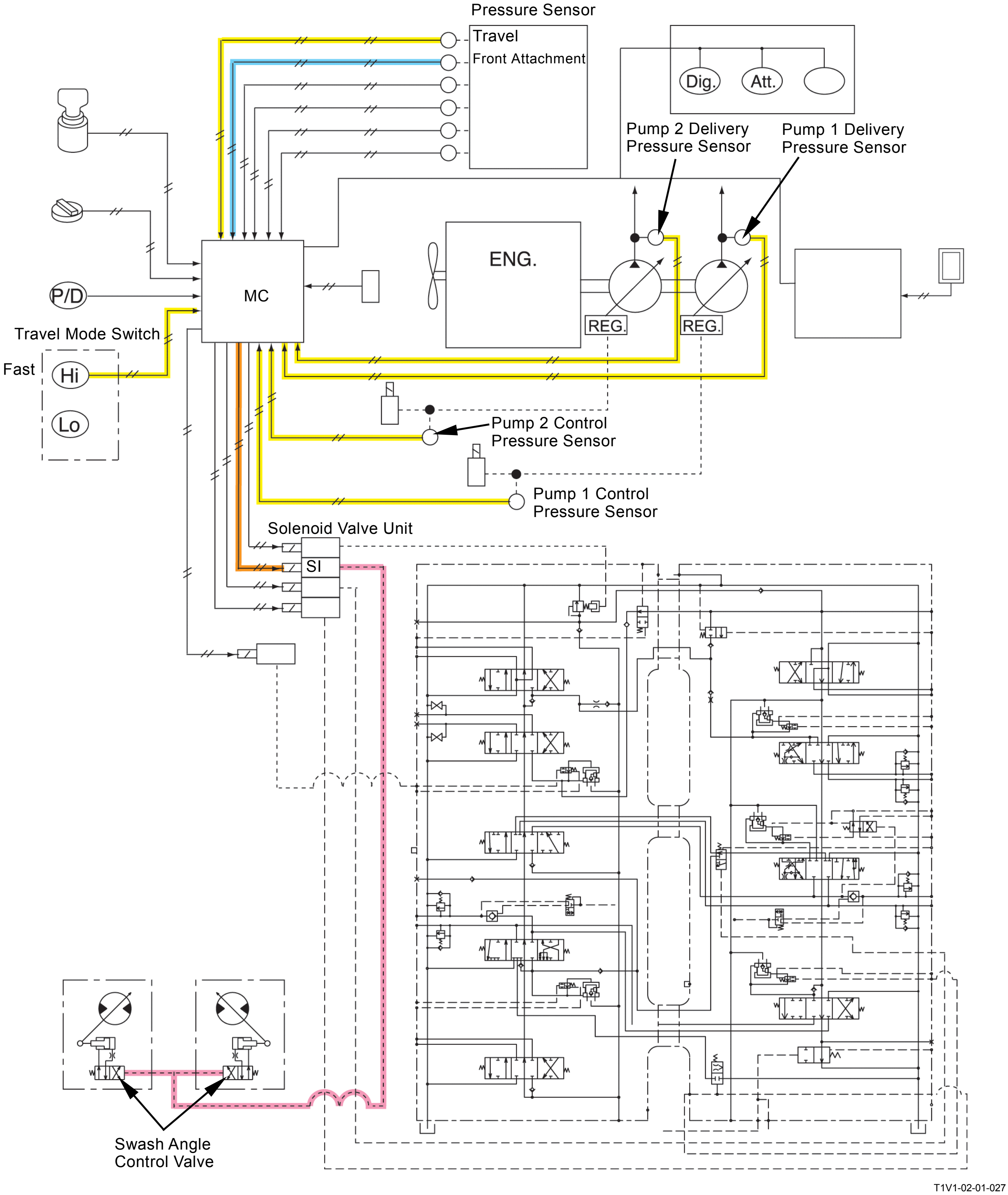
- Slow
  When the travel mode switch is in the SLOW position, the travel motor swash angle is kept in the maximum angle so that the travel speed is slow.
- Fast

1. When MC receives the signals from travel pressure sensor, pump 1 and 2 delivery pressure sensors, pump 1 and 2 control pressure sensors under the following conditions with the travel mode switch in the FAST position, 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: Both pump control pressures are high. (Reference: 2.2 MPa (22 kgf/cm^2, 320psi) or more)

NOTE: 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.
When one side track is raise off the ground and is rotated, the one side pump control pressure does not increase, so that the raised track does not rotate at fast speed.

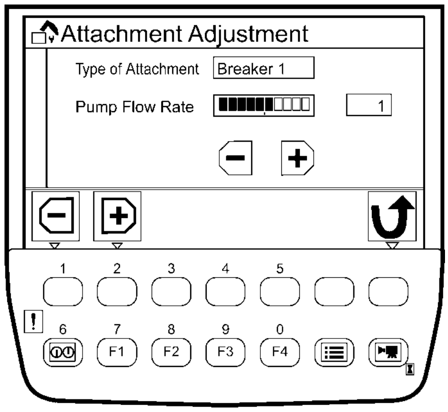

Pressure Sensor
Travel
Front Attachment
Dig.
Att.
Pump 2 Delivery Pressure Sensor
Pump 1 Delivery Pressure Sensor
ENG.
MC
P/D
Travel Mode Switch
Fast
Hi
Lo
REG.
REG.
Pump 2 Control Pressure Sensor
Pump 1 Control Pressure Sensor
Solenoid Valve Unit
SI
Swash Angle Control Valve
T1V1-02-01-027

HSB Breaker Control (Optional)

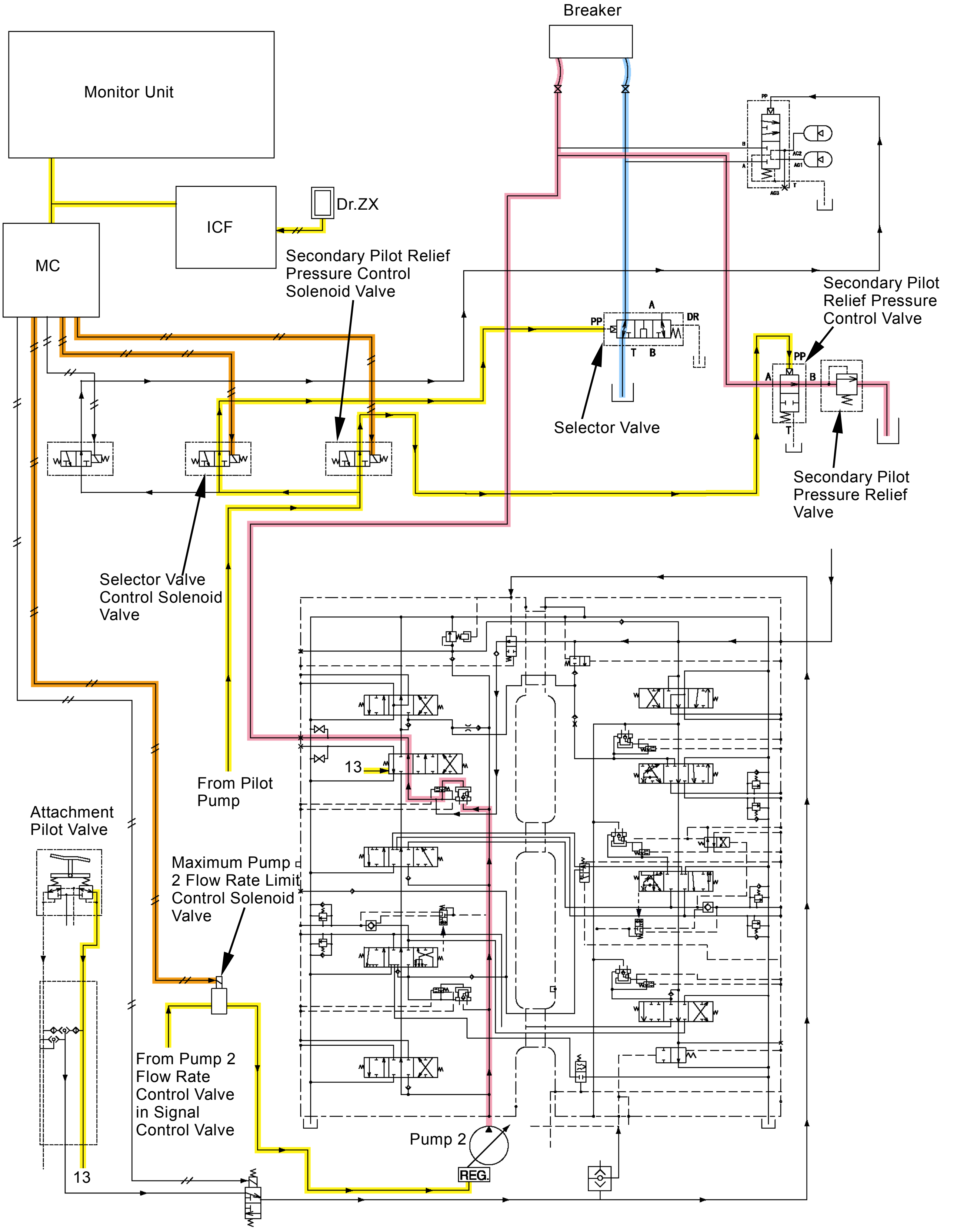
IMPORTANT: HSB breaker is set at breaker 1 of attachment mode in monitor unit when the machine is carried out. When breaker 3 to 5 is used, set the setting by using Dr. ZX.

Operation:

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



T1V5-05-01-111



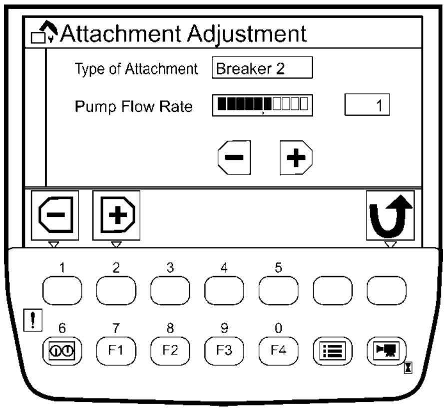
T1V1-02-01-033

NPK Breaker Control (Optional)

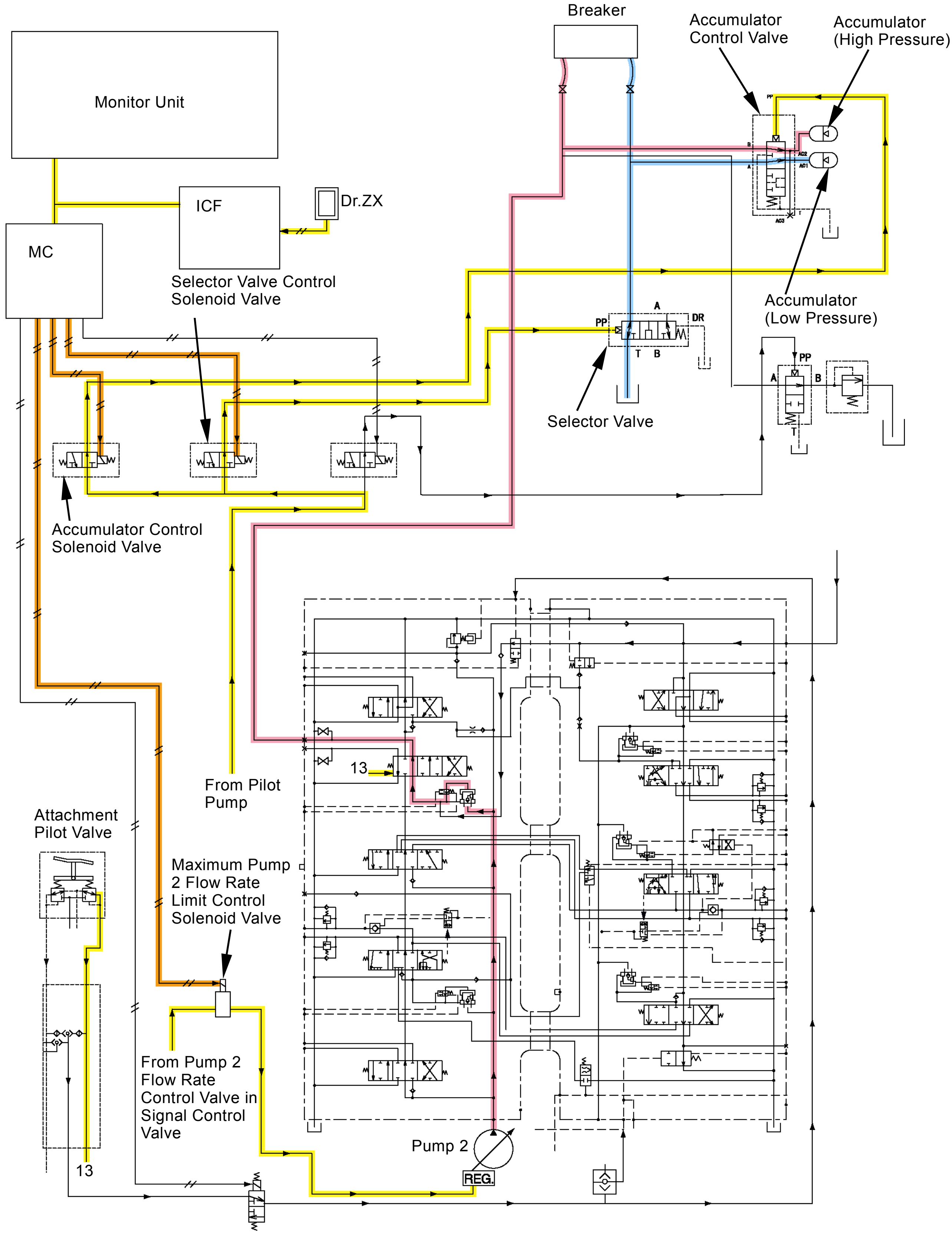
IMPORTANT: NPK breaker is set at breaker 2 of attachment mode in monitor unit when the machine is carried out. When breaker 3 to 5 is used, set the setting by using Dr. ZX.

Operation:

1. When selecting breaker 2 in monitor unit, MC drives the selector valve control solenoid valve.
2. Pressure oil from the pilot pump flows through the selector valve control solenoid valve, shifts the selector valve, and the return circuit in breaker is connected to the hydraulic oil tank.
3. 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



T1V1-02-01-032

Secondary Crusher Control (Optional)

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

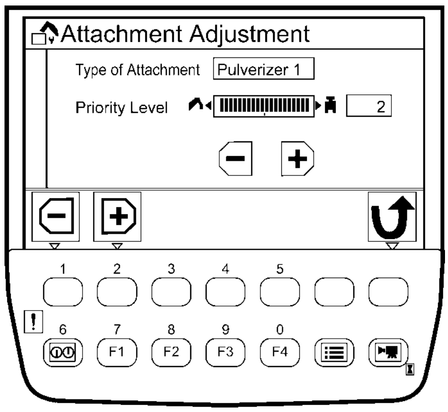
Purpose: Increases operating speed of the secondary crusher.
Reduces flow rate through the auxiliary spool and improve arm, boom, swing or travel operation during combined operation of arm roll-out, arm roll-out+ boom raise, swing or travel and secondary crusher.

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

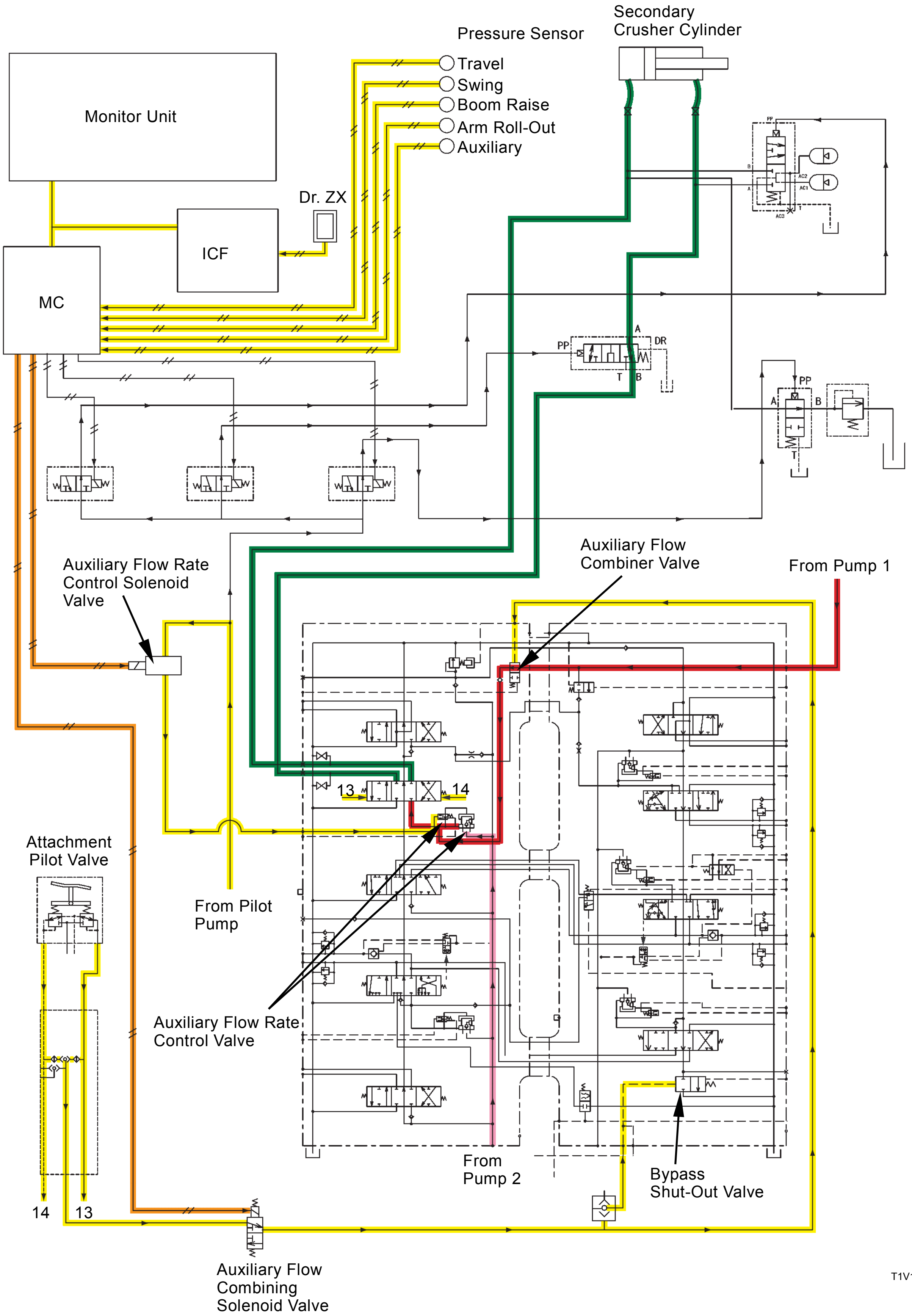
During Combined Operation

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

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



T1V5-05-01-024



T1V1-02-01-030

Primary Crusher Control (Optional)

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

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

Operation:

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

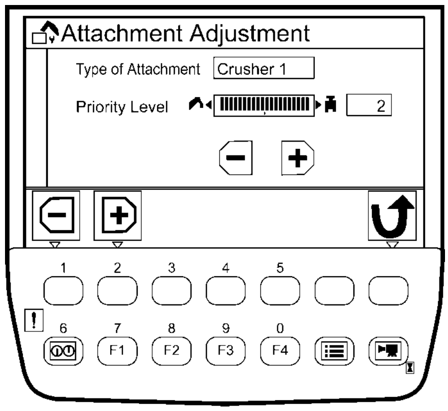
During Combined Operation

Operation:

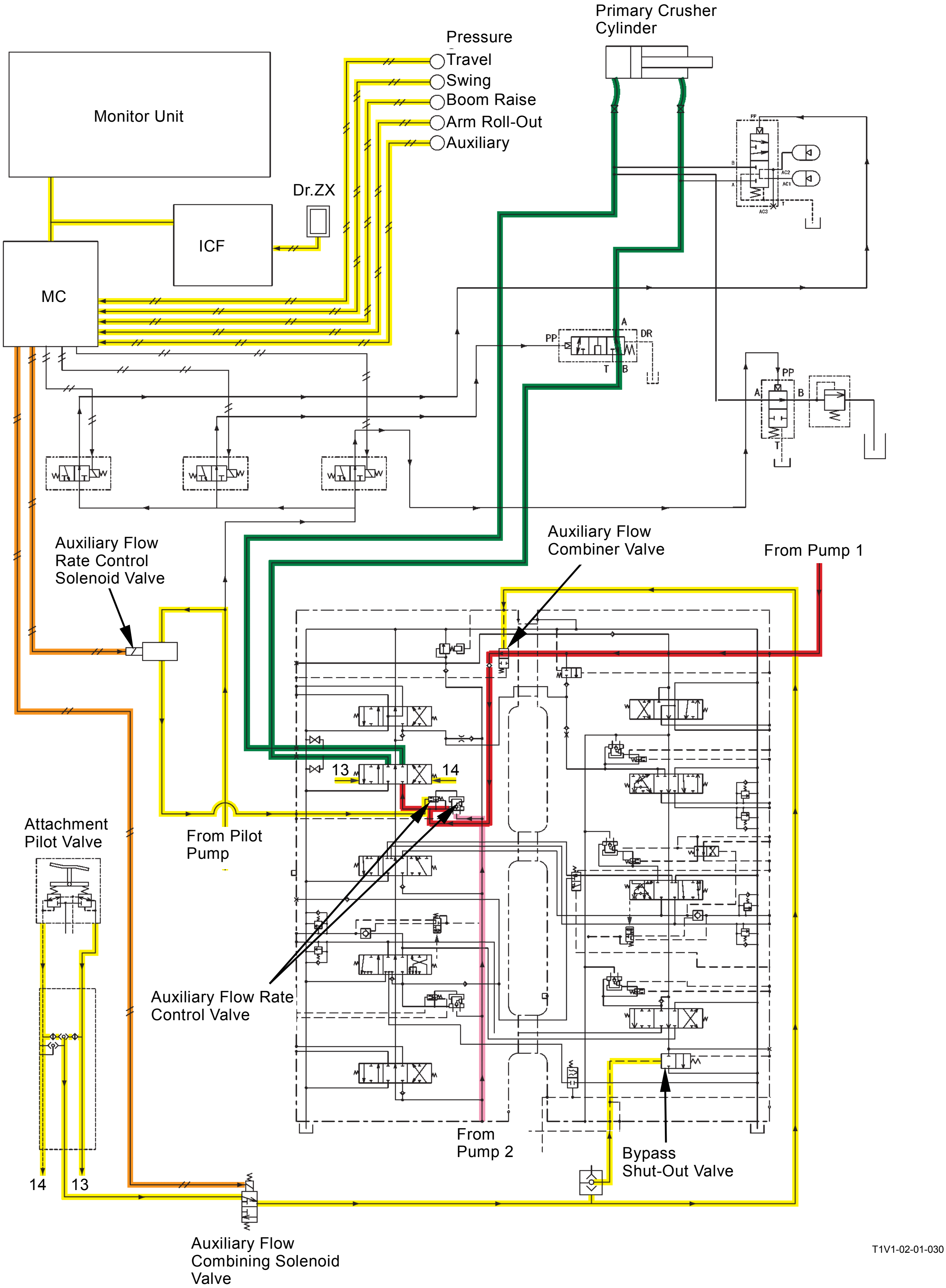
1. When the following conditions exist, MC drives the auxiliary flow rate control solenoid valve. MC controls restricted flow rate of the auxiliary flow rate control solenoid valve and reduces pressure oil which flows to the primary crusher through the auxiliary spool from pump 2.
2. As the primary crusher is heavier than the secondary crusher, restricted flow rate increases of the auxiliary flow rate control valve and gives priority to arm roll-out or arm roll-out+ boom raise during combined operation of arm roll-out or arm roll-out+ boom raise and primary crusher.

Condition:

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



T1V5-05-01-113


Primary Crusher Cylinder
Pressure
Travel
Swing
Boom Raise
Arm Roll-Out
Auxiliary
Monitor Unit
Dr.ZX
ICF
MC
Auxiliary Flow Rate Control Solenoid Valve
Auxiliary Flow Combiner Valve
From Pump 1
13
14
Attachment Pilot Valve
From Pilot Pump
Auxiliary Flow Rate Control Valve
From Pump 2
Bypass Shut-Out Valve
14
13
Auxiliary Flow Combining Solenoid Valve
T1V1-02-01-030

OTHER CONTROLS

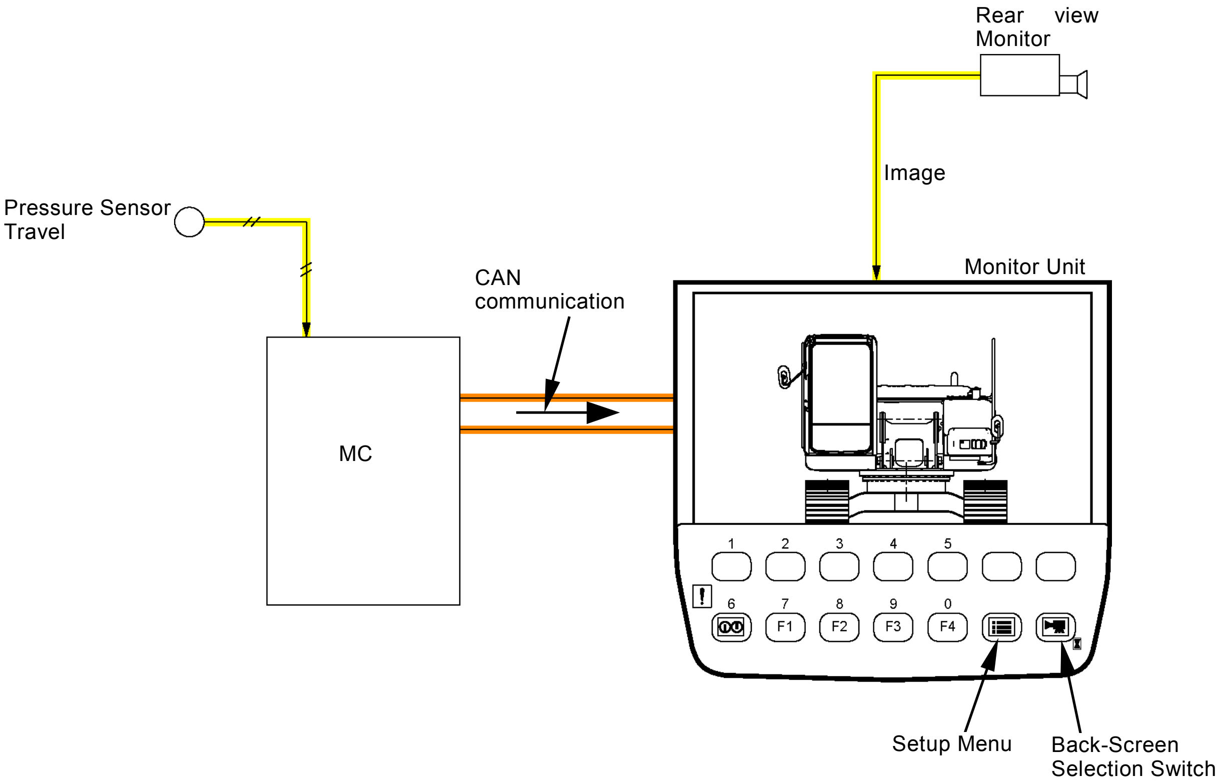
Rear View Image Selection Control

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

Operation:

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

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



T1V1-02-01-100

Work Mode Control

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

- Digging Mode:
  Normal control is performed.

- Front Attachment Mode:
  Functions only when the attachment in the optional kit is operated.
  In response to attachment control operation, increasing or decreasing of engine speed (refer to T2-2-24, 26.), increasing or decreasing pump flow rate (refer to T2-2-36, 38.) and valve selection (refer to T2-2-58 to 63) are controlled.
  The engine speed and pump flow rate control settings are made by using Dr. ZX.

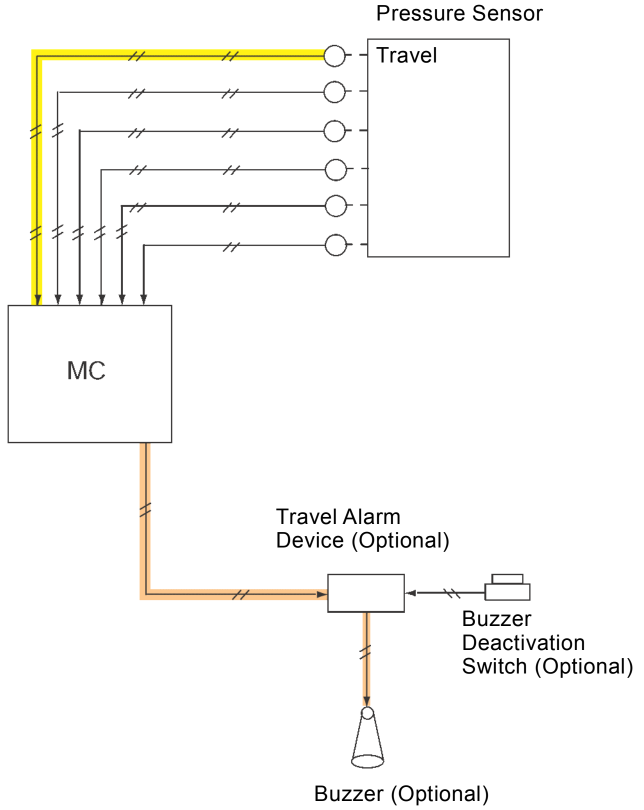
NOTE: As the attachment mode, one to five attachment modes can be selected from breaker 1 to 5, secondary crusher 1 to 5, crusher 1 to 5 and vibrating hammer 1 to 5 by using Dr. ZX

Travel Alarm Control (Only Machine Equipped with Optional Parts)

Purpose: Sounds the buzzer (optional) while traveling.

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

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



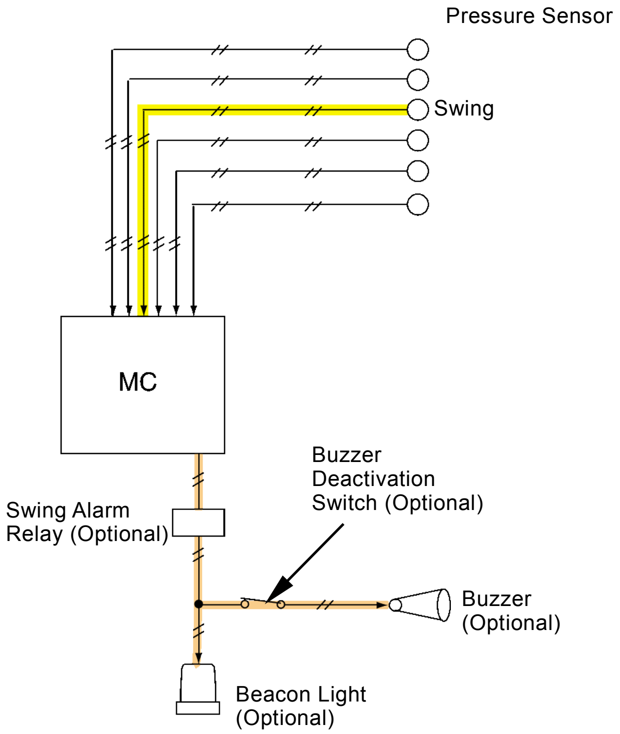
T178-02-01-025

Swing Alarm Control (Only Machines Equipped with Optional Parts)

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

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

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



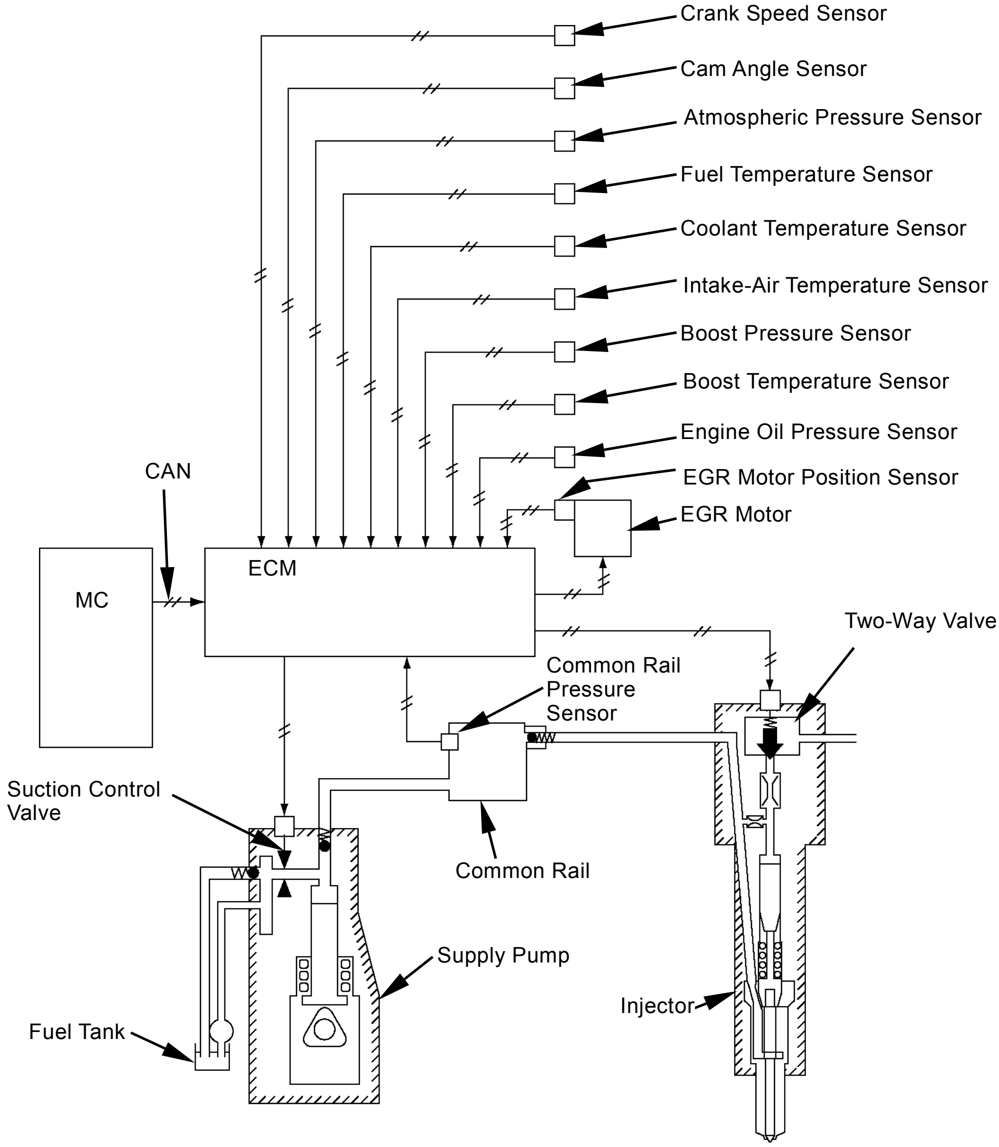
T178-02-01-026

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.



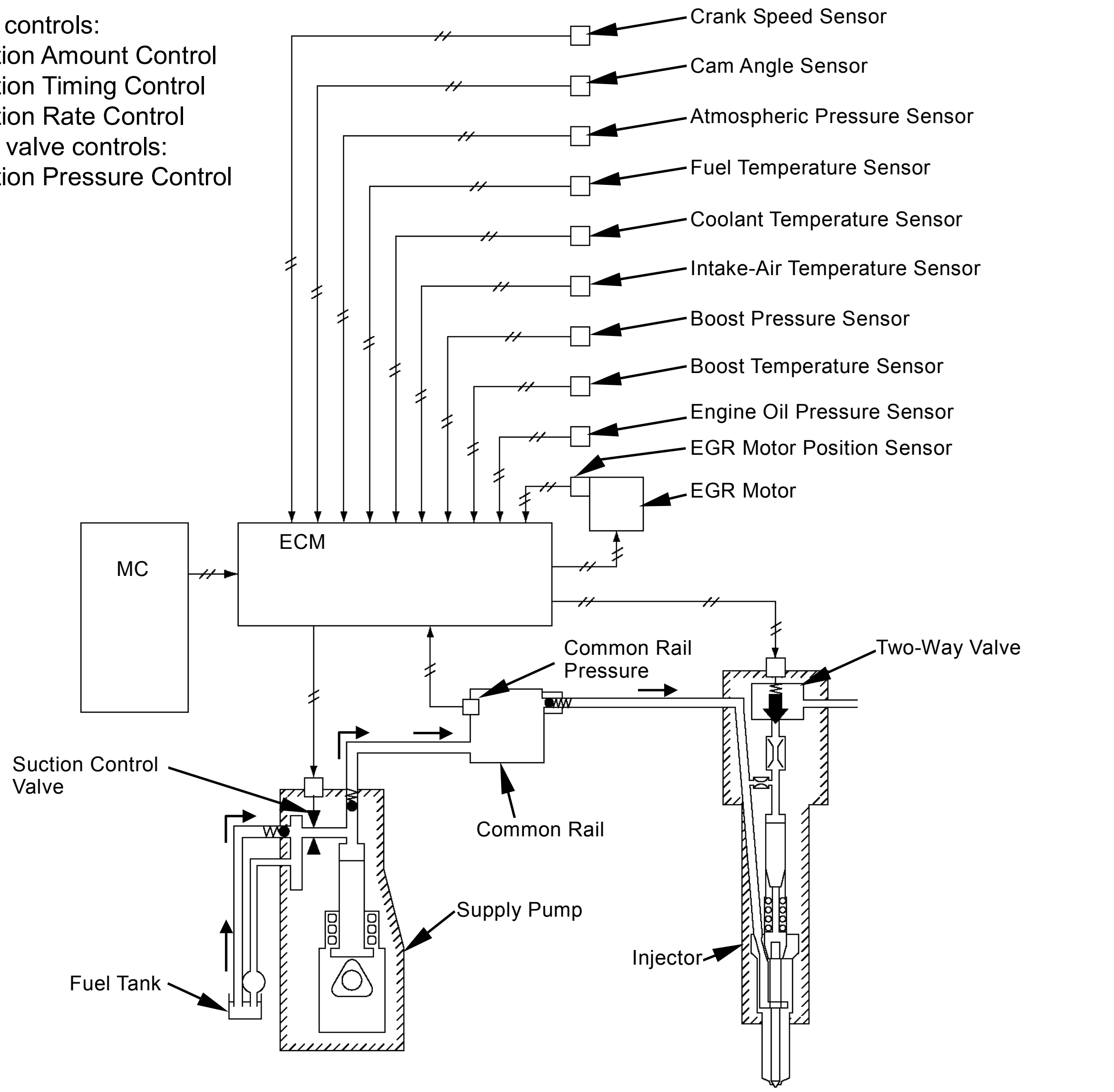
T1GR-02-02-001

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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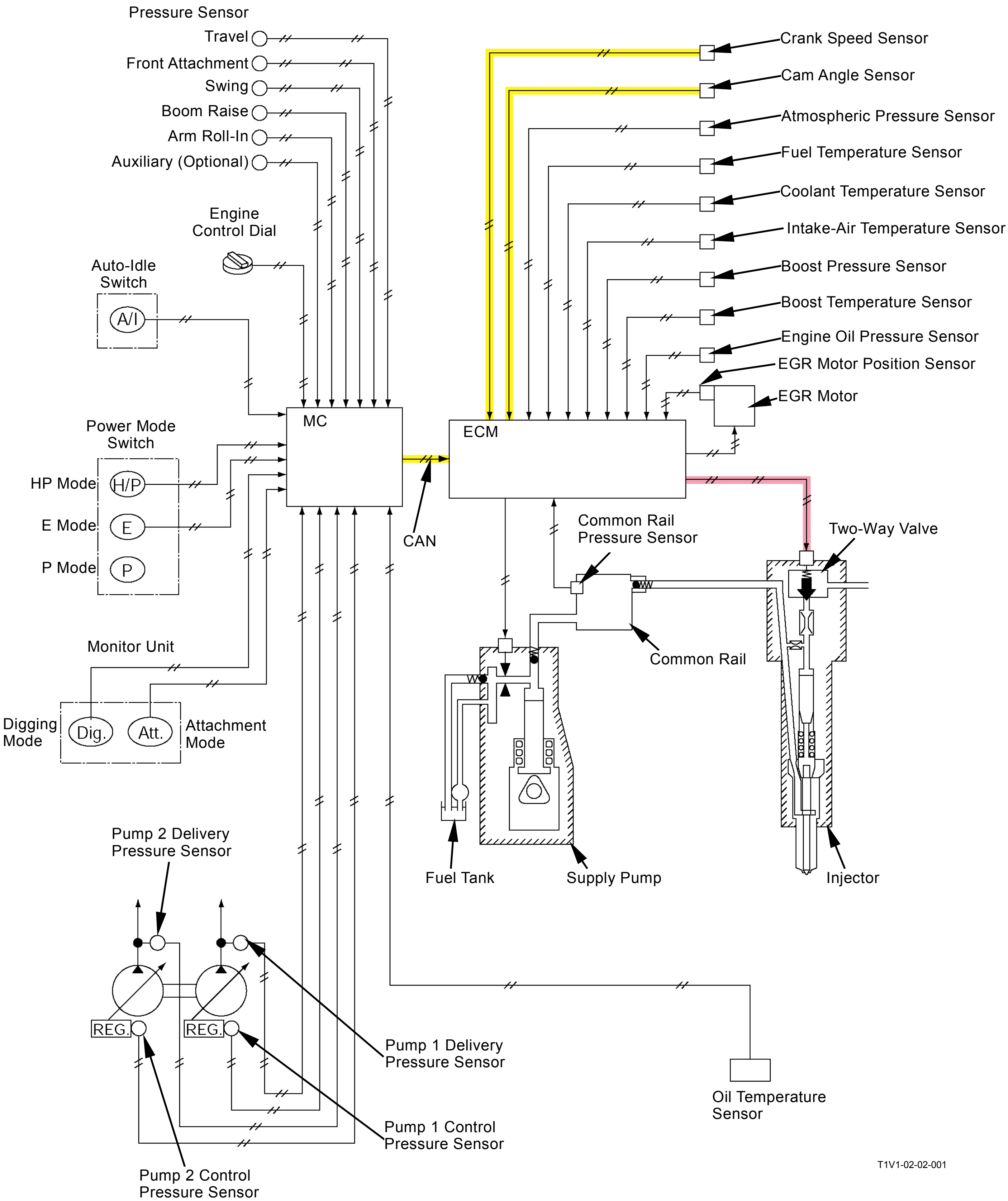
Fuel Injection Amount Control

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.

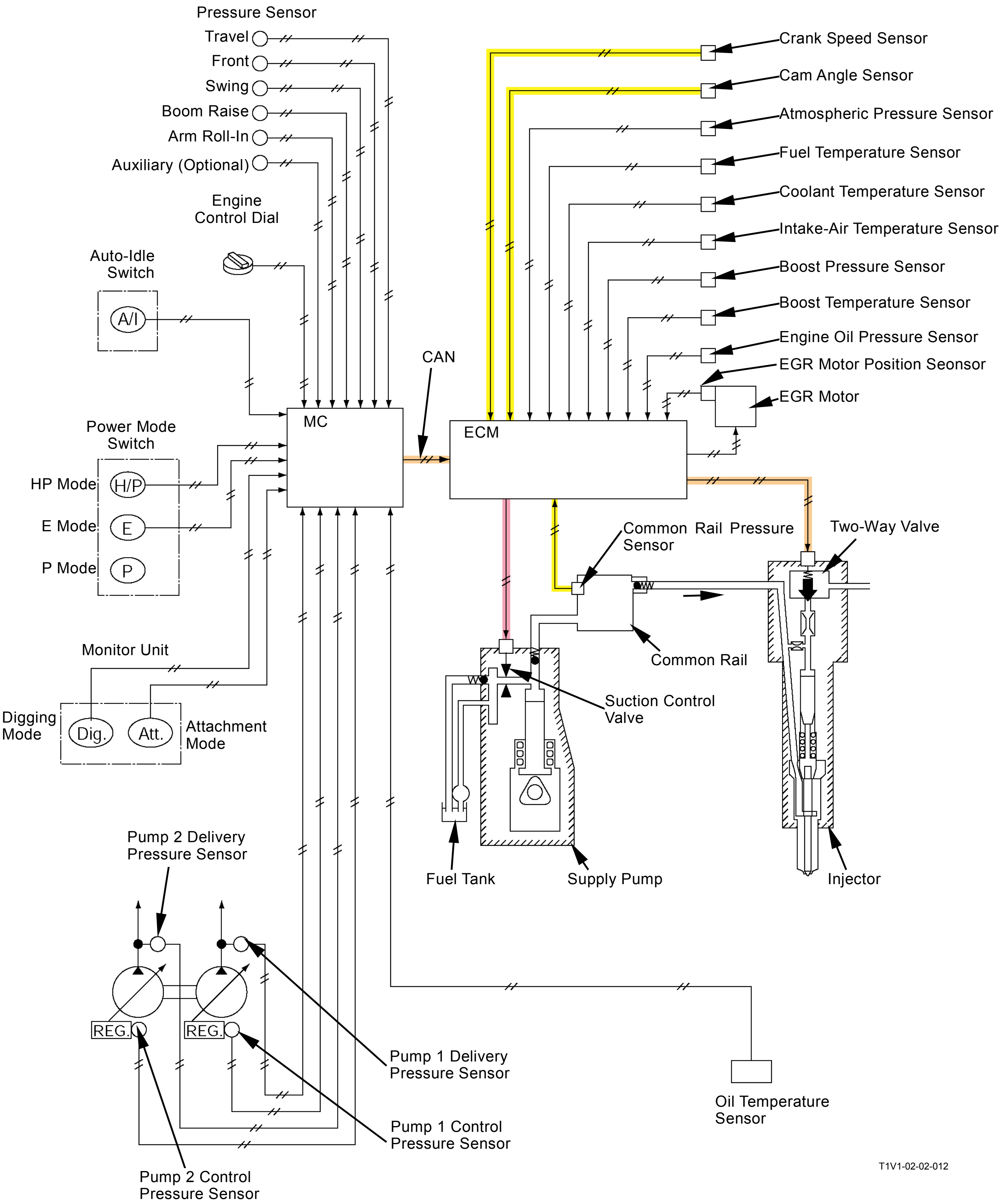

Pressure Sensor
Travel
Front Attachment
Swing
Boom Raise
Arm Roll-In
Auxiliary (Optional)
Engine Control Dial
Auto-Idle Switch
A/I
MC
ECM
CAN
Power Mode Switch
HP Mode
H/P
E Mode
E
P Mode
P
Monitor Unit
Digging Mode
Dig.
Att.
Attachment Mode
Pump 2 Delivery Pressure Sensor
REG.
REG.
Pump 1 Delivery Pressure Sensor
Pump 1 Control Pressure Sensor
Pump 2 Control Pressure Sensor
Crank Speed Sensor
Cam Angle Sensor
Atmospheric Pressure Sensor
Fuel Temperature Sensor
Coolant Temperature Sensor
Intake-Air Temperature Sensor
Boost Pressure Sensor
Boost Temperature Sensor
Engine Oil Pressure Sensor
EGR Motor Position Sensor
EGR Motor
Common Rail Pressure Sensor
Two-Way Valve
Common Rail
Fuel Tank
Supply Pump
Injector
Oil Temperature Sensor
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.

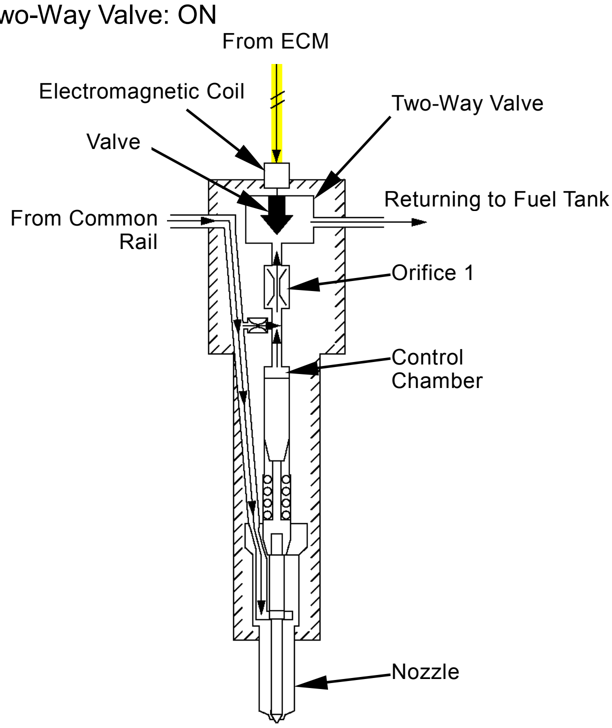
Fuel Injection Rate Control

Purpose: Improves combustion in the engine cylinder.

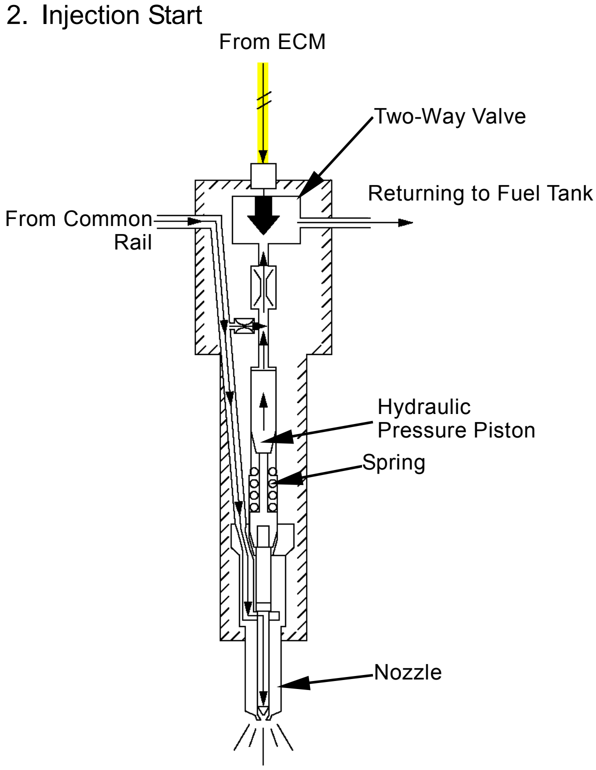
Operation:
1. The injector injects small amount of fuel (pilot injection) first and ignites.
2. After igniting, the injector injects fuel (main injection). ECM controls fuel injection timing and fuel injection amount by turning the two-way valve in injector ON/OFF.

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.

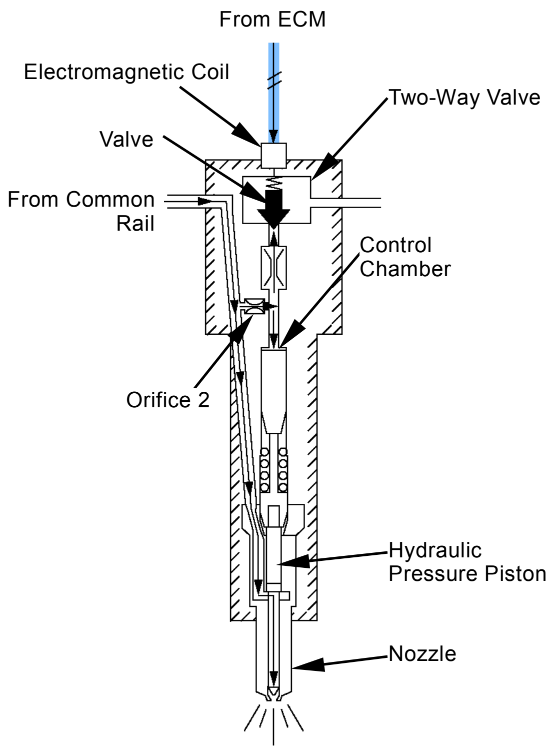
1. Two-Way Valve: ON



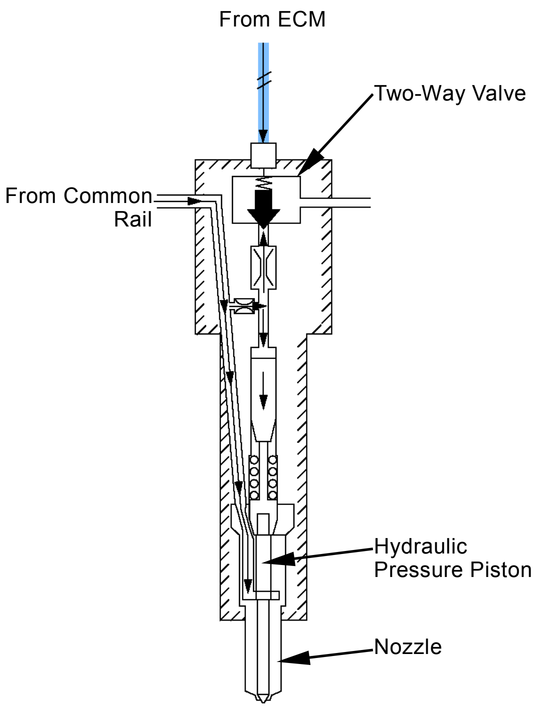
2. Injection Start



3. Two-Way Valve: OFF



4. Injection Stop



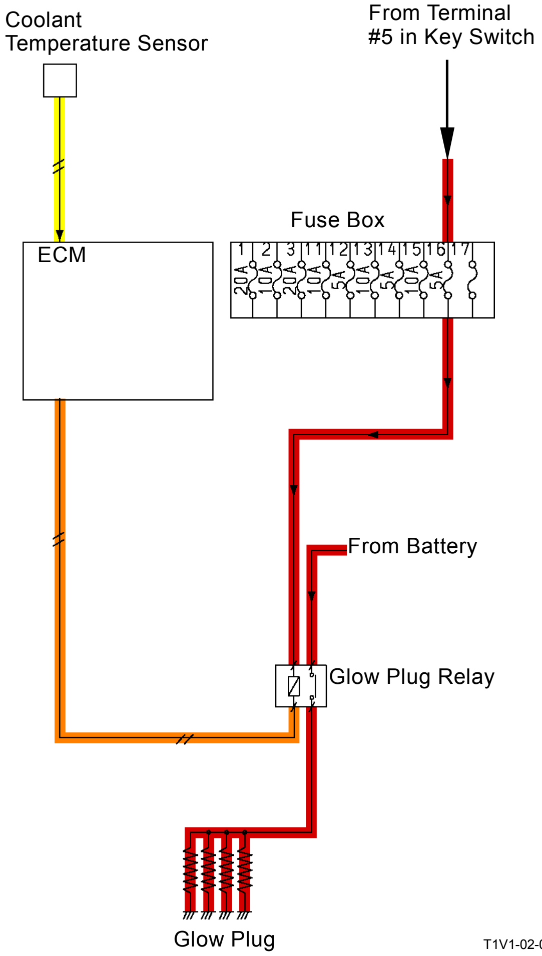
T1GR-02-02-012

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.



T1V1-02-02-003

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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

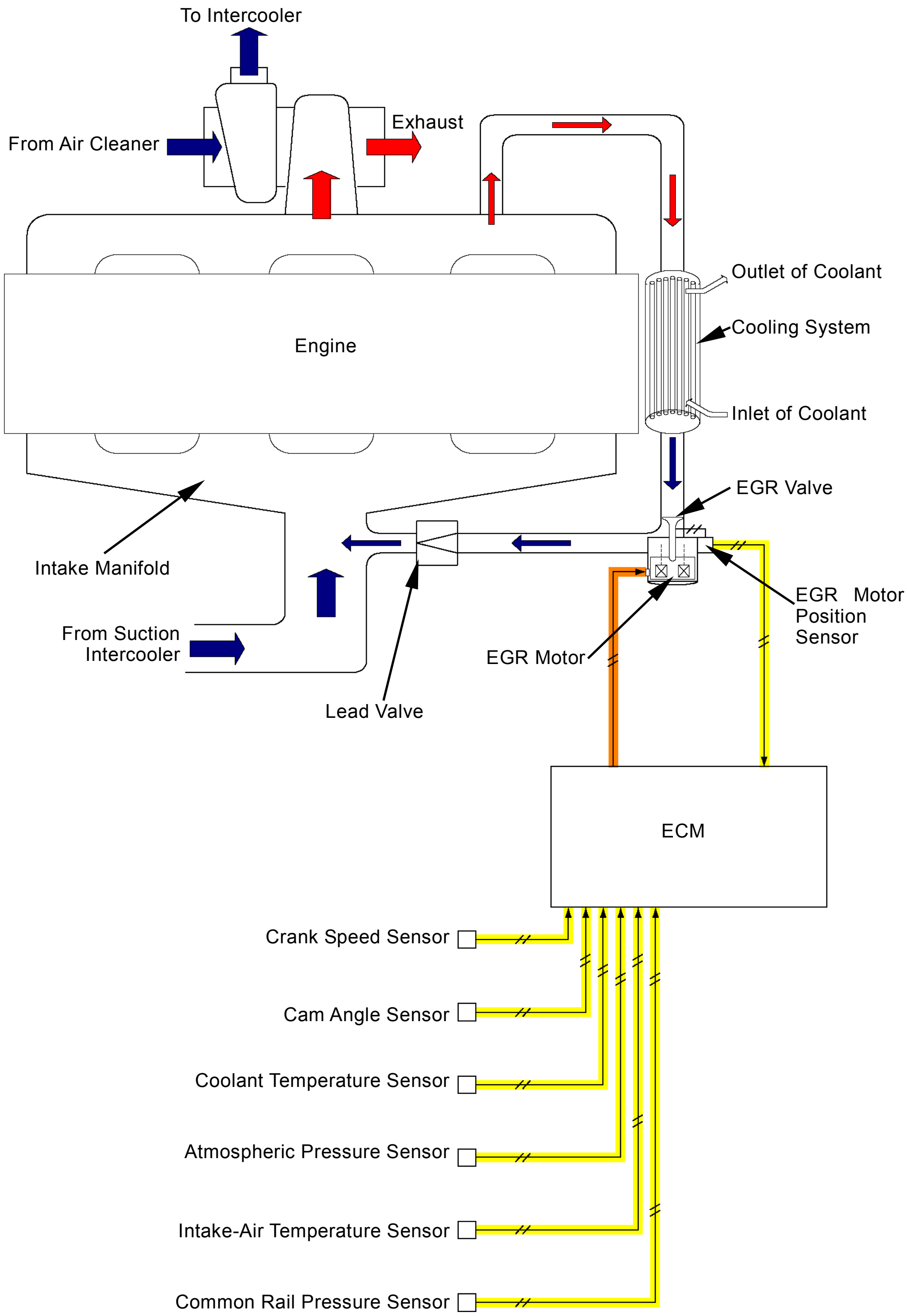
1. ECM decides EGR gas amount according to engine speed, fuel flow rate, coolant temperature, atmospheric pressure and intake-air temperature.
2. ECM drives EGR motor, opens EGR valve and sends EGR gas to the intake manifold in response to engine condition so that EGR gas is combined with intake-air.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

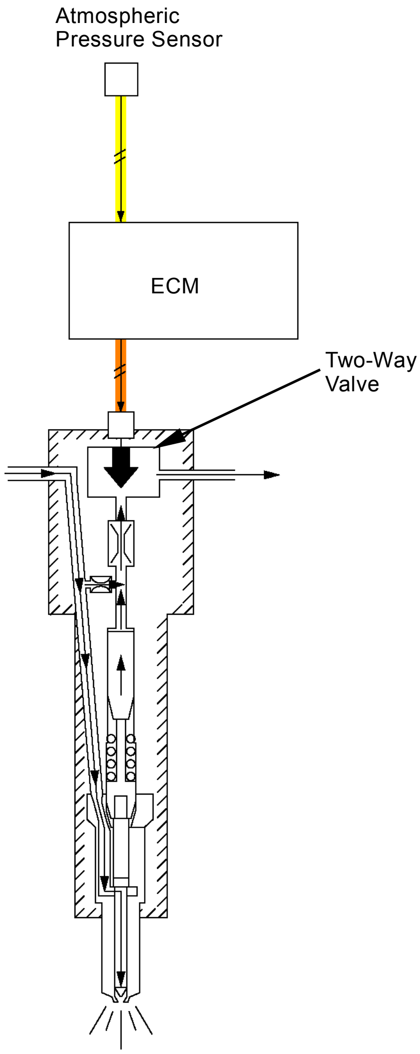


T1V1-02-02-007

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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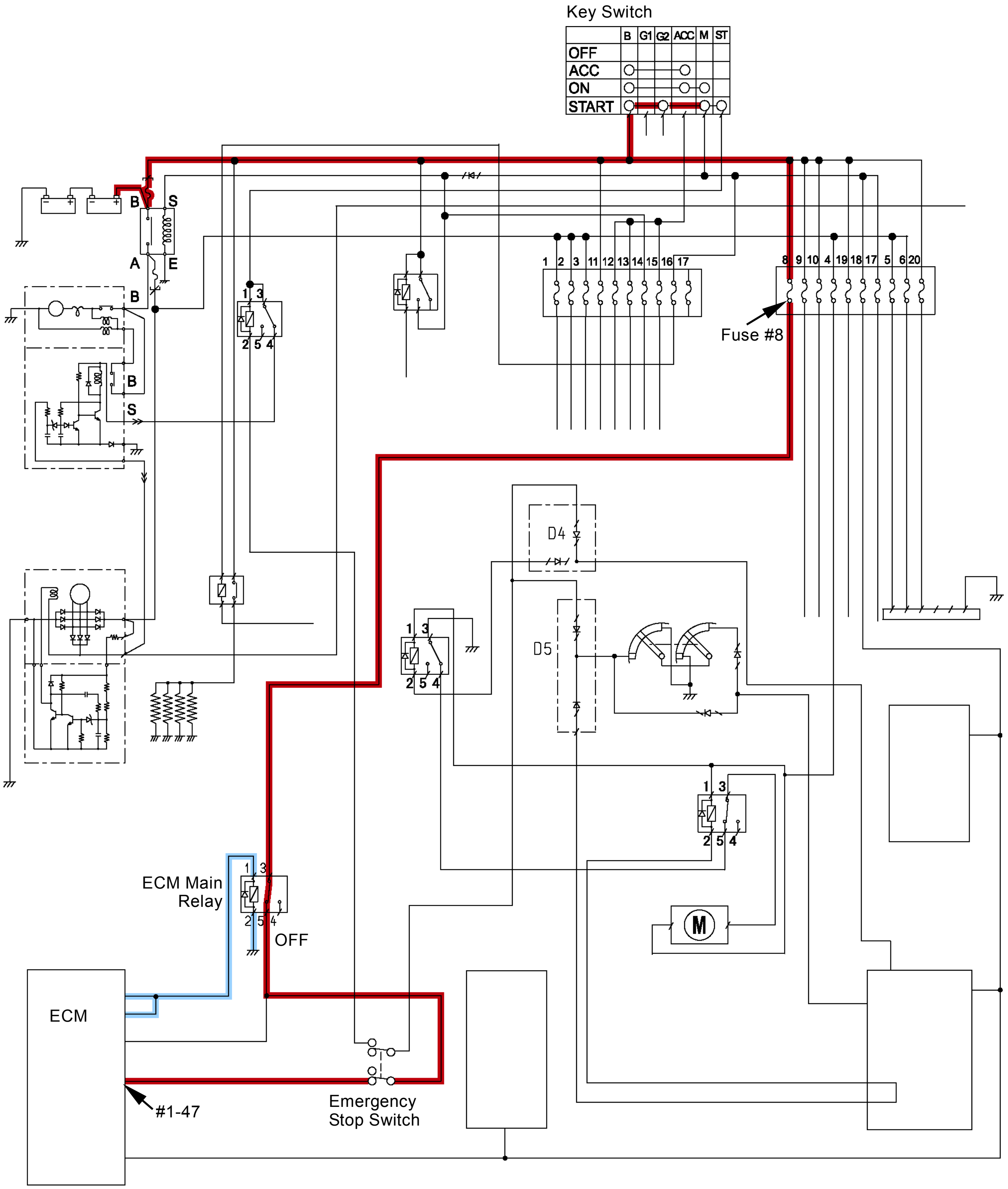
ENGINE STOP CONTROL

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.



T1V1-02-05-010

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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)

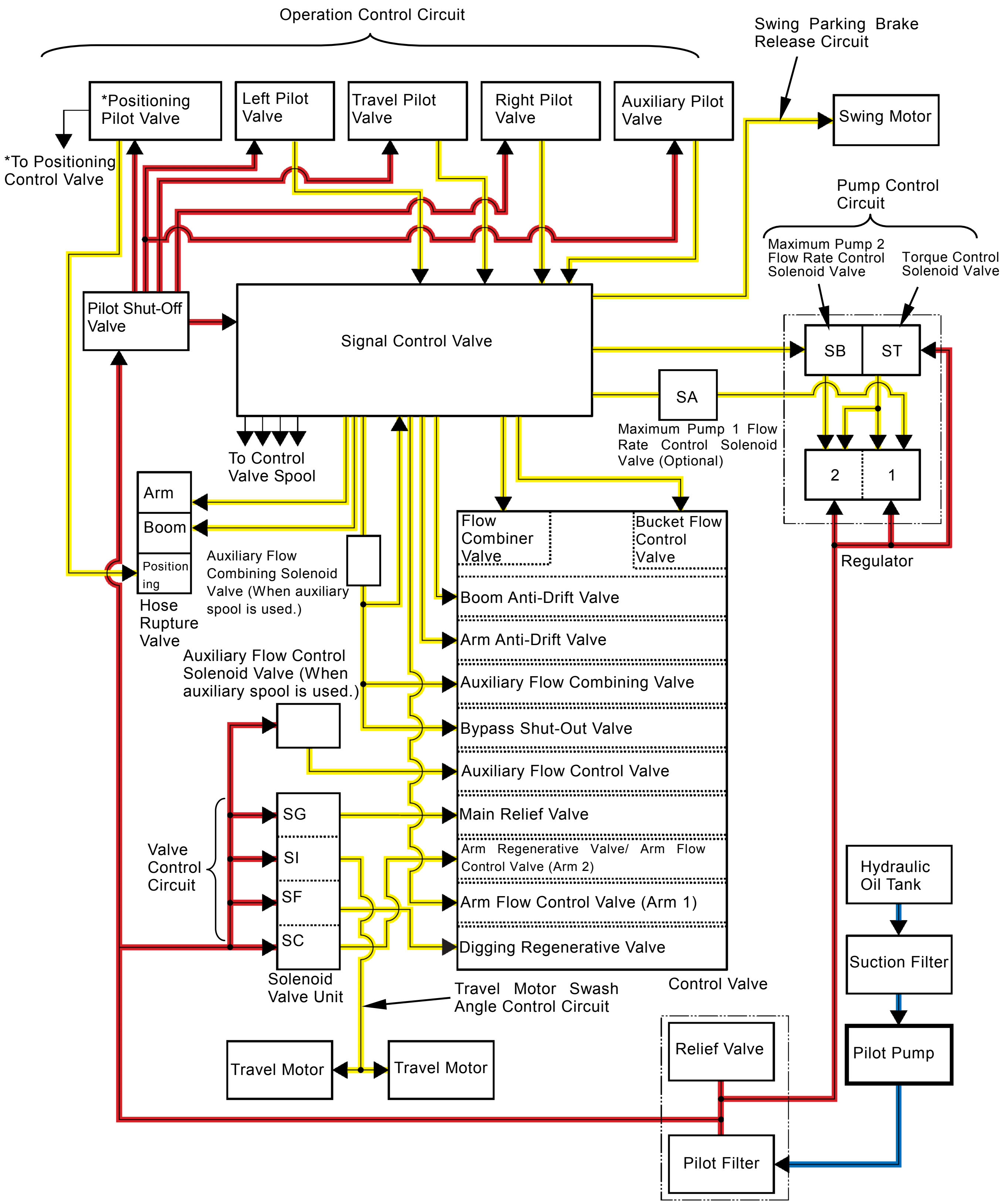
Pilot Circuit:

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).

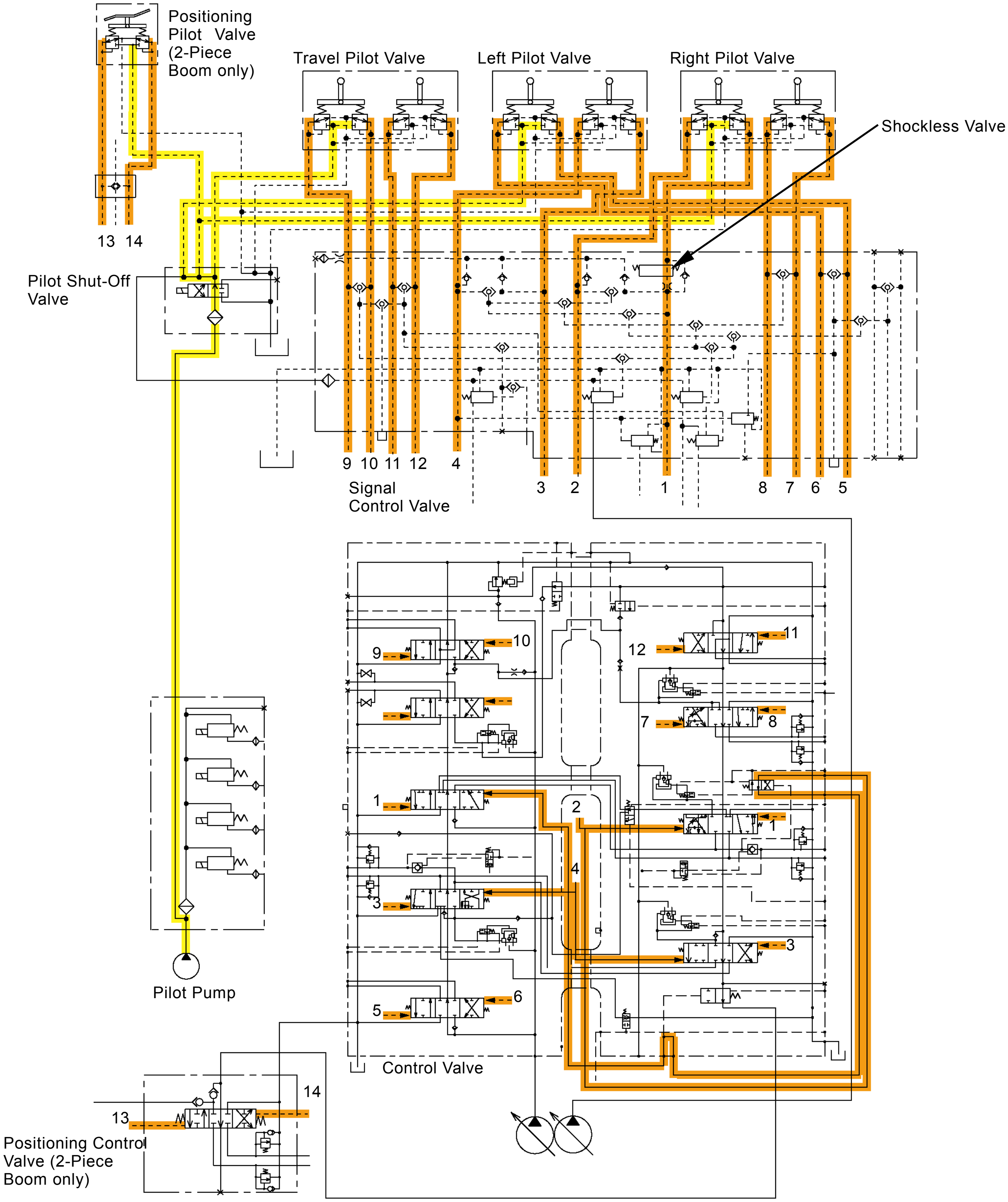


T1V1-02-03-104

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.)



T1V1-02-03-011

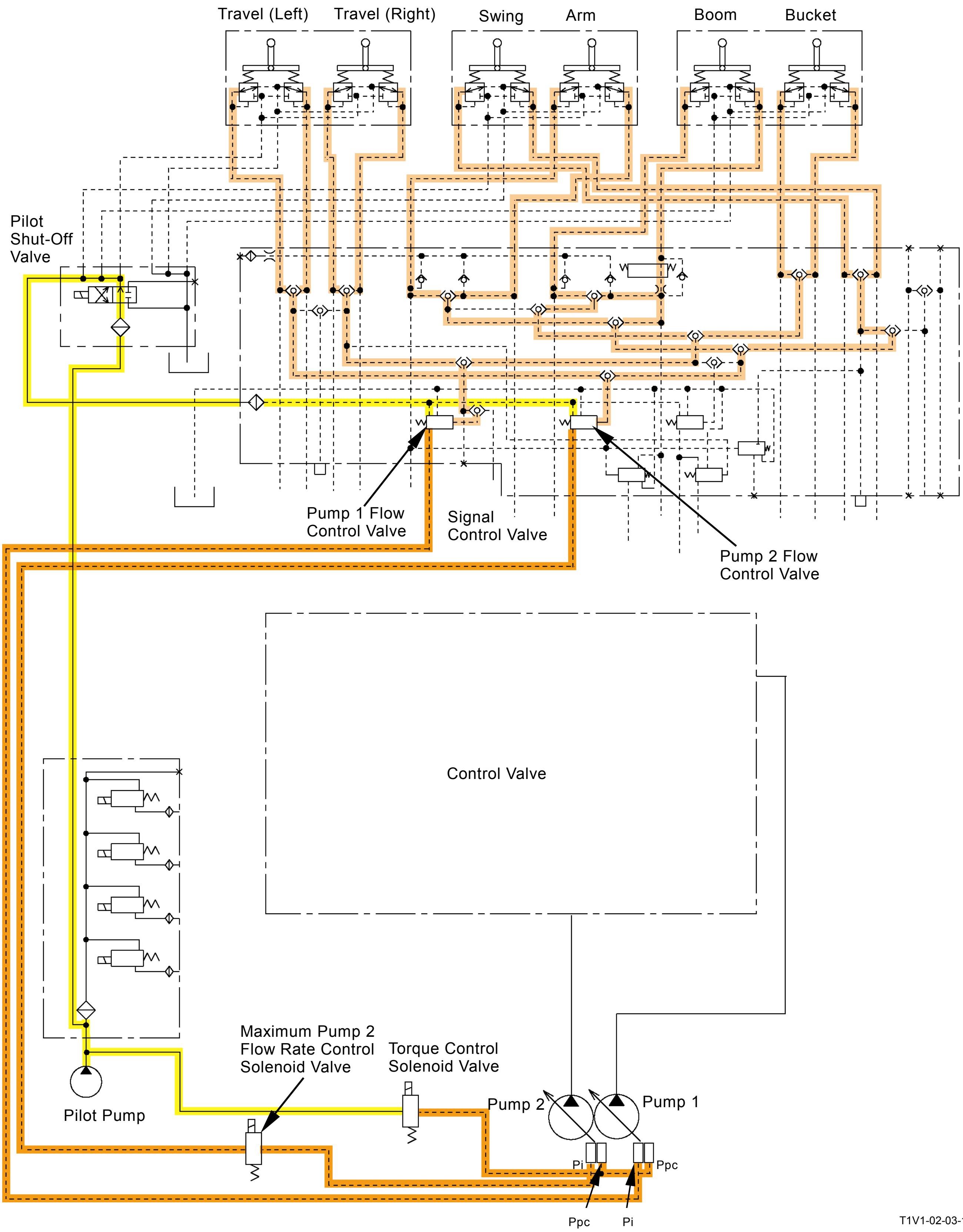
1 – Boom Raise
2 – Boom Lower
3 – Arm Roll-Out
4 – Arm Roll-In
5 - Left Swing
6 - Right Swing
7 - Bucket Roll-In
8 - Bucket Roll-Out
9 - Left Travel Forward
10 - Left Travel Reverse
11 - Right Travel Forward
12 - Right Travel Reverse
13 - Positioning Lower
14 - Positioning Raise

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.



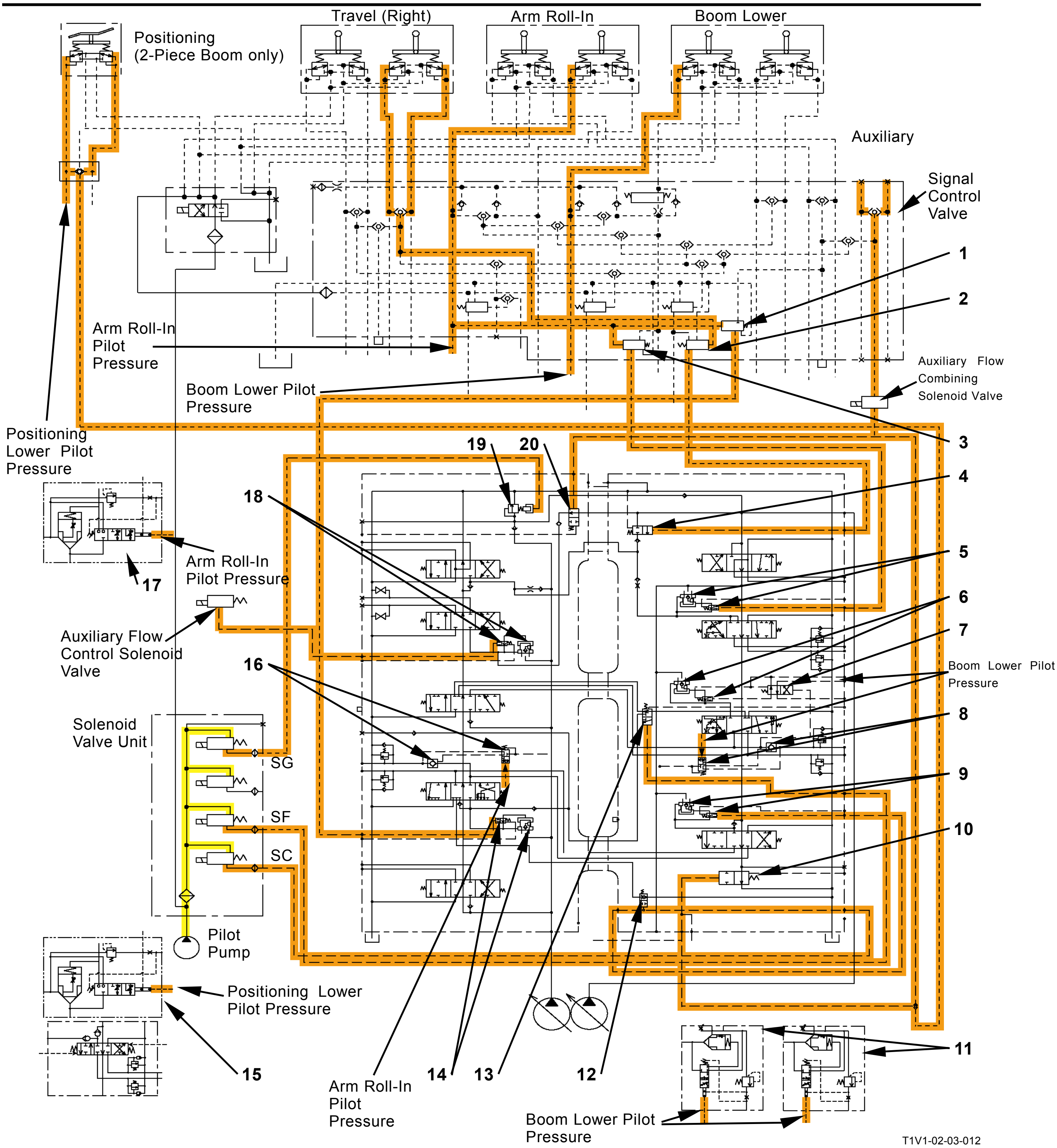
T1V1-02-03-100

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 (19) (increasing the set-pressure)
  - Auxiliary Flow Control Solenoid Valve: Auxiliary Flow Control Valve (18) (When the auxiliary spool is used.)
  - Auxiliary Flow Combining Selection Solenoid Valve: Boom, Arm and Bucket Pilot Pressure
  - Flow Combiner Valve Control Spool: Flow Combiner Valve (4)
  - Bucket Flow Control Valve Control Spool: Bucket Flow Control Valve (5)
  - Arm Flow Control Valve Control Spool: Arm Flow Control Valve (Arm 1) (14)
  - Positioning Lower Pilot Pressure (2-Piece Boom), Bypass Shut-Out Valve (10), Hose Rupture Valve (Optional) (15)
  - Positioning Raise Pilot Pressure (2-Piece Boom), Bypass Shut-Out Valve (10)

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



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 - Auxiliary Flow Control Valve
19 - Main Relief Valve
20 - Auxiliary Flow Combining Valve

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

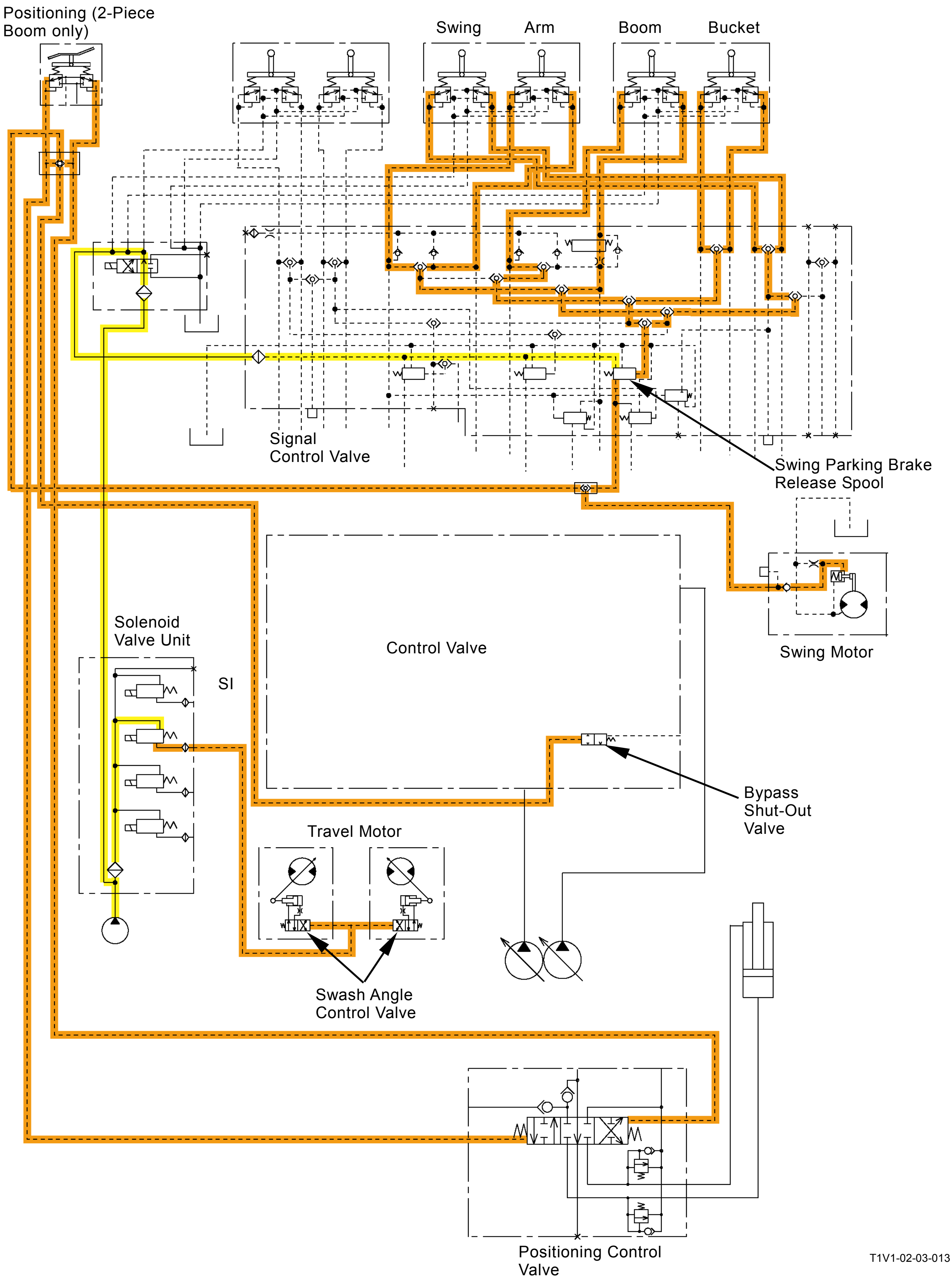
- When operating the front attachment or swing, pilot pressure SH is selected by the shuttle valve in signal control valve and shifts the swing parking brake release spool.
- As a result, the release signal pressure is supplied to the swing motor and the swing parking brake is released.

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.

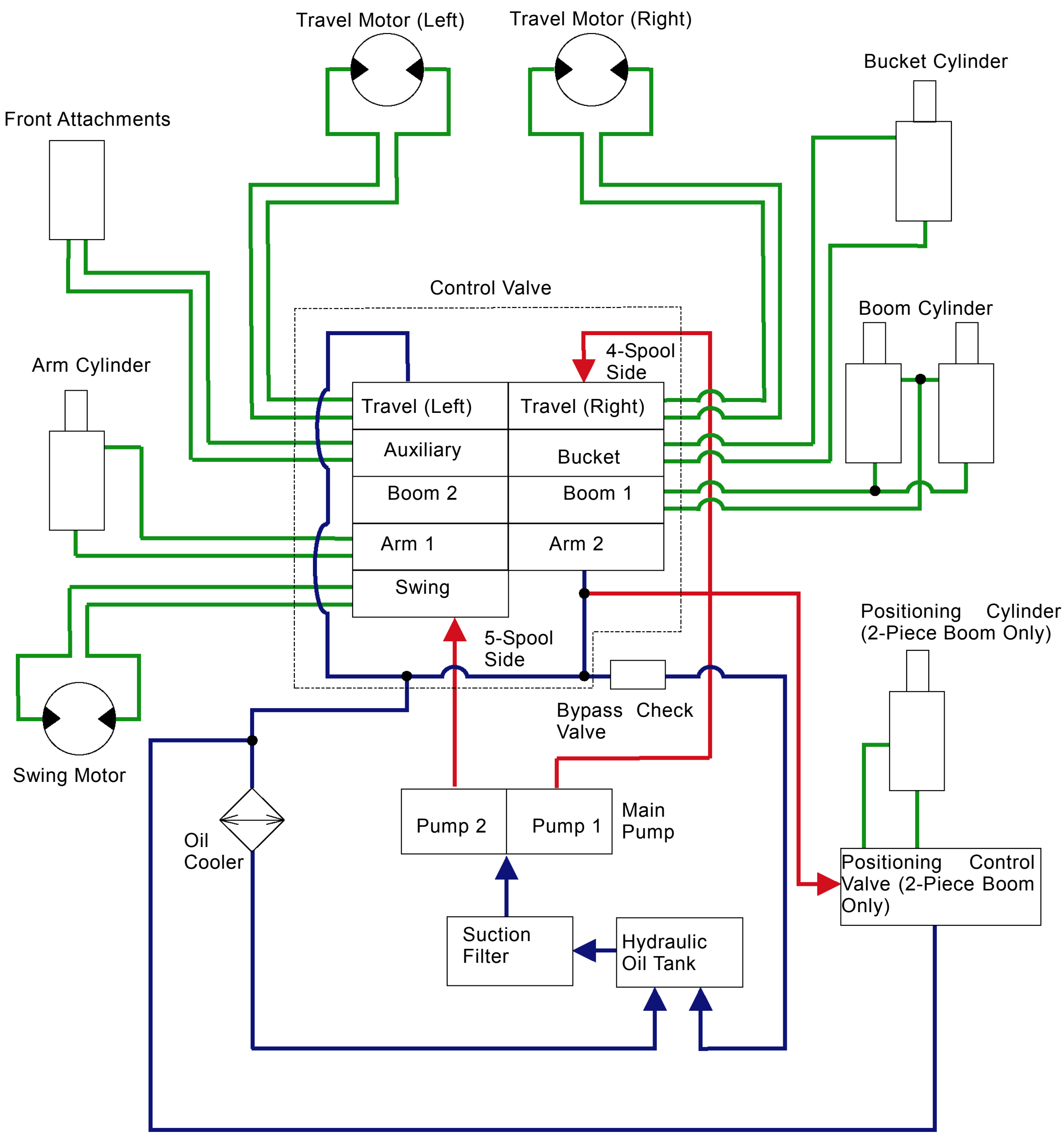


T1V1-02-03-013

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.



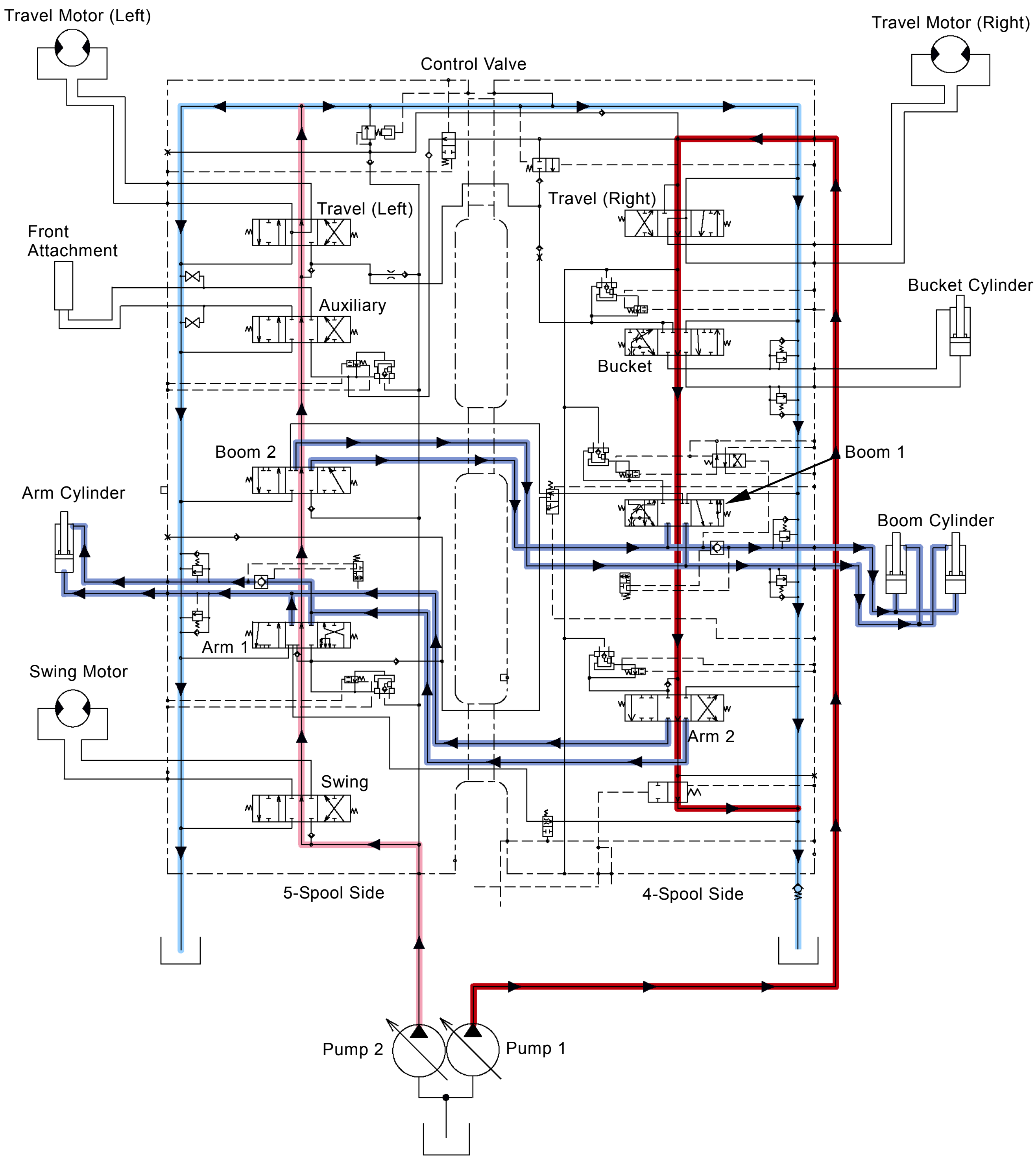
T1V1-02-03-103

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

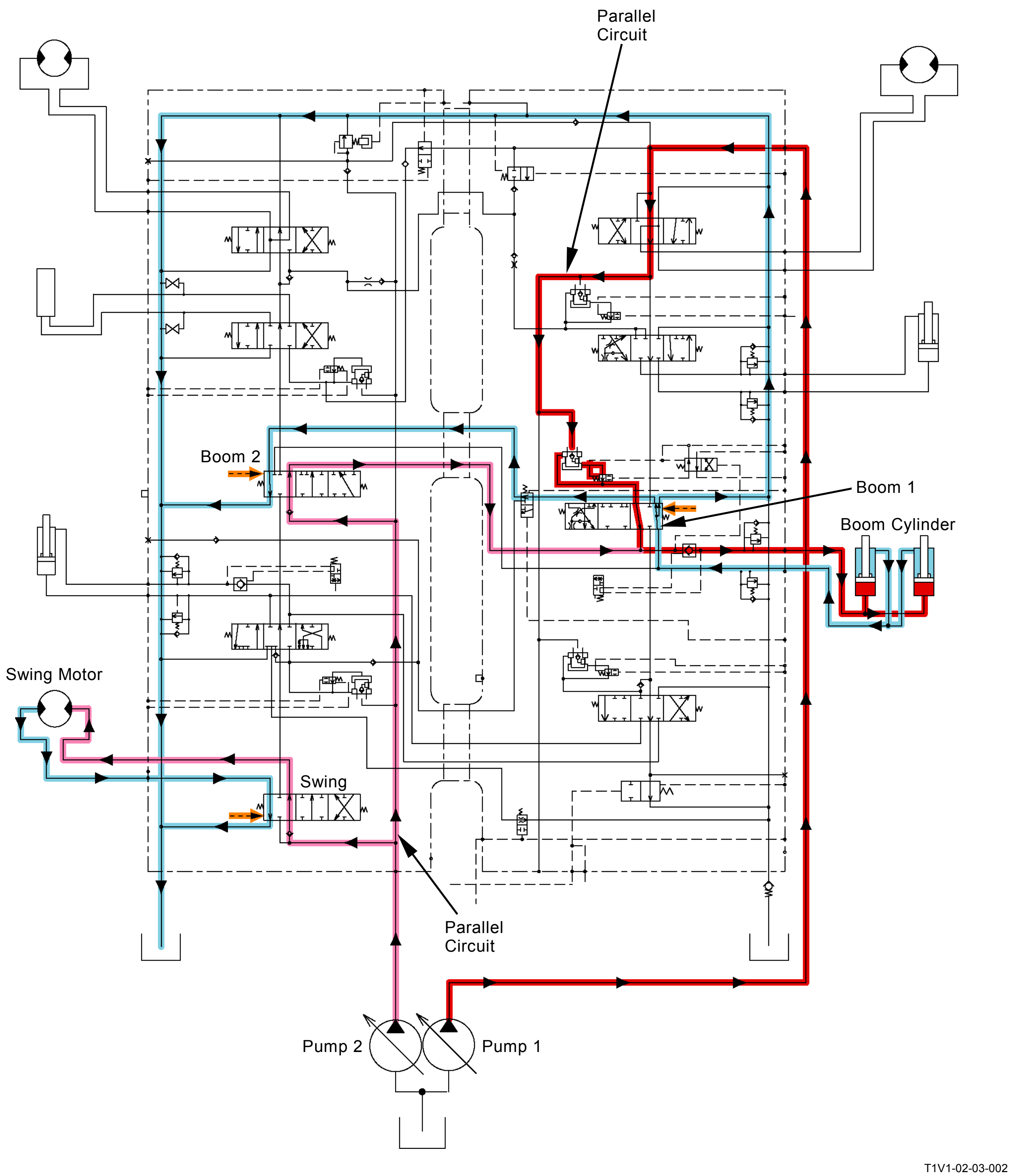
- Pressure oil from pump 1 flows to each spool of right travel, bucket, boom 1 and arm 2 through the 4-spool control valve.
- Pressure oil from pump 2 flows to each spool of swing, arm 1, boom 2, auxiliary and left travel through the 5-spool control valve.
- The boom and arm are actuated by pressure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



T1V1-02-03-001

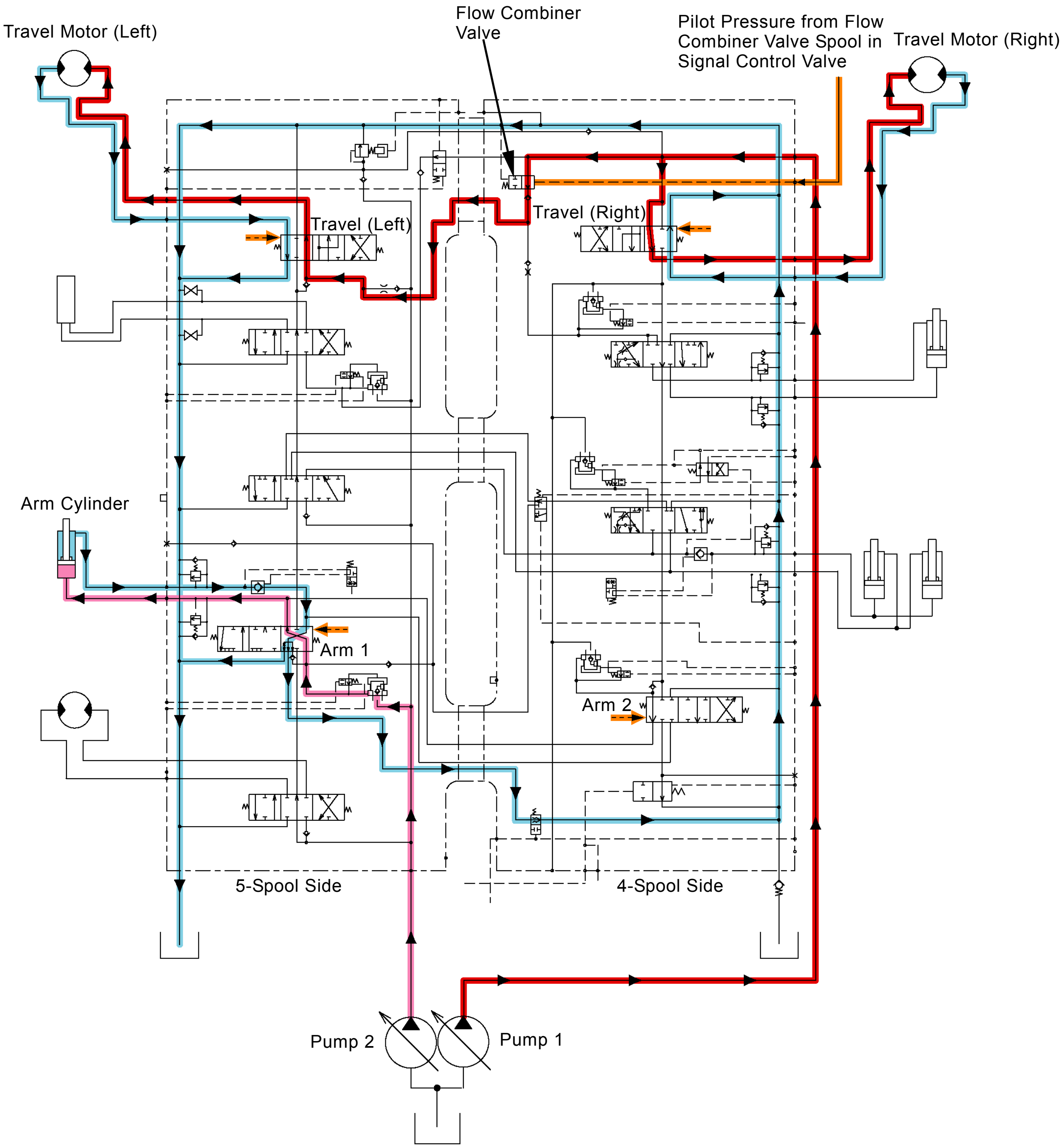
Combined Operation Circuit

- 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.


Parallel
Circuit
Boom 2
Boom 1
Boom Cylinder
Swing Motor
Swing
Parallel
Circuit
Pump 2
Pump 1
T1V1-02-03-002

- 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.



T1V1-02-03-003

Positioning Circuit (2-Piece Boom Only)
Neutral Circuit

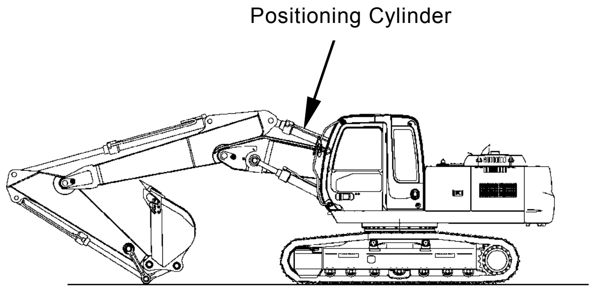
- When the positioning lever is in neutral, pressure oil from pump 1 returns to the hydraulic oil tank through the control valve.

Single Operation Circuit

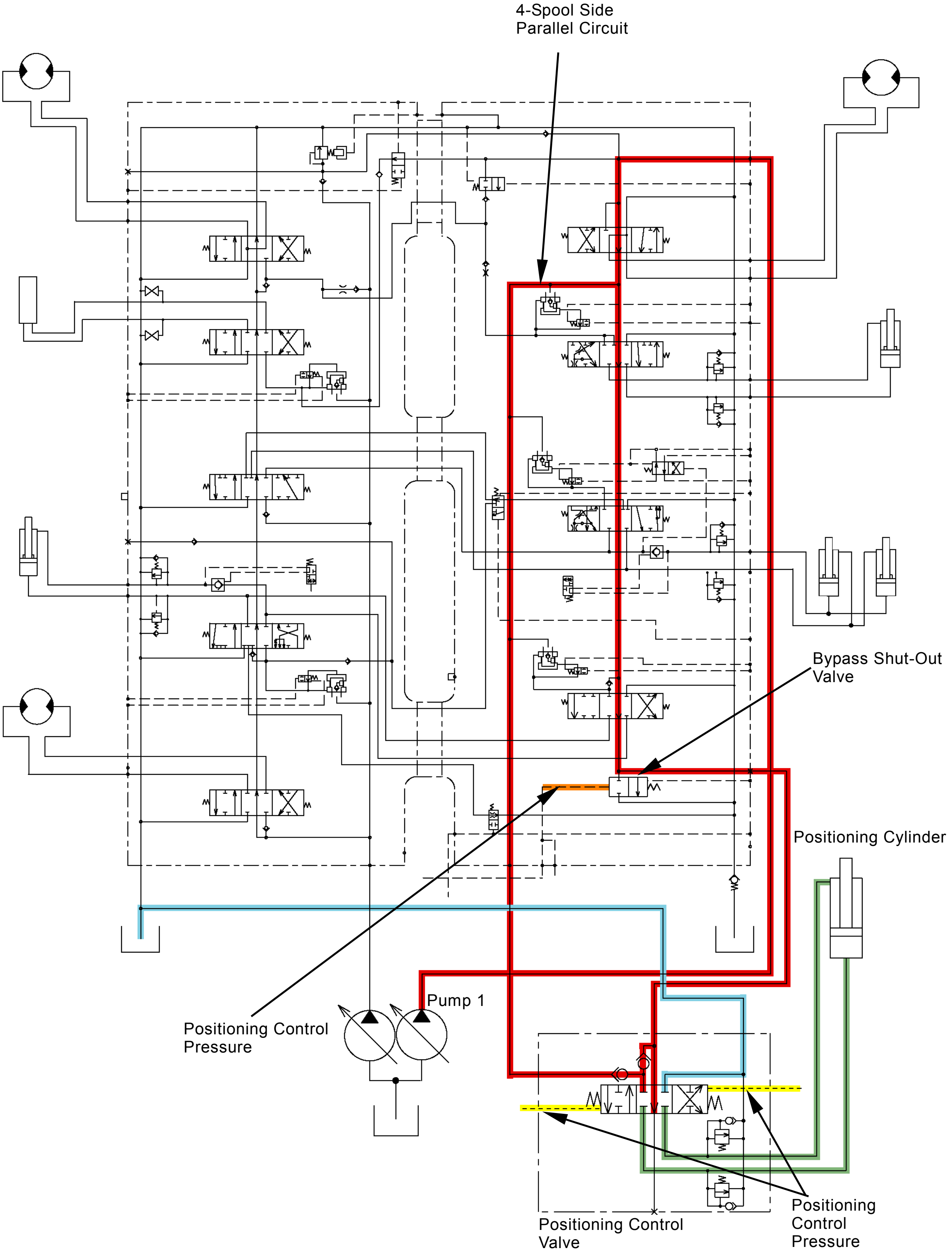
- During positioning operation, the spools of bypass shut-out valve and positioning control valve are shifted.
- Pressure oil from pump 1 flows to the spool in positioning control valve and moves the positioning cylinder.

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

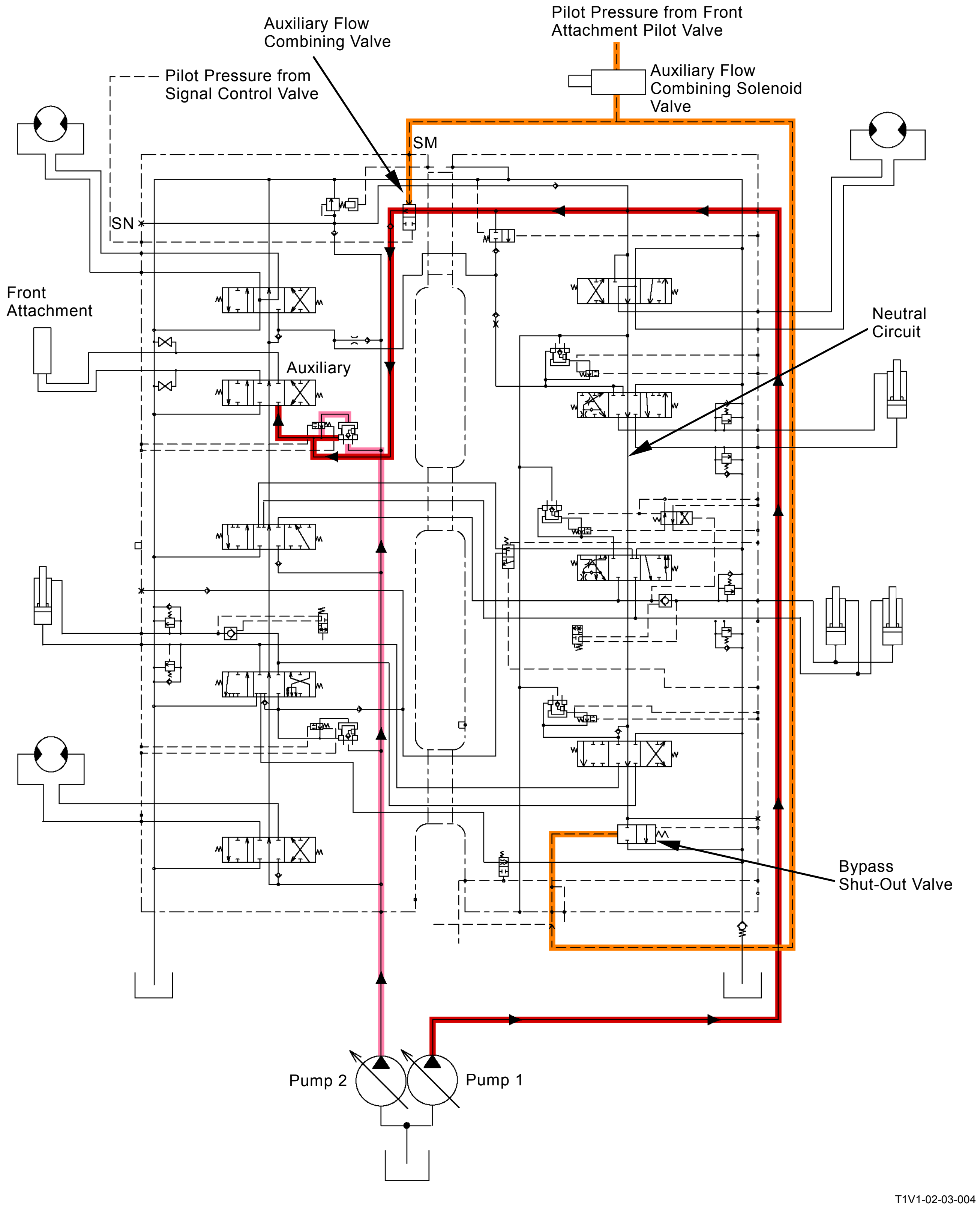


T1V1-02-03-014

Auxiliary Circuit

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

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


Pilot Pressure from Front Attachment Pilot Valve
Auxiliary Flow Combining Valve
Pilot Pressure from Signal Control Valve
Auxiliary Flow Combining Solenoid Valve
SM
SN
Front Attachment
Auxiliary
Neutral Circuit
Bypass Shut-Out Valve
Pump 2
Pump 1
T1V1-02-03-004

BOOM LOWER METER-IN CUT CONTROL

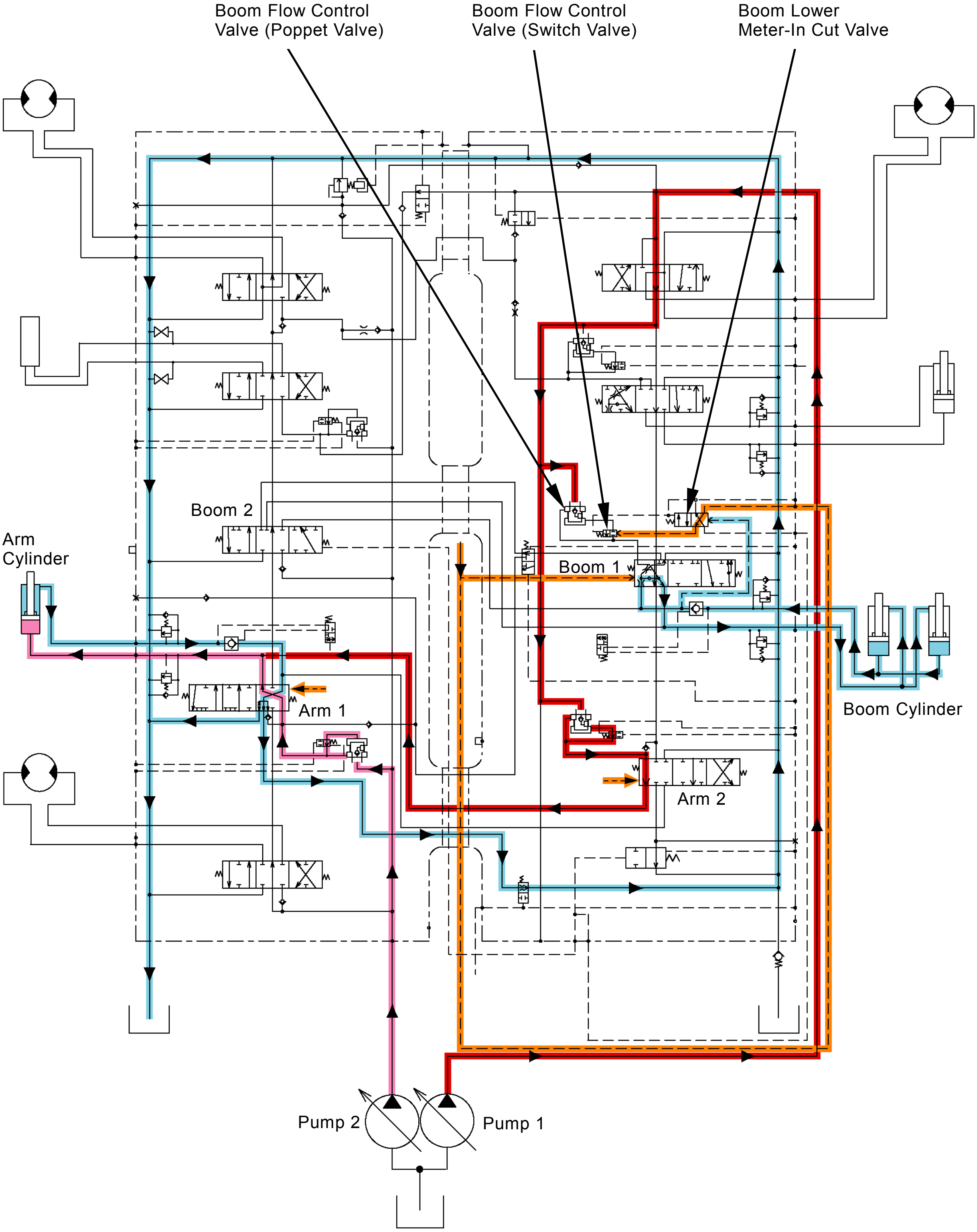
Purpose: During combined operation of boom lower and arm, bucket, swing or travel with the front attachment above the ground, pressure oil to the boom cylinder from the pump is cut, the boom falls due to own weight by using the regenerative circuit, pressure oil is used for other actuators and the control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

Operation:

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

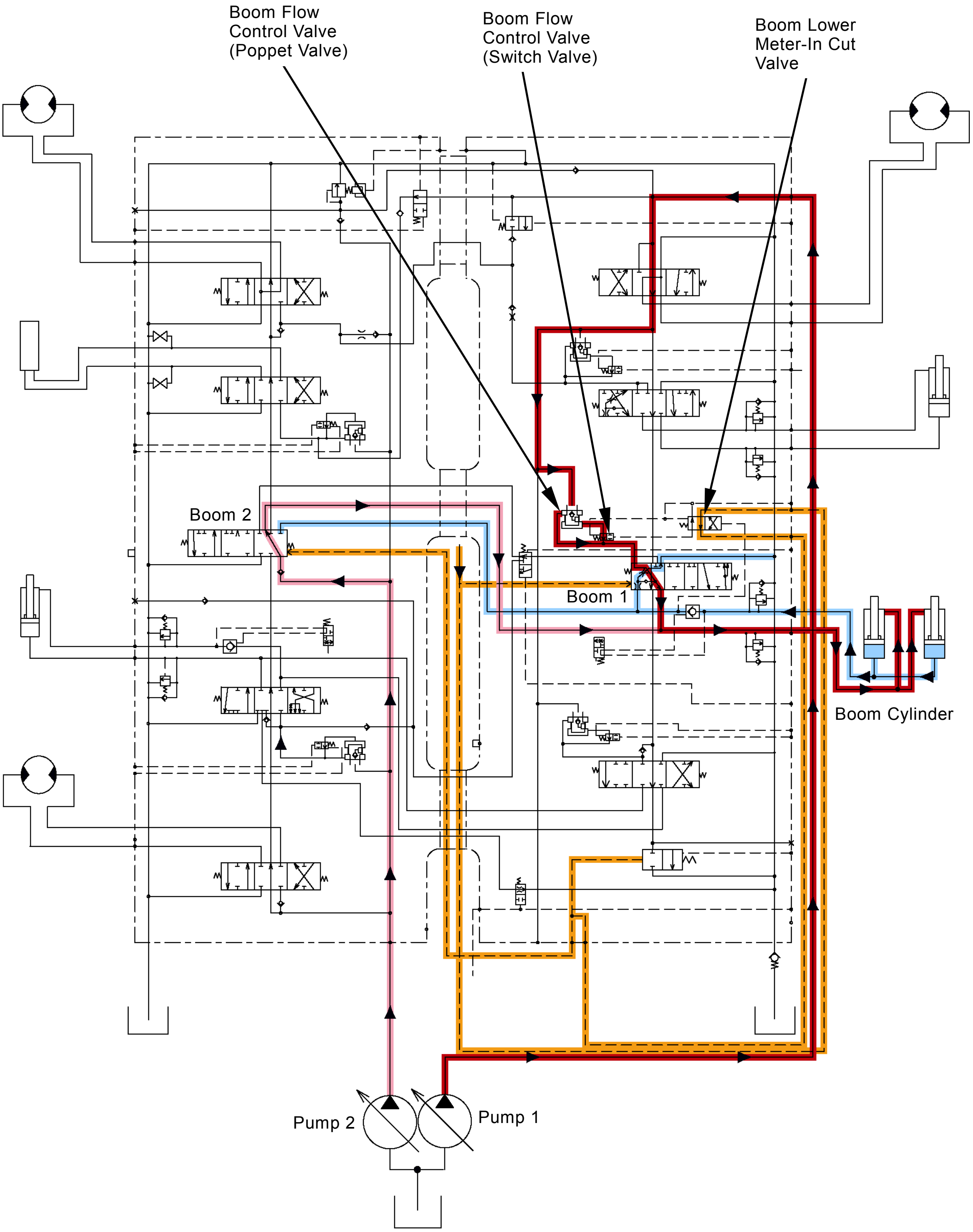
1. During combined operation of boom lower and other actuators with the boom raised, the boom lower meter-in cut valve is shifted by the boom cylinder bottom pressure. As boom lower pilot pressure does not act due to the boom lower meter-in cut valve, the boom 2 spool does not move.
2. The boom flow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

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



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.



T1V1-02-03-006

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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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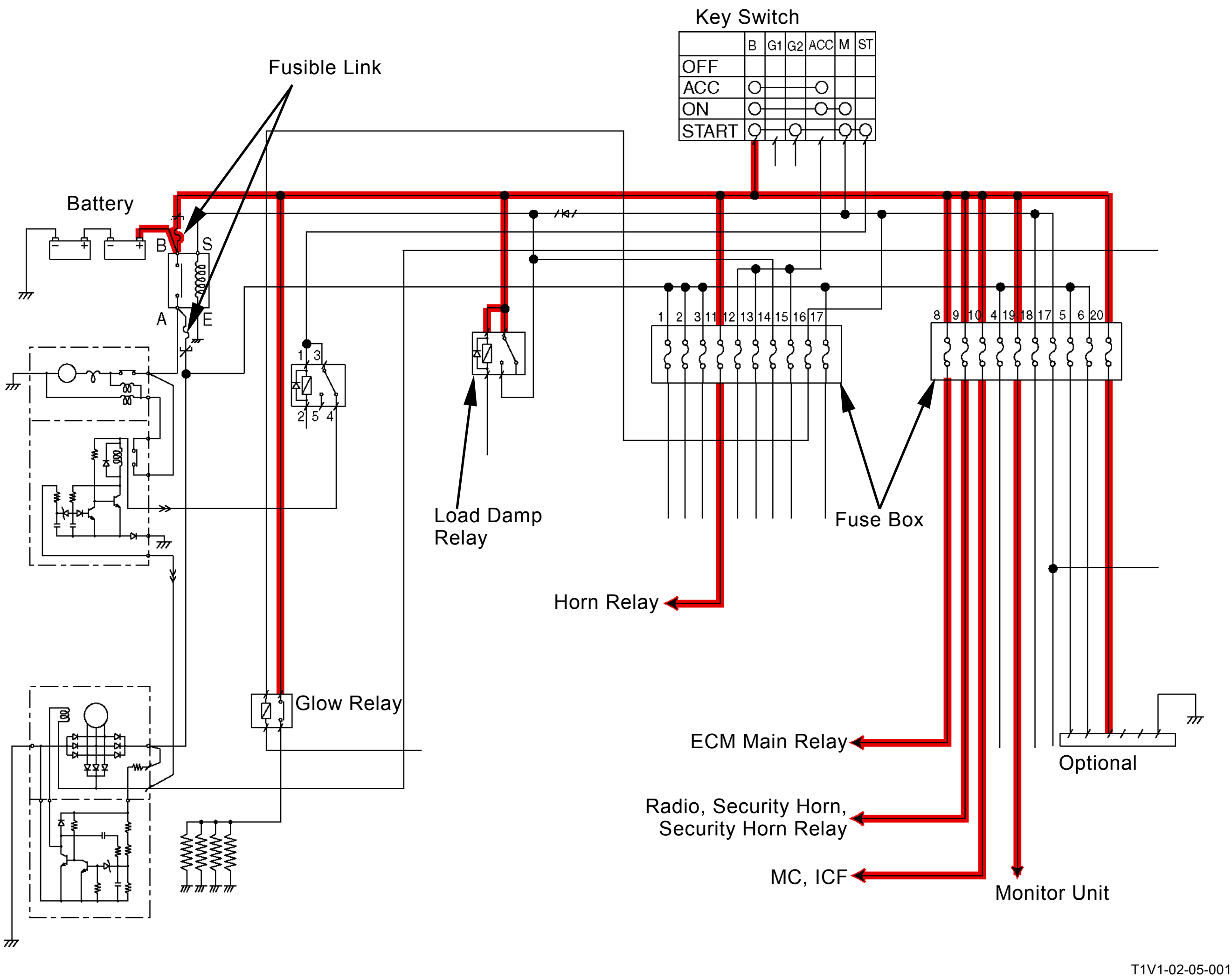
ELECTRIC POWER CIRCUIT (KEY SWITCH: OFF)

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.

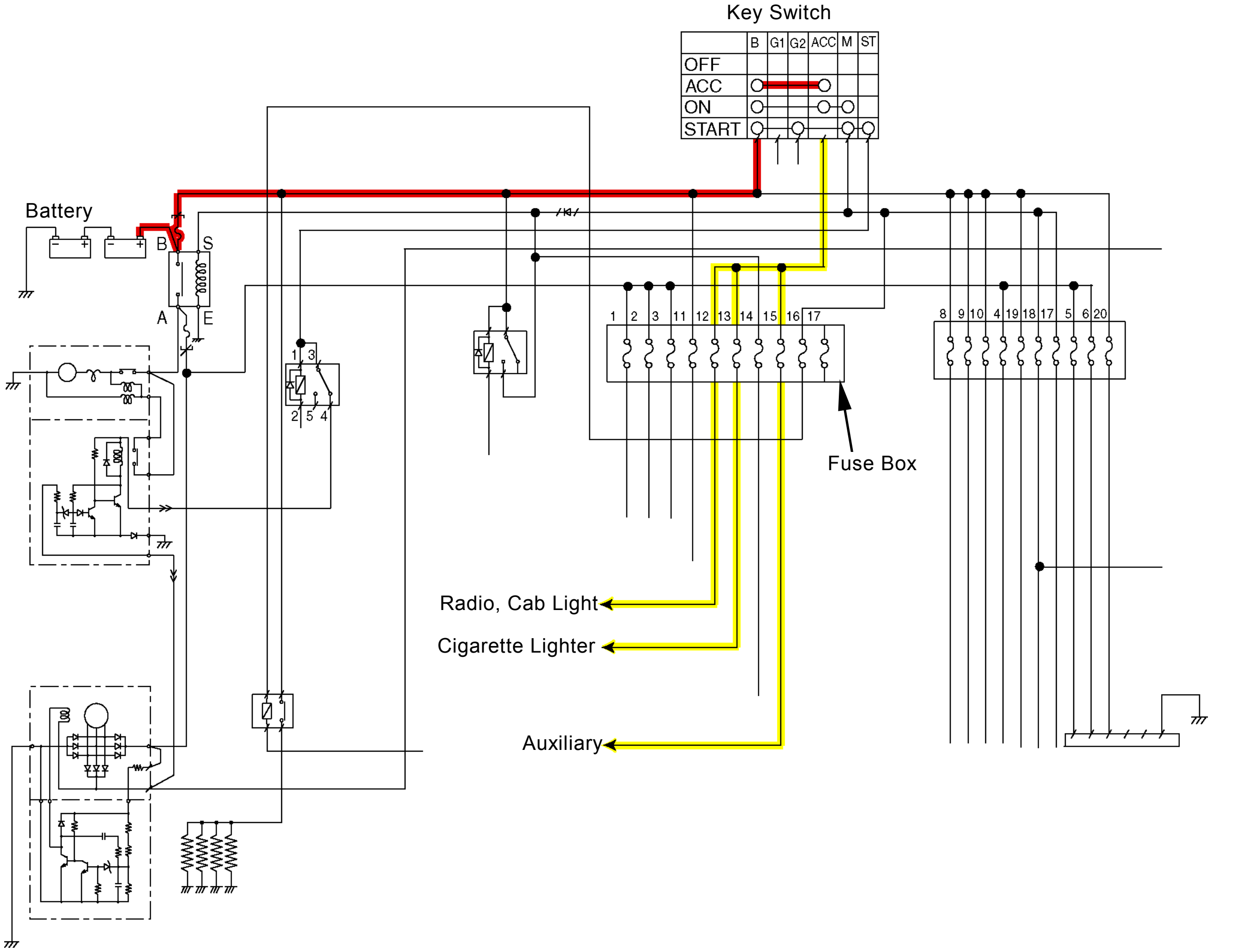
Battery
↓
Fusible Link
- →Glow Plug Relay (Power)
- →Key Switch (B)
- →Load Damp Relay
- →Fuse Box
  - →Terminal #8: ECM Main Relay (Power)
  - →Terminal #9: Radio (Backup Power)
    Security Horn (Backup Power)
    Security Horn Relay (Backup Power)
  - →Terminal #10: MC (Power), ICF (Power)
  - →Terminal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


Key Switch
B
G1
G2
ACC
M
ST
OFF
ACC
ON
START
Fusible Link
Battery
B
S
A
E
1
3
2
5
4
Load Damp
Relay
Fuse Box
Horn Relay
Glow Relay
ECM Main Relay
Radio, Security Horn,
Security Horn Relay
MC, ICF
Monitor Unit
Optional
T1V1-02-05-001

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.



T1V1-02-05-002

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.

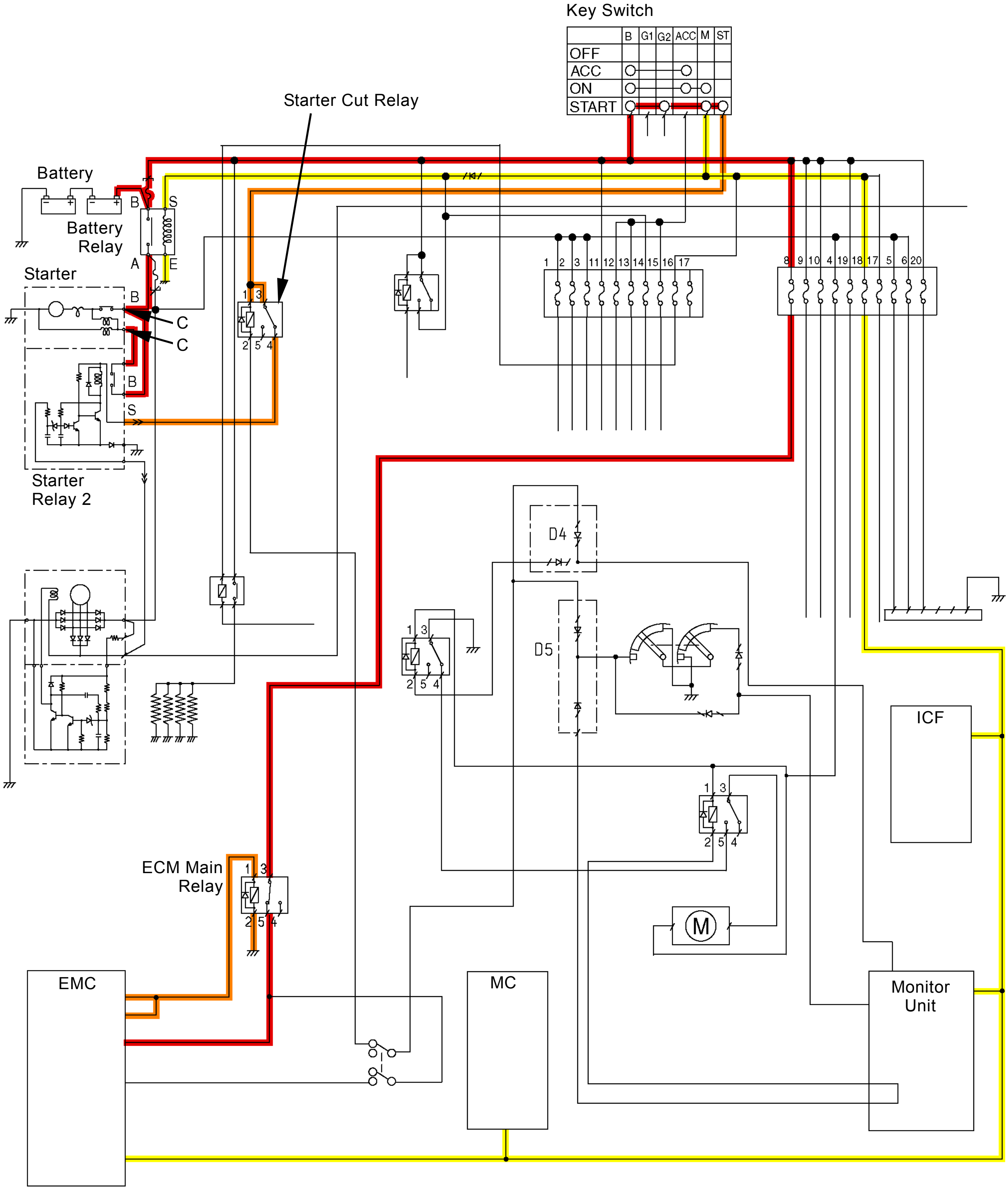
6. Consequently, the relay in starter is turned ON so that the starter begins rotating.

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.



T1V1-02-05-007

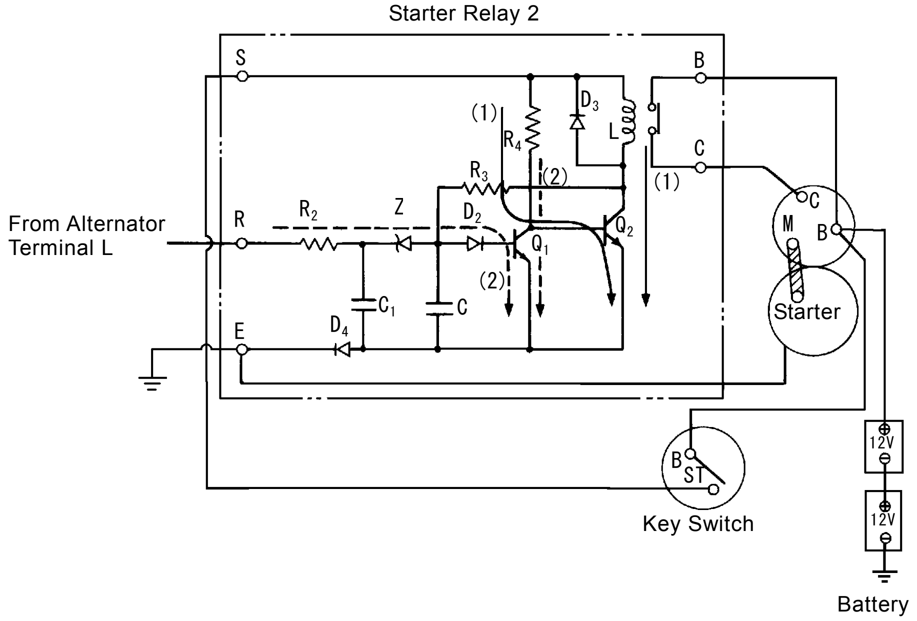
Starter Relay 2 Operation

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)

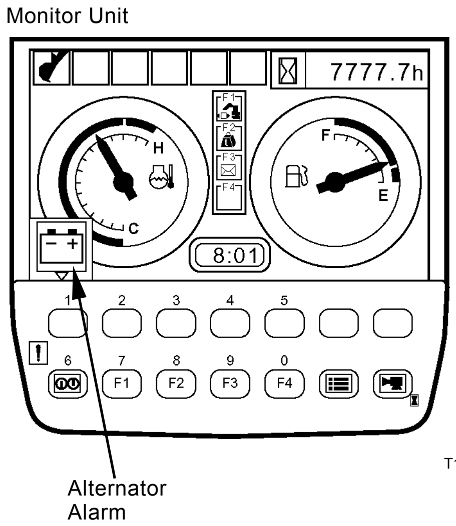
1. After the engine starts and the key switch is released, the key switch moves to the ON position.

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

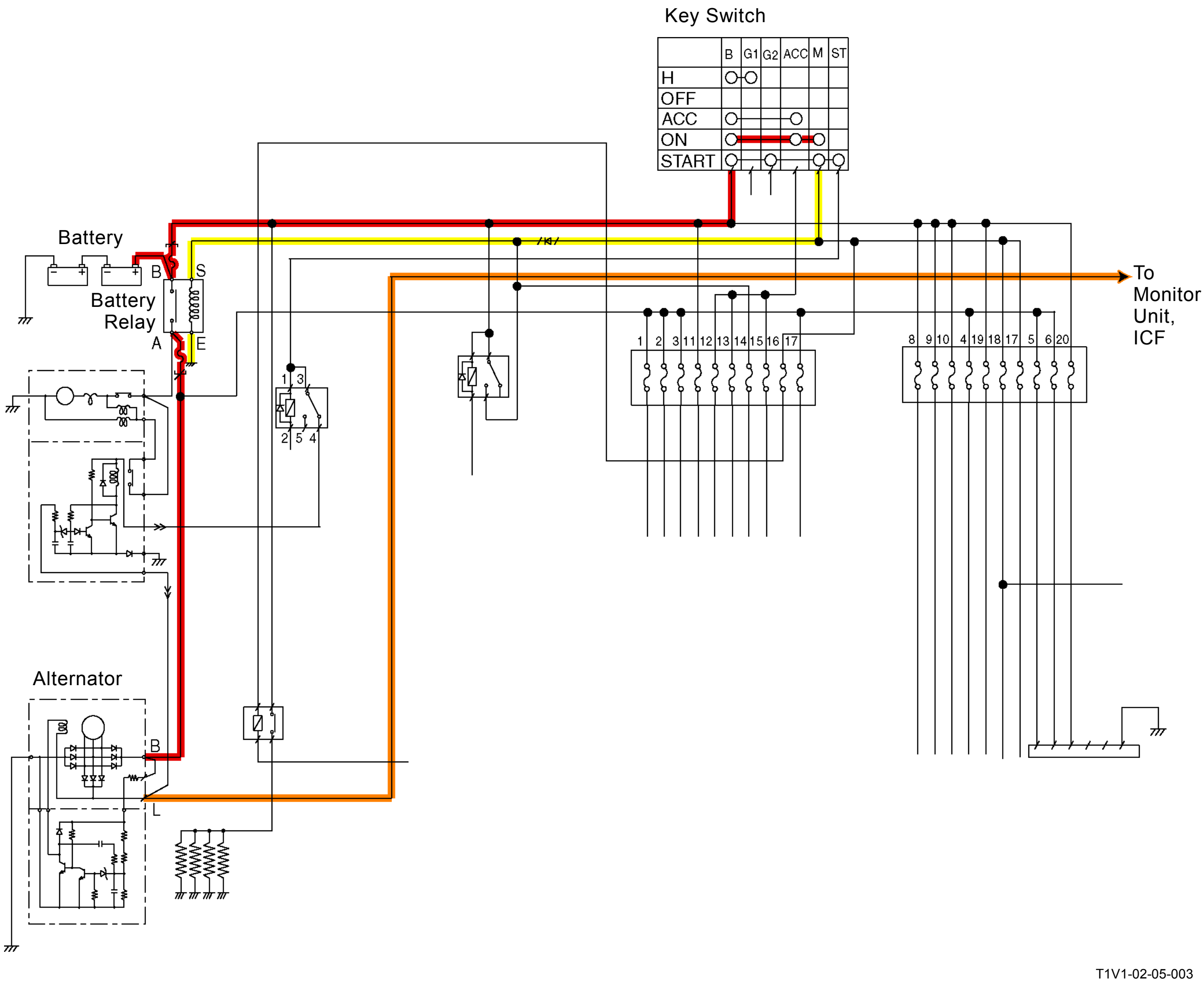
3. The alternator starts generating electricity with the engine running. Current from alternator terminal B flows to the batteries through the battery relay and charges the batteries.

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.

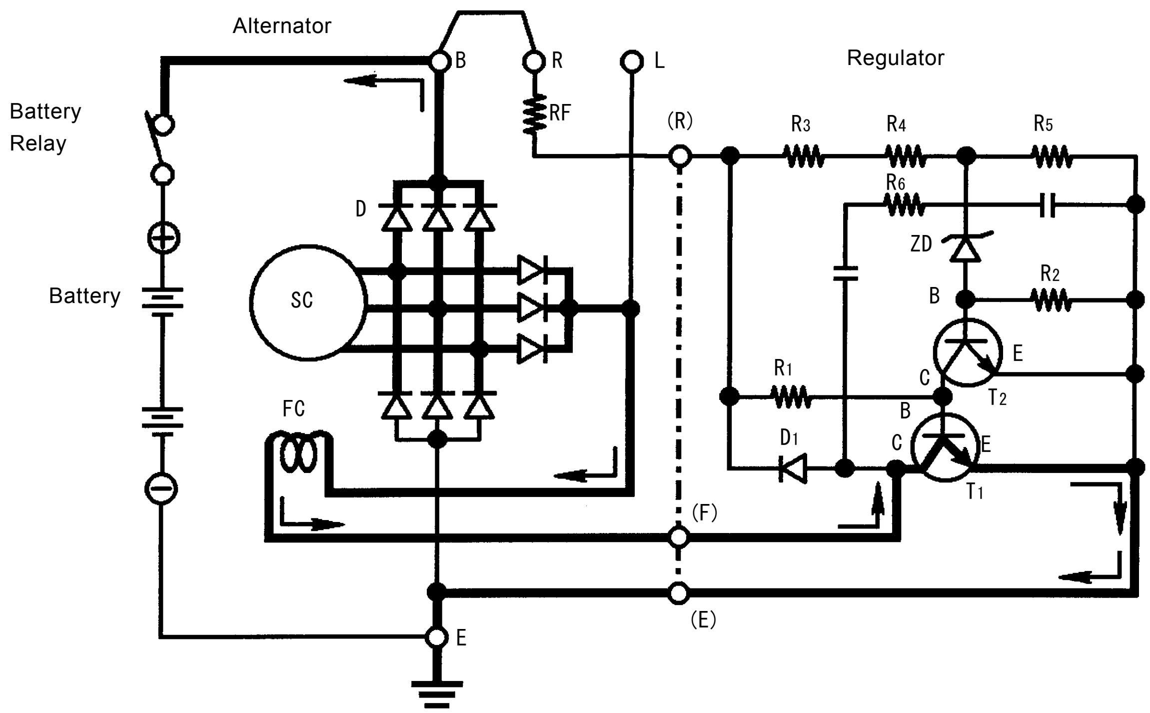


T1V1-05-01-117


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
3
2
5
4
1 2 3 11 12 13 14 15 16 17
8 9 10 4 19 18 17 5 6 20
Alternator
B
L
T1V1-02-05-003

Alternator Operation

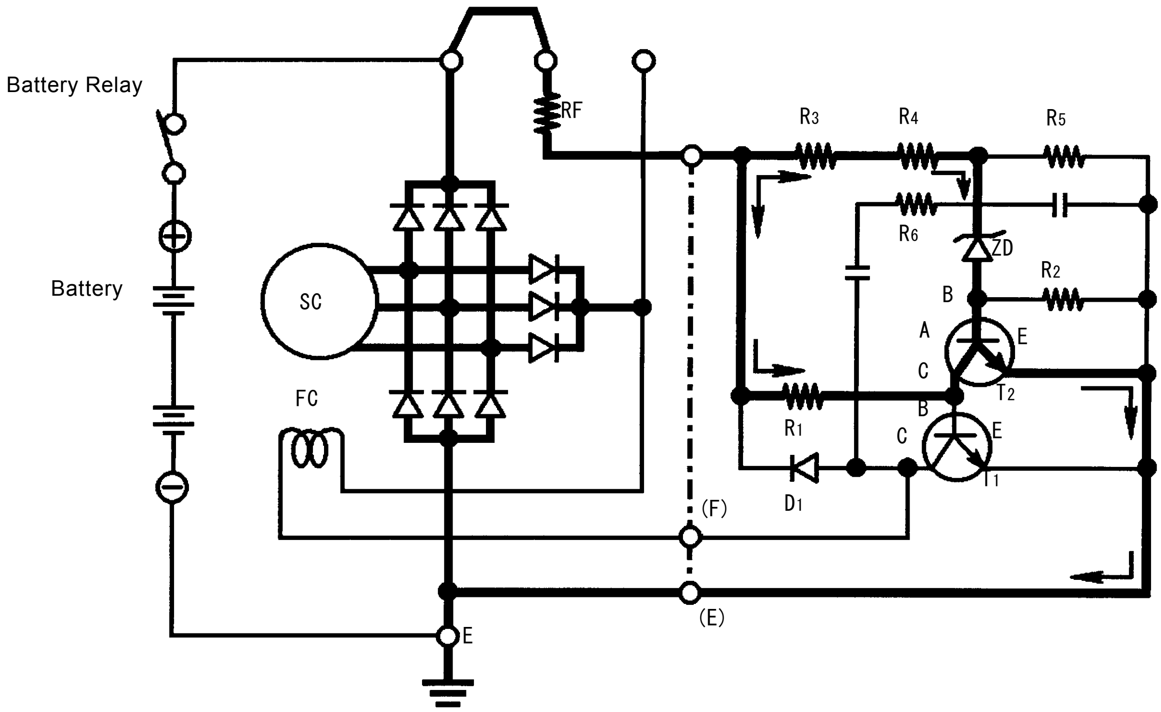
- The alternator consists of field coil FC, stator coil SC and diode D. The regulator consists of transistors (T1 and T2), Zener diode ZD and resistances (R1 and R2).
- Alternator terminal B is connected to base B of transistor T1 through the circuit [B → R → RF → (R) → (R1)].
- When the battery relay 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.

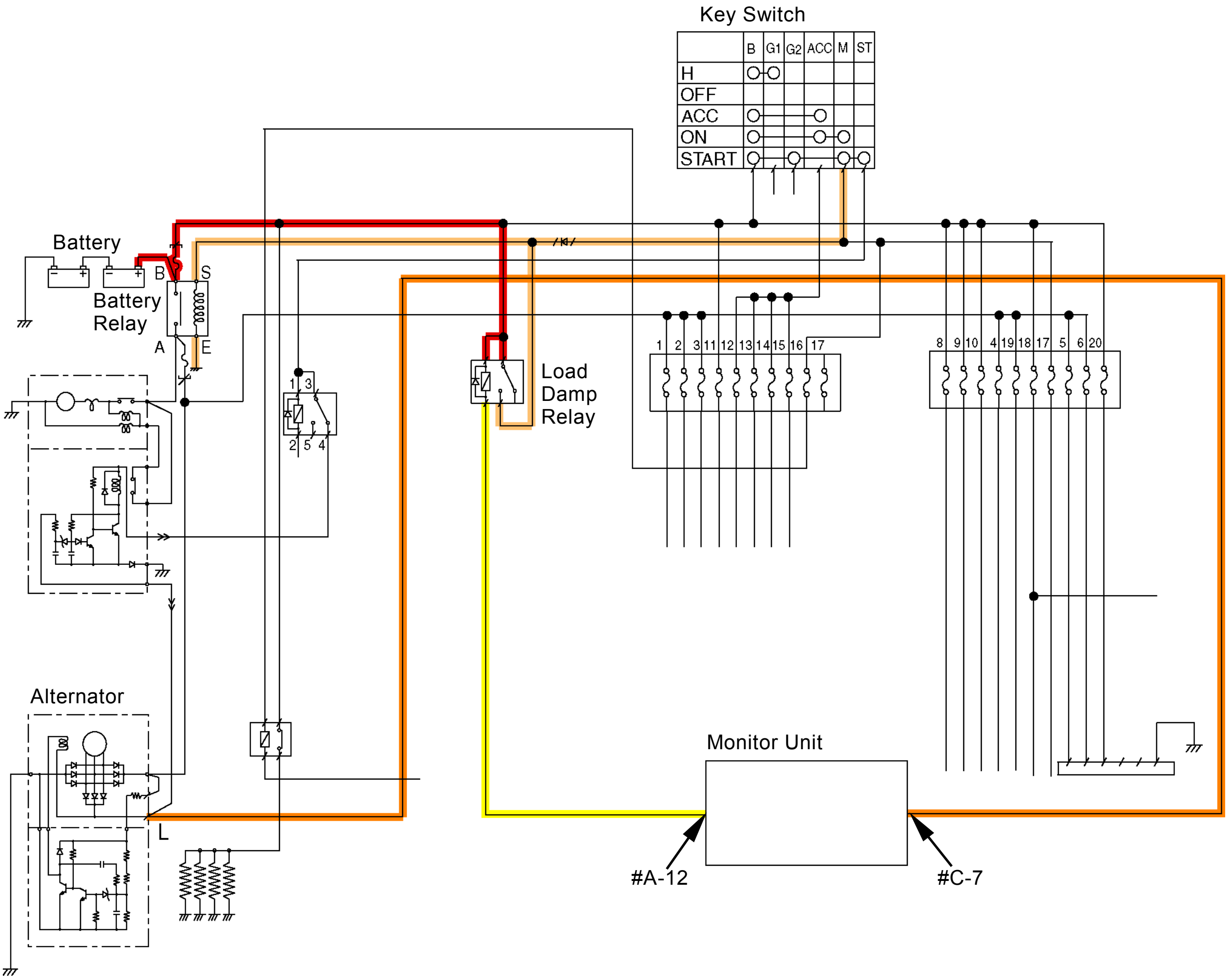
2. The engine continues to rotate due to inertia force just after the key switch is turned OFF so that the alternator continues to generate electricity.

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.

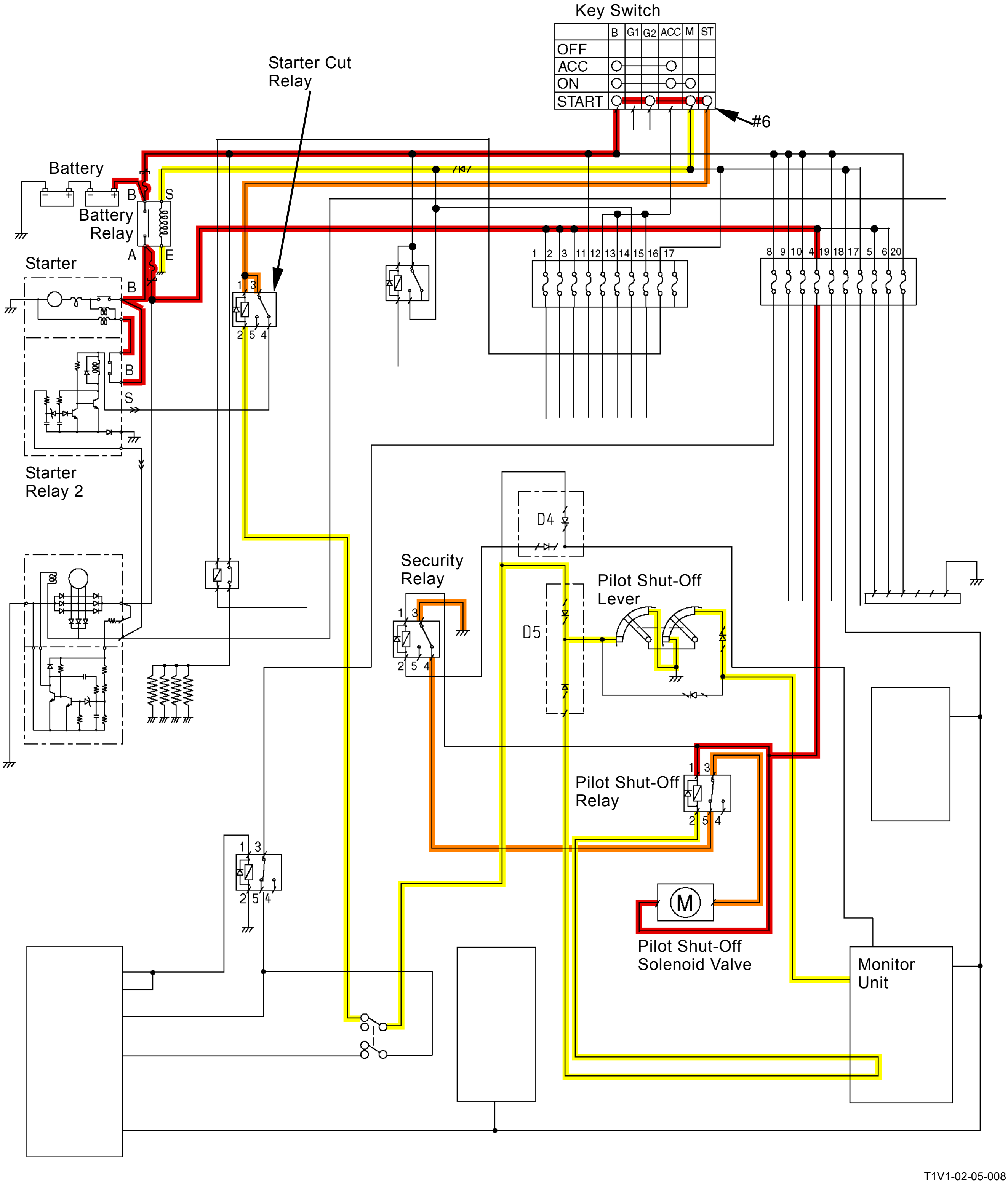
6. Accordingly, even if the key switch is turned OFF while the engine is rotating, battery current continues to excite the battery relay through the load damp relay. Until the alternator stops generating, the battery relay is kept ON.



T1V1-02-05-004

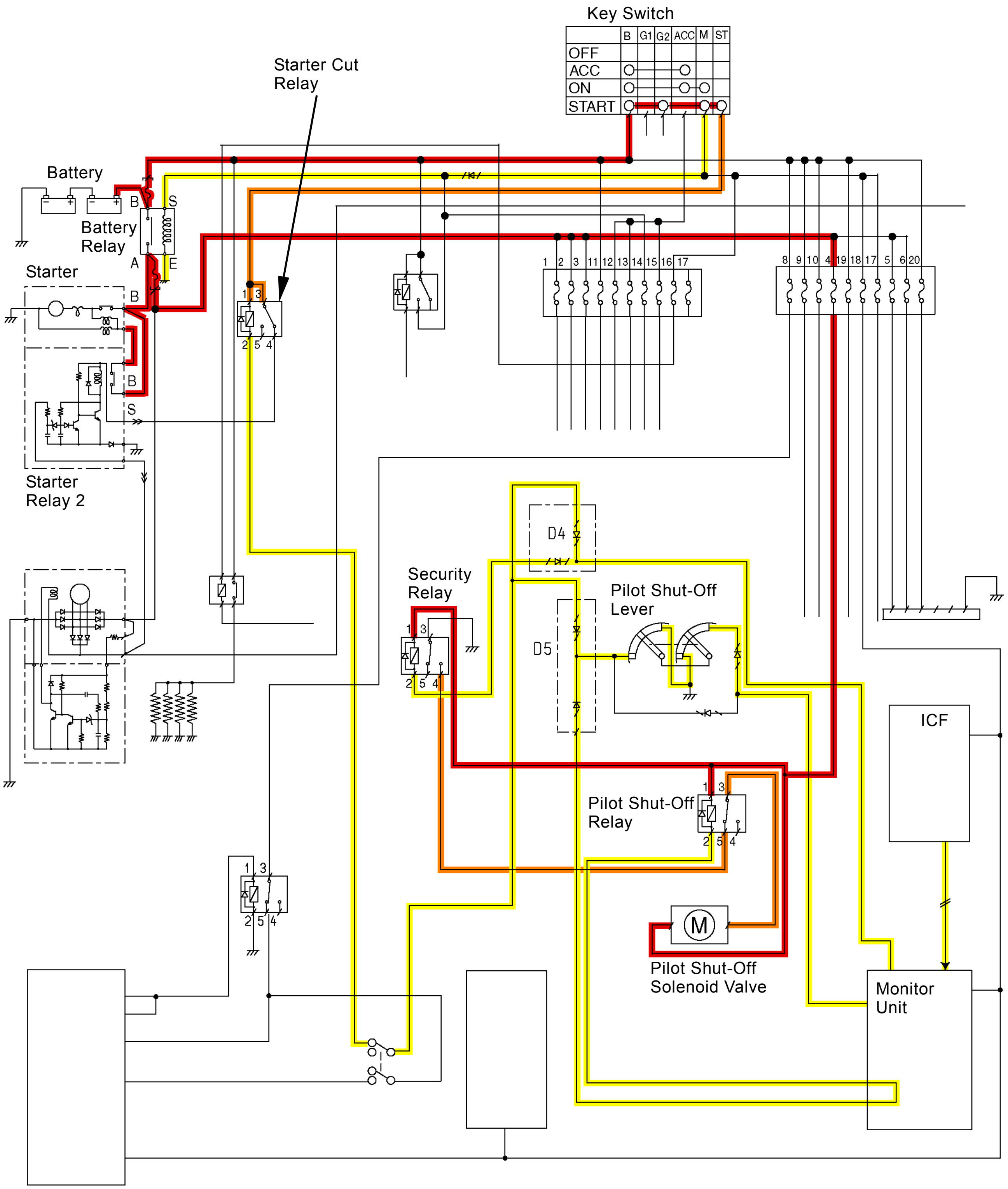
PILOT SHUT-OFF CIRCUIT (KEY SWITCH: ON)

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.


Key Switch
B
G1
G2
ACC
M
ST
OFF
ACC
ON
START
#6
Starter Cut
Relay
Battery
Battery
Relay
B
S
A
E
Starter
B
B
S
Starter
Relay 2
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
D4
D5
Security
Relay
Pilot Shut-Off
Lever
Pilot Shut-Off
Relay
M
Pilot Shut-Off
Solenoid Valve
Monitor
Unit
T1V1-02-05-008

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.



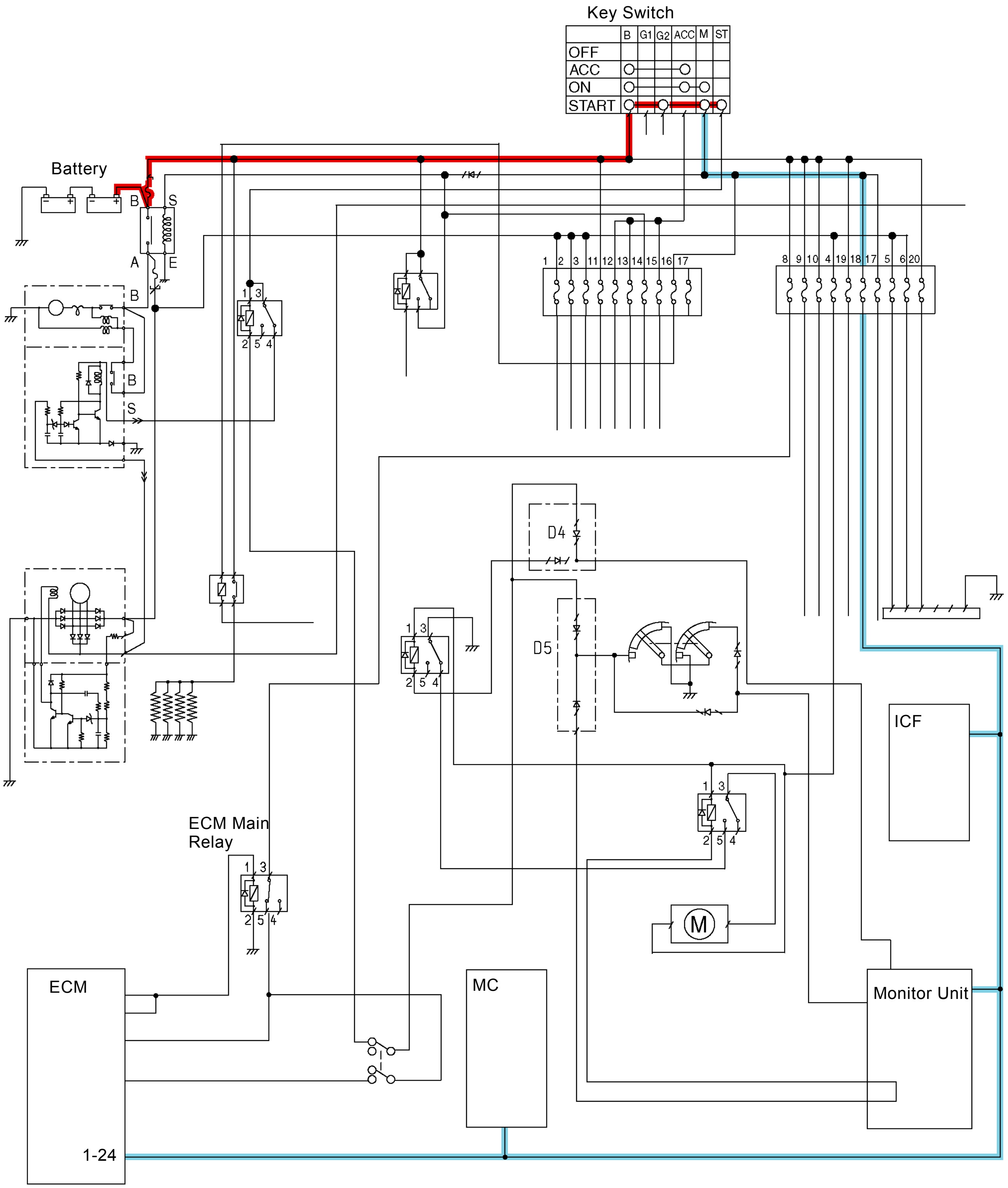
T1V1-02-05-009

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.

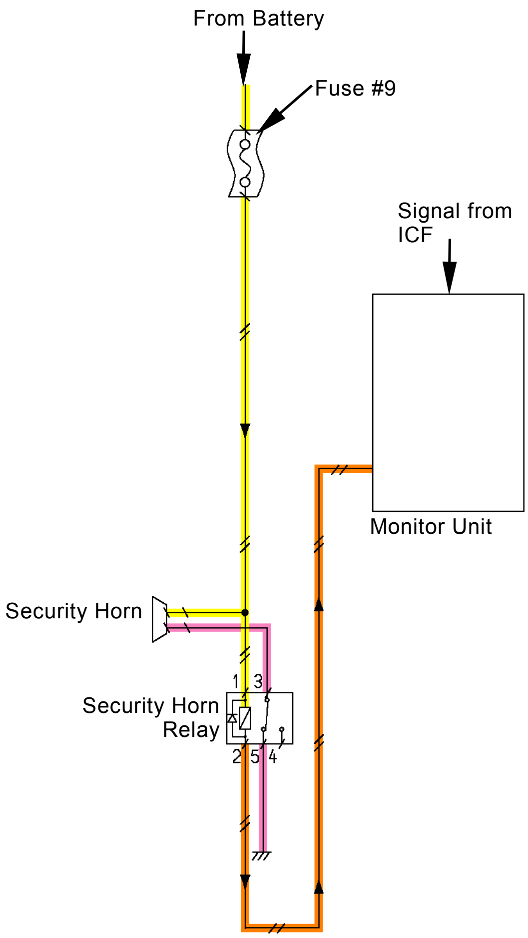
3. When the engine stops, ECM turns the ECM main relay OFF.



T1V1-02-05-011

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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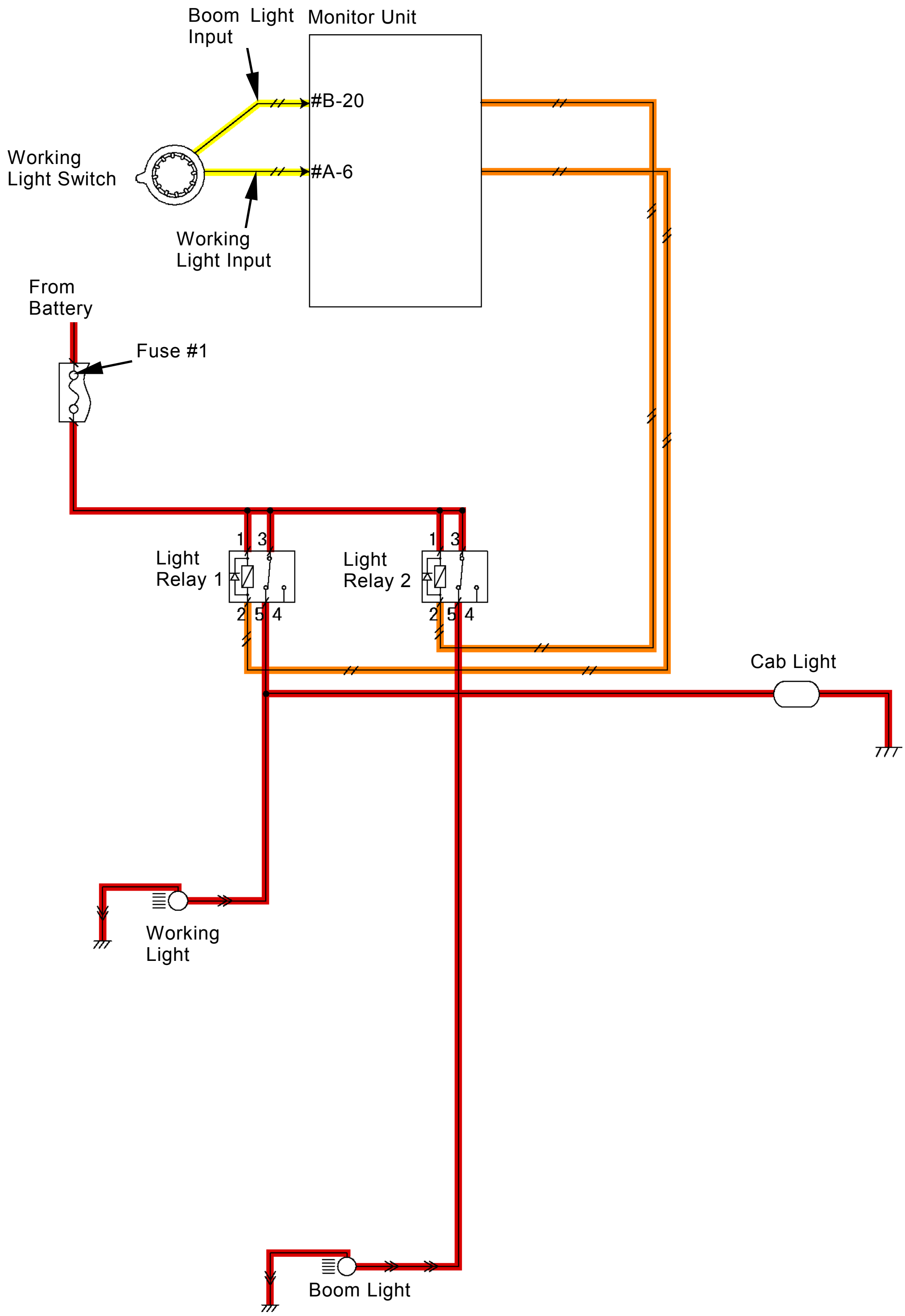
WORKING LIGHT CIRCUIT

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

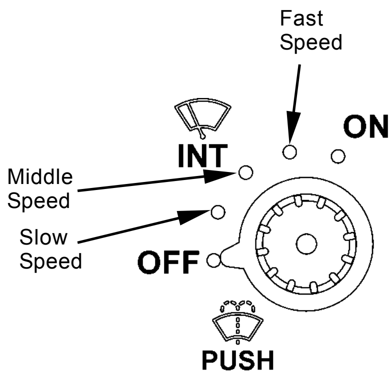
WIPER CIRCUIT

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

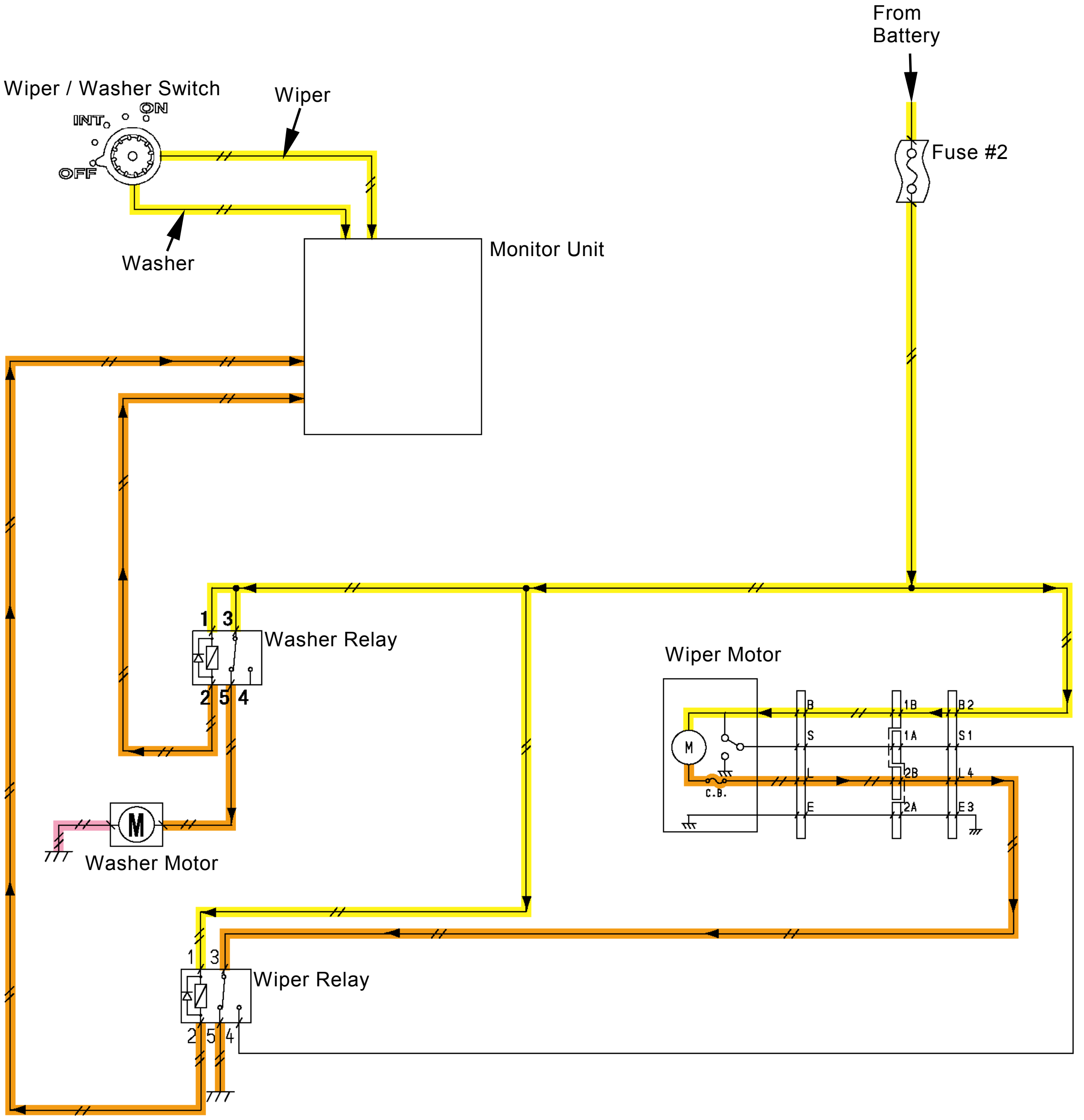
Position ITN.	Set Time
Slow	8 seconds
Middle	6 seconds
Fast	3 seconds

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

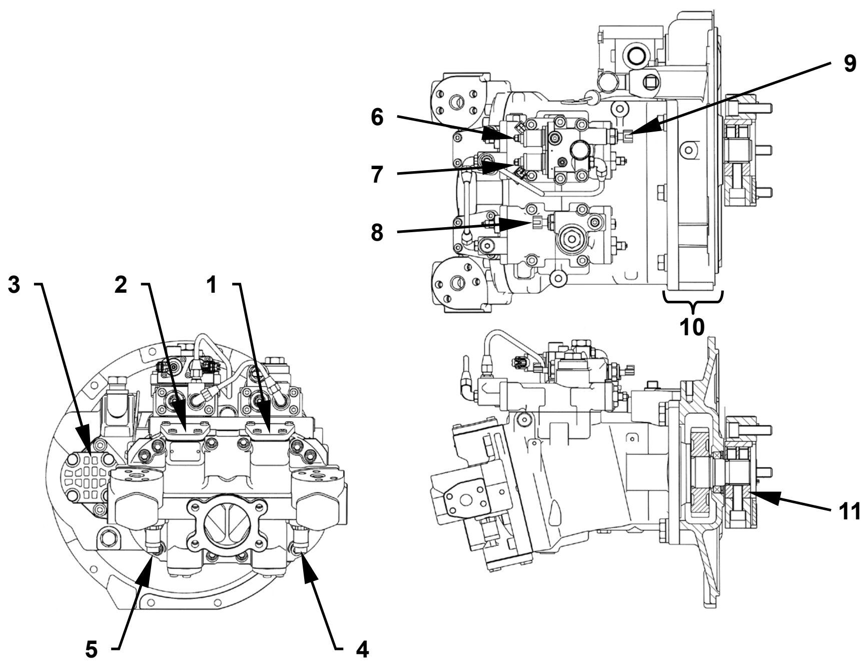
CONTENTS

Group 7 Others (Upperstructure)

Group 8 Others (Undercarriage)

OUTLINE

The pump device consists of transmission (11), main pump (pump 1 (1), pump 2 (2)) and pilot pump (3).
The engine output is transmitted to transmission (11) via coupling (12). After being distributed by the gear, the engine power drives pump 1 (1), 2 (2) and pilot pump (3). Both reduction gear ratios of the main pump and pilot pump (3) are 1:1. Transmission (11) is lubricated with engine oil.
The main pump is a bent-axis type variable displacement axial plunger pump. Pump 1 (1) and pump 2 (2) are integrated as two units in one housing.
Pilot pump (3) is a gear pump.
Pump delivery pressure sensors (4, 5) and pump control pressure sensors (8, 9) are installed in order to control the pump and valve.
(Refer to the Control System group in SYSTEM.)

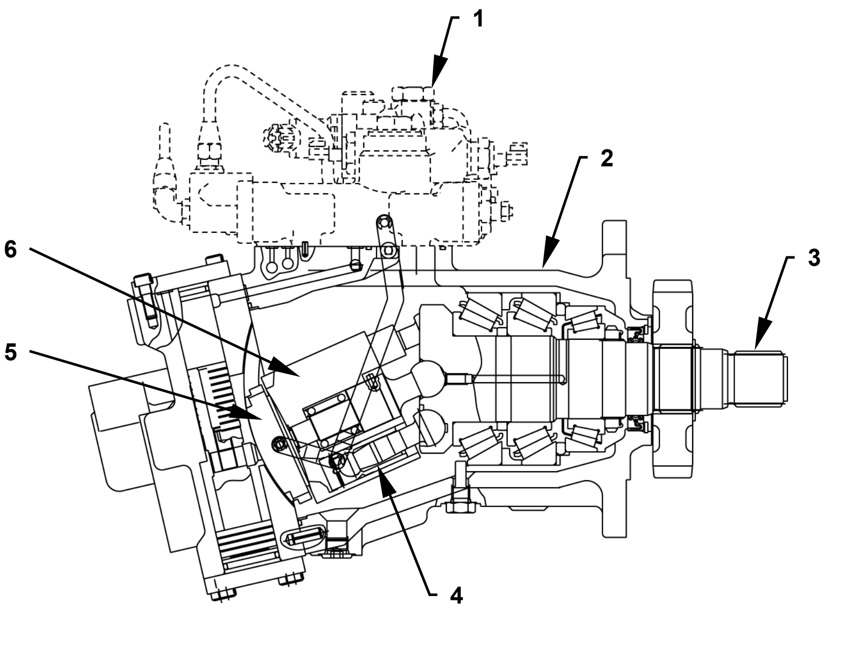


T1V1-03-01-006

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

MAIN PUMP

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

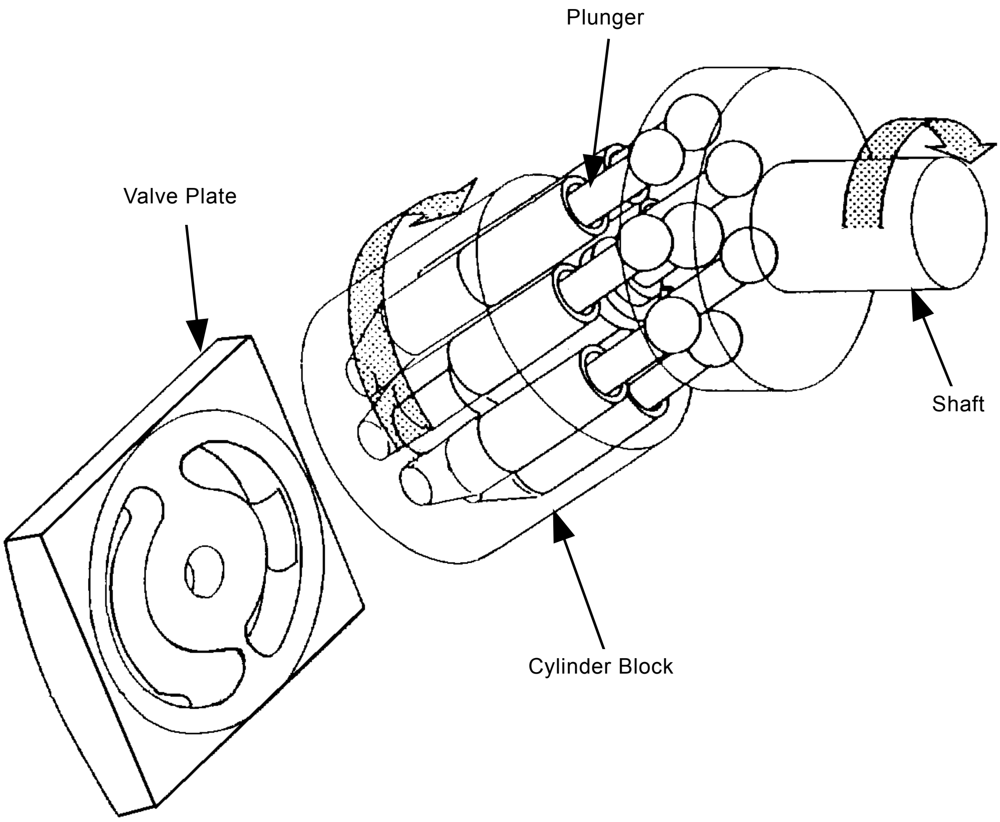


T1V1-03-01-007

1 - Regulator	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.

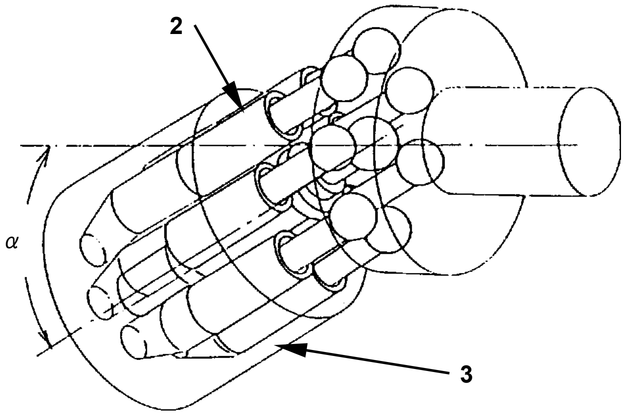


T105-02-03-002

Increasing and Decreasing Flow Rate

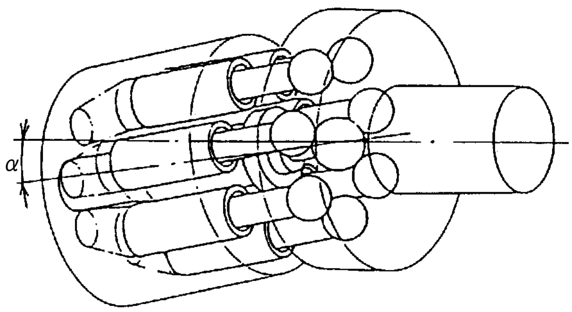
Changing inclination of cylinder block (3) causes the plunger (2) stroke to increase or decrease depending on the slant angle in order to control the main pump flow rate. Up-down movement of servo piston (6) changes inclination of cylinder block (3). Servo piston (6) is interlocked with valve plate (4) 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:

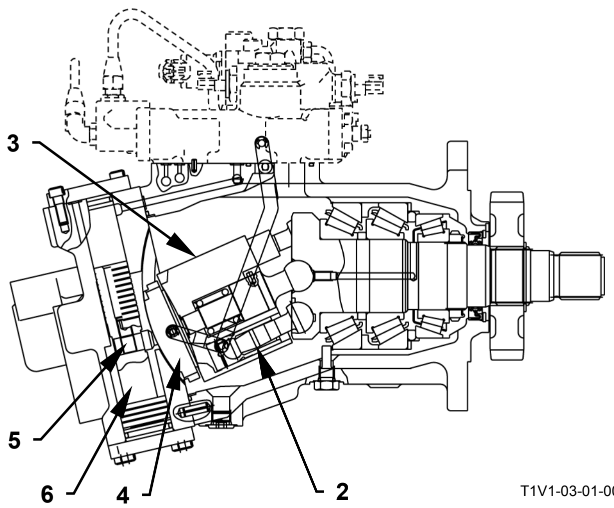


T105-02-03-021

Minimum Displacement Angle (Operable Limit Angle):



T105-02-03-022



T1V1-03-01-008

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

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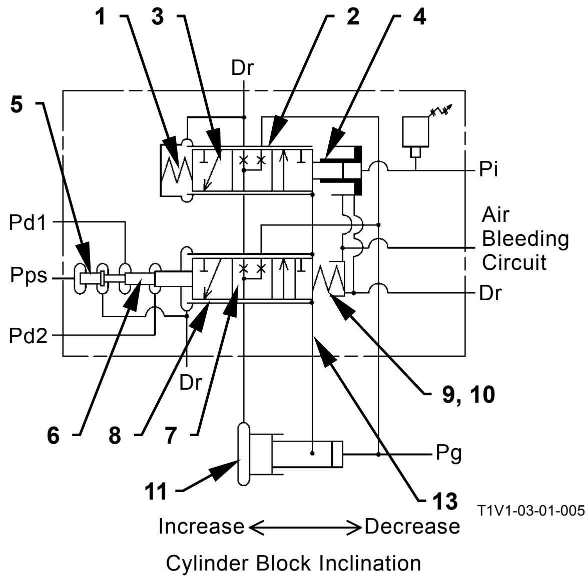
REGULATOR

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 (8), spool A (3), spool B (7), piston (4), load piston 1 (5), load piston 2 (6), inner spring (9) and outer spring (10). According to the various command signal pressures, the regulator opens or closes the circuit to servo piston (11), the inclination of cylinder block (12) is changed and the pump flow rate is controlled.

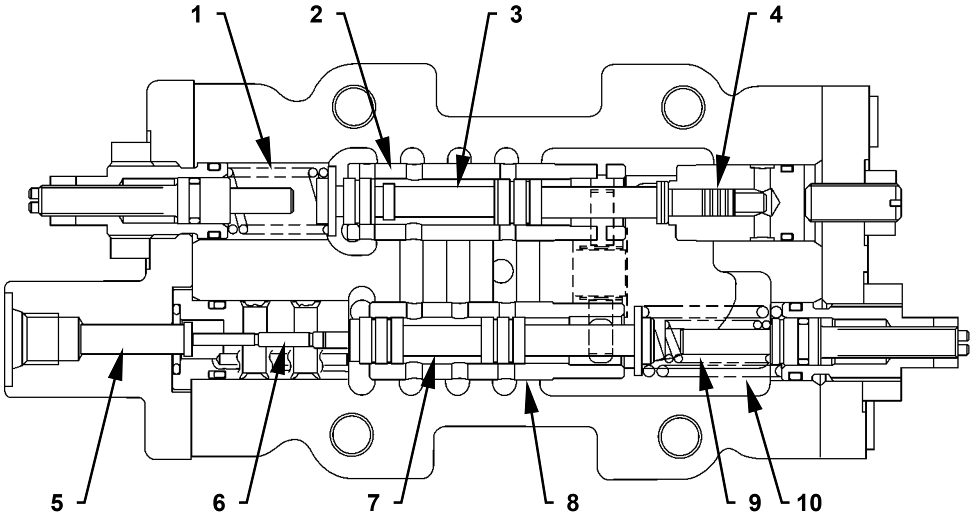
NOTE: Pilot oil pressure is constantly supplied in the smaller chamber side of servo piston (11).



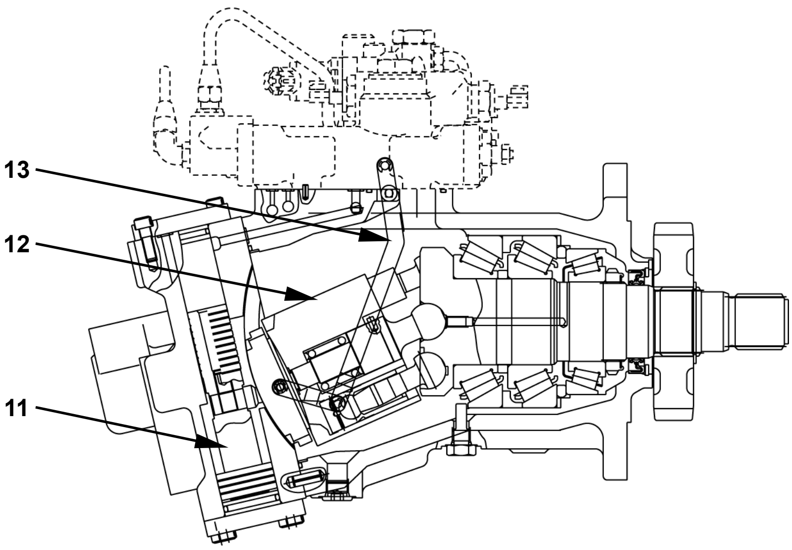
T1V1-03-01-005

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

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



T1V1-03-01-009



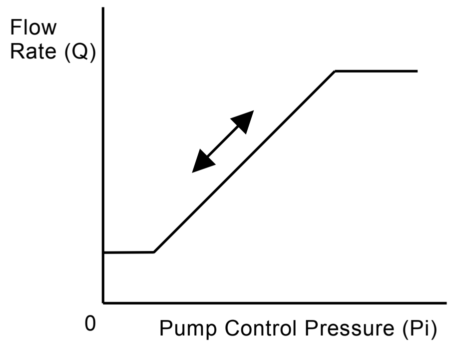
T1V1-03-01-007

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

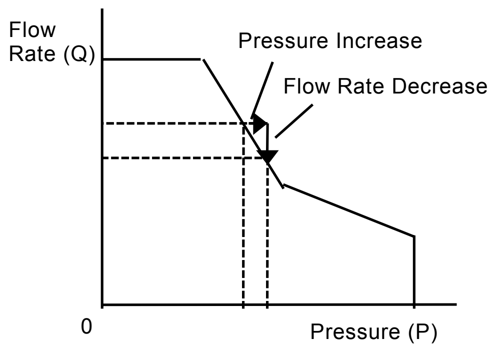
Regulator Control Function

The regulator has the following four control functions.

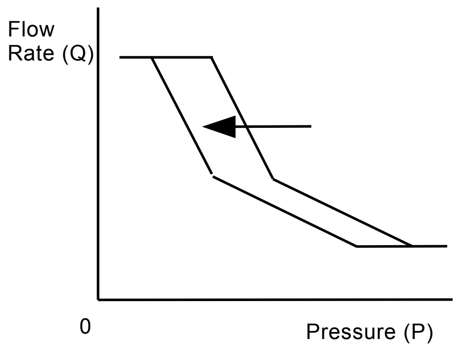
- Control by Pump Control Pressure
  When a control lever is operated, the pump flow rate control valve in signal control valve regulates pump control pressure Pi in response to the lever stroke. When the regulator receives pump control pressure Pi, the regulator controls the pump delivery flow rate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



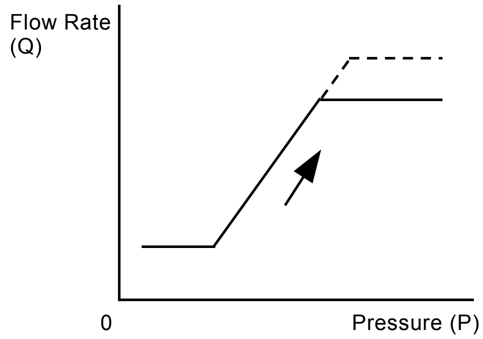
- Control by Own or Opponent Pump Delivery Pressure
  The regulator receives own pump delivery pressure Pd1 and opponent pump delivery pressure Pd2 as control signal pressures. If the two average pressures increase over the set P-Q line, the regulator reduces both pump delivery flow rates and the total 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)

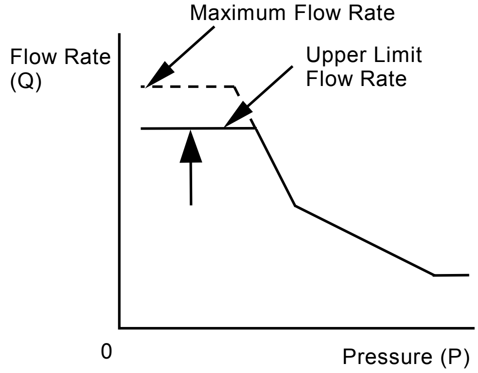


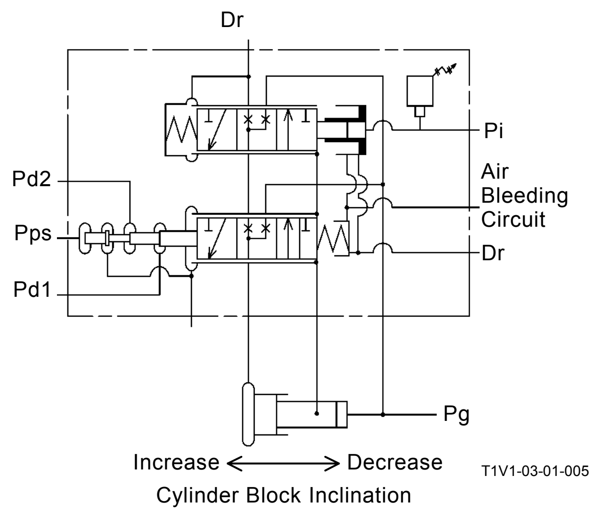
- Control by Pilot Pressure from Torque Control Solenoid Valve
  The main controller (MC) operates based on both the engine target speed input data and actual speed information signals and outputs the signals to the torque control solenoid valve. In response to the signals from MC, the torque control 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 group.)



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



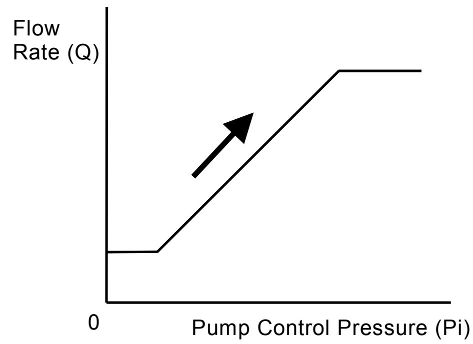


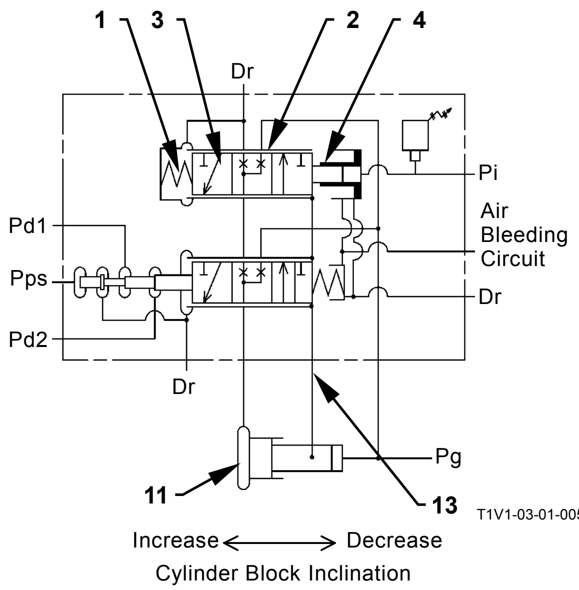


Pd1 - Pump 1 Delivery Pressure
Pd2 - Pump 2 Delivery Pressure
Dr - Returning to Hydraulic Oil Tank
Pi - Pump Control Pressure
Pps - Torque Control Pressure
Pg - Primary Pilot Pressure (From Pilot Pump)

Control by 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. By this movement, the circuit from the large chamber of servo piston (11) is opened to the hydraulic oil tank.
  4. As pilot pressure is always routed into the small chamber of servo piston (11), servo piston (11) is moved toward direction of the arrow. Then, the cylinder block is rotated in the maximum inclination direction and the pump delivery flow rate increases.
  5. The movement of cylinder block is transmitted to sleeve A (2) via link (13). Sleeve A (2) is moved in the same direction as spool A (3).
  6. When sleeve A (2) is moved by the same stroke as spool A (3), the open part between spool A (3) and sleeve A (2) is closed and the circuit from large chamber of servo piston (11) to the hydraulic oil tank is closed. Therefore, servo piston (11) is stopped and the flow rate increasing operation is completed.

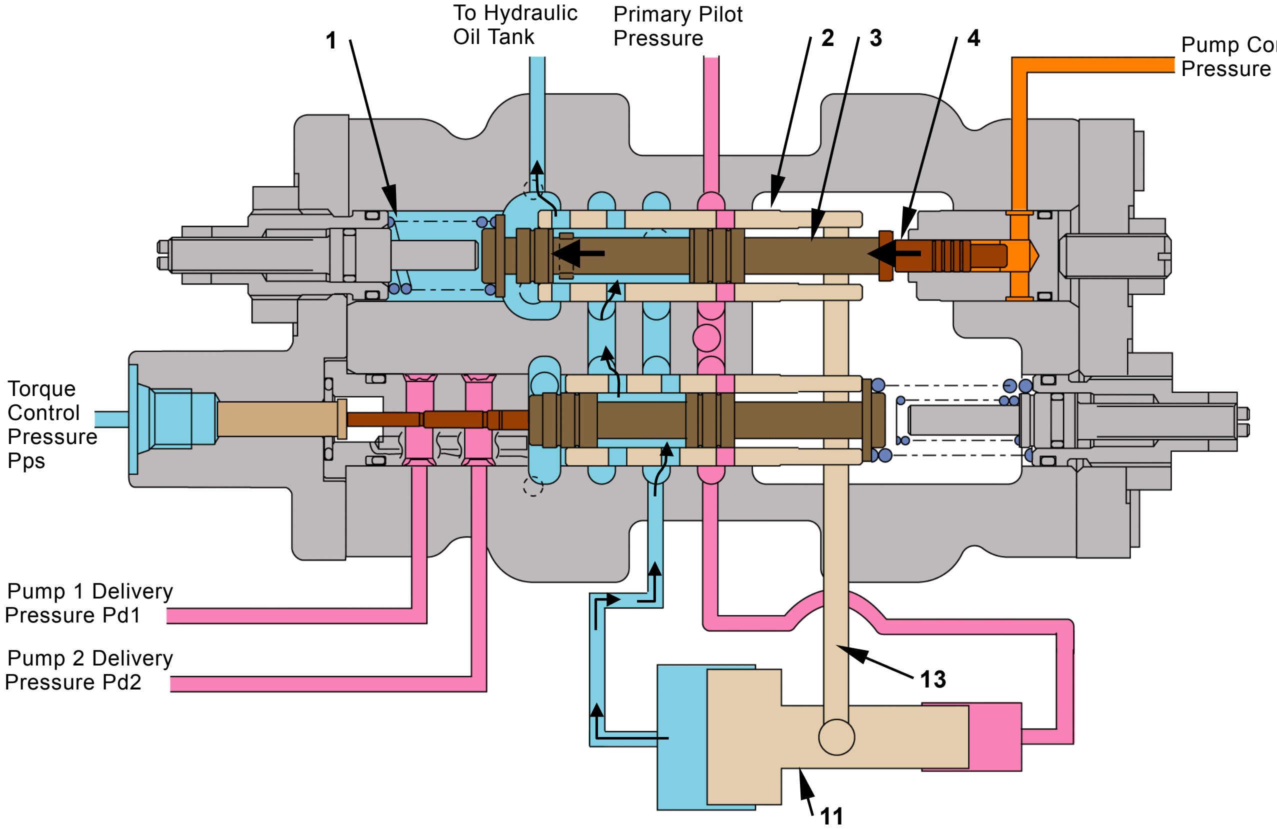




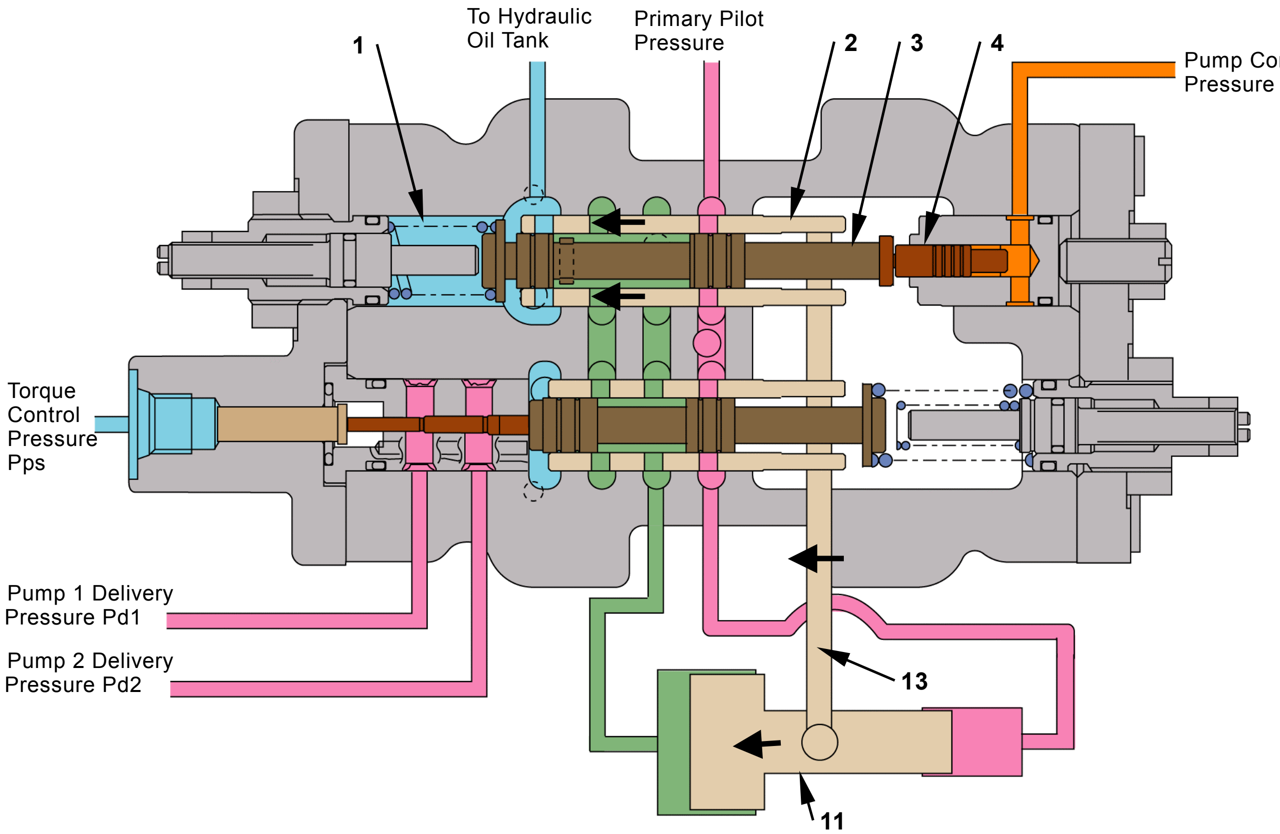
T1V1-03-01-005

1 - Spring	4 - Piston
2 - Sleeve A	11 - Servo Piston
3 - Spool A	13 - Link

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



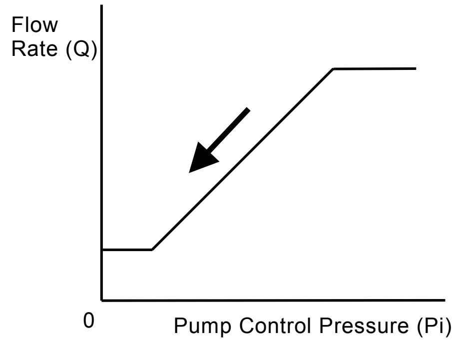
T1V1-03-01-010

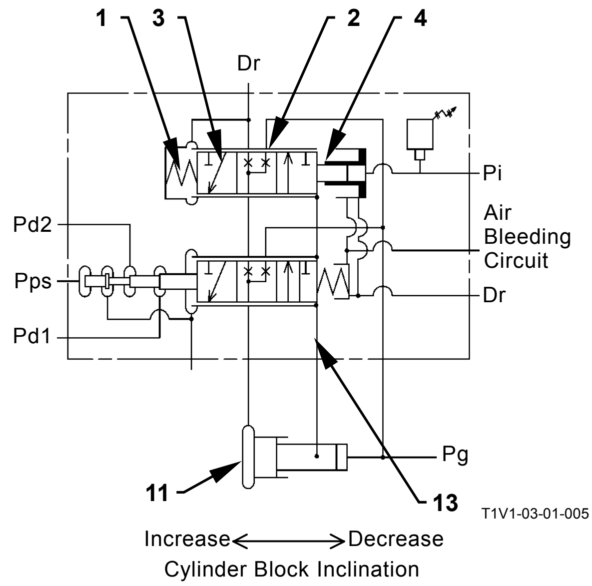


T1V1-03-01-011

1 - Spring
2 - Sleeve A
3 - Spool A
4 - Piston
11 - Servo Piston
13 - Link

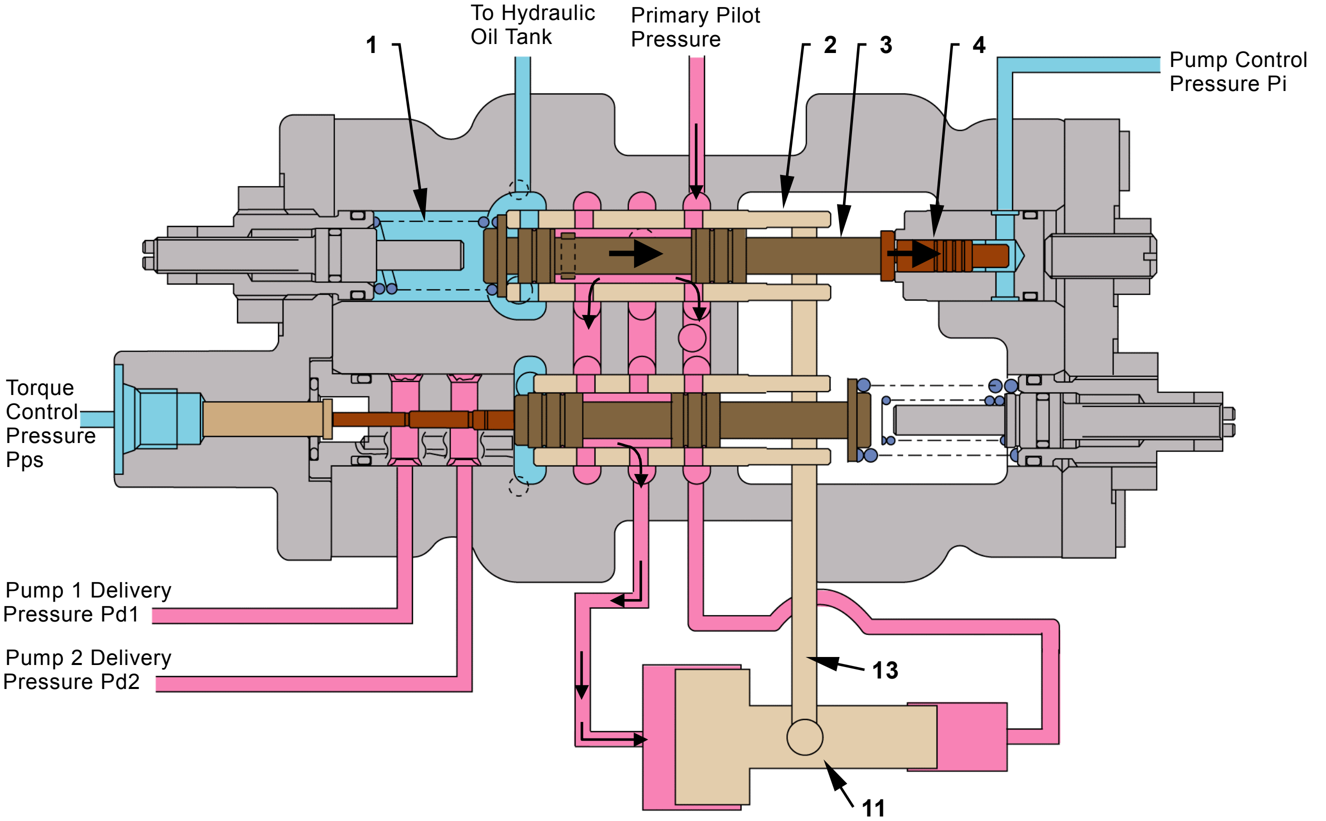
- Decreasing Flow Rate
  1. When a control lever is returned, the flow rate control valve in signal control valve is returned and pump control pressure Pi decreases.
  2. Piston (4) and spool A (3) are pushed by spring (1) so that spool A (3) is moved toward direction of the arrow.
  3. Pilot pressure is also routed to the large chamber of servo piston (11).
  4. Due to the difference in diameter between the large and small chambers, servo piston (11) is moved toward direction of the arrow. Therefore, the cylinder block is rotated in the minimum inclination direction and the pump delivery flow rate decreases.
  5. The movement of cylinder block is transmitted to sleeve A (2) via link (13). Sleeve A (2) is moved in the same direction as spool A (3).
  6. When sleeve A (2) is moved by the same stroke as spool A (3), the open part between sleeve A (2) and spool A (3) is closed and pilot pressure to servo piston (11) is blocked. Therefore, servo piston (11) is stopped and the flow rate decreasing operation is completed.



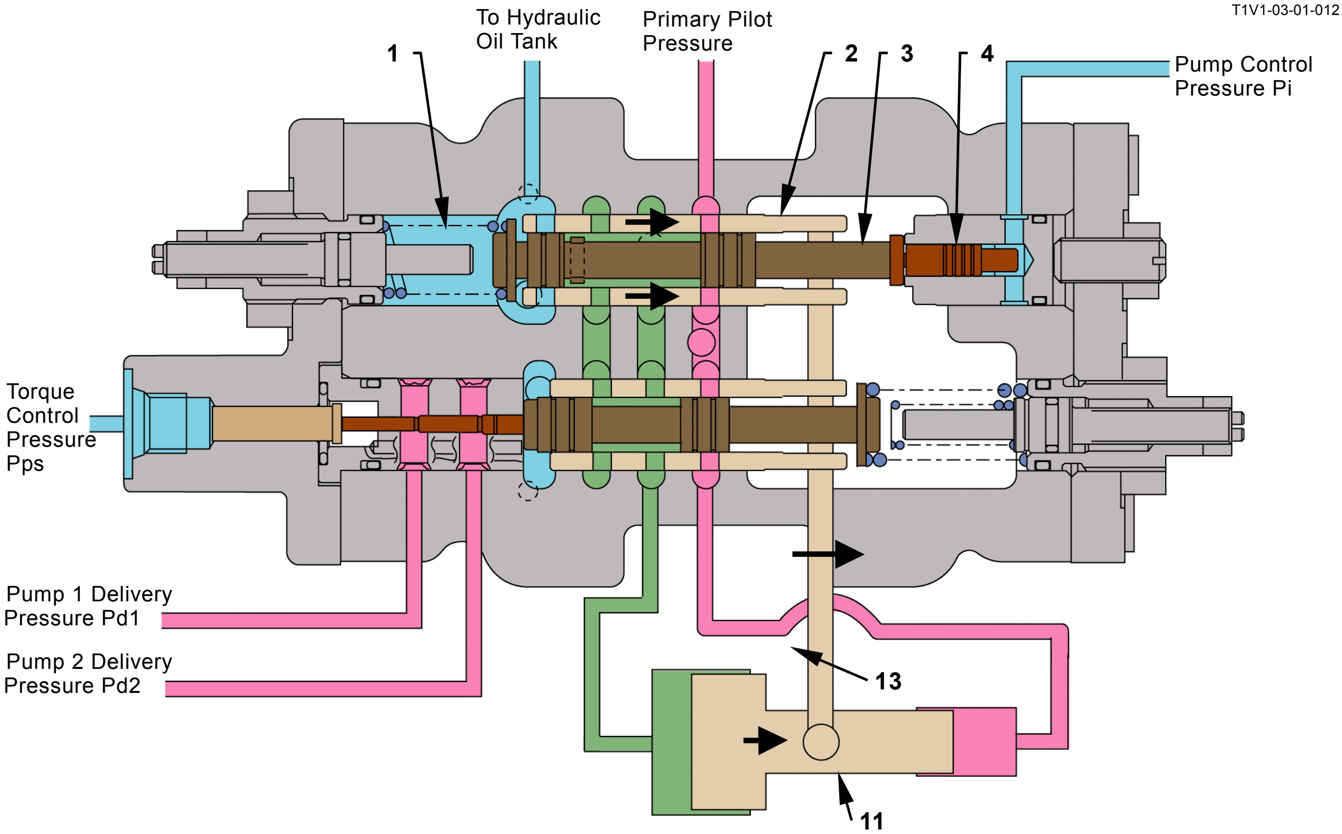


1 - Spring
2 - Sleeve A
3 - Spool A
4 - Piston
10 - Servo Piston
12 - Link

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)



T1V1-03-01-012



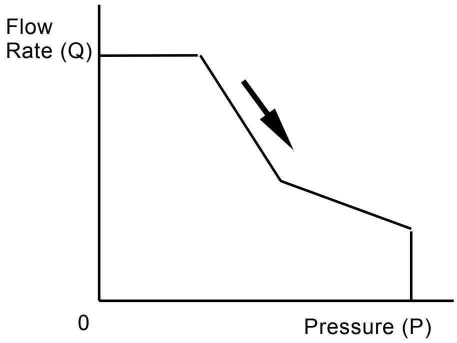
T1V1-03-01-013

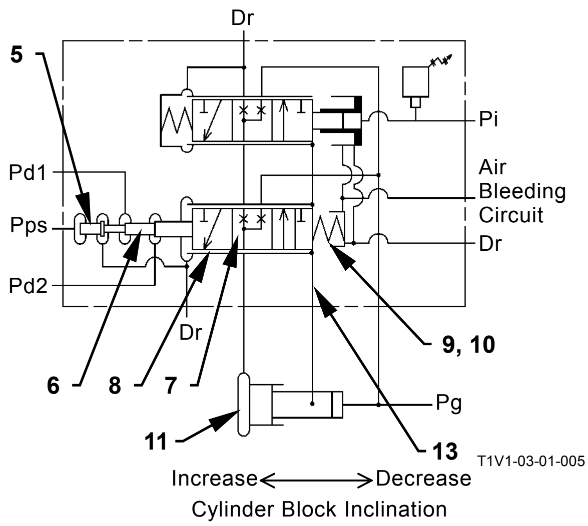
1 - Spring	3 - Spool A	11 - Servo Piston	13 - Link
2 - Sleeve A	4 - Piston		

Control by Own or Opponent Pump Delivery Pressure

- Decreasing Flow Rate

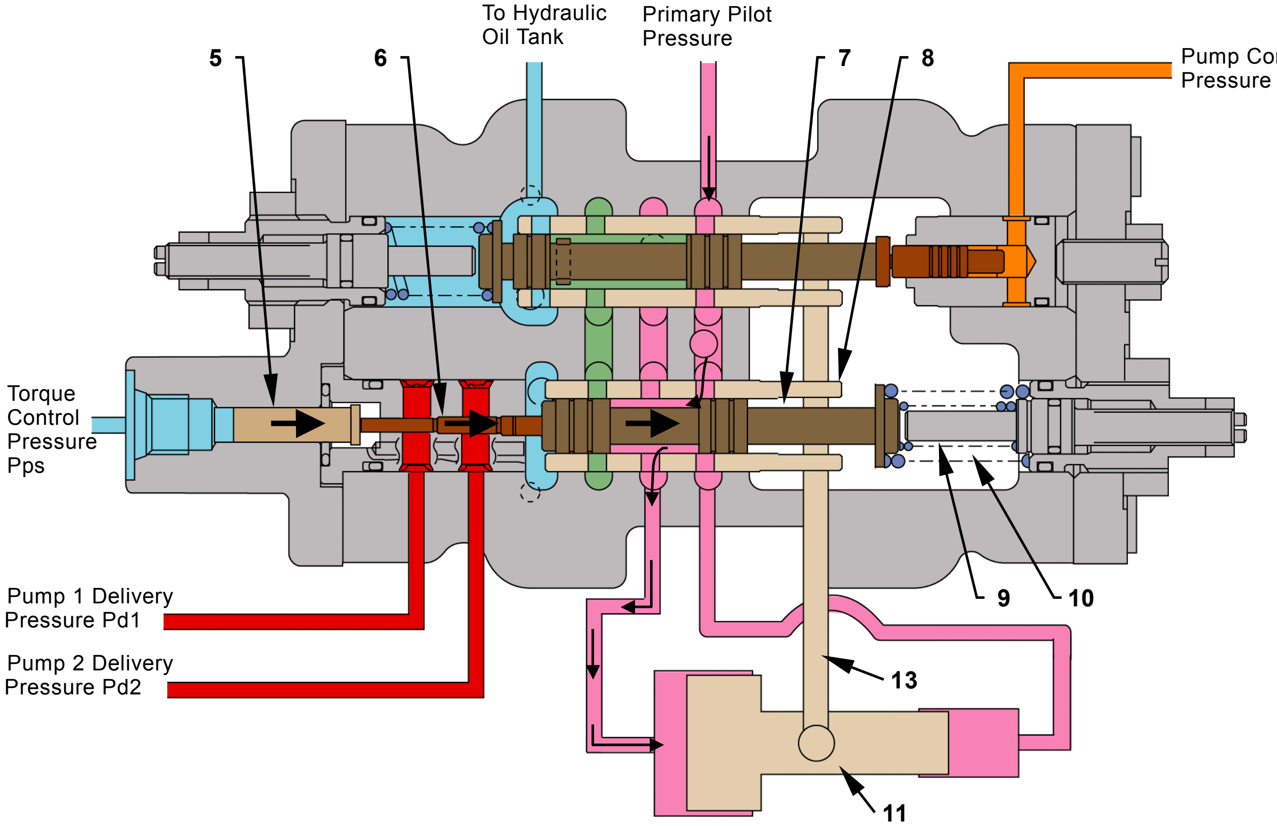
1. When the pump is loaded by operating any of the control levers, either pump 1 delivery pressure Pd1 or pump 2 delivery pressure Pd2 increases. (During operation, pump control pressure Pi is kept increased.) Load piston 1 (5) is moved toward direction of the arrow by pilot pressure Pps.
2. Load piston 2 (6) pushes spool B (7), inner spring (9) and outer spring (10). Spool B (7) moves toward direction of the arrow.
3. Due to the movement of spool B (7), pilot pressure is routed to the large chamber of servo piston (11).
4. Due to the difference in diameter between the large and small chambers, servo piston (11) 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 (8) via link (13). Sleeve B (8) is moved in the same direction as spool B (7).
6. When sleeve B (8) is moved by the same stroke as spool B (7), the open part between sleeve B (8) and Spool B (7) is close and pilot pressure to servo piston (11) is blocked. Therefore, servo piston (11) is stopped and the flow rate decreasing operation is completed.



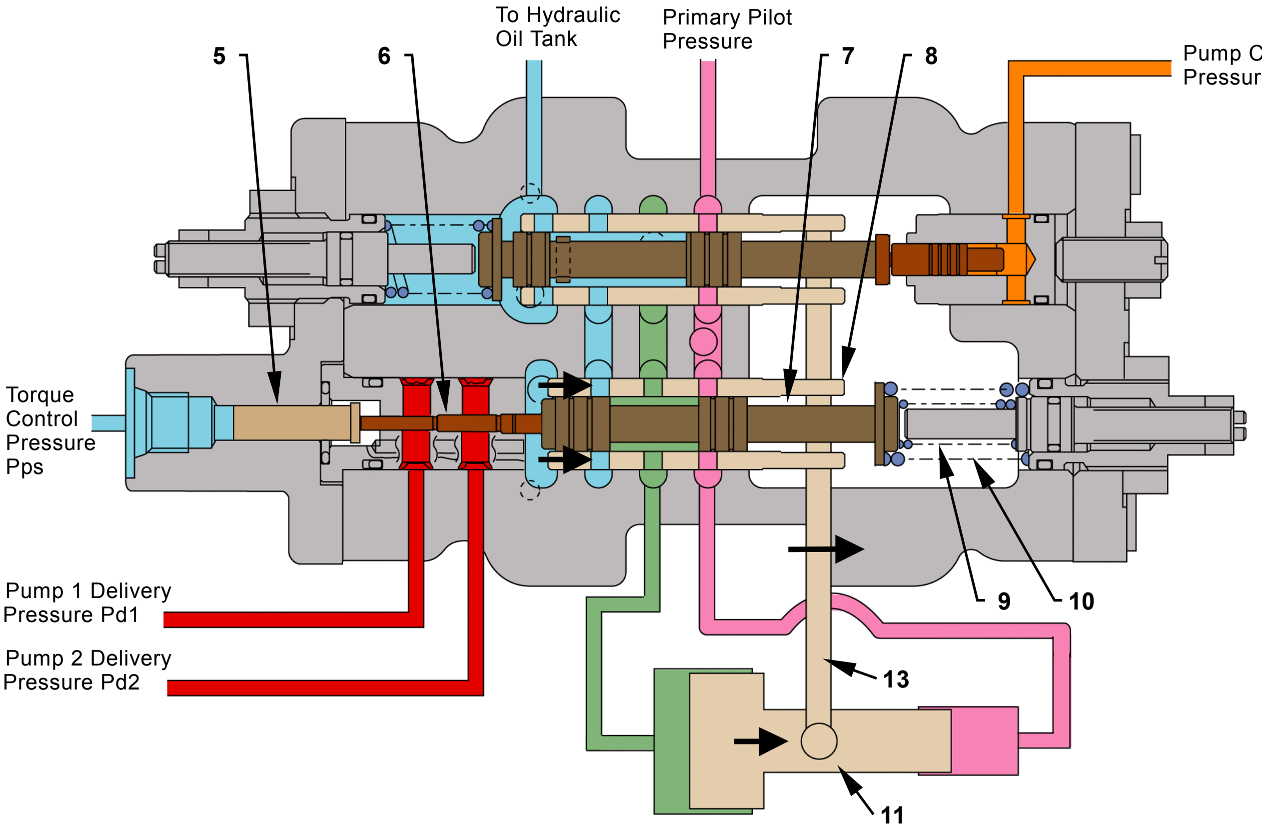


5 - Load Piston 1	9 - Inner Spring
6 - Load Piston 2	10 - Outer Spring
7 - Spool B	11 - Servo Piston
8 - Sleeve B	13 - Link

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



T1V1-03-01-014

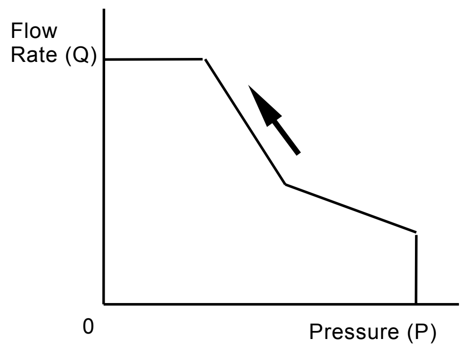


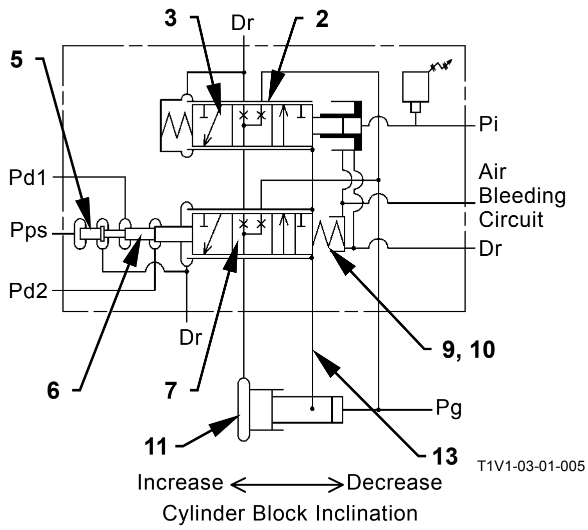
T1V1-03-01-015

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

- Increasing Flow Rate

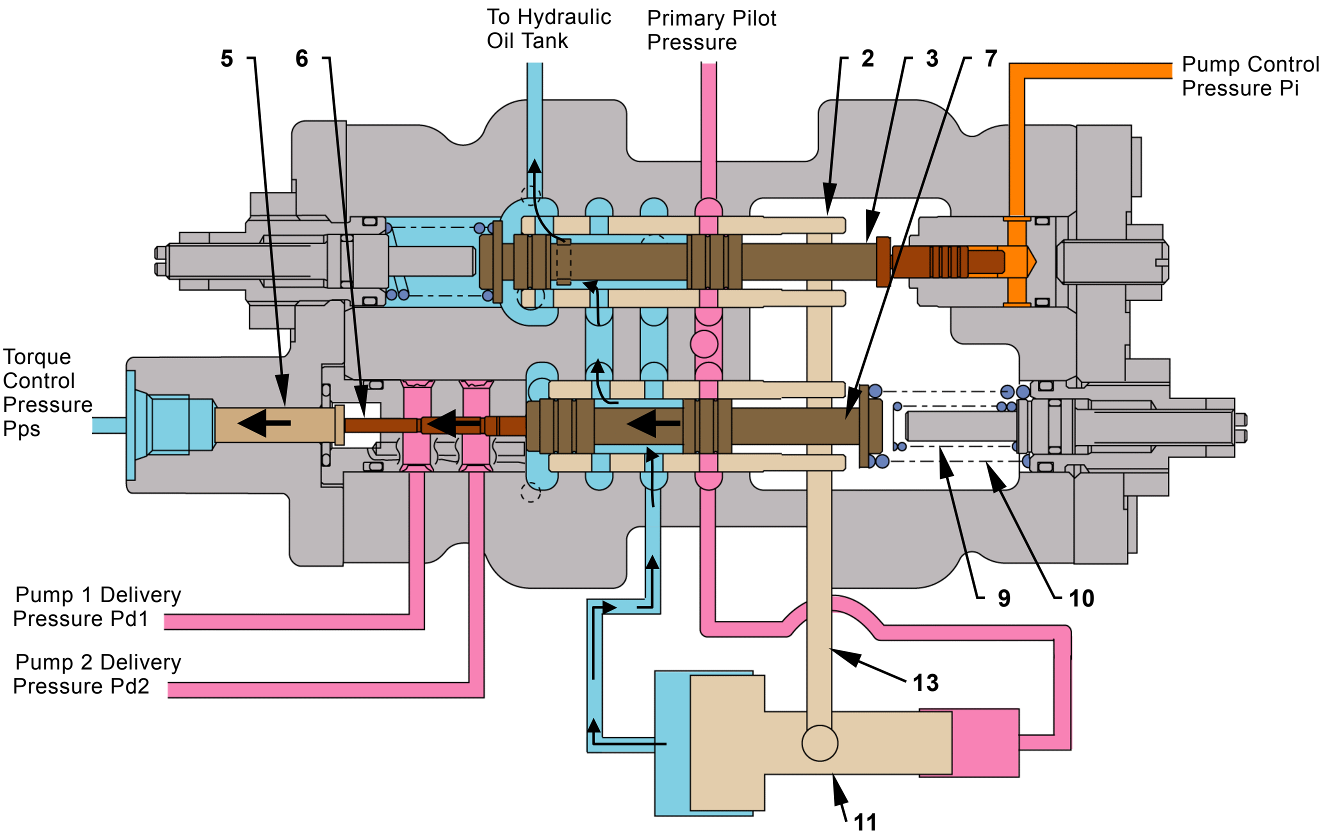
1. When the pump load is reduced, either pump 1 delivery pressure Pd1 or pump 2 delivery pressure Pd2 decreases. (During operation, pump control pressure Pi is kept increased.)
2. Load piston 1 (5), load piston 2 (6) and spool B (7) are pushed by inner spring (9) and outer spring (10). Spool B (7) moves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



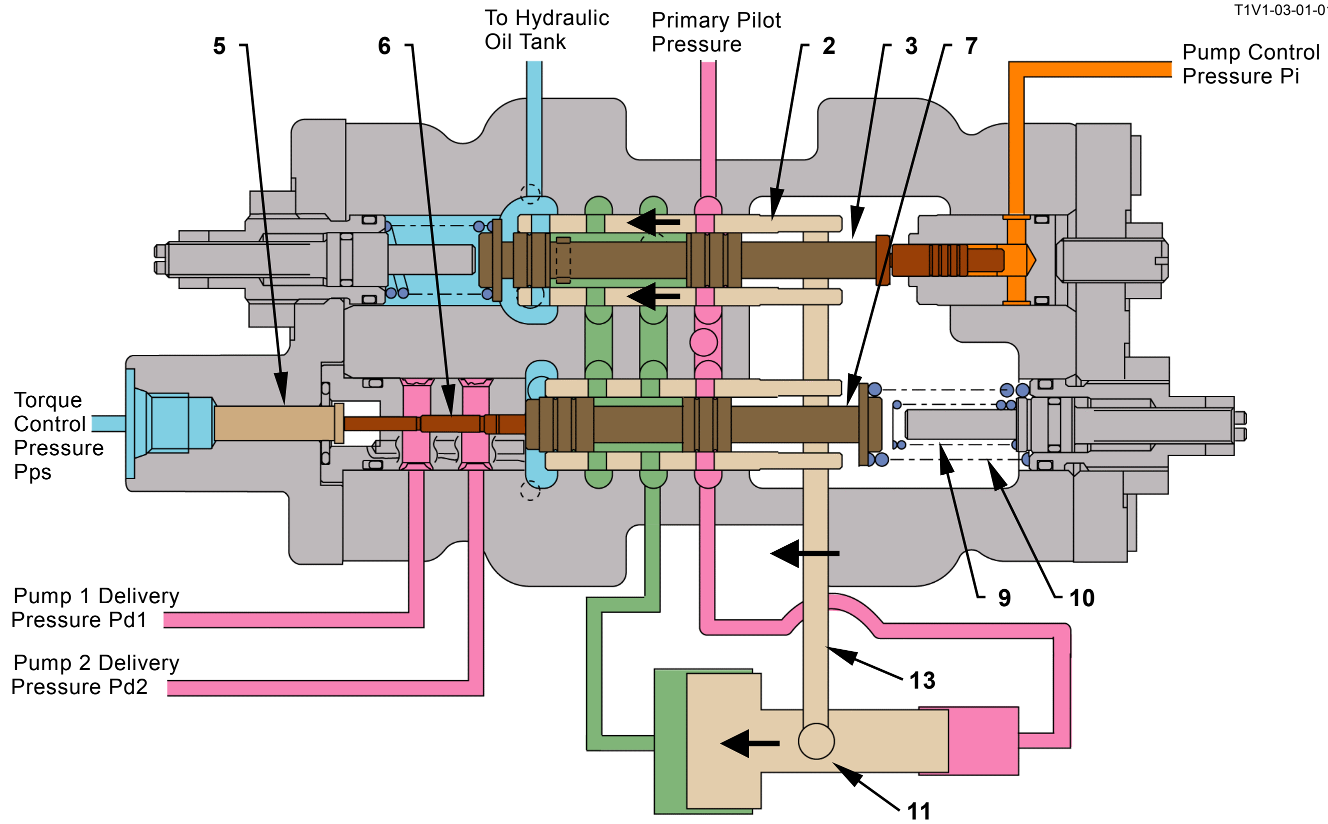


2 - Sleeve A	9 - Inner Spring
3 - Spool A	10 - Outer Spring
5 - Load Piston 1	11 - Servo Piston
6 - Load Piston 2	13 - Link
7 - Spool B	

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



T1V1-03-01-016



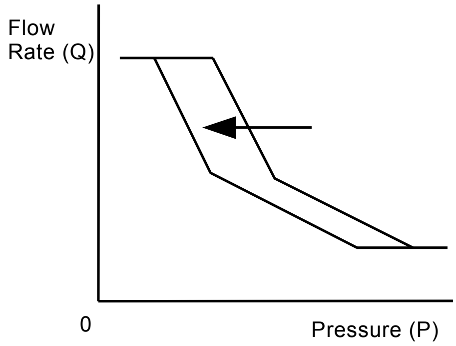
T1V1-03-01-017

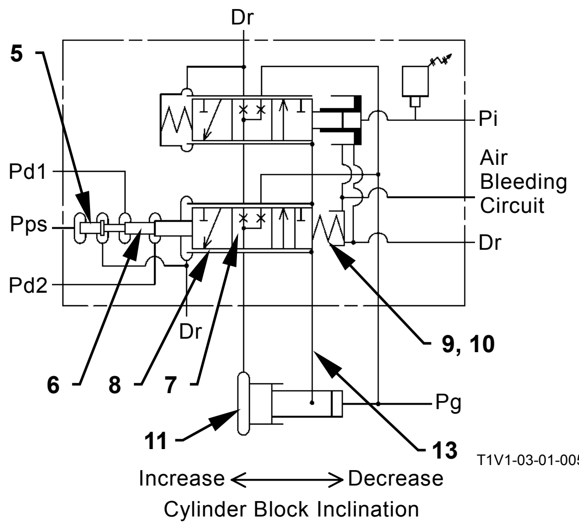
2 - Sleeve A
3 - Spool A
6 - Load Piston 2
7 - Spool B
9 - Inner Spring
10 - Outer Spring
11 - Servo Piston
13 - Link

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 1 delivery pressure Pd1 or pump 2 delivery pressure Pd2 are combined and applied to load piston 1 (5).
3. Load piston 1 (5) pushes load piston 2 (6), spool B (7) and inner spring (9) and outer spring (10). Spool B (7) moves toward direction of the arrow.
4. Due to the movement of spool B (7), pilot pressure is routed into the large chamber of servo piston (11).
5. Due to the difference in diameter between the large and small chambers, servo piston (11) is moved toward direction of the arrow. Therefore, the cylinder block is rotated in the minimum inclination direction and the pump delivery flow rate decreases.
6. The movement of cylinder block is transmitted to sleeve B (8) via link (13). Sleeve B (8) is moved in the same direction as spool B (7).
7. When sleeve B (8) is moved by the same stroke as spool B (7), the open part between sleeve B (8) and spool B (7) is closed and pilot pressure to the large chamber of servo piston (11) is blocked. Therefore, servo piston (11) is stopped and the flow rate decreasing operation is completed.

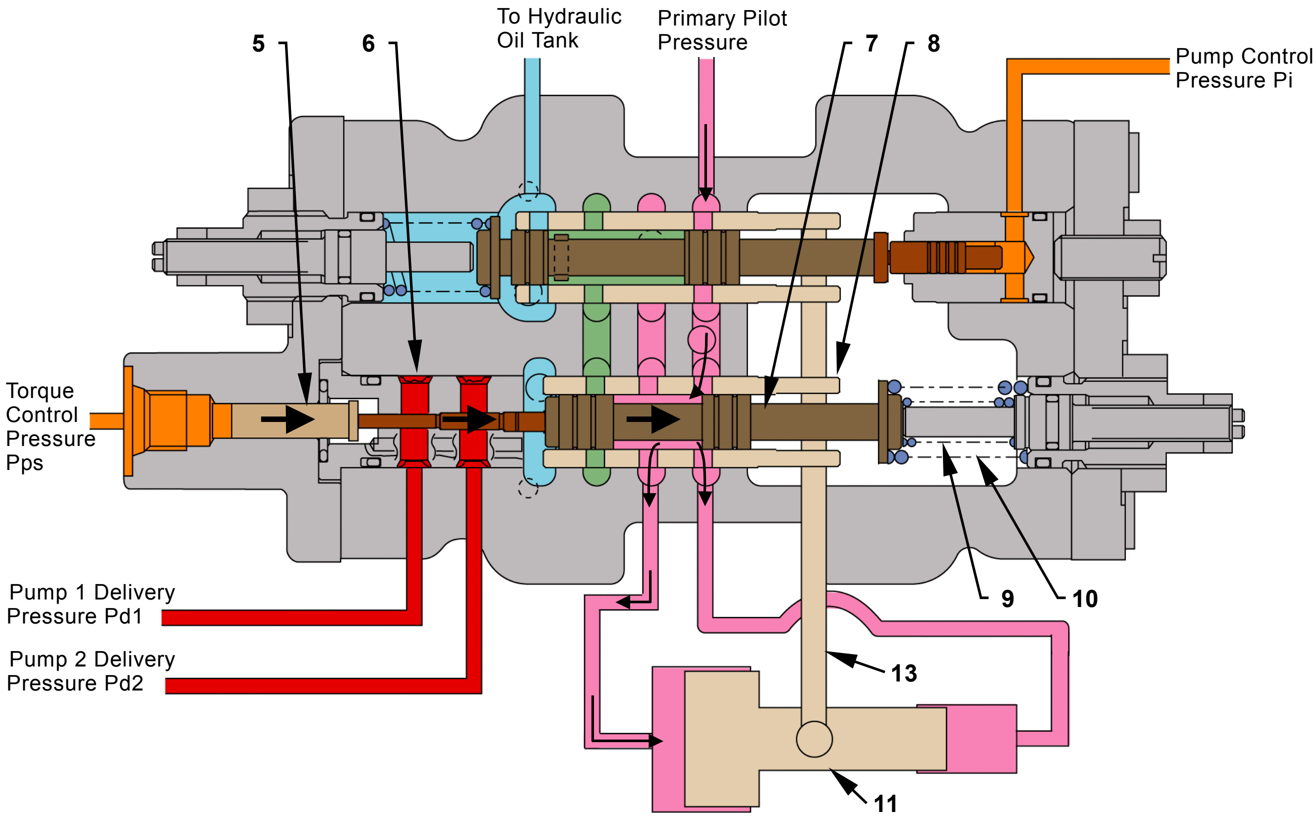




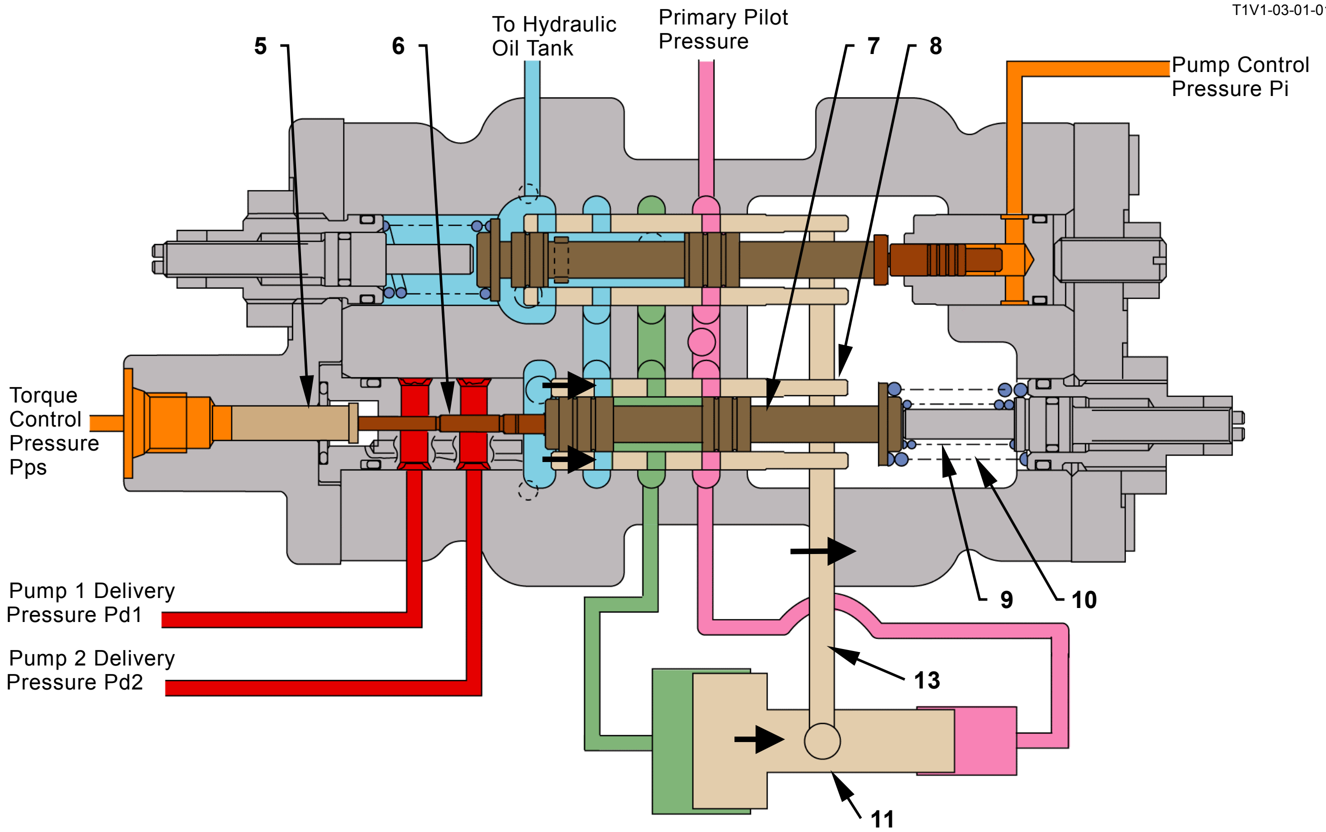
T1V1-03-01-005

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

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



T1V1-03-01-018



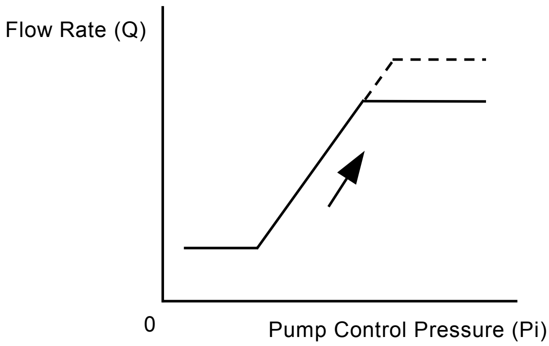
T1V1-03-01-019

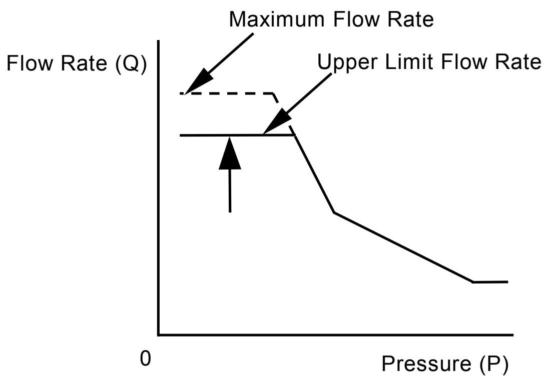
5 - Load Piston 1
6 - Load Piston 2
7 - Spool B
8 - Sleeve B
9 - Inner Spring
10 - Outer Spring
11 - Servo Piston
13 - Link

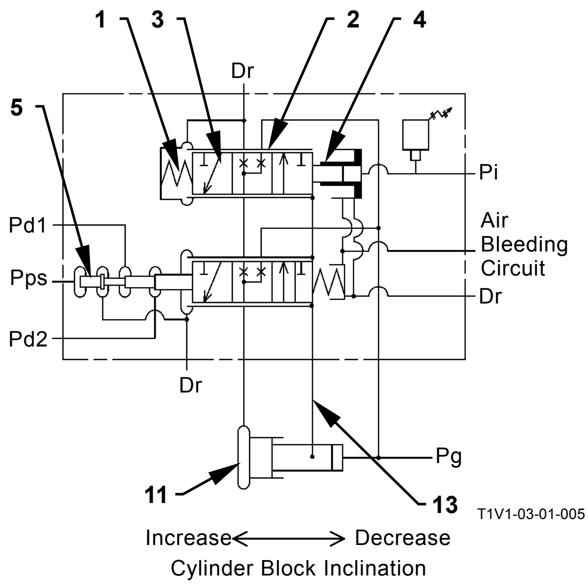
Control by Pilot Pressure from Flow Rate Control Solenoid Valve

- 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 pressure 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 the small chamber of servo piston (11), servo piston (11) is moved toward direction of the arrow. Therefore, the cylinder block is rotated in the maximum inclination direction and the pump delivery flow rate increases.
8. The movement of cylinder block is transmitted to sleeve A (2) via link (13). Sleeve A (2) is moved in the same direction as spool A (3).
9. When sleeve A (2) is moved by the same stroke as spool A (3), the open part between spool A (3) and sleeve A (2) is closed and pilot pressure to the large chamber of servo piston (11) is blocked.
10. Therefore, servo piston (11) is stopped and the flow rate increasing operation is completed.
11. Accordingly, pump control pressure 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 (11) are reduced so that the maximum flow rate becomes less than usual.

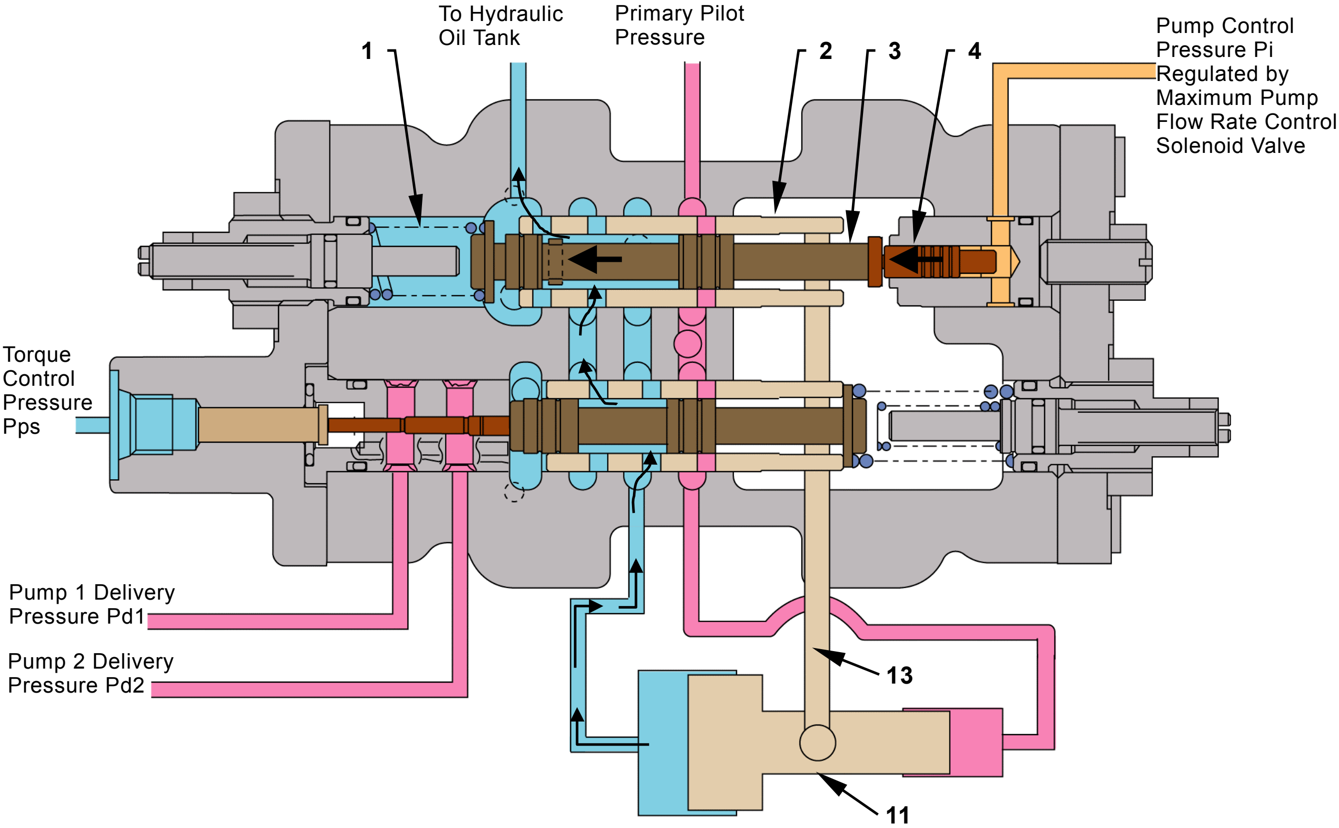




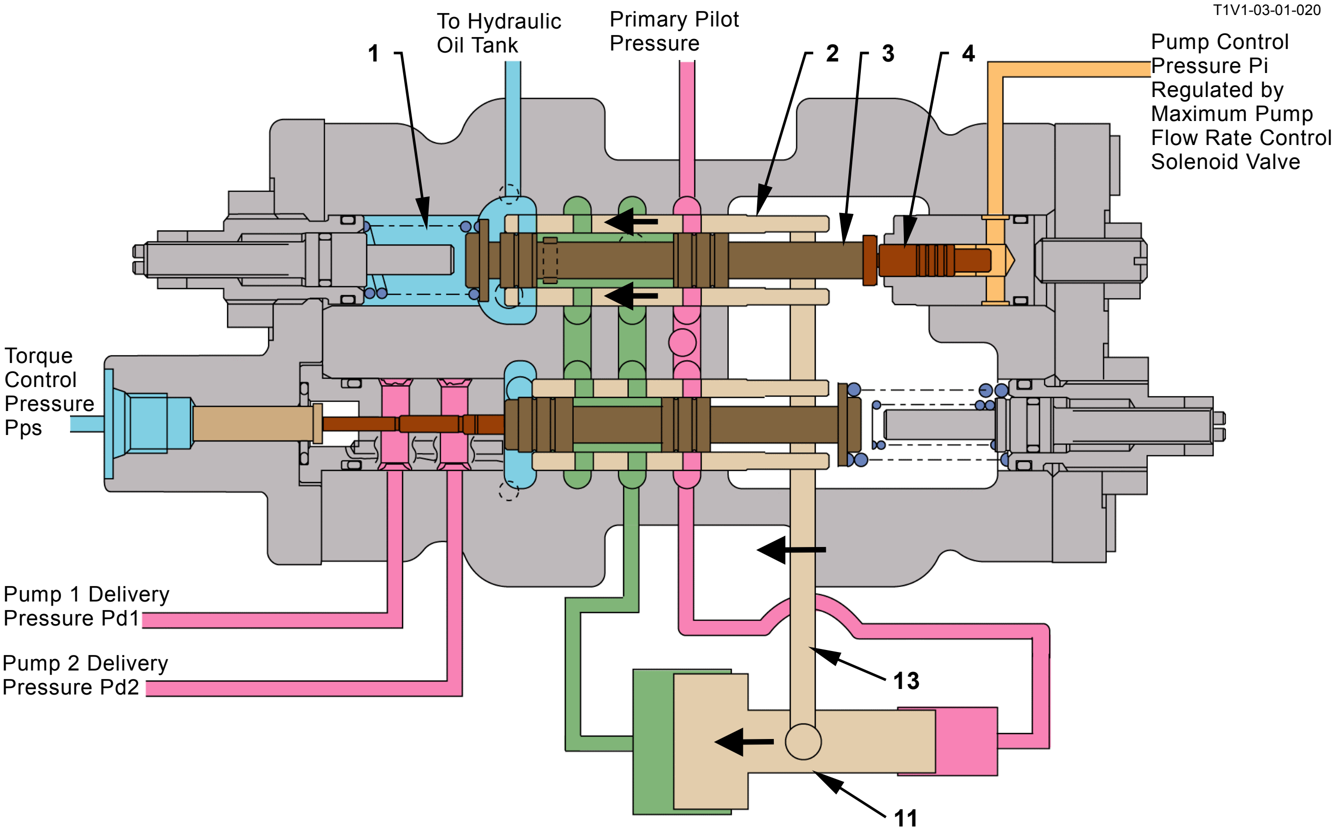


1 - Spring	4 - Piston
2 - Sleeve A	11 - Servo Piston
3 - Spool A	13 - Link

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



T1V1-03-01-020



T1V1-03-01-021

1 - Spring	3 - Spool A	11 - Servo Piston	13 - Link
2 - Sleeve A	4 - Piston		

SOLENOID VALVE

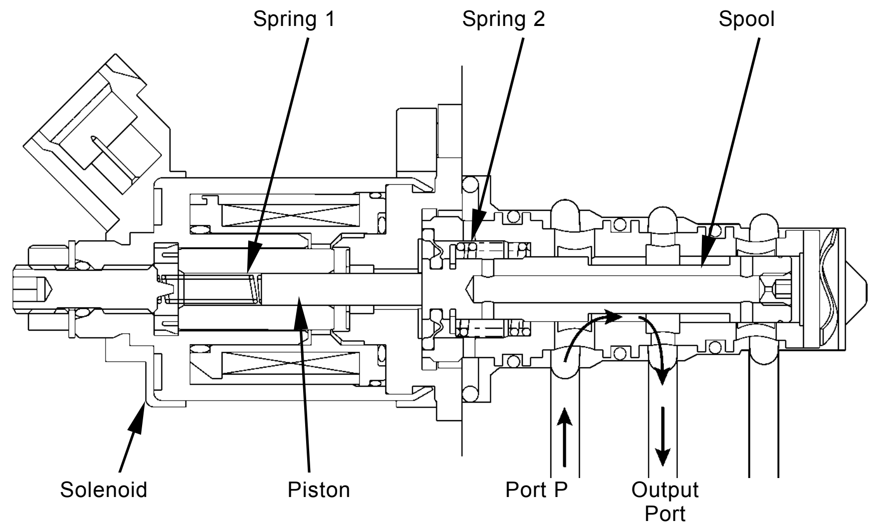
The torque control solenoid valve and maximum pump 2 flow rate limit control solenoid valve are provided on the pump 2 regulator. The torque control solenoid valve supplies torque control pressure Pps to both the pump 1 and pump 2 regulators and the pump delivery flow rate decreases. The maximum pump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

Operation

1. When in neutral, port P is connected to the output port through the notch on spool.
2. When the current flows to the solenoid from the main controller (MC), the solenoid is magnetized and pushes the piston.
3. The piston pushes the spool so that the output port is connected to port T through the notch on spool.
4. Thereby, pressure at the output port begins to decrease.
5. As for the notch, spool diameter (B) is larger than spool diameter (A).
6. Accordingly, when pressure at the output port begins to decrease, the spool is move toward the right side because of the force as $Fsol + P1 \times B + S1 > P1 \times A + S2$.
7. When pressure at the output port disappears and when $Fsol + P1 \times B + S1$ becomes equal to $P1 \times A + S2$, the spool stops moving.

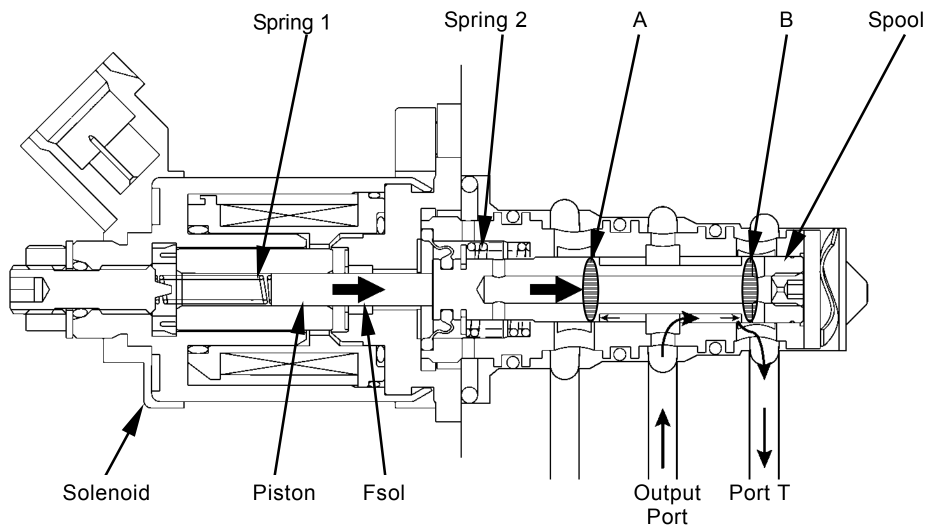
P1 : Pressure at the output port
A and B: Pressure receiving area on the spool
S1 : Spring 1 force
(pushing the spool toward the right side)
S2 : Spring 2 force
(pushing the spool toward the left side)
Fsol: Force of the solenoid

Neutral state:



T1V1-03-01-002

Operating state:

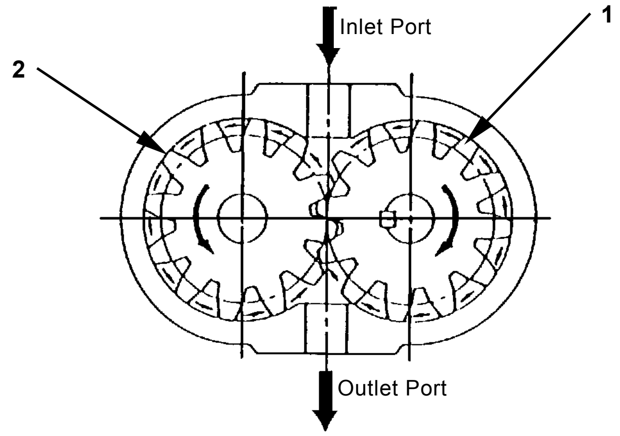


T1V1-03-01-003

PILOT PUMP

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

1 - Drive Gear
2 - Driven Gear

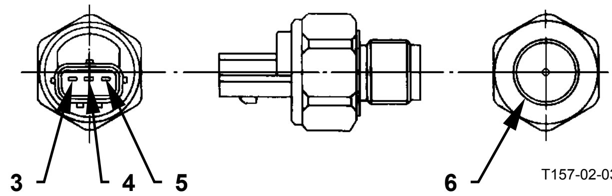


T137-02-03-005

PUMP DELIVERY PRESSURE SENSOR

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

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

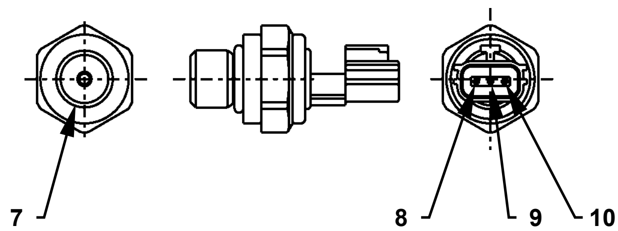


T157-02-03-010

PUMP CONTROL PRESSURE SENSOR

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

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

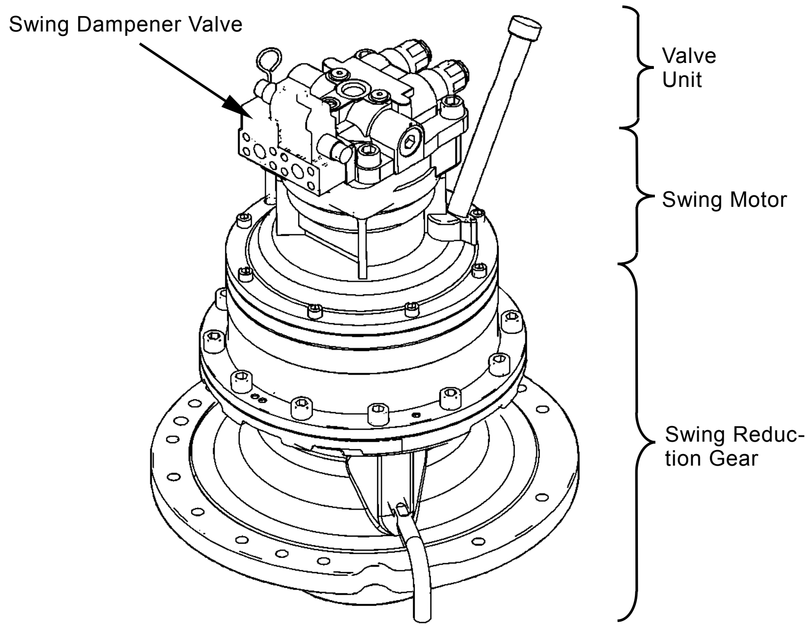


T176-03-01-023

OUTLINE

The swing device consists of the valve unit, the swing motor and the swing reduction gear.
The valve unit prevents the cavitation and overloads in the swing circuit.
The swing motor is a swash plate type axial plunger motor (with built-in swing parking brake), which is driven by pressure oil from the pump, and the rotation is transmitted to the swing reduction gear.
The swing reduction gear turns the swing motor with large torque at a low speed and swings the upper-structure.

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



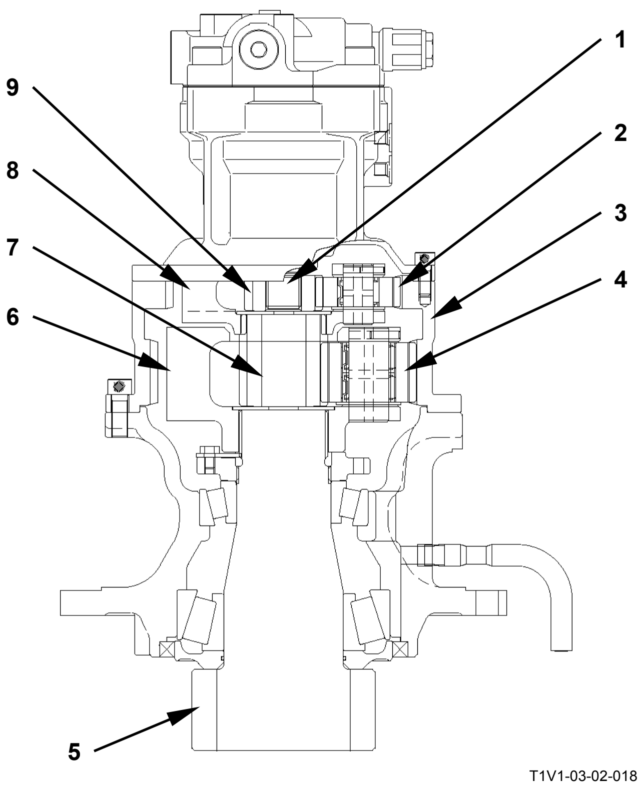
T1V1-03-02-003

SWING REDUCTION GEAR

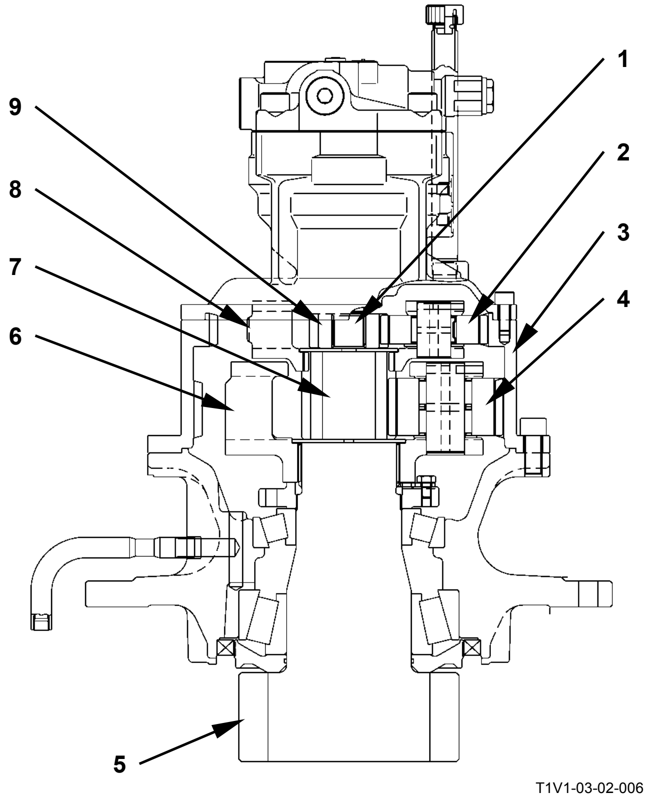
The swing reduction gear is a two-stage planetary reduction gear.
Ring gear (3) is monolithically built with the housing bolted to the upperstructure and does not allow to rotate.
Shaft (1) of the swing motor turns first stage sun gear (9), whose turning torque is transmitted to second stage sun gear (7) through first stage planetary gear (2) and first stage carrier (8).
Second stage sun gear (7) turns shaft (5) through second stage planetary gear (4) and second stage carrier (6).

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

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class

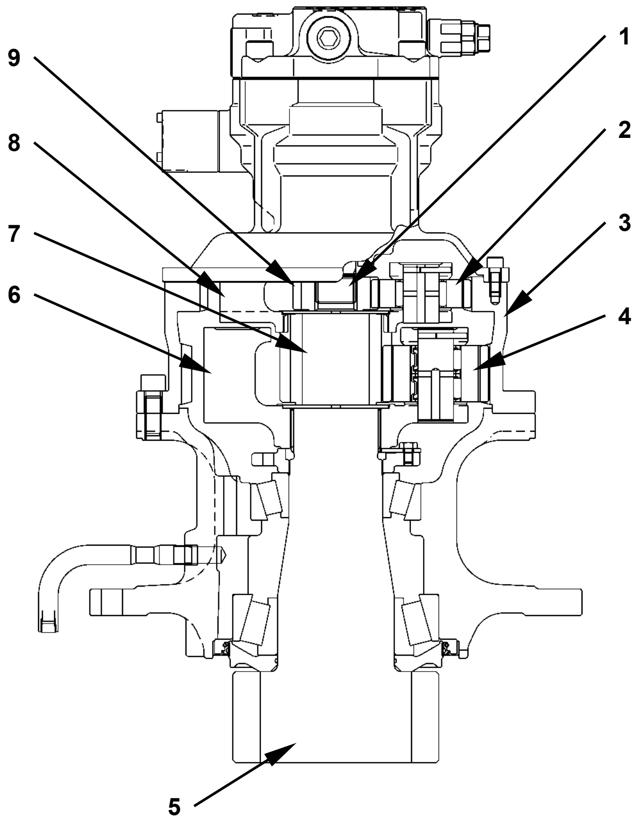


ZX240-3 class



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

ZX270-3 class



T1V1-03-02-007

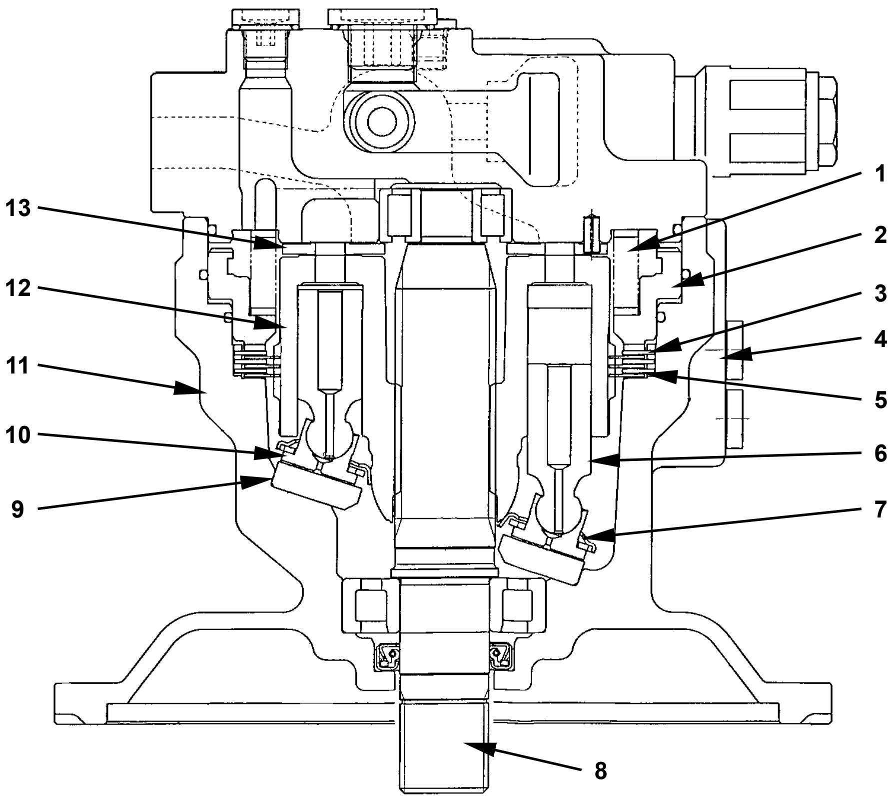
1 - Shaft (Swing Motor)
2 - First Stage Planetary Gear
3 - Ring Gear
4 - Second Stage Planetary Gear
5 - Shaft
6 - Second Stage Carrier
7 - Second Stage Sun Gear
8 - First Stage Carrier
9 - First Stage Sun Gear

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.

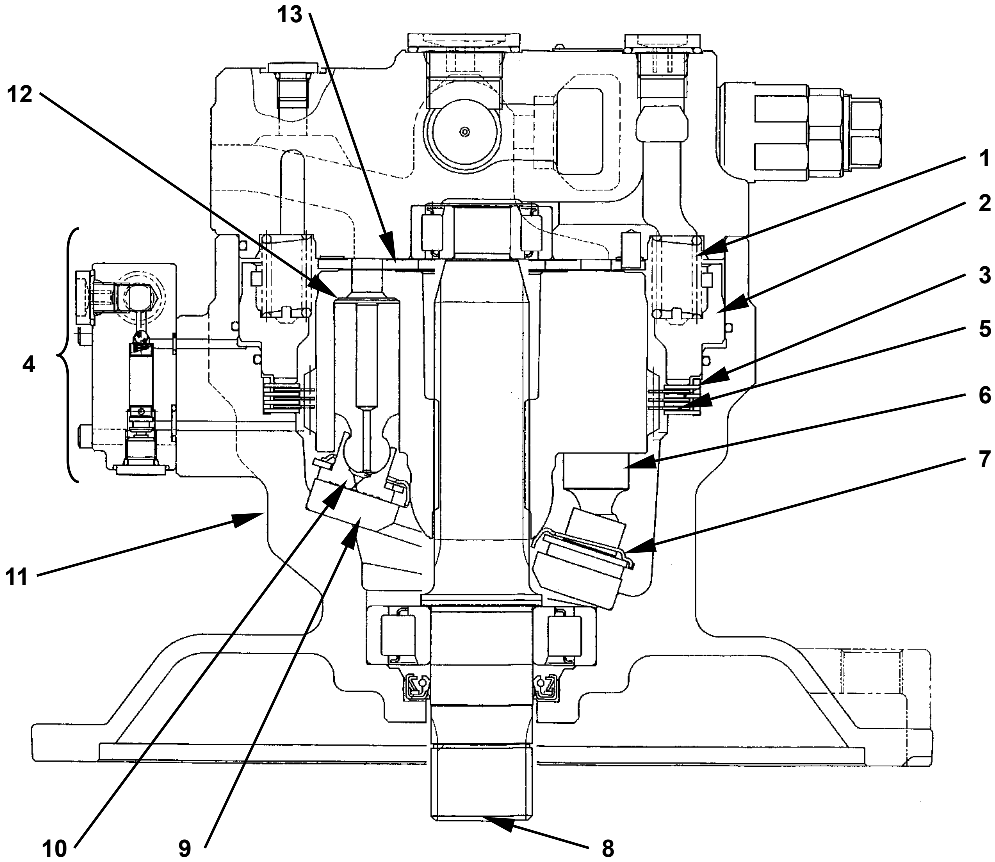
ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class



T1V1-03-02-008

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

ZX270-3 class



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 multi-plate disc brake and a negative mechanism that releases the brake when brake release pressure acts on the brake piston chamber.
The brake release pressure is supplied from the pilot pump only when either swing or front attachment is operated.
In other cases (including engine stopping), the brake release pressure returns to the hydraulic oil tank, so that the brake is applied automatically by the spring.

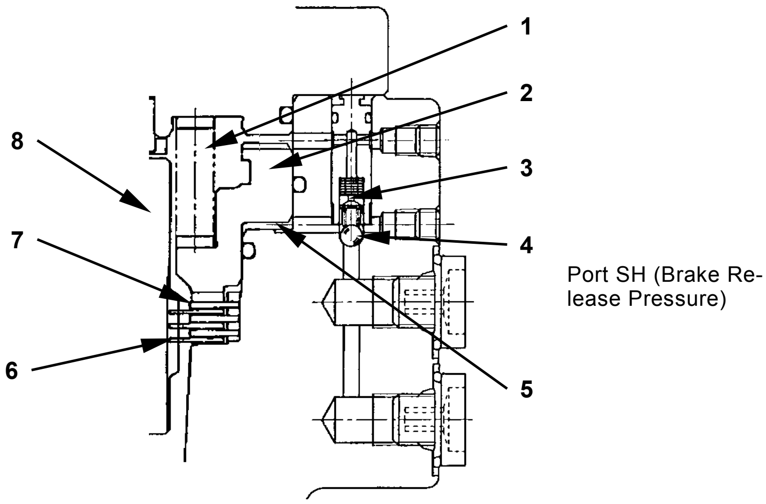
When Brake is Released

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

When Brake is Applied

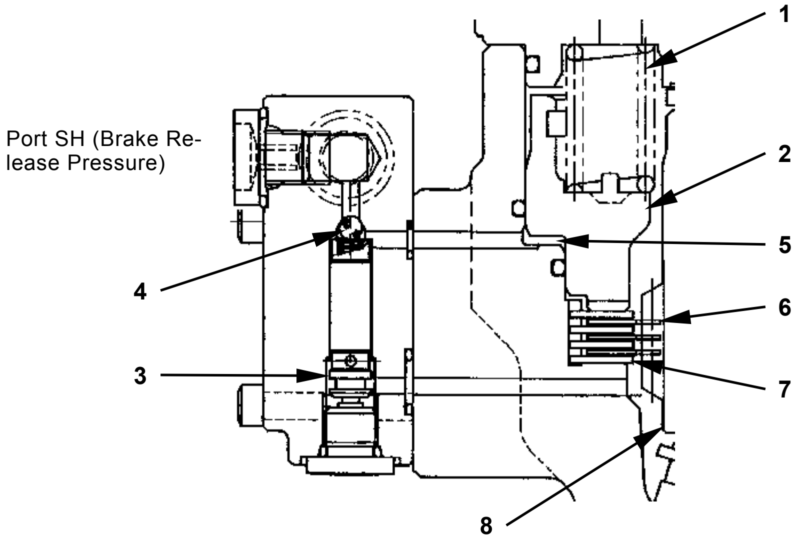
1. When the swing or front attachment control lever is returned to neutral, the swing parking brake release spool in signal control valve is returned to neutral and pilot pressure to port SH disappears.
2. Check valve (4) is closed and the brake release pressure through orifice (3) is released to the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

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class



T178-03-02-003

ZX270-3 class



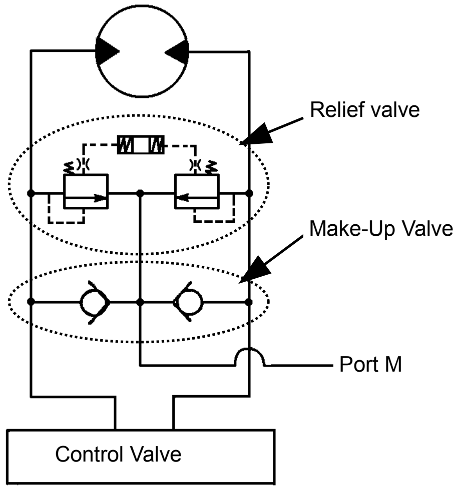
T1V7-03-02-002

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

VALVE UNIT

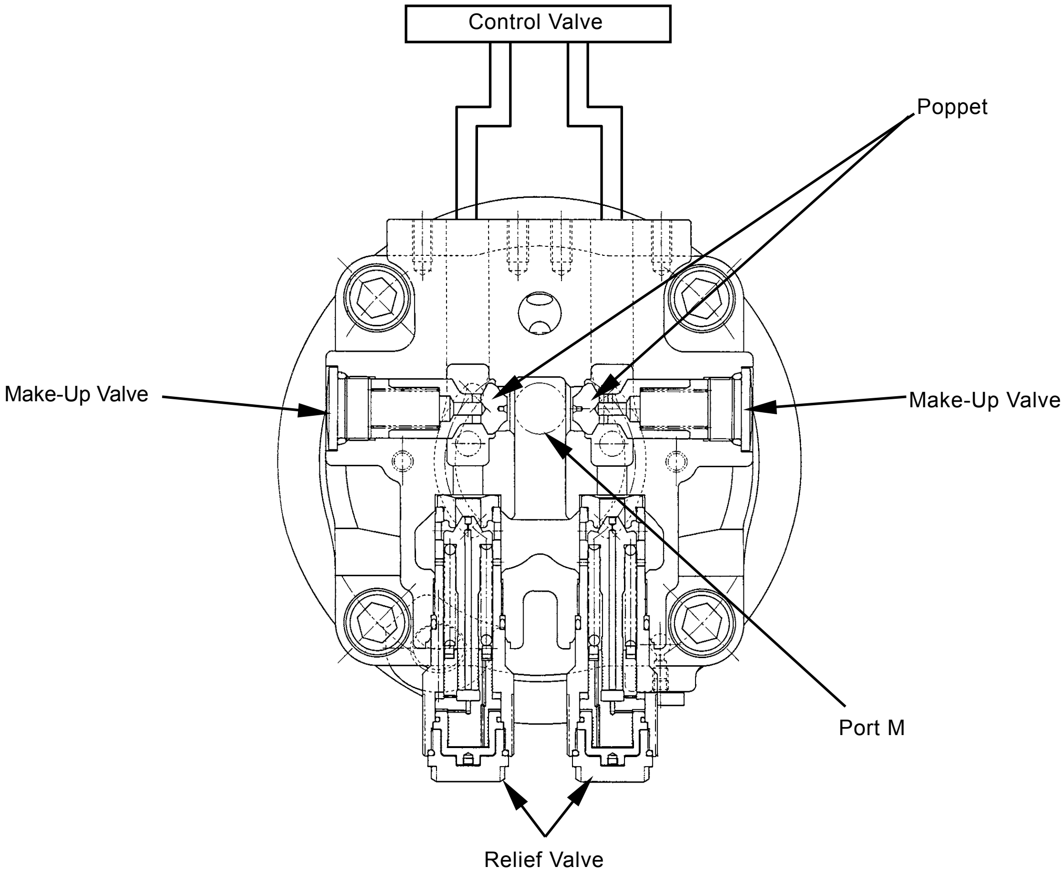
The valve unit consists of make-up valve and relief valve.
The make-up valve prevents cavitation in the circuit and the relief valve prevents surge pressure and overloads in the circuit.

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.



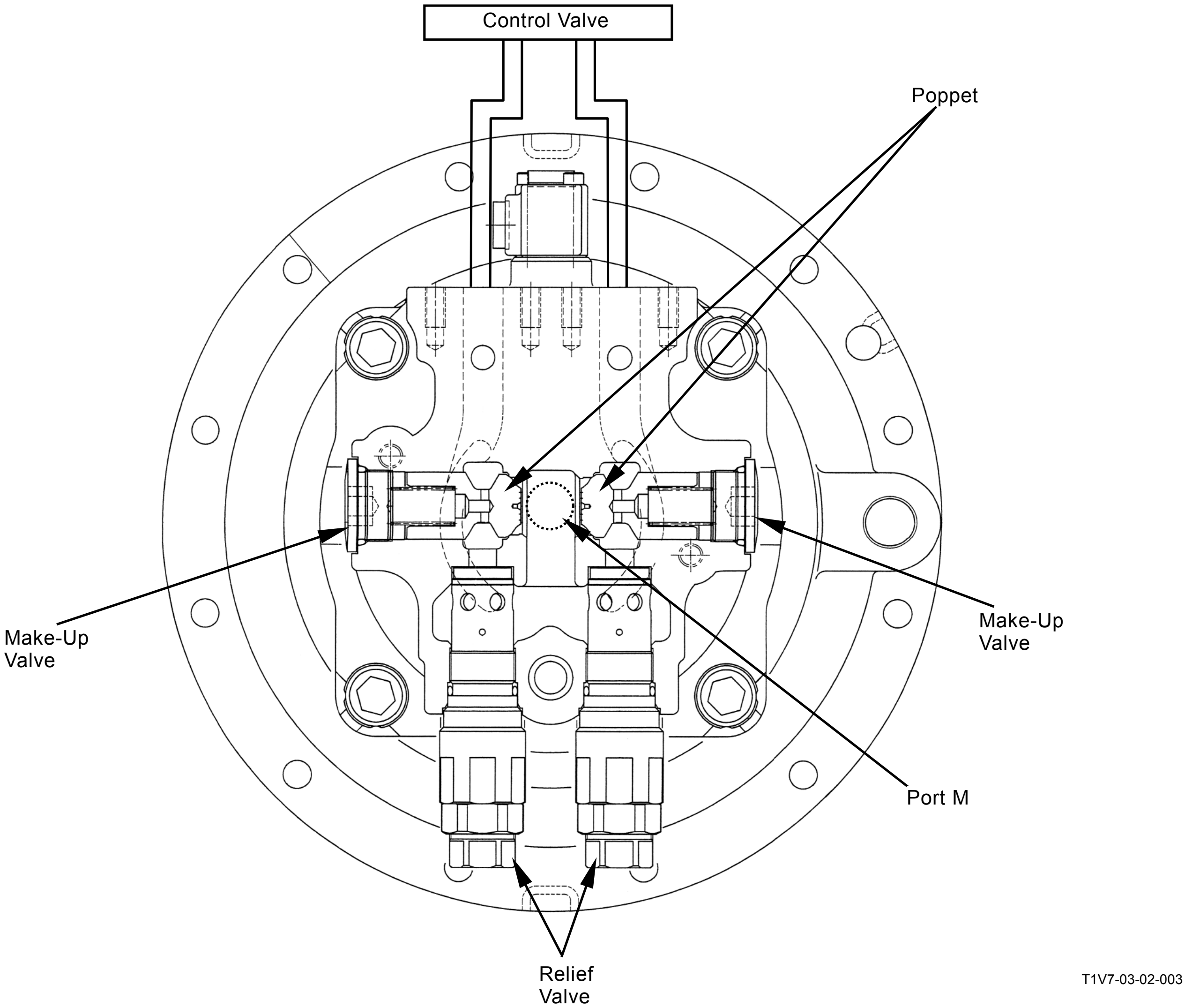
T107-02-04-013

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class



T1V1-03-02-011

ZX270-3 class



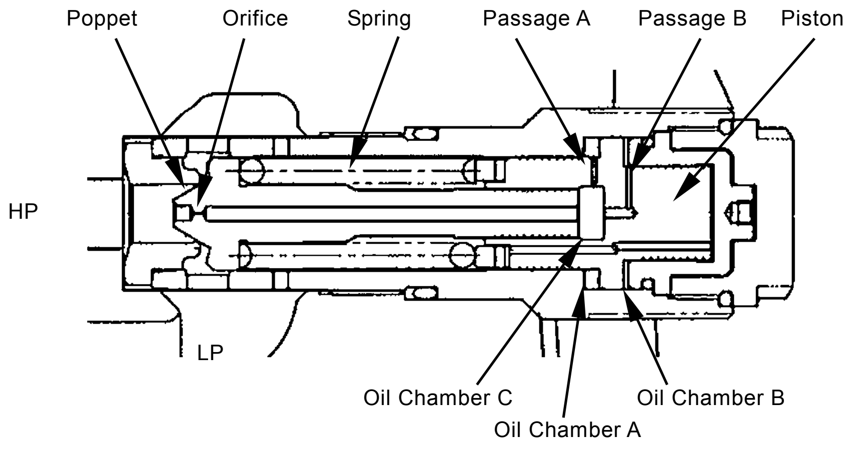
Relief Valve

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

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class

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

- High Pressure Relief Operation (Overload Prevention):
  1. After the piston is moved to full stroke, the spring is compressed so that the circuit pressure becomes the set-pressure.
  2. If pressure at port HP increases more than the spring set-pressure, the poppet is unseated and pressure oil flows to port LP.
  3. When pressure at port HP is reduced to the specified level, the poppet is seated by the spring force.

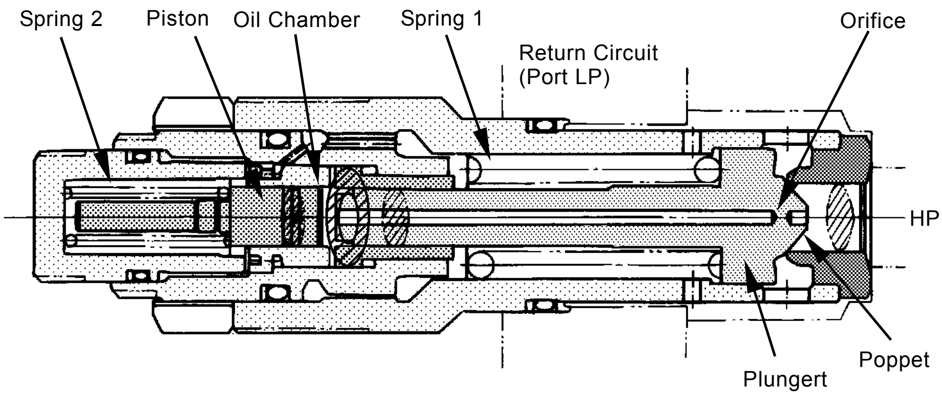


T178-03-02-005

ZX270-3 class

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

- High Pressure Relief Operation (Overload Prevention):
  1. After the piston is moved to full stroke, the circuit pressure becomes the relief set-pressure.
  2. If pressure at port HP increases more than the spring 1 set-pressure, the poppet is unseated pressure oil flows to port LP.
  3. When pressure at port HP is reduced to the specified level, the poppet is seated by the spring 1 force.



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

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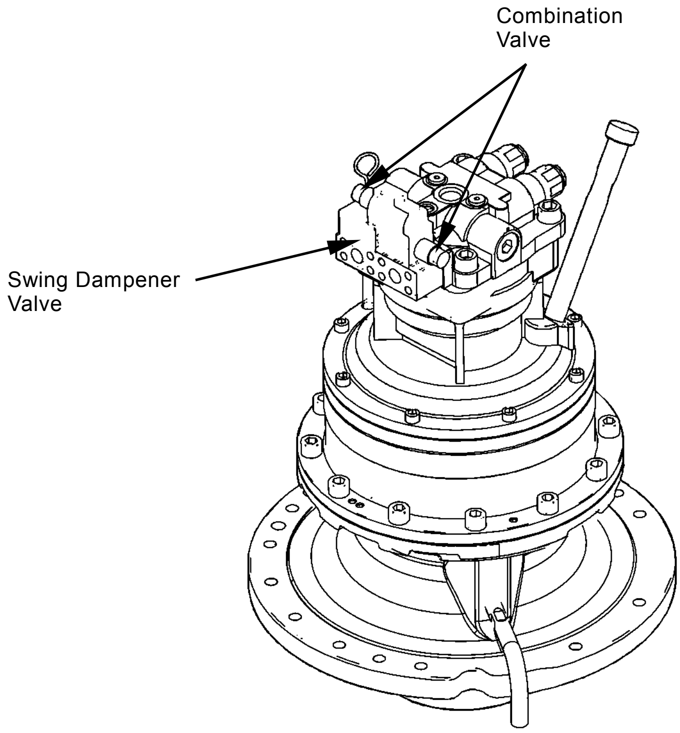
SWING DAMPENER VALVE

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.



T1V1-03-02-003

Operation

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

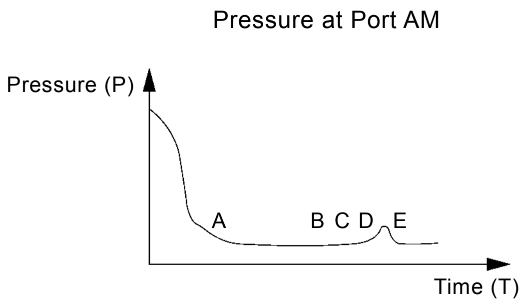
1. When releasing the control lever, the spool in control valve moves to the neutral position. As the swing motor rotates due to the inertia force of machine, pressure in the circuit at port BM (return side) increases momentarily and operates the swing relief valve.
2. Pressure oil from port BM acts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

- Operation of Combination Valve (A):

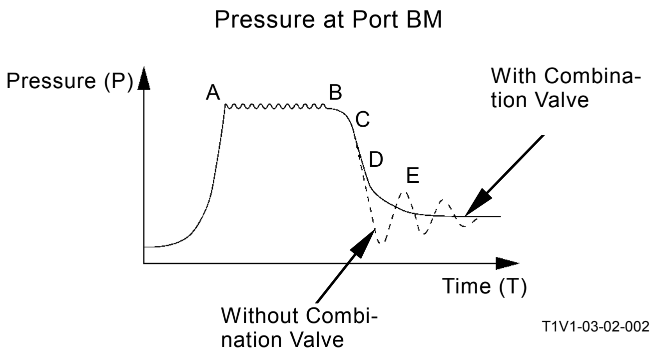
3. Pressure oil acting on combination valve (A) opens ball (2) and flows to chamber N through poppet (1).
4. When pressure in chamber N is larger than spring (4) force and spring (7) force (pressure in chamber N > spring (4) force + spring (7) force), piston (5) tries to move to the left. However, piston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

- Operation of Combination Valve (B):

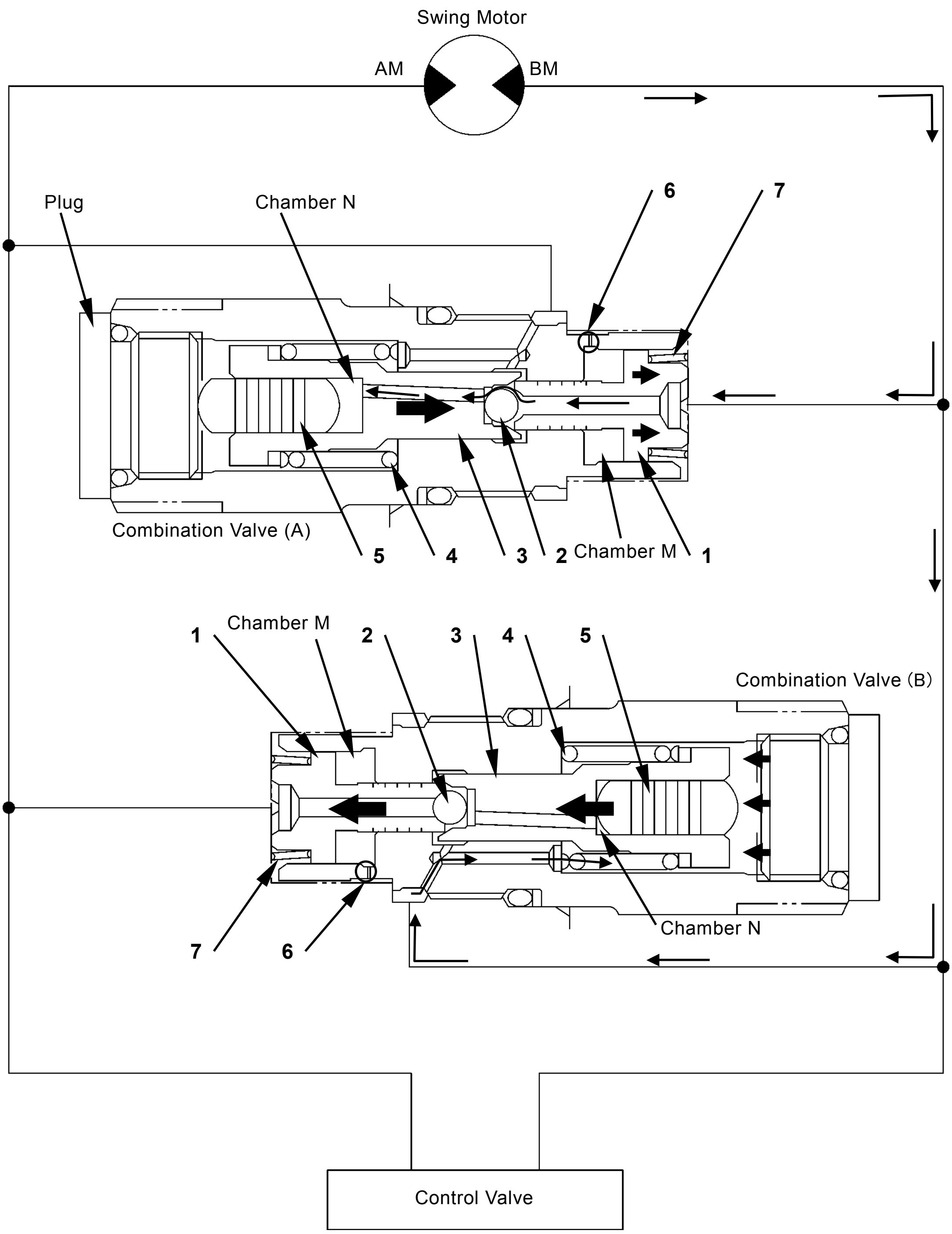
6. Pressure oil acting on combination valve (B) flows to the spring (4) chamber through the inner passage.
7. When pressure in spring (4) chamber is larger than spring (4) force and spring (7) force (pressure in spring (4) chamber > spring (4) force + spring (7) force), plunger (3), piston (5) and poppet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



T1V1-03-02-001



T1V1-03-02-002



T1V1-03-02-013

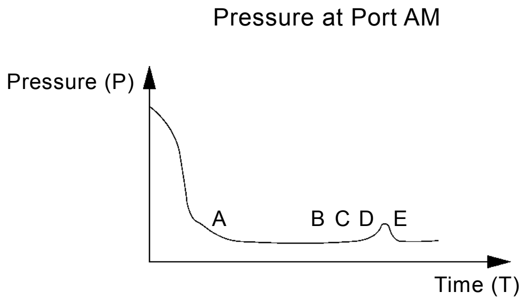
1 - Poppet	3 - Plunger	5 - Piston	7 - Spring
2 - Ball	4 - Spring	6 - Orifice	

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

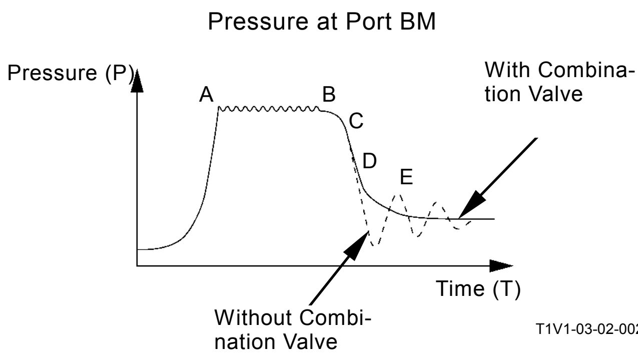
When the swing motor rotation due to the inertia force of machine is reduced, pressure at port BM decreases. At this time, combination valve (A) functions as the following.

- Operation of Combination Valve (A):

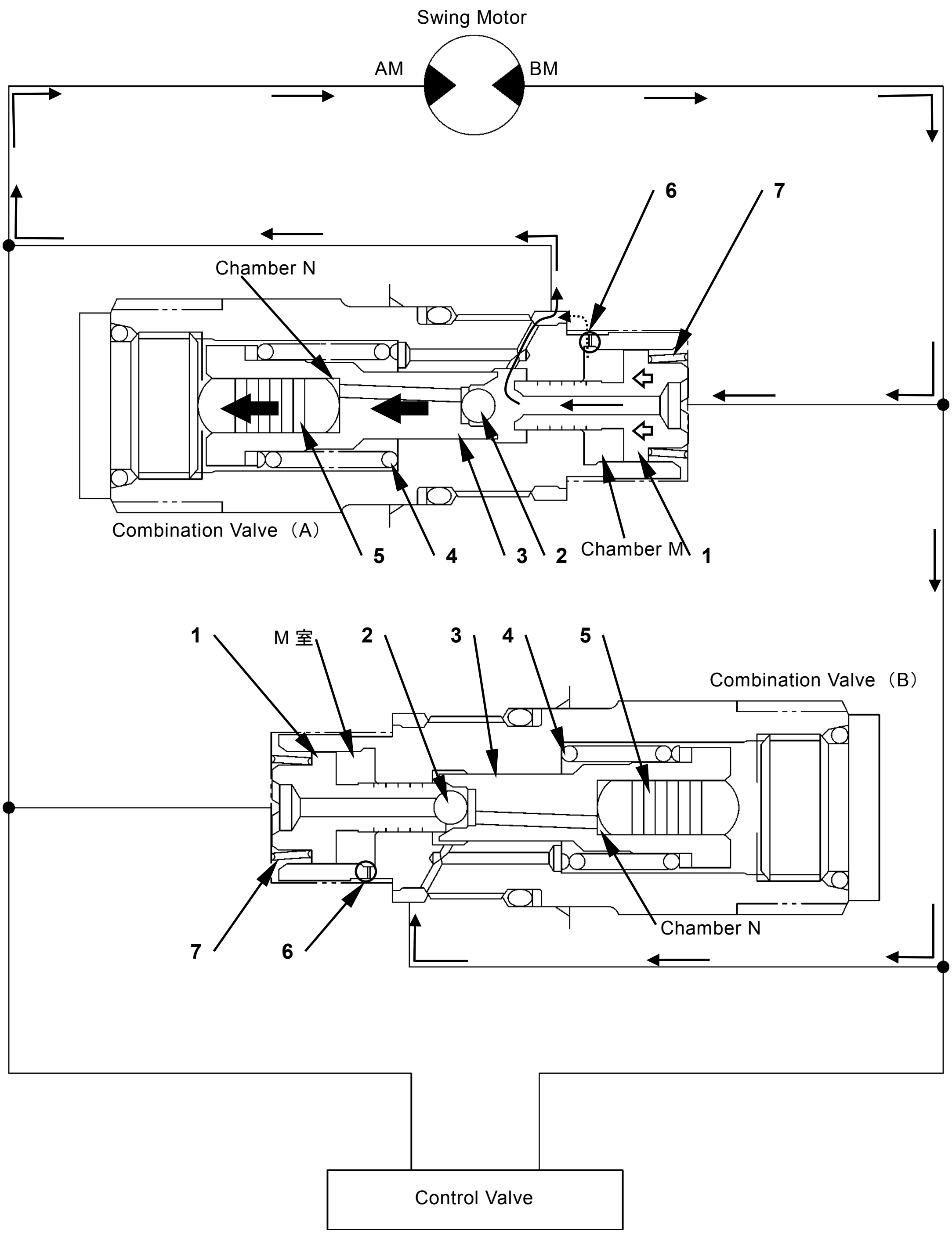
1. When pressure at port BM decreases, pressure acting to chamber N also decreases.
2. When pressure in chamber N becomes smaller than the spring (4) force, the spring (4) force moves plunger (3) to the left.
3. At the same time, poppet (1) is pushed to the left by the spring (7) force.
4. As the pressure 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).



T1V1-03-02-001



T1V1-03-02-002



T1V1-03-02-014

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

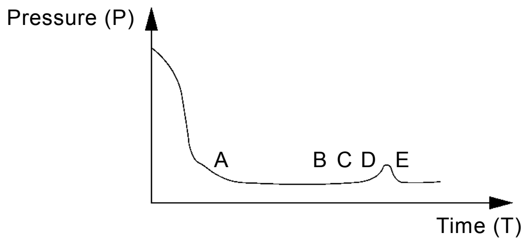
- Output Curve: Between C and D (Pressure at port BM decreases)

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):

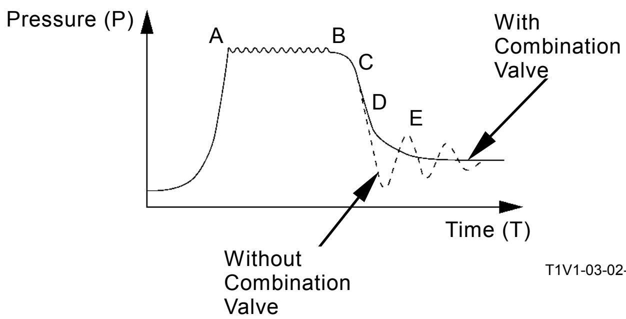
1. When pressure at port BM decreases more, pressure acting on the spring (4) chamber in combination valve (B) also decreases.
2. When pressure in the spring (4) chamber becomes smaller than the spring (4) force, the spring (4) force moves plunger (3) to the right.
3. At the same time, poppet (1) is pushed to the right by the spring (7) force.
4. As the pressure difference due to orifice (6) appears, pressure in chamber M increases.
5. Therefore, poppet (1) moves to the right more slowly.
6. Consequently, the clearance between poppet (1) and plunger (3) appears. Pressure oil from port BM acts on poppet (1) and ball (2).
7. Therefore, ball (2) is pushed by poppet (1). 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).

Pressure at Port AM

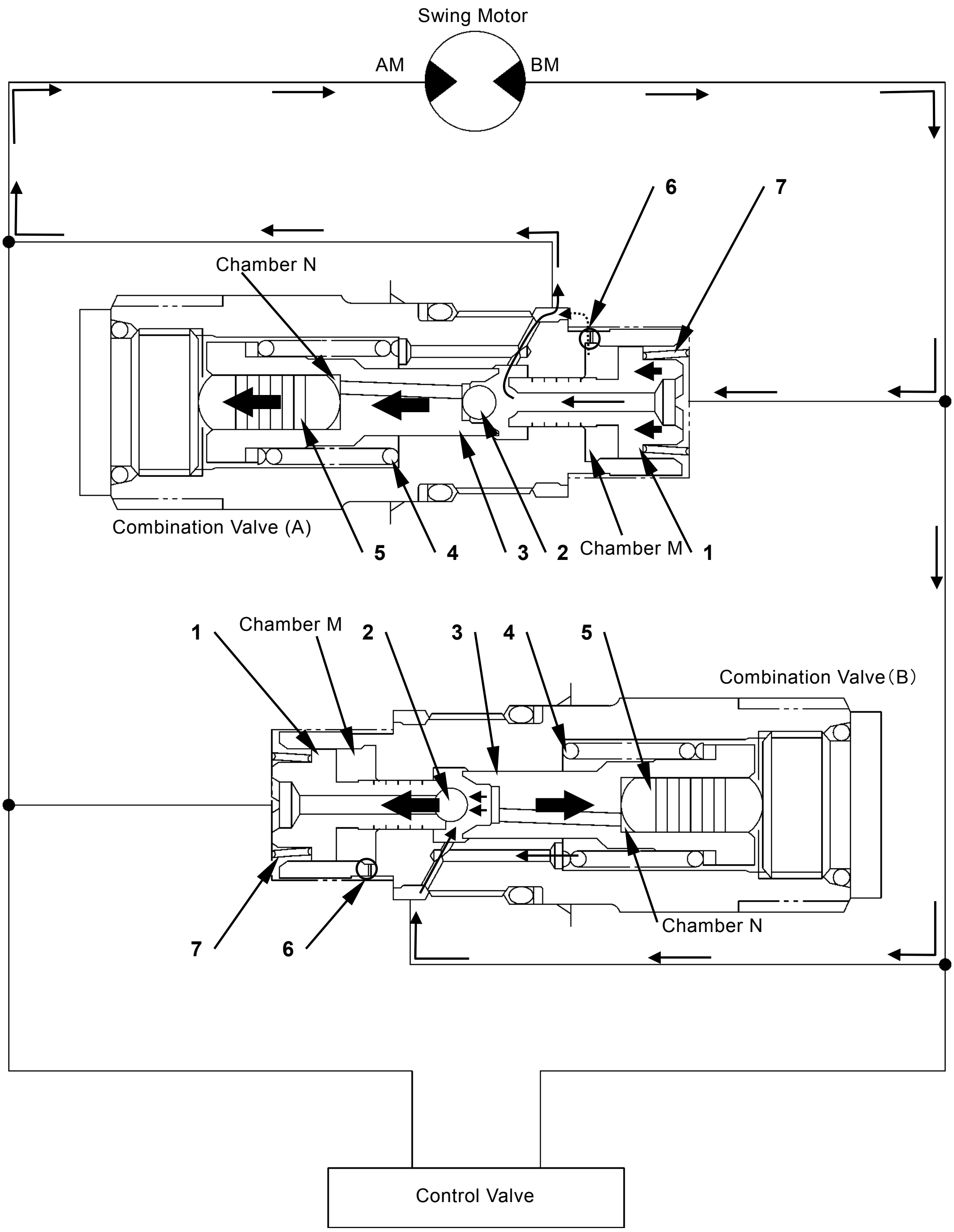


T1V1-03-02-001

Pressure at Port BM



T1V1-03-02-002



T1V1-03-02-015

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

• Output Curve: Between D and E (During aftershock)
When the swing motor stops rotating, aftershock pressure appears at port AM and pressure at port AM increases. (Port AM: High Pressure, Port BM: Low Pressure)
At this time, combination valves (A, B) function as the following.

- Operation of Combination Valve (A):

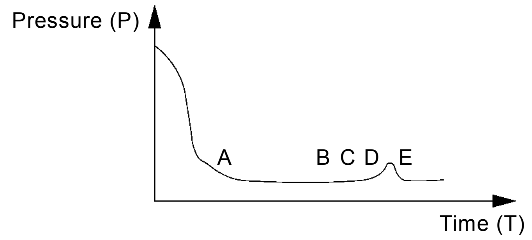
1. Pressure oil from port AM acts on ball (2) and poppet (1) through the inner passage.
2. Therefore, ball (2) and poppet (1) move to the right.
3. As combination valve (A) functions like this, and when aftershock pressure appears, pressure is relieved promptly.

- Operation of Combination Valve (B):

4. Pressure oil from port AM opens ball (2) and flows to port BM through poppet (1).
5. As combination valve (B) makes pressure oil from port AM (high-pressure) flow to port BM (low-pressure), pressure increase at high-pressure side is controlled and aftershock pressure is reduced.

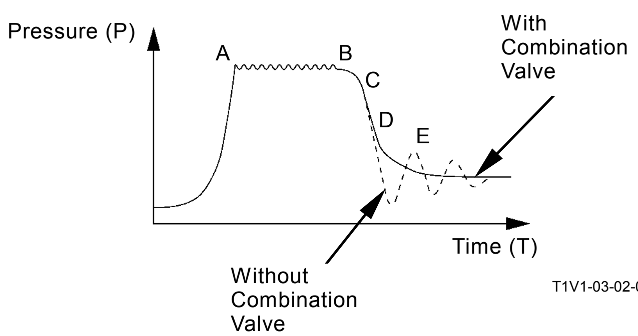
6. Combination valves (A, B) repeat these procedures and prevent aftershock of the machine.
When pressures at ports AM and BM decrease completely, the combination valve stops functioning.

Pressure at Port AM

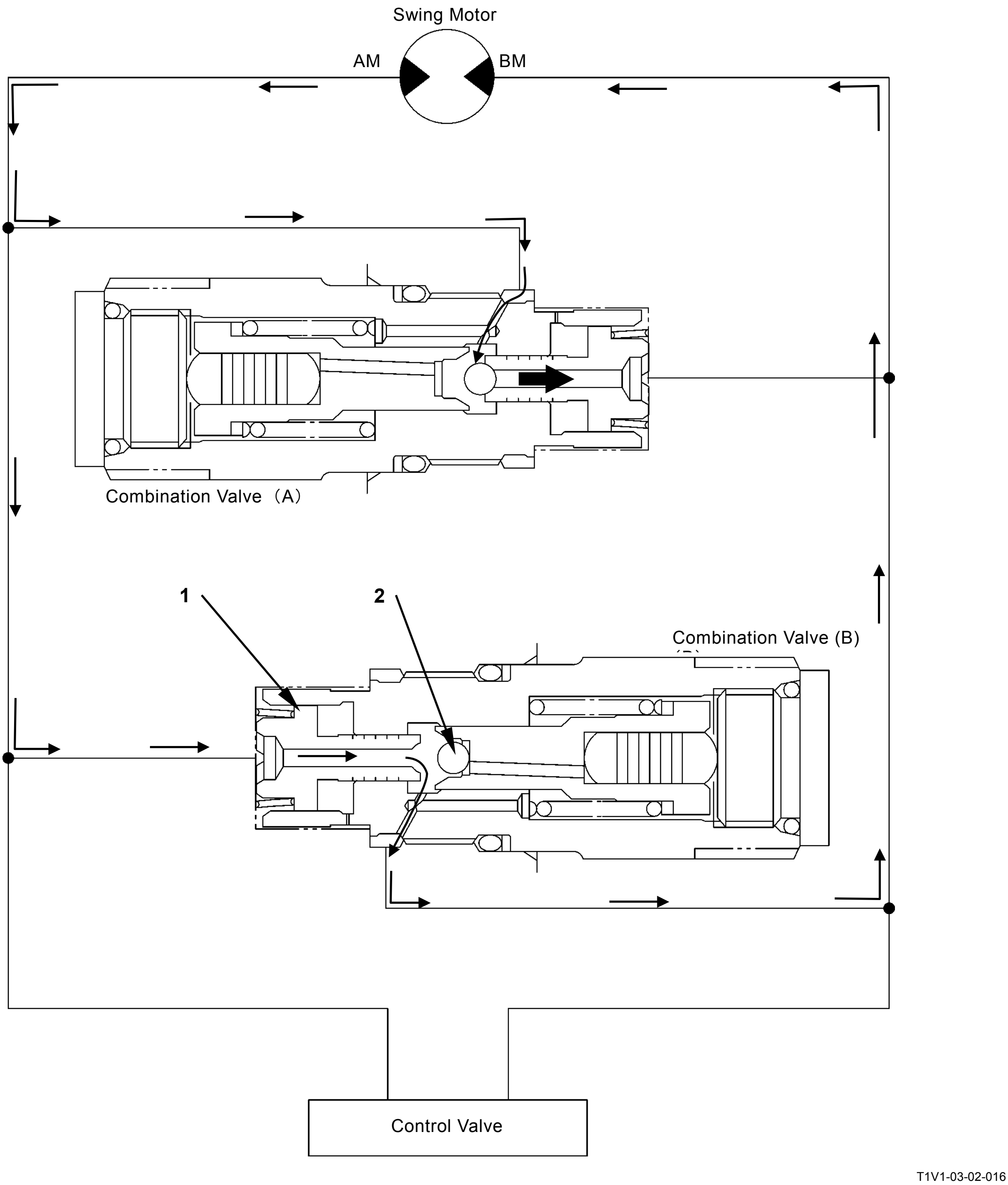


T1V1-03-02-001

Pressure at Port BM



T1V1-03-02-002



1 - Poppet
2 - Ball

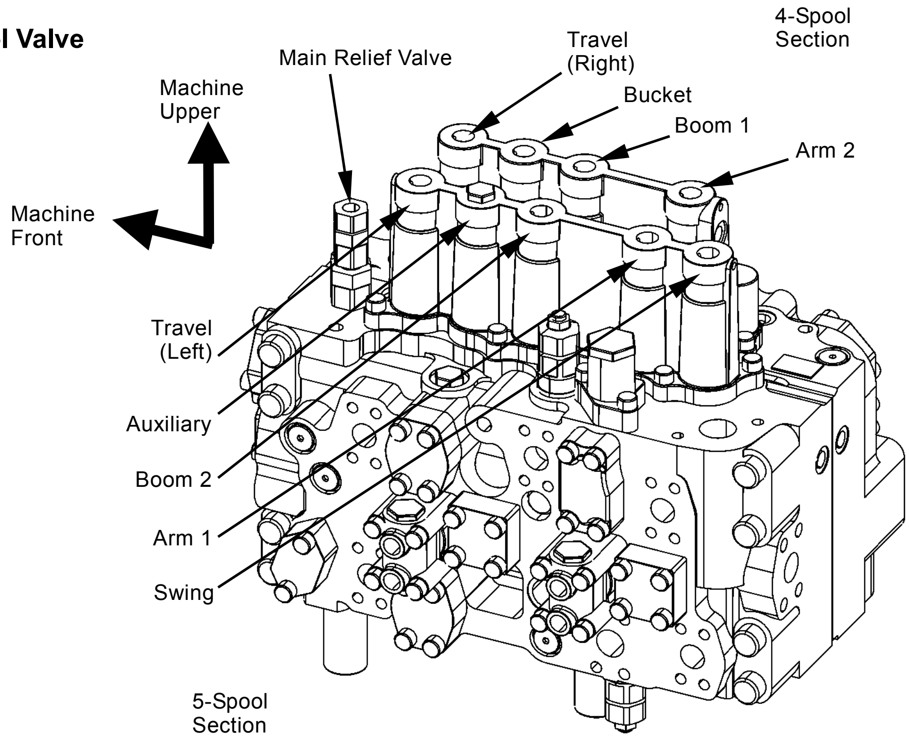
(Blank)

OUTLINE

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

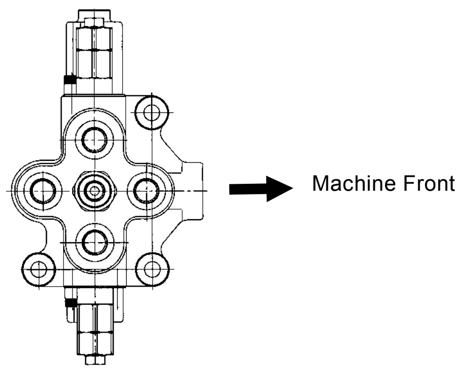
As for the spools, in the 4-spool section, right travel, bucket, boom 1 and arm 2 are arranged in that order as viewed from the machine front. In the 5-spool section, left travel, auxiliary, boom 2, arm 1 and swing are arranged in that order as viewed from the machine front.

Control Valve



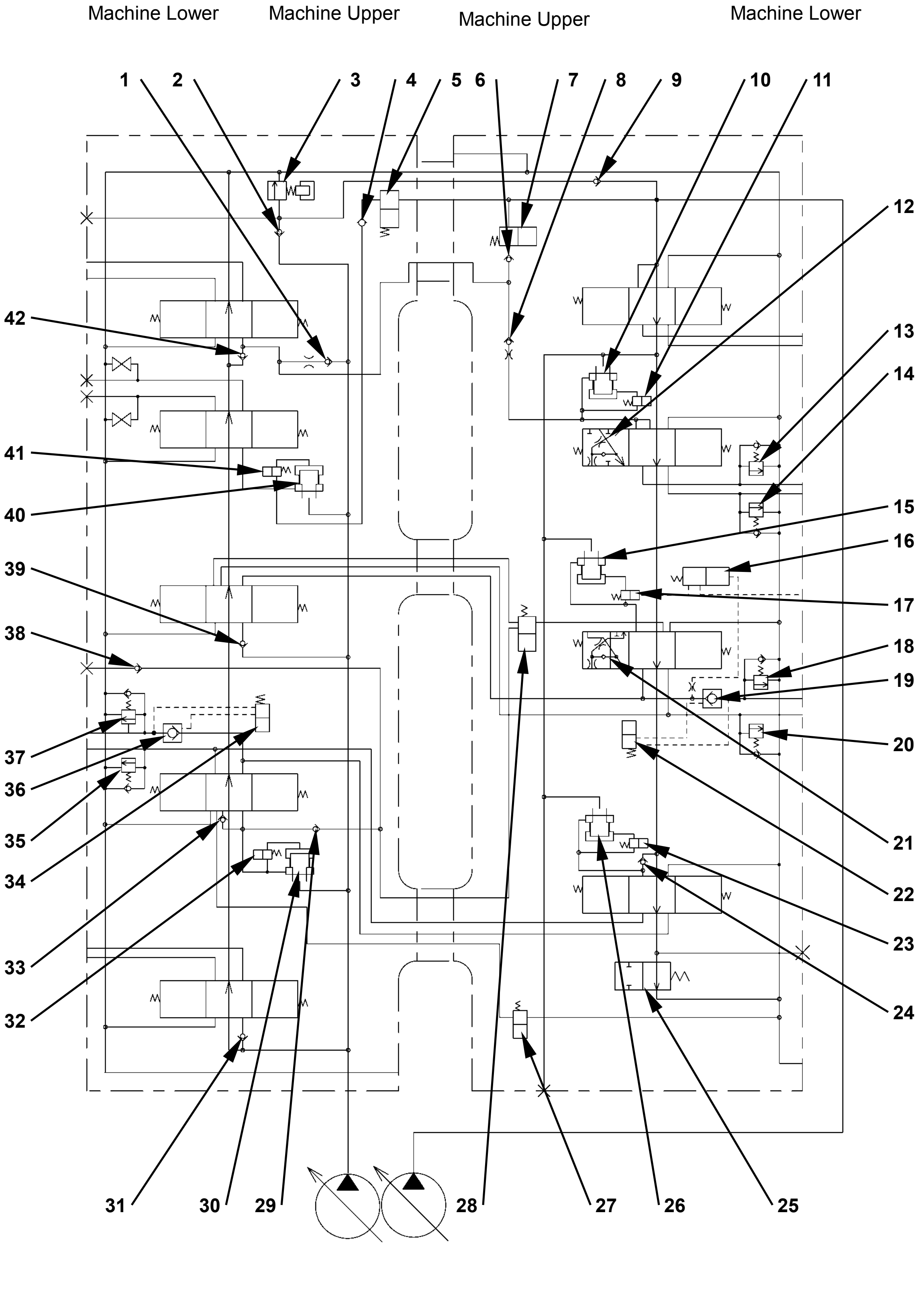
T1V1-03-03-072

Positioning Control Valve (2-Piece Boom Only)

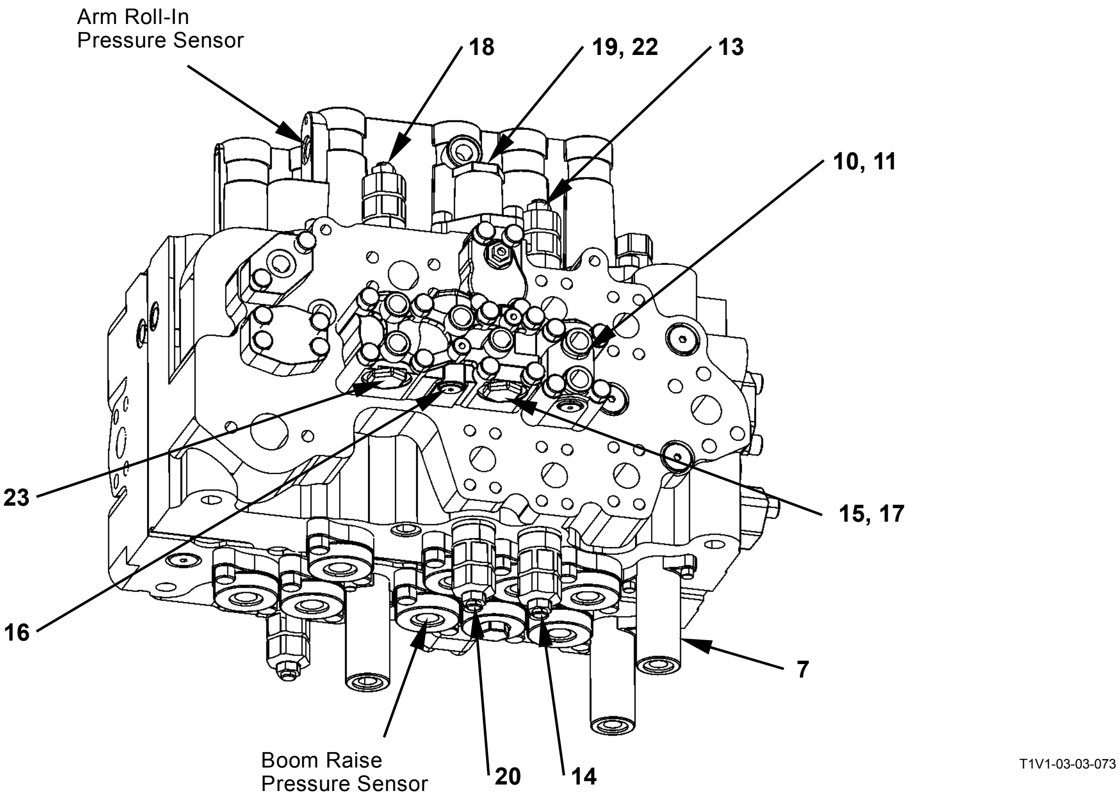


T178-03-03-370

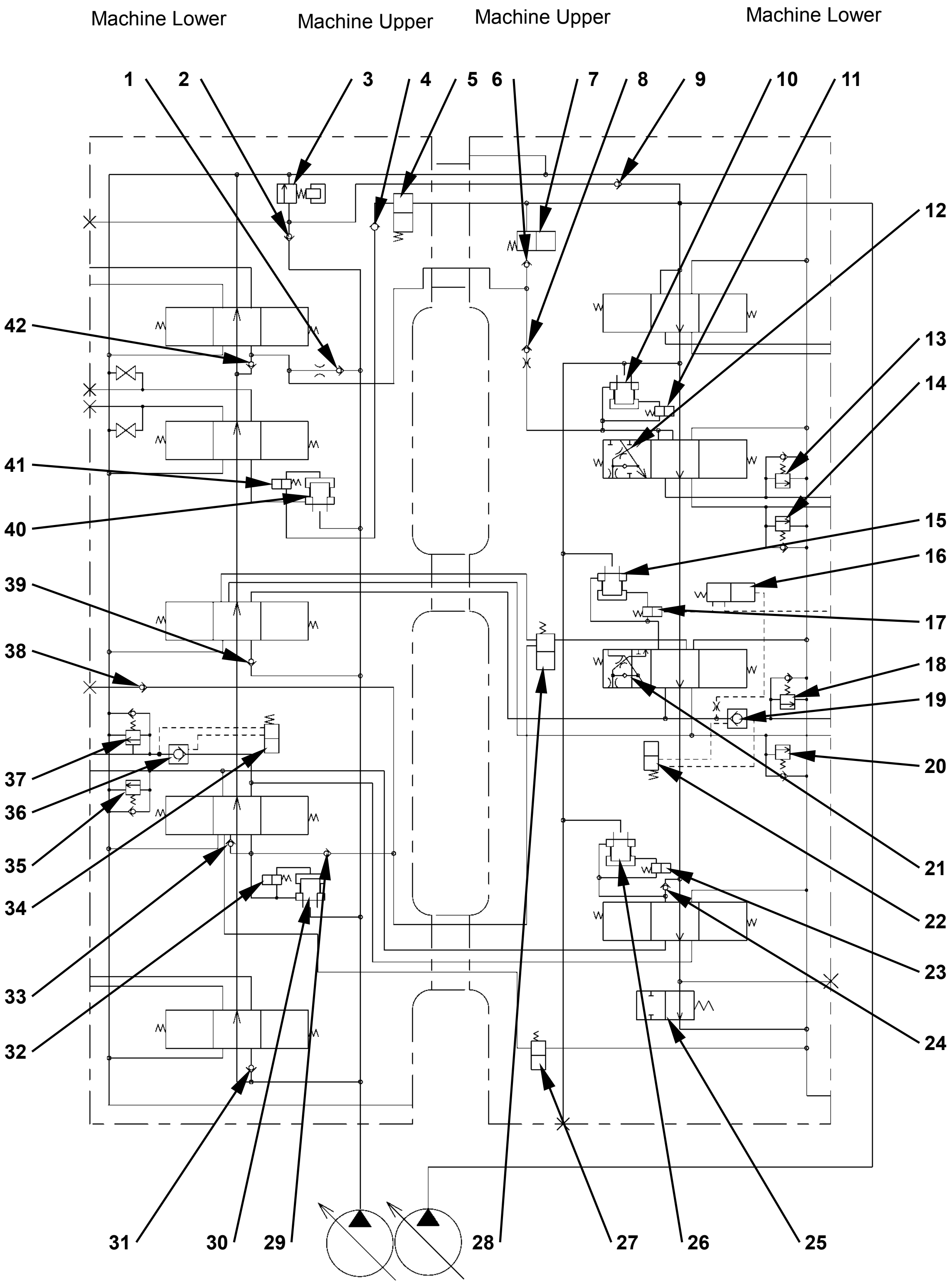
Layout of Control Valve



4-Spool Section

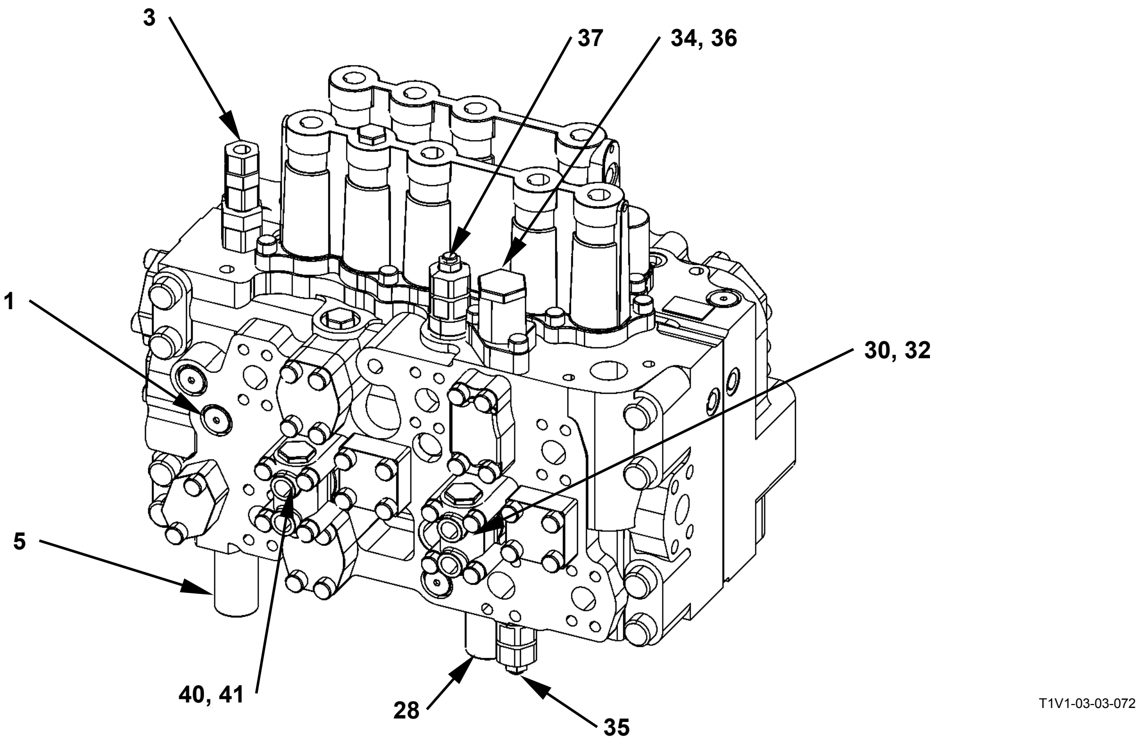


1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Combining Valve Circuit)
5 - Auxiliary Flow Combiner Valve
6 - Check Valve (Flow Combiner Valve Circuit)
7 - Flow Combiner Valve
8 - Load Check Valve (Orifice) (Bucket)
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 - Auxiliary Flow Rate Control Valve (Poppet Valve)
41 - Auxiliary Flow Rate Control Valve (Switch Valve)
42 - Load Check Valve (Left Travel Tandem Circuit)

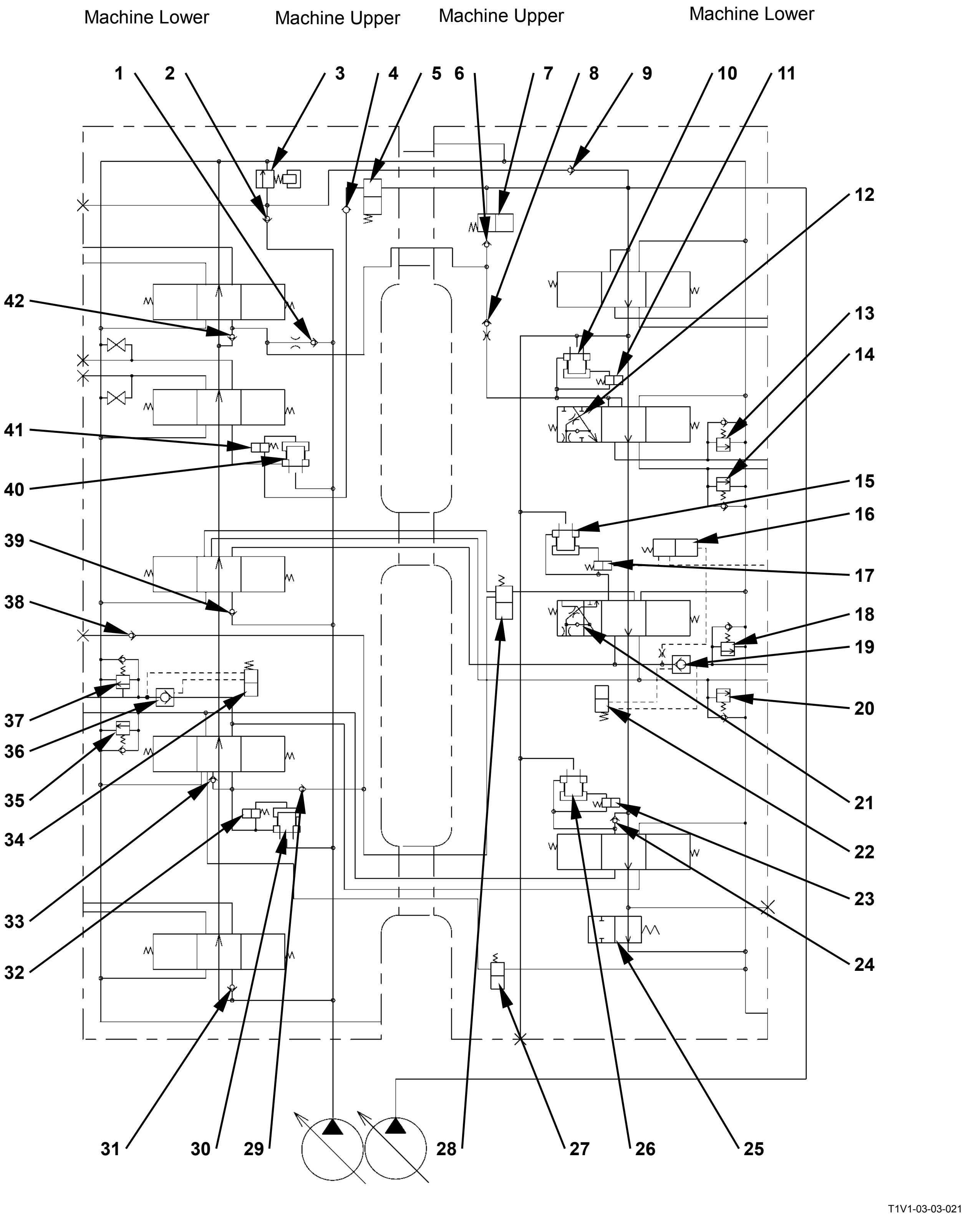


T1V1-03-03-021

5-Spool Section



1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Combining 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 - Auxiliary Flow Rate Control Valve (Poppet Valve)
41 - Auxiliary Flow Rate Control Valve (Switch Valve)
42 - Load Check Valve (Left Travel Tandem Circuit)


Machine Lower
Machine Upper
Machine Upper
Machine Lower
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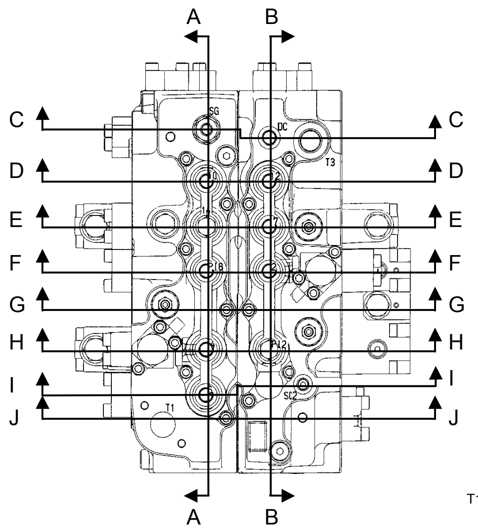
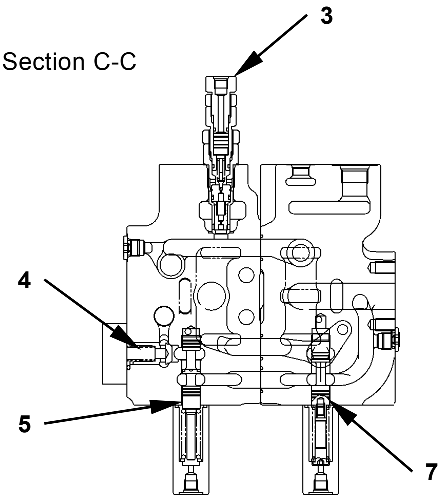
T1V1-03-03-021



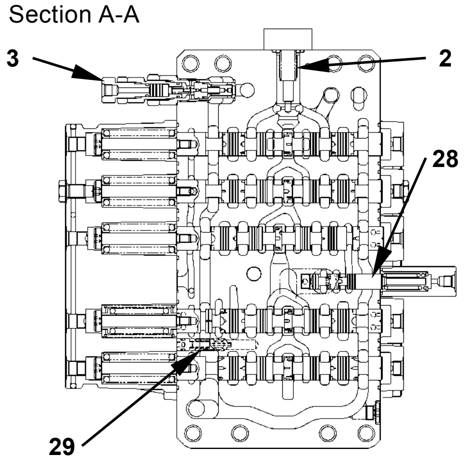
T1V1-03-03-026

Cross Section C-C



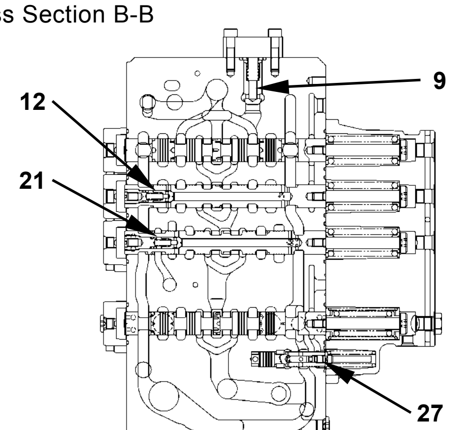
T1V1-03-03-003

Cross Section A-A



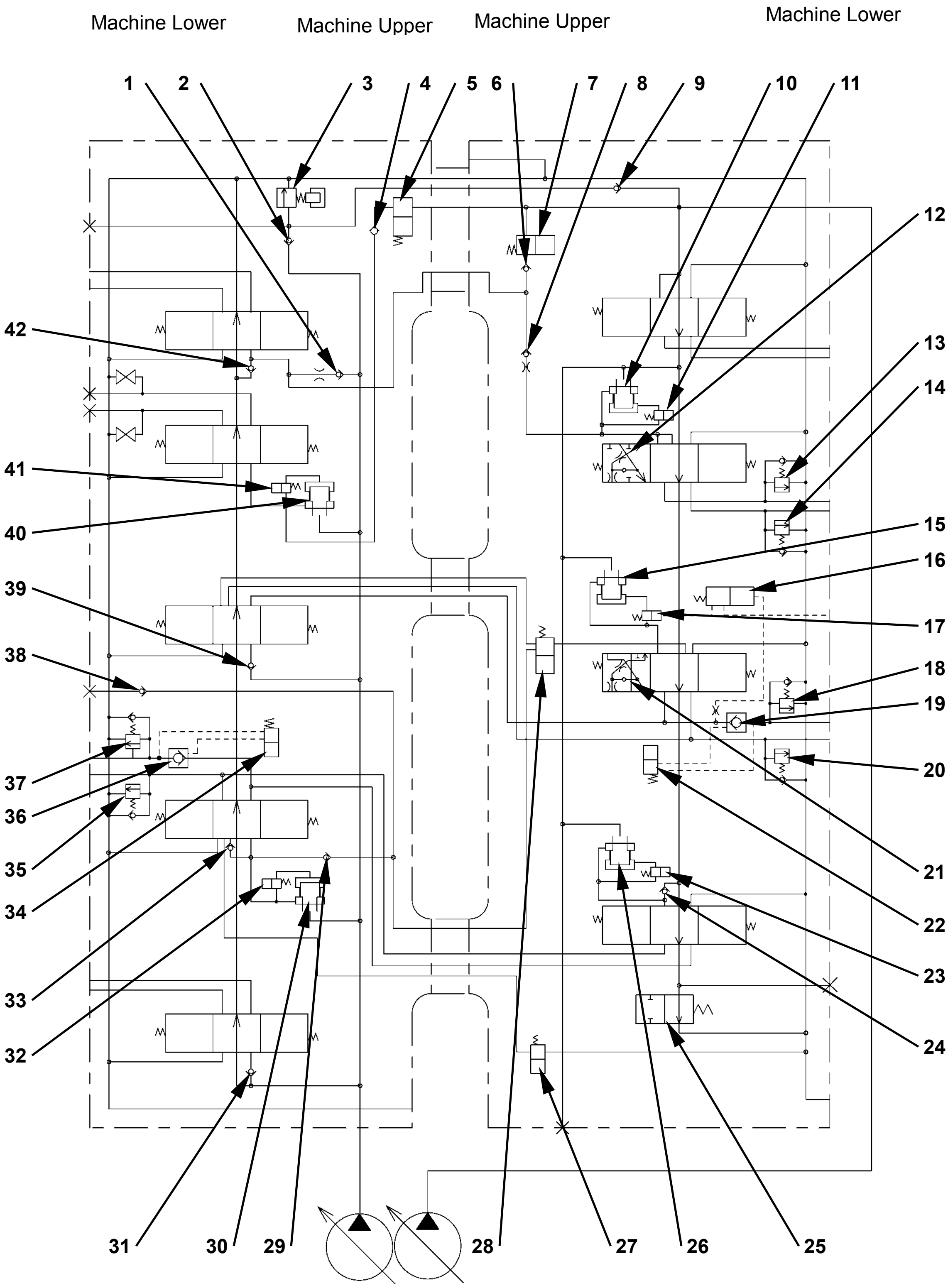
T1V1-03-03-001

Cross Section B-B



T1V1-03-03-002

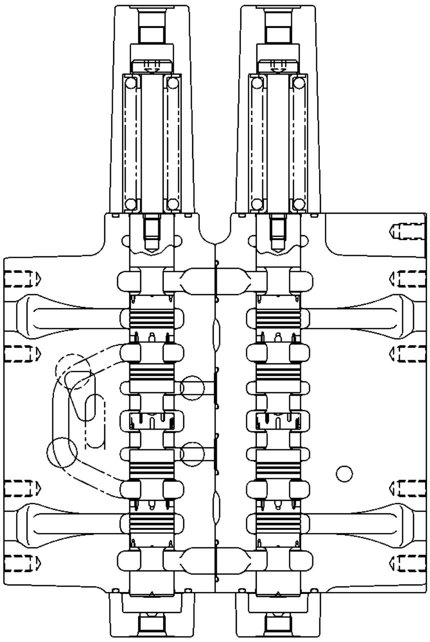
1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Combining Valve Circuit)
5 - Auxiliary Flow Combiner Valve
6 - Check Valve (Flow Combiner Valve Circuit)
7 - Flow Combiner Valve
8 - Load Check Valve (Orifice) (Bucket)
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 - Auxiliary Flow Rate Control Valve (Poppet Valve)
41 - Auxiliary Flow Rate Control Valve (Switch Valve)
42 - Load Check Valve (Left Travel Tandem Circuit)



T1V1-03-03-021

Cross Section D-D

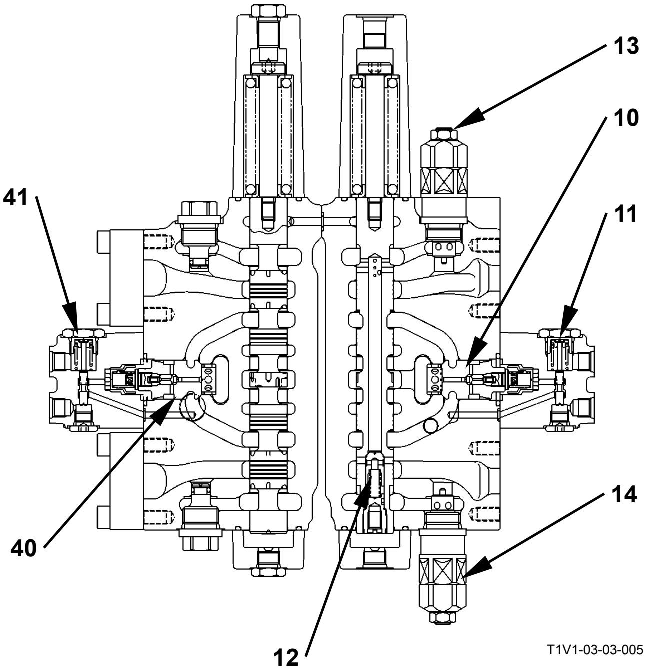
Travel (left) Travel (right)



T1V1-03-03-004

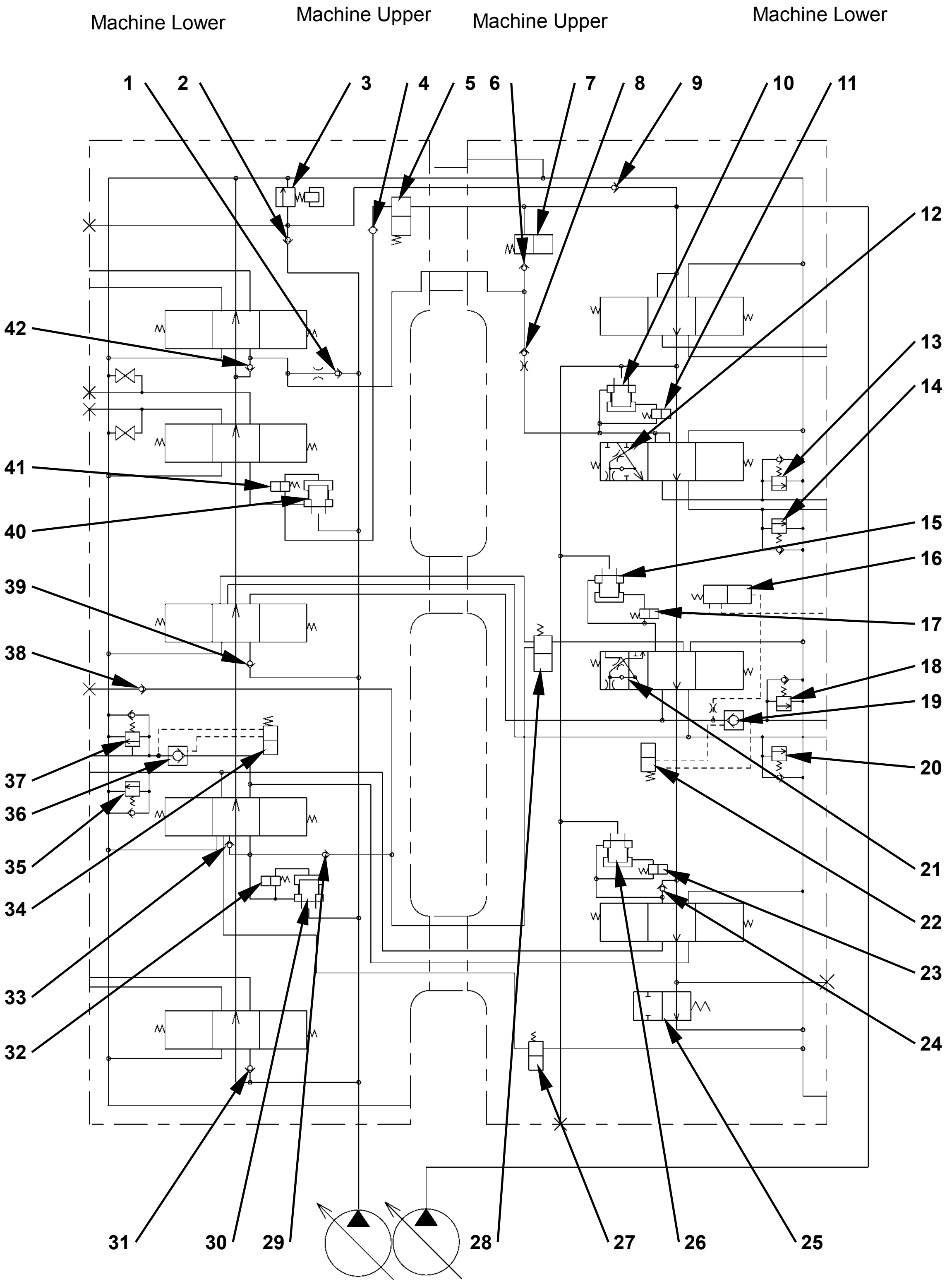
Cross Section E-E

Auxiliary Bucket



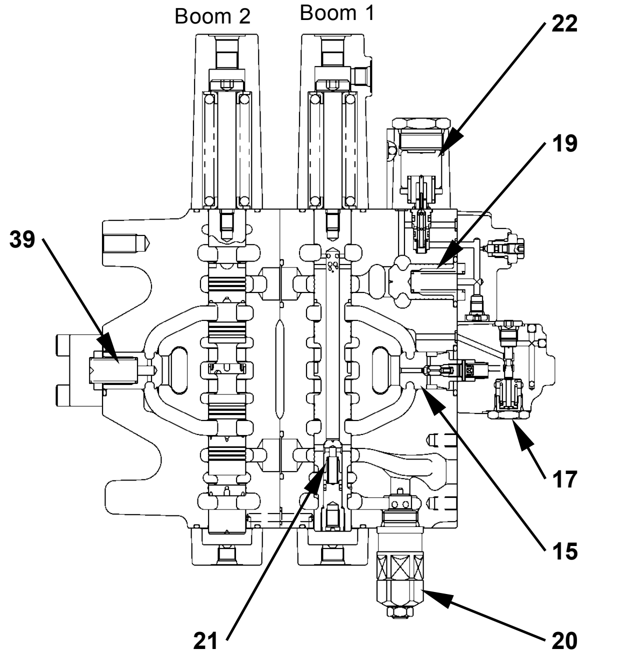
T1V1-03-03-005

1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Combining 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 - Auxiliary Flow Rate Control Valve (Poppet Valve)
41 - Auxiliary Flow Rate Control Valve (Switch Valve)
42 - Load Check Valve (Left Travel Tandem Circuit)



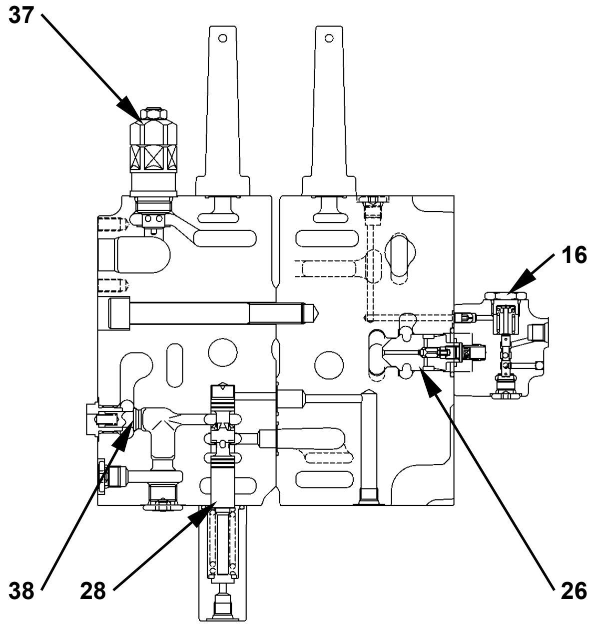
T1V1-03-03-021

Cross Section F-F



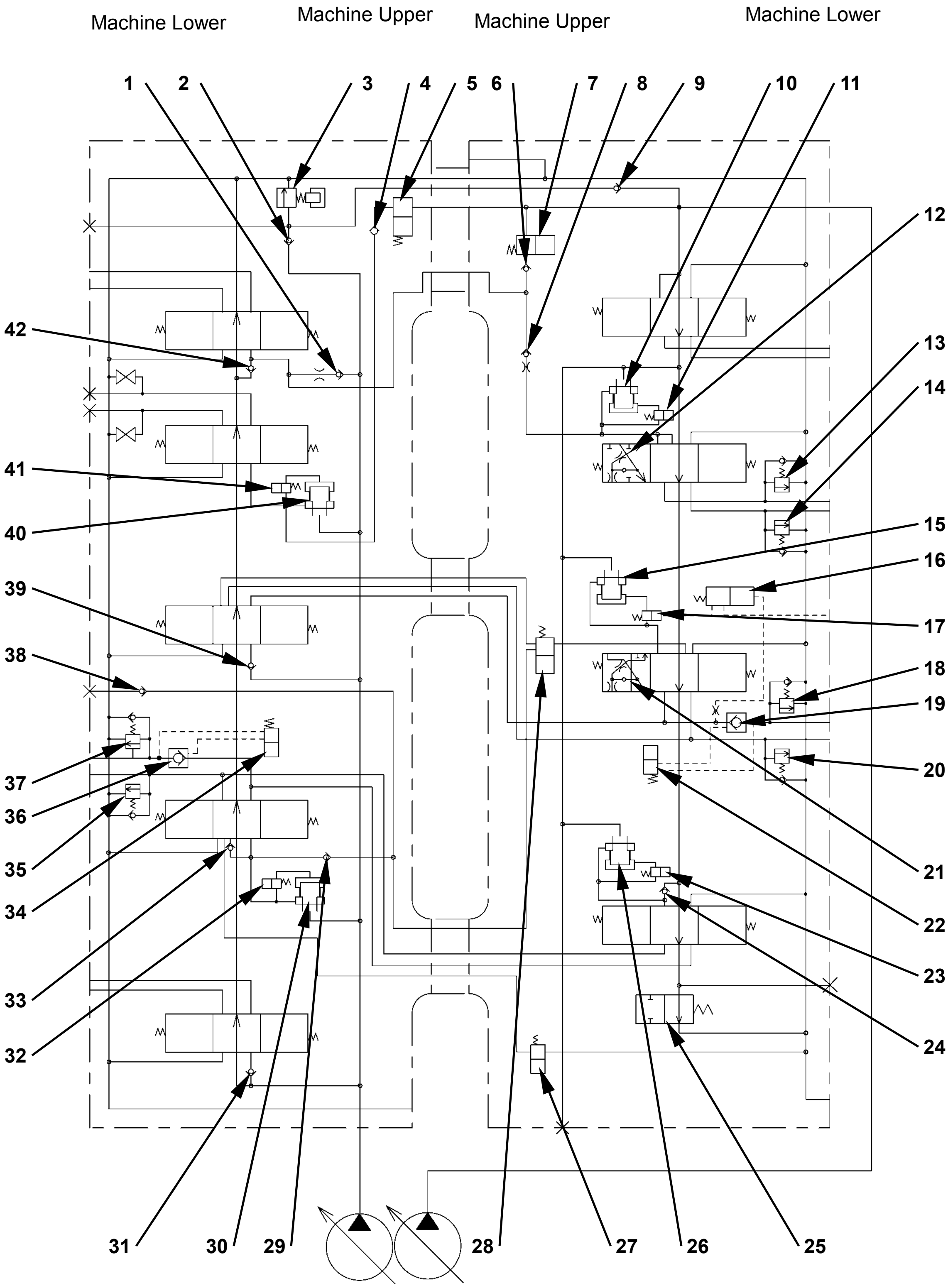
T1V1-03-03-006

Cross Section G-G



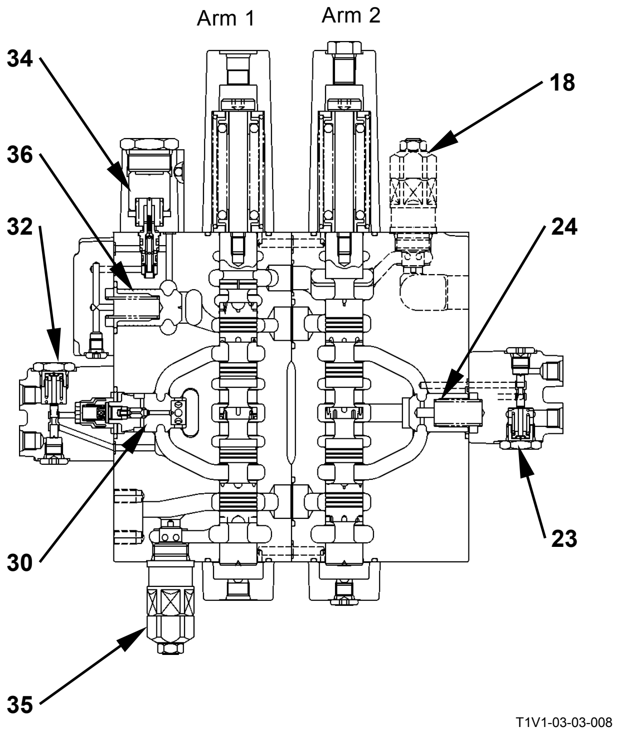
T1V1-03-03-007

1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Combining 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 - Auxiliary Flow Rate Control Valve (Poppet Valve)
41 - Auxiliary Flow Rate Control Valve (Switch Valve)
42 - Load Check Valve (Left Travel Tandem Circuit)



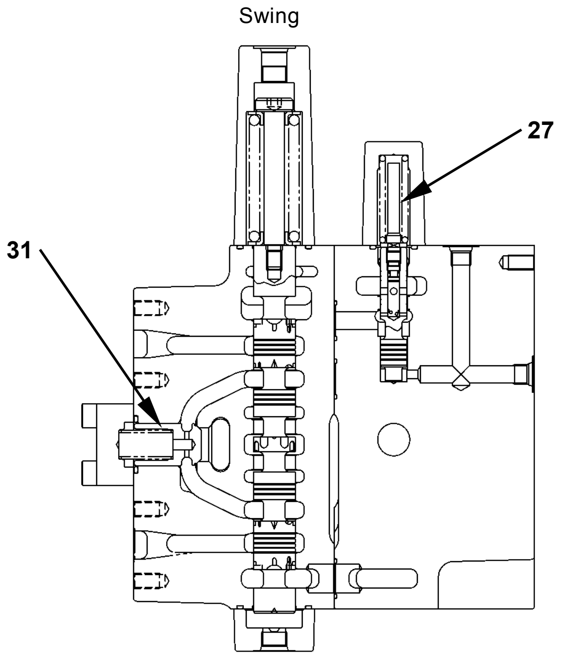
T1V1-03-03-021

Cross Section H-H



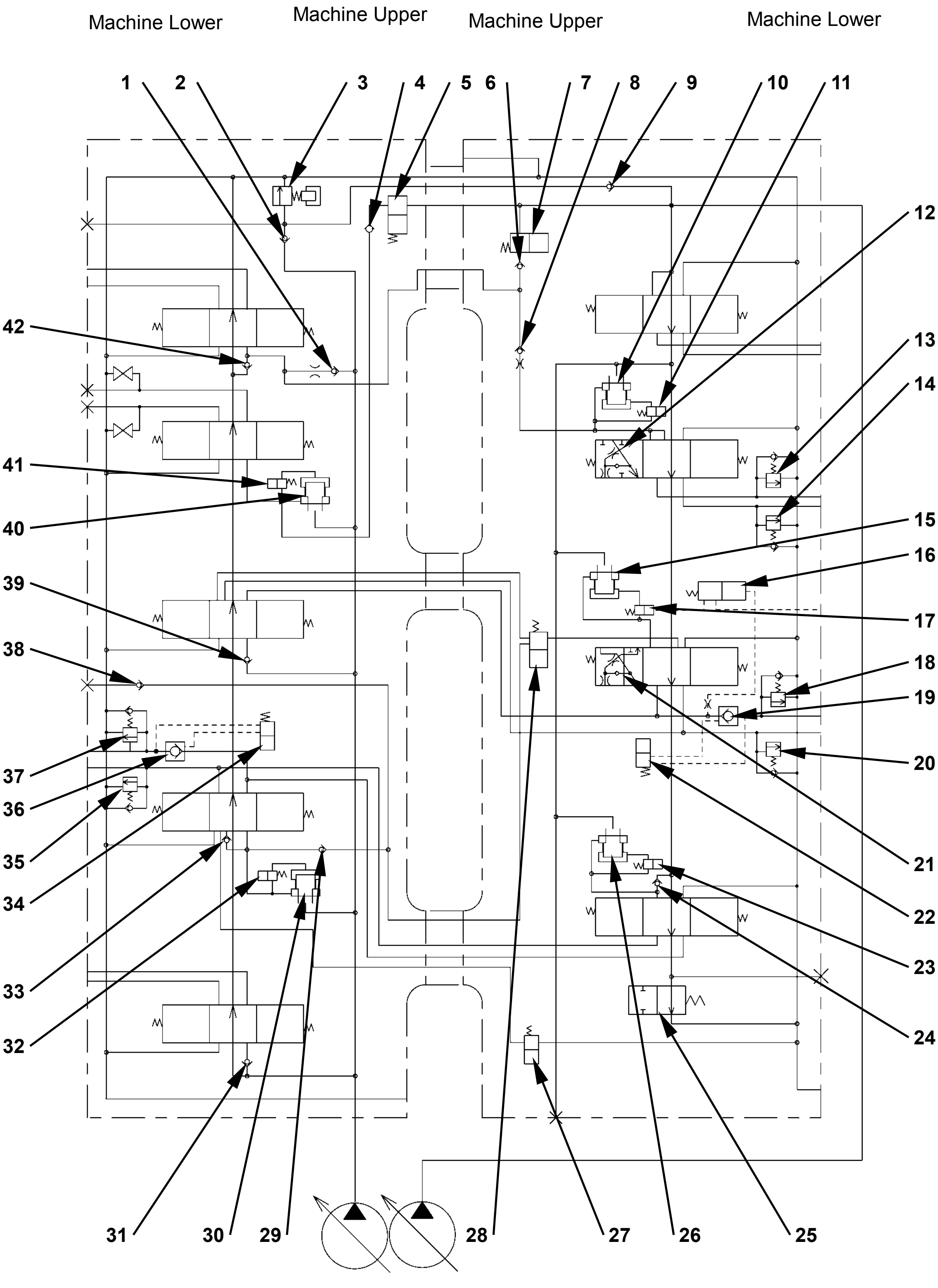
T1V1-03-03-008

Cross Section I-I



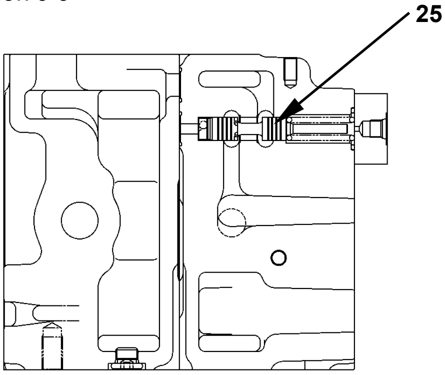
T1V1-03-03-009

1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Combining 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 - Auxiliary Flow Rate Control Valve (Poppet Valve)
41 - Auxiliary Flow Rate Control Valve (Switch Valve)
42 - Load Check Valve (Left Travel Tandem Circuit)

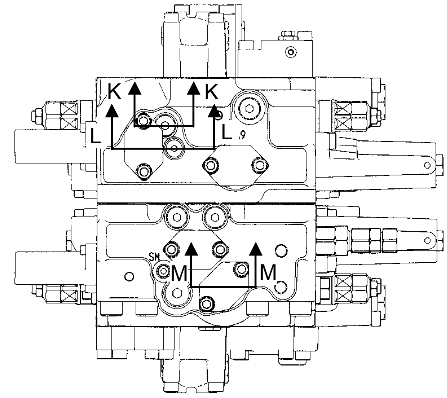


T1V1-03-03-021

Cross Section J-J

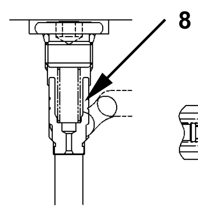


T1V1-03-03-010

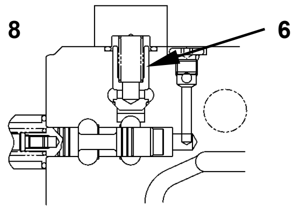


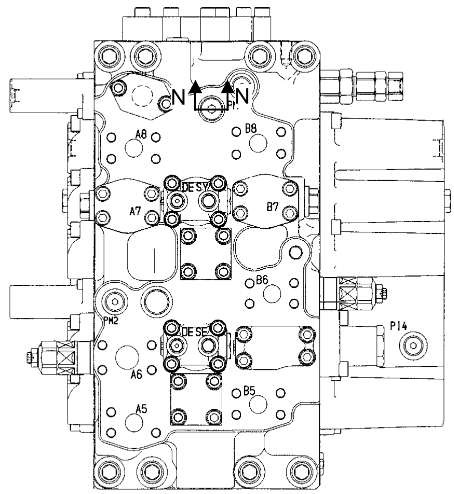
T1V1-03-03-027

Cross Section K-K



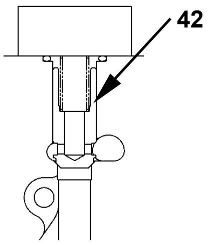
Cross Section L-L



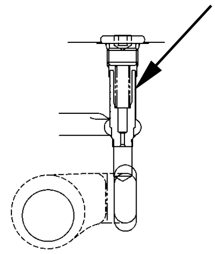


T1V1-03-03-028

Cross Section M-M



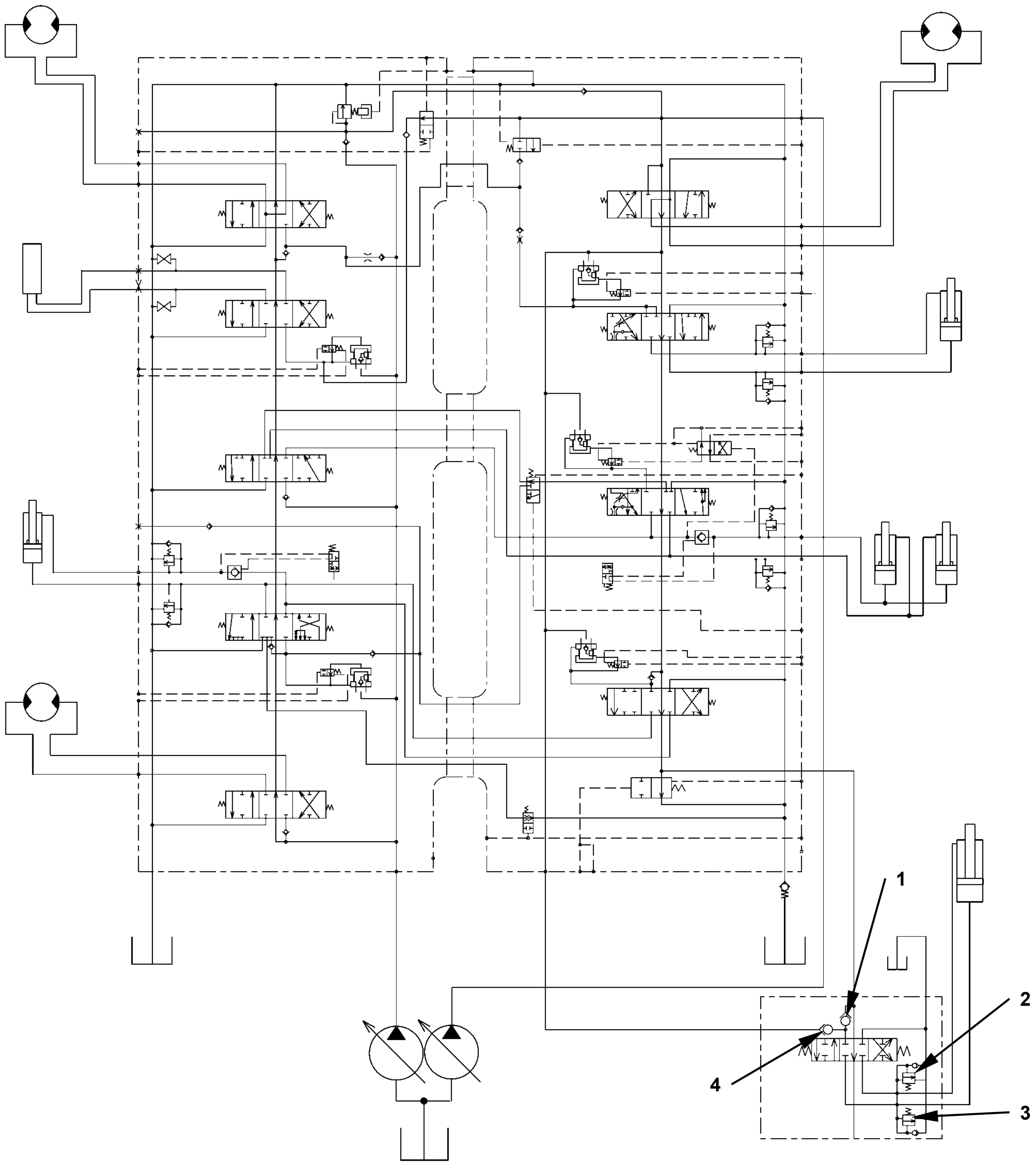
Cross Section N-N



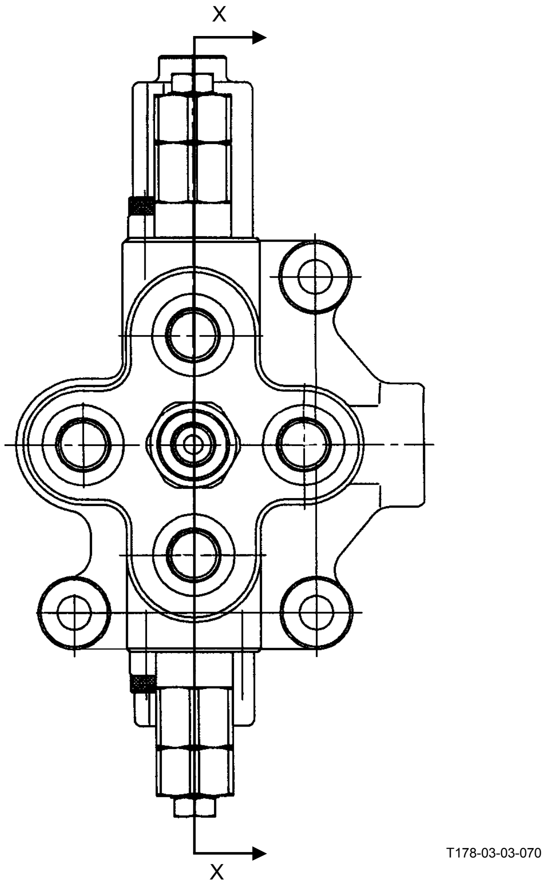
T1V1-03-03-022

1 - Load Check Valve (Left Travel Parallel Circuit)
2 - Check Valve (Main Relief Circuit)
3 - Main Relief Valve
4 - Check Valve (Auxiliary Combining 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 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 Generative 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 - Auxiliary Flow Rate Control Valve (Poppet Valve)
41 - Auxiliary Flow Rate Control Valve (Switch Valve)
42 - Load Check Valve (Left Travel Tandem Circuit)

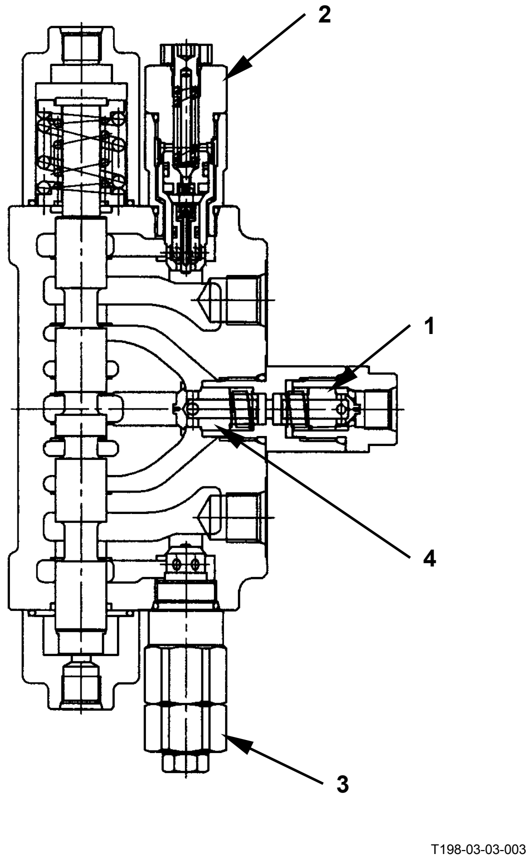
Layout of Positioning Control Valve (2-Piece Boom)



T1V1-03-03-019



Cross Section X-X



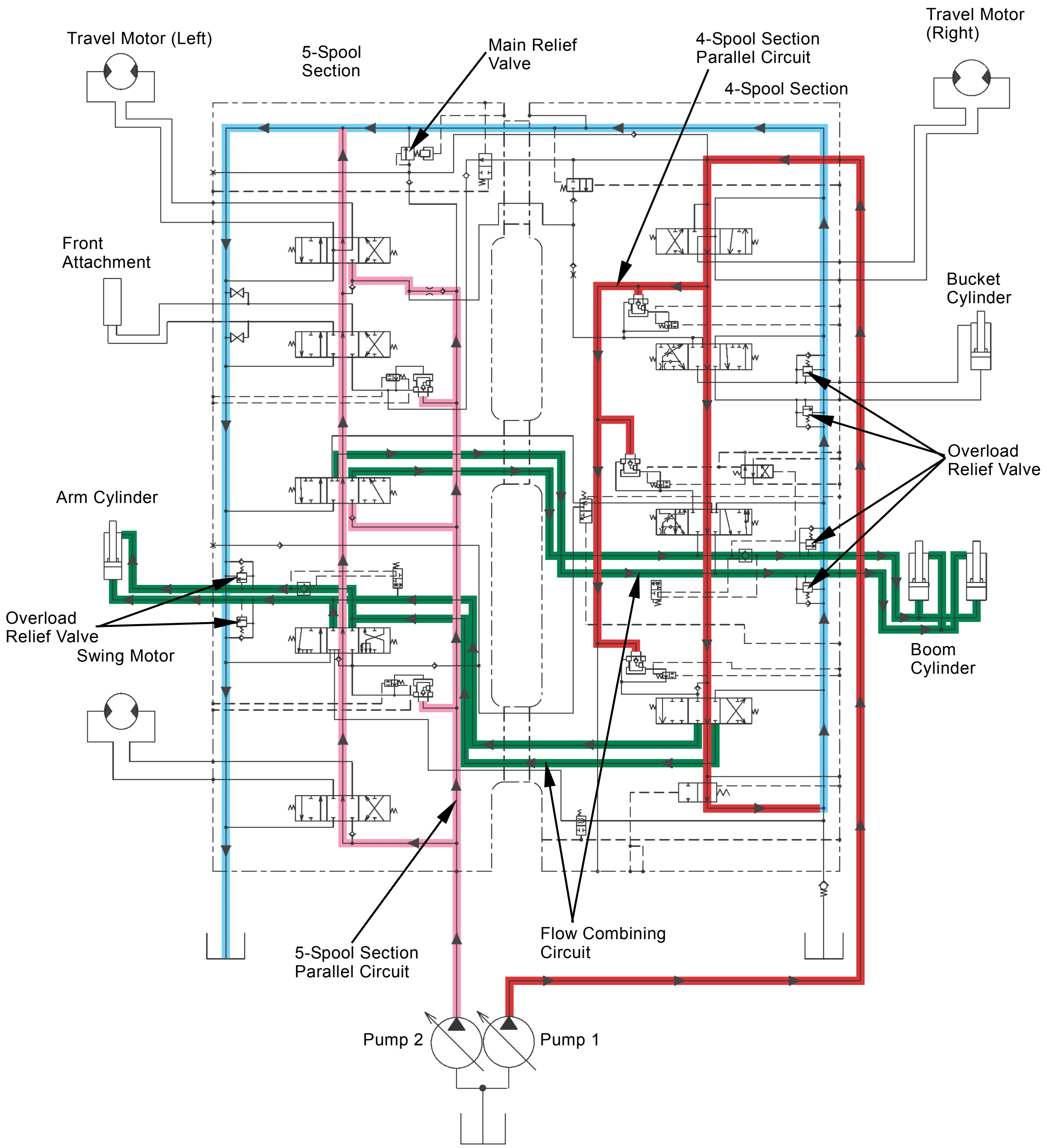
1 - Load Check Valve (Positioning Tandem Circuit)
2 - Overload Relief Valve (Positioning: Rod Side)
3 - Overload Relief Valve (Positioning: Bottom Side)
4 - Load Check Valve (Positioning Parallel Circuit)

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.

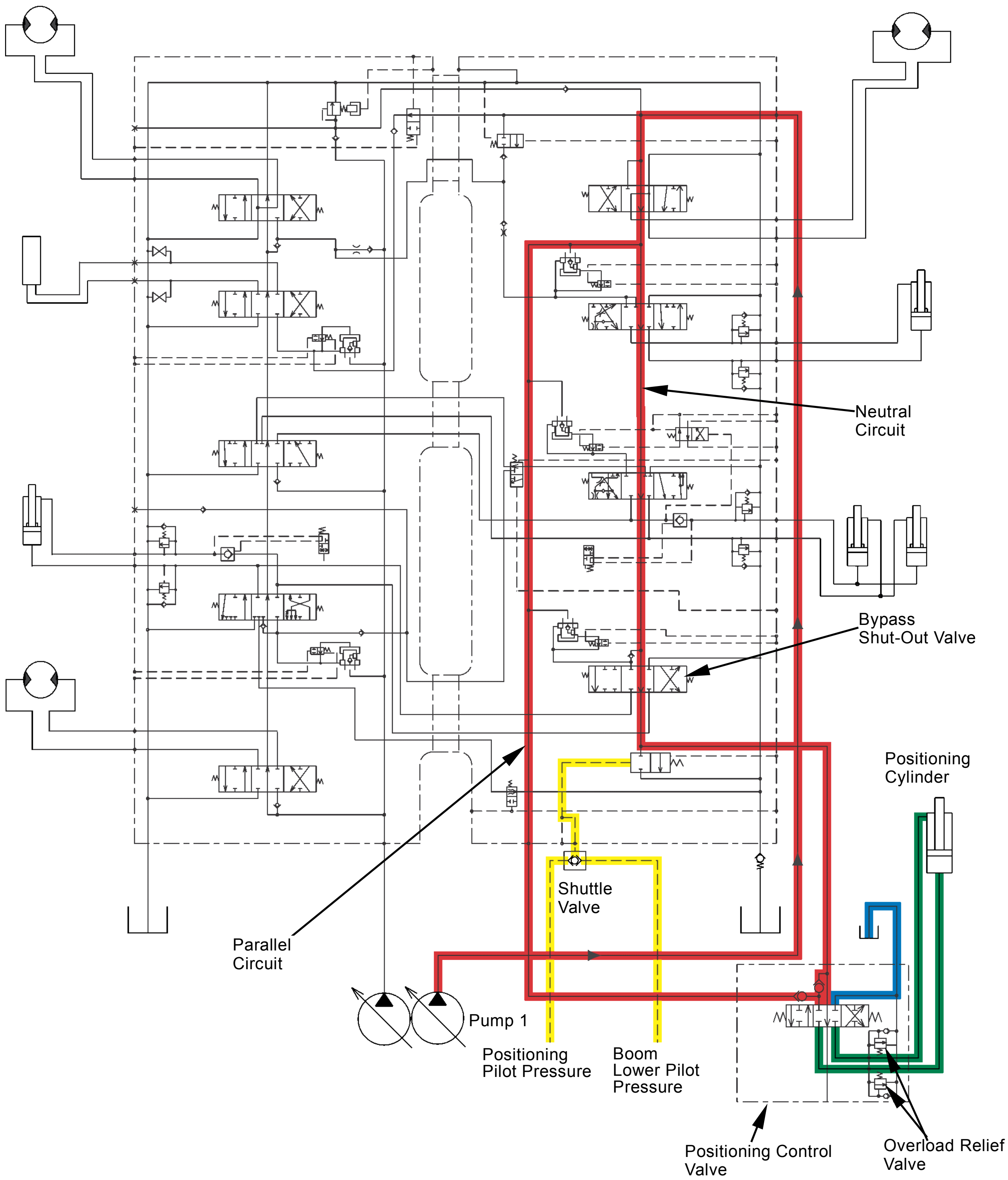
The main relief valve is provided in the main circuit (between pump and actuator). The main relief valve works so that pressure in the main circuit does not exceed the set pressure when the spool is in operation (or when the control lever is in operation).
The overload relief valve is provided in the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



T1V1-03-03-018

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).



T1V1-03-03-020

Pilot Control Circuit

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

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

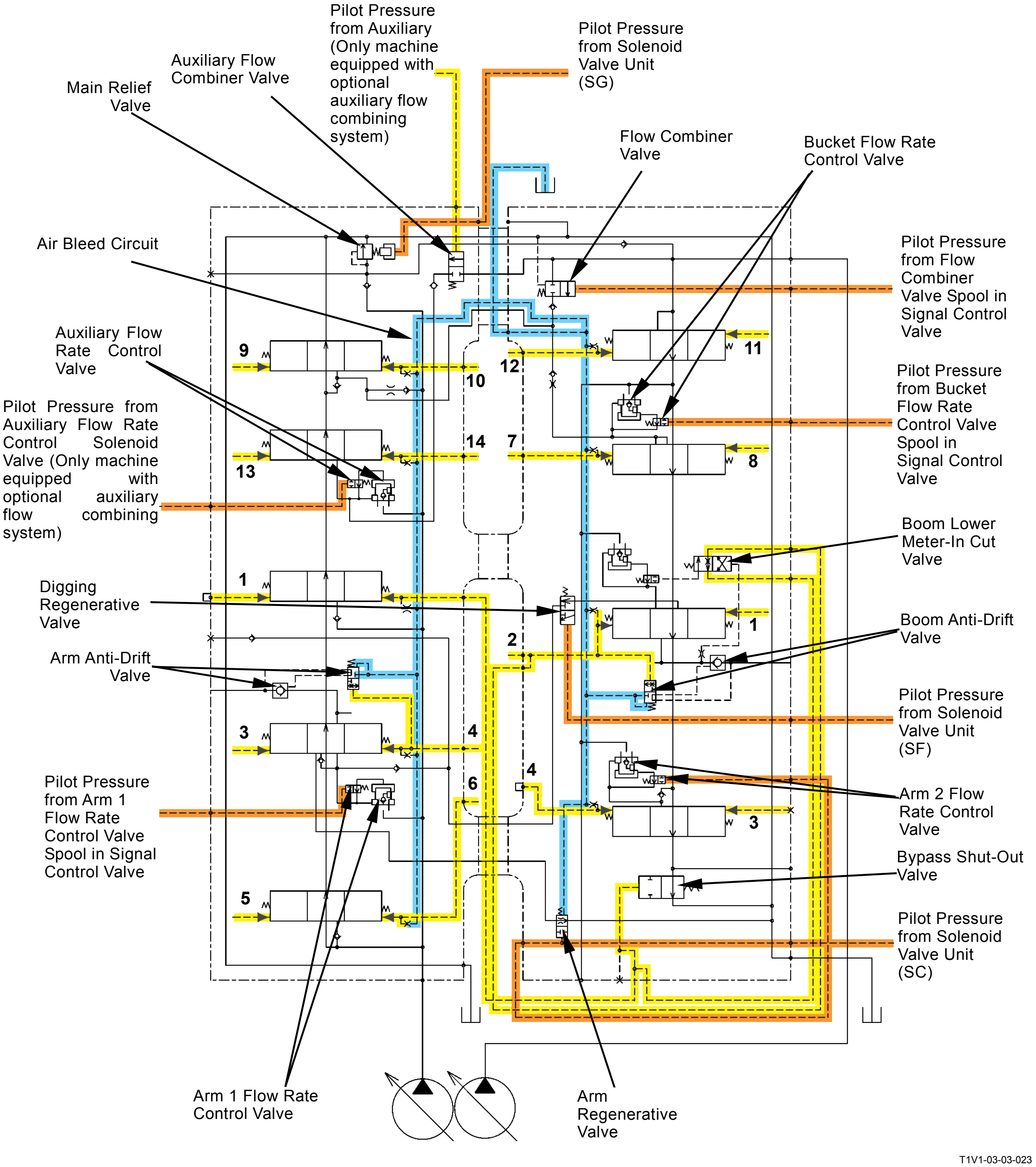
- During arm roll-in (4) operation, pressure oil moves the arm spool and shifts the spool in switch valve of arm anti-drift valve.
- During boom lower (2) operation, pressure oil moves the boom 1 spool and shifts the spool in switch valve of boom anti-drift valve.
- During boom lower (2) operation, divided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

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

External Pilot Pressure Circuit

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

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



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.

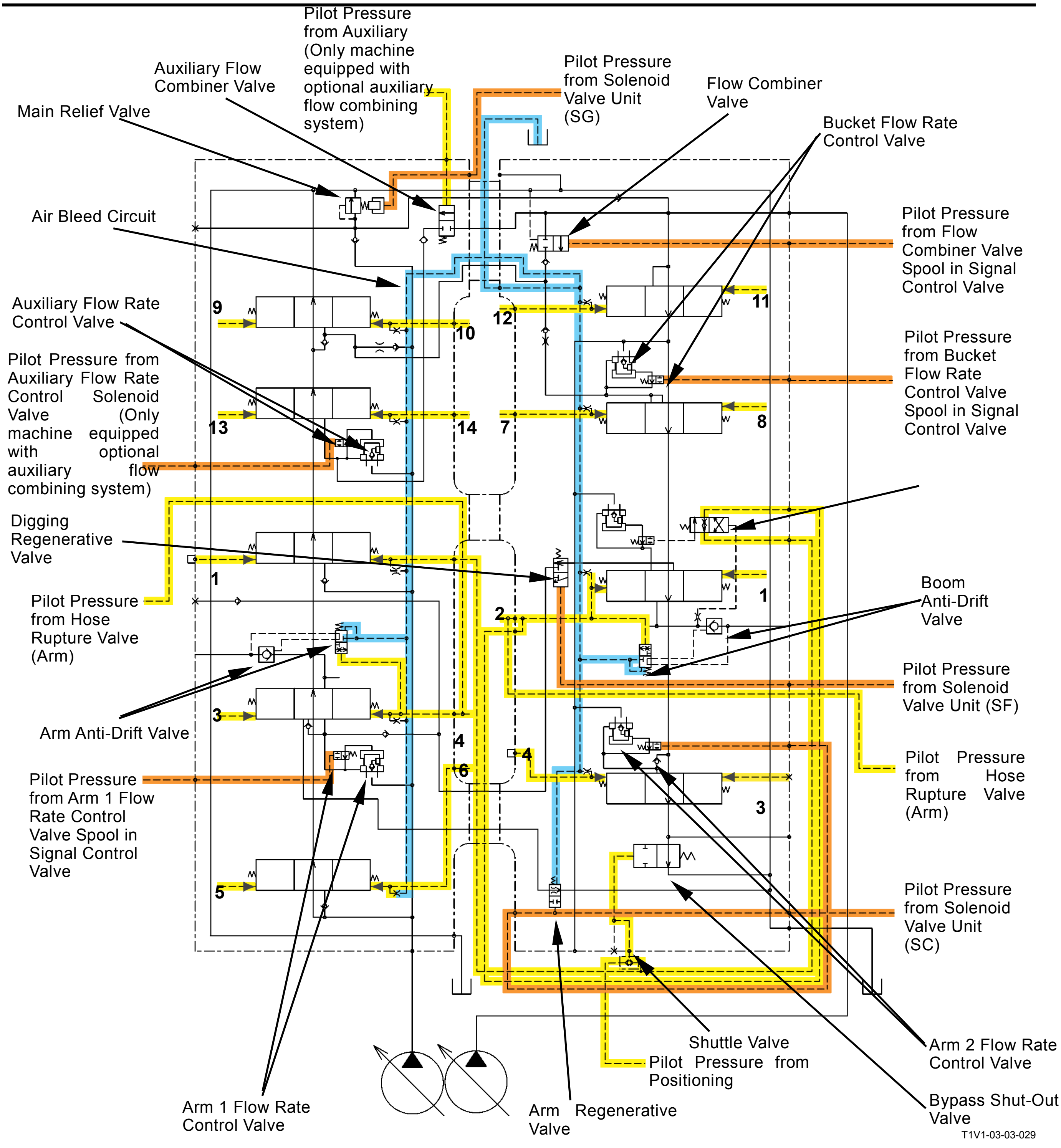
- During arm roll-in (4) operation, pressure oil moves the arm spool and shifts the switch valve in arm anti-drift valve and the spool in hose rupture valve (arm).
- During boom lower (2) operation, pressure oil moves the boom 1 spool and shifts the switch valve in boom anti-drift valve and the spool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

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

External Pilot Pressure Circuit (2-Piece Boom)

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

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

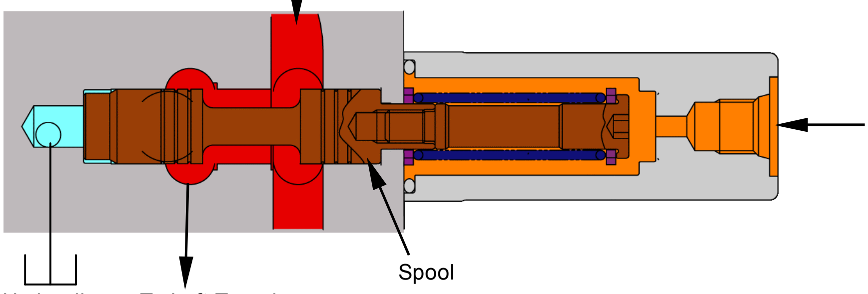


1 - Boom Raise
2 - Boom Lower
3 - Arm Roll-Out
4 - Arm Rool-In
5 - Left Swing
6 - Right Swing
7 - Bucket Roll-In
8 - Bucket Roll-Out
9 - Travel (Left Forward)
10 - Travel (Left Reverse)
11 - Travel (Right Forward)
12 - Travel (Right Reverse)
13 - Auxiliary (Open)
14 - Auxiliary (Close)

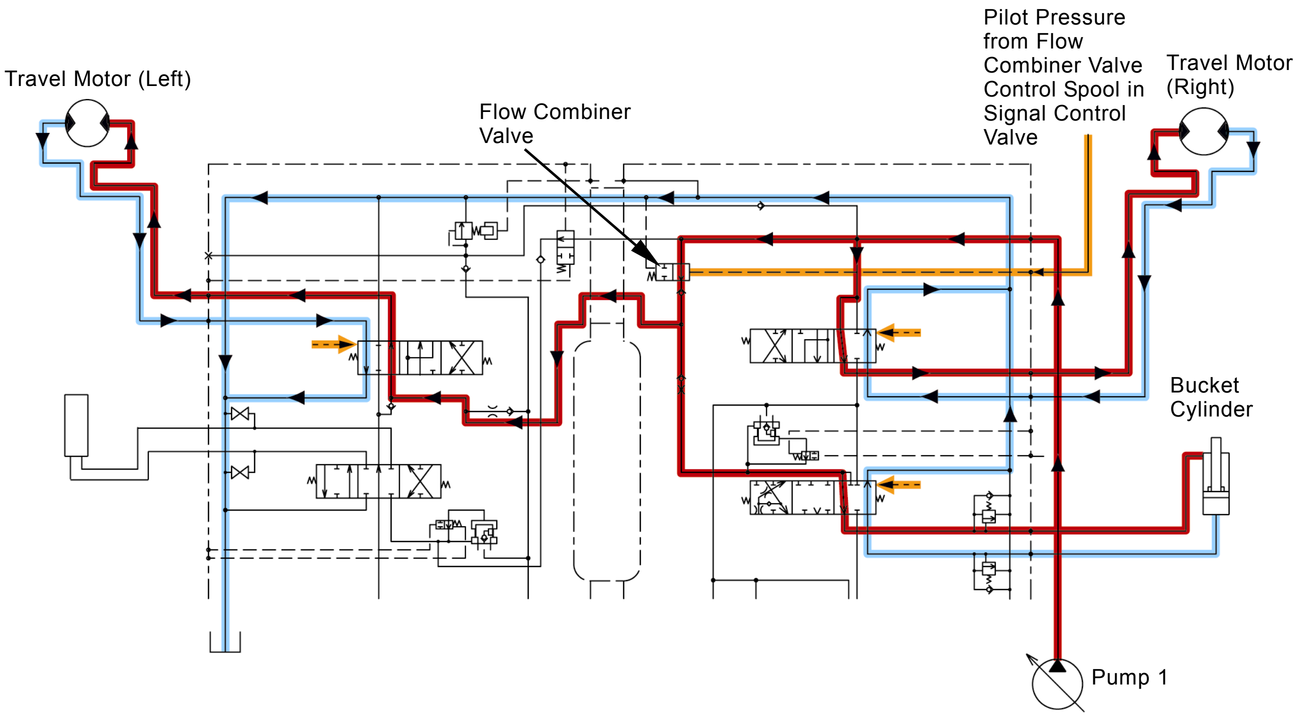
NOTE: Yellow line: Pilot control circuit
Orange line: External pilot pressure circuit

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.



T1V1-03-03-056



T1V1-03-03-046

MAIN RELIEF VALVE

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

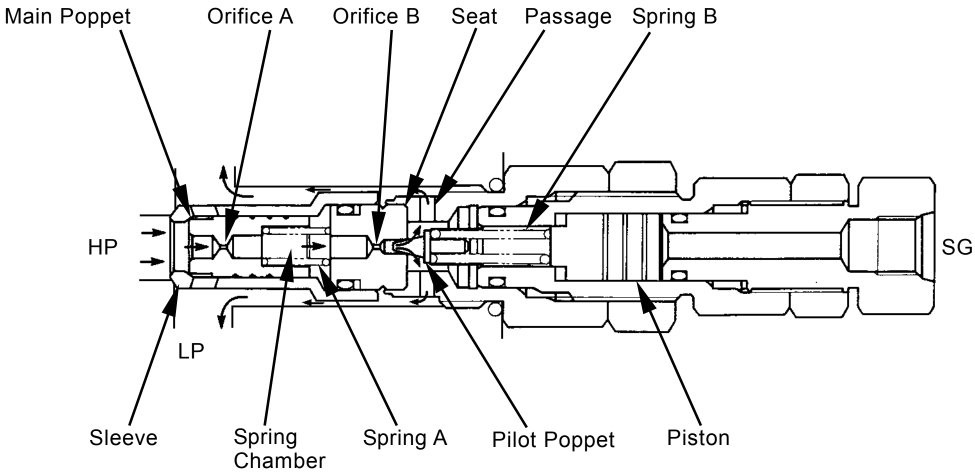
Relief Operation

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

Set Pressure Increasing Operation

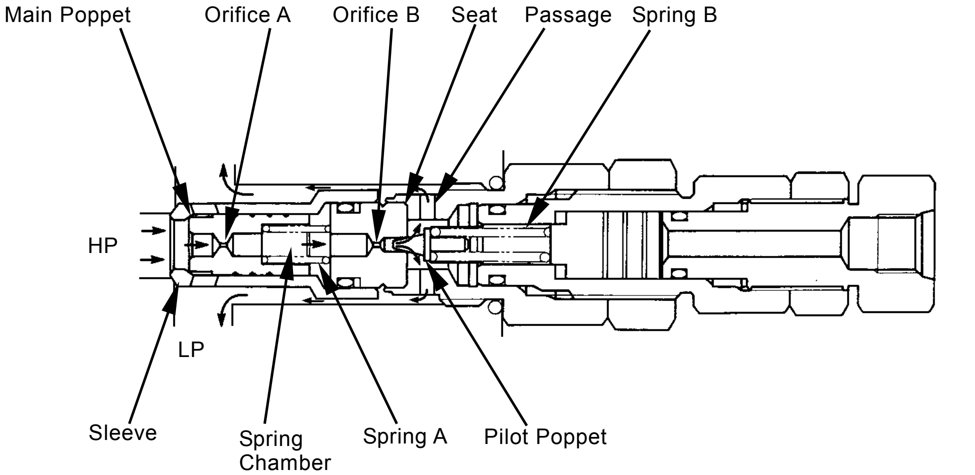
1. When pilot pressure from solenoid valve unit (SG) acts to port SG, spring B is compressed by the piston.
2. Therefore, the force of spring B becomes strong.
3. Consequently, as pressure required in order to open the pilot poppet is increased, the relief set pressure is increased.

During Normal Operation:



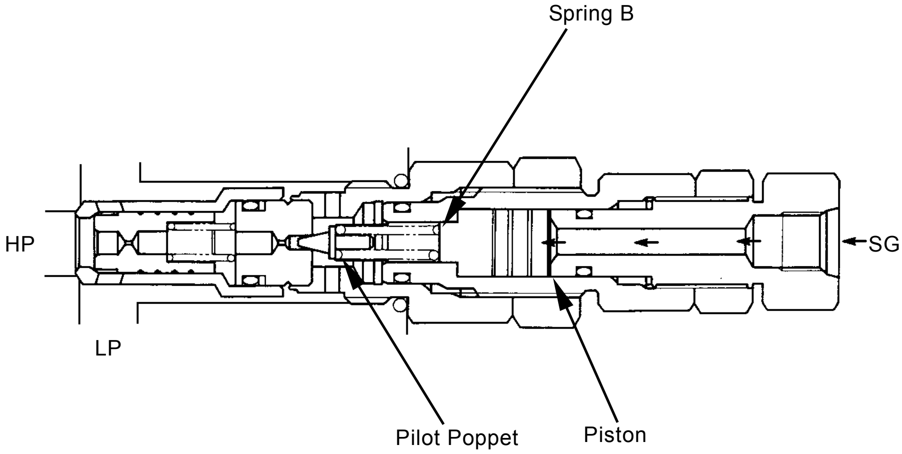
T157-02-05-003

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.

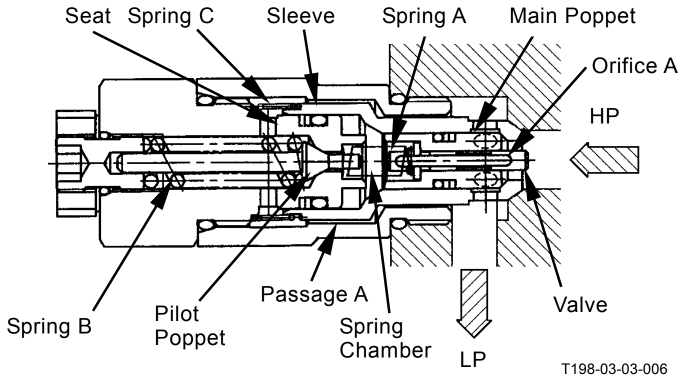
Relief Operation

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

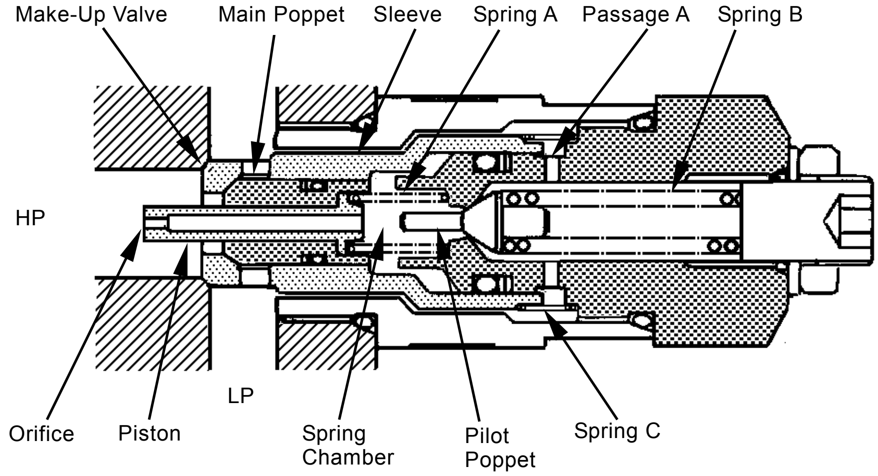
Make-Up Operation

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

For Positioning Control Valve

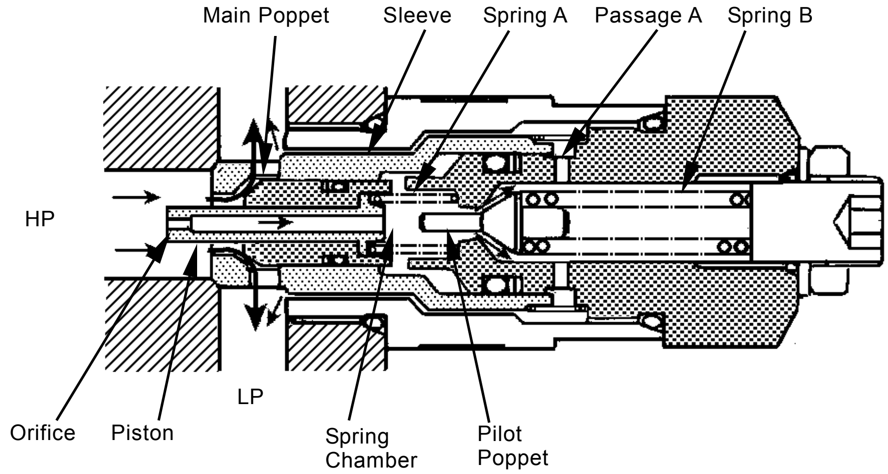


During Normal Operation:



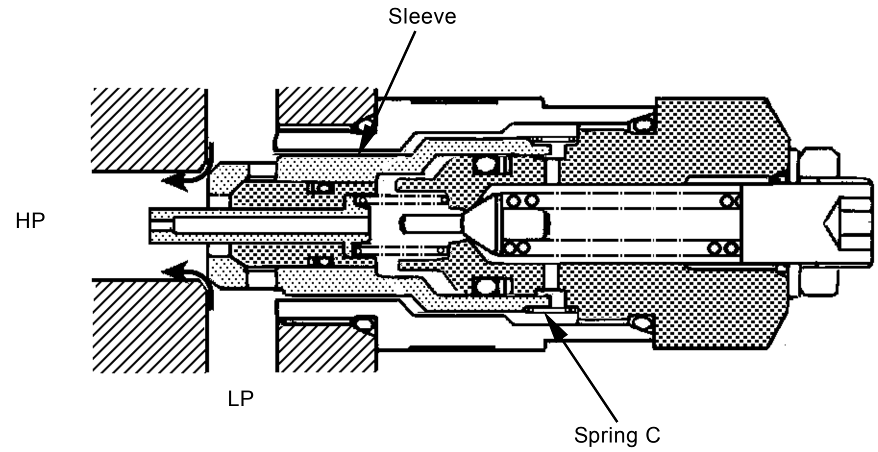
T107-02-05-019

During Relief Operation:



T178-03-03-049

During Make-Up Operation:



T178-03-03-050

REGENERATIVE VALVE

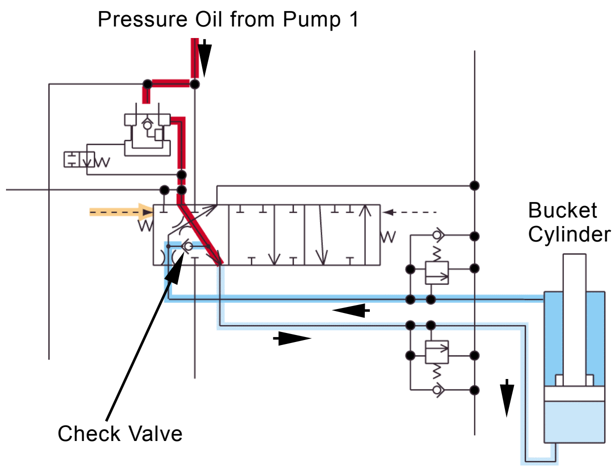
The regenerative valves are provided in the boom lower, arm roll-in and bucket roll-in circuits. The regenerative valve increases cylinder speeds in order to prevent cylinder hesitation, and improves machine controllability.

Boom Regenerative Valve and Bucket Regenerative Valve

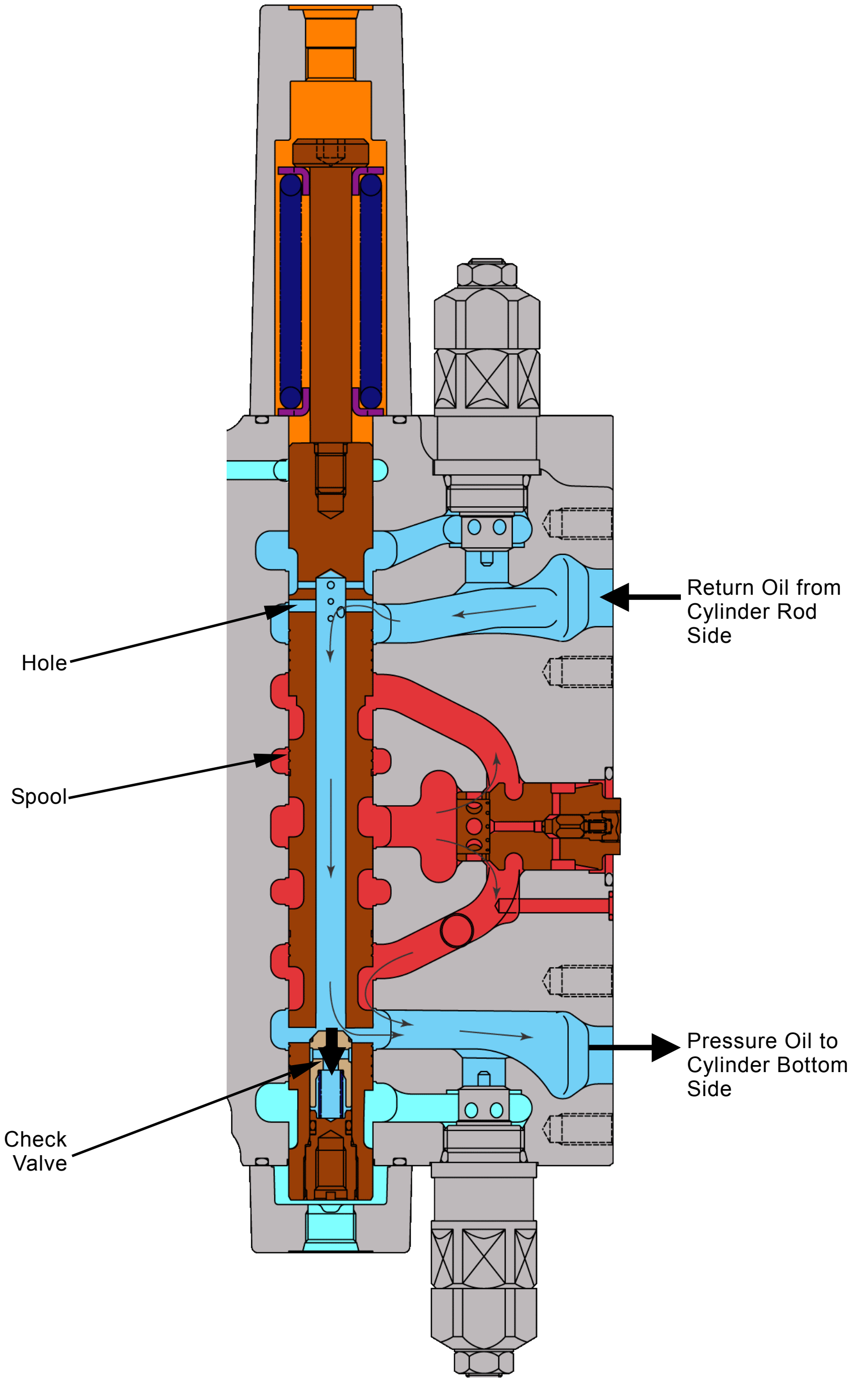
NOTE: *Operational principle of the boom regenerative valve is identical to that of the bucket regenerative valve. Therefore, the bucket generative valve is explained as an example.*

Operation

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



T176-03-03-027



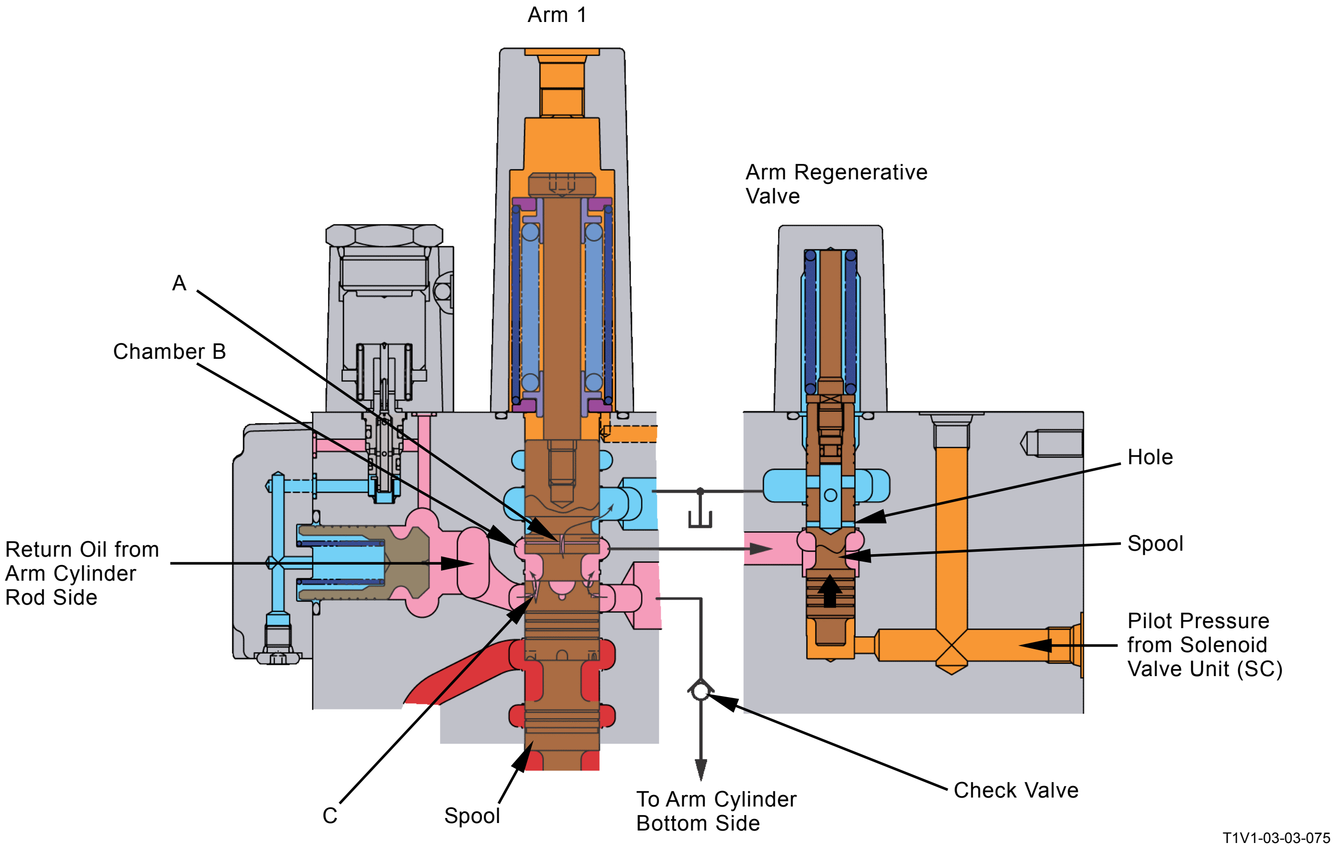
T1V1-03-03-057

ARM REGENERATIVE VALVE

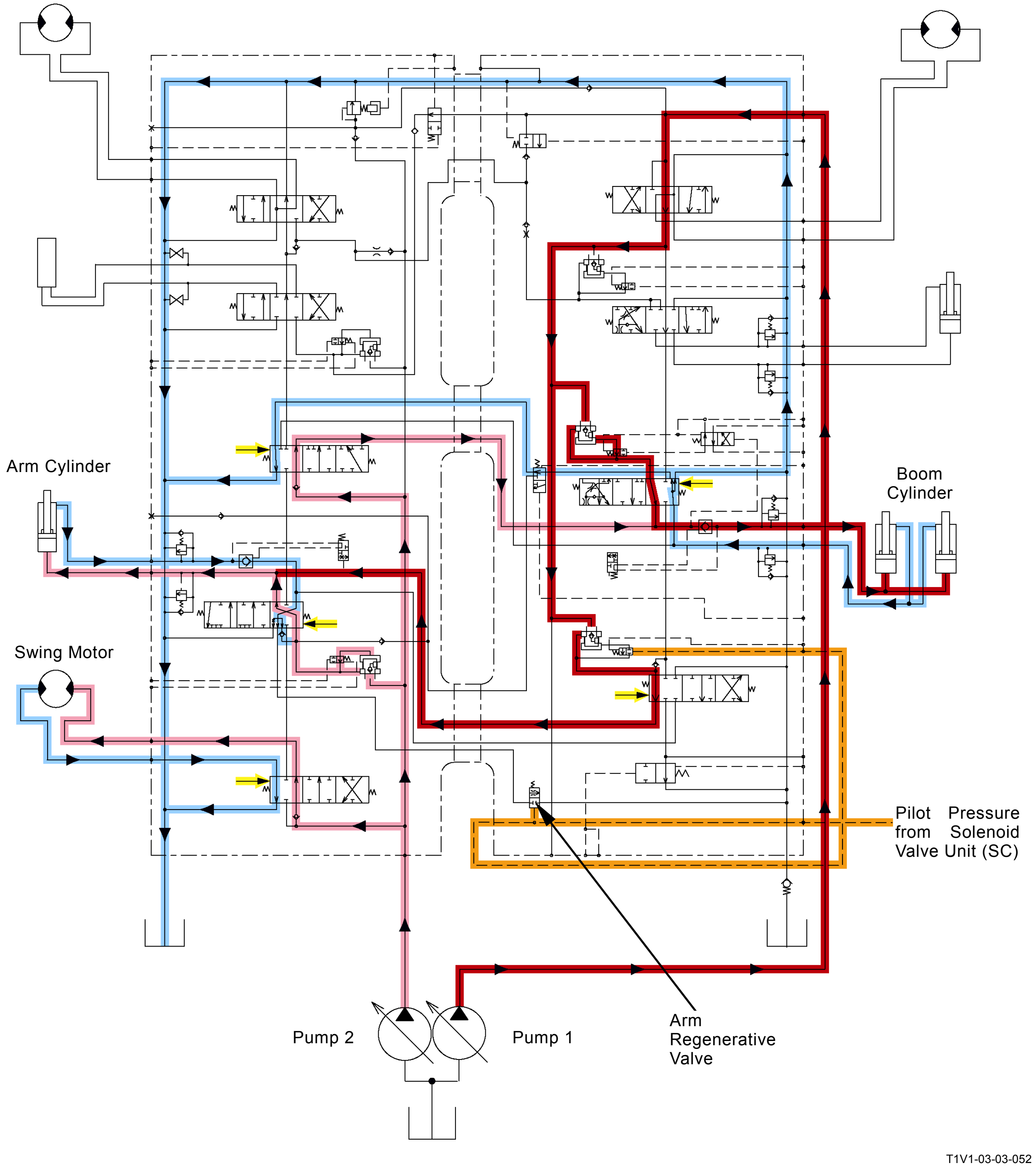
- During Normal Operation:
  1. During normal arm roll-in operation, return oil from the cylinder rod side flows to chamber B through notch (C) on the arm 1 spool.
  2. Return oil is divided from chamber B. One flows to the hydraulic oil tank through notch (A) on the arm 1 spool. The other flows to the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

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

During Regenerative Operation:



During Regenerative Operation:



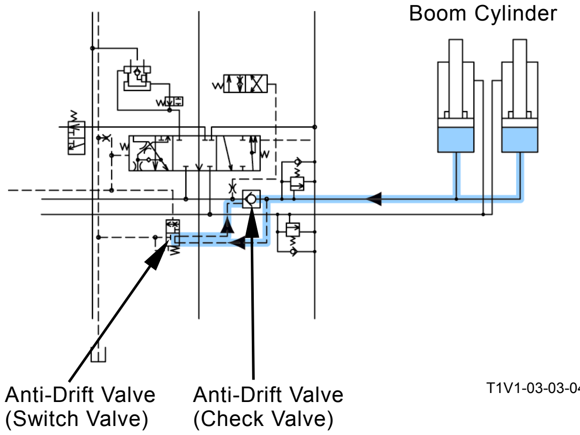
ANTI-DRIFT VALVE

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

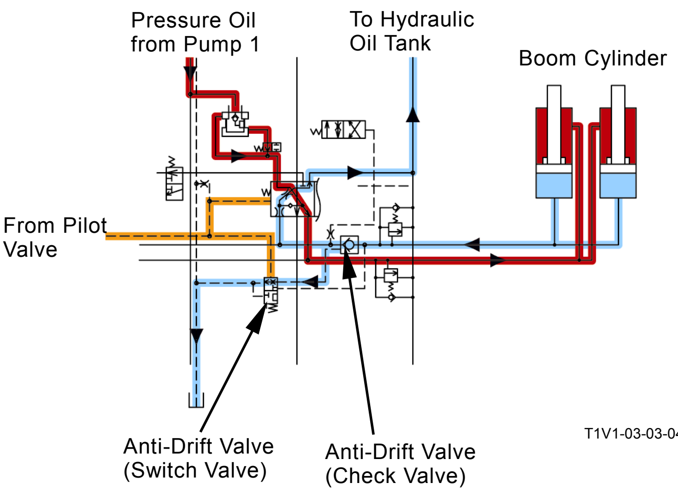
1. When the control lever is in neutral (neutral spool position), the switch valve in anti-drift valve is not shifted.
2. Pressure at the boom cylinder bottom side (arm cylinder rod side) passes through the switch valve and acts to the check valve in anti-drift valve.
3. Consequently, as the check valve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



T1V1-03-03-047

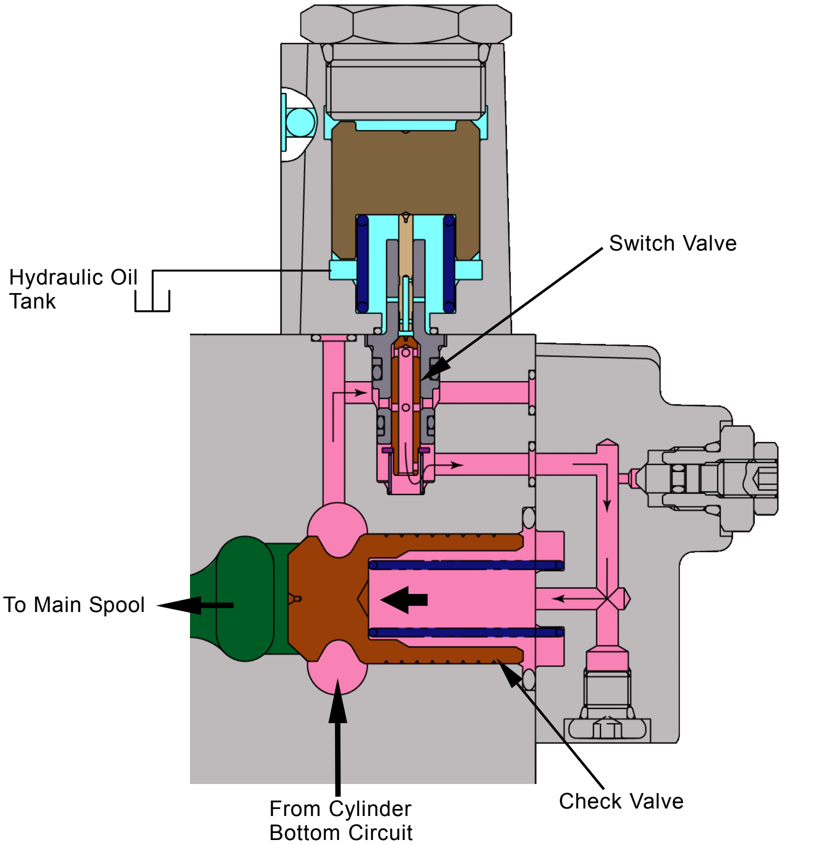
Releasing Operation

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.



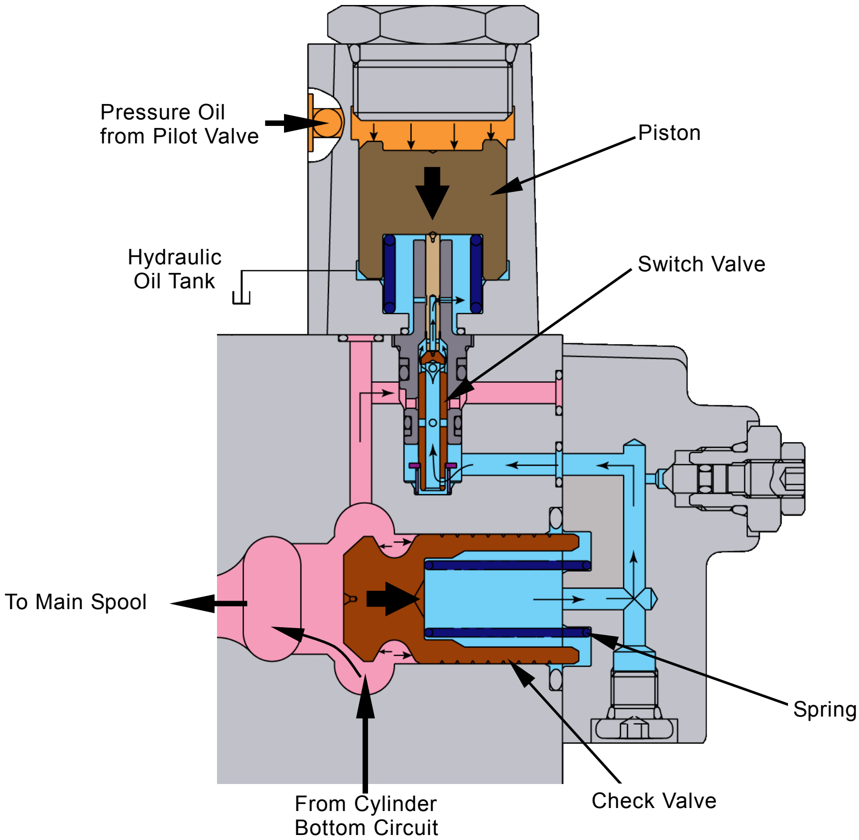
T1V1-03-03-048

Holding Operation:



T1V1-03-03-060

Releasing Operation:



T1V1-03-03-061

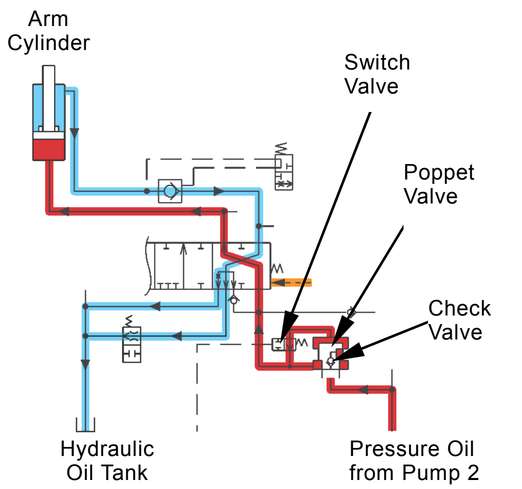
FLOW RATE CONTROL VALVE

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

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

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

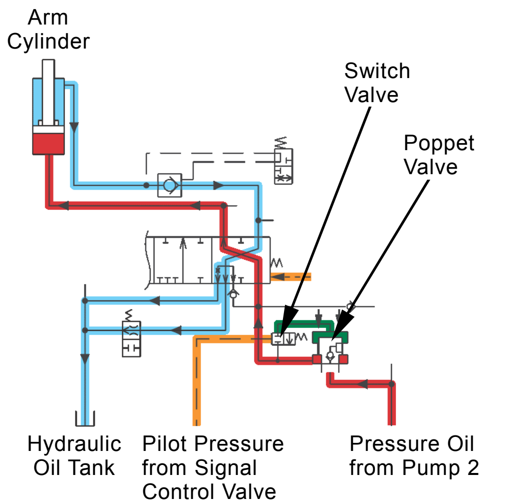
NOTE: *The arm 1 flow rate control valve is explained here.*



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.

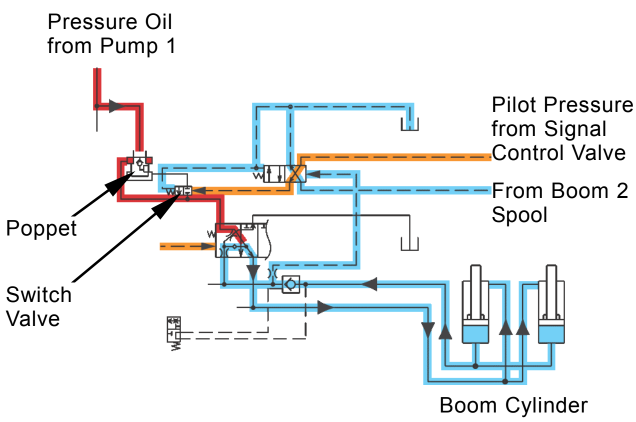


T1V1-03-03-050

Flow Rate Control Operation

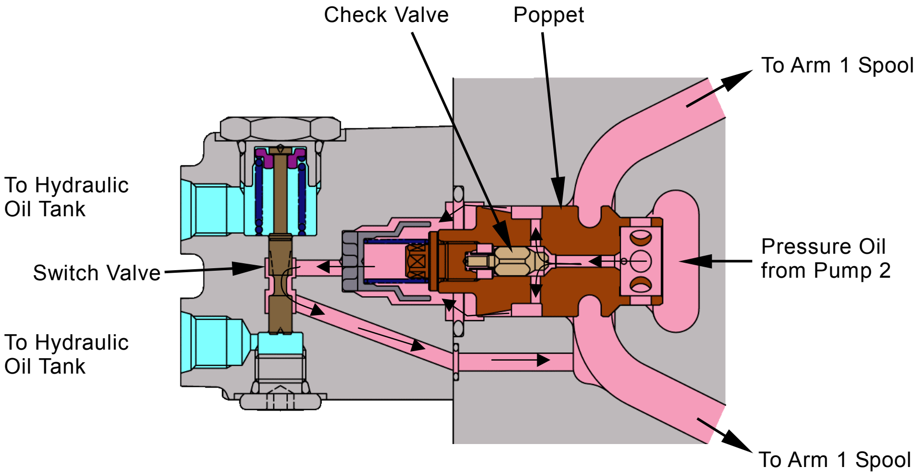
1. The switch valve in arm 1 flow rate control valve is shifted by pilot pressure from the arm 1 flow rate control valve spool in signal control valve.
2. Therefore, back pressure in the poppet valve increases and the force to close the poppet valve appears.
3. Consequently, the poppet valve restricts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



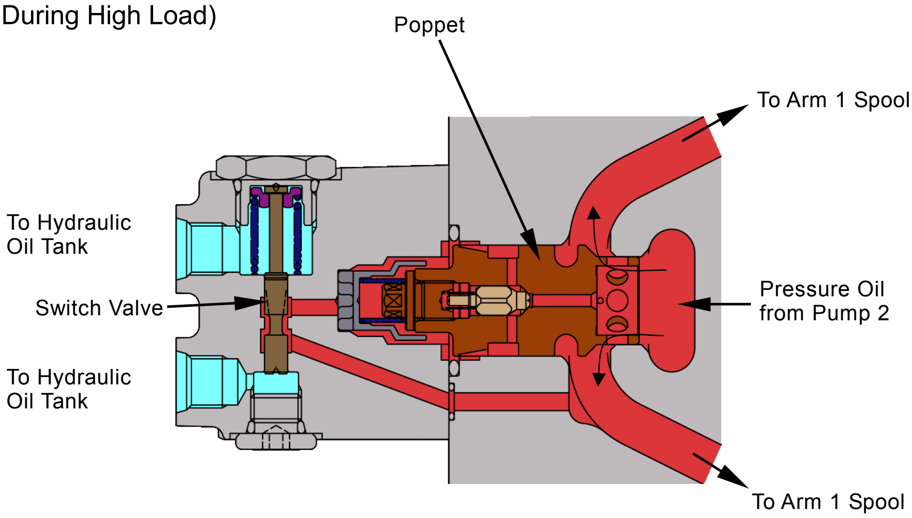
T1V1-03-03-076

Normal Operation (During Low Load)



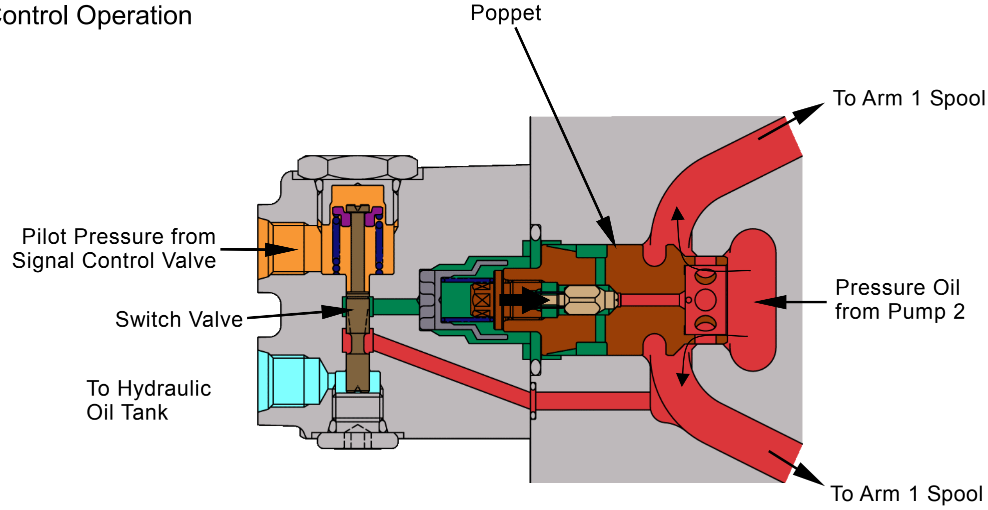
T1V1-03-03-062

Normal Operation (During High Load)



T1V1-03-03-063

Flow Rate Control Operation



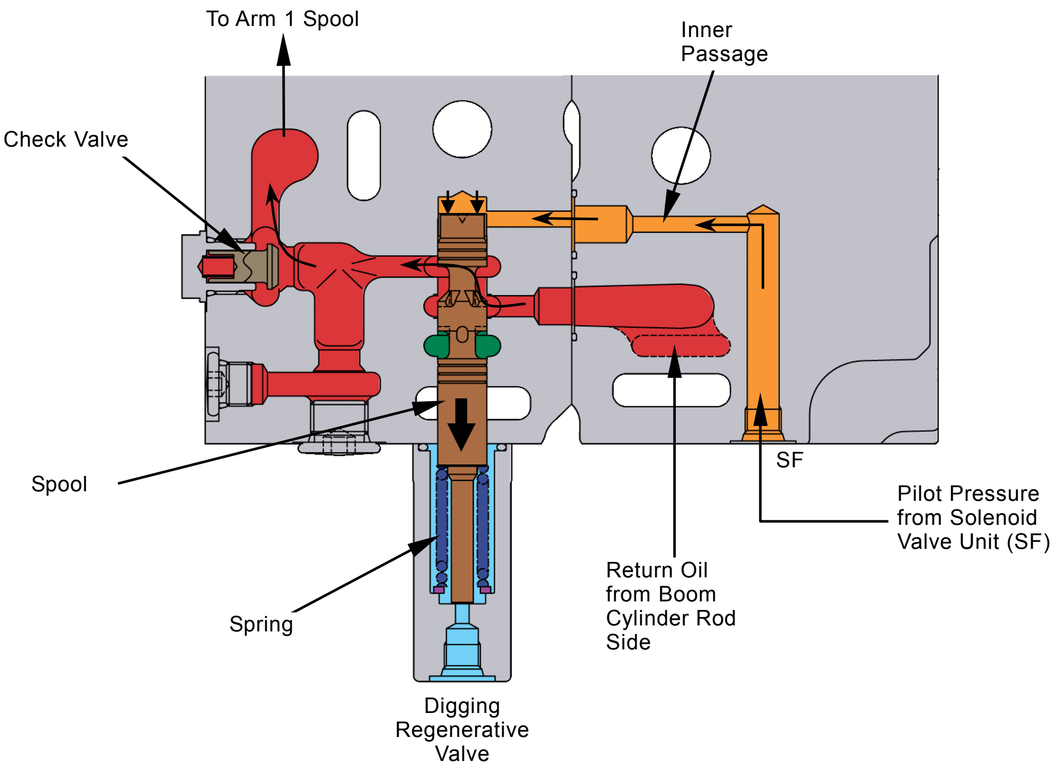
T1V1-03-03-064

DIGGING REGENERATIVE VALVE

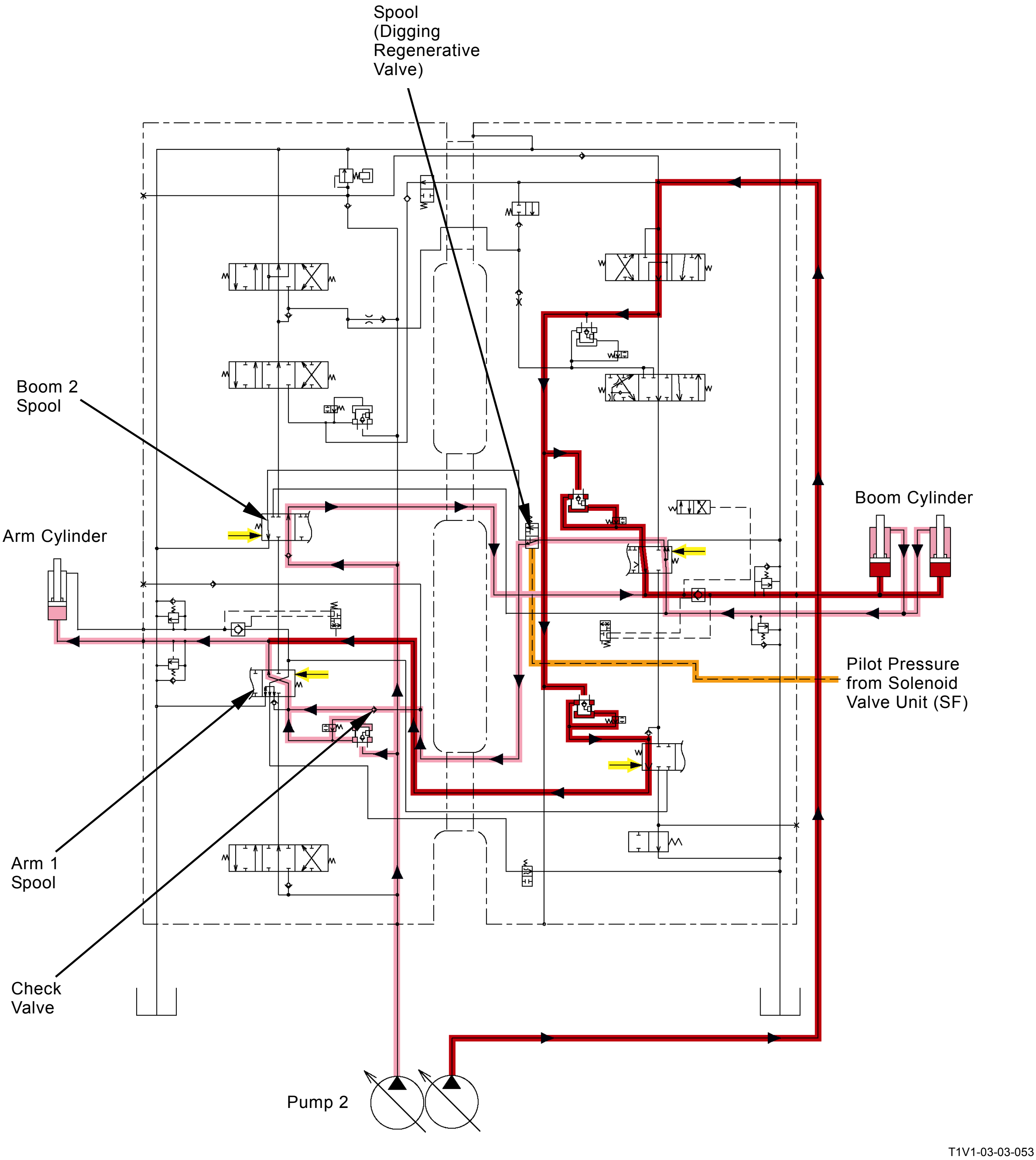
The digging regenerative valve is provided in the return circuit of boom lower and functions during combined operation of boom raise and arm roll-in.
When the digging regenerative valve is shifted, pressure oil from the boom cylinder rod side (return side) through the digging regenerative valve is combined with pressure oil from pump 2 and flows to the arm 1 spool. Therefore, speed of arm roll-in increases.
(Refer to Section "Control System"/ SYSTEM.)

Operation

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



T1V1-03-03-069


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
T1V1-03-03-053

BOOM LOWER METER-IN CUT VALVE

The boom lower meter-in cut valve is provided in the boom lower circuit and functions with the boom flow control valve together.
During boom lower operation with the front attachment above the ground, the boom flow rate control valve restricts pressure oil which flows to the boom 1 spool from pump 1 and blocks pilot pressure to the arm 2 spool.
Therefore, during operation of boom lower and other actuator, the boom falls due to own weight by the regenerative circuit and uses pressure oil from the pump for other actuator so that speed of other actuator increases. (Refer to “Hydraulic System”/ SYSTEM.)

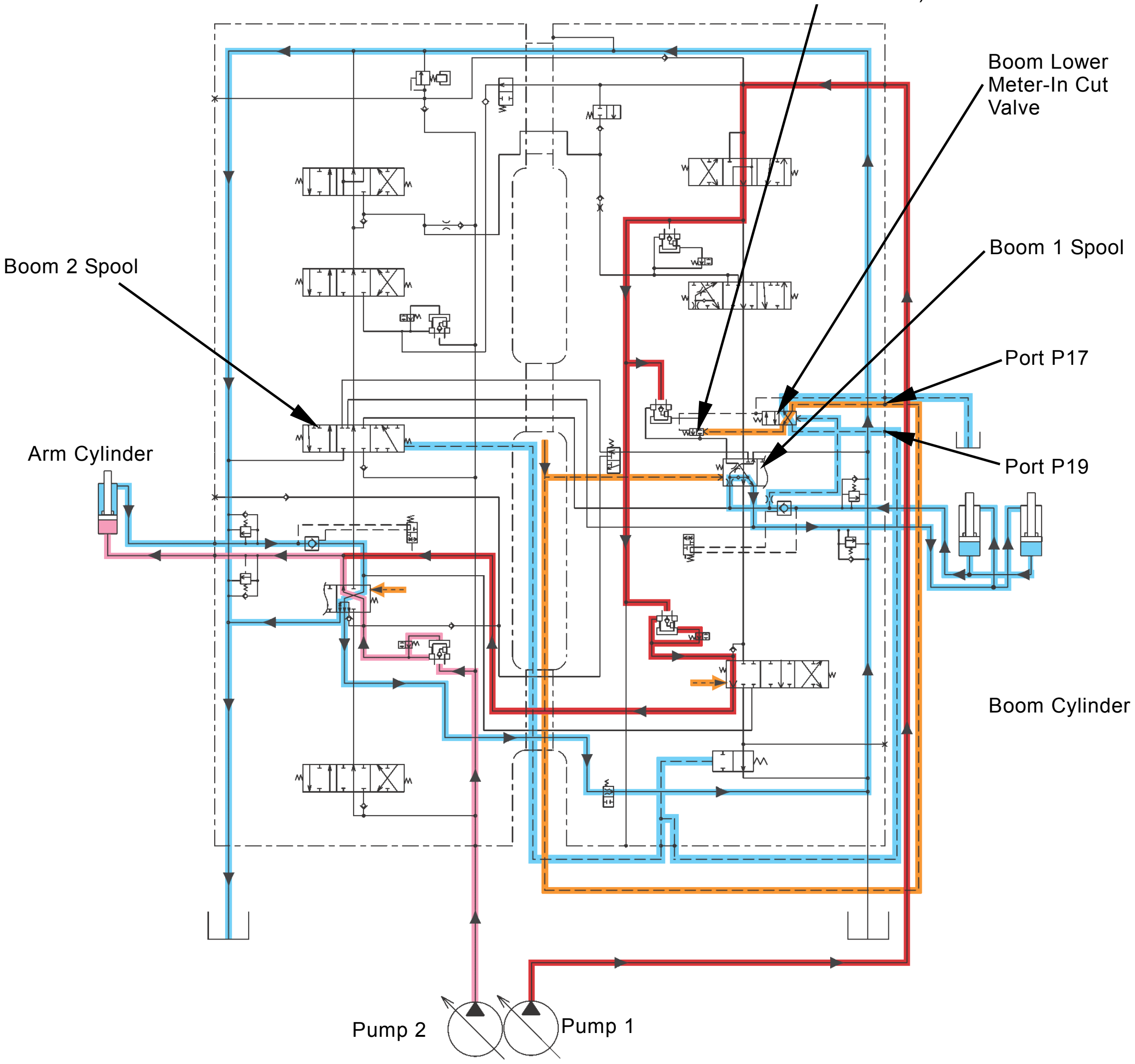
Operation (Boom Lower with Front Attachment above Ground)

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

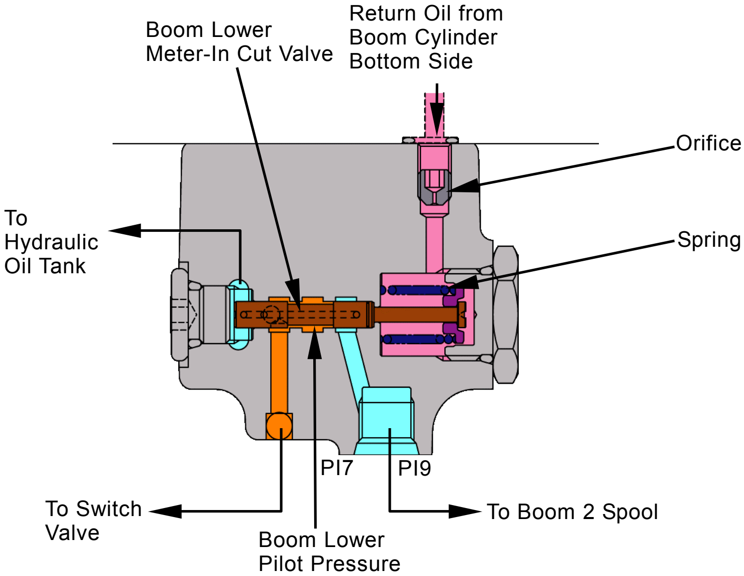
Operation (Jack-Up)

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

Boom Lower with Front Attachment above Ground



T1V1-03-03-051



T1V1-03-03-074

AUXILIARY FLOW COMBINER VALVE AND BYPASS SHUT-OUT VALVE

The auxiliary flow combiner valve and the bypass shut-out valve are provided in the 5-spool section circuit and the rear of 4-spool section circuit respectively.
These valve functions differ depending on whether only the front attachment is single-operated or combined- operated.

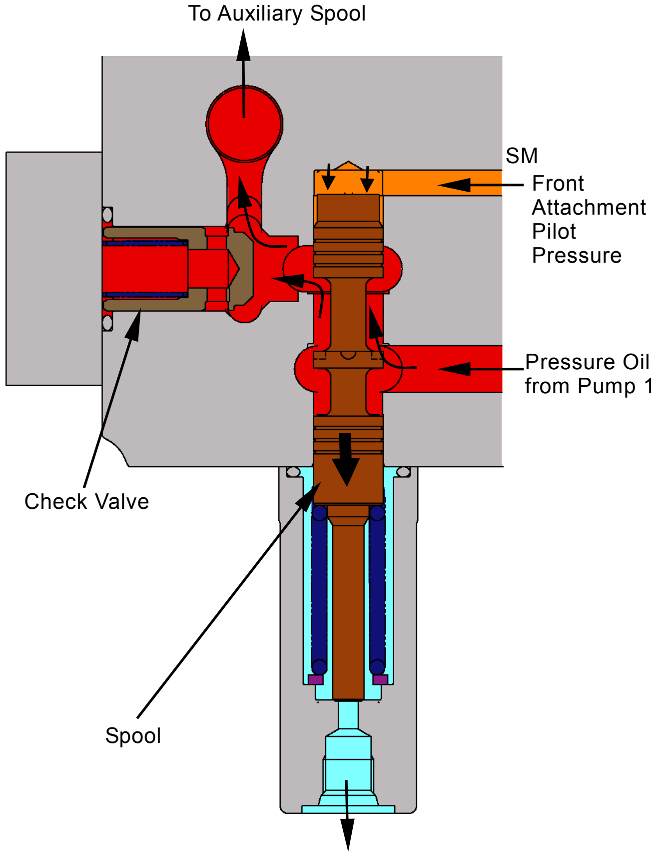
During Single Operation

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

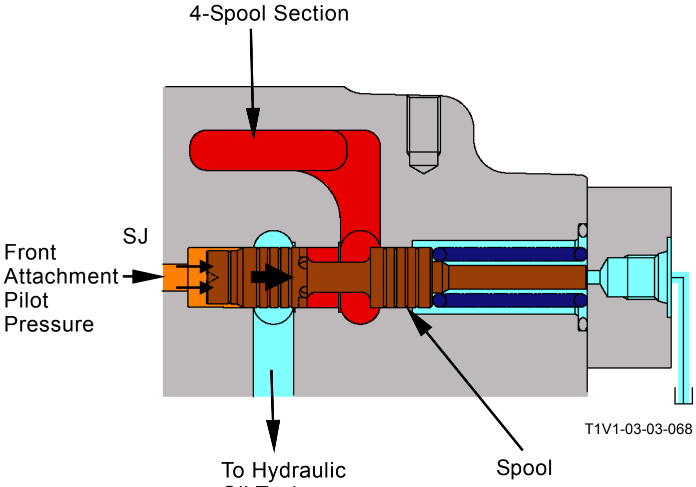
1. When the front attachment is single operated, front attachemt pilot pressure acts to ports SM and SJ and the spools in auxiliary flow combiner valve and bypass shut-out valve are shifted.
2. When the spool in bypass shut-put valve is shifted, the neutral circuit in 4-spool section is blocked.
3. At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

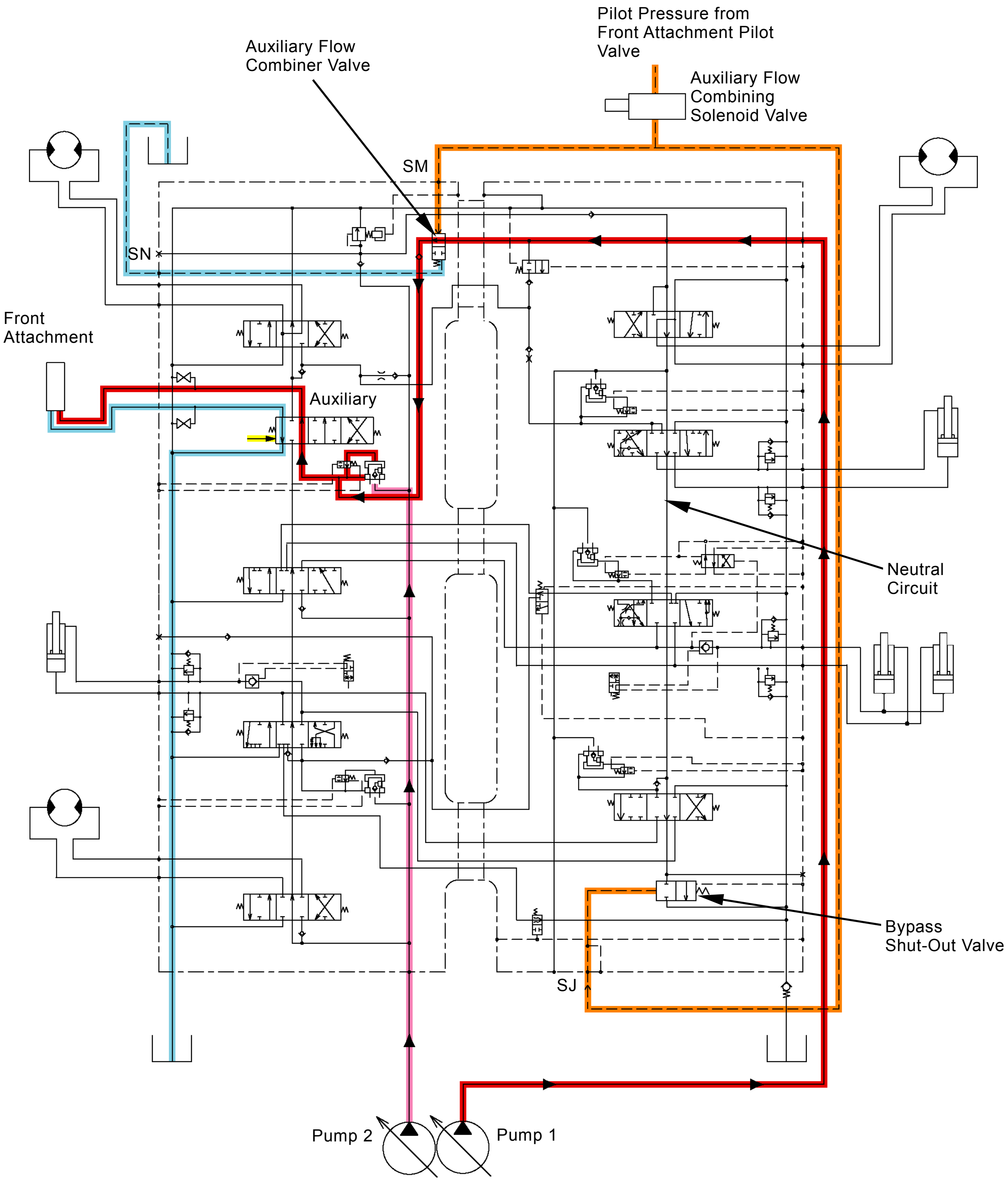
NOTE: *The external shuttle valve is installed to the machine equipped with the optional auxiliary flow combining system. During front attachment operation, front attachment pilot pressure shifts the pump 1 flow rate control valve in signal control valve through the external shuttle valve.*
Therefore,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

Auxiliary Flow Combiner Valve



Bypass Shut-Out Valve





T1V1-03-03-054

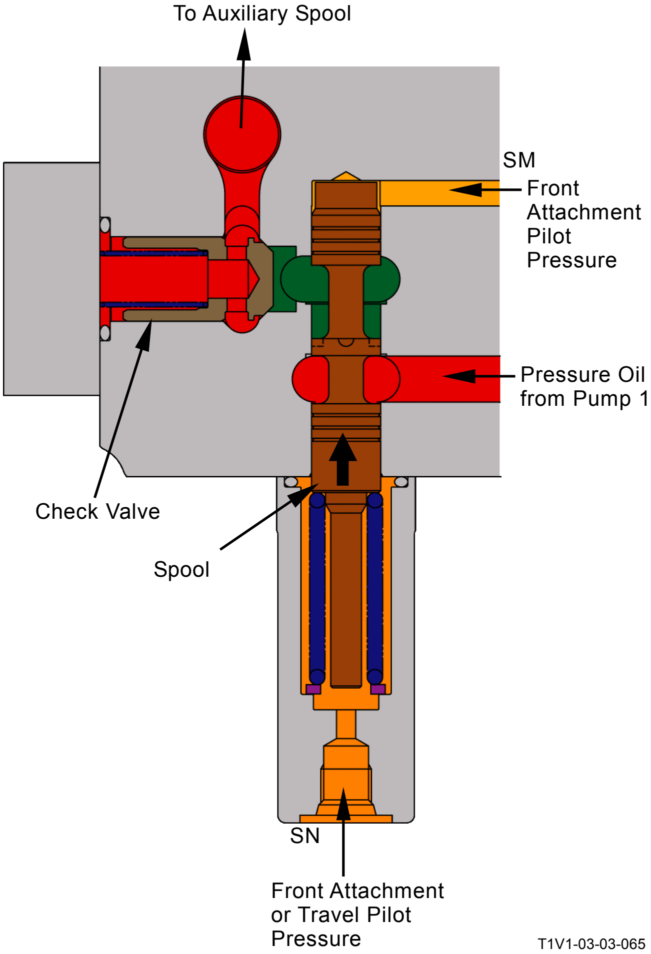
NOTE: The illustration shows auxiliary (open) operation.

During Combined Operation

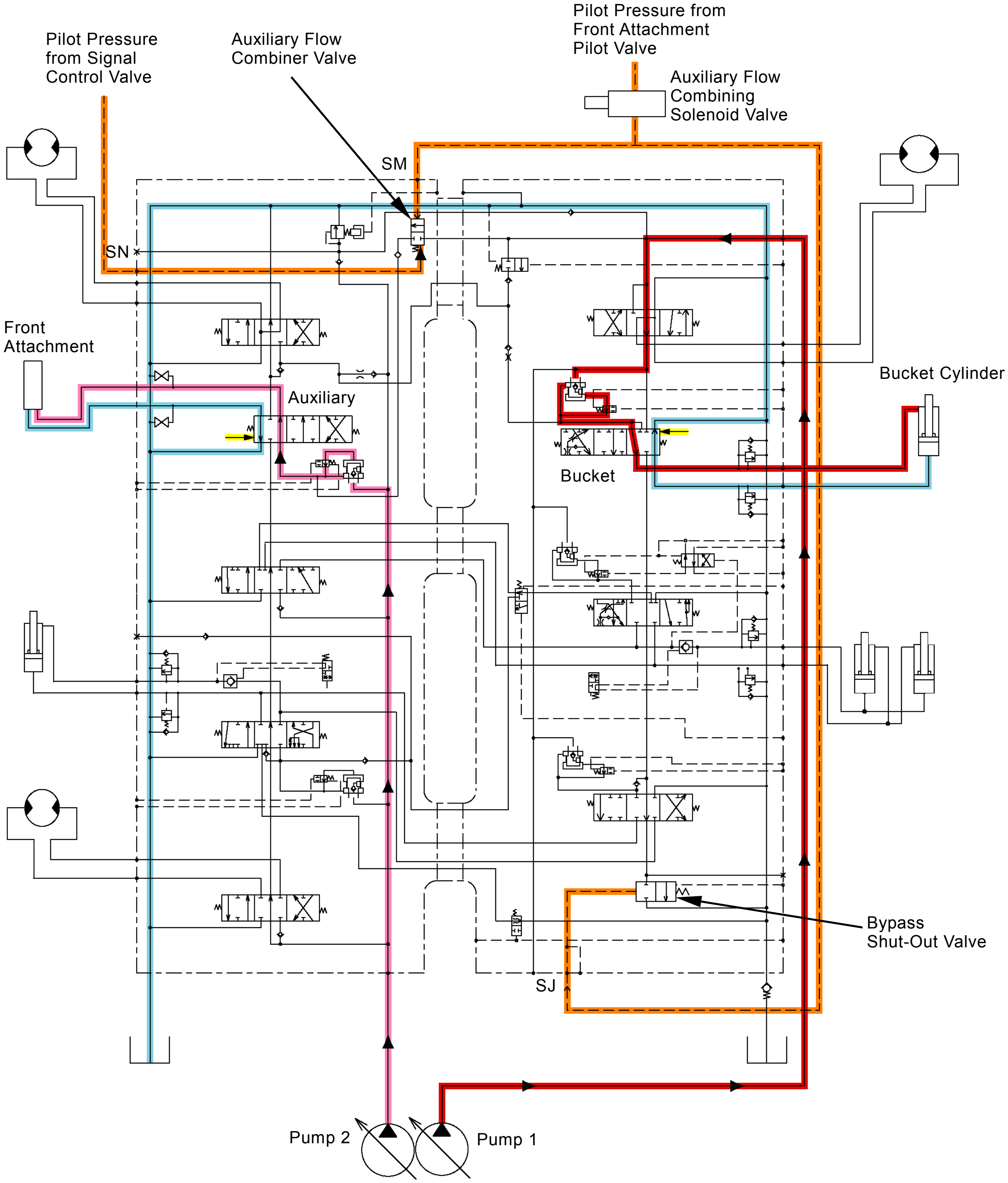
During combined operation of front attachment and boom, arm, bucket or travel, do not shift the auxiliary flow combiner valve. Therefore, operating speed of boom, arm, bucket and travel is maintained.

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

Auxiliary Flow Combiner Valve



T1V1-03-03-065



T1V1-03-03-055

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

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OUTLINE

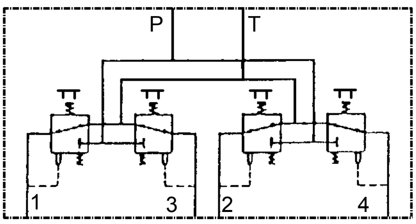
The pilot valve controls pilot pressure oil in order to move the spool in control valve. The pilot valve outputs pressure according to the control lever stroke by PPC (Pressure Proportional Control Valve) function and moves the spool in control valve.
The 4-port pilot valves for front attachment/swing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

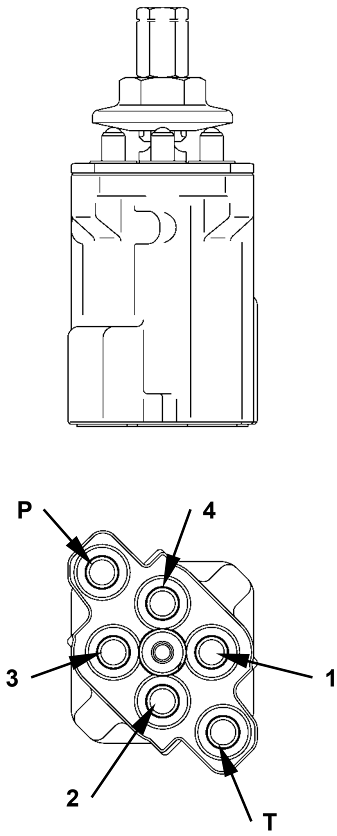
- Front Attachment / Swing Pilot Valve

	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



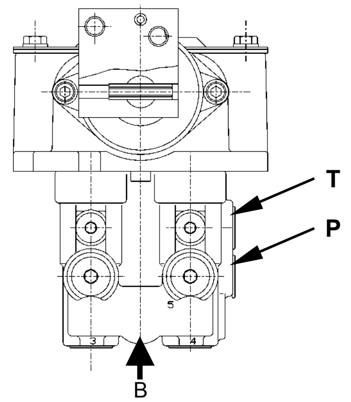
T105-02-07-020



T1V1-03-04-001

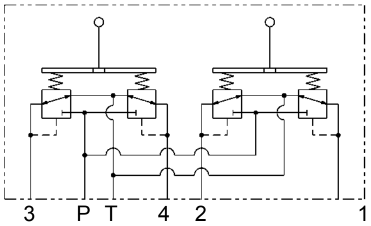
- Travel Pilot Valve

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



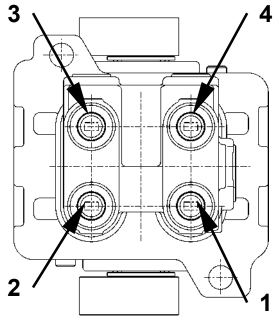
T1M9-03-05-004

Hydraulic Symbol



T178-03-04-017

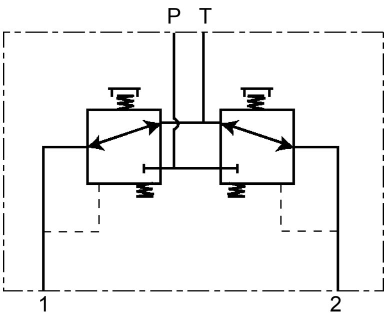
View B



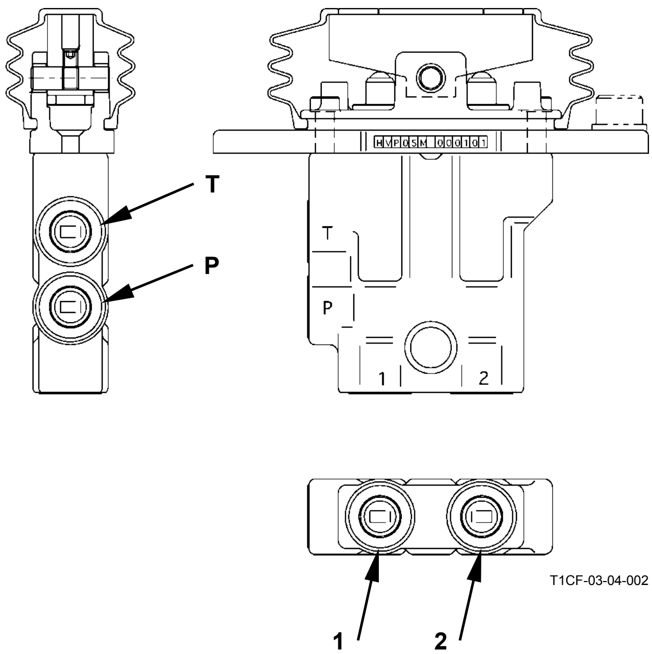
T1M9-03-05-005

- Auxiliary / Positioning Pilot Valve

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



T1CF-03-04-001



T1CF-03-04-002

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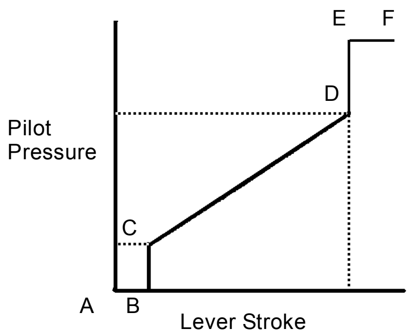
OPERATION

• 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).

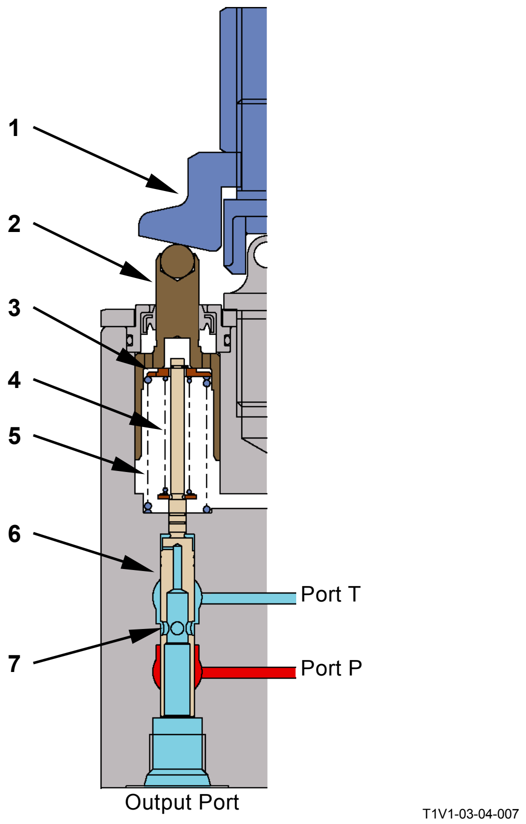


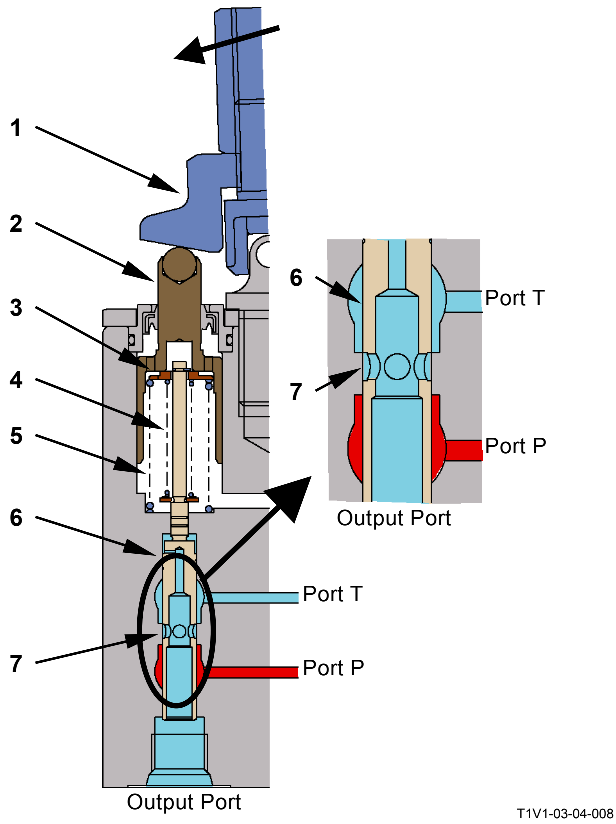
T523-02-05-001

Neutral (Output Curve: A to B):

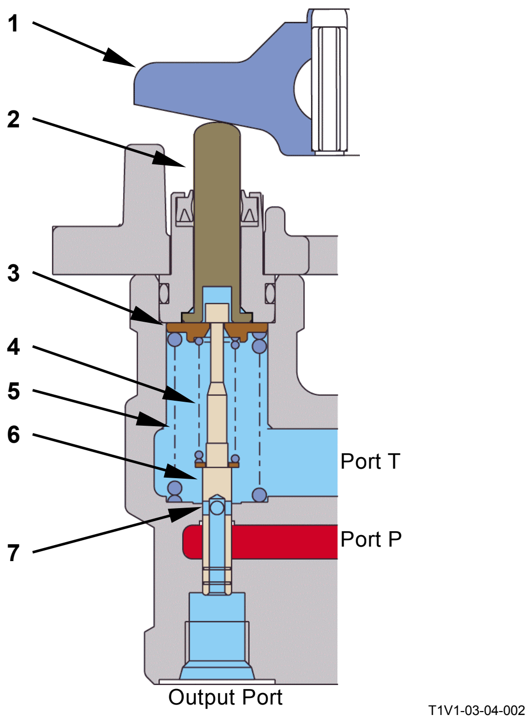
1. When in neutral, spool (6) totally blocks pressure oil from port P (the pilot pump). The output port is opened to port T (hydraulic oil tank) through the inner passage in spool (6).
2. Therefore, pressure in the output port is equal to that in port T.
3. When the control lever is slightly tilted, 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.

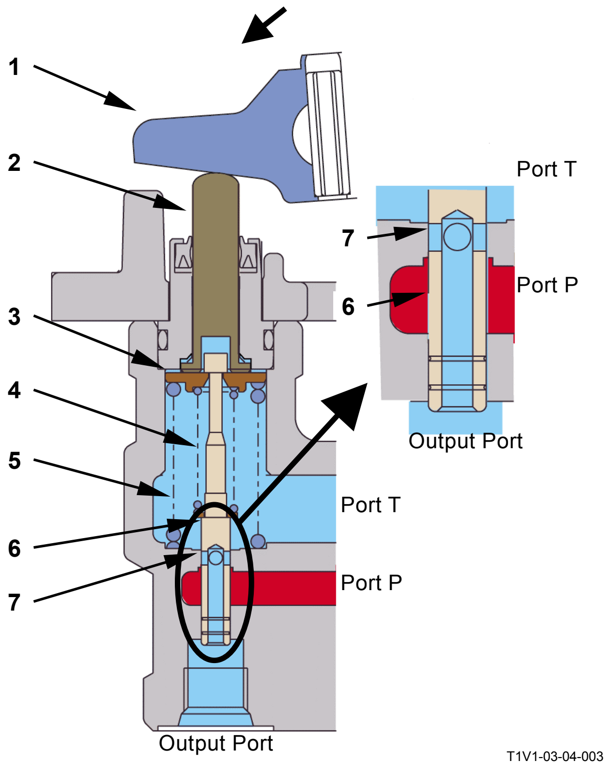
Front Attachment / Swing Pilot Valve





Travel Pilot Valve

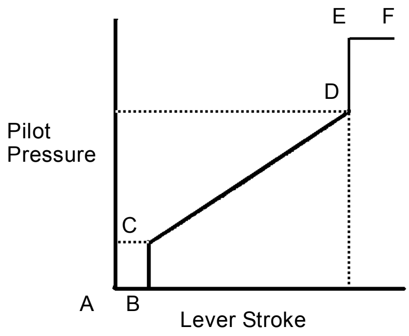




1 - Cam
2 - Pusher
3 - Spring Guide
4 - Balance Spring
5 - Return Spring
6 - Spool
7 - Hole

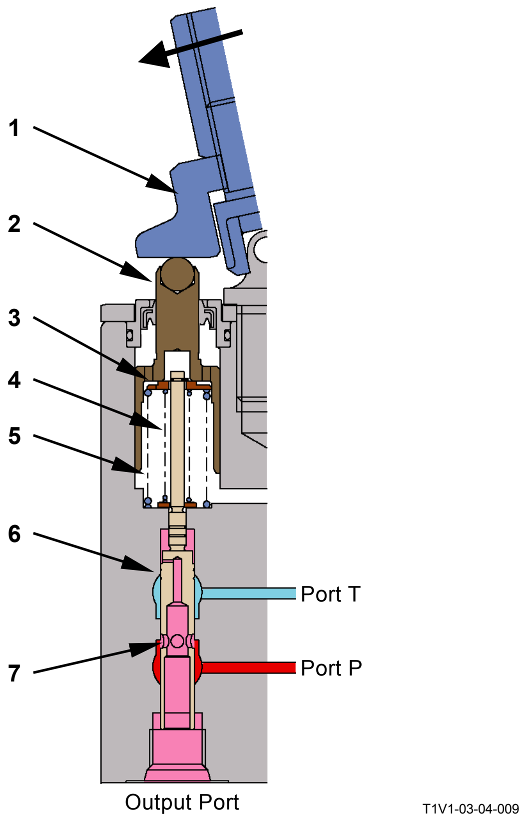
During Metering or Decompressing (Output Curve: C to D)

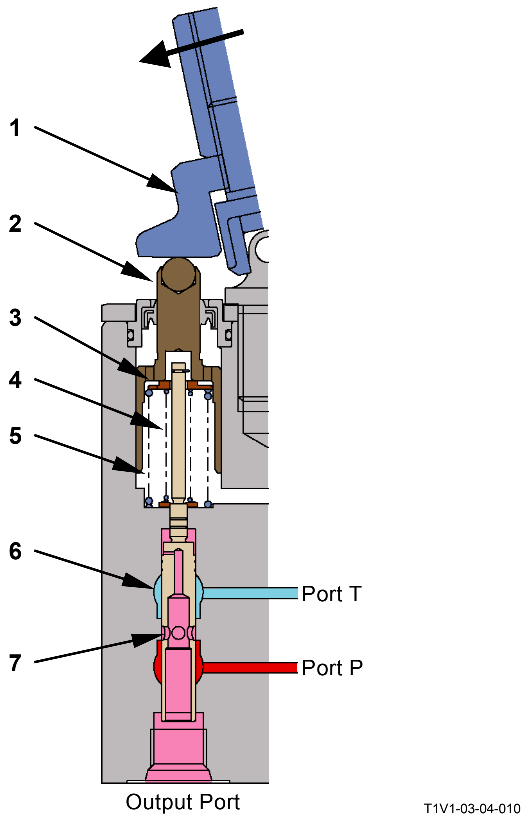
1. When the control lever is further tilted in order to move pusher (2) downward more, hole (7) on spool (6) is opened to port P and pressure oil in port P flows into the output port.
2. Pressure in the output port acts on the bottom surface of spool (6) so that spool (6) is pushed upward.
3. Until upward 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.



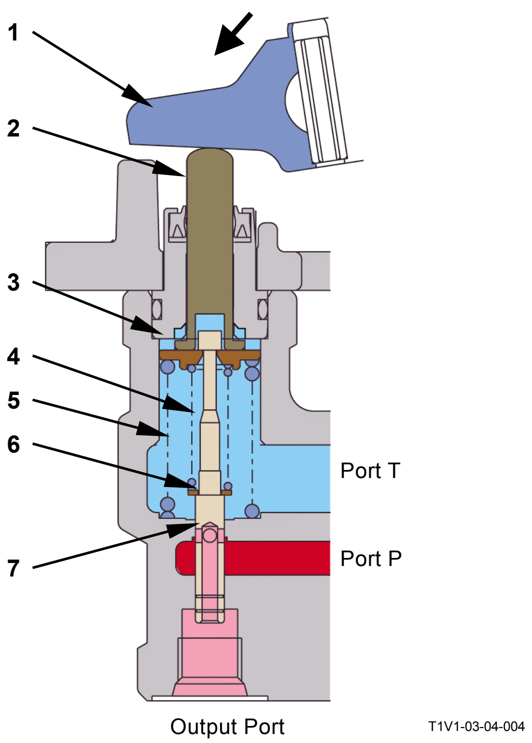
T523-02-05-001

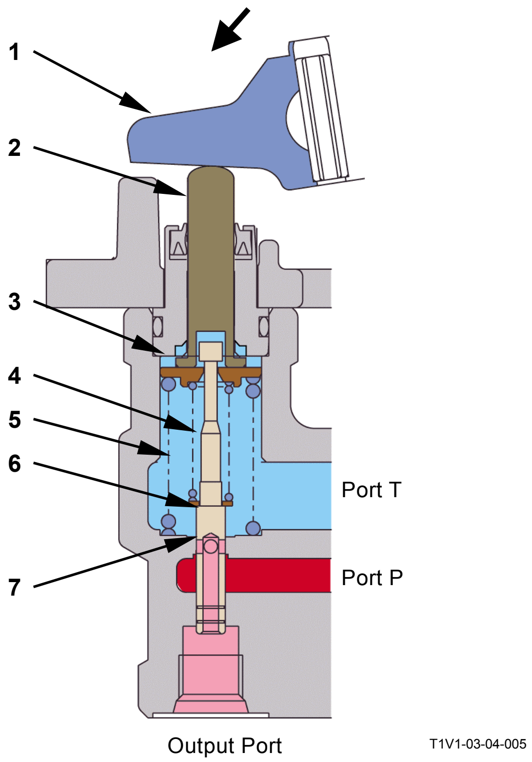
Front Attachment / Swing Pilot Valve





Travel Pilot Valve



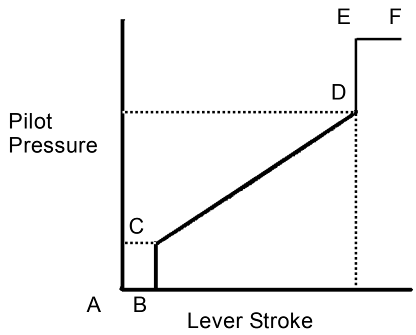


1 - Cam
2 - Pusher
3 - Spring Guide
4 - Balance Spring
5 - Return Spring
6 - Spool
7 - Hole

Full Stroke (Output Curve: E to F)

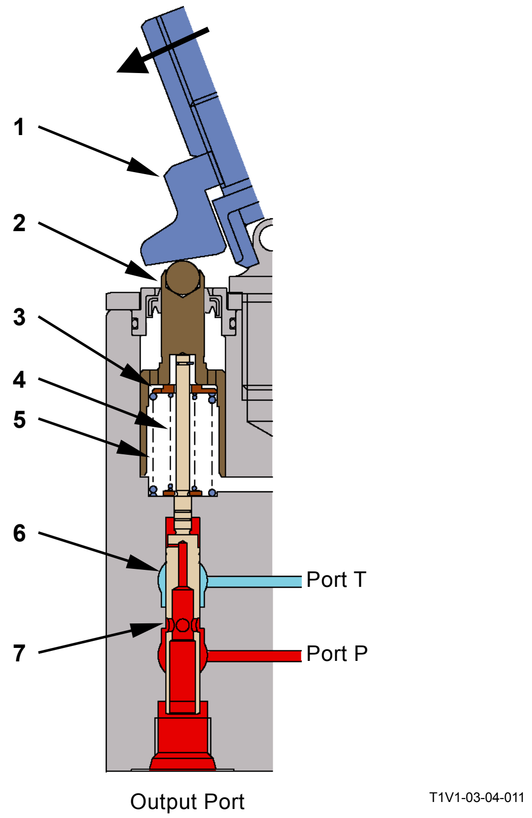
1. When the control lever is fully stroked, pusher (2) is moved downward until pusher (2) on the front attachment / swing pilot valve comes in contact with the casing shoulder, or cam (1) on the travel pilot valve comes in contact with the casing.
2. At this time, the bottom surface of pusher (2) directly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

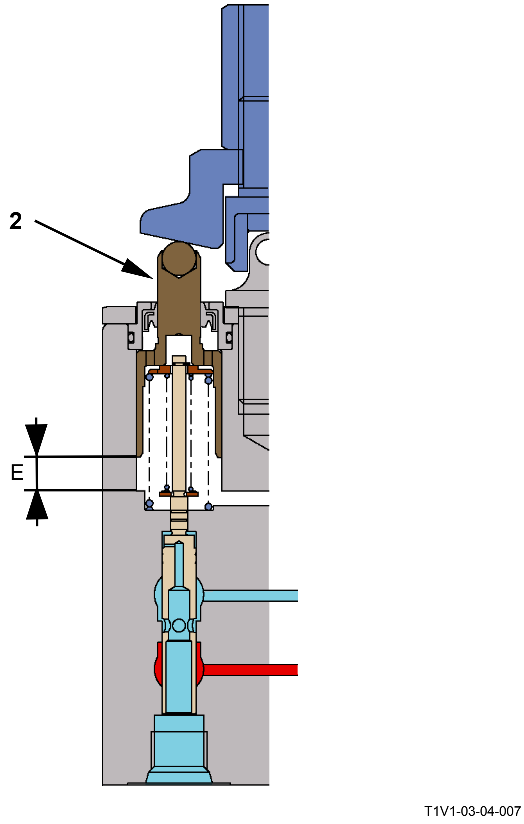
NOTE: Total lever strokes for front attachment and swing controls are determined by stroke dimension (E) of pusher (2). Total lever stroke for travel control is determined by stroke dimension (E) of cam (1).



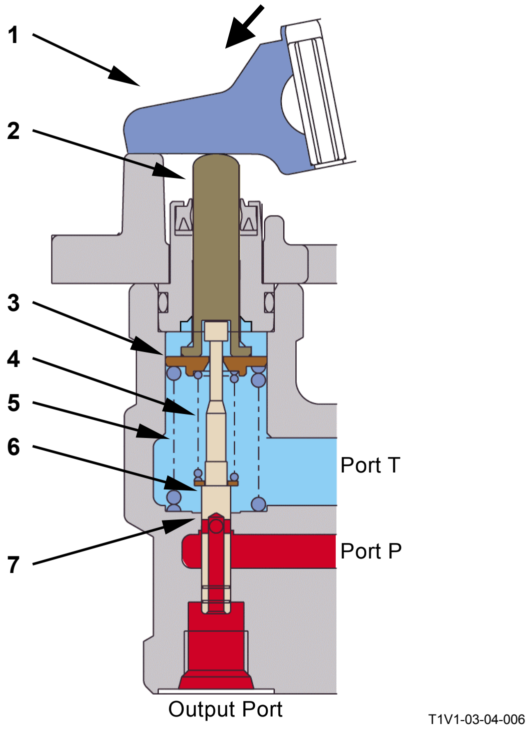
T523-02-05-001

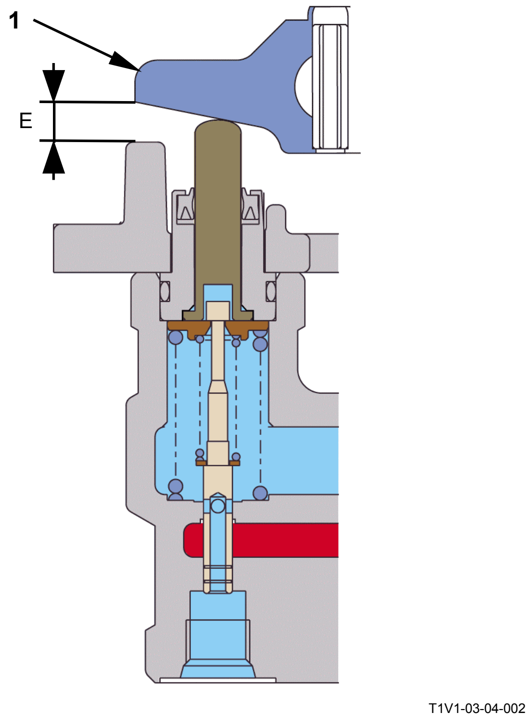
Front Attachment / Swing Pilot Valve





Travel Pilot Valve





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

- Auxiliary / Positioning Pilot Valve

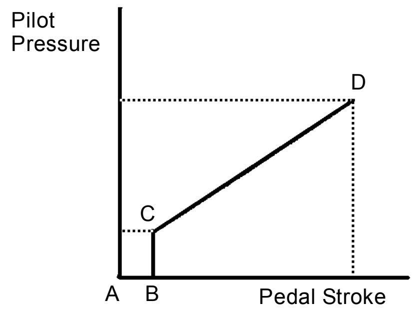
In Neutral (Output Curve: A to B)

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.

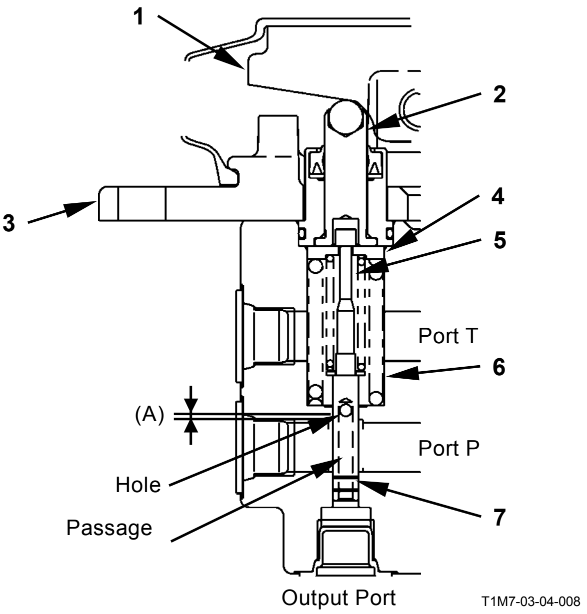
During Metering or Decompressing (Output Curve: C to D)

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.

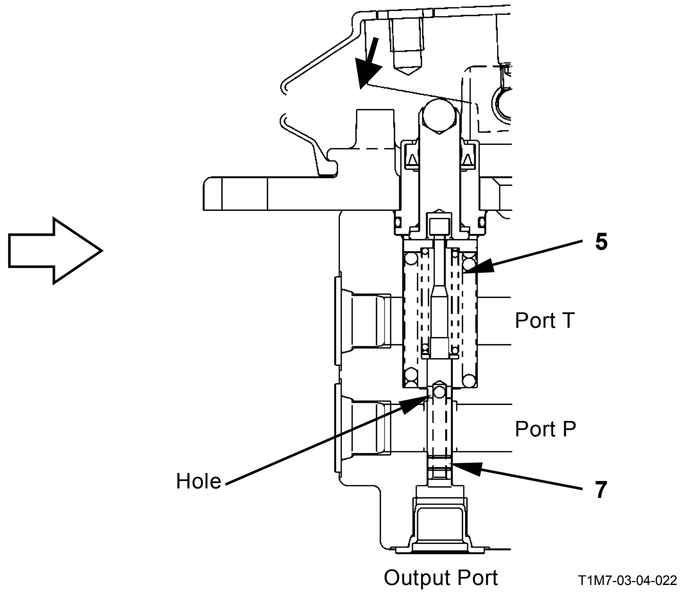


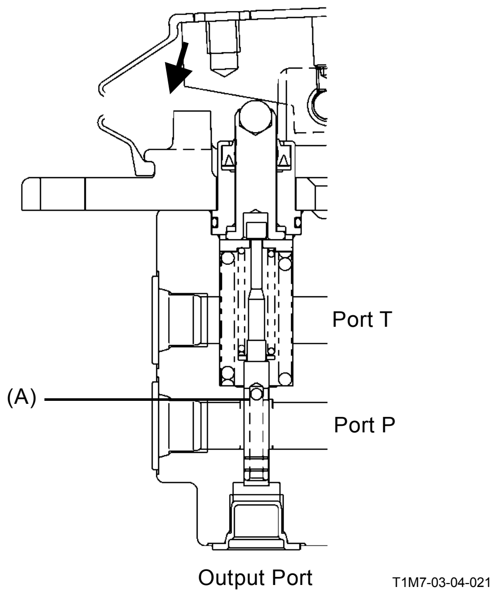
T1F3-03-09-004

In Neutral (Output Curve: A to B)



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





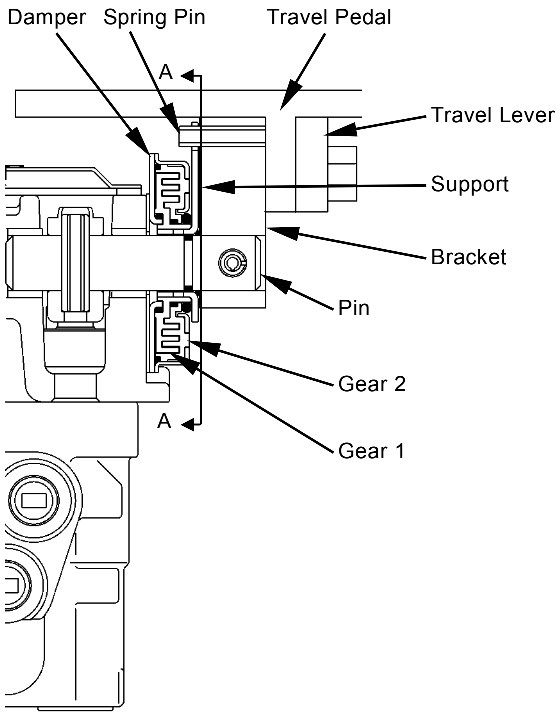
1 - Cam
2 - Pusher
3 - Plate
4 - Spring Guide
5 - Balance Spring
6 - Return Spring
7 - Spool

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.

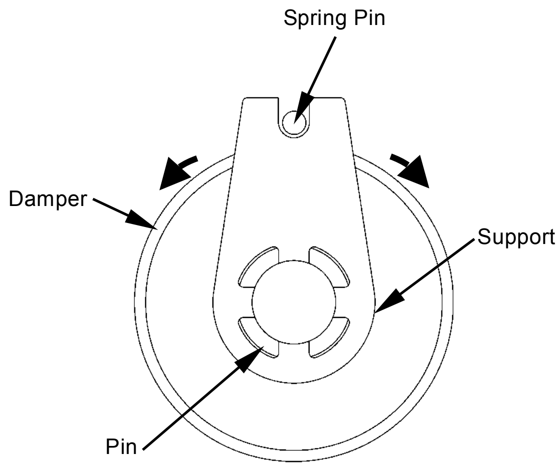
Operation

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

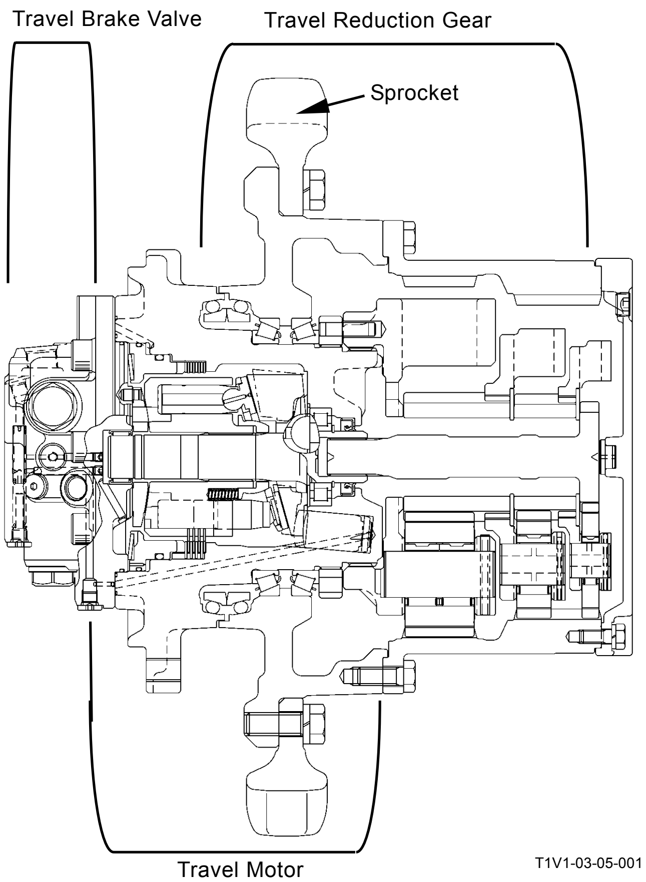
OUTLINE

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.

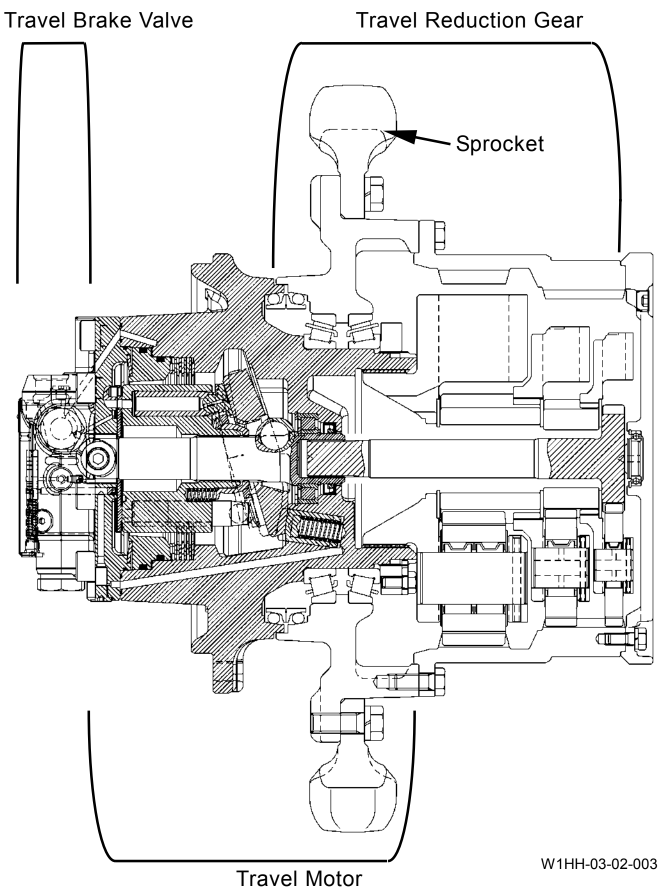
The travel reduction gear is a three stage reduction planetary gear type, converts rotary power transmitted from the travel motor to slow large torque and rotates the sprocket and track. The travel brake valve protects the travel circuit from being overloaded and prevents the occurrence of cavitation.

NOTE: *The structure and theory of operation of the travel device for ZX200-3 class, ZX225US-3 class, ZX225USR-3 class and ZX240-3 class can be thought as identical. Only some parts differs. This section describes the operation of ZX200-3 class and ZX270-3 class.*

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class



ZX270-3 class

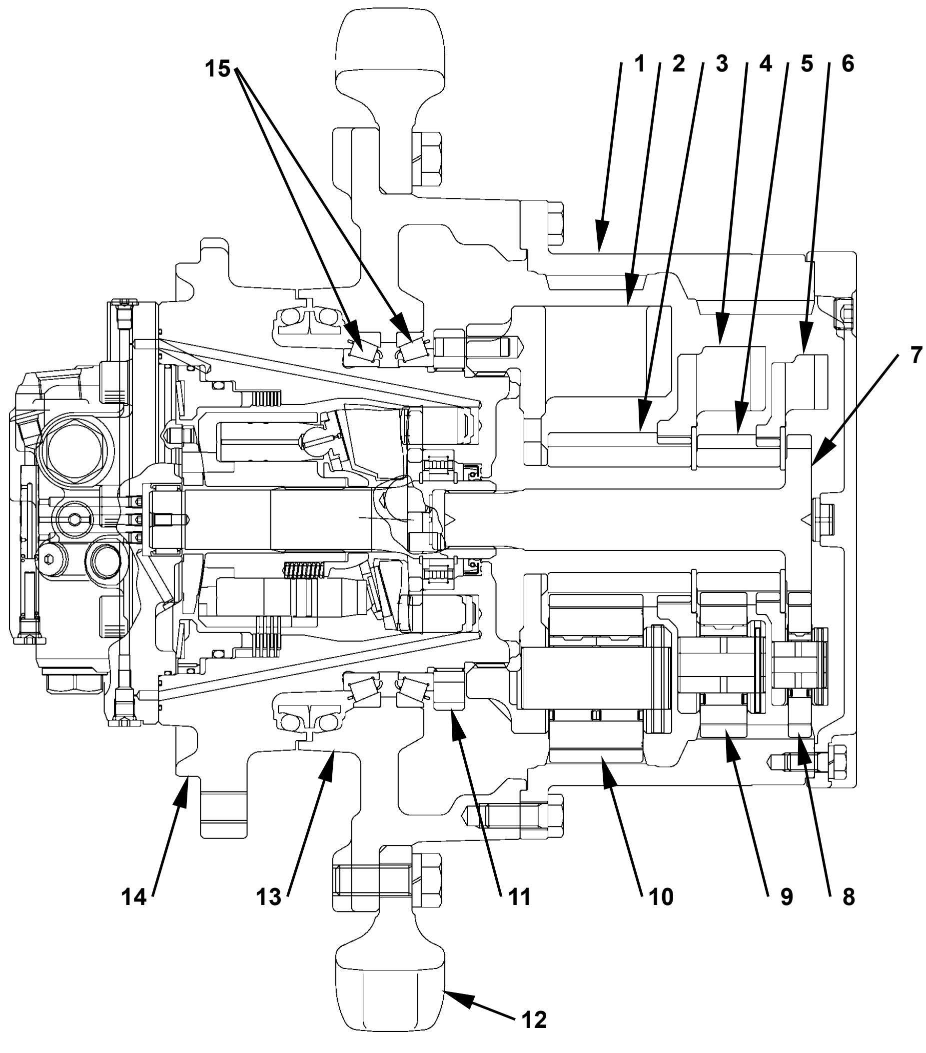


TRAVEL REDUCTION GEAR

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

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

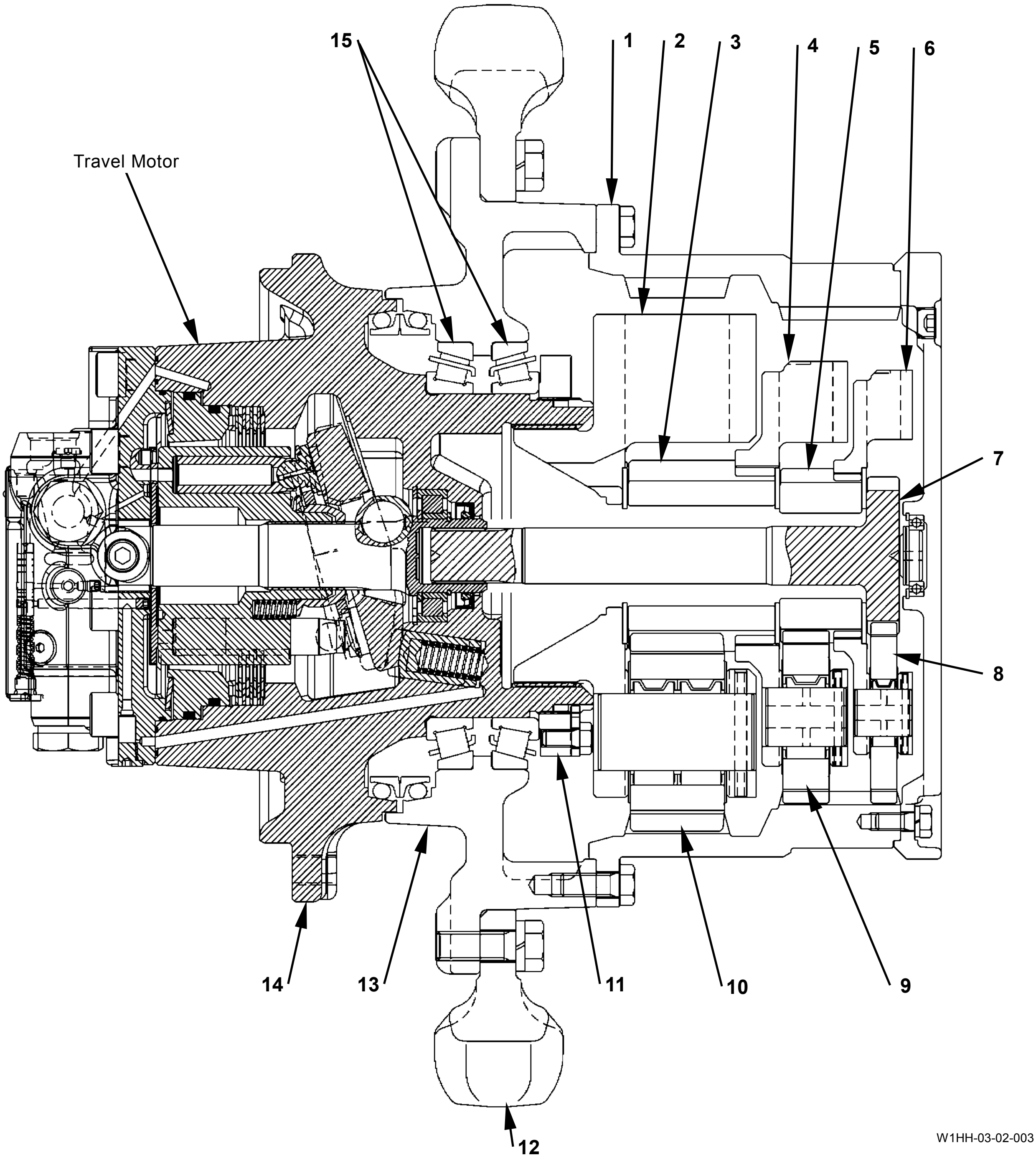
ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class



T178-03-05-001

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

ZX270-3 class



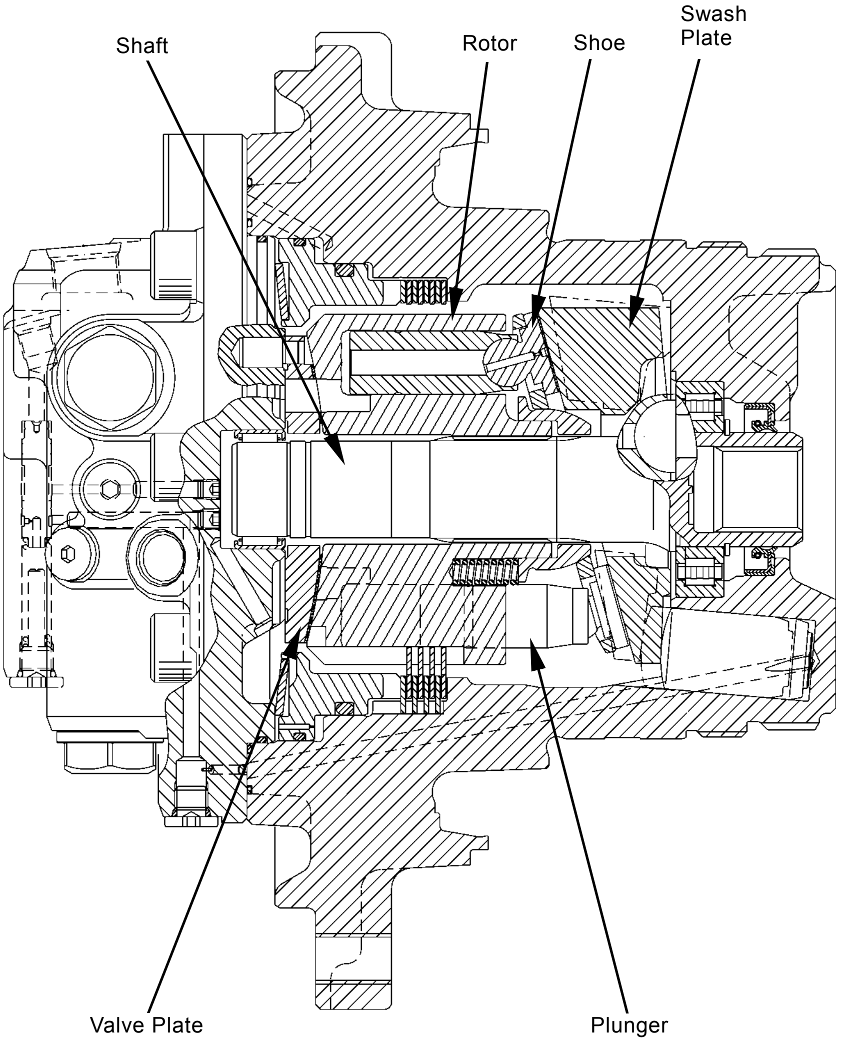
1 - Ring Gear	5 - Second Stage Sun Gear	9 - Second Stage Planetary Gear	13 - Drum
2 - Third Stage Carrier	6 - First Stage Carrier	10 - Third Stage Planetary Gear	14 - Housing
3 - Third Stage Sun Gear	7 - Propeller Shaft	11 - Bearing Nut	15 - Bearing
4 - Second Stage Carrier	8 - First Stage Planetary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

TRAVEL MOTOR

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

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

ZX200-3 class, ZX225US-3 class, ZX225USR-3 class, ZX240-3 class



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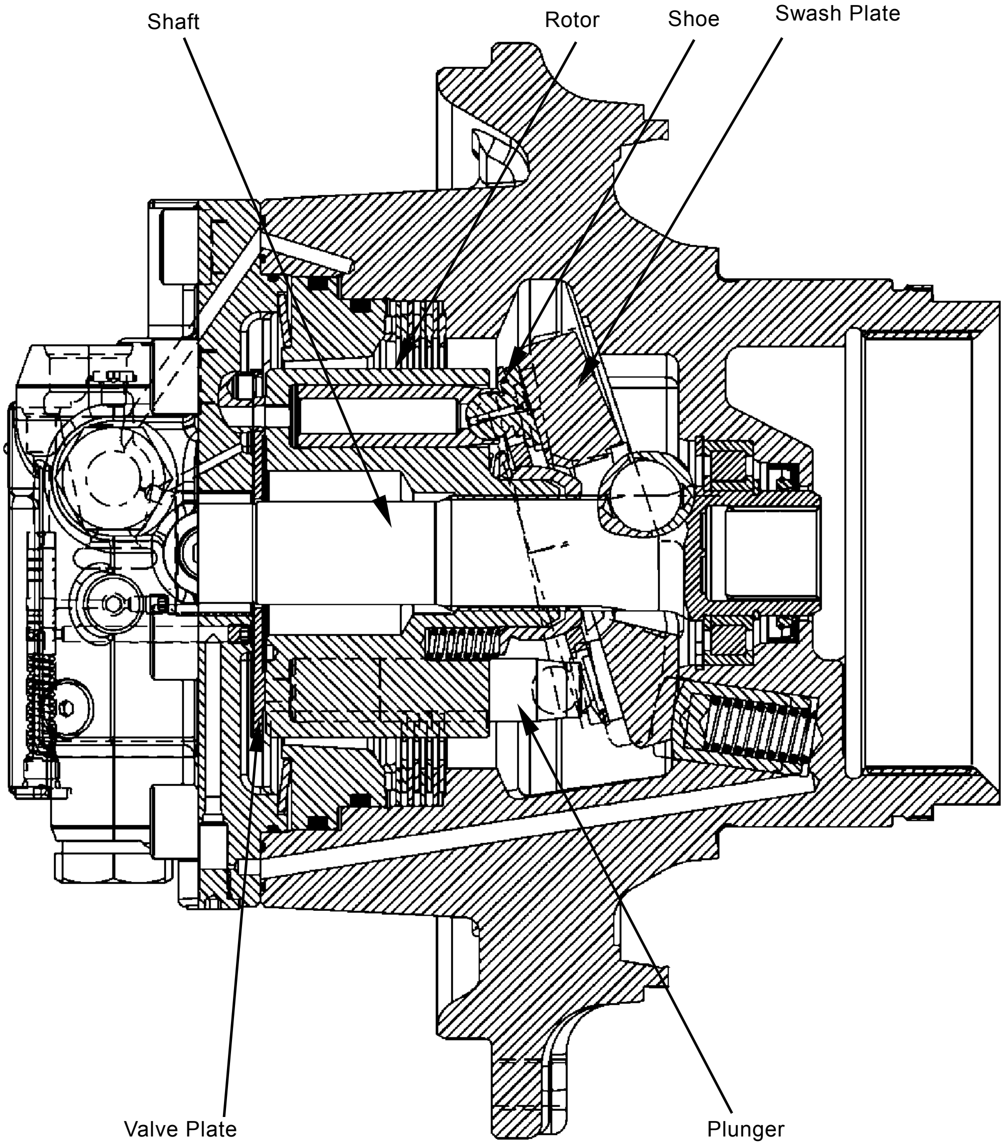
ZX270-3 class



W1HH-03-02-006

PARKING BRAKE

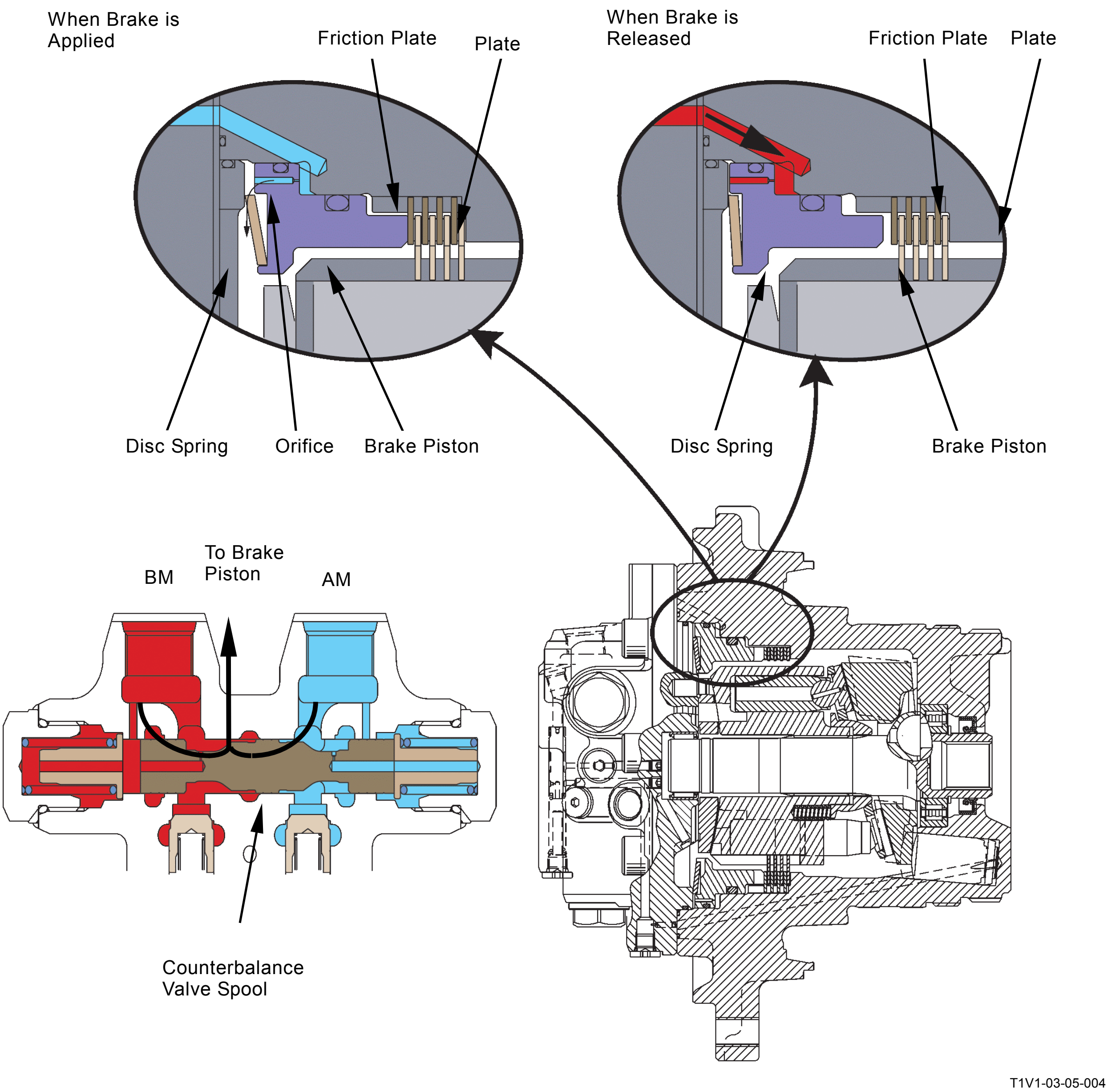
The parking brake is a wet-type multi disc brake. The brake is a negative type so that it is released only when the brake release pressure oil is routed into the brake piston chamber. The parking brake is automatically applied unless the travel function is operated. The friction plates and plates are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

Releasing Brake

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

Applying Brake

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



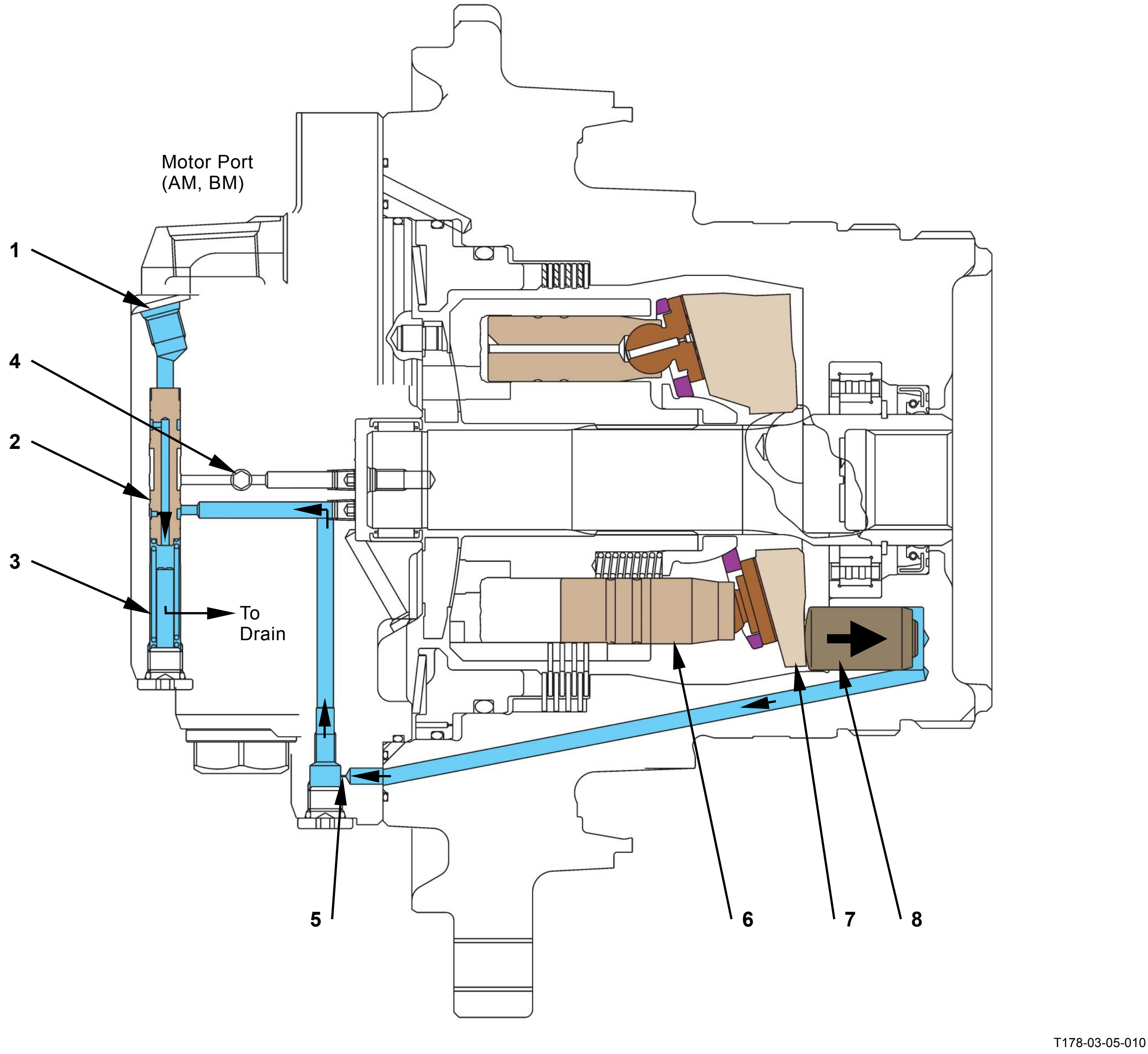
NOTE: The illustration shows ZX200-3 class.

TRAVEL MODE CHANGE

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

- Slow Speed Mode

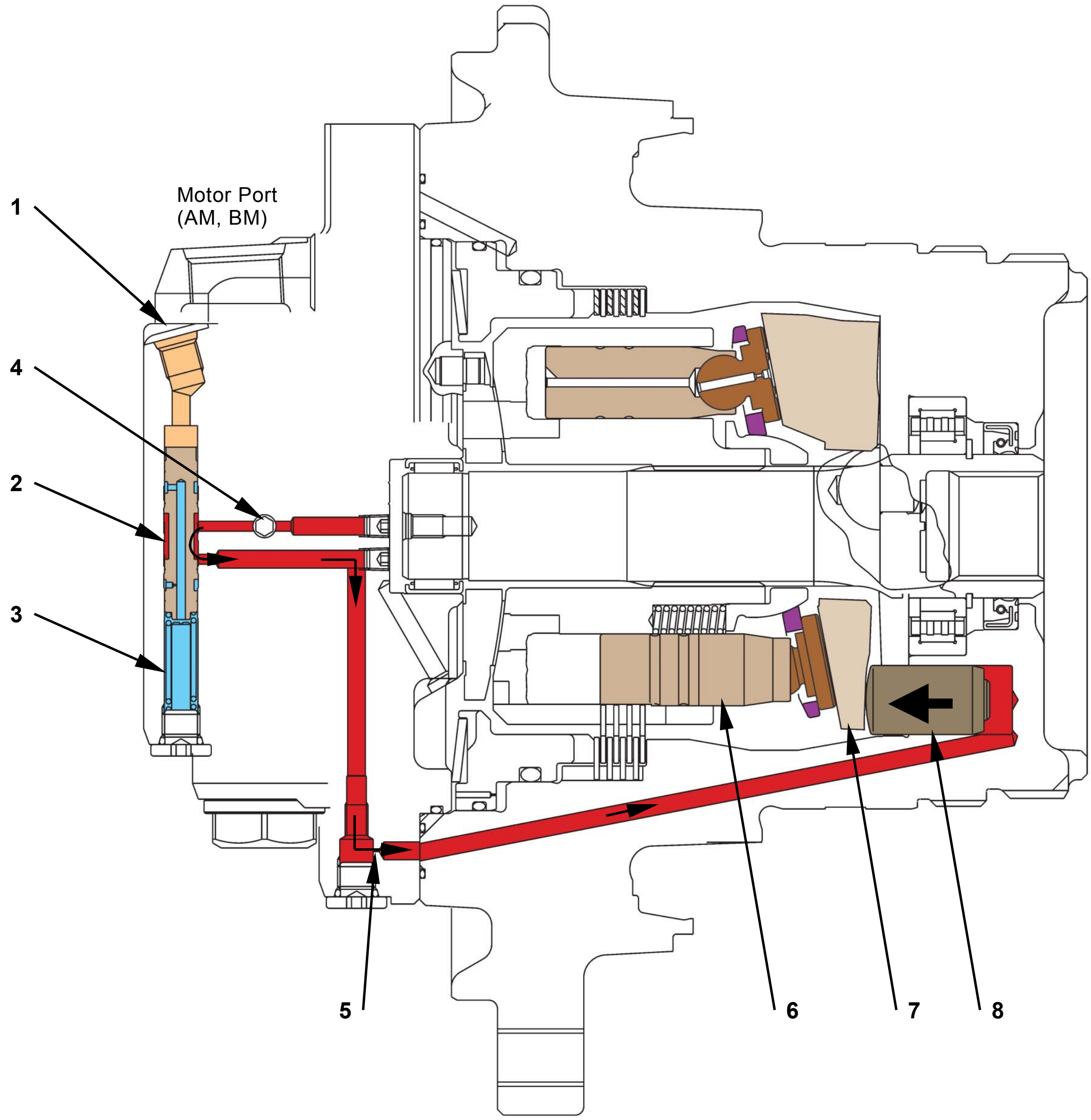
1. When the travel mode switch is in the SLOW position, MC (main controller) does not send the signals to solenoid valve unit (SI) so that pilot pressure is not routed to pilot port (1). Spool (2) is kept raised by spring (3).
2. Therefore, piston (8) is not acted by pressure oil and secured at the maximum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



1 - Pilot Port
2 - Spool
3 - Spring
4 - Shuttle Valve for Piston Operation
5 - Orifice (for Fast / Slow Speed)
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 (2) downward.
3. Pressure oil in high-pressure motor port (AM or BM) acts on piston (8) through orifice (5).
4. Piston (8) pushes swash plate (7) so that the swash angle of swash plate (7) is reduced. Thereby, as the plunger (6) stroke is reduced, the travel motor rotates at fast speed.



T178-03-05-011

1 - Pilot Port

2 - Spool

3 - Spring

4 - Shuttle Valve for Piston Operation

5 - Orifice (for Fast/Slow Speed)

6 - Plunger

7 - Swash Plate

8 - Piston

TRAVEL BRAKE VALVE

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

- Counterbalance Valve:
  Makes starting and stopping travel operations smooth and prevents the machine from running away while descending slopes. Routes the travel motor operating pressure oil in high pressure port (AV or BV) to the parking brake.

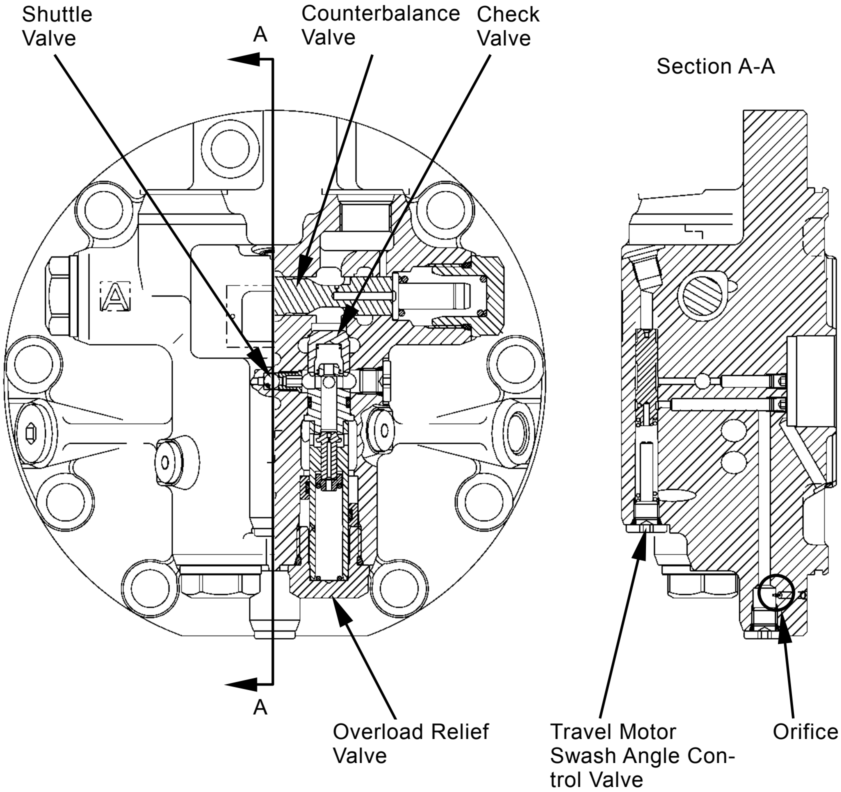
- Check Valve:
  Assists the counterbalance valve operation and prevents cavitation in the motor circuit.

- Overload Relief Valve:
  Prevents the occurrence of overload and surge pressure in the motor circuit and reduces shock loads developed when stopping travel operation.

- Shuttle Valve:
  Routes the travel motor operating high pressure oil in high pressure port (AM or BM) to the slow or fast side piston so that the piston is controlled.

- Travel Motor Swash Angle Control Valve:
  Delivers pressure oil routed by the shuttle valve for piston operation to the piston through the orifice (for slow / fast speed).

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



T1V1-03-05-003

While Traveling:

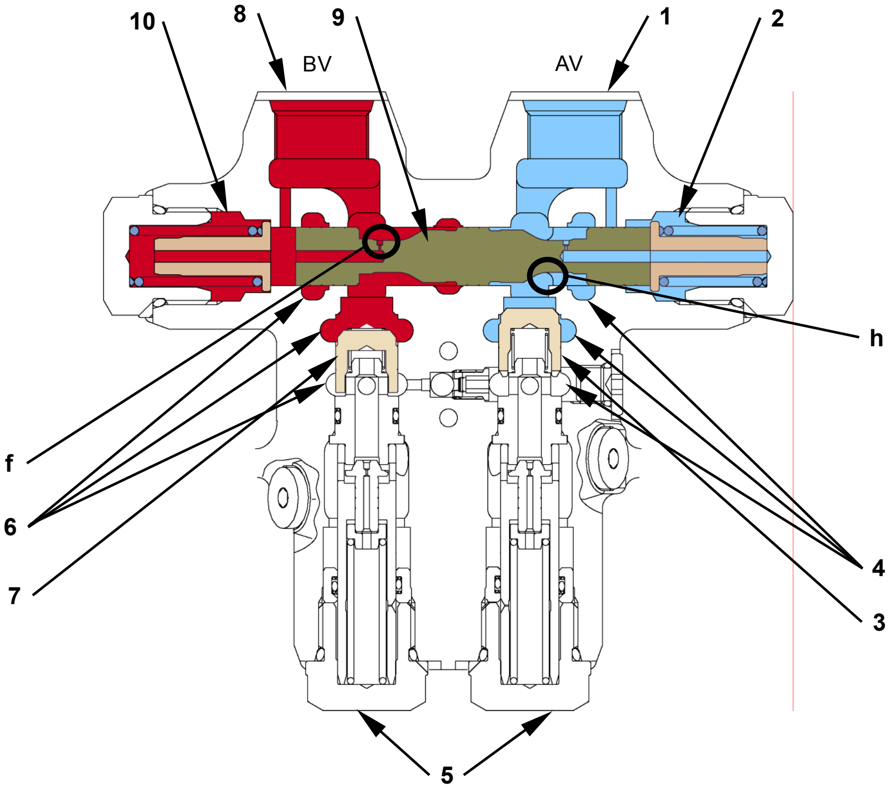
1. When pressure oil from the control valve flows to port BV (8), pressure oil flows around the outer diameter of spool (9), unseats check valve BC (7) and flows further to motor port BM (6).
2. On the other hand, return oil from the travel motor is routed to motor port AM (4). However, its passage is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



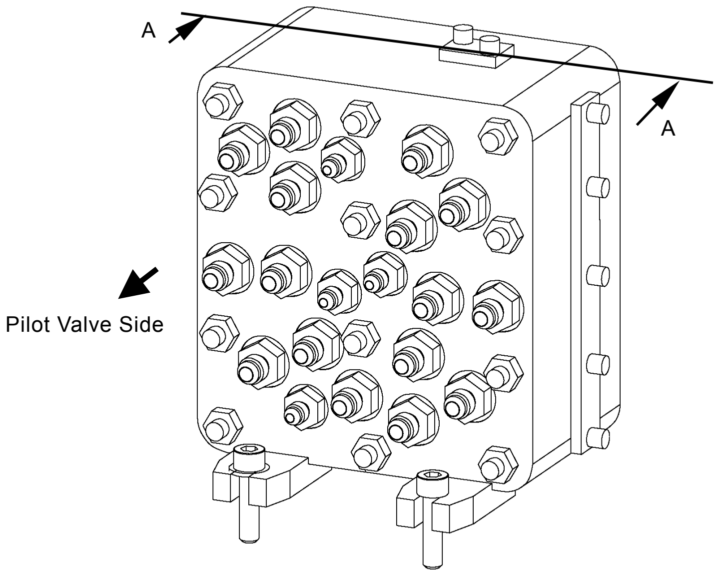
T178-03-05-006

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

(Blank)

OUTLINE

The signal control valve is provided in the pilot circuit between the pilot valve and control valve, and controls pilot signal pressure to regulate the pumps and various kinds of valves.
The major components of signal control valve are shuttle valve, shockless valve, pump 1 flow rate control valve, pump 2 flow rate control valve, flow combiner valve spool, bucket flow rate control valve spool, swing parking brake release spool and arm 1 flow rate control valve spool.



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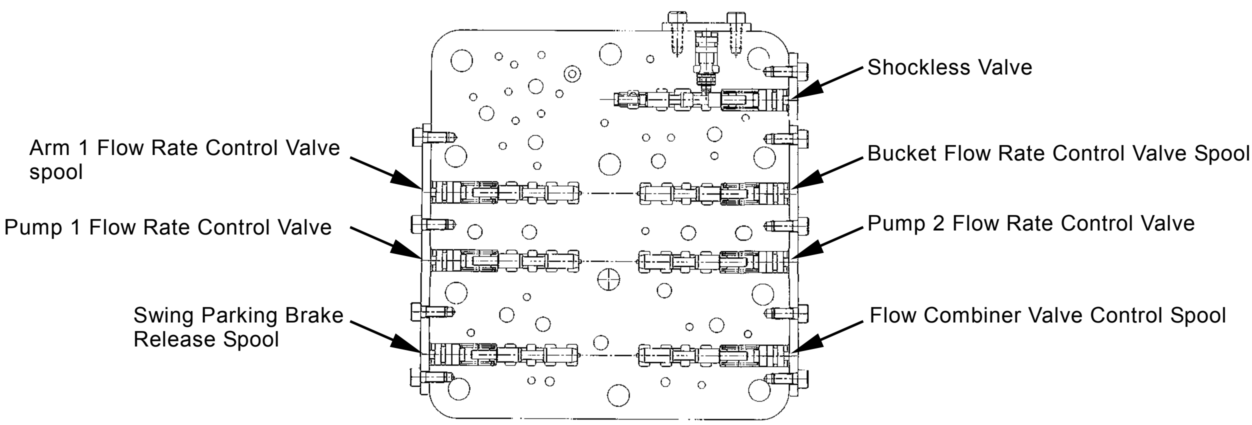
Cross Section A-A



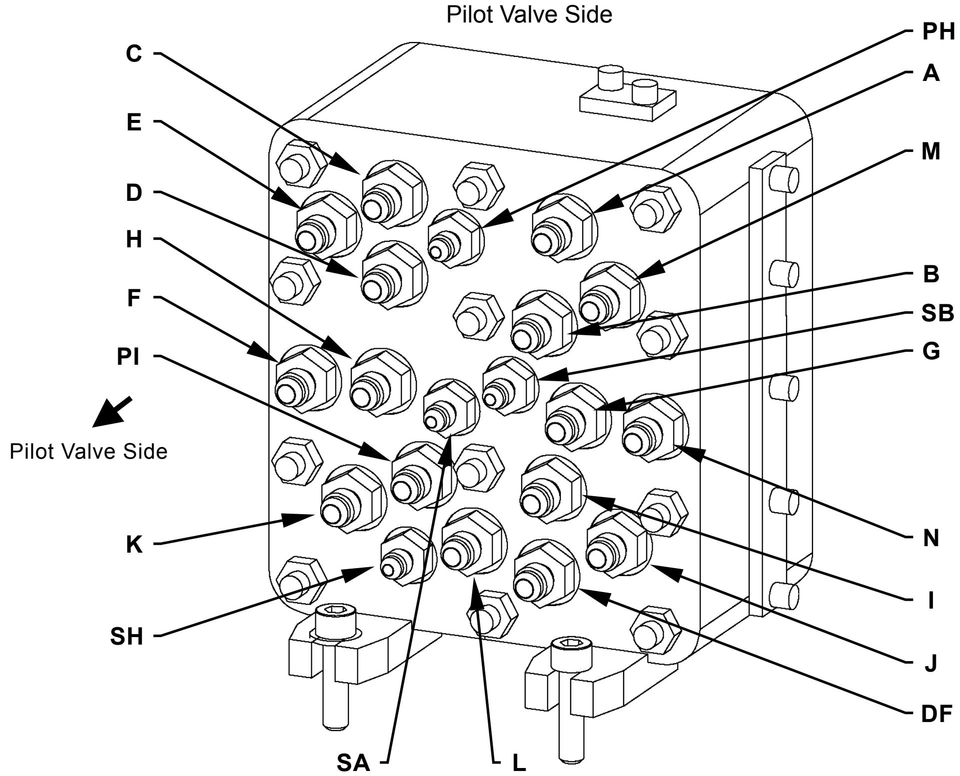
T178-03-06-002

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

Pilot Valve Side



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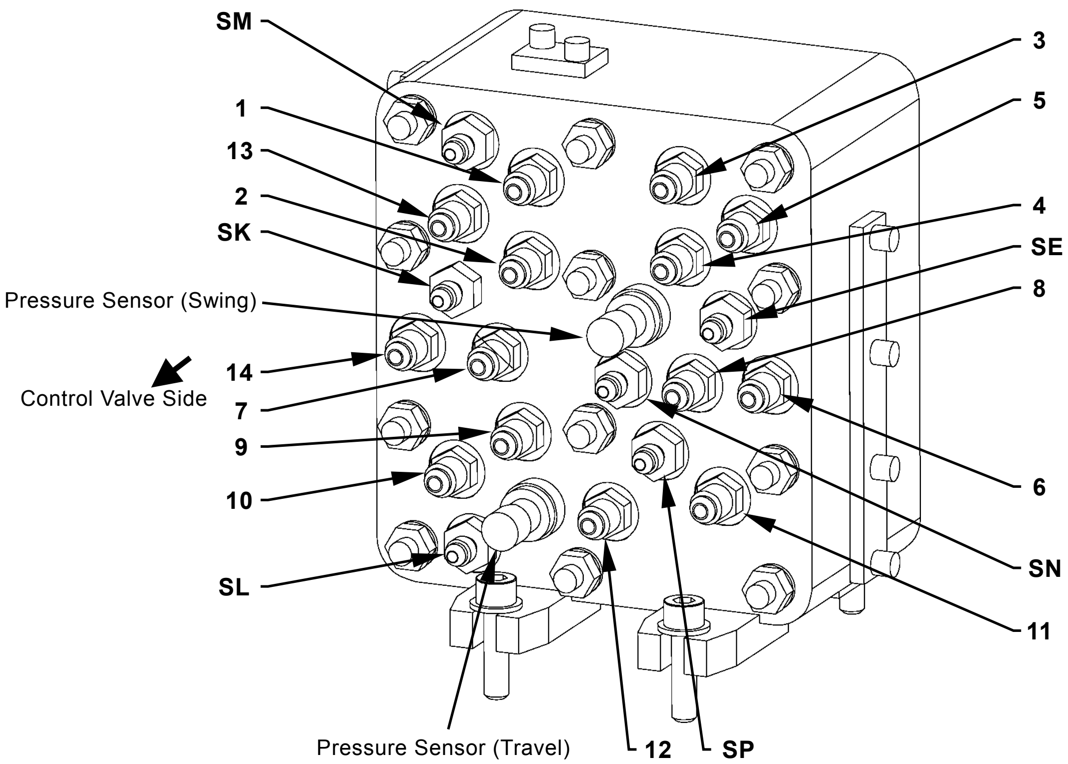
Control Valve Side



T178-03-06-015

Control Valve Side

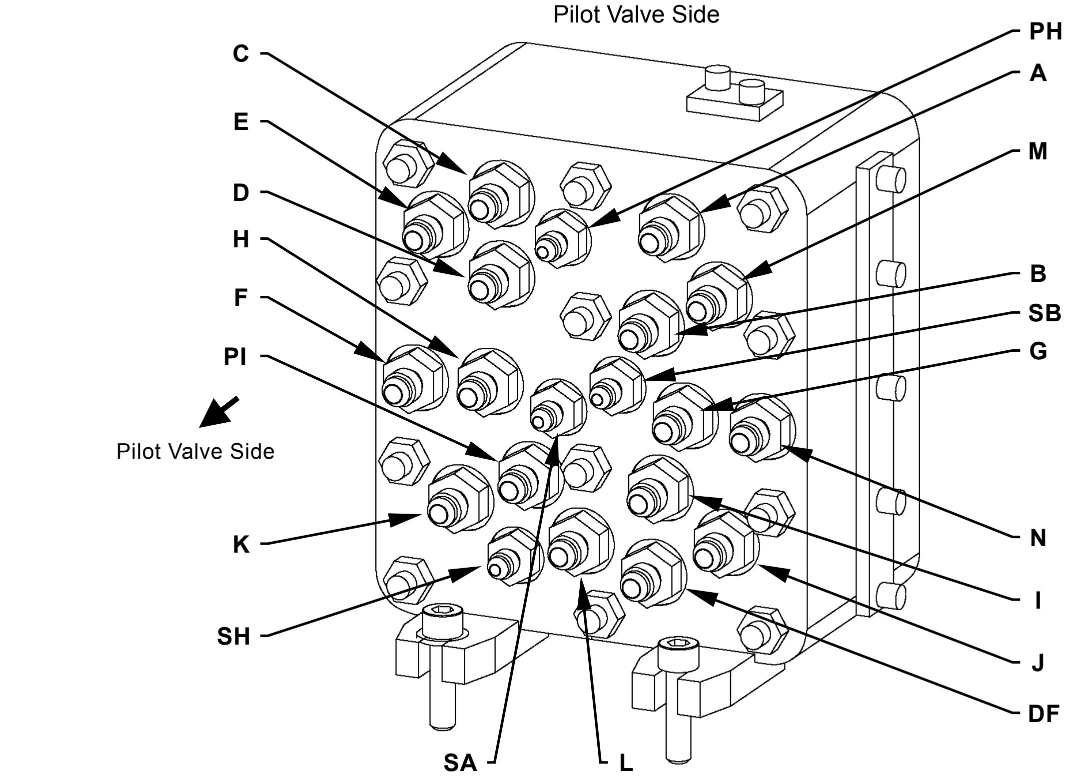
Port Name	Connecting to	Remark
Port 1	Control Valve	Boom Raise Pilot Pressure
Port 2	Control Valve	Boom Lower Pilot Pressure
Port 3	Control Valve	Arm Roll-Out Pilot Pressure
Port 4	Control Valve	Arm Roll-In Pilot Pressure
Port 5	Control Valve	Left Swing Pilot Pressure
Port 6	Control Valve	Right Swing 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 Combiner Solenoid Valve	Auxiliary Flow Rate Combiner Valve Control Pressure
Port SN	Auxiliary Flow Rate Combiner Control Valve	Auxiliary Flow Rate Combiner Valve Control Pressure
Port SP	Auxiliary Flow Rate Combiner Solenoid Valve	Pump 1 Control Pressure



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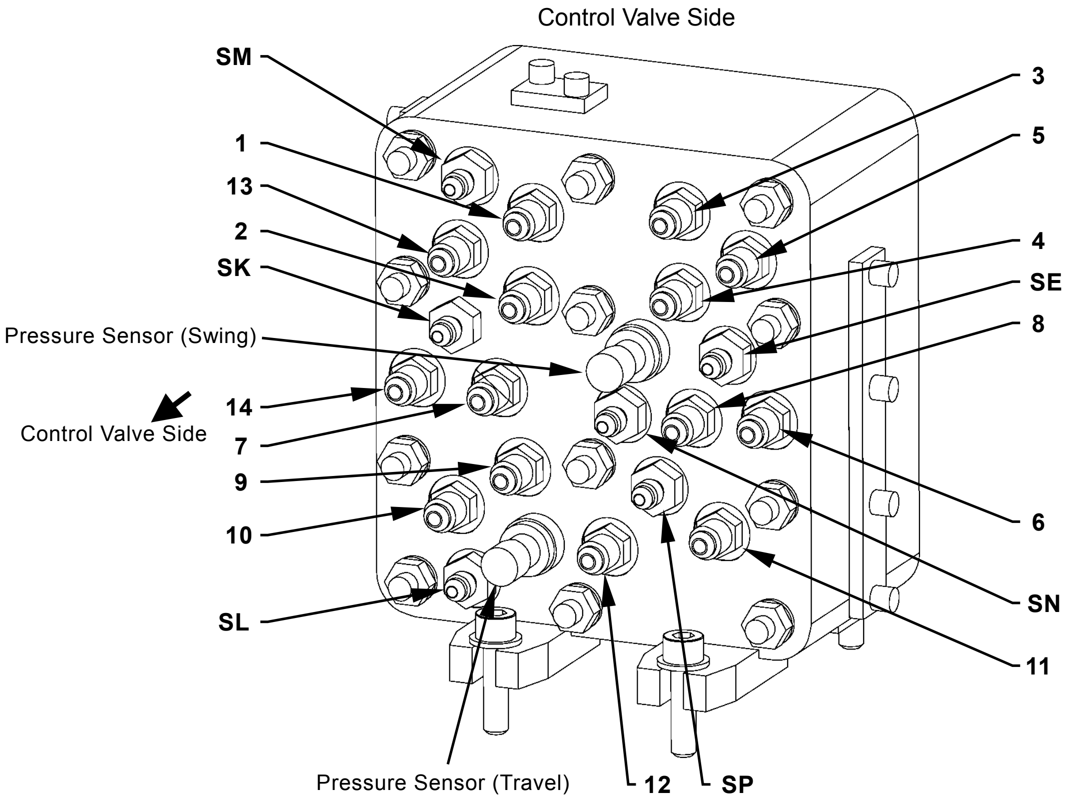


T178-03-06-015

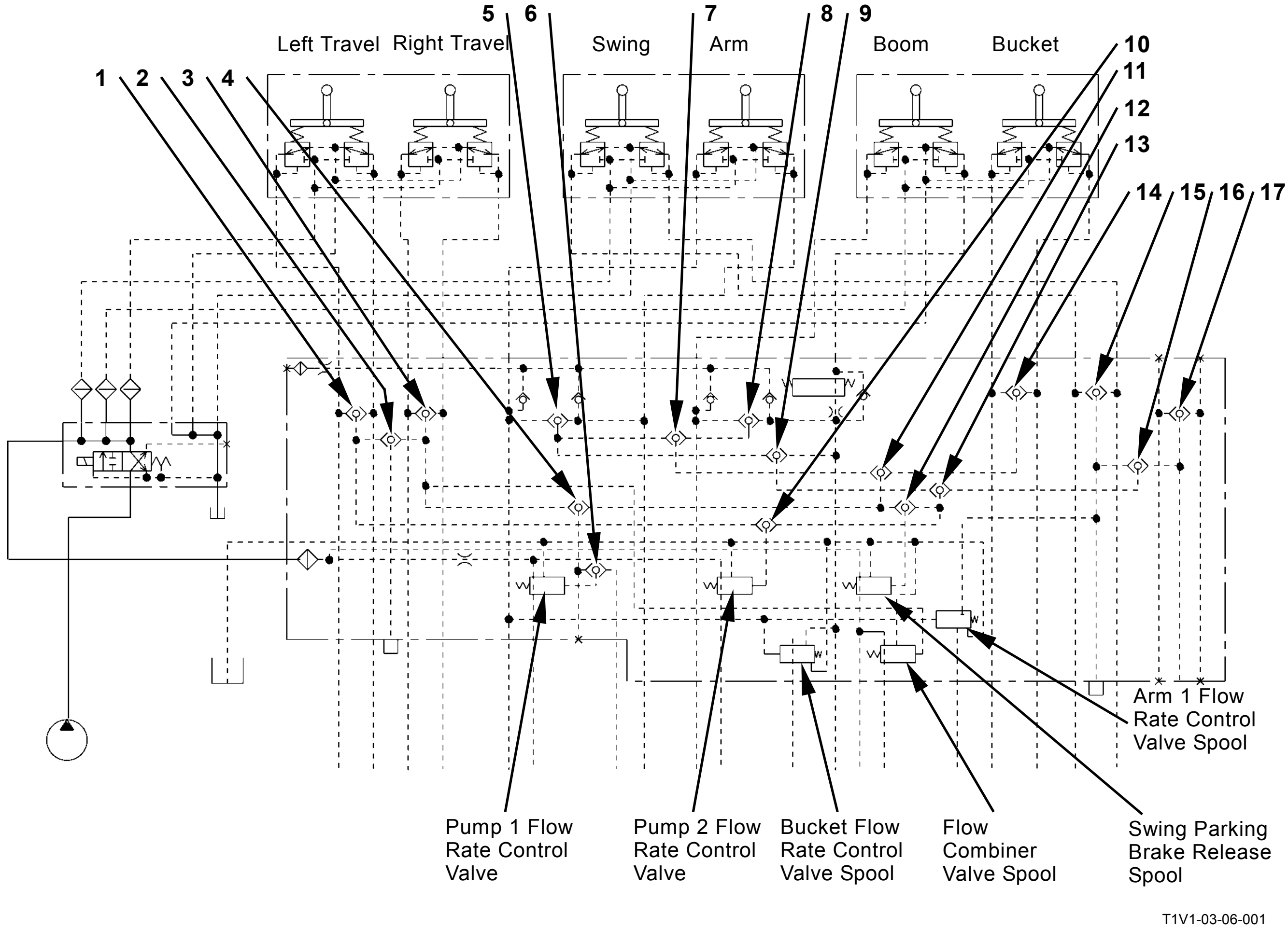
SHUTTLE VALVE

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)	○	-	-	-	-	-

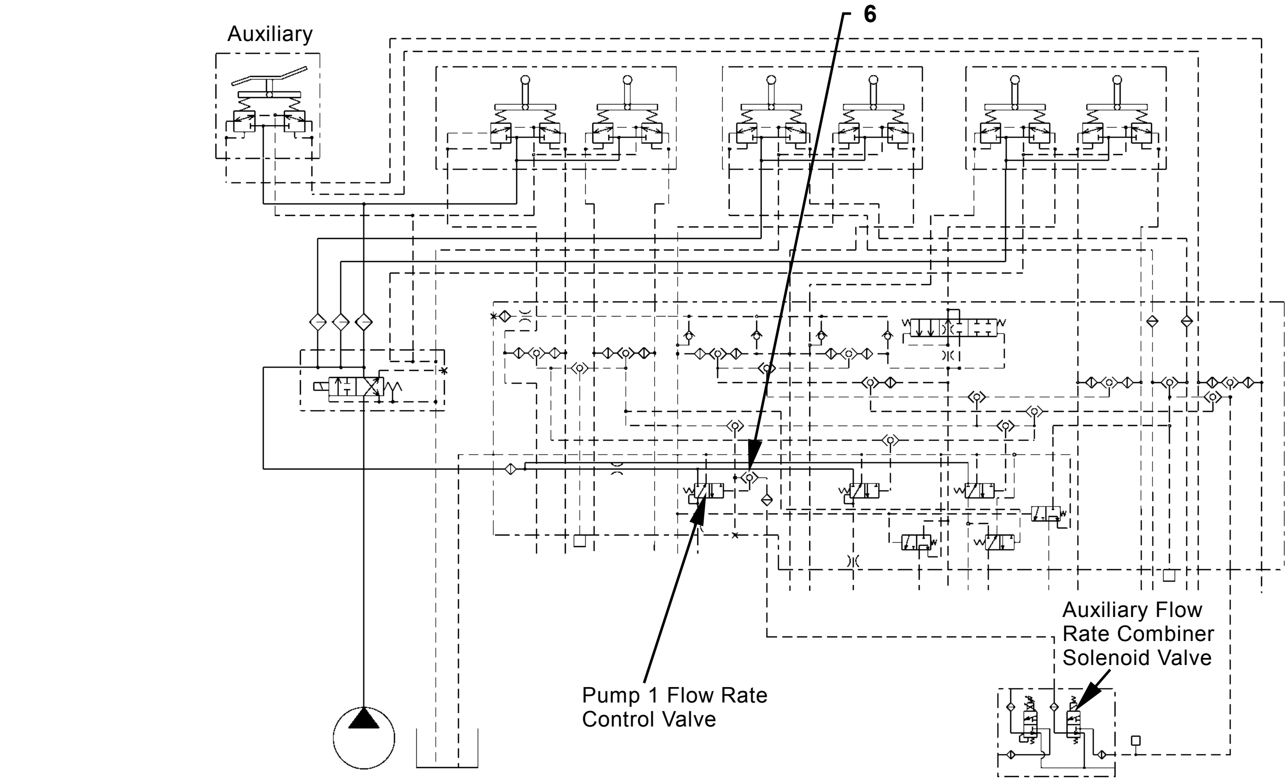
NOTE: *As for the match with front attachment (secondary crushers 1 to 5 and hydraulic crushers 1 to 5) attached, the pump 1 flow rate control valve is operated by pressure from the auxiliary pilot valve.*

Monoblock Boom / STD Specification



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)



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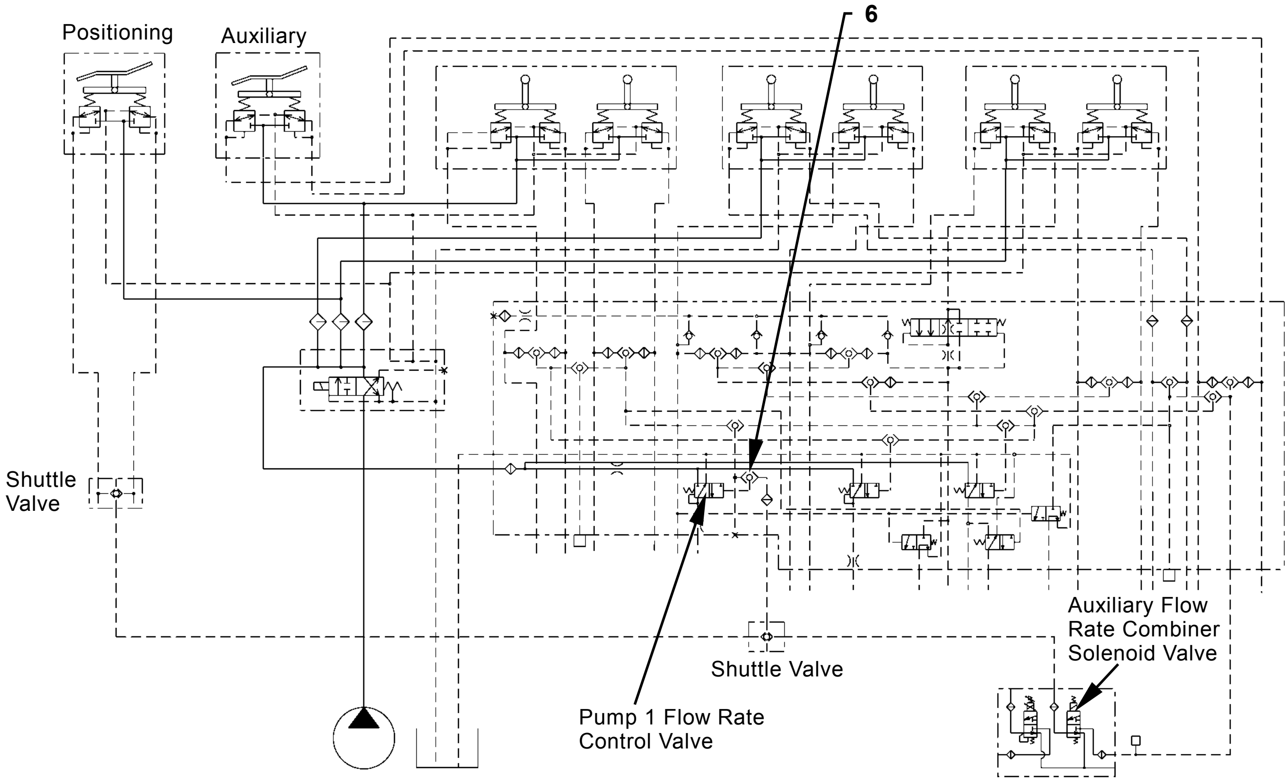
Machine with 2-Piece Boom and Auxiliary Combining Attached (Optional)



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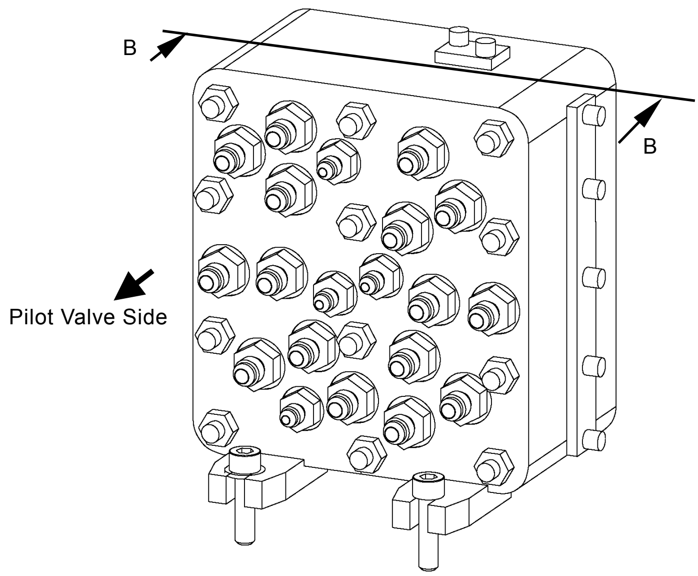
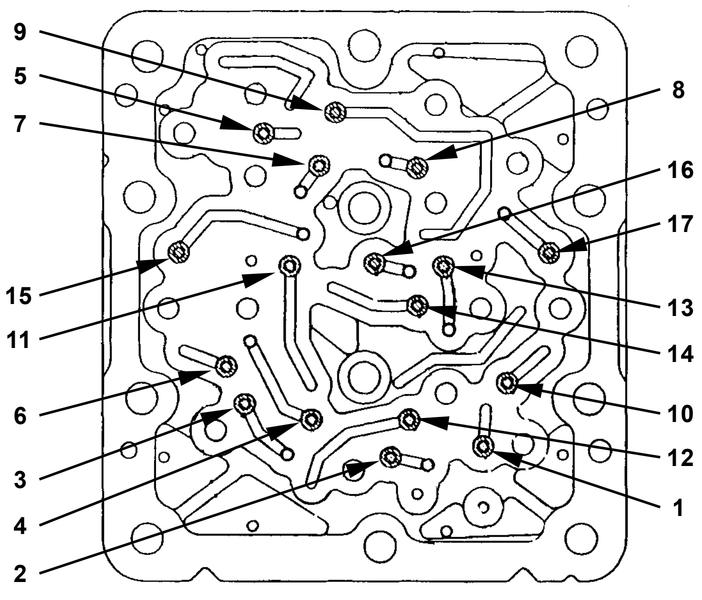


T178-03-06-016

Cross Section B-B



T178-03-06-009

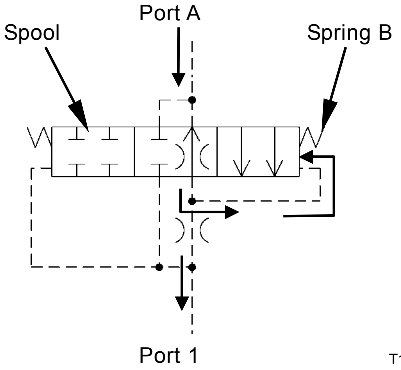
1 - Left Travel
2 - Left Travel/Right Travel
3 - Right Travel
4 - Boom / Arm / Bucket / Right Travel
5 - Arm
6 - Boom / Arm / Bucket / Right Travel / Auxiliary / Positioning
7 - Boom / Arm
8 - Boom
9 - Arm / Boom Raise
10 - Boom Raise / Arm / Left Travel / Swing
11 - Boom / Arm / Bucket
12 - Boom / Arm / 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 oil is routed into port A and acts on the spool.
2. Immediately after operation is started, low pilot pressure oil flows into the spring B chamber through clearance between spool and housing. At the same time, pilot pressure oil flows to port 1 through inner passage 2.
3. When pilot pressure increases, pressure in the spring B chamber increases, and the spool pushes spring A and moves to the left.
4. As the spool is moved, port A is connected to port 1 and pressure in port 1 increase so that the spool in control valve is moved.



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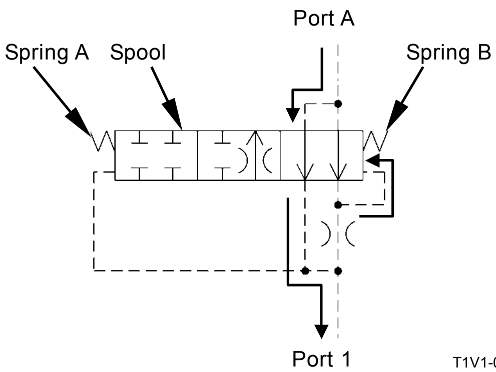
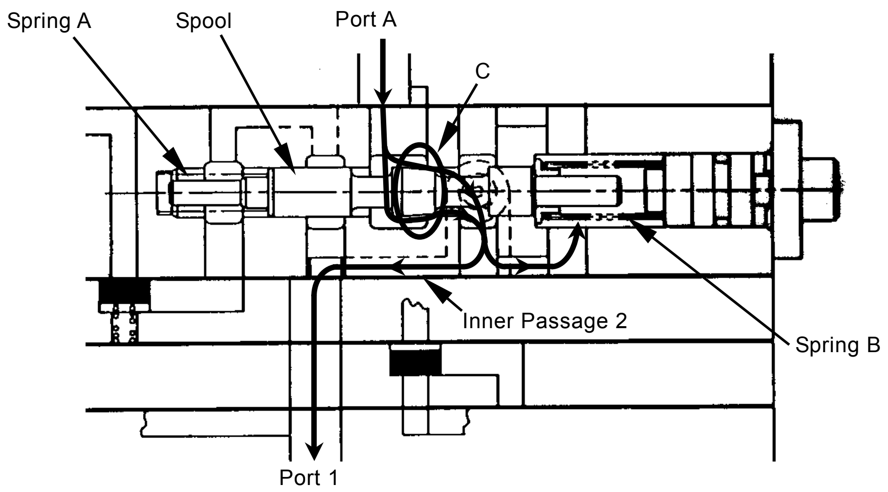
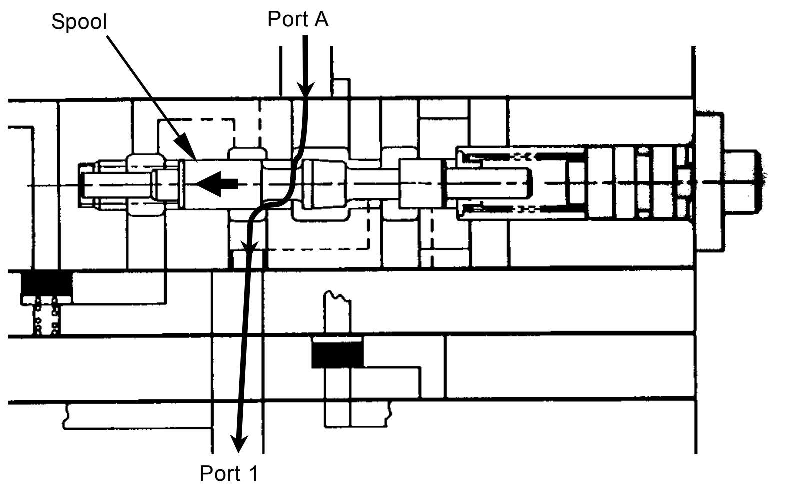


T1V1-03-06-002

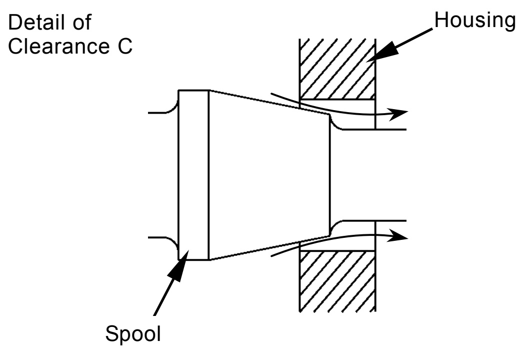
During Boom Raising Operation



T183-03-06-003



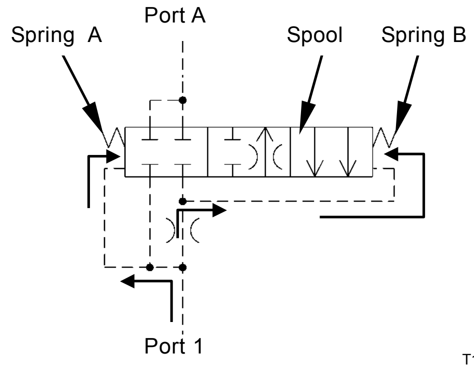
T183-03-06-004



T1V1-03-06-008

During Boom Lowering Operation (Shock Reducing Operation)

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



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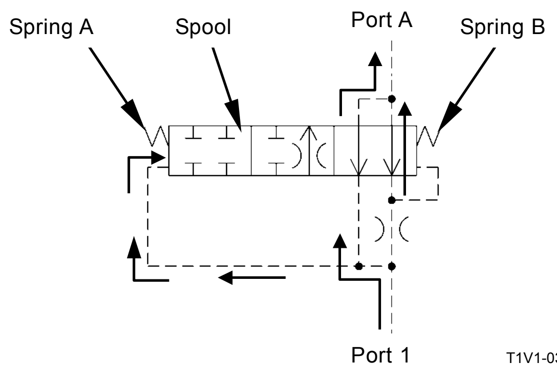
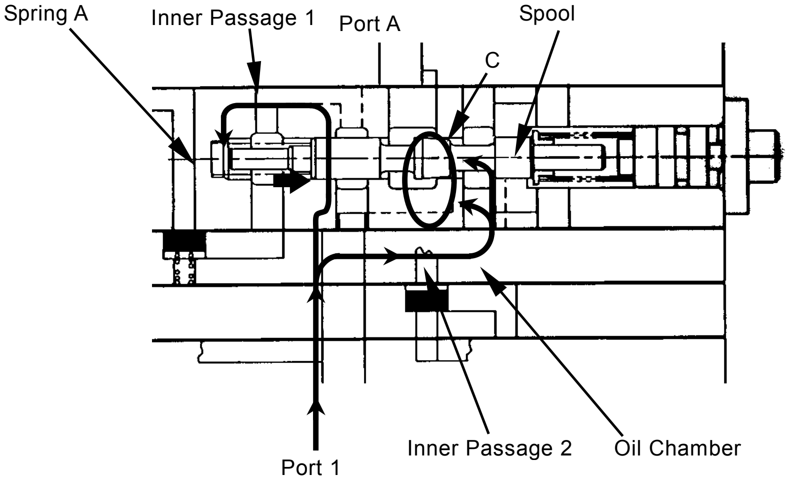
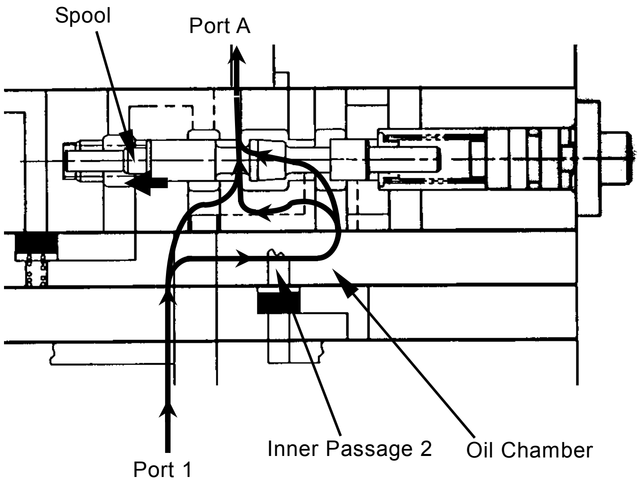


T1V1-03-06-002

During Boom Lowering Operation (Shockless Operation)

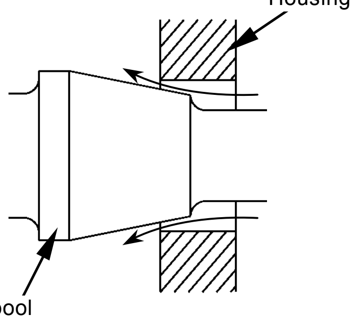


T183-03-06-005



T183-03-06-004

Detail of Clearance C



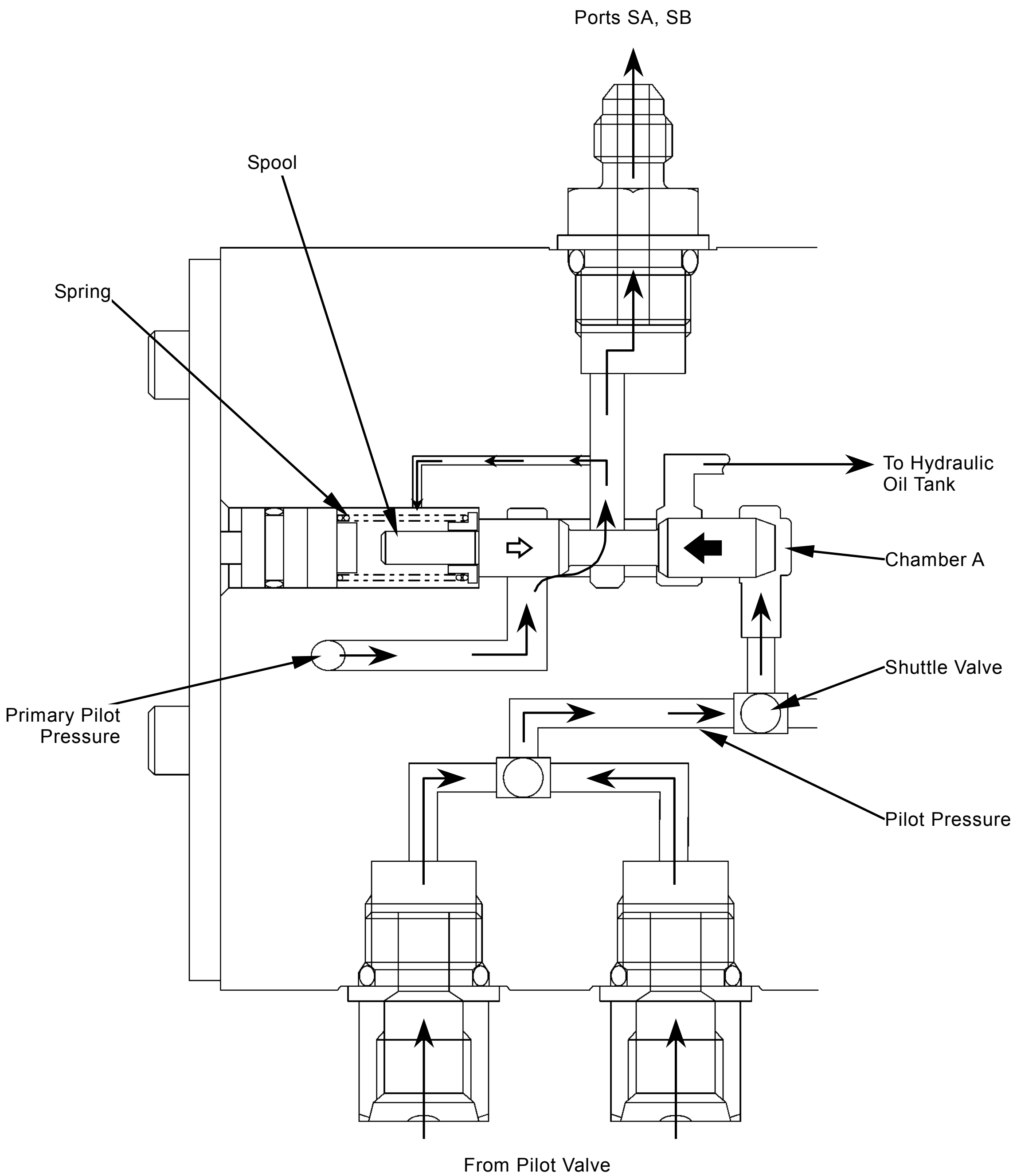
T1V1-03-06-008

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

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



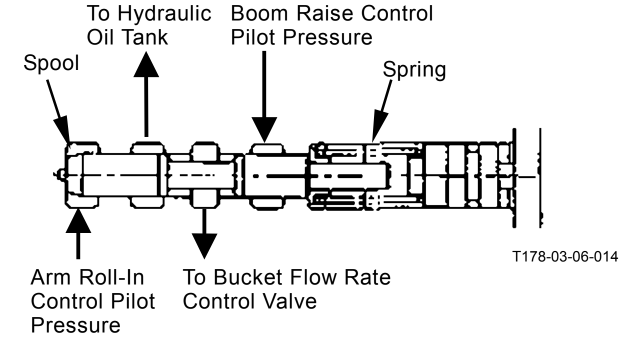
T1V1-03-06-005

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

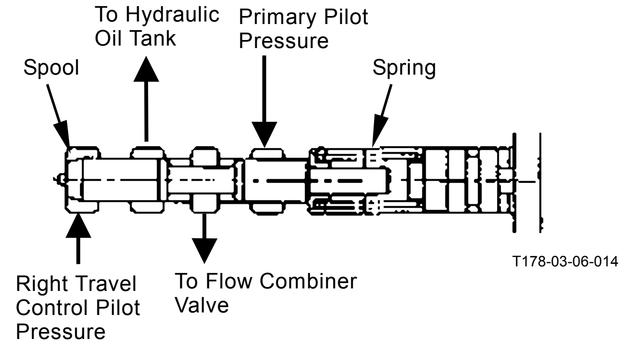
NOTE: The spools above are identical in operational principle.

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

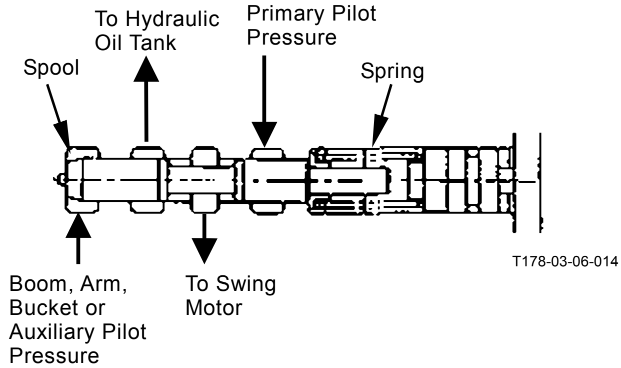
Bucket Flow Rate Control Valve Control Spool:



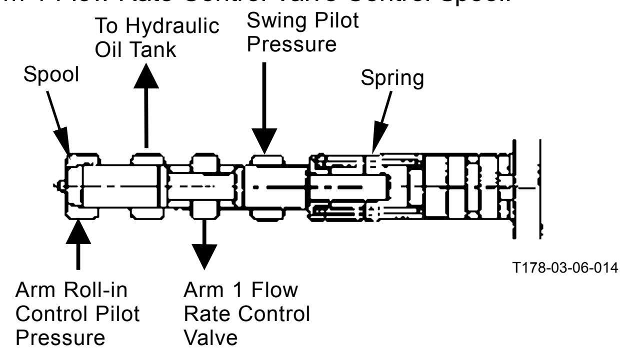
Flow Combiner Valve Control Spool:



Swing Parking Brake Release Spool:

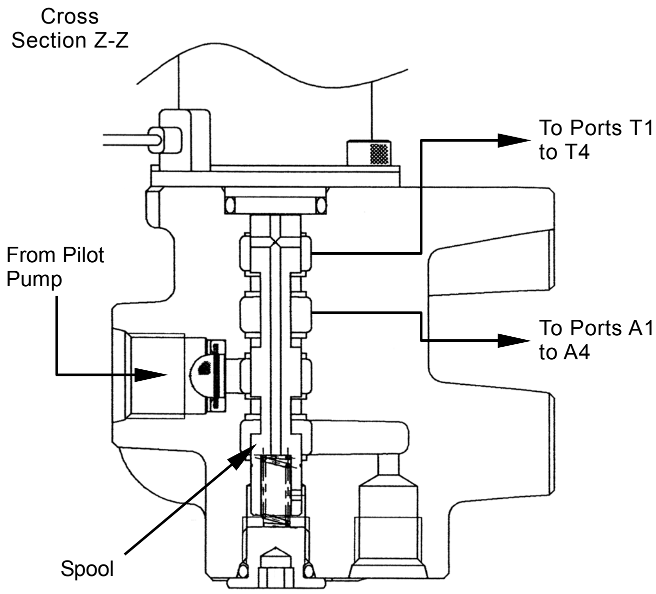


Arm 1 Flow Rate Control Valve Control Spool:

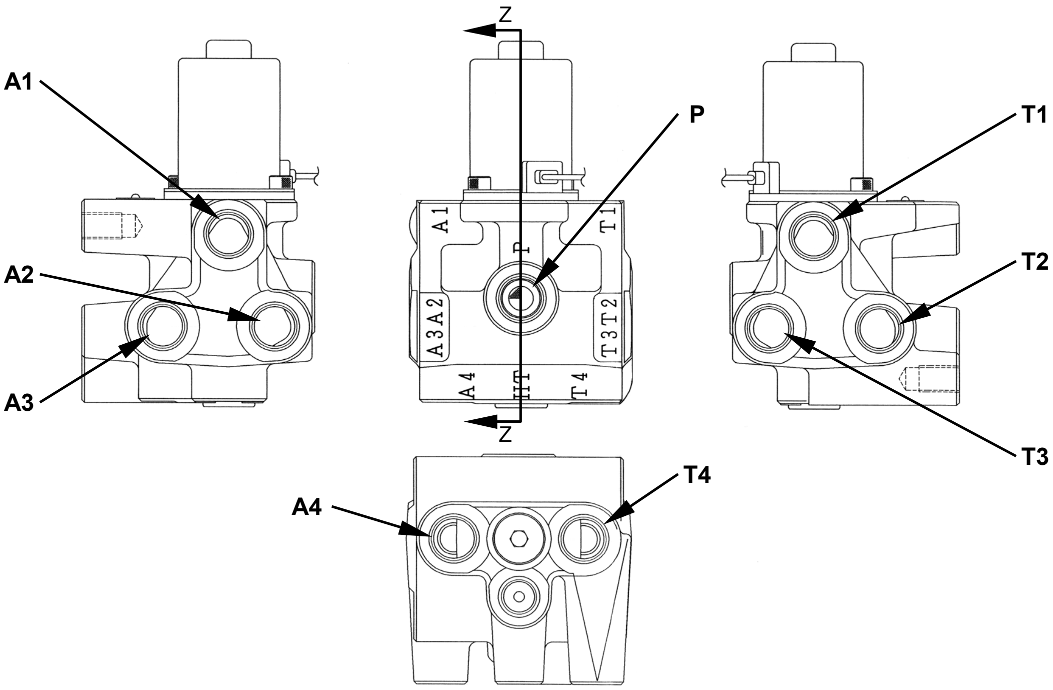


PILOT SHUT-OFF SOLENOID VALVE

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



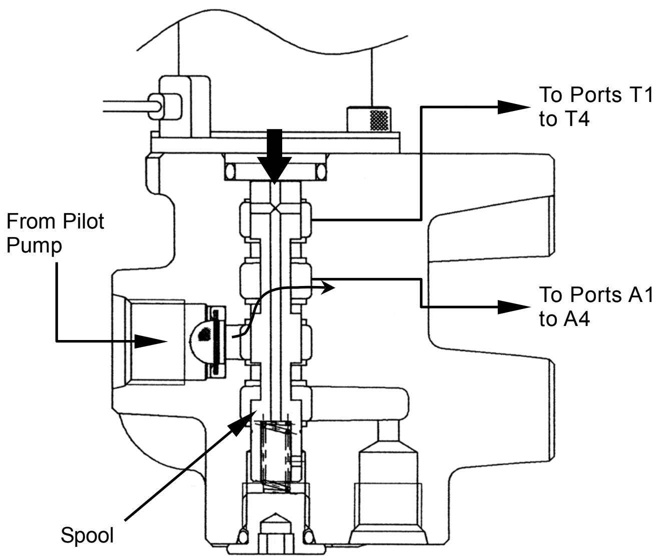
T1V1-03-07-011

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 the 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

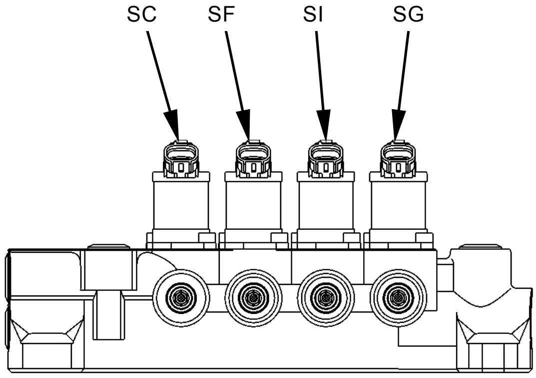
SOLENOID VALVE

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

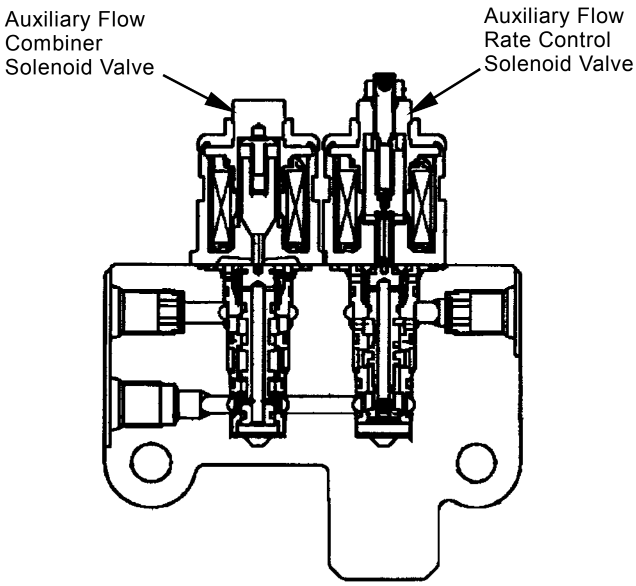
2-Spool Solenoid Valve Unit (Optional)

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

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

(Refer to Control System / SYSTEM.)

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



T1GL-03-10-002

Proportional Solenoid Valve

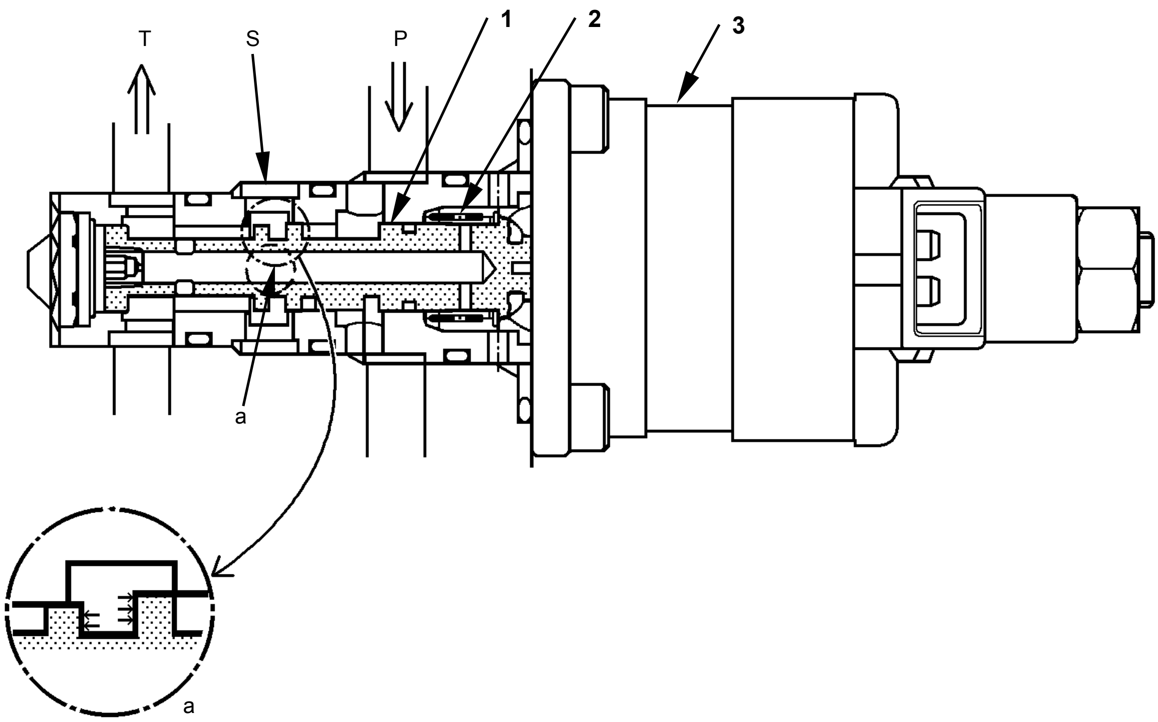
Controls by an electric current signal from MC and outputs pressure in proportional to degree of the electric current.

- When not energized (In neutral):

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

- When energized:

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



T107-02-07-005

1 - Spool 2 - Spring 3 - Solenoid

ON / OFF Solenoid Valve

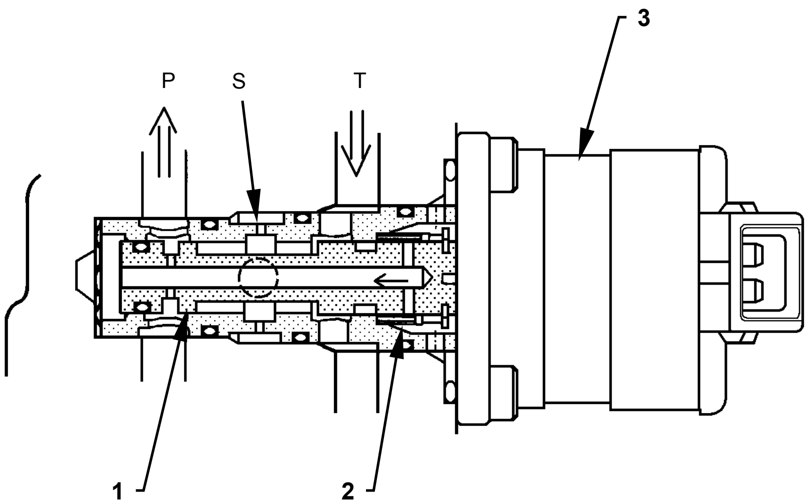
The ON / OFF solenoid valve shifts the brake switch and each control switch in order to shift pilot pressure.

- 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

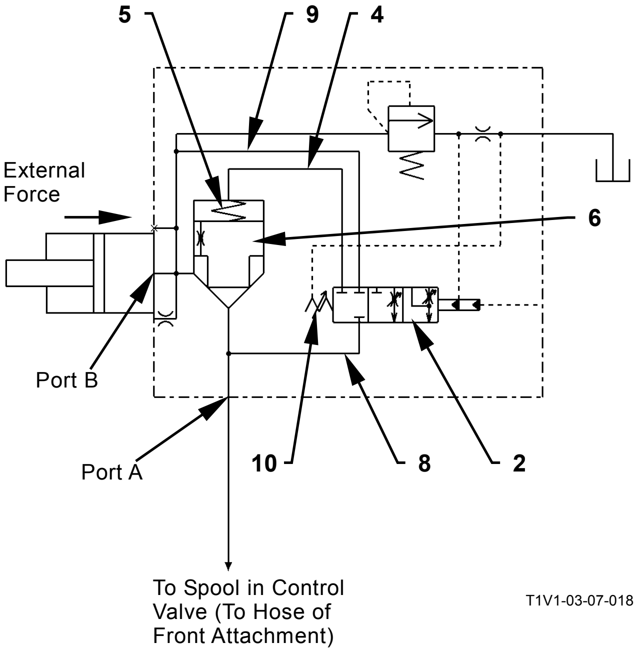
1 - Spool   2 - Spring   3 - Solenoid

HOSE RUPTURE VALVE

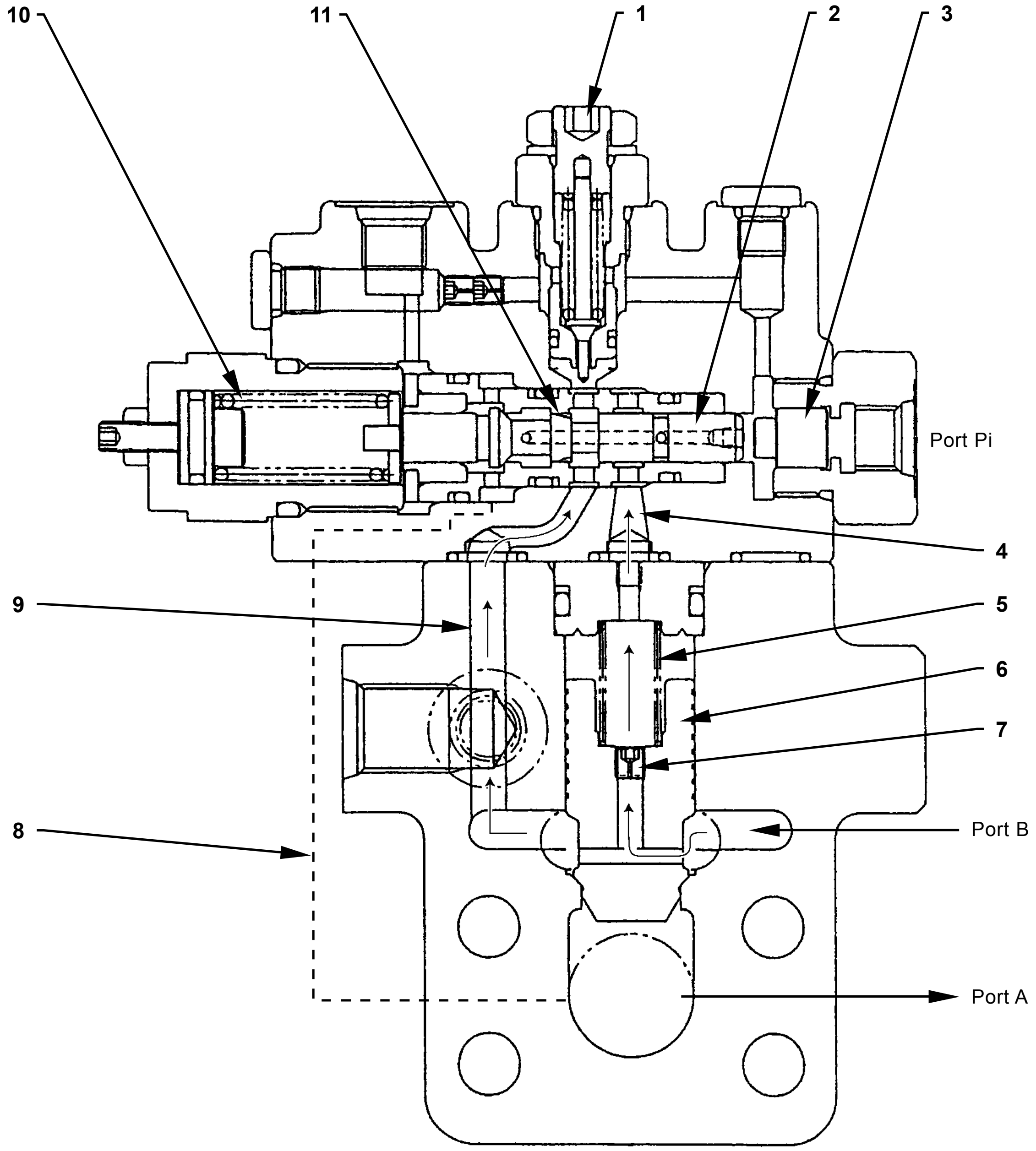
The hose rupture valve is installed to boom cylinder (bottom side circuit), arm cylinder (rod side circuit) and positioning cylinder (2-piece boom) (rod side circuit).
When the hose of front attachment is damaged, the hose rupture valve holds the front attachment and prevents the front attachment from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



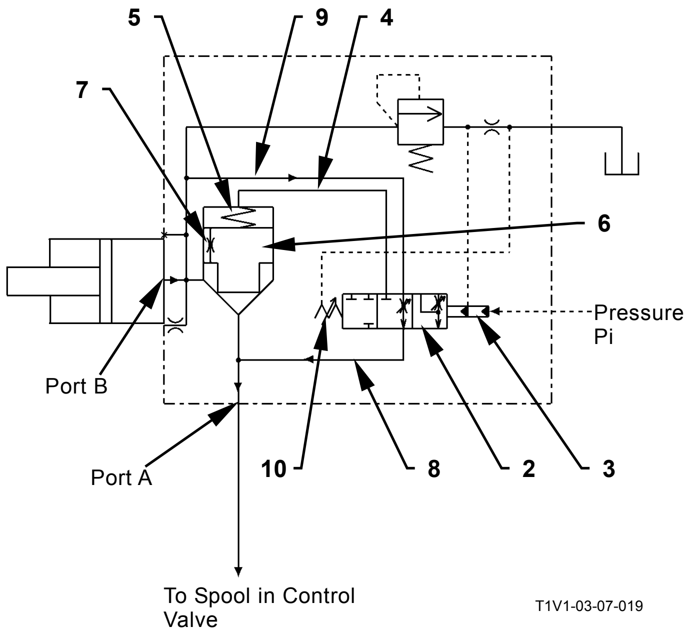
2 - Spool
4 - Passage A
5 - Spring
6 - Poppet
8 - Passage B
9 - Passage C
10 - Spring



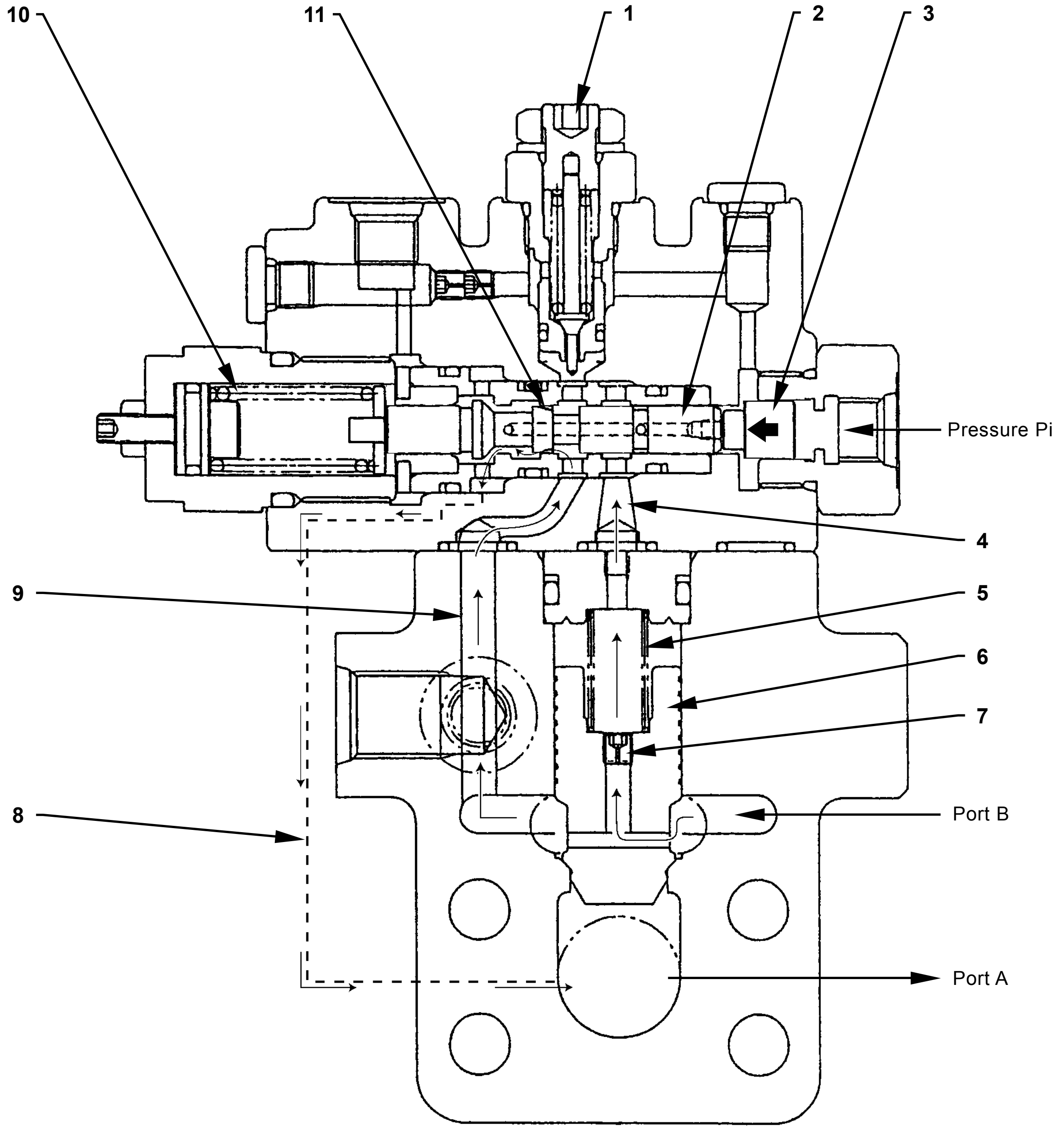
T1V1-03-07-017

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

- During Boom Lowering Operation (Control Lever Stroke: Less then 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.

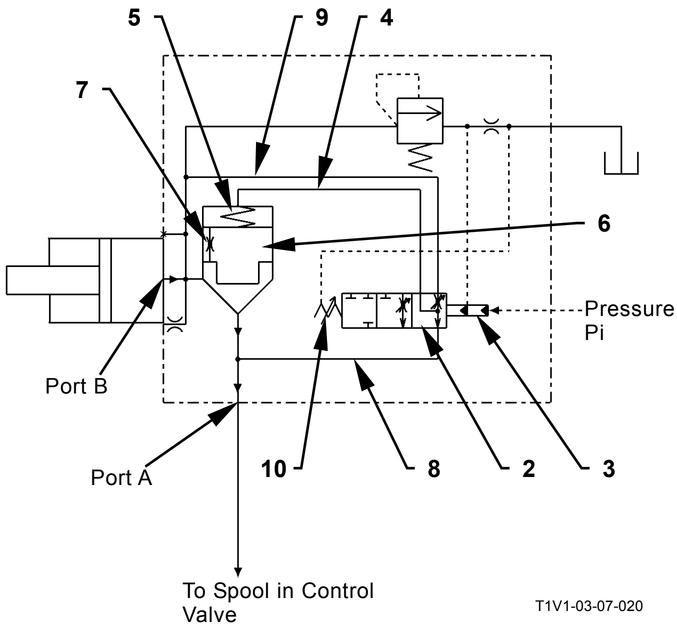


2 -	Spool	7 -	Orifice
3 -	Piston	8 -	Passage B
4 -	Passage A	9 -	Passage C
5 -	Spring	10 -	Spring
6 -	Poppet		

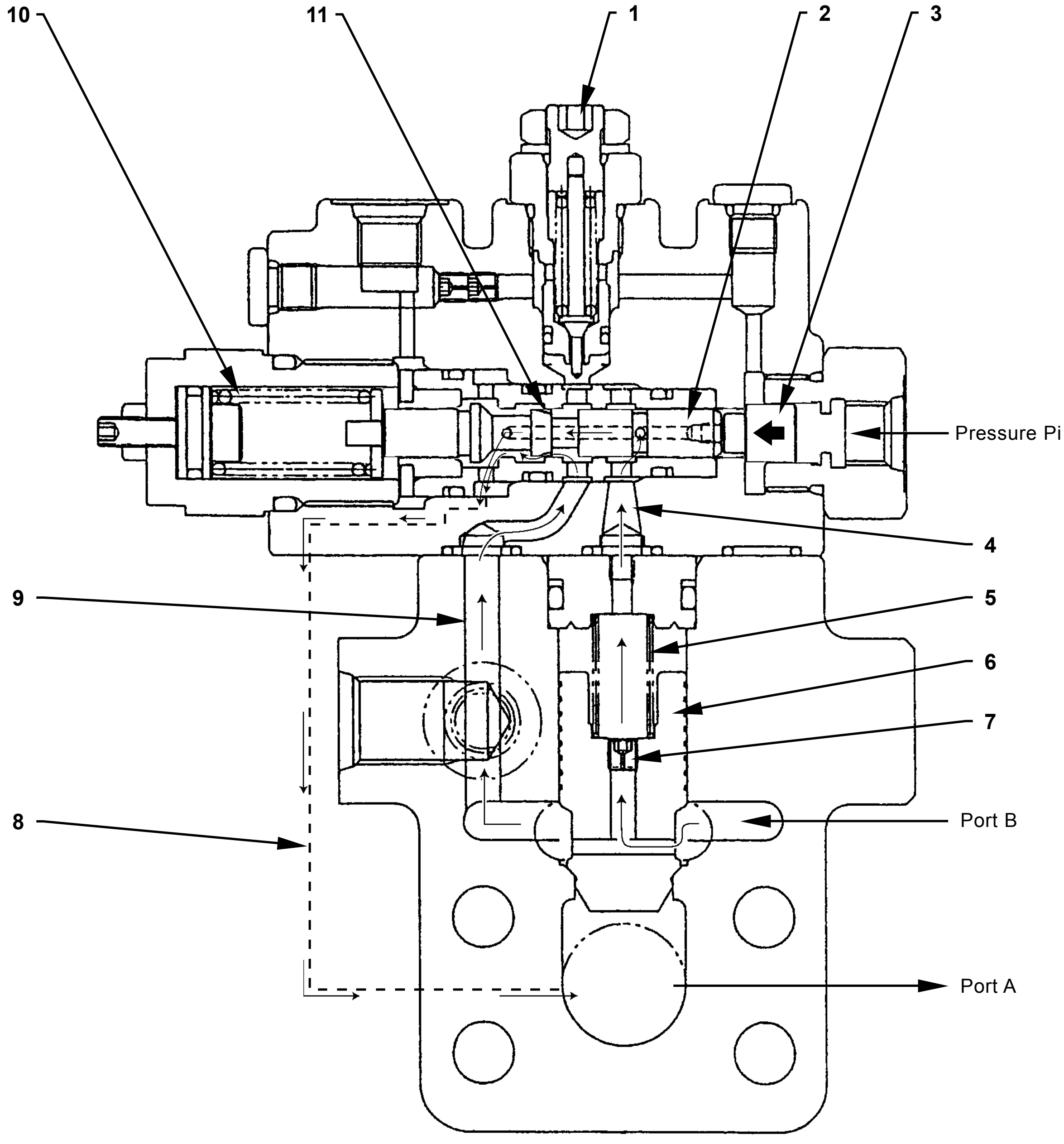


1 - Relief valve:	4 - Passage A	7 - Orifice	10 - Spring
2 - Spool	5 - Spring	8 - Passage B	11 - Orifice
3 - Piston	6 - Poppet	9 - Passage C	

- 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.



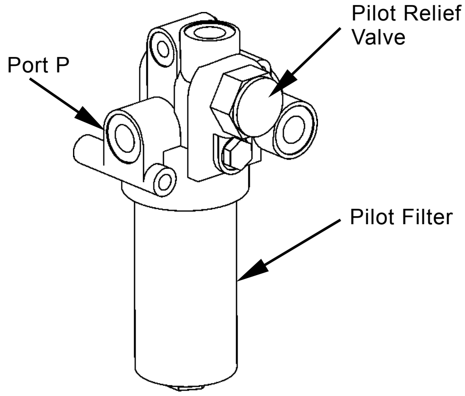
2 - Spool
3 - Piston
4 - Passage A
5 - Spring
6 - Poppet
7 - Orifice
8 - Passage B
9 - Passage C
10 - Spring



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

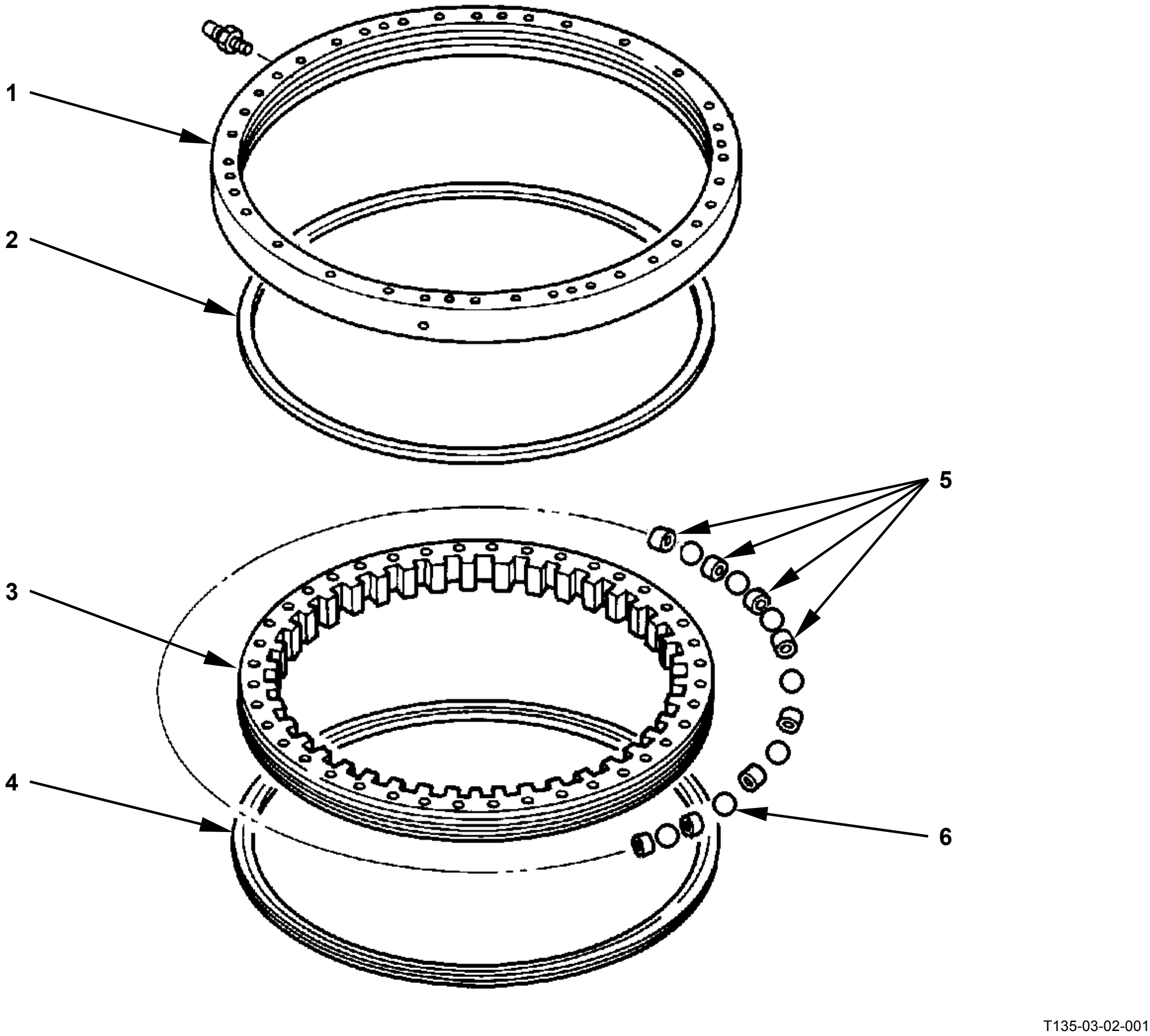
The pilot relief valve has a pilot filter incorporated.
The pilot relief valve functions to regulate pilot pump pressure oil routed to port P to a set constant pressure.



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.

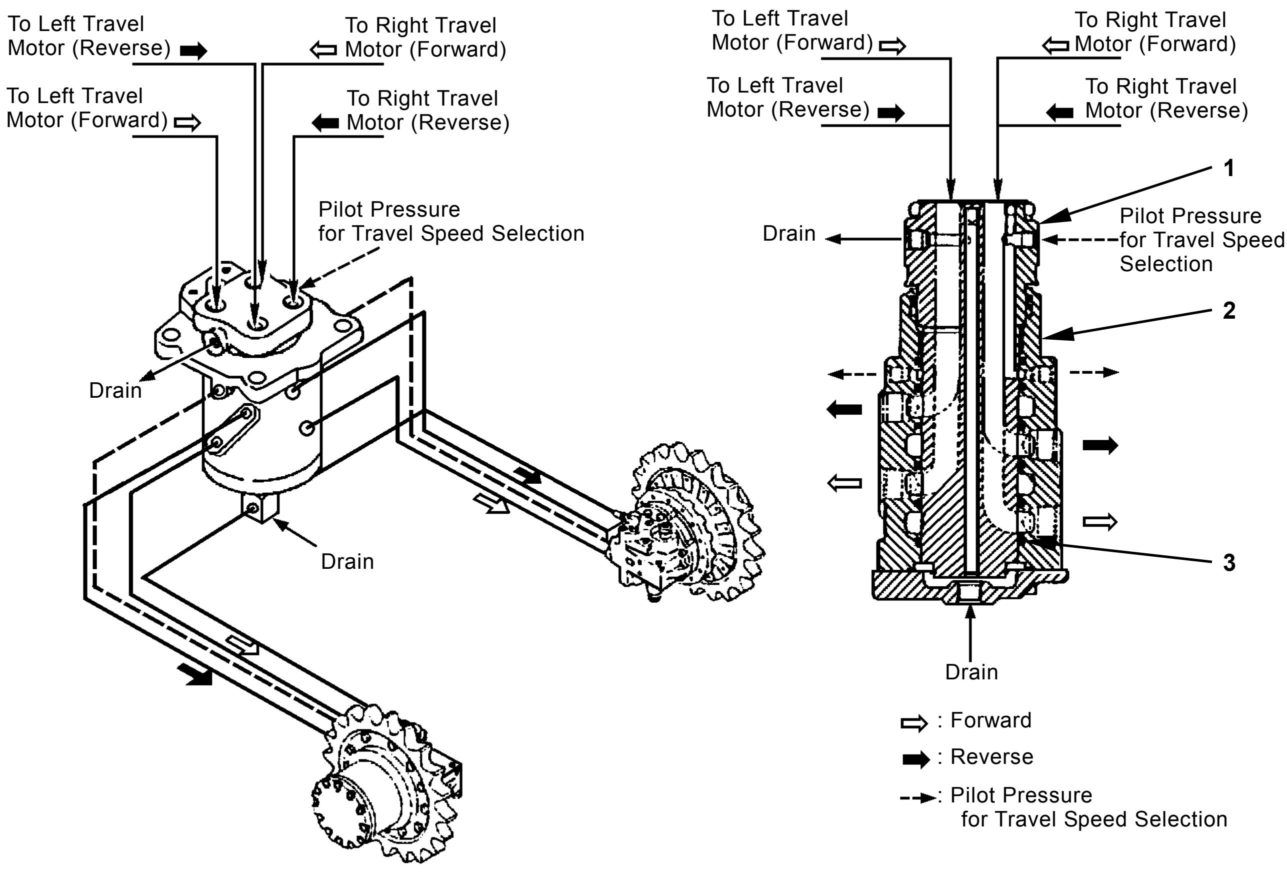


1 - Outer Race	3 - Inner Race	5 - Support	6 - Ball
2 - Seal	4 - Seal		

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

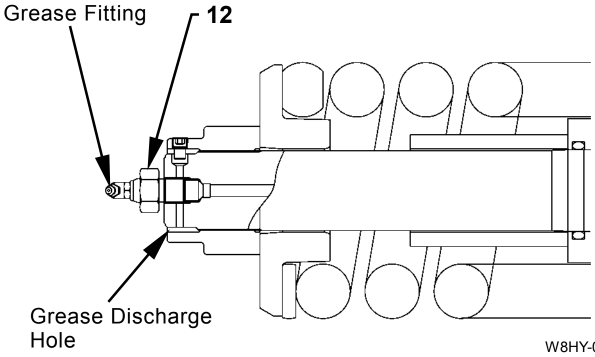
TRACK ADJUSTER

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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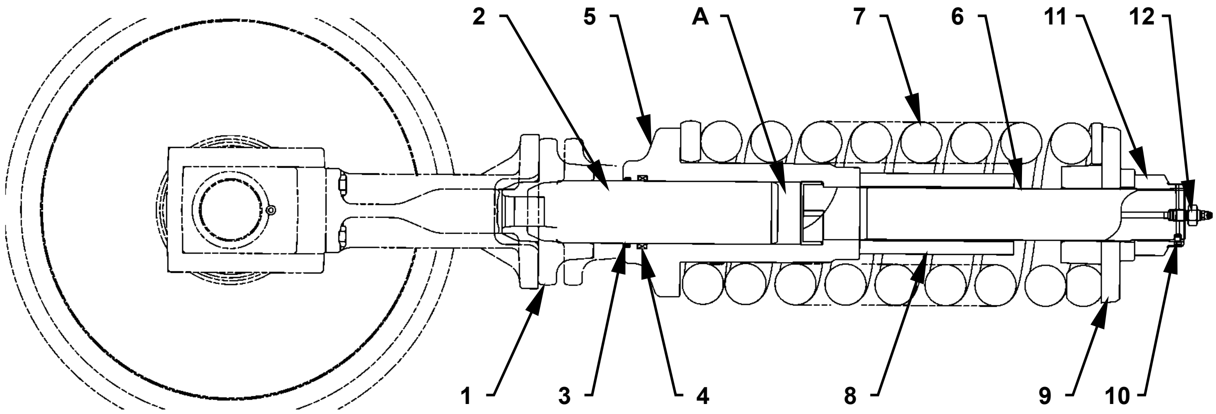

W1V7-03-04-002

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

(Blank)

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