PART NO. TO4GC-E-00

HITACHI

Technical Manual

Operational Principle

ZW

220
250

Wheel Loader

Service Manual consists of the following separate Part No;

Technical Manual (Operational Principle)	:	Vol. No. TO4GC-E
Technical Manual (Troubleshooting)	:	Vol. No. TT4GC-E
Workshop Manual	:	Vol. No. W4GC-E

INTRODUCTION

TO THE READER

- This manual is written for an experienced technician to provide technical information needed to maintain and repair this machine.

  ・Be sure to thoroughly read this manual for correct product information and service procedures.

・If you have any questions or comments, at if you found any errors regarding the contents of this manual, please contact using “Service Manual Revision Request Form” at the end of this manual.
(Note: Do not tear off the form. Copy it for usage.):

Publications Marketing & Product Support
Hitachi Construction Machinery Co. Ltd.
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FAX: 81-29-831-1162

ADDITIONAL REFERENCES

- Please refer to the materials listed below in addition to this manual.

  ・The Operator’s Manual
  ・The Parts Catalog

・The Engine Manual
・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

Consecutive Page Number for Each Group
Group Number
Section Number
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.

SECTION 1 GENERAL

SECTION 2 SYSTEM

SECTION 3 COMPONENT OPERATION

TECHNICAL MANUAL (Troubleshooting)

SECTION 4 OPERATIONAL PERFORMANCE TEST

SECTION 5 TROUBLESHOOTING

WORKSHOP MANUAL

SECTION 1
GENERAL

—CONTENTS—

Group 1 Specifications

Group 2 Component Layout

Group 3 Component Specifications

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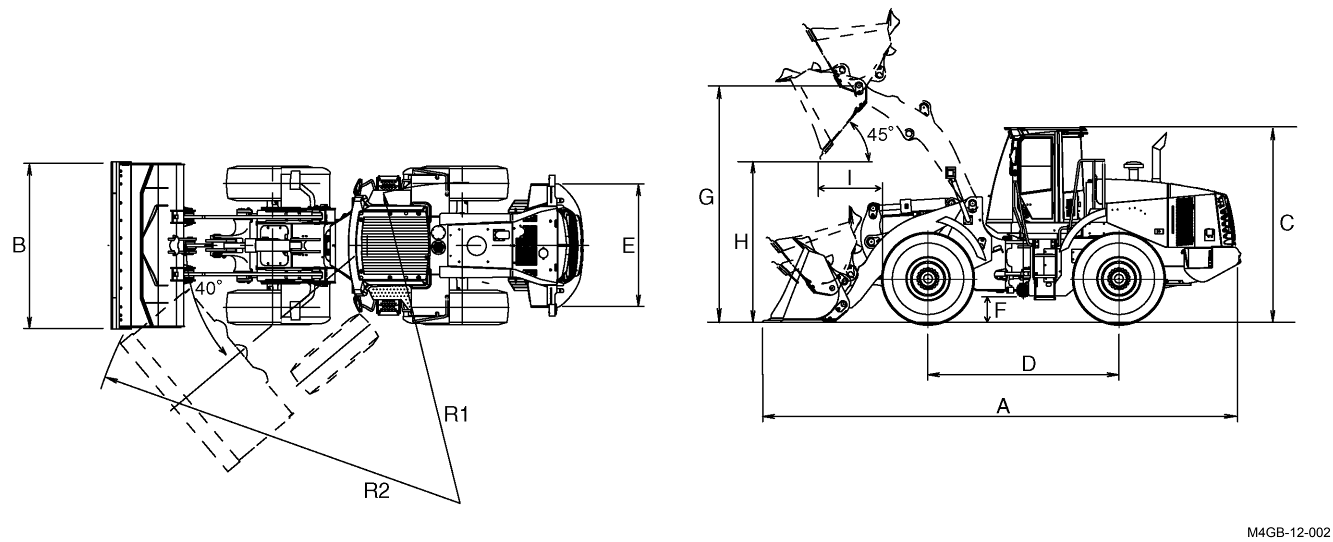
SPECIFICATIONS



Type	–	ZW220 (Standard)	ZW250 (Standard)
Operating Weight	kg(lb)	3.4 (BOC)	3.7 (BOC)
Static Tipping Load (Full Turn)	kg(lb)	17290	19610
Rated Loading Weight	kg(lb)	5120	5600
Engine	–	ISUZU 6HK1 139.3 kW/2170 rpm (189 PS/2170 rpm)	ISUZU 6HK1 163.0 kW/2240 rpm (221.5 PS/2240 rpm)
A: Overall Length	mm(ft.in)	8245	8385
B: Overall Width (Bucket)	mm(ft.in)	2910	3050
C: Overall Height	mm(ft.in)	3375	3405
D: Wheel Base	mm(ft.in)	3300	3350
E: Tread	mm(ft.in)	2160	2200
F: Ground Clearance	mm(ft.in)	450	425
G: Height to Bucket Hinge Pin, Fully Raised	mm(ft.in)	4090	4195
H: Dumping Clearance 45 Degree, Full Height	mm(ft.in)	2880	2950
I: Dumping Reach, 45 Degree Dump, Full Height	mm(ft.in)	1150	1120
R1: Turning Radius (Centerline of Outside Tire)	mm(ft.in)	5620	5715
R2: Loader Clearance Circle, Bucket in Carry Position	mm(ft.in)	6620	6780
Maximum Travel Speed (Forward/Reverse)	km/h(mph)	34.5/34.5	34.5/34.5
Number of Travel Shift (Forward/Reverse)	–	4/4	4/4
Articulation Angle (Left/Right)	Degree(%)	40	40
Tire Size	–	23.5-25-16PR	23.5-25-16PR

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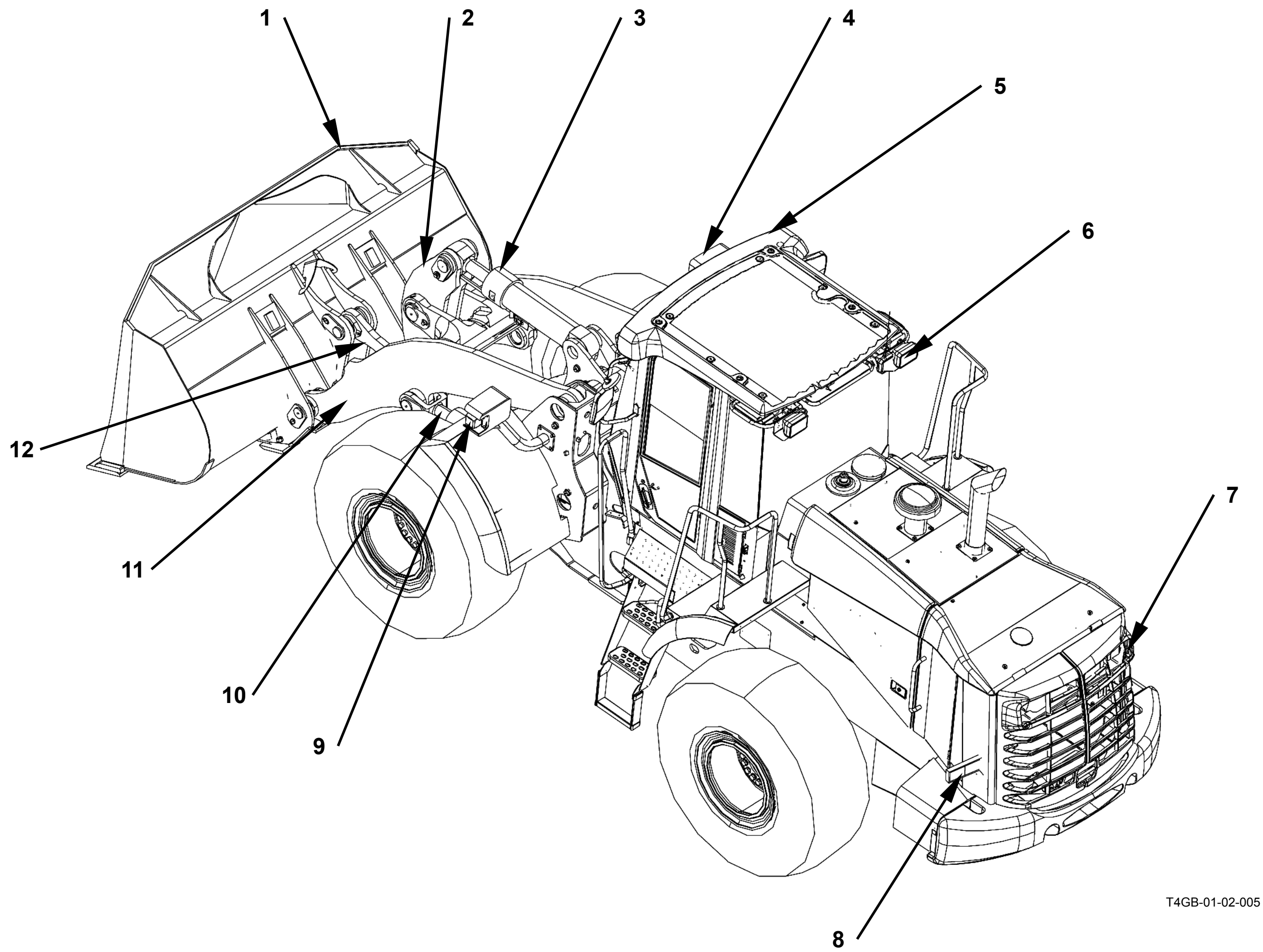
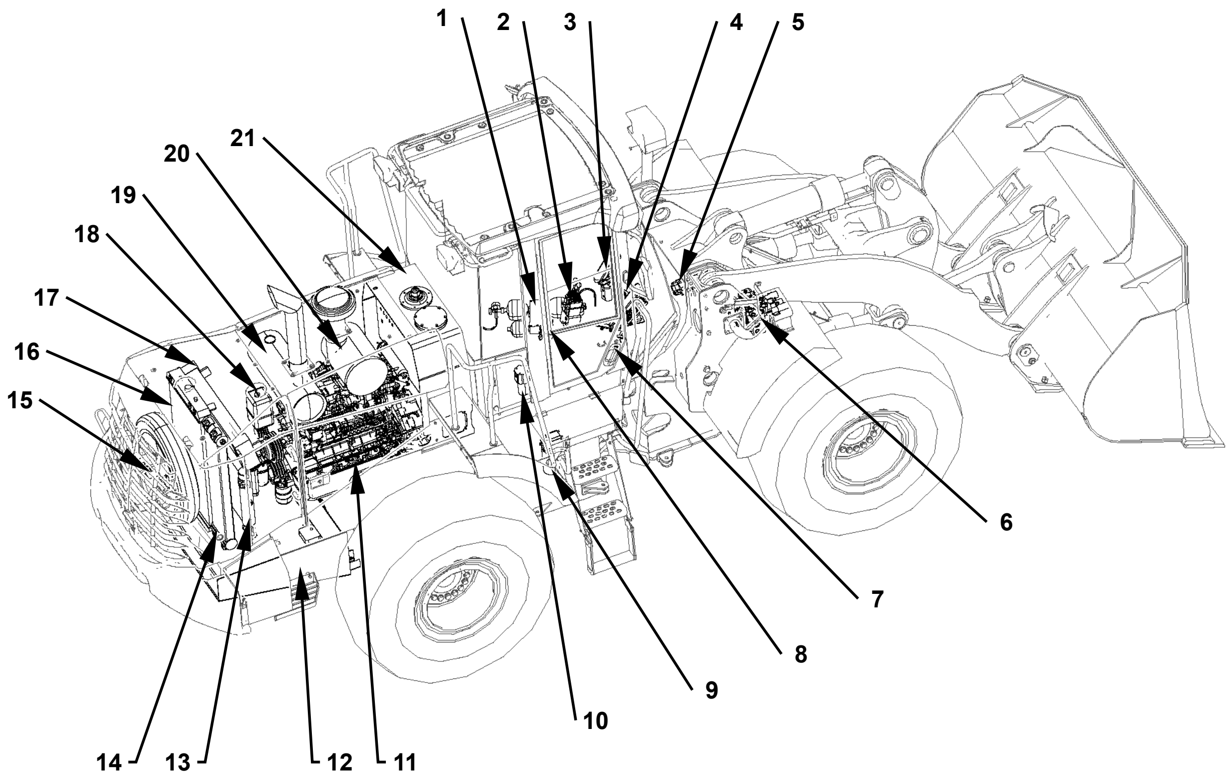
MAIN COMPONENT LAYOUT (OVERVIEW)



1 - Bucket	4 - Head Light	7 - Rear Working Light	10 - Lift Arm Cylinder
2 - Bell Crank	5 - Front Working Light	8 - Rear Combination Light (Turn Signal, Hazard Light Clearance Light and Brake Light)	11 - Lift Arm
3 - Bucket Cylinder	6 - Rear Working Light (Optional)	9 - Turn Signal, Hazard Light and Clearance Light	12 - Bucket Link

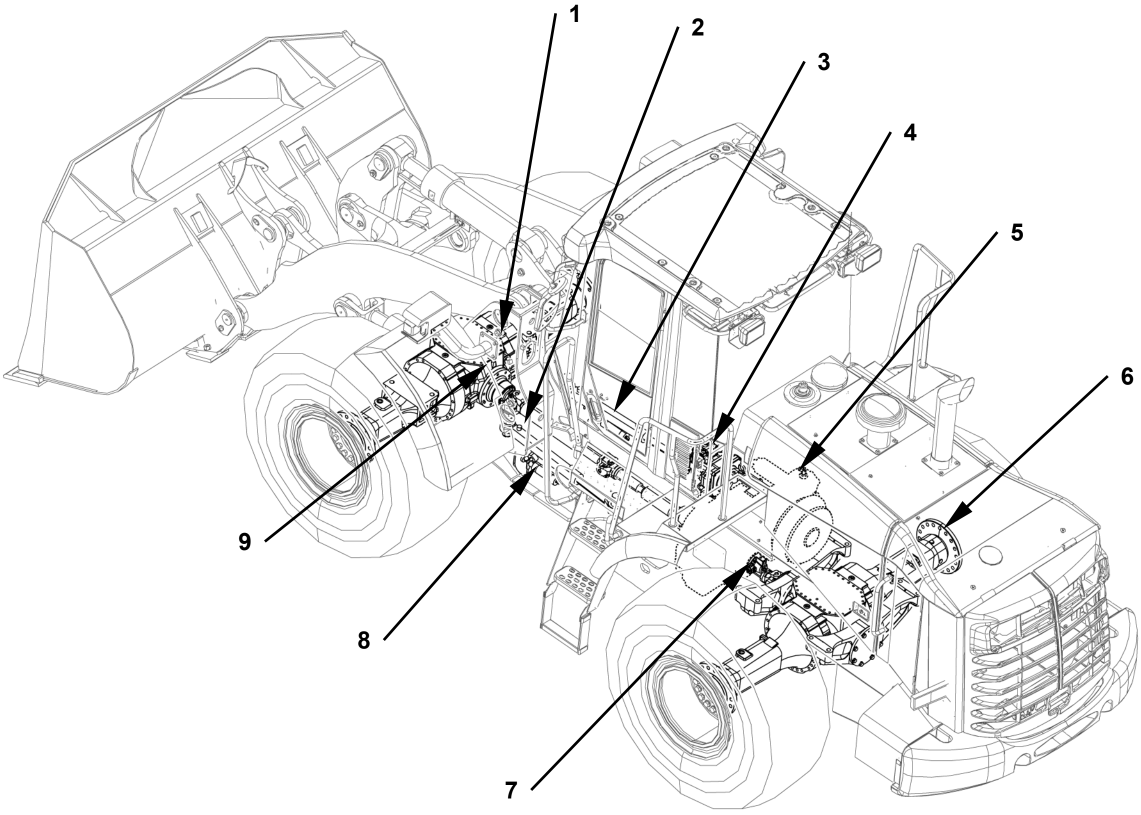
MAIN COMPONENT LAYOUT (UPPERSTRUCTURE)



T4GB-01-02-002

1 - Charging Block
2 - Pilot Valve
3 - Brake Valve
4 - Steering Pilot Valve
5 - Steering Valve
6 - Control Valve
7 - Stop Valve
8 - Pilot Shutoff Valve
9 - Engine Oil Filter
10 - Pilot Filter
11 - Engine
12 - Fuel Tank
13 - Torque Converter Cooler
14 - Oil Cooler
15 - Fan Motor
16 - Radiator
17 - Inter Cooler
18 - Reserve Tank
19 - Muffler
20 - Air Cleaner
21 - Hydraulic Tank

MAIN COMPONENT LAYOUT (TRAVEL SYSTEM)



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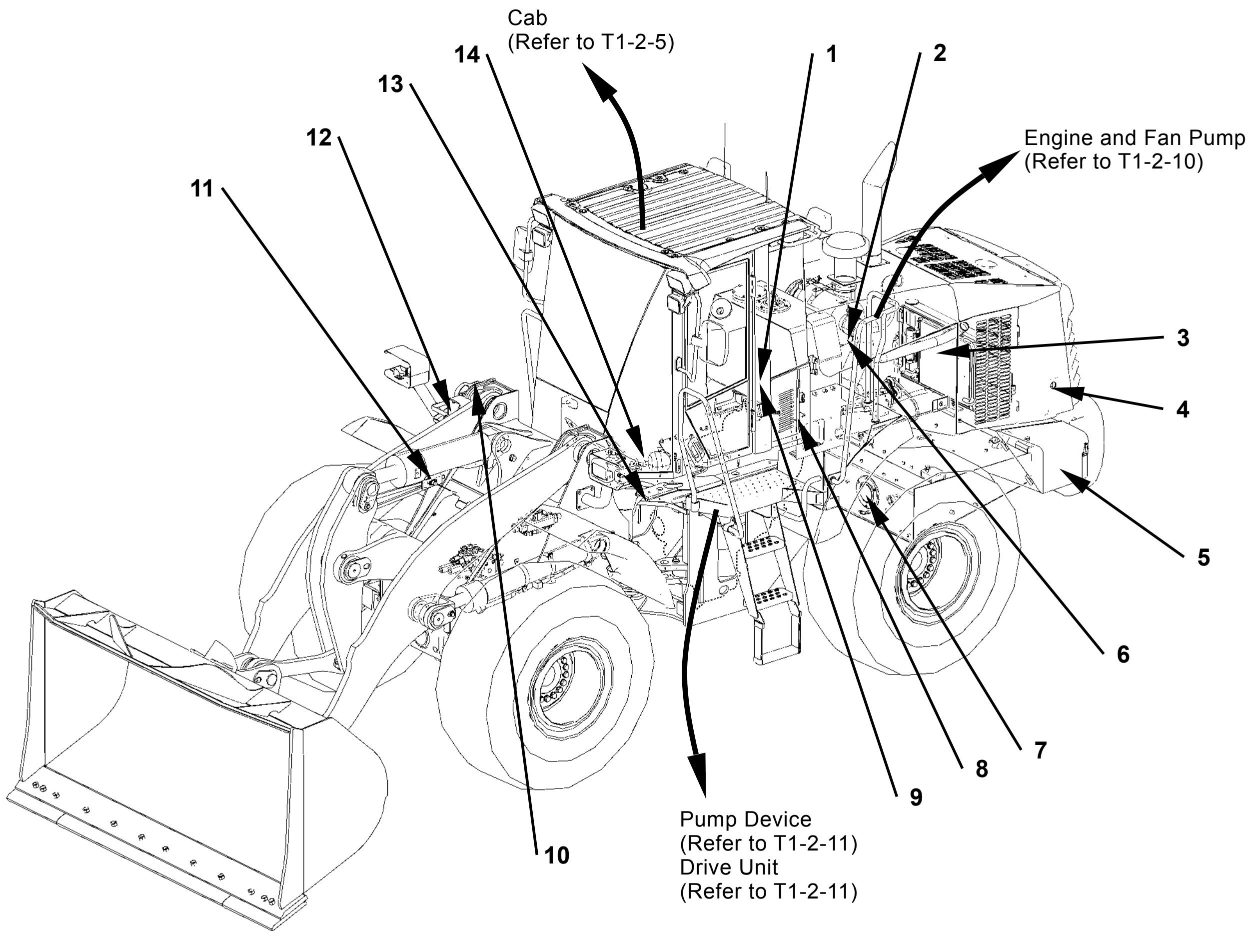
1 - Front Axle
2 - Propeller Shaft (Front)
3 - Steering Cylinder
4 - Pump Device
5 - Transmission
5 - Rear Axle
6 - Propeller Shaft (Rear)
7 - Steering Accumulator
8 - Brake Pressure Sensor

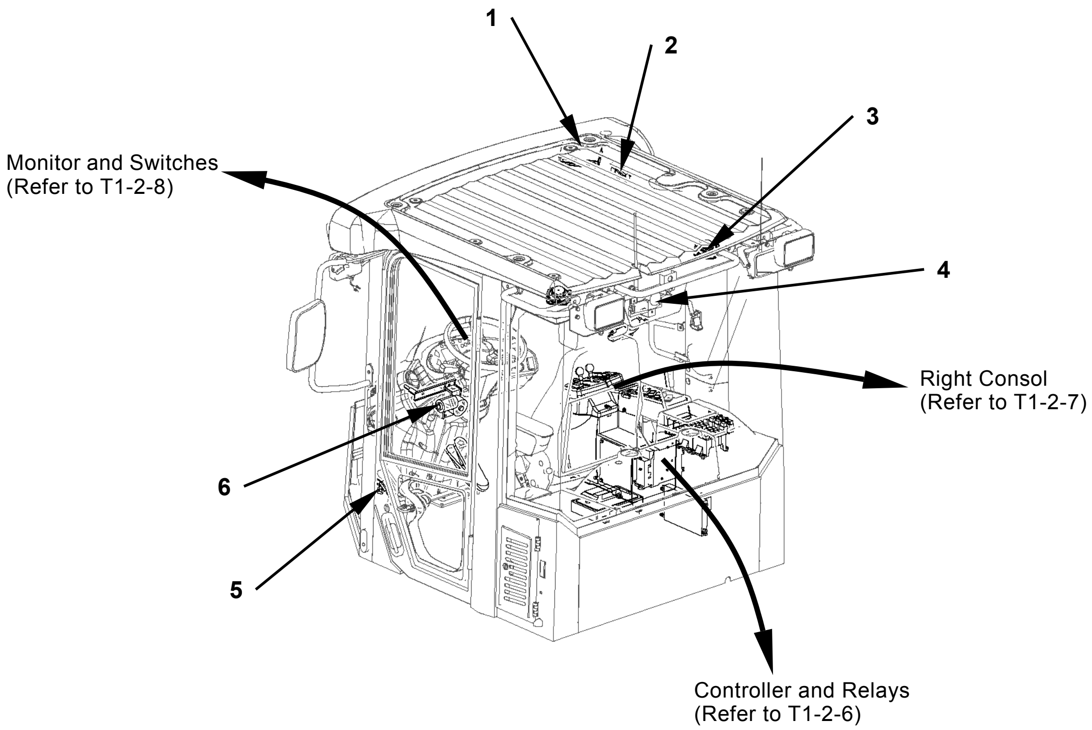
ELECTRIC COMPONENT LAYOUT (OVERVIEW)



T4GB-01-02-019

1 - Hydraulic Oil Level Switch
2 - Air Filter Restriction Switch
3 - ECM
4 - Reverse Buzzer
5 - Battery
6 - Boost Pressure Sensor
7 - Fuel Level Sensor
8 - Hydraulic Oil Temperature Sensor
7 - Emergency Steering Pump Delivery Pressure Switch
8 - Lift Arm Angle Sensor (Optional)
9 - Bucket Proximity Switch
10 - Lift Arm Proximity Switch
11 - Implement Pressure Sensor
12 - Out Side Temperature Sensor

ELECTRICAL SYSTEM (CAB)



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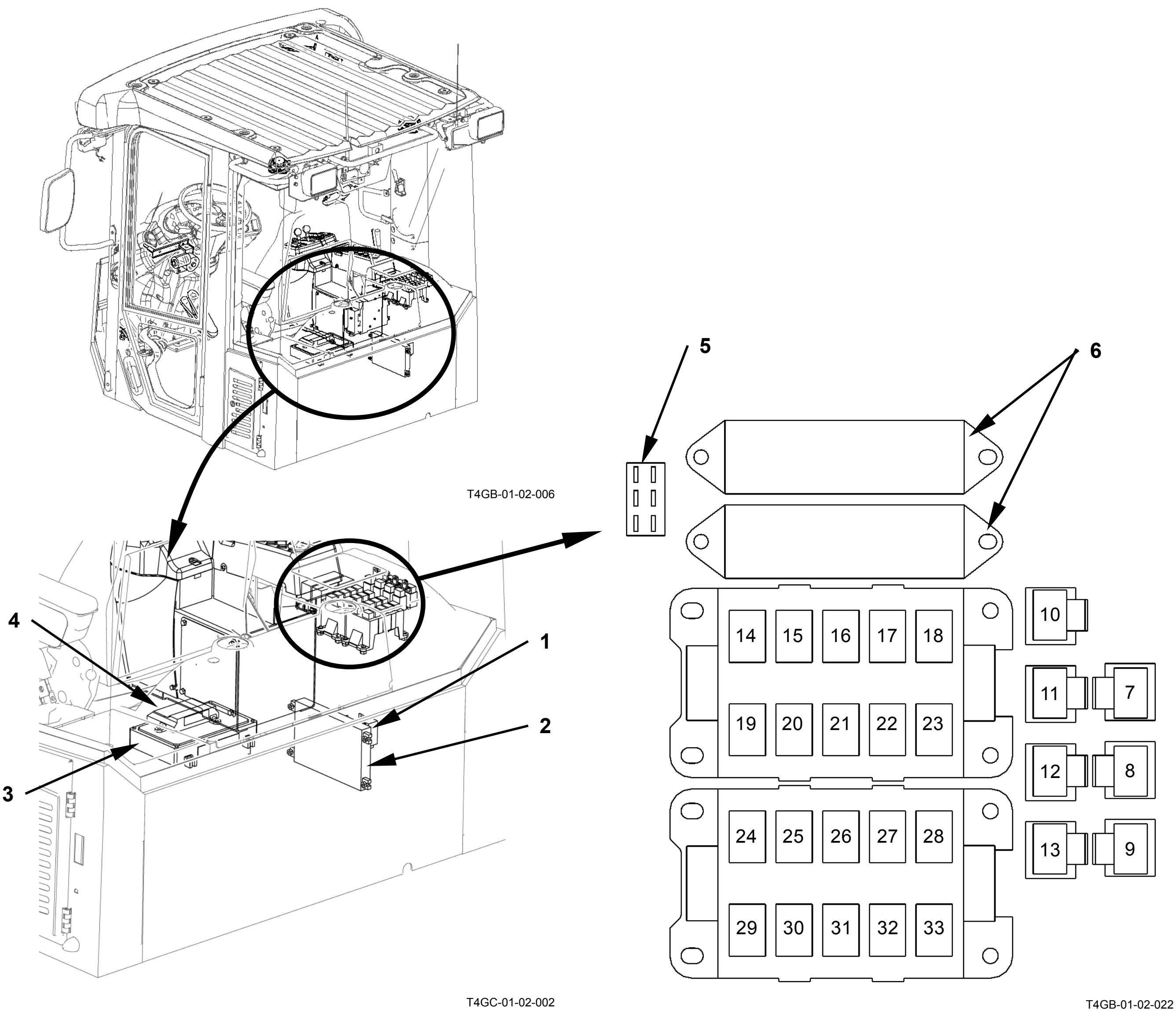
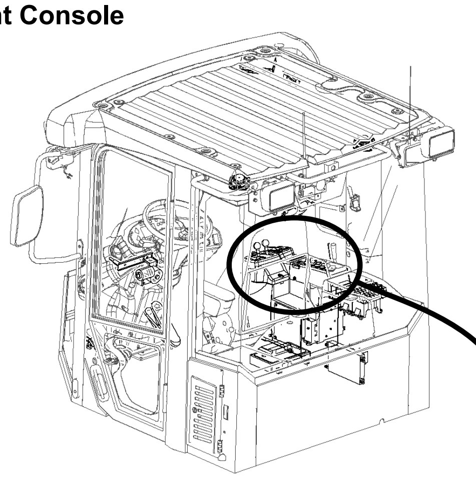
1 - Radio
2 - Auxiliary Switch Panel (Optional)
3 - Speaker
4 - Rear Wiper Motor
5 - Brake Lamp Switch
6 - Front Wiper Motor

Controller and Relays



1 - Flasher Relay
2 - Option Controller (Optional)
3 - MCF
4 - ICF
5 - Dr.ZX Connector
6 - Fuse Box
7 - Fog Light Relay (Optional)
8 - Auxiliary
9 - Front Window Heater Relay
10 - Neutral Relay
11 - Rear Window Heater Relay
12 - Wiper Relay (Left)
13 - Wiper Relay (Right)
14 - Reverse Light Relay (A-R5)
15 - Brake Light Relay (A-R4)
16 - High Beam Relay (A-R3)
17 - Head Light Relay (Right) (A-R2)
18 - Head Light Relay (Left) (A-R1)
19 - Emergency Steering Relay (A-R10)
20 - Hone Relay (A-R9)
21 - Turn Signal Relay (Right) (A-R8)
22 - Working Light Relay (Rear) (A-R7)
23 - Working Light Relay (Front) (A-R8)
24 - Front Wiper Relay (B-R5)
25 - Neutral Relay (B-R4)
26 - Load Dump Relay (B-R3)
27 - Parking Brake Relay (B-R2)
28 - Parking Brake Relay (B-R1)
29 - Fuel Pump Relay (B-R10)
30 - Main Relay (B-R9)
31 - Rear Washer Relay (B-R8)
32 - Turn Signal Relay (Left) (B-R7)
33 - Rear Wiper Relay (B-R6)

Right Console



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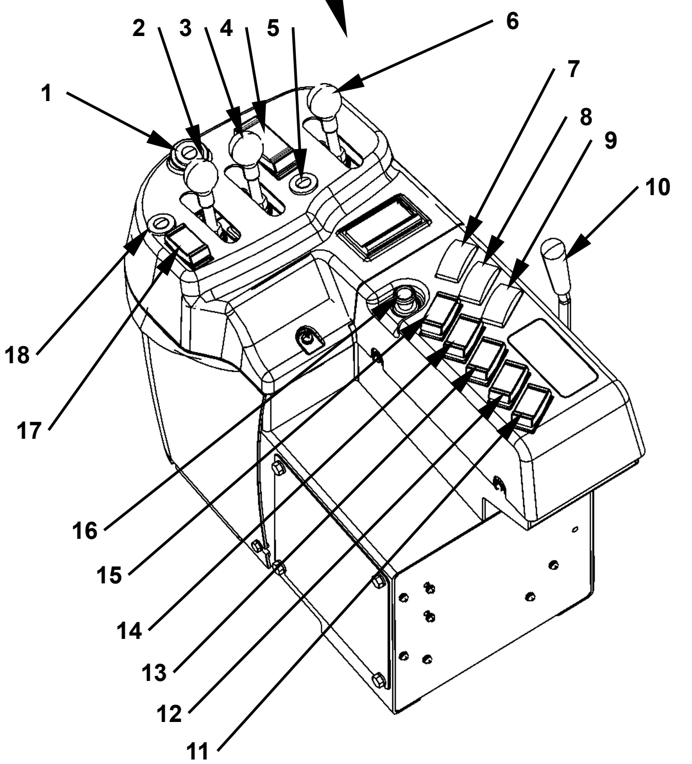

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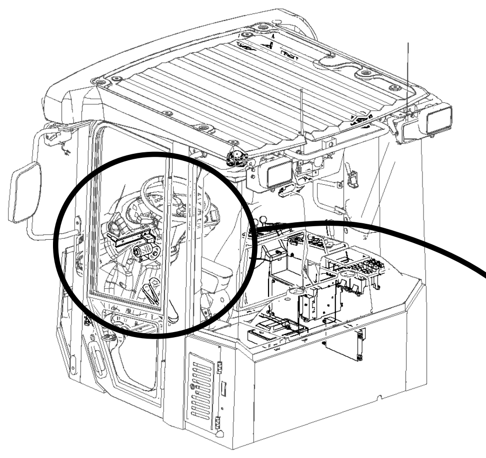
1 - Down Shift Switch	6 - Auxiliary Control Lever (Optional)	11 - Emergency Steering Check Switch	15 - Forward/Reverse Selector Switch
2 - Bucket Control Lever	7 - Quick Coupler Switch (Optional)	12 - Fan Reversing Switch	16 - Cigar Lighter
3 - Lift Arm Control Lever	8 - Lift Arm Auto Leveler Downward Set Switch (Optional)	13 - Fog Light Switch (Optional)	17 - Up-shift/Down-shift Switch
4 - Forward/Reverse Switch	9 - Lift Arm Auto Leveler Upward Set Switch (Optional)	14 - Ride Control Switch (Optional)	18 - Hold Switch
5 - Hone Switch	10 - Front Control Lock Lever		

Monitor and Switchs



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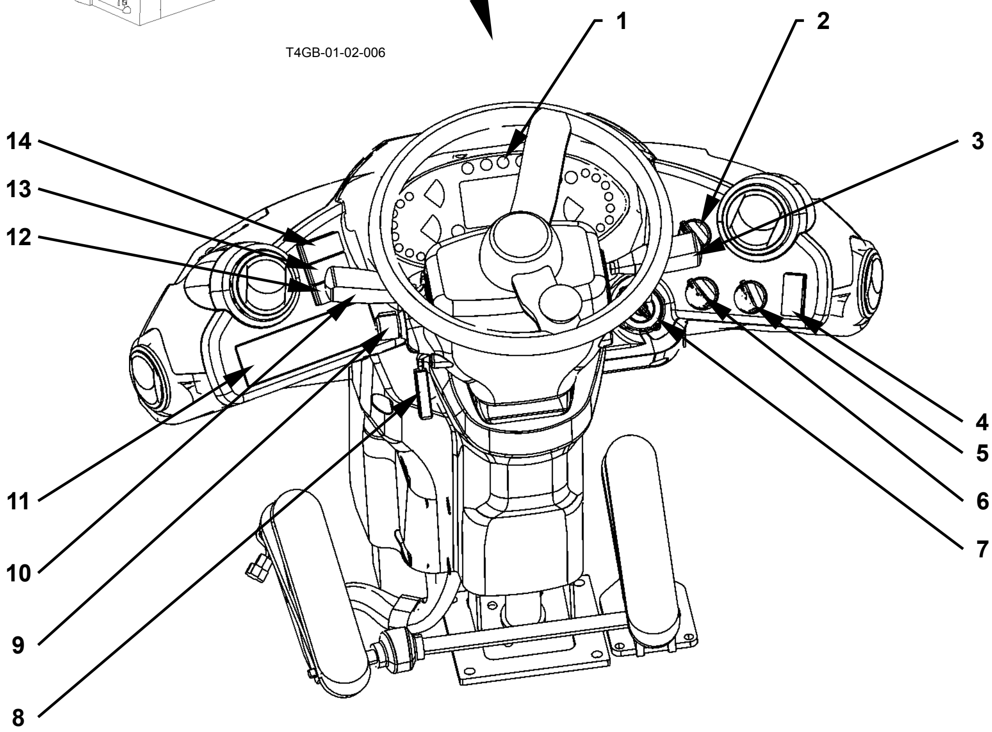

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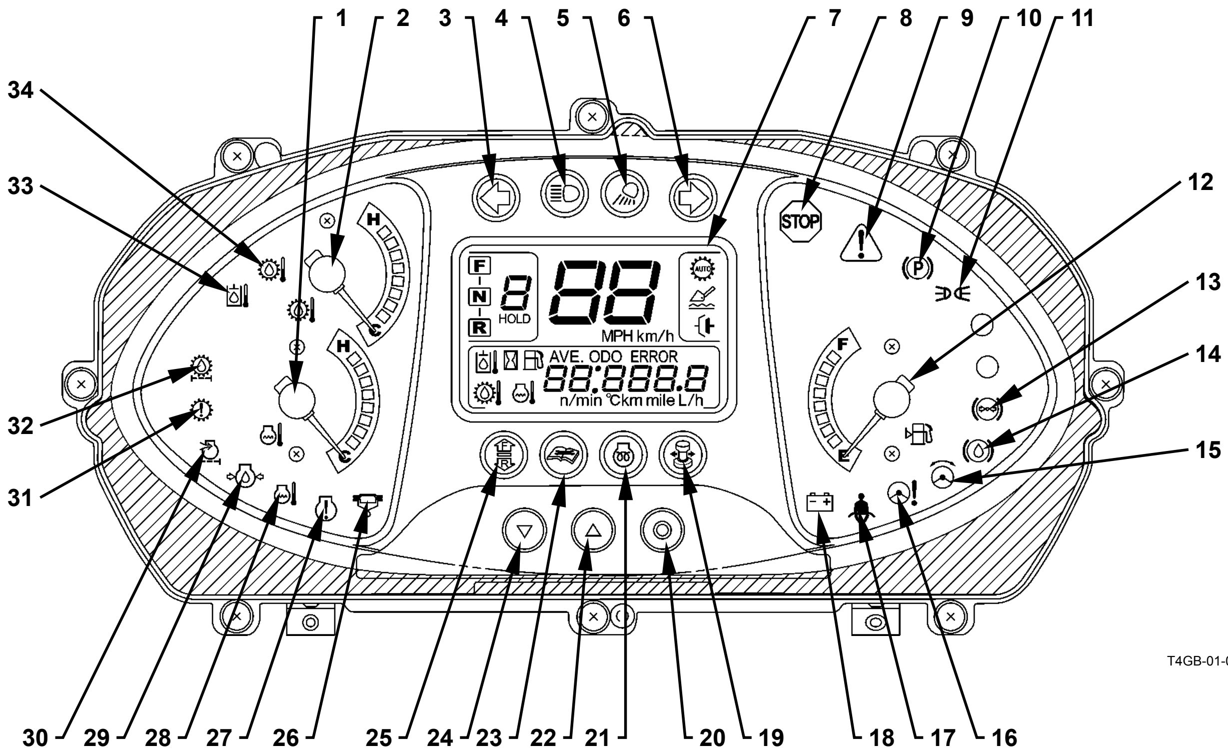
1 - Monitor Panel (Refer to T1-2-9)
2 - Driving Mode Switch
3 - Turn Signal Lever /Head Light Switch/Dimmer Switch
4 - Parking Brake Switch
5 - Work Mode Selector Switch
6 - Clutch Cat Position Switch
7 - Key Switch
8 - Steering Column Tilt /Telescopic Lever
9 - Front Wiper Switch
10 - Forward/Reverse Lever and Shift Switch
11 - Air Conditioner Switch Panel
12 - Rear Wiper Switch
13 - Working Light Switch
14 - Hazard Light Switch

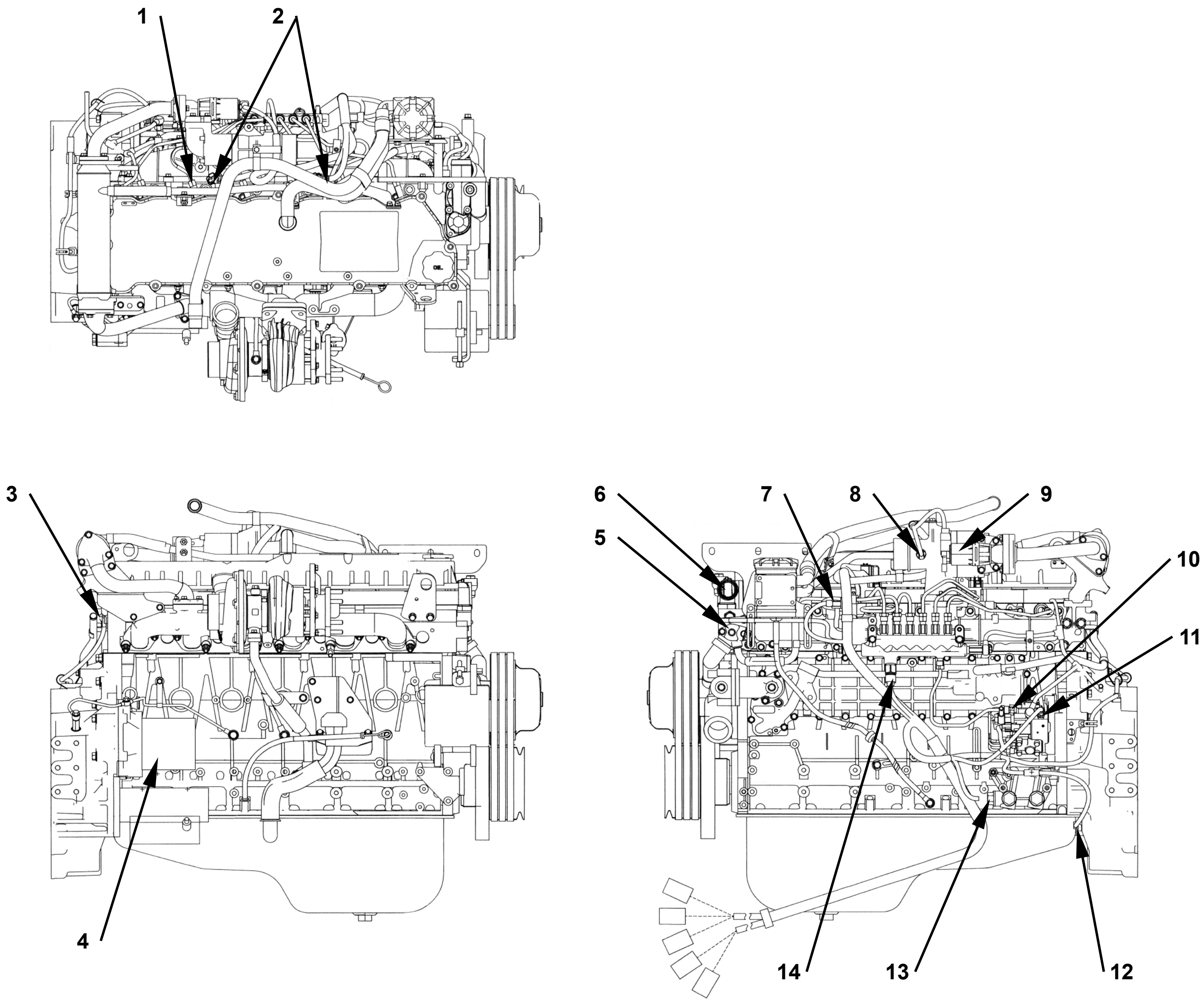
Monitor Panel



T4GB-01-02-001

1 - Coolant Temperature Gauge
2 - Transmission Oil Temperature Gauge
3 - Turn Signal Indicator (Left)
4 - High Beam Indicator
5 - Working Light Indicator
6 - Turn Signal Indicator (Right)
7 - Monitor Display
8 - Stop Indicator
9 - Service Indicator
10 - Parking Brake Indicator
11 - Clearance Light Indicator
12 - Fuel Gauge
13 - Brake Low Oil Pressure Indicator
14 - Brake Low Oil Level Indicator
15 - Emergency Steering Indicator (Optional)
16 - Low Steering Oil Pressure Indicator
17 - Seat Belt Indicator
18 - Discharge Warning Indicator
19 - Lever Steering Indicator (Optional)
20 - Monitor Mode Selector
21 - Glow Signal
22 - Monitor Display Selector (Up)
23 - Maintenance Indicator
24 - Monitor Display selector (Down)
25 - Forward/Reverse Switch Indicator
26 - Water Separator Indicator
27 - Engine Warning Indicator
28 - Overheat Indicator
29 - Engine Low Oil Pressure Indicator
30 - Air Filter Restriction Indicator
31 - Transmission Warning Indicator
32 - Transmission Oil Filter Restriction Indicator
33 - Hydraulic Oil Temperature Indicator
34 - Transmission Oil Temperature Indicator

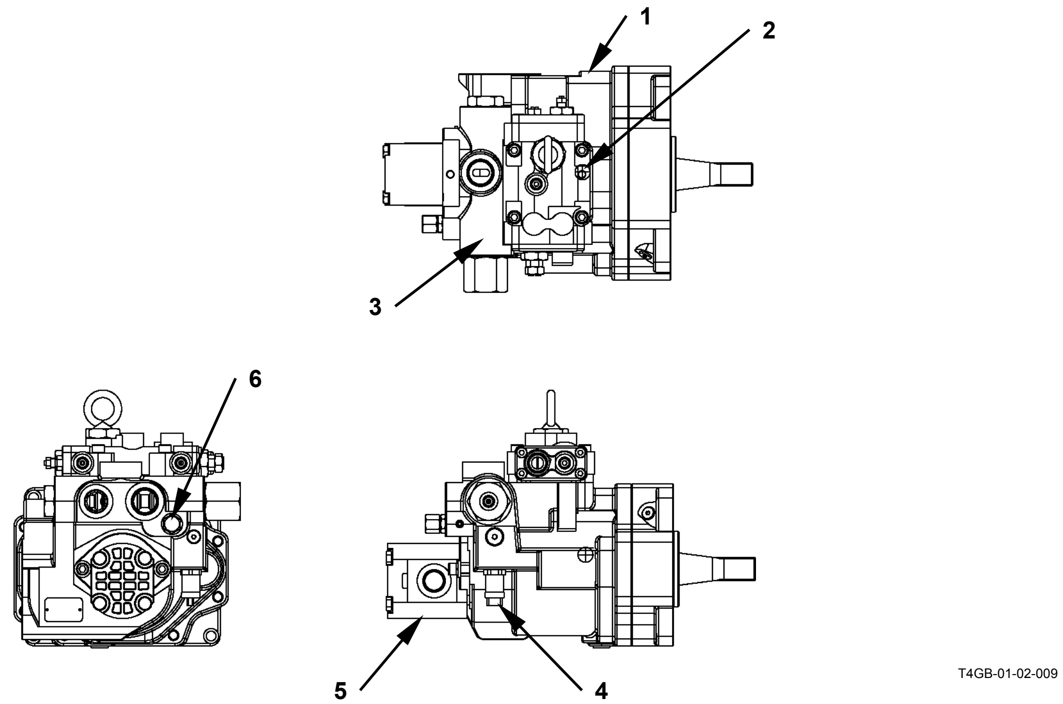
ENGINE AND FAN PUMP



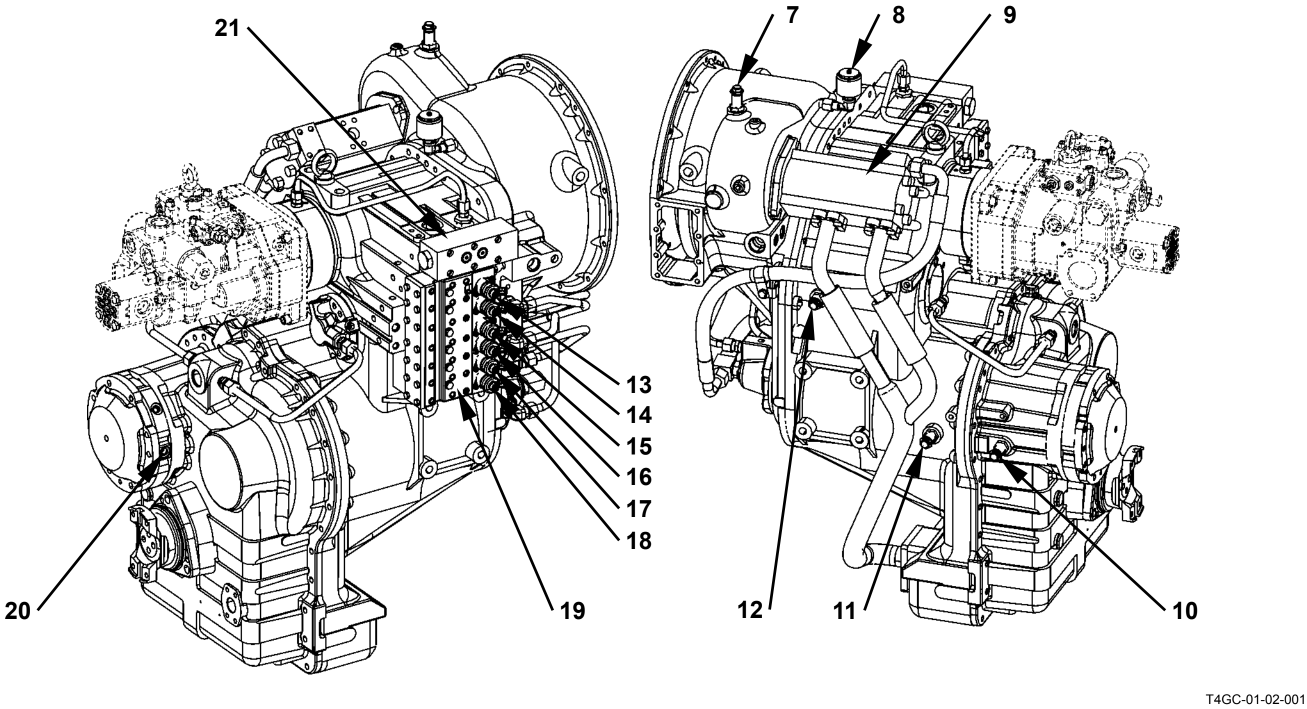
T4GB-01-02-025

1 - Glow Plug
2 - Injector
3 - Cam Angle Sensor
4 - Fan Pump
5 - Coolant Temperature Sensor
6 - Overheat Switch
7 - Boost Pressure Sensor
8 - Boost Temperature Sensor
9 - EGR Valve
10 - Supply Pump
11 - Fuel Temperature Sensor
12 - Crank Revolution Sensor
13 - Engine Oil Pressure Sensor
14 - Common Rail Pressure Sensor

PUMP DEVICE



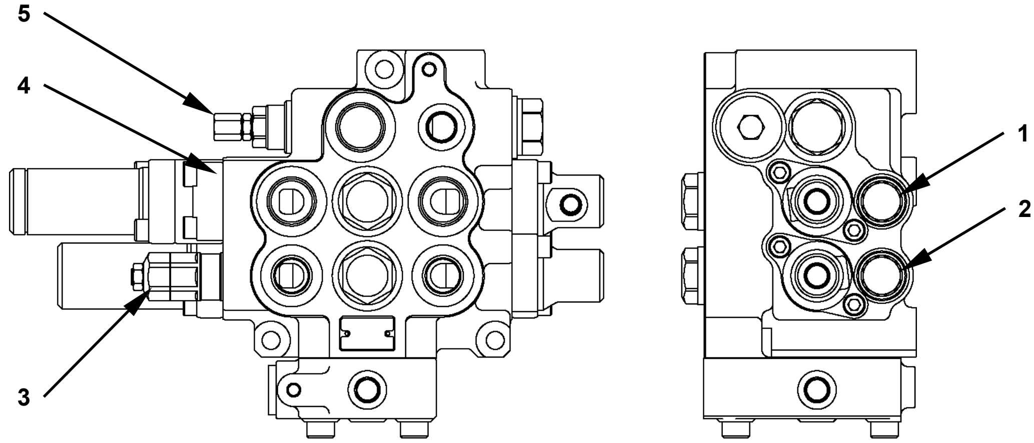
DRIVE UNIT



1 - Main Pump
2 - Regulator
3 - Priority Valve
4 - Pump Delivery Pressure Switch
5 - Pilot Pump
6 - Steering Relief Valve
7 - Torque Converter Input Speed Sensor
8 - Air Breather
9 - Charge Pump
10 - Vehicle Speed Sensor
11 - Transmission Output Speed Sensor
12 - Transmission Middle Shaft Sensor
13 - Forward Clutch Solenoid Valve
14 - Reverse Clutch Solenoid Valve
15 - 1st Clutch Solenoid Valve
16 - 2nd Clutch Solenoid Valve
17 - 3rd Clutch Solenoid Valve
18 - 4th Clutch Solenoid Valve
19 - Transmission Control Valve
20 - Parking Brake Pressure Switch
21 - Regulator Valve

CONTROL VALVE

ZW220



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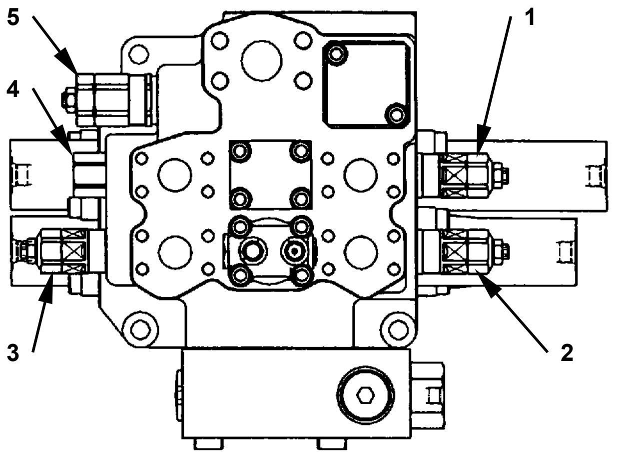
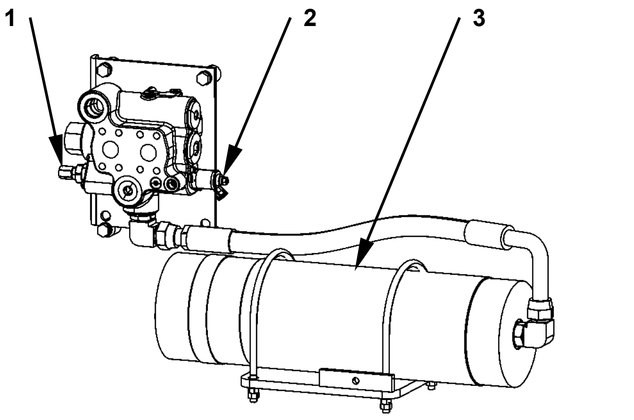
ZW250



T4GB-03-02-002

1 - Over Load Relief Valve (Lift Arm: Bottom)
2 - Over Load Relief Valve (Bucket: Bottom)
3 - Over Load Relief Valve (Bucket: Rod)
4 - Make-up Valve (Lift Arm: Rod)
5 - Main Relief Valve

RIDE CONTROL VALVE (OPTIONAL)



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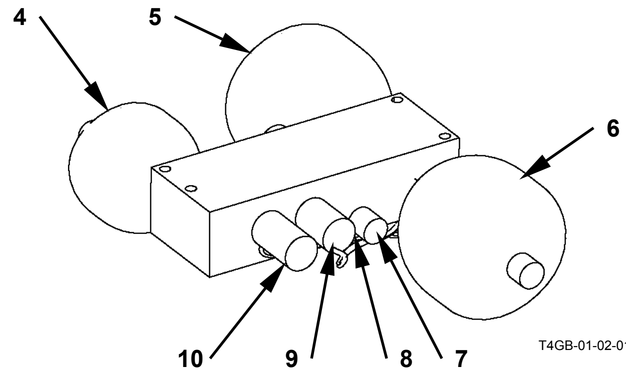
CHARGING BLOCK



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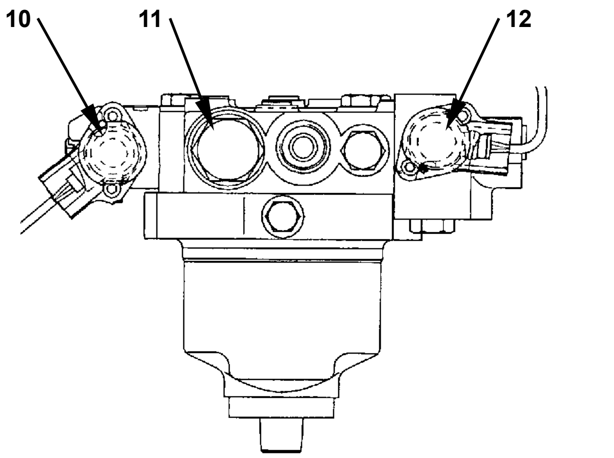
FAN MOTOR



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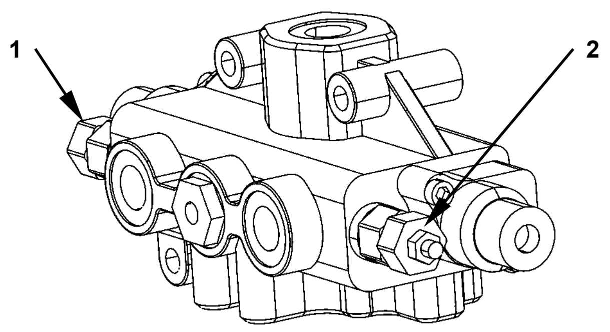
1 - Overload Relief Valve	5 - Service Brake Accumulator (Front)	8 - Pilot Relief Valve	11 - Reverse Control Solenoid Valve
2 - Ride Control Solenoid Valve	6 - Service Brake Accumulator (Rear)	9 - Pump Torque Control Solenoid Valve	12 - Relief Valve
3 - Ride Control Accumulator	7 - Relief Valve	10 - Parking Brake Solenoid Valve	13 - Flow Control Solenoid Valve
4 - Pilot Accumulator			

STEERING VALVE



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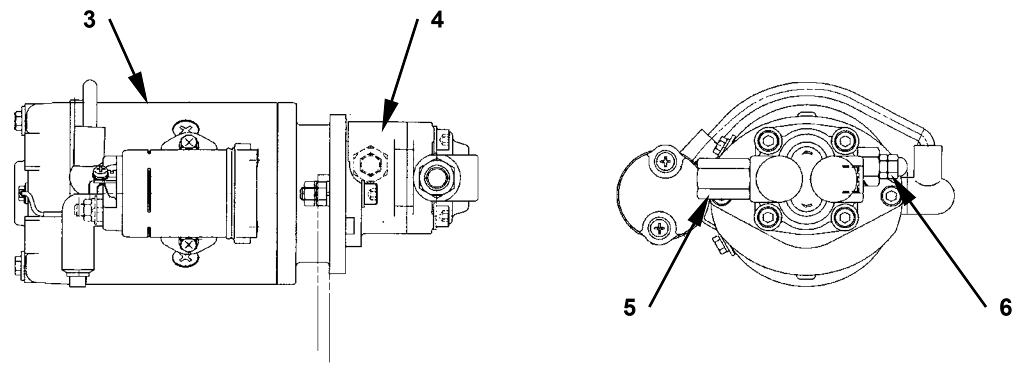
EMERGENCY STEERING PUMP (OPTIONAL)



T4GB-01-02-010

1 - Overload Relief Valve
2 - Overload Relief Valve
3 - Electric Motor
4 - Gear Pump
5 - Check Valve
6 - Relief Valve

ENGINE

ZW220

Manufacturer	ISUZU
Model	AH-6HK1XYWT
Type	Diesel, 4 Cycle, Water Cooled, Over Head Valve, Inline, Direct Injection, Turbo Charged
Cyl. NO. - Bore×Stroke	6-115 mm×125 mm (4.53 in×4.92 in)
Piston Displacement	7790 cm^3 (475 in^3)
Rated Output	139.3±3 kW/2170 min^{-1} (189±4 PS/2170 rpm)
Max. Output	164.3±3 kW/2000 min^{-1} (223.4±4 PS/2000 rpm)
Compression Ratio	17.5
Dry Weight	630 kg (1389 lb)
Firing Order	1-5-3-6-2-4
Rotation Direction	Clock Wise (Viewed from fan side)

ZW250

Manufacturer	ISUZU
Model	AH-6HK1XYWT
Type	Diesel, 4 Cycle, Water Cooled, Over Head Valve, Inline, Direct Injection, Turbo Charged
Cyl. NO. - Bore×Stroke	6-115 mm×125 mm (4.53in×4.92 in)
Piston Displacement	7790 cm^3 (475 in^3)
Rated Output	163.0±3 kW/2240 min^{-1} (222±4 PS/2240 rpm)
Max. Output	179.1±3 kW/2000 min^{-1} (243.5±4 PS/2000 rpm)
Compression Ratio	17.5
Dry Weight	630 kg (1389 lb)
Firing Order	1-5-3-6-2-4
Rotation Direction	Clock Wise (Viewed from fan side)

COOLING SYSTEM

Cooling Fan	Diameter 850 mm (33.47 in), 6 Blades (N6G-Type Blade, Steel Center), Draw-in Type
Thermostat	Cracking Temperature at Atmospheric Pressure: 82 °C (180 °F) Full Open (Stroke: 10 mm (0.39 in) or more) Temperature: 95 °C (203 °F)
Fan Pump	Gear Pump

LUBRICATION SYSTEM

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

STARTING SYSTEM

Motor .... Magnetic Pinion Shift Reduction Type
Voltage/Output.. 24 V·5 kW

PREHEAT SYSTEM

Preheating Method .... Glow Plug (QOS II Type with After Glow)

ENGINE STOP SYSTEM

Stop Method .... Fuel Shut Off (Electrically Controlled)

ALTERNATOR

Type.. Regulator Integrated AC Type
Voltage/Output.. 24 V·50 A (Brush less)

SUPERCHARGING SYSTEM

Model... RHG6
Type.. Exhaust Turbocharger Type

FUEL SYSTEM

Type.. Common Rail Type (HP4 Model)
Governor .... Electrically Controlled
Injection Nozzle .... Electric Multi Hole Injector (G2 Type)

PERFORMANCE

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

ZW220

Fuel Consumption Ratio	212.0±13.6 g/kW·h (156±10 g/PS·h) @ 2000 min^{-1} (rpm)
Maximum Output Torque	981±60 N·m (100±6 kgf·m) @ at approx. 1400 min^{-1} (rpm)
Compression Pressure	3.04 Mpa (31 kgf/cm^2) @ 200 min^{-1} (rpm)
Valve Clearance (Inlet/Exhaust)	0.4/0.4 mm (when cool)
No Load Speed	Slow: (at Full Load: 850±20 min^{-1} (rpm)) Fast: (at Full Load: 2260±20 min^{-1} (rpm))

ZW250

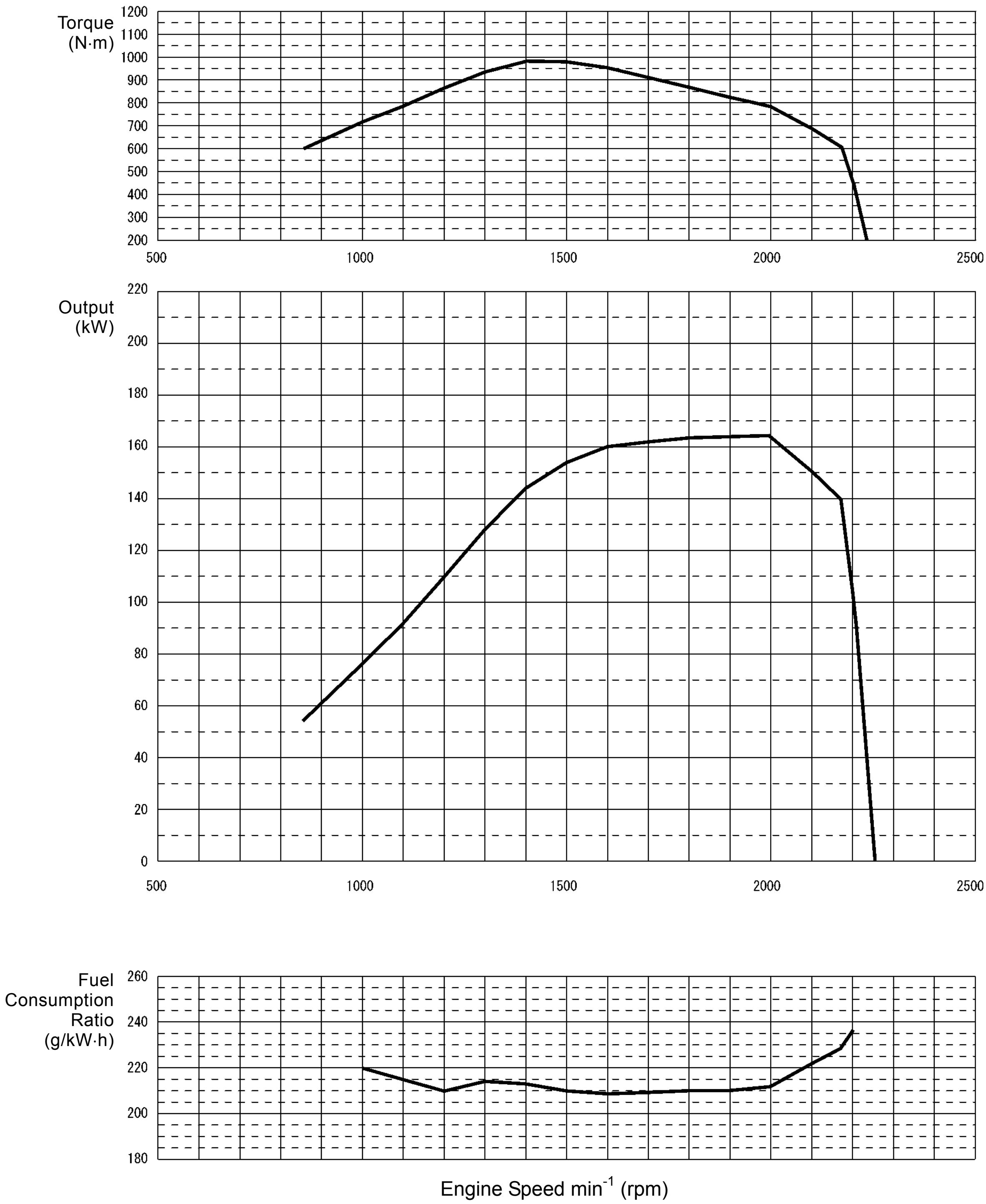
Fuel Consumption Ratio	212.0±13.6 g/kW·h (156±10 g/PS·h) @ 2000 min^{-1}(rpm)
Maximum Output Torque	1022±60 N·m (104±6 kgf·m) @ at approx 1400 min^{-1} (rpm)
Compression Pressure	3.04 MPa (31 kgf/cm^2) @ 200 min^{-1} (rpm)
Valve Clearance (Inlet/Exhaust)	0.4/0.4 mm (0.016/0.016 in) (when cool)
No load Speed	Slow: (at Full Load: 850±20 min^{-1} (rpm)) Fast: (at Full Load: 2330±20 min^{-1} (rpm))

ZW220

Engine Performance Curve (AH-6HK1XYWT)

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.



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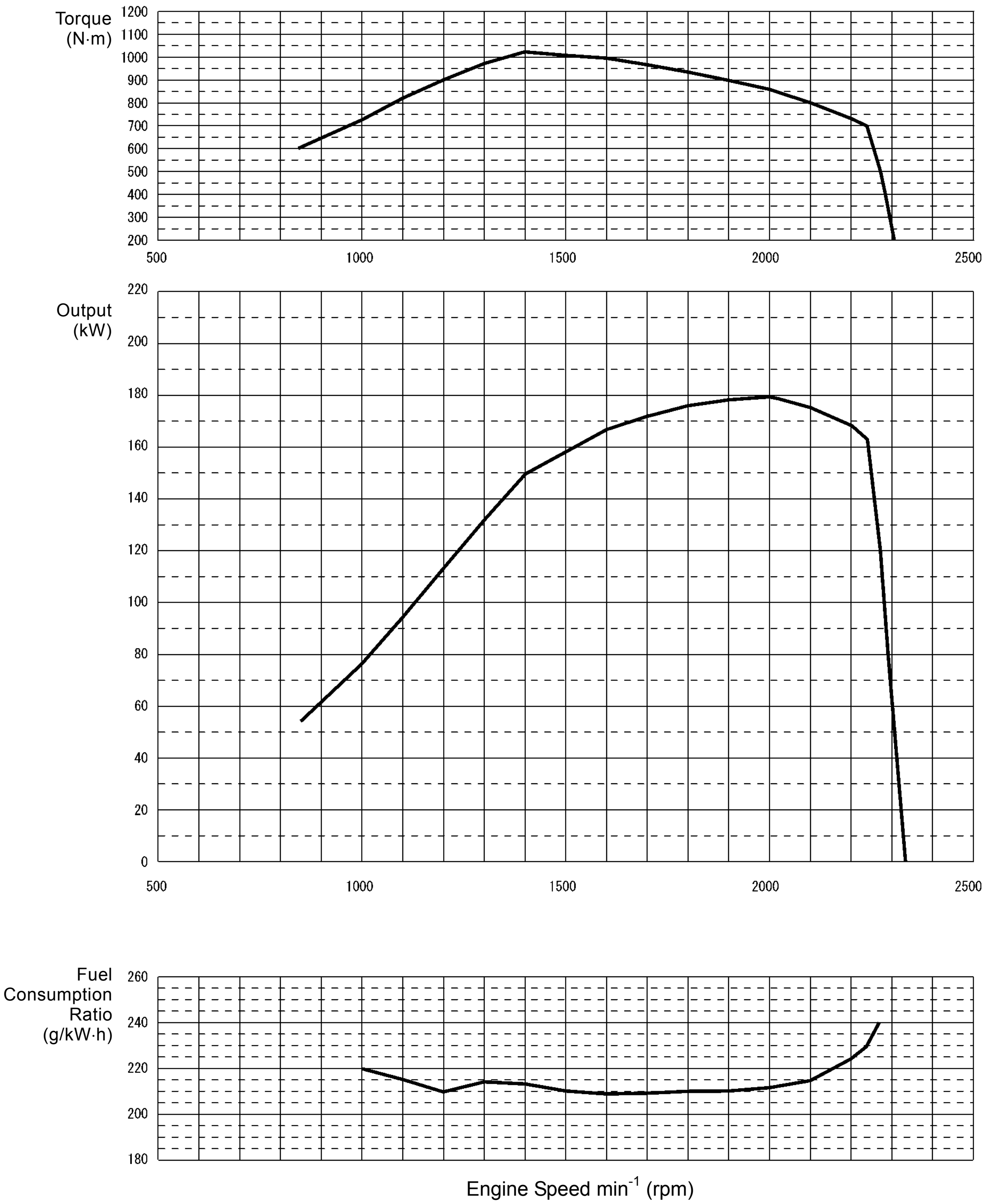
ZW250

Engine Performance Curve (AH-6HK1XYWT)

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.



T4GC-01-03-002

ENGINE ACCESSORIES

RADIATOR ASSEMBLY

Type	Radiator and Oil Cooler Tandem Type Assembly Inter Cooler and Torque Converter Cooler Tandem Type Assembly
Weight	67 kg (148 lb) (ZW220) 74.5 kg (164 lb) (ZW250)

ZW220

	Radiator	Oil Cooler
Capacity	15 L (4 US gal)	5.1 L (3.3 US gal)
Air-Tight Test Pressure	100 kPa (1.0 kgf/cm^2, 14.5 psi)	1500 kPa (15 kgf/cm^2, 217 psi))
Cap Opening Pressure	49 kPa (0.5 kgf/cm^2, 7 psi)	–

	Intercooler	Torque Converter Cooler
Capacity	11.5 L (3 US gal)	10.2 L (2.7 US gal)
Air-Tight Test Pressure	245 kPa (2.5 kgf/cm^2, 36 psi)	1500 kPa (15 kgf/cm^2, 217 psi)
Cap Opening Pressure	–	–

ZW250

	Radiator	Oil Cooler
Capacity	18 L (4.8 US gal)	5.1 L (1.3 US gal)
Air-Tight Test Pressure	100 kPa (1.0 kgf/cm^2,14.5 psi)	1500 kPa (15 kgf/cm^2,217 psi))
Cap Opening Pressure	49 kPa (0.5 kgf/cm^2, 7 psi)	–

	Intercooler	Torque Converter Cooler
Capacity	12.5 L (3.3 US gal)	10.7 L (2.8 US gal)
Air-Tight Test Pressure	245 kPa (2.5 kgf/cm^2, 36 psi)	1500 kPa (15 kgf/cm^2, 217 psi)
Cap Opening Pressure	–	–

BATTERY

Voltage	12 V
Capacity	108 Ah

HYDRAULIC FAN PUMP

Model.. SGP1A27D2H1
Type.. Fixed Displacement Type Gear Pump
Maximum Flow (Theoretical Value).......... 60 L/min (15.85 US gpm)

HYDRAULIC FAN MOTOR

Relief Set Pressure .... 20.6 MPa (210 kgf/cm^2) @ 5 L/min (1.32 US gpm)

SOLENOID VALVE

Function.. Fan Motor Reverse Control
Fan Motor Speed Control

HYDRAULIC COMPONENT

MAIN PUMP

Type.. Bent Axis Type Variable Displacement Axial Plunger Pump
Maximum Flow (Theoretical Value).......... 270 L/min (71 US gum) (ZW220)
290 L/min (77 US gum) (ZW250)

REGULATOR

Type.. Hydraulic Pressure Operated Type

PRIORITY VALVE

Relief Set Pressure .... 27.4 MPa (280 kgf/cm^2) @ 70 L/min (18.5 US gpm) (ZW220)
29.4 MPa (300 kgf/cm^2) @ 90 L/min (23.8 US gpm) (ZW250)

PILOT PUMP

Model.. HY/ZFS11/16.8
Type.. Fixed Displacement Type Gear Pump
Maximum Flow (Theoretical Value).......... 35 L/min (9.3 US gpm)

CONTROL VALVE

ZW220

Type.. Pilot Pressure Operated Type (2 Spools)
Main Relief Set Pressure.......................... 27.4 MPa (280 kgf/cm^2) @ 200 L/min (52.8 US gpm)
Overload Relief Set Pressure................... 34.3 MPa (350 kgf/cm^2) @ 35 L/min (9.3 US gpm)
(Lift Arm)
30.4 MPa (310 kgf/cm^2) @ 35 L/min (9.3 US gpm)
(Bucket Tilt)
30.4 MPa (310 kgf/cm^2) @ 50 L/min (13 US gpm)
(Bucket Dump)

ZW250

Type.. Pilot Pressure Operated Type (2 Spools)
Main Relief Set Pressure.......................... 29.4 MPa (300 kgf/cm^2) @ 220 L/min (58 US gpm)
Overload Relief Set Pressure................... 36.8 MPa (375 kgf/cm^2) @ 50 L/min (13 US gpm)
(Lift Arm)
32.5 MPa (330 kgf/cm^2) @ 50 L/min (13 US gpm)
(Bucket Tilt, Bucket Dump)

RIDE CONTROL VALVE (OPTIONAL)

Type.. Pilot Pressure Operated Type
Overload Relief Set Pressure.................. 39.2 MPa (400 kgf/cm^2) @ 50 L/min (13 US gpm)
Charge Cut Pressure............................... 11.3 MPa (115 kgf/cm^2)

RIDE CONTROL ACCUMULATOR (OPTIONAL)

Capacity... 4 L (244 in^3)
Charging Pressure .... 2.9 MPa (30 kgf/cm^2)

CHARGING BLOCK

Charging Pressure .... Cut In Pressure: 11.8 MPa (120 kgf/cm^2)
Cut Out Pressure: 14.7 MPa (150 kgf/cm^2)
Pilot Relief Valve Set Pressure................ 3.7 MPa (38 kgf/cm^2) @ 40 L/min (10.6 US gpm)

SOLENOID VALVE (For Charging Block)

Function... • Main Pump Torque Control
• Parking Brake

SERVICE BRAKE ACCUMULATOR

Capacity... 1.4 L (85.4 in^3)
Charging Pressure .... 4.4 MPa (45 kgf/cm^2)

PILOT ACCUMULATOR

Capacity... 0.75 L (45.8 in^3)
Charging Pressure .... 2.0 MPa (20 kgf/cm^2)

PILOT SHUT OFF VALVE

Type.. Rotary Type

STEERING VALVE

Type.. Flow Amp Type
Over Load Relief Set Pressure .... 32.3 MPa (330 kgf/cm^2) @50 L/min (13 US gpm) (ZW220)
34.3 MPa (350 kgf/cm^2) @50 L/min (13 US gpm) (ZW250)

STEERING PILOT VALVE

Type.. Orbitroll Type
Gerotor Capacity .... 96 cm^3/rev (5.9 in^3/rev)

STEERING ACCUMULATOR v

Capacity.. 0.2 L (12 in^3)
Charging Pressure .... 8 MPa (82 kgf/cm^2)

BRAKE VALVE

Brake Pressure... 3.9 MPa (40 kgf/cm^2)

- Travel System

TRANSMISSION

Type.. Counter Shaft Type
Gear Ratio .... Forward 1st : 3.225
Forward 2nd : 1.901
Forward 3rd : 1.026
Forward 4th : 0.605
Reverse 1st : 3.225
Reverse 2nd : 1.901
Reverse 3rd : 1.026
Reverse 4th : 0.605
Parking Brake Release Pressure .... 2.7 MPa (28 kgf/cm^2)

STANDARD AXLE (FRONT/REAR)

ZW220

Model... Two Stage Transmission
Brake Type .... Wet Multiplate Disk Brake
Brake Pressure.. 3.92 MPa (40 kgf/cm^2)
Final Reduction Gear Ratio...................... 25.766

ZW250

Model... Two Stage Transmission
Brake Type .... Wet Multiplate Disk Brake
Brake Pressure.. 3.92 MPa (40 kgf/cm^2)
Final Reduction Gear Ratio...................... 26.760

STANDARD PROPELLER SHAFT

Type.. Cruciform Joint Type
Dimension between Pins.......................... Front : 1500 mm (59.06”)
Rear : 367.18 mm (14.46”)

- Front Attachment

CYLINDER

ZW220	Lift Arm (Left/Right)	Bucket	Steering
Rod Diameter	85 mm (3.35”)	95 mm (3.74”)	45 mm (1.77”)
Cylinder Bore	130 mm (5.12”)	165 mm (6.5”)	70 mm (2.76”)
Stroke	880 mm (34.65”)	510 mm (20.08”)	442 mm (17.40”)
Fully Retracted Length	1420 mm (55.91”)	1060 mm (41.73”)	804 mm (31.65”)
Plating Thickness	30 μm (1.2 μin)	30 μm (1.2 μin)	30 μm (1.2 μin)

ZW250	Lift Arm (Left/Right)	Bucket	Steering
Rod Diameter	85 mm (3.35”)	100 mm (3.94”)	45 mm (1.77”)
Cylinder Bore	130 mm (5.12”)	165 mm (6.5”)	70 mm (2.76”)
Stroke	940 mm (37.01”)	530 mm (20.87”)	542 mm (21.34”)
Fully Retracted Length	1481 mm (58.31”)	1090 mm (42.91”)	900 mm (35.43”)
Plating Thickness	30 μm (1.2 μin)	30 μm (1.2 μin)	30 μm (1.2 μin)

ELECTRIC COMPONENT

ENGINE OIL PRESSURE SENSOR

Operation Pressure .... 29.4 kPa (0.3 kgf/cm^2)

OVER HEAT SWITCH

Operation Temperature .... 105±2 ° C (221±2 °F)

COOLANT TEMPERATURE SENSOR
(For Coolant Temperature Gauge)

Operation Temperature .... 25 to 120 °C (77 to 248 °F)

AIR FILTER RESTRICTION SWITCH

Operation Pressure .... 6.3±0.6 kPa (635±58 mmH_2O)

FUEL LEVEL SENSOR

Resistance Value...................................... Empty: $90^{+10}_{0}\,\Omega$, Full: $10^{0}_{-4}\,\Omega$

ENGINE OIL TEMPERATURE SENSOR

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

BATTERY RELAY

Voltage/Current .... 24 V·100 A

GLOW RELAY

Voltage.. 24 V

SAFETY RELAY

Voltage.. 24 V

HORN

Voltage/Current .... 24 V·3.0±0.5 A
Sound Pressure.. 113±5 dB (A) @ 2 m (6’ 7”)

ILLUMINATION

Work Light	: Halogen 24 V, 55/70 W
Cab Light	: 24 V, 10 W
Head Light	: Halogen 24 V、75/70 W
Turn Signal Light	: Front : 24 V, 25 W
	:Rear : 24 V, 21 W
Clearance Light	: 24 V, 5 W
License Light	: 24 V, 12 W
Reverse Light	: 24 V, 21 W
Tail Light	: 24 V, 5 W
Brake Light	: 24 V, 21 W

AIR CONDITIONER

Refrigerant	134a
Cooling Ability	4.65 kW (16.74 MJ, 3999 kcal) or more
Cool Air Volume	550 m^3/h or more
Heating Ability	5.81 kW (20.92 MJ, 4997 kcal) or more
Warm Air Volume	400 m^3/h or more
Temperature Adjusting System	Electronic Type
Refrigerant Quantity	1050±50 g
Compressor Oil Quantity	160 cm^3

EMERGENCY STEERING PUMP UNIT

Type	Electric Motor Operated Type
Maximum Flow	17 L/min (4.49 gpm) @10.3 MPa (105 kgf/cm^2)

ELECTRIC MOTOR

Voltage	24 V, 2.4 kW

MEMO

MEMO

SECTION 2

SYSTEM

—CONTENTS—

Group 1 Control System

Group 2 ECM System

Group 3 Hydraulic System

Group 4 Electrical System

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GENERAL

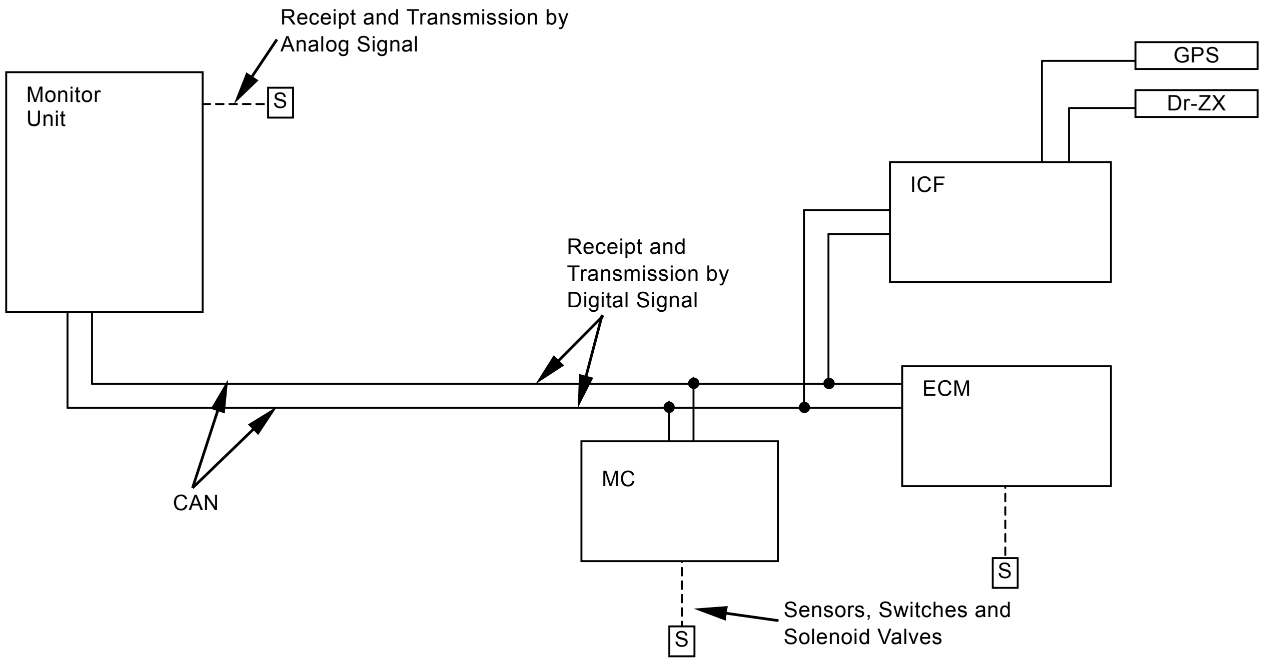
There are four controllers as shown below with MC – Main Controller – installed at their center.

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

Controllers are mutually connected through CAN, and each controller uploads analog signals detected by sensors and switches as well as analog output signals of solenoid valves on the CAN by converting them into digital ones.
As the signals are processed into the digital ones, a large amount of signals detected at each controller can be transmitted through few wires in a shirt time.

MC, ECM, and monitor unit display indications on monitors and make various controls of the vehicle body by using analog signals received by each controller as well as digital signals detected on the CAN.

ICF stores machine history, receives digital signals for various adjustments from Dr-ZX, transmits them to the CAN, and transmits the vehicle body signal (digital signal) received by each controller to Dr-ZX.
A GPS-provision (optional) vehicle makes location arithmetic operation, utilising signals received by artificial sattelites, and transmits body information to the e-service host computer through artificial satellites. (Refer to the TROUBLESHOOTING/ICF)



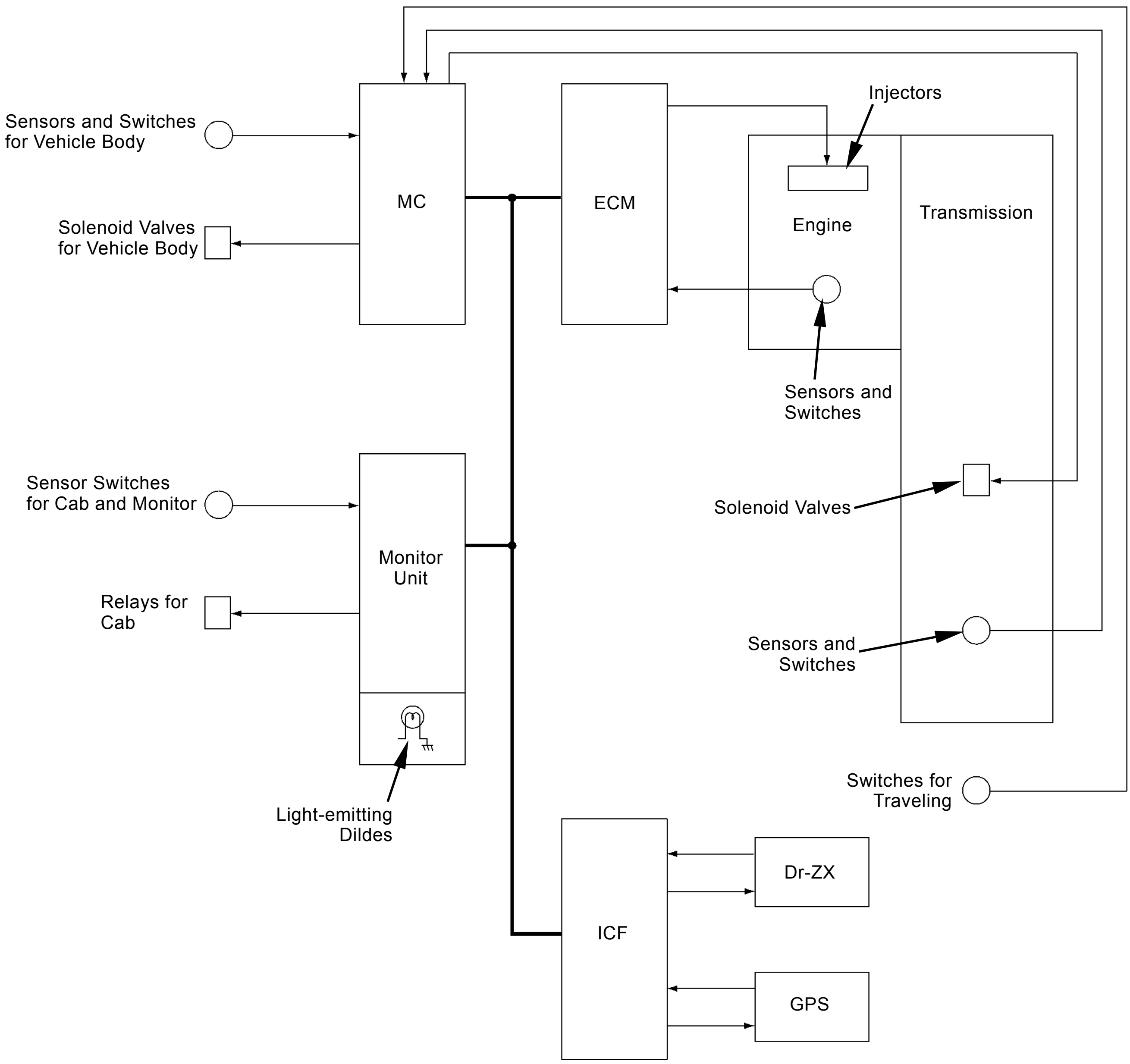
MC, ECM, and Monitor Unit are used for various operation controls of the body.

- Analog input signals from sensors and switches attached to devices other than the engine and monitor unit as well as analog output signals from solenoid valves are transmitted into the MC, and converted into digital signals to be uploaded on the CAN.
- Analog input signals from sensors attached to the engine are transmitted to the ECM, and converted into digital signals to be uploaded on the CAN.
- Analog input signals from cabin, and analog input signals from sensors and switches necessary for indication of the monitor are transmitted into the monitor unit, and converted into digital signals to be uploaded on the CAN.

Each controller detects lacking information necessary for the control program from among the CAN data. (digital signals)

Each controller makes various control program arithmetic operations using the detected data (digital signals), outputs actuation signals to the solenoid valves unit and torque control solenoid valve, and controls the pump, engine, transmission, and valves.

Analog signals from various sensors, switches, and solenoid valves are periodically transmitted into each controller, and converted into digital signals to be uploaded on the CAN.
By repeating the above operations, the vehicle body movement is watched and controlled.



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Sensors and switches to detect signals for various operation controls and their controllers are as shown below.

Input Signals

- Accelerator Pedal Sensor →
- Driving Mode Switch →
- Work Mode Selector Switch →
- Fan Reversing Switch →
- Ride Control Switch →
- Parking Brake Pressure Sensor →
- Pump Delivery Pressure Switch →
- Imprement Pressure Sensor →
- Hydraulic Oil Temperature sensor →
- Clutch Cut Position Sensor →
- Lift Arm Kick-out Switch →
- Lift Arm Angle Sensor (OP) →
- Lift Arm Auto-leveler Upwards Set Switch (OP) →
- Lift Arm Auto-leveler Downwards Set Switch (OP) →
-

MC

CAN

(See next chart)

Output Signals

Engine Control

→Accelerator Pedal Control

→Automatic Warming Up Control

→Engine Torque Control

Pump Control

→Standard Torque Control

→Torque Reduction Control

Other Controls

→Hydraulic Fan Cooling Control

→Hydraulic Fan Cleaning Control

→Transmission Alarm Control

→Forward/Reverse Indicator Control

→Reverse Traveling Alarm Control

→Parking Brake Alarm Control

Control by Electric and Hydraulic Combined Circuit

→*Ride Control

Bucket Auto-leveler Control

Lift Arm Float Control

→Lift Arm Kick-out Control

→*Lift Arm Auto-leveler Upward Control

→*Lift Arm Auto-leveler Downward Control

NOTE: OP : Stands for optional.

** : Controls for optional parts provision machines only*

Input Signal

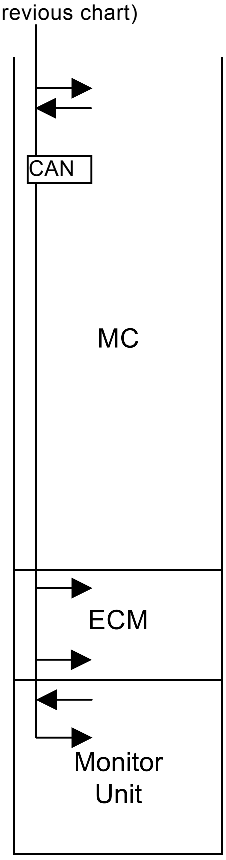
(See previous chart)

Output Signal

- Forward/Reverse Lever →
- Shift Switch →
- Down Shift Switch →
- Up Shift Switch →
- Hold Switch →
- Forward/Reverse Selector Switch →
- Forward/Reverse Switch →
- Brake Pressure Sensor →
- Torque Converter Input Speed Sensor →
- Torque Converter Output Speed Sensor →
- Transmission Middle Shaft Sensor →
- Vehicle Speed Sensor →

(Refer to the SYSTEM/ECM System) →

- Engine Coolant Temperature Sensor →
- Torque Converter Oil Temeperature Sensor →



Transmission control

→Neutral Control
→Forward/Reverse Lever Priority Control
→Forward/Reverse Selector Control While Traveling
→Manual Speed Shift Control
→Automatic Speed Shift Control
→Down Shift Control
→Up Shift Control
→Clutch Cut Control
→Shift Holding Control

→(Refer to the SYSTEM/ECM System)

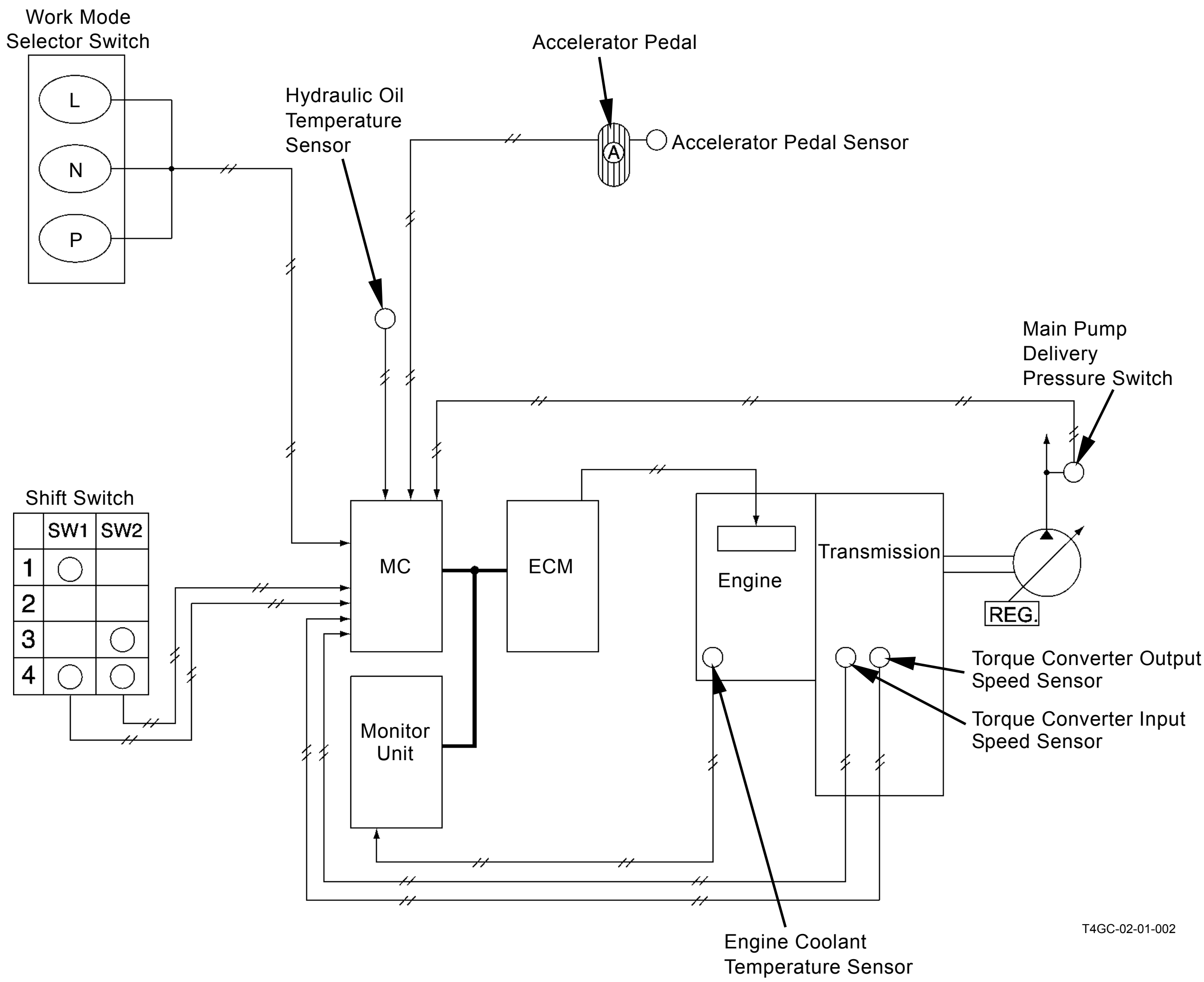
NOTE: ECM controls the engine speed and others based on the target engine speed transmitted from the MC and the converted signal of the torque curve, and on the signals detected by the sensors installed at the engine. For details, refer to the SYSTEM/ECM System.

ENGINE CONTROL

Following engine controls are made.

- Accelerator pedal Control
- Automatic warming up control
- Engine torque control

Engine Control System Layout



Accelerator Pedal Control

Purpose: Control of the engine speed in response to stepping amount of accelerator

Operation:

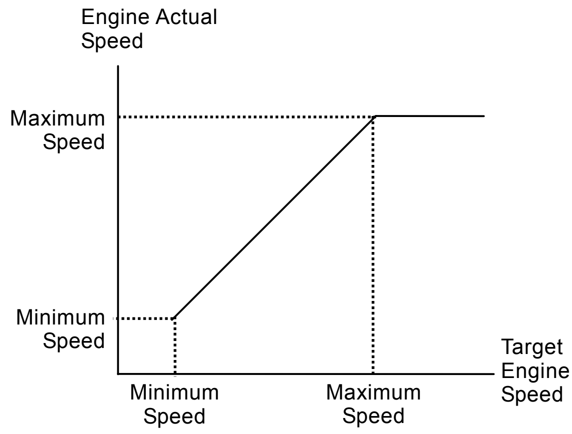
1. MC converts the input value into the target engine speed, and transmits it to the ECM.
2. ECM controls the engine speed in response to the target engine speed.

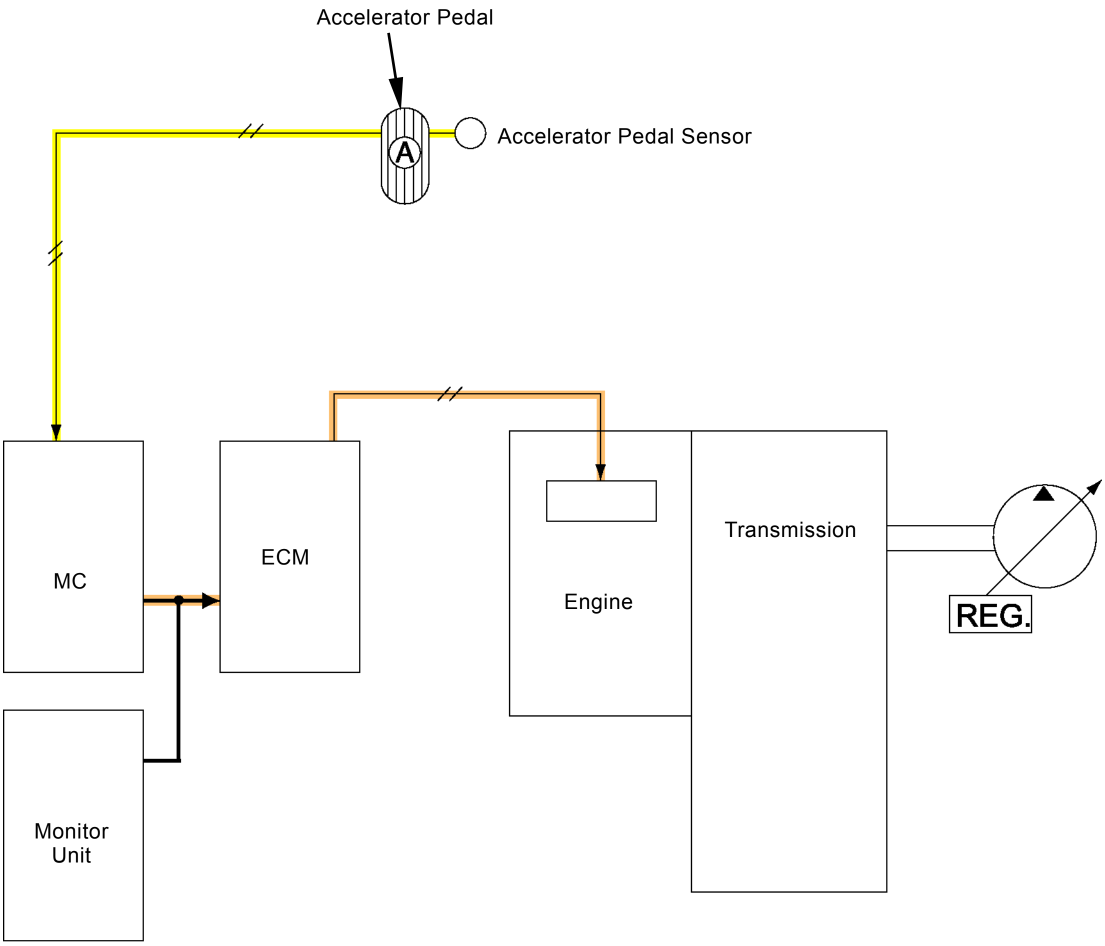
NOTE: Output value of the accelerator pedal sensor is 0.5 V – 4.5 V.

NOTE: In case the accelerator pedal sensor becomes abnormal, the MC makes back-up control, and the engine speed is fixed at about 1000 min^{-1}.

NOTE: In case the MC becomes out of order, or the CAN fails, the ECM makes back-up control, and the engine speed is fixed at about 1000 min^{-1}.

NOTE: In case the MC becomes out of order with the accelerator remaining normal, control of the engine speed is possible by connecting the accelerator pedal sensor wires directly to the ECM.





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Automatic Warming Up Control

Purpose: Automatic warming up of the engine in response to the hydraulic oil temperature

Operation:

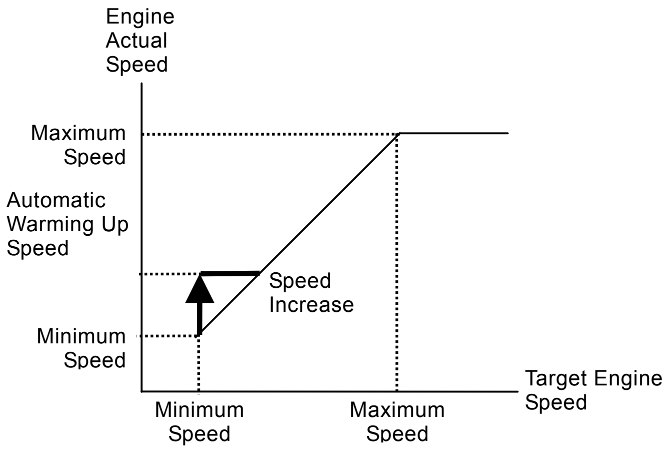
1. At start of the engine, if the hydraulic oil temperature is 0°C (32°F) or below, the MC transmits signal to the ECM for setting the engine minimum speed at 1000 min^{-1}.
2. ECM increases the minimum engine speed to 1000 min-1.
3. When the engine coolant temperature or hydraulic oil temperature is 40°C (104°F) or above, or when 10 minutes have passed, the MC stops signals, and the ECM decreases the engine minimum speed to the idling value.

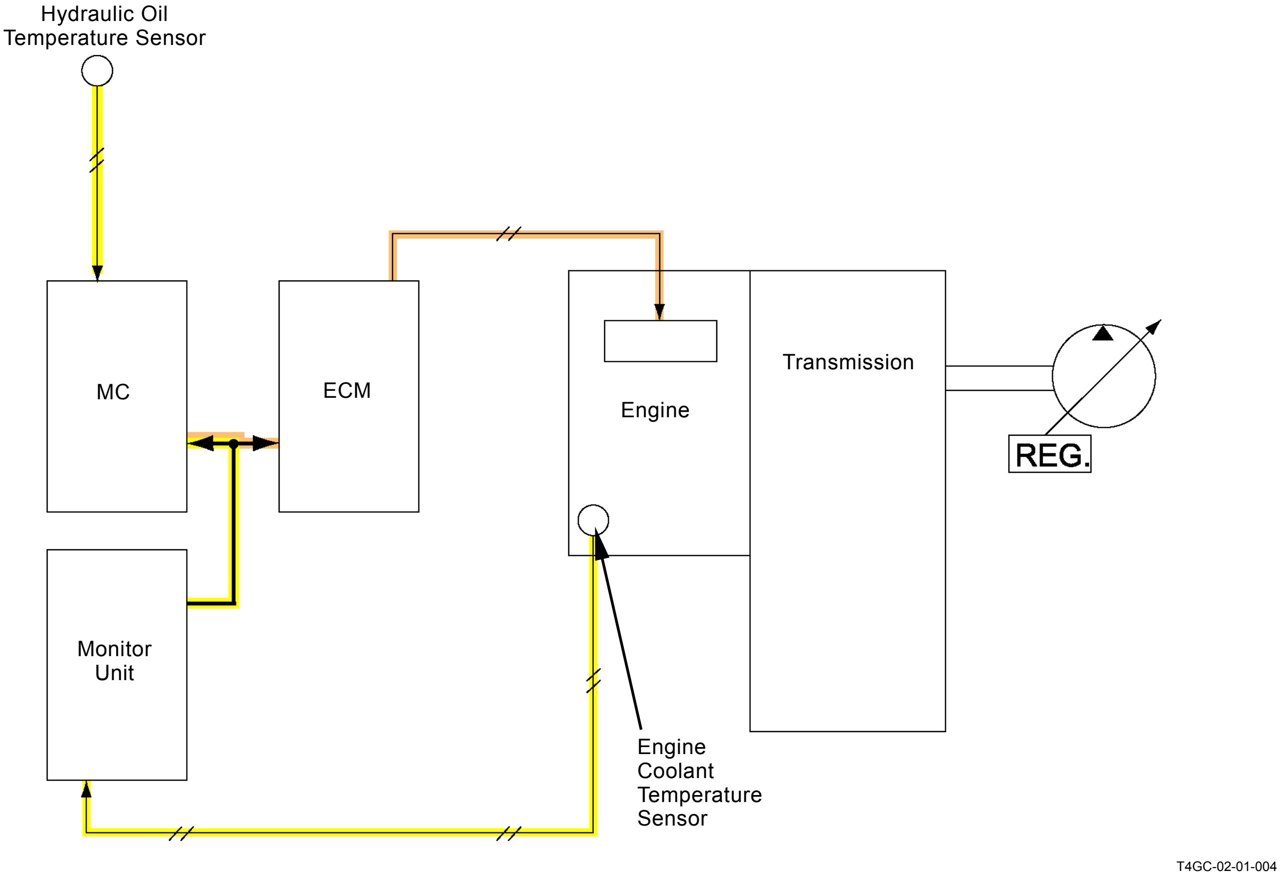
NOTE: *At start of the engine, if the hydraulic oil temperature is 1°C (34°F) or above, automatic warming up control is not made.*

NOTE: *In case the hydraulic oil temperature sensor becomes abnormal, automatic warming up control is not made.*

NOTE: *When the parking brake switch is turned OFF, automatic warming up control is released.*

NOTE: *In case automatic warming up control is released by Dr. ZX, retrieve the automatic warming up control effective by Dr. ZX the moment releasing becomes unnecessary. (Retrieving is impossible by just turning the key switch OFF.)*



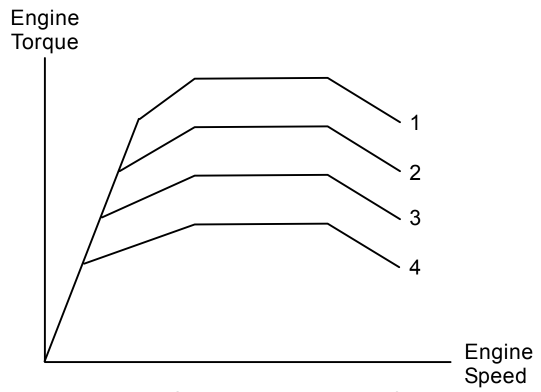

Hydraulic Oil Temperature Sensor
MC
ECM
Engine
Transmission
REG.
Monitor Unit
Engine Coolant Temperature Sensor
T4GC-02-01-004

Engine Torque Control

Purpose: Improving fuel consumption rate by changing the torque curve in response to input signals from the work mode selector switch, shift switch, and vehicle speed sensor

Operation:

1. When the signal of the selected work mode is transmitted to the MC, it detects signals from the main pump delivery pressure switch, shift switch, torque converter input speed sensor, and torque converter output speed sensor.
2. MC has programmed torque curves to be selected in response to the combination of work mode, speed shift, torque converter speed ratio, and pump delivery pressure, and outputs to the ECM the selection command signal most suitable to each time.
   - When the light mode (L) is selected, Torque Curve 4 or 3 is primarily used, which is advantageous in making much of low fuel consumption at light-load work.
   - When normal mode (N) is selected, Torque Curve 3 or 2 is primarily used, which is advantageous in making much of production as well as low fuel consumption.
   - When the power mode (P) is selected, Torque Curve 1 or 2 is primarily used, which is advantageous in making much of production mainly as well as low fuel consumption slightly.
3. ECM controls torque curves in response to the inputted torque curve selection command signal.



Conceptual Diagram of Engine Torque Curve

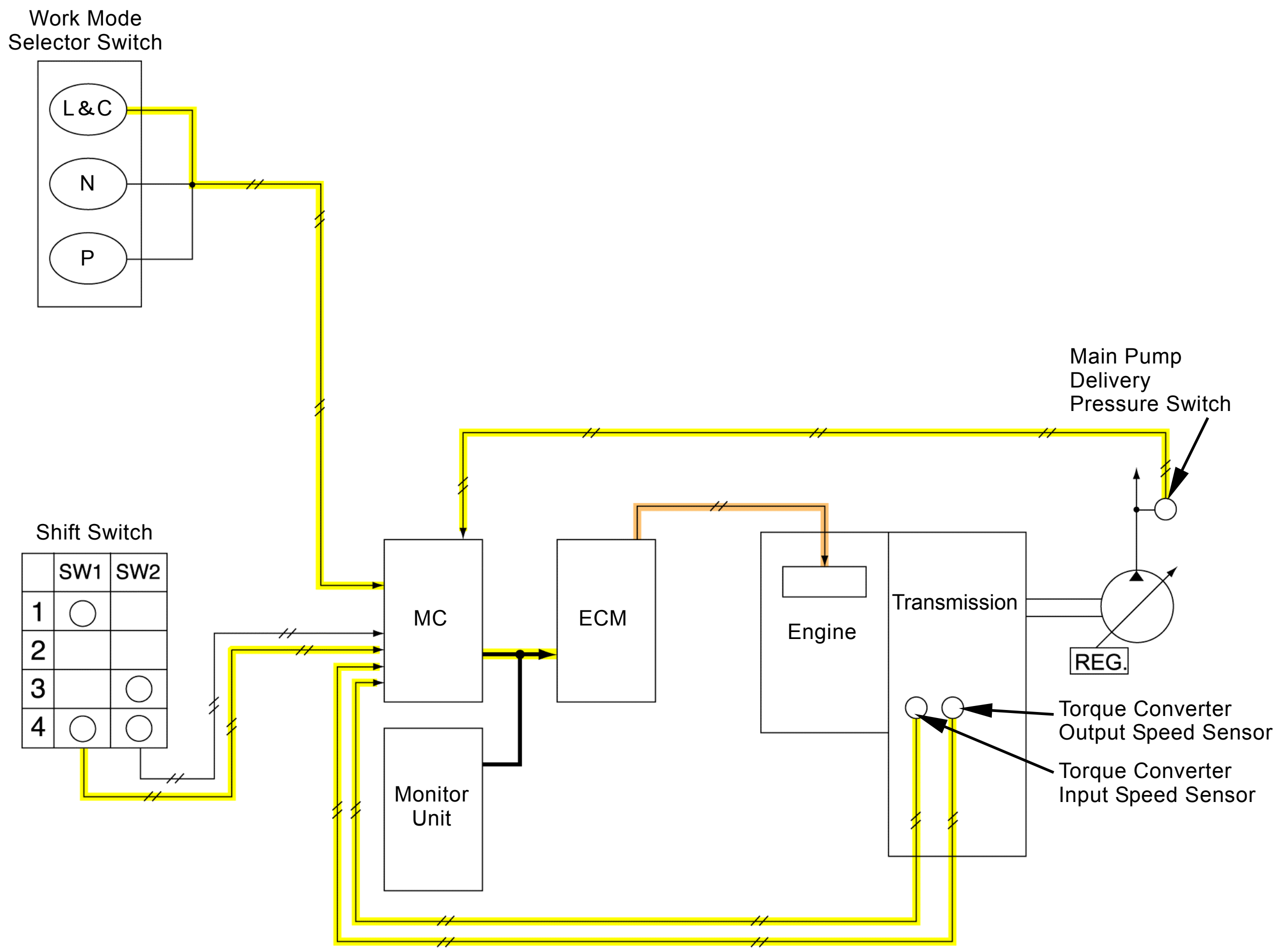
NOTE: *In case the signal from the work mode selector switch is not transmitted to the MC, back-up control of fixing the work mode to the normal mode is made.*

NOTE: *In case the signal from the torque converter input speed sensor or the torque converter output sensor is not transmitted to the MC, engine torque control is made by setting the vehicle speed at the back-up speed.*

NOTE: *In case the signal from the shift switch is not transmitted to the MC, back-up control of fixing to Torque Curve 2 is made.*

NOTE: *Each mode switch of the mode selector switch is supplied with respectively different voltages from the monitor unit, and when the switch selects a mode, the MC judges which mode has been selected by the input voltage.*

NOTE: *Shift switch has two switches, and the combination of their ON varies depending on each speed shift. Controller judges which speed shift has been selected by the combination of the two input signals.*



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NOTE: Illustration shows flow of the signal in case the light mode of the work mode selector switch and Speed 1 of the speed shift switch have been selected.

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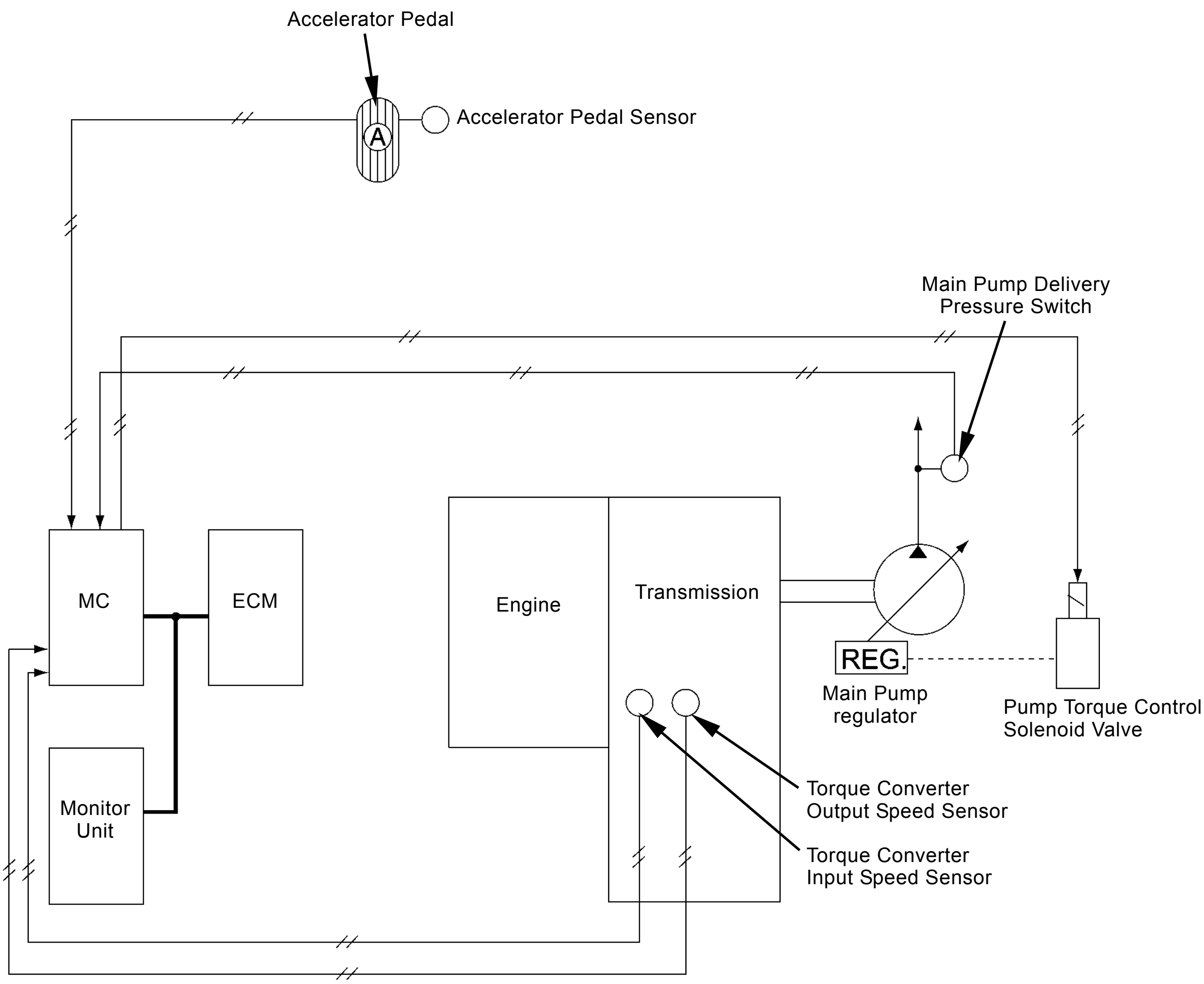
PUMP CONTROL

Following pump controls are made.

- Standard Torque Control
- Torque Reduction Control

Pump Control System Layout



T4GC-02-01-006

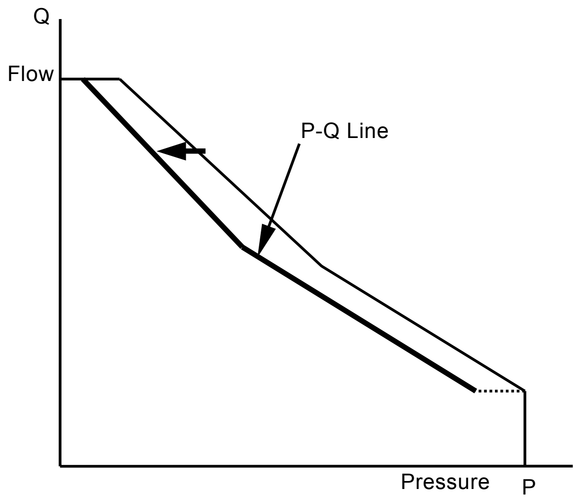
Standard Torque Control

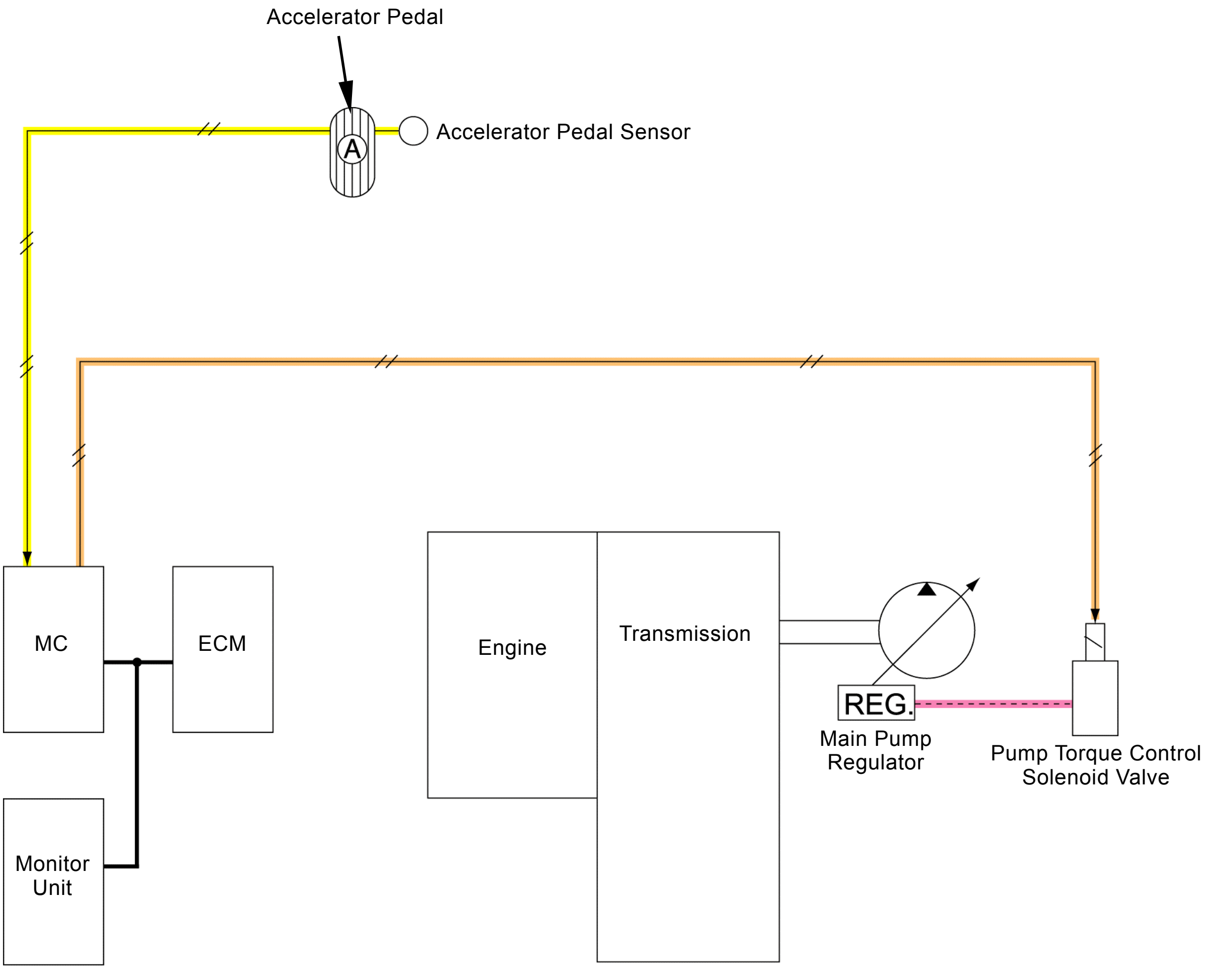
Purpose: Effectively utilizing engine horsepower by changing pump flow in response to increase or decrease of engine speed

Operation:

1. When accelerator pedal is stepped, MC makes arithmetic operation of the target engine speed.
2. MC makes arithmetic operation of the pump maximum tilting angle by receiving the target engine speed signal, and transmits signal to the pump torque control solenoid valve.
3. Pump torque control solenoid valve transmits pilot pressure corresponding to the amplitude of signal to the main pump regulator, and controls the pump flow rate.

NOTE: In case the pump torque control solenoid valve becomes abnormal, standard-torque control is not made.





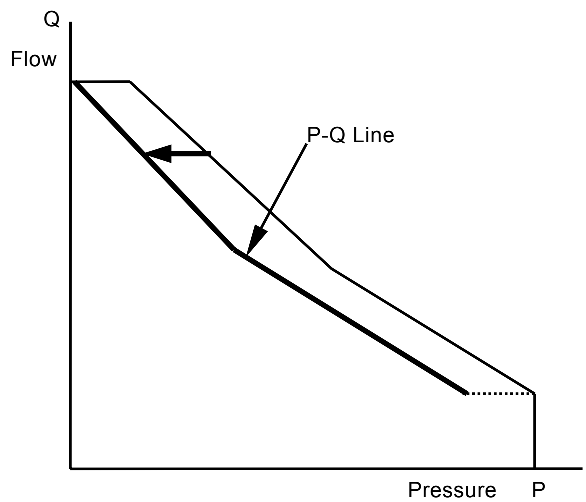
T4GC-02-01-007

Torque Reduction Control

Purpose: Effectively utilizing engine horsepower by changing pump flow in response to increase or decrease of the engine speed due to traveling load

Operation:

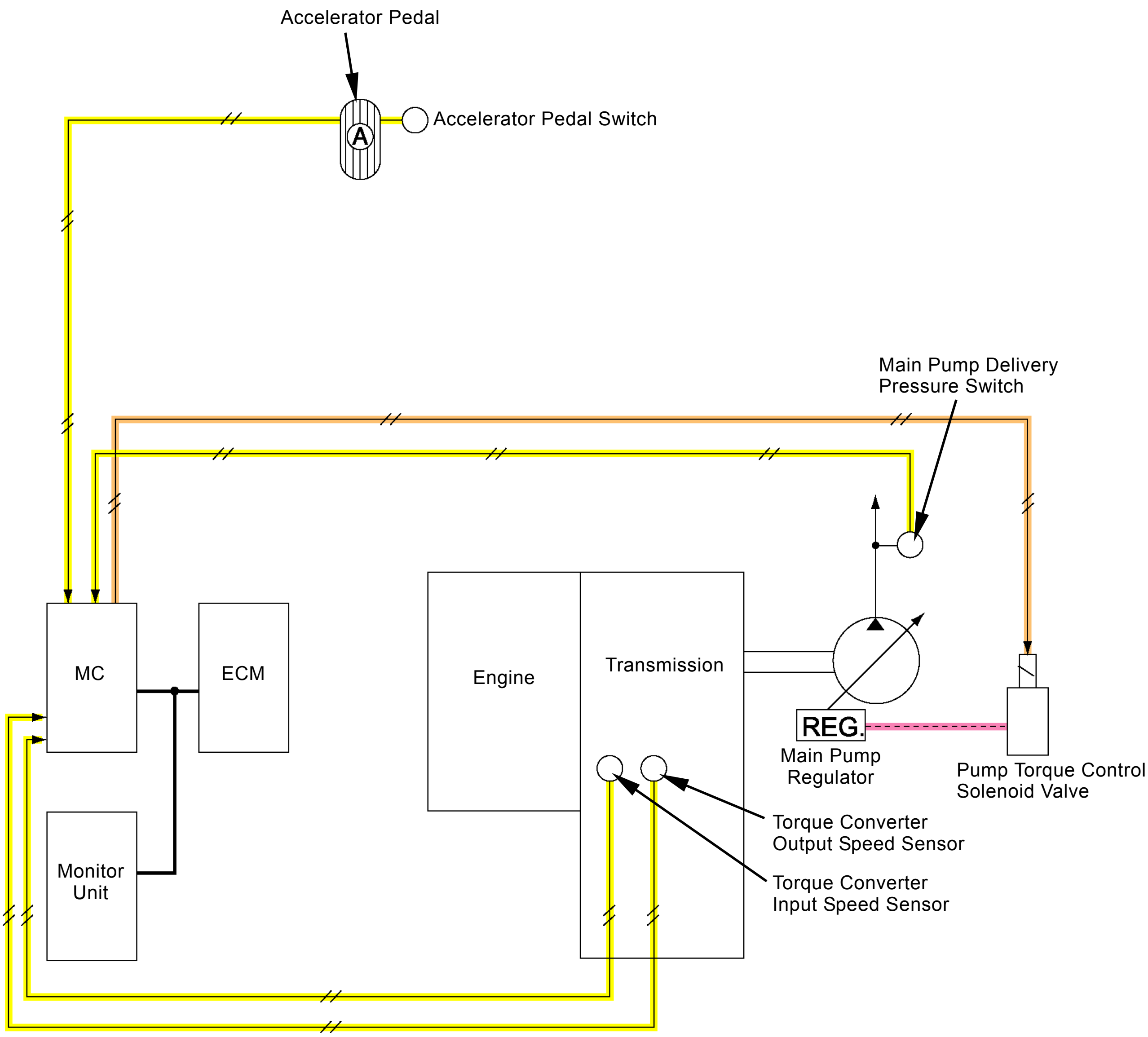
1. When accelerator pedal is stepped, MC makes arithmetic operation of the target engine speed.
2. MC makes arithmetic operation, using the target engine speed and signals from the main pump delivery pressure switch, torque converter input speed sensor, and torque converter output speed sensor, and figures out the pump maximum tilting angle most suitable to each time to transmit it to the pump torque control solenoid valve.
3. Pump torque control solenoid valve transmits pilot pressure corresponding to the amplitude of signal to the main pump regulator, and controls the pump flow rate.
4. If load applied to the engine becomes large and decreases the actual engine speed than the target speed, the pump tilting angle is decreased to reduce delivery flow. Thus, maneuverability of the vehicle body is improved.
5. MC makes arithmetic operation of the actual engine speed, receiving signal from the torque converter input speed sensor.



NOTE: *In case the accelerator pedal becomes abnormal, the back-up control of the accelerator controls and fixes the engine speed at 1000 min^{-1}.*

NOTE: *In case signal from either the main pump delivery pressure switch, torque converter input speed sensor, or torque converter output speed sensor is not transmitted to the MC, it does not make torque reduction control, but makes pump control by the standard-torque control.*

NOTE: *In case the pump torque control solenoid valve becomes abnormal, neither standard-torque control nor torque reduction control is made.*



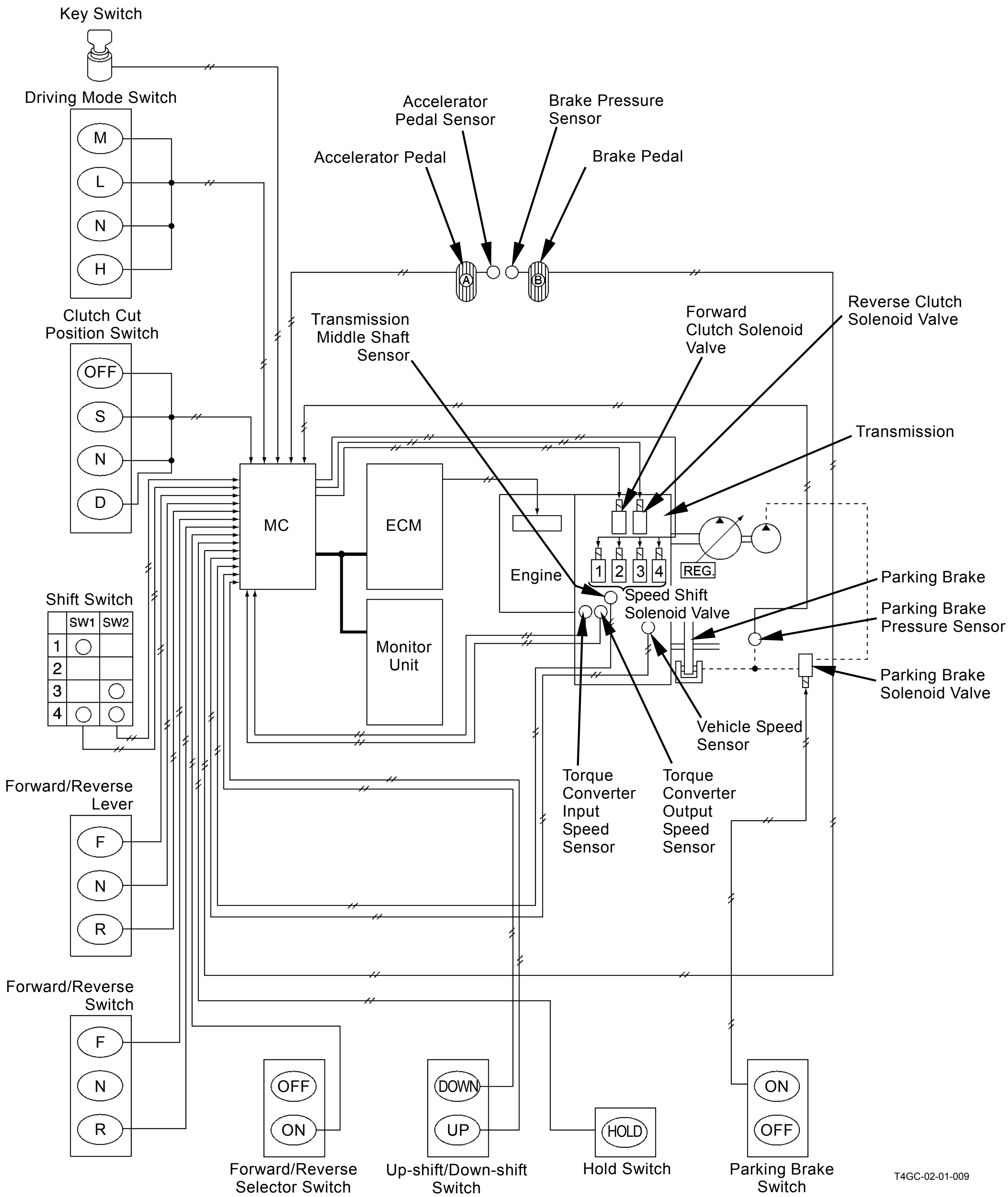
T4GC-02-01-008

TRANSMISSION CONTROL

Following transmission controls are made.

- Neutral Control
- Forward/Reverse Lever Priority Control
- Forward/Reverse Selector Control While Traveling
- Manual Speed Shift Control
- Automatic Speed Shift Control
- Down Shift Control
- Up Shift Contrl
- Clutch Cut Control
- Shift Holding Control

Transmission Control System Layout



T4GC-02-01-009

Neutral Control

Purpose: Protection of transmission during working of parking brake by restricting clutch connection despite operation of forward/reverse lever or forward/reverse switch

Operation:

1. In case either of the signal from forward/reverse lever, forward signal or reverse signal of the forward/*reverse* switch is transmitted to the MC, the MC confirms the detected value of the parking brake pressure sensor.
2. When the parking brake pressure is higher than the set pressure, the MC transmits signal to the clutch solenoid valve, but does not when lower than that.

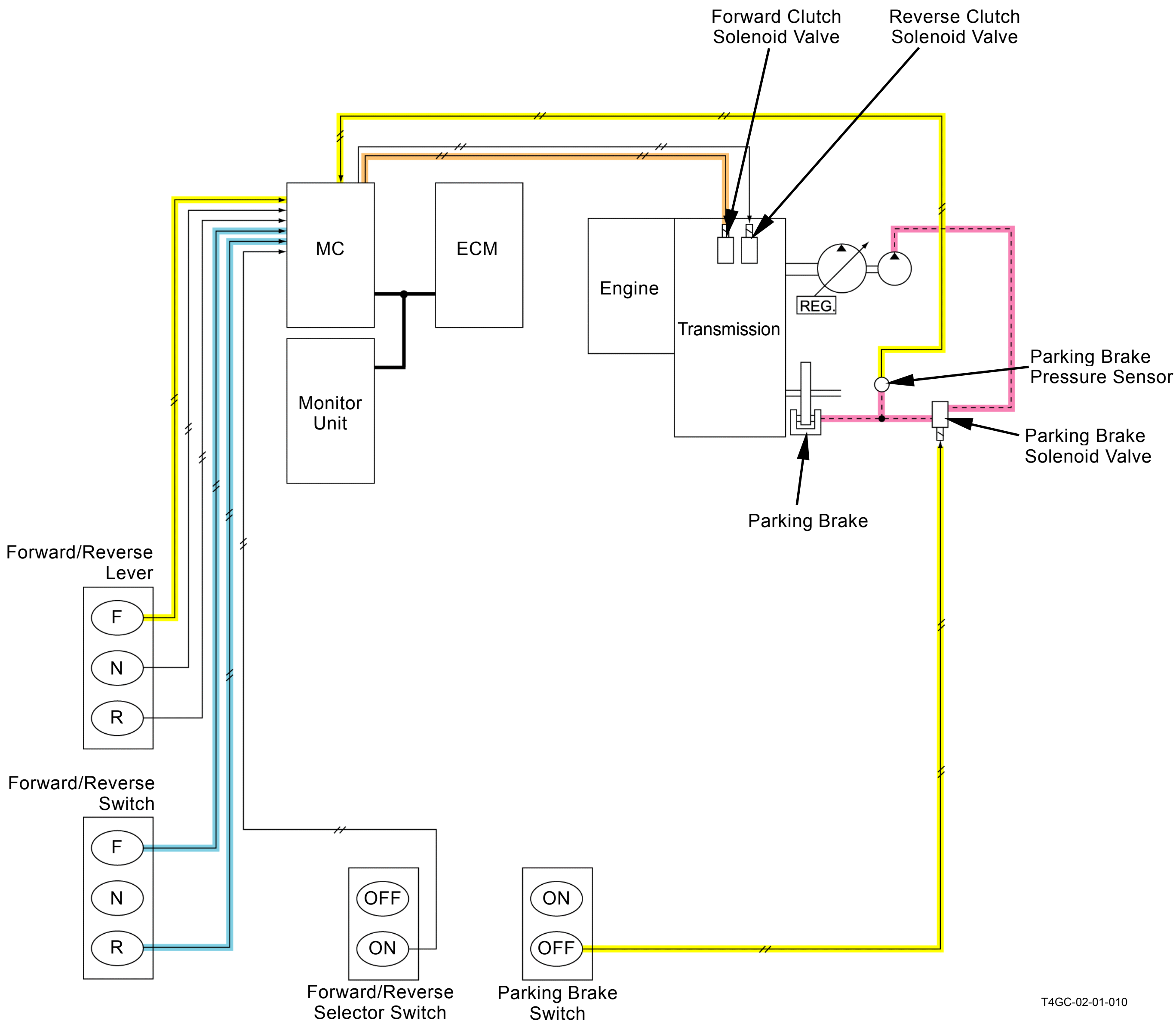
NOTE: When the pilot pressure is transmitted, the parking brake of the vehicle body is released.

*NOTE: In case short-circuiting takes place inside the forward/*reverse *lever, transmission is made neutral forcedly.*

*NOTE: In case electric abnormality takes place involving the forward/*reverse *switch, traveling by the forward/*reverse *lever is possible as an emergency measure.*

NOTE: Forward/reverse switch does not transmit neutral signal. In case of no electric current from the forward/reverse switch, the controller judges the switch as neutral (N).

IMPORTANT: Be careful that in case the parking brake pressure sensor is abnormal, traveling is possible even if the parking brake switch is ON and the parking brake is at work because the parking brake alarm lamp is turned OFF and fixed (release).



NOTE: Illustration shows flow of the signal in case. Forward of the forward/reverse lever have been selected with the parking brake switch turned OFF – transmitting brake release signal.

Forward/Reverse Lever Priority Control

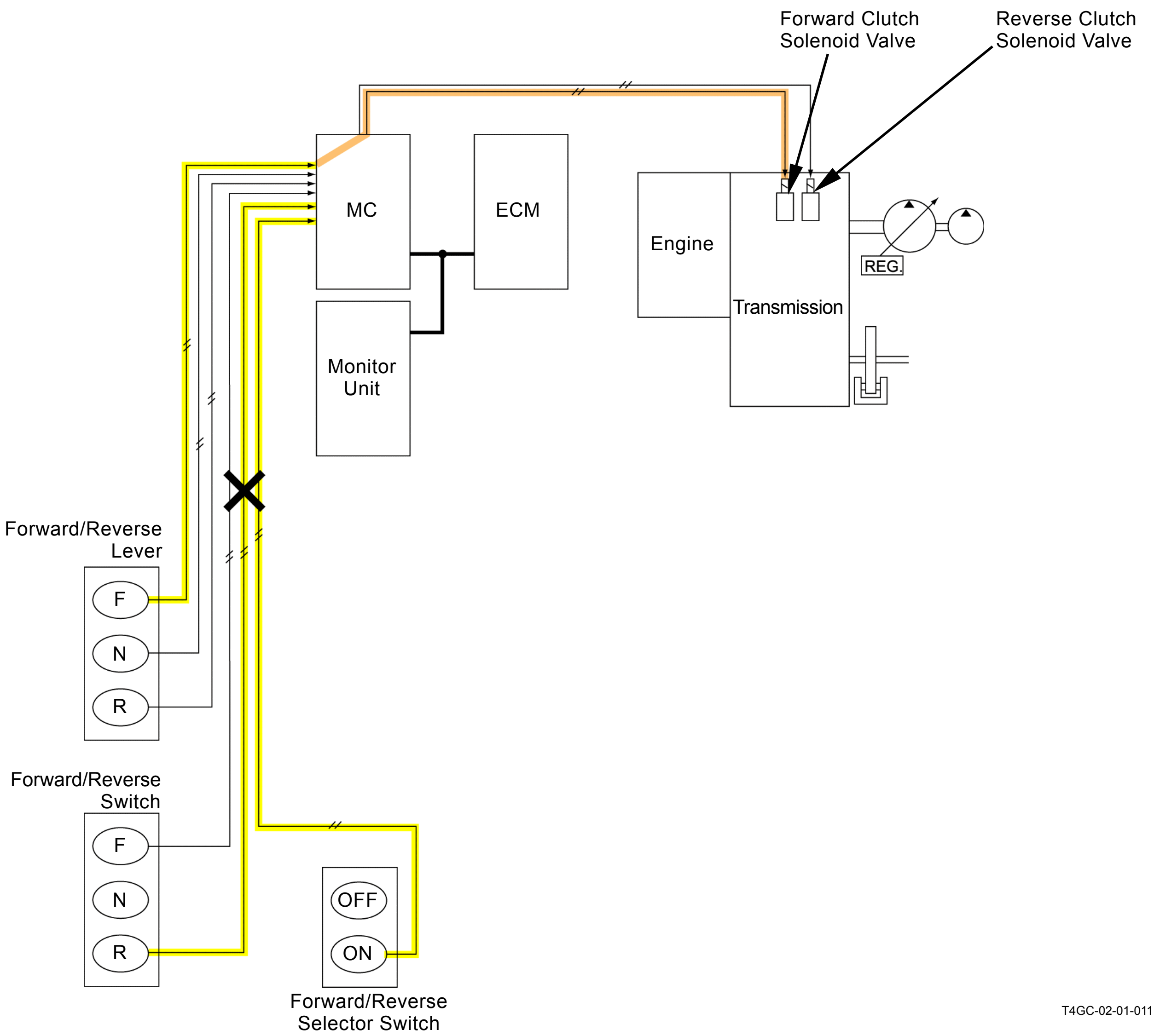
Purpose: Smoothening danger-preventive function in forward/reverse operation by giving priority to signal from forward/reverse lever over signal from forward/reverse switch

Operation:

1. In case the forward/reverse lever is operated while traveling using the forward/reverse switch, the MC disables operation of the forward/reverse switch, and makes forward/reverse control by input signal from the forward/reverse lever.
2. For restarting operation using the forward/reverse switch, have the forward/reverse switch effective again by turning the forward/reverse selector switch ON while making both the forward/reverse lever and the forward/reverse switch at the neutral position.
3. From then on until the forward/reverse lever is operated next, the MC makes forward/reverse control by the forward/reverse switch input signal.

NOTE: In case short-circuiting takes place inside the forward/reverse lever, transmission is made neutral forcedly, and traveling becomes impossible, which requires towing. However, in case the forward/reverse switch is out of order, traveling by the forward/reverse lever is possible as an emergency measure.

NOTE: Forward/reverse switch does not transmit neutral signal. In case of no electric current from the forward/reverse switch, the controller judges the switch as neutral (N).



NOTE: *Illustration shows flow of the signal in case forward of the forward/*reverse *selector lever has been selected while traveling* reverse *of the forward/*reverse *lever.*

Forward/Reverse Selector Control While Traveling

Purpose: Protection of transmission in traveling at set speed and above by preventing forward/reverse selector unless the vehicle speed is lowered than that

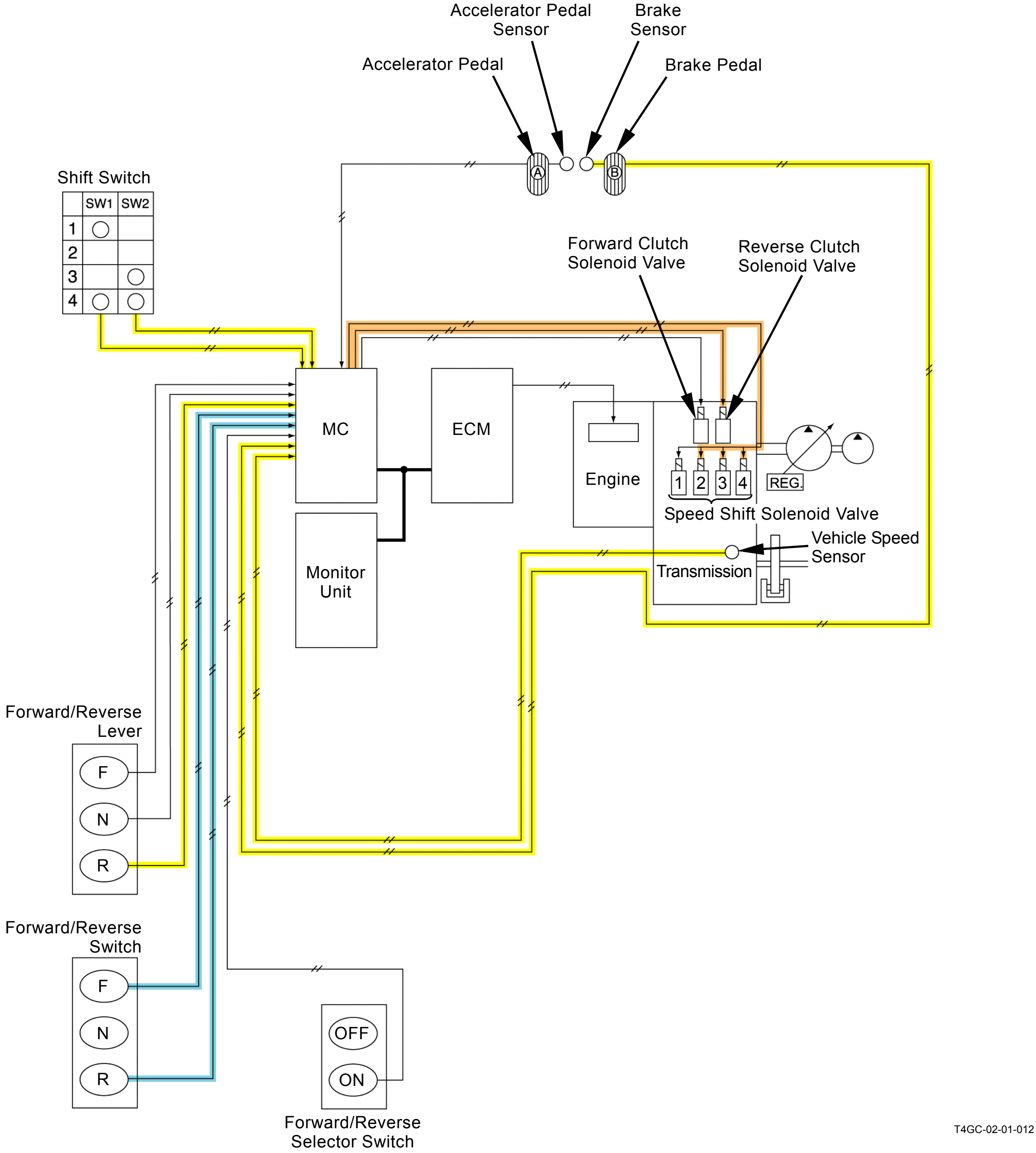
Operation:

1. In case the forward/reverse lever is changed to reverse while traveling forward at speed higher than the speed allowed for operation of the forward/reverse lever, the MC lowers the speed shift by transmitting speed shift signal of Speed 4→3→2 to the transmission if the speed shift is Speed 4.
2. If the vehicle speed is lowered to the set speed by operation of the brake pedal or otherwise, the MC transmits signal to the reverse clutch solenoid valve to have the clutch shifted reverse.
3. As the speed increases when the accelerator pedal is stepped, the MC transmits speed shift signal of Speed 2 to Speed 3 to each speed shift solenoid valve, and increases the speed shift.

NOTE: In case the forward/reverse lever is operated when the vehicle speed is below the value allowed for changeover of the forward/reverse clutch, the forward/reverse clutch is operated regardless of the speed shift.

NOTE: Shift switch has two switches, and the combination of their ON varies depending on each speed shift. Controller judges which speed shift has been selected by the combination of the two input signals.

NOTE: Forward/reverse switch does not transmit neutral signal. In case of no electric current from the forward/reverse switch, the controller judges the switch as neutral (N).



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*NOTE: Illustration shows flow of the signal in case reverse of the forward/*reverse *lever has been selected and the brake pedal has been stepped while traveling forward at Speed 4 above the value allowable for selection of the forward/reverse clutch.*

Manual Speed Shift Control

Purpose: Making speed shift manually

Operation:

1. When manual (M) of the Driving mode switch is selected, the MC is provided with voltage of 1V.
2. Manual speed shift program is started in the MC.
3. Shift switch is the rorary type, and has two switches inside. When the speed shift is selected from among Speed 1 through Speed 4, signal of the selected speed shift is transmitted to the MC depending on the combination of ON inside the speed shift switch.

Speed Shift	Speed 1	Speed 2	Speed 3	Speed 4
Internal Switch 1	ON			ON
Internal Switch 2			ON	ON

4. MC transmits signal to the solenoid valve of the selected speed shift.
5. If forward or *reverse* of the forward/*reverse* lever or the forward/*reverse* switch is selected, traveling is started when the accelerator pedal is stepped.
6. When the vehicle speed reaches the set speed change to the selected speed shift, the MC transmits signal to the solenoid valve of the selected speed shift.

NOTE: *MC is so programmed as to dtermine necessary vehicle speed ranges for changing to the respective speed shifts.*

NOTE: *In case speed shift from Speed 3 to Speed 1 is attempted while traveling by operating the speed shift switch, Speed 2 is automatically selected first, and Speed 1 is reached after the vehicle speed is lowered to the speed range for Speed 1.*

NOTE: *In case the solenoid valve of either of the Speed 1, Speed 3, or Speed 4 becomes abnormal, the travel speed will be fixed to Speed 2. In case either of the forward clutch solenoid valve, reverse clutch solenoid valve, or Speed 2 solenoid valve becomes abnormal, only the abnormal one cannot be used.*

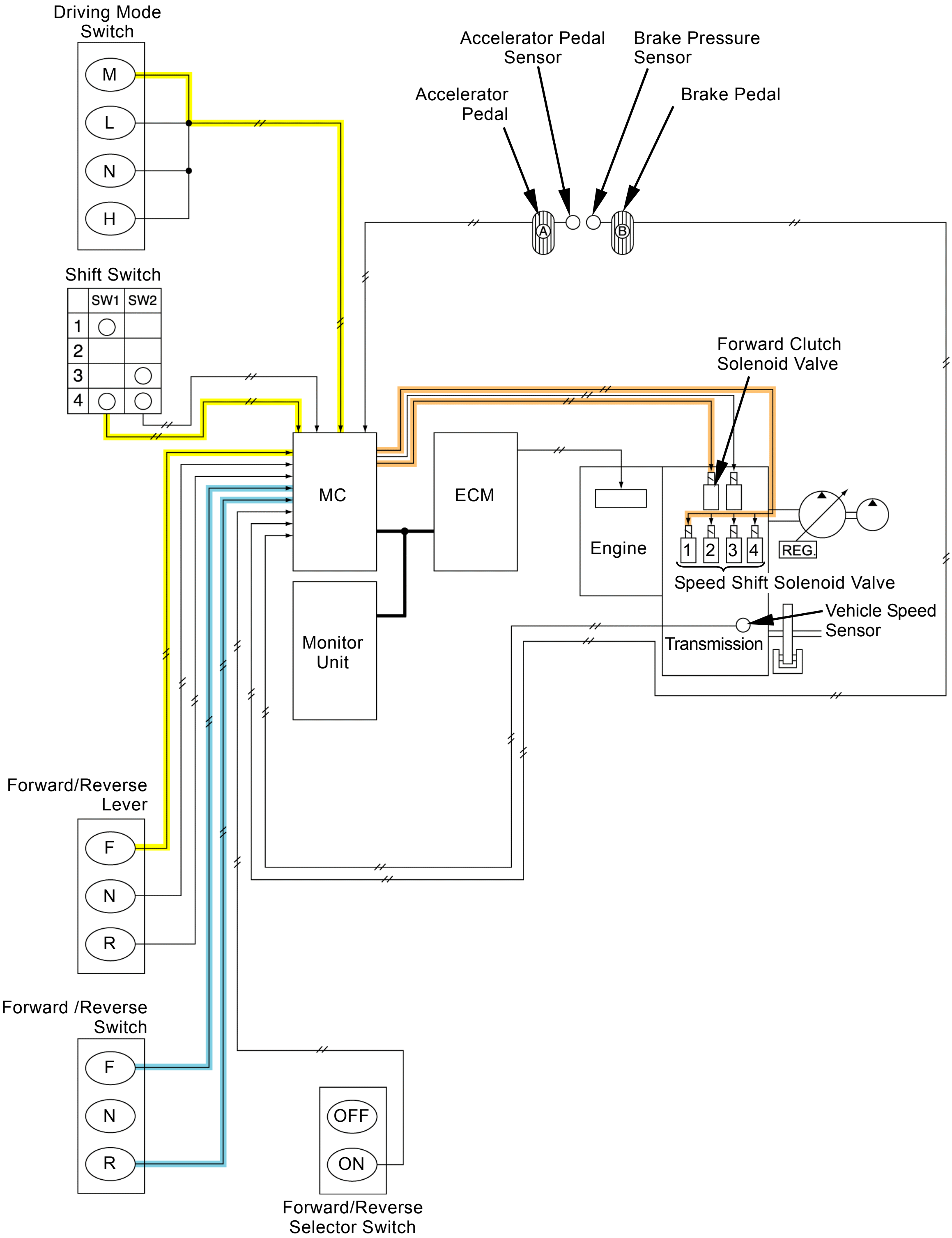
NOTE: *In case speed shift is raised, the selected speed shift is immediately obtained regardless of the vehicle speed.*

NOTE: *Shift switch has two switches, and the combination of their ON varies depending on each speed shift. Controller judges which speed shift has been selected by the combination of the two input signals.*

NOTE: *Forward/reverse switch does not transmit neutral signal. In case of no electric current from the forward/reverse switch, the controller judges the switch as neutral (N).*

NOTE: *Each mode switch of the driving mode switch is supplied with respectively different voltages from the monitor unit, and if a switch is selected, the MC judges which mode has been selected.*

NOTE: *Speed shift selected by the speed shift switch is the highest speed shift.*



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NOTE: *Illustration shows flow of the signal in case forward of the forward/*reverse *lever has been selected when manual of the Driving Mode switch and Speed 1 of the speed shift switch have been selected.*

Automatic Speed Shift Control

Purpose: Automatically changing speed shift with three kinds of timing selection of automatic speed shift change

Operation:

1. If either of L, N, and H of the Driving Mode switch is selected, the MC is supplied with votage corresponding to the selected mode.

Mode	Automatic L	Automatic N	Automatic H
Output Voltage	2 V	3 V	4 V

2. MC started the selected automatic speed shift program.

- In Automatic L control, the timing of speed shifting up is slow when started at Speed 2, which is advantageous in making much of low fuel consumption.
- In Automatic N control, the timing of speed shifting up is fast when started at Speed 2, which is advantageous in making much of production as well as low fuel consumption.
- In Automatic H control, though started at Speed 2, besides slow speed shifting up, speed shift to Speed 1 is necessary if traveling load is high, which is advantageous in making much of production.

NOTE: *In whichever of Modes L, N, and H, starting is made at Speed 1, if the speed shift switch of Speed 1 is selected.*

3. Shift switch is the rorary type, and has two switches inside. When the speed shift is selected from among Speed 1 through Speed 4, signal of the selected speed shift is transmitted to the MC depending on the combination of ON inside the speed shift switch.

Speed Shift	Speed 1	Speed 2	Speed 3	Speed 4
Internal Switch 1	ON			ON
Internal Switch 2			ON	ON

4. MC transmits signal to the right speed shift solenoid valve in response to the output value each time of the torque converter input speed sensor, torque converter output speed sensor, vehicle speed sensor, and accelerater pedal sensor. MC eventually makes speed shift control until the selected speed shift.

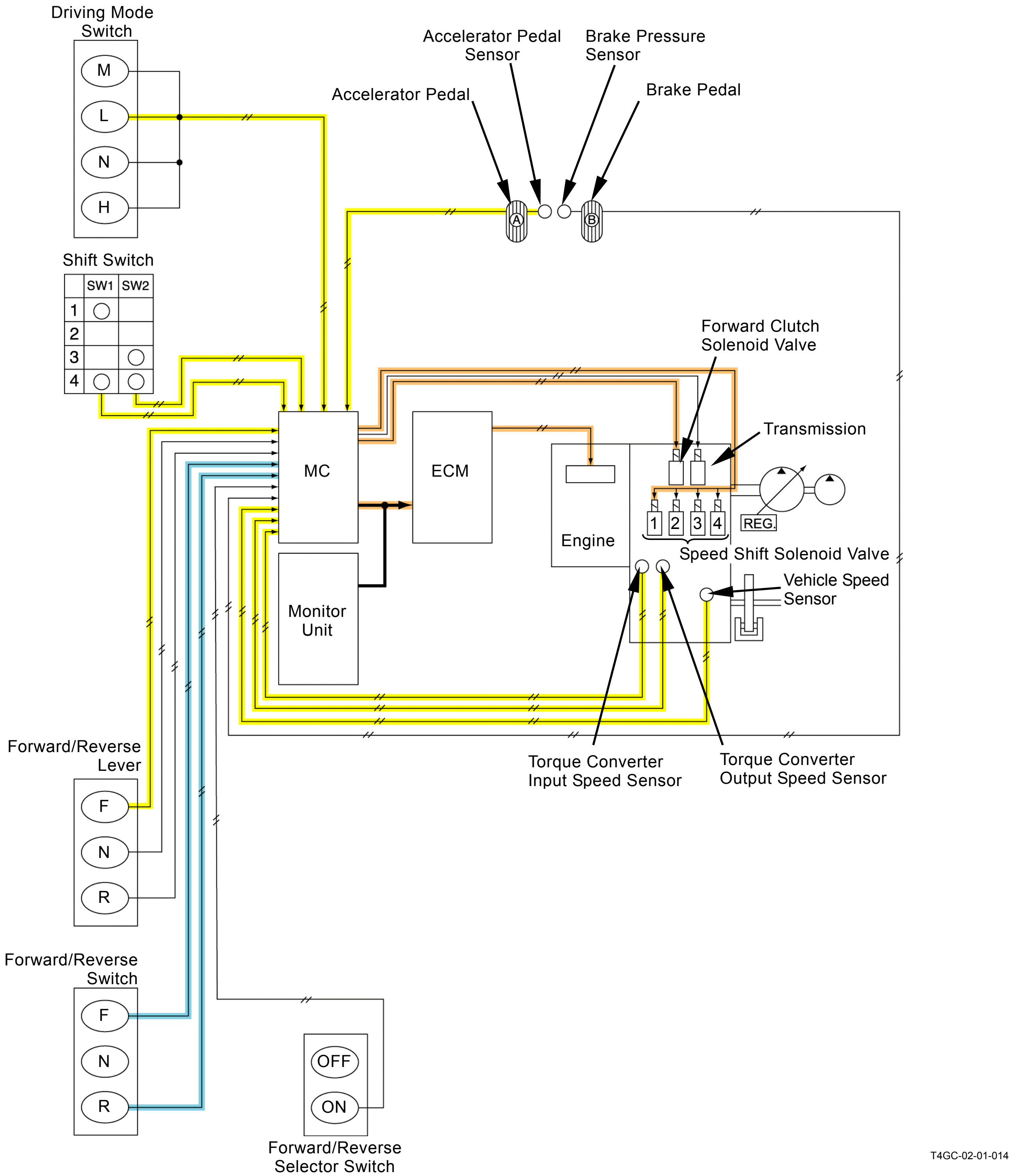
NOTE: *MC is so programmed as to dtermine necessary vehicle speed ranges for changing to the respective speed shifts and accelerator pedal output value. Therefore, in case Automatic L of the Driving mode switch and Speed 3 of the speed shift switch are selected at start of traveling, traveling is started at Speed 2 first, and shifted up to Speed 3 as the vehicle speed increases. Conversely, in case speed shift from Speed 3 to Speed 1 is attempted while traveling by operating the speed shift switch, Speed 2 is automatically selected first, and Speed 1 is reached after the vehicle speed is lowered to the speed range for Speed 1.*

NOTE: *In case the Driving mode switch becomes out of order, the MC makes speed shift control in the manual traveling mode.*

NOTE: *In case the solenoid valve of either of the Speed 1, Speed 3, or Speed 4 becomes abnormal, the travel speed will be fixed to Speed 2. In case either of the forward clutch solenoid valve, reverse clutch solenoid valve, or Speed 2 solenoid valve becomes abnormal, only the abnormal one cannot be used.*

NOTE: *In case the travel speed sensor has become abnormal, the travel speed is calculated using the transmission intermediate shaft sensor, but with a large error. In case both of the travel speed sensor and the transmission intermediate shaft sensor have become abnormal, travel at Speed 2 is fixed.*

NOTE: *Speed shift selected by the speed shift switch is the highest speed shift.*



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NOTE: *Illustration shows flow of the signal in case Automatic L mode of the Driving mode switch, Speed 4 of the speed shift switch, and forward of the forward/*reverse *selector lever have been selected, while the brake pedal has been stepped.*

Down Shift Control

Purpose: Decreasing the speed shift by pushing the switch installed at the right console.

Operation:

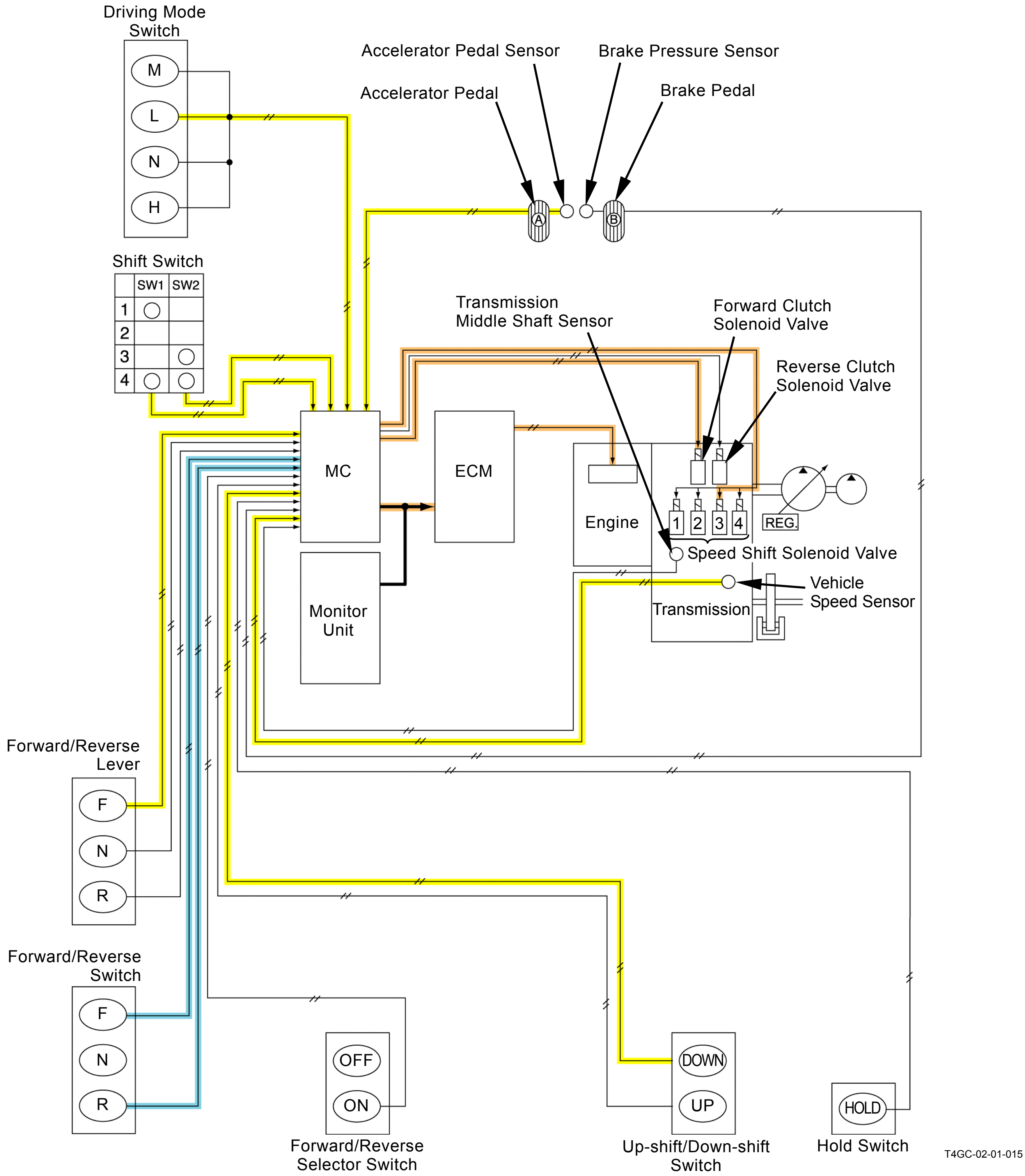
1. When traveling at Speed 4 in Automatic L mode of the Driving mode switch, signal is transmitted to the MC by pushing the down shift switch once.
2. When traveling faster than the allowable speed shift, the MC cancels the signal from the down shift switch, but transmits signal to the speed shift solenoid valve of Speed 3, when traveling slow.
3. Further, if the down shift switch is pushed and the vehicle speed is lowered to the range allowing the speed shift, the speed shift of Speed 2 is selected.
4. In case automatic mode of the Driving mode switch is selected, automatic speed shift control is recovered three seconds after the speed shift has lowered, and then the speed shift is automatically raised once the vehicle speed increases.
5. By keeping pushing the down shift switch, the speed shift is lowered to Speed 2, and Speed 2 is kept during pushing.
6. If the down switch is pushed again within three seconds after removing the finger once, Speed 1 is obtained in case the vehicle speed is slow enough to allow the speed shift down.
7. When the down shift switch is pushed in manual mode of the Driving mode switch, in case the vehicle speed is slow enough to allow the down shift, the speed shift is lowered and the shifted speed is kept.
8. In case of the following, the down shift switch control is canceled.
   - Operation of the forward/reverse lever or the forward/reverse switch
   - Operation of the shift switch
   - Operation of the Driving mode switch
   - Pushing the hold switch
     (Only in Automatic mode of the Driving mode switch)

NOTE: *In case the vehicle speed sensor becomes abnormal, the MC receives signal from the transmission middle shaft sensor, and controls by making arithmetic operation of the vehicle speed allowable for the speed shift. In case both the vehicle speed sensor and the transmission middle shaft sensor are abnormal, lowering the speed shift is possible as an emergency measure only when the engine stops for one reason or another but traveling is not stopped.*

NOTE: *Shift switch has two switches, and their combination of ON varies depending on each speed shift. Controller judges which speed shift has been selected by the combination of the two input signals.*

NOTE: *Forward/reverse switch does not transmit neutral signal. In case of no electric current from the forward/reverse switch, the controller judges the switch as neutral (N).*

NOTE: *Each mode switch of the Driving mode switch is supplied with respectively different voltages from the monitor unit, and when the switch selects a mode, the MC judges which mode has been selected by the input voltage.*



NOTE: Illustration shows flow of the signal from the MC in case Speed 3 has been selected during forward traveling at Speed 4 and Automatic L of the Driving mode switch.

Up Shift Control

Purpose: Raising the speed shift by putting the left hand on the steering wheel and pressing the switch installed at the right console

Operation:

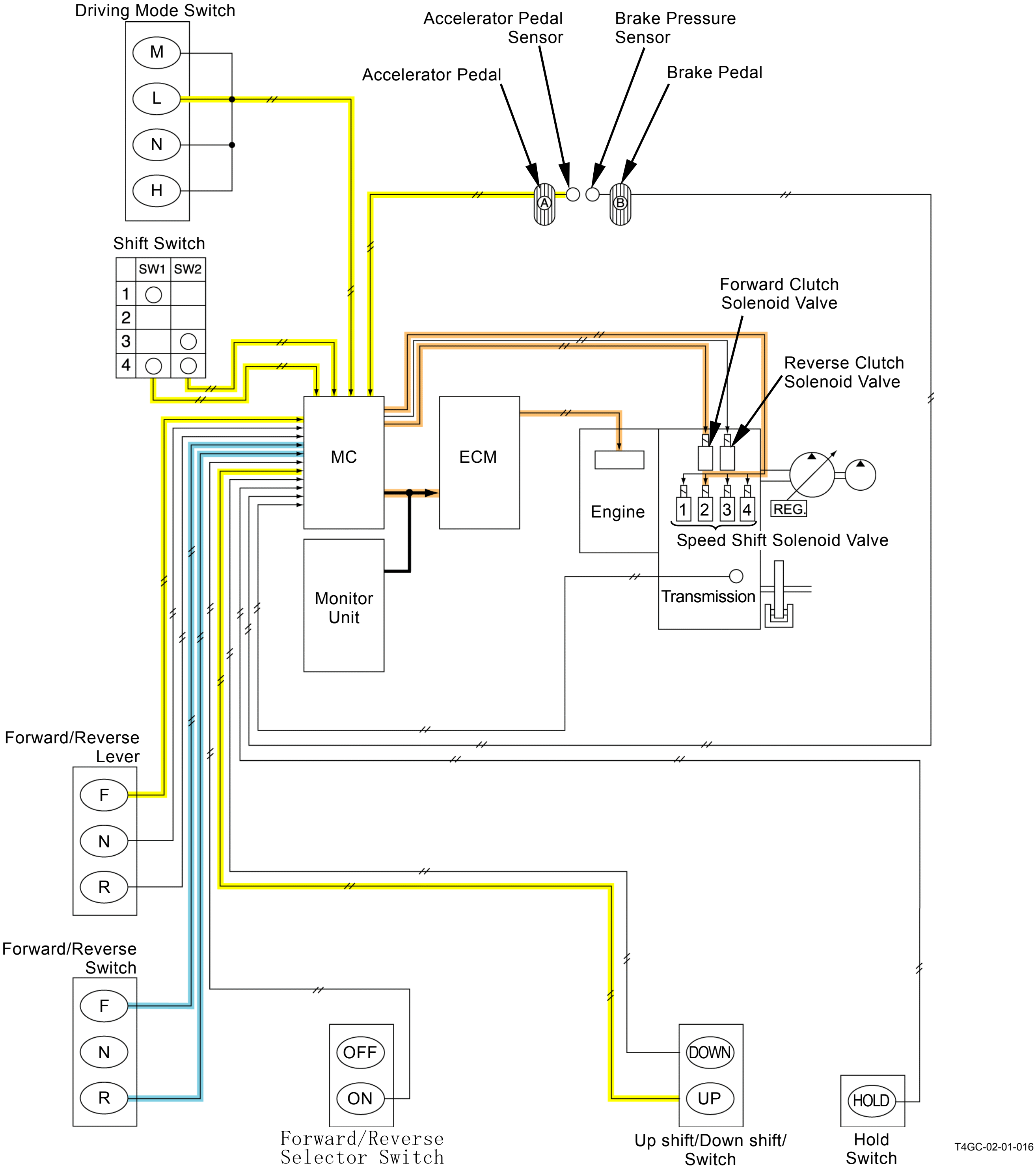
1. Signal is transmitted to the MC by pushing the up shift switch once when traveling at Automatic L mode of the Driving mode switch and Speed 4 of the shift switch.
2. MC transmits signal to the speed shift solenoid valve of Speed 2, and the speed shift is raised.
3. If the up shift switch is pushed, the speed shift is further raised to Speed 3 and Speed 4.
4. In case automatic of the Driving mode switch is selected, the speed shift is raised, and returned to the automatic speed shift control in three seconds, eventually raising automatically to the speed shift selected in advance.
5. In case manual of the Driving mode switch is selected, the raised speed shift is kept.
6. In case the following operations are made, the up shift switch is released.
   - Operation of the forward/reverse lever or forward/reverse switch
   - Operation of the shift switch
   - Operation of the Driving mode switch
   - Pushing the hold switch
     (only when the automatic of the Driving mode switch is selected)

NOTE: *Even if the up shift switch is pushed during traveling at the speed shift slected by the shift switch, the speed shift is not raised further.*

NOTE: *Shift switch has two switches, and their combination of ON varies depending on each speed shift. Controller judges which speed shift has been selected by the combination of the two input signals.*

NOTE: *Forward/reverse switch does not transmit neutral signal. In case of no electric current from the forward/reverse switch, the controller judges the switch as neutral (N).*

NOTE: *Each mode switch of the Driving mode switch is supplied with respectively different voltages from the monitor unit, and when the switch selects a mode, the MC judges which mode has been selected by the input voltage.*



NOTE: *Illustration shows flow of the signal from the MC in case Speed 2 has been selected during forward traveling at Speed 1 and Automatic L of the Driving mode switch.*

Clutch Cut Control

Purpose: Enabling release of the forward/reverse clutch of the transmission for making the most of the engine torque by operating the brake during operation of the front attachment.

Amount of stepping the brake at the time of declutching can be selected from among three kinds depending on the driver's preference.

Operation:

1. When either mode of the clutch cut position switch is selected, voltage corresponding to the selected mode is transmitted to the MC.

Mode	OFF	S	N	D
Input Voltage	1 V	2 V	3 V	4 V

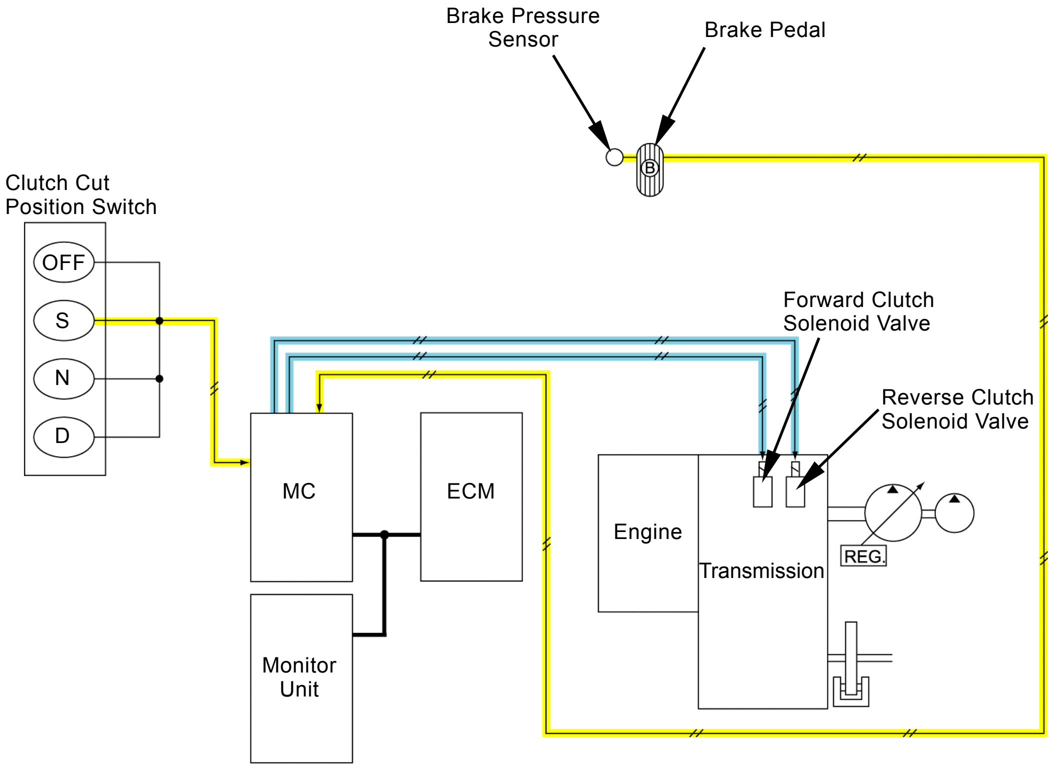
2. MC starts the corresponding clutch cut control program.

- Clutch cut does not work in OFF mode.
- In Mode S, clutch cut is made at output voltage equivalent to the set pressure of Mode S, and clutching is made again at voltage equivalent to pressures lower than that of Mode S.
- In Mode N, clutch cut is made at output voltage equivalent to the set pressure of Mode N, and clutching is made again at voltage equivalent to pressures lower than that of Mode N.
- In Mode D, clutch cut is made at output voltage equivalent to the set pressure of Mode D, and clutching is made again at voltage equivalent to pressures lower than that of Mode D.

3. In case the brake pedal is stepped in Mode S, signal from the brake pressure sensor is transmitted to the MC.
4. For signal higher than the set voltage, the MC declutches by lowering signal transmitted to the excited solenoid valve among the respective solenoid valves.
5. In case the brake pressure is lowered below the set pressure by reducing the amount of stepping of the brake pedal, signal transmitted to the clutch solenoid valve is raised, and clutching is made again.

NOTE: In case either of the clutch cut position switch and brake pressure sensor becomes out of order, clutch cut control is not made

NOTE: Each mode switch of the clutch cut position switch is supplied with respectively different voltages from the monitor unit, and when the switch selects a mode, the MC judges which mode has been selected by the input voltage.



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NOTE: *Illustration shows flow of the signal in case the brake pedal has been stepped in Mode S of the clutch cut position switch.*

Shift Holding Control

Purpose: Enabling to hold the speed shift during towing or traveling uphill

Operation:

1. When the hold switch is pressed once, signal is transmitted to the MC.
2. MC keeps transmitting signal to the speed shift solenoid valve of each time, and after that the speed shift is fixed even if the the accelerator or the brake pedal is stepped.

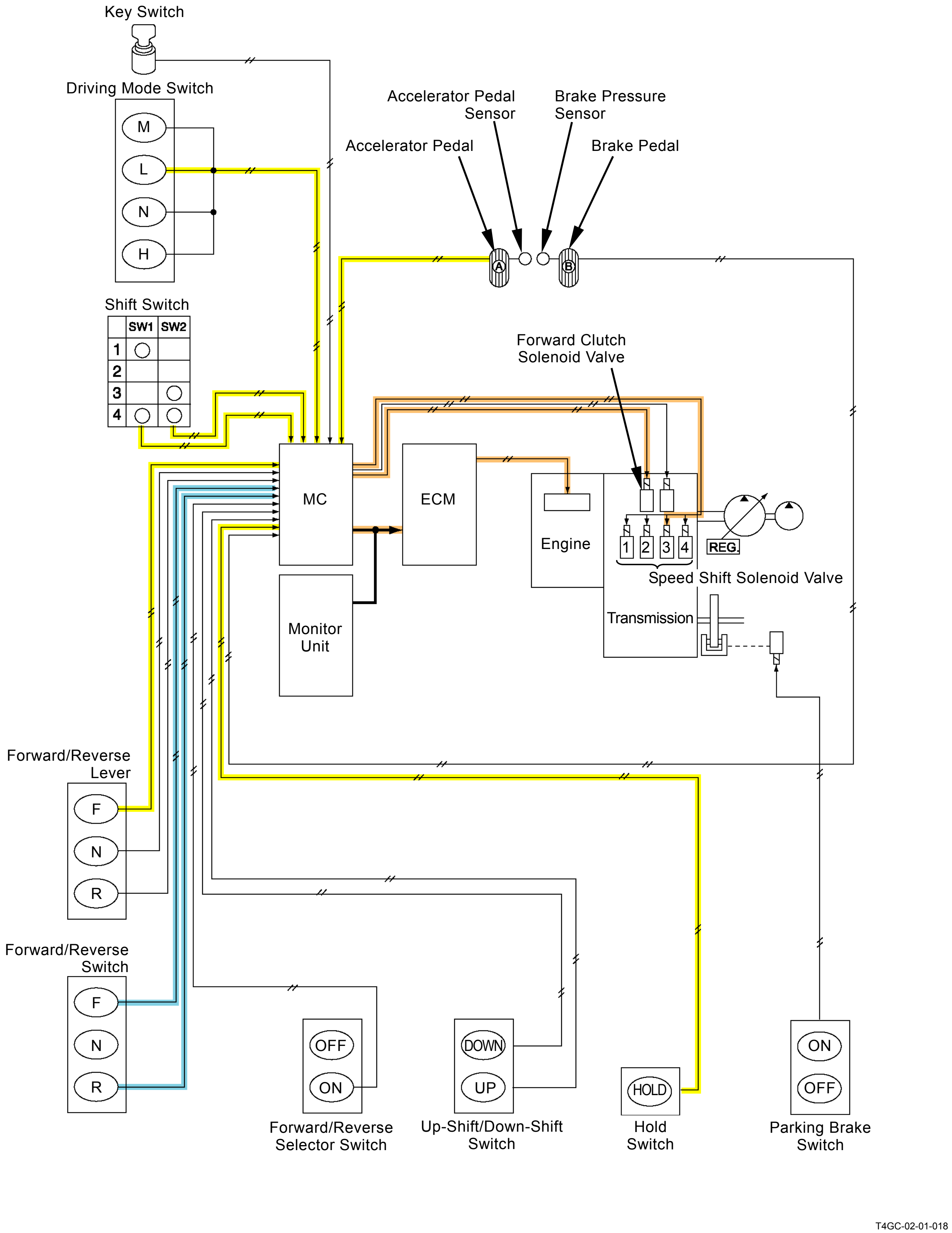
NOTE: Speed shift holding control is made only when automatic (L, N, or H) of the Driving mode switch is selected.

3. MC releases the speed shift holding control in case the following operations are made or the following switches are operated.
- Turning OFF the key switch
- Pushing the hold switch again
- Down shift switch
- Up shift switch
- Forward/reverse lever
- Forward/reverse selector switch (only when effective)
- Forward/reverse switch (only when effective)
- Speed shift switch
- Driving mode switch
- Parking brake switch

NOTE: Shift switch has two switches, and their combination of ON varies depending on each speed shift. Controller judges which speed shift has been selected by the combination of the two input signals.

NOTE: Forward/reverse switch does not transmit neutral signal. In case of no electric current from the forward/reverse switch, the controller judges the switch as neutral (N).

NOTE: Each mode switch of the Driving mode switch is supplied with respectively different voltages from the monitor unit, and if a switch is selected, the MC judges which mode has been selected.


Key Switch
Driving Mode Switch
M
L
N
H
Shift Switch
SW1
SW2
1
2
3
4
Accelerator Pedal Sensor
Brake Pressure Sensor
Accelerator Pedal
Brake Pedal
A
B
Forward Clutch Solenoid Valve
MC
ECM
Engine
1
2
3
4
REG.
Speed Shift Solenoid Valve
Transmission
Monitor Unit
Forward/Reverse Lever
F
N
R
Forward/Reverse Switch
F
N
R
OFF
ON
Forward/Reverse Selector Switch
DOWN
UP
Up-Shift/Down-Shift Switch
HOLD
Hold Switch
ON
OFF
Parking Brake Switch
T4GC-02-01-018

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OTHER CONTROLS

Following other controls are made.

- Hydraulic fan cooling control
- Hydraulic fan cleaning control
- Transmission alarm control
- Forward/reverse indicator control
- Reverse Traveling alarm control
- Parking brake alarm control

Hydraulic Fan Cooling Control

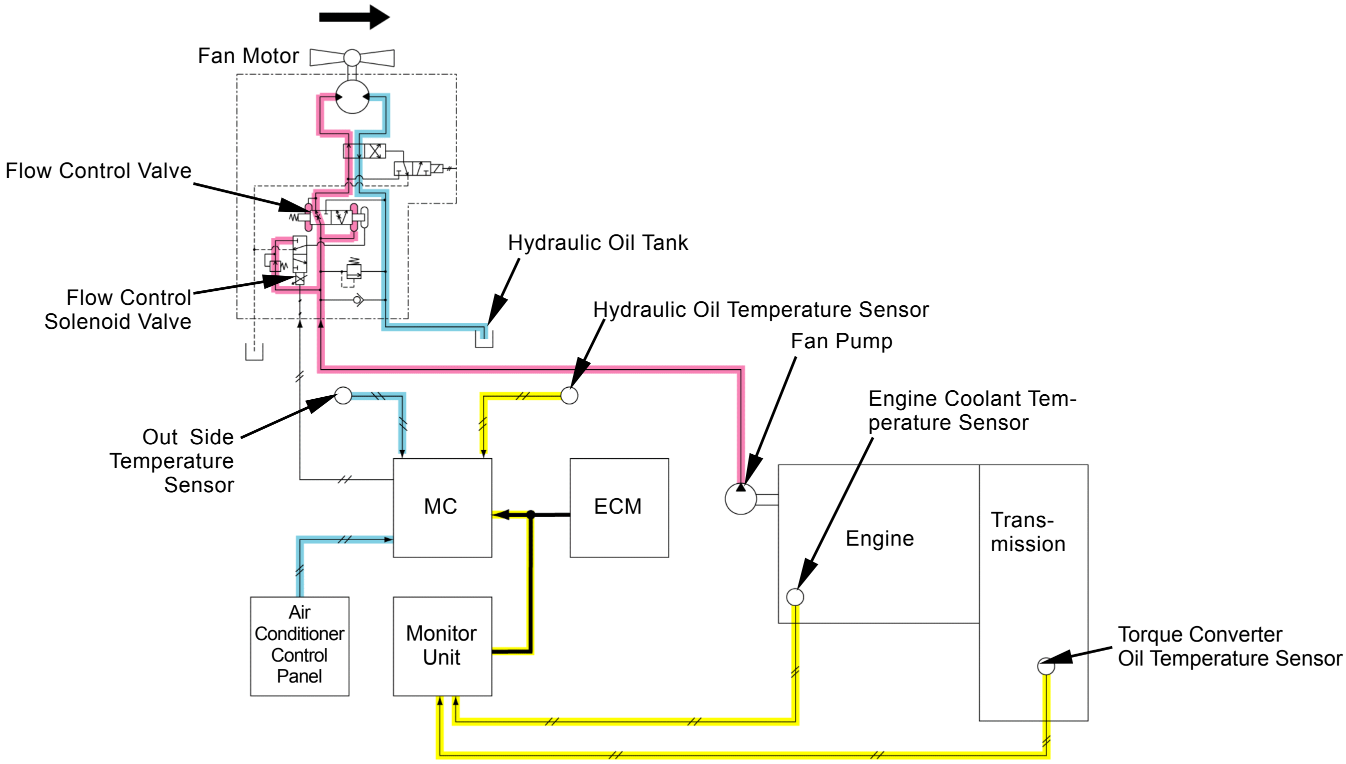
Purpose: Improving fuel consumption rate and noise reduction by restricting the hydraulic fan speed in response to oil temperature and coolant temperature.

Operation:

1. When the engine is started, the fan pump rotates, and discharges oil to the fan motor.
2. Signals from the hydraulic oil temperature sensor, engine coolant temperature sensor, and torque converter oil temperature sensor are simultaneously transmitted to the MC, and arithmetic operation of three target hydraulic fan speeds are carried out.
3. MC selects the highest speed, and transmits signal to the flow control solenoid valve.
4. Flow control solenoid valve operates, and pressure oil coming from it flows into the right end of the flow control valve, so the flow control valve spool moves left.
5. When the flow control valve spool moves left, part of the pressure oil flowing to the fan motor flows to the tank port, and the fan motor speed is lowered accordingly.
6. In case oil temperature or coolant temperature of any part is above the set temperature, the hydraulic fan speed is maximum when the engine speed is maximum.
7. In case oil temperature or coolant temperature of any part is below the set temperature, the hydraulic fan speed is lowered in response to the datum of the highest temperature.
8. Besides, the signal from the outside air temperature sensor also enters the MC, and rotates the fan always at the maximum speed, disregarding the controls in 2 through 7 in case the air conditioner switch is ON at the outside air temperature of 35 °C (95 °F) and above.

NOTE: *In case any of the engine speed sensor, hydraulic oil temperature sensor, engine coolant temperature sensor, torque converter oil temperature sensor and out side temperature sensor becomes out of order, cooling by hydraulic fan control is always made at the maximum speed.*

At oil temperature or coolant temperature above the set temperature (Uncontrolled speed operation)



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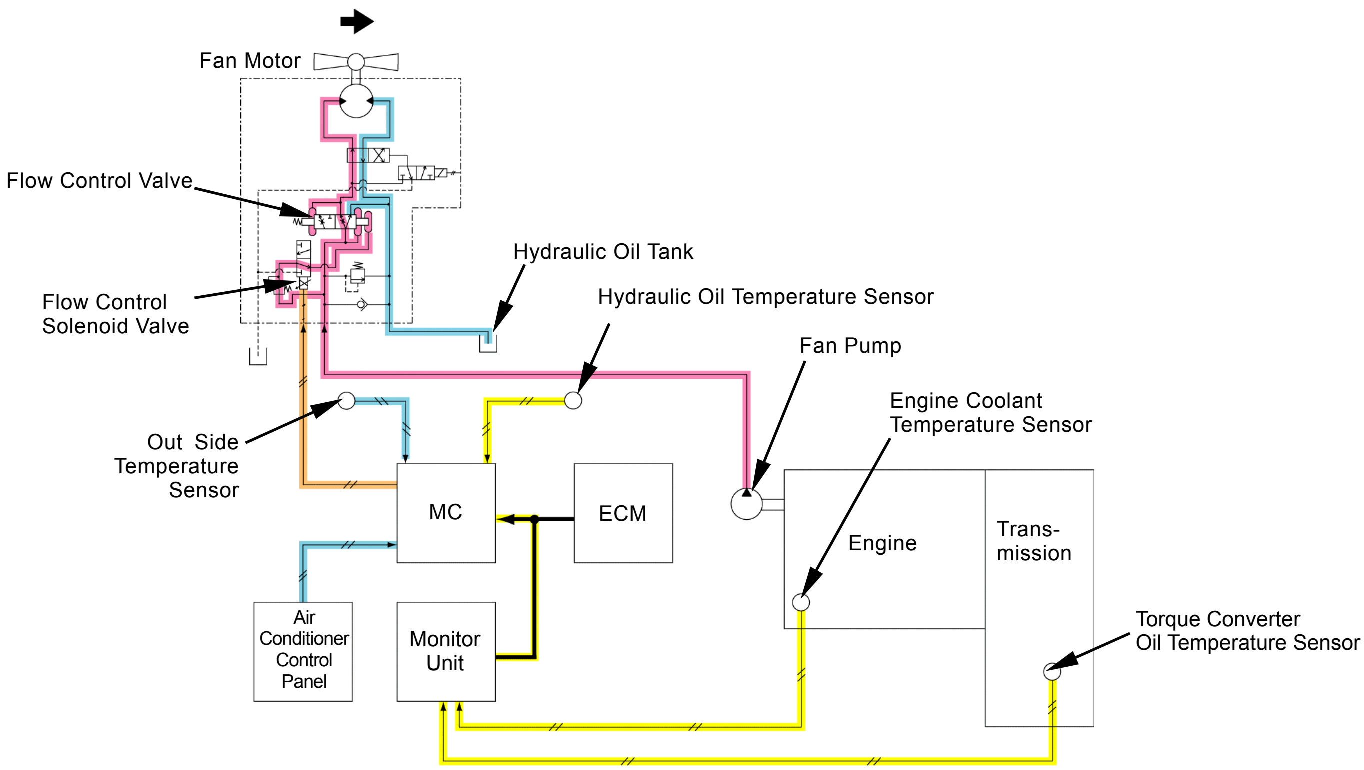
At oil temperature or coolant temperature below the set temperature (Controlled speed operation)



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Hydraulic Fan Cleaning Control

Purpose: Controlling cleaning by hydraulic fan by reversing the hydraulic fan to blow away dust in case cleaning of the radiator, and oil cooler are needed

Operation:

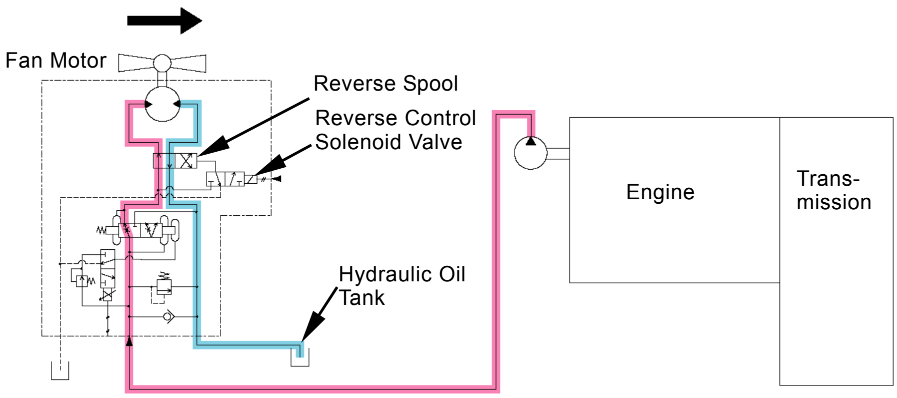
1. When the engine is started after preparing the following conditions and turning the fan reversing switch ON, signal is transmitted from the MC to the reverse control solenoid valve.
2. When the reverse control solenoid valve is operated, the reverse spool strokes, and the fan motor rotation is reversed.
3. In reverse rotation, as hydraulic fan cooling control is not made, the fan speed fluctuates from maximum to minimum in response to the amount of stepping of the accelerator pedal.
4. In case any one of the conditions below is changed during reverse rotation, the engine speed is immediately fixed to idling.
5. Hydraulic fan cleaning control is not released by turning the fan reversing switch OFF only. Control is released by the procedure of turning the fan reversing switch OFF – turning the key switch OFF – turning the key switch ON.
6. In case the engine speed is fixed to idling also, the control is released by the procedure of turning the fan reversing switch OFF – turning the key switch OFF – turning the key switch ON.

Conditions:

- Fan reversing switch: ON
- Parking brake switch: ON (Brake is effective.)
- Forward/reverse lever: neutral
- Forward/reverse switch: neutral

NOTE: Reverse control solenoid valve is turned ON temporarily when the key switch is turned ON because the spool can stick in case the reverse control solenoid valve is not operated for a long time. It is also turned ON once every one minute after the key switch is turned ON. This operation is not made during the hydraulic fan cleaning operation.

In cooling operation (Normal rotation)



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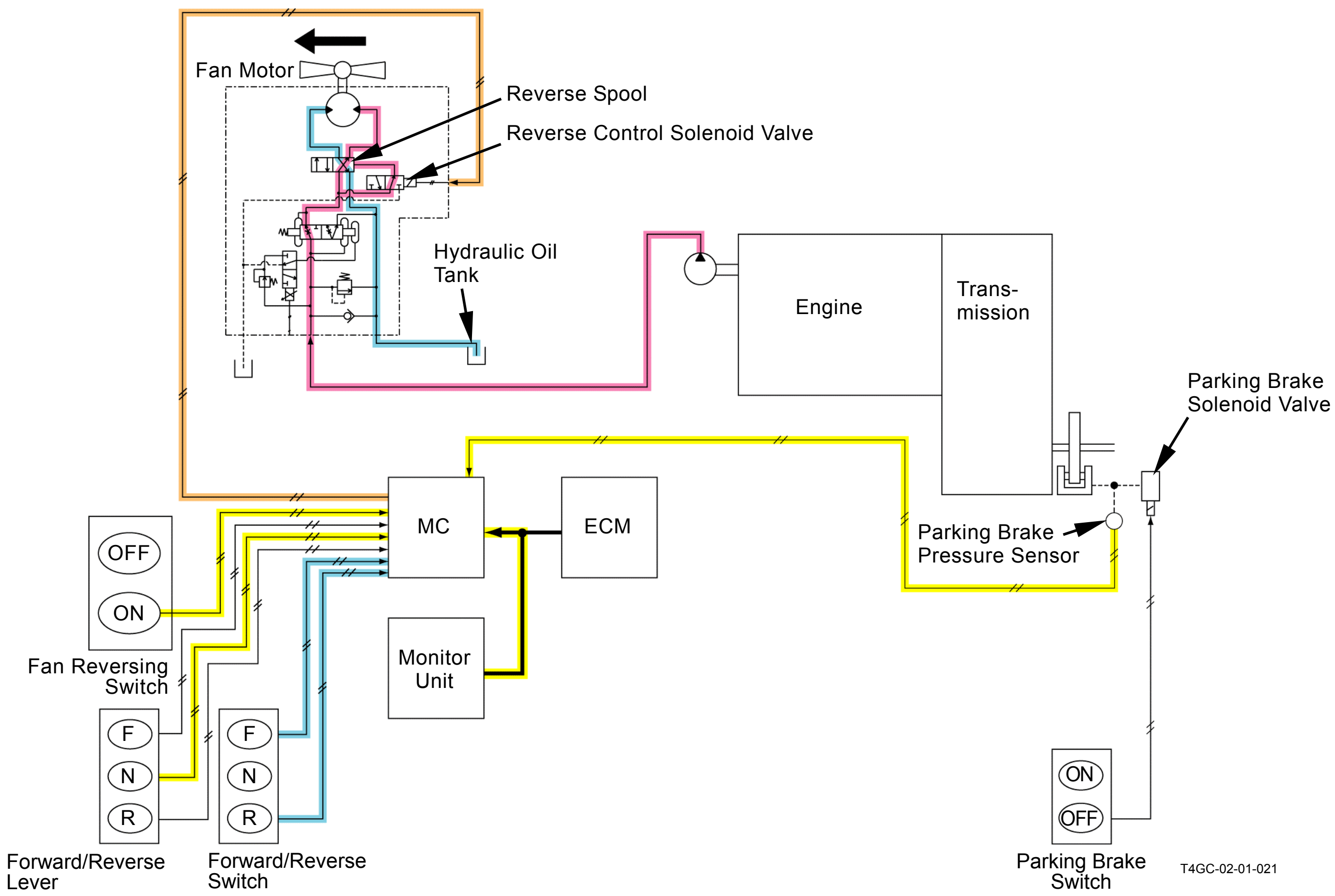
In cleaning operation (Reverse rotation)



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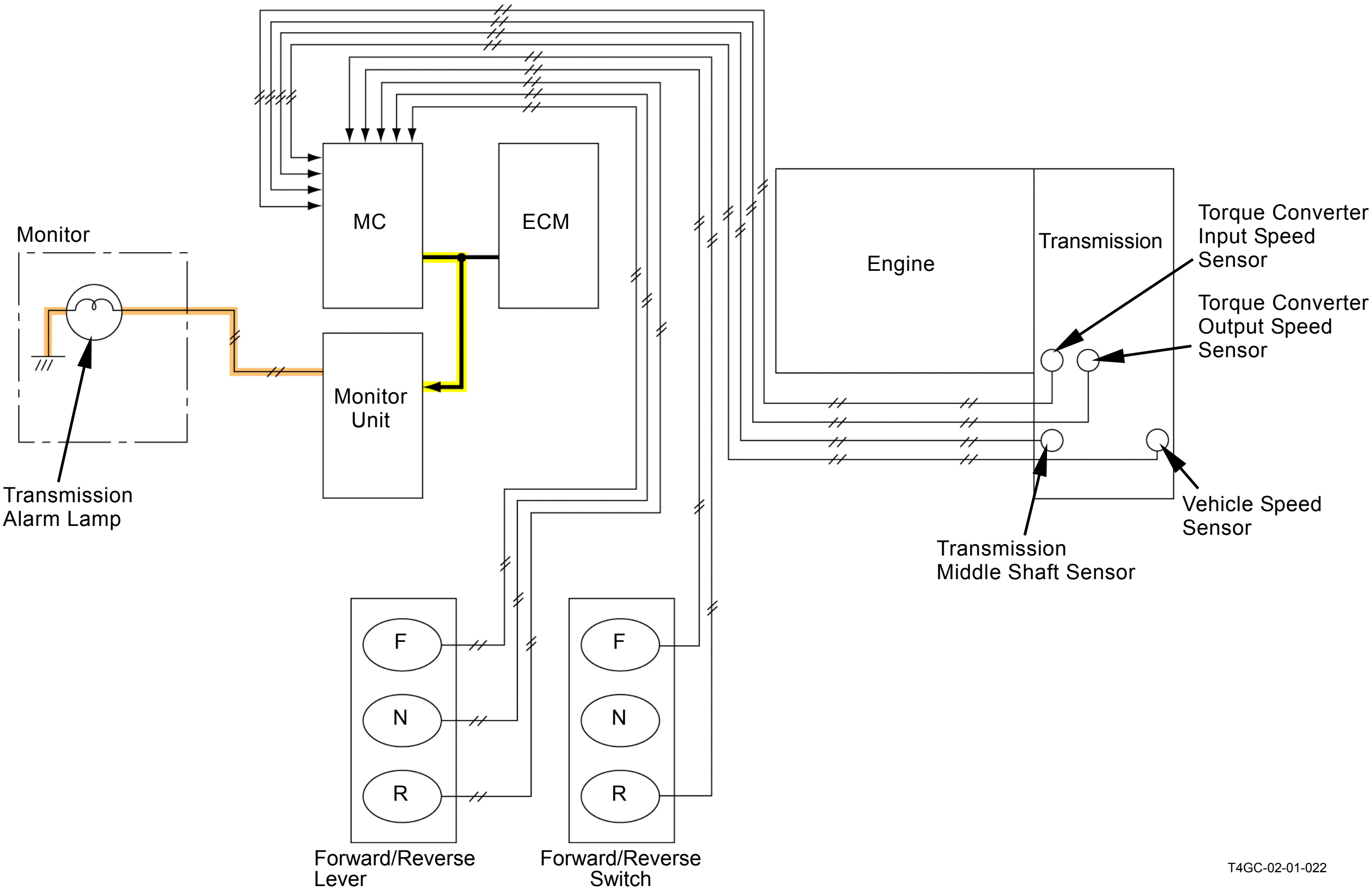
Transmission Alarm Control

Purpose: Lighting the transmission alarm lamp on the monitor unit for protection of the transmission in case of disorder of partslikely to cause damage to the transmission

Operation: In case any of the parts shown right becomes out of order, the MC transmits signal to the monitor unit, and the transmission alarm lamp is lit.

- Torque converter input speed sensor
- Torque converter output speed sensor
- Vehicle speed sensor
- Transmission middle shaft sensor
- Forward/reverse lever
- Forward/reverse switch during work



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Forward/Reverse Indicator Control

Purpose: Lighting the forward/reverse indicator on the monitor when the forward/reverse switch is effective

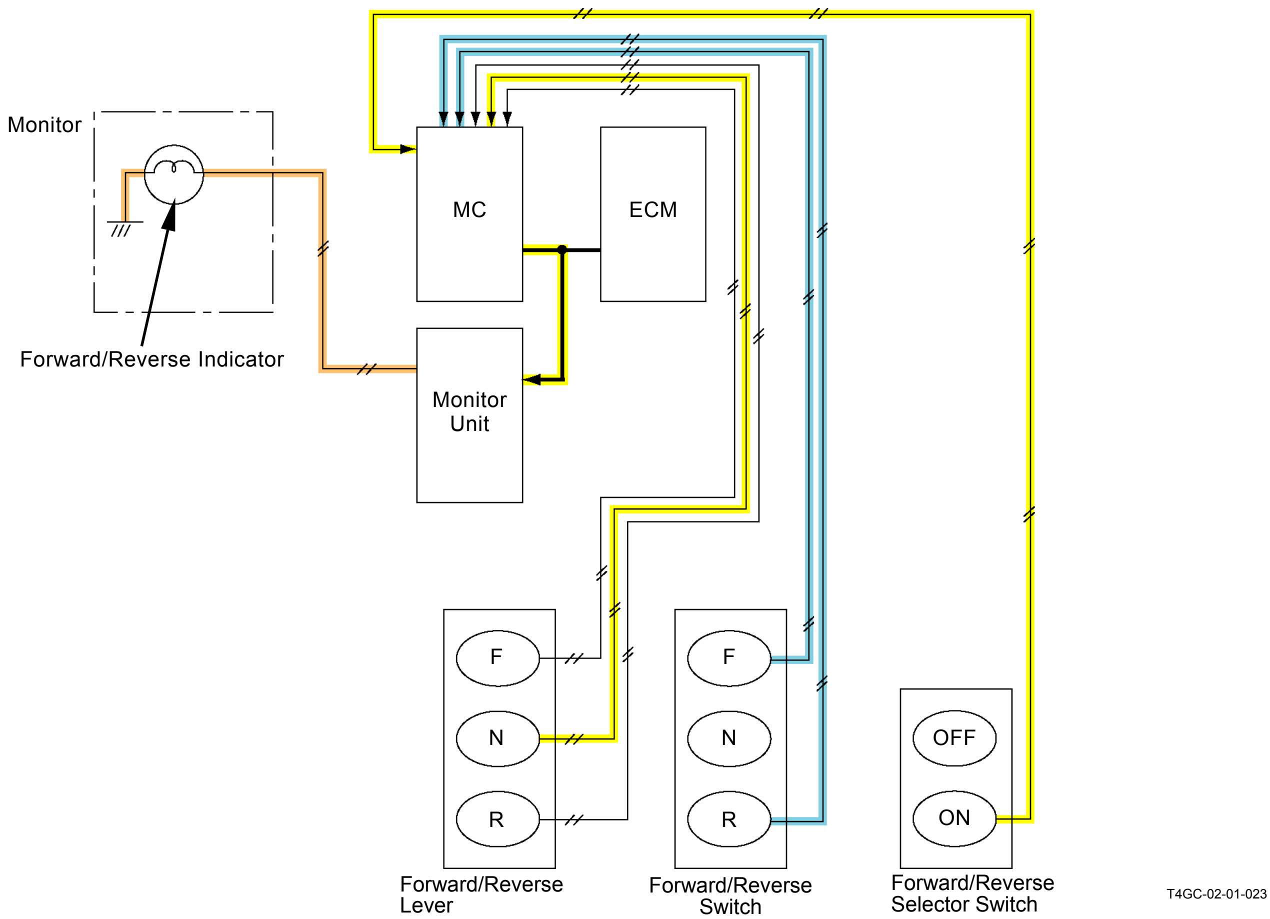
Operation:

1. Forward/reverse selector switch is turned ON after the forward/reverse lever and the forward/reverse switch are positioned at neutral.
2. Then the forward/reverse switch becomes effective, and the monitor unit lights the forward/reverse indicator of the monitor.

NOTE: In case the forward/reverse lever becomes out of order, input to the forward/reverse switch becomes ineffective, and the forward/reverse indicator is unlit and fixed.

NOTE: In case the forward/reverse lever is operated while traveling using the forward/reverse switch, input to the forward/reverse switch becomes ineffective, and the vehicle body moves by operating the forward/reverse lever. (Refer to the Forward/Reverse Lever Priority Control)

NOTE: Forward/reverse switch does not transmit neutral signal. In case of no electric current from the forward/reverse switch, the controller judges the switch as neutral (N).

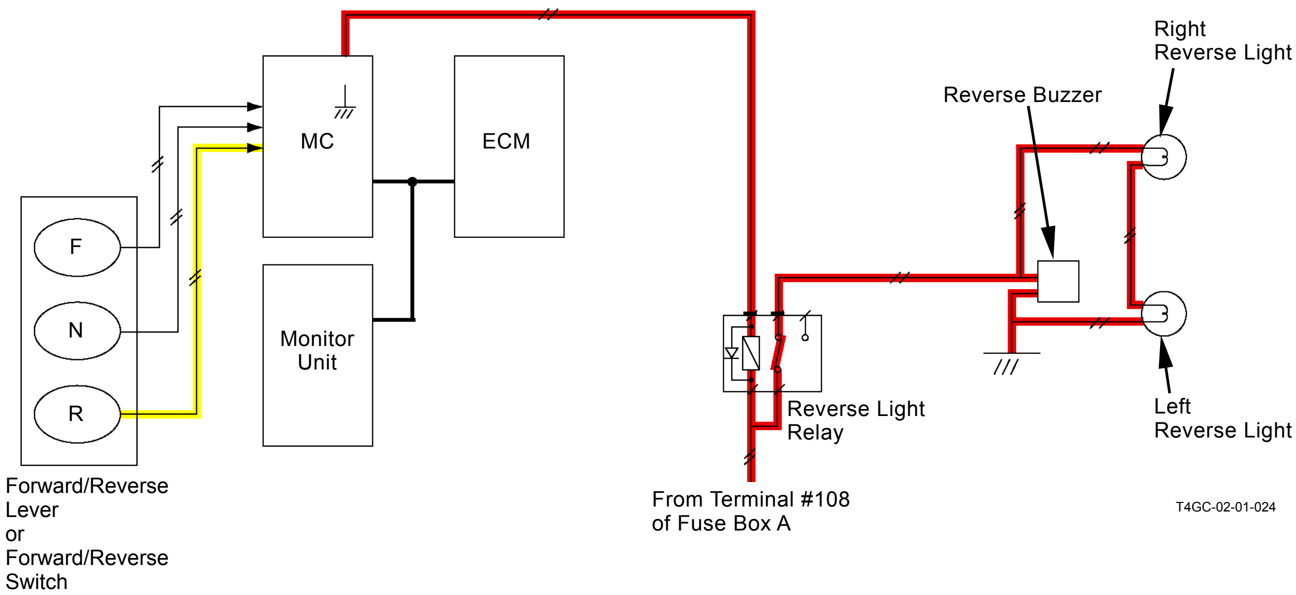


Reverse Traveling Alarm Control
(Refer to the SYSTEM/Electric System)

Purpose: Sounding alarm buzzer when the forward/reverse lever or the forward/reverse switch is selected

Operation:

1. When reverse of the forward/reverse lever or the forward/reverse switch is selected, the MC earths the terminal from the reverse light relay.
2. Reverse light relay is excited, and electric current flows to the reverse light and the reverse buzzer.



Parking Brake Alarm Control

Purpose: Lighting the parking brake alarm lamp on the monitor unit during parking operation of the brake

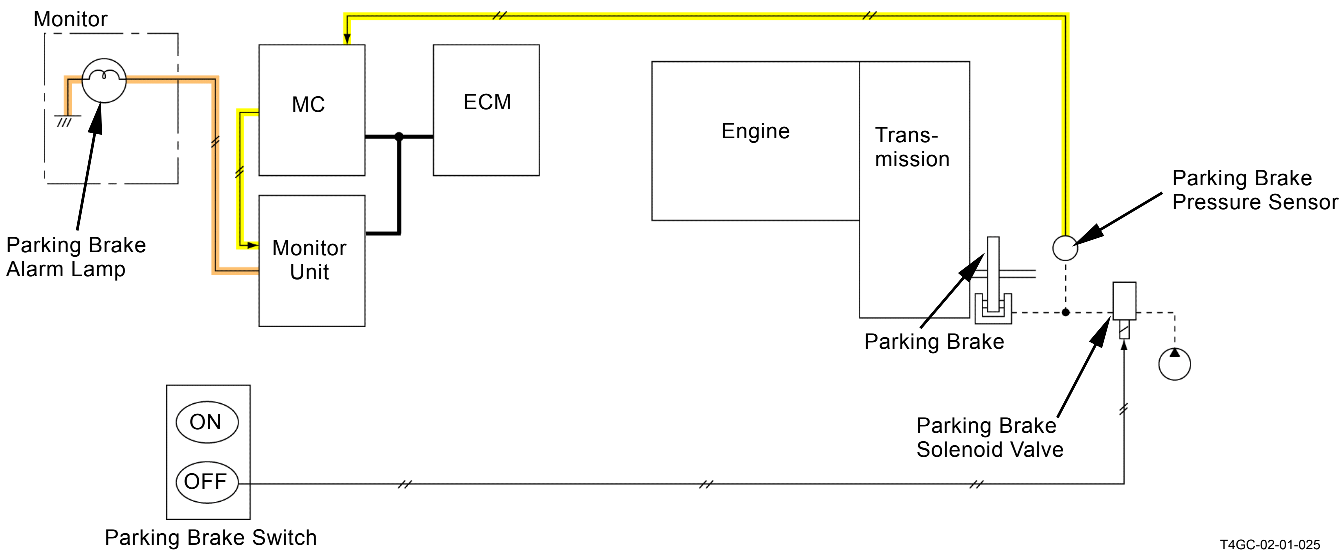
Operation:

1. When the parking brake switch is turned ON, the MC confirms signal of the parking brake pressure sensor.
2. At pressure below the set pressure, the MC transmits signal to the monitor unit, and the parking brake alarm lamp is lit.

NOTE: Parking brake of the vehicle body is released if the pilot pressure flows in.

NOTE: For operation circuit of the parking brake, refer to the SYSTEM/Electric System.

IMPORTANT: Be careful that in case the parking brake pressure sensor is abnormal, traveling is possible even if the parking brake switch is ON and the parking brake is at work because the parking brake alarm lamp is fixed to OFF (release).



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CONTROL BY ELECTRIC AND HYDRAULIC COMBINED CIRCUIT

Electric and hydraulic combined circuit has the following controls.

- Ride control (optional)
- Bucket positioner control
- Lift arm float control
- Lift arm kick-out control
- Lift arm auto-leveler upward control (Optional)
- Lift arm auto-leveler downward control (Optional)

Ride Control (Optional)

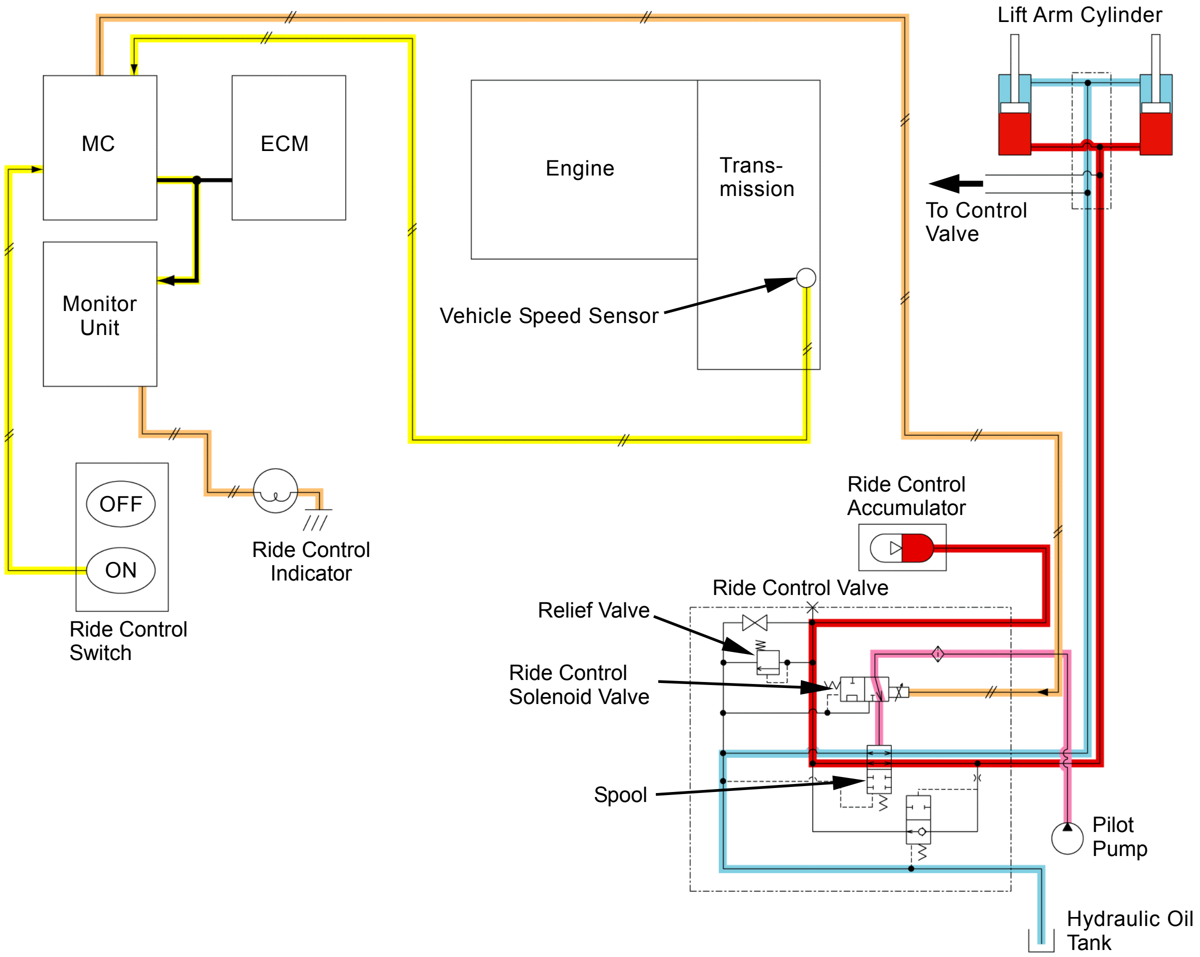
Purpose: Reducing fatigue of the operator by organizing a damper circuit in the lift arm cylinder and reducing shock in traveling on rough roads

Operation:

1. When the ride control switch is turned ON, the MC makes the ride control effective, and the ride control indicator of the monitor is lit.
2. At vehicle speed of 7 km/h (4 mph) and above, the MC receives signal from the vehicle speed sensor, and transmits electric current to the ride control solenoid valve.
3. When the ride control solenoid valve is operated and the spool moves, a damper circuit is organized between the rod end and the bottom end of the lift arm cylinder. When the vehicle body travels on bumpy roads, the fluctuation of the bottom pressure of the lift arm cylinder is absorbed by the ride control accumulator, and the shock of the whole vehicle body is reduced.

NOTE: Ride control is not made at the vehicle speed of 7 km/h (4 mph) and below.

NOTE: In case the ride control switch or the ride control solenoid valve becomes out of order, the ride control is not made.



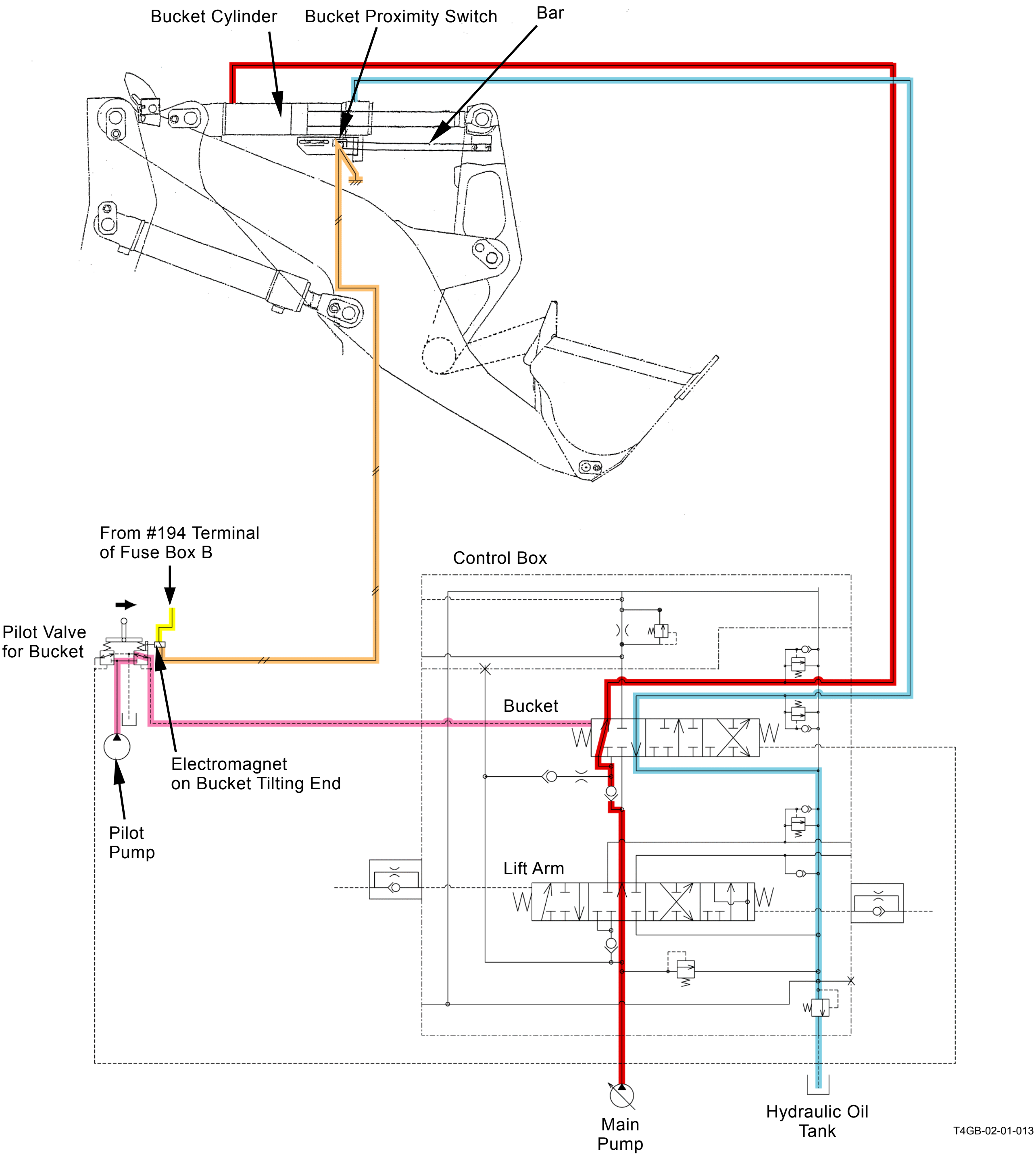
T4GC-02-01-026

Bucket Auto-leveler Control (ZW220)

Purpose: Automatically tilting the bucket at an appropriate angle (horizontal) to start digging in returning the bucket to the tilting position

Operation:

1. In dumping operation of the bucket, the bar is located in front of the bucket proximity switch.
   While the bar passes by the bucket proximity switch, the bucket proximity switch becomes ON, and excites the electromagnet on the bucket tilting end of the pilot valve.
2. When the bucket operation lever is moved farther than the bucket tilting detent position (position to move farther than the tilting position), the bucket operation lever is retained by the electromagnet on the bucket tilting end, and pressure oil from the pilot valve moves the bucket spool of the control valve.
3. Pressure oil from the main pump flows into the bottom end of the bucket cylinder through the bucket spool of the control valve, and extends the bucket cylinder. When the bucket cylinder is extended, the bar also passes by the bucket proximity switch.
4. When the bar becomes distant from the bucket proximity switch, the bucket proximity switch is turned OFF, and the electromagnet on the bucket tilting end is also turned OFF, which makes the bucket operation lever in the neutral position. As the bucket spool of the control valve also returns to neutral, the bucket cylinder stops. As a result, the bucket is tilted at the right digging angle (horizontal).

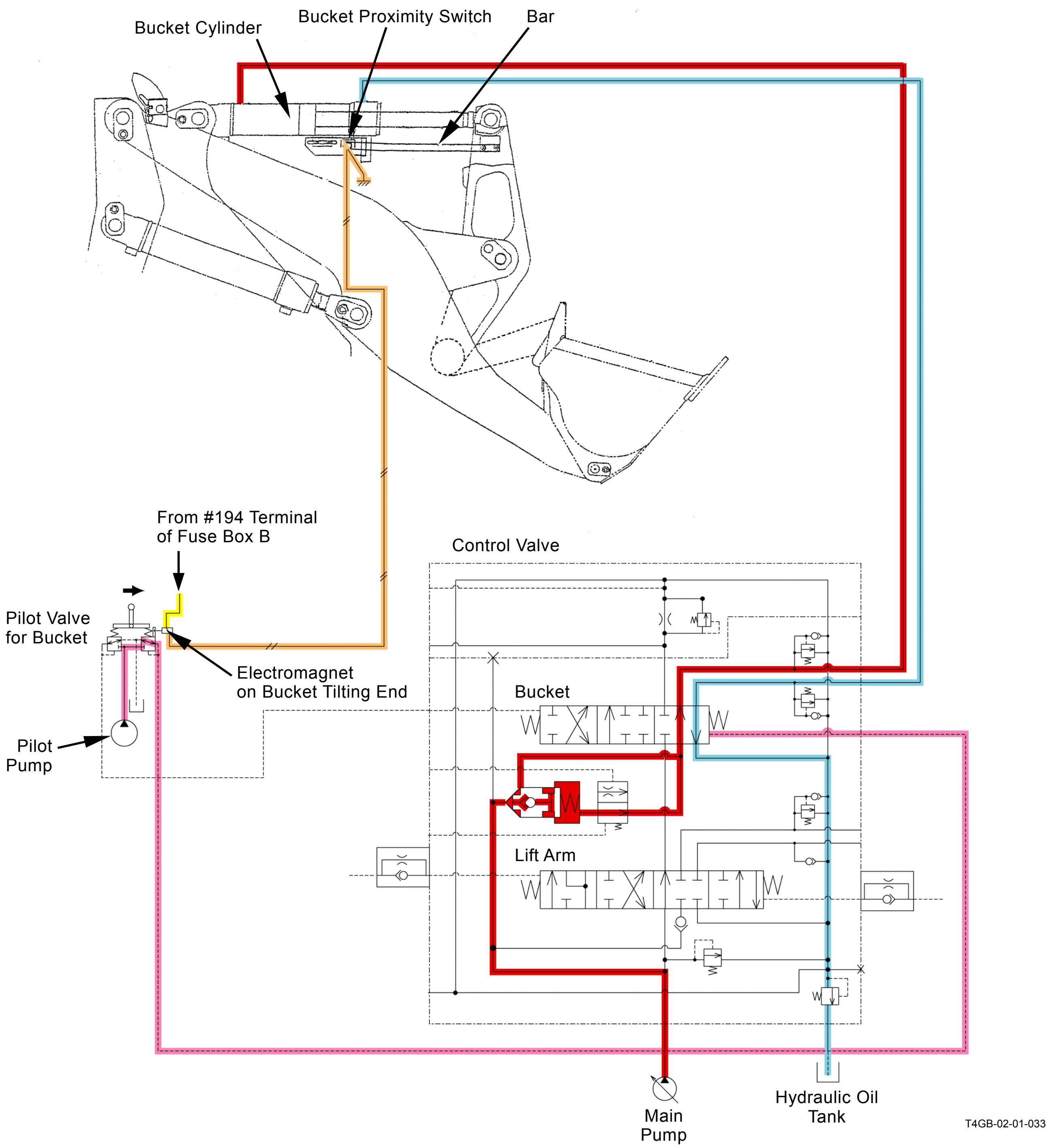

Bucket Cylinder
Bucket Proximity Switch
Bar
From #194 Terminal of Fuse Box B
Control Box
Pilot Valve for Bucket
Bucket
Electromagnet on Bucket Tilting End
Pilot Pump
Lift Arm
Main Pump
Hydraulic Oil Tank
T4GB-02-01-013

Bucket Auto-leveler Control (ZW250)

Purpose: Automatically tilting the bucket at an appropriate angle (horizontal) to start digging in returning the bucket to the tilting position

Operation:

1. In dumping operation of the bucket, the bar is located in front of the bucket proximity switch.
   While the bar passes by the bucket proximity switch, the bucket proximity switch becomes ON, and excites the electromagnet on the bucket tilting end of the pilot valve.
2. When the bucket operation lever is moved farther than the bucket tilting detent position (position to move farther than the tilting position), the bucket operation lever is held by the electromagnet on the bucket tilting end, and pressure oil from the pilot valve moves the bucket spool of the control valve.
3. Pressure oil from the main pump flows into the bottom end of the bucket cylinder through the bucket spool of the control valve, and extends the buket cylinder. When the bucket cylinder is extended, the bar also passes by the bucket proximity switch.
4. When the bar becomes distant from the bucket proximity switch, the bucket proximity switch is turned OFF, and the electromagnet on the bucket tilt end is also turned OFF, which makes the bucket operation lever in the neutral position. As the bucket spool of the control valve also returns to neutral, the bucket cylinder stops. As a result, the bucket is tilted at the right digging angle (horizontal).


Bucket Cylinder
Bucket Proximity Switch
Bar
From #194 Terminal of Fuse Box B
Control Valve
Pilot Valve for Bucket
Electromagnet on Bucket Tilting End
Bucket
Pilot Pump
Lift Arm
Main Pump
Hydraulic Oil Tank
T4GB-02-01-033

Lift Arm Float Control (ZW220)

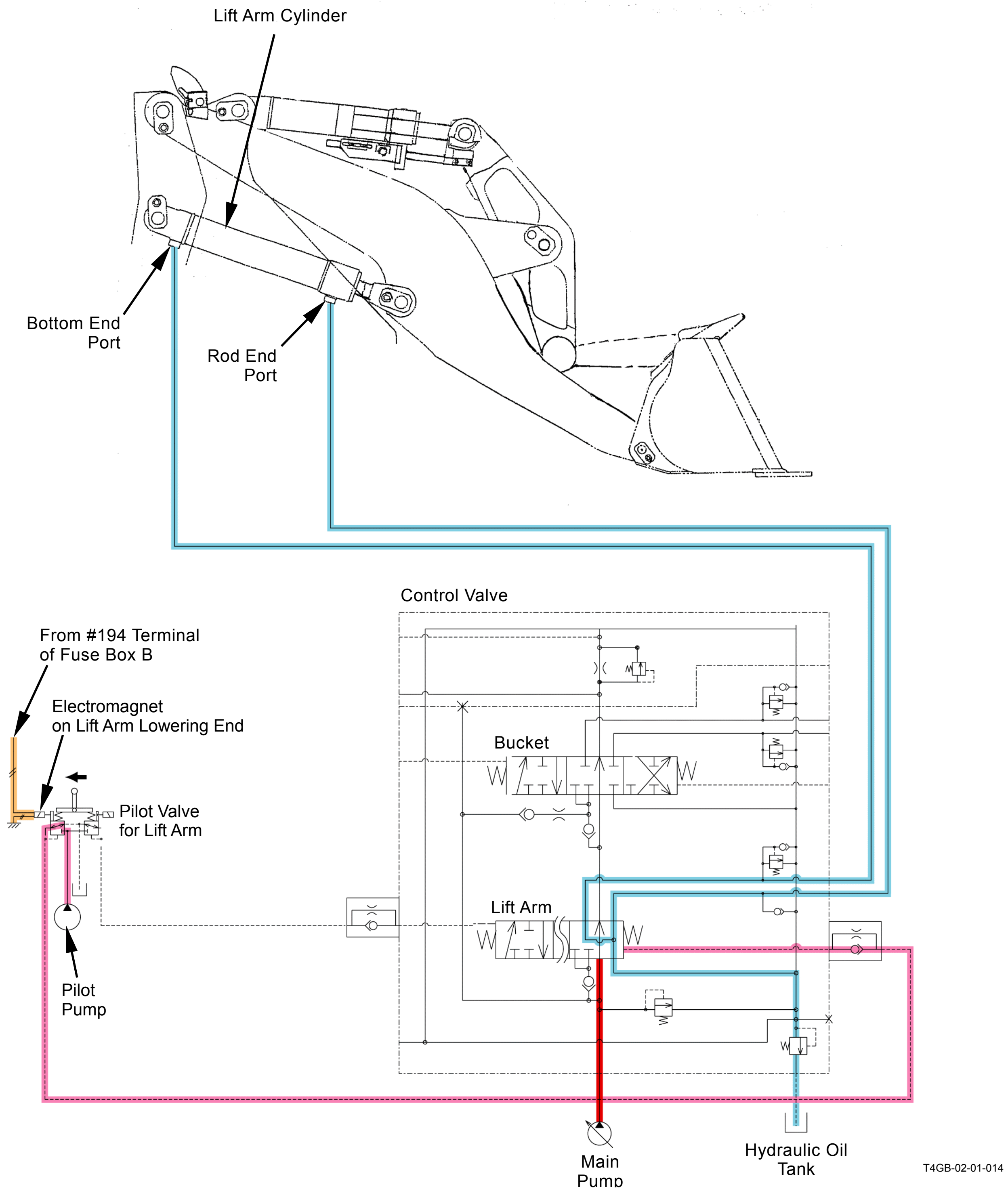
Purpose: Free raising and lowering of the lift arm in response to the external load for snow removing and road cleaning

Operation:

1. When the lift arm operation lever is moved to the floating position (farther position than the lift arm lowering position), the lift arm operation lever is retained by the electromagnet on the lift arm lowering end, and pressure oil from the pilot valve moves the lift arm spool of the control valve up to the floating position (farthest right position).

NOTE: When the engine is rotating, the electromagnet on the lift arm lowering end is always excited by the electric current from #194 terminal of Fuse Box B.

2. Pressure oil from the main pump is blocked by the lift arm spool, and ports on the rod end and the bottom end of the lift arm cylinder are connected through the lift arm spool, leading to the tank port. As the both ports of the lift arm cylinder have the same pressure as the hydraulic oil tank, the lift arm cylinder is not restricted, allowing free movement of the lift arm depending on the external force.
3. Lift arm operation lever returns to neutral, if pulled more strongly than the magnetic force of the electromagnet. As the lift arm spool of the control valve also returns to neutral, the lift arm floating control is released.


Lift Arm Cylinder
Bottom End Port
Rod End Port
Control Valve
From #194 Terminal of Fuse Box B
Electromagnet on Lift Arm Lowering End
Bucket
Pilot Valve for Lift Arm
Lift Arm
Pilot Pump
Main Pump
Hydraulic Oil Tank
T4GB-02-01-014

Lift Arm Float Control (ZW250)

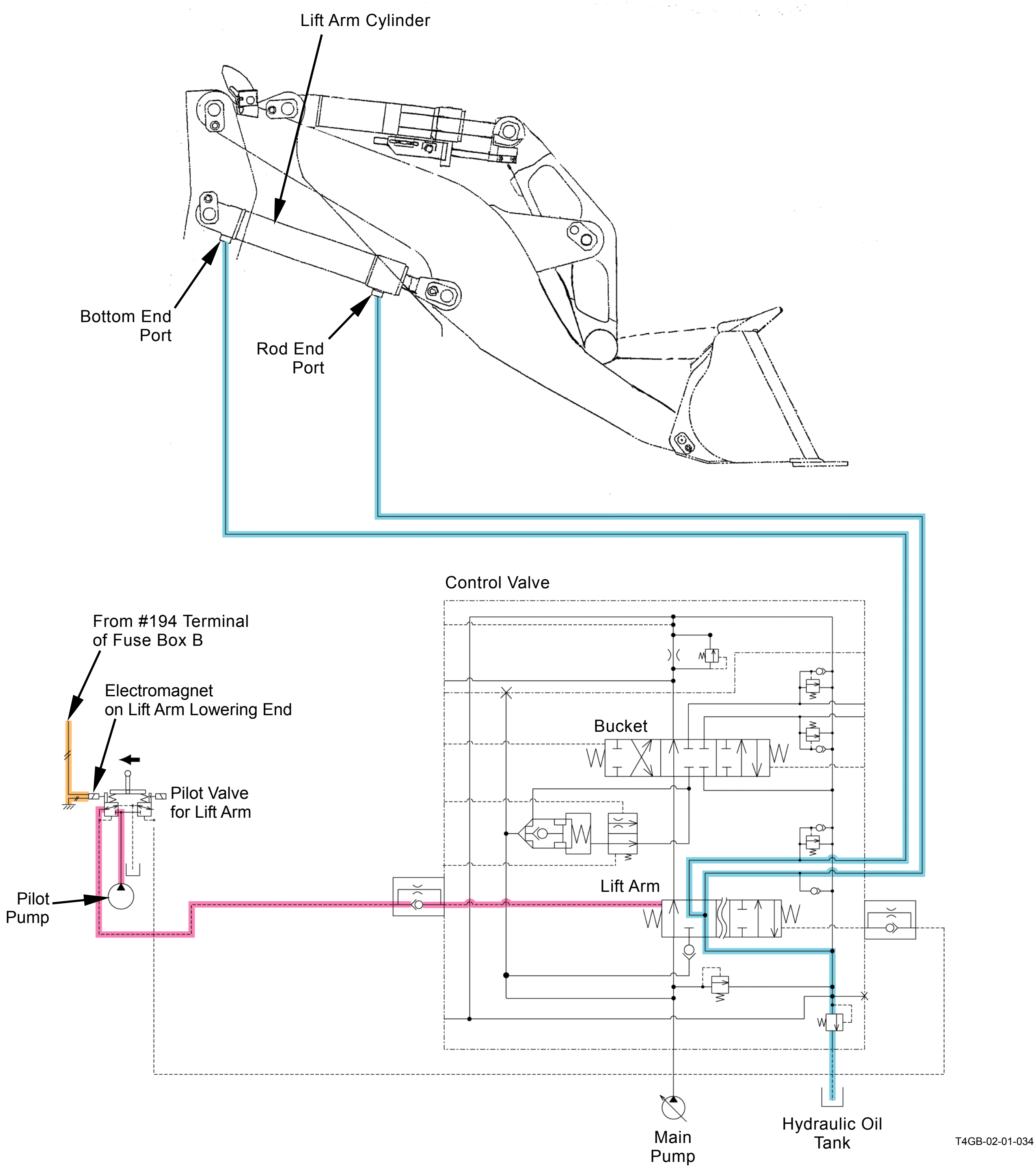
Purpose: Free raising and lowering of the lift arm in response to the external load for snow removing and road cleaning

Operation:

1. When the lift arm operation lever is moved to the floating position (farther position than the lift arm lowering position), the lift arm operation lever is retained by the electromagnet on the lift arm lowering end, and pressure oil from the pilot valve moves the lift arm spool of the control valve up to the floating position (farthest left position).

NOTE: When the engine is rotating, the electromagnet on the lift arm lowering end is always excited by the electric current from #194 terminal of Fuse Box B.

2. Pressure oil from the main pump is blocked by the lift arm spool, and ports on the rod end and the bottom end of the lift arm cylinder are connected through the lift arm spool, leading to the tank port. As the both ports of the lift arm cylinder have the same pressure as the hydraulic oil tank, the lift arm cylinder is not restricted, allowing free movement of the lift arm depending on the external force.
3. Lift arm operation lever returns to neutral, if pulled more strongly than the magnetic force of the electromagnet. As the lift arm spool of the control valve also returns to neutral, the lift arm floating control is released.

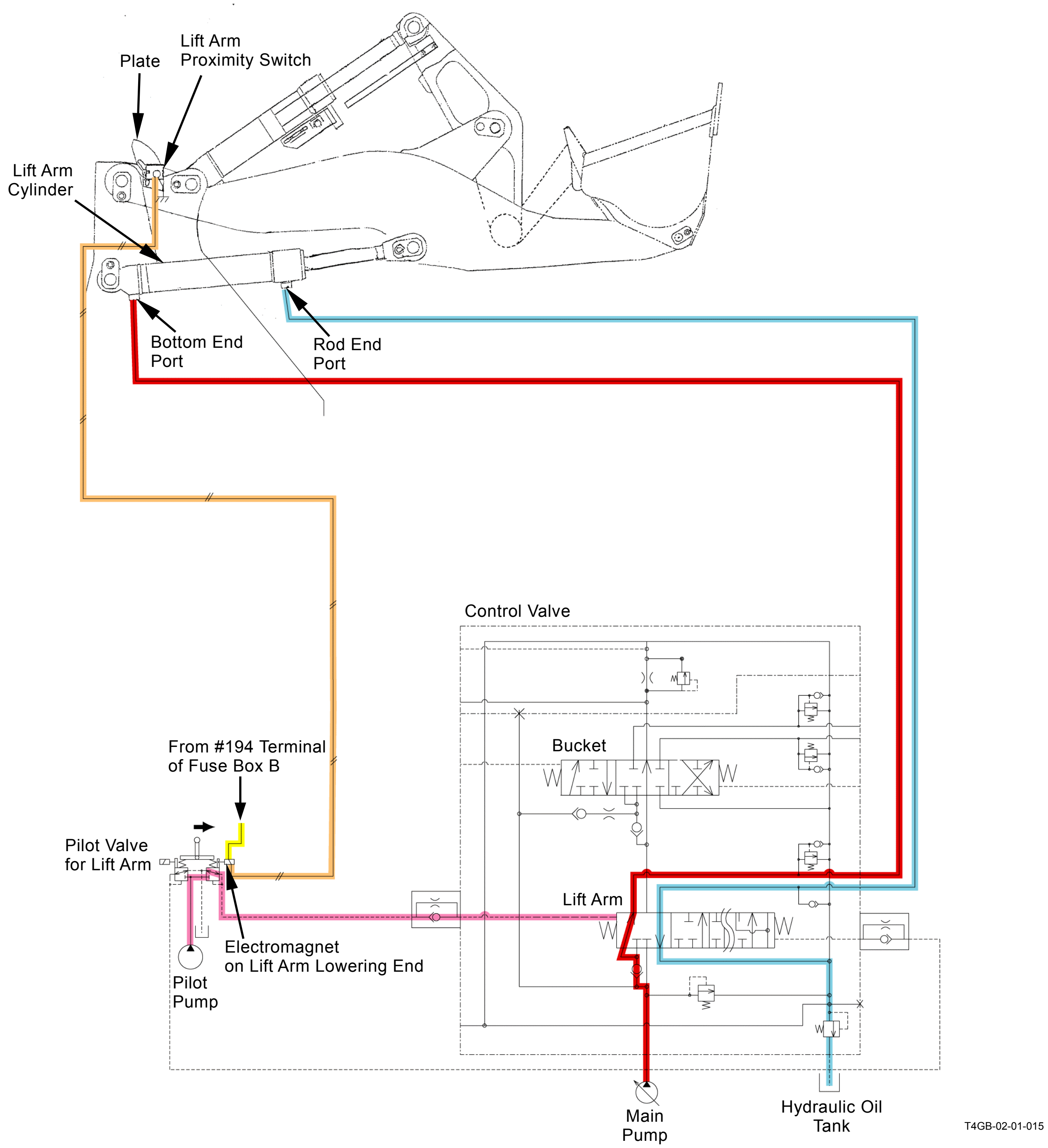

Lift Arm Cylinder
Bottom End Port
Rod End Port
Control Valve
From #194 Terminal of Fuse Box B
Electromagnet on Lift Arm Lowering End
Bucket
Pilot Valve for Lift Arm
Pilot Pump
Lift Arm
Main Pump
Hydraulic Oil Tank
T4GB-02-01-034

Lift Arm Kick-out Control (ZW220)

Purpose: Automatically locating the lift arm at proper height in returning the lift arm to the highest position

Operation:

1. When lowering the lift arm, the plate is located in front of the lift arm proximity switch.
   While the plate passes by the lift arm proximity switch, the lift arm proximity switch becomes ON, and the electromagnet on the lift arm end is also excited.
2. When the lift arm operation lever is moved farther than the lift arm raising detent position (position to pull farther than the raising position), the bucket operation lever is retained by the electromagnet on the lift arm raising end, and pressure oil from the pilot valve moves the lift arm spool of the control valve toward raising.
3. Pressure oil from the main pump flows into the bottom end of the lift cylinder through the lift arm spool of the control valve, and extends the lift arm cylinder. When the lift arm cylinder is extended, the plate also passes by the lift arm proximity switch.
4. When the plate becomes distant from the lift arm proximity switch, the lift arm proximity switch is turned OFF, and the electromagnet on the lift arm raising end is also turned OFF, which makes the lift arm operation lever in the neutral position. As the lift arm spool of the control valve also returns to neutral, the lift arm cylinder stops. As a result, the lift arm stops.


Lift Arm
Proximity Switch
Plate
Lift Arm
Cylinder
Bottom End
Port
Rod End
Port
Control Valve
Bucket
From #194 Terminal
of Fuse Box B
Pilot Valve
for Lift Arm
Lift Arm
Electromagnet
on Lift Arm Lowering End
Pilot
Pump
Main
Pump
Hydraulic Oil
Tank
T4GB-02-01-015

Lift Arm Kick-out Control (ZW250)

Purpose: Automatically locating the lift arm at proper height in returning the lift arm to the highest position

Operation:

1. When lowering the lift arm, the plate is located in front of the lift arm proximity switch.
   While the plate passes by the lift arm proximity switch, the lift arm proximity switch becomes ON, and the electromagnet on the lift arm end is also excited.
2. When the lift arm operation lever is moved farther than the lift arm raising detent position (position to pull farther than the raising position), the bucket operation lever is retained by the electromagnet on the lift arm raising end, and pressure oil from the pilot valve moves the lift arm spool of the control valve toward raising.
3. Pressure oil from the main pump flows into the bottom end of the lift cylinder through the lift arm spool of the control valve, and extends the lift arm cylinder. When the lift arm cylinder is extended, the plate also passes by the lift arm proximity switch.
4. When the plate becomes distant from the lift arm proximity switch, the lift arm proximity switch is turned OFF, and the electromagnet on the lift arm raising end is also turned OFF, which makes the lift arm operation lever in the neutral position. As the lift arm spool of the control valve also returns to neutral, the lift arm cylinder stops. As a result, the lift arm stops.

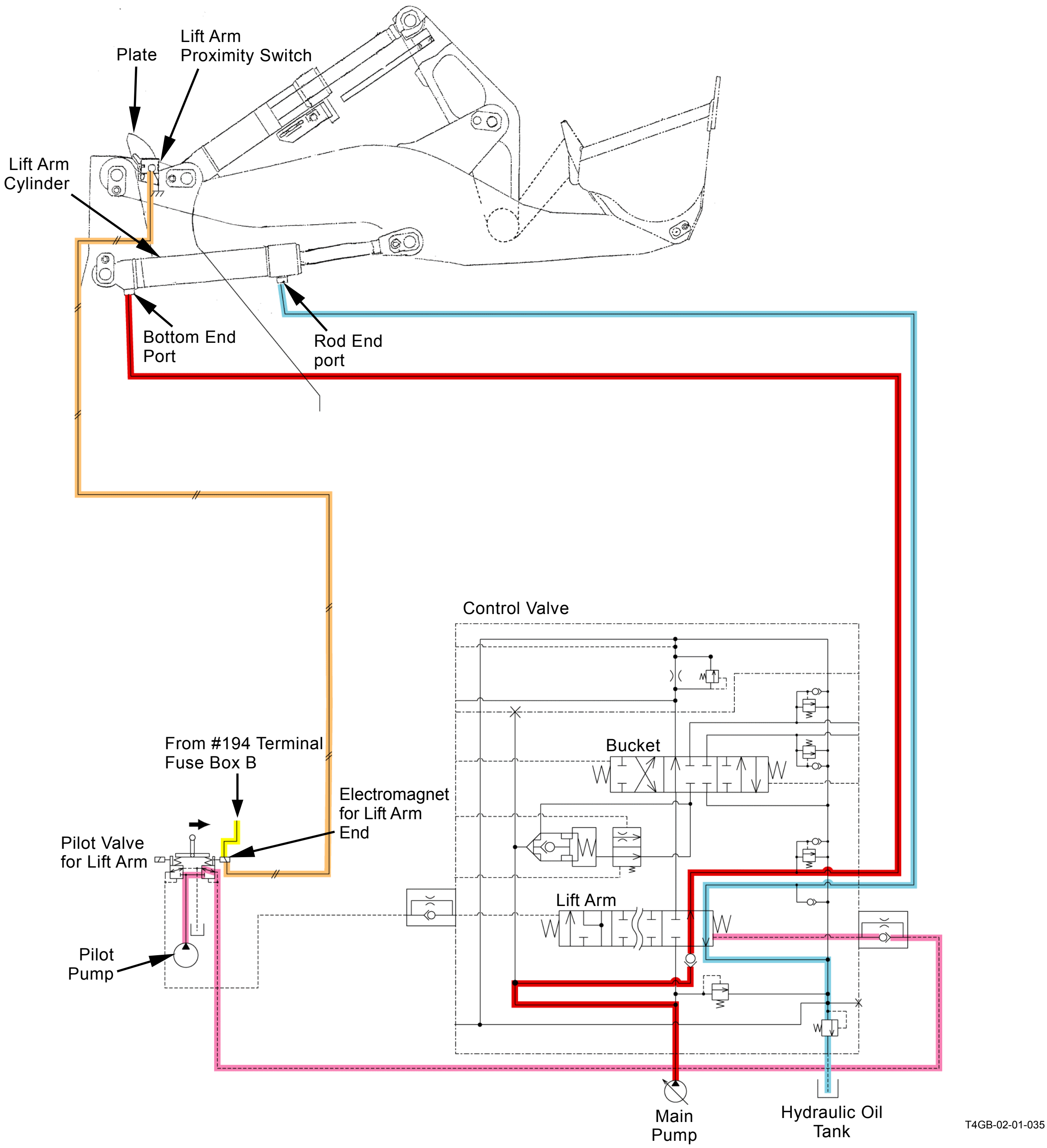


Plate
Lift Arm
Proximity Switch
Lift Arm
Cylinder
Bottom End
Port
Rod End
port
Control Valve
Bucket
From #194 Terminal
Fuse Box B
Electromagnet
for Lift Arm
End
Pilot Valve
for Lift Arm
Lift Arm
Pilot
Pump
Main
Pump
Hydraulic Oil
Tank
T4GB-02-01-035

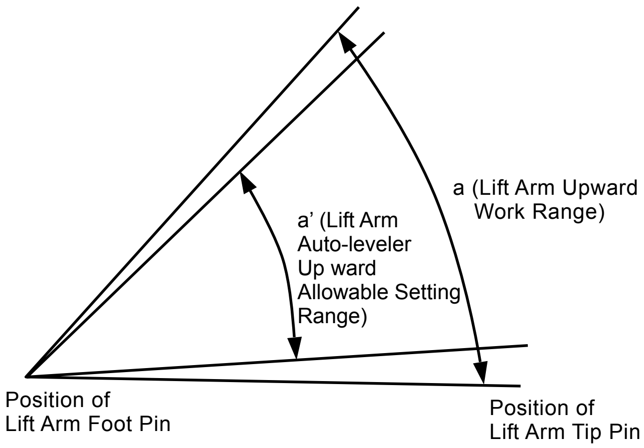
Lift Arm Auto-leveler Upward Control (Optional) (ZW220)

Purpose: Free locating of the lift arm between the horizon and the highest position

Operation:

1. If the SET position of the lift arm auto-leveler upward set switch is selected after the lift arm is located within the allowable location of the lift arm auto-leveler (a’ in the illustration), signal from the lift arm angle sensor is memorized by the MC, and that is the lift arm auto-leveler upward location.

NOTE: When the lift arm is outside a’, even if the SET position of the lift arm auto-leveler upward set switch is selected, setting of the lift arm auto- leveler upward cannot be made. In case setting was thus unsuccessful, or setting in a different position is needed, make setting again with the above in mind.

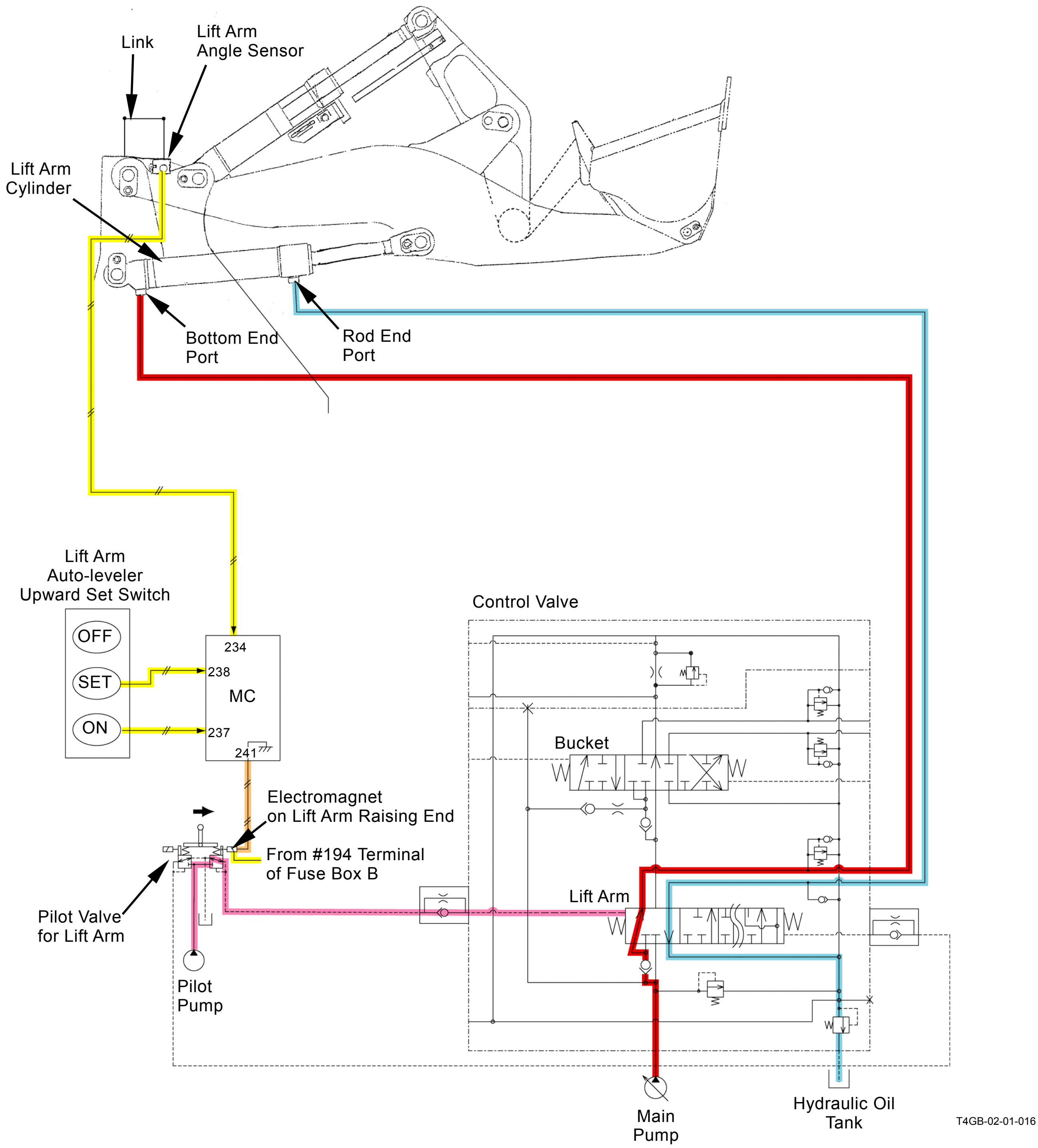


2. When the lift arm auto-leveler upward switch is turned ON, #241 terminal of the MC is earthed, and excites electromagnet on the lift arm upward end of the pilot valve. When the lift arm operation lever is moved to the lift arm upward detent position (position to pull farther than the upward position), the lift arm operation lever is retained by the electromagnet on the lift arm upward end, and pressure oil is supplied to the control valve from the pilot valve.
3. Pressure oil from the main pump flows into the bottom end port of the lift cylinder through the lift arm spool of the control valve, and raises the lift arm.
4. When the lift arm angle sensor moves up to the lift arm auto-leveler upward locating position, earthing of #241 terminal of the MC is released, and the electromagnet on the lift arm upward end is unexcited. Thus the lift arm operation lever returns to the neutral position, and supply of pressure oil from the pilot valve to the control valve is stopped.
5. As the lift arm spool of the control valve also returns to neutral, the lift arm stops at the lift arm auto-leveler upward stop position.

NOTE: Above the lift arm upward set position, the electromagnet on the lift arm raising end is always excited.

NOTE: In case the lift arm angle sensor becomes out of order, the lift arm auto-leveler upward control is not made.

IMPORTANT: In case either the lift arm angle sensor or the MC has been replaced, be sure to make learning control of the lift arm angle sensor. (Refer to the OPERATIONAL PERFORMANCE TEST/Adjustment)


Link
Lift Arm Angle Sensor
Lift Arm Cylinder
Bottom End Port
Rod End Port
Lift Arm Auto-leveler Upward Set Switch
OFF
SET
ON
234
238
MC
237
241
Control Valve
Bucket
Electromagnet on Lift Arm Raising End
From #194 Terminal of Fuse Box B
Pilot Valve for Lift Arm
Lift Arm
Pilot Pump
Main Pump
Hydraulic Oil Tank
T4GB-02-01-016

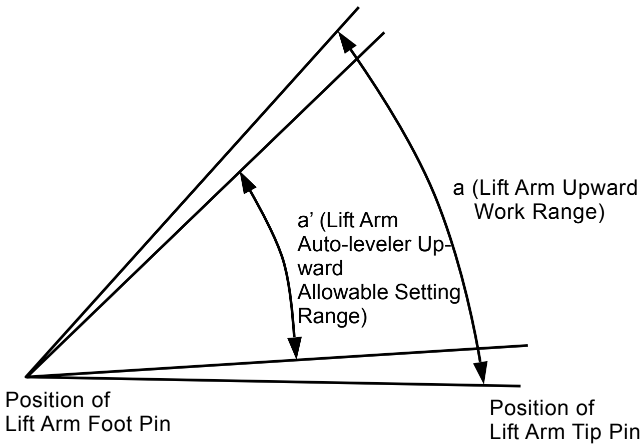
Lift Arm Auto-leveler Upward Control (Optional) (ZW250)

Purpose: Free locating of the lift arm between the horizon and the highest position

Operation:

1. If the SET position of the lift arm auto-leveler upward set switch is selected after the lift arm is located within the allowable location of the lift arm auto-leveler (a' in the illustration), signal from the lift arm angle sensor is memorized by the MC, and that is the lift arm auto-leveler upward location.

NOTE: *When the lift arm is outside a', even if the SET position of the lift arm auto-leveler upward set switch is selected, setting of the lift arm auto- leveler upward cannot be made. In case setting was thus unsuccessful, or setting in a different position is needed, make setting again with the above in mind.*

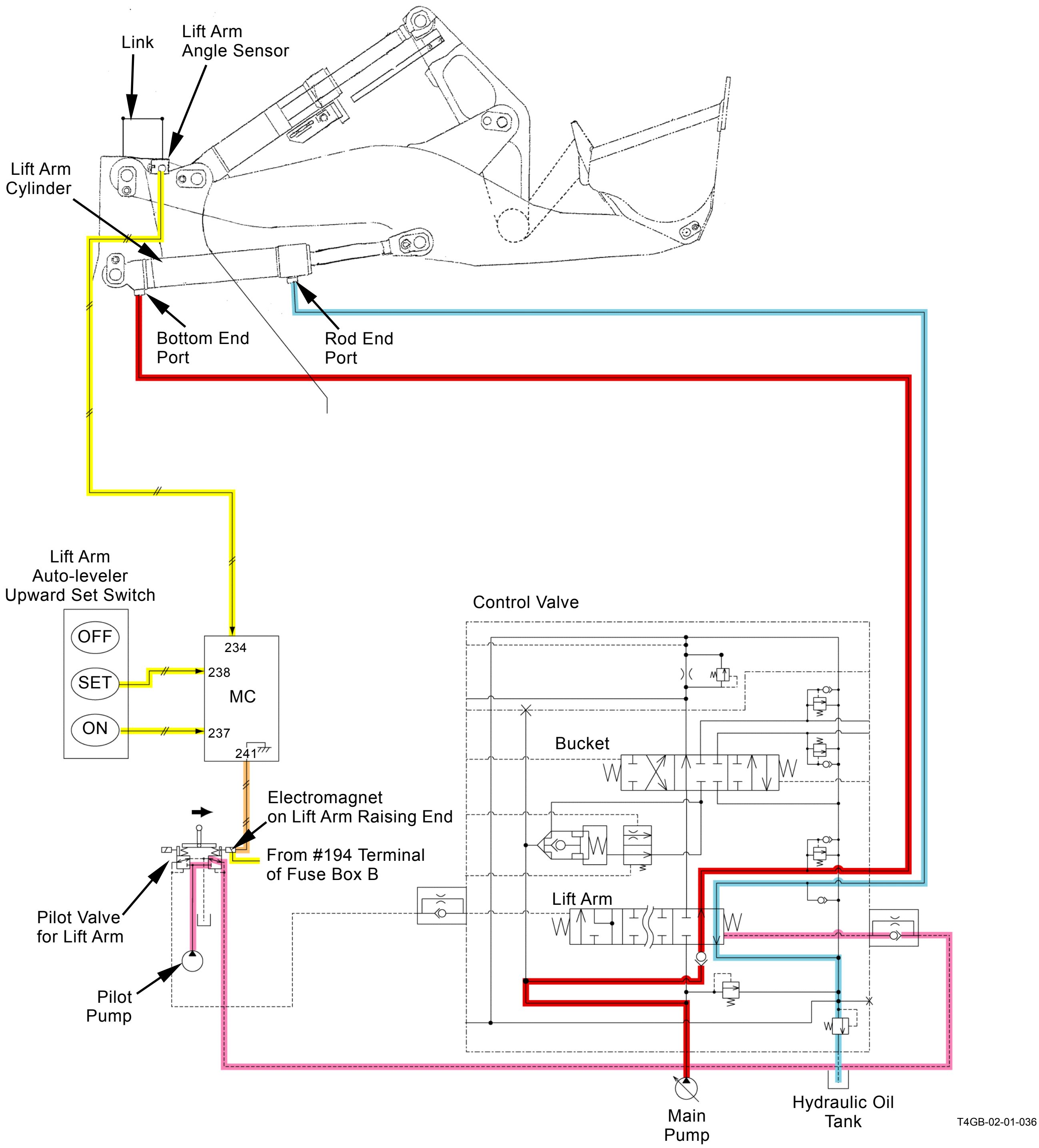


2. When the lift arm auto-leveler upward switch is turned ON, #241 terminal of the MC is earthed, and excites electromagnet on the lift arm upward end of the pilot valve. When the lift arm operation lever is moved farther than the lift arm upward detent position (position to pull farther than the upward position), the lift arm operation lever is retained by the electromagnet on the lift arm upward end, and pressure oil is supplied to the control valve from the pilot valve.
3. Pressure oil from the main pump flows into the bottom end port of the lift cylinder through the lift arm spool of the control valve, and raises the lift arm.
4. When the lift arm angle sensor moves up to the lift arm auto-leveler upward locating position, earthing of #241 terminal of the MC is released, and the electromagnet on the lift arm upward end. Thus the lift arm operation lever returns to the neutral position, and supply of pressure oil from the pilot valve to the control valve is stopped.
5. As the lift arm spool of the control valve also returns to neutral, the lift arm stops at the lift arm auto-leveler upward stop position.

NOTE: *Above the lift arm upward set position, the electromagnet on the lift arm raising end is always excited.*

NOTE: *In case the lift arm angle sensor becomes out of order, the lift arm auto-leveler upward control is not made.*

IMPORTANT: In case either the lift arm angle sensor or the MC has been replaced, be sure to make learning control of the lift arm angle sensor. (Refer to the OPERATIONAL PERFORMANCE TEST/Adjustment)



Link
Lift Arm
Angle Sensor
Lift Arm
Cylinder
Bottom End
Port
Rod End
Port
Lift Arm
Auto-leveler
Upward Set Switch
OFF
SET
ON
234
238
MC
237
241
Control Valve
Bucket
Electromagnet
on Lift Arm Raising End
From #194 Terminal
of Fuse Box B
Pilot Valve
for Lift Arm
Lift Arm
Pilot
Pump
Main
Pump
Hydraulic Oil
Tank
T4GB-02-01-036

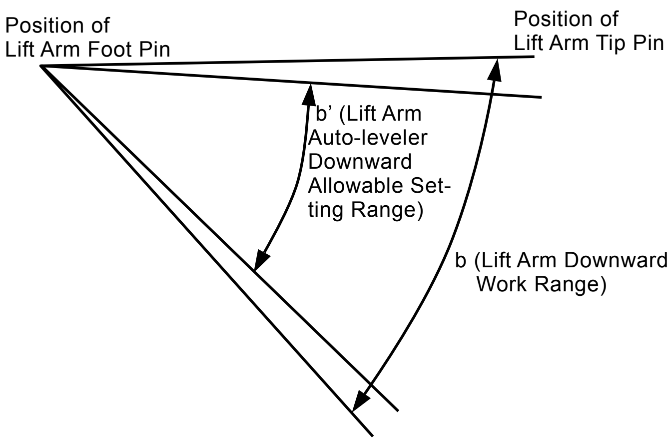
Lift Arm Auto-leveler Downward Control (Optional)(ZW220)

Purpose: Free locating of the lift arm between the horizon and the lowest position

Operation:

1. If the SET position of the lift arm auto-leveler downward set switch is selected after the lift arm is located within the allowable location of the lift arm auto-leveler (b' in the illustration), signal from the lift arm angle sensor is memorized by the MC, and that is the lift arm auto-leveler downward location.

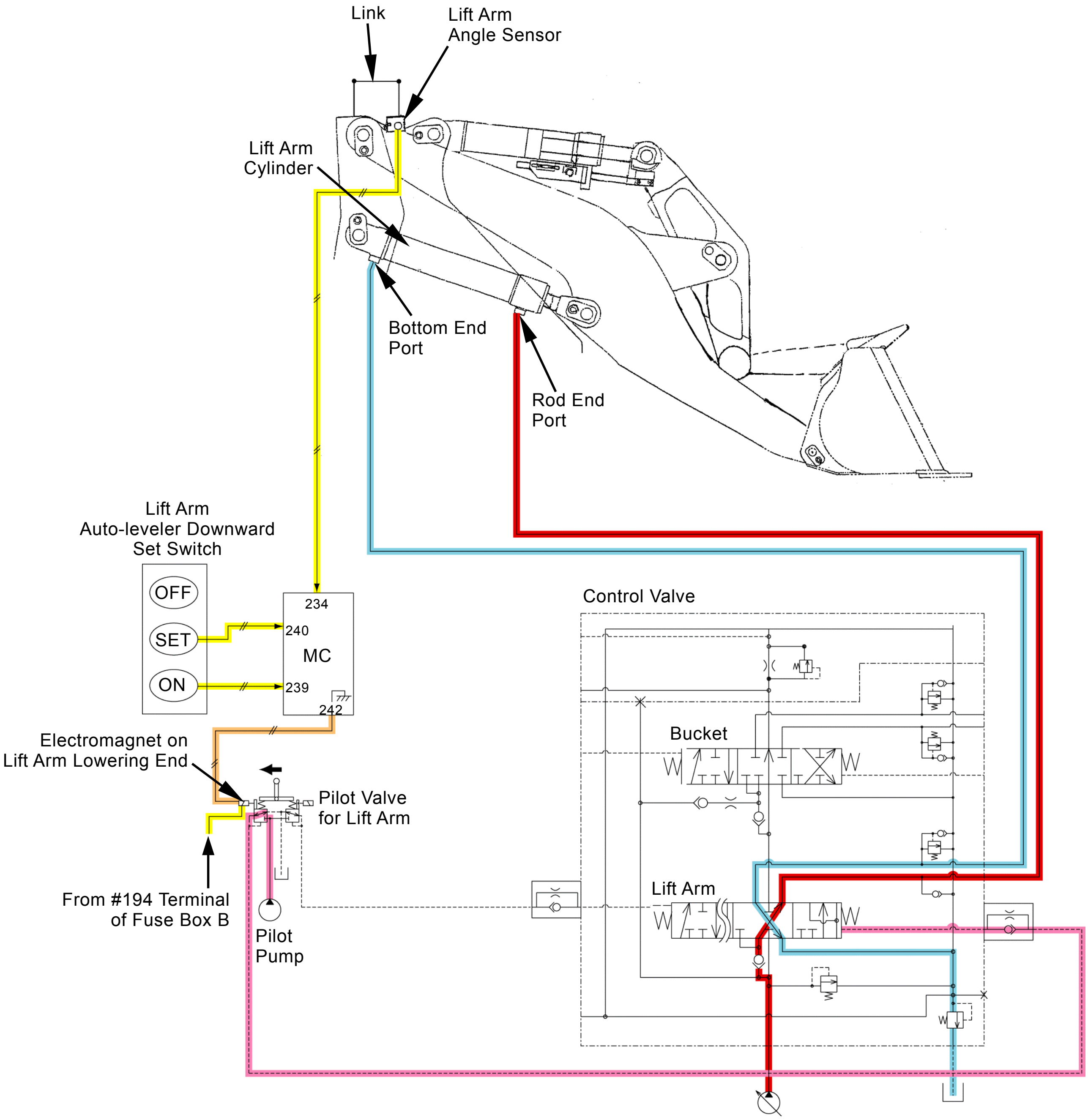
NOTE: *When the lift arm is outside b', even if the SET position of the lift arm auto-leveler downward set switch is selected, setting of the lift arm auto- leveler downward cannot be made. In case setting was thus unsuccessful, or setting in a different position is needed, make setting again with the above in mind.*



2. When the lift arm auto-leveler downward switch is turned ON, #242 terminal of the MC is earthed, and excites electromagnet on the lift arm downward end of the pilot valve. When the lift arm operation lever is moved to the lift arm downward detent position (position farther than the downward position), the lift arm operation lever is retained by the electromagnet on the lift arm downward end, and pressure oil is supplied to the control valve from the pilot valve.
3. Pressure oil from the main pump flows into the rod end port of the lift cylinder through the lift arm spool of the control valve, and lowers the lift arm.
4. When the lift arm angle sensor moves down to the lift arm auto-leveler downward locating position, earthing of #242 terminal of the MC is released, and the electromagnet on the lift arm downward end is unexcited for a while until it is excited again soon after.
5. Thus the lift arm operation lever returns to the neutral position, and supply of pilot pressure from the pilot valve to the control valve is stopped.
6. As the lift arm spool of the control valve also returns to neutral, the lift arm stops at the lift arm auto-leveler downward stop position.

NOTE: *In case the lift arm angle sensor becomes out of order, the lift arm auto-leveler downward control is not made.*

IMPORTANT: In case either the lift arm angle sensor or the MC has been replaced, be sure to make learning control of the lift arm angle sensor. (Refer to the OPERATIONAL PERFORMANCE TEST/Adjustment)



T4GB-02-01-017

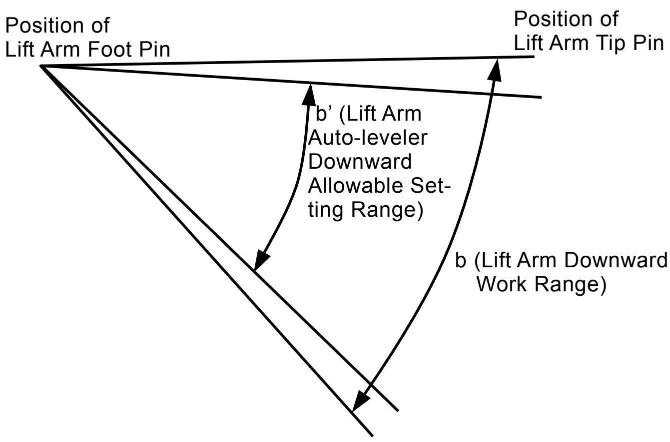
Lift Arm Auto-leveler Downward Control (Optional)(ZW250)

Purpose: Free locating of the lift arm between the horizon and the lowest position

Operation:

1. If the SET position of the lift arm auto-leveler downward set switch is selected after the lift arm is located within the allowable location of the lift arm auto-leveler (b' in the illustration), signal from the lift arm angle sensor is memorized by the MC, and that is the lift arm auto-leveler downward location.

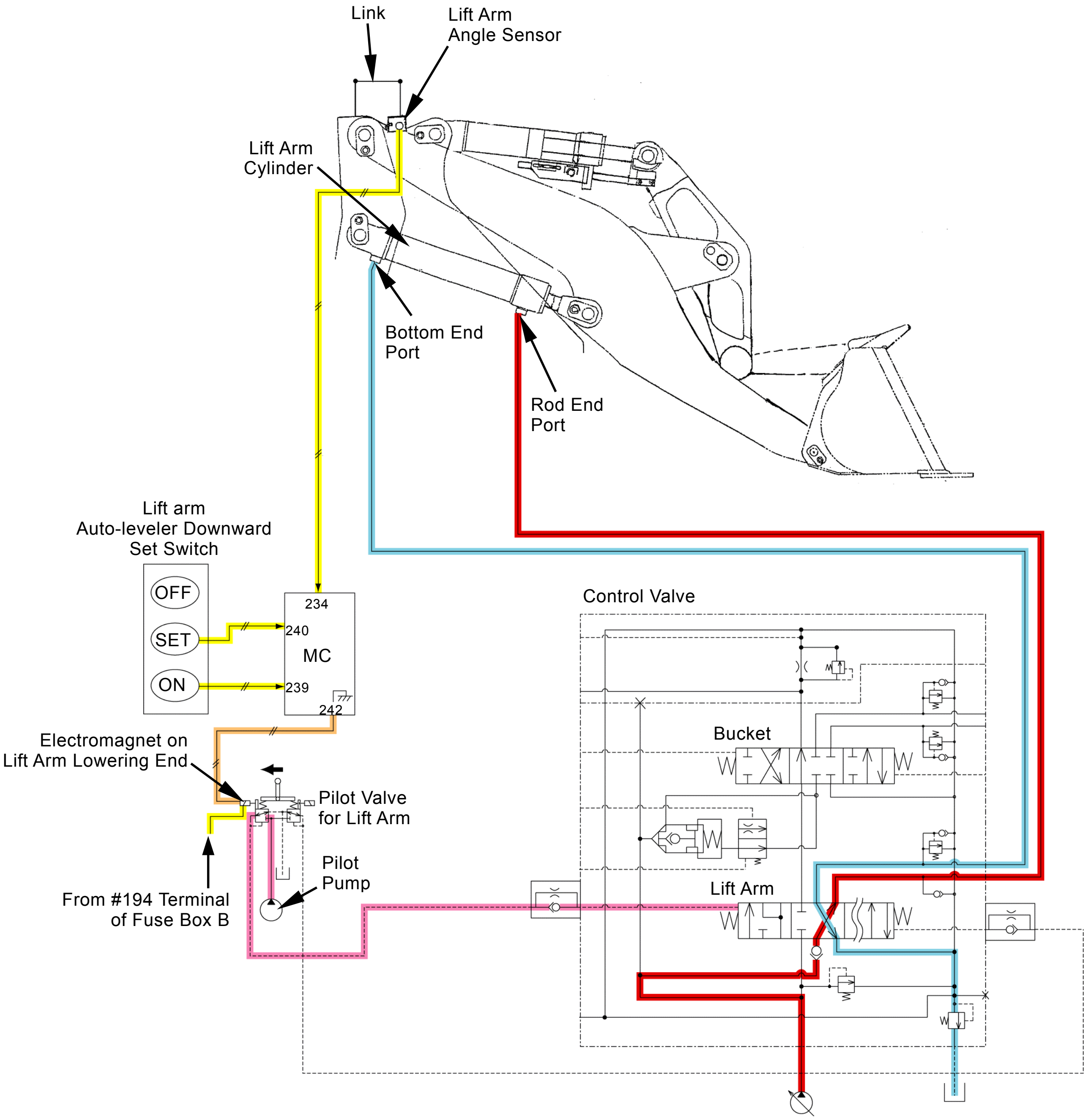
NOTE: When the lift arm is outside b', even if the SET position of the lift arm auto-leveler downward set switch is selected, setting of the lift arm auto- leveler downward cannot be made. In case setting was thus unsuccessful, or setting in a different position is needed, make setting again with the above in mind.



2. When the lift arm auto-leveler downward switch is turned ON, #242 terminal of the MC is earthed, and excites electromagnet on the lift arm downward end of the pilot valve. When the lift arm operation lever is moved to the lift arm downward detent position (position farther than the downward position), the lift arm operation lever is retained by the electromagnet on the lift arm downward end, and pressure oil is supplied to the control valve from the pilot valve.
3. Pressure oil from the main pump flows into the rod end port of the lift cylinder through the lift arm spool of the control valve, and lowers the lift arm.
4. When the lift arm angle sensor moves down to the lift arm auto-leveler downwards locating position, earthing of #242 terminal of the MC is released, and the electromagnet on the lift arm downward end is unexcited for a while until it is excited again soon after.
5. Thus the lift arm operation lever returns to the neutral position, and supply of pilot pressure from the pilot valve to the control valve is stopped.
6. As the lift arm spool of the control valve also returns to neutral, the lift arm stops at the lift arm auto-leveler downward stop position.

NOTE: In case the lift arm angle sensor becomes out of order, the lift arm auto-leveler downward control is not made.

IMPORTANT: In case either the lift arm angle sensor or the MC has been replaced, be sure to make learning control of the lift arm angle sensor. (Refer to the OPERATIONAL PERFORMANCE TEST/Adjustment)



T4GB-02-01-037

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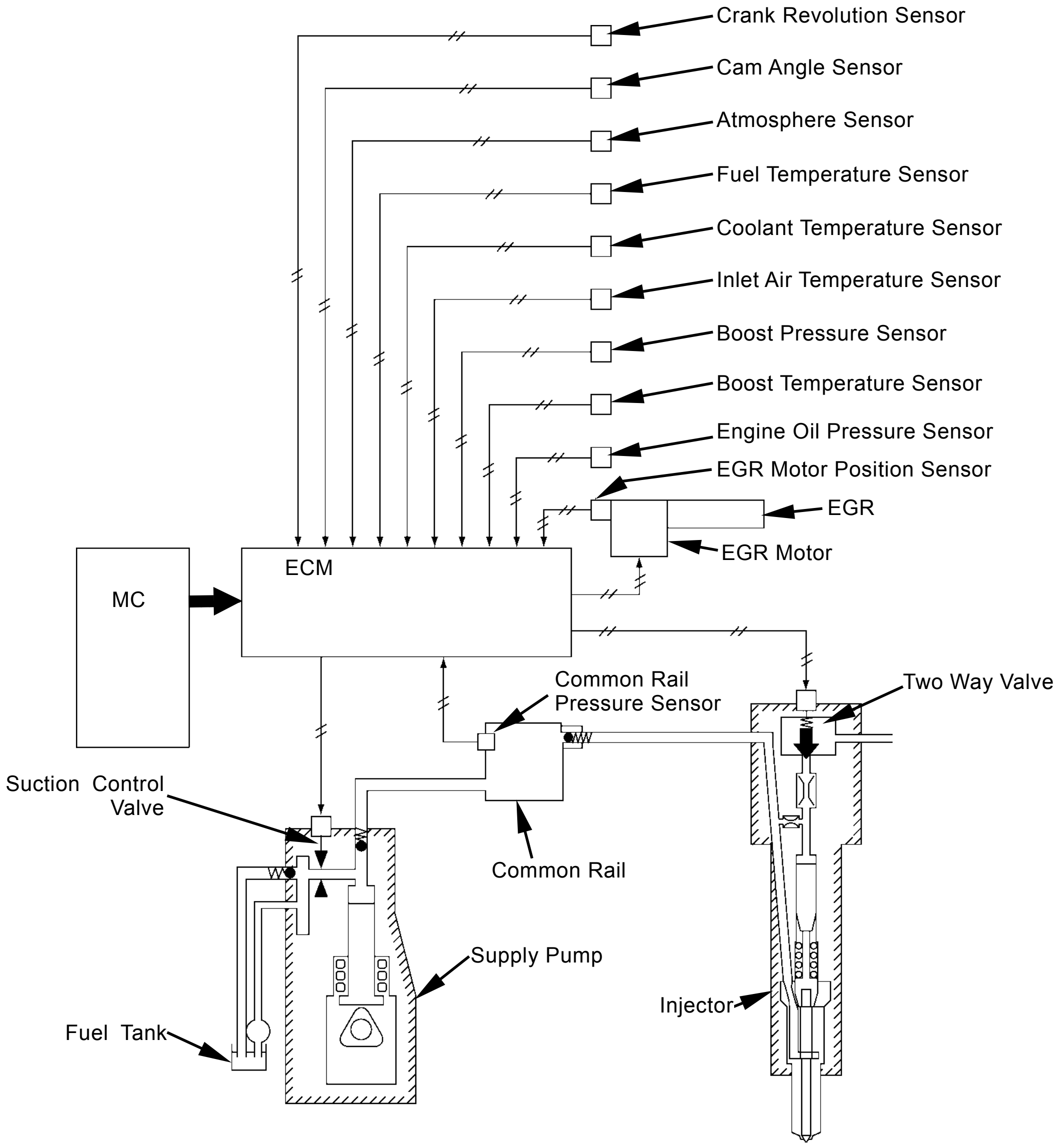
OUTLINE

Signals from sensors and MC (Main Controller) are input to ECM (Engine Control Module).
ECM calculates and drives two way valve, suction control valve and EGR motor in order to control supply pump, injector and EGR (Exhaust Gas Recirculation).

- Fuel Injection Control
- Engine Start Control
- EGR Control
- Correction of Fuel Injection Volume
- Engine Stop Control (Refer to System/Electric System)

- Supply pump is driven by engine and generates high pressure fuel.
- Common rail distributes high pressure fuel generated by supply pump to injector of each engine cylinder.
- Injector injects high pressure fuel from common rail.



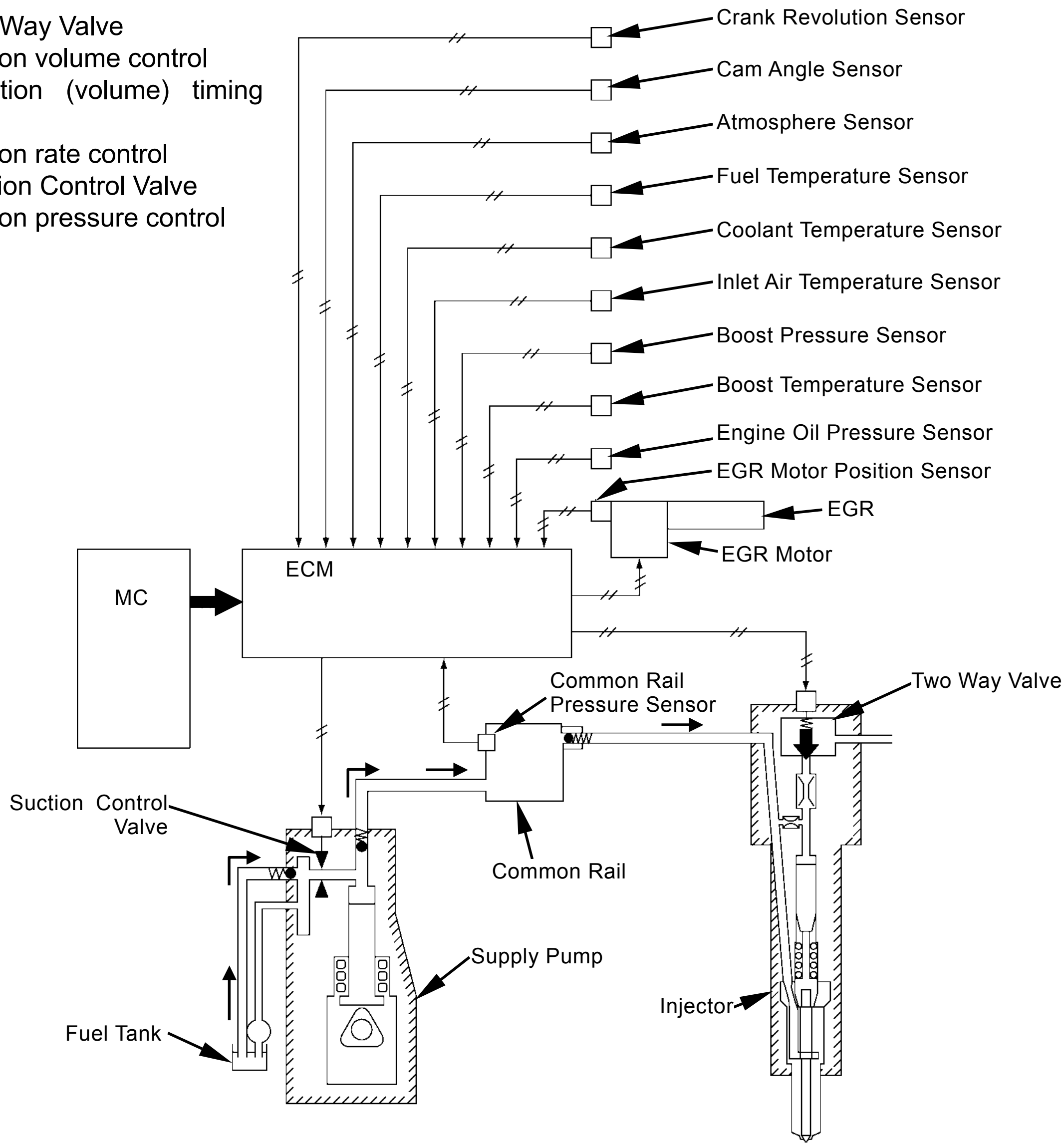
T4GB-02-02-022

FUEL INJECTION CONTROL

ECM monitors running state of engine according to signals from each sensor and MC. ECM controls the volume, pressure, timing and rate of fuel injection

Control by Two Way Valve
- Fuel injection volume control
- Fuel injection (volume) timing control
- Fuel injection rate control

Control by Suction Control Valve
- Fuel injection pressure control



T4GB-02-02-022

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Fuel Injection Volume Control

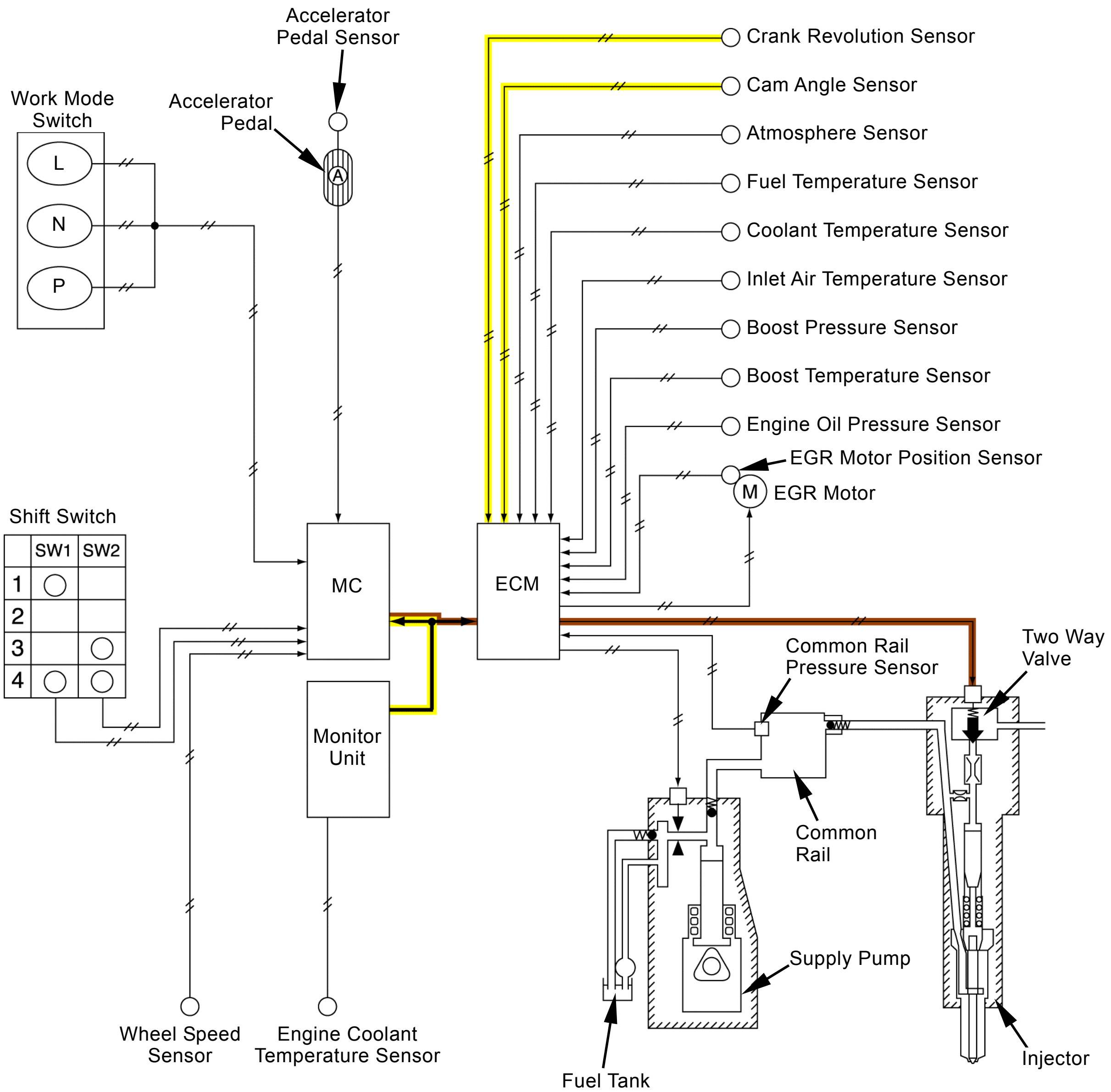
Function: Controls fuel injection volume in order to be optimum.

Operation:

1. ECM detects engine speed according to input signals from crank revolution sensor and cam angle sensor.
2. MC calculates target engine speed according to input signals from sensors and switches. MC sends signal to ECM. (Refer to System/Control System.)
3. ECM turns two way valve in the injector into ON or OFF mainly according to the engine speed and signal from MC in order to control fuel injection volume.

NOTE: Mode switches of the work mode switch are supplied with respectively different voltages from the monitor unit. MC judges the selected mode by the supplied voltage.

NOTE: Two switches are installed inside the shift switch, and the turning ON condition varies depending on the combination of speed shifts. MC judges the selected speed shift by the combination of two input currents.



T4GC-02-02-004

Fuel Injection Pressure Control

Function: Controls fuel injection pressure according to fuel pressure in common rail.

Operation:

1. ECM calculates fuel injection volume according to engine speed and target engine speed signal of MC. (Refer to Page T2-2-4).
2. Common rail pressure sensor sends signal corresponding to pressure in common rail to ECM.
3. ECM calculates appropriate pressure in common rail according to engine speed, fuel injection volume and common rail pressure sensor signal. ECM drives suction control valve in supply pump and appropriate volume of fuel to common rail.
4. Fuel in common rail is supplied to each engine cylinder through injector from common rail.

NOTE: Mode switches of the work mode switch are supplied with respectively different voltages from the monitor unit. MC judges the selected mode by the supplied voltage.

NOTE: Two switches are installed inside the shift switch, and the turning ON condition varies depending on the combination of speed shifts. MC judges the selected speed shift by the combination of two input currents.

Fuel Injection Timing Control

Function: Calculates appropriate fuel injection timing.

Operation:

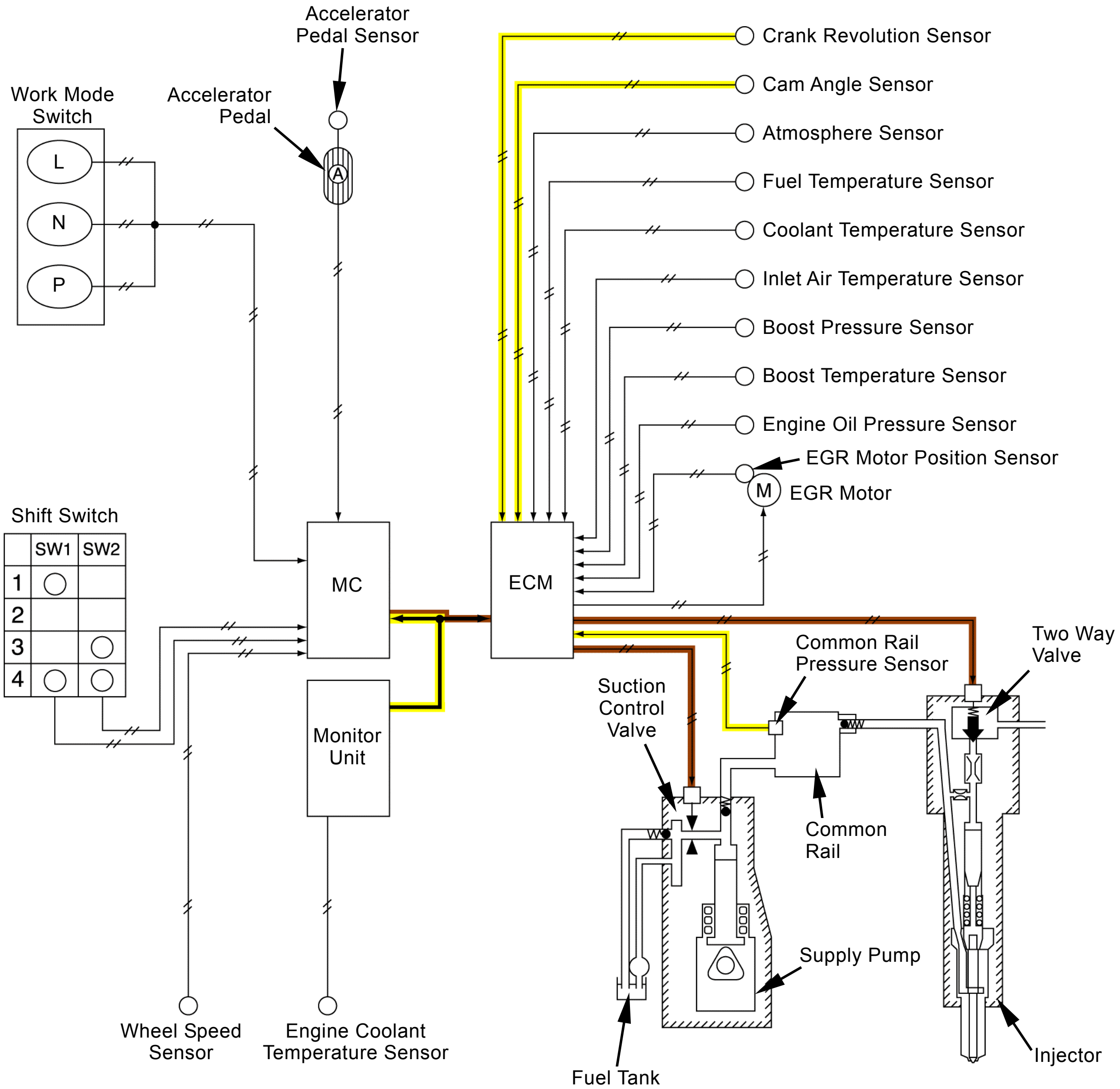
1. ECM calculates fuel injection timing according to engine speed and fuel injection volume.
2. ECM drives ON/OFF of two way valve in injector in order to control fuel injection timing.

Fuel Injection Rate Control

Function: Improves combustion inside the engine cylinders.

Operation:

1. Injector initially injects small amount of fuel (pilot injection) for ignition.
2. Injector executes the second injection (main injection) after ignition. ECM drives ON/OFF of two way valve in injector in order to control fuel injection timing and volume.

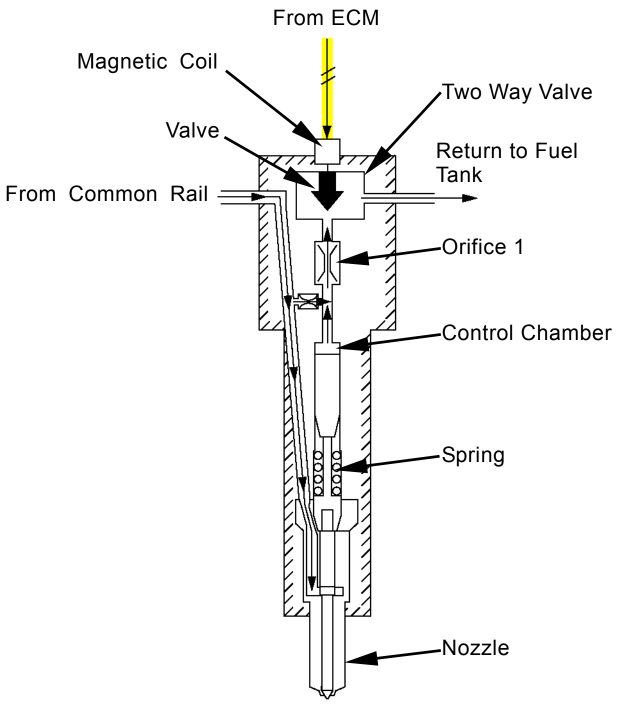


T4GC-02-02-005

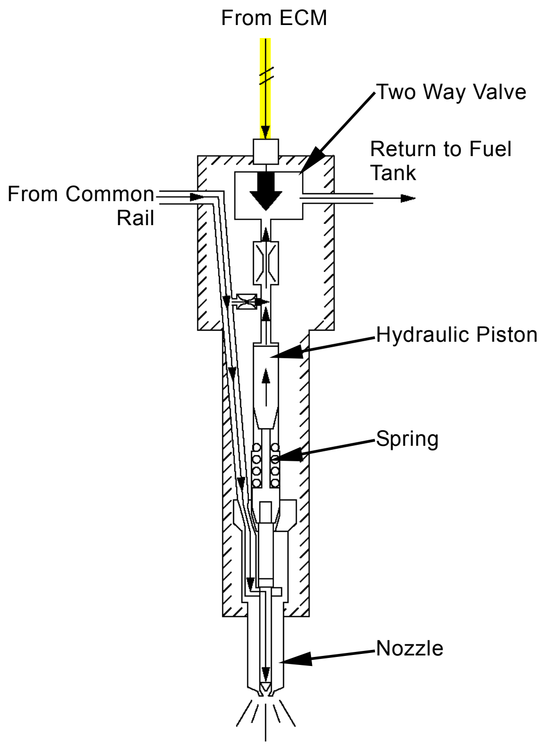
Fuel Injection

1. Fuel pressure is constantly applied to the injector nozzle.
2. When the magnetic coil of the two-way valve is turned ON, the valve is opened, and the high-pressure fuel in the control chamber returns to the fuel tank through Orifice 1.
3. Spring force raises the hydraulic piston, and the nozzle is opened to start injection.
4. When the magnetic coil of the two-way valve is turned OFF, the valve is closed, and the circuit leading to the fuel tank is closed.
5. In this way, the control chamber is filled with high-pressure fuel.
6. Difference of top and bottom pressure of the piston lowers the piston, and the nozzle is closed to finish injection.

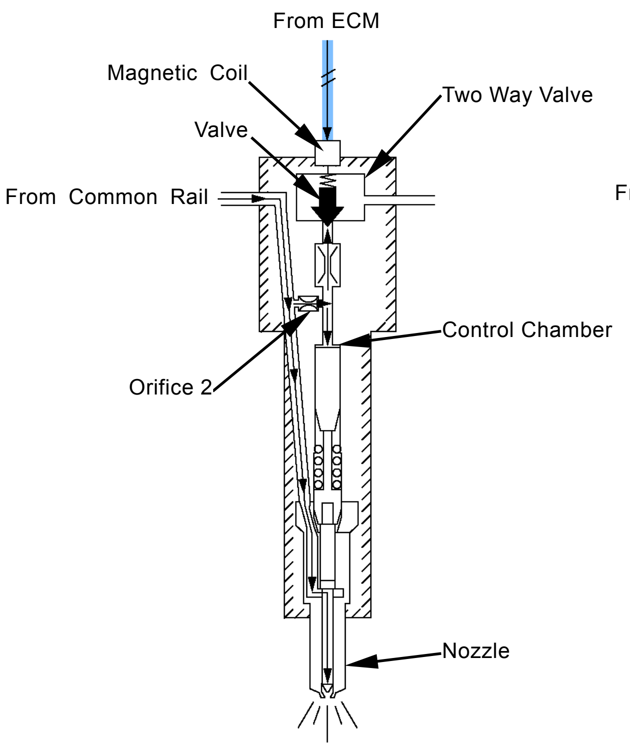
1. Two Way Valve: ON



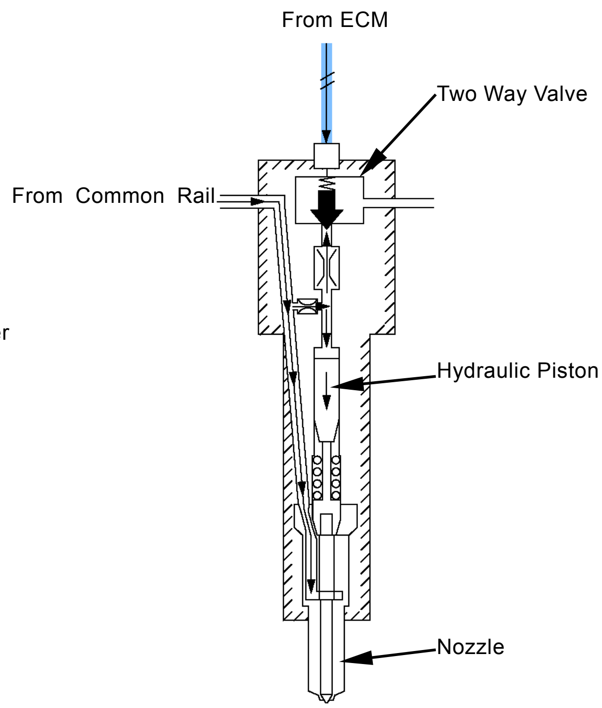
2. Fuel Injection Start



3. Two Way Valve: OFF



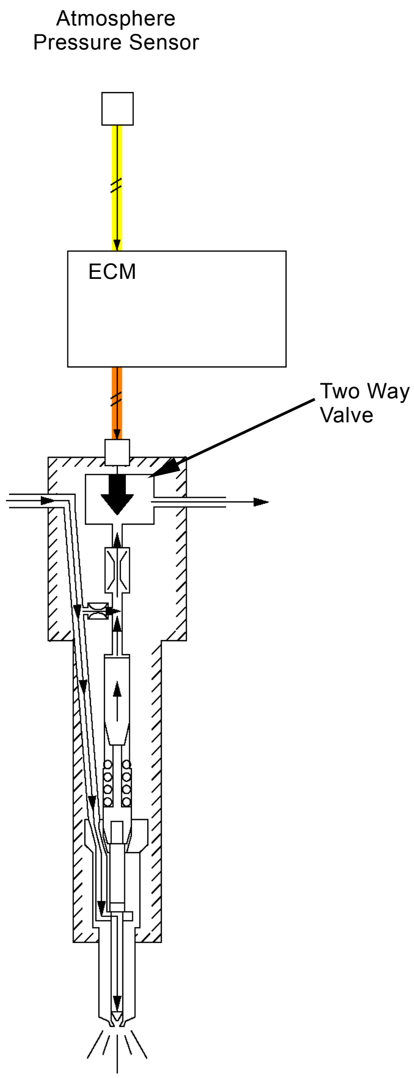
4. Fuel Injection Stop



T1GR-02-02-012

COMPENSATION OF FUEL INJECTION VOLUME

1. Atmosphere pressure sensor sends signal corresponding to atmospheric pressure to ECM.
2. ECM calculates atmospheric pressure according to input signal. ECM controls two way valve in injector and corrects of fuel injection volume.



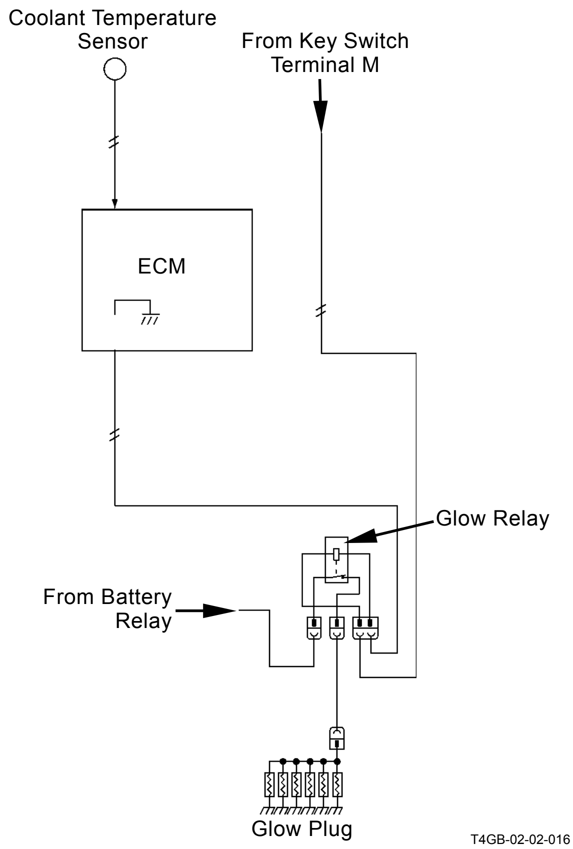
T1GR-02-02-002

ENGINE START CONTROL

Function: Controls energizing time of glow plug by coolant temperature and improves start-ability of engine.

Operation:

1. Coolant temperature sensor sends signal corresponding to coolant temperature to ECM.
2. ECM connects the ground circuit of glow relay according to signals and controls energizing time of glow plug.



EGR (EXHAUST GAS RECIRCULATION) CONTROL

Function: EGR controls lets part of exhaust gas recirculate inside intake manifold and mix it with intake air. Consequently, the combustion temperature is lowered and generation of nitrogen oxide (Nox) is reduced.

Operation:

- EGR Gas Amount Control

1. ECM determines amount of EGR gas according to engine speed, fuel flow rate, coolant temperature, atmospheric pressure and intake air temperature.
2. ECM drives the EGR motor, and opens the EGR valve. And transfer the EGR gas corresponding to the engine condition to the intake manifold to be mixed with the intake air.
3. At the same time, EGR motor position sensor detects amount of opening of EGR valve.

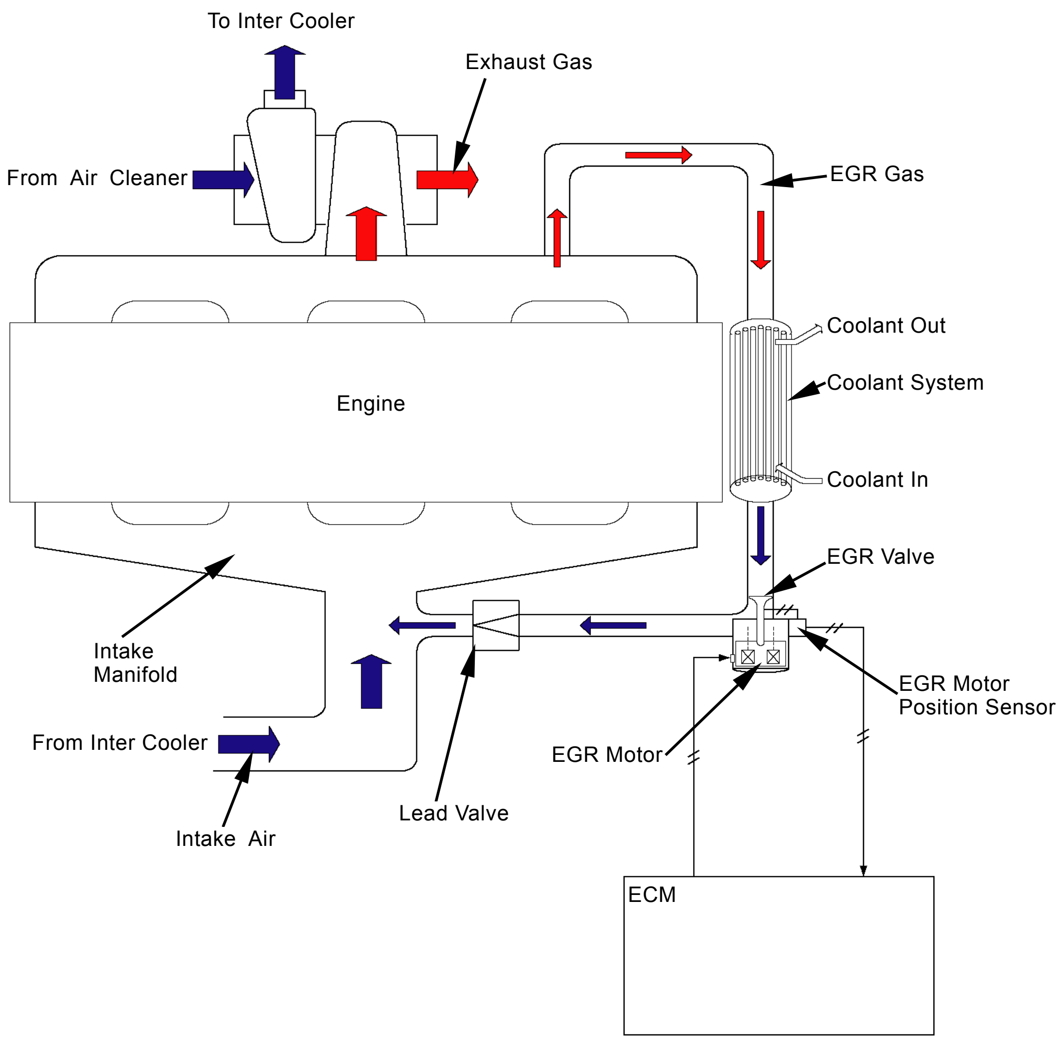
- EGR Gas Coolant

  EGR gas is cooled by coolant system located along EGR gas passage.

  By mixing the cooled EGR gas with the intake air, the combustion temperature is lowered, and the NOx is reduced in comparison with ordinary EGR gas.
- Lead Valve

  Lead valve prevents new air from entering into EGR gas passage and reverse flow of EGR gas.

  As EGR gas flows in one direction.



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OUTLINE

Hydraulic system is broadly be divided into the main circuit, pilot circuit, steering circuit, and hydraulic drive fan circuit.

- Main Circuit
  Main circuit consists of the priority valve circuit, neutral circuit, single operation circuit, and combined operation circuit – composed of the main pump, priority valve, control valve, cylinders, etc.

- Pilot Circuit
  Pilot circuit consists of the charging block circuit, front attachment operation control circuit, pump control circuit, brake circuit, and ride control circuit (optional) – composed of the pilot pump, charging block and valves for controlling each circuit.

- Steering Circuit
  Steering circuit consists of the normal steering circuit, steering shock damping circuit, emergency steering circuit (optional), steering stop circuit– composed of the pump, priority valve, steering valve, cylinders, and other valves.

- Hydraulic Drive Fan Circuit
  Hydraulic drive fan circuit consists of the flow control circuit and reverse rotation control circuit – composed of the motor for radiator cooling fan and the pump for radiator cooling fan.

NOTE: Steering circuit can be divided into the main circuit and the pilot circuit, but is described here as an single circuit for making explanation clear.

MAIN CIRCUIT

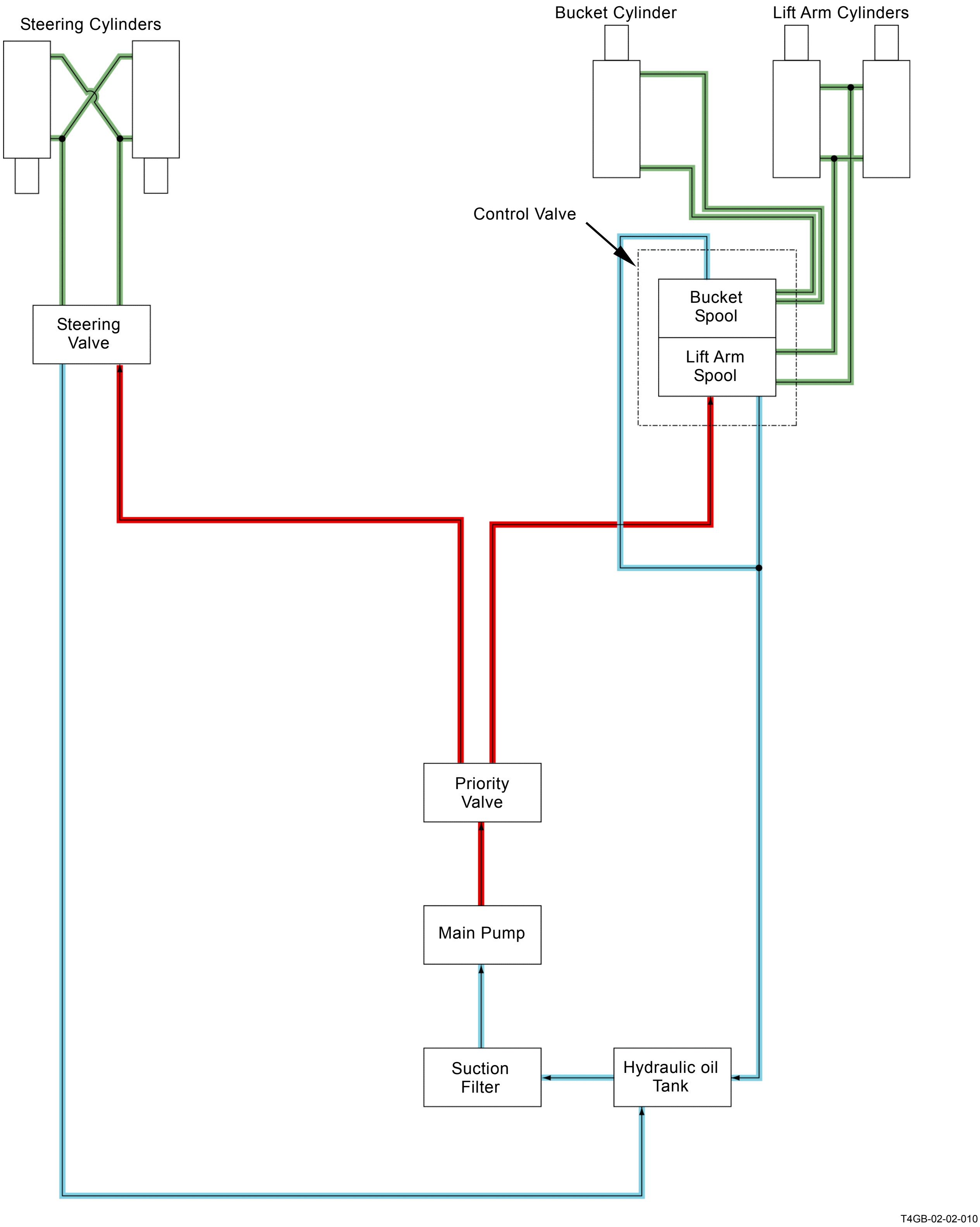
Outline

- Main pump draws hydraulic oil, from the hydraulic oil tank through the suction filter and delivers.

- Delivered pressure oil flows to the steering valve and the control valve through the priority valve.

- Pressure oil led to the steering valve flows to the steering cylinders in response to operation of the spool in the steering valve and the return oil flows back to the hydraulic oil tank through the steering valve.

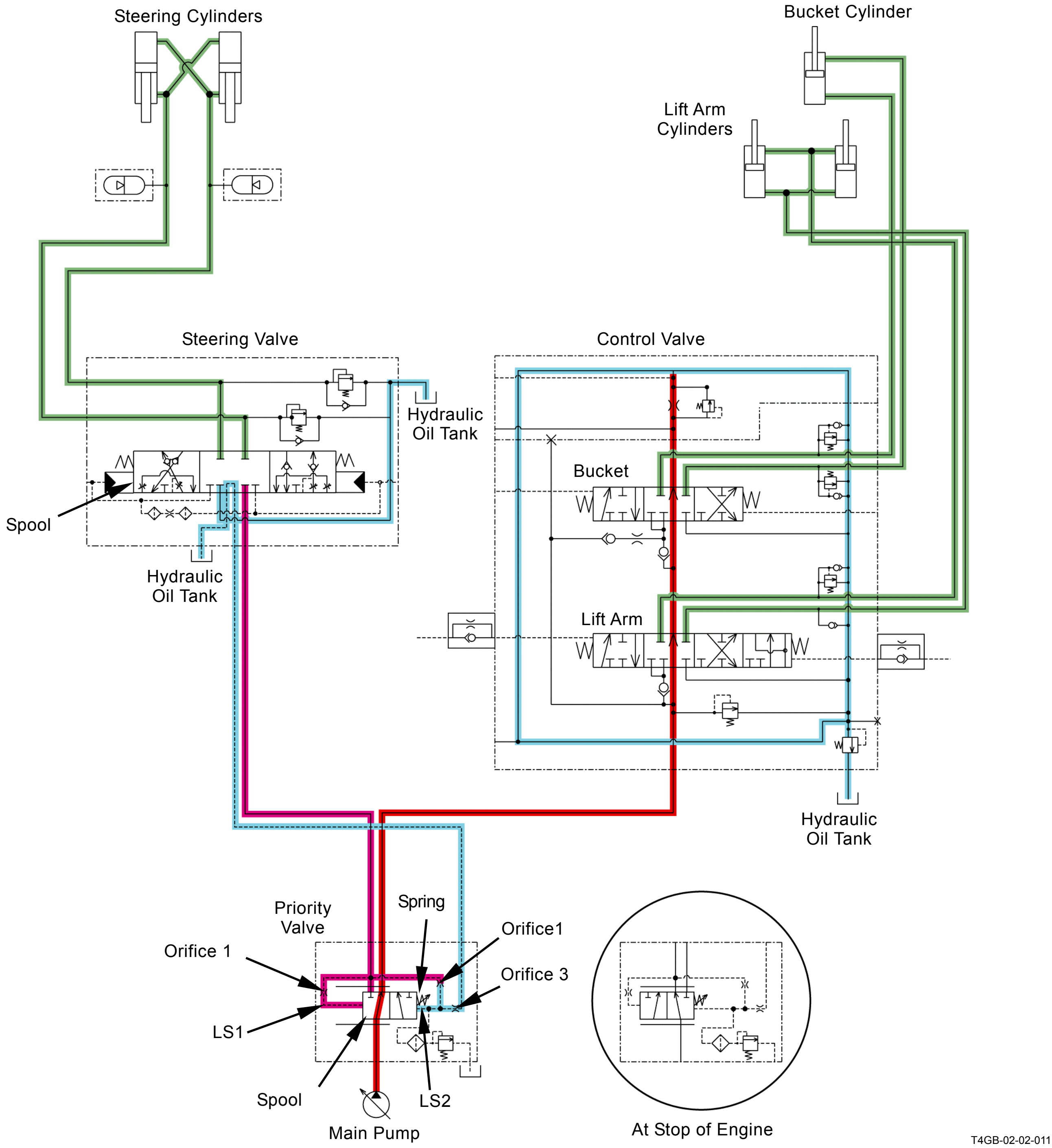
- Pressure oil led to the control valve flows to the cylinders in response to operation of the spool in the control valve, and the return oil flows back to the hydraulic oil tank through the control valve.


Steering Cylinders
Bucket Cylinder
Lift Arm Cylinders
Control Valve
Bucket Spool
Lift Arm Spool
Steering Valve
Priority Valve
Main Pump
Suction Filter
Hydraulic oil Tank
T4GB-02-02-010

Priority Valve Circuit

- At stop of the engine, the priority valve spool is pushed leftward, by the spring force.
- When the engine is started, pressure oil from the main pump flows toward the steering valve through the priority valve spool, while also entering Ports LS1 and LS2 through Orifices 1 and 2 respectively.
- At neutral of the steering valve, pressure oil led to Port LS2 flows to the hydraulic oil tank through Orifice 3 and the steering valve spool, so Port LS2 is not pressurized.
- As pressure at LS1 causes larger force than the spring force, the priority valve spool moves right, and pressure oil from the main pump is all supplied to the control valve.
- Priority valve spool is provided with a notch for leading pressure oil from the main pump toward the steering valve and a notch for leading pressure oil from the main pump toward the control valve, which are both connected to the main pump delivery port constantly.
- When the priority valve spool moves right, the notch for leading pressure oil from the main pump toward the steering valve moves until the delivery port on the steering valve side in the priority valve is closed. When pressure balance is obtained and the spool stops moving.
- When the steering valve spool moves, the tank port connected with Port LS2 is closed.
- At this time, Port LS2 is connected with the main circuit through the steering valve spool, and pressure corresponding to movement of the steering valve spool arises at Port LS2.
- When pressure at Port LS2 and the spring force overcome pressure at Port LS1, the priority valve spool moves left.
- Larger the movement of the steering valve spool is, the higher the pressure at Port LS2 rises, the larger the priority valve spool moves left, and the more pressure oil from the main pump is supplied to the steering valve.

NOTE: Orifice 2 of the priority valve is installed for warming up the circuit by flowing pressure oil to the hydraulic oil tank from Port LS2 at neutral of the steering valve. Diameter of Port 2 is small, and temperature of the oil passing through it rises rapidly, but pressure is not raised enough to influence movement of the priority valve spool.



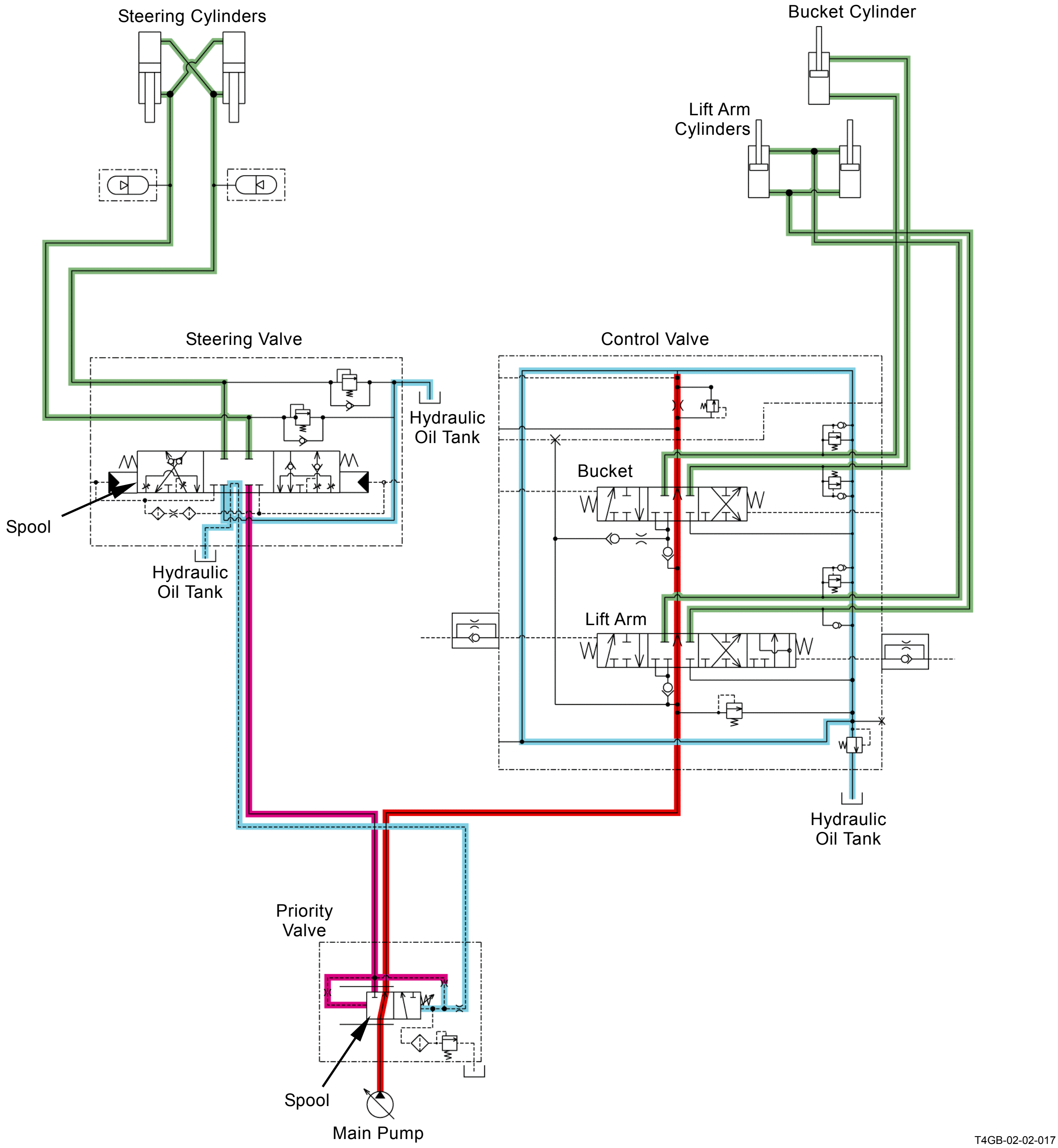
NOTE: Illustration shows oil flow in idling operation while the engine is rotating. Control valve illustrated is for ZW220.

Neutral Circuit

- At neutral position of the control lever, pressure oil from the main pump returns to the hydraulic oil tank through the neutral circuit of the control valve.
- Only when the steering valve spool moves actuated by the priority valve, pressure oil is supplied to the steering valve, the steering valve is not provided with a neutral circuit. (Refer to Priority Valve Circuit in this section.)

Single Operation Circuit

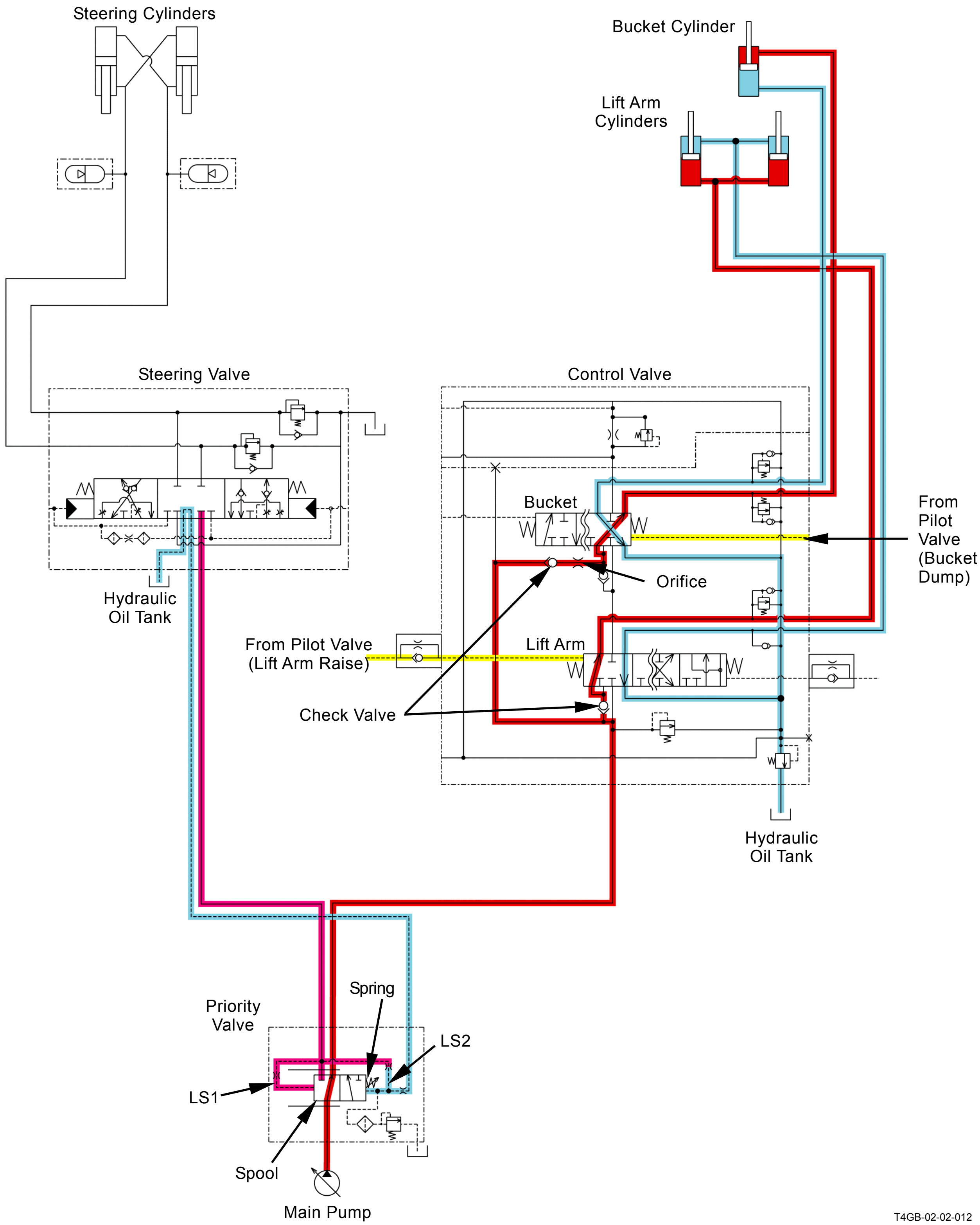
- Pressure oil from the main pump enters the control valve, and flows to the lift arm and bucket spools.
- When the steering valve spool moves, the priority valve spool moves left, and pressure oil from the main pump flows to the steering valve. (Refer to Priority Valve Circuit in this section.)



NOTE: Illustration shows oil flow in idling operation while the engine is rotating. Control valve illustrated is for ZW220.

Combined Operation Circuit (ZW220)

- Lift Arm Raising/Bucket Dumping
  - When the bucket is dumped with the lift arm raised, pilot pressure shifts the lift arm and bucket spools.
  - Pressure from the own pump is applied to Port LS1 of the priority valve, but Port LS2 is not pressurized because it is connected to the hydraulic oil tank port.
  - Pressure at Port LS1 causes larger force than the spring force of the priority valve, and moves the spool right.
  - Therefore, pressure oil from the main pump flows to the lift arm cylinders through the check valve in the control valve and the lift arm spool, and raises the lift arm.
  - Pressure oil from the main pump also flows to the buket cylinder through the check valve, orifice, and bucket spool in the control valve, and dumps the bucket.
  - Lift arm raising operation is more heavy loaded than the bucket dumping operation, but pressure oil passing the bucket operation circuit enters the bucket cylinder after passing the check valve and orifice, allowing smooth movement of both the lift arm cylinders and the buket cylinder.

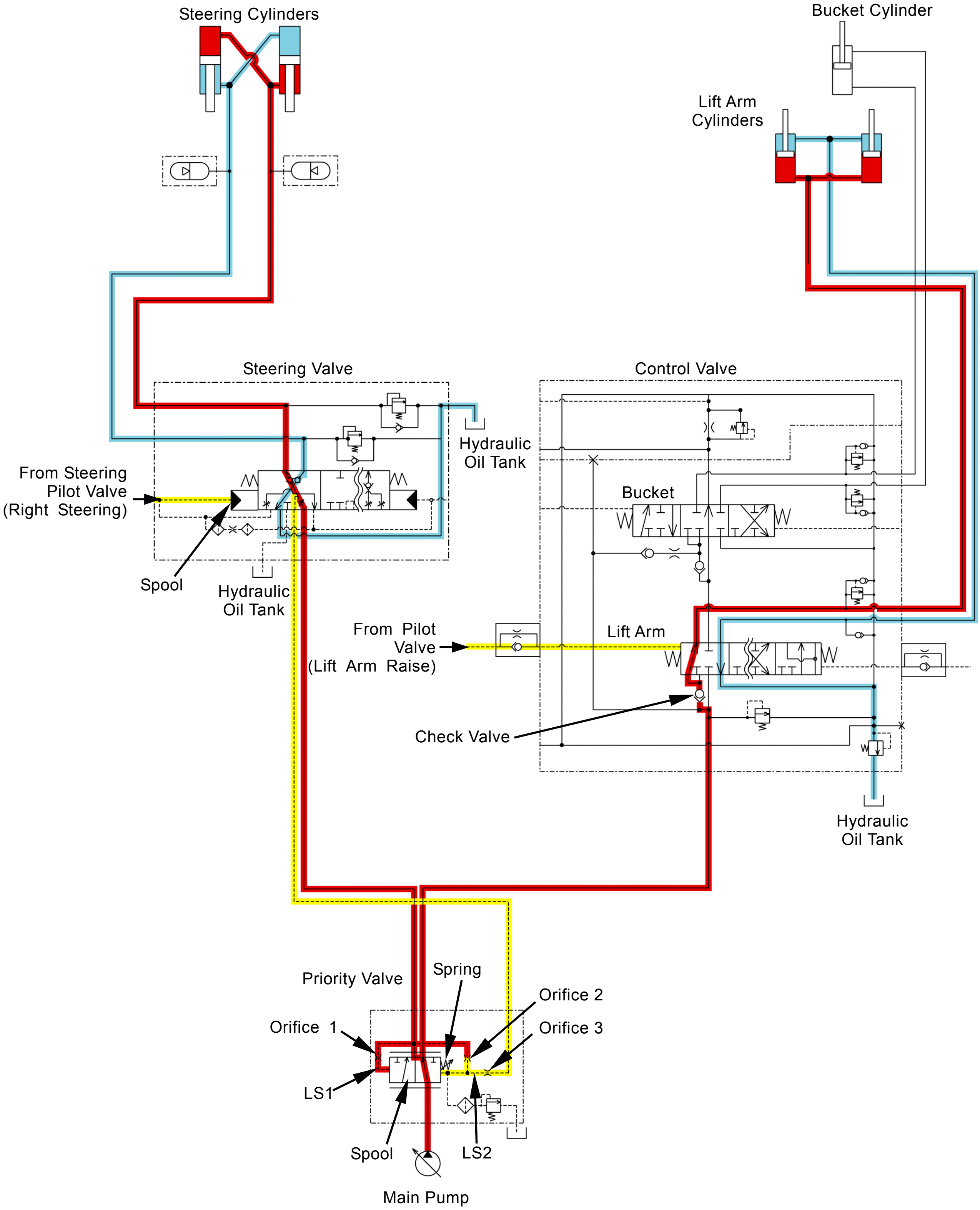


T4GB-02-02-012

- Lift Arm Raising/Steering Right
  - When the steering wheel is turned right with the lift arm raised, pilot pressure shifts the lift arm spool in the control valve and the steering valve spool.
  - Pressure from the own pump is applied to Port LS1 of the priority valve through Orifice 1, and main pressure returning from the steering valve spool through Orifice 3 and the spring force are applied to Port LS2.
  - Pressure at Port LS2 changes in proportion to the steering valve spool stroke, and when pressure at Port LS2 is low, the priority valve spool moves left slightly, and when it is high, the spool moves left drastically.
  - Flow rate and direction of the main pump are controlled by the leftward stroke of the priority valve spool, and the flow rate corresponding to the stroke flows to the steering valve, and the remainder flow rate flows to the control valve.

NOTE: *If the steering wheel is turned quickly and largely for reasons of avoiding danger or something, the priority valve spool largely moves left, and much of the pressure oil from the main pump is supplied to the steering valve, delaying movement of the front attachment.*

  - Pressure oil led to the steering valve flows to the steering cylinders, and the vehicle body turns right.
  - Pressure oil led to the control valve also flows to the lift arm cylinder though the check valve and the lift arm spool, and raises the lift arm.
  - In this way, steering and lift arm operations are simultaneously made.



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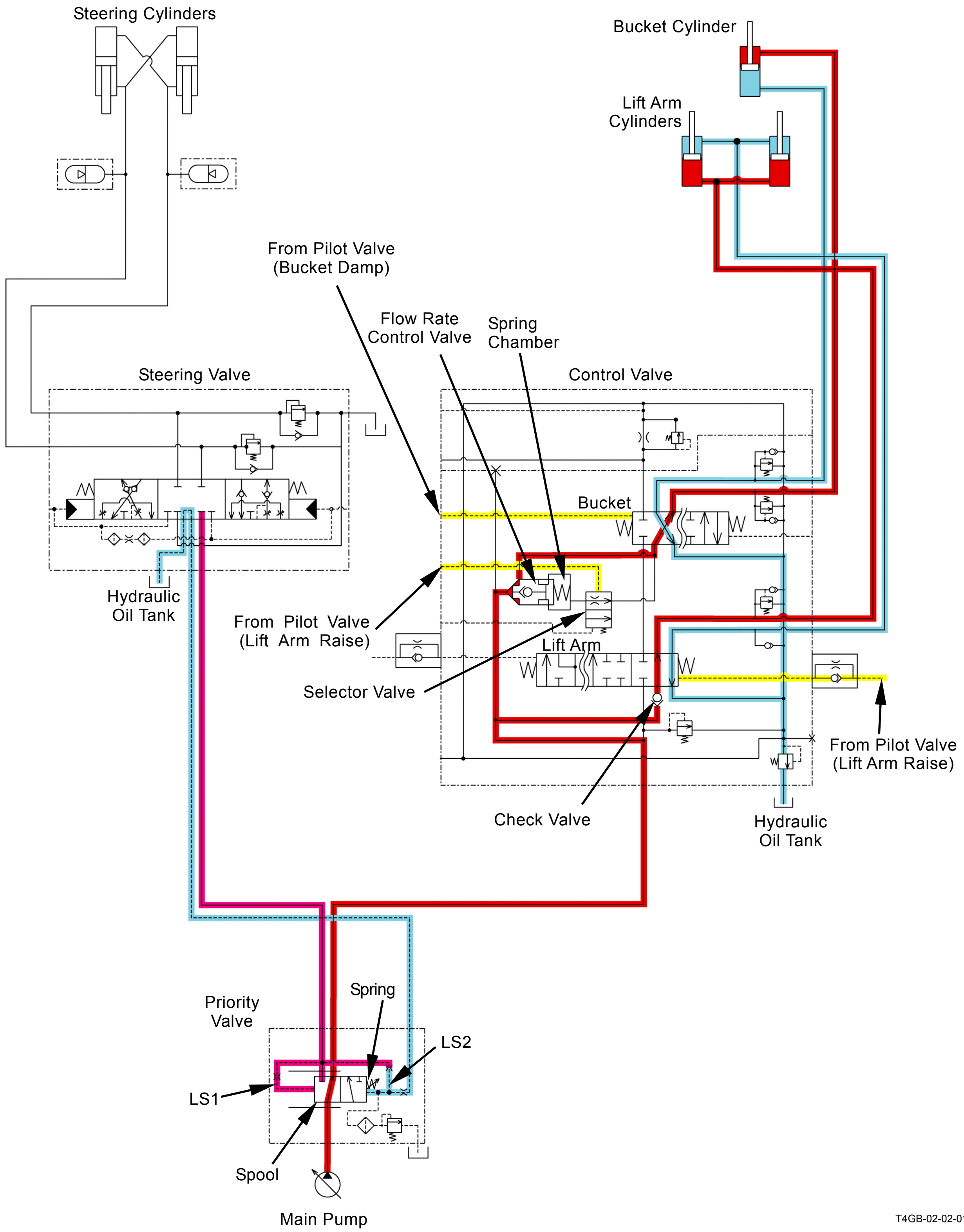
Combined Operation Circuit (ZW250)

- Lift Arm Raising/Bucket Dumping
  - When the bucket is dumped with the lift arm raised, pilot pressure shift the lift arm and bucket spools in the control valve.
  - Also, the same pilot pressure that changed the lift arm spool in the control valve shifts the selector valve spool downward as well.
  - Pressure from the own pump is applied to Port LS1 of the priority valve, but Port LS2 is not pressurized because it is connected to the hydraulic oil tank.
  - Pressure at Port LS1 causes larger force than the spring force of the priority valve, and moves the spool right.
  - By movement of the spool, pressure oil from the main pump flows to the lift arm cylinders through the check valve in the control valve and the lift arm spool, and raises the lift arm.
  - Pressure oil from the main pump also flows to the bucket cylinder though the flow rate control valve in the control valve and the bucket spool, and dumps the bucket.
  - Lift arm raising operation is more heavy loaded than the bucket dumping operation, but pressure inside the spring chamber rises in the bucket dumping operation because shift of the selector valve is over.
  - Raised pressure in the spring chamber prevents the flow rate control valve from moving much, and flow of pressure oil to the bucket spool is restricted.
  - As a result, flow rate to the lift arm cylinders is secured, causing smooth operation of the lift arm cylinders and bucket cylinder.

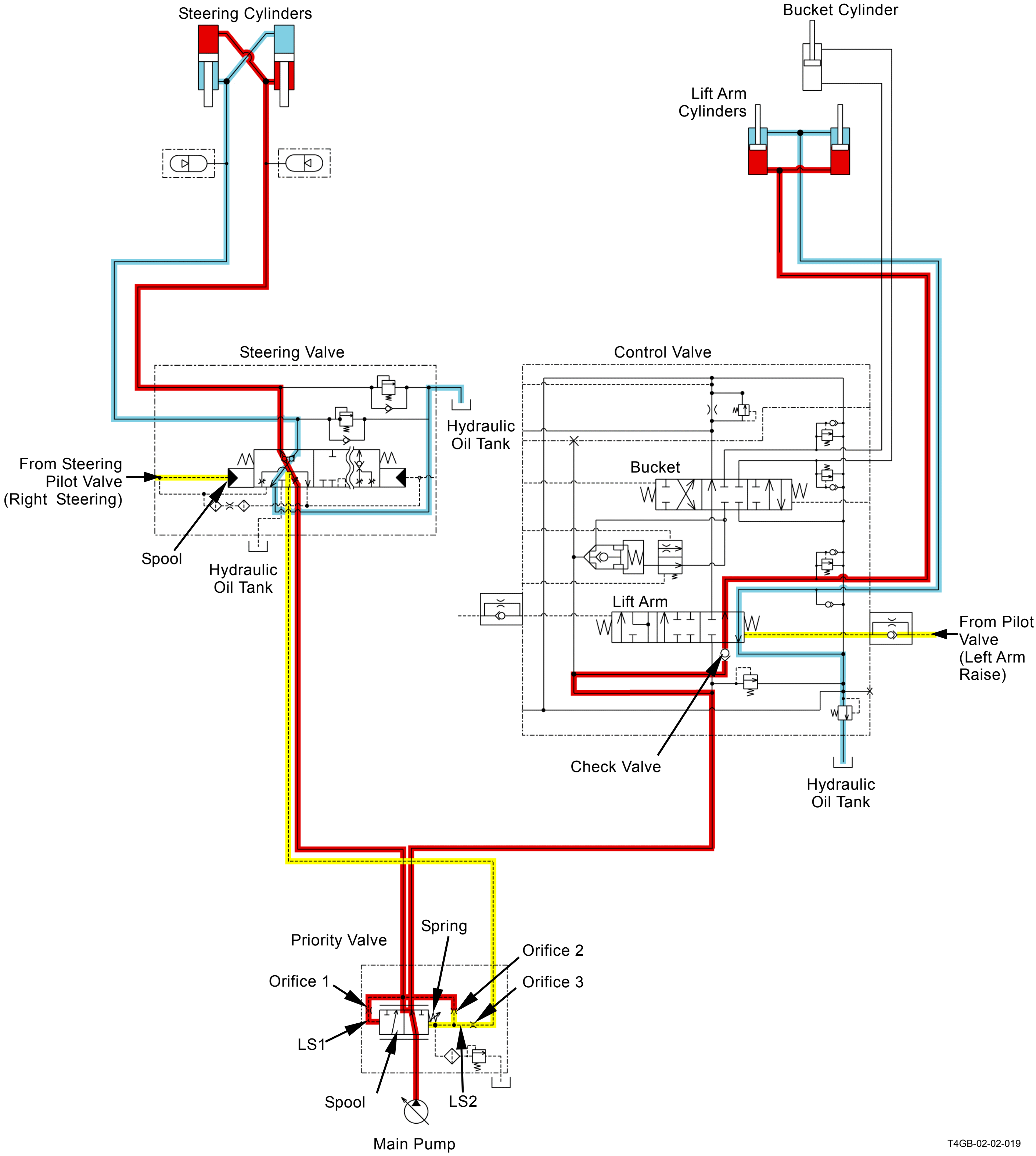


T4GB-02-02-018

- Lift Arm Raising/Steering right
  - When the steering wheel is turned right with the lift arm raised, pilot pressure shifts the lift arm spool in the control valve and the steering valve spool.
  - Pressure from the own pump is applied to Port LS1 of the priority valve through Orifice 1, and main pressure returning from the steering valve spool through Orifice 3 and the spring force are applied to Port LS2.
  - Pressure at Port LS2 changes in proportion to the steering valve spool stroke, and when pressure at Port LS2 is low, the priority valve spool moves left slightly, and when it is high, the spool moves left drastically.
  - Flow rate and direction of the main pump are controlled by the leftward stroke of the priority valve spool, and the flow rate corresponding to the stroke flows to the steering valve, and the remainder flow rate flows to the control valve.

NOTE: When the steering wheel is turned quickly and largely for reasons of avoiding danger or something, the priority valve spool largely moves left, and much of the pressure oil from the main pump is supplied to the steering valve, delaying movement of the front attachment.

  - Pressure oil led to the steering valve flows to the steering cylinders, and the vehicle body turns right.
  - Pressure oil led to the control valve also flows to the lift arm cylinders though the check valve and the lift arm spool, and raises the lift arm.
  - In this way, steering and lift arm operations are simultaneously made.



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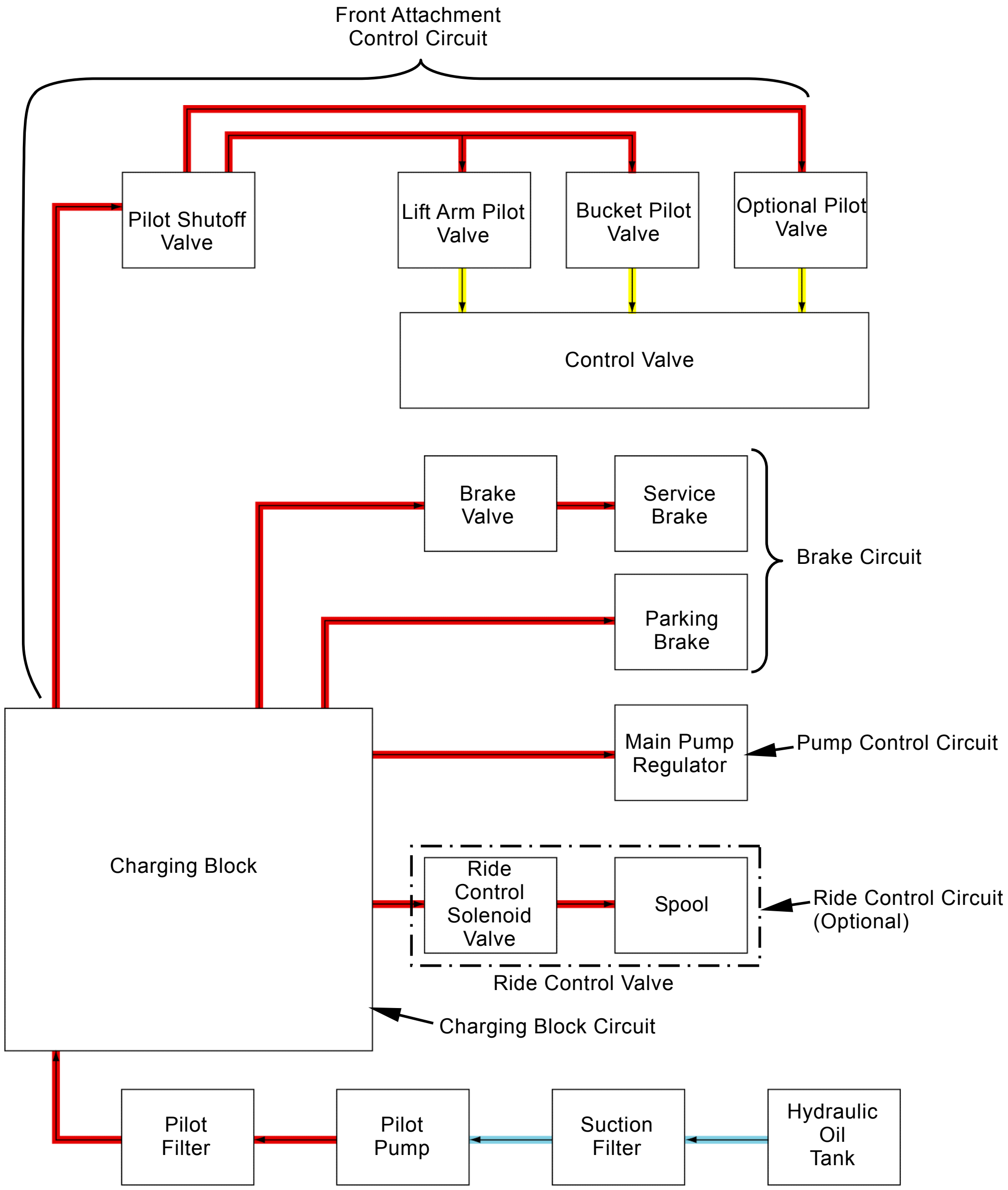
PILOT CIRCUIT

Outline:

Pressure oil from the pilot pump is used to operate the circuit below.

- Charging Block Circuit
- Front Attachment Operation Control Circuit
- Pump Control Circuit
- Brake Circuit
- Ride Control Circuit (Optional)



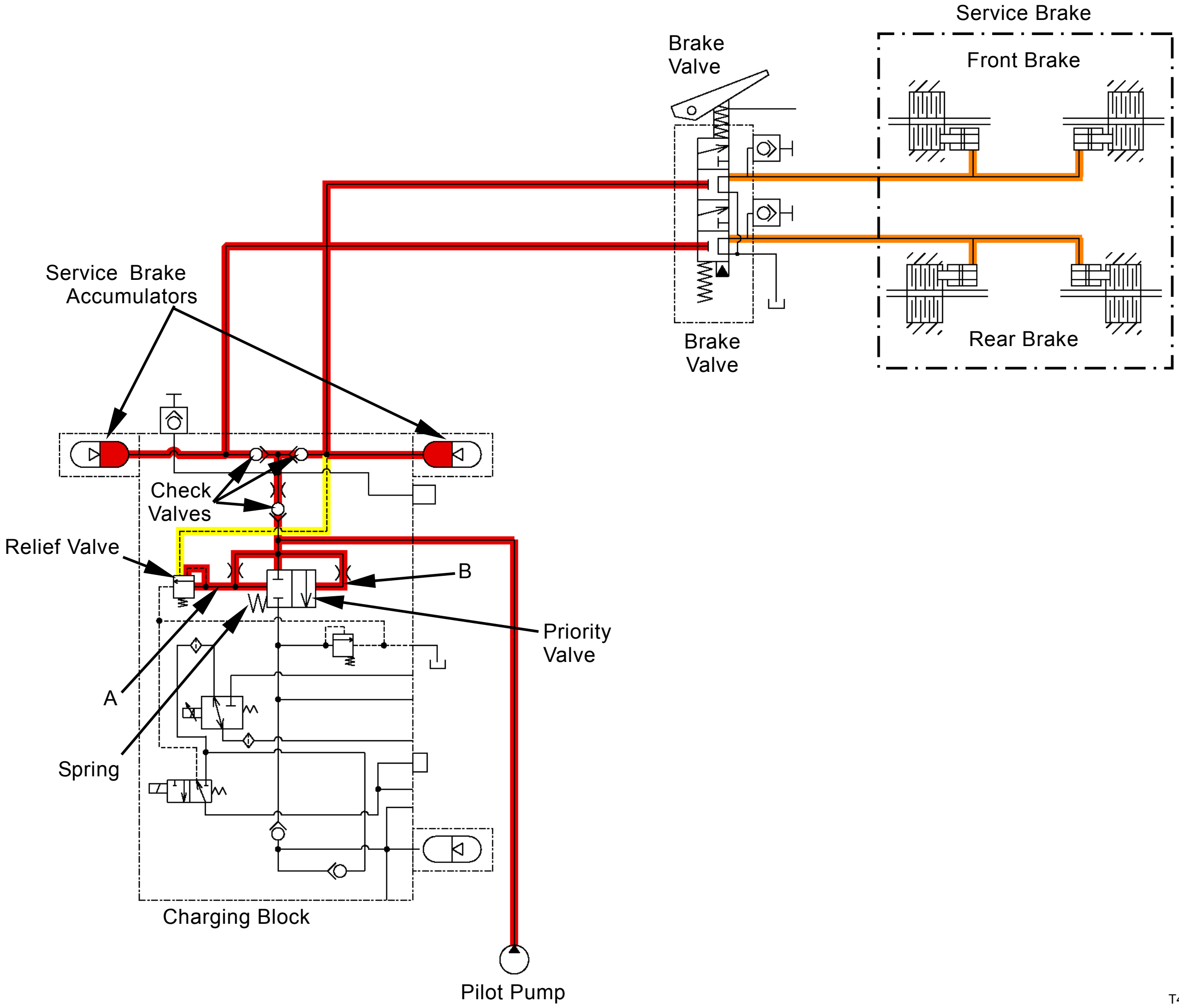
T4GC-02-02-001

Charging Block Circuit

- Charging block is installed for supplying pressure oil from the pilot pump preferentially to the service brake circuit, while distributing it to other pilot circuits as well.
- When the engine is started, oil is delivered from the pilot pump, and enters the charging block.
- At this time, when the amount of accumulated pressure of the service brake accumulators is low, the relief valve is closed.
- In this case, only pilot pressure is applied to Port B of the priority valve, but both the pilot pressure and the spring force are applied to Port A. So, the priority valve moves right, restricting pressure oil to flow further.
- Pressure oil from the pilot pump flows toward the service brake circuit through the check valve, and accumulates the service brake accumulators.

(to be continued to T2-3-20)

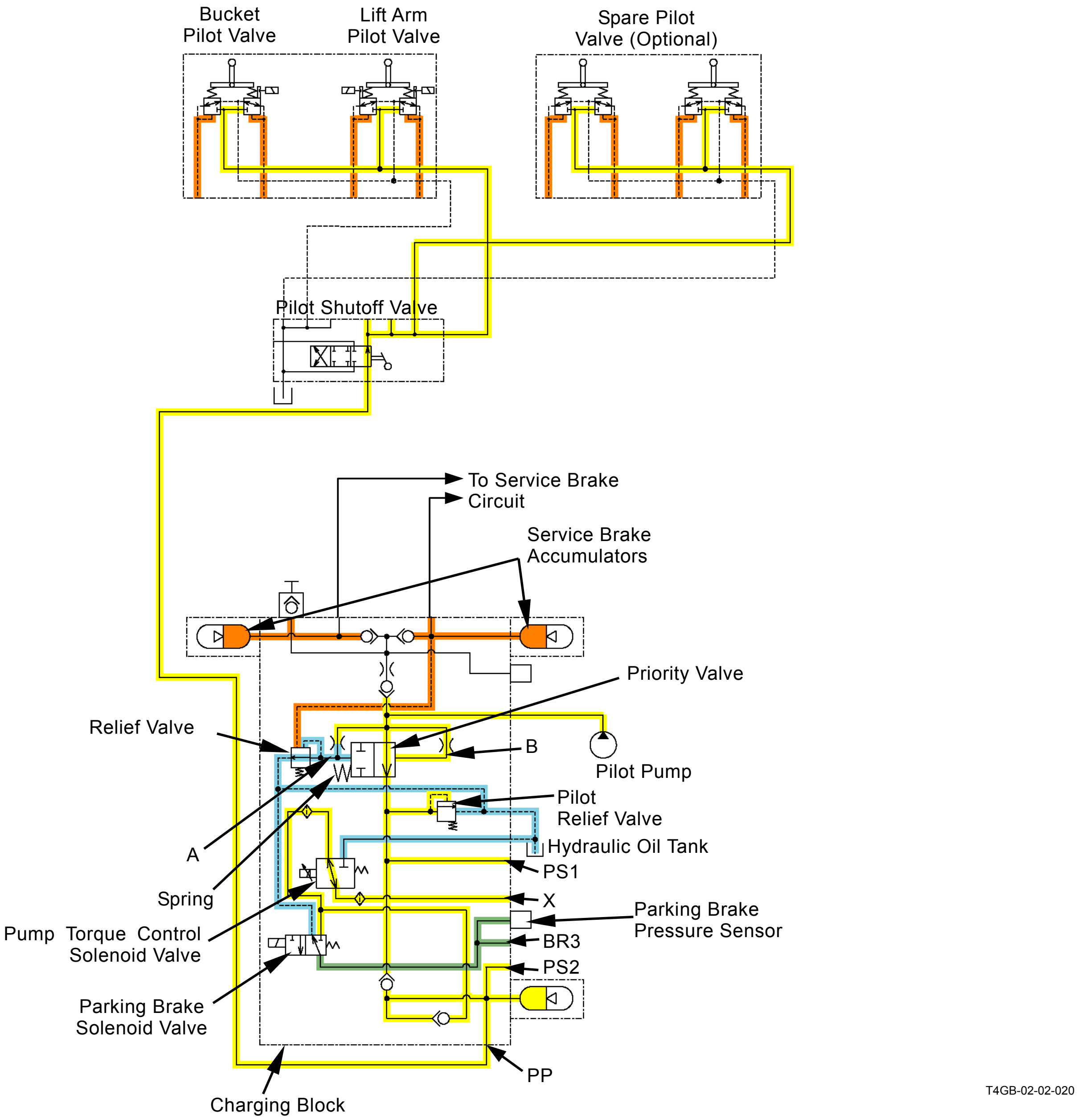
NOTE: *Spring of the priority valve is so adjusted that the valve is not completely closed. Even in the minimum opening condition, a certain amount of pressure oil is being supplied to the circuits downstream.*



T4GC-02-02-002

NOTE: *Illustration shows oil flow when the priority valve is closed in response to pressure decrease in the service brake circuit.*

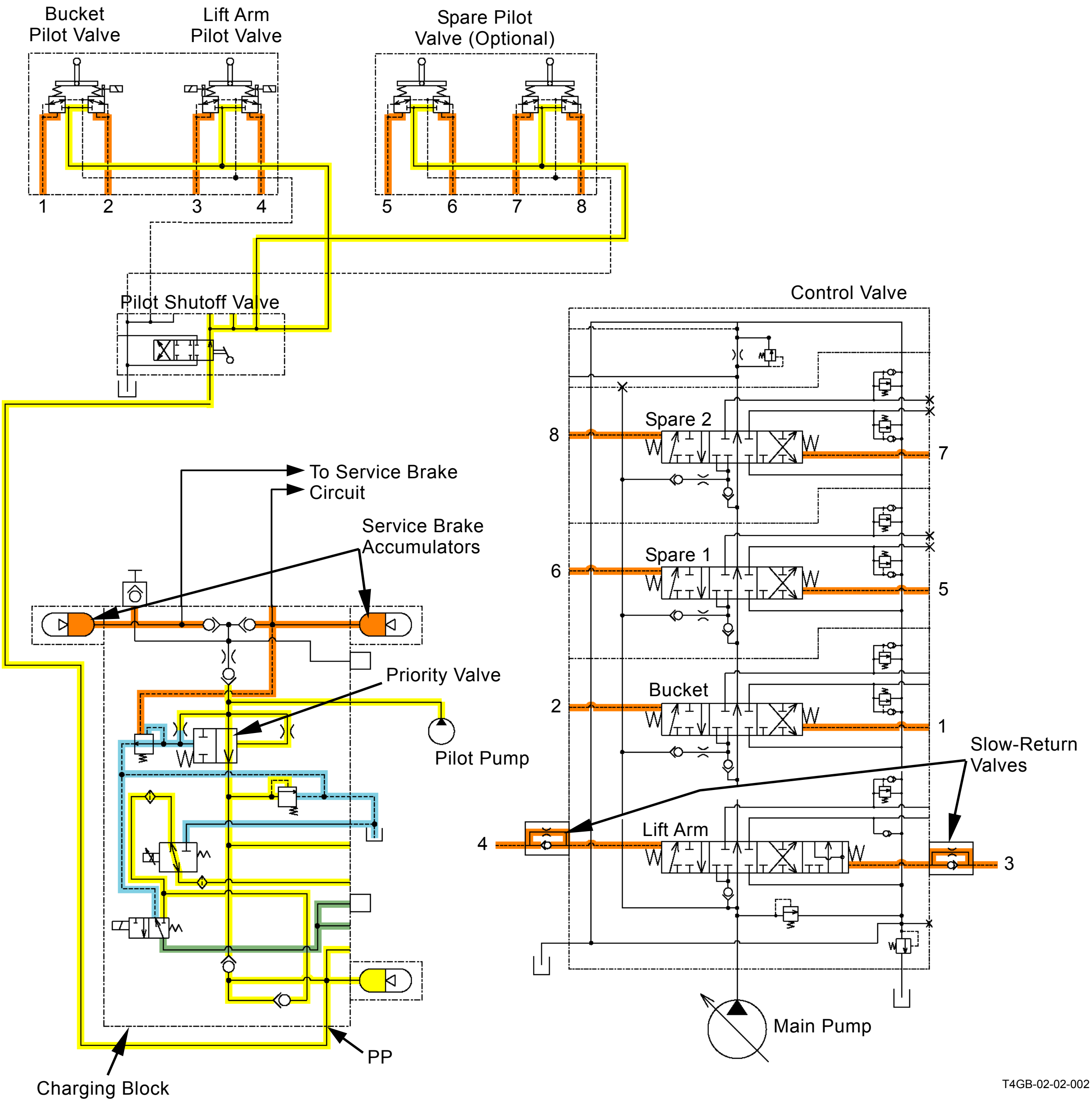
- When the service accumulators are pressurized to a certain amount, the relief valve opens, and pressure is lost because Port A of the priority valve is connected to the hydraulic oil tank.
- Pressure at Port B of the priority valve causes larger force than the spring force, and moves the priority valve spool left. So, pressure oil from the pilot pump is all supplied to the priority valve and the circuits downstream.
- Pressure oil from the priority valve is supplied through each port to the respective pilot circuits.
- When pressure in the pilot circuit rises higher than a certain amount, the pilot relief valve opens, and prevents components of the pilot circuit from being damaged.
- Pressure oil from Port PS1 passes the steering pilot valve to be supplied for actuation of the steering valve spool. (Refer to Steering Circuit.)
- Pressure oil from Port X changes its flow in response to the stroke of the pump torque control solenoid valve which is controlled by the signal from MC, and is used for controlling the main pump regulator.
  (Refer to Pump Control Circuit.)
- Pressure oil from Port BR3 is supplied for parking brake release pressure by operation of the parking brake solenoid valve. (Refer to Parking Brake Circuit)
- Pressure oil from Port PS2 is supplied for controlling the servo piston of the main pump (Refer to Pump Control Circuit.) and the spool of the ride control valve (Refer to Ride Control Circuit.).
- Pressure oil from Port PP enters each pilot valve through the pilot shutoff valve, and is supplied to the control valve for actuation of the spool. (Refer to Front Attachment Operation Control Circuit.)



NOTE: *Illustration shows the oil flow in neutral condition of the pilot valve when the service brake accumulators are pressurized, the priority valve is open, and the pilot shutoff valve is open.*

Front Attachment Operation Control Circuit (ZW220)

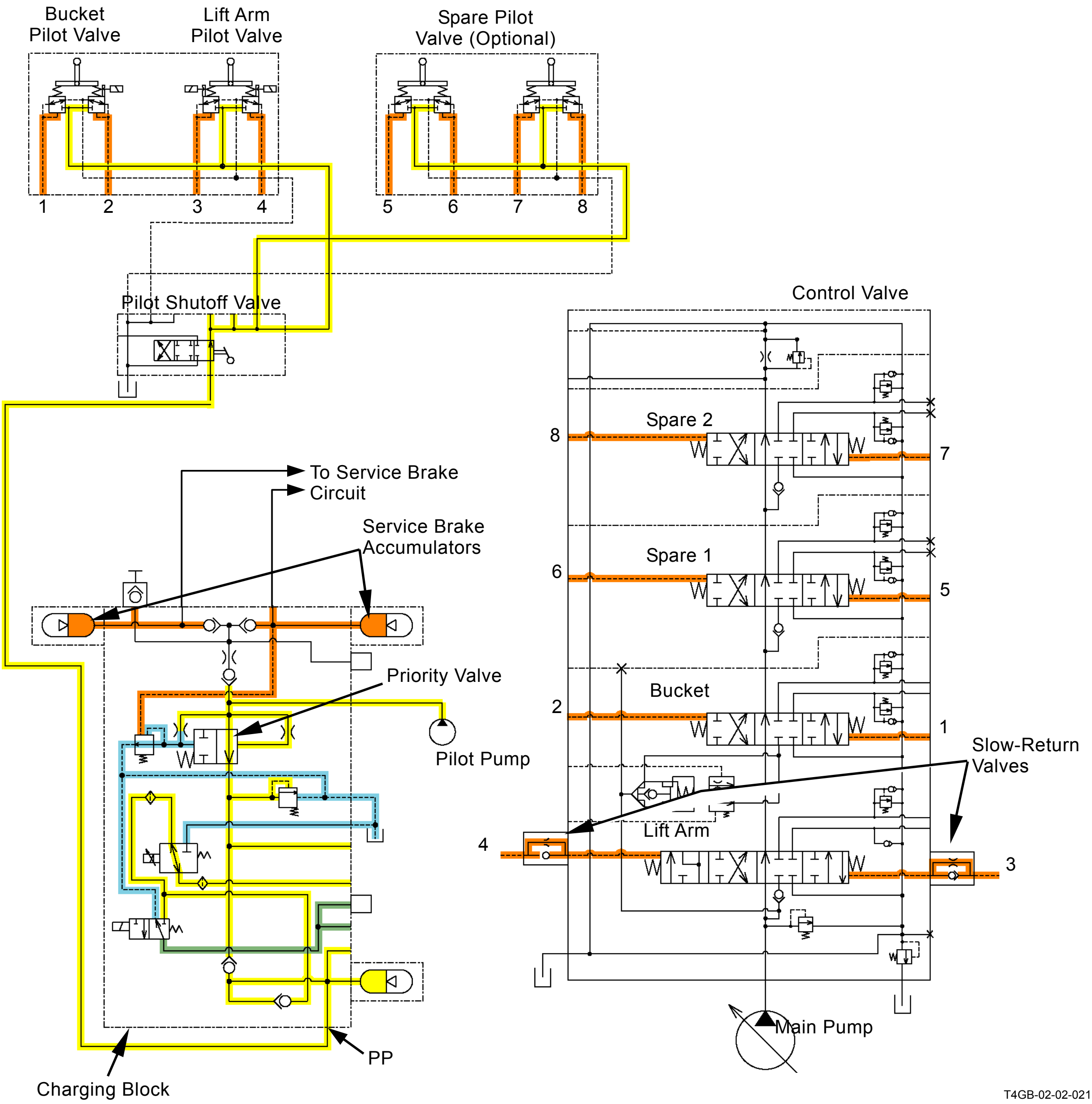
- Pressure oil from the pilot pump flows the charging block, and comes out of Port PP of the charging block to be supplied to each pilot valve through the pilot shutoff valve.
- Priority valve of the charging block supplies pressure oil preferentially to the service brake circuit when pressure in the service brake accumulators are lowered. (Refer to Charging Block Circuit.)
- Pilot shutoff valve is a manually operated type, and is installed for prevention of accidents due to mistaken operation by stopping suppy of pressure oil to the pilot valve when it is closed.
- By controlling each pilot valve, pressure oil from the pilot pump shifts the control valve spools.
- At both ends of the spool for the lift arm cylinders of the control valve, slow-return valves are installed for moderating sudden movement of the spool.



NOTE: Numeral of each port of the pilot valves and the control valve shows the port to be connected.
Illustration shows the oil flow in neutral condition of the pilot valve when the service brake accumulators are pressurized, the priority valve is open, and the pilot shutoff valve is open.

Front Attachment Operation Control Circuit (ZW250)

- Pressure oil from the pilot pump flows the charging block, and comes out of Port PP of the charging block to be supplied to each pilot valve through the pilot shutoff valve.
- Priority valve of the charging block supplies pressure oil preferentially to the service brake circuit when pressure in the service brake accumulators are lowered. (Refer to Charging Block Circuit.)
- Pilot shutoff valve is a manually operated type, and is installed for prevention of accidents due to mistaken operation by stopping suppy of pressure oil to the pilot valve when it is closed.
- By controlling each pilot valve, pressure oil from the pilot pump shifts the control valve spool.
- At both ends of the spool for the lift arm cylinders of the control valve, slow-return valves are installed for moderating sudden movement of the spool.



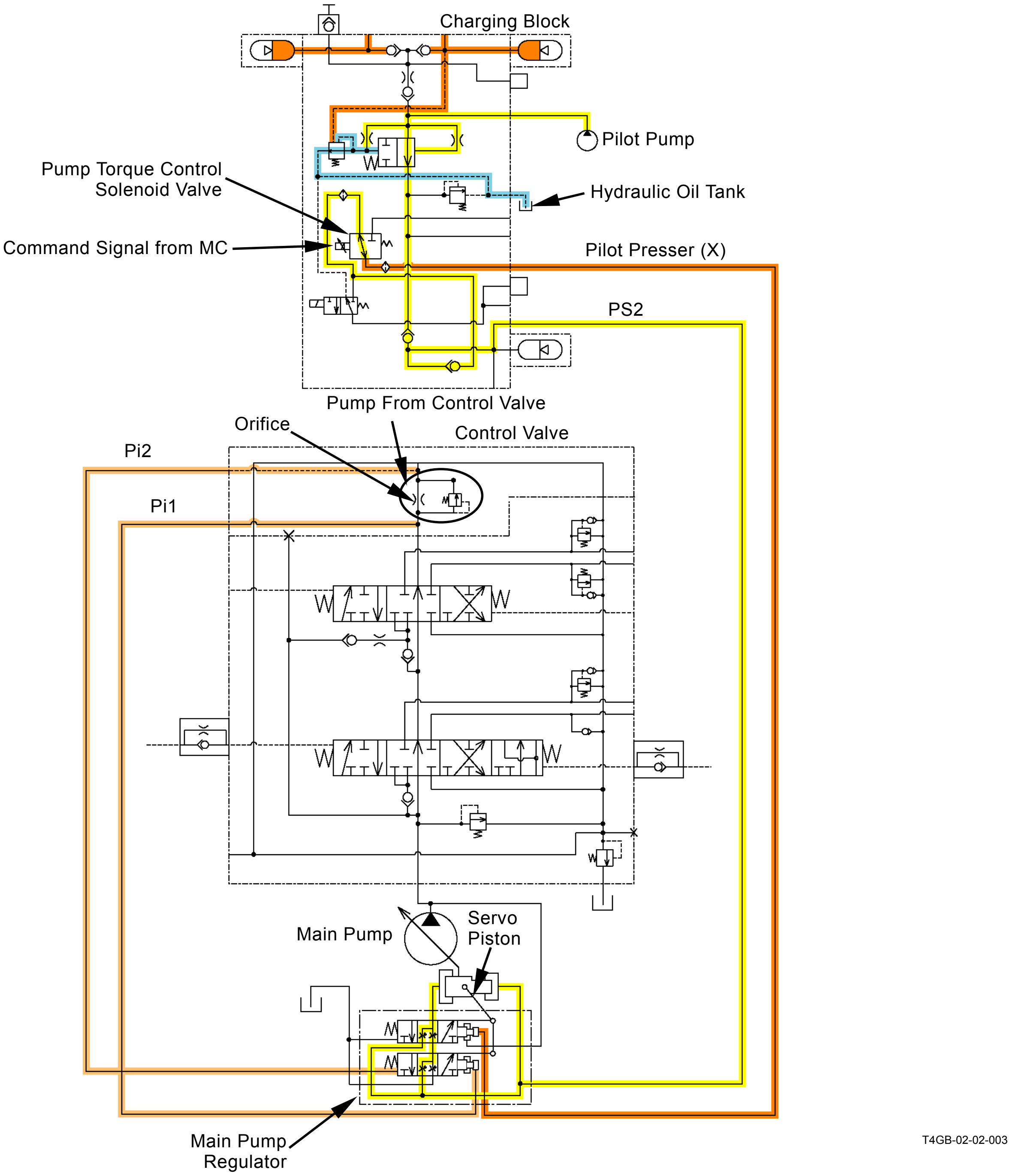
NOTE: *Numeral of each port of the pilot valves and the control valve shows the port to be connected.*
Illustration shows the oil flow in neutral condition of the pilot valve when the service brake accumulators are pressurized, the priority valve is open, and the pilot shutoff valve is open.

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

- Pump Control by Servo Piston Control Pressure
  - Servo piston control pressure (PS2) is supplied from the charging block for actuation of the servo piston of the main pump.

- Pump Flow Rate Control by Flow Rate Control Pressure (Pi1/Pi2)
  - Pressures upward and downward the orifice – Pi1 and Pi2 – of the pump flow rate control valve installed at the farthest downstream of the control valve neutral circuit are supplied to the main pump regulator for adjusting the pump flow rate.

- Pump Flow Rate Control by Pump Torque Control Solenoid Valve
  - Signal from MC actuates the pump torque control solenoid valve, and controls the pressure (X) supplied to the main pump regulator for controlling the pump flow rate.



NOTE: *Control valve illustrated is for ZW220.*

Brake Circuit

Service Brake Circuit

(Refer to COMPONENT OPERATION / Charging Block)

(Refer to COMPONENT OPERATION / Brake Valve)

- Pressure oil from the pilot pump flows through the charging block, and is accumulated in the service brake accumulators.
- By stepping the brake pedal, pressure in the service brake accumulators is applied to the front brake and the rear brake through the brake valve, and actuates the service brake.
- When the brake pedal is stepped several times, pressure inside the service brake accumulators is lowered, and the relief valve is closed.
- Priority valve spool moves right, and pressure in the service brake accumulators is kept constant by preferentially supplying pressure oil from the pilot pump to the service brake circuit, and firmly brakes the vihicle.

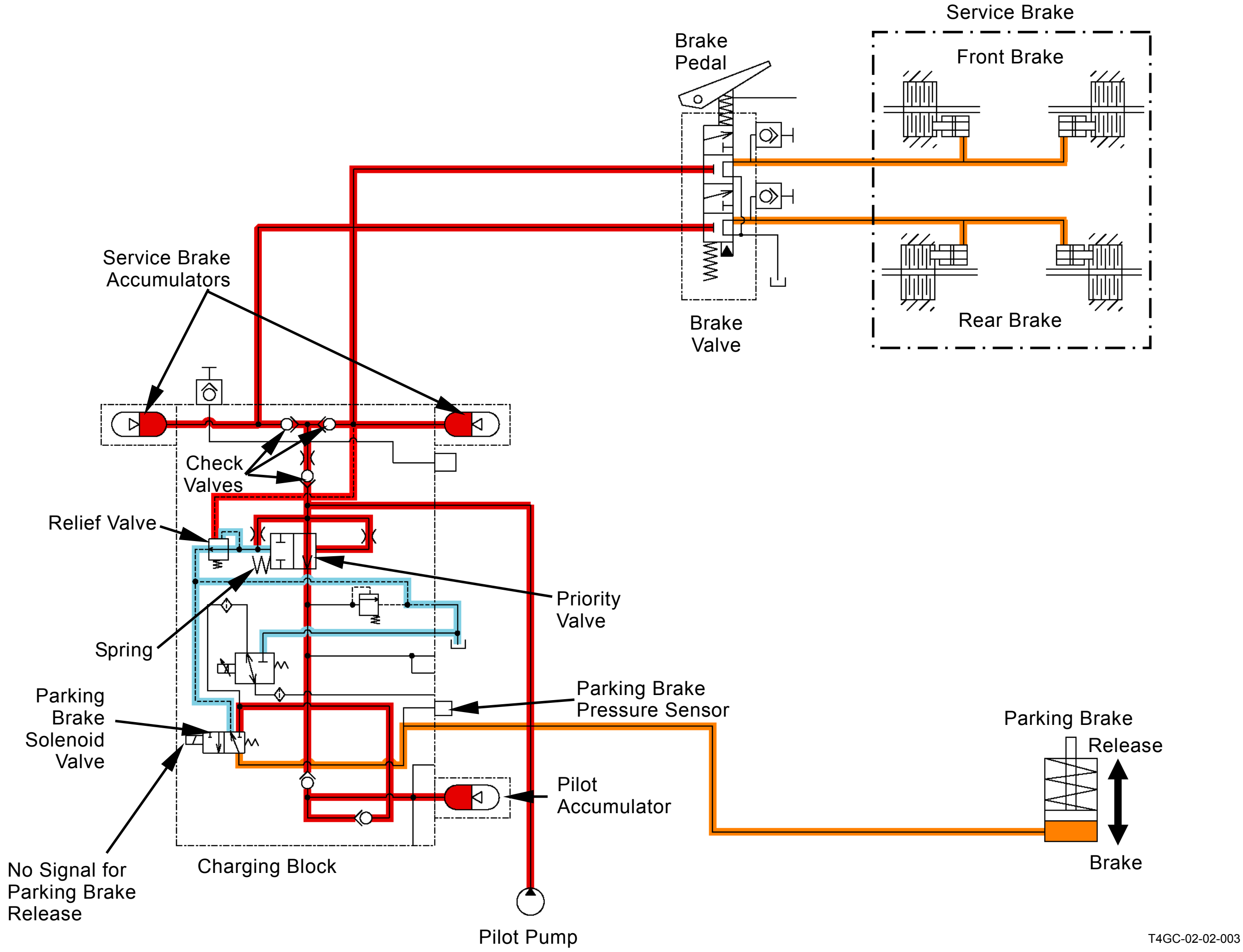
NOTE: *Spring of the priority valve is so adjusted that the valve is not completely closed. Even in the minimum opening condition, a certain amount of pressure oil flow is being supplied to the circuits downstream.*

NOTE: *Even when the engine is stopped, the service brake circuit pressure is retained for a while with the functions of the service brake accumulators and the check valve.*

Parking Brake Circuit

- Pressure oil from the pilot pump is applied to the parking brake solenoid valve through the charging block.
- When the parking brake is switched OFF, the parking brake solenoid valve is excited, and pressure oil entering the parking brake cylinder releases the parking brake.
- If the parking barke is switched ON, the parking brake solenoid valve is unexcited, and resultant stop of pressure oil supply to the parking brake causes working of the parking brake.
- Even if pressure is lowered caused by damage of hose or something in the upstream of the solenoid valve, the parking brake accumulators so function as to retain the parking brake circuit pressure for a certain period of time.

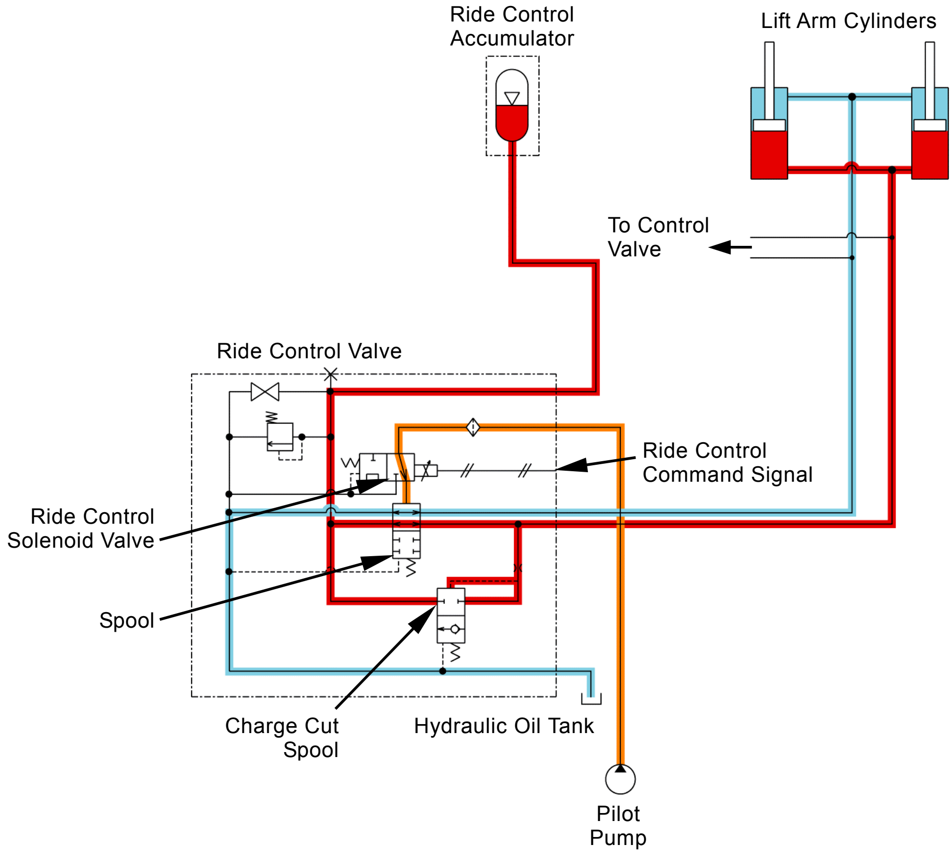
NOTE: *Parking brake is released when the solenoid valve is excited.*



NOTE: Illustration shows oil flow when the relief valve and the priority valve are open in response to pressure increase in the service brake circuit, and also oil flow when the parking brake is working with the unexcitement of the parking brake solenoid valve.

Ride Control Circuit (Optional)
(Refer to SYSTEM / Electric-Hydraulic Combined Circuit Control in Control System)

- In front attachment operation, operating pressure from the lift arm cylinders is accumulated in the ride control accumulator through the charge cut spool.
- When the ride control switch is turned ON, the ride control solenoid valve is excited, and the spool moves downward.
- Bottom end of the lift arm cylinders is connected with the ride control accumulator, while the rods side end of the lift arm cylinders is connected to the hydraulic oil tank.
- In this way, force to raise the front attachment is relieved to the hydraulic oil tank, and force to lower the front attachment is absorbed by the ride control accumulator, thus enabling stable traveling on rough roads.



T4GB-02-02-009

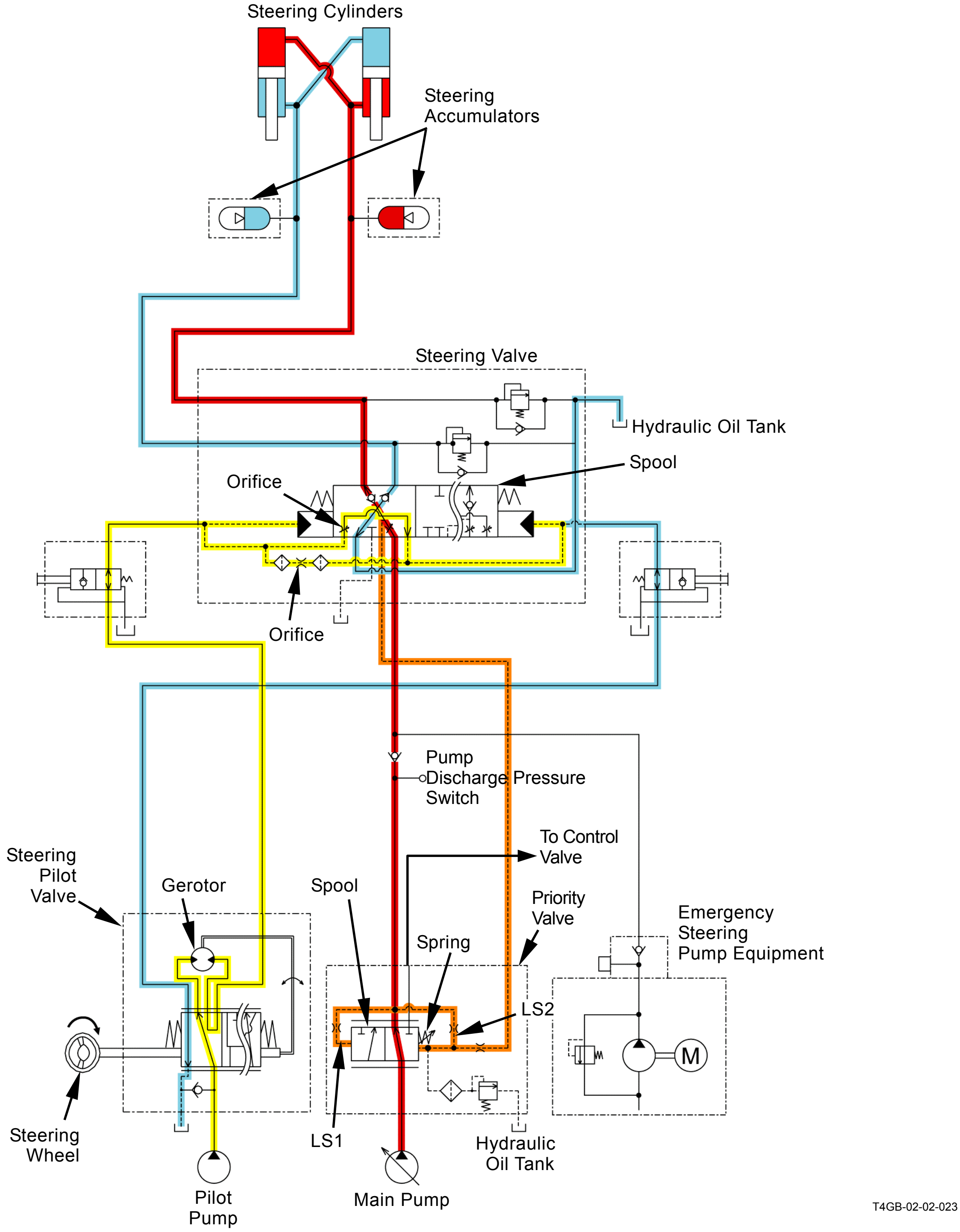
NOTE: Illustration shows oil flow when the ride control solenoid valve is excited.

STEERING CIRCUIT

Normal Steering Circuit

- Normally, pressure oil from the main pump flows to the steering valve through the priority valve, but is not pressurized because the pilot line (LS2) is led to the hydraulic oil tank.
- Therefore, pressure oil is all supplied to the control valve because the priority valve spool is shifted to the right pushed by pressure (LS1) from the own main pump large enough to overcome the spring force of the priority valve.
- When the steering wheel is turned, the spool in the steering pilot valve is shifted, and pressure oil from the pilot pump moves the steering valve spool.
- When the steering wheel is quickly turned, a large amount of pilot pressure oil is supplied in a short period of time to the end of the steering valve spool through the steering pilot valve, and the steering valve spool moves quickly and largely.
- When the steering wheel is slowly turned, a small amount of pilot pressure oil is supplied gradually to the end of the steering valve spool through the steering pilot valve, and the steering valve spool moves slowly and slightly.
- In proportion to the stroke of the steering valve spool, pressure in the pilot line (LS2) rises, and the priority valve spool is pushed left by the spring force of the priority valve and pressure of the pilot line (LS2).
- In this way, pressure oil from the main pump flows to the steering cylinders through the priority valve and the steering valve, and the steering cylinders are actuated. (Refer to COMPONENT OPERATION / Pump Device)

NOTE: *When pressure oil passes inside the steering pilot valve, it flows to the steering valve after passing the Gerotor part.*
Gerotor is connected with the middle shaft of the pilot steering valve, so powered steering effect is generated. (Refer to COMPONENT OPERATION / Steering Pilot Valve)



NOTE: Illustration shows flow of pressure oil when the steering wheel is turned right.

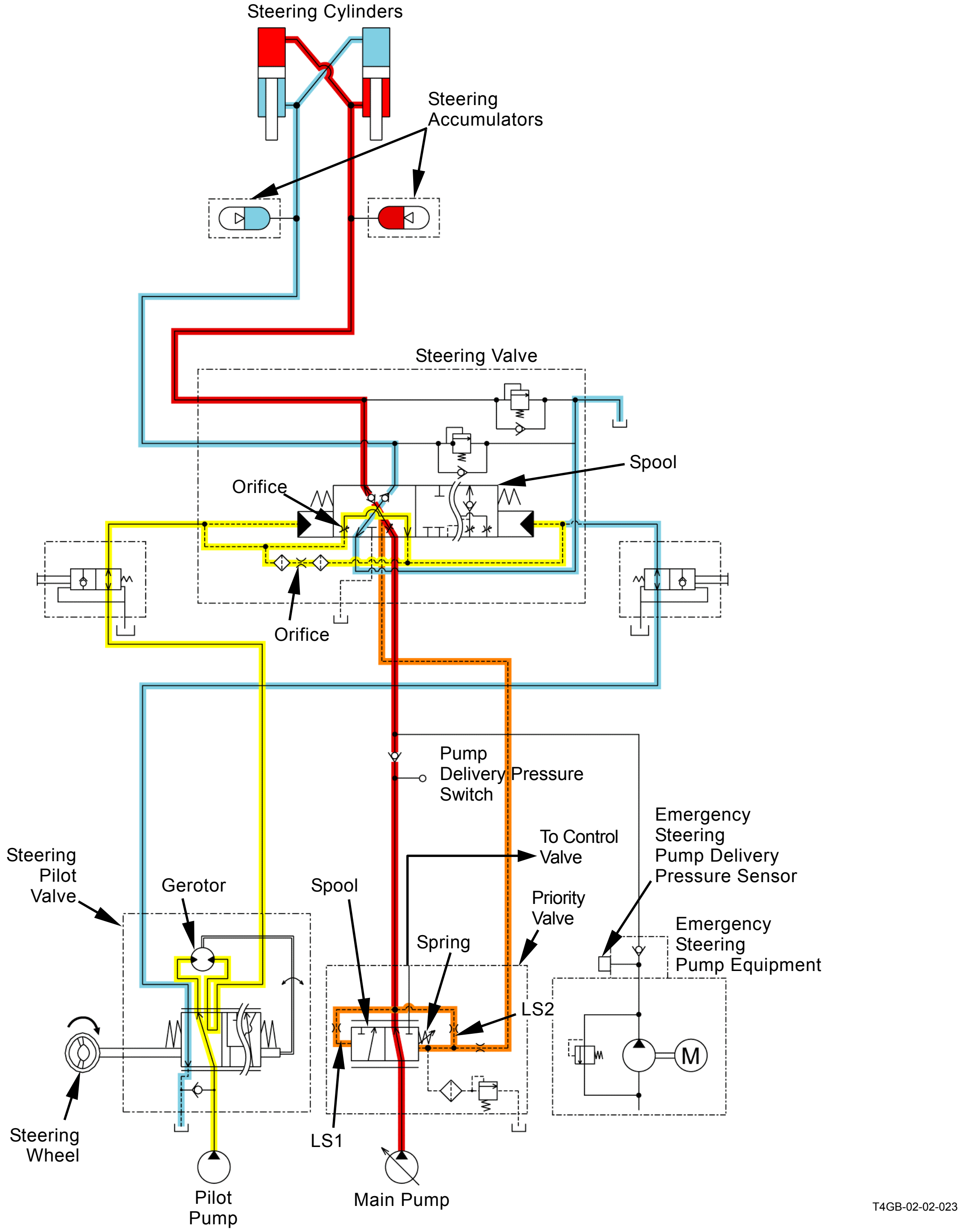
Steering Shock Damping Circuit

- Pressure of the pressure oil supplied from the steering pilot valve to the spool end of the steering valve is reduced by passing through the orifice inside the steering valve, and is applied to the spool end of the opposite side. In this way, the vehicle shock due to sudden shift of the spool is damped, and stable steering operation is possible. (Refer to COMPONENT OPERATION / Steering Valve)
- Steering accumulators are provided for damping the joggling of the vehicle taking place at stop of the steering wheel rotation.

Emergency Steering Circuit (Optional)

- When traveling, if the main pump delivery is stopped or drastically decreased caused by failure of the engine or the main pump, the signal of the pump delivery pressure switch is transmitted into the monitor controller, and the monitor controller starts the motor of the emergency steering pump equipment.
- Pressure oil is supplied from the emergency steering pump for 1 minute, and steering operation is possible.
- When 1 minute have passed or when the key switch has been turned OFF after moving the vehicle to a safe place, the emergency steering pump stops.

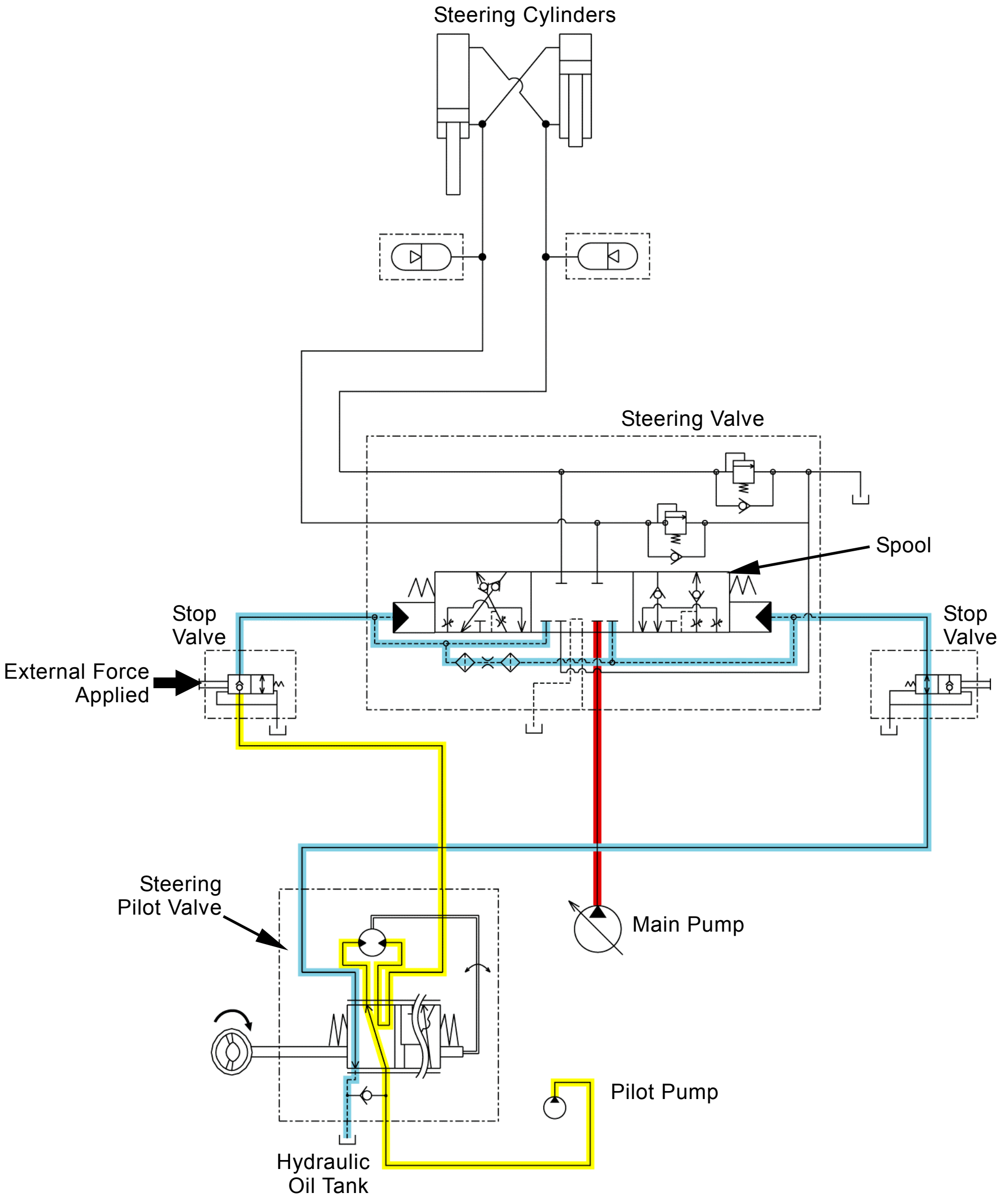
NOTE: When engine is started, the monitor unit automatically starts the emergency steering pump unit to confirm its function. When the pressure sensing signal of the emergency steering pump delivery pressure switch enters the monitor unit, the emergency steering pump unit automatically stops.



NOTE: *Illustration shows flow of pressure oil when the steering wheel is turned right.*

Steering Stop Circuit
(Refer to COMPONET OPERATION / Steering Valve)

- When either of the left or right cylinder is at the stroke end, the stop valve spool contacts the frame, and the stop valve closes to block pressure oil from being supplied to the steering valve from the steering pilot valve.
- As a result, the steering valve spool is shifted at neutral, and supply of pressure oil from the main pump to the steering cylinders is stopped.



T4GB-02-02-00

NOTE: Illustration shows flow of oil when the steering valve is turned right.

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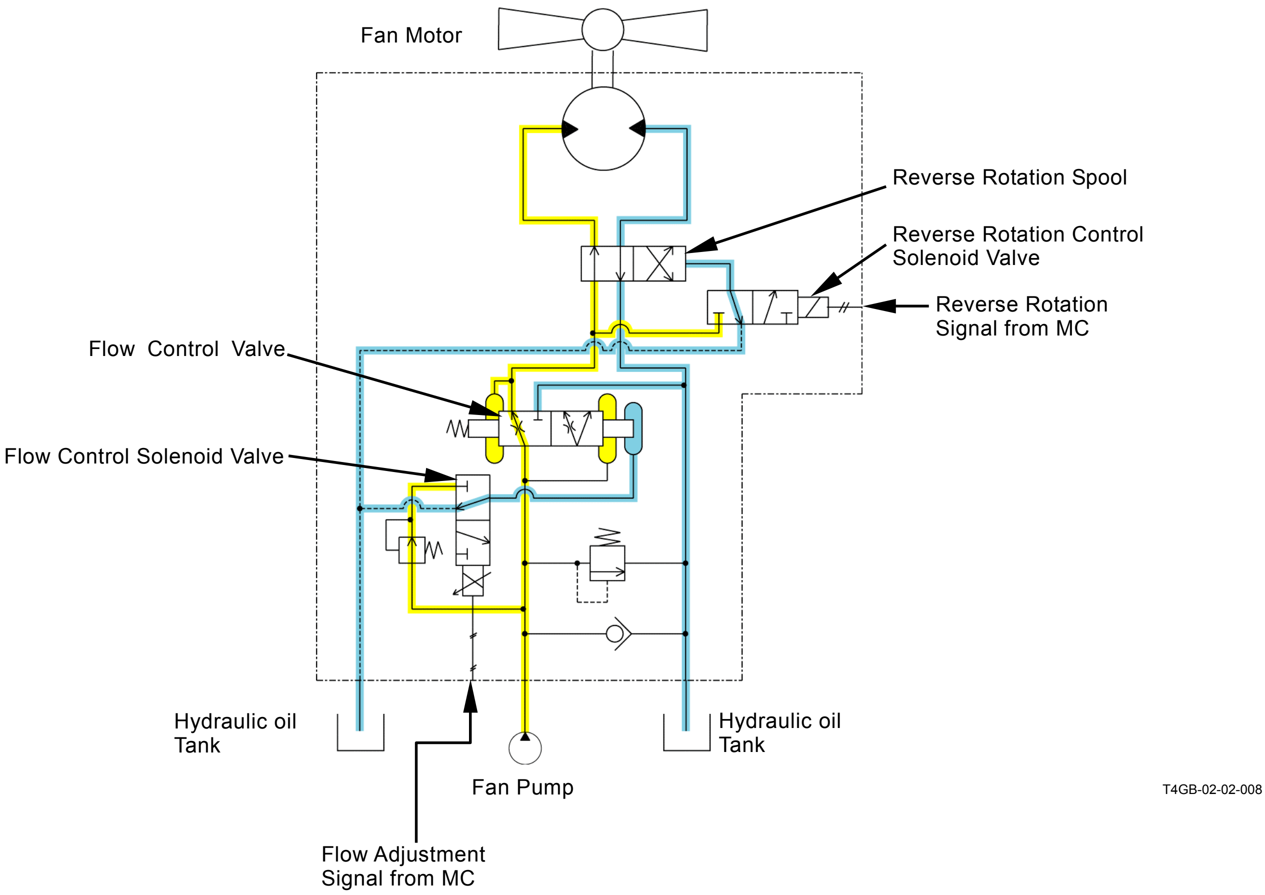
HYDRAULIC DRIVE FAN CIRCUIT

(Refer to COMPONET OPERATION / Others)
(Refer to COMPONET OPERATION / Hydraulic Fan Motor)

- Pressure oil from the fan pump flows to the fan motor for radiator cooling through the flow control valve and the reverse rotation spool.
- Electric current corresponding to the oil temperature is sent from MC to the flow control solenoid valve.
- Pressure oil is supplied to the flow control valve spool end in response to the stroke of the flow control solenoid valve, when it is excited.
- When the flow control valve is operated, pressure oil from the fan pump to the fan motor is restricted, and speed of the fan motor is controlled.
- When the fan reversing rotation switch is turned ON, electric current flows from MC to the reverse rotation control solenoid valve.
- When the reverse rotation control solenoid valve is operated, pressure oil is supplied to the reverse rotation spool end.
- When the reverse rotation spool is shifted, the inlet port of pressure oil supplied to the fan motor is shifted, and the fan motor rotates reversely.



NOTE: Illustration shows flow of pressure oil controlling nothing.

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OUTLINE

Electric circuit can largely be divided into the main circuit part, lamplight circuit and control circuit

- Main Circuit
  Circuit for engine start/stop, circuit for battery charging, and circuit for accessories

- Lamplight Circuit
  Circuit for use in traveling (composed of head lights, turn signals, brake lights, and horn)

- Control Circuit (Refer to the SYSTEM/Control System.)
  Control circuit for engine, pumps, transmission, and valves [composed of actuators like solenoid valves, MC (main controller), ECM (engine control module), ICF (information controller), monitor unit, switches, sensors, and pressure switches]

In this chapter, functions and compositions of the main circuit and lamplight circuit are explained.

MAIN CIRCUIT

- Electric Power Circuit: for supplying electricity to the electric system as power source
- Indicator Light Check Circuit: for checking monitor warning lamps and indicators
- Accessory Circuit: for working at ACC of the key switch
- Preheat Circuit: for assisting engine start in chilly weather
- Starting Circuit: for starting engine
- Charging Circuit: for supplying electricity to the battery and replenishing electricity
- Surge Voltage Prevention Circuit: for preventing occurrence of surge voltage at stop of the engine
- Engine Stop Circuit: for stopping the engine by the ECM

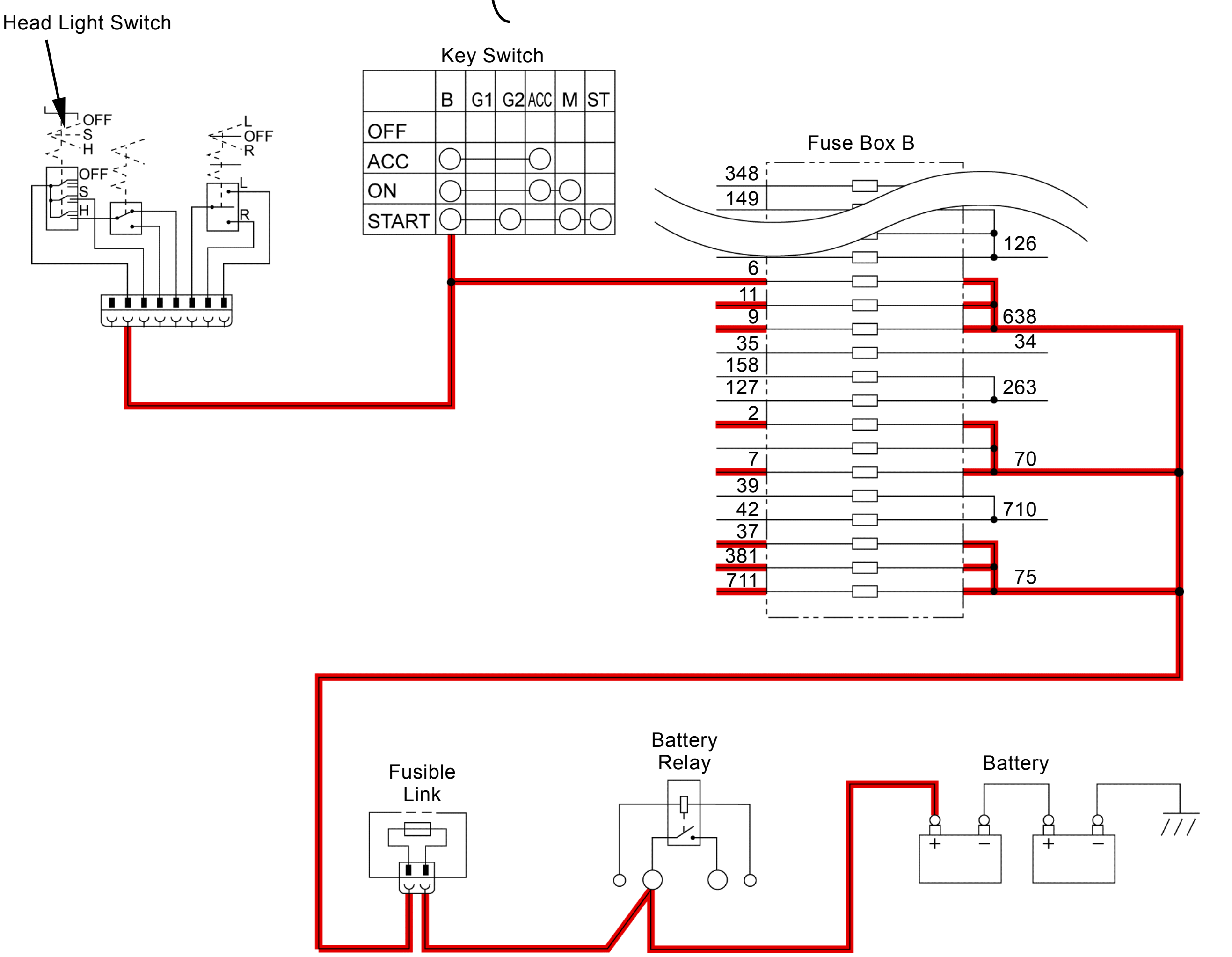
ELECTRIC POWER CIRCUIT (KEY SWITCH:OFF)

Ground terminal of the battery is earthed to the base machine. Electric current from the plus terminal flows as follows at OFF of the key switch.

Even at OFF of the key switch, very small amount of electric current is being supplied to the circuit, so the ground terminal of the battery needs to be disconnected in case of a long downtime.

Battery
↓
Fusible Link → Fuse Box B →

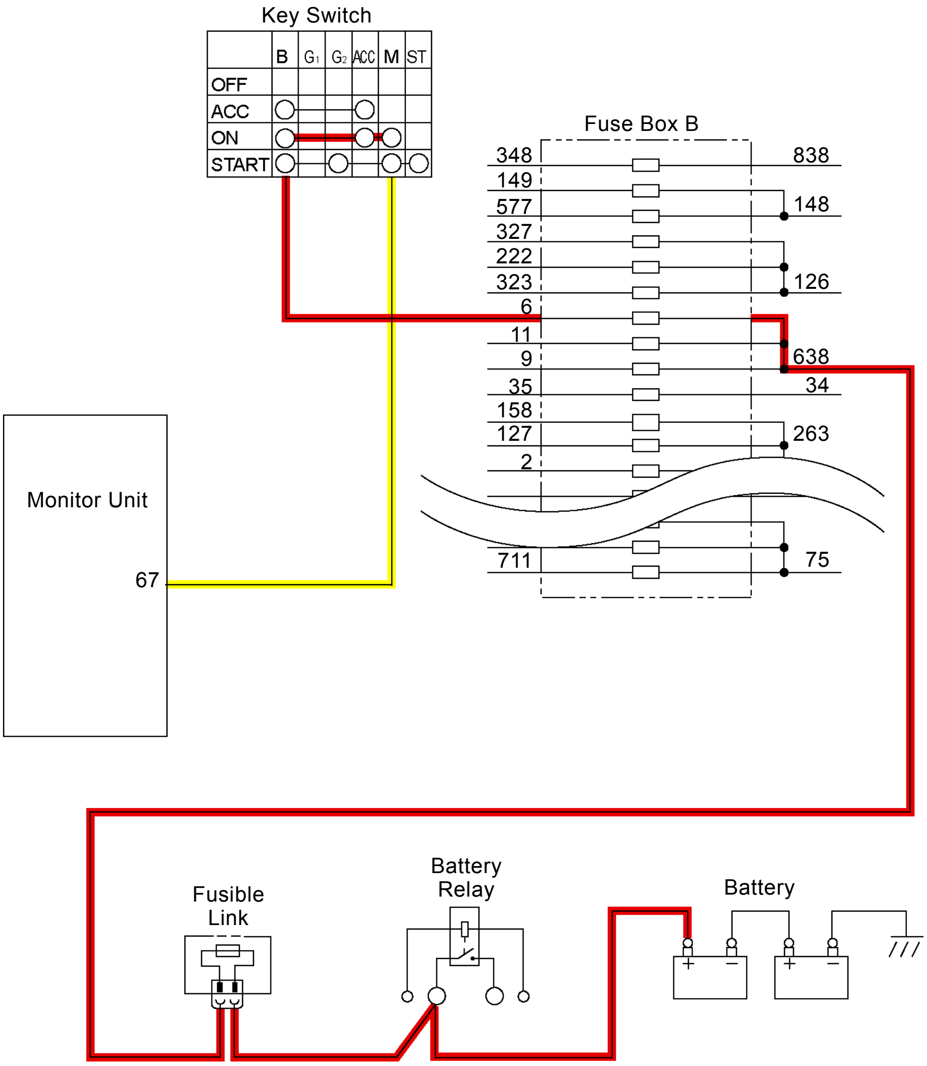
- → #6 Terminal — Key Switch, Head Light Switch
- → #11 Terminal — Flasher Relay
- → #9 Terminal — Load Dump Relay
- → #2 Terminal — GPS, ICF, MC, Optional Control Unit (Optional)
- → #7 Terminal — ECM Relay
- → #37 Terminal — Interior Light, Radio, MC
- → #381 Terminal — Optional Control Unit (Optional)
- → #711 Terminal — Monitor Unit



T4GC-02-04--001

INDICATOR LIGHT CHECK CIRCUIT (KEY SWITCH:ON)

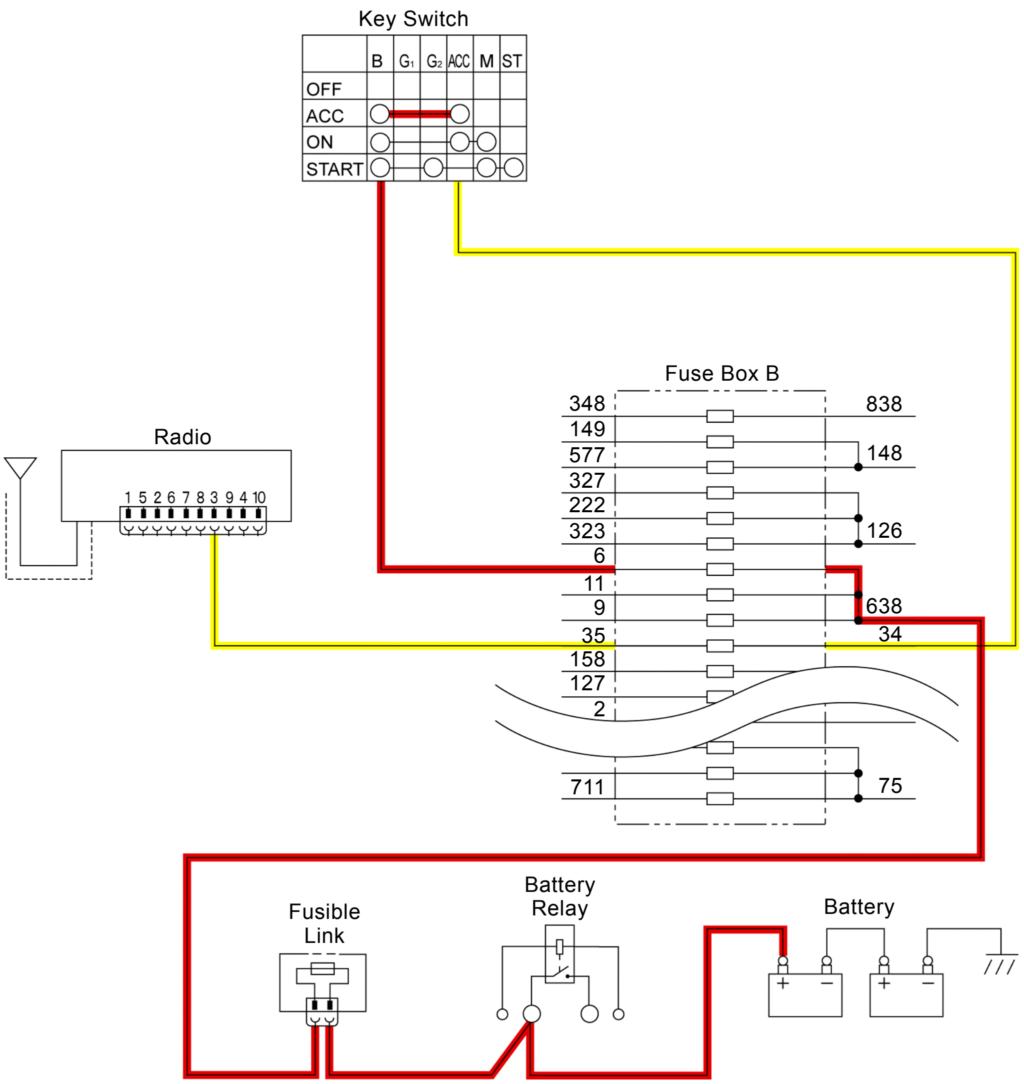
- When the key switch is turned ON, Terminal B is connected inside the key switch to ACC and Terminal M.
- Electric current from Terminal M of the key switch is enters #67 Terminal of the monitor unit.
- Monitor unit checks warning lamps and indicators by lighting them, and also starts the liquid crystal display.



T4GB-02-03-002

ACCESSORY CIRCUIT

- At ACC of the key switch, Terminal B is connected inside the key switch to Terminal ACC.
- Electric current from Terminal ACC of the key switch enters #3 Terminal of the radio through #34 and #35 Terminals of Fuse Box B, enabling the radio to work.

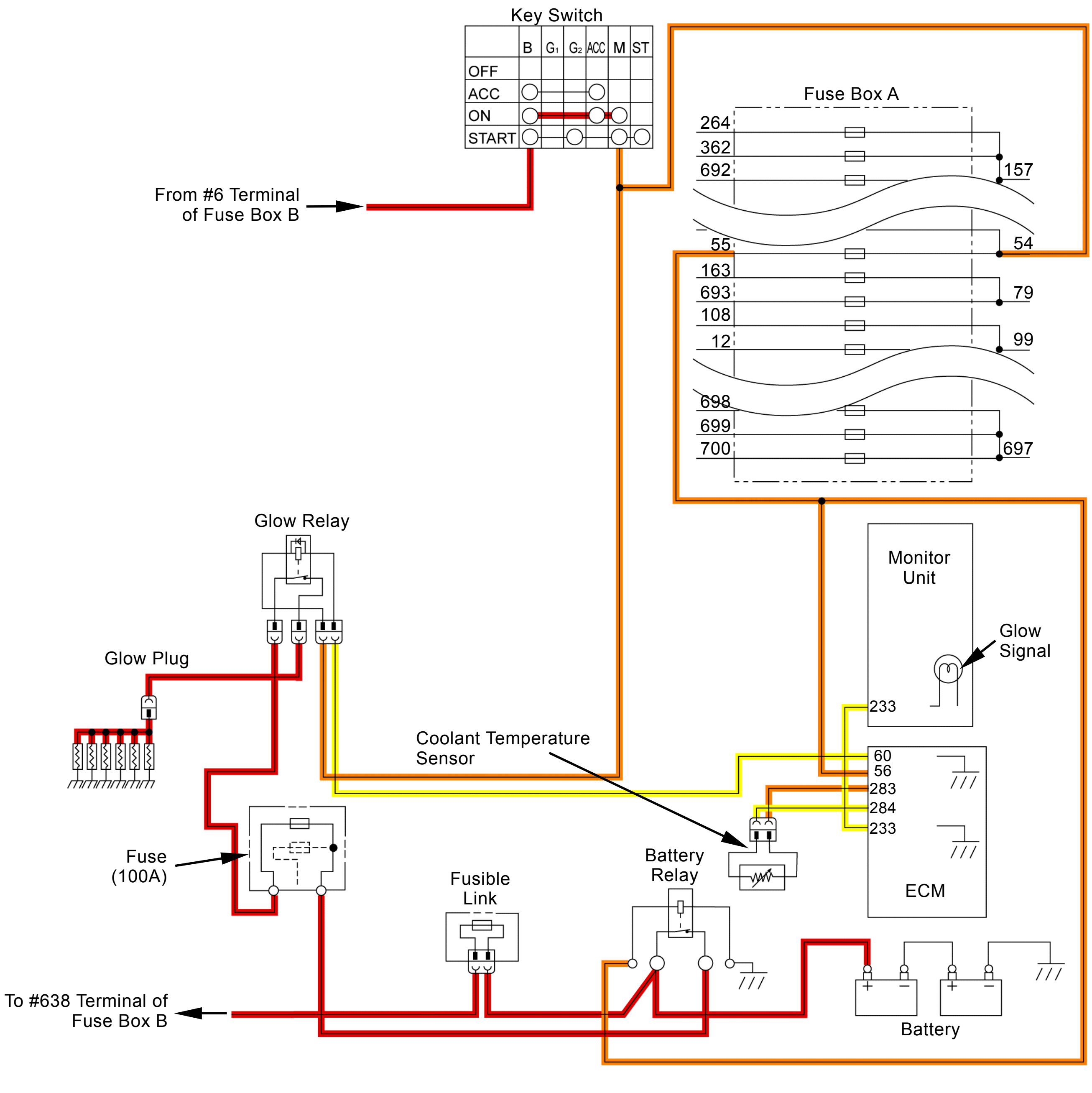


T4GB-02-03-003

PREHEAT CIRCUIT (KEY SWITCH:ON)

- When the key switch is turned ON, Terminal B is connected inside the key switch to Terminal M.
- Part of the electric current from Terminal M flows to the glow relay, and the remainder excites the battery relay through #54 and #55 Terminals of Fuse Box A, and the battery power source supplies electricity to the glow relay through the fuse (100A).
- Electric current from #55 Terminal of Fuse Box A also enters #56 Terminal of ECM, and the preheating circuit of the ECM is started.
- Signal corresponding to the coolant temperature is being transmitted from the coolant temperature sensor to #283 Terminal of the ECM.
- ECM earths #60 Terminal, and controls the excitement time of the glow relay if the coolant temperature is below a set temperature.
- While the glow relay is being excited, electricity from the power source is supplied to the glow plug from the glow relay, and so preheating is made.
- While preheating is being made, as #233 Terminal of the ECM is earthed, electricity flows from #233 Terminal of the monitor unit to #233 terminal of the ECM, and the monitor unit lights the glow signal.
- In case preheating is not made, the glow signal is lit for two seconds for checking of indicator lights.

NOTE: In case preheating has been made, preheating continues for a certain period of time even after the engine start (after-heating), but the glow signal is not lit.



T4GB-02-03-004

NOTE: Illustration shows flow of electricity in case preheating is being made with the glow relay excited and glow plug supplied with electricity from the power source.

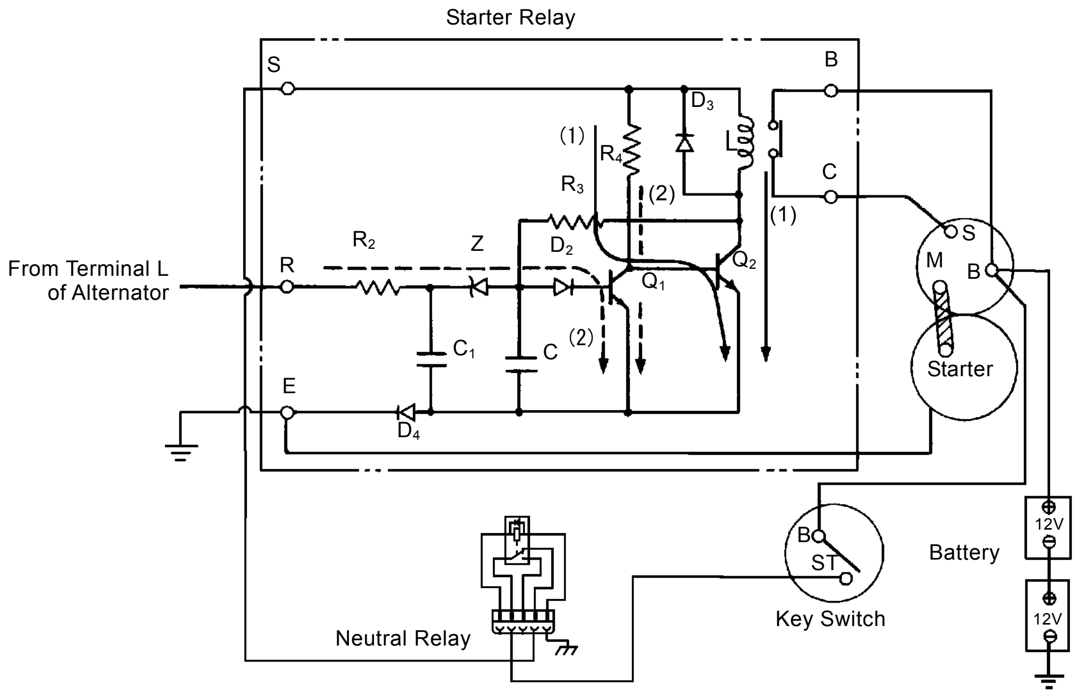
STARTING CIRCUIT (KEY SWITCH: START)

Forward/Reverse Lever at Neutral Position

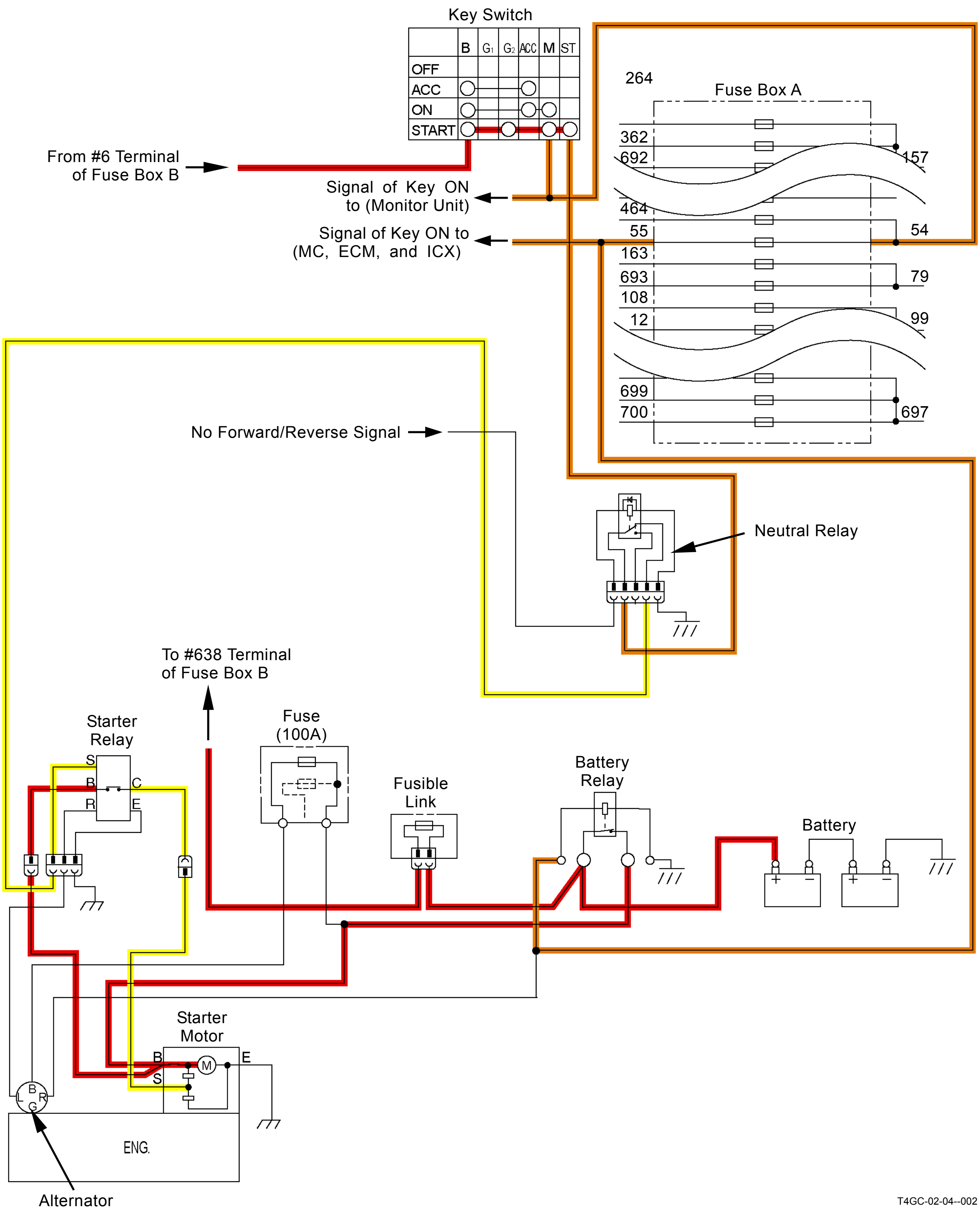
- At START of the key switch, Terminal B is connected inside the key switch to Terminals M and ST.
- Electric current from Terminal M excites the battery relay through #54 and #55 Terminals of Fuse Box A, so electricity from the battery power source is led from the battery relay to Terminals B of the starter motor and the starter relay.
- Electric current from Terminal ST of the key switch flows through the neutral relay to Terminal S of the starter relay and the coil inside.
- Starter relay is turned ON, and electric current also flows to Terminal S of the starter from Terminal C of the starter relay.
- As a result, the relay inside the starter is turned ON, and the starter motor rotates.
- Also, the electric current from Terminal M of the key switch flows to all the controllers as a signal for notifying the key position at ON or START.

Operation of Starter Relay

- At START of the key switch, continuity is made between Terminals B and ST of the key switch, and electric current flows to the base of Transistor Q_2 through Resistance R_4 inside the starter relay. Transistor Q_2 is turned ON, and electric current flows to Coil L of the relay.
  As a result, Terminals B and S of the starter are connected, and the starter operates.
- When the engine is started, the alternator begins charging, and the voltage of Terminal R of the starter relay raises.
- If this voltage reaches 21 – 22 V, Zener Diode Z is turned ON. As a result, Transistor Q_1 is turned ON, and Transistor Q_2 is turning OFF because no electric current flows to its base.
  At this moment, continuity between Terminals B and S of the starter is lost, and the starter is turned OFF.
- C_1 shown in the illustration below indicates a condenser for stabilizing working voltage.
  D_4 is a diode for protection from reverse connection of the battery.



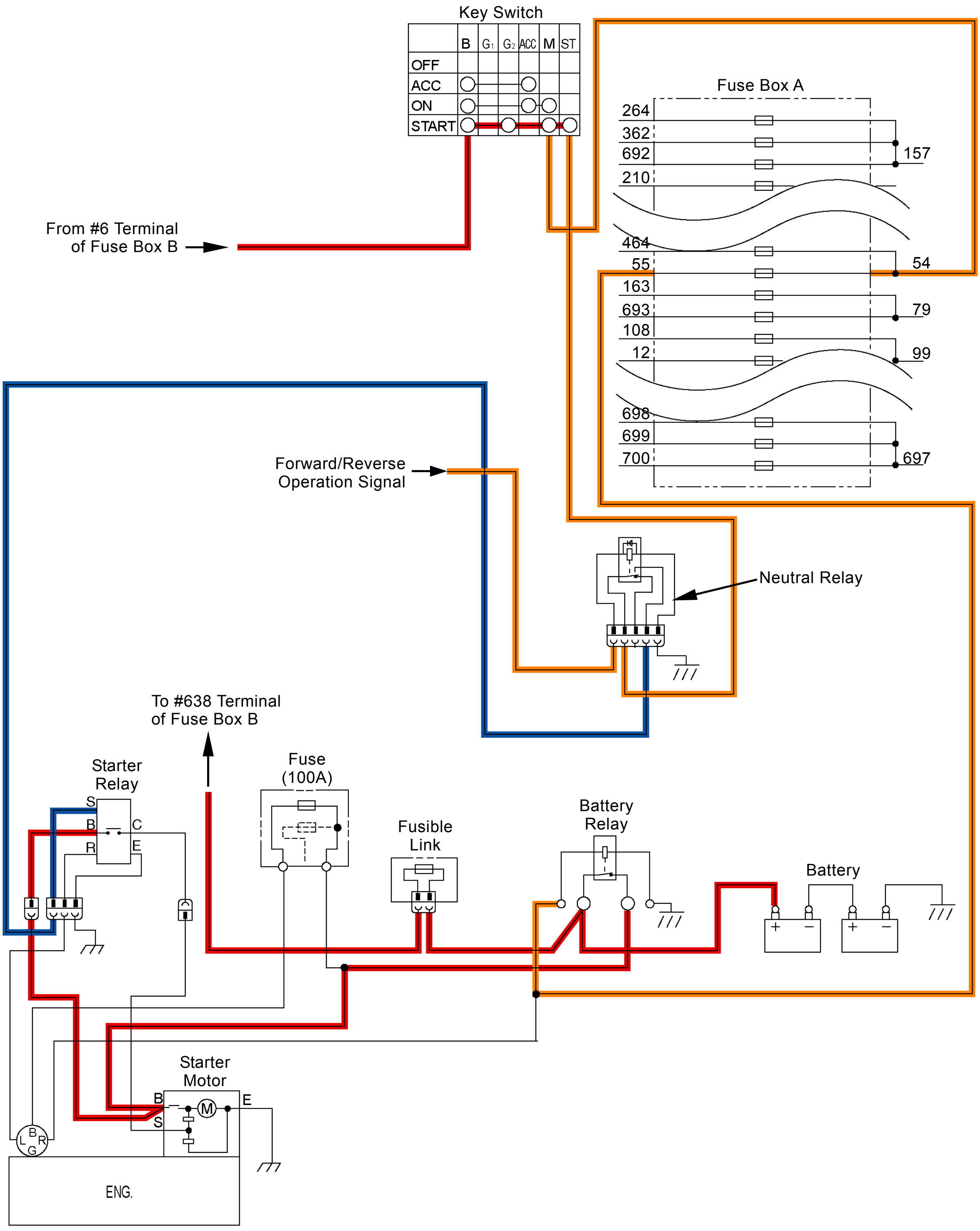
T4GB-02-03-019



T4GC-02-04--002

Forward/Reverse Lever at Operate Position

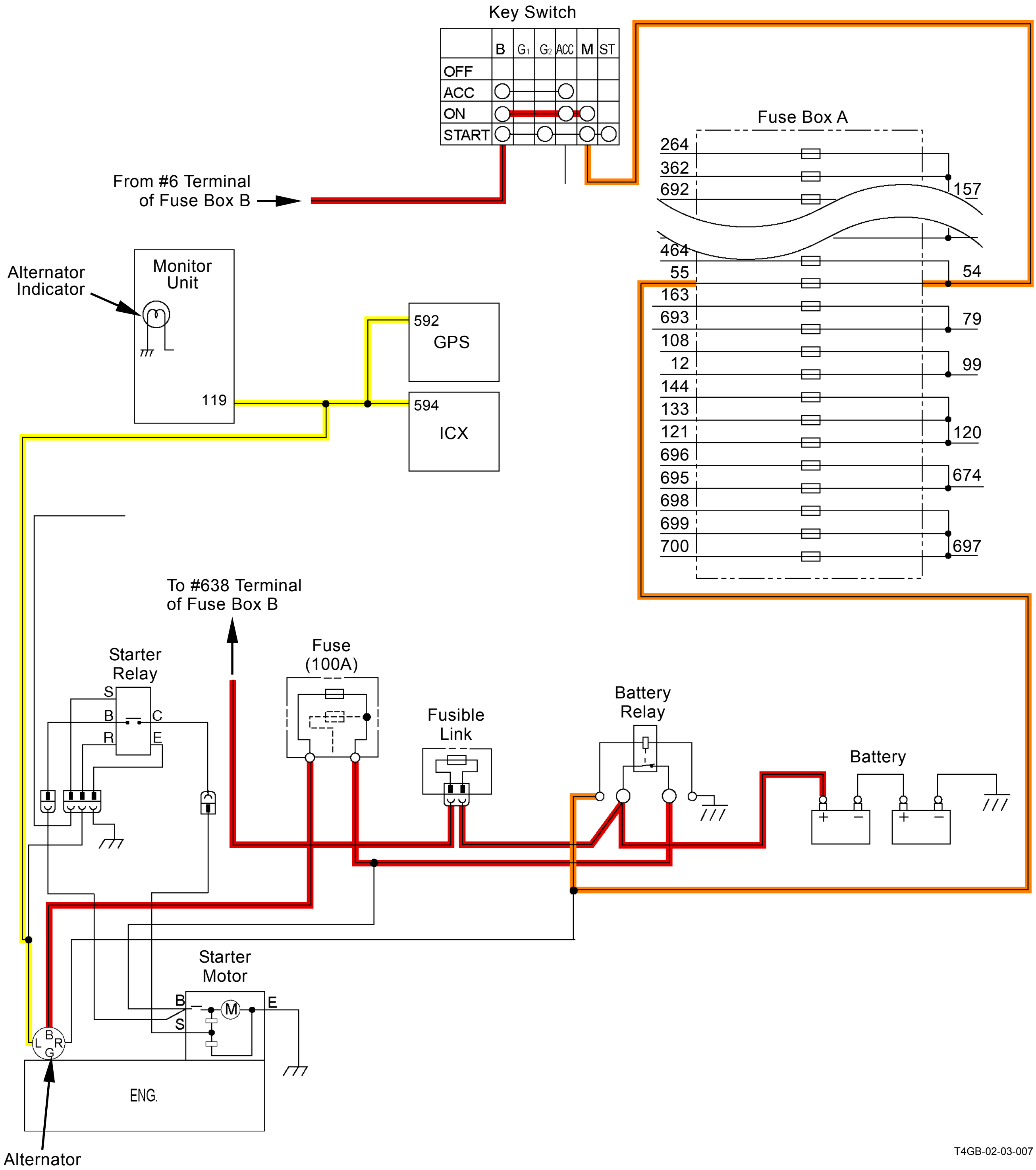
- Starting Safety Circuit (Neutral Relay)
  - At START of the key switch, Terminal B can be connected inside the key switch to Terminals M and ST.
  - Electric current from Terminal ST of the key switch flows to the neutral relay, and the electric current from Terminal M of the key switch flows to the Terminals #54 and #55 of Fuse Box A then excites the battery relay.
  - By exciting the battery relay, electricity from the battery power source flows to Terminals B of the starter motor and the starter relay.
  - At this moment, either of the forward-reverse lever and the forward-reverse switch is at forward or reverse, the neutral relay is excited.
  - Circuit between the neutral relay and Terminal S of the starter relay is blocked by excites the neutral relay.
  - Therefore, in case either of the forward-reverse lever and the forward-reverse switch is at forward or reverse, the starter motor is not operated even if the key switch is at START.



T4GB-02-03-006

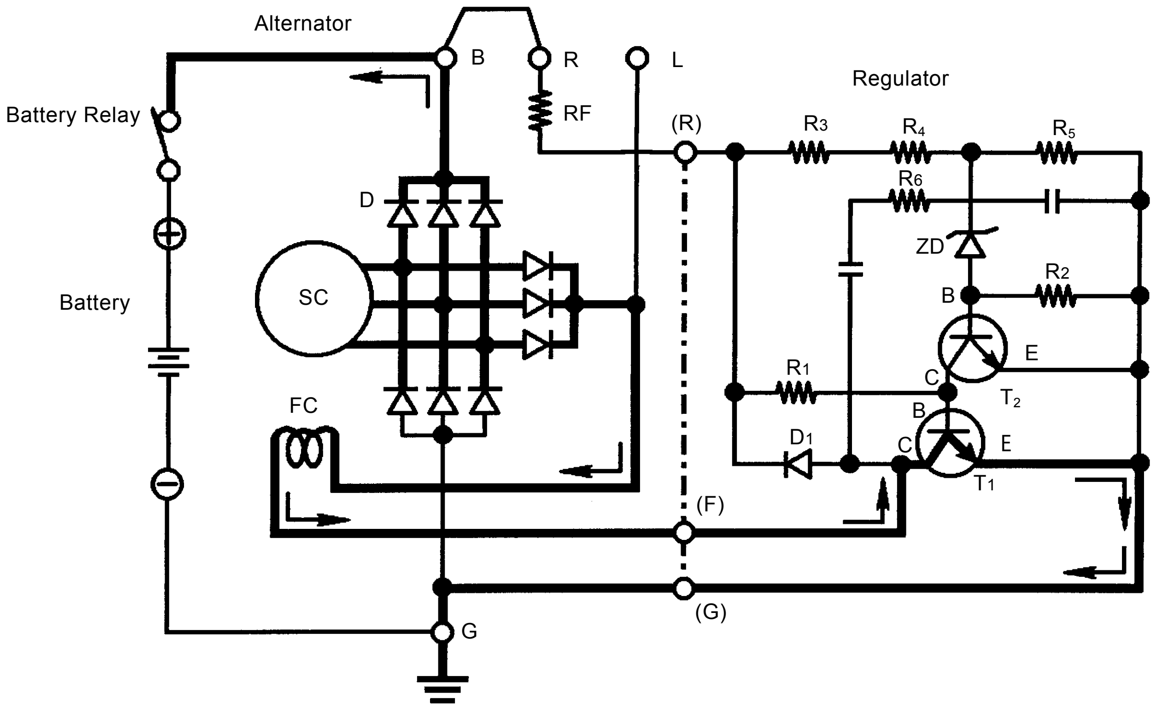
CHARGING CIRCUIT (KEY SWITCH:ON)

- Engine starts, and the key switch returns to ON automatically.
- At ON, Terminal B is connected inside the key switch to ACC and Terminal M.
- Electric current from Terminal M of the key switch excites the battery relay through #54 and #55 Terminals of Fuse Box A.
- When the engine rotates, the alternator begins to generate electricity, and the electric current from Terminal B of the alternator flows to the battery through the battery relay, charging the battery.
- In the mean time, the electric current from Terminal L of the alternator flows to #119 Terminal of the monitor unit to have the monitor unit turn off the alternator indicator, and also flows to #594 Terminal of the ICF and #592 Terminal of the GPS to record history data of the engine operation time.


Key Switch
B
G1
G2
ACC
M
ST
OFF
ACC
ON
START
From #6 Terminal of Fuse Box B
Fuse Box A
264
362
692
157
464
55
54
163
693
79
108
12
99
144
133
121
120
696
695
674
698
699
700
697
Alternator Indicator
Monitor Unit
119
592
GPS
594
ICX
To #638 Terminal of Fuse Box B
Starter Relay
S
B
C
R
E
Fuse (100A)
Fusible Link
Battery Relay
Battery
Starter Motor
B
S
M
E
L
B
R
G
ENG.
Alternator
T4GB-02-03-007

Operation of Alternator

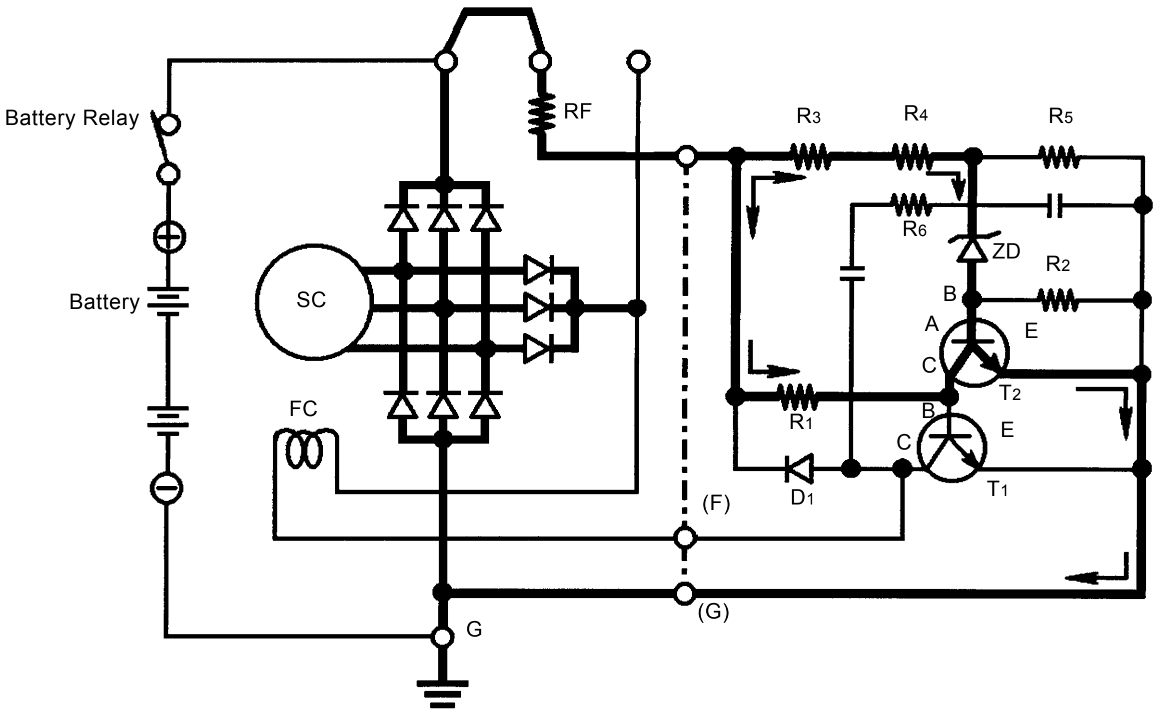
- Alternator consists of Field Coil FC, Stator Coil SC, Diode D, and others.
- Regulator consists of Transistors T_1 and T_2, Zener Diode ZD, Resistances R_1 and R_2, and others.
- Terminal B of the alternator is connected to Base B of Transistor T_1 as follows.
- B - R - RF - (R) - R_1 - Base B of Transistor T_1
- At On of the battery relay, the battery voltage works on Base B of Transistor T_1 of the regulator, and continuity is made between Collector C and Emitter E. In other words, the earth end of Field Coil FC is grounded through Transistor T_1.
- At first, electric current is not flowing to Field Coil FC. When the rotor rotates, alternating voltage is generated in Stator Coil SC by the remanent magnetism of the rotor itself.
- Electric current flows to Field Coil FC, and further magnetizes the rotor, resulting in rise of electric generation voltage. This further raises electric generation voltage, and charging the battery begins.



T157-04-02-008

Operation of Regulator

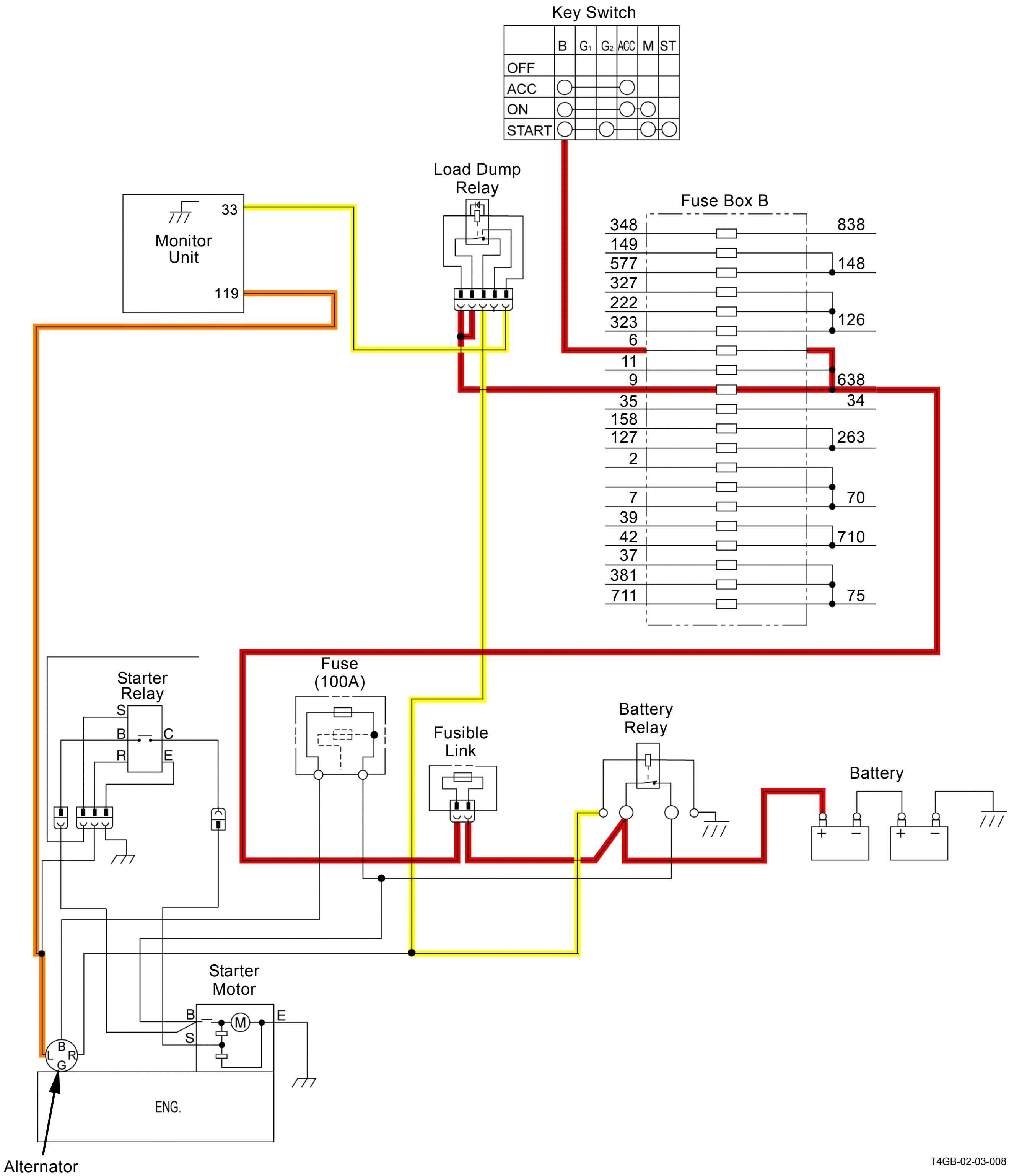
- As electric generation voltage rises higher than the set voltage of Zener Diode ZD, electric current flows to Base B of Transistor T_2, and continuity is made between Connector C and Emitter E.
- Operation of Transistor T_2 stops flow of the electric current to Base B of Transistor T_1, and turns T_1 OFF.
- Electric current stops flowing to Field Coil FC, and electric generation voltage of Stator Coil SC lowers.
- If voltage working on Zener Diode ZD lowers below the set voltage, Transistor T_2 is turned OFF, and Transistor T_1 is turned ON again.
- Electric current flows to Field Coil FC, and electric generation voltage of Stator Coil SC is raised.
- Electric generation voltage of the alternator is kept constant by repeating the above operations.



T157-04-02-009

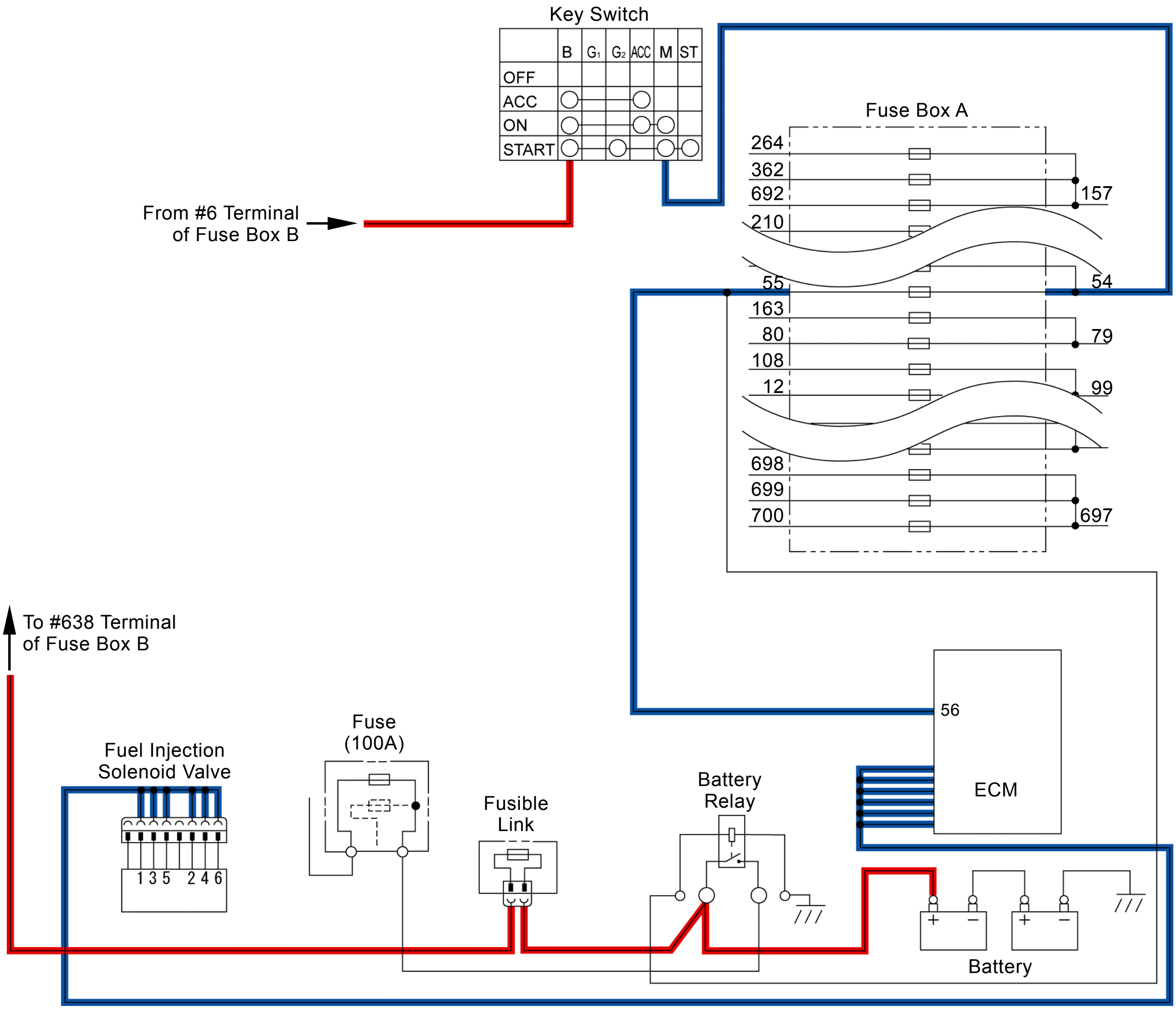
SURGE VOLTAGE PREVENTION CIRCUIT

- When the engine is stopped (key switch: OFF), the electric current from Terminal M of the key switch is stopped, and the battery relay is turned OFF.
- Even if the key switch is turned off, the engine does not stop immediately keeping freewheeling, and the alternator continues generation of electricity.
- As the generated electric current does not flow to the battery, surge voltage (voltage rise) is generated, resulting in causes for failures of electronic equipment like the controller and other parts. For this reason, the surge voltage protection circuit is provided.
- During charging, the electric generation current from Terminal L of the alternator enters #119 Terminal of the monitor unit. Monitor unit earths #33 Terminal to the ground.
- Electric current flows to the excitement circuit of the load dump relay, and the load dump relay works.
- Therefore, even if the key switch is turned OFF during rotation of the engine, the electric current from the battery keeps exciting the battery relay through the load dump relay. Also, the battery relay is turned OFF about ten seconds after the alternator stops generation of electricity.


Key Switch
B
G1
G2
ACC
M
ST
OFF
ACC
ON
START
Load Dump Relay
Monitor Unit
33
119
Fuse Box B
348
149
577
327
222
323
6
11
9
35
158
127
2
7
39
42
37
381
711
838
148
126
638
34
263
70
710
75
Starter Relay
S
B
C
R
E
Fuse (100A)
Fusible Link
Battery Relay
Battery
Starter Motor
B
S
M
E
L
B
R
G
ENG.
Alternator
T4GB-02-03-008

ENGINE STOP CIRCUIT

- When the key switch is turned OFF from ON, the electric current flowing from Terminal M to #56 Terminal of the ECM to show the key switch at ON is stopped.
- ECM unexcited the fuel injection solenoid valve, and the engine is stopped.



T4GB-02-03-009

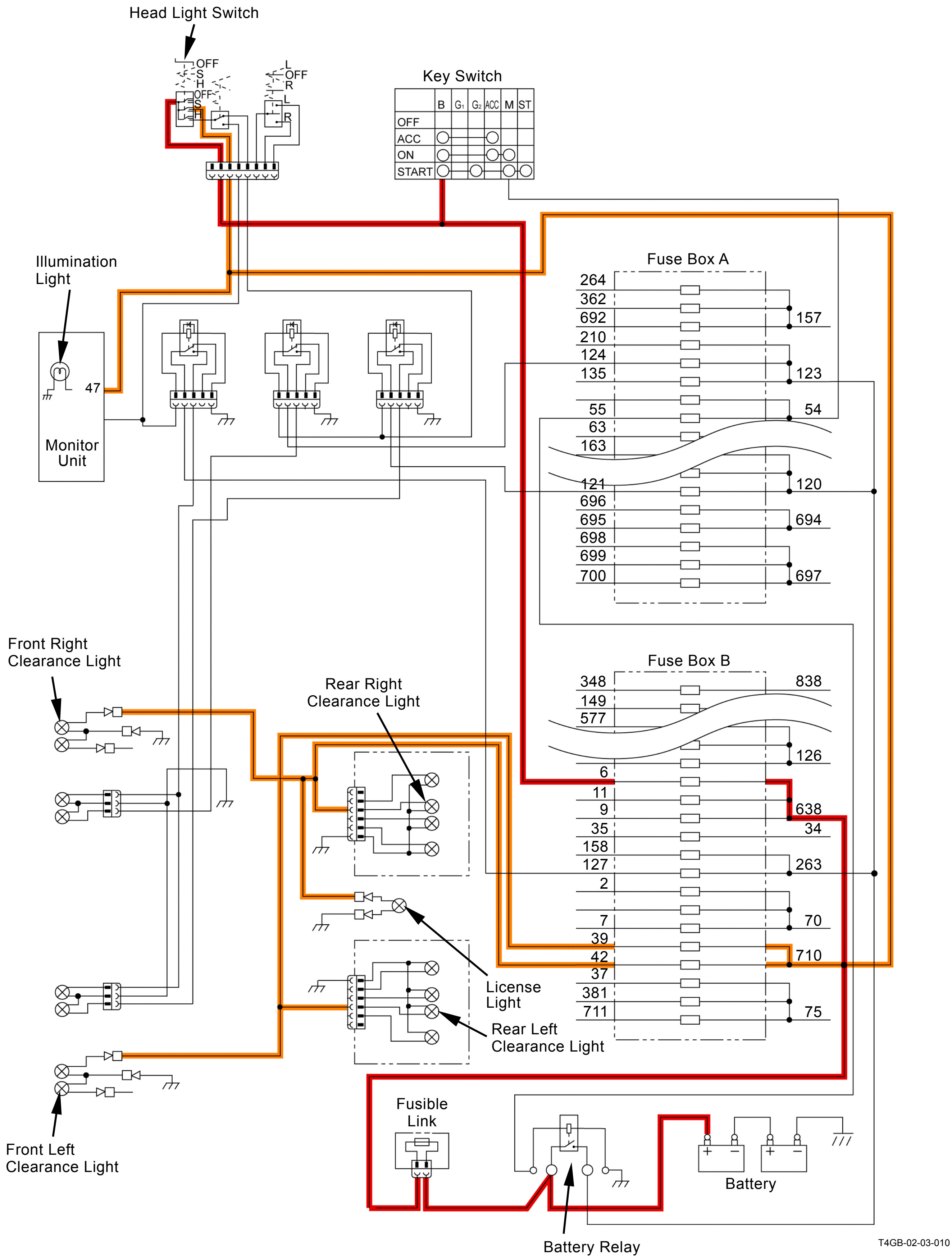
LAMPLIGHT CIRCUIT

- Head Light Circuit: for turning on and off head lights, clearance lights and license light.
- Turn Signal Circuit: for turning on and off turn signals
- Brake Light Circuit: for turning on and off brake lights
- Hazard Light Circuit: for turning on and off hazard light indicators
- Horn Circuit: for sounding horn
- Reverse Light/Buzzer Circuit: for turning on and off reverse lights and reverse buzzer
- Parking Brake Circuit: for working and releasing parking brake
- Emergency Steering Check Circuit (Optional): for confirming operation of emergency steering pump unit

HEAD LIGHT CIRCUIT

Clearance and License Light Circuit

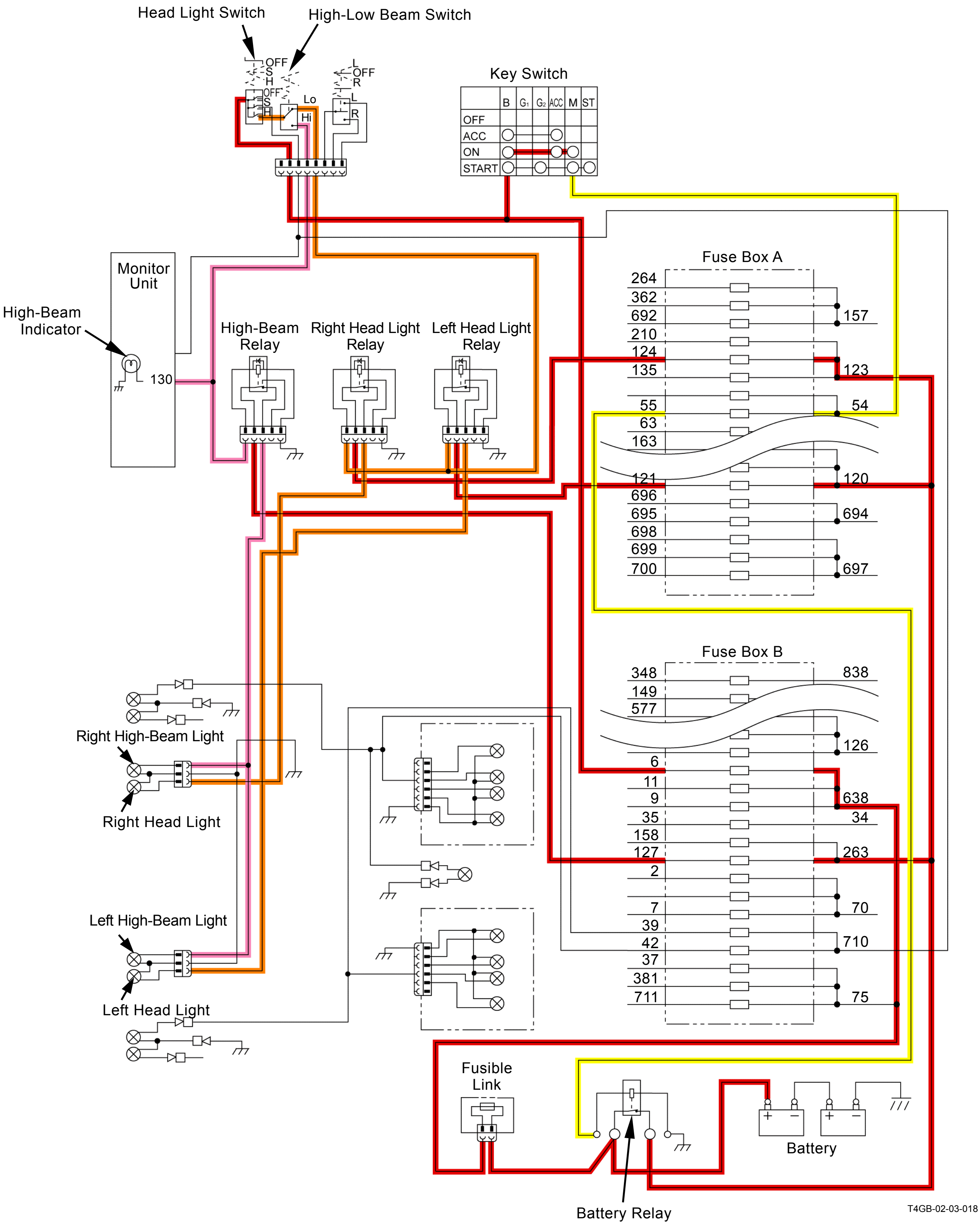
- Terminal B of the key switch is directly connected to the head light switch.
- When the head light switch is positioned at (Clearance Lights), part of the electricity from the S terminal of the head light switch enters #47 Terminal of the monitor unit, and the illumination light of the monitor unit is lit.
- Remainder of the electricity from the S terminal of the head light switch enters #710 Terminal of Fuse Box B, and further divided to #39 and #42 Terminals.
- Electricity from the power source coming out of #39 Terminal of Fuse Box B lights front left and rear left clearance lights.
- Electricity from the power source coming out of #42 Terminal of Fuse Box B lights the license light and the front right and rear right clearance lights.



Head Light Switch
OFF
S
H
OFF
S
H
L
OFF
R
L
R
Key Switch
B
G1
G2
ACC
M
ST
OFF
ACC
ON
START
Illumination Light
47
Monitor Unit
Fuse Box A
264
362
692
210
124
135
55
63
163
121
696
695
698
699
700
157
123
54
120
694
697
Front Right Clearance Light
Rear Right Clearance Light
Fuse Box B
348
149
577
6
11
9
35
158
127
2
7
39
42
37
381
711
838
126
638
34
263
70
710
75
License Light
Rear Left Clearance Light
Front Left Clearance Light
Fusible Link
Battery
Battery Relay
T4GB-02-03-010

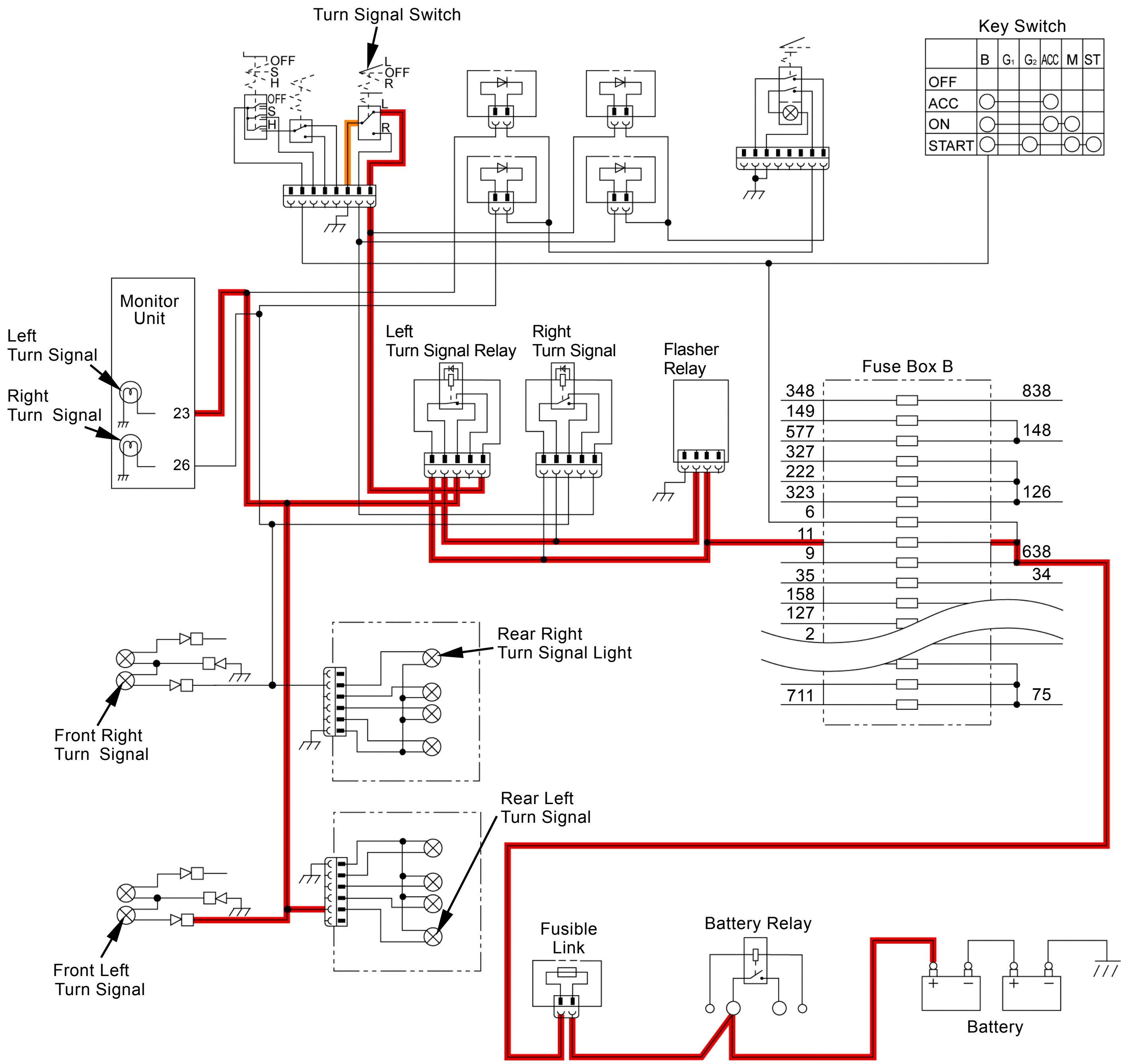
Head Light Lighting Circuit

- When the key switch is turned ON, the electricity from the power source coming out of Terminal M of the key switch excites the battery relay through #54 and #55 Terminals of Fuse Box A, and the electricity from the battery power source flows to Fuse Box A and Fuse Box B.
- Electricity from the battery power source coming out of #124 Terminal of Fuse Box A enters the right head light relay.
- Electricity from the battery power source coming out of #121 Terminal of Fuse Box A enters the left head light relay.
- Electricity from the battery power source coming out of #127 Terminal of Fuse Box B enters the high beam relay.
- When the head light switch is positioned at ≣D (Head Lights), the electricity from the power source coming out of Terminal S lights each of the clearance lights (Refer to Clearance Light Lighting Circuit.), and the electricity from the power source coming out of Terminal H flows to the high-low beam switch.
- At this moment, if the high-low beam switch is turned to Lo (Low Beam), the electricity from the power source enters the right head light relay and the left head light relay, and the electricity from the battery power source enters the head lights to light them by exciting the respective relays.
- If the high-low beam switch is turned to Hi (High Beam), the electricity from the power source excites the high-beam relay, and the electricity from the battery power source enters and lights the high-beam lights. Electricity from the power source coming out of the high-low beam switch also enters #130 Terminal of the monitor unit, and lights the high-beam indicators.


Head Light Switch
High-Low Beam Switch
OFF
S
H
Lo
Hi
L
R
Key Switch
B
G1
G2
ACC
M
ST
OFF
ACC
ON
START
Monitor Unit
High-Beam Indicator
130
High-Beam Relay
Right Head Light Relay
Left Head Light Relay
Fuse Box A
264
362
692
210
124
135
55
63
163
121
696
695
698
699
700
157
123
54
120
694
697
Fuse Box B
348
149
577
6
11
9
35
158
127
2
7
39
42
37
381
711
838
126
638
34
263
70
710
75
Right High-Beam Light
Right Head Light
Left High-Beam Light
Left Head Light
Fusible Link
Battery
Battery Relay
T4GB-02-03-018

TURN SIGNAL CIRCUIT

- Electricity from the battery power source also flows to the flasher relay coming out of #11 Terminal of Fuse Box B.
- In case the turn signal switch is turned to left (L), Terminal L of the turn signal switch is earthed, and the left turn signal relay is excited.
- Electricity from the power source coming out of the flasher relay enters the front and rear left turn signal lights and #23 Terminal of the monitor unit through the left turn signal relay.
- As a result, front and rear left turn signal lights and the left turn signal indicators flicker.

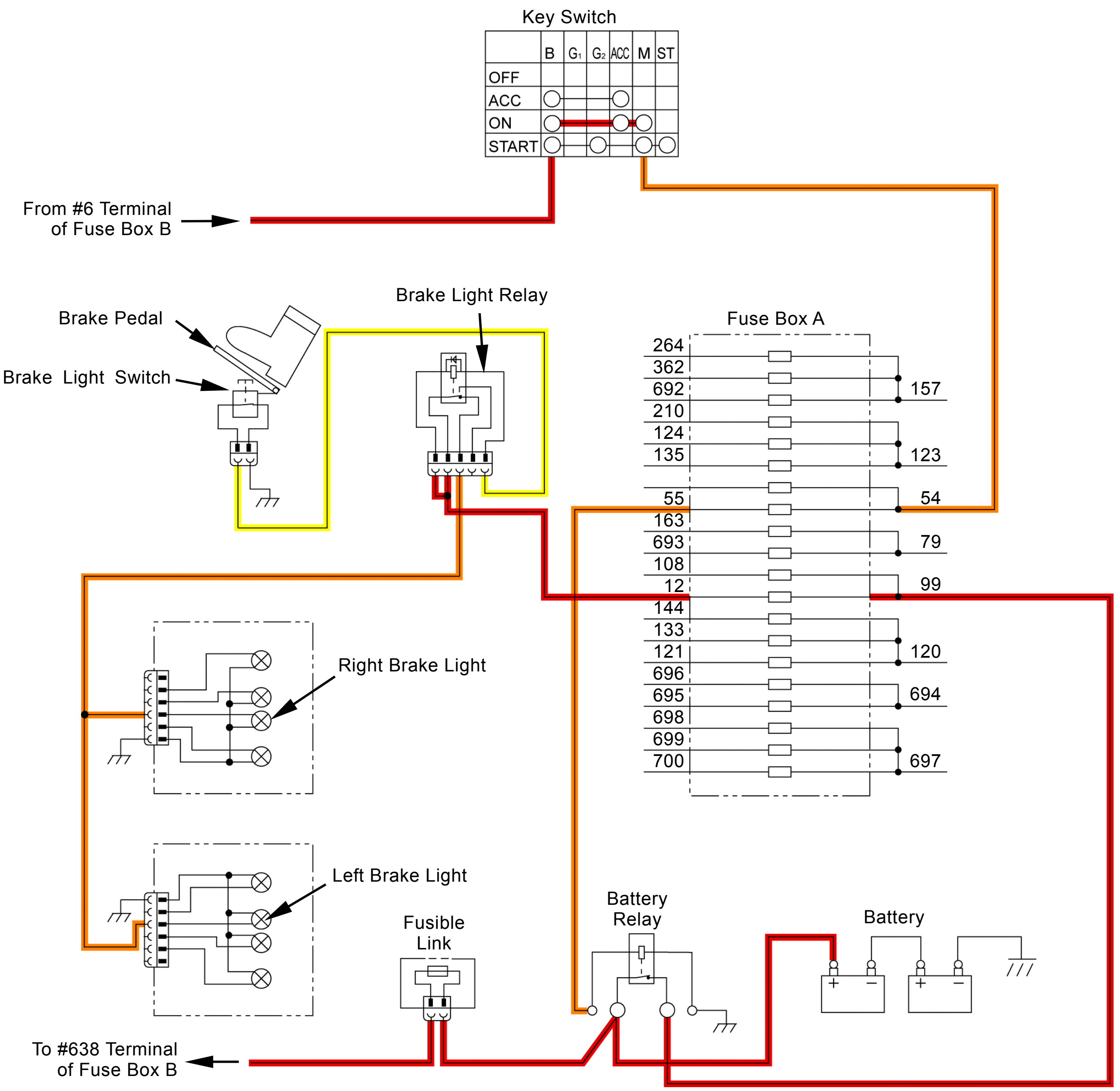


T4GB-02-03-011

BRAKE LIGHT CIRCUIT

- When the key switch is turned ON, the electricity from the power source coming out of Terminal M of the key switch excites the battery relay, and the electricity from the battery power source enters #99 Terminal of Fuse Box A and the brake light relay through #12 Terminal.

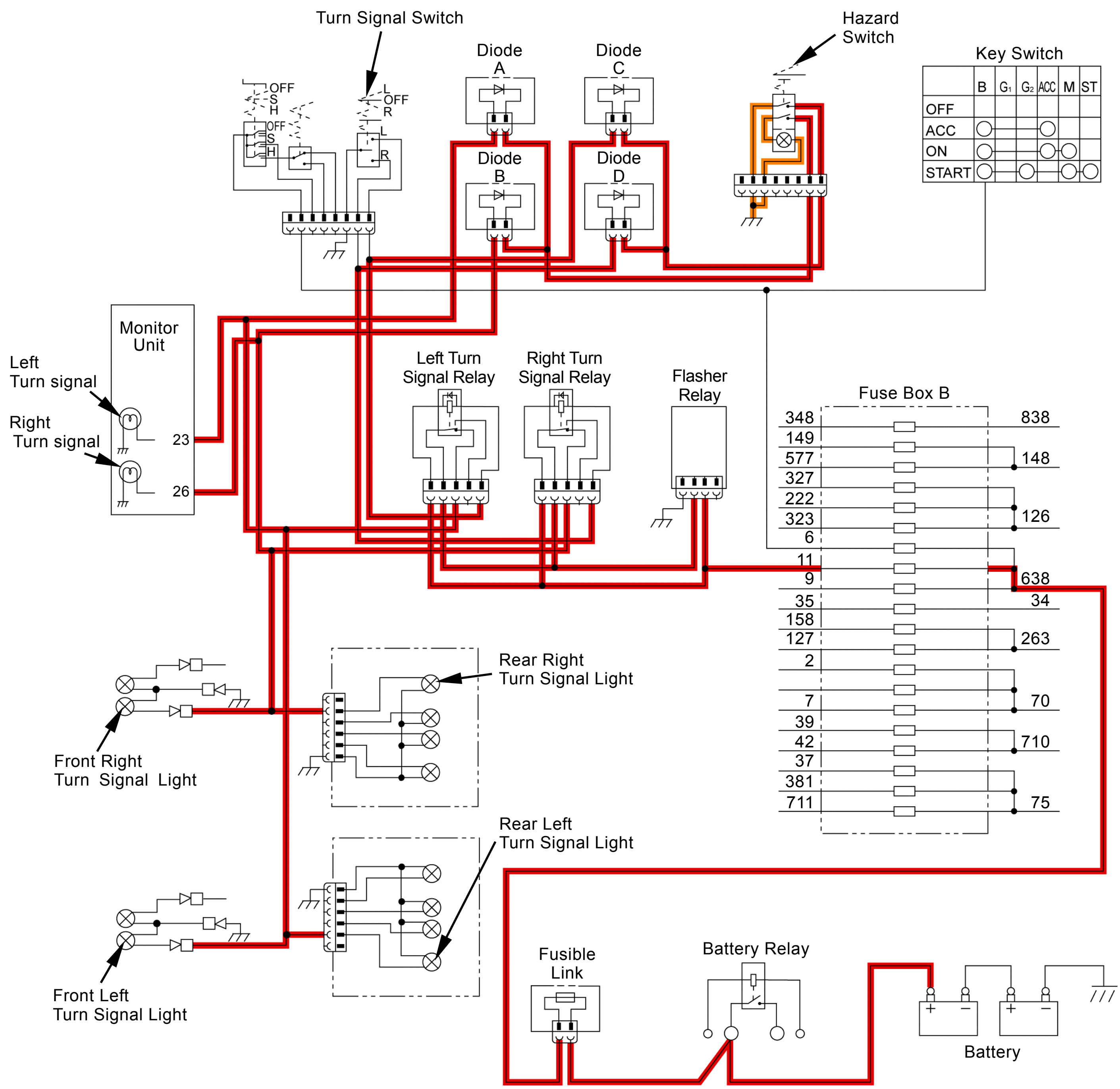
- When the brake pedal is stepped, the brake light switch is earthed.
- As a result, the brake light relay is excited, and the electricity from the battery power source enters the brake lights, and light them.



T4GB-02-03-012

HAZARD LIGHT CIRCUIT

- Electricity from the battery power source also flows to the flasher relay coming out of #11 Terminal of Fuse Box B.
- In case the hazard switch is turned ON, the hazard switch is earthed, and the left and right turn signal relays are excited.
- Electricity from the power source coming out of the flasher relay enters all of the front and rear left and right turn signal lights and #23 and #26 Terminals of the monitor unit through the left and right turn signal relays.
- As a result, all of the front and rear left and right turn signal lights and the left and right turn signal indicators flicker.

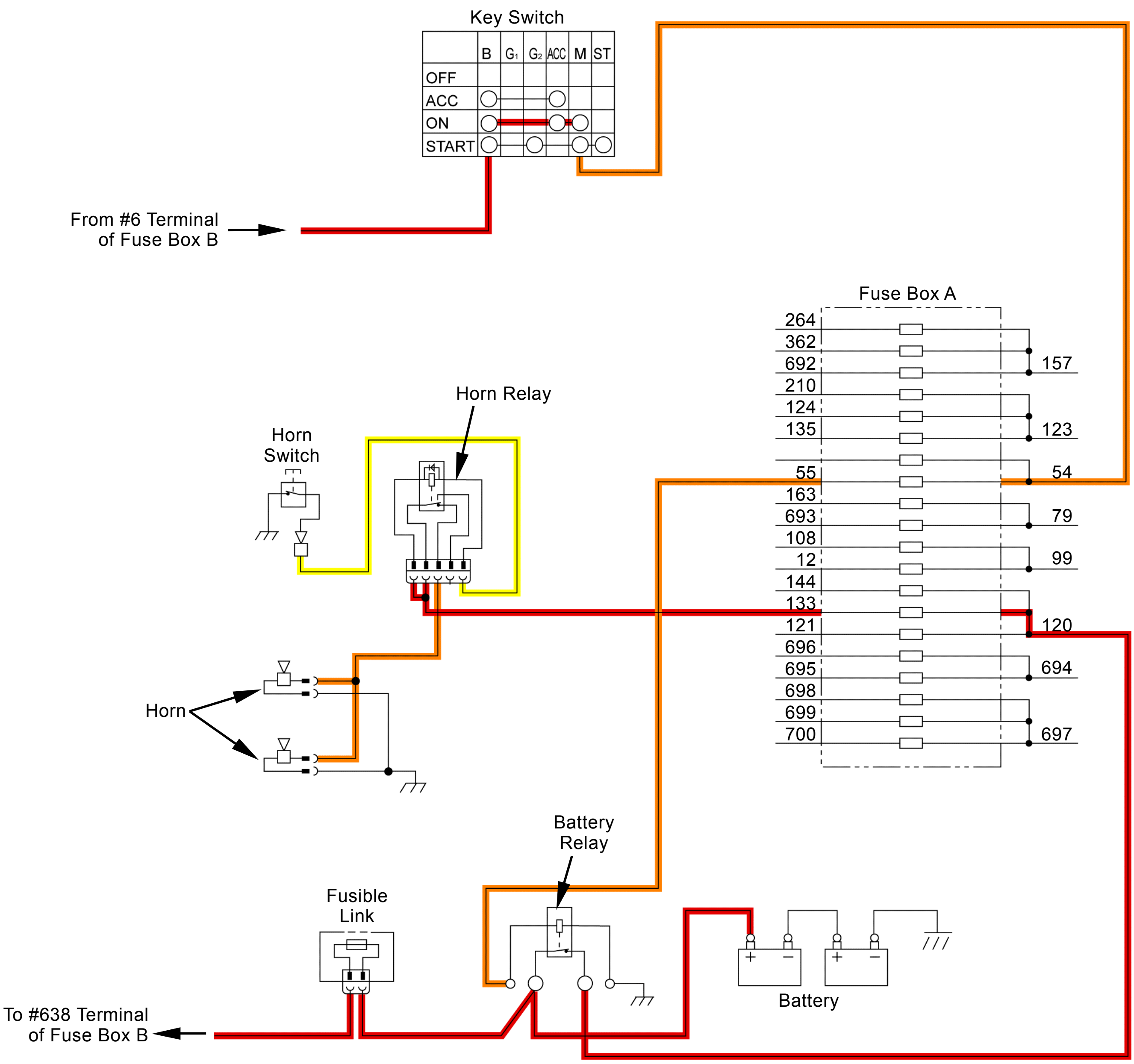


T4GB-02-03-013

HORN CIRCUIT

- When the key switch is turned ON, the electricity from the power source coming out of Terminal M excites the battery relay through #54 and #55 Terminals of Fuse Box A, and the electricity from the battery power source enters #120 Terminal of Fuse Box A and the horn relay through #133 Terminal.

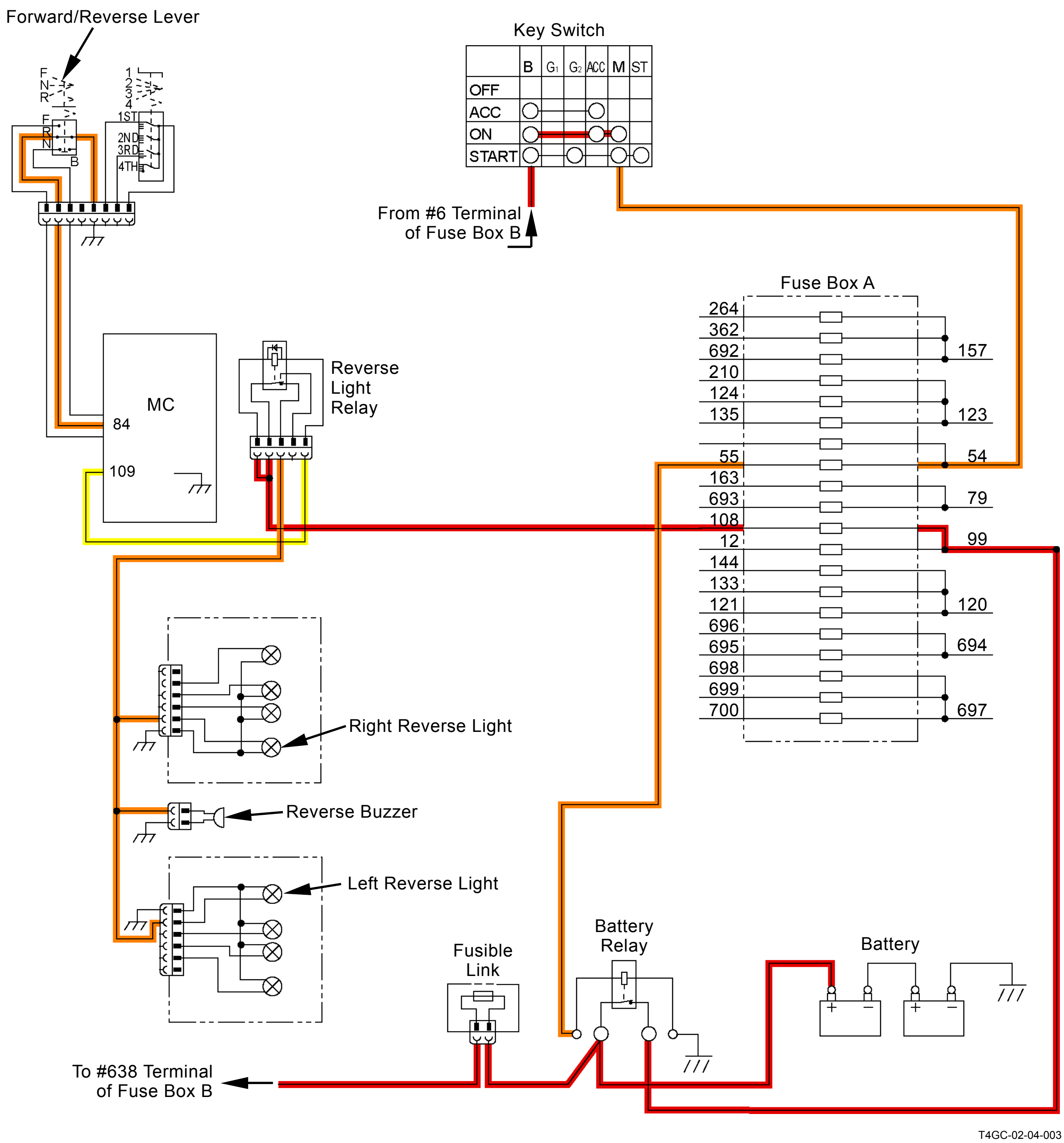
- Horn switch is earthed when pushed.
- As a result, the horn relay is excited, and the electricity from the battery power source enters the horn, and the horn sounds.



T4GB-02-03-014

REVERSE LIGHT/BUZZER CIRCUIT

- When the key switch is turned ON, the electricity from the power source coming out of Terminal M excites the battery relay through #54 and #55 Terminals of Fuse Box A.
- Electricity from the battery power source enters #99 Terminal of Fuse Box A, and enters the reverse light relay through #108 Terminal.
- When the forward-reverse lever is turned to reverse, Terminal R is earthed, and the MC earths #109 Terminal because the electricity from the power source flows to the forward-reverse lever through #84 Terminal of the MC.
- As a result, the reverse light relay is excited, and the electricity from the battery power source flows to the reverse light and the reverse buzzer.



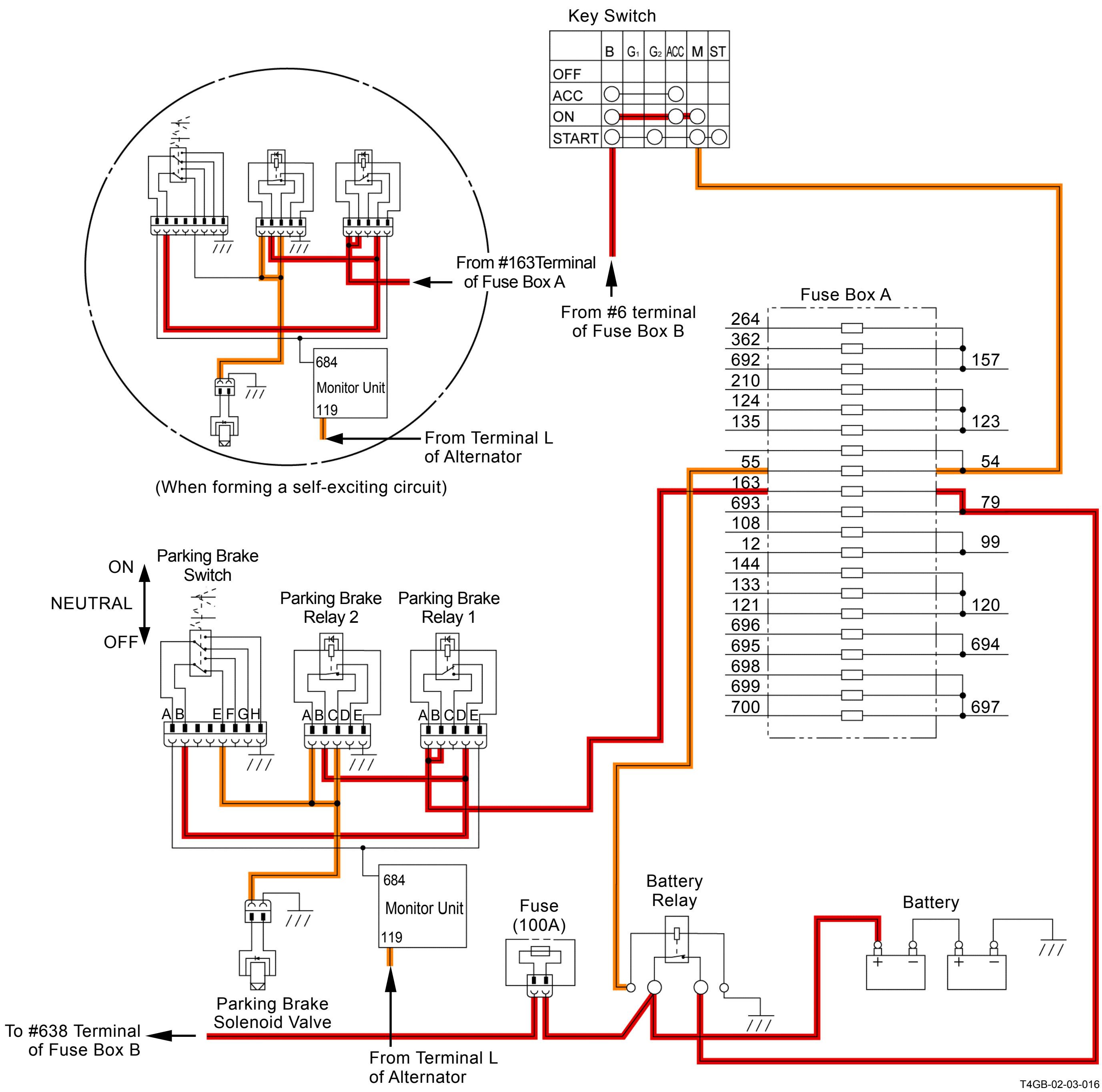
Forward/Reverse Lever
F
N
R
1
2
3
4
1ST
2ND
3RD
4TH
B
Key Switch
B
G1
G2
ACC
M
ST
OFF
ACC
ON
START
From #6 Terminal of Fuse Box B
Fuse Box A
264
362
692
210
124
135
55
163
693
108
12
144
133
121
696
695
698
699
700
157
123
54
79
99
120
694
697
MC
84
109
Reverse Light Relay
Right Reverse Light
Reverse Buzzer
Left Reverse Light
Fusible Link
Battery Relay
Battery
To #638 Terminal of Fuse Box B
T4GC-02-04-003

PARKING BRAKE CIRCUIT

- When the key switch is turned ON, the electricity from the power source coming out of Terminal M excites the battery relay through #54 and #55 Terminals of Fuse Box A.
- Electricity from the power source enters #79 Terminal of Fuse Box A and Parking Brake Relay 1 through #163 Terminal of Fuse Box A.
- Electricity from the power source coming out of Terminal D of Parking Brake Relay 1 through Terminal B of Parking Brake Relay 1 flows to Terminal B of Parking Brake Relay 2 and Terminal B of the parking brake switch.
- Parking brake switch is composed of three circuits of ON, NEUTRAL, and OFF, and so constructed as to remain at ON when turned ON, but to automatically return to NEUTRAL when turned OFF.
- When the parking brake switch is turned OFF, electric current flows from Terminal E of the parking brake switch to Terminal A of Parking Brake 2 and the parking brake solenoid valve.
- At this moment, if the engine is not running, Parking Brake Relay 1 is excited because #684 Terminal of the monitor unit is earthed.
- Therefore, the parking brake cannot be released because the electricity from the power source having been supplied through Parking Brake 1 to Terminal B of the parking brake switch and Terminal B of the parking brake relay is blocked.
- In case the engine is running, Parking Brake Relay 2 is excited because the electric current from Terminal L of the alternator enters #119 Terminal of the monitor unit, releasing earthing of #684 Terminal of the monitor unit.
- As a result, a circuit in which electricity flows from Terminal C of Parking Brake Relay 2 to Terminal A of Parking Brake Relay 2 (self-exciting circuit) is formed, and the parking brake solenoid valve works, releasing the parking brake.
- As the parking brake switch automatically returns to neutral, the circuit from Terminal E of the parking brake switch to Parking Brake Relay 2 is blocked.
- However, as a self-exciting circuit is formed in Parking Brake Relay 2, electric current keeps flowing to the parking brake solenoid valve, keeping the released condition of the parking brake until the key switch is turned OFF or the parking brake switch is turned ON.

IMPORTANT: Parking brake cannot be released unless the engine is running.

- When the parking brake switch is turned ON, Terminal A of the parking brake switch is earthed, and Parking Brake Relay 1 is excited.
- Electricity from the power source having been supplied to Terminal B of Parking Brake Relay 2 and Terminal B of Parking Brake Switch through Terminal D of Parking Brake Relay 2 is blocked.
- As a result, the parking brake works because Parking Brake Relay 2 and the parking brake solenoid valve are unexcited.



NOTE: Illustration shows flow of electric current when the parking brake switch remains pushed after the parking brake switch has been turned OFF during rotation of the engine.

EMERGENCY STEERING CHECK CIRCUIT (OPTIONAL)

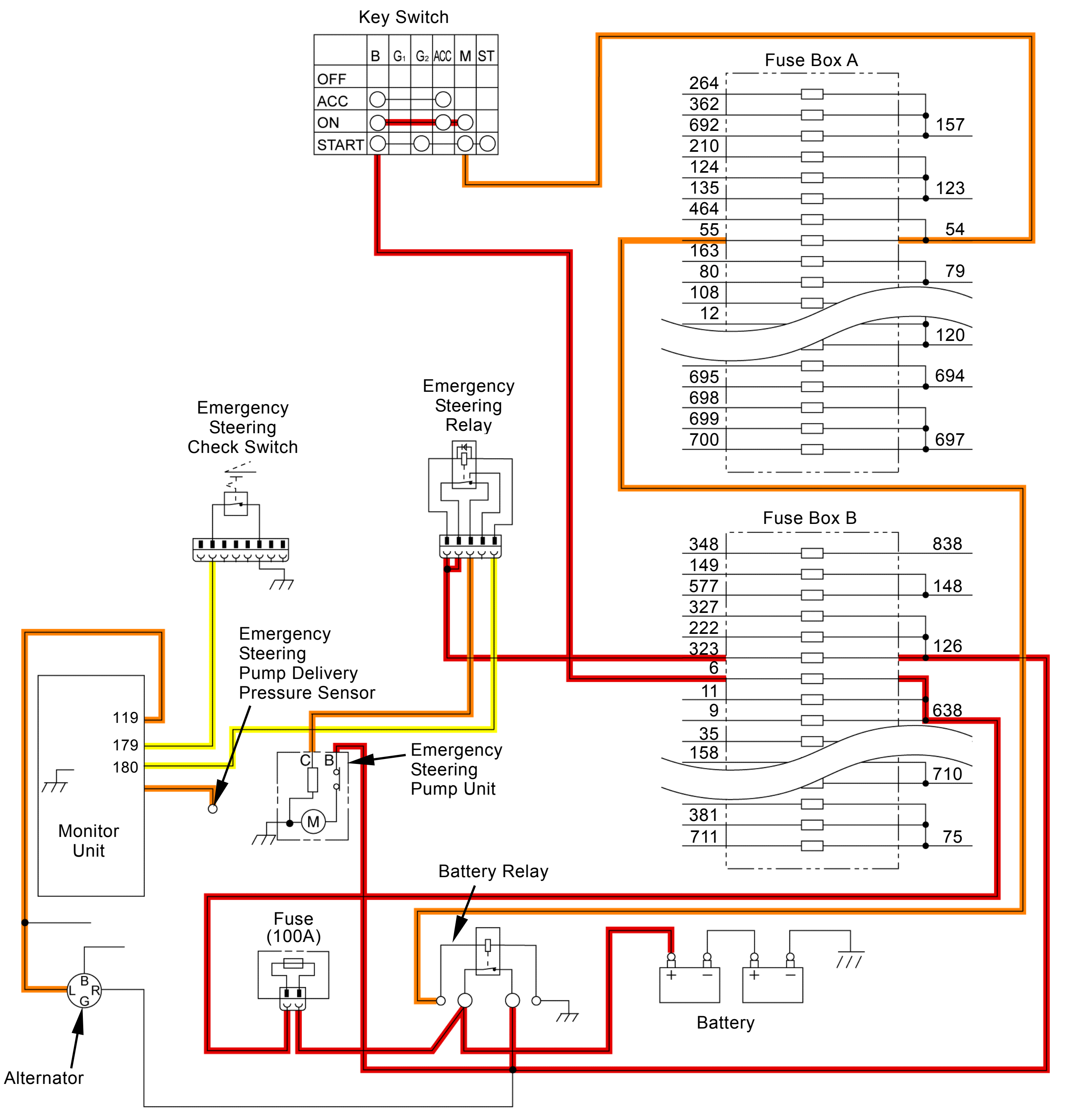
(Manual Check Circuit)

- When the key switch is turned ON, the electric current from Terminal M the battery relay, and the electricity from the power source enters the emergency steering relay through #323 terminal of Fuse Box B, and also enters Terminal B of the emergency steering pump unit.
- When the emergency steering check switch is turned ON, electric current flows to #179 Terminal of the monitor unit.
- At the same time, as the monitor unit excites #180 Terminal, the emergency steering relay is excited.
- Electricity from the power unit enters Terminal C of the emergency steering pump unit through the emergency steering relay, exciting Terminal B, and the emergency steering pump unit is started.

IMPORTANT: Emergency steering pump unit is not so designed as to be operated for a long time. When its operation has been confirmed, turn the emergency steering check switch OFF by stopping pushing the switch.

(Auto Check Circuit)

- When the engine is started by turning the key switch to the ST position, the alternator starts generating electricity.
- When part of the electricity generation signal from Terminal L of the alternator enters the monitor unit, and rises to the predetermined voltage, Terminal #180 is earthed, and the emergency steering relay is excited.
- Electricity from the power unit enters Terminal C of the emergency steering pump unit through the emergency steering relay, exciting Terminal B, and the emergency steering pump unit is started.
- The emergency steering pump unit works for several seconds, and then the earthed circuit of Terminal #180 is automatically cancelled and the emergency steering pump unit stops.
- In case hydraulic oil higher than the predetermined value has been being delivered during operation of the emergency steering pump unit, the emergency steering pump delivery pressure switch is turned OFF, and the automatic inspection operation is stopped normally.
- In case hydraulic oil higher than the predetermined value has not been being delivered, the emergency steering pump delivery pressure switch remains ON, and the emergency steering operation warning lamp on the monitor unit flickers to notify abnormality of the emergency steering pump unit.



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MEMO

MEMO

SECTION 3
COMPONENT OPERATION

CONTENTS

Group 7 Charging Block

Group 8 Ride Control Valve

Group 9 Drive Unit

Group 10 Axle

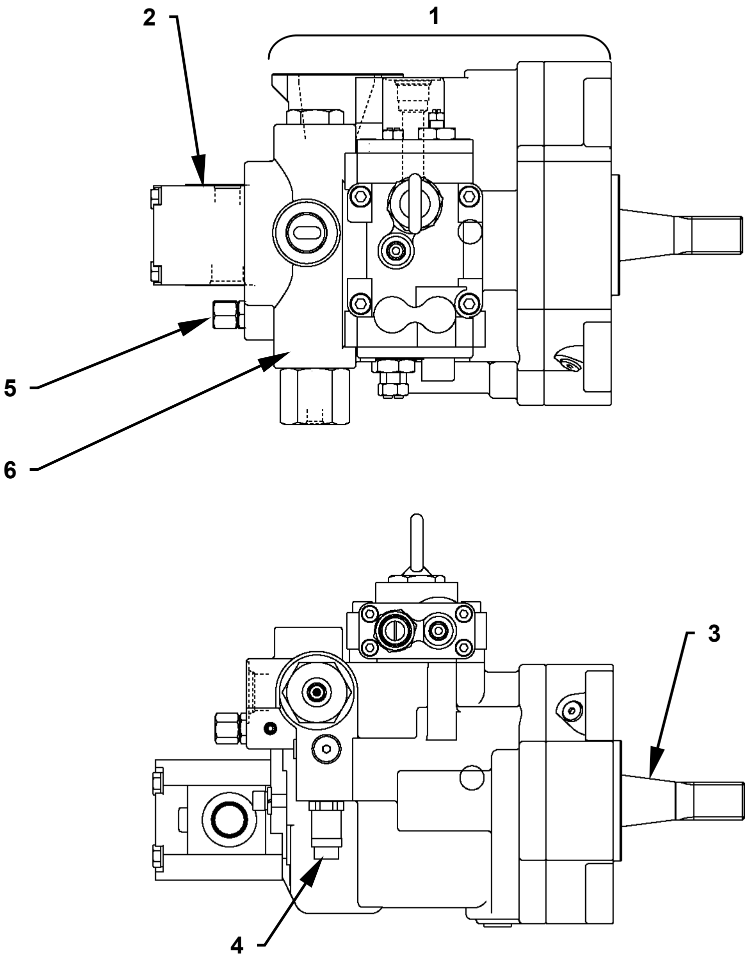
Group 11 Brake Valve

Group 12 Others

OUTLINE

Pump device has a main pump (1) and a pilot pump (2), and main pump (1) has a built-in priority valve (6).
Driving force of the engine is transmitted to the shaft (3) through the transmission input shaft, and actuates main pump (1) and pilot pump (2).

Main pump (1) is a swash-plate type variable displacement axial plunger pump.
Pilot pump (2) is a gear pump.
Pump delivery pressure switch (4) is provided for controlling the main pump.



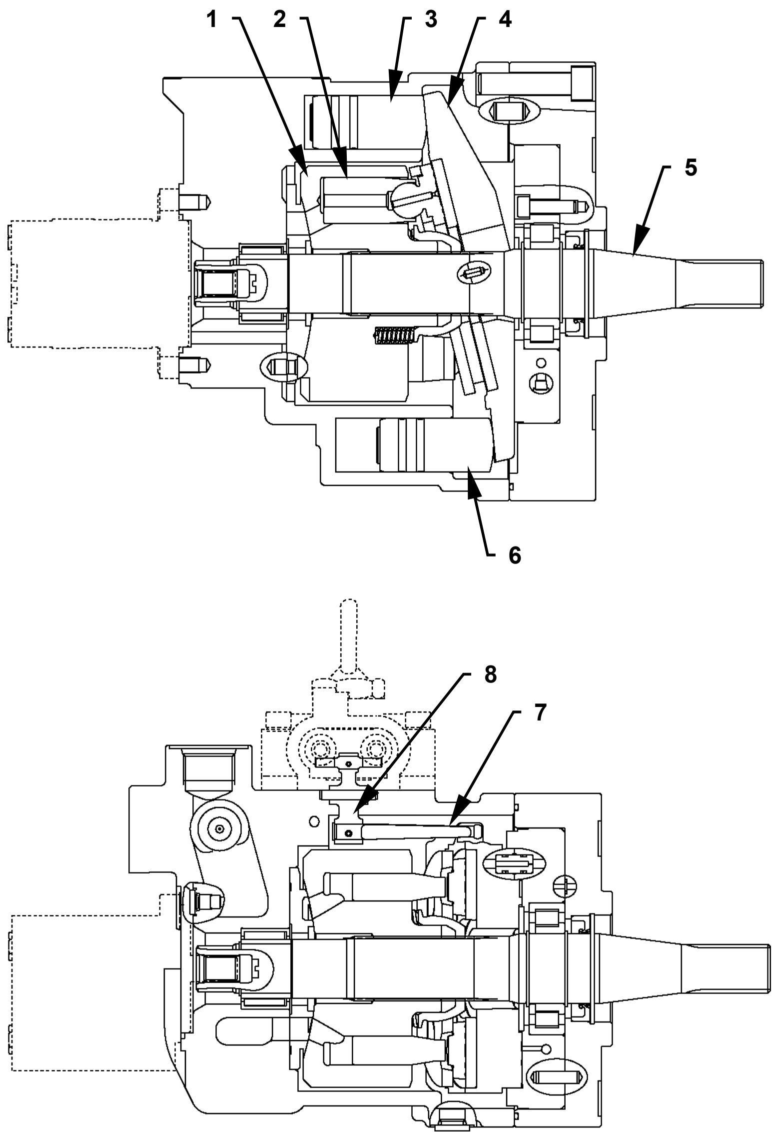
T4GB-03-01-001

1 - Main Pump
2 - Pilot Pump
3 - Shaft
4 - Pump Delivery Pressure Switch
5 - Steering Main Relief Valve
6 - Priority Valve

MAIN PUMP

Main pump supplies pressure oil for operating the cylinders and other hydraulic components. Also, the pump is provided with a regulator for controlling the delivery flow.
Shaft (5) is connected with the cylinder block (1), and shaft (5) and cylinder block (1) corotate.

When cylinder block (1) rotates, plungers (2) reciprocate inside the cylinder block because of the tilting of swash plate (4), and delivers the hydraulic oil.
Control of the main pump delivery is made by changing the tilting angle of swash plate (4) with servo piston 1 (3) and servo piston 2 (6) which increase or decrease the stroke of plungers (2).



T4GB-03-01-002

1 - Cylinder Block
2 - Plunger
3 - Servo Piston 1 (2 pieces)
4 - Swash Plate
5 - Shaft
6 - Servo Piston 2
7 - Feed Back Lever
8 - Link

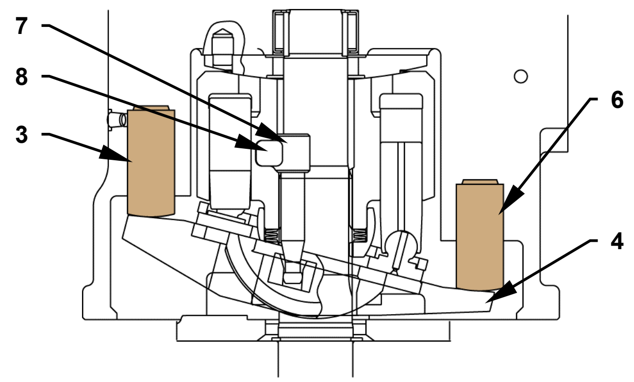
Increase and Decrease Operations of Delivery Flow

Tilting angle variation of swash plate (4) is made by the movement of servo piston 1 (3) and servo piston 2 (6).
Movement of the servo pistons is controlled by the regulator. Also, the feed back of the swash plate movement is given to the regulator by feed back lever (7) and link (8).

NOTE: Refer to the following pages for operation of the regulator.

- Tilting Change Operation
  Tilting center of the swash plate is located at A in the drawings right.
  Pilot pressure is always applied to servo piston 2 (6). Therefore, when the circuit of servo piston 1's (3) is connected to the hydraulic oil tank, swash plate (4) tilts clockwisw around A.
  Conversely, as there are two servo piston 1's (3), when pilot pressure is applied to both of servo piston 1's (3) and servo piston 2, the swash plate (4) tilts counterclockwise around A.

- Feed Back Operation
  End of feed back lever (7) is inserted into the boss on the side face of the swash plate (4). When swash plate (4) tilts, the boss also moves, and feed back lever (7) moves together.
  For example, if swash plate (4) tilts to the maximum tilting position from the minimum tilting position, the center of feed back lever (7) moves from B to C.
  This movement of feed back lever (7) moves link (8), and feed back is given to the regulator.



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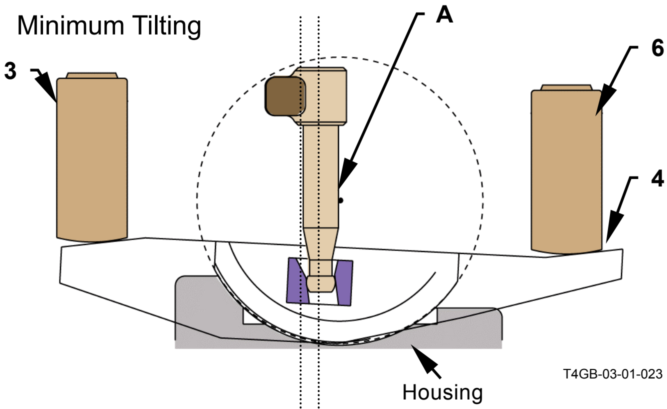

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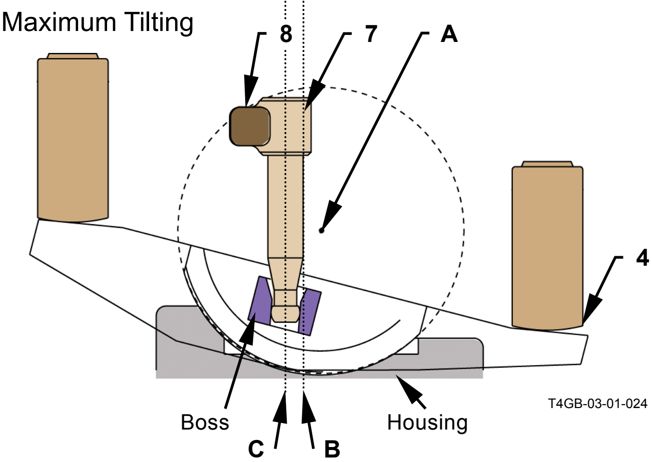
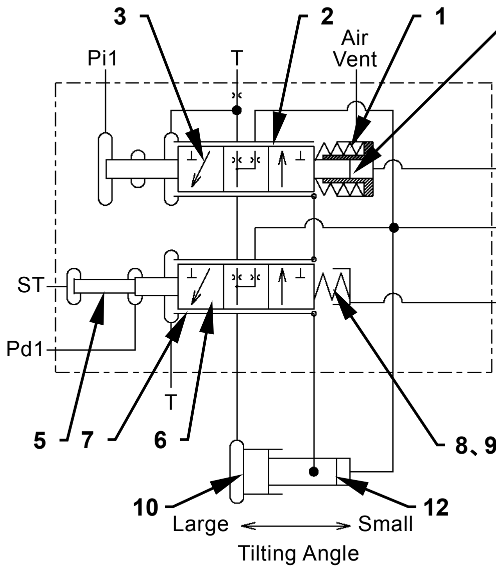


T4GB-03-01-024

REGULATOR

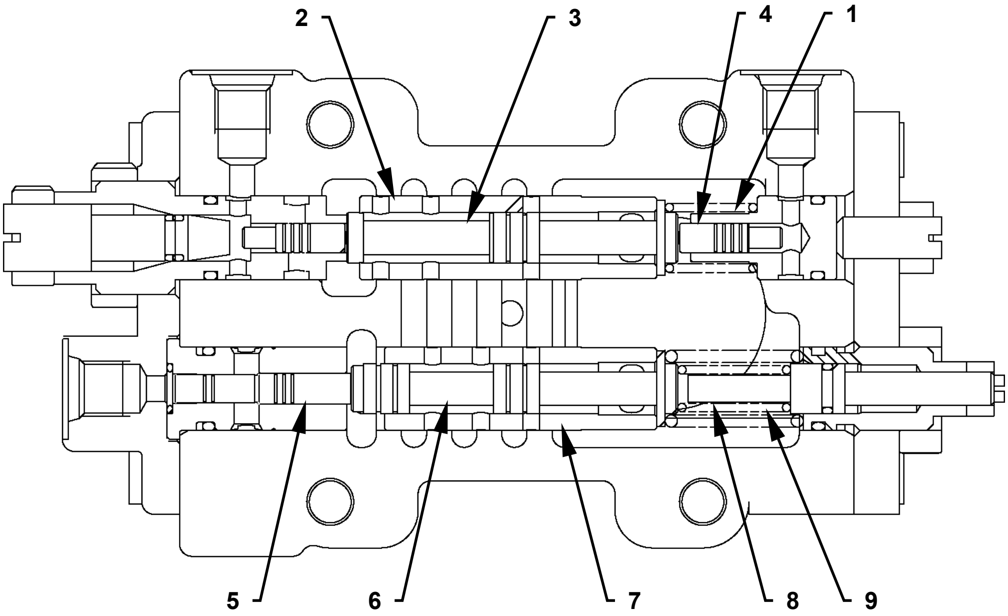
Regulator controls flow of the main pump, receiving various kinds of signal pressure.
The regulator includes the spring (1), sleeve 1 (2), sleeve 2 (7), spool 1 (3), spool 2 (6), piston (4), load piston (5), inner spring (8), and outer spring (9).
Regulator opens and closes the circuit leading to servo piston 1 (10) by receiving various kinds of signal pressure, and controls delivery flow of the pump by varying the tilting angle of swash plate (11).

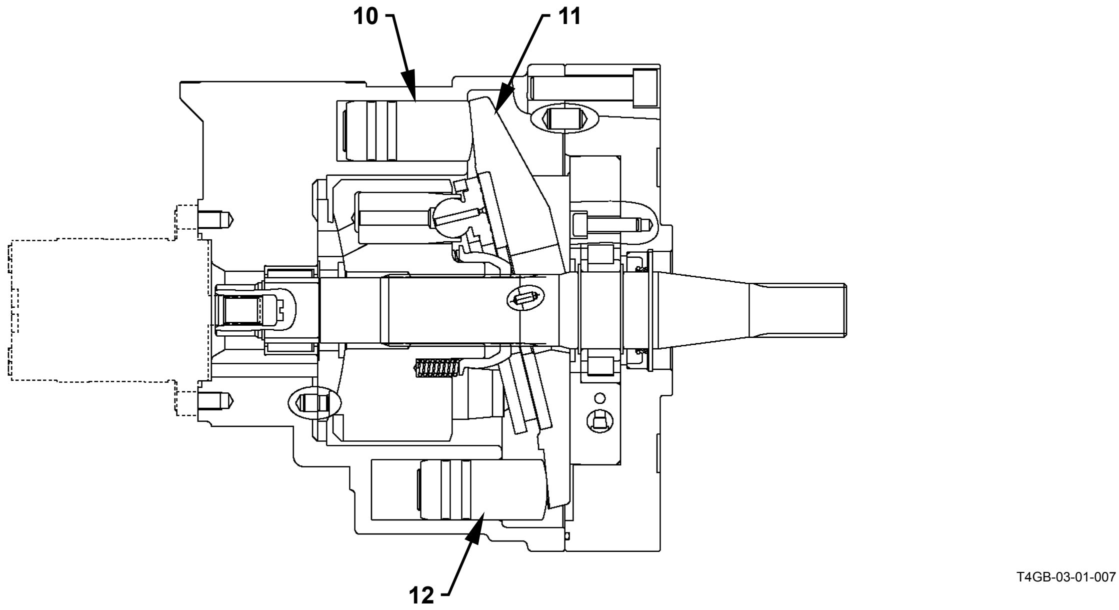
NOTE: Pilot primary pressure (Pg) is always applied to Servo Piston 2 (12).



T4GB-03-01-006

Pd1 -	Pump Delivery Pressure (Self Delivery Pressure)	Pi1 -	Pump Control Pressure 1
ST -	Pump Torque Control Pressure	Pi2 -	Pump Control Pressure 2
T -	Return Line to Hydraulic Oil Tank	Pg -	Pilot Primary Pressure (From Pilot Pump)



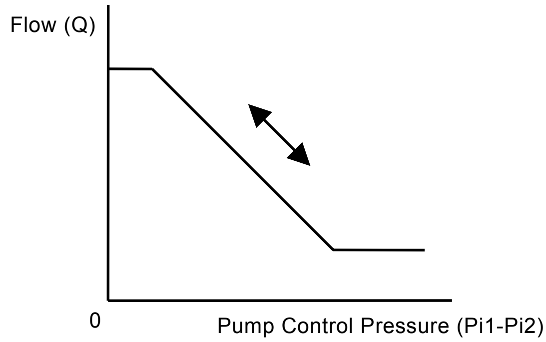


1 - Spring	4 - Piston	7 - Sleeve 2	10 - Servo Piston 1(2 pieces)
2 - Sleeve 1	5 - Load Piston	8 - Inner Spring	11 - Swash Plate
3 - Spool 1	6 - Spool 2	9 - Outer Spring	12 - Servo Piston 2

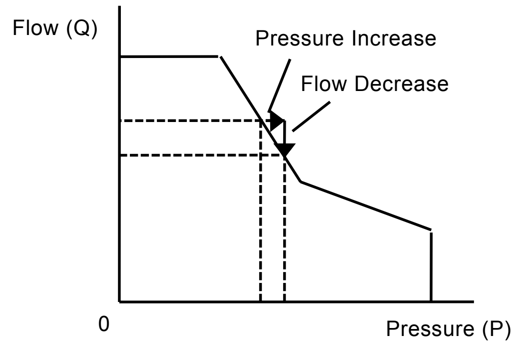
Control Function of Regulator

Regulator has the following three control functions.

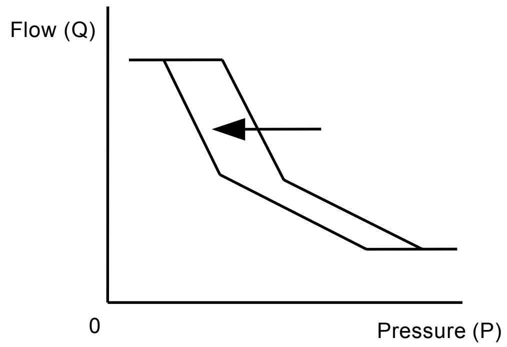
- Control by Pump Control Pressure
  Pump flow control valve inside the control valve controls the pump control pressure (Pi1 - Pi2) in response to the operating stroke of the control lever. By receiving this pump control pressure (Pi1 - Pi2), the regulator increases or decreases the pump delivery flow in response to the pressure.
  When the control lever is operated, pump control pressure (Pi1 - Pi2) lowers, and the regulator increases the pump delivery flow. If the control lever is returned to neutral, pump control pressure (Pi1 - Pi2) rises, and the regulator decreases the pump delivery flow.



- Control by Pump Delivery Pressure (Self Delivery Pressure)
  Pump Delivery Pressure (Self Delivery Pressure) Pd1 enters the regulator. In case this pump pressure exceeds the set P - Q line, the pump delivery flow is decreased to return the pressure to the P - Q line.



- Control by Pilot Pressure from Torque Control Solenoid Valve
  MC (Main Controller) makes arithmetic operations of the operating conditions of the vehicle body, and transmits signals to the pump torque control solenoid valve to obtain needed pump torque.
  Pump torque control solenoid valve transmits Pump Torque Control Pressure ST corresponding to this signal to the regulator. Regulator, receiving the pilot pressure, decreases the pump delivery flow.



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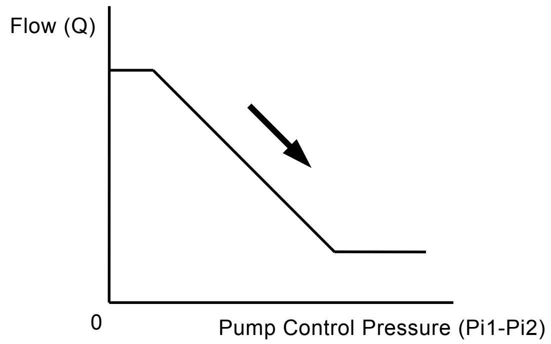
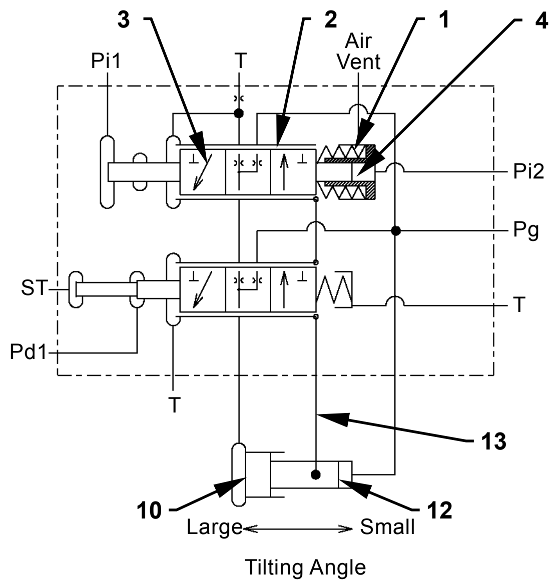
Control by Pump Control Pressure

Flow Decrease

1. When the control lever stroke is reduced, pressure difference arising before and after the flow control valve (difference between pressure Pi1 and Pi2) in the control valve is enlarged.
2. Pump Control Pressure Pi1 pushes Spool 1 (3), and Spool 1 (3) moves toward the arrow.
3. This movement causes Pilot Primary Pressure Pg to be led to servo piston 1 (10) also.
4. As there are two servo piston 1's (10), the swash plate (11) tilts toward the flow decreasing direction.
5. Movement of swash plate (11) is conveyed to sleeve 1 (2) through feed back lever link (13). Sleeve 1 (2) moves toward the movement of spool 1 (3).
6. Pilot pressure having been led to servo piston 1 (10) is blocked when sleeve 1 (2) has moved the same distance as spool 1 (3). This causes servo piston 1's (10) to stop and the flow decrease is completed.

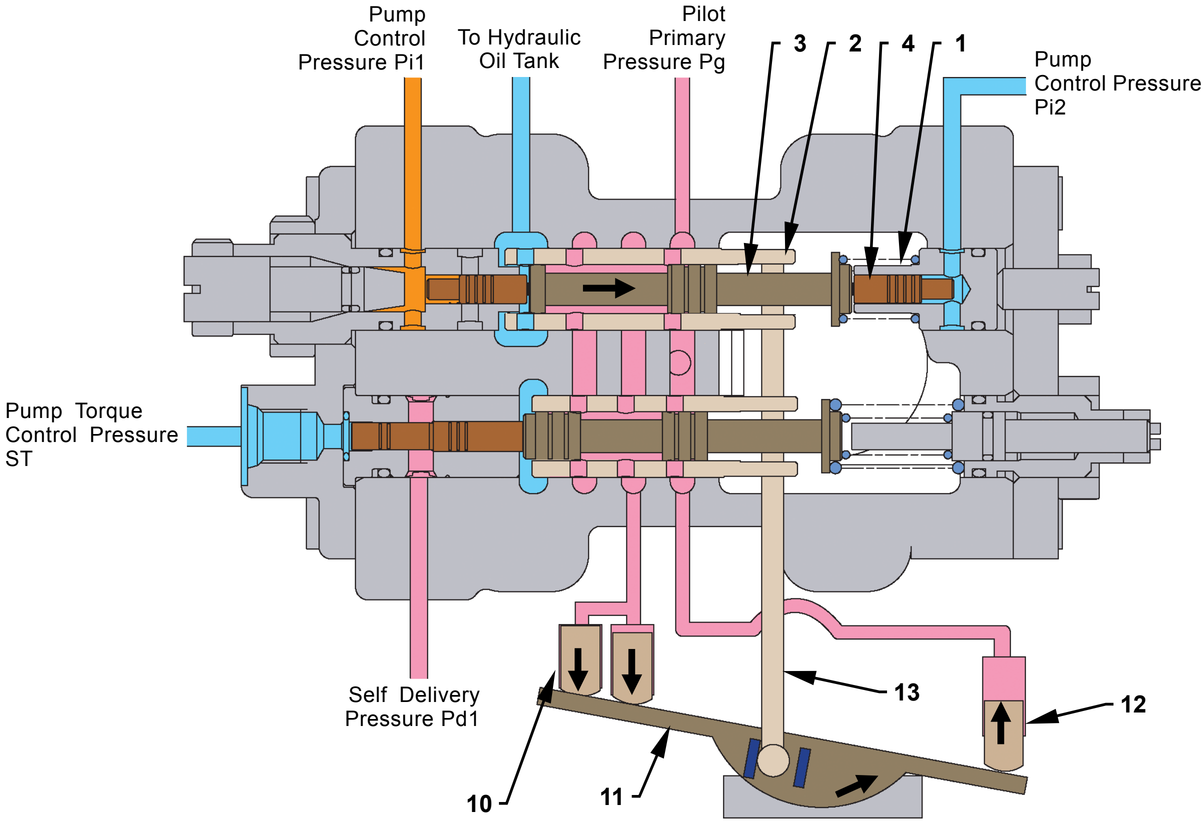




T4GB-03-01-006

1 -	Spring	10 -	Servo Piston 1
2 -	Sleeve 1	11 -	Swash Plate
3 -	Spool 1	12 -	Servo Piston 2
4 -	Piston	13 -	Feed Back Lever Link

Pd1 -	Pump Delivery Pressure (Self Delivery Pressure)	Pi1 -	Pump Control Pressure 1
ST -	Torque Control Pressure	Pi2 -	Pump Control Pressure 2
T -	Return Line to Hydraulic Oil Tank	Pg -	Pilot Primary Pressure (From Pilot Pump)



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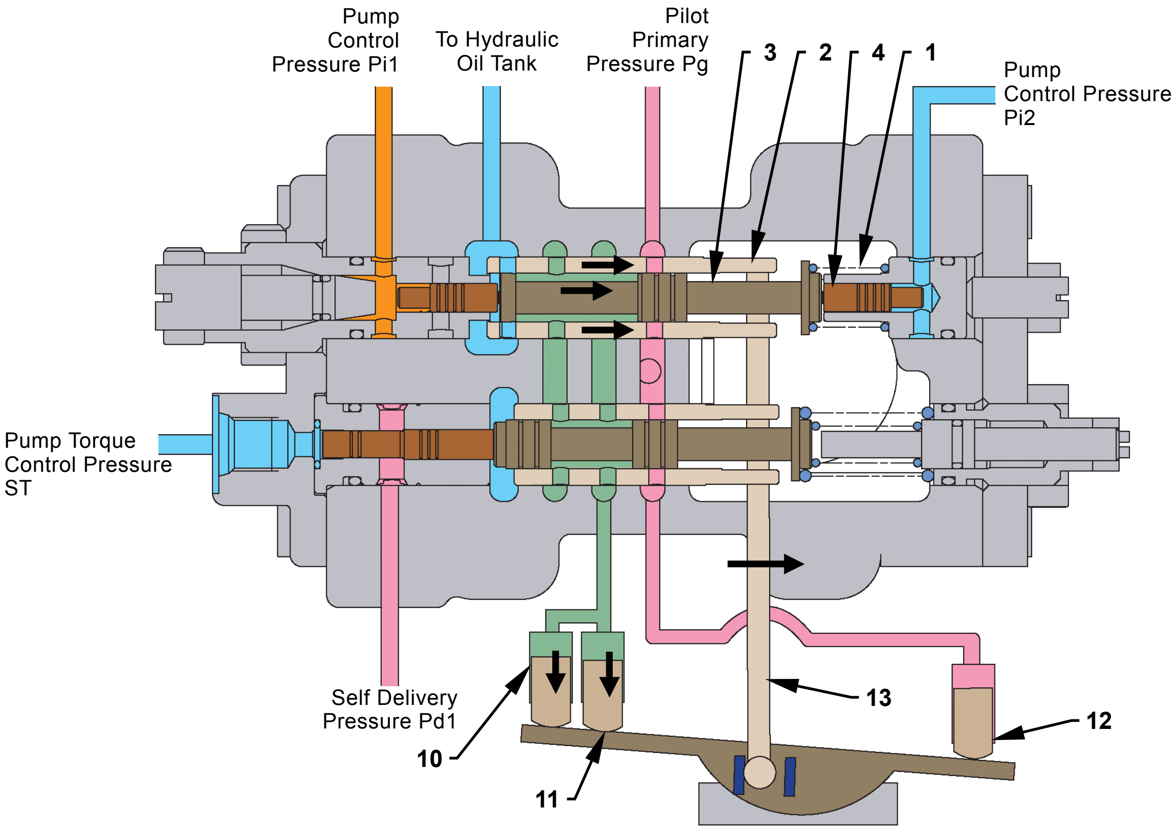
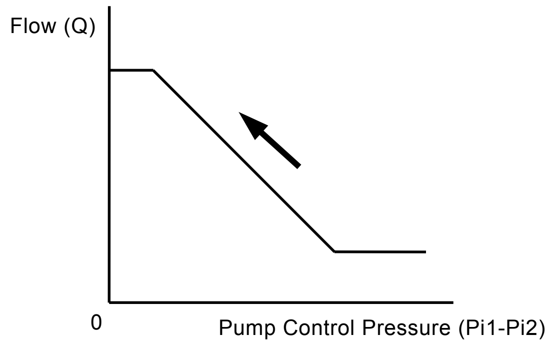
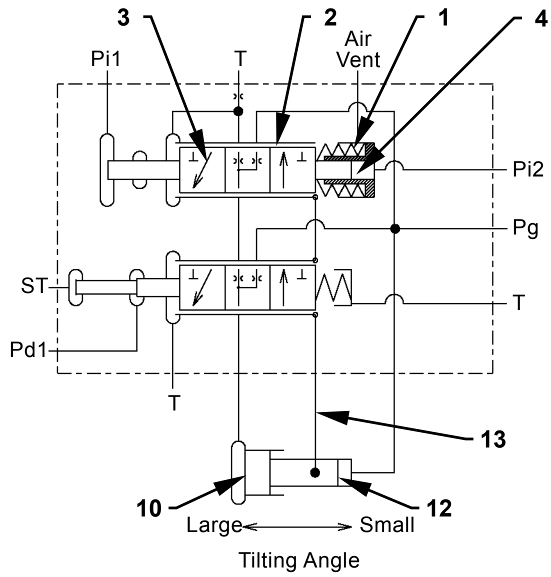


T4GB-03-01-009

Flow Increase

1. When the control lever stroke is enlarged, pressure difference arising before and after the flow control valve (difference between pressure Pi1 and Pi2) in the control valve is reduced.
2. Force due to spring (1) and Pump Control Pressure Pi2 pushes spool 1 (3), and spool 1 (3) moves toward the arrow.
3. This movement causes the circuit of servo piston 1's (10) to be led to the hydraulic oil tank.
4. As Pilot Primary Presuure Pg is always applied to servo piston 2 (12), the swash plate (11) tilts toward the flow increasing direction.
5. Movement of the swash plate (11) is transmitted to sleeve 1 (2) through the feed back lever link (13). Sleeve 1 (2) moves toward the movement of spool 1 (3).
6. When sleeve 1 (2) has moved the same distance as spool 1 (3) did, communication of servo piston 1's (10) with the hydraulic tank is stopped, and this causes servo piston 1's (10) to stop and the flow increase is completed.

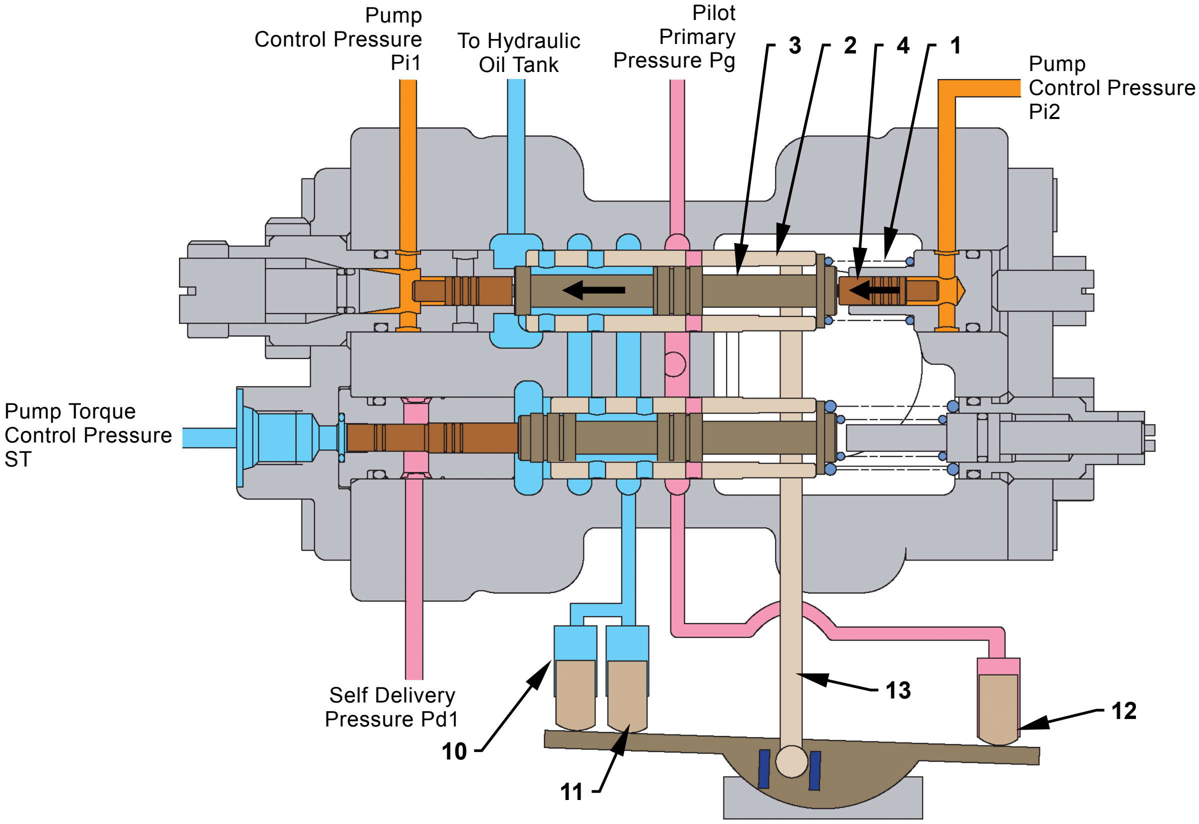




T4GB-03-01-006

1 - Spring	10 - Servo Piston 1
2 - Sleeve 1	11 - Swash Plate
3 - Spool 1	12 - Servo Piston 2
4 - Piston	13 - Feed Back Lever Link

Pd1 -	Pump Delivery Pressure (Self Delivery Pressure)	Pi1 -	Pump Control Pressure 1
ST -	Pump Torque Control Pressure	Pi2 -	Pump Control Pressure 2
T -	Return Line to Hydraulic Oil Tank	Pg -	Pilot Primary Pressure (From Pilot Pump)



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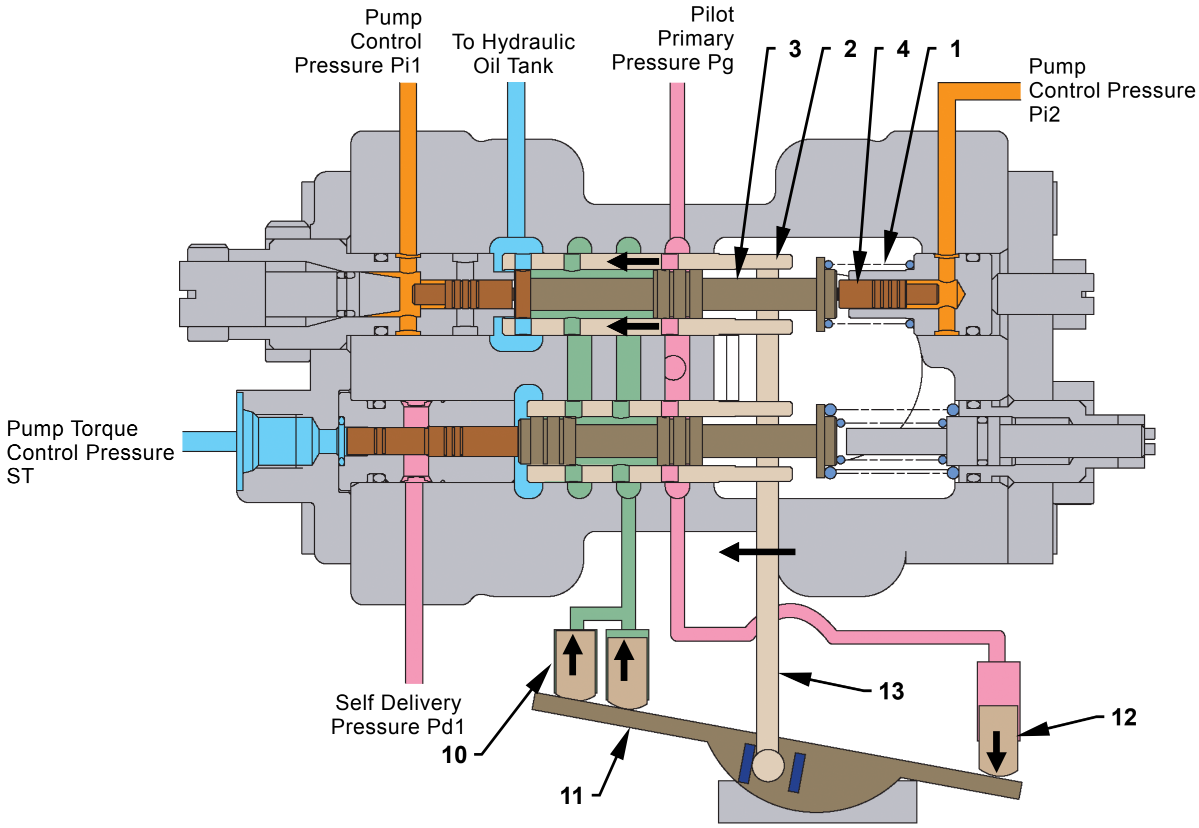
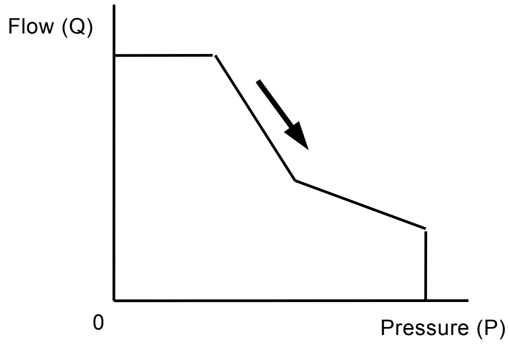


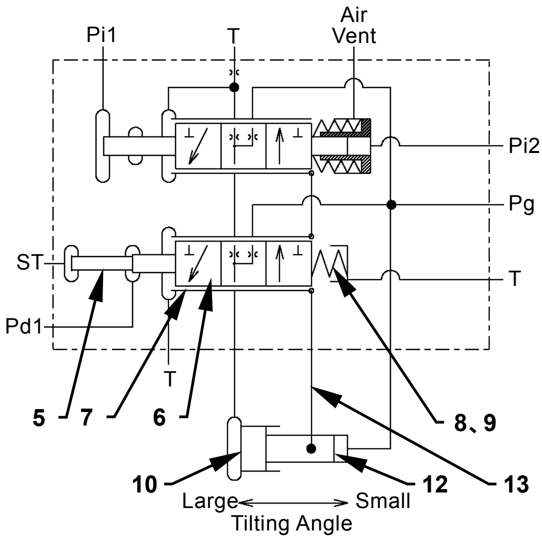
T4GB-03-01-011

Control by Pump Delivery Pressure (Self Delivery Pressure)

Flow Decrease

1. When load is applied to the pump by making one operation or another, Pump Delivery Pressure Pd1 rises. (As done during an operation, the pump control pressure (Pi1 - Pi2) remains lowered.)
2. Load piston (5) pushes spool 2 (6), the inner spring (8), and the outer spring (9), and Spool 2 (6) moves toward the arrow.
3. This movement causes Pilot Primary Pressure Pg to be led to servo piston 1's (10) also.
4. As there are two servo piston 1 (10), the swash plate (11) tilts toward the flow decreasing direction.
5. This movement of the swash plate (11) is conveyed to sleeve 2 (7) through the feed back lever link (13). Sleeve 2 (7) moves toward the movement of spool 2 (6).
6. Pilot pressure having been led to servo piston 1 (10) is blocked when sleeve 2 (7) has moved the same distance as spool 2 (6). This causes servo piston 1's (10) to stop and the flow decrease is completed.





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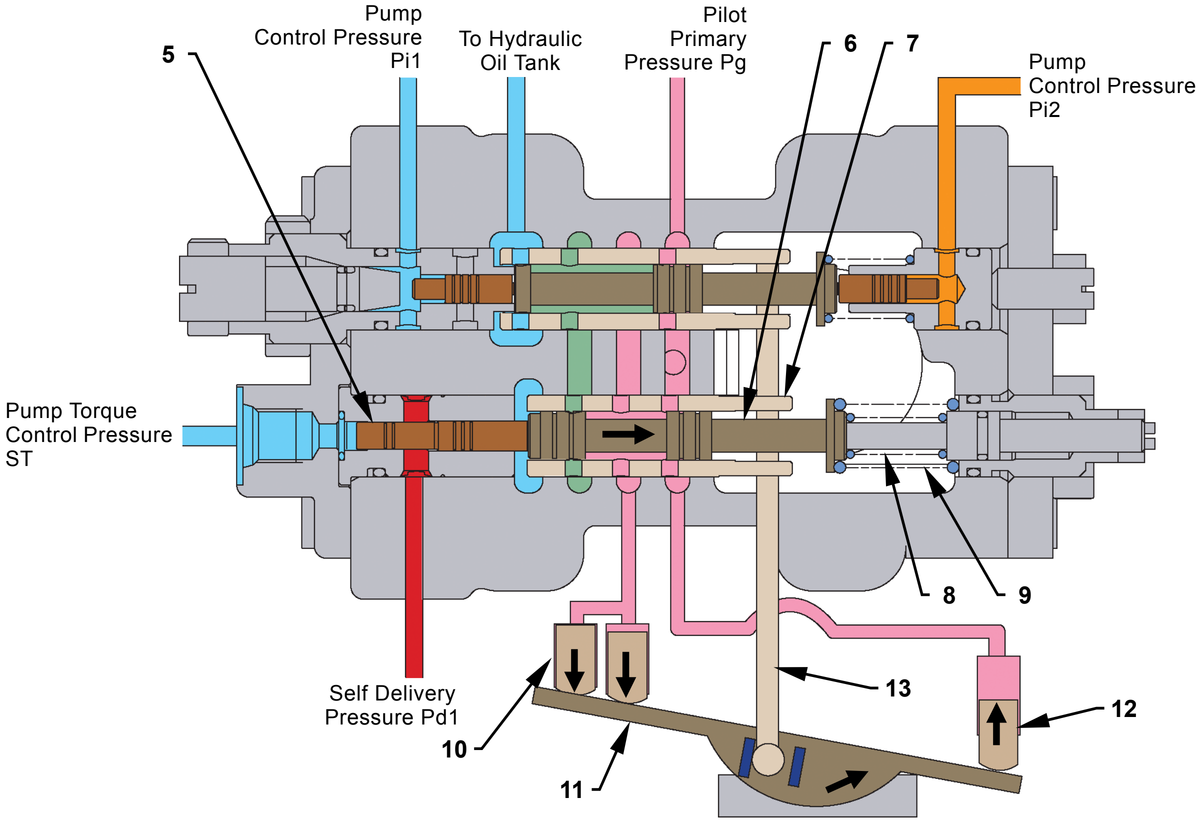
5 - Load Piston
6 - Spool 2
7 - Sleeve 2
8 - Inner Spring
9 - Outer Spring
10 - Servo Piston 1
11 - Swash Plate
12 - Servo Piston 2
13 - Feed Back Lever Link

Pd1 - Pump Delivery Pressure (Self Delivery Pressure)
ST - Pump Torque Control Pressure
T - Return Line to Hydraulic Oil Tank
Pi1 - Pump Control Pressure 1
Pi2 - Pump Control Pressure 2
Pg - Pilot Primary Pressure (From Pilot Pump)



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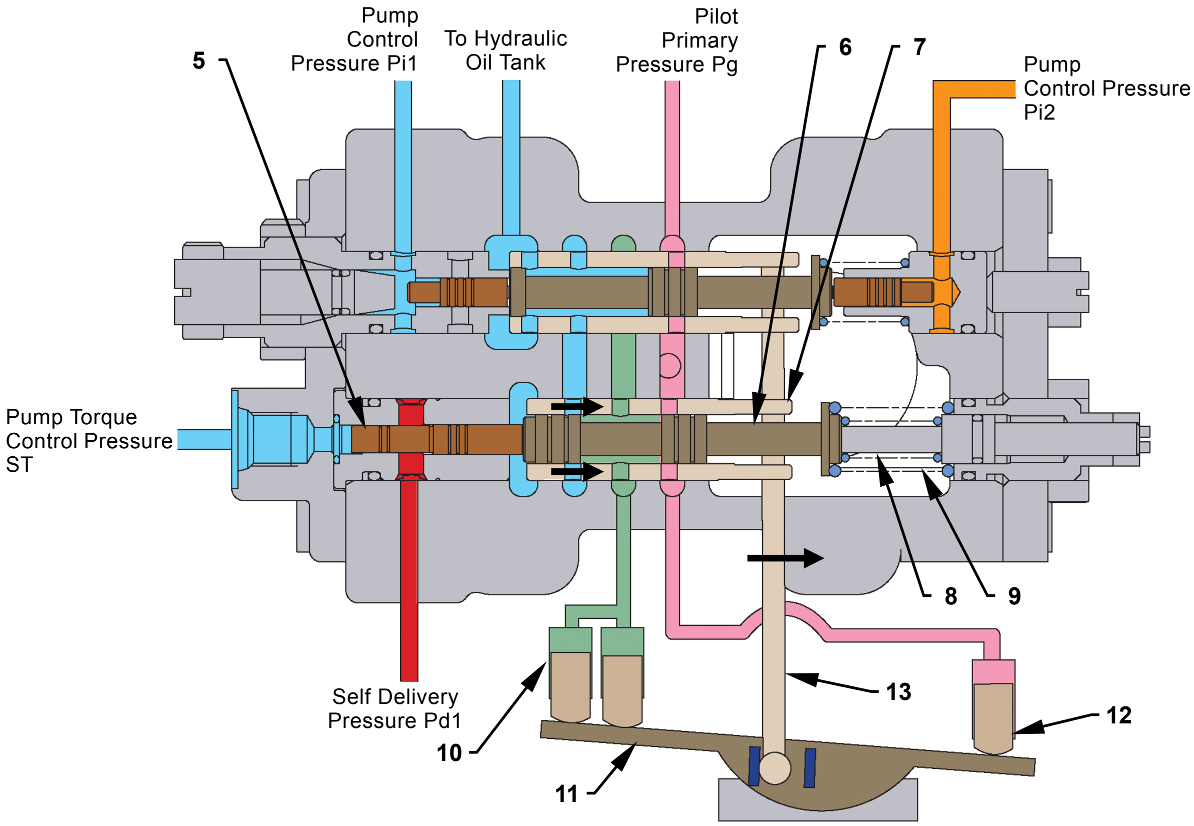

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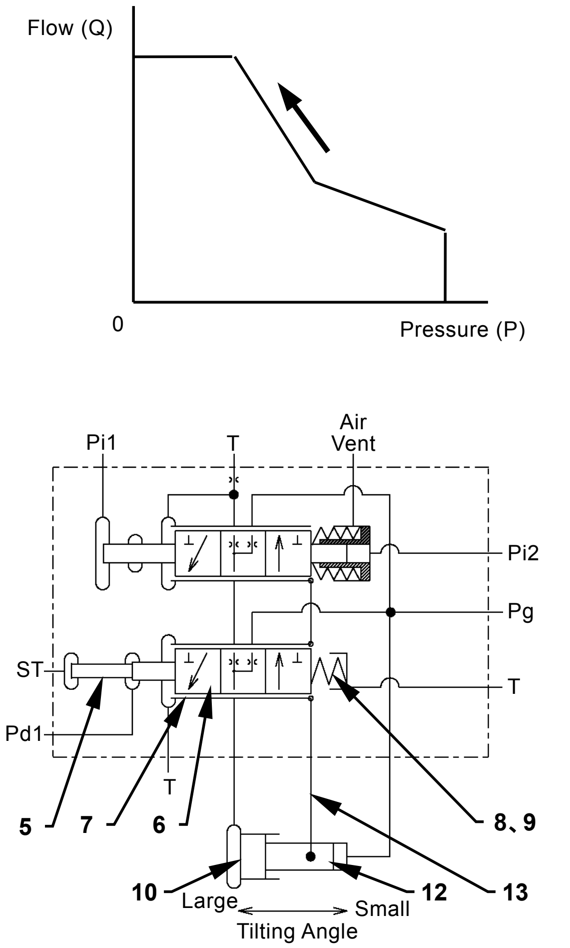
Flow Increase

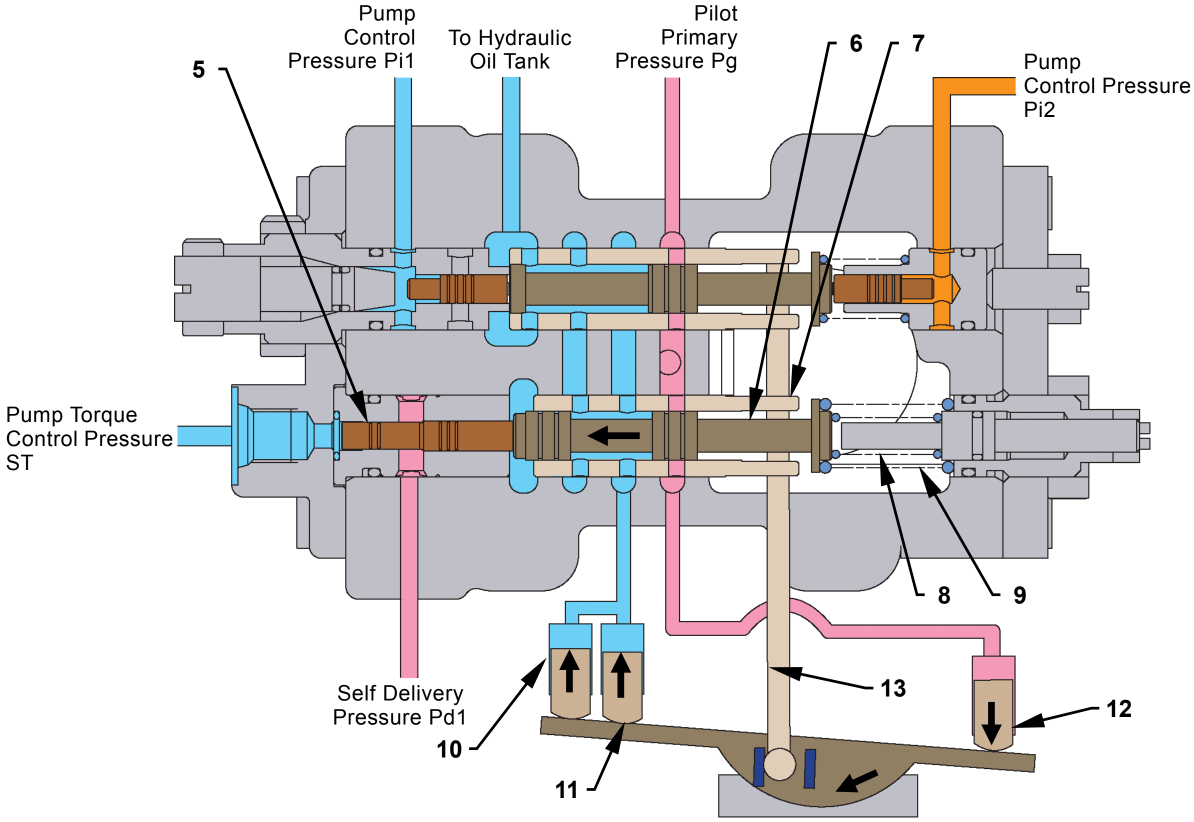
1. When the pump load is reduced, Self Delivery Pressure Pd1 lowers. (As done during an operation, the pump control pressure (Pi1 - Pi2) remains lowered.)
2. Load piston (5) and spool 2 (6) are pushed by inner spring (8) and outer spring (9), and spool 2 (6) moves toward the arrow.
3. This movement causes the circuit of servo piston 1's (10) to be led to the hydraulic oil tank.
4. As Pilot Primary Presuure Pg is always applied to servo piston 2 (12), swash plate (11) tilts toward the flow increasing direction.
5. Movement of swash plate (11) is conveyed to sleeve 2 (7) through feed back lever link (13). sleeve 2 (7) moves toward the movement of spool 2 (6).
6. When sleeve 2 (7) has moved the same distance as spool 2 (6), the openings of spool 2 (6) and sleeve 2 (7) close, stopping communication of servo piston 1's (10) with the hydraulic tank, and this causes servo piston 1's (10) to stop and the flow increase is completed.



T4GB-03-01-006

5 - Load Piston
6 - Spool 2
7 - Sleeve 2
8 - Inner Spring
9 - Outer Spring
10 - Servo Piston 1
11 - Swash Plate
12 - Servo Piston 2
13 - Feed Back Lever Link

Pd1 - Pump Delivery Pressure (Self Delivery Pressure)
ST - Pump Torque Control Pressure
T - Return Line to Hydraulic Oil Tank
Pi1 - Pump Control Pressure 1
Pi2 - Pump Control Pressure 2
Pg - Pilot Primary Pressure (From Pilot Pump)



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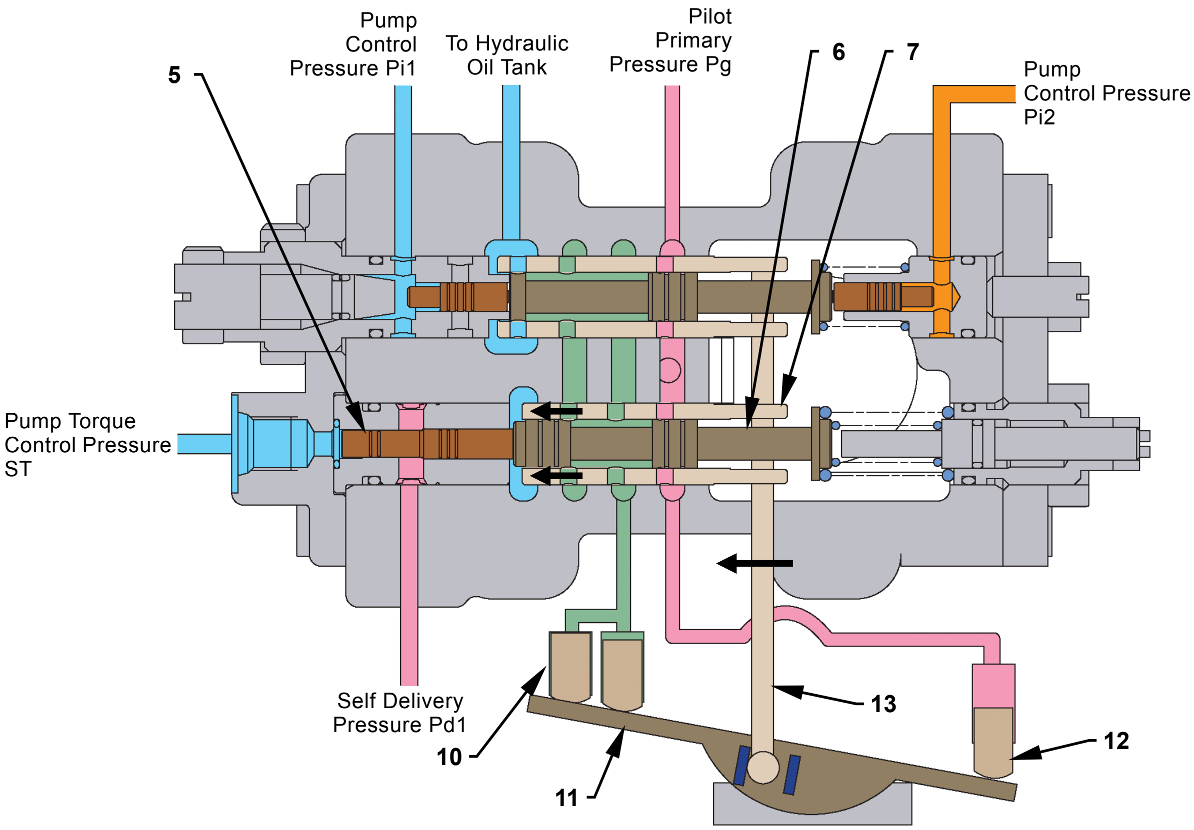
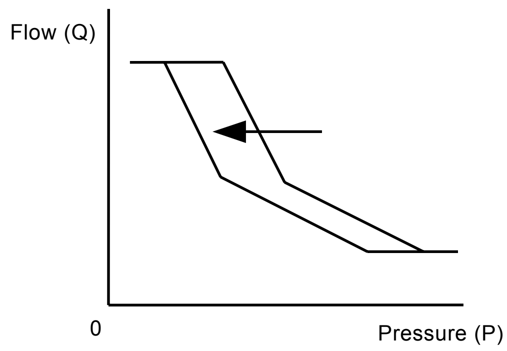


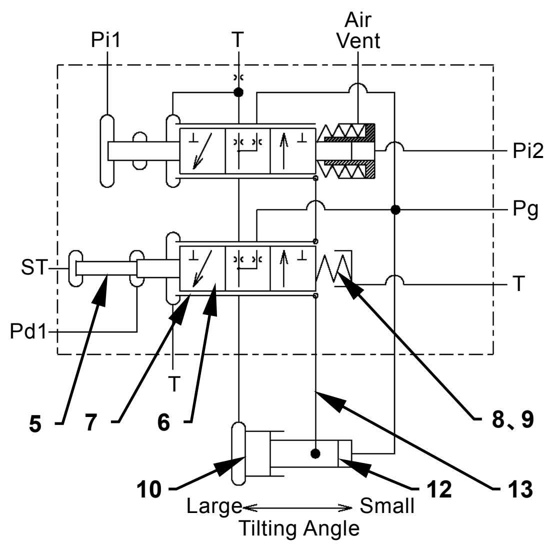
T4GB-03-01-015

Control of Torque Control Solenoid Valve by Pilot Pressure

Flow Decrease

1. Command from the MC (main controller) drives the pump torque control solenoid valve, and Pump Torque Control Pressure ST enters the regulator.
2. Adding to Self Delivery Pressure Pd1, Pump Torque Control Pressure ST works on load piston (5).
3. Load piston (5) pushes spool 2 (6), inner spring (8), and outer spring (9), and spool 2 (6) moves toward the arrow.
4. This movement causes Pilot Primary Pressure Pg to be led to servo piston 1's (10) also.
5. As there are two servo piston 1 (10), swash plate (11) tilts toward the flow decreasing direction.
6. This movement of swash plate (11) is conveyed to sleeve 2 (7) through feed back lever link (13). sleeve 2 (7) moves toward the movement of spool 2 (6).
7. Pilot pressure having been led to servo piston 1 (10) is blocked when sleeve 2 (7) has moved the same distance as spool 2 (6). This causes servo piston 1's (10) to stop and the flow decrease is completed.





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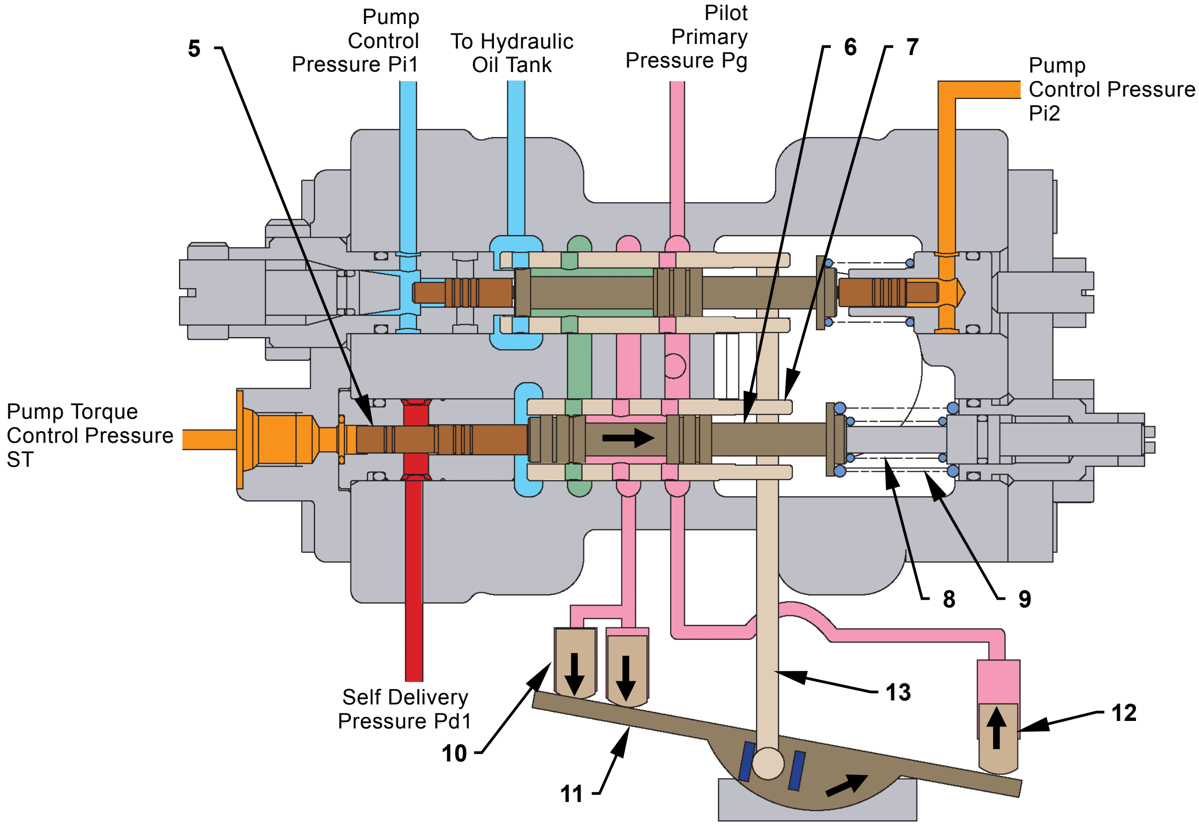
5 -	Load Piston	10 -	Servo Piston 1
6 -	Spool 2	11 -	Swash Plate
7 -	Sleeve 2	12 -	Servo Piston 2
8 -	Inner Spring	13 -	Feed Back Lever Link
9 -	Outer Spring		

Pd1 -	Pump Delivery Pressure (Self Delivery Pressure)	Pi1 -	Pump Control Pressure 1
ST -	Pump Torque Control Pressure	Pi2 -	Pump Control Pressure 2
T -	Return Line to Hydraulic Oil Tank	Pg -	Pilot Primary Pressure (From Pilot Pump)



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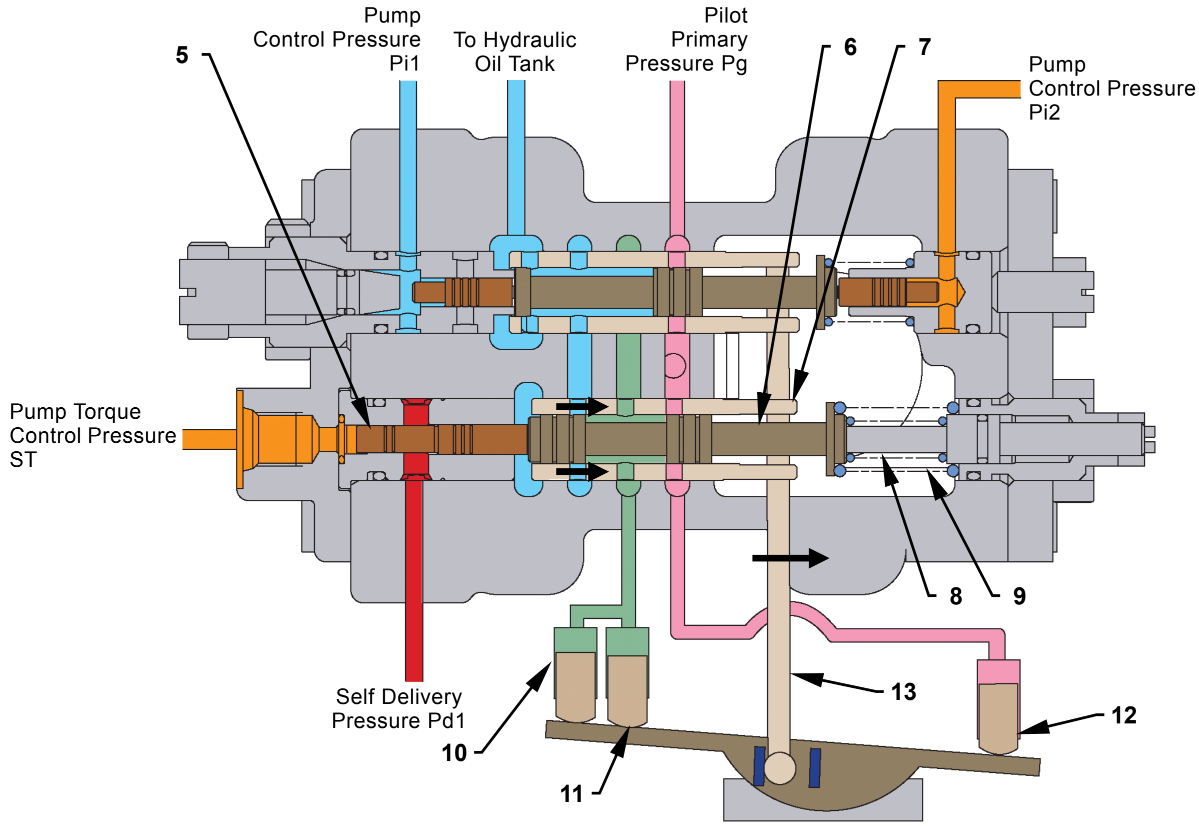


T4GB-03-01-017

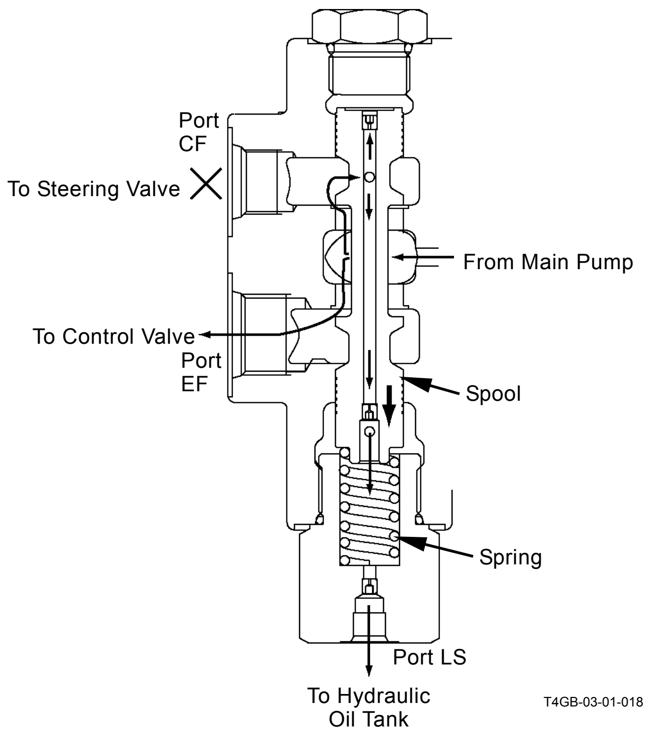
PRIORITY VALVE
(Refer to the Main Curcuit in the SYSTEM / Hydraulic System)

Main pump has a built-in priority valve.
Priority valve is installed for effectively distributing the main pump delivery oil to the steering valve and the control valve.

Operation

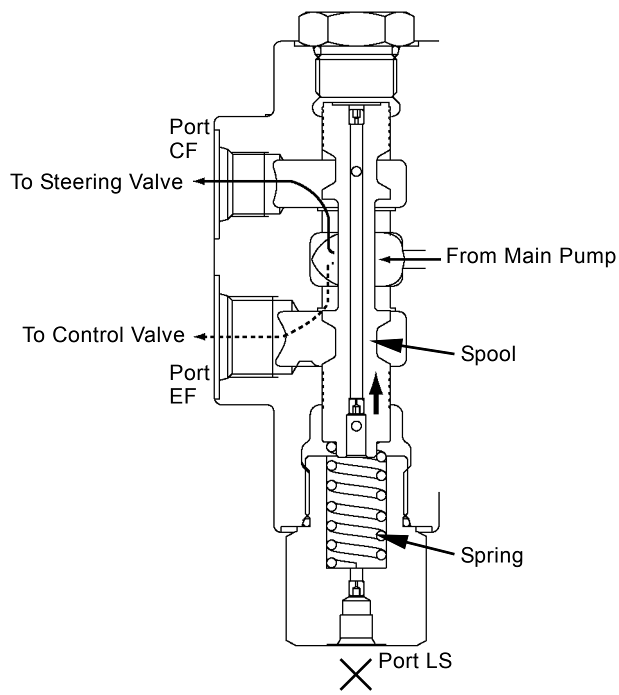
1. Before Steering Operation
   Pressure oil from the main pump tends to flow to the steering valve through Port CF, but flows to the both ends of the priority valve spool because Port CF is blocked.
   Pressure oil on one end of the spool flows from Port LS to the hydraulic oil tank through the steering valve, and its pressure is lowered. The spool to both ends of which different pressures are applied moves toward Port LS, overcoming the the spring force. Therefore, the majority of the main pump pressure oil flows to the control valve through Port EF.
2. In Steering Operation
   If steering is operated, and the steering valve spool moves, pressure at Port LS rise in response to the amount of the steering valve spool movement. The spool is pushed up by the pressure at Port LS and the spring force. Therefore, the main pump pressure oil flows to both Port EF and Port CF. When the steering valve spool moves to the maximum stroke, the majority of the main pump pressure oil flows to the steering valve through Port CF.

Before Steering Operation



T4GB-03-01-018

In Steering Operation

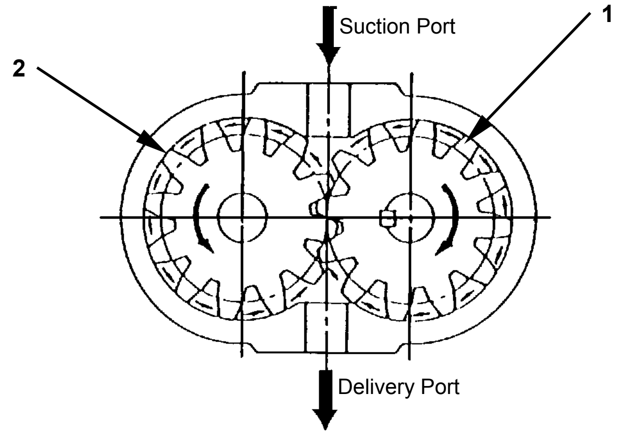


T4GB-03-01-019

PILOT PUMP

Drive gear (1) is driven throught the shaft of the main pump, and the diven gear (2) geared to this also rotates.

1 - Drive Gear
2 - Driven Gear

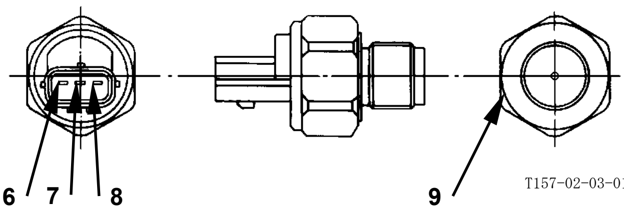


T137-02-03-005

PUMP DELIVERY PRESSURE SWITCH

Pump delivery pressure necessary for various kinds of control is sensed. Hydraulic pressure is received by the diaphragm (9), and deformation of the diaphragm is sensed as an electric signal.

6 - Earth
7 - Output
8 - Electric Source (5V)
9 - Pressure-applied Part (Diaphragm)



T157-02-03-010

STEERING MAIN RELIEF VALVE

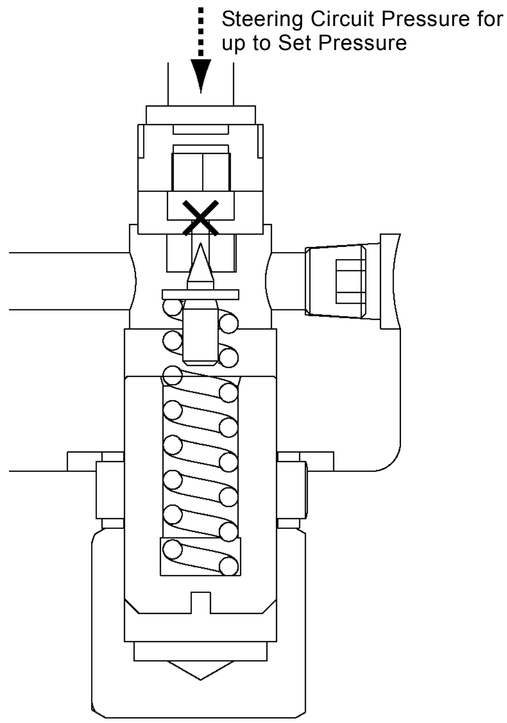
Main pump has a built-in steering main relief valve. When the steering circuit pressure exceed the set pressure, pressure oil is returned to the hydarulic oil tank through inside of the main pump housing.

Operation

In case steering circuit pressure exceed the set pressure, the puppet is pushed toward the spring, and pressure is returned to the hydraulic oil tank through inside of the main pump housing.

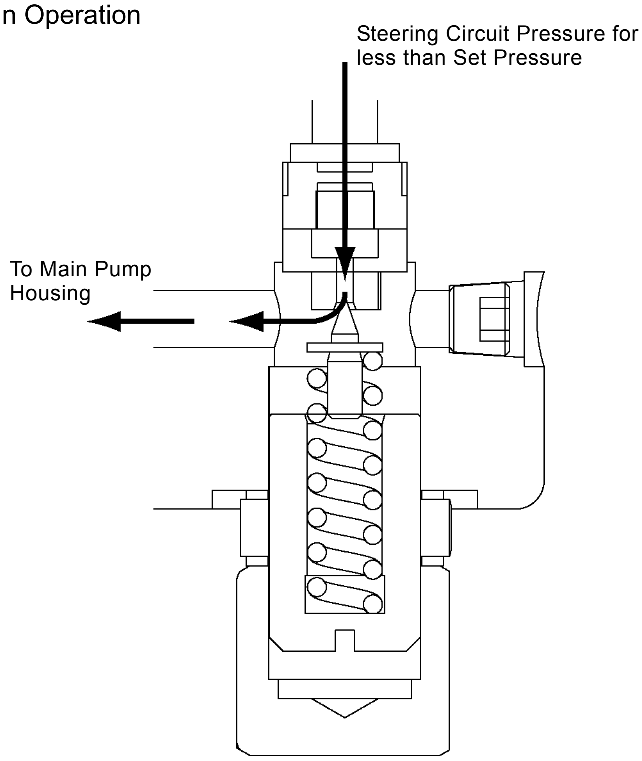
NOTE: *When the steering relief valve is operated, the spool of the priority valve moves to the Port LS end, and the majority of the pressure oil from the main pump flows to the control valve through Port EF. (Refer to T3-1-18.)*

Before Operation



T4GB-03-01-020

In Operation

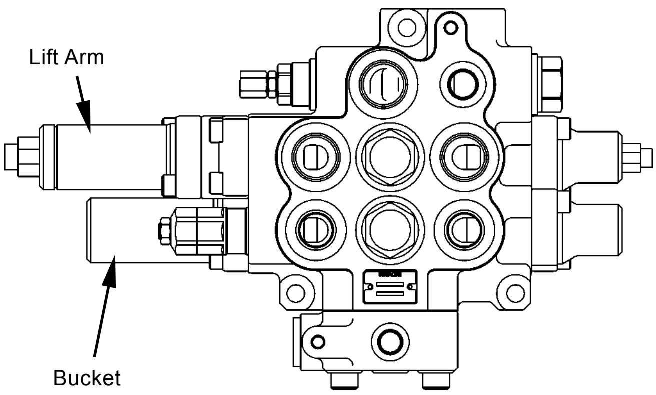


T4GB-03-01-021

OUTLINE

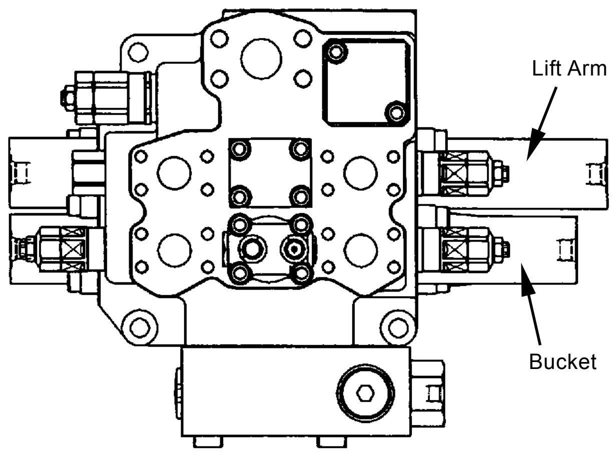
Control valve controls pressure, flow, and direction of oil in the hydraulic circuit.
The control valve includes the main relief valve, overload relief valve, negative control valve, restriction valve, flow control valve, and spool, and its operation is of the hydraulic pilot type.

ZW220



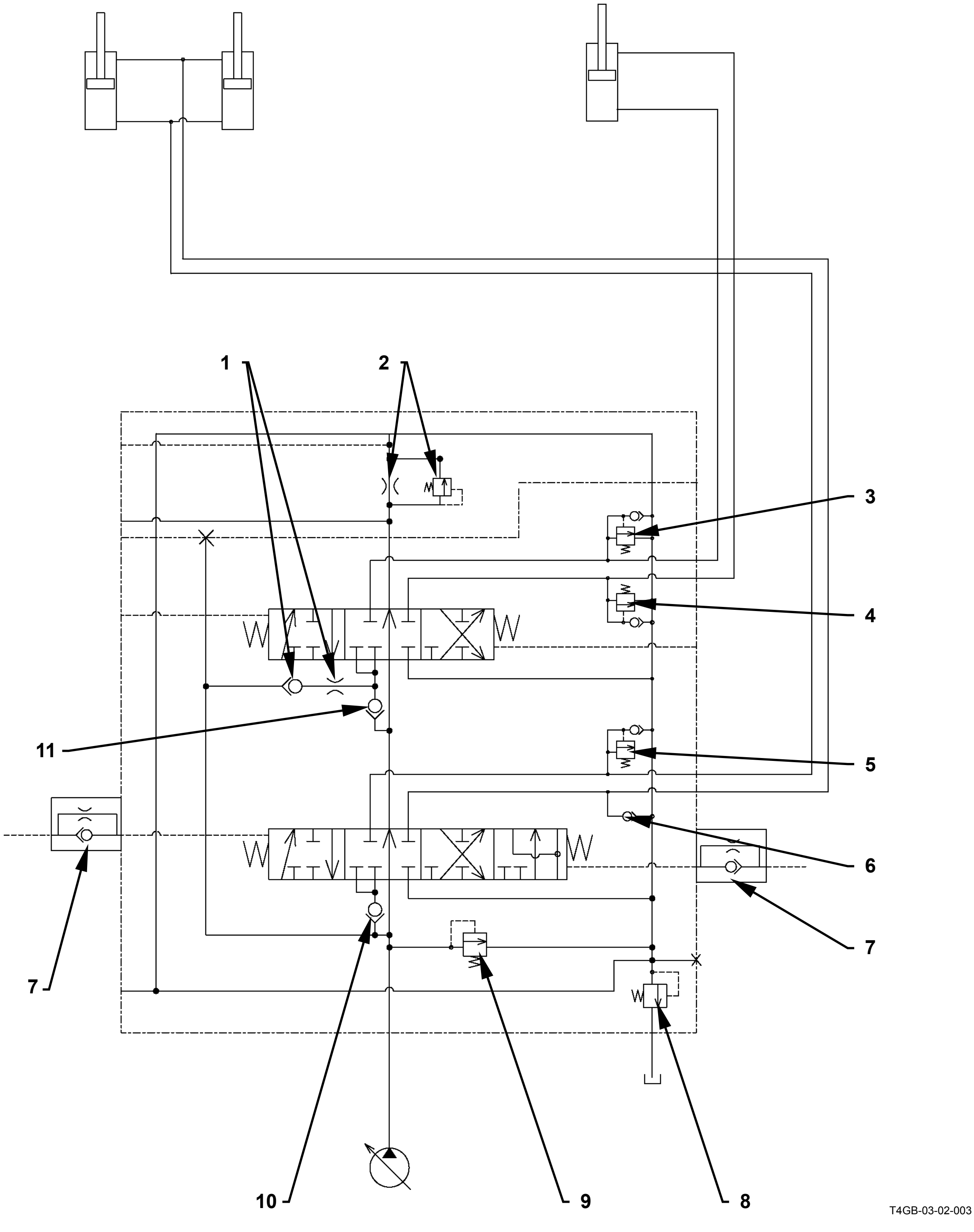
T4GB-03-02-001

ZW250

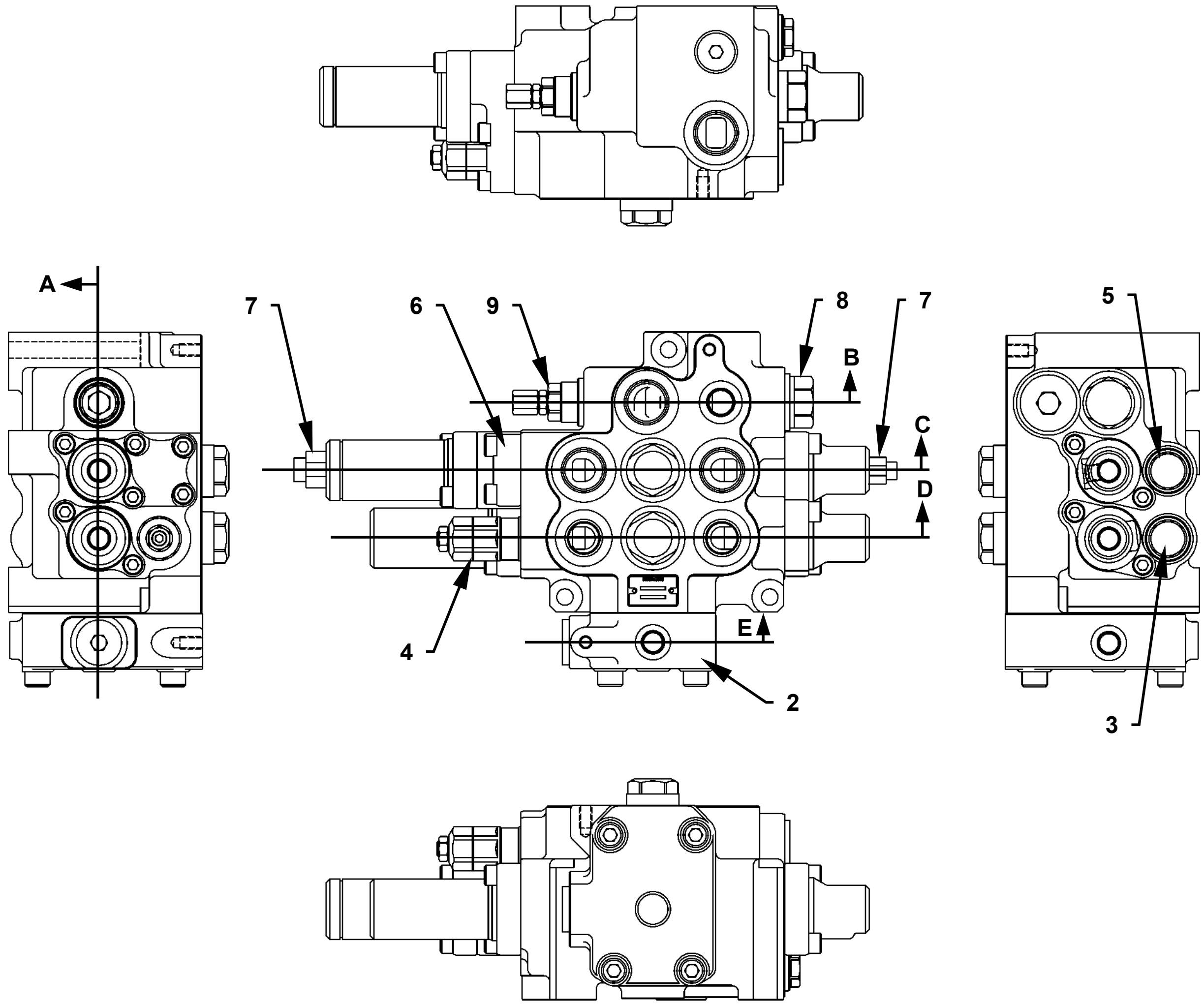


T4GB-03-02-002

Component Layout
ZW220



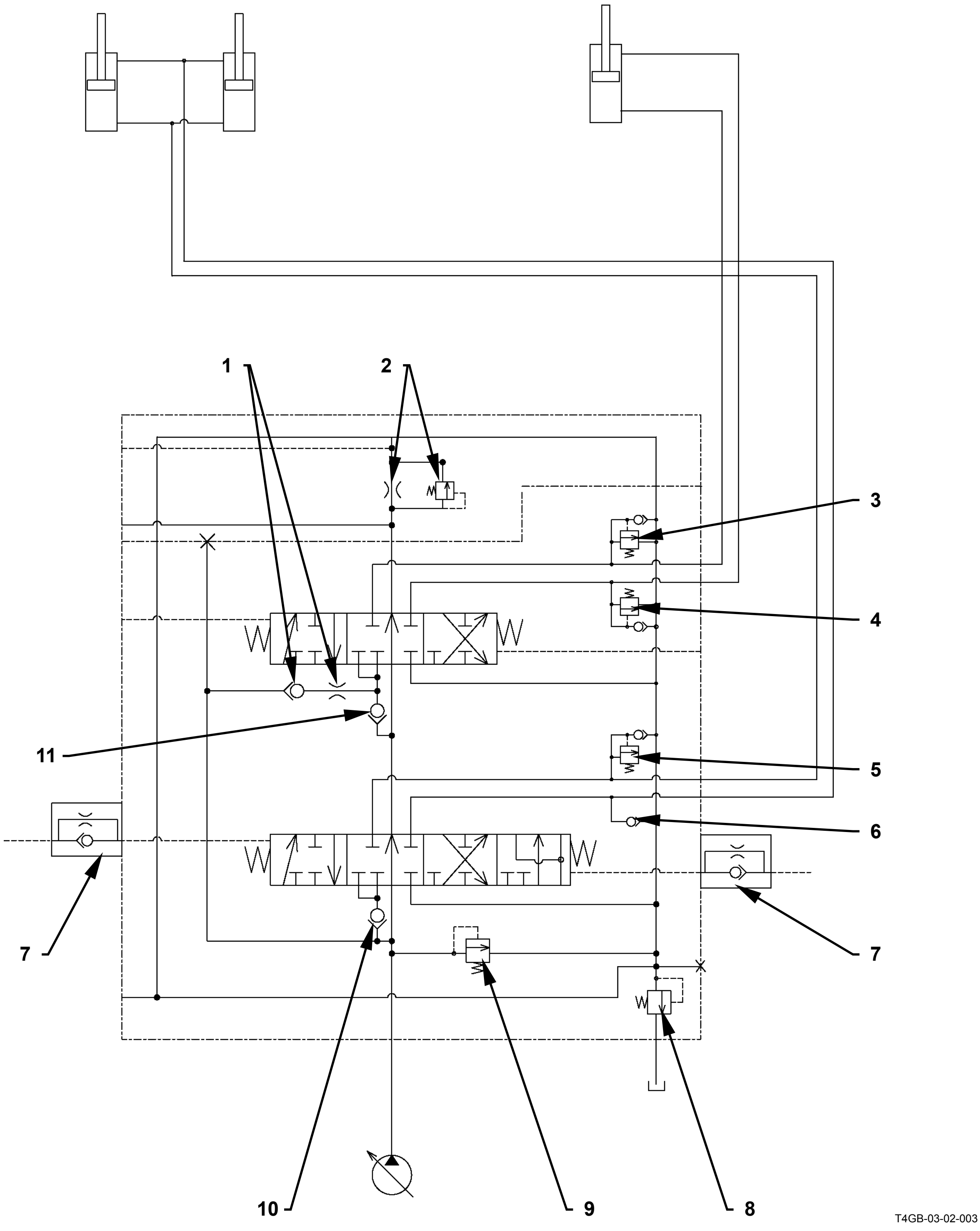
ZW220



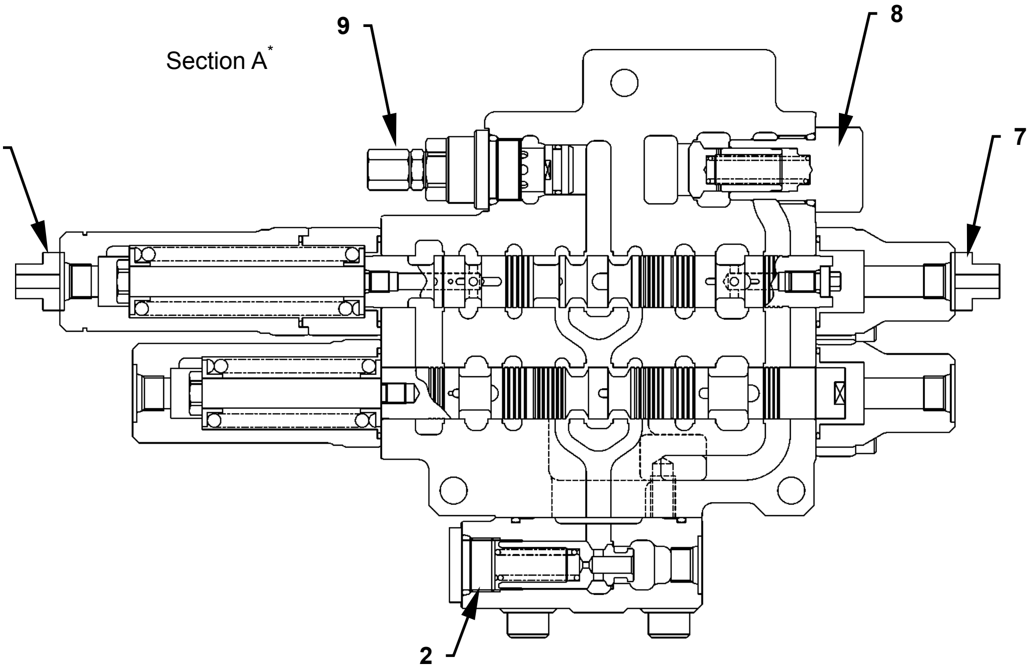
T4GB-03-02-004

1 - Bucket Flow Control Valve
2 - Negative Control Valve
3 - Overload Relief Valve (Bucket: Bottom End)
4 - Overload Relief Valve (Bucket: Rod End)
5 - Overload Relief Valve (Lift Arm: Bottom End)
6 - Make-up Valve (Lift Arm: Rod End)
7 - Restriction Valve
8 - Low-pressure Relief Valve
9 - Main Relief Valve
10 - Load Check Valve (Arm Lift Circuit)
11 - Load Check Valve (Bucket Circuit)

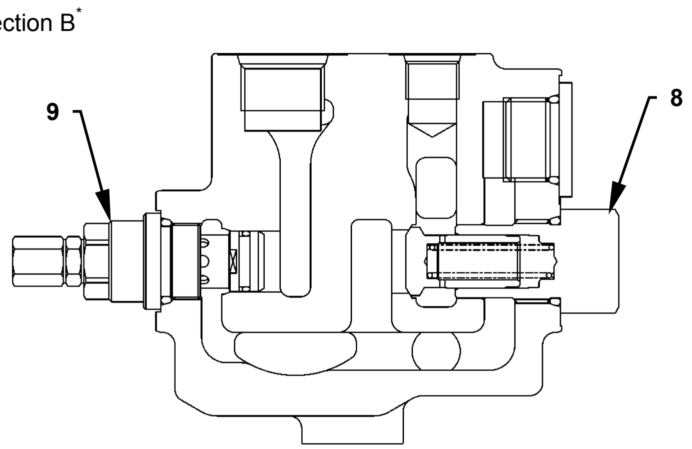
ZW220



ZW220



T4GB-03-02-005

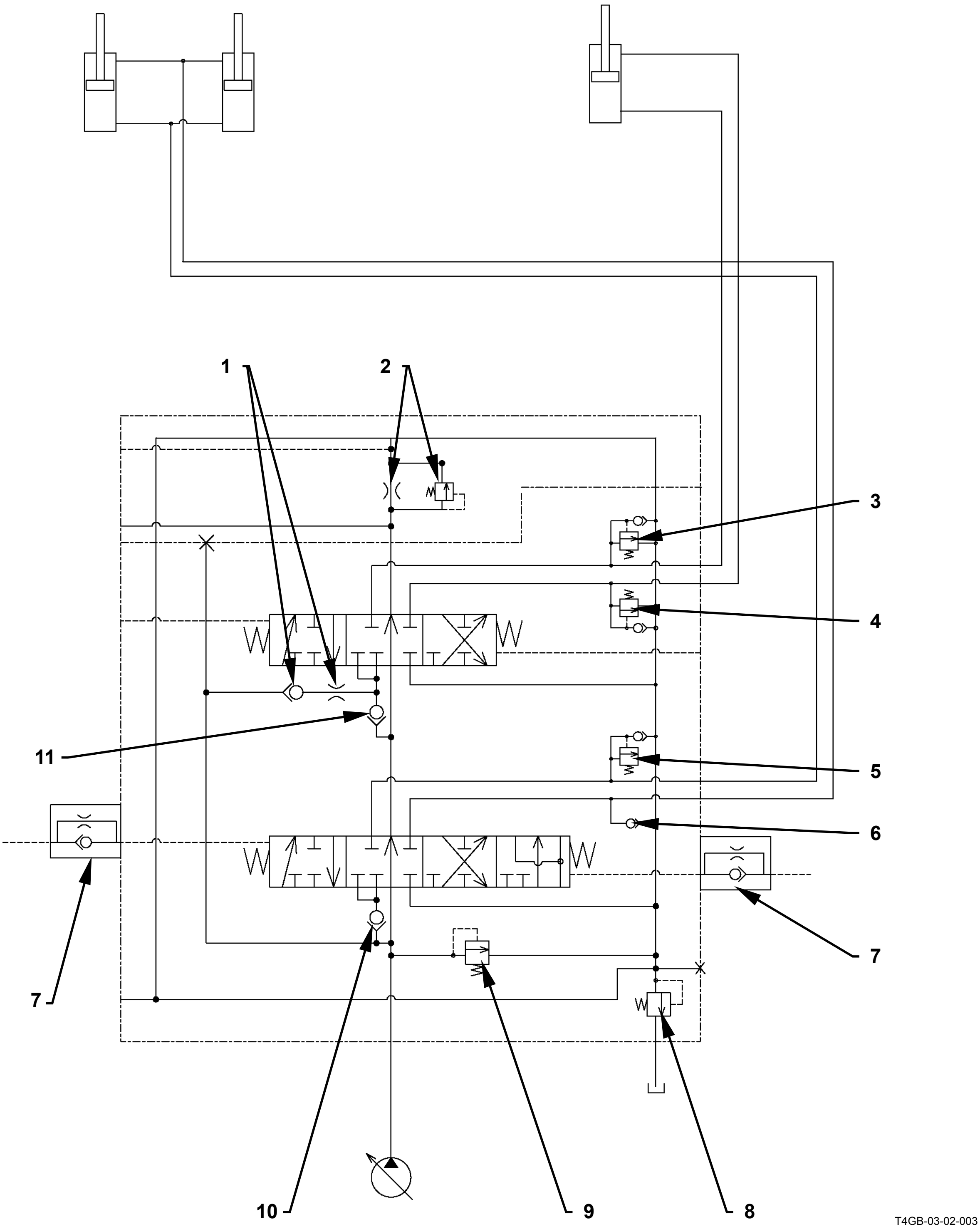


T4GB-03-02-006

1 - Bucket Flow Control Valve
2 - Negative Control Valve
3 - Overload Relief Valve (Bucket: Bottom End)
4 - Overload Relief Valve (Bucket: Rod End)
5 - Overload Relief Valve (Lift Arm: Bottom End)
6 - Make-up Valve (Lift Arm: Rod End)
7 - Restriction Valve
8 - Low-pressure Relief Valve
9 - Main Relief Valve
10 - Load Check Valve (Arm Lift Circuit)
11 - Load Check Valve (Bucket Circuit)

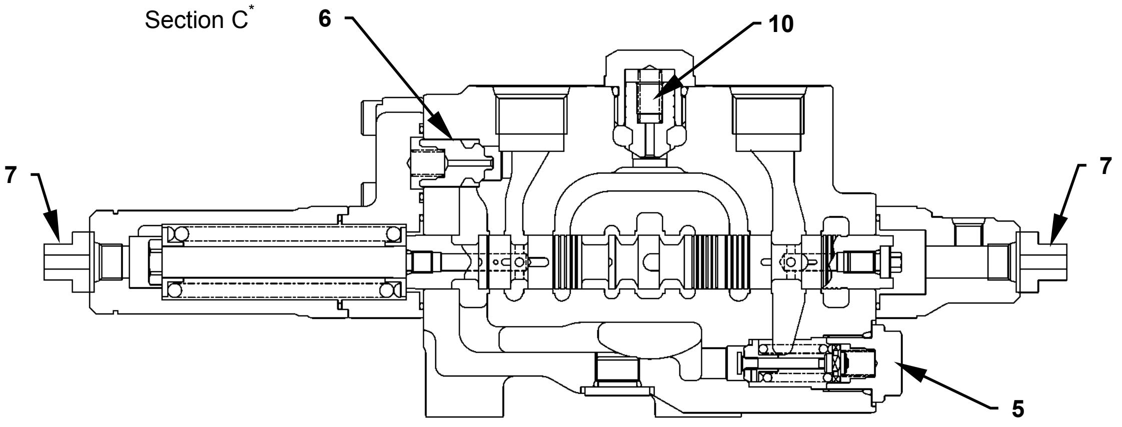
* Refer to T3-2-3.

ZW220

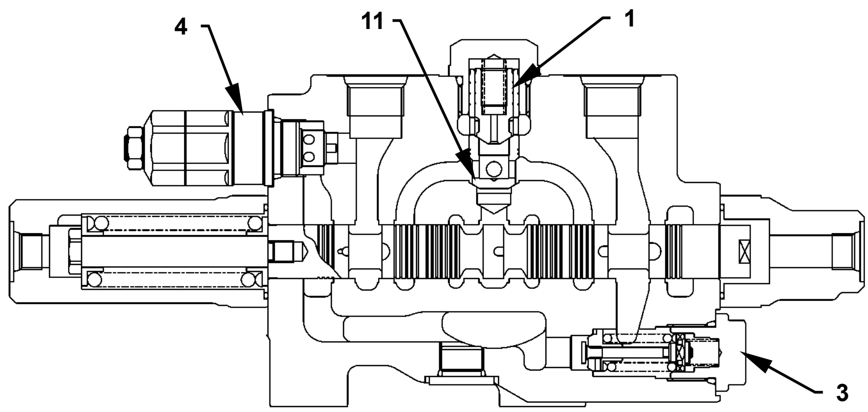


ZW220

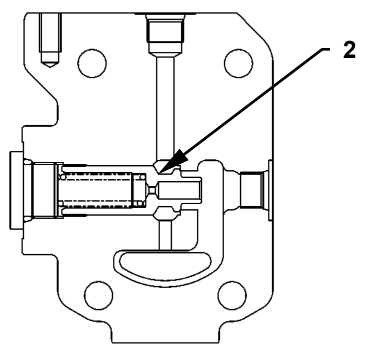
Section C*



Section D*



Section E*

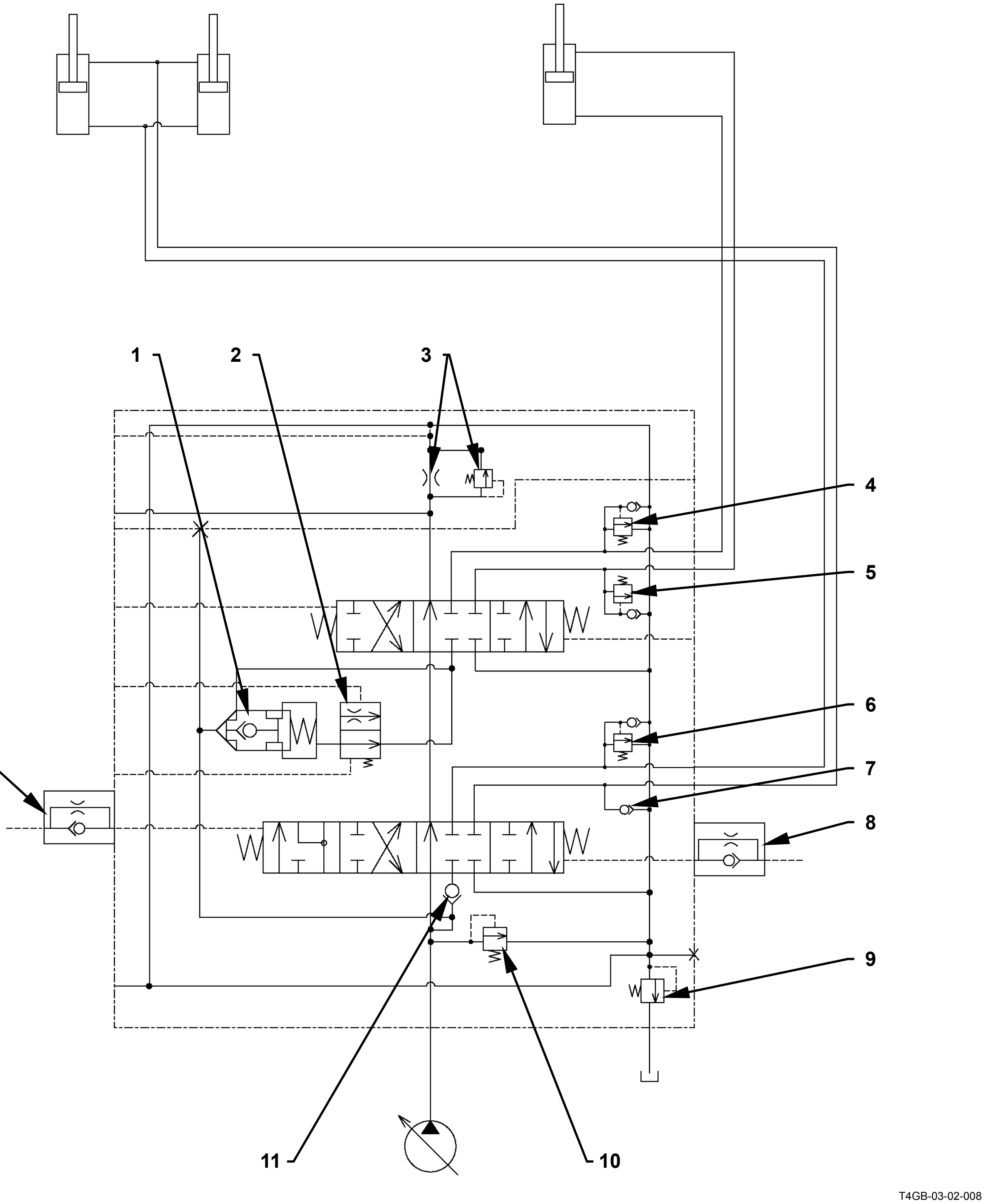


T4GB-03-02-007

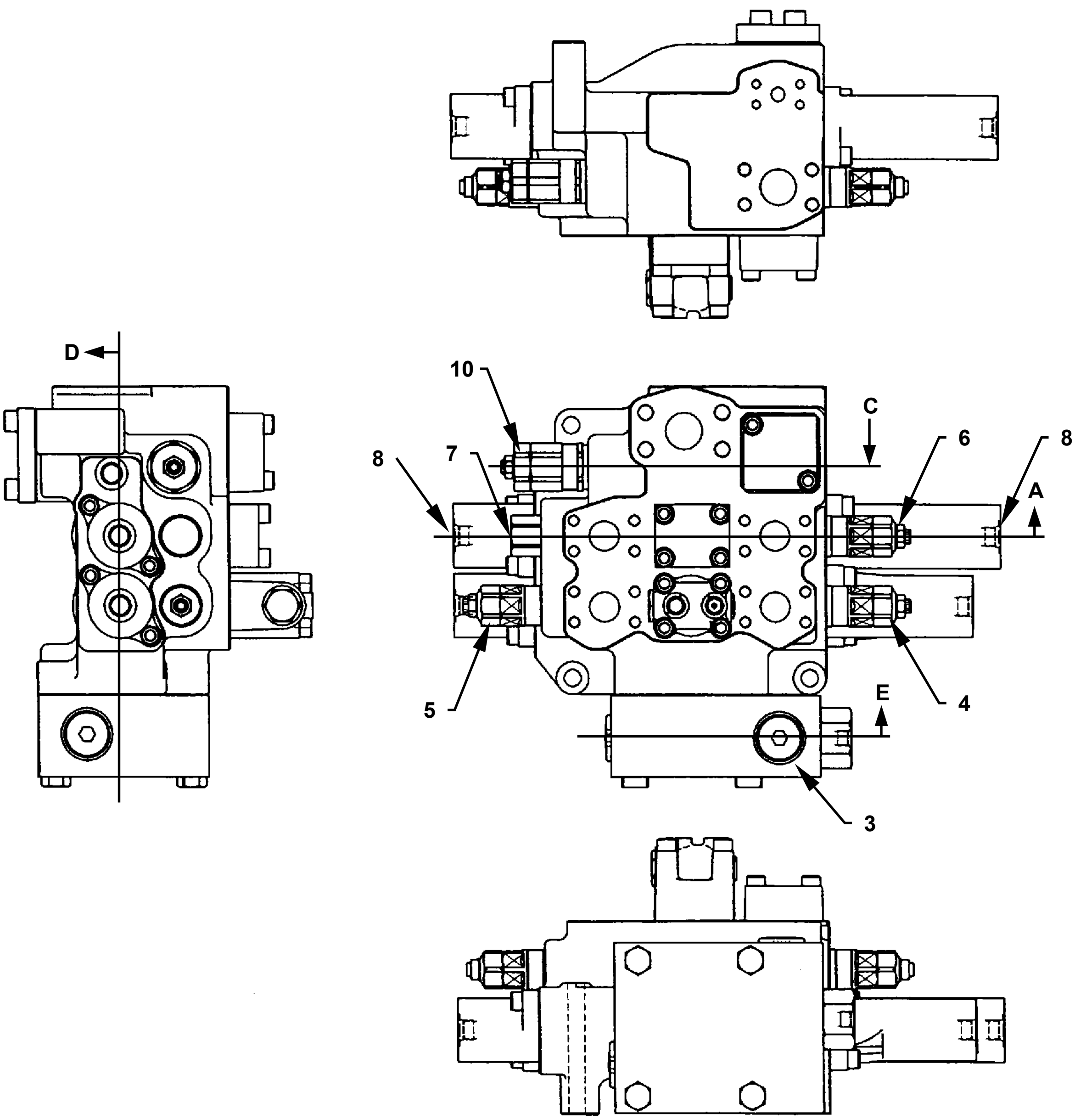
1 - Bucket Flow Control Valve
2 - Negative Control Valve
3 - Overload Relief Valve (Bucket: Bottom End)
4 - Overload Relief Valve (Bucket: Rod End)
5 - Overload Relief Valve (Lift Arm: Bottom End)
6 - Make-up Valve (Lift Arm: Rod End)
7 - Restriction Valve
8 - Low-pressure Relief Valve
9 - Main Relief Valve
10 - Load Check Valve (Arm Lift Circuit)
11 - Load Check Valve (Bucket Circuit)

* Refer to T3-2-3.

ZW250



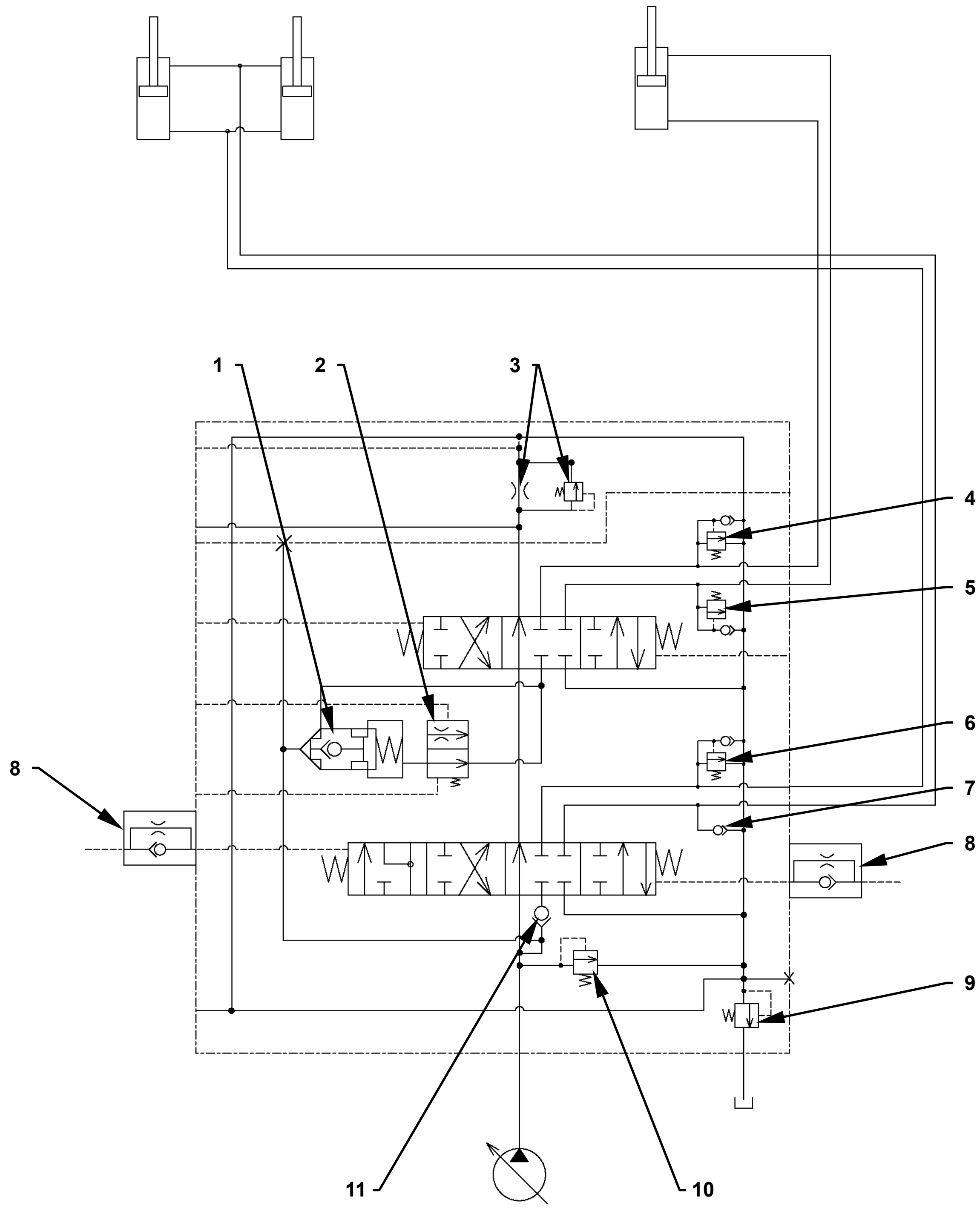
ZW250



T4GB-03-02-009

1 - Flow Control Valve (Poppet)
2 - Flow Control Valve (Changeover Valve)
3 - Negative Control Valve
4 - Overload Relief Valve (Bucket: Bottom End)
5 - Overload Relief Valve (Bucket: Rod End)
6 - Overload Relief Valve (Lift Arm: Bottom End)
7 - Make-up Valve (Lift Arm: for Rod)
8 - Restriction Valve
9 - Low-pressure Relief Valve
10 - Main Relief Valve
11 - Load Check Valve (Lift Arm Circuit)

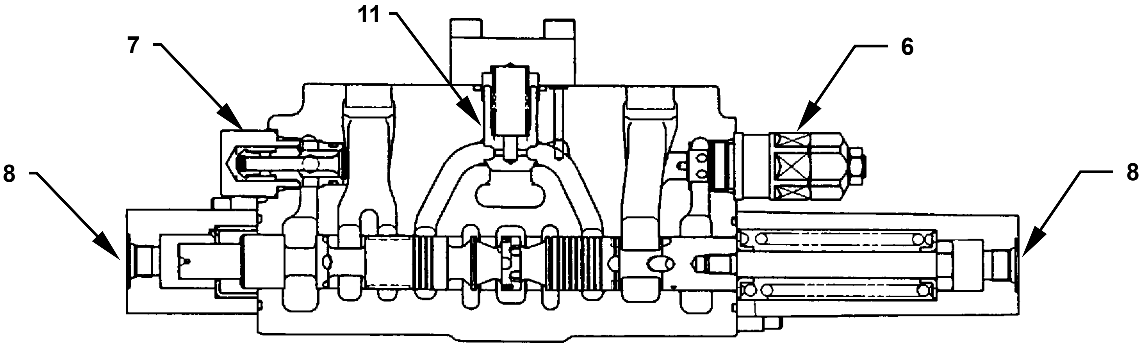
ZW250



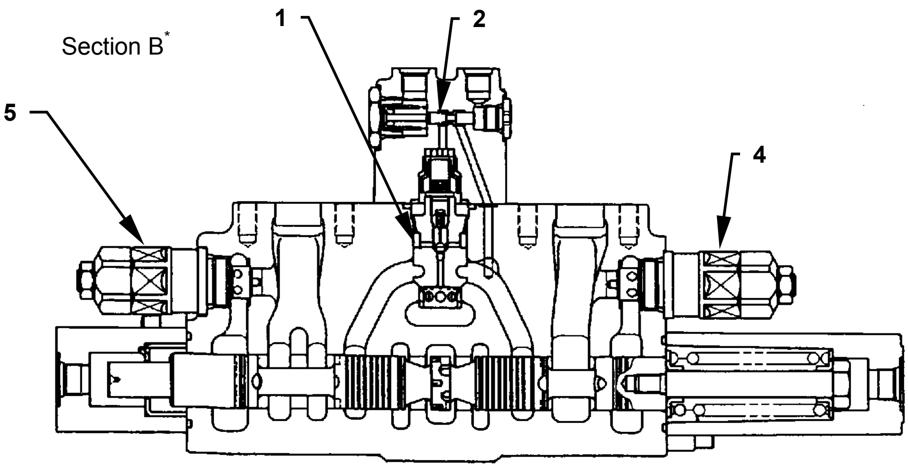
T4GB-03-02-008

ZW250

Section A*



Section B*

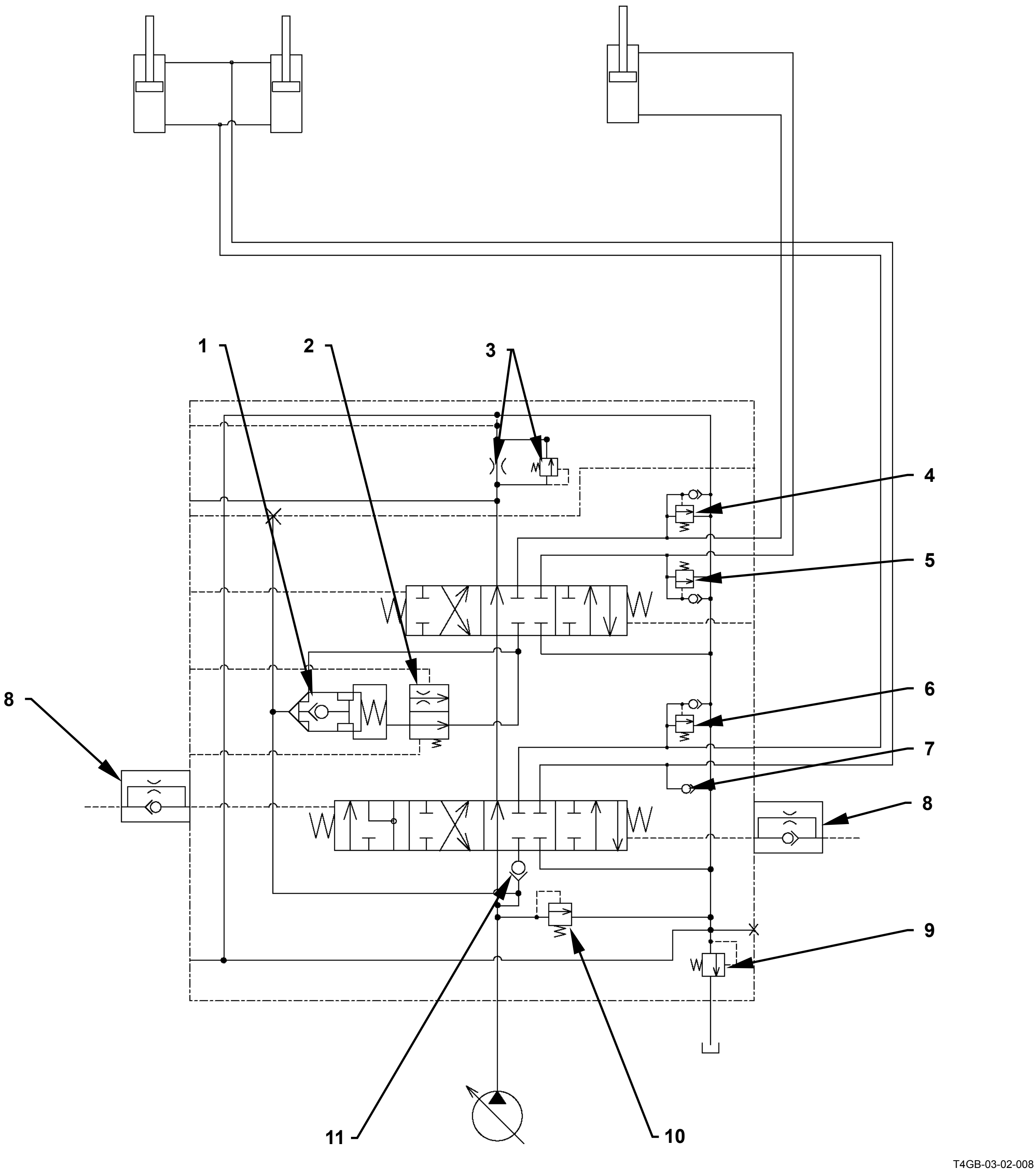


T4GB-03-02-010

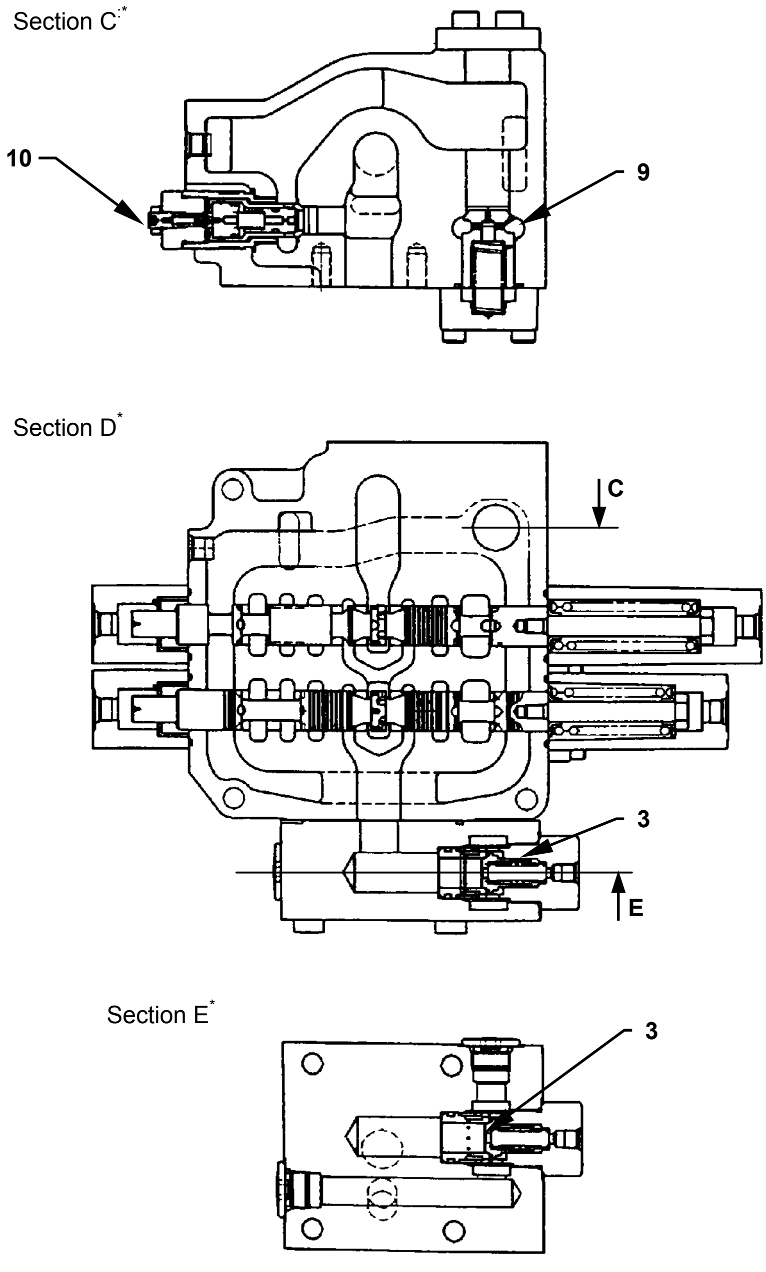
1 - Flow Control Valve (Poppet)
2 - Flow Control Valve (Changeover Valve)
3 - Negative Control Valve
4 - Overload Relief Valve (Bucket: Bottom End)
5 - Overload Relief Valve (Bucket: Rod End)
6 - Overload Relief Valve (Lift Arm: Bottom End)
7 - Make-up Valve (Lift Arm: for Rod)
8 - Restriction Valve
9 - Low-pressure Relief Valve
10 - Main Relief Valve
11 - Load Check Valve (Lift Arm Circuit)

* Refer to T3-2-9.

ZW250



ZW250



T4GB-03-02-011

1 - Flow Control Valve (Poppet)
2 - Flow Control Valve (Changeover Valve)
3 - Negative Control Valve
4 - Overload Relief Valve (Bucket: Bottom End)
5 - Overload Relief Valve (Bucket: Rod End)
6 - Overload Relief Valve (Lift Arm: Bottom End)
7 - Make-up Valve (Lift Arm: for Rod)
8 - Restriction Valve
9 - Low-pressure Relief Valve
10 - Main Relief Valve
11 - Load Check Valve (Lift Arm Circuit)

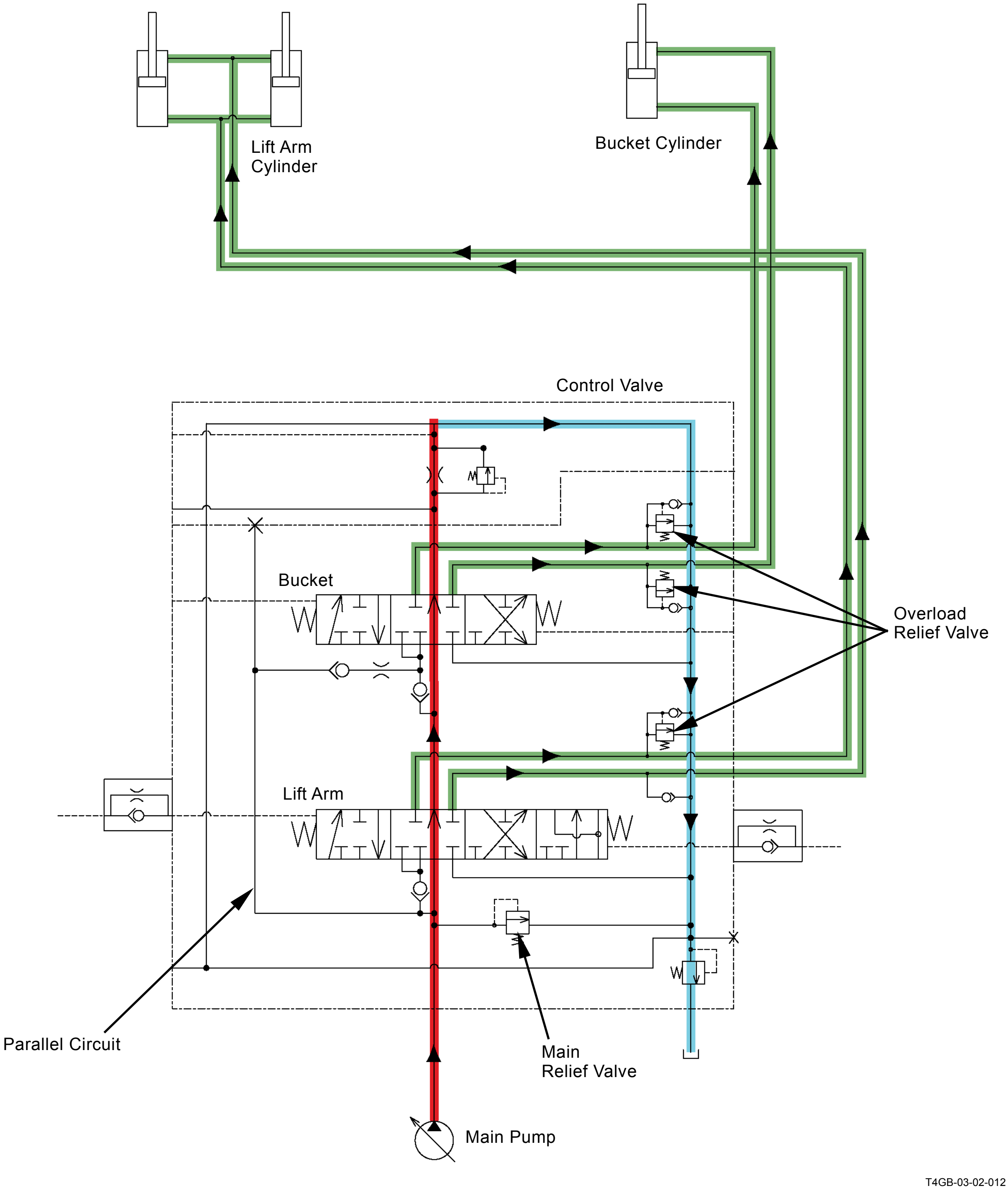
* Refer to T3-2-9.

HYDRAULIC CIRCUIT

ZW220
Main Circuit

Main circuit contains a parallel circuit, which enables compound operations.

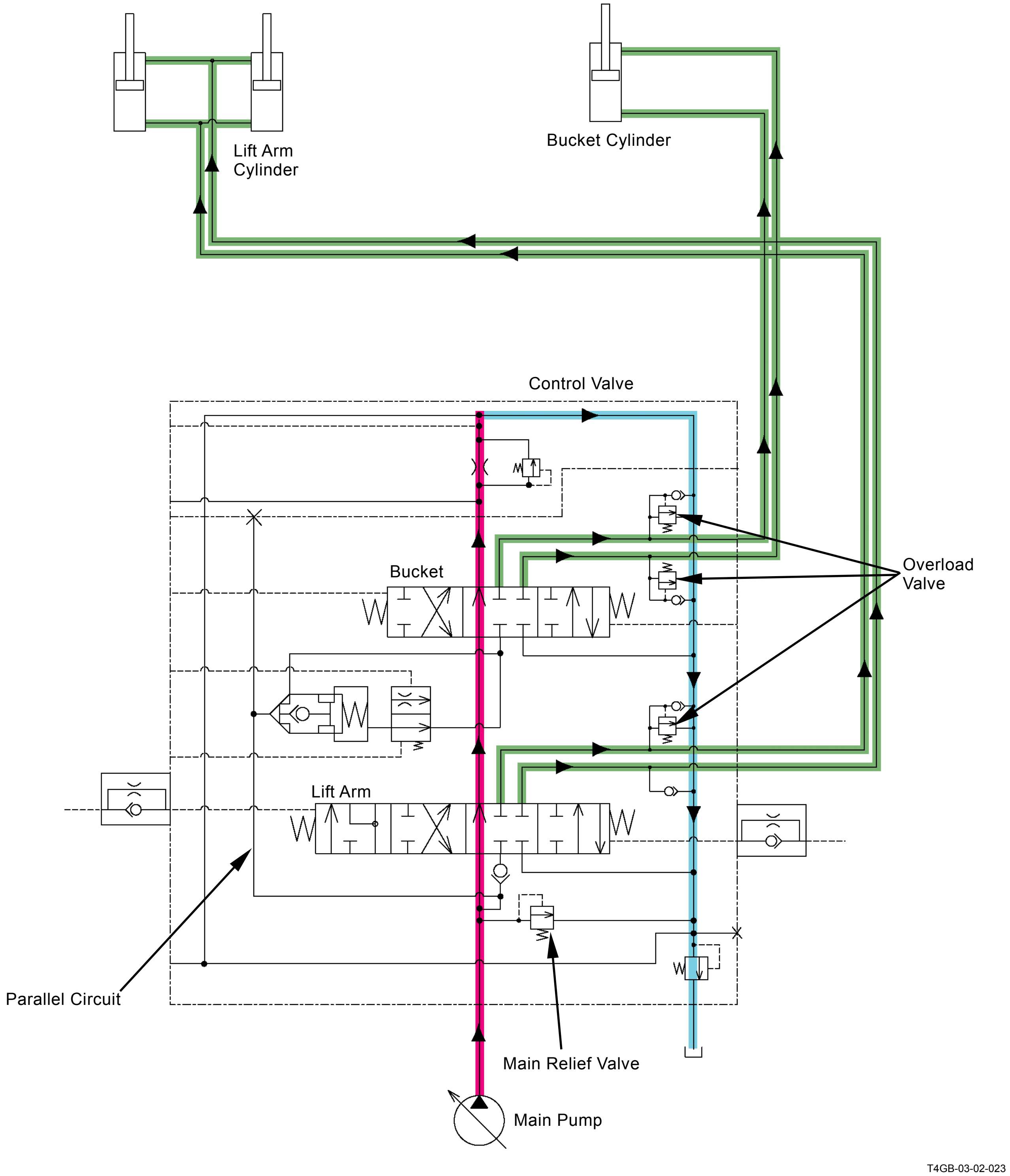
Main circuit (between the pump and the cylinder) is provided with the main relief valve. The main relief valve prevents pressure inside the main circuit from increasing over the set pressure during operation (when any control lever is operated).
Front circuit (between the control valve and the cylinder) of the lift arm bucket is provided with the overload relief valve. Overload relief valve prevents surge pressure from being developed be external loads in the front circuit and from increasing over the set pressure at neutral position of the spool (neutral position of the control lever).


Lift Arm Cylinder
Bucket Cylinder
Control Valve
Bucket
Overload Relief Valve
Lift Arm
Parallel Circuit
Main Relief Valve
Main Pump
T4GB-03-02-012

ZW250
Main Circuit

Main circuit contains a parallel circuit, which enables compound operations.

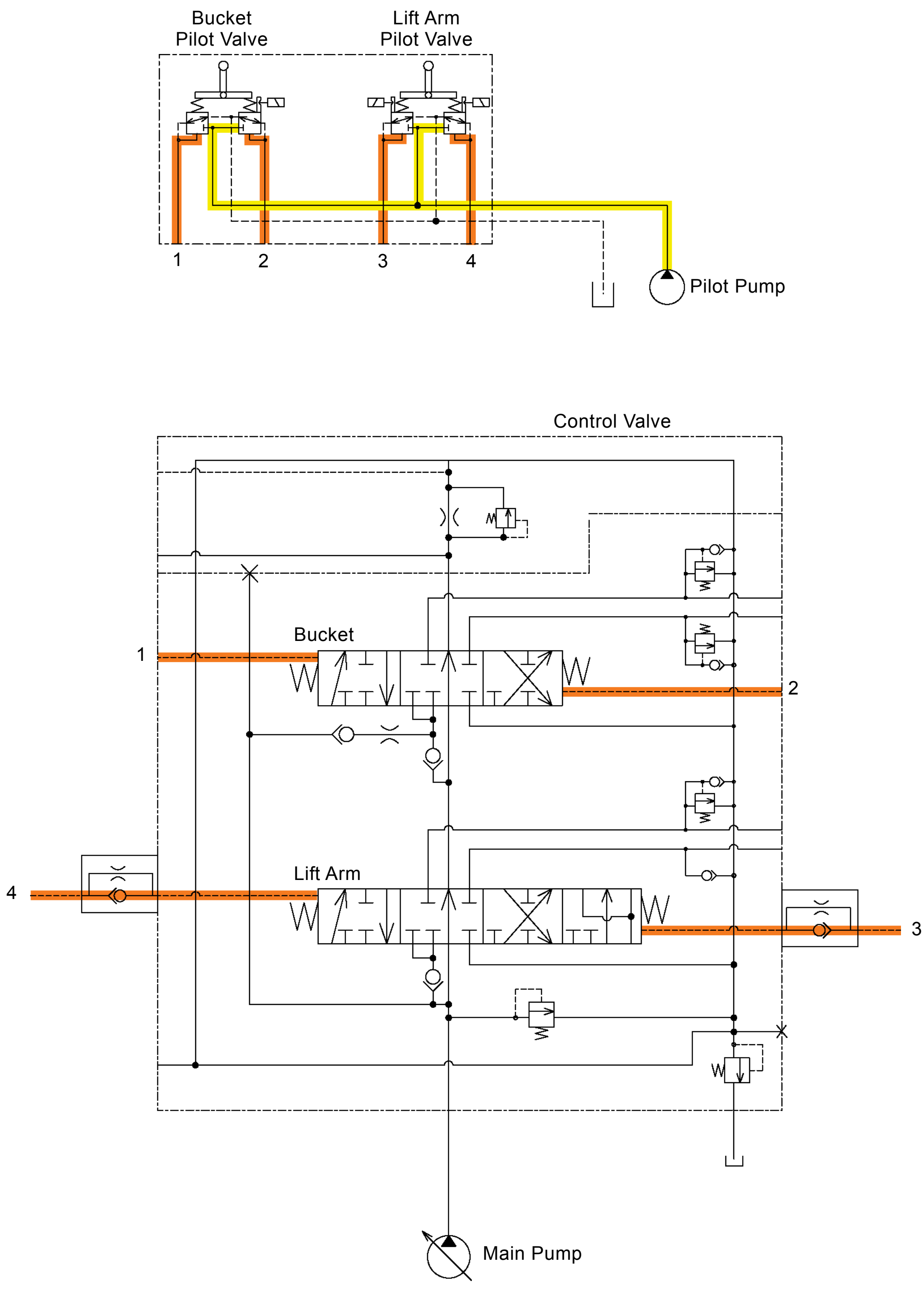
Main circuit (between the pump and the cylinder) is provided with the main relief valve. The main relief valve prevents pressure inside the main circuit from increasing over the set pressure during operation (when any control lever is operated).
Front circuit (between the control valve and the cylinder) of the lift arm bucket is provided with the overload relief valve. Overload relief valve prevents surge pressure from being developed be external loads in the front circuit and from increasing over the set pressure at neutral position of the spool (neutral position of the control lever).


Lift Arm Cylinder
Bucket Cylinder
Control Valve
Bucket
Overload Valve
Lift Arm
Parallel Circuit
Main Relief Valve
Main Pump
T4GB-03-02-023

Pilot Operation Circuit
ZW220

Pressure oil from the pilot valve (shown in numerals) works on the spool of the control valve, and moves the spool.

- Pressure oil is being sent to the bucket spool for dumping and crowding operations.
- Pressure oil is being sent to the lift arm spool for raising and lowering operations.
  Spool for lowering is two-staged, and the first stage is for lowering the lift arm, while the second stage is for floating the lift arm.

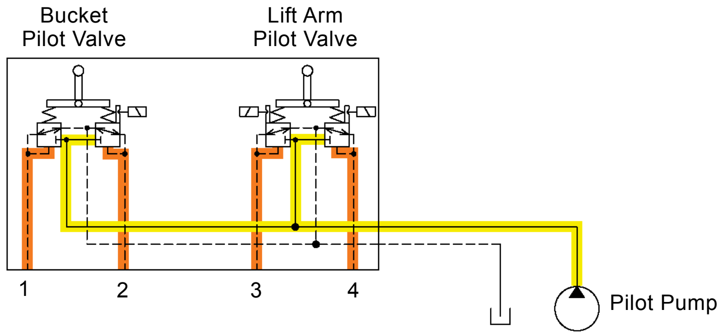


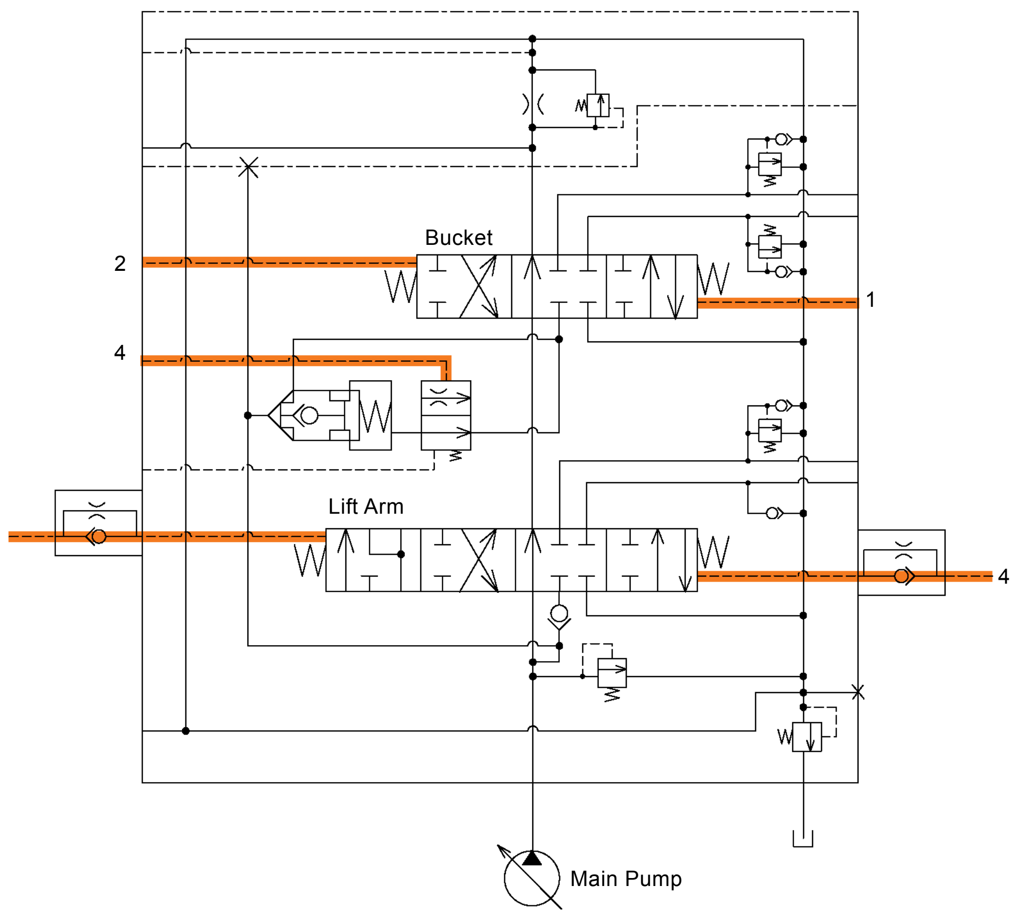
1 - Bucket Crowding
2 - Bucket Dumping
3 - Lift Arm Lowering
4 - Lift Arm Raising

ZW250

Pressure oil from the pilot valve (shown in numerals) works on the spool of the control valve, and moves the spool.

- Pressure oil is being sent to the bucket spool for dumping and crowding operations.
- Pressure oil is being sent to the lift arm spool for raising and lowering operations.
  Spool for lowering is two-staged, and the first stage is for lowering the lift arm, while the second stage is for floating the lift arm.





1 - Bucket Crowding
2 - Bucket Dumping
3 - Lift Arm Lowering
4 - Lift Arm Raising

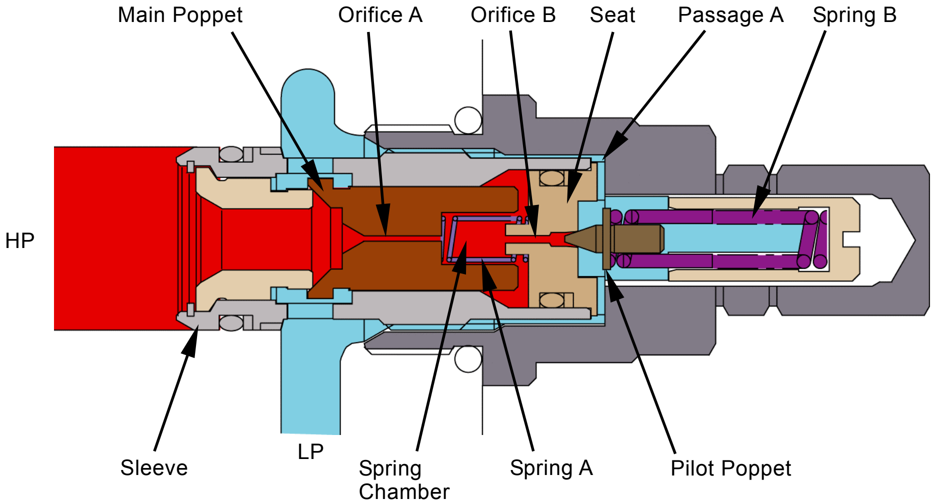
MAIN RELIEF VALVE

Main relief valve prevents pressure inside the main circuit from increasing over the set pressure during operation of the cylinder.
This prevents oil leakage from the hoses and piping fittings as well as cylinder breakage.

ZW220
Operation of Relief Valve

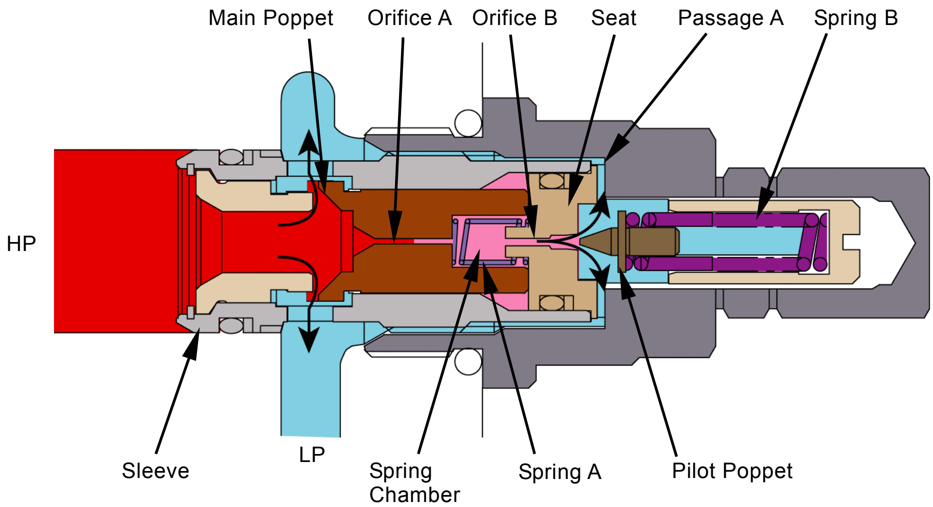
1. Pressure at port HP (in the main circuit) works on the pilot poppet through orifice A of the main poppet and orifice B of the seat.
2. When the pressure at Port HP rises to the setting force of spring B, the pilot poppet opens, and pressure oil flows to port LP (in the hydraulic oil tank) passing through passage A and the periphery of the sleeve.
3. At this time, pressure difference arises between port HP and the spring chamber, caused by orifice A.
4. When this pressure difference reaches the value corresponding to the set force of spring A, the main poppet opens, and the pressure oil at port HP flows to port LP.
5. As a result, pressure in the main circuit lowers.
6. If the main circuit pressure lowers to the set pressure, the main poppet is closed by the force of spring A.

In Normal Condition:



T4GB-03-02-034

When Relieving:



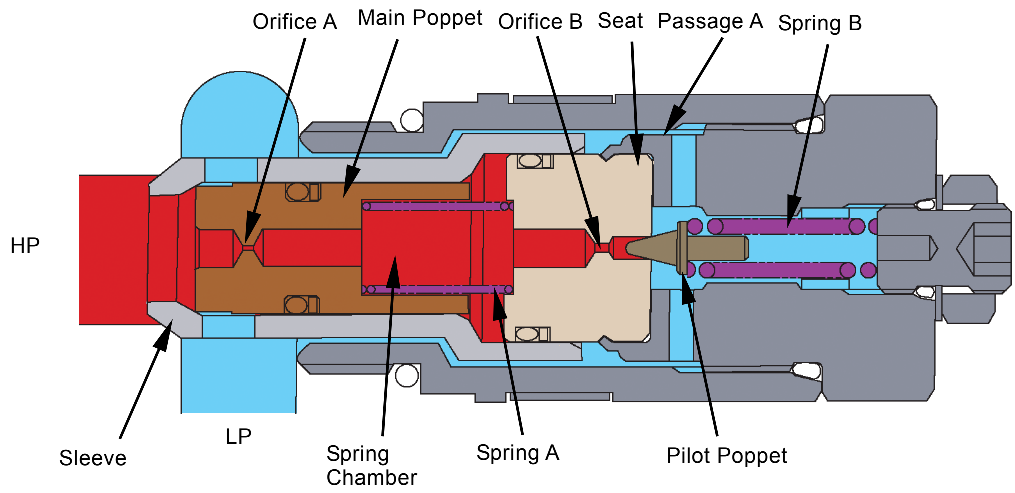
T4GB-03-02-035

ZW250

Operation of Relief Valve

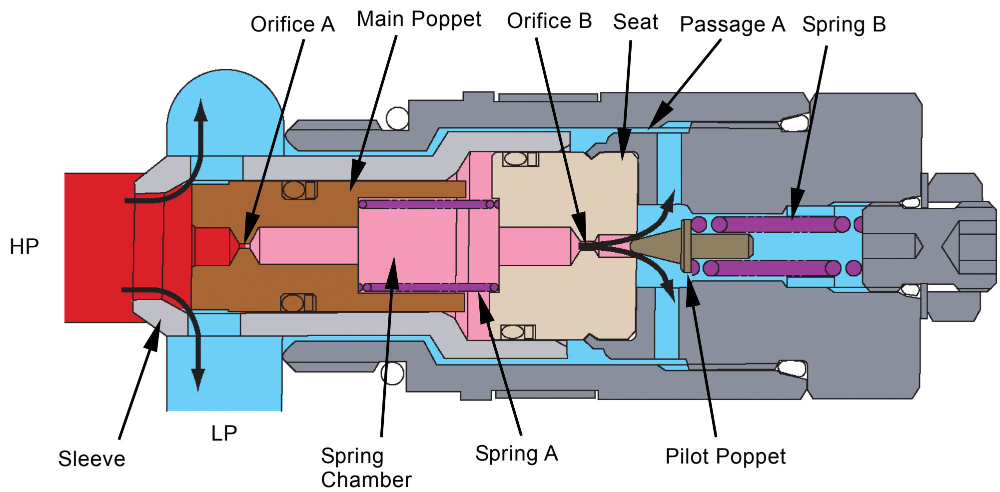
1. Pressure at port HP (in the main circuit) works on the pilot poppet through orifice A of the main poppet and orifice B of the seat.
2. When the pressure at port HP rises to the setting force of spring B, the pilot poppet opens, and pressure oil flows to port LP (in the hydraulic oil tank) passing through passage A and the periphery of the sleeve.
3. At this time, pressure difference arises between port HP and the spring chamber, caused by orifice A.
4. When this pressure difference reaches the value corresponding to the set force of spring A, the main poppet opens, and the pressure oil at port HP flows to port LP.
5. As a result, pressure in the the main circuit lowers.
6. If the main circuit pressure lowers to the set pressure, the main poppet is closed by the force of spring A.

In Normal Condition:



T4GB-03-02-025

When Relieving:



T4GB-03-02-026

OVERLOAD RELIEF VALVE

(With Make-up Function)

Overload relief valve is installed on the bottom end of the lift arm and the bottom and rod ends of the bucket. Overload relief valve so controls pressure in each front circuit not to rise abnormally. It also makes make-up operation by refilling oil from the hydraulic oil tank for preventing cavitation.

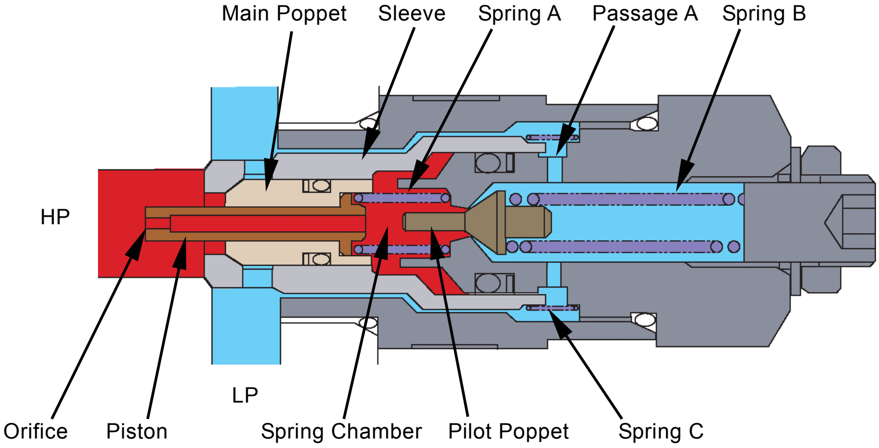
Operation of Relief Valve in ZW220 (Port on Bucket Rod) & ZW250 (All Ports)

1. Pressure at port HP (in the front circuit) works on the pilot poppet through the orifice of the piston.
2. When the pressure at port HP rises to the setting force of spring B, the pilot poppet opens, and pressure oil flows to port LP (in the hydraulic oil tank) passing through passage A and the periphery of the sleeve.
3. At this time, pressure difference arises between port HP and the spring chamber, caused by the orifice.
4. When this pressure difference reaches the value corresponding to the set force of spring A, the piston and the main poppet open, and the pressure oil at port HP flows to port LP.
5. As a result, pressure in the the main circuit lowers.
6. If the front circuit pressure lowers to the set pressure, the piston and the main poppet are closed by the force of spring A.

Make-up Operation

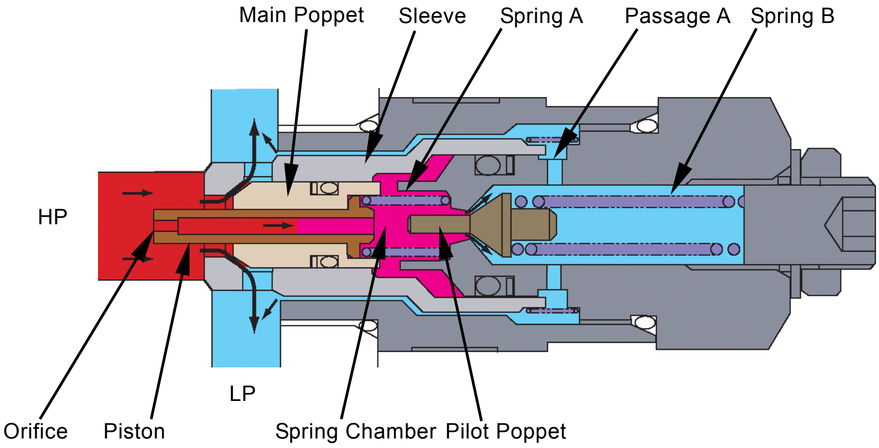
1. When the pressure at port HP (in the front circuit) lowers than the pressure at port LP (in the hydraulic oil tank), the sleeve moves right.
2. Hydraulic oil at port LP flows into port HP, and cavitation is prevented.
3. When the pressure at port HP rises to the set pressure, the sleeve is closed by the force of spring C.

In Normal Condition:



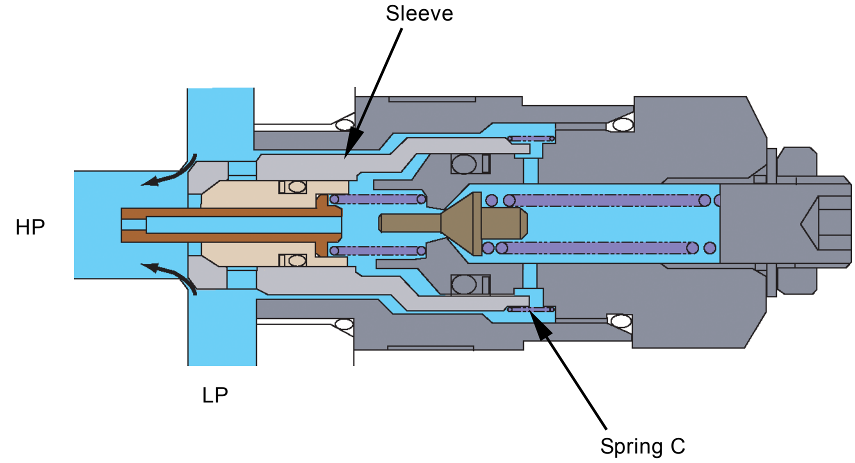
T4GB-03-02-030

When Relieving:



T4GB-03-02-031

In Make-up Operation:



R4GB-03-02-032

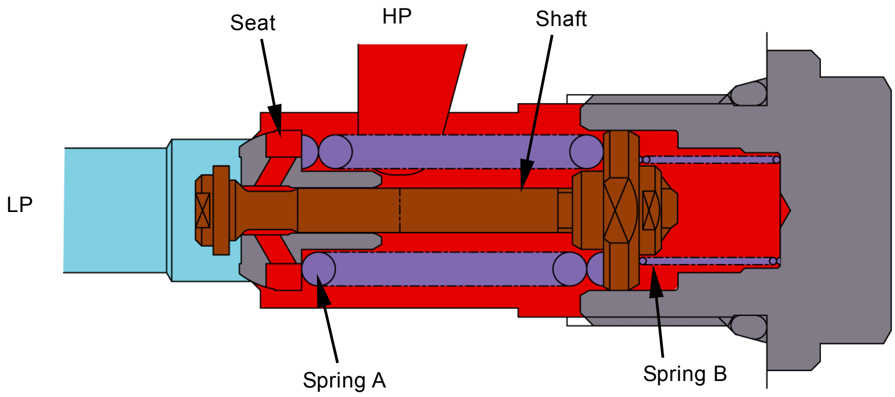
Operation of Relief Valve in ZW220 (Ports on Bottom End of Lift Arm and Bucket)

1. Pressure at port HP (front circuit) passes the seat, and works on the shaft.
2. When the pressure at port HP rises to the value corresponding to the set force of spring A, the shaft moves, and pressure oil flows to port LP.
3. As a result, the pressure in the front circuit lowers.
4. If the pressure in the front circuit lowers to the set pressure, the shaft is moved by the force of spring A, and the oil passage closes.

Make-up Operation

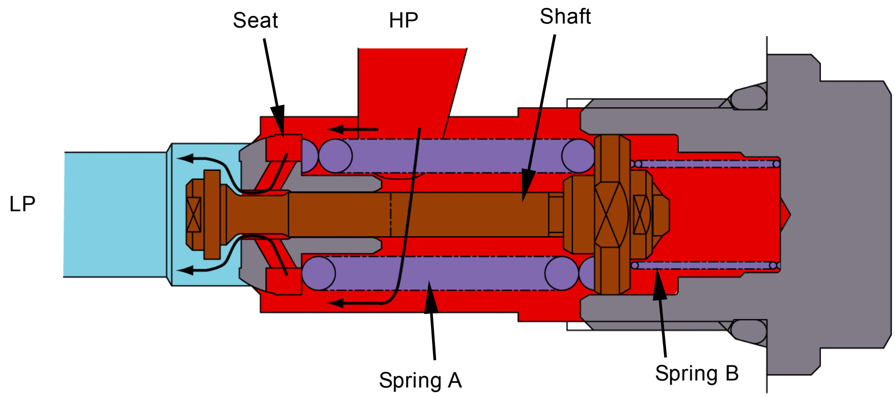
1. When the pressure at port HP (in the front circuit) lowers than the pressure at port LP (in the hydraulic oil tank), the sleeve moves right.
2. Hydraulic oil at port LP flows into port HP, and cavitation is prevented.
3. When the pressure at port HP rises to the set pressure, the sleeve is closed by the force of spring C.

In Normal Condition:



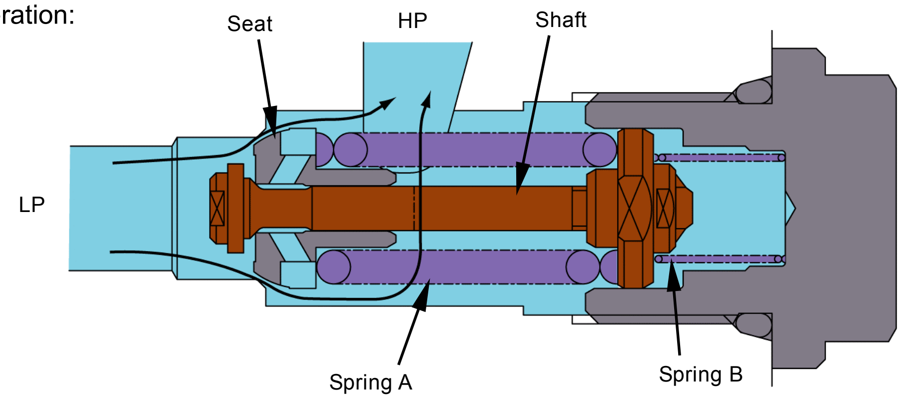
T4GB-03-02-027

When Relieving:



T4GB-03-02-028

In Make-up Operation:

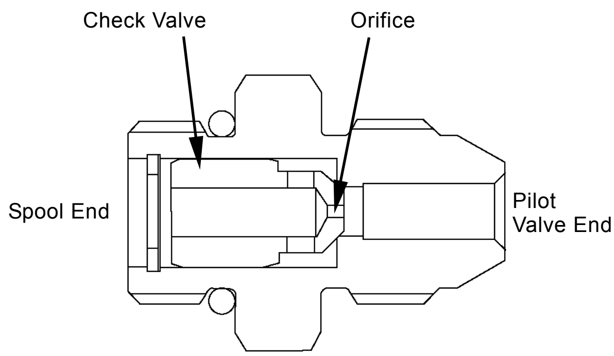


T4GB-03-02-029

(Blank)

RESTRICTION VALVE

Restriction valve is installed at the inlet part to the pilot circuit on the both ends of the spool for the lift arm.
If the pilot valve is made at the neutral position during operation of the lift arm, the pilot pressure oil having been supplied to the spool for the lift arm is drained through the orifice of the check valve of the restriction valve, and pilot pressure gradually lowers.
As a result, shock to the body occurring in operation of the front attachment can be reduced by gradually returning the lift arm spool to the neutral position.



T4GB-03-02-014

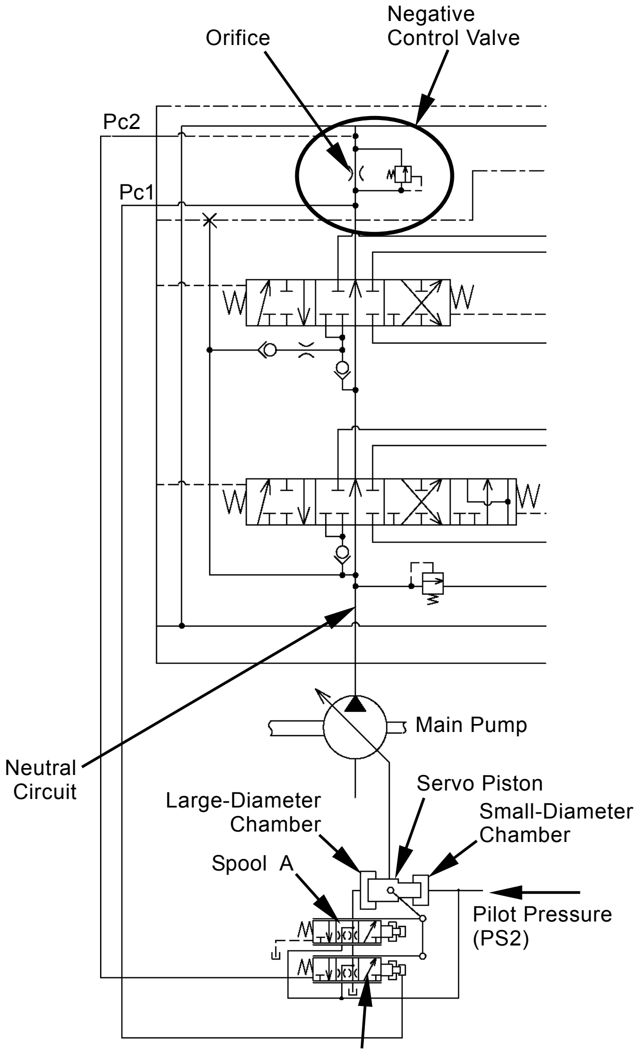
NEGATIVE CONTROL VALVE

Control valve has a built-in negative control valve. Negative control valve controls the main pump delivery flow of the main pump by the flow control pressure (Pc1 and Pc2).

Operation

- At Neutral
  Pressure oil coming through the control valve neutral circuit at neutral position of the control valve is supplied as pilot pressure for controlling the pump delivery flow from before and after the orifice of the negative control valve installed at the outlet of the control valve.
  At this time, spool B moves left because differential pressure is occurring between the Pc1 and Pc2. Therefore, pilot pressure (PS2) enters the large-diameter chamber for the servo piston through spool B and spool A. Pilot pressure (PS2) also enters the small-diameter chamber for the servo piston, but as the the large-diameter chamber has a larger area than the small-diameter chamber, the servo piston moves right, and the pump delivery flow is reduced.
- In Operation
  In operations handling the lift arm and the bucket, pressure oil is not supplied to Pc1 and Pc2.
  At this time, differential pressure is lowered between the Pc1 and Pc2, so the regulator for the main pump is at neutral, and restriction of delivery flow is not made (increase pump delivery flow).

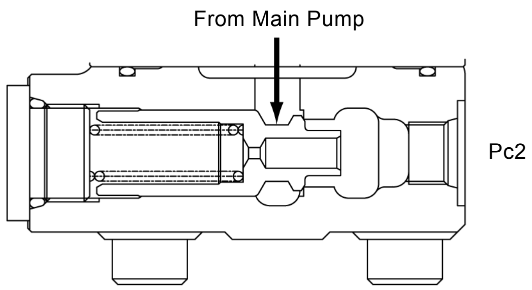
NOTE: Illustration shows the control valve for the ZW220.



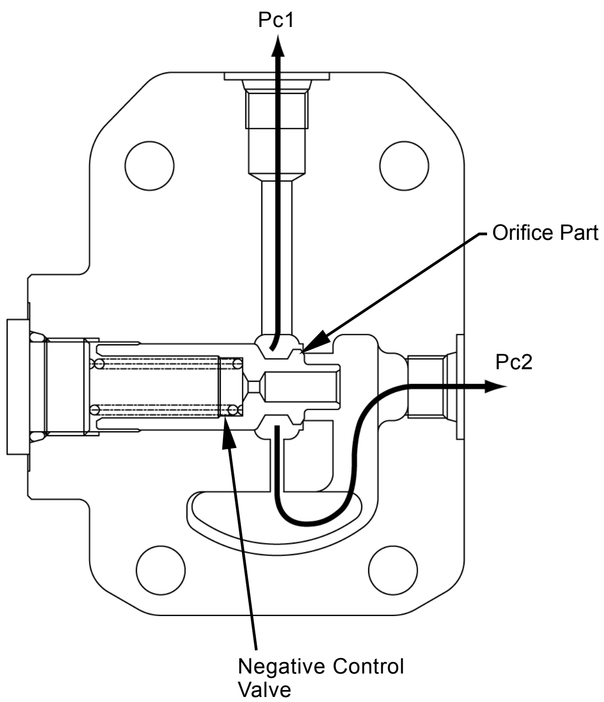
T4GB-03-02-015

ZW220

Section A[*1,*2]



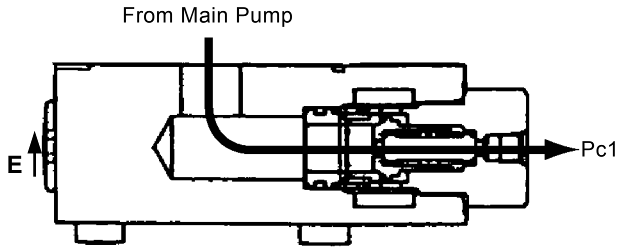
Section E[*1]



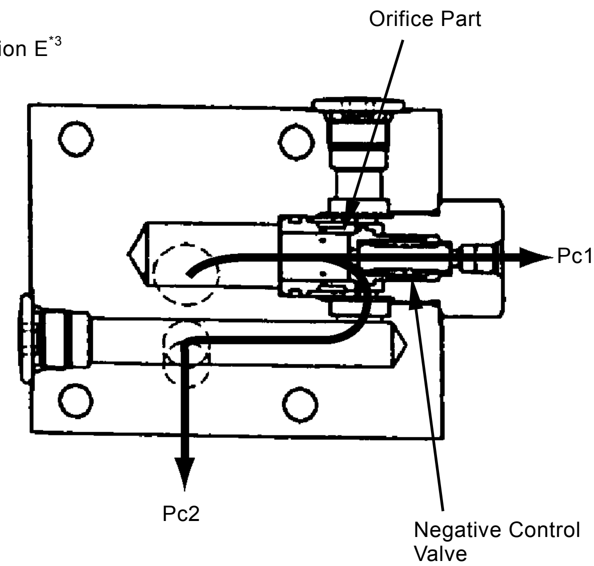
T4GB-03-02-016

ZW250

Section D[*3,*4]



Section E[*3]



T4GB-03-02-017

*1: Refer to T3-2-3.
*2: Refer to T3-2-5.
*3: Refer to T3-2-9.
*4: Refer to T3-2-13.

FLOW CONTROL VALVE

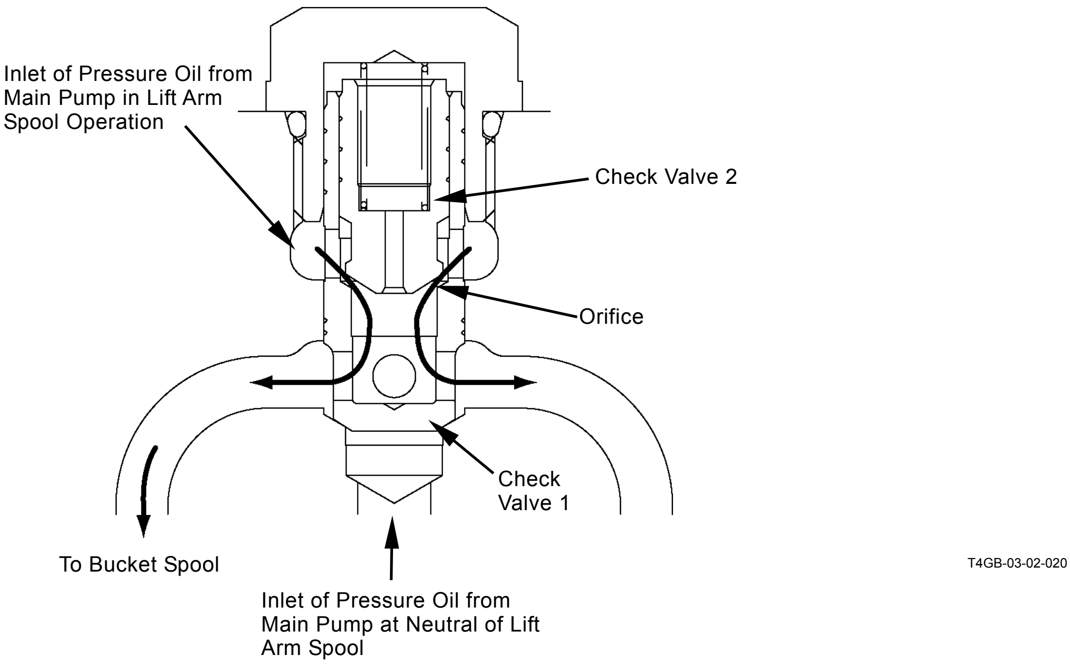
Flow control valve is installed in the bucket circuit, and narrows the circuit in compound operations, giving priority to operations of the other actuators.

ZW220
In Single Operation of Bucket Crowding

1. Pressure oil from the main pump passes the lift arm spool.
2. Pressure oil from the lift arm spool flows to the bucket spool through check valve 1, and is supplied to the bucket cylinder.

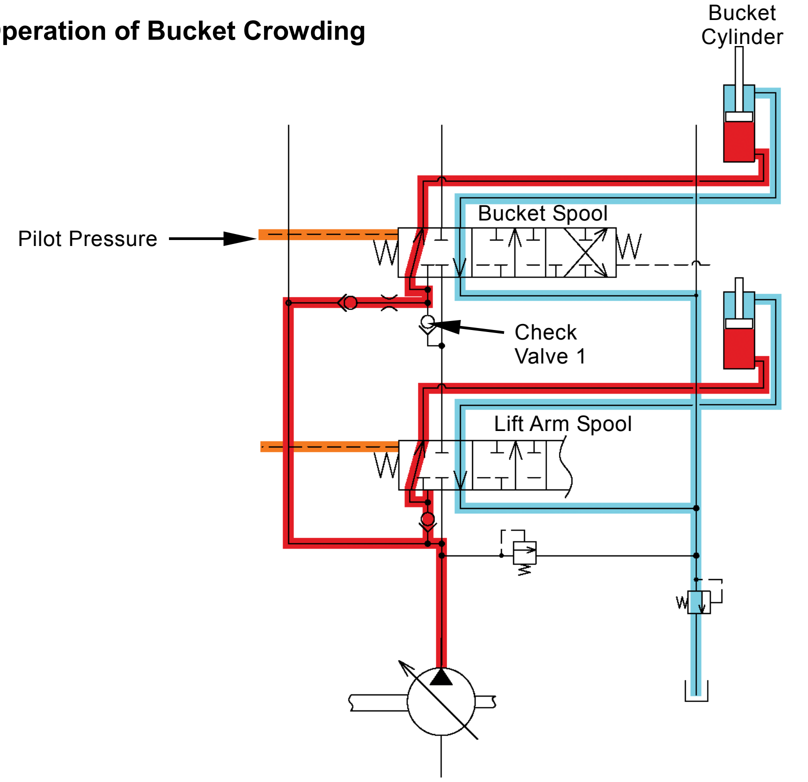
In Compound Operation of Bucket Crowding and Lift Arm Raising

1. Part of the pressure oil from the main pump is supplied to the lift arm cylinder through the lift arm spool.
2. Remainder of the pressure oil from the main pump is supplied to the bucket spool through the parallel circuit.
3. At that time, flow is restricted because pressure oil passes the orifice through check valve 2.
4. Pressure oil having passed the orifice flows to the bucket spool, and is supplied to the bucket cylinder.
5. As a result, flow to the bucket spool is restricted, and more pressure oil is supplied to the lift arm end having higher pressure, and both the bucket and the arm move.



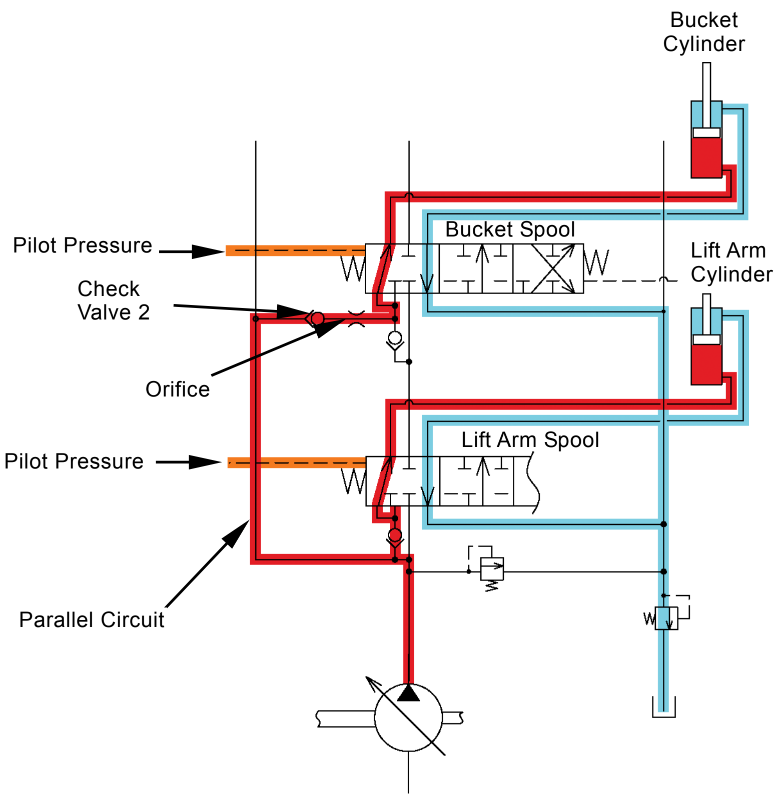
ZW220

In Single Operation of Bucket Crowding



T4GB-03-02-019

In Compound Operation of Bucket Crowding and Lift Arm Raising



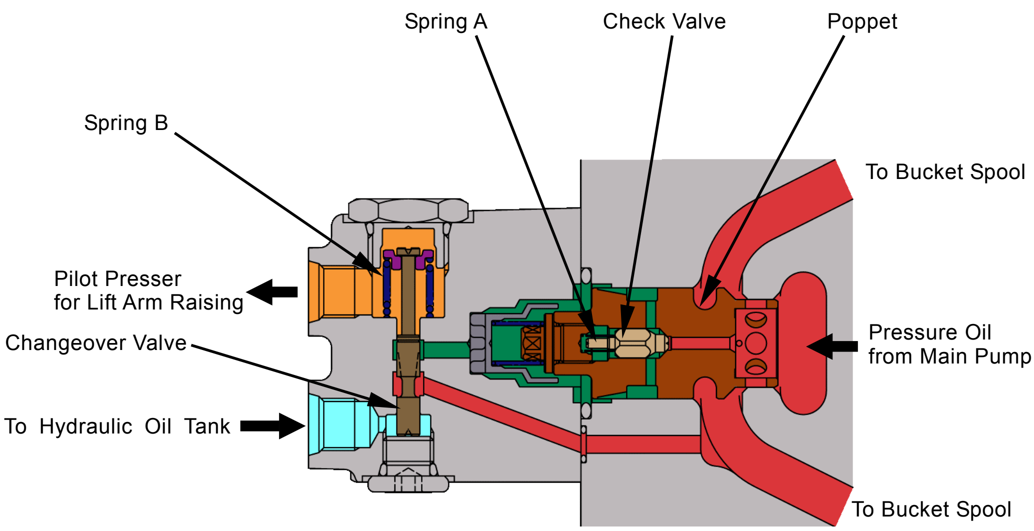
T4GB-03-02-019

ZW250
In Single Operation of Bucket Crowding

1. Pressure oil from the main pump flows toward the poppet.
2. Pressure oil entering the poppet pushes the poppet left, and flows to the bucket spool, with its small portion also flowing to the bucket spool through the check valve inside the poppet to be supplied to the bucket cylinder.

In Compound Operation of Bucket Crowding and Lift Arm Raising

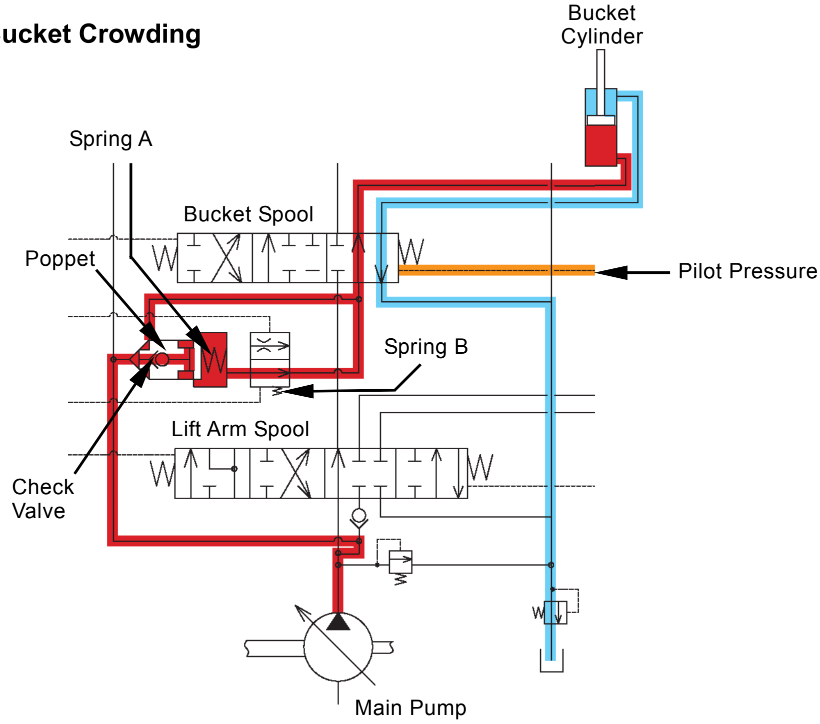
1. Part of the pressure oil from the main pump is supplied to the lift arm cylinder through the lift arm spool.
2. Remainder of the pressure oil from the main pump is supplied toward the bucket spool.
3. Pressure oil from the main pump passes the parallel circuit, and flows to the changeover valve through the check valve of the poppet.
4. At this time, the changeover valve is positioned on the orifice end because pilot pressure for raising the lift arm is working on the changeover valve.
5. By the effect of the orifice of the changeover valve, pressure on the spring end of the poppet rises, and force to push the poppet right (for closing) arises.
6. As a result, flow to the bucket spool is restricted, and more pressure oil is supplied to the lift arm end having higher pressure, and both the bucket cylinder and the arm cylinder move.



T1V1-03-03-064

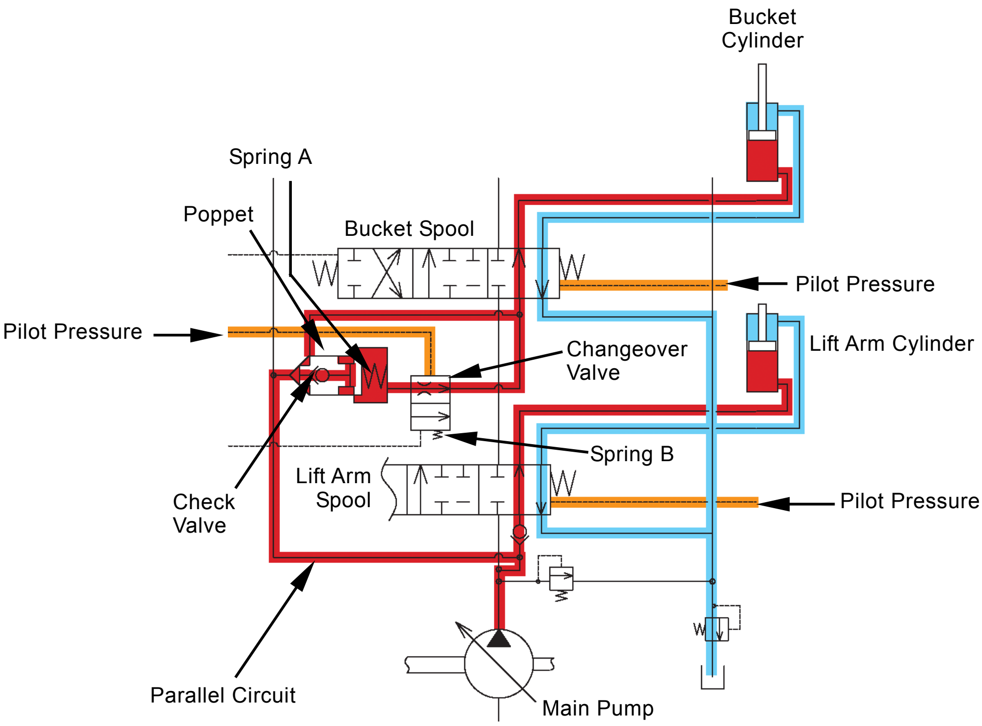
ZW250

In Single Operation of Bucket Crowding



T4GB-03-02-021

In Compound Operation of Bucket Crowding and Lift Arm Raising



T4GB-03-02-022

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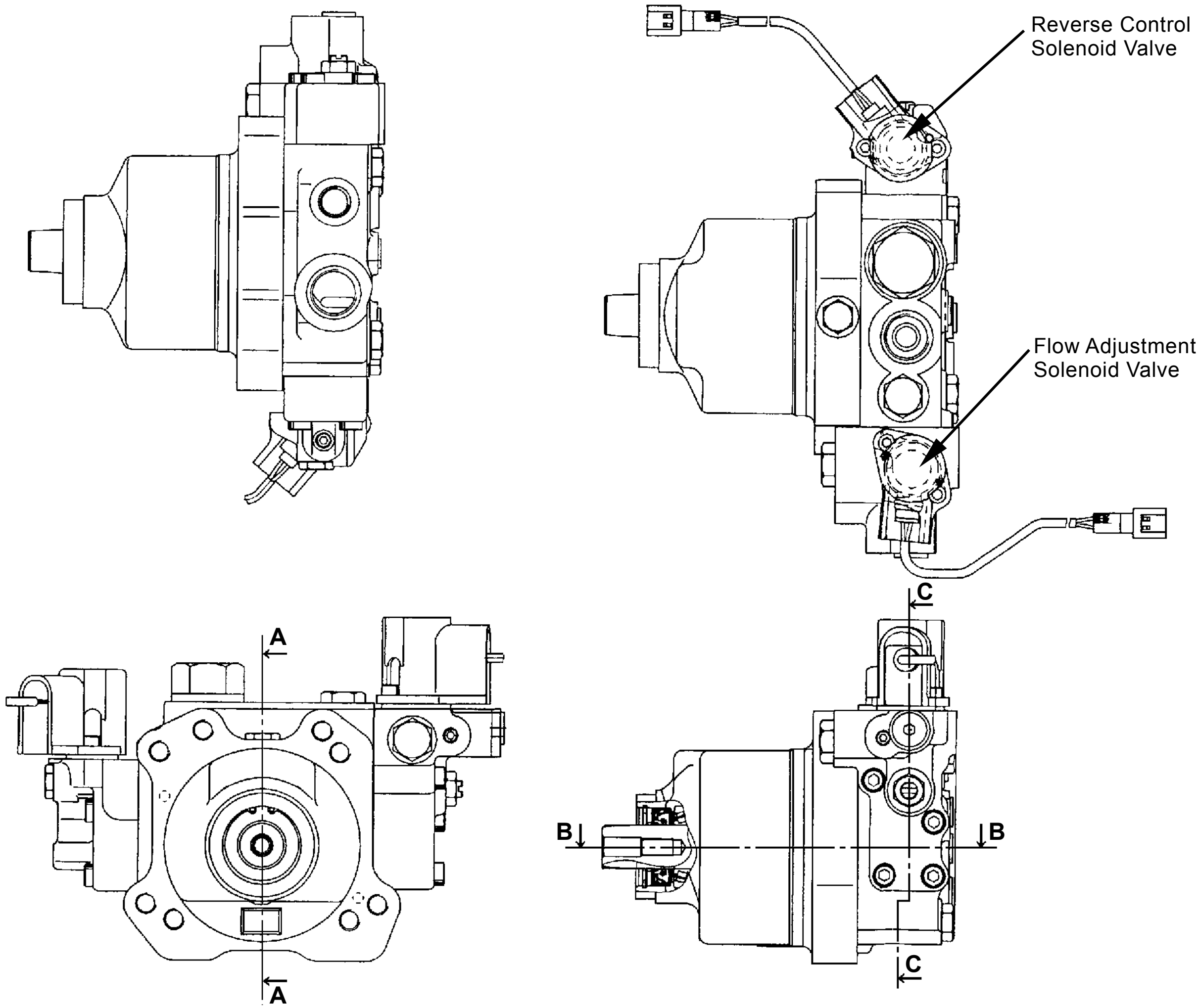
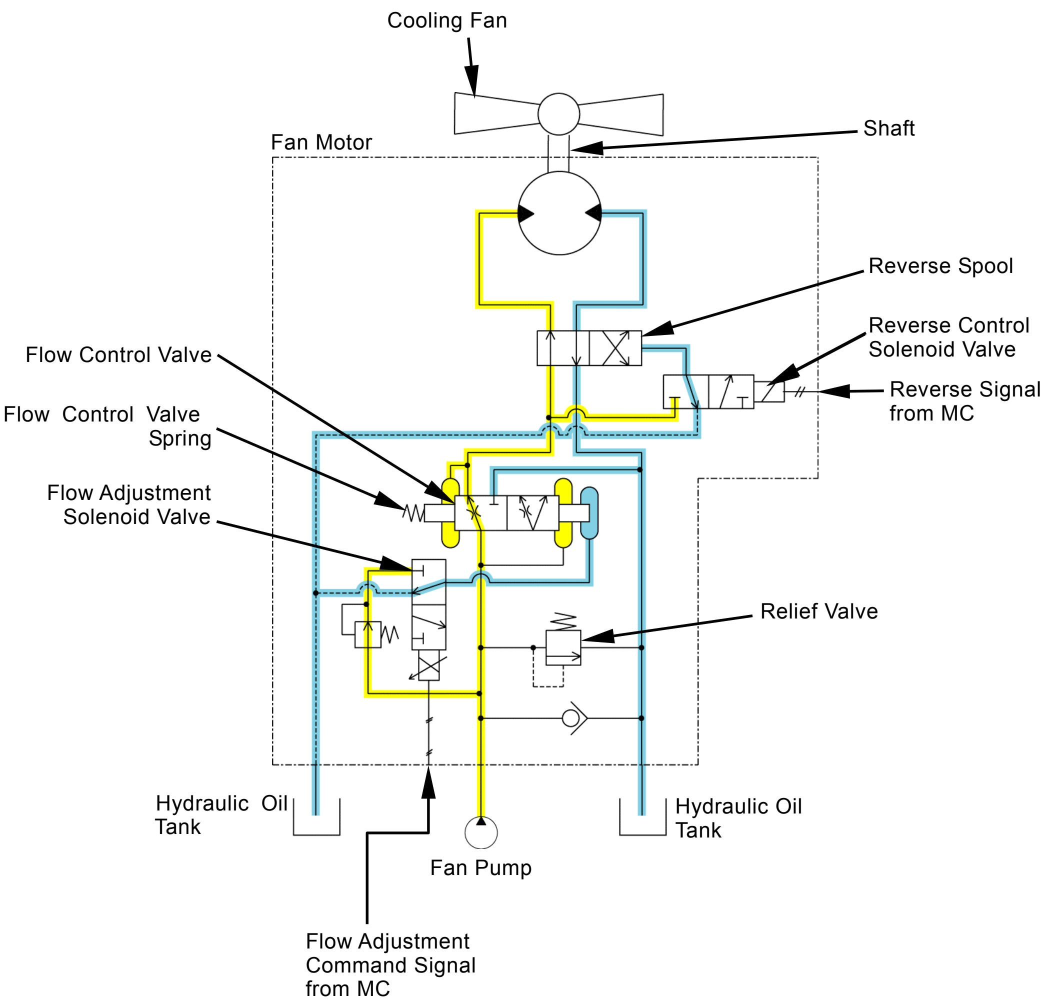
OUTLINE

Shaft of the fan motor is provided with the cooling fan, and the pressure oil from the fan pump rotates the cooling fan by driving the shaft.
Fan motor has a built-in reverse control solenoid valve, a flow adjustment solenoid valve, and others, and controls the motor rotational direction and rotation speed.

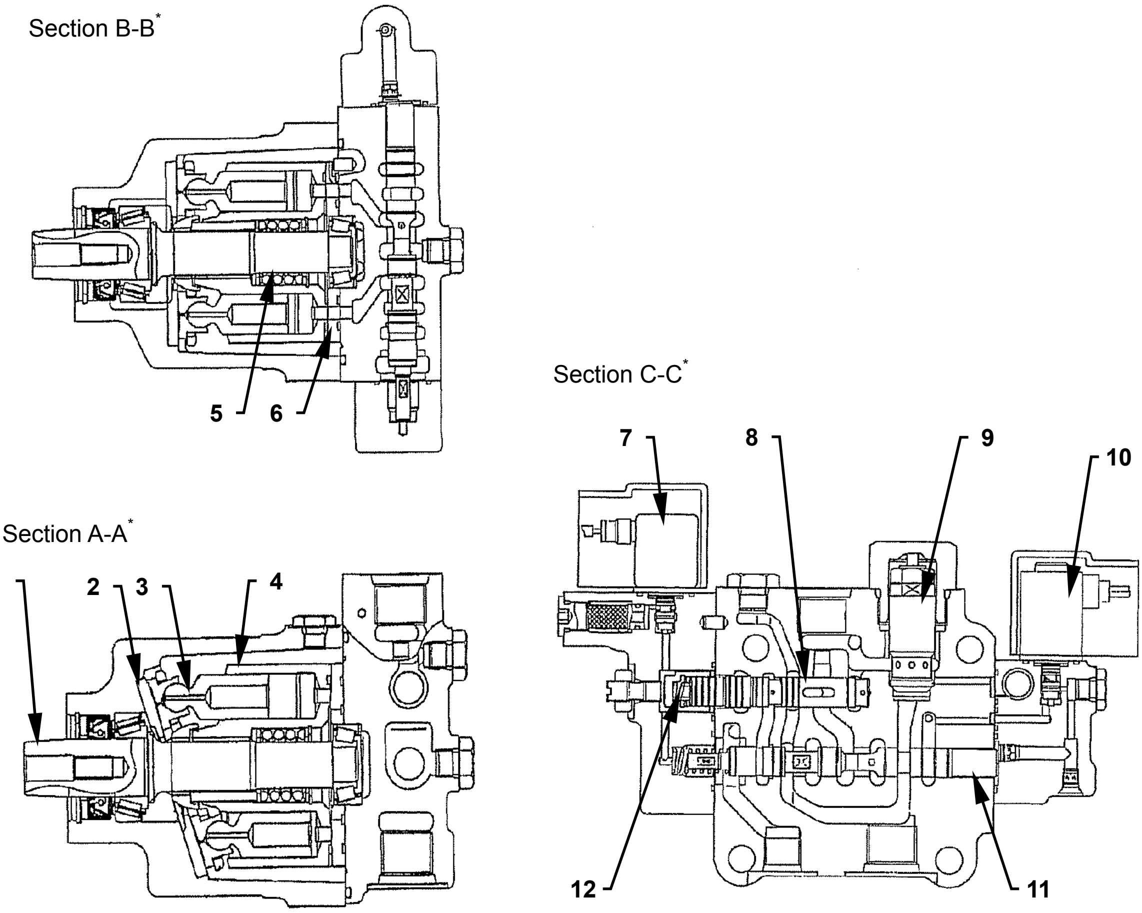


T4GB-03-03-001

Component Layout



T4GB-02-02-008



T4GB-03-03-002

1 - Shaft
2 - Thrust Plate
3 - Piston
4 - Cylinder Block
5 - Center Spring
6 - Valve Plate
7 - Flow Adjustment Solenoid Valve
8 - Flow Control Valve
9 - Relief Valve
10 - Reverse Control Solenoid Valve
11 - Reverse Spool
12 - Flow Control Valve Spring

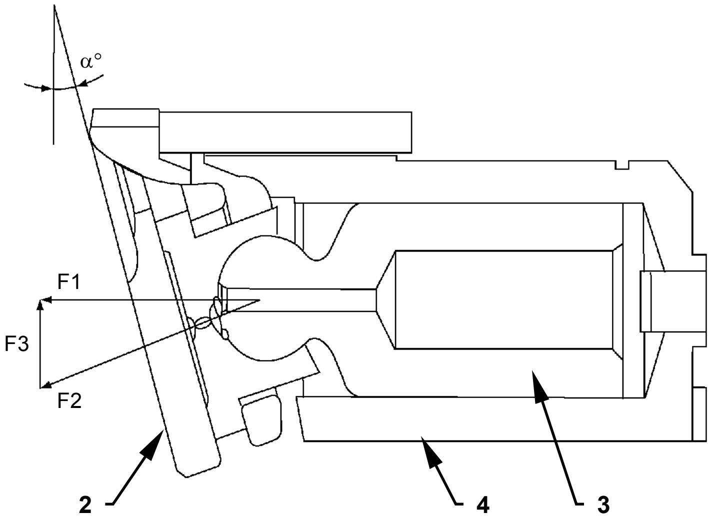
*Refer to T3-3-1

OPERATION

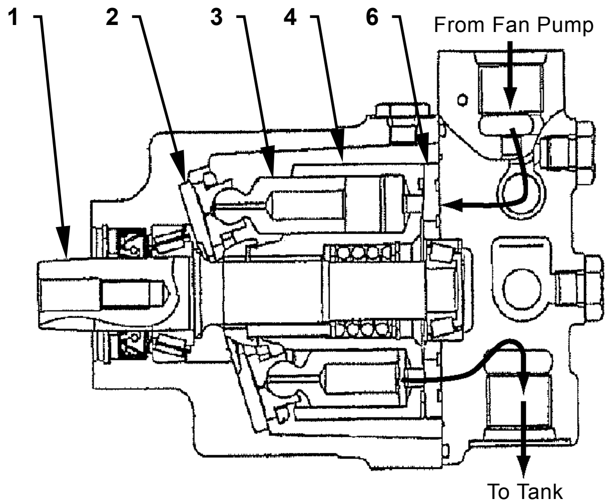
Fan motor is a swash-plate type axial piston motor, and converts the pressure oil sent from the fan motor into rotational motion.

Operation Principle of Hydraulic Motor

1. Pressure oil from the fan motor is led to cylinder block (4) through valve plate (6).
2. Pressure oil entering cylinder block (4) pushes respective pistons (3).
3. This force F1 works on thrust plate (2), and is divided into the component forces of F2 and F3 because thrust plate (2) is fixed to shaft (1) at an angle of $\alpha°$.
4. Resultant force of F3 is a rotational force, and rotates cylinder block (4) through pistons (3).
5. Cylinder block (4) is conncted to shaft (1) by the splines, and the output shaft rotates.



T4GB-03-03-003



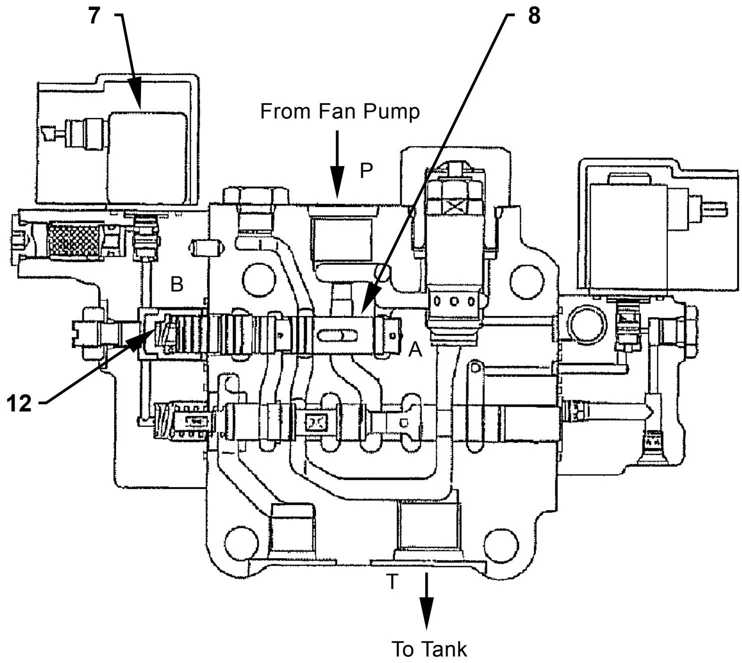
T4GB-03-03-004

FLOW CONTROL VALVE

In case the cooling water and oil are below the set temperature, the flow control valve supplies necessary amount of the pressure oil from the fan pump, and returns redundant amount to the tank to make control for lowering the engine load and wind noise of the cooling fan.

Operation

1. Pressure oil flowing from port P works on the A end as upstream pressure of flow control valve orifice (8), and on the B end as its downstream pressure, and the differential pressure works on flow control valve spring (12).
2. When the pressure difference becomes larger than the set force, flow control valve spool (8) moves, and redundant flow flows to port T.



T4GB-03-03-005

REVERSE CONTROL VALVE

Fan motor is reversed by operations of the reverse control solenoid valve and the reverse spool.

Operation

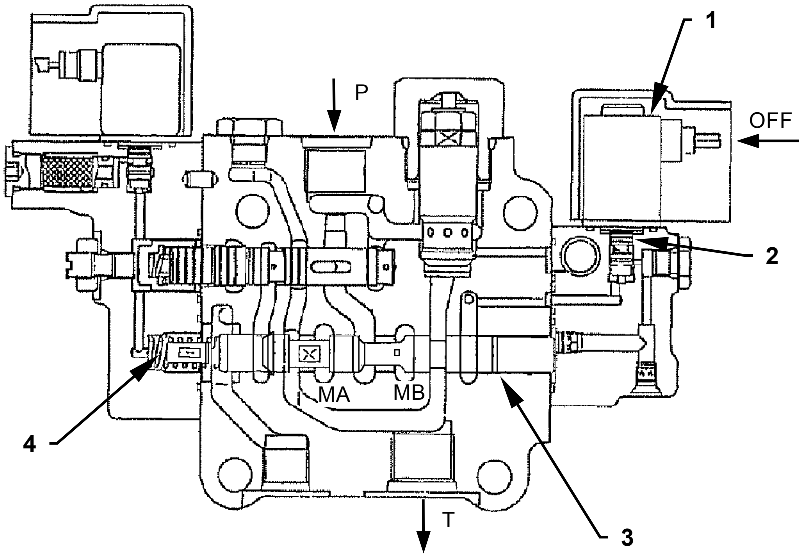
- At Neutral of Reverse Control Solenoid Valve

1. When reverse control solenoid valve (1) is at neutral, the pressure oil (P) from the fan pump is blocked by changeover valve (2).
2. As reverse spool (11) is being pushed by spring (4), the pressure oil (P) from the fan pump flows to port MB, and the fan motor rotates normally.

- In Operation of Reverse Control Solenoid Valve

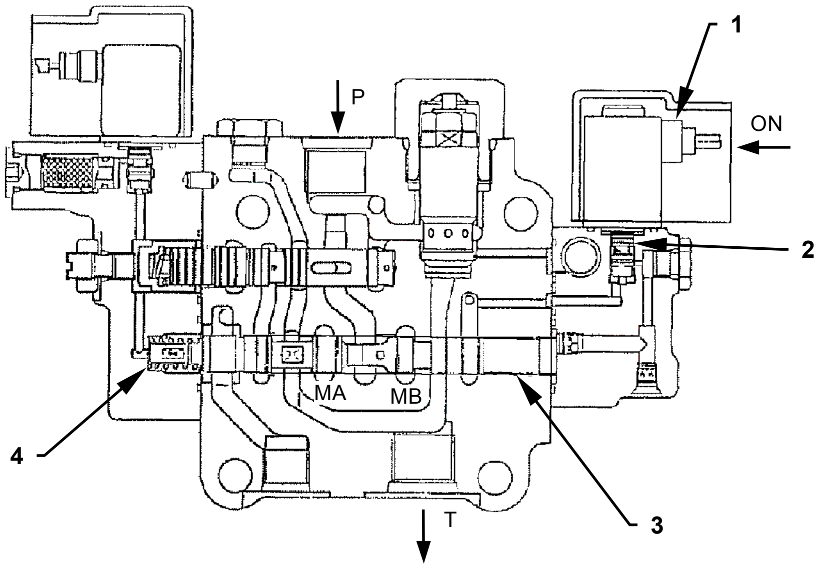
1. When reverse control solenoid valve (1) is operated, the pressure oil from the fan pump flows to the right end of reverse spool (11) through changeover valve (2).
2. When the pressure oil entering the right end of reverse spool (11) overcomes the spring (4), reverse spool (11) moves leftwards.
3. Pressure oil (P) from the fan pump flows to port MA, and the fan motor makes reverse rotation.

At Neutral



T4GB-03-03-006

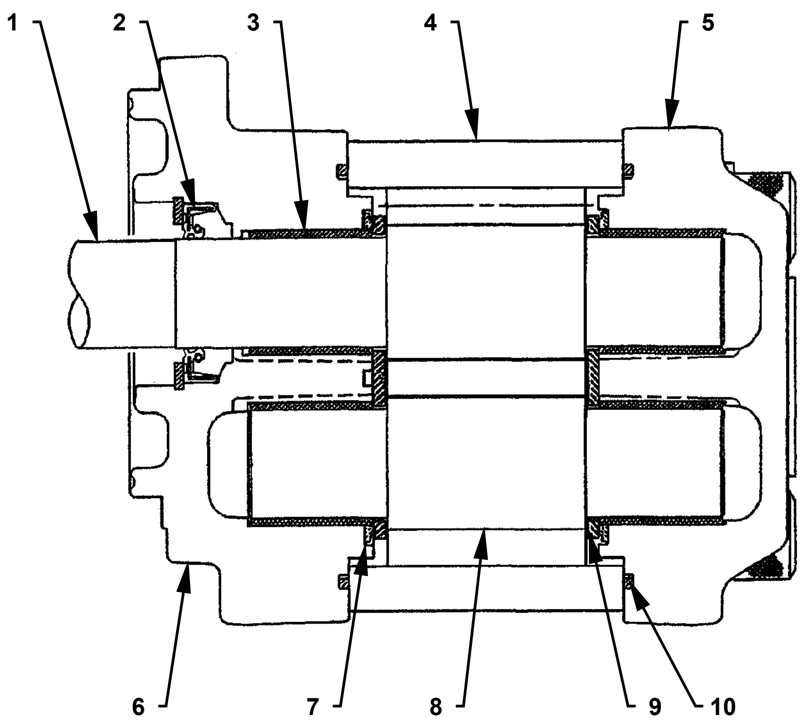
In Operation



T4GB-03-03-007

FAN PUMP

Fan pump is a gear pump always supplying pressure oil to the fan motor during the engine operation.
Fan pump is installed to the engine.

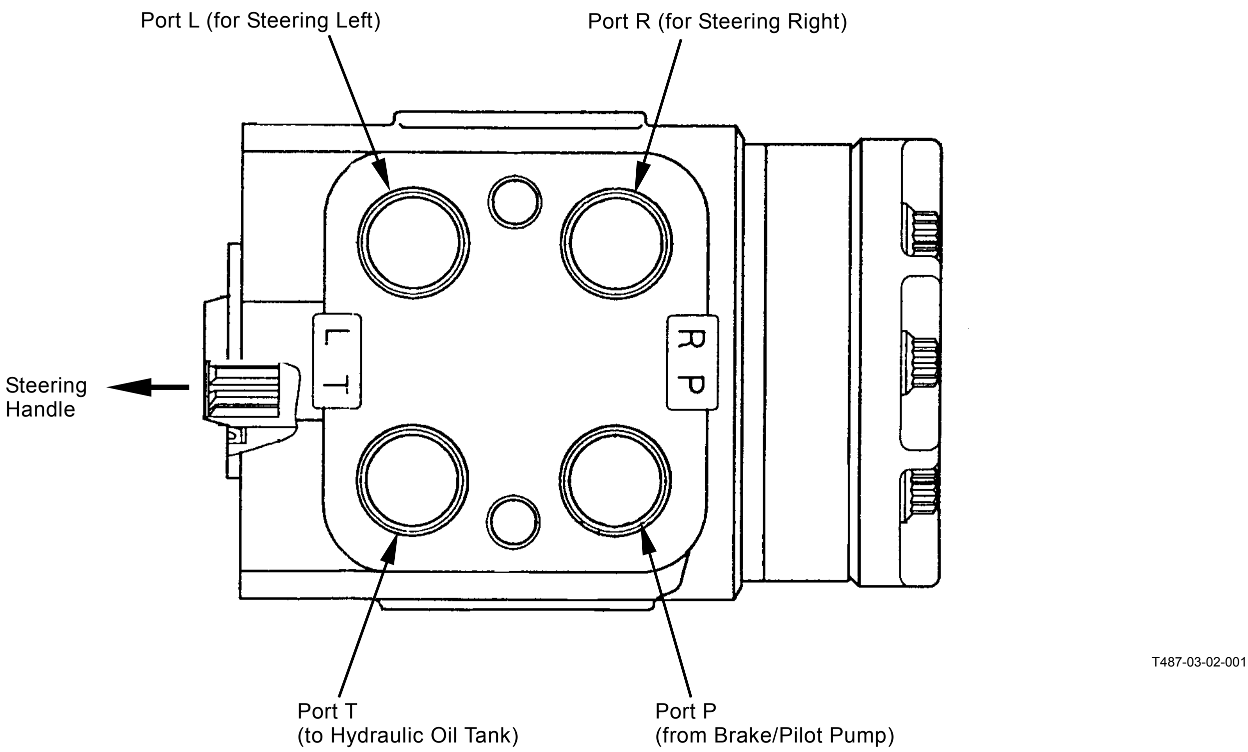


T4GB-03-03-008

1 - Drive Gear
2 - Oil Seal
3 - Bushing
4 - Body
5 - Cover
6 - Front Cover
7 - Gasket
8 - Driven Gear
9 - Side Plate
10 - Gasket

OUTLINE

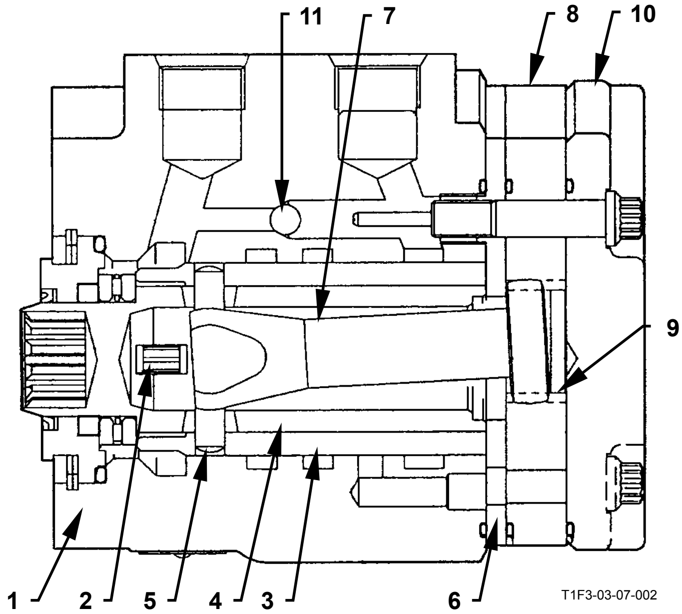
Steering pilot valve is located between the brake/pilot pump and the steering valve.
Steering pilot valve supplies the pressure oil from the pilot pump to the steering valve in response to the movement of the steering handle. (Refer to the Steering Curcuit in the SYSTEM / Hydraulic System)



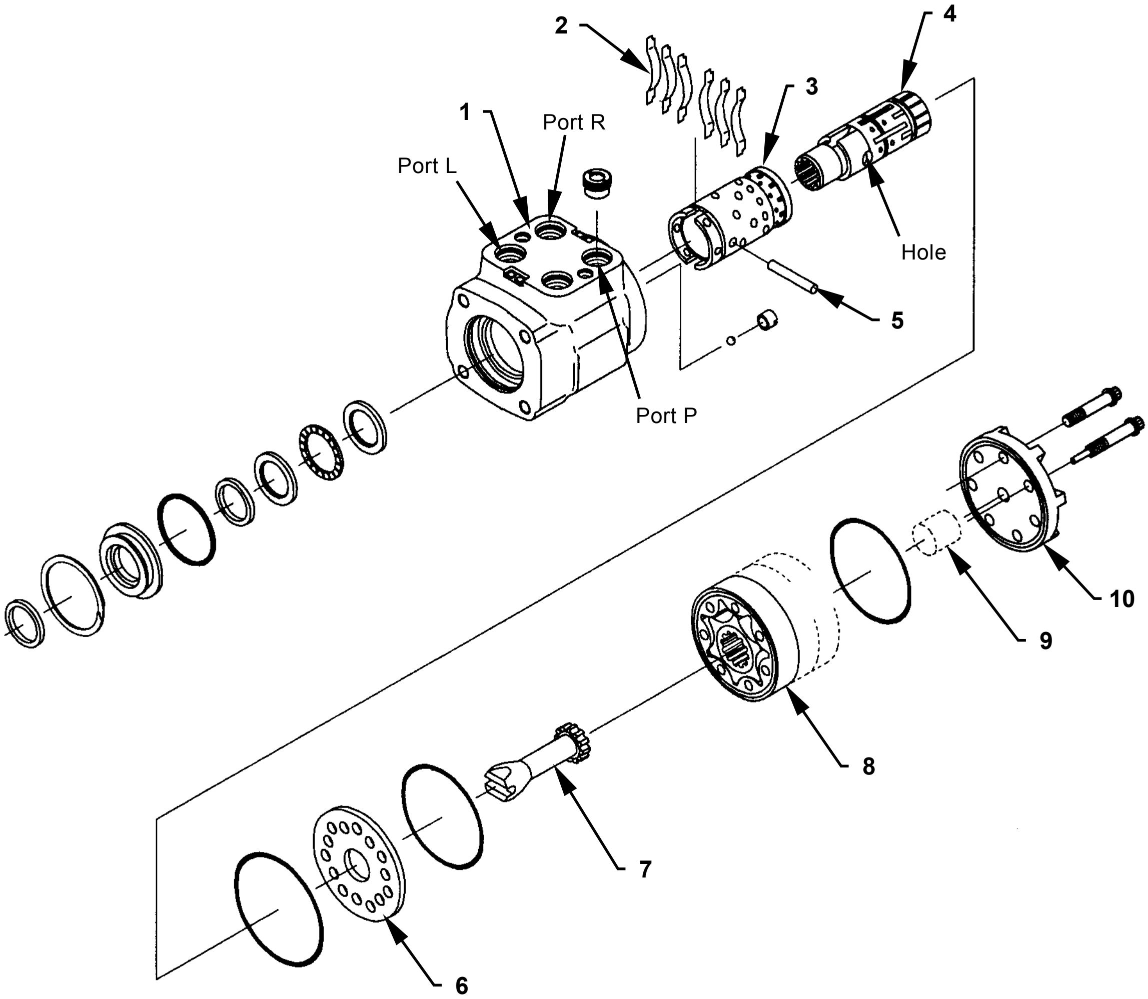
CONSTRUCTION

Steering pilot valve consists of gerotor (8), drive (7), sleeve (3), spool (4), pin (5), housing (1), centering springs (2), and others.

When the steering handle is rotated, spool (4) rotates, and an oil passage is generated between spool (4) and sleeve (3). Flow of the pressure oil from the pilot pump is controlled by spool (4) and sleeve (3), and flows to the steering valve.
Centering springs (2) are arranged both in spool (4) and sleeve (3), and so function as to return sleeve (3) to the neutral position when holding the handle is stopped.



T1F3-03-07-002

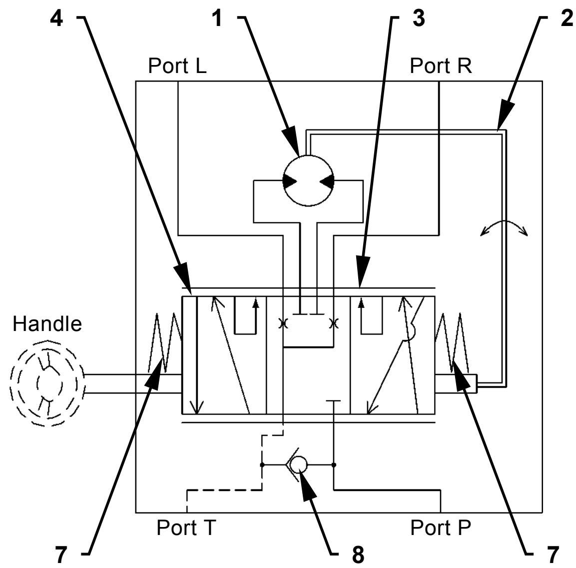


T4GB-03-04-008

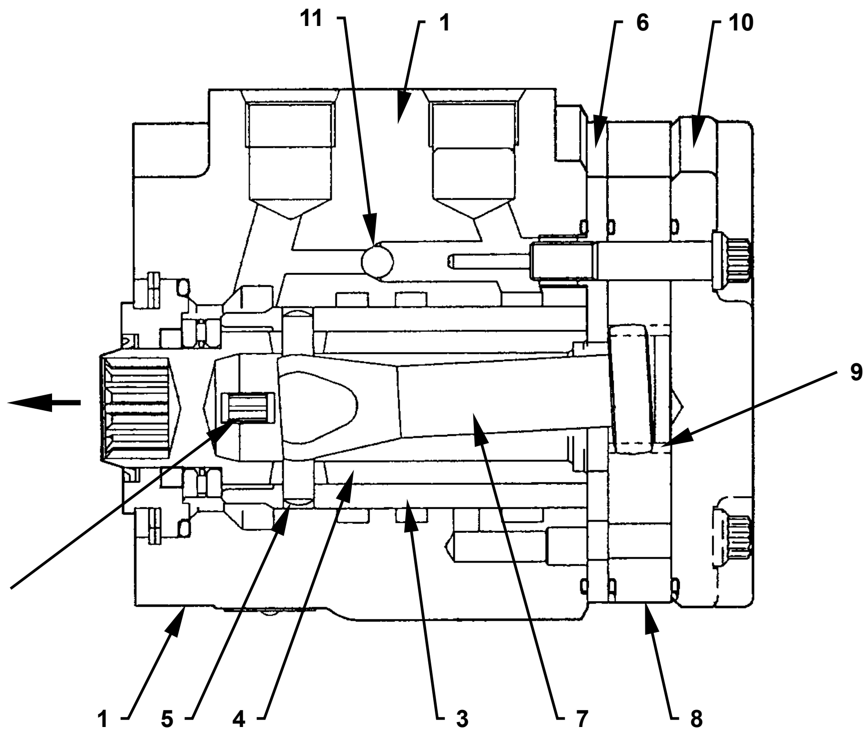
1 - Housing	4 - Spool	7 - Drive	10 - Cap
2 - Centering Spring	5 - Pin	8 - Gerotor	11 - Check Valve
3 - Sleeve	6 - Plate	9 - Spacer	

OPERATION

Sleeve (3), spool (4), and drive (7) are mutually connected by pin (5). When the handle (or the spool (4)) is turned, a relative angular difference arises between sleeve (3) and spool (4) because the hole of spool (4) is a lengthened one.
Movement of the steering handle is conveyed only to spool (4), and port P (from the steering pump) is connected to port R (to the steering valve) or port L through sleeve (3) and spool (4).



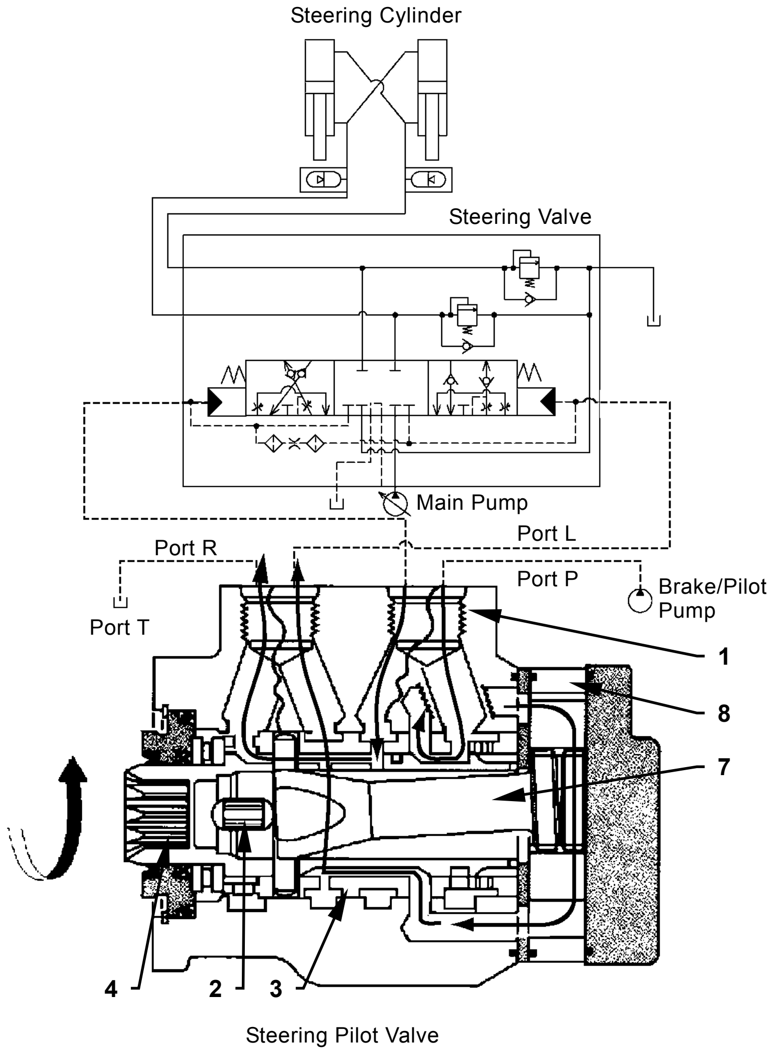
T4GB-03-04-007



T1F3-03-07-002

Steering Left:

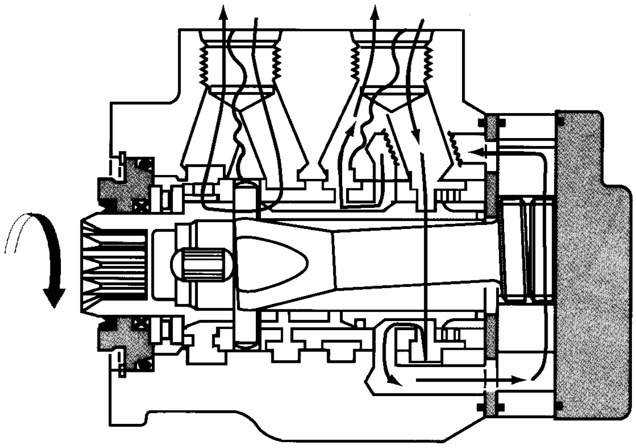
1. When the steering handle is turned left, spool (4) rotates, and the pressure oil from the brake/pilot pump flows in the order of port P - sleeve (3) - spool (4) - sleeve (3) - housing (1) - gerotor (8).
2. Pressure oil from gerotor (8) flows in the order of housing (1) - sleeve (3) - spool (4) - sleeve (3) - port L - steering valve, and controls the steering valve.
3. Steering valve drives the steering cylinder with the pressure oil from the main pump, and directs the vehicle body toward left.
4. Return oil from the steering valve enters port R, and flows in the order of housing (1) - sleeve (3) - spool (4) - sleeve (3) - port T to return to the hydraulic oil tank.
5. When the pressure oil from the brake/pilot pump enters gerotor (8), gerotor (8) rotates leftwards. Rotation of gerotor (8) is transmitted to the sleeve (3) through drive (7), and sleeve (3) rotates leftwards similarly.
6. When sleeve (3) rotates the same amount of turns as spool (4), passages of sleeve (3) and spool (4) are closed, and operation of the steering valve is stopped.
7. Therefore, gerotor (8) rotates in response to rotation of the handle, and the steering valve is operated in response to the amount of turns of the handle.



T4GB-03-04-009

Steering Right

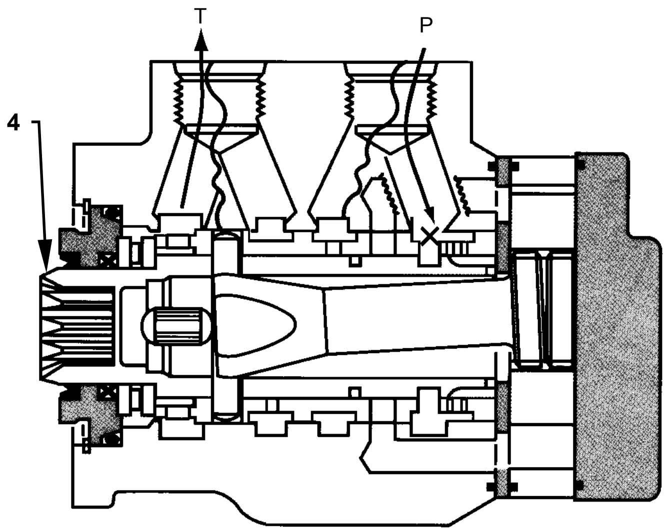
When the steering handle is turned right, the pressure oil from the pilot pump flows in the order of port P - port R - steering cylinder, and operates the steering valve to direct the front wheel right.
Return oil from the steering valve flows in the order of port L - port T to return to the hydraulic oil tank.



T4GB-03-04--010

Neutral

When the steering handle is not being turned, the oil from the pilot pump works on port P of the steering pilot valve, but does not flow to the steering valve because it is blocked by spool (4). Therefore, the steering cylinder is not operated.



T4GB-03-04--011

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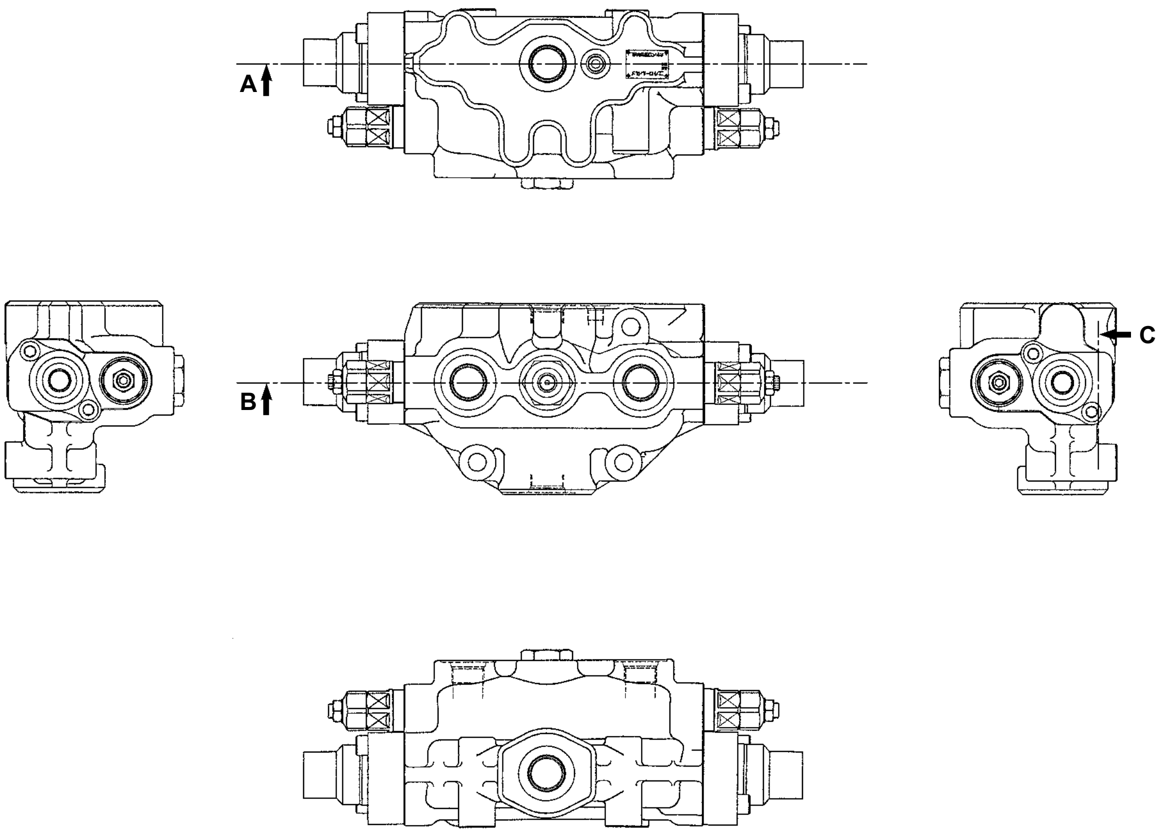
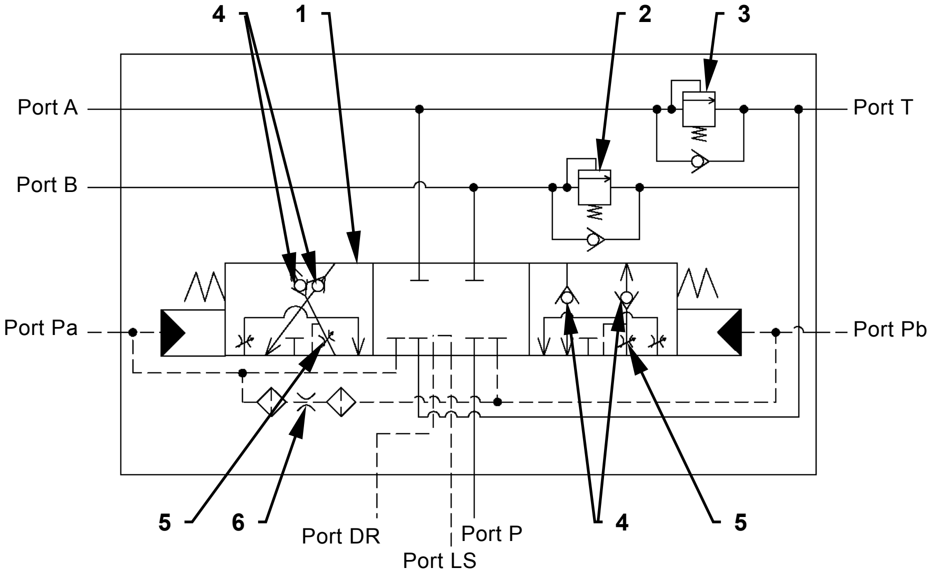
OUTLINE

Steering valve is located between the main pump and the steering cylinder.
Steering valve supplies the pressure oil from the main pump to the steering cylinder in response to the pilot oil pressure of the steering pilot valve.
Steering cylinder is provided with the overload relief valve.



T4GB-03-04-001

Component Layout

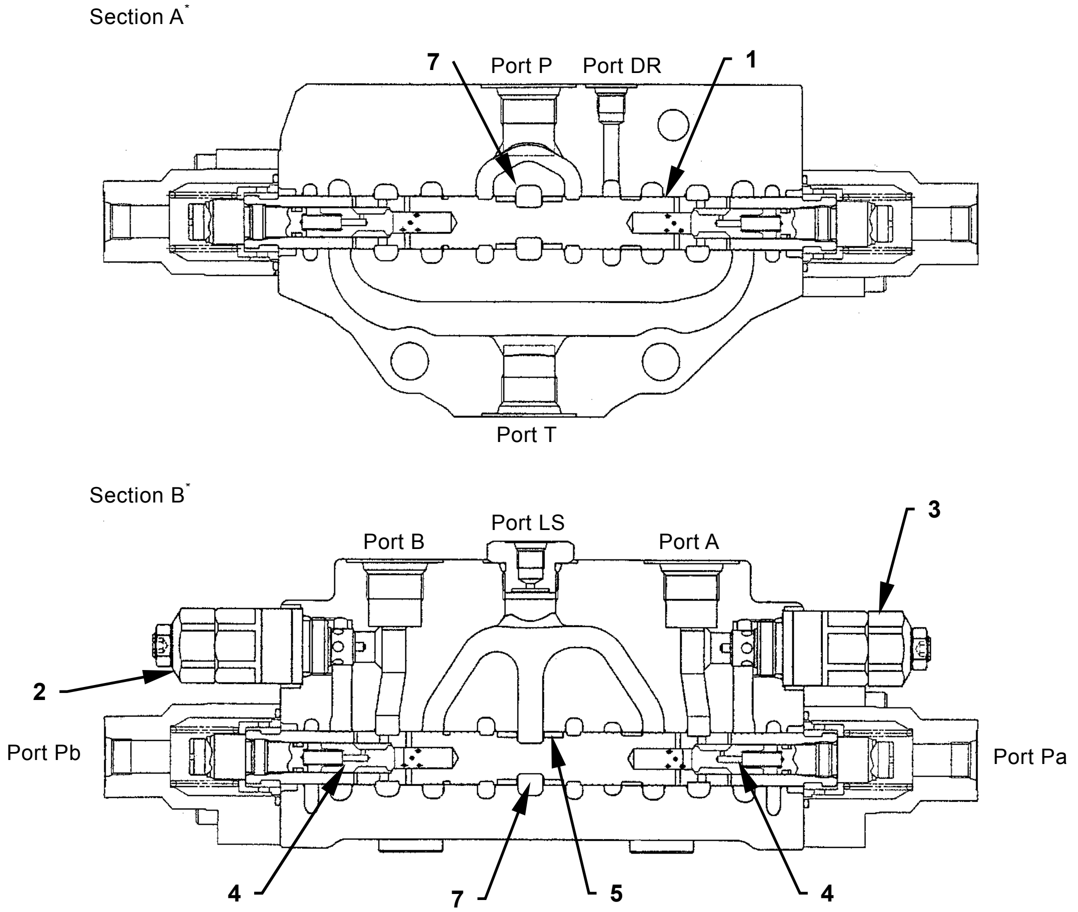


Port A: Pressure for Steering Right
Port P: From Main Pump

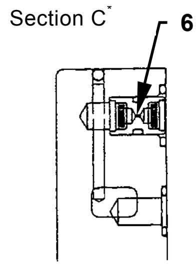
Port B: Pressure for Steering Left
Port T: Return to Hydraulic Oil Tank

Port Pa: Pilot Pressure for Steering Right
Port LS: To Port LS of Priority Valve

Port Pb: Pilot Pressure for Steering Left
Port DR: Return to Hydraulic Oil Tank



T4GB-03-04-003



T4GB-03-04-006

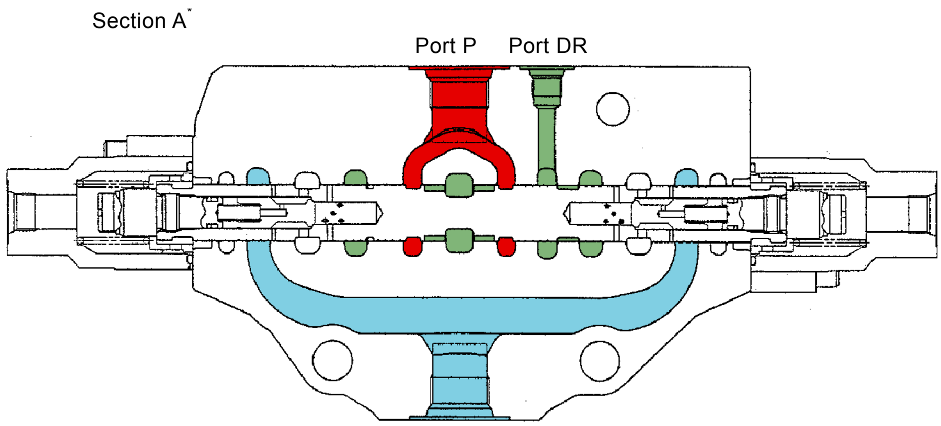
1 - Spool
2 - Overload Relief Valve
3 - Overload Relief Valve
4 - Lord Check Valve
5 - Variable Orifice
6 - Fixed Orifice
7 - Passage A

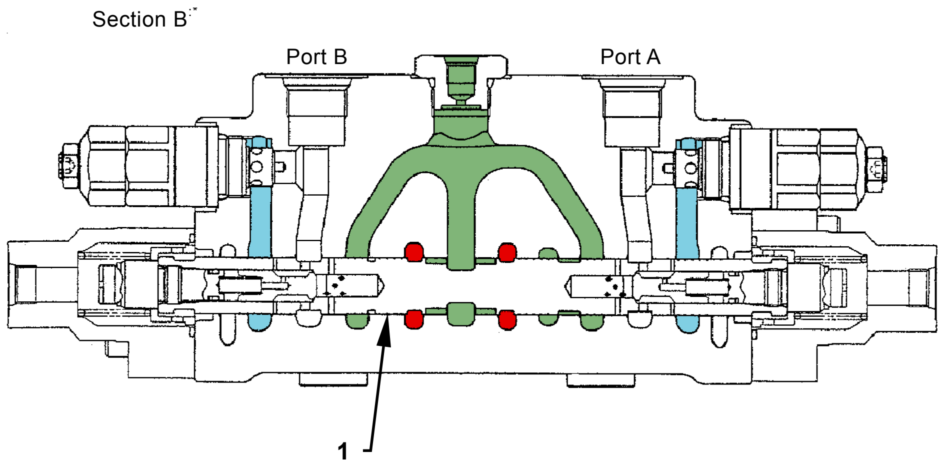
*: Refer to T3-5-1

OPERATION

In Neutral

1. When steering spool (1) is in the neutral position, port A and port B of the steering cylinder are closed.
2. Pressure oil from the main pump does not flow to the steering cylinder because port P is closed.





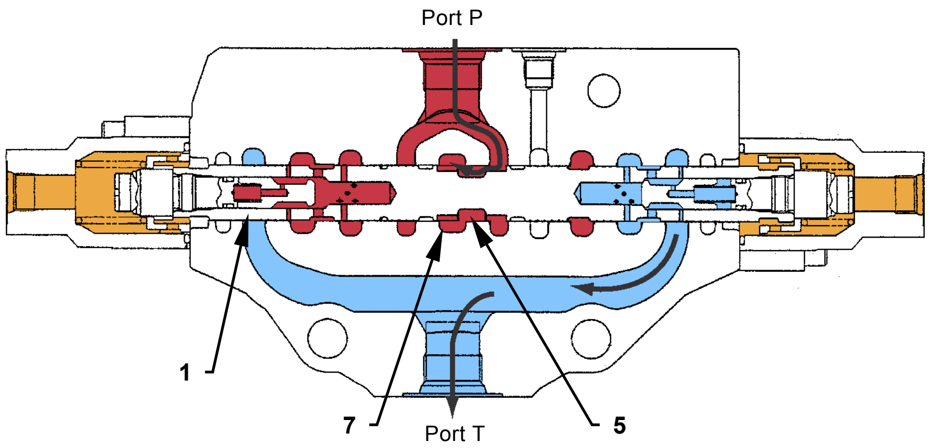
T4GB-03-04-004

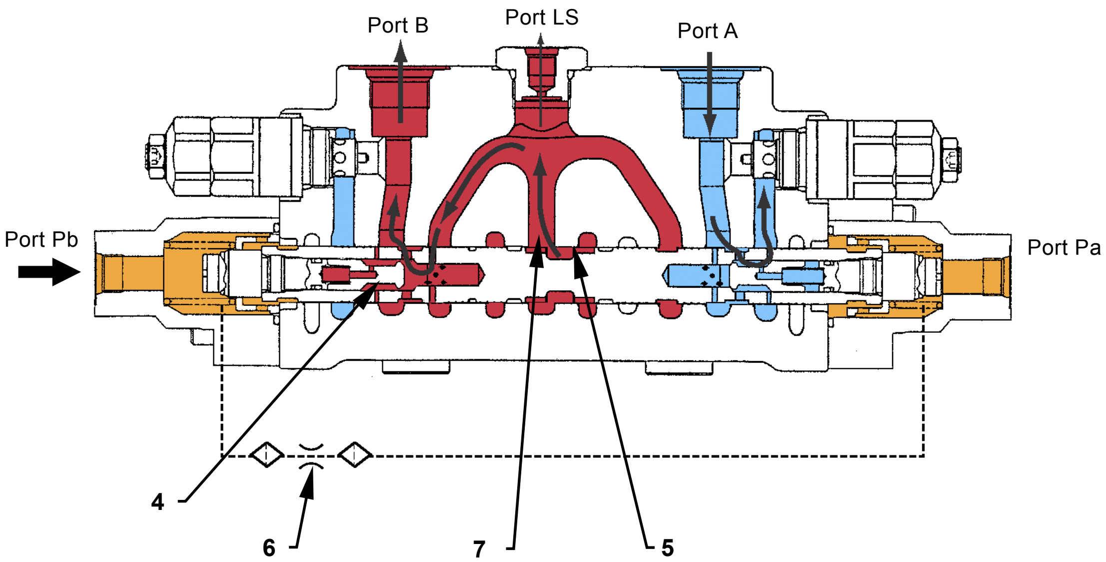
*: Refer to T3-5-1.

When Steering Left

1. When the steering handle is turned left, the pilot pressure oil is sent to port Pb from the steering pilot valve, and spool (1) moves right.
2. Pressure oil from the main pump is sent to the steering valve through port P, and further sent to passage A (7) through variable orifice (5).
3. Pressure oil in passage A (7) pushes and opens load check valve (4), and flows to the steering cylinder through port B.
4. And the return oil from the steering cylinder enters spool (1) through port A, and returns to the hydraulic oil tank through port T.
5. Also, the pilot pressure oil flowing into port Pb pushes spool (1) on port Pb end, while flowing to port Pa after being decompressed by fixed orifice (6). This reduces the shock caused by fast operation of the handle. (Refer to T3-5-2 and also Steering Curcuit in the SYSTEM / Hydraulic System)

NOTE: Opening area of the variable orifice (5) is proportional to the amount of stroke of the spool (1) due to the pilot pressure from the steering pilot valve. (Refer to the Steering Curcuit in the SYSTEM / Hydraulic System)





T4GB-03-04-005

STEERING OVERLOAD RELIEF VALVE

Steering overload relief valve is installed in the left and right steering circuits. Overload relief valve controls pressure in the respective steering circuits from rising abnormally high when the steering cylinder is moved by an external force.

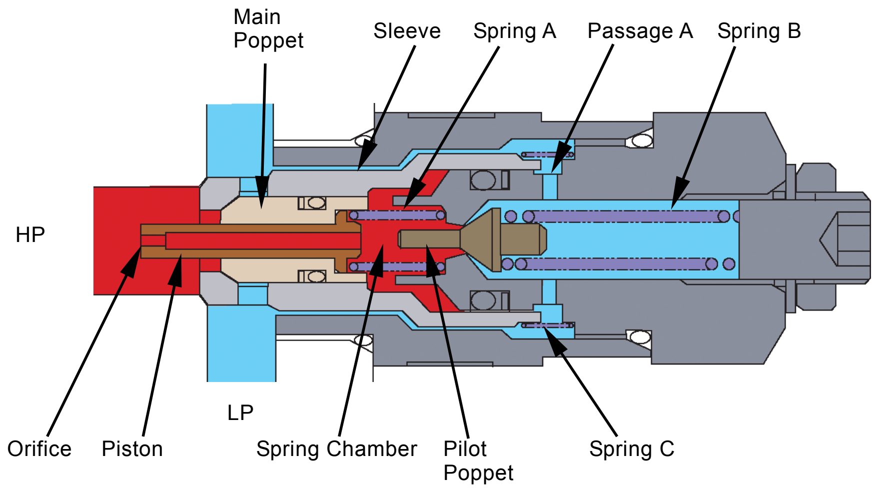
Operation of Relief Valve

1. Pressure at port HP (in the steering circuit) works on the pilot poppet, passing the orifice in the piston.
2. When the pressure at port HP rises to the setting force of spring B, the pilot poppet opens, and pressure oil flows to port LP (in the hydraulic oil tank), passing passage A and the periphery of the sleeve.
3. At this moment, pressure difference arises between port HP and the spring chamber caused by the orifice.
4. When this pressure difference reaches the value corresponding to the set force of spring A, the piston and the main poppet open, and the pressure oil at port HP flows to port LP.
5. As a result, the pressure in the steering cylinder circuit lowers.
6. If the steering cylinder circuit pressure lowers to the set pressure value, the piston and the main poppet are closed by the force of spring A.

Make-up Operation

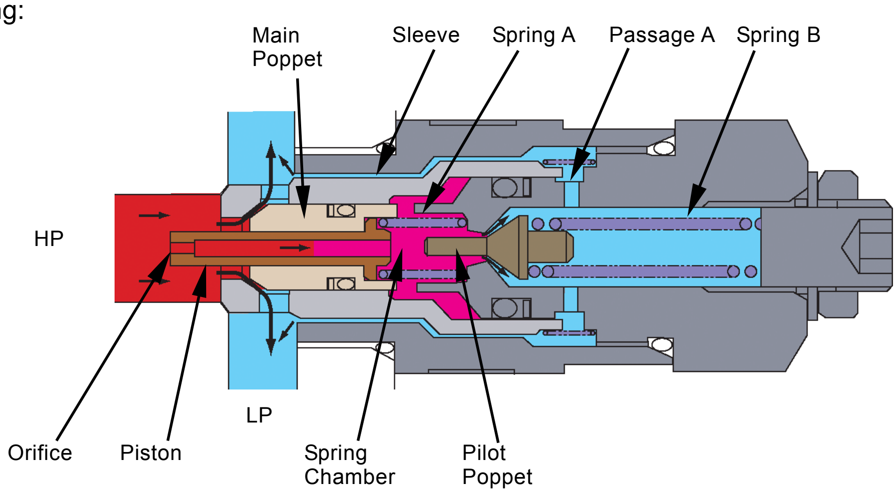
1. When the pressure at port HP (in the steering cylinder circuit) lowers than the pressure at port LP (in the hydraulic oil tank), the sleeve moves right.
2. Hydraulic oil flows into port HP, and cavitation is prevented.
3. If the pressure at port HP rises to the set pressure value, the sleeve is closed by the force of spring C.

Normally (When not Relieving):



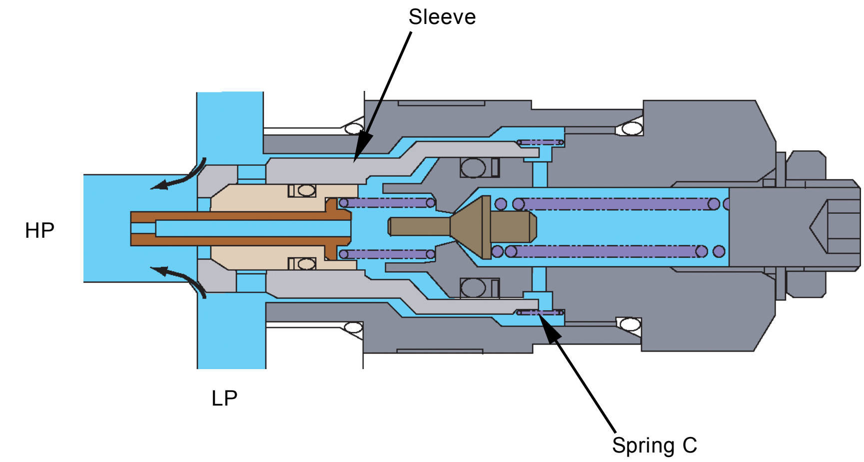
T4GB-03-02-030

When Relieving:



T4GB-03-02-031

In Make-up Operation:



T4GB-03-02-032

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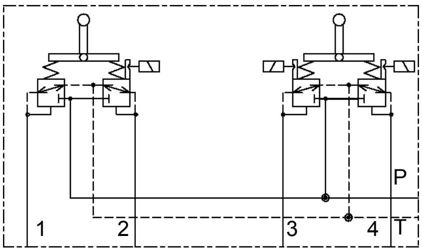
OUTLINE (TWO LEVER TYPE PILOT VALVE FOR FRONT ATTACHMENT)

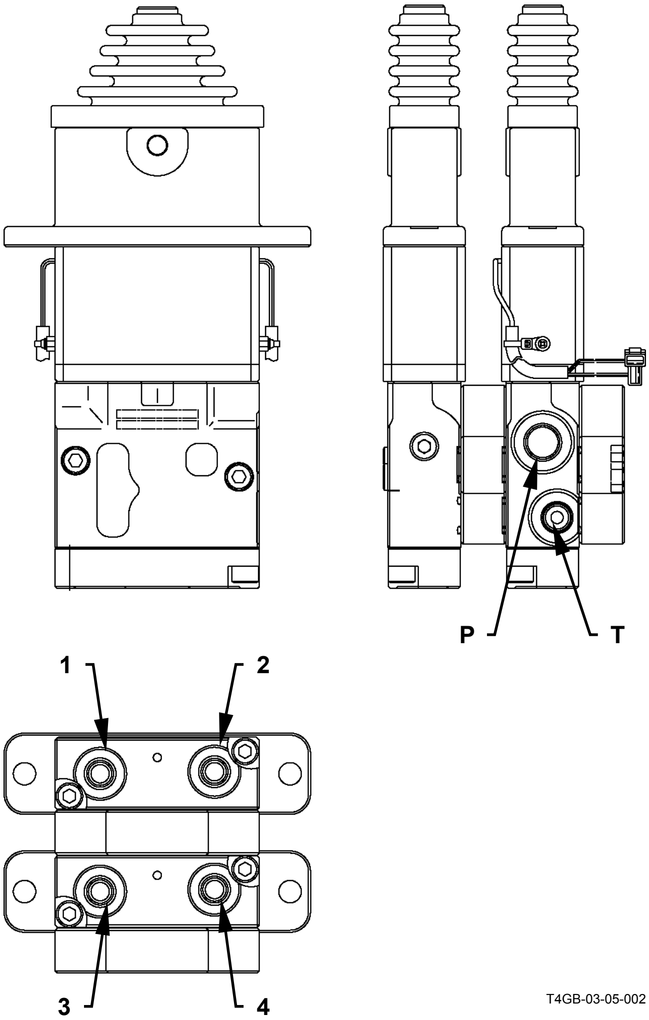
Pilot valve is a valve for controlling the pilot pressure oil for moving the spool of the control valve. Provided with the PPC (Pressure Proportional Control Valve) function, the pilot valve outputs pressure corresponding to the control lever stroke of the control lever, and moves the spool of the control valve.
The bi-directional, four-port type is adopted for the front-end attachment.

Port No.	
1	Bucket Crowd
2	Bucket Tilting Out
3	Lift Arm Lower
4	Lift Arm Raise

Hydraulic Symbol



T4GB-03-05-001



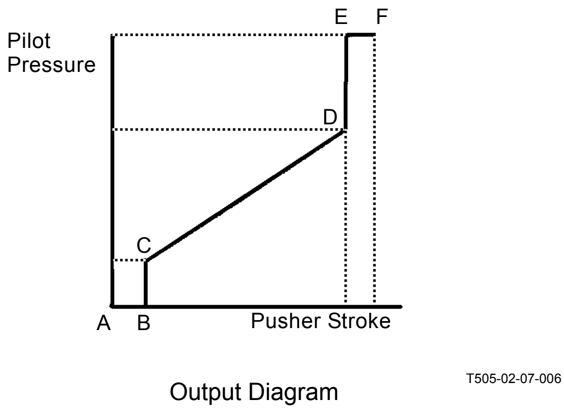
T4GB-03-05-002

OPERATION

At Neutral (between A and B of Pusher Stroke)

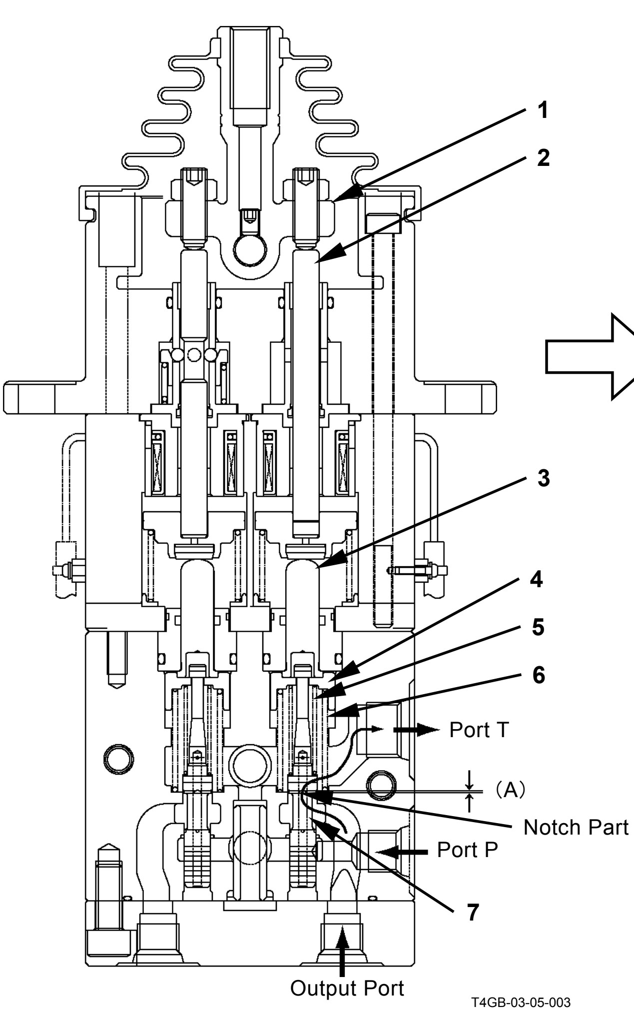
1. At the neutral position of the control lever, spool (7) is completely blocking the pressure oil of port P. Also, the outlet port is connected to port T through the notch part of spool (7), and the pressure oil at the output port is equal to the pressure in the hydraulic tank.
2. When the control lever is moved slightly, lever (1) is tilted, and push rod (2) and pusher (3) are pushed in. Pusher (3) and spring guide (4) remain mutually connected, and move downward, compressing return spring (6).
3. At this time, spool (7) is pushed by balance spring (5), and moves downward until the clearance in Part A becomes zero.
4. During this movement, the output port remains connected with port T, and pressure oil is not supplied to the output port.

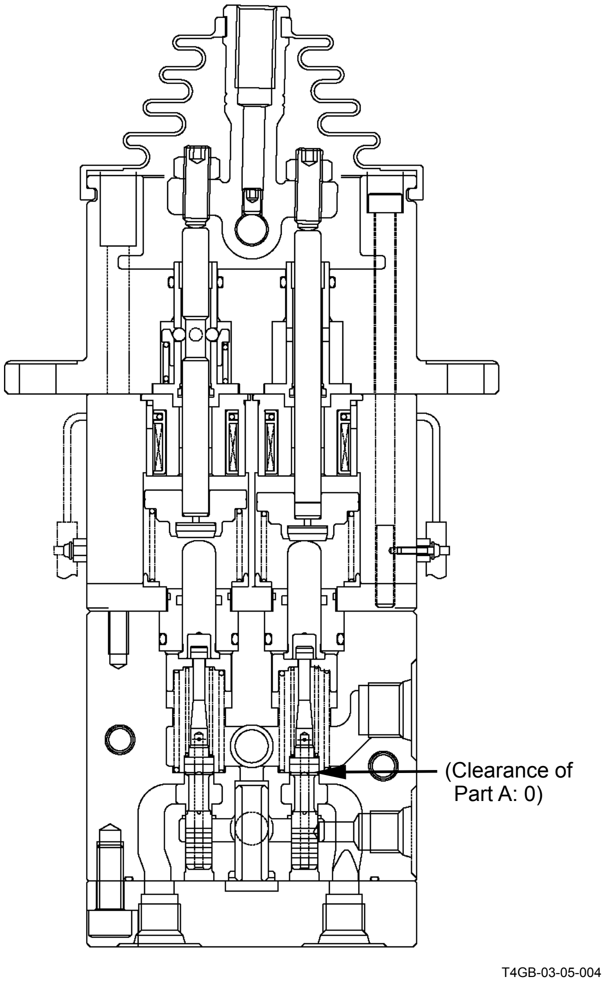
NOTE: Lever stroke during the period when the clearance (A) becomes zero is the play of the control lever.



Output Diagram

Pusher Stroke: between A and B





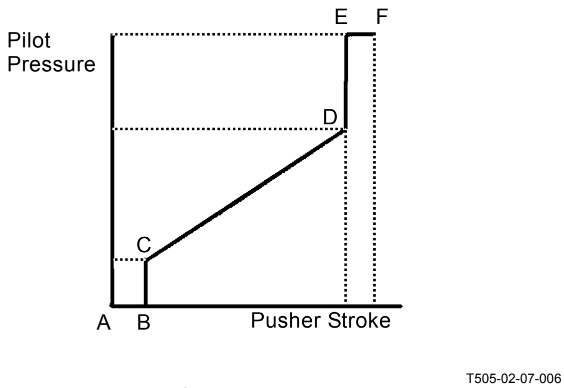
1 - Lever
2 - Push Rod
3 - Pusher
4 - Spring Guide
5 - Balance Spring
6 - Return Spring
7 - Spool

During Metering or Pressure Decrease (In Pusher Stroke between C and D)

1. When the control lever is further tilted, the ouput port is connected with port P through spool (7).
2. Pressure oil from Port P flows into the output port through spool (7), and the pressure at the output port is raised.
3. Pressure at the output port works on face B of spool (7), and tends to push up spool (7).
4. In case the force tending to push up the spool (7) is smaller than the spring force of balance spring (5), balance spring (5) is not compressed. Therefore, port P and the output port remain connected, and the pressure at the output port keeps rising.
5. When the pressure at the output port rises further, the force tending to push spool (7) up increases. If this force becomes larger than the force of balance spring (5), spool (7) moves upwards, compressing the balance spring (5).
6. When spool (7) moves upward, the output port is not connected any longer, and pressure oil stops flowing from port P to the output port.
   And pressure increase at the output port is stopped.
7. In this way, balance spring (5) is compressed by the amount spool (7) is pushed down, and the pressure at the output port is the balanced pressure working on the spring force and spool (7).

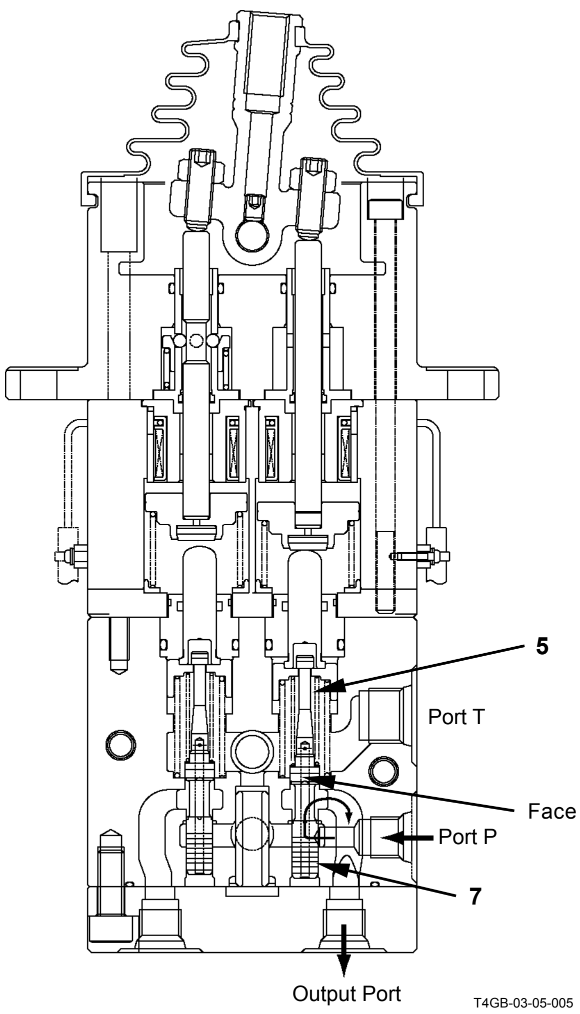
Full Stroke (Pusher Stroke between E and F)

1. When the control lever is fully stroked, pusher (3) moves downward until spring guide (4) contacts the shoulder part of the casing.
2. At this time, spool (7) is directly pushed by the bottom of pusher (3). Therefore, the output port remains connected with port P through the notch part of spool (7) because even if the pressure at the output port is raised, spool (7) does not move upward.
3. As a result, the pressure on the output port end is equal to the pressure at port P.
   Stroke amount C of the pusher determines the total stroke of the lever.

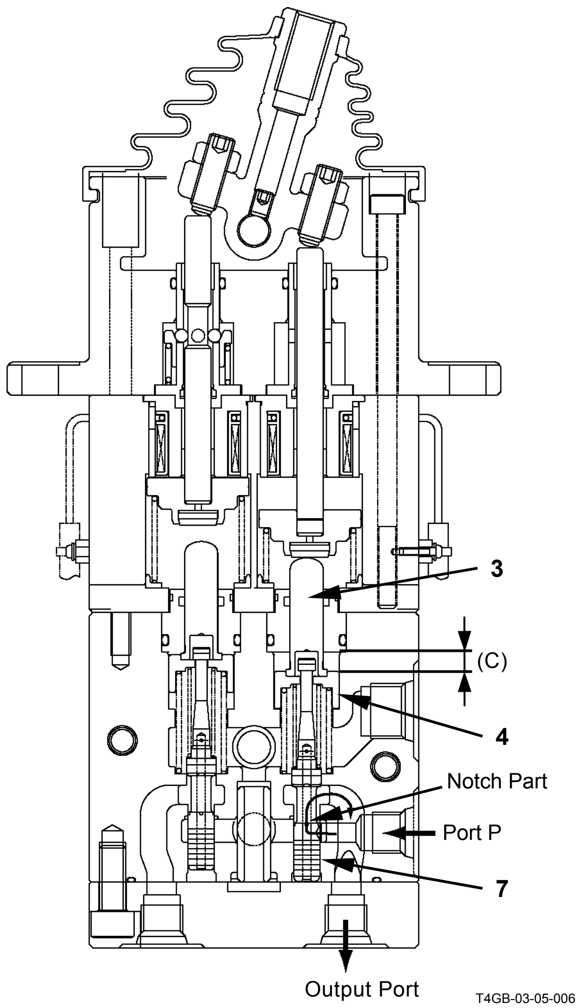


Output Diagram

Pusher Stroke: between C and D



Pusher Stroke: between E and F



3- Pusher

4 - Spring Guide

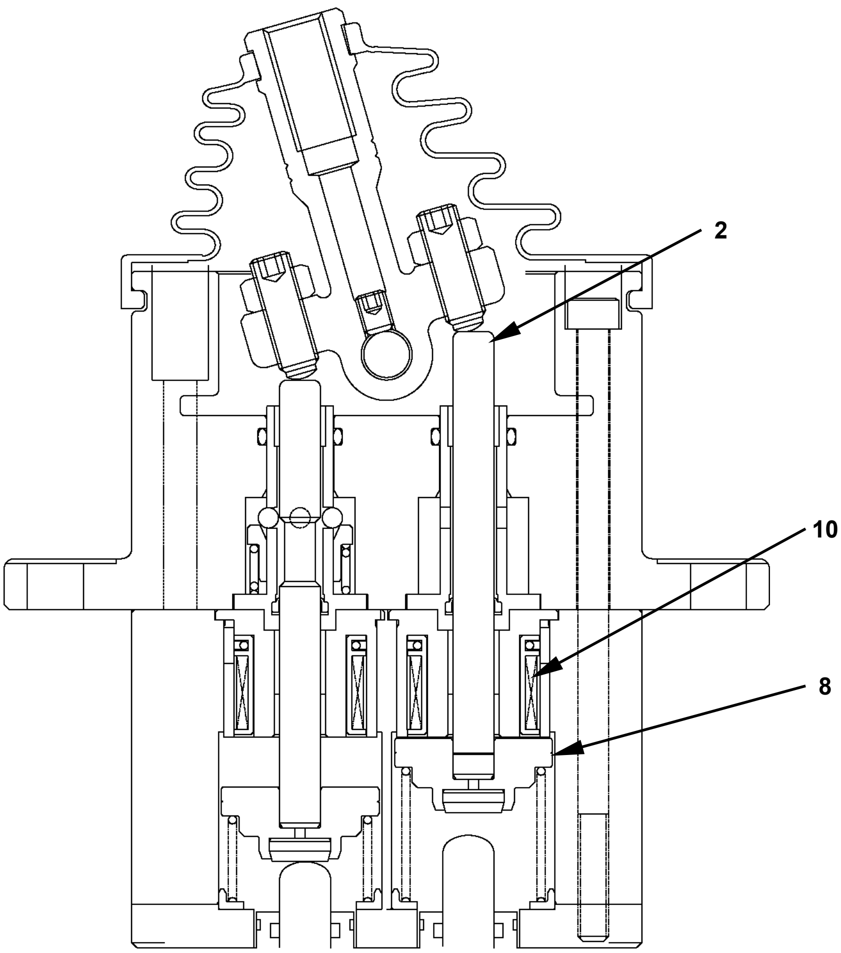
5 - Balance Spring

7 - Spool

Electromagnetic Detent

Coil for detent is installed at the push rod part of the pilot valve.

1. When one of the control levers is tilted, push rod (2) and plate (8) of the other are pushed upwards by the spring force.
2. If the control lever is operated until its stroke end, plate (8) of the other is adsorbed by coil assembly (10).
3. Adsorbed condition is retained until the coil assembly is unexcited or until adsorption is forcefully cancelled by moving the control lever the other way around.

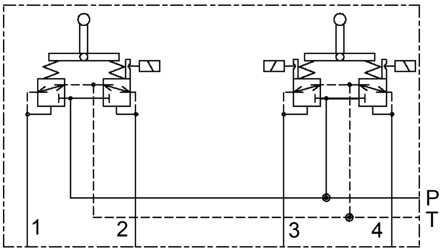


2 - Push Rod
8 - Plate
10 - Coil Assembly

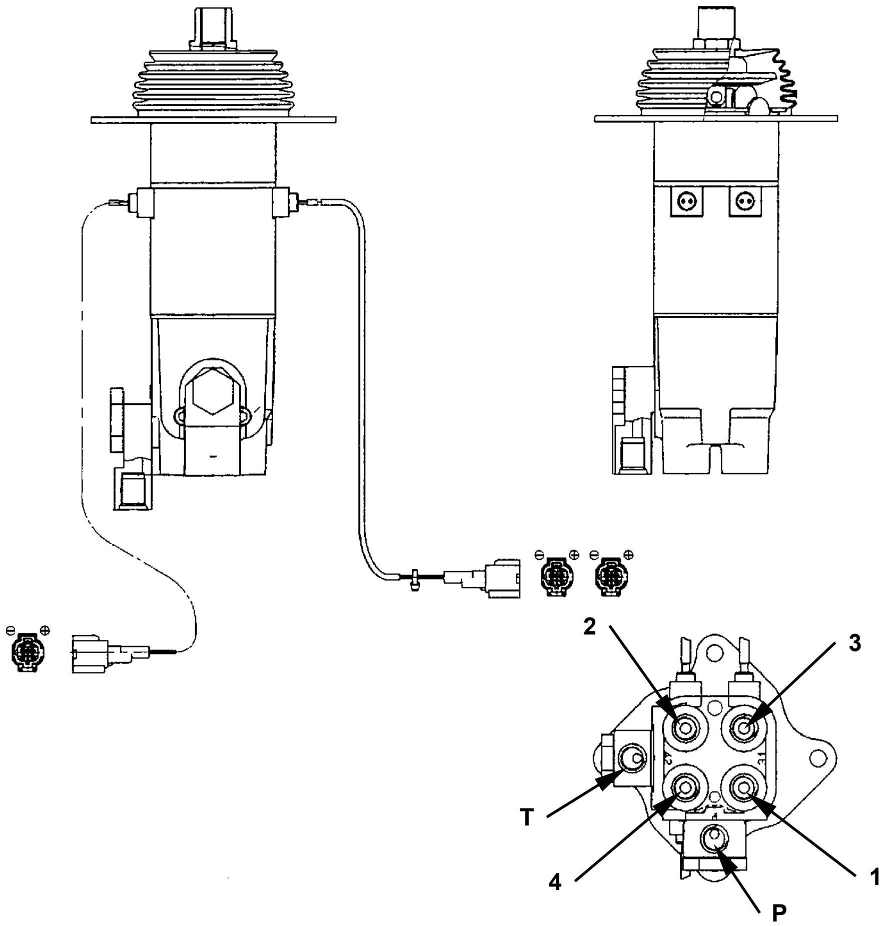
OUTLINE (JOYSTICK TYPE PILOT VALVE FOR FRONT ATTACHMENT)

Port No.	
1	Bucket Crowd
2	Bucket Tilting Out
3	Lift Arm Lower
4	Lift Arm Raise

Hydraulic Symbol



T4GB-03-05-001



T4GB-03-05-008

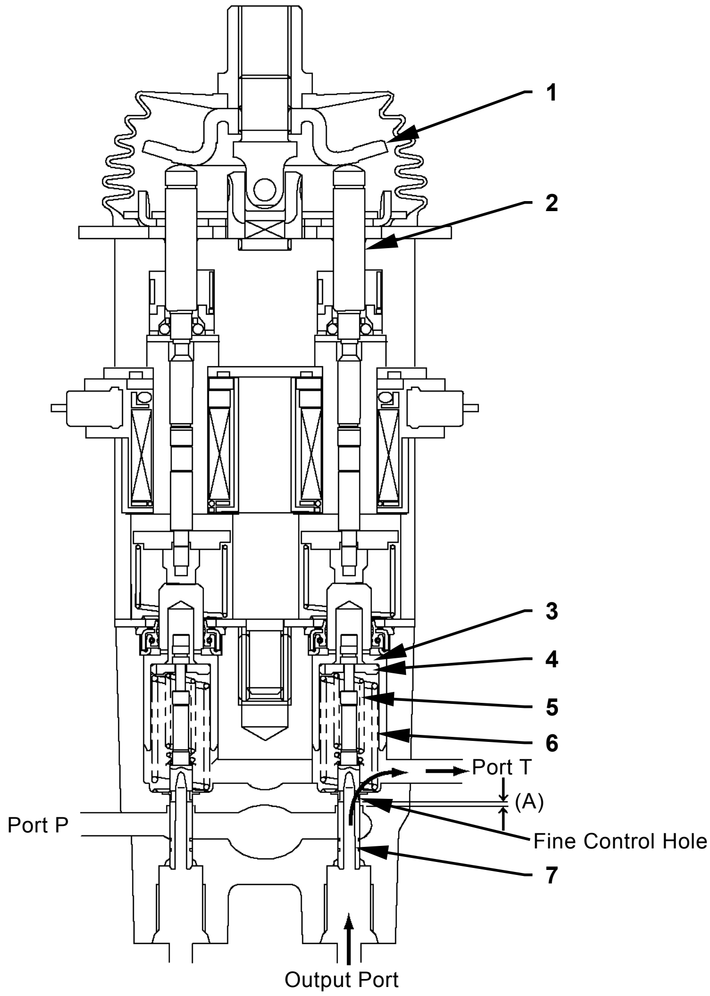
OPERATION

At Neutral

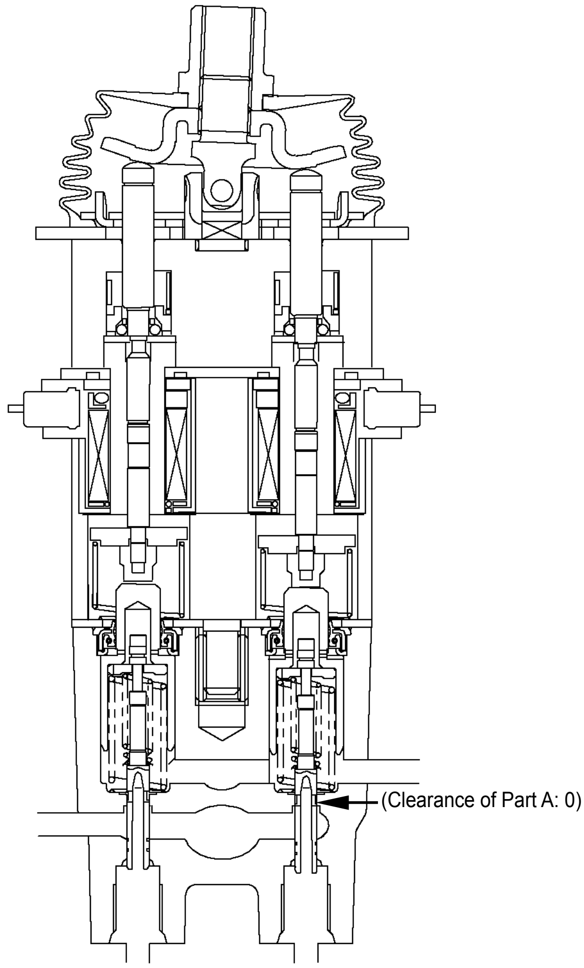
1. At neutral, spool (7) completely blocks the pressure oil at port P. Also, the output port is connected with port T through the fine control hole of spool (7).
   For this reason, the pressure at the output port is equal to the pressure at port T.
2. If the control lever is tilted slightly, disc (1) is tilted, and push rod (2) and piston (3) are pushed in. Piston (3) pushes down spring guide (4) and balance spring (5), and moves downward.
3. At this time, spool (7) is pushed by spring (5), and moves downward until the clearance at part A becomes zero.
4. During this movement, the output port remains connected with port T, and pressure oil is not supplied to the output port.

NOTE: Lever stroke during the period when the clearance (A) becomes zero is the play of the control lever.

At Neutral



T4GB-03-05-009



T4GB-03-05-010

1-	Disc	3 -	Piston	5 -	Balance Spring	7 -	Spool
2-	Push Rod	4 -	Spring Guide	6 -	Return Spring		

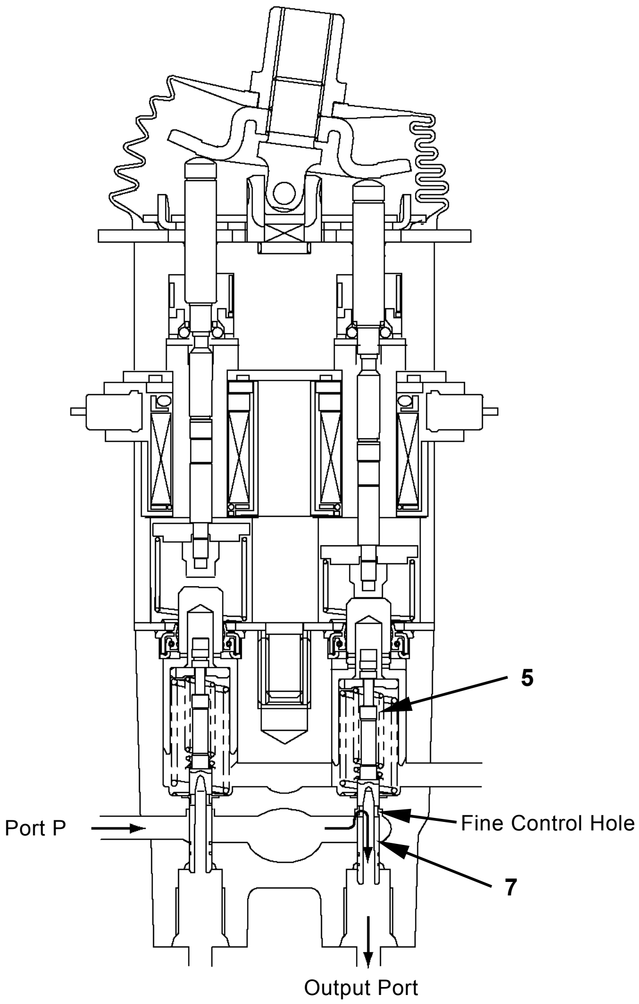
During Metering or Pressure Decrease

1. When the control lever is further tilted, the ouput port is connected with port P through the fine control hole of spool (7).
2. Pressure oil from port P flows into the output port through spool (7), and the pressure at the output port is raised.
3. Pressure at the output port works on spool (7), and tends to push up spool (7).
4. In case the force tending to push up spool (7) is smaller than the spring force of balance spring (5), balance spring (5) is not compressed. Therefore, port P and the output port remain connected, and the pressure at the output port keeps rising.
5. When the pressure at the output port rises further, the force tending to push spool (7) up increases. If this force becomes larger than the force of balance spring (5), spool (7) moves upwards, compressing the balance spring (5).
6. When spool (7) moves upward, the output port is not connected any longer, and pressure oil stops flowing from port P to the output port.
   And pressure increase at the output port is stopped.
7. In this way, balance spring (5) is compressed by the amount spool (7) is pushed down, and the pressure at the output port is the balanced pressure working on the spring force and spool (7).

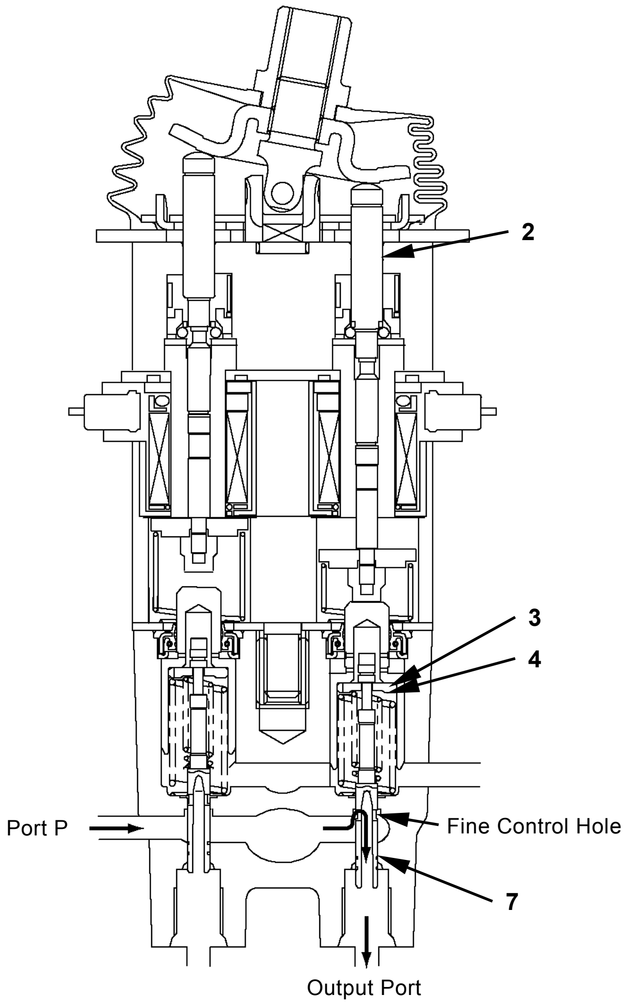
Full Stroke

1. When the control lever is fully stroked, disc (7) pushes down push rod (2) and piston (3), and spring guide (4) pushes down spool (7).
2. Output port is connected with port P through the fine control hole of spool (7).
3. Spool (7) is being pushed down by spring guide (4), and the output port remains connected through the fine control hole of spool (7) because even if the pressure at the output port is raised, spool (7) does not move upward.
4. As a result, the pressure on the output port end is equal to the pressure at Port P.

During Metering or Pressure Decrease



Full Stroke

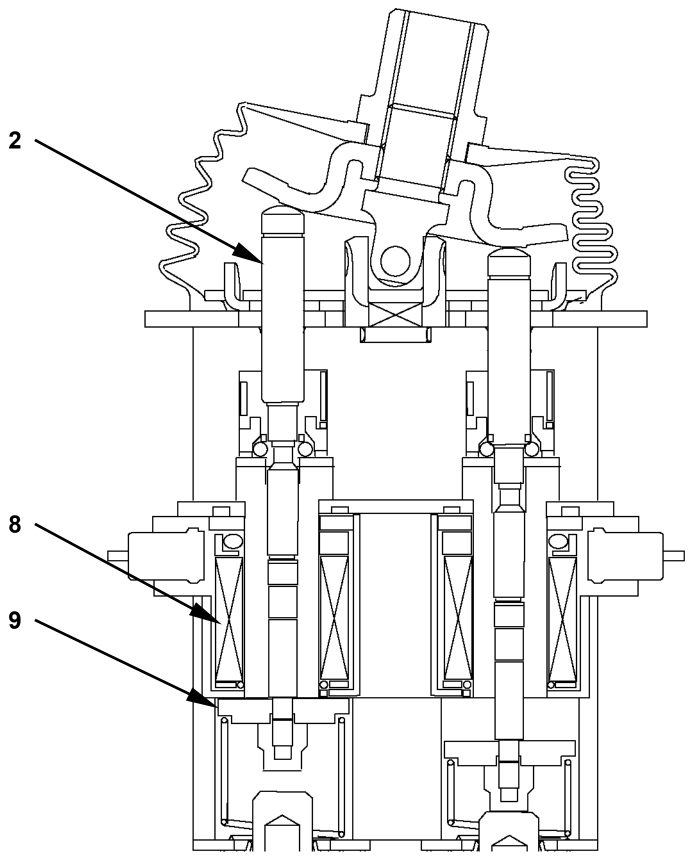


2 - Push Rod
3 - Piston
4 - Spring Guide
5 - Balance Spring
7 - Spool

ELECTROMAGNETIC DETENT

Coil for detent is installed at the push rod part of the pilot valve.

1. When one of the control levers is tilted, push rod (2) and plate (9) of the other are pushed upwards by the spring force.
2. If the control lever is operated until its stroke end, plate (9) of the other is adsorbed by coil assembly (8).
3. Adsorption condition is retained until coil assembly (8) is unexcited or until adsorption is forcefully cancelled by operating the control lever toward the other direction.



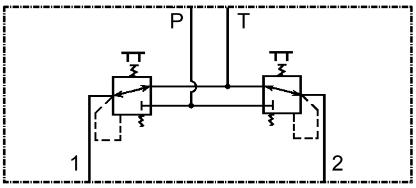
T4GB-03-05-013

2 - Push Rod   8 - Coil Assembly   9 - Plate

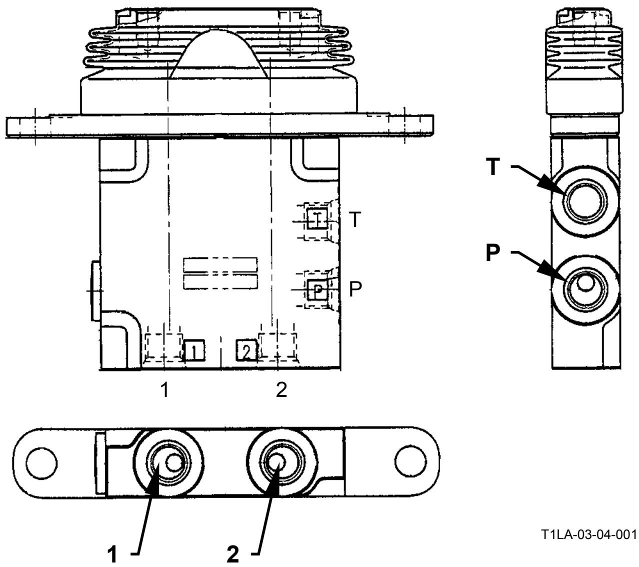
OUTLINE (LEVER TYPE PILOT VALVE FOR ADDITIONAL CIRCUIT) (OPTIONAL)

Port No.	
1	Optional
2	Optional

Hydraulic Symbol



T554-02-07-009



T1LA-03-04-001

OPERATION

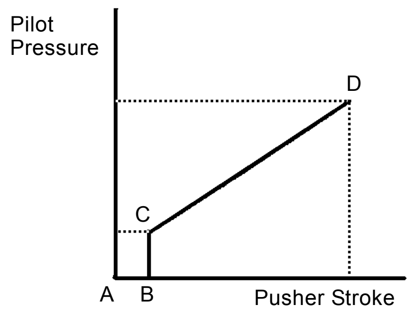
At Neutral (between A and B of Pusher Stroke)

1. At the neutral position of the control lever, spool (7) is completely blocking the pressure oil of port P. Also, the outlet port is connected to port T through the notch part of spool (7), and the pressure oil at the output port is equal to the pressure in the hydraulic tank.
2. When the control lever is moved slightly, cam (1) is tilted, and pusher (2) and spring guide (4) are pushed in. Pusher (3) and spring guide (4) move downward, remaining mutually connected, and compressing return spring (6).
3. At this time, spool (7) is pushed by balance spring (5), and moves downward until the clearance in Part A becomes zero.
4. During this movement, the output port remains connected with port T, and pressure oil is not supplied to the output port.

NOTE: Lever stroke during the period when Part A becomes zero is the play of the control lever.

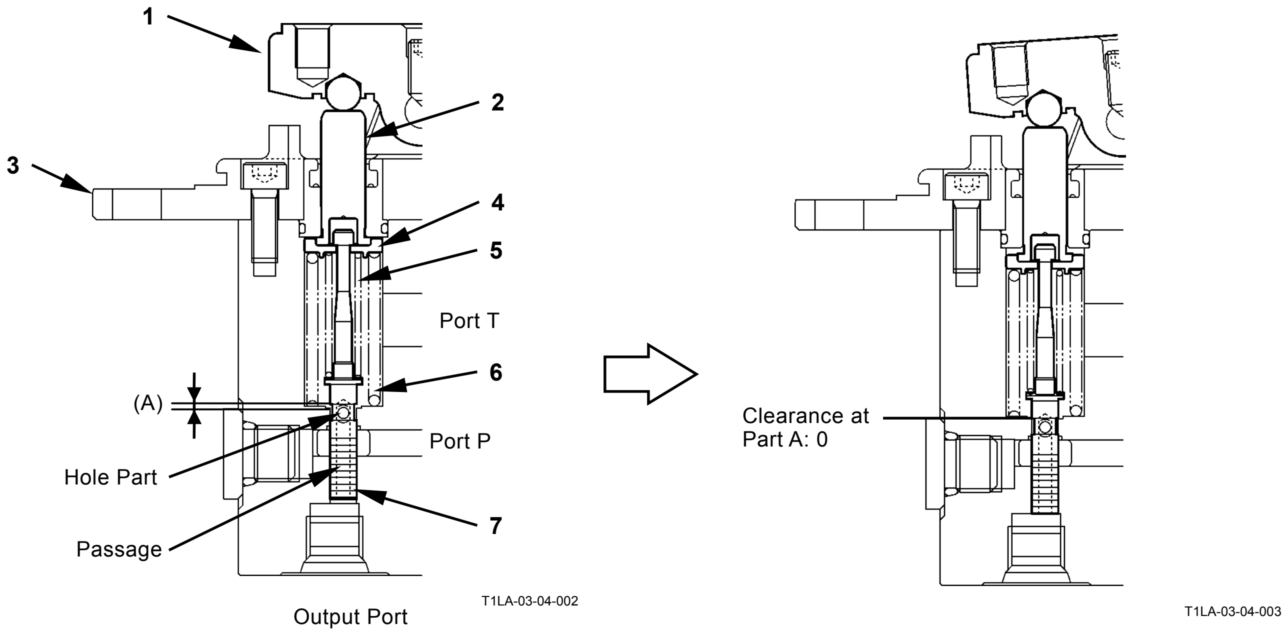
During Metering or Pressure Decrease (In Pusher Stroke between C and D)

1. When the control lever is further tilted, the hole part of spool (7) is connected with notch part (B).
2. Pressure oil from port P flows into the output port through notch part (B) and the hole part of spool (7), and the pressure at the output port is raised.
3. Pressure at the output port works on the bottom of spool (7), and tends to push up spool (7).
4. In case the force tending to push up spool (7) is smaller than the spring force of balance spring (5), balance spring (5) is not compressed. Therefore, port P and the output port remain connected, and the pressure at the output port keeps rising.
5. When the pressure at the output port rises further, the force tending to push spool (7) up increases. If this force becomes larger than the force of balance spring (5), spool (7) moves upwards, compressing balance spring (5).
6. When spool (7) moves upward, the notch part closes, and pressure oil stops flowing from port P to the output port. And pressure increase at the output port is stopped.
7. In this way, balance spring (5) is compressed by the amount the spool (7) is pushed down, and the pressure at the output port is the balanced pressure working on the spring force and spool (7).

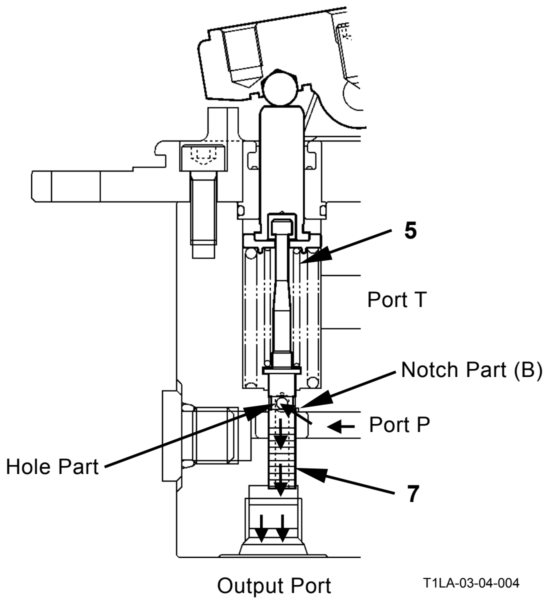


Output Diagram

Between A and B of Pusher Stroke



Between C and D of Pusher Stroke



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

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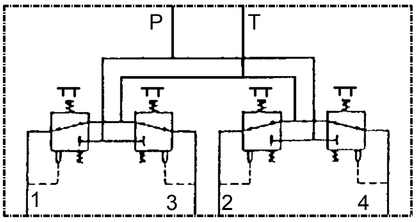
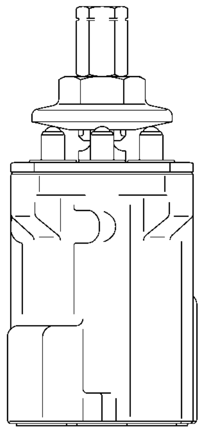
OUTLINE (JOYSTICK TYPE PILOT VALVE FOR ADDITIONAL CIRCUIT) (OPTIONAL)

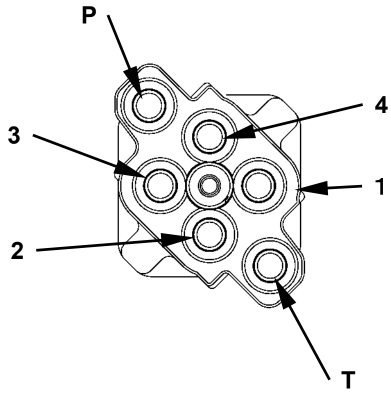
Port No.	
1	Optional
2	Optional
3	Optional
4	Optional

Hydraulic Symbol



T105-02-07-020





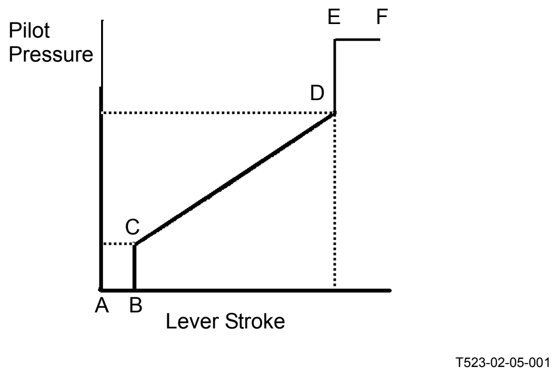
T1V1-03-04-001

OPERATION

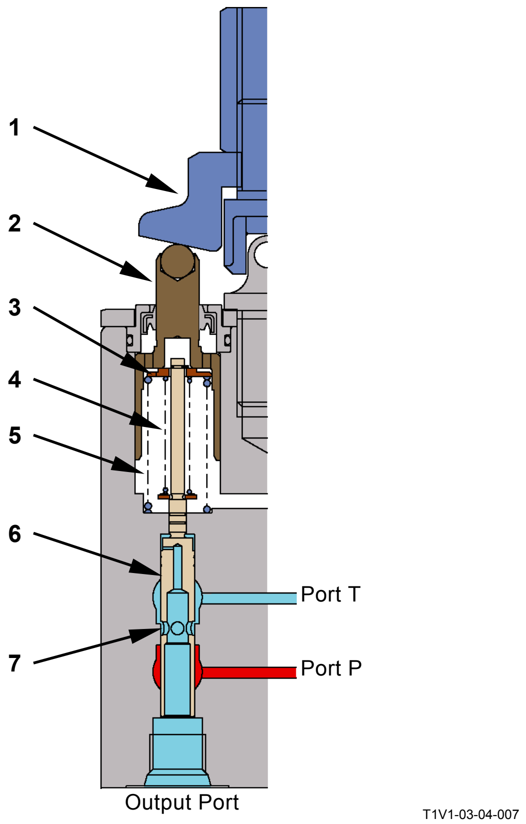
Head of spool (6) is hung by the top face of spring guide (3). Spring guide (3) is lifted up by return spring (5).

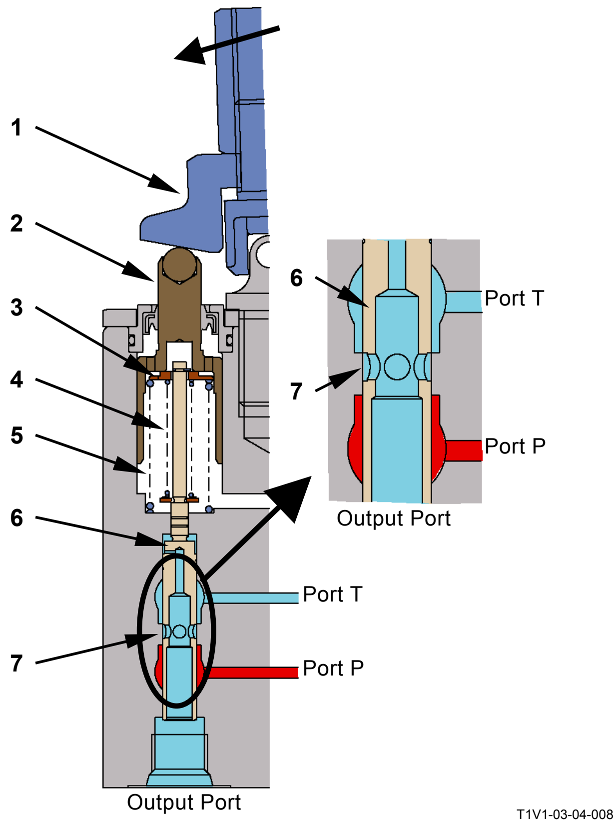
At Neutral (Output Diagram: between A and B):

1. At neutral, spool (6) completely blocks the pressure oil at port P (from the pilot pump). Also, the output port is connected with port T (to the hydraulic oil tank) through the internal passage of spool (6).
2. For this reason, the pressure at the output port (to the control valve) is equal to the pressure at Port T.
3. If the control lever is tilted slightly, cam (1) is tilted, and pusher (2) is pushed in. Pusher (2) and spring guide (3), mutually connected, push down return spring (5), and moves downward.
4. At this time, the pressures at the output port and port T are equal, so spool (6) moves downward with the bottom face of its head keeping contact with spring guide (3) by the force of balance spring (4).
5. This condition continues until hole part (7) of spool (6) is connected with port P.



Output Diagram

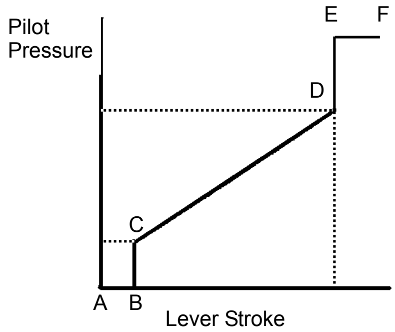




1 - Cam
2 - Pusher
3 - Spring Guide
4 - Balance Spring
5 - Return Spring
6 - Spool
7 - Hole Part

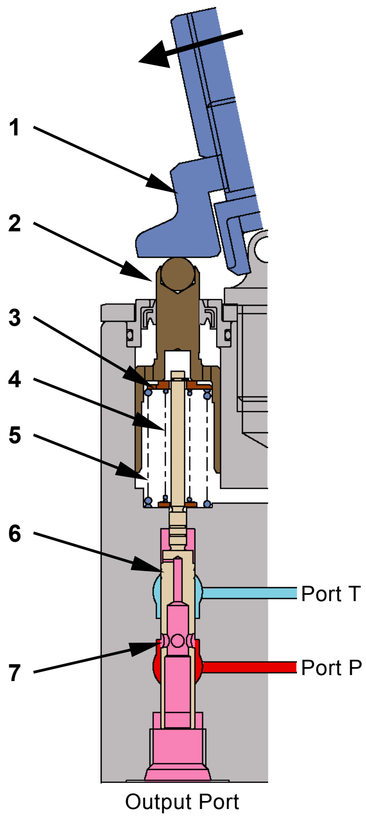
During Metering or Pressure Decrease (Output Diagram: between C and D)

1. When the control lever is further tilted and pusher (2) is pushed down, hole part (7) of spool (6) reaches port P, and the prsessure oil from port P flows into the output port.
2. Pressure at the output port works on the bottom of spool (6), and tends to push up spool (6).
3. In case the force working on spool (6) is smaller than the spring force of balance spring (4), balance spring (5) is not compressed. Therefore, spool (6) is not pushed up, and the pressure at the output port keeps rising.
4. When the pressure at the output port rises further, the force tending to push spool (6) up increases. If this force becomes larger than the force of the balance spring (4), spool (6) moves upwards, compressing the balance spring (4).
5. When spool (6) moves upward, hole part (7) closes, pressure oil stops flowing from Port P to the output port, and pressure increase at the output port is stopped.
6. In this way, the balance spring (4) is compressed by the amount spool (6) is pushed down, and the pressure at the output port is the balanced pressure working on the spring force and spool (6).

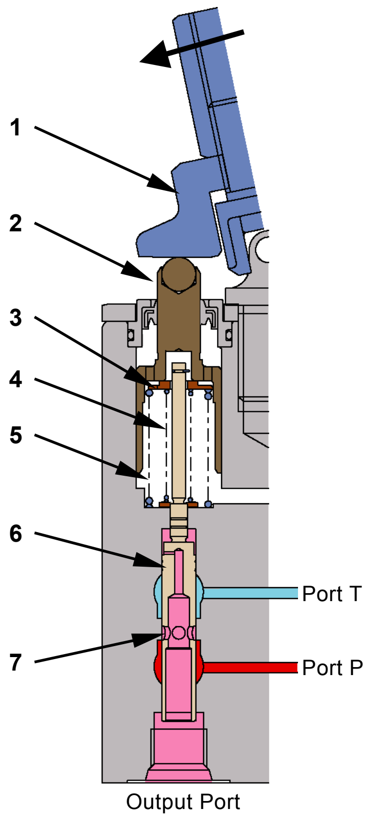


T523-02-05-001

Output Diagram



T1V1-03-04-009



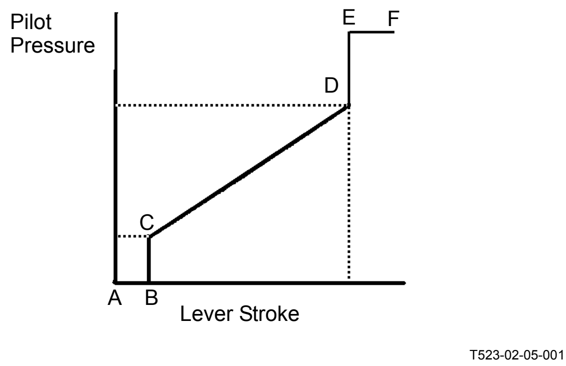
T1V1-03-04-010

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

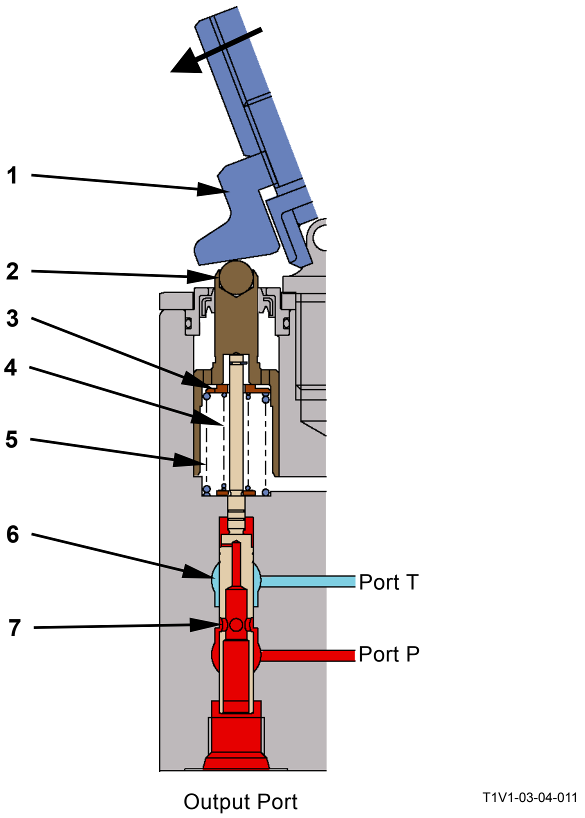
Full Stroke (Output Diagram: between E and F)

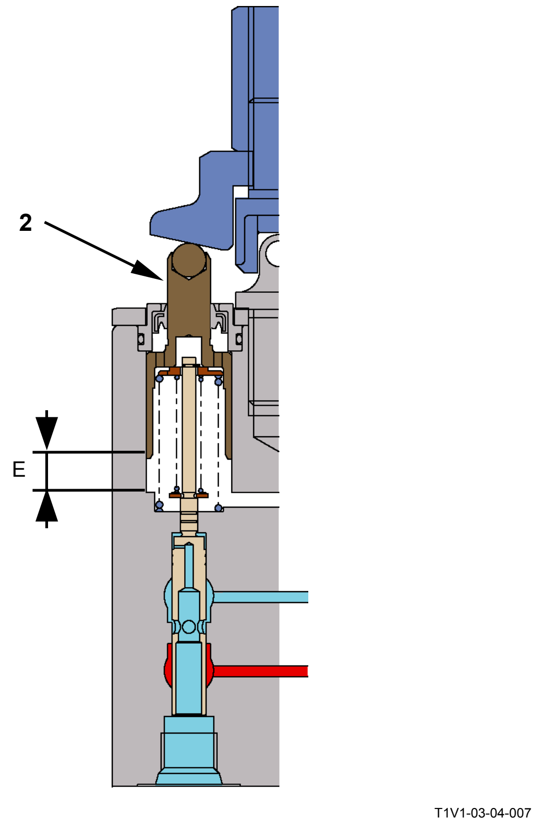
1. When the control lever is fully stroked, pusher (2) moves downward until it contacts the shoulder part of the casing.
2. At this time, spool (6) is directly pushed by the bottom of the pusher (2). Therefore, even if the pressure at the output port is raised, hole part (7) of spool (6) is not closed.
3. As a result, the pressure on the output port end is equal to the pressure at port P.

NOTE: Stroke amount E of the pusher (2) determines the total stroke of the lever.



Output Diagram



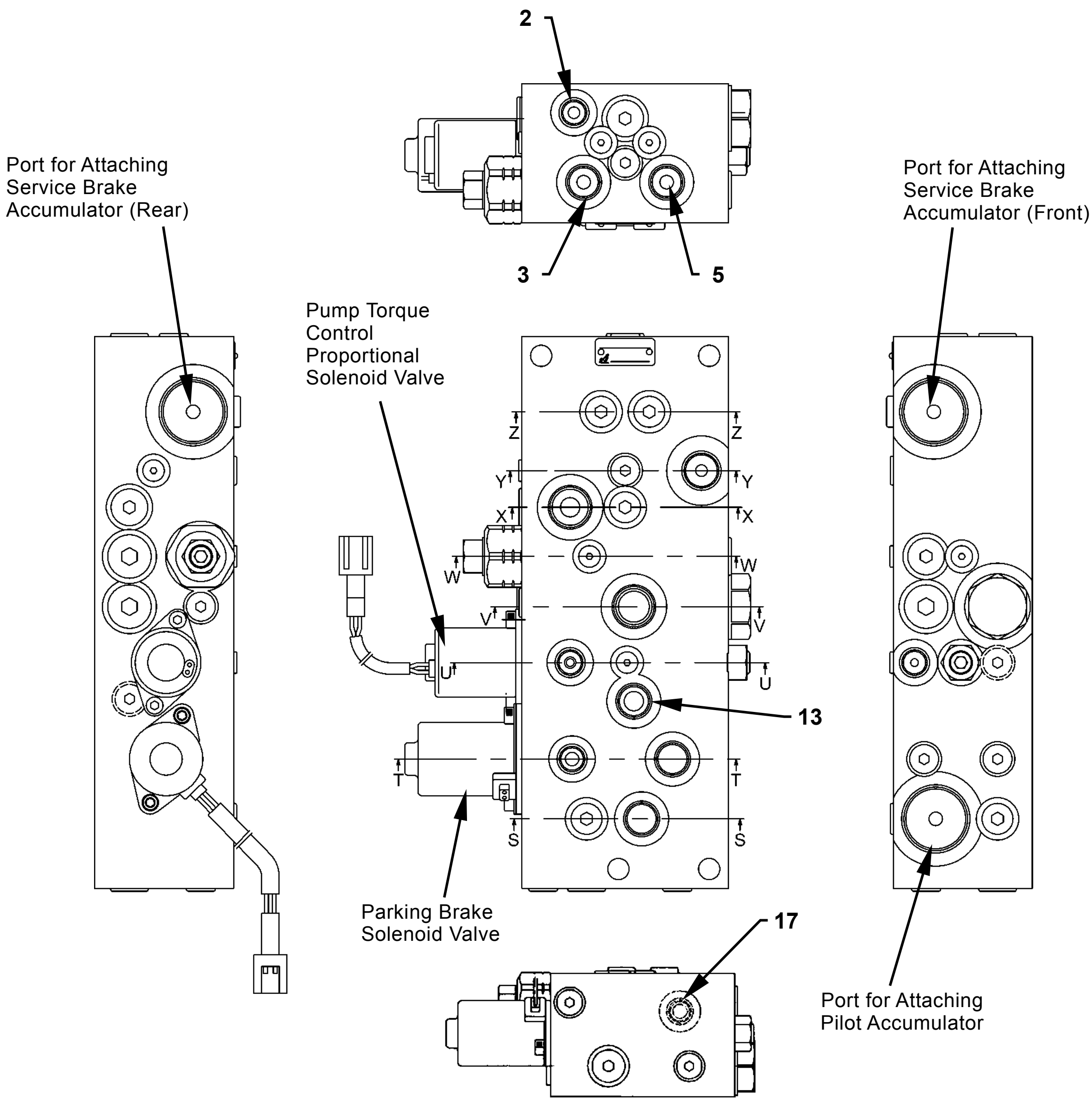


1 - Cam
2 - Pusher
3 - Spring Guide
4 - Balance Spring
5 - Return Spring
6 - Spool
7 - Hole Part

(Blank)

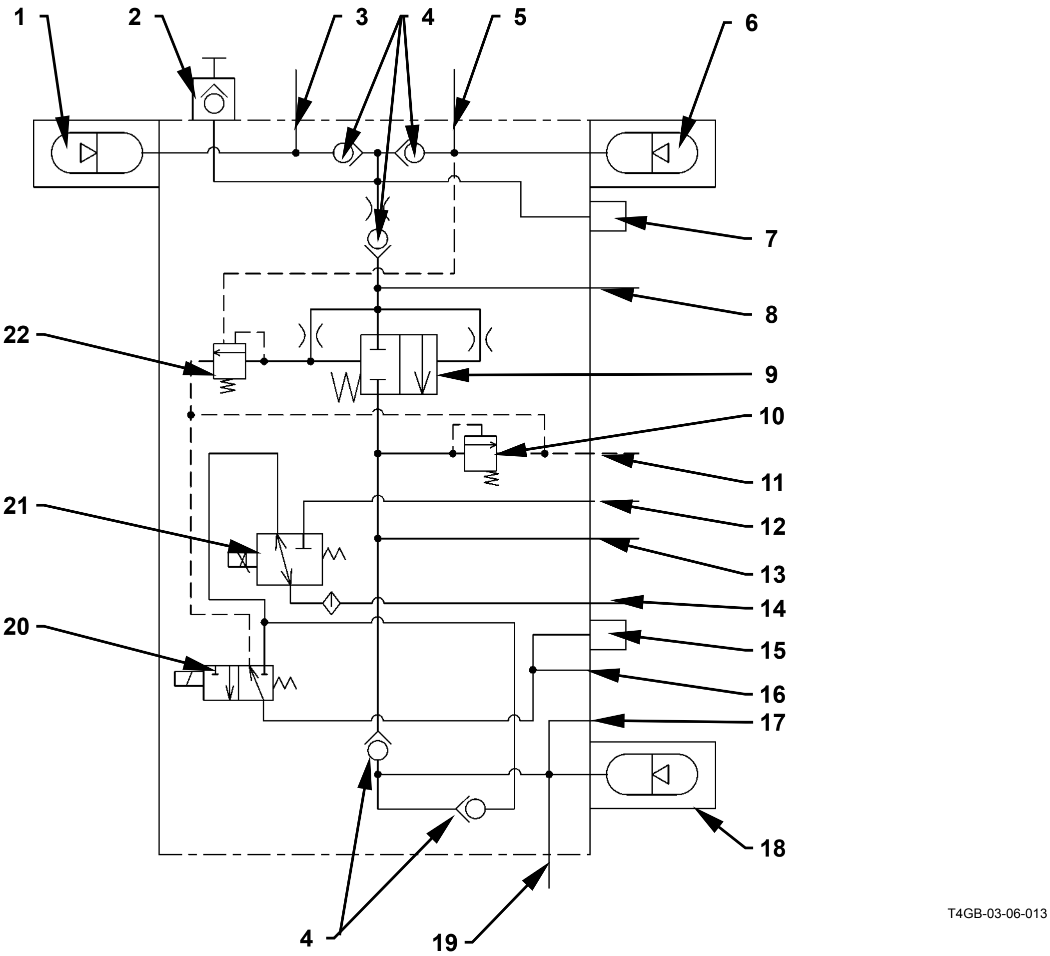
OUTLINE

Charging block is installed for supplying the pressure oil from the pilot pump not only to the service brake accumulator and the brake valve by giving them priority, but also to the parking brake, the steering pilot valve, and others.
Charging block consists of the priority valve, relief valve, pump torque control proportional solenoid valve, pilot relief valve, check valve, and others.

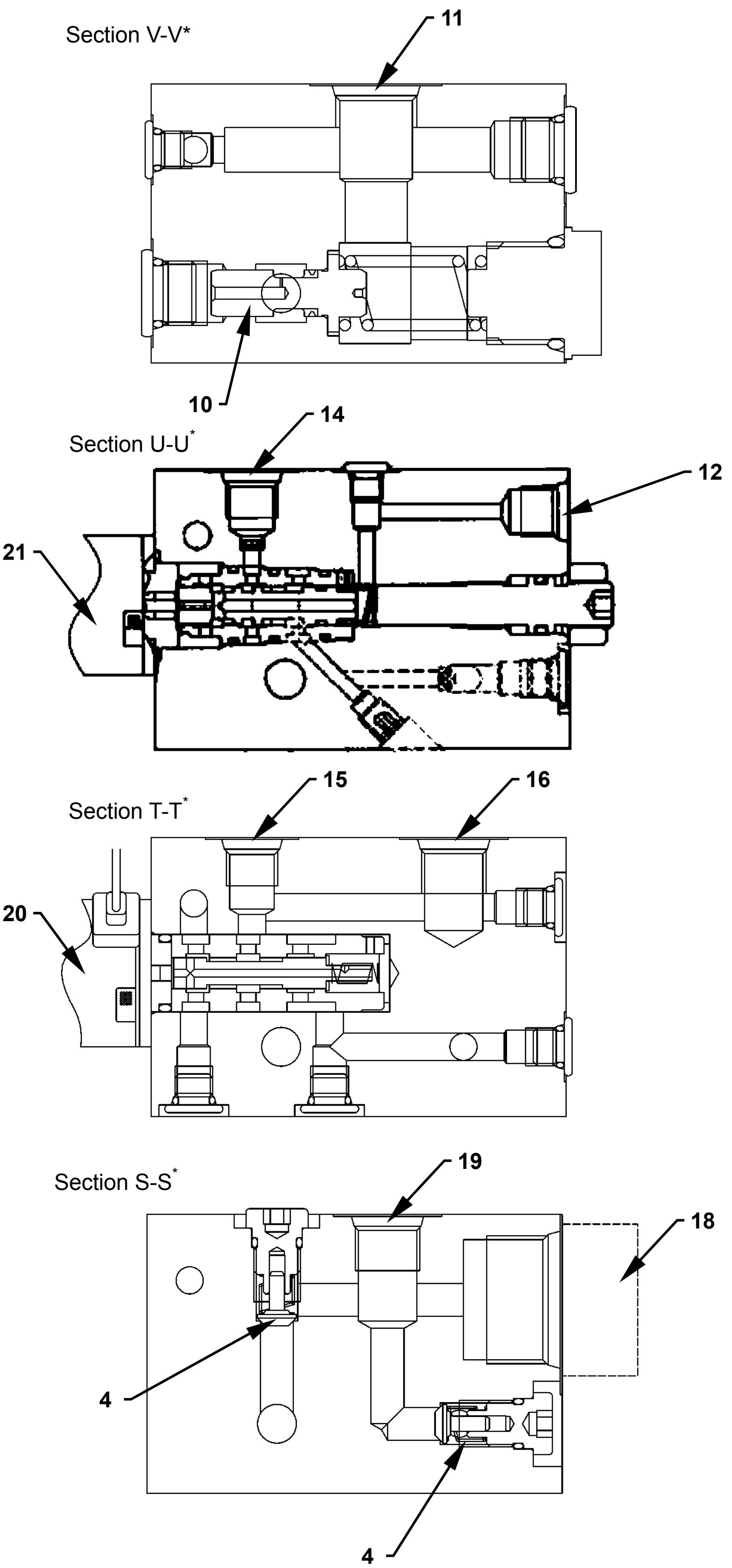


T4GB-03-06-001

Component Layout



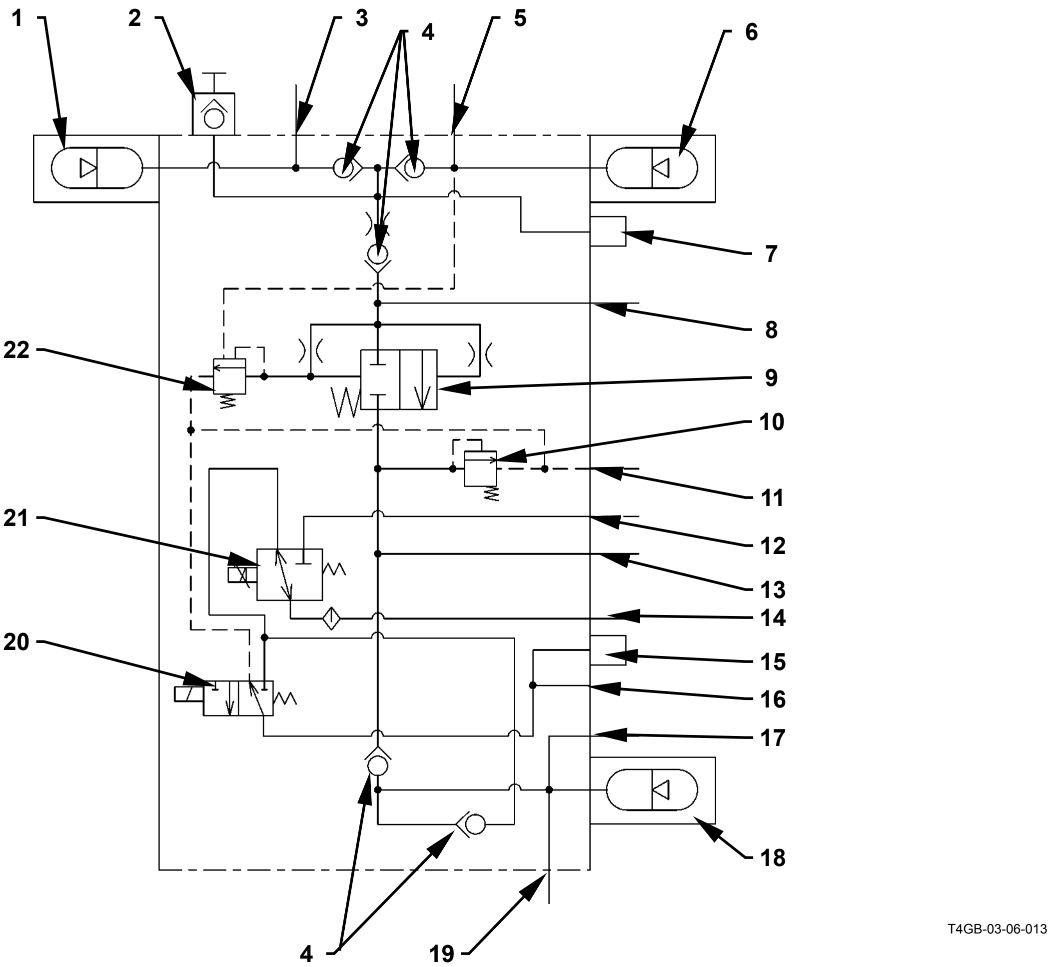
1 - Service Brake Accumulator (Rear)
2 - Adaptor
3 - Port M2 (To Rear End of Brake Valve)
4 - Check Valve
5 - Port M1 (To Front End of Brake Valve)
6 - Service Brake Accumulator (Front)
7 - Service Brake Pressure Sensor
8 - Port P (from Pilot Pump)
9 - Priority Valve
10 - Pilot Relief Valve
11 - Port DR (To Hydraulic Oil Tank)
12 - Port DR2(To Hydraulic Oil Tank)
13 - Port PS1 (To Steering Pilot Valve)
14 - Port X（To Main Pump Regulator）
15 - Parking Brake Pressure Sensor
16 - Port BR3（To Parking Brake）
17 - Port PS2 (To Main Pump Regulator and Ride Control Valve (Optional))
18 - Pilot Accumulator
19 - Port PP（To Pilot Shutoff Valve）
20 - Parking Brake Solenoid Valve
21 - Pump Torque Control Proportional Solenoid Valve
22 - Relief Valve



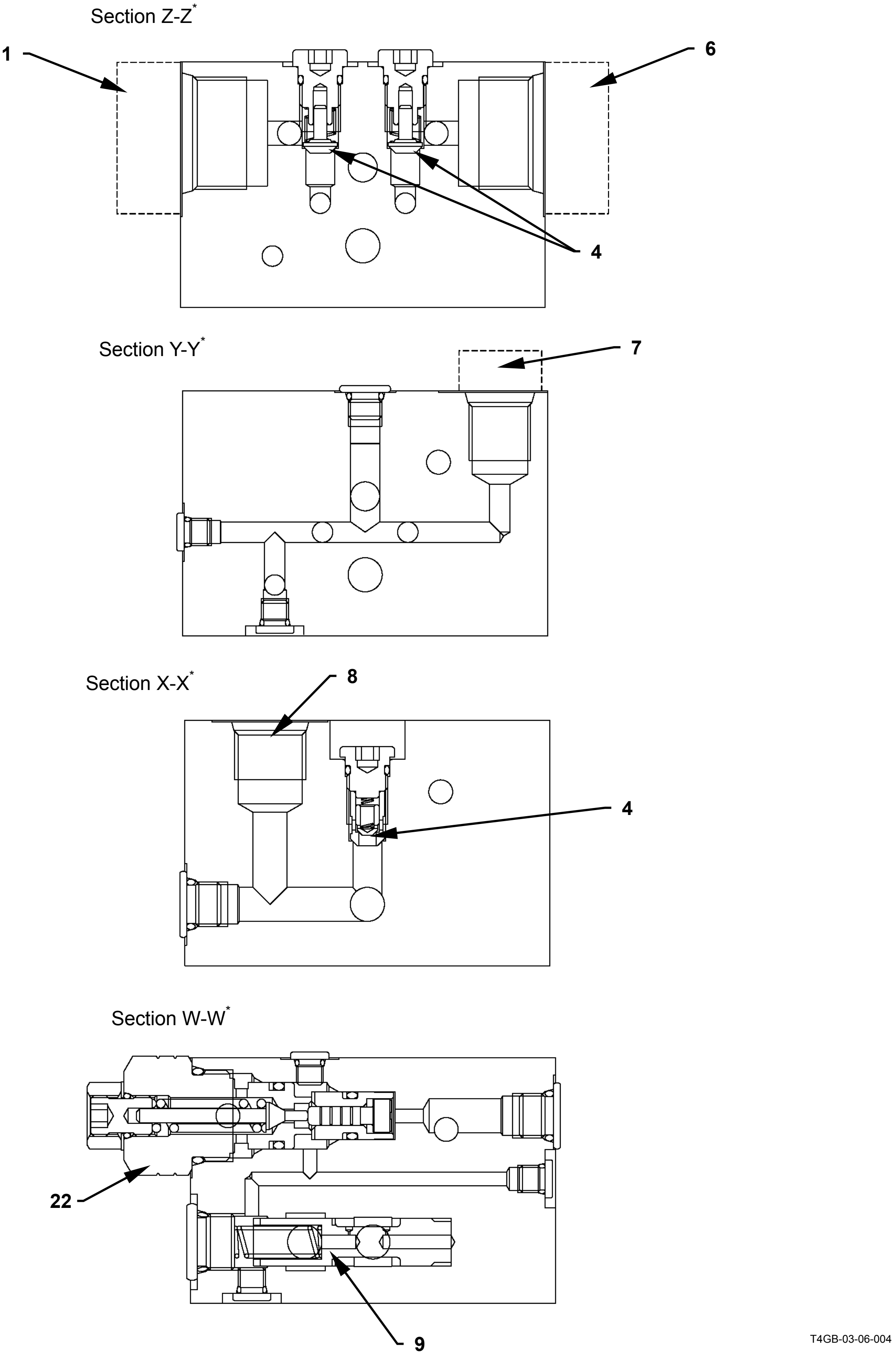
T4GB-03-06-003

*Refer to T3-7-1.

Layout Drawing



1 - Service Brake Accumulator (Rear)
2 - Adaptor
3 - Port M2 (To Rear End of Brake Valve)
4 - Check Valve
5 - Port M1 (To Front End of Brake Valve)
6 - Service Brake Accumulator (Front)
7 - Service Brake Pressure Sensor
8 - Port P (From Pilot Pump)
9 - Priority Valve
10 - Pilot Relief Valve
11 - Port DR (To Hydraulic Oil Tank)
12 - Port DR2 (To Hydraulic Oil Tank)
13 - Port PS1 (To Steering Pilot Valve)
14 - Port X (To Main Pump Regulator)
15 - Parking Brake Pressure Sensor
16 - Port BR3 (To Parking Brake)
17 - Port PS2 (To Main Pump Regulator and Ride Control Valve (Optional))
18 - Pilot Accumulator
19 - Port PP (To Pilot Shutoff Valve)
20 - Parking Brake Solenoid Valve
21 - Pump Torque Control Proportional Solenoid Valve
22 - Relief Valve

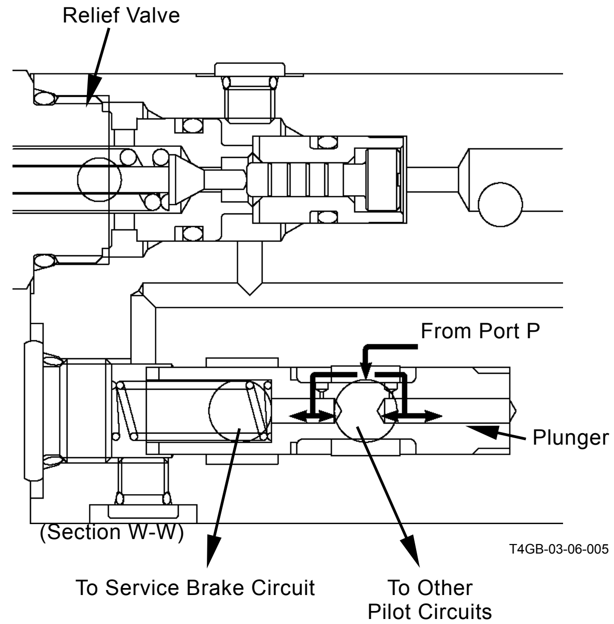


*Refer to T3-7-1.

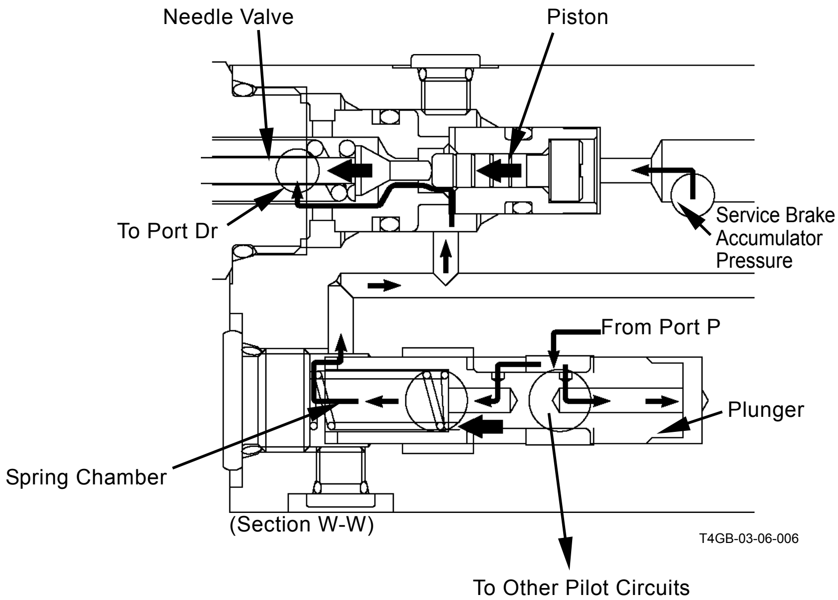
PRIORITY VALVE (REFER TO THE PILOT CURCUIT IN THE SYSTEM / HYDRAULIC SYSTEM)

1. Pressure oil from the pilot pump flows in through port P, and works on the both ends of the plunger of the priority valve.
2. Same pressure is applied to the both ends of the plunger, so the plunger does not move, and a restricted amount of pressure oil is supplied to the other pilot circuits.
3. When the service brake accumulator is accumulated exceeding the set pressure, the piston of the relief valve pushes the needle valve.
4. Pressure oil in the spring chamber of the plunger flows to the hydraulic oil tank through port DR.
5. Plunger is pushed toward the spring chamber to stroke because the spring chamber is decompressed.
6. A larger amount of the pressure oil from the pilot pump is supplied to the other pilot circuits through the priority valve.

Below Set Pressure of Service Brake Accumulator



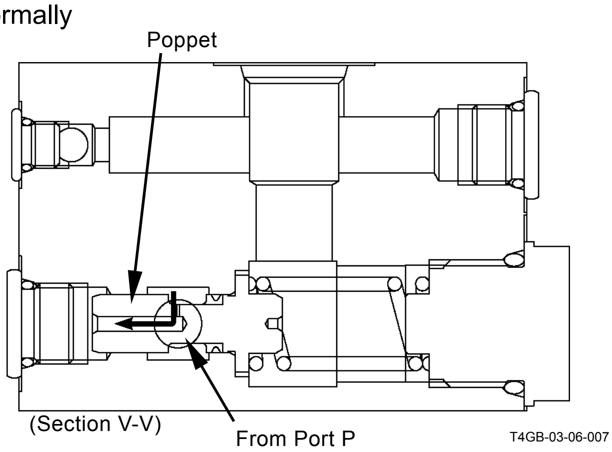
Above Set Pressure of Service Brake Accumulator



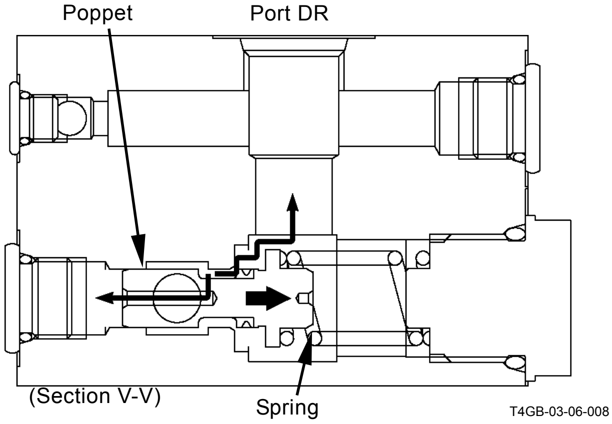
PILOT RELIEF VALVE

1. Pilot relief valve prevents the pressure in the pilot circuit from increasing over the set pressure during operations of the actuators like the pilot valve.
2. When the pilot circuit pressure is above the set pressure, pressure oil works on the poppet of the pilot relief valve.
3. Poppet works toward the spring to be connected with port DR.
4. Pressure oil in the pilot circuit returns to the hydraulic oil tank through port DR.
5. When the pilot circuit pressure is below the set pressure to the spring force, the poppet moves left, closing connection of port DR.

Normally



When Relieving

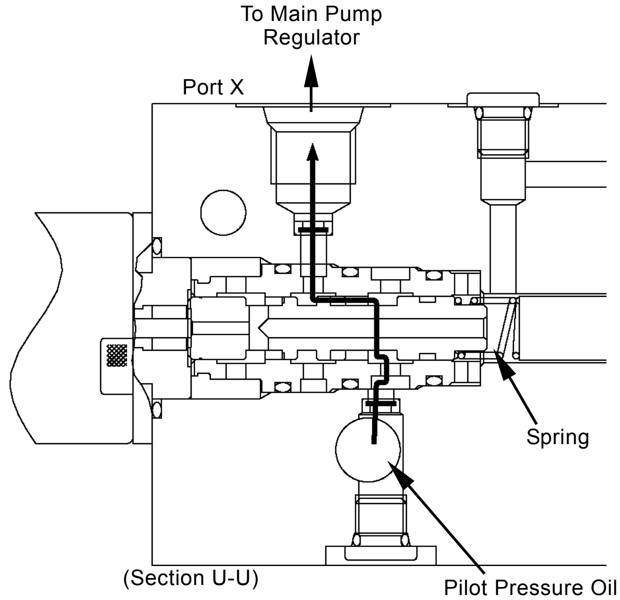


PUMP TORQUE CONTROL PROPORTIONAL SOLENOID VALVE (REFER TO THE PILOT CURCUIT IN THE SYSTEM / HYDRAULIC SYSTEM)

Pilot pressure supplied to the main pump regulator for controlling the pump delivery flow is controlled by the operation of the pump torque control proportional solenoid valve.

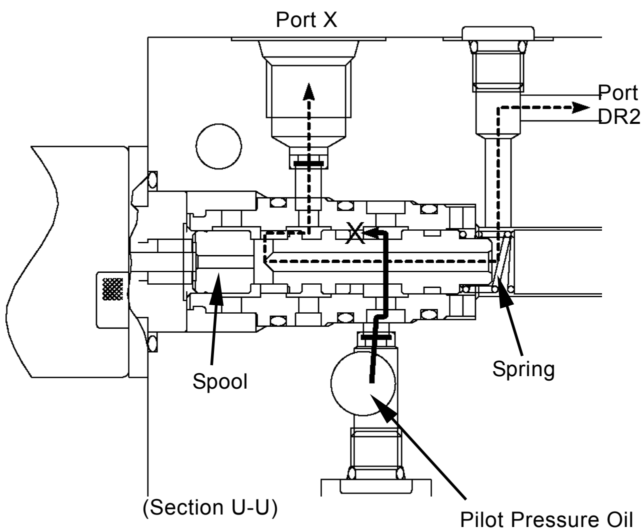
1. When there is no signal from the MC (Main Controller), the spool of the solenoid valve is being pushed by the spring.
2. Pilot pressure oil is supplied to port ST of the main pump regulator through port X.
3. When signal is transmitted from the MC, the spool moves toward the spring in response to the signal of the spool, and the amount of the pilot pressure oil flowing out of port X is lowered.
4. When the signal from the MC becomes the maximum value, the spool fully strokes toward the spring, and the pilot pressure oil is blocked by the spool.
5. Port X and port DR2 are connected, and the pilot pressure oil at port X is lost.

Not in Operation of Solenoid Valve



T4GB-03-06-009

In Operation of Solenoid Valve

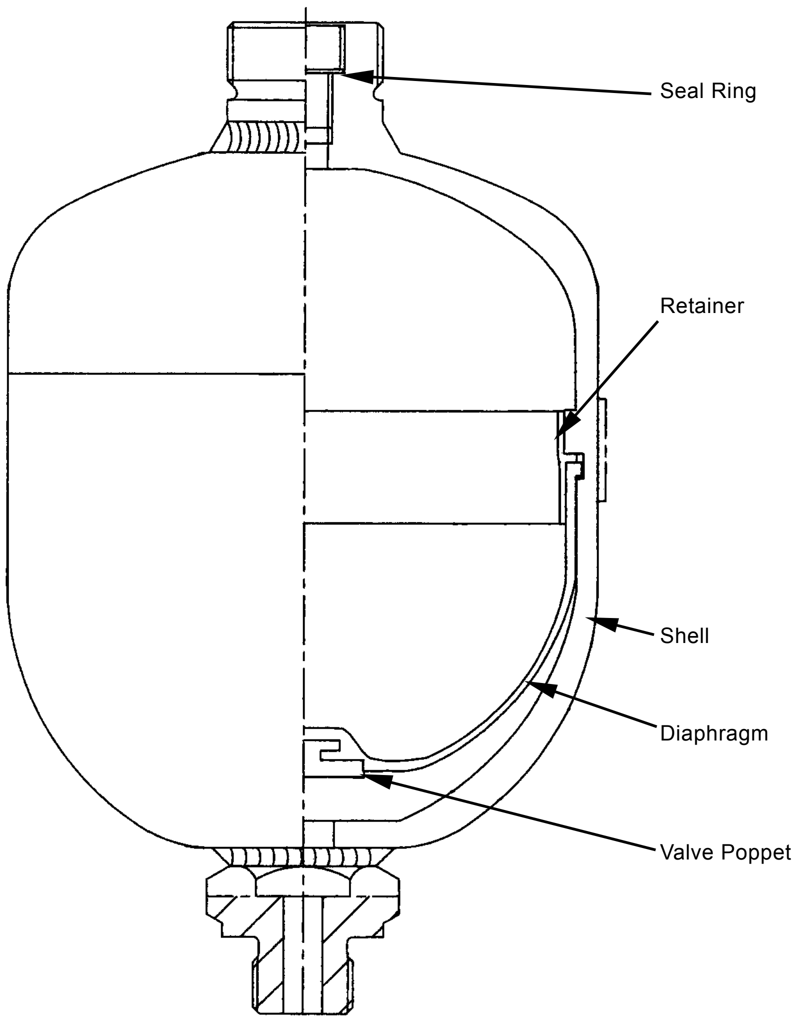


T4GB-03-06-010

SERVICE BRAKE ACCUMULATOR / PILOT ACCUMULATOR

Accumulator is installed in the pilot circuit leading to the service brake and the pilot valve.
High-pressure nitrogen gas is contained in the accumulator, and the pilot pressure oil compresses the nitrogen gas through the diaphragm.
Circuit pressure oil is retained by compression of the nitrogen gas.

IMPORTANT: Construction of the accumulator does not allow disassembly. Replace the whole assembly, when necessary.

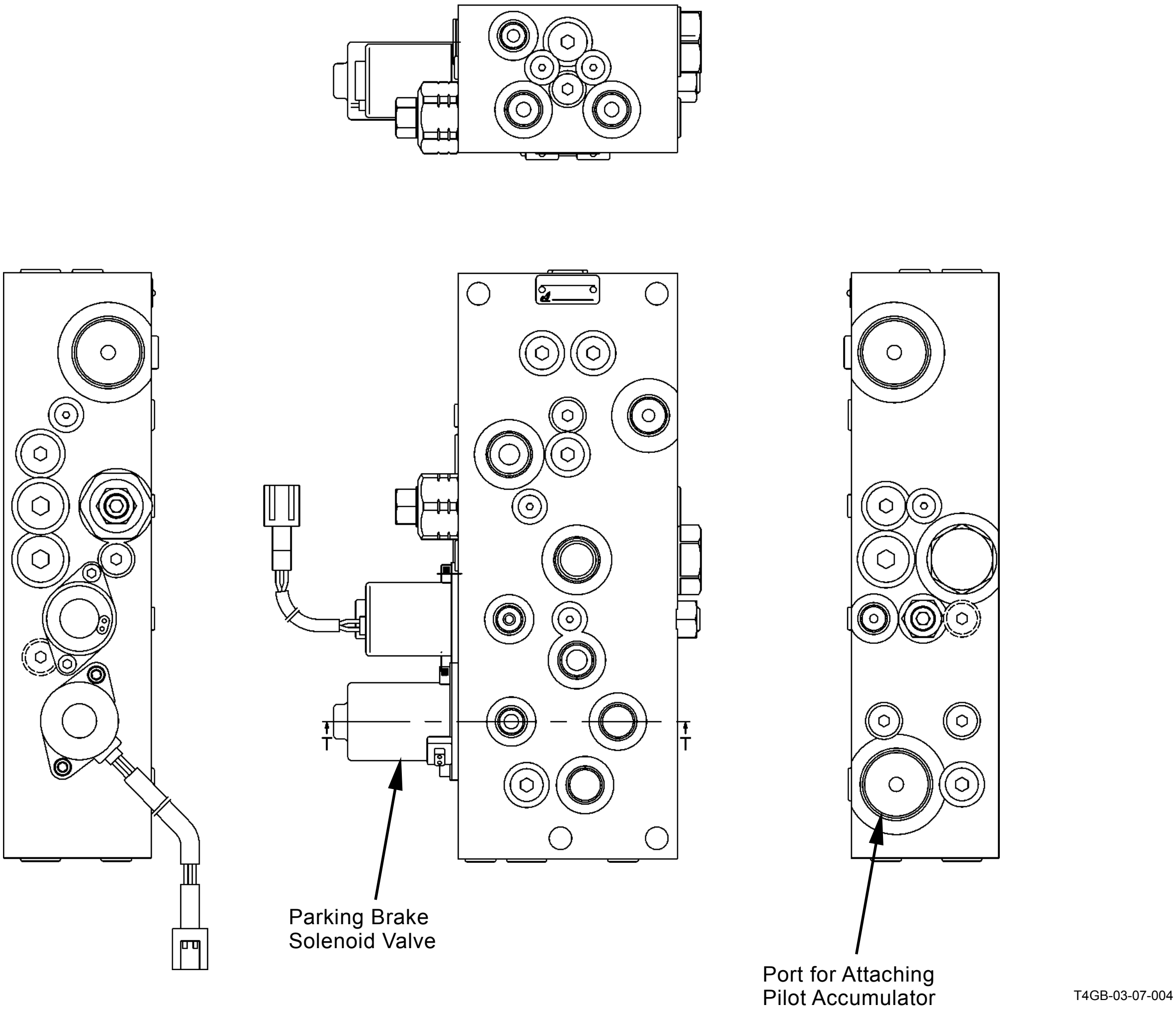


T4GB-03-06-011

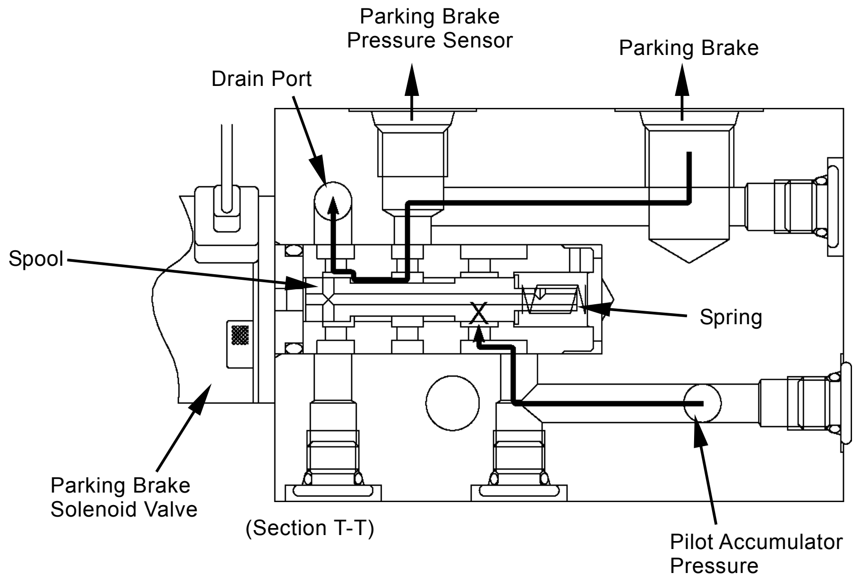
PARKING BRAKE SOLENOID VALVE

Pressure oil from the pilot pump is accumulated in the pilot accumulator, and its pressure always works on the outlet of the parking brake solenoid valve.

When the parking brake solenoid valve is operated, the pilot accumulator enters the parking brake through the spool, and releases the parking brake.

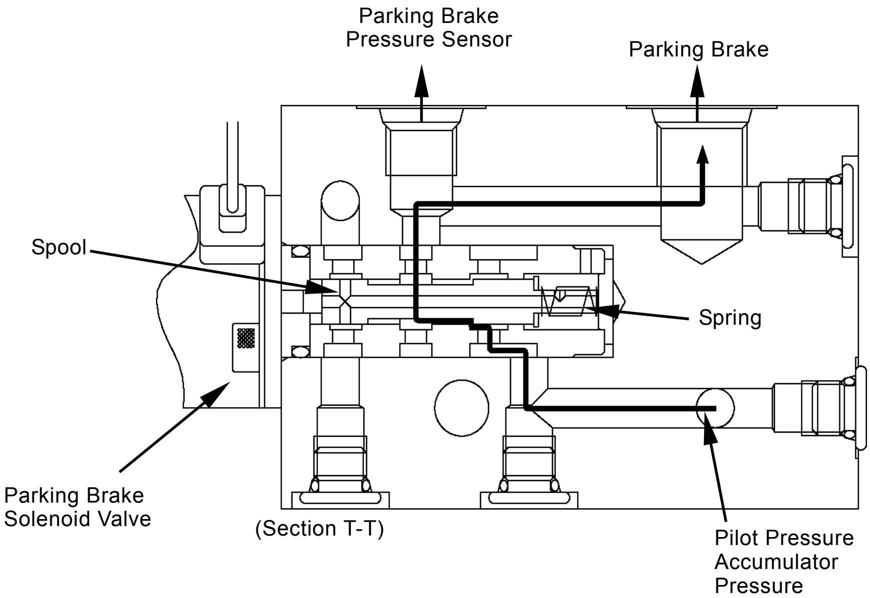


Not in Operation



T4GB-03-07-005

In Operation

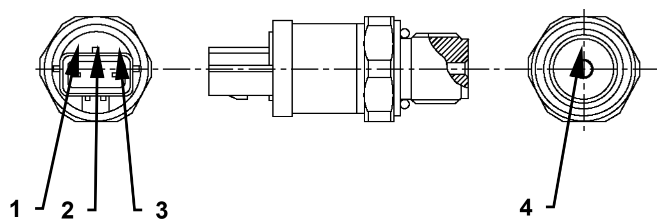


T4GB-03-07-006

SERVICE BRAKE PRESSURE SENSOR

Brake pressure necessary for the service brake is sensed. Sensor is installed in the service brake circuit of the charging block, and senses the oil pressure of the service brake accumulator.

1 - Earth
2 - Output
3 - Electric Power Source（5V）
4 - Pressure Applied Part（Diaphragm）

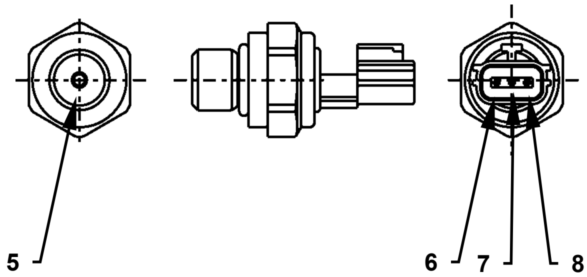


T4GB-03-06-012

PARKING BRAKE PRESSURE SENSOR

Brake pressure oil necessary for the parking brake is sensed. Sensor is installed in the parking brake circuit of the charging block, and senses the oil pressure of the pilot accumulator.

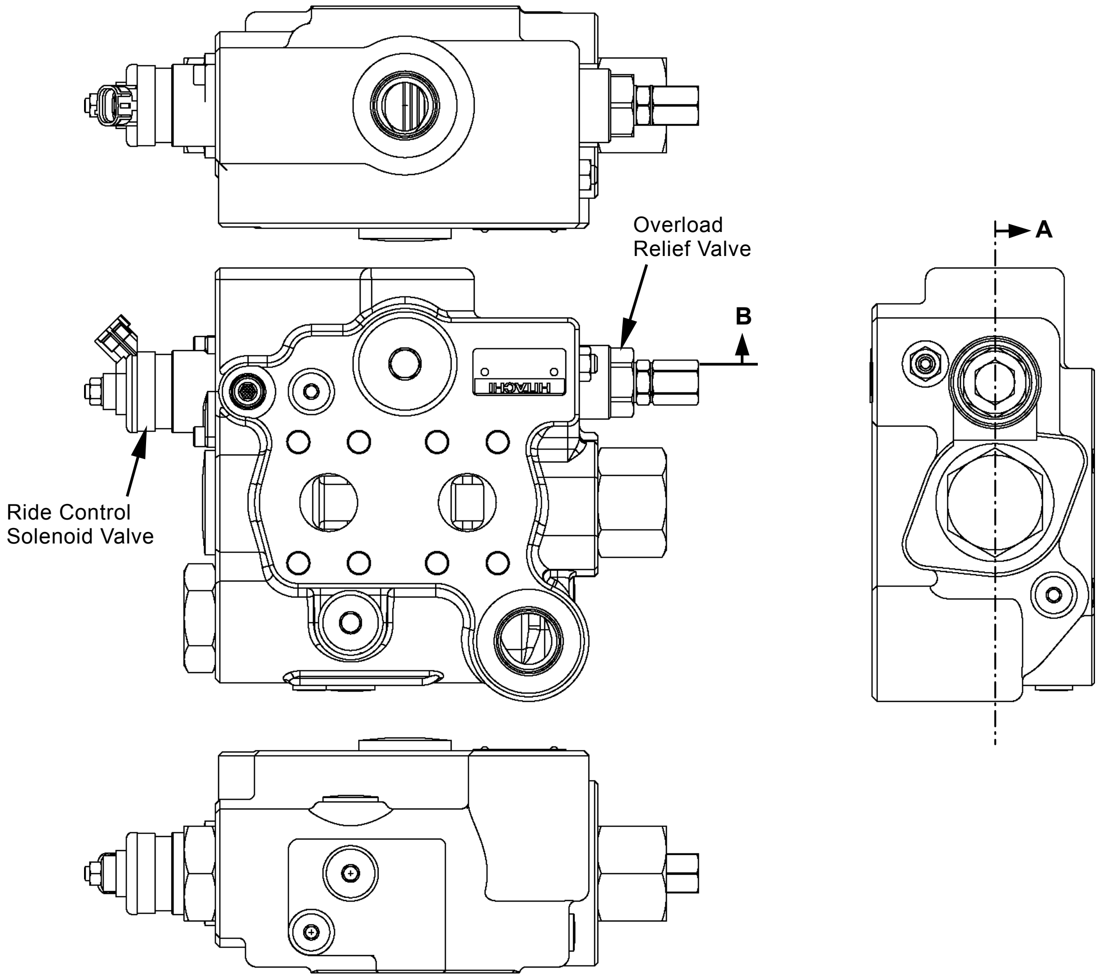
3 - Pressure-applied Part
5 - (Diaphragm)
6 - Earth
7 - Output
8 - Electric Source（5V）



T176-03-01-023

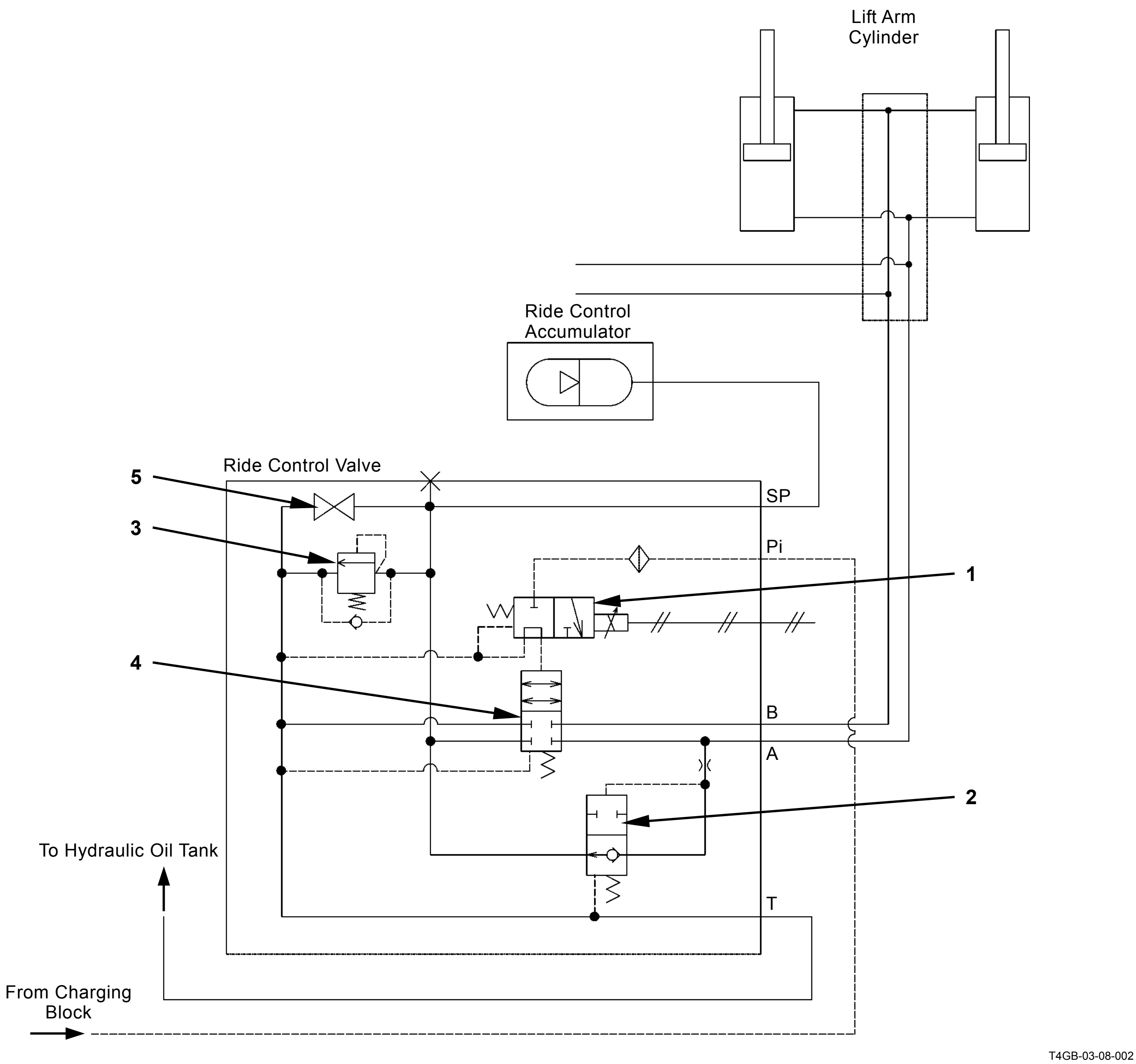
OUTLINE
(Refer to the SYSTEM / Control System)

Ride control valve enables stable traveling by absorbing the force generated in the lift arm cylinder in traveling on rough roads.
Ride control valve consists of the ride control solenoid valve, spool, charge-cut spool, overload relief valve, and others.



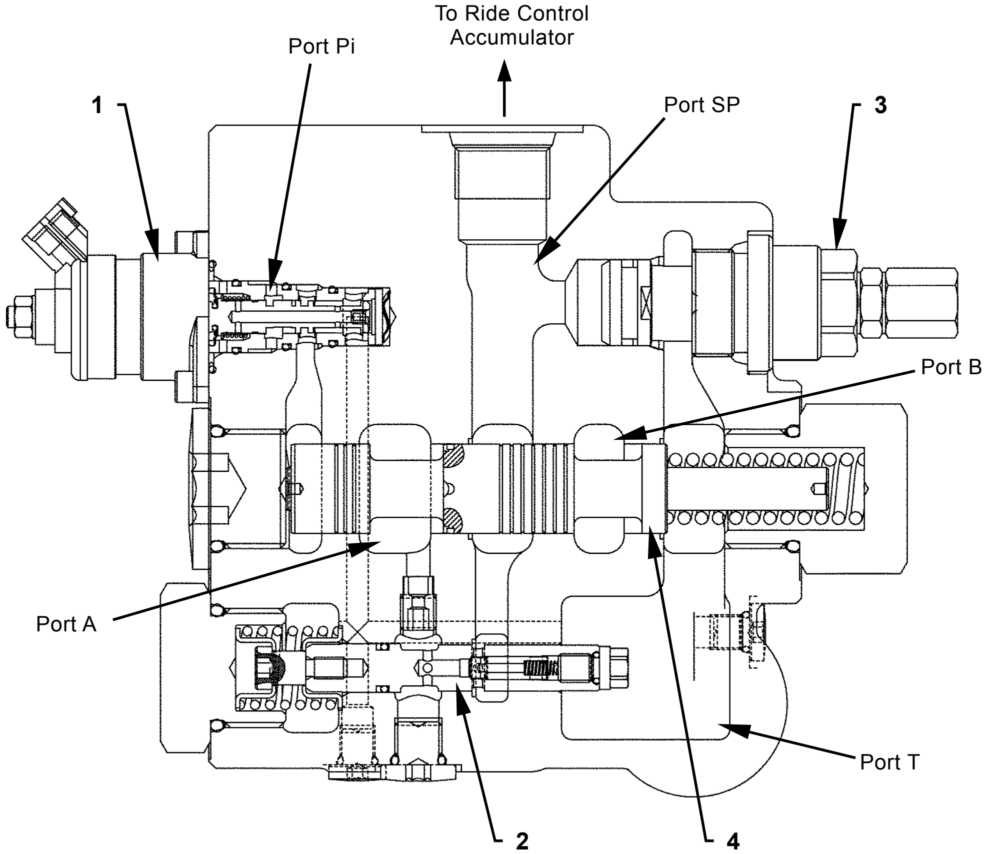
T4GB-03-08-001

Component Layout



1 - Ride Control Solenoid Valve
2 - Charge-cut Spool
3 - Overload Relief Valve
4 - Spool
5 - Draing Plug

Section A*

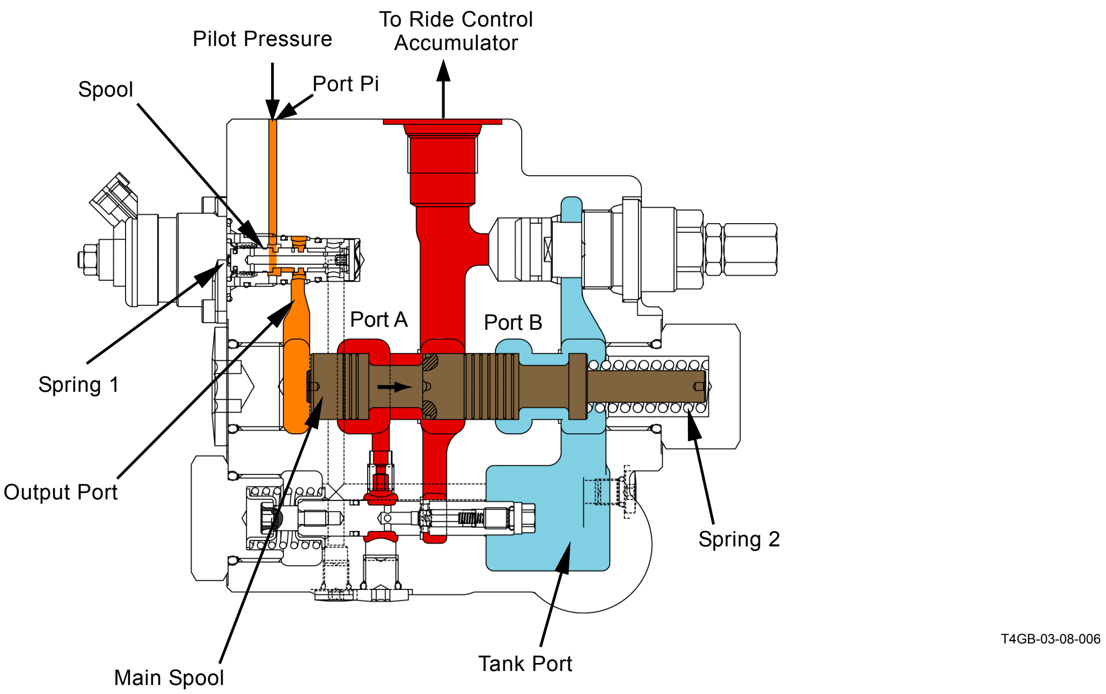


*Refer to T3-8-1.

OPERATION

1. At neutral, port Pi and the ouput port are not connected, blocked by the spool.
2. When the signal from the MC (Main Controller) enters the solenoid, the solenoid is excited.
3. Solenoid pushes the spool with the force corresponding to the signal from the MC, so port Pi and the output port are connected, and pilot pressure oil pushes the main spool.
4. When the main spool is pushed toward spring 2, port A (on the bottom end of the lift arm cylinder) and the ride control accumulator are connected, and port B (on the rod end of the lift arm cylinder) and port T are connected.
5. As a result, the pushing force of the lift arm cylinder is absorbed by the accumulator, and the load generated by the pushing up force is absorbed by sucking up the hydraulic oil from the tank port.

Section A*



*Refer to T3-8-1.

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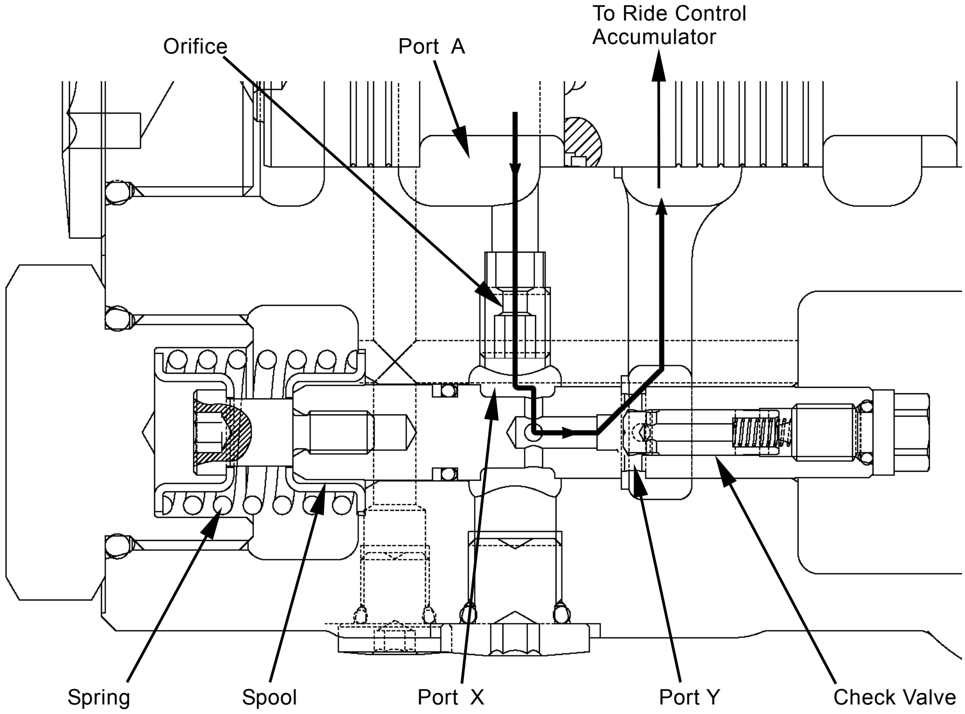
CHARGE-CUT SPOOL

Charge-cut spool accumulates the pressure oil in the lift arm cylinder in the ride control accumulator, and shuts down the pressure oil from the lift arm cylinder when the ride control accumulator is accumulated to the set pressure.

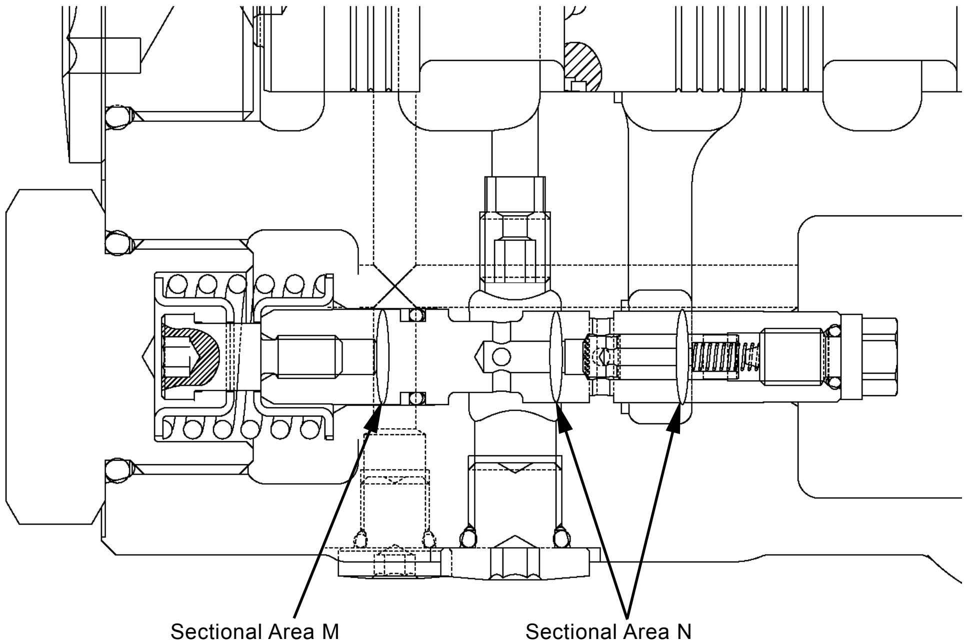
1. When the ride control is not in operation, the pressure oil on the lift arm cylinder bottom end flows to port X, passing the orifice through port A.
2. Pressure oil flowing into port X passes in the spool of the charge-cut spool, and opening the check valve, flows into port Y to be accumulated in the ride control accumulator.
3. As Spool Sectional Area M is larger than Spool Sectional Area N, when the ride control accumulator is accumulated to the set pressure, the pressure oil from port X pushes the spool toward the spring.
4. When the spool moves toward the spring, the passage of the pressure oil from the spool to port Y is closed, and accumulating the ride control accumulator is stopped.

During Accumulation of Accumulator



T4GB-03-08-007

After Accumulation of Accumulator



T4GB-03-08-008

OVERLOAD RELIEF VALVE

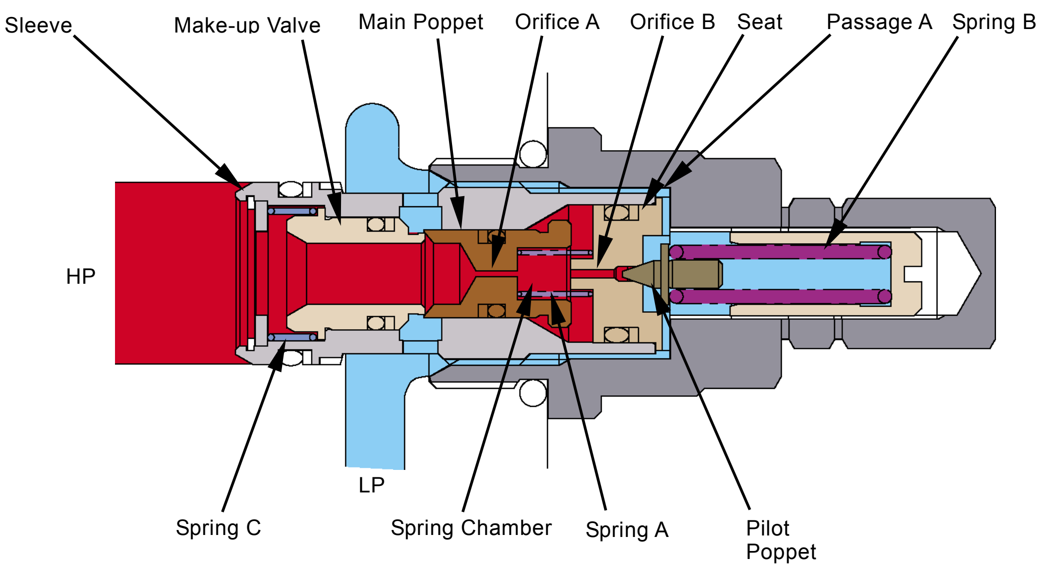
Overload relief valve is installed for preventing hoses and the ride control accumulator from being damaged in case the pressure in the bottom end circuit of the lift arm cylinder is suddenly raised by an external force or something during operation of the lift arm cylinder.

Operation

1. Pressure at port HP (in the main circuit) works on the pilot poppet, passing orifice A of the main poppet and orifice B of the seat.
2. When the pressure at port HP rises to the setting force of spring B, the pilot poppet opens, and pressure oil flows to port LP, passing passage A and the periphery of the sleeve.
3. At this moment, pressure difference arises between port HP and the spring chamber caused by orifice A.
4. When this pressure difference reaches the value corresponding to the set force of spring A, the main poppet opens, and the pressure oil at port HP flows to port LP.
5. As a result, the pressure in the actuator circuit lowers.
6. If the actuator circuit pressure lowers to the set pressure, the main poppet is closed by the force of spring A.

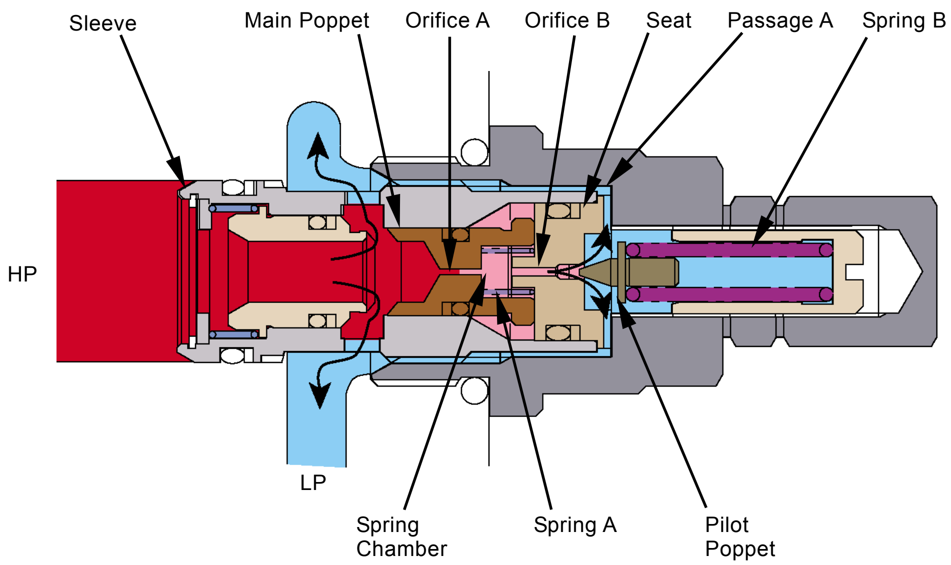
IMPORTANT: Never disassemble or adjust the overload relief valve. Replace the whole assembly, when necessary.

Normally:



T176-03-03-012

When Relieving:

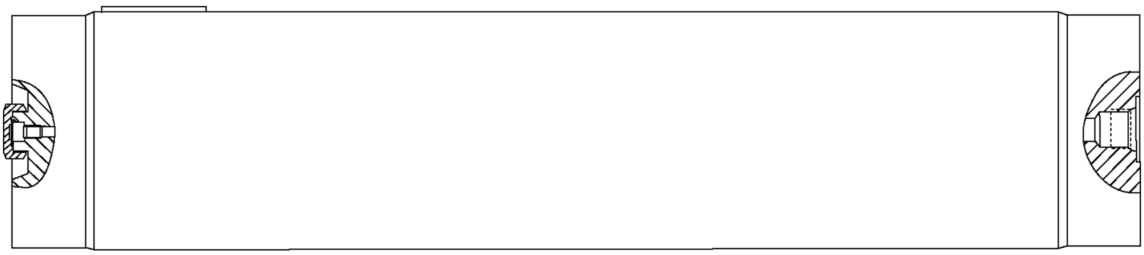


T176-03-03-013

RIDE CONTROL ACCUMULATOR

Ride control accumulator is installed in the accumulation circuit of the ride control.
High-pressure nitrogen gas is contained in the accumulator, and the pressure oil compresses the nitrogen gas through the piston.
Compression of the nitrogen gas dampens shock of the pressure oil due to pitching and the like of the lift arm cylinder raising circuit.

IMPORTANT: Construction of the ride control accumulator does not allow disassembly. Replace the whole assembly, when necessary.



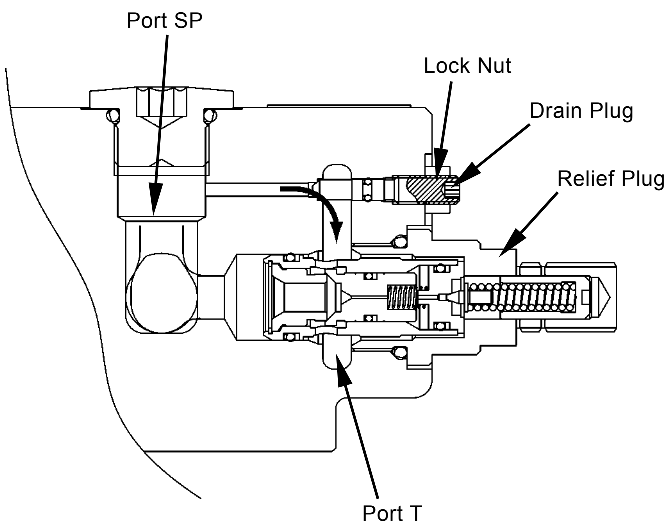
T4GB-03-08-009

DRAIN PLUG

Ride control valve is provided with the drain plug for returning the pressure oil of the ride control accumulator to the oil tank at the time of maintenance or something.
When necessary, connect the accumulator port (port SP) and the tank port (port T) by loosening the lock nut first and the drain plug later.

CAUTION: Excessive loosening (More than 2 turns) of the drain plug can result in oil burst due to removal of the drain plug itself.

Section B*



T4GB-03-08-010

*Refer to T3-8-1.

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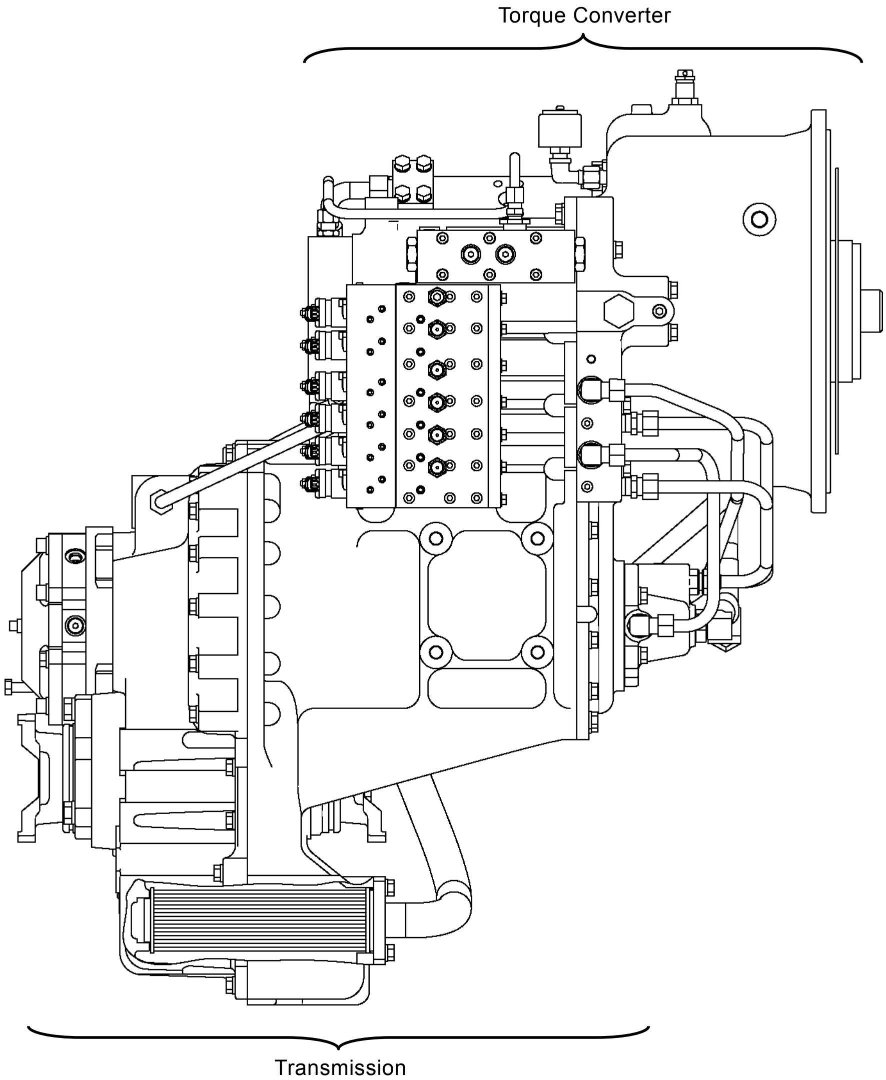
OUTLINE

Drive unit consists of the transmission and the torque converter.
Drive unit is connected with the engine. Power from the engine is transmitted to the transmission through the engine flywheel and the torque converter.



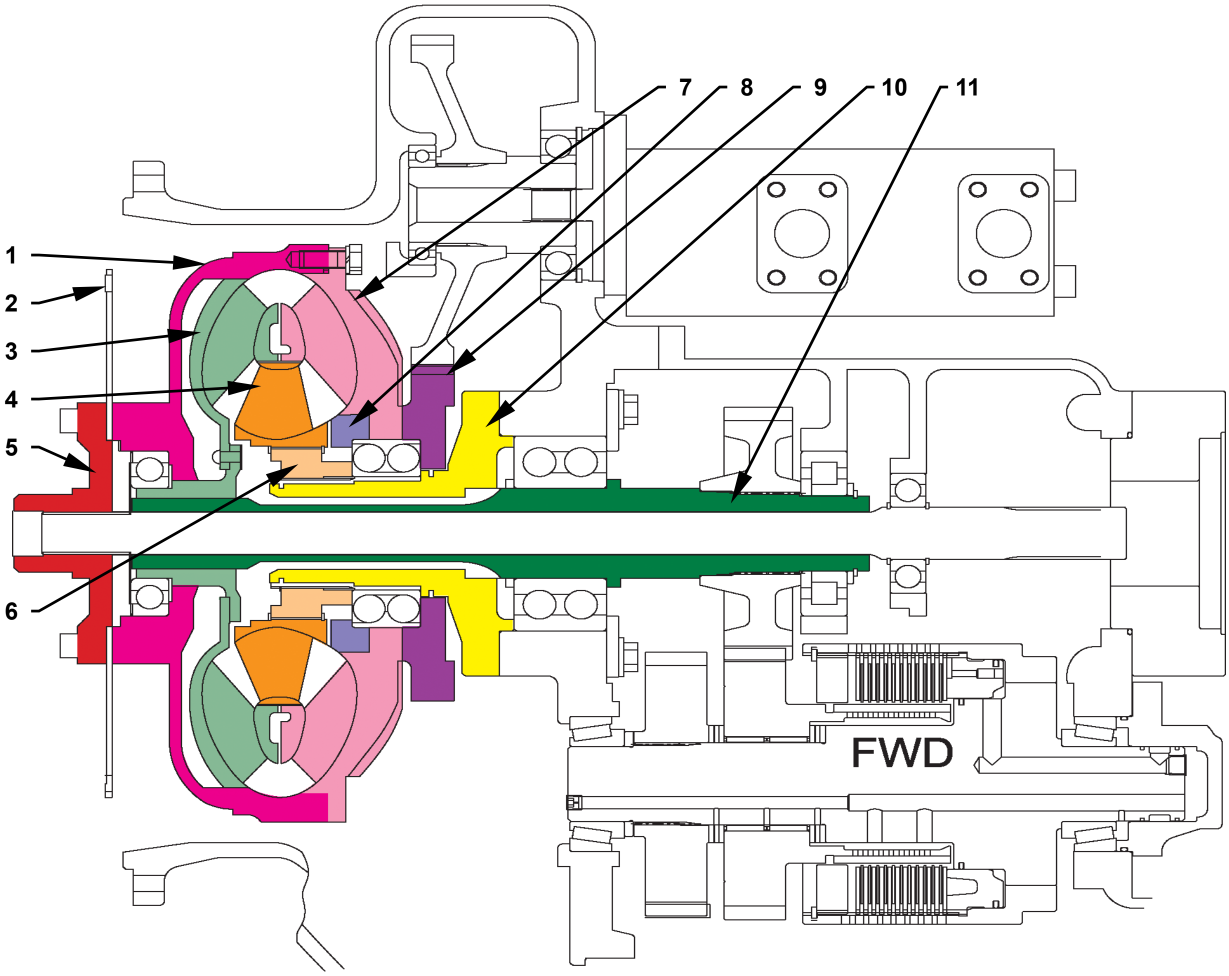
T4GC-03-09-005

TORQUE CONVERTER

Torque converter consists of the converter wheel assembly, pump drive device, turbine shaft, and others. In the converter wheel assembly, impeller (7) and turbine (3) are mutually opposed with stator (4) installed in between, and they are all contained in the casing filled with oil.

Engine rotation is transmitted from the engine wheel to the transmission through input plate (2), cover wheel (1), impeller (7), turbine (3), and turbine shaft (11).

Hydraulic oil for the torque converter supplied from the transmission control valve enters the converter wheel through the oil passage of the stator support.
When impeller (7) is rotated by the engine rotation, oil flows along the blade of impeller (7) toward the periphery, and flows into the turbine (3). This oil flow collides with the blade of turbine (3), and rotates turbine (3) and turbine shaft (11). Also, the output torque of turbine shaft (11) is generated by the reaction force caused by the oil flow direction change due to collision of oil with the blade of turbine (3).
Stator (4) always rectifies the oil flow coming out of turbine (3) in the determined direction, and flows the oil into impeller (7) for enlarging torque.

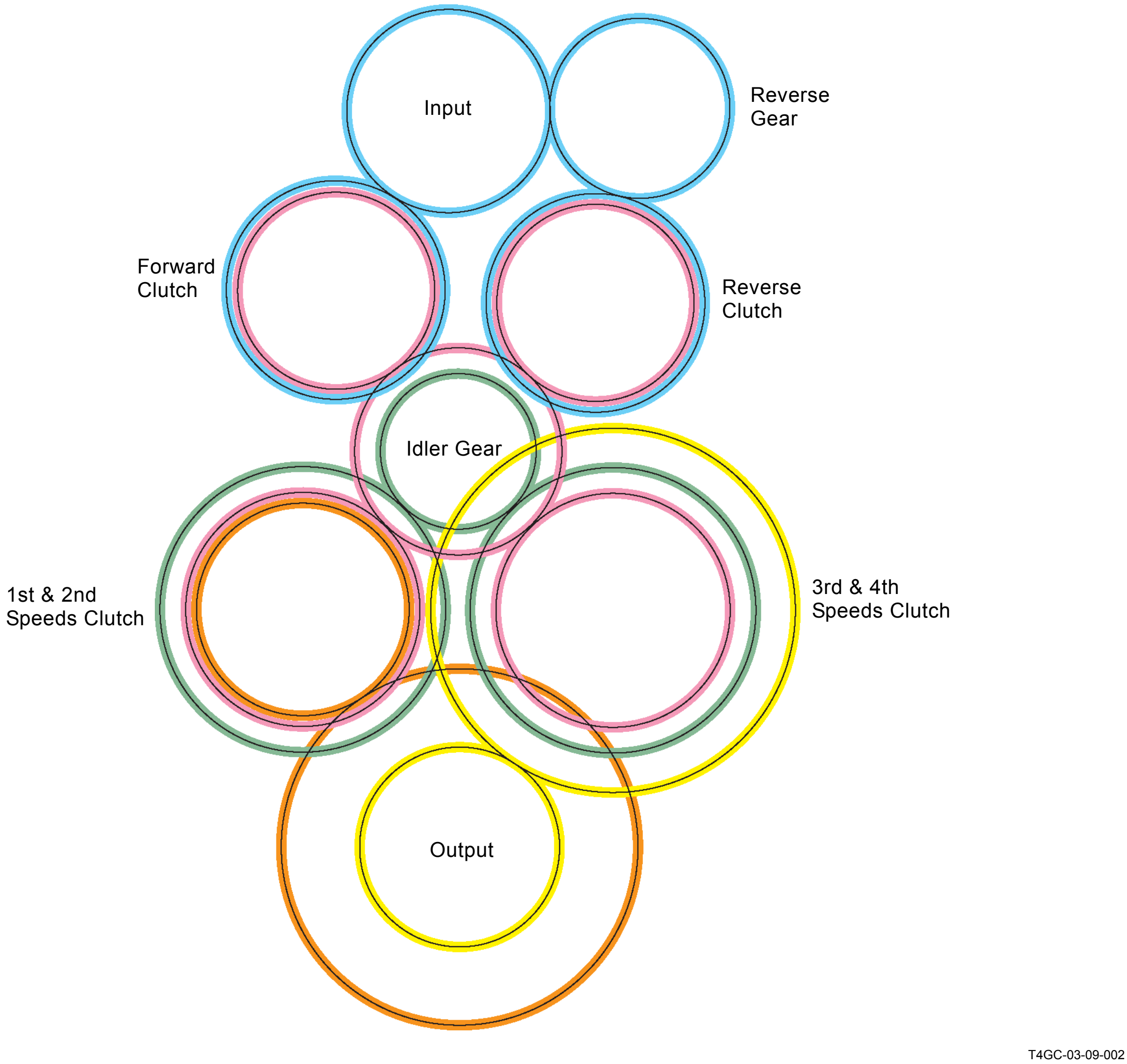


T4GC-03-09-001

1 - Cover Wheel
2 - Input Plate
3 - Turbine
4 - Stator
5 - Input Guide
6 - Stator Hub
7 - Impeller
8 - Impeller Hub
9 - Pump Drive Gear
10 - Guide Carrier
11 - Turbine Shaft

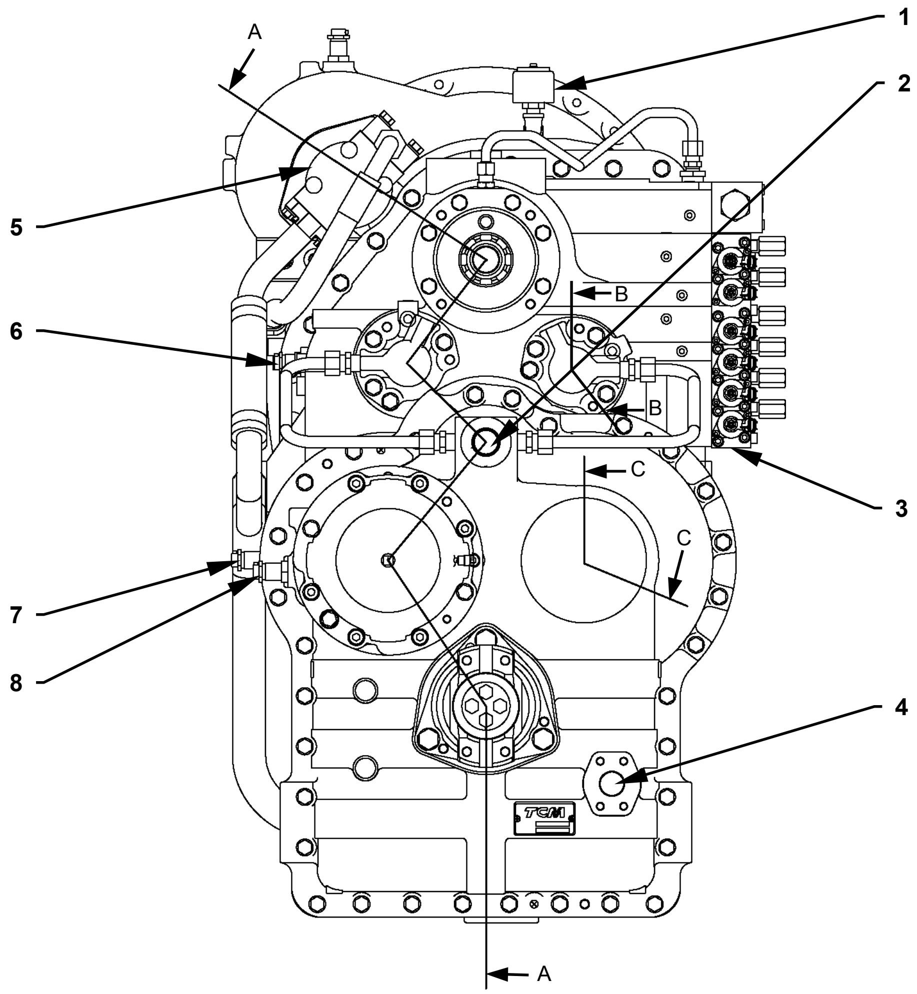
TRANSMISSION

Transmission so fuctions as to transform the rotation speed and rotation direction of the power transmitted from the torque converter.
Transmission is composed of the four clutch shaft assemblies, the reverse gear, output shaft, parking brake, control valve, and others.
Safety valve is installed at the inlet part of the hydraulic oil for the torque converter, and relieves redundant oil into the converter housing.



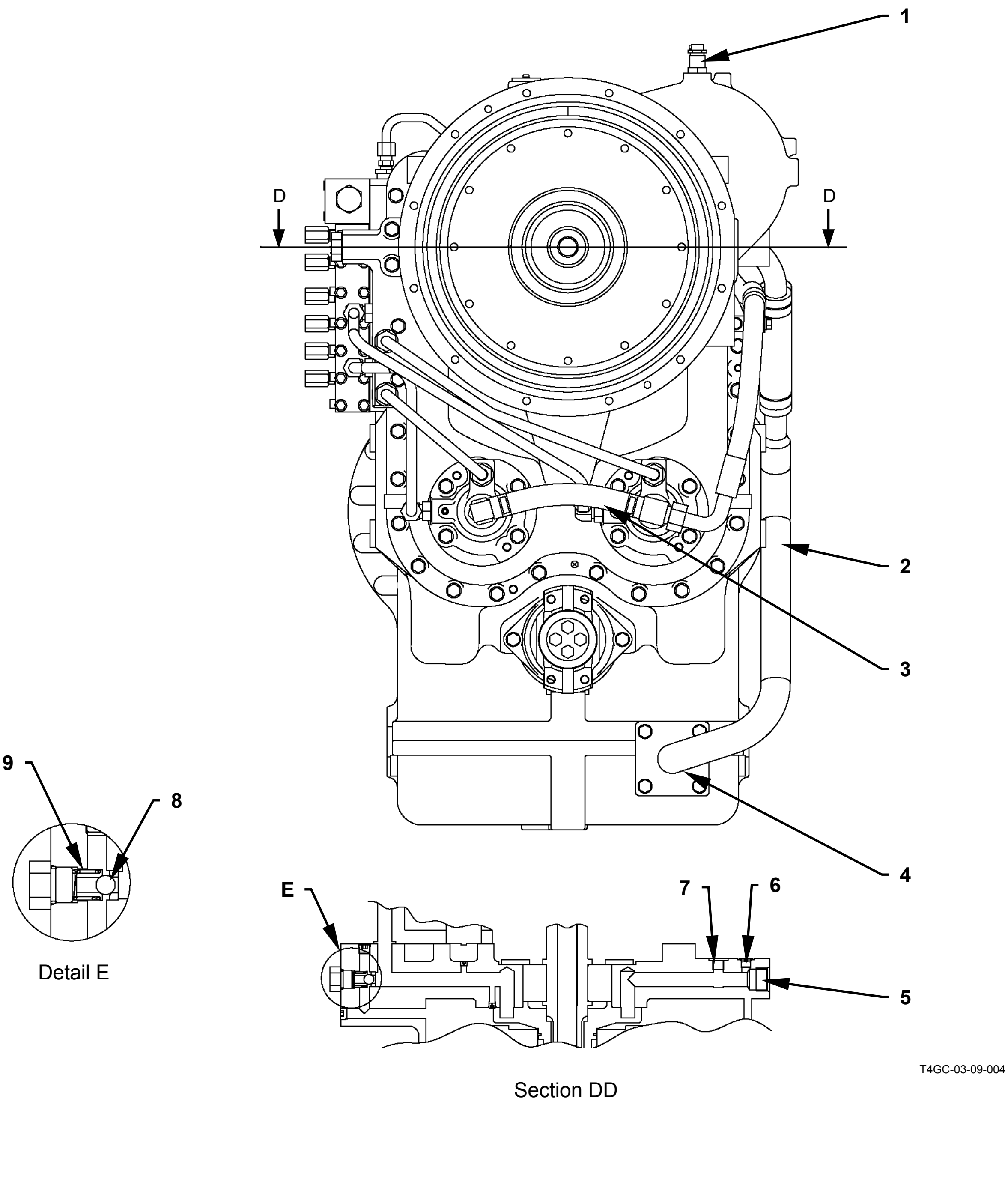
Transmission Gear Layout Drawing
(Viewed from Vehicle Front End)

Front View of Transmission



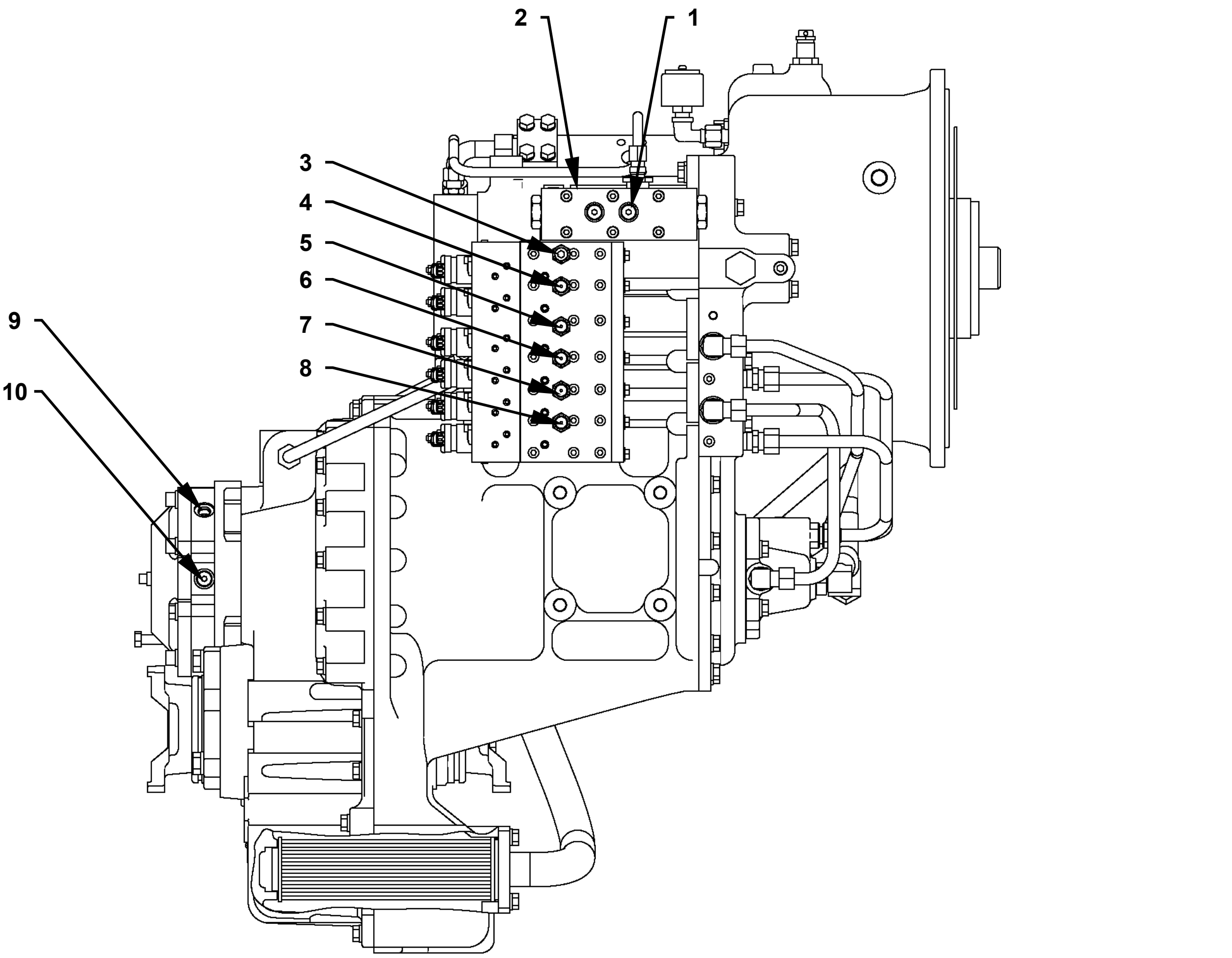
1 - Breather	3 - Control Valve	5 - Charging Pump	7 - Rotation Sensor (B)
2 - from Oil Cooler	4 - Oil Feed Port	6 - Rotation Sensor (A)	8 - Vehicle Speed Sensor

Rear View of Transmission



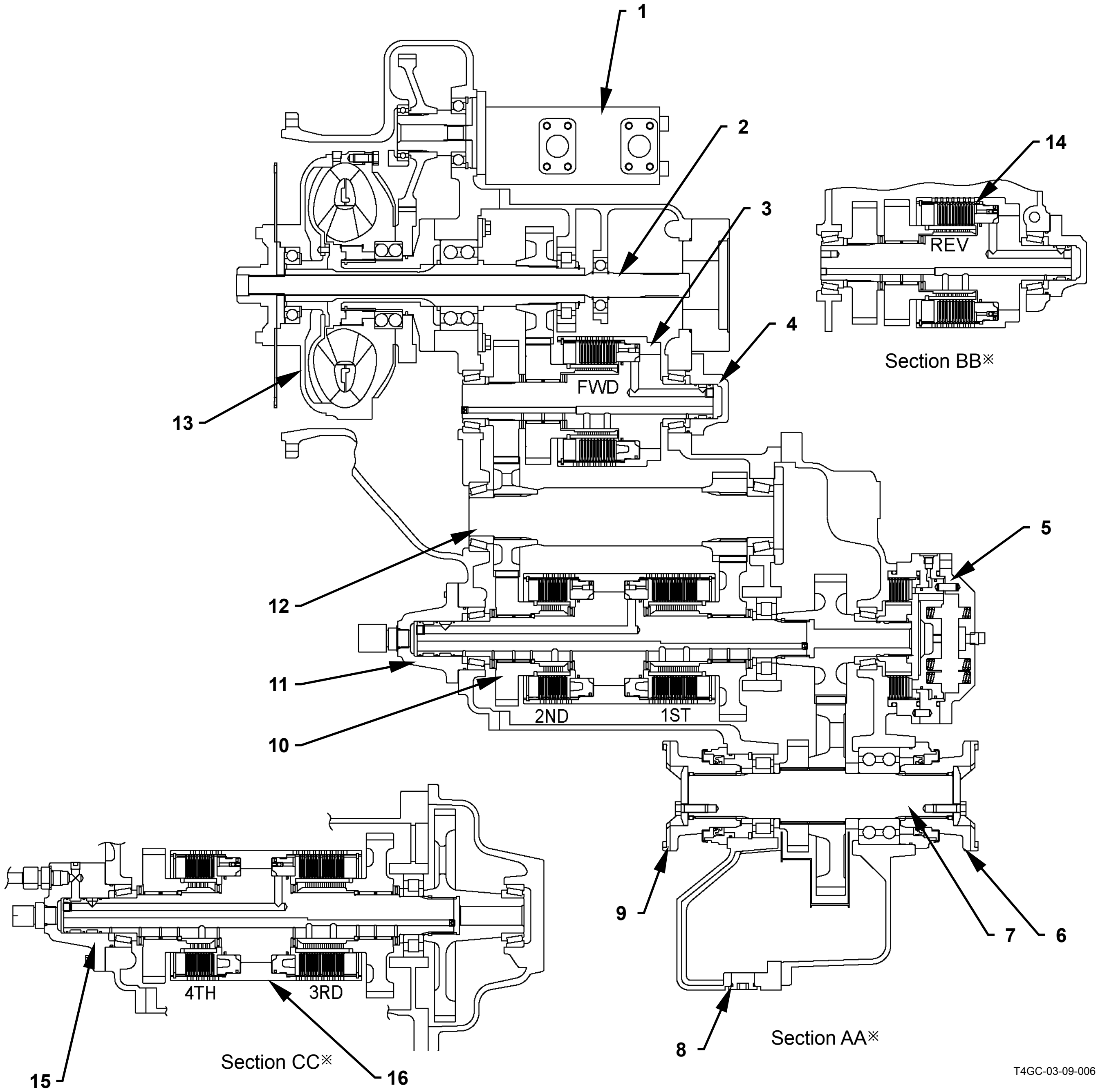
1 - Engine Speed Sensor
2 - Suction Tube
3 - Hose
4 - Strainer
5 - To Oil Cooler
6 - Converter Outlet Boss
7 - Oil Pressure Gauge Port
8 - Safety Valve
9 - Spring

Side View of Transmission



1 - Converter Inlet Pressure Port
2 - Regulator Valve
3 - Forward Clutch Pressure Port
4 - Reverse Clutch Pressure Port
5 - 1st Speed Clutch Pressure Port
6 - 2nd Speed Clutch Pressure Port
7 - 3rd Speed Clutch Pressure Port
8 - 4th Speed Clutch Pressure Port
9 - Parking Brake Release Pressure Inlet
10 - Parking Brake Pressure Switch Port

Cross-Sectional Drawing of Transmission

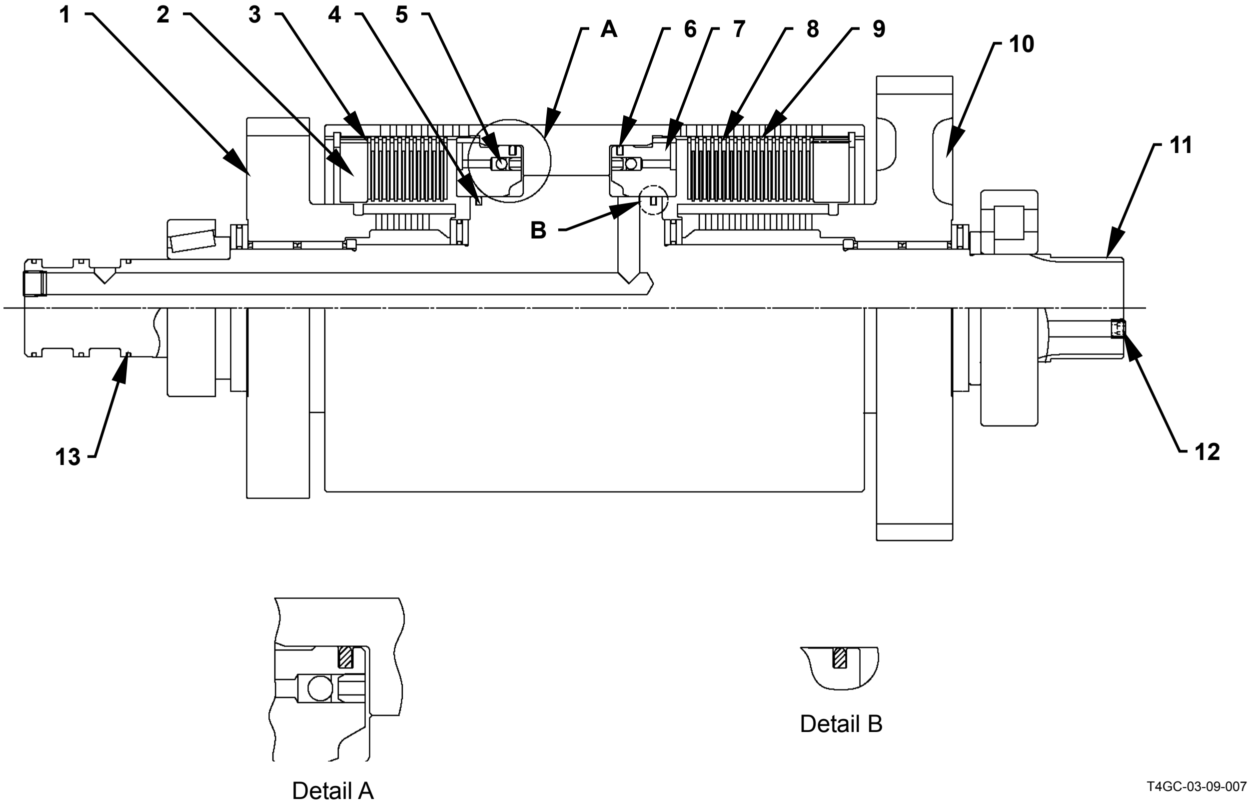


1 - Charging Pump
2 - Pump Drive Shaft
3 - Forward Clutch
4 - Distributor Cap
5 - Parking Brake
6 - Front Output Flange
7 - Output Shaft
8 - Drain Plug
9 - Rear Output Flange
10 - 1st & 2nd Speeds Clutch
11 - Distributor Cap
12 - Idler Shaft
13 - Torque Converter
14 - Reverse Clutch
15 - Distributor Cap
16 - 3rd & 4th Speeds Clutch

※Refer to T3-9-5

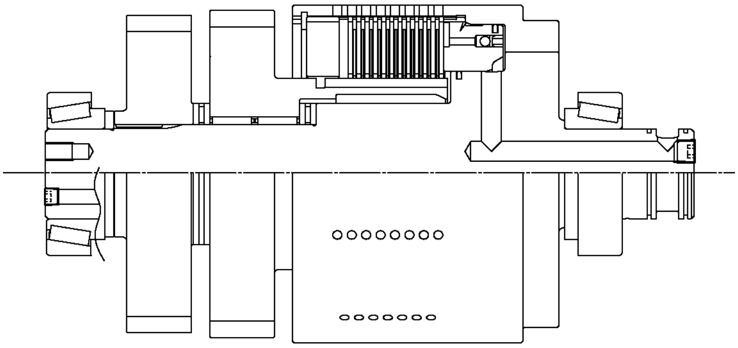
Clutch Shaft

Clutch shaft assemblies contain clutch discs of the respective speed shifts, and transmit or stop power.



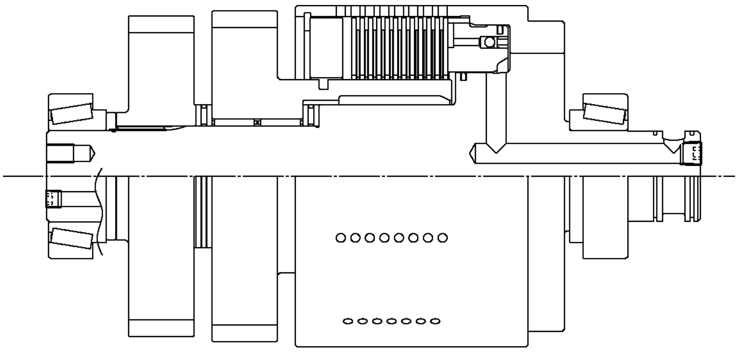
1 - Hub Gear
2 - End Plate
3 - Return Spring
4 - Seal Ring (Inner)
5 - Bleed Valve
6 - Seal Ring (Outer)
7 - Piston
8 - Disk
9 - Plate
10 - Hub Gear
11 - Shaft
12 - Plug
13 - Seal Ring

(Forward Clutch Shaft)



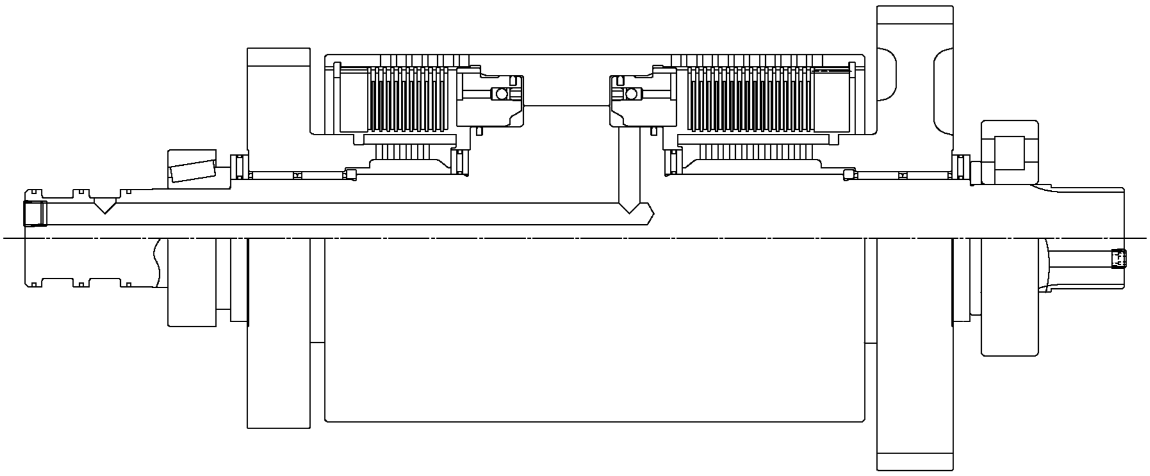
T4GC-03-09-008

(Reverse Clutch Shaft)



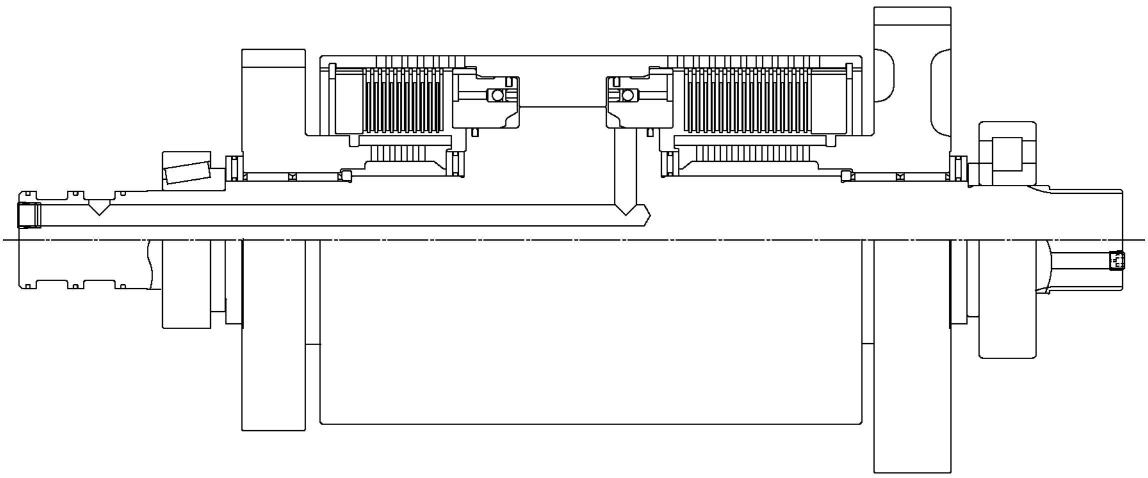
T4GC-03-09-009

(1st & 2nd Speeds Clutch Shaft)



T4GC-03-09-010

(3rd & 4th Speeds Clutch Shaft)



T4GC-03-09-011

Operation

In Operation

Clutch is operated by the pressure oil from the transmission control valve.

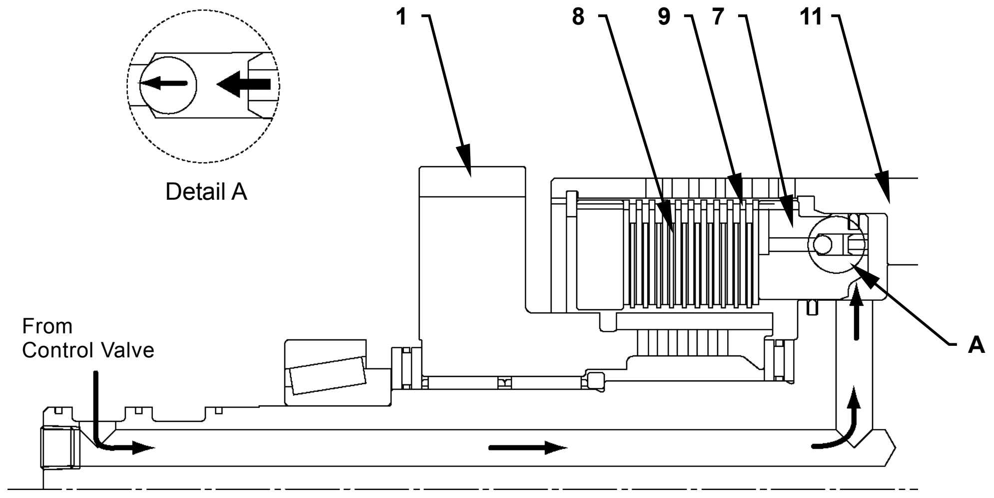
Pressure oil transmitted from the transmission control valve reaches the back of piston (7) through the oil passage inside shaft (11). Oil passage is blocked because the pressure oil pushes the bleed valve (5) in piston (7) toward disc (8), and piston (7) is pushed toward disc (8). Piston (7) transmits power to the whole of shaft (11) and hub gear (1) connected by pressing and adhering disc (8) and plate (9).

Not in Operation

When pressure oil is not transmitted from the transmission control valve, bleed valve (5) is opened by the centrifugal force of shaft (11), so the risidual pressure oil in the piston and others are discharged toward disc (8). Piston (7) is pushed back by the return spring (3) between plates (9).

There arises a clearance between disc (8) and plate (9), so shaft (11) and clutch hub gear (1) rotate separately, and power is not transmitted.

In Operation



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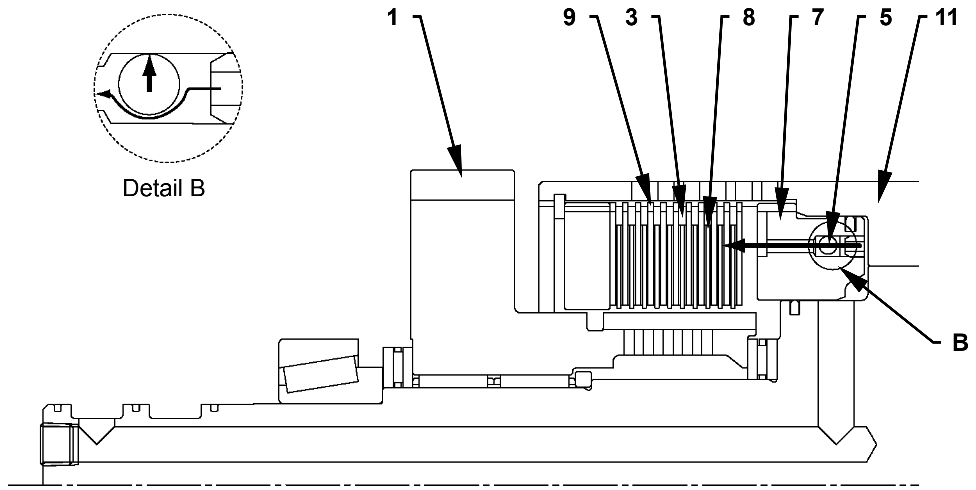
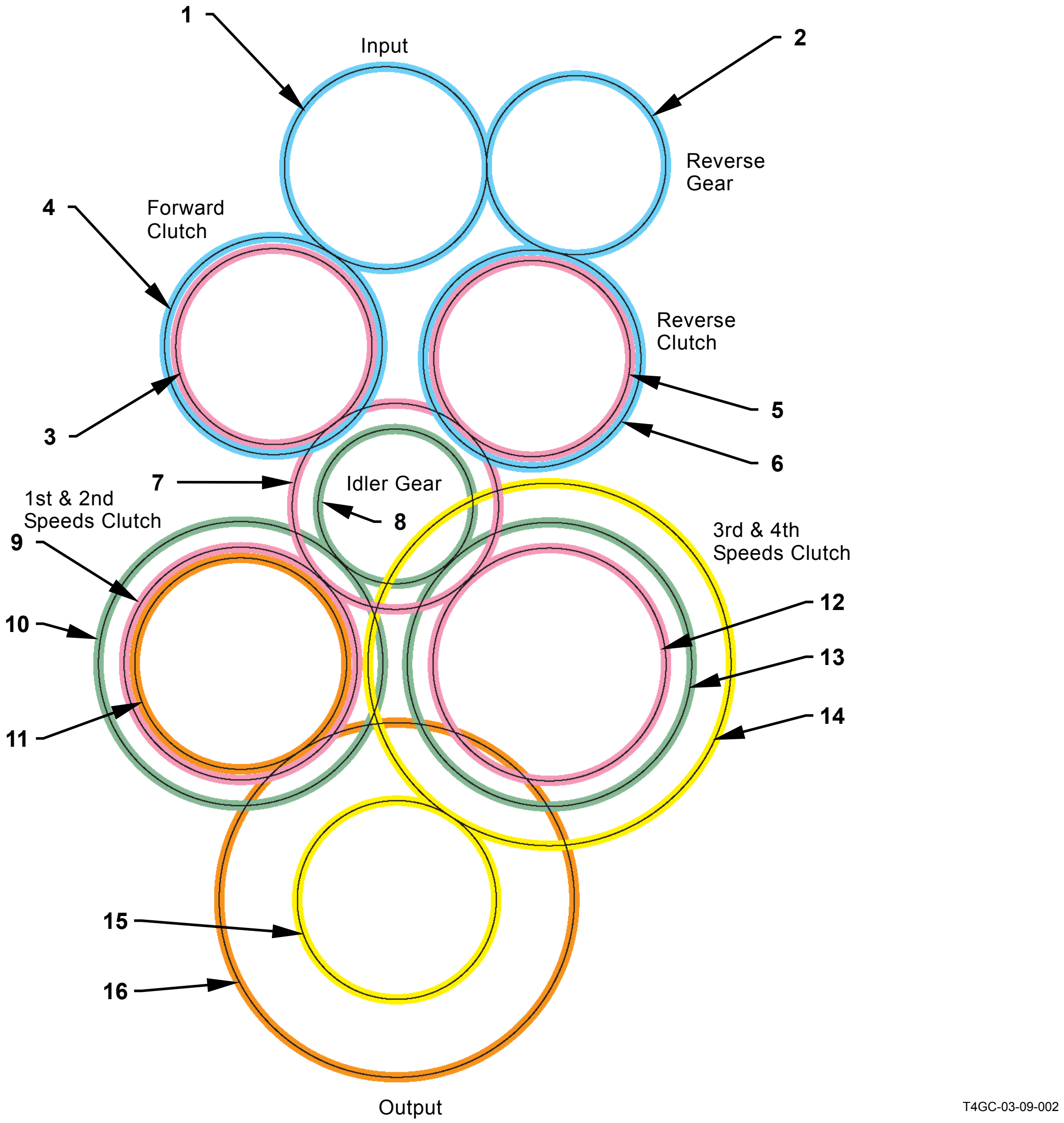
Not in Operation



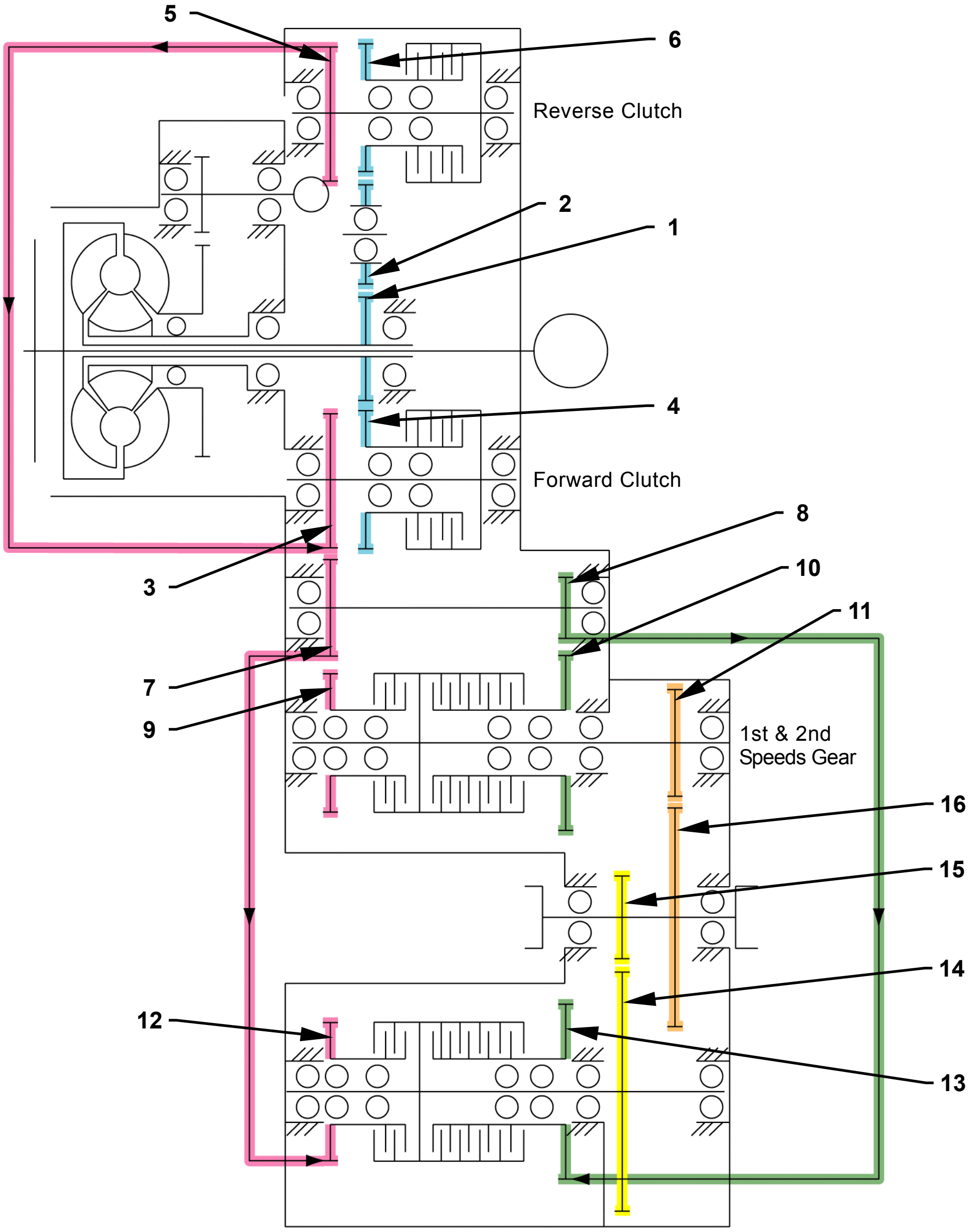
T4GC-03-09-013

1 - Hub Gear
3 - Return Spring
5 - Bleed Valve
7 - Piston
8 - Disk
9 - Plate
11 - Shaft

Transmission of Power



1 - Input Gear	5 - F-R Gear	9 - 2nd Hub Gear	13 - 3rd Hub Gear
2 - Reverse Gear	6 - R Hub Gear	10 - 1st Hub Gear	14 - High-range Gear
3 - F-R Gear	7 - Idler Gear	11 - Low-range Gear	15 - Output Gear
4 - F Hub Gear	8 - Idler Gear	12 - 4th Hub Gear	16 - Output Gear

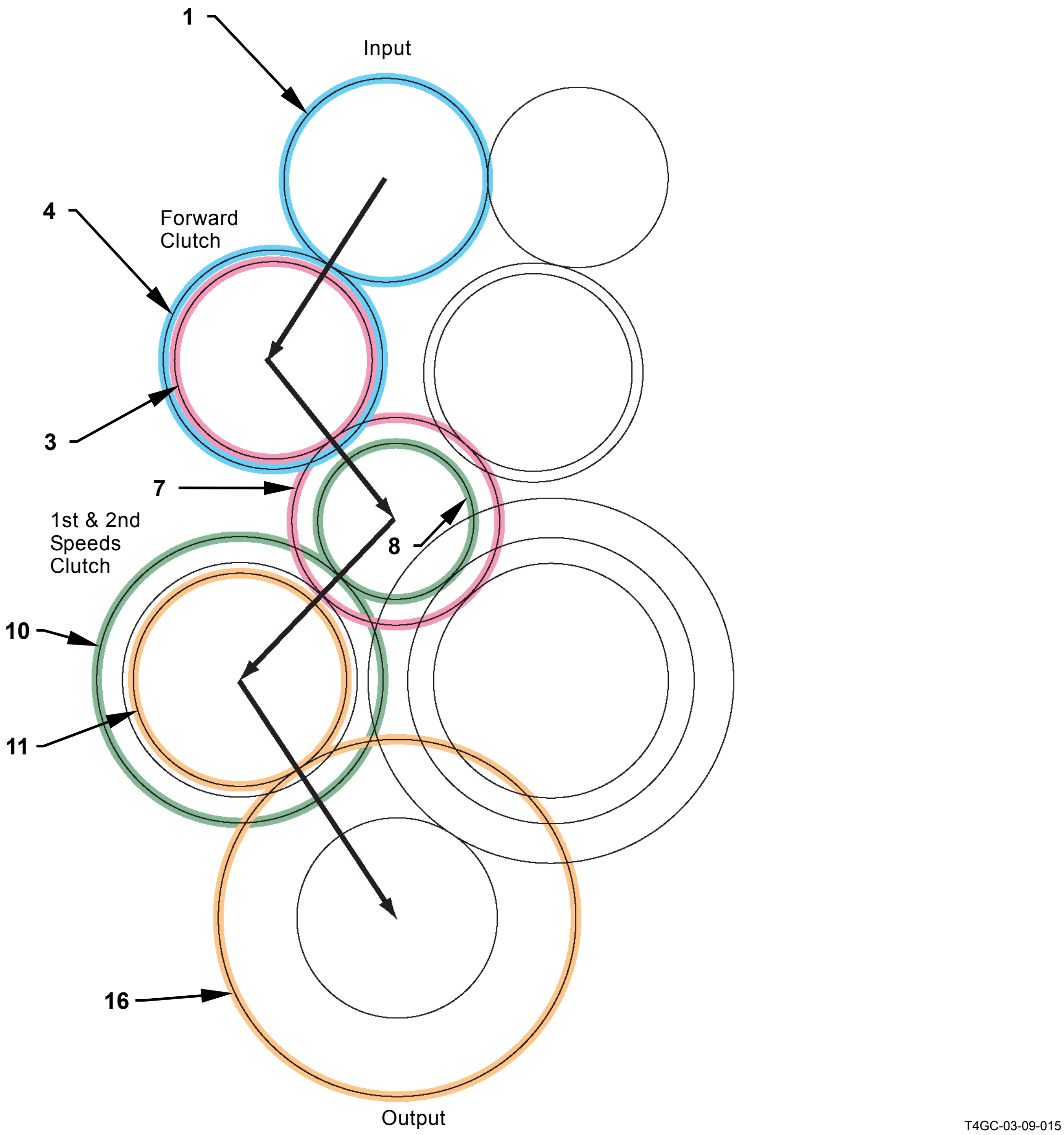


T4GC-03-09-014

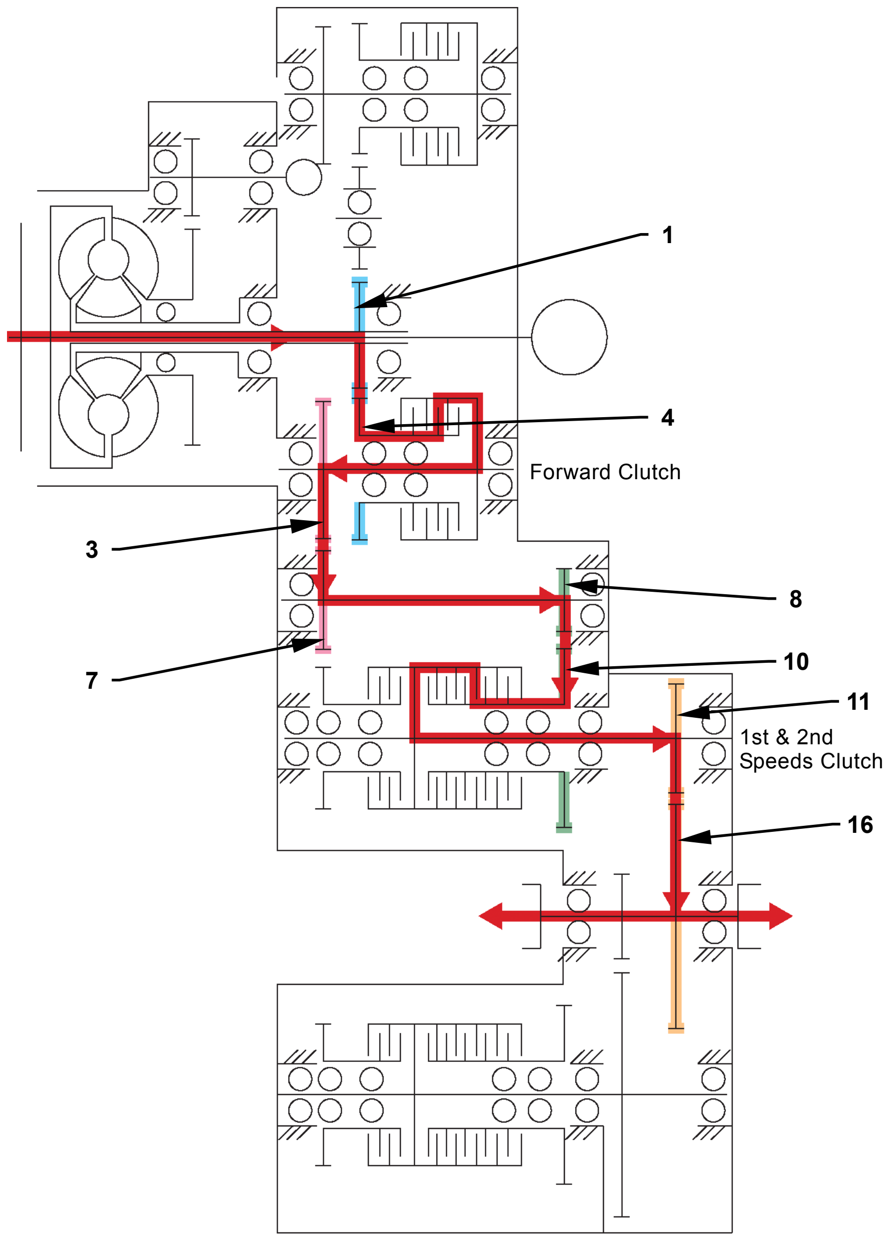
Forward 1st Speed

In the case of forward 1st speed, the forward clutch and the 1st speed part of the 1st & 2nd speeds clutch are connected. Torque converter transmits torque to F hub gear (4) geared to the input gear (1).
Torque from F hub gear (4) is transmitted to the 1st speed hub gear (10) through F - R gear (3), the idler gear (7), and the idler gear (8).

Furthermore, torque is outputted from the 1st hub gear (10) to the low-range gear (11), and eventually outputted to the output gear (16).



Power Flow: Forward 1st Speed

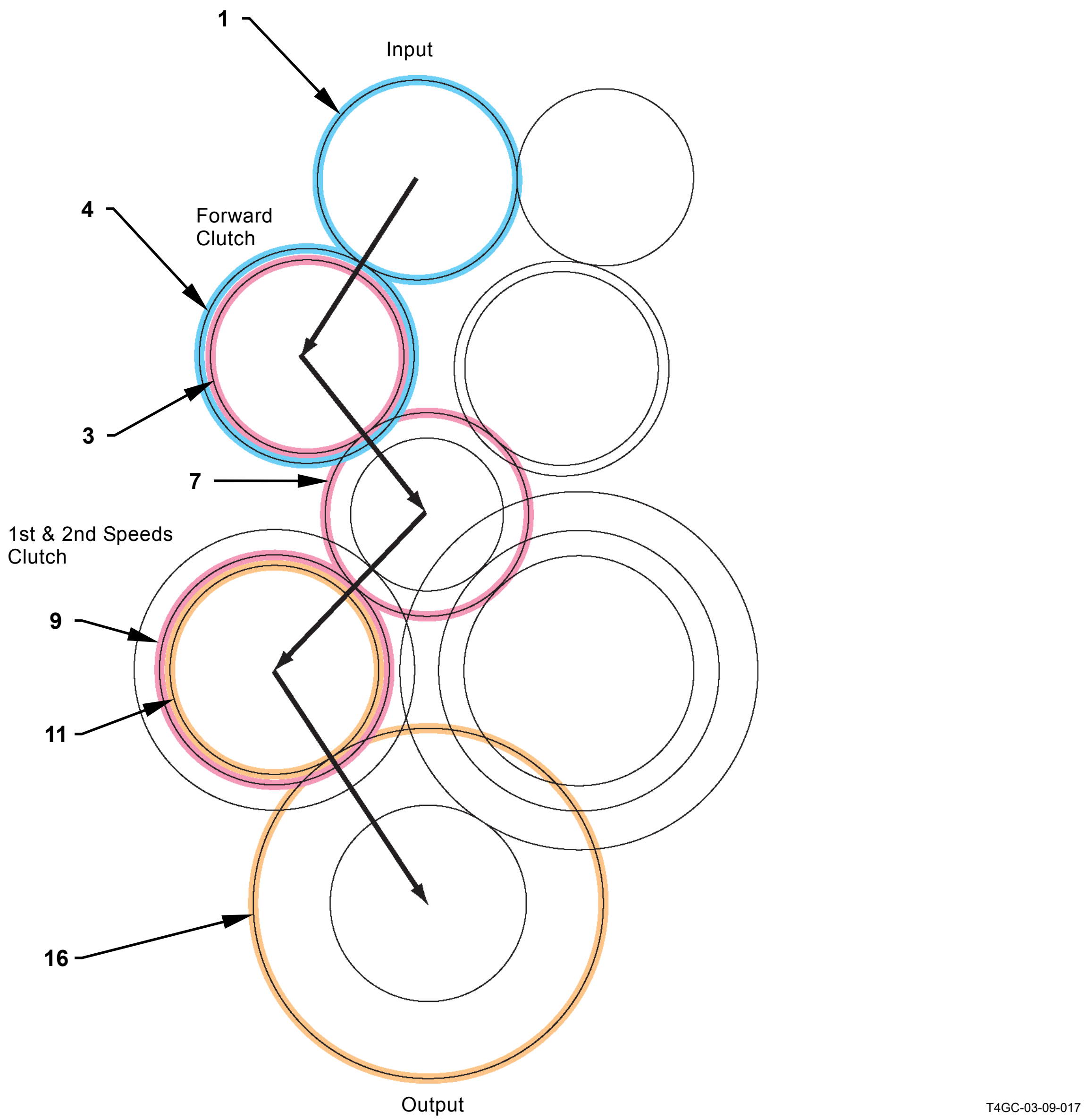


1 - Input Gear
3 - F–R Gear
4 - F Hub Gear
7 - Idler Gear
8 - Idler Gear
10 - 1st Speed Hub Gear
11 - Low-Range Gear
16 - Output Gear

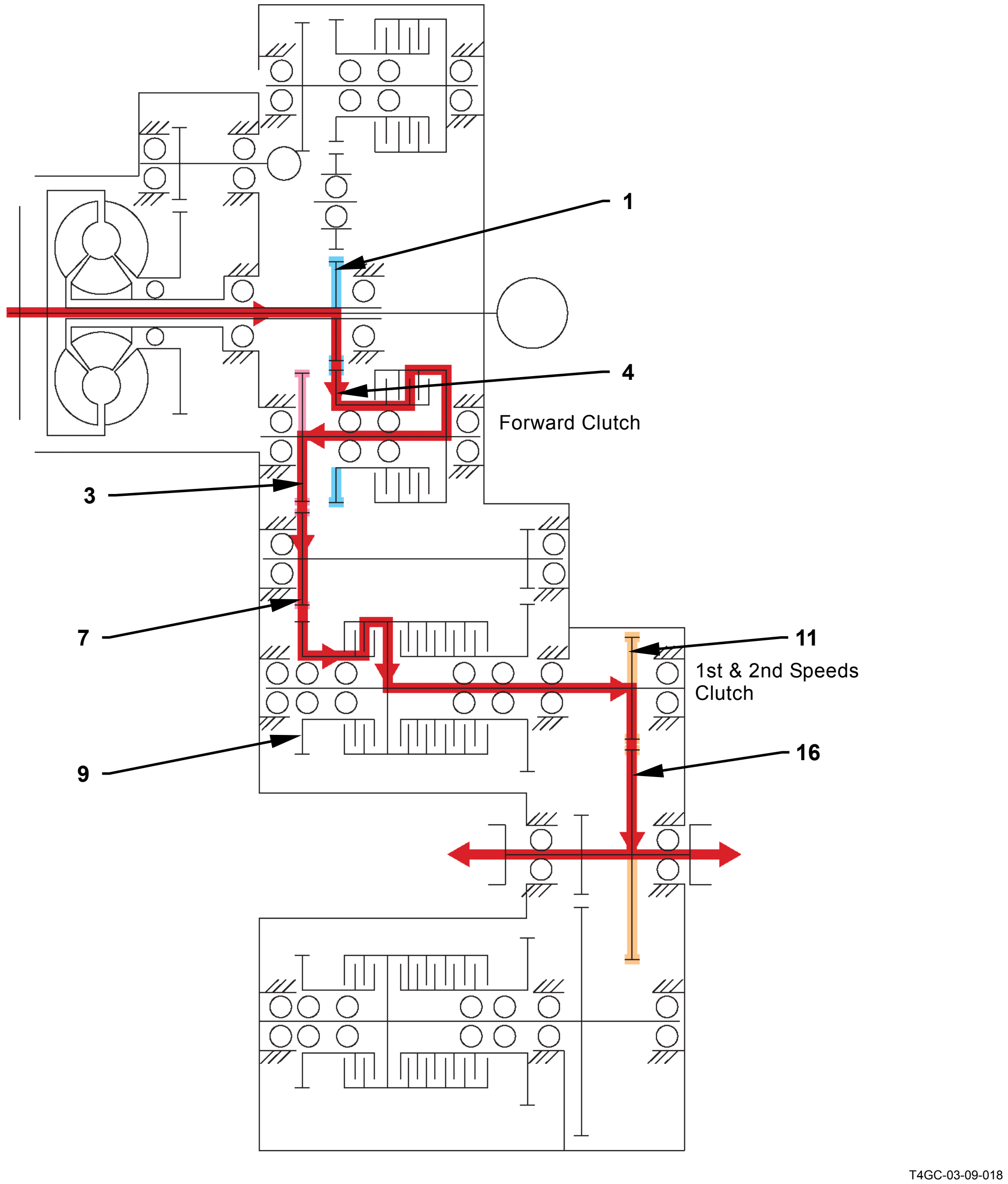
Forward 2nd Speed

In the case of forward 2nd speed, the forward clutch and the 2nd speed part of the 2nd speed clutch are connected. Torque converter transmits torque to F hub gear (4) geared to input gear (1).
Torque from F hub gear (4) is transmitted to the 2nd speed hub gear (9) through F - R gear (3) and idler gear (7).

Furthermore, torque is outputted from 2nd hub gear (9) to low-range gear (11), and eventually outputted to output gear (16).



Power Flow: Forward 2nd Speed

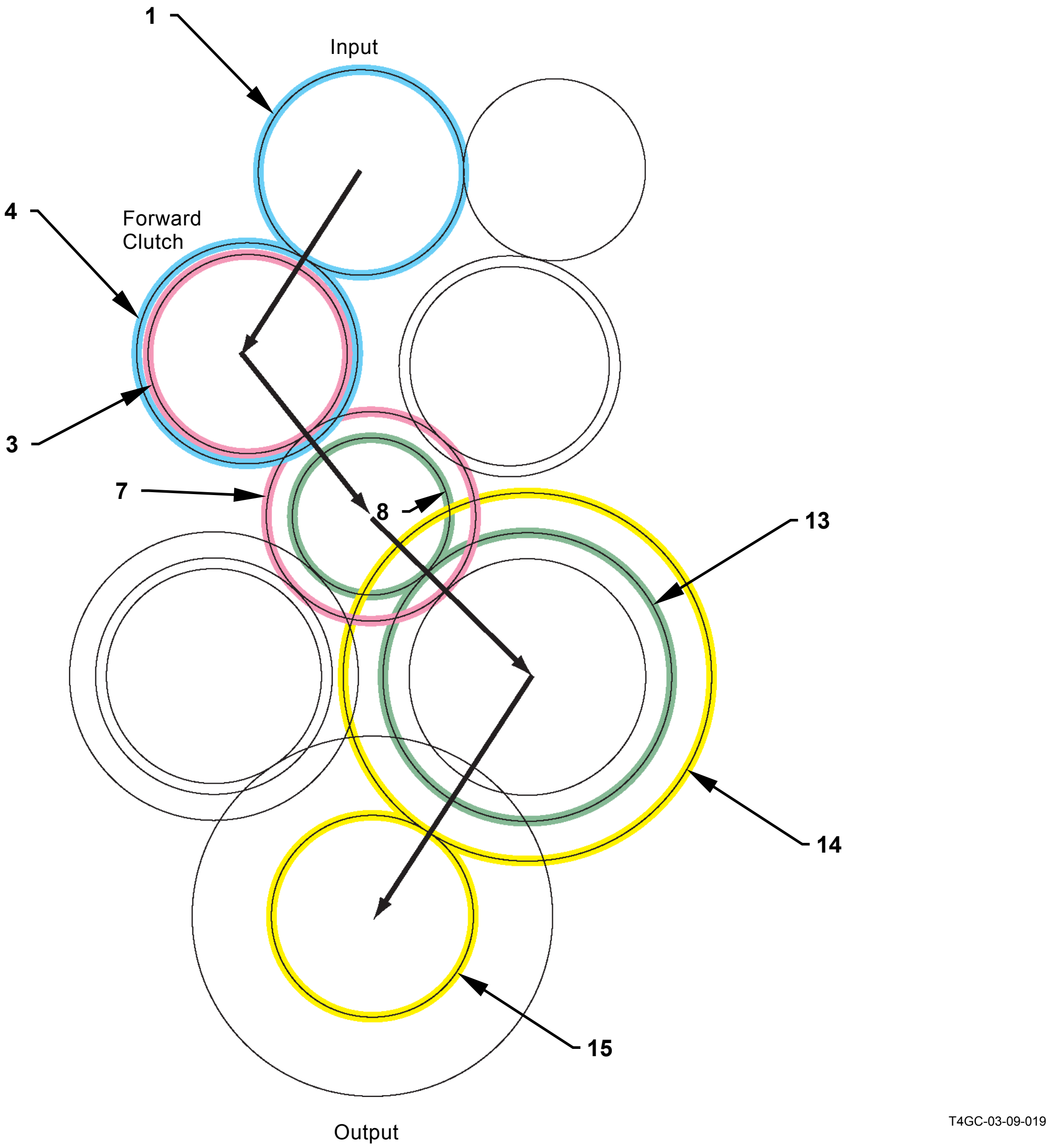


1 - Input Gear
3 - F–R Gear
4 - F Hub gear
7 - Idler Gear
9 - 2nd Speed Hub Gear
11 - Low-range Gear
16 - Output Gear

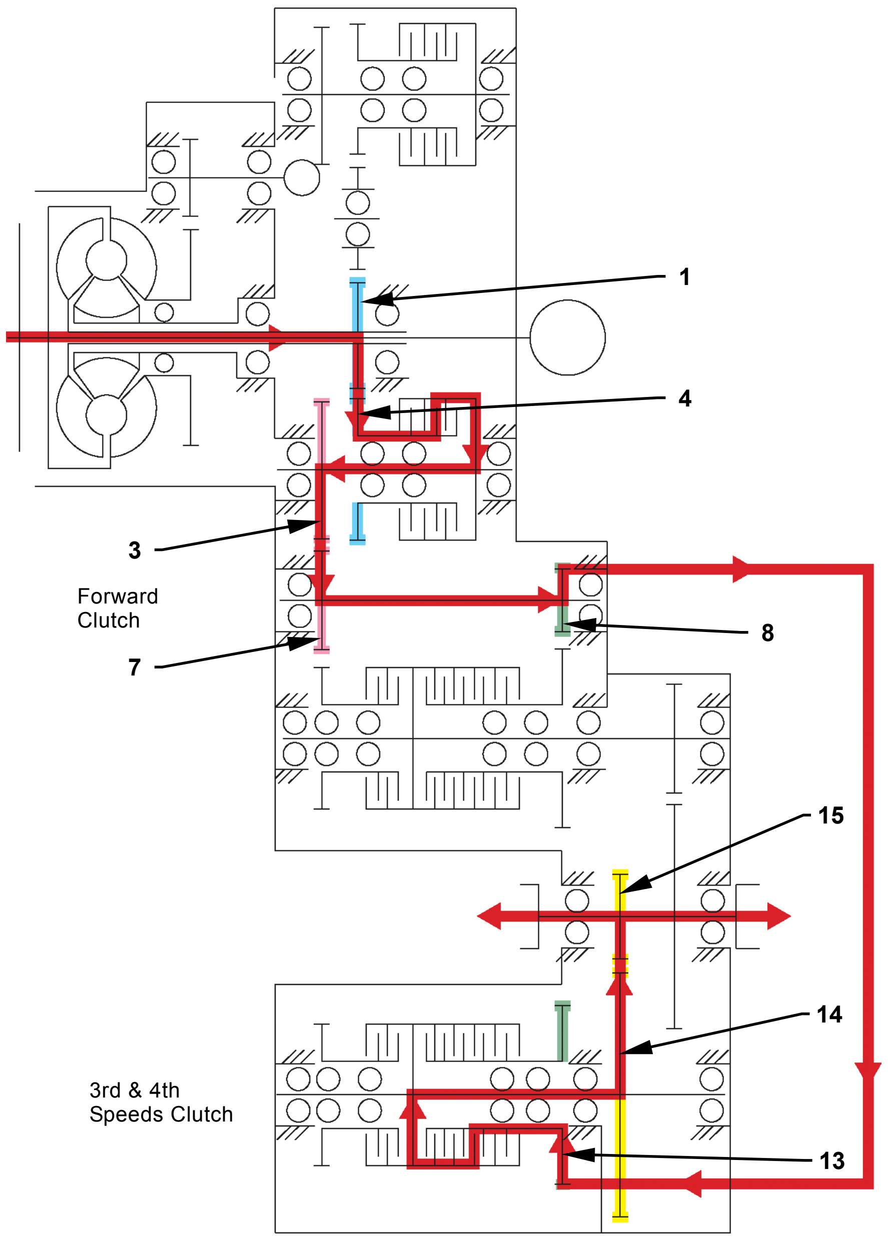
Forward 3rd Speed

In the case of forward 3rd speed, the forward clutch and the speed 3 part of the 3rd & 4th Speeds clutch are connected. Torque converter transmits torque to F hub gear (4) geared to the input gear (1).
Torque from F hub gear (4) is transmitted to 3rd Speed hub gear (13) through F - R gear (3) and idler gear (8).

Furthermore, torque is outputted from 3rd hub gear (13) to high-range gear (14), and eventually outputted to output gear (15).



Power Flow: Forward 3rd Speed



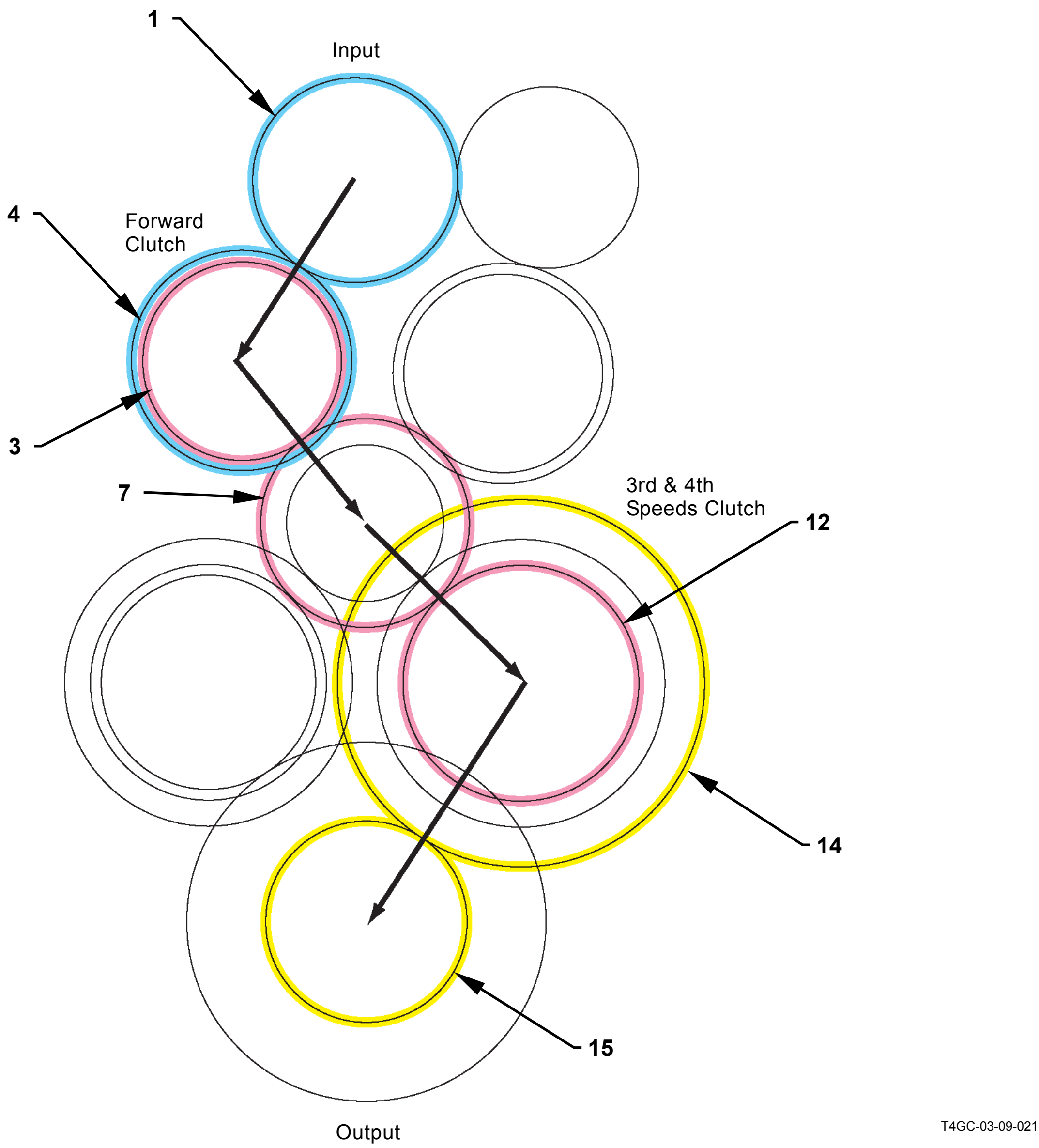
T4GC-03-09-020

1 - Input Gear
3 - F–R Gear
4 - F Hub Gear
7 - Idler Gear
8 - Idler Gear
13 - 3rd Hub Gear
14 - High-Range Gear
15 - Output Gear

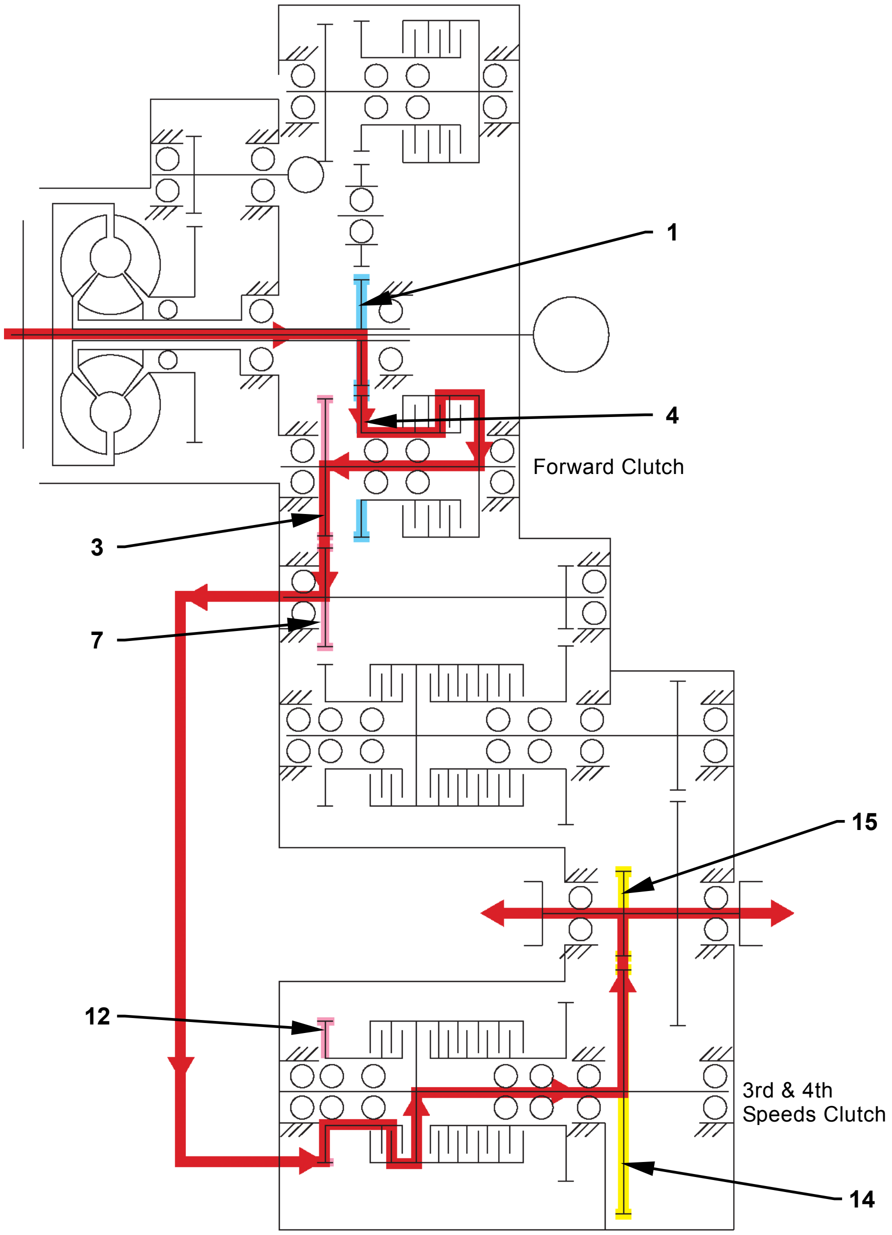
Forward 4th Speed

In the case of forward 4th speed, forward clutch and the 4th speed part of 3rd & 4th speeds clutch are connected. Torque converter transmits torque to F hub gear (4) geared to input gear (1).
Torque from F hub gear (4) is transmitted to 4th speed hub gear (12) through F - R gear (3) and the idler gear (7).

Furthermore, torque is outputted from the 4th hub gear (12) to the high-range gear (14), and eventually outputted to the output gear (15).



Power Flow: Forward 4th Speed

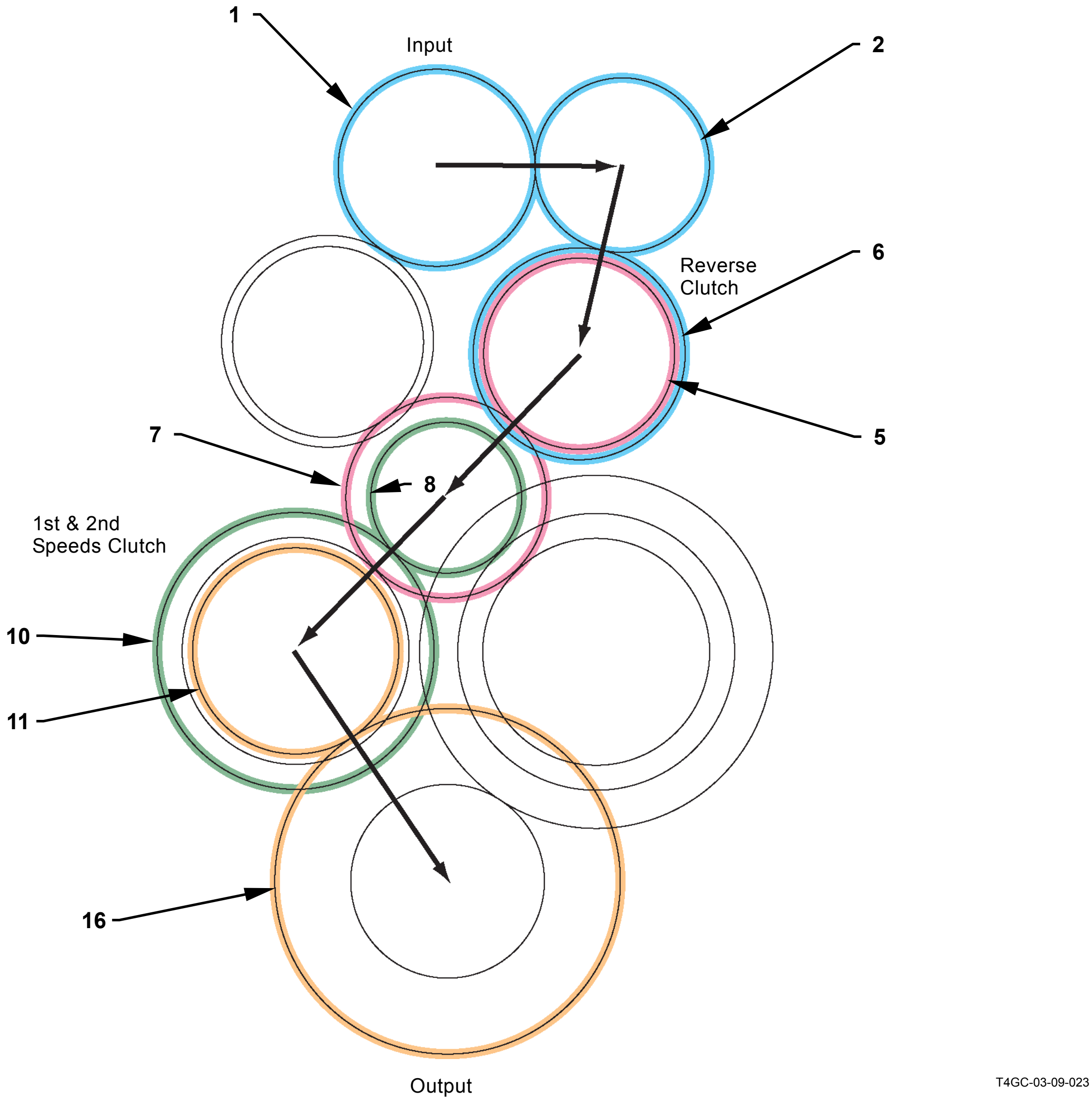


1 - Input Gear
3 - F–R Gear
4 - F Hub Gear
7 - Idler Gear
12 - 4th Hub Gear
14 - High-Range Gear
15 - Output Gear

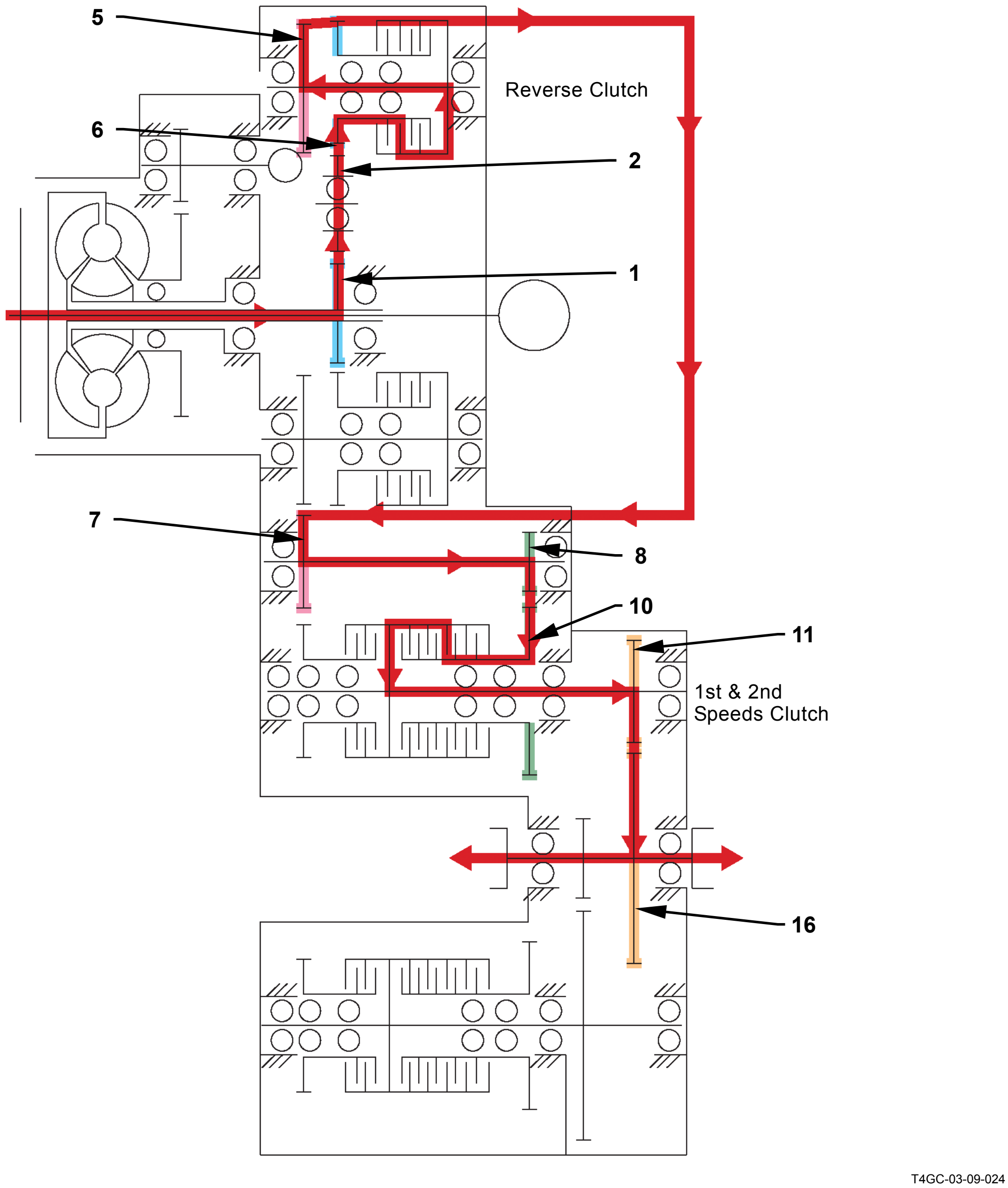
Reverse 1st Speed

In the case of reverse 1st speed, the reverse clutch and the 1st Speed part of the 1st & 2nd Speeds clutch are connected. Torque converter transmits torque to R hub gear (6) from reverse gear (2) geared to input gear (1).
Torque from R hub gear (6) is transmitted to 1st speed gear (10) through F - R gear (5), idler gear (7), and idler gear (8).

Furthermore, torque is outputted from 1st hub gear (10) to low-range gear (11), and eventually outputted to output gear (16).
Processes of the idler gear and after are applied to the other reverse speed shifts similarly.



Power Flow: Reverse 1st Speed



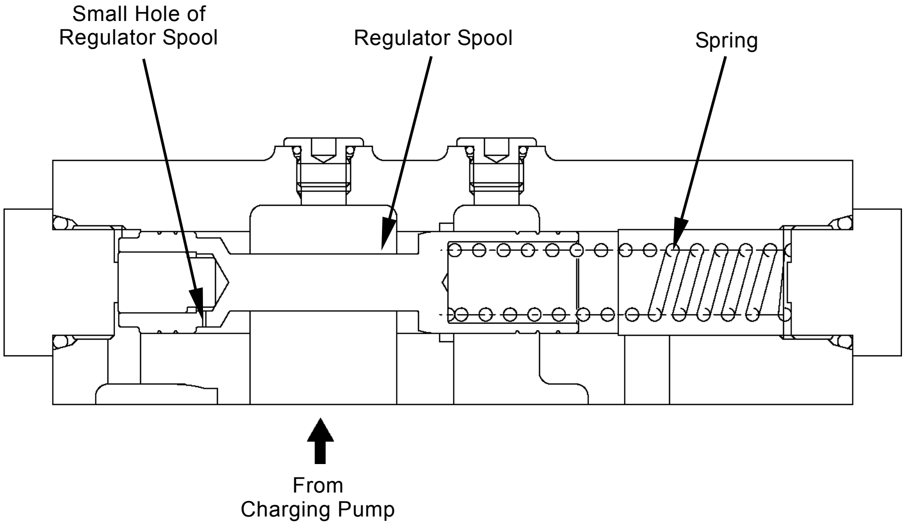
1 - Input Gear
2 - Reverse Gear
5 - FR Gear
6 - R Hub Gear
7 - Idler Gear
8 - Idler Gear
10 - 1st Hub Gear
11 - Low-Range Gear
16 - Output Gear

TRANSMISSION REGULATOR VALVE

The transmission regulator valve so controls the pressure oil from the charging pump as to be constant, and supplies it to the transmission control valve for controlling the clutch.

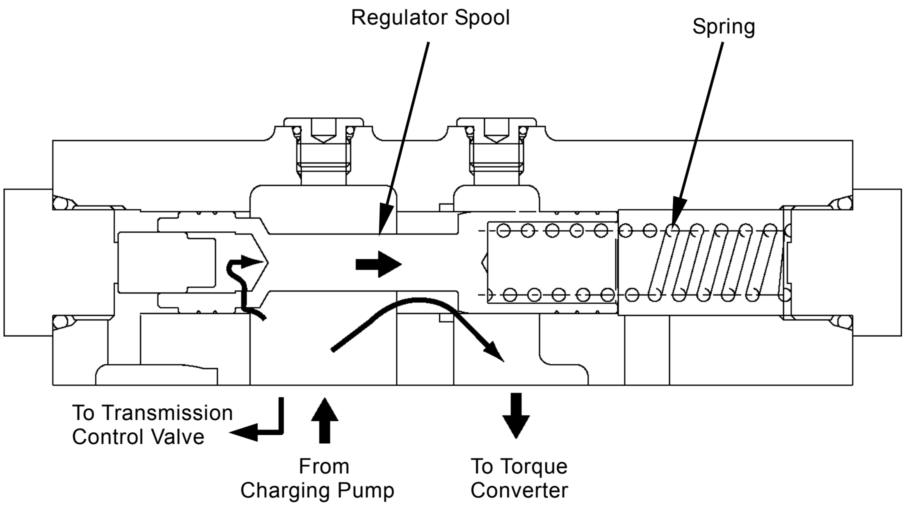
Pressure oil entering the P port of the regulator valve from the charging pump passes the small hole of the regulator spool, and enters the back chamber of the spool. When the oil pressure entering the back chamber rises higher than the pressure corresponding to the spring force, the regulator spool moves toward the spring, and the pressure oil at the P port flows from the outlet port to the torque converter. This movement of the spool keeps the pressure at port P constant. port P is connected to the transmission control valve, and pressure oil of a constant pressure is supplied to the transmission control valve. The pressure oil from Port P passes the oil passage inside the transmission casing, and is transferred to the transmission control valve. Oil overflow passes the oil passage in the mission case, and is transferred to the torque converter.

Normally



T4GC-03-09-025

When overflowing



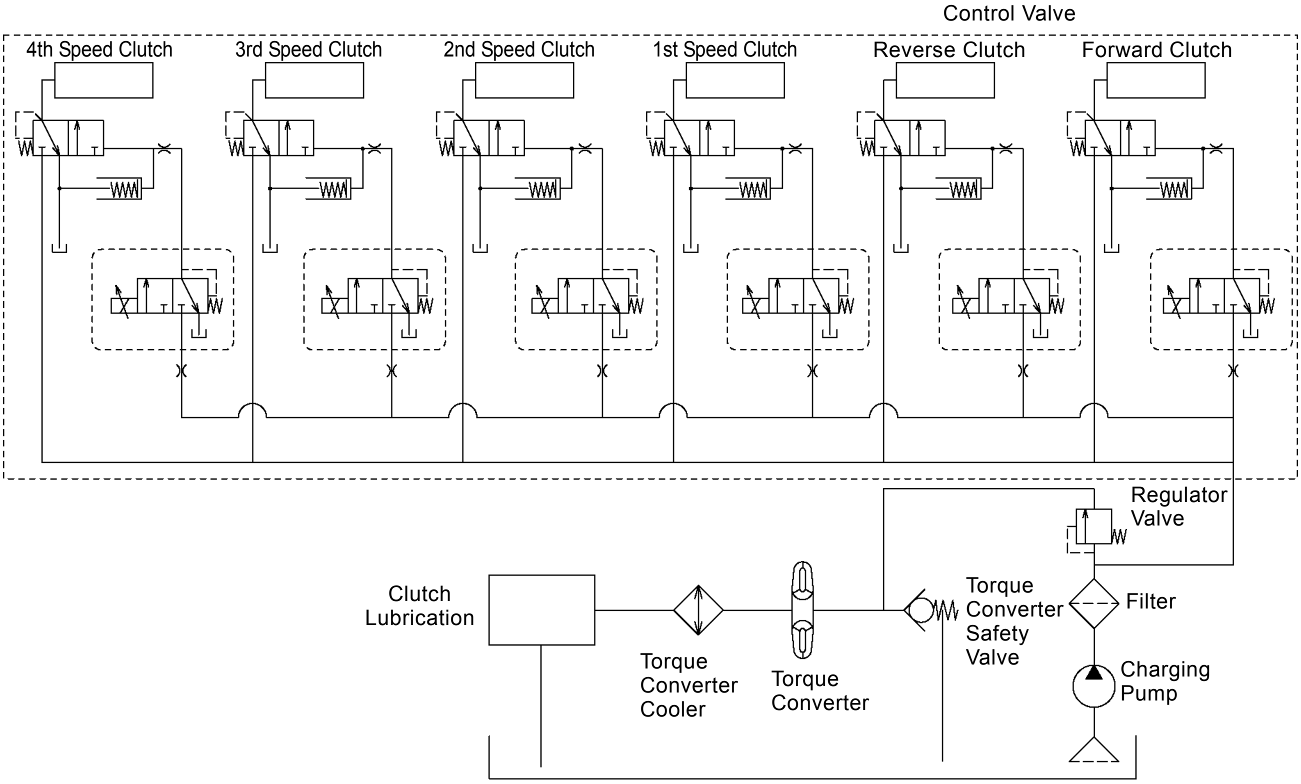
T4GC-03-09-026

TRANSMISSION CONTROL VALVE

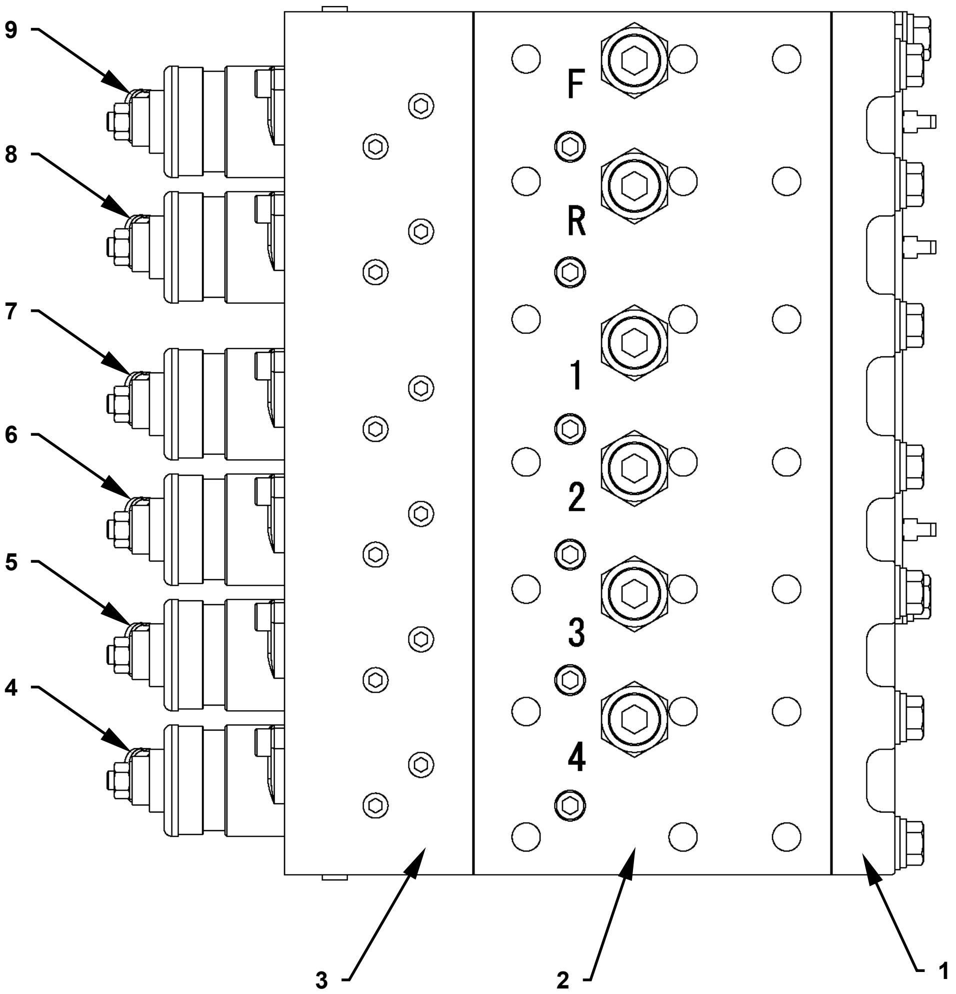
Transmission control valve transfers to each clutch the oil sent from the regulator valve, and makes changeover of the vehicle travel direction and speed shift.

Transmission control valve is composed of the valve body and the solenoid valves for the respective clutches, and controls the clutch oil pressure by operating the shift lever to actuate each solenoid valve, and by moving the modulation spool of the valve body.

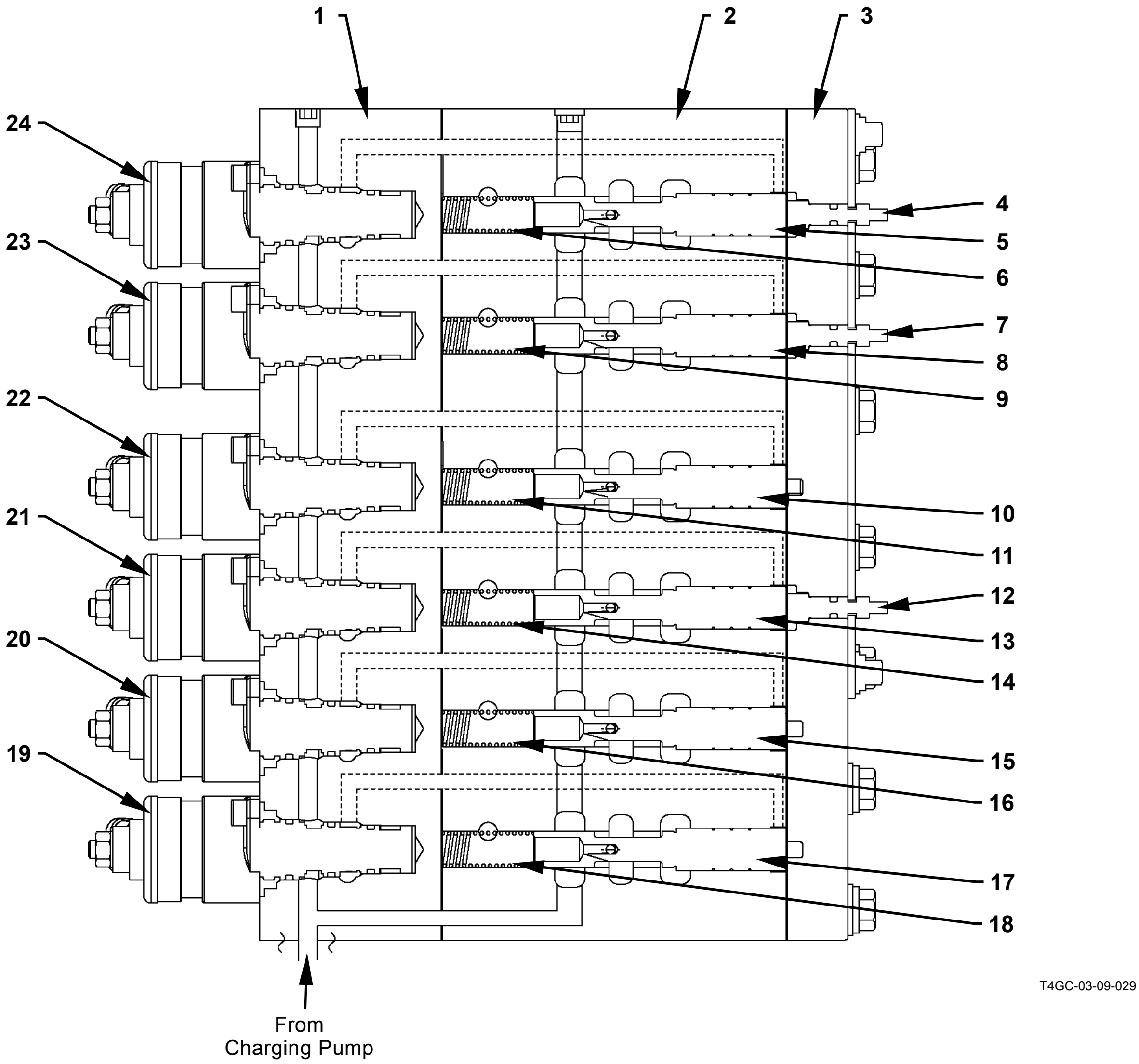
Proportional solenoid valves are controlled about their oil pressure by the electric signal transmitted from the controller, and can obtain oil pressure waves of different characteristics depending on the vehicle condition.



T4GC-03-09-027



1 - Cover	4 - 4th Speed Proportional Solenoid Valve	7 - 1st Speed Proportional Solenoid Valve
2 - Valve Body	5 - 3rd Speed Proportional Solenoid Valve	8 - Reverse Proportional Solenoid Valve
3 - Solenoid Body	6 - 2nd Speed Proportional Solenoid Valve	9 - Forward Proportional Solenoid Valve

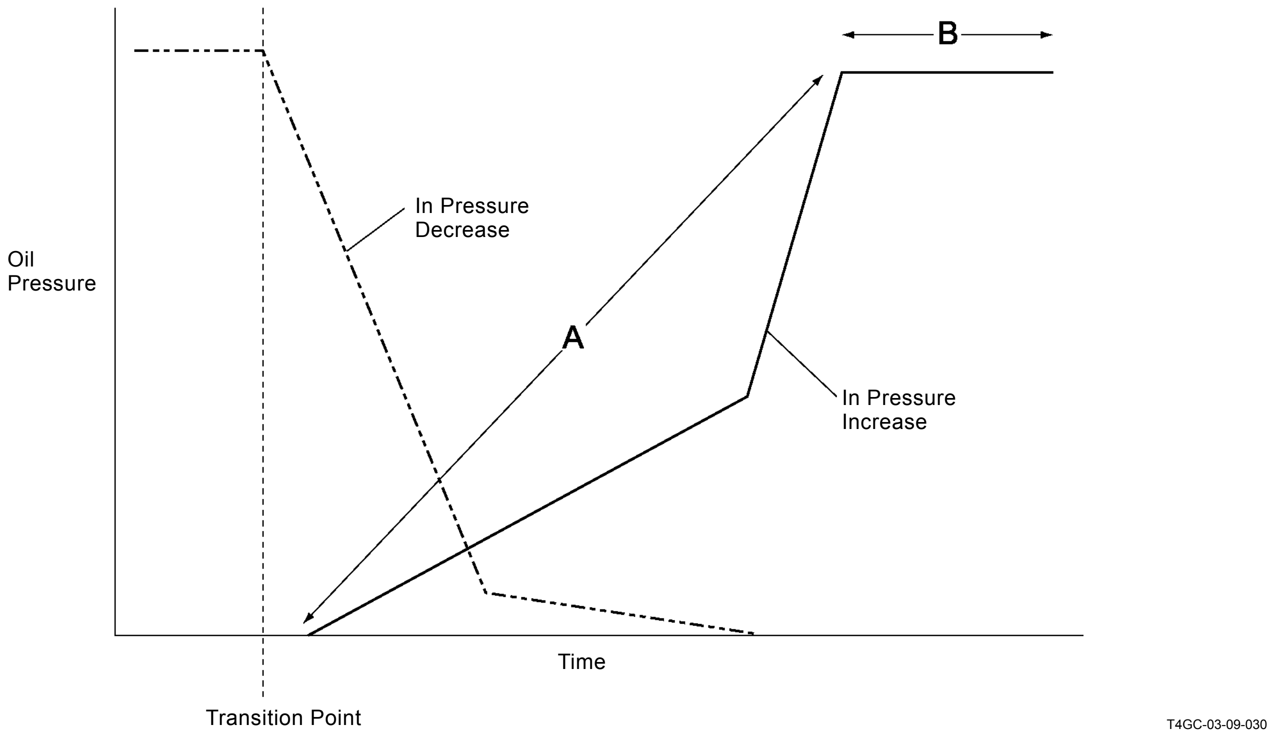


1 - Solenoid Body
2 - Valve Body
3 - Cover
4 - Emergency Forward Spool
5 - Forward Modulation Spool
6 - Forward Modulation Spring
7 - Emergency Reverse Spool
8 - Reverse Modulation Spool
9 - Reverse Modulation Spring
10 - 1st Speed Modulation Spool
11 - 1st Speed Modulation Spring
12 - Emergency 2nd Speed Spool
13 - 2nd Speed Modulation Spool
14 - 2nd Speed Modulation Spring
15 - 3rd Speed Modulation Spool
16 - 3rd Speed Modulation Spring
17 - 4th Speed Modulation Spool
18 - 4th Speed Modulation Spring
19 - 4th Speed Proportional Solenoid Valve
20 - 3rd Speed Proportional Solenoid Valve
21 - 2nd Speed Proportional Solenoid Valve
22 - 1st Speed Proportional Solenoid Valve
23 - Reverse Proportional Solenoid Valve
24 - Forward Proportional Solenoid Valve

Operation

Modulation mechanism enables smoother speed change by varying the pressure increase wave or pressure decrease wave of each clutch depending on the the vehicle condition (engine speed, vehicle speed, and others).
Vehicle condition is judged by analyzing the information (electric signal) sensed by the engine speed sensor, vehicle speed sensor, and shift lever utilizing the mission controller, and the electric signal is transmitted from the controller to the proportional solenoid valve depending on the shift change.

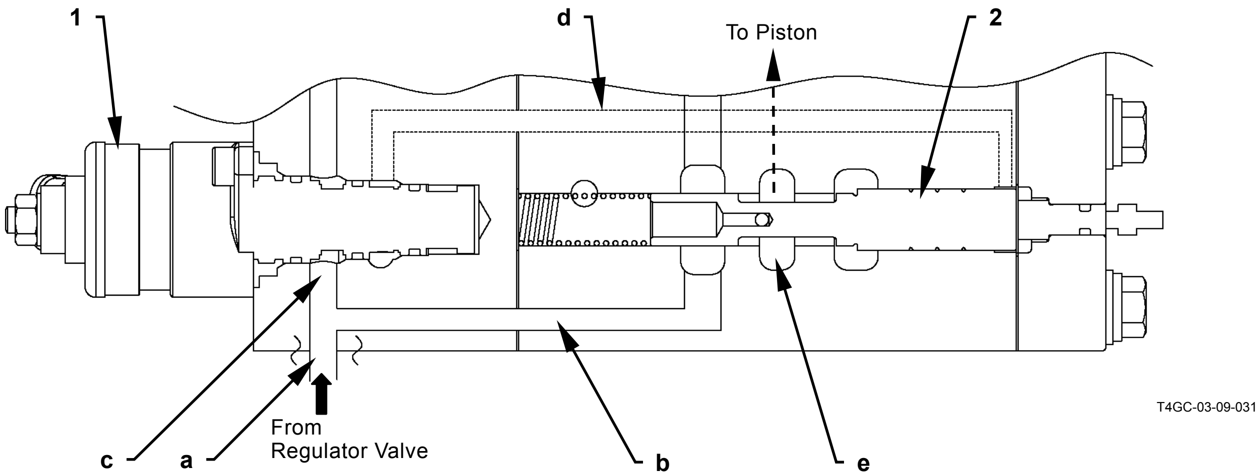
Proportional solenoid valve regulates the oil pressure depending on the electric signal transmitted from the controller, and transfers oil to the modulation spool.
Modulation spool regulates the clutch oil pressure also, depending on the oil pressure transmitted from the proportional solenoid valve, and transfers oil to the clutch piston.



Clutch Oil Pressure Wave

At Neutral

Pressure oil regulated by the regulator valve flows to the oil passage (a) of the transmission control valve, and is divided flowing into the oil passage (b) leading to the proportional solenoid valve (1) and the oil passage (c) of the modulation spool (2).
Oil does not flow from the oil passage (b) to the oil passage (d) because the electric signal to be transmitted from the controller to the proportional solenoid valve (1) is stopped in the neutral condition.
Also, oil is confined between the oil passage (c) and the oil passage (e) of the piston, so the clutch pressure is not raised, becoming the neutral condition.



1 - Proportional Solenoid Valve
2 - Modulation Spool

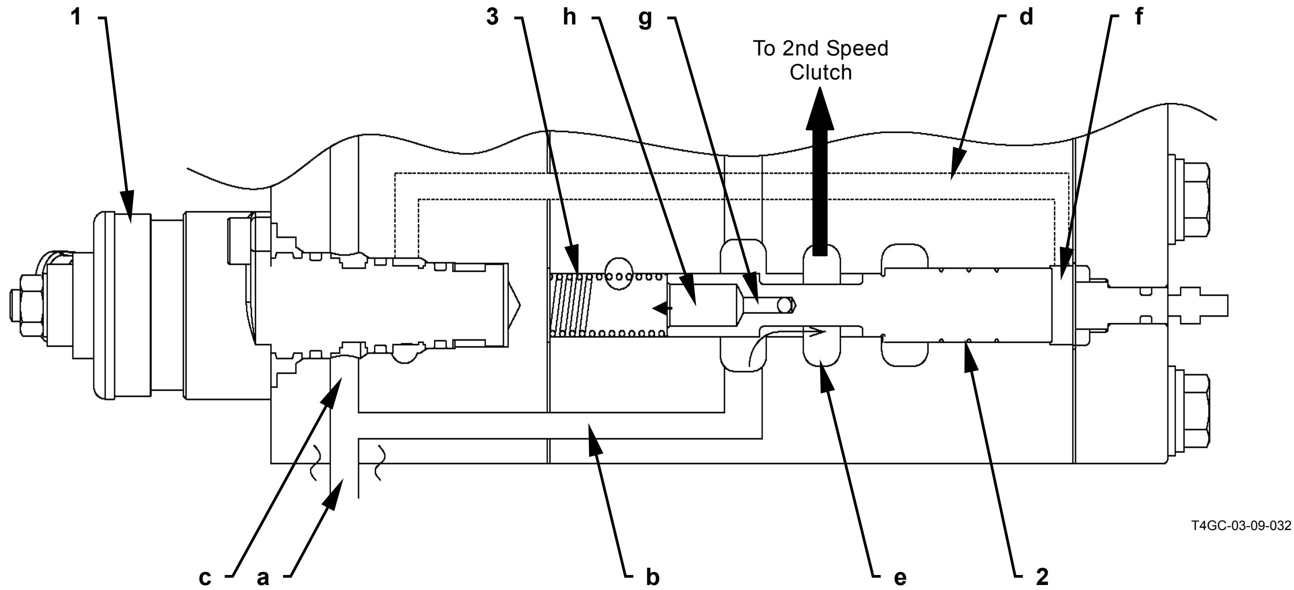
Shift to 2nd Speed from Neutral (In Pressure Increase)

- In Process of Clutch Connection
  (Refer to Oil Pressure Wave A of T3–9–32.)

  When the transmission is shifted by the lever, electric signal is transmitted from the controller to proportional solenoid valve (1).
  During oil pressure wave A, the oil transferred to oil passage (b) of proportional solenoid valve (1) is regulated to the pressure corresponding to the electric signal of the controller, and is transferred to the oil passage (d).

1. Oil transferred to oil passage (d) is transferred to pressure chamber (f) of the modulation spool (2), overcomes the force of modulation spring (3), and moves modulation spool (2) to the left column.
   As a result, oil is transferred from the oil passage (c) to oil passage (e) of the clutch piston, and the clutch pressure is raised.
2. Also, the oil transferred to the oil passage (e) passes back chamber (g) of modulation spool (2), and is sent to back chamber (h) of the modulation spool (2).
   As modulation spring (3) is assembled in back chamber (h) of modulation spool (2), overcomes the oil pressure in oila passage (e), and moves modulation spool (2) right, closing oil passage (e) temporarily.

Electric current from the controller is enlarged gradually, and repeats the processes in 1. and 2. As a result, the clutch oil pressure is gradually raised.



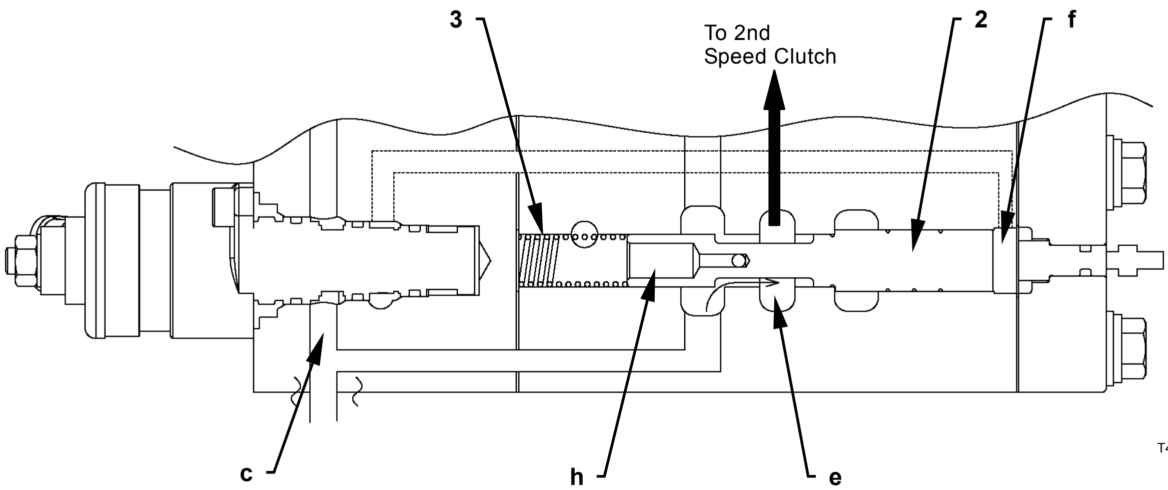
1 - Proportional Solenoid Valve
2 - Modulation Spool
3 - Modulation Spring

- At End of Clutch Connection
  (Refer to Pressure Oil Wave B of T3-9-32.)

  Finally, pressures in pressure chamber (f) and pressure chamber (h) become equal.
  Spring (3) is assembled in pressure chamber (h), but as the spool diameter in the pressure chamber (f) is larger than the diameter corresponding to the pressure chamber (h) plus spring (3) force, the modulation spool (2) is pushed to fully stroke. Therefore, completely opening oil passage (c) and the oil passage (e). (Refer to the drawing below.)
  As a result, the clutch pressure and the regulator pressure become equal and constant.

- In Shift Down Condition from Forward 2nd Speed to 1st Speed [at DSS]

  Pressure increase of the 1st Speed clutch pressure is similar to “Speed Shift Change from Neutral to 2nd Speed.”
  Pressure decrease of the 2nd Speed clutch pressure is operated reversely, and the clutch pressure is gradually lowered by gradually lowering the electric signal (electric current value) from the high condition.
  Overlapping the clutch pressure of the partner clutch pressure by gradually raising the 1st Speed clutch pressure and gradually lowering the 2 nd clutch pressure eliminates lack of torque at the time of shift down in digging, and achieves smooth workability.
  Proportional solenoid valve and the modulation spool organize a set in terms of construction, and enables obtaining constantly best modulation pressure wave by combining the pressure increase characteristics and the pressure decrease characteristics. (Refer to Clutch Oil Pressure Wave on T3-9-32.)



1 - Modulation Spool
2 - Modulation Spring

MANUAL SPOOL (EMERGENCY TRAVEL SPOOL)

In case the solenoid valve cannot be operated caused by electric disorders (e.g.: disconnection), changeover of the control valve to Forward 2nd Speed or Reverse 2nd Speed is possible by manually operating this spool. This spool is used for self-traveling of the vehicle to the place of maintenance in an emergency or something.

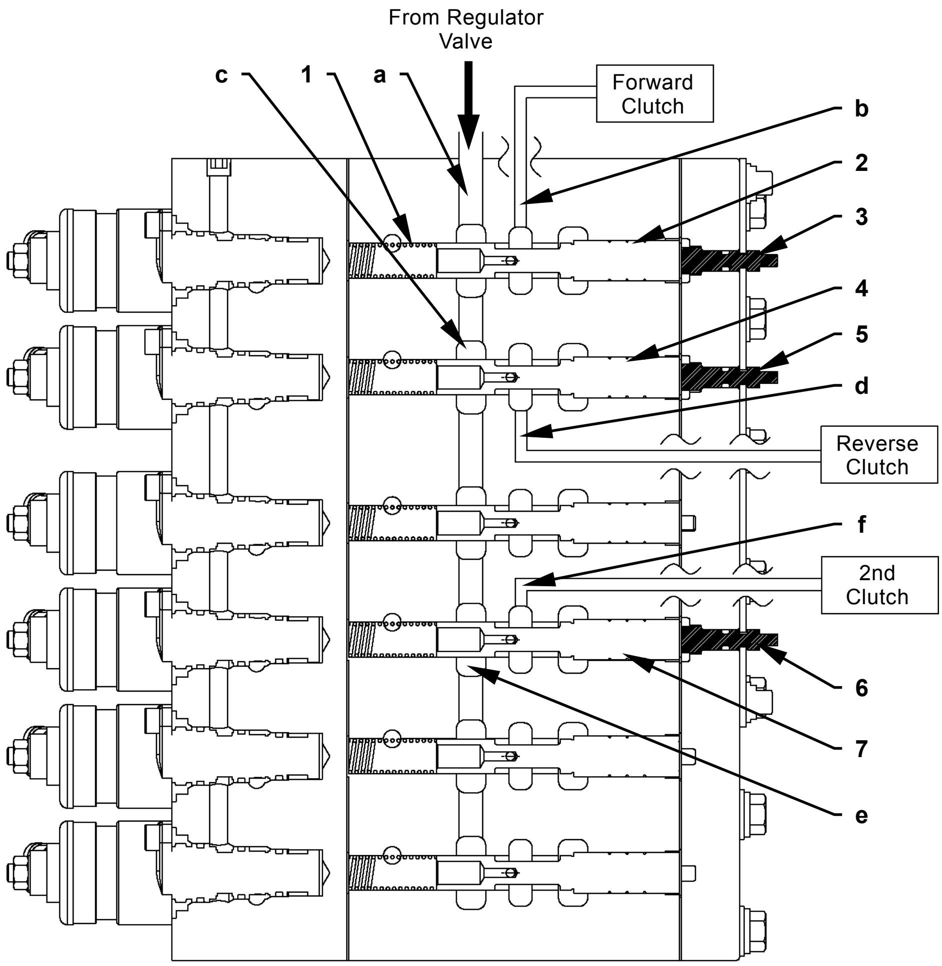
IMPORTANT: Prior to use of the manual spool, stop the engine. Operating the manual spool while the engine is running is dangerous because the vehicle can begin moving.

Operation

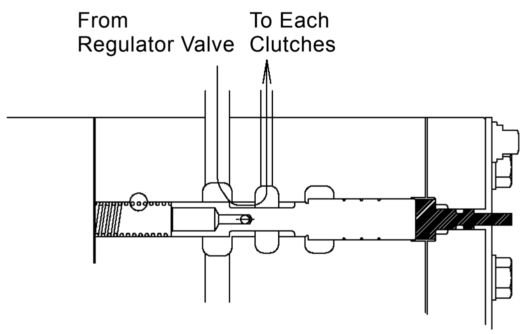
- Forward 2nd Speed
  When changeover to Forward 2nd Speed is made, push in the forward emergency travel spool (3) and 2nd emergency travel spool (5) each by 5 mm, and turn them 90 degrees, keeping pushing them.
  Oil regulated to the regulator pressure flows into the passage (b) through the passage (a) opened by the forward modulation spool, and flows to the forward clutch to connect the clutch.
  Similarly, the 2nd clutch also flows into the oil passage (f) through the oil passage (e) opened by the 2nd modulation spool (7), and flows to the 2nd clutch to connect the clutch.

- Reverse 2nd Speed
  When the forward emergency travel spool (3) is turned by 90 degrees, the spool returns to the original position by the force of the spring (1).
  Similarly to forward 2nd speed, in reverse 2nd speed, push in the reverse emergency travel spool (5) by 5 mm, and turns it 90 degrees.
  Oil regulated to the regulator pressure flows into the oil passage (d), through the oil passage (c) opened by the reverse modulation spool (4), and flows to the reverse clutch to connect the clutch.

IMPORTANT: Avoid simultaneous use of the forward emergency travel spool (3) and the reverse emergency travel spool (5).
Breakage of the clutch can be caused.



• In Operation of Manual Spool



T4GC-03-09-034

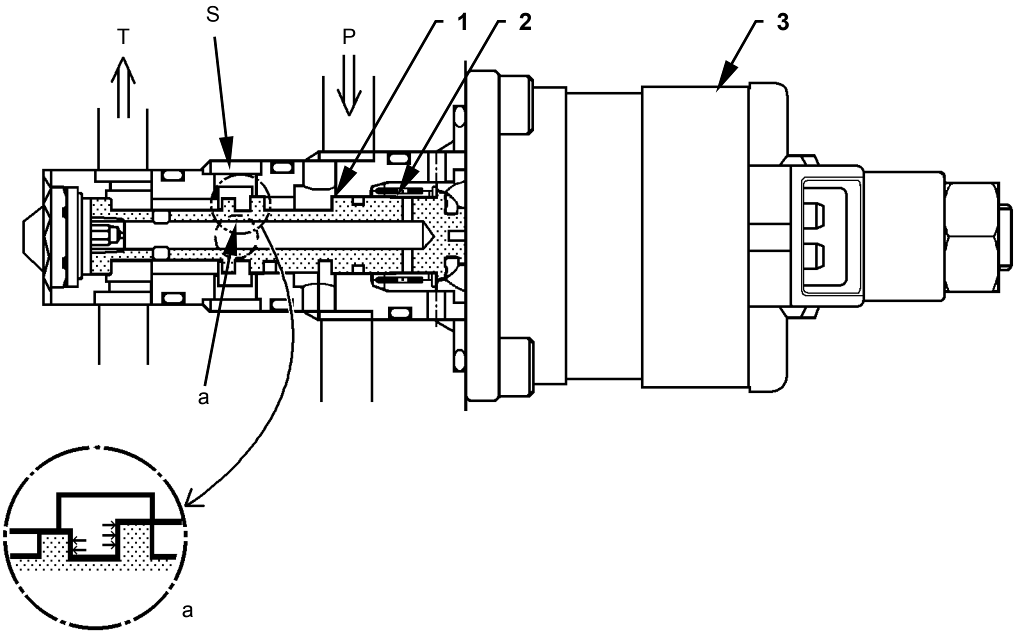
1 - Modulation Spring
2 - Forward Modulation Spool
3 - Emergency Forward Spool
4 - Reverse Modulation Spool
5 - Emergency Reverse Spool
6 - Emergency 2nd Speed Spool
7 - 2nd Speed Modulation Spool

PROPORTIONAL SOLENOID VALVE

Proportional splenoid valve is used as a pilot valve for the clutch oil pressure, and transfers oil to the modulation spool by receiving the electric signal from the controller, and by raising or lowering the oil pressure.

Operation

- At Neutral: Spool (1) is pushed right by the spring (2), and outlet port S is connected with tank port T.
- At Excitement: Solenoid valve (3) pushes the spool (1) left with a force in proportion to the electric current flowing at the solenoid (3). Pilot pressure oil flows to output port S from port P, and the pressure at output port S rises.
  This pressure at output port S works on the shoulder part ‘a’ of the spool (1). Shoulder part ‘a’ has different sectional areas, and generates a force to push the spool (1). When the pressure at output port S rises, and the force pushing the spool (1) right becomes larger than the force due to the solenoid (3) to push the spool (1) left, the spool (1) is returned to the right, the passage between output port S and port P is closed, and the pressure at output port S stops rising.



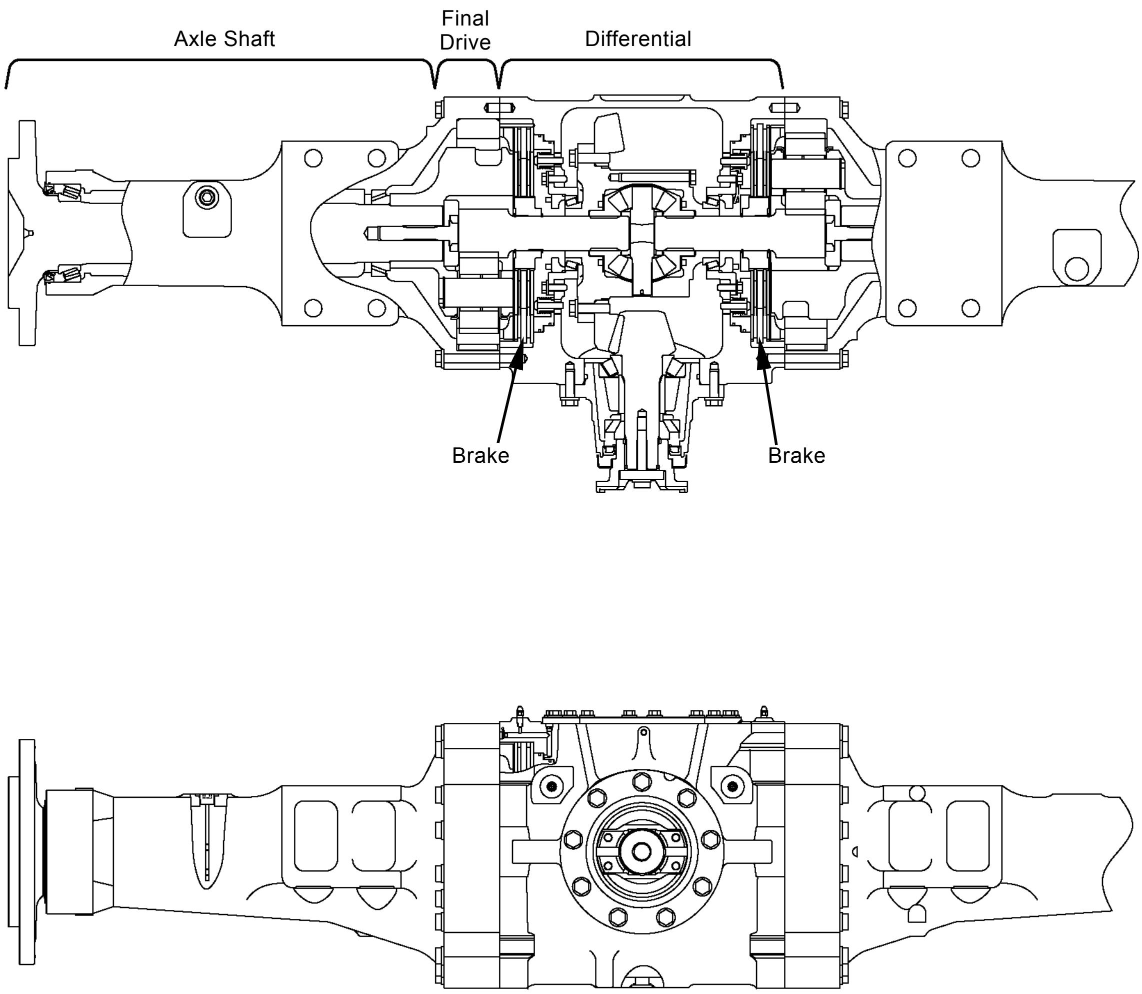
T107-02-07-005

1 - Spool
2 - Spring
3 - Solenoid

OUTLINE

Axle consists of the differential, final drive, axle shaft, brake, and others.

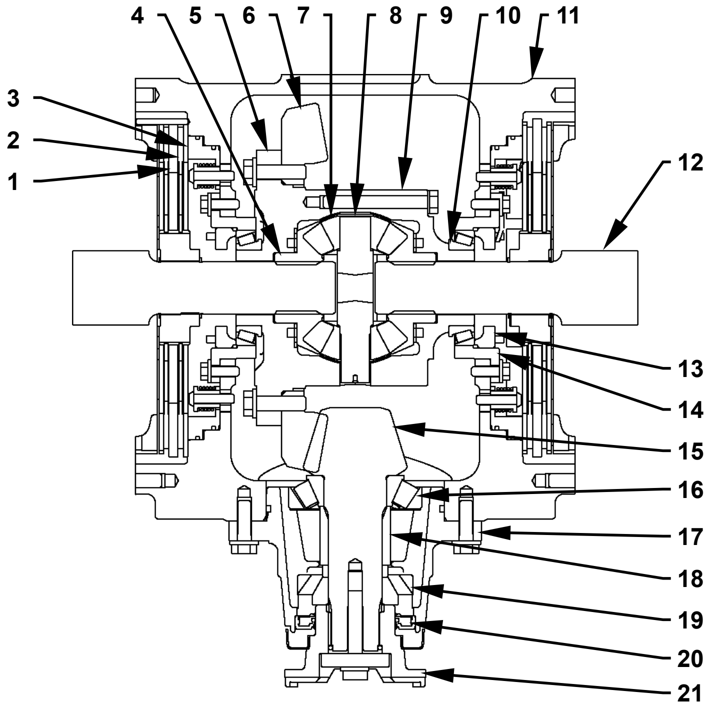
Power from the transmission is transmitted to the front axle and the rear axle through the propeller shaft. Inside the axle, power is transmitted to the differential, and divided into left and right, and drives the axle shaft and the wheels through the final drive.



T4GB-03-10-001

DIFFERENTIAL

Differential enables the left and the right drive wheels to rotate at different rotating speeds in steering of the vehicle body or traveling on bumpy roads.



T4GB-03-10-002

1 - Brake Ring	7 - Pinion Gear	13 - Adjusting Nut	19 - Roller Bearing
2 - Brake Disc	8 - Spider	14 - Bearing Retainer	20 - Oil Seal
3 - Piston	9 - Case B	15 - Pinion Shaft	21 - Flange
4 - Side Gear	10 - Roller Bearing	16 - Roller Bearing	
5 - Case A	11 - Differential Body	17 - Bearing Cage	
6 - Ring Gear	12 - Gear & Shaft	18 - Spacer	

Function

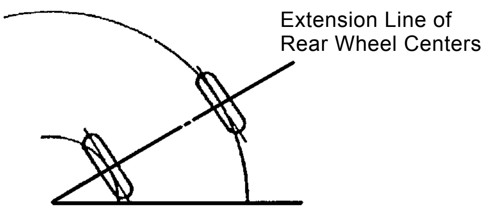
- **Purpose of Differential**

  When the vehicle body is steered, the inner wheel turns with a smaller radius, so the outer wheel needs to rotate faster for smooth steering.

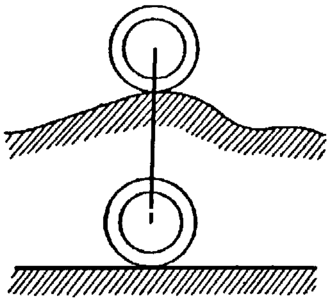
  Suppose driving the rear wheel by directly installing the gear to the propeller shaft with a shaft having no differential.

  In this case, the outer wheel and the rear wheel rotate the same amount. In other words, when the vehicle body is steered, the outer wheel cannot rotate more than the inner wheel, and as a result, skidding sideways or tire wear takes place. Also, the axle shaft is subjected to torsional stress, resulting in unstable transmission of drive force.

  On the other hand, in case a differential is installed, the inner and the outer wheels can rotate at different speeds, and the problem mentioned above can be eliminated.



In Turning of Vehicle Body

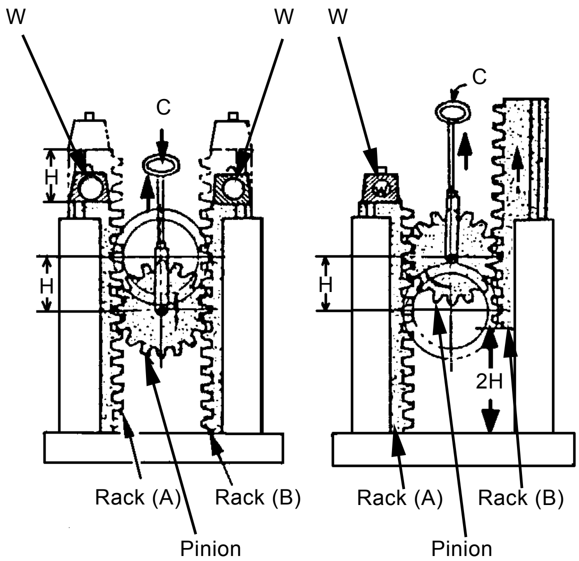


In Traveling of Vehicle Body on Rough Roads

T202-03-05-005

- **Principle of Differential**

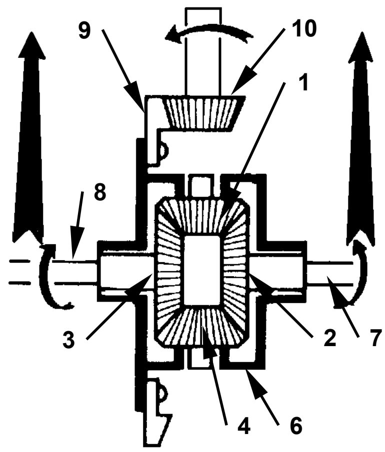
Operation principle of the differential is explained here comparing it to the racks and the pinion gear in the drawing.
When the load W is equally applied to the racks A and B, if C is moved upward by the distance of H, the racks A and B both move by the same distance of H in unison with the pinion.
If moved by removing the load to the rack B, the pinion rotates on the rack A (with load applied), and moves the rack B upward. At this time, the distance the rack B moves is longer than the distance the pinion moves rotating.
Distance the rack B moves can be calculated using the equation of H+H=2H. This principle is applied to the differential.



T202-03-05-006

- **Operation of Differential**

In Traveling Straight
In case resistances applied to the axle shafts (7) and (8) connected by spline to the differential side gears (2) and (3) are the same, or in case the vehicle body is traveling straight on plane roads, the differential pinion gears (1) and (4) remain unrotated.
Differential pinion gears (1) and (4) and the side gears (2) and (3) remain fixed by being mutually geared, and rotate in unison with the housing (6) connected with the ring gear (9).
In case the constituent portion of the whole is rotating solidly like this, the differential function of the differential does not work, but gears (1), (2), (3), and (4) play only the role of joints for connecting the axle shafts (7) and (8).



T487-03-06-014

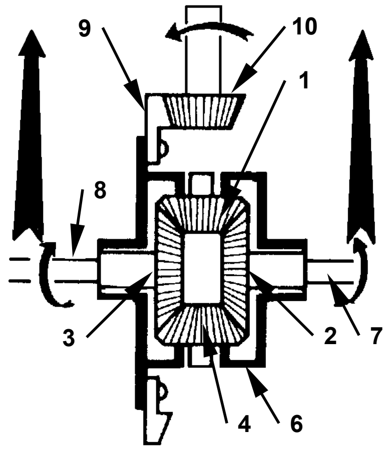
In Steering

When the vehicle body swings, uneven resistances are applied to the drive wheels. Therefore, caused by the difference of the resistances applied to the inner and outer wheels, the differential pinion gears (1) and (4) begin revolving on the side gears (2) and (3), each rotating round the pinion shaft. As a result, in case the resistance force applied to the shaft (7) is large, the pinion gears (1) and (4) rotate in the same direction as the rotational direction on the side gear (2) of the shaft (7). And the speed of the shaft (7) is lowered, and the amount of the speed reduction is applied to the shaft (8), working the differential function.

Suppose the ring gear (9) is driven by the drive pinion (10) at the speed of 100. In the condition of the vehicle body traveling straight, the drive wheels on the both sides rotate at the same speed.

However, in case the vehicle body swings, and the speed of the right drive wheel is lowered to 90, the left wheel turns at the speed of 100+(100−90)=110 because the speed of 10(100−90=10) is added to the speed of the left wheel.

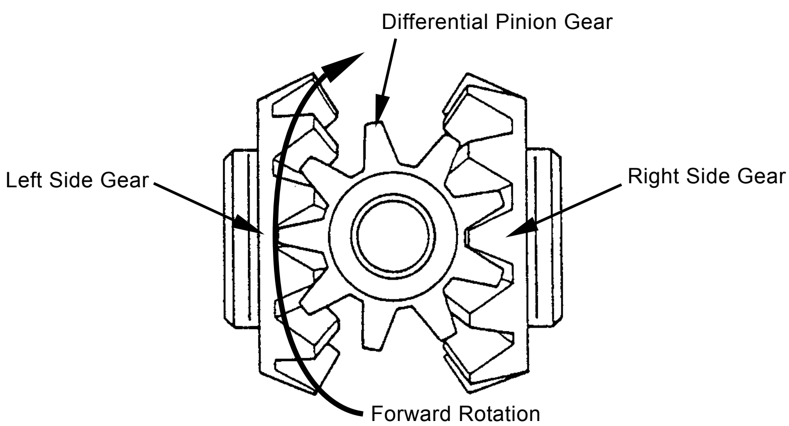
If the ring gear (9) rotates at 100, the summation of the speeds of the left and right wheels becomes always 200 regardless of movement of the respective wheels.



T487-03-06-014

TORQUE PROPORTIONING DIFFERENTIAL (TPD)

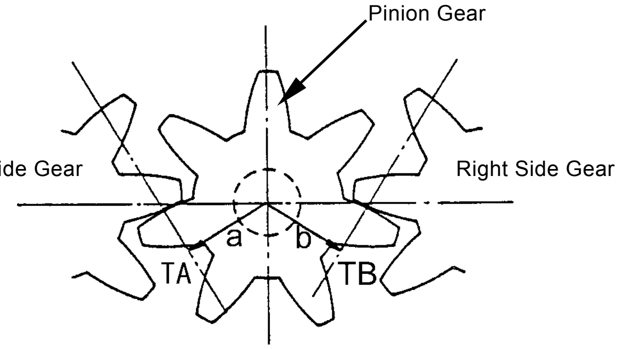
Wheel loader is operated mostly on roads of bad conditions. In case of skidding, working efficiency and tire lives are lowered. In order to avoid lowering of working efficiency and tire lives, the axle is provided with the torque proportioning differential.
Differential pinion gear of the torque proportioning differential has an odd number of teeth, and the differential pinion gear and the side gear have special tooth profiles. Therefore, the difference of the road resistances to the left and right tires causes deviation of the gearing locations between the differential pinion gear and the left and right side gears, and the drive force transferred to the left and right tires changes.



T487-03-06-015

Traveling Straight with the Same Resistances to Left and Right Tires

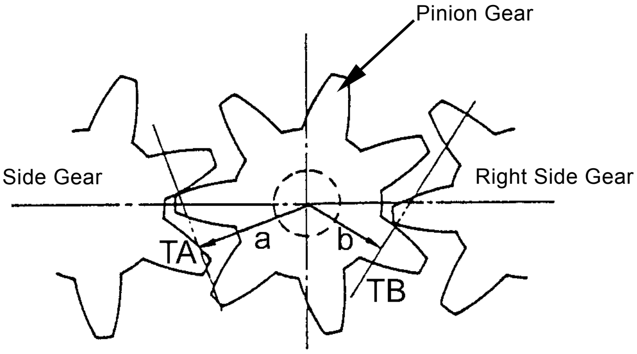
In case resistances to the left and right tires are the same, the distances ‘a’ and ‘b’ from the differential pinion gear center to the respective contact points of the left and right side gears are the same. Therefore, the differential pinion gear and the left and right side gears solidly rotate toward forward, and the drive forces of the left and right tires become the same.



T487-03-06-016

Traveling on Soft Roads (Different Resistances to Left and Right Tires)

In traveling on soft roads, if the left tire skids, the side gear on the left tire receiving little resistance tends to rotate more forward than the right side gear. This rotation causes deviation of the contact points of the differential pinion gear and the left and right side gears in the torque proportioning differential.
In case the left side gear rotates slightly more forward than the right side gear, the distance ‘a’ of the contact point of the differential pinion gear and the left side gear is lengthened. Correlation of the forces at this time is as follows. a×TA (force applied to the left side gear) = b×TB (force applied to the right side gear).
Until the difference of the road resistances exceeds certain value, the differential pinion gear does not roate, but the left and right side gears rotate at the same speed solidly. Besides, the left tire does not rotate reduntantly, and does not skid. (Right tire can have drive force larger than the left tire.) Therefore, tire lives are prolonged, and working efficiency is improved.



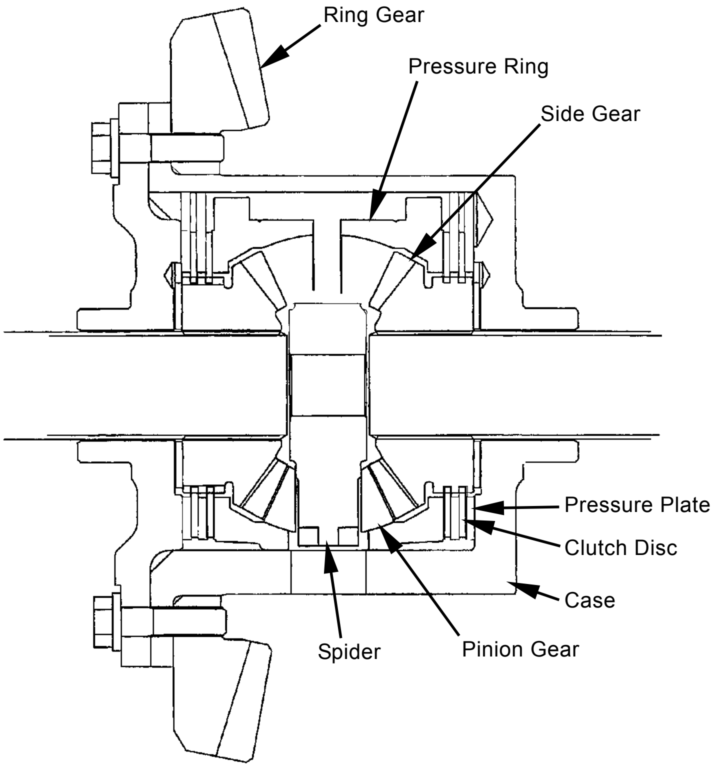
T487-03-06-017

LIMITED SLIP DIFFERENTIAL (LSD) (Optional)

Wheel loader, as required by the kind of work, must be operated in places where skidding takes place easily like sand and muddy soil. In places like these, Tires can slip even if the torque proportioning differential (TPD) is installed. Rotation is transmitted to the slipping tire, but not to the tires contacting the earth, so not only the funtion of the wheel loader is worsened, but the tire lives are shortened.
In order to avoid this, the limited slip differential (LSD) provided with the differential movement restriction device for avoiding different movement of the left and right wheels is adopted. Drive force transmitted to the left and right tires further changes.

Operation Principle

LSD is so constructed that the clutch disc is inserted between the pressure ring supporting the spider with the cam and the case, which makes restriction of different movement by keeping the tire speeds the same by the resistances of the friction surfaces. Also, the variation of the dive force transmitted to the left and right tires is made larger than the TPD.

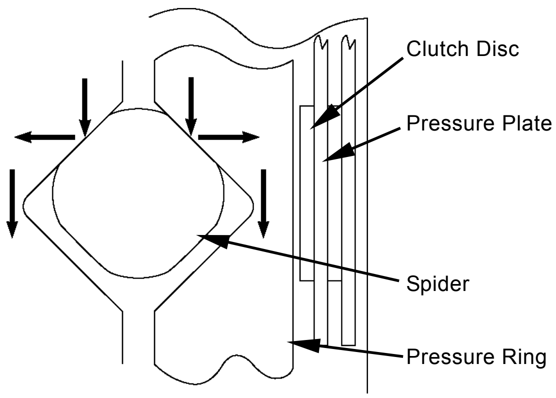


T4GB-03-10-003

Traveling Straight with the Same Road Resistances to Left and Right Tires

As the differential pinion gear and the left and right pinion gears rotate solidly, the drive forces of the left and right tires are the same similarly to the TPD.

Traveling on Soft Roads (Different Road Resistances to Left and Right Tires)



T4GB-03-10-004

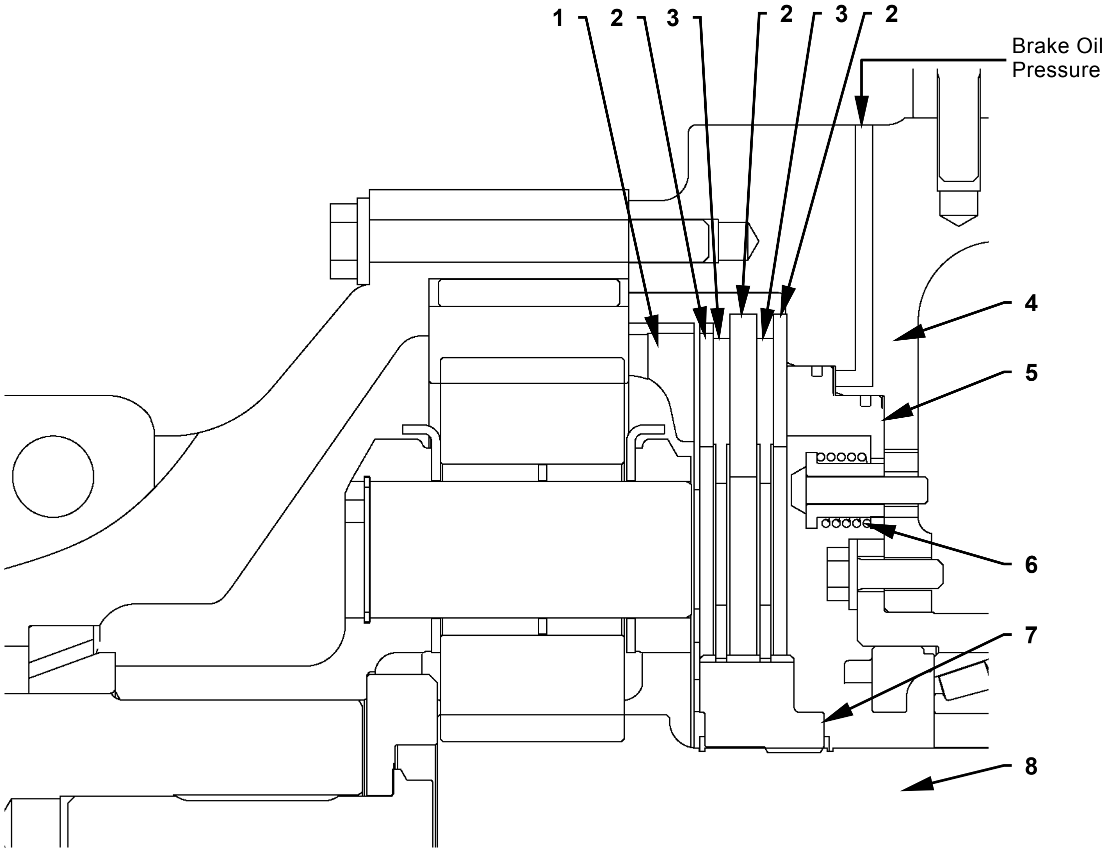
Drive force is transmitted to the case, pressure ring, and spider through the ring gear. At this time, the spider having the cam construction pushes the pressure ring with the thrust P. Clutch disc is geared with the case through the pressure ring. Side gears fitted to the clutch disc by spline rotate solidly with the case, and the left and right gears rotate at the same speed.
Like this, the left and right axle shafts fitted to the side gears by spline tend to rotate solidly with the case, and the differential movement restriction works.
In case the drive force provided for the skidding tire is larger than the road resistance, part of the torque of the skidding tire is added to the tire contacting the road by the differential movement restriction (because of the same speed of the left and right tires), and the tire contacting the road is provided with more torque.
Until the difference of the resistances between the left and right tires exceeds certain value (until the clutch disc begins to slip), the left and right gears solidly rotate at a constant speed. On such soft roads, the drive force increases by 1.5 times the value for the TPD if the LSD is provided.

SERVICE BRAKE

Brake adopted is the wet type multi-disc brake, and is assembled in the differential body of the axle. Four wheels of this vehicle has all this disc brake.

- In Operation of Brake
  Oil pressure from the brake valve works on the back of brake piston (5) to move brake piston(5), and brake disc (3) and brake ring (2) is compressed. Inner surface of brake disc (3) is fitted by spline to shaft (8) through disk hub (7). Also, the outer surface of brake ring (2) is fixed to differential body (4). Therefore, the rotation of the pushed and compressed brake disc (3) stops, restricting the vehicle.

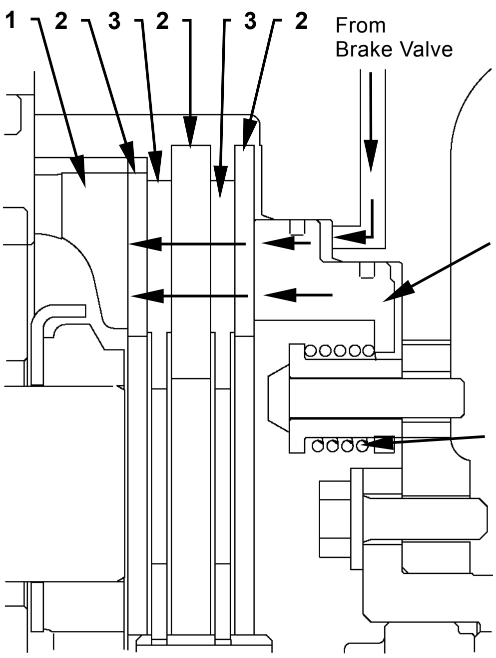
- In Release of Brake
  When the oil pressure from the brake valve is decreased, brake piston(5) is returned by return spring (6), and brake disc (3) is freed. Restriction of the vehicle is released.



T4GB-03-10-005

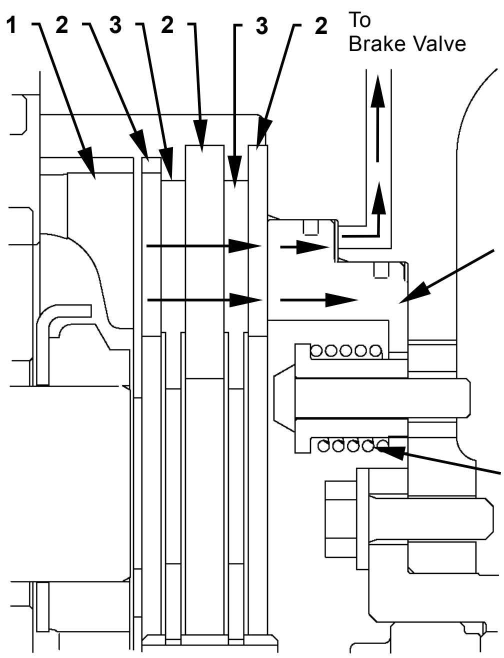
1 - End Plate
2 - Brake Ring
3 - Brake Disc
4 - Differential Body
5 - Brake Piston
6 - Return Spring
7 - Disc Hub
8 - Shaft

- Operation



T4GB-03-10-007

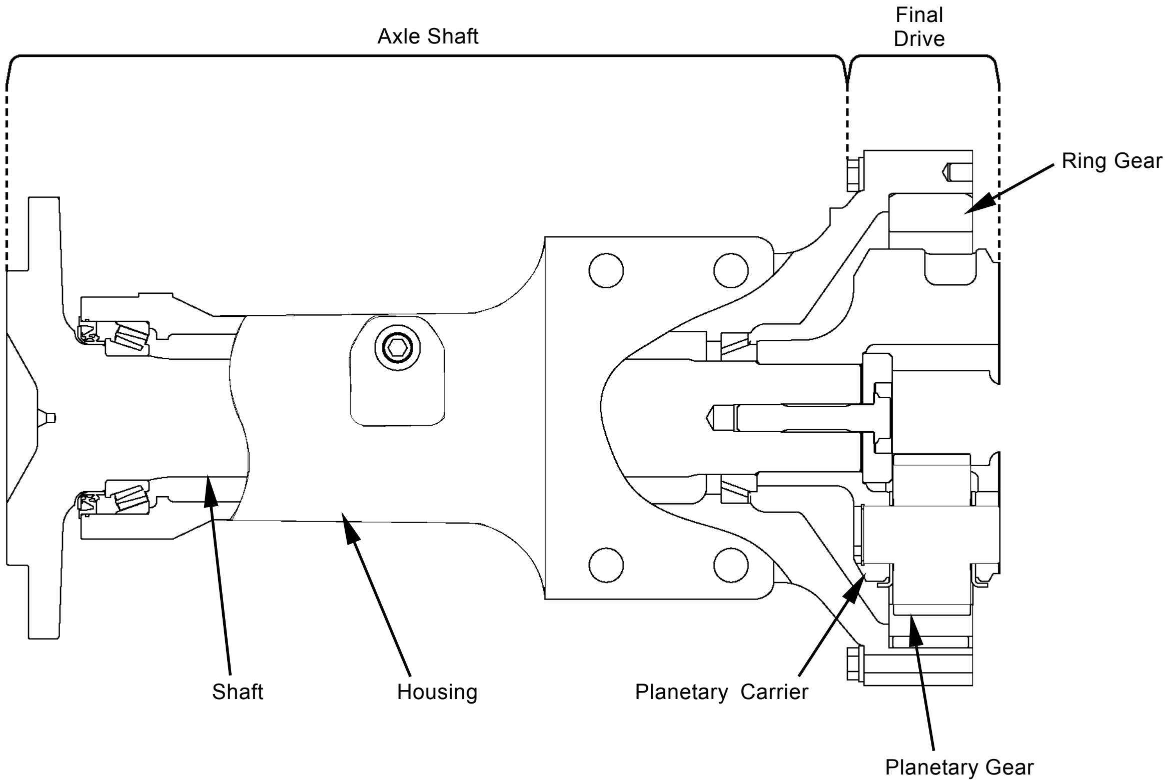
- Release



T4GB-03-10-008

FINAL DRIVE / AXLE SHAFT

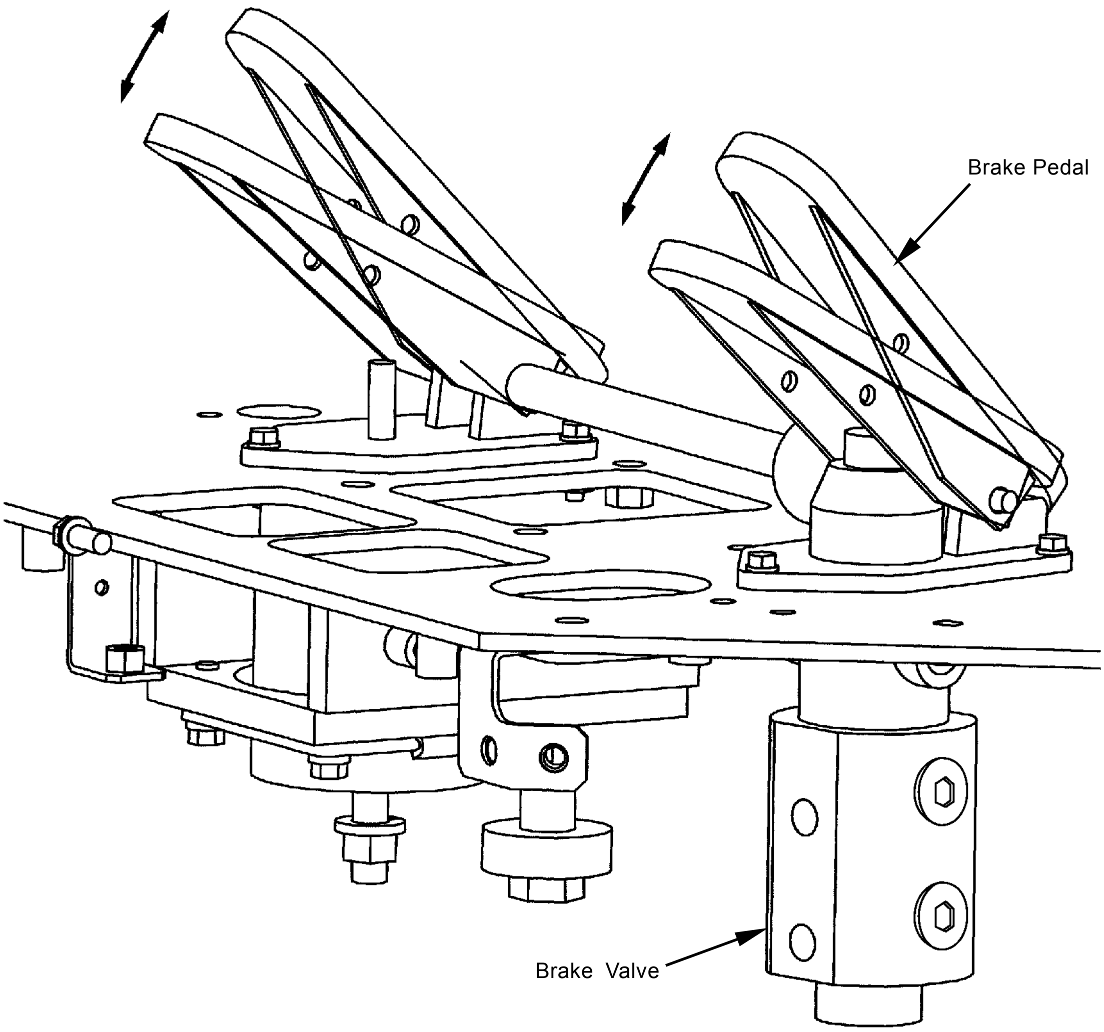
Final drive is the device for finally decreasing the speed in the power transmission system, and of the planetary gear type. As for power transmission, the power from the differential, transmitted from the shaft, rotates the three planetary gears in the ring gear, and transmits rotation of the planetary carrier to the axle shaft through the planetary carrier.



T4GB-03-10-006

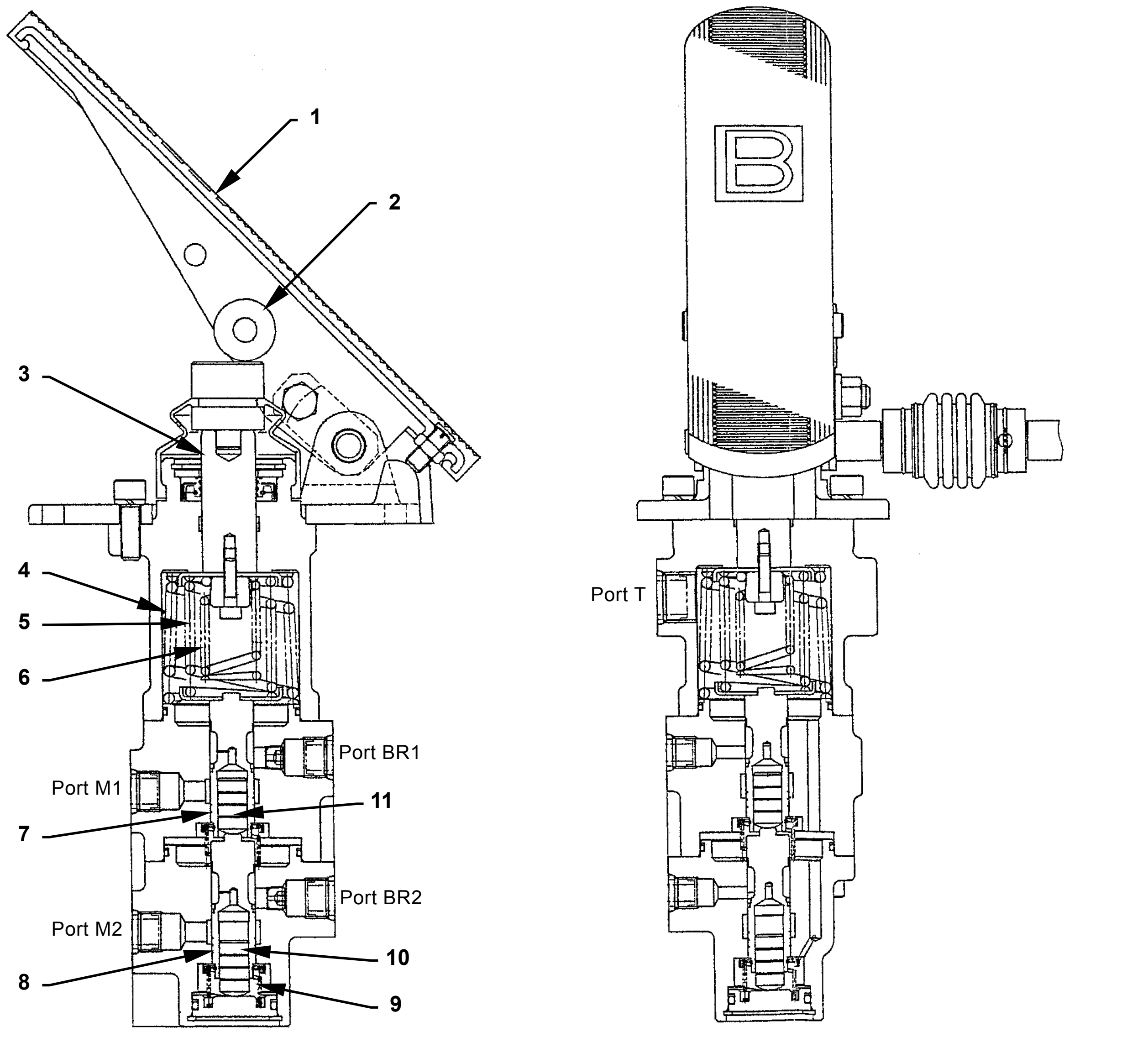
OUTLINE

Brake valve is operated by the brake pedal. (Refer to the Brake Circuit of SYSTEM/Hydraulic System)
Brake valve sends pilot pressure depending on the extent of stepping the brake pedal, and operates the fore wheel or rear wheel service brake.

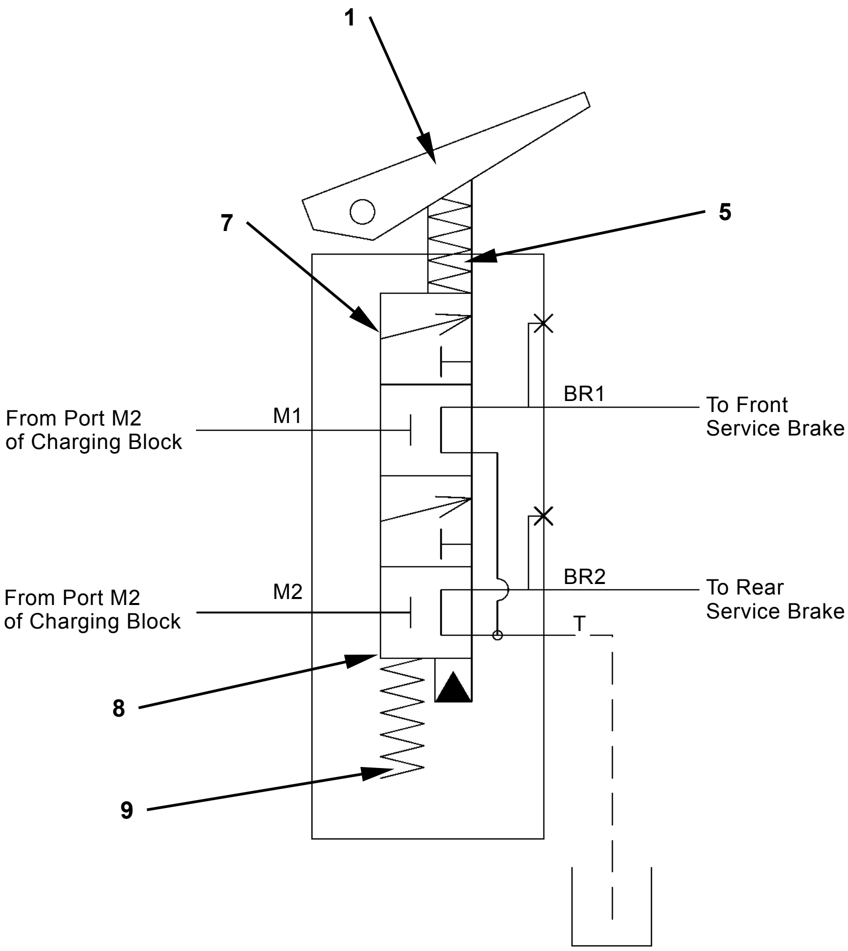


T4GB-03-11-001

Component Layout



1 - Pedal	4 - Spring	7 - Spool	10 - Plunger
2 - Roller	5 - Spring	8 - Spool	11 - Plunger
3 - Spool Input	6 - Spring	9 - Spring	

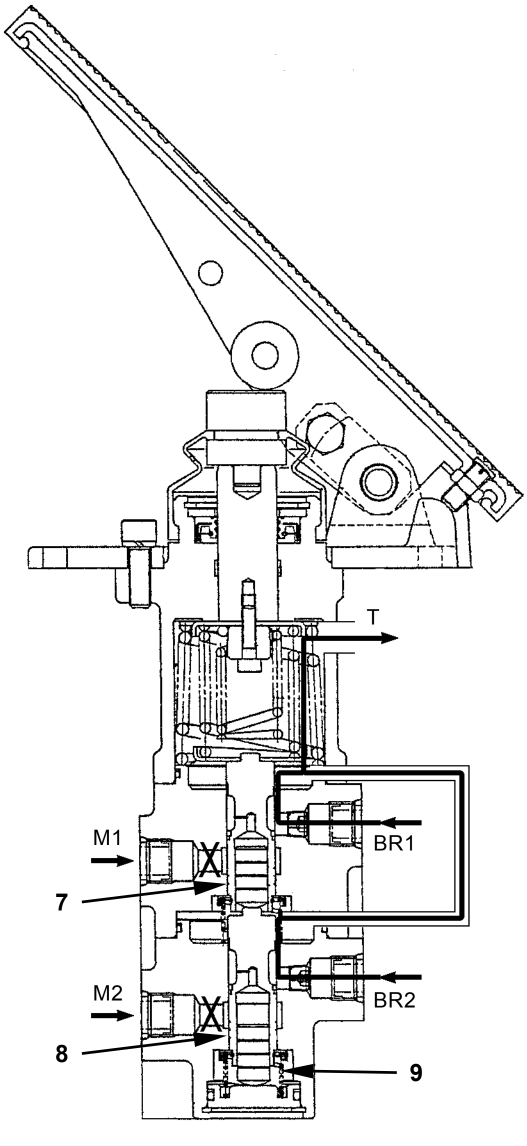


T4GB-03-11-003

OPERATION

Not in Operation of Brake

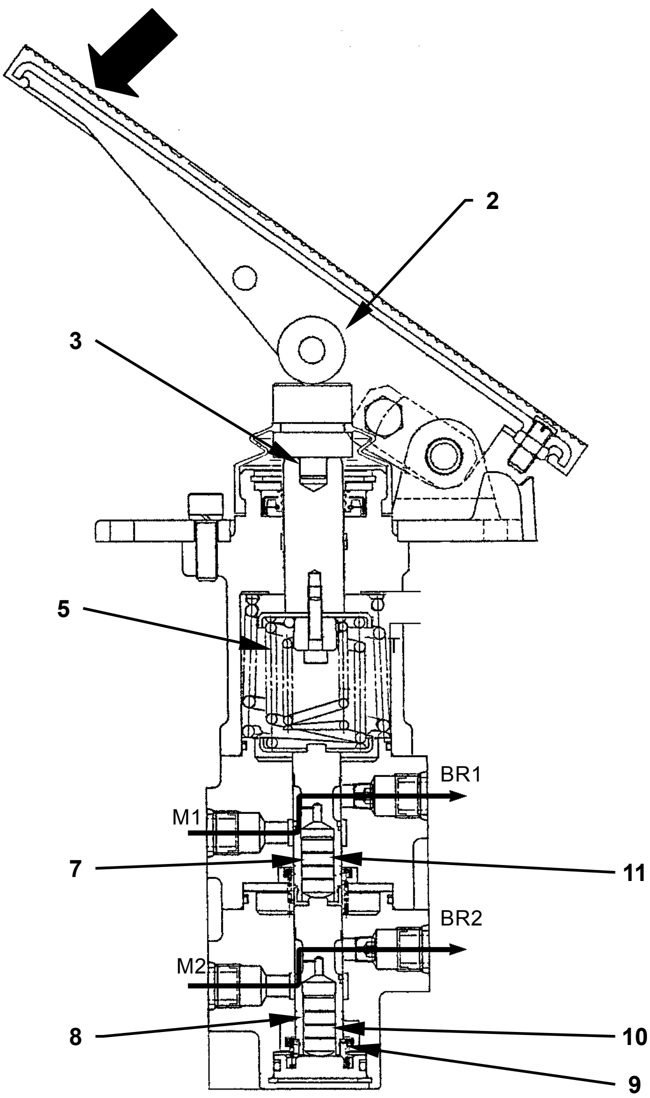
1. When the brake valve is not in operation, the ports (BR1 and BR2) are connected with the tank port (T) because the spring (9) returns the spools (7 and 8) to the non-operating position.
2. Ports (M1 and M2) and the brake ports (BR1 and BR2) are blocked by the spools (7 and 8), and the pressure oil in the service brake accumulator is retained.



T4GB-03-11-004

In Operation of Brake

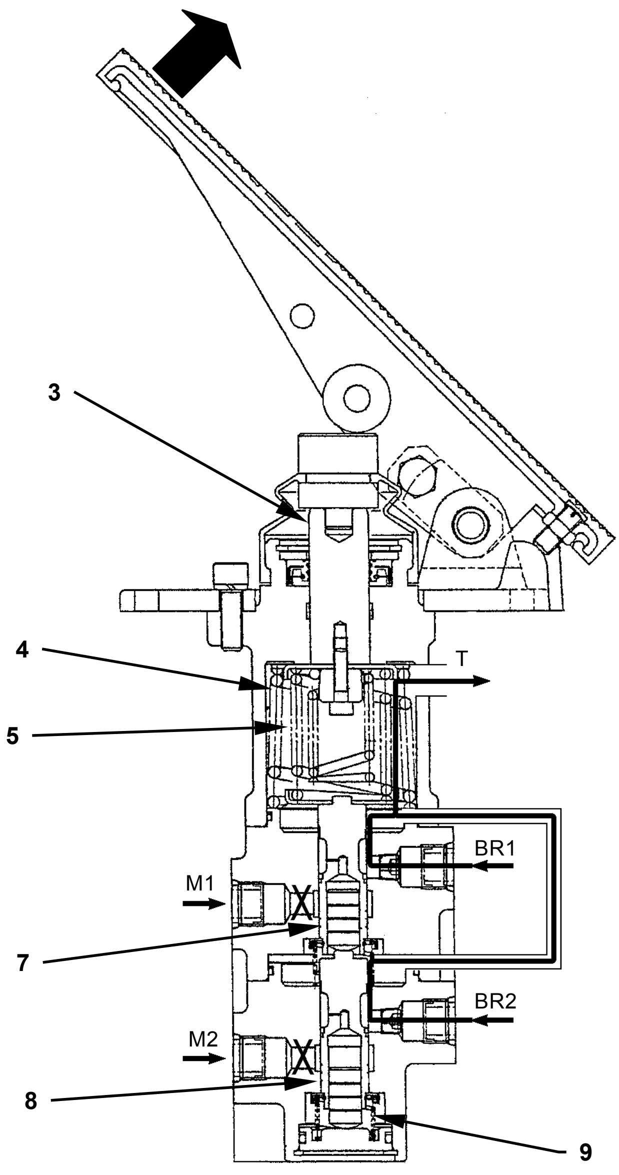
1. When the brake valve is stepped, spool input (3) is pushed through roller (2).
   Spool input moves the spools (7 and 8) forward through the spring (5).
2. When the spools (7 and 8) moves forward, ports (BR1 and BR2) and port (T) are disconnected. When spools (7 and 8) are further moved forward, the ports (BR1 and BR2) and the ports (M1 and M2) are connected, and the pressure oil of the accumulator flows out from the ports (BR1 and BR2), beginning braking operation.
3. Pressure oil on the ports (BR1 and BR2) end passes the orifices installed in spools (7 and 8), and works on the built-in plungers (10 and 11) of spools (7 and 8) as the return force (oil pressure rection force) of the spools (7 and 8). Summation of this oil pressure reaction force and the load of spring (9) balances with the load of spring (5), and controls the brake oil pressure on the brake ports (BR1 and BR2) end.
4. Deflection and load of spring (5) are fed back as the stroke and operating force of the brake pedal, and provides the operator with virtual operation feeling.



T4GB-03-11-005

In Brake Release

1. When the operating force is released, spool input (3) is pushed back by spring (4).
2. Compression of spring (5) is released, and spools (7 and 8) are returned to the non-operation position by the summation of the oil pressure reaction force working on the plunger and load of the spring (9).
3. At this time, the ports (BR1 and BR2) and the port (M1 and M2) are blocked by the spools (7 and 8), and the ports (BR1 and BR2) are relieved to the port (T).
   Pressure oil on the ports (BR1 and BR2) end is discharged to the port (T), and the brake operation is released.



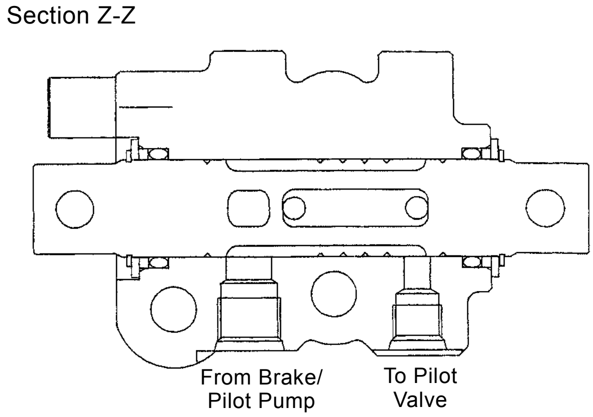
T4GB-03-11-006

PILOT SHUTOFF VALVE

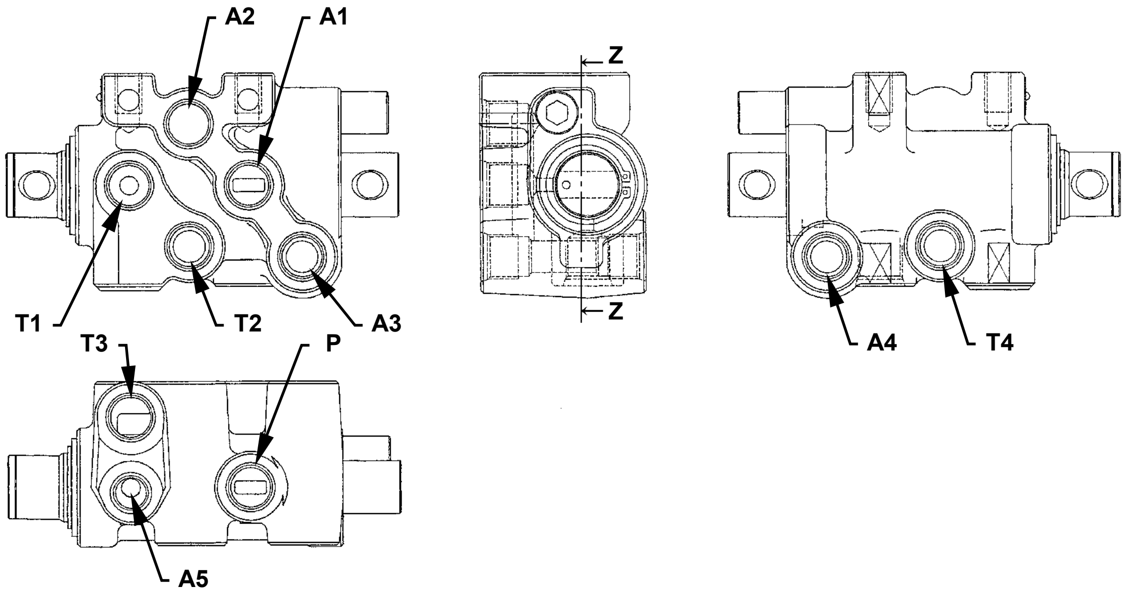
Pilot shutoff valve is a munually operated changeover valve, and by operating the pilot control shutoff lever, rotates the spool to turn ON and OFF the pilot pressure to the pilot valve.

Shutoff Position of Pilot Shutoff Valve
At OFF of the pilot shutoff valve, the pressure oil from the pilot pump does not flow to the pilot valve. Oil on the pilot valve end flows to the hydraulic oil tank.

At ON of Pilot Control Shutoff Lever
At ON of the pilot shutoff valve, the drain circuit is blocked, and the pressure oil from the pilot pump flows to the pilot valve.



T4GB-03-12-001



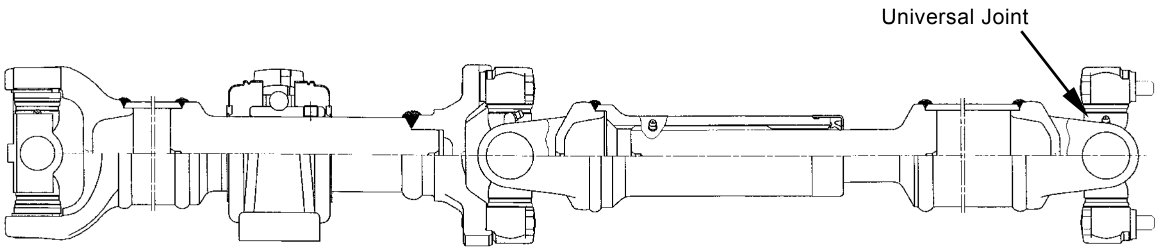
T4GB-03-12-002

A1 - Extra	A4 - To Pilot Valve	T1 - From Pilot Valve	T3 - From Pilot Valve (Optional)
A2 - Extra	A5 - Extra	T2 - Extra	T4 - To Hydraulic Oil Tank
A3 - To Pilot Valve (Optional)	P - From Brake/Pilot Pump		

PROPELLER SHAFT

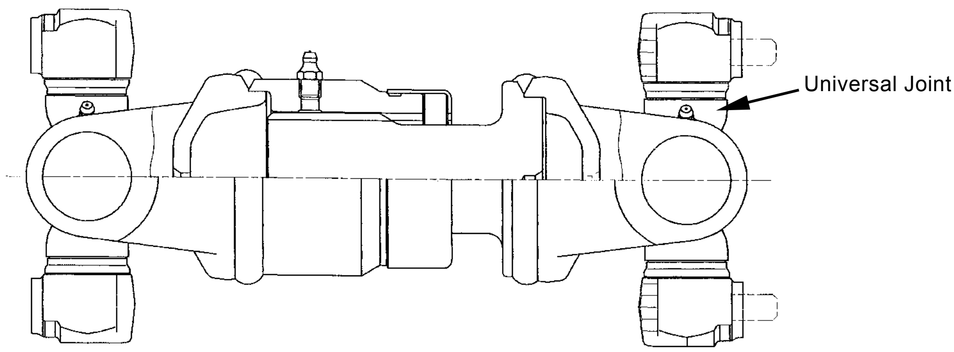
Propeller shafts are installed between the transmission and the front axle, and between the transmission and the rear axle, respectively.
Propeller shaft transmits the power from the transmission to the front axle and the rear axle. Joint adopted is the universal joint most commonly used.

Between Front Axle and Transmission



T4GB-03-12-003

Between Transmission and Rear Axle

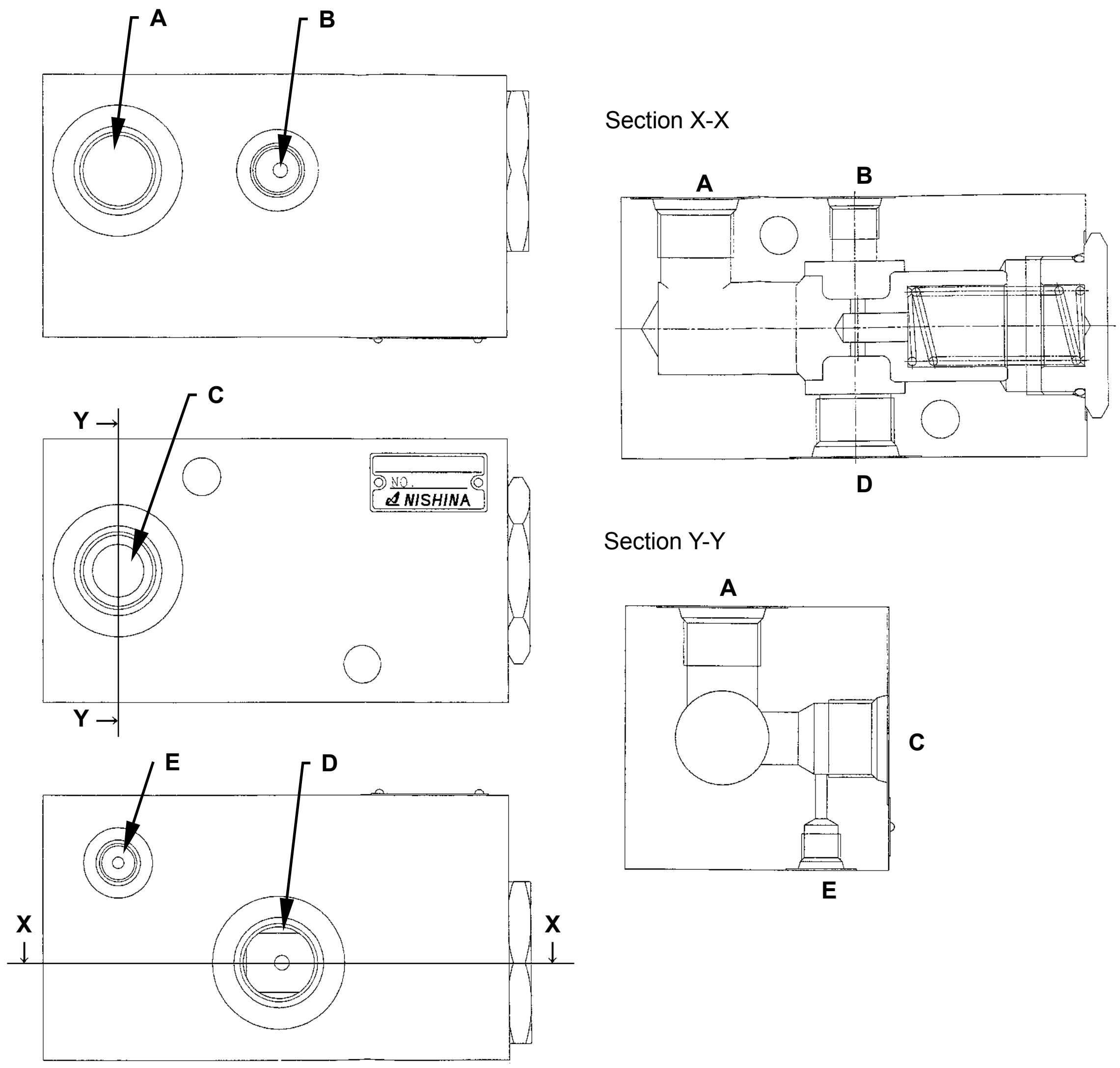


T4GB-03-12-004

EMERGENCY STEERING CHECK BLOCK

Emergency steering check block is installed between the main pump and steering valve.
Built-in check valve is provided for preventing the delivery oil of the emergency steering pump from flowing to the main pump.

A: from main pump
B: from emergency steering pump
C: pressure sensor port
D: to steering valve
E: to hydraulic oil tank

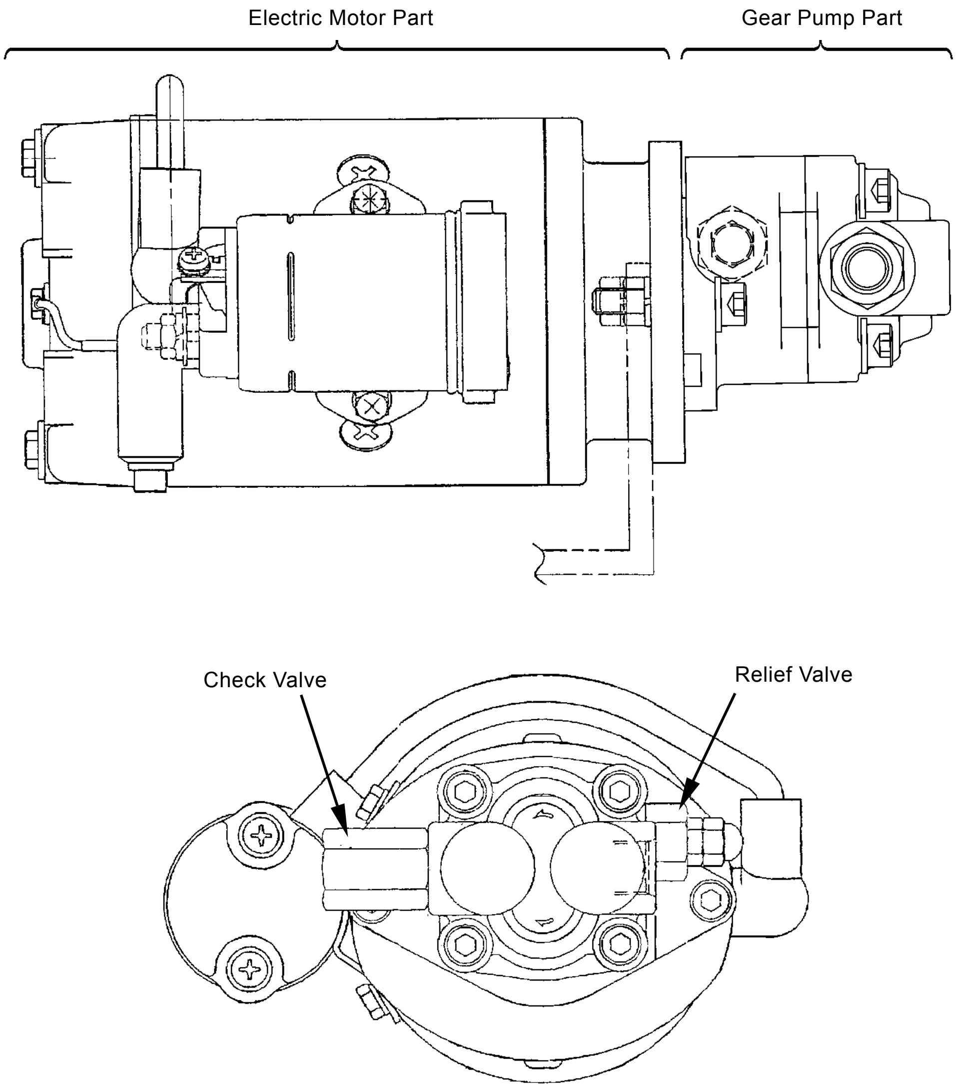


T4GB-03-12-007

EMERGENCY STEERING PUMP (OPTIONAL)

Emergency steering pump is installed to be started in case supply of the pressure oil from the main pump is suddenly stopped for one reason or another, and for supplying pressure oil to the steering valve in place of the main pump until the time when the vehicle body is moved to a safe place.

Emergency steering pump consists of the gear pump, electric motor, relief valve, and check valve.



T4GB-03-12-008

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