

Technical Manual

Operational Principle

ZW

180

Wheel Loader

 **Hitachi Construction Machinery Co., Ltd.**

URL:<http://www.hitachi-c-m.com>

INTRODUCTION

TO THE READER

- This manual is written for an experienced technician to provide technical information needed to maintain and repair this machine.
- Be sure to thoroughly read this manual for correct product information and service procedures.
- If you have any questions or comments, at if you found any errors regarding the contents of this manual, please contact using “Service Manual Revision Request Form” at the end of this manual. (Note: Do not tear off the form. Copy it for usage.):
Publications Marketing & Product Support
Hitachi Construction Machinery Co. Ltd.
TEL: 81-29-832-7084
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

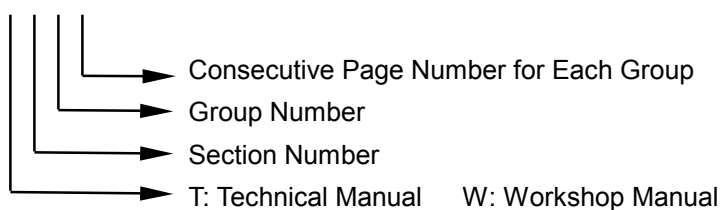
MANUAL COMPOSITION

- 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



INTRODUCTION

SAFETY ALERT SYMBOL AND HEADLINE NOTATIONS

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

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

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

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

- **CAUTION:**

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

- **IMPORTANT:**

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

- **NOTE:**

Indicates supplementary technical information or know-how.

UNITS USED

- SI Units (International System of Units) are used in this manual.

MKSA system units and English units are also indicated in parentheses just behind SI units.

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

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

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

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

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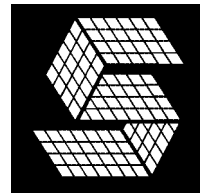
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- Group 9 Steering Cylinder

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-

SECTION 1 GENERAL



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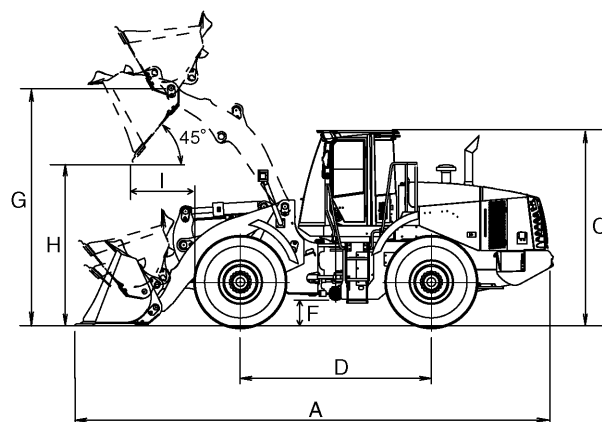
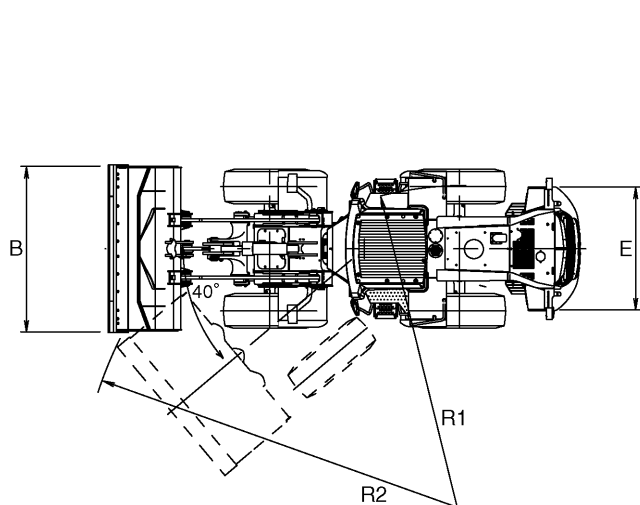
Group 3 Component Specifications

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GENERAL / Specification

SPECIFICATIONS



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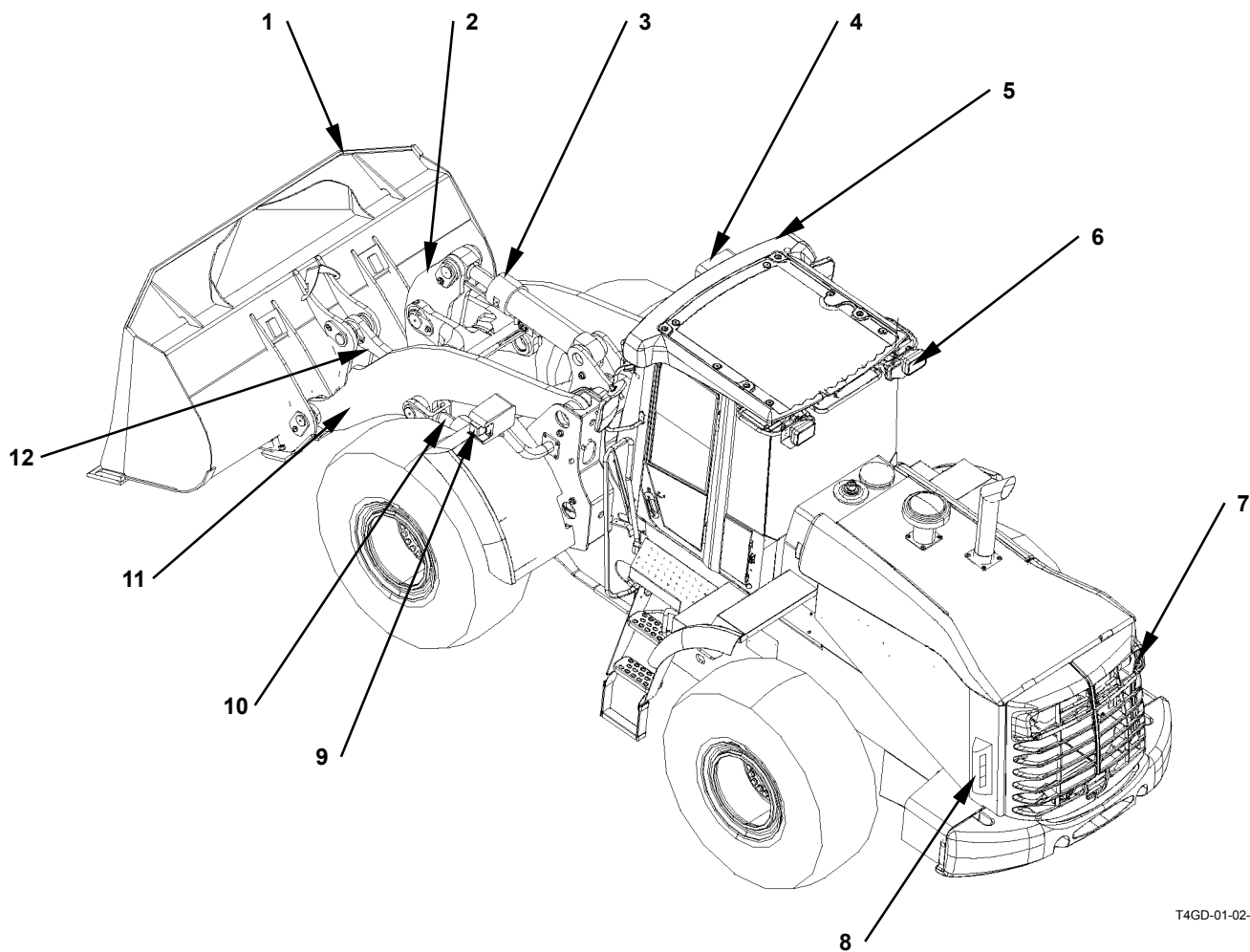
Type	—	ZW180
Bucket Capacity: heaped	m ³ (yd ³)	2.8 (3.7) [BOC]
Operating Weight	kg (lb)	14200 (31300)
Rated Loading Weight	kg (lb)	4480 (9877)
Engine	—	Cummins QSB 6.7 129.0 kW/2200 min ⁻¹ (175 PS/2200 rpm)
A: Overall Length	mm (ft-in)	7610 (25' 0")
B: Overall Width (Bucket)	mm (ft-in)	2690 (9' 0")
C: Overall Height	mm (ft-in)	3280 (10' 9")
D: Wheel Base	mm (ft-in)	3050 (10' 0")
E: Tread	mm (ft-in)	2050 (6' 9")
F: Ground Clearance	mm (ft-in)	395 (1' 4")
G: Bucket Hinge Height	mm (ft-in)	3920 (12' 10")
H: Dumping Clearance (45°)	mm (ft-in)	2800 (9' 2")
I: Dumping Reach (45°)	mm (ft-in)	1070 (3' 6")
R1: Minimum Rotation Radius (Center of Outside Tire)	mm (ft-in)	5230 (17' 2")
R2: Minimum Rotation Radius (Bucket Outside Edge)	mm (ft-in)	6110 (20' 1")
Travel Speed (Forward/Reverse)	km/h (mph)	38.0/38.0 (22.4/22.4)
Transmission Speeds (Forward/Reverse)	—	4/4
Articulation Angle (Left/Right)	Degree (%)	40 (84)
Tire Size	—	20.5-25-12PR

GENERAL / Specification

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GENERAL / Component Layout

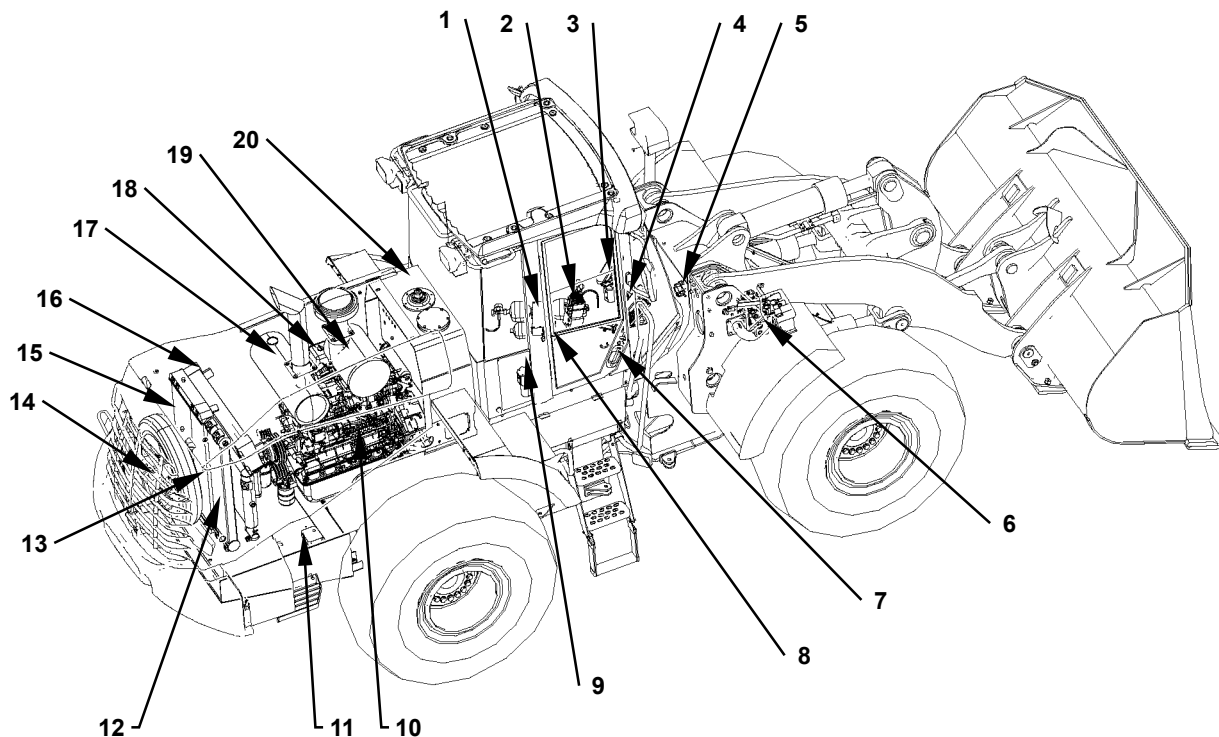
MAIN COMPONENT (OVERVIEW)



- | | | | |
|---------------------|--------------------------------------|--|------------------------|
| 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, Brake Light and
Back Light) | 11 - Lift Arm |
| 3 - Bucket Cylinder | 6 - Rear Working Light
(Optional) | 9 - Turn Signal, Hazard Light and
Clearance Light | 12 - Bucket Link |

GENERAL / Component Layout

MAIN COMPONENT (UPPERSTRUCTURE)

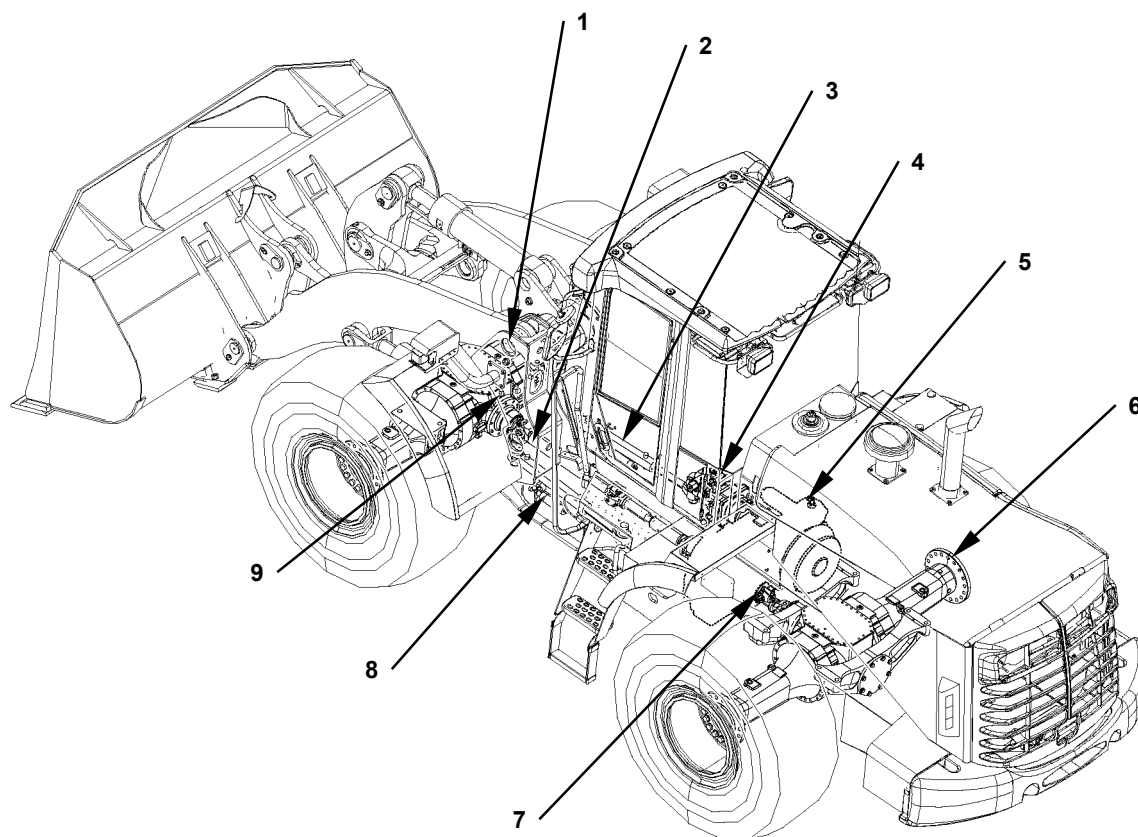


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|--------------------------|--------------------------|------------------------------|-------------------------|
| 1 - Charging Block | 6 - Control Valve | 11 - Fuel Tank | 16 - Oil Cooler |
| 2 - Pilot Valve | 7 - Stop Valve | 12 - Intercooler | 17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

GENERAL / Component Layout

MAIN COMPONENT LAYOUT (TRAVEL SYSTEM)

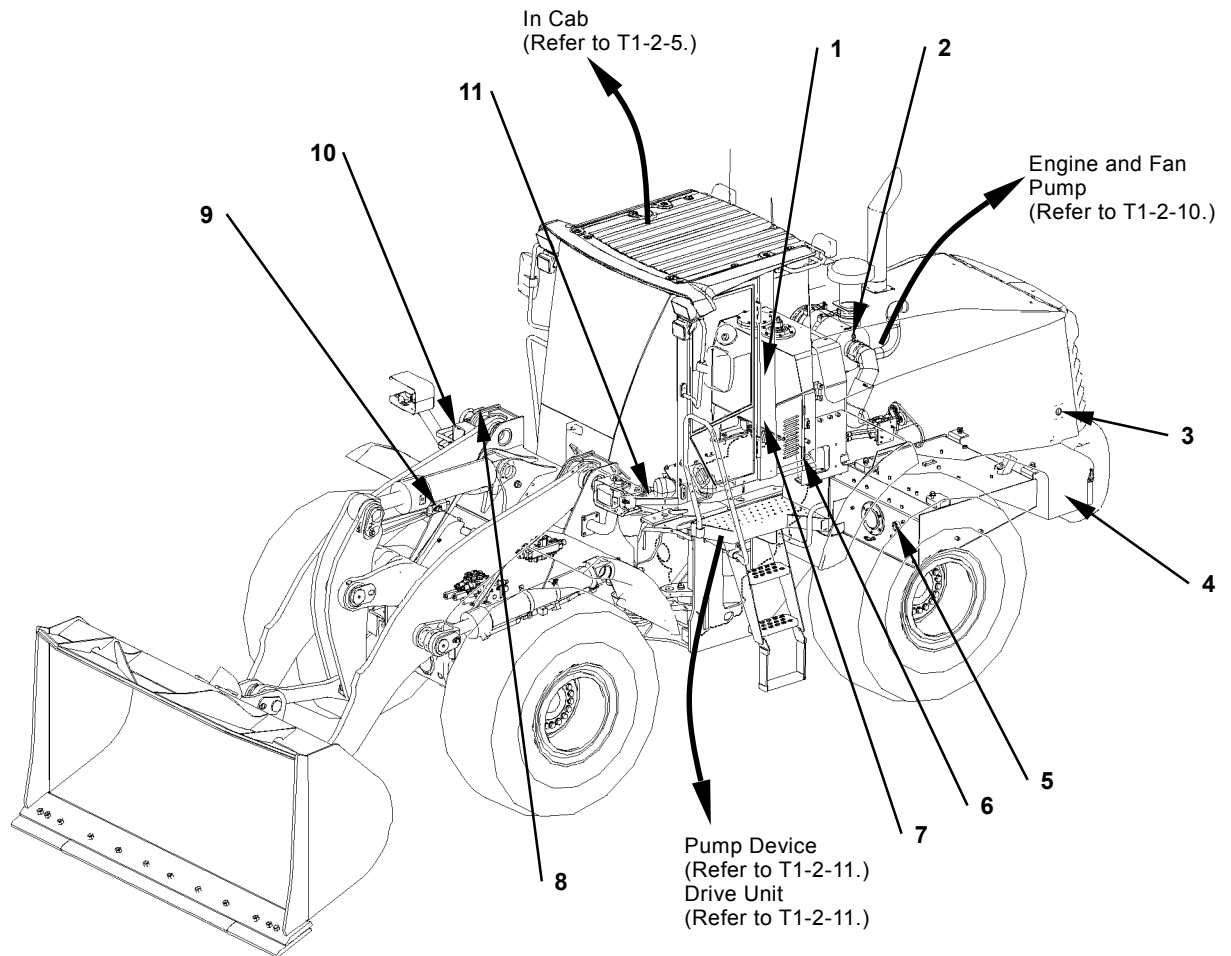


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- | | | | |
|-----------------------------|------------------|----------------------------|---------------------------|
| 1 - Front Axle | 4 - Pump Device | 6 - Rear Axle | 8 - Steering Accumulator |
| 2 - Propeller Shaft (Front) | 5 - Transmission | 7 - Propeller Shaft (Rear) | 9 - Brake Pressure Sensor |
| 3 - Steering Cylinder | | | |

GENERAL / Component Layout

ELECTRICAL SYSTEM (OVERVIEW)

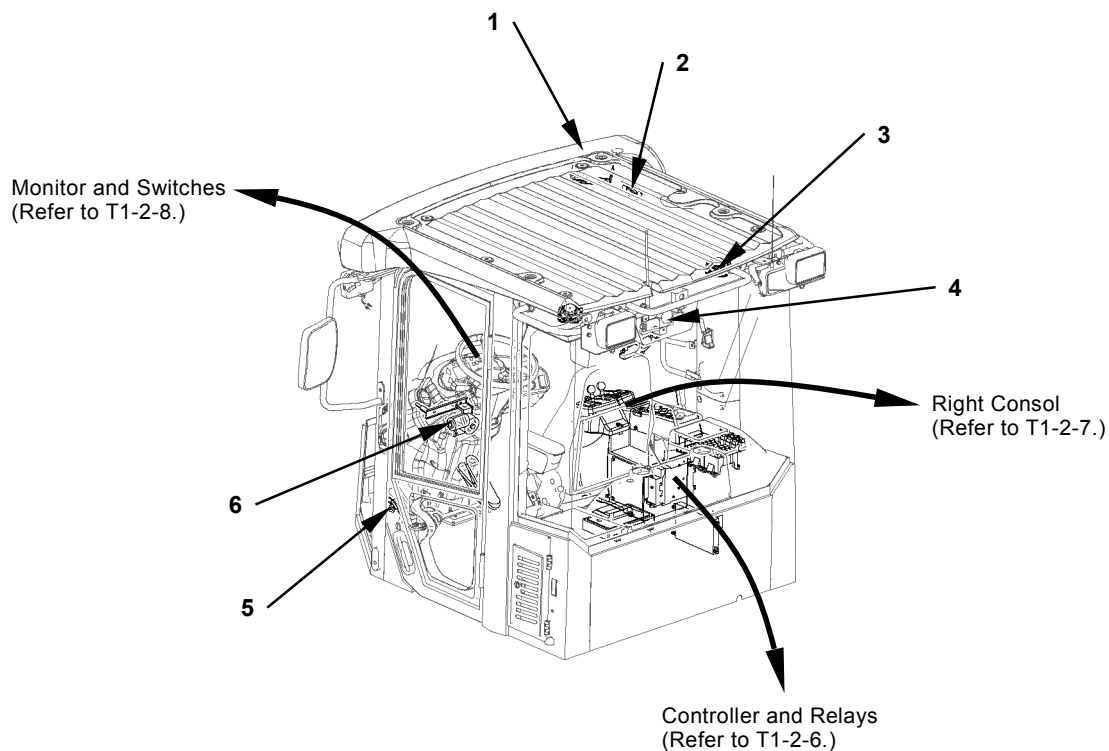


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- | | | | |
|-----------------------------------|--------------------------------------|--|-----------------------------------|
| 1 - Hydraulic Oil Level Switch | 4 - Battery | 7 - Emergency Steering Pump Delivery Pressure Switch | 10 - Lift Arm Proximity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

GENERAL / Component Layout

ELECTRICAL SYSTEM (IN CAB)



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1 - Radio
2 - Auxiliary Switch Panel
(Optional)

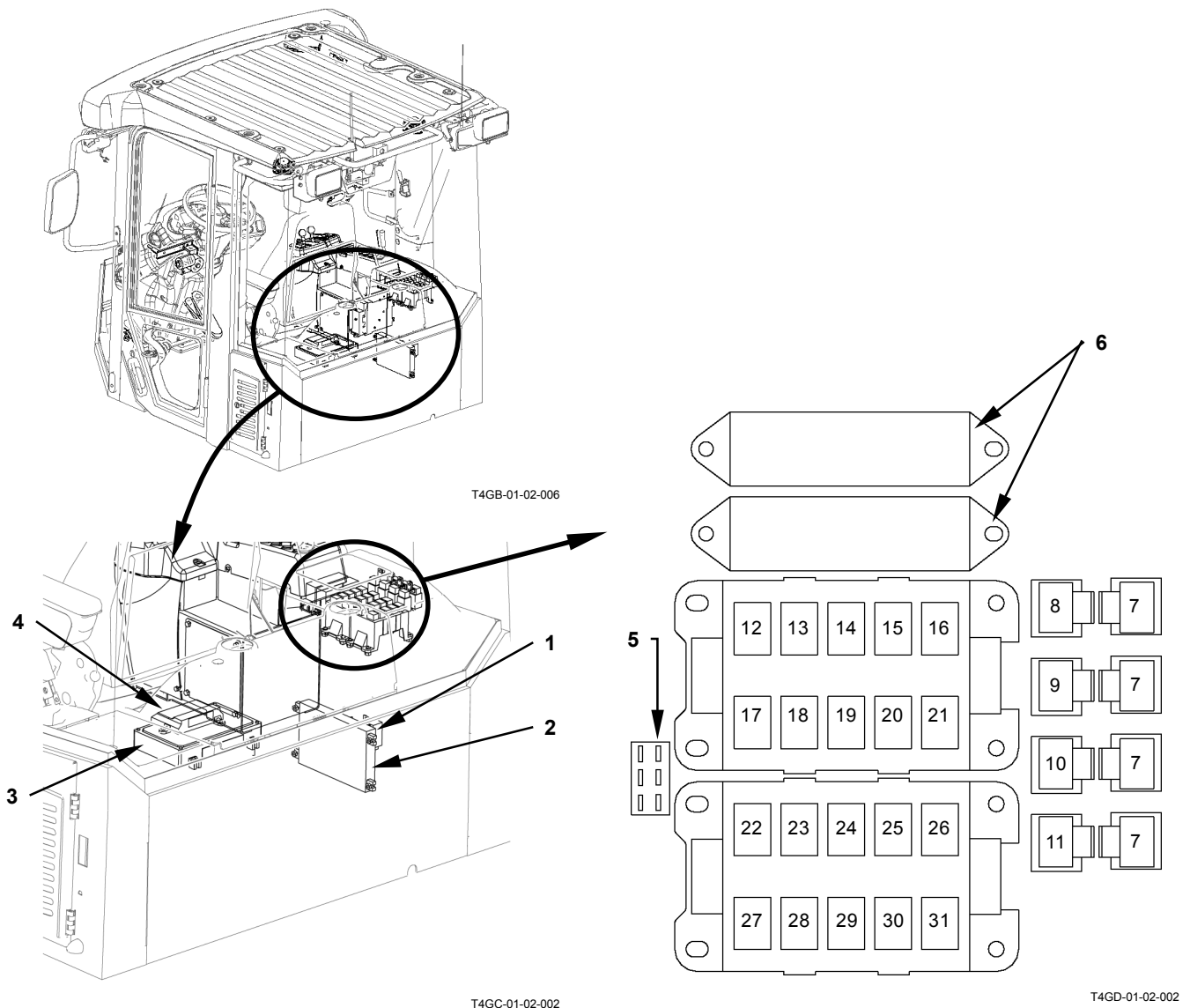
3 - Speaker
4 - Rear Wiper Motor

5 - Brake Light Switch

6 - Front Wiper Motor

GENERAL / Component Layout

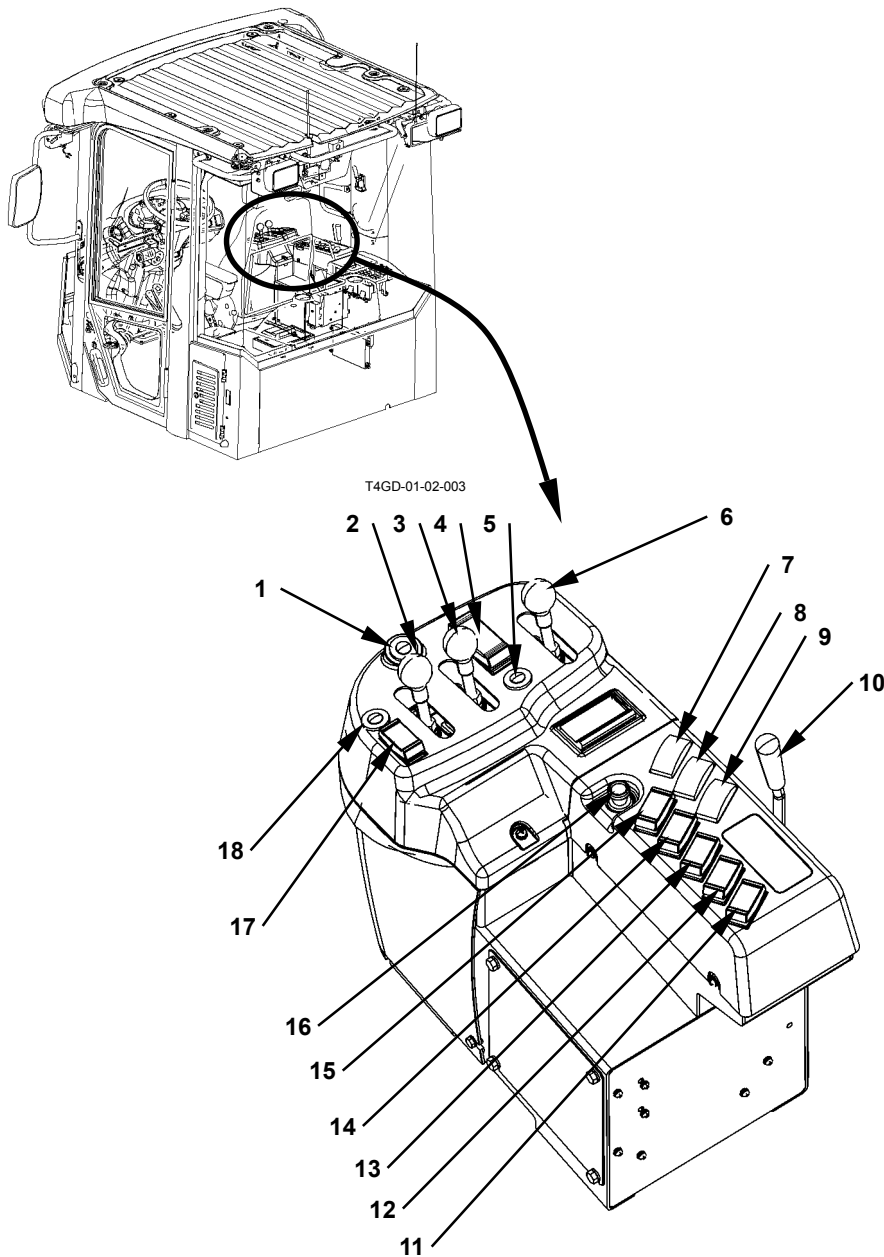
Controller and Relays



- | | | | |
|----------------------------------|--------------------------------------|---|---------------------------------------|
| 1 - Flusher Relay | 9 - Parking Brake Relay 1 | 17 - Emergency Steering Relay (A-R10) | 25 - Overheat Relay (B-R2) |
| 2 - Option Controller (Optional) | 10 - Parking Brake Relay 2 | 18 - Turn Signal Relay (Left) (A-R9) | 26 - Engine Oil Pressure Relay (B-R1) |
| 3 - MC | 11 - Front Wiper Relay | 19 - Turn Signal Relay (Right) (A-R8) | 27 - Kick-Out Relay (B-R10) |
| 4 - ICF | 12 - Horn Relay (A-R5) | 20 - Working Light Relay (Rear) (A-R7) | 28 - Leveler Relay (B-R9) |
| 5 - Dr. ZX Connector | 13 - Brake Light Relay (A-R4) | 21 - Working Light Relay (Front) (A-R6) | 29 - Rear Washer Relay (B-R8) |
| 6 - Fuse Box | 14 - High Beam Relay (A-R3) | 22 - Back Buzzer Relay (B-R5) | 30 - Rear Wiper Relay (B-R7) |
| 7 - Auxiliary Relay (4 Used) | 15 - Head Light Relay (Right) (A-R2) | 23 - Neutral Relay (B-R4) | 31 - Register Relay (B-R6) |
| 8 - ECM Relay | 16 - Head Light Relay (Left) (A-R1) | 24 - Load Dump Relay (B-R3) | |

GENERAL / Component Layout

Right Consol

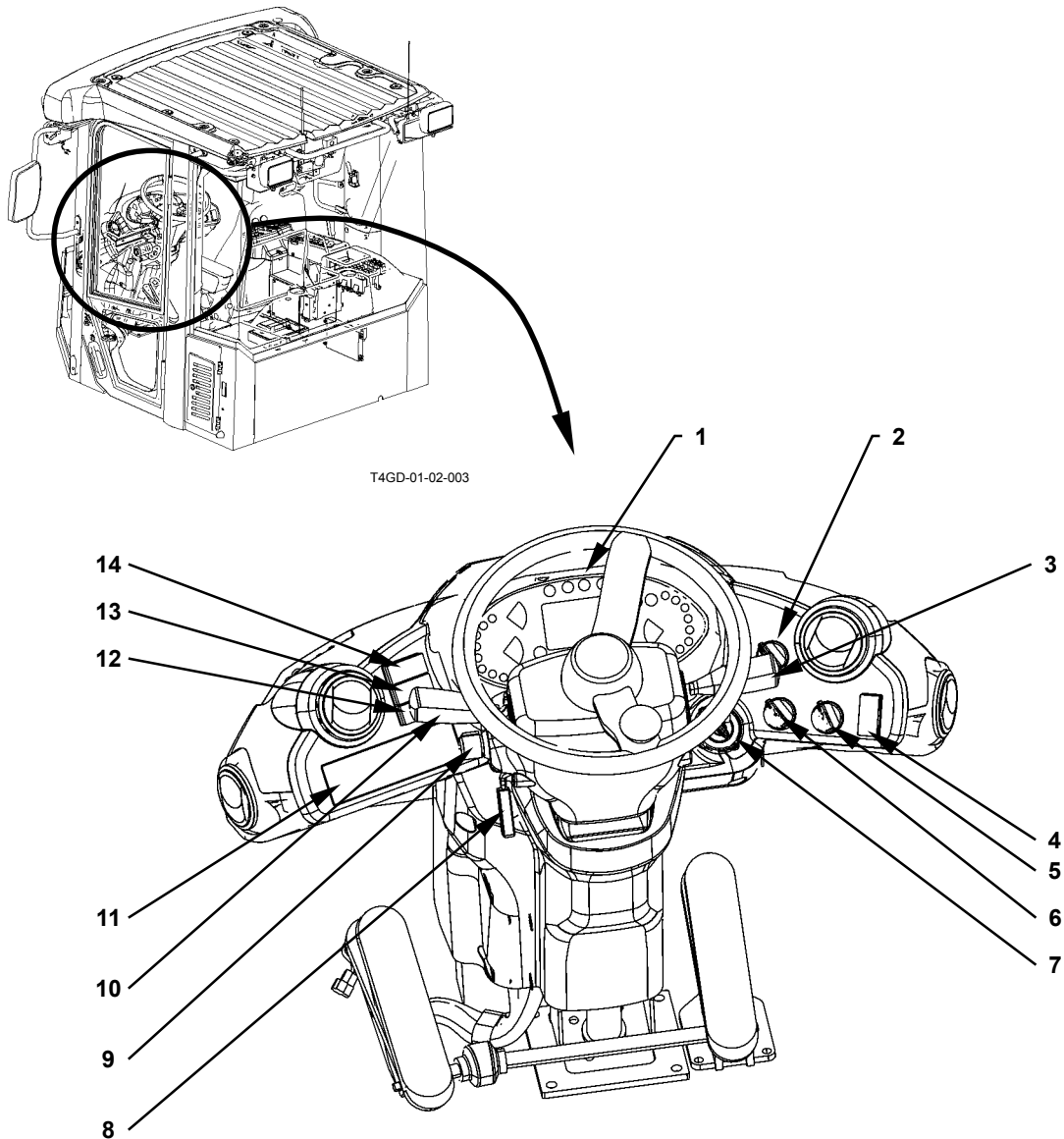


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- | | | | |
|-----------------------------|--|---|---|
| 1 - DSS (Down Shift) Switch | 6 - Auxiliary Control Lever (Optional) | 11 - Emergency Steering Check Switch (Optional) | 15 - FNR Selector Switch |
| 2 - Bucket Control Lever | 7 - Quick Coupler 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 - DSS/USS (Down Shift/Up Shift Switch) |
| 4 - FNR Switch | 9 - Lift Arm Auto Leveler Upward Set Switch (Optional) | 14 - Ride Control Switch (Optional) | 18 - Hold Switch |
| 5 - Horn Switch | 10 - Front Control Lock Lever | | |

GENERAL / Component Layout

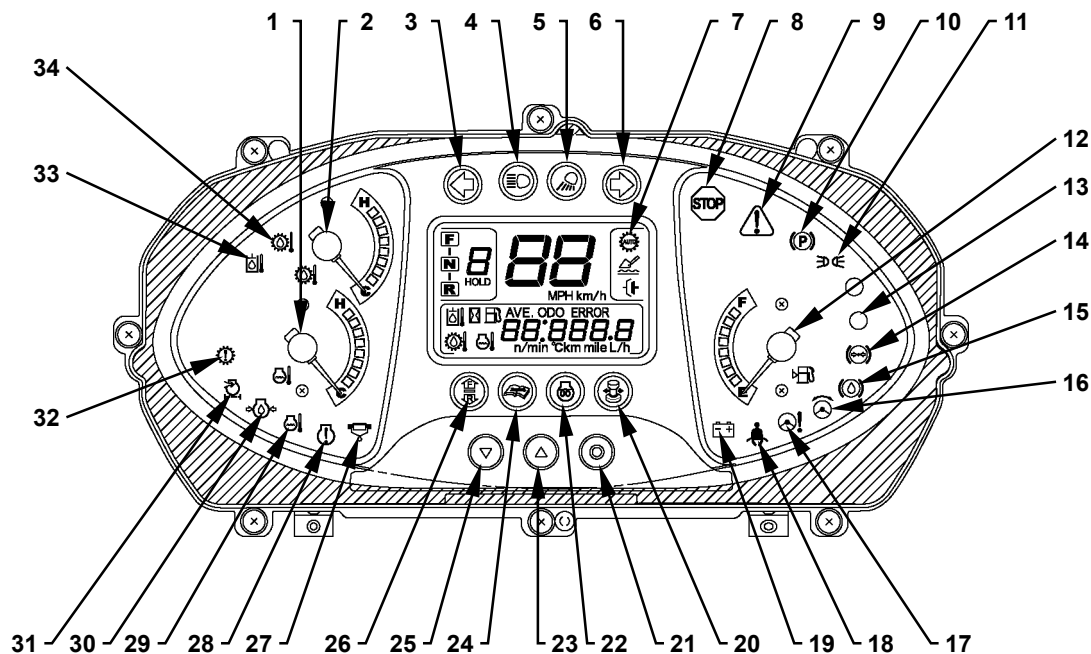
Monitor and Switches



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

GENERAL / Component Layout

Monitor Panel

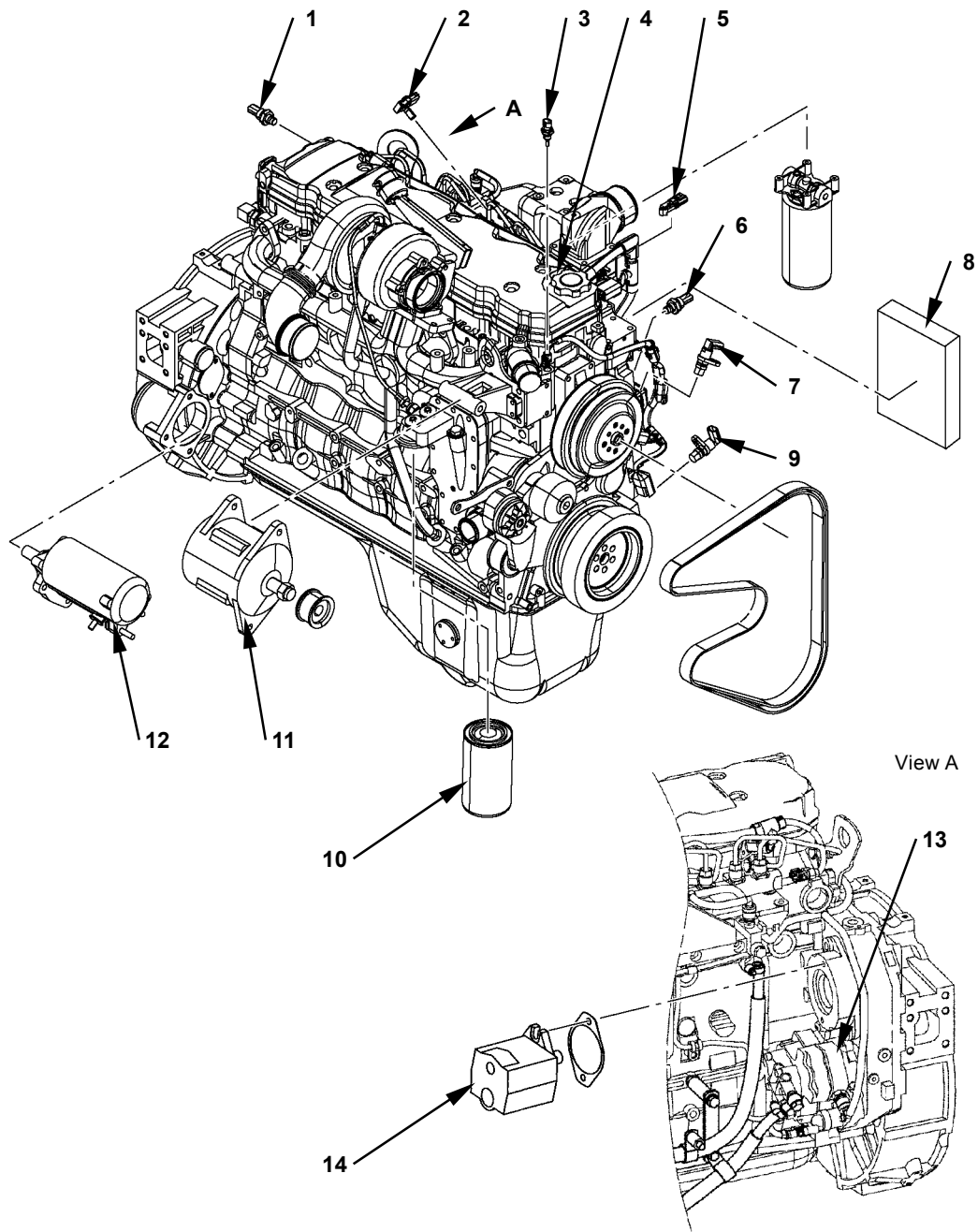


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- | | | | |
|--|--|--|---|
| 1 - Engine Coolant Temperature Gauge | 10 - Parking Brake Indicator | 19 - Discharge Warning Indicator | 28 - Engine Failure Indicator |
| 2 - Transmission Oil Temperature Gauge | 11 - Clearance Light Indicator | 20 - Lever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

GENERAL / Component Layout

ENGINE AND FAN PUMP

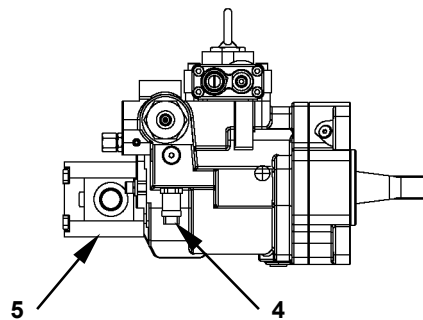
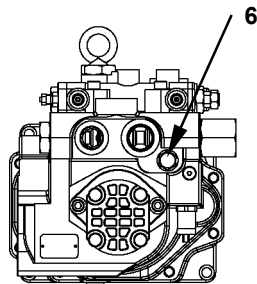
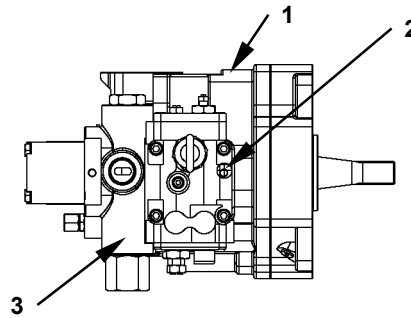


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- | | | | |
|---|---------------------------------------|--------------------------------------|-------------------------|
| 1 - Common Rail Pressure Sensor | 5 - Ambient Pressure Sensor | 9 - Engine Speed Sensor (Crankshaft) | 12 - Starter |
| 2 - Intake Manifold Pressure / Intake Manifold Temperature Sensor | 6 - Engine Oil Pressure Switch | 10 - Engine Oil Filter | 13 - High-Pressure Pump |
| 3 - Coolant Temperature Sensor | 7 - Engine Position Sensor (Camshaft) | 11 - Alternator | 14 - Fan Pump |
| 4 - Injector | 8 - ECM | | |

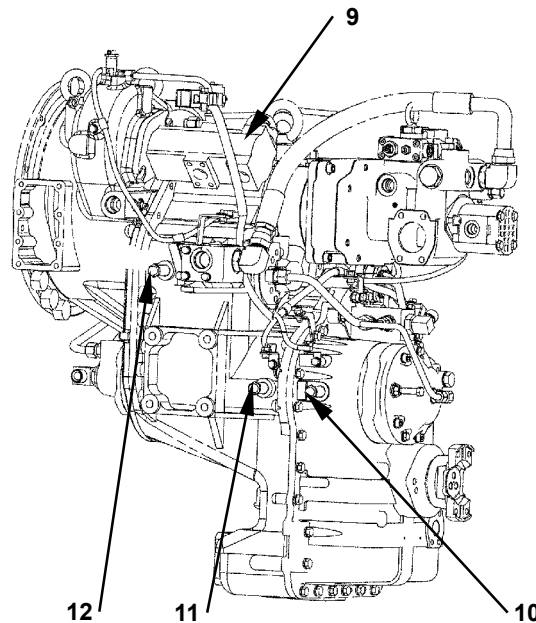
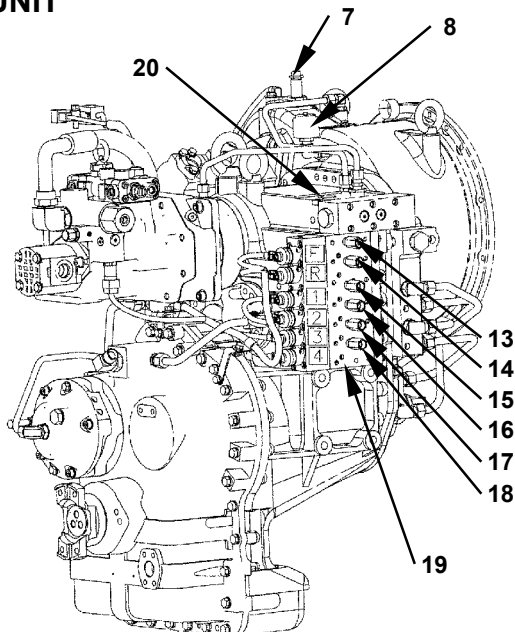
GENERAL / Component Layout

PUMP DEVICE



T4GB-01-02-009

DRIVE UNIT

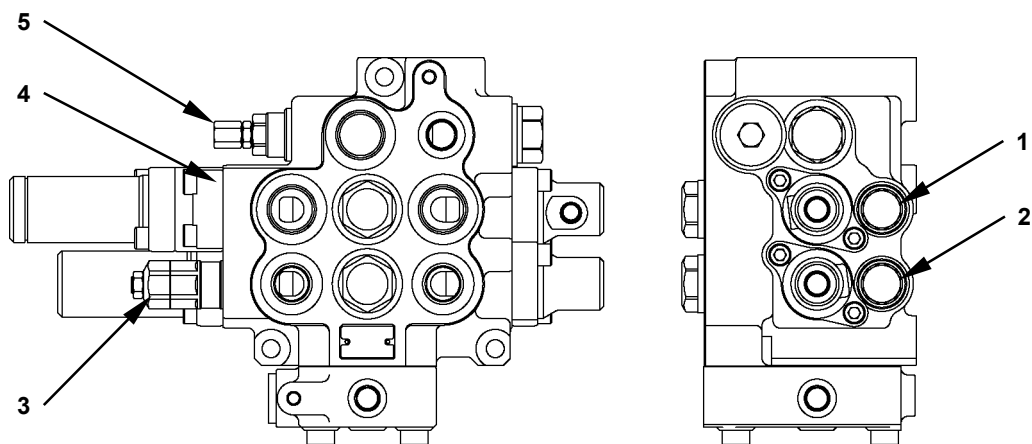


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|-----------------------------------|---|---------------------------------------|--------------------------------------|
| 1 - Main Pump | 6 - Steering Relief Valve | 11 - Transmission Output Speed Sensor | 16 - 2nd Speed Clutch Solenoid Valve |
|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

GENERAL / Component Layout

CONTROL VALVE



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- 1 - Overload Relief Valve
(Lift Arm: Bottom Side)
- 2 - Overload Relief Valve
(Bucket: Bottom Side)

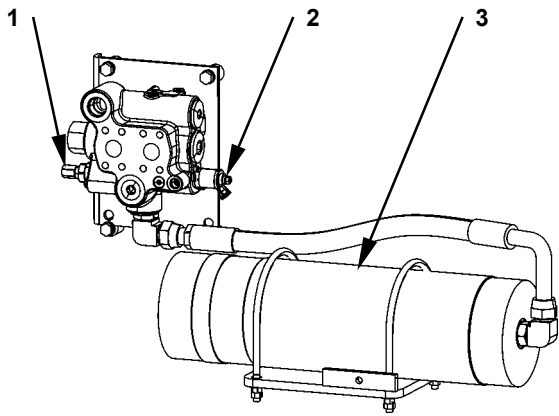
- 3 - Overload Relief Valve
(Bucket: Rod Side)

- 4 - Make-Up Valve
(Lift Arm: Rod Side)

- 5 - Main Relief Valve

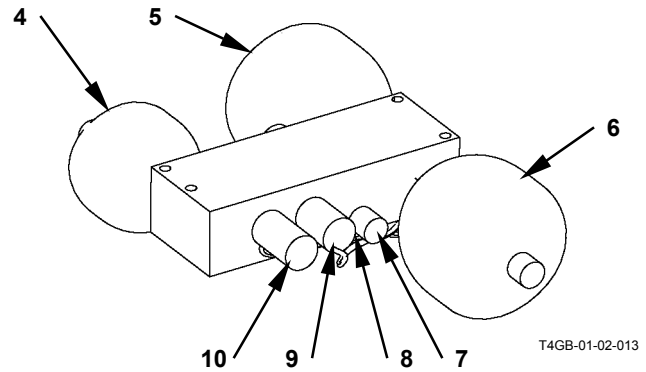
GENERAL / Component Layout

RIDE CONTROL VALVE (OPTIONAL)



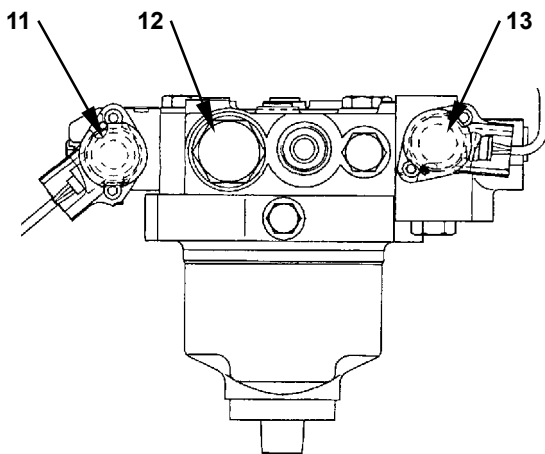
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CHARGING BLOCK



T4GB-01-02-013

FAN MOTOR

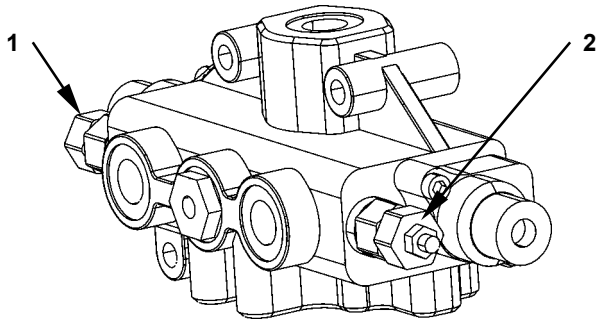


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- | | | | |
|---------------------------------|---------------------------------------|---|---------------------------------------|
| 1 - Overload Relief Valve | 5 - Service Brake Accumulator (Front) | 8 - Pilot Relief Valve | 11 - Reverse Control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

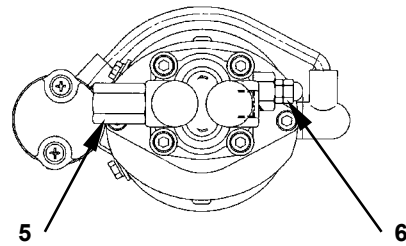
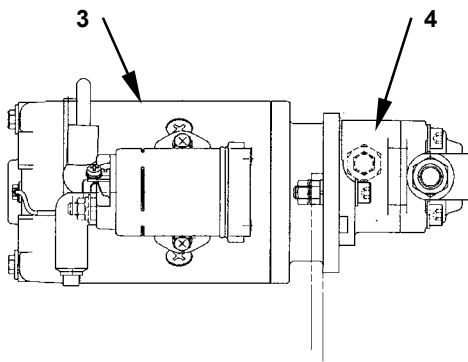
GENERAL / Component Layout

STEERING VALVE



T4GB-01-02-020

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

GENERAL / Component Specifications

ENGINE

Manufacturer	Cummins Inc.
Model	QSB6.7
Type	Diesel, 4 Cycle, Water Cooled, Over Head Valve, Inline, Direct Injection, Turbo Charged
Cyl. NO. - Bore×Stroke	6-107 mm×124 mm (4.21 in×4.88 in)
Piston Displacement	6690 cm ³ (408 in ³)
Rated Output	128±6.4 kW/2200 min ⁻¹ (174±9 PS/2200 rpm)
Compression Ratio	17.2
Dry Weight	540 kg (1190 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: 82.2 °C (180 °F) Full Open Temperature: 95 °C (203 °F)
Fan Pump	Gear Pump

GENERAL / Component Specifications

LUBRICATION SYSTEM

Lubrication Pump Type..... Trochoid Type
Oil Filter Strata Pore (Plastic fiber) / Spin-on Type
Oil Cooler Water Cooled Type

STARTING SYSTEM

Motor Magnetic Pinion Shift Reduction Type
Voltage/Output..... 24 V·7.8 kW

PREHEAT SYSTEM

Preheating Method Grid Air Heater (24 V·100 A)

ENGINE STOP SYSTEM

Stop Method Fuel Shut Off (Electrically Controlled)

ALTERNATOR

Type..... Regulator Integrated AC Type
Voltage/Output..... 24 V·65 A (Brush less)

SUPERCHARGING SYSTEM

Type..... Exhaust Turbocharger Type

FUEL SYSTEM

Type..... Common Rail Type
Governor..... Electrically Controlled
Injection Nozzle Electric Multi Hole Injector

GENERAL / Component Specifications

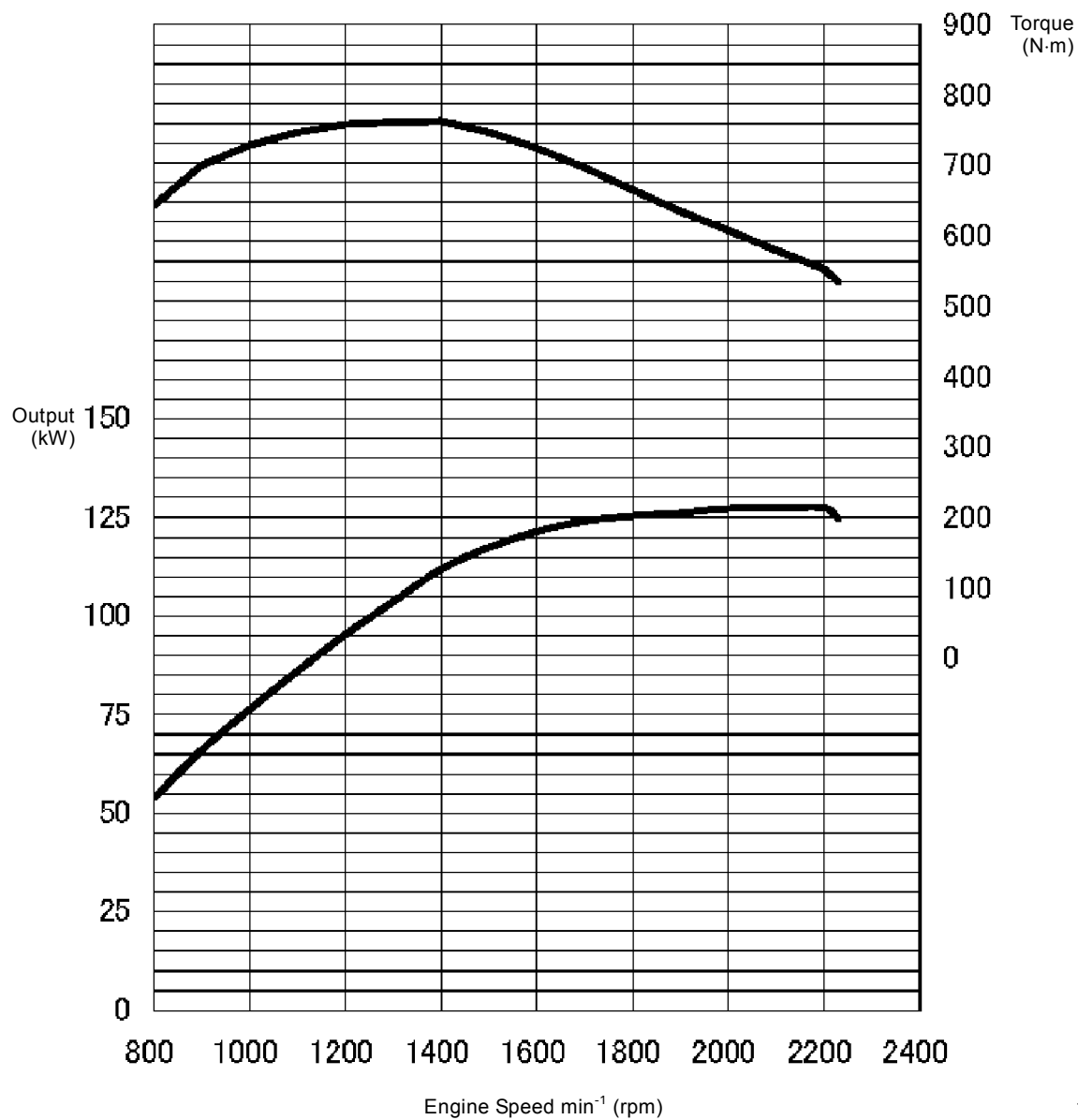
PERFORMANCE

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

Fuel Consumption Ratio.....	233±12 g/kW·h (171±9 g/PS·h) @ 2200 min ⁻¹ (rpm)
Maximum Output Torque	763±39 N·m (77.8±4 kgf·m) @ at approx. 1400 min ⁻¹ (rpm)
No Load Speed.....	Slow: (at Full Load: 900±20 min ⁻¹ (rpm)) Fast: (at Full Load: 2350±30 min ⁻¹ (rpm))

GENERAL / Component Specifications

Engine Performance Curve (QSB6.7)



T4GD-01-03-001

GENERAL / Component Specifications

ENGINE ACCESSORIES

RADIATOR ASSEMBLY

Type.....	Radiator, Inter Cooler and Torque Converter Cooler Tandem Type Assembly Oil Cooler	
	Radiator	Oil Cooler
Capacity.....	9.9 L (2.6 US gal)	5.5 L (1.4 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)	—
Weight	15.5 kg (34.2 lb)	13.7 kg (30.2 lb)
	Intercooler	Torque Converter Cooler
Capacity.....	—	4.9 L (1.3 US gal)
Air-Tight Test Pressure	150 kPa (1.5 kgf/cm ² , 22 psi)	1500 kPa (15 kgf/cm ² , 218 psi)
Cap Opening Pressure.....	—	—
Weight	12.5 kg (27.6 lb)	13.4 kg (29.5 lb)

BATTERY

Voltage.....	12 V
Capacity.....	112 Ah

GENERAL / Component Specifications

HYDRAULIC FAN PUMP

Model..... SGP1A25D2H1
Type..... Fixed Displacement Type Gear Pump
Maximum Flow (Theoretical Value)..... 55 L/min (14.51 US gpm)

HYDRAULIC FAN MOTOR

Relief Set Pressure 20.6 MPa (210 kgf/cm²) @ 5 L/min (1.32 US gpm)

SOLENOID VALVE

Function..... Fan Motor Reverse Control
Fan Motor Speed Control

GENERAL / Component Specifications

HYDRAULIC COMPONENT

MAIN PUMP

Type Bent Axis Type Variable Displacement Axial Plunger Pump
Maximum Flow (Theoretical Value) 209 L/min (55 US gpm)

REGULATOR

Type Hydraulic Pressure Operated Type

PRIORITY VALVE

Relief Set Pressure 27.4 MPa (280 kgf/cm²) @ 70 L/min (18.5 US gpm)

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

Type Pilot Pressure Operated Type (2 Spools)
Main Relief Set Pressure 27.4 MPa (280 kgf/cm²) @ 150 L/min (39.6 US gpm)
Overload Relief Set Pressure 34.3 MPa (350 kgf/cm²) @ 35 L/min (9.3 US gpm)
(Lift Arm)
30.4 MPa (310 kgf/cm²) @ 35 L/min (9.3 US gpm)
(Bucket Tilt)
30.4 MPa (310 kgf/cm²) @ 50 L/min (13 US gpm)
(Bucket Dump)

GENERAL / Component Specifications

RIDE CONTROL VALVE (OPTIONAL)

Type..... Pilot Pressure Operated Type
Overload Relief Set Pressure..... 39.2 MPa (400 kgf/cm²) @ 50 L/min (13 US gpm)
Charge Cut Pressure..... 11.3 MPa (115 kgf/cm²)

RIDE CONTROL ACCUMULATOR (OPTIONAL)

Capacity..... 4 L (244 in³)
Charging Pressure 2.9 MPa (30 kgf/cm²)

CHARGING BLOCK

Charging Pressure Cut In Pressure: 11.8 MPa (120 kgf/cm²)
Cut Out Pressure: 14.7 MPa (150 kgf/cm²)
Pilot Relief Valve Set Pressure..... 3.7 MPa (38 kgf/cm²) @ 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 in³)
Charging Pressure 4.4 MPa (45 kgf/cm²)

PILOT ACCUMULATOR

Capacity..... 0.75 L (45.8 in³)
Charging Pressure 2.0 MPa (20 kgf/cm²)

PILOT SHUT OFF VALVE

Type..... Rotary Type

STEERING VALVE

Type..... Flow Amp Type
Over Load Relief Set Pressure 32.3 MPa (330 kgf/cm²) @50 L/min (13 US gpm)

GENERAL / Component Specifications

STEERING PILOT VALVE

Type Orbitroll Type
Gerotor Capacity 96 cm³/rev (5.9 in³/rev)

STEERING ACCUMULATOR v

Capacity 0.2 L (12 in³)
Charging Pressure 8 MPa (82 kgf/cm²)

BRAKE VALVE

Brake Pressure 3.9 MPa (40 kgf/cm²)

GENERAL / Component Specifications

- Travel System

TRANSMISSION

Type	Counter Shaft Type
Gear Ratio	Forward 1st : 3.324
	Forward 2nd : 1.963
	Forward 3rd : 1.022
	Forward 4th : 0.603
	Reverse 1st : 3.324
	Reverse 2nd : 1.963
	Reverse 3rd : 1.022
	Reverse 4th : 0.603
Parking Brake Release Pressure	2.7 MPa (28 kgf/cm ²)

STANDARD AXLE (FRONT/REAR)

Model	Two Stage Transmission
Brake Type	Wet Multiplate Disk Brake
Brake Pressure	3.92 MPa (40 kgf/cm ²)
Final Reduction Gear Ratio	22.176

STANDARD PROPELLER SHAFT

Type	Cruciform Joint Type
Dimension between Pins	Front : 1419 mm (4'8")
	Rear : 276 mm (11")

GENERAL / Component Specifications

- Front Attachment

CYLINDER

	Lift Arm (Left/Right)	Bucket	Steering
Rod Diameter	75 mm (2.95")	85 mm (3.35")	45 mm (1.77")
Cylinder Bore.....	125 mm (4.92")	150 mm (5.91")	70 mm (2.76")
Stroke	765 mm (2'6")	495 mm (1'8")	442 mm (1'5")
Fully Retracted Length	1296 mm (4'3")	965 mm (3'2")	804 mm (2'8")
Plating Thickness	30 µm (1.2 µin)	30 µm (1.2 µin)	30 µm (1.2 µin)

GENERAL / Component Specifications

ELECTRIC COMPONENT

ENGINE OIL PRESSURE SENSOR

Operation Pressure 41.4 kPa (0.4 kgf/cm²)

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 mmH₂O)

FUEL LEVEL SENSOR

Resistance Value..... Empty: 90⁺¹⁰₀ Ω, Full: 10⁰₋₄ Ω

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")

GENERAL / Component Specifications

ILLUMINATION

Work Light	: Halogen 24 V, 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	950±50 g
Compressor Oil Quantity	160 cm ³

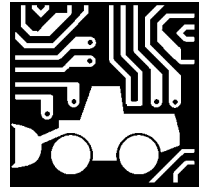
EMERGENCY STEERING PUMP UNIT

Type	Electric Motor Operated Type
Maximum Flow	17 L/min (4.49 gpm) @10.3 MPa (105 kgf/cm ²)
Electric Motor	24 V·2.4 kW

GENERAL / Component Specifications

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SECTION 2 SYSTEM



—CONTENTS—

Group 1 Control System

General	T2-1-1
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Hazard Light Circuit.....	T2-4-26
Horn Circuit	T2-4-27
Reverse Light/Buzzer Circuit	T2-4-28
Parking Brake Circuit.....	T2-4-30
Emergency Steering Check Circuit (Optional)	T2-4-32

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SYSTEM / Control System

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

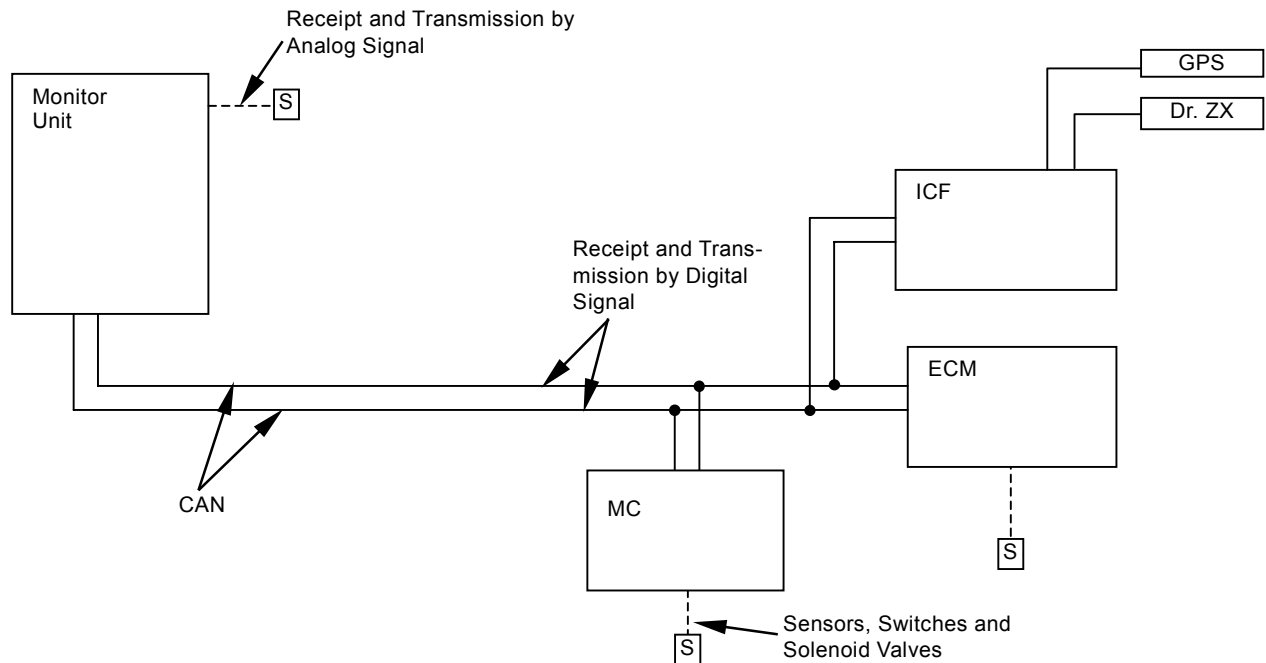
The controllers are mutually connected through CAN, and each controller uploads the analog signals detected by the sensors and switches as well as the analog output signals to the solenoid valves on CAN by converting them into the digital signals.

As the signals are processed into the digital signals, a large amount of signals detected by each controller can be transmitted through few wires in a short time.

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

ICF stores machine history, receives the digital signals for various adjustments from Dr. ZX, transmits them to CAN, and transmits the vehicle body information (digital signal) received by each controller to Dr. ZX.

A GPS-provision (optional) vehicle makes location arithmetic operation, utilising the signals received by artificial satellites and transmits body information to the e-service host computer through the artificial satellites. (Refer to the TROUBLESHOOTING/e-wheel group.)



SYSTEM / Control System

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

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

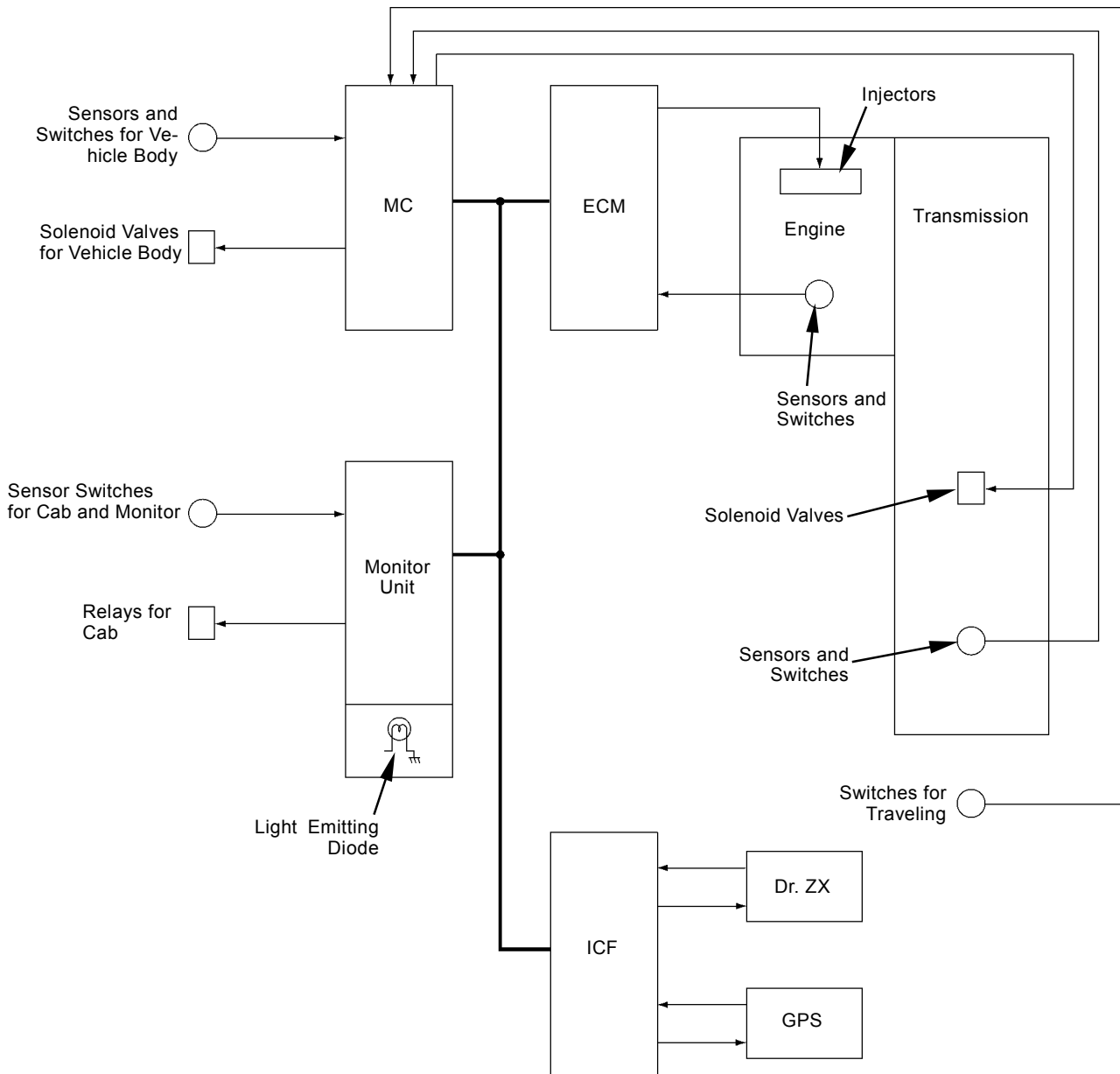
Each controller detects lacking information necessary for the control program from the CAN data. (digital signals)

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

The analog signals from various sensors, switches and solenoid valves are periodically transmitted to each controller, and converted into the digital signals to be uploaded on CAN.

By repeating the above operations, the vehicle body movement is watched and controlled.

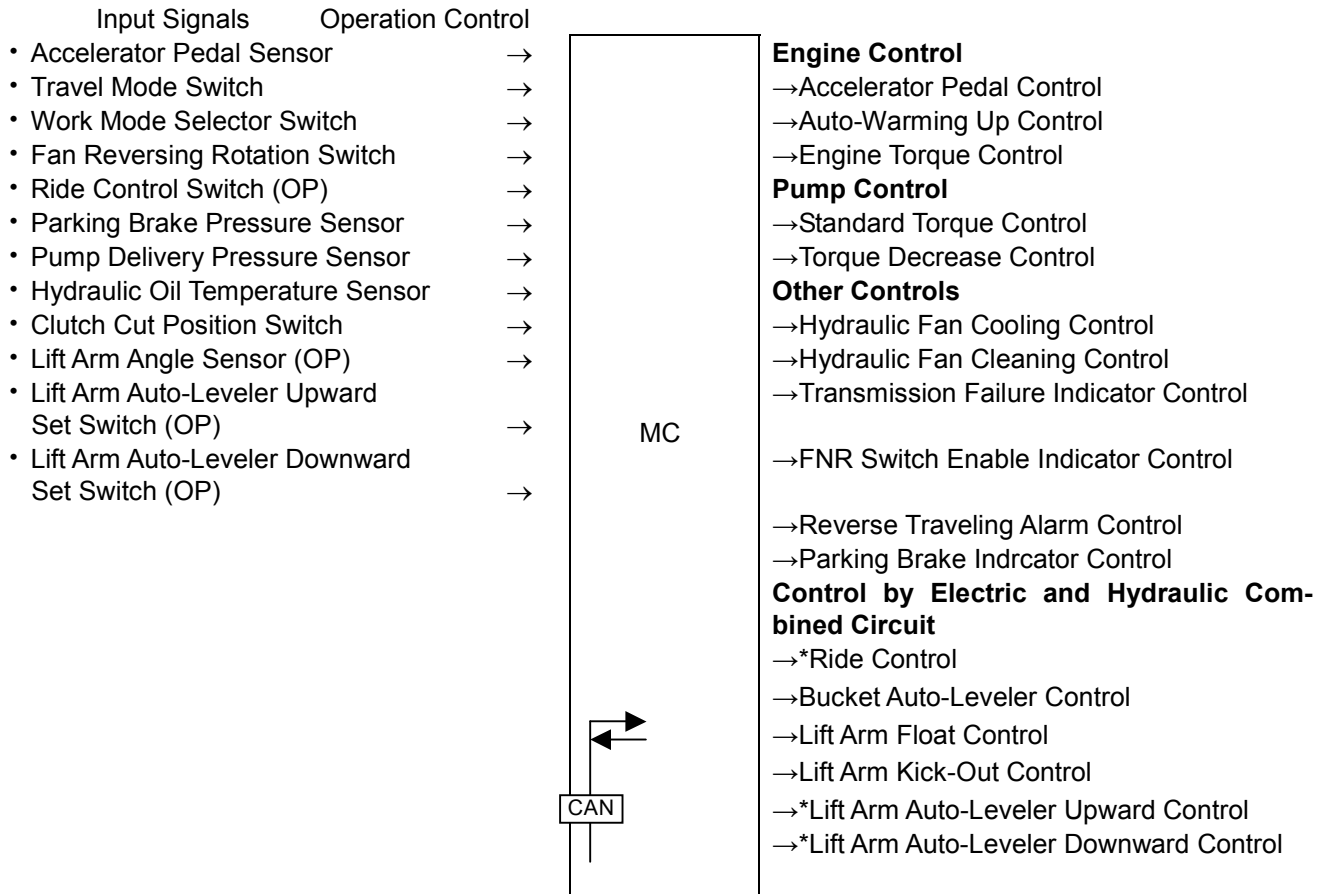
SYSTEM / Control System



T4GC-02-01-001

SYSTEM / Control System

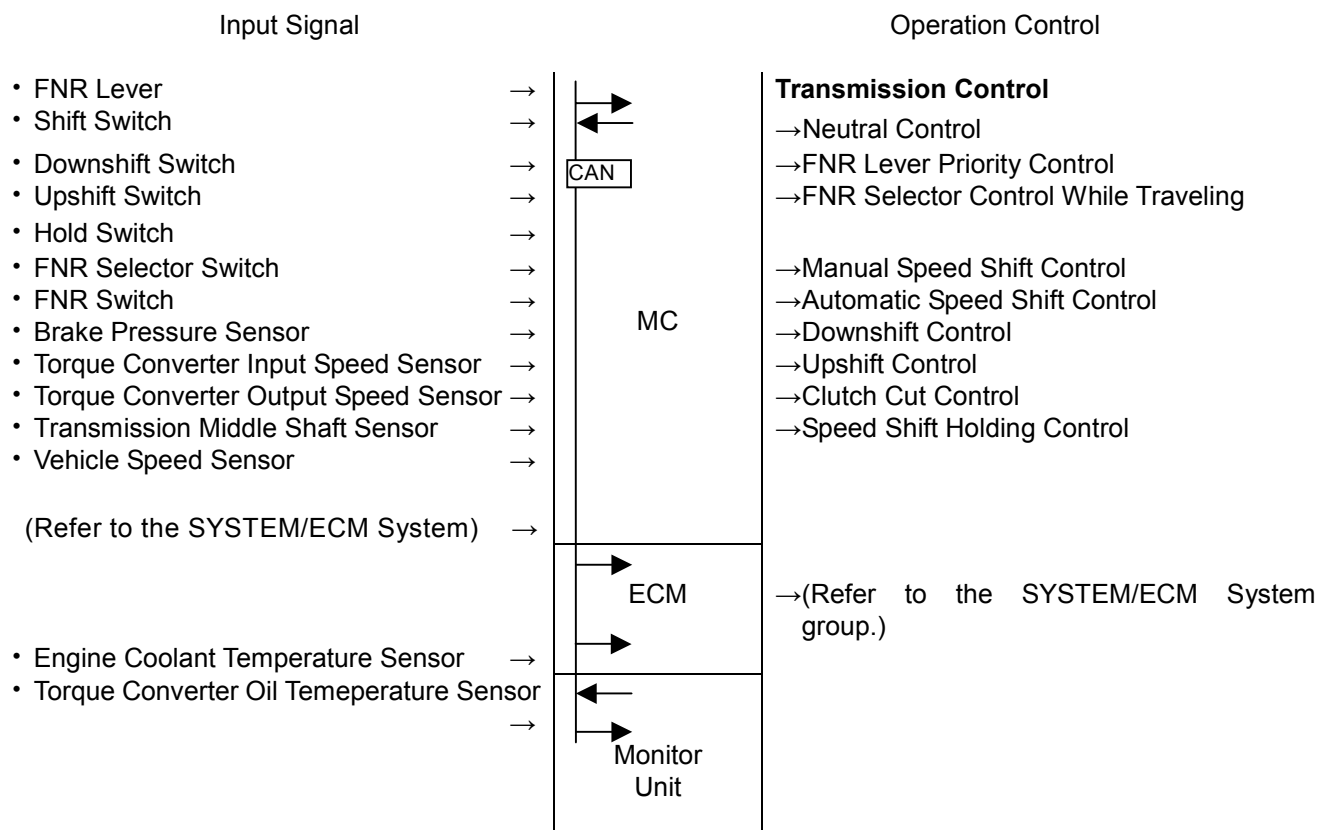
The sensors and switches to detect the signals for various operation controls and their controllers are as shown below.



NOTE: OP :Optional

*: Controls for only the machines with optional parts equipped

SYSTEM / Control System



NOTE: ECM controls the engine speed and others based on the target engine speed from 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 group.

SYSTEM / Control System

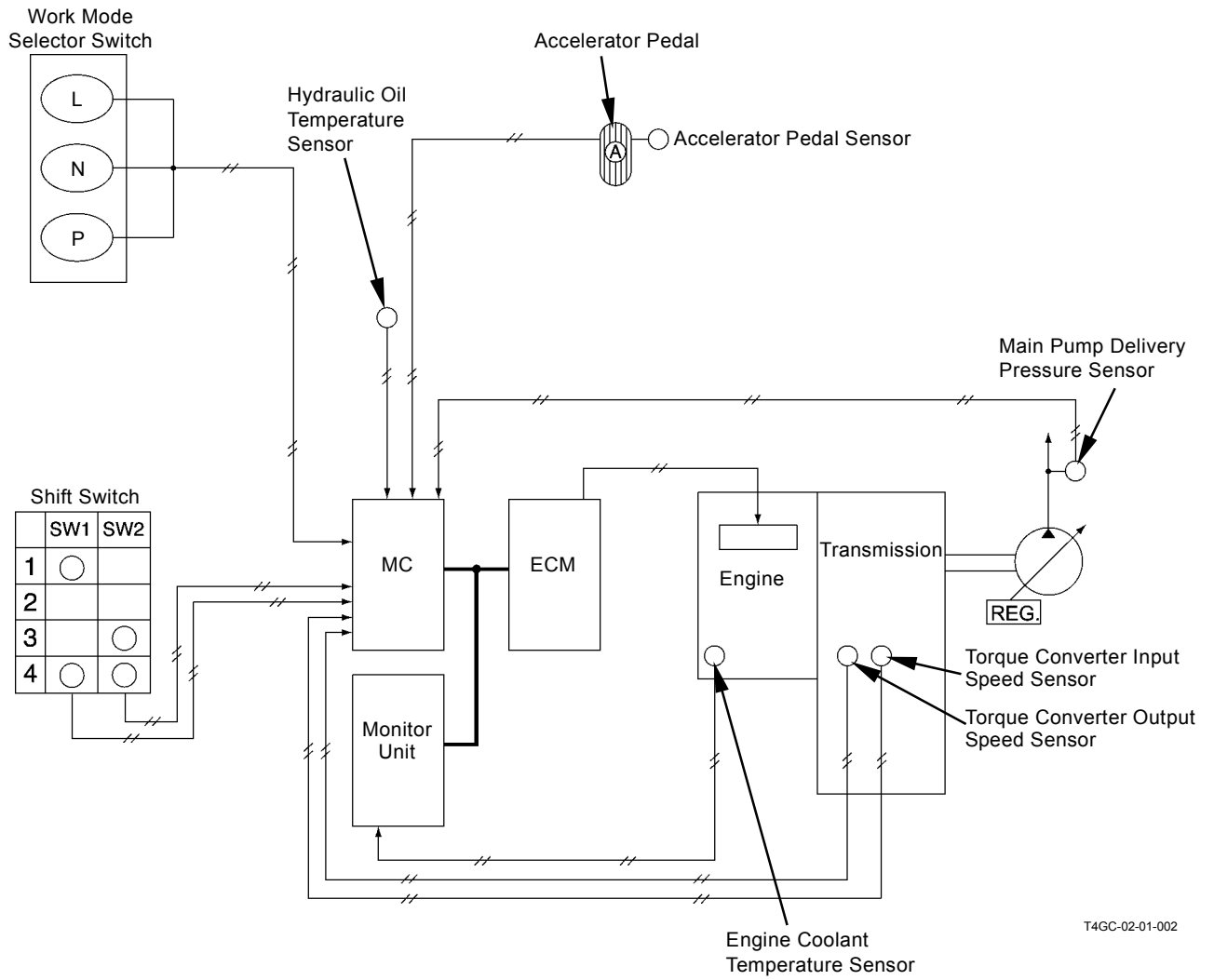
ENGINE CONTROL

The engine controls consist of the followings.

- Accelerator Pedal Control
- Auto-Warming Up Control
- Engine Torque Control

SYSTEM / Control System

Engine Control System Layout



SYSTEM / Control System

Accelerator Pedal Control

Purpose: To control the engine speed in response to stepping amount of the accelerator pedal.

Operation:

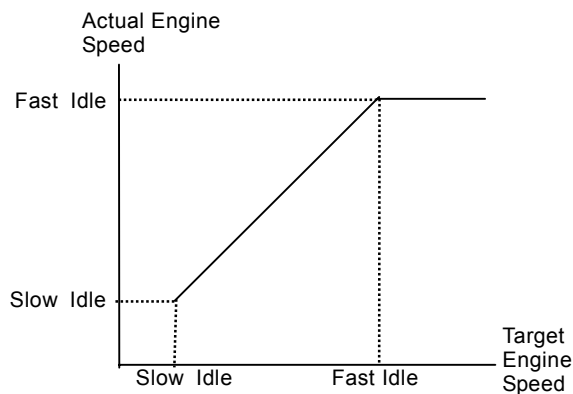
1. MC converts the input value from the accelerator pedal into the target engine speed and transmits it to ECM.
2. ECM controls the engine speed in response to the target engine speed.

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

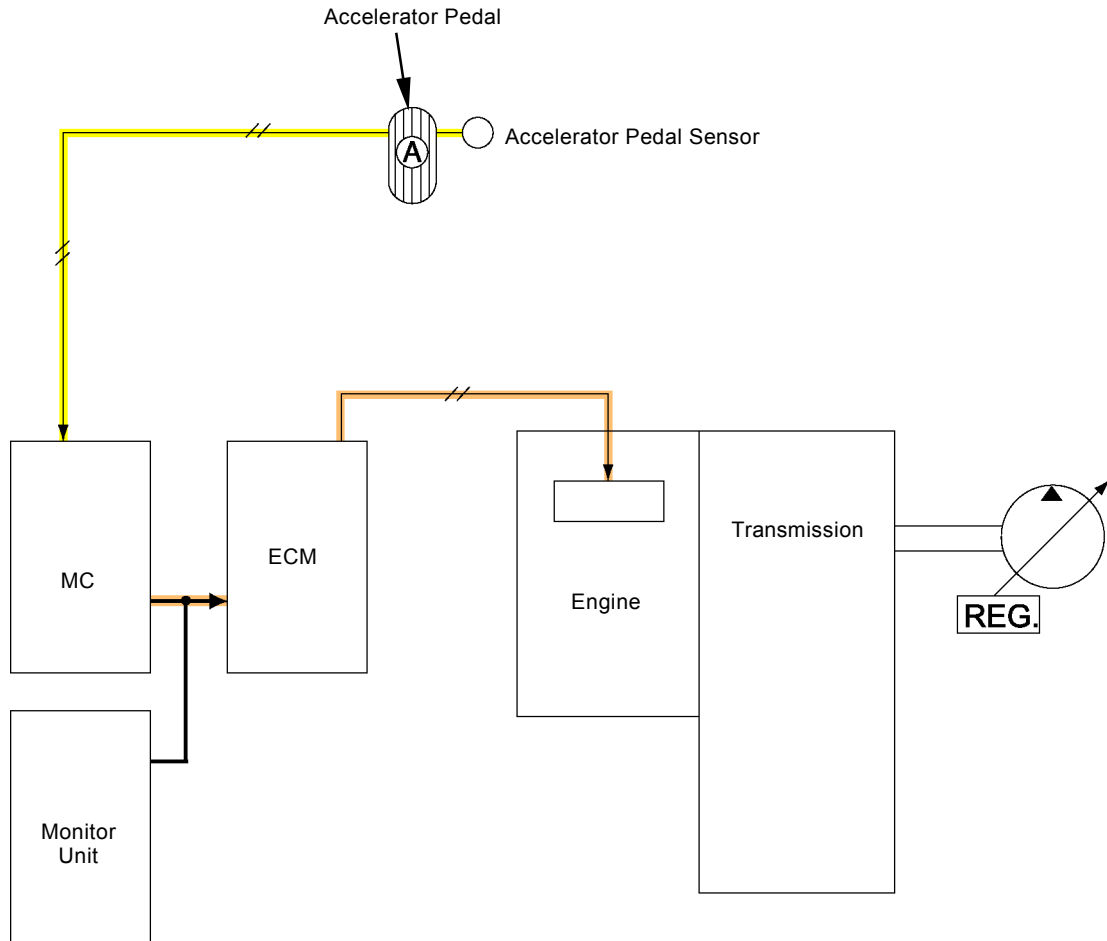
 **NOTE:** In case the accelerator pedal sensor becomes abnormal, MC makes backup control, and the engine speed is fixed at about 1100 min^{-1} .

 **NOTE:** In case MC becomes out of order, or CAN fails, ECM makes backup control, and the engine speed is fixed at about 1100 min^{-1} .

 **NOTE:** In case 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 ECM.



SYSTEM / Control System



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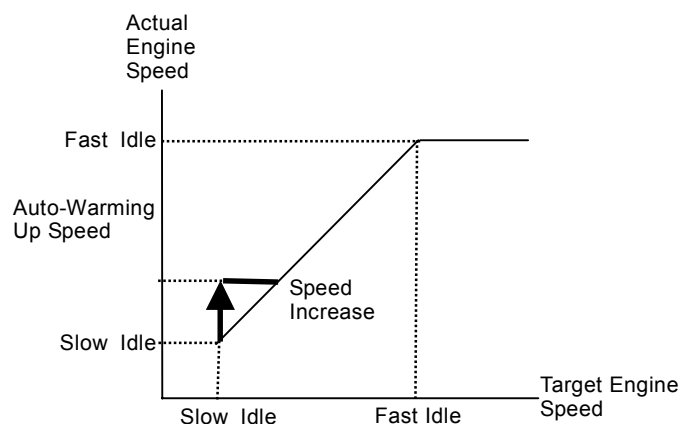
SYSTEM / Control System

Auto-Warming Up Control

Purpose: To warm up the engine in response to the hydraulic oil temperature automatically.

Operation:

1. At start of the engine, if the hydraulic oil temperature is 0°C (32°F) or below, MC transmits the signal that the engine slow idle speed is set at 1100 min^{-1} to ECM.
2. ECM increases the engine slow idle speed to 1100 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, MC stops the signals and ECM decreases the engine slow idle speed to the idling speed.



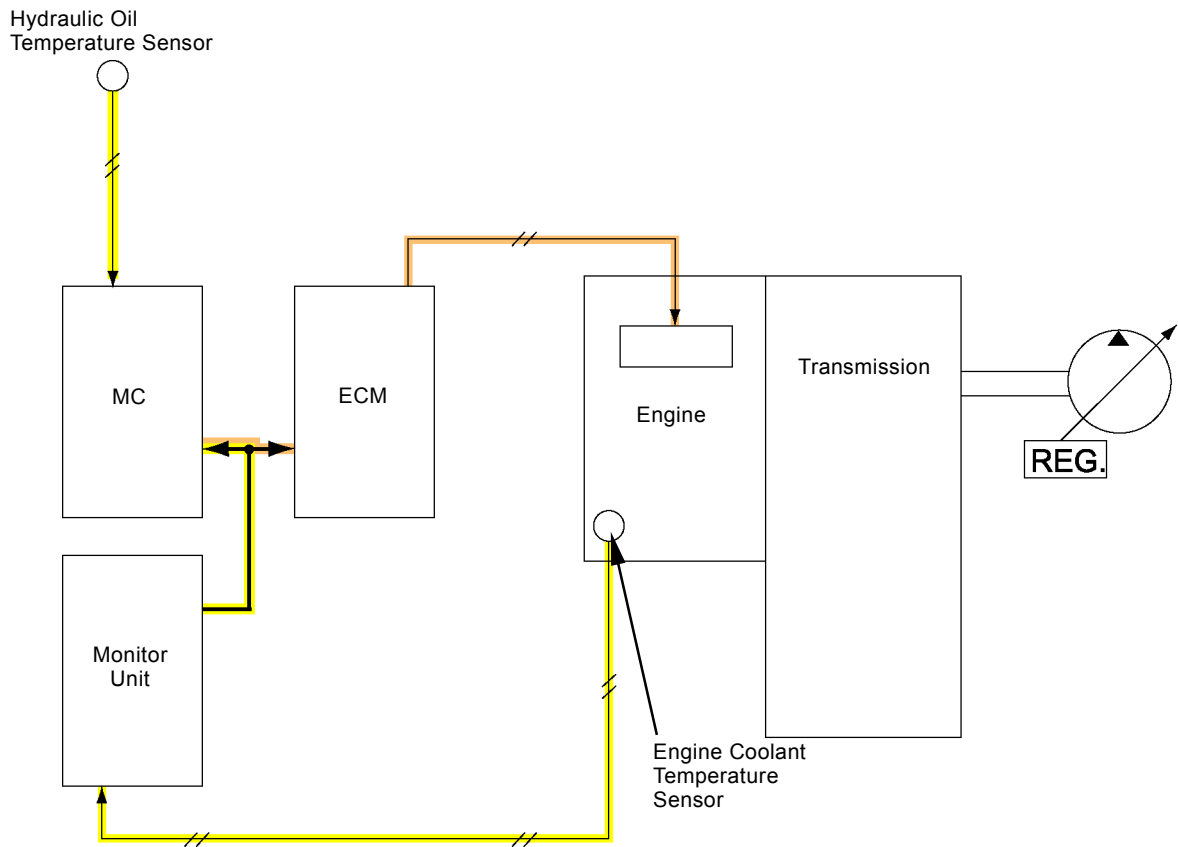
 **NOTE:** At start of the engine, if the hydraulic oil temperature is 1°C (34°F) or above, auto-warming up control is not made.

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

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

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

SYSTEM / Control System



T4GC-02-01-004

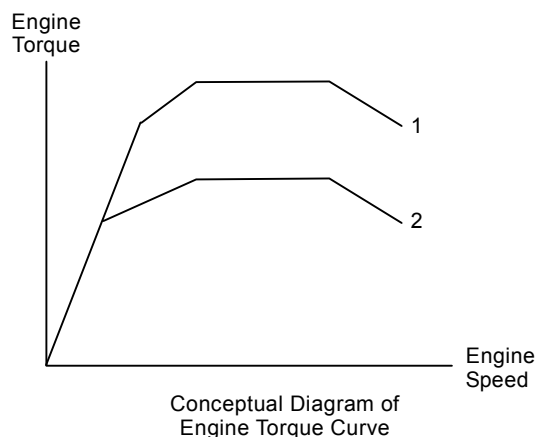
SYSTEM / Control System

Engine Torque Control

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

Operation:

1. When MC receives the signal of the selected work mode, MC detects the shift point.
2. MC has programmed torque curves to be selected in response to the combination of work mode and speed shift. MC outputs the selection command signal most suitable to each time to ECM.
 - When light mode (L) is selected, torque curve 1 or 2 is used.
 - When normal mode (N) or power mode (P) is selected, torque curve 1 is used.
3. ECM carries out alteration control of torque curves in response to the input torque curve selection command signal.



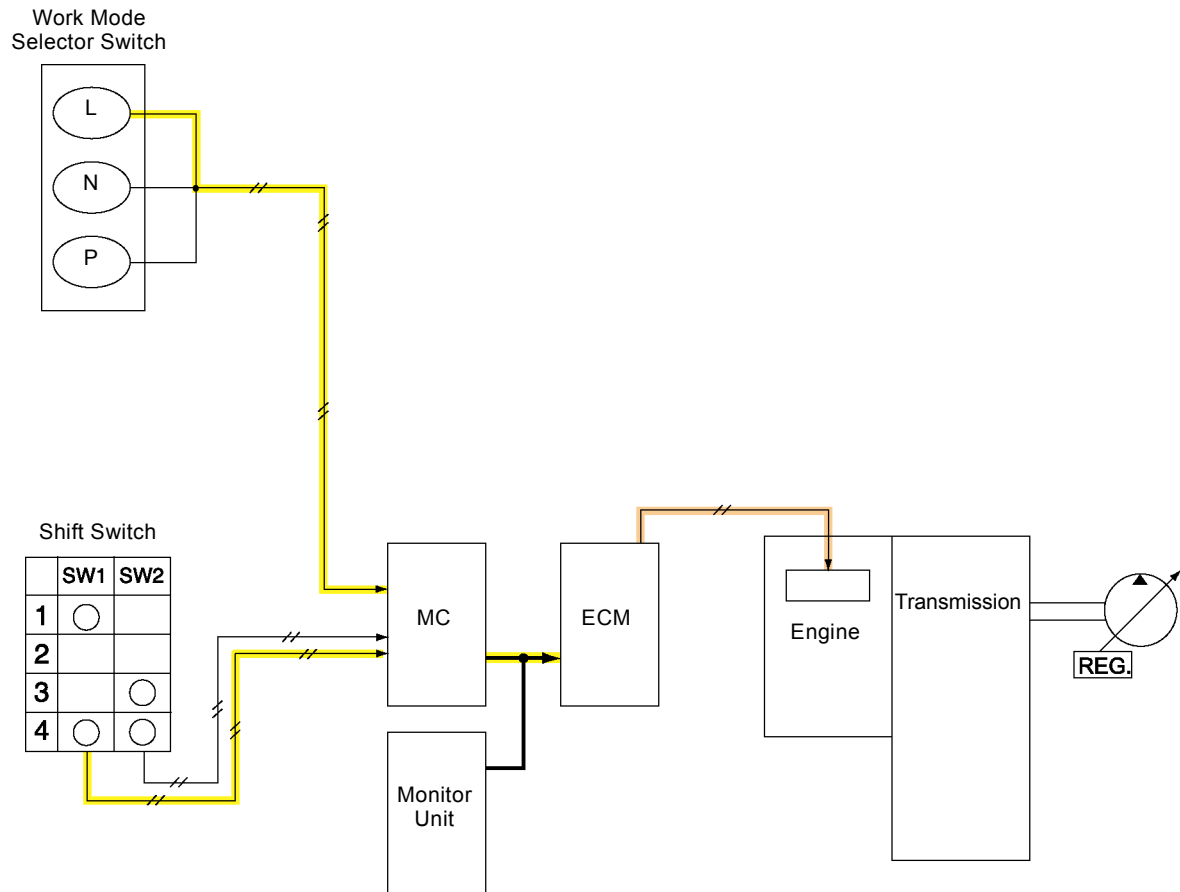
 **NOTE:** In case the signal from the work mode selector switch is not transmitted to MC, backup control that the work mode is fixed to the normal mode is made.

 **NOTE:** In case the signal from the shift switch is not transmitted to MC, backup control that Torque Curve 1 is selected is made.

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

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

SYSTEM / Control System



T4GD-02-01-007

 **NOTE:** The illustration shows the signal flow while mode L of work mode selector switch and speed 1 of the shift switch are selected.

SYSTEM / Control System

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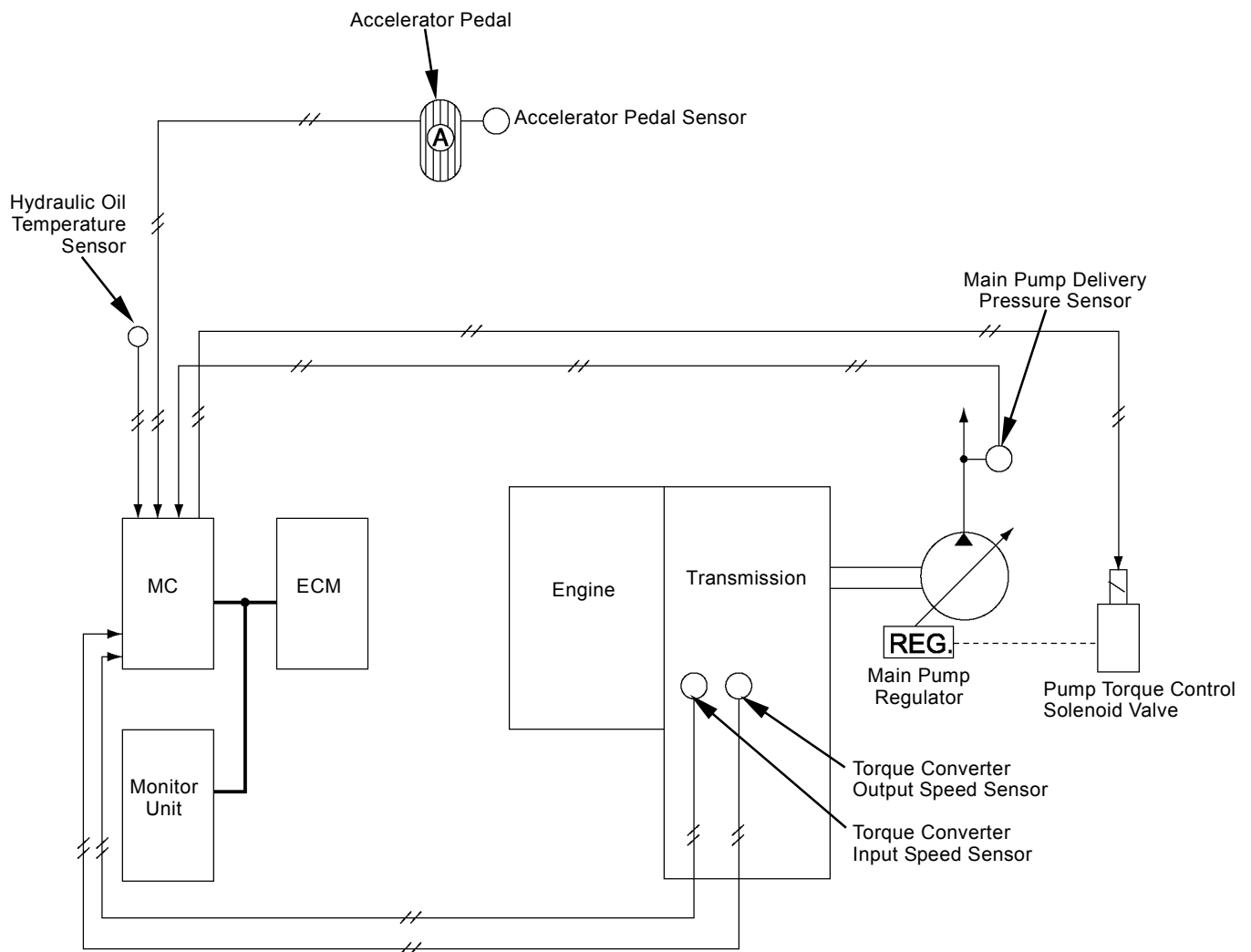
SYSTEM / Control System

PUMP CONTROL

The pump controls consist of the followings.

- Standard Torque Control
- Torque Decrease Control

Pump Control System Layout



T4GD-02-01-008

SYSTEM / Control System

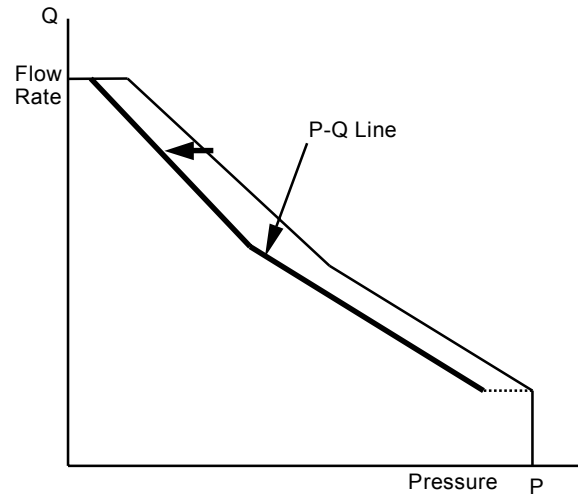
Standard Torque Control

Purpose: To utilize engine output power by changing pump delivery flow rate in response to increase or decrease of engine speed and hydraulic oil temperature effectively.

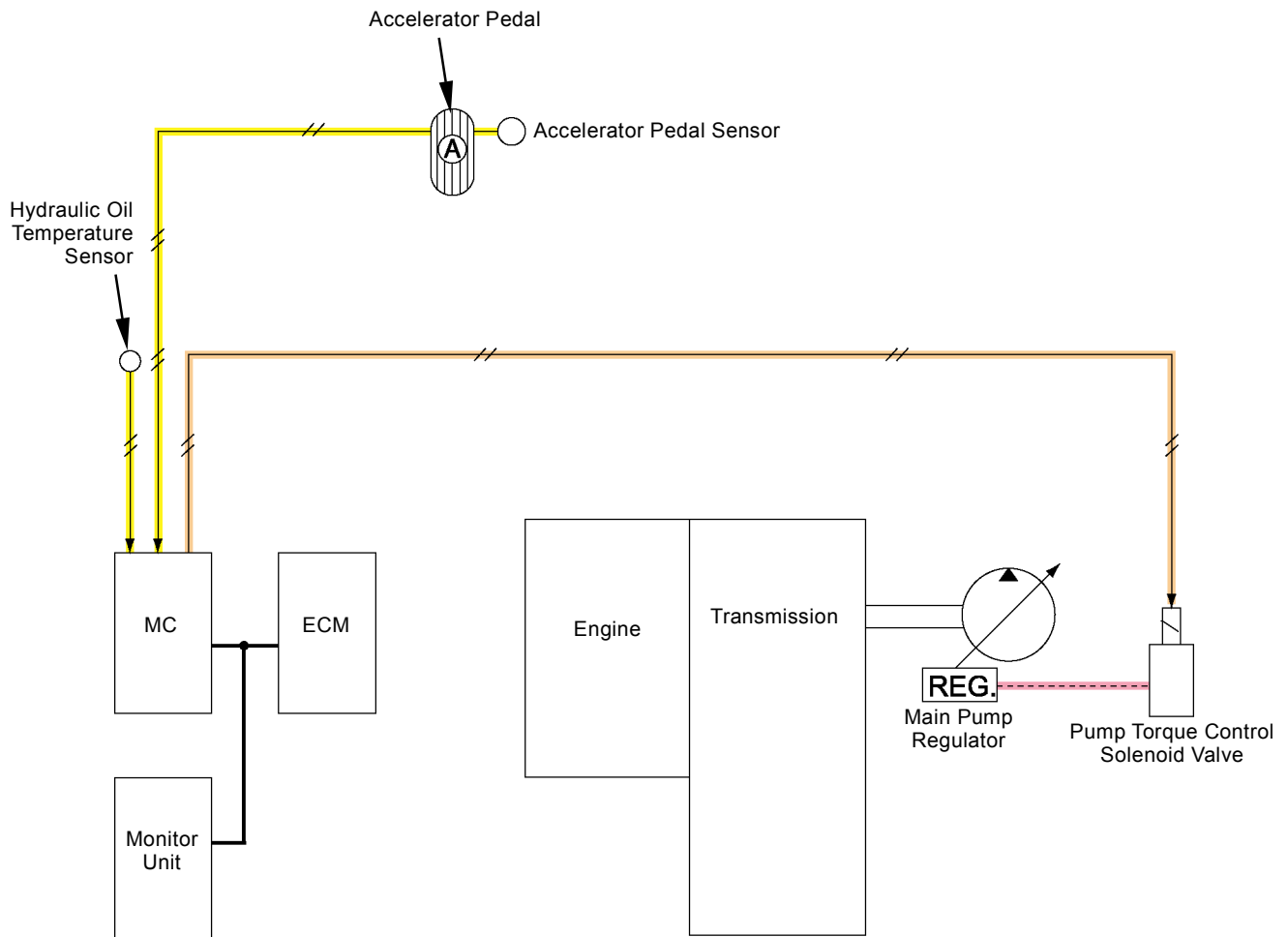
Operation:

1. When the accelerator pedal is depressed, MC calculates the target engine speed.
2. MC calculates the pump maximum displacement angle by receiving the target engine speed signal and hydraulic oil temperature, and transmits the signal to the pump torque control solenoid valve.
3. The pump torque control solenoid valve transmits pilot pressure according to the signal to the main pump regulator, and controls the pump delivery flow rate.

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



SYSTEM / Control System



T4GD-02-01-009

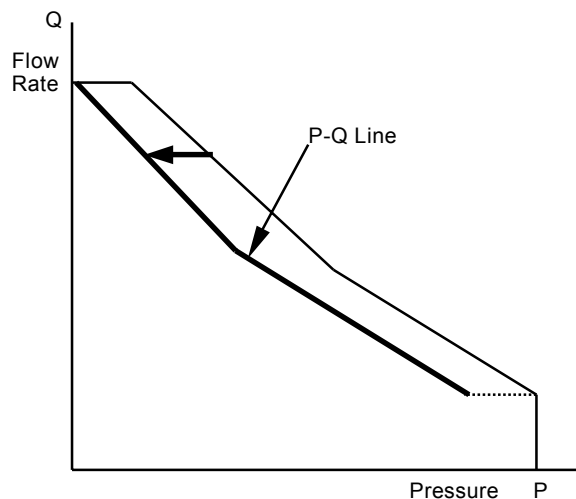
SYSTEM / Control System

Torque Decrease Control

Purpose: To utilize engine output power by changing pump delivery flow rate in response to increase or decrease of the engine speed due to traveling load effectively.

Operation:

1. When the accelerator pedal is depressed, MC calculates the target engine speed.
2. MC calculates the pump maximum displacement angle most suitable to each time, by using the target engine speed and the signals from the main pump delivery pressure sensor, torque converter input speed sensor and torque converter output speed sensor, and transmits the signal to the pump torque control solenoid valve.
3. The pump torque control solenoid valve transmits pilot pressure according to the signal to the main pump regulator, and controls the pump delivery flow rate.
4. If load applied to the engine becomes large and decreases the actual engine speed below the target speed, the pump displacement angle is decreased and delivery flow rate is decreased. Thus, operation of the vehicle body is improved.
5. MC calculates the actual engine speed by receiving the signal from the torque converter input speed sensor.

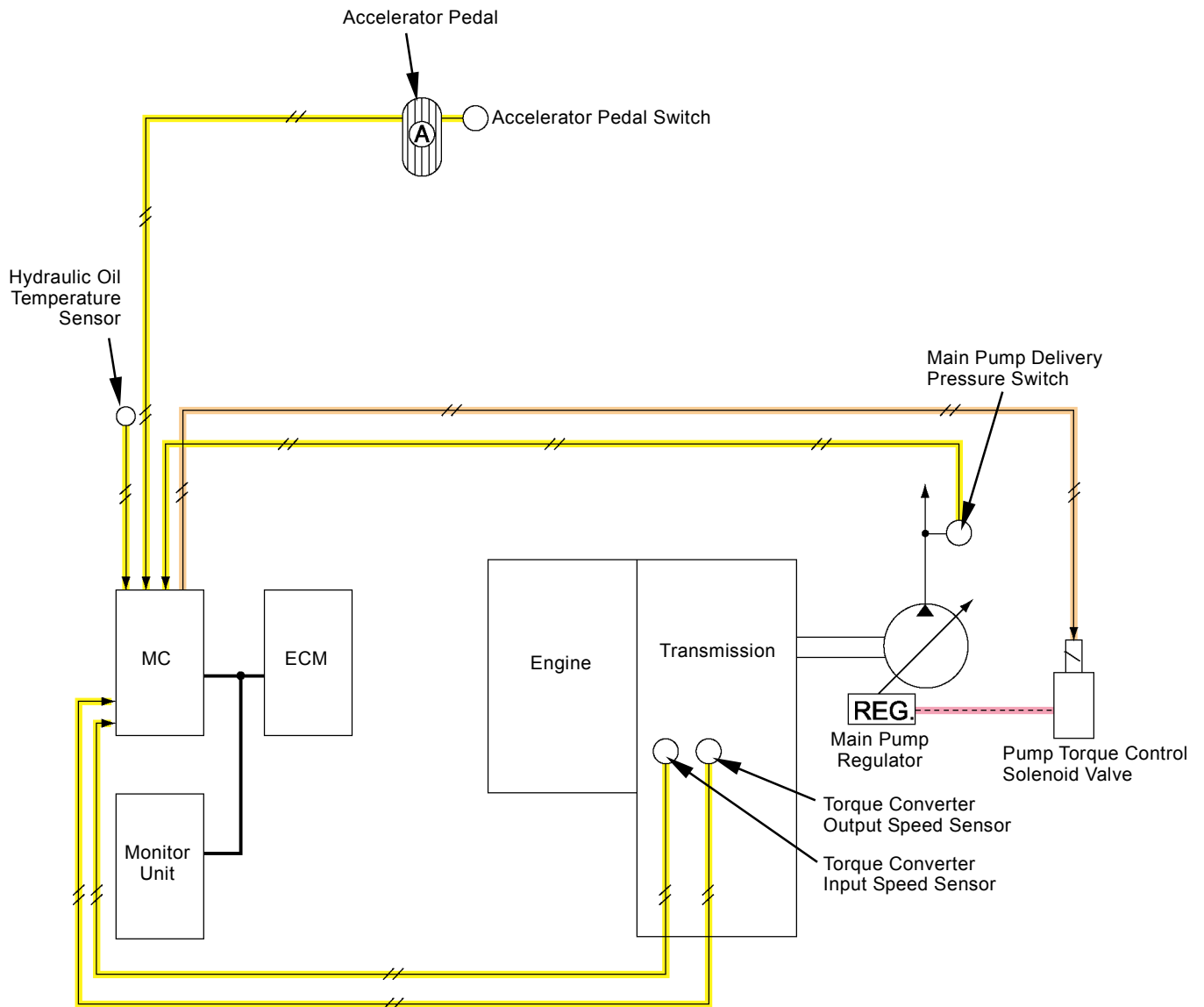


NOTE: In case the accelerator pedal becomes abnormal, the backup control of the accelerator pedal control fixes the engine speed at 1100 min^{-1} .

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

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

SYSTEM / Control System



T4GD-02-01-010

SYSTEM / Control System

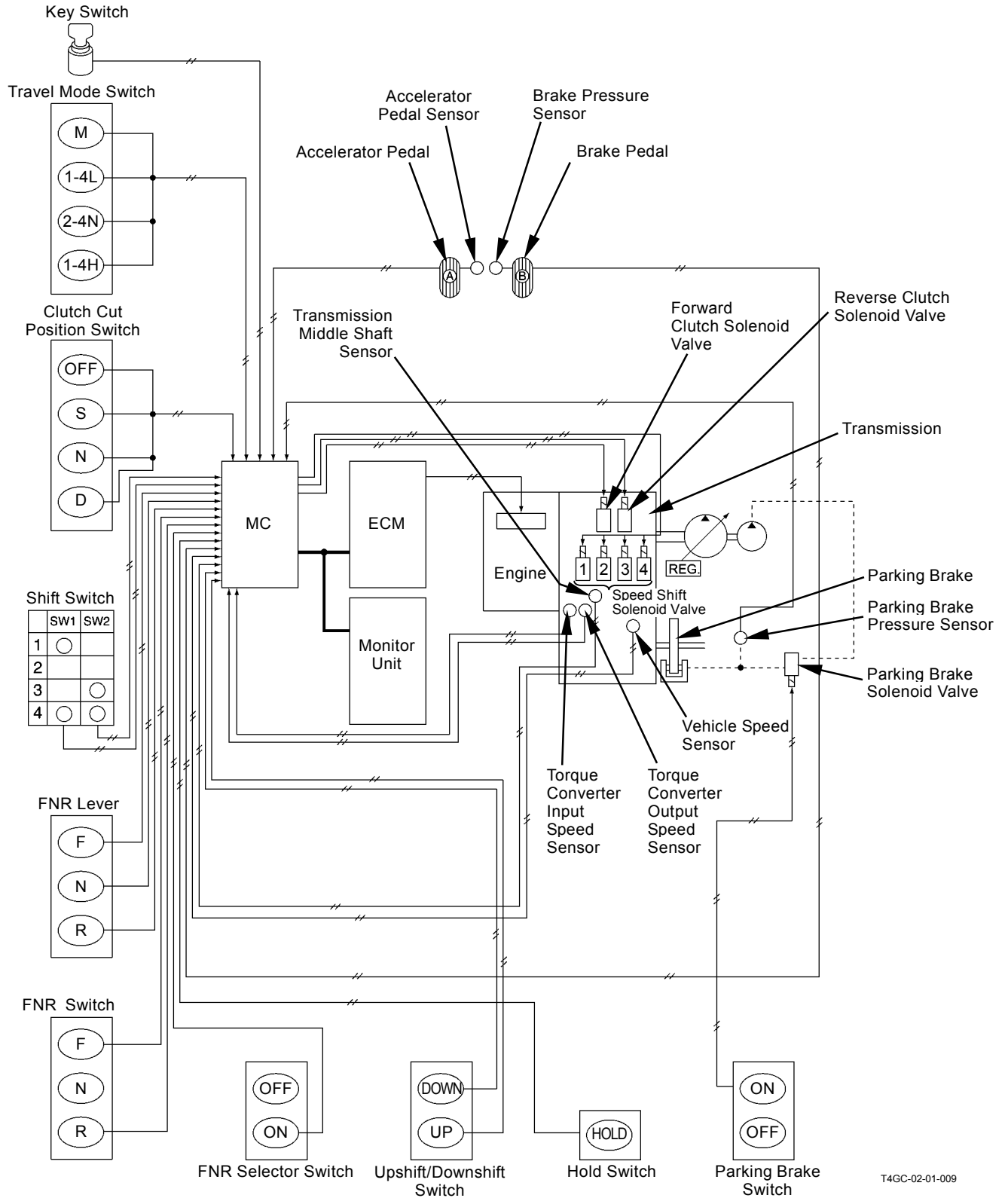
TRANSMISSION CONTROL

The transmission controls consist of the followings.

- Neutral Control
- FNR Lever Priority Control
- Forward/Reverse Selector Control While Traveling
- Manual Speed Shift Control
- Automatic Speed Shift Control
- Downshift Control
- Upshift Control
- Clutch Cut Control
- Speed Shift Holding Control

SYSTEM / Control System

Transmission Control System Layout



T4GC-02-01-009

SYSTEM / Control System

Neutral Control

Purpose: To protect transmission by restricting clutch connection despite operation of FNR lever or FNR switch while applying the parking brake.

Operation:

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

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

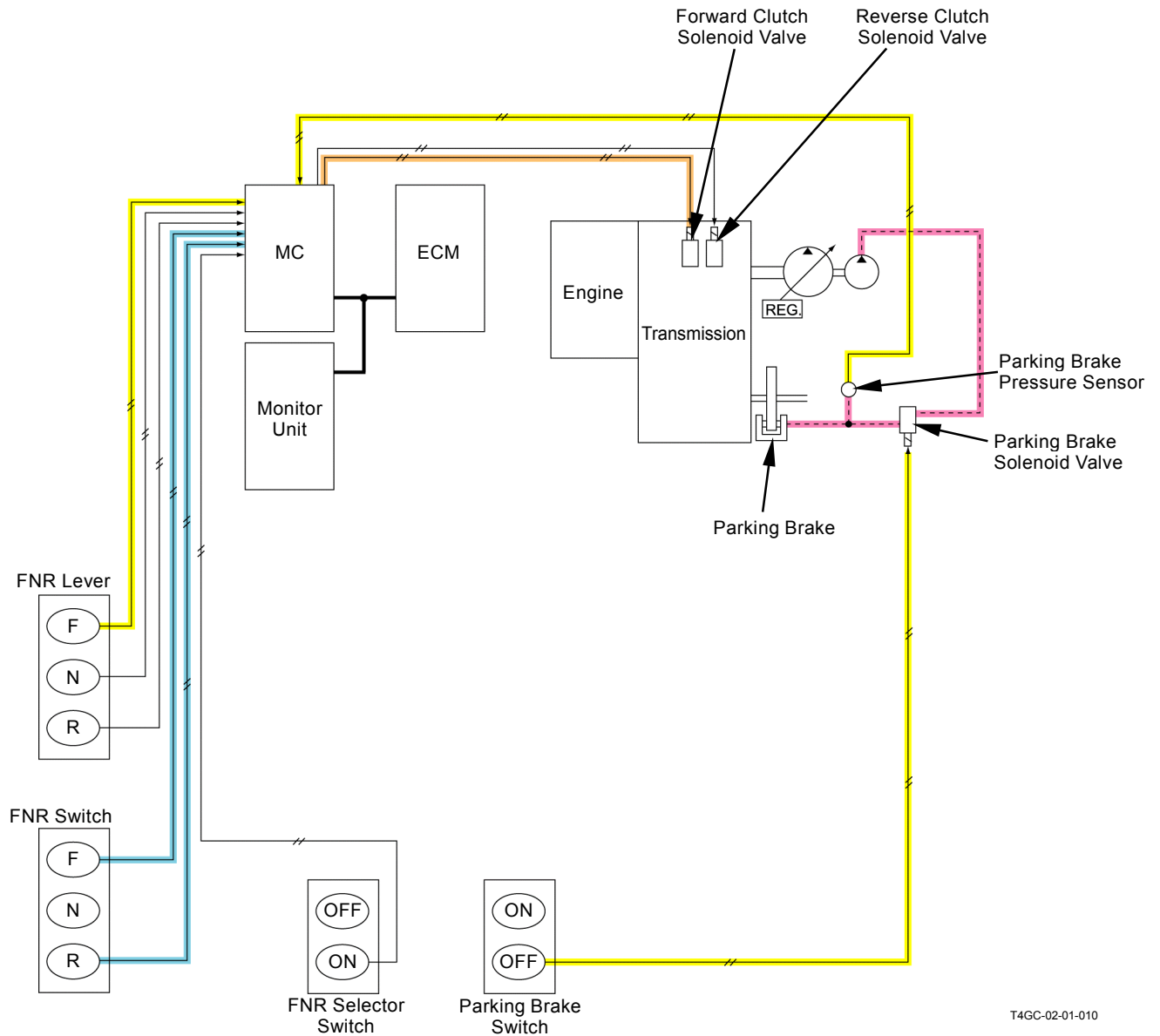
 **NOTE:** In case short-circuiting takes place inside the FNR lever, the transmission is made neutral forcedly.

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

 **NOTE:** The FNR switch does not transmit the neutral signal. In case of no electric current from the FNR switch, the controller judges that the switch is 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 applied as the parking brake indicator is kept OFF (release).

SYSTEM / Control System



T4GC-02-01-010

NOTE: The illustration shows the signal flow in case forward of the FNR lever have been selected with the parking brake switch OFF (Transmitting brake release signal).

SYSTEM / Control System

FNR Lever Priority Control

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

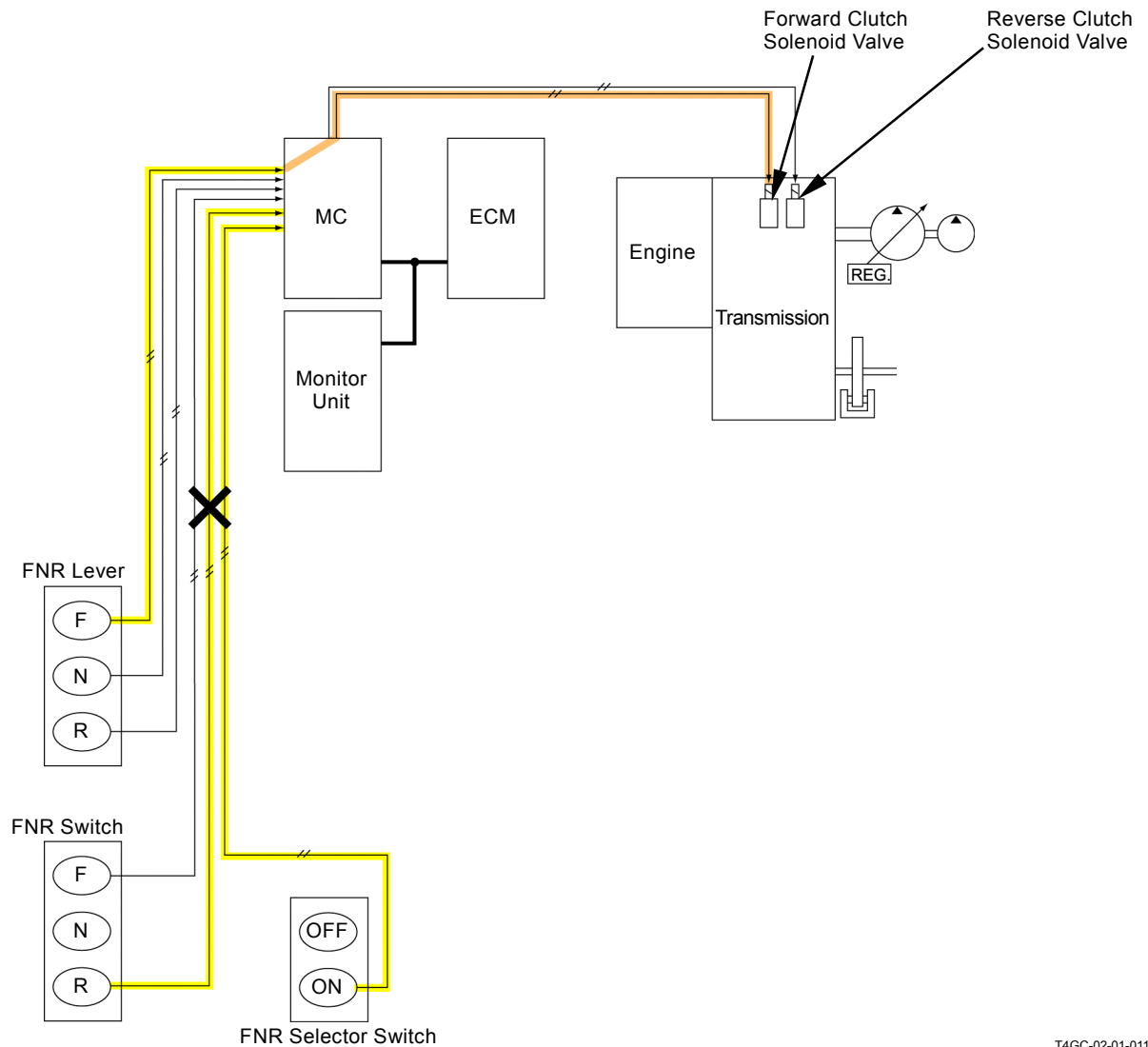
Operation:

1. In case the FNR lever is operated while traveling by using the FNR switch, MC disables operation of the FNR switch, and makes forward/reverse control by the input signal from the FNR lever.
2. When operating again by using the FNR switch, the FNR switch is effective again by turning the FNR selector switch ON while both the FNR lever and the FNR switch are at the neutral position.
3. Until the FNR lever is operated next from that time, MC makes forward/reverse control by the FNR switch input signal.

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

 **NOTE:** *The FNR switch does not transmit the neutral signal. In case of no electric current from the FNR switch, the controller judges that the switch is neutral (N).*

SYSTEM / Control System



T4GC-02-01-011

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

SYSTEM / Control System

Forward/Reverse Selector Control while Traveling

Purpose: To protect the transmission by preventing forward/reverse selector unless the vehicle speed is lowered than the set speed when traveling over the set speed.

Operation:

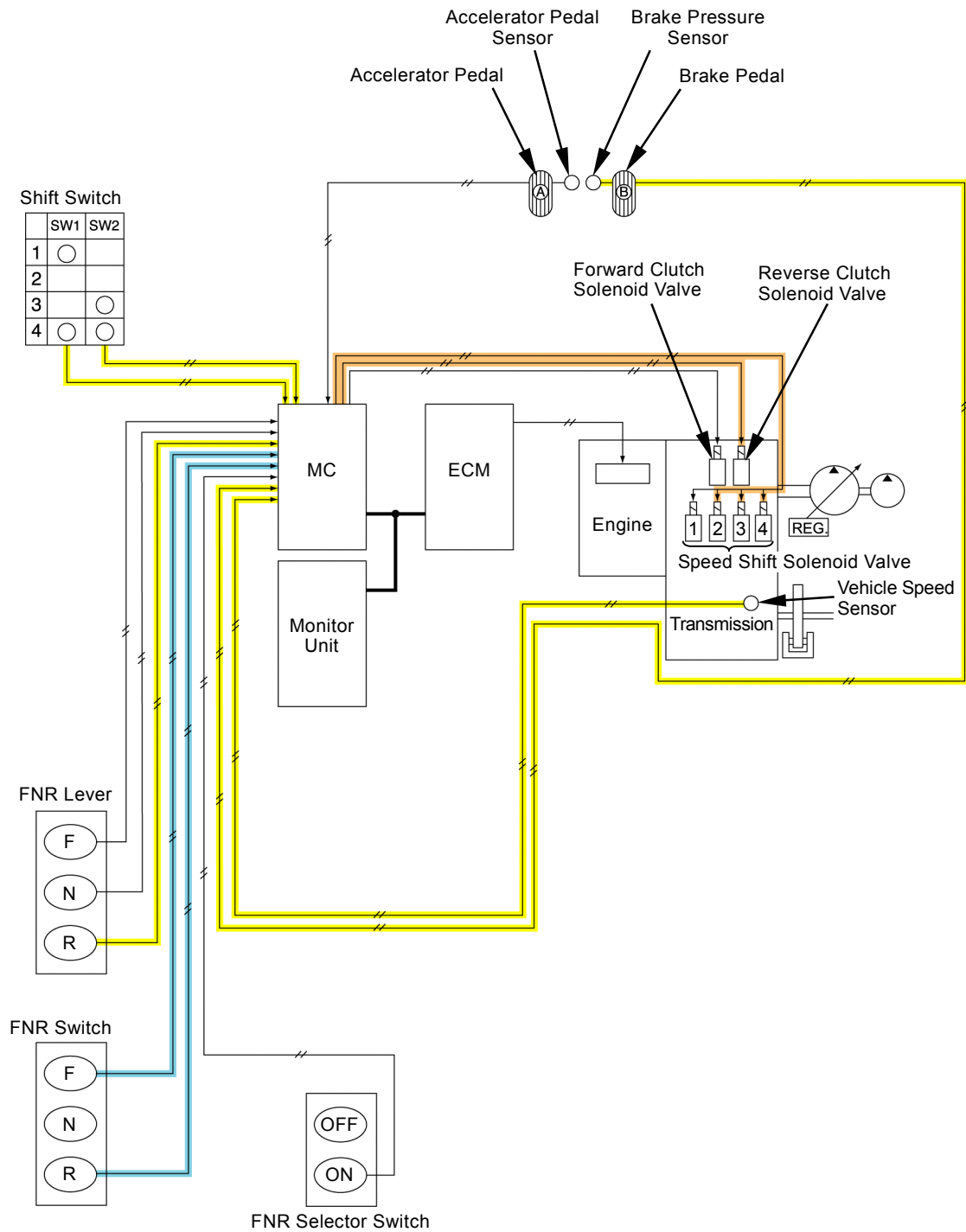
1. In case the FNR lever is turned to reverse while traveling forward speed is higher than the allowable speed of FNR clutch selection, MC reduces the vehicle speed shift by sending the speed shift signal in order from 4→3→2 if the speed was set in speed 4.
2. If the vehicle speed is lowered to the set speed by operation of the brake pedal, MC transmits the signal to the reverse clutch solenoid valve and turns the clutch into reverse.
3. When the vehicle speed increases while the accelerator pedal is depressed, MC shifts up by sending the speed shift signal from speed 2 to speed 3 to each speed shift solenoid valve.

 **NOTE:** In case the FNR lever is operated when the vehicle speed is below the allowable speed of FNR clutch selection, the FNR clutch is operated regardless of the speed shift.

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

 **NOTE:** The FNR switch does not transmit the neutral signal. In case of no electric current from the FNR switch, the controller judges that the switch is neutral (N).

SYSTEM / Control System



T4GC-02-01-012

NOTE: The illustration shows the signal flow in case the FNR lever is set in reverse and the brake pedal is depressed while traveling forward at speed 4 exceeding the allowable speed for shifting the FNR clutch.

SYSTEM / Control System

Manual Speed Shift Control

Purpose: To shift the speed manually

Operation:

1. When manual (M) of the travel mode switch is selected, MC is provided with voltage of 1V.
2. The manual speed shift program is started in MC.
3. The shift switch is a rotary type and has two switches inside. When one of a speed among speed 1 through speed 4 is selected, the signal of the selected shift position is transmitted to MC according to the combination of ON of the shift switches.

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

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

 **NOTE:** MC is programmed in order to determine the vehicle speed ranges to change to the respective speed shifts.

 **NOTE:** When the shift switch is turned from speed 3 to speed 1 while traveling, the vehicle automatically shifts down to speed 2, and then shifts down to speed 1 after the vehicle speed becomes the range of speed 1.

 **NOTE:** In case a malfunction occurs in either solenoid valve of speed 1, speed 3, or speed 4, the vehicle speed is fixed at speed 2. In case a malfunction occurs in either the forward clutch solenoid valve or reverse clutch solenoid valve, only the abnormal one cannot be used.

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

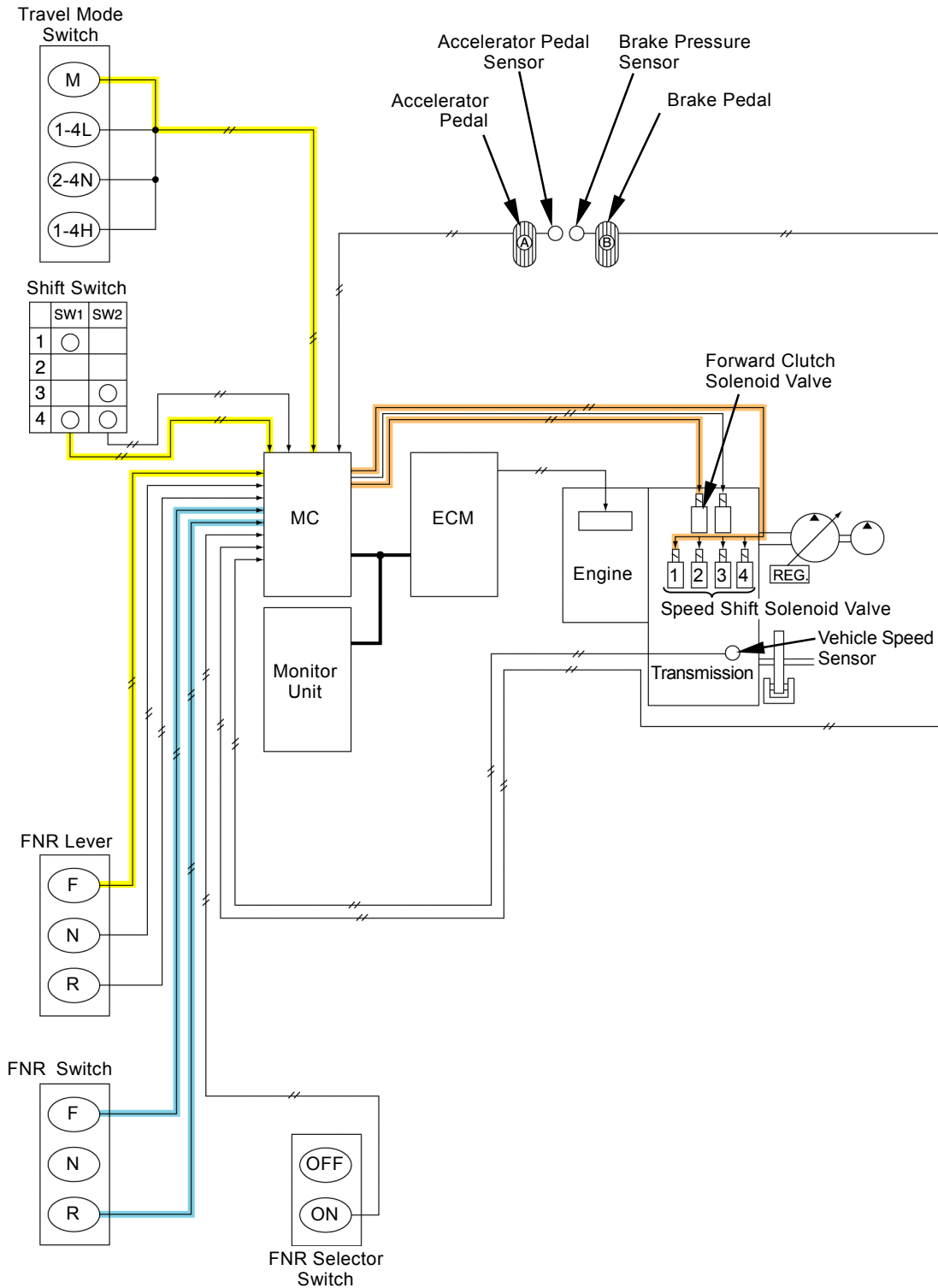
 **NOTE:** The shift switch has two switches, and the combination of their ON varies depending on each speed shift. The controller judges which speed shift has been selected by the combination of the two input signals.

 **NOTE:** The FNR switch does not transmit the neutral signal. In case of no electric current from the FNR switch, the controller judges that the switch is neutral (N).

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

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

SYSTEM / Control System



T4GC-02-01-013

NOTE: The illustration shows the signal flow when the FNR lever is set in forward while the travel mode switch is set in manual and the speed shift switch is set in speed 1.

SYSTEM / Control System

Automatic Speed Shift Control

Purpose: To shift the speed automatically with three kinds of timing selection of automatic speed shift change

Operation:

1. If either of 1-4L, 2-4N and 1-4H of the travel mode switch is selected, MC is supplied with voltage according to the selected mode.

Mode	Auto 1-4L	Auto 2-4N	Auto 1-4H
Output Voltage	2 V	3 V	4 V

2. MC starts the selected automatic speed shift program.

- The vehicle starts with speed 2 in auto 1-4L control, and it automatically be shifted down to speed 1 if travel load is too high. In this mode, the vehicle shifts at early timing during low engine speed.
- The vehicle starts with speed 2 in auto 2-4N control. In this mode, the vehicle shifts at higher engine speed than auto 1-4L control.
- The vehicle starts with speed 2 in auto 1-4H control, and it automatically be shifted down to speed 1 if travel load is too high. In this mode, the vehicle shifts at higher engine speed than auto 1-4L control.

 **NOTE:** Even if a mode of 1-4L, 2-4N, or 1-4H is selected, the vehicle starts with speed 1 if the shift switch is selected.

3. The shift switch is a rotary type and has two switches inside. When a speed shift is selected among speed 1 through speed 4, the selected shift signal is transmitted to MC according to the combination of ON in the 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 the signal to the 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 accelerator pedal sensor. MC eventually makes speed shift control until the selected speed shift.

 **NOTE:** Each shift position specifies necessary vehicle speed and accelerator pedal output value that allows shifting change to its position. The setting parameter is programmed in MC. Thus, when the travel mode switch is set in auto 1-4L and the shift switch is set in speed 3, the vehicle starts with speed 2, and then shifts up speed 3 according to the acceleration of the vehicle speed. On the other hand, when the shift switch is changed from speed 3 to speed 1 while traveling, the vehicle shifts down to speed 2 automatically, and then shifts down speed 1 if the vehicle speed reduces in the range of speed 1.

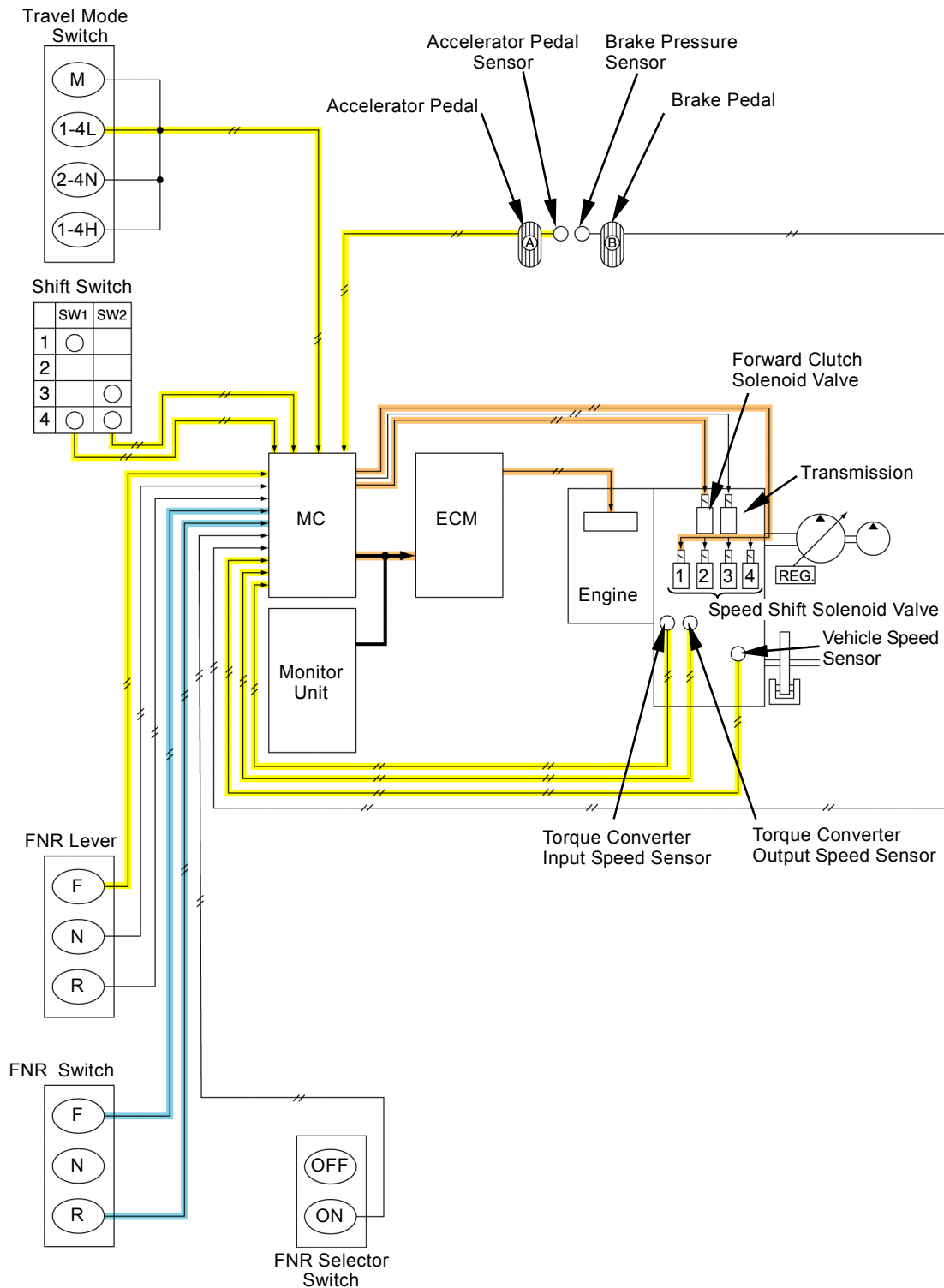
 **NOTE:** In case the travel mode switch becomes out of order, MC makes speed shift control in the manual traveling mode.

 **NOTE:** In case a malfunction occurs in either solenoid valve of speed 1, speed 3, or speed 4, the vehicle speed fixed is at speed 2. In case a malfunction occurs in either of the forward clutch solenoid valve, reverse clutch solenoid valve, or speed 2 solenoid valve, only the abnormal one cannot be used.

 **NOTE:** In case a malfunction occurs in the vehicle speed sensor, the vehicle speed is detected by using the transmission middle shaft sensor, which may have large margin error. In case a malfunction occurs in both vehicle speed sensor and the transmission middle shaft sensor, the vehicle speed is fixed at speed 2.

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

SYSTEM / Control System



T4GC-02-01-014

NOTE: The illustration shows the signal flow when the travel mode switch is set in auto 1-4L mode, the shift switch is set in speed 4, and the FNR lever is shifted to forward, while the brake pedal is depressed.

SYSTEM / Control System

Downshift Control

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

Operation:

1. When traveling at speed 4 while the travel mode switch is set in auto 1-4L mode, the signal is transmitted to MC by pushing the downshift switch once.
2. When the vehicle speed is faster than the allowable speed to shift down, MC cancels the signal from the downshift switch. On the other hand, MC transmits a signal to the speed shift solenoid valve of speed 3 when the vehicle speed is slow enough.
3. When the downshift switch is pushed while the vehicle speed is slow enough to shift down, speed 2 is selected.
4. In case auto mode of the travel mode switch is selected, auto 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. When the downshift switch is continue to be pushed, the speed shift is lowered to speed 2, and speed 2 is kept during pushing.
6. At this time, when the downshift switch is released and pushed again within three seconds while the vehicle speed is slow enough to shift down, the vehicle shifts to speed 1.
7. When the downshift switch is in the manual mode of the travel mode switch, in case the vehicle speed is slow enough to shift down, the speed shift is lowered and the shifted speed is kept.

8. In case of the following, the downshift switch control is canceled.

- Operation of the FNR lever or the FNR switch
- Operation of the shift switch
- Operation of the travel mode switch
- Pushing the hold switch
(Only in auto mode of the travel mode switch)

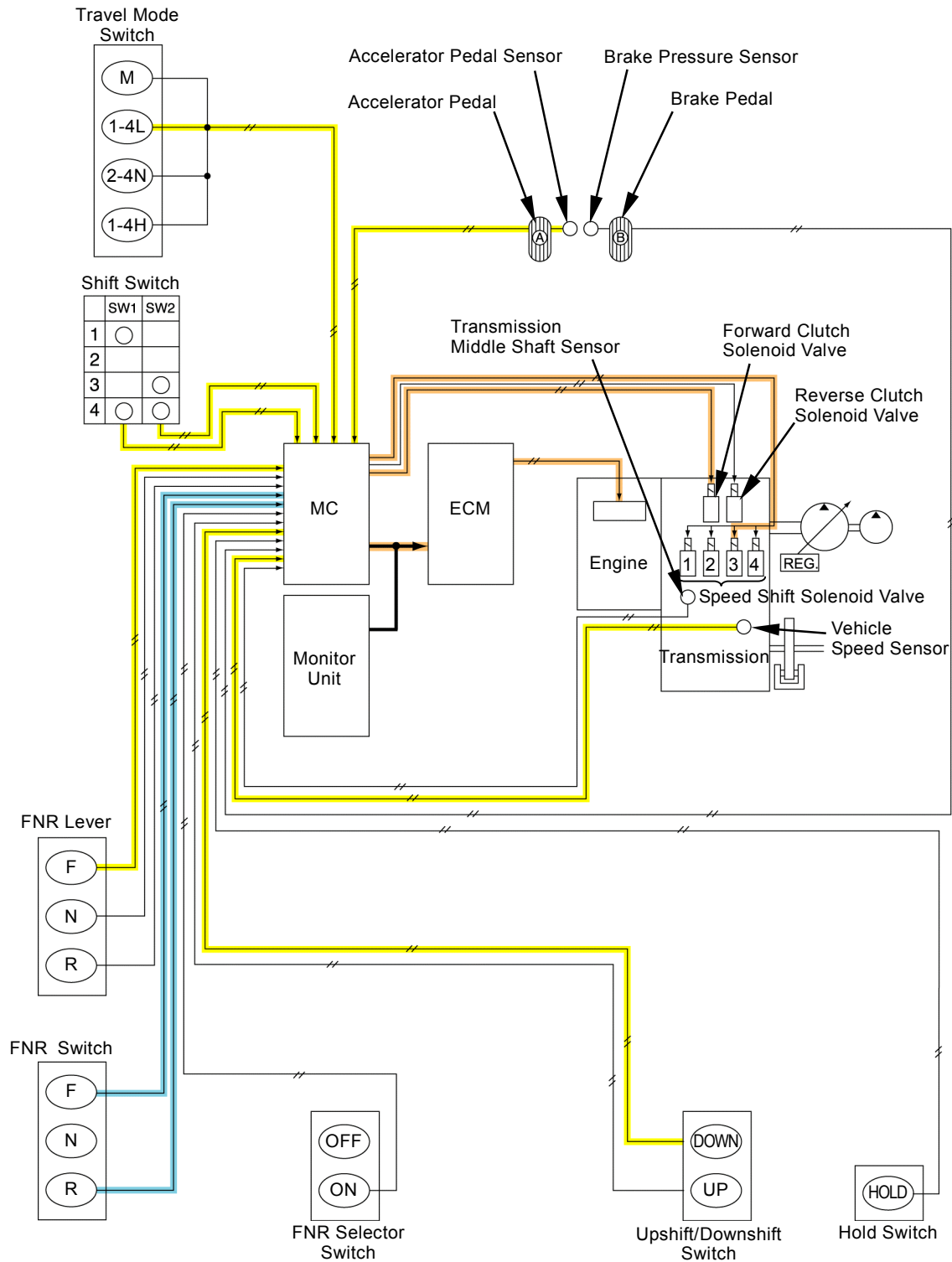
 **NOTE:** In case the vehicle speed sensor becomes abnormal, MC receives the signal from the transmission middle shaft sensor, and controls by calculating the vehicle speed allowable for the speed shift. In case both the vehicle speed sensor and the transmission middle shaft sensor are abnormal, lowering 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:** The shift switch has two switches, and their combination of ON varies depending on each speed shift. The controller judges which speed shift has been selected by the combination of the two input signals.

 **NOTE:** The FNR switch does not transmit the neutral signal. In case of no electric current from the FNR switch, the controller judges that the switch is neutral (N).

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

SYSTEM / Control System



T4GC-02-01-015

NOTE: The illustration shows the signal flow when MC transmits a signal to speed 3 solenoid valve by pushing the downshift switch once while traveling forward at speed 4 and the travel mode switch is set in auto 1-4L.

SYSTEM / Control System

Upshift Control

Purpose: To raise the speed shift by putting the left hand on the steering wheel and pushing the switch installed at the right console

Operation:

1. MC receives a signal by pushing the upshift switch once when traveling with speed 1 while the travel mode switch is set in auto 1-4L mode and the shift switch is set in speed 4.
2. MC transmits the signal to the speed shift solenoid valve of speed 2, and shifts up the vehicle speed.
3. When the upshift switch is pushed, the vehicle speed is further raised to speed 3 and speed 4.
4. In case auto of the travel mode switch is selected, the speed shift is raised, and returned to the auto speed shift control in three seconds, eventually raising automatically to the speed shift selected in advance.
5. In case manual of the travel mode switch is selected, the raised speed shift is kept.
6. In case of the following, the upshift switch control is canceled.
 - Operation of the FNR lever or the FNR switch
 - Operation of the shift switch
 - Operation of the travel mode switch
 - Pushing the hold switch
(only when the auto mode of the travel mode switch is selected)

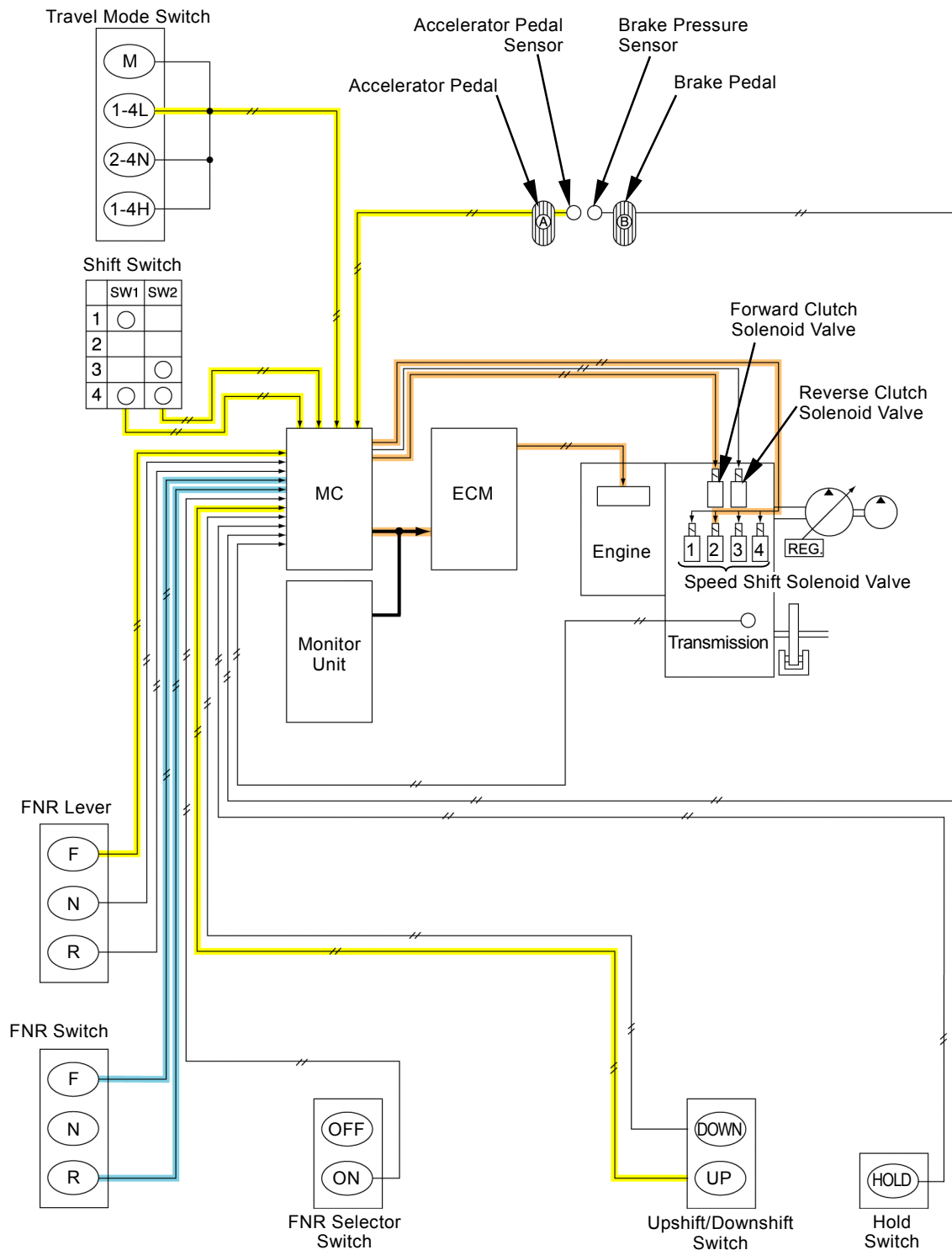
 **NOTE:** Although the upshift switch is pushed while traveling at the speed shift selected by the shift switch, the speed shift is not raised further.

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

 **NOTE:** The FNR switch does not transmit the neutral signal. In case of no electric current from the FNR switch, the controller judges that the switch is neutral (N).

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

SYSTEM / Control System



NOTE: The illustration shows the signal flow when MC transmits a signal to speed 2 solenoid valve by pushing the upshift switch once while traveling forward at speed 1 and the travel mode switch is set in auto 1-4L.

SYSTEM / Control System

Clutch Cut Control

Purpose: To release the FNR clutch of the transmission in order to make the most of the engine torque by operating the brake during operation of the front attachment.

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

Operation:

1. When either mode of the clutch cut position switch is selected, voltage according to the selected mode is transmitted to 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 is not made in OFF mode.
- In mode S, clutch cut is made at output voltage of the brake pressure sensor beyond the set pressure of mode S, and clutching is made again at output voltage below that of mode S.
- In mode N, clutch cut is made at output voltage of the brake pressure sensor beyond the set pressure of mode N, and clutching is made again at output voltage below that of mode N.
- In mode D, clutch cut is made at output voltage of the brake pressure sensor beyond the set pressure of mode D, and clutching is made again at output voltage below that of mode D.

3. In case the brake pedal is depressed in mode S, the signal from the brake pressure sensor is transmitted to MC.

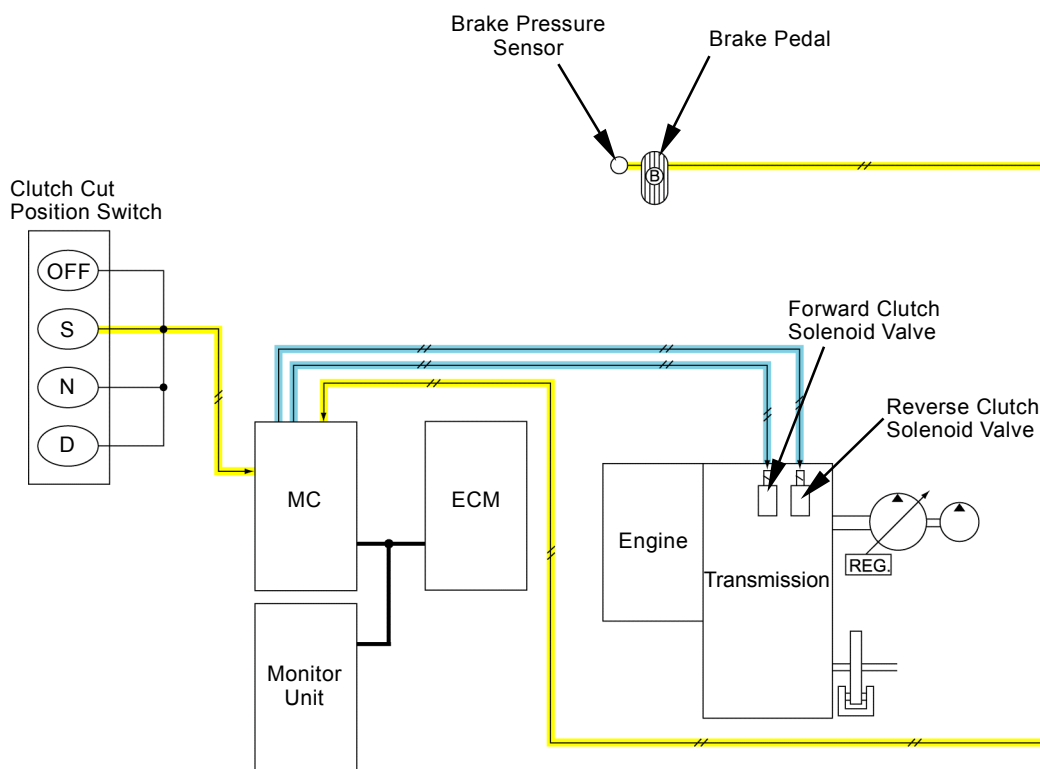
4. When the signal is higher than the set voltage, MC declutches by lowering the signal transmitted to the excited solenoid valve among the respective solenoid valves.

5. In case the brake pressure is lowered below the set pressure by reducing the depressing amount of the brake pedal, the signal transmitted to the clutch solenoid valve is raised again, and clutching is made.

 **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, MC judges which mode has been selected by the input voltage.

SYSTEM / Control System



T4GC-02-01-017

 **NOTE:** The illustration shows the signal flow in case the brake pedal has been depressed in mode S of the clutch cut position switch.

SYSTEM / Control System

Speed Shift Holding Control

Purpose: To hold the speed shift while towing or traveling uphill.

Operation:

1. When the hold switch is pushed once, the signal is transmitted to MC.
2. MC continues to transmit the signal to the speed shift solenoid valve of each time, and after that, the speed shift is fixed although if the accelerator pedal or the brake pedal is depressed.

 **NOTE:** The speed shift holding control is made only when auto (1-4L, 2-4N, or 1-4H) of the travel mode switch is selected.

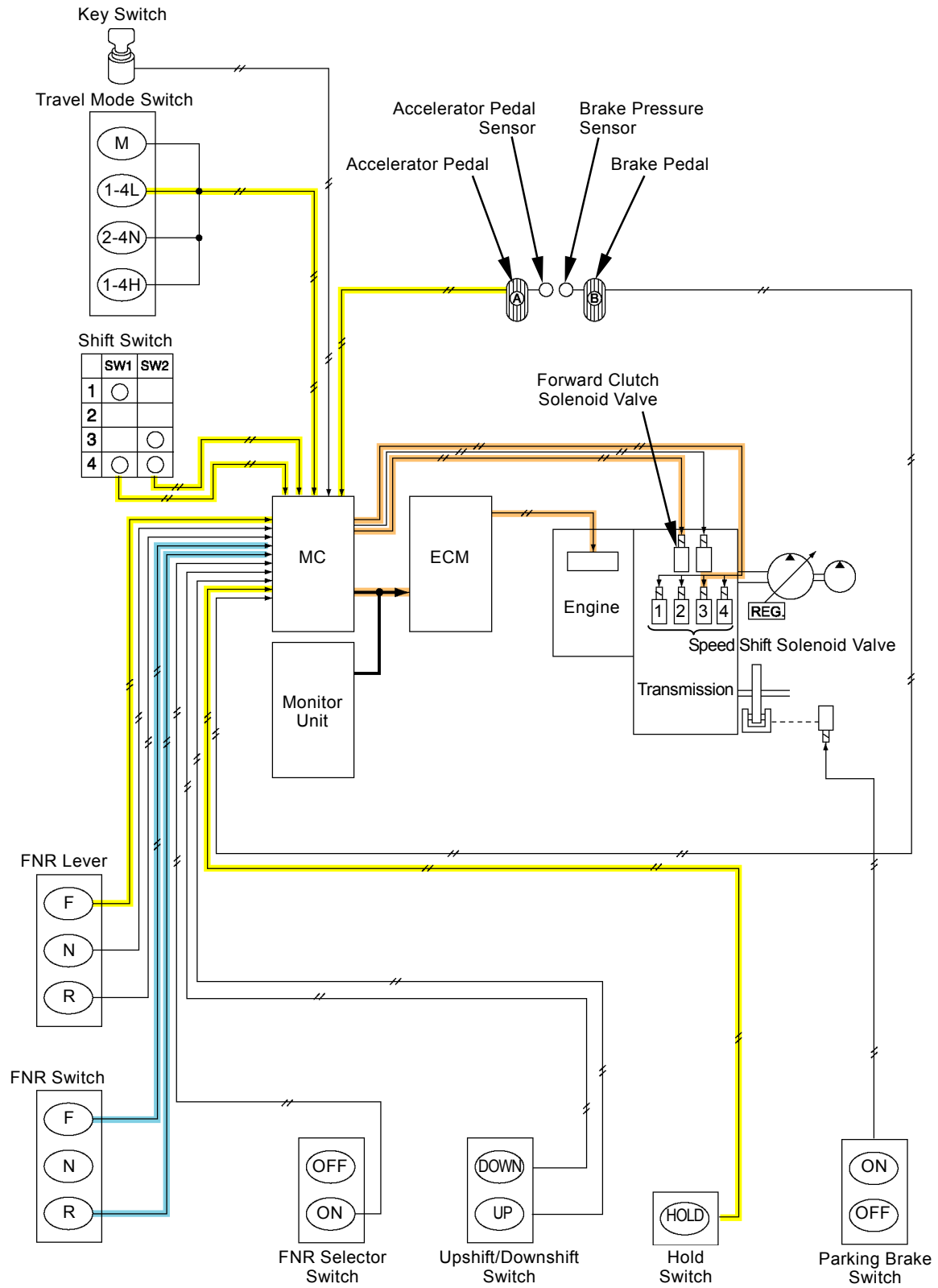
3. MC releases the speed shift holding control in case the following switches operations are made.
 - Turning the key switch OFF
 - Pushing the hold switch again
 - Downshift switch
 - Upshift switch
 - FNR lever
 - FNR selector switch (only when effective)
 - FNR switch (only when effective)
 - Speed shift switch
 - Travel mode switch
 - Parking brake switch

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

 **NOTE:** The FNR switch does not transmit the neutral signal. In case of no electric current from the FNR switch, the controller judges that the switch is neutral (N).

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

SYSTEM / Control System



T4GC-02-01-018

SYSTEM / Control System

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SYSTEM / Control System

OTHER CONTROLS

The other controls consist of the following.

- Hydraulic Fan Cooling Control
- Hydraulic Fan Cleaning Control
- Transmission Failure Indicator Control
- FNR Switch Enable Indicator Control
- Reverse Traveling Alarm Control
- Parking Brake Indicator Control

SYSTEM / Control System

Hydraulic Fan Cooling Control

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

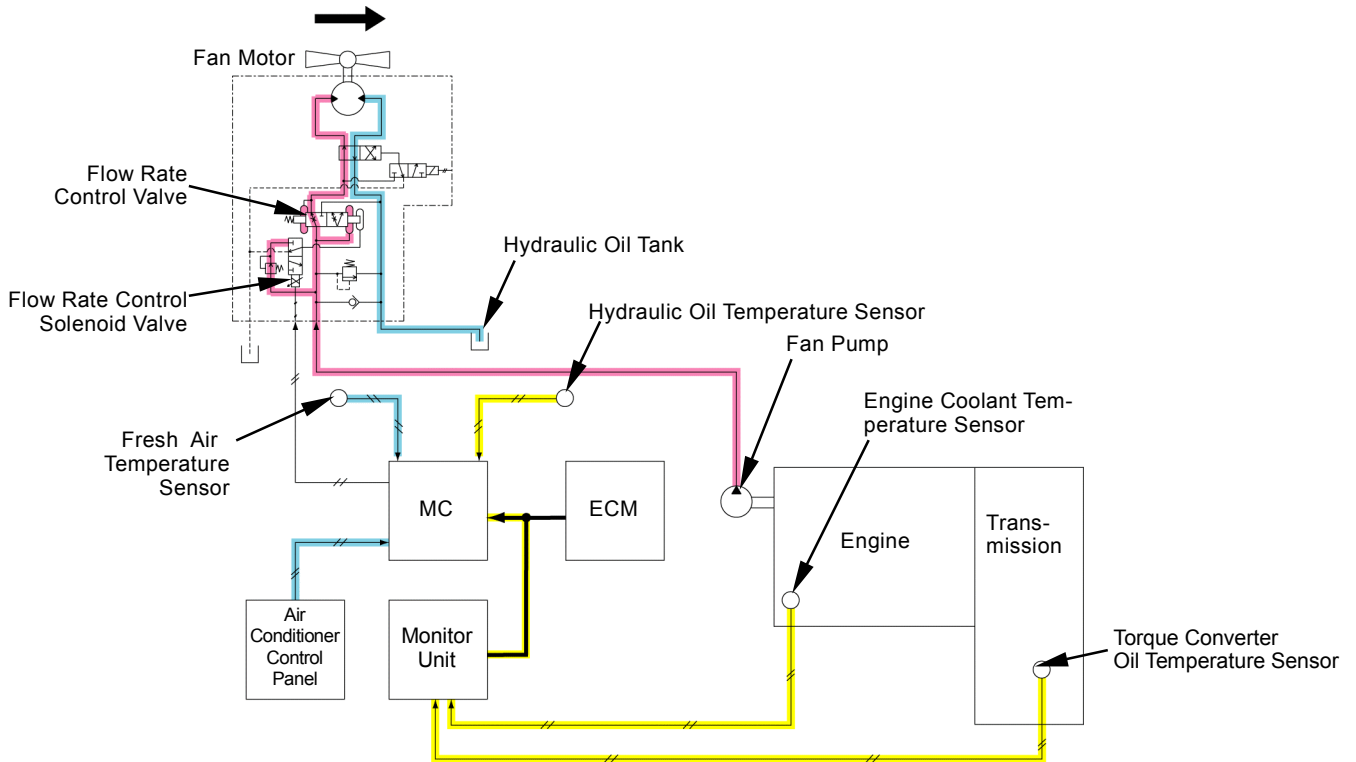
Operation:

1. When the engine is started, the fan pump rotates and delivers oil to the fan motor.
2. MC receives the signals from the hydraulic oil temperature sensor, engine coolant temperature sensor and torque converter oil temperature sensor at the same time, and calculates three target hydraulic fan speeds.
3. MC selects the fastest speed, and transmits the signal to the flow rate control solenoid valve.
4. The flow rate control solenoid valve is operated. As pressure oil from the flow rate control solenoid valve flows into the right end of the flow rate control valve, the flow rate control valve spool moves to the left.
5. When the flow rate control valve spool moves to the left, as a part of pressure oil to the fan motor flows to the tank port, the fan motor speed is lowered accordingly.
6. In case either oil temperature or coolant temperature is above the set temperature, the hydraulic fan speed is maximum when the engine speed is maximum.
7. In case either oil temperature or coolant temperature is below the set temperature, the hydraulic fan speed is lowered in response to the data of the highest temperature.
8. As, the signal from the fresh air temperature sensor also enters MC, the fan is always rotated at the maximum speed while disregarding the controls in 2 to 7 in case the air conditioner switch is ON at the fresh 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 or fresh air temperature sensor is abnormal, hydraulic fan cooling control is always made at the maximum speed.

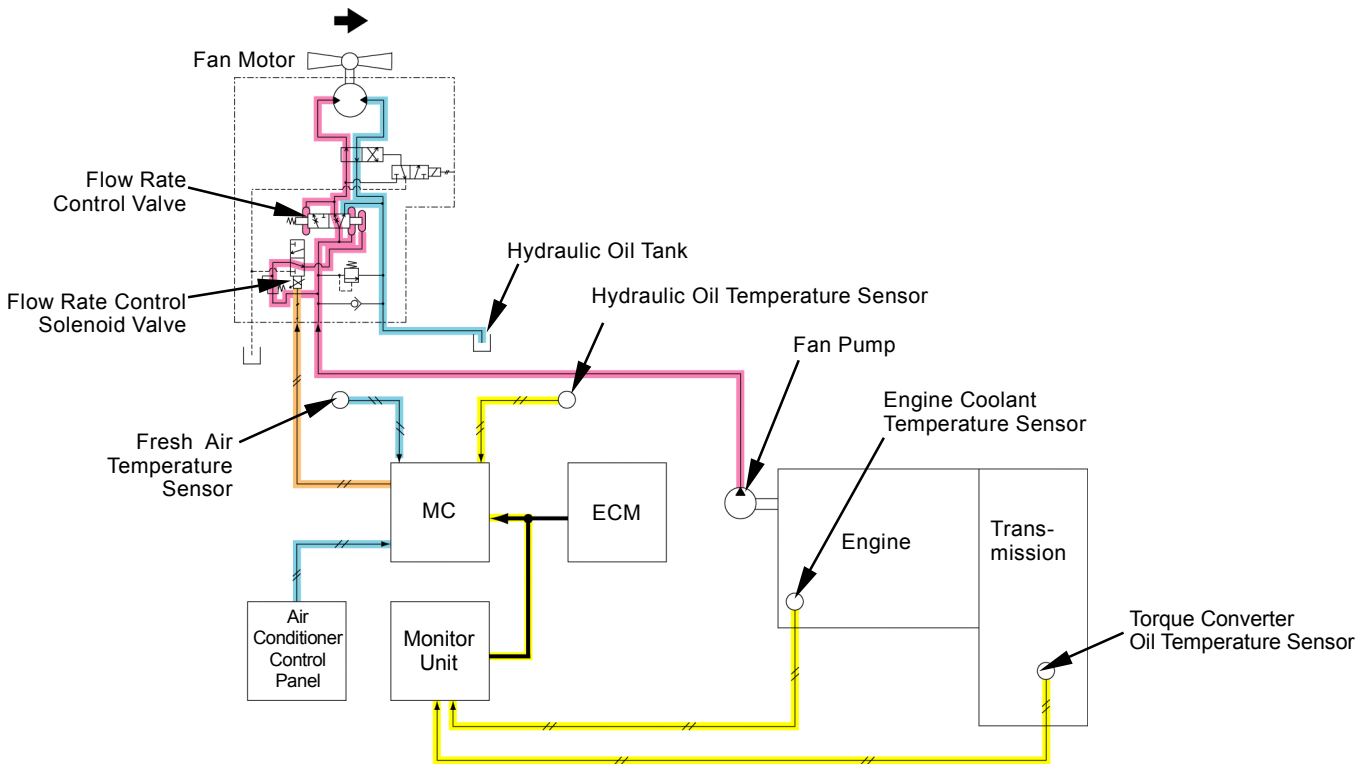
SYSTEM / Control System

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



T4GC-02-01-019

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



T4GC-02-01-020

SYSTEM / Control System

Hydraulic Fan Cleaning Control

Purpose: To clean the radiator and oil cooler by reversing the hydraulic fan in order to blow away dust in case cleaning of the radiator and oil cooler are needed.

 **NOTE:** *Temporarily turn the reverse rotation control solenoid valve ON when the key switch is turned ON as the spool maybe stuck in case the reverse rotation control solenoid valve is not operated for a long time. It is turned ON once every one minute after the key switch is turned ON. This operation is not made during the hydraulic fan cleaning control.*

Operation:

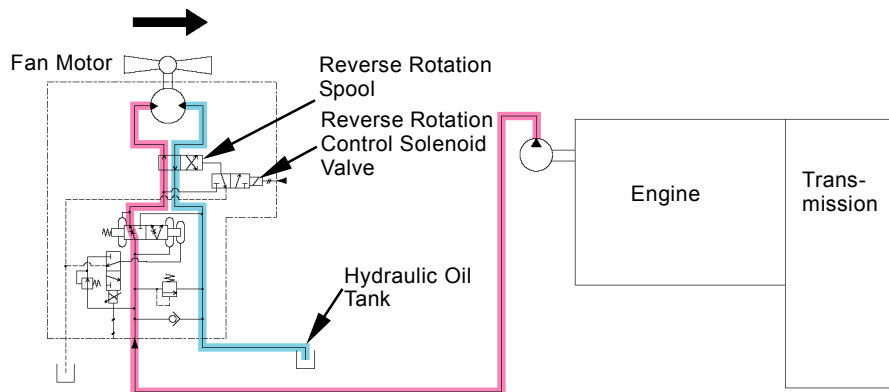
1. When the engine is started after the following conditions exist and the fan reverse rotation switch is turned ON, the signal is transmitted from MC to the reverse rotation control solenoid valve.
2. When the reverse rotation control solenoid valve is operated, the reverse rotation spool is shifted, and the fan motor rotation is reversed.
3. In reverse rotation, as hydraulic fan cooling control is not made, the fan speed changes from maximum to minimum in response to the depressing amount of the accelerator pedal.
4. In case any one of the following conditions are changed during reverse rotation, the engine speed is immediately fixed to idle speed.
5. Hydraulic fan cleaning control is not released only by turning the fan reverse rotation switch OFF. This control is released by the procedure of turning the fan reverse rotation switch OFF – turning the key switch OFF – turning the key switch ON.
6. In case the engine speed is fixed to idle speed, this control is released by the procedure of turning the fan reverse rotation switch OFF – turning the key switch OFF – turning the key switch ON.

Conditions:

- Fan reverse rotation switch: ON
- Parking brake switch: ON (Brake is effective.)
- FNR lever: neutral
- FNR switch: neutral

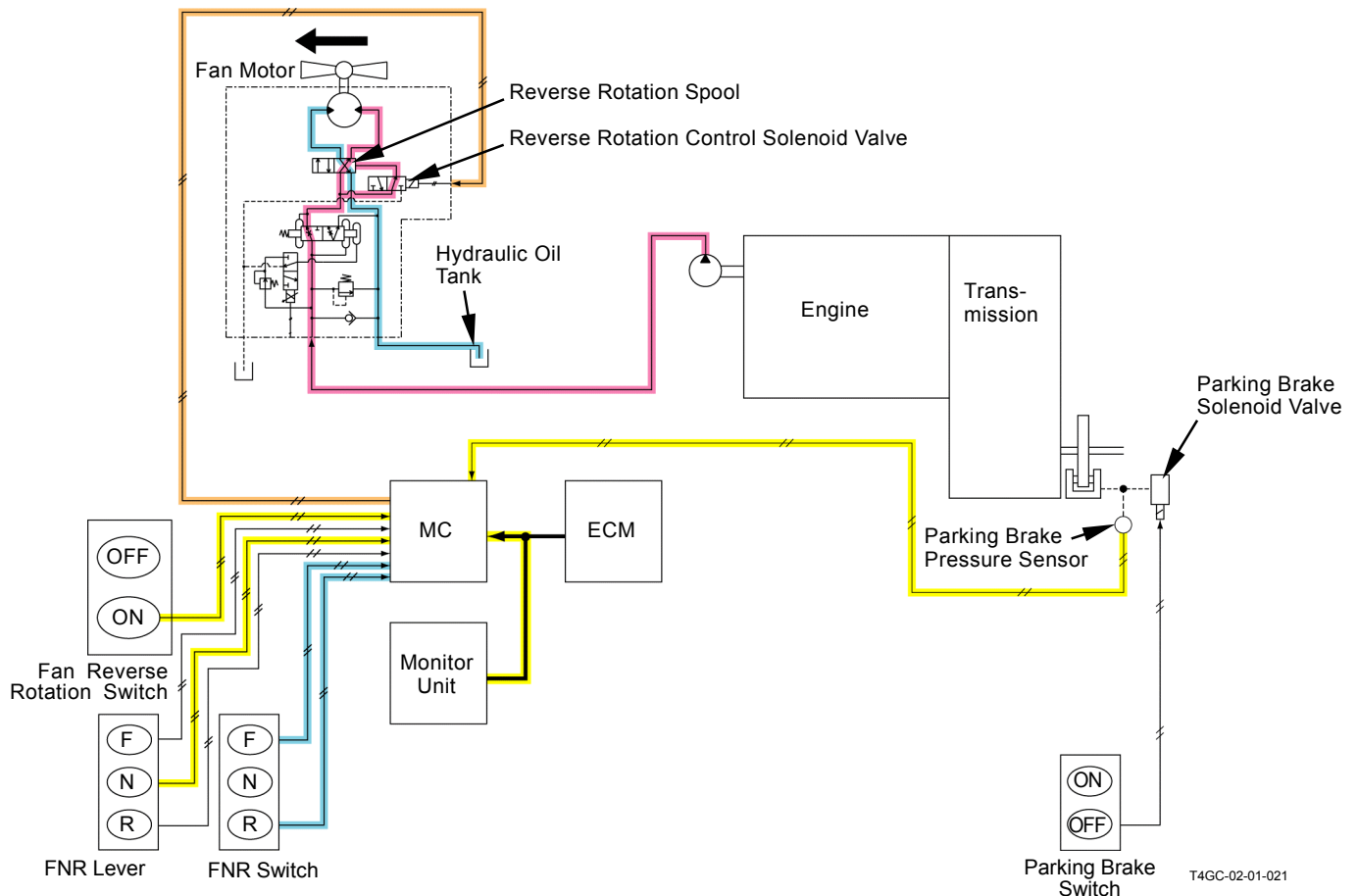
SYSTEM / Control System

During cooling operation (Normal rotation)



T4GB-02-01-007

During cleaning operation (Reverse rotation)



T4GC-02-01-021

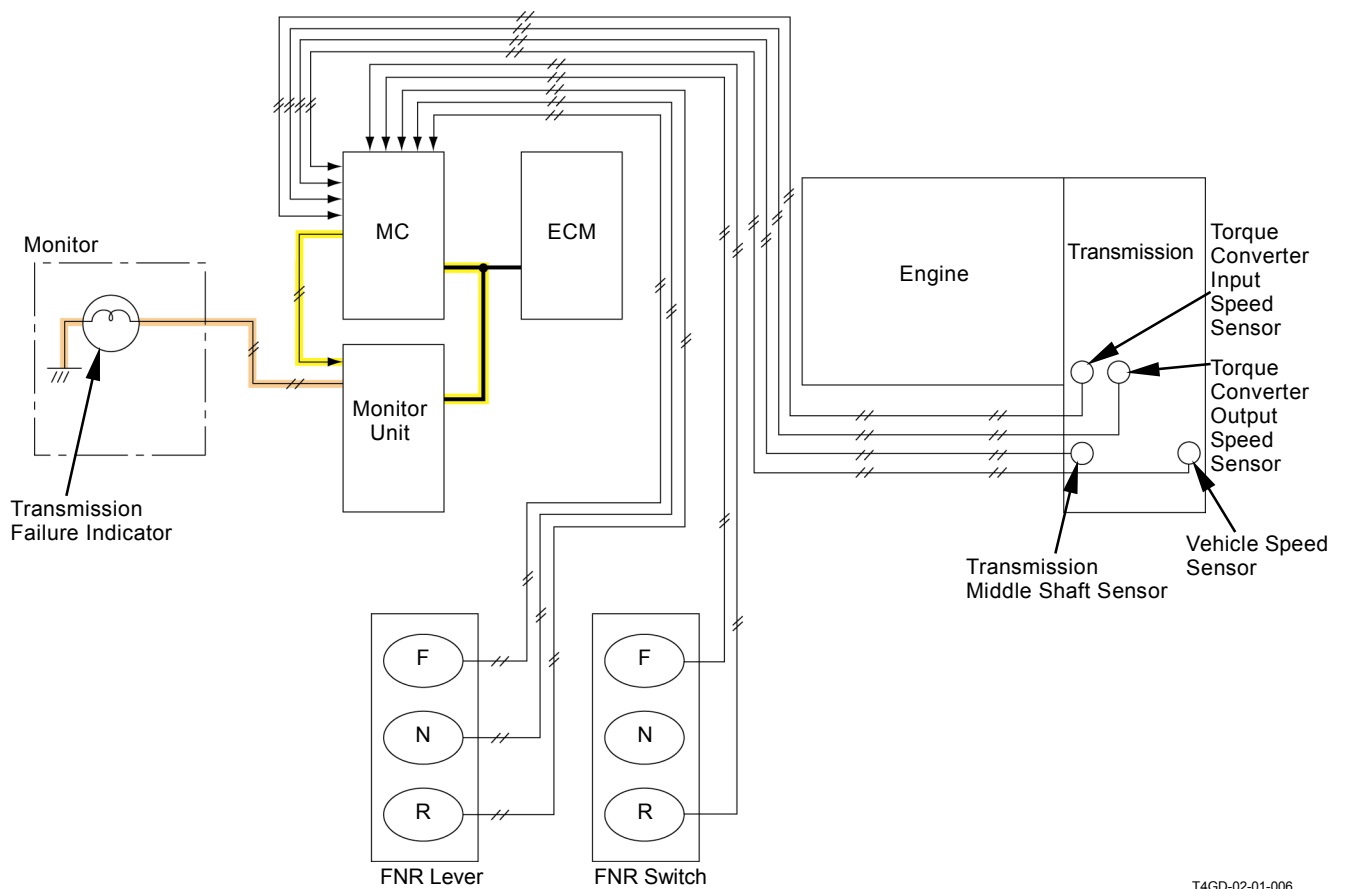
SYSTEM / Control System

Transmission Failure Indicator Control

Purpose: To light the transmission failure indicator on the monitor unit for protection of the transmission in case of disorder of parts likely to cause damage to the transmission

Operation: In case any of the parts shown in the right becomes out of order, MC transmits the signal to the monitor unit and lights the transmission failure indicator.

- Torque converter input speed sensor
- Torque converter output speed sensor
- Vehicle speed sensor
- Transmission middle shaft sensor
- FNR lever
- FNR switch



T4GD-02-01-006

SYSTEM / Control System

FNR Switch Enable Indicator Control

Purpose: To light the FNR switch enable indicator on the monitor when the FNR switch is effective.

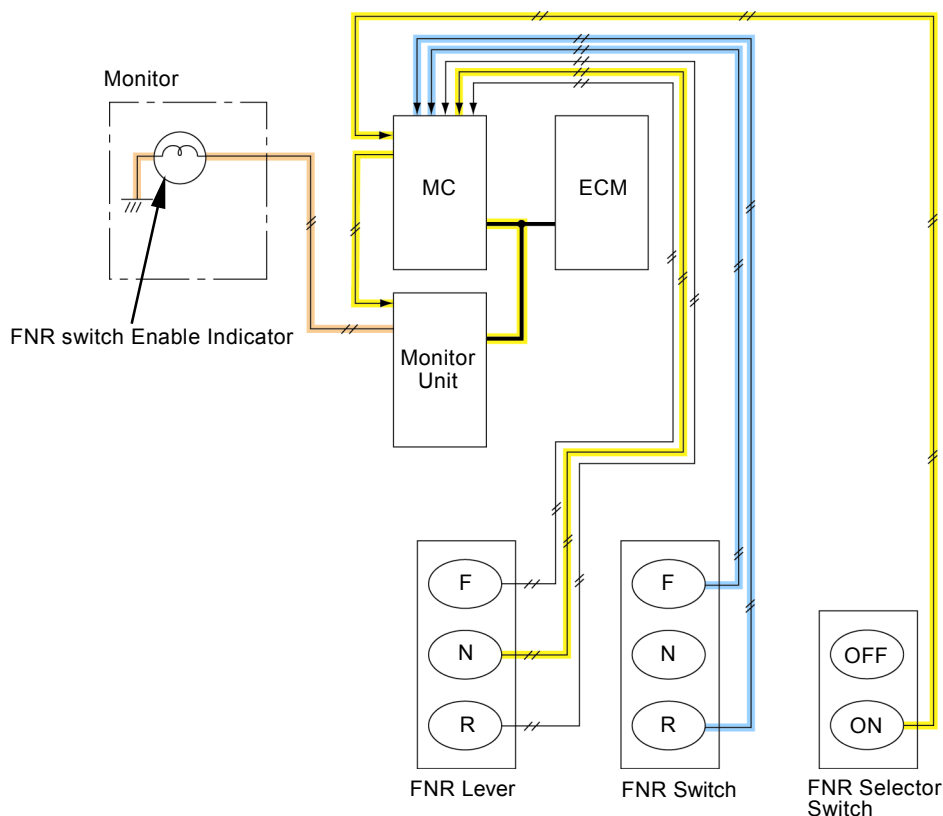
Operation:

1. Turn the FNR selector switch ON after the FNR lever and the FNR switch are positioned at neutral.
2. Then the FNR switch becomes effective and the monitor unit lights the FNR switch enable indicator on the monitor.

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

NOTE: The FNR switch does not transmit the neutral signal. In case of no electric current from the FNR switch, the controller judges that the switch is neutral (N).

NOTE: In case the FNR lever becomes out of order, input to the FNR switch becomes ineffective and the FNR switch enable indicator is kept OFF.



T4GD-02-01-005

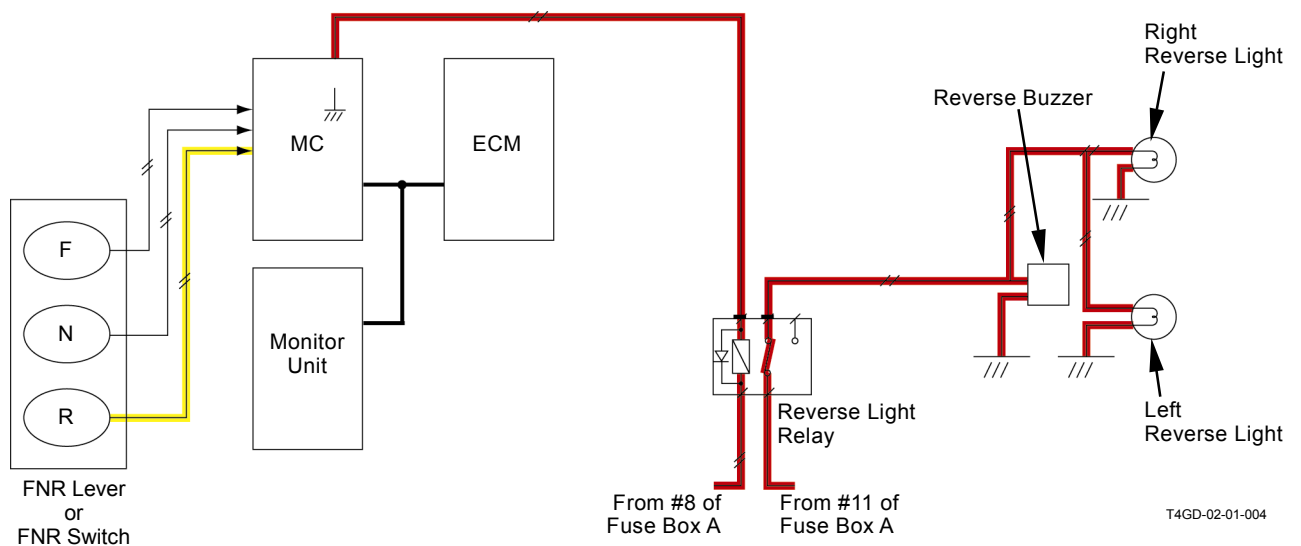
SYSTEM / Control System

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

Purpose: To sound the alarm buzzer when reverse of the FNR lever or the FNR switch is selected.

Operation:

1. When reverse of the FNR lever or the FNR switch is selected, MC grounds the terminal from the reverse light relay.
2. The reverse light relay is excited, and current flows to the reverse light and the reverse buzzer.



SYSTEM / Control System

Parking Brake Indicator Control

Purpose: To light the parking brake indicator on the monitor unit during parking brake operation.

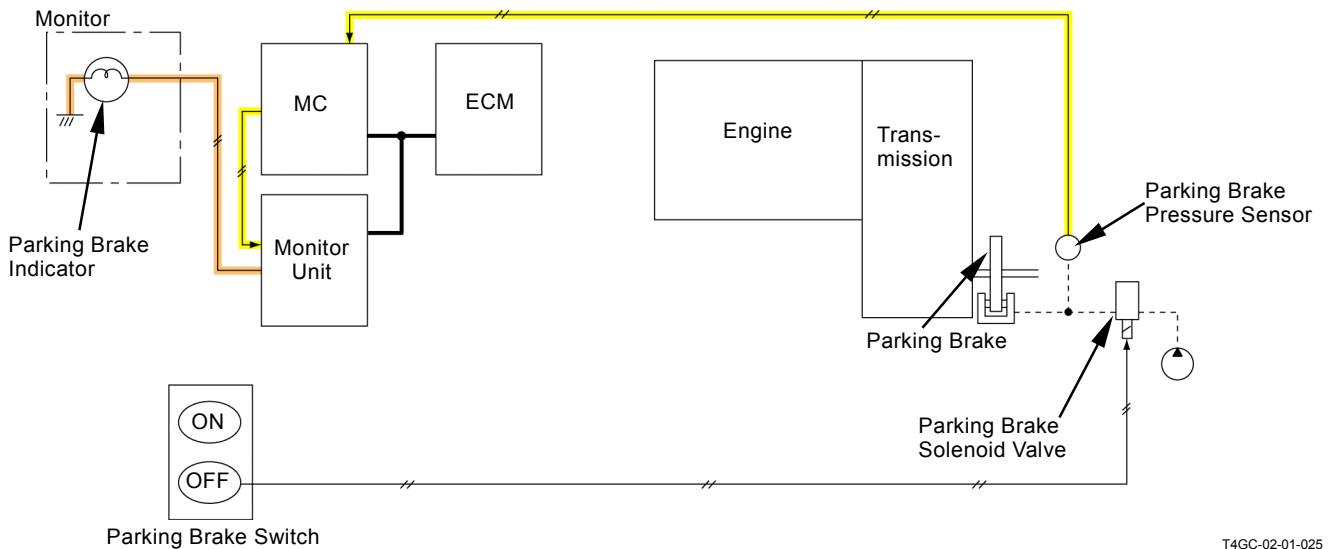
NOTE: The parking brake of the vehicle body is released if pilot pressure is routed.

Operation:

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

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

IMPORTANT: Be careful that in case the parking brake pressure sensor is abnormal, traveling is possible although the parking brake switch is ON and the parking brake is applied as the parking brake indicator is fixed to OFF (release).



T4GC-02-01-025

SYSTEM / Control System

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SYSTEM / Control System

CONTROL BY ELECTRIC AND HYDRAULIC COMBINED CIRCUIT

The electric and hydraulic combined circuit has the following controls.

- Ride Control (Optional)
- Bucket Auto-Leveler Control
- Lift Arm Float Control
- Lift Arm Kick-Out Control
- Lift Arm Auto-Leveler Upward Control (Optional)
- Lift Arm Auto-Leveler Downward Control (Optional)

SYSTEM / Control System

Ride Control (Optional)

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

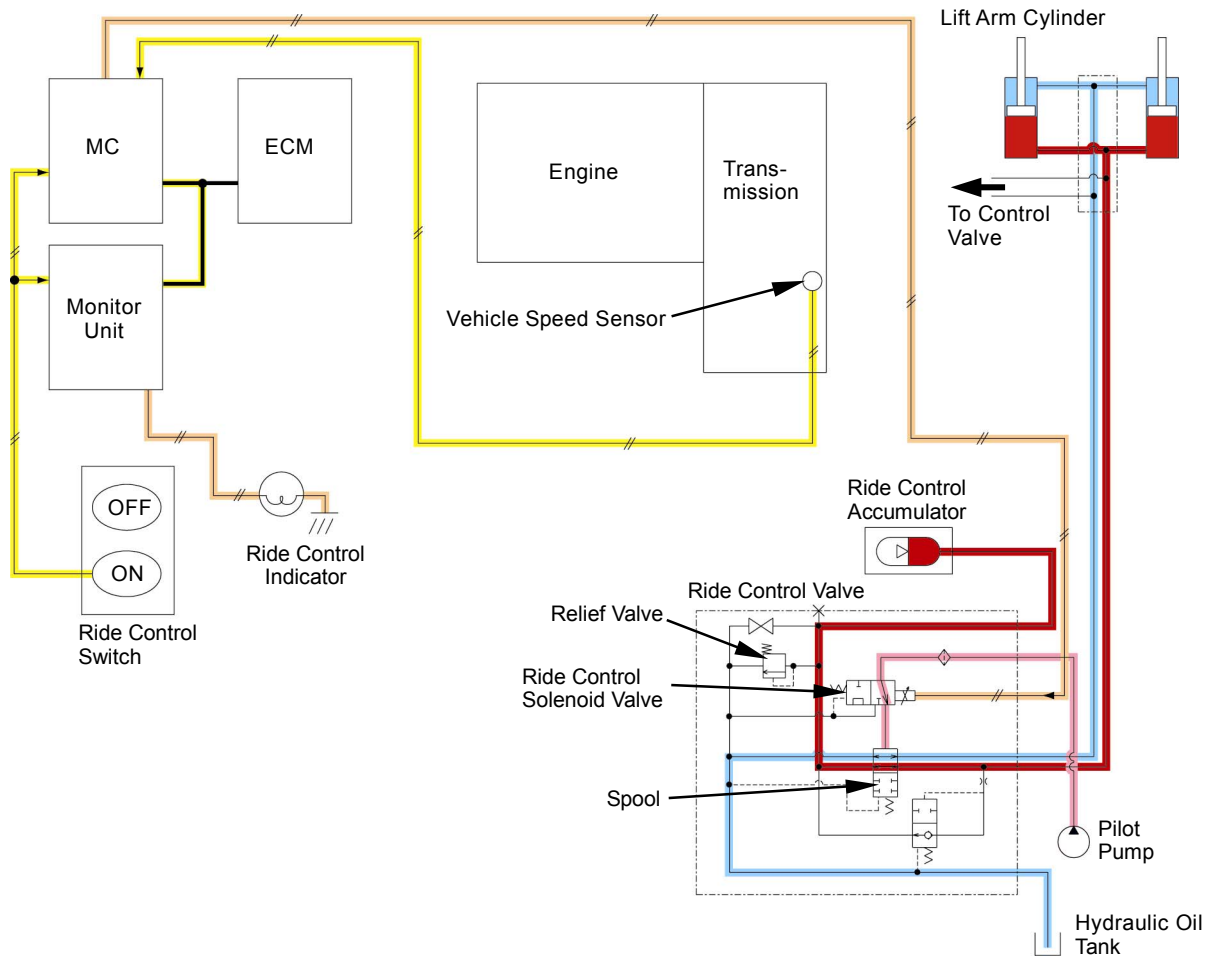
Operation:

1. When the ride control switch is turned ON, MC makes the ride control effective and the ride control indicator on the monitor is lit.
2. At vehicle speed of 7 km/h (4 mph) and above, MC receives the signal from the vehicle speed sensor and transmits 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 side and the bottom side of the lift arm cylinder. When the vehicle body travels on rough 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:** The 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.

SYSTEM / Control System



T4GD-02-01-003

SYSTEM / Control System

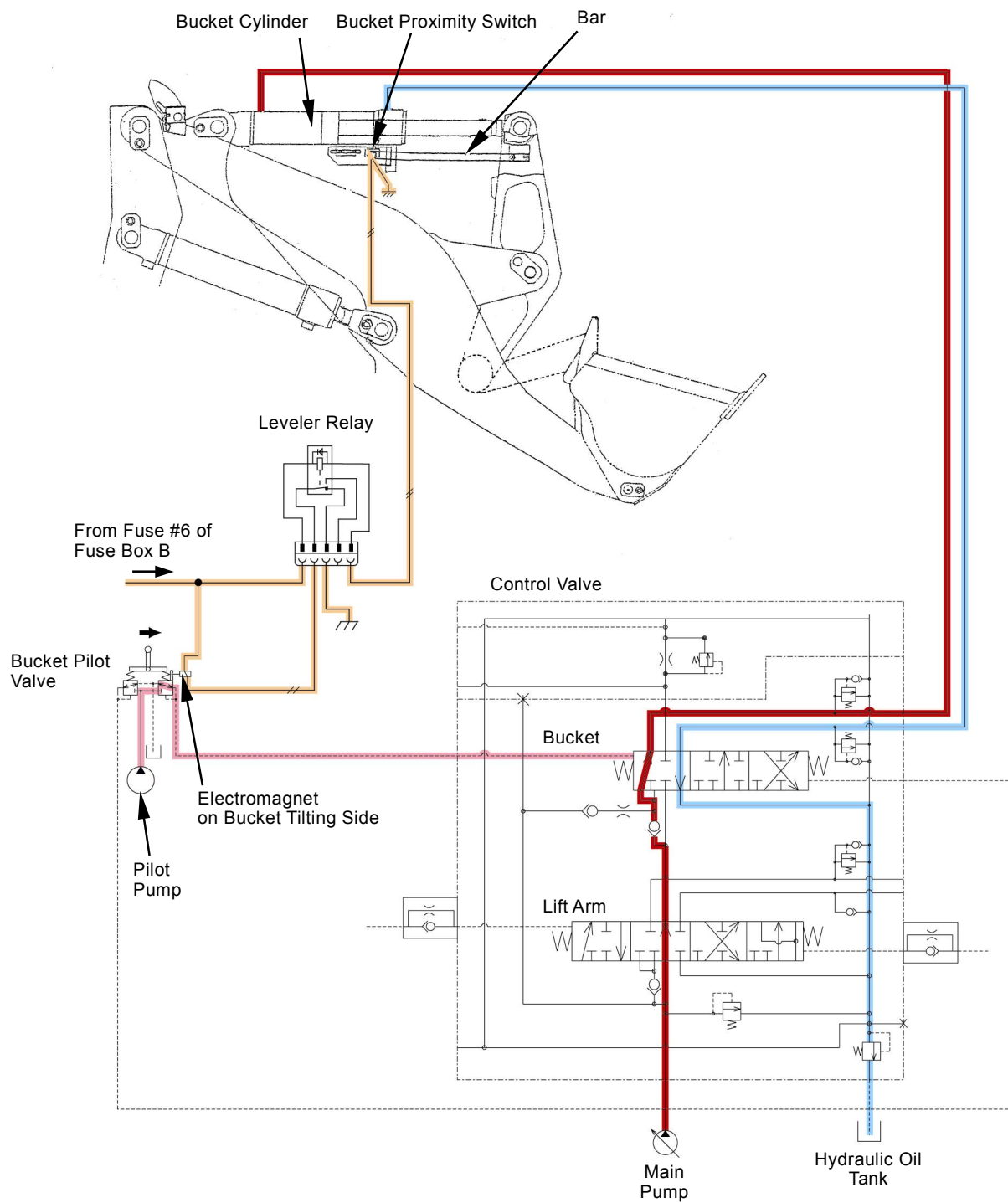
Bucket Auto-Leveler Control

Purpose: Automatically to tilt the bucket at a proper angle (horizontal) to start digging when returning the bucket to the tilting position

Operation:

1. When bucket dump operation is carried out, the bar is located in front of the bucket proximity switch.
While the bar passes near the bucket proximity switch, the bucket proximity switch is turned ON. This excites the leveler relay and electromagnet at the bucket tilt side in the pilot valve.
2. When the bucket control lever is moved farther than the bucket tilting detent position (position to move farther than the tilting position), the bucket control lever is retained by the electromagnet on the bucket tilting side, and pressure oil from the pilot valve moves the bucket spool in the control valve.
3. Pressure oil from the main pump flows to the bottom side of the bucket cylinder through the bucket spool in the control valve, and extends the bucket cylinder. When the bucket cylinder is extended, the bar also passes by the bucket proximity switch at the same time.
4. When the bar moves apart from the bucket proximity switch, the bucket proximity switch is turned OFF. As the leveler relay and the electromagnet at the bucket tilt side are unexcited, the bucket control lever is returned to the neutral position. As the bucket spool in the control valve also returns to neutral, the bucket cylinder stops. Consequently, the bucket is kept at the proper digging angle (horizontal).

SYSTEM / Control System



SYSTEM / Control System

Lift Arm Float Control

Purpose: Free to raise and lower the lift arm in response to the external force in order to remove snow and clean road.

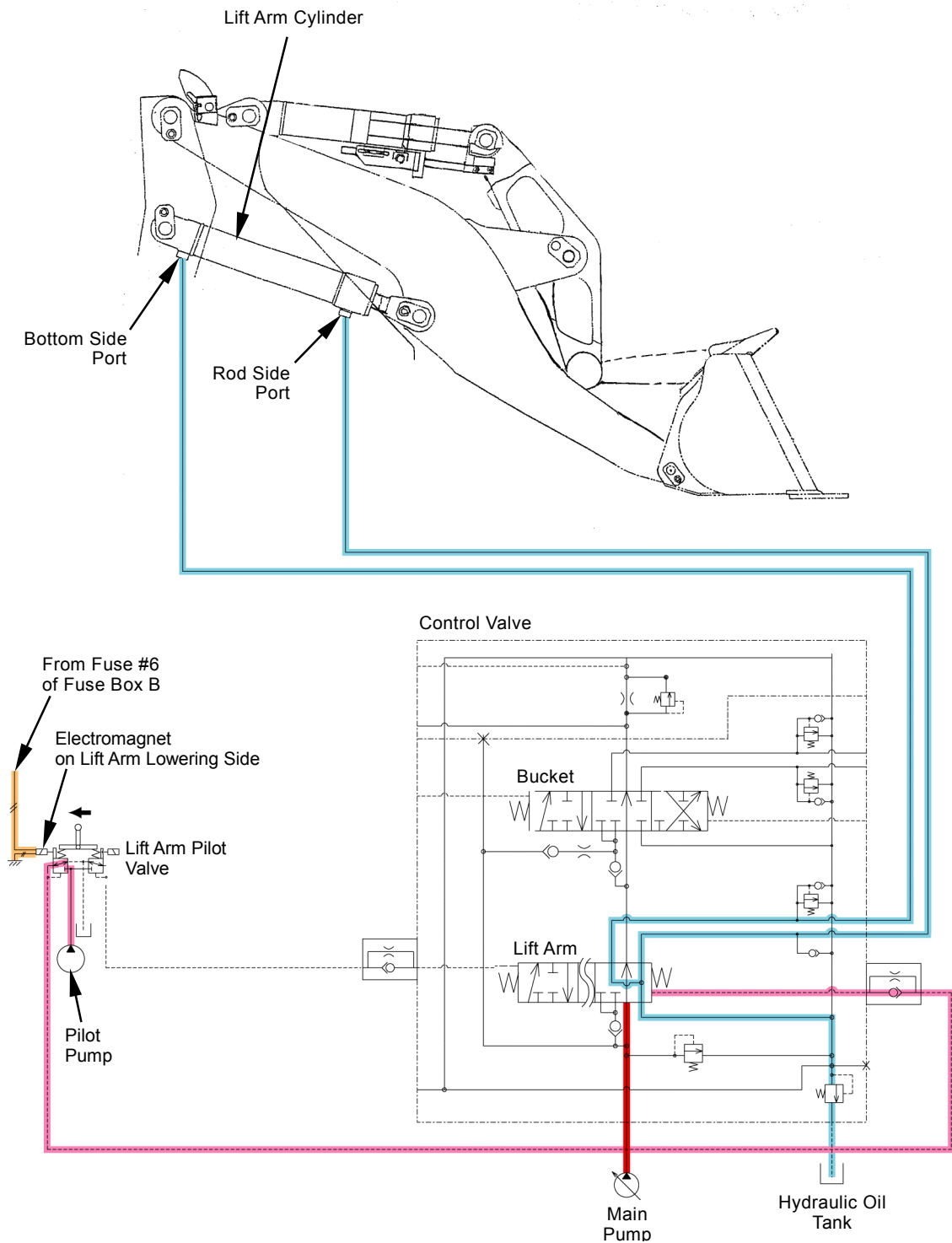
Operation:

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

 **NOTE:** *When the engine is running, the electromagnet on the lift arm lowering side is always excited by current from fuse #6 of fuse box B.*

2. Pressure oil from the main pump is blocked by the lift arm spool, and the ports on the rod side and the bottom side of the lift arm cylinder are connected, to the tank port through the lift arm spool. 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 and the lift arm can move in response to the external force.
3. The lift arm control lever returns to neutral if pulled more strongly than the magnetic force of the electromagnet. As the lift arm spool in the control valve also returns to neutral, the lift arm float control is released.

SYSTEM / Control System



SYSTEM / Control System

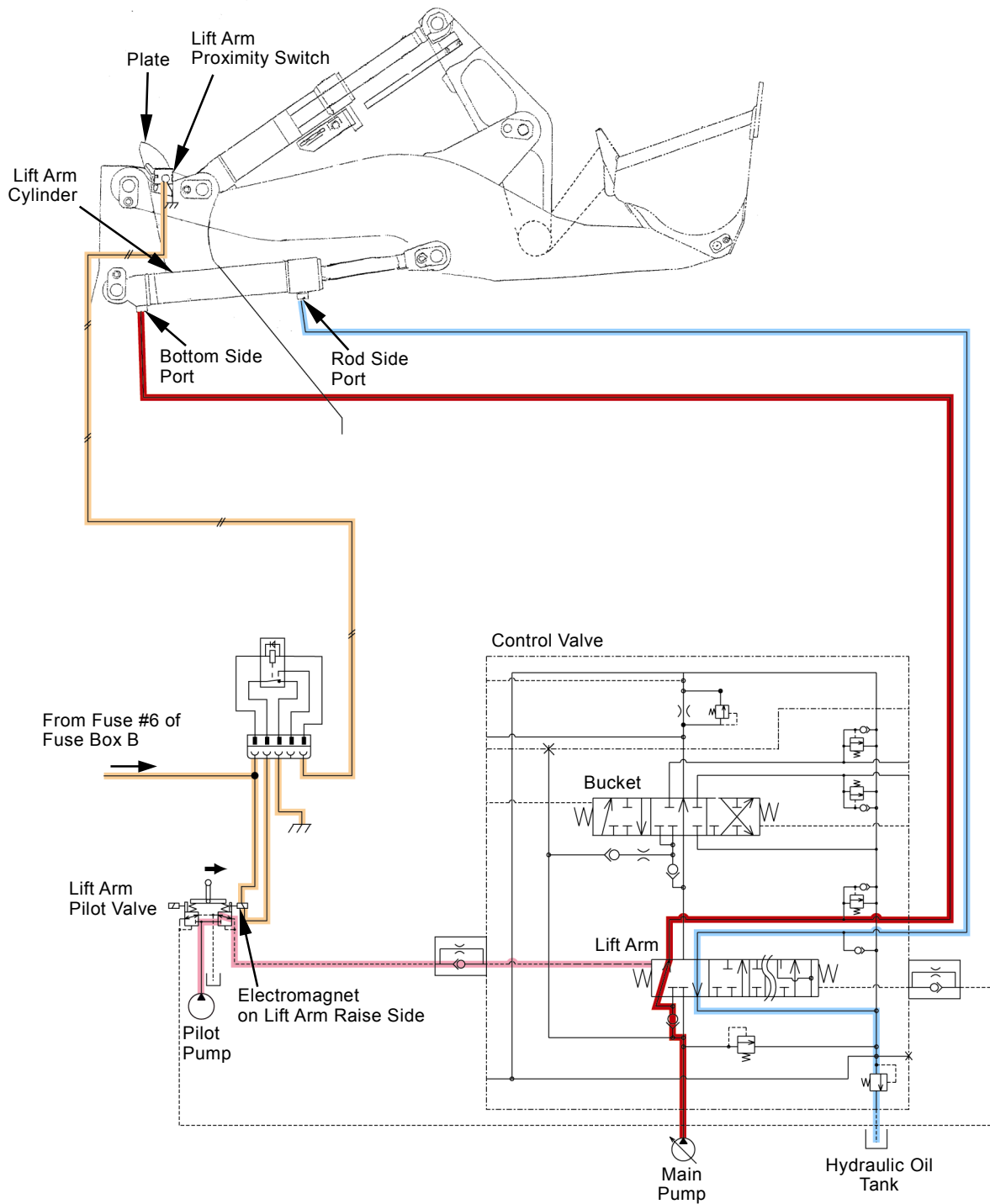
Lift Arm Kick-Out Control

Purpose: Automatically to locate the lift arm at proper height when 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.
When the plate is passing near the lift arm proximity switch, the lift arm proximity switch is turned ON. Therefore, the kick-out relay and the electromagnet at the lift arm raise side are excited.
2. When the lift arm control lever is moved farther than the lift arm raise detent position (position to pull farther than the raise position), the bucket control lever is retained by the electromagnet on the lift arm raise side, and pressure oil from the pilot valve moves the lift arm spool in the control valve to the raise side.
3. Pressure oil from the main pump flows to the bottom side of the lift cylinder through the lift arm spool in 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 moves apart from the lift arm proximity switch, the lift arm proximity switch is turned OFF, and the electromagnet on the lift arm raise side is also turned OFF. This moves the lift arm control lever to the neutral position. As the lift arm spool in the control valve also returns to neutral, the lift arm cylinder stops. Consequently, the lift arm stops.

SYSTEM / Control System



T4GD-02-01-002

SYSTEM / Control System

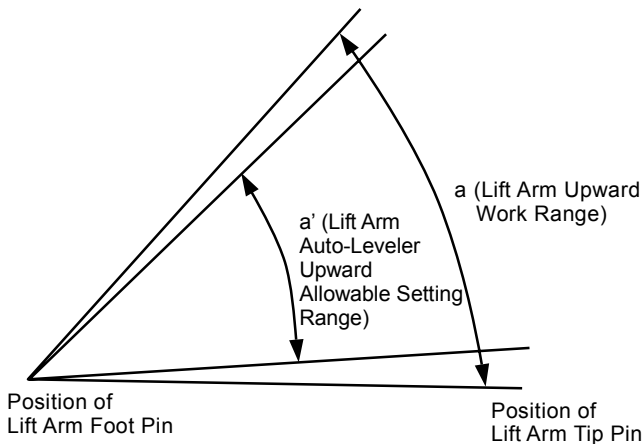
Lift Arm Auto-Leveler Upward Control (Optional)

Purpose: To locate 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), the signal from the lift arm angle sensor is memorized by MC, and that is the lift arm auto-leveler upward stop location.

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



2. When the lift arm auto-leveler upward switch is turned ON, terminal A-25 of MC is grounded, and excites the electromagnet on the lift arm raise side of the pilot valve. When the lift arm control lever is moved to the lift arm raise detent position (position to pull farther than the raise position), the lift arm control lever is retained by the electromagnet on the lift arm raise side, and pressure oil from the pilot valve is supplied to the control valve.

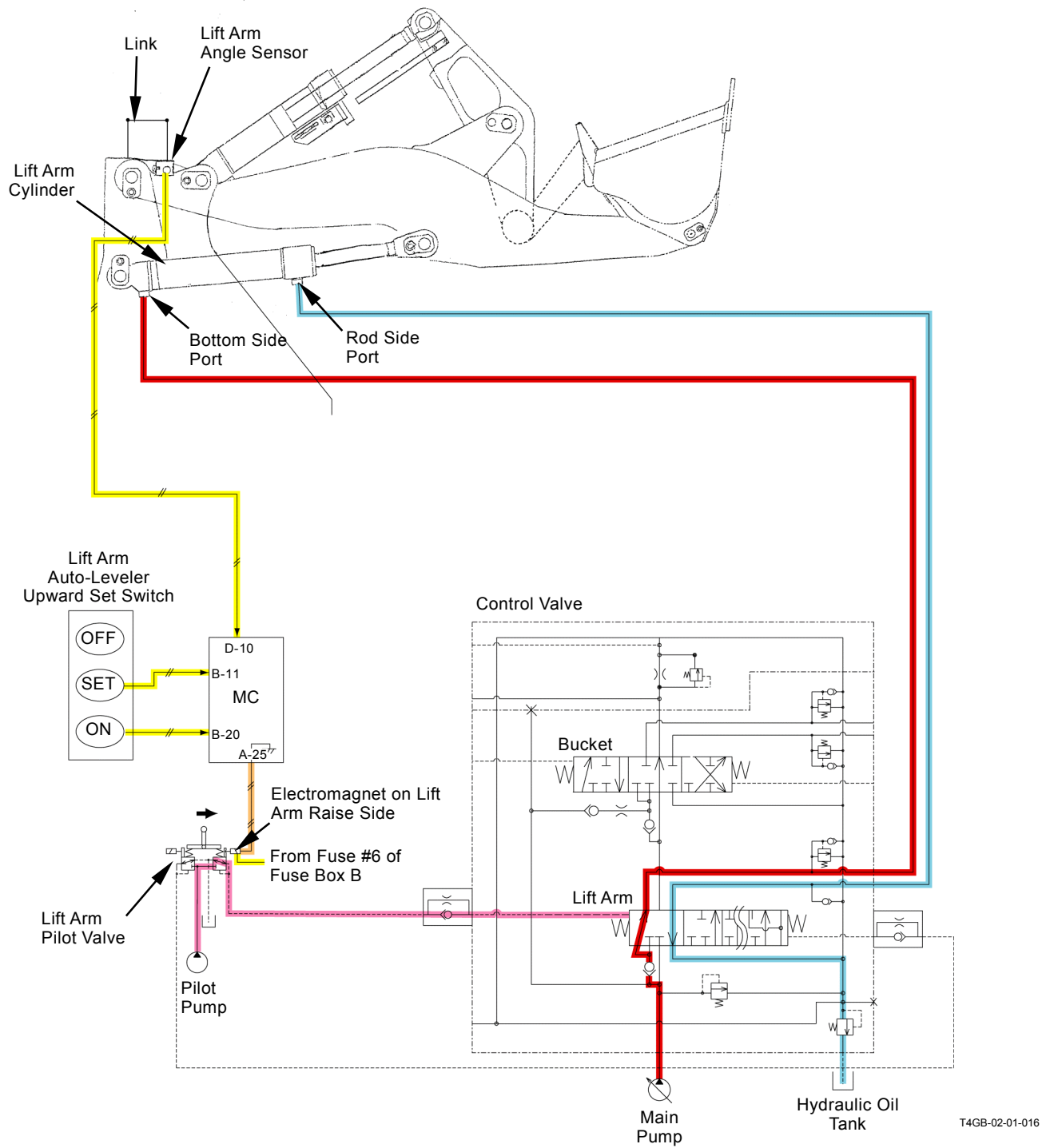
3. Pressure oil from the main pump flows to the bottom side port of the lift cylinder through the lift arm spool in the control valve, and raises the lift arm.
4. When the lift arm angle sensor moves to the lift arm auto-leveler upward stop position, terminal A-25 of MC is hot grounded, and the electromagnet on the lift arm raise side is unexcited. Thus the lift arm control lever returns to the neutral position, and pressure oil from the pilot valve stops flowing to the control valve.
5. As the lift arm spool in 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 raise side is always excited.

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

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

SYSTEM / Control System



SYSTEM / Control System

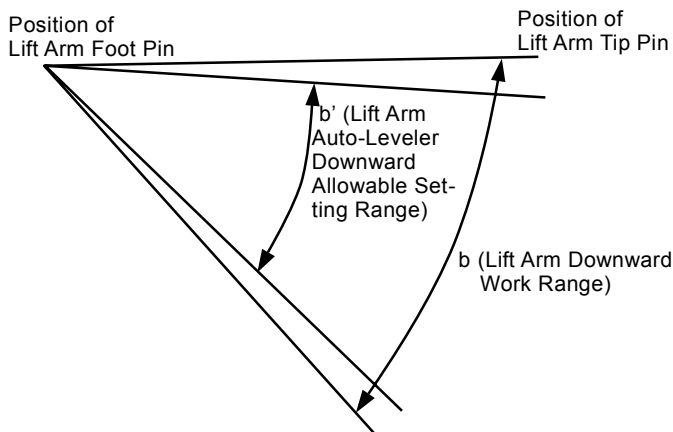
Lift Arm Auto-Leveler Downward Control (Optional)

Purpose: To locate 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), the signal from the lift arm angle sensor is memorized by MC, and that is the lift arm auto-leveler downward stop position.

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



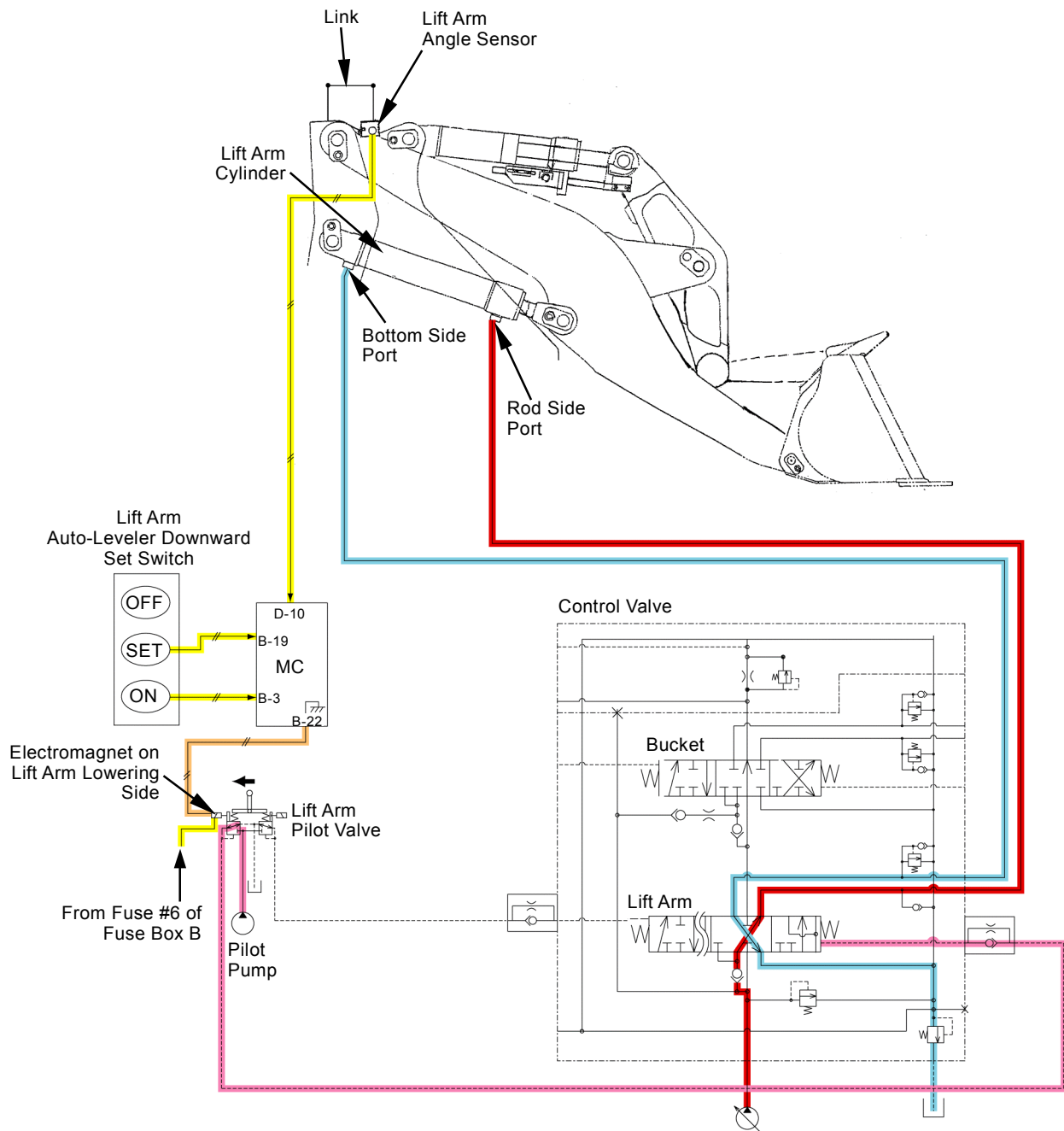
2. When the lift arm auto-leveler downward switch is turned ON, terminal B-22 of MC is grounded, and excites the electromagnet on the lift arm downward side of the pilot valve. When the lift arm control lever is moved to the lift arm lowering detent position (position farther than the lowering position), the lift arm operation lever is retained by the electromagnet on the lift arm lowering side, and pressure oil from the pilot valve is supplied to the control valve.

3. Pressure oil from the main pump flows to the rod side port of the lift cylinder through the lift arm spool in the control valve, and lowers the lift arm.
4. When the lift arm angle sensor moves to the lift arm auto-leveler downward stop position, terminal B-22 of MC is not grounded, and the electromagnet on the lift arm lowering side is unexcited for a while until it is excited again soon after.
5. Thus the lift arm control lever returns to the neutral position, and pilot pressure from the pilot valve stops flowing to the control valve.
6. As the lift arm spool in 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 is abnormal, the lift arm auto-leveler downward control is not made.

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

SYSTEM / Control System



T4GB-02-01-017

SYSTEM / Control System

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SYSTEM / ECM System

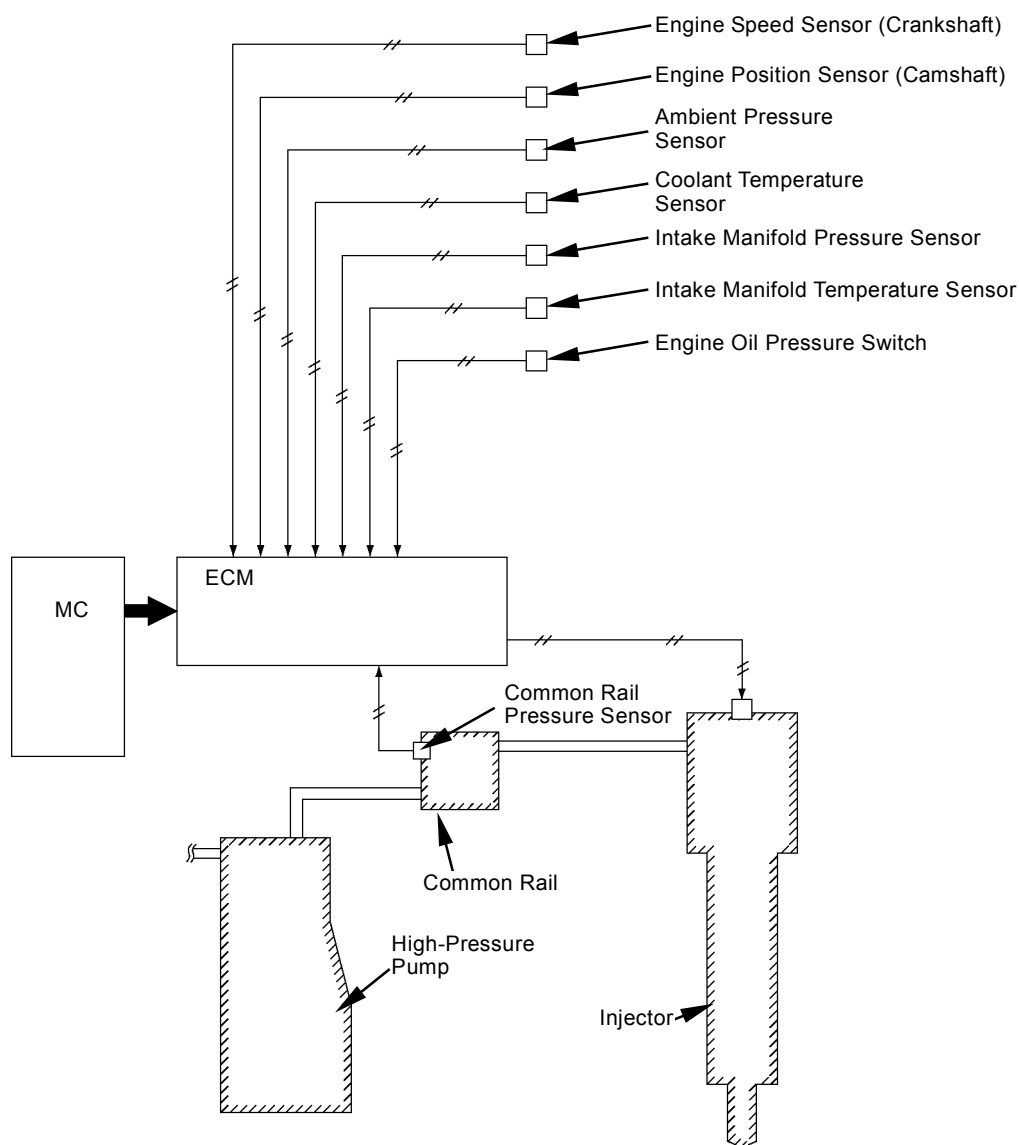
OUTLINE

ECM (Engine Control Module) receives the signals from sensors and MC (Main Controller) attached to the engine.

ECM processes according to the detected signals and performs the following control to the injector.

- Fuel Injection Control
- Engine Start Control
- Engine Stop Control (Refer to the Electrical System group.)

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



T4GD-02-02-001

SYSTEM / ECM System

FUEL INJECTION CONTROL

Purpose: To control the fuel injection according to the command signal from MC.

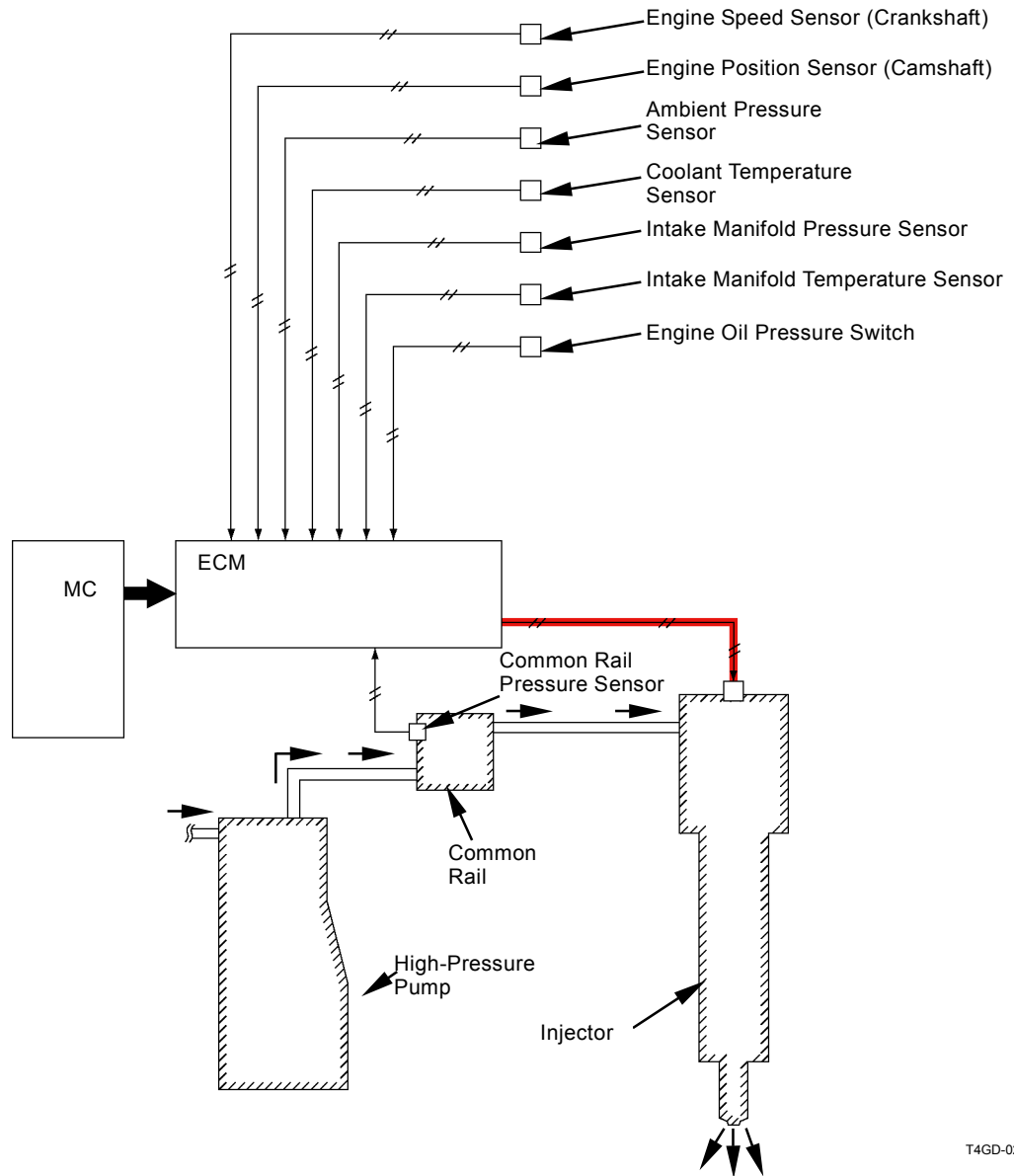
Operation:

1. ECM detects the signals from engine speed sensor, engine position sensor, ambient pressure sensor, coolant temperature sensor, intake manifold pressure sensor, Intake manifold temperature sensor, engine oil pressure switch and common rail pressure sensor, and detects the engine operating condition.
2. When detecting the signal from MC, ECM processes and controls the fuel injection of injector while detecting the engine operating condition.
3. The solenoid valve is attached to the injector. The solenoid valve controls operation of start and stop for injection according to the signal from ECM.

 **NOTE:** MC sends the command signals as shown below.

- Target Engine Speed Value
- Torque Curve Switching Command Signal
(Refer to the Control System group.)

SYSTEM / ECM System



T4GD-02-02-002

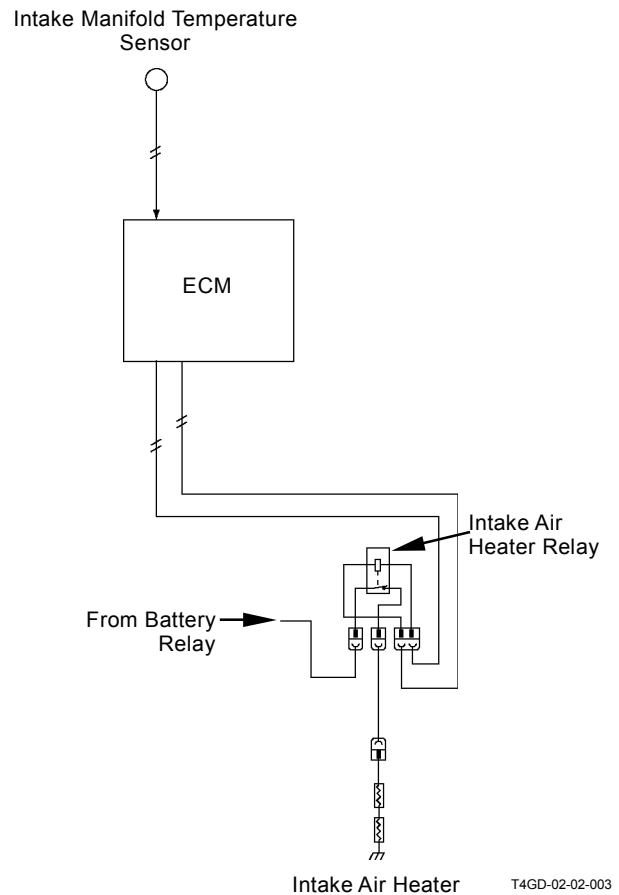
SYSTEM / ECM System

ENGINE START CONTROL

Purpose: To control time for continuity of current for the intake air heater according to temperature in the intake manifold and improve the starting of engine.

Operation:

1. The intake manifold temperature sensor sends the signals according to temperature in the intake manifold to ECM.
2. ECM controls the exciting time of intake air heater relay according to the signal. Therefore, the time for continuity of current for intake air heater is controlled.
(Refer to the Electrical System group.)



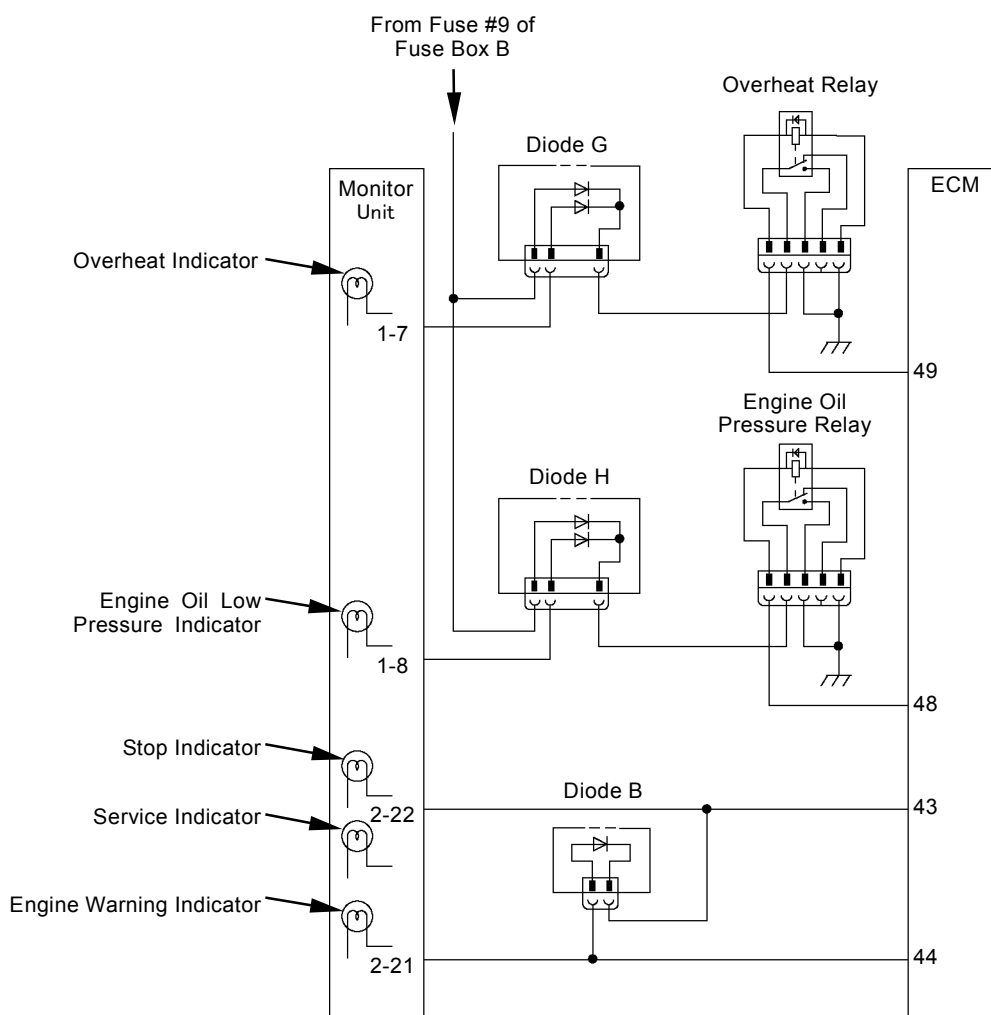
T4GD-02-02-003

SYSTEM / ECM System

OTHER CONTROLS

Other control systems consist of the following systems.

- Overheat Indicator Control
- Engine Oil Low Pressure Indicator Control
- Engine Warning Indicator Control
- Engine Warning Indicator and Stop Indicator Control



T4GD-02-02-004

SYSTEM / ECM System

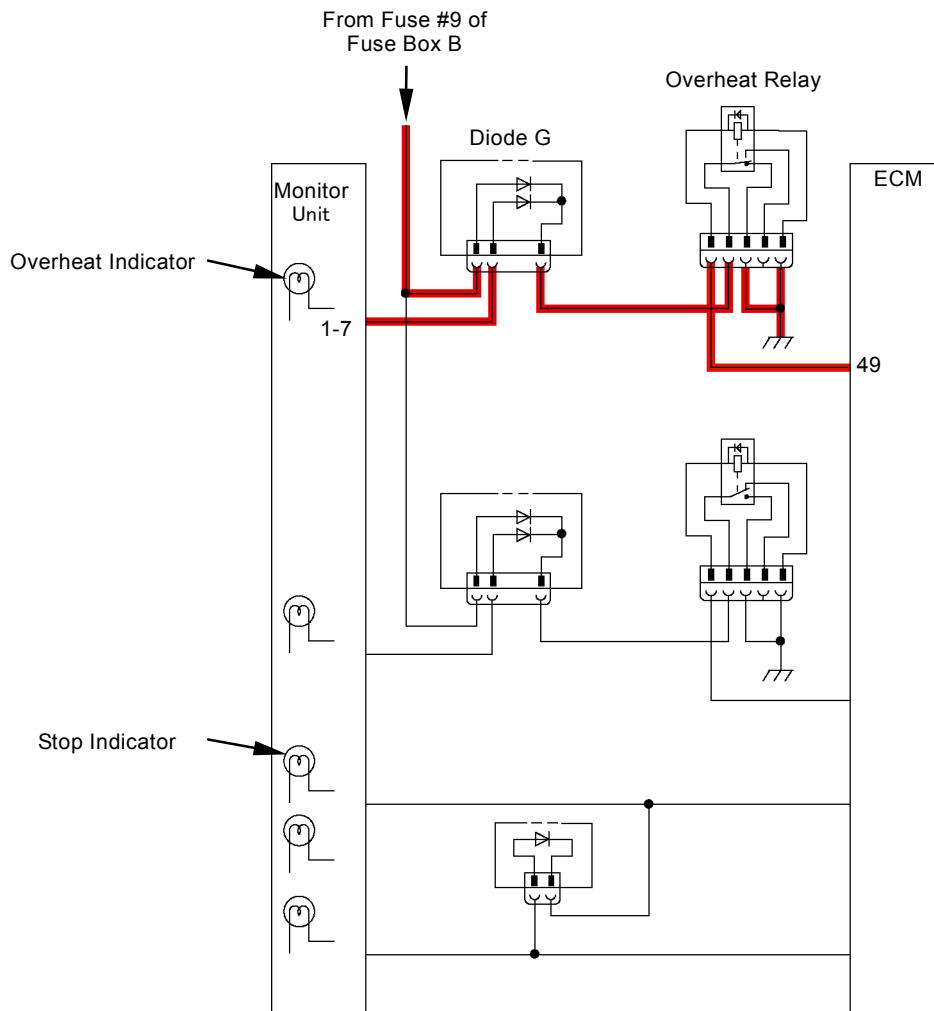
Overheat Indicator Control

Purpose: To light the overheat indicator on monitor unit in order to inform the abnormal rising in the engine coolant temperature to the operator.

Operation:

1. When the engine coolant temperature exceeds the normal value, ECM excites the overheat relay. Therefore, terminal 1-7 of the monitor unit is grounded.
2. When terminal 1-7 of the monitor unit is grounded, the monitor unit lights the overheat indicator.
3. When the engine coolant temperature returns to the normal value, ECM demagnetizes the overheat relay. Therefore, terminal 1-7 of the monitor unit is disconnected from the ground.
4. When terminal 1-7 of the monitor unit is disconnected from the ground, the monitor unit turns off the overheat indicator.

 **NOTE:** The monitor unit lights the stop indicator as well as the overheat indicator.



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SYSTEM / ECM System

Engine Oil Low Pressure Indicator Control

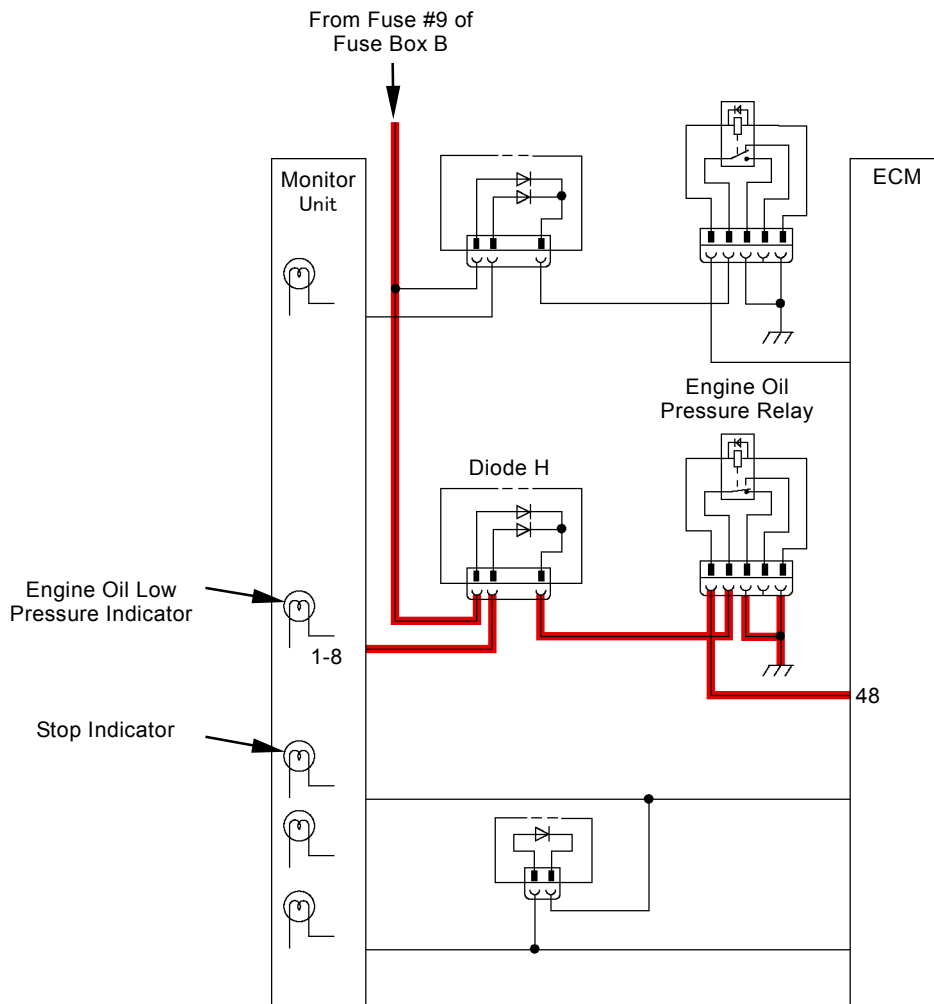
Purpose: To light the engine oil pressure indicator on monitor unit in order to inform the pressure lowering in engine lubricant oil to the operator.

Operation:

1. When the engine lubricant oil pressure becomes lower than the normal range, ECM excites the engine oil pressure relay. Therefore, terminal 1-8 of the monitor unit is grounded.
2. When terminal 1-8 of the monitor unit is grounded, the monitor unit lights the engine oil pressure indicator.

3. When the engine lubricant oil pressure returns to the normal range, ECM demagnetizes the engine oil pressure relay. Therefore, terminal 1-8 of the monitor unit is disconnected from the engine.
4. When terminal 1-8 of the monitor unit is disconnected from the engine, the monitor unit turns off the engine oil low pressure indicator.

 **NOTE:** The monitor unit lights the stop indicator as well as the engine oil pressure indicator.



T4GD-02-02-006

SYSTEM / ECM System

Engine Warning Indicator Control

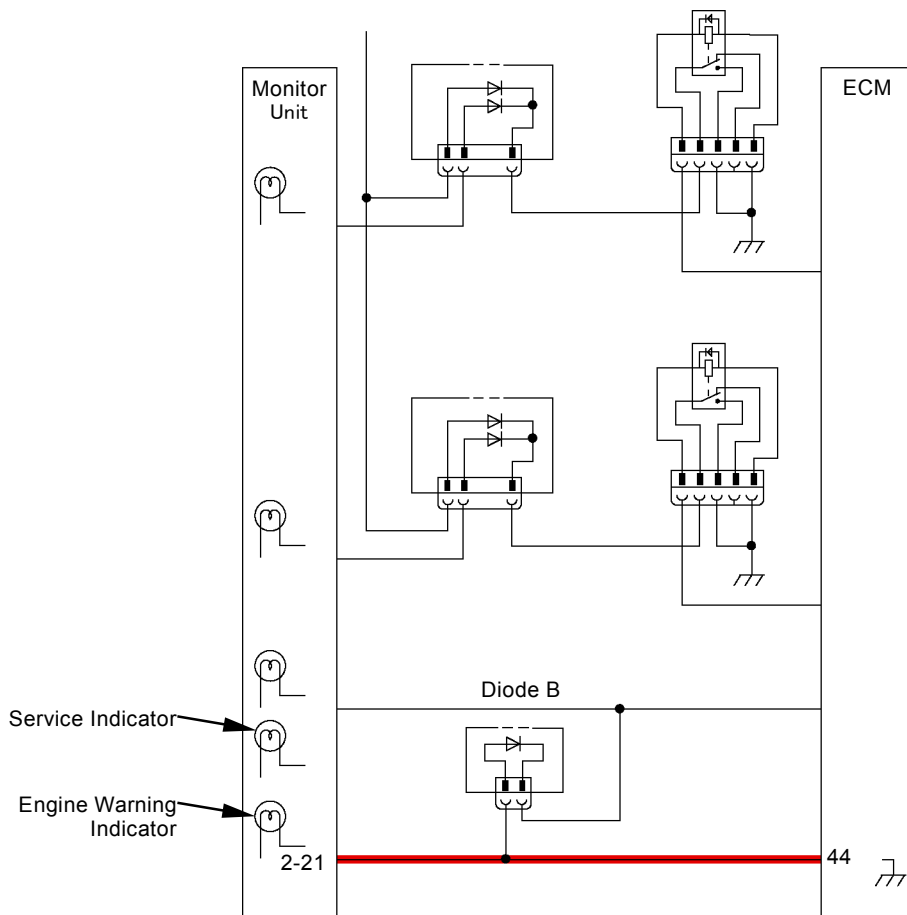
Purpose: To light the engine warning indicator on monitor unit in order to inform the engine failure detected by ECM to the operator.

Operation:

1. When detecting the engine failure, ECM grounds terminal #44. Therefore, terminal 2-21 of the monitor unit is grounded.
2. When the monitor unit terminal is grounded, the monitor unit lights the engine warning indicator.

3. When the engine returns to normal conditions, ECM deactivates the ground connection to terminal #44. Therefore, terminal 2-21 of the monitor unit is disconnected from the engine.
4. When terminal 2-21 of the monitor unit is disconnected from the engine, the monitor unit turns off the engine warning indicator.

 **NOTE:** The monitor unit lights the service indicator as well as the engine warning indicator.



T4GD-02-02-008

SYSTEM / ECM System

Engine Warning Indicator and Stop Indicator Control

Purpose: To light the engine warning indicator and stop indicator on monitor unit in order to inform the engine serious failure detected by ECM to the operator.

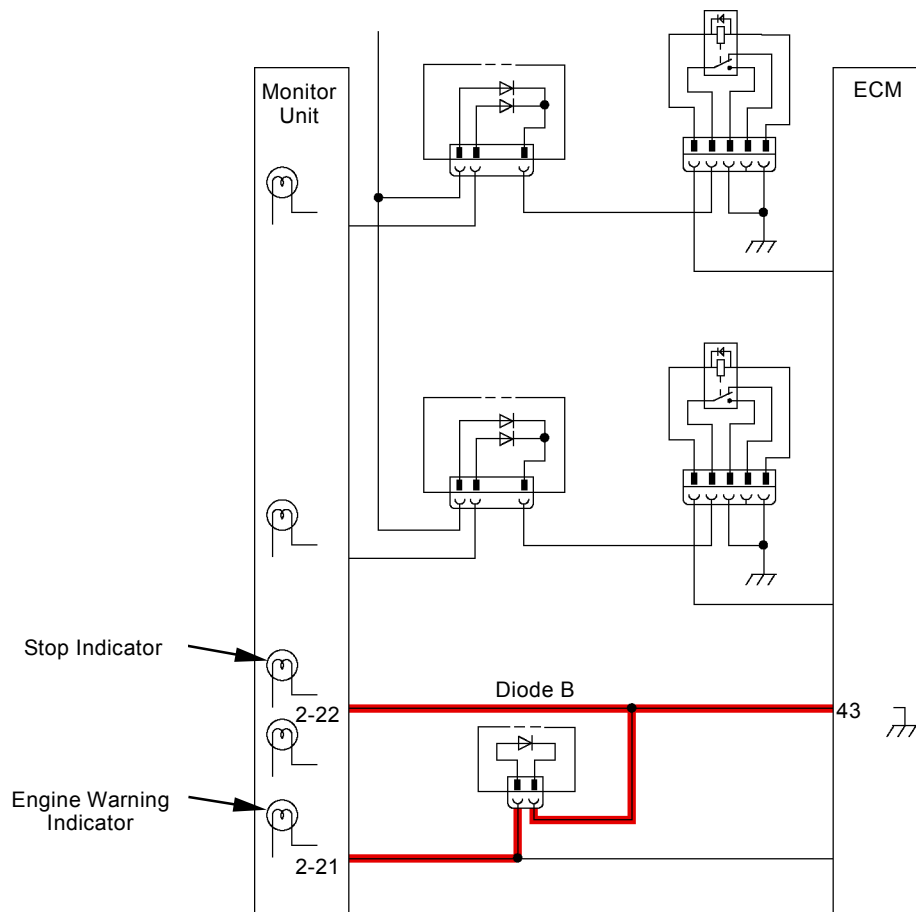
Operation:

1. When detecting the engine serious failure, ECM grounds terminal #43. Therefore, terminals 2-21 and 2-22 of the monitor unit are grounded.
2. When terminals 2-21 and 2-22 of the monitor unit are grounded, the monitor unit lights the engine warning indicator and stop indicator.

3. When the engine returns to normal conditions, ECM deactivates the ground connection to terminal #43. Therefore, terminals 2-21 and 2-22 of the monitor unit are disconnected from the engine.

4. When terminals 2-21 and 2-22 of the monitor unit are disconnected from the engine, the monitor unit turns off the engine warning indicator and stop indicator.

NOTE: As priority is given to lighting the stop indicator, the service indicator does not light.



T4GD-02-02-007

SYSTEM / ECM System

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SYSTEM / Hydraulic System

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 circuit, pump control circuit, brake circuit and ride control circuit (optional) – composed of the pilot pump, charging block and valves to control each circuit.

- Steering Circuit

Steering circuit consists of the normal steering circuit, steering shockless 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 hydraulic fan motor and the fan pump.

 **NOTE:** *Steering circuit can be divided into the main circuit and the pilot circuit. It is described here as an independent circuit.*

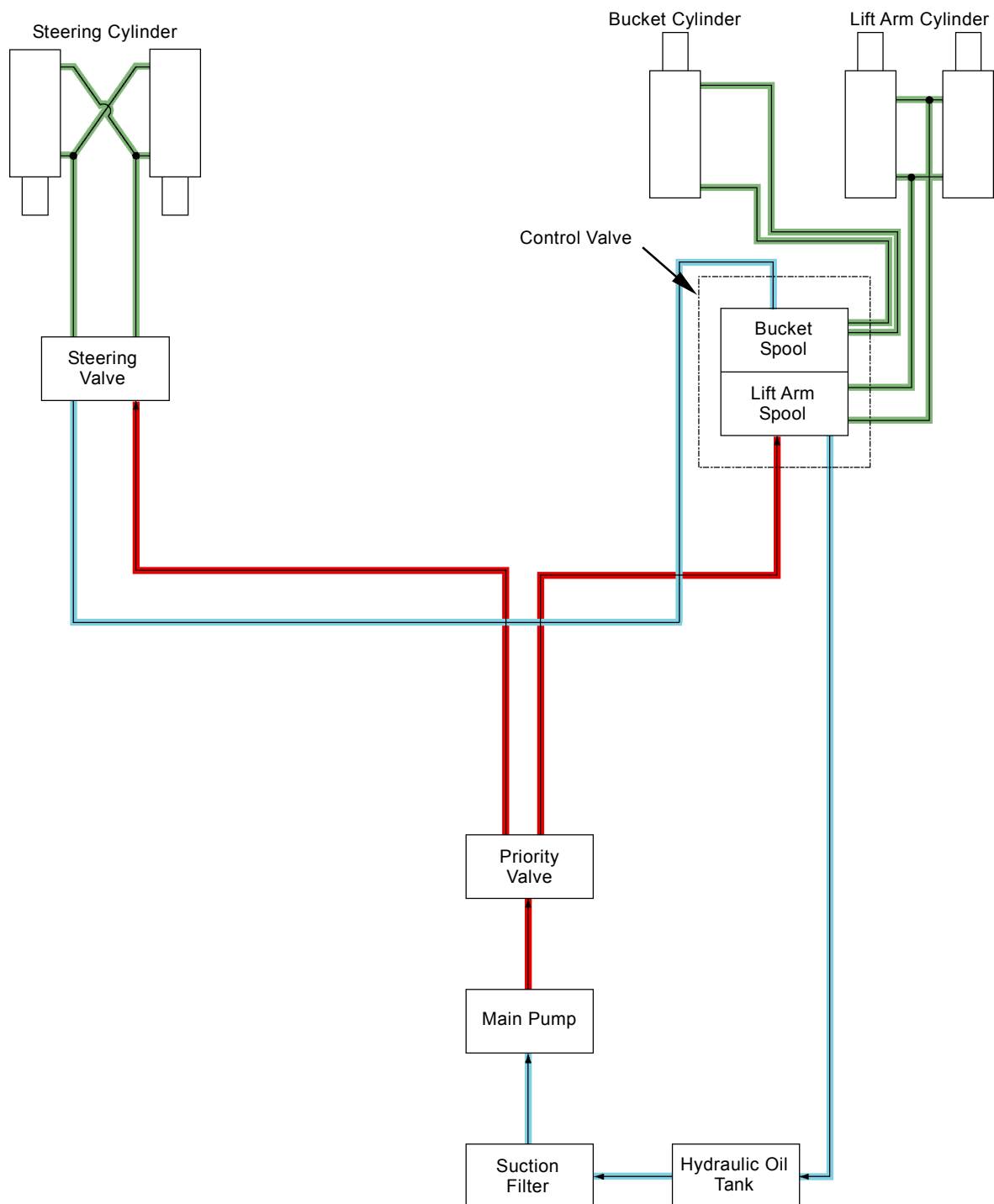
SYSTEM / Hydraulic System

MAIN CIRCUIT

Outline

- Main pump draws and delivers hydraulic oil, from the hydraulic oil tank through the suction filter.
- Delivered pressure oil flows to the steering valve and the control valve through the priority valve.
- Pressure oil 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 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.

SYSTEM / Hydraulic System



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SYSTEM / Hydraulic System

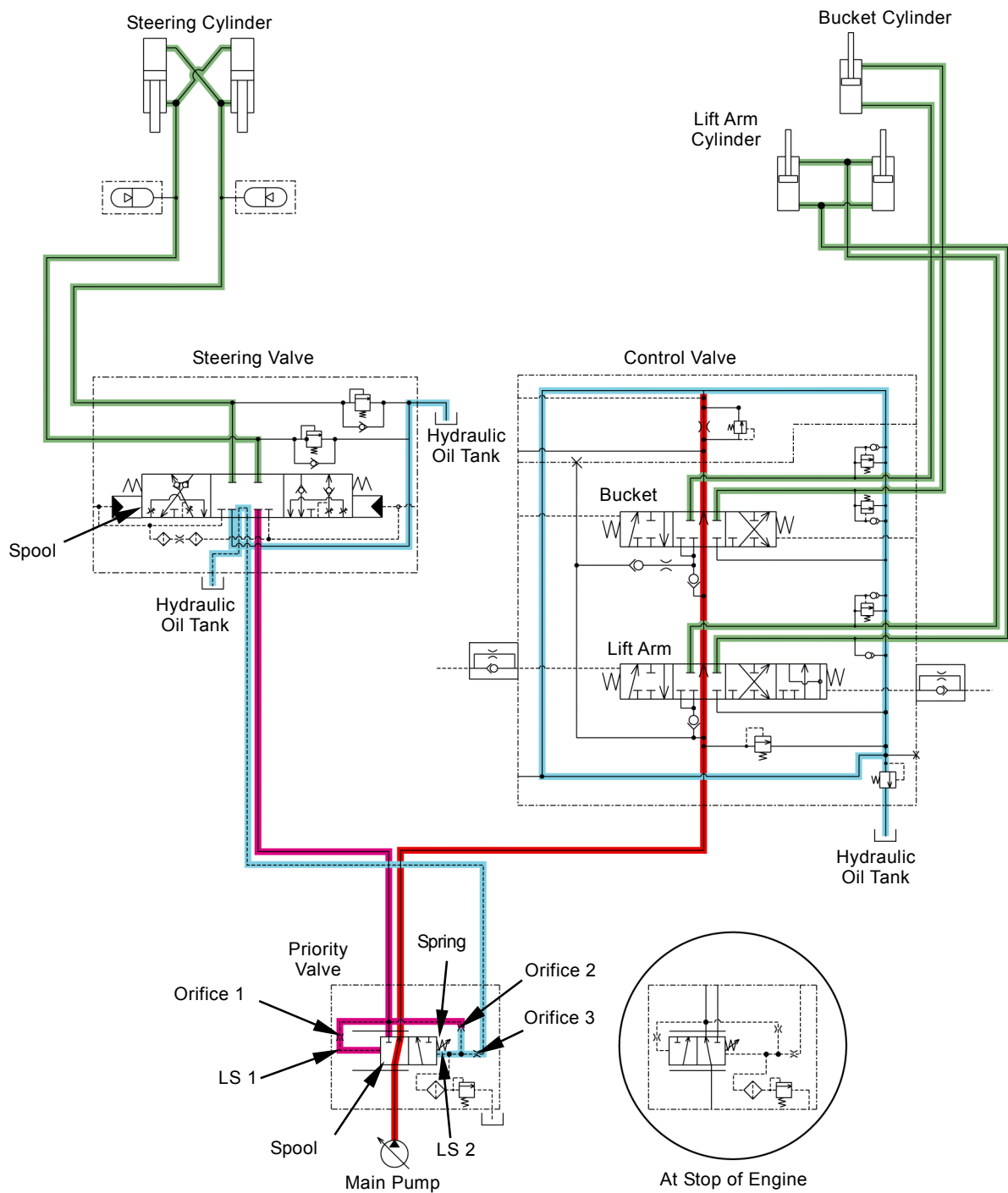
Priority Valve Circuit

- 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 to the steering valve through the priority valve spool, and also flows to ports LS1 and LS2 through orifices 1 and 2 respectively.
- At neutral of the steering valve, as pressure oil to port LS2 flows to the hydraulic oil tank through orifice 3 and the steering valve spool, port LS2 is not pressurized.
- As pressure at port LS1 is larger than the spring force, the priority valve spool moves rightward, and all pressure oil from the main pump is supplied to the control valve.
- The priority valve spool is provided with a notch to lead pressure oil from the main pump to the steering valve and a notch to lead pressure oil from the main pump to the control valve, which are both connected to the main pump delivery port constantly.
- When the priority valve spool moves rightward, the notch to lead pressure oil from the main pump to 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 to port LS2 is closed.
- At this time, as port LS2 is connected to the main circuit through the steering valve spool, 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 leftward.
- Larger the movement of the steering valve spool is, the higher the pressure at port LS2 rises, the larger the priority valve spool moves leftward, and the more pressure oil from the main pump is supplied to the steering valve.



NOTE: Orifice 2 of the priority valve is installed in order to warm up the circuit by flowing pressure oil to the hydraulic oil tank from port LS2 at neutral of the steering valve. Although diameter of port 2 is small and temperature of the oil passing through it rises rapidly, pressure is not raised enough to influence movement of the priority valve spool.

SYSTEM / Hydraulic System



T4GB-02-02-011

NOTE: This illustration shows oil flow without operation while the engine is running.

SYSTEM / Hydraulic System

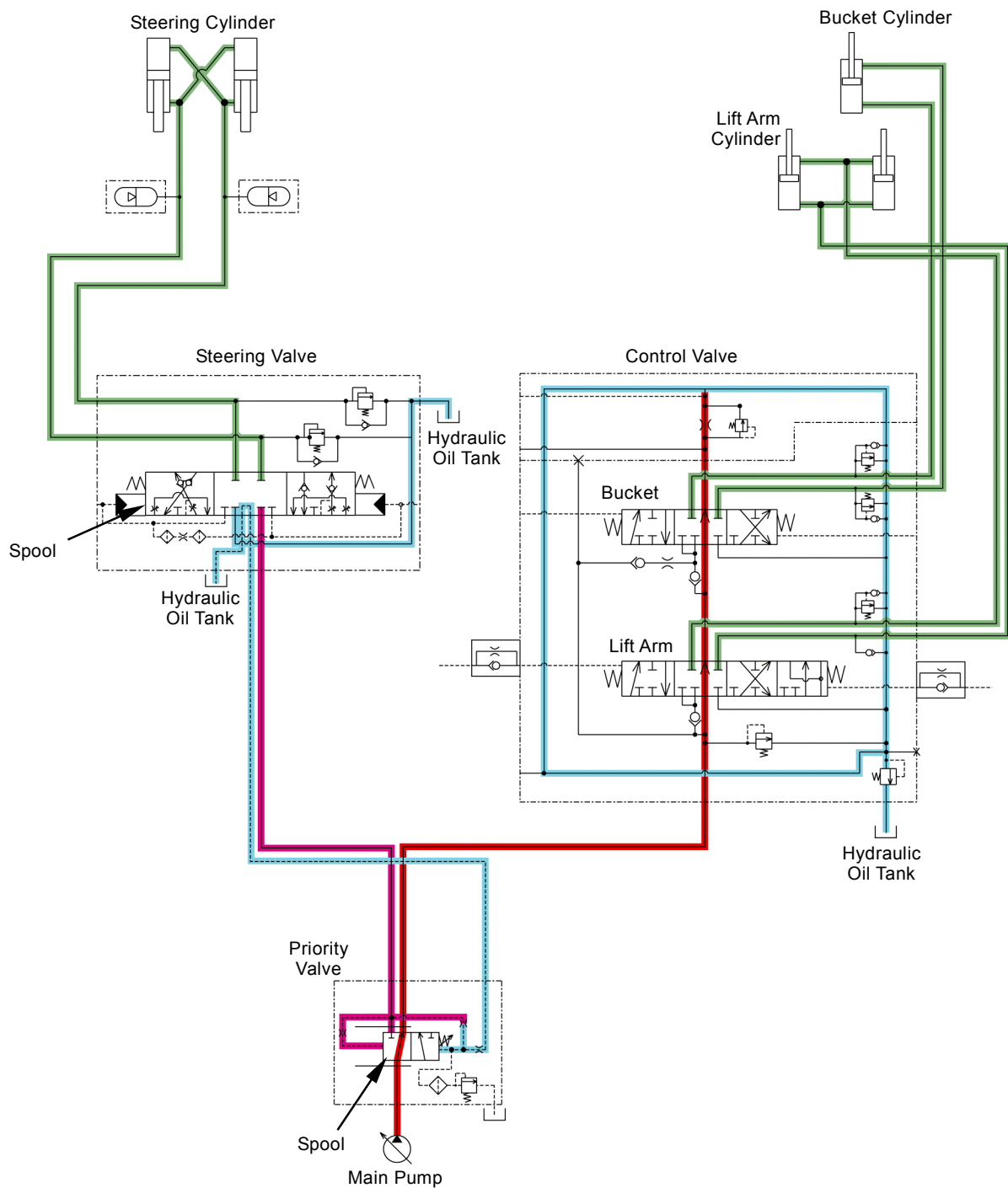
Neutral Circuit

- At neutral 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 due to the priority valve, pressure oil is supplied to the steering valve. Therefore, 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 flows to the control valve, and flows to the lift arm and bucket spools.
- When the steering valve spool moves, the priority valve spool moves leftward, and pressure oil from the main pump flows to the steering valve. (Refer to Priority Valve Circuit in this section.)

SYSTEM / Hydraulic System



T4GB-02-02-017

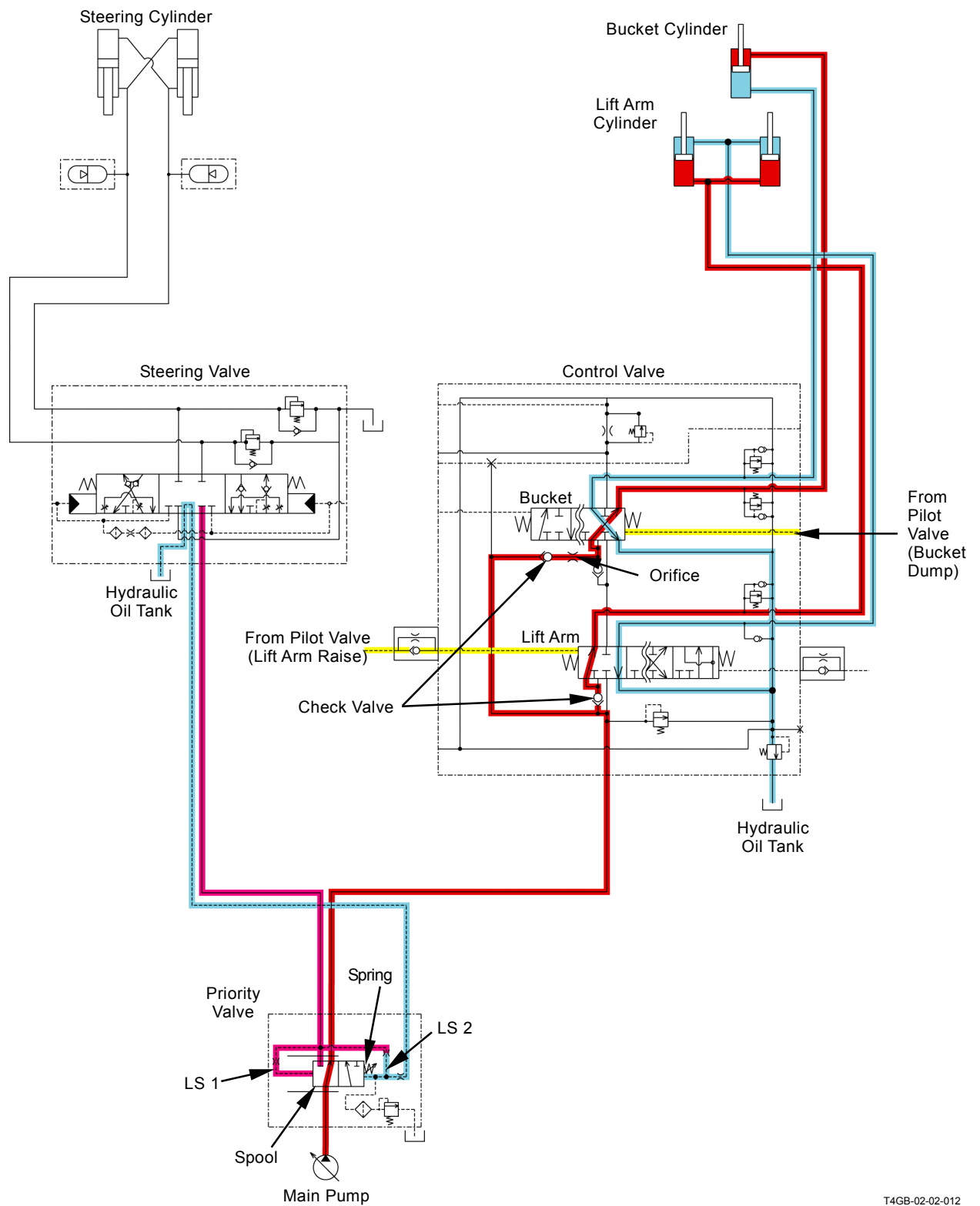
 **NOTE:** This illustration shows oil flow without operation while the engine is running.

SYSTEM / Hydraulic System

Combined Operation Circuit

- **Lift Arm Raise/Bucket Dump**
 - When the bucket is dumped with the lift arm raised, pilot pressure shifts the lift arm and bucket spools.
 - Although pressure from the own pump is applied to port LS1 of the priority valve, port LS2 is not pressurized as it is connected to the hydraulic oil tank.
 - As pressure at port LS1 is larger than the spring force of the priority valve, the spool moves rightward.
 - Therefore, pressure oil from the main pump flows to the lift arm cylinder through the check valve and the lift arm spool in the control valve, and raises the lift arm.
 - Pressure oil from the main pump also flows to the bucket cylinder through the check valve, orifice and bucket spool in the control valve, and dumps the bucket.
 - Although lift arm raising operation is more heavy loaded than the bucket dumping operation, pressure oil through the bucket operation circuit flows to the bucket cylinder after passing the check valve and orifice. Therefore, both the lift arm cylinder and the bucket cylinder move smoothly.

SYSTEM / Hydraulic System



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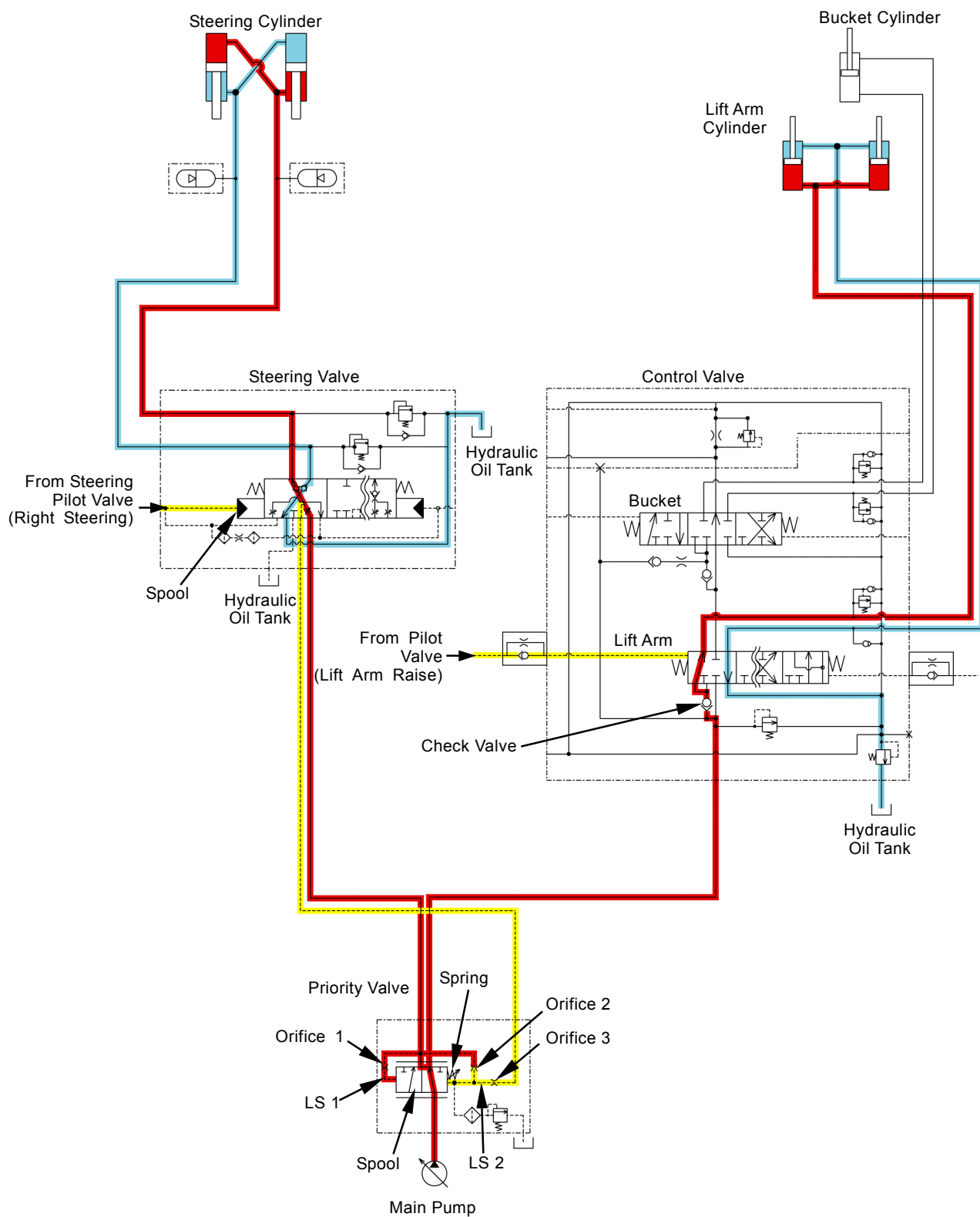
SYSTEM / Hydraulic System

- Lift Arm Raise/Right Steering
 - When the steering wheel is turned to the 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. 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 movement. When pressure at port LS2 is low, the priority valve spool moves leftward slightly, and when it is high, the spool moves leftward drastically.
 - Flow rate and direction of the main pump are controlled by the leftward movement of the priority valve spool. The oil flow rate corresponding to the movement 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 leftward, and much of pressure oil from the main pump is supplied to the steering valve. Therefore the front attachment moves slowly.*

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

SYSTEM / Hydraulic System



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SYSTEM / Hydraulic System

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SYSTEM / Hydraulic System

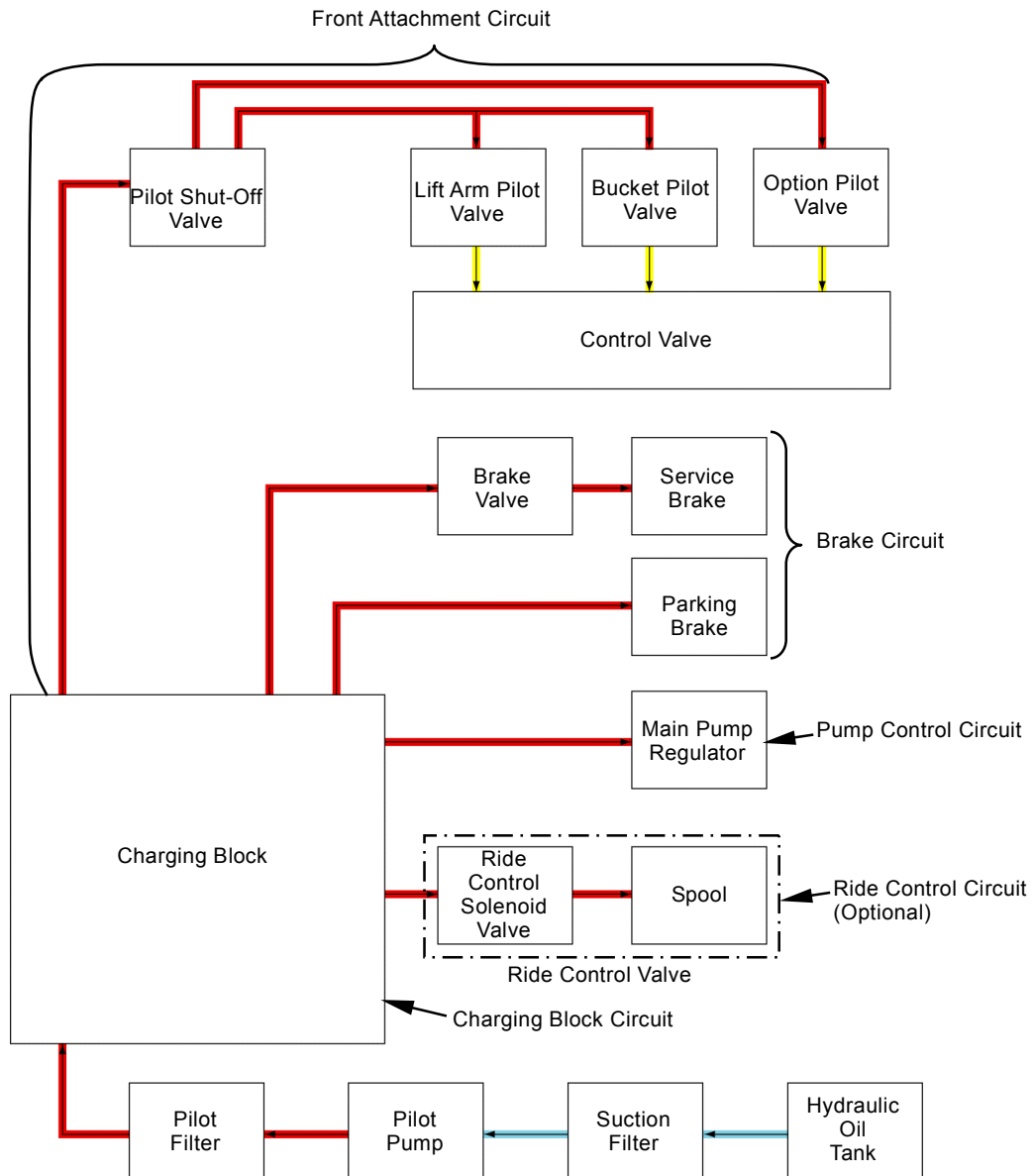
PILOT CIRCUIT

Outline:

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

- Charging Block Circuit
- Front Attachment Operation Circuit

- Pump Control Circuit
- Brake Circuit
- Ride Control Circuit (Optional)



T4GC-02-02-001

SYSTEM / Hydraulic System

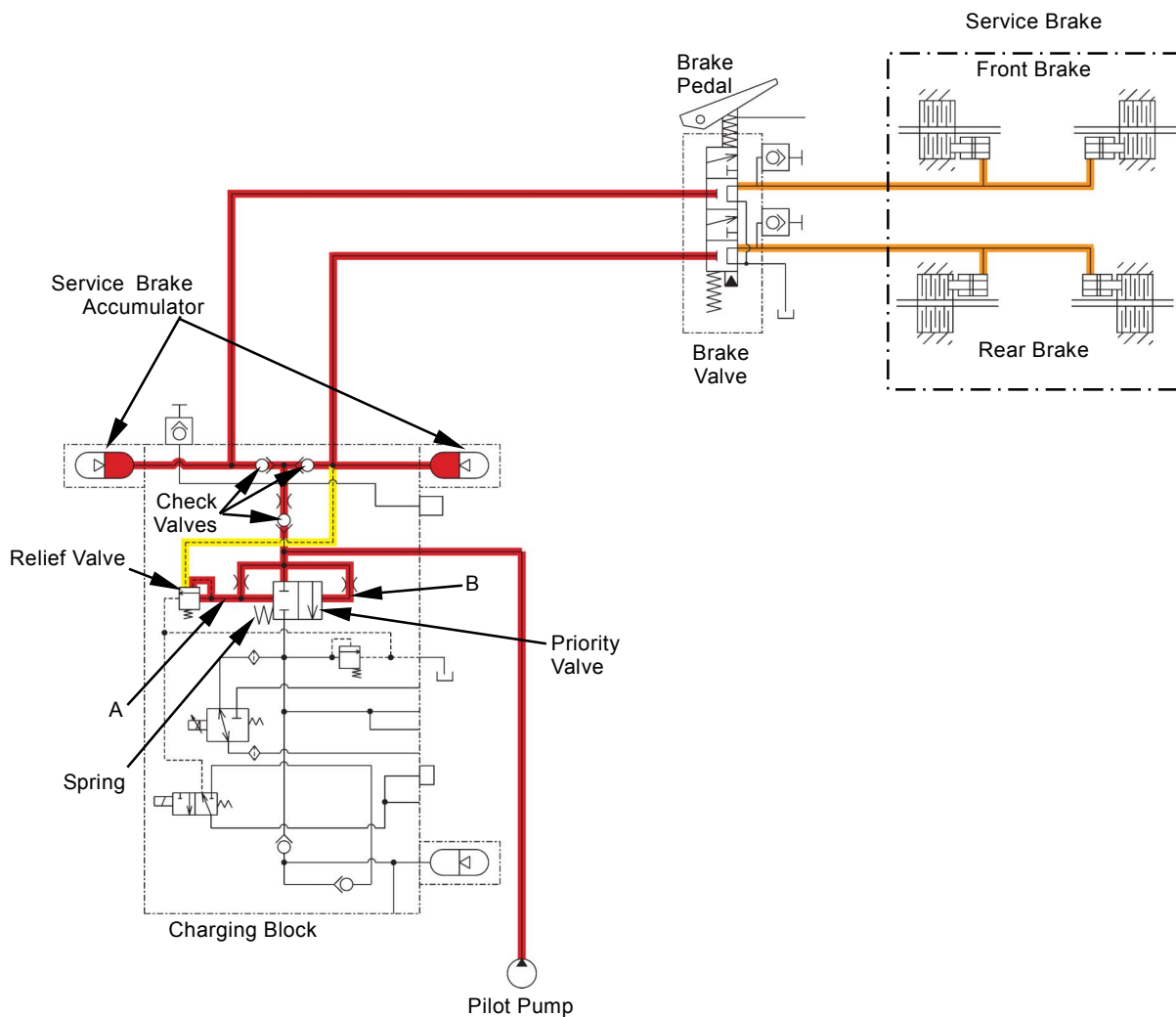
Charging Block Circuit

- Charging block is installed in order to supply pressure oil from the pilot pump preferentially to the service brake circuit and distribute to other pilot circuits as well.
- When the engine is started, oil from the pilot pump is delivered to 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. As both pilot pressure and the spring force are applied to port A, the priority valve moves rightward and controls pressure oil to flow further.
- Pressure oil from the pilot pump flows to the service brake circuit through the check valve, and accumulates the service brake accumulators.

(To be continued to T2-3-16)

 **NOTE:** *The spring of the priority valve is adjusted so that the priority valve is not completely closed. Although the priority valve is closed completely, a certain amount of pressure oil is being supplied to the circuits downstream.*

SYSTEM / Hydraulic System



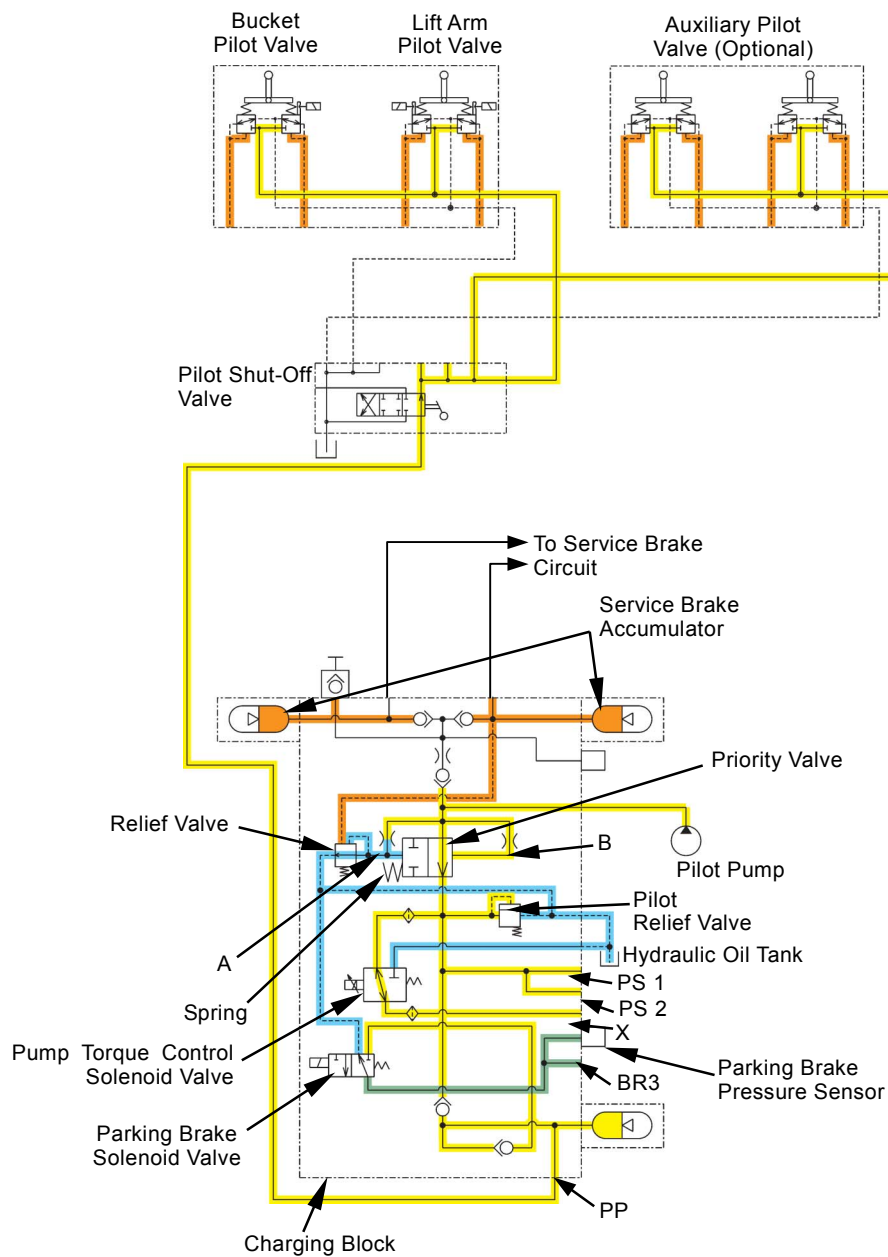
T4GD-02-03-001

 **NOTE:** The illustration shows oil flow when the relief valve and the priority valve are closed in response to pressure decrease in the service brake circuit.

SYSTEM / Hydraulic System

- When the service brake accumulators are pressurized to a certain amount, the relief valve opens. As port A of the priority valve is connected to the hydraulic oil tank, pressure is lost.
- As pressure at port B of the priority valve is larger force than the spring force, the priority valve spool moves leftward. Therefore, all pressure oil from the pilot pump is supplied to the priority valve and the circuit downstream.
- Pressure oil from the priority valve is supplied to the respective pilot circuits through each port.
- 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 and is 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 to control 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 to control 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 shut-off valve, and is supplied to the control valve for actuation of the spool. (Refer to Front Attachment Operation Circuit.)

SYSTEM / Hydraulic System



T4GD-02-03-002

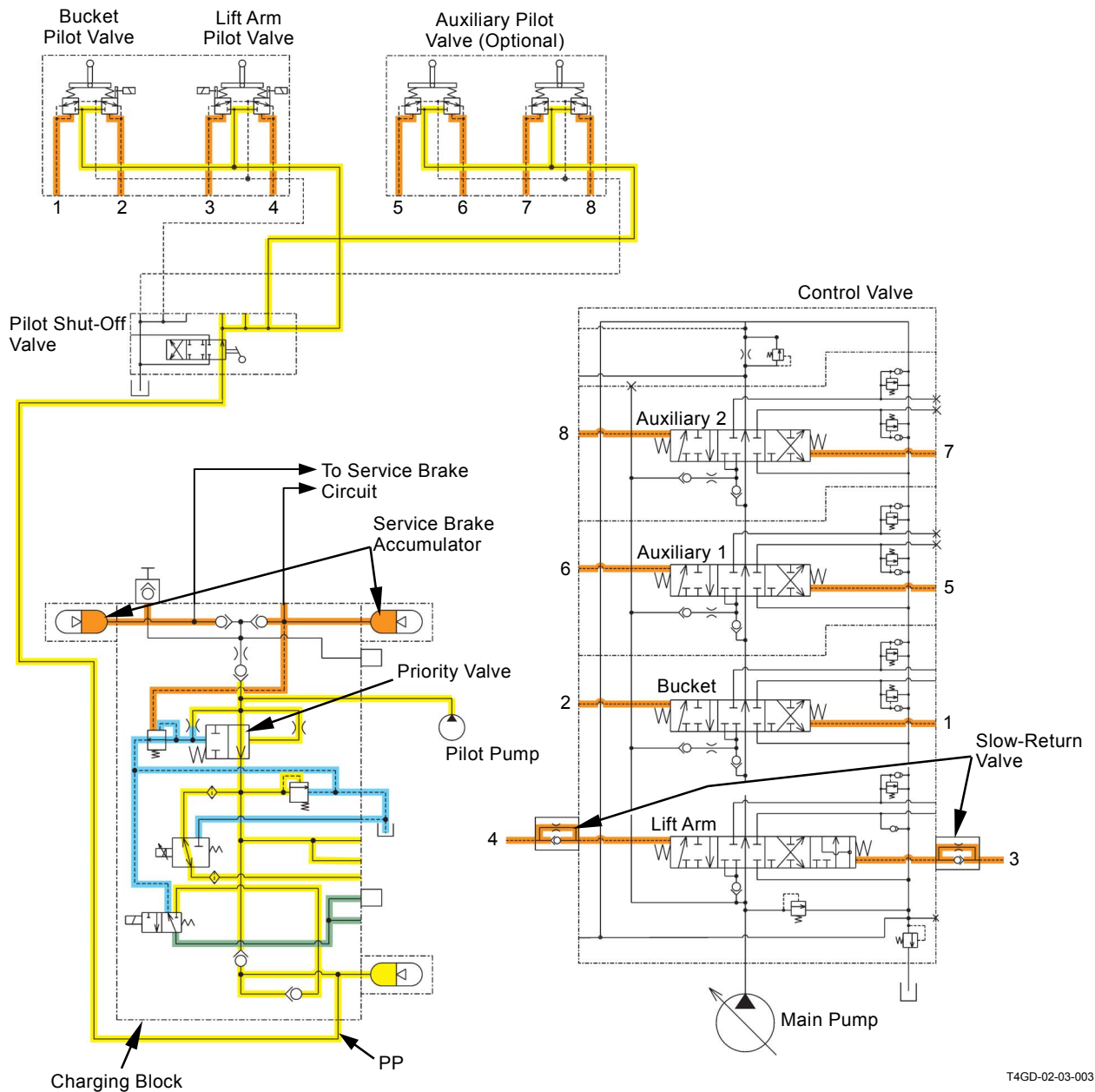
NOTE: The illustration shows the oil flow in neutral condition of the pilot valve when the service brake accumulators are pressurized, the priority valve is open, and the pilot shut-off valve is open.

SYSTEM / Hydraulic System

Front Attachment Operation Circuit

- Pressure oil from the pilot pump flows to the charging block, comes out of port PP of the charging block and is supplied to each pilot valve through the pilot shut-off valve.
- The priority valve of the charging block supplies pressure oil preferentially to the service brake circuit when pressure in the service brake accumulators is lowered. (Refer to Charging Block Circuit.)
- The pilot shut-off valve is a manually operated type, and is installed in order to prevent accidents due to wrong operation by stopping supply 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, the slow-return valves are installed in order to moderate sudden movement of the spool.

SYSTEM / Hydraulic System



NOTE: Numeral of each port of the pilot valves and the control valve shows the port to be connected.

The 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 shut-off valve is open.

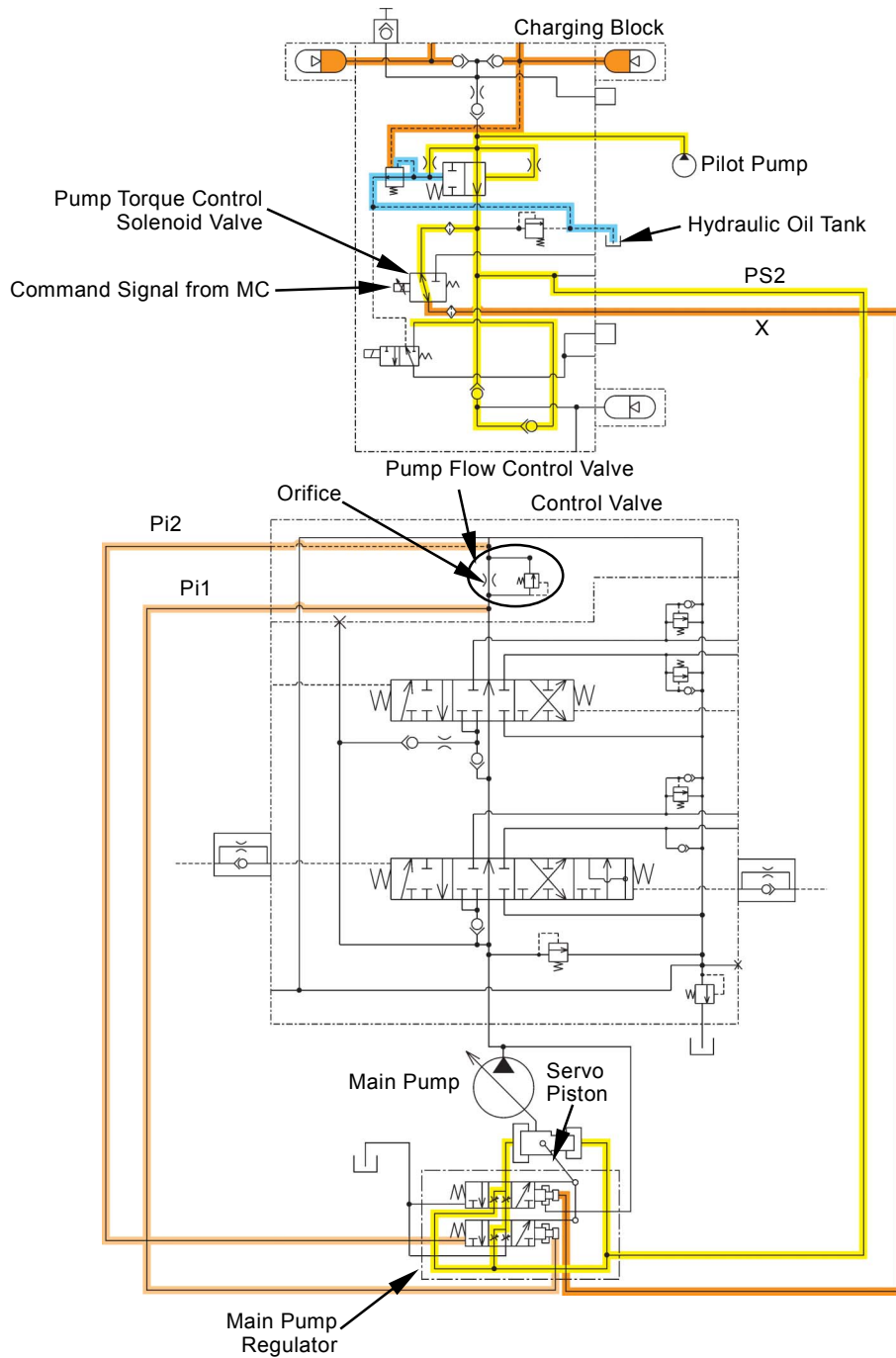
SYSTEM / Hydraulic System

Pump Control Circuit

(Refer to the 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 Control by Flow Control Pressure (Pi1/Pi2)
 - Pressures upward and downward the orifice – Pi1 and Pi2 – of the pump flow control valve installed at the farthest downstream of the control valve neutral circuit are supplied to the main pump regulator in order to adjust the pump flow.
- Pump Flow Control by Pump Torque Control Solenoid Valve
 - The signal from MC actuates the pump torque control solenoid valve, and controls pilot pressure (X) supplied to the main pump regulator in order to control the pump flow.

SYSTEM / Hydraulic System



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SYSTEM / Hydraulic System

Brake Circuit

Service Brake Circuit

(Refer to the **COMPONENT OPERATION / Charging Block group.**)

(Refer to the **COMPONENT OPERATION / Brake Valve group.**)

- 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.
- The priority valve spool moves rightward, 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 vehicle.

 **NOTE:** The spring of the priority valve is adjusted so that the priority valve is not completely closed. Although the priority valve is closed completely, a certain amount of pressure oil is being supplied to the circuits downstream.

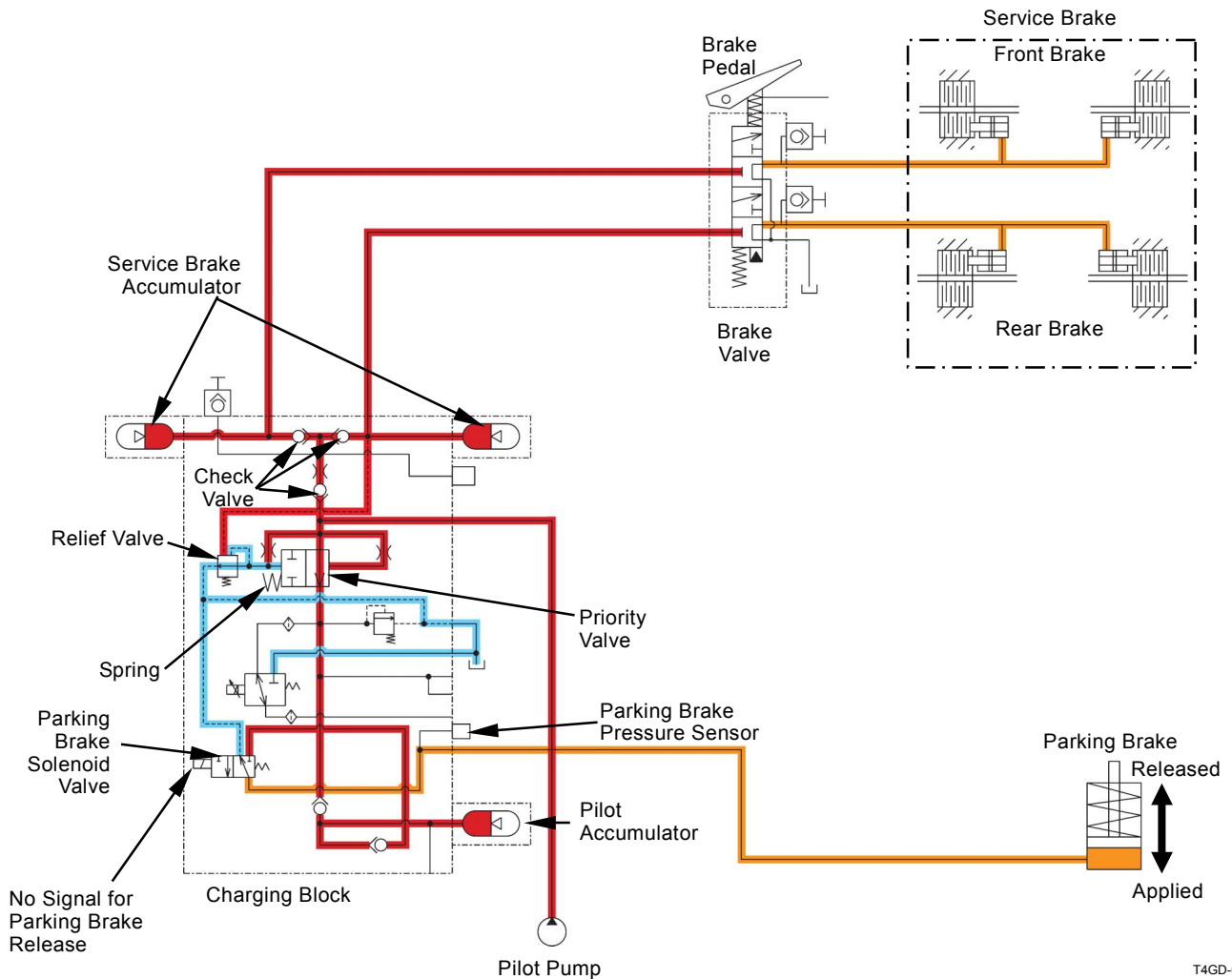
 **NOTE:** Although the engine is stopped, the service brake circuit pressure is retained for a while due to the functions of the service brake accumulators and the check valve.

Parking Brake Circuit

- Pressure oil from the pilot pump is applied to the parking brake solenoid valve in the charging block.
- When the parking brake is turned OFF, the parking brake solenoid valve is excited, and pressure oil entering the parking brake cylinder releases the parking brake.
- If the parking brake is turned ON, the parking brake solenoid valve is unexcited, and pressure oil stops supplying to the parking brake. Therefore the parking brake is applied.
- Although pressure is lowered caused by damage of hose or something in the upstream of the parking brake solenoid valve, pressure for parking brake circuit is maintained for a while by the pilot accumulator.

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

SYSTEM / Hydraulic System



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NOTE: The 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 applied with the unexcitement of the parking brake solenoid valve.

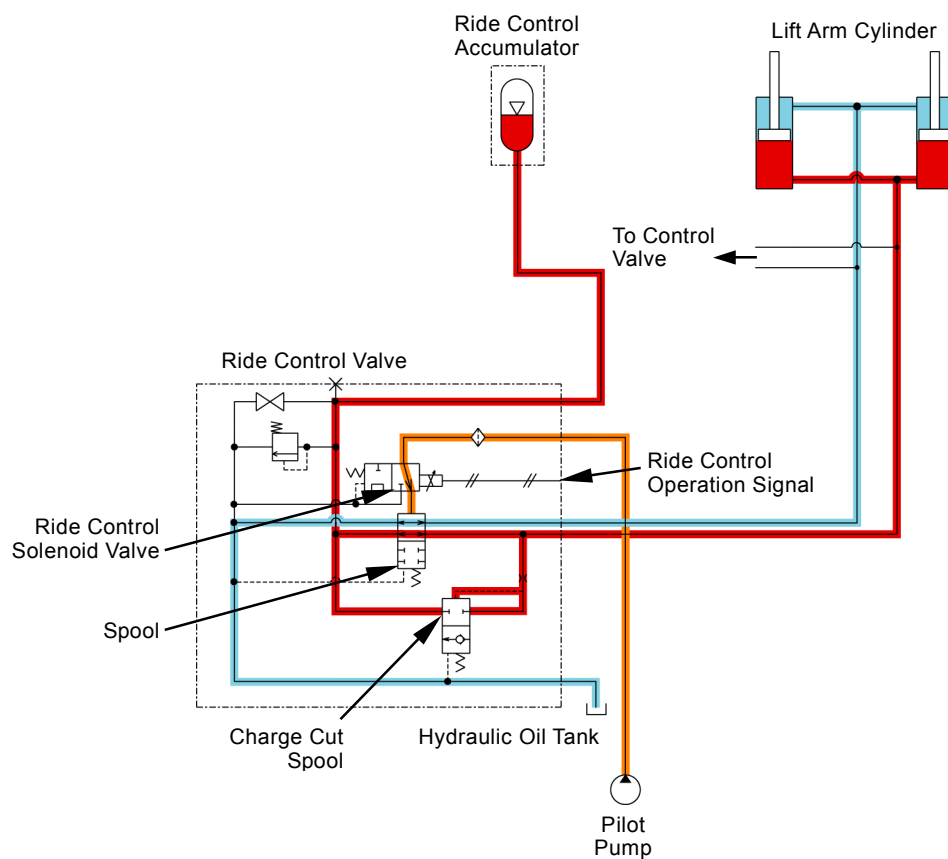
SYSTEM / Hydraulic System

Ride Control Circuit (Optional)

(Refer to SYSTEM / Control System Electric / the Hydraulic Combined Circuit Control in group.)

- 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.
- As the bottom end of the lift arm cylinder is connected to the ride control accumulator, the rod side of the lift arm cylinder is connected to the hydraulic oil tank.
- In this way, the force to raise the front attachment is relieved to the hydraulic oil tank, and the force to lower the front attachment is absorbed by the ride control accumulator. Therefore, the machine travels stably when traveling on rough roads.

SYSTEM / Hydraulic System



T4GB-02-02-009

 **NOTE:** The illustration shows oil flow when the ride control solenoid valve is excited.

SYSTEM / Hydraulic System

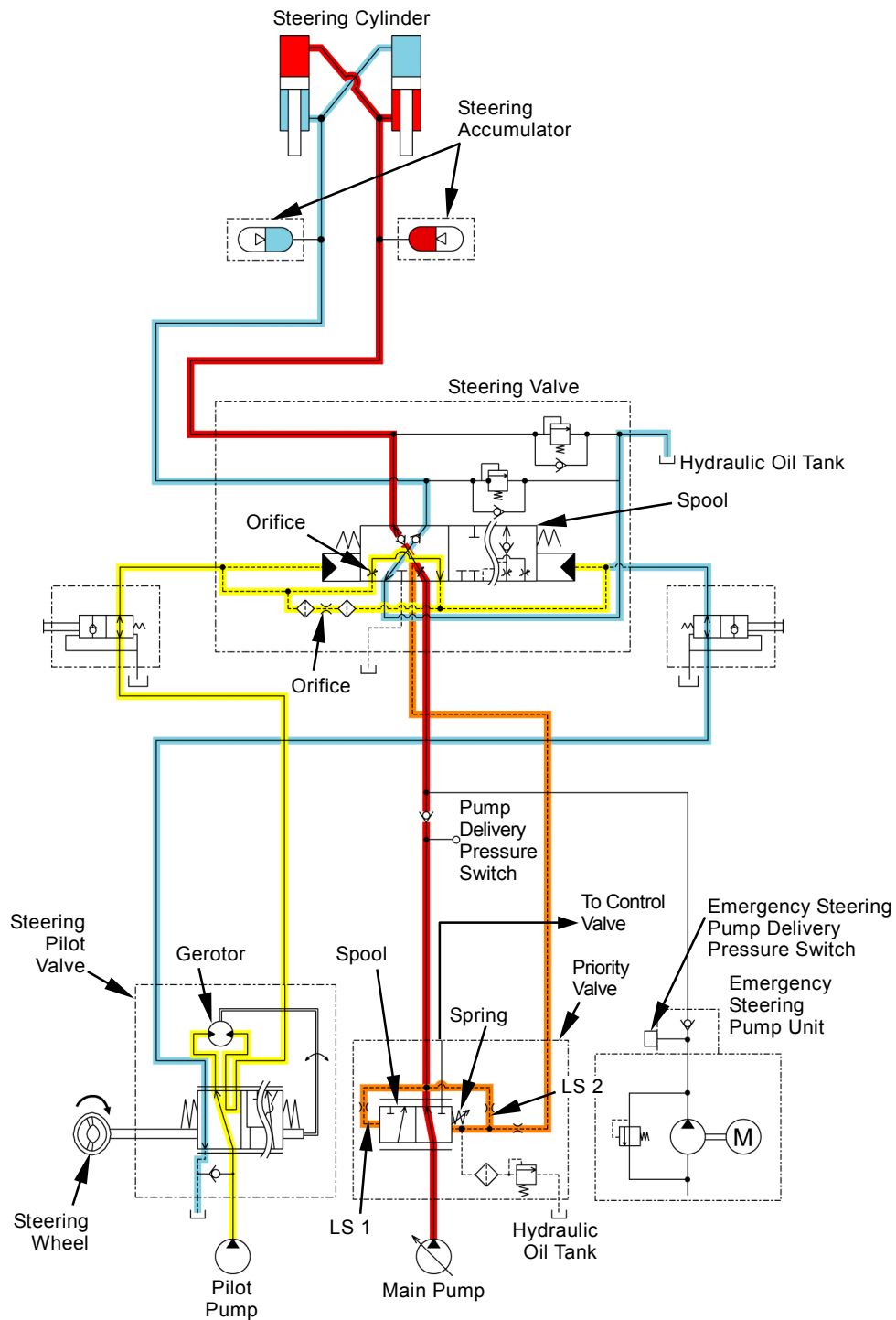
STEERING CIRCUIT

Normal Steering Circuit

- Normally, pressure oil from the main pump flows to the steering valve through the priority valve. As pilot line (LS2) is connected to the hydraulic oil tank, pressure is lost.
- The priority valve spool is moved to rightward pushed as pressure (LS1) from the own pump overcomes the spring force of the priority valve. Therefore, all pressure oil is supplied to the control valve.
- When the steering wheel is turned, the steering pilot valve spool is shifted, and pressure oil from the pilot pump moves the steering valve spool.
- When the steering wheel is quickly turned, as 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, the steering valve spool moves quickly and largely.
- When the steering wheel is slowly turned, as a small amount of pilot pressure oil is supplied gradually to the end of the steering valve spool through the steering pilot valve, the steering valve spool moves slowly and slightly.
- In proportion to the movement of the steering valve spool, pressure in pilot line (LS2) rises. Therefore, the priority valve spool is pushed leftward by the spring force of priority valve and pressure of 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 the COMPONENT OPERATION / Pump Device group.)

 **NOTE:** When pressure oil passes inside the steering pilot valve, pressure oil flows to the steering valve through the gerotor part. As the gerotor is connected to the middle shaft of the pilot steering valve, powered steering effect is generated. (Refer to the COMPONENT OPERATION / Steering Pilot Valve group.)

SYSTEM / Hydraulic System



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NOTE: The illustration shows the pressure oil flow when the steering wheel is turned to the right.

SYSTEM / Hydraulic System

Steering Shockless Circuit

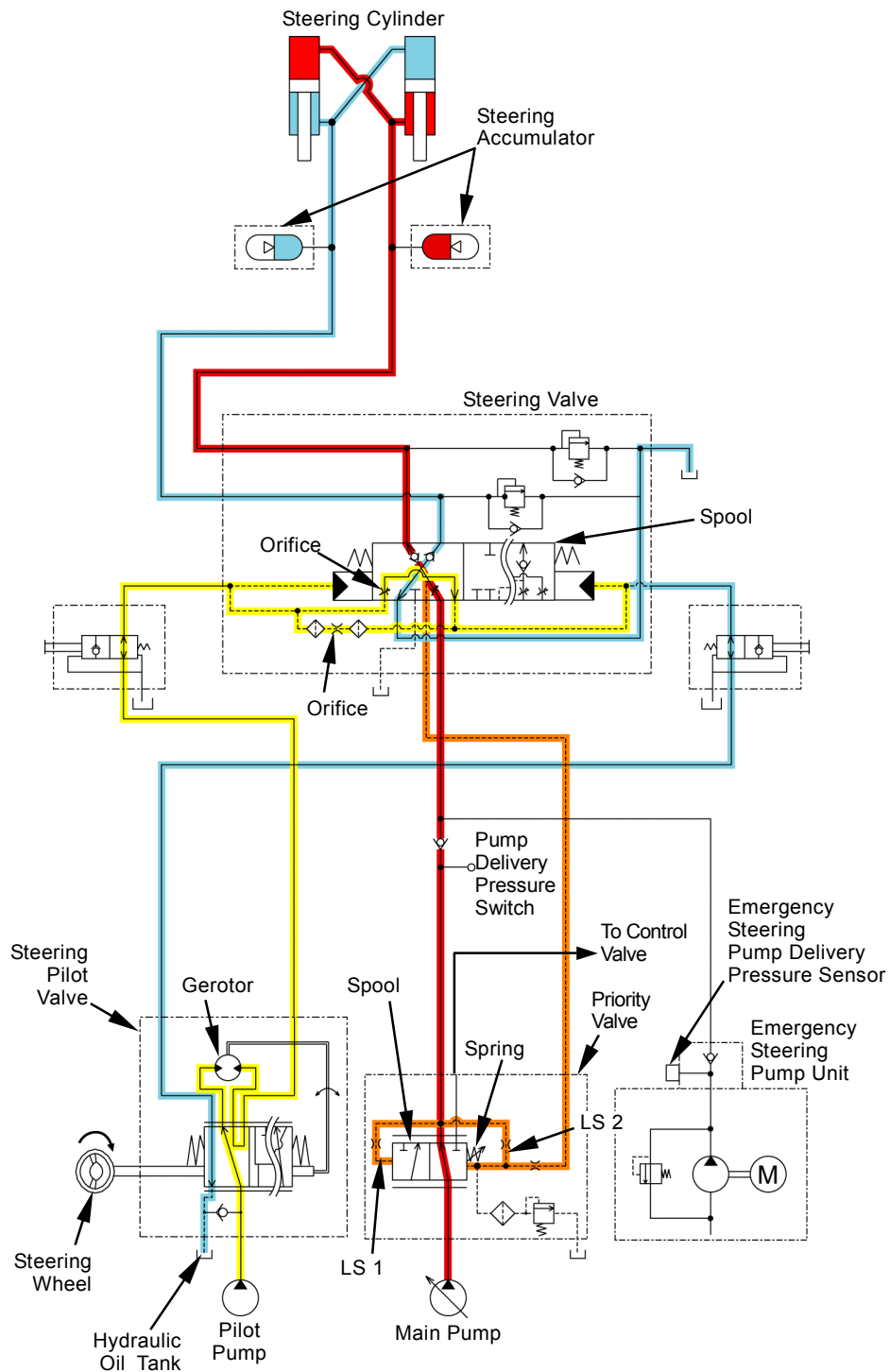
- Pilot pressure oil supplied from the steering pilot valve to the spool end of the steering valve is reduced by passing through the orifice inside the steering valve, and is applied to the spool end of the opposite side. In this way, the vehicle shock due to sudden shift of the spool is reduced, and stable steering operation is possible. (Refer to the COMPONENT OPERATION / Steering Valve group.)
- The steering accumulators are provided in order to reduce the joggling of the vehicle when stopping 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 pressure sensing signal of the pump delivery pressure switch is transmitted into the monitor controller. Then, the monitor controller starts the motor of the emergency steering pump unit.
- Pressure oil is supplied from the emergency steering pump for 1 minute. Therefore, 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 the engine is started, the monitor unit automatically starts the emergency steering pump unit in order to confirm its function. When the pressure sensing signal of the emergency steering pump delivery pressure switch is transmitted to the monitor unit, the emergency steering pump unit automatically stops.*

SYSTEM / Hydraulic System



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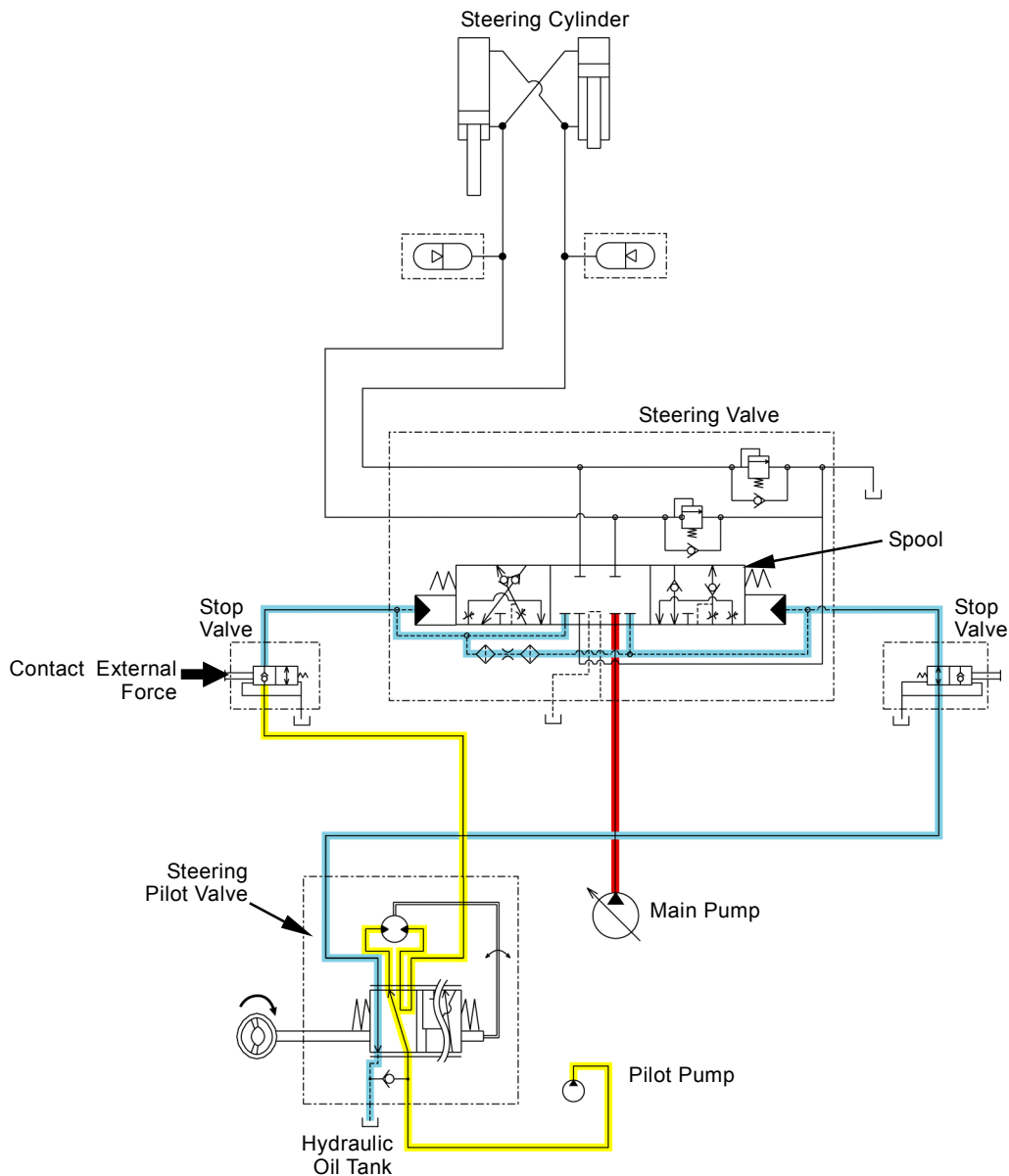
 **NOTE:** The illustration shows the pressure oil flow when the steering wheel is turned to the right.

SYSTEM / Hydraulic System

Steering Stop Circuit

(Refer to the **COMPONENT OPERATION / Steering Valve group.**)

- When either of the left or right cylinder is at the stroke end, the stop valve contacts the frame. Then the stop valve closes and pressure oil to the steering valve from the steering pilot valve is blocked.
- Consequently, as the steering valve spool is in neutral, supply of pressure oil from the main pump to the steering cylinders is stopped.



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 **NOTE:** The illustration shows the oil flow when the stop valve is closed during the right steering.

SYSTEM / Hydraulic System

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SYSTEM / Hydraulic System

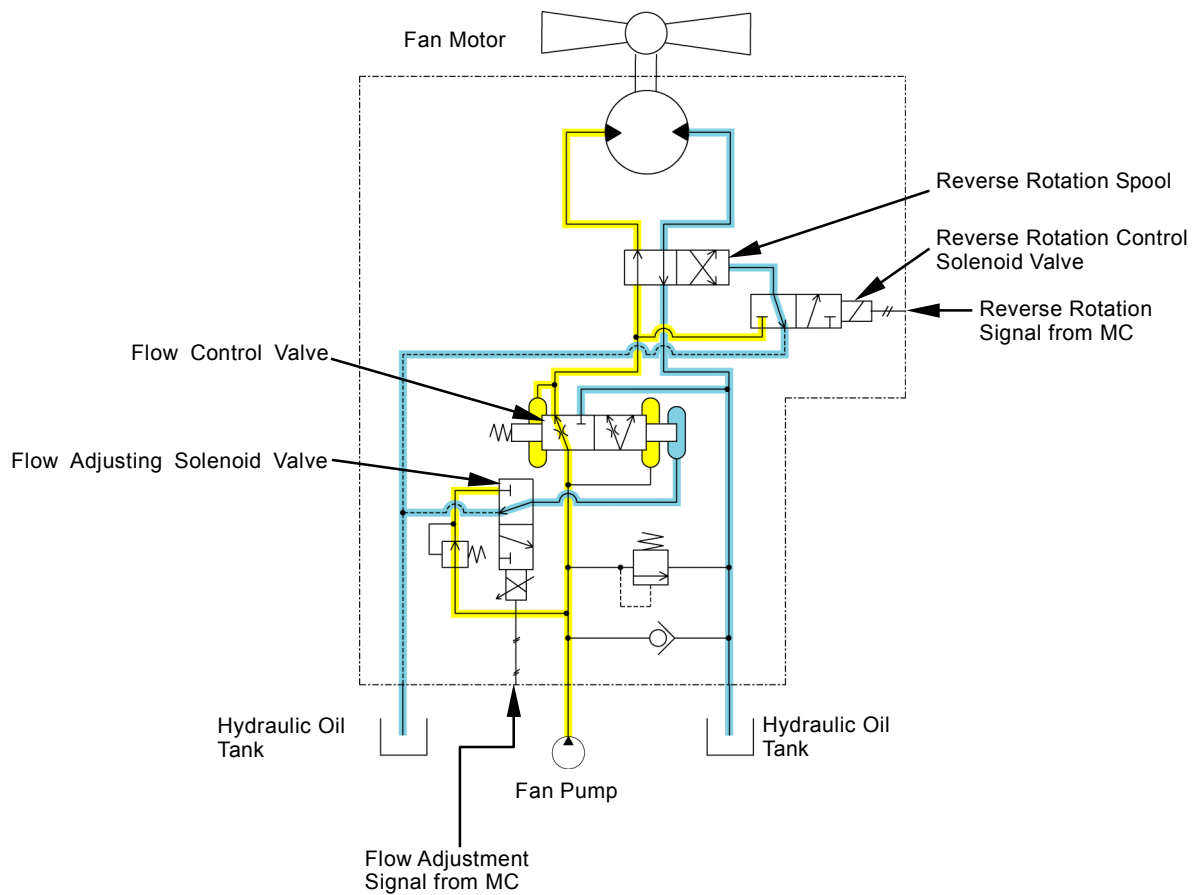
HYDRAULIC DRIVE FAN CIRCUIT

(Refer to the **COMPONENT OPERATION / Others group.**)

(Refer to the **COMPONENT OPERATION / Hydraulic Fan Motor group.**)

- Pressure oil from the fan pump flows to the fan motor through the flow control valve and the reverse rotation spool.
- Current corresponding to the hydraulic oil temperature is sent from MC to the flow control solenoid valve.
- Pressure oil is supplied to the flow control valve end in response to the stroke when the flow adjusting solenoid valve is excited.
- When the flow rate 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 reverse rotation switch is turned ON, 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.

SYSTEM / Hydraulic System



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 **NOTE:** The illustration shows the pressure oil flow without any control.

SYSTEM / Hydraulic System

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SYSTEM / Electrical System

OUTLINE

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

- **Main Circuit**
Circuit for engine start/stop, circuit for battery charging and circuit for accessories
- **Lamplight Circuit**
Circuit for traveling (composed of head lights, turn signals, brake lights and horn)
- **Control Circuit** (Refer to the SYSTEM/Control System group.)
Control circuit for engine, pumps, transmission and valves [composed of actuators as solenoid valves, MC (main controller), ECM (engine control module), ICF (information controller), monitor unit, switches, sensors and pressure switches]

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

SYSTEM / Electrical System

MAIN CIRCUIT

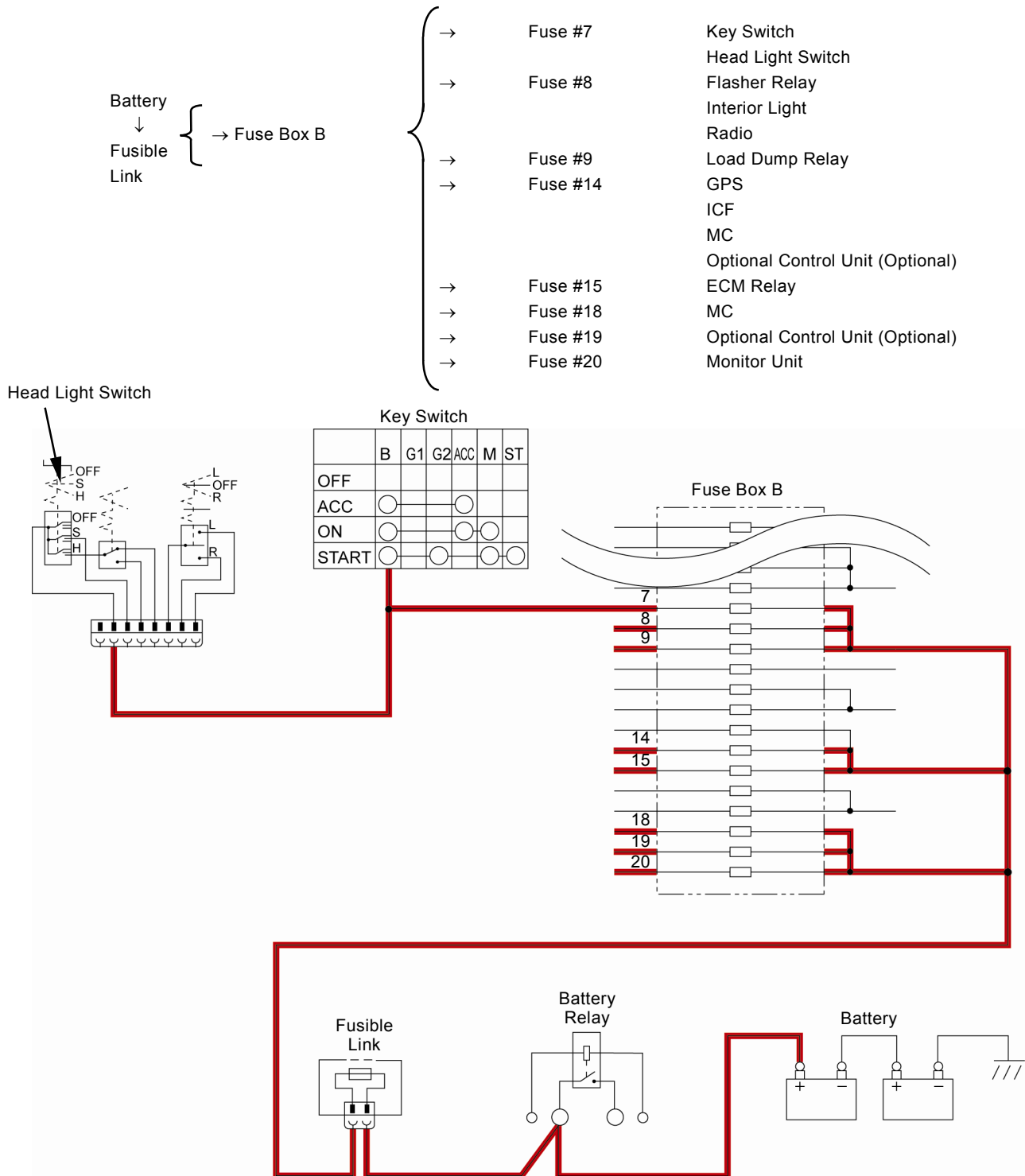
- Electric Power Circuit: for supplying electricity to the electric system as power source
- Indicator Light Check Circuit: for checking monitor warning lamps and indicators
- Accessory Circuit: for working at ACC of the key switch
- Preheat Circuit: for assisting engine start in cold weather
- Starting 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 ECM

SYSTEM / Electrical System

ELECTRIC POWER CIRCUIT (KEY SWITCH: OFF)

The battery ground terminal is connected to the vehicle frame. Current from the battery plus terminal flows as follows when the key switch is in the OFF position.

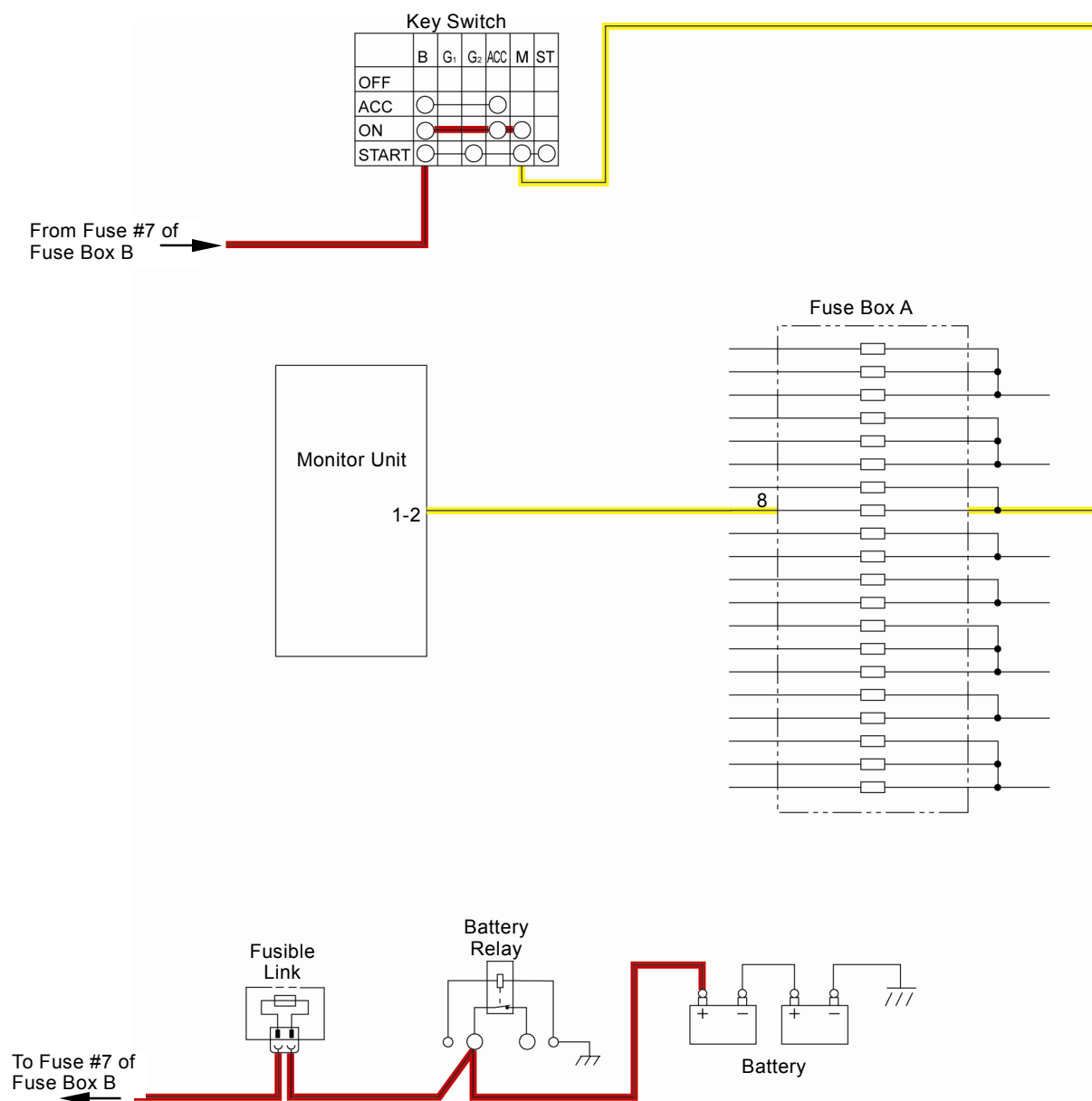
Although the key switch is in the OFF position, very small amount of current is supplied to the circuit. Disconnect the battery ground terminal in case of a long downtime.



SYSTEM / Electrical System

INDICATOR LIGHT CHECK CIRCUIT (KEY SWITCH: ON)

- When the key switch is turned to the ON position, terminal B is connected to terminals ACC and M inside the key switch.
- Current from terminal M of the key switch flows from fuse #8 of fuse box A to terminal 1-2 of the monitor unit.
- The monitor unit checks the bulbs breakage of warning lamp and indicator by lighting them and also starts the liquid crystal display.

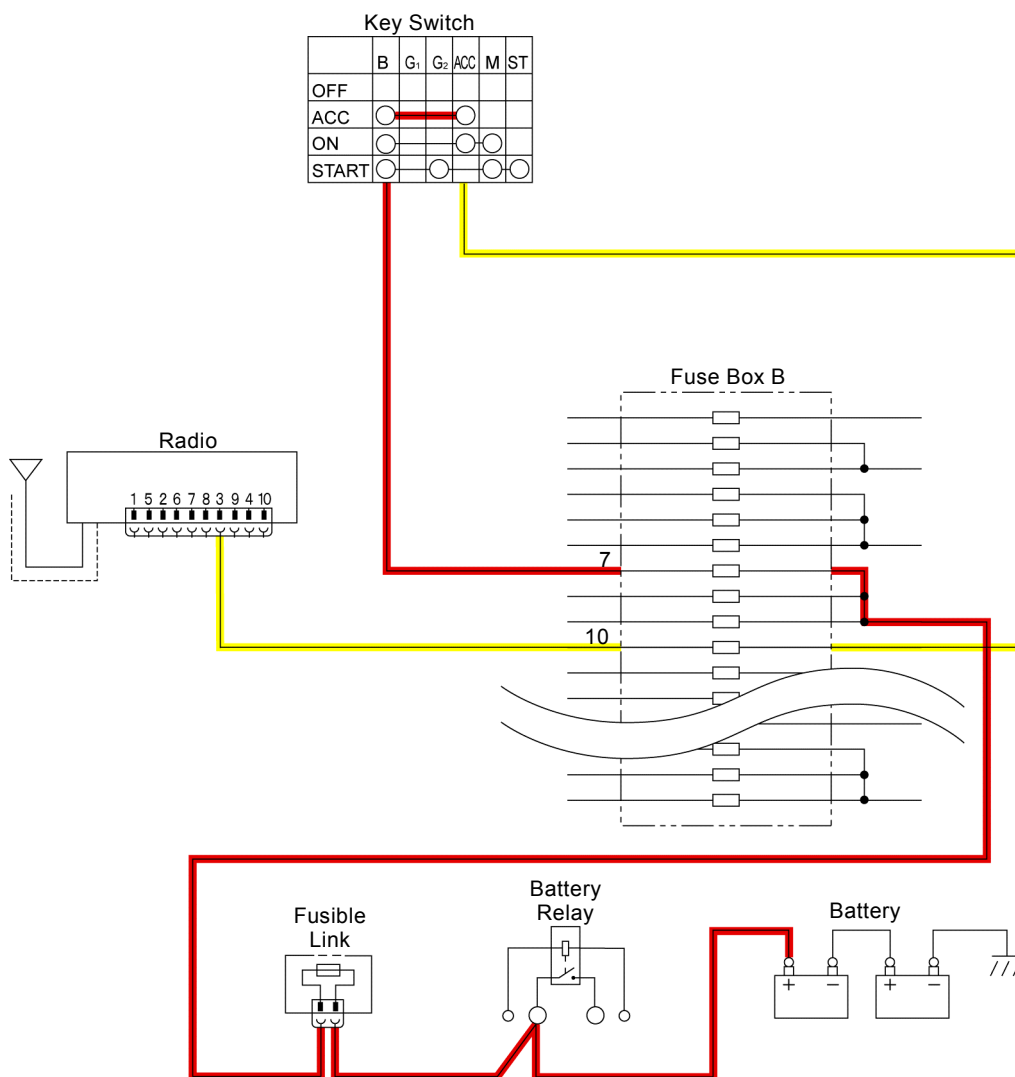


T4GD-02-04-011

SYSTEM / Electrical System

ACCESSORY CIRCUIT

- When the key switch is turned to the ACC position, terminal B is connected to terminal ACC inside the key switch.
- Current from terminal ACC of the key switch flows from fuse #10 of fuse box B to terminal #3 of the radio and makes the radio operable.



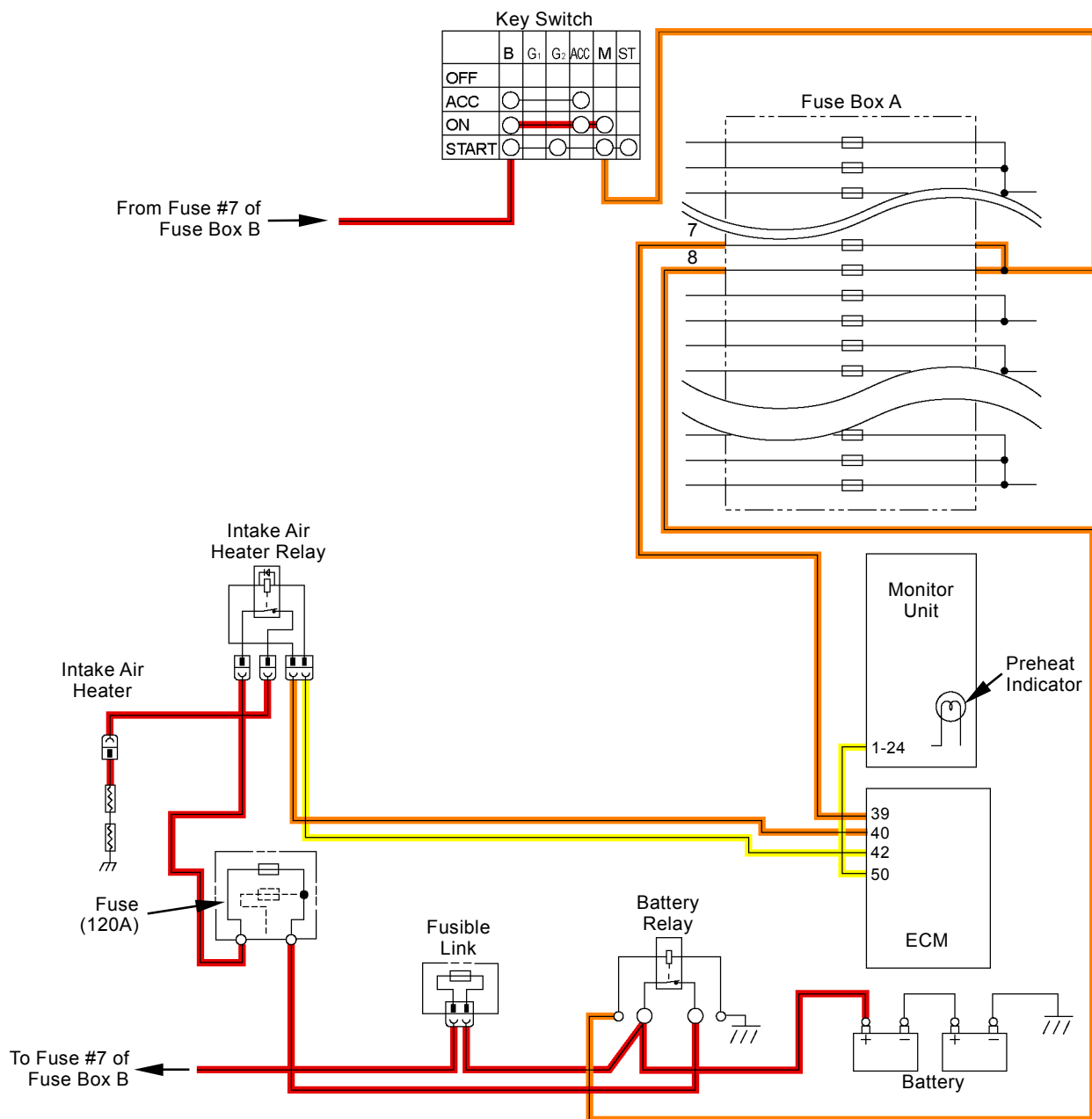
T4GB-02-03-003

SYSTEM / Electrical System

PREHEAT CIRCUIT (KEY SWITCH: ON)

- When the key switch is turned to the ON position, terminal B is connected to terminal M inside the key switch.
- Current from terminal M excites the battery relay through fuse #8 of fuse box A. The battery power is supplied to the intake-air heater relay through the fuse (120A).
- Current from fuse #7 of fuse box A flows to terminal #39 of ECM.
- ECM controls the exciting time of the intake-air heater relay.
- While the intake-air heater relay is excited, power is supplied to the intake-air heater from the intake-air heater relay and preheats it.
- While preheating is made, as terminal #50 of ECM is grounded, current flows from terminal #1-24 of the monitor unit to terminal #50 of ECM. Therefore, the monitor unit lights the preheat indicator.
- If preheating is not made, the preheat indicator lights for two seconds in order to check the bulb breakage of indicator.

SYSTEM / Electrical System



T4GD-02-04-012

NOTE: The illustration shows the current flow when preheating is made with the intake-air heater relay excited and the power supplied to the intake-air heater.

SYSTEM / Electrical System

STARTING CIRCUIT (KEY SWITCH: START)

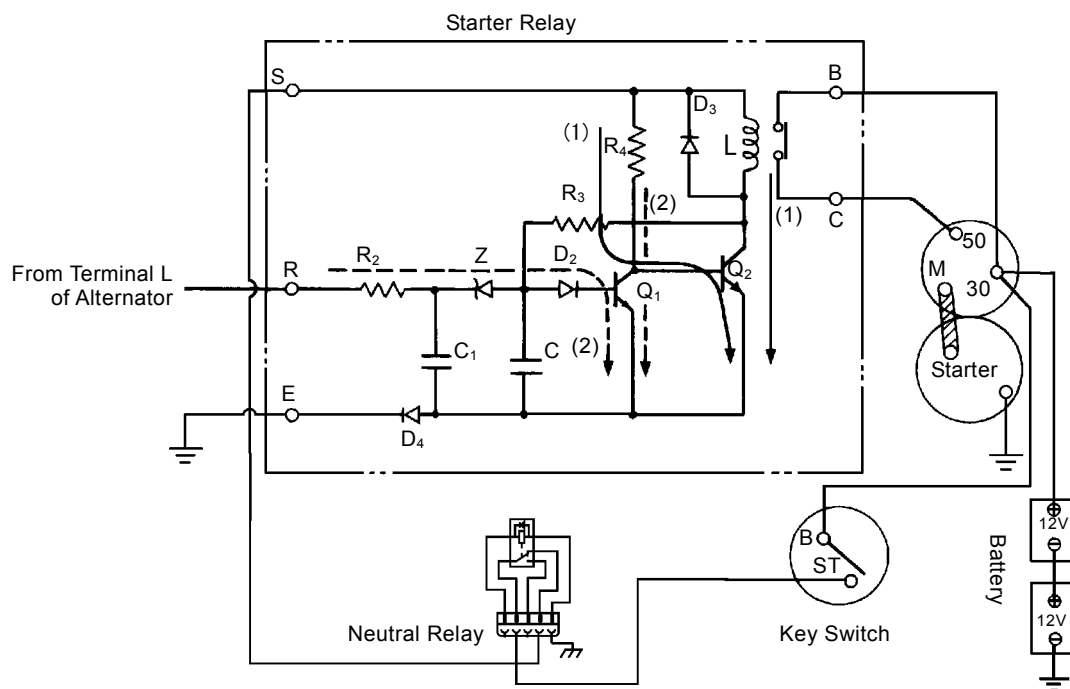
FNR Lever in Neutral

- When the key switch is turned to the START position, terminal B is connected to terminals M and ST inside the key switch.
- As current from terminal M excites the battery relay through fuse #8 of fuse box A, the battery power is routed from the battery relay to terminal #30 of the starter motor and terminal B of the starter relay.
- Current from terminal ST of the key switch flows to terminal S of the starter relay and the coil inside through the neutral relay.
- The starter relay is turned ON and current flows to terminal #50 of the starter from terminal C of the starter relay.
- Consequently, the relay inside the starter is turned ON and the starter motor rotates.
- Current from terminal M of the key switch flows to all the controllers as a signal that the key switch is in ON or START.

Operation of Starter Relay

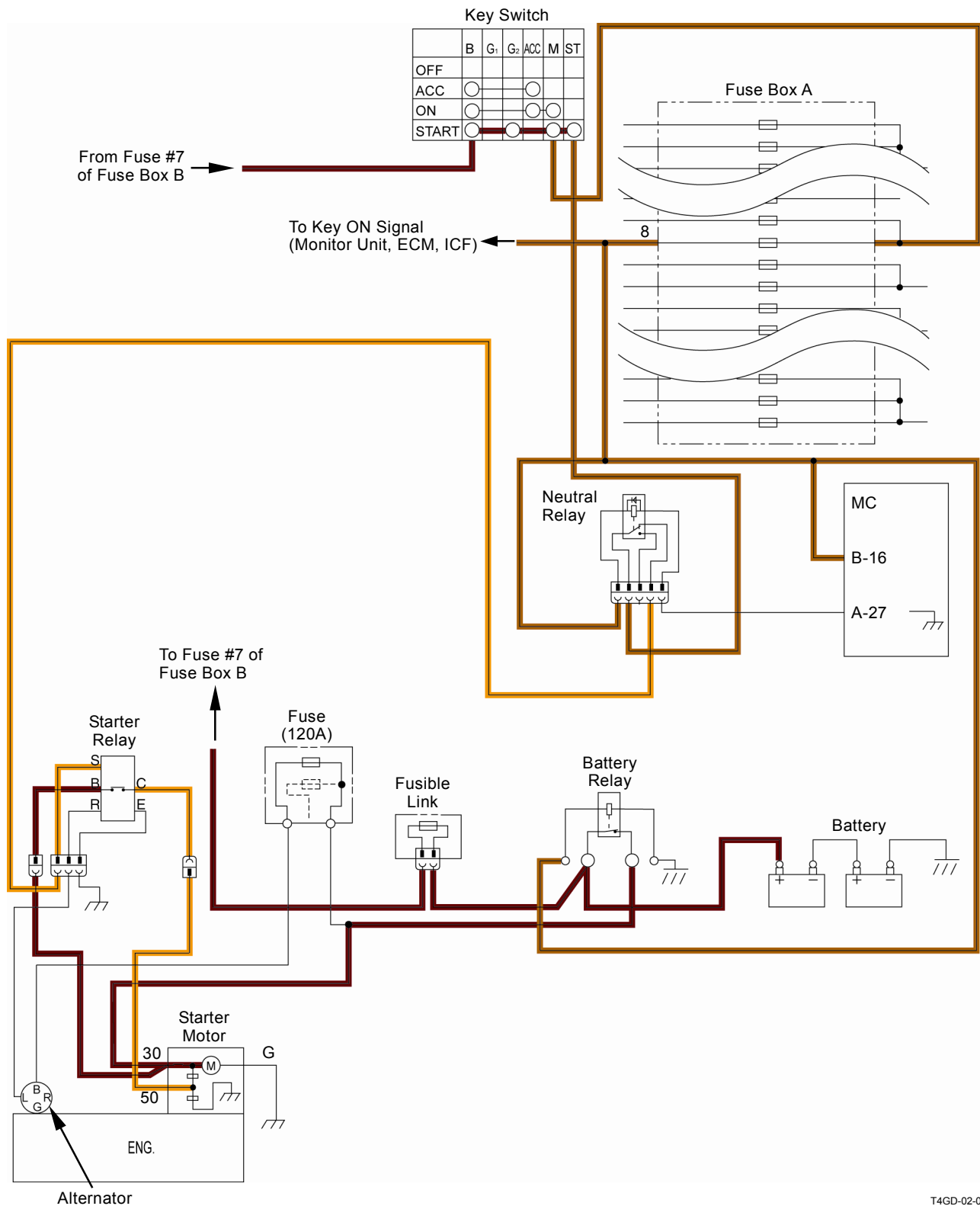
- When the key switch is turned to the START position, continuity between terminals B and ST of the key switch is made. Current flows to the base of transistor Q2 through resistance R4 inside the starter relay. Transistor Q2 is turned ON and current flows to coil L of the relay. Consequently, terminals #30 and #50 of the starter are connected and the starter is operated.
- When the engine is started, the alternator begins charging and the voltage at terminal R of the starter relay increases.
- When this voltage reaches 21 to 22 V, Zener diode Z is turned ON. Consequently, transistor Q1 is turned ON transistor Q2 is turned OFF as no current flows to the base of transistor Q2. At this moment, continuity between terminals #30 and #50 of the starter is lost and the starter is turned OFF.

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



T4GD-02-04-017

SYSTEM / Electrical System



T4GD-02-04-013

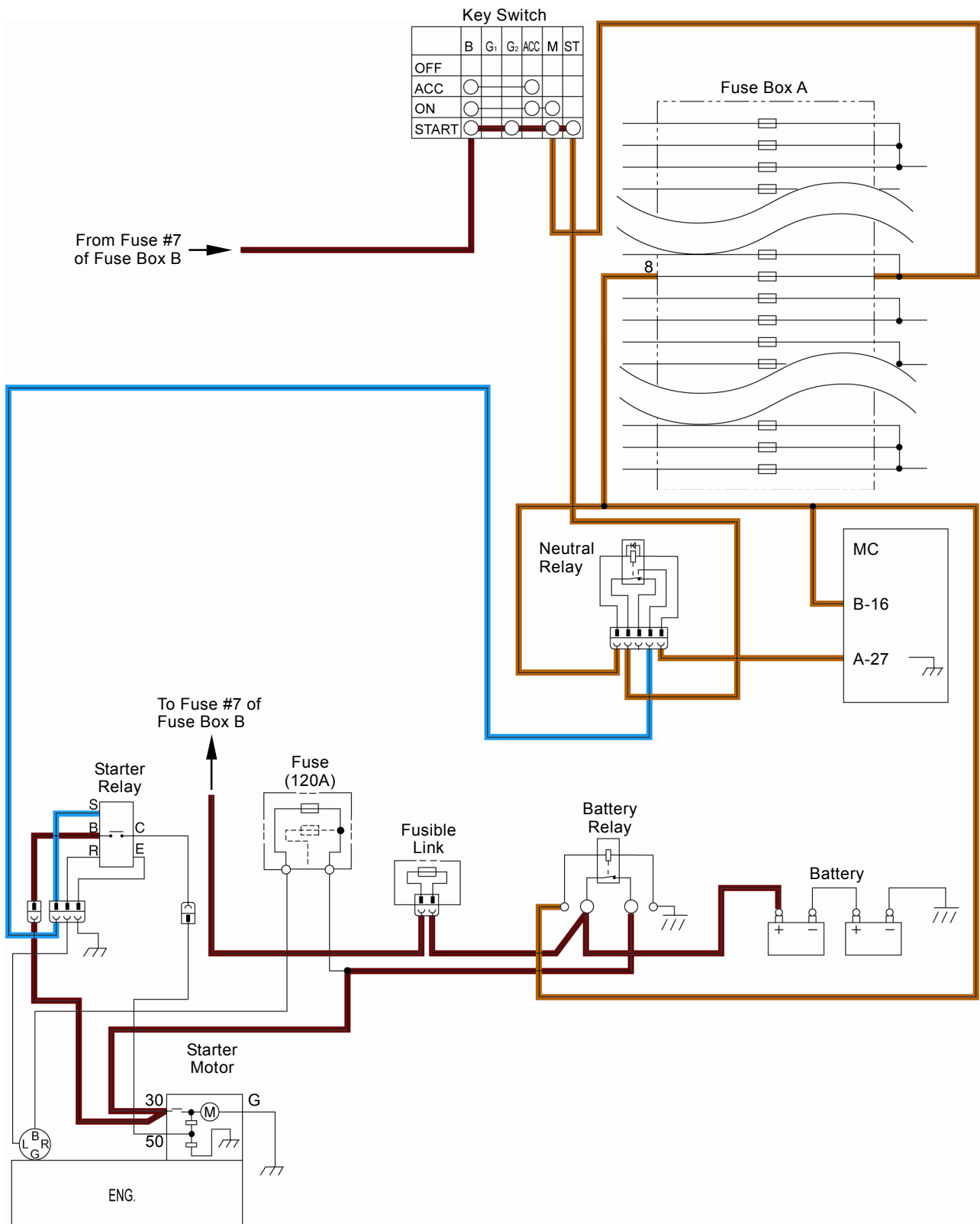
NOTE: The illustration shows the current flow when the FNR lever and the FNR switch are in the neutral position.

SYSTEM / Electrical System

FNR Lever at Operated Position

- Starting Circuit (Neutral Relay)
 - When the key switch is turned to the START position, terminal B is connected to terminals M and ST inside the key switch.
 - Current from terminal ST of the key switch flows to the neutral relay. Current from terminal M of the key switch flows to fuse #8 of fuse box A and excites the battery relay.
 - By exciting the battery relay, the battery power flows to terminals B of the starter motor and the starter relay.
 - At this time, when either of the FNR lever or the FNR switch is in the forward or reverse position, terminal A-27 of MC is connected to the ground and the neutral relay is excited.
 - By exciting the neutral relay, the circuit between the neutral relay and terminal S of the starter relay is blocked.
 - Therefore, when either of the FNR lever and the FNR switch is at forward or reverse, the starter motor is not operated although the key switch is turned to the START position.

SYSTEM / Electrical System



T4GD-02-04-014

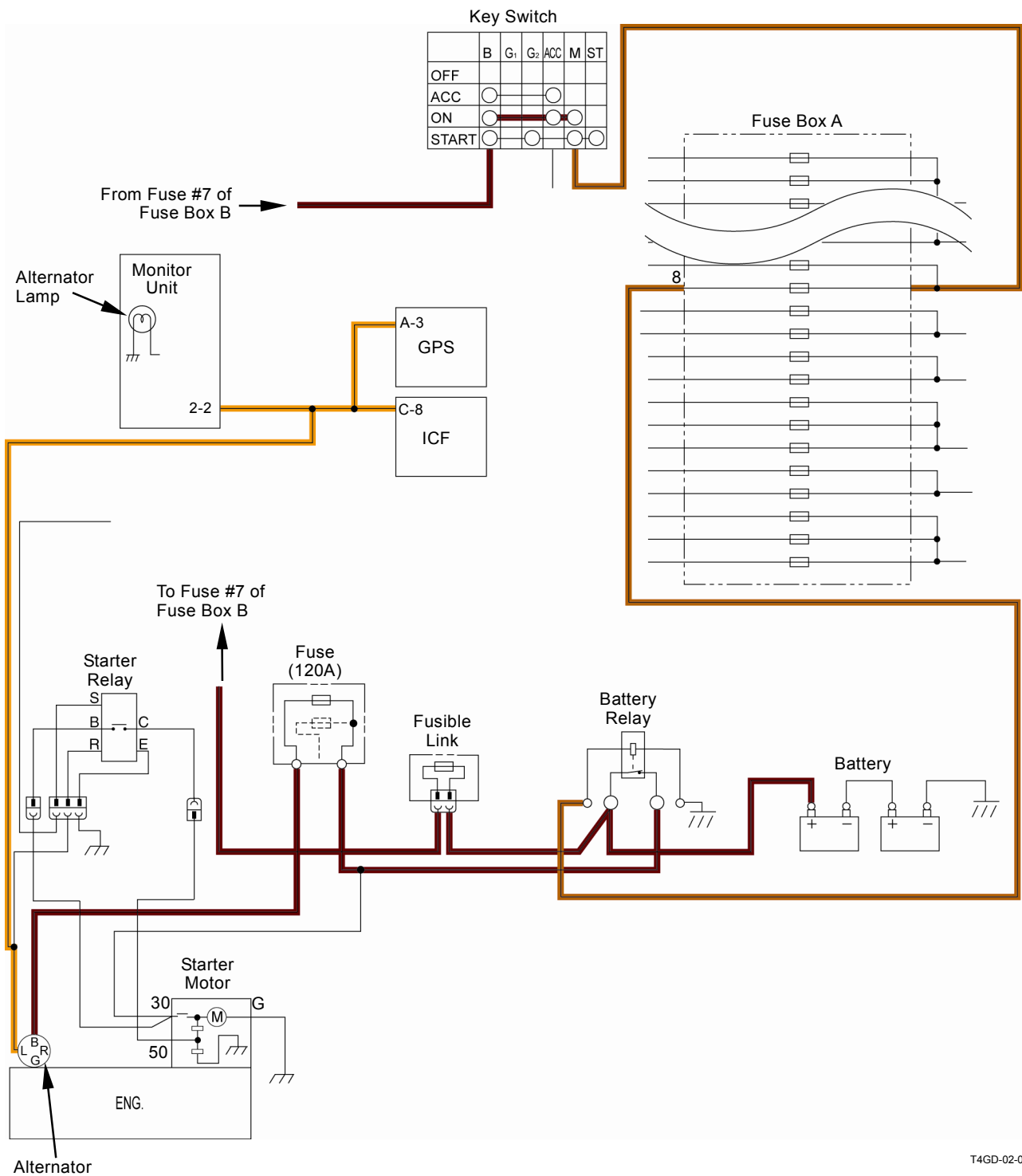
NOTE: The illustration shows the current flow when either of the FNR lever or the FNR switch is in the forward or reverse position.

SYSTEM / Electrical System

CHARGING CIRCUIT (KEY SWITCH: ON)

- When the engine starts and the key switch is released, the key switch returns to the ON position.
- Terminal B is connected inside the key switch to terminals ACC and M with the key switch ON.
- Current from terminal M of the key switch excites the battery relay through fuse #8 of fuse box A.
- When the engine rotates, the alternator begins generating electricity. Current from terminal B of the alternator flows to the battery through the battery relay and charges the battery.
- Current from terminal L of the alternator flows to terminal 2-2 of the monitor unit as a signal that the alternator begins generating and the monitor unit turns off the alternator indicator, and also flows to terminal C-8 of ICF and terminal A-3 of GPS in order to record history data of the engine operation time.

SYSTEM / Electrical System



SYSTEM / Electrical System

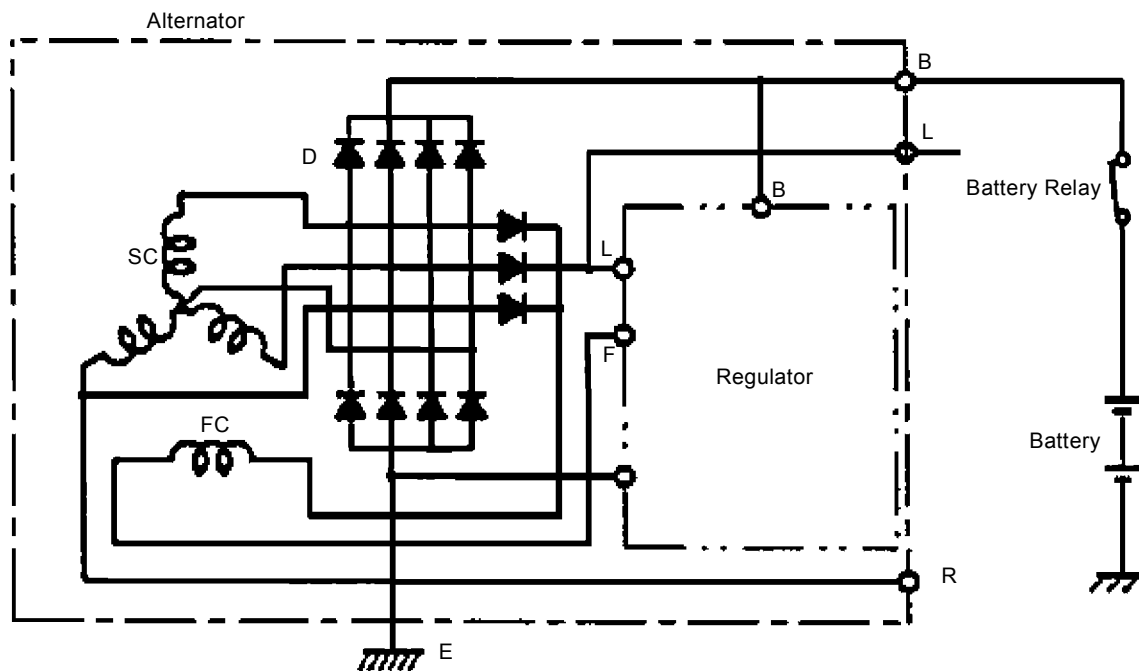
Alternator Operation

- The alternator consists of field coil FC, stator coil SC and diode D.
- At the beginning, no current is flowing through field coil FC. When the rotor starts rotating, alternate current is generated in stator coil SC by the rotor remanent magnetism.
- When current flows through field coil FC, the rotor is further magnetized so that the generating voltage increases. Thereby, current flowing through field coil FC increases. Therefore, generating voltage increases further and the batteries start charging.

Operation of Regulator

- The regulator is an IC chip, which maintains generating voltage at a constant level.
- When generating voltage exceeds the set-voltage, the regulator decreases current through field coil FC. This decreases generating voltage of stator coil SC.
- When generating voltage becomes lower than the set-voltage, the regulator increases current through field coil FC. This increases generating voltage of stator coil SC.
- The above operation is repeated so that the alternator generating voltage is kept constant.

SYSTEM / Electrical System



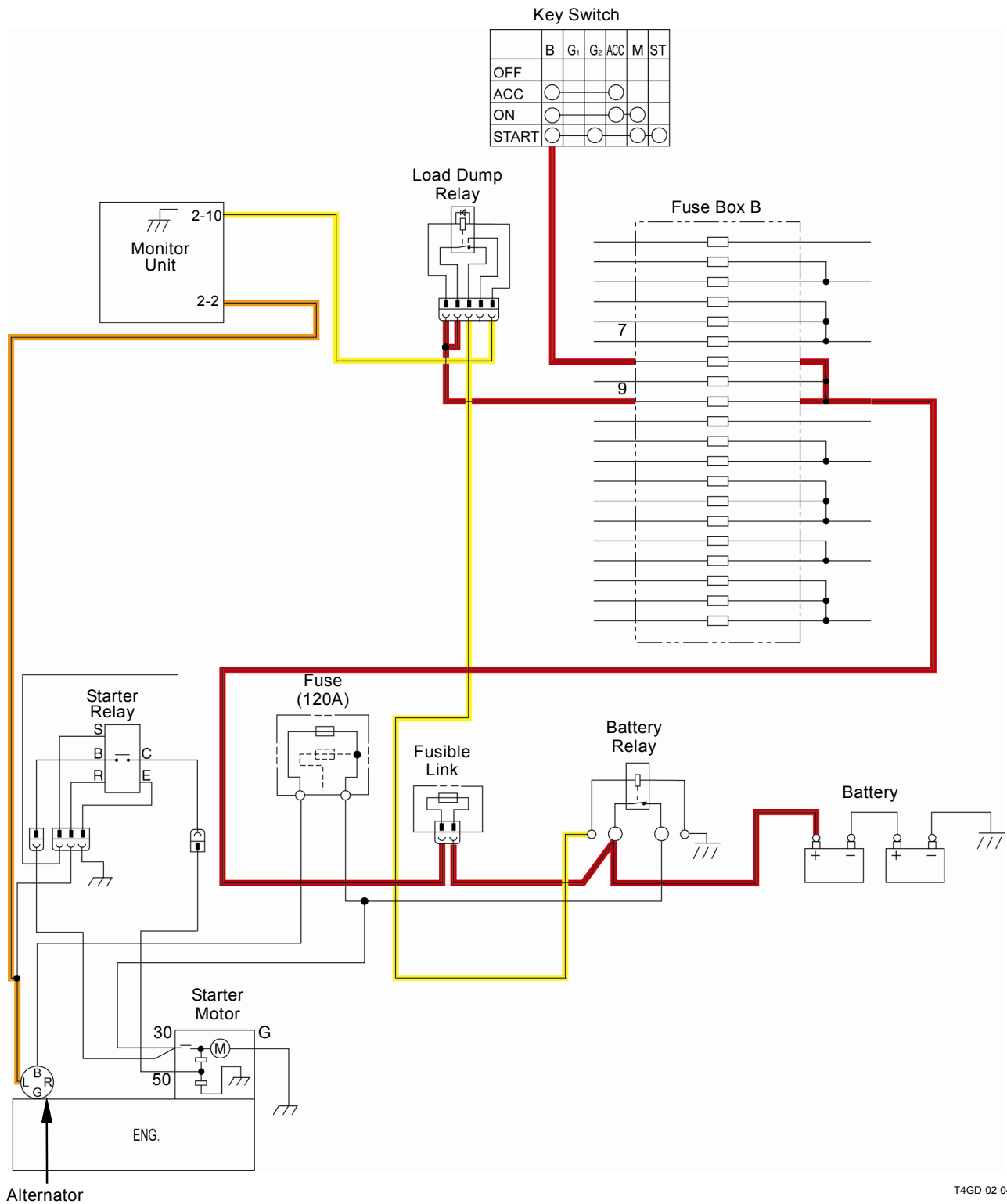
T4GD-02-04-019

SYSTEM / Electrical System

SURGE VOLTAGE PREVENTION CIRCUIT

- When the engine is stopped (key switch: OFF), current from terminal M of the key switch is stopped and the battery relay is turned OFF.
- Although the key switch is turned OFF, the engine does not stop immediately due to inertia force so that the alternator continues to generate electricity.
- As the generating current cannot flow to the battery, surge voltage arises in the circuit and failures of the electronic components, such as the controller, possibly cause. In order to prevent the occurrence of surge voltage, the surge voltage prevention circuit is provided.
- When the alternator is generating electricity, generating current from terminal L of the alternator flows to terminal 2-2 of the monitor unit. The monitor unit connects terminal 2-10 to the ground.
- Current flows through the load dump relay exciting circuit and the load dump relay is turned ON.
- Accordingly, although the key switch is turned OFF while the engine is rotating, battery current continues to excite the battery relay through the load dump relay. In addition, the battery relay is turned OFF in ten seconds after the alternator stops generating of electricity.

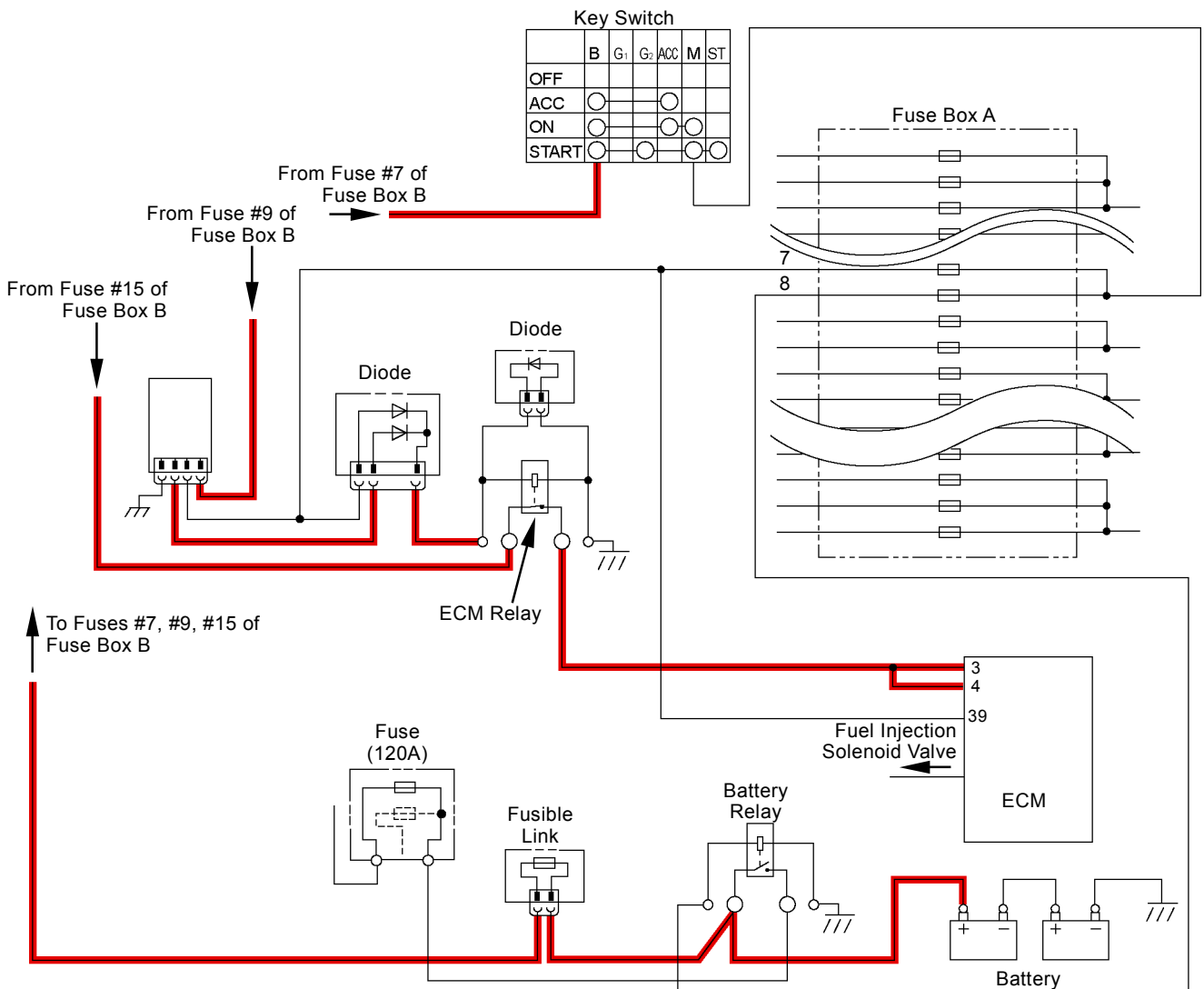
SYSTEM / Electrical System



SYSTEM / Electrical System

ENGINE STOP CIRCUIT

- When the key switch is turned from the ON position to the OFF position, the signal current indicating that the key switch is ON stops flowing from terminal M to terminal #39 of ECM.
- ECM unexcited the fuel injection solenoid valve and the engine is stopped.
- The ECM relay is excited for 30 seconds after the key switch is OFF by the timer function. Thus, current flows to terminals #3 and #4 of ECM, and ECM is kept ON.
- After 30 seconds, the timer stops and ECM is turned OFF.



T4GD-02-04-018

NOTE: The illustration shows the current flow when the timer is working with the key switch OFF.

SYSTEM / Electrical System

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 lights
- Horn Circuit: for sounding horn
- Reverse Light/Buzzer Circuit: for turning on and off reverse lights and reverse buzzer
- Parking Brake Circuit: for applying and releasing parking brake
- Emergency Steering Check Circuit (Optional): for confirming operation of emergency steering pump unit

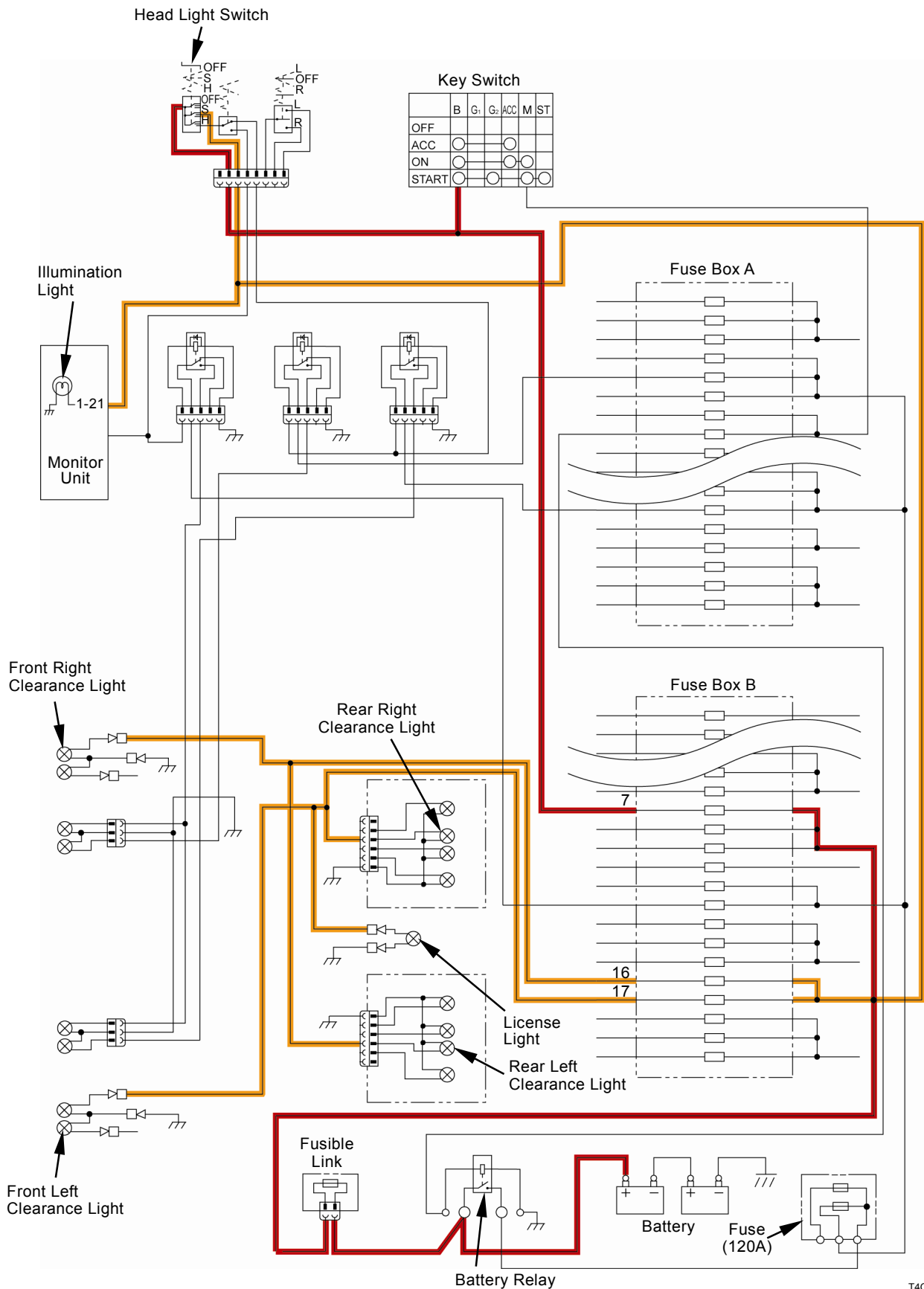
SYSTEM / Electrical System

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), one of power from terminal S of the head light switch enters terminal 1-21 of the monitor unit and the illumination light of the monitor unit lights.
- Another of power from terminal S of the head light switch is divided into to fuse #16 and fuse #17 of fuse box B.
- Power from fuse #16 of fuse box B lights front right and rear left clearance lights.
- Power from terminal #42 of fuse box B lights the license light and the front left and rear right clearance lights.

SYSTEM / Electrical System



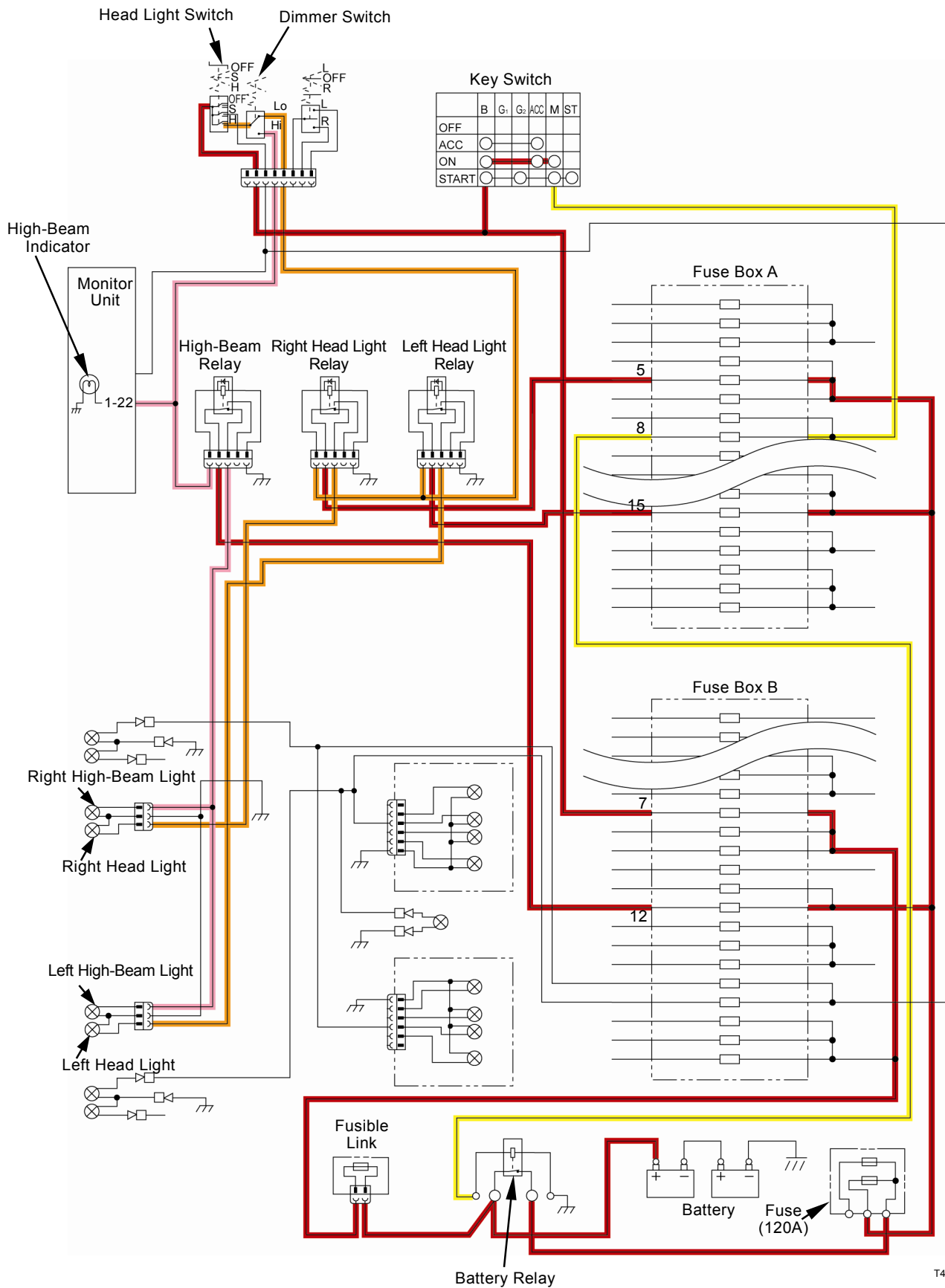
T4GD-02-04-001

SYSTEM / Electrical System

Head Light Lighting Circuit

- When the key switch is turned to the ON position, the power from terminal M of the key switch excites the battery relay through fuse #8 of fuse box A, and the battery power flows to fuse box A and fuse Box B.
- The battery power from fuse #5 of fuse box A enters the right head light relay.
- The battery power from fuse #15 of fuse box A enters the left head light relay.
- The battery power from fuse #12 of fuse box B enters the high beam relay.
- When the head light switch is positioned at $\Rightarrow$ (Head Light), the power from terminal S lights each of the clearance lights (Refer to Clearance Light Lighting Circuit.), and the power from terminal H flows to the dimmer switch.
- At this time, if the dimmer switch is turned to Lo (Low Beam), the power enters the right head light relay and the left head light relay. The battery power enters the head lights and lights them by exciting the respective relays.
- If the dimmer switch is turned to Hi (High Beam), the power excites the high-beam relay, and the battery power enters and lights the high-beam lights. The power from the dimmer switch also enters terminal 1-22 of the monitor unit and lights the high-beam indicators.

SYSTEM / Electrical System

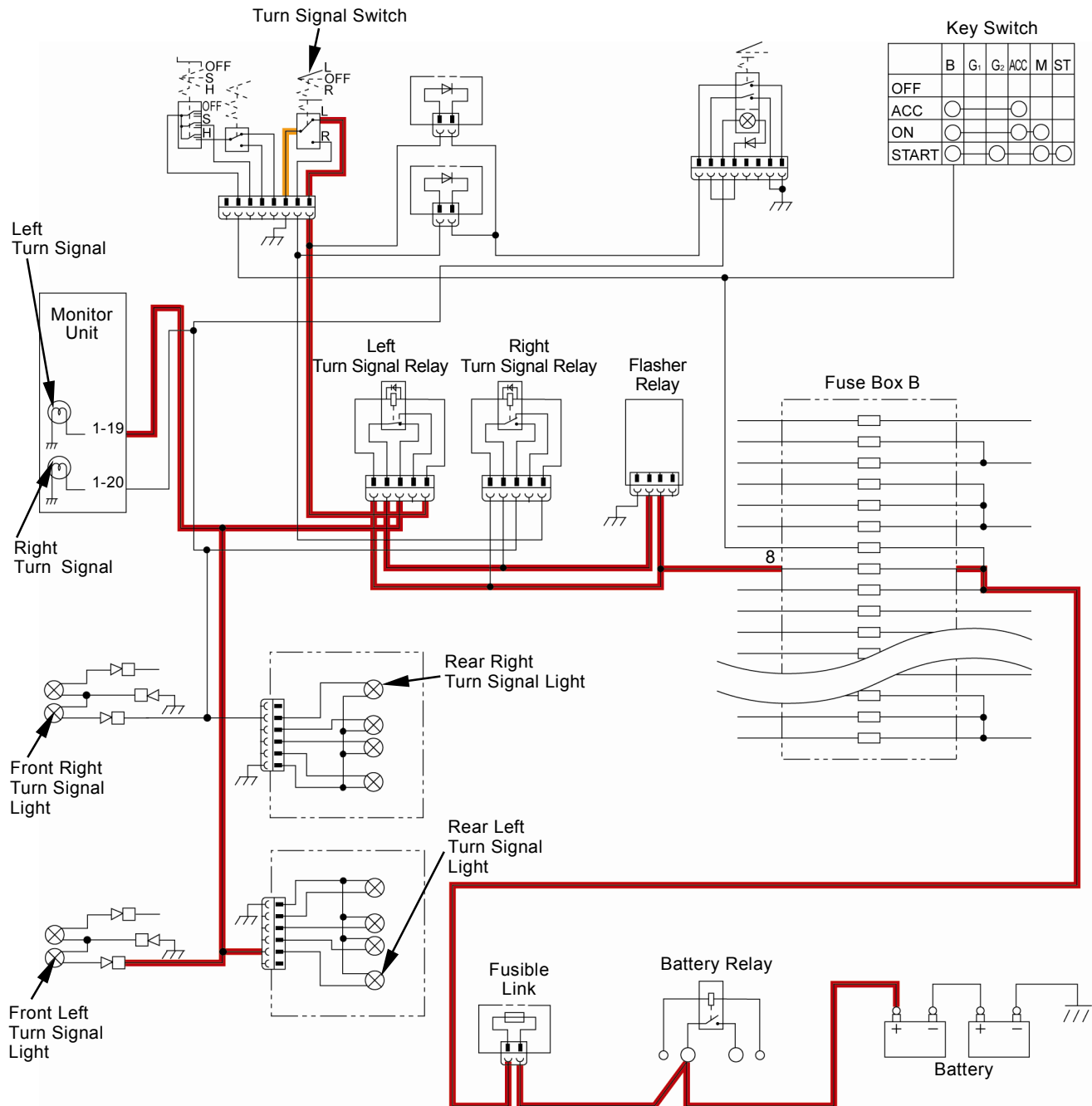


T4GD-02-04-002

SYSTEM / Electrical System

TURN SIGNAL CIRCUIT

- The battery power also flows to the flasher relay from fuse #8 of fuse box B.
- When the turn signal switch is turned to left (L), terminal L of the turn signal switch is grounded and the left turn signal relay is excited.
- The power from the flasher relay enters the front and rear left turn signal lights and terminal 1-19 of the monitor unit through the left turn signal relay.
- Consequently, the front and rear left turn signal lights and the left turn signal indicators blink.

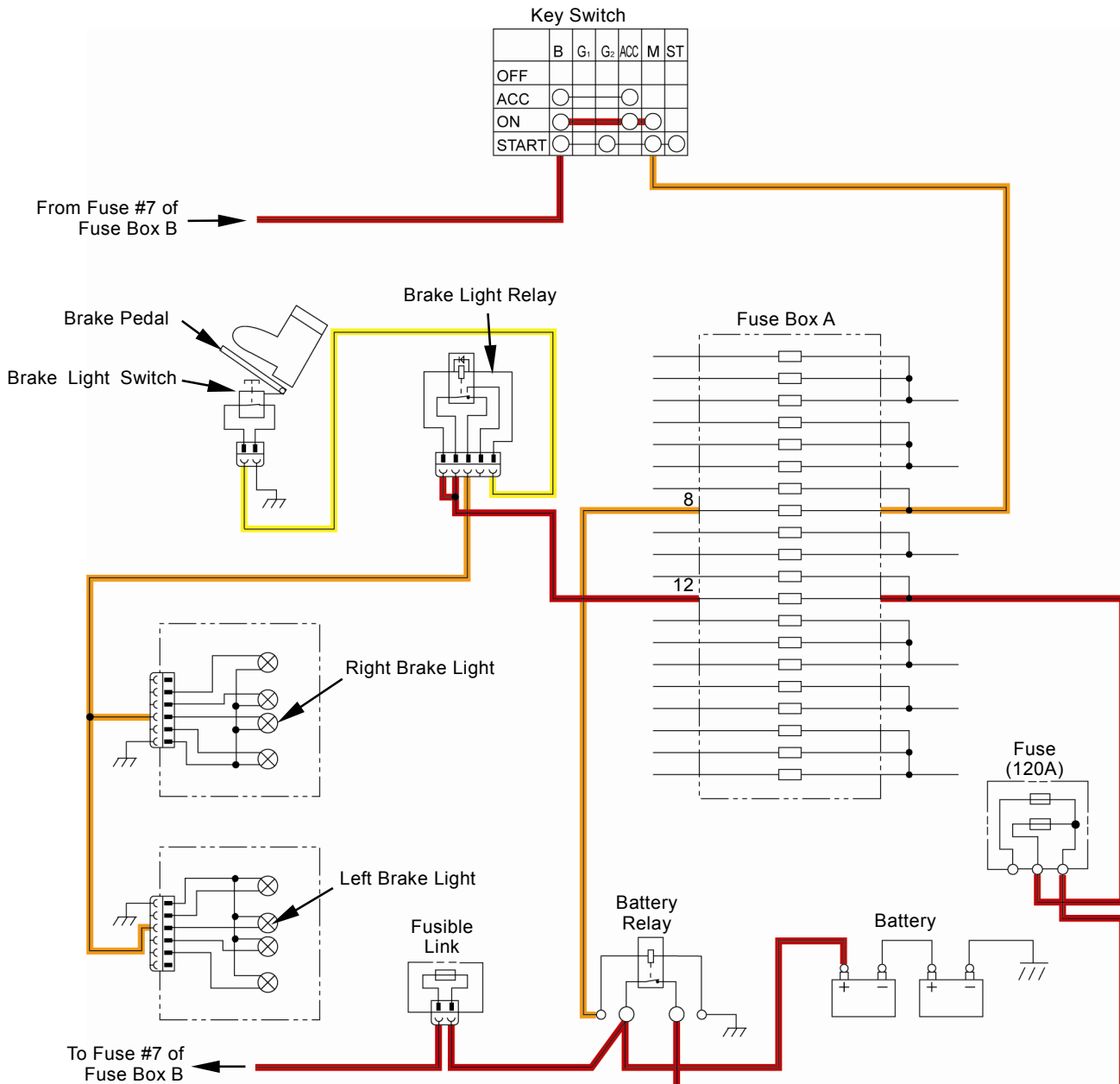


T4GD-02-04-005

SYSTEM / Electrical System

BRAKE LIGHT CIRCUIT

- When the key switch is turned to the ON position, the power from terminal M of the key switch excites the battery relay. The battery power is routed to the brake light relay through fuse #12 of fuse box A.
- When the brake pedal is depressed, the brake light switch is grounded.
- Therefore, the brake light relay is excited and the battery power enters the brake lights and lights them.

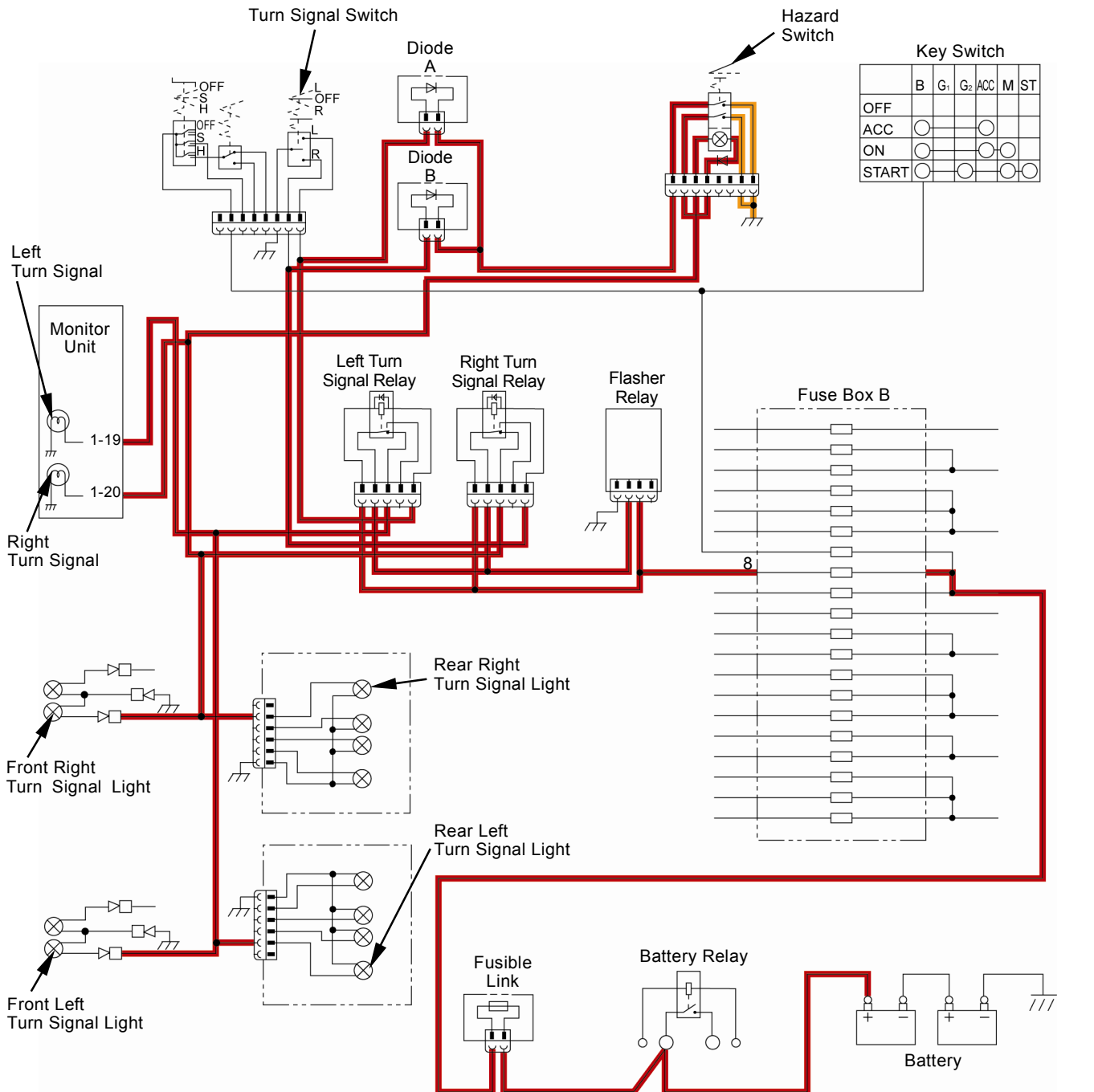


T4GD-02-04-003

SYSTEM / Electrical System

HAZARD LIGHT CIRCUIT

- Although the key switch is OFF, the battery power also flows to the flasher relay from terminal #8 of fuse box B.
- When the hazard switch is turned to the ON position, the hazard switch is grounded and the left and right turn signal relays are excited.
- The power from the flasher relay enters all of the front, rear, left and right turn signal lights and terminals 1-19 and 1-20 of the monitor unit through the left and right turn signal relays.
- Consequently, all of the front, rear, left and right turn signal lights and the left and right turn signal indicators blink.

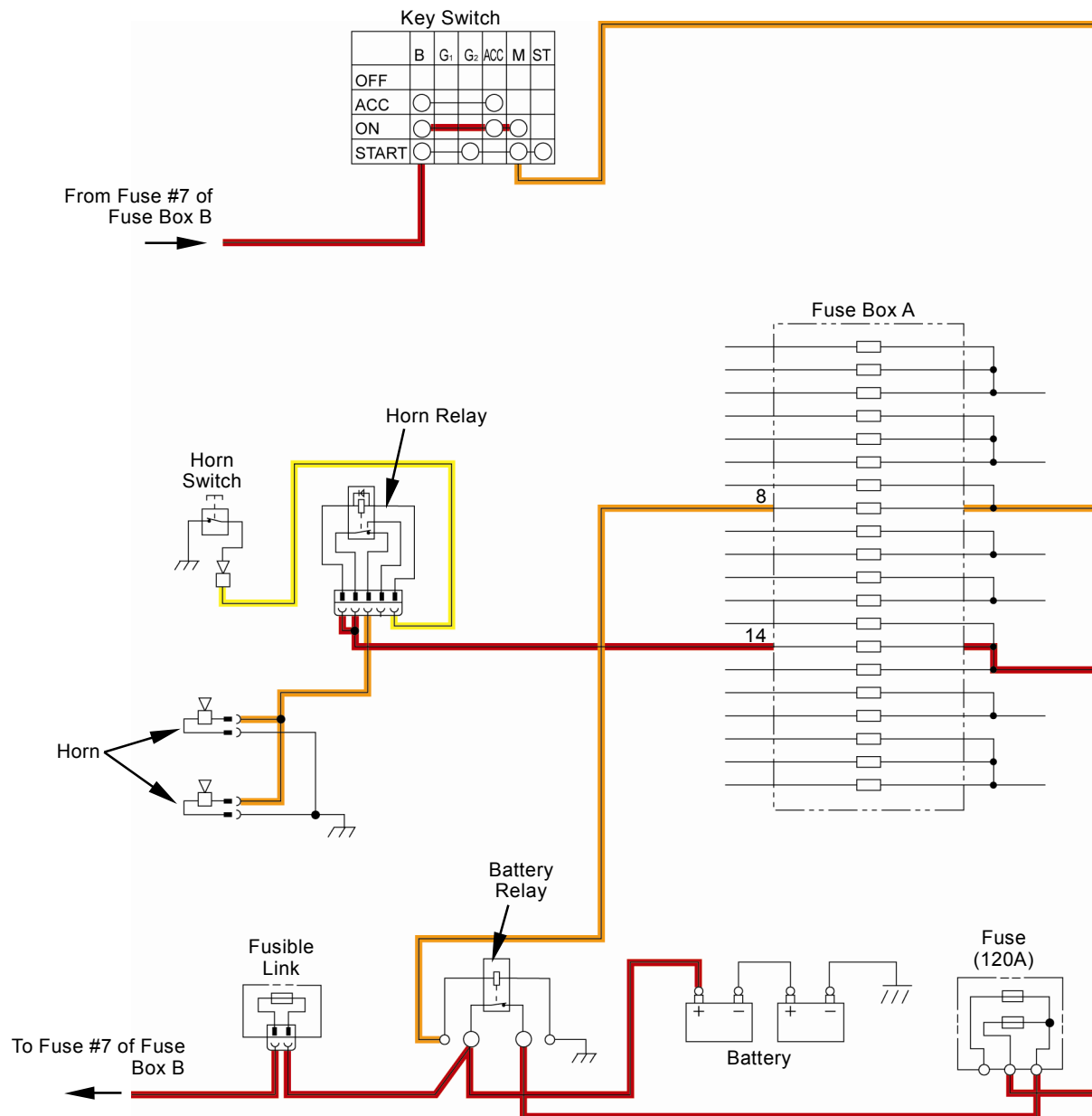


T4GD-02-04-006

SYSTEM / Electrical System

HORN CIRCUIT

- When the key switch is turned to the ON position, the power from terminal M excites the battery relay through fuse #8 of fuse box A. The battery power is routed to the horn relay through fuse #14 of fuse box A.
- When the horn switch is pushed, it is grounded.
- Therefore, the horn relay is excited. The battery power enters the horn and the horn sounds.



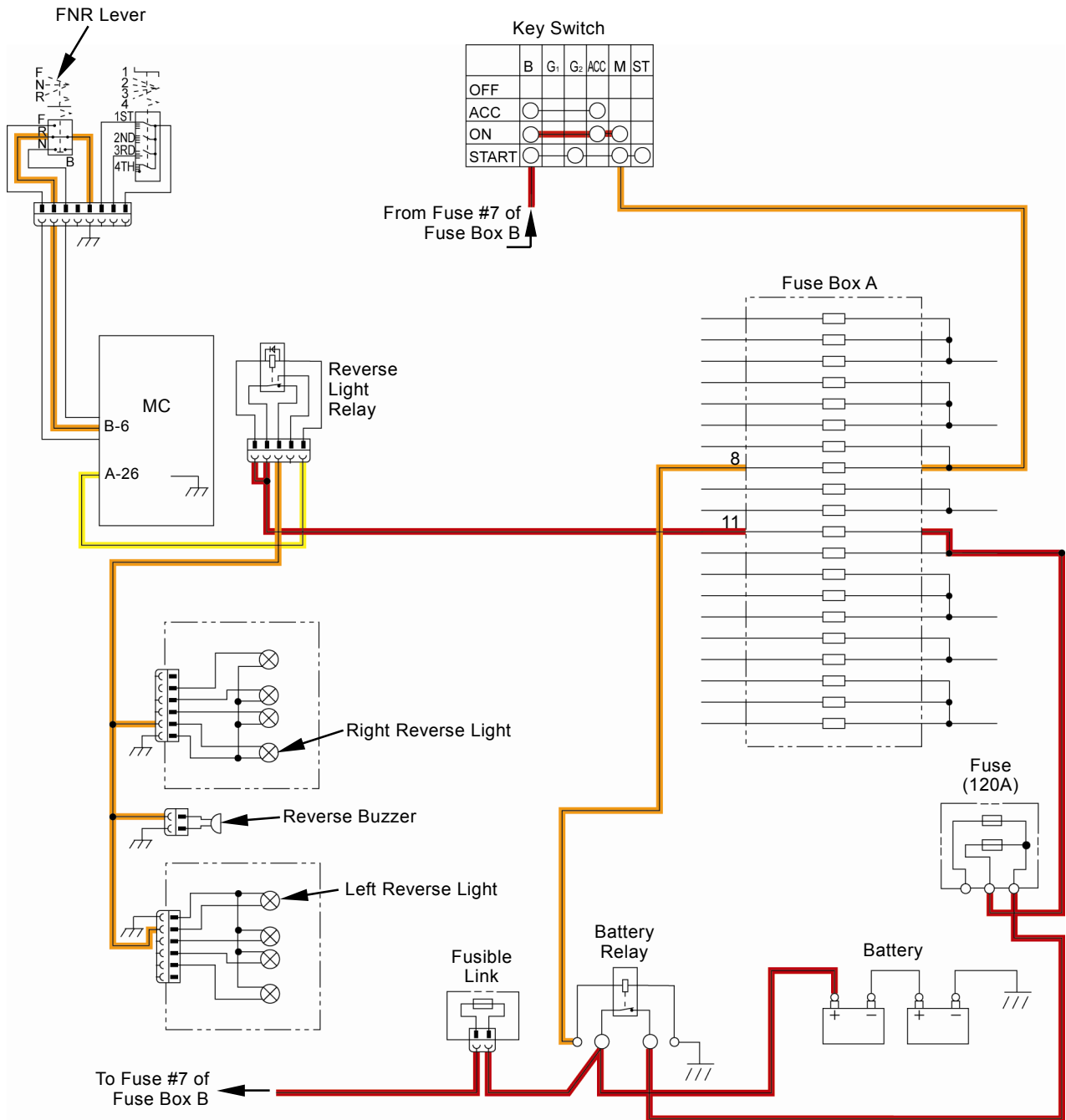
T4GD-02-04-008

SYSTEM / Electrical System

REVERSE LIGHT/BUZZER CIRCUIT

- When the key switch is turned to the ON position, the power from terminal M excites the battery relay through fuse #8 of fuse box A.
- The battery power enters the reverse light relay through fuse #11 of fuse box A.
- When the FNR lever is turned to reverse, terminal R is grounded. The power flows to the FNR lever from terminal B-6 of MC and terminal A-26 of MC is grounded.
- Therefore, the reverse light relay is excited, and the battery power flows to the reverse light and the reverse buzzer.

SYSTEM / Electrical System



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SYSTEM / Electrical System

PARKING BRAKE CIRCUIT

- When the key switch is turned to the ON position, the power from terminal M excites the battery relay through fuse #8 of fuse box A.
- The battery power flows to parking brake relay 1 through fuse #2 of fuse box B.
- The power flows to terminal D of parking brake relay 1 through terminal B of parking brake relay 1. The power flows to terminal B of parking brake relay 2 and terminal B of the parking brake switch.
- The parking brake switch consists of three circuits of ON, NEUTRAL and OFF, and it is kept ON when turned ON, and it is automatically returned to NEUTRAL when turned OFF.
- When the parking brake switch is turned to the OFF position, current flows from terminal E of the parking brake switch to terminal A of parking brake relay 2 and the parking brake solenoid valve.
- At this time, if the engine is not running, parking brake relay 1 is excited as terminal 2-18 of the monitor unit is grounded.
- Therefore, the parking brake cannot be released as the power between parking brake relay 1 and terminal B of the parking brake switch and terminal B of the parking brake relay is blocked.
- If the engine is running, parking brake relay 2 is excited as current from terminal L of the alternator enters terminal 2-2 of the monitor unit and releases grounded terminal 2-18 of the monitor unit.
- Consequently, a circuit in which electricity flows from terminal C of parking brake relay 2 to terminal A of parking brake relay 2 and the parking brake solenoid valve (self-exciting circuit) is formed. Therefore, the parking brake solenoid valve is activated and the parking brake is released.
- 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, current keeps flowing to the parking brake solenoid valve, and keeps the released condition of the parking brake until the key switch is turned to the OFF position or the parking brake switch is turned to the ON position.

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

- When the parking brake switch is turned to the ON position, terminal A of the parking brake switch is grounded, and parking brake relay 1 is excited.
- The power to terminal B of parking brake relay 2 and terminal B of the parking brake switch through terminal D of parking brake relay 1 is blocked.
- Consequently, the parking brake is applied as parking brake relay 2 and the parking brake solenoid valve are unexcited.

SYSTEM / Electrical System

EMERGENCY STEERING CHECK CIRCUIT (OPTIONAL)

(Manual Check Circuit)

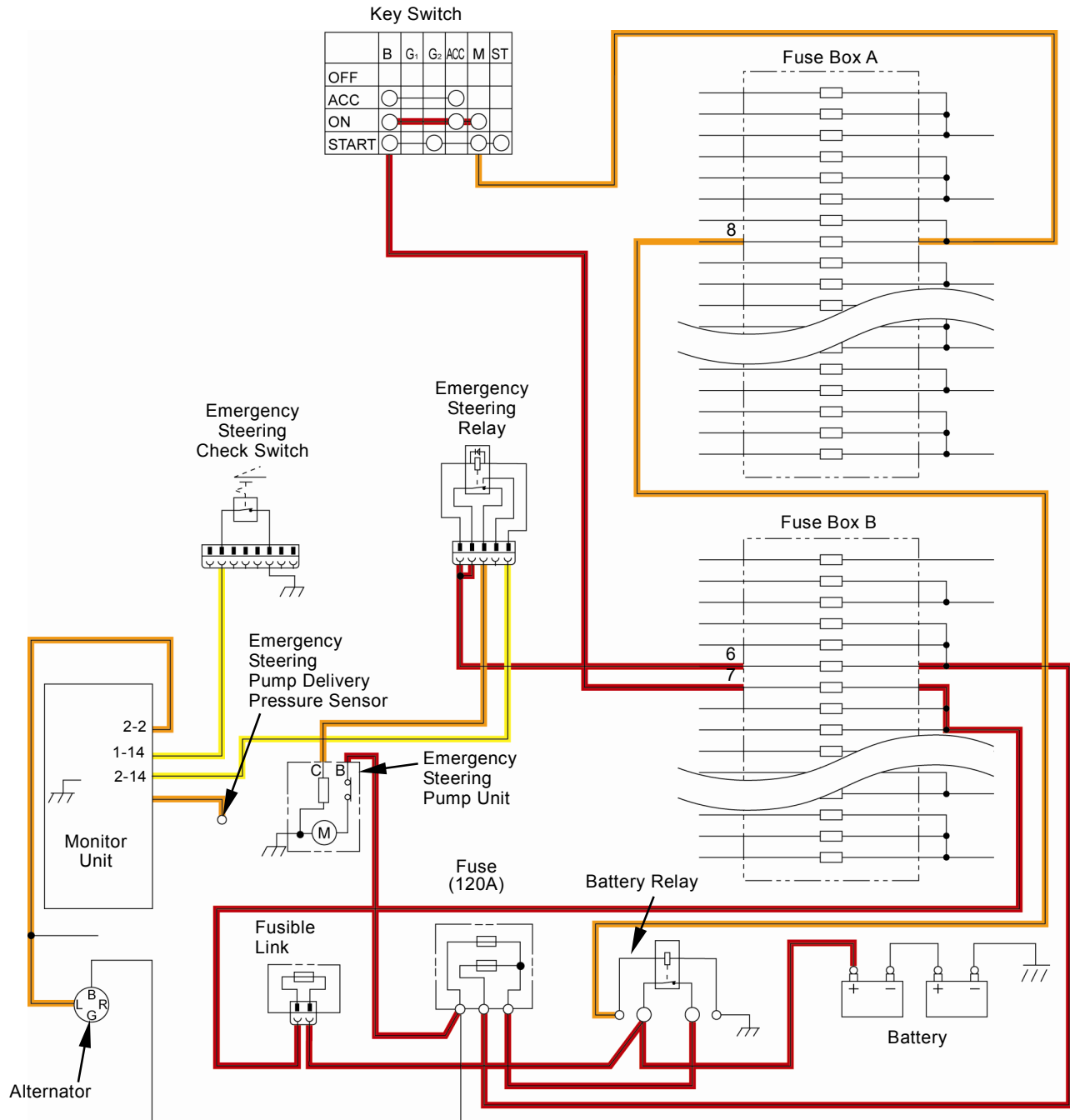
- When the key switch is turned to the ON position, current from terminal M excites the battery relay. The battery power enters the emergency steering relay through fuse #6 of fuse box B and also enters terminal B of the emergency steering pump unit.
- When the emergency steering check switch is turned to the ON position, current flows to terminal 1-14 of the monitor unit.
- At the same time, as the monitor unit grounds terminal 2-11, the emergency steering relay is excited.
- The power enters terminal C of the emergency steering pump unit through the emergency steering relay. The power excites terminal B and the emergency steering pump unit is started.

IMPORTANT: The emergency steering pump unit is not designed in order 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 generating signal from terminal L of the alternator enters the monitor unit and increases to the specified voltage, terminal 2-11 of the monitor unit is grounded, and the emergency steering relay is excited.
- The power enters terminal C of the emergency steering pump unit through the emergency steering relay. The power excites terminal B and the emergency steering pump unit is started.
- The emergency steering pump unit works for several seconds, and then the ground circuit of terminal 2-11 of the monitor unit is automatically released. Therefore, the emergency steering pump unit stops.
- If hydraulic pressure higher than the specified value is 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.
- If hydraulic pressure higher than the specified value is not delivered, the emergency steering pump delivery pressure switch is kept ON. The emergency steering operation warning lamp on the monitor unit blinks in order to notify that the emergency steering pump unit is abnormal.

SYSTEM / Electric System

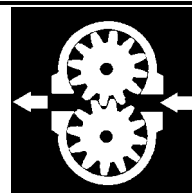


T4GD-02-04-010

SYSTEM / Electric System

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SECTION 3 COMPONENT OPERATION



CONTENTS

Group 1 Pump Device

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Priority Valve	T3-1-18
Pilot Pump	T3-1-19
Pump Delivery Pressure Sensor	T3-1-19
Steering Main Relief Valve	T3-1-20

Group 2 Control Valve

Outline	T3-2-1
Hydraulic Circuit	T3-2-8
Main Relief Valve	T3-2-12
Overload Relief Valve	T3-2-14
Restriction Valve	T3-2-19
Negative Control Valve	T3-2-20
Flow Rate Control Valve	T3-2-22

Group 3 Hydraulic Fan Motor

Outline	T3-3-1
Operation	T3-3-4
Flow Rate Control Valve	T3-3-6
Reverse Rotation Control Valve	T3-3-8
Fun Pump	T3-3-10

Group 4 Steering Pilot Valve

Outline	T3-4-1
Construction	T3-4-2
Operation	T3-4-3

Group 5 Steering Valve

Outline	T3-5-1
Operation	T3-5-4
Steering Overload Relief Valve	T3-5-8

Group 6 Pilot Valve

Outline (Standard Lever Type Pilot Valve for Front Attachment)	T3-6-1
Operation	T3-6-2
Electromagnetic Detent	T3-6-6
Outline (Joystick Type Pilot Valve for Front Attachment)	T3-6-7
Operation	T3-6-8
Electromagnetic Detent	T3-6-12
Outline (Two-Derectional Lever Type Pilot Valve for Additional Circuit) (Optional)	T3-6-13
Operation	T3-6-14
Outline (Joystick Type Pilot Valve for Additional Circuit) (Optional)	T3-6-17
Operation	T3-6-18

Group 7 Charging Block

Outline	T3-7-1
Priority Valve	T3-7-6
Pilot Relief Valve	T3-7-7
Pump Torque Control Proportional Solenoid Valve	T3-7-8
Service Brake Accumulator / Pilot Accumulator	T3-7-9
Parking Brake Solenoid Valve	T3-7-10
Service Brake Pressure Sensor	T3-7-12
Parking Brake Pressure Sensor	T3-7-12

Group 8 Ride Control Valve

Outline	T3-8-1
Operation	T3-8-4
Charge-Cut Spool	T3-8-6
Overload Relief Valve	T3-8-8
Ride Control Accumulator	T3-8-10
Drain Plug	T3-8-11

Group 9 Drive Unit

Outline	T3-9-1
Torque Converter	T3-9-2
Transmission	T3-9-4
Transmission Regulator Valve	T3-9-26
Transmission Control Valve	T3-9-28
Manual Spool (Emergency Travel Spool)	T3-9-36
Proportional Solenoid Valve	T3-9-38
Parking Brake	T3-9-40

Group 10 Axle

Outline	T3-10-1
Differential	T3-10-2
Torque Proportioning Differential (TPD) ..	T3-10-6
Limited Slip Differential (LSD) (Optional)	T3-10-8
Service Brake	T3-10-10
Final Drive / Axle Shaft	T3-10-12

Group 11 Brake Valve

Outline	T3-11-1
Operation	T3-11-4

Group 12 Others

Pilot Shut-Off Valve	T3-12-1
Propeller Shaft	T3-12-2
Emergency Steering Check Block	T3-12-3
Emergency Steering Pump (Optional)	T3-12-4

COMPONENT OPERATION / Pump Device

OUTLINE

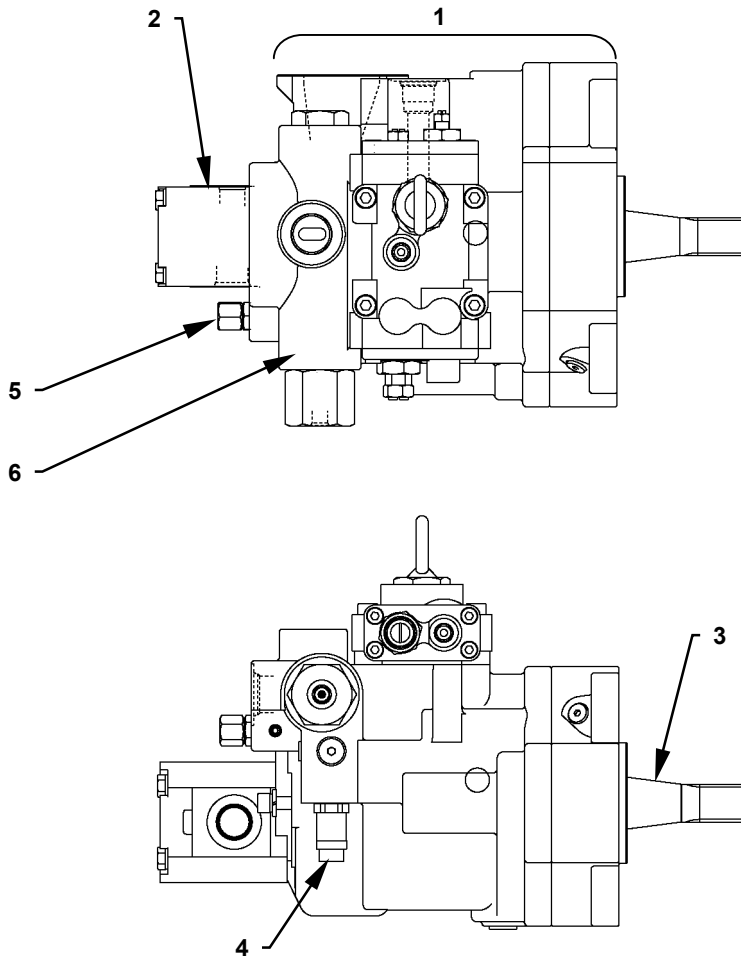
Pump device consists of main pump (1) and pilot pump (2). Main pump (1) has built-in steering main relief valve (5) and priority valve (6).

Driving force of the engine is transmitted to 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 sensor (4) is provided in order to control the main pump.



T4GB-03-01-001

1 - Main Pump

2 - Pilot Pump

3 - Shaft

4 - Pump Delivery Pressure
Sensor

5 - Steering Main Relief
Valve

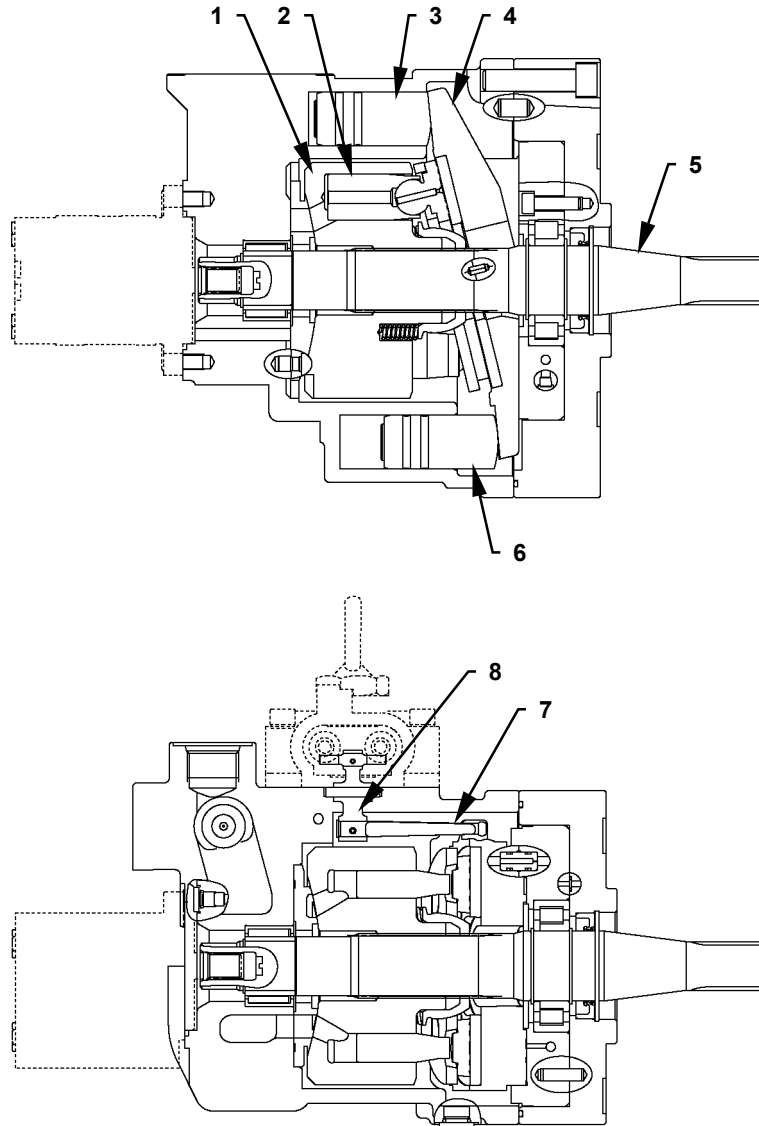
6 - Priority Valve

COMPONENT OPERATION / Pump Device

MAIN PUMP

The main pump supplies pressure oil to operate the cylinders and other hydraulic components. The pump is provided with a regulator to control the delivery flow. Shaft (5) is connected to cylinder block (1) in the pump. Shaft (5) and cylinder block (1) rotate together.

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



T4GB-03-01-002

1 - Cylinder Block
2 - Plunger

3 - Servo Piston 1 (2 Used)
4 - Swash Plate

5 - Shaft
6 - Servo Piston 2

7 - Feedback Lever
8 - Link

COMPONENT OPERATION / Pump Device

Increase and Decrease Operations of Delivery Flow

The displacement angle of swash plate (4) is changed by the movement of servo piston 1 (3) and servo piston 2 (6).

Movement of the servo piston is controlled by the regulator. The feedback of the swash plate movement is given to the regulator by feedback lever (7) and link (8).

 **NOTE:** Refer to the following pages as 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 (3) is connected to the hydraulic oil tank, swash plate (4) tilts clockwise around A.

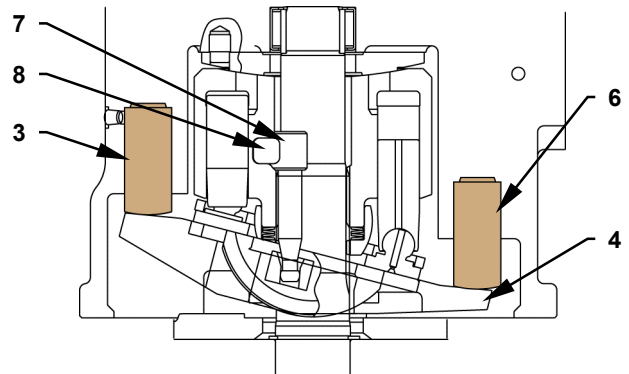
Conversely, as there are two servo pistons 1 (3), when pilot pressure is applied to both of servo piston 1 (3) and servo piston 2 (6), swash plate (4) tilts counterclockwise around A.

- Feedback Operation

End of feedback lever (7) is inserted into the projection on the side of swash plate (4). When swash plate (4) tilts, the projection also moves, and feedback lever (7) moves together.

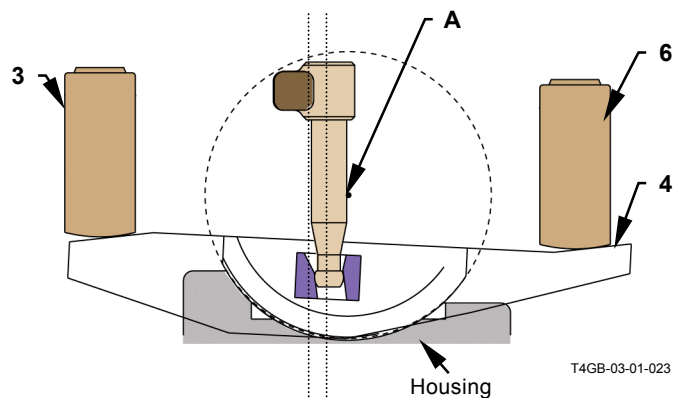
For example, if swash plate (4) tilts to the maximum displacement angle position from the minimum displacement angle position, the center of feedback lever (7) moves from B to C.

This movement of feedback lever (7) moves link (8), and feedback is given to the regulator.



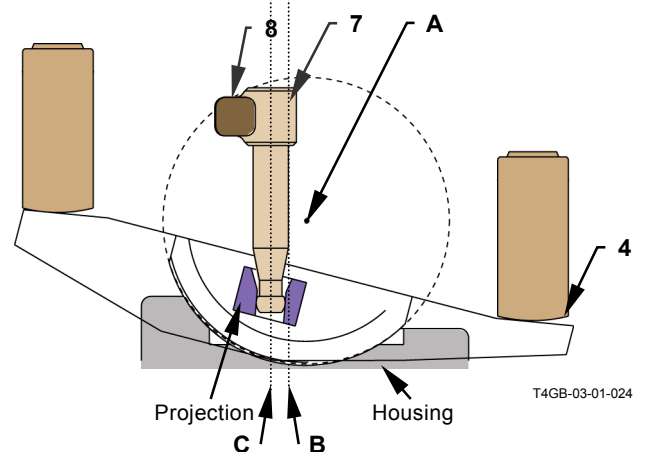
T4GB-03-01-022

Minimum Displacement Angle:



T4GB-03-01-023

Maximum Displacement Angle:



T4GB-03-01-024

COMPONENT OPERATION / Pump Device

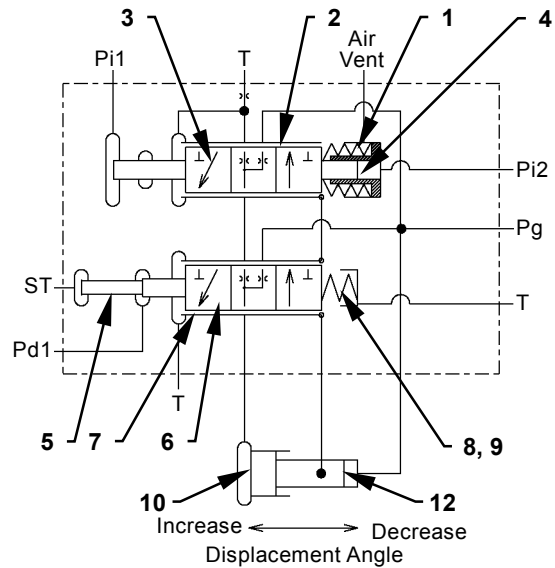
REGULATOR

The regulator controls flow of the main pump by receiving various kinds of signal pressure.

The regulator includes 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).

The regulator opens and closes the circuit to servo piston 1 (10) by receiving various kinds of signal pressure, and controls delivery flow of the pump by changing the displacement angle of swash plate (11).

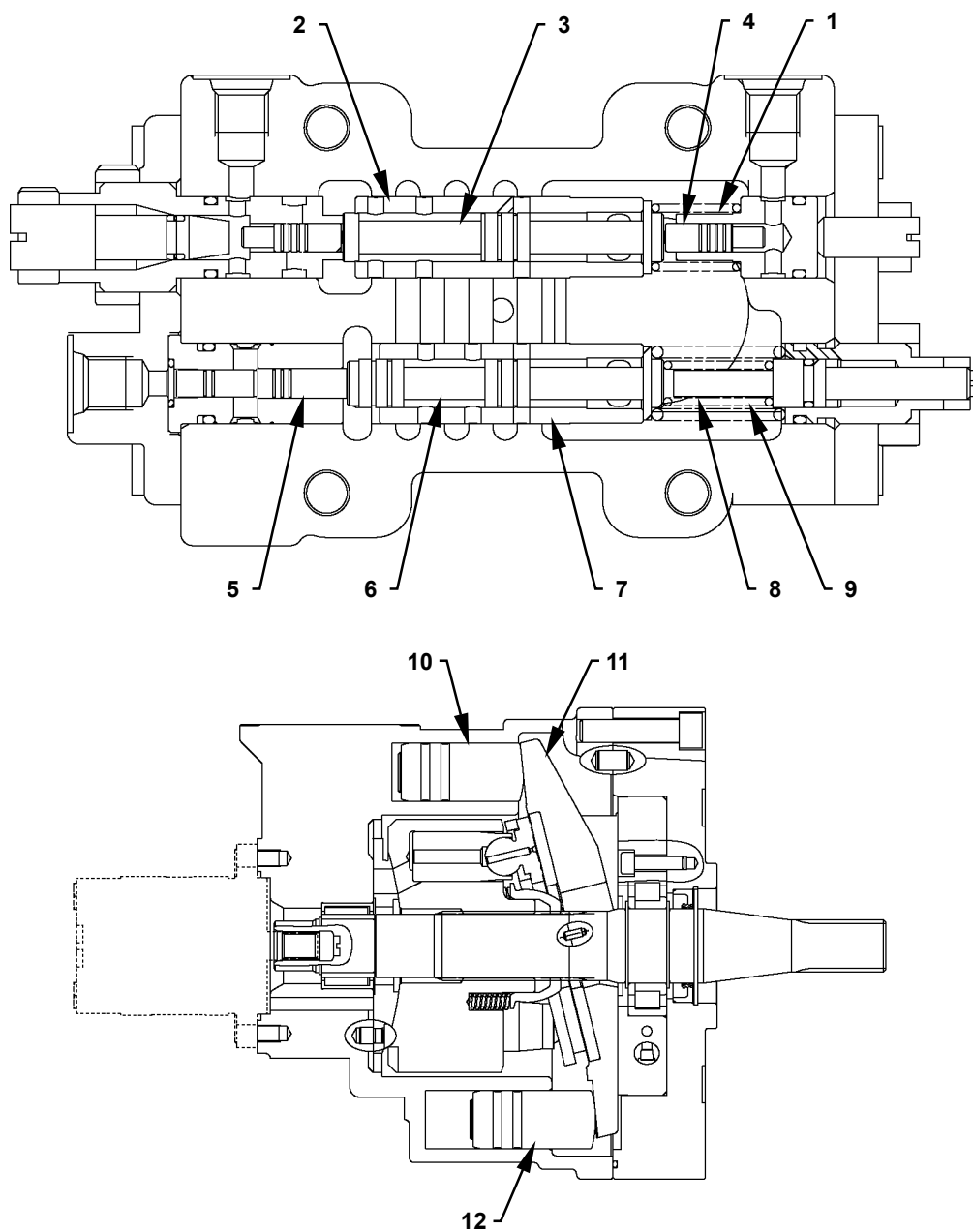
 **NOTE:** Primary pilot pressure (Pg) is always applied to servo piston 2 (12).



T4GB-03-01-006

Pd1 - Own Pump Pressure	Pi1 - Pump Control Pressure 1
ST - Pump Torque Control Pressure	Pi2 - Pump Control Pressure 2
T - Returning to Hydraulic Oil Tank	Pg - Primary Pilot Pressure (From Pilot Pump)

COMPONENT OPERATION / Pump Device



T4GB-03-01-007

1 - Spring
2 - Sleeve 1
3 - Spool 1

4 - Piston
5 - Load Piston
6 - Spool 2

7 - Sleeve 2
8 - Inner Spring
9 - Outer Spring

10 - Servo Piston 1 (2 Used)
11 - Swash Plate
12 - Servo Piston 2

COMPONENT OPERATION / Pump Device

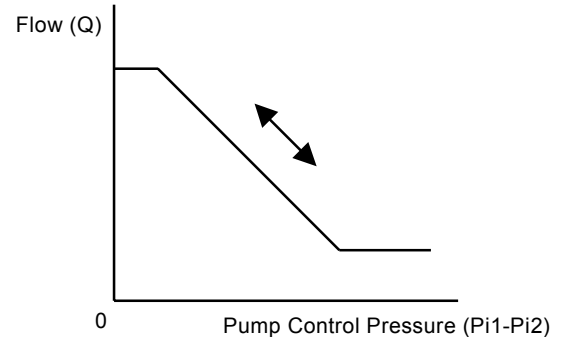
Regulator Control Function

Regulator has the following three control functions.

- Control by Pump Control Pressure

The pump flow control valve inside the control valve controls pump control pressure (P_{i1} - P_{i2}) in response to the operating stroke of the control lever. The regulator increases or decreases the pump delivery flow in response to the pressure by receiving this pump control pressure (P_{i1} - P_{i2}).

When the control lever is operated, pump control pressure (P_{i1} - P_{i2}) lowers, and the regulator increases the pump delivery flow. If the control lever is returned to neutral, pump control pressure (P_{i1} - P_{i2}) rises, and the regulator decreases the pump delivery flow.



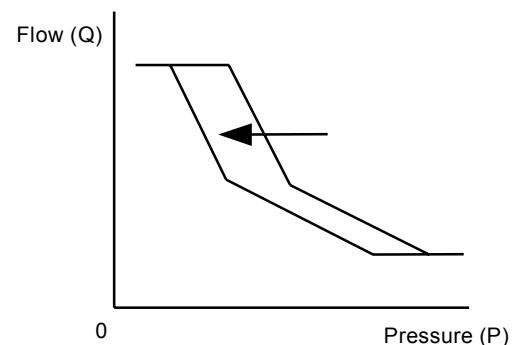
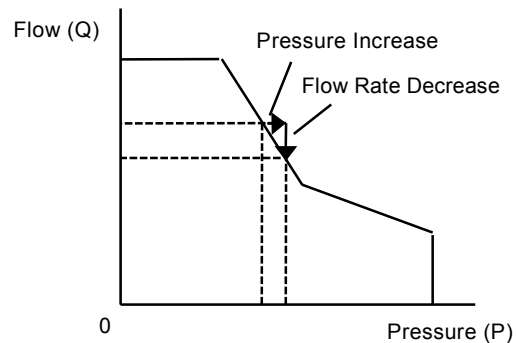
- Control by Own Pump Pressure

Own pump pressure P_{d1} enters the regulator. In case this pump pressure exceeds the set P - Q line, the pump delivery flow is decreased and the pressure returns 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 the signals to the pump torque control solenoid valve in order to obtain required pump torque.

The pump torque control solenoid valve transmits pump torque control pressure ST corresponding to this signal to the regulator. The regulator decreases the pump delivery flow by receiving the pilot pressure.



COMPONENT OPERATION / Pump Device

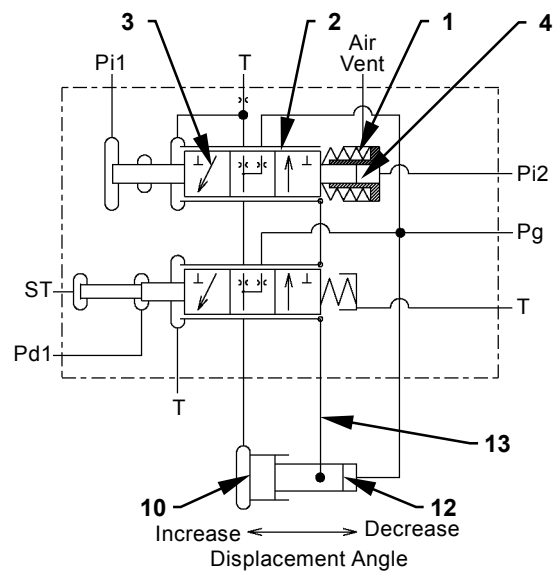
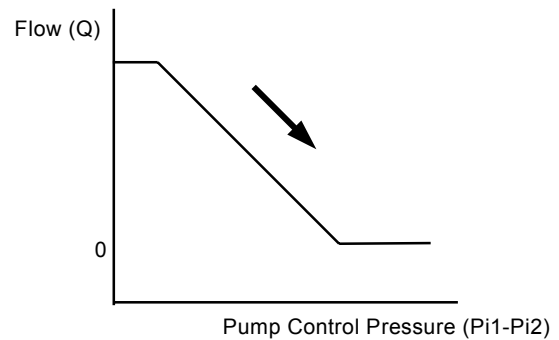
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COMPONENT OPERATION / Pump Device

Control by Pump Control Pressure

Decreasing Flow

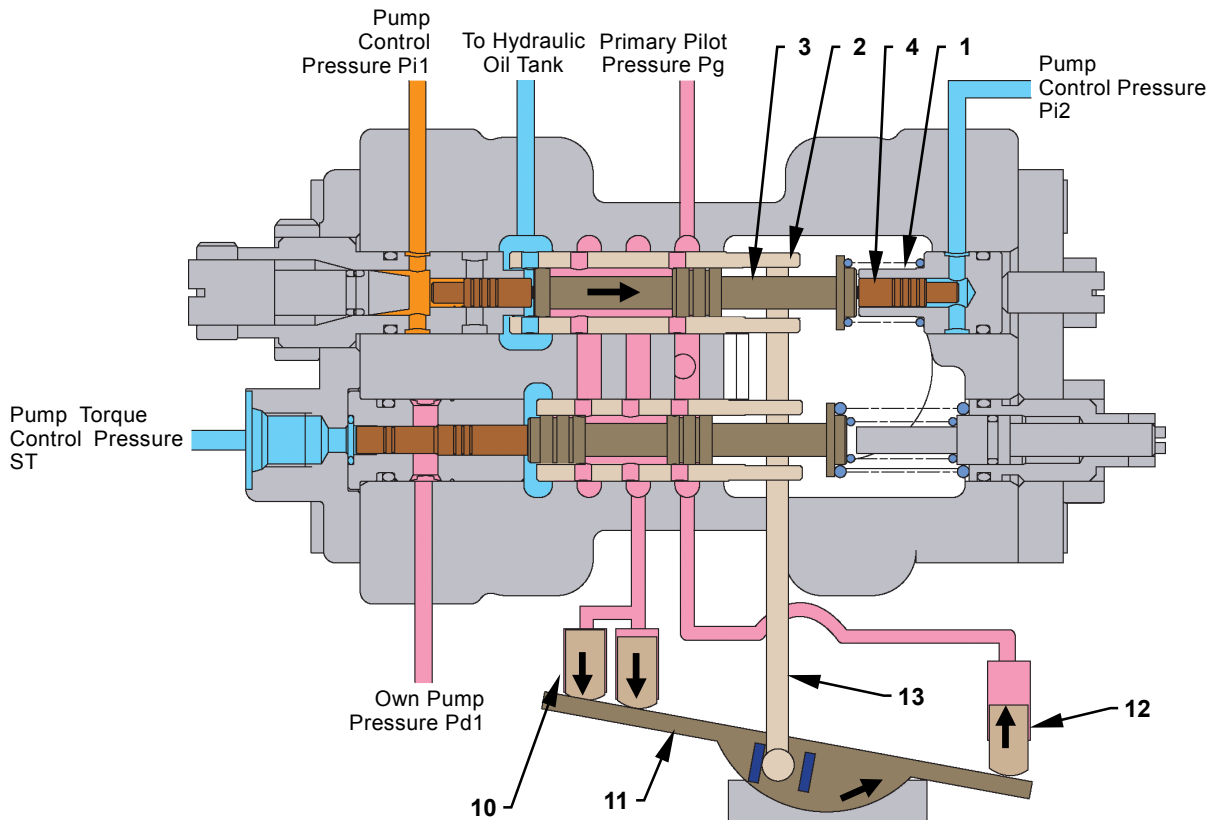
1. When the control lever stroke is reduced, pressure difference (difference between pressure P_{i1} and P_{i2}) arising at the flow control valve in the control valve is larger.
2. Pump control pressure P_{i1} pushes spool 1 (3) and spool 1 (3) moves toward the arrow.
3. Therefore, primary pilot pressure P_g is led to servo piston 1 (10).
4. As there are two servo pistons 1 (10), swash plate (11) tilts toward the flow decreasing direction.
5. Movement of swash plate (11) is transmitted to sleeve 1 (2) through feedback lever link (13). Sleeve 1 (2) moves toward the movement of spool 1 (3).
6. Pilot primary pressure P_g to servo piston 1 (10) is blocked when sleeve 1 (2) has moved the same distance as spool 1 (3). Therefore, servo piston 1 (10) stops and the flow decrease is completed.



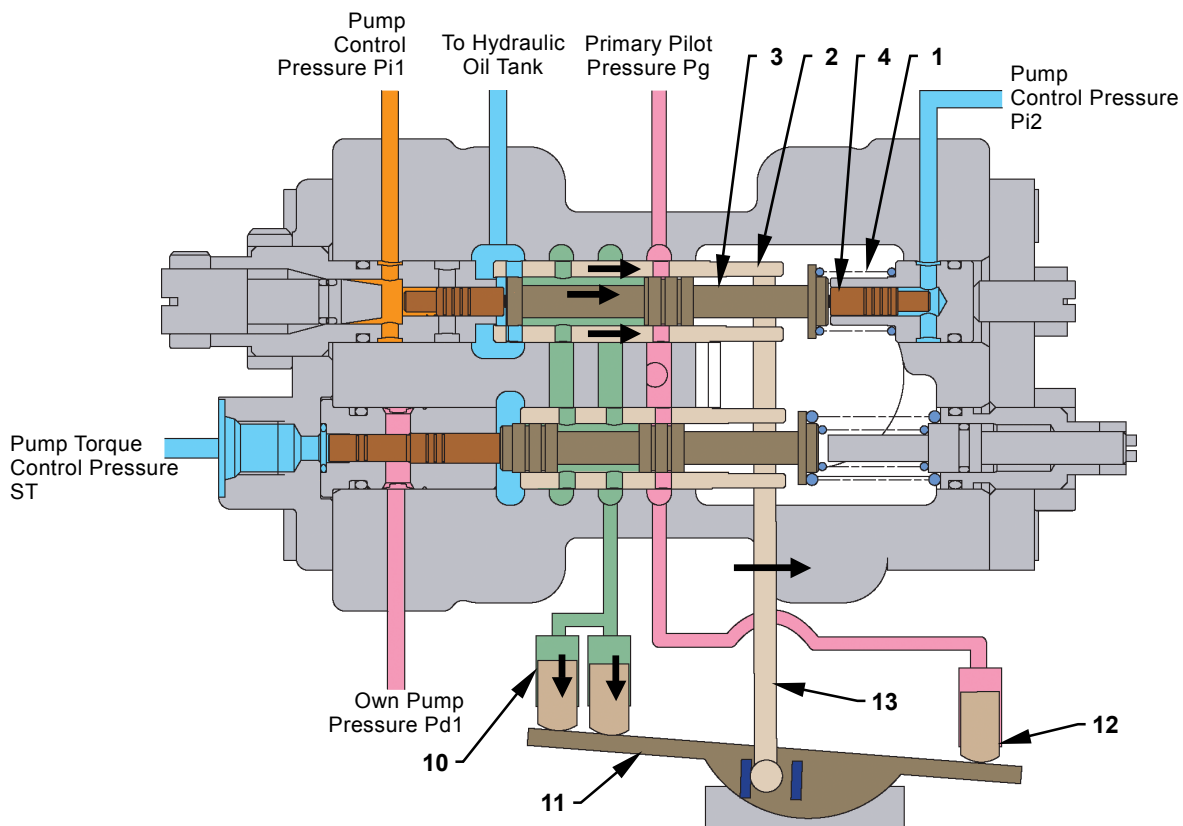
T4GB-03-01-006

- | | |
|-------------------------------------|---|
| 1 - Spring | 10 - Servo Piston 1 |
| 2 - Sleeve 1 | 11 - Swash Plate |
| 3 - Spool 1 | 12 - Servo Piston 2 |
| 4 - Piston | 13 - Feedback Lever Link |
| Pd1 - Own Pump Pressure | Pi1 - Pump Control Pressure 1 |
| ST - Torque Control Pressure | Pi2 - Pump Control Pressure 2 |
| T - Returning to Hydraulic Oil Tank | Pg - Primary Pilot Pressure (From Pilot Pump) |

COMPONENT OPERATION / Pump Device



T4GB-03-01-008

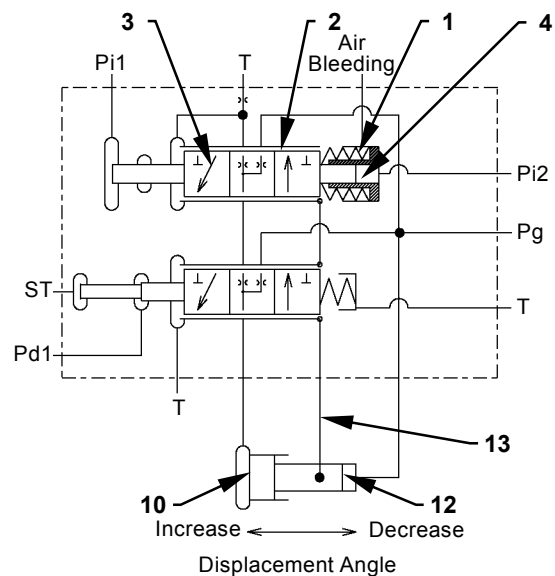
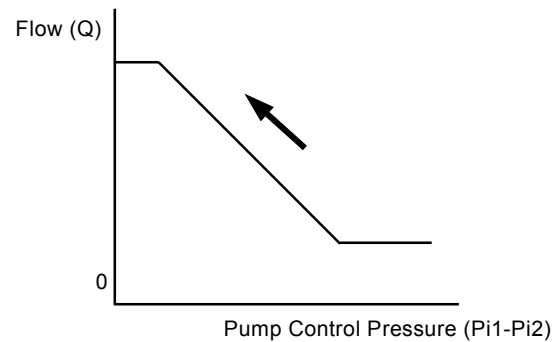


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COMPONENT OPERATION / Pump Device

Increasing Flow

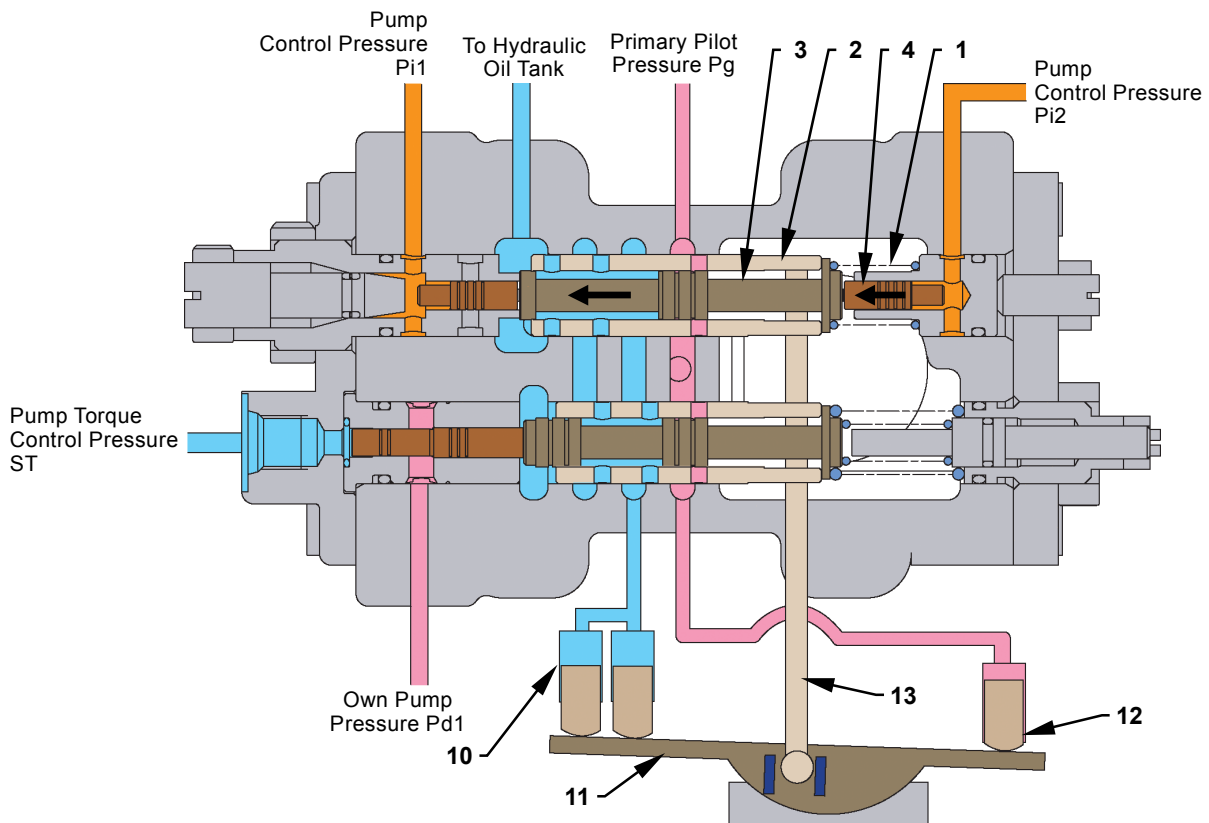
1. When the control lever stroke is larger, pressure difference (difference between pressure P_{i1} and P_{i2}) arising at the flow control valve in the control valve is reduced.
2. Force due to spring (1) and pump control pressure P_{i2} pushes spool 1 (3) and spool 1 (3) moves toward the arrow.
3. Therefore, the circuit of servo piston 1 (10) is led to the hydraulic oil tank.
4. As pilot primary pressure P_g is always applied to servo piston 2 (12), swash plate (11) tilts toward the flow increasing direction.
5. Movement of swash plate (11) is transmitted to sleeve 1 (2) through the feedback 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) servo piston 1 (10) is not connected to the hydraulic oil tank. Therefore, servo piston 1 (10) stops and the flow increase is completed.



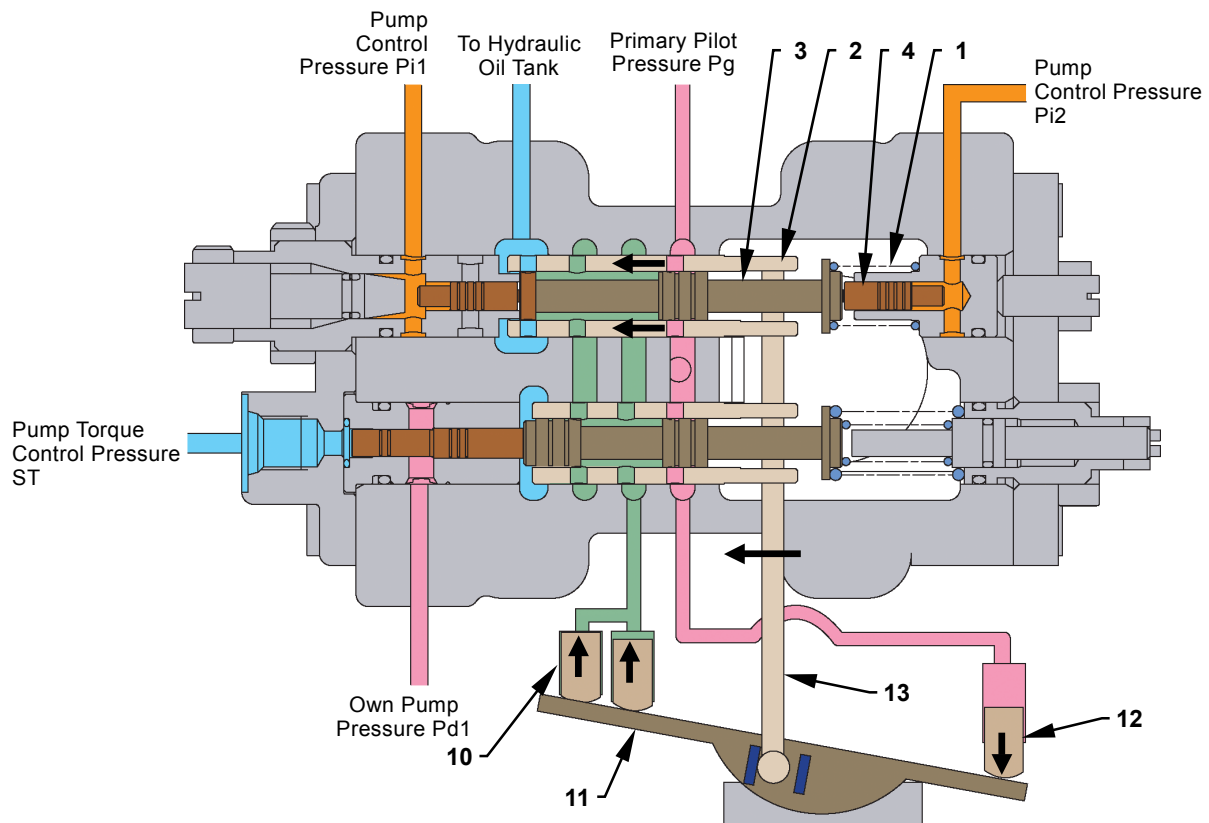
T4GB-03-01-006

- | | |
|-------------------------------------|---|
| 1 - Spring | 10 - Servo Piston 1 |
| 2 - Sleeve 1 | 11 - Swash Plate |
| 3 - Spool 1 | 12 - Servo Piston 2 |
| 4 - Piston | 13 - Feedback Lever Link |
| Pd1 - Own Pump Pressure | Pi1 - Pump Control Pressure 1 |
| ST - Pump Torque Control Pressure | Pi2 - Pump Control Pressure 2 |
| T - Returning to Hydraulic Oil Tank | Pg - Primary Pilot Pressure (From Pilot Pump) |

COMPONENT OPERATION / Pump Device



T4GB-03-01-010



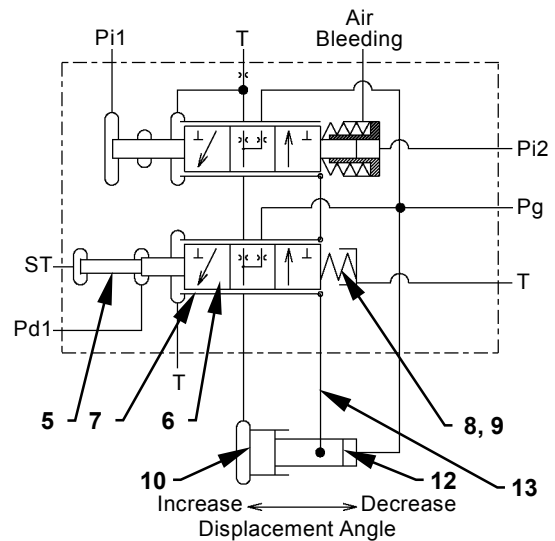
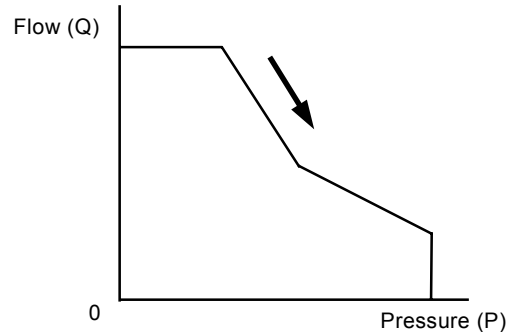
T4GB-03-01-011

COMPONENT OPERATION / Pump Device

Control by Own Pump Pressure

Decreasing Flow

1. When load is applied to the pump due to any operation, own pump pressure P_{d1} rises. (Pump control pressure (P_{i1} - P_{i2}) remains lowered during an operation.)
2. Load piston (5) pushes spool 2 (6), inner spring (8) and outer spring (9), and spool 2 (6) moves toward the arrow.
3. Therefore, primary pilot pressure P_g is led to servo piston 1 (10).
4. As there are two servo pistons 1 (10), swash plate (11) tilts toward the flow decreasing direction.
5. Movement of swash plate (11) is transmitted to sleeve 2 (7) through feedback lever link (13). Sleeve 2 (7) moves toward the movement of spool 2 (6).
6. Primary pilot pressure P_g to servo piston 1 (10) is blocked when sleeve 2 (7) has moved the same distance as spool 2 (6). Therefore, servo piston 1 (10) stops and the flow decrease 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 - Feedback Lever Link

P_{d1} - Own Pump Pressure

P_{i1} - Pump Control Pressure 1

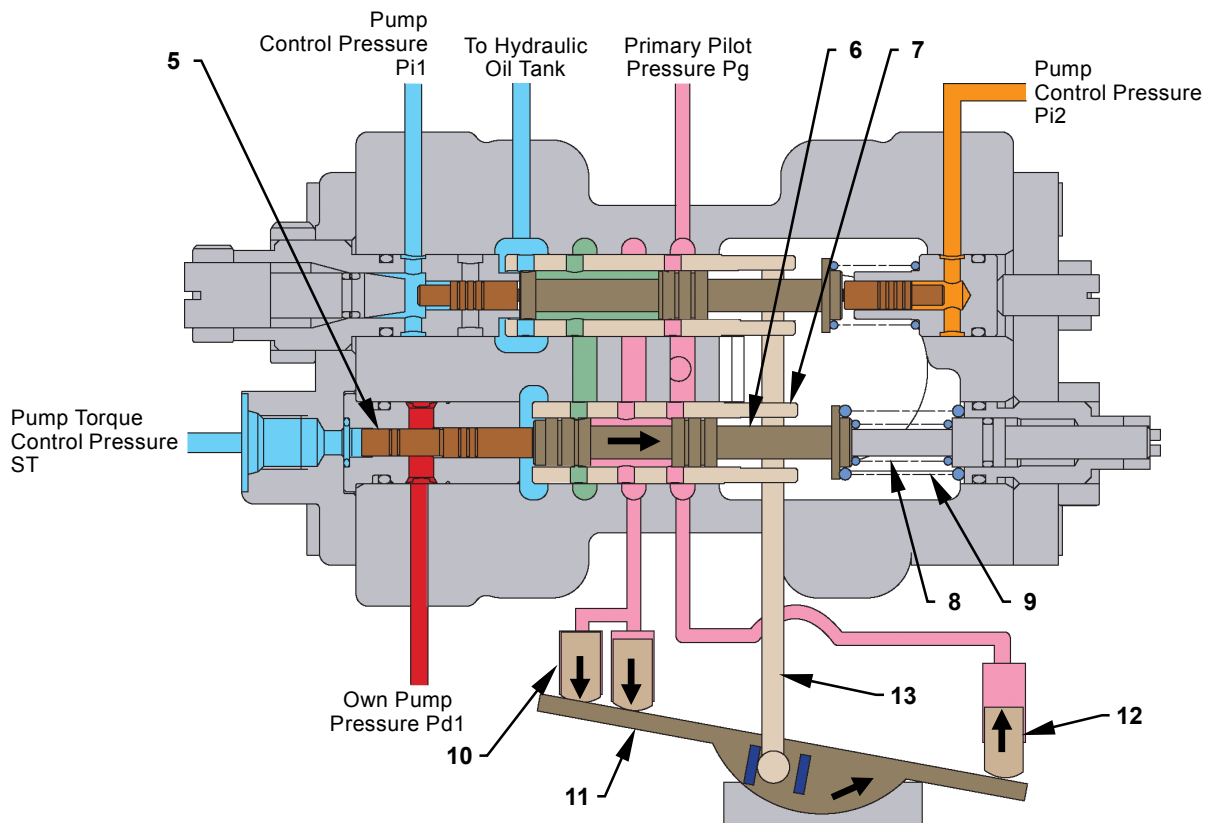
ST - Pump Torque Control Pressure

P_{i2} - Pump Control Pressure 2

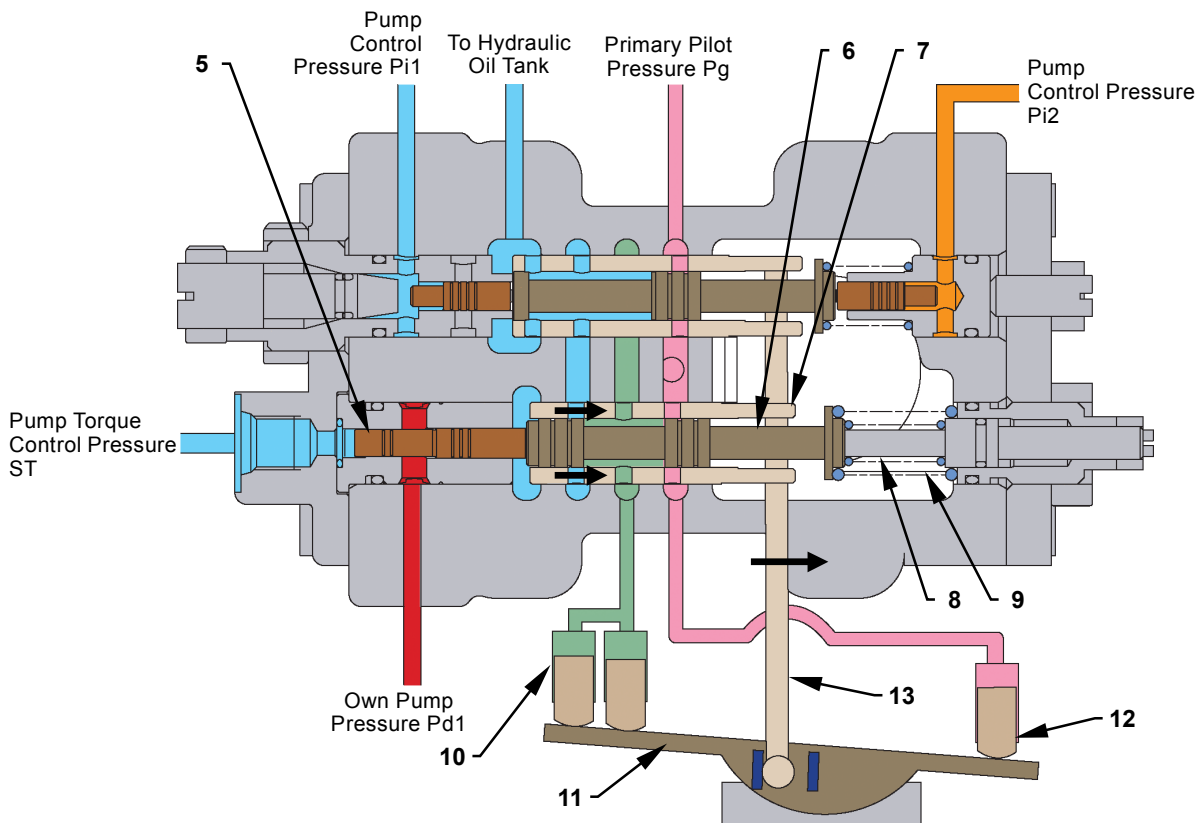
T - Returning to Hydraulic Oil Tank

P_g - Primary Pilot Pressure (From Pilot Pump)

COMPONENT OPERATION / Pump Device



T4GB-03-01-012

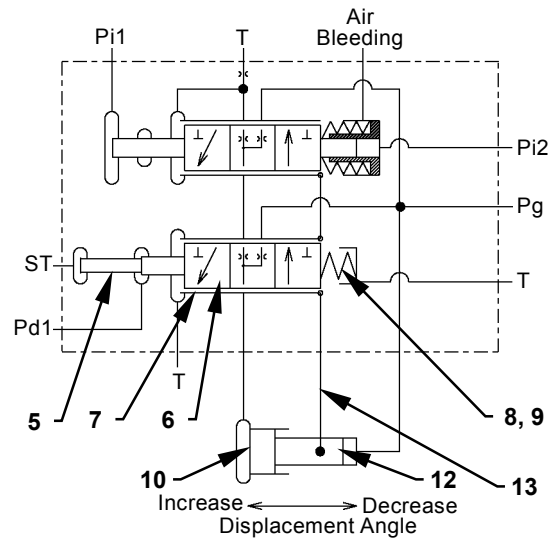
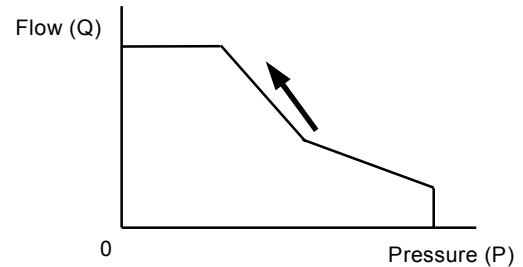


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COMPONENT OPERATION / Pump Device

Increasing Flow

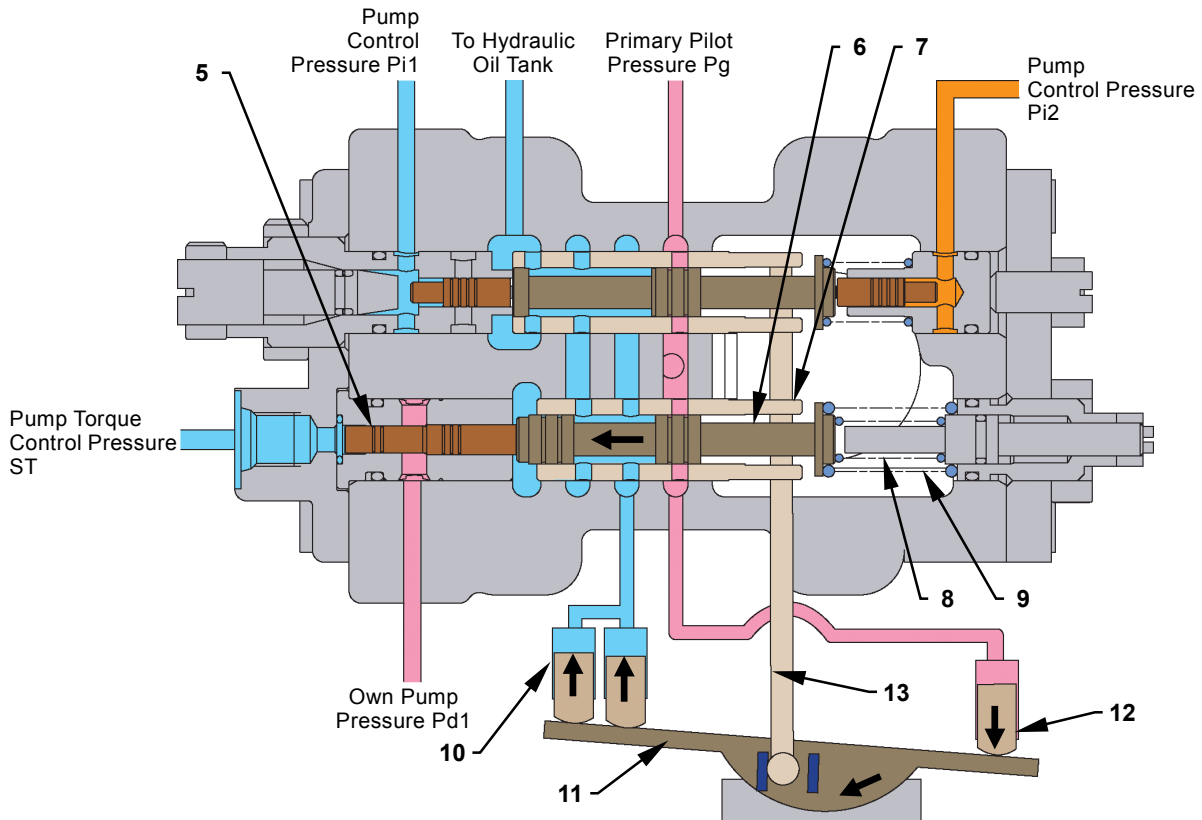
1. When the pump load is reduced, own pump pressure Pd1 lowers. (Pump control pressure (Pi1 - Pi2) remains lowered during an operation.)
2. Load piston (5) and spool 2 (6) are pushed by inner spring (8) and outer spring (9), and spool 2 (6) moves toward the arrow.
3. Therefore, the circuit of servo piston 1 (10) is connected to the hydraulic oil tank.
4. As primary pilot pressure Pg is always applied to servo piston 2 (12), swash plate (11) tilts toward the flow rate increasing direction.
5. Movement of swash plate (11) is transmitted to sleeve 2 (7) through feedback 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, servo piston 1 (10) is not connected to the hydraulic oil tank. Therefore, servo piston 1 (10) stops and the flow increase is completed.



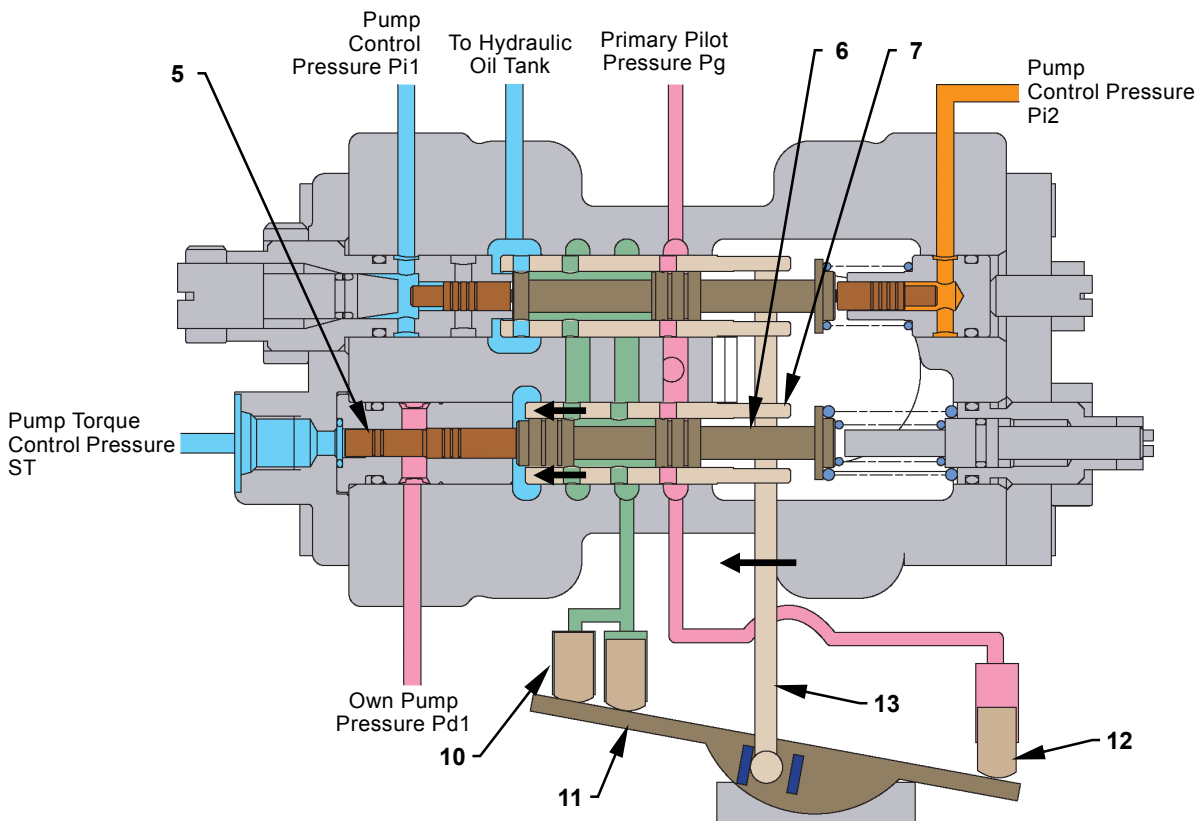
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- | | |
|-------------------------------------|---|
| 5 - Load Piston | 10 - Servo Piston 1 |
| 6 - Spool 2 | 11 - Swash Plate |
| 7 - Sleeve 2 | 12 - Servo Piston 2 |
| 8 - Inner Spring | 13 - Feedback Lever Link |
| 9 - Outer Spring | |
| Pd1 - Own Pump Pressure | Pi1 - Pump Control Pressure 1 |
| ST - Pump Torque Control Pressure | Pi2 - Pump Control Pressure 2 |
| T - Returning to Hydraulic Oil Tank | Pg - Primary Pilot Pressure (From Pilot Pump) |

COMPONENT OPERATION / Pump Device



T4GB-03-01-014



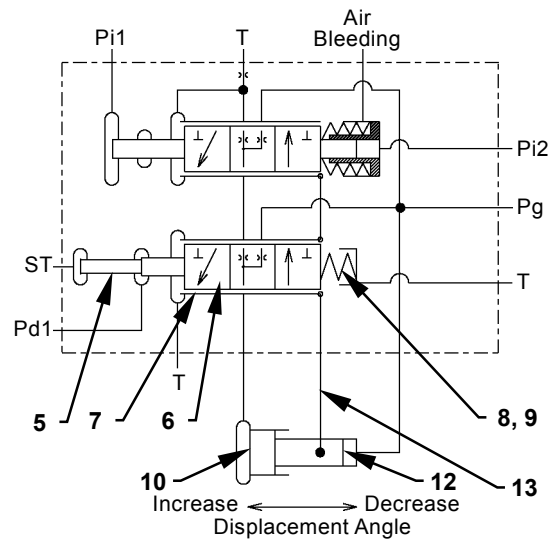
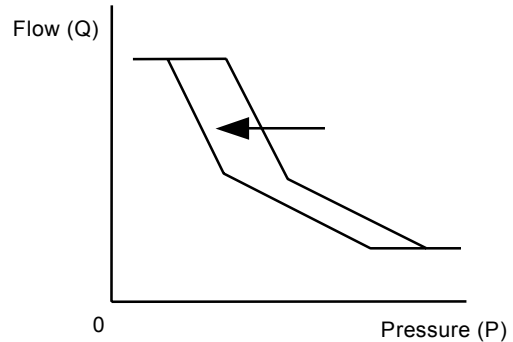
T4GB-03-01-015

COMPONENT OPERATION / Pump Device

Control by Pilot Pressure from Torque Control Solenoid Valve

Decreasing Flow

1. Command from the MC (main controller) drives the pump torque control solenoid valve and pump torque control pressure ST enters the regulator.
2. Pump torque control pressure ST acts on load piston (5) by adding to own pump pressure Pd1.
3. Load piston (5) pushes spool 2 (6), inner spring (8) and outer spring (9), and spool 2 (6) moves toward the arrow.
4. Therefore, primary pilot pressure Pg is led to servo piston 1 (10).
5. As there are two servo pistons 1 (10), swash plate (11) tilts toward the flow rate decreasing direction.
6. Movement of swash plate (11) is transmitted to sleeve 2 (7) through feedback lever link (13). Sleeve 2 (7) moves toward the movement of spool 2 (6).
7. Primary pilot pressure Pg to servo piston 1 (10) is blocked when sleeve 2 (7) has moved the same distance as spool 2 (6). Therefore, servo piston 1 (10) stops and the flow decrease is completed.

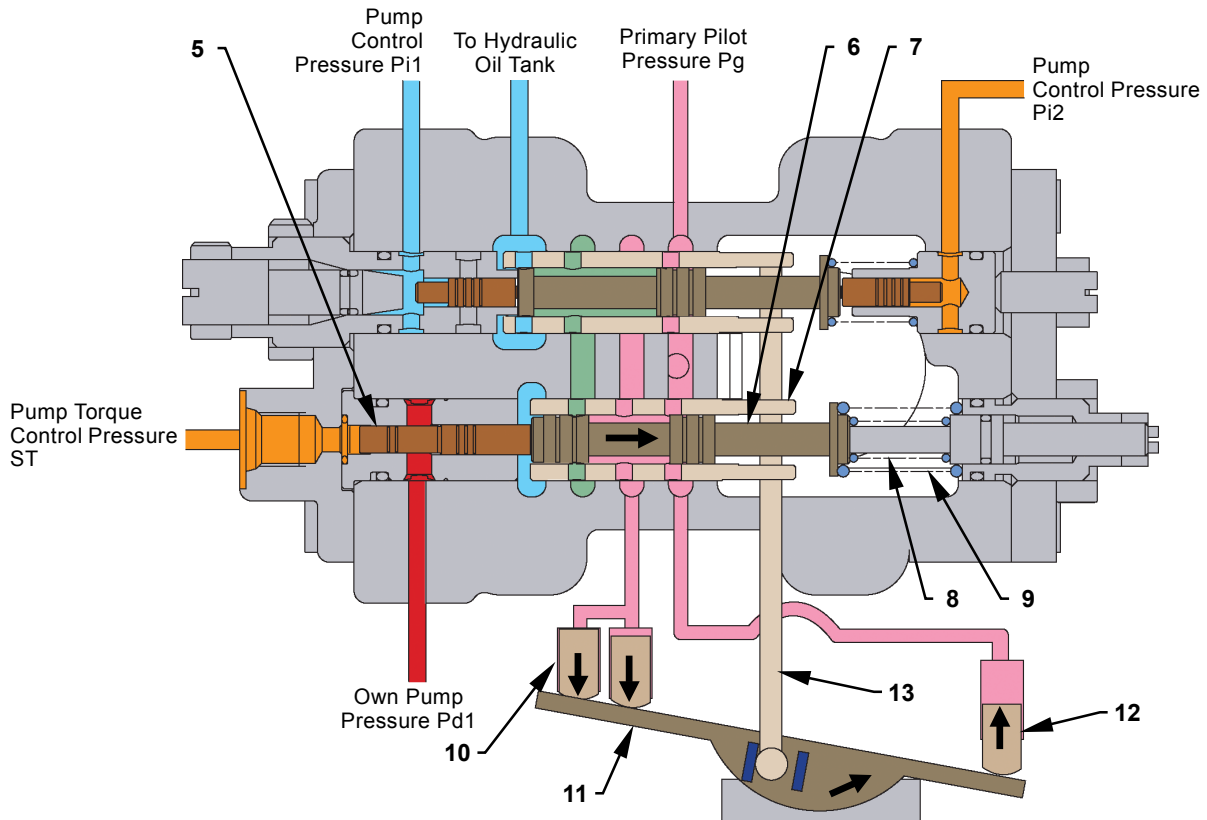


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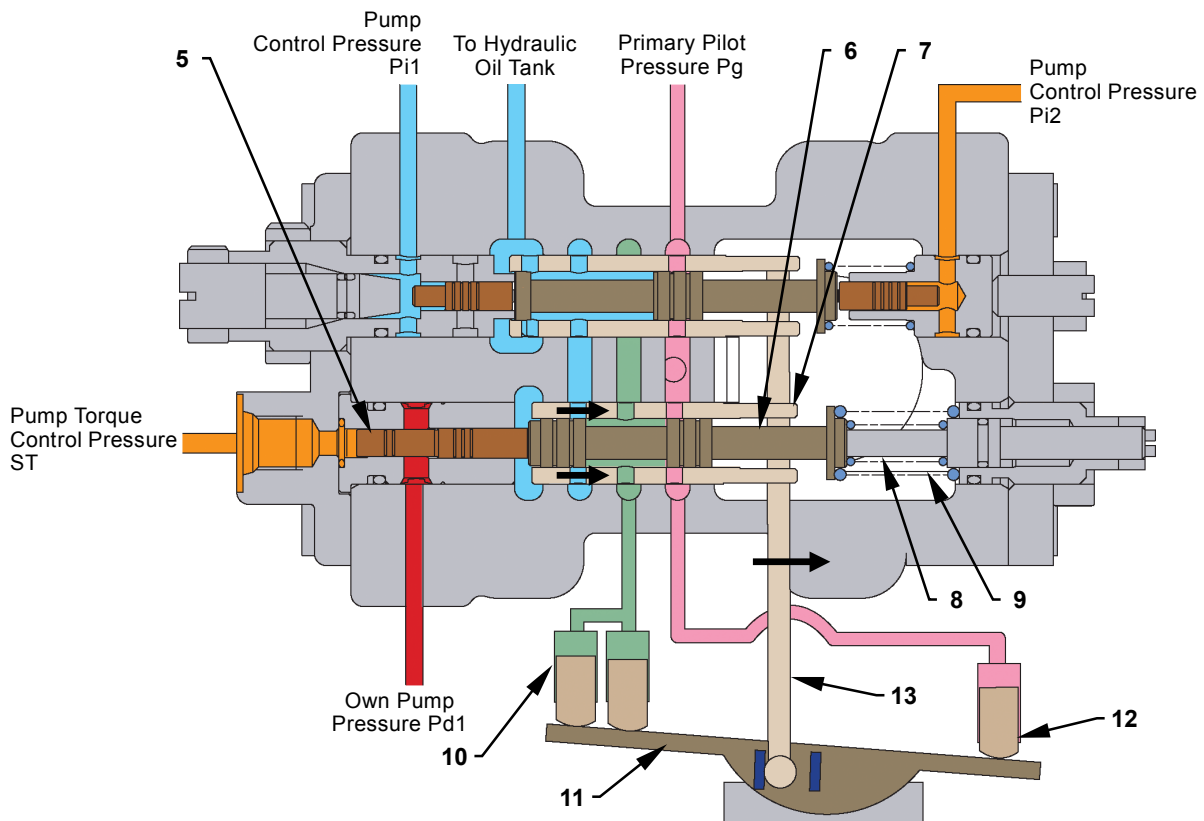
- | | |
|------------------|--------------------------|
| 5 - Load Piston | 10 - Servo Piston 1 |
| 6 - Spool 2 | 11 - Swash Plate |
| 7 - Sleeve 2 | 12 - Servo Piston 2 |
| 8 - Inner Spring | 13 - Feedback Lever Link |
| 9 - Outer Spring | |

- | | |
|-------------------------------------|---|
| Pd1 - Own Pump Delivery Pressure | Pi1 - Pump Control Pressure 1 |
| ST - Pump Torque Control Pressure | Pi2 - Pump Control Pressure 2 |
| T - Returning to Hydraulic Oil Tank | Pg - Primary Pilot Pressure (From Pilot Pump) |

COMPONENT OPERATION / Pump Device



T4GB-03-01-016



T4GB-03-01-017

COMPONENT OPERATION / Pump Device

PRIORITY VALVE

(Refer to the Main Curcuit in the SYSTEM / Hydraulic System group.)

The main pump has a built-in priority valve.
The 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

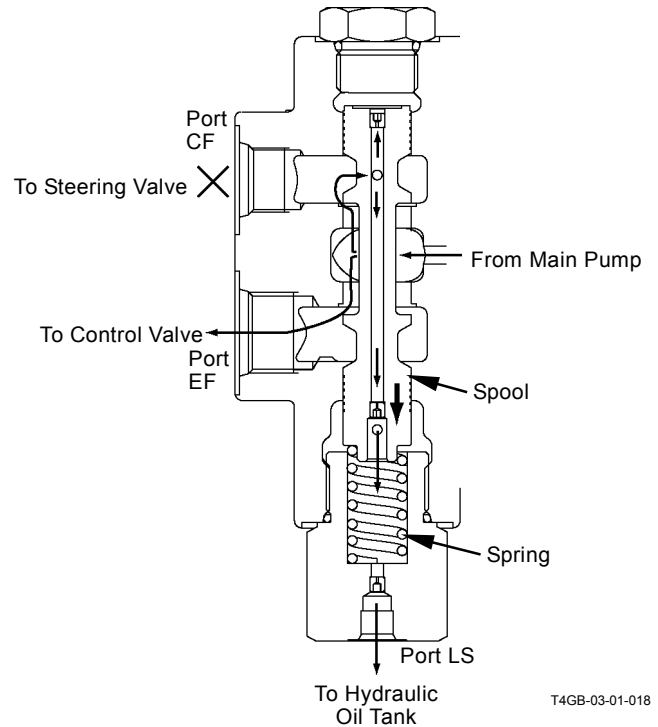
Pressure oil from the main pump flows to the steering valve through port CF. Pressure oil flows to the both ends of the priority valve spool as port CF is blocked.

As pressure oil on one end of the spool flows from port LS to the hydraulic oil tank through the steering valve, pressure is lowered. The spool to both ends of which different pressures are applied overcomes spring force and moves toward port LS. Therefore, the majority of the main pump pressure oil flows to the control valve through port EF.

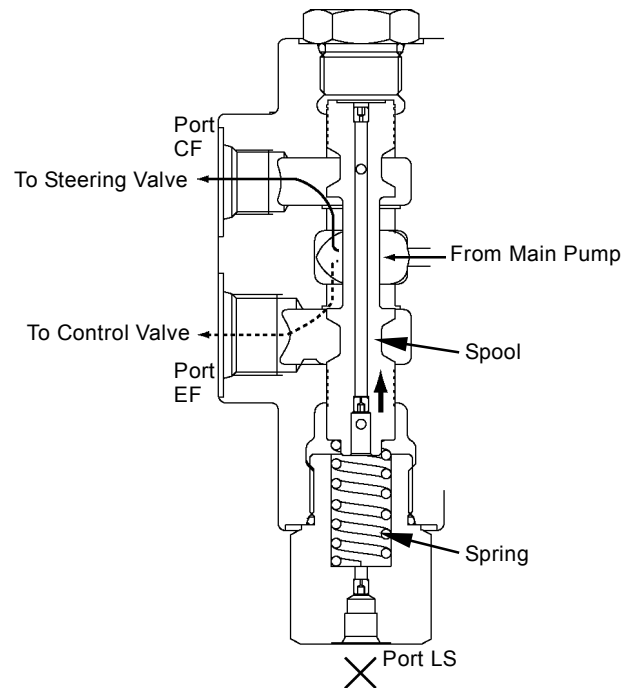
2. During Steering Operation

If the steering is operated and the steering valve spool moves, pressure at port LS rise in response to the movement of the steering valve spool. The spool is pushed up by 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



During Steering Operation



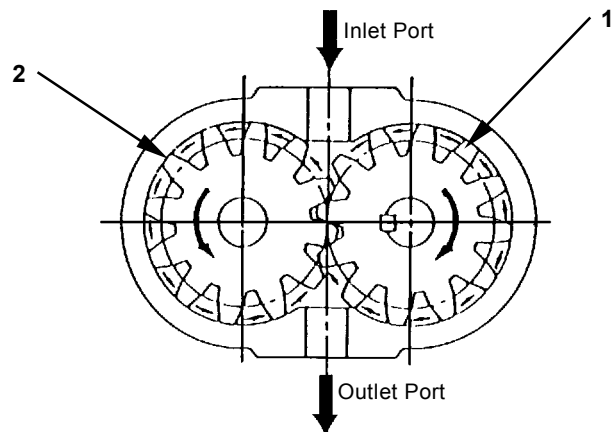
COMPONENT OPERATION / Pump Device

PILOT PUMP

Drive gear (1) is driven via the shaft in the main pump, which rotates driven gear (2) as they are meshed together.

1 - Drive Gear

2 - Driven Gear



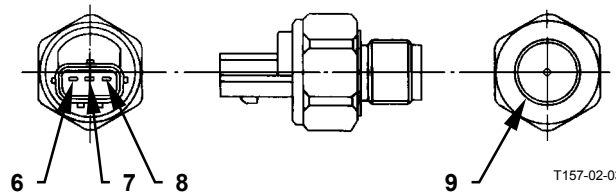
T137-02-03-005

PUMP DELIVERY PRESSURE SENSOR

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

6 - Ground
7 - Output

8 - Power Source (5V)
9 - Pressure Receiving Area
(Diaphragm)



T157-02-03-010

COMPONENT OPERATION / Pump Device

STEERING MAIN RELIEF VALVE

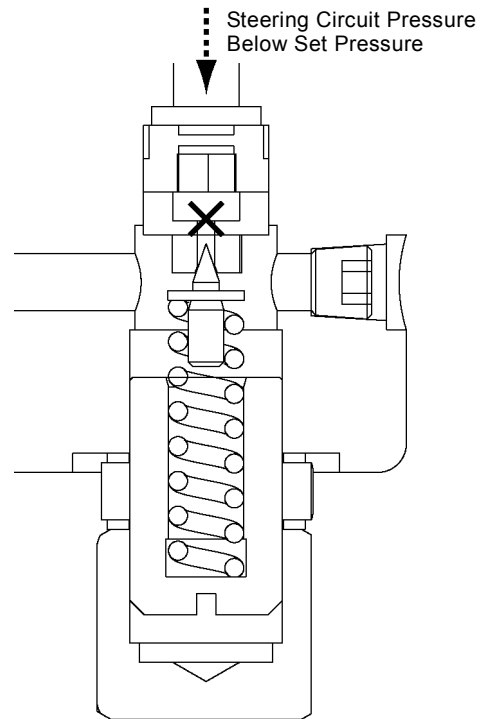
The main pump has a built-in steering main relief valve. When the steering circuit pressure exceeds the set pressure, pressure oil is returned to the hydraulic oil tank through the main pump casing.

Operation

When the steering circuit pressure exceeds the set pressure, the poppet is pushed toward the spring and pressure oil is returned to the hydraulic oil tank through the main pump casing.

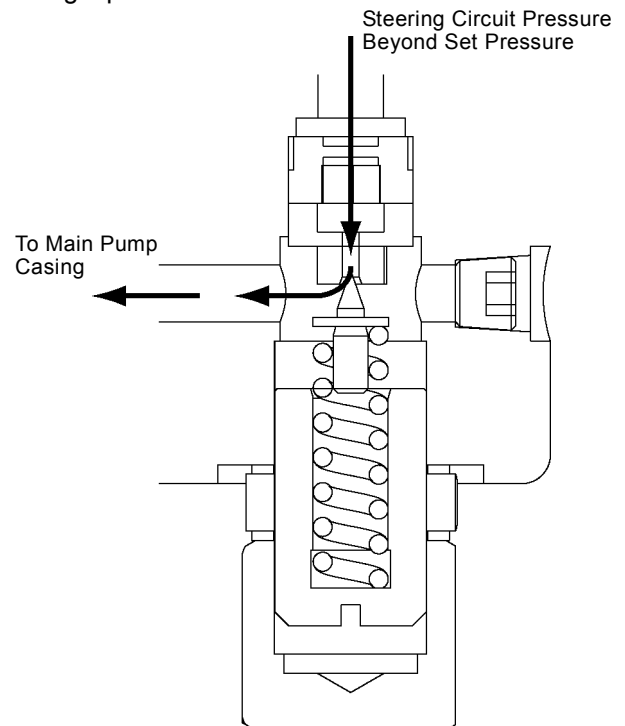
NOTE: When the steering relief valve is operated, the spool of the priority valve moves toward port LS and the majority pressure oil from the main pump flows to the control valve through port EF. (Refer to T3-1-18.)

Before Operation



T4GB-03-01-020

During Operation



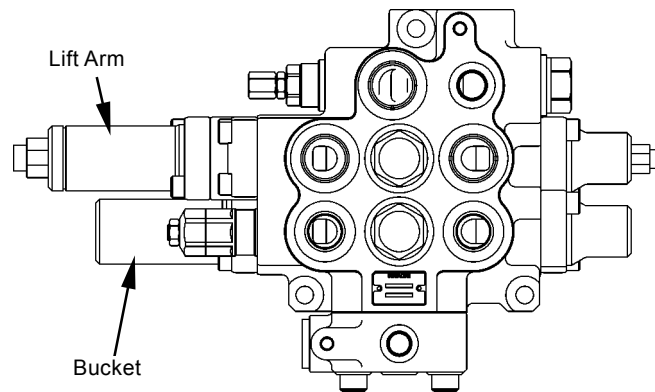
T4GB-03-01-021

COMPONENT OPERATION / Control Valve

OUTLINE

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

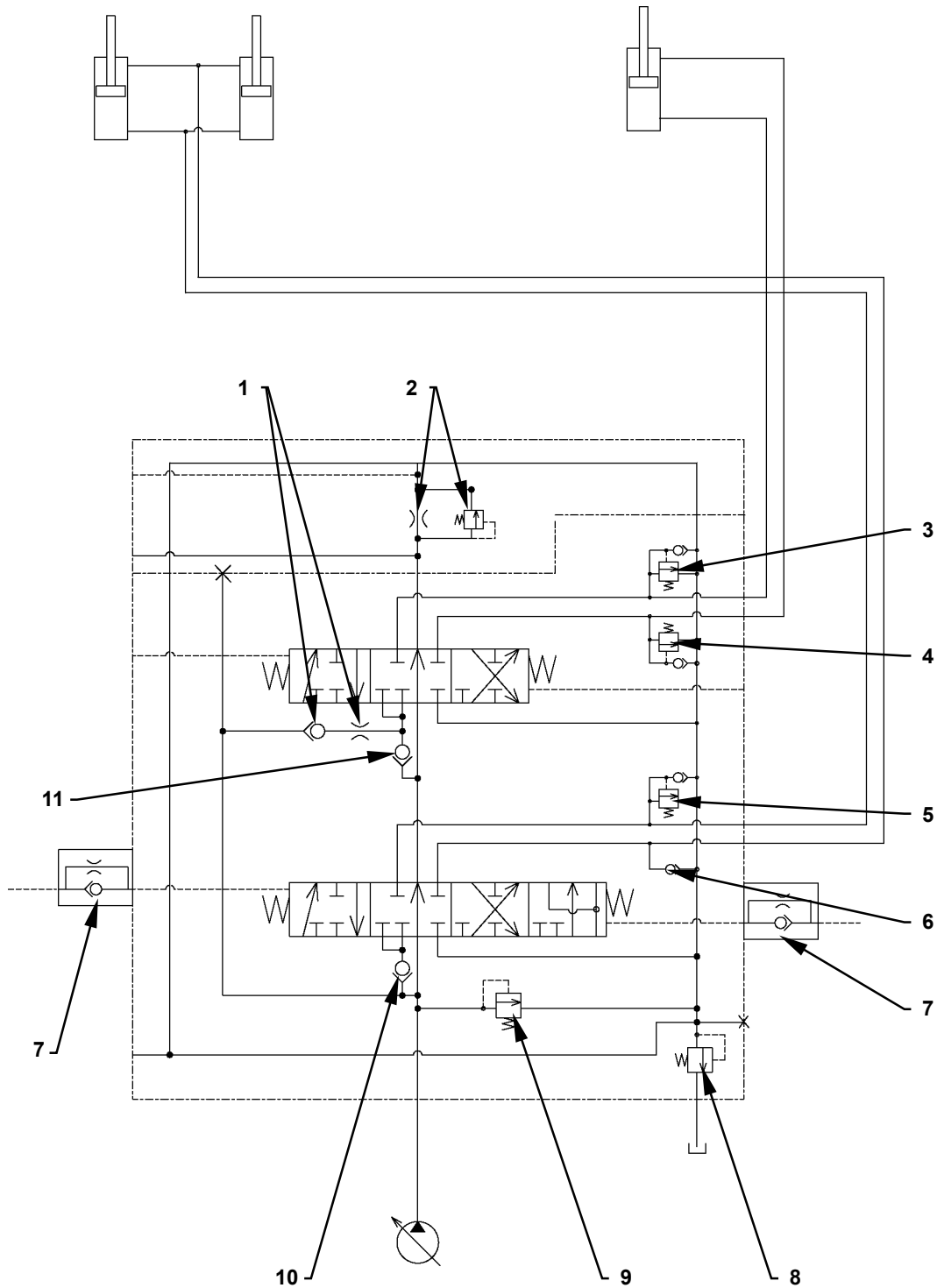
The control valve consists of the main relief valve, overload relief valve, negative control valve, restriction valve, flow rate control valve and spools, and its operation is the hydraulic pilot type.



T4GB-03-02-001

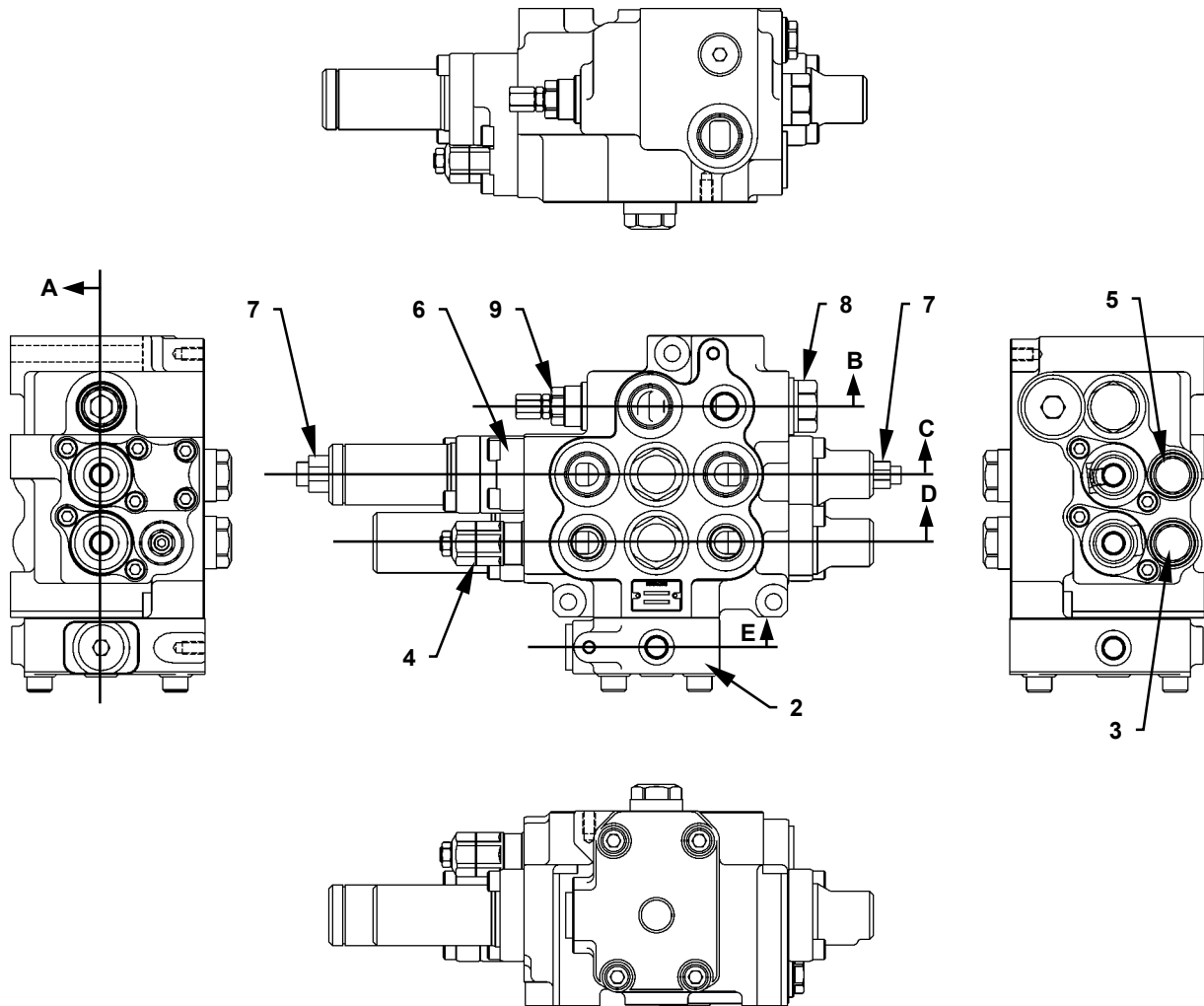
COMPONENT OPERATION / Control Valve

Component Layout



T4GB-03-02-003

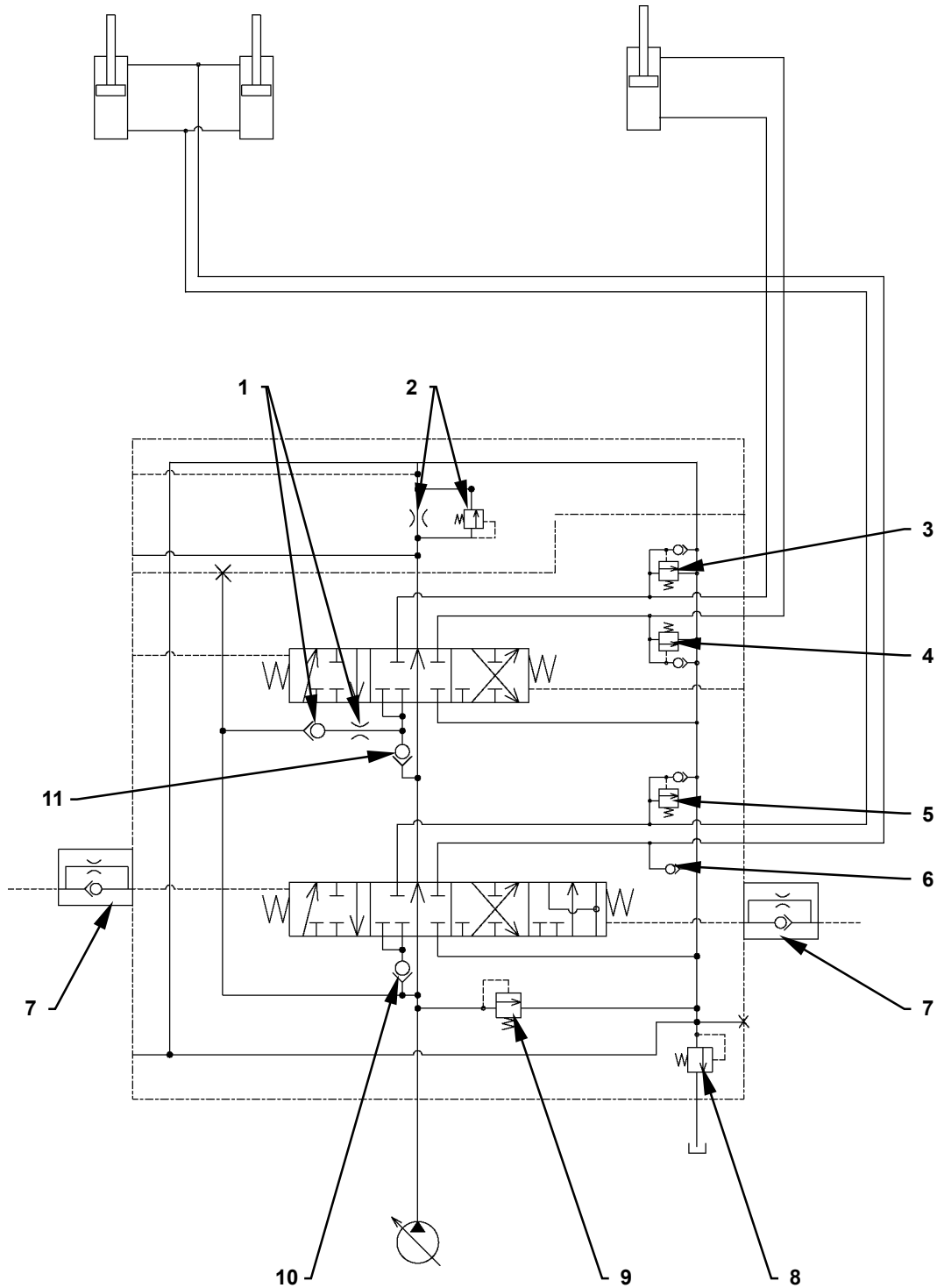
COMPONENT OPERATION / Control Valve



T4GB-03-02-004

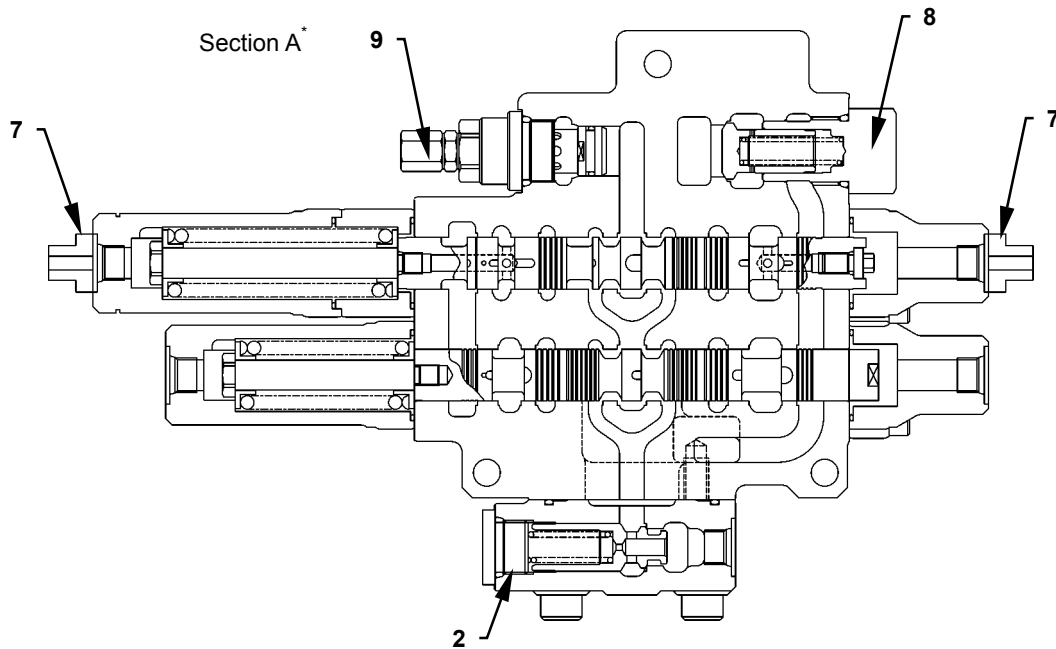
- | | | | |
|---|---|-------------------------------|--|
| 1 - Bucket Flow Rate Control Valve | 4 - Overload Relief Valve (Bucket: Rod Side) | 7 - Restriction Valve | 10 - Load Check Valve (Arm Lift Circuit) |
| 2 - Negative Control Valve | 5 - Overload Relief Valve (Lift Arm: Bottom Side) | 8 - Low-Pressure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

COMPONENT OPERATION / Control Valve

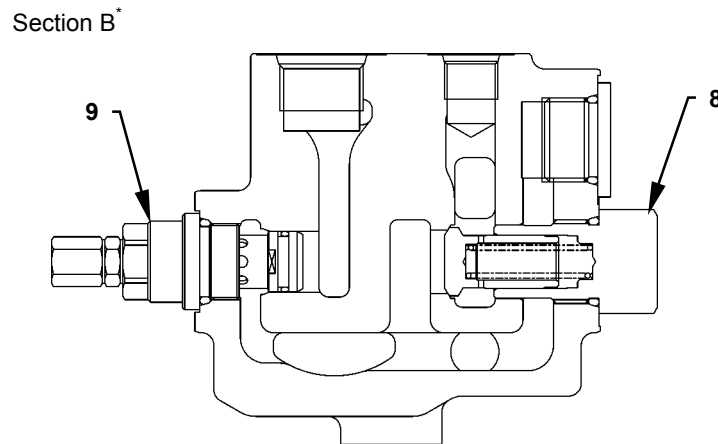


T4GB-03-02-003

COMPONENT OPERATION / Control Valve



T4GB-03-02-005

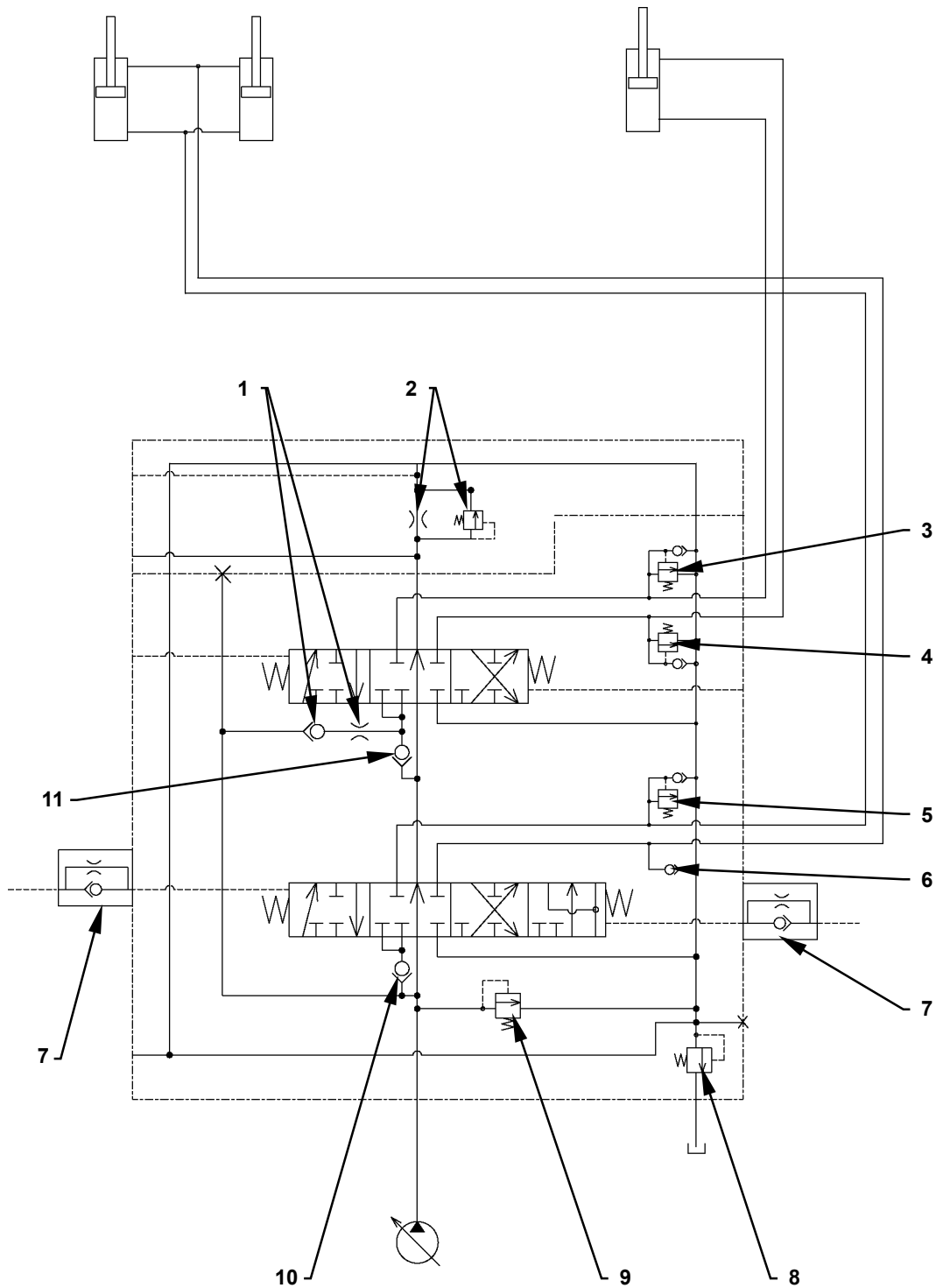


T4GB-03-02-006

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

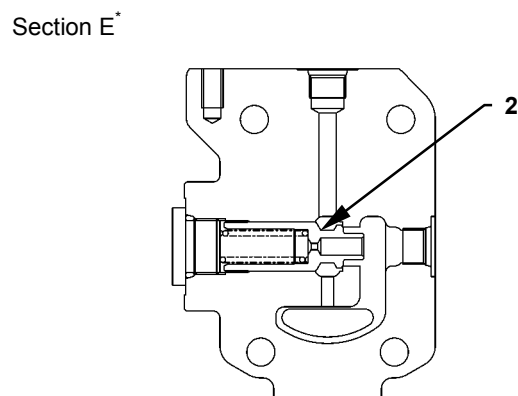
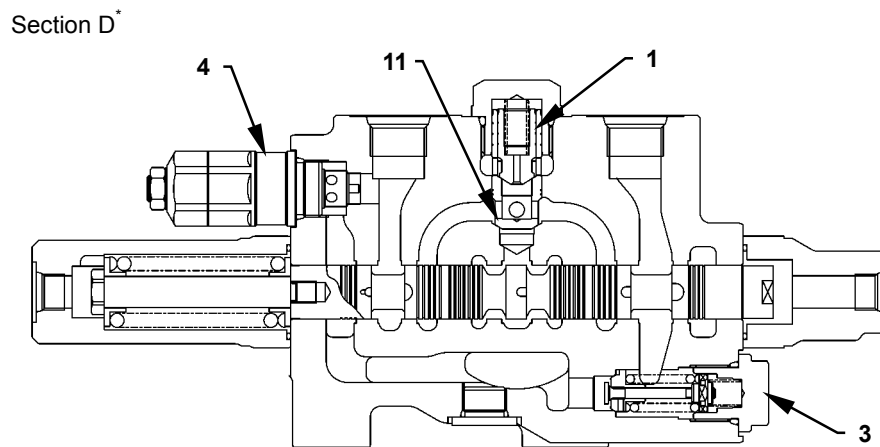
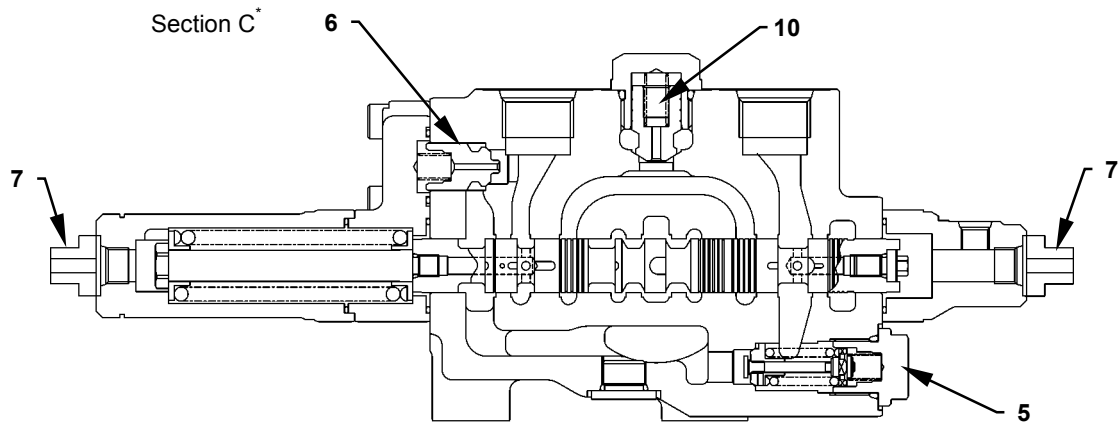
 **NOTE:** *Refer to T3-2-3.

COMPONENT OPERATION / Control Valve



T4GB-03-02-003

COMPONENT OPERATION / Control Valve



T4GB-03-02-007

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

 **NOTE:** *Refer to T3-2-3.

COMPONENT OPERATION / Control Valve

HYDRAULIC CIRCUIT

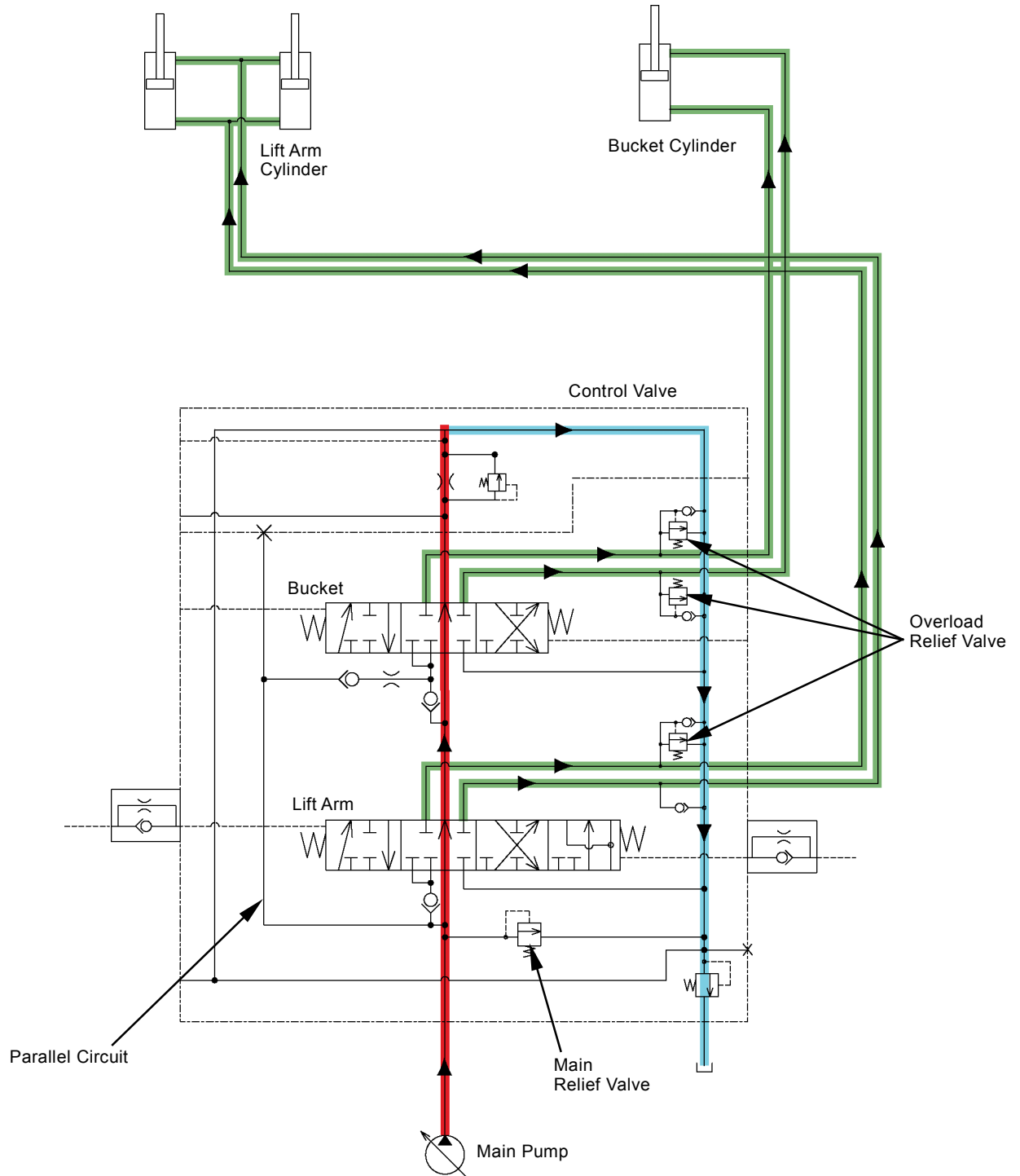
Main Circuit

The main circuit contains a parallel circuit, which enables combined operations.

The 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 of the spool (when the control lever is operated).

The front circuit (between the control valve and the cylinder) of the lift arm and bucket is provided with the overload relief valve. The overload relief valve prevents surge pressure developed by external loads in the front circuit from increasing over the set pressure with the spool in neutral (when the control lever is neutral).

COMPONENT OPERATION / Control Valve



T4GB-03-02-012

COMPONENT OPERATION / Control Valve

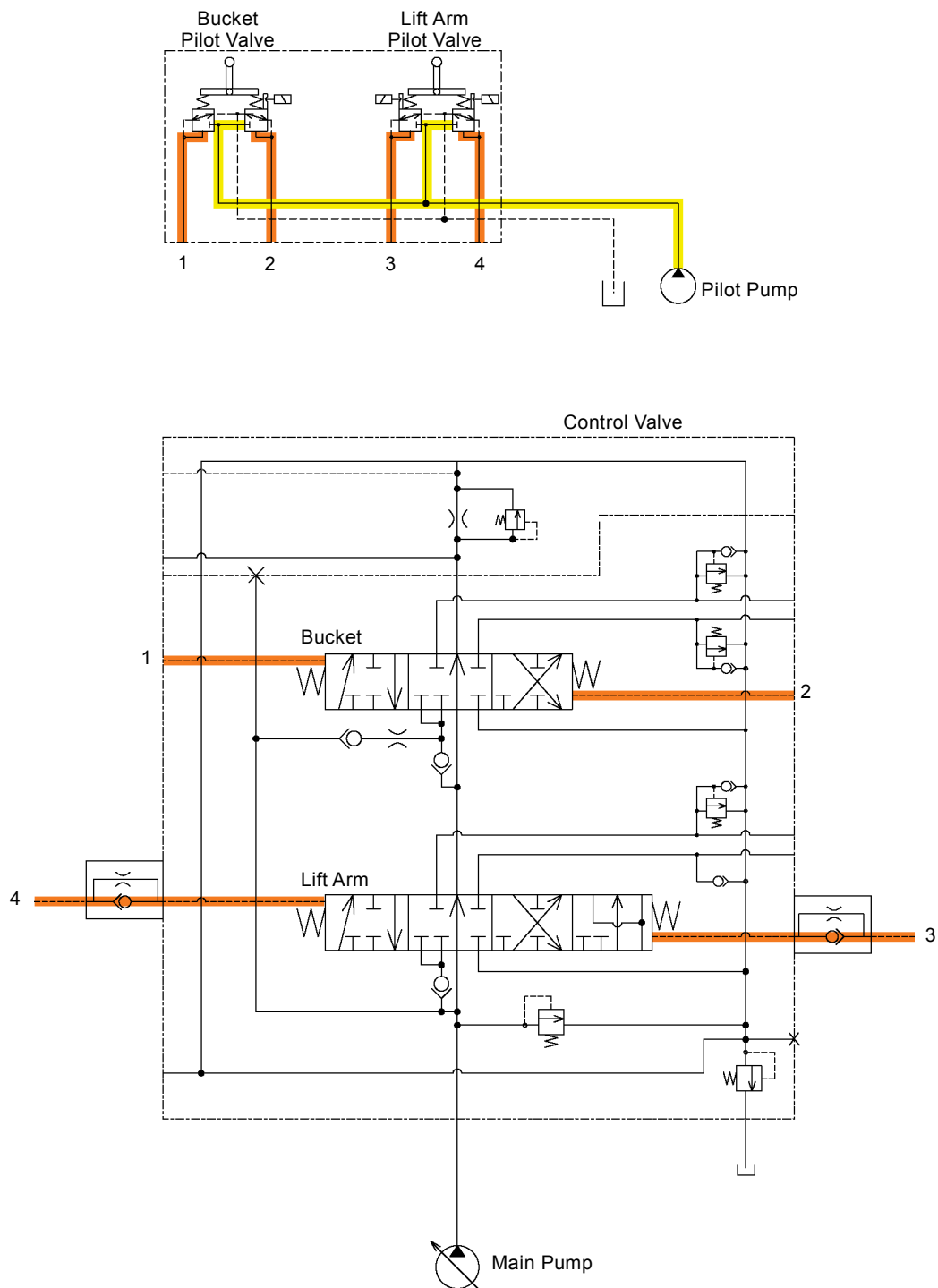
Pilot Operation Circuit

Pressure oil indicated with numbers from the pilot valve acts on the spool of the control valve, and moves the spool.

- Pressure oil is sent to the bucket spool for dumping and crowding operations.
- Pressure oil is sent to the lift arm spool for raising and lowering operations.

The spool for lowering is two-staged. The first stage is when lowering the lift arm and the second stage is when floating the lift arm.

COMPONENT OPERATION / Control Valve



T4GB-03-02-013

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

COMPONENT OPERATION / Control Valve

MAIN RELIEF VALVE

The main relief valve prevents pressure inside the main circuit from increasing over the set pressure during operation of the cylinder.

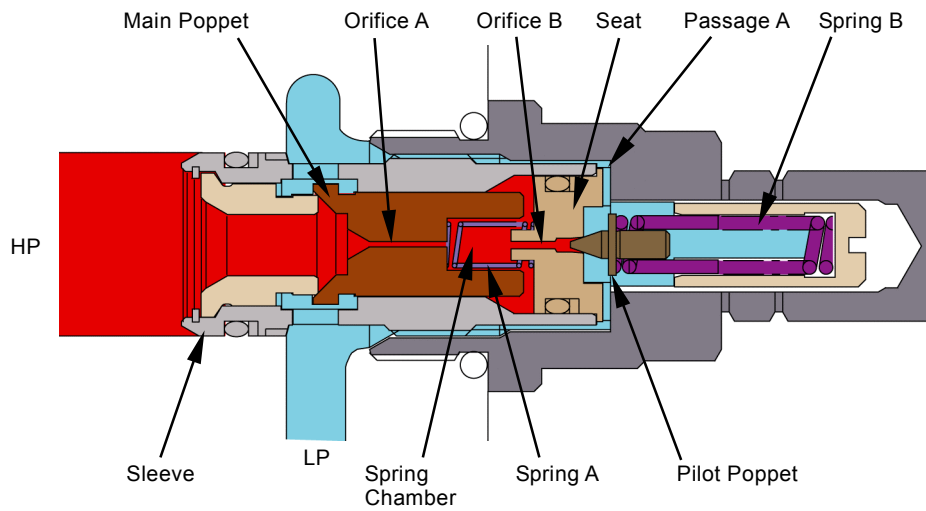
This prevents oil leakage from the hoses and piping fittings as well as cylinder breakage.

Relief Operation

1. Pressure at port HP (the main circuit) acts on the pilot poppet through orifice A of the main poppet and orifice B of the seat.
2. When the pressure at port HP reaches the set force of spring B, the pilot poppet opens and pressure oil flows to port LP (the hydraulic oil tank) through passage A and the periphery of the sleeve.
3. At this time, the pressure difference arises between port HP and the spring chamber due to orifice A.
4. When this pressure difference reaches the set force of spring A, the main poppet opens, and pressure oil in port HP flows to port LP.
5. Consequently, pressure in the main circuit decreases.
6. If the main circuit pressure decreases to the set pressure, the main poppet is closed by the force of spring A.

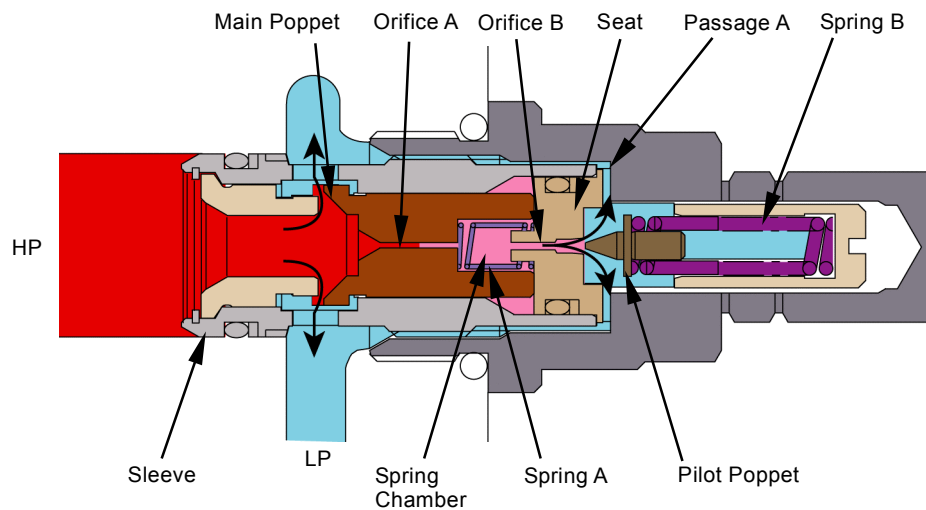
COMPONENT OPERATION / Control Valve

Normal State:



T4GB-03-02-034

Relief State:



T4GB-03-02-035

COMPONENT OPERATION / Control Valve

OVERLOAD RELIEF VALVE

(With Make-Up Function)

The overload relief valve is provided with the circuit in the bottom side of the lift arm and the bottom and rod side of the bucket. The overload relief valve controls pressure in each front circuit in order not to rise abnormally when each front attachment is operated by external force. It also makes make-up operation by refilling oil from the hydraulic oil tank in order to prevent cavitation when pressure in the front circuit decreases.

Rod Side Circuit of Bucket

Relief Operation

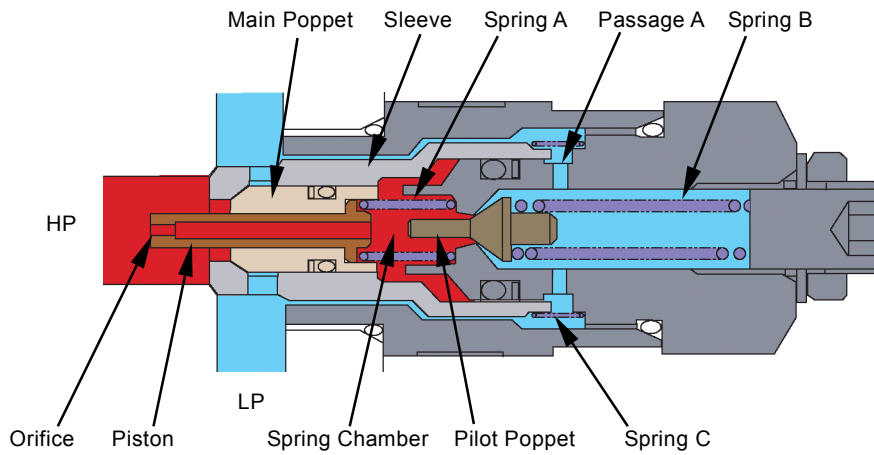
1. Pressure at port HP (the front circuit) acts on the pilot poppet through the orifice of the piston.
2. When pressure at port HP reaches the set force of spring B, the pilot poppet opens and pressure oil flows to port LP (the hydraulic oil tank) through passage A and the periphery of the sleeve.
3. At this time, the pressure difference arises between port HP and the spring chamber due to the orifice.
4. When this pressure difference reaches the set force of spring A, the piston and main poppet open, and pressure oil in port HP flows to port LP.
5. Consequently, pressure in the front circuit decreases.
6. If the front circuit pressure decreases to the set pressure, the piston and main poppet are closed by the force of spring A.

Make-Up Operation

1. When the pressure at port HP (the front circuit) decreases lower than the pressure at port LP (the hydraulic oil tank), the sleeve moves to the right.
2. Hydraulic oil in 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.

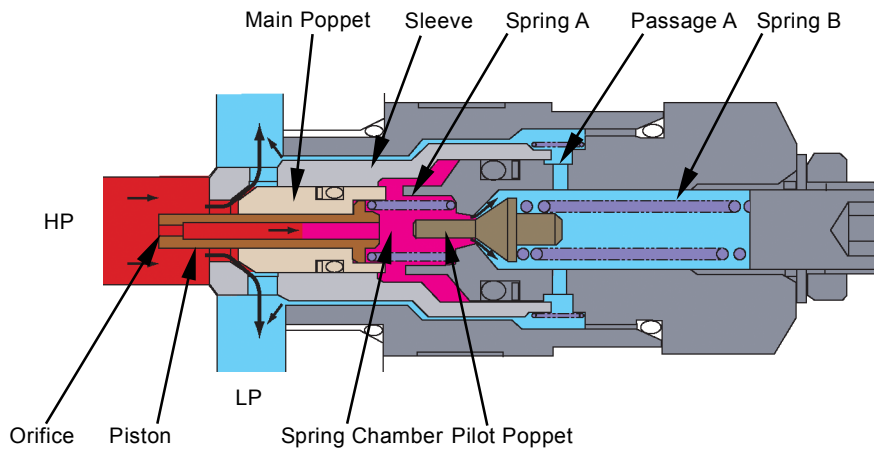
COMPONENT OPERATION / Control Valve

Normal State:



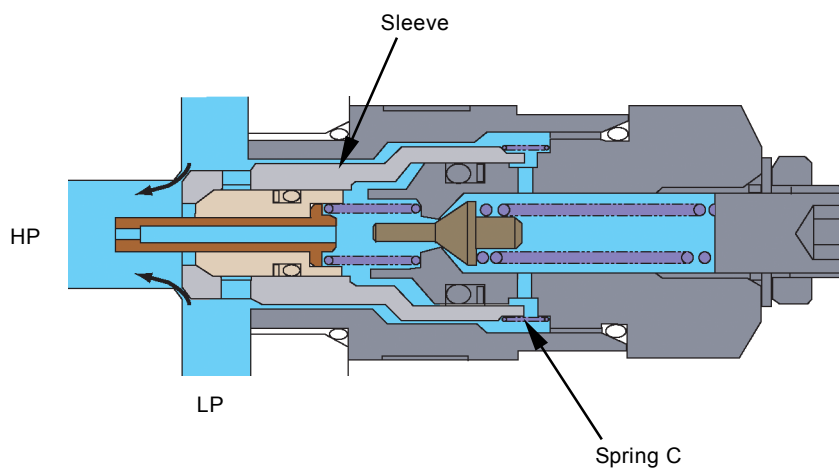
T4GB-03-02-030

Relief State:



T4GB-03-02-031

Make-Up Operation:



R4GB-03-02-032

COMPONENT OPERATION / Control Valve

Bottom Side Circuit of Lift Arm and Bucket

Relief Operation

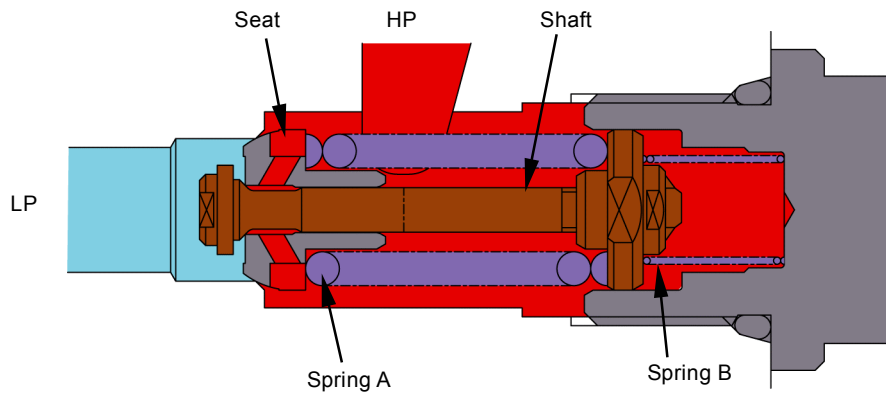
1. Pressure at port HP (the front circuit) acts on the shaft through the seat.
2. When the pressure at port HP reaches the set force of spring A, the shaft moves and pressure oil flows to port LP.
3. Consequently, the pressure in the front circuit decreases.
4. If pressure in the front circuit decreases to the set pressure, the shaft is moved by the force of spring A and the oil passage is closed.

Make-Up Operation

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

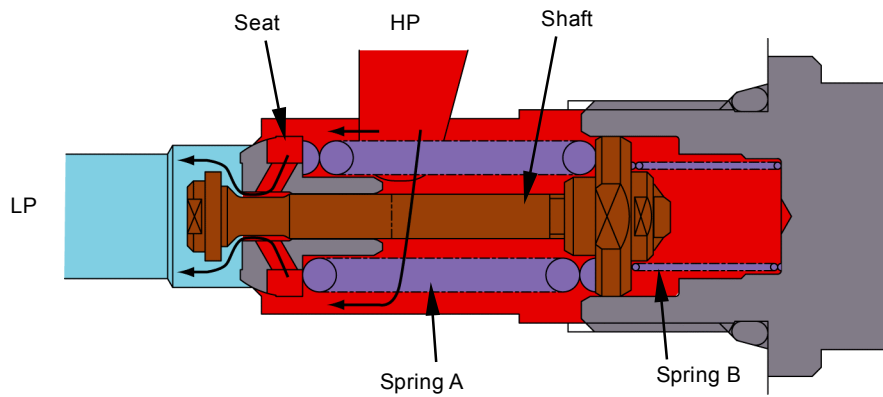
COMPONENT OPERATION / Control Valve

Normal State:



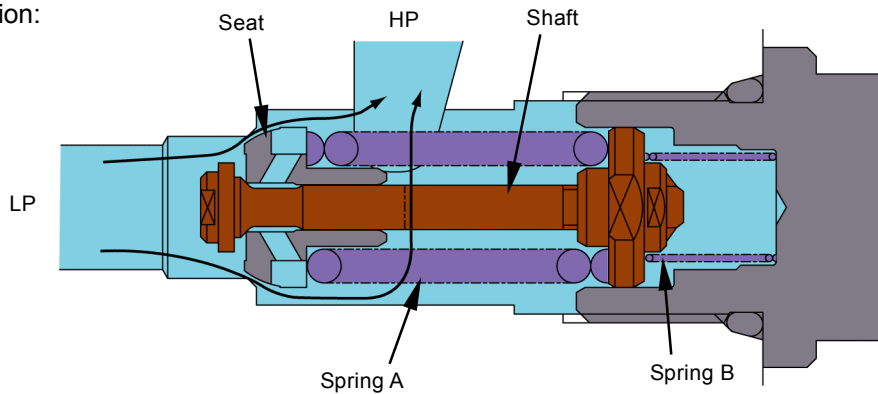
T4GB-03-02-027

Relief State:



T4GB-03-02-028

Make-Up Operation:



T4GB-03-02-029

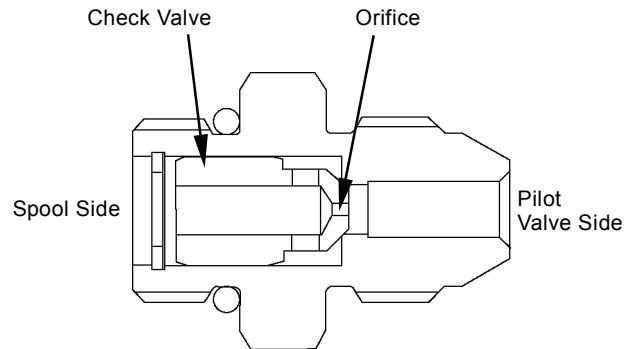
COMPONENT OPERATION / Control Valve

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COMPONENT OPERATION / Control Valve

RESTRICTION VALVE

The 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 tuned to the neutral position during operation of the lift arm, the pilot pressure oil supplied to the spool for the lift arm is drained through the orifice of the check valve of the restriction valve. Thereby, pilot pressure gradually decreases. Therefore, shock to the body occurring during operation of the front attachment can be reduced by gradually returning the lift arm spool to the neutral position.



T4GB-03-02-014

COMPONENT OPERATION / Control Valve

NEGATIVE CONTROL VALVE

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

Operation

- In Neutral

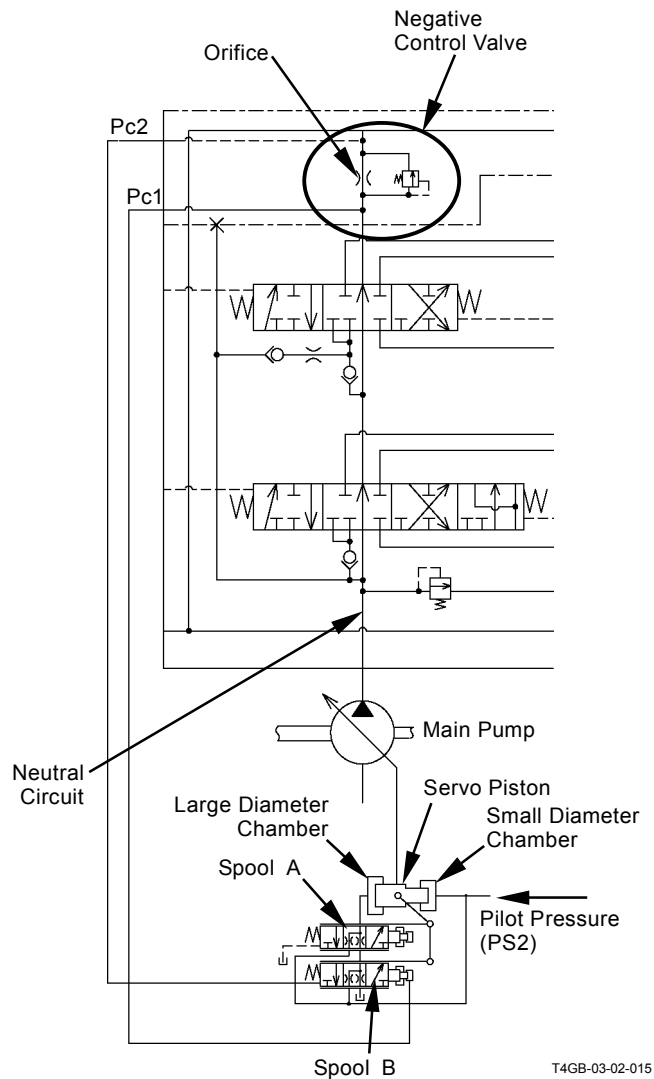
Pressure oil through the control valve neutral circuit with the control valve in neutral position is supplied as pilot pressure for controlling the pump delivery flow from the front and rear of the orifice of the negative control valve installed at the outlet of the control valve.

At this time, spool B moves to the left as the differential pressure occurs between Pc1 and Pc2. Therefore, pilot pressure (PS2) enters the large diameter chamber in the servo piston through spool B and spool A. Pilot pressure (PS2) also enters the small diameter chamber in the servo piston. As the large diameter chamber is larger than the small diameter chamber, the servo piston moves to the right and the pump delivery flow is reduced.

- In Operation

During operation of the lift arm and the bucket, pressure oil is not supplied to Pc1 and Pc2.

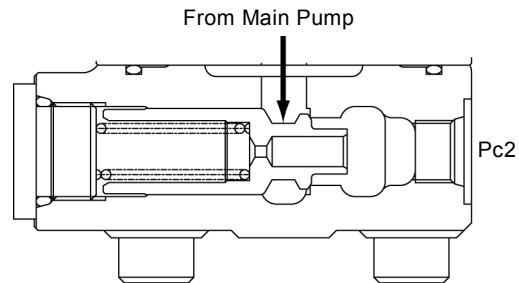
At this time, as the differential pressure between Pc1 and Pc2 disappears, the regulator in the main pump is in neutral and the delivery flow is not restricted (the pump delivery flow increases).



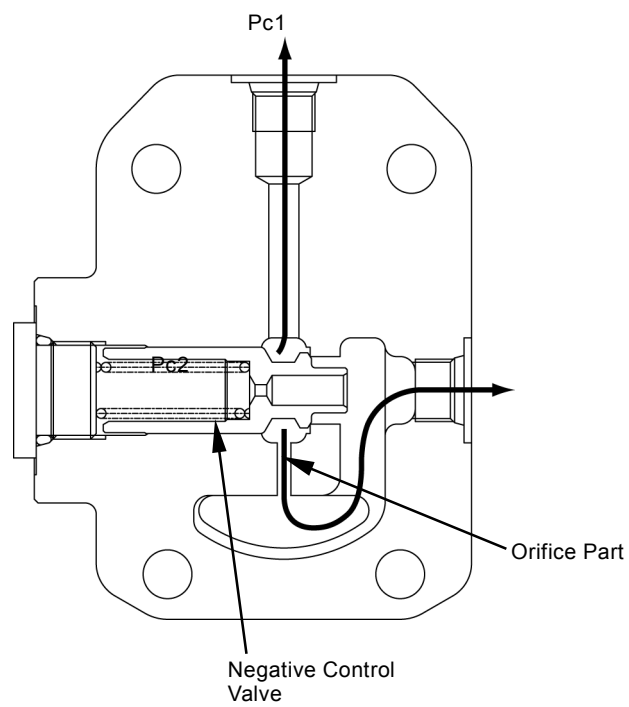
T4GB-03-02-015

COMPONENT OPERATION / Control Valve

Section A



Section E**



 **NOTE:** *Refer to T3-2-3, T3-2-5.
**Refer to T3-2-5.

T4GB-03-02-016

COMPONENT OPERATION / Control Valve

FLOW RATE CONTROL VALVE

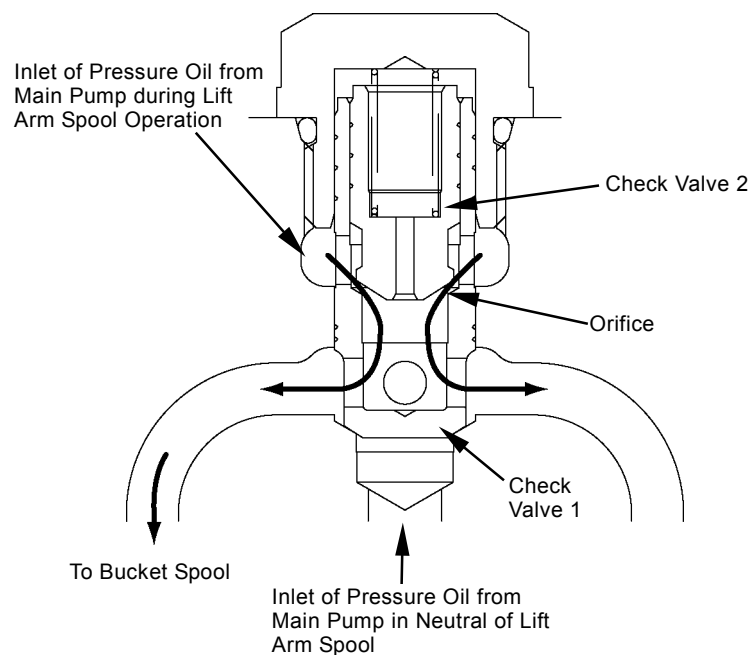
The flow rate control valve is installed in the bucket circuit, restricts the circuit during the combined operation and gives priority to operations of the other actuators.

Single Operation of Bucket Crowding

1. Pressure oil from the main pump flows through 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.

Combined Operation of Bucket Crowding and Lift Arm Raising

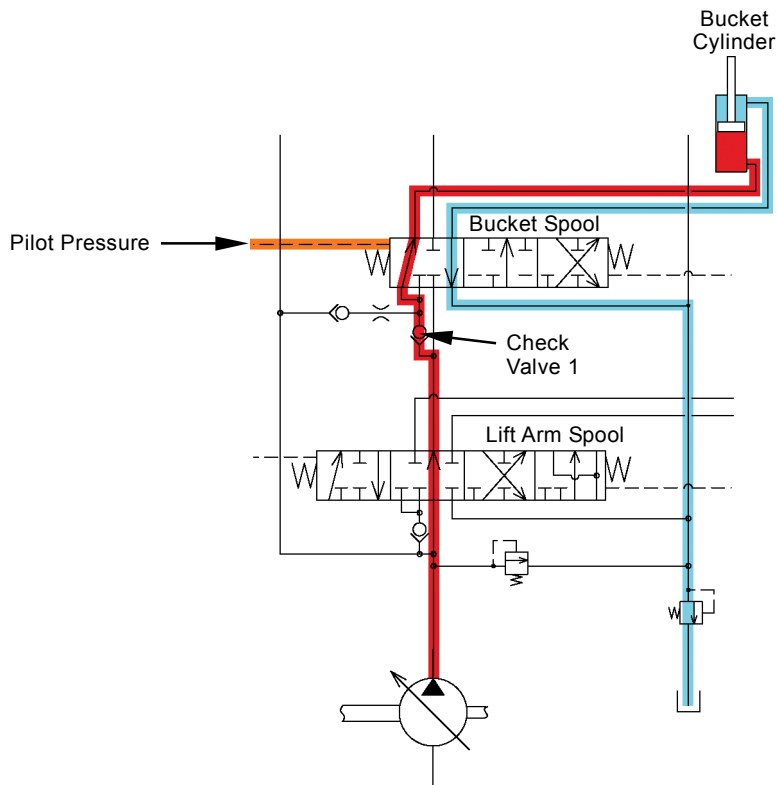
1. One of pressure oil from the main pump is supplied to the lift arm cylinder through the lift arm spool.
2. Another of pressure oil from the main pump is supplied to the bucket spool through the parallel circuit.
3. At this time, pressure oil is restricted through the orifice from check valve 2.
4. Pressure oil through the orifice flows to the bucket spool and is supplied to the bucket cylinder.
5. Therefore, as pressure oil to the bucket spool is restricted and more pressure oil is supplied to the lift arm side having higher pressure, both the lift bucket and the lift arm move at the same time.



T4GB-03-02-020

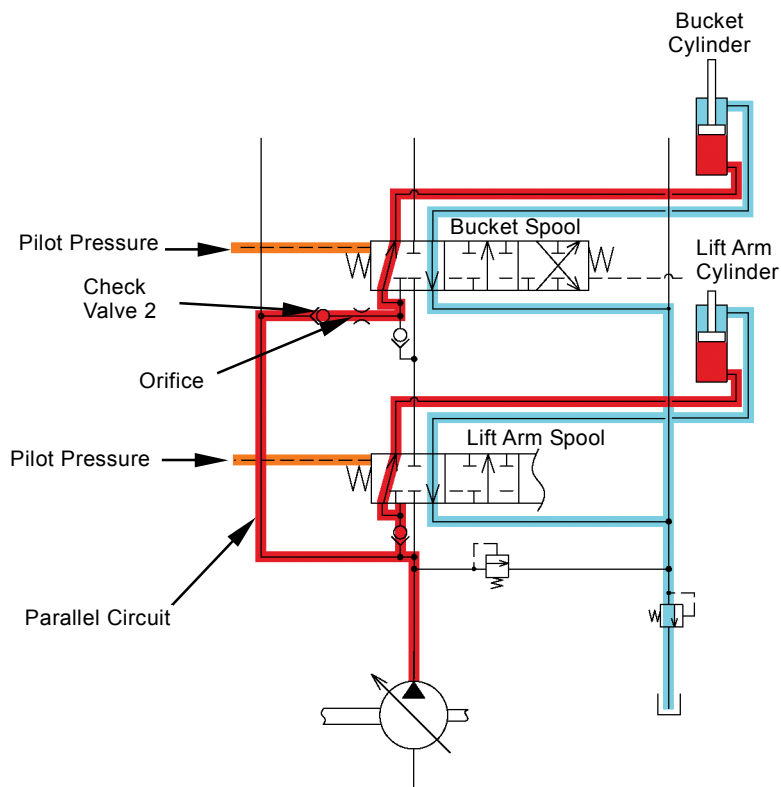
COMPONENT OPERATION / Control Valve

Single Operation of Bucket Crowding



T4GB-03-02-018

Combined Operation of Bucket Crowding and Lift Arm Raising



T4GB-03-02-019

COMPONENT OPERATION / Control Valve

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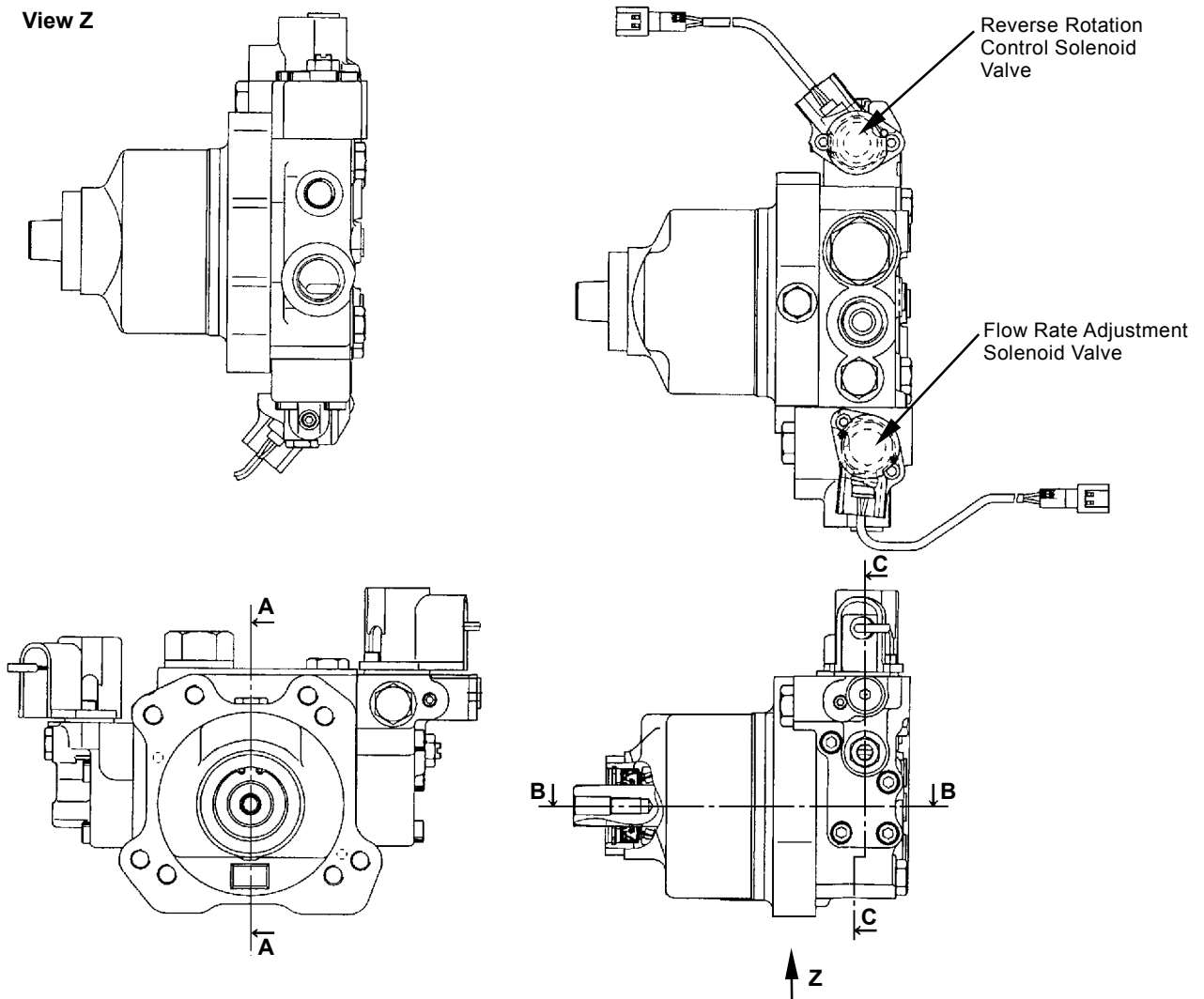
COMPONENT OPERATION / Hydraulic Fan Motor

OUTLINE

The shaft of the fan motor is equipped with the cooling fan. Pressure oil from the fan pump rotates the cooling fan by driving the shaft.

The fan motor has a built-in reverse rotation control solenoid valve and a flow rate adjustment solenoid valve, which control the motor rotation direction and rotation speed.

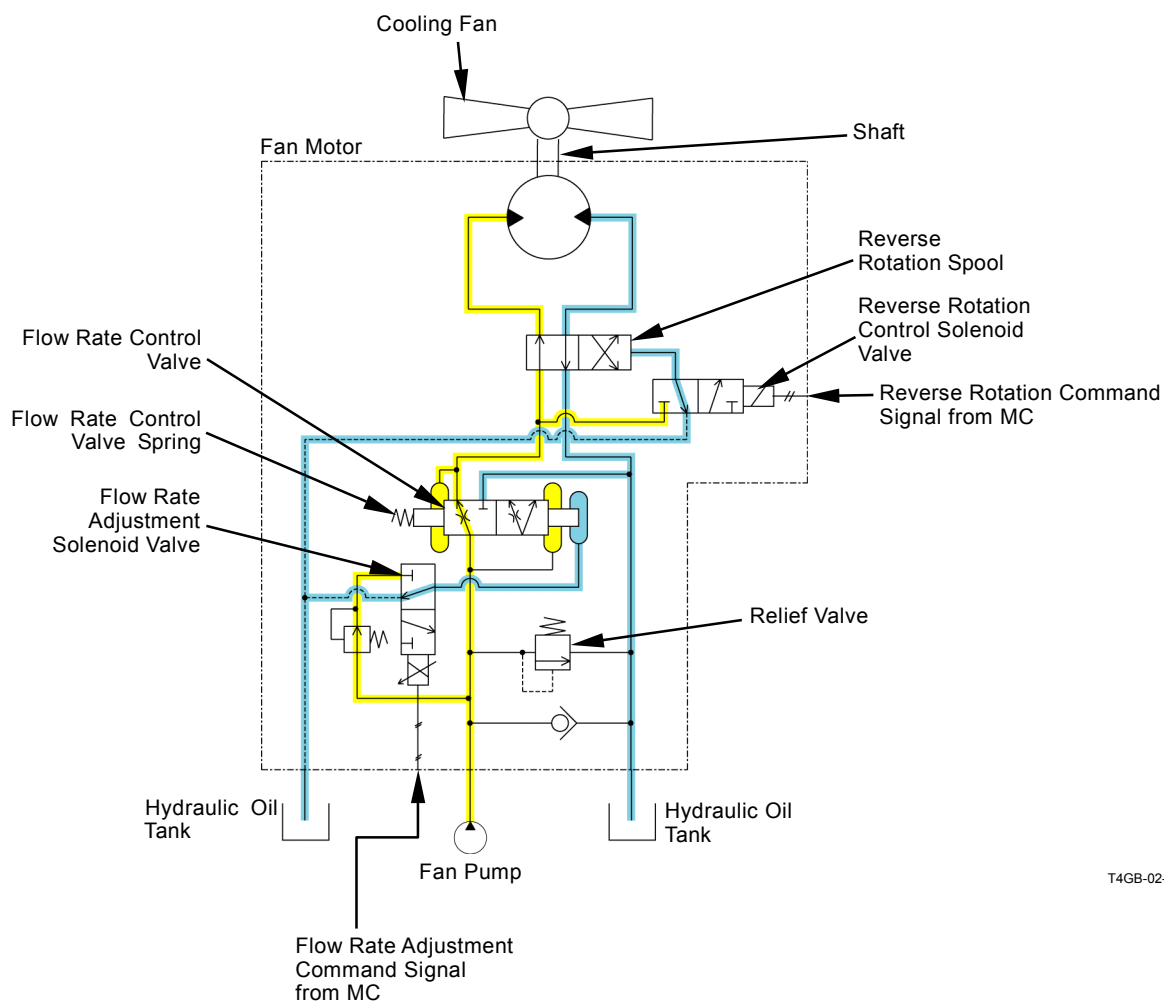
View Z



T4GB-03-03-001

COMPONENT OPERATION / Hydraulic Fan Motor

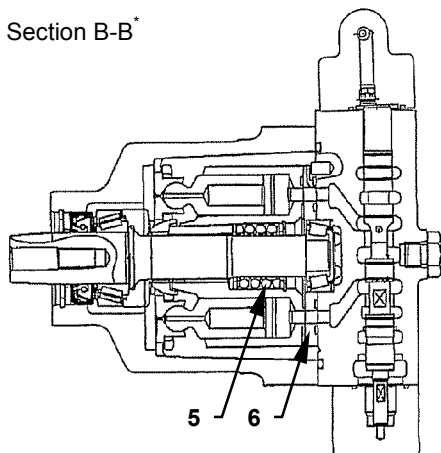
Component Layout



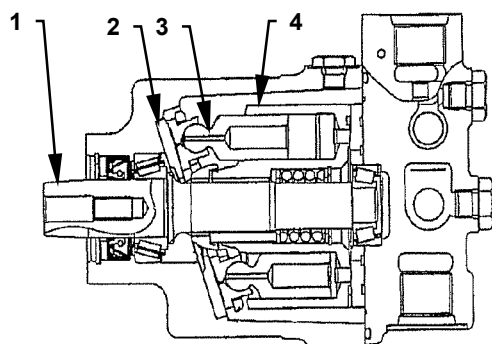
T4GB-02-02-008

COMPONENT OPERATION / Hydraulic Fan Motor

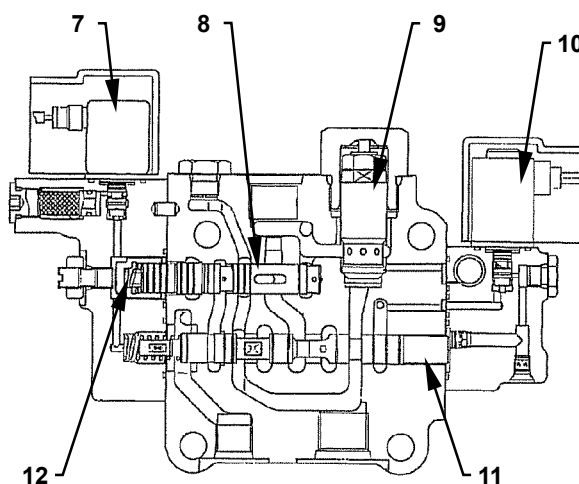
Section B-B*



Section A-A*



Section C-C*



T4GB-03-03-002

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

*: Refer to T3-3-1.

COMPONENT OPERATION / Hydraulic Fan Motor

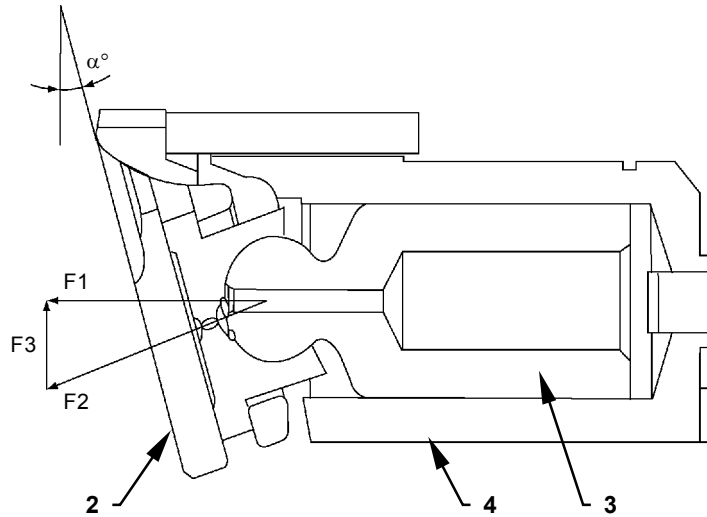
OPERATION

The fan motor is a swash plate type axial piston motor, and converts pressure oil from the fan pump into rotation.

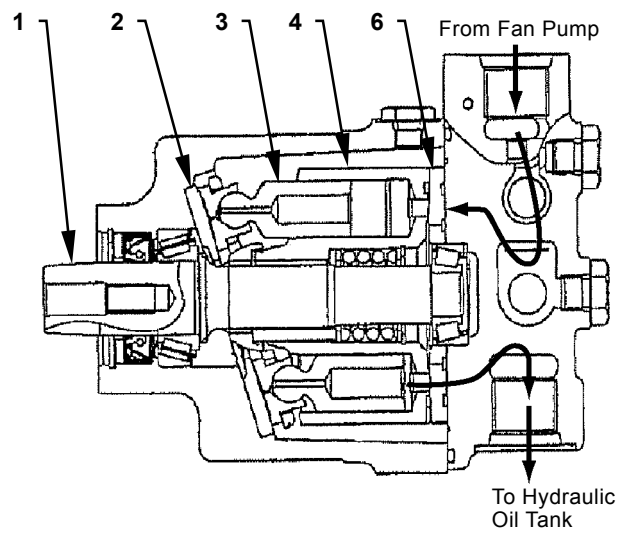
Operational Principle of Hydraulic Motor

1. Pressure oil from the fan pump is routed to cylinder block (4) through valve plate (6).
2. Pressure oil into cylinder block (4) pushes piston (3).
3. Although force F_1 acts on thrust plate (2), as thrust plate (2) is fixed to output shaft (1) at angle α° , force F_1 is divided into component forces F_2 and F_3 .
4. Resultant force F_3 is a rotation force and rotates cylinder block (4) via piston (3).
5. As cylinder block (4) is connected to shaft (1) by the splines, output shaft (1) rotates.

COMPONENT OPERATION / Hydraulic Fan Motor



T4GB-03-03-003



T4GD-03-03-001

COMPONENT OPERATION / Hydraulic Fan Motor

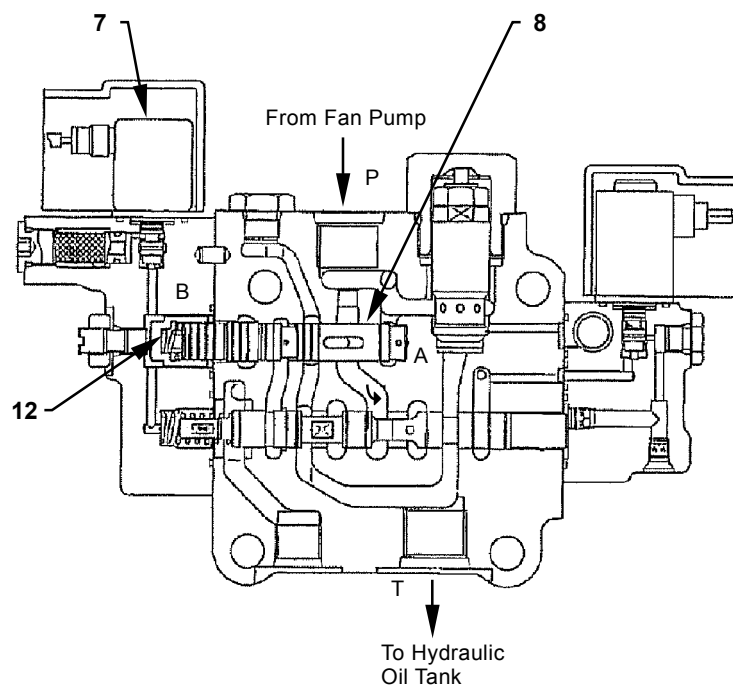
FLOW RATE CONTROL VALVE

When temperature in the coolant or oil is less than the set temperature, the flow rate control valve supplies necessary amount of pressure oil from the fan pump to the motor, and returns redundant amount of pressure oil to the hydraulic oil tank. This controls to lower the engine load and wind noise of the cooling fan.

Operation

1. Pressure oil from port P acts on side A as upstream pressure and on side B as downstream pressure of flow rate control valve spool (8), and pressure difference acts on flow rate control valve spring (12).
2. When pressure difference becomes higher than the set force, flow rate control valve spool (8) moves and redundant flow rate of pressure oil flows to port T.

COMPONENT OPERATION / Hydraulic Fan Motor



T4GB-03-03-005

COMPONENT OPERATION / Hydraulic Fan Motor

REVERSE ROTATION CONTROL VALVE

The fan motor rotates reversely by operations of the reverse rotation control solenoid valve and the reverse rotation spool.

Operation

- Reverse Rotation Control Solenoid Valve in Neutral

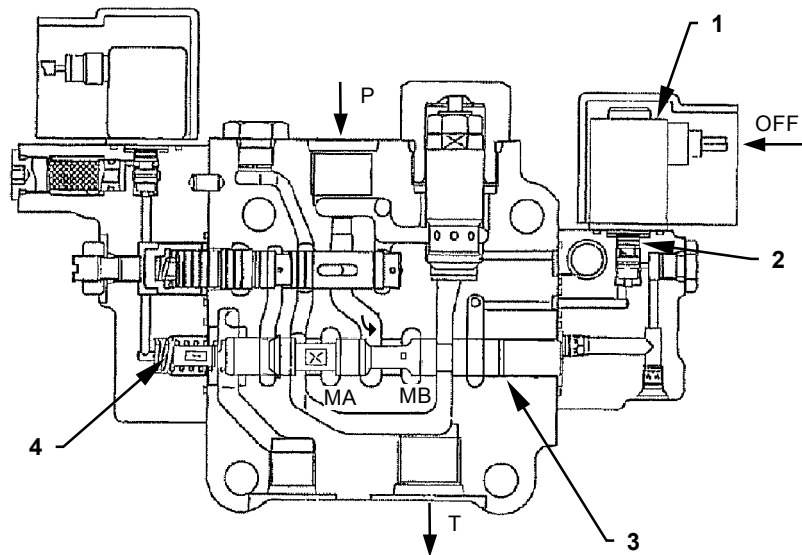
1. When reverse rotation control solenoid valve (1) is in neutral, pressure oil (P) from the fan pump is blocked by selection valve (2).
2. As reverse rotation spool (3) is pushed by spring (4), pressure oil (P) from the fan pump flows to port MB and the fan motor rotates normally.

- Reverse Rotation Control Solenoid Valve in Operation

1. When reverse rotation control solenoid valve (1) is operated, pressure oil (P) from the fan pump flows to the right end of reverse rotation spool (3) through selection valve (2).
2. When pressure oil into the right end of reverse rotation spool (3) overcomes the spring (4) force, reverse rotation spool (3) moves to the left.
3. Pressure oil (P) from the fan pump flows to port MA and the fan motor rotates reversely.

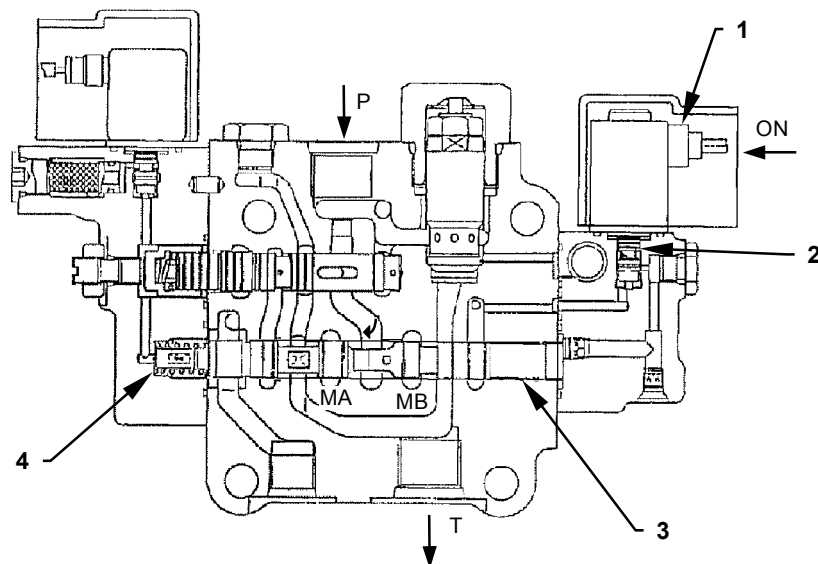
COMPONENT OPERATION / Hydraulic Fan Motor

In Neutral



T4GB-03-03-006

In Operation



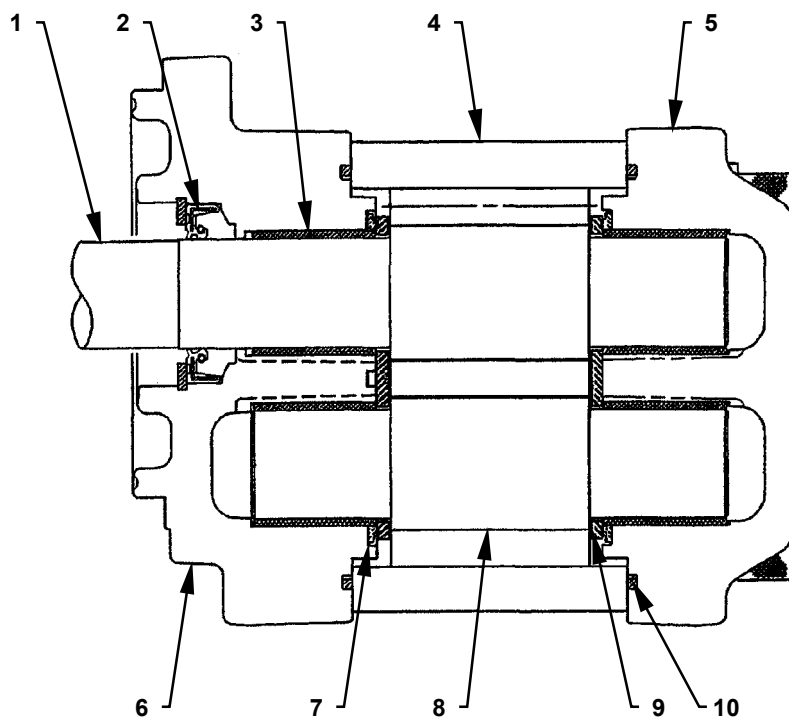
T4GB-03-03-007

COMPONENT OPERATION / Hydraulic Fan Motor

FAN PUMP

The fan pump is a gear pump and always supplies pressure oil to the fan motor when the engine is running.

The 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

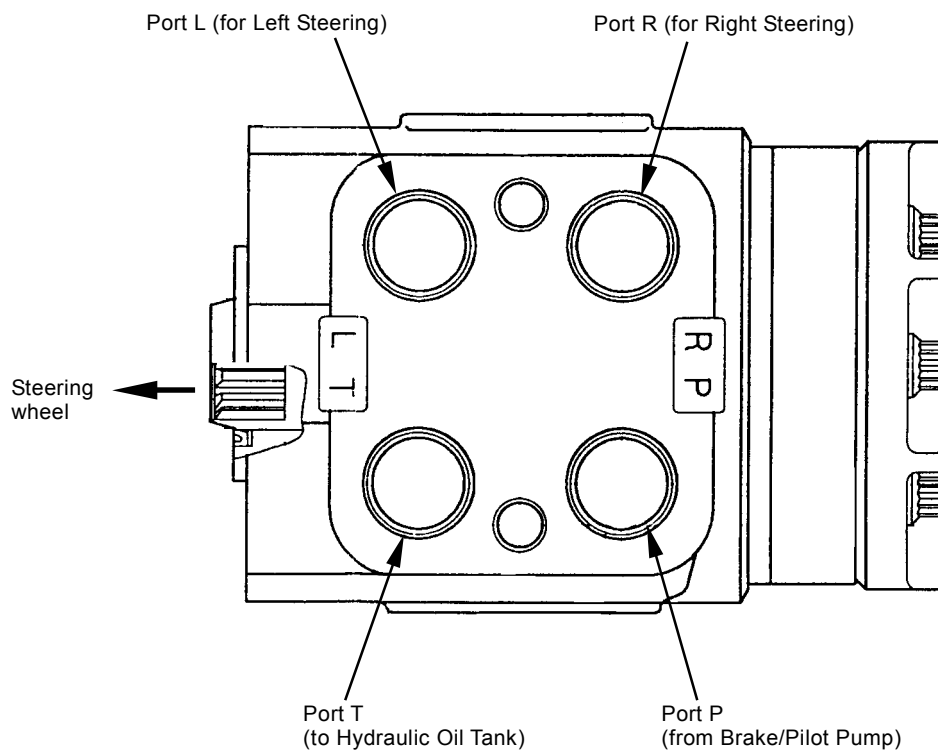
10 - Gasket

COMPONENT OPERATION / Steering Pilot Valve

OUTLINE

The steering pilot valve is located between the brake/pilot pump and the steering valve.

The steering pilot valve supplies pressure oil from the pilot pump to the steering valve in response to the movement of the steering wheel. (Refer to the Steering Circuit in the SYSTEM / Hydraulic System group)



T487-03-02-001

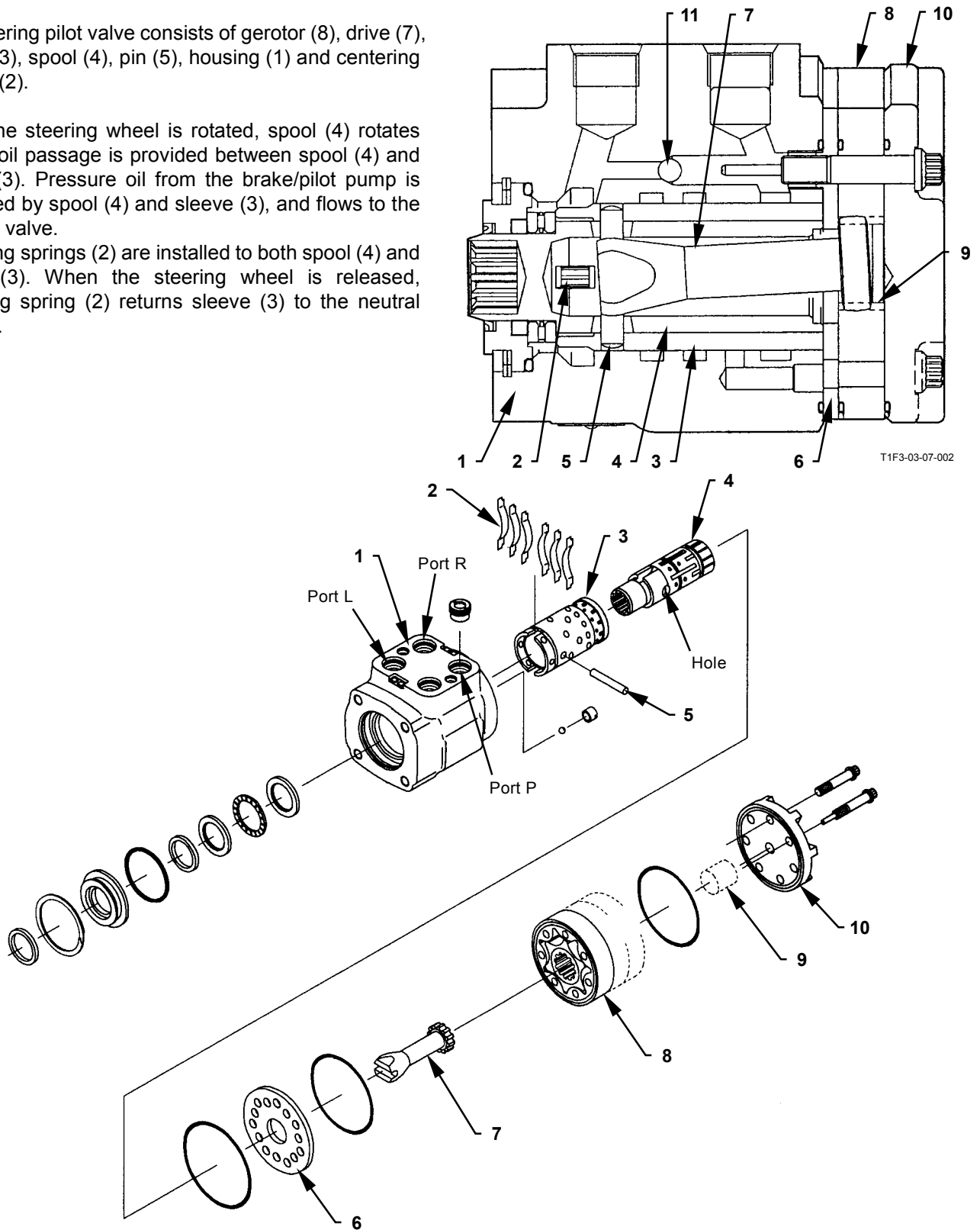
COMPONENT OPERATION / Steering Pilot Valve

CONSTRUCTION

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

When the steering wheel is rotated, spool (4) rotates and an oil passage is provided between spool (4) and sleeve (3). Pressure oil from the brake/pilot pump is controlled by spool (4) and sleeve (3), and flows to the steering valve.

Centering springs (2) are installed to both spool (4) and sleeve (3). When the steering wheel is released, centering spring (2) returns sleeve (3) to the neutral position.



T1F3-03-07-002

T4GB-03-04-008

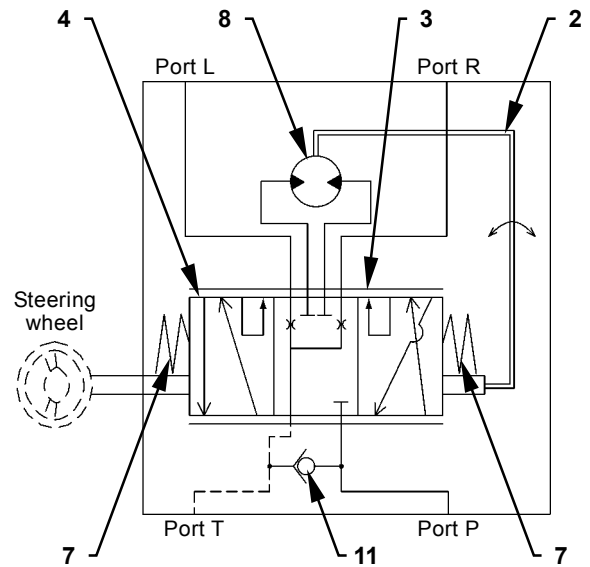
- | | | | |
|----------------------|-----------|-------------|------------------|
| 1 - Housing | 4 - Spool | 7 - Drive | 10 - Cap |
| 2 - Centering Spring | 5 - Pin | 8 - Gerotor | 11 - Check Valve |
| 3 - Sleeve | 6 - Plate | 9 - Spacer | |

COMPONENT OPERATION / Steering Pilot Valve

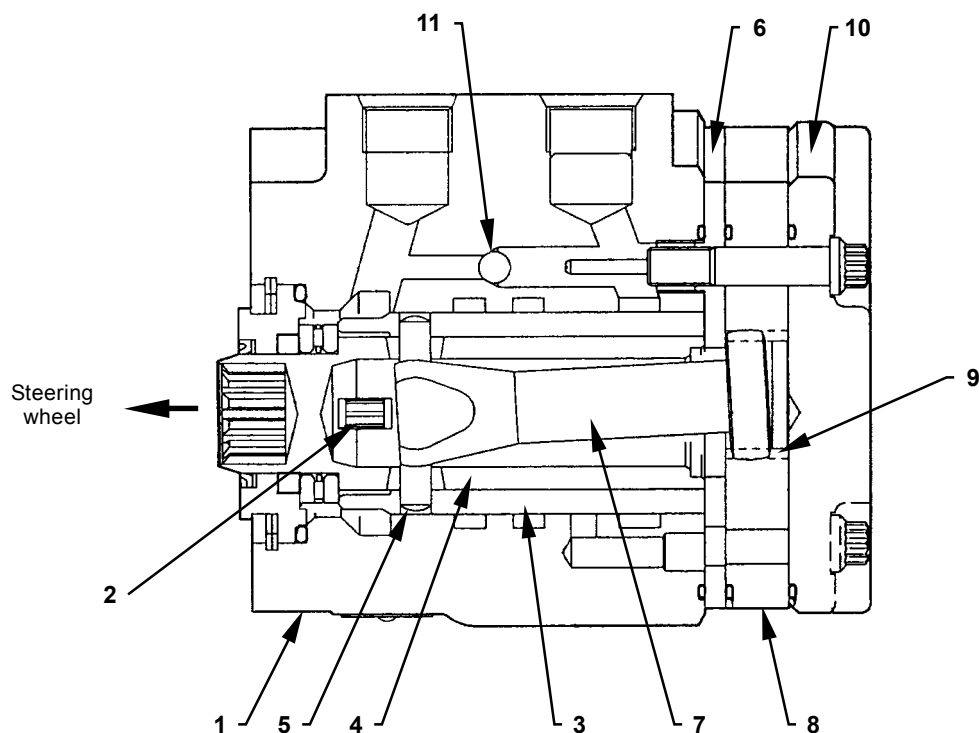
OPERATION

Sleeve (3), spool (4) and drive (7) are mutually connected by pin (5). When the steering wheel (spool (4)) is turned, a relative displacement angle arises between sleeve (3) and spool (4) due to the long hole of spool (4).

The movement of the steering wheel is transmitted only to spool (4), and port P (from the steering pump) is connected to port R (to the steering valve) or port L via sleeve (3) and spool (4).



T4GB-03-04-007

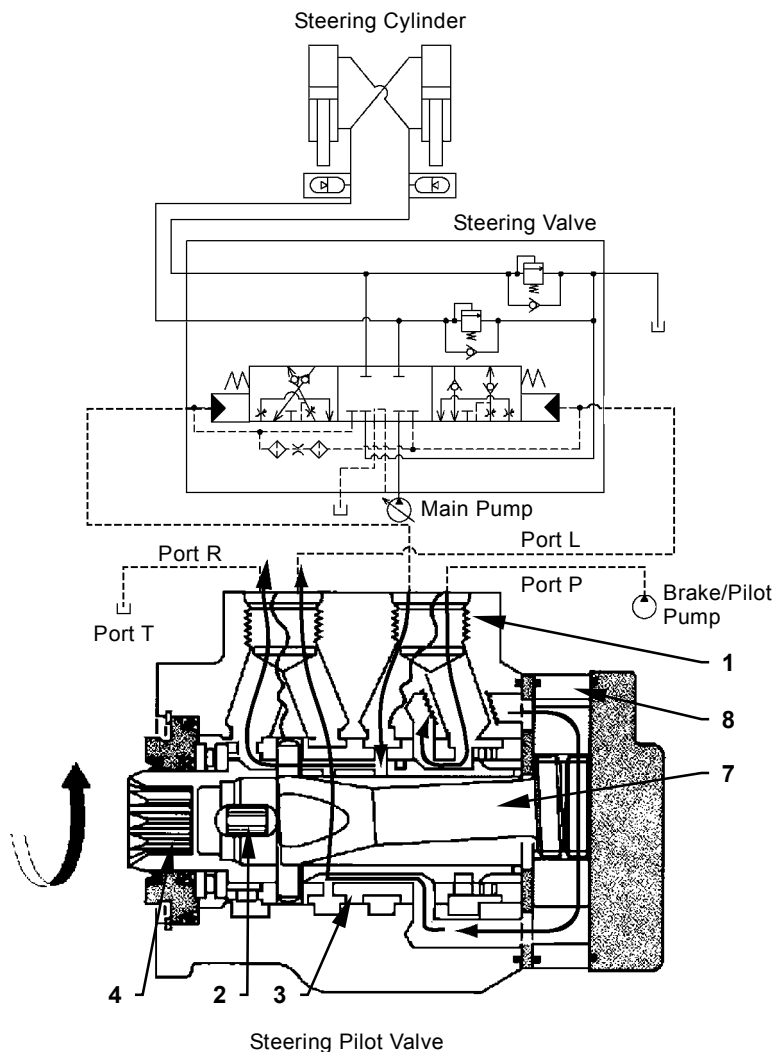


T1F3-03-07-002

COMPONENT OPERATION / Steering Pilot Valve

Left Steering

1. When the steering wheel is turned to the left, spool (4) rotates. 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 – the steering valve, and controls the steering valve.
3. The steering valve operates the steering cylinder by pressure oil from the main pump, and directs the vehicle body toward left.
4. Returning oil from the steering valve flows to port R, flows in the order of housing (1) - sleeve (3) - spool (4) - sleeve (3) - port T and returns to the hydraulic oil tank.
5. When pressure oil from the brake/pilot pump flows to gerotor (8), gerotor (8) rotates to the left. Rotation of gerotor (8) is transmitted to sleeve (3) via drive (7), and sleeve (3) rotates to the left.
6. When sleeve (3) rotates by the same amount of spool (4), the passage between sleeve (3) and spool (4) is closed and operation of the steering valve is stopped.
7. Therefore, gerotor (8) rotates in response to rotation of the steering wheel, and the steering valve is operated in response to the amount of turns of the steering wheel.



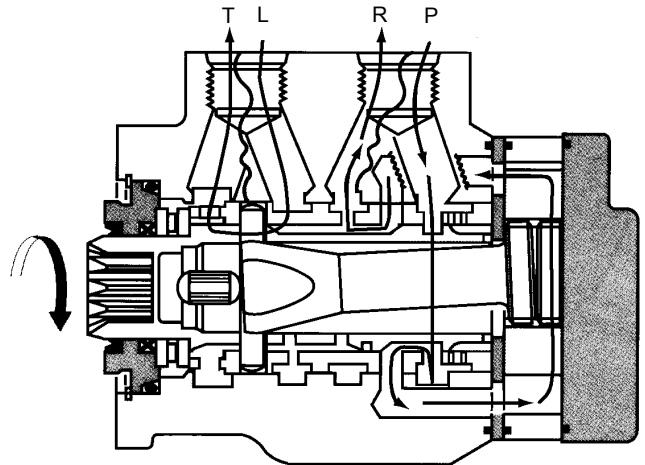
T4GB-03-04-009

COMPONENT OPERATION / Steering Pilot Valve

Right Steering

When the steering wheel is turned to the right, pressure oil from the brake/pilot pump flows in the order of port P - port R - the steering cylinder, operates the steering valve and directs the front wheel to the right.

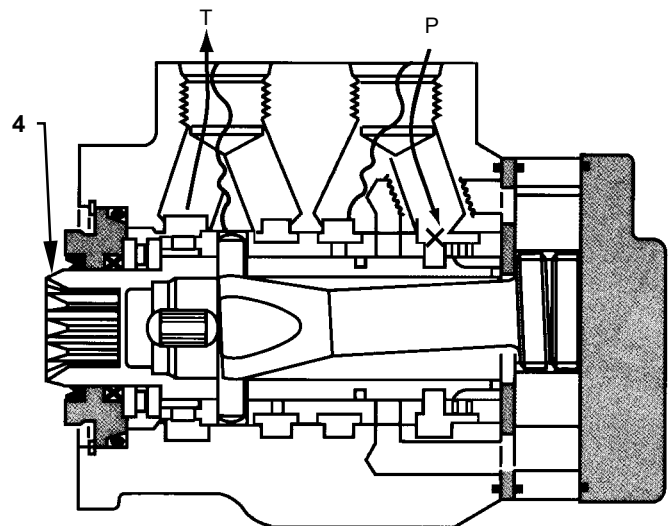
Returning oil from the steering valve flows in the order of port L - port T and returns to the hydraulic oil tank.



T4GB-03-04-010

Neutral

When the steering wheel is not turned, pressure oil from the pilot pump acts on port P in the steering pilot valve. However, pressure oil does not flow to the steering valve as it is blocked by spool (4). Therefore, the steering cylinder is not operated.



T4GB-03-04-011

COMPONENT OPERATION / Steering Pilot Valve

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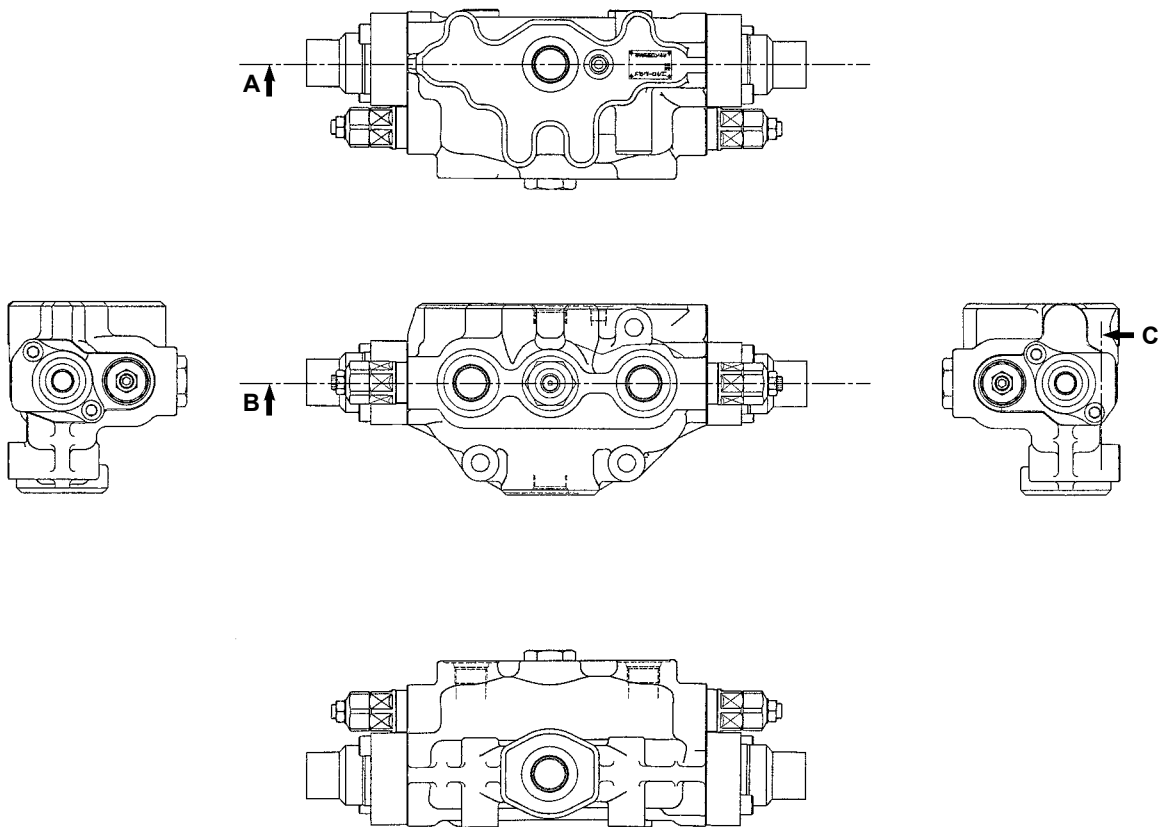
COMPONENT OPERATION / Steering Valve

OUTLINE

The steering valve is located between the main pump and the steering cylinder.

The steering valve supplies pressure oil from the main pump to the steering cylinder in response to pilot oil pressure in the steering pilot valve.

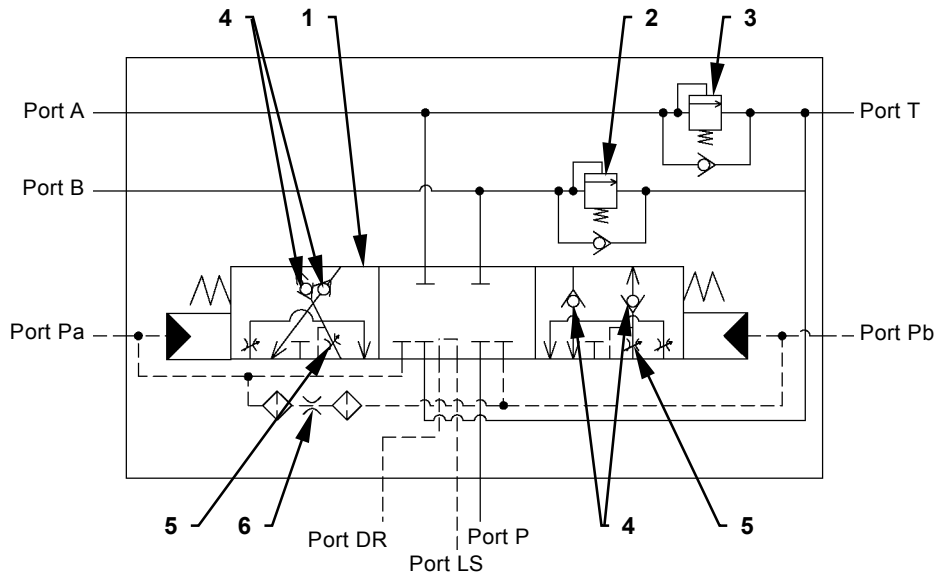
The steering cylinder is equipped with the overload relief valve.



T4GB-03-04-001

COMPONENT OPERATION / Steering Valve

Layout



T4GB-03-04-002

Port A: Right Steering Pressure

Port B: Left Steering Pressure

Port Pa: Right Steering Pilot Pressure

Port Pb: Left Steering Pilot Pressure

Port P: From Main Pump

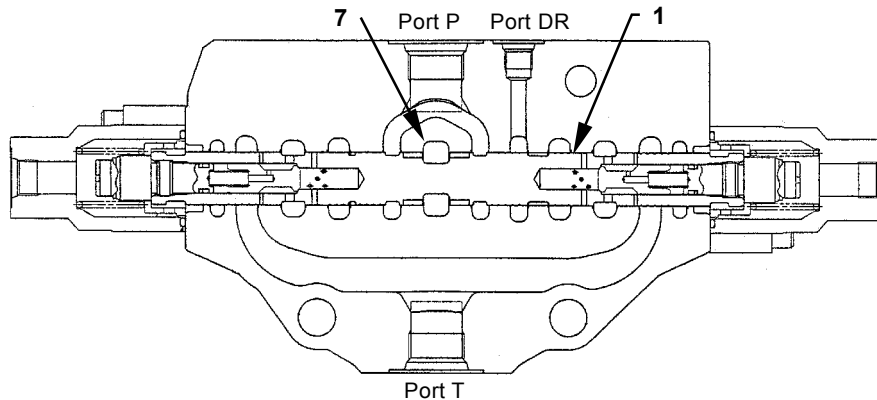
Port T: Returning to Hydraulic Oil Tank

Port LS: To Port LS of Priority Valve

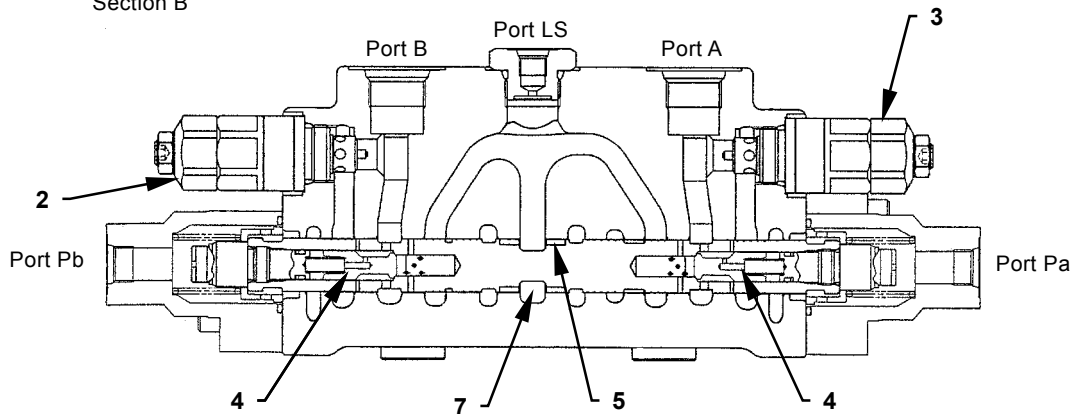
Port DR: Returning to Hydraulic Oil Tank

COMPONENT OPERATION / Steering Valve

Section A

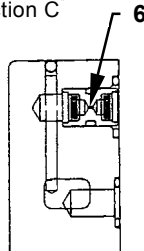


Section B



T4GB-03-04-003

Section C



T4GB-03-04-006

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

*: Refer to T3-5-1

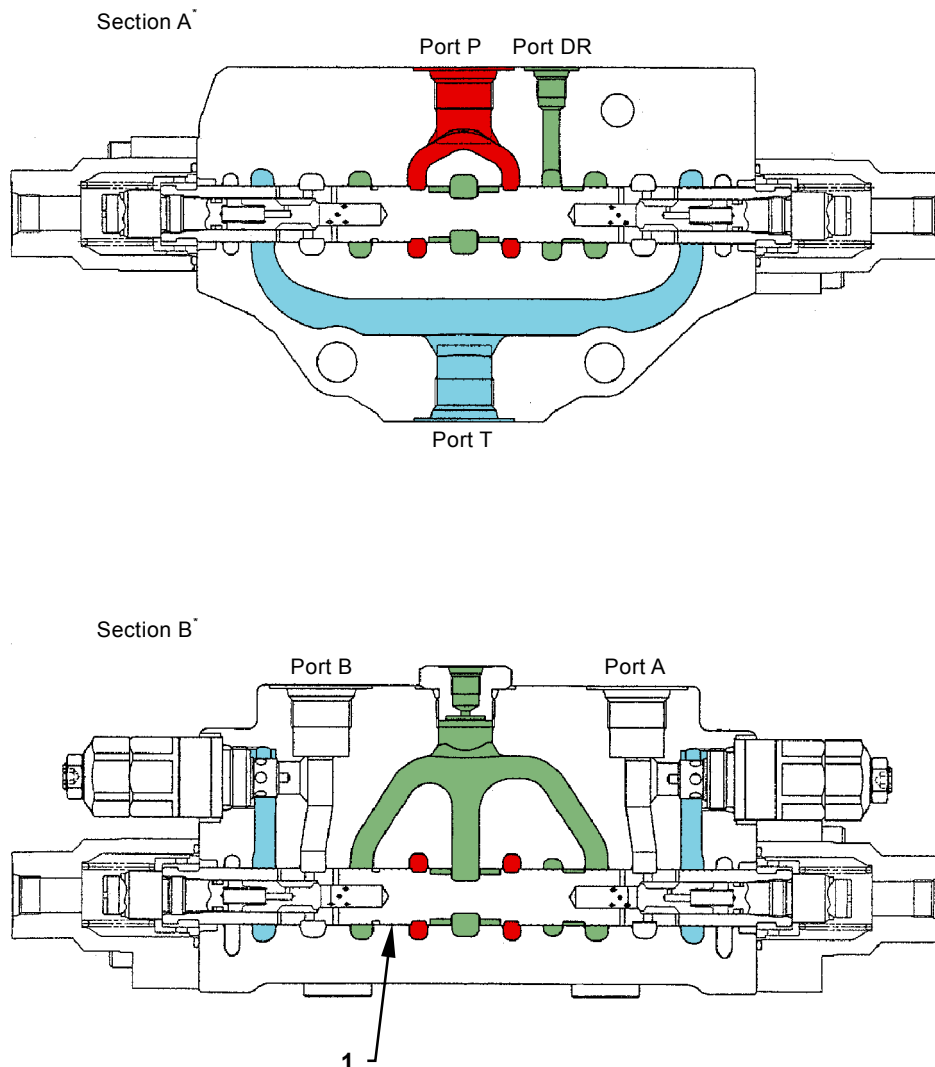
COMPONENT OPERATION / Steering Valve

OPERATION

In Neutral

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

COMPONENT OPERATION / Steering Valve



T4GB-03-04-004

*: Refer to T3-5-1.

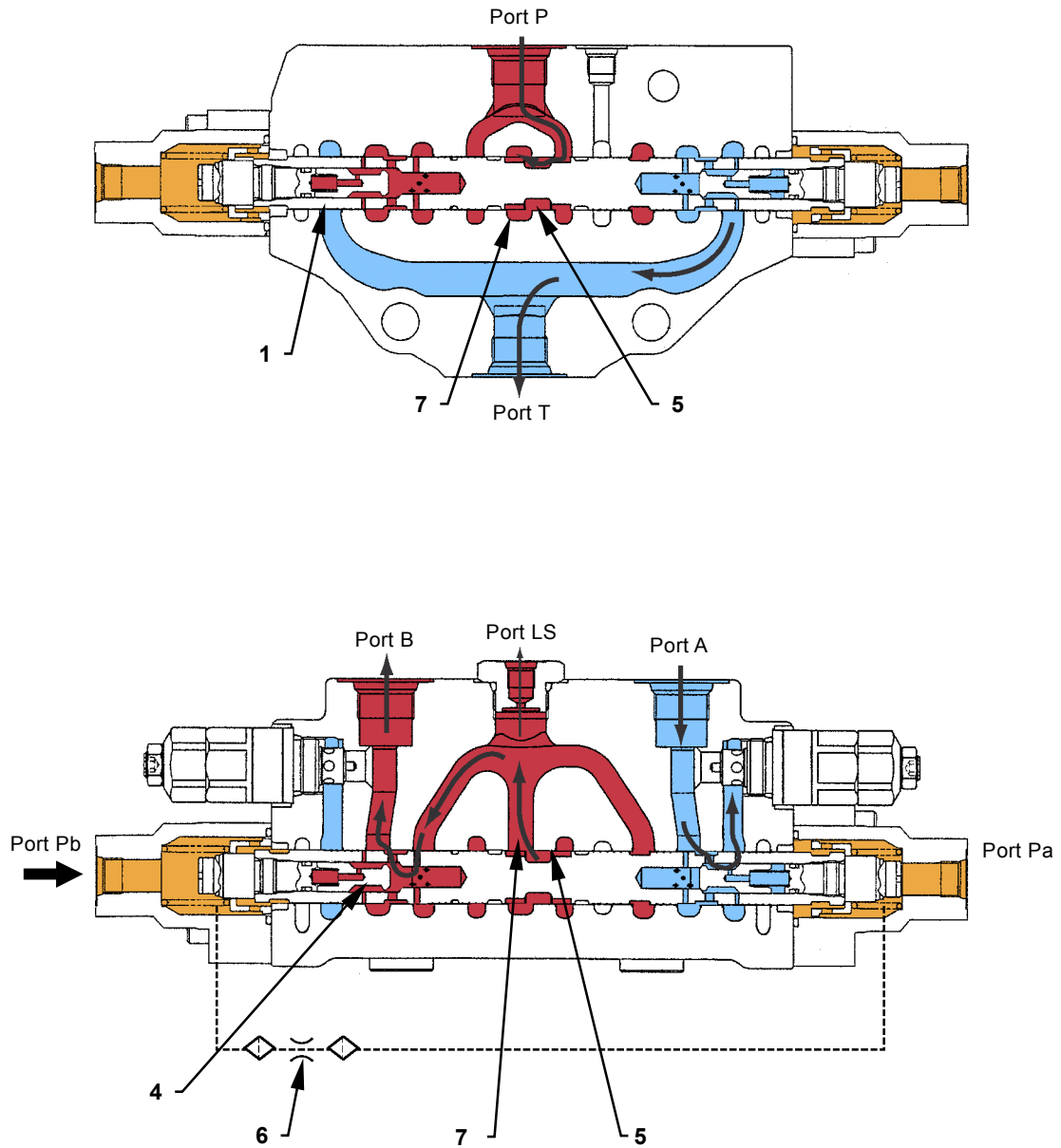
COMPONENT OPERATION / Steering Valve

When Steering Left

1. When the steering handle is turned to the left, pilot pressure oil is supplied to port Pb from the steering pilot valve and spool (1) moves to the right.
2. Pressure oil from the main pump is supplied to the steering valve from port P, and supplied 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. Returning oil from the steering cylinder enters spool (1) through port A and returns to the hydraulic oil tank through port T.
5. Pilot pressure oil flowing into port Pb pushes spool (1) at the port Pb side and flows to port Pa after being reduced by fixed orifice (6) at the same time. This reduces the shock caused by fast operation of the handle. (Refer to the Layout on T3-5-2 and the Steering Circuit in the SYSTEM / Hydraulic System group.)

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

COMPONENT OPERATION / Steering Valve



T4GB-03-04-005

COMPONENT OPERATION / Steering Valve

STEERING OVERLOAD RELIEF VALVE

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

Relief Operation

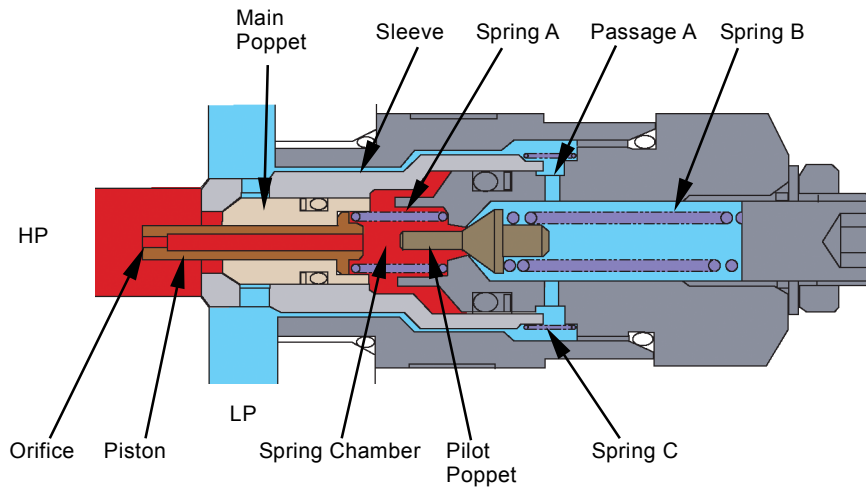
1. Pressure at port HP (steering cylinder circuit) acts on the pilot poppet through the orifice in the piston.
2. When pressure at port HP reaches the set force of spring B, the pilot poppet opens. Pressure oil flows to port LP (hydraulic oil tank) through passage A and the periphery of the sleeve.
3. At this time, pressure difference arises between port HP and the spring chamber by the orifice.
4. When this pressure difference reaches the set force of spring A, the piston and the main poppet open, and pressure oil at port HP flows to port LP.
5. Consequently, pressure in the steering cylinder circuit decreases.
6. If pressure in the steering cylinder circuit decreases to the set pressure value, the piston and the main poppet are closed by the force of spring A.

Make-Up Operation

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

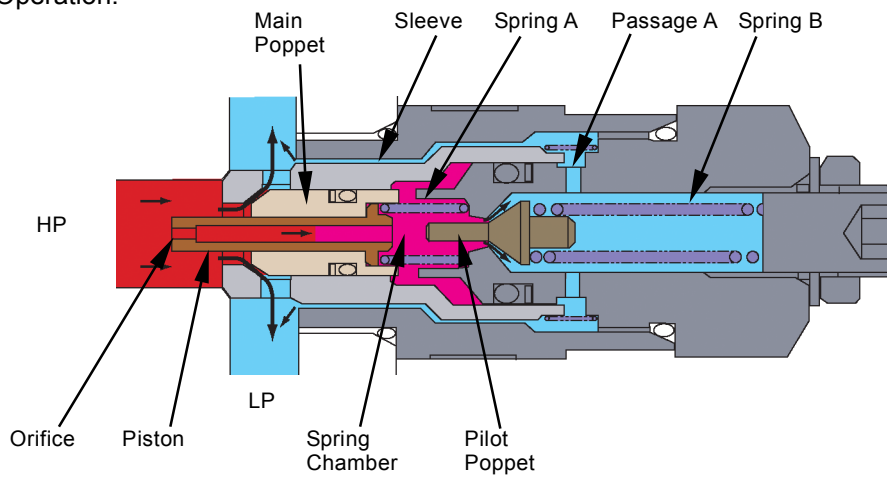
COMPONENT OPERATION / Steering Valve

During Normal Operation:



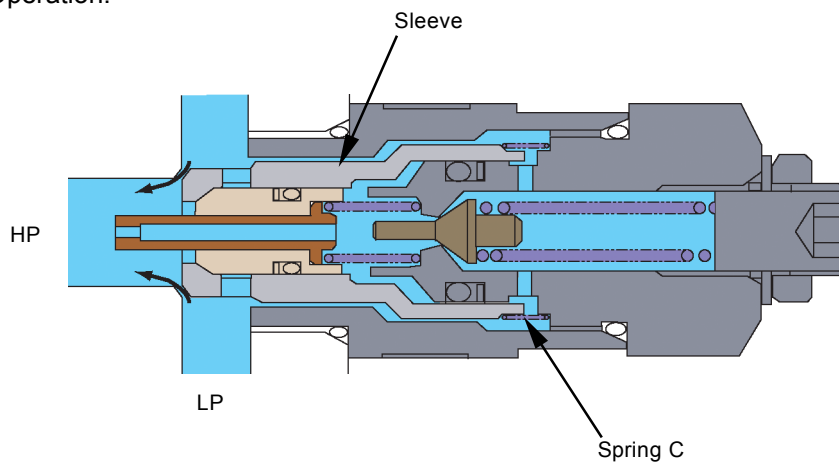
T4GB-03-02-030

During Relief Operation:



T4GB-03-02-031

During Make-Up Operation:



T4GB-03-02-032

COMPONENT OPERATION / Steering Valve

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COMPONENT OPERATION / Pilot Valve

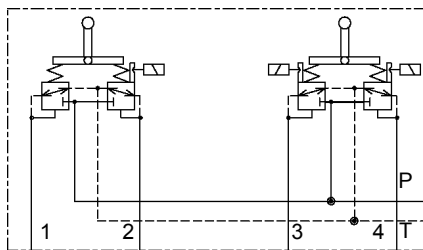
OUTLINE (STANDARD LEVER TYPE PILOT VALVE FOR FRONT ATTACHMENT)

The pilot valve is a valve to control pilot pressure oil to move the spool of the control valve. The pilot valve, which is provided with the PPC (Pressure Proportional Control Valve) function, outputs pressure corresponding to the control lever stroke of the control lever, and moves the spool of the control valve.

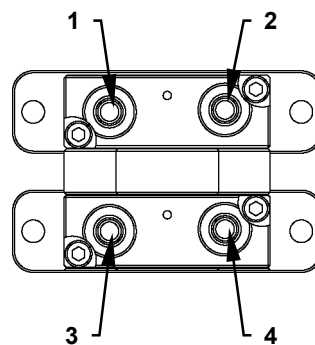
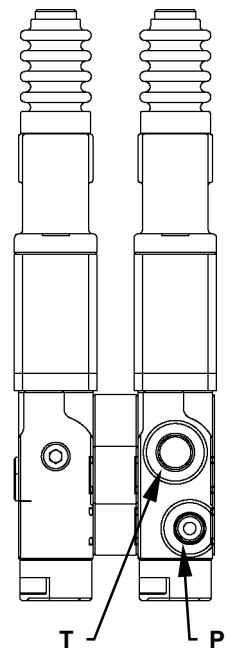
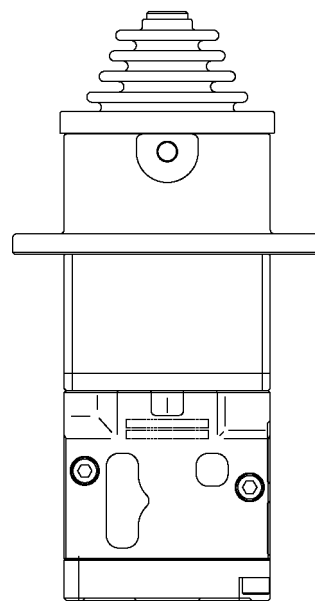
The two-direction, four-port type is adopted for the front attachment.

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

Hydraulic Symbol



T4GB-03-05-001



T4GD-03-06-001

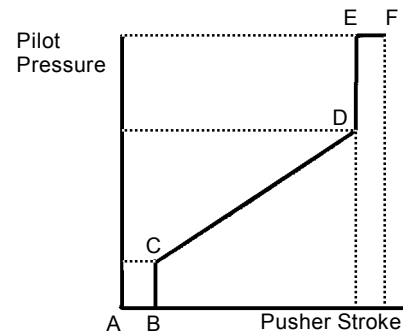
COMPONENT OPERATION / Pilot Valve

OPERATION

At Neutral (Pusher Stroke: Between A and B)

1. At the neutral position of the control lever, spool (7) completely blocks pressure oil of port P. As the outlet port is connected to port T through the notch part of spool (7), pressure at the output port is equal to pressure in the hydraulic oil 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 while 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:** The lever stroke during the period when clearance (A) becomes zero is play of the control lever.

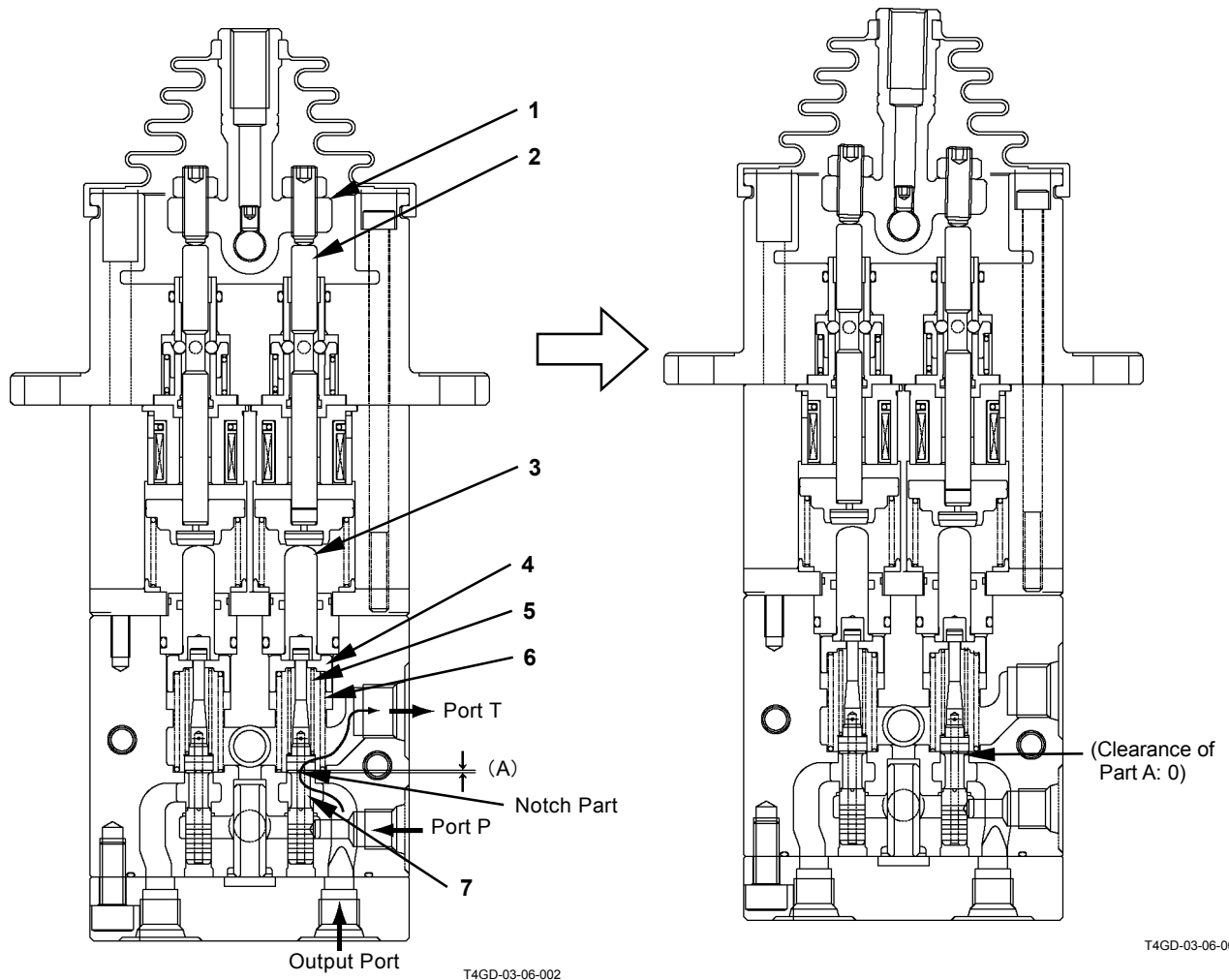


Output Diagram

T505-02-07-006

COMPONENT OPERATION / Pilot Valve

Pusher Stroke: Between A and B



1 - Lever
2 - Push Rod

3 - Pusher
4 - Spring Guide

5 - Balance Spring
6 - Return Spring

7 - Spool

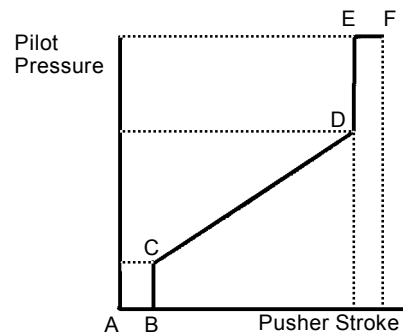
COMPONENT OPERATION / Pilot Valve

During Metering or Pressure Decrease (Pusher Stroke: Between C and D)

1. When the control lever is further tilted, the output port is connected to port P via spool (7).
2. Pressure oil of port P flows into the output port through spool (7) and pressure at the output port is raised.
3. Pressure at the output port acts on surface B of spool (7) and tends to push spool (7) upward.
4. In case the force push spool (7) upward is smaller than the spring force of balance spring (5), balance spring (5) is not compressed. Therefore, port P and output port remain connected, and pressure at the output port keeps rising.
5. When pressure at the output port rises further, the force pushing spool (7) upward increases. If this force becomes larger than the force of balance spring (5), spool (7) moves upward by compressing balance spring (5).
6. When spool (7) moves upward, the output port is not connected to port P 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 downward, and pressure at the output port is the balanced pressure acting on spool (7) and the spring force.

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 to port P through the notch part of spool (7) although pressure at the output port is raised, and as spool (7) does not move upward.
3. Consequently, pressure at the output port side is equal to pressure at port P. Stroke amount C of the pusher determines the total stroke of the lever.

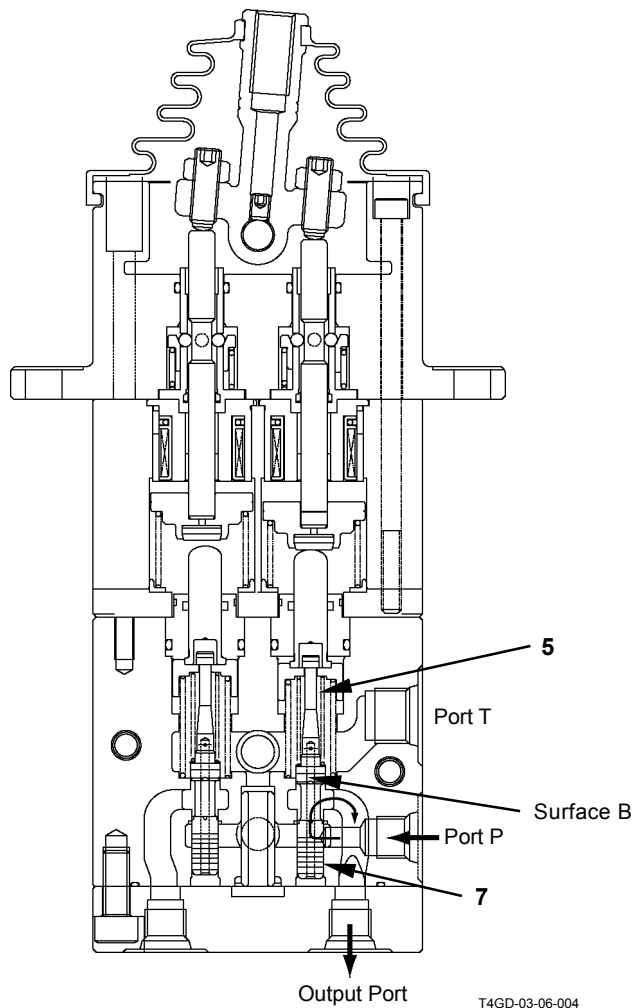


Output Diagram

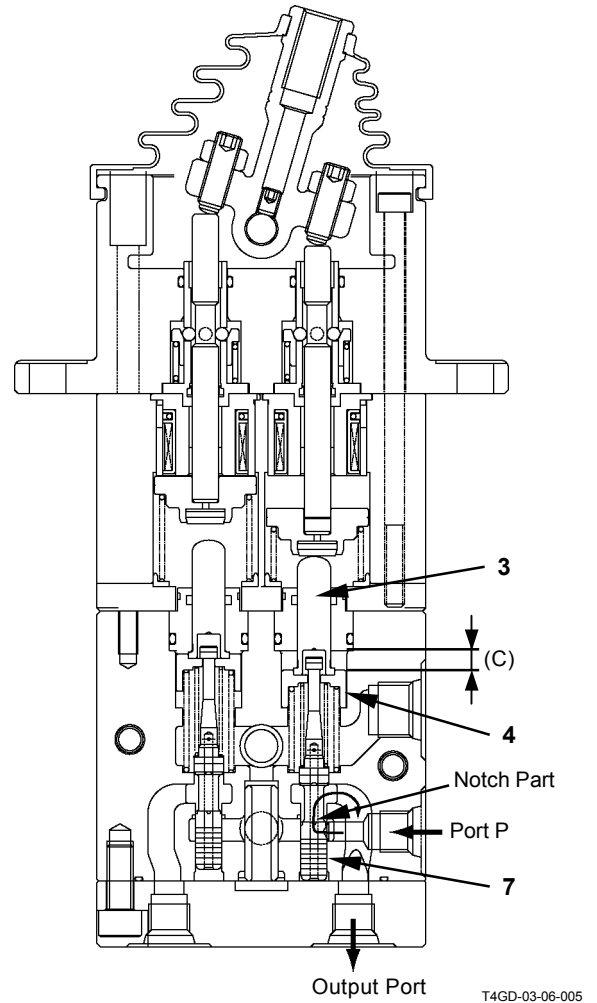
T505-02-07-006

COMPONENT OPERATION / Pilot Valve

Pusher Stroke: Between C and D



Pusher Stroke: Between E and F



3- Pusher

4 - Spring Guide

5 - Balance Spring

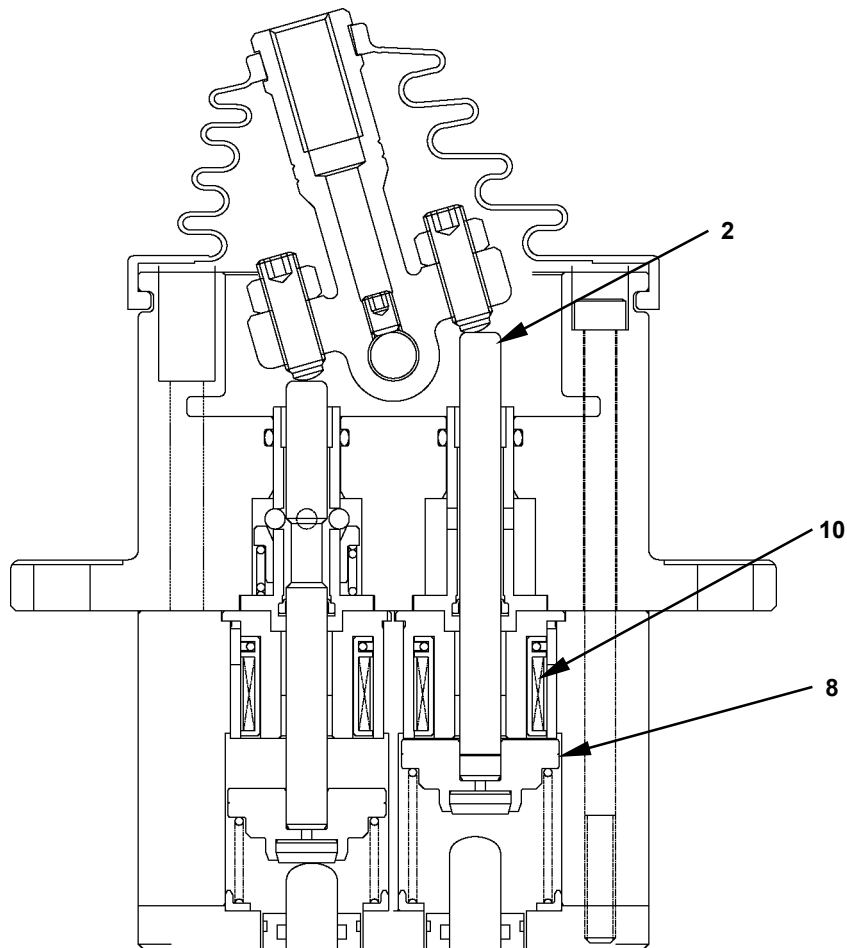
7 - Spool

COMPONENT OPERATION / Pilot Valve

ELECTROMAGNETIC DETENT

The 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 upward by the spring force.
2. If the control lever is operated to its stroke end, plate (8) of the other is attracted by coil assembly (10).
3. Adsorbed condition is retained until the coil assembly (10) is unexcited or until attraction is forcefully cancelled by operating the control lever to the other direction.



T4GB-03-05-007

2 - Push Rod

8 - Plate

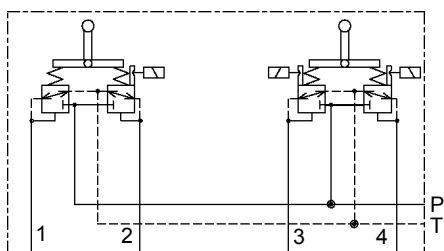
10 - Coil Assembly

COMPONENT OPERATION / Pilot Valve

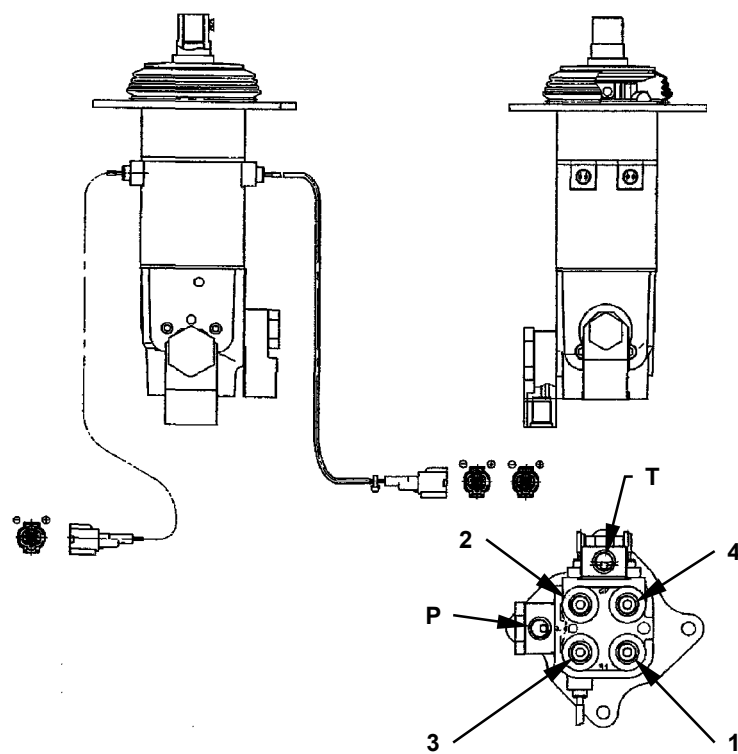
OUTLINE (JOYSTICK TYPE PILOT VALVE FOR FRONT ATTACHMENT)

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

Hydraulic Symbol



T4GB-03-05-001



T4GD-03-06-006

COMPONENT OPERATION / Pilot Valve

OPERATION

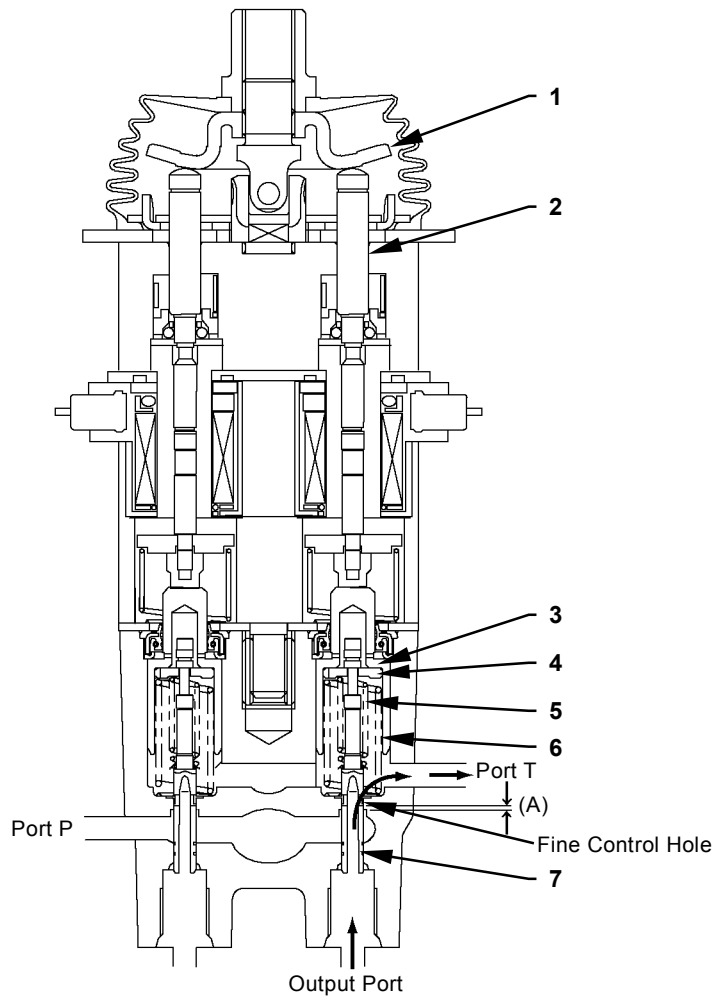
At Neutral

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

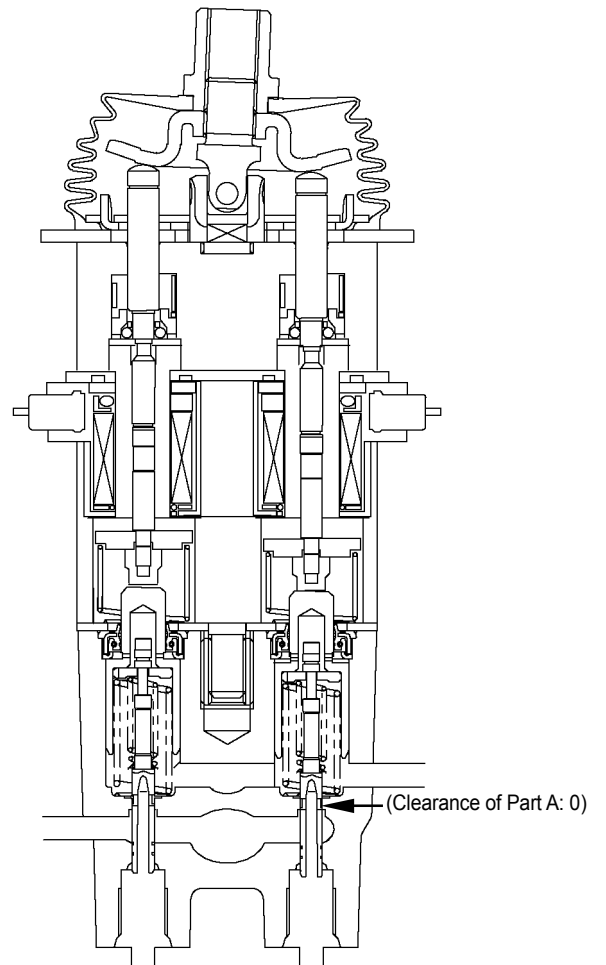
 **NOTE:** *The lever stroke during the period when clearance (A) becomes zero is play of the control lever.*

COMPONENT OPERATION / Pilot Valve

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 | |

COMPONENT OPERATION / Pilot Valve

During Metering or Pressure Decrease

1. When the control lever is further tilted, the output port is connected to port P via the fine control hole on spool (7).
2. Pressure oil of port P flows into the output port through spool (7) and pressure at the output port is raised.
3. Pressure at the output port acts on spool (7) and tends to push spool (7) upward.
4. In case the force pushing spool (7) upward 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 pressure at the output port keeps rising.
5. When pressure at the output port rises further, the force pushing spool (7) upward increases. If this force becomes larger than the force of balance spring (5), spool (7) moves upward by compressing balance spring (5).
6. When spool (7) moves upward, the output port is not connected to port P 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 downward, and pressure at the output port is the balanced pressure acting on spool (7) and the spring force.

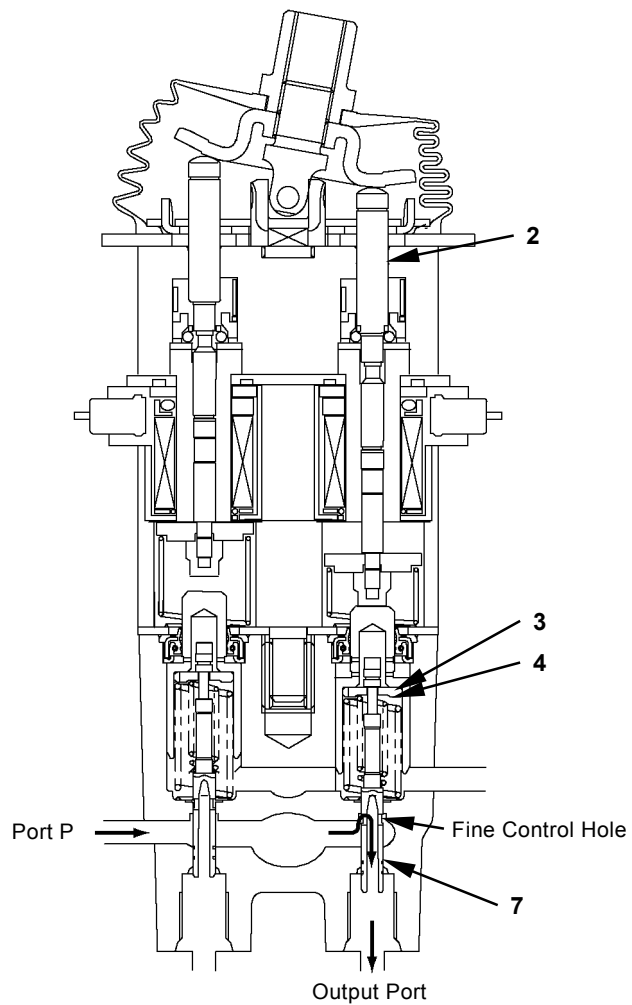
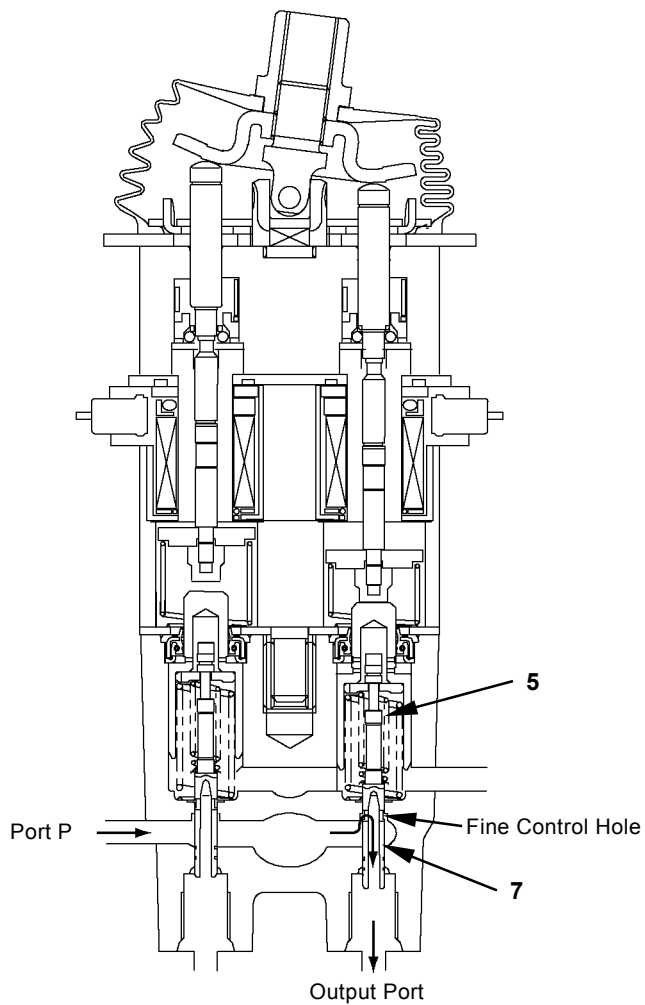
Full Stroke

1. When the control lever is fully stroked, disc (7) pushes push rod (2) and piston (3) downward, and spring guide (4) pushes spool (7) downward.
2. The output port is connected to port P via the fine control hole on spool (7).
3. As spool (7) is pushed down by spring guide (4), the output port remains connected via the fine control hole of spool (7) although pressure at the output port is raised and as spool (7) does not move upward.
4. Consequently, pressure at the output port side is equal to pressure at port P.

COMPONENT OPERATION / Pilot Valve

During Metering or Pressure Decrease

Full Stroke



2 - Push Rod
3 - Piston

4 - Spring Guide
5 - Balance Spring

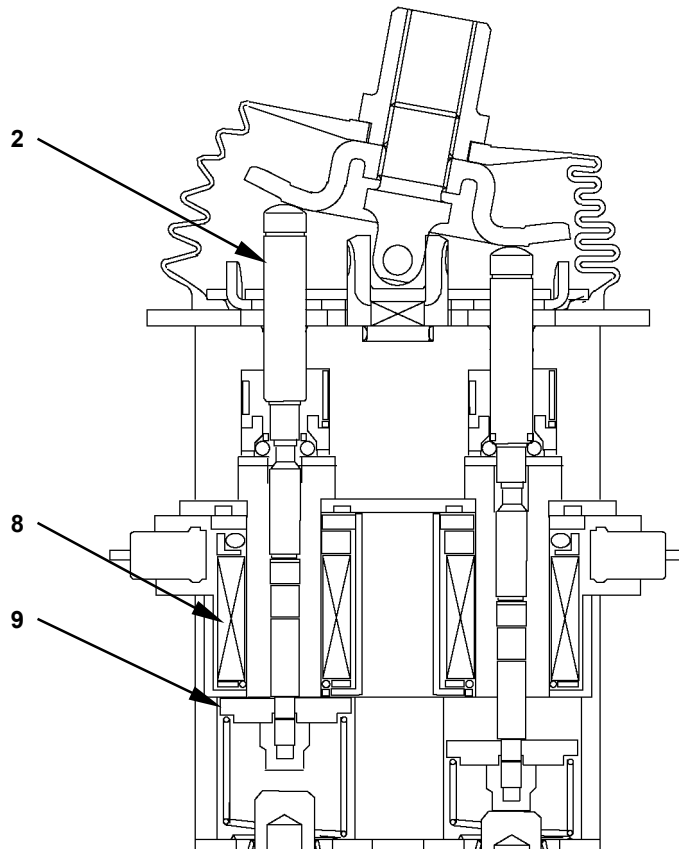
7 - Spool

COMPONENT OPERATION / Pilot Valve

ELECTROMAGNETIC DETENT

The 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 upward by the spring force.
2. If the control lever is operated to its stroke end, plate (9) of the other is attracted by coil assembly (8).
3. Adsorption condition is retained until coil assembly (8) is unexcited or until attraction is forcefully cancelled by operating the control lever to the other direction.



T4GB-03-05-013

2 - Push Rod

8 - Coil Assembly

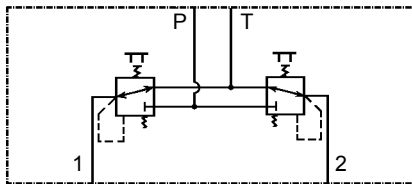
9 - Plate

COMPONENT OPERATION / Pilot Valve

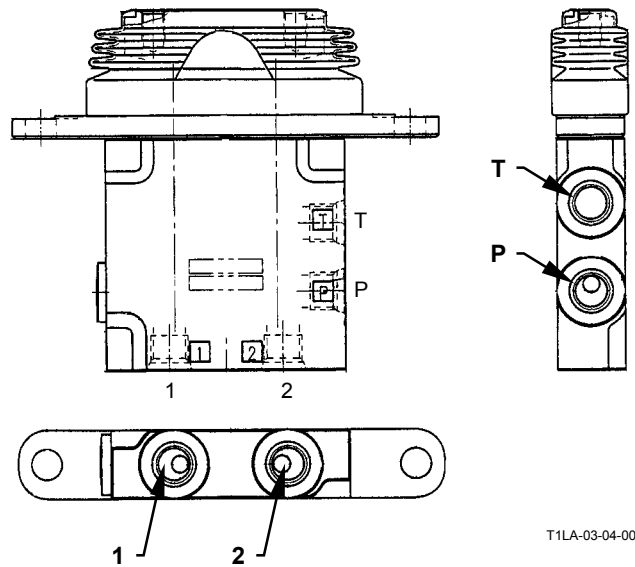
OUTLINE (TWO-DIRECTIONAL LEVER TYPE PILOT VALVE FOR ADDITIONAL CIRCUIT) (OPTIONAL)

Port No.	
1	Optional
2	Optional

Hydraulic Symbol



T554-02-07-009



T1LA-03-04-001

COMPONENT OPERATION / Pilot Valve

OPERATION

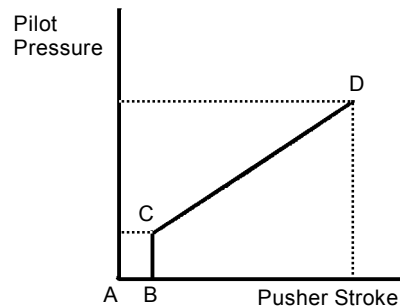
At Neutral (Pusher Stroke: Between A and B)

1. At the neutral position of the control lever, spool (7) completely blocks pressure oil of port P. As the outlet port is connected to port T through the notch part of spool (7), pressure at the output port is equal to pressure in the hydraulic oil tank.
2. When the control lever is moved slightly, cam (1) is tilted, and pusher (2) and spring guide (4) are pushed in. Pusher (2) and spring guide (4) remain mutually connected, move downward while 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.
5. When pressure at the output port rises further, the force pushing spool (7) upward increases. If this force becomes larger than the force of balance spring (5), spool (7) moves upwards by compressing balance spring (5).
6. When spool (7) moves upward, notch part (B) 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 spool (7) is pushed downward, and pressure at the output port is the balanced pressure acting on spool (7) and the spring force.

 **NOTE:** The 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 on spool (7) is connected to notch part (B).
2. Pressure oil of port P flows into the output port through notch part (B) and the hole part on spool (7), and pressure at the output port is raised.
3. Pressure at the output port acts on the bottom of spool (7) and tends to push spool (7) upward.
4. In case the force pushing spool (7) upward 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 pressure at the output port keeps rising.

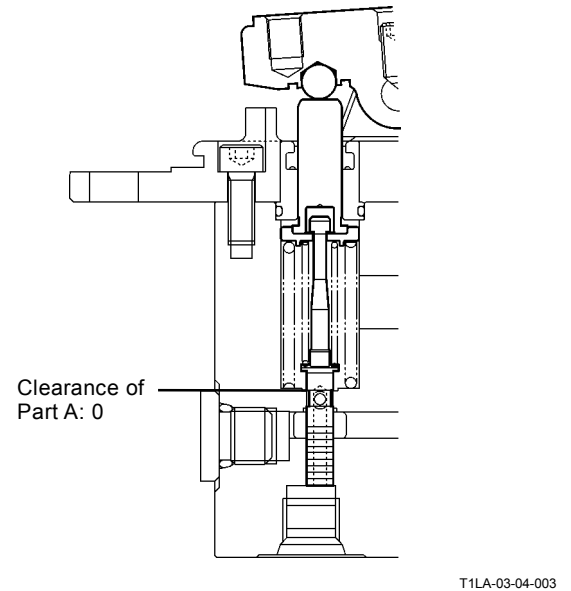
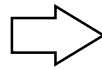
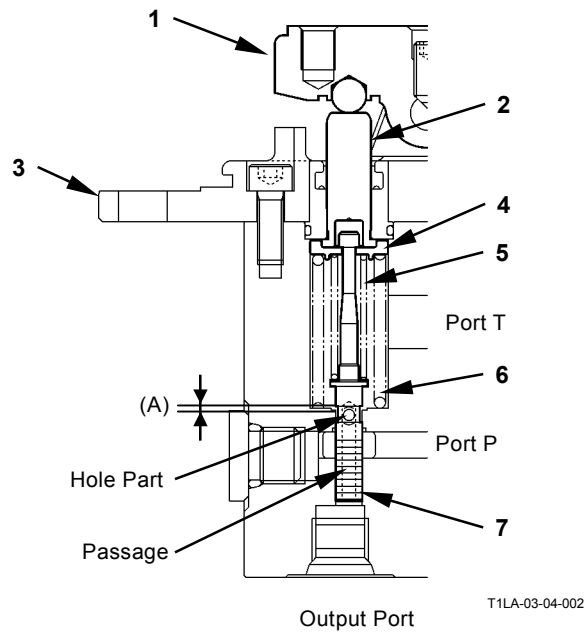


Output Diagram

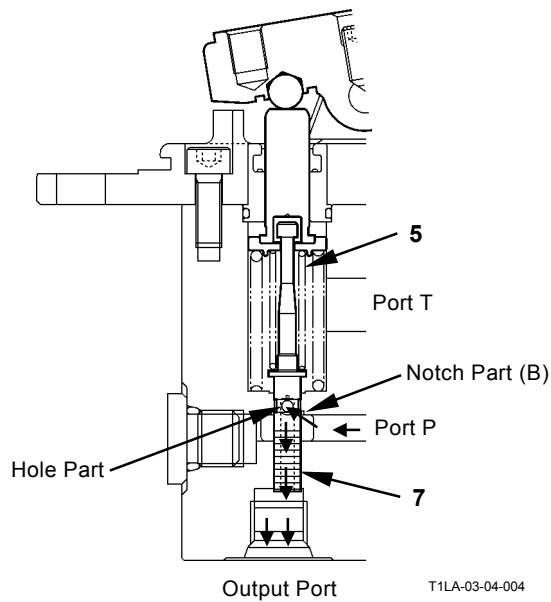
T1F3-03-09-004

COMPONENT OPERATION / Pilot Valve

Pusher Stroke: Between A and B



Pusher Stroke: Between C and D



1 - Cam
2 - Pusher

3 - Plate
4 - Spring Guide

5 - Balance Spring
6 - Return Spring

7 - Spool

COMPONENT OPERATION / Pilot Valve

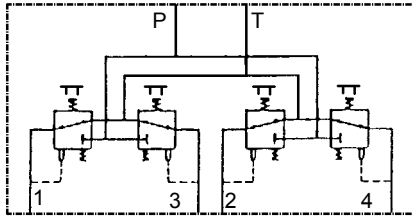
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COMPONENT OPERATION / Pilot Valve

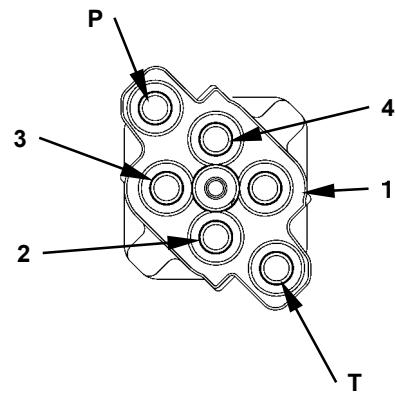
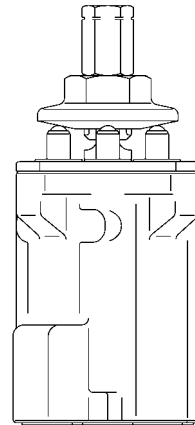
OUTLINE (JOYSTICK TYPE PILOT VALVE FOR ADDITIONAL CIRCUIT) (OPTIONAL)

Port No.	
1	Optional
2	Optional
3	Optional
4	Optional

Hydraulic
Symbol



T105-02-07-020



T1V1-03-04-001

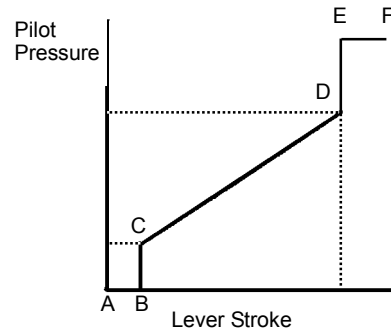
COMPONENT OPERATION / Pilot Valve

OPERATION

The head of spool (6) is supported by the top surface of spring guide (3). Spring guide (3) is lifted up by return spring (5).

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

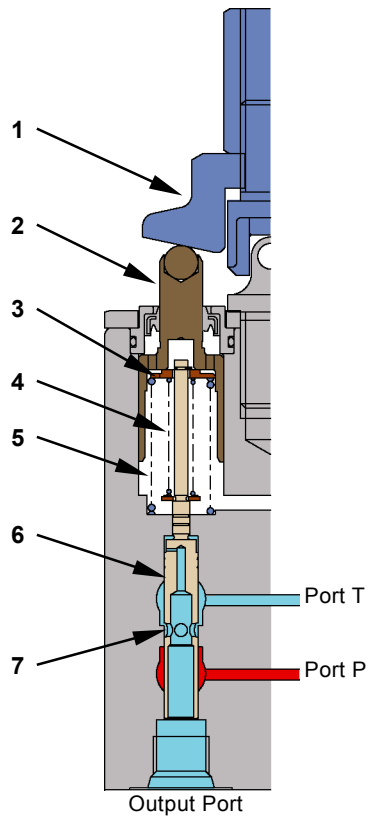
1. At neutral, spool (6) completely blocks pressure oil of port P (from the pilot pump). As the output port is connected to port T (to the hydraulic oil tank) through the internal passage of spool (6).
2. Therefore, pressure at the output port (to the control valve) is equal to pressure at port T.
3.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



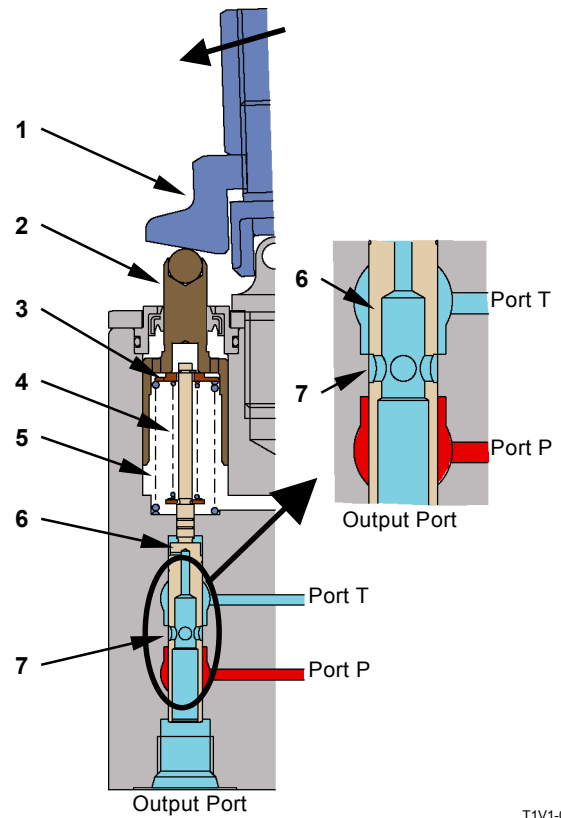
T523-02-05-001

Output Diagram

COMPONENT OPERATION / Pilot Valve



T1V1-03-04-007



T1V1-03-04-008

1 - Cam
2 - Pusher

3 - Spring Guide
4 - Balance Spring

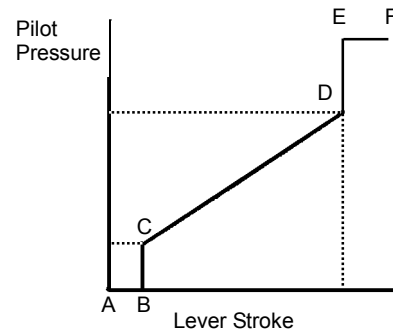
5 - Return Spring
6 - Spool

7 - Hole Part

COMPONENT OPERATION / Pilot Valve

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

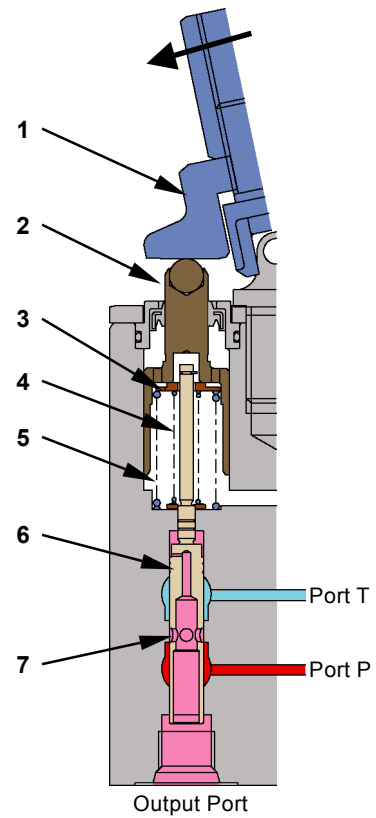
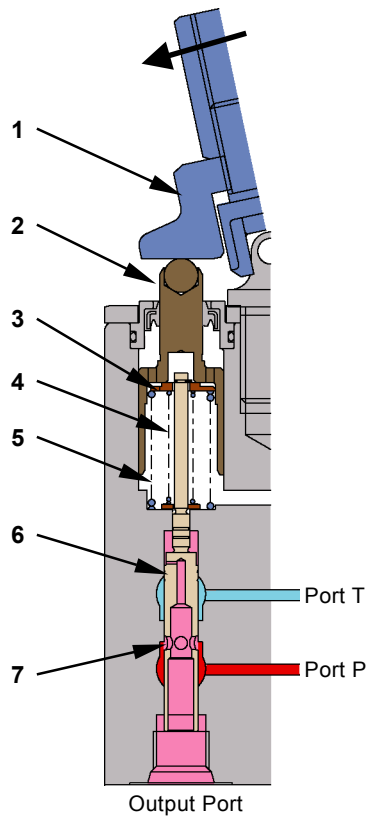
1. When the control lever is further tilted and pusher (2) is pushed down, hole part (7) on spool (6) reaches port P and pressure oil of port P flows into the output port.
2. Pressure at the output port acts on the bottom of spool (6) and tends to push spool (6) upward.
3. In case the force acting on spool (6) is smaller than the spring force of balance spring (4), balance spring (4) is not compressed. Therefore, spool (6) is not pushed upward, and pressure at the output port keeps rising.
4. When pressure at the output port rises further, the force pushing spool (6) upward increases. If this force becomes larger than the force of balance spring (4), spool (6) moves upward by compressing 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, balance spring (4) is compressed by the amount spool (6) is pushed downward, and pressure at the output port is the balanced pressure acting on spool (6) and the spring force.



Output Diagram

T523-02-05-001

COMPONENT OPERATION / Pilot Valve



1 - Cam
2 - Pusher

3 - Spring Guide
4 - Balance Spring

5 - Return Spring
6 - Spool

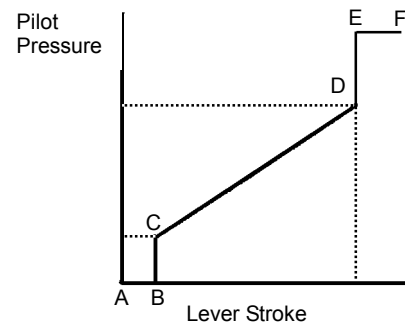
7 - Hole Part

COMPONENT OPERATION / Pilot Valve

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 pusher (2). Therefore, although pressure at the output port is raised, hole part (7) on spool (6) is not closed.
3. Consequently, pressure at the output port side is equal to pressure at port P.

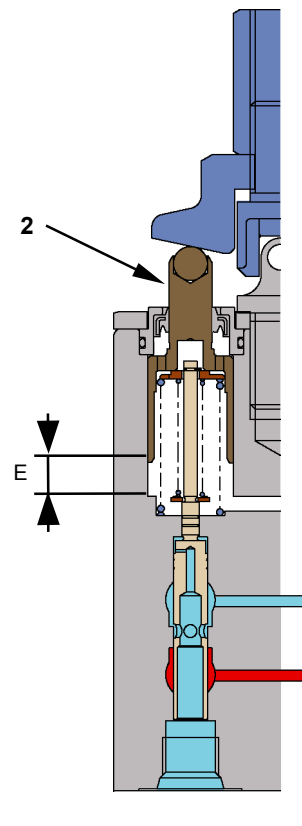
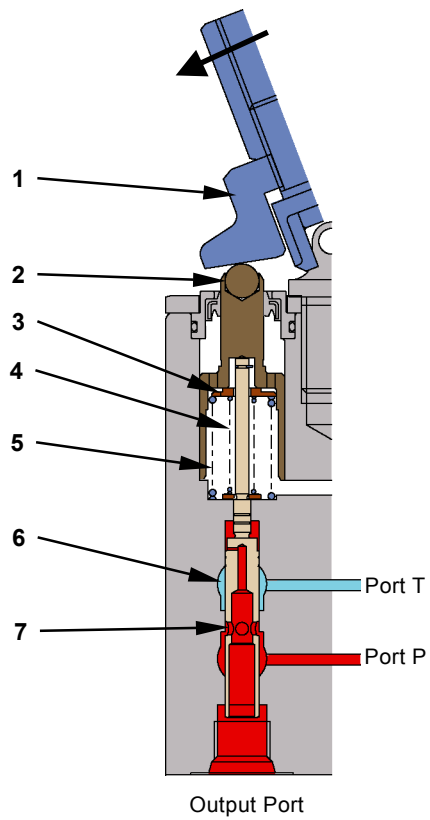
 **NOTE:** Stroke dimension E of pusher (2) determines the total stroke of the lever.



Output Diagram

T523-02-05-001

COMPONENT OPERATION / Pilot Valve



COMPONENT OPERATION / Pilot Valve

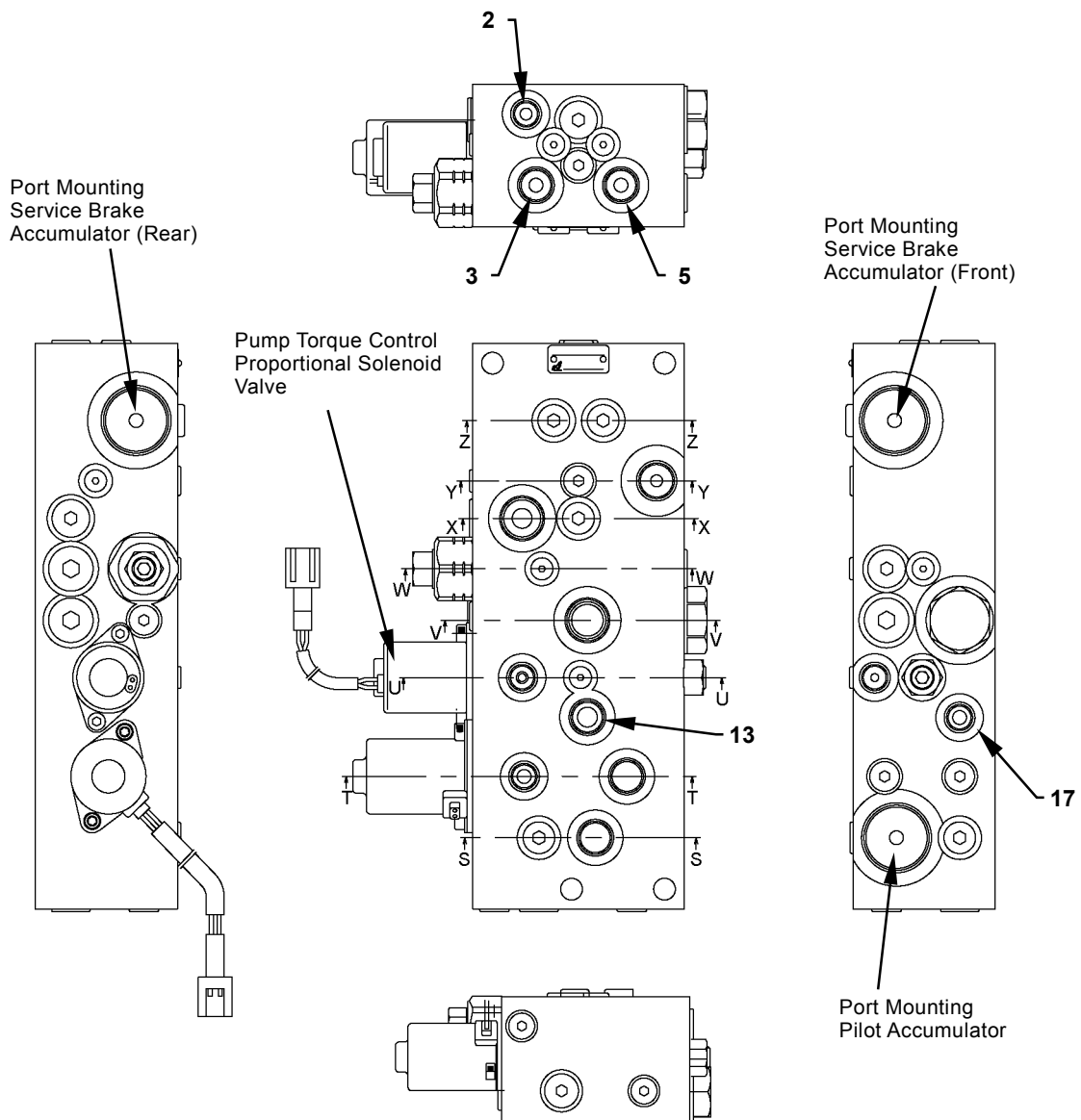
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COMPONENT OPERATION / Charging Block

OUTLINE

The charging block is installed in order to supply 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 and the steering pilot valve.

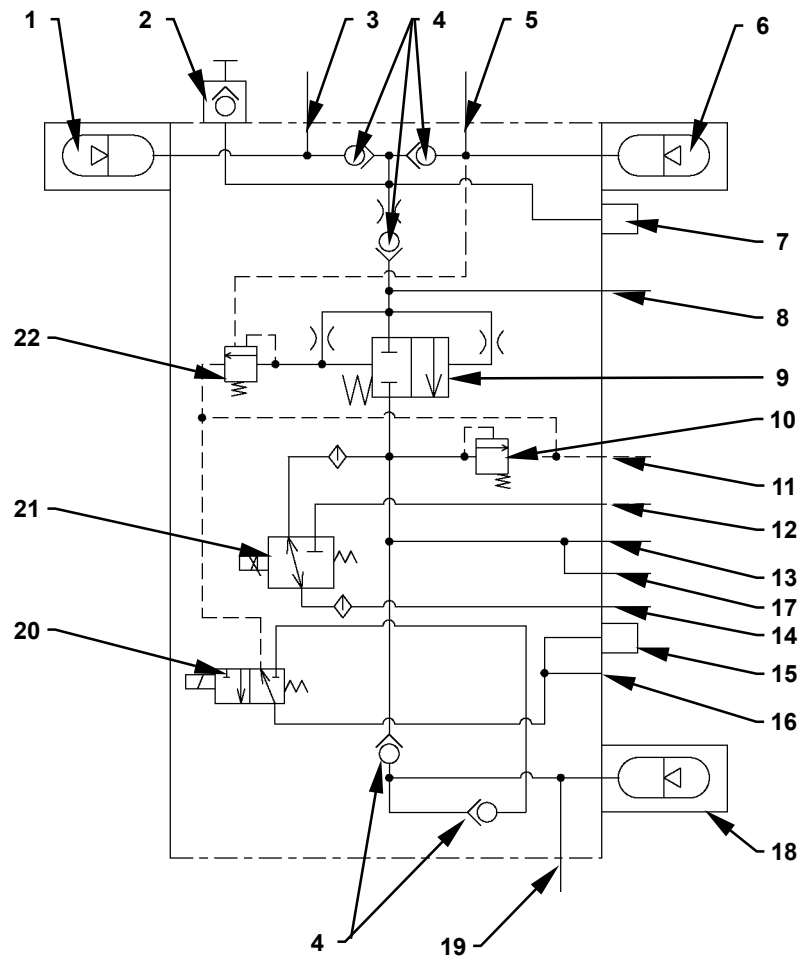
The charging block consists of the priority valve, relief valve, pump torque control proportional solenoid valve, pilot relief valve and check valve.



T4GD-03-07-002

COMPONENT OPERATION / Charging Block

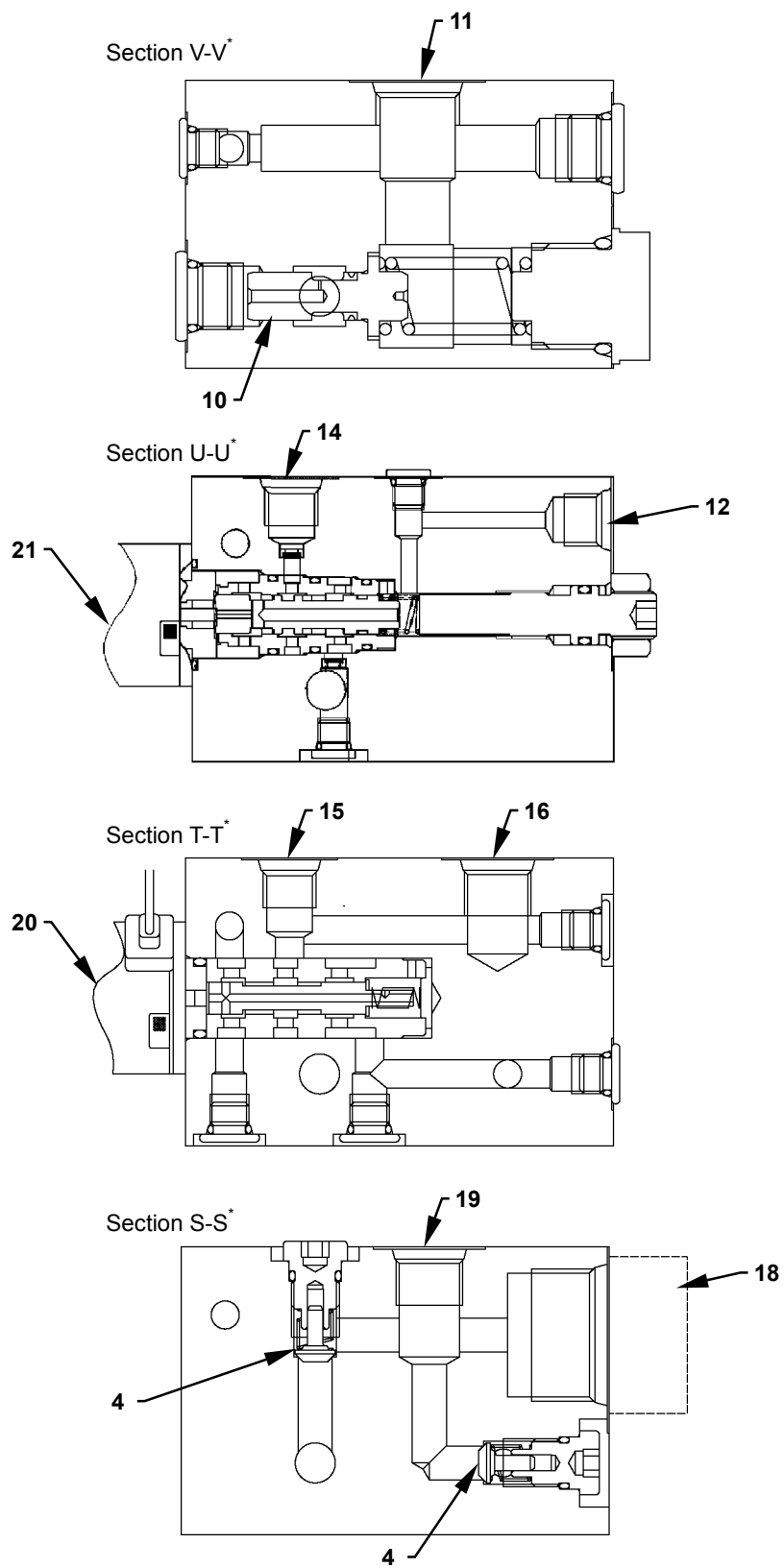
Layout



T4GD-03-07-001

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

COMPONENT OPERATION / Charging Block

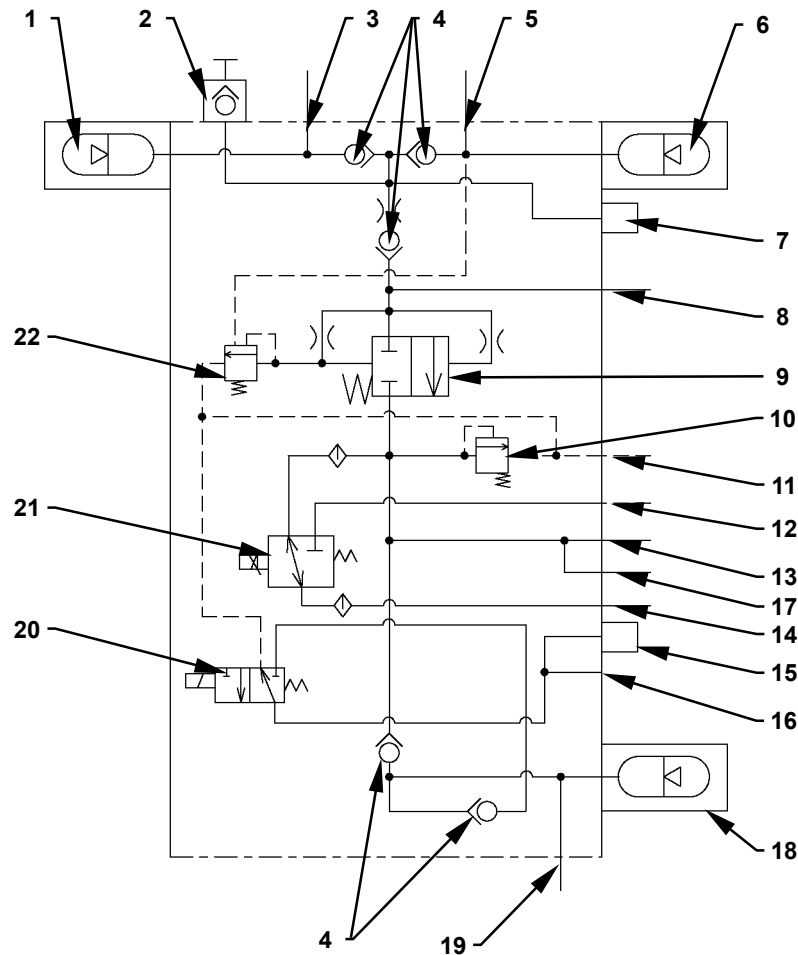


T4GD-03-07-004

*: Refer to T3-7-1.

COMPONENT OPERATION / Charging Block

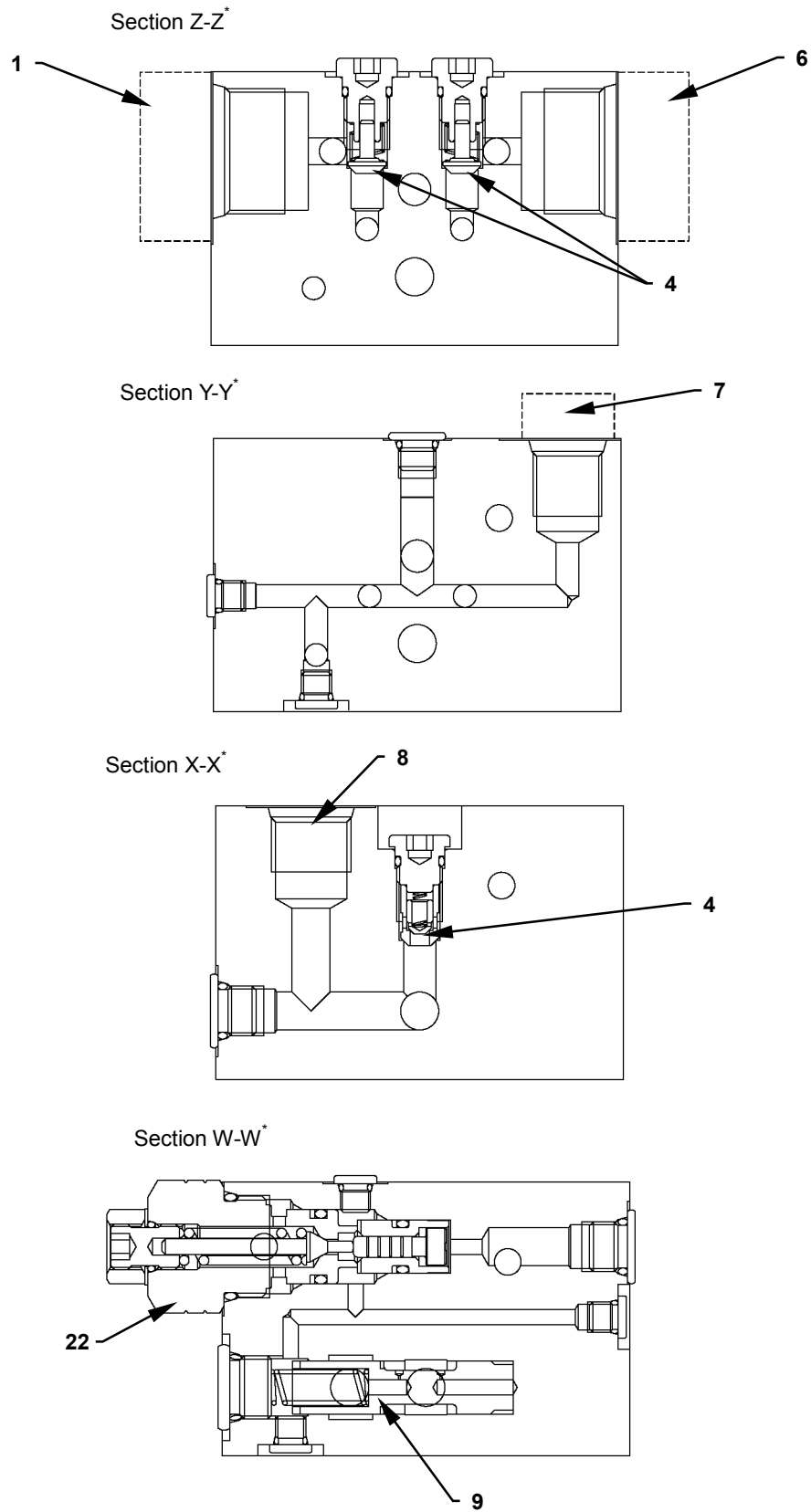
Layout



T4GD-03-07-001

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

COMPONENT OPERATION / Charging Block



T4GB-03-06-004

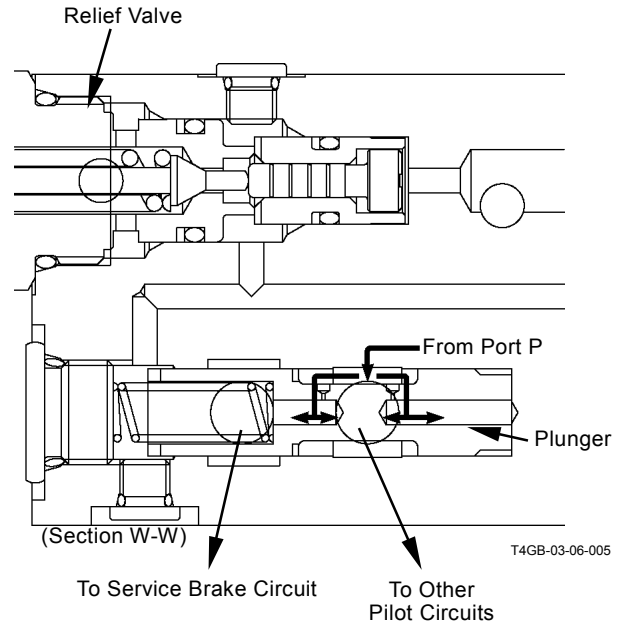
*: Refer to T3-7-1.

COMPONENT OPERATION / Charging Block

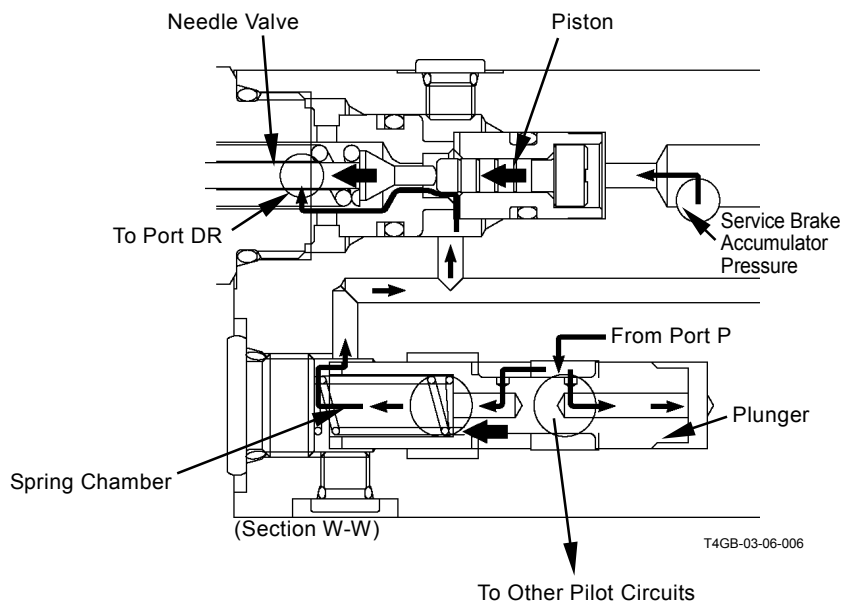
PRIORITY VALVE (REFER TO THE PILOT CIRCUIT IN THE SYSTEM / HYDRAULIC SYSTEM GROUP.)

1. Pressure oil from the pilot pump flows through port P and acts on the both ends of the plunger in the priority valve.
2. As same pressure acts on the both ends of the plunger, the plunger does not move and a restricted amount of pressure oil is supplied to other pilot circuits.
3. When service brake accumulator pressure is accumulated and is more than 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. The plunger is pushed toward the spring chamber and is shifted as the spring chamber pressure is reduced.
6. A larger amount of pressure oil from the pilot pump is supplied to other pilot circuits through the priority valve.

When service brake accumulator pressure is lower than set pressure;



When service brake accumulator pressure is more than set pressure;

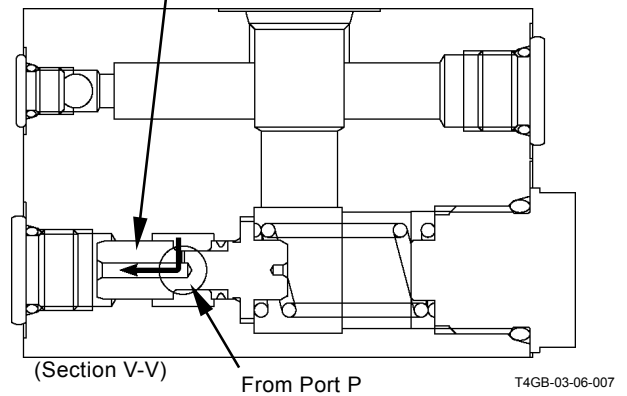


COMPONENT OPERATION / Charging Block

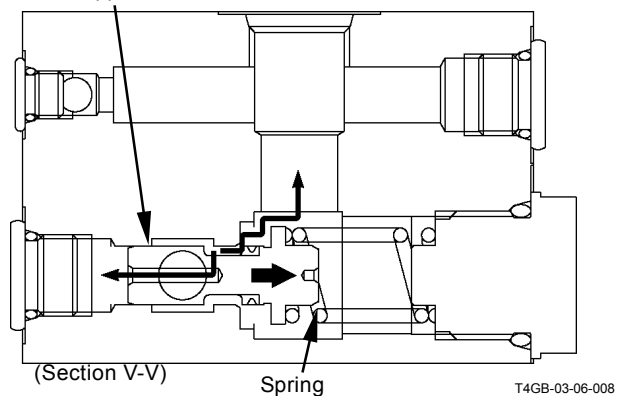
PILOT RELIEF VALVE

1. The pilot relief valve prevents 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 more than the set pressure, pressure oil acts on the poppet in the pilot relief valve.
3. The poppet moves toward the spring and is connected to 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 spring force, the poppet moves to the left and is not connected to port DR.

During Normal Operation
Poppet



During Relief Operation
Poppet Port DR



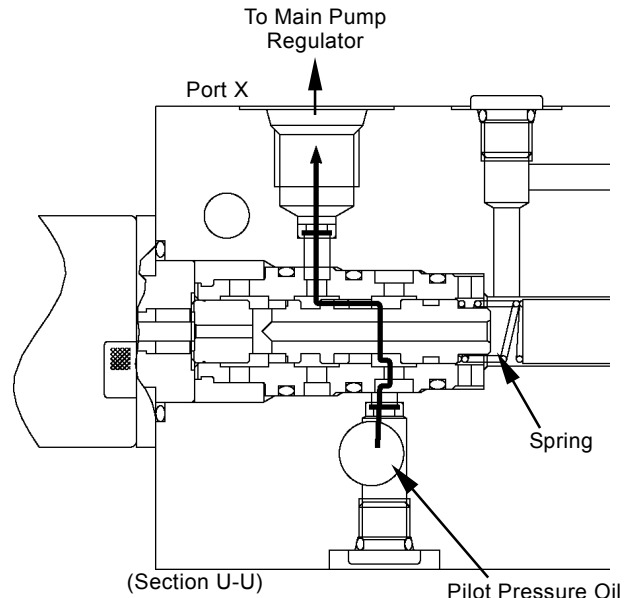
COMPONENT OPERATION / Charging Block

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

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

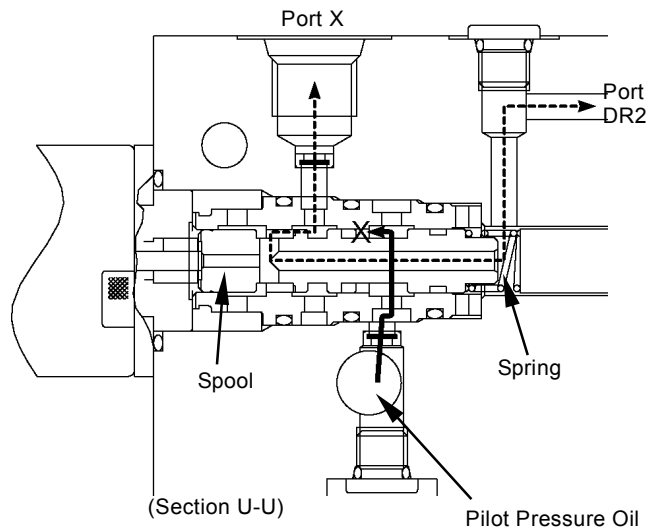
1. When there is no signal from MC (Main Controller), the spool of the solenoid valve is pushed by the spring.
2. Pilot pressure oil is supplied to port ST in the main pump regulator through port X.
3. When the signal is transmitted from MC, the spool moves toward the spring in response to the signal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

COMPONENT OPERATION / Charging Block

SERVICE BRAKE ACCUMULATOR / PILOT ACCUMULATOR

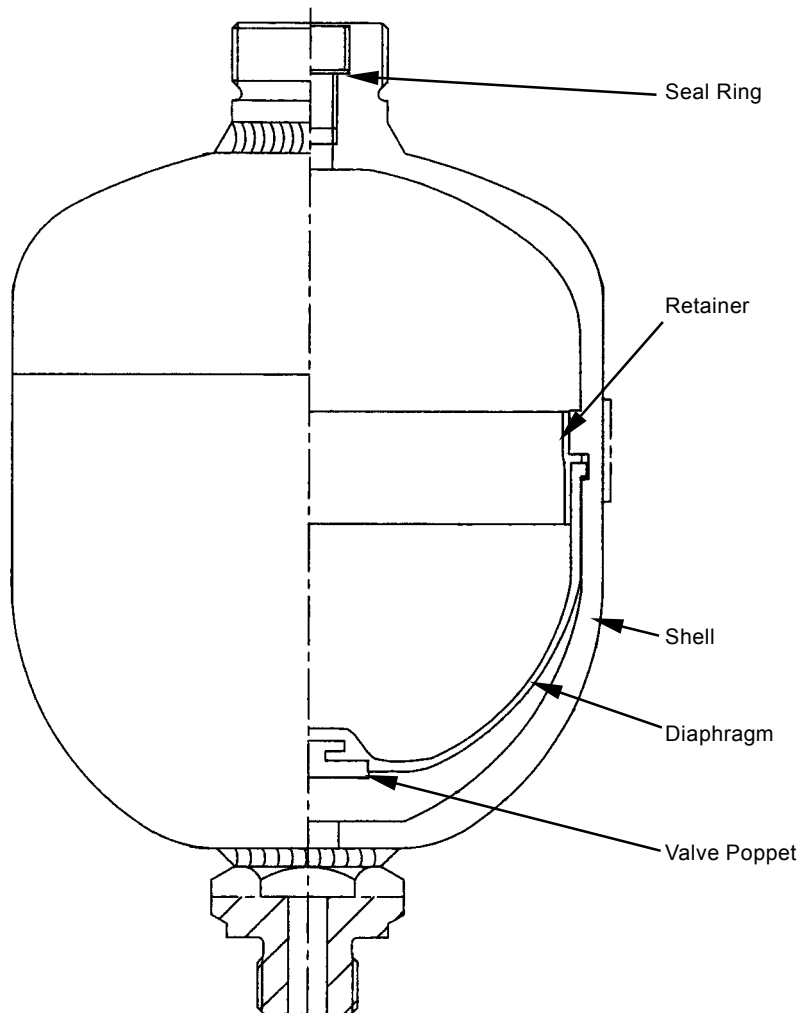
The accumulator is installed in the pilot circuit to the service brake and the pilot valve.

High-pressure nitrogen gas is contained in the accumulator. Pilot pressure oil compresses nitrogen gas via the diaphragm.

Pressure oil in the circuit is retained by compressing nitrogen gas.

IMPORTANT: The accumulator cannot be disassembled.

Replace the accumulator as an assembly if necessary.



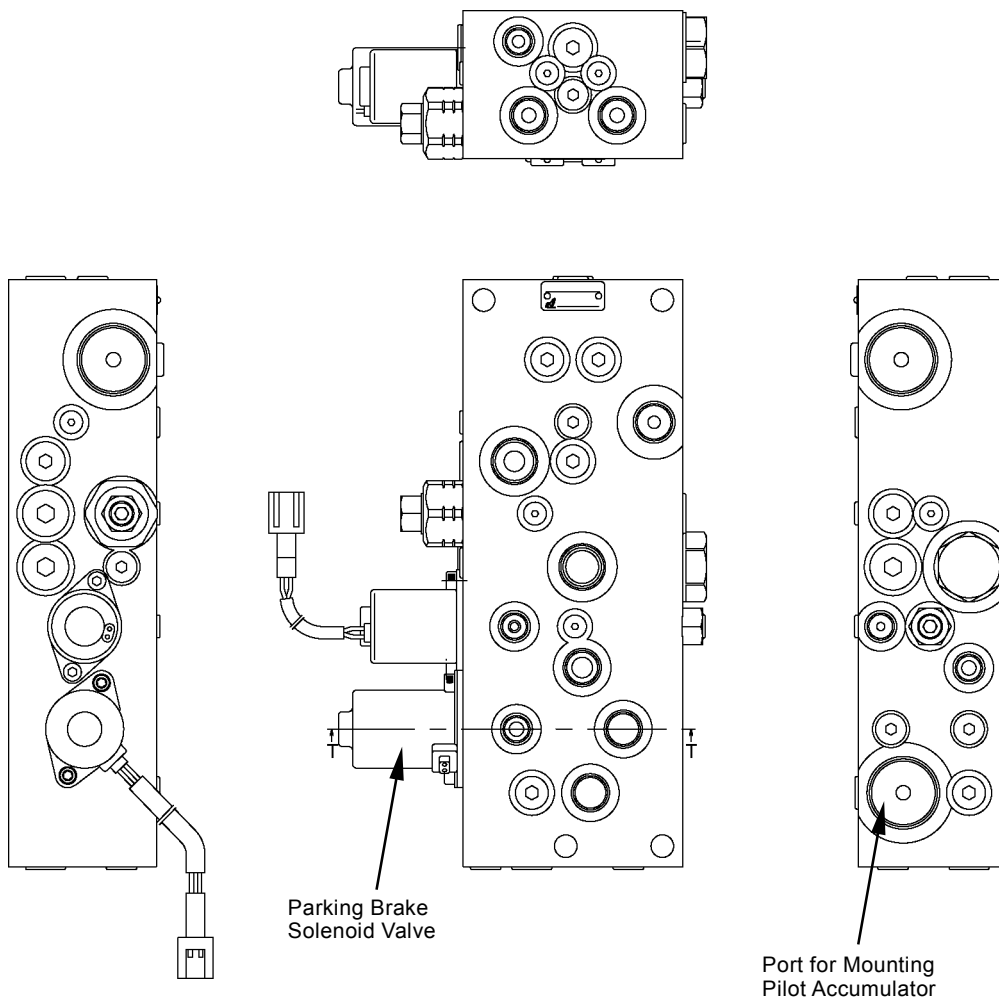
T4GB-03-06-011

COMPONENT OPERATION / Charging Block

PARKING BRAKE SOLENOID VALVE

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

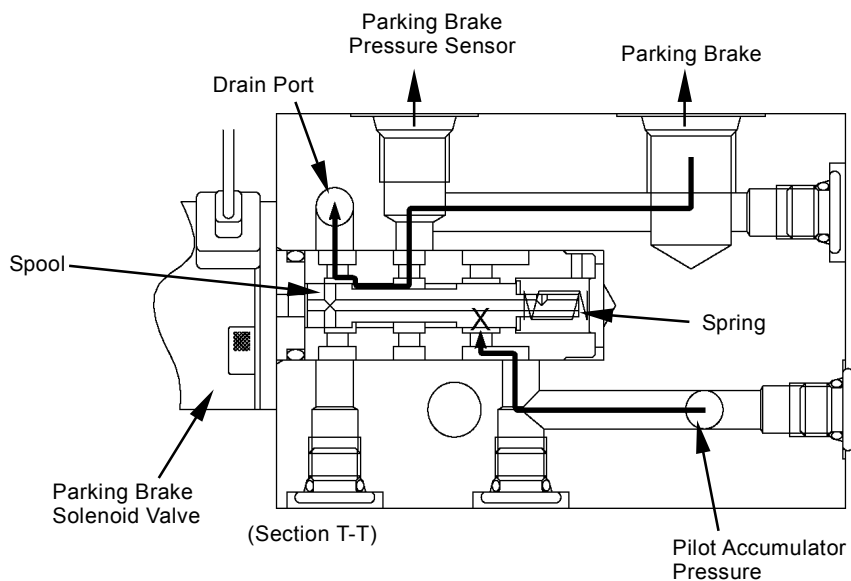
When the parking brake solenoid valve is operated, pressure oil in the pilot accumulator flows to the parking brake through the spool and releases the parking brake.



T4GD-03-07-003

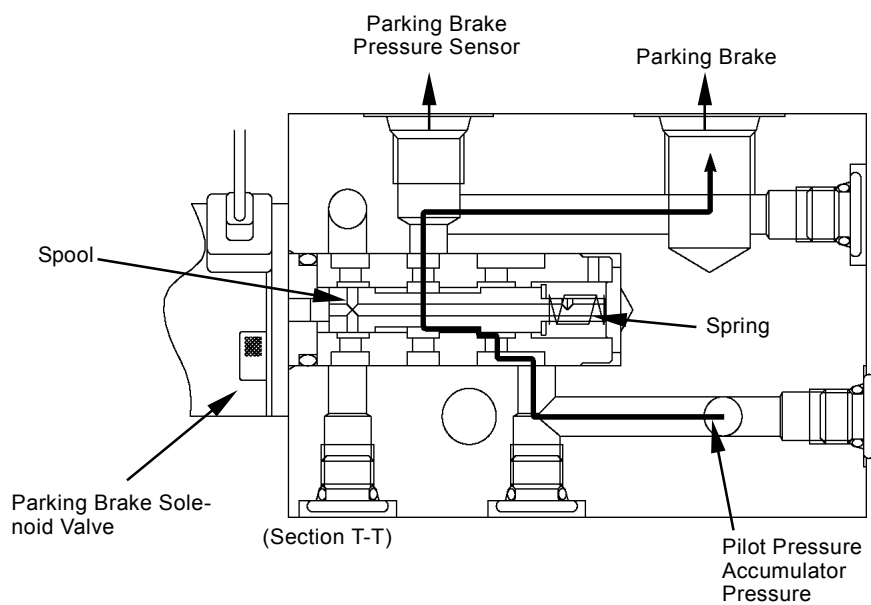
COMPONENT OPERATION / Charging Block

Not in Operation



T4GB-03-07-005

In Operation



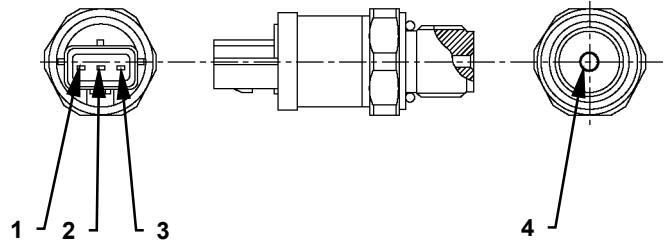
T4GB-03-07-006

COMPONENT OPERATION / Charging Block

SERVICE BRAKE PRESSURE SENSOR

This sensor detects brake pressure necessary for the service brake. The sensor is installed in the service brake circuit of the charging block and detects oil pressure of the service brake accumulator.

- | | |
|------------|---|
| 1 - Ground | 3 - Power Source (5V) |
| 2 - Output | 4 - Pressure Receiving Area (Diaphragm) |

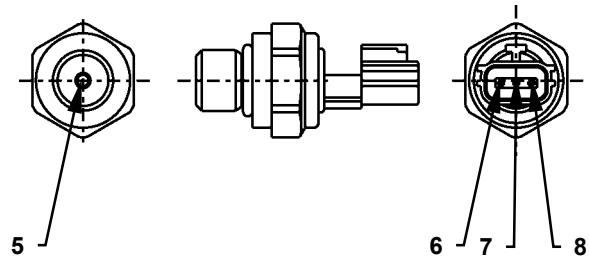


T4GB-03-06-012

PARKING BRAKE PRESSURE SENSOR

This sensor detects brake pressure necessary for the parking brake. The sensor is installed in the parking brake circuit of the charging block and detects the oil pressure of the pilot accumulator.

- | | |
|---|-----------------------|
| 5 - Pressure Receiving Area (Diaphragm) | 7 - Output |
| 6 - Ground | 8 - Power Source (5V) |



T176-03-01-023

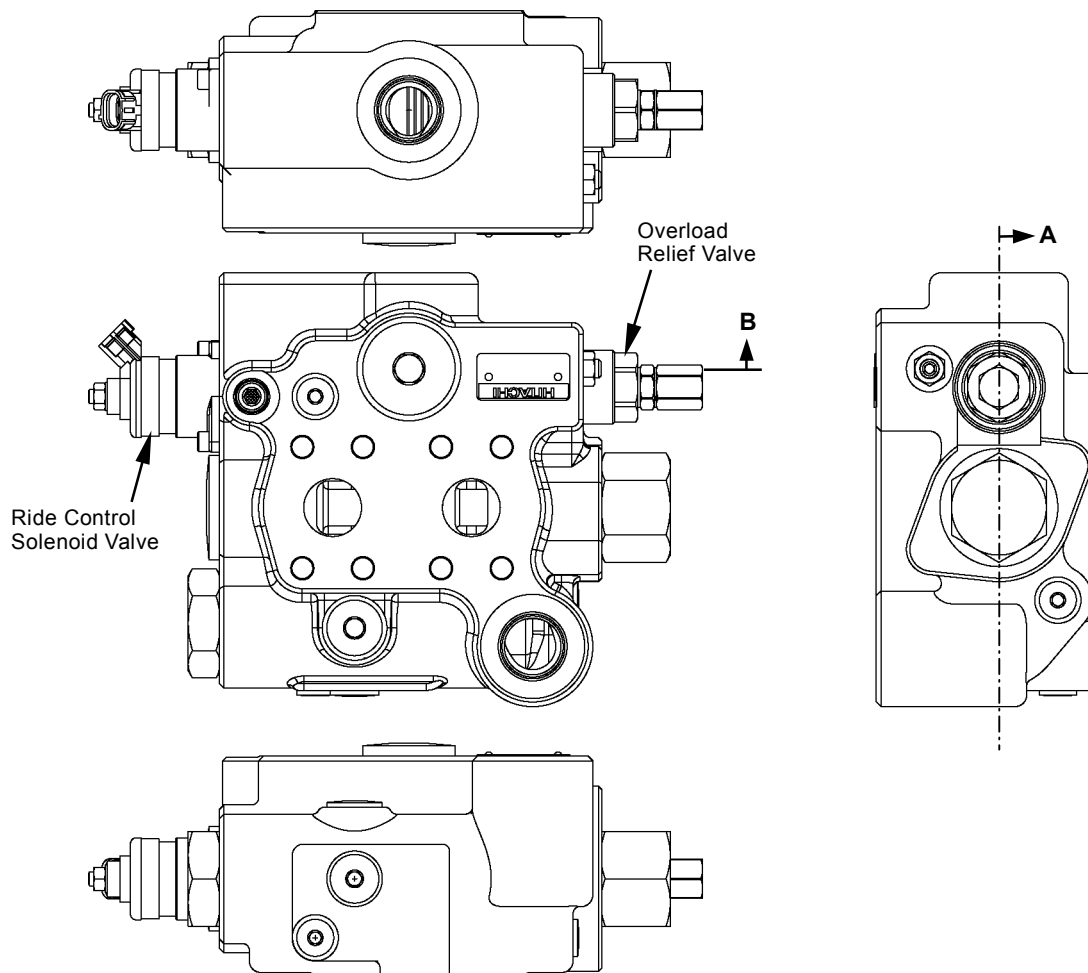
COMPONENT OPERATION / Ride Control Valve

OUTLINE

(REFER TO THE CONTROL BY COMBINED OPERATION OF ELECTRICAL CIRCUIT AND HYDRAULIC CIRCUIT / THE SYSTEM / CONTROL SYSTEM GROUP.)

The ride control valve makes the vehicle travel stably by absorbing the force generated in the lift arm cylinder traveling on rough ground.

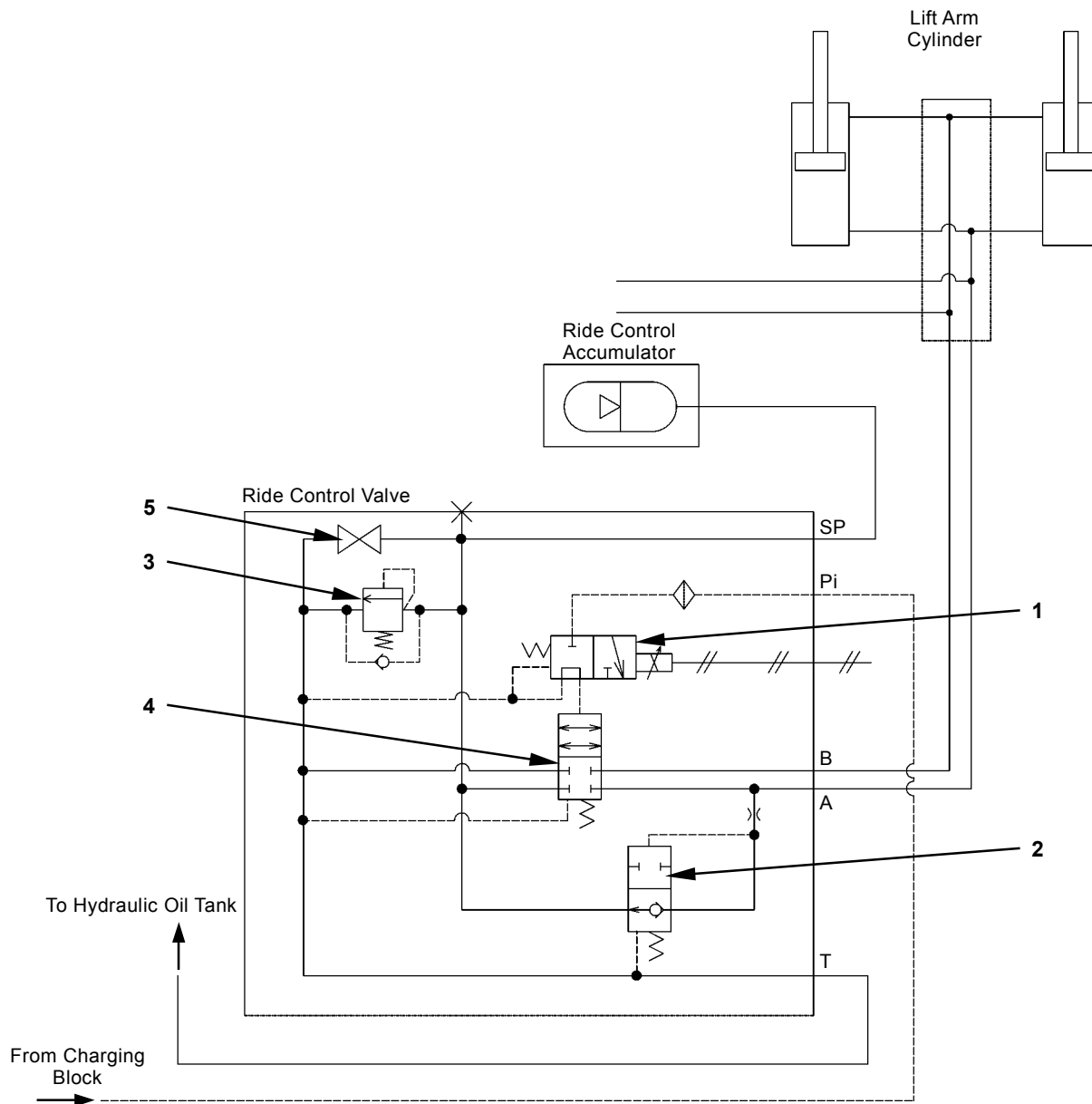
The ride control valve consists of the ride control solenoid valve, spool, charge-cut spool and overload relief valve.



T4GB-03-08-001

COMPONENT OPERATION / Ride Control Valve

Layout

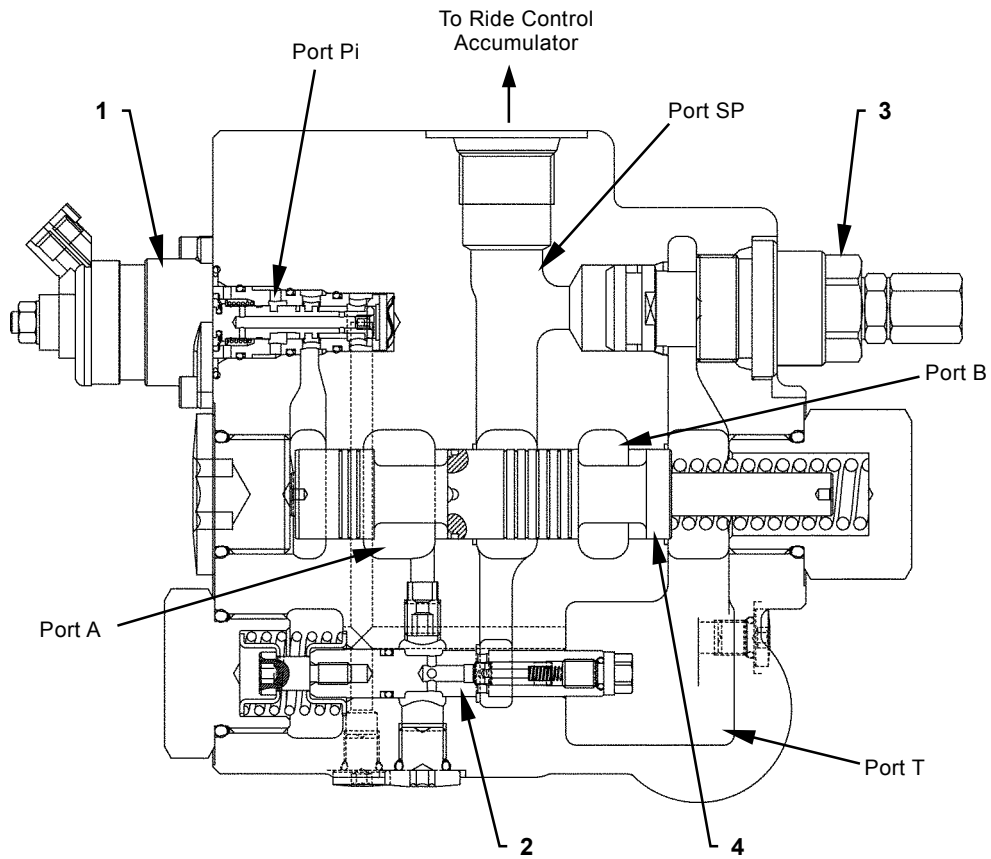


T4GB-03-08-002

- | | | |
|---------------------------------|---------------------------|-------------------|
| 1 - Ride Control Solenoid Valve | 3 - Overload Relief Valve | 5 - Draining Plug |
| 2 - Charge-Cut Spool | 4 - Spool | |

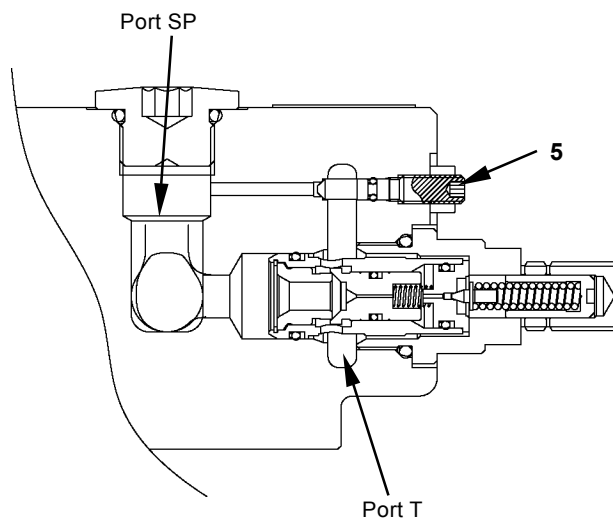
COMPONENT OPERATION / Ride Control Valve

Section A*



T4GB-03-08-003

Section B*



T4GD-03-08-001

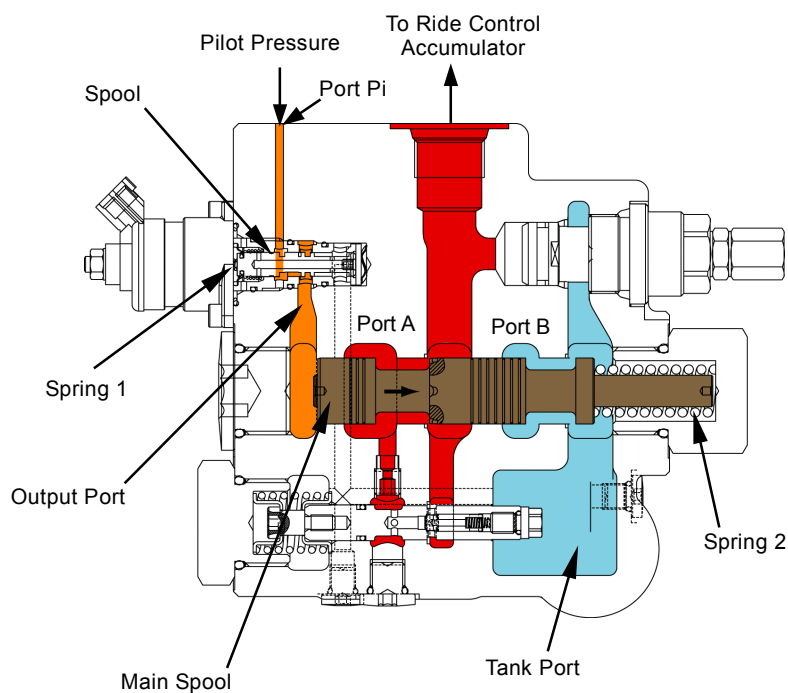
*: Refer to T3-8-1.

COMPONENT OPERATION / Ride Control Valve

OPERATION

1. In neutral, port Pi and the output port are not connected via the spool.
2. When the signal from MC (Main Controller) enters the solenoid, the solenoid is excited.
3. As the solenoid pushes the spool with the force corresponding to the signal from MC, 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 (the bottom side of the lift arm cylinder) and the ride control accumulator are connected, and port B (the rod side of the lift arm cylinder) and port T are connected.
5. Therefore, 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 drawing hydraulic oil from the tank port.

Section A*



T4GB-03-08-006

*: Refer to T3-8-1.

COMPONENT OPERATION / Ride Control Valve

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COMPONENT OPERATION / Ride Control Valve

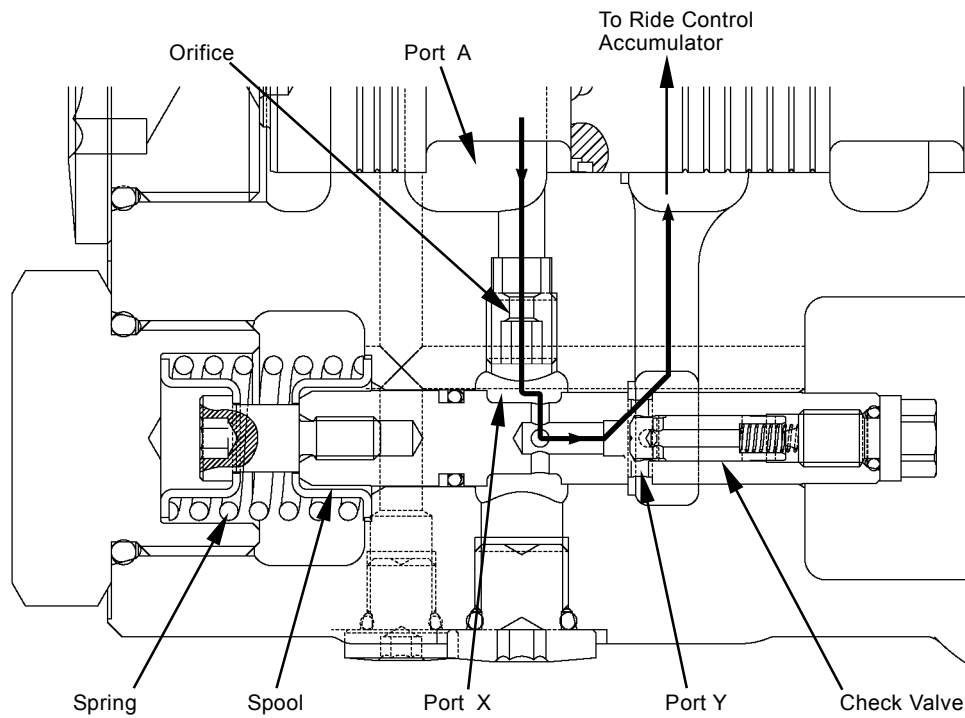
CHARGE-CUT SPOOL

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

1. When the ride control is not operated, pressure oil at the lift arm cylinder bottom side flows to port X through port A and the orifice.
2. Pressure oil into port X flows to the spool of the charge-cut spool, opens the check valve, flows to port Y and is accumulated in the ride control accumulator.
3. As spool sectional area M is larger than spool sectional area N, when the ride control accumulator pressure is accumulated to the set pressure, pressure oil from port X pushes the spool toward the spring.
4. When the spool moves toward the spring, the passage of pressure oil from the spool to port Y is closed, and accumulating the ride control accumulator pressure is stopped.

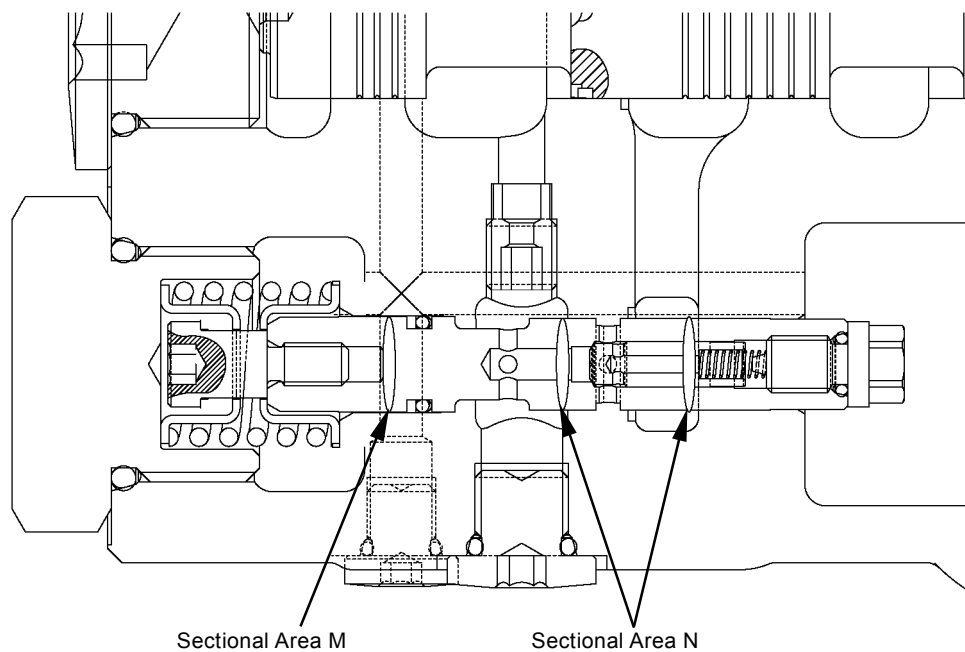
COMPONENT OPERATION / Ride Control Valve

When Accumulating Accumulator Pressure



T4GB-03-08-007

After Accumulating Accumulator Pressure



T4GB-03-08-008

COMPONENT OPERATION / Ride Control Valve

OVERLOAD RELIEF VALVE

The overload relief valve is installed in order to prevent the hoses and the ride control accumulator from being damaged in case pressure in the bottom side circuit of the lift arm cylinder is suddenly raised by an external force or something during operation of the lift arm cylinder.

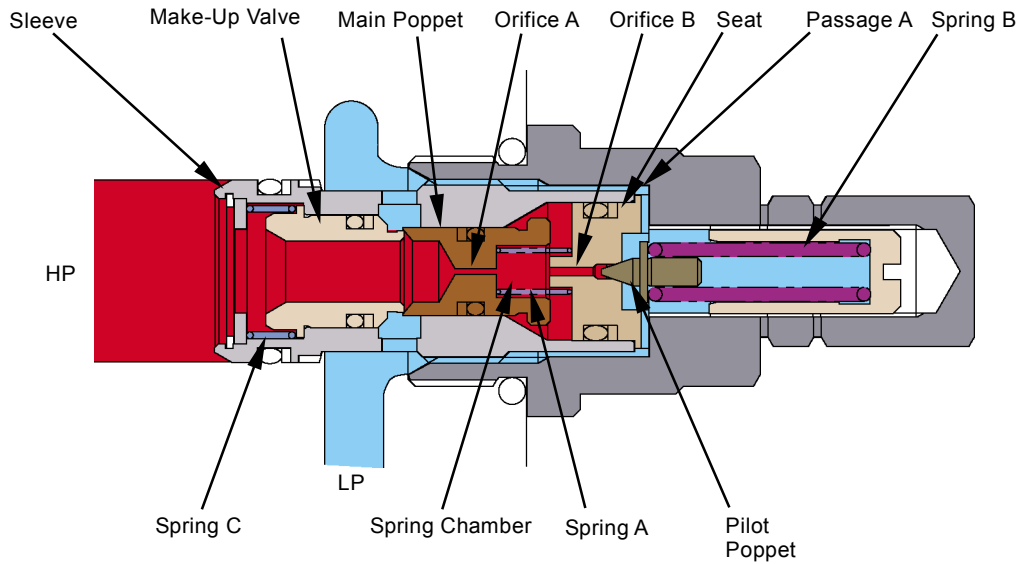
Operation

1. Pressure at port HP acts on the pilot poppet via orifice A of the main poppet and orifice B of the seat.
2. When pressure at port HP reaches the set force of spring B, the pilot poppet opens and pressure oil flows to port LP, through passage A and the periphery of the sleeve.
3. At this time, pressure difference arises between port HP and the spring chamber by orifice A.
4. When this pressure difference reaches the set force of spring A, the main poppet opens and pressure oil at port HP flows to port LP.
5. Consequently, pressure in the actuator circuit lowers.
6. If pressure in the actuator circuit is lower than the set pressure, the main poppet is closed by the force of spring A.

IMPORTANT: Do not disassemble or adjust the overload relief valve. Replace the overload relief valve as an assembly, if necessary.

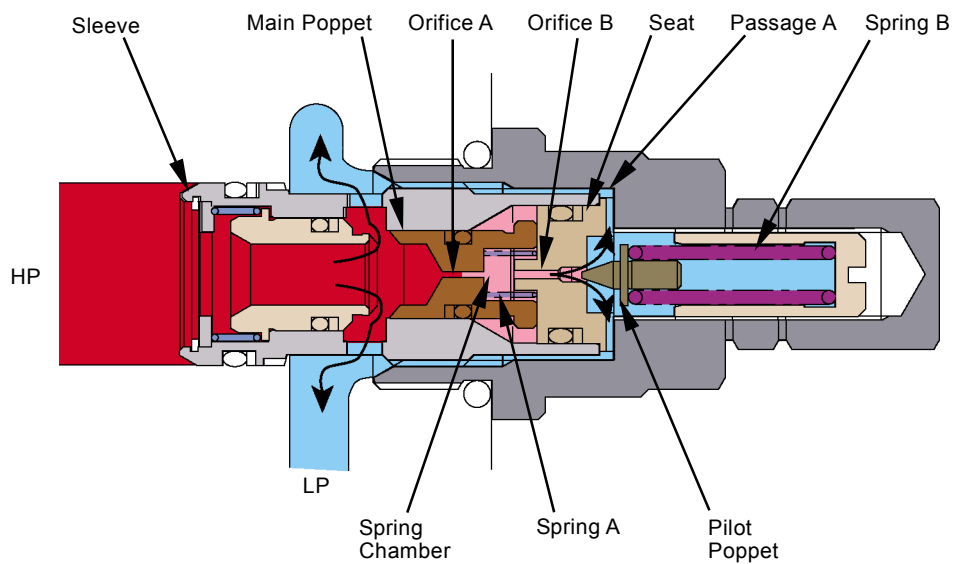
COMPONENT OPERATION / Ride Control Valve

During Normal Operation:



T176-03-03-012

During Relief Operation:



T176-03-03-013

COMPONENT OPERATION / Ride Control Valve

RIDE CONTROL ACCUMULATOR

The ride control accumulator is installed in the accumulation circuit of the ride control.

High-pressure nitrogen gas is contained in the accumulator and pressure oil compresses nitrogen gas via the piston.

Compression of nitrogen gas dampens shock of pressure oil due to pitching of the lift arm cylinder raise circuit.

IMPORTANT: The ride control accumulator cannot be disassembled. Replace the ride control accumulator as an assembly if necessary.



T4GB-03-08-009

COMPONENT OPERATION / Ride Control Valve

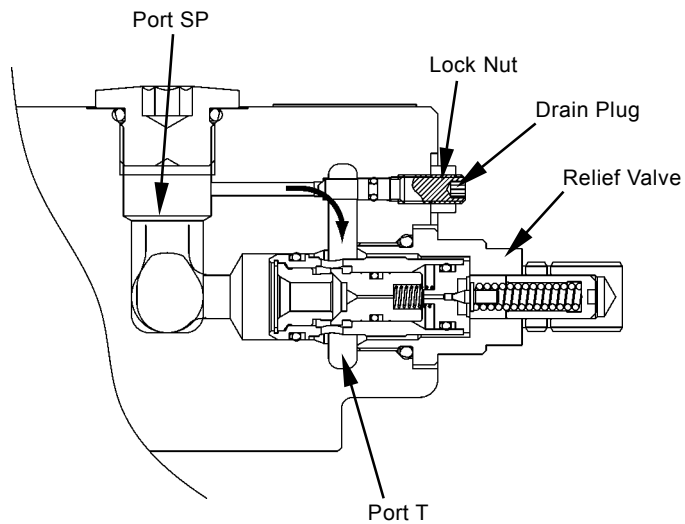
DRAIN PLUG

The drain plug is provided for the ride control valve in order to return pressure oil in the ride control accumulator to the hydraulic oil tank for maintenance. If necessary, loosen the lock nut and the drain plug. Connect the accumulator port (port SP) to the tank port (port T).



CAUTION: When the drain plug is loosened too much, the drain plug is removed from the valve body and oil may sprush out. Do not loosen the drain plug by 2 turns or more.

Section B*



T4GB-03-08-010

*: Refer to T3-8-1.

COMPONENT OPERATION / Ride Control Valve

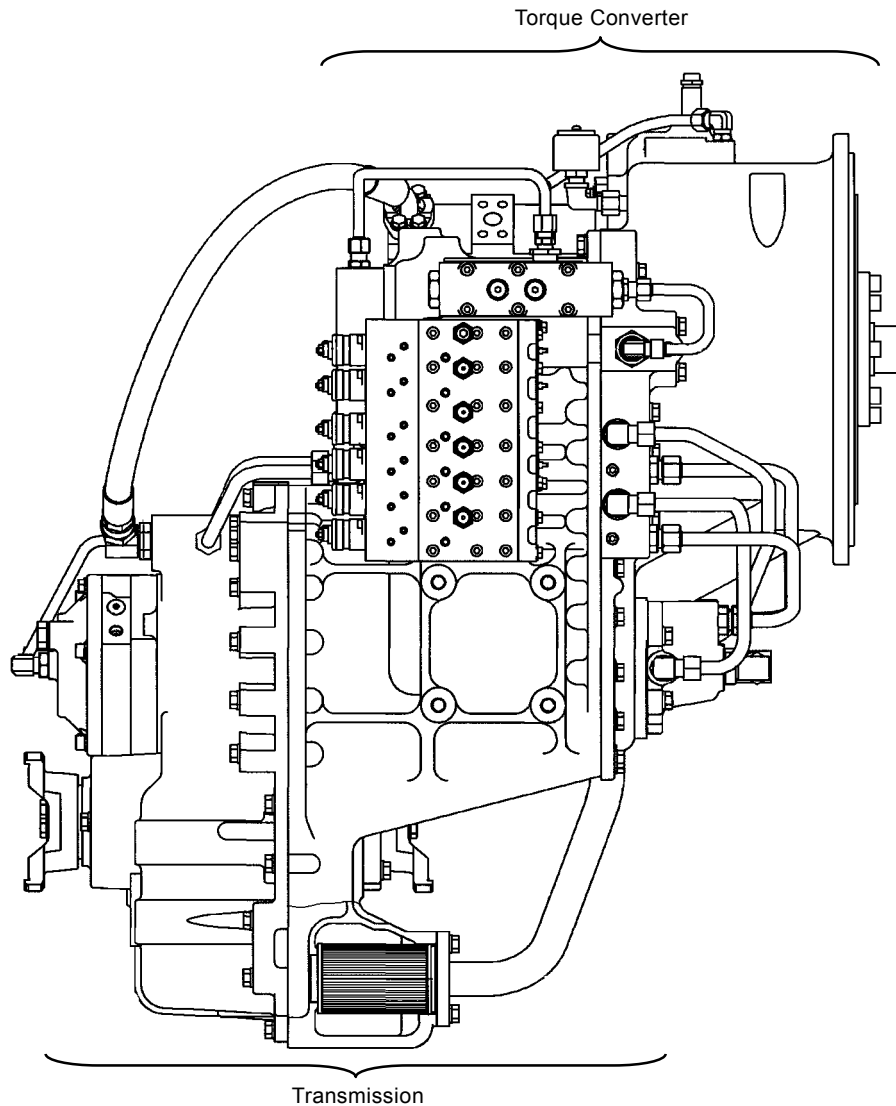
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COMPONENT OPERATION / Drive Unit

OUTLINE

The drive unit consists of the transmission and the torque converter.

The drive unit is connected to the engine. Output power from the engine is transmitted to the transmission through the engine flywheel and the torque converter.



T4GD-03-09-004

COMPONENT OPERATION / Drive Unit

TORQUE CONVERTER

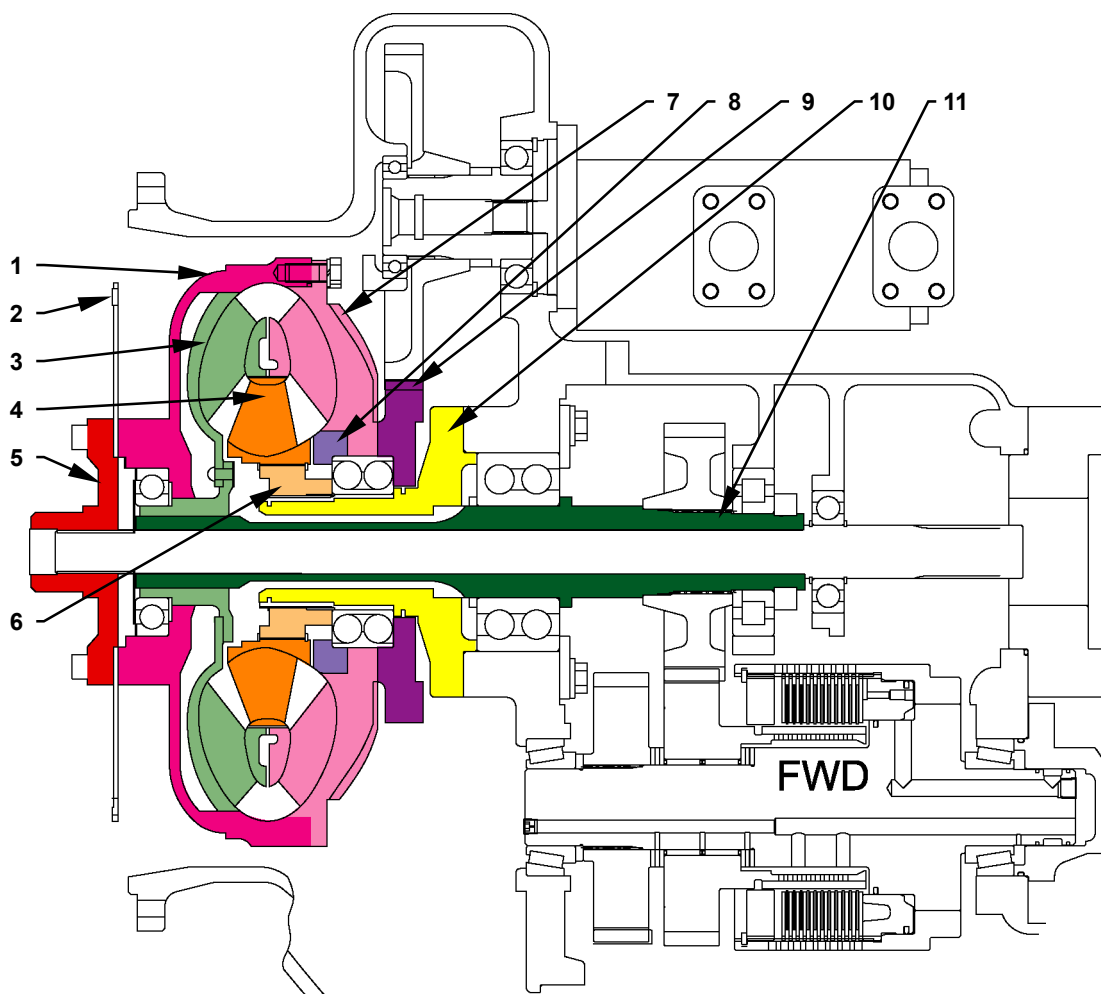
The torque converter consists of the converter wheel assembly, pump drive device, turbine shaft, and others. In the converter wheel assembly, impeller wheel (7) and turbine wheel (3) are mutually opposed with stator wheel (4) installed between them and they are all contained in the case filled with oil.

Engine rotation is transmitted from the engine flywheel to the transmission through input plate (2), cover wheel (1), impeller wheel (7), turbine wheel (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 wheel (7) is rotated by the engine rotation, oil flows along the blade of impeller wheel (7) toward the periphery, and flows into turbine (3). This oil flow collides with the blade of turbine wheel (3). Therefore, turbine wheel (3) and turbine shaft (11) rotate. The output torque of turbine shaft (11) is generated by the reaction force caused by the oil flow direction change due to the blade of turbine wheel (3). Stator wheel (4) always rectifies the oil flow from turbine wheel (3) in the determined direction, and flows oil into impeller wheel (7) in order to increase torque.

COMPONENT OPERATION / Drive Unit



T4GD-03-09-018

1 - Cover Wheel
2 - Input Plate
3 - Turbine Wheel

4 - Stator Wheel
5 - Input Guide
6 - Stator Hub

7 - Impeller Wheel
8 - Impeller Hub
9 - Pump Drive Gear

10 - Guide Carrier
11 - Turbine Shaft

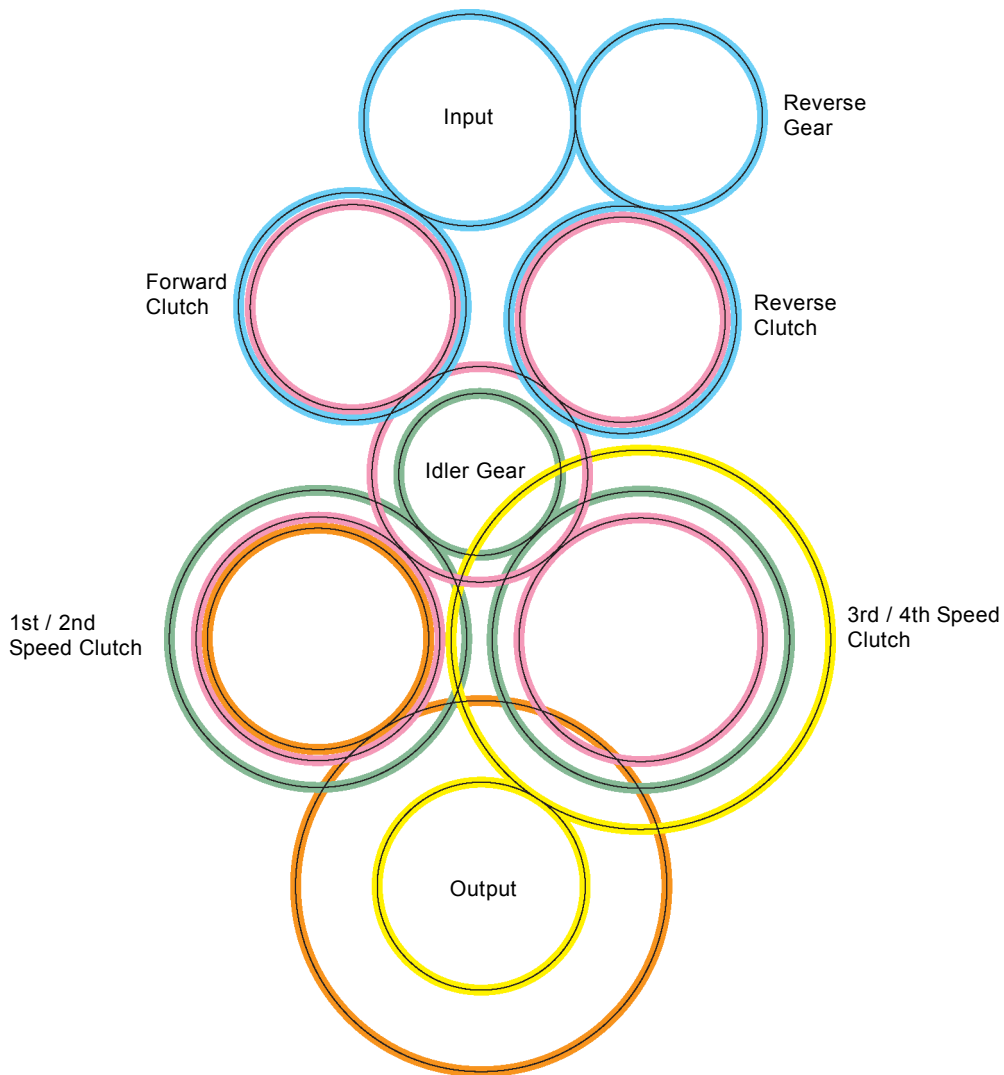
COMPONENT OPERATION / Drive Unit

TRANSMISSION

The transmission functions to transform the rotation speed and rotation direction of the output power transmitted from the torque converter.

The transmission consists of four clutch shaft assemblies, the reverse gear, output shaft, parking brake, control valve, and others.

The relief valve is installed at the inlet part of the hydraulic oil for the torque converter, and relieves oil more than required into the converter housing.

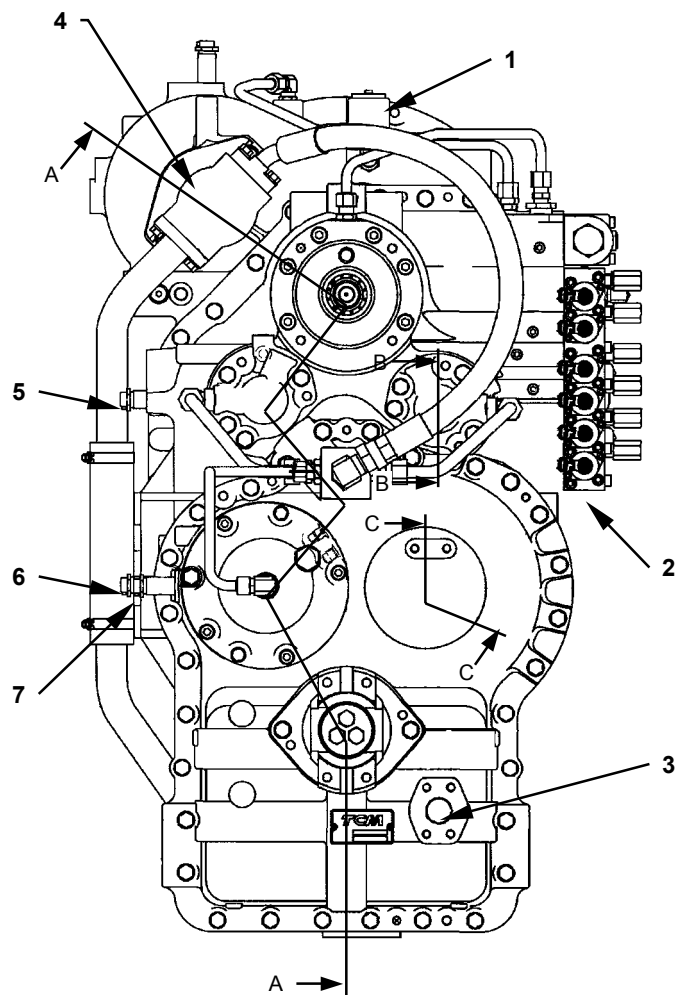


Transmission Gear Layout
(Viewed from Machine Front)

T4GC-03-09-002

COMPONENT OPERATION / Drive Unit

Front View of Transmission



T4GD-03-09-003

1 - Breather
2 - Control Valve

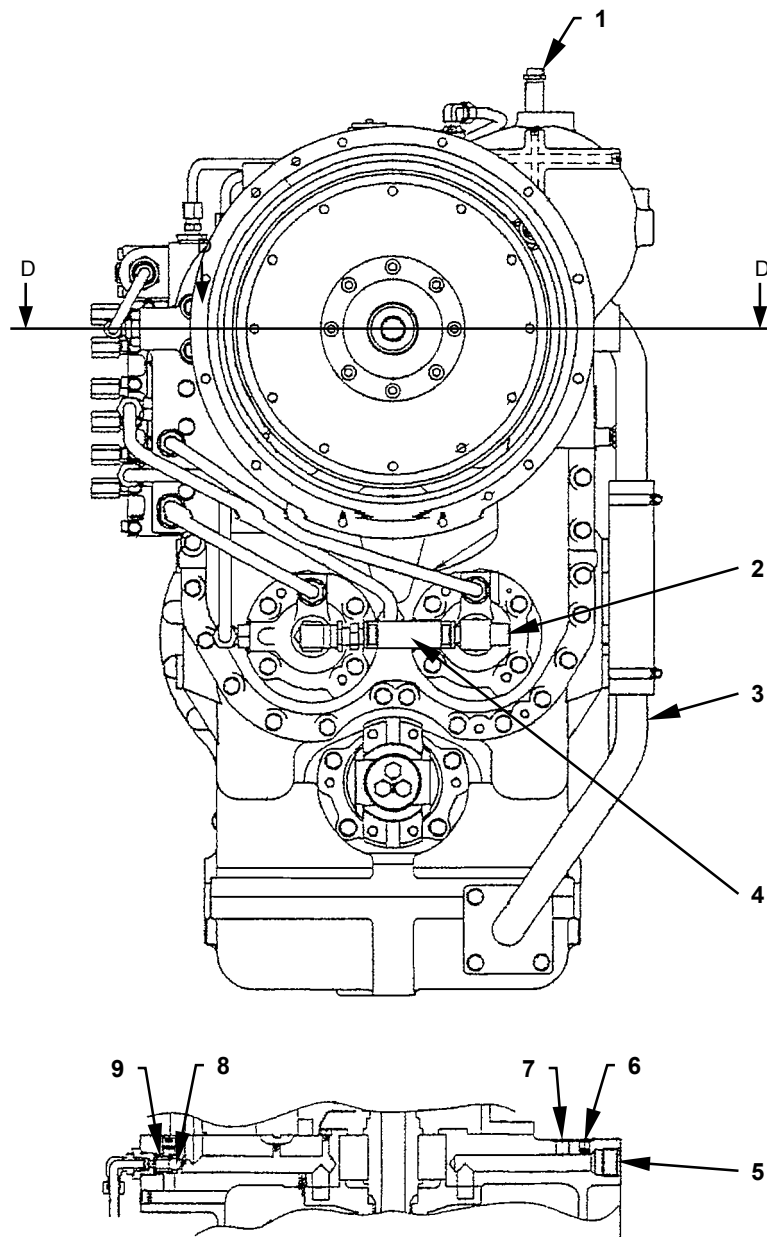
3 - Oil Feed Port
4 - Charging Pump

5 - Rotation Sensor (A)
6 - Rotation Sensor (B)

7 - Travel Speed Sensor

COMPONENT OPERATION / Drive Unit

Rear View of Transmission



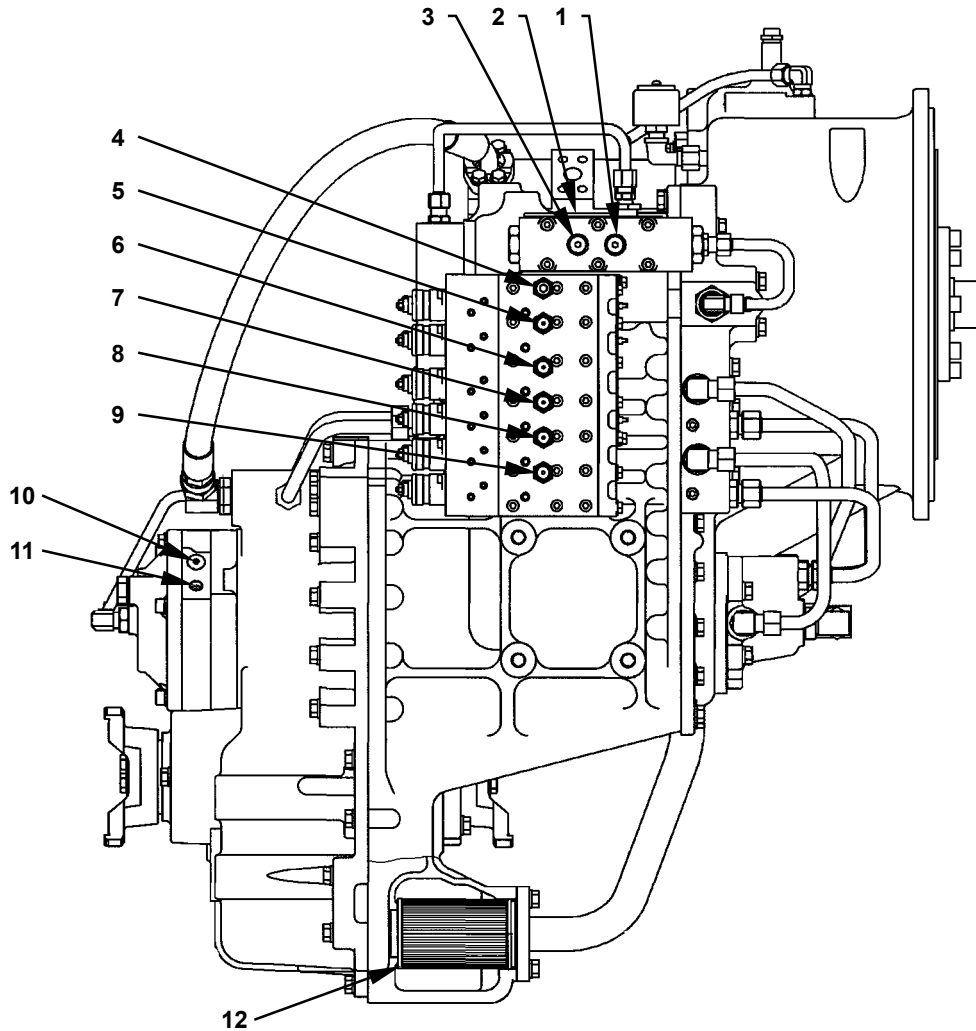
Section D-D

T4GD-03-09-001

- | | | | |
|-------------------------|-------------------|--|------------------|
| 1 - Engine Speed Sensor | 4 - Hose | 6 - Converter Outlet Pressure Port | 8 - Relief Valve |
| 2 - From Oil Cooler | 5 - To Oil Cooler | 7 - Hydraulic Oil Temperature Sensor Mounting Port | 9 - Spring |
| 3 - Suction Tube | | | |

COMPONENT OPERATION / Drive Unit

Side View of Transmission

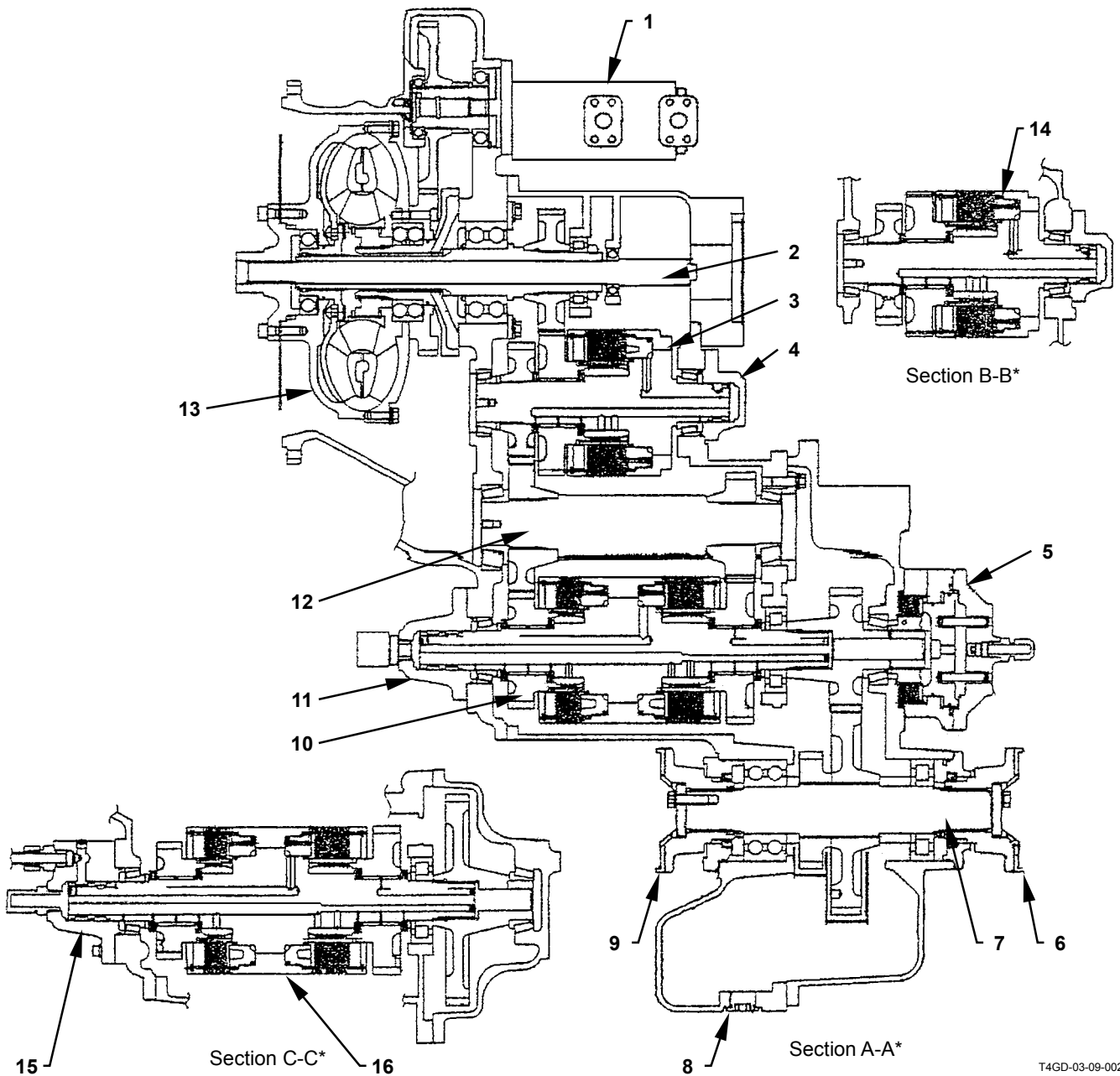


T4GD-03-09-004

- | | | | |
|-----------------------------------|------------------------------------|------------------------------------|---|
| 1 - Converter Inlet Pressure Port | 4 - Forward Clutch Pressure Port | 7 - 2nd Speed Clutch Pressure Port | 10 - Parking Brake Pressure Port |
| 2 - Regulator Valve | 5 - Reverse Clutch Pressure Port | 8 - 3rd Speed Clutch Pressure Port | 11 - Parking Brake Release Pressure Inlet |
| 3 - Regulator Pressure Port | 6 - 1st Speed Clutch Pressure Port | 9 - 4th Speed Clutch Pressure Port | 12 - Strainer |

COMPONENT OPERATION / Drive Unit

Section of Transmission



T4GD-03-09-002

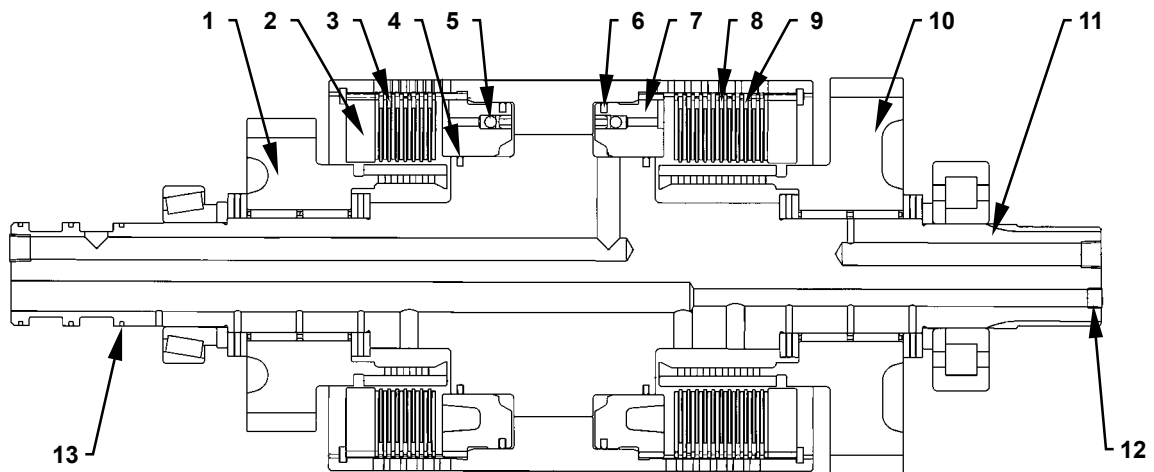
- | | | | |
|----------------------|-------------------------|-----------------------------|-----------------------------|
| 1 - Charging Pump | 5 - Parking Brake | 9 - Rear Output Flange | 13 - Torque Converter |
| 2 - Pump Drive Shaft | 6 - Front Output Flange | 10 - 1st / 2nd Speed Clutch | 14 - Reverse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

*Refer to T3-9-5

COMPONENT OPERATION / Drive Unit

Clutch Shaft

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

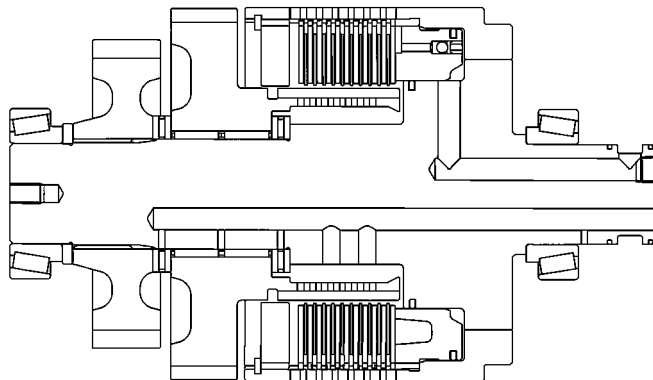


T4GD-03-09-007

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

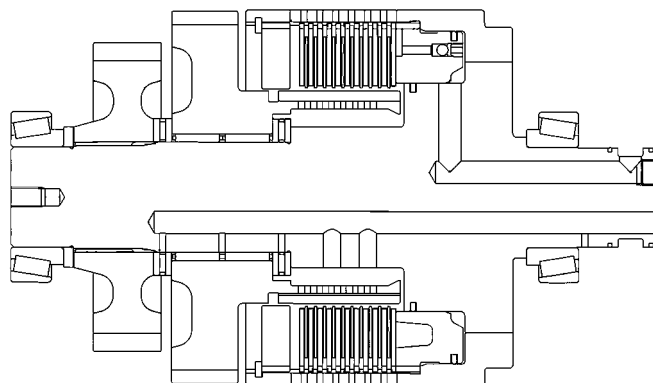
COMPONENT OPERATION / Drive Unit

(Forward Clutch Shaft)



T4GD-03-09-005

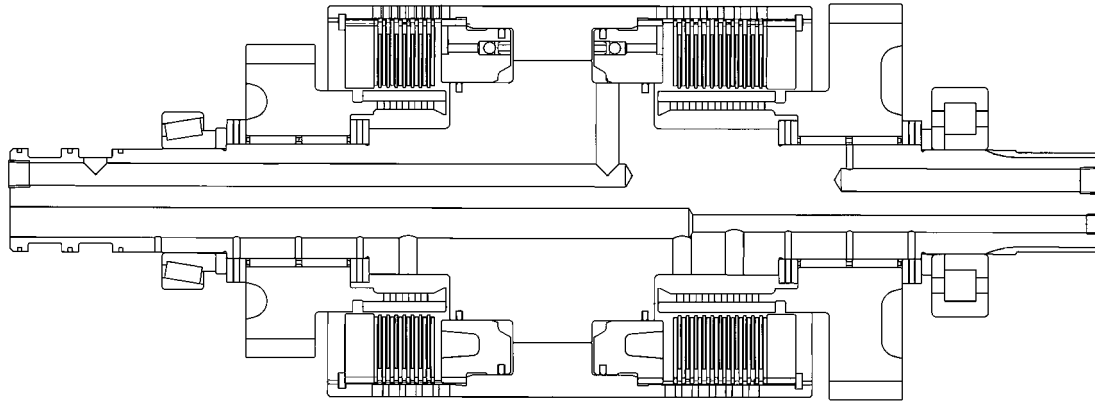
(Reverse Clutch Shaft)



T4GD-03-09-006

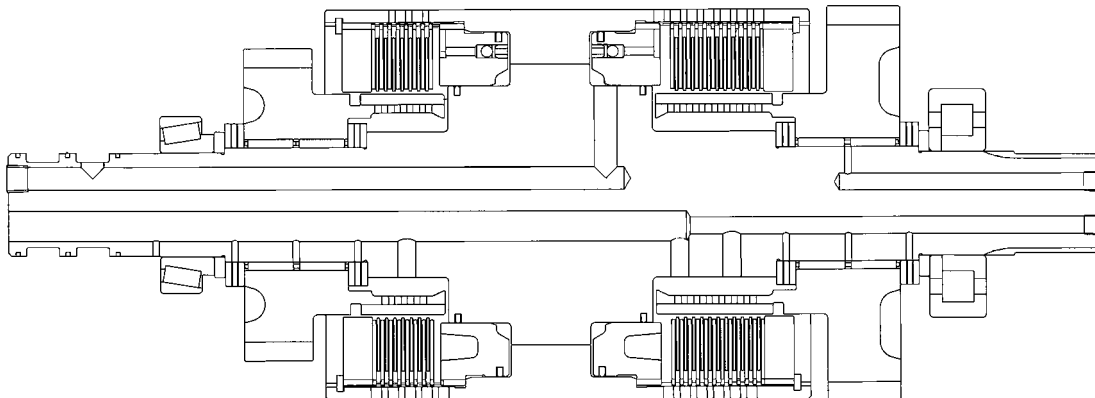
COMPONENT OPERATION / Drive Unit

(1st / 2nd Speed Clutch Shaft)



T4GD-03-09-007

(3rd / 4th Speed Clutch Shaft)



T4GD-03-09-008

COMPONENT OPERATION / Drive Unit

Operation

During Operation

The clutch is operated by pressure oil from the transmission control valve.

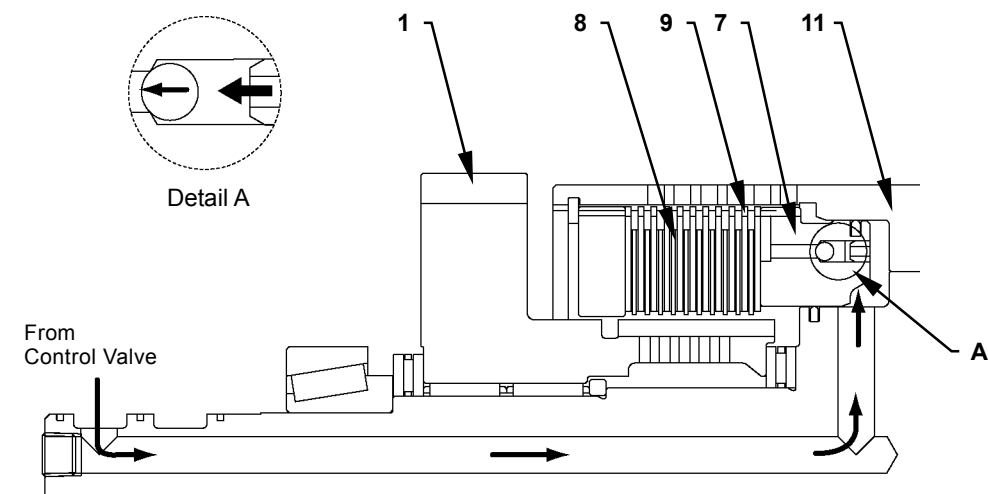
Pressure oil from the transmission control valve reaches the back of clutch piston (7) through the oil passage inside shaft (11). The oil passage is blocked as pressure oil pushes bleed valve (5) in clutch piston (7) toward disc (8). Therefore, clutch piston (7) is pushed toward disc (8). Clutch piston (7) transmits power to the whole of shaft (11) and hub gear (1) connected by pushing disc (8) and plate (9) tightly.

Not during Operation

When pressure oil is not supplied from the transmission control valve, bleed valve (5) is opened by the centrifugal force of shaft (11). Therefore, the residual pressure in the piston and others are discharged toward disc (8). Clutch piston (7) is pushed back by return spring (3) between plates (9). As there arises a clearance between disc (8) and plate (9), shaft (11) and hub gear (1) rotate separately, and power is not transmitted.

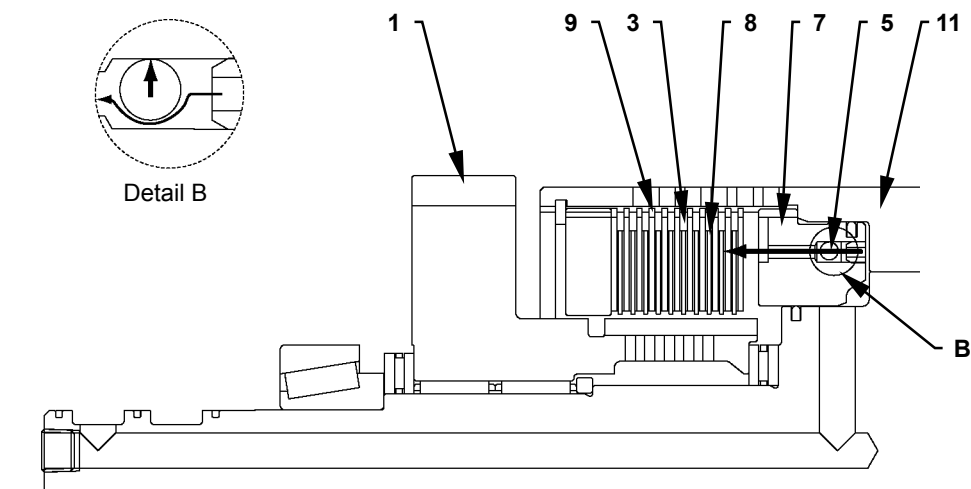
COMPONENT OPERATION / Drive Unit

During Operation



T4GC-03-09-012

Not during Operation



T4GC-03-09-013

1 - Hub Gear
3 - Return Spring

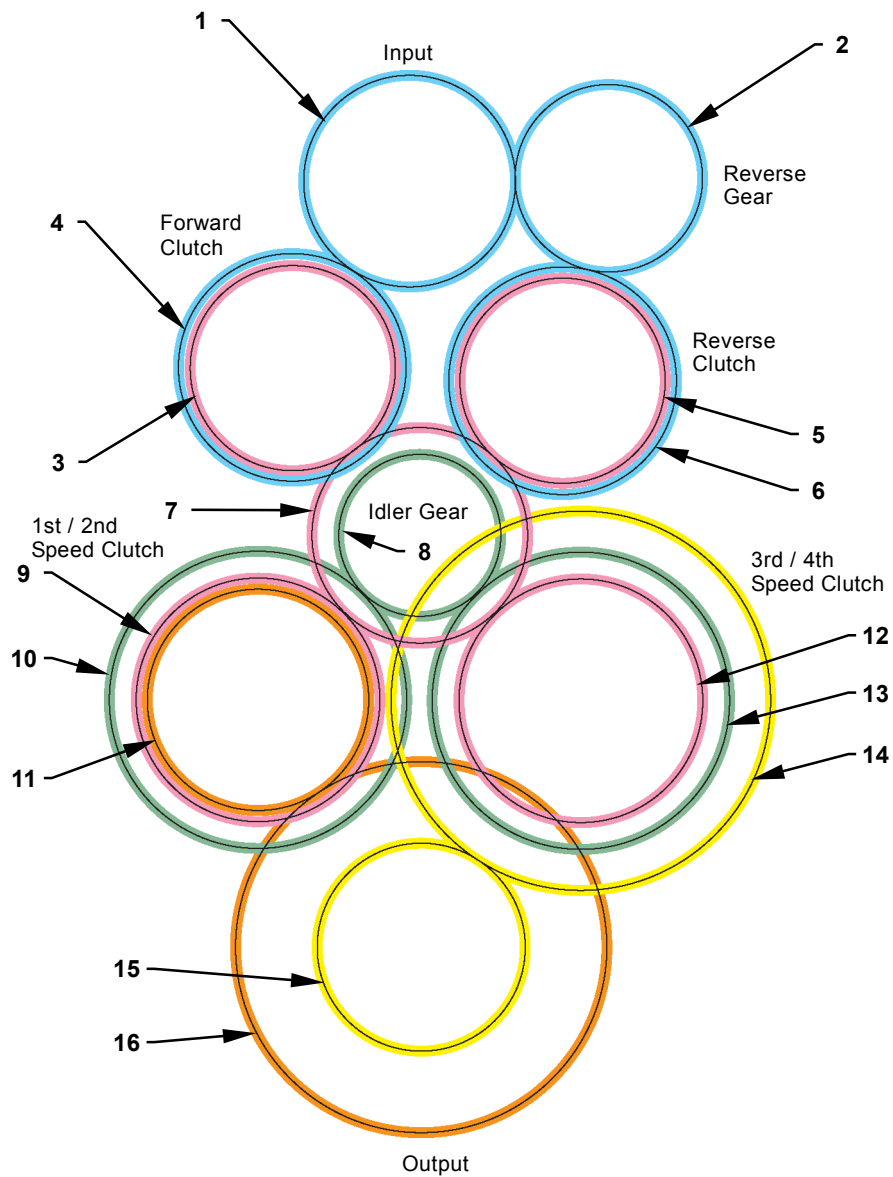
5 - Bleed Valve
7 - Clutch Piston

8 - Disc
9 - Plate

11 - Shaft

COMPONENT OPERATION / Drive Unit

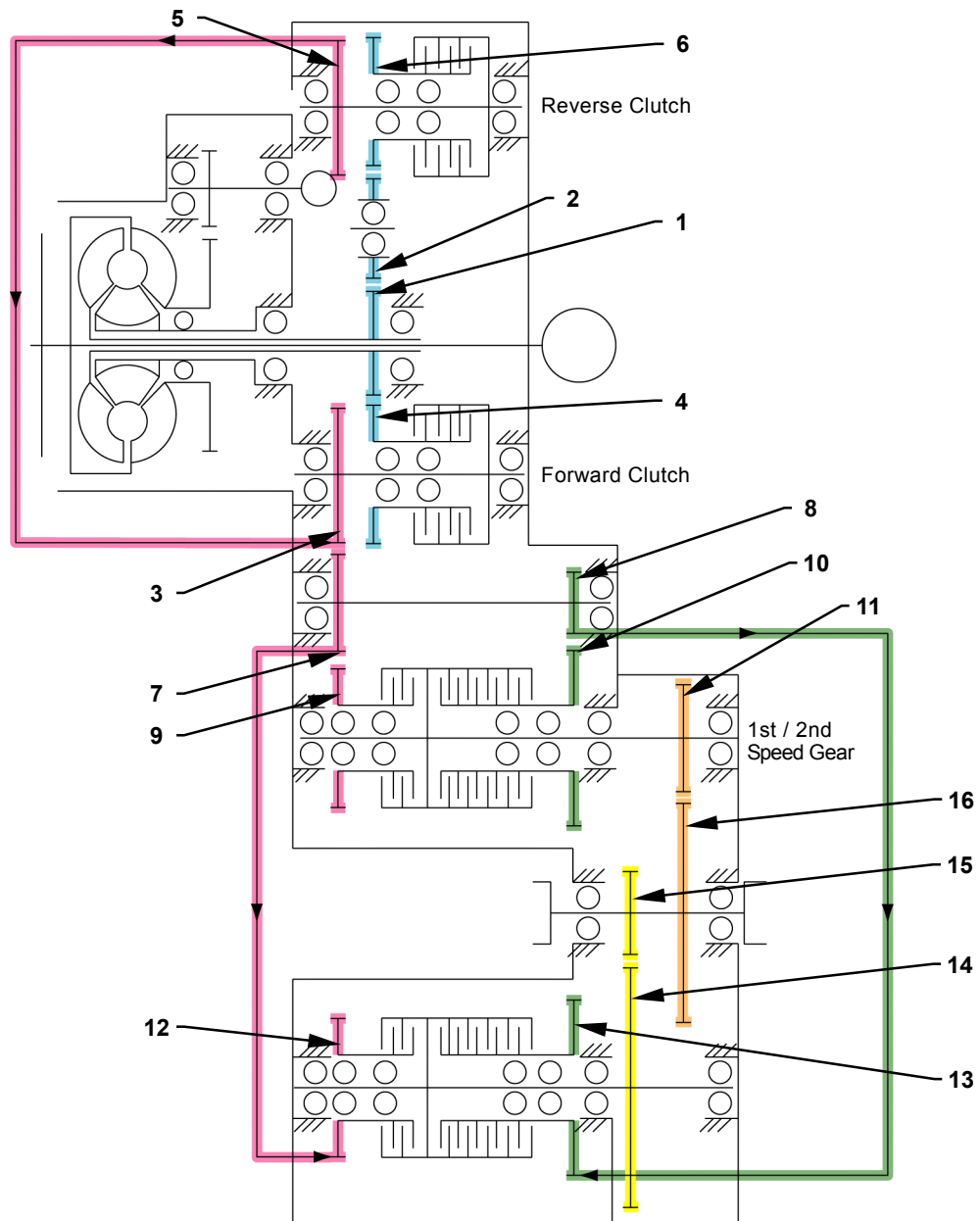
Transmission of Power



T4GC-03-09-002

- | | | | |
|------------------|----------------|-------------------------|-------------------------|
| 1 - Input Gear | 5 - F-R Gear | 9 - 2nd Speed Hub Gear | 13 - 3rd Speed Hub Gear |
| 2 - Reverse Gear | 6 - R Hub Gear | 10 - 1st Speed 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 Speed Hub Gear | 16 - Output Gear |

COMPONENT OPERATION / Drive Unit



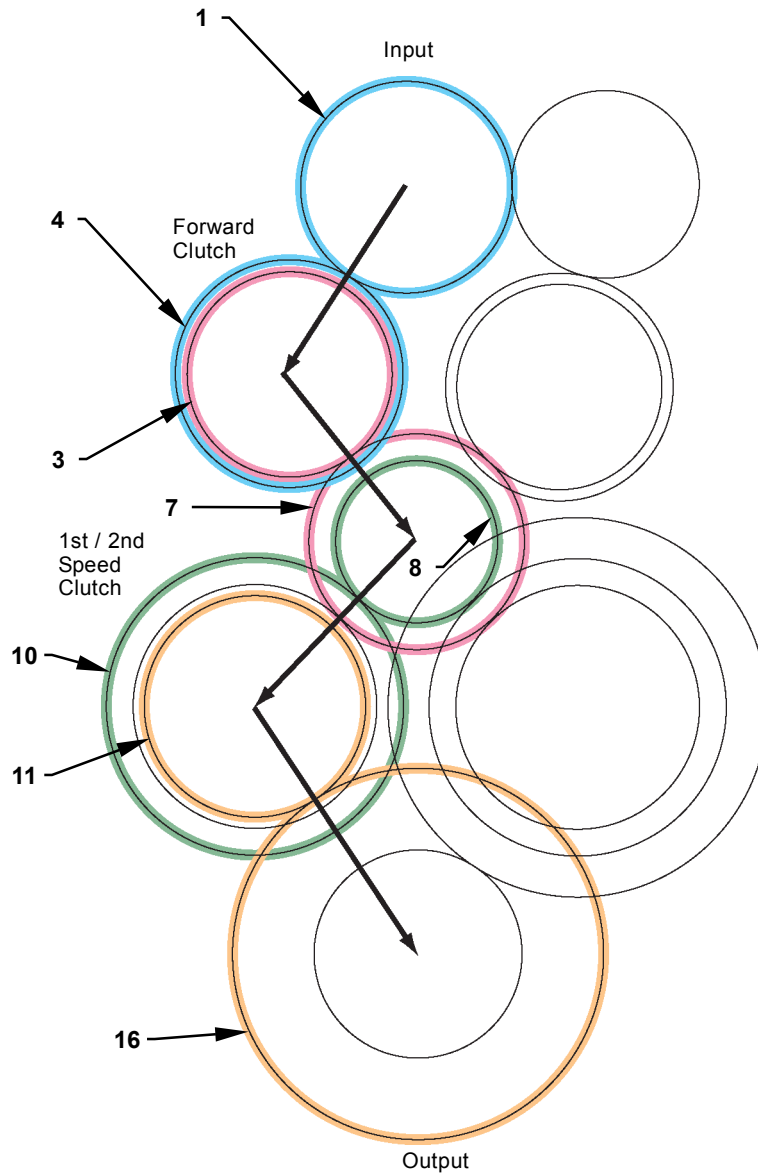
T4GC-03-09-014

COMPONENT OPERATION / Drive Unit

Forward 1st Speed

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

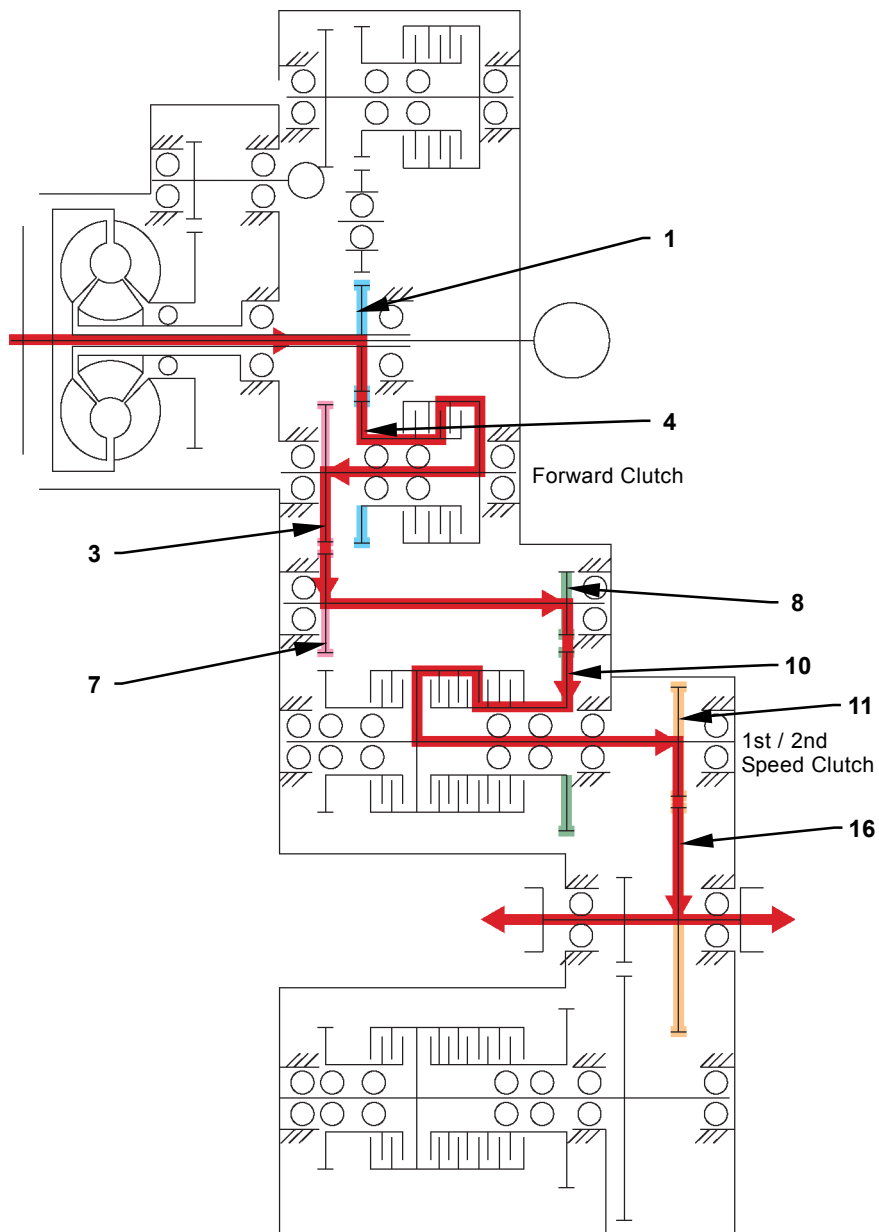
In addition, torque is transmitted from 1st hub gear (10) to low-range gear (11), and finally to output gear (16).



T4GC-03-09-015

Power Flow: Forward 1st Speed

COMPONENT OPERATION / Drive Unit



T4GC-03-09-016

1 - Input Gear
3 - F-R Gear

4 - F Hub Gear
7 - Idler Gear

8 - Idler Gear
10 - 1st Speed Hub Gear

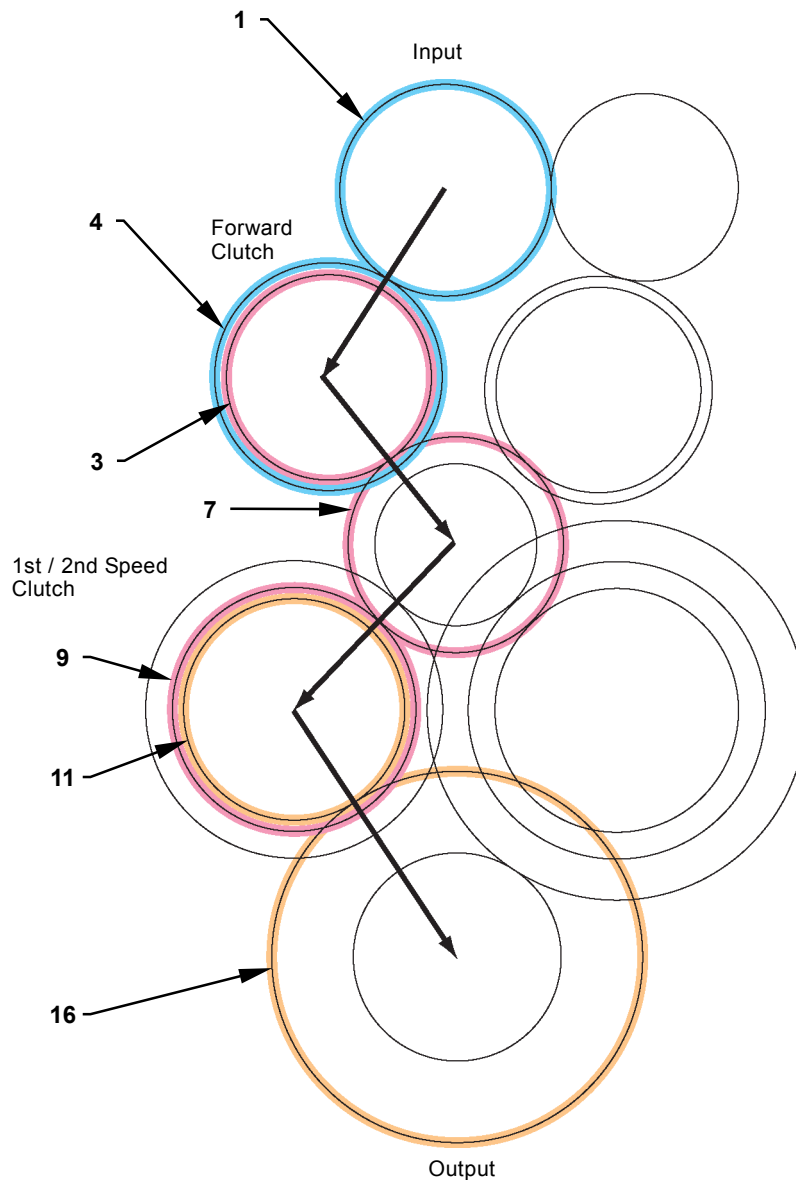
11 - Low-Range Gear
16 - Output Gear

COMPONENT OPERATION / Drive Unit

Forward 2nd Speed

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

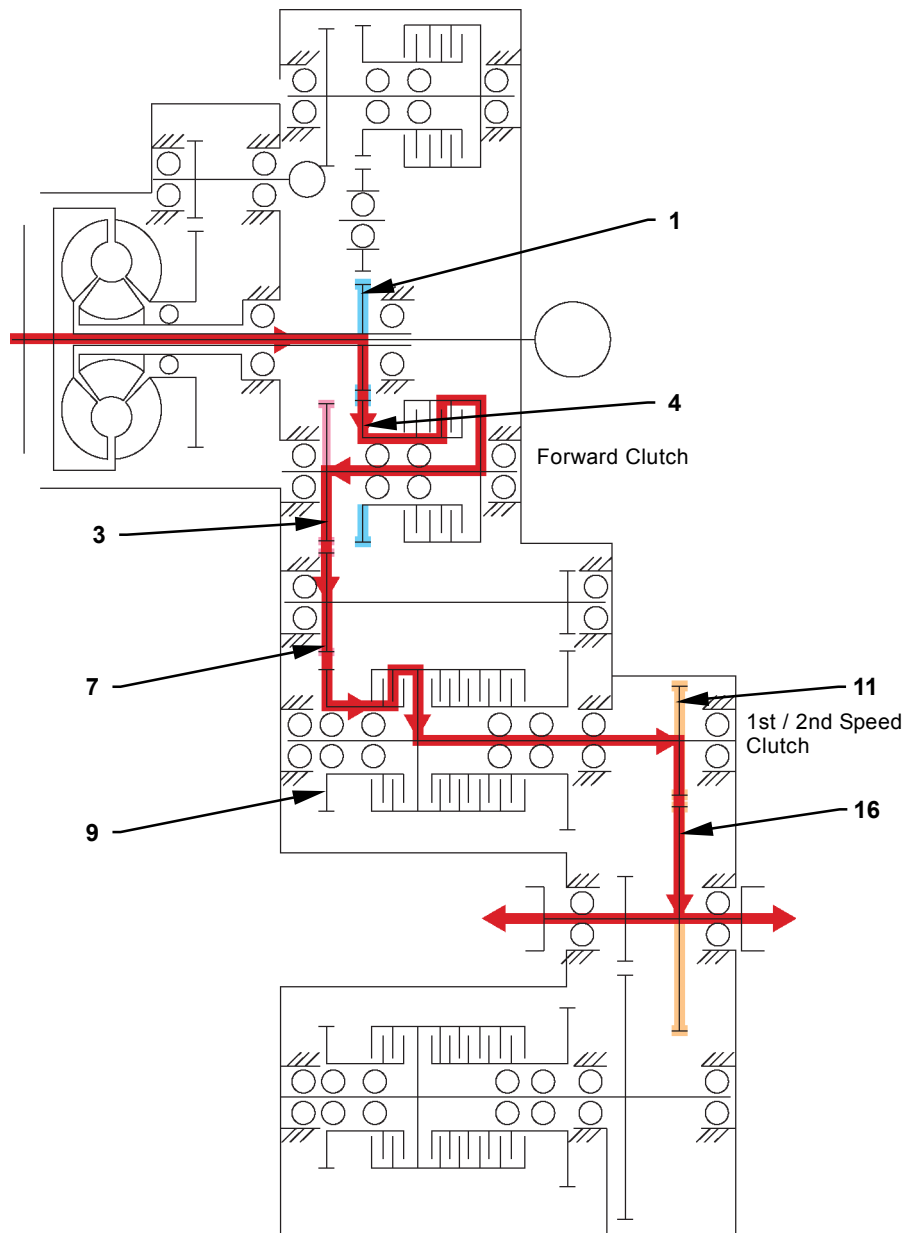
In addition, torque is transmitted from 2nd speed hub gear (9) to low-range gear (11), and finally to output gear (16).



Power Flow: Forward 2nd Speed

T4GC-03-09-017

COMPONENT OPERATION / Drive Unit



T4GC-03-09-018

1 - Input Gear
3 - F-R Gear

4 - F Hub gear
7 - Idler Gear

9 - 2nd Speed Hub Gear
11 - Low-Range Gear

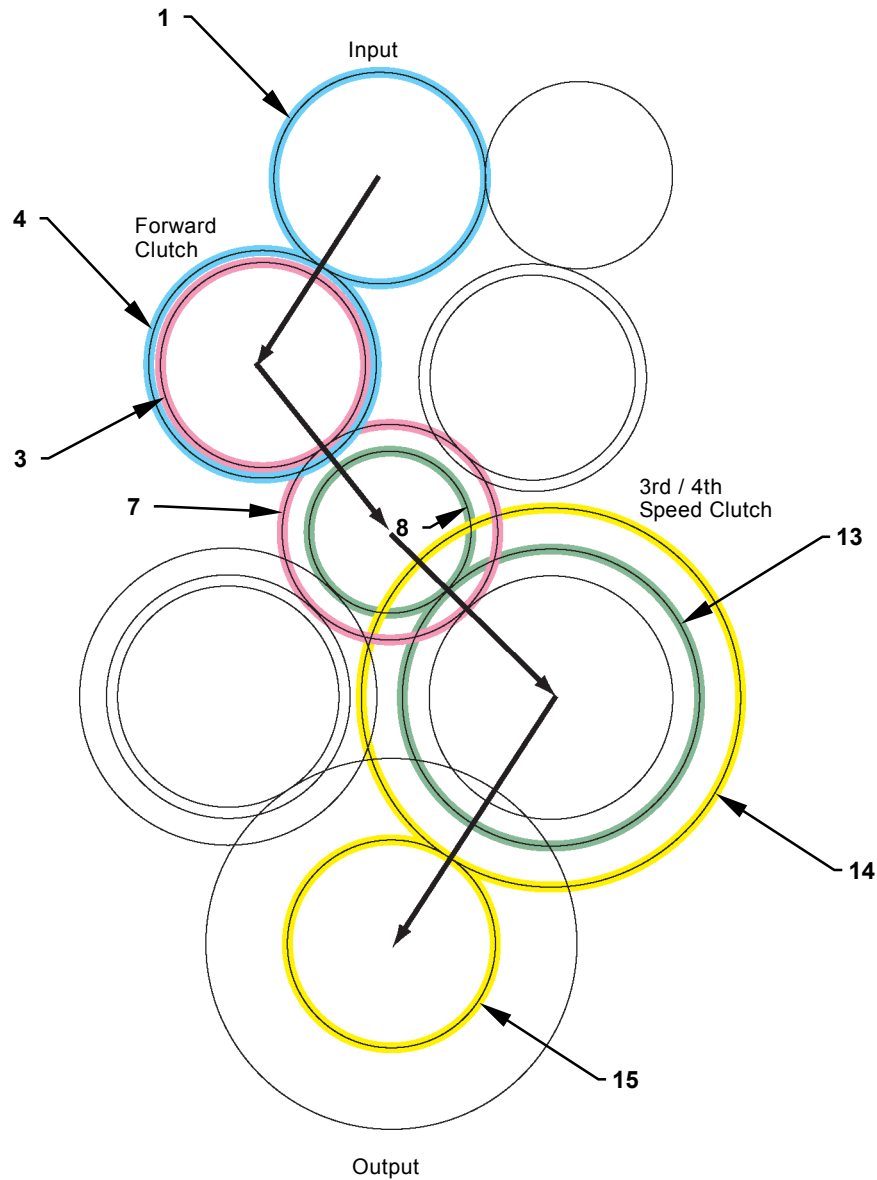
16 - Output Gear

COMPONENT OPERATION / Drive Unit

Forward 3rd Speed

In case of forward 3rd speed, the forward clutch is connected to the 3rd speed part of the 3rd / 4th speed clutch. The torque converter transmits torque to F hub gear (4) which is meshed with 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).

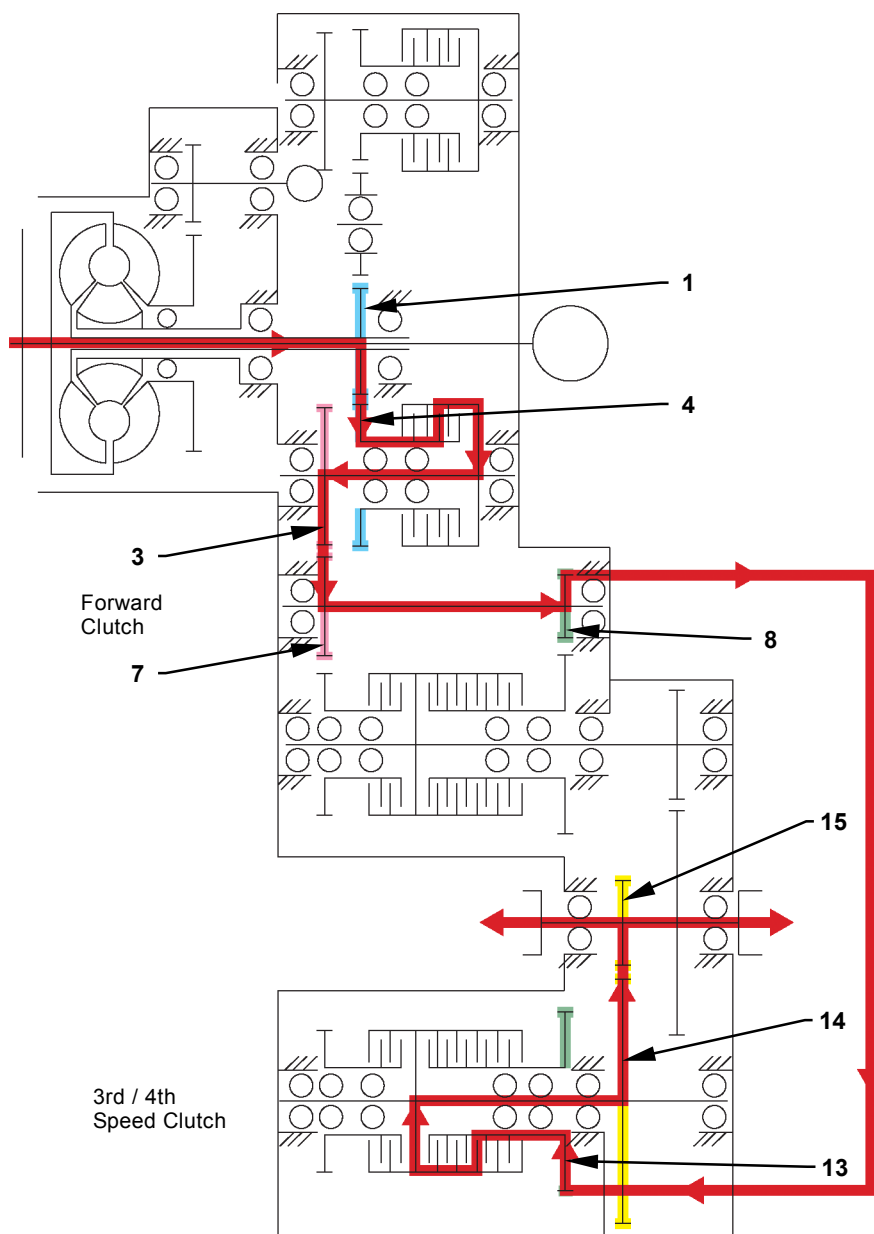
In addition, torque is transmitted from 3rd speed hub gear (13) to high-range gear (14), and finally to output gear (15).



T4GC-03-09-019

Power Flow: Forward 3rd Speed

COMPONENT OPERATION / Drive Unit



T4GC-03-09-020

1 - Input Gear
3 - F-R Gear

4 - F Hub Gear
7 - Idler Gear

8 - Idler Gear
13 - 3rd speed Hub Gear

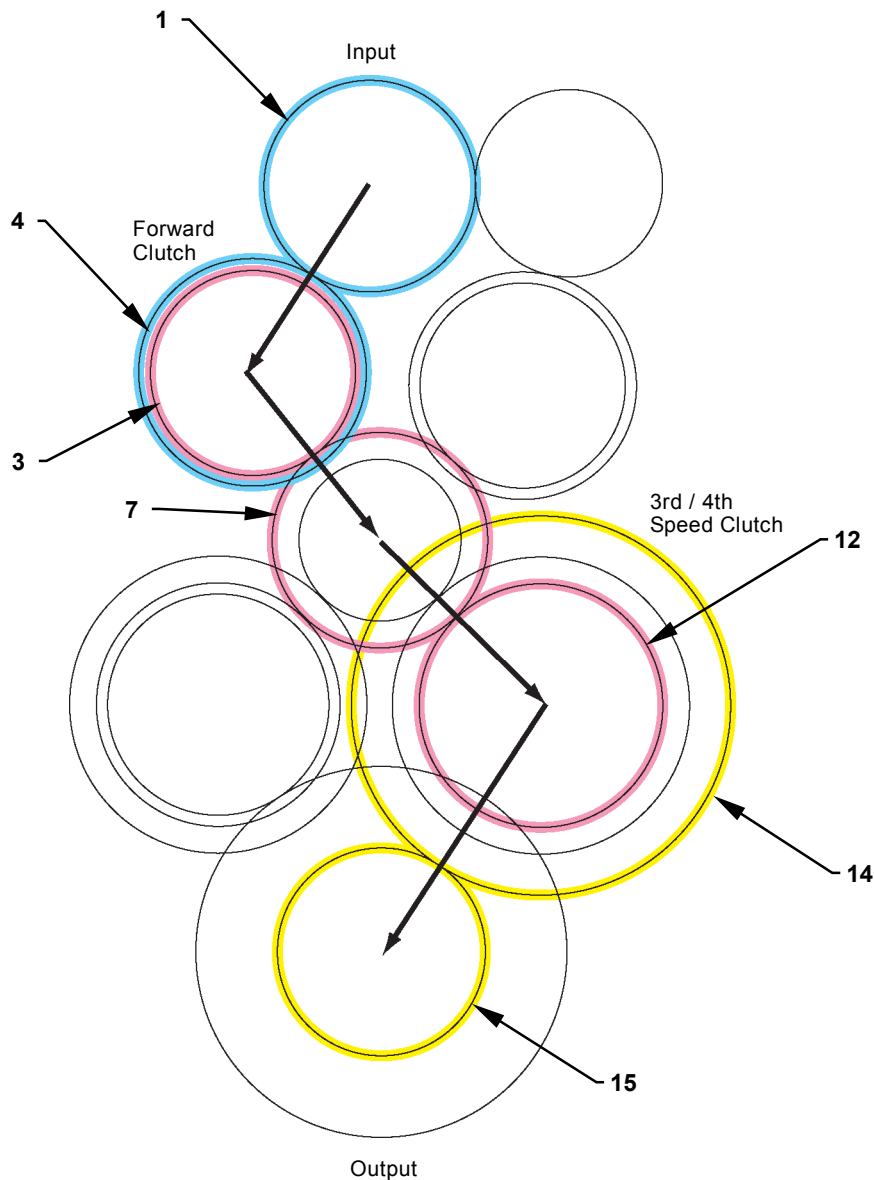
14 - High-Range Gear
15 - Output Gear

COMPONENT OPERATION / Drive Unit

Forward 4th Speed

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

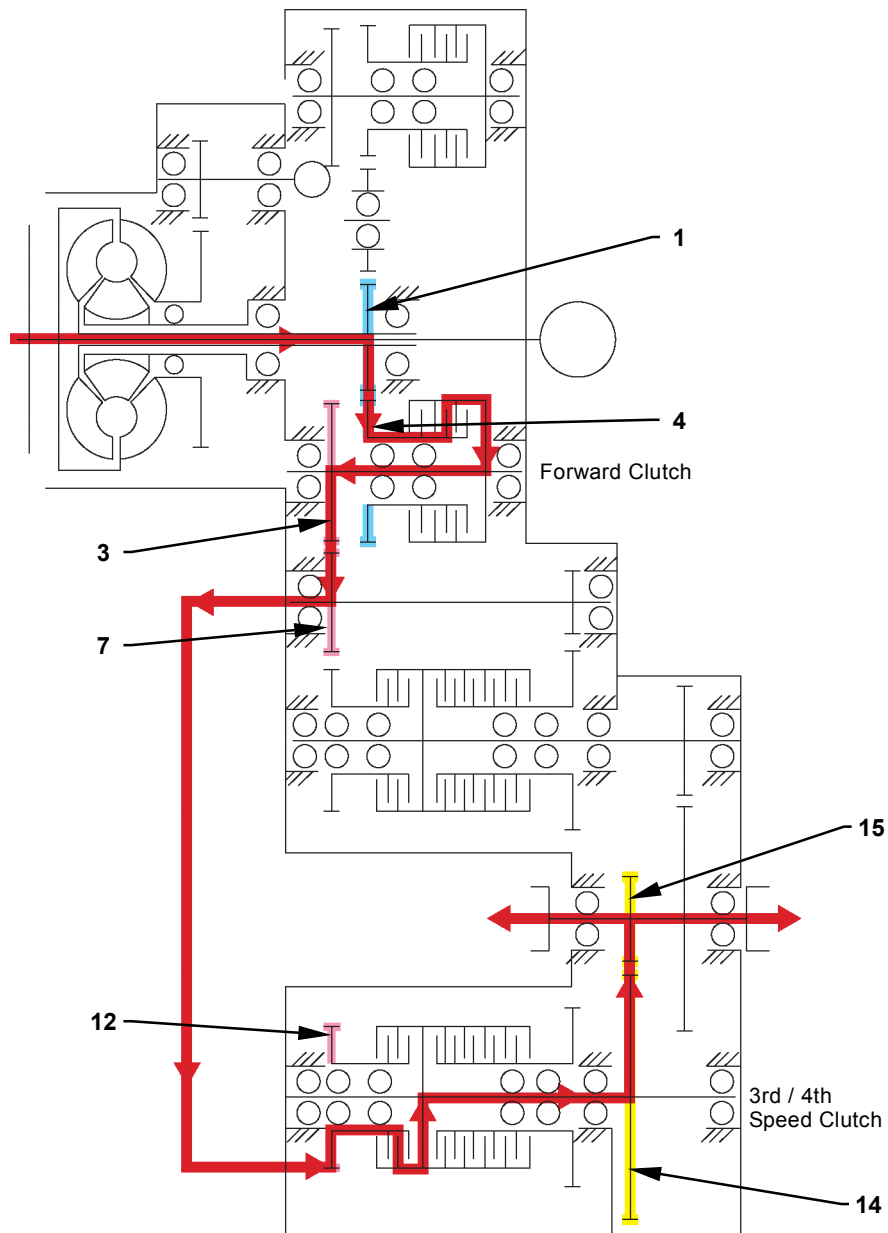
In addition, torque is transmitted from 4th hub gear (12) to high-range gear (14), and finally to output gear (15).



T4GC-03-09-021

Power Flow: Forward 4th Speed

COMPONENT OPERATION / Drive Unit



T4GC-03-09-022

1 - Input Gear
3 - F-R Gear

4 - F Hub Gear
7 - Idler Gear

12 - 4th Speed Hub Gear
14 - High-Range Gear

15 - Output Gear

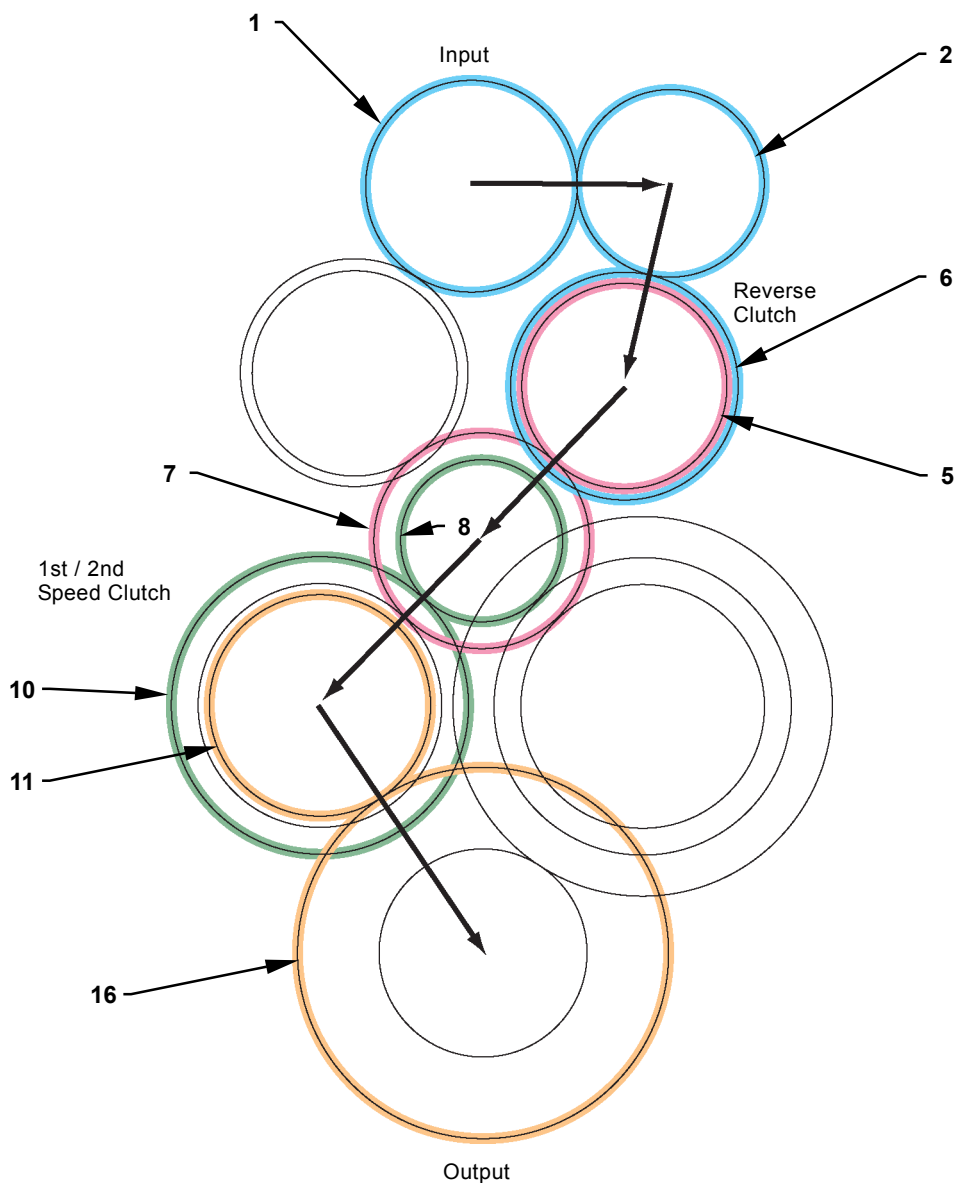
COMPONENT OPERATION / Drive Unit

Reverse 1st Speed

In case of reverse 1st speed, the reverse clutch is connected to the 1st speed part of the 1st / 2nd speed clutch. The torque converter transmits torque to R hub gear (6) from reverse gear (2) which is meshed with input gear (1). Torque from R hub gear (6) is transmitted to 1st speed hub gear (10) through F-R gear (5), idler gear (7) and idler gear (8).

In addition, torque is transmitted from 1st speed hub gear (10) to low-range gear (11), and finally to output gear (16).

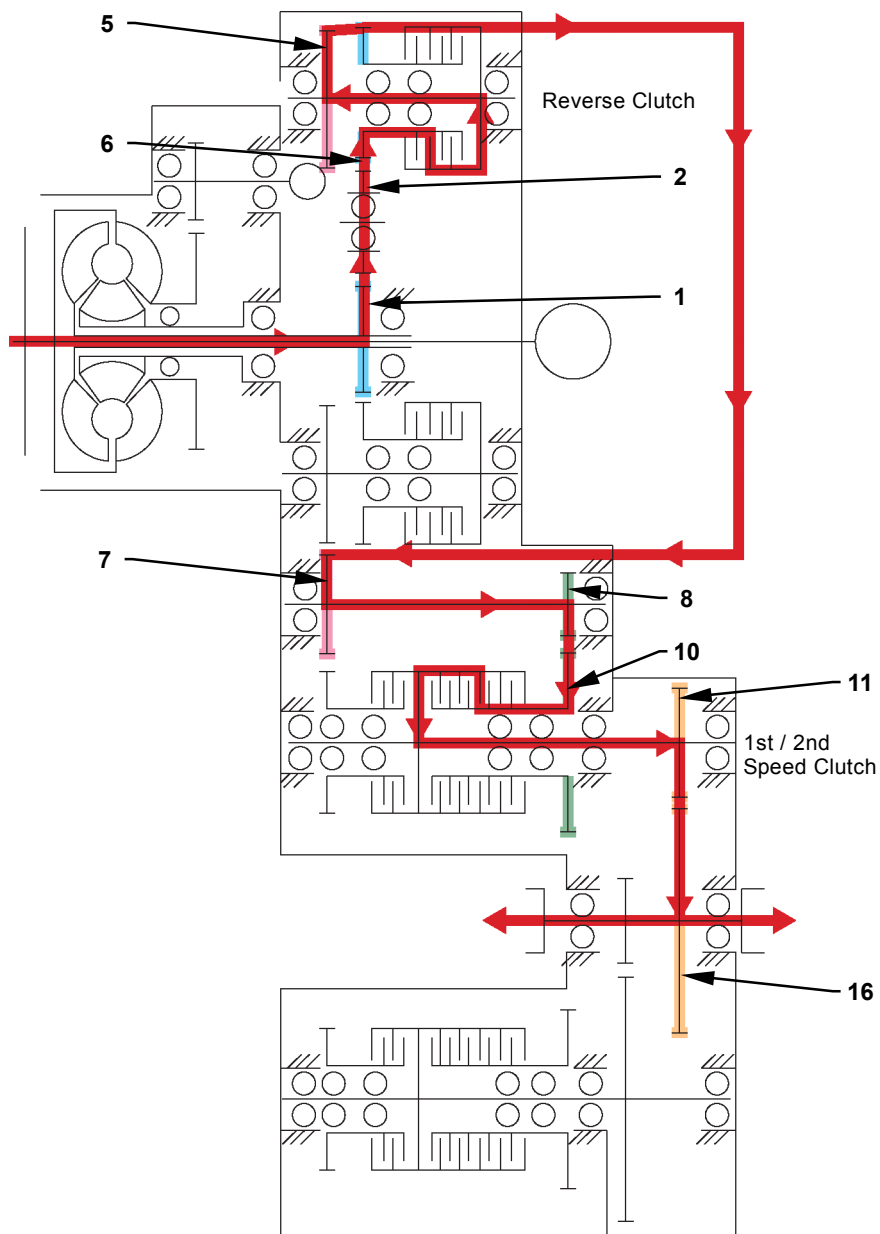
The processes of the idler gear and after for the other reverse speed shifts are similar to those for the forward.



T4GC-03-09-023

Power Flow: Reverse 1st Speed

COMPONENT OPERATION / Drive Unit



T4GC-03-09-024

1 - Input Gear
2 - Reverse Gear
5 - F-R Gear

6 - R Hub Gear
7 - Idler Gear

8 - Idler Gear
10 - 1st speed Hub Gear

11 - Low-Range Gear
16 - Output Gear

COMPONENT OPERATION / Drive Unit

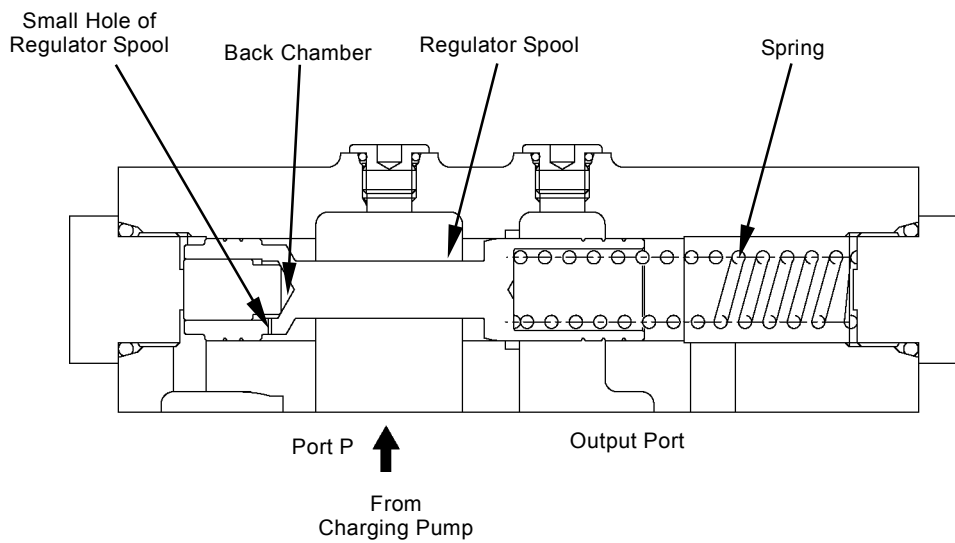
TRANSMISSION REGULATOR VALVE

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

Pressure oil entering port P 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 oil pressure in the back chamber becomes higher than the spring force, the regulator spool moves to the right, and pressure oil at port P flows from the outlet port to the torque converter. This movement of the spool keeps 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. Pressure oil from port P passes the oil passage in the transmission case, and is supplied to the transmission control valve. Overflowing oil passes the oil passage in the transmission case, and is supplied to the torque converter.

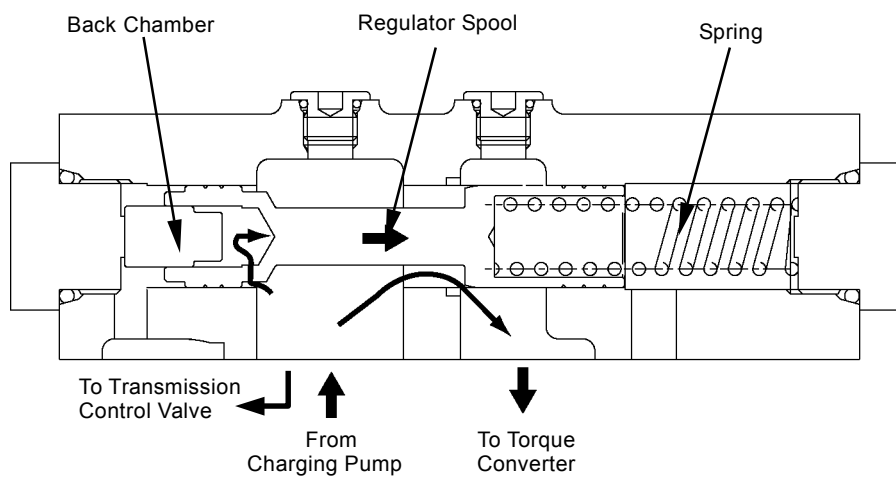
COMPONENT OPERATION / Drive Unit

Normal state



T4GC-03-09-025

Overflowing state



T4GC-03-09-026

COMPONENT OPERATION / Drive Unit

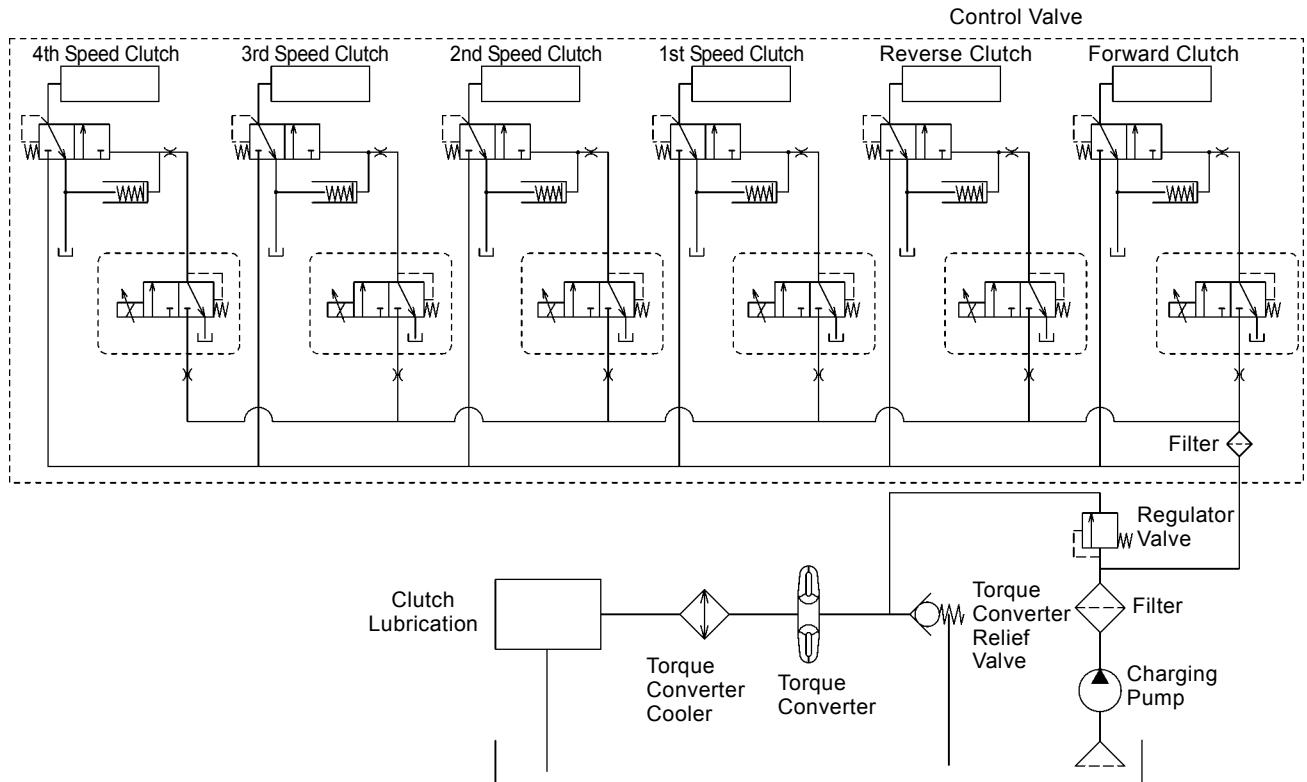
TRANSMISSION CONTROL VALVE

The transmission control valve supplies oil that is maintained at constant pressure by the regulator valve to each clutch. This changes vehicle travel direction and speed.

The transmission control valve is composed of the valve body and the proportional solenoid valve for each clutch. It controls the clutch oil pressure by operating the shift lever, actuating each proportional solenoid valve, and moving the modulation spool of the valve body.

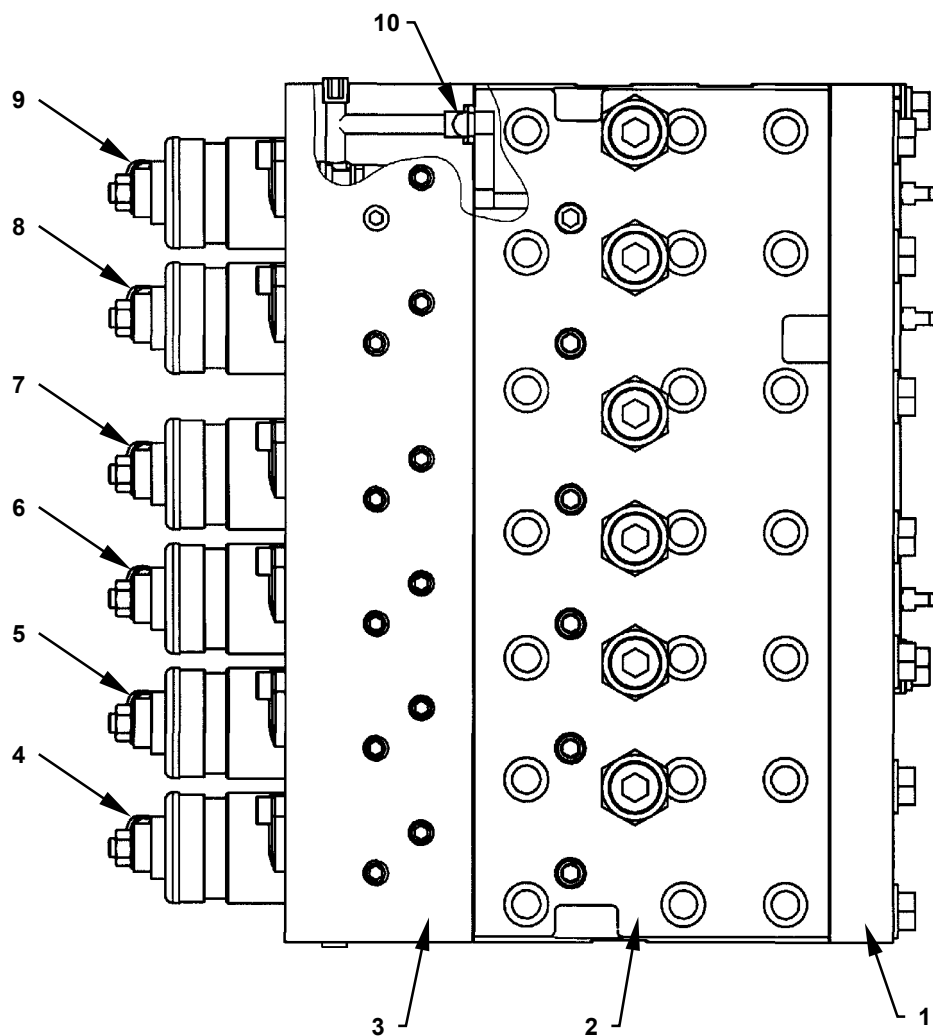
The proportional solenoid valve controls oil pressure according to the electric signals from the controller. Therefore, the proportional solenoid valve can receive variety of hydraulic waveforms depending on the vehicle conditions.

COMPONENT OPERATION / Drive Unit



T4GD-03-09-009

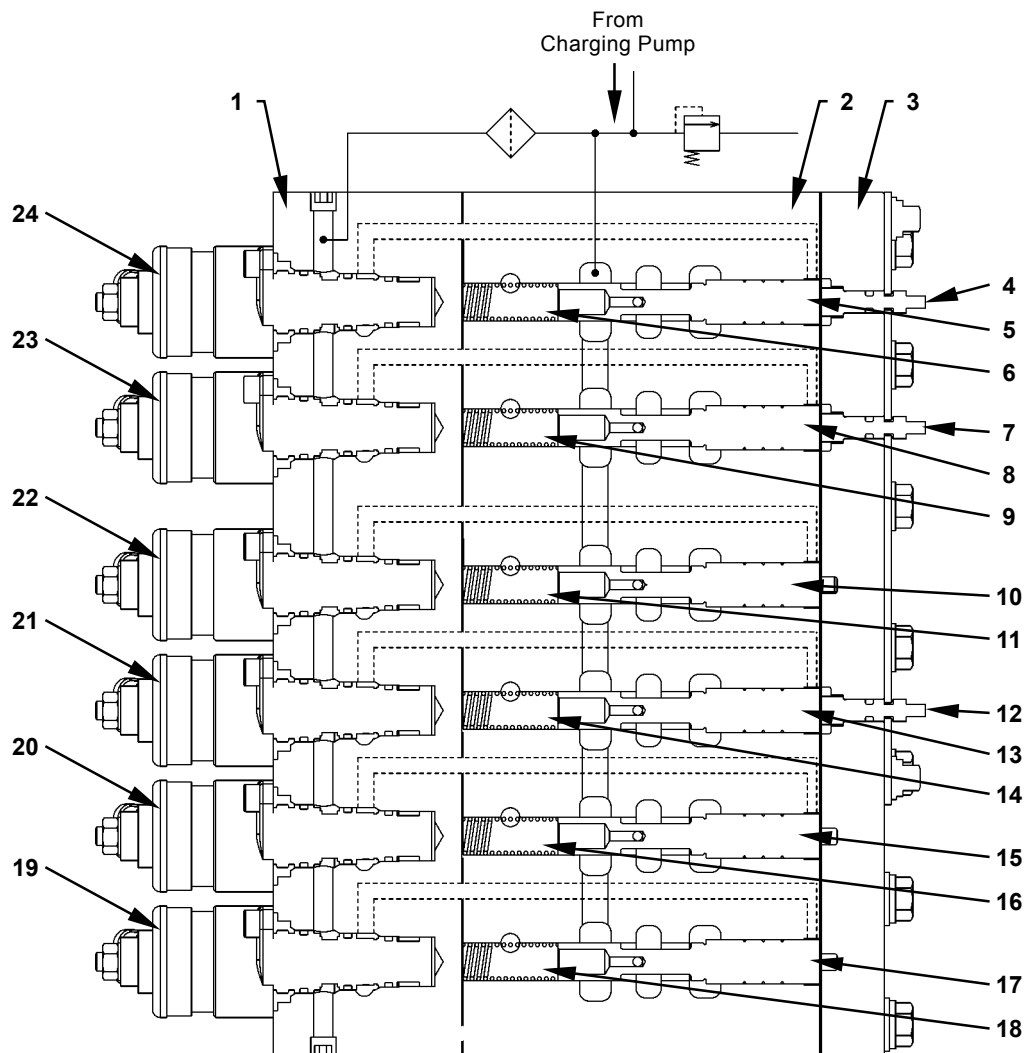
COMPONENT OPERATION / Drive Unit



T4GD-03-09-010

- | | | | |
|-------------------|---|---|---|
| 1 - Cover | 4 - 4th Speed Proportional Solenoid Valve | 7 - 1st Speed Proportional Solenoid Valve | 9 - Forward Proportional Solenoid Valve |
| 2 - Valve Body | 5 - 3rd Speed Proportional Solenoid Valve | 8 - Reverse Proportional Solenoid Valve | 10 - Filter |
| 3 - Solenoid Body | 6 - 2nd Speed Proportional Solenoid Valve | | |

COMPONENT OPERATION / Drive Unit



T4GD-03-09-011

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

COMPONENT OPERATION / Drive Unit

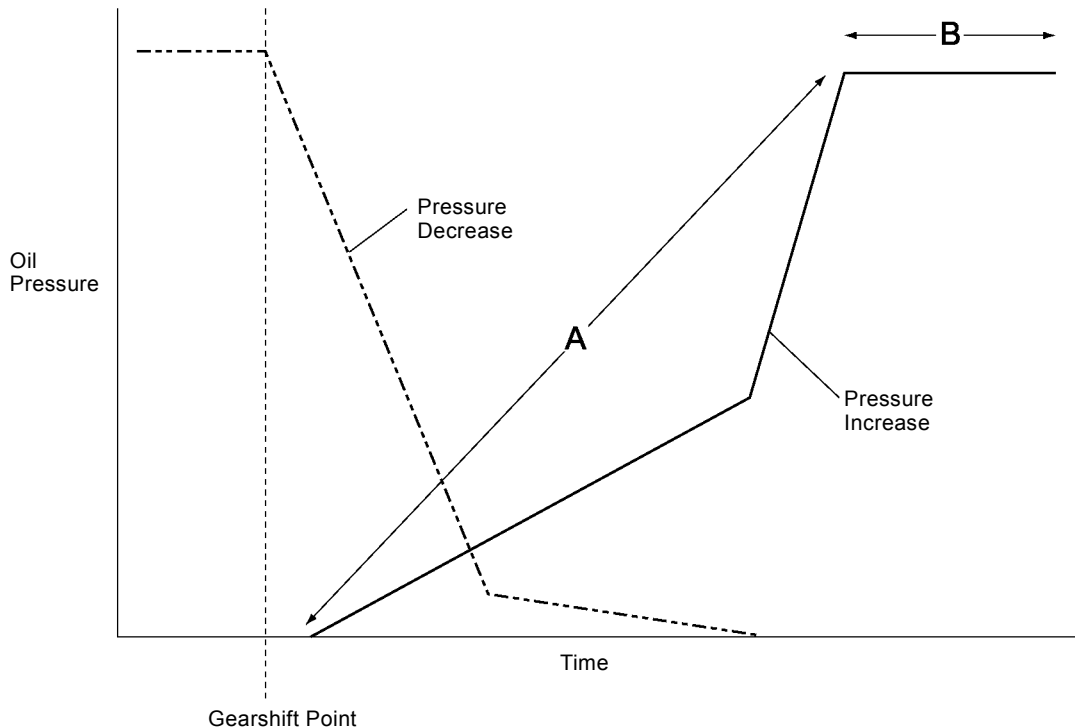
Operation

Modulation mechanism enables smoother gearshift by changing the pressure increase waveform or pressure decrease waveform of each clutch depending on the vehicle condition (engine speed, travel speed, and others).

Vehicle condition is judged by analyzing the information (electric signal) sensed by the engine speed sensor, travel speed sensor and shift lever with the transmission controller. Therefore, the electric signal depending on the gearshift is transmitted from the controller to the proportional solenoid valve.

The proportional solenoid valve supplies pressure oil depending on the electric signal from the controller, to the modulation spool.

The modulation spool regulates the clutch oil pressure depending on the oil pressure from the proportional solenoid valve, and supplies pressure oil to the clutch piston.



T4GC-03-09-030

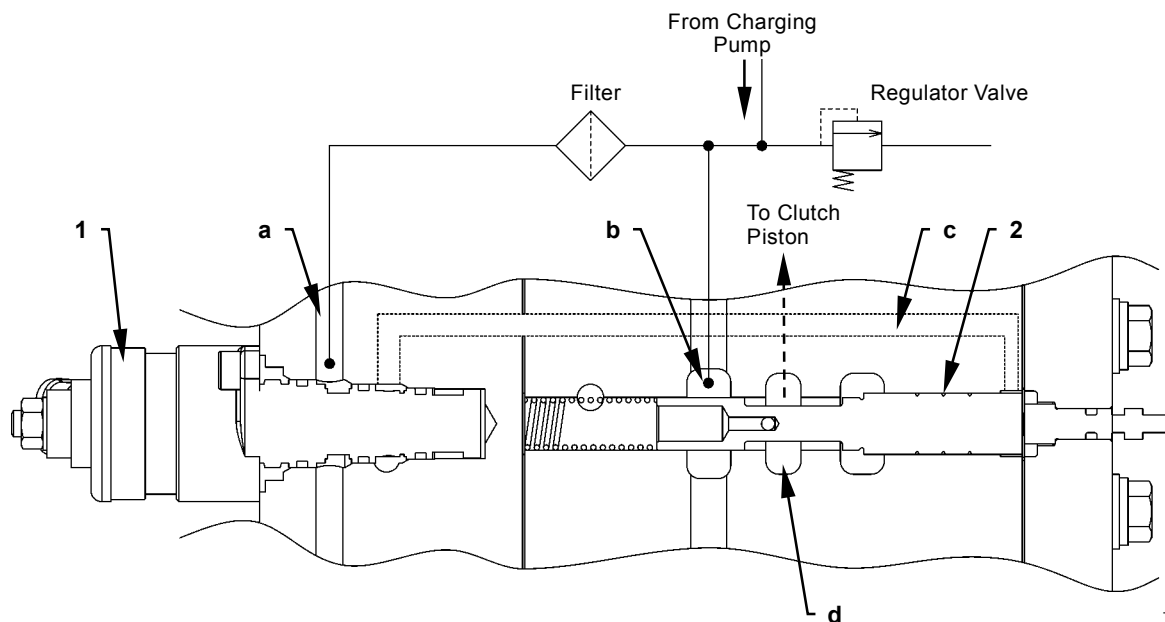
Clutch Oil Pressure Waveform

COMPONENT OPERATION / Drive Unit

In Neutral

Pressure oil maintained at constant pressure by the regulator valve flows to the transmission control valve, and is divided into oil passage (a) to proportional solenoid valve (1) and oil passage (b) to modulation spool (2).

Pressure oil does not flow from oil passage (a) to oil passage (c) as the electric signal to be transmitted from the controller to proportional solenoid valve (1) is stopped in neutral. As oil passage (d) between oil passage (b) and the clutch piston is blocked by modulation spool (2), clutch pressure is not raised and becomes neutral.



T4GD-03-09-013

- 1 - Proportional Solenoid Valve
- 2 - Modulation Spool

COMPONENT OPERATION / Drive Unit

Clutch Connection from Neutral (Clutch Pressure Increase)

- During Clutch Connection
(Refer to Oil Pressure Waveform A on T3-9-32.)

When the transmission is shifted by the lever, the electric signal is transmitted from the controller to proportional solenoid valve (1).

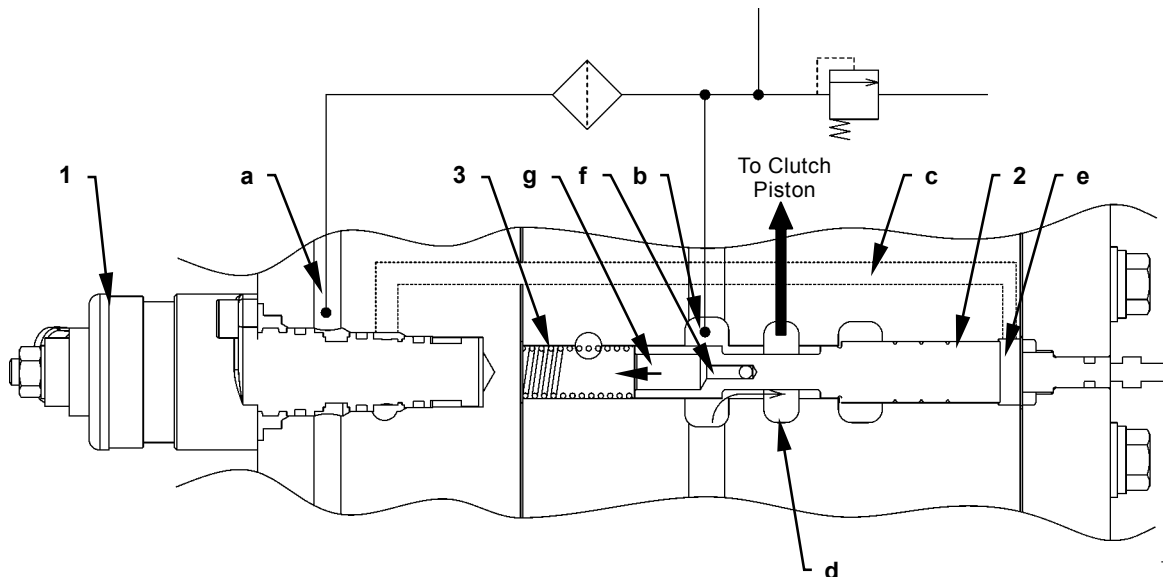
During oil pressure waveform A, pressure oil to oil passage (a) of proportional solenoid valve (1) is regulated to the pressure corresponding to the electric signal of the controller, and is supplied to oil passage (c).

1. Pressure oil to oil passage (c) is supplied to pressure chamber (e) of modulation spool (2), overcomes the force of modulation spring (3), and moves modulation spool (2) leftward. Therefore, pressure oil is supplied from oil passage (b) to oil passage (d) of the clutch piston, and the clutch pressure increases.

2. In addition, pressure oil to oil passage (d) passes back chamber (f) of modulation spool (2), and is supplied to back chamber (g) of modulation spool (2).

As modulation spring (3) is installed in back chamber (g) of modulation spool (2), it overcomes the oil pressure in oil passage (d), moves modulation spool (2) rightward and closes oil passage (d) temporarily.

Electric current from the controller is enlarged gradually, and steps 1 and 2 are repeated. Therefore, the clutch oil pressure gradually increases.



T4GD-03-09-014

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

COMPONENT OPERATION / Drive Unit

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

Finally, pressures in oil chamber (e) and oil chamber (g) become equal.

Spring (3) is installed in oil chamber (g). As the force pushing leftward of oil chamber (e) is larger than the force pushing rightward of oil chamber (g) and spring (3) force, modulation spool (2) is pushed to the left end. Therefore, oil passage (b) and oil passage (d) are completely open. (Refer to the illustration below.)

Consequently, the clutch pressure and the regulator pressure become equal and constant.

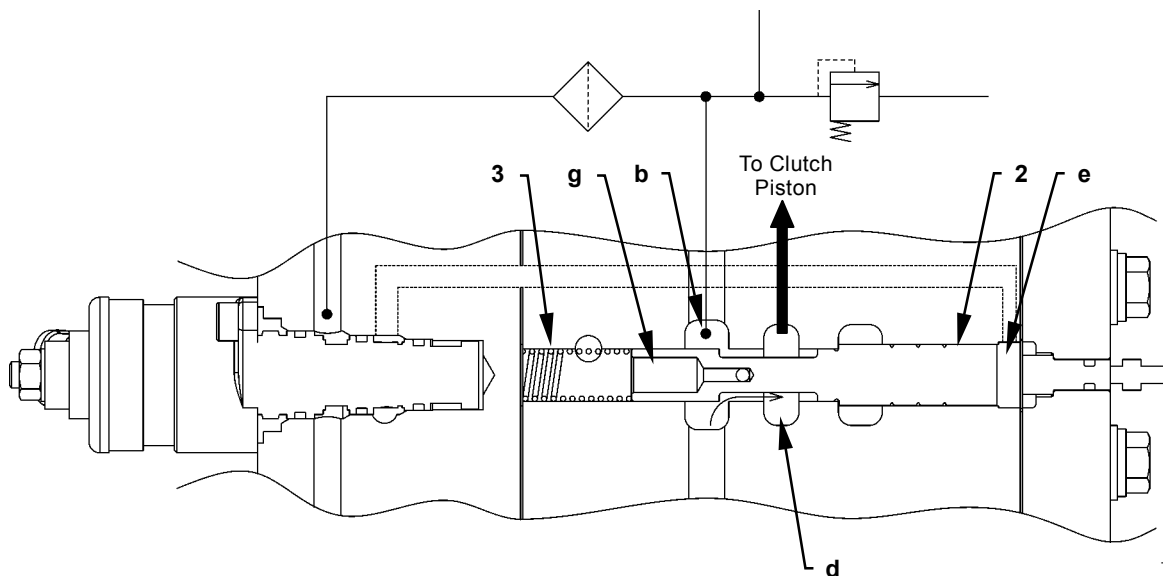
- During Shift Down Condition from Forward 2nd Speed to 1st Speed [at DSS]

Pressure increase of the 1st speed clutch pressure is similar to "Clutch Connection from Neutral".

Pressure decrease of the 2nd speed clutch pressure is operated reversely against pressure increase. The clutch pressure is gradually decreased by gradually decreasing the electric signal (electric current value) from the high condition.

Both clutch pressures overlap by gradually increasing the 1st speed clutch pressure and gradually decreasing the 2nd speed clutch pressure. Therefore, lack of torque at shift down during digging is prevented and the operation can be done smooth.

The proportional solenoid valve and modulation spool (2) organize a set in terms of construction, and are installed to each clutch. Therefore, the best modulation pressure waveform can be always obtained by combining the pressure increase characteristics and the pressure decrease characteristics. (Refer to Clutch Oil Pressure Waveform on T3-9-32.)



- 1 - Modulation Spool
- 2 - Modulation Spring

COMPONENT OPERATION / Drive Unit

MANUAL SPOOL (EMERGENCY TRAVEL SPOOL)

When the solenoid valve cannot be operated due to electric malfunction (e.g.: disconnection), the control valve is shifted to forward 2nd speed or reverse 2nd speed by manually operating this spool.

This spool is used for self-traveling of the vehicle to the place for maintenance in an emergency or something.

IMPORTANT: Before operating the manual spool, stop the engine. If operating the manual spool while the engine is running, the vehicle may start moving.

Operation

- Forward 2nd Speed

When shifting to forward 2nd speed, push in forward emergency travel spool (3) and 2nd speed emergency travel spool (6) each by 5 mm (0.2 in), and turn them 90° while holding them.

Pressure oil regulated to the regulator pressure flows to passage (b) through passage (a) opened by forward modulation spool (2), flows to the forward clutch, and connects the clutch.

As for the 2nd speed clutch, pressure oil flows to oil passage (f) through oil passage (e) opened by 2nd speed modulation spool (7), flows to the 2nd speed clutch, and connects the clutch.

- Shift from Forward 2nd speed to Reverse 2nd Speed

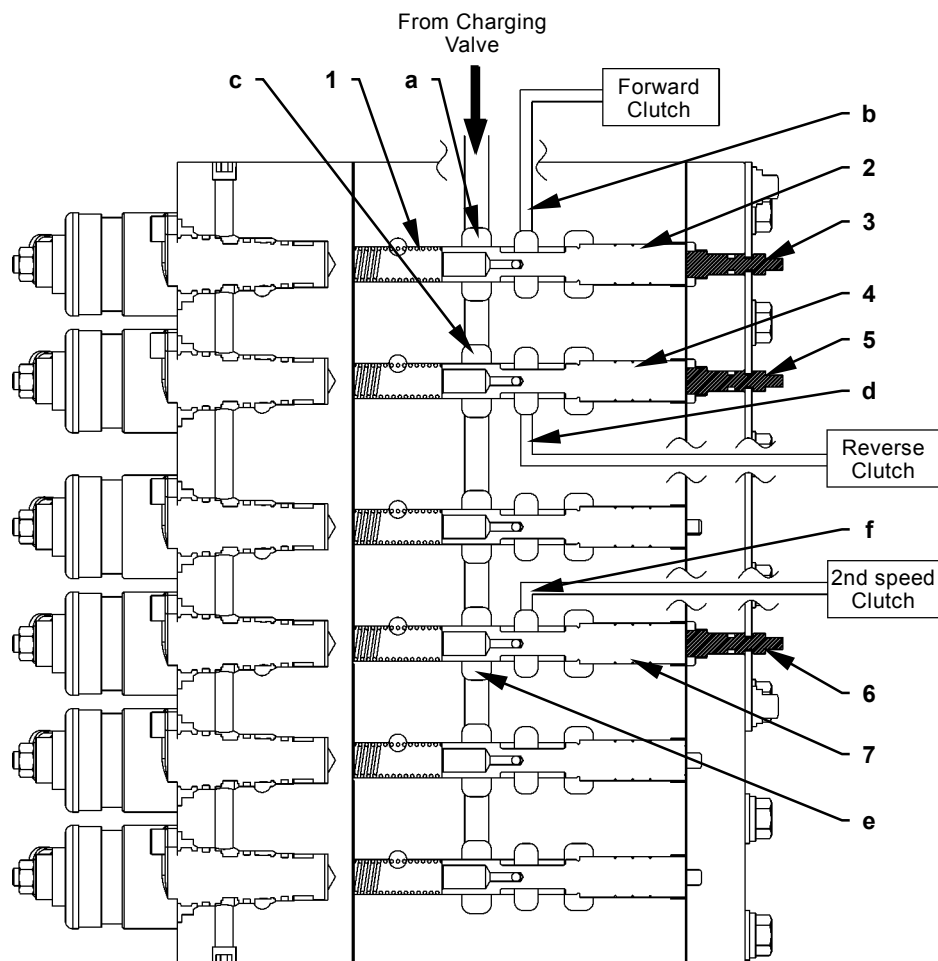
When turning forward emergency travel spool (3) by 90°, the spool returns to the original position by the force of spring (1).

As for reverse 2nd speed, similarly to forward 2nd speed, push in reverse emergency travel spool (5) by 5 mm, and turns it 90°.

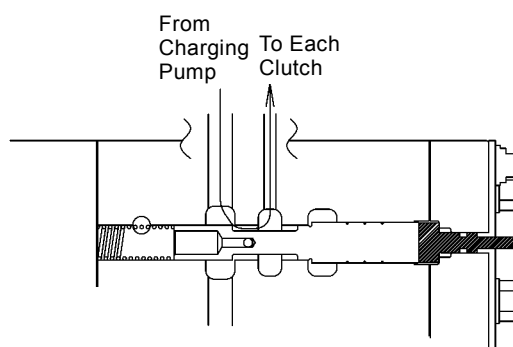
Pressure oil regulated to the regulator pressure flows to oil passage (d) through oil passage (c) opened by reverse modulation spool (4), flows to the reverse clutch, and connects the clutch.

IMPORTANT: Do not operate forward emergency travel spool (3) and reverse emergency travel spool (5). Breakage of the clutch can be caused.

COMPONENT OPERATION / Drive Unit



• When Operating of Manual Spool



T4GD-03-09-012

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

COMPONENT OPERATION / Drive Unit

PROPORTIONAL SOLENOID VALVE

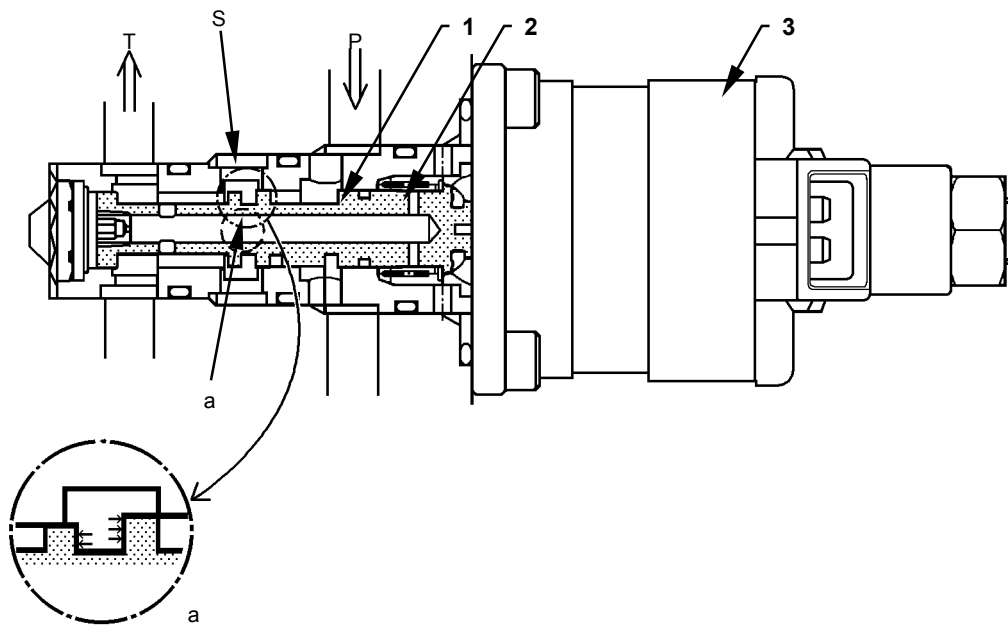
The proportional solenoid valve is used as a pilot valve for the clutch oil pressure, and supplies pressure oil to the modulation spool by receiving the electric signal from the controller and by increasing or decreasing oil pressure.

Operation

- In Neutral: Spool (1) is pushed rightward by spring (2). Output port S is connected to tank port T.
- When Excited: Solenoid (3) pushes spool (1) leftward with a force in proportion to the electric current flowing through solenoid (3). Pilot pressure oil flows to output port S from port P, and the pressure at output port S increases.

This pressure at output port S acts on step part a of spool (1). A force to push spool (1) rightward occurs due to the difference of pressure-receiving area at step part a. When the pressure at output port S increases, and the force to push spool (1) rightward becomes larger than the force to push spool (1) leftward by solenoid (3), 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 increasing.

COMPONENT OPERATION / Drive Unit



T107-02-07-005

1 - Spool

2 - Spring

3 - Solenoid

COMPONENT OPERATION / Drive Unit

PARKING BRAKE

The parking brake is a wet type multiplate disc brake. The brake is a negative type so that it is released only when the brake release pressure acts on the oil chamber in the brake piston.

The parking brake is installed on 1st speed / 2nd speed shaft of the transmission through the disc hub.

- **Applying Brake**

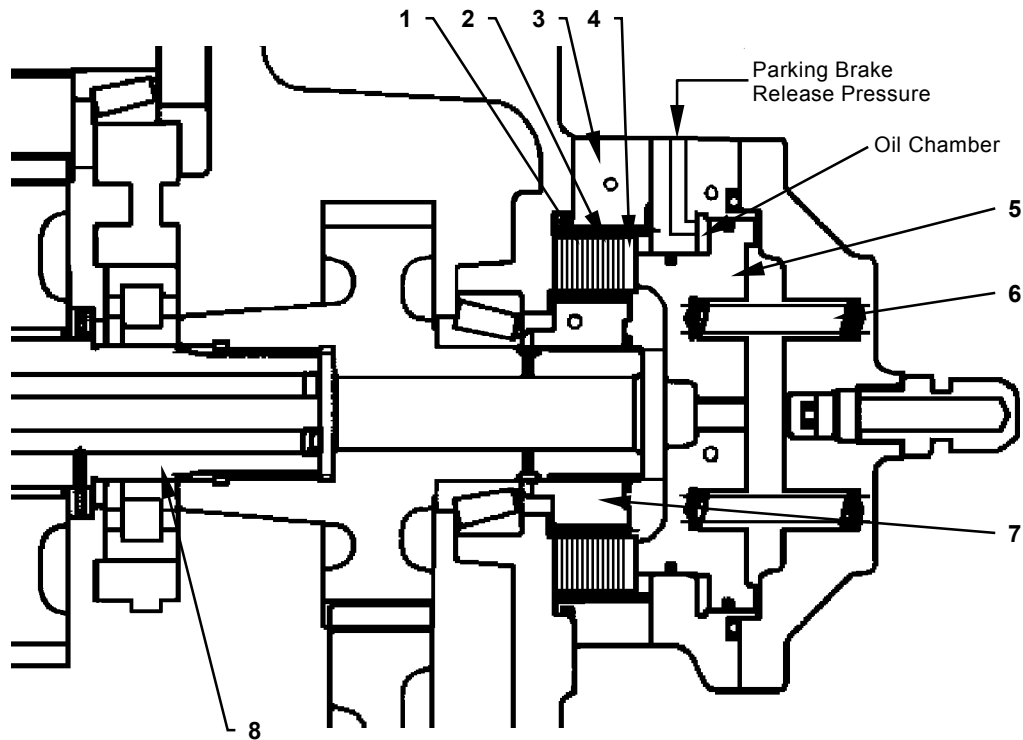
When the parking brake switch is turned to the ON position, the brake release pressure from the charging block does not act on the oil chamber in brake piston (5). Spring (6) moves brake piston (5) leftward and brake disc (2) and brake plate (1) come in contact tightly.

The inner surface of brake disc (2) is splined to shaft (8) through disc hub (7). The outer surface of brake plate (1) is fixed to brake housing (3). Therefore, the rotation of tightly contacted brake disc (2) is stopped so that the parking brake is applied.

- **Releasing Brake**

When the parking brake switch is turned to the OFF (Release) position, the brake release pressure from the charging block acts on the oil chamber in brake piston (5). Brake piston (5) moves rightward, brake disc (2) is to be free, and the parking brake is released.

COMPONENT OPERATION / Drive Unit



T4GD-03-09-016

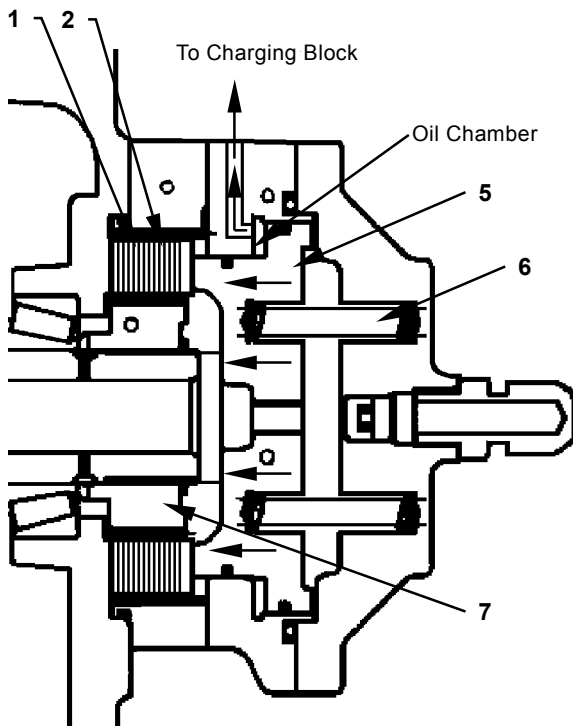
1 - Brake Plate
2 - Brake Disc

3 - Brake Housing
4 - End Plate

5 - Brake Piston
6 - Spring

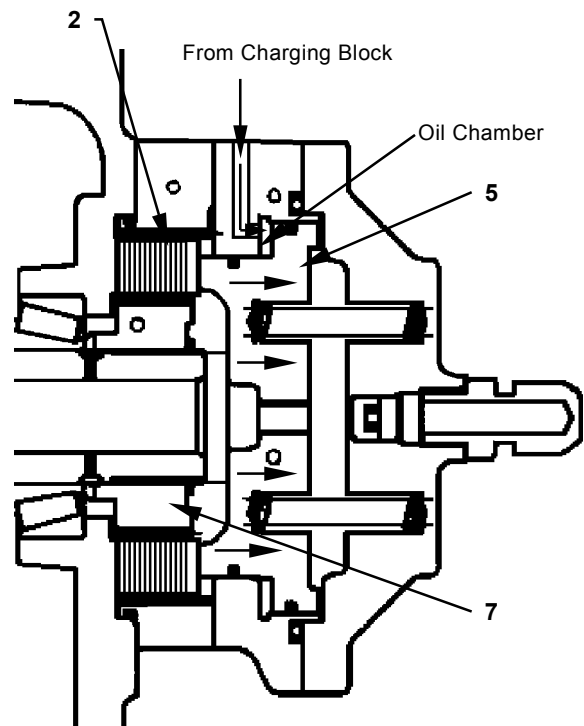
7 - Disc Hub
8 - Shaft

• Operation



T4GD-03-09-017

• Release



T4GD-03-09-017

COMPONENT OPERATION / Drive Unit

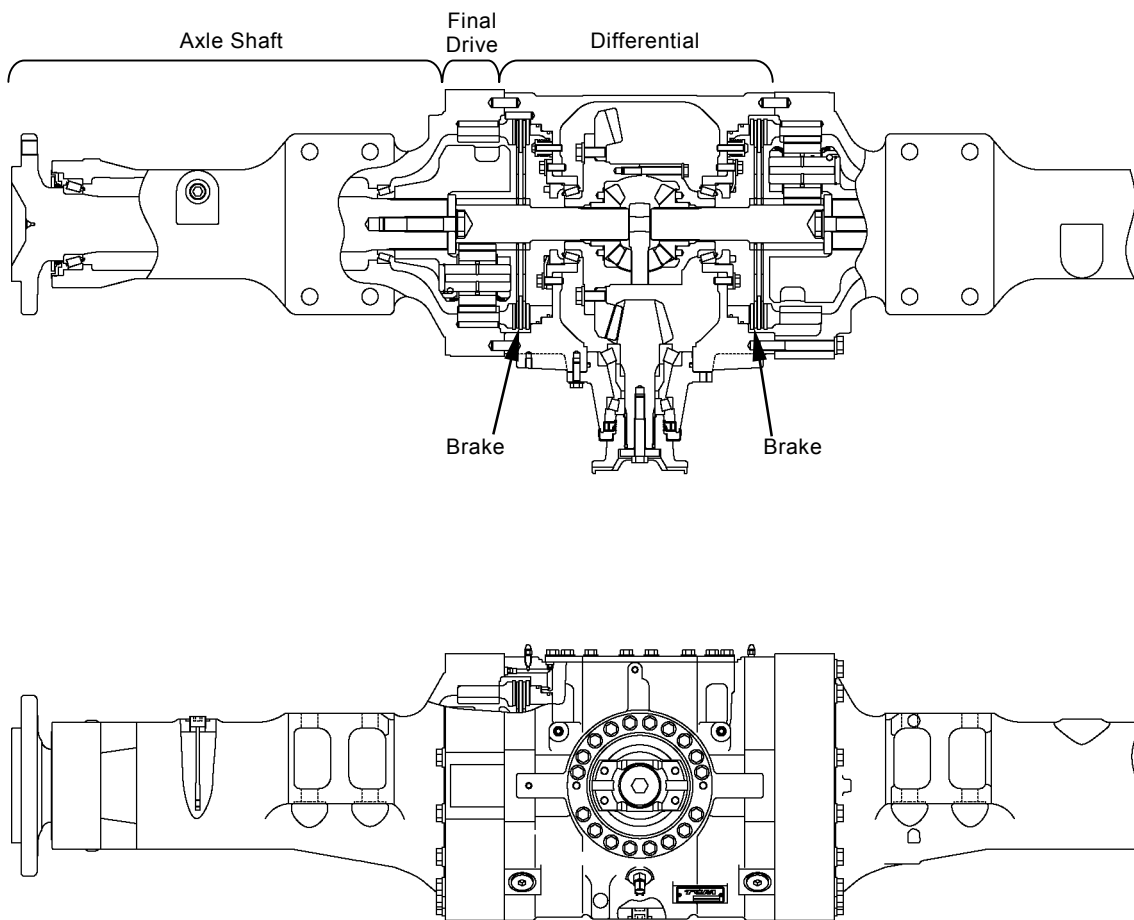
(Blank)

COMPONENT OPERATION / Axle

OUTLINE

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

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

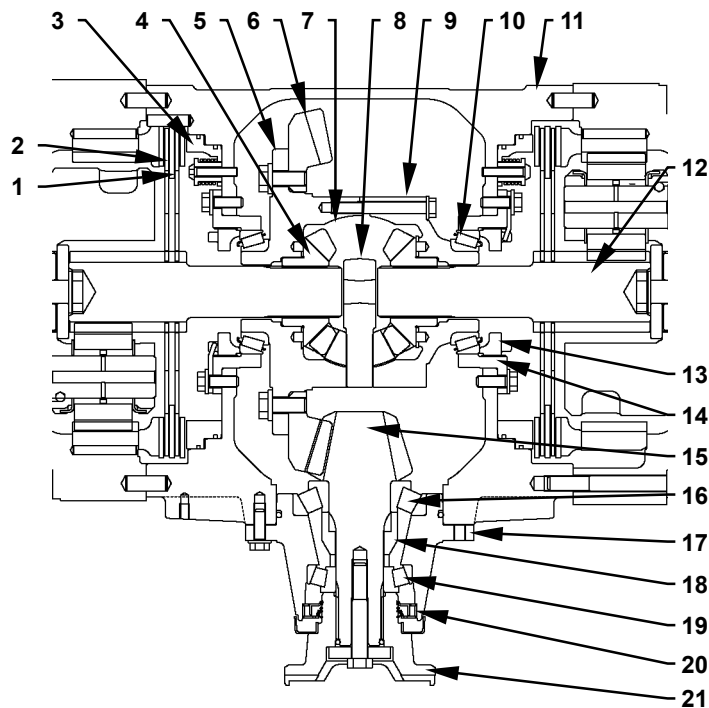


T4GD-03-10-001

COMPONENT OPERATION / Axle

DIFFERENTIAL

The 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.



T4GD-03-10-003

- | | | | |
|----------------|-----------------------------|-----------------------|---------------------|
| 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 Gear Body | 17 - Bearing Cage | |
| 6 - Ring Gear | 12 - Gear & Shaft | 18 - Spacer | |

COMPONENT OPERATION / Axle

Function

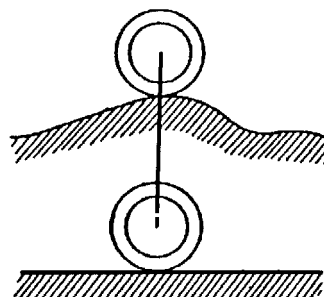
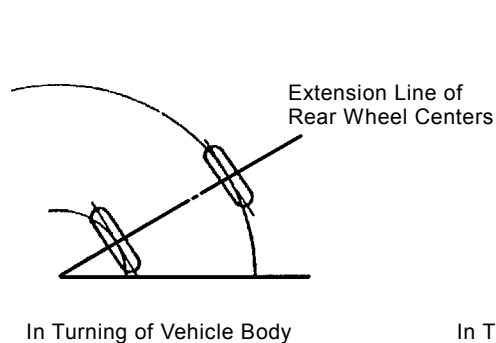
- **Purpose of Differential**

When the vehicle body is steered, as the inner wheel turns with a smaller radius, 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 inner 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 skidding sideways or tire wear takes place. As the axle shaft is subjected to torsional stress, transmission of drive force becomes unstable.

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



T202-03-05-005

COMPONENT OPERATION / Axle

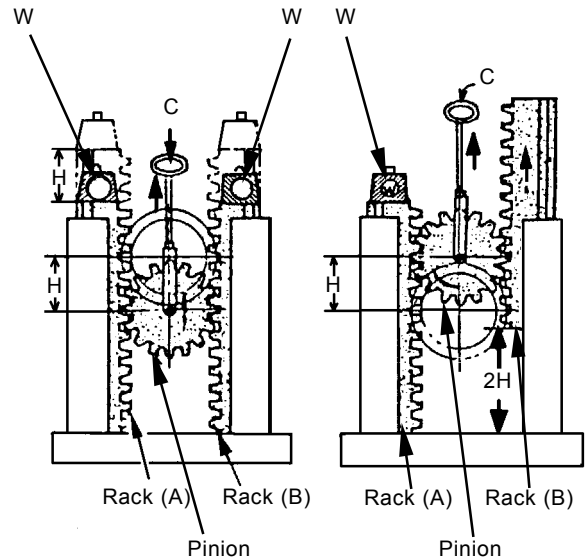
• Principle of Differential

Operational principle of the differential is explained comparing it to the racks and the pinion gear in the drawing.

When load W is equally applied to racks A and B, if C is moved upward by the distance of H , racks A and B move by the same distance of H in unison with the pinion together.

If moved by removing the load to rack B, the pinion rotates on rack A (with load applied) and moves rack B upward. At this time, the distance where rack B moves is longer than the distance where the pinion moves while rotating.

Distance where rack B moves can be calculated by using the equation $H+H=2H$. This principle is applied to the differential.



T202-03-05-006

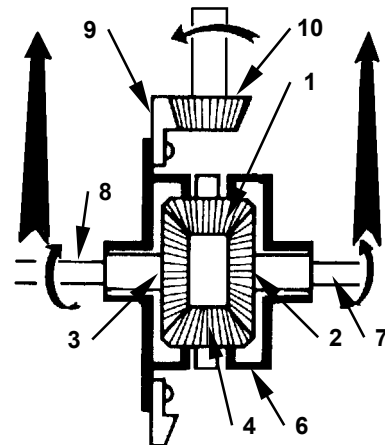
• Operation of Differential

In Traveling Straight

In case resistances applied to axle shafts (7, 8) connected by spline to differential side gears (2, 3) are the same, or in case the vehicle body is traveling straight on plane roads, differential pinion gears (1, 4) do not rotate.

Differential pinion gears (1, 4) and side gears (2, 3) remain fixed by being mutually geared, and rotate with housing (6) connected with ring gear (9).

In case all parts are rotating solidly like this, the differential function of the differential does not work, and gears (1, 2, 3, 4) play only the role of joints to connect axle shafts (7, 8).



T487-03-06-014

COMPONENT OPERATION / Axle

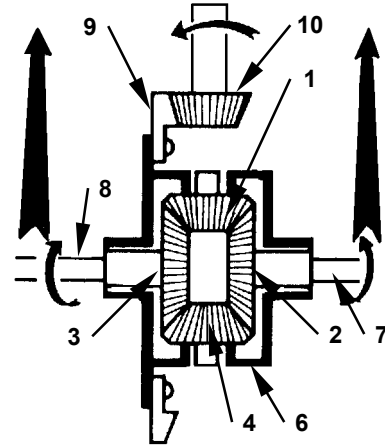
In Steering

When the vehicle body is turned, uneven resistances are applied to the drive wheels. Therefore, due to the difference of the resistances applied to the inner and outer wheels, differential pinion gears (1, 4) start revolving on side gears (2, 3), while rotating round the pinion shaft. Consequently, in case the resistance force applied to shaft (7) is large, pinion gears (1, 4) rotate in the same direction as the rotational direction on side gear (2) of shaft (7). The speed of shaft (7) is lowered, the amount of the speed reduction is applied to shaft (8) and the differential function is performed.

Suppose ring gear (9) is driven by 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 is turned and the speed of the right drive wheel is lowered to 90, the left wheel turns at the speed of $100 + (100 - 90) = 110$ as the speed of $10(100 - 90 = 10)$ is added to the speed of the left wheel.

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



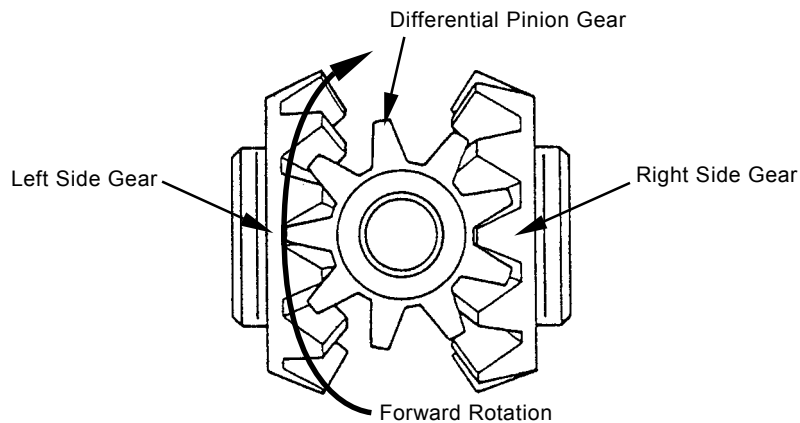
T487-03-06-014

COMPONENT OPERATION / Axle

TORQUE PROPORTIONING DIFFERENTIAL (TPD)

The wheel loader is operated mostly on rough ground condition. Working efficiency and tire lives are lowered due to tire slippage. In order to avoid lowering of working efficiency and tire lives, the axle is provided with the torque proportioning differential.

The 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 ground 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 driving force transferred to the left and right tires changes.

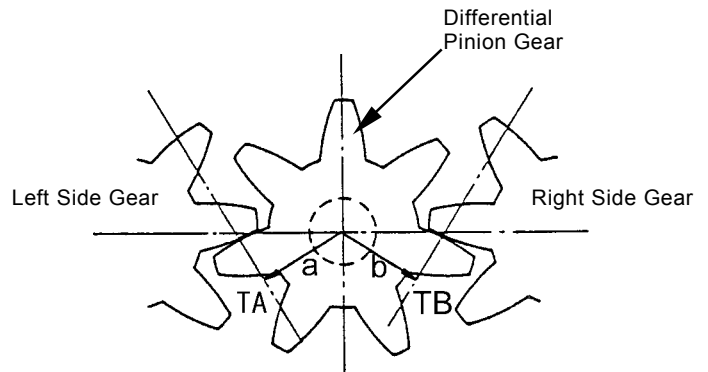


T487-03-06-015

COMPONENT OPERATION / Axle

Traveling Straight with the Same Resistances to Left and Right Tires

In case resistances to the left and right tires are the same, 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, as the differential pinion gear and the left and right side gears solidly rotate forward, the driving forces of the left and right tires become the same.



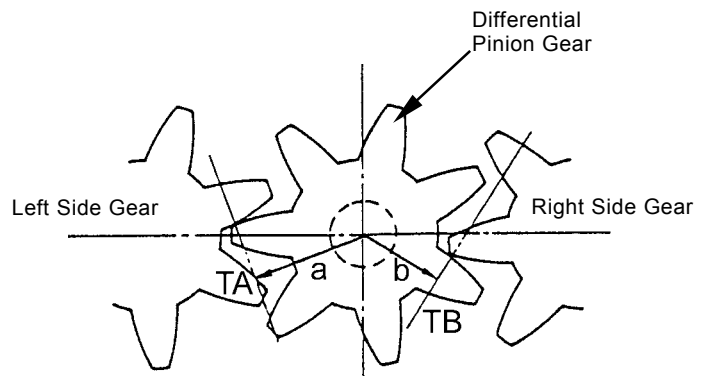
T487-03-06-016

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

In traveling on soft ground, if the left tire slips, 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, 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. $a \times TA$ (force applied to the left side gear) = $b \times TB$ (force applied to the right side gear).

Until the difference of the ground resistances exceeds certain value, the differential pinion gear does not rotate, and the left and right side gears rotate at the same speed solidly. As the left tire does not rotate redundantly, it does not slip. (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

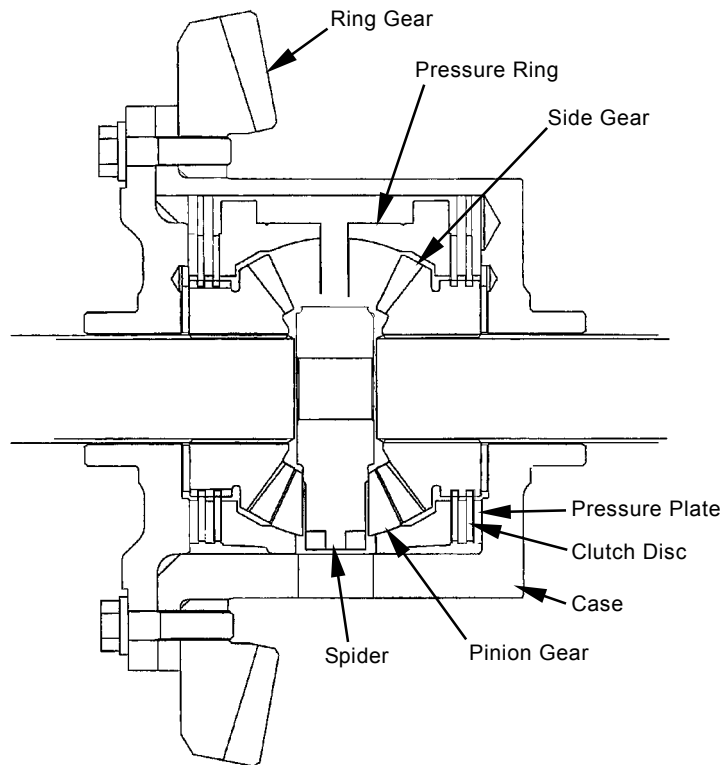
COMPONENT OPERATION / Axle

LIMITED SLIP DIFFERENTIAL (LSD) (OPTIONAL)

The wheel loader must be operated on slippery ground condition like sand and muddy soil. In places like these, the tires can slip although the torque proportioning differential (TPD) is installed. As rotation is transmitted to the slipping tire and not to the tires contacting the road, not only the function 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 in order to avoid different movement of the left and right wheels is adopted. Driving force transmitted to the left and right tires further changes.

Operational 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. The variation of the driving force transmitted to the left and right tires is made larger than TPD.



T4GB-03-10-003

COMPONENT OPERATION / Axle

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

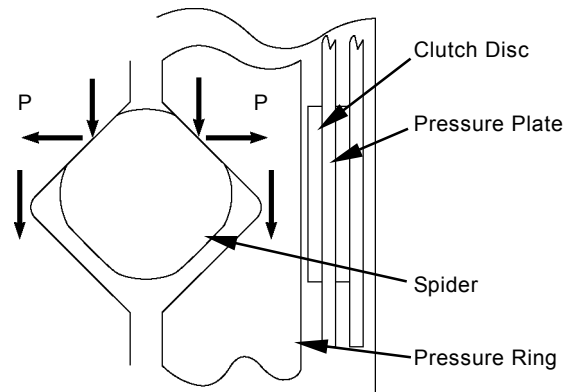
As the differential pinion gear and the left and right pinion gears rotate solidly, the driving forces of the left and right tires are the same similarly to TPD.

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

Driving 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 thrust force (P). The clutch disc is geared with the case through the pressure ring. As the side gears fitted to the clutch disc by spline rotate solidly with the case, 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 driving force provided for the slipping tire is larger than the road resistance, part of the torque of the slipping tire is added to the tire contacting ground by the differential movement restriction (because of the same speed of the left and right tires), and the tire contacting ground 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 ground, the driving force increases by 1.5 times the value for TPD if LSD is provided.



T4GB-03-10-004

COMPONENT OPERATION / Axle

SERVICE BRAKE

The brake is the wet type multi-disc brake and is assembled in the differential gear body of the axle. Four wheels of this vehicle has the disc brake respectively.

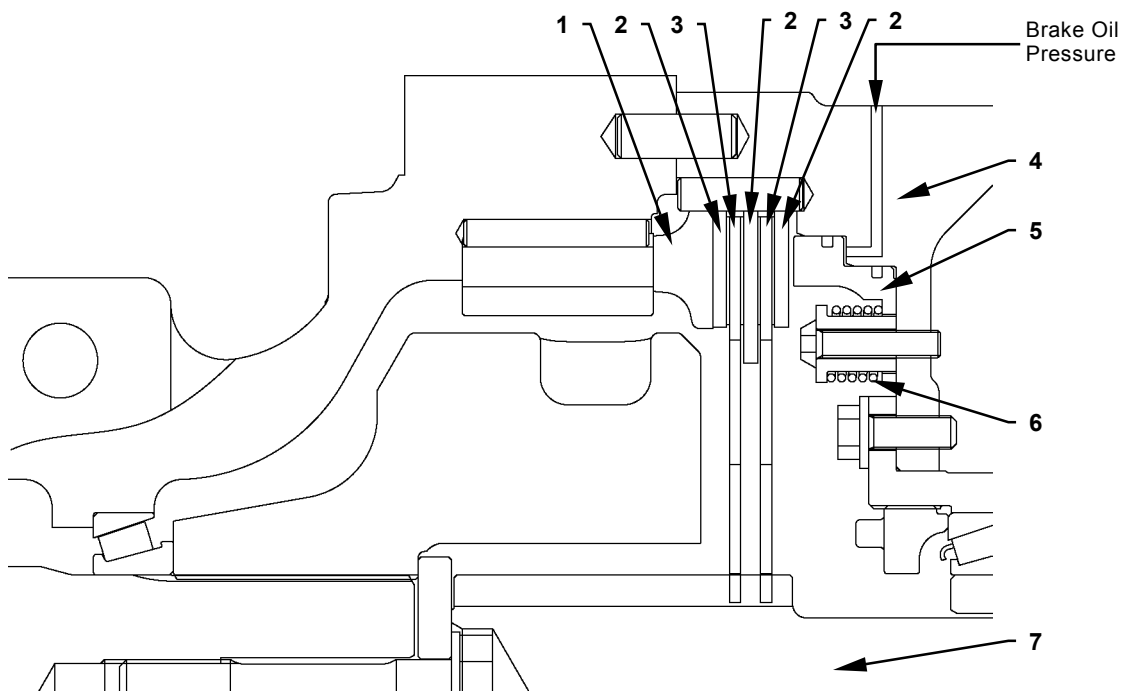
- In Operation of Brake

Oil pressure from the brake valve acts on the back of brake piston (5) and moves brake piston (5). Brake disc (3) and brake ring (2) are compressed. The inner surface of brake disc (3) is fitted to gear & shaft (7). The outer surface of brake ring (2) is fixed to differential gear body (4). Therefore, the rotation of the pushed and compressed brake disc (3) stops, and the vehicle stops.

- In Release of Brake

When oil pressure from the brake valve is decreased, brake piston (5) is returned by return spring (6). Brake disc (3) is freed and the vehicle can travel.

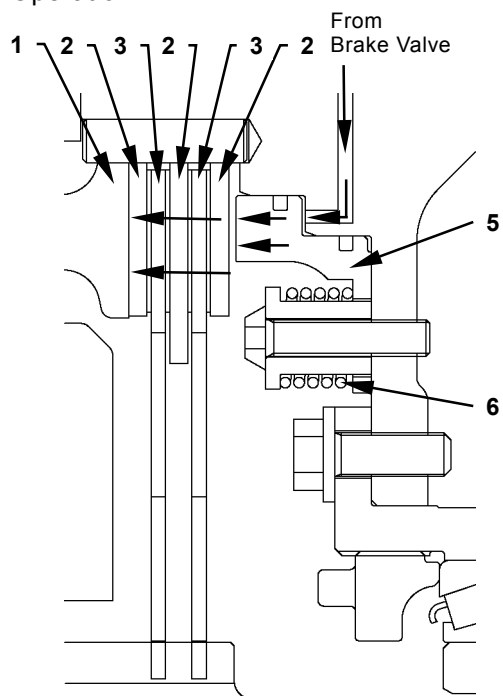
COMPONENT OPERATION / Axle



T4GD-03-10-004

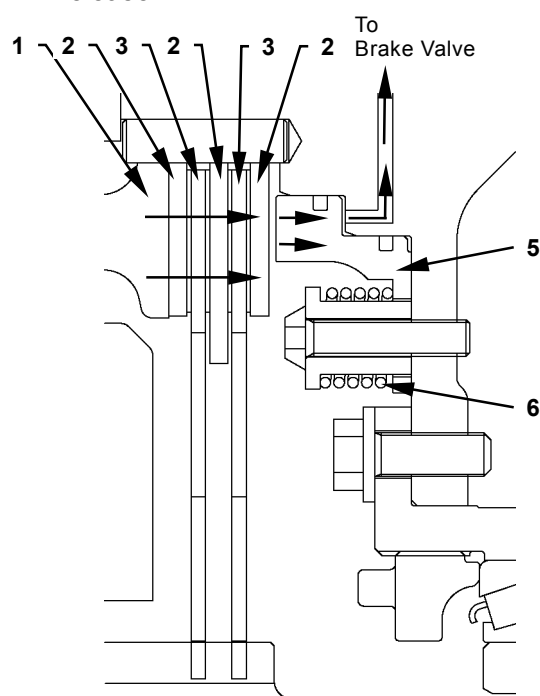
- | | | | |
|----------------|----------------------------|-------------------|------------------|
| 1 - End Plate | 3 - Brake Disc | 5 - Brake Piston | 7 - Gear & Shaft |
| 2 - Brake Ring | 4 - Differential Gear Body | 6 - Return Spring | |

• In Operation



T4GD-03-10-005

• In Release

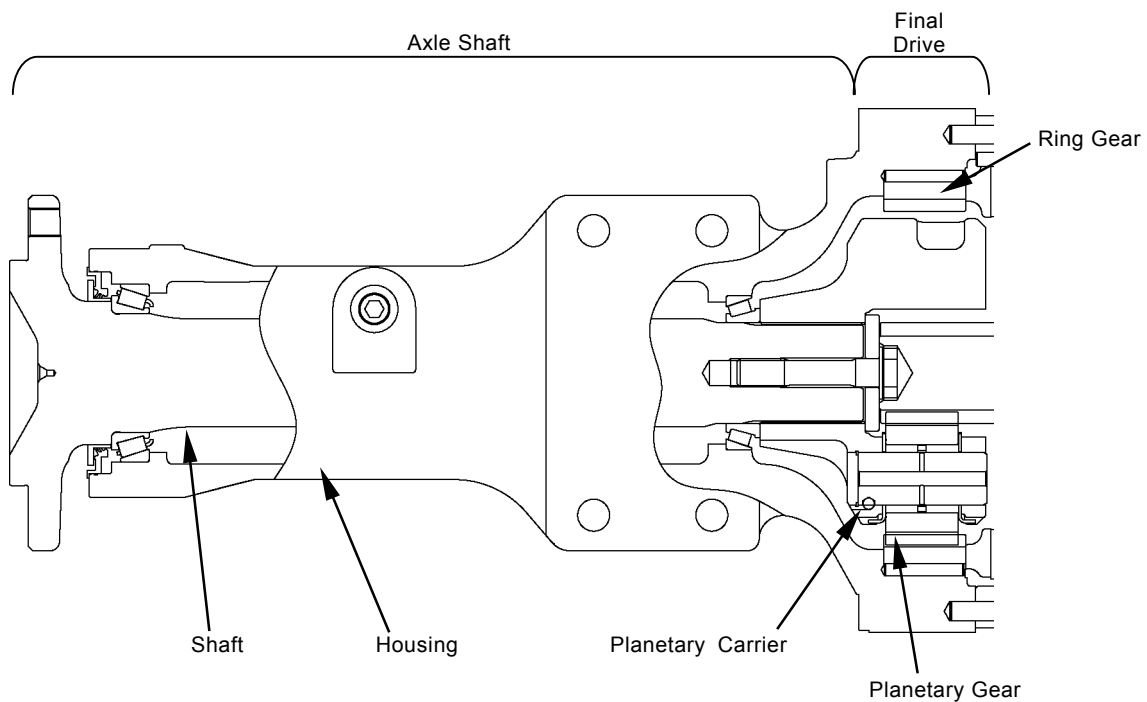


T4GD-03-10-005

COMPONENT OPERATION / Axle

FINAL DRIVE / AXLE SHAFT

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



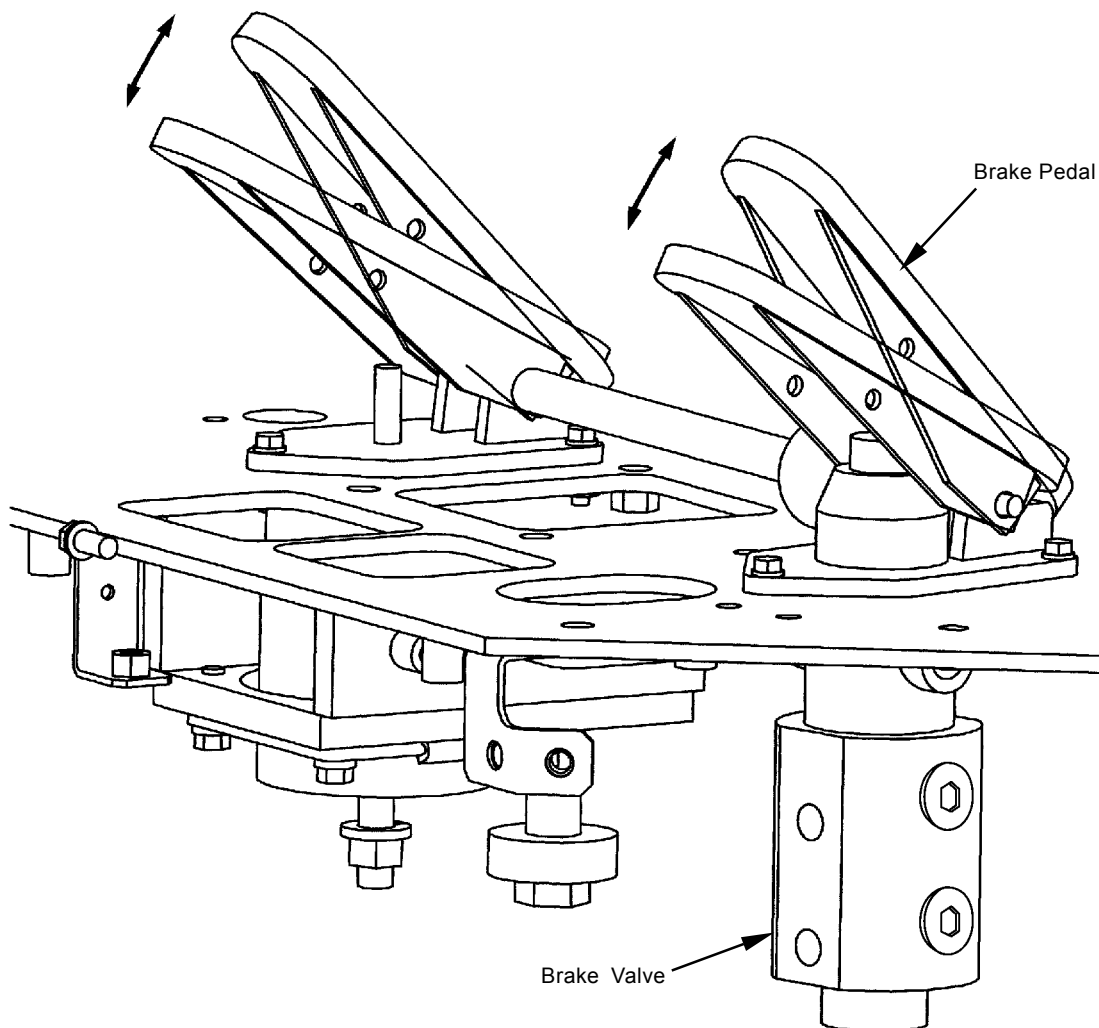
T4GD-03-10-002

COMPONENT OPERATION / Brake Valve

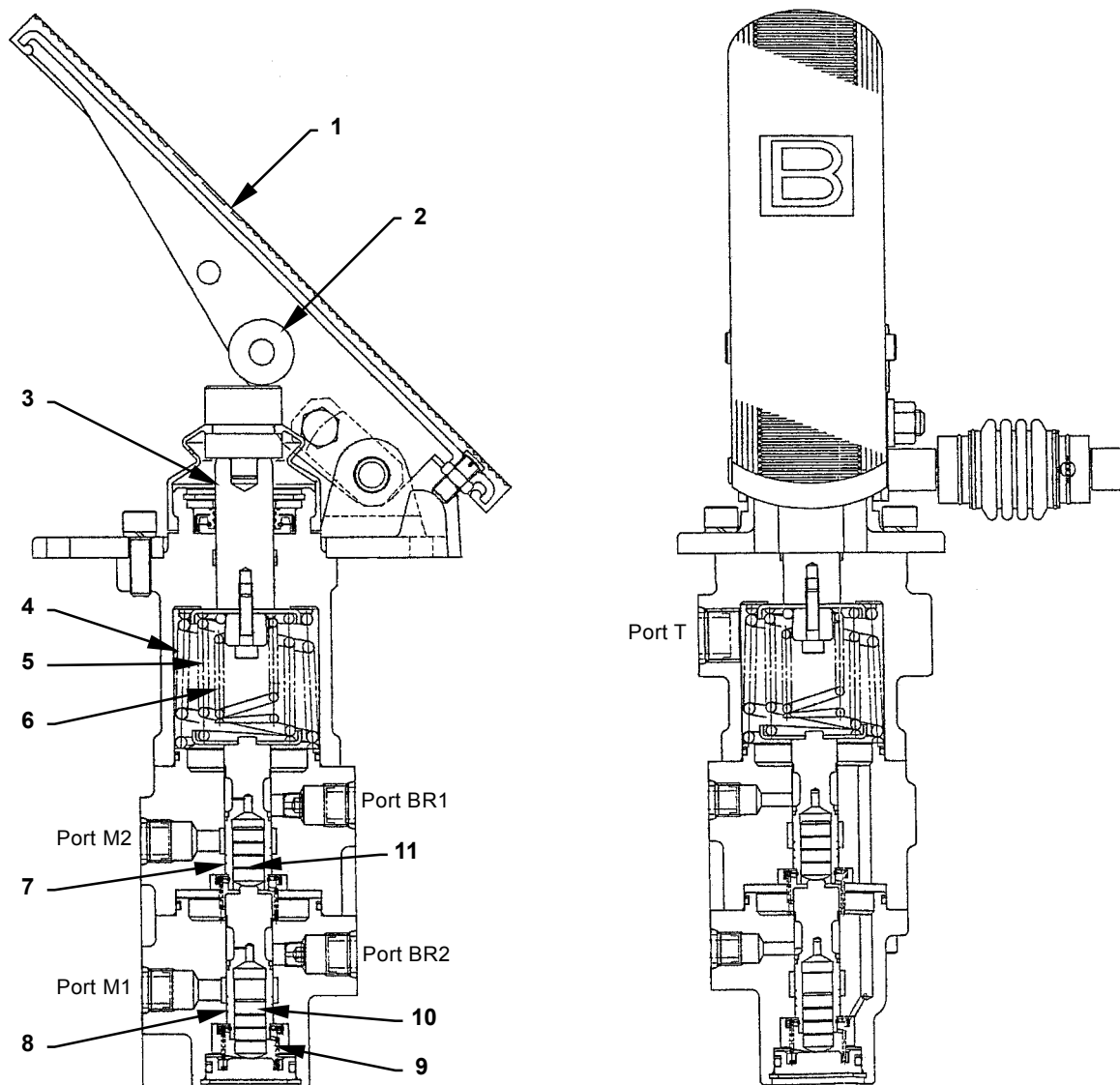
OUTLINE

The brake valve is operated by the brake pedal. (Refer to the Brake Circuit in the SYSTEM/Hydraulic System group)

The brake valve delivers pilot pressure in response to the depressing stroke of the brake pedal and operates the front or rear wheel service brake.

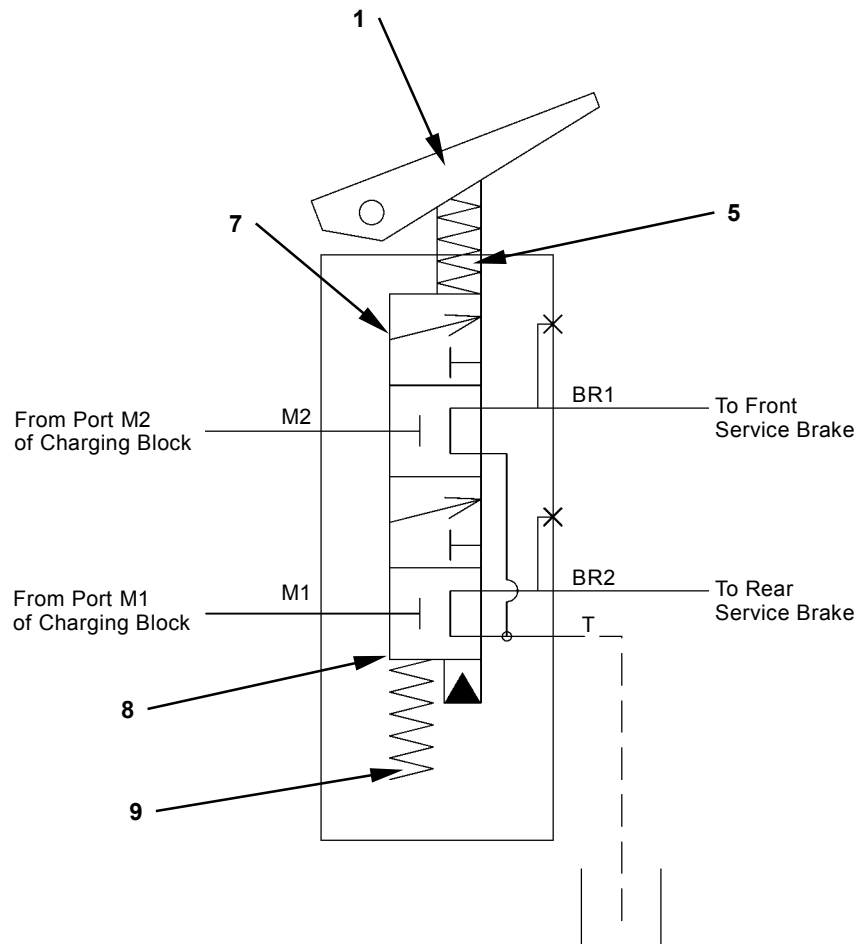


T4GB-03-11-001



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

COMPONENT OPERATION / Brake Valve



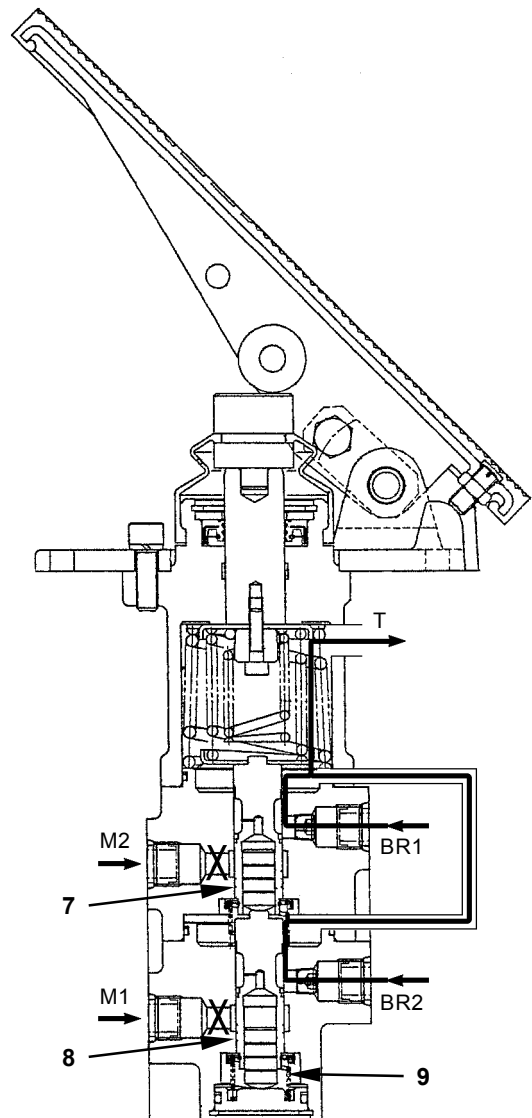
T4GB-03-11-003

COMPONENT OPERATION / Brake Valve

OPERATION

Not in Operation of Brake

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

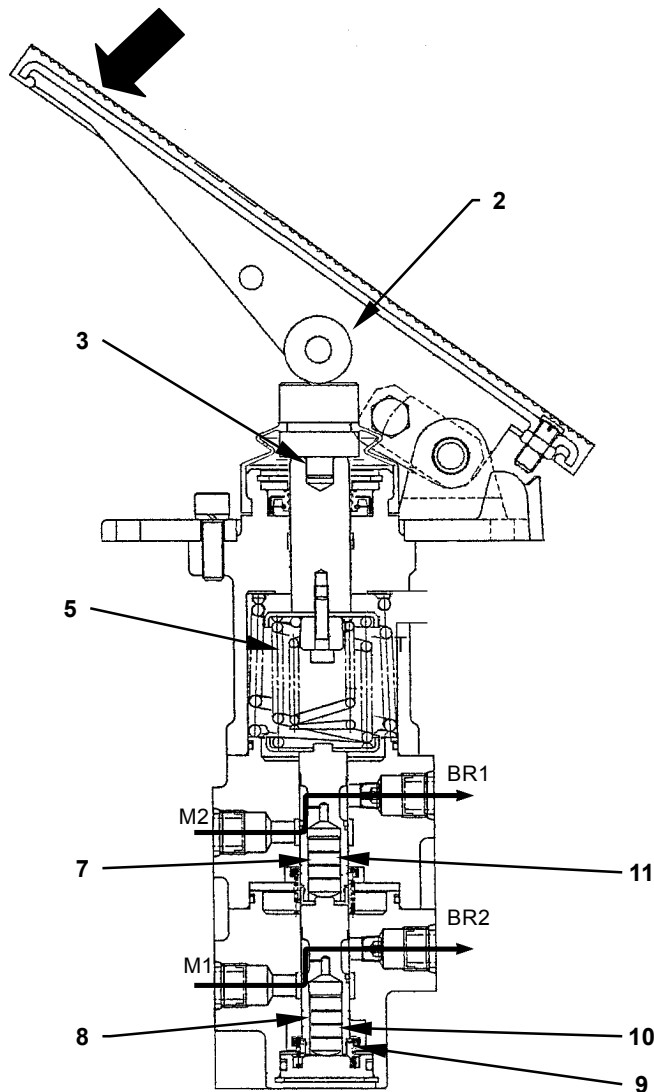


T4GB-03-11-004

COMPONENT OPERATION / Brake Valve

When Brake is Applied

1. When the brake pedal is depressed, spool input (3) is pushed via roller (2). Spool input (3) moves spools (7, 8) forward via spring (5).
2. When spools (7, 8) are moved forward, ports (BR1, BR2) and port (T) are disconnected. When spools (7, 8) are further moved forward, ports (BR1, BR2) and ports (M1, M2) are connected, and pressure oil in the accumulator flows from ports (BR1, BR2) and the brake is applied.
3. Pressure oil at the ports (BR1, BR2) side passes the orifices in spools (7, 8) and acts on plungers (10, 11) built in spools (7, 8) as the returning force (hydraulic reaction force) against spools (7, 8). Summation of this hydraulic reaction force and the load of spring (9) balances with the load of spring (5), and controls the brake oil pressure at the brake ports (BR1, BR2) side.
4. Deflection and the 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.

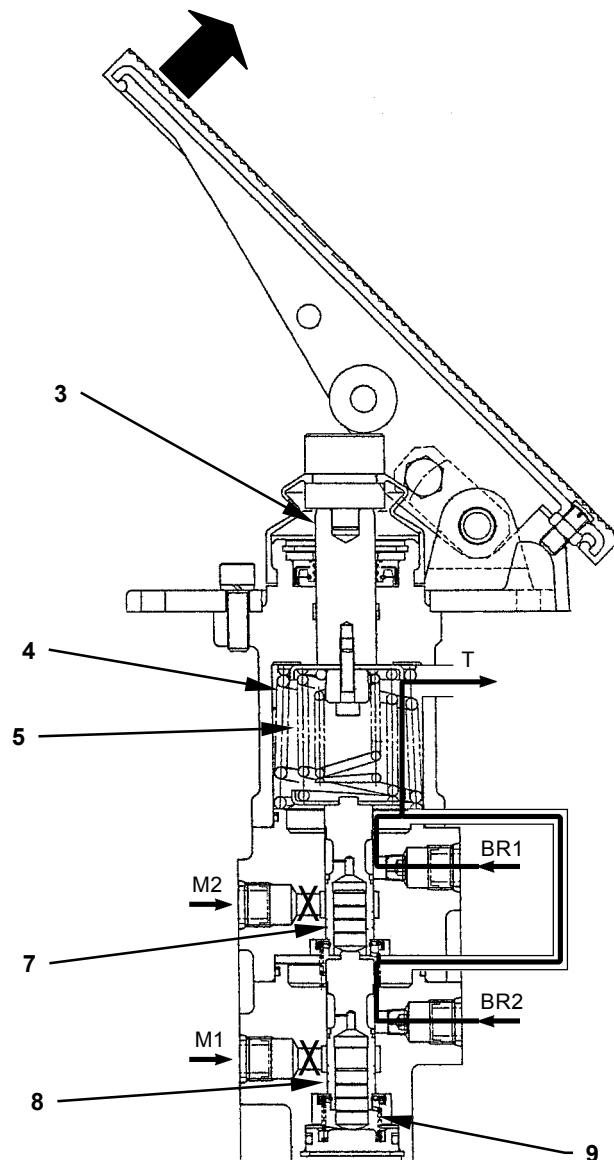


T4GB-03-11-005

COMPONENT OPERATION / Brake Valve

When Brake is Released

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



T4GB-03-11-006

COMPONENT OPERATION / Others

PILOT SHUT-OFF VALVE

The pilot shut-off valve is a manually operated selection valve, and by operating the pilot shut-off lever, rotates the spool in order to turn ON and OFF pilot pressure oil to the pilot valve.

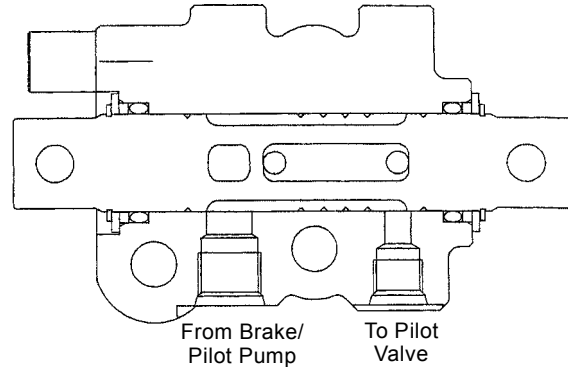
When Pilot Shut-Off Lever is in LOCK Position

When the pilot shut-off valve is turned OFF, pressure oil from the pilot pump does not flow to the pilot valve. Pressure oil at the pilot valve side flows to the hydraulic oil tank.

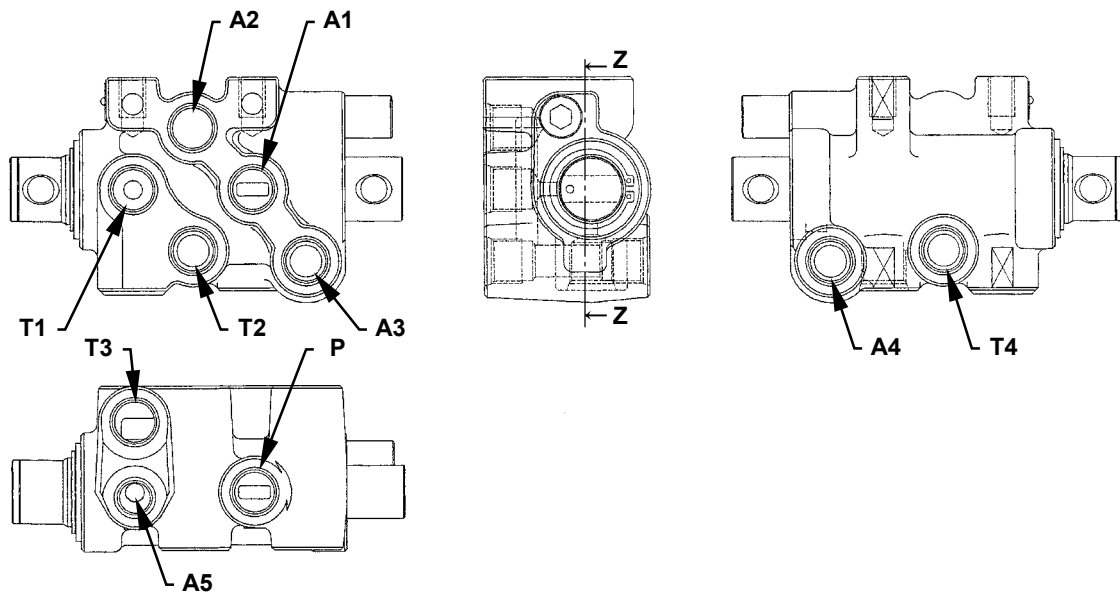
When Pilot Shut-Off Lever is in UNLOCK Position

When the pilot shut-off valve is turned ON, the drain circuit is blocked and pressure oil from the pilot pump flows to the pilot valve.

Section Z-Z



T4GB-03-12-001



T4GB-03-12-002

A1 - Auxiliary
A2 - Auxiliary
A3 - To Pilot Valve (Optional)

A4 - To Pilot Valve
A5 - Auxiliary
P - From Brake/Pilot Pump

T1 - From Pilot Valve
T2 - Auxiliary

T3 - From Pilot Valve (Optional)
T4 - To Hydraulic Oil Tank

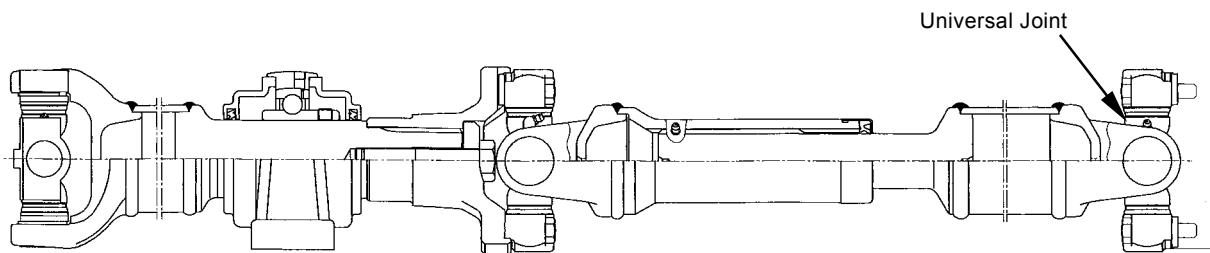
COMPONENT OPERATION / Others

PROPELLER SHAFT

The propeller shafts are installed between the transmission and the front axle, and between the transmission and the rear axle respectively.

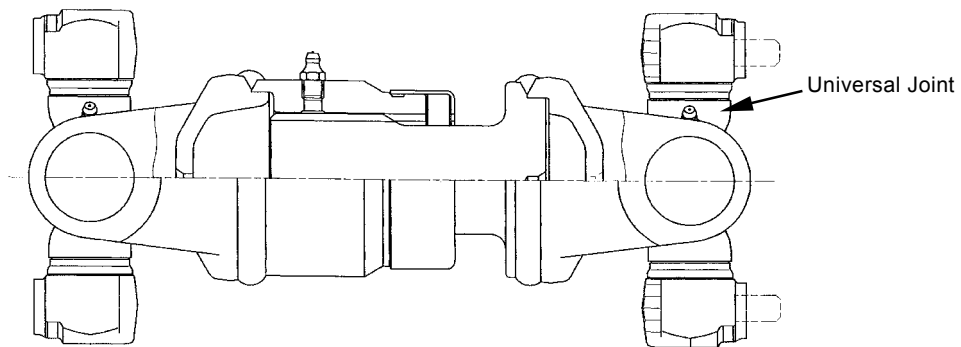
The propeller shaft transmits the power from the transmission to the front axle and the rear axle. The universal joint most commonly used is provided.

Between Front Axle and Transmission



T4GD-03-12-001

Between Transmission and Rear Axle



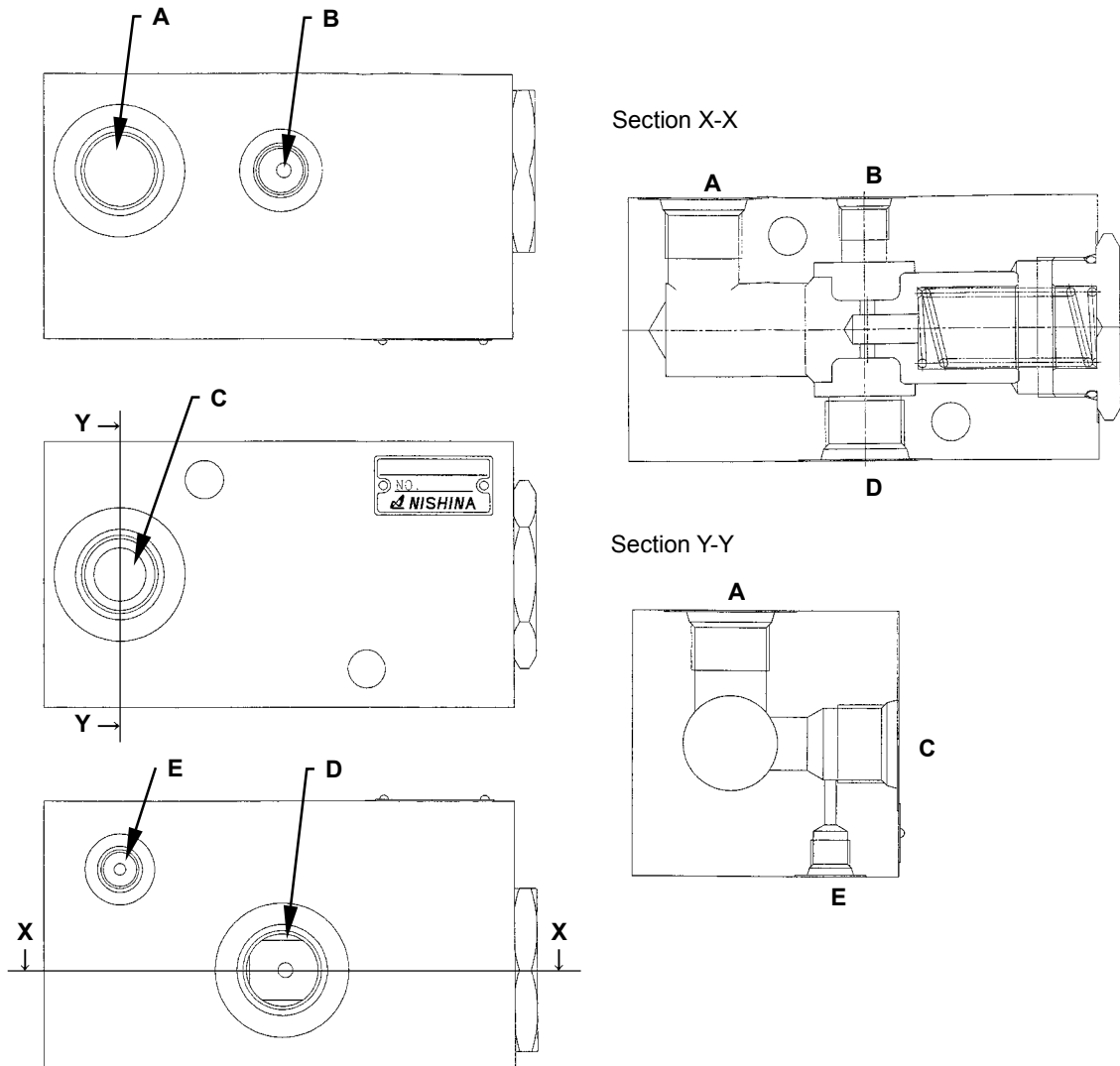
T4GB-03-12-004

COMPONENT OPERATION / Others

EMERGENCY STEERING CHECK BLOCK

The emergency steering check block is installed between the main pump and the steering valve. The built-in check valve prevents delivery oil from the emergency steering pump from flowing to the main pump.

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



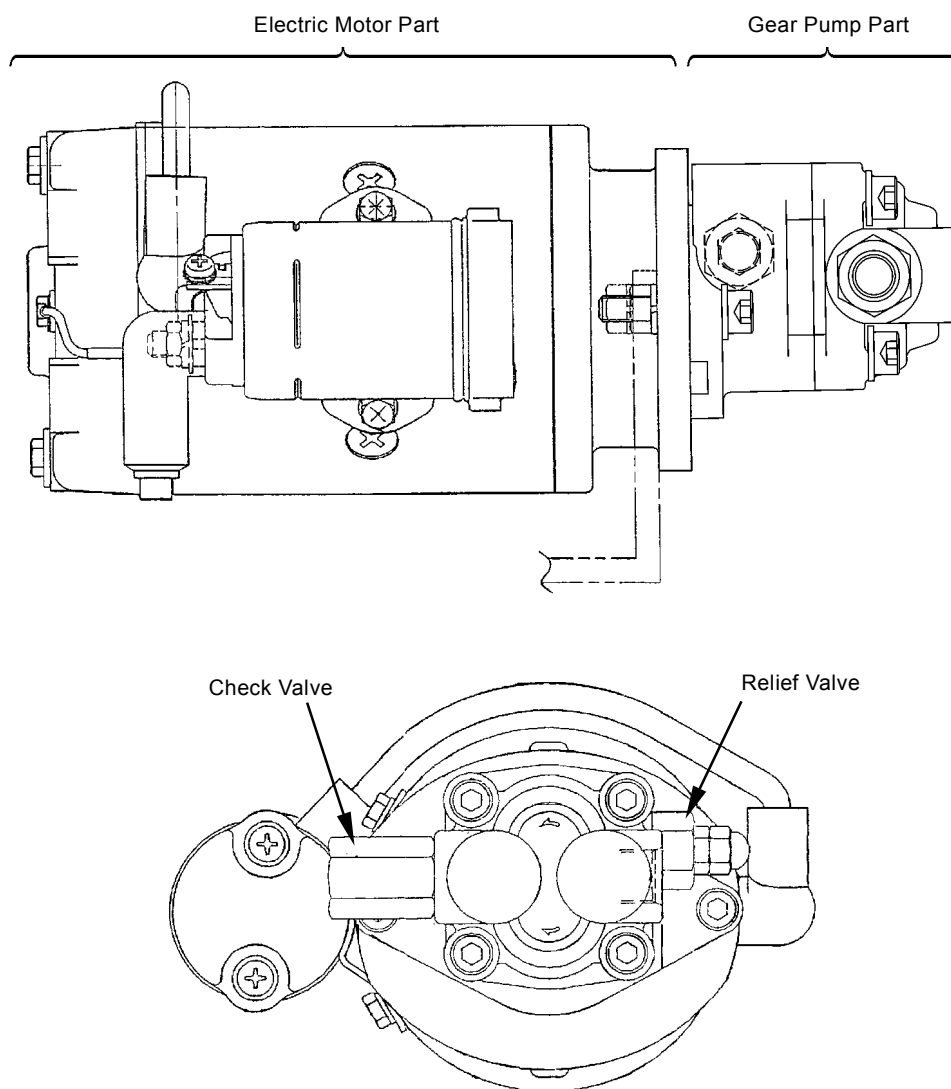
T4GB-03-12-007

COMPONENT OPERATION / Others

EMERGENCY STEERING PUMP (OPTIONAL)

The emergency steering pump is available in case supply of pressure oil from the main pump is suddenly stopped, and delivers pressure oil to the steering valve in place of the main pump until the vehicle body is moved to a safe place.

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



T4GB-03-12-008

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