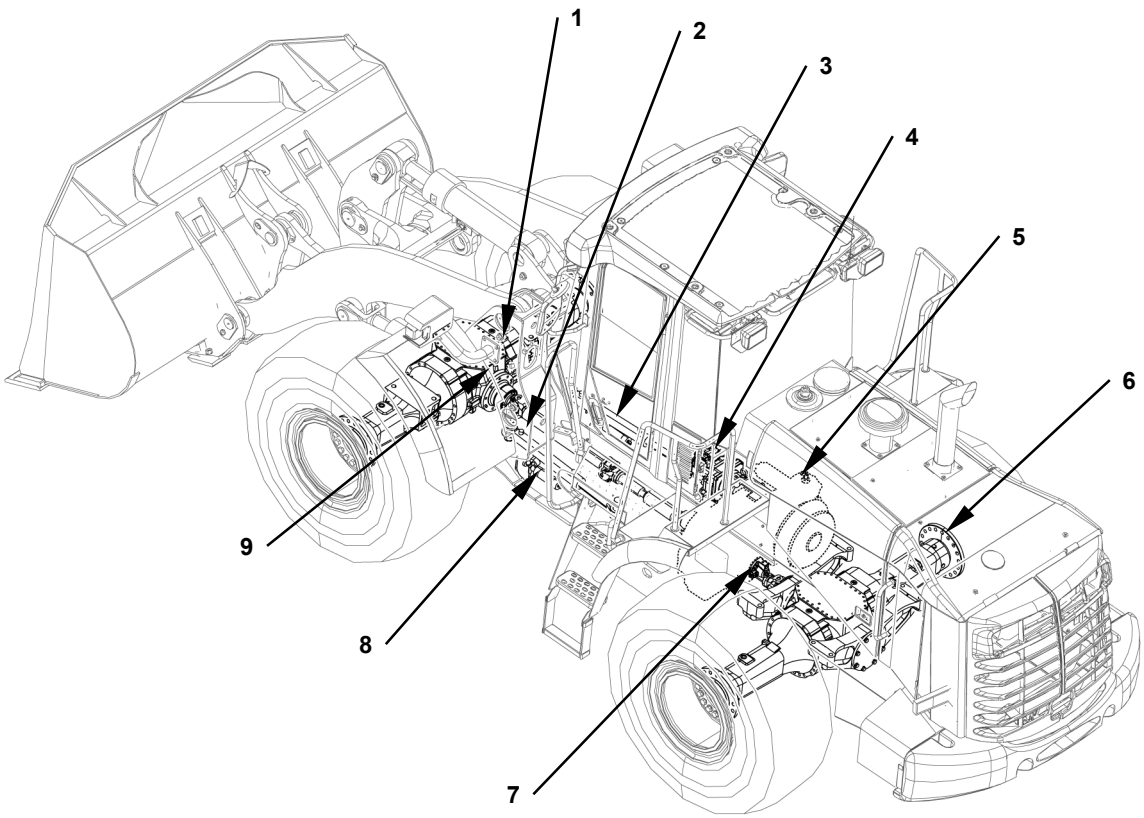
WORKSHOP MANUAL

SECTION 1
GENERAL

—CONTENTS—

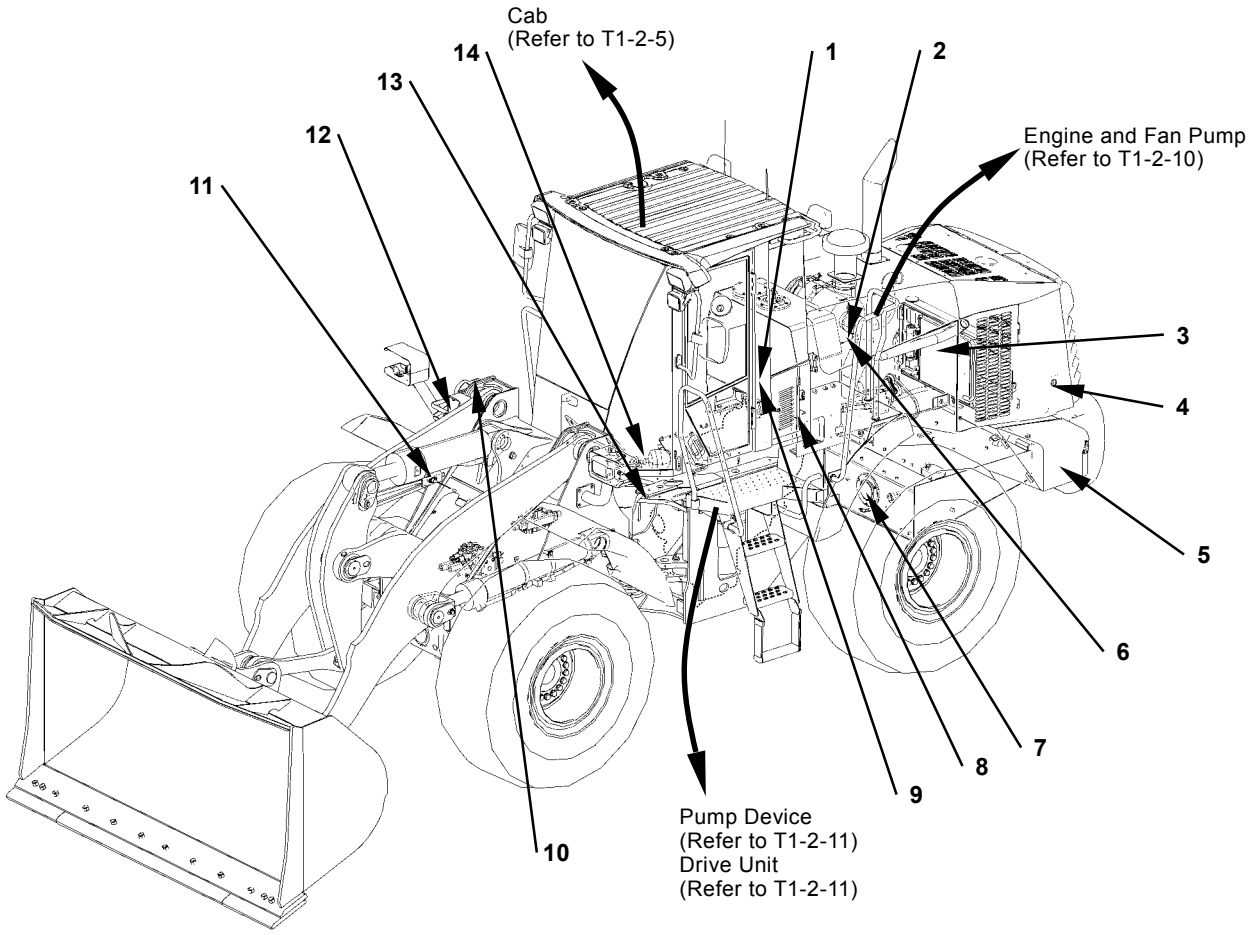
MAIN COMPONENT LAYOUT (TRAVEL SYSTEM)



T4GB-01-02-004

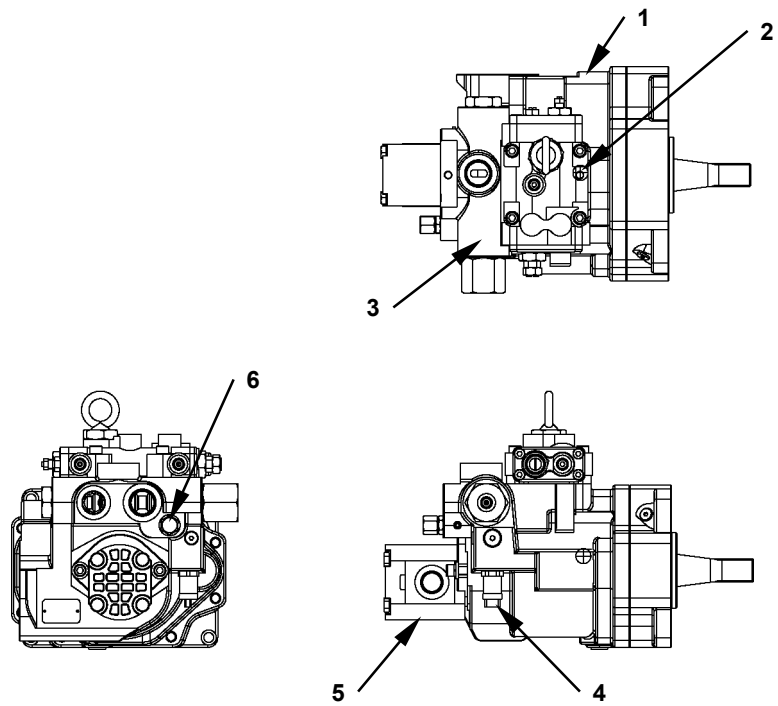
1 - Front Axle
2 - Propeller Shaft (Front)
3 - Steering Cylinder
4 - Pump Device
5 - Transmission
6 - Rear Axle
7 - Propeller Shaft (Rear)
8 - Steering Accumulator
9 - Brake Pressure Sensor

ELECTRIC COMPONENT LAYOUT (OVERVIEW)



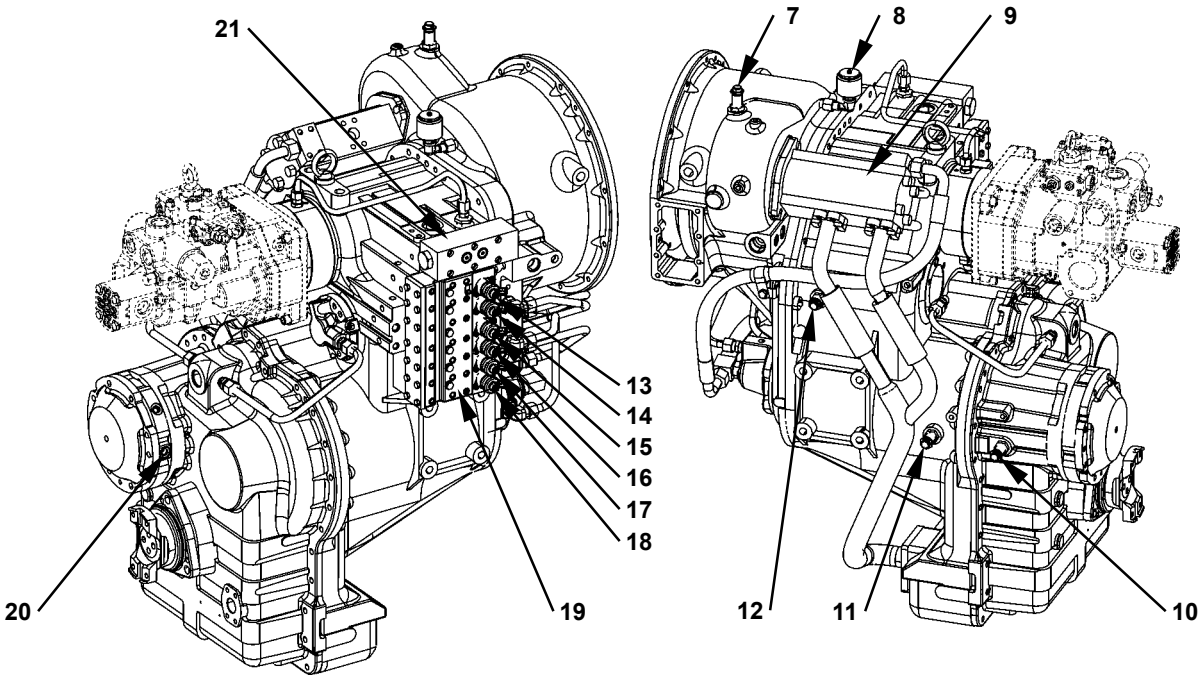
1 - Hydraulic Oil Level Switch
2 - Air Filter Restriction Switch
3 - ECM
4 - Reverse Buzzer
5 - Battery
6 - Boost Pressure Sensor
7 - Fuel Level Sensor
8 - Hydraulic Oil Temperature Sensor
9 - Emergency Steering Pump Delivery Pressure Switch
10 - Lift Arm Angle Sensor (Optional)
11 - Bucket Proximity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

PUMP DEVICE



T4GB-01-02-009

DRIVE UNIT



T4GC-01-02-001

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

ENGINE

ZW220

Manufacturer	ISUZU
Model	6HK1XYWT-01
Type	Diesel, 4 Cycle, Water Cooled, Over Head Valve, Inline, Direct Injection, Turbo Charged
Cyl. NO. - Bore×Stroke	6-115 mm×125 mm (4.53 in×4.92 in)
Piston Displacement	7790 cm^3 (475 in^3)
Rated Output	139.3±3 kW/2170 min^{-1} (189±4 PS/2170 rpm)
Max. Output	164.3±3 kW/2000 min^{-1} (223.4±4 PS/2000 rpm)
Compression Ratio	17.5
Dry Weight	630 kg (1389 lb)
Firing Order	1-5-3-6-2-4
Rotation Direction	Clock Wise (Viewed from fan side)

ZW250

Manufacturer	ISUZU
Model	6HK1XYWT-02
Type	Diesel, 4 Cycle, Water Cooled, Over Head Valve, Inline, Direct Injection, Turbo Charged
Cyl. NO. - Bore×Stroke	6-115 mm×125 mm (4.53in×4.92 in)
Piston Displacement	7790 cm^3 (475 in^3)
Rated Output	163.0±3 kW/2240 min^{-1} (222±4 PS/2240 rpm)
Max. Output	179.1±3 kW/2000 min^{-1} (243.5±4 PS/2000 rpm)
Compression Ratio	17.5
Dry Weight	630 kg (1389 lb)
Firing Order	1-5-3-6-2-4
Rotation Direction	Clock Wise (Viewed from fan side)

COOLING SYSTEM

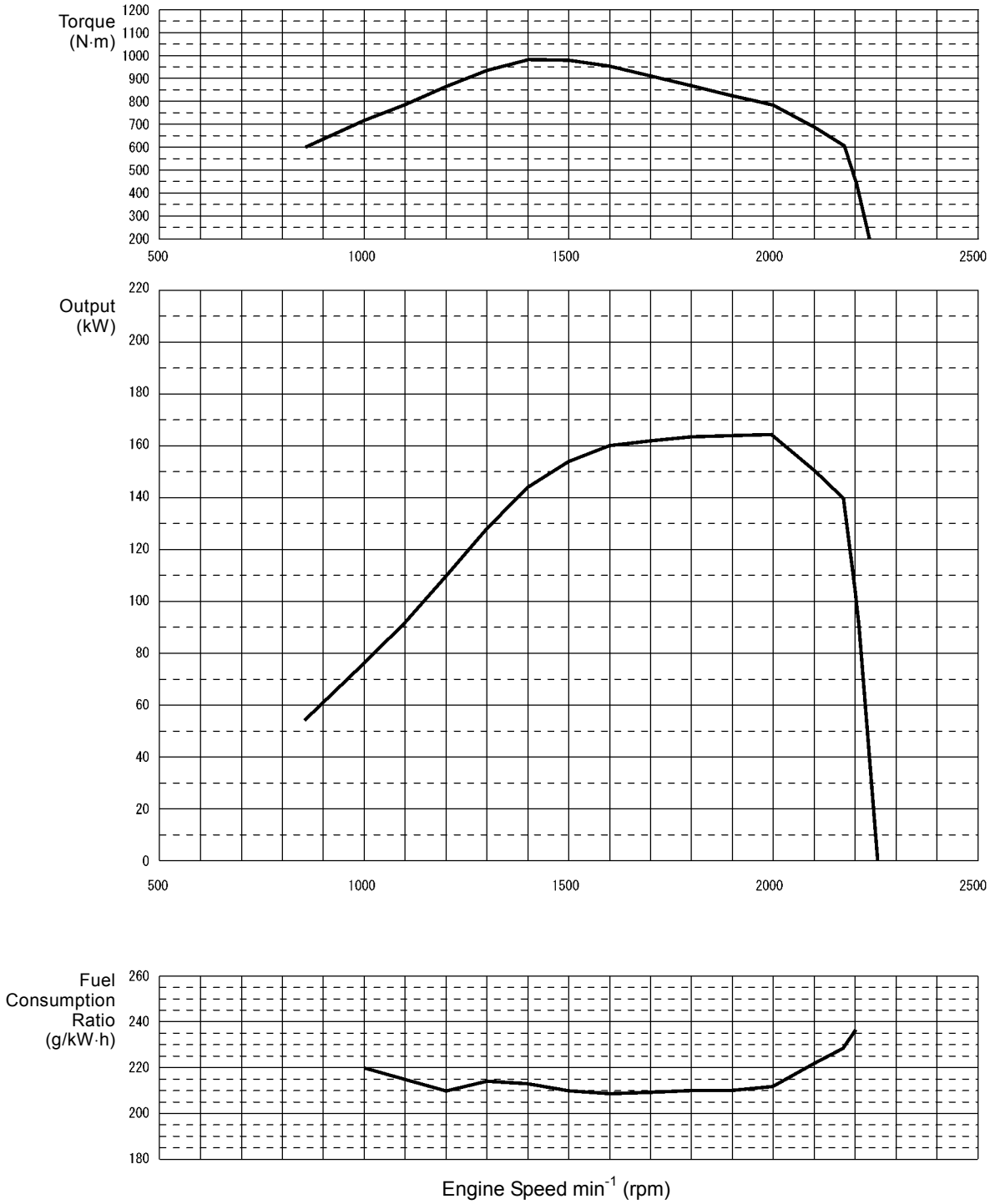
Cooling Fan	Diameter 850 mm (33.47 in), 6 Blades (N6G-Type Blade, Steel Center), Draw-in Type
Thermostat	Cracking Temperature at Atmospheric Pressure: 82 °C (180 °F) Full Open (Stroke: 10 mm (0.39 in) or more) Temperature: 95 °C (203 °F)
Fan Pump	Gear Pump

ZW220

Engine Performance Curve (6HK1XYWT-01)

Test Condition:

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



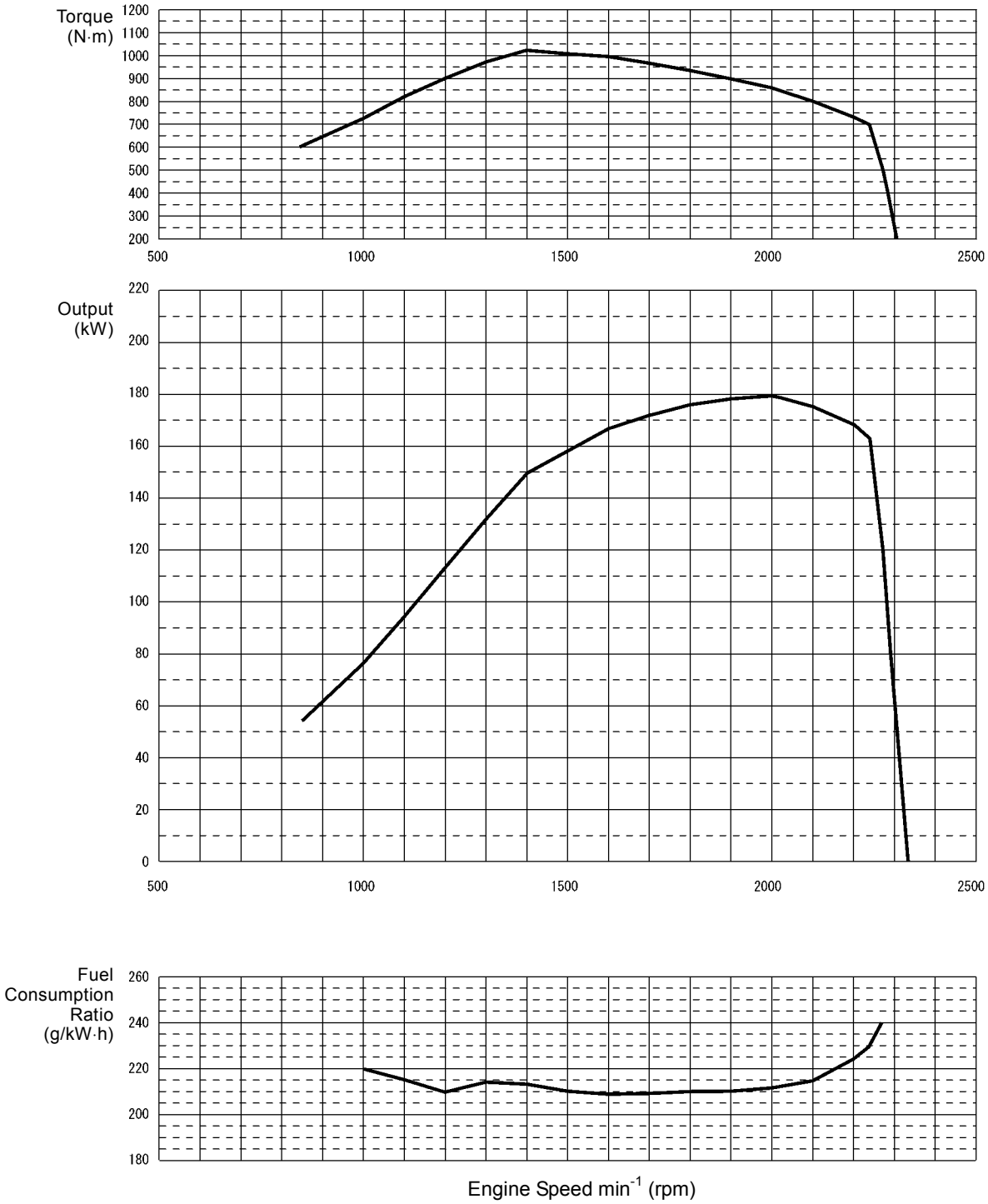
T4GC-01-03-001

ZW250

Engine Performance Curve (6HK1XYWT-02)

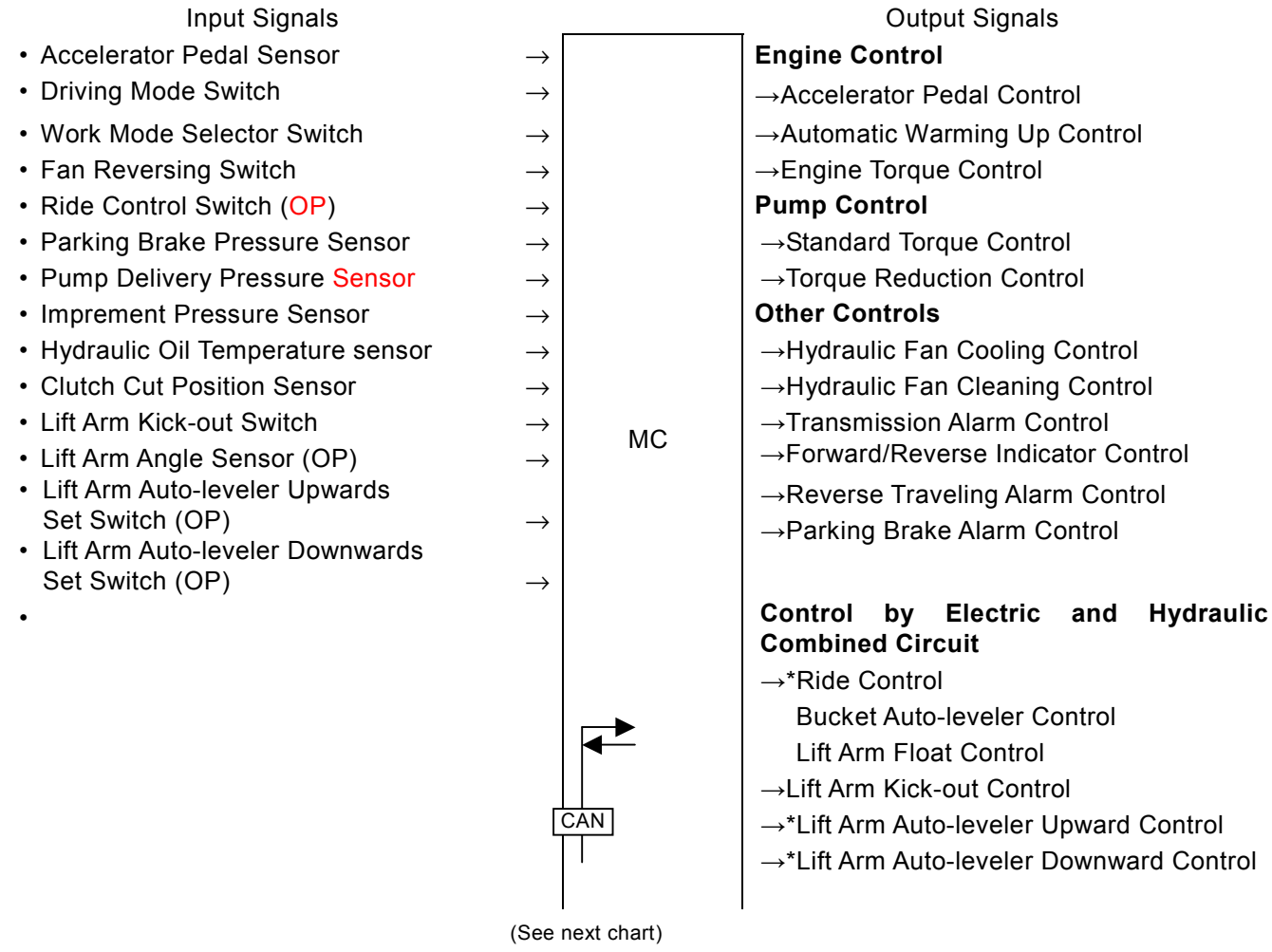
Test Condition:

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



T4GC-01-03-002

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

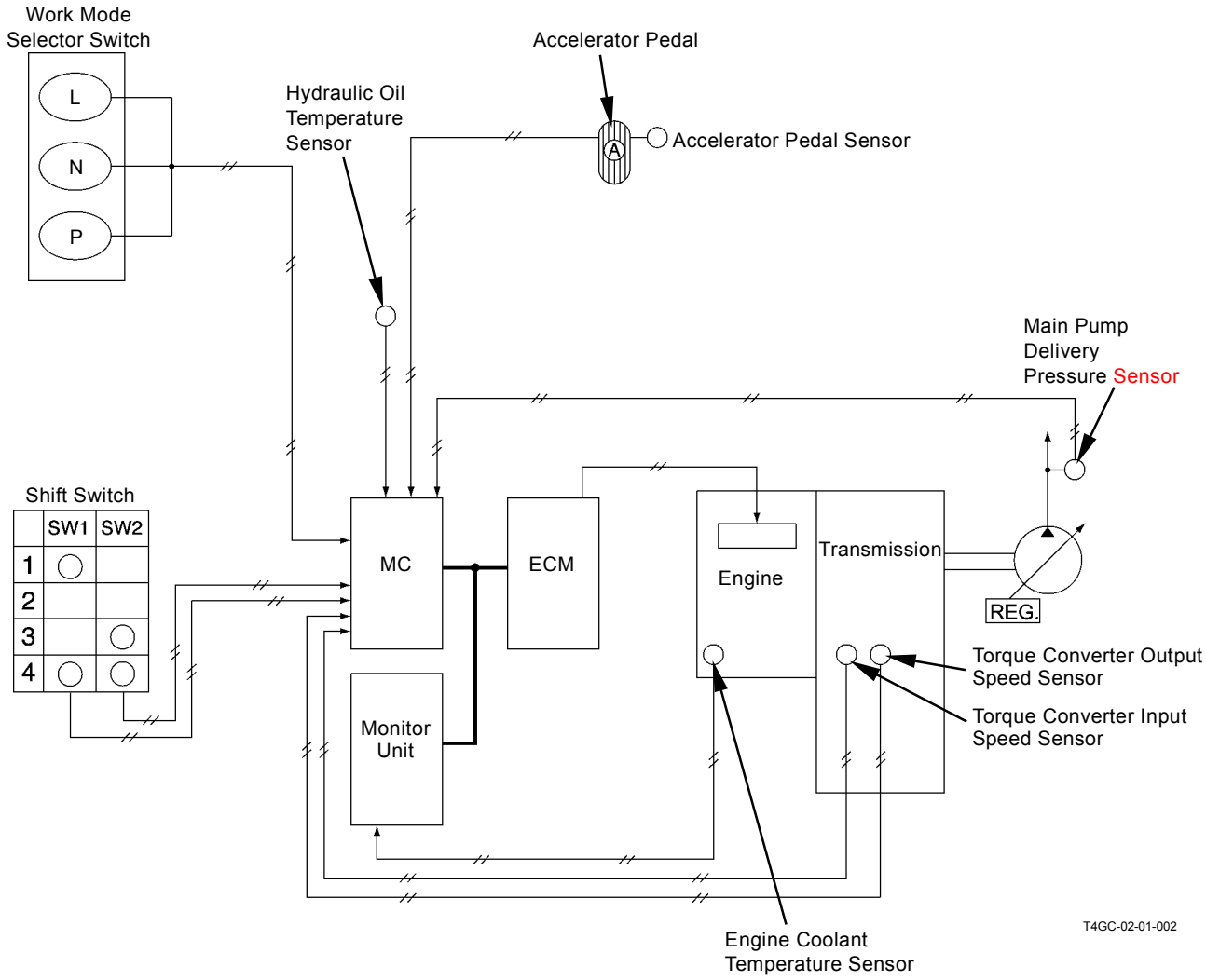


(See next chart)

NOTE: OP : Stands for optional.

** : Controls for optional parts provision machines only*

Engine Control System Layout

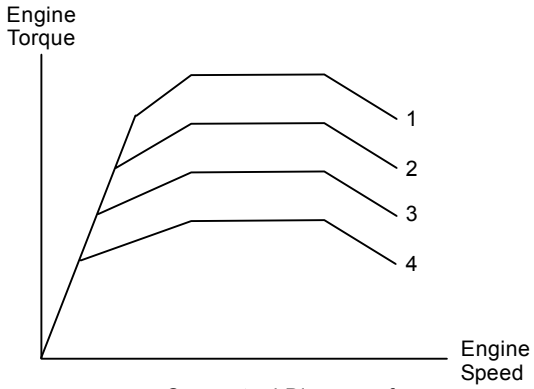


Engine Torque Control

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

Operation:

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



Conceptual Diagram of Engine Torque Curve

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

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

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

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

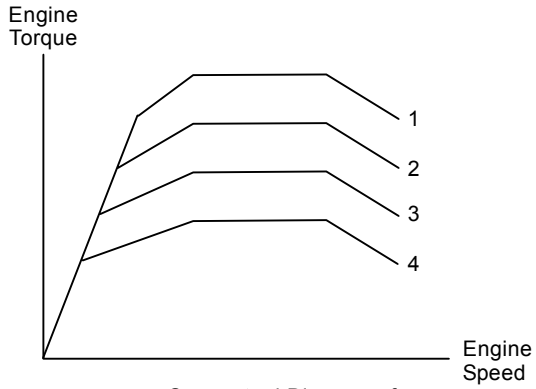
NOTE: Shift switch has two switches, and the combination of their ON varies depending on each speed shift. Controller judges which speed shift has been selected by the combination of the two input signals.

Engine Torque Control

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

Operation:

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



Conceptual Diagram of
Engine Torque Curve

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

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

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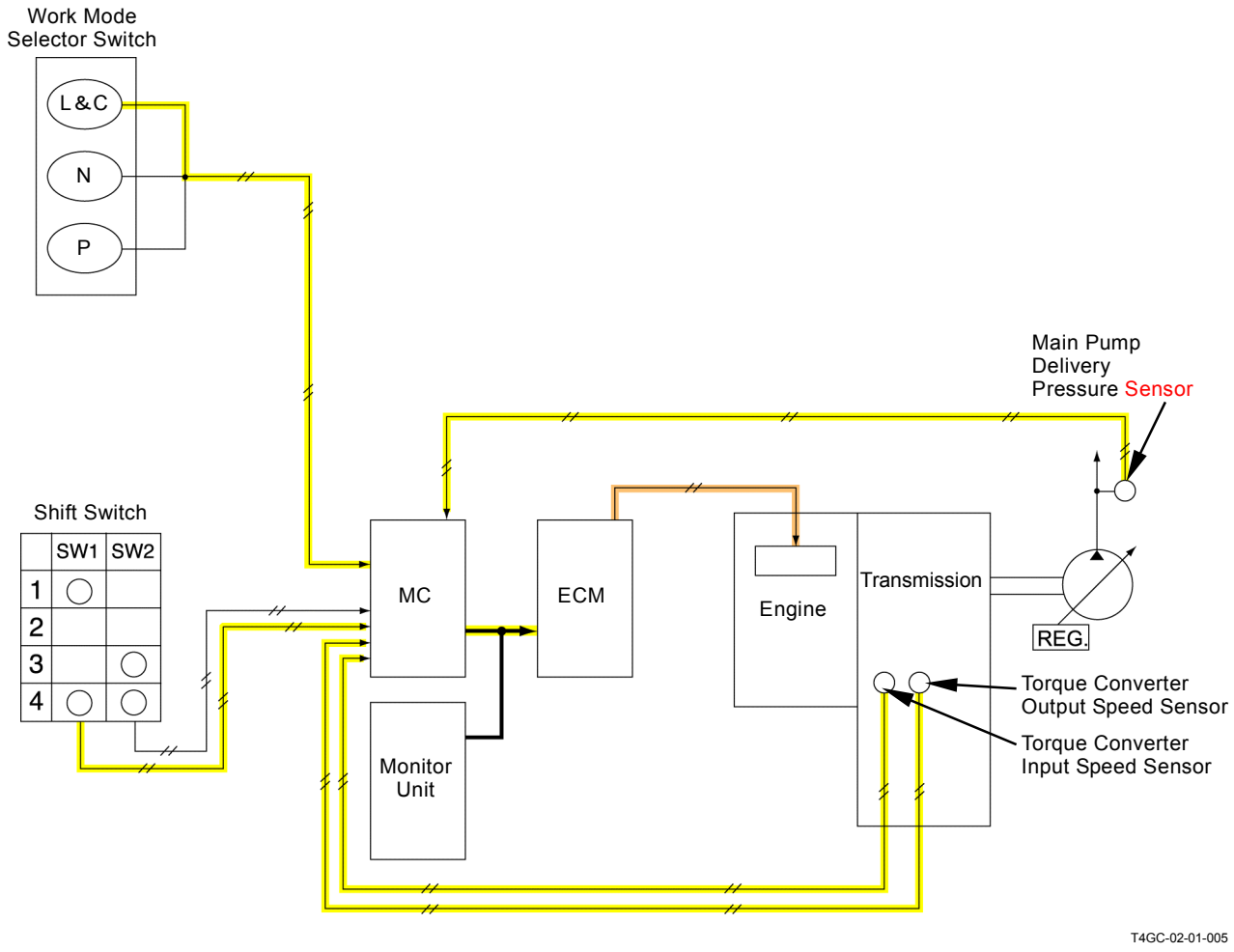


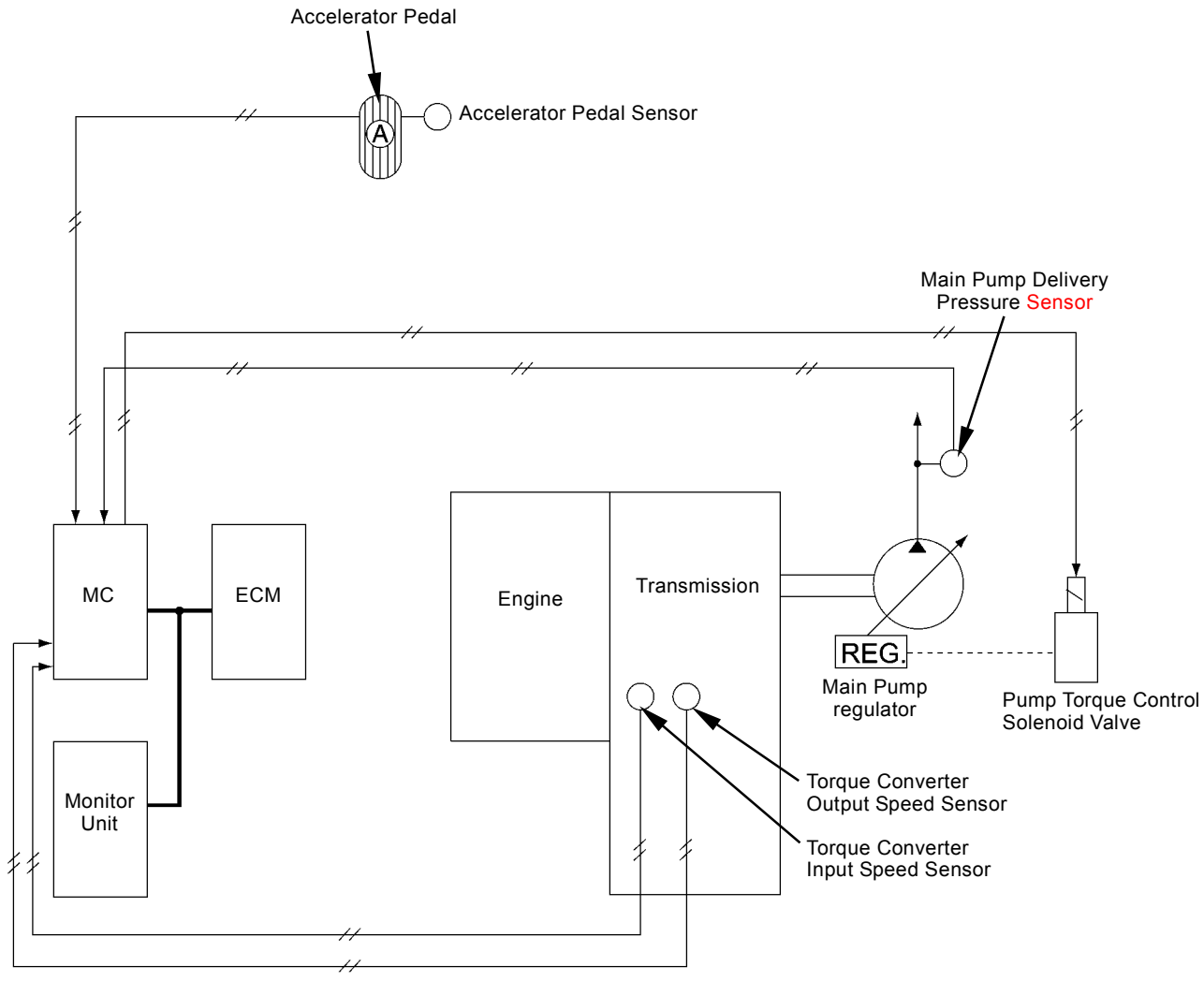
NOTE: Illustration shows flow of the signal in case the light mode of the work mode selector switch and Speed 1 of the speed shift switch have been selected.

PUMP CONTROL

Following pump controls are made.

- Standard Torque Control
- Torque Reduction Control

Pump Control System Layout

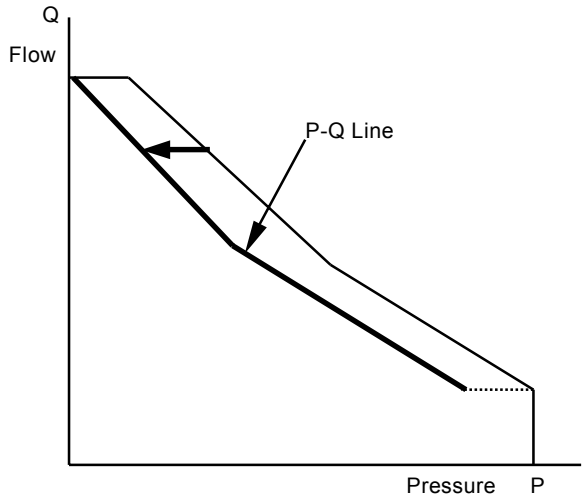


Torque Reduction Control

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

Operation:

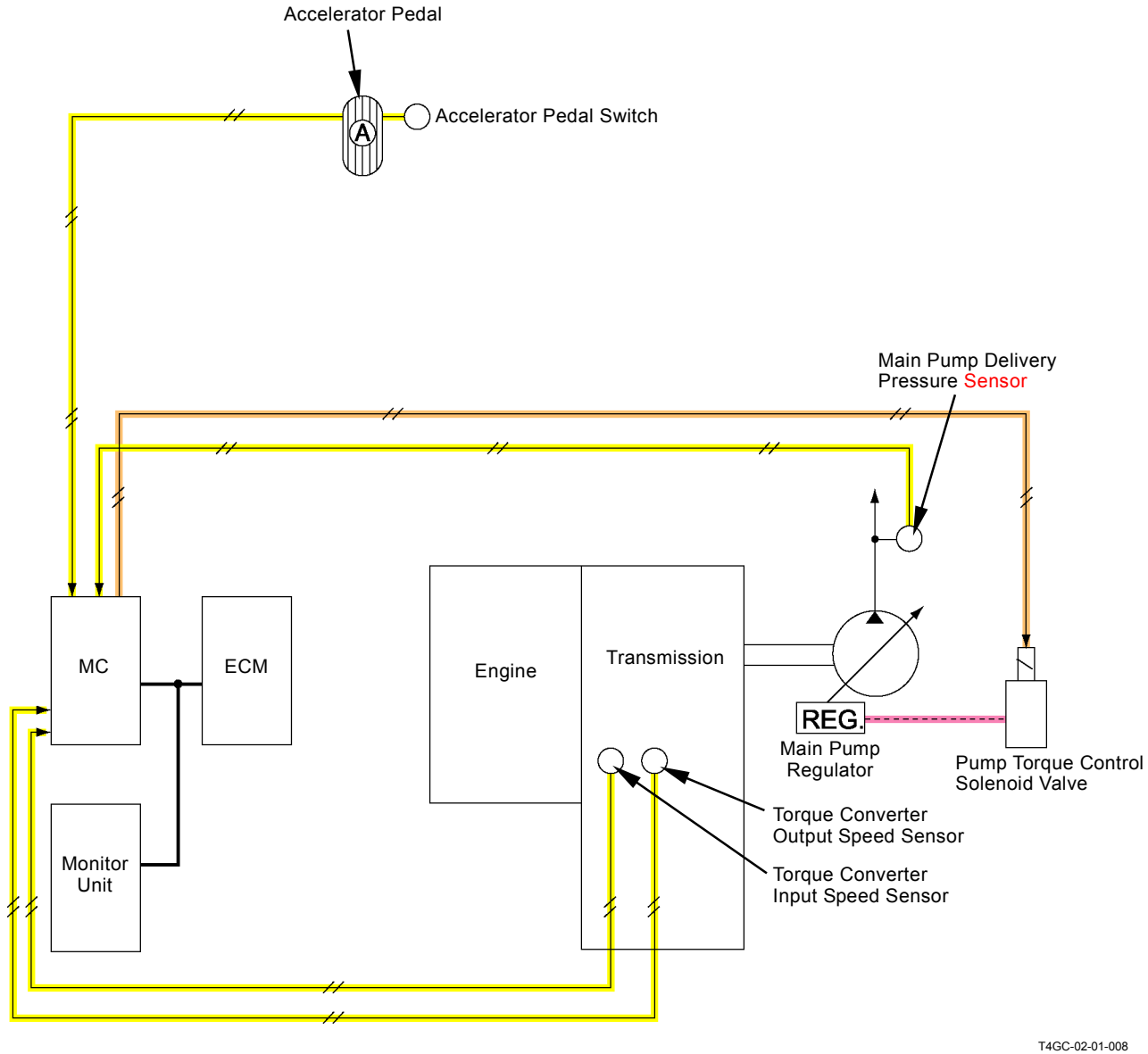
1. When accelerator pedal is stepped, MC makes arithmetic operation of the target engine speed.
2. MC makes arithmetic operation, using the target engine speed and signals from the main pump delivery pressure sensor, torque converter input speed sensor, and torque converter output speed sensor, and figures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

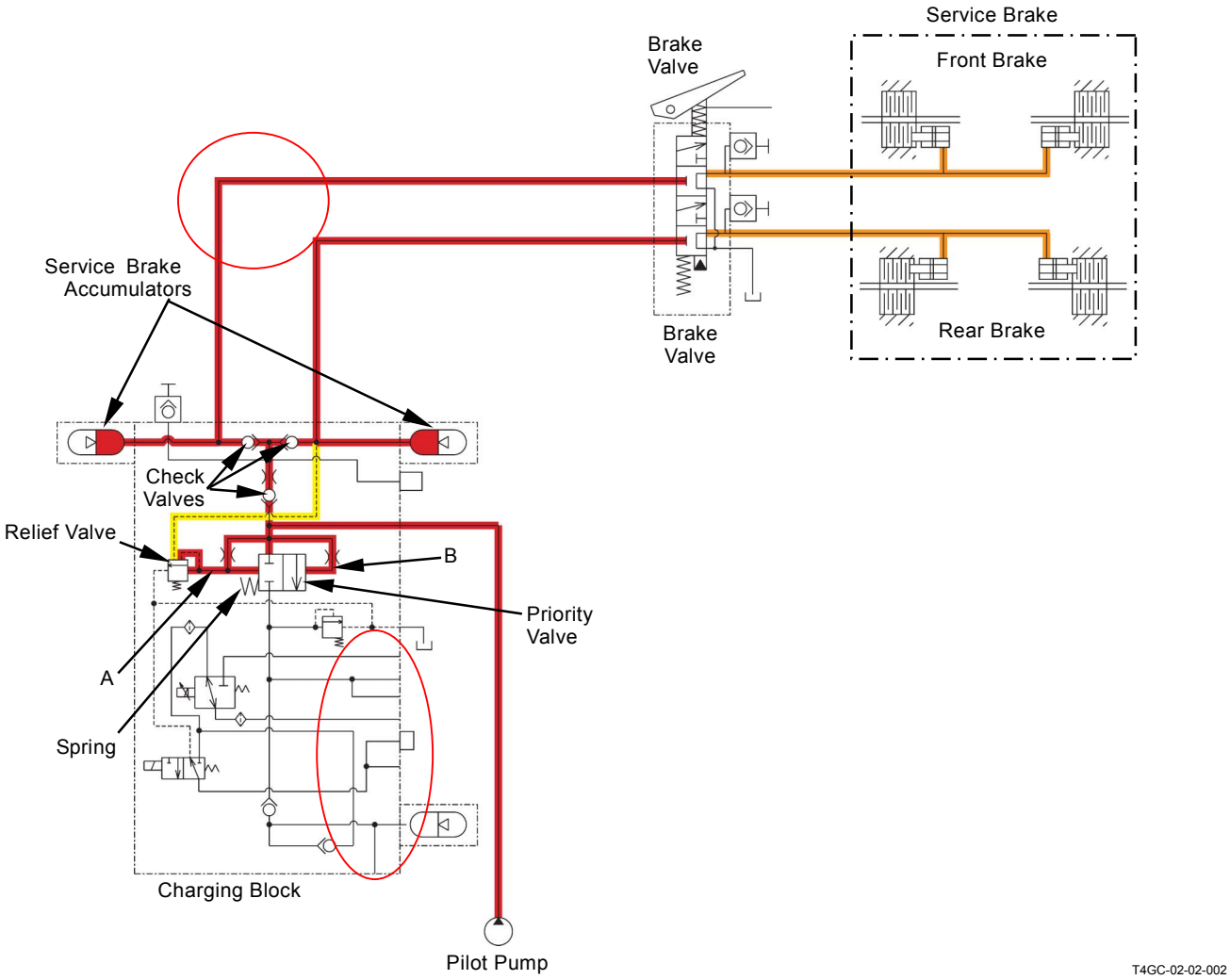


NOTE: In case the accelerator pedal becomes abnormal, the back-up control of the accelerator controls and fixes the engine speed at 1000 min^{-1}.

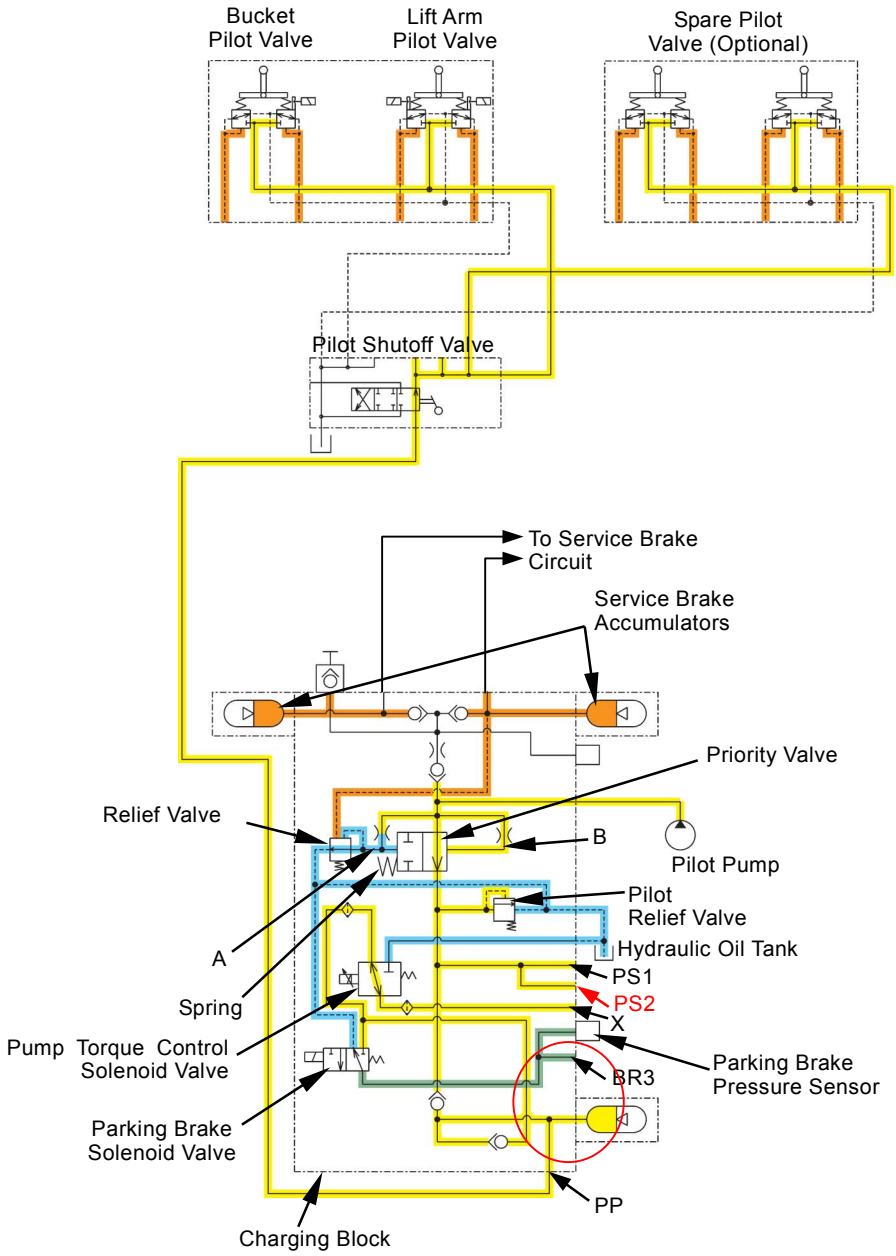
NOTE: In case signal from either the main pump delivery pressure sensor, torque converter input speed sensor, or torque converter output speed sensor is not transmitted to the MC, it does not make torque reduction control, but makes pump control by the standard-torque control.

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

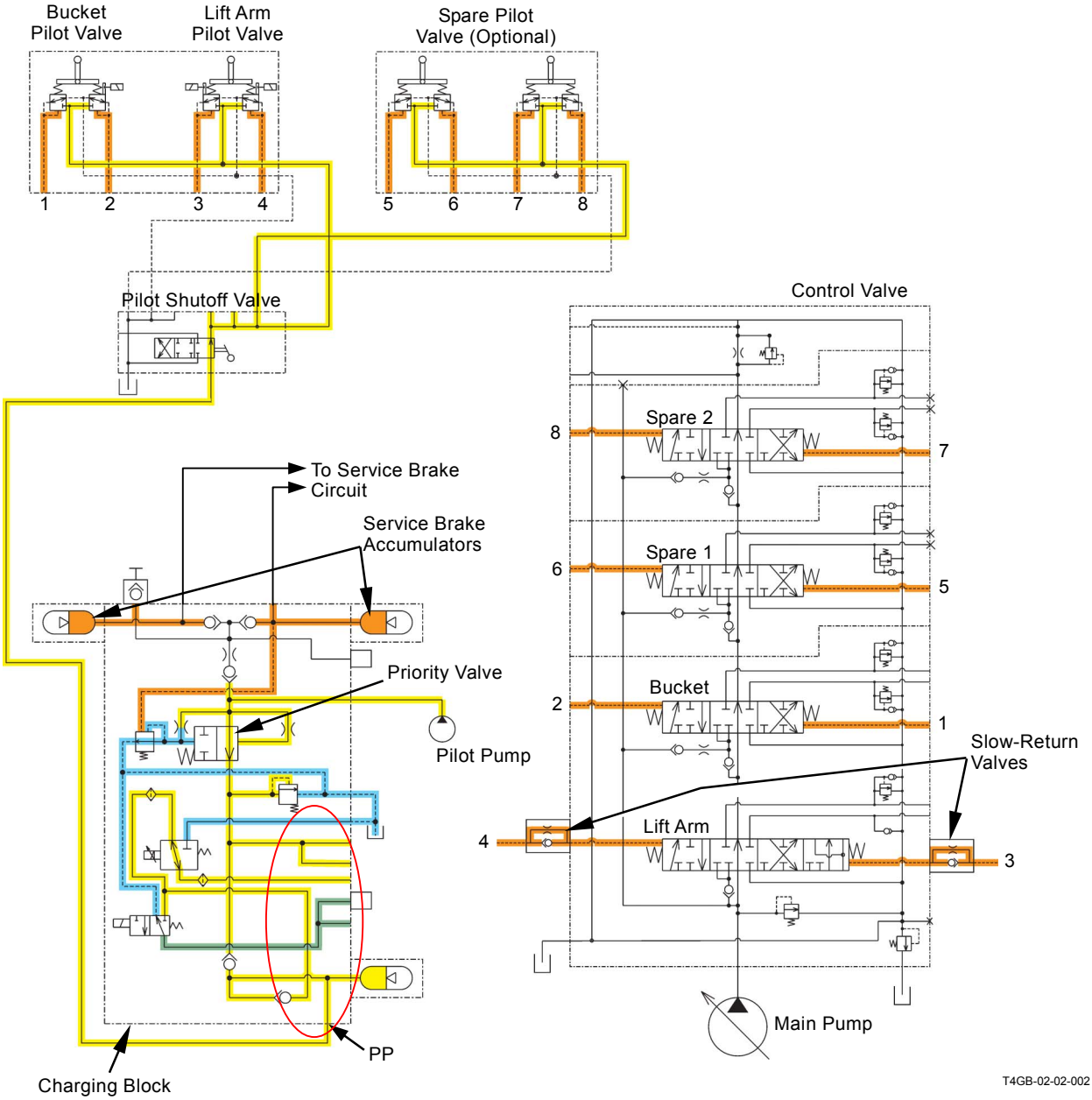

Accelerator Pedal
A
Accelerator Pedal Switch
Main Pump Delivery
Pressure Sensor
MC
ECM
Monitor
Unit
Engine
Transmission
REG.
Main Pump
Regulator
Pump Torque Control
Solenoid Valve
Torque Converter
Output Speed Sensor
Torque Converter
Input Speed Sensor
T4GC-02-01-008



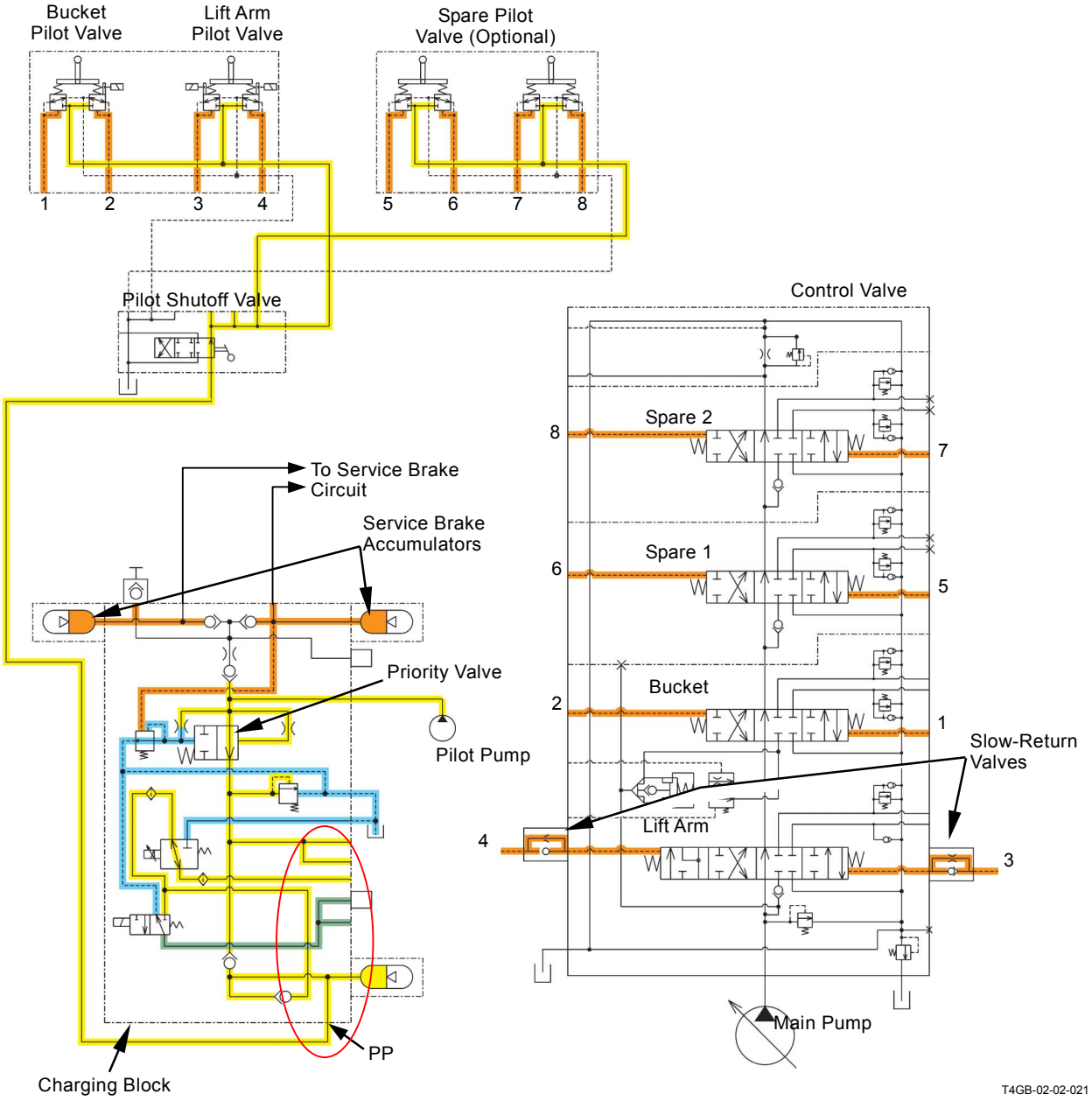
NOTE: Illustration shows oil flow when the priority valve is closed in response to pressure decrease in the service brake circuit.



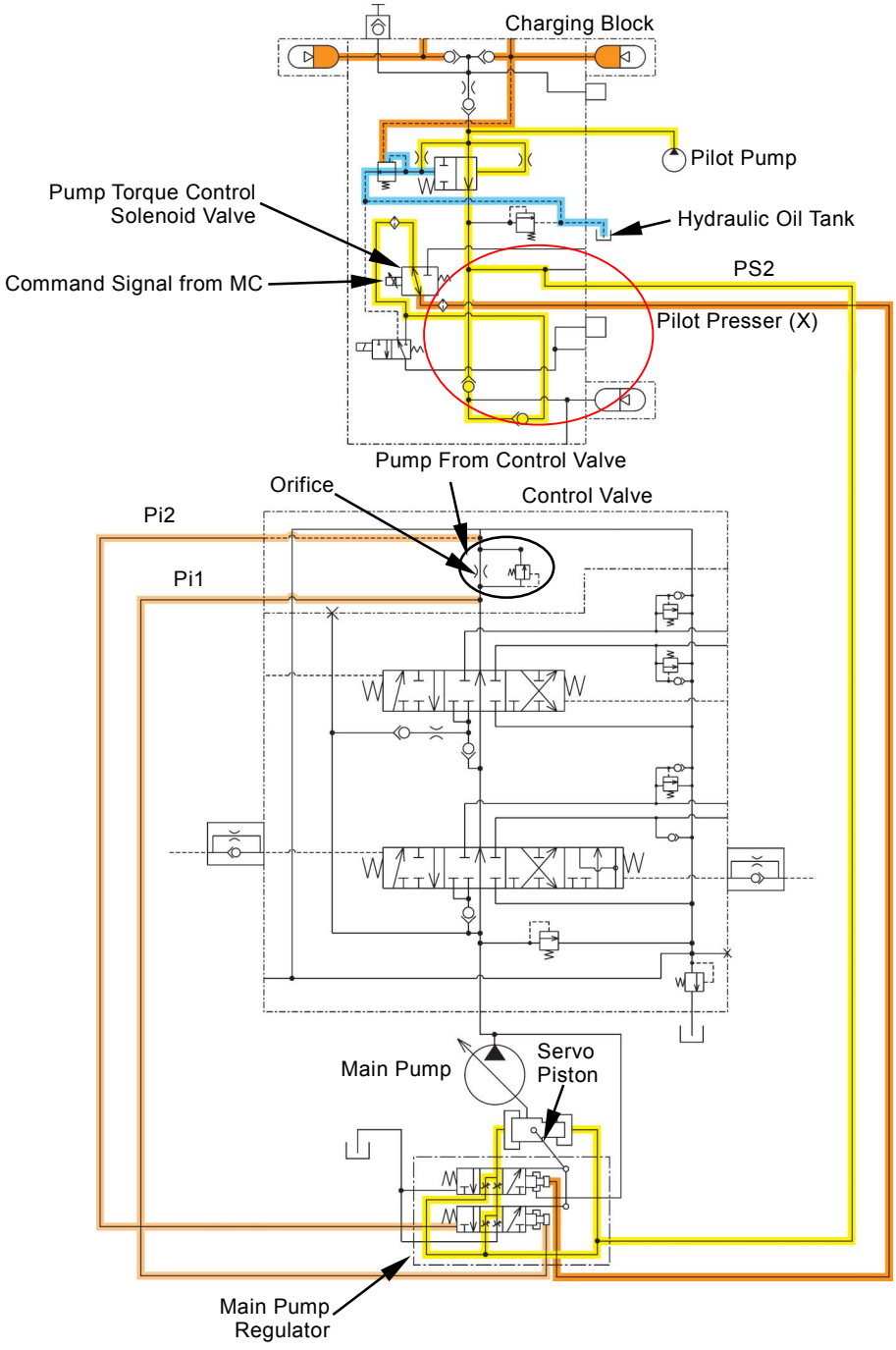
NOTE: Illustration shows the oil flow in neutral condition of the pilot valve when the service brake accumulators are pressurized, the priority valve is open, and the pilot shutoff valve is open.



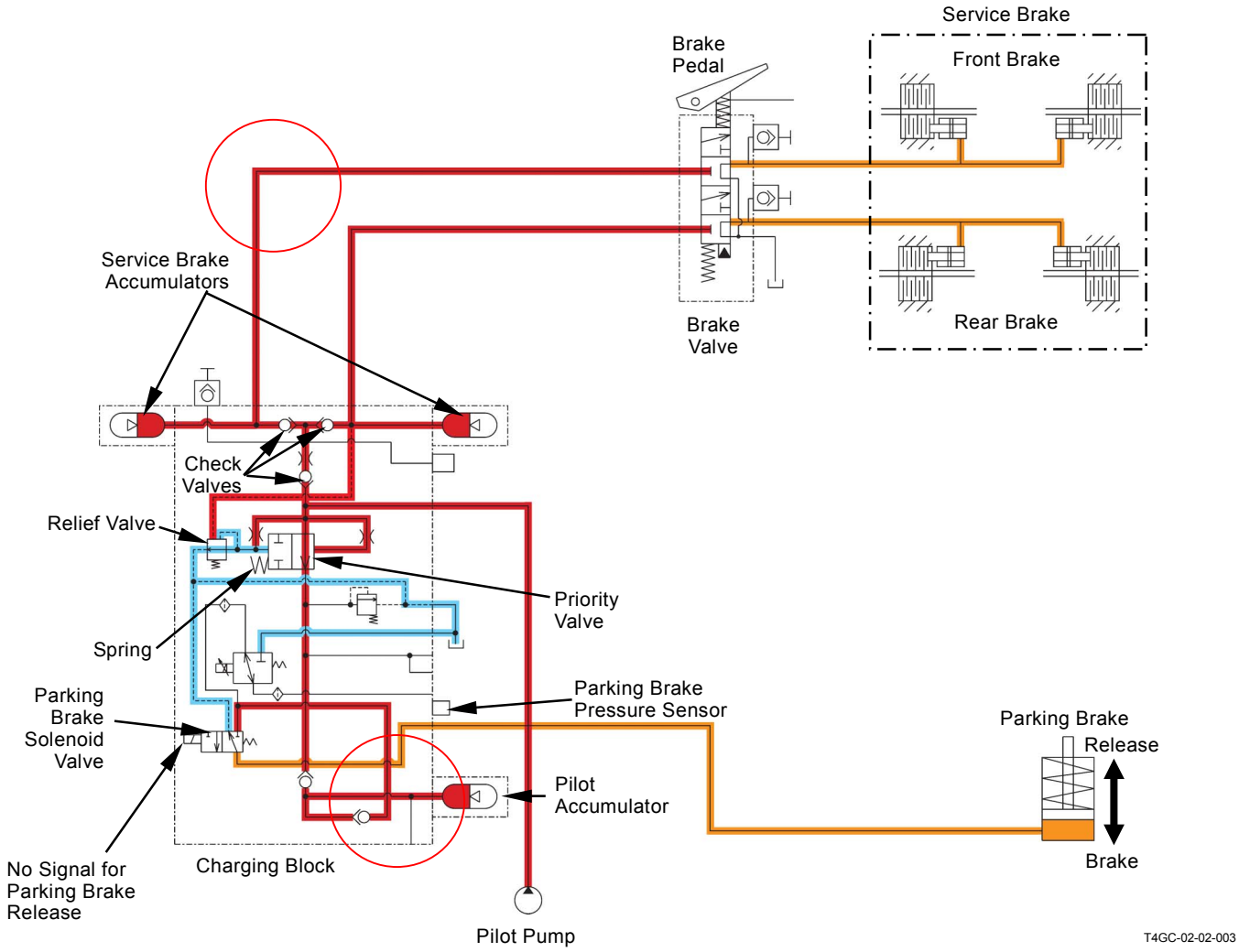
NOTE: Numeral of each port of the pilot valves and the control valve shows the port to be connected.
Illustration shows the oil flow in neutral condition of the pilot valve when the service brake accumulators are pressurized, the priority valve is open, and the pilot shutoff valve is open.



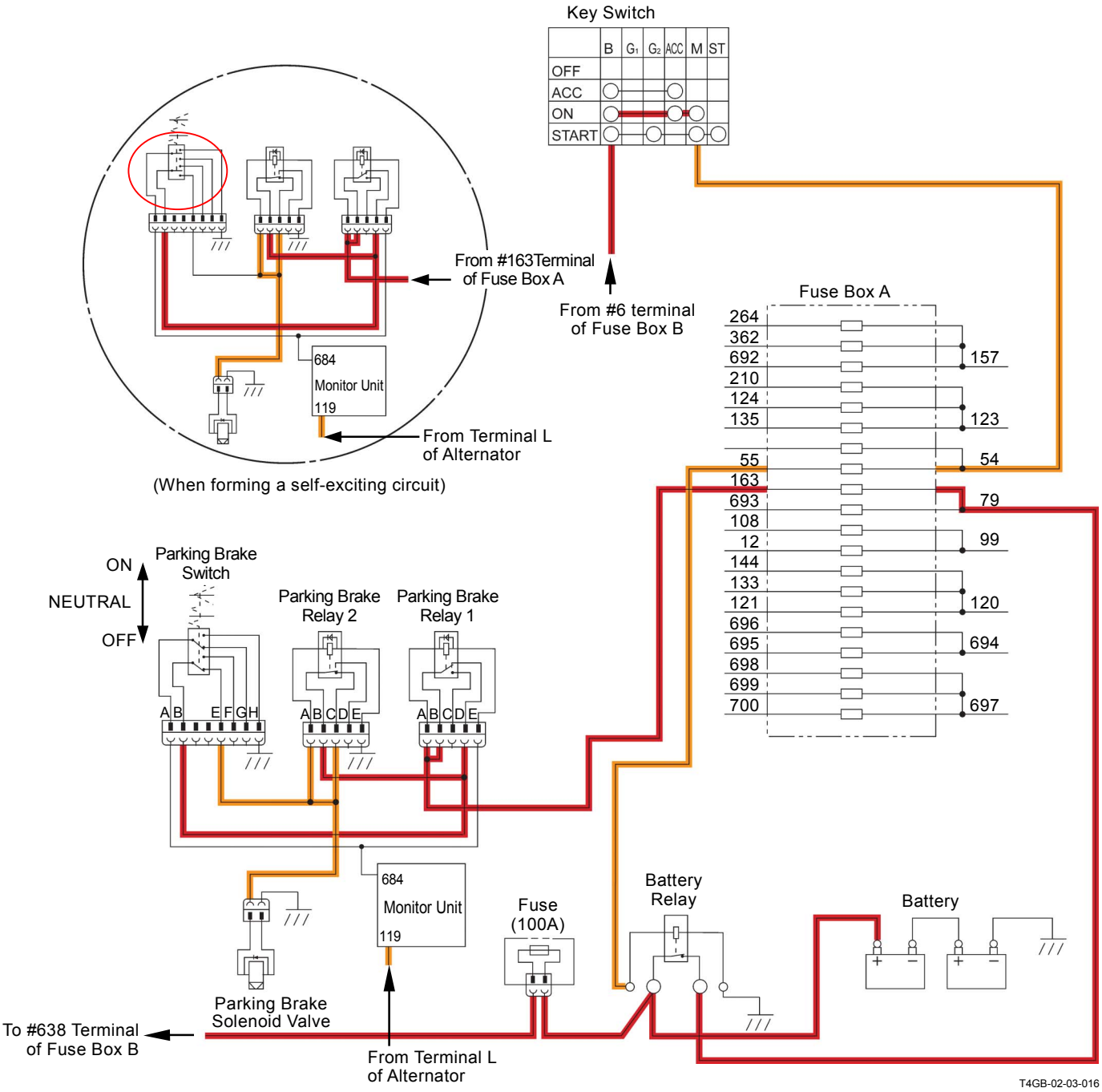
NOTE: Numeral of each port of the pilot valves and the control valve shows the port to be connected.
Illustration shows the oil flow in neutral condition of the pilot valve when the service brake accumulators are pressurized, the priority valve is open, and the pilot shutoff valve is open.



NOTE: Control valve illustrated is for ZW220.



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

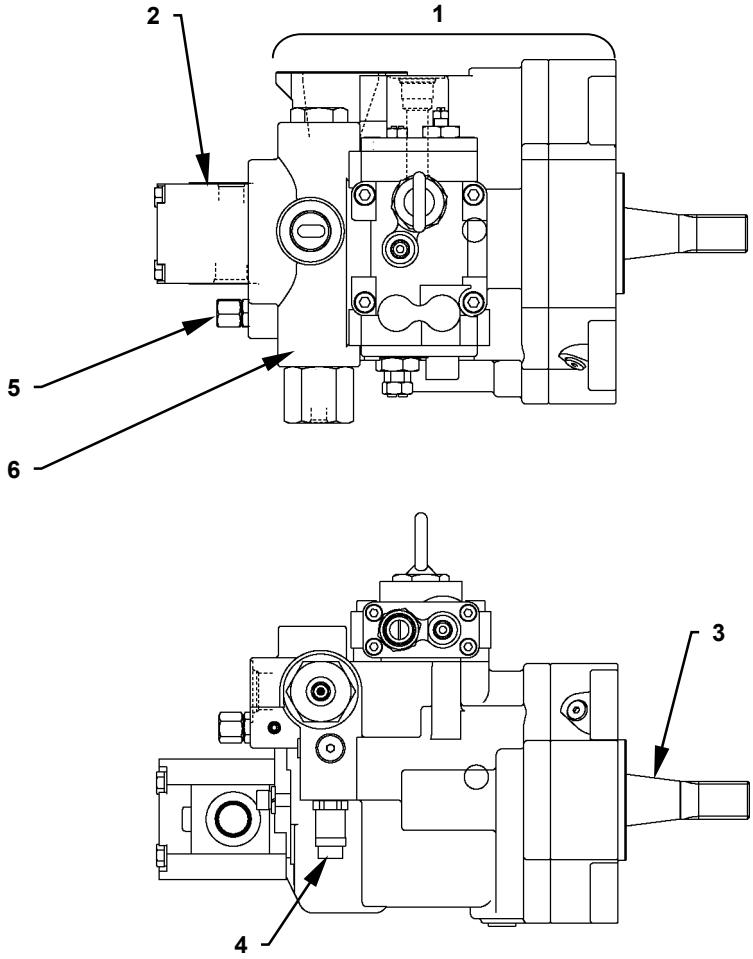


NOTE: Illustration shows flow of electric current when the parking brake switch remains pushed after the parking brake switch has been turned OFF during rotation of the engine.

OUTLINE

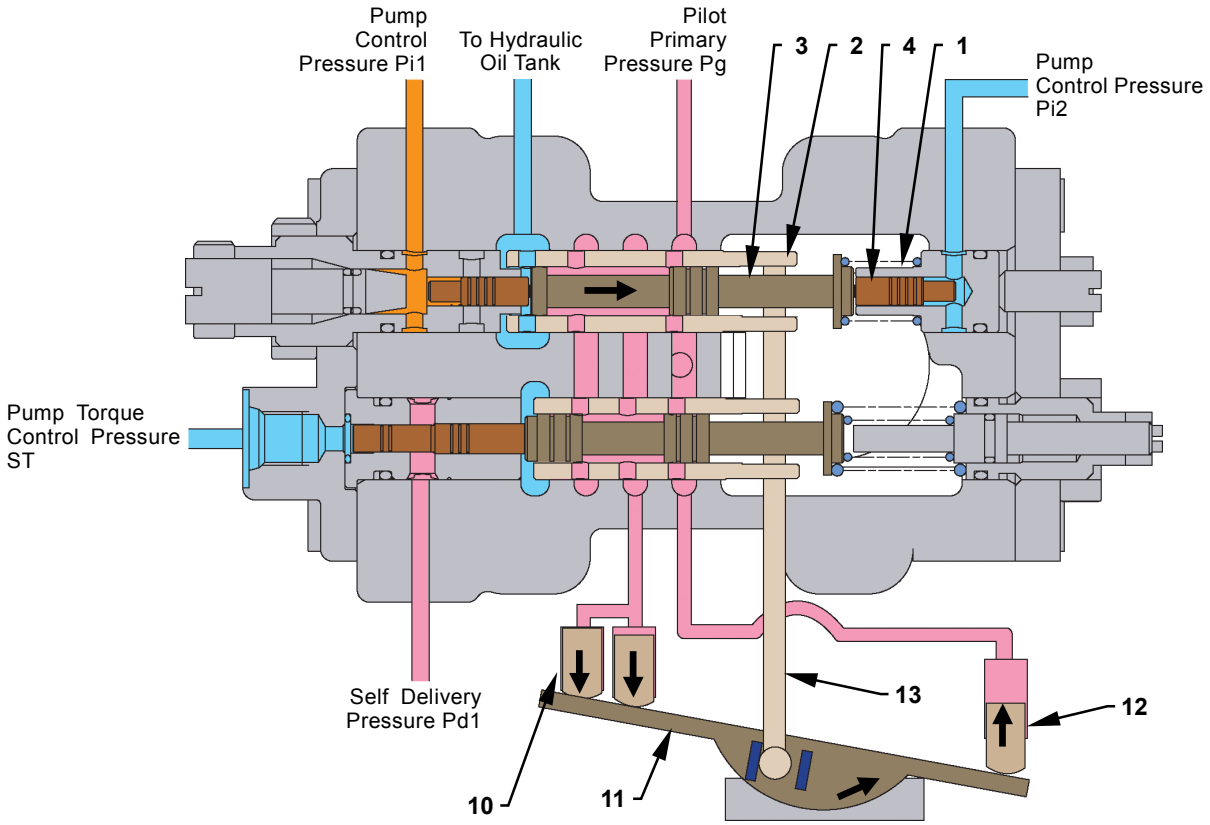
Pump device has a main pump (1) and a pilot pump (2), and main pump (1) has a built-in priority valve (6).
Driving force of the engine is transmitted to the shaft (3) through the transmission input shaft, and actuates main pump (1) and pilot pump (2).

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



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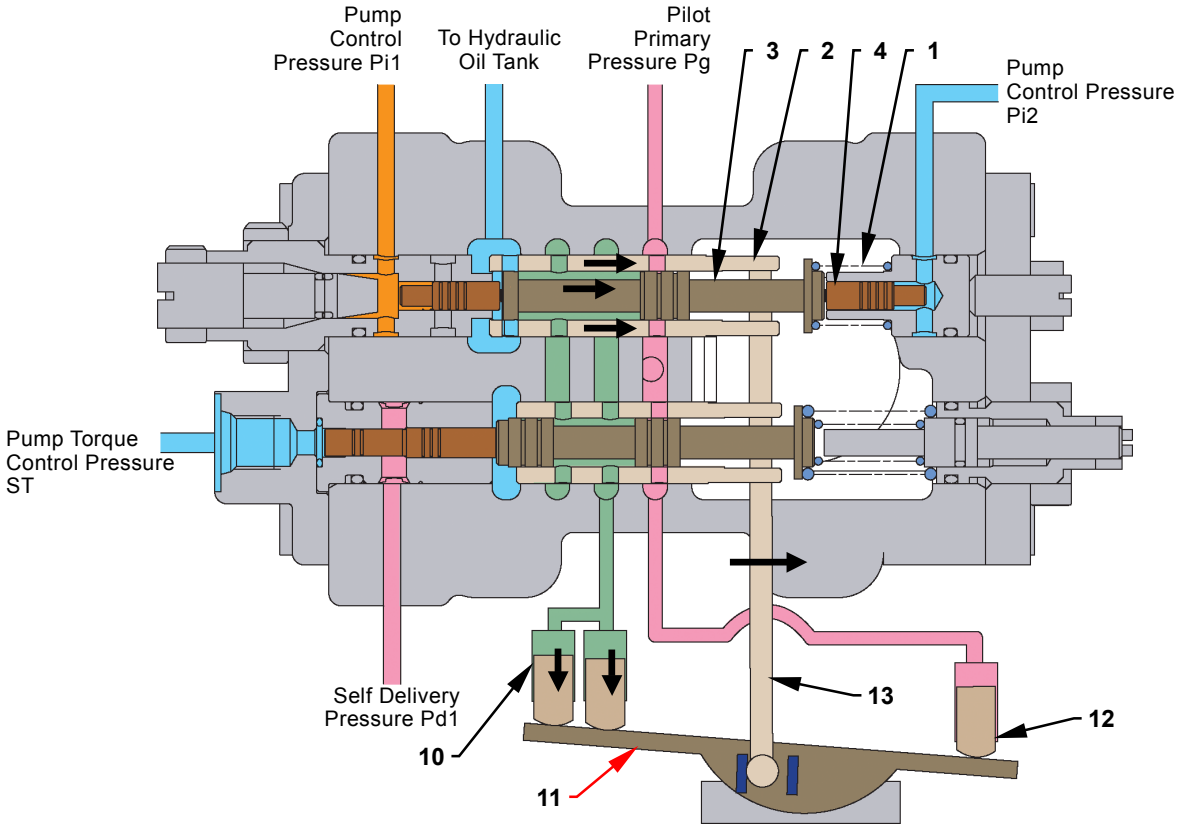

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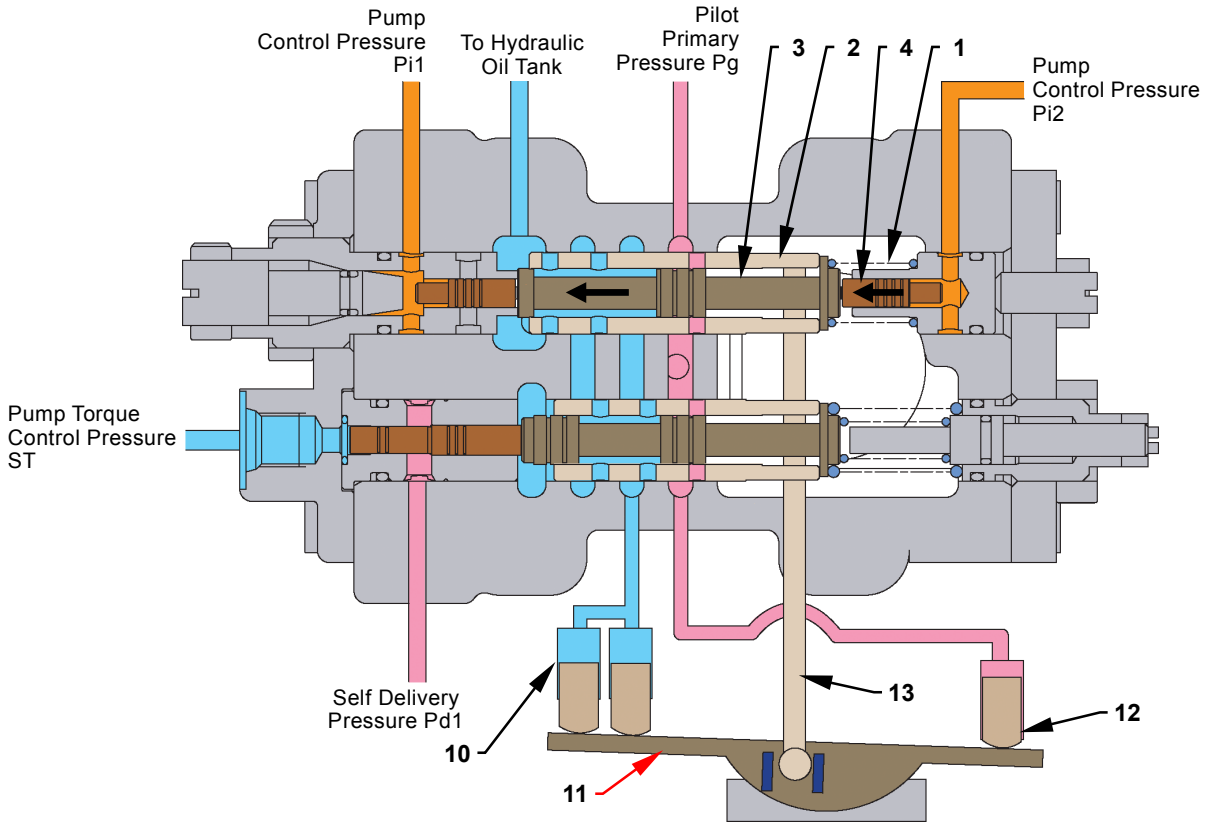

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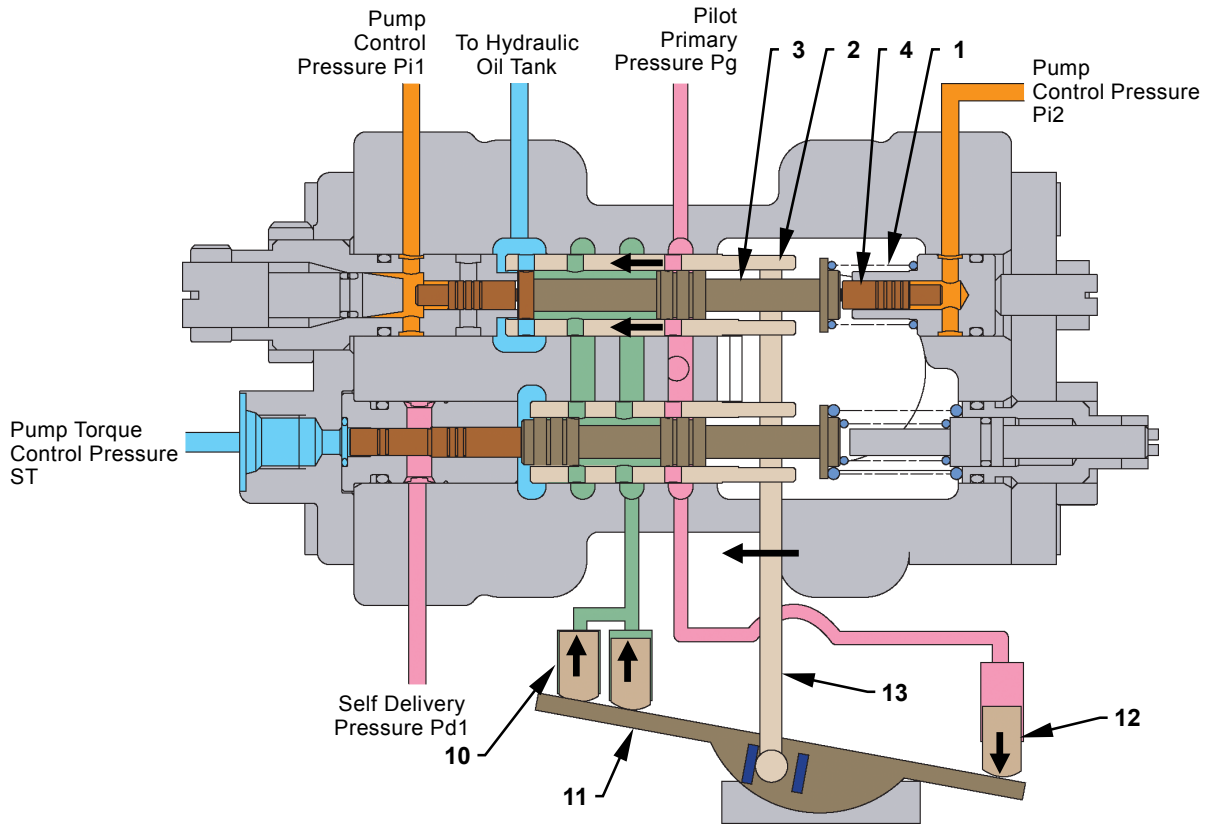

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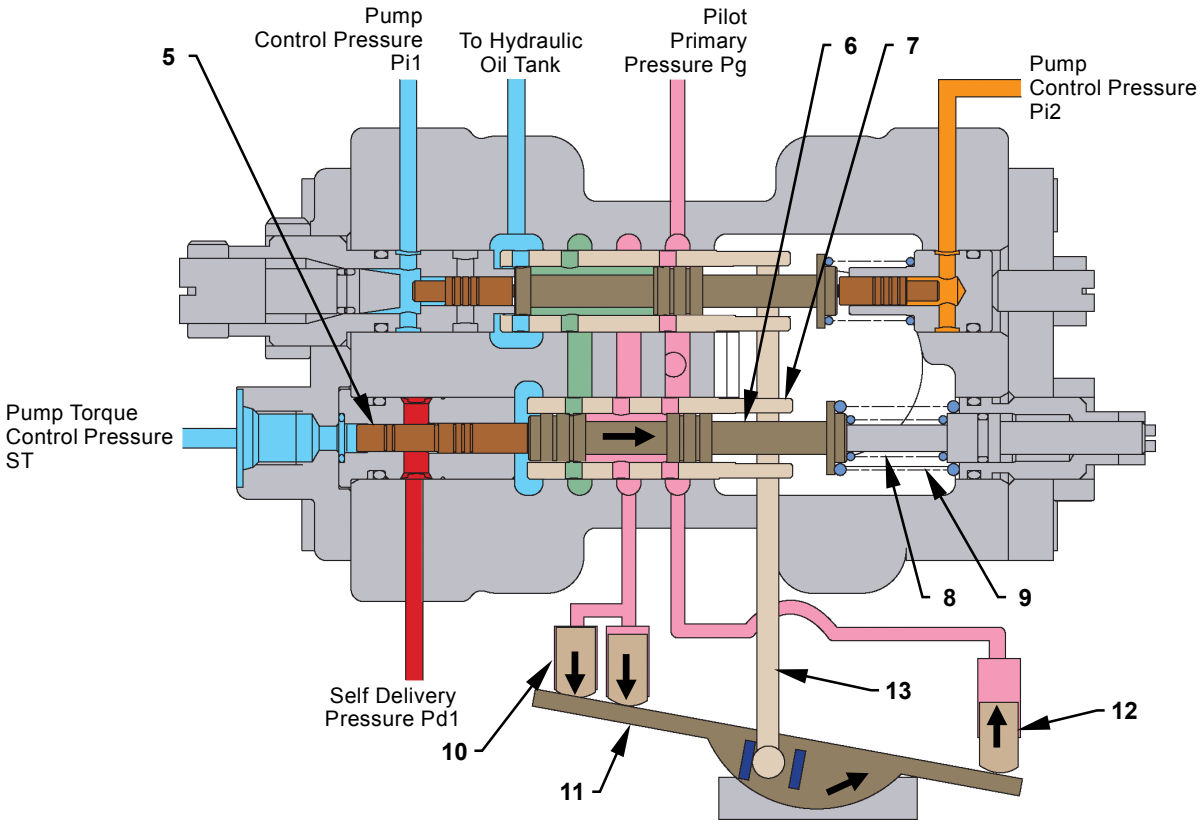

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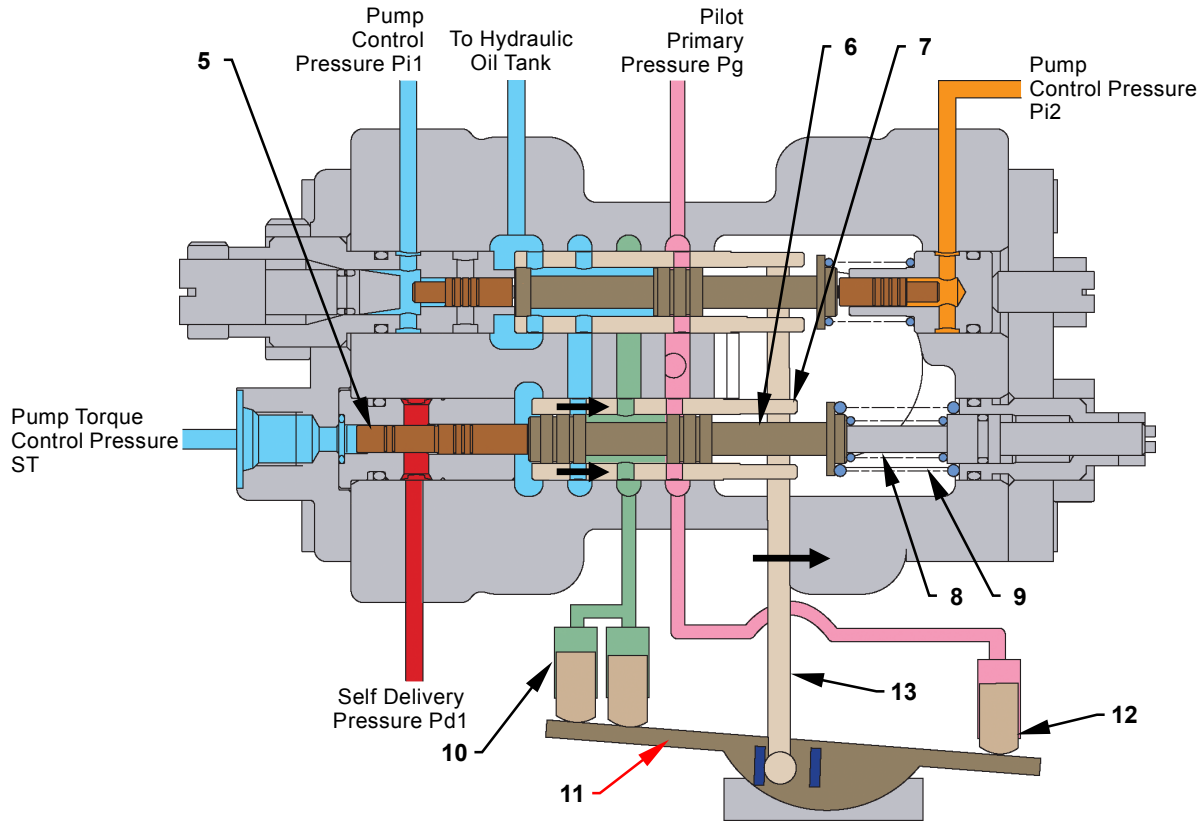

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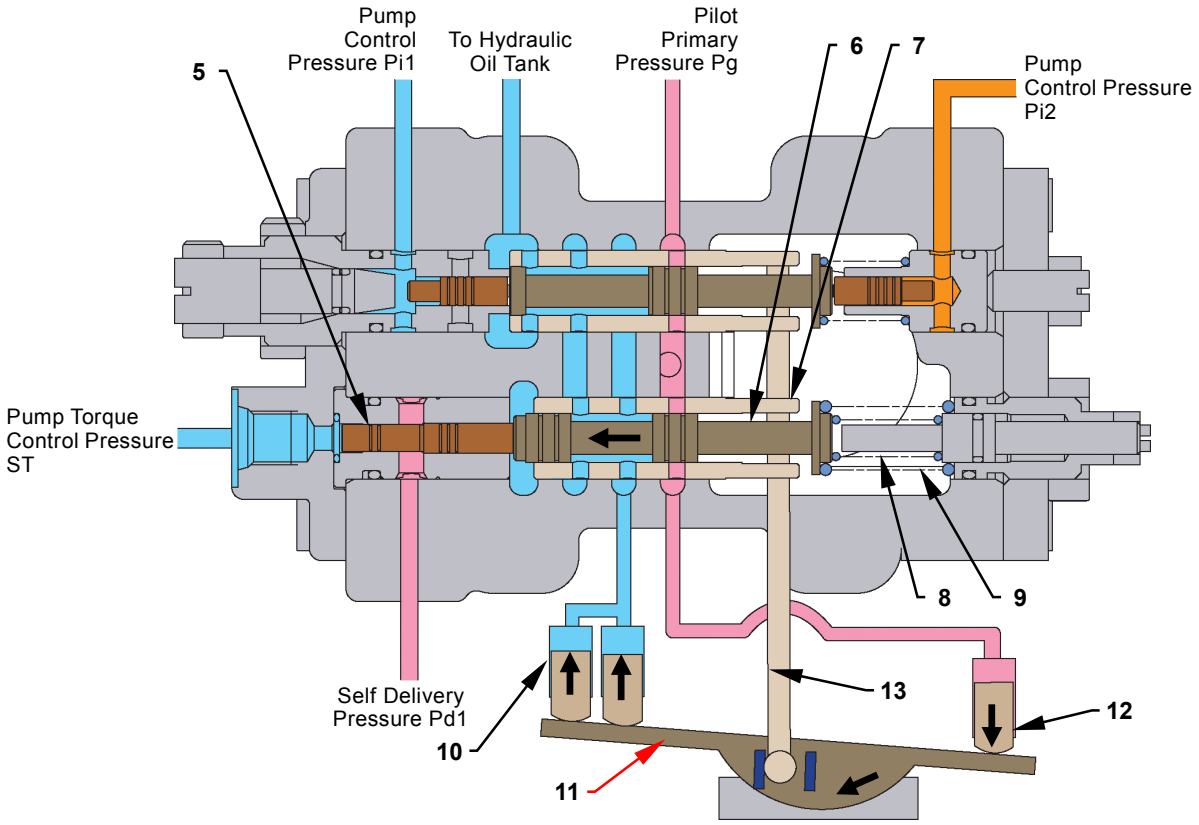

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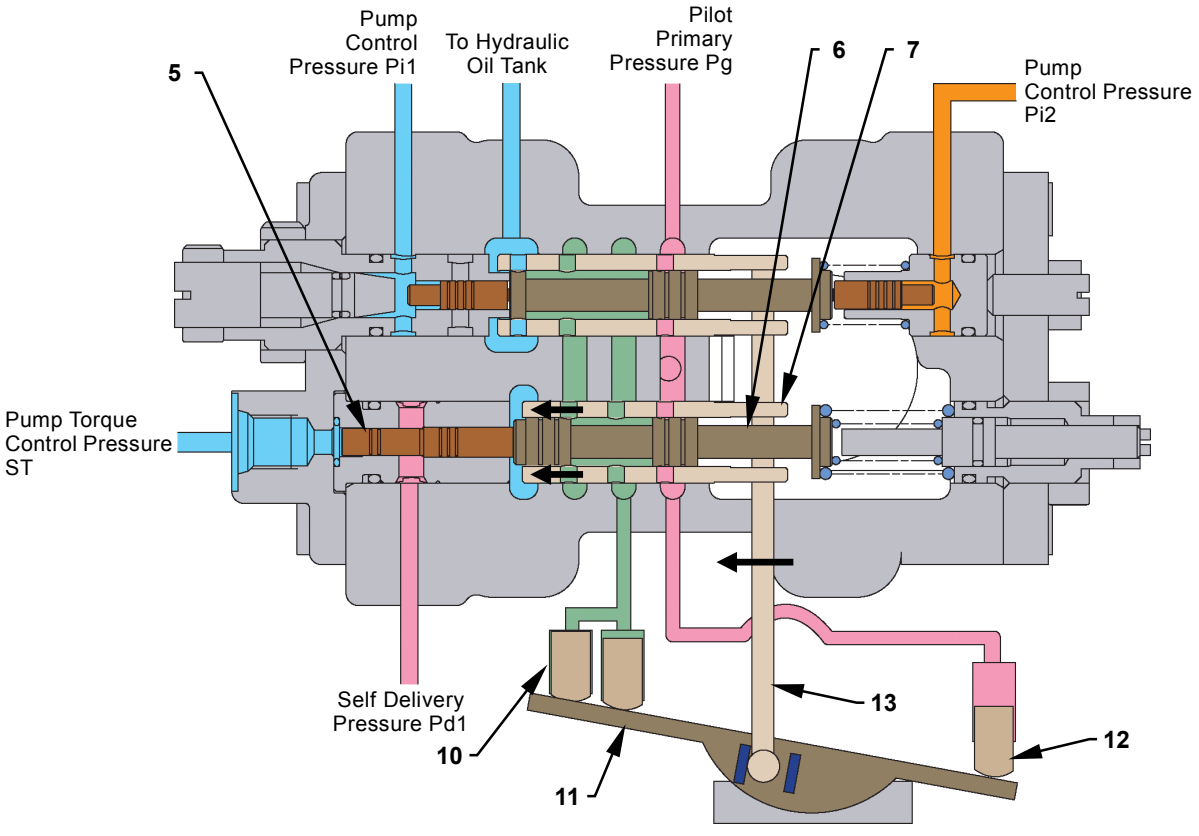

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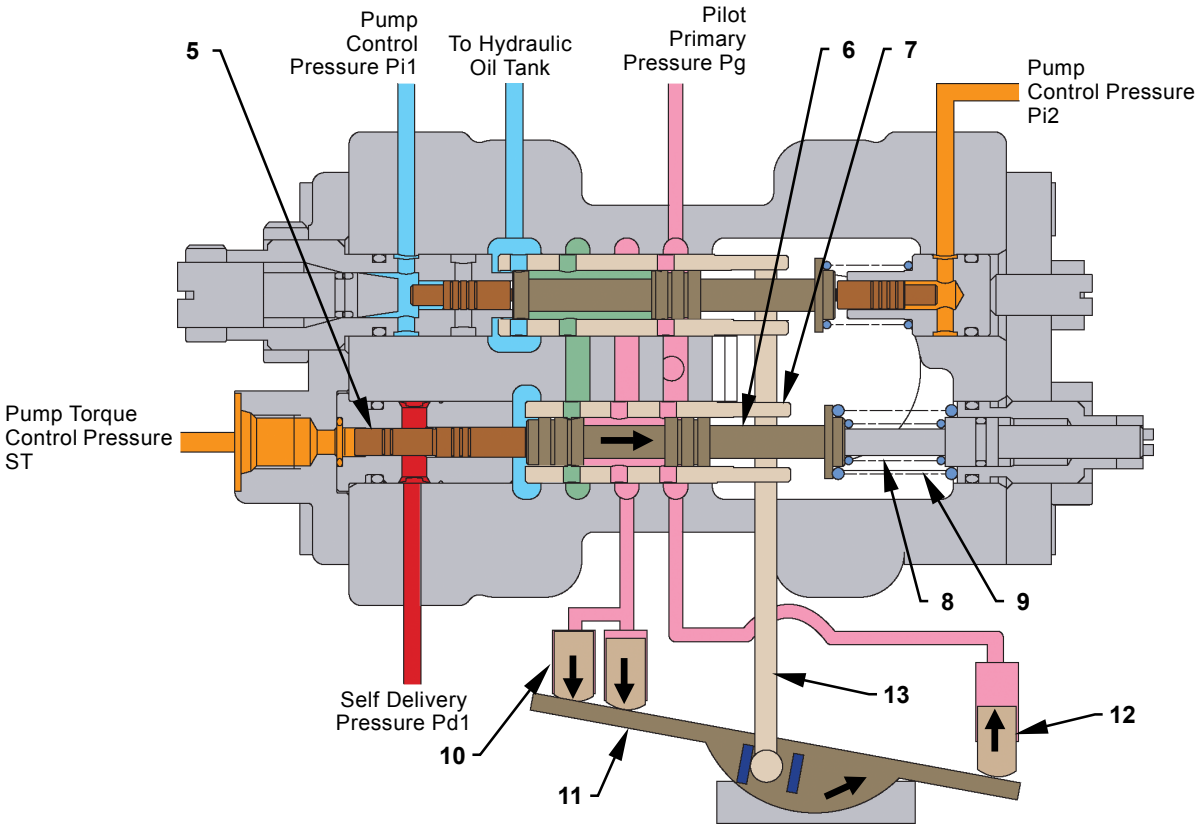

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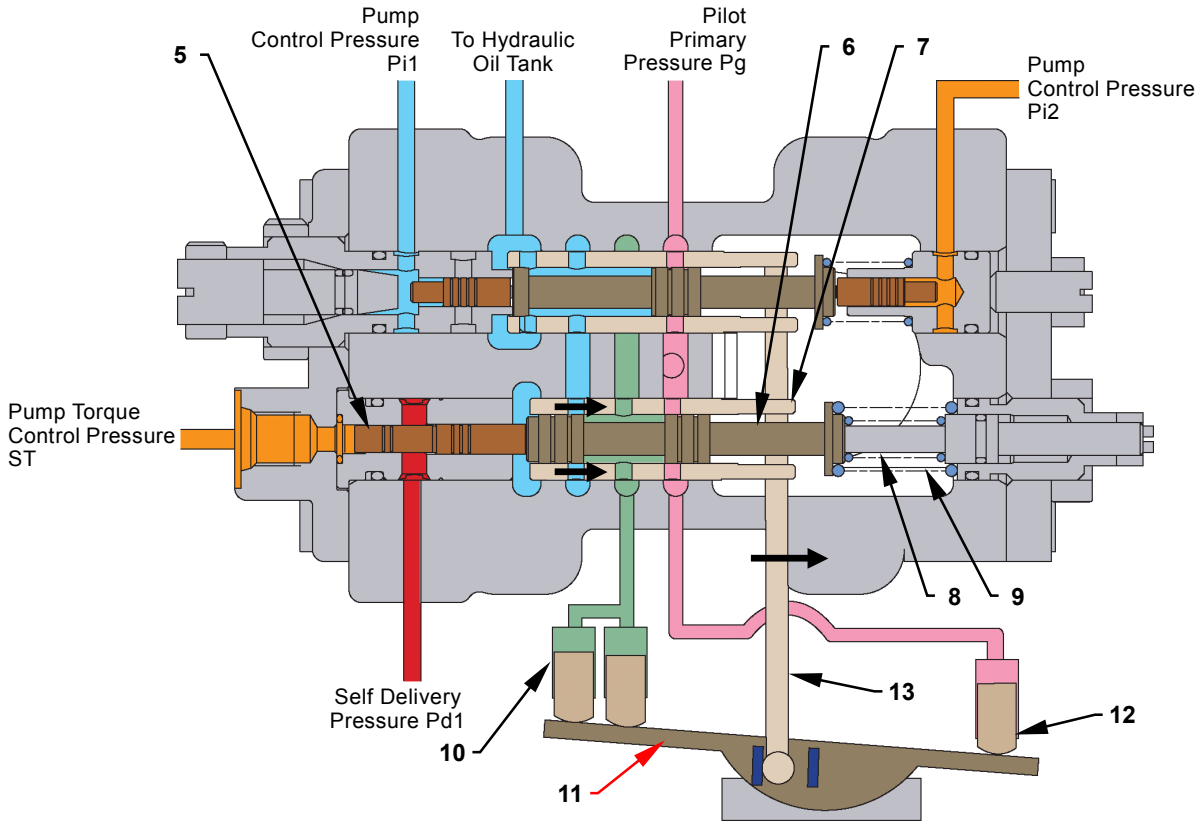
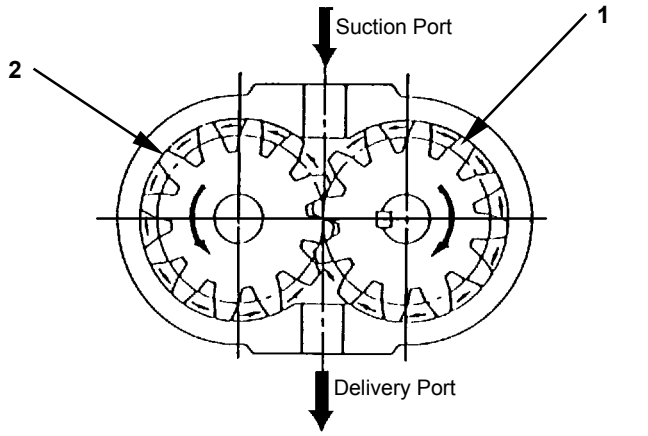


T4GB-03-01-017

PILOT PUMP

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

1 - Drive Gear
2 - Driven Gear

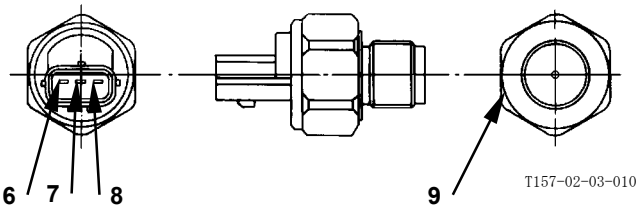


T137-02-03-005

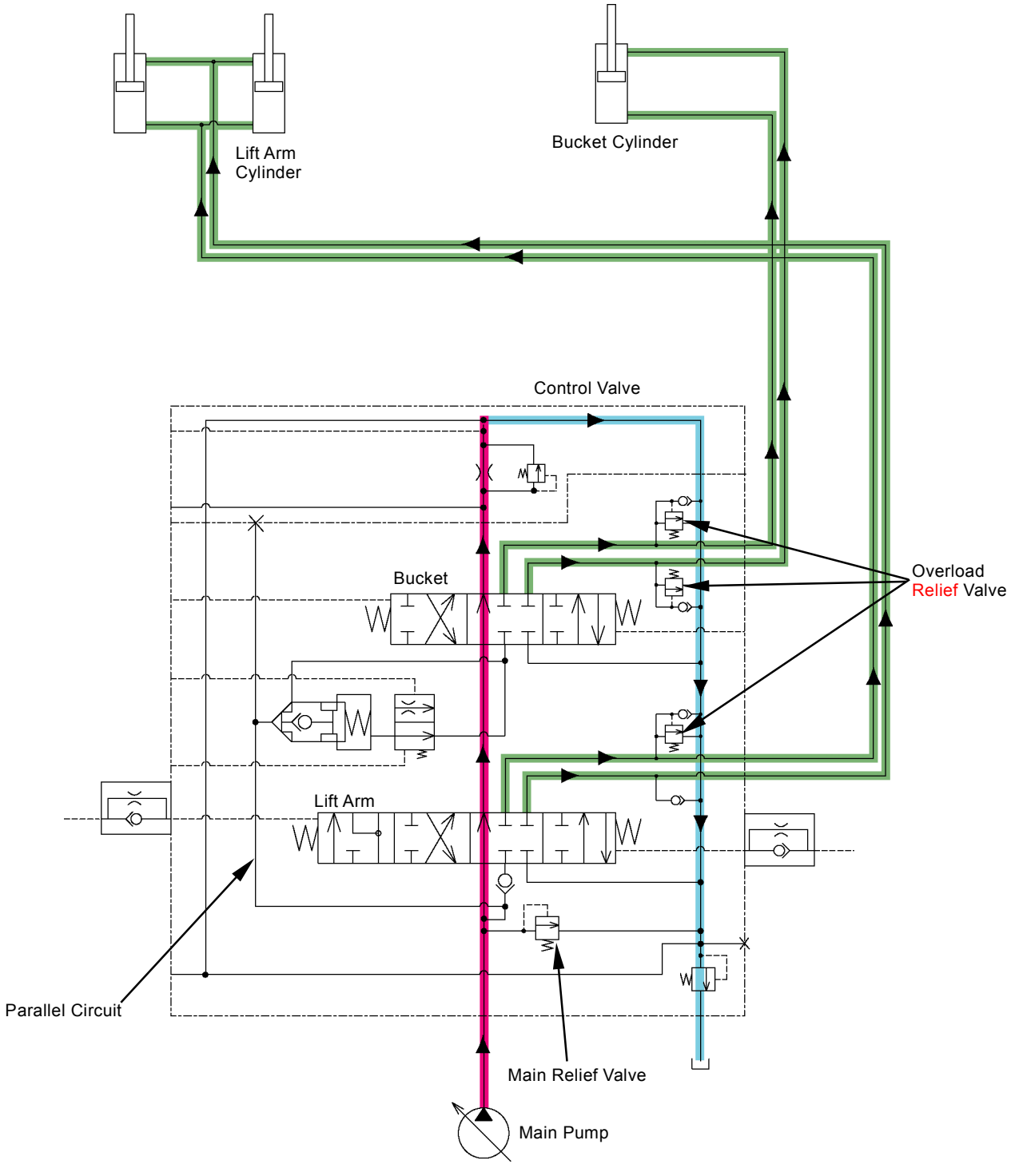
PUMP DELIVERY PRESSURE SENSOR

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

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



T157-02-03-010


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

REVERSE CONTROL VALVE

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

Operation

- At Neutral of Reverse Control Solenoid Valve

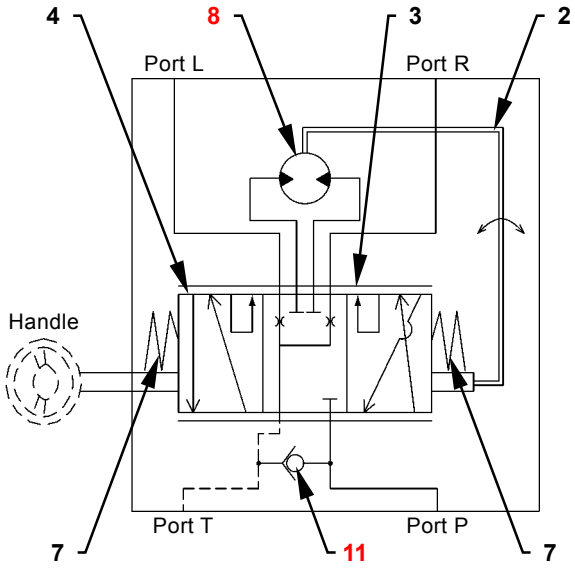
1. When reverse control solenoid valve (1) is at neutral, the pressure oil (P) from the fan pump is blocked by changeover valve (2).
2. As reverse spool (3) is being pushed by spring (4), the pressure oil (P) from the fan pump flows to port MB, and the fan motor rotates normally.

- In Operation of Reverse Control Solenoid Valve

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

OPERATION

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



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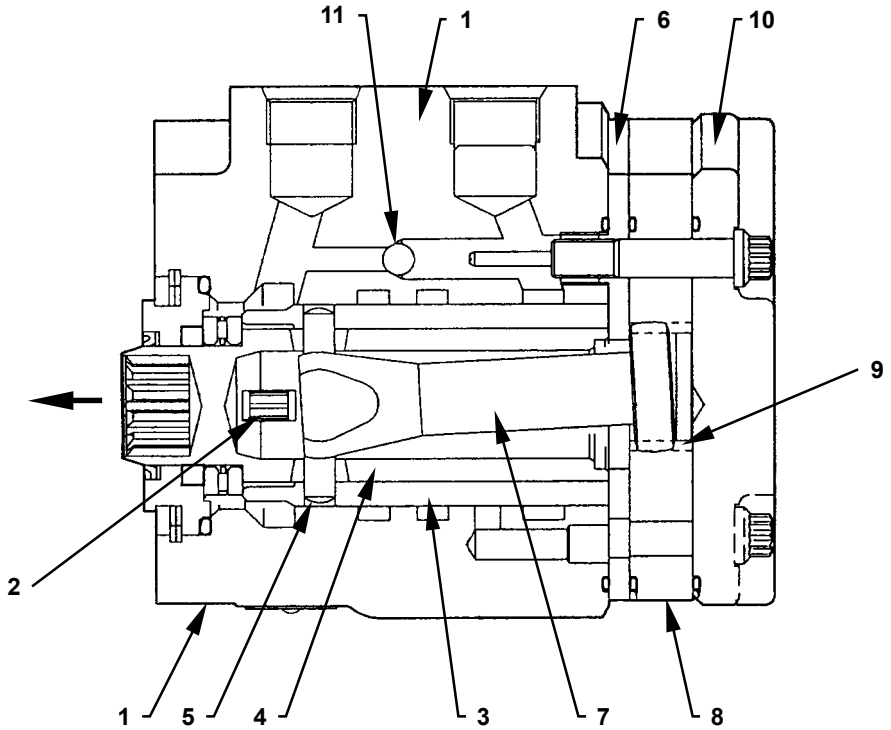
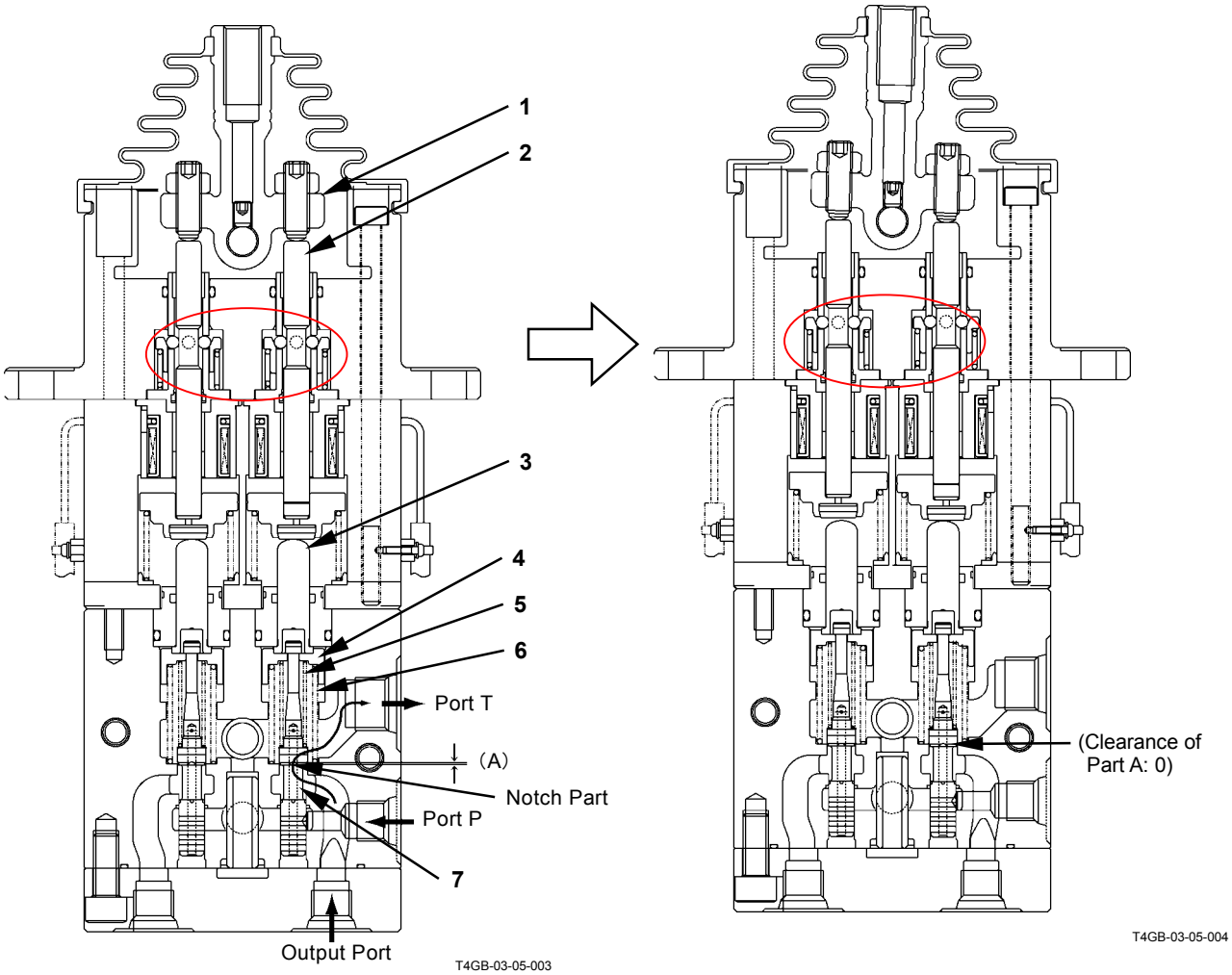


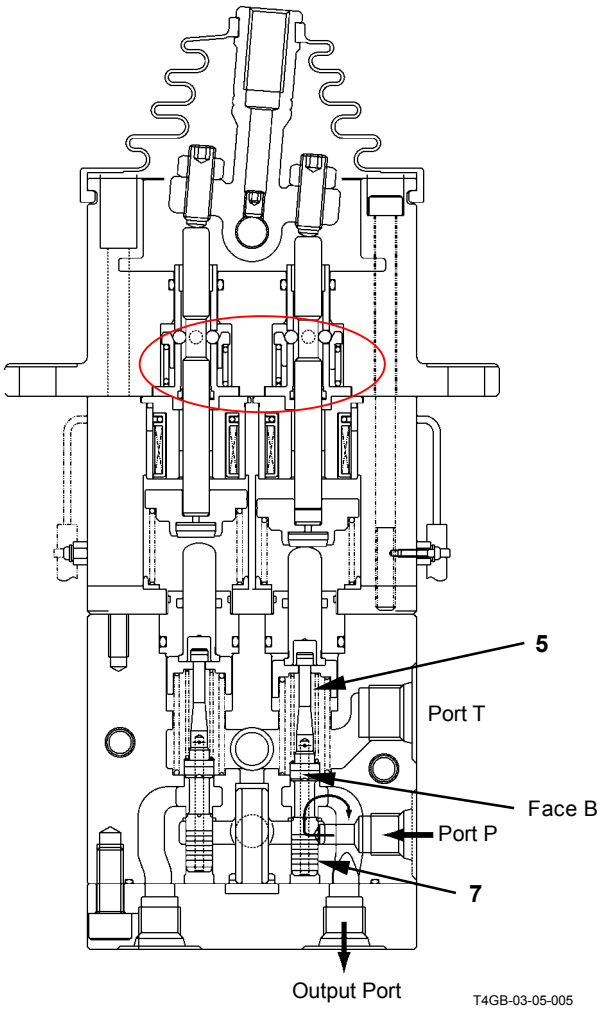
T1F3-03-07-002

Pusher Stroke: between A and B

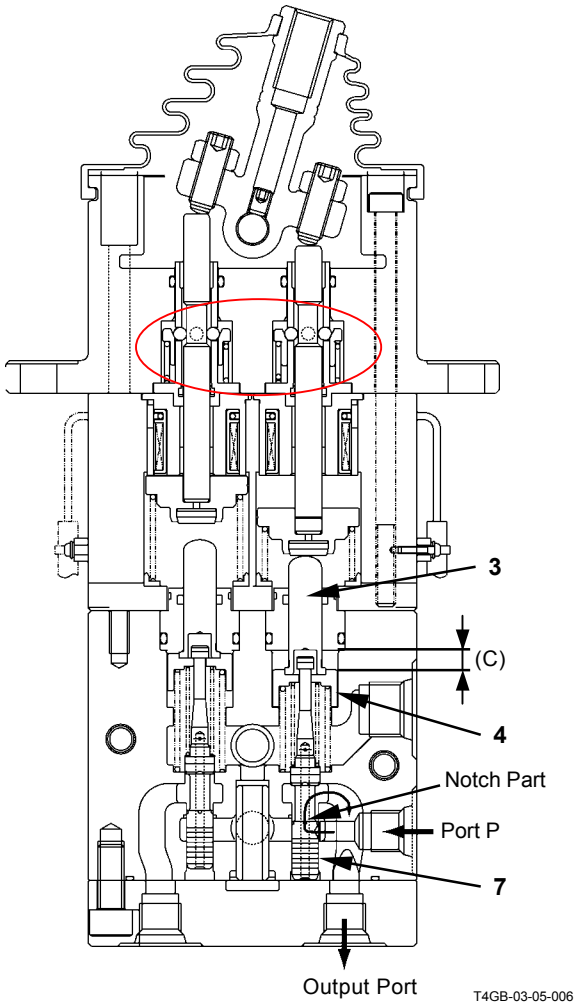


1 - Lever
2 - Push Rod
3 - Pusher
4 - Spring Guide
5 - Balance Spring
6 - Return Spring
7 - Spool

Pusher Stroke: between C and D



Pusher Stroke: between E and F

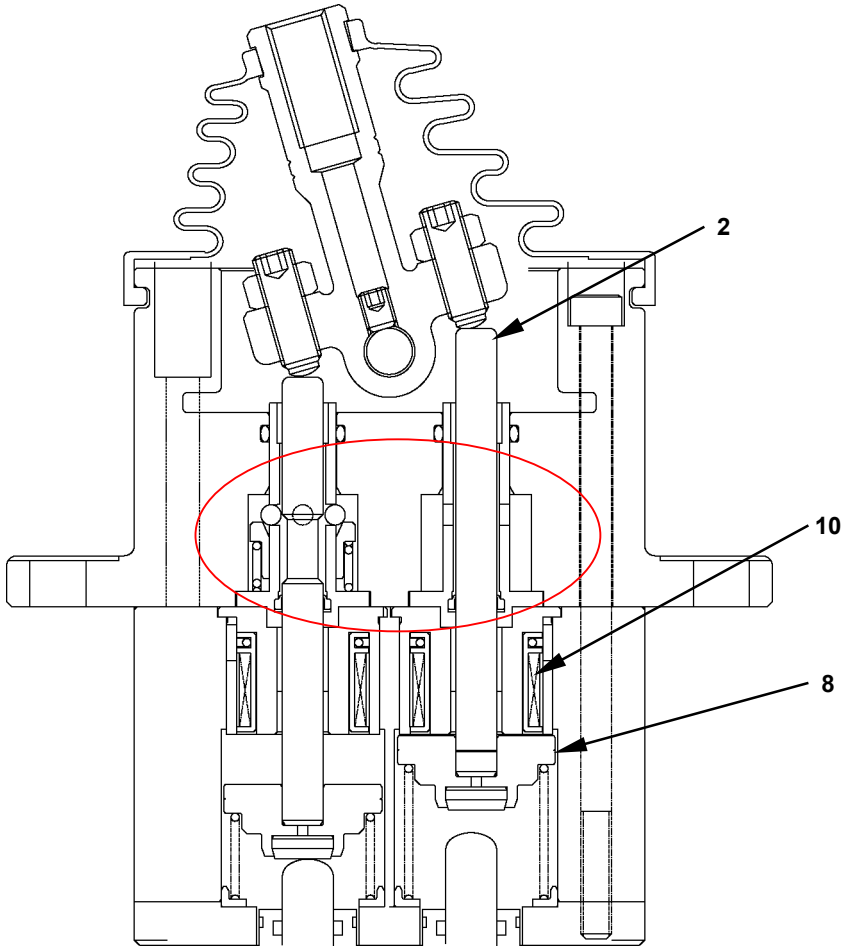


3- Pusher
4 - Spring Guide
5 - Balance Spring
7 - Spool

Electromagnetic Detent

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

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



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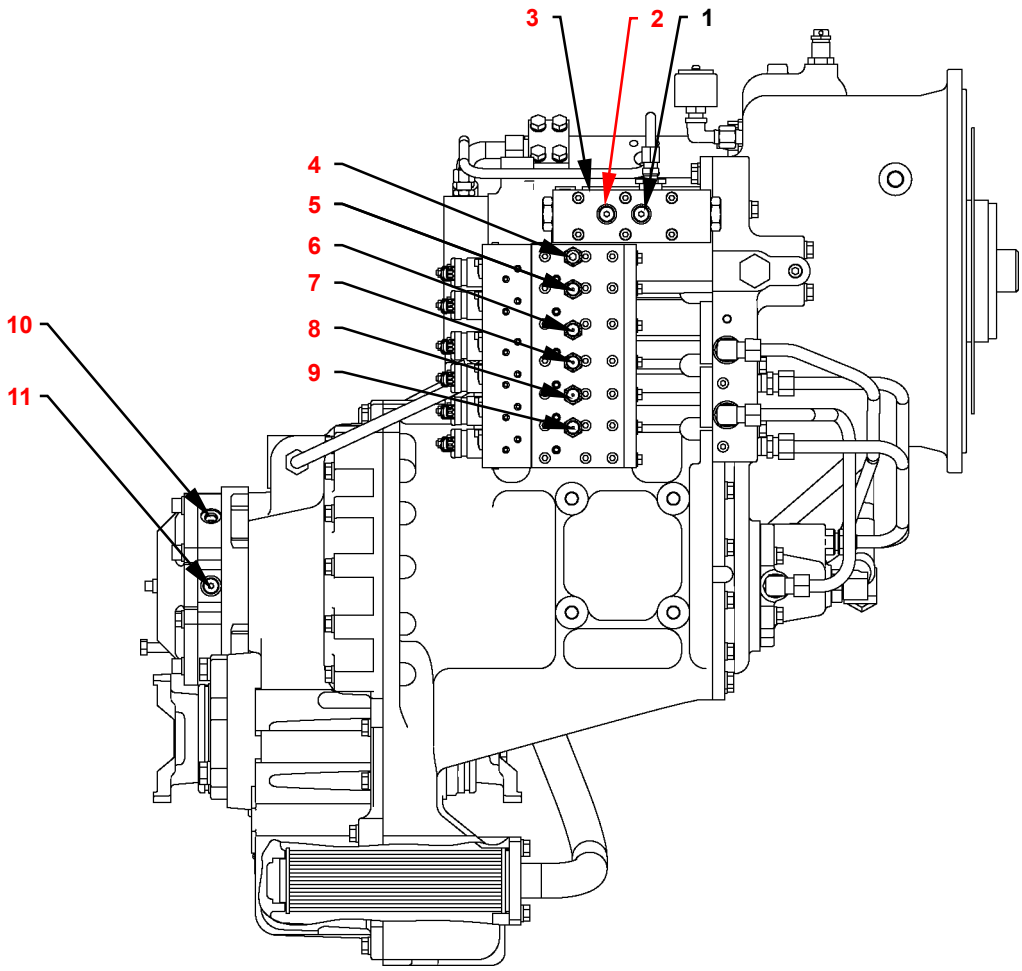
2 - Push Rod
8 - Plate
10 - Coil Assembly

Side View of Transmission



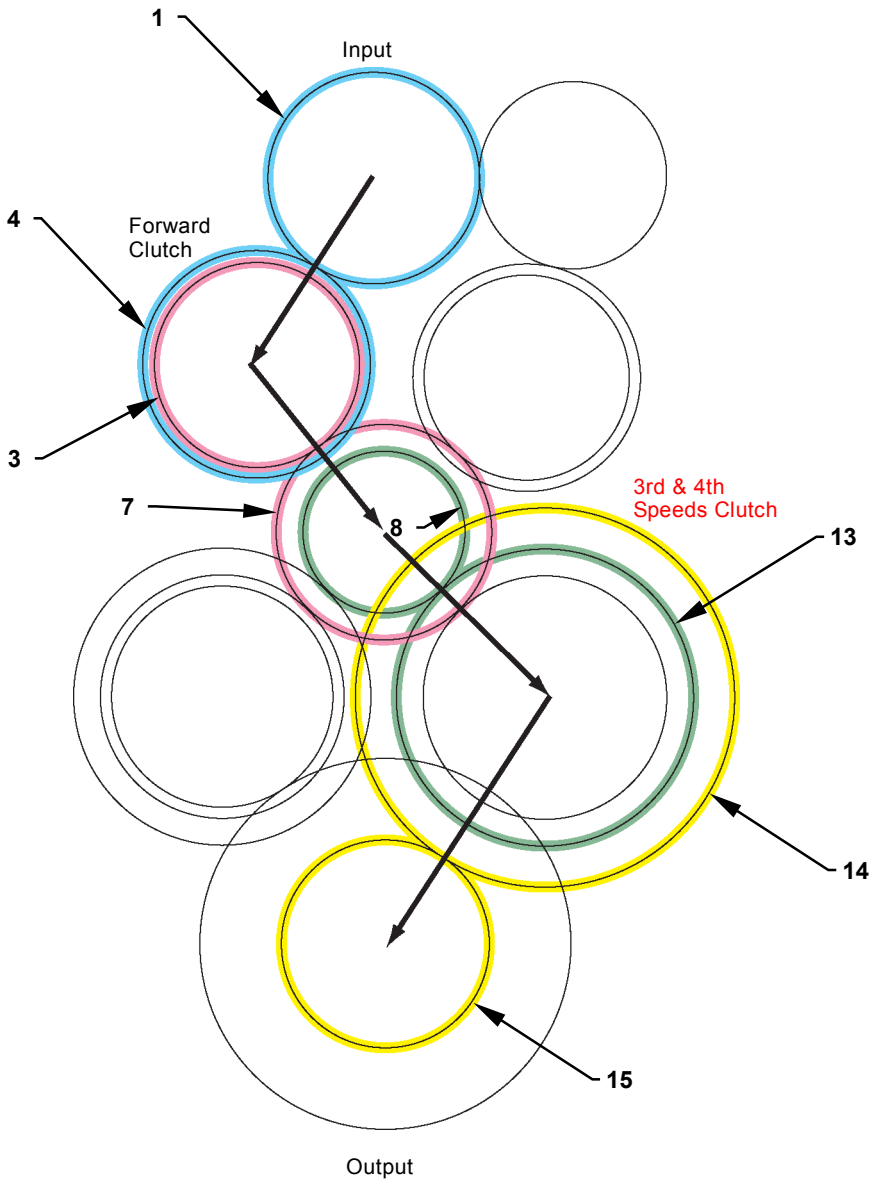
T4GC-03-09-005

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

Forward 3rd Speed

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

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



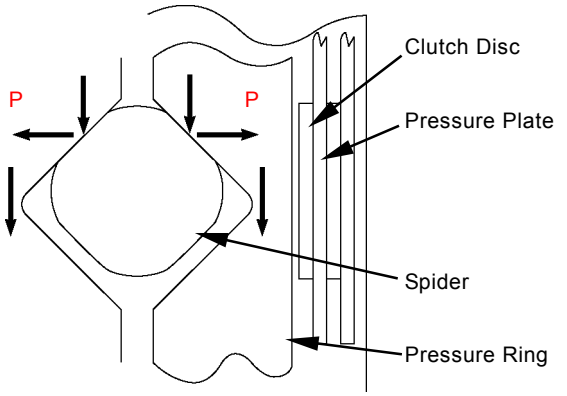
Power Flow: Forward 3rd Speed

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

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

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

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



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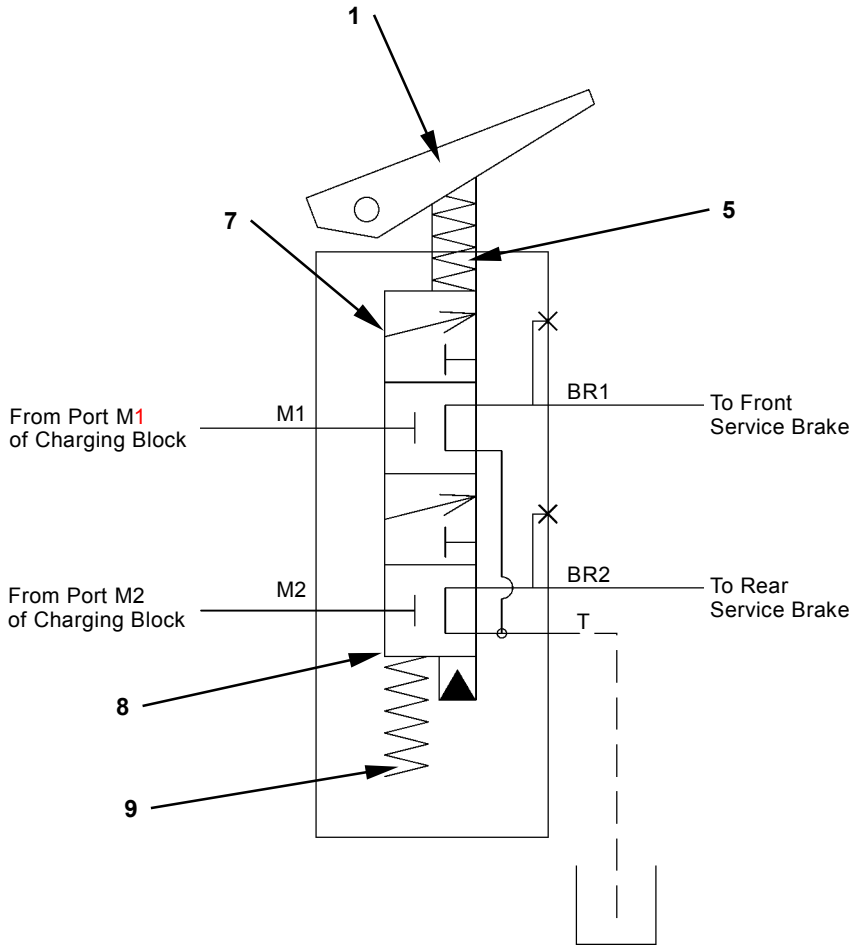

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