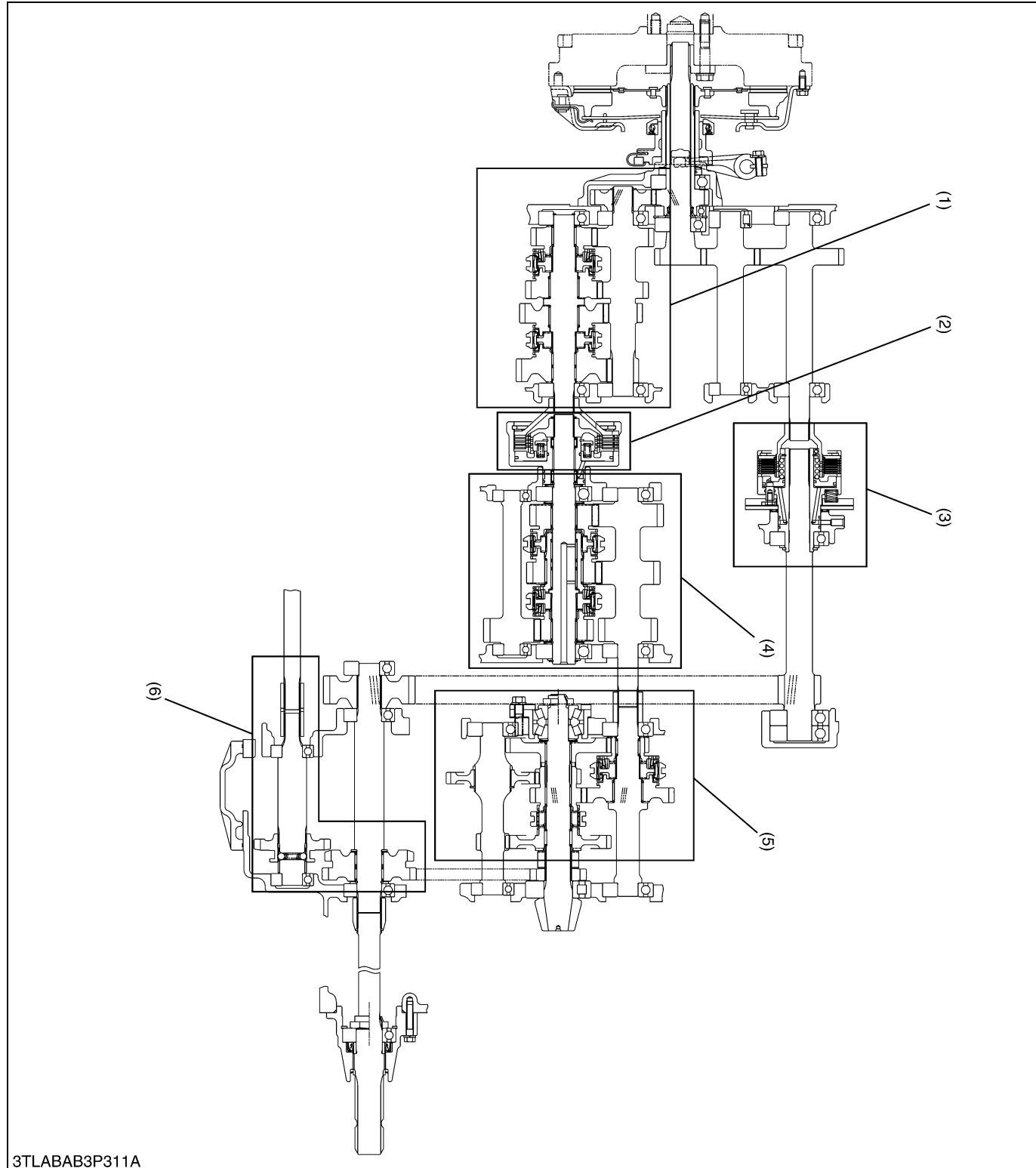


2. GLIDE SHIFT TRANSMISSION (GST) MODEL

[1] STRUCTURE



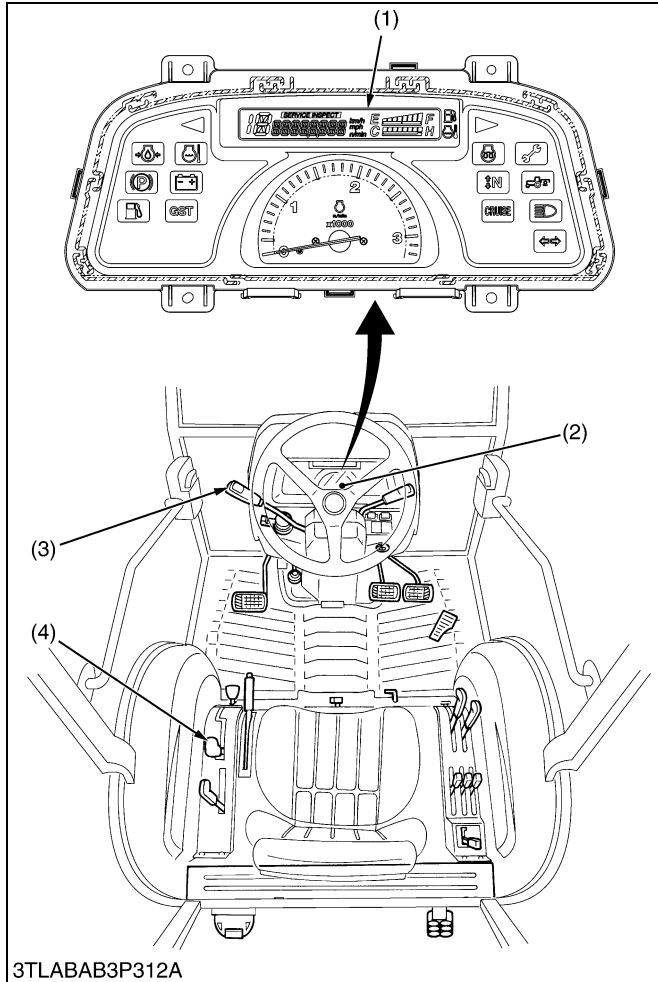
(1) Main Gear Shift Section
(2) Clutch Pack for GST

(3) PTO Clutch Section
(4) Shuttle Shift Section

(5) Range Gear Shift Section

(6) Front Wheel Drive Shift Section

[2] CHARACTERISTIC AND SYSTEM OUTLINE



The GST of a new version is adapted in the L30 series tractor. In addition to the former GST system that controls the gear shifting and clutch operation hydraulically, this new GST has the function to control these operations electrically.

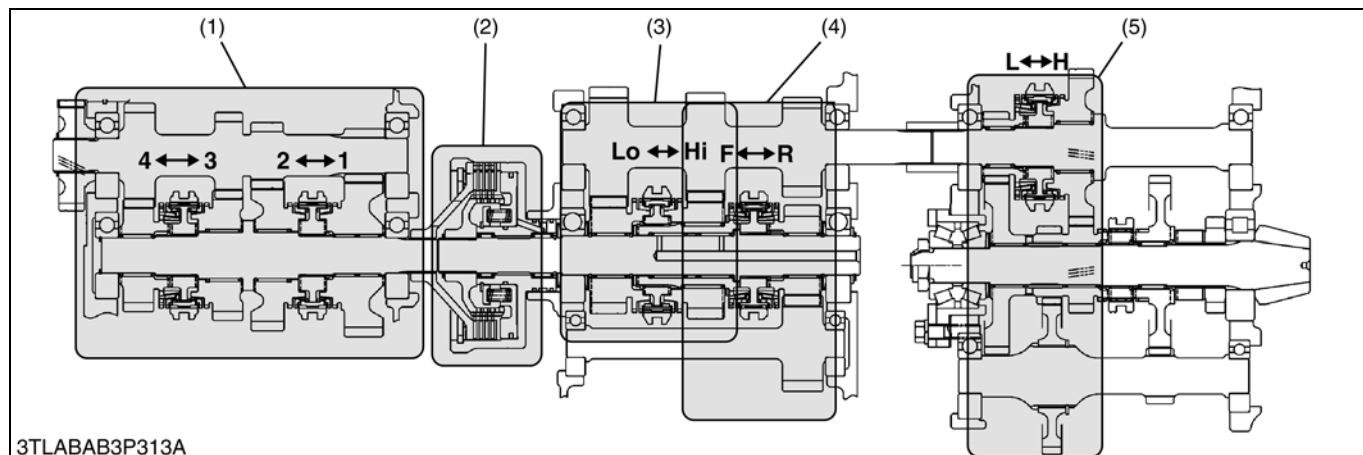
12 forward and 8 reverse speeds can shift only by operating the main shift lever (GST lever) (4) and shuttle shift lever (3) without the clutch operation as well as the former GST system. In addition, the movement and gear shifting according to the oil temperature and the traveling speed can be achieved by having electronically controlled the GST system, and a smoother operation can be done.

Moreover, because the selected speed and the traveling speed can be confirmed by the liquid crystal display (LCD) (1) of electronic instrument panel (IntelliPanel) (2), it can do a comfortable tractor operation. And it is excellent in service because it can confirm the error indication with an electronic instrument panel (2) when the electric wiring is disconnected or short-circuited.

- | | |
|--|----------------------------------|
| (1) Liquid Crystal Display (LCD) | (3) Shuttle Lever |
| (2) Electronic Instrument Panel (IntelliPanel) | (4) Main Shift Lever (GST Lever) |

W1014583

[3] POWER TRAIN



(1) Main Shift Section

(2) GST Clutch Pack

(3) Sub-range Shift Section

(4) Shuttle Shift Section

(5) Main Range Shift Section

The transmission is composed of the fully synchronized gear shifting and the hydraulic clutch as shown above figure. And the double cone type synchromesh is adapted on the 4th speed side of main shift section (1), shuttle shift section (4) and L side of main range shift section (5).

As for the speed changing, only by operating the GST lever, the shifter of the gear changing is moved by hydraulic operation which is electrically controlled. And as for each gear changing, each shift is moved according to the shift pattern input to the electric control unit (ECU). The shift pattern is shown in the table below.

Regarding a double cone type synchromesh system and front wheel drive section, these are basically similar to manual transmission model and refer to page 3-M3 and 3-M4.

(Forward shift pattern)

Lever Location at Lever Guide	1	2	3	4	5	6	7	8	9	10	11	12
Display on LCD	1	2	3	4	5	6	7	8	9	10	11	12
(1) Main Shift	1	2	3		4		1		2		3	4
(3) Sub-range Shift	Hi		Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi		
(5) Main Range Shift	L						H					

(Reverse shift pattern)

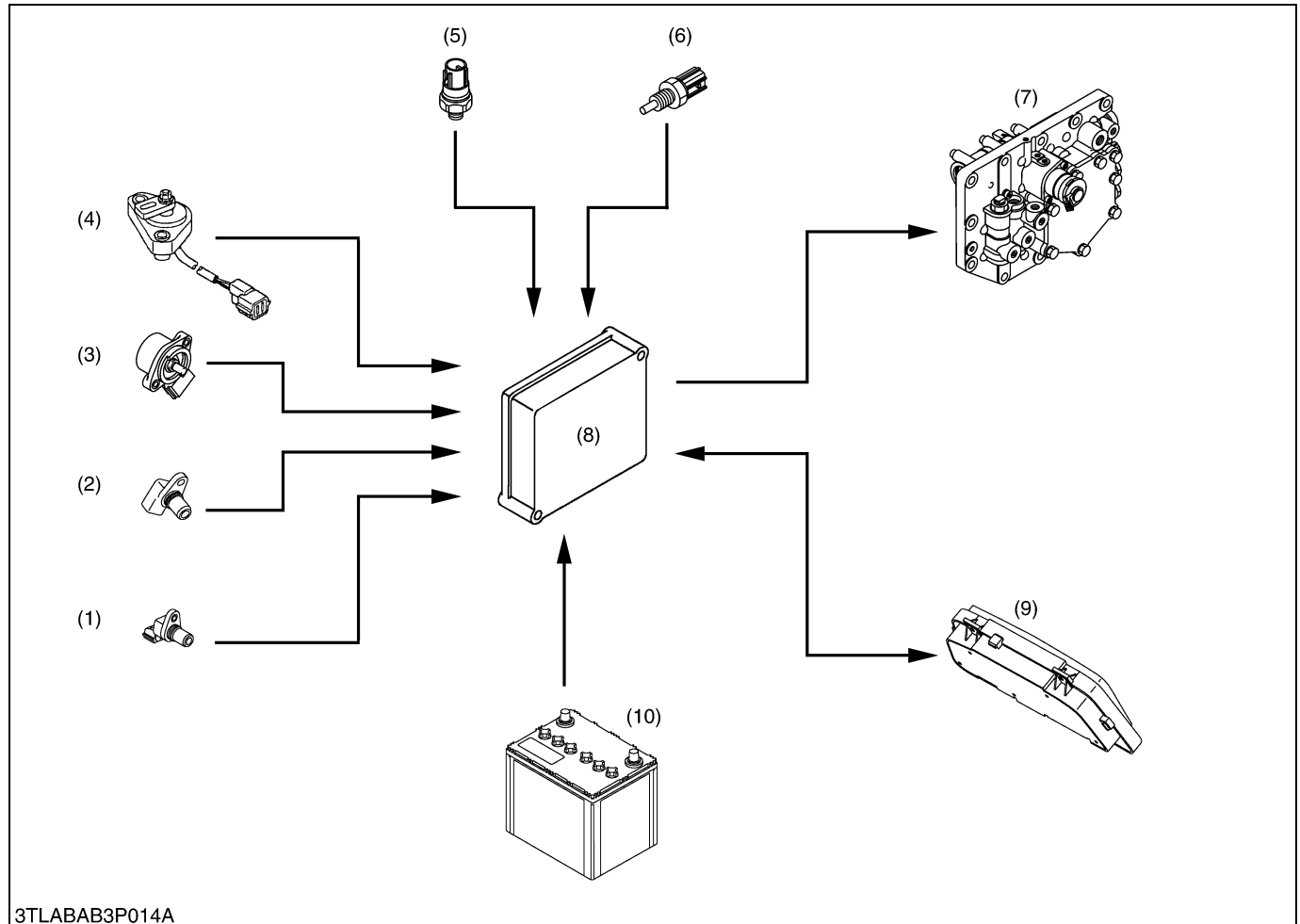
Lever Location at Lever Guide	1	2	3	4	5	6	7	8	9	10	11	12
Display on LCD	1	2	3		4		5		6		7	8
(1) Main Shift	1	2	3		4		1		2		3	4
(5) Main Range Shift	L						H					

[4] ELECTRICAL CONTROL SYSTEM

■ NOTE

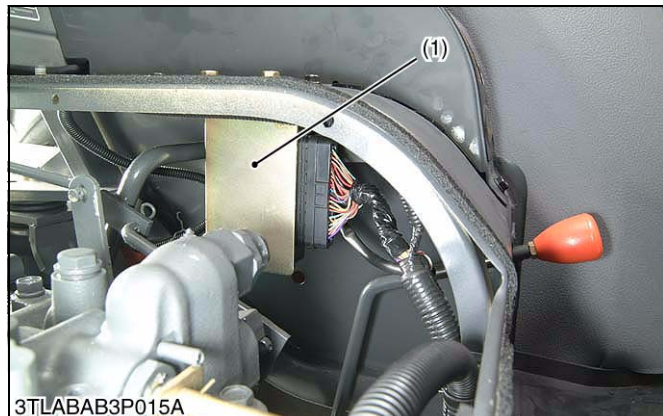
- Only the electrical control system concerning the GST operation has been described in this section. Therefore, refer to “ELECTRICAL SYSTEM” section (Section 9) for a general electrical control system.

(1) Construction and Function of Components



- | | | | |
|------------------------------|----------------------------|------------------------------|---------------------------------|
| (1) Traveling Speed Sensor | (4) Shuttle Switch | (7) GST Valve | (8) Electric Control Unit (ECU) |
| (2) Engine Tachometer Sensor | (5) Pressure Switch | (Solenoid Valve and | (9) Electronic Instrument Panel |
| (3) GST Lever Sensor | (6) Oil Temperature Sensor | Proportional Reducing Valve) | (10) Battery |

The electric control of the GST system is composed by parts shown in the above figure.



■ Electric Control Unit (ECU)

This unit incorporates an electronic circuit for various control of GST system and it is equipped on the left under of the platform.

The ECU processes and judges the input data from various switches and sensors and send the signal to various solenoid valves (solenoid valves and proportional reducing valve). At the same time, it also sends the communication data to display the selected-speed and several messages in electronic instrument panel.

- (1) Electric Control Unit

W1015703

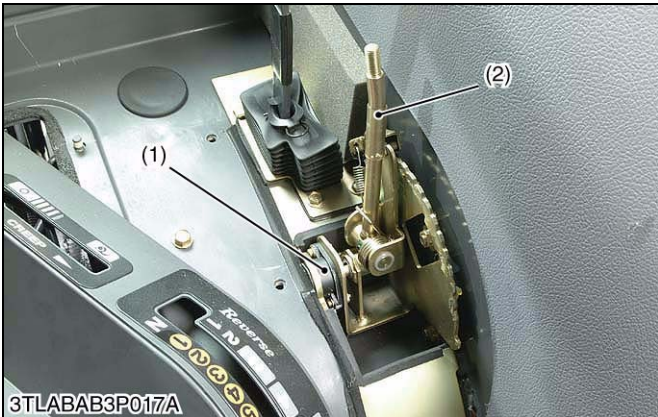


■ Electronic Instrument Panel (IntelliPanel)

The 8 bits CPU is built into this panel.

The electronic instrument panel has functions to receive several data of GST control from the ECU, and output them to the liquid crystal display and the monitor lamps. Moreover, it transmits the model data and the sensor data, etc. also to the ECU.

W1015755



■ GST Lever Sensor

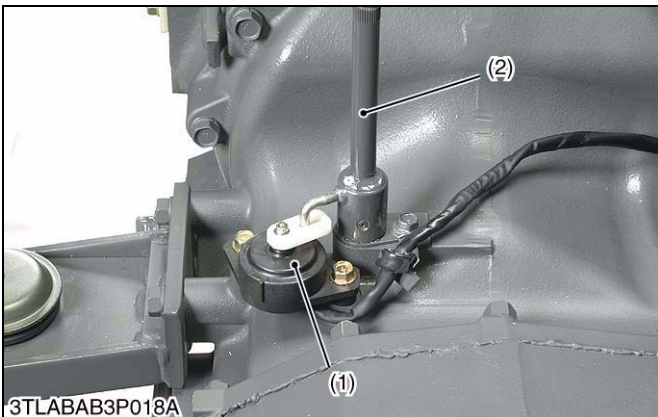
This sensor has function to detect the GST lever position, and it is equipped on the bottom of the GST lever (2).

This sensor is a variable resistor of the rotation displacement type, and all resistance is 2 kΩ, and electrically effective angle is 140 degrees. Then, the lever position from **N** to 12 speed is output within the range from about 0.7 to 4.2 voltages.

(1) GST Lever Sensor

(2) GST Lever

W1015847



■ Shuttle Switch

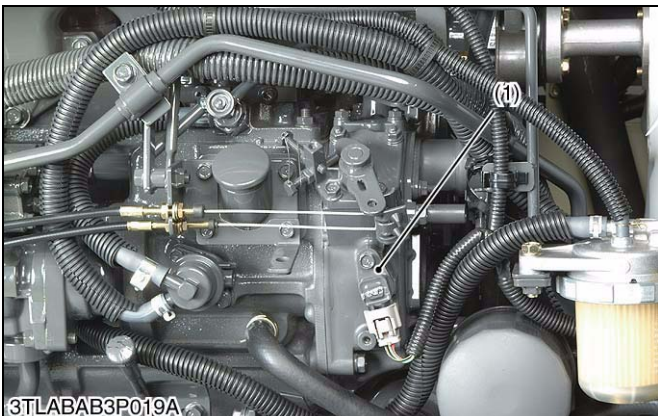
This switch has function to detect the shuttle lever position, and it is equipped on the bottom of the shuttle lever rod (2).

This switch has three contact points, which is **Forward**, **Neutral** and **Reverse**, and detects their position. As for GST control, it judges the shuttle start condition.

(1) Shuttle Switch

(2) Shuttle Lever Rod

W1015891

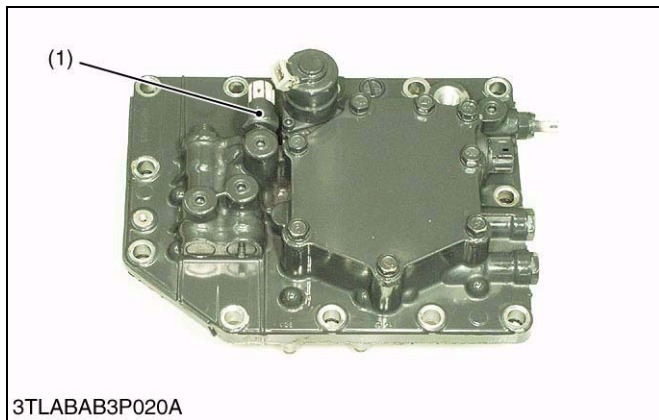


■ Engine Tachometer Sensor

This sensor is to detect the engine rotating speed, and it is equipped on the left side of the engine gear case. This sensor perceives tooth of the fuel camshaft gear and emits the pulse. This pulse is sent to the electronic instrument panel, and converted at the engine speed. The data of engine speed is always sent to the ECU.

(1) Engine Tachometer Sensor

W1015946



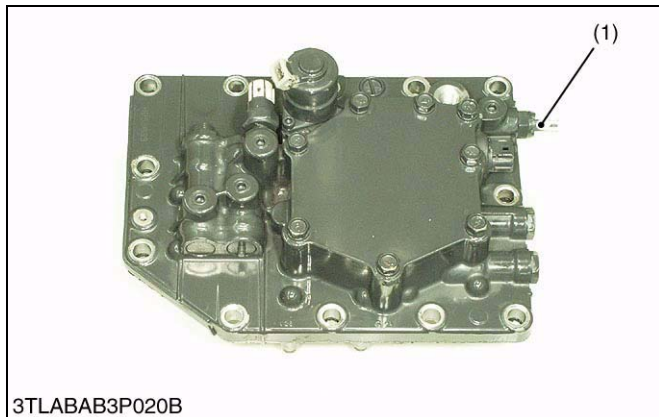
■ Pressure Switch

This switch is to detect the gear change completion and hydraulic clutch operation, and it is equipped on the GST valve.

This switch is turned **ON** when the pressure in the GST valve becomes higher than 0.49 MPa (5 kgf/cm², 71 psi) of the pilot pressure, and it is turned **OFF** at a pressure lower than 0.34 MPa (3.5 kgf/cm², 50 psi).

(1) Pressure Switch

W1015998



■ Oil Temperature Sensor

This sensor is to detect the temperature of transmission fluid, and it is equipped on the GST valve.

This is provided to make correction for driving time and current of proportional reducing valve in accordance with the oil temperature. This is used to thermistor, and it has such characteristics that its resistance decreases at high temperature and increases at low temperature.

(1) Oil Temperature Sensor

W1016064



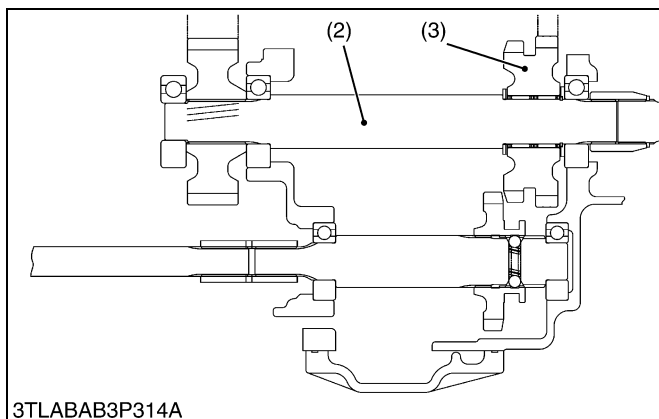
■ Traveling Speed Sensor

This sensor is to detect the traveling speed, and it is equipped on the right bottom side of the differential case. This sensor perceives tooth of the front wheel drive gear (3) on the PTO drive shaft (2) and emits pulse. This pulse is sent to the electronic instrument panel, and the traveling speed is calculated by the coefficient which is set according to the tire size. The data of traveling speed is always sent to the ECU.

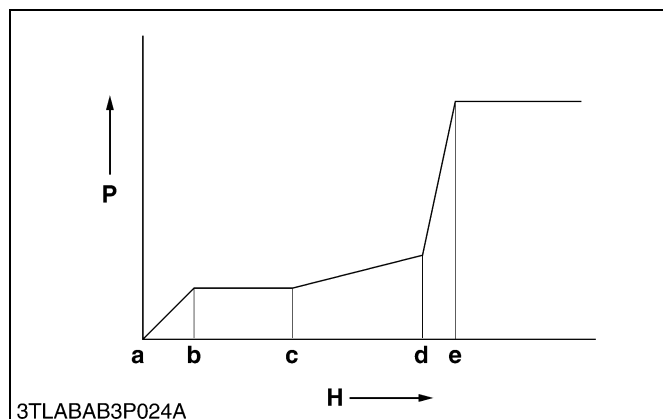
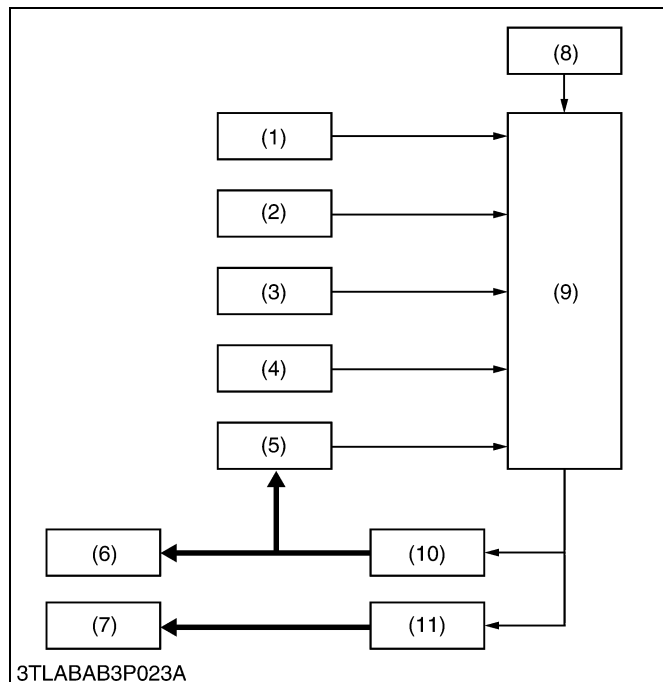
(1) Traveling Speed Sensor
(2) PTO Drive Shaft

(3) Front Wheel Drive Gear

W1015587



(2) Electrical Control



An electrical control of GST system is as follows.

1. Shift the GST lever and shuttle lever to desired position.
2. The output voltage of selected gear shift position is output to microcomputer of the ECU by lever sensor.
3. The ECU detects the gear shift position with GST lever sensor and shuttle switch, and excites various solenoid valves in accordance with selected position.
4. When the desired solenoid is excited, oil is sent to the desired shift piston.
5. A pressure in the circuit is raised because the movement of shift piston shuts the shift check pin. When the pressure in the circuit reaches 0.49 MPa (5 kgf/cm², 71 psi), the pressure switch becomes **ON**.
6. By means of the pressure switch's **ON**, the ECU detects the present condition (traveling speed, engine speed and oil temperature) from various sensors, and pressure in the hydraulic clutch is raised according to the respective condition.

■ NOTE

- By means of speed increasing, speed decreasing, traveling speed, engine speed and oil temperature, the indicated pressure period from c to d is controlled at appropriate pressure respectively.
7. A pressurizing to hydraulic clutch has been done until it reaches the system pressure, and pressure in the clutch is maintained at this state.

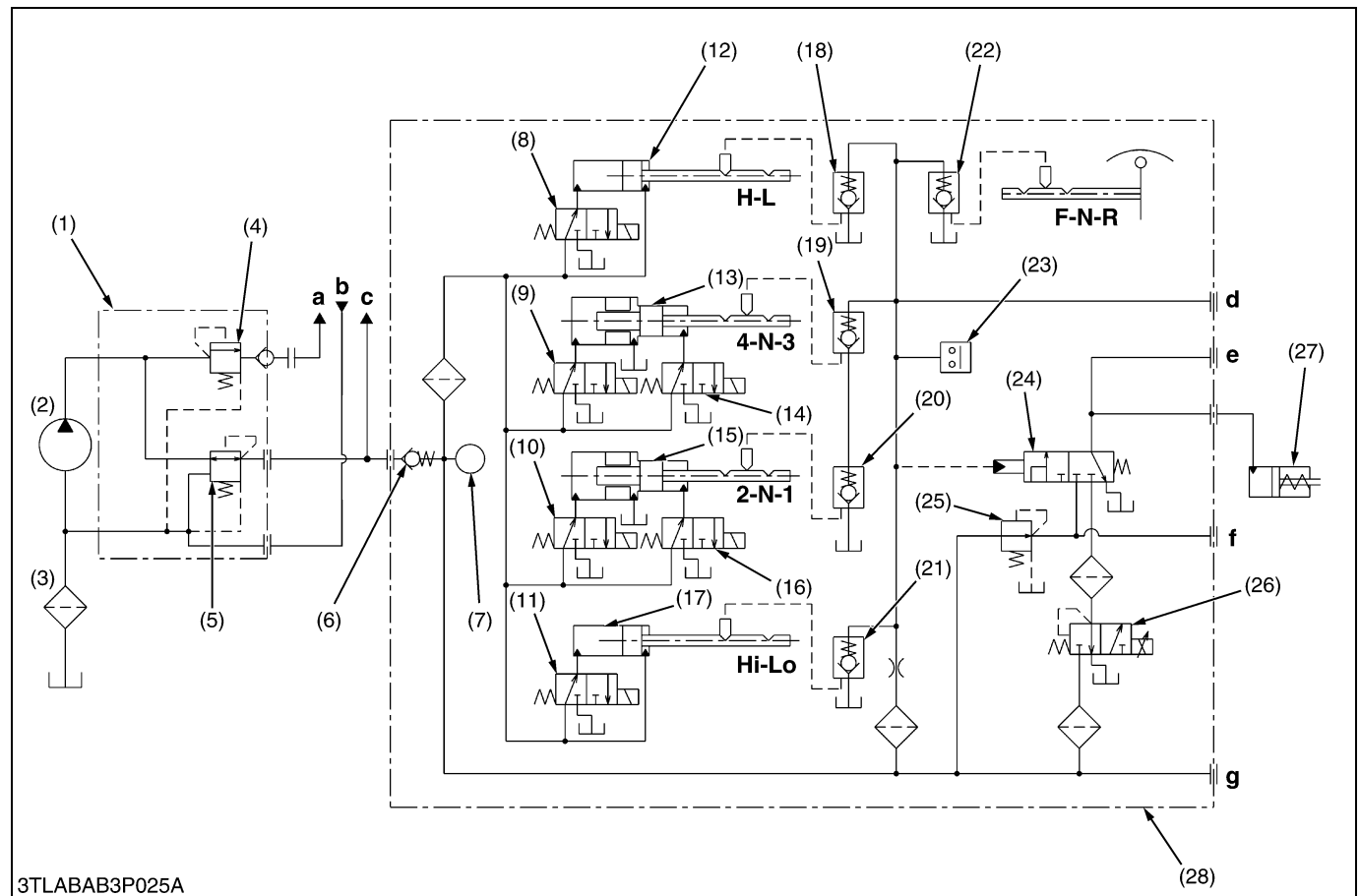
- (1) Oil Temperature Sensor
- (2) Engine Tachometer Sensor
- (3) Traveling Speed Sensor
- (4) Shuttle Switch
- (5) Pressure Switch
- (6) Shift Piston
- (7) Clutch Valve
- (8) GST Lever Sensor
- (9) ECU
- (10) Solenoid Valves
- (11) Proportional Reducing Valve

- P : Pressure**
H : Time
a : Starting of clutch engaging
b : Low-pas pressure
c : Starting of pressurized
c to d :Specified pressure from ECU
e : Gear shifting completion

W1016324

[5] HYDRAULIC CONTROL SYSTEM

(1) Hydraulic Circuit and System Outline



- | | | |
|--|--|---|
| (1) Regulating Valve Assembly | (11) Solenoid Valve 5
(Sub-range Shift) | (19) 3-4 Shift Check Valve |
| (2) Hydraulic Pump | (12) Shift Piston
(Main Range Shift) | (20) 1-2 Shift Check Valve |
| (3) Hydraulic Oil Filter | (13) 3-4 Shift Piston | (21) Shift Check Valve
(Sub-range Shift) |
| (4) Regulating Valve | (14) Solenoid Valve 4 | (22) Shift Check Valve, Shuttle |
| (5) Pressure Reducing Valve | (15) 1-2 Shift Piston | (23) Pressure Switch |
| (6) Check Valve | (16) Solenoid Valve 2 | (24) Clutch Valve |
| (7) Oil Temperature Sensor | (17) Shift Piston (Sub-range Shift) | (25) Low-pass Valve |
| (8) Solenoid Valve 6
(Main Range Shift) | (18) Shift Check Valve
(Main Range Shift) | (26) Proportional Reducing Valve |
| (9) Solenoid Valve 3 | | (27) GST Clutch |
| (10) Solenoid Valve 1 | | (28) GST Valve Assembly |

- a : To Steering Controller**
b : From Steering Controller
c : To PTO Clutch Valve
d : Check port for pilot pressure
e : Check port for clutch pressure
f : Check port for Low-pass pressure
g : Check port for system pressure

- Oil is supplied from the power steering hydraulic pump (2) while running the engine.
- The oil entering the regulating valve assembly (1) flows through the pressure reducing valve (5) to the GST circuit. This oil pressure is maintained at a fixed level by the pressure reducing valve (5).
- When the GST lever is operated, the desired shift solenoids (8), (9), (10), (11), (14) or (16) are excited according to the output voltage from the GST lever sensor.
- When the solenoid valve is operated, oil is supplied to corresponded shift pistons (12), (13), (15) or (17), and the shift piston is moved. The shift arm that is moved by the shift piston moves shifter of synchromesh to shift the gear. At this time, GST clutch (27) has been disengaging until gear shifting is completed.
The GST clutch (27) is engaging except where the condition is neutral, is gear shifting and is engine stopping.
- Pressure in the pilot circuit rises because the shift check valves (18), (21) and (19) or (20) are shut by the movements of shift pistons at the same time as completing gear shifting.
- By means of pressure rising of the circuit, the clutch valve (24) is actuated. And, oil flows through the low-pass valve (25) and the proportional reducing valve (26) to the GST clutch (27). This oil flows until becoming the compound pressure which is both of setting pressure for closing of low-pass valve, and controlled indication pressure of the proportional reducing valve.

(Reference)

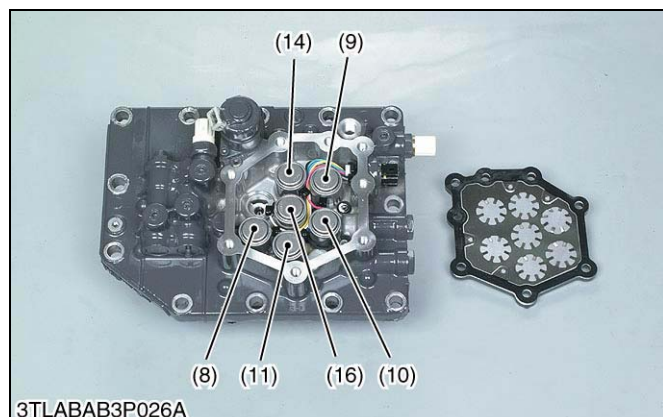
- Setting pressure for closing of low-pass valve : 0.24 MPa (2.5 kgf/cm², 34.1 psi)
- Because pressure in the GST clutch (27) is gradually pressurized by function of proportional reducing valve (26), clutch is able to engage without shock and smoothly.
 - When the pressure in the circuit rises to the system pressure, pressure is maintained. And the GST clutch is maintained at engaging condition until the next gear shifting.

State of energizing of solenoid**(Forward)**

	N	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Solenoid 1(10)		ON						ON	ON				
Solenoid 2 (16)			ON							ON	ON		
Solenoid 3 (9)				ON	ON							ON	
Solenoid 4 (14)						ON	ON						ON
Solenoid 5 (11)				ON		ON		ON		ON			
Solenoid 6 (8)	(ON)	ON	ON	ON	ON	ON	ON						

(Reverse)

	N	1st	2nd	3rd	4th	5th	6th	7th	8th
Solenoid 1 (10)		ON				ON			
Solenoid 2 (16)			ON				ON		
Solenoid 3 (9)				ON				ON	
Solenoid 4 (14)					ON				ON
Solenoid 6 (8)	(ON)	ON	ON	ON	ON				

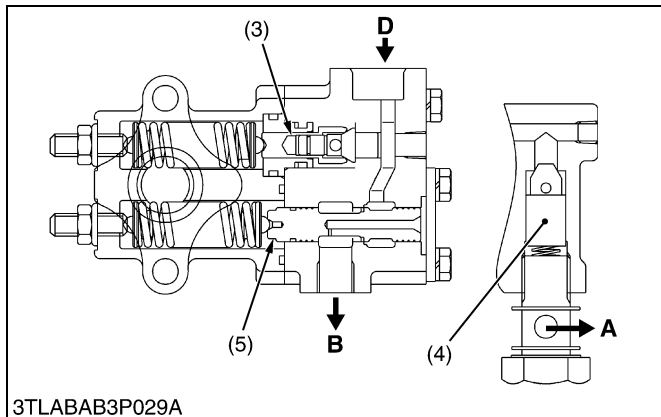
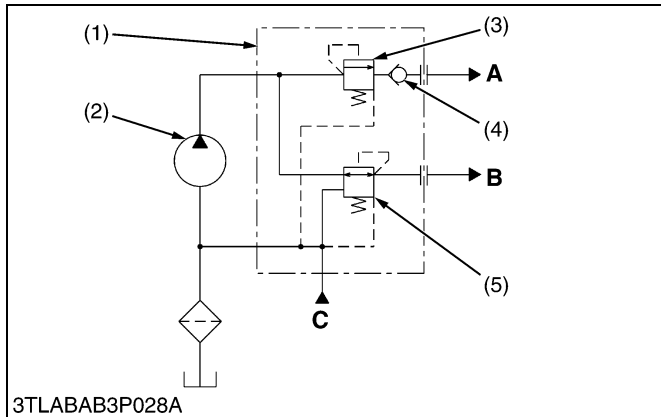
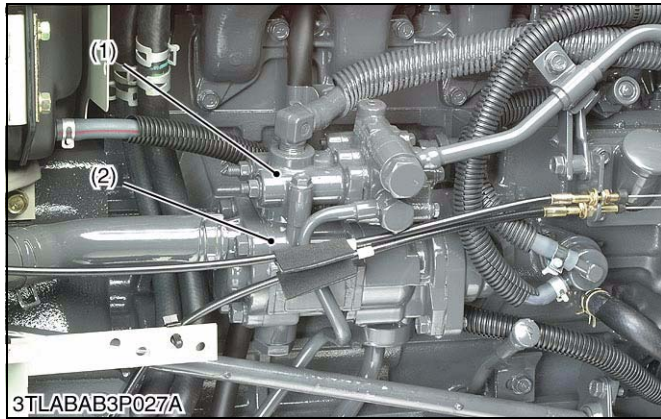


No.	Solenoid	Color of wiring
(10)	Solenoid 1	Black
(16)	Solenoid 2	White
(9)	Solenoid 3	Red
(14)	Solenoid 4	Green
(11)	Solenoid 5, Sub-range Lo-Hi	Blue
(8)	Solenoid 6, Main range L-H	Yellow

W1019092

(2) Construction and Function of Components

(A) Regulating Valve



The oil from the hydraulic pump for the power steering system flows to the GST circuit to set the pressure of the circuit. Other oil flows to the power steering circuit.

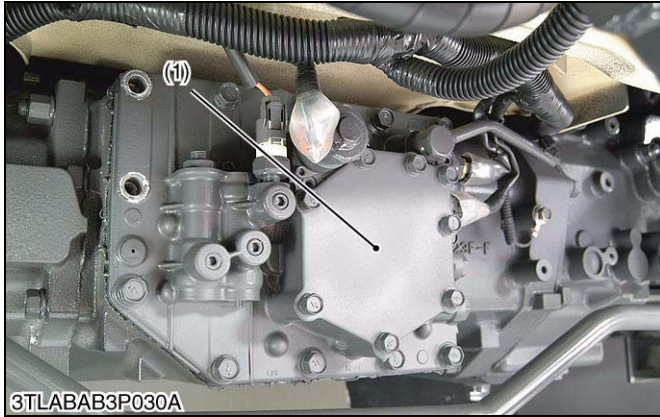
The oil from the power steering hydraulic pump (2) flows through the pressure reducing valve (5) to the GST circuit. When the oil is filled into the circuit, the pressure reducing valve (5) is closed to maintain the pressure in the GST system circuit to 2.45 MPa (25.0 kgf/cm², 356 psi).

The oil from the power steering pump passes through the regulating valve (3) and check valve (4), and then it flows to power steering circuit. The regulating valve (3) is provided to maintain 2.94 MPa (30.0 kgf/cm², 427 psi) at inlet pressure of the pressure reducing valve (5) except when the power steering is operated. Thereby getting 2.45 MPa (25.0 kgf/cm², 356 psi) of the GST circuit pressure.

- (1) Regulating Valve Assembly
- (2) Hydraulic Pump
- (3) Regulating Valve
- (4) Check Valve
- (5) Pressure Reducing Valve

- A : To Power Steering Circuit**
- B : To GST Circuit and PTO Clutch Valve**
- C : From Power Steering Circuit**
- D : From Hydraulic Pump**

W1019304

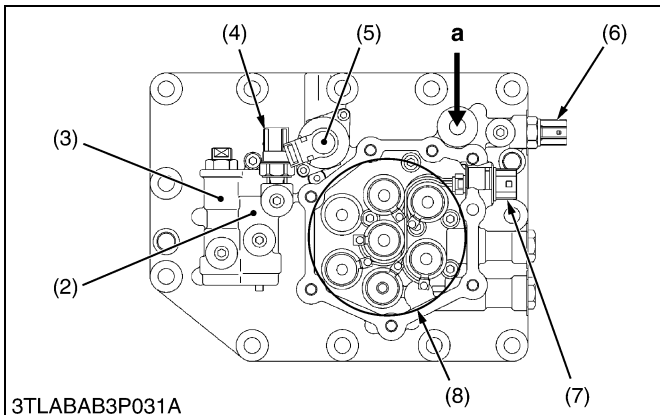
(B) GST Valve**■ GST Valve Assembly**

The GST valve assembly is installed at the left side of the transmission mid case. In the GST valve assembly, many parts comprising the system are installed, including the solenoid valves, shift pistons, shift check valves, low-pass valve, proportional reducing valve, clutch valve, check valves, sensor and switches. The GST valve assembly functions as the central unit of the GST system.

- | | |
|-----------------------------------|--|
| (1) GST Valve Assembly | (6) Connector for Oil Temperature Sensor |
| (2) Clutch Valve | (7) Connector for Solenoid Valve |
| (3) Low-pass Valve | (8) Solenoid Valves |
| (4) Connector for Pressure Switch | |
| (5) Proportional Reducing Valve | |

a : Oil From Regulating Valve

W1019626

**■ Solenoid Valve**

When the GST lever is operated, the solenoid valve controls the flow of oil according to the gear shifting operation.

When the solenoid is not excited, oil from regulating valve flows to the shift piston through the surrounding of the ball (10) in the valve. When the solenoid is excited, plunger (9) presses the ball against the valve seat (11) to open the unload passage (12), and drain the oil.

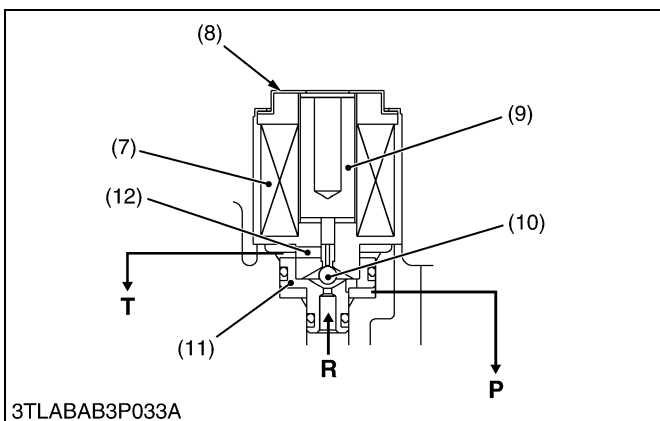
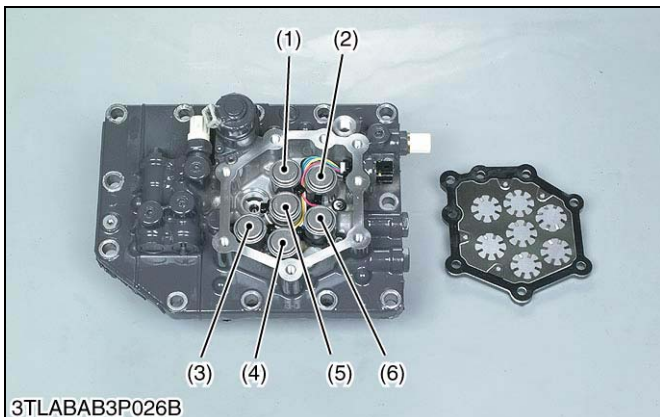
- | | |
|---|---------------------|
| (1) Solenoid Valve 4 | (9) Plunger |
| (2) Solenoid Valve 3 | (10) Ball |
| (3) Solenoid Valve 6 (Main Range Shift) | (11) Valve Seat |
| (4) Solenoid Valve 5 (Sub-range Shift) | (12) Unload Passage |
| (5) Solenoid Valve 2 | |
| (6) Solenoid Valve 1 | |
| (7) Coil | |
| (8) Solenoid Valve | |

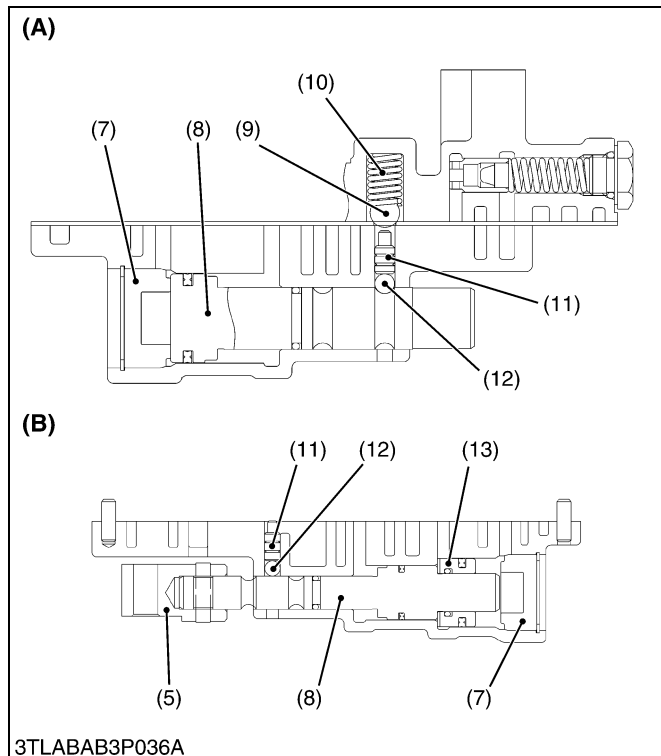
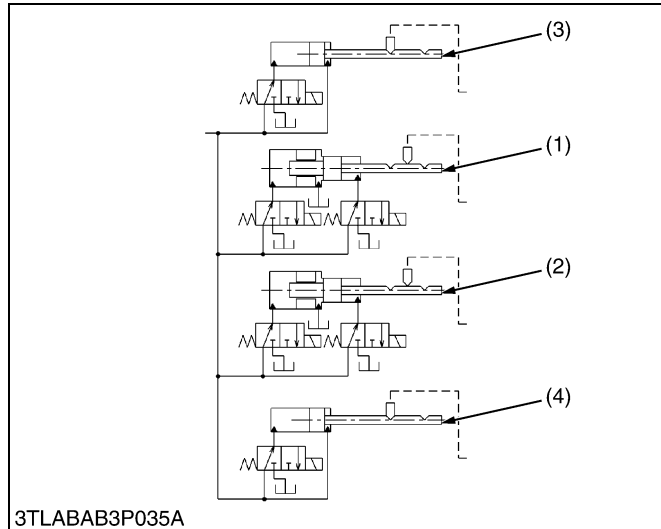
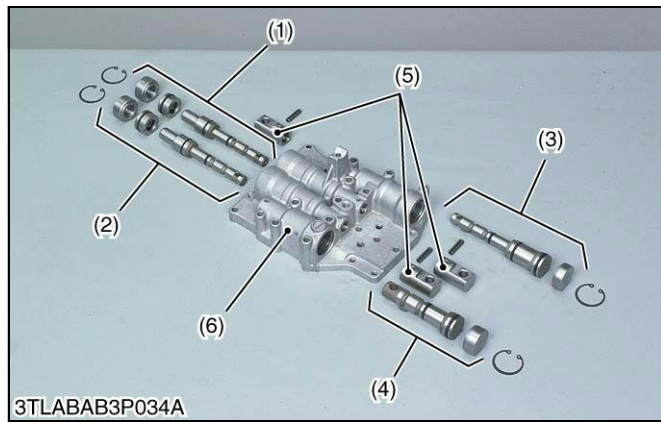
T : Drain Port

R : IN Port

P : To Shift Piston

W1019949





■ Shift Piston

The shift pistons (1), (2), (3), (4) are actuated by the oil distributed by the each solenoid valve. At the tip of these shift pistons (1), (2), (3) are installed the shifters (5), which are connected to each shift rod and shift the gear.

There are neutral positions in 1-2 shift piston (2) and 3-4 shift piston (1).

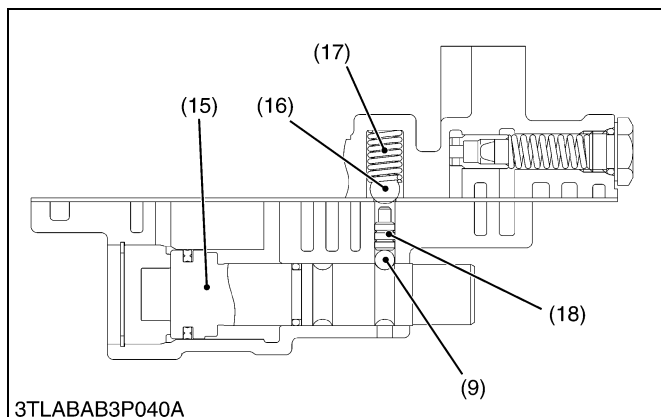
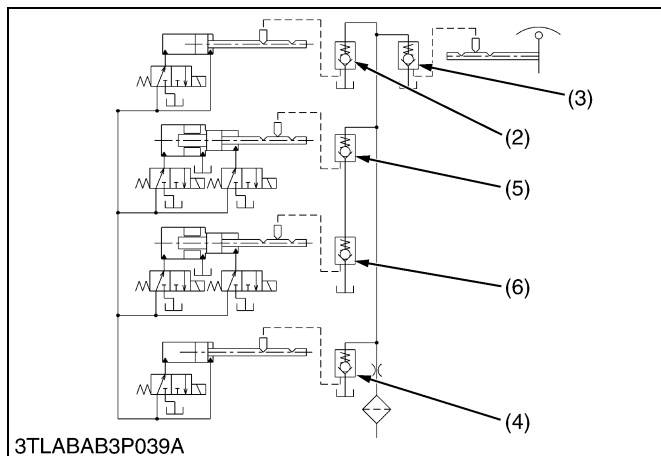
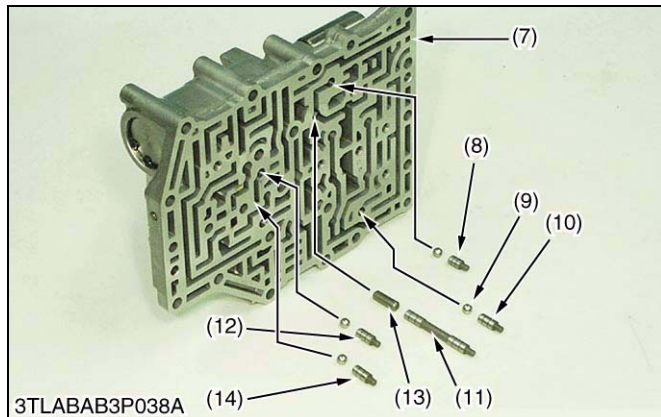
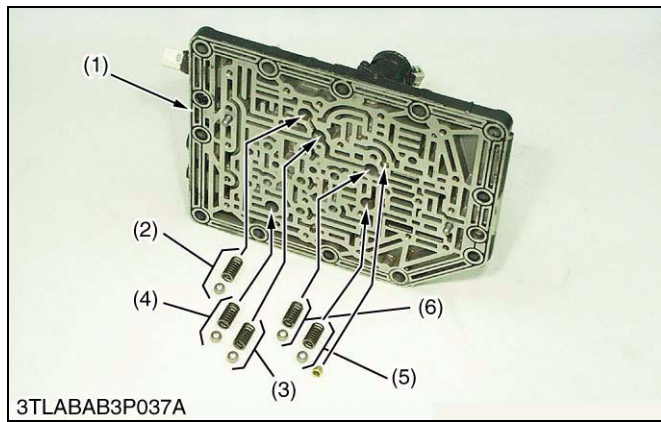
- (1) 3-4 Shift Piston
- (2) 1-2 Shift Piston
- (3) Main Range Shift Piston
- (4) Sub-range Shift Piston
- (5) Shifter
- (6) Valve Body
- (7) Cover
- (8) Piston
- (9) Ball for Check Valve

- (10) Spring
- (11) Check Pin
- (12) Ball for Detent
- (13) Neutral Piston

A : Shift Piston for Main Range Shift

B : 1-2 and 3-4 Shift Piston

W1020109



Shift Check Valve

The shift check valves (2), (3), (4), (5), (6) are provided on each shift piston and the shuttle shift rod.

From the start to the end of gear shifting, the shift check valves (2), (4), (5), (6) of the shift pistons are opened because the ball (9) of the check pin (18) is on the straight portion, the oil in the pilot circuit of the clutch valve passes through the shift check valves (2), (3), (4), (5), (6) to be drained into the tank, causing the GST clutch to be disengaged.

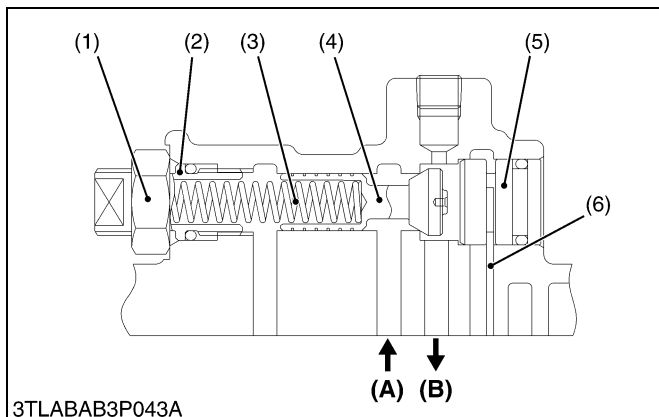
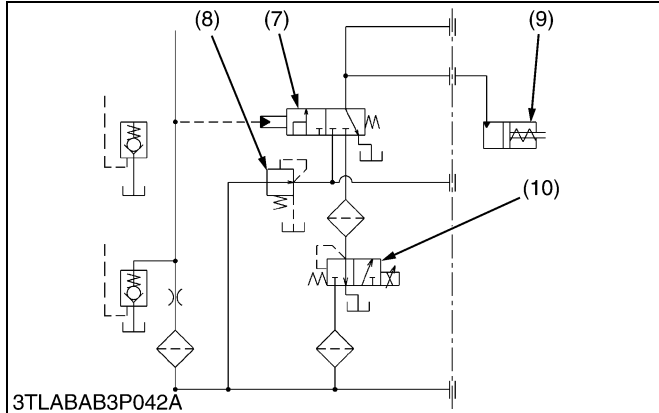
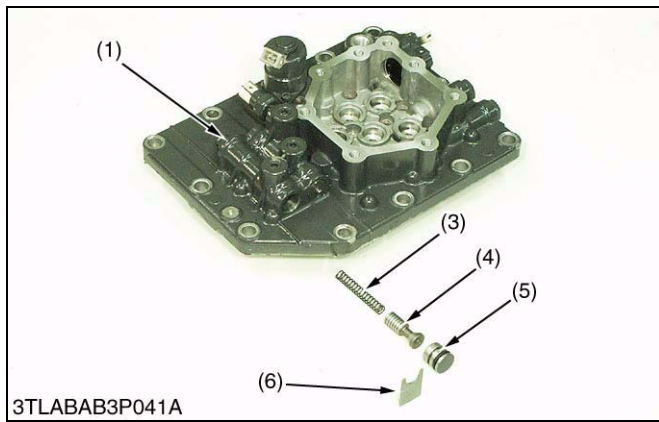
When the gear shifting is completed, the ball (9) of the check pin (18) enters the groove of the shift piston; the check valve is closed, causing the pilot circuit pressure to rise and the clutch valve to open. Thus, the oil flows into the GST clutch to engage it. The 1-2 shift check valve (6) and 3-4 shift check valve (5) compose a serial circuit. When either valve is closed, the oil in the pilot circuit will not be drained into the tank.

In case of the shuttle shifting, the shift check valve (3) is opened and closed by the groove of the shuttle shift rod.

Note that the shuttle shift fork rod has a slot into which the shift fork mounting bolt is inserted. Therefore, when the shuttle shift lever is moved, the shuttle shift fork rod is moved before the shuttle shift fork is moved, disengaging the clutch pack and thus moving the shuttle shift fork.

- | | |
|----------------------------------|-------------------------------------|
| (1) GST Valve Cover | (10) Main Range Check Pin |
| (2) Main Range Shift Check Valve | (11) Shuttle Check Pin |
| (3) Shuttle Shift Check Valve | (12) 3-4 Check Pin |
| (4) Sub-range Shift Check Valve | (13) Pin |
| (5) 3-4 Shift Check Valve | (14) 1-2 Check Pin |
| (6) 1-2 Shift Check Valve | (15) Shift Piston (Sub-range Shift) |
| (7) GST Valve Body | (16) Ball |
| (8) Sub-range Check Pin | (17) Spring |
| (9) Ball for Detent | (18) Check Pin |

W1020427



■ Low-pass Valve

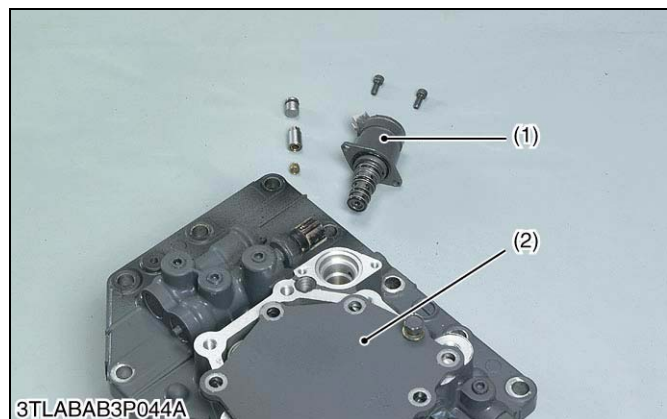
After completion of the gear shifting, the low-pass valve (8) opens immediately to flow oil into the GST clutch (9), to promote the engagement of the clutch.

When the gear shifting starts, the oil in the GST clutch (9) passes the clutch valve (7) to be drained into the tank. So prior to beginning of the GST clutch connection and after completion of gear shifting, it is necessary to flow oil to the GST clutch quickly. It is the low-pass valve that does this operation with the proportional reducing valve (10) simultaneously.

The oil from the regulating valve flows in from the **IN-port (A)**, passes through the low-pass valve poppet (4), flows out from **OUT-port (B)**, and flows to the clutch valve (7) and clutch (9). When the pressure on the side of the **OUT-port (B)** reaches setting pressure, the poppet (4) pushes the spring (3) to close the circuit.

- | | |
|-------------------|----------------------------------|
| (1) Nut | (8) Low-pass Valve |
| (2) Adjuster | (9) GST Clutch |
| (3) Spring | (10) Proportional Reducing Valve |
| (4) Poppet | |
| (5) Plug | |
| (6) Stopper Plate | |
| (7) Clutch Valve | |
| | (A) IN-Port |
| | (B) OUT-Port |

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■ Proportional Reducing Valve

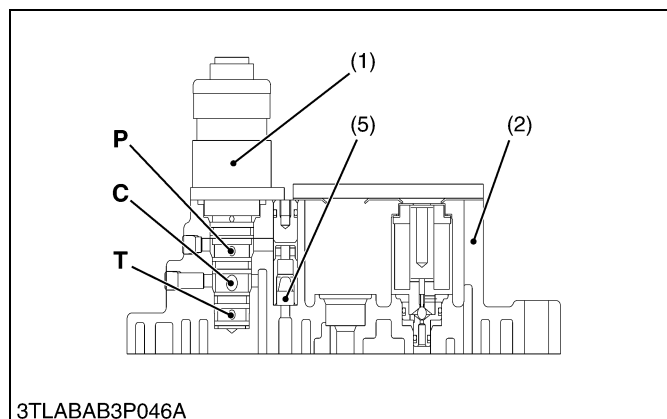
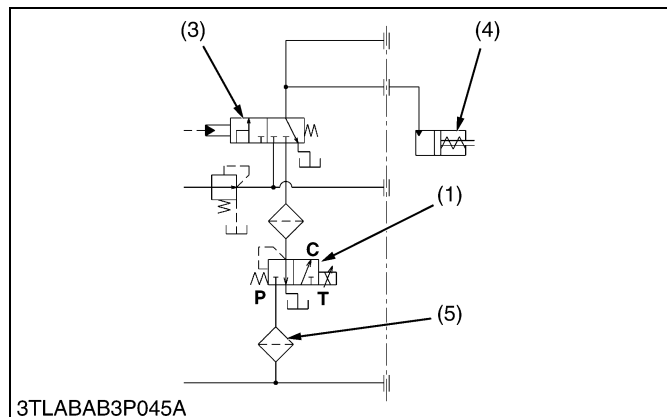
After the gear shifting is completed, this valve has function which gradually rises the pressure in the clutch (4) in order to make a clutch engaging for without shock and smoothly.

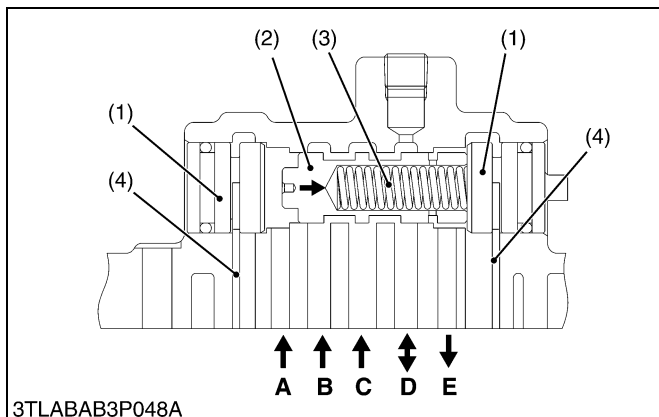
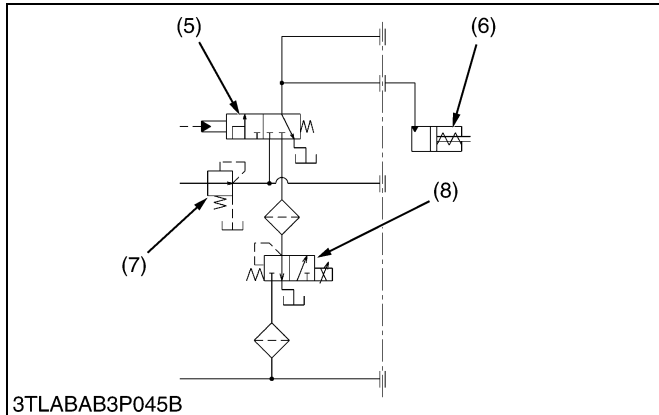
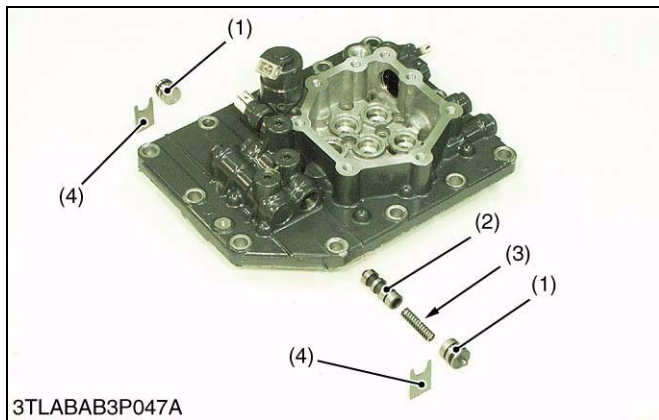
When the gear shifting is completed, the pressure switch is turned **ON**. By means of turning on the pressure switch, the microcomputer of ECU calculates and judges the charging of pressure and its time according to the oil temperature sensor and gear shifting period, and the traveling speed and speed acceleration according to the traveling speed sensor. By these instructions from microcomputer of ECU, the proportional reducing valve adjusts pressure in the clutch to become a appropriate acceleration.

- (1) Proportional Reducing Valve
- (2) GST Valve Assembly
- (3) Clutch Valve
- (4) GST Clutch
- (5) Filter

P : IN Port (From Regulating Valve)
C : OUT Port (To Clutch Valve)
T : DRAIN Port (To Tank)

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■ Clutch Valve

The clutch valve (5) changes the flow of the oil flowing to the GST clutch to carry out **“ENGAGE”** / **“DISENGAGED”** of the clutch.

Except for during gear shifting, the oil of the pilot circuit flows in from the **A**-port to push the spool to the right when the pilot circuit is pressurized. Therefore, the oil from the low-pass valve (7) and proportional reducing valve (8) flows in from **B** and **C**-port, flows out from the **D**-port, and flows to the GST clutch (6).

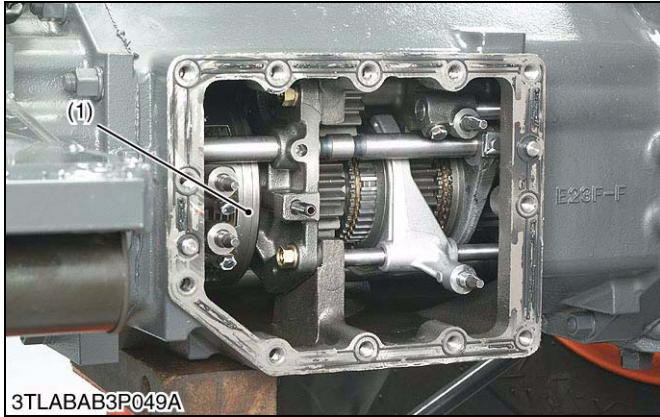
When the pilot circuit pressure is zero, that is, from the start to the left with the spring (3) to cut the oil flow of **B** and **C**-port, and stopping the oil flow to the GST clutch (6). Furthermore, the oil of the GST clutch flows in from **D**-port, and is drained from **E**-port, and then the GST clutch is disengaged.

- (1) Plug
- (2) Spool
- (3) Spring
- (4) Stopper Plate
- (5) Clutch Valve
- (6) GST Clutch
- (7) Low-pass Valve
- (8) Proportional Reducing Valve

- A** : A-Port (From Pilot Circuit)
- B** : B-Port (From Low-pass Valve)
- C** : C-Port (From Proportional Reducing Valve)
- D** : D-Port (To GST Clutch)
- E** : E-Port (To Tank)

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(C) GST Clutch



The GST clutch is hydraulic multiple plate type and is provided between the counter shaft (3) and the shuttle shaft (8), and it “engages” and “disengages” the power from the engine. This is controlled by the operation of clutch valve (2).

■ Engaging (When the shift gear is at desired position while engine is running)

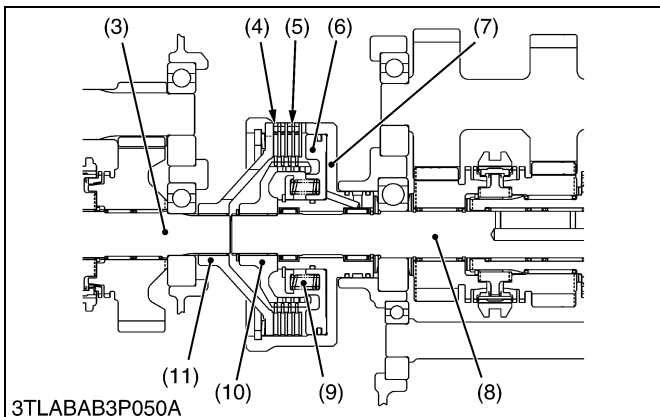
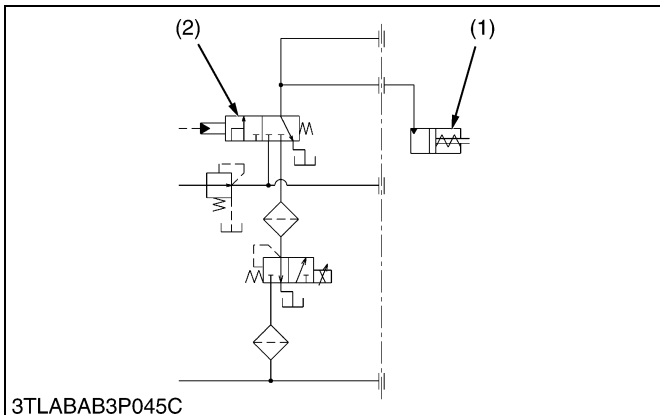
The oil from clutch valve (2) flows in to push the return spring (9) and the piston (6). The piston is pushed to the left by the oil, thereby pushing the clutch discs (4) and the plates (5) to transmit the power.

■ Disengaging (When the engine stop, the shift levers are neutral position, between from start to end of the gear shifting)

The oil of the GST clutch (1) is pushed out with return spring (9) and piston (6), and flowed to the tank.

- | | |
|-------------------|------------------------|
| (1) GST Clutch | (7) Clutch Case |
| (2) Clutch Valve | (8) Shuttle Shaft |
| (3) Counter Shaft | (9) Return Spring |
| (4) Clutch Disc | (10) Clutch Output Hub |
| (5) Plate | (11) Clutch Input Hub |
| (6) Piston | |

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[6] SHIFT LINKAGE MECHANISM

For shift linkage mechanism of “Shuttle Lever” and “Front Wheel Drive Lever”, refer to page 3-M6.