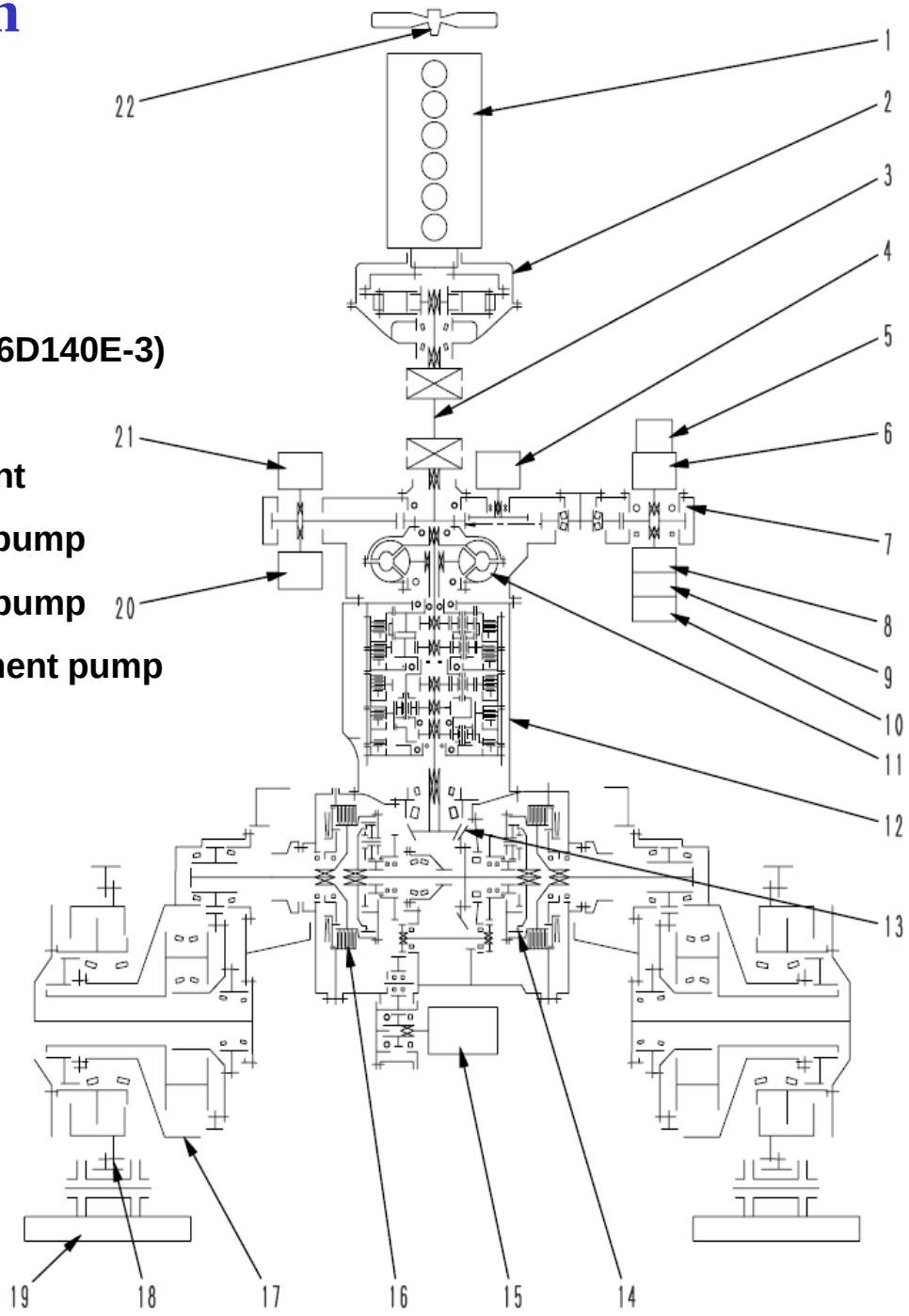
# D155AX-5 Bulldozers

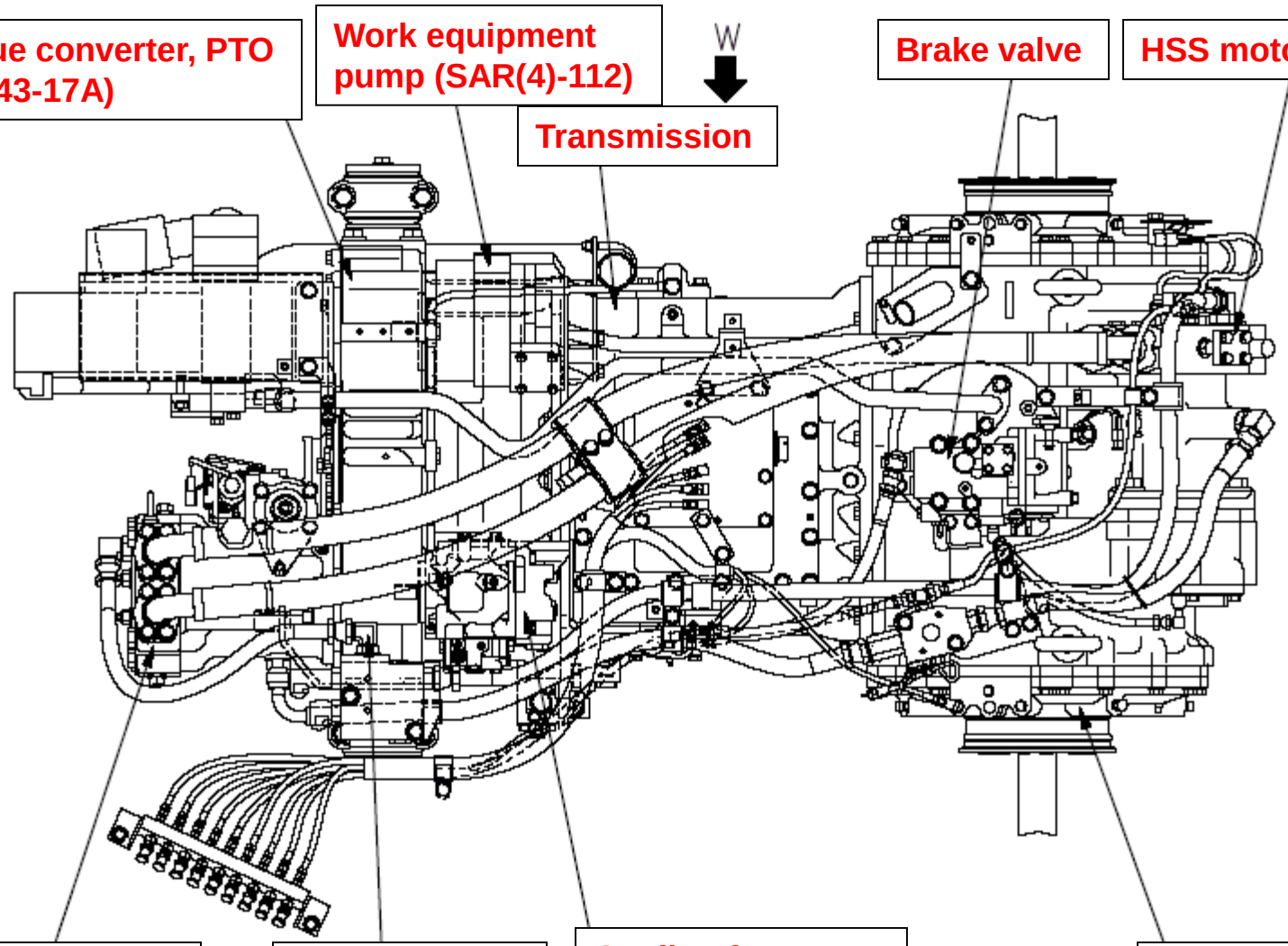

# Chapter 5 : Power train

# Power train

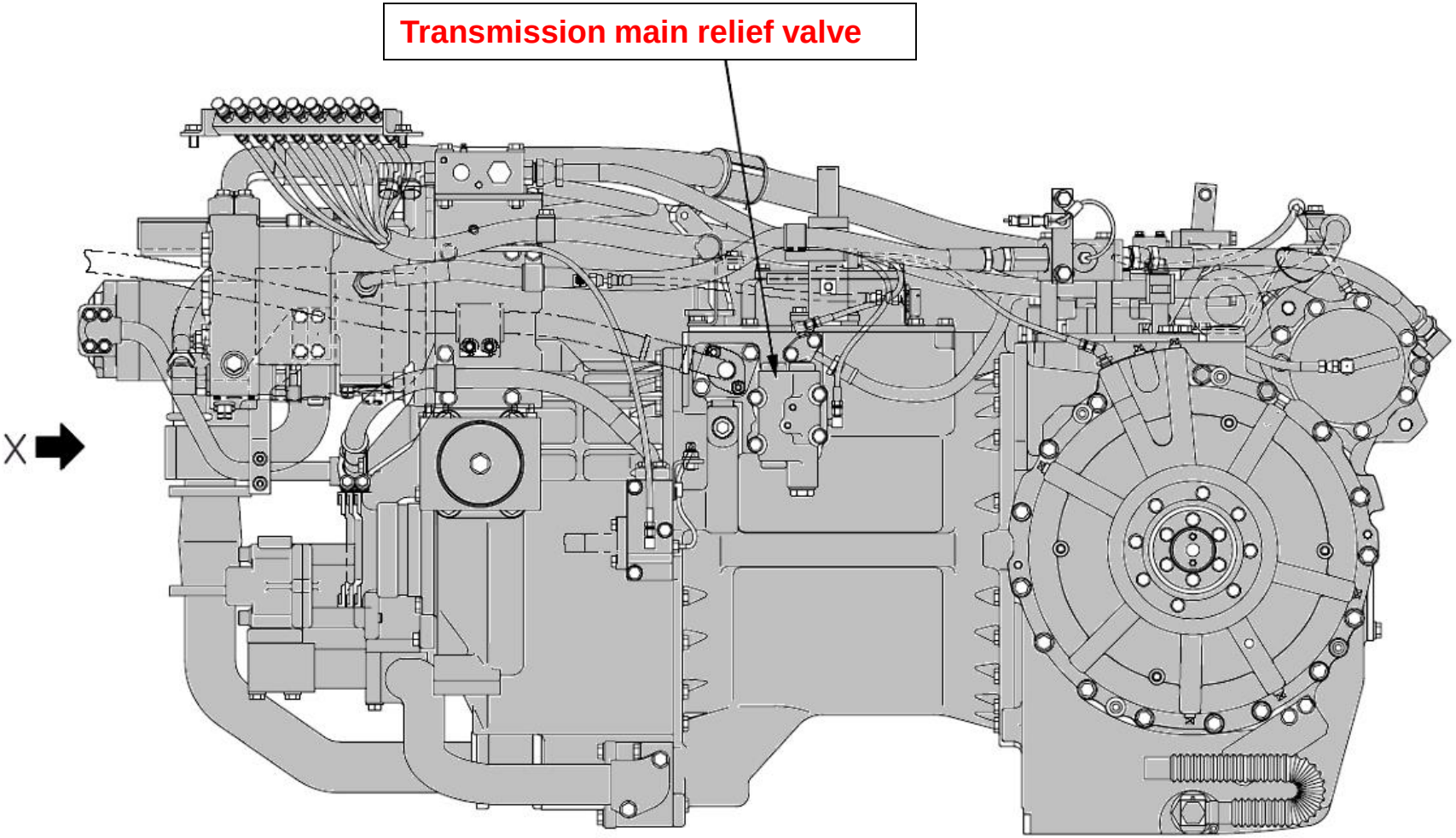



1. Engine (SDA6D140E-3)
2. Damper
3. Universal joint
4. Scavenging pump
5. HSS charge pump
6. Work equipment pump (SAR(4)-112)
7. PTO
8. Steering lubricating oil pump (SAR(3)-100)
9. Power train pump (SAL(2)-56)
10. Torque converter charge pump (SAL(2)-25)
11. Torque converter
12. Transmission
13. Bevel gear
14. HSS unit
15. HSS motor (HMF140)
16. Brake
17. Final drive
18. Sprocket
19. Track shoe
20. Fan pump (LPV45)
21. HSS pump (HPV160)
22. Fan motor (LMF55)

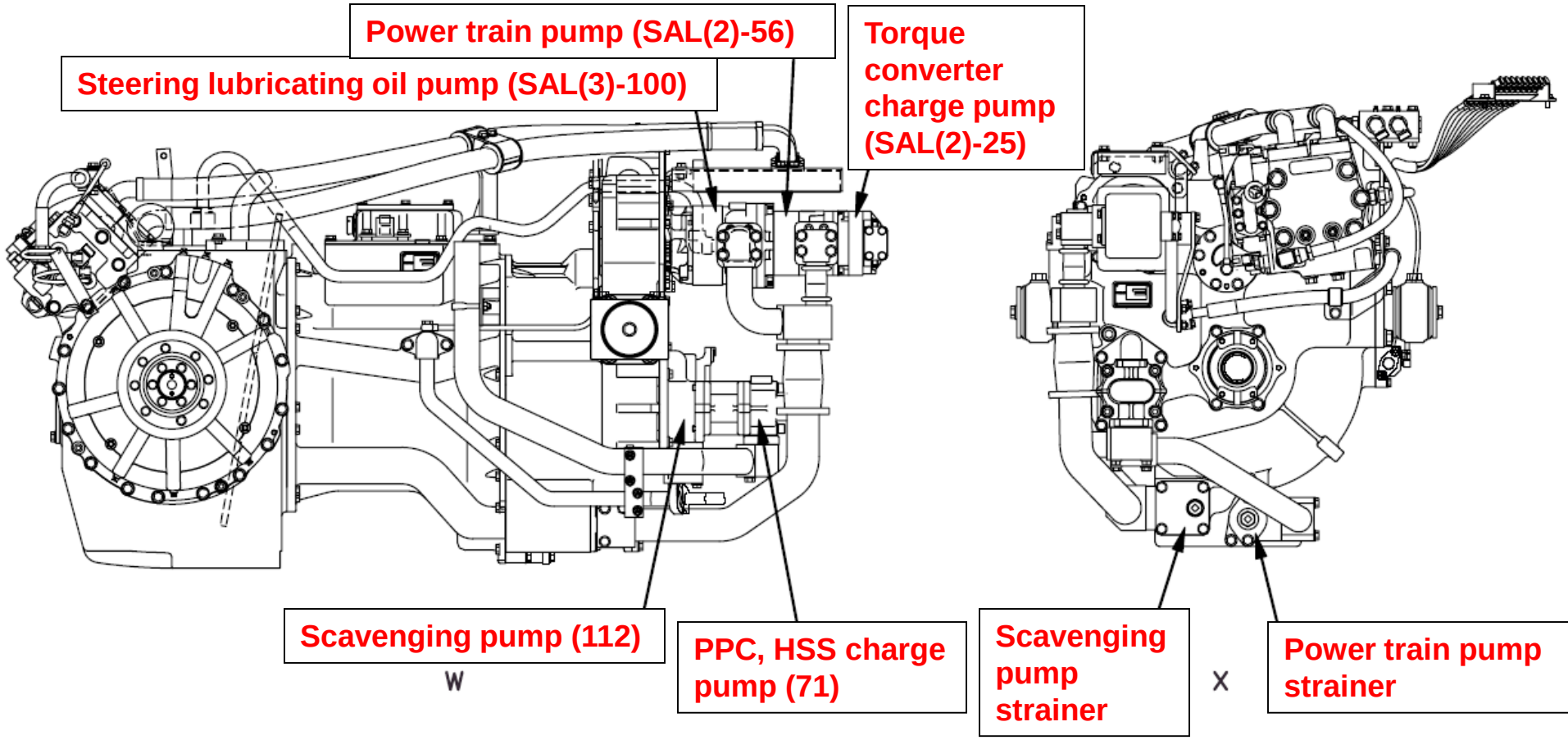
# Power train unit



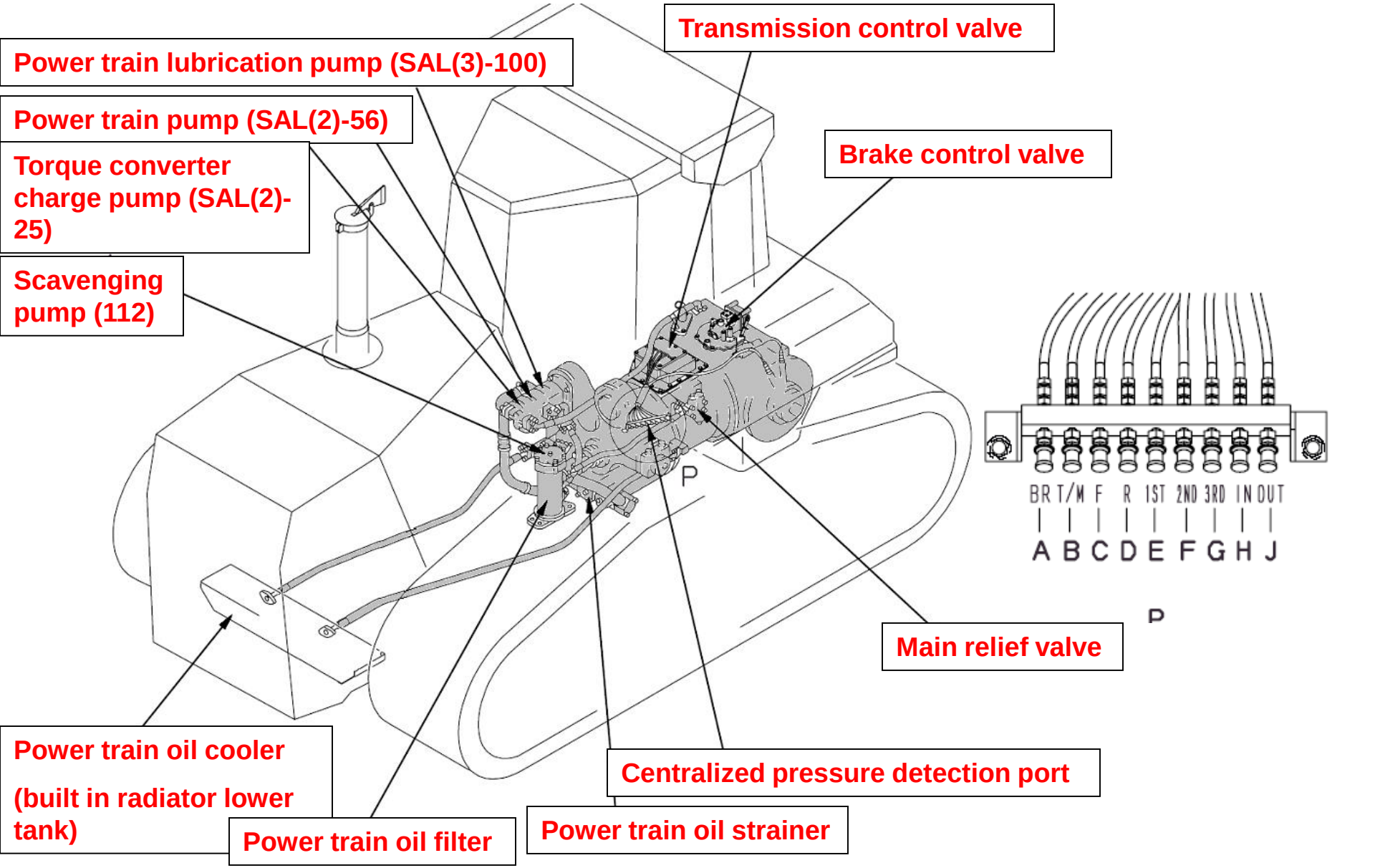
# Power train unit



# Power train unit



# POWER TRAIN


Transmission control valve
Power train lubrication pump (SAL(3)-100)
Power train pump (SAL(2)-56)
Brake control valve
Torque converter charge pump (SAL(2)-25)
Scavenging pump (112)
P
BR T/M F R 1ST 2ND 3RD IN OUT
A B C D E F G H J
P
Main relief valve
Power train oil cooler
(built in radiator lower tank)
Centralized pressure detection port
Power train oil filter
Power train oil strainer

# Torque converter

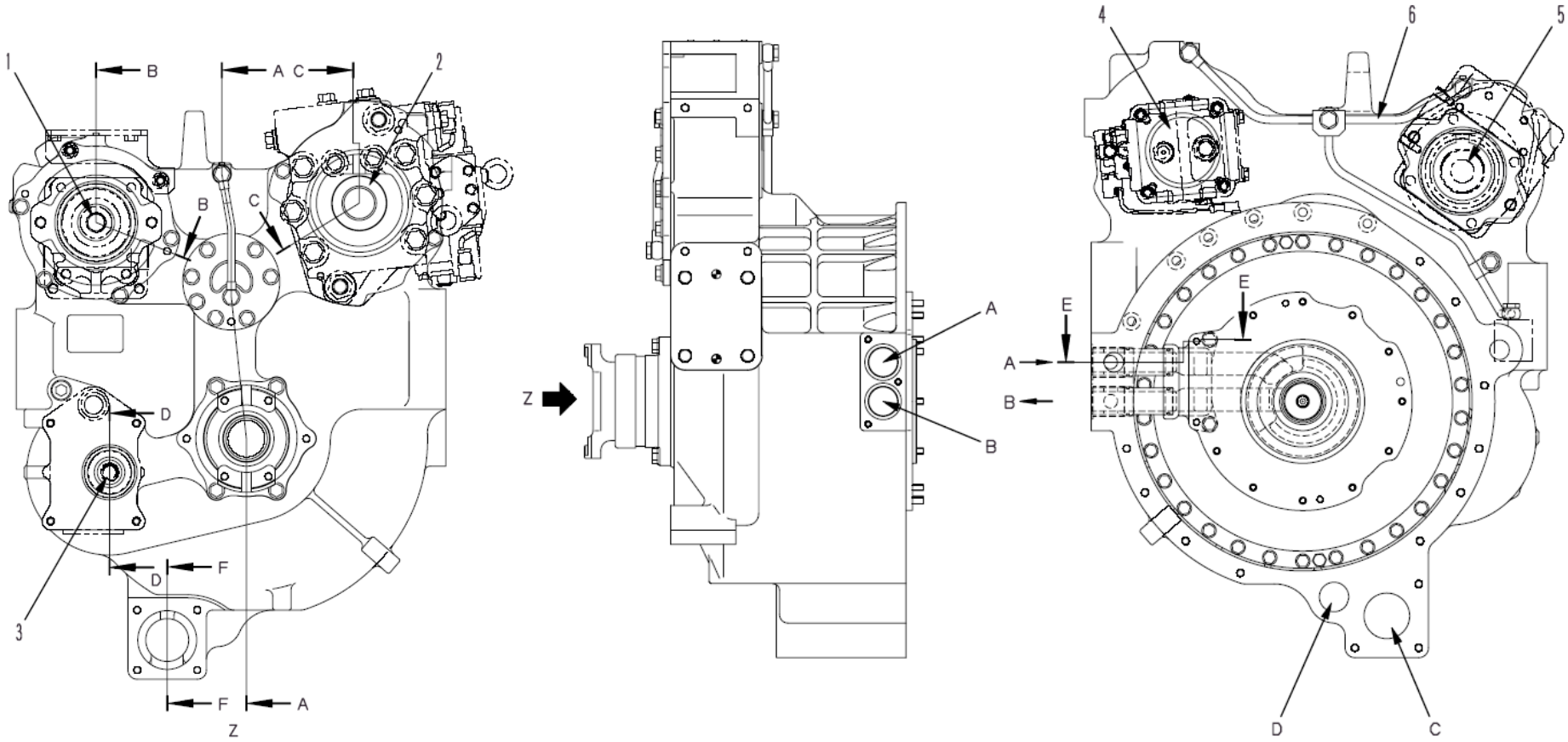
A. Torque converter oil inlet port

B. To oil cooler

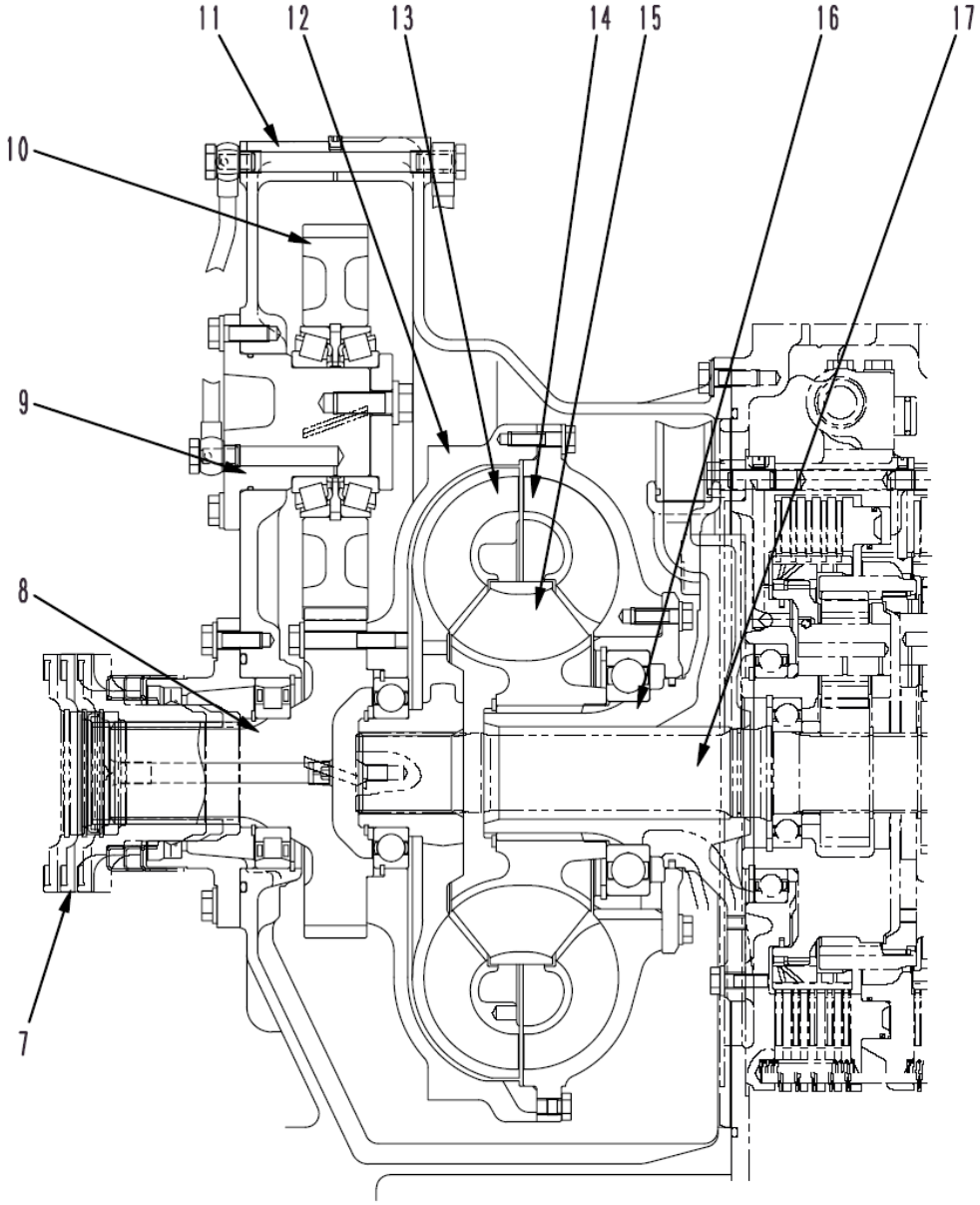
C. From transmission case (to power train/steering lubrication pimp)

D. To transmission case (passage)

1. Power train/steering lubrication pump mount
2. HSS pump mount
3. Scavenging pump mount
4. Fan pump mount
5. Work equipment pump mount
6. PTO lubrication tube



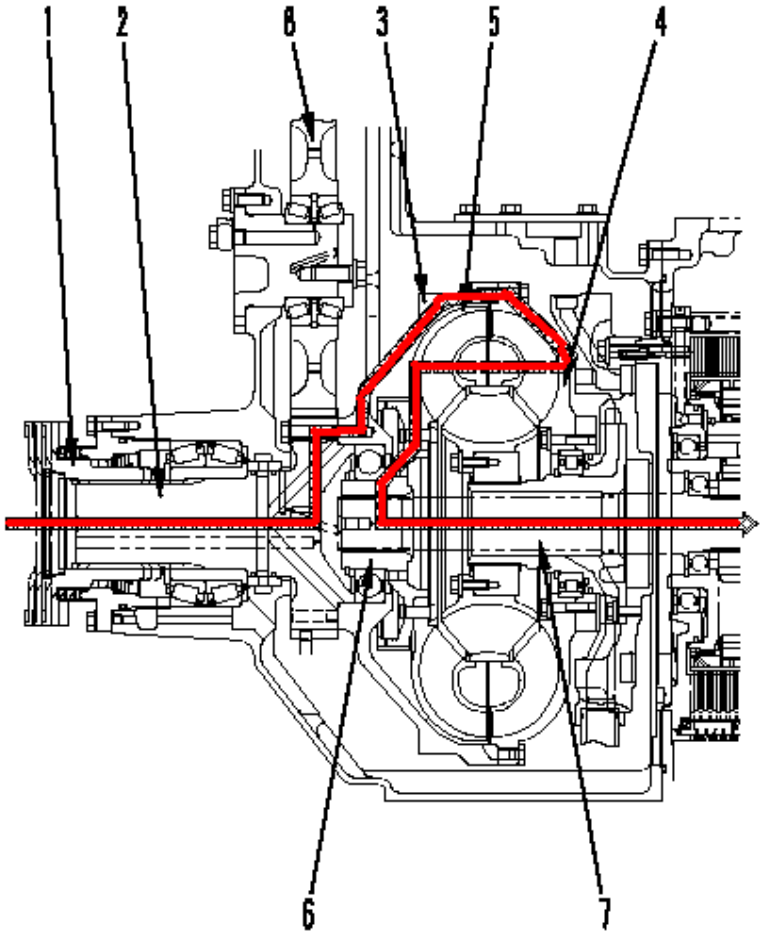
# Torque converter

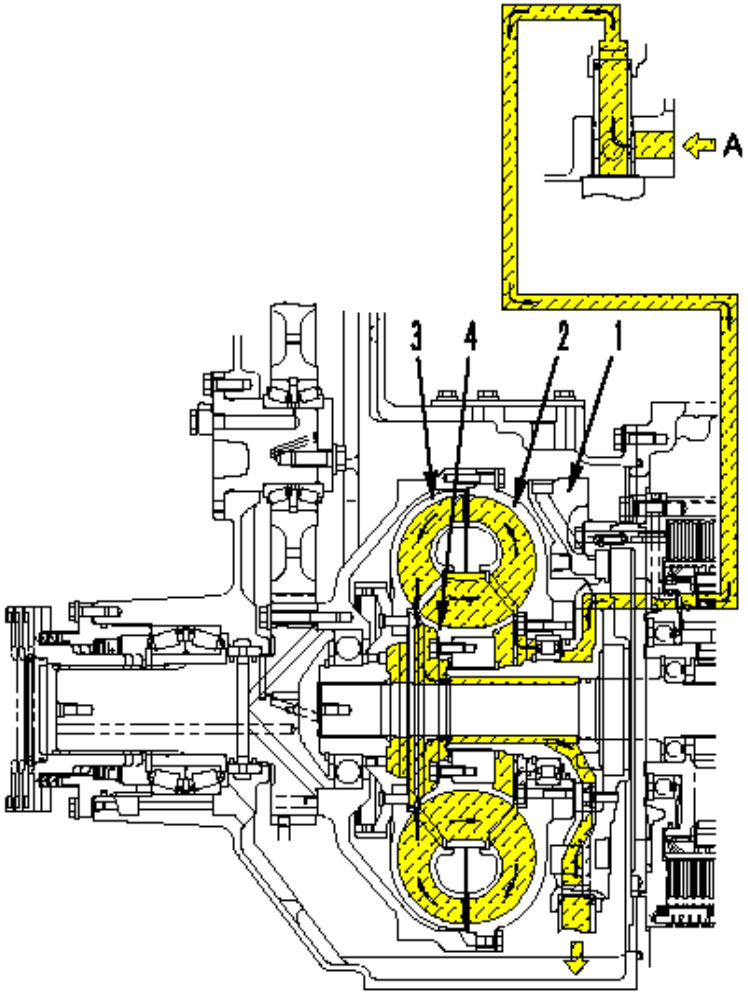



A – A

7. Input coupling
8. PTO drive gear (No. of teeth: 55)
9. PTO idler gear shaft
10. PTO idler gear (No. of teeth: 74)
11. PTO case
12. Drive case
13. Turbine
14. Pump
15. Stator
16. Stator shaft
17. Transmission input shaft

# Torque converter




## Flow of power

• The engine power is transmitted through the damper and universal joint to coupling (1) and rotates input shaft (2), drive case (3), and pump (4) as 1 unit. The power of the pump rotates turbine (5) through oil. Then, the power of the turbine is transmitted through turbine boss (6) to transmission input shaft (7). The power of input shaft (2) is used to drive gear pumps through idler gear (8).

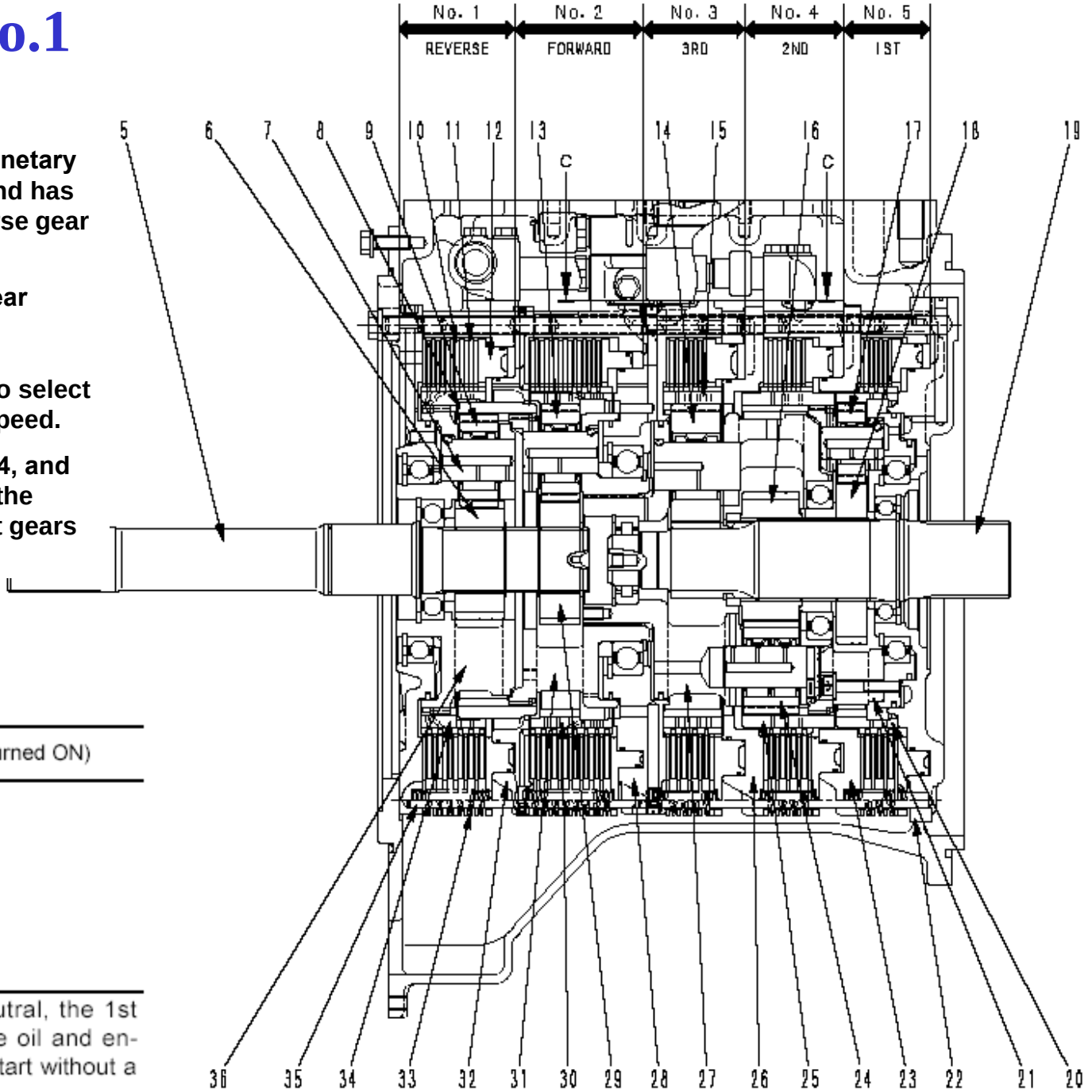
## Flow of oil

• The oil is sent through the main relief valve and its pressure is reduced below the set pressure by the torque converter relief valve. Then, it flows in inlet port A and through the oil path of stator front housing (1) to pump (2). The oil is given centrifugal force by pump (2) and flows in turbine (3) and gives its energy to turbine (3). The oil from turbine (3) is sent to stator (4) and then returned to pump (2). A part of the oil is sent from stator (4) through outlet port B to the oil cooler, however.

# Transmission No.1

## Outline

- **The transmission consists of planetary gear systems and disc clutches and has 3 forward gear speeds and 3 reverse gear speeds.**
- **Among the 5 sets of planetary gear system and disc clutch of the transmission, 2 clutches are fixed hydraulically with control valves to select 1 rotating direction and rotating speed.**
- **Clutches No. 1, No. 2, No. 3, No. 4, and No. 5 are fixed respectively when the reverse, forward, 3rd, 2nd, and 1st gears are selected.**

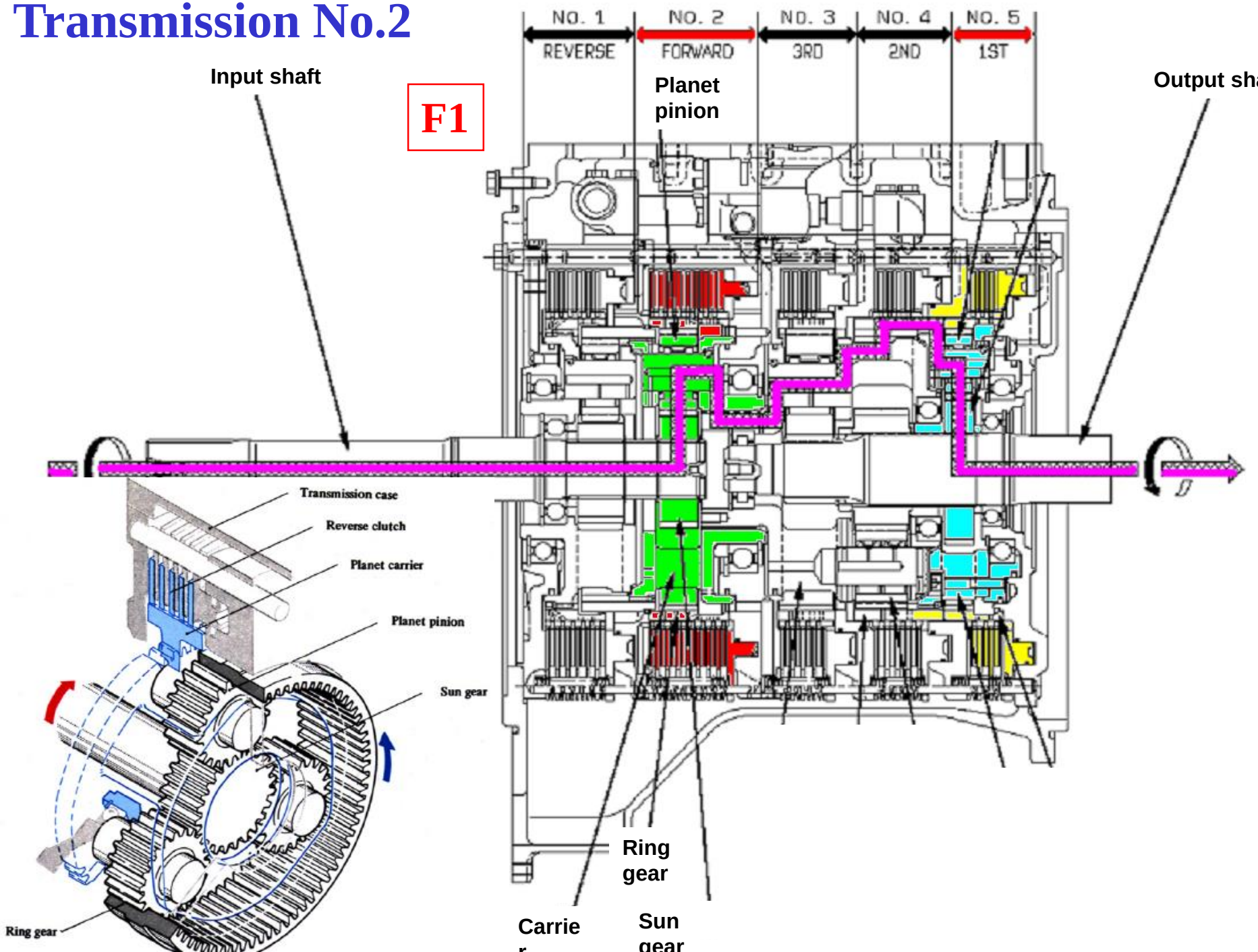



Gear speeds and operated clutches

| Gear speed | Operated clutches (Turned ON) |
|---|---|
| Forward 1st | No.2·No.5 |
| Forward 2nd | No.2·No.4 |
| Forward 3rd | No.2·No.3 |
| Neutral | ※1. No.5 |
| Reverse 1st | No.1·No.5 |
| Reverse 2nd | No.1·No.4 |
| Reverse 3rd | No.1·No.3 |

※1: While the transmission is in neutral, the 1st clutch is filled with low-pressure oil and engaged so that the machine can start without a time lag.

# Transmission No.2



# Transmission No.3

No. 2 clutch is actuated by the hydraulic pressure applied to the clutch piston, and holds ring gear 1 in position. No. 5 clutch is actuated by the hydraulic pressure applied to the clutch piston, and engages ring gear 3.

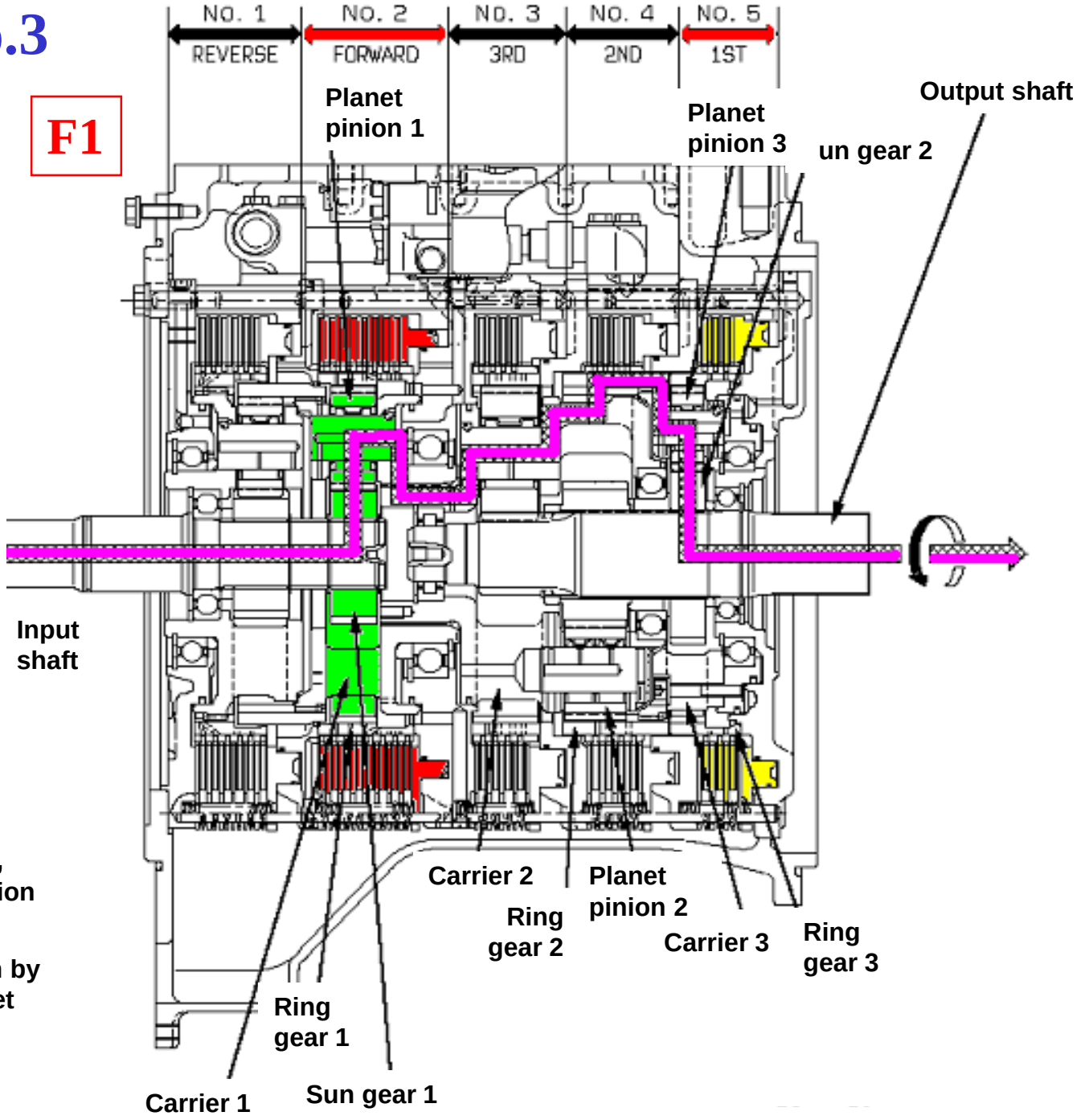
The motive force from the torque converter is transmitted to input shaft, and the rotation of the input shaft passes through sun gear 1 and is transmitted to planet pinion 1.

Ring gear 1 is held in position by No. 2 clutch, so the rotation of planet pinion 1 rotates carrier 1, which is on the inside of ring gear1.

Carrier 1 and carrier 2 are joined by a spline, and rotate as one unit, so the rotation of carrier 2 passes through planet pinion 2 and is transmitted to ring gear 2.

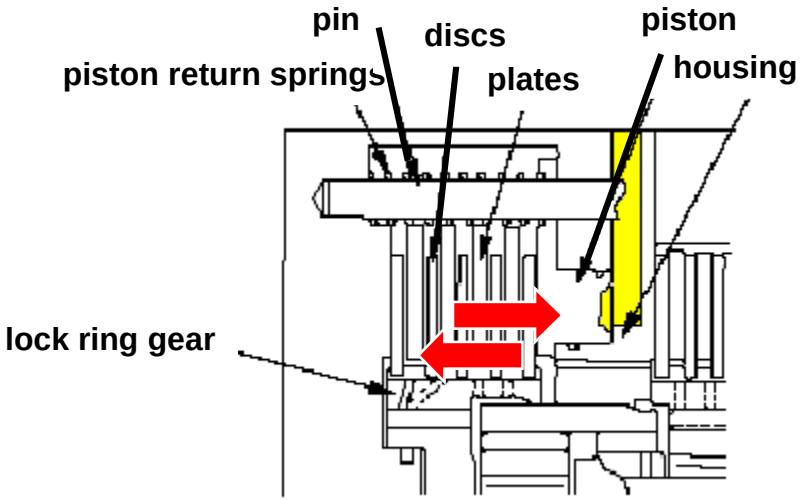
Carrier 3 is meshed with ring gear 2, and rotates as one unit, so the rotation is transmitted to planet pinion 3.

Ring gear 3 is being held in position by No. 5 clutch, so the rotation of planet pinion 3 rotates sun gear 2, and this rotates output shaft.



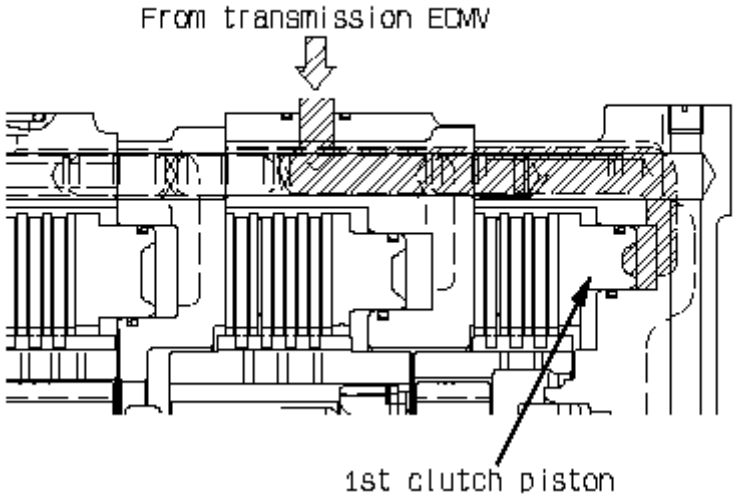
## Operation of disc clutch

• To lock ring gear a disc clutch is used. The clutch consists of piston, plates, discs, pin and piston return springs. The internal teeth of the disc engage with the external teeth of the ring gear. The teeth on the outside diameter of the plate engage with pins secured by housing.



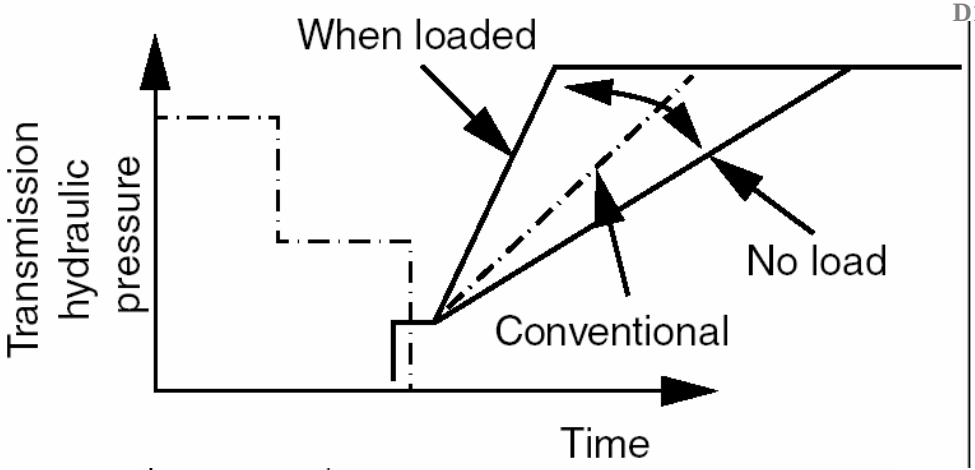

## Oil circuit of 1st clutch

Since the 1st clutch is the farthest from the control valve and has the longest circuit to the cylinder, takes the longest time to fill the circuit.
To solve this problem, the oil is supplied to the 1st clutch even if the gear shift lever is in the NEUTRAL position,
Accordingly, when the gear shift lever is shifted from the NEUTRAL position to the F1 position, the pump is required to supply oil of only a quantity to fill the forward clutch.
When the gear shift switch is changed from the F1 to F2, the pump is required to supply fill of only quantity to fill the 2nd clutch since the forward clutch has been filled with the oil.
The time lag in the gear shifting operation is reduced by using the oil as explained above.

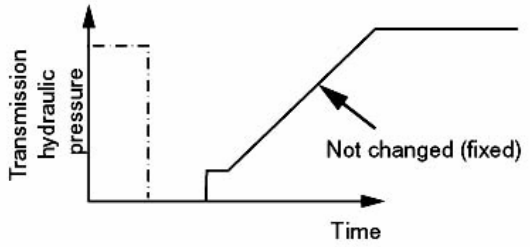


# Transmission Modulation comparison

| | D155AX-5 | D155AX-2 |
|---|---|---|
| Features | D155AX-5 transmission uses an all-speed electronic modulation system. Controller automatically adjusts each clutch engagement depending on travel conditions such as gear speed, rpm and shift pattern. This provides shockless smooth clutch engagement. | D155AX-2 only one clutch engagement hydraulic pressure pattern, it is impossible to control smooth and optimum clutch engagement. (Electric operated mechanical modulation) |




D155AX-2 stem has five-piece ON-OFF type solenoids and selects clutch, but it is impossible to change clutch engagement hydraulic pressure pattern due to mechanical control.

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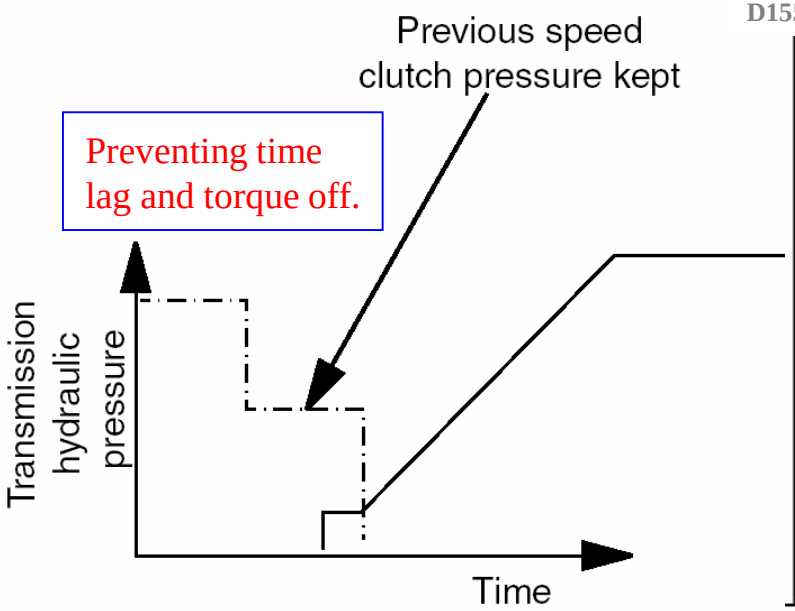
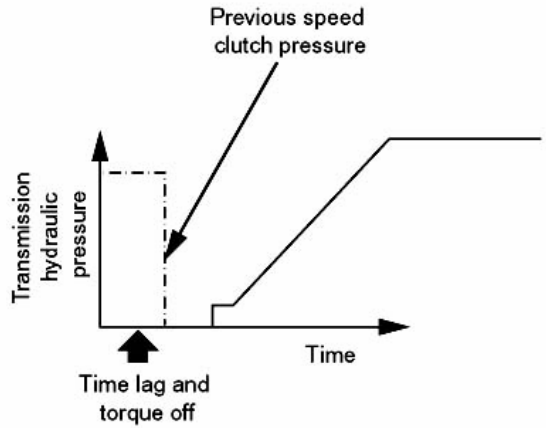



D155AX-2 ystem loses previous clutch engagement pressure when gear shifting, causing time lag and torque off.

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# TRANSMISSION ECMV [No.1]

## Outline of ECMV

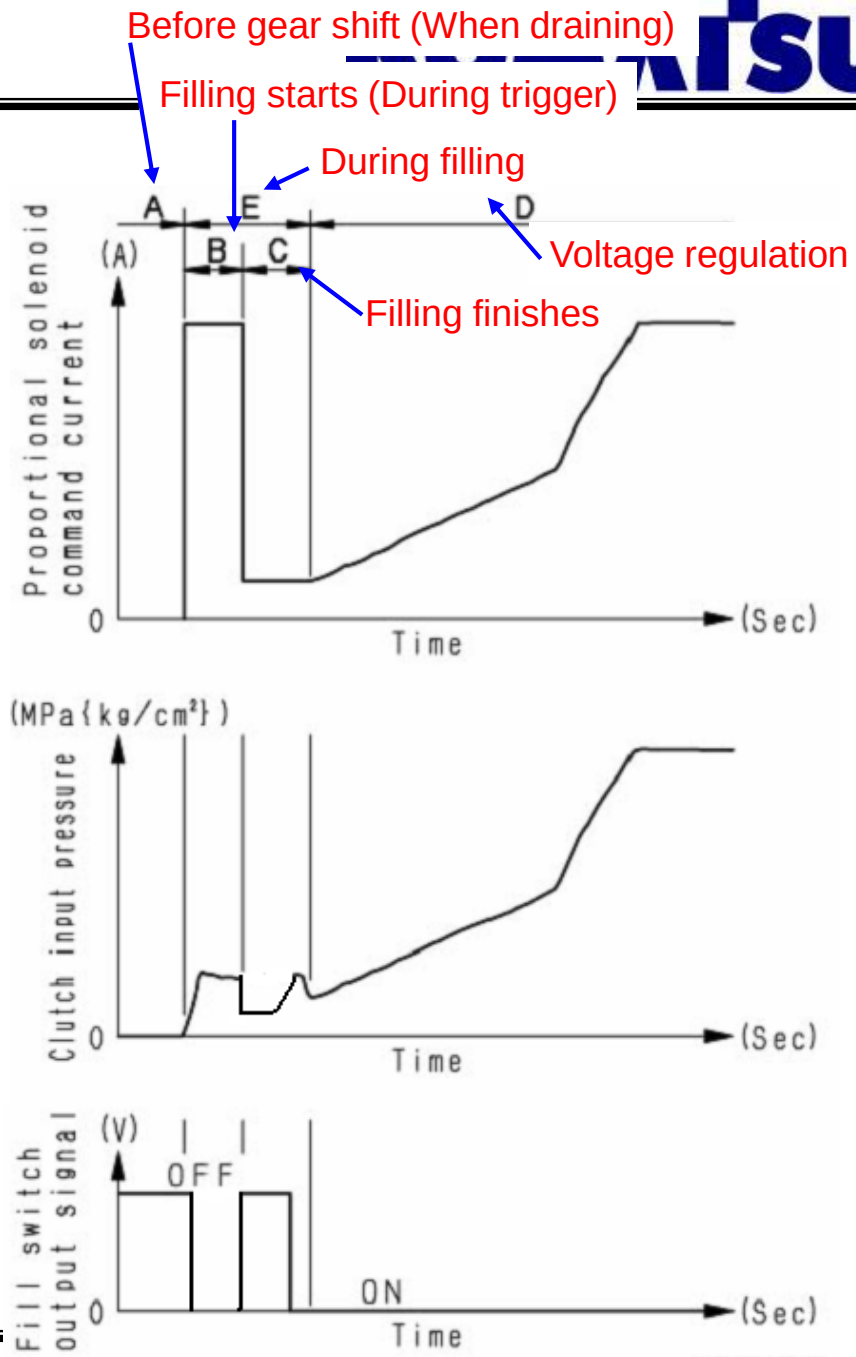
- ECMV (Electronic Control Modulation Valve) consists of the following two units, a pressure control valve and fill switch.

**Pressure control valve**

- Converts a current sent from the transmission controller to the proportional solenoid valve, to an oil pressure.

**Fill switch**

- Detects that the clutch is filled with oil. It has the functions below.
- 1) It outputs a signal (fill signal) to the controller as soon as the clutch is filled with oil to report the completion of filling.
- 2) It outputs a signal (fill signal) to the controller while an oil pressure is applied to the clutch to report the presence/absence of oil pressure.



# TRANSMISSION ECMV [No.2]

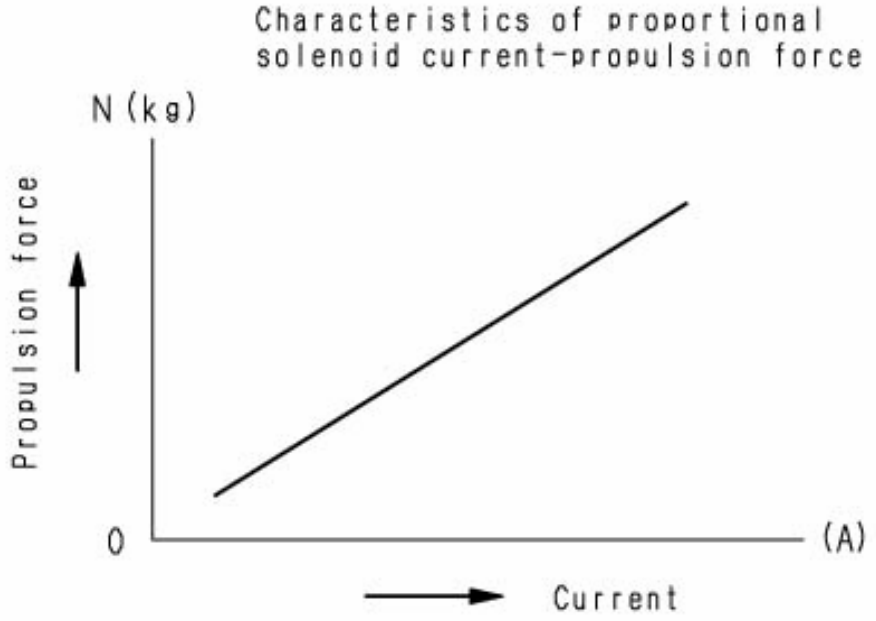
## ECMV and proportional solenoid

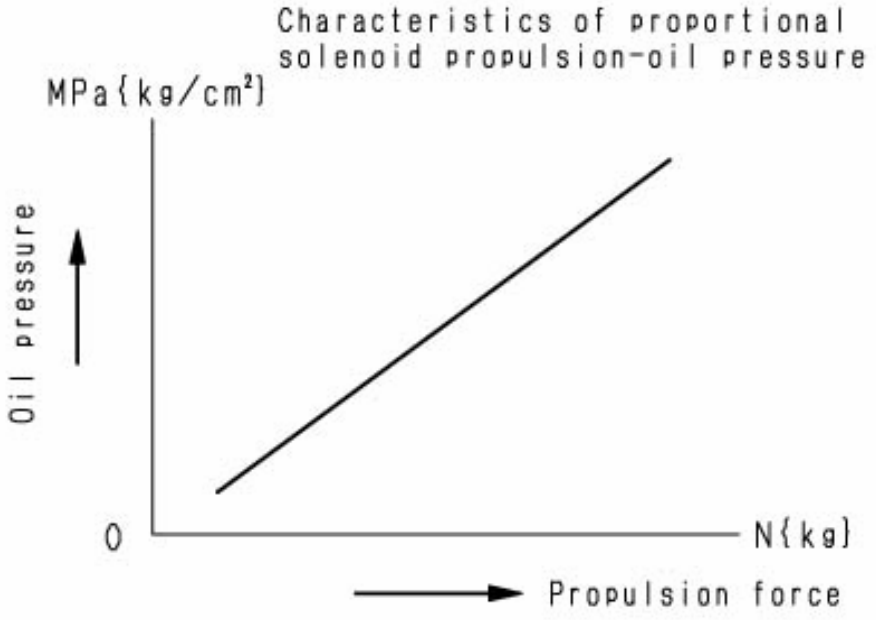
- One proportional solenoid is attached to one ECMV. After receiving the command current from the controller, it produces thrust in the right figure.

  By making the proportional solenoid-produced thrust act on the pressure control valve spool, it produces an oil pressure shown in the figure below. By controlling the amount of command current, the thrust is changed to operate the pressure control valve, controlling the oil flow and oil pressure.

## ECMV and fill switch

- One fill switch is attached to one ECMV.
- When the clutch completes filling, the pressure of the clutch turns "ON" the fill switch. By this signal, the oil pressure starts build-up.

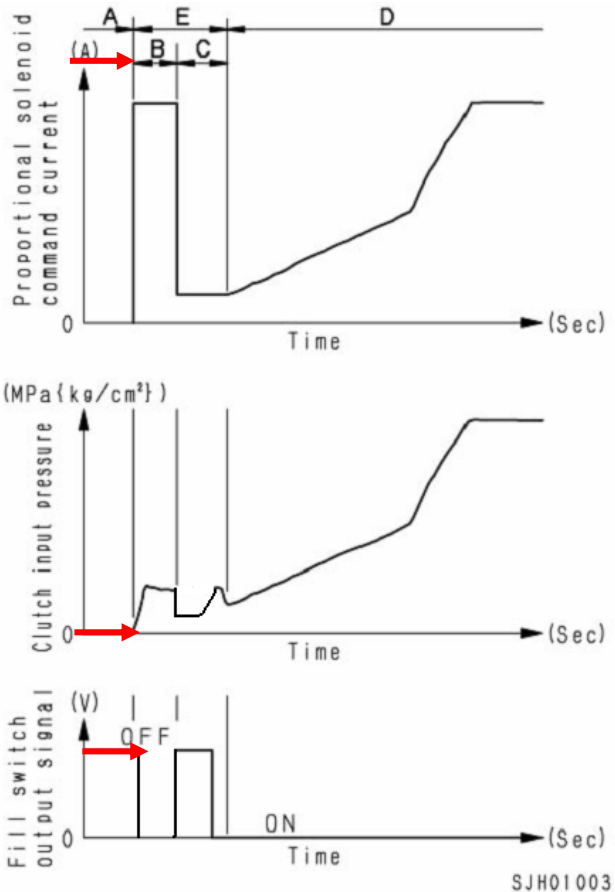


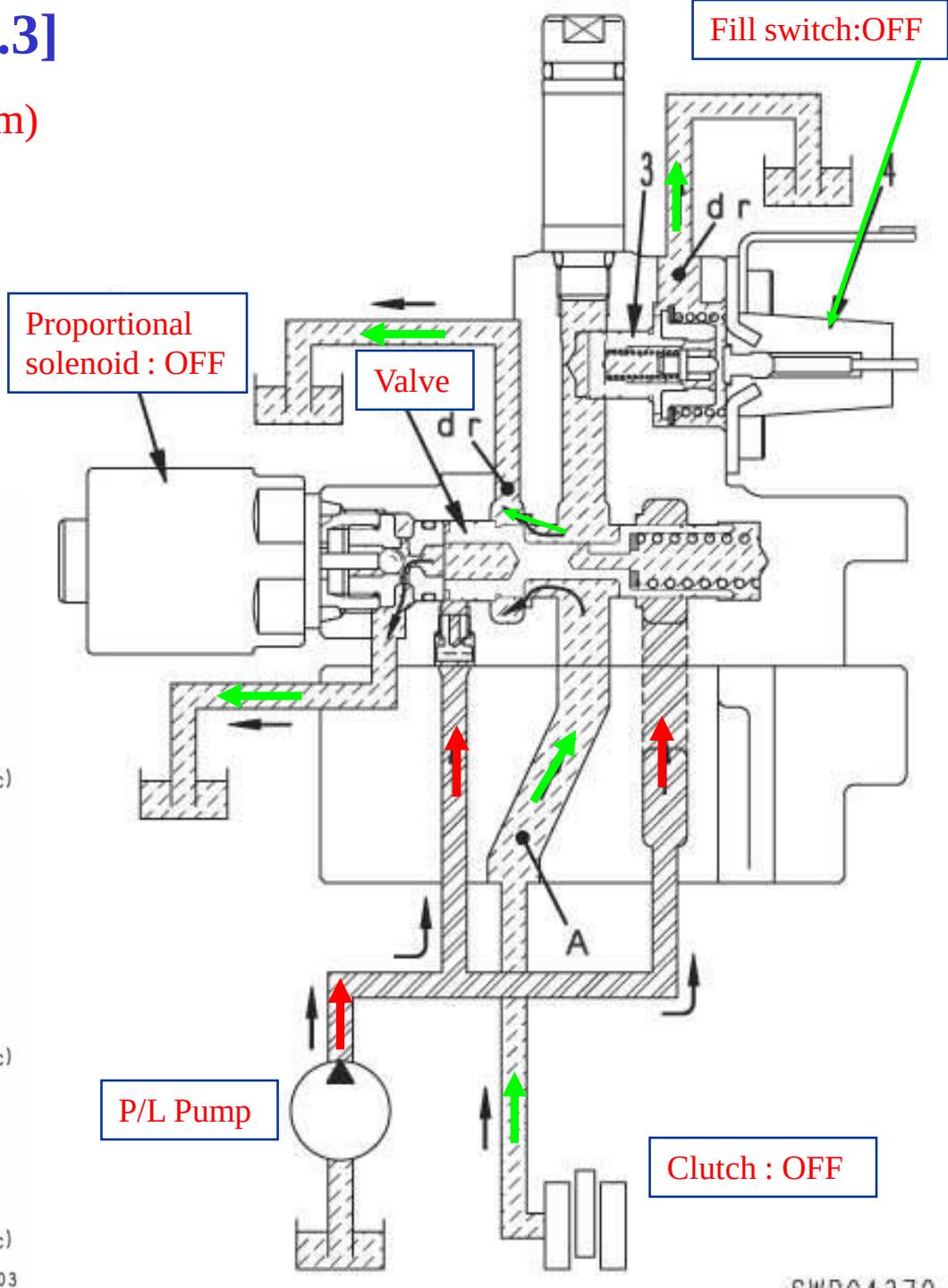



# TRANSMISSION ECMV [No.3]

## 1. Before gear shift (Region A in the diagram)

- When a current is not carried to the proportional solenoid, the pressure control valve is draining the oil at the clutch port A through the drain port dr.
  Since, at that time, no oil pressure acts on the oil pressure detection valve, the fill switch is OFF.



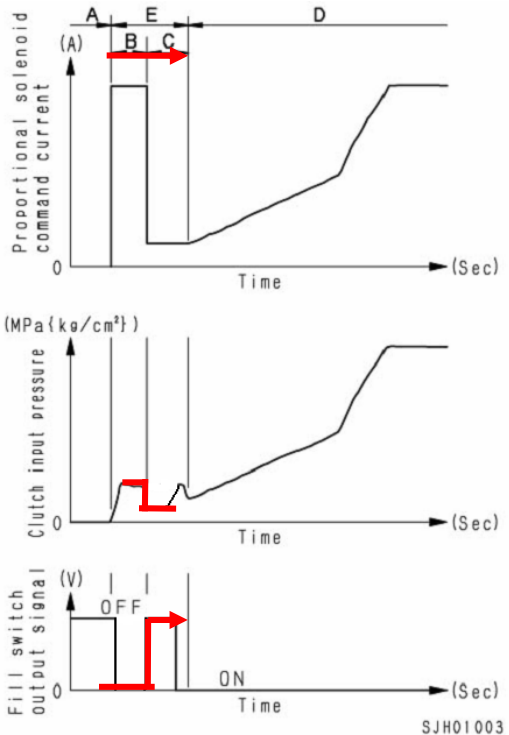
# TRANSMISSION ECMV [No.4]

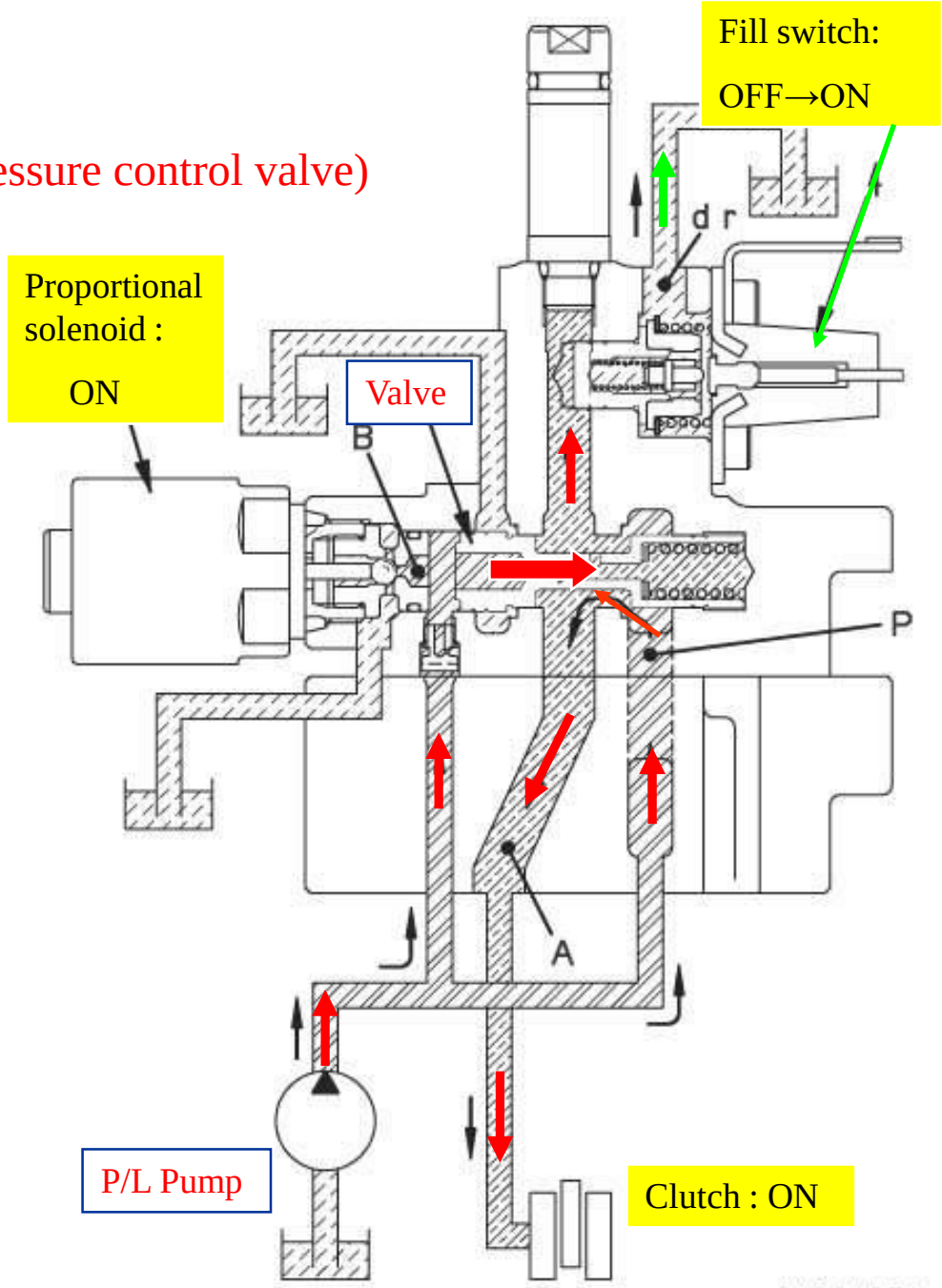
## 2. When filling

## (When inputting the trigger command to the pressure control valve)

### (B and C regions in the diagram)

- If you supply a current to the proportional solenoid with no oil in the clutch, an oil pressure proportional to the solenoid force acts on the chamber B, pushing the pressure control valve rightward. This operation opens the pump port P and clutch port A to start filling the clutch with oil. When the clutch is filled with oil, the fill switch is turned ON.

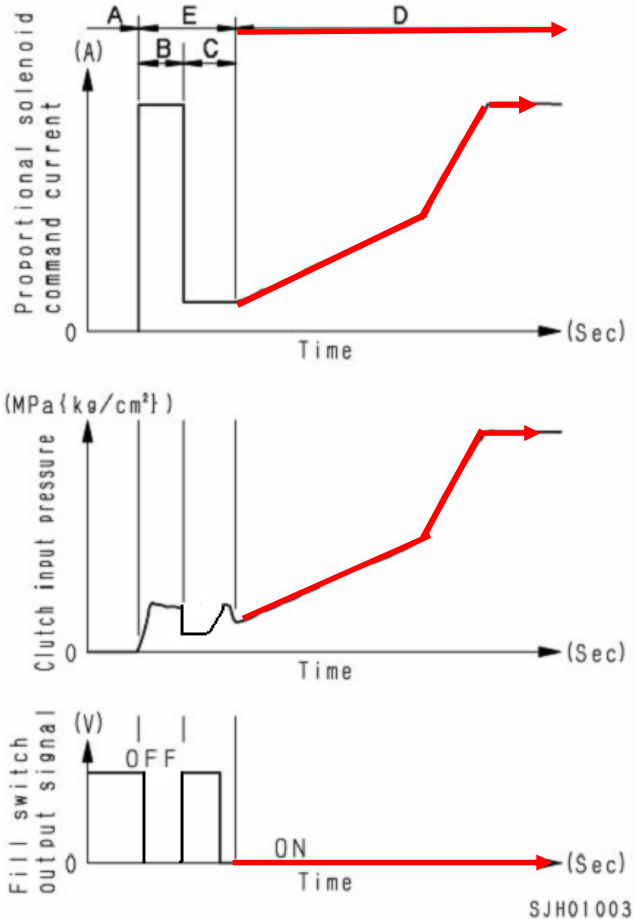


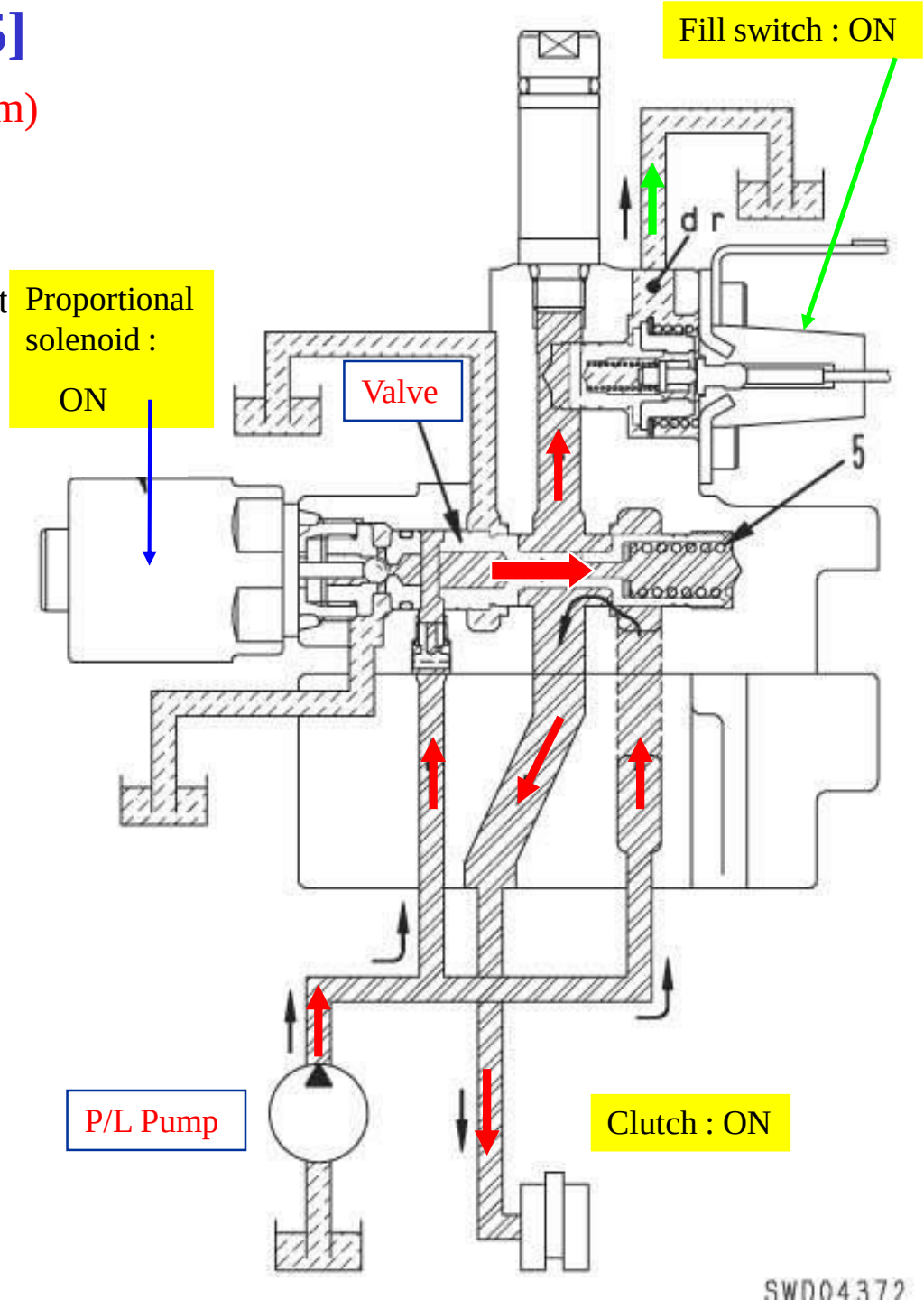



# TRANSMISSION ECMV [No.5]

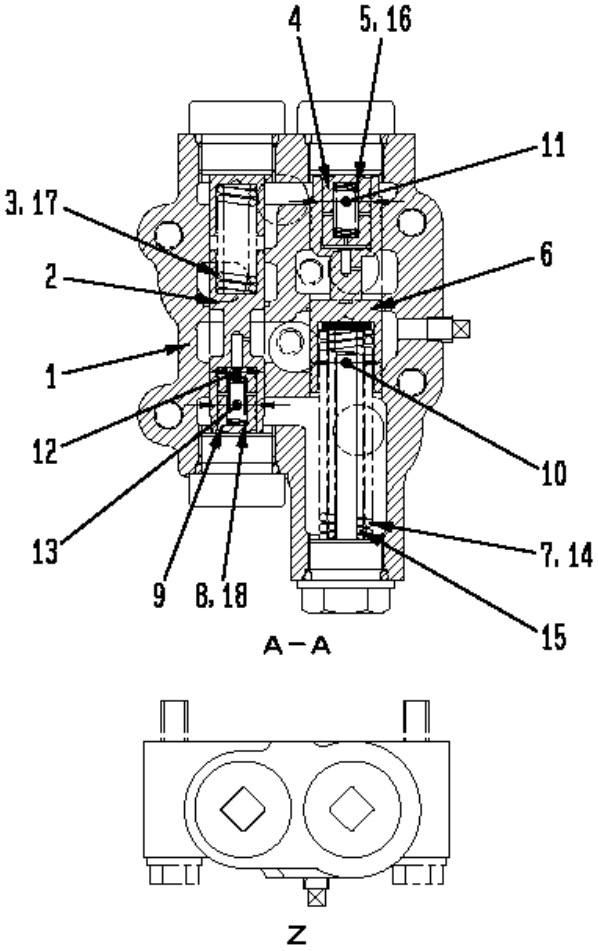
## 3. Pressure regulation (D region in the diagram)

- If you flow a current to the proportional solenoid, the solenoid produces thrust proportional to the current. Pressure is regulated by striking a balance among the thrust of the solenoid, the thrust of the oil pressure of the clutch port, and reaction force of the pressure control spring.



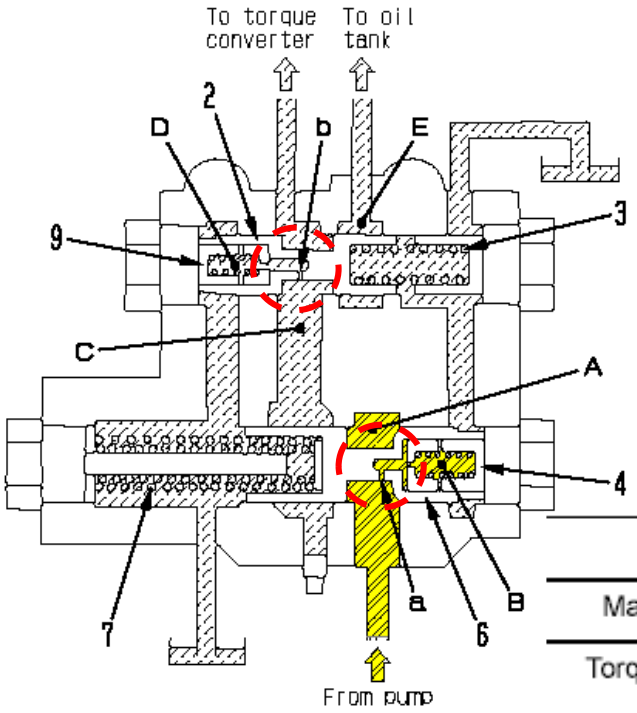



# Main relief valve & T/C valve No.2




1. Body
2. Torque converter relief valve
3. Valve spring
4. Piston
5. Piston spring
6. Main relief valve
7. Valve spring
8. Piston spring
9. Piston

# Main relief valve & T/C valve No.3



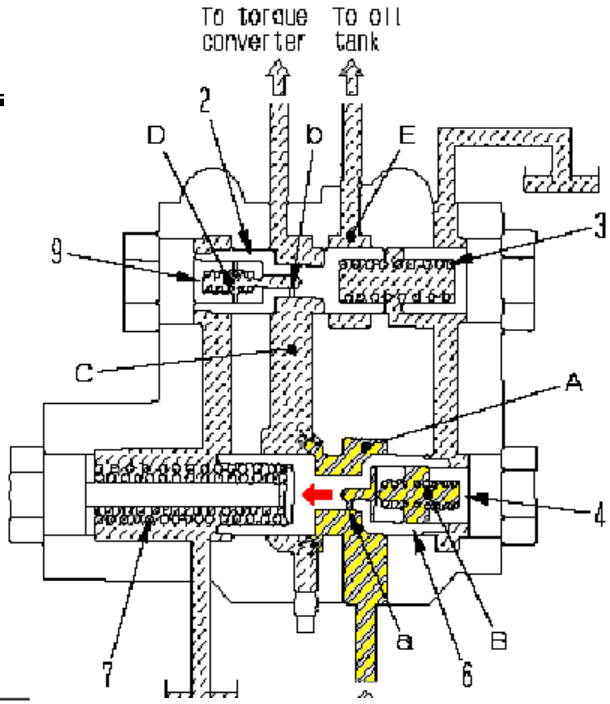

## Main relief valve

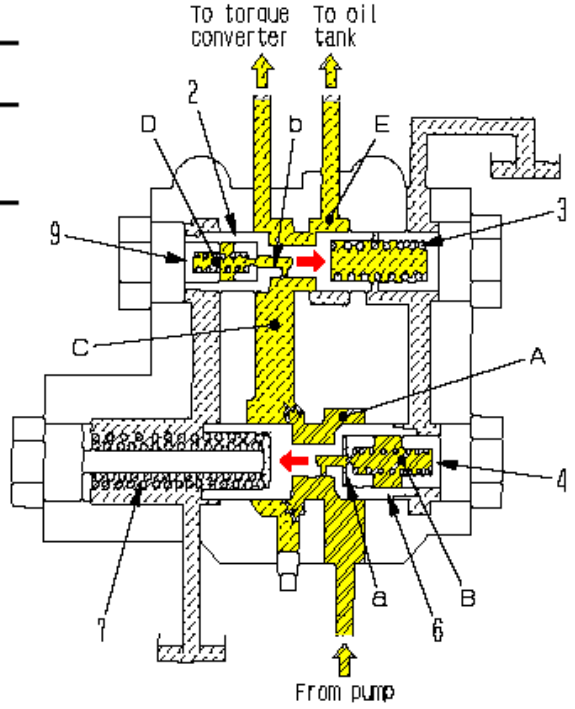
**Main relief valve sets the set pressure of the oil pressure for the transmission, steering clutch and brake.**

| | Set pressure |
|---|---|
| Main relief pressure | 3.2 ± 0.1{32.7 ± 1.0} |
| Torque converter relief pressure | 0.98 ± 0.05{10.2 ± 0.5} |

## Torque converter relief valve

**Torque converter relief valve acts to protect the torque converter from abnormal high pressure by relieving the circuit if the torque converter inlet port pressure rises above the set pressure.**



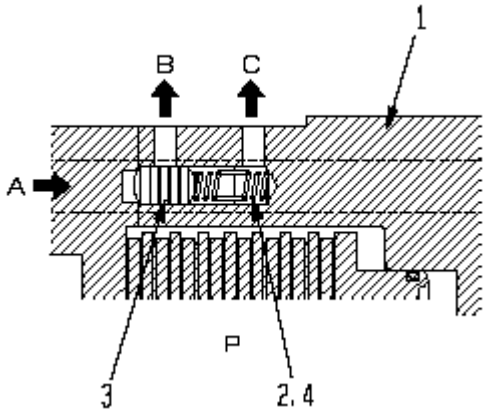



# Lubrication relief valve

## Outline

- The oil leaving the torque converter passes through the oil cooler built in the radiator lower tank. It then goes through the lubrication relief valve and lubricates the transmission and PTO.
- The lubrication relief valve is installed to the right side face of the forward clutch housing. And prevents any abnormal pressure in the lubrication oil.

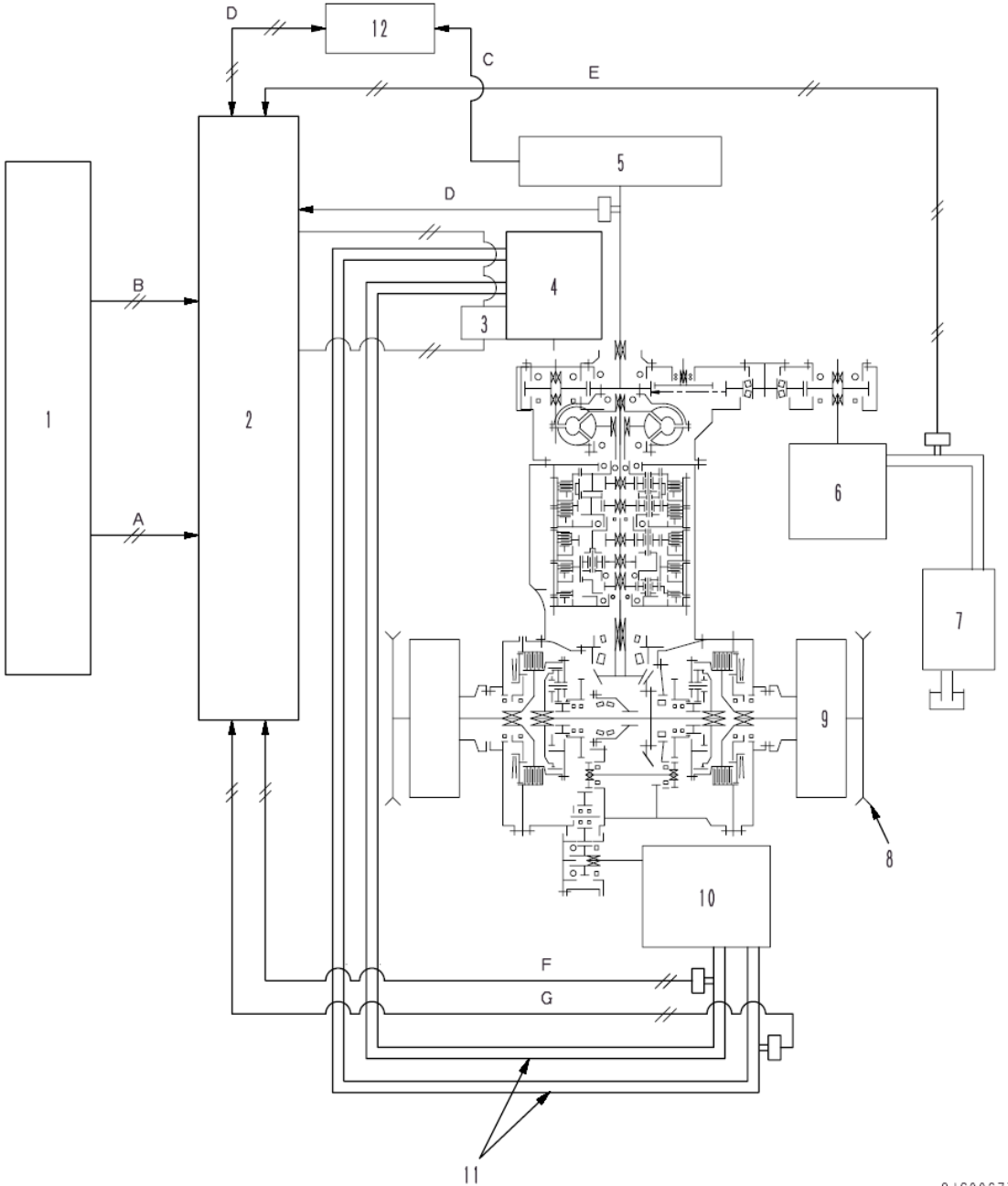
| | Set pressure |
|---|---|
| Pressure when normal | 0.14 ± 0.05 {1.4 ± 0.5} |
| Cracking pressure | 0.30 ± 0.03 {3.0 ± 0.3} |




1. Forward clutch housing
2. Spring
3. Piston

A. From oil cooler
B. Drain
C. Drain

# HSS System




1. PCCS lever
2. Transmission, steering controller
3. Servo valve
4. HSS pump
5. Engine
6. Work equipment pump
7. Work equipment control valve
8. Sprocket
9. Final drive
10. HSS motor
11. HSS closed circuit
12. Engine controller

A. FORWORD REVERSE signal

B. STEERING signal

C. Control information

D. CAN communication network

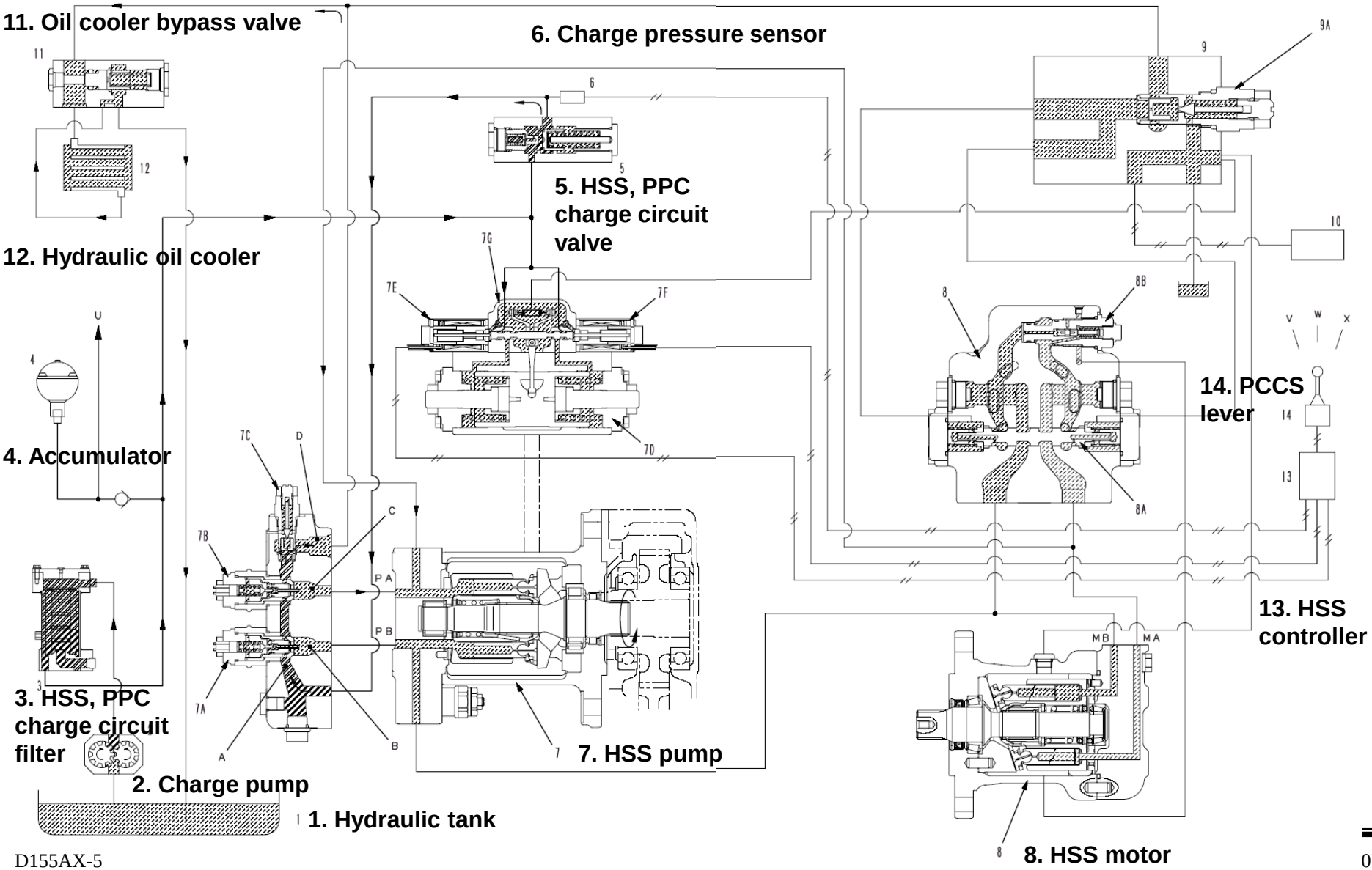
E. Work equipment pressure signal

F. Steering circuit pressure signal A

G. Steering circuit pressure signal B

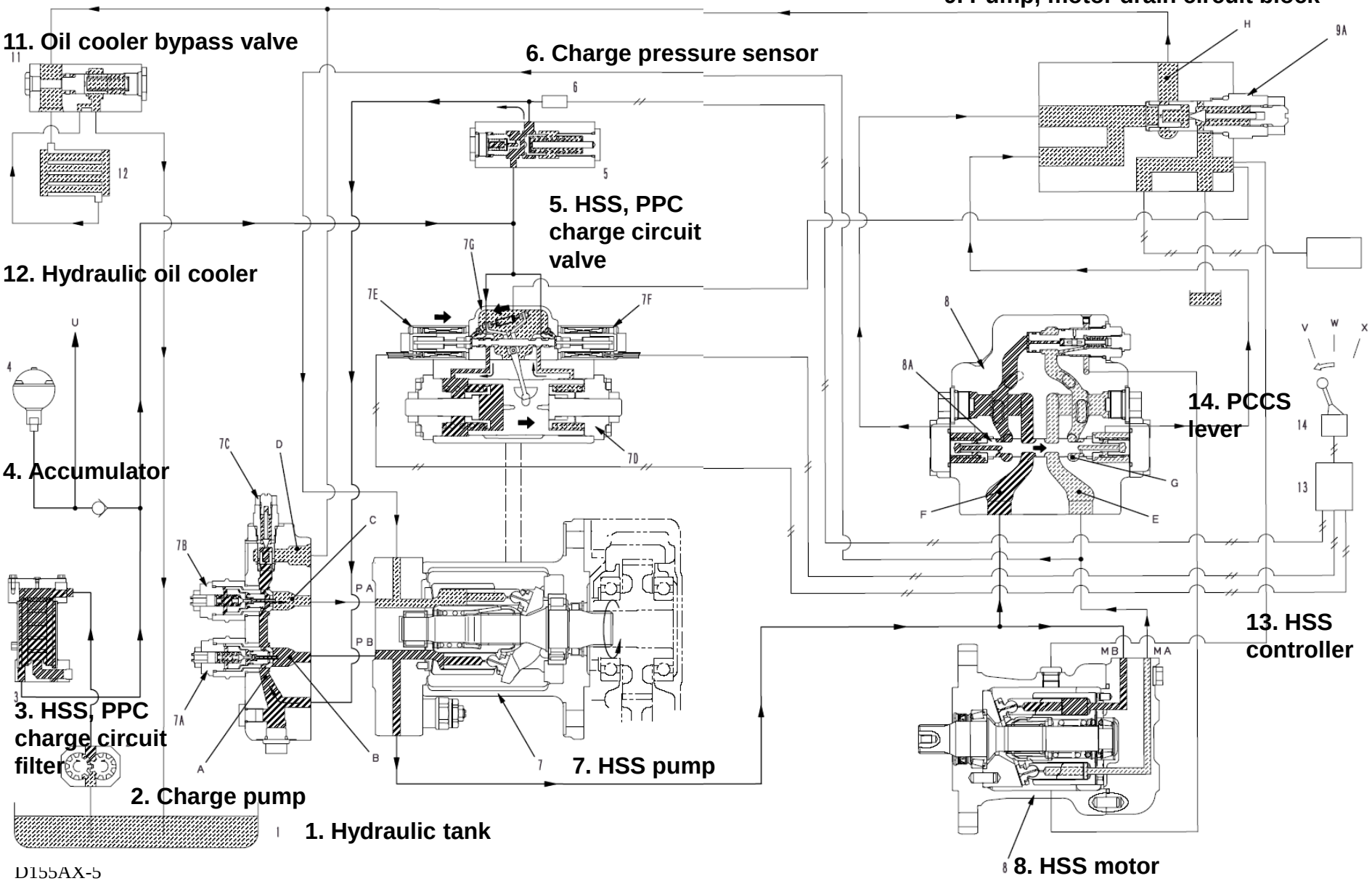
# Actuation of HSS System

## PCCS lever at NEUTRAL and machine stopped

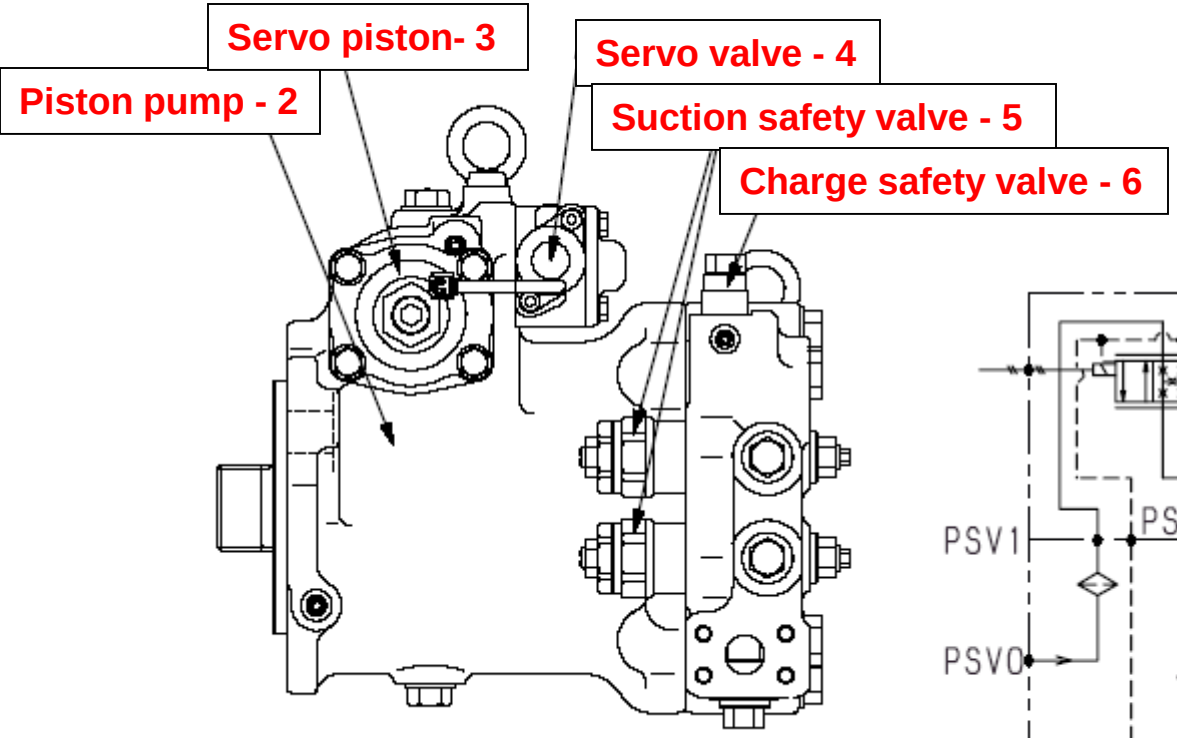


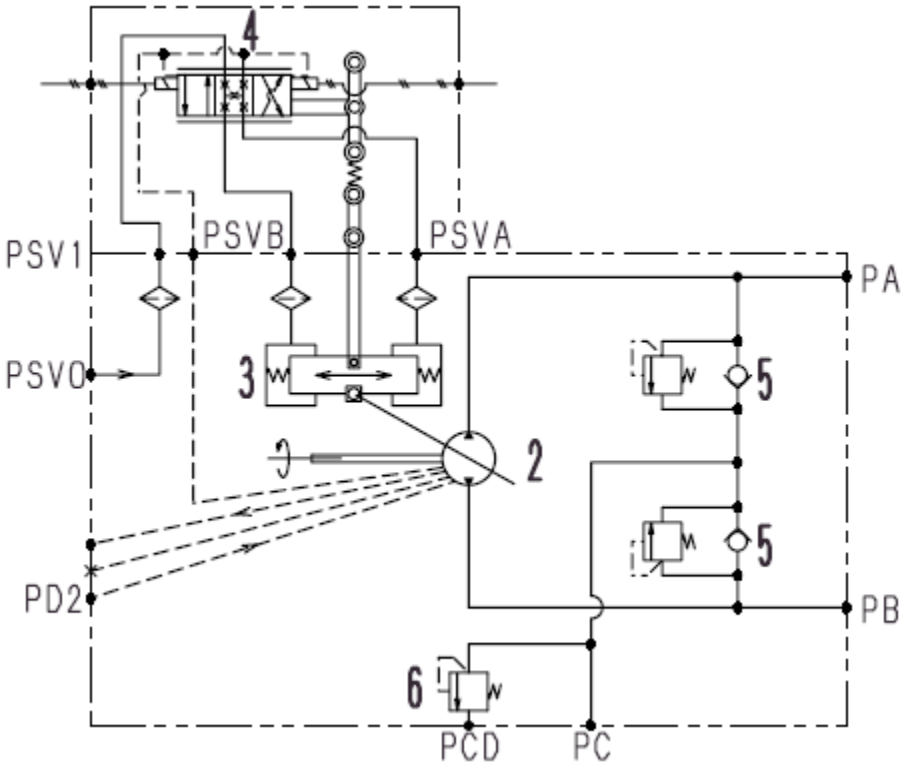
# Actuation of HSS System

## PCCS lever at FORWARD and left turn

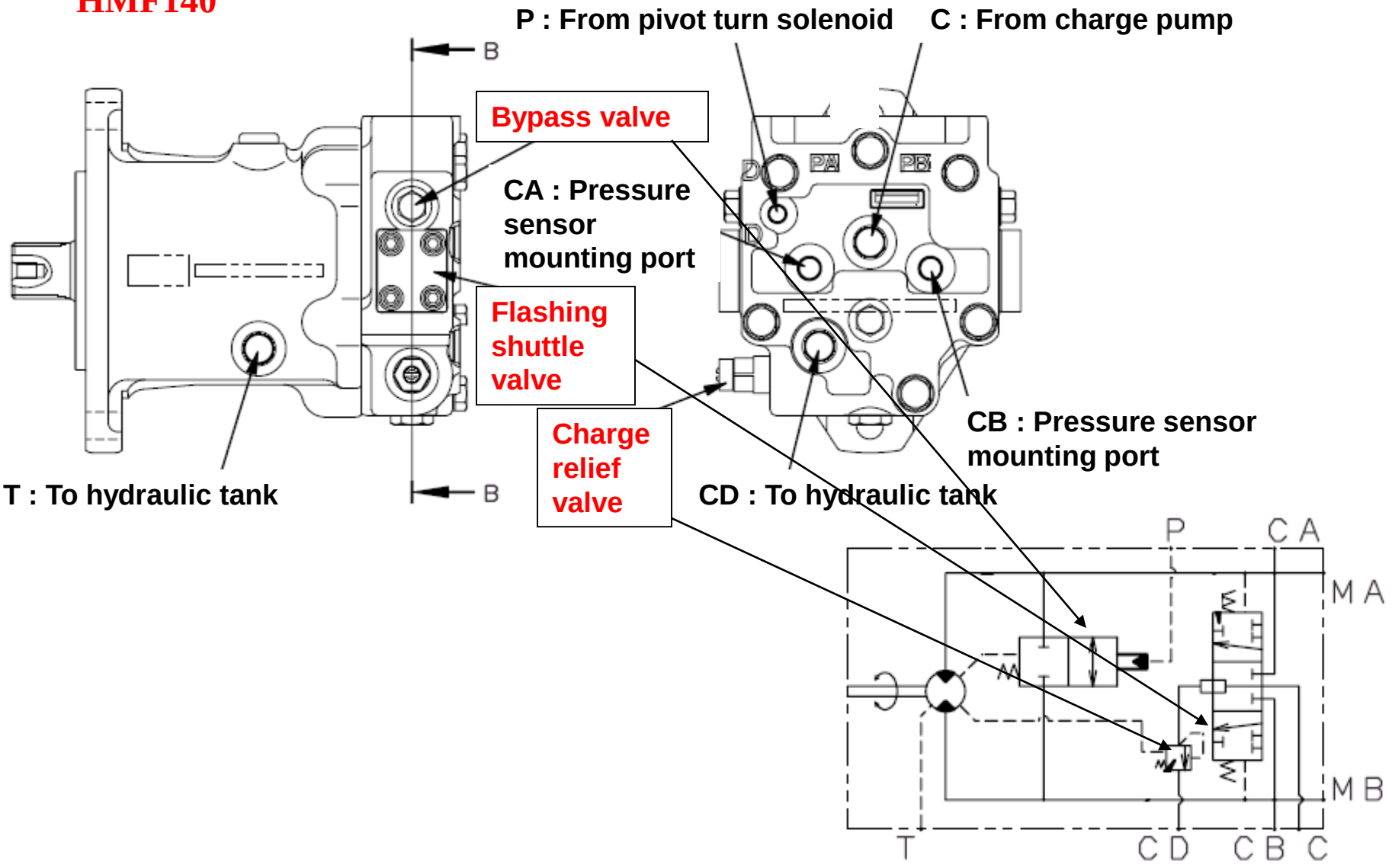


## HPV160


Servo piston- 3
Servo valve - 4
Piston pump - 2
Suction safety valve - 5
Charge safety valve - 6

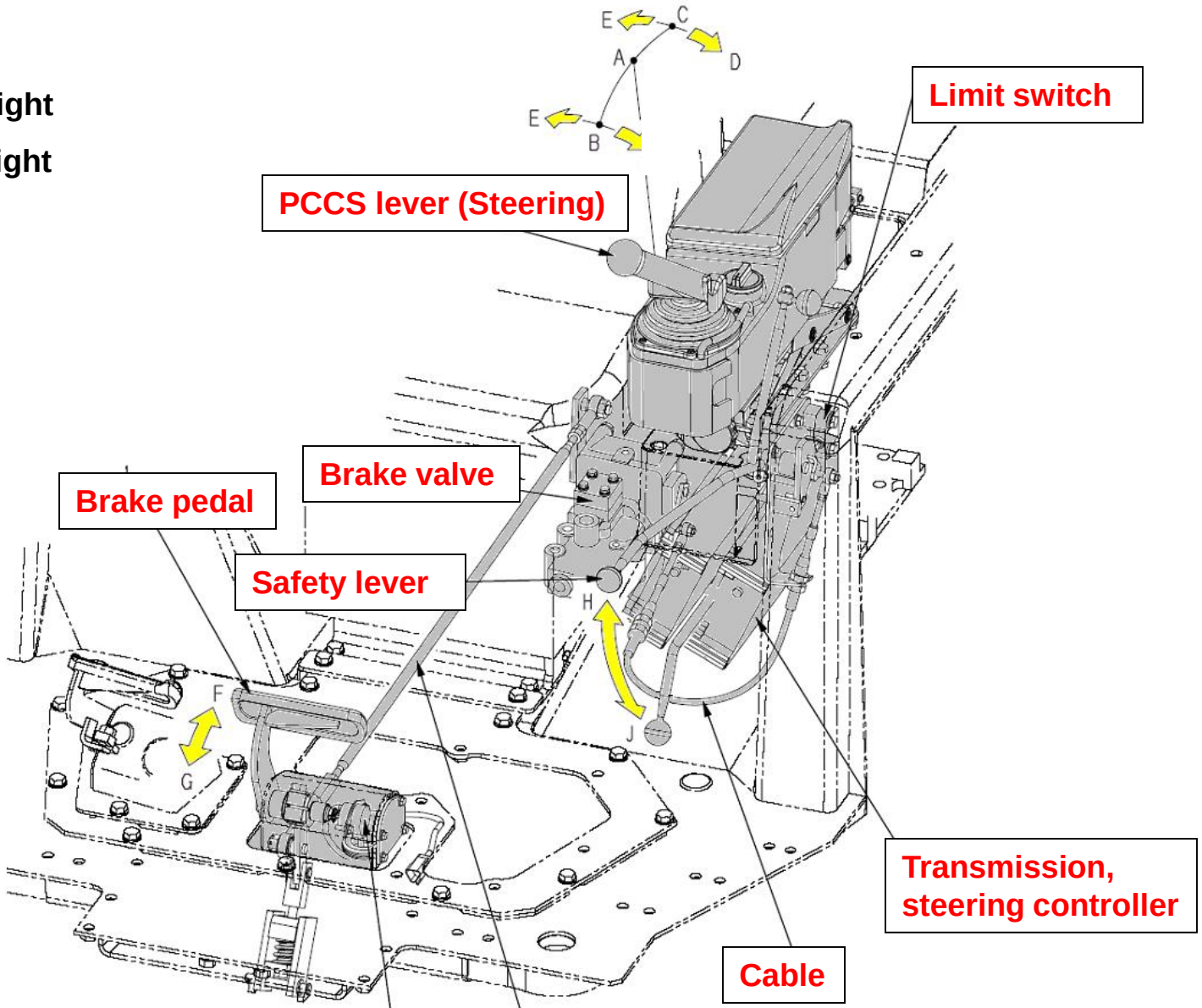

4
PSV1
PSVB
PSVA
PA
PSVO
3
5
2
5
PD2
PB
6
PCD
PC

## HMF140

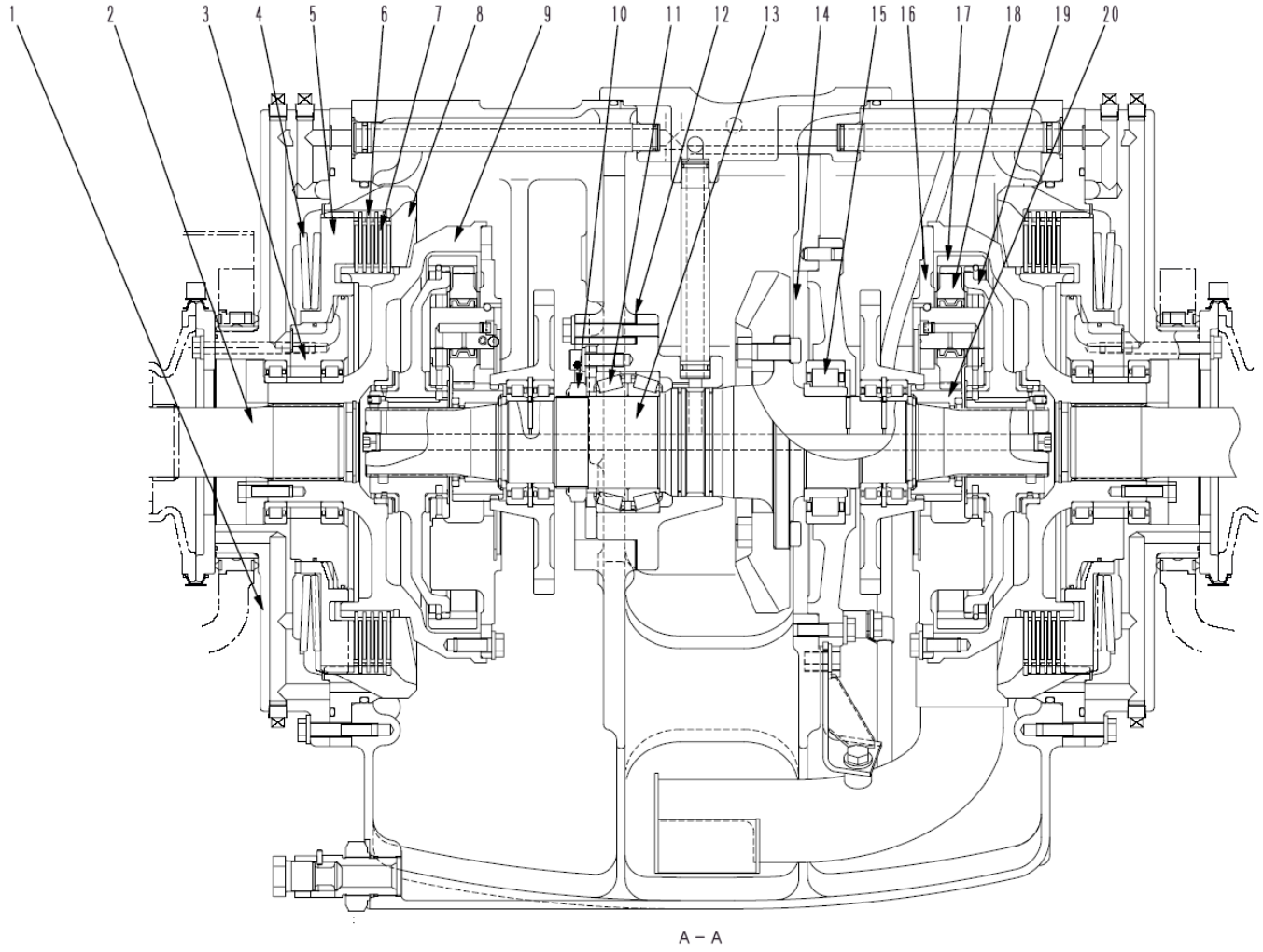

P : From pivot turn solenoid
C : From charge pump
B
Bypass valve
CA : Pressure sensor mounting port
Flashing shuttle valve
Charge relief valve
T : To hydraulic tank
CD : To hydraulic tank
CB : Pressure sensor mounting port
PA
PB
P
C A
M A
M B
T
C D
C B
C

# Steering and brake control

A. Neutral
B. Forward straight
C. Reverse straight
D. Left turn
E. Right turn
F. Brake OFF
G. Brake ON
H. Free
J. Lock



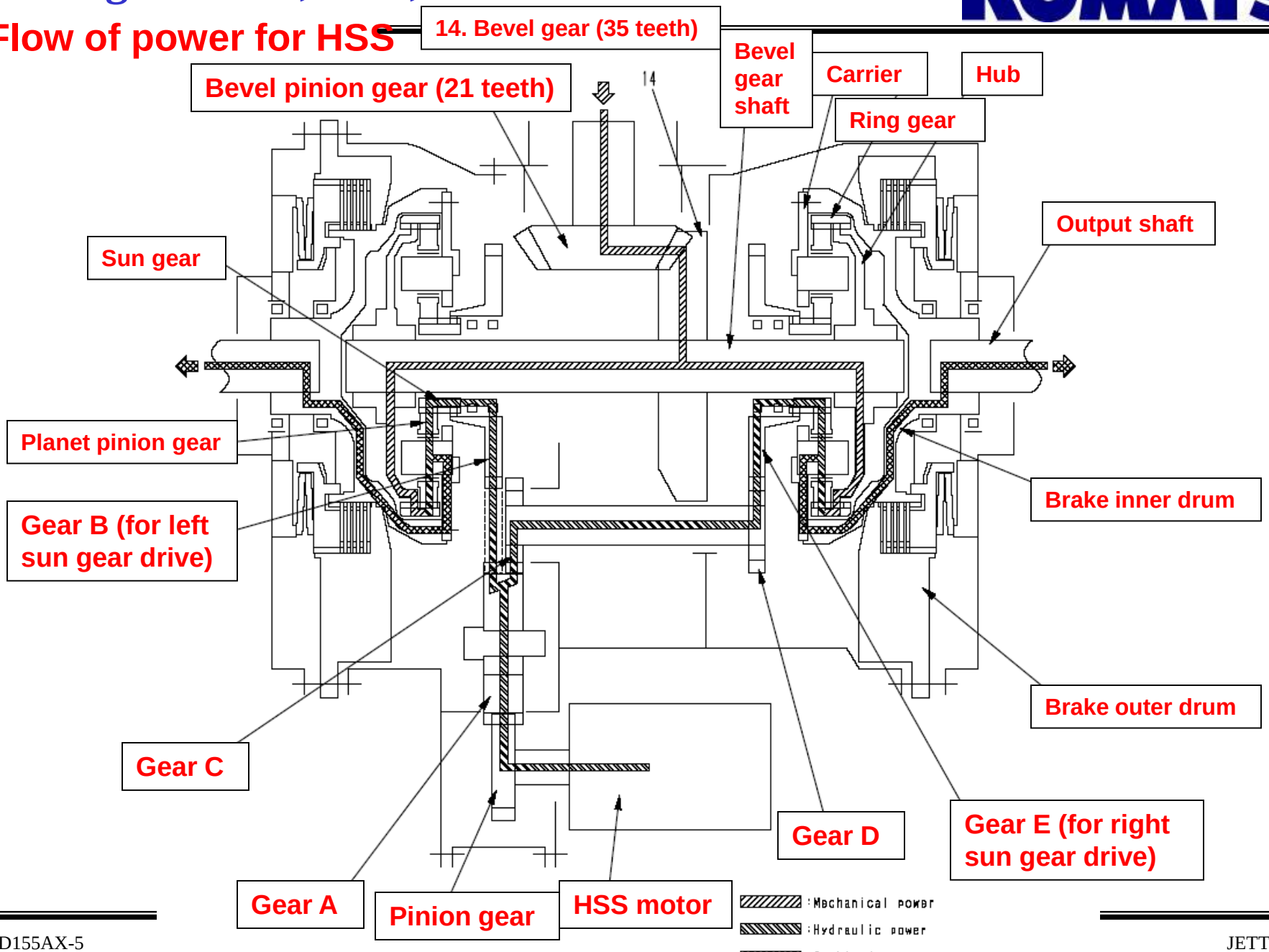
# Bevel gear shaft, HSS, brake




1. Cover
2. Output shaft
3. Bearing cage
4. Spring
5. Brake piston
6. Brake plate (4 on each side)
7. Brake disc (5 on each side)
8. Brake outer drum
9. Brake inner drum
10. Nut
11. Bearing A
12. Shim (for adjusting preload of bevel gear)
13. Bevel gear shaft
14. Bevel gear (35 teeth)
15. Bearing B
16. Carrier
17. Ring gear
18. Planet pinion gear
19. Hub
20. Sun gear

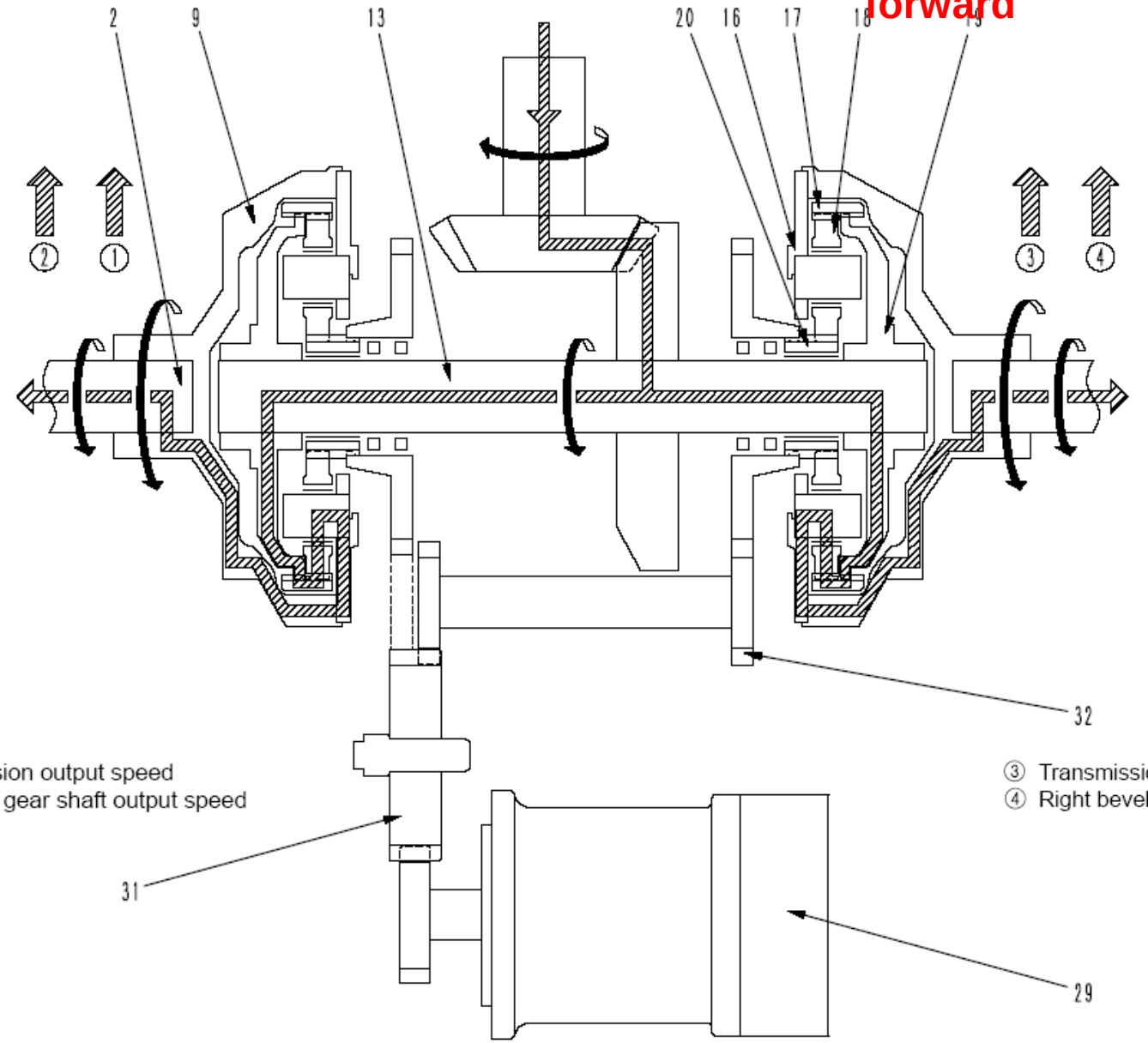
# Bevel gear shaft, HSS, brake

## Flow of power for HSS



## When PCCS lever is at NEUTRAL

## Travelling straight forward

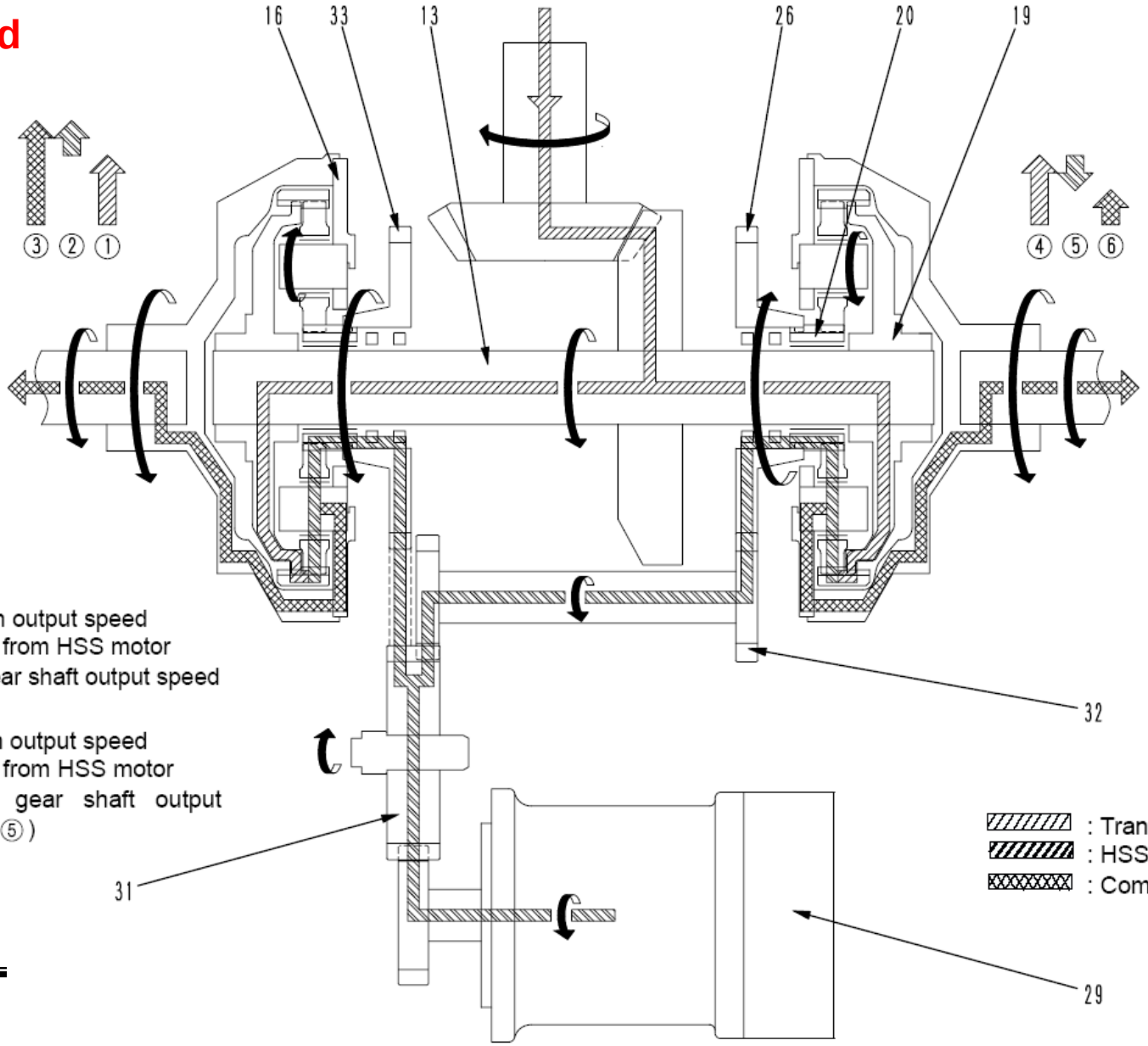



① Transmission output speed
② Left bevel gear shaft output speed

③ Transmission output speed
④ Right bevel gear shaft output speed

## PCCS lever operated to RIGHT TURN

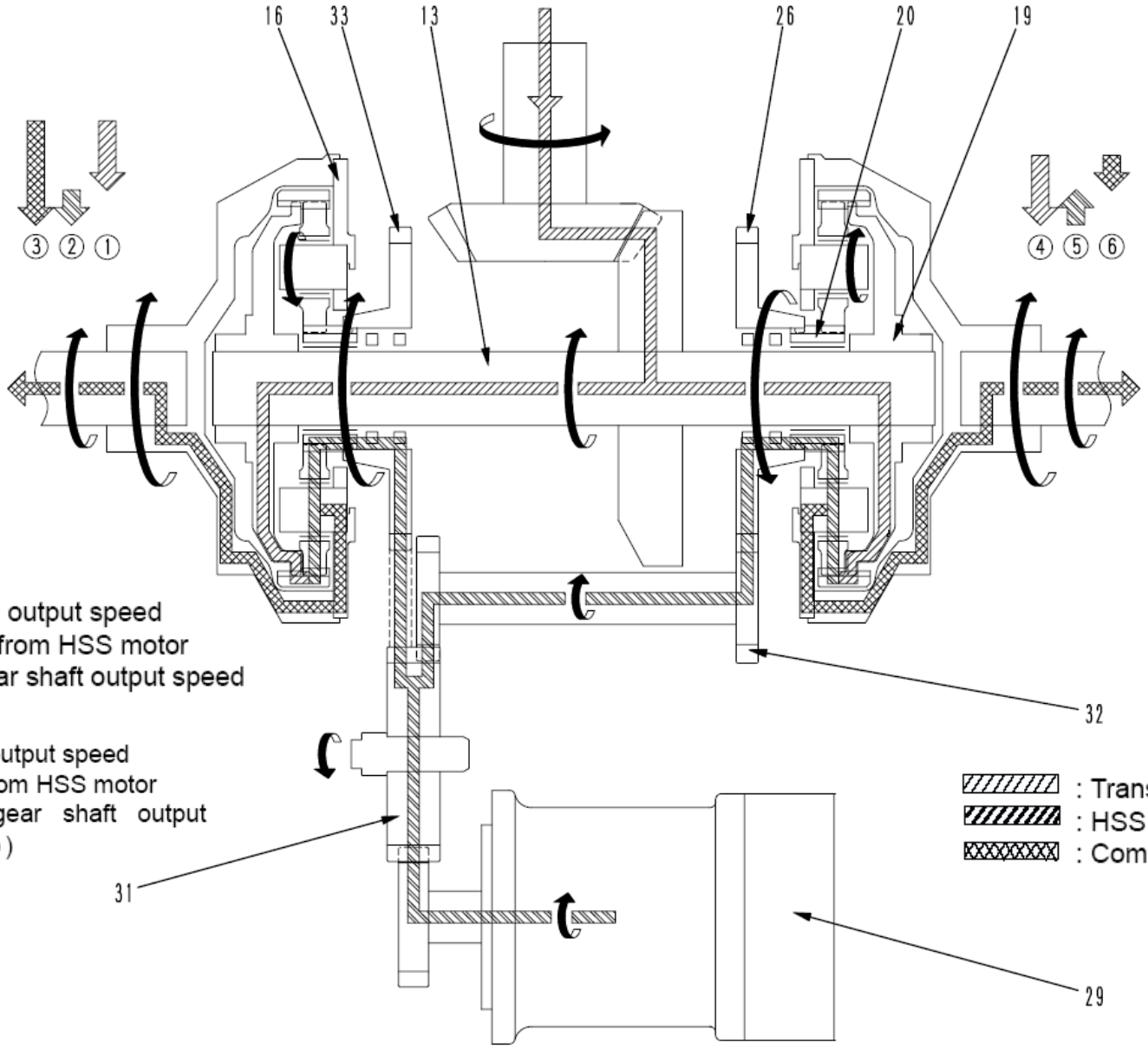
### Forward




① Transmission output speed
② Acceleration from HSS motor
③ Left bevel gear shaft output speed (① + ②)
④ Transmission output speed
⑤ Deceleration from HSS motor
⑥ Right bevel gear shaft output speed (④ - ⑤)

: Transmission power
: HSS motor power
: Combined power

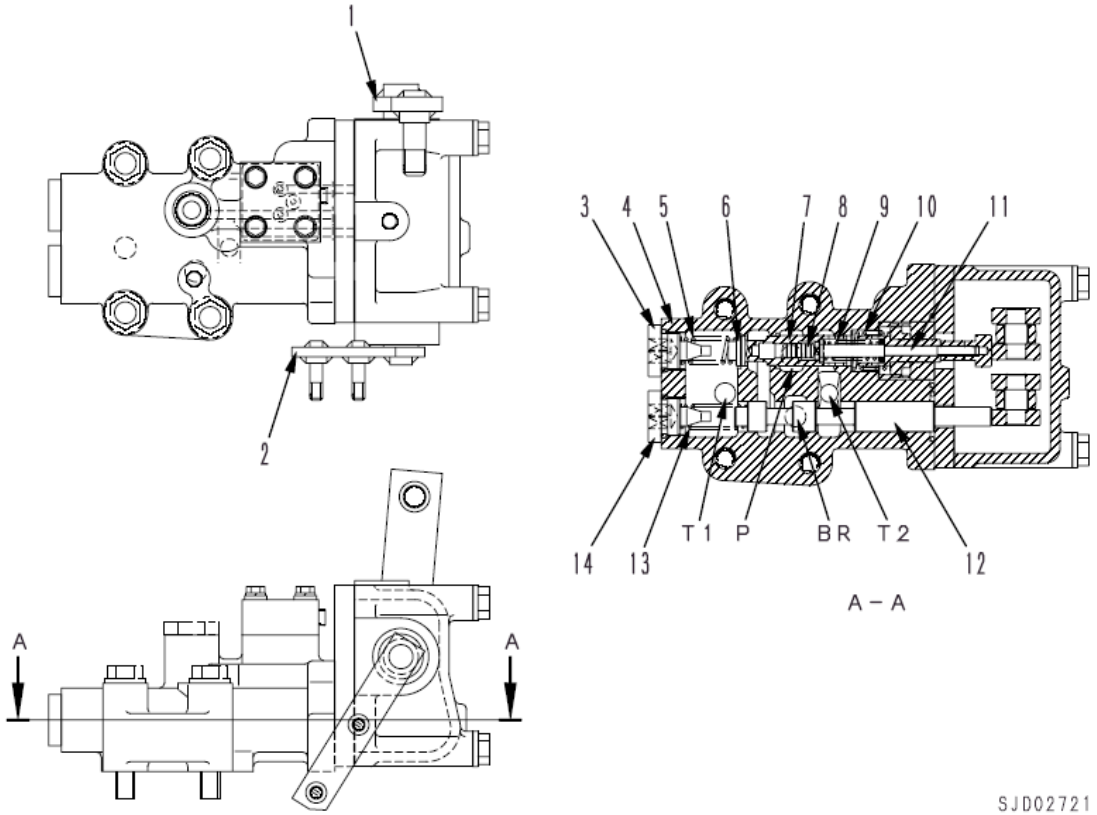
## Reverse




① Transmission output speed
② Acceleration from HSS motor
③ Left bevel gear shaft output speed (① + ②)
④ Transmission output speed
⑤ Deceleration from HSS motor
⑥ Right bevel gear shaft output speed (④ - ⑤)

: Transmission power
: HSS motor power
: Combined power

# Brake valve




**Outline**

**. The brake valve is in the circuit between the power train pump through the main relief valve and the brake piston inside the HSS unit. It consists of the main brake valve, parking brake valve, and solenoid valve.**

**. When the brake pedal is depressed, the pressurized oil flowing to the brake piston is shut off, so the brake piston pushes the disc and plate into tight contact because of the force of the spring, and the brake is applied. In the case of the HSS, the brake is used only for braking the machine, so the left and right brakes are actuated at the same time.**

**1. Main brake lever**

**2. Parking brake lever**

**3. Plug**

**4. Body**

**5. Spring**

**6. Seat**

**7. Brake valve**

**8. Piston**

**9. Spring (small)**

**10. Spring (large)**

**11. Shaft (main brake)**

**12. Shaft (parking brake)**

**13. Spring**

**14. Plug**

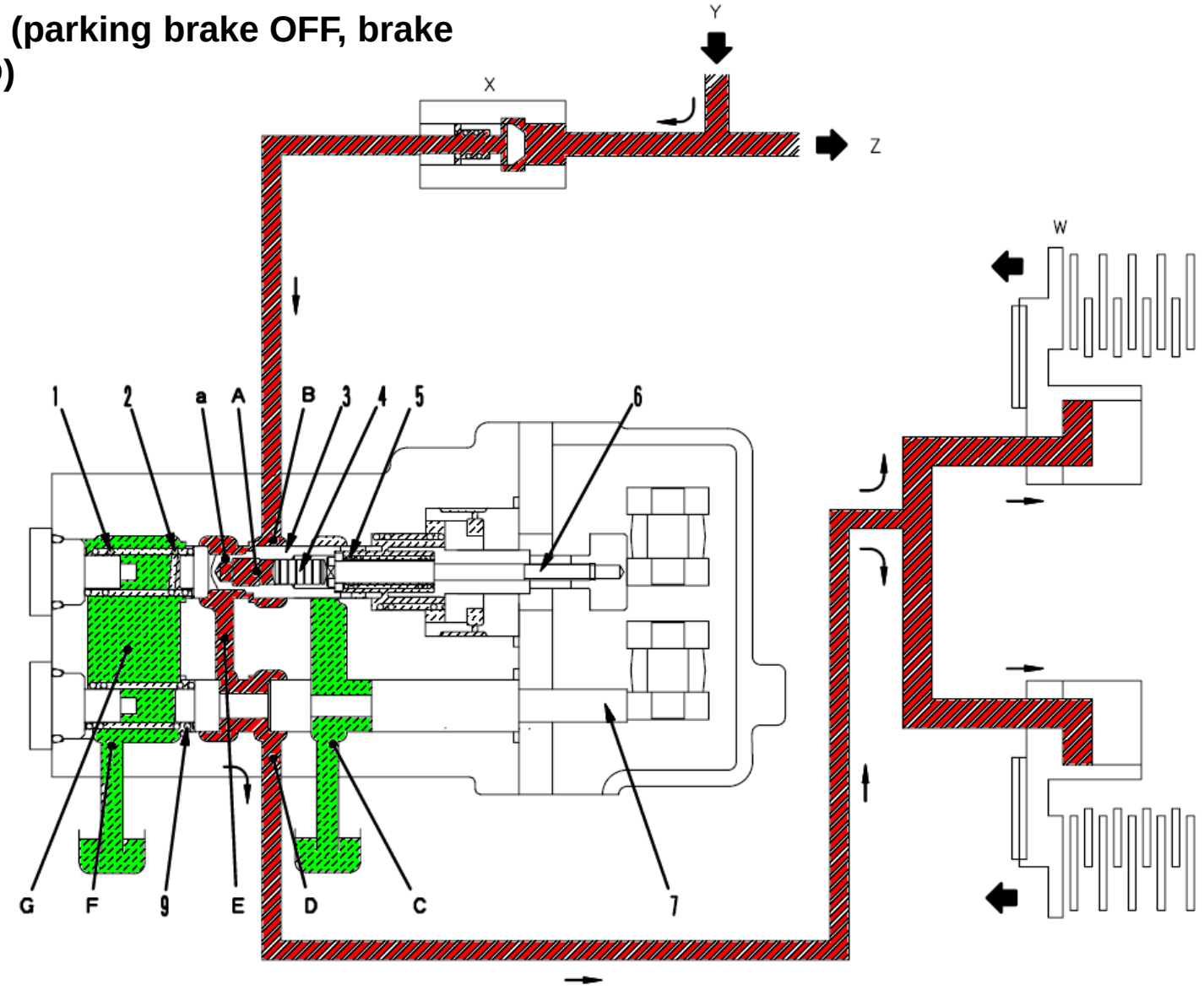
**T2: Drain**

**BR:To brake piston**

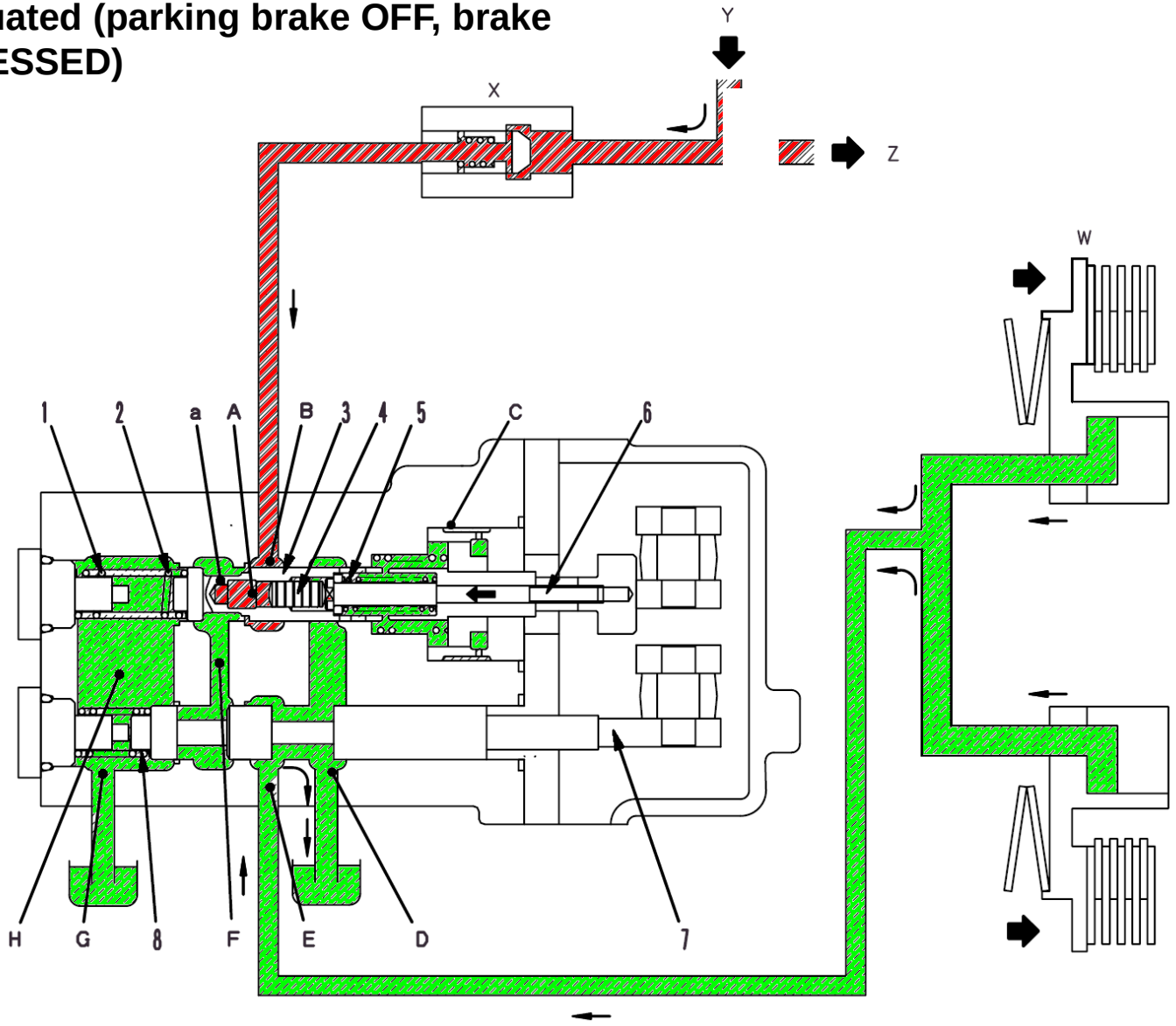
**P: From power train pump**

**T1: Drain**

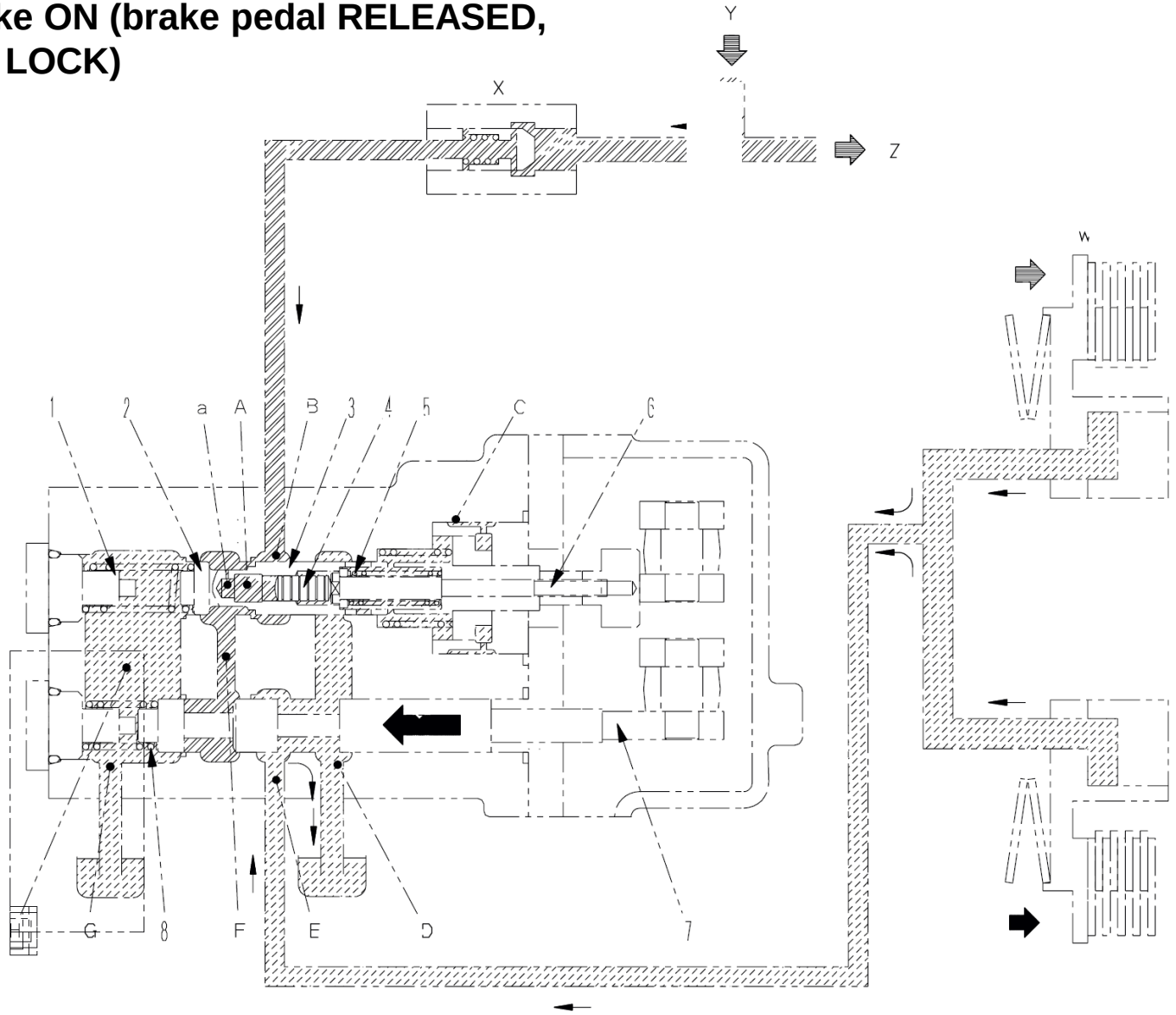
## 1. Brake released (parking brake OFF, brake pedal RELEASED)



## 2. Brake actuated (parking brake OFF, brake pedal DEPRESSED)



## 3. Parking brake ON (brake pedal RELEASED, safety lever at LOCK)



## Flow of power