UEBM000500

Shop Manual

PW170ES-6K

HYDRAULIC EXCAVATOR

SERIAL NUMBERS **PW170ES-6 -K30001** and up

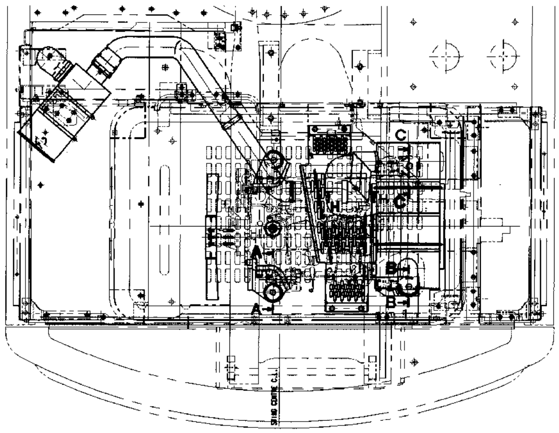
It is our policy to improve our products whenever it is possible and practical to do so. We reserve the right to make changes or add improvements at any time without incurring any obligation to install such changes on products sold previously.

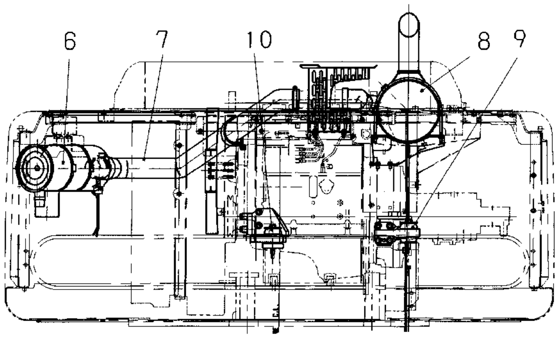
Due to this continuous program of research and development, periodic revisions may be made to this publication. It is recommended that customers contact their distributor for information on the latest revision.

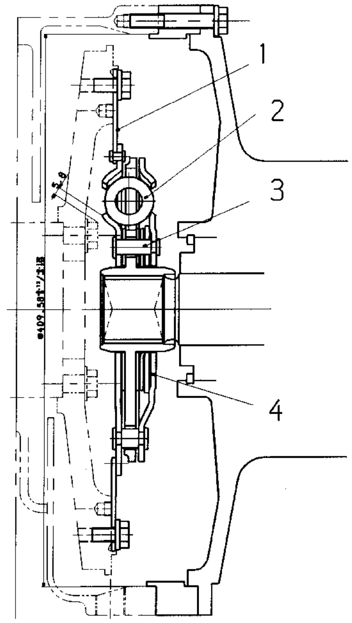
July 1999

10 STRUCTURE AND FUNCTION

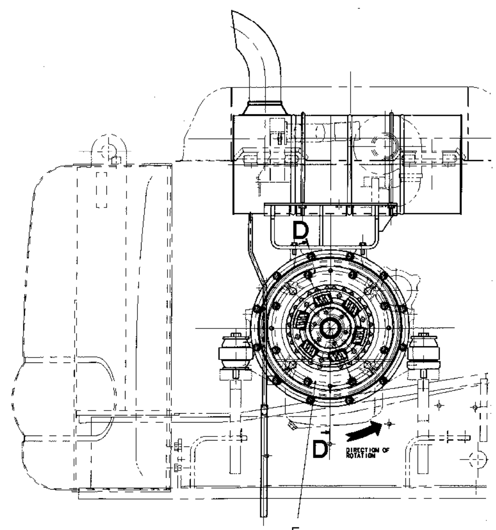
ENGINE RELATED PARTS

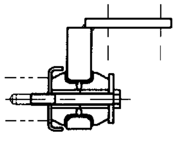




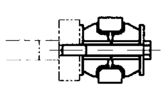


D- D

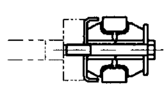




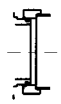
A-A



B-B



C-C



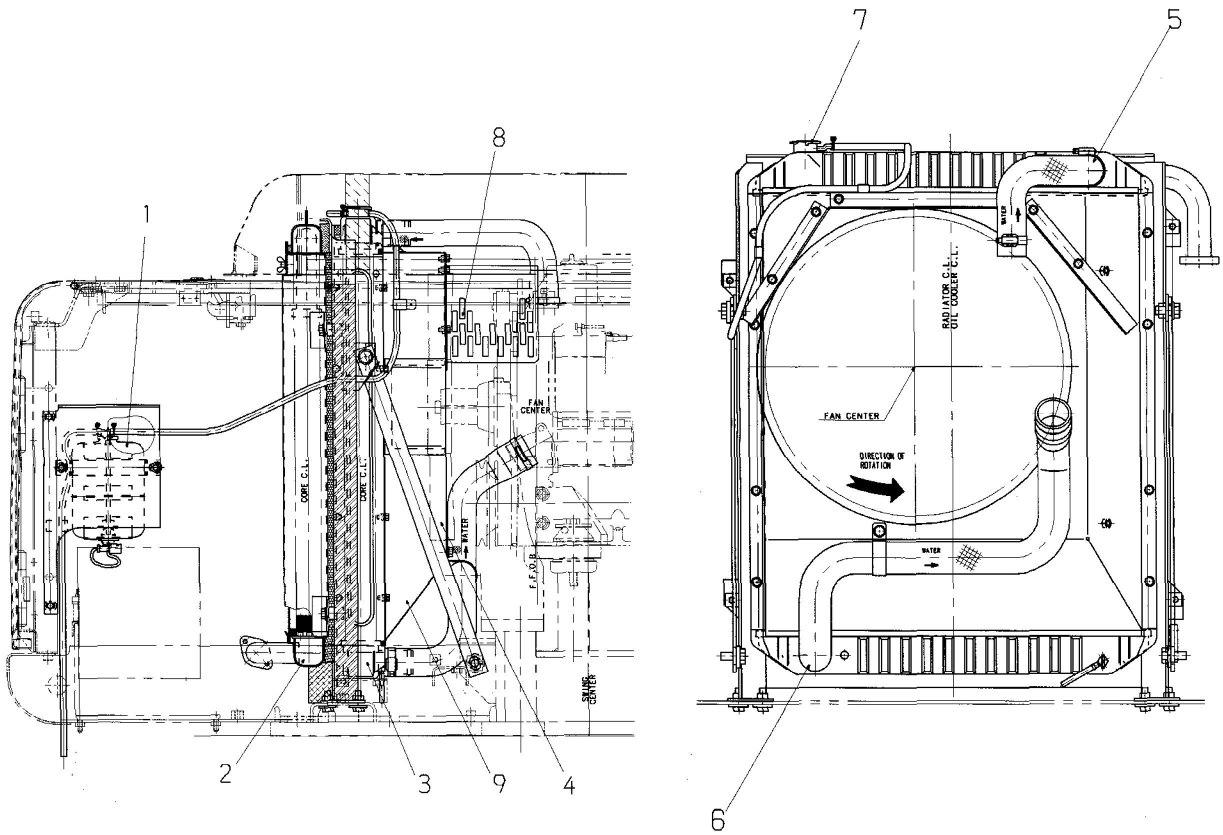
H-H

1. Drive plate
2. Torsion spring
3. Stopper pin
4. Friction plate
5. Damper assembly
6. Air cleaner
7. Intake connector
8. Muffler
9. Rear engine mount
10. Front engine mount

OUTLINE

- The damper assembly is a dry type.

RADIATOR • OIL COOLER

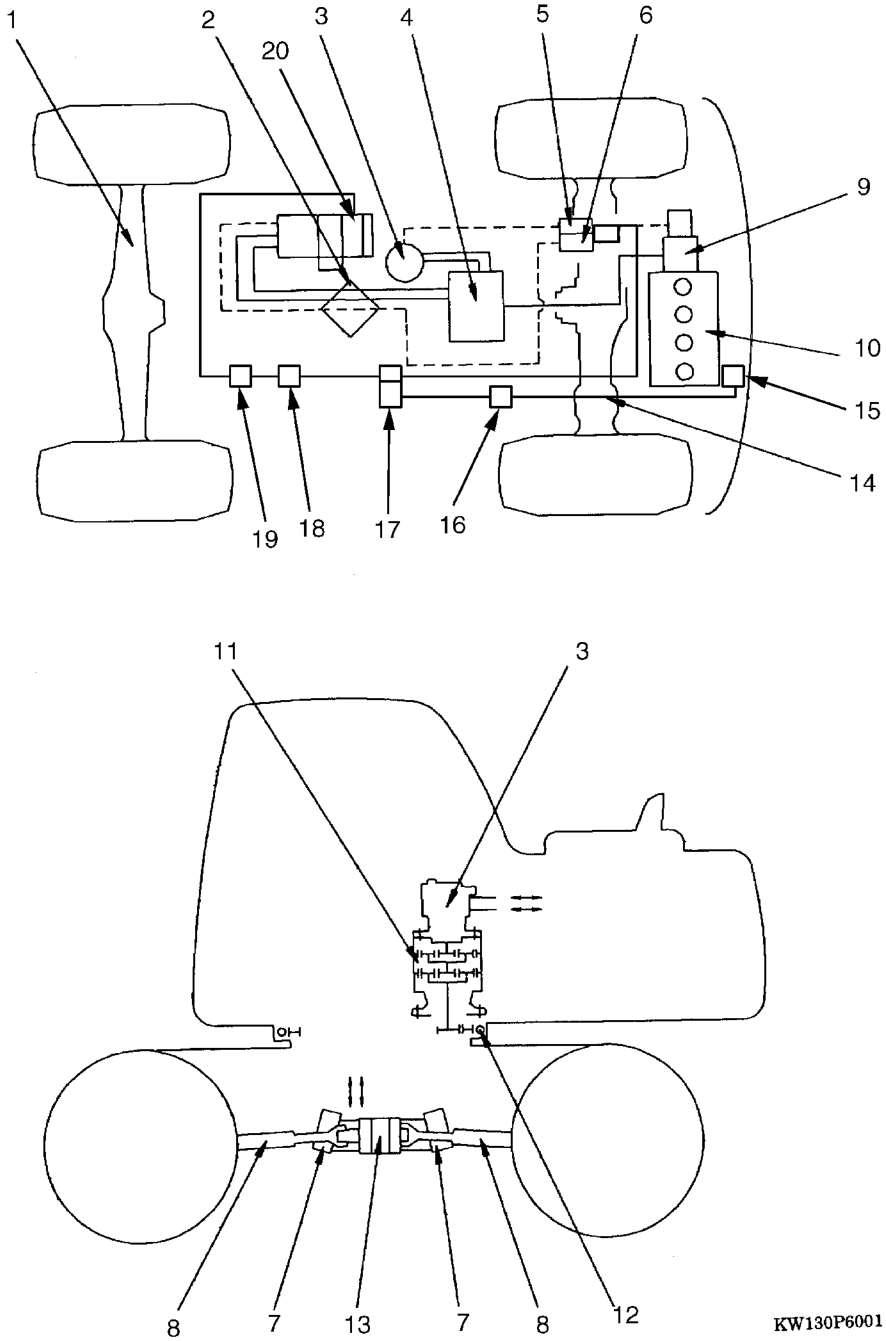


1. Reservoir tank
2. Oil cooler
3. Radiator
4. Fan
5. Radiator inlet hose
6. Radiator outlet hose
7. Radiator cap
8. Net
9. Shroud

SPECIFICATIONS

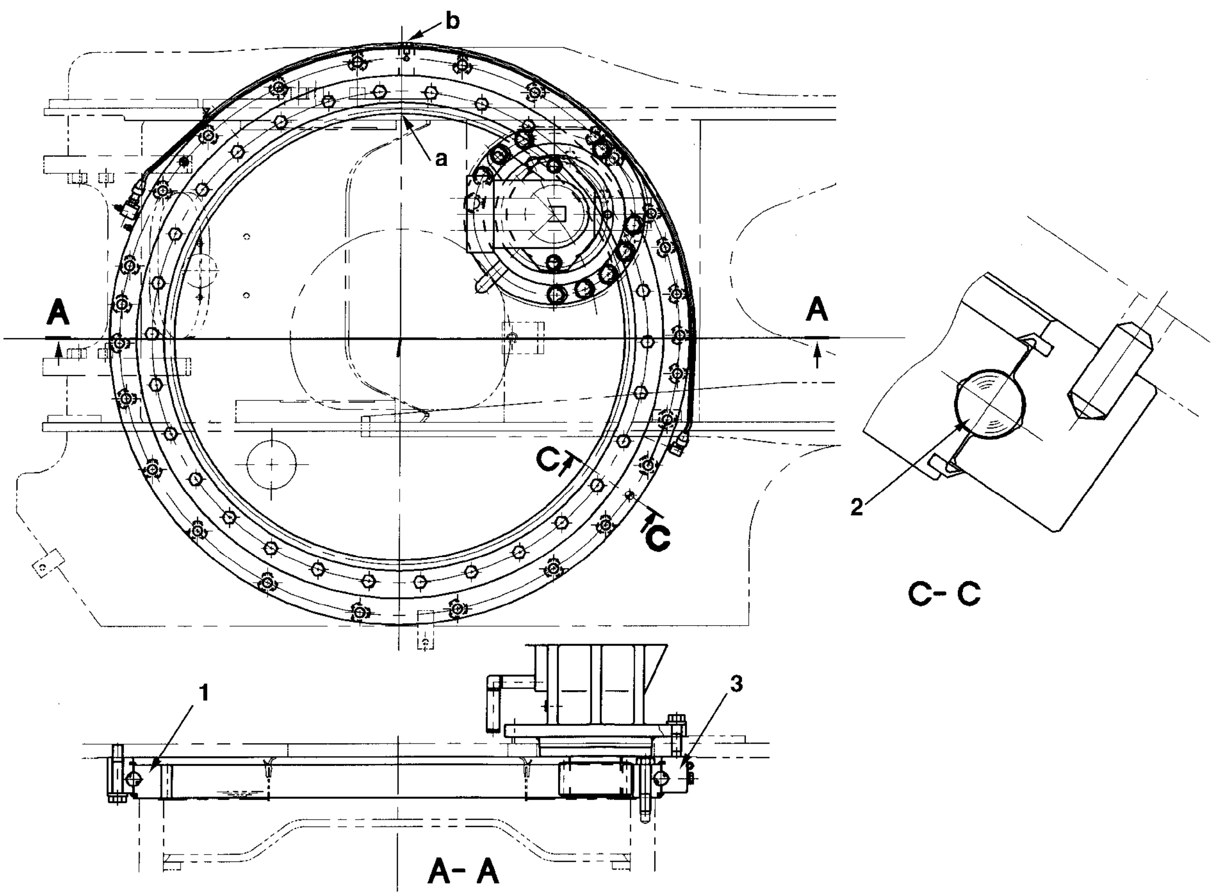
Radiator: CWX-4

Oil cooler: SF-3



1. Front axle
2. Center swivel joint
3. Swing motor
4. Control valve
5. Swing brake solenoid valve
6. Travel speed solenoid valve
7. Travel motor
8. Propshaft
9. Hydraulic pump
10. Engine
11. Swing machinery
12. Swing circle
13. Transmission
14. Rear axle
15. Gear pump
16. Priority valve
17. Power brake valve
18. Pressure reducing valve
19. Clutch control valve
20. Clutch

SWING CIRCLE



1. Swing circle inner race (No. of teeth: 94)
2. Ball
3. Swing circle outer race

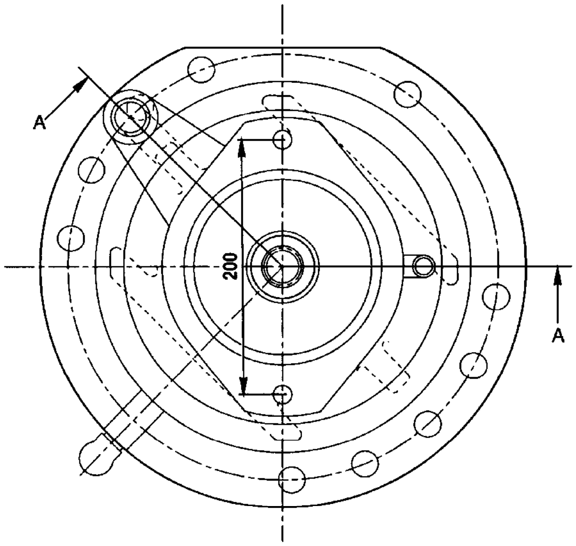
a. Inner race soft zone **S** position
b. Outer race soft zone **S** position

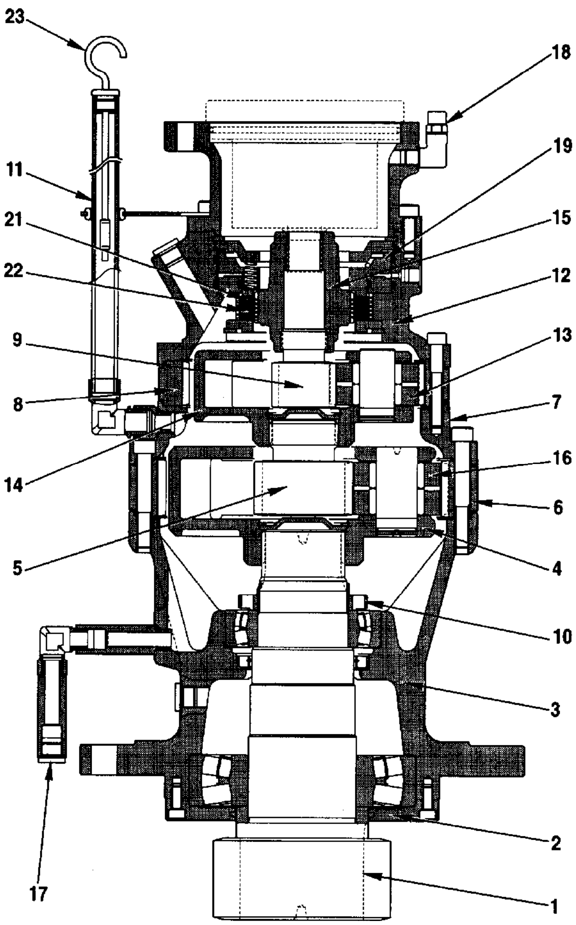
SPECIFICATIONS

reduction ratio: $\frac{94}{12} = 7.833$

amount of grease: 8/(G2-LI)

SWING MACHINERY





1. Swing pinion (No. of teeth: 12)
2. Cover
3. Case
4. No. 2 of planetary carrier
5. No. 2 sun gear (No. of teeth: 24)
6. No. 2 ring gear (No. of teeth: 78)
7. Case
8. No. 1 ring gear (No. of teeth: 78)
9. No. 1 sun gear (No. of teeth: 18)
10. Retainer
11. Oil level gauge
12. Cover
13. No. 1 planetary gear (No. of teeth: 29)
14. No. 1 planetary carrier
15. Coupling
16. No. 2 planetary gear (No. of teeth: 26)
17. Drain plug
18. Breather
19. Parking brake piston
20. Parking brake spring
21. Parking brake disc
22. Parking brake plate
23. Gauge rod

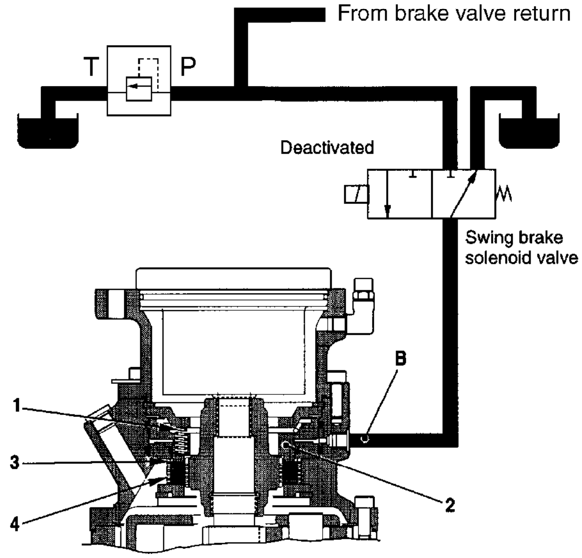
SPECIFICATIONS

reduction ratio: $\frac{24+78}{24} \times \frac{18+78}{18} = 22.667$

SWING HOLDING BRAKE

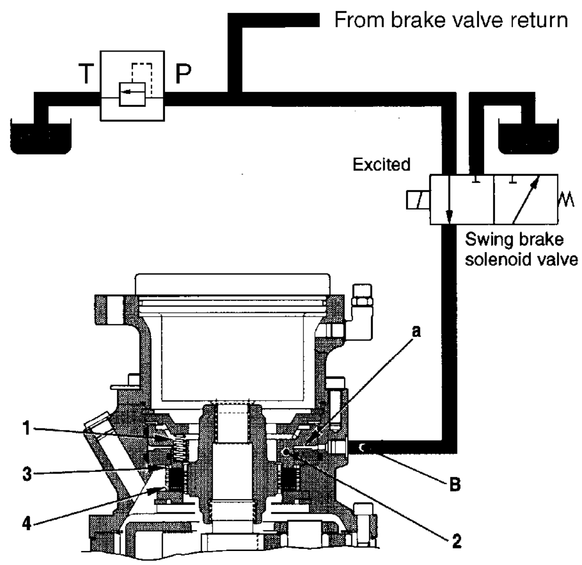
OPERATION

1) **When swing brake solenoid valve is deactivated**
   When the swing brake solenoid is deactivated, the pressurized oil from the PPC pressure reducing valve is shut off and port **B** is connected to the tank circuit.
   Because of this, brake piston (2) is pushed down in the direction of the arrow by brake spring (1), so disc (3) and plate (4) are pushed together and the brake is applied.

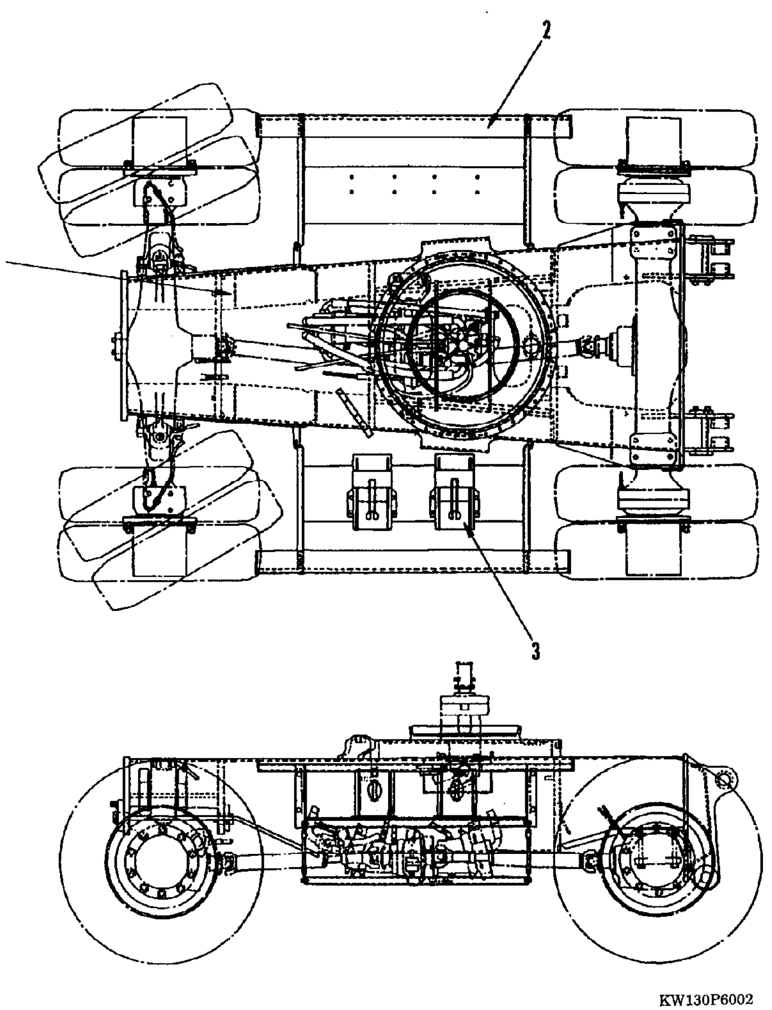


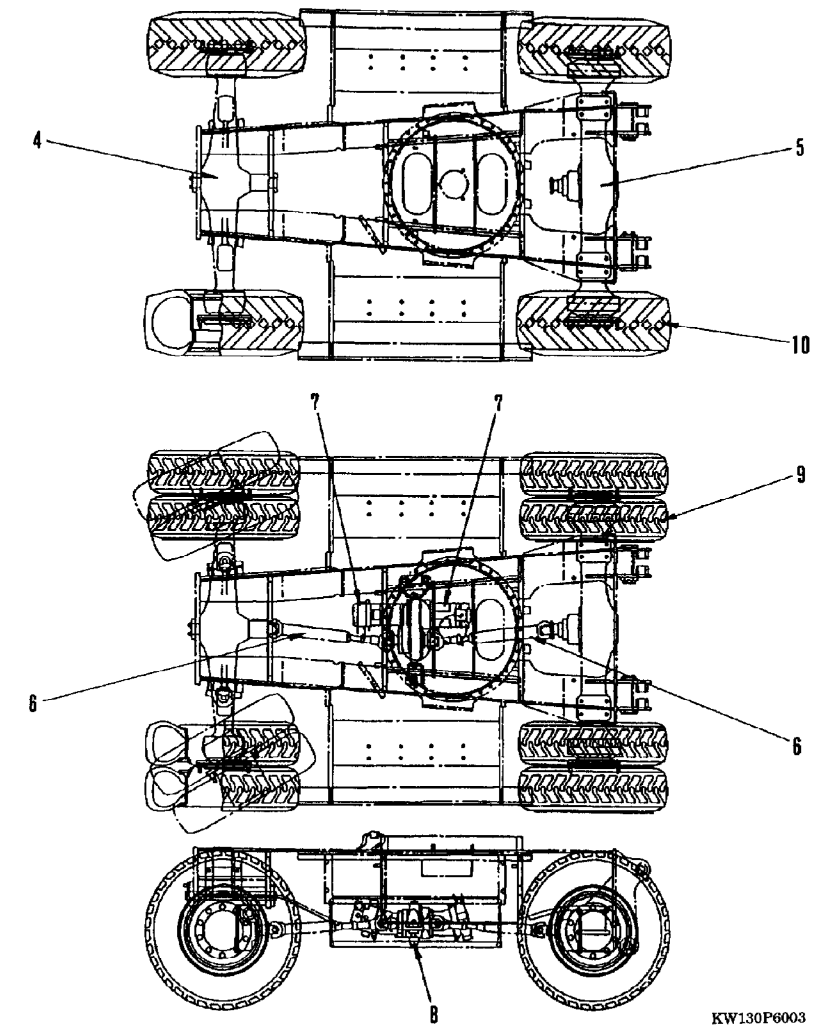
2) **When swing brake solenoid valve is excited**
   When the swing solenoid valve is excited, the valve is switched, and the pressurized oil from the PPC pressure reducing valve enters port **B** and flows to brake chamber "**a**".
   The pressurized oil entering chamber "**a**" overcomes the force of brake spring (1), and brake piston (2) is pushed up in the direction of the arrow. Because of this, disc (3) and plate (4) separate, and the brake is released.

1. Brake spring
2. Brake piston
3. Disc
4. Plate



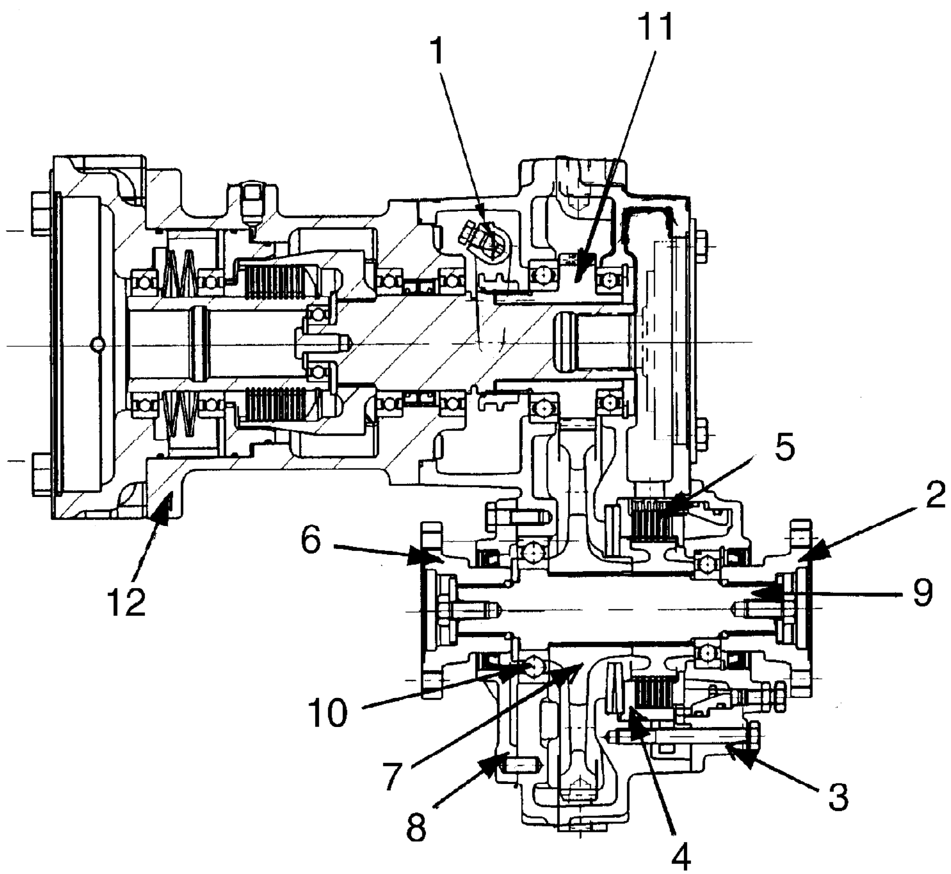
UNDERCARRIAGE





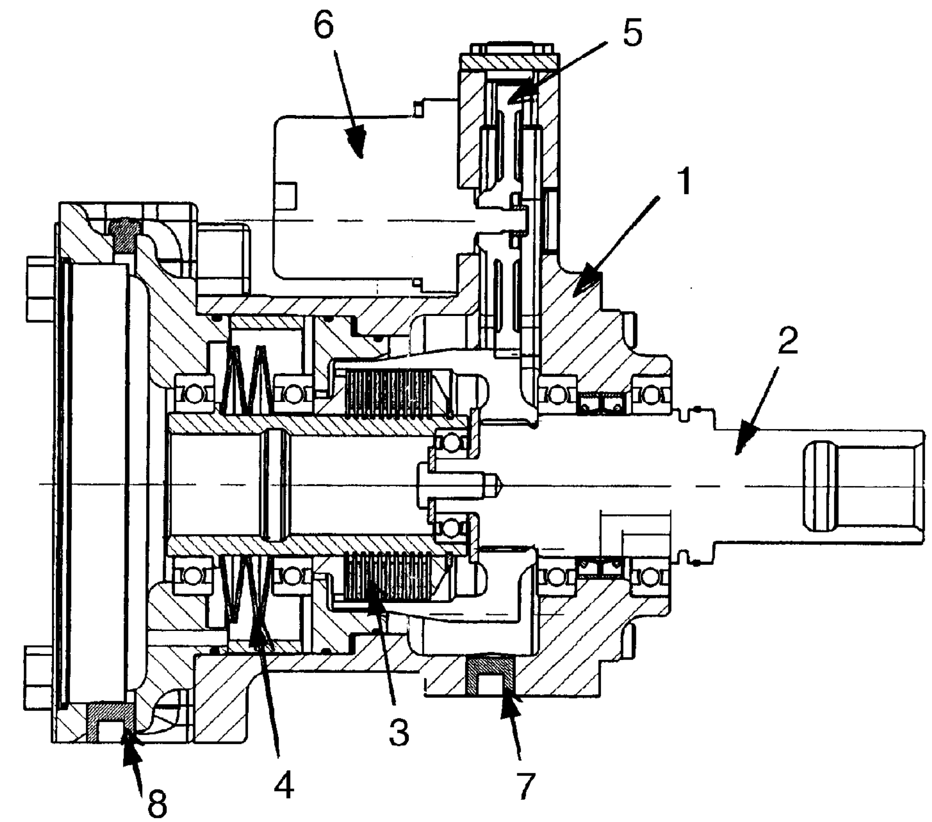
1. Undercarriage
2. Step
3. Wheel chock
4. Front oscillating steering axle
5. Rear axle
6. Propshaft
7. Travel motor
8. Transmission
9. Double wheel ass'y
10. Single wheel ass'y

TRANSMISSION



1. Screw-fork to shaft
2. Flange
3. Brake cylinder
4. Brake drum
5. Friction disk
6. Flange
7. Gear
8. Cover
9. Output shaft
10. Bearing
11. Gear
12. Clutch ass'y

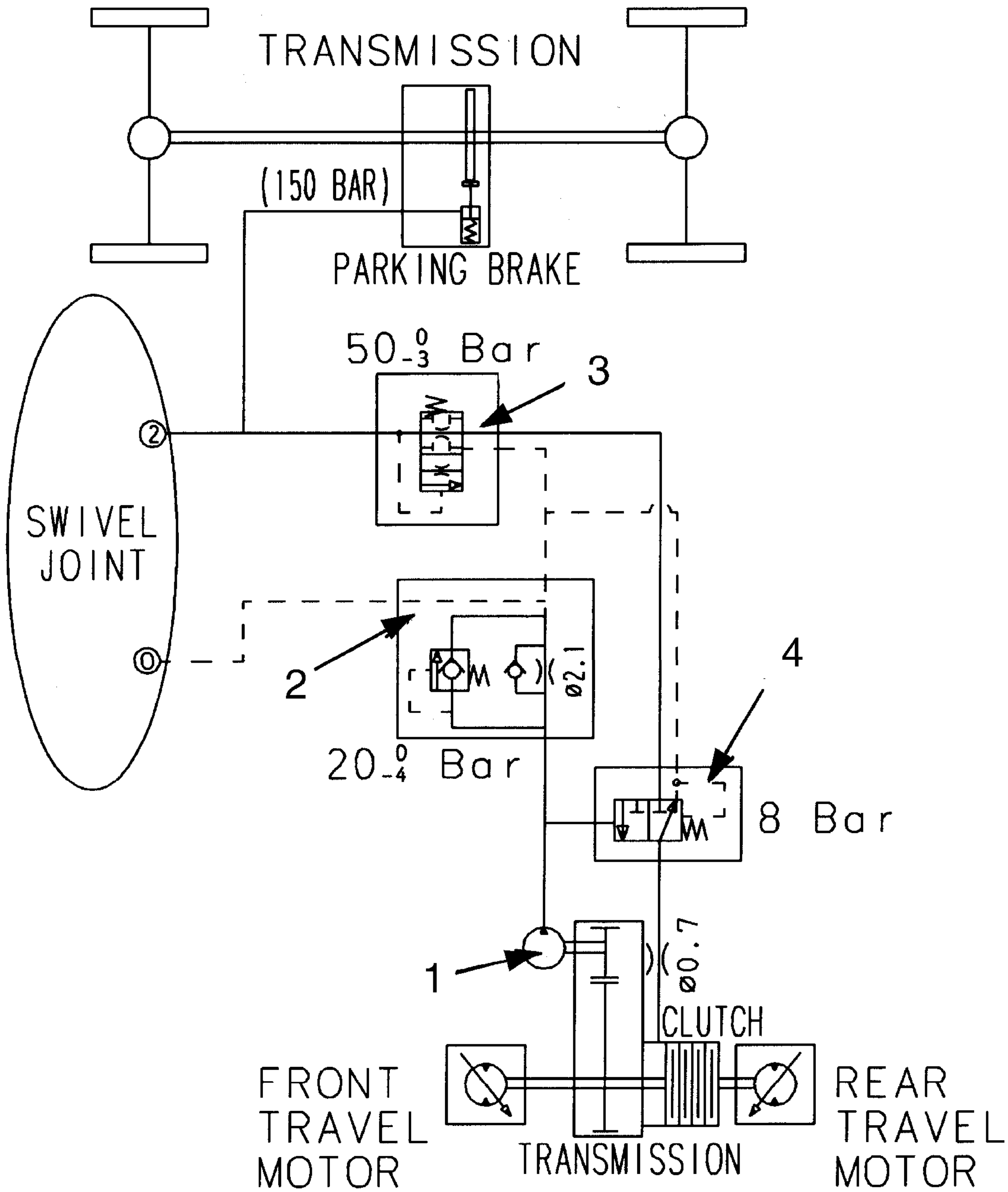
CLUTCH ASS'Y



1. Casing
2. Drive shaft
3. Friction plates
4. Spring discs
5. Gear
6. Clutch control gear pump
7. Plug
8. Plug

CLUTCH CONTROL CIRCUIT

STRUCTURE



1. Clutch control pump
2. Pressure relief valve ass'y
3. Pressure reducing valve
4. Clutch control valve

FUNCTION

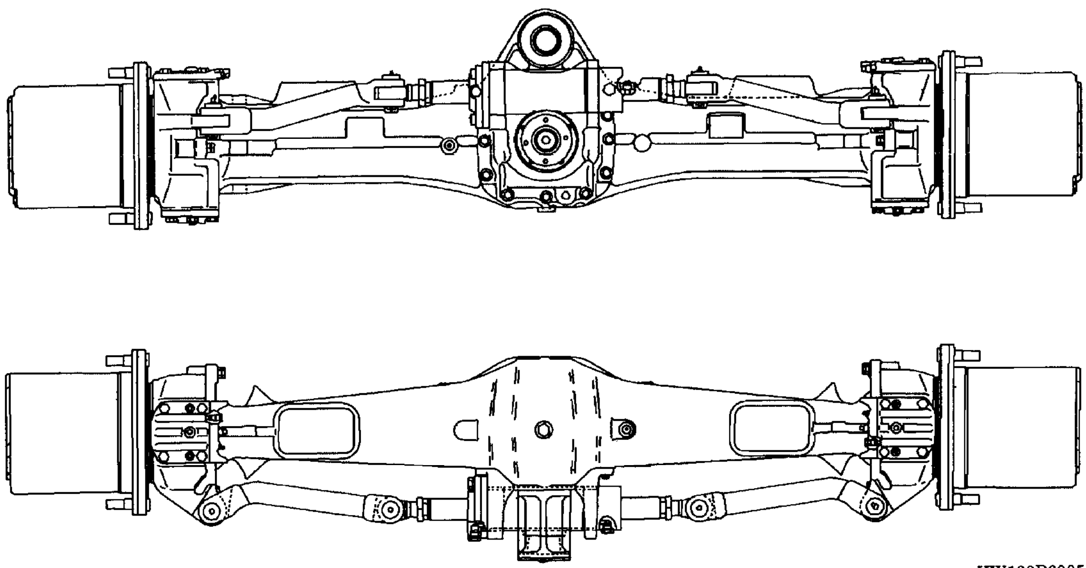
The clutch is a device which automatically disengages the drive between the 200 cc (rear) travel motor and the transmission. This occurs when the machine is accelerating and the disengagement occurs at 11 Kph. The transmission system becomes more efficient (by reducing losses caused by the unnecessary rotation of the rear travel motor) providing better acceleration and enabling a maximum speed of 30 Kph.
When the machine decelerates from a high speed the clutch will re-engage automatically at 9 Kph and will remain engaged until the speed is increased above 11 Kph again.

AXLE

OUTLINE

- Each axle consists of an axle housing supporting the chassis weight, a differential set in the axle housing, a final drive, and a brake provided at each and.
- A trunnion-type axle shaft with a king pin at the final drive end is used to enable the direction of travel of the machine to be changed.

FRONT AXLE



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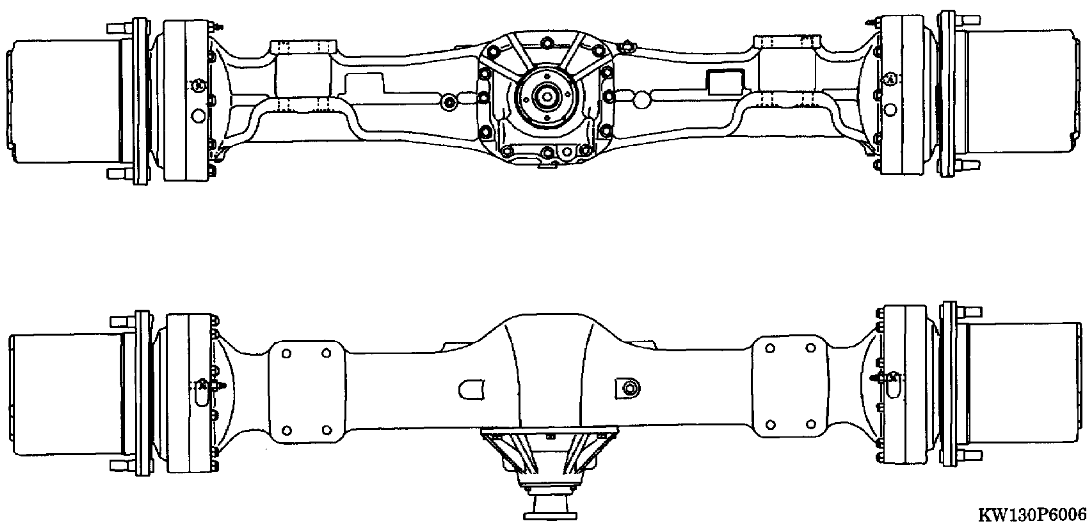
REAR AXLE



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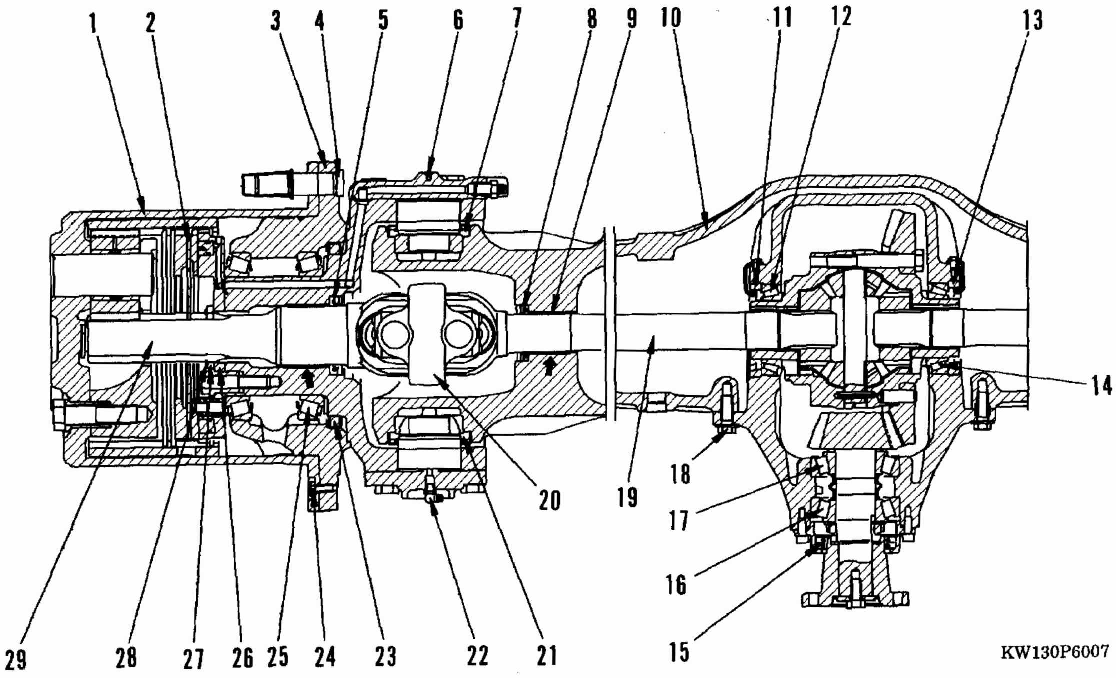
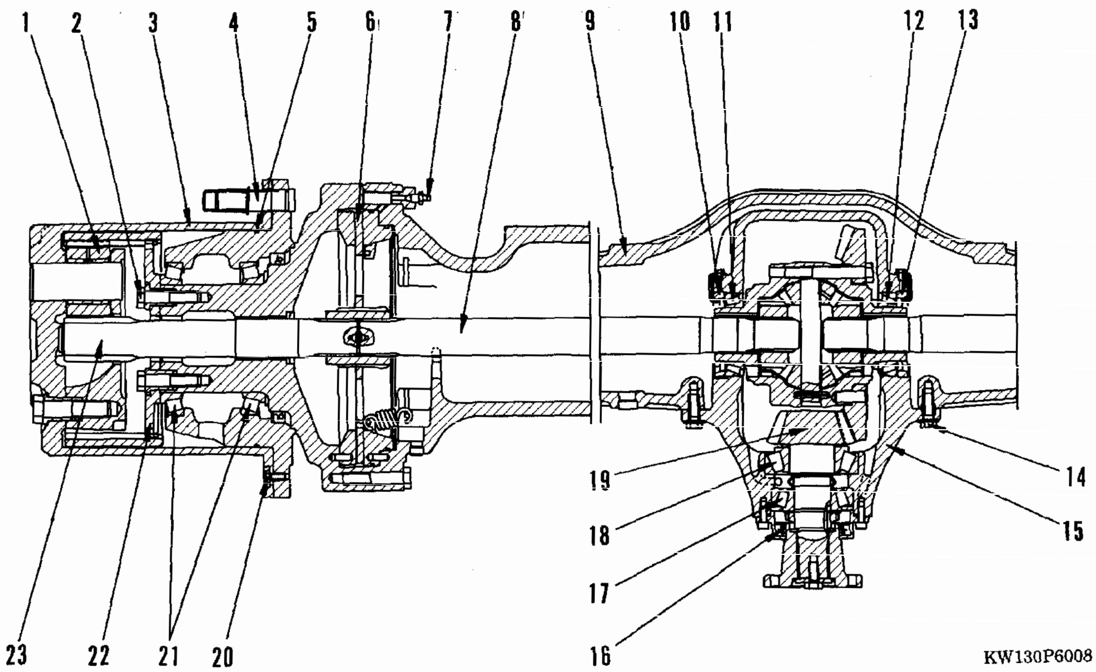
FRONT AXLE



Axle reduction ratio = 17, 73:1

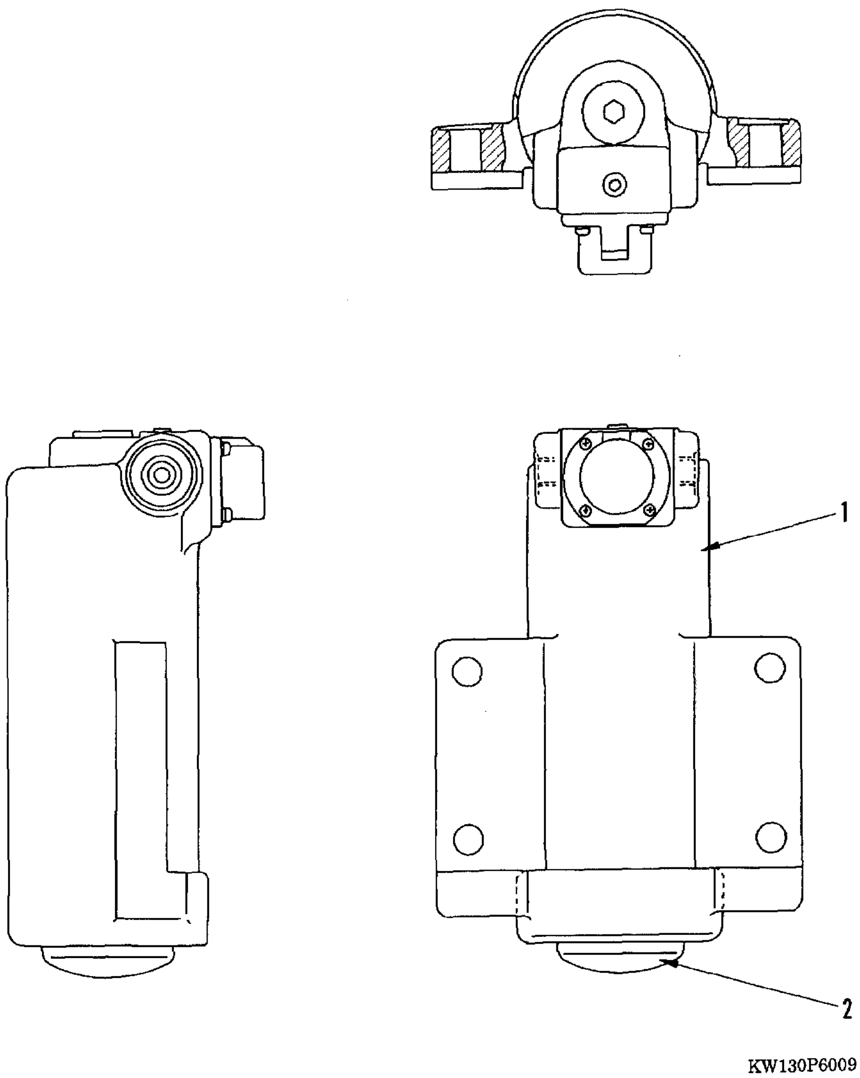
1. Planetary carrier
2. Washer
3. Brake drum
4. Pin
5. Seal ring
6. Grease nipple
7. Seal ring
8. Seal ring
9. Bushing
10. Axle tube
11. Ring nut
12. Ball bearing
13. Ring nut
14. Ball bearing
15. Seal ring
16. Roller bearing
17. Roller bearing
18. Hexagon head screw
19. Shaft
20. Joint
21. Bushing
22. Brease nipple
23. Seal ring
24. Cylinder head screw
25. Roller bearing
26. Washer
27. Ring
28. Hexagon head screw
29. Sun gear

REAR AXLE



1. Planetary gear
2. Bolt
3. Planetary carrier
4. Stud
5. Wheel Hub
6. Bushing
7. Socket
8. Shaft
9. Axle tube
10. Ring nut
11. Roller bearing
12. Roller bearing
13. Shim
14. Bolt
15. Cover
16. Seal ring
17. Roller bearing
18. Roller bearing
19. Bevel gear
20. Cylinder head screw
21. Bearing
22. Ring gear plate
23. Sun gear

SUSPENSION LOCK CYLINDER



1. Barrel
2. Plunger

Specifications

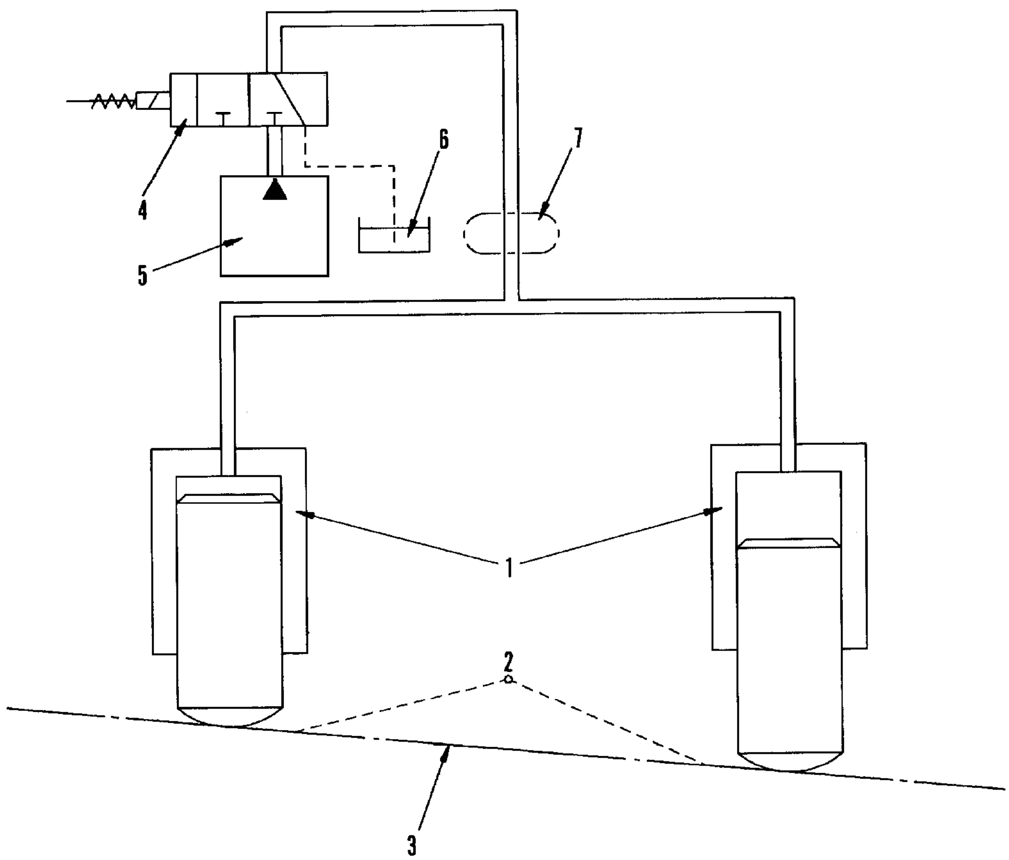
Piston: ø100mm
Stroke: 155mm
Operating pressure: 40.0 MPa (408 Kg/cm^2)
Pilot pressure: 3.0 MPa (30.6 Kg/cm^2)
Max 5.0 MPa (51.0 Kg/cm^2)

CIRCUIT

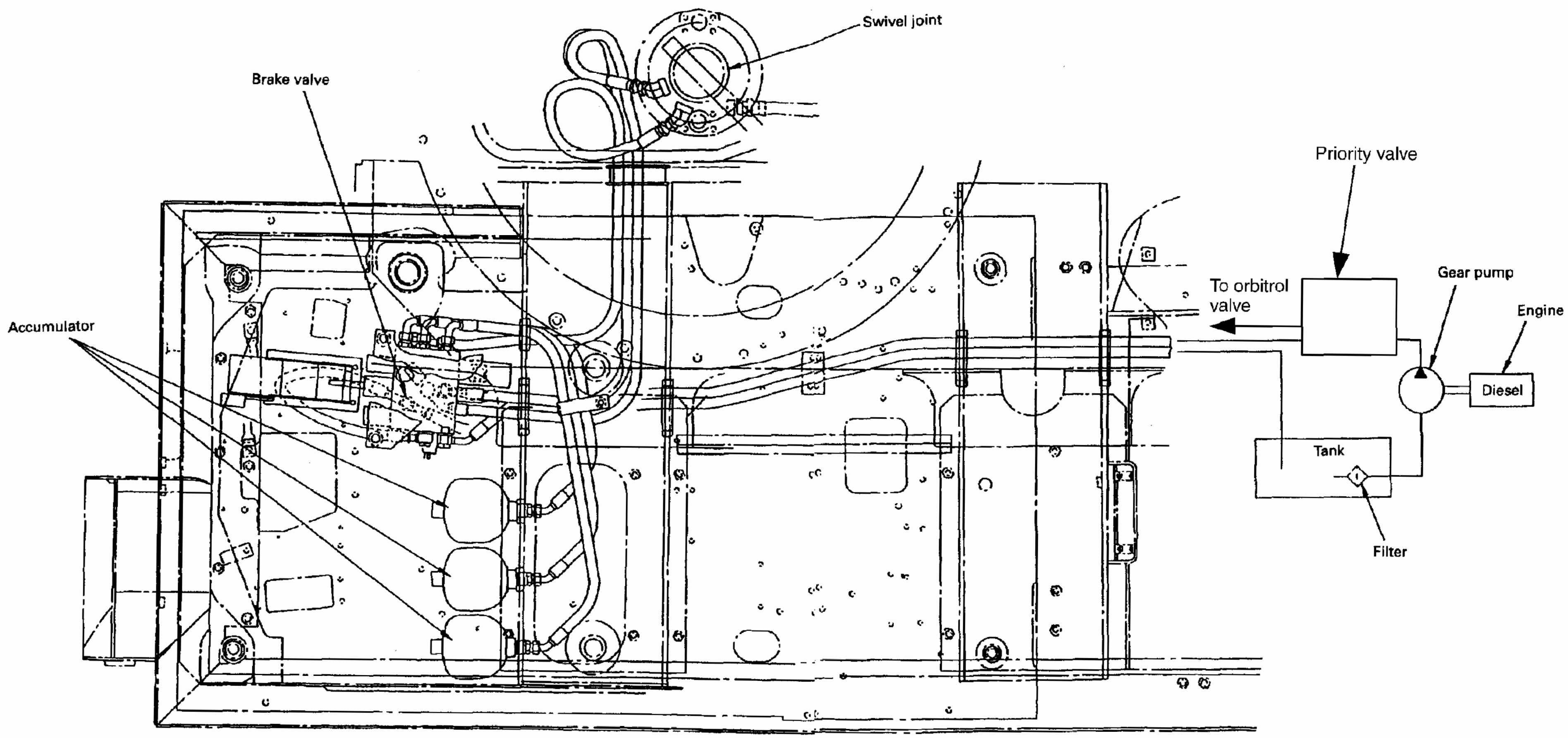
Purpose
The undercarriage of wheeled hydraulic excavators have one of the two driven axles oscillating mounted. This makes it possible to fully utilize the excavator's rimpull in rough terrain - all of the wheels being constantly in contact with the ground.
An oscillating blocking ram is fitted on each side of the undercarriage to block the axle during digging or lifting work.
Blocking the axle increases the excavator's stability.

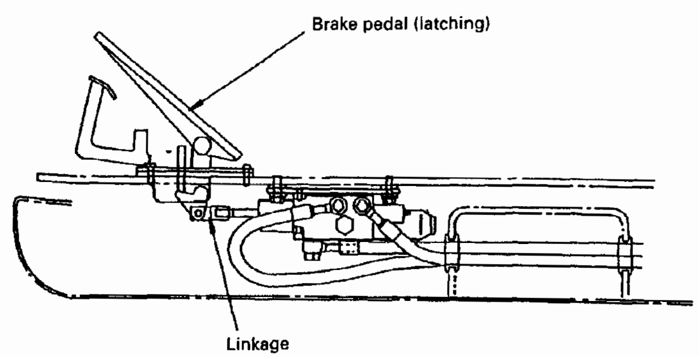
1. Ram
2. Axle oscillating point
3. Oscillating axle
4. Oscillation lock solenoid valve
5. PPC pressure reducing valve
6. Hydraulic tank
7. Swivel joint

Function
The oscillating axle (3) is mounted in bearing (2) in the middle of the excavator. The two rams (1) which are full of hydraulic oil are connected through pipelines to the oscillation lock solenoid valve (4).
When the excavator is being moved, the oscillation lock solenoid valve should be de-energized so that the hydraulic oil in the ram can be returned to tank as the axle is oscillating up and down. Before commencing excavating operations, the oscillation lock solenoid valve should be energized to pressurize the oil in the rams. This will lock the axle in the position it is in.

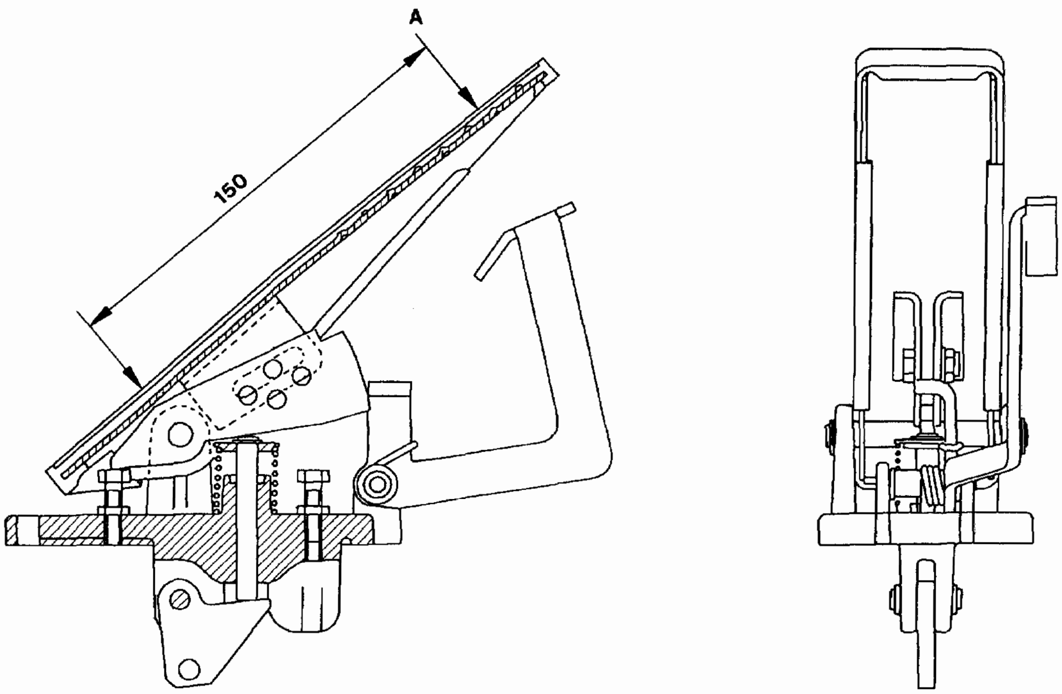


BRAKING TRAIN





BRAKE PEDAL

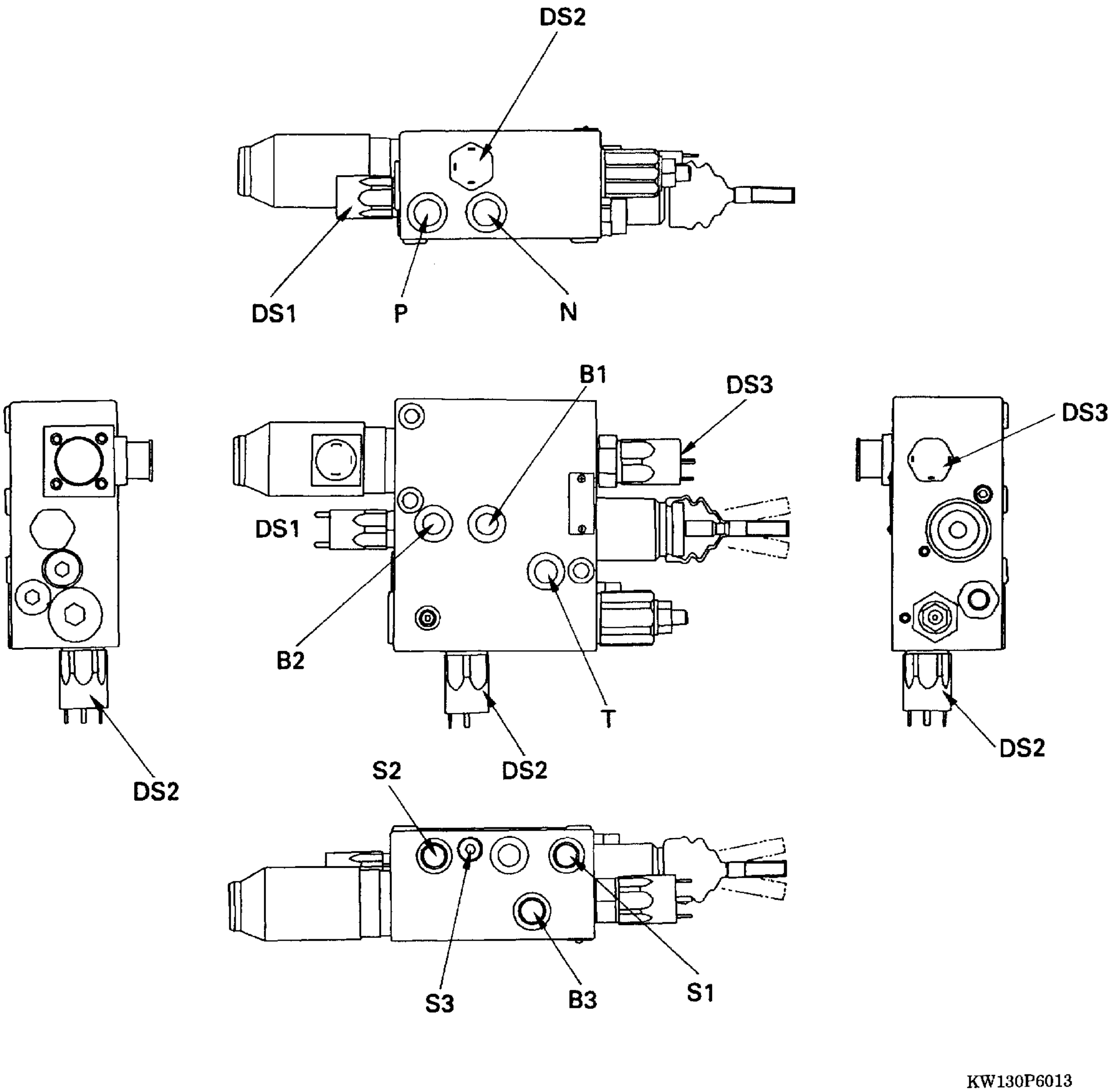


KW130P6012

Actuation force at 'A' = 300 - 350 N
(30.6 - 35.7 kg)

When installed in machine

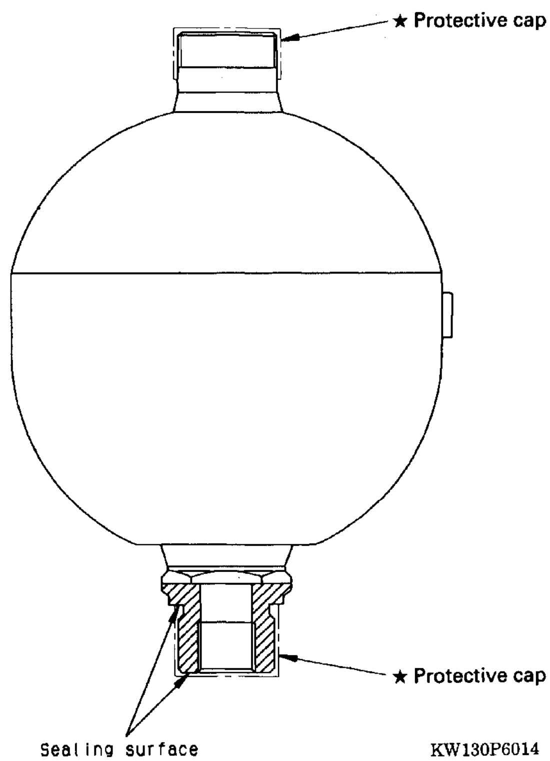
BRAKE VALVE



P = Pump
N = Secondary circuit
T = Tank
B1 = Service brake
B2 = Service brake
B3 = Parking brake

S1 = Accumulator service brake
S2 = Accumulator service brake
S3 = Accumulator parking brake
DS1 = Pressure switch stop light
DS2 = Pressure switch acculator-pressure
DS3 = Pressure switch parking brake

ACCUMULATOR FOR BRAKE SYSTEM

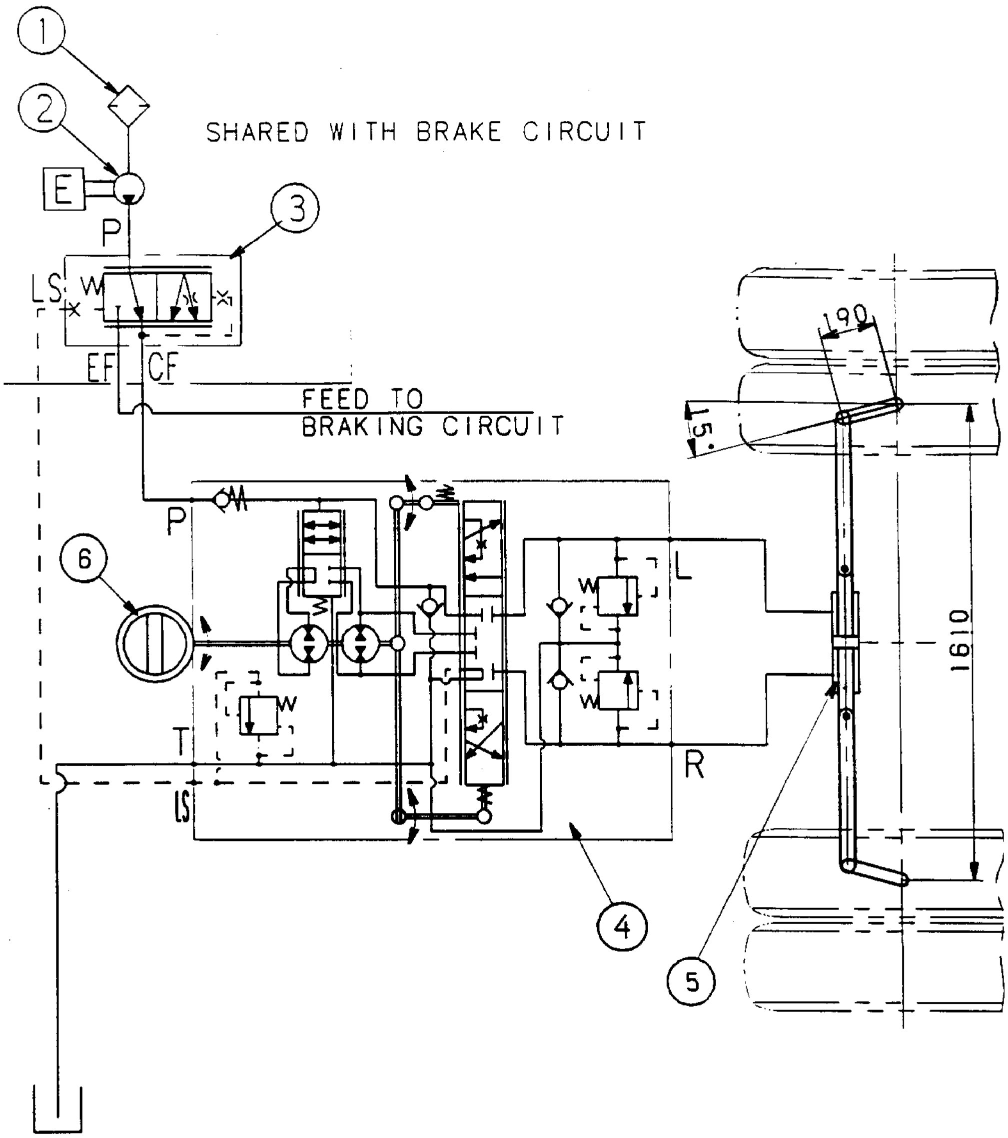


Specifications

Volume: 0.75 ℓ
Max working pressure: 210 bar
Precharge pressure: 50 bar

✶ Remove before installation

STEERING TRAIN



STRUCTURE AND FUNCTION

- The steering is fully hydraulic. The oil sent by steering pump (2) mounted on the steering PTO at the front of the engine (1) flows to steering valve (4). From here is passed through swivel joint (6) and is sent to steering cylinder (7). The steering cylinder then extends or retracts to move tie-rod and steer the machine.
- The hydraulic power from steering pump (2) is sent to the steering cylinder and converted back to mechanical power to operate the steering.

ITEM
POSITIONS

1. HYDRAULIC OIL FILTER
2. HYDRAULIC OIL PUMP (SHARED WITH BRAKING CIRCUIT) 18cc/REV
3. PRIORITY VALVE
   CONTROL SPRING PRESSURE .... 7 bar
4. STEERING VALVE ....OSPD 70/195 LS DYN.
5. STEERING CILINDER ....D=Ø90, d=Ø50, STROKE=170^{0}_{-1}
   STEERING CILINDER VOLUME = $\frac{(9 -5) \times \pi}{4}$ x 17 = 748 cmm^2
6. STEERING WHEEL Ø352

QUANTITIY OF STEERING TURNS

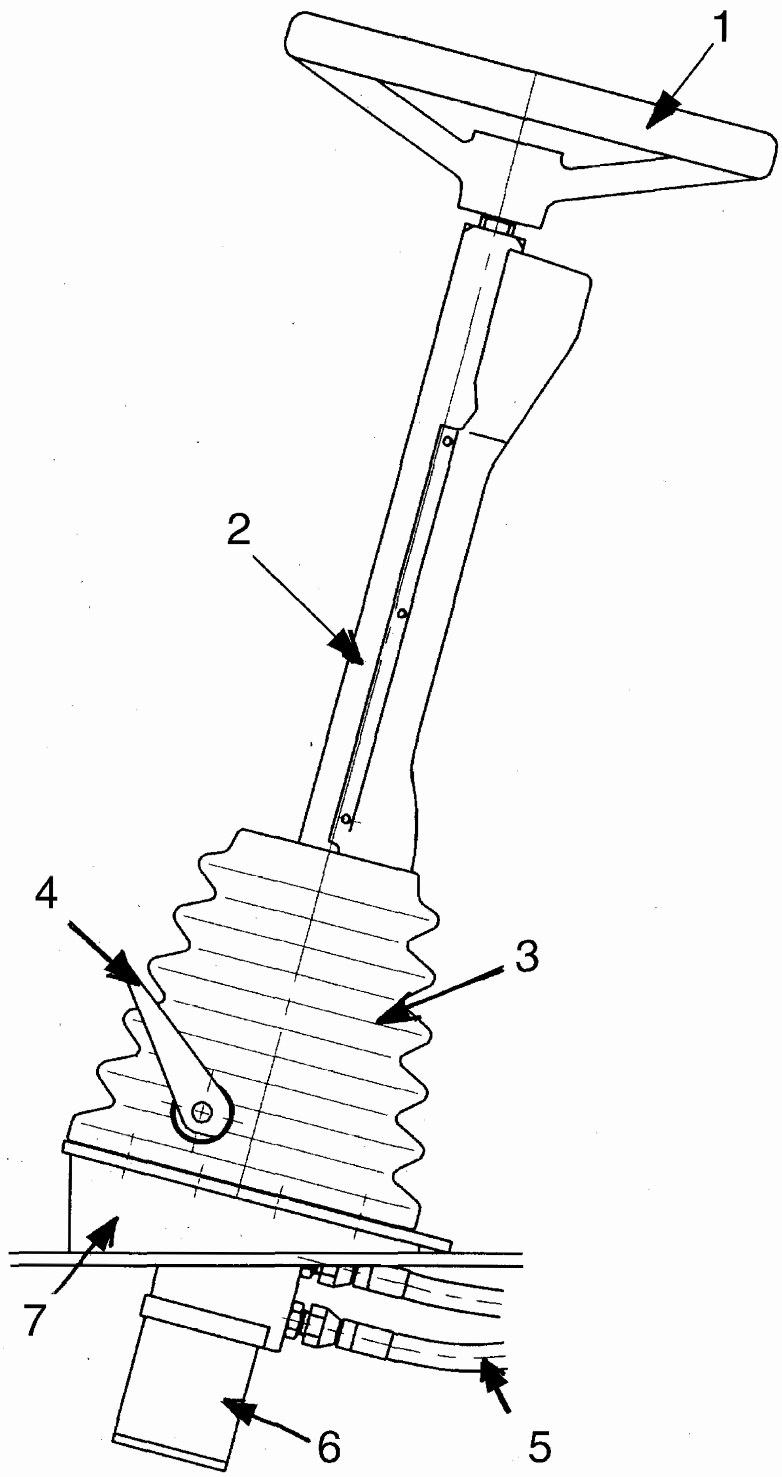
NORMAL

$$1 = \frac{CYL.VOL}{PUMP.VOL} = \frac{748\ cm^3}{195\ cm^3} = 3.8\ TURNS$$

EMERGENCY

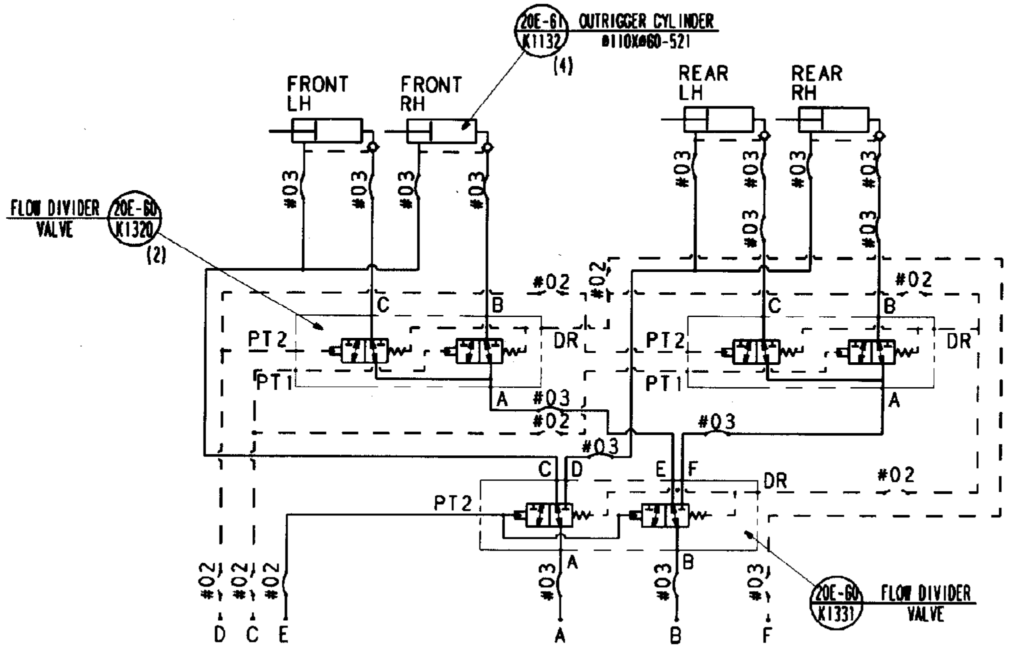
$$1 = \frac{CYL.VOL}{PUMP.VOL} = \frac{748\ cm^3}{70\ cm^3} = 10.7\ TURNS$$

STEERING COLUMN

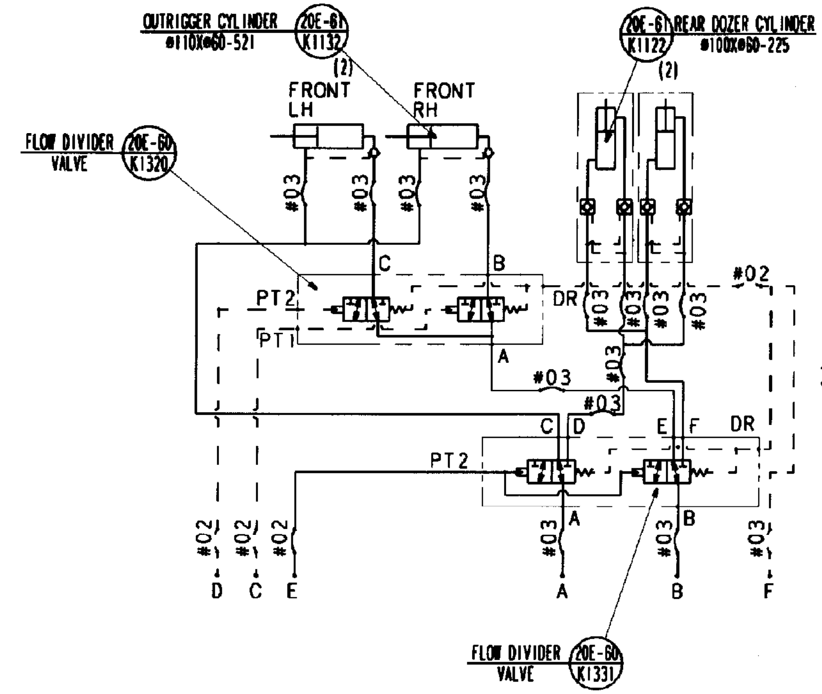


1. Steering wheel
2. Steering column
3. Gaiter
4. Pedal
5. Hose
6. Orbitroll valve
7. Mounting bracket

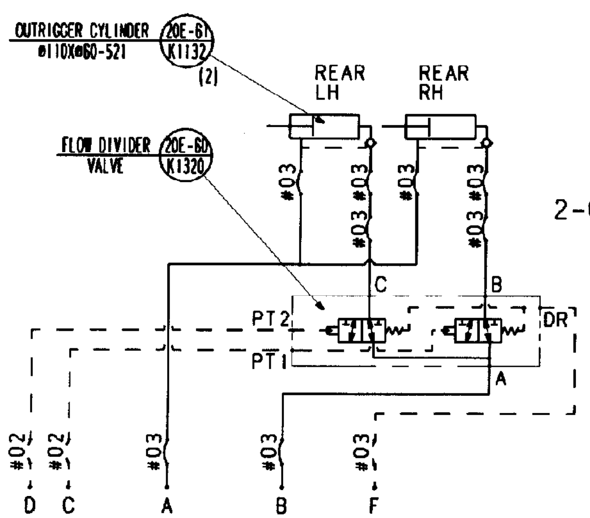
HYDRAULIC CIRCUIT DIAGRAM



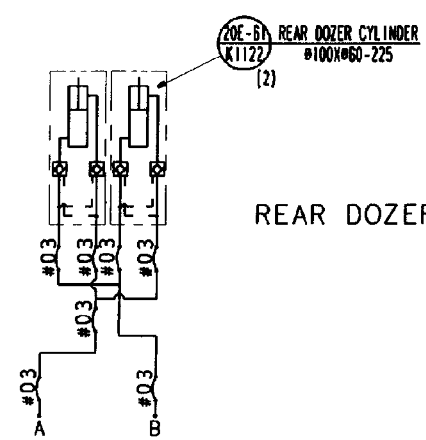
4-OUTRIGGER



REAR DOZER
&
2-OUTRIGGER

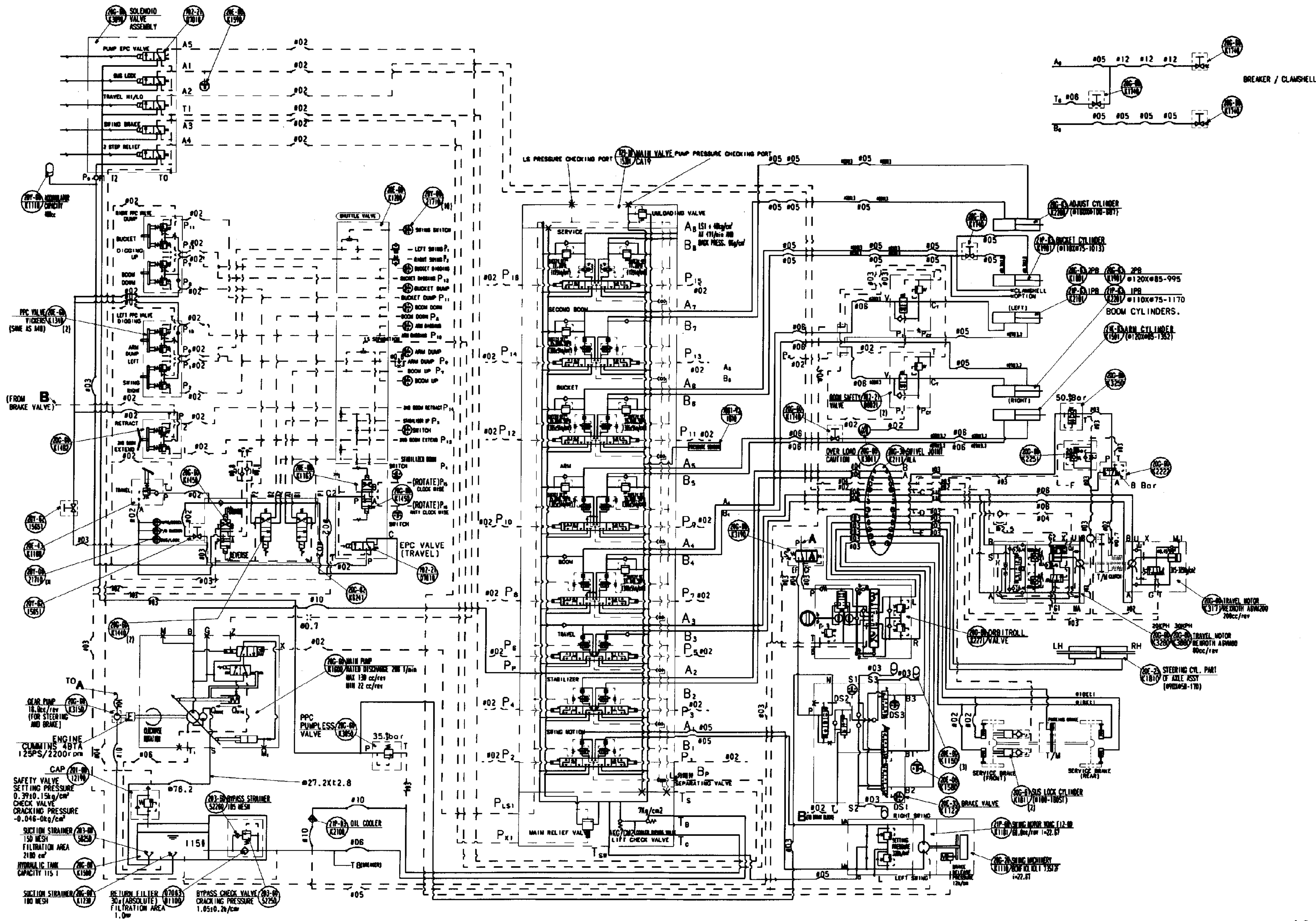


2-OUTRIGGER

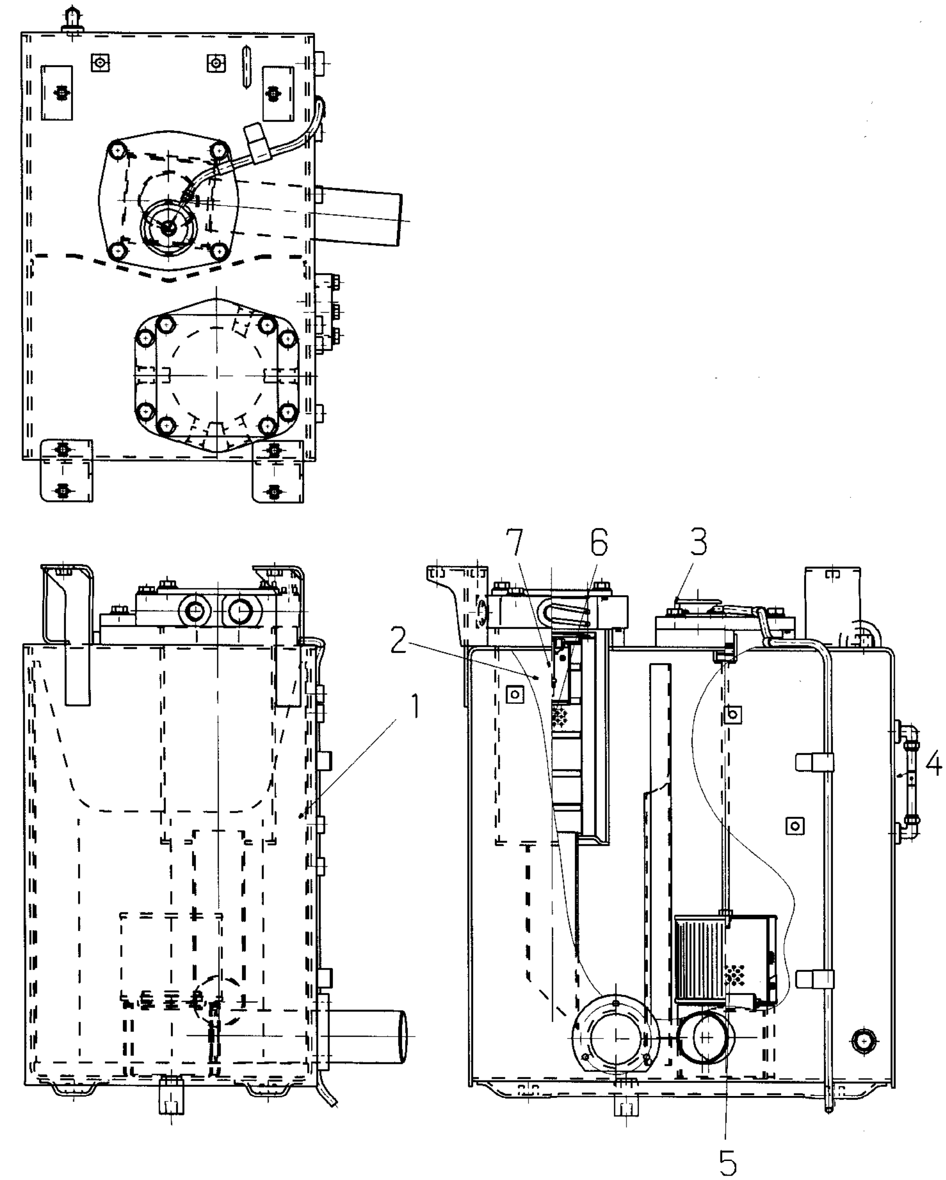


REAR DOZER

HYDRAULIC CIRCUIT DIAGRAM



HYDRAULIC TANK

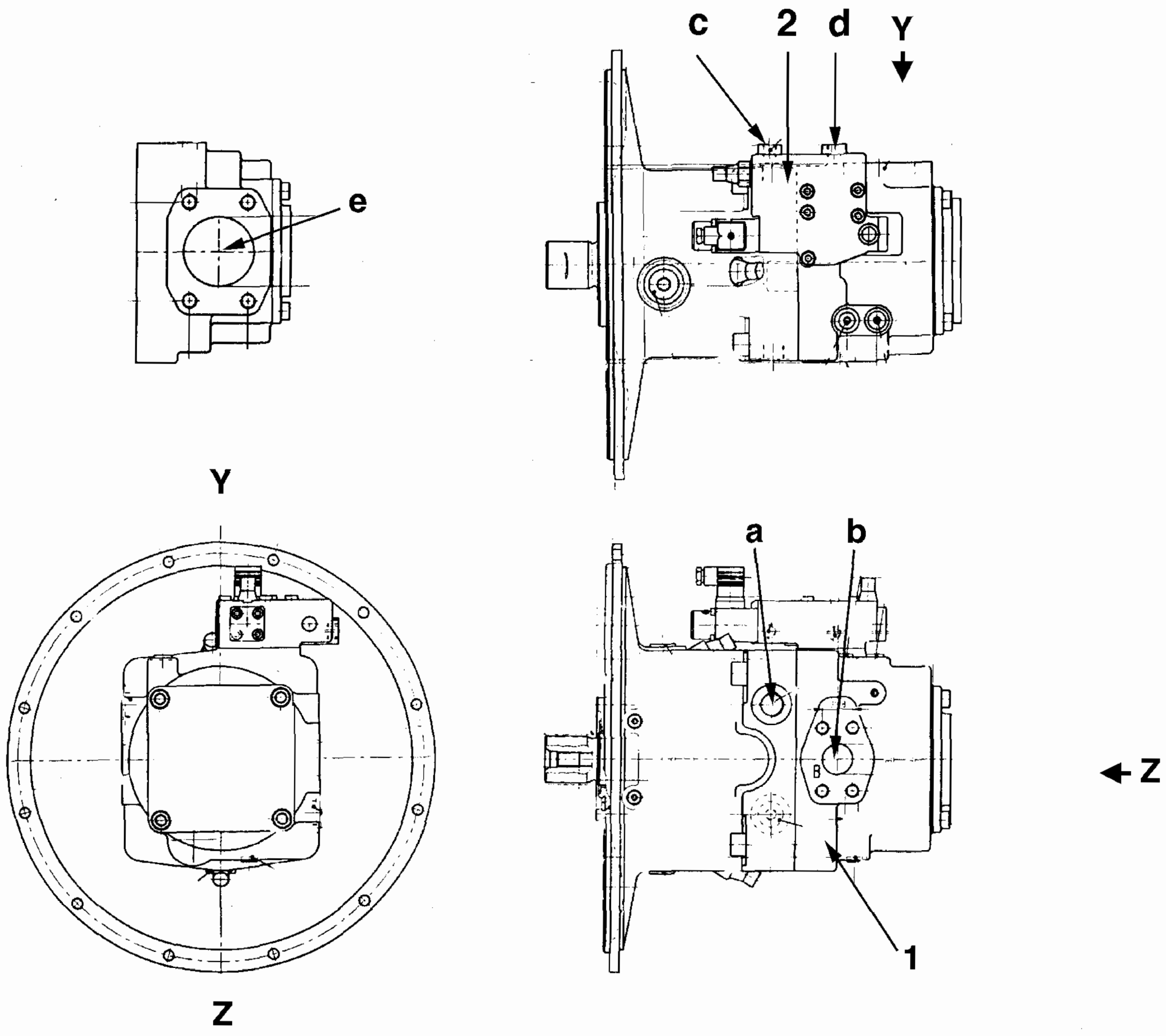


1. Hydraulic tank
2. Bypass valve
3. Oil filter cap
4. Sight gauge
5. Suction strainer
6. Filter element
7. Bypass strainer

Specifications

Tank capacity:	
Amount of oil inside tank:	
Pressure valve	
Relief cracking pressure:	0.038 ± 0.015 MPa (0.39 ± 0.15 kg/cm^2)
Suction cracking pressure:	0 - 0.0045 MPa (0 - 0.046 kg/cm^2)
Bypass valve set pressure:	0.103 ± 0.02 MPa (1.05 ± 0.2 kg/cm^2)

HYDRAULIC PUMP

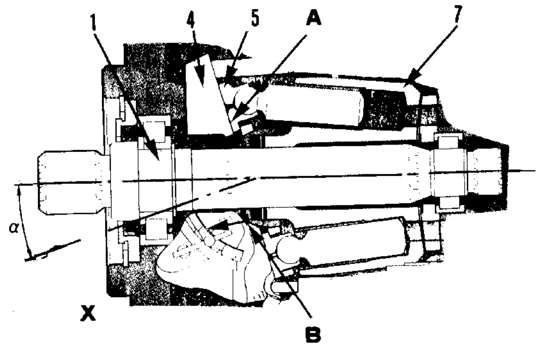


a. Pump drain port **PD**
b. Pump delivery port **PA**
c. Pump LS pressure port **PLS**
d. LS control EPC pressure port **PSIG**
e. Main pump suction port **PS**

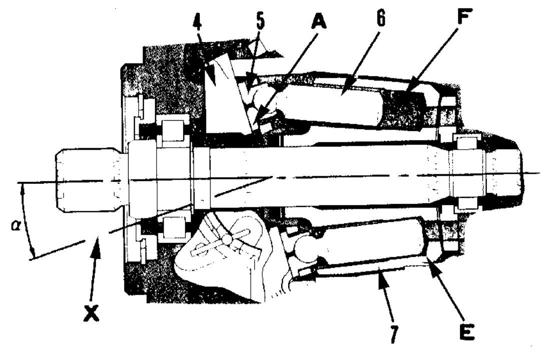
1. Main pump
2. TVC•LS valve

OPERATION

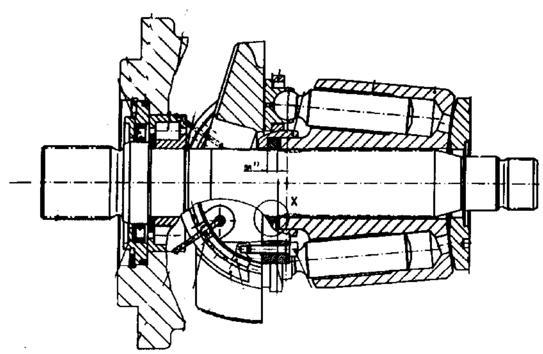
1. Operation of pump



1) cylinder block (7) rotates together with shaft (1), and shoe (5) slides on flat surface **A**.
   When this happens, rocker cam (4) moves along cylindrical surface **B**, so angle α between center line **X** of rocker cam (4) and the axial direction of cylinder block (7) changes. (Angle α is called the swash plate angle.)

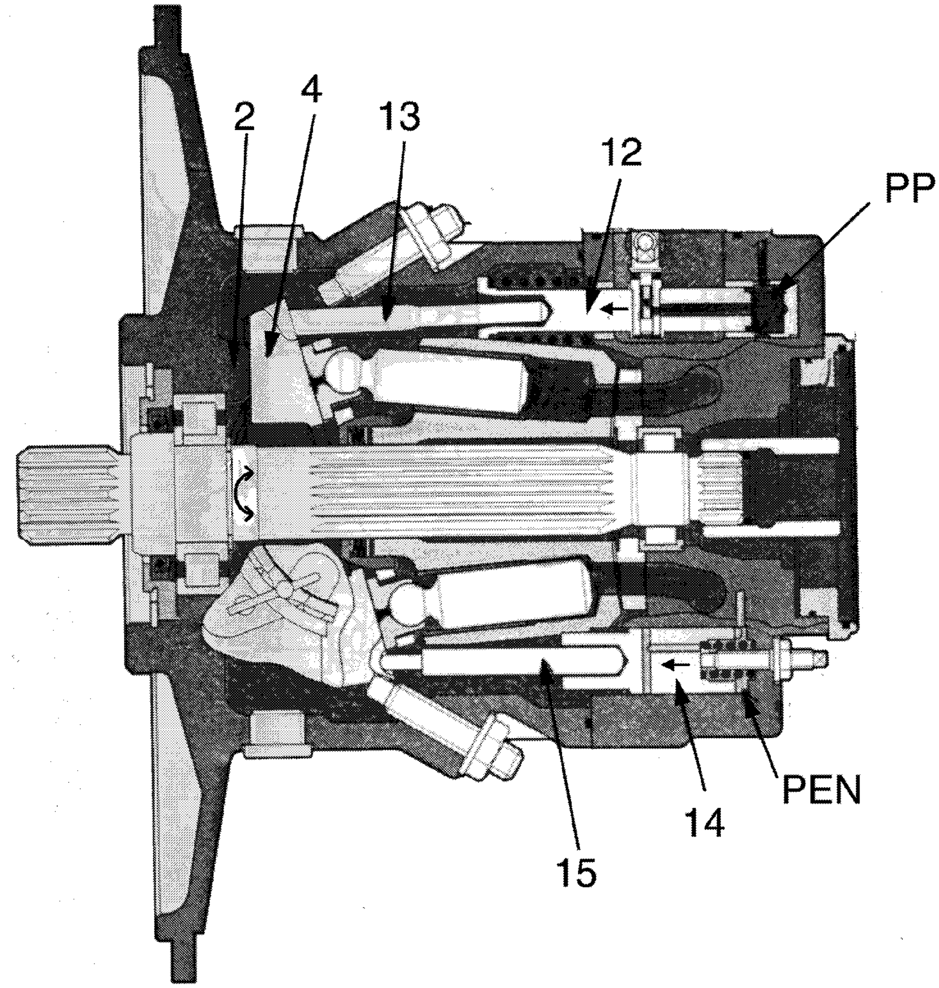


2) Center line **X** of rocker cam (4) maintains swash plate angle α in relation to the axial direction of cylinder block (7), and flat surface **A** moves as a cam in relation to shoe (5).
   In this way, piston (6) slides on the inside of cylinder block (7), so a difference between volume **E** and **F** is created inside cylinder block (7). The suction and discharge is carried out by this difference **F** - **E**.
   In other words, when cylinder block (7) rotates and the volume of chamber **E** becomes smaller, the oil is discharged during that stroke. On the other hand, the volume of chamber **F** becomes larger, and as the volume becomes bigger, the oil is sucked in.

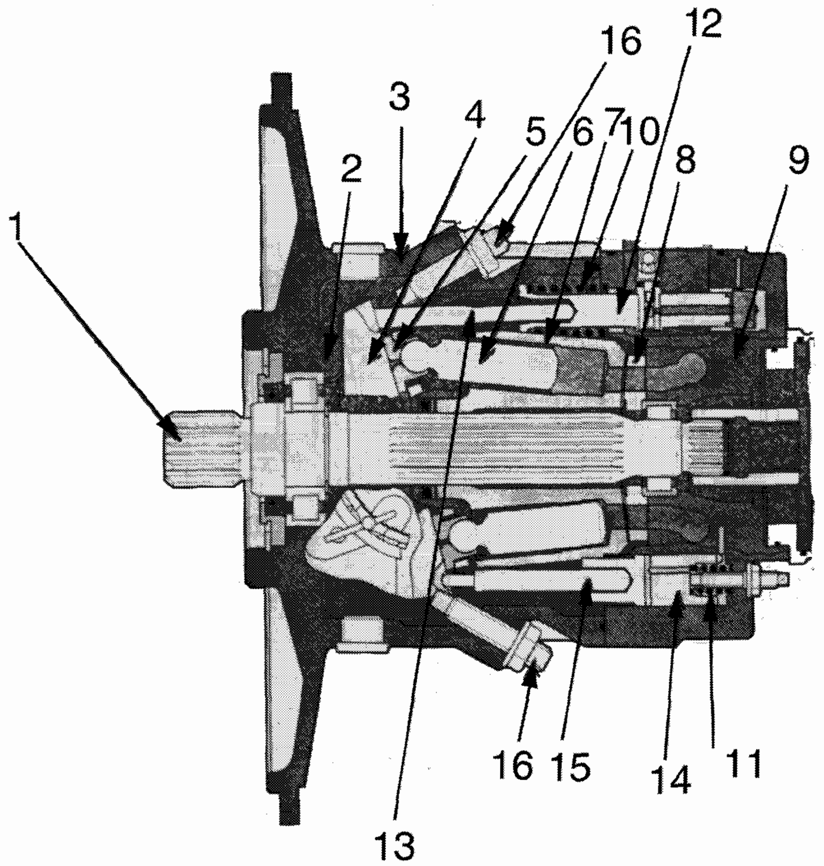


3) If center line X of rocker cam (4) is in line with the axial direction of cylinder block (7) (swash plate angle = 0), the difference between volumes **E**' and **F**' inside cylinder block (7) becomes 0, so the pump does not carry out any suction or discharge of oil. (In actual fact, the swash plate angle never becomes 0.)

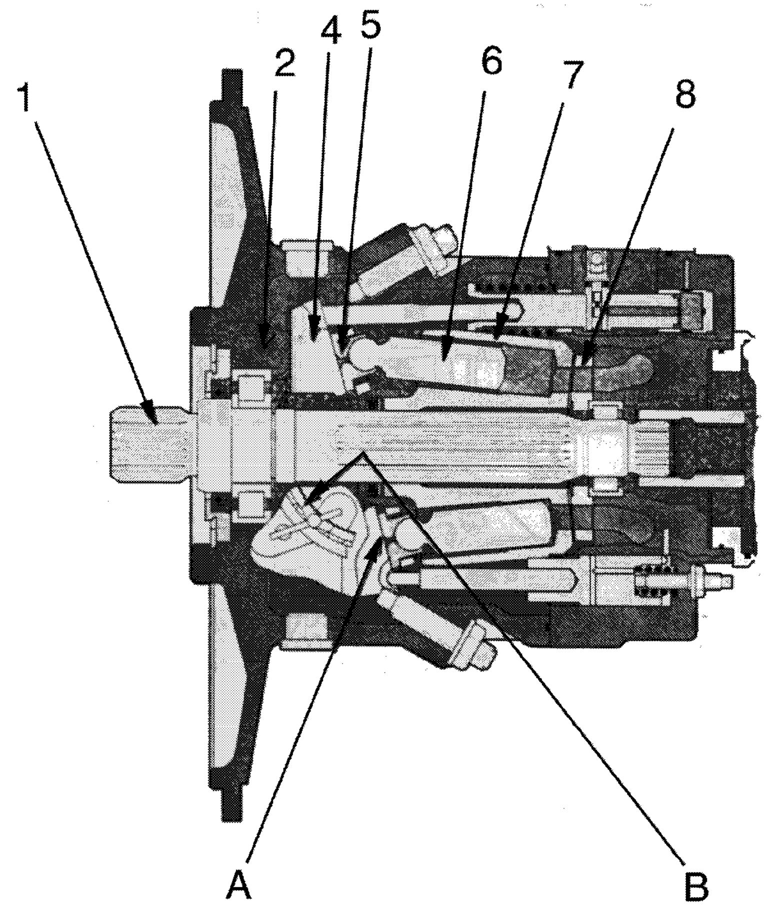
2. CONTROL OF DISCHARGE AMOUNT



- If swash plate angle α becomes larger, the difference in volumes **E** and **F** becomes larger and discharge volume **Q** increases.
- Swash plate angle α is changed by positioning piston (12) and return piston (14).
- Servo piston (12) moves in a reciprocal movement ($\longleftrightarrow$) according to the spring force and pump output pressure.
- This straight line movement is transmitted through rod (13) and (15) to rocker cam (4), and rocker cam (4), which is supported by the cylindrical surface to cradle (2), moves in a swinging movement on the cylindrical surface in (direction).
- Piston (14) moves in a reciprocal movement ($\longleftrightarrow$) according to the command from the TVC•LS valve and the spring force.
- Main pump discharge pressure (self-pressure) **PP** is always connected to the chamber receiving the pressure on piston (12) end. (the self-pressure is brought in).
- Output pressure **PEN** of the LS valve is brought to the chamber receiving the pressure at piston (14) end.
- The relationship between piston (12) and piston (14) controls swash plate (4) angle.



1. Shaft
2. Cradle
3. Case
4. Rocker cam
5. Shoe
6. Piston
7. Cylinder block
8. Valve plate
9. End cap
10. Spring
11. Spring
12. Positioning piston
13. Rod
14. Return piston
15. Rod
16. Stopper



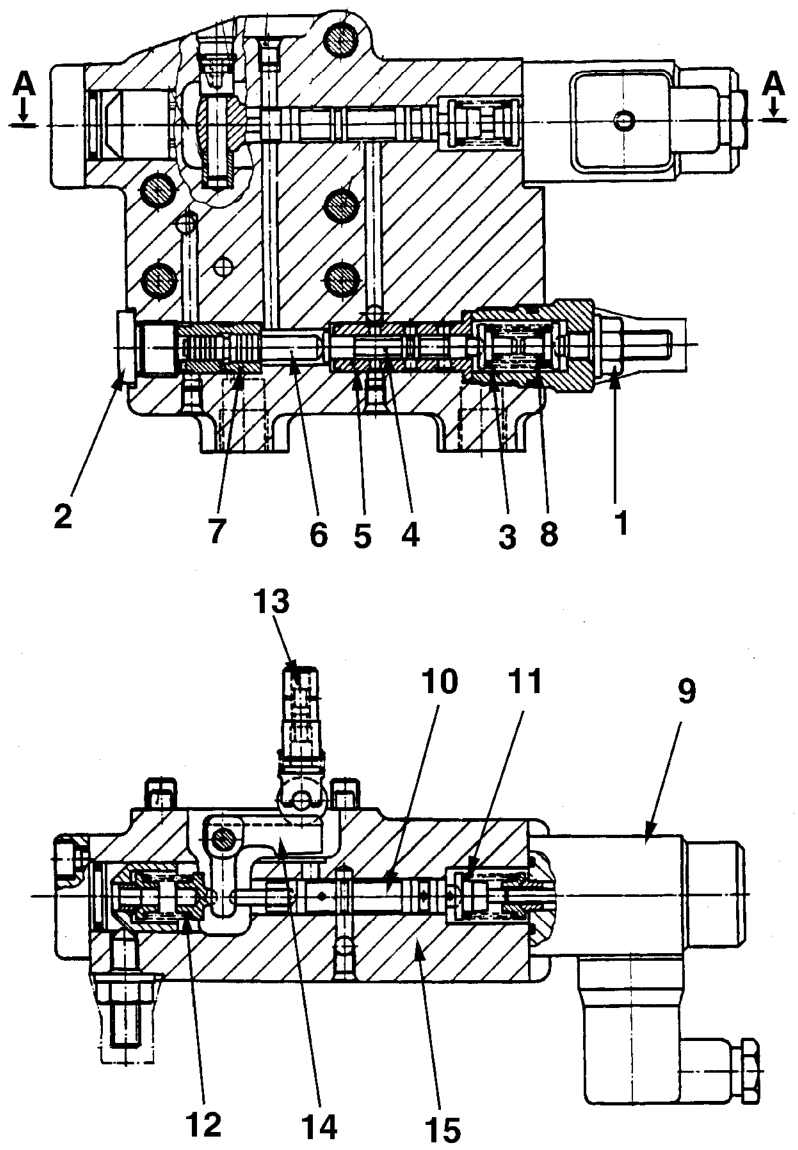
FUNCTION

- The engine rotation and torque transmitted to the pump shaft is converted into hydraulic energy, and pressurized oil is discharged according to the load.
- It is possible to change the delivery amount by changing the swash plate angle.

STRUCTURE

- Cylinder block (7) is supported to shaft (1) by a spline, and shaft (1) is supported by the front and rear bearings.
- The tip of piston (6) is a convex ball, and shoe (5) is caulked to it to form one unit. Piston (6) and shoe (5) form a spherical bearing.
- Rocker cam (4) has flat surface **A**, and shoe (5) is always pressed agaist this surface while sliding in a circular movement.
- Rocker cam (4) brings high pressure oil at cylindrical surface **B** with cradle (2), which is secured to the case, and forms a static pressure bearing when it slides.
- Piston (6) carries out relative movement in the axial direction inside each cylinder chamber of cylinder block (7).
- The cylinder block seals the pressure oil to valve plate (8) and carries out relative rotation. This surface is disigned so that the oil pressure balance is maintained at a suitable level.
  The oil inside each cylinder chamber of cylinder block (7) is sucked in and discharged through valve plate (8).

2. TVC. LS valve

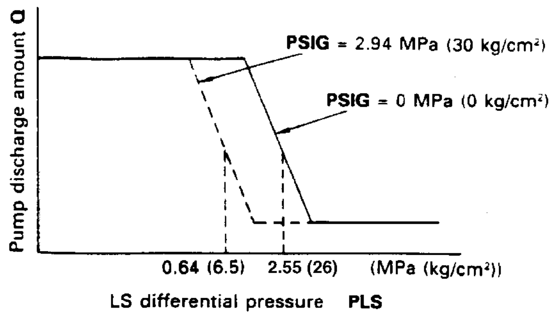


LS VALVE
1. Locknut
2. Plug
3. Spring
4. Spool
5. Sleeve
6. Piston
7. Sleeve
8. Spring

TVC VALVE
9. Solenoid
10. Piston
11. Spring
12. Spring
13. Piston
14 Lever
15 Valve body

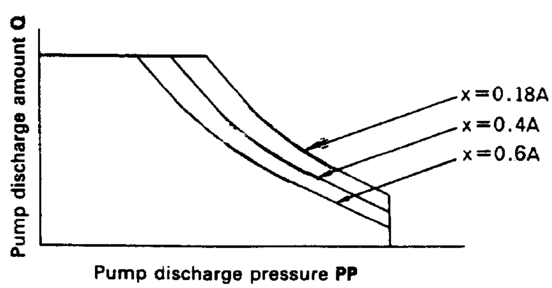
FUNCTION

1. LS VALVE



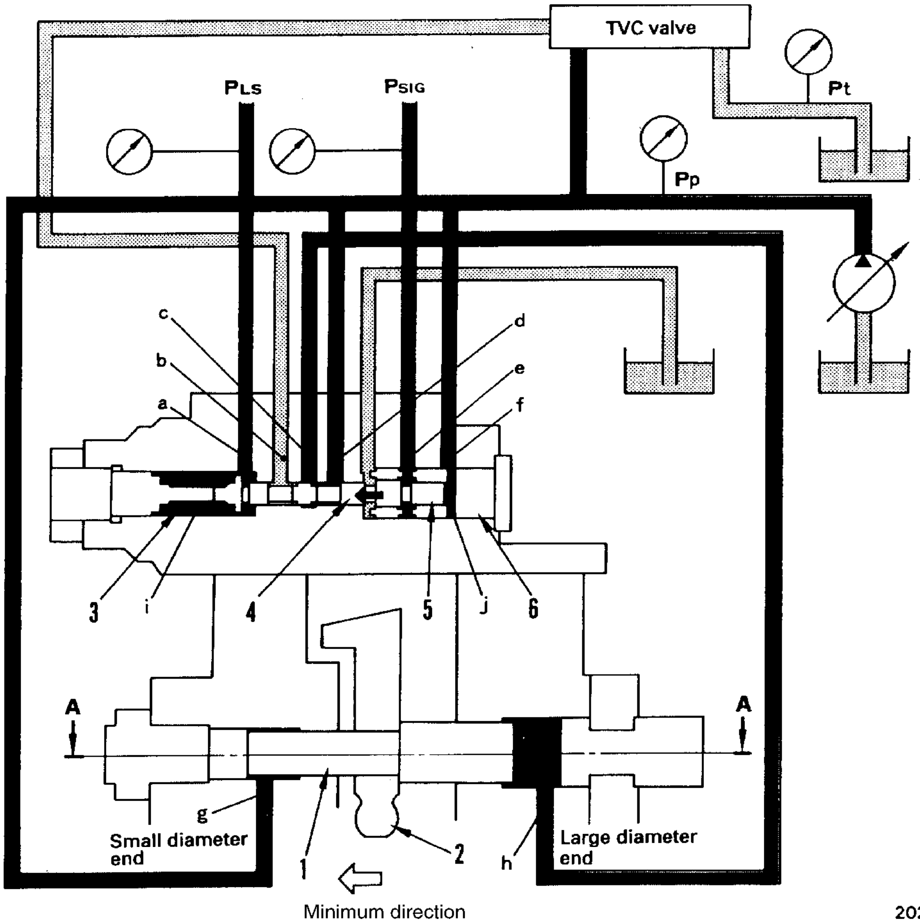
- The **LS** valve detects the load and controls the discharge amount.
  This valve controls main pump discharge amount **Q** according to differential pressure △**PLS** (=**PP** - **PLS**) (the difference between main pump pressure **PP** and control valve outlet port pressure **PLS**) (called the **LS** differential pressure).
- Main pump pressure **PP**, pressure **PLS** (called the **LS** pressure) coming from the control valve output, and pressure **PSIG** (called the **LS** selection pressure) from the proportional solenoid vlve enter this valve. The reletionship between discharge amount **Q** and differential pressure △**PLS**, (the difference between main pump pressure **PP** and **LS** pressure **PLS**) (=**PP** - **PLS**) changes as shown in the diagram on the right according to **LS** selector pressure **PSIG**.
- When **PSIG** changes between 0 and 2.94 MPa (0 and 30 kg/ cm^2), the spool load changes according to this, and the selector point for the pump discharge amount changes at the rated central value between 0.64 and 2.55 MPa (6.5 and 26 kg/cm^2).

2. TVC VALVE



- When the pump discharge pressure **PP** (selfpressure) is high, the TVC valve controls the pump so that no more oil than the constant flow (in accordance with the discharge pressure) flows even if the stroke of the control valve becomes larger. In this way it carries out equal horsepower control so that the horsepower absorbed by the pump does not exceed the engine horsepower.
- In other words, if the load during the operation becomes larger and the pump discharge pressure rises, it reduces the discharge amount from the pump; and if the pump discharge pressure drops, it increases the discharge amount from the pump. The relation between the pump discharge pressure **PP** and pump discharge amount **Q** is shown on the right, with the current given to the TVC valve solenoid shown as a parameter. However, in the heavy-duty operation mode, there are cases where it is given the function of sensing the actual speed of the engine, and if the speed drops because of an increase in the load, it reduces the pump discharge amount to allow the speed to recover. In other words, when the load increases and the engine drops below the set value, the command to the TVC valve solenoid from the controller increases according to the drop in the engine speed to reduce the pump swash plate angle.

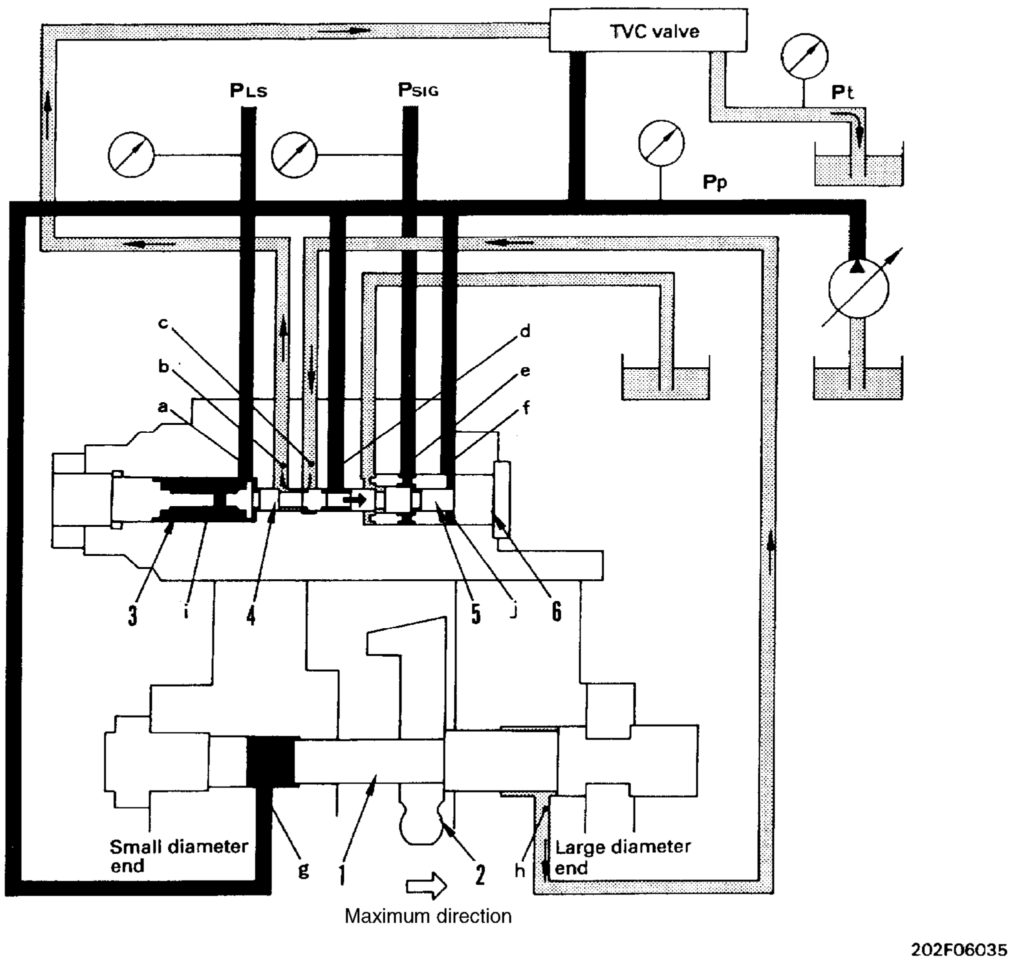
OPERATION



202F06033

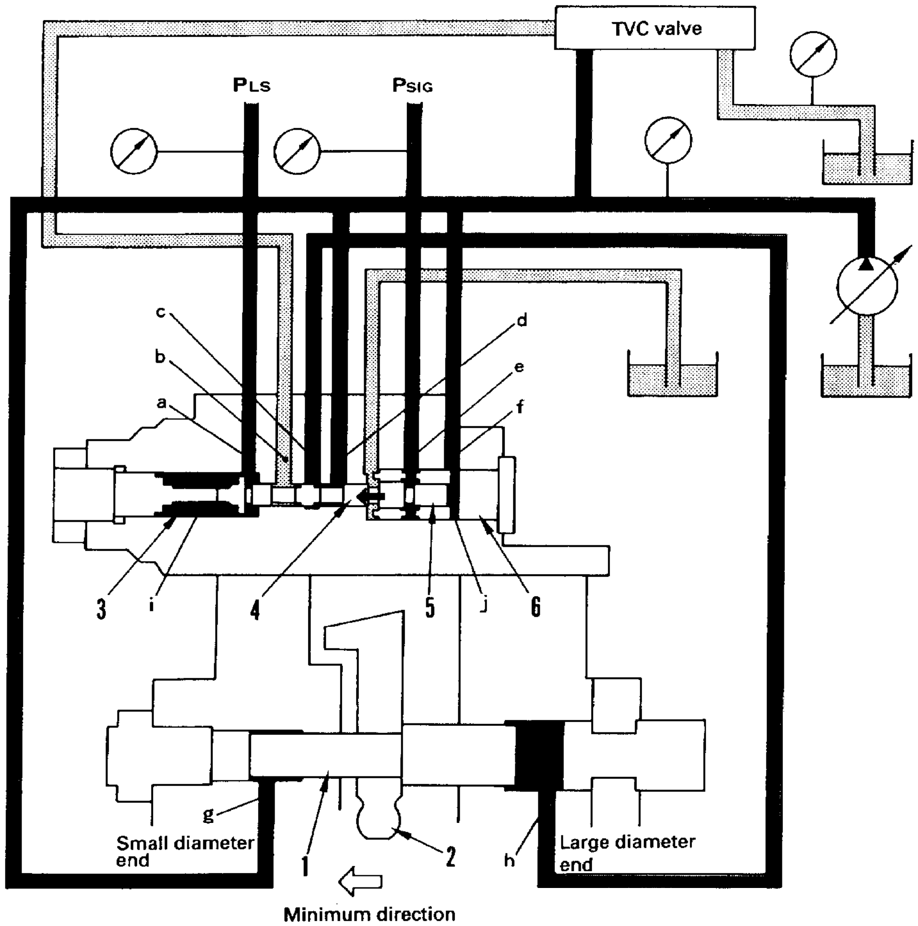
1. **LS valve**
1) **When control valve is at "NEUTRAL" position**

- The LS valve is a three-way selector valve, with pressure **PLs** (LS pressure) from the outlet port of the control valve brought to spring chamber **i**, and main pump discharge pressure PP brought to chamber **j** of plug (6). The size of this LS pressure **PLs** + force **F** of spring (3) and the main pump pressure (self pressure) **Pp** determines the position of spool (4). However, the size of the output pressure **Psig** (the LS selection pressure) of the EPC valve for the LS valve entering port **e** also changes the position of spool (4). (The set pressure of the spring changes.)
- Before the engine is started, servo piston (1) is pushed to the right by spring (7) installed to rod (2). (See the diagram on the right.)
- When the engine is started and the control lever is at the "NEUTRAL" position, LS pressure **PLs** is 0 MPa (0 kg/cm^2). (It is interconected with the drain circuit through the control valve spool.) At this point, spool (4) is pushed to the left, and port **d** and port C are connected. Pump pressure **Pp** enters the large diameter end of the piston from port **h**, and the same pump pressure **Pp** also enters the small diameter end of the piston, so the swash plate is moved to the minimum angle by the difference in area of piston (1).



2) Operation in maximum direction for pump discharge amount

- When the difference between main pump pressure **Pp** and LS pressure **PLs**, in other words, LS differential pressure **PLs**, becomes smaller (for example, when the area of opening of the control valve becomes larger and pump pressure **Pp** drops), spool (4) is pushed to the right by the combined force of LS pressure **PLs** and the force of spring (3).
- When spool (4) moves, port **b** and port **c** are joined and connected to the TVC valve. When this happens, the TVC valve is connected to the drain port, so cicuit **c** - **h** becomes drain pressure **Pt**. (The operation of the TVC valve is explained later.)
- For this reason, the pressure at the large piston diameter end of servo piston (1) becomes drain pressure **Pt**, and pump pressure **Pp** enters the small diameter end, so servo piston (1) is pushed to the right. Therefore, rod (2) moves to the right and moves the swash plate in the direction to make the discharge amount larger.
- If the output pressure of the EPC valve for the LS valve enters port **e**, this pressure creates a force to move piston (5) to the left. If piston (5) is pushed to the left, it acts to make the set pressure of spring (3) weaker, and the difference between **PLs** and **Pp** changes when ports **b** and **c** of spool (4) are connected.



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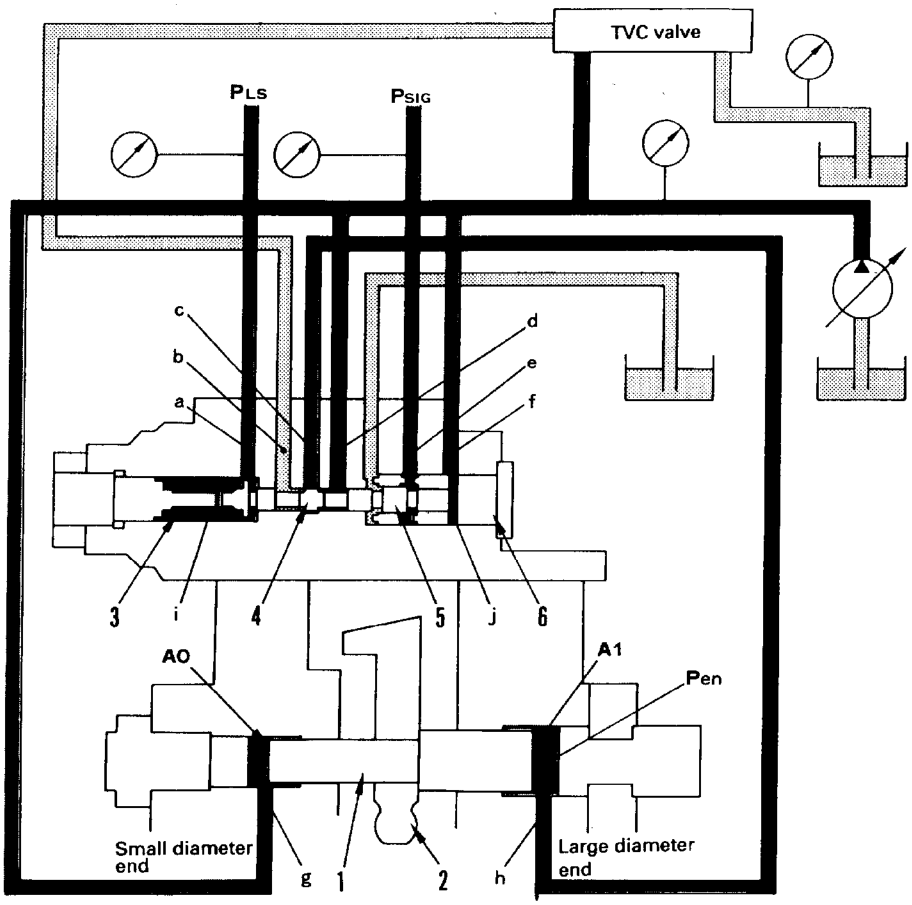
3) Operation in minimum direction for pump discharge amount

- The following explains the situation if servo piston (1) moves to the left (the discharge amount becomes smaller). When LS pressure △**PLs** becomes larger (for example, when the area of opening of the control valve becomes smaller and pump pressure **Pp** rises), pump pressure **P**p pushes spool (4) to the left.
- When spool (4) moves, main pump pressure **Pp** flows from port **d** to port **c**, and from port **h**, it enters the large piston diameter end.
- Main pump pressure **Pp** also enters the small piston diameter end, but because of the difference in area between the large piston diameter end of servo piston (1) and the small piston diameter end of servo piston (1) is pushed to the left. As a result, rod (2) moves in the direction to make the swash plate angle smaller.
- If LS selection pressure **Psig** enters port **e**, it acts to make the set pressure of spring (3) weaker.



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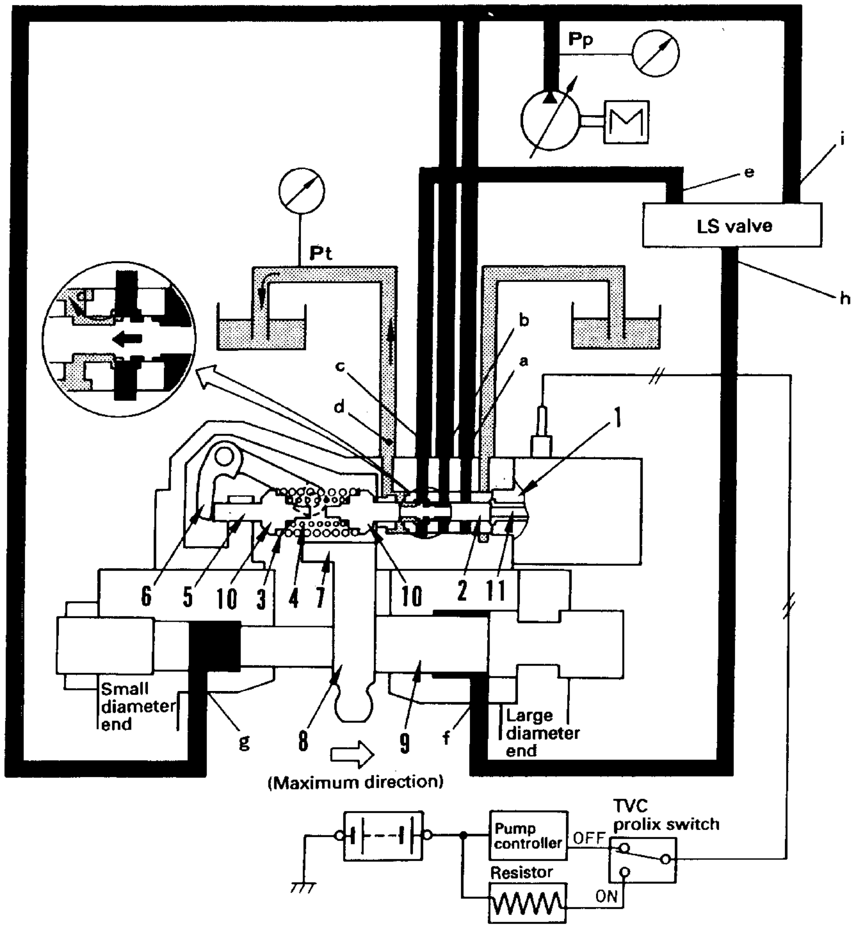
4) When servo piston is balanced

- Let us take the area receiving the pressure at the large piston diameter end as **A1**, the area receiving the pressure at the small diameter end as **A0**, and the pressure flowing into the large piston diameter end as **Pen**. If the main pump pressure **Pp** of the LS valve and the combined force of force **F** of spring (3) and LS pressure **PLs** are balanced, and the relationship is **A0** x **Pp** = **A1** x **Pen**, servo piston (1) will stop in that position, and the swash plate will be kept at an intermediate position. (It will stop at a position where the opening from port **b** to port **c** and from port **d** to port **c** of spool (4) is approximately the same.)
- At this point, the relationship between the area receiving the pressure at both ends of piston (1) is **A0:A1** = 1:2, so the pressure applied to both ends of the piston when it is balanced becomes **Pp**: **Pen** = 2:1.
- The position where spool (4) is balanced and stopped is the standard center, and the force of spring (3) is adjusted so that it is determined when **Pp** - **PLs** = 2.11 MPa (21.5 kg/cm^2). However, if **Psig** (the output pressure of 0 - 2.94 MPa (0 - 30 kg/cm^2) of the EPC valve of the LS valve) is applied to port **e**, the balance stop position will change in proportion to pressure **Psig** between **Pp** - **Pls** = 2.11 $\longleftrightarrow$ 0.637 MPa (21.5 $\longleftrightarrow$ 6.5 kg/cm^2).



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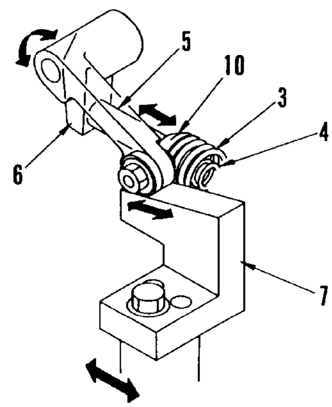

202F06139

2. TVC valve

1) When pump controller is normal

a. When the load on the actuator is small and pump pressure Pp is low

(1) Movement of solenoid (1)

- The command current from the pump controller flows to solenoid (1). This command current changes the internal force pushing solenoid push pin (11).
- On the opposite site to the force pushing this solenoid push pin (11) is the spring set pressure of springs (3) and (4) and pump pressure **Pp**. Piston (2) stops at a position where the combined force pushing piston (2) is balanced, and the pressure (pressure of port **c**) output from the TVC valve changes according to this piston.
- The size of command current **X** is determined by the nature of the operation (lever operation), the selection of the working mode, and the set value and actual value for the engine speed.