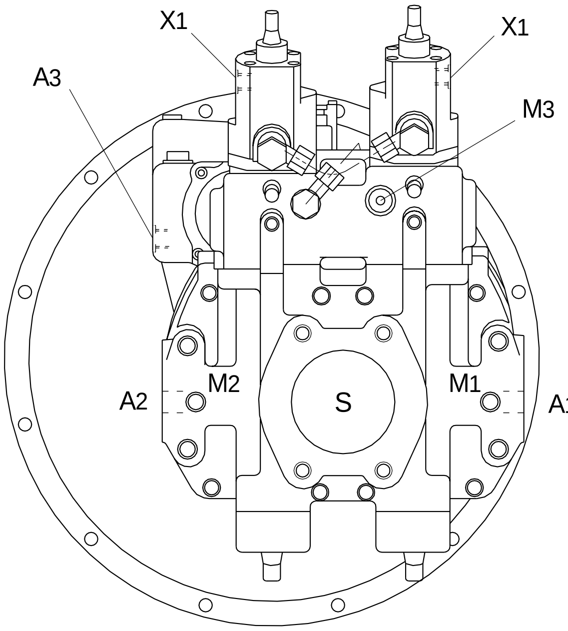
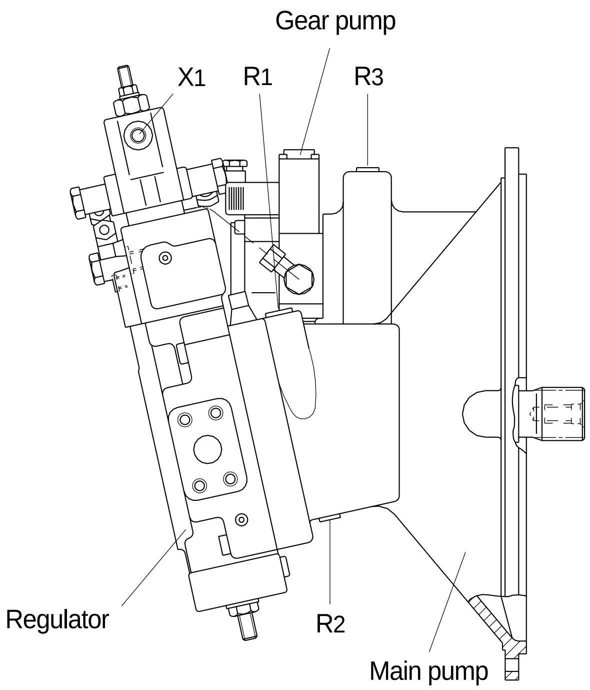
SECTION 2 STRUCTURE AND FUNCTION

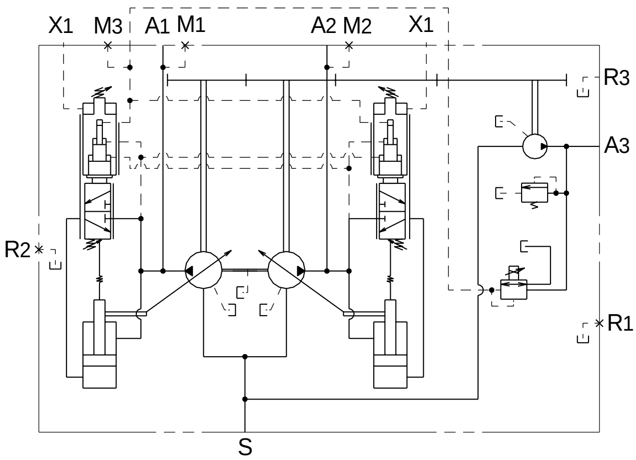
GROUP 1 PUMP DEVICE

1. STRUCTURE

The pump device consists of main pump, regulator and gear pump.





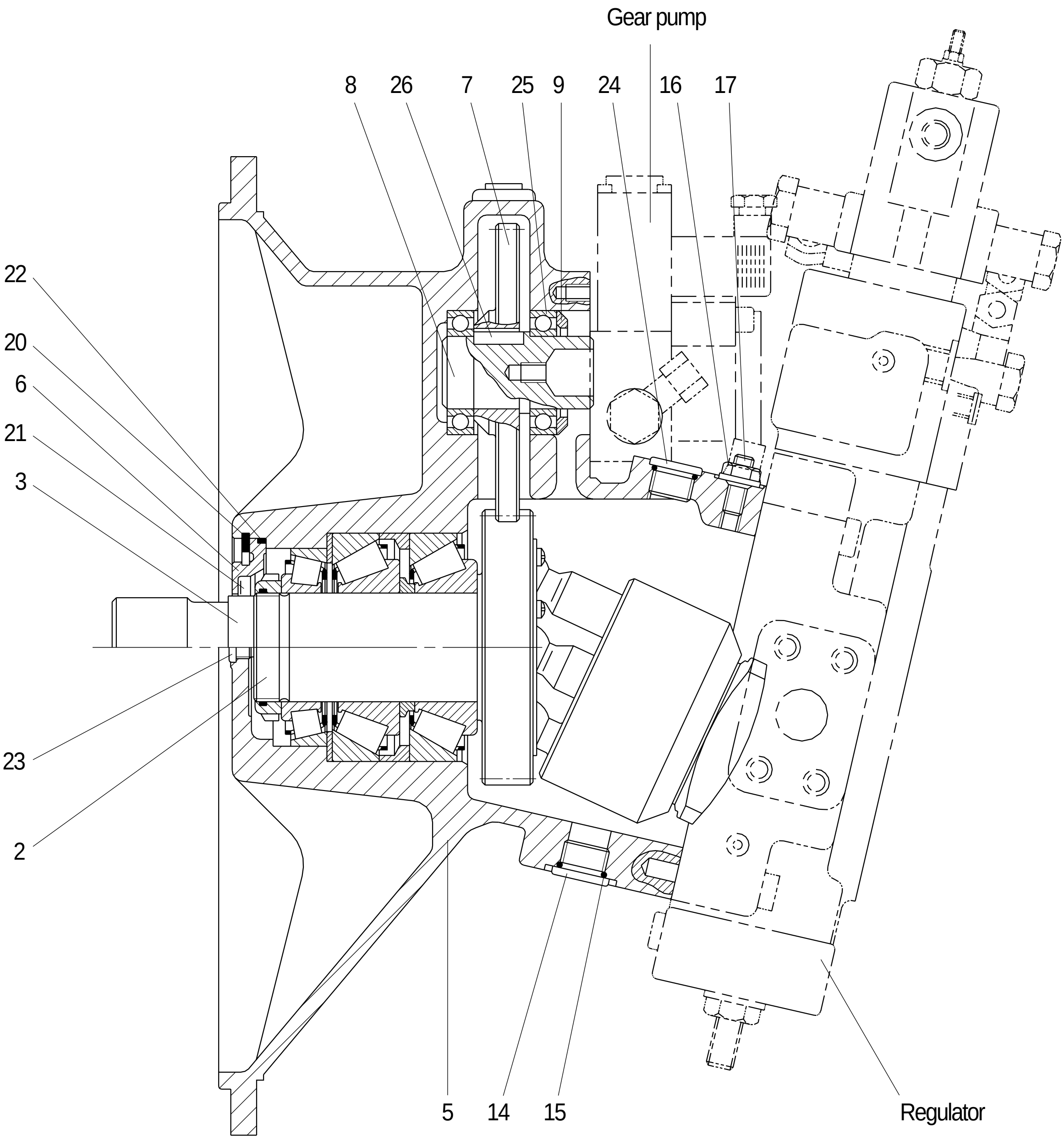


Hydraulic circuit

Port	Port name	Port size
A1,2	Delivery port	SAE6000psi 1"
S	Suction port	SAE500psi 3 1/2"
R2	Drain port	M14×1.5
A3	Gear pump delivery port	M14×1.5
X1	Negative control port	M14×1.5
M1,2,3	Gauge port	M14×1.5
R1,3	Air bleed port	M14×1.5

1) MAIN PUMP(1/2)

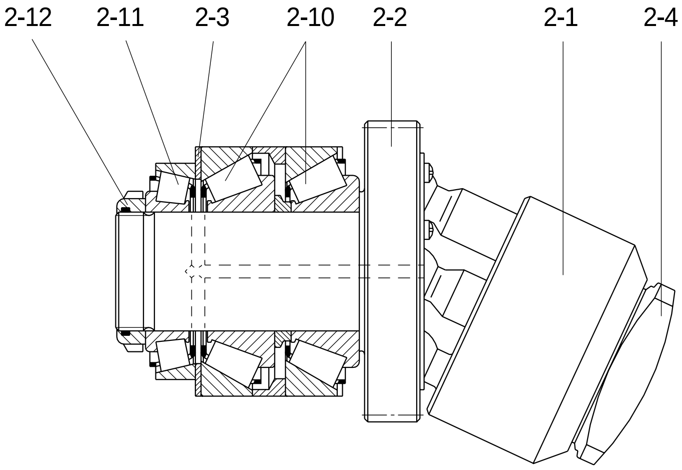
Variable double pump with two axial tapered piston rotary groups of bent axis design in open circuit.



2	Rotary group	9	Spacer	21	Shaft seal ring
3	Rotary group	14	Locking screw	22	O-ring
5	Pump housing	15	O-ring	23	Locking screw
6	Cover	16	Seal lock nut	24	Locking screw
7	Gear	17	Threaded pin	25	Ball bearing
8	Stub shaft	20	Retaining ring	26	Shaft key

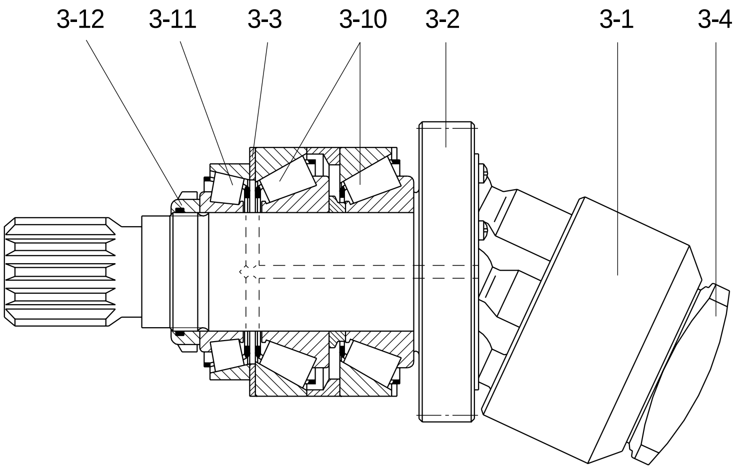
MAIN PUMP(2/2)

· **Rotary group**(item 2)



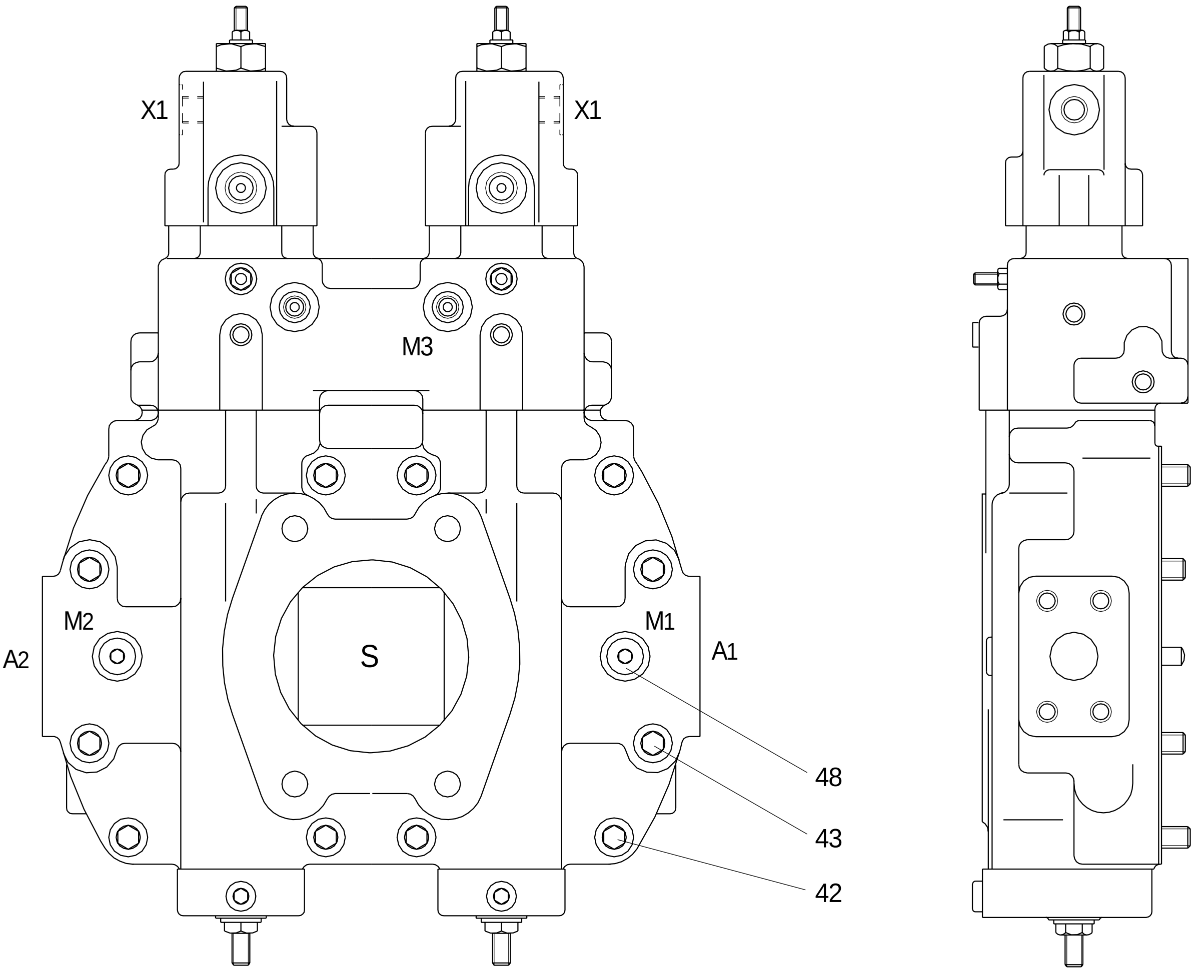
2-1	Hydraulic section	2-4	Control lens	2-11	Tapered roller bearing
2-2	Pinion gear	2-10	Tapered roller bearing	2-12	Ring nut
2-3	Shim				

· **Rotary group**(item 3)



3-1	Hydraulic section	3-4	Control lens	3-11	Tapered roller bearing
3-2	Drive shaft	3-10	Tapered roller bearing	3-12	Ring nut
3-3	Shim				

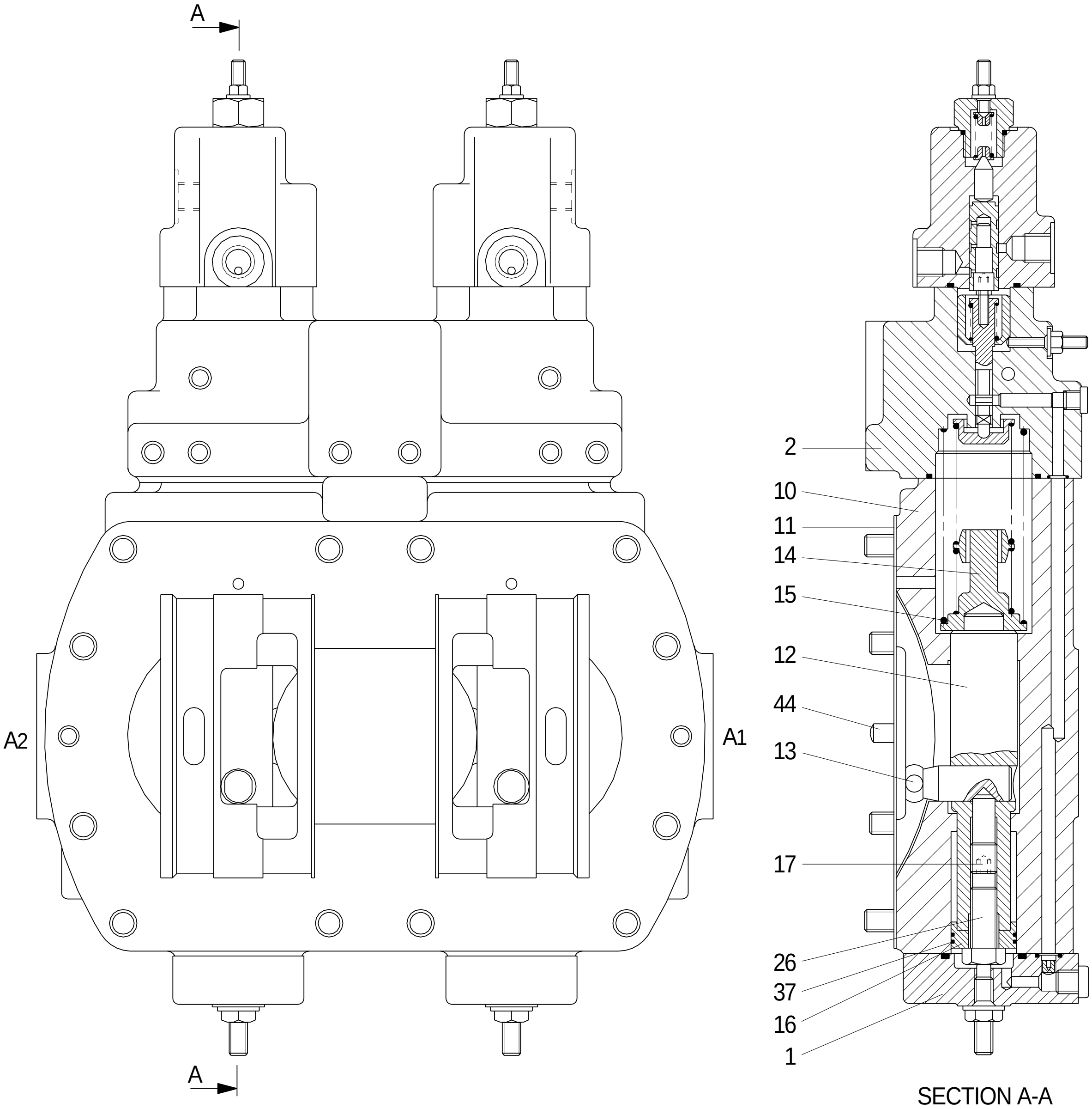
2) REGULATOR(1/3)



Port	Port name	Port size
A1,2	Delivery port	SAE6000psi 1"
S	Suction port	SAE500psi 3 1/2"
M1,2,3	Gauge port	M14 × 1.5
X1	Negative control port	M14 × 1.5

42 Socket head screw
43 Socket head screw
48 Locking screw

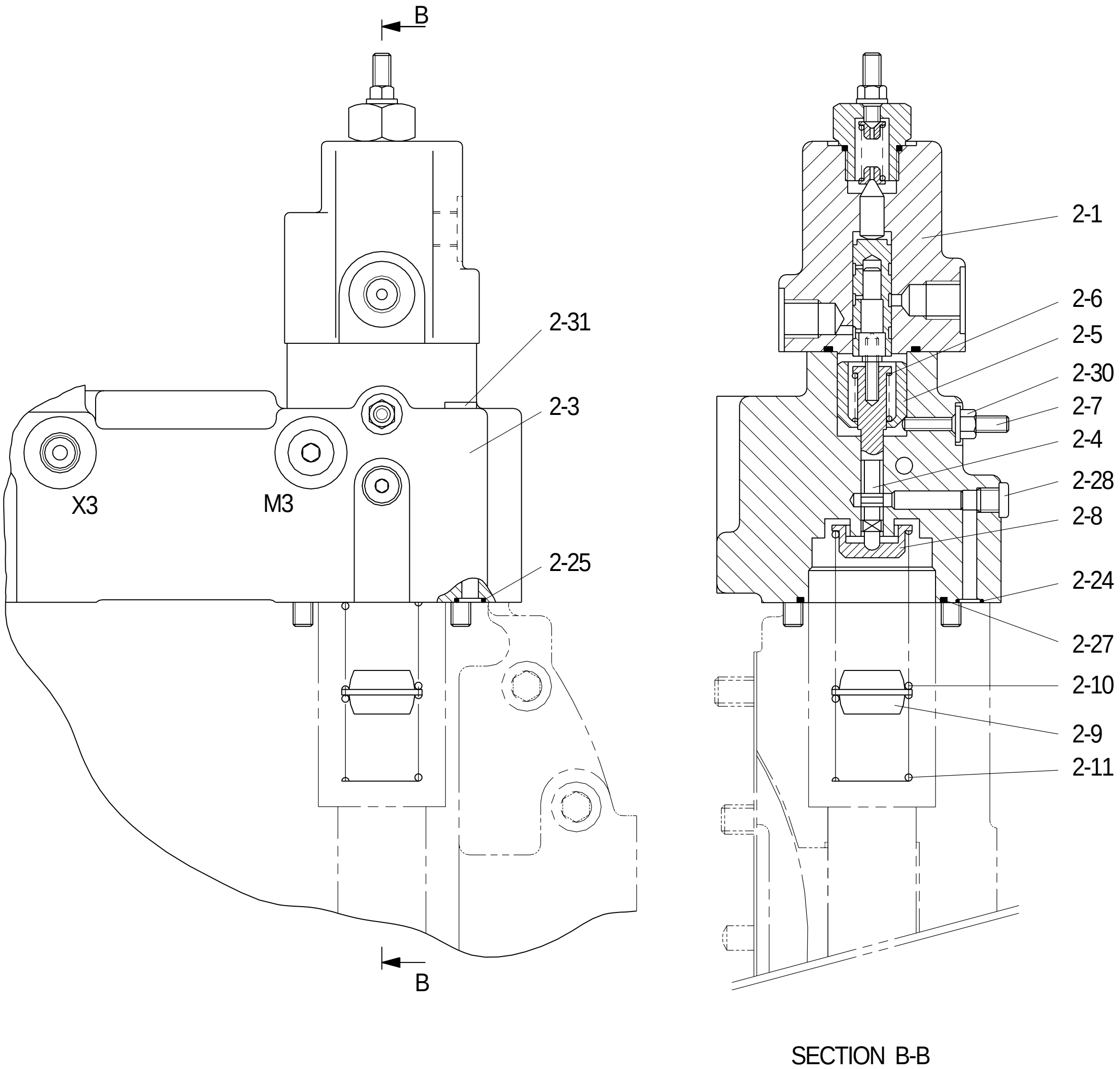
REGULATOR(2/3)



1	Cover assy	13	Positioning trunnion	17	Thread pin
2	Control module assy	14	Spring collar	26	Hexagon screw
10	Control housing	15	Pressure spring	37	Square ring
12	Positioning piston	16	Piston	44	Cylinder pin

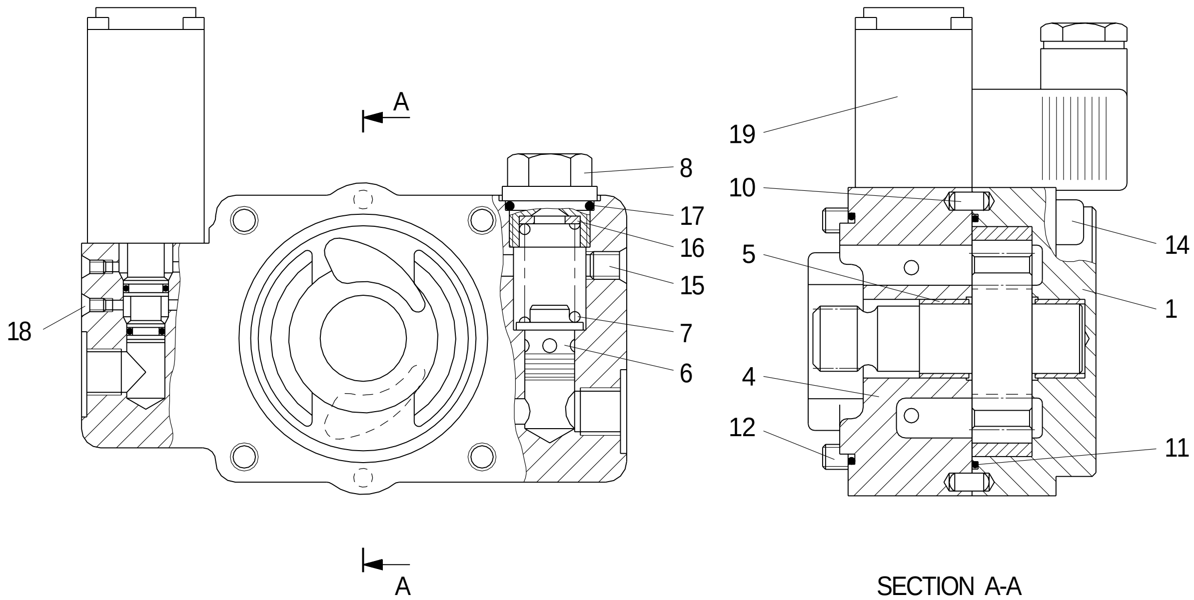
REGULATOR(3/3)

· **Control module assy**(item 2)



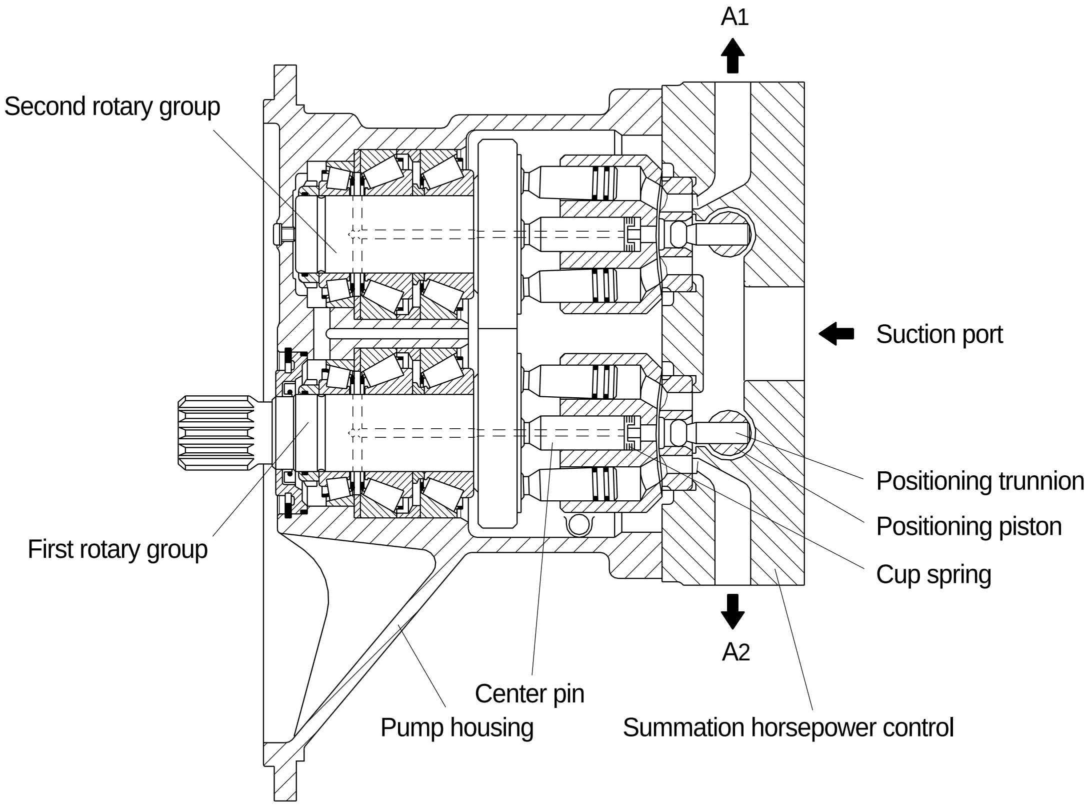
2-1	Control module	2-8	Spring collar	2-27	O-ring
2-3	Control housing	2-9	Spring collar	2-28	Locking screw
2-4	Control piston	2-10	Pressure spring	2-29	Locking screw
2-5	Spring bushing	2-11	Pressure spring	2-30	Lock nut
2-6	Pressure spring	2-24	O-ring	2-31	Socket head screw
2-7	Threaded pin	2-25	O-ring	2-32	Double break-off pin

3) GEAR PUMP

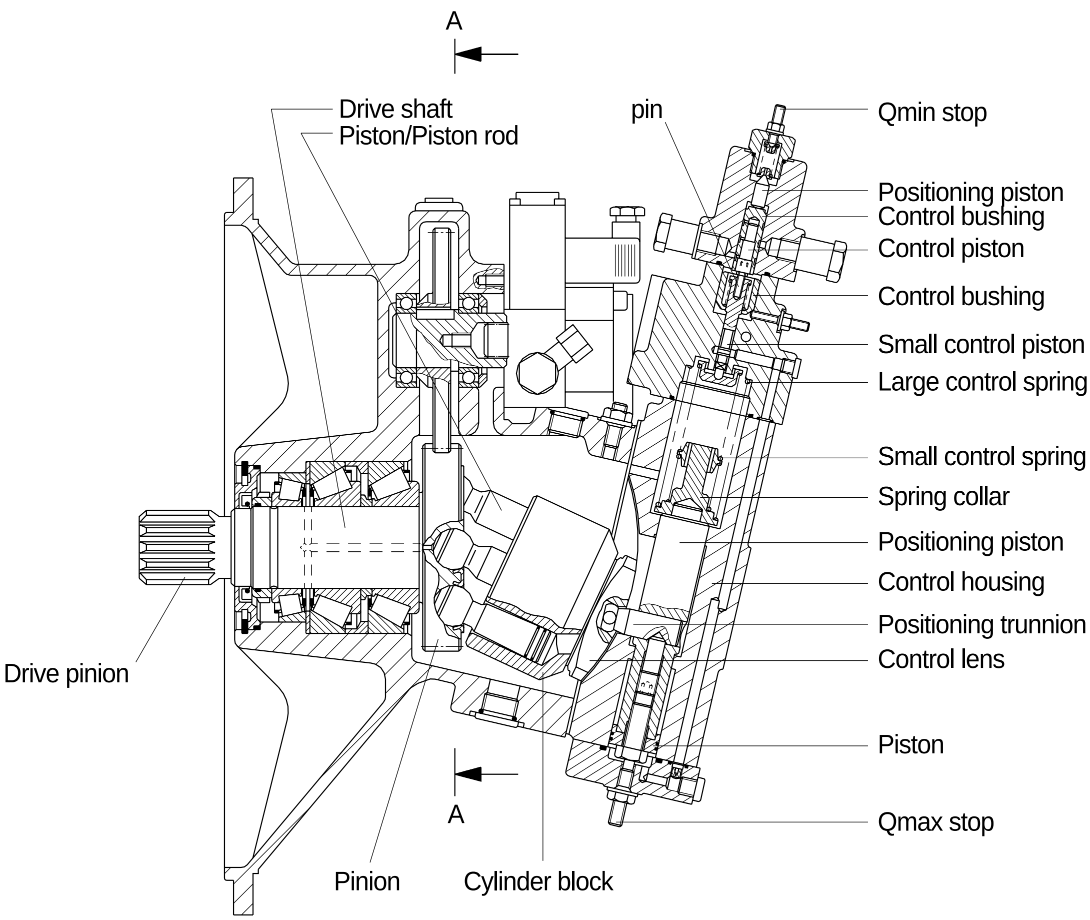


1	Pump cover	8	Locking screw	15	Double brake off pin
4	Sandwich plate	10	Cylinder pin	16	Washer
5	Bearing bushing	11	O-ring	17	O-ring
6	Valve piston	12	O-ring	18	Double brake off pin
7	Pressure spring	14	Socket head screw	19	Pressure control valve

2. FUNCTION

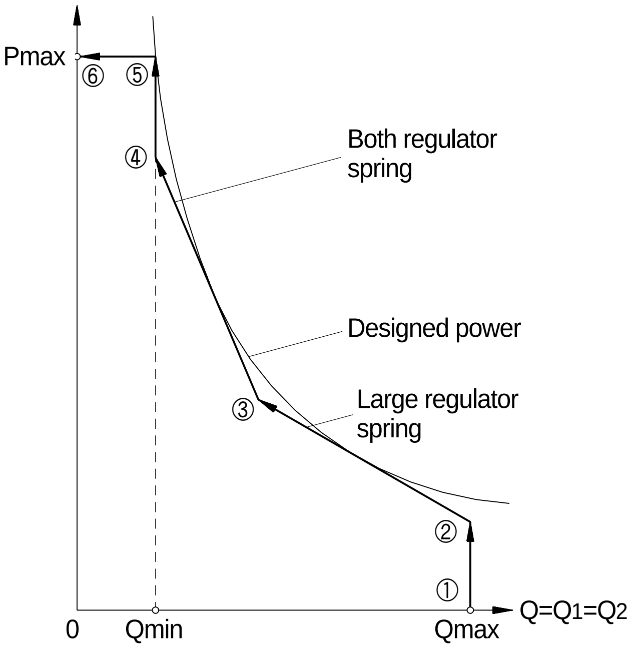


A1
Second rotary group
Suction port
Positioning trunnion
Positioning piston
First rotary group
Cup spring
A2
Center pin
Pump housing
Summation horsepower control



A
Drive shaft
Piston/Piston rod
pin
Qmin stop
Positioning piston
Control bushing
Control piston
Control bushing
Small control piston
Large control spring
Small control spring
Spring collar
Positioning piston
Control housing
Positioning trunnion
Control lens
Drive pinion
Piston
A
Qmax stop
Pinion
Cylinder block

Power curve



① At pressure P=0, both rotary groups are at max. swivel angle.

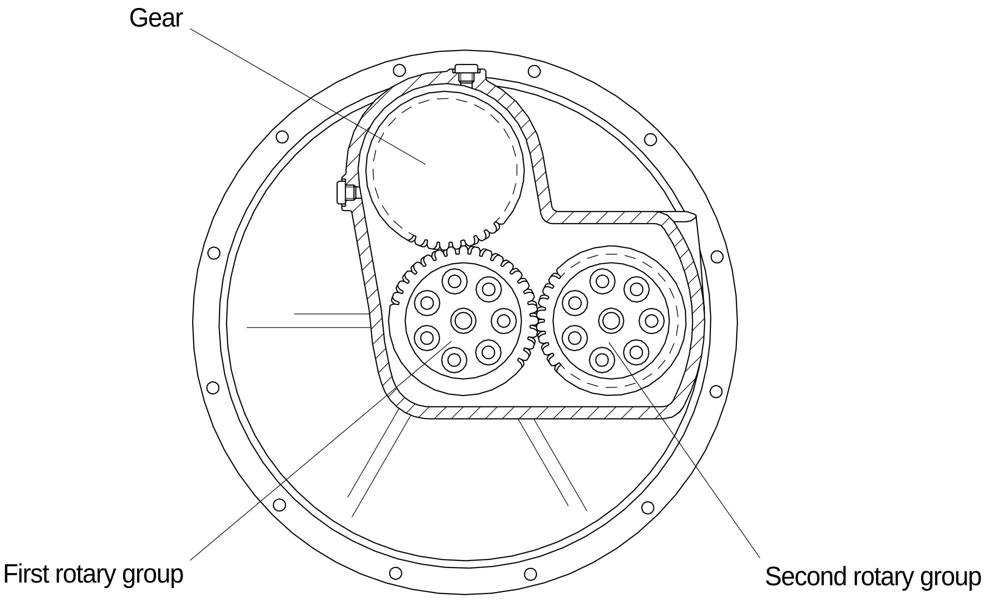
② This point is the start of the control. Full output flow(Qmax) is available at both rotary groups as long as the sum of pressures $P_1=P_2$ lies below the set value for the start of control.

③ When the sum of P_1+P_2 rises above point(2), the rotary groups swivel against the force of the large regulator spring.

④ Further increase in pressure P_1+P_2 beyond point(3) causes a further swivelling of the rotary groups against the additional force of the small regulator spring to point(4), where the fixed stop(Qmin) is reached.

⑤ Further pressure increase of P_1+P_2 beyond(4) causes no further swivelling of the rotary groups, until the set value of the pressure relief valves is reached.

⑥ This point is the set value of the relief valves.



SECTION A-A

1) DESCRIPTION

Two rotary groups of bent axis design are built into the pump casing. Mechanically, these two units are connected by gears, and on the hydraulic side are controlled by a common summation horsepower control. The output flow of both rotary groups is therefore steplessly variable, and dependent upon the sum of the two working pressures, so that the drive motor receives an almost constant torque.

2) FUNCTION

The first rotary group is driven directly by the drive shaft, together with the drive pinion. The second rotary group rotates in the opposite direction. Because both rotary groups swivel in the same direction-vertical to the plane of the diagram-the pressure lines are connected to ports A_1 and A_2. Both rotary groups are supplied from a common suction port, which is also connected to the inside of the pump casing.

Seven ball-ended piston rods are connected to each of the geared drive shafts of the rotary group, such that the piston cause the cylinder block to rotate with the shaft. Each cylinder block rotates on a spherical control lens, which in turn slides on a cylindrically formed slideway in the regulator housing. Kidney-shaped slots in the control lens and oil passages in the slideway allow pressure oil to be fed to pressure ports A_1 and A_2.

Center hole of control lens holds one end of trunnion. The other end of the trunnion is held to positioning piston of regulator.
Movement of the positioning piston adjusts the position of the control lenses, and therefore the swivel angle of the rotary groups.

At zero pressure, the cylinder blocks are pressed against the control lenses by the cup spring on the center pin. As pressure rises, the forces between the cylinder blocks and control lenses are balanced by hydraulic forces, so that even at high loads an oil film remains between the control faces and also on the slideway, while at the same time the leakage oil is held within narrow limits.
The leakage oil is also partly used for lubrication of all moving parts within the rotary group.
The ball ends of the piston rods and the center pin are lubricated within their seats, as are the bearings, via the center pin seat, which also has a longitudinal drilling at the drive shaft.

When a piston moves within its cylinder bore from the lower to the upper dead point, it will traverse a stroke dependent on the swivel angle. This will cause a volume of oil proportional to the piston area and the stroke travelled to be sucked into the cylinder via the control slots in the control lens.
Movement of the piston from the upper to the lower deadpoint will cause this volume of oil to be moved into the pressure side of the system.

3) SUMMARY

In the pilot operated summation horsepower control, the working pressures of the two circuits are added and converted into forces. The total force on the regulating spool operates on the measuring spring system. When the total pressure in both circuits, or the pressure in one circuit alone, exceeds the set start of control, the two rotary groups are swivelled inwards together. The distance which the assembly must move in order to balance the hydraulic forces and spring forces is that distance necessary for the adjustment, in which the output flows of both rotary groups is separately varied. Increasing the sum of the pressures causes an inward swivelling towards a smaller swivel angle and lower output flow; falling summed pressure causes the unit to swive out to a larger angle and higher output flow.

4) TOTAL HORSEPOWER CONTROL

The regulator decreases the pump tilting angle(delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P_1 of the self pump and the delivery pressure P_2 of the companion pump.

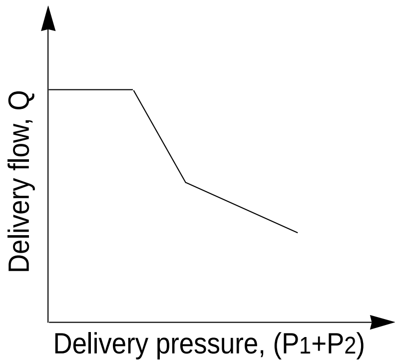
(The input horsepower is constant when the speed is constant.)

Since the regulator is of the simultaneous total horsepower type that operates by the sum of load pressures of the two pumps in the tandem double-pump system, the prime mover is automatically prevented from being overloaded, irrespective of the load condition of the two pumps, when horsepower control is under way.

Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles(displacement volumes) of the two pumps to the same value as represented by the following equation :

$$Tin = P_1 \times q/2\pi + P_2 \times q/2\pi$$
$$= (P_1+P_2) \times q/2\pi$$

The horsepower control function is the same as the flow control function and is summarized in the following.



5) NEGATIVE FLOW CONTROL

By changing the pilot pressure X_1, the pump tilting angle(delivery flow) is regulated arbitrarily, as shown in the figure.

This regulator is of the negative flow control in which the delivery flow Q decreases as the pilot pressure X_1 rises.

With this mechanism, when the pilot pressure corresponding to the flow required for the work is commanded, the pump discharges the required flow only, and so it does not consume the power uselessly.