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[54] **SERVO-CONTROL DEVICE FOR VARYING THE DELIVERY AND DIRECTION OF DISTRIBUTION OF A VARIABLE DELIVERY PUMP**

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[51] **Int. Cl.** **F15b 15/18**

[58] **Field of Search** ..... 60/52 VS, 442, 443, 60/479, 487, 488, 489, 493

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[57] **ABSTRACT**

A servo-control device for varying the delivery and distribution of a variable delivery pump to a hydraulic motor comprises means for varying the output of the pump and a two-way distributor between the outlet of the pump and two inlets of the motor. The distributor has two control chambers connected to two outlets of an auxiliary two-way distributor, the inlet of which is connected to the outlet of a feed pump driven by the variable delivery pump. The outlet of the feed pump is connected to the inlet of a control distributor which supplies fluid to two chambers of a ram having a ram rod coupled to the means for varying the output of the pump. The spool valves of the auxiliary distributor and the control distributor are operated by a common actuating lever.

12 Claims, 3 Drawing Figures

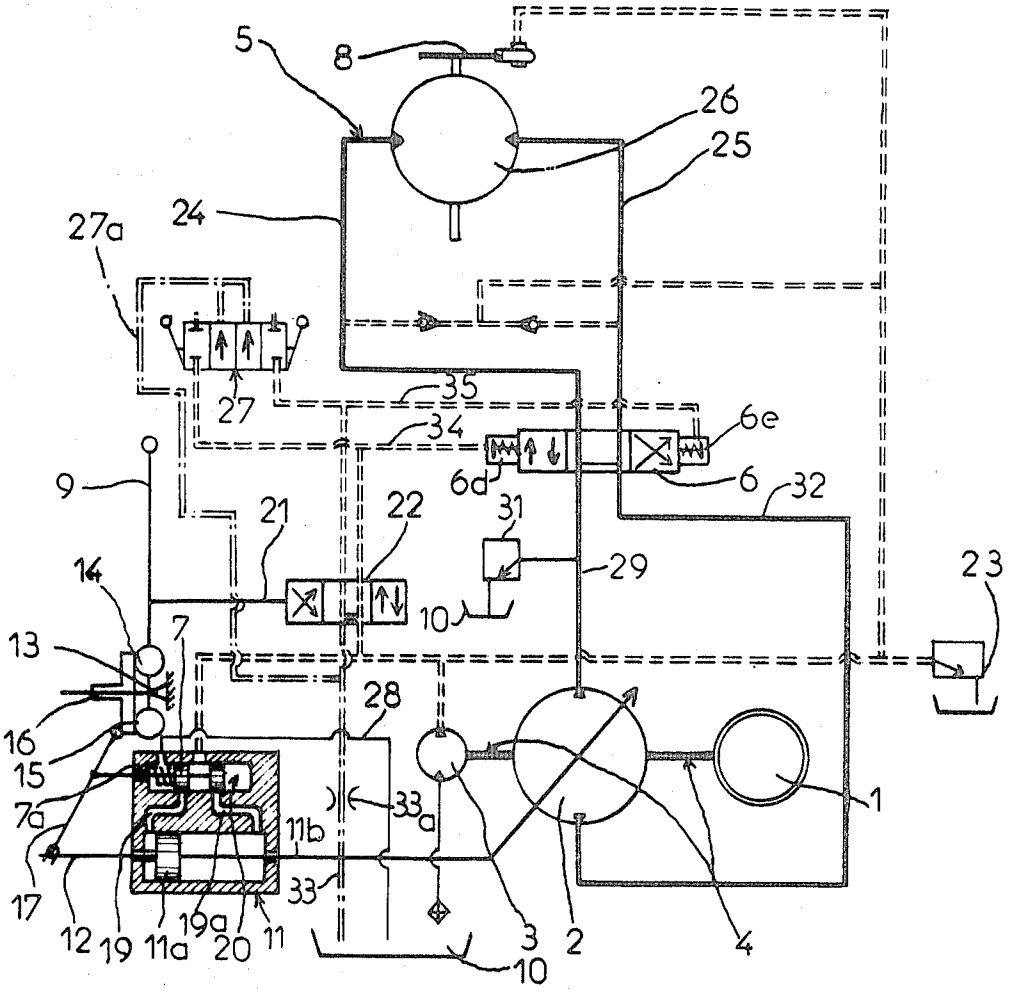
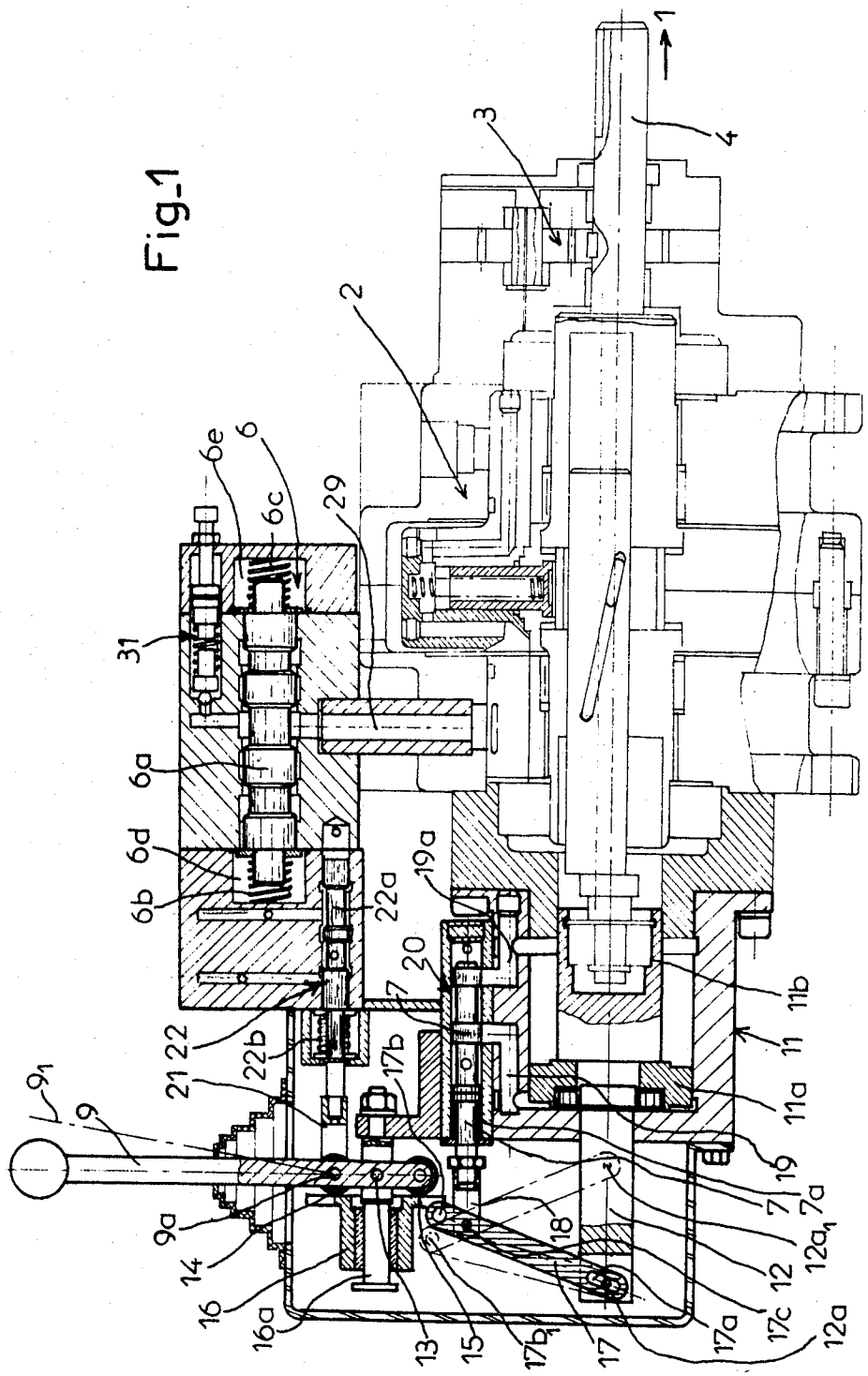


Fig.1


1
3
4
2
6e
6
6c
29
31
6a
6d
6b
19a
22a
20
17
11b
11
11a
21 22
22b
17b
9₁
9
19
7
7a
9a
18
12a₁
14
12
16
16a
13
15
17b₁
17
17a
17c
12a

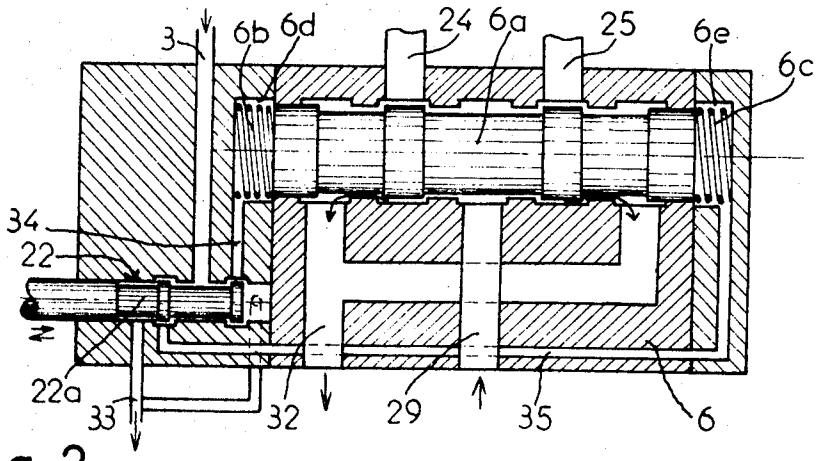
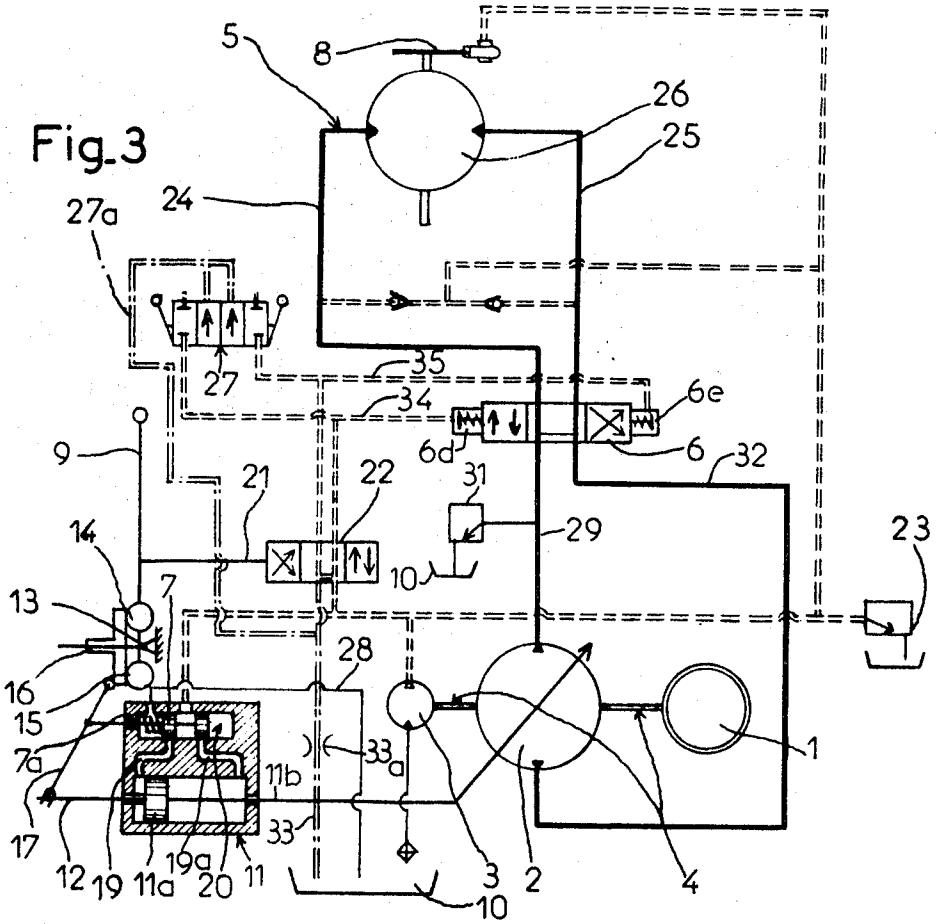

3
6b
6d
24
6a
25
6e
6c
34
22
22a
33
32
29
35
6

Fig_2

Fig_3


5
8
26
25
24
27a
27
35
34
6e
6d
6
32
9
21
22
31
29
23
14
10
13
7
28
16
15
7a
33a
11b
1
17
33
12
19
11a
19a
20
11
3
2
4
10

SERVO-CONTROL DEVICE FOR VARYING THE DELIVERY AND DIRECTION OF DISTRIBUTION OF A VARIABLE DELIVERY PUMP

The present invention relates to a servo-control device for varying the rate of flow and direction of distribution of a variable delivery pump feeding a hydraulic motor through a two-way distributor.

A hydraulic transmission is already known which comprises a pump delivering its output into a circuit having an element for controlling the rate of flow in the circuit, this element consisting of an adjustable restrictor device. In a transmission of this kind, the adjustable restrictor device is coupled mechanically to the main two-way distributor connected between the pump and the hydraulic motor.

A transmission of this type has particular disadvantages in that there is a risk of cavitation, it requires a pressurized tank and it is impossible to employ the hydraulic circuit for a braking action.

Variable delivery pumps are also known, of the barrel or cylinder type, which require slow controls and substantial forces to be applied to modify the rate of delivery. Furthermore, the barrel assembly must be tilted to obtain a variation in delivery.

Moreover, another disadvantage inherent in pumps of the barrel type is that there is a substantial neutral range and that, due to this, a brake acting on a hydraulic motor supplied by the pump and stopping this motor during a pressure drop, remains applied during the initial delivery stage of the pump.

The present invention has for its object to eliminate the disadvantages set out above.

The present invention consists in a servo-control device for varying the delivery and direction of distribution of a variable delivery pump to a hydraulic motor comprising a member for varying the output of the pump, a two-way distributor connected between the outlet of the pump and two inlets of the motor, the distributor having two control chambers connected, respectively, to two outlets of an auxiliary two-way distributor, the inlet of which is connected to the outlet of a feed pump driven by the variable delivery pump, said last-named outlet also being connected to the inlet of a control distributor which supplies fluid to two chambers of a ram whose rod is coupled to the member for varying the output of the pump, the spool valves of the auxiliary distributor and control distributor being operated by a common actuating lever.

The advantages of a device of this kind consist in removing all risks of cavitation and in allowing bracking action by means of the hydraulic circuit.

FIG. 1 is a sectional view of a servo-control device according to the present invention in combination with a variable delivery pump.

FIG. 2 is a sectional view showing the connections between the main and auxiliary distributor valves shown in FIG. 1 and,

FIG. 3 is a hydraulic diagram of the main pump, hydraulic motor and servo-control device of the present invention.

The hydraulic servo-control device illustrated in FIGS. 1 to 3 operates in combination with a main pump 2 which is driven by an electric motor 1 whose spindle 4 also drives a feed or auxiliary pump 3. The pump 2 is a variable displacement pump of the type comprising a crankshaft whose crank pin has a throw which is variable depending on the position of an axial rod 11*b* which causes variation in the piston stroke and in the delivery rate of the pump.

The main pump 2 delivers pressurized motive fluid into a main supply circuit 5, illustrated by thick lines, and feeds a fluid motor comprising a hydraulic motor 26 connected in the circuit through a main distributor 6 of the two-way type comprising a spool valve 6*a* directional-control (FIGS. 1 and 2) which is moved axially in both directions by springs 6*b* and 6*c* housed, respectively, in control chambers 6*d* and 6*e* of the body of the distributor 6.

The outlet of the pump 2 is connected to an inlet of the distributor 6 by a pipe or duct 29 which is in communication with a reservoir of fluid 10 through a safety valve 31 having an adjustable "threshold" setting. The return connection of the distributor 6 communicates through a duct or passage 32 with the intake connection of the pump 2. The two outlets of the distributor 6 are connected to the two inlets of the motor 26, respectively, through the ducts 24 and 25. In the neutral position of the distributor 6, that is to say in the central position of the spool valve 6*a*, a leak connection is provided between the inlet of the distributor 6 and the return connection to the duct 32.

The feed or auxiliary pump 3 has an orifice connected to the tank 10 and has its outlet connected with the inlet orifice of an auxiliary distributor 22 comprising a spool valve 22*a* which is biassed to its neutral position by a spring 22*b*. In the neutral position of the auxiliary distributor 22, its inlet orifice is in communication with a return orifice which is connected by a duct 33 to the tank 10 via a restrictor 33*a*. A permanent leakage flow path is thus established in the distributor 22 in the neutral position.

The two outlets of the auxiliary distributor 22 are connected, respectively, through ducts 34 and 35 to the control chambers 6*d* and 6*e* of the main distributor 6. The outlet of the feed pump 3 is also connected to the inlet orifice of a control distributor 20. The chamber accommodating the return spring 7*a* is in communication with the tank 10 through a return passage 28. The control distributor 20 has two outlet orifices connected, respectively, through ducts 19 and 19*a*, to the two chambers of a servo-control ram or fluid actuator 11. The piston 11*a* of the ram 11 is connected with a rod 11*b* which is coupled to the element of the pump 2 which renders it possible to vary the delivery of the latter (in this case being a device which varies the eccentricity of a crank pin of a crankshaft driving one or more pistons) following the axial sliding of the rod 11*b*.

The piston 11*a* is also connected with a rod 12 which extends leftwards (as viewed in FIG. 1) from the ram 11 and is coupled to the lower extremity of a lever 17 by means of a stud 12*a* mounted on the rod 12 which engages a slot 17*a* formed in the lever 17.

The lever 17 is pivoted adjacent its upper end on a pin 17*b* mounted on the lower part of a movable abutment 16. The lever 17 is also pivotally mounted intermediate its ends on a pin 17*c*, fixed to a clevis 18 extending from the spool valve 7 of the distributor 20.

The abutment 16 is arranged to slide axially on a horizontally disposed spindle 16*a* and the right-hand face of this abutment (as viewed in FIG. 1) has two rollers 14 and 15 bearing against it which are rotatably mounted on an actuating lever 9. This lever 9, which is vertical in the neutral position illustrated in FIG. 1, is

pivotally mounted on the spindle **16***a* by a transversely extending stud **13** positioned between the rollers **14** and **15**, the latter being positioned at the lower end of the lever **9**.

The lever **9** is pivotally mounted on a pin **9***a*, which conveniently may be on the axis of rotation of the roller **14**, connected to a rod **21** extending externally of and connected to the auxiliary directional control spool valve **22***a* of the distributor **22**.

The lever **9** makes it possible to vary the delivery of the main pump **2** and also the direction of feed to the hydraulic motor **26**. The lever **9** may be operated manually, as illustrated in FIGS. **1** and **2**, or it may be operated by other means, for example, a double-acting ram including means ensuring automatic return to the neutral position, or by an electro-magnet.

To the outlet of the feed pump **3** is also connected a calibrating valve **23** and a brake **8** which is applied when the pressure drops in the main hydraulic circuit. The feed pump **3** performs the following functions:

a. it feeds the main pump **2** under low pressure in such a manner as to prevent cavitation;

b. it replaces oil leakage from the main circuit **5**;

c. it makes it possible to increase the fluid pressure to a predetermined value to operate the main distributor **6**, the servo-control ram **11** through the distributor **20**, also the release of the safety brake **8**.

The operation of the servo-control device will now be described.

When the lever **9** is in the neutral vertical position shown in FIGS. **1** and **3**, communication is established between the inlet and return connections of the auxiliary distributor **22** and the liquid of this circuit thus returns to the tank **10** through the restrictor **33***a* and the duct **33**. The liquid is then raised to a low pressure P_0 which is however sufficient to move the piston **11***a* of the servo-control ram **11** to its extreme left position in which the rod **11***b* sets the delivery of the main pump **2** to zero so that the pump idles. Thus, in the neutral position of the lever **9**, a small part only of the power applied for feeding is lost.

Owing to the low pressure P at the outlet of the feed pump **3**, the safety brake **8** is applied and the hydraulic motor **26** is immobilized.

If it is desired to drive the hydraulic motor **26** in one direction or the other, the lever **9** is pivoted towards the right or the left and at an angle proportional to the speed required, that is to say, to the delivery of the pump **2** which is required. Assuming the lever **9** is pivoted clockwise about the pin **13** to a position 9_1 shown diagrammatically by dash-dotted lines in FIG. **1**, such pivotal movement causes a rightward displacement of the rod **21** and of the spool valve **22***a* against the return spring **22***b* which causes the interruption of the communication between the inlet and return connections of the distributor **22** and places these connections in communication with, respectively, the ducts **34** and **35** which are connected, respectively, to the chambers **6***d* and **6***e* of the distributor **6**.

The control chamber **6***d* is then supplied through the distributor **22** and the duct **34** with liquid at a pressure P_1 which is determined by the calibrating valve **23**. This pressure P_1, which is higher than the pressure P_0, has a magnitude or value sufficient for the different functions which are to be carried out by the feed circuit. The pressurization of the control chamber **6***d* results in the movement of the spool valve **6***a* towards the right and the feeding of liquid under pressure to the left-hand duct **24** which is placed in communication with the feed duct **29**, the other duct **25** being connected to the return passage **32**. The raising of the pressure in the circuit to the value P_1 releases the safety brake **8** which thus allows rotation of the motor **26** in the direction required, for example clockwise.

It will be seen that if the lever **9** had been pivoted in the opposite direction, i.e., towards the left in FIG. **1**, the spool valve **6***a* would have been moved towards the left and caused the pressurization of the duct **25** and consequently the rotation of the motor **26** in the other direction.

While the lever **9** causes the movement to the right in FIGS. **1** and **3** of the spool valve **22***a* of the auxiliary distributor **22**, it also causes by means of its lower roller **15**, leftward movement of the abutment **16** on the spindle **16***a* so that the upper pin **17***b* is moved to a position marked $17b_1$. Since the piston **11***a*, and consequently its rod **12**, is stationary at this instant, the stud **12***a* acts as a pivot for the lever **17** which, due to the fact that the upper pin **17***b* is displaced towards the left, thus pivots around the stud **12***a* in a counterclockwise direction. The pin **17***c* is thus moved leftward, as is the spool valve **7** of the control distributor **20**, against the return spring **7***a*. This has the result of establishing communication between the inlet connection of the control distributor **20** and the duct **19** and consequently the left-hand operating chamber of the ram **11**. Thus, the feed liquid under the pressure P_1 is fed into this operating chamber and causes displacement of the piston **11***a* towards the right.

During this displacement, since the upper pin **17***b* is held by the lever **9**, the movement of the stud **12***a* with the rod **12** towards the right causes a rightward displacement of the pin **17***c* and spool valve **7**. At a given instant, when the stud **12***a* reaches the position $12a_1$, the piston **11***a* will have been displaced towards the right by a distance sufficient for the spool valve **7** to have returned to the neutral position at which it closes off the duct **19**. The amplitude of the displacement of the piston **11***a* of the ram **11** is thus proportional to the displacement of the abutment **16**, that is to say as a function of the angle of inclination of the lever **9**. The greater is the angle of inclination, the greater is the displacement of the abutment **16** towards the left and the greater is the stroke of the piston **11***a* required for the spool valve **7** to return to the central neutral position.

The displacement of the ram **11***a* and of the rod **11***b* causes a proportional adjustment of the eccentric crank pin of the main pump **2** and consequently of its delivery. If, starting from the position 9_1 of the lever **9**, it is desired to increase the delivery of the pump, the clockwise inclination of the lever is increased.

The return of the pump delivery to zero is effected by pivoting the lever **9** in the opposite direction, i.e. the counterclockwise in FIG. **1**, from the position 9_1. At this instant, the stud **12***a*, being positioned at $12a_1$ in FIG. **1**, acts as a fixed pivot for the lever **17** which is moved clockwise by the return spring **7***a* thrusting the spool valve **7** which is connected to the lever **17** towards the right. The pivoting movement of the lever **17** causes the rightward displacement of the pin **17***b* from the position $17b_1$ and also the movement towards the right of the abutment **16** which returns to the idle position. At the same time, the spool valve **7**, displaced to the right-hand position, establishes communication be-

tween the inlet connection of the control distributor **20** and the duct **19***a*. The feed fluid at the pressure P_1 is then fed into the right-hand operating chamber of the servo-control ram **11** which causes displacement of the piston **11***a* towards the left. During this displacement, the lever **17** pivots clockwise around the upper pin **17***b* and thus moves the spool valve **7** of the distributor **20** towards the left. At the end of the leftward stroke of the piston **11***a* the distributor has returned to the neutral position and the delivery from the main pump **2** has been terminated.

An end-of-stroke unit **27** (FIG. 3) comprising two valves which are normally closed and whose inlets are connected respectively, to the ducts **34** and **35**, while the outlets are jointly connected by a duct **27***a* to the tank **10**, may be used in combination with the device already described. When one of these valves, for example the right-hand valve of the unit **27** is opened at the end of the stroke by an element actuated by the motor **26**, its opening places the duct **35** in communication with the tank **10**, which results in a slight pressure drop in the feed circuits. As a result of this pressure drop, the main distributor **6** is returned to the neutral position so that the motor **26** is no longer supplied and the safety brake **8** is applied. With a pressure in the feed circuit of a few pounds, the actuating lever **9** returns to the neutral position, the piston **11** and its rods **12** and **11***b* return to the extreme left position corresponding to zero delivery of the pump **2**. The feed fluid then escapes through the duct **19** and the passage **28** is connected to the tank **10**. The pump **2** will thus start up again with a zero delivery at the next actuating displacement.

What we claim is:

1. A servo-control device for varying the delivery and direction of distribution of a variable delivery pump to a hydraulic motor comprising a member for varying the output of the pump, a two-way distributor valve connected between the outlet of the pump and two inlets of the motor and having two control chambers, an auxiliary two-way distributor valve having two outlets connected respectively to said two control chambers and an inlet connected to the outlet of a feed pump, a control distributor valve having an inlet connected to the feed pump outlet for controlling the supply of fluid to two chambers of a ram, said ram having a piston and a rod connected to said piston and wherein said rod is coupled to the member for varying the output of the variable delivery pump, and a common actuating lever for actuating the spool valves of the auxiliary distributor valve and the control distributor valve.

2. A device as claimed in claim **1**, wherein the spool valve of the auxiliary distributor is pivotally mounted on the actuating lever, an axially movable abutment having said lever pivotally mounted thereon and bearing thereagainst, a linking lever pivotally mounted adjacent one of its extremities on said rod of the ram and pivotally mounted adjacent its other extremity to said abutment, and wherein said spool valve of the control distributor is pivotally connected to said linking lever.

3. A device as claimed in claim **2**, wherein the actuating lever is provided with spaced rollers positioned respectively, on either side of the pivot of said actuating lever, said rollers bearing against an end face of the sliding abutment.

4. A device as claimed in claim **3**, wherein the auxiliary distributor valve includes a return connection normally in communication with its inlet when the distributor spool valve is in a neutral position, said return connection being in communication with a tank through a restrictor in such a manner as to obtain a low pressure fluid fed to the outlet of the feed pump when the auxiliary distribuor spool valve is in the neutral position.

5. A device as claimed in claim **4**, wherein the outlet of the feed pump is connected to a calibrating valve arranged in such manner as to open at an adjustable second pressure which is higher than the pressure normally prevailing in the circuit when the auxiliary distributor spool valve is in the neutral position, this outlet of the feed pump also being connected to a safety brake associated with the hydraulic motor.

6. A fluid system comprising: a variable displacement pump operable to pressurize a fluid and deliver same at a variable delivery rate as motive fluid and having a movable control member for variably setting the delivery rate in dependence upon the position of said control member; a fluid motor actuatable in two different directions in response to motive fluid applied thereto; a main distribution circuit having means receptive of the motive fluid delivered from said variable displacement pump for applying same to said fluid motor and including a fluid-activated directional control valve actuatable into various working positions to control the output direction of said fluid motor in dependence upon the position of said valve; an auxiliary pump operable to pressurize a fluid and deliver same as working fluid; a fluid actuator connected to said control member and responsive to working fluid applied thereto to move said control member to vary the delivery rate of said variable displacement pump; and an auxiliary distribution circuit having means receptive of the working fluid delivered from said auxiliary pump for selectively applying same to both said fluid-actuated directional control valve to actuate same to its various working positions to thereby control the output direction of said fluid motor and to said fluid actuator to actuate same to thereby control the delivery rate of said variable displacement pump.

7. A fluid system according to claim **8**; wherein said auxiliary distribution circuit comprises a mechanically-actuated auxiliary directional control valve actuatable into plural working positions to valve the working fluid to and from said fluid-actuated directional control valve to thereby control the actuation of same, a mechanically-actuated control valve actuatable into plural working positions to valve the working fluid to and from said fluid actuator to thereby control the actuation of same, and actuating means including a pivotal actuating lever connected to both said mechanically-actuated auxiliary directional control valve and said mechanically-actuated control valve for effecting concurrent actuation of both said last-named valves in response to pivotal movement of said actuating lever.

8. A fluid system according to claim **7**; wherein said auxiliary distribution circuit includes a feedback linkage assembly interconnecting said mechanically-actuated control valve and said fluid actuator operative to feedback the movement of said fluid actuator to said control valve to reposition same into a neutral position wherein same does not valve working fluid to said fluid actuator to thereby maintain said fluid actuator in a desired position.

9. A fluid system according to claim **7**; wherein said actuating means comprises a slideable member having

thereon a pair of abutment surfaces, a pair of camming rollers each rotatably mounted on said actuating lever and engageable with respective ones of said abutment surfaces, means mounting said actuating lever for pivotal movement about an axis situated between said pair of rollers whereby pivotal movement of said actuating lever in either direction effects sliding movement of said slideable member in the same direction due to the camming action of said rollers against said abutment surfaces, and biasing means biasing said actuating lever into a neutral position wherein same does not effect actuation of either said auxiliary directional control valve or said control valve.

10. A fluid system according to claim **9**; wherein said actuating means includes means connecting said auxiliary directional control valve to said actuating lever to effect actuation of the former in response to pivotal movement of the latter, and means connecting said control valve to said slideable member to effect actuation of the former in response to sliding movement of the latter caused by pivotal movement of said actuating lever.

11. A fluid system according to claim **7**; wherein said auxiliary distribution circuit includes brake means for braking said fluid motor whenever the pressure of the working fluid is below a predetermined valve and responsive to the pressure of the working fluid when same reaches said predetermined value to release said brake means.

12. A fluid system according to claim **7**; wherein said auxiliary distribution circuit includes a safety valve operable to bleed the working fluid from said auxiliary distribution circuit independently of the position of said actuating lever, and spring means for biasing said fluid-actuated directional control valve into its neutral position wherein same effects recirculation of the motive fluid delivered from said variable displacement pump whenever the working fluid is bled from said auxiliary distribution circuit.

* * * * *