(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 243 964 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
27.10.2010 Bulletin 2010/43

(51) Int Cl.:
F15B 13/04 *(2006.01)*

(21) Application number: **10158618.8**

(22) Date of filing: **31.03.2010**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA ME RS

(30) Priority: **24.04.2009 SE 0900563**

(71) Applicant: **Nordhydraulic AB**
872 24 Kramfors (SE)

(72) Inventors:
- **Hägglund, Per**
  931 51 Skellefteå (SE)
- **Marklund, Martin**
  931 51 Skellefteå (SE)

(74) Representative: **Holmberg, Nils Anders Patrik**
BRANN AB
Västgötagatan 2
P.O. Box 17192
104 62 Stockholm (SE)

(54) **Control valve**

(57) The invention relates to a control valve (1) for maneuvering a hydraulic consumer, (11) such as a single acting telescopic cylinder, the valve including a valve housing (2) with an inlet port (12) connected to a pump for delivering a hydraulic flow, a motor port (14) to which said consumer (11) is connected, an outlet port (13) connected to a tank and a maneuverable slide (3) with a first and a second end (3a, 3b), respectively, which is provided with port tracks (7,20,21) and which is arranged in the valve housing, wherein the slide can control the hydraulic flow between the inlet port and the consumer and between the consumer and the tank, the valve housing including a first flow path (I) over first end of the slide and a second flow path (II) over the second end of the slide, and wherein the return flow from the consumer to the tank through the valve housing may be conveyed via said flow paths. In order to provide improved control performance the control valve includes a regulating device (30) that is connected to the slide (3) and from a position with maximal velocity upon lowering of a load where the return flow from the consumer (11) is conveyed via said both flow paths (I, II) over the first end (3a) and second end (3b) of the slide, is arranged to provide a limited lowering velocity through adjustment of the slide in the axial direction and conveying of the flow over the first flow path (I) on the first end (3a) of the slide only.

EP 2 243 964 A2

Description

[0001] The present invention relates to a control valve according to the preamble of claim 1.

[0002] Vehicles with wagon bridges, e.g. tipping lorries, are commonly used for transport of material such as gravel and soil to and from construction locations, wherein the load is tipped at the desired location by means of a tipping cylinder arranged on the wagon bridge. The hydraulic cylinder on such tipping arrangements is usually of a single-acting telescoping type. In other words, the hydraulic cylinder is of the type that includes a number of cylinder sections comprised in each other and mounted between the wagon bridge and vehicle frame, which sections by the action of a pressurized fluid may be extended in a number of sequential steps. When the wagon bridge is to be lowered from a tilted and substantially vertical tipping position to a horizontal position the telescopic cylinder is retracted under the influence of the weight of the wagon bridge. The maximum velocity at which the wagon bridge may be lowered is limited by the flow through the control valve, wherein the flow limitation also implies that the vehicle remains stationary and ineffective while the wagon bridge is lowered towards a bottom position in which the wagon bridge rests horizontally and the vehicle is ready to fetch a new load. This is a disadvantage that of course impairs the degree of utilization of the capacity and efficiency of the vehicle.

[0003] SE 526 222 discloses a control valve that solves this problem by allowing the flow to take two paths past the slide upon emptying of the consumer and lowering of a load. Hence, the flow through the valve is larger in the direction in which the hydraulic cylinder is emptied of its fluid for lowering of the wagon bridge after tipping than at filling of the hydraulic cylinder for raising of the wagon bridge. In a known fashion this conventional control valve includes a valve housing that houses a slidably arranged slide, openings or ports that are connected to a source for emitting a pressurized fluid, and to a consumer that e.g. may be a hydraulic cylinder or a tank for collection and storage of surplus fluid. The slide has a first and a second end, respectively, and is displaceable in the valve housing for controlling of the flow between an inlet port in connection to the pressure source and an outlet port that is connected to the consumer, or alternatively, from the consumer to the tank. In order to achieve an especially large flow in only one direction the valve housing is provided with a bore that makes sure that the flow at emptying of the hydraulic cylinder may take two paths over the slide, namely a first flow path over the first end of the slide, and a second flow path over the second end of the slide. In other words, at draining of the consumer to the tank, the flow is led via both these flow paths from the consumer to the tank.

[0004] Although the above mentioned and formerly known control valve has proven to be well functioning and has contributed to a substantially higher degree of utilization of the capacity of a vehicle, due to shorter downtimes during tipping, it has proven desirable to be able to control the flow velocity of the control valve in a feasible manner as the hydraulic cylinder is emptied of its fluid upon lowering of a load. When a wagon bridge is being emptied of its load it is of course desirable to have a maximal lowering velocity for the wagon bridge all the way down to a horizontal position, but in certain cases it may however be justified to interrupt a commenced tipping. Such an example is for instance if the operator, after a commenced tipping, discovers that something is wrong and in haze needs to interrupt the tipping, e.g. by lowering the wagon bridge, before the load has been tipped off. It is implicit that due to the fact that the wagon bridge still carries the whole load or at least a part of the load the lowering velocity will not only be affected by the own weight of the wagon bridge, but also of the weight of the load it carries, which implies that the lowering velocity in certain cases may become uncontrollable high, i.e. so high that there is a risk that the wagon bridge collides with the vehicle frame, which in turn constitutes an important safety hazard.

[0005] An object of the present invention is to provide a control valve of the type described above, but with an improved controlling performance and which control valve although it allows a very sudden lowering of the wagon bridge it also allows regulation of the flow velocity of the control valve during lowering of a load. A further object of the invention is to provide a control valve that makes it possible to simultaneously, at an arbitrary moment during a commenced tipping operation, take command of the control valve and limit the flow and thus the maximal velocity of the lowering velocity of the load. On modern vehicles the space for installation of pneumatic operating devices is very limited. A third object of the invention is therefore to achieve a control valve that allows electrical remote controlling and that is easily implemented in an operator's cab and may be controlled with electrical push buttons from the cab.

[0006] These objects of the invention are achieved with a control valve that involves the features and characteristics of claim 1. Further advantages of the invention are apparent from the dependent claims.

[0007] In the following, a control valve according to invention is described in detail with reference to the accompanying drawings, of which;

Fig. 1 shows a cross section of a known control valve of a presented type,

Fig. 2a-2d shows a cross section of a control valve according to the invention in a number of different maneuver positions and including the valve housing shown in fig. 1, in a view that is orthogonal to the cross section shown in fig. 1,

Fig. 3 schematically shows a control system with electromagnetic valves for regulating and controlling an actuator unit arranged on the control valve, and

Fig. 4 shows a longitudinal section of the actuator unit involved in the device according to the invention.

[0008] The known control valve 1 of figure 1 for directional control of the flow of fluid includes a valve housing 2, in which a slide 3 is arranged to slide inside a sleeve 4. The slide 3 is arranged to be slidably and continuously displaced in the sleeve 4 between a first and a second end position. The slide 3 has a first and a second end 3a and 3b, respectively, wherein means in form of a compression spring 6 is arranged at said first end and wherein the second end extends through a sealing 7. As long as the slide 3 is unaffected by the operator it strives to assume a neutral position under the action of the compression spring 6. The valve housing 2 is divided into a first side 8, defined as the part of the valve housing that the slide's first end 3a is located in, and a second side 9, defined as the part of the valve housing that the slide's second end 3b is located in. The slide 3 exhibits a number of machined port tracks 10 through which fluid may pass. At displacement of the slide 3 the corresponding ports in the valve housing 2 are opened or closed, respectively. The reference numeral 11 denotes a consumer in the form of a single acting and telescoping hydraulic cylinder that may communicate with one of said ports.

[0009] Now, with reference to both fig. 1 and 2a-2d, the valve housing 2 is provided with an inlet 12 and an outlet 13. The inlet 12 is connected to a pump (not shown), which delivers a hydraulic flow. The outlet 13 is connected to a tank (not shown). A connection 14 (denoted A in fig. 2a-2d), i.e. a so called motor port, for conveying fluid to the consumer 11 is arranged between the inlet 12 and the outlet 13. The motor port 14 is provided with a bore in form of an eccentric areal enlargement 15 in order to increase the available flow area from the consumer 11 through the valve housing 2 and via the outlet 13 to the tank. The increase of the flow arises since the return flow from the consumer 11 may flow via two paths back to the tank. As is apparent at a closer look on fig. 1, the areal enlargement 15 is eccentrically located in relation to the original connection. Adjacent to the areal enlargement there is a sealing ring 16 which encloses a sealing stopper 17. The sealing stopper 17 is a substitute to a pressure relieving valve that conventionally is mounted in connection to the motor port 14. A bored channel 18 in the axial direction of the stopper 17 extends through the valve housing 2 at a substantially right angle with respect to the motor port 14 that is located at the first end of the channel 18. The motor port 14 is connected to the channel 18 and a port track 20 that is arranged in connection to an end 3b of the slide 3 that is located in the second side 9 of the valve housing. An enlarged port track 21 is arranged in connection to the end 3a of the slide 3 that is located in the first side 8 of the valve housings, i.e. a port track with an extended measure in the axial direction of the slide 3, which at the first end position of the slide 3 according to figure 2a communicates with the tank via a second channel 22. This enlargement of the port track opens up for communication with the main pressure relieving valve 19 from both the pump and the consumer. When the return flow reaches the eccentric areal enlargement 15 of the motor port 14, i.e. when the return flow is conveyed back into the valve housing 2, it is divided into two substantially equally big flows I and II, respectively, in accordance with figures 1 and 2a. The first flow I is conveyed to the enlarged port track 21 in the first side 5 of the valve housing via the tank channel 22 to the outlet 13. The second flow II is conveyed through the bored channel 18 to the port track 20 of the slide 3 in the second side 6 of the valve housing which is connected to the centre channel 23 and further on to the tank. In other words, the valve housing 2 includes a first flow path I over the first end 3a of the slide and a second flow path II over the second end 3b of the slide, wherein the return flow from the consumer 11 to the tank is conveyed via said flow paths through the valve housing 2. With this arrangement, the wagon bridge of a vehicle may be lowered with a substantially higher velocity than at the use of conventional control valves where the flow may be conveyed over only one path past the slide 3.

[0010] Now, with reference to fig. 2a-2d, the control valve 1 is shown in a position in right angle compared to the view shown in the cross section of fig. 1. A device for regulation of the slide 3 and generally denoted with reference numeral 30 is arranged at the control valve 1 and which jointly with the slide regulates and controls the displacement of the slide in the axial direction. Thanks to the device according to the invention the flow through the control valve 1 may be regulated although the present control valve as such is adapted to very high flow velocities at lowering of a load.

[0011] The regulation device 30 arranged at the control valve 1 includes a first and a second pneumatic actuator 31, 31', of which the first (the rear actuator) 31 is of a single acting type while the second (the front actuator) 31' is of double acting type. Both the rear and the front actuator 31, 31' include one rod section 32, 32' each with a corresponding piston rod 33, 33', respectively, which are both arranged to move forth and backwards in a cylinder section 34, 34'. Each rod section 32, 32' defines a first and a second chamber 32:1, 32:2, and 32':1, 32':2 respectively, inside the corresponding cylinder wherein the rear piston rod 33 extends into a forwardly adjacent chamber 32':1. Both of the actuators 31, 31' are mounted coaxially in series one after the other such that the actuators together forms an actuator unit which is uniformly arranged on the first side 8 of the valve housing 2, i.e. the part of the valve housing where the first end 3a of the slide 3 is positioned for coaxial interaction with the same. The piston rod 33, 33' of each actuator 31, 31' each has a rear part 36, 36', respectively, which extends in a fluid tight manner out through a forwardly adjacent butt end 37, 37' and are thus arranged that they may be brought in and out of contact with each other at 38. Namely, the front end of the rear piston rod 33 may be brought in and out of contact with the rear end of the front piston rod 33'. The piston rod 33 of the rear actuator 31 forms a movement limiting stop at said contact for the rod section 32' of the front actuators 31'. As is apparent from fig. 4, the rear actuator 31 is provided with a stroke limiting organ 39, here represented by a

pair of bolts in form of an adjusting nut and a check nut by means of which of the axial position of the rear piston rod 33 in the rod section 32 may be calibrated during adjustment of the control valve 1 to a limited lowering velocity. Such calibration is normally only performed at rare occasions and in conjunction with adaptation of the control valve 1 with respect to the hydraulic units it is arranged to control.

[0012] In the detailed enlargement of fig. 2a, a connecting device 40 is closely shown, which has a shape that locks the slide 3 at the end of the front piston rod 33'. The connecting device 40 includes a thickened part 42 housed in an undercut track 41, wherein axial power transmission between the front end of the piston rod 33' and the first end 3a of the slide 3 is allowed in both the pulling and the pressing direction. Both of the actuators 31, 31' are provided with inlets or ports denoted P1, P2 and P3 for letting in an air pressure medium that functions as a signal feeding for adjustment or positioning of the respective rod sections 32, 32' in relation to each other in the corresponding cylinder 34, 34'.

[0013] From a closer study of figs. 2a-2d and fig. 3 it is apparent that the actuator unit 31, 31' as a whole comprises three inlet ports P1, P2, P3, wherein the signals to said inlet ports are generated by the control circuit 46 shown in fig. 3. The ports P1, P2, P3 may be put in and out of connection to the atmosphere or a pressure medium source, respectively by actuation of valve means 47, 48, 49, in form of a corresponding electromagnetically adjustable two way valve, arranged via signaling lines 43, 44, 45 to each port. The electromagnetic valves 47, 48, 49 are affected by a voltage of 24 volts and are connected and disconnected by means of switches 50, 51, 52 such as push buttons adapted to be placed on a distance from the control valve 1 and in communication with the corresponding actuator unit 30 by means of electrical lines 60, 61, 62. One of the major advantages of the possibility of electrical remote controlling of the actuator unit 31, 31' is that electrical lines are very simple to implement in e.g. the operator's cab of a vehicle in comparison to pneumatic signaling lines. The control valve 1 according to the invention functions in such a manner that is possible to obtain a lowering velocity that is adaptable to the load, through switching of the air pressure to the ports P1, P2, P3 of the actuator unit 31, 31' by means of a push of a button, wherein the actuator unit pulls or pushes the slide in the desired manner in the valve housing 2.

[0014] Table 1 schematically illustrates how the control circuit 46 of the control valve 1 operates, wherein the following logical symbols are used; 0=Air pressure off, corresponding to the atmosphere pressure and 1= Air pressure activated, e.g. corresponding to a overpressure of about 6 kPa. A and B denotes the motor ports of the control valve 1, whereas P and T denotes the control valve's 1 inlet port for the pressure side and outlet port to the tank, respectively.

Table 1

Flow	Function	P3	P2	P1
P→A B→T	Raising	0 or 1	1	0
P→B A→T	Slow Motion Lowering	1	0	1
P→T A/B→T	Super Rapid Lowering	0	0	1
P→Y A/B Closed	Neutral	0 or 1	0	0

[0015] The device has the following operational function:

[0016] As illustrated in fig. 2a the control valve 1 is adjusted for maximal lowering velocity denoted "Super Rapid" in which position the port P1 is fed with a signal "1" at the same time as the two other ports P2 and P3 receives no signal "0", i.e. P2 and P3 are set to atmospheric pressure. Under the influence of the compressed air at port P1 the rod section 32' of the front actuators 31' are forced to a rear end position in the cylinder and under the influence of said rod section the rear rod section 32 of the actuator 31 is forced backwards to its rear end position. As a consequence, the slide 3 is retracted about 7 mm into the valve housing 2 with respect to the centre line 53. In this position maximal lowering velocity is achieved in that the cylinder 11 is drained of its fluid via both the first flow path I over the first end 3a of the slide 3 and the second flow path II over the second end 3b of the slide 3. Also, see fig. 1.

[0017] In the position shown in fig. 2b the ports P1 and P3 are fed with pressure signals "1" while the port P2 receives no signal "0" and are set to atmospheric pressure. Under the influence of the compressed air to the ports P1 and P3 the rod section 32' of the front actuator 31' is forced backwards at the same time as the rod section 32 of the rear actuator 31 is forced forwvard. As they are moving towards each other the rear rod section 32 acts, by means of its comparatively larger area, as a stop for the front rod section 32' when they reach each other. As a consequence, the slide is only retracted about 3 mm into the valve housing 2. Hence, a comparatively slow lowering velocity is provided, which is

denoted "Slow Motion", in that the cylinder 11 is drained of its fluid in a limited manner since the flow is only conveyed via the first flow path I over the first end 3a of the slide 3. It should be implicit that in this flow reducing position the second flow path II, i.e. over the second end 3b of the slide 3, is closed. See also fig. 1. As a consequence, the flow mounts to about 50 % of the flow at the maximal lowering velocity "Super Rapid".

[0018] Now, with reference to fig. 2c, the control valve is adjusted into a neutral position "Neutral", in which position the port P2 is fed with a signal "1" at the same time as the two other ports P1 and P3 receives no signal "0", or alternatively none of the ports P1, P2, P3 receives a signal "0", wherein each of the ports are set to atmospheric pressure. In the neutral position the slide 3 is balanced on the centre line 53, i.e. 0 mm, under the action of the actuator unit 31, 31'.

[0019] In fig. 2d the device is adjusted to the raising position, "Raise" in which position the port P2 is fed with a signal "1" at the same time as the two other ports P1 and P3 receives no signal "0". The slide 3 is forced about 7 mm out of the valve housing 2, under the action of the actuator unit 31, 31', wherein pressurized fluid flows from the inlet 12 to the motor port 14 (denoted A in fig. 2a-2d) and from there further on to the consumer 11.

[0020] The invention is not limited to the embodiments described above and shown on the accompanying drawings. Instead it may be altered and modified in a number of manners within the scope of the spirit of the invention as defined in the following claims.

Claims

1. Control valve (1) for maneuvering a hydraulic consumer (11) such as a single acting telescopic cylinder, including a valve housing (2) with an inlet port (12) connected to a pump for delivering of a hydraulic flow, a motor port (14) to which said consumer (11) is connected, a outlet port (13) connected to a tank, and a maneuverable slide (3) provided with port tracks (7,20,21) and arranged in the valve housing with a first and a second end (3a, 3b), respectively, which slide is adapted to control the hydraulic flow between the inlet port and the consumer and between the consumer and the tank, wherein the valve housing includes a first flow path (I) over the first end (3a) of the slide and a second flow path (II) over the second end (3b) of the slide, wherein the return flow from the consumer to the tank may be led via said flow paths through the valve housing, **characterized in that** it includes a regulating device (30) connected to the slide (3), which device from a position with maximal velocity at lowering of a load, in which the return flow from the consumer (11) is conveyed via both the first and the second flow paths (I, II) over the first end (3a) and the second end (3b) of the slide, is arranged to provide a limited lowering velocity through adjustment of the slide in the axial direction and conveying of the flow over the first flow path (I) only, on the first end (3a) of the slide.

2. Control valve according to claim 1, wherein the regulating device (30) includes an actuator unit (31, 31') which is uniformly arranged on the side of the valve housing (2) towards which the first end (3a) of the slide (3) is faced.

3. Control valve according to claim 2, wherein the actuator unit (31, 31') is formed of a first and a second pneumatically acting actuator (31, 31'), which are coaxially arranged one after the other, whereof each includes a rod section (32, 32') with a corresponding piston rod (33, 33') that are both movably arranged forth and backwards inside a cylinder section (34, 34') where the first rod section of the actuator (32) forms a positive stop for the second rod section (32') of the actuator.

4. Control valve according to claim 3, wherein the actuator unit (31, 31') includes a stroke limiting organ (39) by means of which the axial position of the first piston rod (33) in the rod section may be adjusted upon adjustment to the limited lowering velocity.

5. Control valve according to claims 3 or 4, wherein each rod section (32, 32') defines a first and a second chamber (32:1, 32:2; 32':1, 32':2), respectively, in the corresponding cylinder section (34, 34') and wherein the rod section (33) of the first actuator (31) partly extends into the first chamber (32':1) of the second actuator (31').

6. Control valve according to claim 2, including a connecting device (40), which is formed so as to lock the first end (3a) of the slide (3) to the actuator unit (31, 31') and which allows axial power transmission in both the pulling and pressing direction between the slide (3) and the actuator unit (31, 31').

7. Control valve according to claim 2, wherein the actuator unit (31, 31') includes inlet ports (P1, P2, P3) and wherein the signals to said inlet ports are generated by a control circuit (46).

8. Control valve according to claim 7, wherein the ports (P1, P2, P3), by means of signal pressure lines (43, 44, 45), may be put in and out of connection to the atmosphere or a pressure medium source, and to a valve means (47,

48, 49) arranged at each port, respectively.

9. Control valve according to claim 8, wherein the valve means (47, 48, 49) include electromagnetically adjustable valves.

10. Control valve according to claim 9, including switches (50, 51, 52) such as push buttons arranged to be located on a distance from the control valve (1), and electrical lines (60, 61, 62) extending between the push buttons and the electromagnetically adjustable valves.

11. Use of the control valve according to any of the preceding claims 1-10 for maneuvering and control of the tipping function of a vehicle with a wagon bridge, such as a lorry or the like.

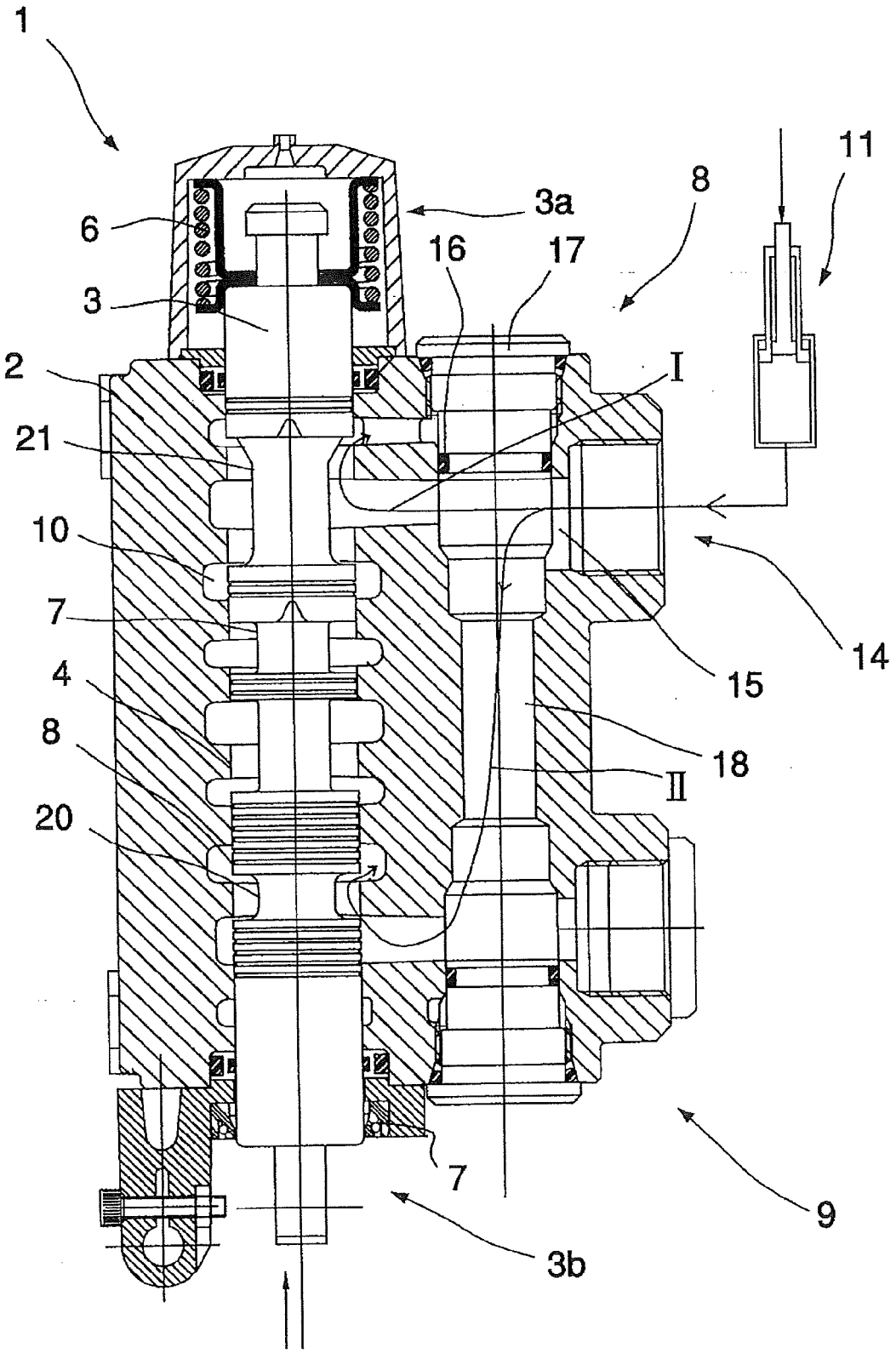

FIG.1

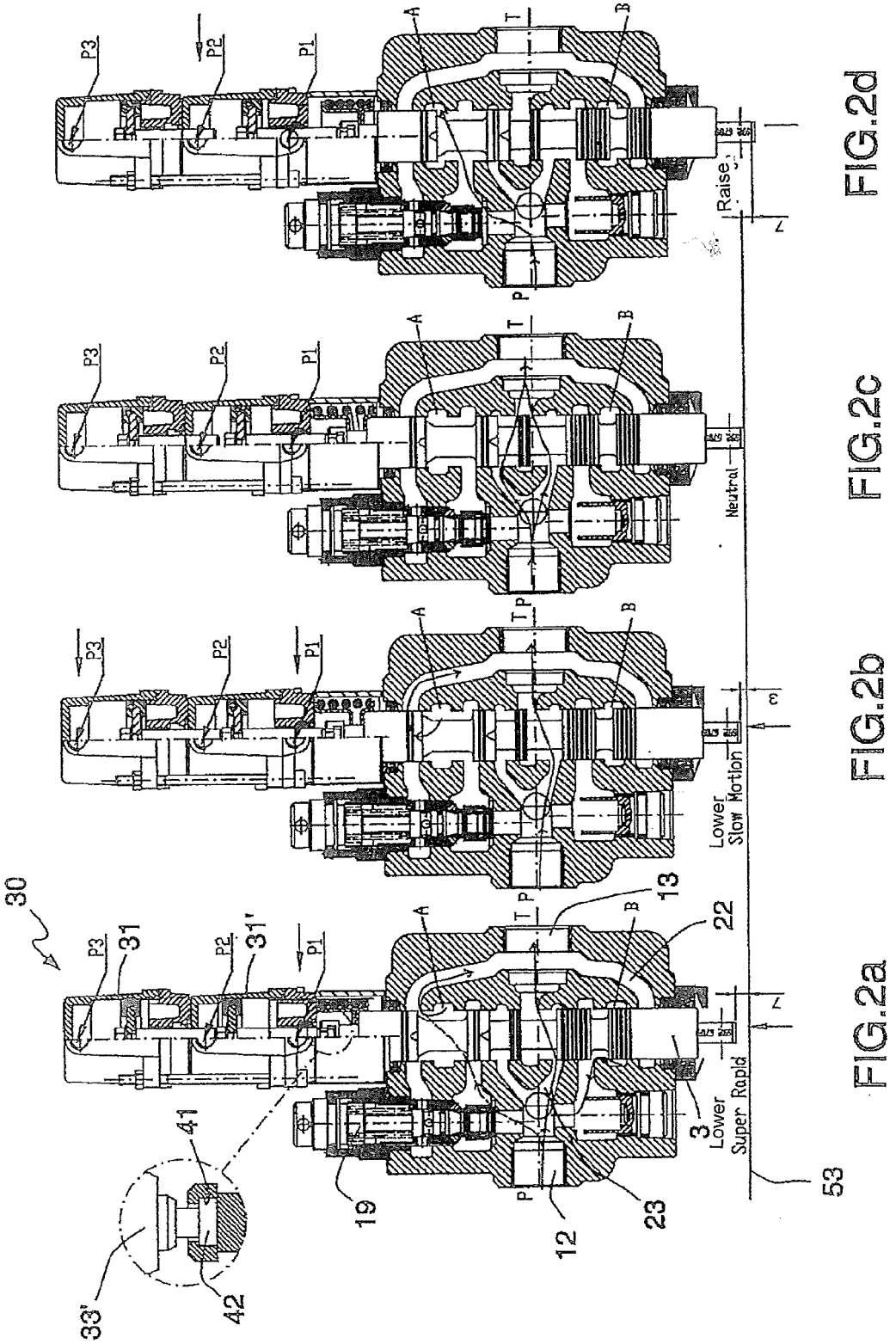

FIG.2a FIG.2b FIG.2c FIG.2d

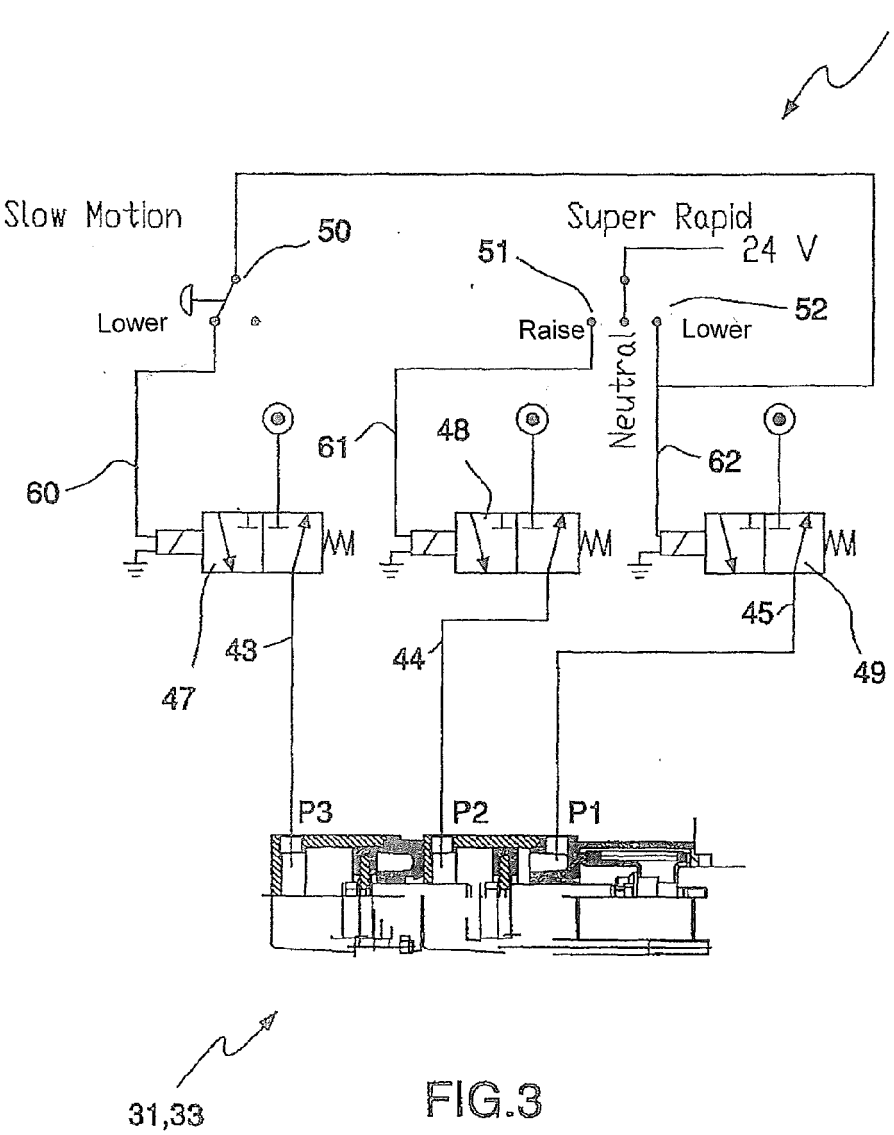
46
Slow Motion
50
Super Rapid
51
24 V
Lower
Raise
52
Lower
Neutral
61
48
62
60
45
43
44
49
47
P3
P2
P1
31,33

FIG.3

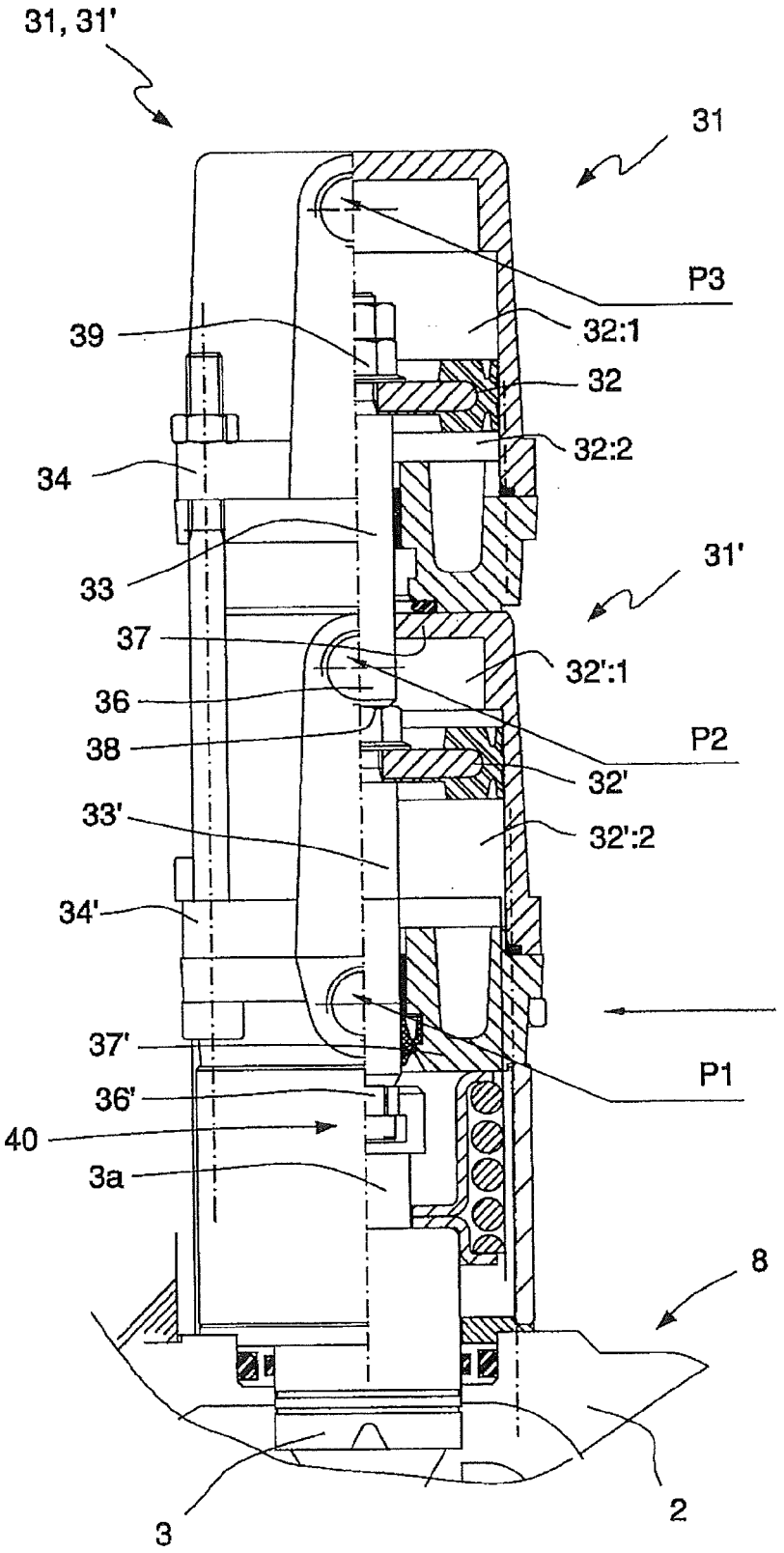
31, 31'
31
P3
39
32:1
32
32:2
34
31'
33
37
32':1
36
P2
38
32'
33'
32':2
34'
37'
P1
36'
40
3a
8
3
2

FIG.4

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- SE 526222 **[0003]**