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HYDRAULIC DIRECTIONAL CONTROL VALVE WITH PRESSURE COMPENSATING MEANS

Technical Field

The invention relates to a hydraulic distributor.

In more detail, the invention relates to the sector of adjustment valves in machines and plants, with special reference to the field of load compensator valves.

Background Art

As is known, machines and plants of different types and applications require regulating organs which regulatedly distribute the available power, which is in general transmitted via a command fluid, generally pressurised oil.

The regulation organs for this purpose are usually constituted by special distributors which act on various parameters of power absorption on the basis of predefined specifications, or by operator control. For example some main power absorption parameters are command fluid flow and/or pressure.

In the field of hydraulic distributors it is usual to regulate the power transmitted by means of regulation of the oil flow in inlet to the user, while the pressurised oil is supplied by a positive displacement pump or a constant-pressure pump. In particular, the user is often required to follow a constant motion law or in any case to move independently of the load involved, and this means that the flow has to be corrected moment by moment in order to achieve the greatest possible correspondence between the motion law of the user and the re-set law of motion.

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Hydraulic distributors of this type generally comprise a distribution organ provided with one or more inlet conduits for supplying the command fluid, and one or more inlet conduits for distributing the command fluid to the user. The distributor organ internally includes mobile means for defining a precise
5 passage section for the command fluid, partialising the flow and thus determining a regulation of the power transmitted to the user.

The regulating of the flow is performed by initially measuring pressure levels of the command fluid upstream and downstream of the mobile means, for example using pressure sensors. The pressure data delivered by the sensors is
10 compared in order to determine the demanded flow rate level and thus the partialisation level of the command fluid through the mobile means. This is linked to the fact that in order to keep the user functioning independent of the load applied to the user, the difference between the upstream and downstream pressures of the mobile means must be kept constant.

15 Following the comparison between the mobile means upstream and downstream levels, the mobile means are activated by actuators to reach operating conditions based on an optimal partialisation level.

This comparison is performed in known devices by transmitting the data to a dedicated processor containing in its memory a series of distributor
20 geometrical and hydraulic data; this enables a calculation to be made according to the pressure data detected and the user pre-set law of motion of the optimal partialisation of the mobile means.

The prior art also describes distributors in which the above-cited comparison is performed by mechanical elements, which measure a pressure difference
25 and transmit the measurement mechanically, i.e. hydraulically, to special

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regulating organs.

This type of distributor has the drawback of requiring the presence of pressure sensors, which can be subject to faulty operation.

Furthermore, the transmission systems of the measured pressure levels,
5 whether electronic or mechanical, are complex and often unwieldy, as well as increasing the manufacturing difficulties of the hydraulic distributor.

Further, the prior-art hydraulic distributors require interaction between components of various natures, such as sensors, the control panel, the mobile means actuators and relative cabling. This can cause delay in the overall
10 system response, given the different responses to transients by the various components, with dangerous repercussions for overall system stability. These distributors are subject to response oscillations which delay the reaching of optimal operating conditions.

The main technical aim of the present invention is to provide a hydraulic
15 distributor which is free of the above-cited drawbacks.

An important aim of the invention is to provide a hydraulic distributor which minimises manufacturing and operational complexities.

A further aim of the invention is to provide a hydraulic distributor which is highly reliable.

20 Furthermore an important aim of the invention is to provide a hydraulic distributor which responds rapidly to operating transients.

These aims and more besides, as will better emerge from the following description, are attained by a hydraulic distributor having the characteristics described in claim 1 and in one or more of the dependent claims.

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Disclosure of Invention

A non-limiting description is now made of a non-exclusive preferred embodiment of the hydraulic distributor of the invention, with reference to the appended figures of the drawings, in which:

5 figure 1 is a section view of the hydraulic distributor of the invention, in a non-operative configuration;

figure 2 is a section view of a portion of the distributor of figure 1, in a non-operative configuration;

10 figure 3 is a section view of a portion of the distributor of figure 1 in a first operative position;

figure 4 is a section view of a portion of the distributor of figure 1 in a second operative position;

figure 5 is a section view of a portion of the distributor of figure 1 in a third operative position;

15 figure 6 is a section view of a portion of the distributor of figure 1 in a fourth operative position.

With reference to the figures of the drawings, the hydraulic distributor of the present invention is denoted in its entirety by 1.

20 The distributor 1 receives in inlet a fluid, preferably pressurised oil, and conveys it under regulated conditions towards a user, which can be for example a hydraulic piston, single- or double-acting, or in any case a user commanded by pressurised oil.

The distributor 1 comprises a support body 2 which is specially shaped to house a plurality of operative elements which are necessary for the distributor
25 1 functioning and which will be described in more detail herein below.

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In particular the distributor 1 comprises a fluid inlet conduit 3, which fluid is supplied by a source of known type, for example a pump P, and a delivery conduit 4 which is connectable to the user. Figure 1 illustrates a user, which in the figure is a double-acting piston denoted by U. The inlet conduit 3 and the delivery conduit 4 are realised in the support body 2 and are in fluid communication with one another, defining a predetermined pathway for the fluid internally of the distributor 1.

The distributor 1 further comprises an obturator 5, active between the inlet conduit 3 and the delivery conduit 4, which obturator 5 realises a variation in fluid flow rate internally of the delivery conduit 4. In particular, the obturator 5, which in the illustrated embodiment is a slide valve 5a, is housed in a respective seating 6 and is mobile among a plurality of operative positions in which fluid flows from the inlet conduit 3 towards the delivery conduit 4. The obturator 5 can preferably also assume closure positions in which it completely obstructs fluid passage from the inlet conduit 3 towards the delivery conduit 4.

The obturator 5 is moved among the plurality of operative positions by special means which will be better described herein below, and which cause the obturator to displace along a sliding direction X.

To control the displacement of the obturator within the preset parameters, the distributor 1 comprises an actuator 7 acting on the obturator 5 to move it between the plurality of operative positions and closure positions.

The obturator 5 is advantageously moved along the sliding direction X directly by the fluid flow transiting in the delivery conduit 4 in line with a user U flow demand, following a functioning principle which will be more

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fully described herein below.

In particular, the actuator 7 is directly activated by a momentaneous difference in fluid flow rate running between the inlet conduit 3 and the delivery conduit 4. The actuator 7 thus has the function of receiving
5 instantaneous command impulses originating from the flow rate change, and imposing, on the basis of this change, a displacement on the obturator 5 along the sliding direction X, to meet the demands of the user U.

Further, the actuator 7 is operatively active between the inlet conduit 3 and the obturator 5 and is advantageously in fluid communication with the
10 obturator 5 to activate it hydraulically to displace among the respective operative and closure positions.

In more detail, the actuator 7 comprises a plunger piston 8, sensitive to instantaneous flow rate variations between the inlet conduit 3 and the delivery conduit 4 and slidable in a respective sliding seating 9 according to the
15 changes detected in the flow rate. The plunger piston 8 exhibits a flow-rate activated portion ; preferably this portion is a first end 10 of the plunger piston 8. In the preferred and illustrated embodiment of the distributor 1, the plunger piston 8 is located between the inlet conduit 3 and the obturator 5.

The plunger piston 8 is slidable internally of the seating 9 along a sliding
20 direction Y which is parallel to a main development direction of the piston 8 itself. Further, the plunger piston 8 internally exhibits a through-hole 11 in the sliding direction Y which places the first end 10 in fluid communication with a second end 12 of the piston 8, opposite the first end 10. The first end 10 is tapered.

25 In more detail, the first end 10 exhibits a central portion 13 which is

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preferably convex, and which engages and occludes a connection conduit 14 between the plunger piston 8 and the obturator 5, and a peripheral portion 15 which is preferably concave, and on which the fluid in inlet from the inlet conduit 3 acts, receiving from the transiting flow rate an axial thrust along the sliding direction Y of the plunger piston.

The second end 12 of the plunger piston 8 is preferably flat and directed perpendicular to the sliding direction Y of the plunger piston 8. Further, the second end 12 is associated to first means for elastic contrast 16, such as for example a helix spring, engaged between the plunger piston 16 and a portion of the support body 2 to contrast the axial thrust exerted by the fluid on the plunger piston 8 itself.

The second end 12 of the piston 8 is in fluid communication with the connection conduit 14 through the through-hole 11.

Further the inlet conduit 3 preferably has an outflow section 17 on the peripheral portion 15 of the first end 10 of the plunger piston 8.

The plunger piston 8 can also have an axial-symmetric conformation with respect to the prevalent development direction thereof, although other shapes are possible, such as for example prismatic or cylindrical conformations.

The actuator 7 further comprises at least a distribution organ 18 having an inlet 19 placed in communication with a fluid source, and at least an outlet 20 in fluid communication with the obturator 5 in order to activate it hydraulically. The distribution organ 18 further comprises a discharge outlet 21 in fluid communication with a fluid collection reservoir.

In the preferred embodiment, illustrated in the accompanying figures of the drawings, the distributor 1 comprises two distribution organs 18 which are

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symmetrically arranged with respect to the plunger piston 8, for activating a user U, which is a double-acting cylinder. There follows a detailed description of structural and functional aspects of one of the two distribution organs 18, as in the preferred embodiment the two distribution organs 18 are
5 identical apart from having a specular symmetry. In a preferred embodiment, not illustrated, the two distribution organs might be structurally different, though having identical functions.

In detail, each distribution organ 18 comprises a respective liner 22 which is slidable within a sliding seating 23 along a respective sliding direction W to
10 intercept the inlet 19 and the outlet 20 of the distribution organ 18.

Further, the distribution organ 18 comprises a pilot piston 24 which is mobile internally of a liner 22 therefor, which selectively places the inlet 19 of the distribution organ 18 in fluid communication with the outlet 20, and the outlet 20 in fluid communication with the discharge outlet 21.

15 The liner 22 is provided with through-holes 25 which place the pilot piston 24 in fluid communication respectively with the inlet 19 and the outlet 20 of the distribution organ 18, and also with the discharge outlet 21. The through holes 25 preferably each comprise an enlarged portion 25a, for example a spot-faced portion, for intercepting the fluid from the inlet 19 or send it on to
20 the discharge outlet 21 following displacements of the liner 22 which cause small misalignments between each opening and the inlet 19 or the discharge outlet 21 to which it is associated.

The pilot piston 24 exhibits a shape composed of two cylindrical parts 26, having greater diameter which is about the same as an internal diameter of the
25 liner 22 so that there is a fluid seal. The two cylindrical parts 26 are separated

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by an intermediate part 27, preferably cylindrical and having a smaller transversal dimension than the cylindrical parts 26 in the sliding direction W of the liner 22. The two cylindrical parts 26 are located at a reciprocal distance which is such as at least partially to associate the two cylindrical parts 26 respectively at the inlet 19 and at the discharge outlet 21 of the distribution organ 18. The cylindrical parts 26 and the intermediate part 27 together define a manoeuvring chamber 28 in fluid communication selectively with the inlet 19 and the discharge outlet 21 according to the position assumed by the pilot piston 24 with respect to the liner 22, and are in perpetual fluid communication with the outlet 20.

The pilot piston 24 can thus assume static positions in which the cylindrical parts thereof 26 close the inlet 19 and the outlet 21 (figure 6), intervention positions in which the inlet 19 is at least partially uncovered from the respective cylindrical part 26 to which it is associated while the discharge outlet 21 is closed (figures from 3 to 5) and release positions in which the discharge outlet 21 is at least partially uncovered by the respective cylindrical part 26 to which it is associated while the inlet 19 is closed (figures 1 and 2).

The pilot piston 24 is activated by a respective pilot actuator 29, comprising a nucleus 29a which is solidly constrained to the pilot piston 24 and a coil 29b which magnetically surrounds the nucleus 29a. The coil 29b is excited by a current which is proportional to a command impulse, for example relating to an entity of displacement of a lever activated by an operator, and generates a displacement of the nucleus 29a which cause a movement of the pilot piston 24 with respect to the liner 22.

The pilot piston 24 is also associated to second elastic contrast means 30,

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preferably comprising a helix spring, which have the function of contrasting the displacement of the pilot piston 24 following the action of the pilot actuator 29.

The distribution organ 18, in particular the liner 22, and the actuator are
5 operatively associated in order to enable the distribution organ 18 to receive displacement impulses from the actuator 7 and transmit consequent displacements to the obturator 5.

For this purpose, the distributor 1 comprises mechanical command means 31 which act between the plunger piston 8 and the liner 22. The mechanical
10 command means 31 comprise a channel 32 afforded on the plunger piston 8, engaged slidably and progressively by a wedge-shaped protuberance 33 associated to the liner 22, for example by a dragging connection.

The sliding direction Y of the plunger piston 8 and the sliding direction W of the liner 22 are preferably directed perpendicularly to one another. Also, the
15 channel 32 and the wedge-shaped protuberance 33 engage along a surface Z which is inclined with respect to the sliding directions Y, W of the plunger piston 8 and the liner 22, so as to convert a translation of the plunger piston 8 along the sliding direction Y into a translation of the liner 22 along the respective sliding direction W. To maintain the channel 32 in reciprocal
20 contact with the wedge-shaped protuberance 33, the liner 22 is advantageously associated with third elastic contrast means 34 acting between the liner 22 and the support body 2, which third elastic contrast means 34 are elastically preloaded to guarantee continuous contact between the wedge-shaped protuberance 33 and the channel 32.

25 The mechanical command means 31 have the function of moving the liner 22

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among a plurality of operative positions of movement of the obturator 5. Due to the structure of the distribution organ 18, each position assumed by the pilot piston 24 and the liner 22 realise a precise operative position of the obturator 5, inasmuch as it defines precise passage holes of the fluid through the manoeuvring chamber 28 and therefore a precise fluid flow destined to activate the obturator 5.

To cause the obturator 5 to move between the relative operative positions and the closure position, the distributor 1 further comprises at least an activating chamber 35, in fluid communication with the outlet 20 of the distribution organ 18 and active on an end of the obturator 5 to transmit an axial sliding thrust to the obturator 5. The activating chamber 35 is fluid-sealed from the outside and its structure enables the obturator 5 to be moved by commanded injections of fluid through the inlet 19 and the outlet 20 of the distribution organ 18 and commanded releases of the fluid contained in the activating chamber 35, which is discharged through the outlet 20 and the discharge outlet 21.

The end of the obturator 5 on which the activation chamber 35 acts is associated to fourth elastic means 36, e.g. a helix spring, which returns the obturator 5 to the non-operative position of figure 1 following displacements of the obturator 5 towards operative positions.

The obturator 5 comprises a main valve 37 which closes the fluid flow rate associated to the delivery conduit 4, selectively interrupting the fluid flow towards the user U. The main valve 37 is thus mobile between a closed position, associated to the non-operative position of the obturator 5 illustrated in figures 1 and 2, and a plurality of open positions associated with the

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plurality of operative positions of the obturator 5, illustrated in figures from 3 to 6.

In non-operative positions, the distributor 1 includes automatic discharge of the fluid coming from the pump, without the fluid itself engaging actively in the distributor 1. For this purpose, the distributor comprises at least a by-pass conduit 38 defining a preferential pathway for the fluid coming from the pump when the main valve 37 is closed. The distributor 1 preferably comprises a pair of by-pass conduits 38 associated to a respective distribution organ 18.

The obturator 5 comprises a first valve 39 associated to the by-pass conduit 38 for closing or at least partially opening the by-pass conduit 38 by sliding the obturator 5 along the sliding direction X. The obturator 5 preferably comprises a pair of first valves 39, each associated to the respective by-pass conduit 38. In figure 1 the first valves 39 are illustrated in the discharge position.

The distributor 1 further comprises an outlet opening 40 to send on the fluid towards the user U, and a return opening 41 for the fluid coming back from the user U. The outlet and return openings 40, 41, are preferably contiguous to the main valve 37 and to the delivery conduit 4, and realise a direct fluid communication with the delivery conduit 4. The obturator 5 also comprises a pair of second valves 42, each associated respectively to the outlet opening 40 and the return opening 41, for at least partially uncovering the outlet opening 40 and the return opening 41 at least when the delivery conduit 4 is open. The second valves 42 preferably have a smaller transversal size than the seating 6 of the obturator 5, and for this reason always leave the outlet 40 and the

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return 41 openings open.

With the purpose of evacuating the fluid returning from the user U, the distributor 1 comprises at least a discharge conduit 43. The distributor 1 preferably comprises a pair of discharge conduits 43, one of which is
5 contiguous to the outlet conduit 40 while the other is contiguous to the return conduit 41. The distributor therefore advantageously has a reversible function, so that the outlet conduit 40 and the return conduit can reciprocally invert their functions according to the operation mode of the device. The obturator 5 comprises at least a third valve 44, associated to the discharge
10 conduit 43. Preferably the obturator 5 comprises a third pair of valves 44, each associated to one of the discharge conduits 43 to uncover the discharge conduit at least when the main valve 37 uncovers the delivery conduit 4.

In the preferred and illustrated embodiment, the distributor 1 comprises a pair of activating chambers 35, each acting on an opposite end of the obturator 5
15 in order to move it in a one sense of the sliding direction X. A helix spring, being the fourth elastic means 36, operates at each end of the obturator 5.

In operation, in a start configuration in which the distributor 1 is in a non-operative equilibrium configuration, illustrated in figures 1 and 2, the pump P is in fluid communication with the inlet conduit 3, with the inlet 19 and the
20 by-pass conduits 38 through a triple offtake downstream of the pump P itself.

The fluid pressure at the inlet 19 is preferably lower than the fluid pressure in the inlet conduit 3 and the by-pass conduit. The distributor organ 18 operates at lower pressure to work pressure of the user U and is therefore equipped with a reduction valve 45 of the pressure between the pump P and the inlet
25 19.

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In the configuration of figures 1 and 2, the plunger piston 8 breasts the connection conduit 14, occluding it, while the liners 22 and the pilot pistons 24 are positioned so as to obstruct fluid supply to the manoeuvring chamber 28 through the respective inlets 19. In this configuration, the fluid delivered
5 by the pump P discharges entirely through the by-pass conduits 38. Furthermore, the discharge outlets 21 are open, creating stable discharge conditions in the manoeuvring chamber 28 and thus the respective activating chambers 35. This places the obturator 5 in a non-operative position, in which it closes the delivery conduit 4 and interrupts the fluid flow towards the user.

10 This closure means that part of the operatively active fluid in previous cycles stays inside the through-hole 11 of the plunger piston 8 and in proximity of the second end 12 of the plunger piston 8.

When a user U demands power, a signal, preferably analog, is sent to one of the two coils 29b in the form of, for example, a modulated current.

15 In a non-limiting description of the present invention, the user U will be, for the present purposes, a double-acting cylinder; thus the respective out and return runs of the piston stem require separate actions, only one of which will be analysed here as the other action is identical.

The excitation of the coil 29b generates a consequent displacement of the
20 nucleus 29a, which draws the respective pilot piston 24. In particular, the pilot piston 24 is brought close to the plunger piston 8.

The movement of the pilot piston 24, the entity of which is determined by the excitation current level crossing the coil 29b, obstructs the discharge outlet 21 and at least partially uncovers the inlet 19. A pressurised fluid delivery
25 follows, flowing into the manoeuvring chamber 28 and, through the

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respective outlet 20, flowing internally of the activating chamber 35, increasing internal pressure therein. This stage is illustrated in figure 3.

The increase in pressure in the activating chamber 35 leads the obturator 5 to displace, translating away from the activating chamber 35, overcoming the
5 reaction of the fourth elastic means 36. During this stage the main valve 37 at least partially uncovers the delivery conduit 4, associating it to the outlet opening 40. A part of the fluid which was initially trapped in the through hole 11 of the plunger piston and in the immediate vicinity of the connection conduit 14 exits; this fluid is then conveyed towards the user U through the
10 outlet opening 40. The user U can return a fluid flow to be discharged, which is conveyed towards the distributor 1 through the return conduit 41. The translation of the obturator 5 leads to the translation of the third valves 44, one of which uncovers the respective discharge conduit 43. In particular, the discharge conduit 43 associated to the return opening 41 is uncovered. The
15 outletting fluid from the user U, transiting internally of the return opening 41, is discharged through the discharge conduit 43.

Further, the translation of the obturator 5 causes a translation of the first valves 39 and therefore a partial constriction of the by-pass conduits 38, followed by an increase in load losses associated to the outflowing of fluid in
20 the by-pass conduits 38. This allows an increase in pressure and consequently the fluid flow-rate through the inlet conduit 3 and the connecting conduit 14 following a reduction of the fluid rate in discharge through the by-pass conduit 38. This stage is illustrated in figure 4.

The progressive outflowing of the fluid from the inlet conduit 3 to the
25 connecting conduit 14, with a consequent reduction of the fluid pressure in

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those zones, creates an imbalance of pressure on the plunger piston 8 which generates a progressive raising thereof. The second portion 12 and the central portion 13 of the first end 10 of the plunger piston 8 are surrounded by a pressure that is consistently lower than at the peripheral portion 15 of the first
5 end 10 of the plunger piston 8. This generates a non-nil axial thrust on the plunger piston 8 which overcomes the reaction of the first elastic means 16. In other words, internally of the through-hole 11 of the plunger piston 8 and in the immediate vicinity, there is lacking a counter-pressure which is sufficient to balance the pump P delivery pressure, which presses on the
10 peripheral portion 15 of the first end 10 of the plunger piston 8. This counter-pressure was present before the delivery conduit 4 was opened.

The raising of the plunger piston 8 causes detachment thereof from the connecting conduit 14 and causes an outflowing of the pressurised fluid from the inlet conduit 3 to the delivery conduit 4, and from there directly to the
15 user U through the outlet opening 40.

The above stage is illustrated in figure 5 which illustrates the progressive evolution of the operative configuration of the distributor 1. Figure 5 shows that the channel 32 and the wedge-shaped protuberance 33 are not in contact, though in reality this does not happen as the third elastic means 34 keep the
20 channel 32 and the wedge-shaped protuberance 33 in a perpetual state of reciprocal contact.

Figure 6 illustrates a stable equilibrium position which is brought about by the raising of the previously-illustrated plunger piston 8, the liner 22 associated to the pilot actuator 29 which was initially excited receiving a
25 thrust in a nearing direction to the plunger piston 8 because of the inclination

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of the inclined surface Z. The displacement of the liner 22 with respect to the pilot piston 24, which persists in its initial perturbed position, causes a progressive closure of the inlet 19, interrupting pressurised fluid supply from the pump P to the manoeuvring chamber 28.

5 The liner associated to the non-excited pilot actuator 29 also undergoes a displacement, nearing the plunger piston 8; however there is no operative consequence to this as the respective pilot piston 24 is still in the initial position and keeps the inlet 19 closed, leaving the discharge opening 21 open, so that the respective manoeuvring chamber 28 is not in fluid communication
10 with the pump P.

The distributor 1 thus reaches a condition of dynamic equilibrium, in which the obturator 5 maintains a translated operative position with respect to its non-operative position and allows passage of a constant fluid delivery from the inlet conduit 3 to the delivery conduit 4 and thus to the user U. Simple
15 theory and practice teaches that if the pressure delivered from the pump P is kept constant, the constancy of the delivery determines the constancy of the hydraulic power absorbed by the user U.

During the distributor 1 operation, transients can occur due for example to load changes associated with the user U. For example, the user might include
20 an earth-moving bucket which, when cutting into the ground, meets an obstacle or a more-compacted layer of earth than before. This generates an increase in resistance which translates into an increase in fluid pressure transiting through the user U, and therefore an increase in pressure in the delivery conduit 4 which opposes the normal transit of the fluid flow from the
25 pump P to the user U.

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For an operator of earth-moving machines and the like, it is particularly important for the user device (for example a bucket as described above) to follow the most constant law of motion possible, a law which is independent of the time-by-time load the user U is subject to.

5 It is therefore necessary that the delivery internally of the delivery conduit 4 is maintained constant, even following variations in fluid pressure in the delivery conduit 4.

Following the increase in pressure of the fluid transiting in the delivery conduit 4, the fluid is subject to a reduction as the increased pressure acts as a
10 counter-pressure at discharge while the pressure of the pump P remains unaltered, thus reducing the transiting delivery. The pressure imbalance occurs at the first end 10 of the plunger piston 8 which, being invested by a smaller fluid delivery, is subject to a smaller axial thrust and consequently the first elastic means 16 can return the plunger piston 8 into a closer position to
15 the connecting conduit 14, thus a lower position according to the accompanying figures than the dynamic equilibrium configuration previously reached and illustrated in figure 6. The pressure increase in the delivery conduit 4 advantageously does not generate an upwards thrust on the plunger piston 8, as the plunger piston 8 exhibits the through hole 11 which transfers
20 the pressure levels at the first end 10 of the plunger piston 8 to the second end 12 of the plunger piston 8. In other words, the special geometry of the plunger piston 8 is such that the plunger piston 8 is sensitive to the fluid flow at the first end 10 thereof and at the variations over time, but there is no passing-on to the plunger piston 8 of any sensitivity to static pressure levels it is subject
25 to.

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The progressive lowering of the plunger piston 8 causes a displacement of the liner 22 associated to the initially-excited pilot actuator 29. This displacement of the liner 22 is in a direction away from the plunger piston 8 because of the orientation of the inclined surface Z of the command means 31. Following the
5 liner 22 displacement, there is an at least partial opening of the inlet 19, as the pilot piston 24 remains in position. The opening of the inlet 19 resets the pump P in fluid communication with the manoeuvring chamber 28 and thus with the activating chamber 35. The pressure inside the activating chamber 35 therefore increases progressively, causing a translation of the obturator 5
10 away from the activating chamber 35 i.e. towards the right in the accompanying figures. The first valve 39 chokes the by-pass conduit 38 by more, causing an increase in pressure which generates an increase in fluid delivery to the user U which contrasts the previous pressure increase in the delivery conduit 4. The distributor progressively reaches a new condition of
15 equilibrium in relation to the increased load on the user U.

In the case of load reduction on the user U, the device operates inversely to what is described above. In more detail, the pressure in the delivery conduit 4 diminishes and attracts a greater fluid delivery from the inlet conduit 3. The plunger piston 8 is therefore raised and in particular the first end 10 receives a
20 greater axial thrust because of the greater flow rate it is subject to, and a displacement of the plunger piston 8 occurs, away from the connecting conduit 14. The action of the third elastic means 34 and the raising of the plunger piston 8 cause the liner 22 to displace towards the plunger piston 8, progressively closing the inlet 19 and uncovering the outlet 21. The
25 pressurised fluid in the activating chamber 35 discharges through the outlet

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opening 21 and the fourth elastic means 36 recall the obturator 5 towards the activating chamber 35. The obturator 5, more precisely the first valve 39, tends to open the by-pass conduit 38, reducing pressure and fluid delivery transiting to the user U.

- 5 The distributor 1 is therefore able to move progressively into a new dynamic equilibrium condition in a totally automatic process.

To bring the distributor 1 into the initial non-operative configuration, it is sufficient to de-excite the coil 29b that was originally excited; this leads to the return of the nucleus 29a into the respective initial position by action of the
10 second elastic contrast means 30. The displacement of the nucleus 29a returns the pilot piston 24 to its initial position, in which it closes off the inlet 19 and at least partially uncovers the discharge outlet 21. There is consequently a pressurised fluid outflow from the activating chamber 35 through the manoeuvring chamber 28, which resets the obturator 5 in the closed position.

- 15 The distributor 1 can work inversely by activating the other coil 29b, and therefore causing the inverse activation of the user U. In this case, the outlet opening 40 and the return opening 41 have their functions inverted.

It is also possible to create special hydraulic connections between the pump P and the distributor 1, for example by connecting the by-pass conduits 38, the
20 discharge conduits 43 and the discharge outlets 21 with a single fluid collection device, for example a collection reservoir, possibly by connecting the device to an aspiration device of the pump P in order to generate a closed circuit of the fluid.

It is further advantageous to connect the inlet conduit 3 and the inlet 19 in
25 derivation from the pump P, in order to reduce the overall complexity of the

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hydraulic connections; the pressure reducer valve 45 for the pressure upstream of the inlet 19 can be used for this.

Also noteworthy is that in a further embodiment the action of the pilot piston 24 can be obtained by means of a pressure-modulated hydraulic actuator
5 instead of the magnetic nucleus associated to the excitation coil 29.

Thus the invention attains its preset aims.

The obturator of the distributor of the invention is moved directly by the flow variation, known as flow-sensing, in transit between the inlet conduit and the delivery conduit caused by a user demand.

10 The distributor of the present invention therefore requires no use of pressure sensors, which very considerably simplifies its realisation; nor does it require the use of complex electrical cabling for the transmission of data to the dedicated command and control units.

Thanks to the lack of sensor and processing devices for the pressure internally
15 of the distributor, the distributor is very reliable.

Also, the distributor of the invention requires no interaction between components of various natures, such as for example hydraulic components, electrical components and processing units; this leads to speed of response to very high operating transients.

Claims.

1. A hydraulic distributor, comprising:

- an inlet conduit (3) connectable to a fluid source and a fluid delivery conduit (4) connectable to a user (U);

an obturator (5), acting between the inlet conduit (3) and the delivery conduit (4), which obturator (5) is mobile among a plurality of operative positions relating to passage of fluid flow from the inlet conduit (3) towards the delivery conduit (4);

wherein the obturator (5) is moved among the plurality of operative positions directly by the fluid flow transiting at a given time in the delivery conduit (4) in consequence of a fluid demand by the user (U).

2. The distributor of claim 1, wherein it comprises an actuator (7) which acts on the obturator (5) to move the obturator (5) among the plurality of operative positions, the actuator (7) being directly and immediately activated by a difference of fluid flow rate between the inlet conduit (3) and the delivery conduit (4).

3. The distributor of claim 2, wherein the actuator (7) acts between the inlet conduit (3) and the obturator (5) and is in fluid communication with the obturator (5) in order hydraulically to activate the obturator (5).

4. The distributor of claim 3, wherein the actuator (7) comprises at least a

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distribution organ (18) having an inlet (19) set in fluid communication with a fluid source and at least an outlet (20) set in fluid communication with the obturator (5) in order hydraulically to activate the obturator (5).

5. The distributor of claim 4, wherein it comprises at least an activating chamber (35) of the obturator (5) set in fluid communication with the outlet (20) of the at least a distribution organ (18).

6. The distributor of claim 4 or 5, wherein the actuator (7) further comprises a plunger piston (8) which is sensitive to flow rate variations of fluid transiting between the inlet conduit (3) and the delivery conduit (4) and which is slidable within a sliding seating (9) in accordance with a detected flow rate variation; the plunger piston (8) commanding the at least a distribution organ (18).

7. The distributor of claim 6, wherein it comprises mechanical command means (31) which act between the plunger piston (8) and the at least a distribution organ (18) in order to move the at least a distribution organ (18) among a plurality of operative positions of the obturator (5).

8. The distributor of claim 7, wherein the command means (31) comprise a channel (32) afforded on the plunger piston (8) which channel (32) is slidably and progressively engaged by a wedge-shaped protuberance (33) exhibited by the at least a distribution organ (18).

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9. The distributor of claim 8, wherein the at least a distribution organ (18) comprises a liner (22), slidable in a sliding seating (23), for intercepting the inlet (19) and the outlet (20) of the distribution organ (18); the wedge-shaped protuberance (33) being associated to the sliding liner (22).

10. The distributor of claim 9, wherein the at least a distribution organ (18) comprises a discharge outlet (21) set in fluid communication with a reservoir, for discharging fluid from the activating chamber (35) of the obturator (5).

11. The distributor of claim 10, wherein the at least a distribution organ (18) comprises a pilot piston (24) which is mobile internally of the liner (22) and selectively places in fluid communication the inlet (19) of the distribution organ (18) with the outlet (20) of the distribution organ (18) and the outlet (20) of the distribution organ (18) with the discharge opening (21) of the distribution organ (18).

12. The distributor of claim 11, wherein the liner (22) affords through-holes (25) for placing the pilot piston (24) in fluid communication with the inlet (19) and outlet (20) of the distribution organ (18) and with the discharge opening (21) of the distribution organ (18).

13. The distributor of any one of claims from 6 to 12, wherein the plunger piston (8) exhibits a first end (10) which acts on the fluid flow rate transiting between the inlet conduit (3) and the delivery conduit (4), the first end (10) exhibiting a central portion (13) which is preferably convex.

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14. The distributor of claim 13, wherein the plunger piston (8) exhibits a through hole (11) in a sliding direction (Y) of the plunger piston (8), which through hole (11) sets in fluid communication a first end (10) of the plunger piston (8) with a second end (12) thereof opposite to the first end (10) thereof, the first end (10) being tapered in order to receive an axial thrust from the transiting fluid flow along the sliding direction (Y) of the plunger piston (8).

15. The distributor of claim 14, wherein the second end (12) of the plunger piston (8) is associated to first elastic means (16).

16. The distributor of any one of the preceding claims, wherein the obturator (5) is a slide valve.

17. The distributor of claim 16, wherein the obturator (5) is associated to the at least an activating chamber (35) in order to receive a sliding thrust and thus be moved among the plurality of positions thereof.

18. The distributor of claim 16 or 17, wherein the obturator (5) comprises a main valve (37) for closing the fluid flow, associated to the delivery conduit (4) in order selectively to interrupt the fluid flow towards the user (U).

19. The distributor of any one of claims from 16 to 18, wherein it comprises at least a by-pass conduit (38) defining a preferential pathway for the fluid coming from the fluid source when the main valve (37) is closed, the

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obturator (5) comprising at least a first valve (39) associated to the at least a by-pass conduit (38) for closing or at least partially opening the by-pass conduit (38).

20. The distributor of claim 18, wherein it comprises an outlet opening (40) for fluid to the user (U) and a return opening (41) for the fluid from the user (U), contiguous to the main valve (37); the obturator (5) comprising a pair of second valves (42), each of which is associated respectively to the outlet opening (40) and the return opening (41) at least when the delivery conduit (4) is open.

21. The distributor of claim 20, wherein it comprises at least a discharge conduit (43) contiguous to the return opening (41) of the fluid; the obturator (5) comprising at least a third valve (44) associated to the at least a discharge conduit (43) which third valve (44) uncovers the discharge conduit (43) at least when the main valve (37) uncovers the delivery conduit (4).

22. The distributor of claim 6, wherein it comprises two distribution organs (18), symmetrically arranged with respect to the plunger piston (8) in order to enable the distributor (1) to operate inversely.

23. The distributor of claim 22, wherein it comprises two activating chambers (35), each of which is set in fluid communication with the outlet (20) of the distribution organ (18); the two activating chambers (35) being used for a reversible operating of the distributor (1).

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24. The distributor of claims 20 and 22, wherein it comprises two discharge conduits (43), respectively contiguous to the outlet opening (40) and the return opening (41) of the fluid, in order to enable a discharge of the fluid when returning from the user (U), including when the distributor (1) is operating inversely.

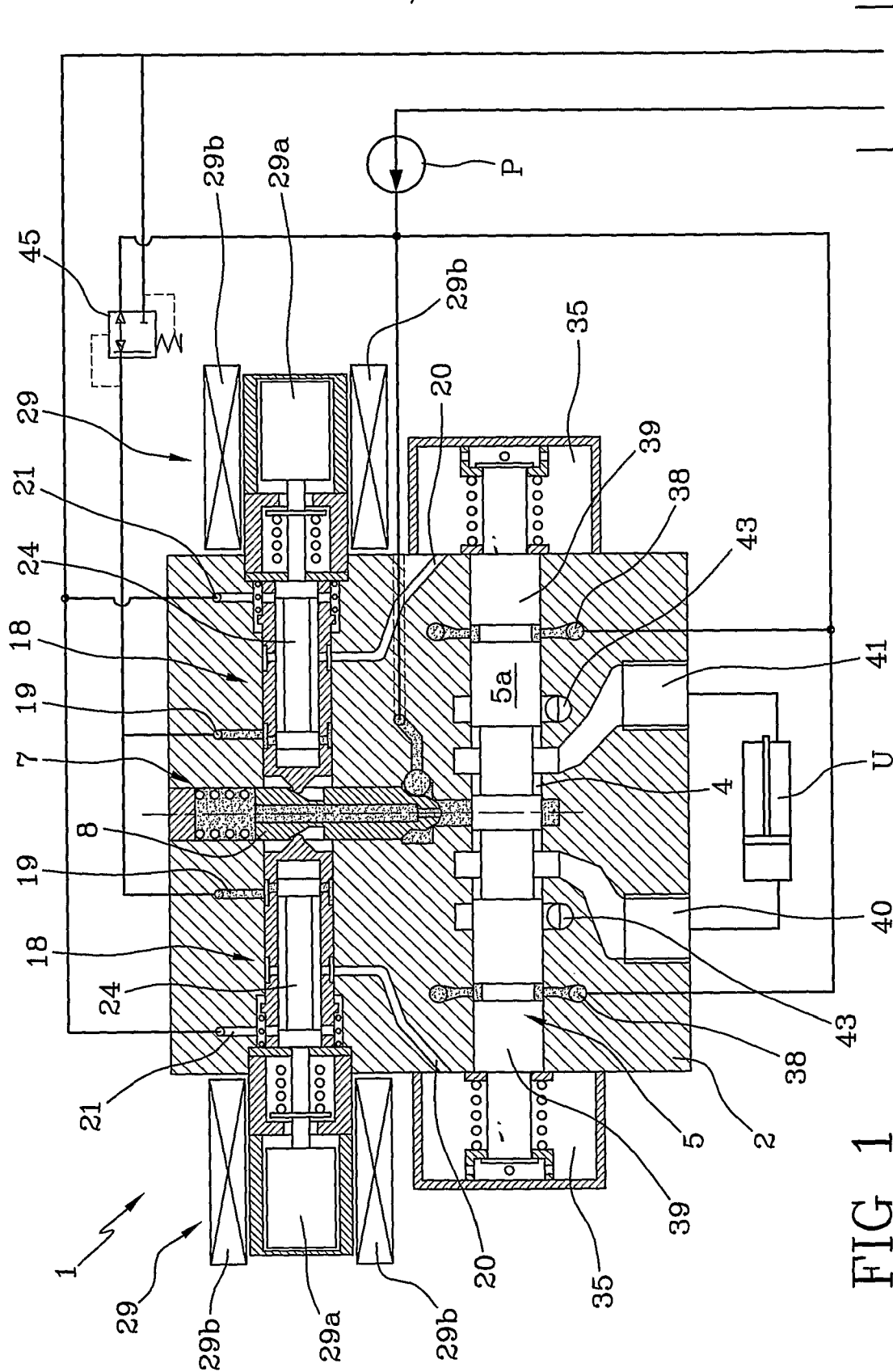
25. The distributor of claim 6, wherein the plunger piston (8) is located between the fluid inlet conduit (3) and the obturator (5).

26. The distributor of claim 11, wherein the plunger piston (8) is activated by a pilot actuator (29) and is associated to second elastic means (30).

27. The distributor of claim 9, wherein the liner (22) is associated to third elastic means (34) which maintain the channel (32) in contact with the wedge-shaped protuberance (33).

28. The distributor of claim 9, wherein the plunger piston (8) and the liner (22) are mobile along respective sliding directions (Y, W) which are perpendicular to one another.

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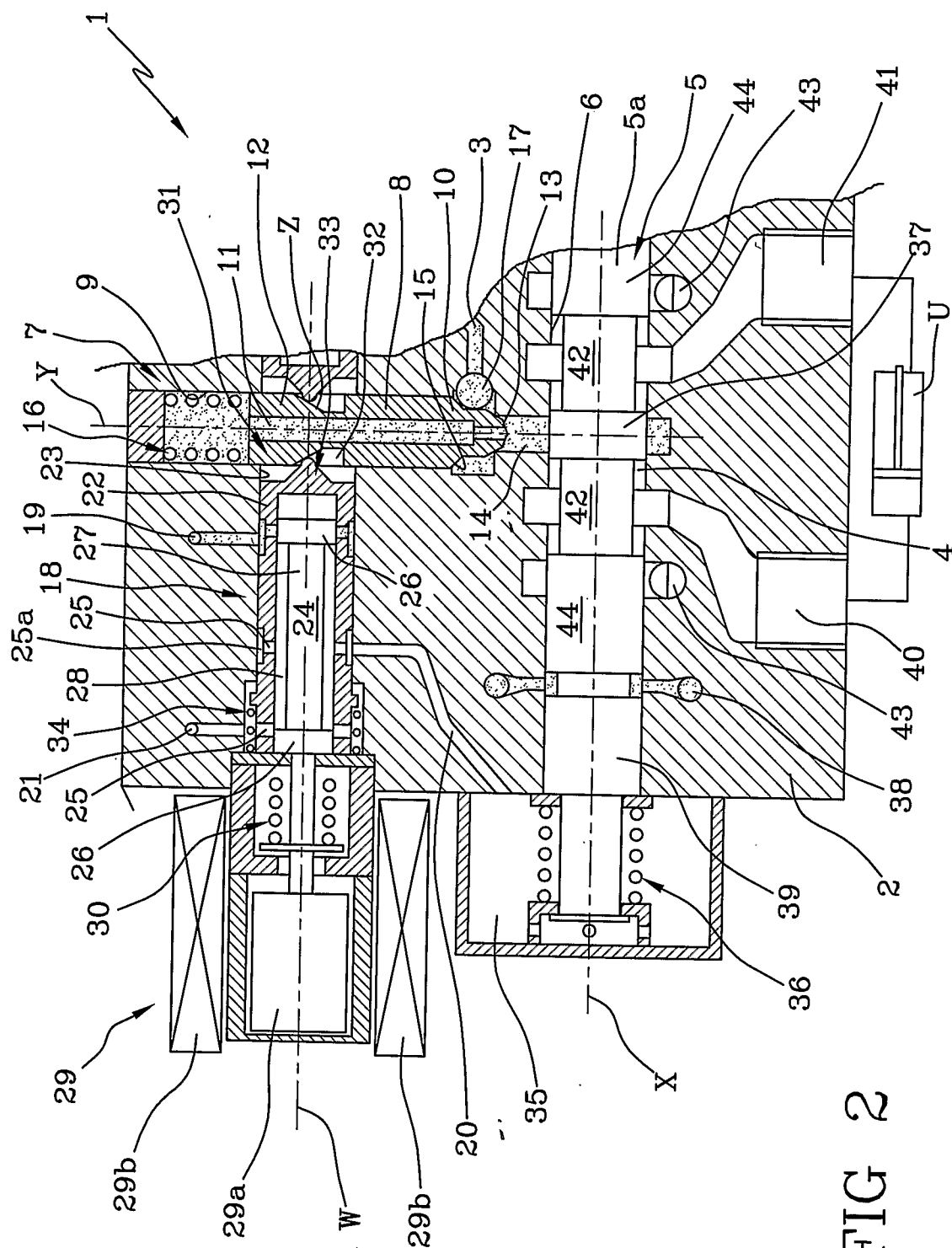
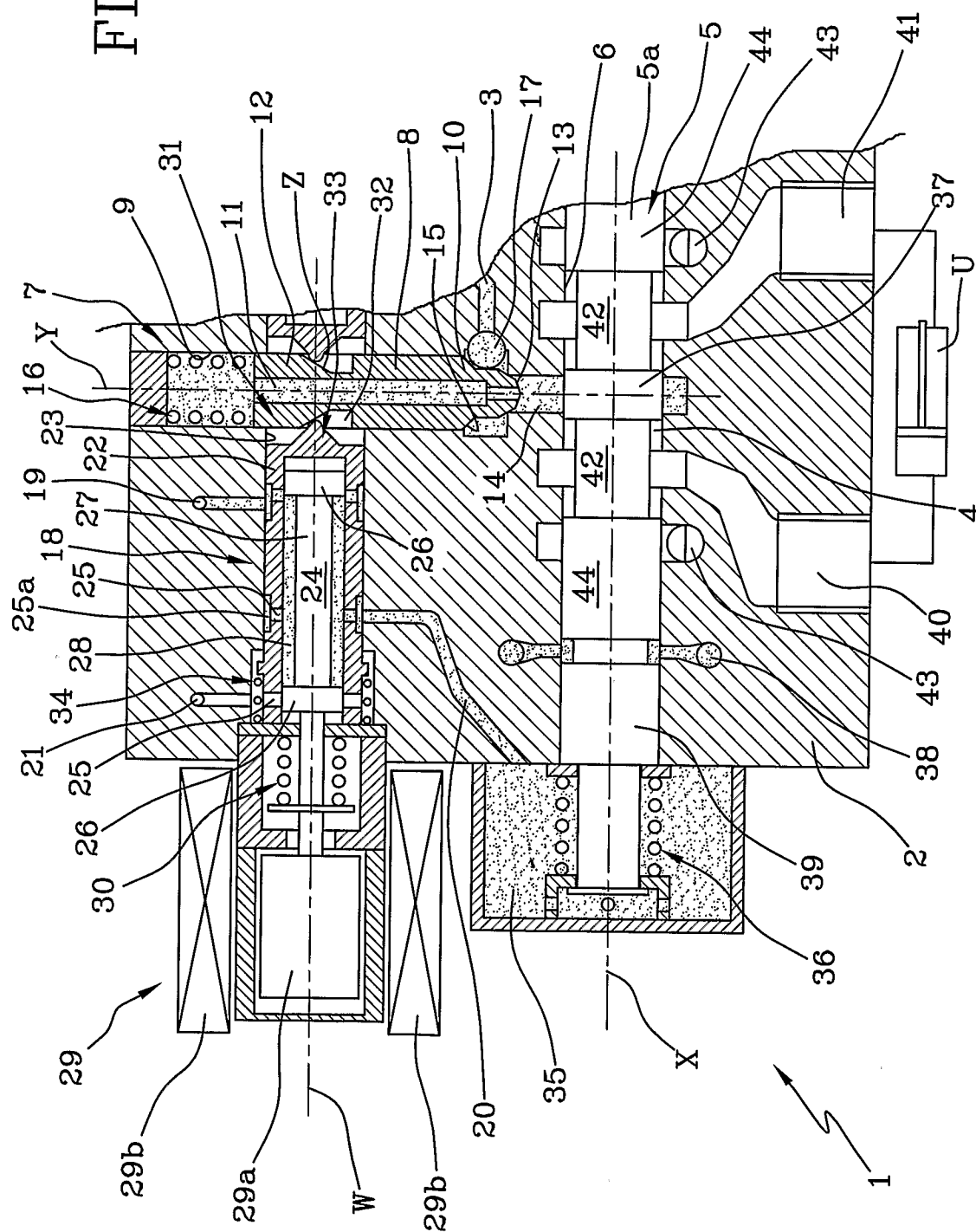


FIG 2

FIG 3



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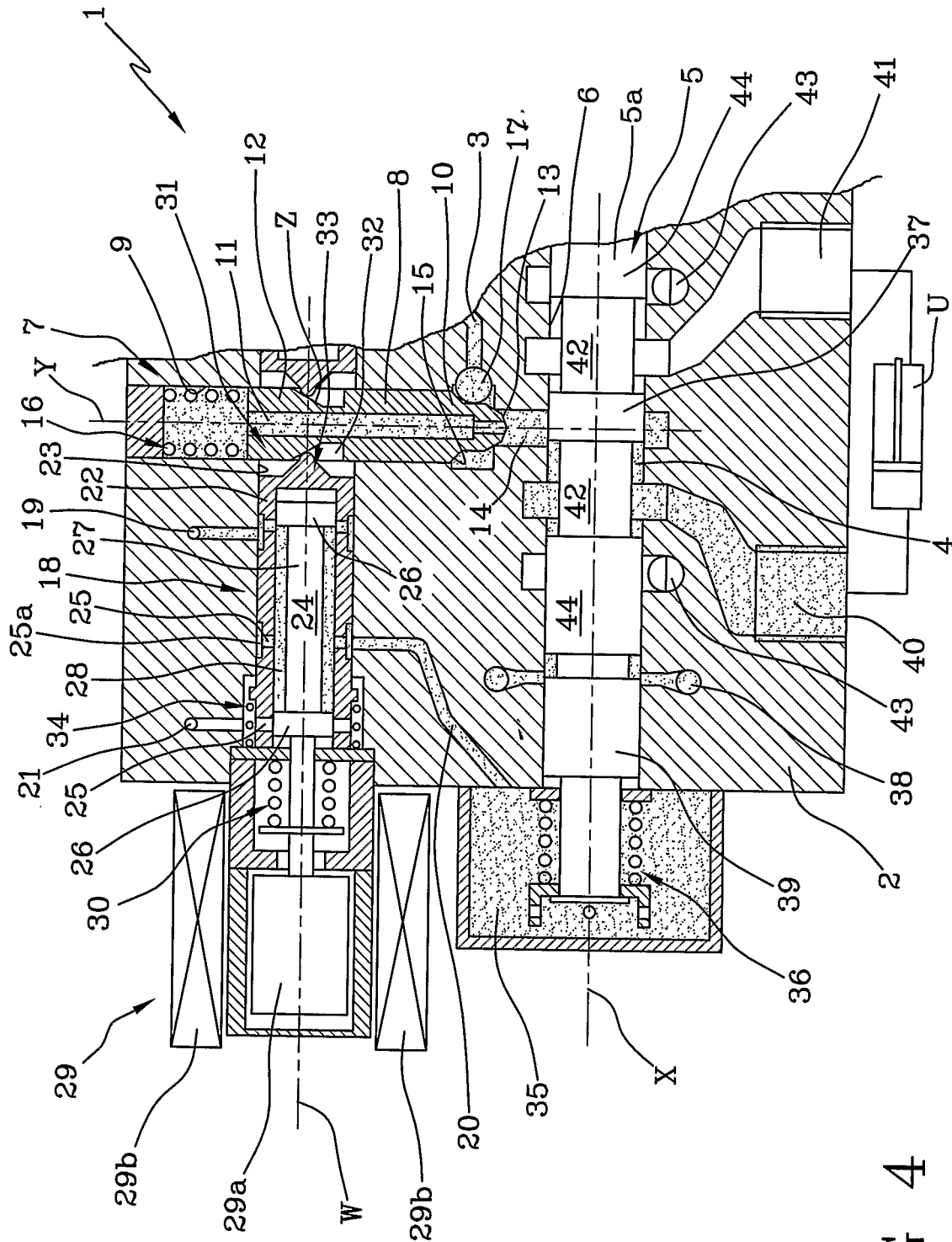


FIG 4

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FIG 5

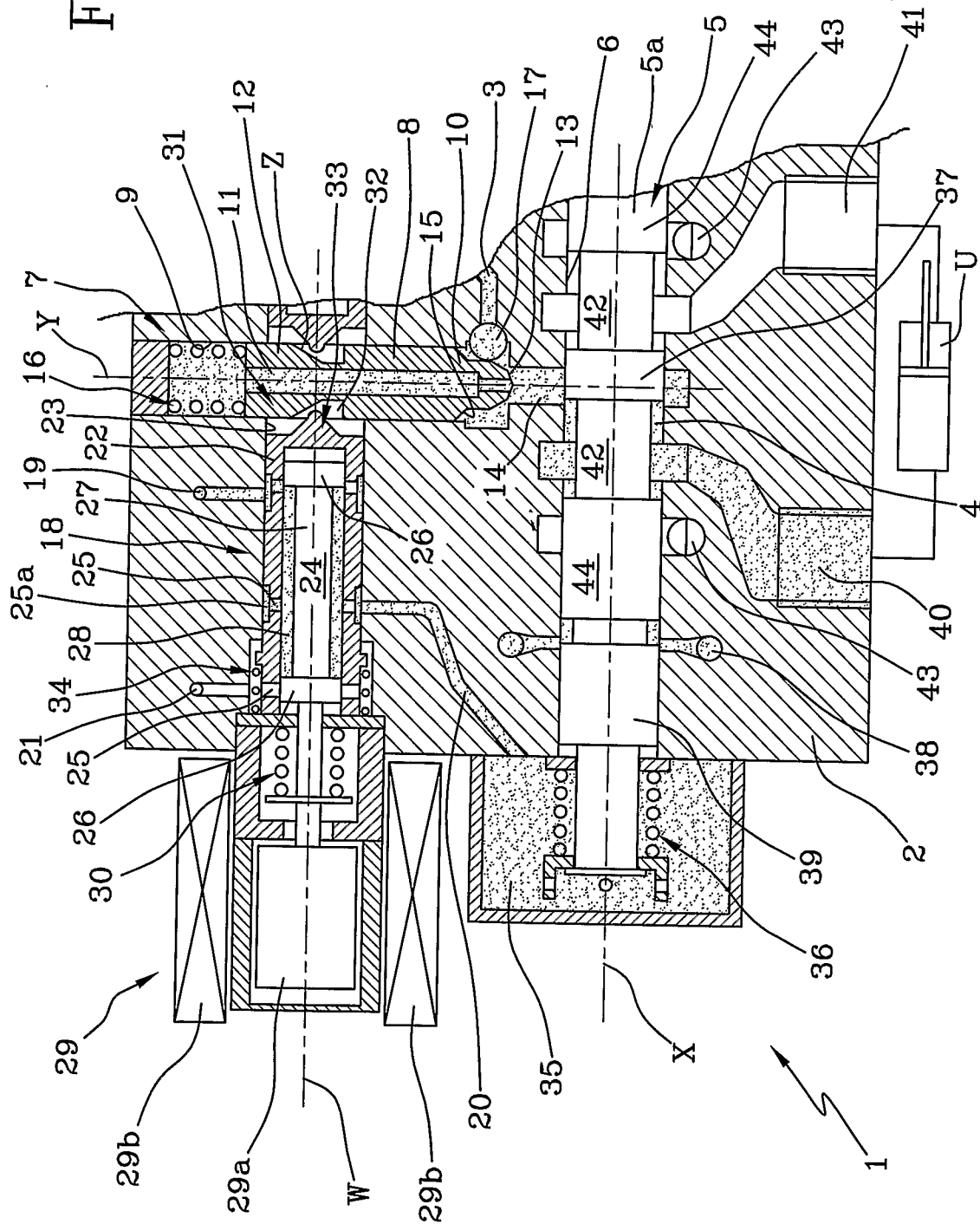
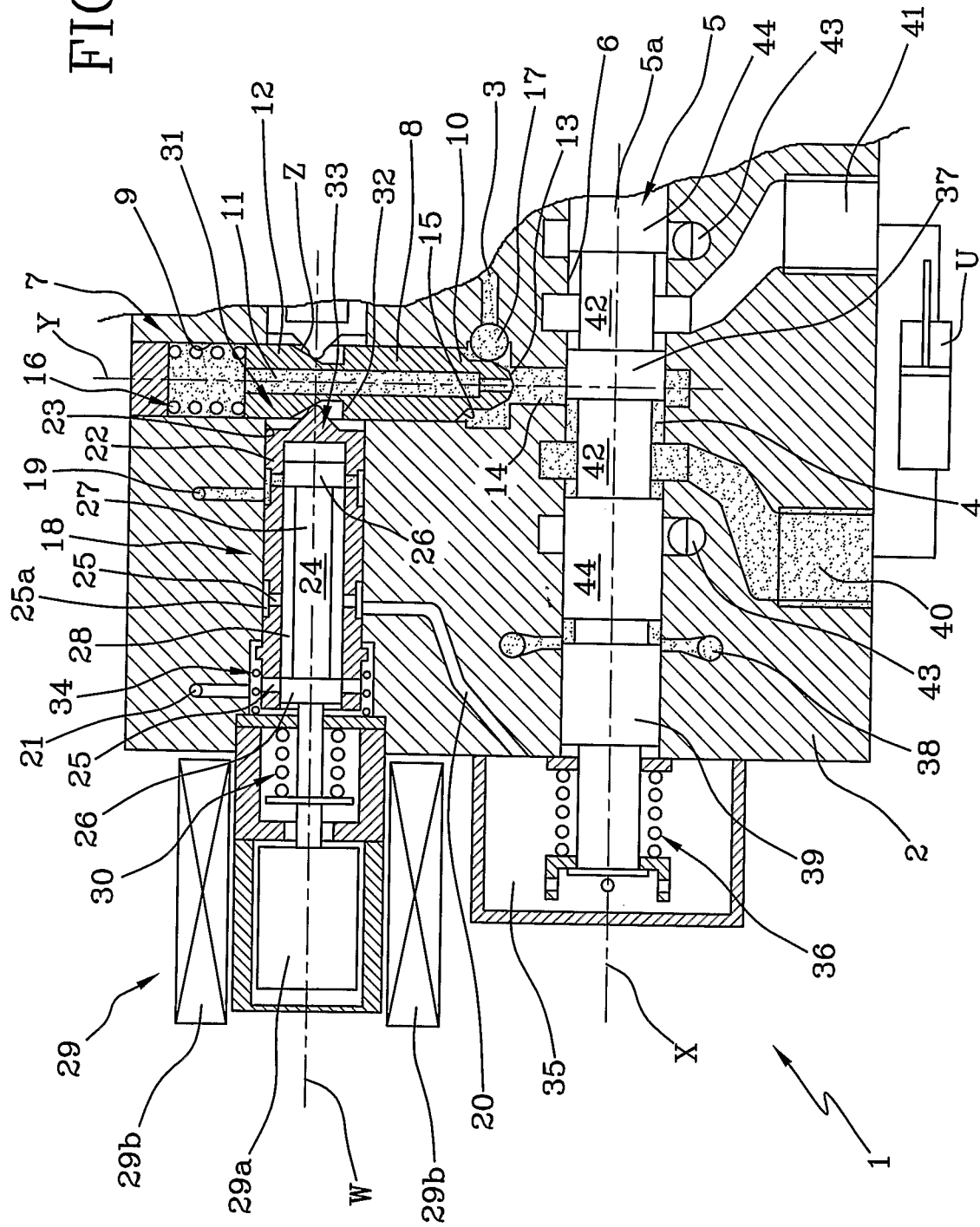


FIG 6



INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2006/000360

A. CLASSIFICATION OF SUBJECT MATTER
INV. F15B13/043 F15B11/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F15B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 24 39 030 A1 (SANDERS ASSOCIATES INC) 27 March 1975 (1975-03-27)	1-7, 16-24
Y	page 11, line 5 - page 12, line 21 page 14, line 17 - page 15, line 18 page 17, line 19 - page 19, line 11; figure 1	8-15,26
Y	----- US 4 290 447 A (KNUTSON DALE) 22 September 1981 (1981-09-22) column 3, line 46 - column 4, line 53 column 6, lines 16-52; figures 1,2,4A	8-12
Y	----- US 3 893 471 A (BYERS JR JAMES OTTO) 8 July 1975 (1975-07-08) column 6, line 48 - column 8, line 44; figure 1	13-15,26
	----- -/--	

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

24 January 2007

Date of mailing of the international search report

02/02/2007

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RECHENMACHER, M

INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2006/000360

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 421 156 A (BEATER PETER [DE] ET AL) 6 June 1995 (1995-06-06) column 4, line 24 - column 5, line 7; figures 1-3 -----	1-7, 16-18,25
X	US 4 569 273 A (ANDERSON GERALD C [US] ET AL) 11 February 1986 (1986-02-11) column 1, line 54 - column 6, line 19; figures 1,2 -----	1-5, 16-19
X	DE 29 42 754 A1 (KUCCHARZYK REINHARD ING GRAD) 7 May 1981 (1981-05-07) page 15, line 1 - page 16, line 11; figure 2 -----	1,2,16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IT2006/000360

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 2439030	A1	27-03-1975	AU 7175274 A	29-01-1976
			JP 51043166 A	13-04-1976
			JP 50059824 A	23-05-1975
			JP 54030076 B	27-09-1979
US 4290447	A	22-09-1981	GB 2076564 A	02-12-1981
			JP 56501294 T	10-09-1981
			SE 440538 B	05-08-1985
			SE 8103530 A	04-06-1981
			WO 8101035 A1	16-04-1981
US 3893471	A	08-07-1975	CA 1020431 A1	08-11-1977
			DE 2445587 A1	17-04-1975
			FR 2246796 A1	02-05-1975
			GB 1437757 A	03-06-1976
			JP 50061734 A	27-05-1975
US 5421156	A	06-06-1995	NONE	
US 4569273	A	11-02-1986	CA 1225568 A1	18-08-1987
			DE 3481780 D1	03-05-1990
			EP 0151174 A1	14-08-1985
			JP 60501869 T	31-10-1985
			WO 8500642 A1	14-02-1985
DE 2942754	A1	07-05-1981	NONE	