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(54) **FLUID OPERATED ASSEMBLY CONTROLLING DOUBLE-ACTING ACTUATORS**

(57) A fluid operated assembly for controlling double-acting actuators has a first overcenter valve having its inlet connected to a distributor device by means of a first connection branch and its outlet connectable to a first chamber of at least one main fluid dynamic cylinder, and a second overcenter valve, having its inlet connected to the distributor device by means of a second connection branch and its outlet connectable to a second chamber of the main fluid dynamic cylinder; the first overcenter valve being controllable by means of a first pilot branch connected to the second connection branch; the second overcenter valve being controllable by means of a second pilot branch connected to the first connection branch; the distributor device further comprises a first piloted check valve, having its inlet removably connected to the distributor device by means of the first connection branch and its outlet connectable to a first chamber of at least one auxiliary fluid dynamic cylinder, and a second piloted check valve, having its inlet removably connected to the distributor device by means of the second connection branch, with the interposition of a sequence valve, and its outlet connectable to a second chamber of the auxiliary fluid dynamic cylinder; the distributor device is adapted to control the operative interconnection between the first connection branch, the second connection branch, a hydraulic fluid delivery branch and a hydraulic fluid return branch, in order to regulate the movement of the main fluid dynamic cylinder and of the auxiliary fluid dynamic cylinder, so as to automatically execute a predefined work cycle.

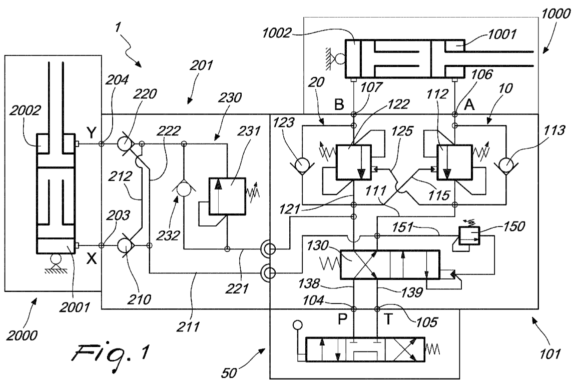

Fig. 1

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Description

[0001] The present invention relates to a fluid operated assembly controlling double-acting actuators.

[0002] More particularly, the present invention relates to a fluid operated device capable of automatically executing a single cycle of strokes of two fluid dynamic actuators, repeated in a non-continuous manner, with the switching occurring at the intermediate reversal point of the strokes, and is implemented by overpressure.

[0003] As is known, oil hydraulics is a technique for transmitting mechanical energy by means of pressurised hydraulic fluids, typically consisting of natural and/or synthetic oils.

[0004] An oil-hydraulic system, in its basic configuration, consists of a generation unit, a control unit and an operating unit.

[0005] In the generation unit, consisting of one or more pumps, mechanical energy is transformed into hydraulic energy, which the utilisation unit, consisting of actuators of different types, transforms back into mechanical energy.

[0006] In the control unit, on the other hand, the hydraulic fluid is conditioned by making it assume certain pressure and flow values and distributing it where necessary.

[0007] Generally, the control units consist of valve assemblies that distribute the hydraulic fluid under pressure to all users, enabling in particular the repetition, interruption and reversal of work movements.

[0008] GB2224081A discloses an arrangement for operating hydraulic actuating means provided with overcenter valves in a rock drilling boom.

[0009] US10969801B1 discloses a proportional flow control and counterbalance valve having a single seat configuration.

[0010] US5490441A discloses an automatic reciprocation of a reversible fluid pressure unit and switching valve therefor.

[0011] US1952690A discloses an automatic reverse valve for stokers, for furnaces and the like, having a reverse mechanism for the piston of the stoker ram.

[0012] CN109253119A discloses an hydraulic device having an outer oil path control device, hydraulic control one-way valves, hydraulic cylinders and counterbalance valves. An oil inlet of the outer oil path control device is connected with a first hydraulic control one-way valve, a second hydraulic control one-way valve, a third hydraulic control one-way valve and pressure guide openings of a first counterbalance valve and a second counterbalance valve, outlets of the first hydraulic control one-way valve, the second hydraulic control one-way valve and the third hydraulic control one-way valve are connected with ends of rod-less cavities of a first hydraulic cylinder, a second hydraulic cylinder and a third hydraulic cylinder, an oil outlet of the outer oil path control device is connected with one end of a rod cavity of the first hydraulic cylinder, the first counterbalance valve, the second counterbalance valve and pressure guide openings of the first hydraulic control one-way valve, the second hydraulic control one-way valve and the third hydraulic control one-way valve, an outlet of the first counterbalance valve is connected with a rod cavity of the second hydraulic cylinder, and an outlet of the counterbalance valve is connected with a rod cavity of the third hydraulic cylinder. According to the clamping hydraulic device, electric control cost is reduced, and production efficiency is improved.

[0013] US4938296A discloses a drill rig assembly to be mounted on a vehicle and having a pivotal link assembly mounted to the vehicle. A mast assembly is attached in slidable relationship to the link assembly and contains feed means and rotary means fully enclosed within the mast assembly. An electronic level within the mast assembly automatically maintains the mast assembly in a predetermined, angular position. The drill rig assembly is capable of drilling either vertically or at selected, incremental angles. The drill rig assembly is designed to be safe in operation and lightweight, while providing performance characteristics of larger drill rigs.

[0014] US5490441A discloses a fluid pressure piston-cylinder drive unit automatically reciprocated by coupling the opposite ends of the cylinder through delivery conduits to a source of fluid pressure and exhaust through a switching valve in which a longitudinally reciprocating spool has a pair of passageways which reversibly couple one end of the cylinder to the source of fluid pressure and the other end of the cylinder to an exhaust conduit. The opposite ends of the switching valve contain shift pistons each of which engages an end of the spool through a coil spring. The shift pistons abut the opposite ends of an elongated rod which extends freely through a bore in the spool. Bypass conduits couple the opposite ends of the cylinder through the delivery conduits one to each end of the valve body such that fluid pressure in one delivery conduit from the source is coupled to one end of the valve body while exhaust fluid pressure from the other delivery conduit is coupled to the other end of the valve body. The exhaust conduit communicates with a detent conduit in which a detent pin is moved by exhaust fluid pressure into a selected detent in the spool to secure the spool against movement. When the piston-cylinder unit is a high volume drive unit, a secondary switching valve is interposed between the cylinder and the primary switching valve to supply high volume fluid pressure to the cylinder by control from the primary switching valve.

[0015] The need is felt to have a fluid-operated control device that is capable of performing a complete single cycle of strokes for the extraction and retraction, or vice versa, of the stem of a fluid-operated cylinder, with a single delivery of working fluid from the pump with free return to the reservoir.

[0016] At the same time, this fluid-operated control device must allow control of the load, whether fixed or variable, that is applied to the fluid-operated cylinder, in both directions of travel and in any angular position of the load, as well as limitation of the maximum pressure induced by the load to the chambers of the cylinder.

[0017] This is required in order to protect the hydraulic circuit against mechanical damage due to the fact that during work the user device applied to the cylinder receives excessive stress from the outside environment and therefore unwanted pressure peaks.

[0018] While the prior art control units may satisfy some specific requirements, none of them is able to compound all the requirements listed above, in an optimal manner.

[0019] The aim of the present invention is to provide a fluid operated assembly, for controlling double-acting actuators, that overcomes the drawbacks of the prior art and has such characteristics as to compound the requirements listed above, in the best way.

[0020] Within the scope of this aim, a particular object of the invention is to provide a fluid operated assembly that is compact, lightweight and easy to install with standard hydraulic connections.

[0021] A further object of the invention is to provide a fluid operated assembly that has a good resistance with respect to the external atmospheric environment and with respect to possible contaminants of the hydraulic working fluid.

[0022] A further object of the invention is to provide a fluid operated assembly that is capable of performing the cycle for switching the direction of flow of the oil from the delivery to the chambers of the fluid-operated cylinder gradually and smoothly, without sudden variations which would affect the structure of the load.

[0023] A further object of the invention is to provide a fluid operated assembly that is capable of performing the locking and the release of the stem of the fluid-operated cylinder, which correspond to the starting and stopping of the movement of the load, in a manner that is gradual and with a speed that is suitable to avoid triggering oscillations of the structure of the load.

[0024] An aim of the present invention is to provide a fluid operated assembly, for controlling double-acting actuators, having a second auxiliary actuator at the oil-hydraulic circuit, adapted to operate in conjunction with a main actuator.

[0025] A particular aim of the invention is to provide a fluid operated assembly which, at each single delivery of hydraulic fluid from the pump, at the command of the operator, is capable of repeating an established cycle of strokes of two fluid operated cylinders, with a previously-established adapted sequence.

[0026] A further object of the present invention is to provide a fluid operated assembly comprising an auxiliary device that can be mechanically and hydraulically coupled and decoupled to a main fluid operated device, quickly and without the use of special tools.

[0027] A further object of the present invention is to provide a fluid operated assembly that allows to control the load on the auxiliary actuator, i.e. allowing it to move when there are hydraulic commands from the operator and blocking its movement, keeping the load stationary in position, when there are no such commands.

[0028] A further object of this invention is to provide a fluid operated assembly with special constructive features ensuring the best reliability and safety in use.

[0029] A further object of the invention is to provide a fluid operated assembly that has a good durability over time.

[0030] This aim and objects, as well as others which will become better apparent below, are achieved by a fluid operated assembly controlling double-acting actuators, as claimed in the appended claims.

[0031] Further characteristics and advantages will become better apparent from the description of a preferred, but not exclusive, embodiment of a fluid operated assembly according to the invention, illustrated by way of non-limiting example in the accompanying drawings wherein:

Figure 1 is a simplified hydraulic diagram of a fluid operated assembly according to the invention;
Figure 2 is a detailed hydraulic diagram of the fluid operated assembly according to the invention;
Figure 3 is a detailed hydraulic diagram of a main device;
Figure 4 is a detailed hydraulic diagram of an accessory device of the fluid operated assembly according to the invention;
Figure 5 is a detailed hydraulic diagram and a cross-sectional portion of the fluid operated assembly according to the invention, shown in POSITION 1;
Figure 6 is a detailed hydraulic diagram and a cross-sectional portion of the fluid operated assembly according to the invention, shown in POSITION 2;
Figure 7 is a detailed hydraulic diagram and a cross-sectional portion of the fluid operated assembly according to the invention, shown in POSITION 3;
Figure 8 is a detailed hydraulic diagram and a cross-sectional portion of the fluid operated assembly according to the invention, shown in POSITION 4;
Figure 9 is a detailed hydraulic diagram and a cross-sectional portion of the fluid operated assembly according to the invention, shown in POSITION 5;
Figure 10 is a detailed hydraulic diagram and a cross-sectional portion of the fluid operated assembly according to the invention, shown in POSITION 6;
Figure 11 is a detailed hydraulic diagram and cross-sectional portion of the fluid operated assembly according to the invention, shown in POSITION 7;
Figure 12 is an exploded perspective view of the fluid operated assembly according to the invention;
Figure 13 is a perspective view of the fluid operated assembly according to the invention;
Figure 14 is another perspective view of the fluid operated assembly according to the invention;
Figure 15 is a perspective view of the main device;
Figure 16 is a perspective view of the accessory device.

[0032] With reference to the above figures, the fluid operated assembly controlling double-acting actuators according to the invention, generally designated by the reference numeral 1, comprises a main device 101 and an accessory device 201 adapted to be combined with each other to regulate the movement of a main fluid dynamic cylinder 1000 and an auxiliary fluid dynamic cylinder 2000.

[0033] The fluid operated assembly 1 is configured to perform a single complete cycle of strokes of the main fluid dynamic cylinder 1000 and the auxiliary fluid dynamic cylinder 2000, according to a pre-set sequence, with a single delivery of a hydraulic fluid from a pump P, not visible in the drawings, with return to a tank T, not visible in the drawings.

[0034] For the sake of convenience, the strokes of the main fluid dynamic cylinder 1000 will be called "MAIN STROKE 1" and "MAIN STROKE 2", and the strokes of the auxiliary fluid dynamic cylinder 2000 will be called "AUXILIARY STROKE 1" and "AUXILIARY STROKE 2".

[0035] The main device 101 comprises a first valve body 102 formed in one piece, preferably of parallelepiped shape, preferably made of metallic material.

[0036] In the first valve body 102 there is a delivery port 104, a return port 105, a first outlet port 106 and a second outlet port 107, made according to statutory standards and designed to fluidically connect the fluid operated assembly 1 to an oil-hydraulic system.

[0037] The delivery port 104 allows the fluid operated assembly 1 to be connected to the pump P, which, on command from an operator, feeds the hydraulic fluid, typically consisting of natural and/or synthetic oil, into the oil-hydraulic system.

[0038] The return port 105 allows the fluid operated assembly 1 to be connected to the tank T, which collects the return hydraulic fluid from the oil-hydraulics system.

[0039] Preferably, the connection between the pressure port 104 and the pump P and the connection between the return port 105 and the tank T, are made by means of a valve 50, for example a four-way three-position valve, which is per se known and not here described in detail.

[0040] The first outlet port 106 and the second outlet port 107 are configured to be respectively connected to a first chamber 1001 and to a second chamber 1002 of the main fluid dynamic cylinder 1000.

[0041] The first chamber 1001 of the main fluid dynamic cylinder 1000 is the one that must pressurise first in the work cycle to be performed, while the second chamber 1002 is the one that must pressurise second in the same cycle.

[0042] In this embodiment of the invention, as illustrated in the figures, the first chamber 1001 is the one on the right and the second chamber 1002 is the one on the left.

[0043] The above described arrangement may be inverted without departing from the invention.

[0044] According to the present invention, the first valve body 102 incorporates multiple mutually operationally connected components, including, in particular, a first and a second overcenter valve 110, 120, also referred to as balancing valves, a distributor device 130, an overpressure valve 150 and a one-way throttling valve 160.

[0045] The inlet of the first overcenter valve 110 is connected to the distributor device 130 by means of a first connection branch 111, while the outlet of the first overcenter valve 110 is configured to be connected to the first chamber 1001 of the main fluid cylinder 1000 by means of the first outlet 106.

[0046] The inlet of the second overcenter valve 120 is connected to the distributor device 130 by means of a second connection branch 121, while the outlet of the second overcenter valve 120 is configured to be connected to the second chamber 1002 of the main fluid cylinder 1000 by means of the second outlet 107.

[0047] In this embodiment of the invention, the first overcenter valve 110 essentially consists of a first pressure control valve 112, of the piloted type, and a first check valve 113, which are arranged in a suitable seat in the first valve body 102.

[0048] The first pressure control valve 112 is controllable by means of a first pilot branch 115 which connects to the second connection branch 121.

[0049] Advantageously, the first pilot branch 115 incorporates a check valve 108, a first throttle 118 placed in series with it, and a drain, essentially consisting of a second throttle 119, toward the first connection branch 111.

[0050] This makes it possible to execute a special dynamic piloting of the first overcenter valve 110, already known from oil-hydraulic technology.

[0051] Advantageously, the first pressure control valve 112 has a calibration means, not visible in the drawings, which can be adjusted from the outside by means of a screw that, once tightened, is protected against tampering.

[0052] In this embodiment of the invention, the second overcenter valve 120 essentially consists of a second pressure control valve 122, of the piloted type, and a second check valve 123, which are arranged in a suitable seat in the first valve body 102.

[0053] The second pressure control valve 122 is piloted by means of a second pilot branch 125 which is connected to the first connection branch 111.

[0054] Advantageously, the second pressure control valve 122 has calibration means, not visible in the drawings, that can be adjusted from the outside by means of a screw that, once tightened, is protected against tampering.

[0055] As mentioned, the first and the second overcenter valves 110, 120 are connected to the distributor device 130, which comprises a slider 131 slidingly engaged fluid-tightly in a tubular casing 132 suitably provided with a plurality of through channels 133a, 133a', 133b, 133b', 133c, 133c', 133d, 133d', 133e and 133e'.

[0056] The tubular casing 132 is arranged in a seat, not visible in the drawings. The seat is formed within the first valve body 102 and axially closed by closing bodies 135a and 135b.

[0057] The slider 131 is a substantially cylindrical body from which four annular septa 136a, 136b, 136c and 136d, protrude and, together with the tubular casing 132, form three annular chambers 137a, 137b and 137c.

[0058] The annular chambers 137a, 137b and 137c allow the various branches of the fluid operated assembly 1 to be connected in different combinations.

[0059] The distributor device 130 is configured to automatically switch between a first operating condition, in which it connects the first connection branch 111 with a delivery branch 138 of the hydraulic fluid and the second connection branch 121 with a return branch 139 of the hydraulic fluid, and a second operating condition, in which it connects the first connection branch 111 with the return branch 139 and the second connection branch 121 with the delivery branch 138.

[0060] In a first operating condition, schematically illustrated in Figures 5 to 7, the slider 131 is positioned so that the first annular chamber 137a connects the feed-through channels 133a and 133a', through which the return branch 139 flows into the tubular casing 132, with the feed-through channels 133b and 133b', through which the second connection branch 121 flows into the tubular casing 132.

[0061] At the same time, the second annular chamber 137b connects the feed-through channels 133c and 133c', through which the delivery branch 138 flows into the tubular housing 132, with the feed-through channels 133d and 133d', through which the first connection branch 111 flows into the tubular housing 132.

[0062] At the same time, the third chamber 137c is put in communication with the return branch 139 by means of a third connection branch 141 incorporating a one-way throttling valve 160, which includes a spring-loaded check valve 161 connected in parallel with a third throttle 162.

[0063] The third chamber 137c is connected by means of through-holes 142 and 143 with a pilot chamber 140 of the distributor device 130, which extends axially in the slider 131.

[0064] In a second operating condition, schematically illustrated in Figures 9 to 11, the slider 131 is positioned so that the second annular chamber 137b connects the feed-through channels 133b and 133b', through which the second connection branch 121 flows into the tubular casing 132, with the feed-through channels 133c and 133c', through which the delivery branch 138 flows into the tubular casing 132.

[0065] At the same time, the third annular chamber 137c connects the feed-through channels 133d and 133d', through which the first connection branch 111 flows into the tubular casing 132, with the feed-through channels 133e and 133e', through which the third connection branch 141 flows into the tubular casing 132 to connect with the pilot chamber 140.

[0066] The third connection branch 141 is connected to the return branch 139 with the interposition of the one-way throttling valve 160, the inlet of which is connected to the pilot chamber 140.

[0067] The switching between the first operating condition and the second operating condition, schematically illustrated in figure 8, is controlled by the overpressure valve 150, which has its inlet connected to the first connection branch 111 by means of a third pilot branch 151 and its outlet connected to the pilot chamber 140.

[0068] The overpressure valve 150 is arranged in a seat in the first valve body 102 and has calibration means, not shown in the figures.

[0069] The calibration means of the overpressure valve 150 can be adjusted from the outside by means of a screw that, once tightened, is protected against tampering.

[0070] The action of the overpressure valve 150 is counteracted by elastic preloading means 144, consisting for example of a spring, interposed between the closing body 135a and the slider 131 in such a way that the latter is normally maintained in the first operating condition.

[0071] The dispenser device 130 and at least some of the components described above also interact with the accessory device 201, which can be quickly and easily connected to the main device 101 in order to extend its basic functionality.

[0072] While the main device 101, when used individually, is configured to perform at each single delivery of hydraulic fluid, controlled by an operator, a cycle of strokes of the main fluid dynamic cylinder 1000 only, for example according to the cycle "START - MAIN STROKE 1 - MAIN STROKE 2 - STOP", with the addition of the accessory device 201 it is possible to also control the auxiliary fluid dynamic cylinder 2000 and perform a more complex cycle of strokes, e.g. according to the cycle "START - AUXILIARY STROKE 1 - MAIN STROKE 1 - MAIN STROKE 2 - AUXILIARY STROKE 2 - STOP", for each single delivery of hydraulic fluid, controlled by an operator.

[0073] The accessory device 201 preferably comprises a second valve body 202 formed from a single piece and preferably made of metallic material.

[0074] It should be noted, however, that in other embodiments of the invention, not shown in the figures, the main device 101 and the accessory device 201 could be incorporated into a single valve body.

[0075] The second valve body 202 has a substantially square profile that follows the parallelepiped external profile of the first valve body 102, so that it is essentially an extension of it; this characteristic is known in the industry as 'bankability'.

[0076] A third outlet port 203 and a fourth outlet port 204 are provided in the second valve body 202. The third outlet port 203 and the fourth outlet port 204 are made according to regulatory standards and are intended to be respectively connected to a first chamber 2001 and a second chamber 2002 of the auxiliary fluid cylinder 2000.

[0077] The first chamber 2001 of the auxiliary fluid dynamic cylinder 2000 is the one that must pressurise first in the work cycle to be performed, while the second chamber 2002 is the one that must pressurise second in the same cycle.

[0078] In this embodiment of the invention, the first chamber 2001 is the one at the bottom, as seen in the drawings, while the second chamber 2002 is the one at the top.

[0079] However, it will be apparent to the person skilled in the art that in an oil-hydraulic system other than the one illustrated here as an example, the chambers may be arranged in an inverted position.

[0080] According to the present invention, the second valve body 202 incorporates a first and a second piloted check valve 210, 220 and a sequence valve 230 operatively connected to the components of the main device 101, as well as to each other.

[0081] The inlet of the first piloted check valve 210 is removably connected to the first connection branch 111, and then to the distributor device 130, by means of a fourth connection branch 211, while the outlet of the first piloted check valve 210 is intended to be connected to the first chamber 2001 of the auxiliary fluid cylinder 2000 by means of the third outlet port 203.

[0082] Similarly, the inlet of the second piloted check valve 220 is removably connected to the second connection branch 121, and thus to the distributor device 130, by means of a fifth connection branch 221, while the outlet of the second piloted check valve 220 is intended to be connected to the second chamber 2002 of the auxiliary fluid cylinder 2000 by means of the fourth outlet port 204.

[0083] Advantageously, the sequence valve 230 is arranged along the fifth connection branch 221, and essentially consists of a third pressure control valve 231 and a third check valve 232, arranged in a suitable seat in the second valve body 202.

[0084] In the sequence valve 230, the flow of hydraulic fluid can freely pass through the third check valve 232 in one direction, effectively creating a differential pressure between the inlet and the outlet of low value, basically tending to zero; in the opposite direction, on the other hand, the flow of hydraulic fluid passes through the third pressure control valve 231, which creates a differential pressure between the inlet and the outlet of high value, which can be set as desired.

[0085] The first piloted check valve 210 is piloted by means of a fourth pilot branch 212 that connects to the inlet of the second piloted check valve 220.

[0086] The second piloted check valve 220 is piloted by means of a fifth pilot branch 222 which connects to the inlet of the first piloted check valve 210.

[0087] Advantageously, the second valve body 202 also contains first through-holes 251 and 252, which connect to the fourth and fifth connection branches 211, 221 respectively.

[0088] The first through-openings 251 and 252 are superimposable and connectable to corresponding first openings, not illustrated, made in the first valve body 102, which connect to the first and second connection branches 111, 121, respectively.

[0089] The hydraulic connection between the main device 101 and the accessory device 201 can thus be improved, for example, by inserting first tight threaded elements 261, 262 into the aforementioned first openings.

[0090] For mechanically connecting the main device 101 to the auxiliary device 201, second openings 171, 172 and 271, 272 are formed through the first valve body 102 and the second valve body 202, respectively.

[0091] The second openings 171, 172 and 271, 272 are stackable and can be connected by inserting second threaded elements 181, 182.

[0092] It is apparent to the person skilled in the art that although the invention has been described with reference to a bankable fluid operated assembly 1, the invention is equally suitable for use with a one-piece fluid operated assembly.

[0093] The operation of the fluid operated assembly according to the present invention is as follows.

[0094] The fluid operated assembly 1 is initially located with the distributor device 130 in the first operating condition, and with the main fluid dynamic cylinder 1000 and the auxiliary fluid dynamic cylinder 2000 locked in their initial position by their closed control valves and the valve 50 in the neutral position, as per POSITION 1 schematically illustrated in Figure 5.

[0095] At this point, the operator starts the cycle with the delivery of hydraulic fluid from pump P, as per POSITION 2 schematically illustrated in figure 6.

[0096] The fluid, pushed through the delivery branch 138, reaches the second annular chamber 137b of the distributor device 130 and from there reaches and passes through the first overcenter valve 110 by means of the first connection branch 111 and enters with the first outlet 106 into the first chamber 1001 of the main fluid dynamic cylinder 1000.

[0097] At the same time, the hydraulic fluid reaches and passes through the first piloted check valve 210 by means of the fourth connection branch 211 and flows by means of the third outlet 203 into the first chamber 2001 of the auxiliary fluid cylinder 2000.

[0098] With the same hydraulic input energy in the two fluid dynamic cylinders 1000, 2000, while the auxiliary fluid dynamic cylinder 2000 encounters no resistance to the outflow of hydraulic fluid at the output, because the second piloted check valve 220, which controls the outflow from the fourth outlet 204, is easily unblocked by means of the fifth pilot branch 222, the main fluid dynamic cylinder 1000 experiences a backpressure against the outflow of hydraulic fluid at the outlet, and thus to movement, created by the second overcenter valve 120 controlling the outflow rate from the second outlet port 107.

[0099] This backpressure value is adjustable from the outside by means of a screw which, once tightened, is protected against tampering.

[0100] Thanks to this effect, the fluid dynamic auxiliary cylinder 2000 moves first, which performs the entire first stroke, known as 'AUXILIARY STROKE 1'.

[0101] During this stroke, the auxiliary fluid dynamic cylinder 2000 expels hydraulic fluid from the second chamber 2002, fluid which flows into the fourth outlet port 204, freely passes through the second piloted check valve 220, freely passes through the third check valve 232 of the sequence valve 230 and, by means of the fifth connection branch 221, reaches the first annular chamber 137a of the distributor device 130, which is still in the first operating condition, and from this reaches the tank T by means of the return branch 139.

[0102] Once the auxiliary fluid cylinder 2000 has completed its stroke named 'AUXILIARY STROKE 1', the hydraulic fluid pressurises the second pilot branch 125 of the second overcenter valve 120 to the value of the release pressure.

[0103] As a result, the second overcenter valve 120 opens and the main fluid cylinder 1000 begins its first stroke, named 'MAIN STROKE 1', as per POSITION 3 and POSITION 4 schematically illustrated in Figures 7 and 8.

[0104] During its 'MAIN STROKE 1' stroke, the main fluid cylinder 1000 expels hydraulic fluid from the second chamber 1002, fluid which through the second outlet 107 reaches and passes through the second overcenter valve 120, which controls the flow by performing the balancing function.

[0105] Subsequently, by means of the second connection branch 121, the hydraulic fluid reaches the first annular chamber 137a of the distributor device 130, which is always in the first operating condition, and from there it reaches the tank T by means of the return branch 139.

[0106] During this operation, any leakage of hydraulic fluid from the system, which could pressurise the pilot chamber 140 and thus lead to a malfunctioning of the operating cycle, is appropriately drained through the return branch 139, by means of the one-way throttling valve 160 located along the third connection branch 141.

[0107] When the main fluid cylinder 1000 has completed its "MAIN STROKE 1" stroke, the pressure in the first connection branch 111 rises to the set value of the pressure relief valve 150, which opens and sends part of the hydraulic fluid into the pilot chamber 140 of the distributor device 130, as per POSITION 4 schematically illustrated in figure 8.

[0108] As a result, the slider 131 moves to the second operating condition, overcoming the action of the elastic preloading means 144, as per POSITION 5 schematically illustrated in Figure 9.

[0109] Therefore the hydraulic fluid, which always arrives from the delivery branch 138, reaches the second annular chamber 137b of the distributor device 130, which is now in the second operating condition, and from this reaches and passes through the second overcenter valve 120 by means of the second connection branch 121 and enters with the second outlet port 107 into the second chamber 1002 of the main fluid dynamic cylinder 1000.

[0110] At the same time, the hydraulic fluid reaches the sequence valve 230 by means of the fifth connection branch 221.

[0111] With the same hydraulic energy input in the two ways, while upstream of the auxiliary fluid cylinder 2000 in the fifth connection branch 221 is the sequence valve 230, which is appropriately adjusted to a high opening value, upstream of the main fluid cylinder 1000 is the second overcenter valve 120, in which the hydraulic fluid encounters no resistance to flow through the second check valve 123.

[0112] Due to this effect, the hydraulic fluid enters with the second outlet port 107 into the second chamber 1002 of the main fluid cylinder 1000, which then moves before the auxiliary fluid cylinder 2000, and which performs its entire second stroke, known as 'MAIN STROKE 2'.

[0113] The stroke of the main fluid cylinder 1000 is also possible because, after passing through the first throttle 118 and after opening the check valve 108, the hydraulic fluid pressurises the first pilot branch 115 of the first overcenter valve 110 to the value of the release pressure.

[0114] Part of the hydraulic fluid from the first pilot branch 115 is drained through the first connection branch 111, by means of the second throttling 119, transforming the piloting of the first overcenter valve 110 from a static condition to a dynamic condition, this to create a damping and delay effect on the opening command of the first overcenter valve 110, as known from oil hydraulic technology.

[0115] When the first overcenter valve 110 also opens, the main fluid cylinder 1000 starts the 'MAIN STROKE 2' stroke.

[0116] During its stroke, in this phase, the main fluid cylinder 1000 expels hydraulic fluid from the first chamber 1001, fluid that through the first outlet 106 reaches and passes through the first overcenter valve 110, which controls the flow by performing the balancing function.

[0117] Subsequently, through the first connection branch 111, the hydraulic fluid reaches the third annular chamber 137c of the distributor device 130, which is in the second operating condition, and from there it passes through the one-way throttling valve 160 and then reaches the tank T by means of the third connection branch 141 and the return branch 139.

[0118] The hydraulic fluid passing through the one-way throttling valve 160 keeps the distributor device 130, and the slider 131, in the second operating condition until the end of the 'MAIN STROKE 2' stroke.

[0119] When the main fluid dynamic cylinder 1000 has completed its "MAIN COURSE 2" stroke, as per POSITION 6 schematically illustrated in Figure 10, the pressure of the second connection branch 121 and the fifth connection branch 221 rises to the opening value of the sequence valve 230 located upstream of the auxiliary fluid dynamic cylinder 2000, which opens and allows the hydraulic fluid to pass.

[0120] The hydraulic fluid, therefore, which always arrives from the delivery branch 138, reaches the second annular chamber 137b of the distributor device 130, which is in the second operating condition, and from there reaches and passes through the open sequence valve 230 and the second piloted check valve 220.

[0121] Subsequently, the hydraulic fluid enters with the fourth outlet 204 into the second chamber 2002 of the auxiliary fluid cylinder 2000, and simultaneously pressurises the fourth pilot branch 212 of the first piloted check valve 210, so allowing flow through the third outlet 203.

[0122] In this way, the fluid dynamic auxiliary cylinder 2000 performs its entire second stroke, known as 'AUXILIARY STROKE 2'.

[0123] At this stage, the hydraulic fluid flowing out of the fourth outlet 204 passes through the first piloted check valve 210 and, by means of the fourth connection branch 211 and the first connection branch 111, reaches the third annular chamber 137c of the distributor device 130, which is in the second operating condition, and from this it passes through the one-way throttling valve 160 and then reaches the tank T by means of the third connection branch 141 and the return branch 139.

[0124] The hydraulic fluid flowing through the one-way throttling valve 160 keeps the distributor device 130, and the slider 131, in the second operating condition until the end of the "AUXILIARY STROKE 2" stroke.

[0125] When the auxiliary fluid dynamic cylinder 2000 has completed its "AUXILIARY STROKE 2" stroke, as per POSITION 7 schematically illustrated in Figure 11, the main fluid dynamic cylinder 1000 and the auxiliary fluid dynamic cylinder 2000 have reached their final position, which coincides with their initial position, effectively terminating the pre-set cycle.

[0126] It should be noted that, at this stage, even if the operator continues to act on the fluid delivery to the system, the main fluid cylinder 1000 and the auxiliary fluid cylinder 2000 remain in their final position without automatically restarting the cycle.

[0127] This is made possible by the fact that the hydraulic fluid fed from the delivery line 138, fluid which passes through the second annular chamber 137b and pressurises the second connection branch 121, passing through the elements of the first pilot branch 115, is fed into the first connection branch 111, reaches the third annular chamber 137c of the distributor device 130 and, passing through the one-way throttling valve 160, keeps the distributor device 130 and the slider 131 in the second operating condition, before reaching the tank T by means of the return branch 139.

[0128] Then, by acting on the valve 50 upstream of the circuit, the operator terminates the delivery of hydraulic fluid by draining the fluid dynamic system, with a special distributor installed in the control area.

[0129] At this point, the main fluid cylinder 1000 is blocked because the first and the second overcenter valves 110, 120 are closed, while the auxiliary fluid cylinder 2000 is blocked because the first and second piloted check valves 210, 220 are closed.

[0130] However, it is still possible to release the main fluid dynamic cylinder 1000 at a maximum peak pressure value, through the relief function of the first and second overcenter valves 110, 120, when the fluid dynamic system receives an overload from the external working environment, so as not to damage the system structure.

[0131] In this circumstance, the fluid operated assembly 1 is depressurised and, through internal drainage orifices, all the annular chambers 137a, 137b and 137c of the distributor device 130 are also depressurised, and the elastic preloading means 144 return the slider 131 to the first operating condition.

[0132] All the elements of fluid operated assembly 1 are in the starting position for a new work cycle.

[0133] In practice, it has been found that the invention achieves its intended aim and object, providing a fluid operated assembly, for controlling double-acting actuators, which offers the possibility of incorporating a second actuator, called an auxiliary actuator, working in conjunction with a main actuator into the oil-dynamic circuit.

[0134] The fluid operated assembly according to the invention is capable of executing a predetermined cycle of strokes of two fluid dynamic cylinders at each single delivery of hydraulic fluid from the pump, at the operator's command, in a predetermined sequence.

[0135] The assembly according to the invention is an accessory device which can be mechanically and hydraulically coupled and decoupled to a double-acting actuator quickly and without the use of special tools.

[0136] The assembly according to the invention offers the possibility of controlling the load on the auxiliary actuator, i.e. it allows its movement when there are hydraulic commands from the operator and blocks its movement, holding the load stationary in position, when there are no such commands.

[0137] The assembly according to the present invention is reliable and safe in use, due to its peculiar manufacturing characteristics.

Claims

1. A fluid operated assembly controlling double-acting actuators, **characterized in that** it comprises a first overcenter valve, having an inlet connected to a distributor device by means of a first connection branch and an outlet connectable to a first chamber of at least one main fluid dynamic cylinder, and a second overcenter valve, having an inlet connected to said distributor device by means of a second connection branch and an outlet connectable to a second chamber of said main fluid dynamic cylinder, said first overcenter valve being controllable by means of a first pilot branch connected to said second connection branch; said second overcenter valve being controllable by means of a second pilot branch connected to said first connection branch; said fluid operated assembly further comprising a first piloted check

valve having an inlet removably connected to said distributor device by means of said first connection branch and an outlet connectable to a first chamber of at least one auxiliary fluid dynamic cylinder, and a second piloted check valve, having an inlet removably connected to said distributor device by means of said second connection branch, with the interposition of a sequence valve, and an outlet connectable to a second chamber of said auxiliary fluid dynamic cylinder; said distributor device being adapted to control an operative interconnection between said first connection branch, said second connection branch, a delivery branch of a hydraulic fluid and a return branch of said hydraulic fluid, in order to regulate the movement of said main fluid dynamic cylinder and of said auxiliary fluid dynamic cylinder, so as to automatically execute a predefined operating cycle.

2. The fluid operated assembly according to claim 1, **characterized in that** said distributor device comprises a pilot chamber and is automatically switchable between at least one first operating condition, in which said first connection branch is connected to said delivery branch and said second connection branch is connected to said return branch and said pilot chamber is connected to said return branch by means of a unidirectional throttling valve, and at least one second operating condition, in which said first connection branch is connected to said return branch by means of said unidirectional throttling valve and said second connection branch is connected to said delivery branch; an overpressure valve switching between said first operating condition and said second operating condition; said overpressure valve having an inlet connected to said first connection branch by means of a third pilot branch and an outlet connected to said pilot chamber.

3. The fluid operated assembly according to one or more of the preceding claims, **characterized in that** said sequence valve comprises a third pressure control valve and a third check valve.

4. The fluid operated assembly according to one or more of the preceding claims, **characterized in that** it comprises a fourth pilot branch connected to the inlet of said second piloted check valve, which is adapted to control said first piloted check valve, and a fifth pilot branch connected to the inlet of said first piloted check valve, which is adapted to control said second piloted check valve.

5. The fluid operated assembly according to one or more of the preceding claims, **characterized in that** it comprises at least one first valve body, adapted to accommodate at least said first and second overcenter valves, said distributor device, said unidirectional throttling valve, said overpressure valve and their corresponding hydraulic connections.

6. The fluid operated assembly according to claim 5, **characterized in that** it comprises at least one second valve body adapted to accommodate at least said first and second piloted check valves, said sequence valve and corresponding hydraulic connections; said second valve body being removably connected to said first valve body and forming an extension thereof.

7. The fluid operated assembly according to claim 6, **characterized in that** said first and second valve bodies each comprise connection interfaces having first through openings and second through openings; wherein said first through openings of said second valve body can be superimposed and connected by means of the insertion of first fluid-tight threaded elements, for an hydraulic connection of said first and second valve bodies, to the corresponding first through openings of said first valve body; and wherein said second through openings of said second valve body can be superimposed and connected by means of the insertion of second tight threaded elements, for the mechanical connection of said first and second valve bodies to the corresponding second through openings of the first valve body.

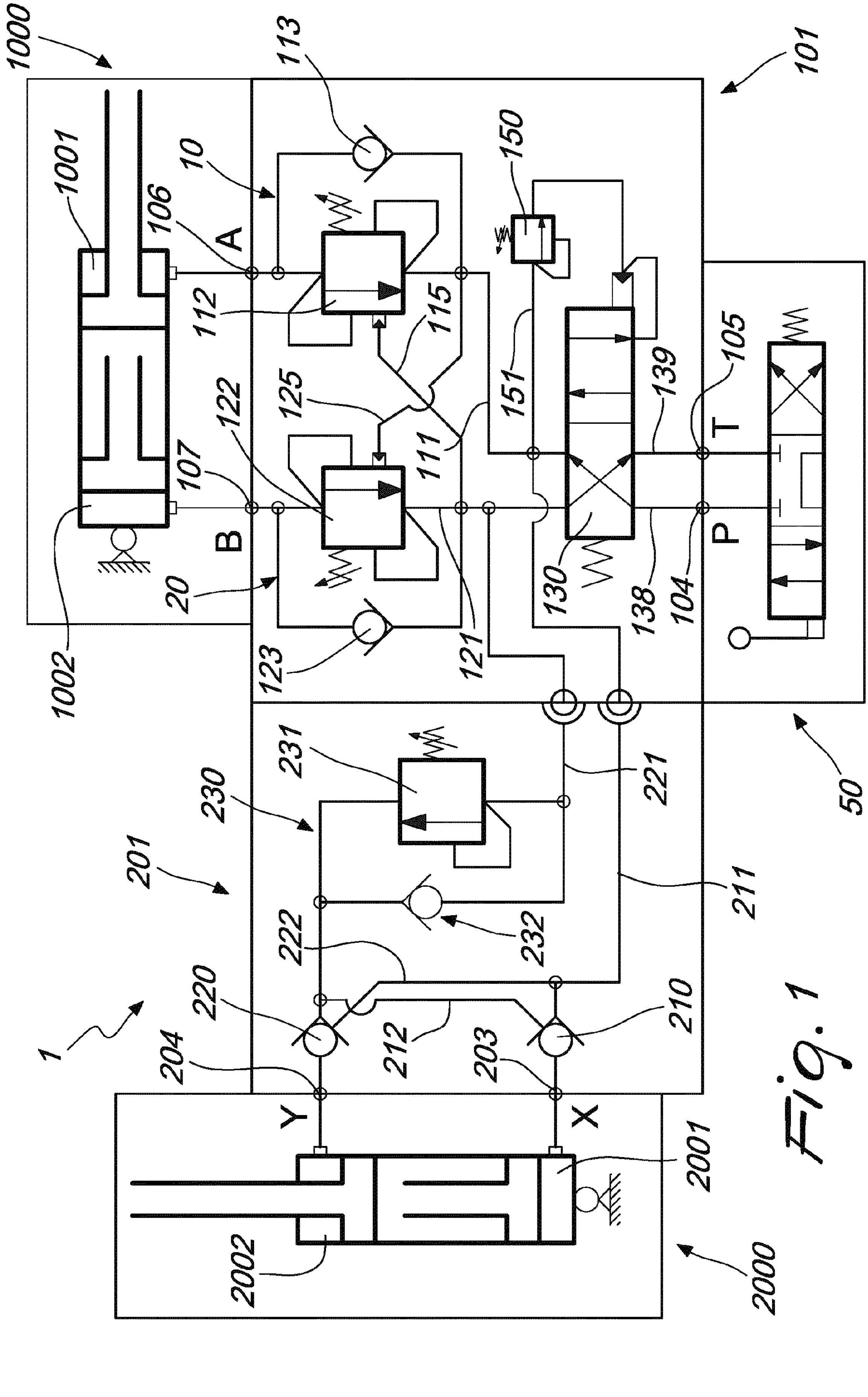
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Fig. 1

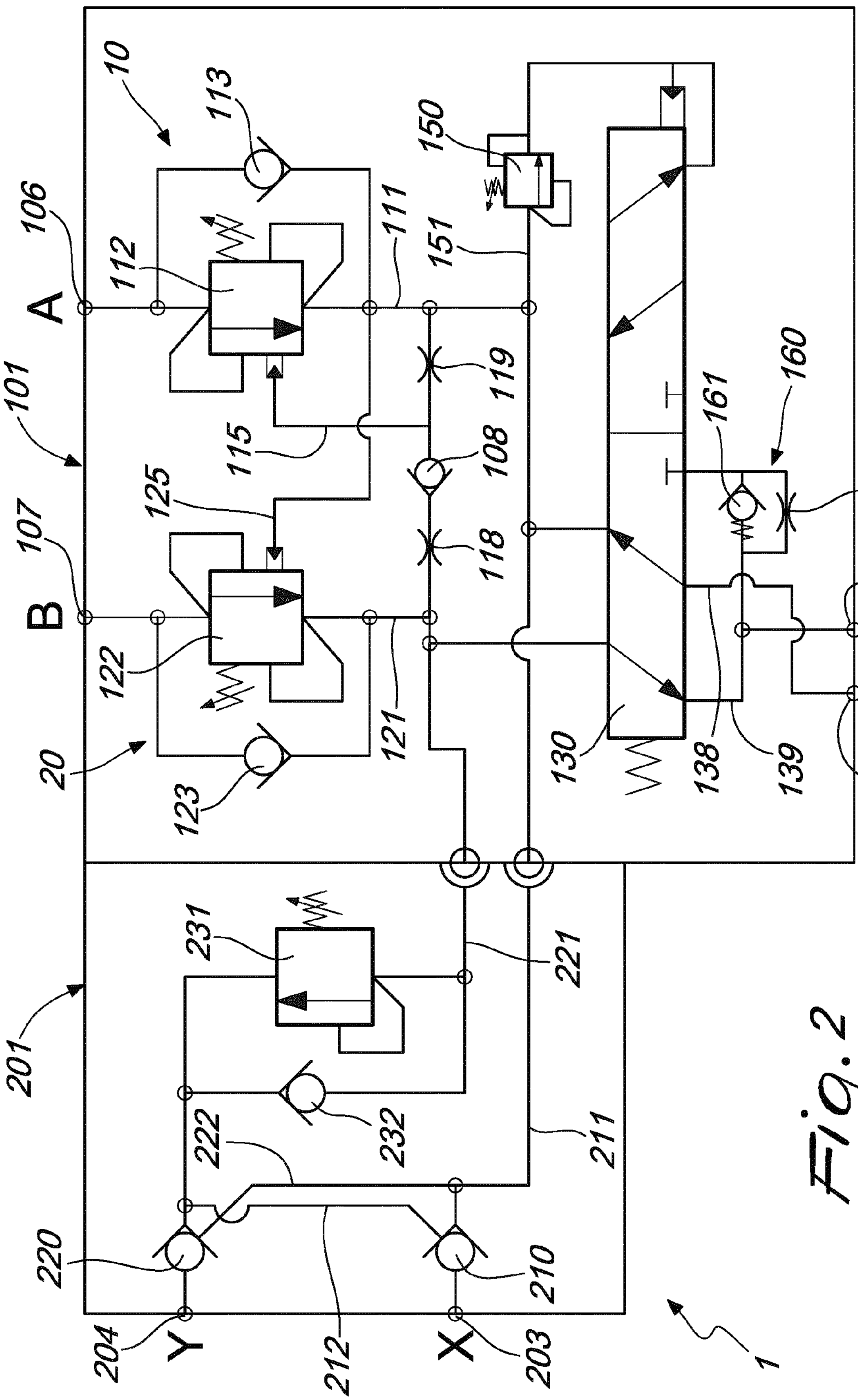
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Fig. 2

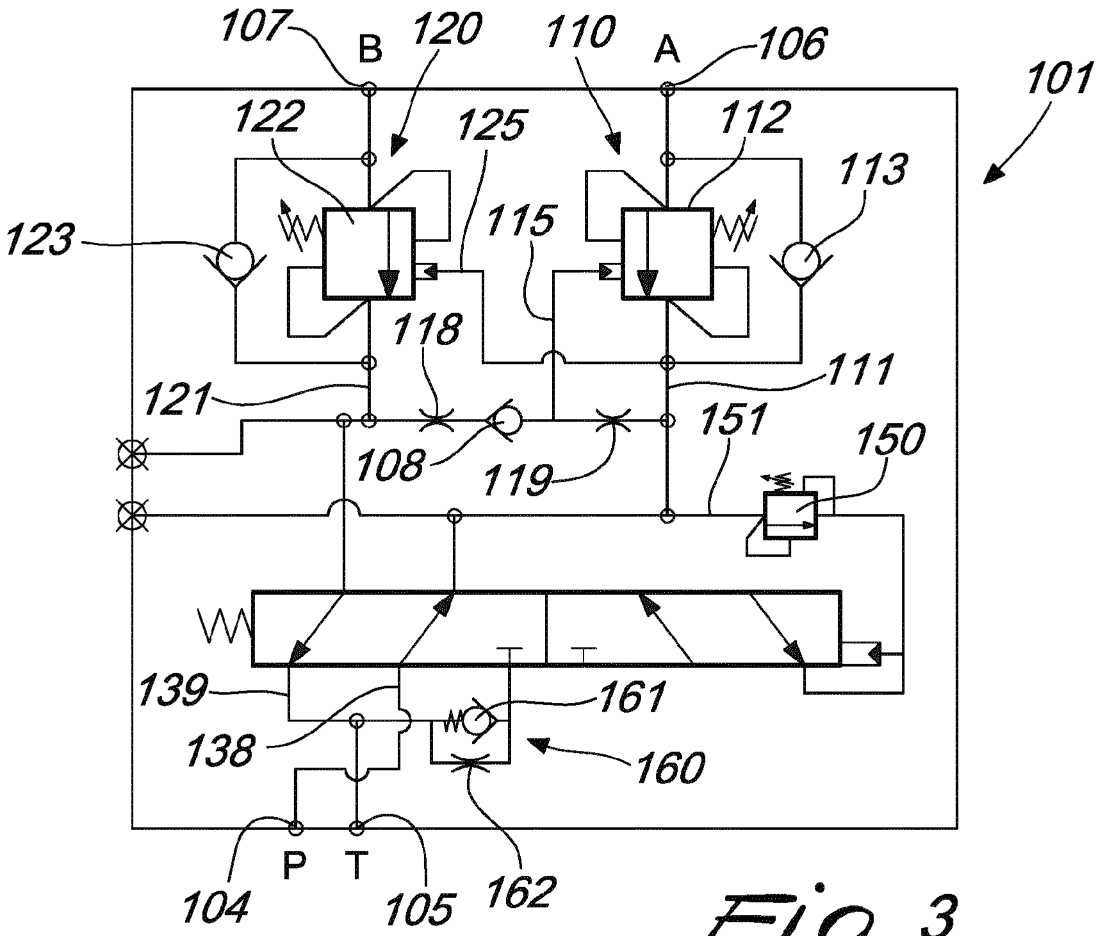
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Fig. 3

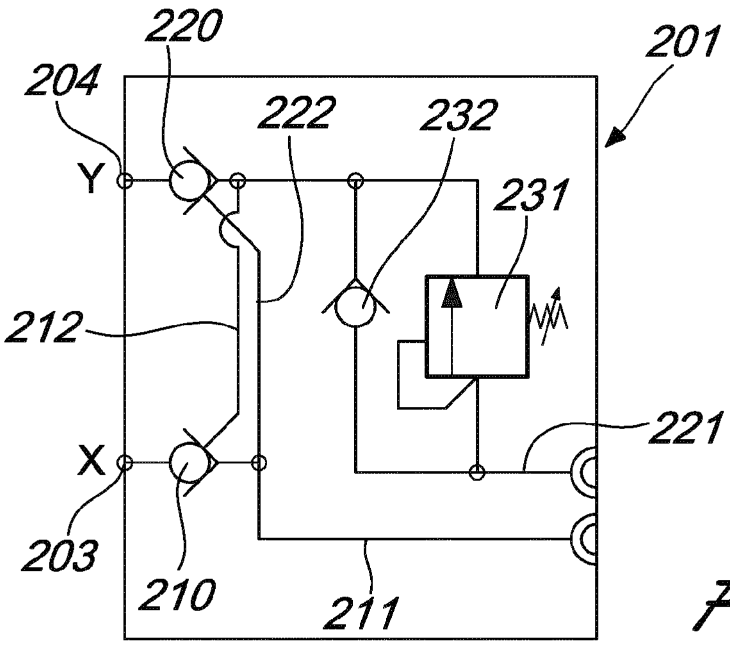
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Fig. 4

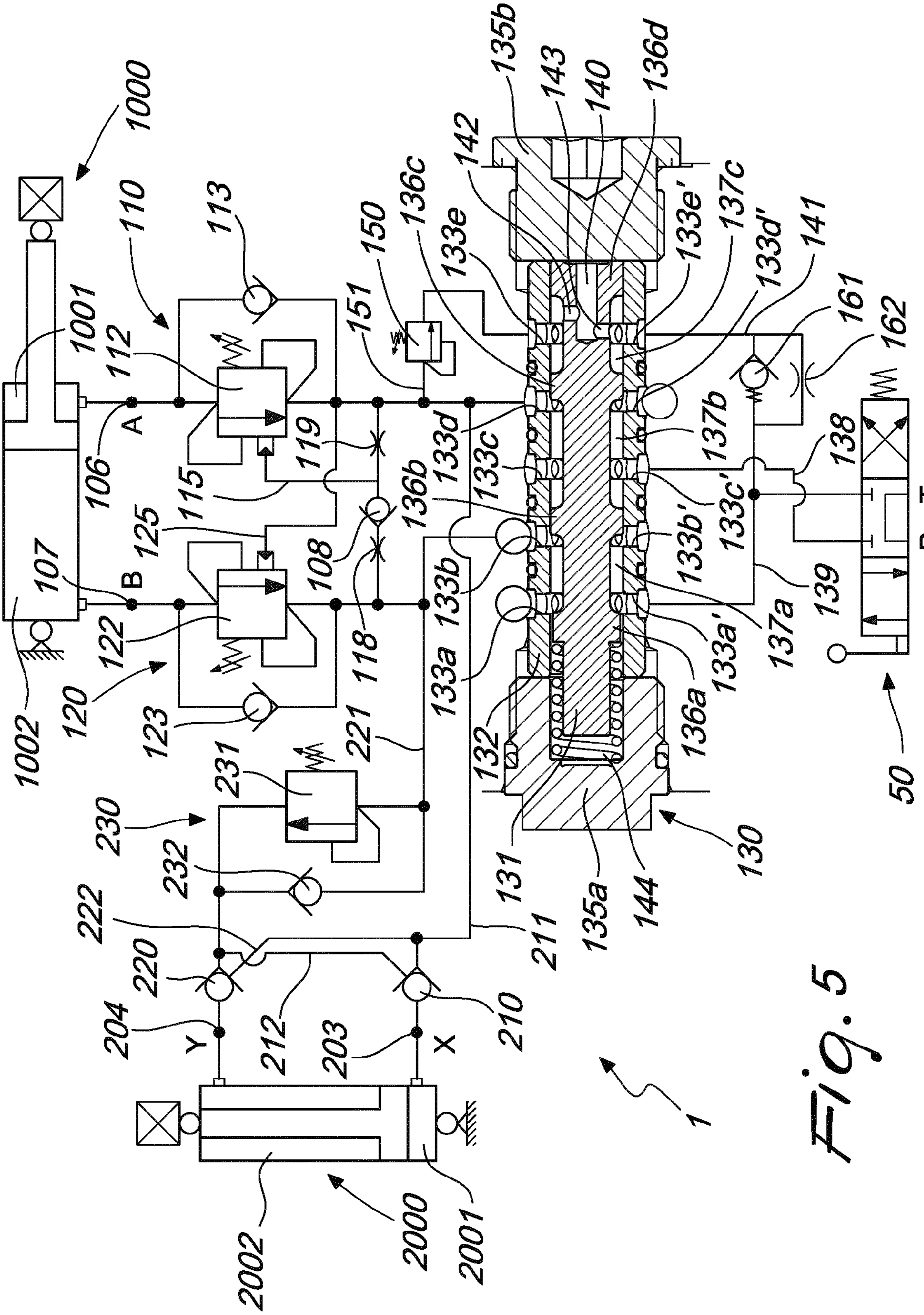
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Fig. 5

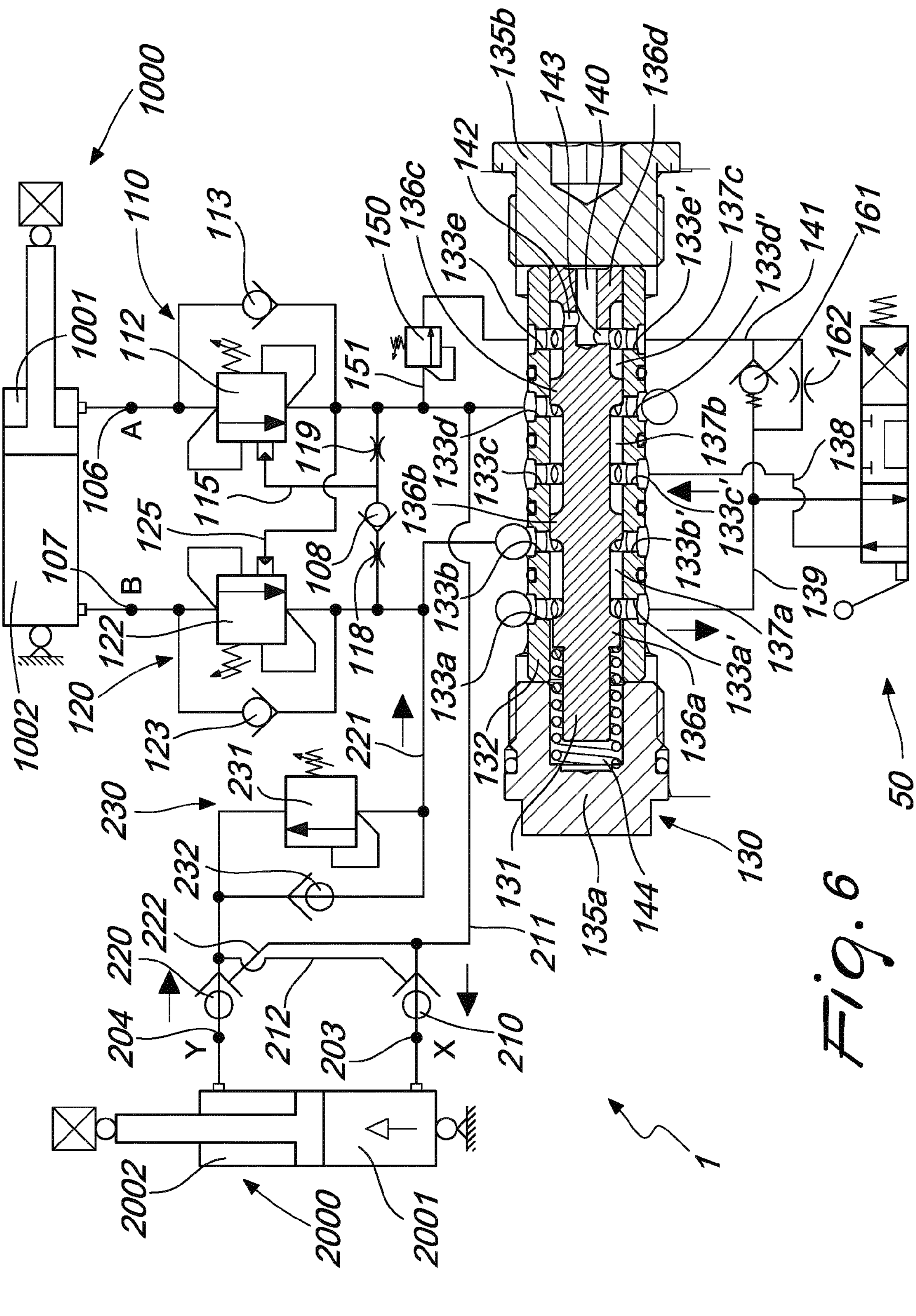
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Fig. 6

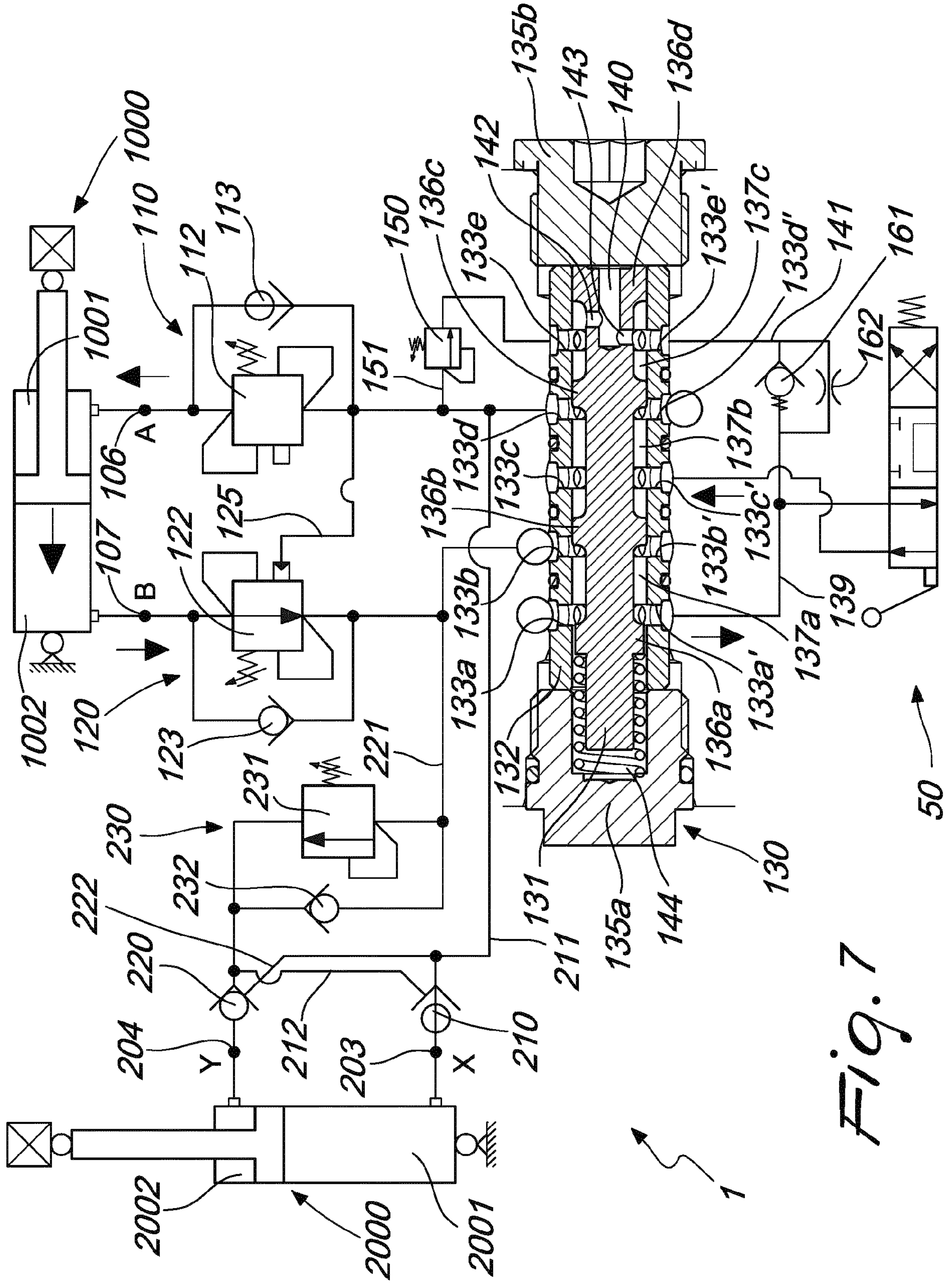
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Fig. 7

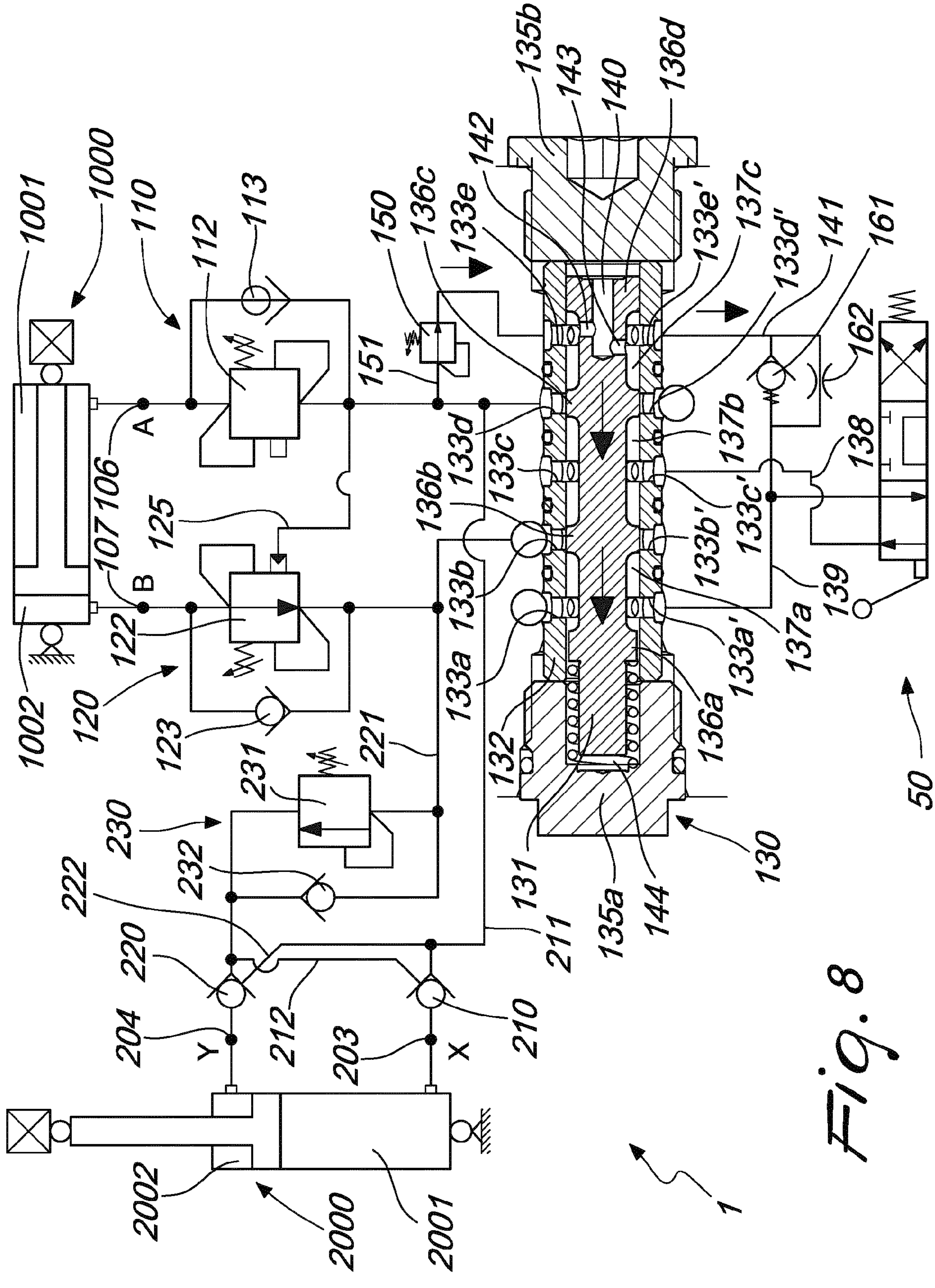
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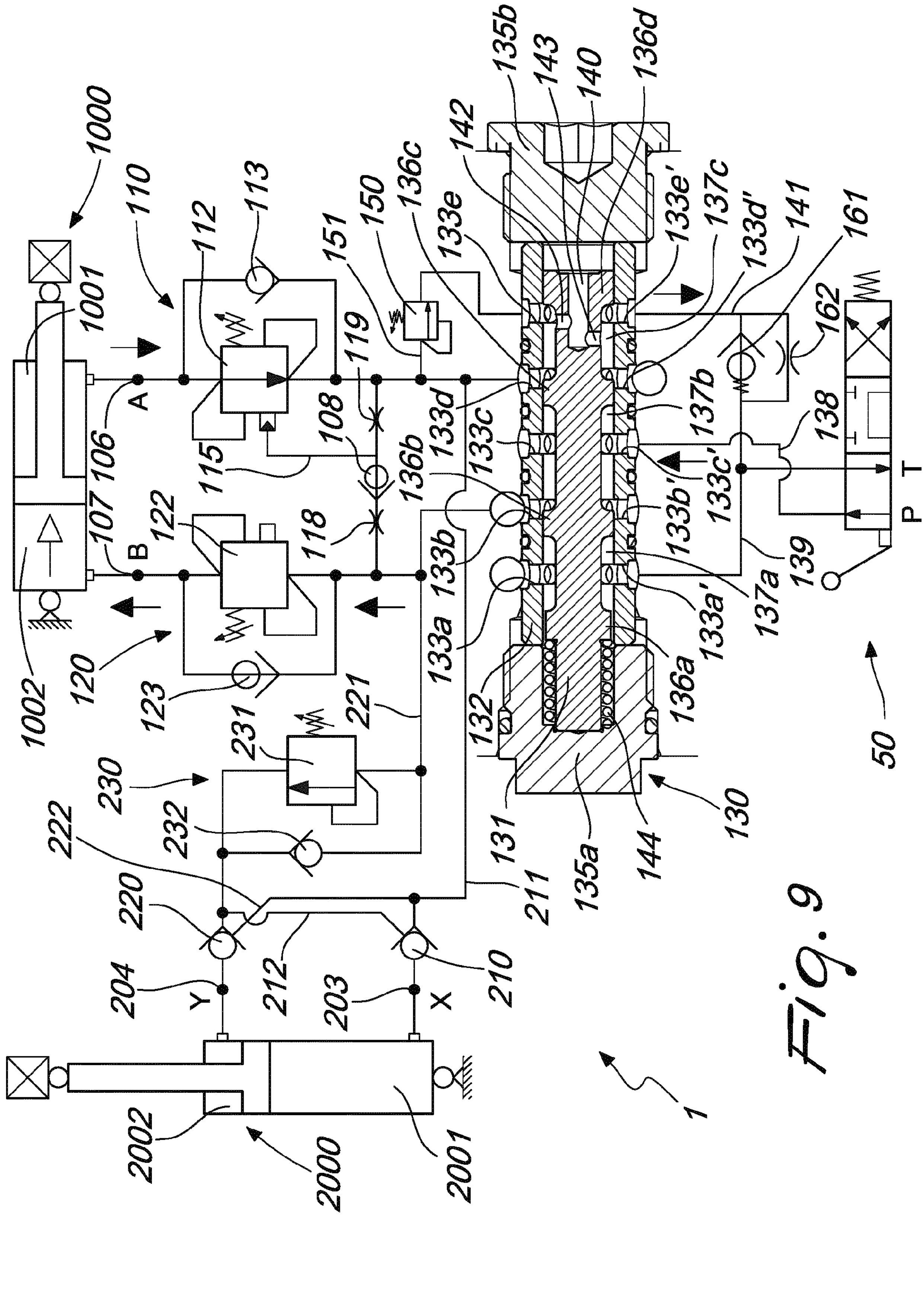
Fig. 8



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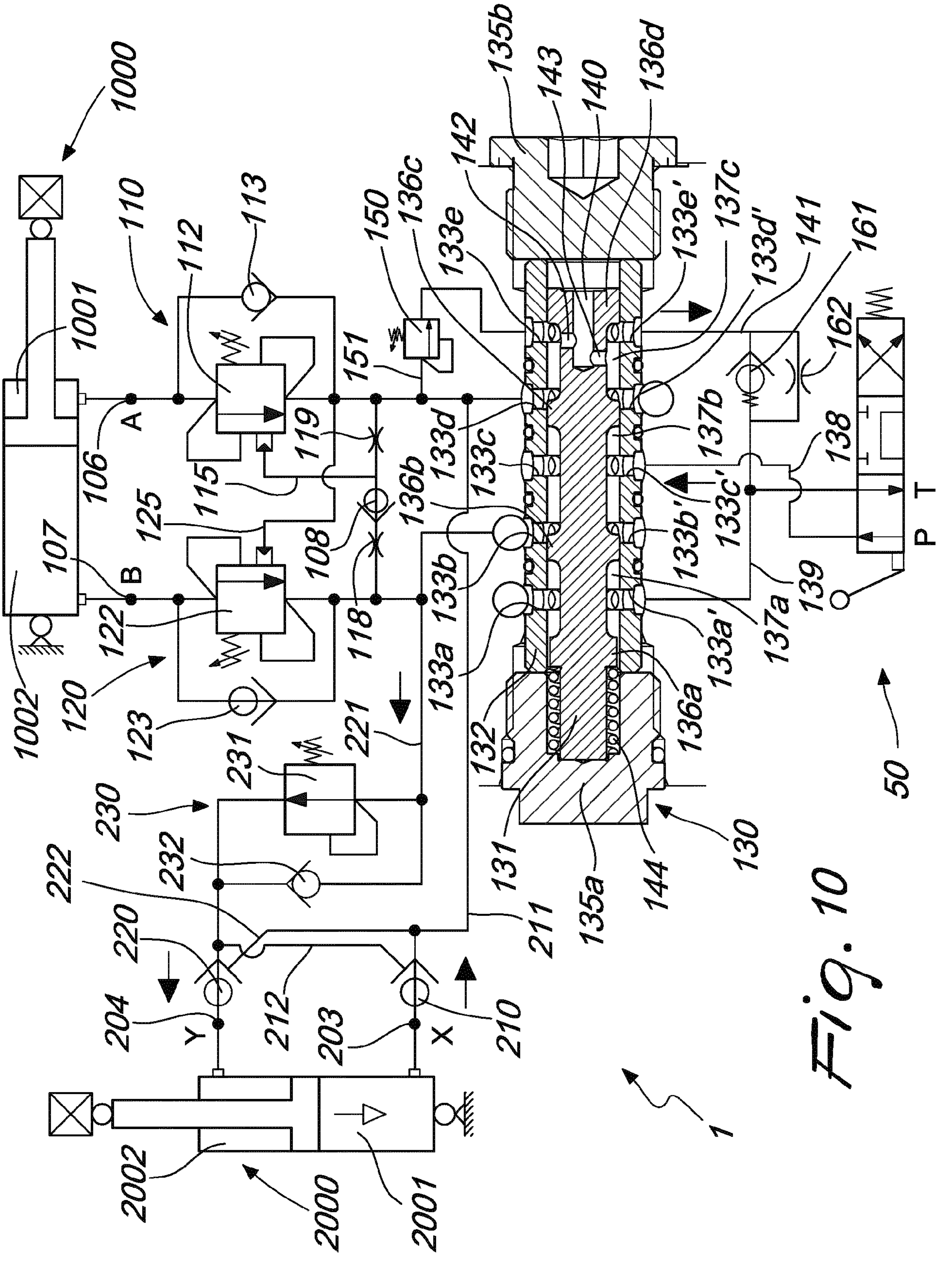
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Fig. 10

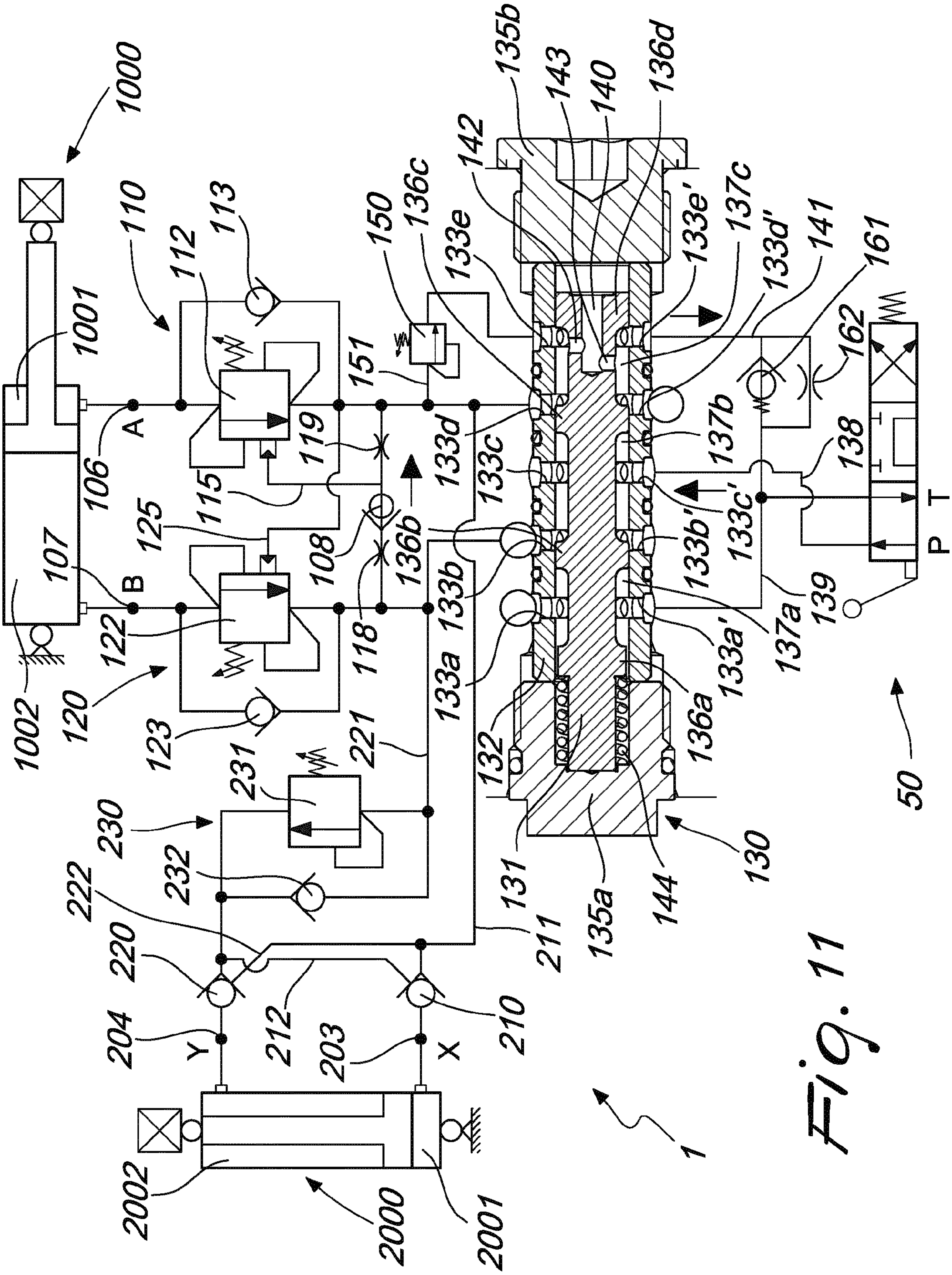
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Fig. 11

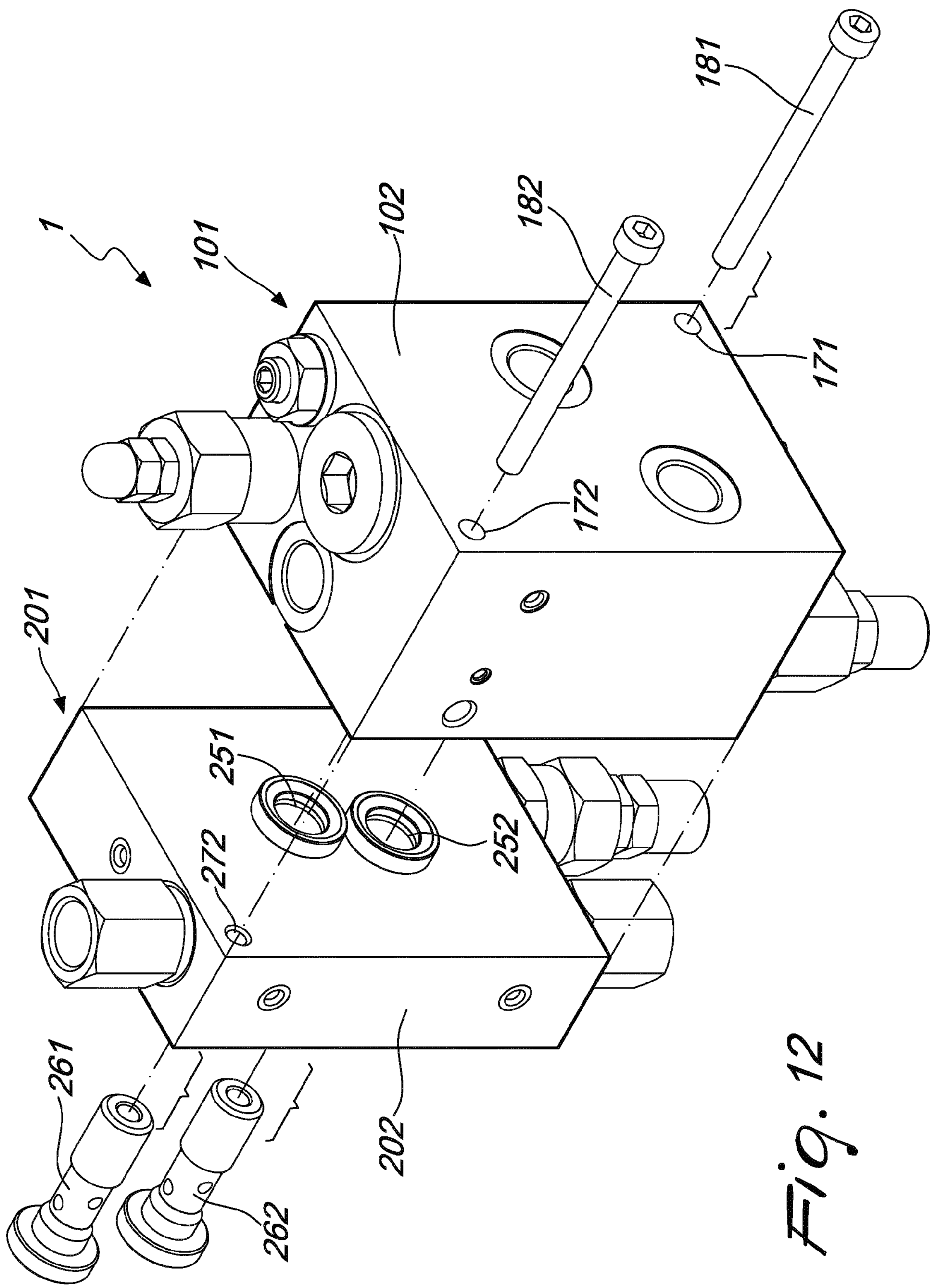

Fig. 12

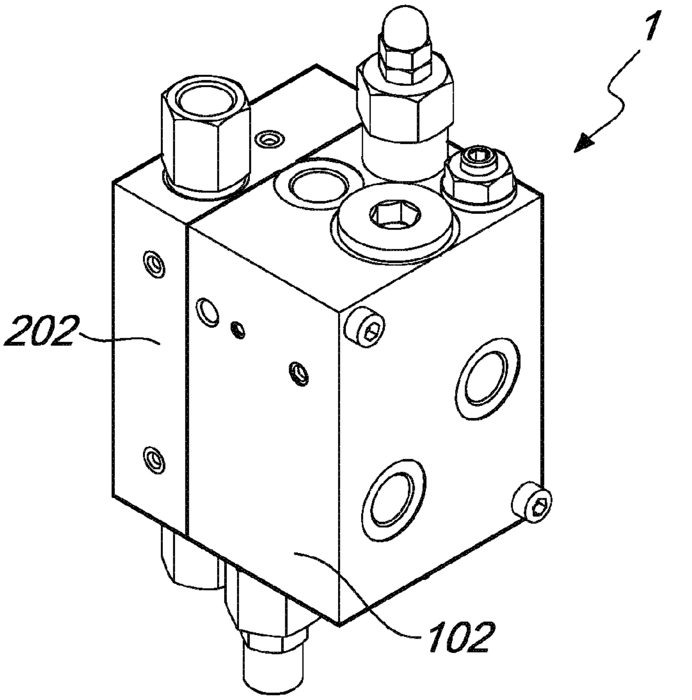

Fig. 13

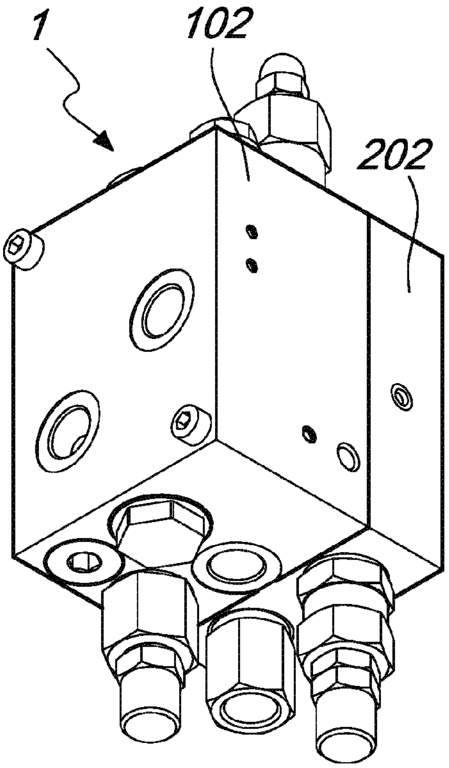

Fig. 14

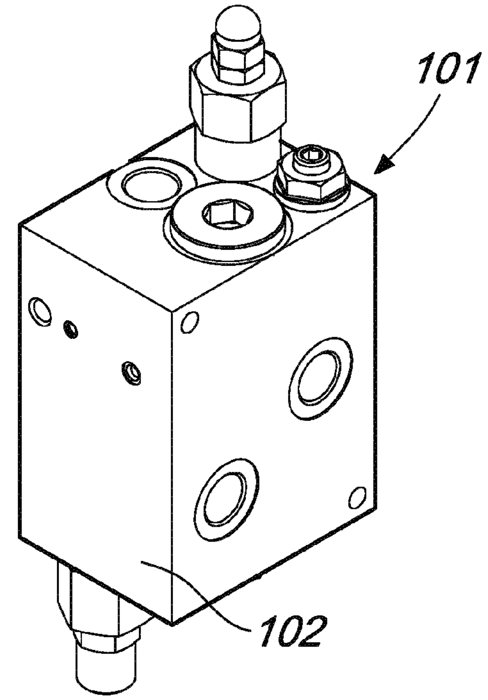

Fig. 15

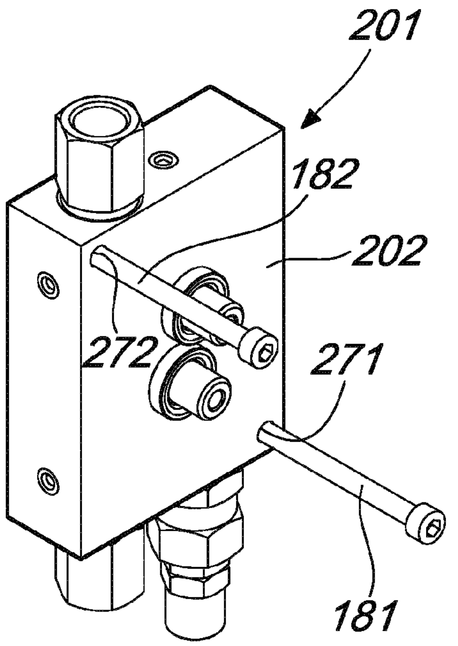

Fig. 16

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 6864

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	CN 109 253 119 A (TAIZHONG YUCI HYDRAULIC IND SHANGHAI CO LTD) 22 January 2019 (2019-01-22) * paragraphs [0018] - [0030]; figure 1; examples 1,2,4,A1,B1 *	1-7	INV. F15B11/00 F15B11/044 F15B11/15 F15B11/16 F15B13/08 F15B11/20
A	US 4 938 296 A (BRAZELL II JAMES W [US]) 3 July 1990 (1990-07-03) * figure 5c; examples 134,35,137,21 *	1	ADD. F15B13/01 F15B13/02
A	US 5 490 441 A (HALLSTROM OLOF A [US] ET AL) 13 February 1996 (1996-02-13) * see "switching valve" in col.2, li.42 - col. 5, li.20; claim 1; figures 1,2,3,4,5,6; examples 28,30,14,16,36 *	1,2	
			TECHNICAL FIELDS SEARCHED (IPC)
			F15B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 May 2024	Deligiannidis, N

2

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