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(54) **Pressurized-medium system and pressurized-medium component as well as a hydraulic splitter**

Druckmittelsystem und druckmittelkomponent sowie hydraulischer Spalter

Système à fluide pressurisé et composant pour fluide pressurisé ainsi que fendeuse hydraulique

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Description

[0001] The present invention relates to a pressurized-medium system, which includes

- a pressurized-medium source,
- a double-acting actuating cylinder, which includes a feed line and a return line,
- a directional control valve for controlling the actuating cylinder,
- pressurized-medium conductors connected from the pressurized-medium source through the directional control valve to the actuating cylinder and back,
- a booster cylinder, which is fitted between the directional control valve and the actuating cylinder, and
- a pressure-controlled sequence valve fitted between the directional control valve and the booster cylinder and connected to the booster cylinder in such a way that, when the pressure increases in the feed line of the actuating cylinder over the setting value of the pressure-controlled sequence valve, changes its position, feeding the pressurized medium to the booster cylinder and from there to the actuating cylinder, in order to increase the operating power of the actuating cylinder automatically,
- a pressure-controlled check valve arranged in the feed line to prevent the increased pressure from escaping to the feed line when the pressure-controlled sequence valve has changed its position,
- a pressure-controlled rapid-travel valve, which is arranged between the directional control valve and the actuating cylinder for recirculating the pressurized medium from the return line of the actuating cylinder to the feed line in order to increase the work velocity, in such a way that, together with the pressure-controlled sequence valve and the booster cylinder, three velocity and power ranges are formed in the pressurized-medium system.

[0002] The invention also relates to a hydraulic splitter.

[0003] The pressurized-medium system according to the introduction is used, for example, in applications, in which a large force is required momentarily. US patent number 4659292 discloses one such system. A double-acting actuating cylinder is used normally controlled by a directional control valve. If necessary, a booster cylinder is operated by a control element, by means of which the pressure entering the actuating cylinder is increased, in order to increase the operating power of the actuating cylinder. However, the aforementioned system is complicated. In addition, the pressure boosting is based on a very small cylinder, in which a small piston moves rapidly backwards and forwards. Thus, the pressure rises slowly and the volume flow of the pressure medium is low, in practice only a few decilitres per minute. At the same time, the velocity of the actuating cylinder nearly stops, which is a significant drawback in many applications. In addition, the pressurized medium is always fed through the booster cylinder, or at least through the channels in it, which increase the flow resistance and causes power losses and overheating. The small channels and high pressure generally require the use of a special oil, which further increases costs.

[0004] JP S63 72904 discloses a pressurized-medium system according the preamble of the Claim 1.

[0005] The invention is intended to create a new type of pressurized-medium system, by means of which a combination of a rapid work movement and high power can be achieved in a small and compact size. In addition, the invention is intended to create a new type of pressurized-medium component, by means of which the power of the pressurized-medium system can be increased simply. Further, the invention is intended to create a new type of hydraulic splitter, which will be more versatile, faster, and efficient than previously, while being easier to operate than previously. The characteristic features of the pressurized-medium system according to the present invention are stated in the accompanying Claims 1. Correspondingly, the characteristic features of the hydraulic splitter according to the invention are stated in the accompanying Claim 10. In the pressurized-medium system according to the invention, hereinafter more simple in the system, control of a surprisingly simple construction but versatile operation, combined with an additional component providing additional operating power, is used. The control is preferably automatic, with the velocity and power of the system changing according to the current situation. Thus, the system is easy to use and above all fast and efficient.

[0006] Such a system has previously been impossible to achieve, or at least it has required complicated and expensive structures and control technology. The pressurized-medium component according to the invention is a compact totality, which can be placed in different types of system, to increase the operating power. In the hydraulic splitter, a combination of a rapid work movement and a high power is achieved, which accelerates working, while there is sufficient power for splitting even large logs of wood.

[0007] In the following, the invention is described in detail with reference to the accompanying drawings showing some embodiments of the invention, in which

Figure 1 shows the system according to the invention fitted to a hydraulic splitter,

Figure 2 shows the circuit diagram of a first embodiment of the system according to the invention,

Figure 3 shows a partial cross-section of the operating elements of the system according to the invention,

Figure 4 shows the circuit diagram of a second embodiment of the system according to the invention, and

Figure 5 shows schematic power and velocity curves of the system according to the invention, as

a function of pressure.

[0008] Figure 1 shows the system according to the invention in a hydraulic splitter. Here, only part of the body 10 is shown, in which a ram 11 and a splitting wedge 12 are arranged. The position and height of the splitting wedge can be adjusted, in order to divide the wood into more than two parts. In Figure 1, the ram 11 is in the retracted position, so that a log of wood 13 can be placed between the ram 11 and the splitting wedge 12. Except for the ram, the moving parts of the hydraulic splitter are entirely inside a protective casing, though in Figure 1 the protective casing is not shown. The actuating cylinder 14 moving the ram 11 is located inside the ram 11 while the piston rod of the actuating cylinder 14 is attached to the front end of the ram 11. The other end of the actuating cylinder is attached to the body 10. Thus, the working stroke of the actuating cylinder causes the ram to push the log against the splitting wedge. Once the log has been split, the ram 11 is returned into the retracted position.

[0009] The hydraulic wood splitter is also referred to as a wood-billet machine. The maximum force is dimensioned mainly on the basis of the size of the hydraulic splitter and the size of the wood it splits, as well as the required splitting length. In practice, the greater the diameter of the hydraulic cylinder, the slower the splitting speed. Correspondingly, with a small hydraulic cylinder a rapid work stroke will be achieved, but the splitting force will remain modest. The same problem is also in other applications, in which a long and rapid work stroke, with a high power is also required. A hydraulic splitter equipped with the booster cylinder described in the introduction would be expensive and complicated, and hopelessly slow.

[0010] Figure 2 shows the construction of the system, and particularly its circuit diagram, in greater detail. First of all, the system includes a pressurized-medium source 15, which in a hydraulic splitter is a hydraulic pump rotated by an electric motor, or the hydraulic output (not shown) of a work machine, such as a tractor. In Figure 2, the pressurized-medium source 15 is shown with an arrow, next to which is a symbol indicating the pressurized-medium tank. In addition, the system includes a double-acting actuating cylinder 14, equipped with a feed line 16 and return line 17, as well as a directional control valve 18 for controlling the actuating cylinder 14. In this case, the directional control valve is of a type that is normally closed. Thus, in order to control the actuating cylinder, the state of the directional control valve must be changed (for example, manually).

[0011] In order to circulate the pressurized medium, the system includes pressurized-medium conductors 19, which are connected from the pressurized-medium source 15 through the directional control valve 18 to the actuating cylinder 14 and back. Thus, the pressure of the pressurized-medium source can pressurize the actuating cylinder and direct it forwards and backwards. The system further includes a booster cylinder 21, which is fitted between the directional control valve 18 and the feed line 16 of the actuating cylinder 14. The booster cylinder can be used to increase the maximum pressure of the pressurized-medium source, so that the actuating cylinder will receive a higher pressure than before. At the same time, the available power increases. The system further includes a control element 37 fitted between the directional control valve 18 and the booster cylinder 21, in order to guide the pressurized medium to the booster cylinder 21 when required and from it on to the actuating cylinder 14, in order to increase the operating power of the actuating cylinder 14. The construction of the control element is dealt with in greater detail later.

[0012] According to the invention, the system further includes a rapid-travel valve 20, which is arranged between the directional control valve 18 and the actuating cylinder 14, in order to recirculate the pressurized medium from the return line 17 of the actuating cylinder to the feed line 16, in order to increase the velocity of the actuating cylinder 14, in such a way that, together with the control element 37 and the booster cylinder 21, three movement velocity and power zones P1, P2, and P3 (Figure 5) are created in the pressurized-medium system. By using suitable components and combinations of them, the system can additionally be made to operate automatically. In other words, the velocity and through it the power both increase and decrease, without any action by the operator. In practice, the rapid-travel valve connects the piston and piston-rod side of the actuating cylinder to each other in the operating-pressure range in the forward motion, without affecting the return motion of the of the actuating cylinder. Thus, the forward motion of the actuating cylinder is accelerated in the ratio of the surface areas of the piston and the piston rod. In other words, in the central position not controlled by the rapid-travel valve, the return line and the feed line are connected to each other. In the embodiment shown in Figure 2, the use of the rapid-travel valve doubles the velocity of the work movement in the operating-pressure range. The rapid-travel valve is preferably of a type that opens automatically at a specific pressure, as in Figure 2, or a mechanical type that is manually operated (not shown). The rapid-travel valve can also be operated by control logic. The control element too can be a valve that opens automatically at a specific pressure or a mechanical, manually operated valve (not shown), or it can also be operated by control logic.

[0013] In the embodiment of the system shown, there is also a pressure-controlled sequence valve 22 fitted between the rapid-travel valve 20 and the booster valve 21, which acts as the control element 37 according to the invention. In this case, the pressure-controlled sequence valve 22 is connected to the booster cylinder 21 in such a way that, when the pressure rises over the setting value of the pressure-controlled sequence valve 22 in the feed line 16 of the actuating cylinder 14, it changes the valve's position, thus feeding the pressurized medium to the booster cylinder 21 and from it on to the actuating cylinder

14, in order to increase the operating power. Thus the pressure increase is entirely automatic. The sequence valve is also referred to as a priority or monitoring valve. The counter-pressure compensated sequence valve admits the pressurized medium behind the piston of the booster cylinder, if the power of the actuating cylinder threatens to run out. The system, as well as its individual components, can also be controlled manually, or, for example, by control logic, which uses, for example, electrical or pneumatic operating elements. However, the described embodiment of the system operates automatically. The operator only needs to control the direction of movement using the directional control valve, the control of which can also be made partly or entirely automatic, for example, using a limit switch or a pressure transmitter. On the other hand, the system described operates completely without sensors or meters. This helps to reduce the system's manufacturing and operating costs. In addition, the valves are durable and maintenance-free.

[0014] By means of the system described above, many advantages are gained. The system is particularly advantageous in applications, which mainly require a rapid work movement, but only momentarily great power. By combining the actuating cylinder, booster cylinder, and control element, a large and slow actuating cylinder, or two parallel actuating cylinders can be replaced with a system that is twice as fast, but nevertheless achieves the same power. In addition, the system becomes compact and the control is versatile, as well as being easily automated and adjusted. The operation of the system is described in greater detail later.

[0015] A second embodiment of the system is shown in Figure 4, in which the rapid-travel valve 20 is formed of two non-return valves and a pressure-controlled sequence valve, in place of the three-position directional control valve and pressure-controlled sequence valve of Figure 2. Otherwise, the construction and operation of Figure 4 correspond to those of the system of Figure 2. In this case, there is additionally a measurement point M in the valve block 23 for pressure measurements. Normally the pressure line in question is plugged.

[0016] Figure 3 shows the pressurized-medium component according to the invention, which is arranged to be connected to the pressurized-medium system. In this case, both the actuating cylinder 14 and the booster cylinder 21 are shown at the start of their work stroke. According to the invention, the work strokes of the actuating cylinder 14 and the booster cylinder 21 are arranged to be in opposite directions. Thus, the forces caused by the movements of the pistons are, at least partly, cancelled out, which reduces vibration and otherwise reduces the loading of the system. In Figure 3, the directions of movement of the cylinders are shown with arrows. In addition, the actuating cylinder 14 and the booster cylinder 21 are arranged essentially parallel to each other and attached to each other. Thus, the actuating cylinder can be used to support the booster cylinder. Thus, a conventional actuating cylinder, for example, can be easily replaced with the pressurized-medium component according to the invention.

[0017] The pressurized-medium component further includes a rapid-travel valve 20, which according to the invention is fitted to the same valve block 23 as the pressure-controlled sequence valve 22. The valve block 23 becomes apparent especially in Figure 3, in which the connections of the valve block are indexed according to Figure 2. Here, the pressurized-medium conductor is a pressure line 24 from the pressurized-medium source, which is connected to the connector D1. Correspondingly, the tank line 25 is connected to the connector D2. The feed line of the actuating cylinder 14 is connected to the connector U2 and the return line 17 to the connector U1. The fifth connector is B2, which is connected to the feed line 16' of the booster cylinder 21. In addition, the high-pressure side of the booster cylinder 21 is connected by a T-connector directly to the feed line of the actuating cylinder 14 and the low-pressure-side return line 26 by a connector to the return line 17 of the actuating cylinder 14. Thus, as little as possible high-pressure-resistant piping is required. In this application, the piping in question is only from the connector U2 of the valve block 23 to the actuating cylinder 14. The other pressurized-medium conductors can be dimensioned according to the non-boosted maximum pressure.

[0018] In Figure 3, the valve block 23 is shown slightly separate from the actuating cylinder and the booster cylinder. According to the invention, the valve block can be supported on the booster cylinder, in which case an even more compact construction will be formed. In addition, the valve block can even be integrated as part of the booster cylinder, in which case a single unified pressurized-medium component will be formed. Existing systems can be easily upgraded using the new type of component. However, when creating a new system, it is preferable to use a thick-walled actuating cylinder. In other words, the wall of the actuating cylinder is thicker than usual, so that it is possible to exploit the considerably higher pressure than the normal operating pressure, created by the booster cylinder. Example calculation are given later.

[0019] Figure 3 also shows the new type of construction of the booster cylinder. According to the invention, the booster cylinder 21 is formed of a low-pressure part 28 and a high-pressure part 29, which are connected end-to-end by an intermediate piece 30, as a continuation of each other. The construction in question is simple to manufacture, because the walls of the low-pressure part and the high-pressure part can be made from tube blanks of different wall thicknesses, which are then joined to each other by the intermediate piece. Naturally, the wall of the high-pressure part is thicker than the wall of the low-pressure part. In addition to the double construction, the booster cylinder also differs in terms of the creation of the pressure. According to the invention, the increased pressure is made purely with the aid of the piston rod of the low-pressure part protruding into the high-pressure

part, without a separate piston. This simplifies the construction, facilitates sealing, and increases durability. In practice, normal seals are sufficient to seal the piston rod. More specifically, the low-pressure part 28 includes a piston 31, which is equipped with a piston rod 32 sealed to the intermediate piece 30, and which is arranged to form the functional piston of the high-pressure part 29. The pressure increase is influenced mainly by the ratio of the surfaced areas of the piston rod and the piston. The piston 33 and the piston rod 34 of the actuating cylinder 14 are shown partly in Figure 3.

[0020] One advantageous application is precisely the hydraulic splitter shown in Figure 1, which includes a body 10 and a splitting wedge in it, as well as a ram 11, for the operation of which the hydraulic splitter includes the pressurized-medium system according to the invention. The actuating cylinder 14 and booster cylinder 21 belonging to the pressurized-medium system are preferably attached to each other and arranged inside the ram 11. Thus, the compact package is protected inside the ram. In addition, the hydraulic splitter can be upgraded by replacing the original actuating cylinder with a new actuating cylinder equipped with a even thicker wall and with the pressurized-medium component according to the invention. As a result, three automatically operating velocity and power ranges are obtained, which makes the hydraulic splitter on the one hand fast, but on the other powerful, without complicated and large structures.

[0021] In the hydraulic splitter shown, the actuating cylinder is, as such, a conventional double-acting hydraulic cylinder, but it is equipped with a cylinder tube that has a thicker wall than normal. In this case, a pressurized-medium component boosting the pressure is installed on top of the actuating cylinder. The booster cylinder can also be alongside the actuating cylinder. In the system according to the invention, unlike in known applications, the pressure is boosted purely by pushing the low-pressure part piston rod into the oil chamber of the high-pressure part. From the high-pressure part, the boosted-pressure oil is led into the reinforced actuating cylinder, so that a greater operating power than before is achieved without altering the capacity of the pressurized-medium source.

[0022] The magnitude of the boosted pressure is determined by the ratio of the surface areas of the low-pressure part's piston rod and piston. The boosted pressure is used mainly only when additional power is momentarily required. In the embodiment shown, during each stroke of the actuating cylinder the boosted pressure is available over a distance of about 100 mm.

[0023] The hydraulic splitter is controlled like a normal double-acting hydraulic cylinder with the aid of a backward-forward directional control valve (Figure 2). The directional control valve is used to guide the flow to the valve block according to the invention, which controls the system automatically between three velocities and powers, depending on the power required. The valve block according to the invention forms a valve unit, by means of which three separate operating valves are combined to form a single compact unit. The unit is small in size and the number of external pipes and hoses remains as small as possible. Despite the boosted pressure, expensive high-pressure hoses are not necessarily required at all, thanks to the valve unit. Thus, the structure of the system according to the invention is compact and simple.

[0024] The actuating cylinder operates in the same manner as a normal double-acting hydraulic cylinder. In the following example, a system is examined, in which the maximum pressure of the pressurized-medium source is 180 bar. As the resistance is low, the actuating cylinder operates with so-called rapid travel, so that the oil on the piston-rod side is circulated through a rapid-travel valve in the valve block, to behind the piston. The rapid travel is fast, but only a force according to the surface area of the piston rod of the actuating cylinder is available for use. In this example, the operating range of the rapid travel is 0 - 130 bar. In Figure 5, this is the velocity and power range P1. As the pressure rises, the power also increases while the velocity remains essentially the same. Once the oil pressure in the system rises above 130 bar, the rapid travel automatically disconnects. In other words, being pressure-controlled, the rapid-travel valve changes its position, when the oil begins to circulate from the piston-rod side to the tank and the pressurized oil goes behind only the piston. At the same time, the velocity of the actuating cylinder slows to one half, but the power is doubled. This operating range is, for example, 130 - 160 bar and is the velocity and power range P2 in Figure 5. The mutual relationships of the velocity and power ranges depend mainly on the dimensioning of the actuating cylinder and the booster cylinder and the settings of the system. As the resistance continues to increase, the pressure continues to rise in the system. In the example, at a pressure of 160 bar, the power of the actuating cylinder threatens to end, because the maximum pressure of the pressurized-medium source is approaching. In this situation, the booster cylinder is brought into operation. However, the actuating cylinder continues to progress, because there is still 20 bar available of the maximum pressure of the pressurized-medium source. According to its setting value, the sequence valve in the valve unit opens at a pressure of 160 bar and releases oil behind the booster piston and begins to push the piston rod into the oil chamber of the high-pressure part, in which the pressure is 160 bar. At the same time, the pressure begins to rise not only in the oil chamber of the high-pressure part, but also in the feed line of the actuating cylinder, and then on the piston side of the actuating cylinder. Due to the increase in pressure, the pressure-controlled check valve 35 in the valve unit closes immediately due to the pressure difference and raises the pressure in the actuating cylinder to 440 bar, at the same time as there is a pressure of 180 bar behind the piston in the booster cylinder. The pressure-controlled check valve prevents the increased pressure from escaping to the tank through the system's pressure-limit

valve. At the same time, the velocity of the actuating cylinder roughly halves, but the power increases to about double. In Figure 5, this is the velocity and power range P3. On the basis of the above, the setting value of the pressure-controlled sequence valve is set to 5 - 20 %, preferably 10 - 15 % lower than the maximum pressure of the pressurized-medium source. Thus, the movement of the actuating cylinder continues without stopping, as the control of the system operates automatically.

[0025] If the resistance gives way, the valves located in the valve block once again control the actuating cylinder according to the prevailing pressure range. The actuating cylinder then returns to its normal velocity or to rapid travel. The return movement of the actuating cylinder operates rapidly in the manner of a normal double-acting cylinder. In the return movement, first of all the piston of the booster cylinder returns and then the piston of the actuating cylinder starts moving. The booster cylinder is then made to operate rapidly backwards and forwards, if the reinforcement distance already achieved is insufficient. In other words, the booster cylinder is made to return rapidly and to continue the work movement with a new boosting stroke.

[0026] The following are theoretical powers and velocities of the actuating cylinder, calculated from the embodiment examples. The calculations are based on a maximum pressure of 180 bar in the pressurized-medium source, the volume flow being 40 l/min. In this case, the diameter of the piston of the actuating cylinder is 50 mm, the diameter of the piston rod being 35 mm. Correspondingly, the diameter of the piston rod of the booster cylinder is 32 mm. Thus, the pressure boosting ratio is 2,44. In addition, the length of stroke of the booster cylinder is 240 mm, the length of stroke of the actuating cylinder being 680 mm. At these values, during the rapid travel, a force of about 1700 kg and the forward length of stroke lasts 0,98 s with the rapid travel. Correspondingly, during the basic movement, a force of about 3500 kg is achieved and the forward length of stroke lasts 2,00 s with the basic movement. With the dimensioning described, a one-off stroke of about 100 mm at a boosted pressure is achieved. At a pressure of 440 bar, a force of about 8600 kg is achieved. Thanks to the rapid travel, the total movement is accelerated by about one third. In other words, when the return movement lasts about one second, the entire work stroke with rapid travel lasts about two seconds, when with a basic movement it would last about three seconds. In practice, the system described has three velocities and powers and its operation is regulated automatically according to the load. The rapid-travel velocity operates in the pressure range 0 - 130 bar, when the available force is 0 - 1700 kg. The normal velocity operates in the pressure range 130 - 160 bar, when the available force is 1700 - 3500 kg. The third velocity operates during pressure boosting. The pressure range is then 160 - 440 bar, the available power being 1700 - 8600 kg. On the basis of the above, the use of a piston diameter of 50 mm achieves a force corresponding to a conventional piston diameter of 75 mm. Even with the rapid travel, the backwards and forwards movement of the larger diameter cylinder would take five seconds, when according to the invention it is only two seconds. On the other hand, by increasing the piston diameter of the actuating cylinder to 75 mm, a force of 8000 - 16 000 kg would be achieved using the system described. In the graph of Figure 5, the pressure of the system is on the X-axis and the force achieved by the actuating cylinder is on the left-hand Y-axis. On the right-hand Y-axis is the relative velocity of the actuating cylinder. The graphs are not based on precisely absolute values, but mainly show the operating principle of the system according to the invention.

[0027] In addition to specific types of components, their dimensioning is important in terms of the operation of the system. At the above values, 40 l/min of oil flows through connector D2 during the work stroke and 80 l/min during the return movement. A 3/4" hose is connected to the connector in question. Correspondingly, 20 l/min of oil flows through connector D1 during the work stroke and 40 l/min during the return movement. A 1/2" hose is connected to the connector in question. Due to the increased pressure, a thick-walled pipe, with an internal diameter of 15 mm, is connected to the connector U2. Correspondingly, a thinner-walled pipe, with an internal diameter of 12 mm, is sufficient for the connectors B2 and U1. In addition, the connector opening 36 of the feed line 16 of the actuating cylinder 14 is made to be spacious, so that during the return movement a large amount of oil can flow through it without unnecessary throttling. In other words, there are small pressure losses in the system, due to the correctly dimensioned piping and flow openings.

[0028] The above description is of a system using oil as the pressurized medium, which is also suitable for pneumatics or water hydraulics. In addition to a hydraulic splitter, the system can also be applied, for instance, in other applications requiring a long and rapid work stroke, but from time to time also large forces. Such are, for example, presses and the operating devices of large valves. For example, in cardboard or waste presses, a significant part of the work stroke of the actuating cylinder is nearly without resistance. Only when the receptacle becomes full does the resistance increase. However, the actuating cylinder and the entire mechanism must, as is known, be dimensioned according to the maximum resistance. Thus, a known waste press is slow. By means of the system according to the invention, it is possible to use an actuating cylinder that is smaller than previously, which can, in addition, be run using rapid travel. The waste press will then become considerably fast and there will be sufficient power to press the waste. The configuration of the system can vary in different applications. For example, a single booster cylinder can be used to boost the working pressure of several actuating cylinders. Such an application is, for example, a punch press, in which there are several actuating cylinders at different work stages. On the other hand, the booster cylinder can

be located far from the actuating cylinder. In that case, in cranes, for example, a clearly smaller actuating cylinder can be located high among the booms, with the booster cylinder being in the lower part of the booms. This increases the effective power of the crane and improves its stability. With suitable variations, the system according to the invention can even boost the pressure led to a hydraulic motor. This will increase, for example, the efficiency of mobile equipment, as a smaller machine unit will be sufficient to produce pressure.

[0029] In addition, the system can be used to replace existing devices containing two or more actuating cylinders. Now, in the system according to the invention, the rapid travel of the actuating cylinder operates, even though a booster cylinder is available. Due to the addition power achieved by the booster cylinder, the piston diameter of the actuating cylinder can be kept advantageously small. The movement of the actuating cylinder then remains rapid and further the return movement is even more rapid. The system according to the invention is simple, fast, and fully automatic. The actuating cylinder starts to move immediately with a rapid travel and changes to a normal velocity as the resistance increases. At the same time, the velocity slows, but the power increases. Only when the resistance continues to increase the oil flows, again advantageously automatically, to the booster cylinder. The velocity of the actuating cylinder then slows again, but the power continues to increase. The boosted pressure is fed to the actuating cylinder until the resistance eases, when the actuating cylinder changes to normal velocity and then to rapid travel, if the resistance continues to ease. The system according to the invention is optimized according to power and velocity. The actuating cylinder never stops in mid-stroke, but instead automatically changes velocity and power. The use of the system also saves energy. For example, in a situation, in which a maximum pressure of 200 bar is required, it has been necessary to use a 15-kW motor. Now, with the aid of the invention, 100 bar is enough, which, if necessary, can be boosted by the booster cylinder to 200 bar and even higher. The 100-bar feed pressure is achieved using a 7,5-kW motor. At the same time, a faster, three-step movement is achieved. The features of the invention can also be exploited the other way round. An existing system can be made more powerful by equipping it with a booster cylinder and valves according to the invention. Pressure boosting is also referred to as stepping up pressure.

Claims

1. Pressurized-medium system, which includes

- a pressurized-medium source (15),
- a double-acting actuating cylinder (14), which includes a feed line (16) and a return line (17),
- a directional control valve (18) for controlling the actuating cylinder (14),
- pressurized-medium conductors (19) connected from the pressurized-medium source (15) through the directional control valve (18) to the actuating cylinder (14) and back,
- a booster cylinder (21), which is fitted between the directional control valve (18) and the actuating cylinder (14), and
- a pressure-controlled sequence valve (22) fitted between the directional control valve (18) and the booster cylinder (21) and connected to the booster cylinder (21) in such a way that, when the pressure increases in the feed line (16) of the actuating cylinder (14) over the setting value of the pressure-controlled sequence valve (22), changes its position, feeding the pressurized medium to the booster cylinder (21) and from there to the actuating cylinder (14), in order to increase the operating power of the actuating cylinder (14) automatically,
- a pressure-controlled check valve (35) arranged in the feed line (16) to prevent the increased pressure from escaping to the feed line (16) when the pressure-controlled sequence valve (22) has changed its position,
- a pressure-controlled rapid-travel valve (20), which is arranged between the directional control valve (18) and the actuating cylinder (14) for recirculating the pressurized medium from the return line (17) of the actuating cylinder (14) to the feed line (16) in order to increase the work velocity, in such a way that, together with the pressure-controlled sequence valve (22) and the booster cylinder (21), three velocity and power ranges (P1, P2, P3) are formed in the pressurized-medium system, **characterized in that** :

  - the pressure-controlled check valve (35) is located between the double-acting cylinder (14) and the pressure-controlled rapid-travel valve (20);
  - the pressure-controlled rapid-travel valve (20) the pressure-controlled sequence valve (22) and the pressure-controlled check valve (35) are arranged in the same valve block (23);
  - the directions of the work strokes of the actuating cylinder (14) and the booster cylinder (21) are arranged to be opposite to each other; and **in that**
  - the actuating cylinder (14) and the booster cylinder (21) are arranged essentially parallel to each other and are attached to each other.

2. Pressurized-medium system according to Claim 1 **characterized in that** the directional control valve

(18) includes control that is implemented manually or using an operating device.

3. Pressurized-medium system according to any of Claims 1-2 **characterized in that** the setting value of the pressure-controlled sequence valve (22) is set to be 5 - 20 %, preferably 10 - 15 % lower than the maximum pressure of the pressurized-medium source (15).

4. Pressurized-medium system according to any of Claims 1-3, **characterized in that** the valve block (23) is supported on, or integrated in the booster cylinder (21).

5. Pressurized-medium system according to any of Claims 1-4, **characterized in that** the actuating cylinder (14) is thick walled.

6. Pressurized-medium system according to any of Claims 1-5, **characterized in that** the booster cylinder (21) is formed of a low-pressure part (28) and a high-pressure part (29), which are joined end-to-end by an intermediate piece (30) as an extension of each other.

7. Pressurized-medium system according to Claim 6, **characterized in that** the low-pressure part (28) includes a piston (31), which is equipped with a piston rod (32), which is sealed to the intermediate piece (30), and which is arranged functionally as the piston of the high-pressure part (29).

8. Hydraulic splitter, which includes a body (10) and a splitting wedge (12) in it, as well as a ram (11), in order to operate which the hydraulic splitter includes a pressurized-medium system, **characterized in that** the pressurized-medium system is according to any of Claims 1-7.

9. Hydraulic splitter according to Claim 8, **characterized in that** the actuating cylinder (14) and booster cylinder (21) belonging to the pressurized-medium system are attached to each other and arranged inside the ram (11).

Patentansprüche

1. Ein Druckmittelsystem, zu dem gehören

   - eine Druckmittelquelle (15),
   - ein doppeltwirkender Steuerzylinder (14), zu dem eine Zulaufleitung (16) und eine Rücklaufleitung (17) gehören,
   - ein Wegeventil (18) zur Regelung des Steuerzylinders (14),
   - Druckmittelleitungen (19) verbunden von einer Druckmittelquelle (15) über ein Wegeventil (18) zu einem Steuerzylinder (14) und zurück,
   - ein Druckverstärkungszylinder (21), der zwischen dem Wegeventil (18) und dem Steuerzylinder (14) angeordnet ist, und
   - ein zwischen dem Wegeventil (18) und dem Druckverstärkungszylinder (21) angeordnetes druckgesteuertes Sequenzventil (22), das mit dem Druckverstärkungsventil (21) auf der Weise verbunden ist, dass es (das Sequenzventil) bei einem Druckanstieg in der Zulaufleitung (16) des Steuerzylinders (14) über den Einstellwert des druckgesteuerten Sequenzventils (22) seine Position ändert und Druckmittel in den Druckverstärkungszylinder (21) einführt und von dort weiter zum Steuerzylinder (14), um dessen Betriebsleistung automatisch zu erhöhen,
   - ein in der Zulaufleitung (16) angeordnetes druckgesteuertes Rückschlagventil (35) zur Vermeidung eines Entweichens des erhöhten Druck in die Zulaufleitung (16), wenn das druckgesteuerte Sequenzventil (22) seine Position geändert hat,
   - ein druckgesteuertes schnelles Stellventil (20), das zwischen dem Wegeventil (18) und dem Steuerzylinder (14) angeordnet ist, zur Rückführung des Druckmittels von der Rücklaufleitung (17) des Steuerzylinders (14) zur Zulaufleitung (16), um die Arbeitsgeschwindigkeit auf der Weise zu erhöhen, dass zusammen mit dem druckgesteuerten Sequenzventil (22) und dem Druckverstärkungszylinder (21) drei Geschwindigkeits- und Leistungsbereiche (P1, P2, P3) im Druckmittelsystem gebildet werden,

   dadurch gekennzeichnet, dass

   - das druckgesteuerte Rückschlagventil (35) zwischen dem doppeltwirkenden Steuerzylinder (14) und dem druckgesteuerten schnellen Stellventil (20) angeordnet ist,
   - das druckgesteuerte schnelle Stellventil (20), das druckgesteuerte Sequenzventil (22) und das druckgesteuerte Rückschlagventil (35) im selben Ventilblock (23) angeordnet sind,
   - die Richtungen der Arbeitsbewegungen vom Steuerzylinder (14) und Druckverstärkungszylinder (21) einander entgegengesetzt angelegt sind; und dass
   - der Steuerzylinder (14) und der Druckverstärkungszylinder (21) wesentlich parallel zueinander angeordnet sind und miteinander befestigt sind.

2. Druckmittelsystem gemäß dem Patentanspruch 1, **dadurch gekennzeichnet, dass** zum Wegeventil (18) eine manuelle Steuerung oder eine Steuerung mit Stellantrieb gehören.

3. Druckmittelsystem gemäß einem der Patentansprüche 1 - 2, **dadurch gekennzeichnet, dass** der Einstellwert des druckgesteuerten Sequenzventils (22) um 5 - 20%, vorzugsweise um 10 - 15% niedriger eingestellt ist als der Maximaldruck der Druckmittelquelle (15).

4. Druckmittelsystem gemäß einem der Patentansprüche 1 - 3, **dadurch gekennzeichnet, dass** der Ventilblock (23) am Druckverstärkungszylinder (21) gestützt oder in ihm integriert ist.

5. Druckmittelsystem gemäß einem der Patentansprüche 1 - 4, **dadurch gekennzeichnet, dass** der Steuerzylinder (14) dickwandig ist.

6. Druckmittelsystem gemäß einem der Patentansprüche 1 - 5, **dadurch gekennzeichnet, dass** der Druckverstärkungszylinder (21) aus einem Niederdruckteil (28) und einem Hochdruckteil (29) besteht, die mit Hilfe eines Zwischenstücks (30) an ihren Enden einander als Verlängerung verbunden sind.

7. Druckmittelsystem gemäß dem Patentanspruch 6, **dadurch gekennzeichnet, dass** zum Niederdruckteil (28) ein Kolben (31) gehört, der mit einer Kolbenstange (32) ausgerüstet ist, die an dem Zwischenstück (30) abgedichtet ist und die als funktionaler Kolben am Hochdruckteil (29) angeordnet ist.

8. Ein Hydraulikspalter, zu dem ein Rahmen (10) und darin eine Spaltklinge (12) sowie ein Stoßschlitten (11) gehören, um diesen in dem Hydraulikspalter einzusetzen, gehört dazu ein Druckmittelsystem, **dadurch gekennzeichnet, dass** das Druckmittelsystem einem der Patentansprüche 1 - 7 entspricht.

9. Ein Hydraulikspalter gemäß dem Patentanspruch 8, **dadurch gekennzeichnet, dass** der zum Druckmittelsystem gehörende Steuerzylinder (14) und der Druckverstärkungszylinder (21) miteinander verbunden sind und im Stoßschlitten (11) angeordnet sind.

Revendications

1. Système à fluide pressurisé, qui comprend

- une source de fluide pressurisé (15),
- un vérin d'actionnement à double effet (14), qui comprend une conduite d'alimentation (16) et une conduite de retour (17),
- une vanne de commande directionnelle (18) pour le contrôle du vérin d'actionnement (14),
- des conducteurs pour le fluide pressurisé (19) reliés depuis la source de fluide pressurisé (15) via la vanne de commande directionnelle (18) au vérin d'actionnement (14) et dans le sens inverse,
- un cylindre multiplicateur de pression (21), qui est disposé entre la vanne de commande directionnelle (18) et le vérin d'actionnement (14), et
- une soupape de séquence commandée par pression (22) disposée entre la vanne de commande directionnelle (18) et le cylindre multiplicateur (21) et reliée au cylindre multiplicateur (21) de sorte que, lorsque la pression dans la conduite d'alimentation (16) du vérin d'actionnement (14) dépasse la valeur de réglage de la soupape de séquence commandée par pression (22), elle change sa position, fournissant le fluide pressurisé au cylindre multiplicateur (21) et de là au vérin d'actionnement (14), pour augmenter automatiquement la puissance de fonctionnement du vérin d'actionnement (14),
- un clapet anti-retour commandé par pression (35) disposé dans la conduite d'alimentation (16) pour éviter que la pression augmentée ne s'échappe dans la conduite d'alimentation (16) quand la soupape de séquence commandée par pression (22) a changé de position,
- une soupape rapide commandée par pression (20), qui est disposée entre la vanne de commande directionnelle (18) et le vérin d'actionnement (14) pour recirculer le fluide pressurisé depuis la conduite de retour (17) du vérin d'actionnement (14) à la conduite d'alimentation (16) pour augmenter la vitesse de travail, de sorte qu'en combinaison avec la soupape de séquence commandée par pression (22) et le cylindre multiplicateur (21) trois gammes de vitesse et de puissance (P1, P2, P3) sont formées dans le système à fluide pressurisé,

caractérisé en ce que :

- le clapet anti-retour commandé par pression (35) est situé entre le vérin à double effet (14) et la soupape rapide commandée par pression (20);
- la soupape rapide commandée par pression (20), la soupape de séquence commandée par pression (22) et le clapet anti-retour commandé par pression (35) sont disposés dans le même bloc de soupapes (23);
- les sens des courses de travail du vérin d'actionnement (14) et du cylindre multiplicateur (21) sont disposés de sorte qu'ils soient opposés l'un à l'autre ; et **en ce que**
- le vérin d'actionnement (14) et le cylindre multiplicateur (21) sont disposés essentiellement parallèles l'un à l'autre et sont attachés l'un à l'autre.

2. Système à fluide pressurisé selon la revendication

1, **caractérisé en ce que** la vanne de commande directionnelle (18) comprend une commande réalisée manuellement ou à l'aide d'un actionneur.

3. Système à fluide pressurisé selon l'une quelconque des revendications 1 à 2, **caractérisé en ce que** la valeur de réglage de la soupape de séquence commandée par pression (22) est réglée de sorte à être de 5 à 20 %, de préférence de 10 à 15 % inférieure à la pression maximale de la source du fluide pressurisé (15).

4. Système à fluide pressurisé selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le bloc de soupapes (23) est soutenu par ou intégré dans le cylindre multiplicateur (21).

5. Système à fluide pressurisé selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** le vérin d'actionnement (14) est muni de parois épaisses.

6. Système à fluide pressurisé selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** le cylindre multiplicateur (21) est composé d'une partie à basse pression (28) et d'une partie à haute pression (29) qui sont rattachées bout à bout l'une dans le prolongement de l'autre à l'aide d'une pièce intermédiaire (30).

7. Système à fluide pressurisé selon la revendication 6, **caractérisé en ce que** la partie à basse pression (28) comprend un piston (31), qui est équipé d'une tige de piston (32) scellée à la pièce intermédiaire (30), et qui est agencé du point de vue fonctionnel en tant que piston de la partie à haute pression (29).

8. Fendeuse hydraulique, qui comprend un châssis (10) et un coin de fendage (12) dans celui-ci, ainsi qu'un poussoir (11), pour l'utilisation duquel la fendeuse hydraulique comprend un système à fluide pressurisé, **caractérisée en ce que** le système à fluide pressurisé est selon l'une quelconque des revendications 1 à 7.

9. Fendeuse hydraulique selon la revendication 8, **caractérisée en ce que** le vérin d'actionnement (14) et le cylindre multiplicateur (21) appartenant au système à fluide pressurisé sont attachés l'un à l'autre et disposés à l'intérieur du poussoir (11).

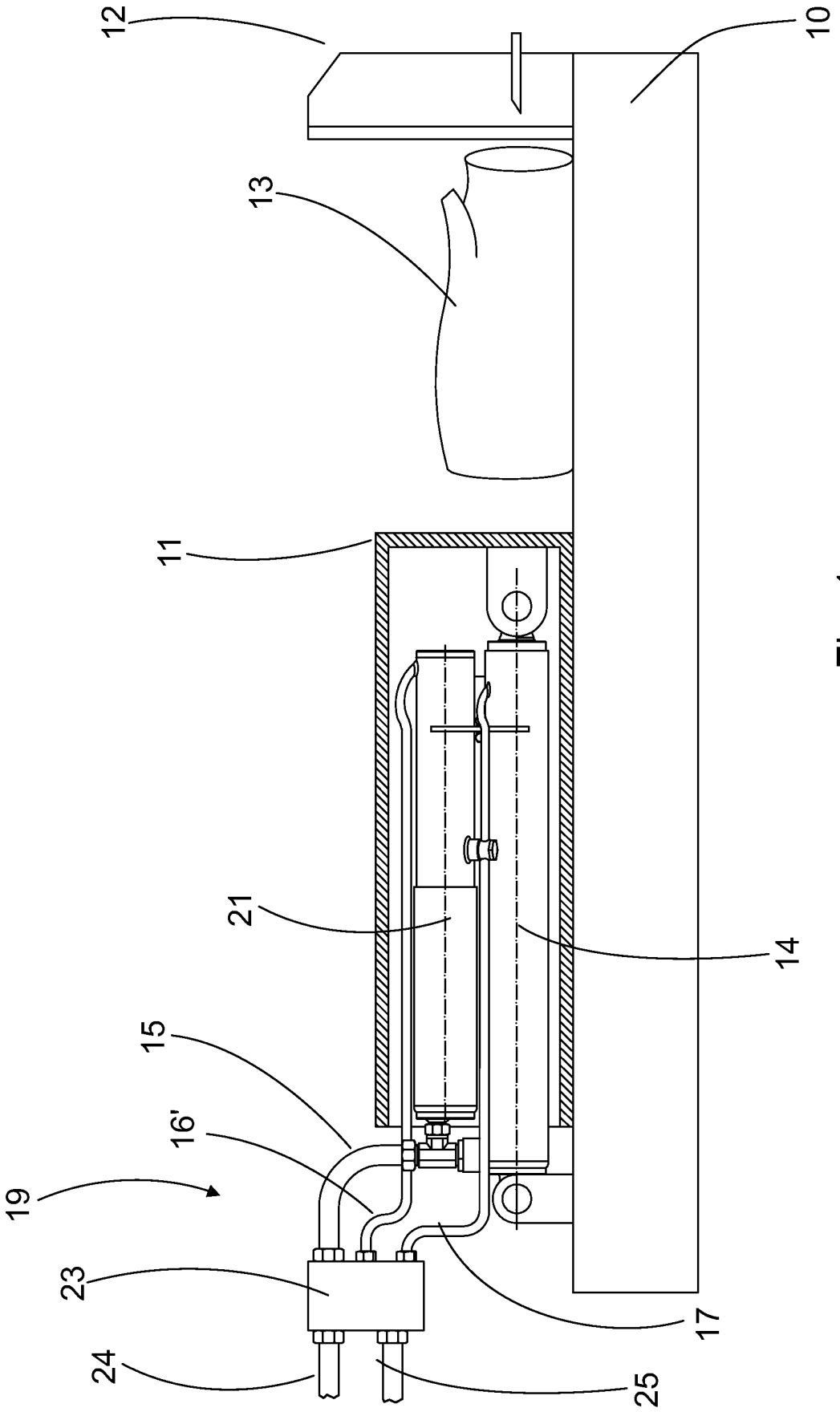


Fig. 1

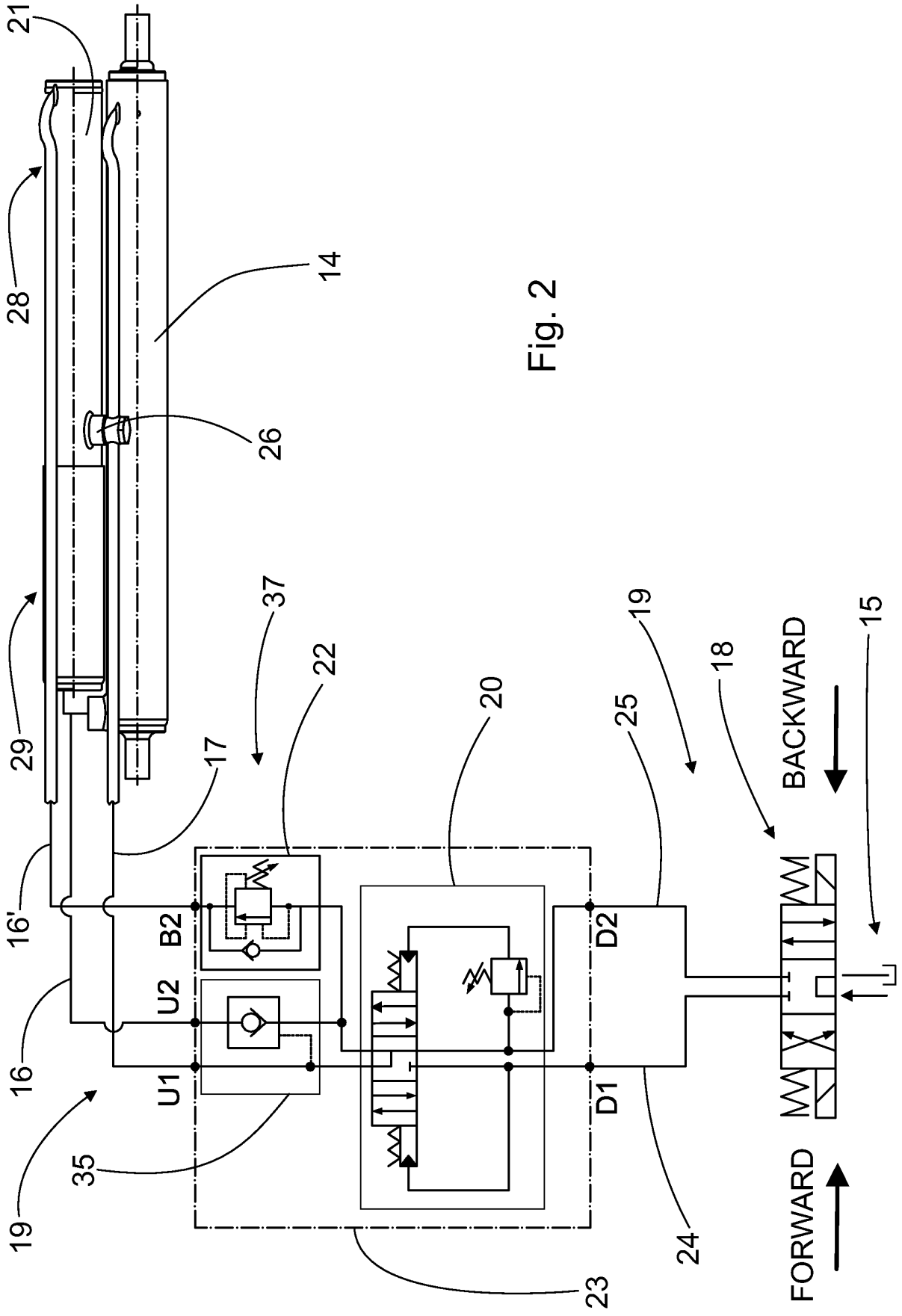

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Fig. 2

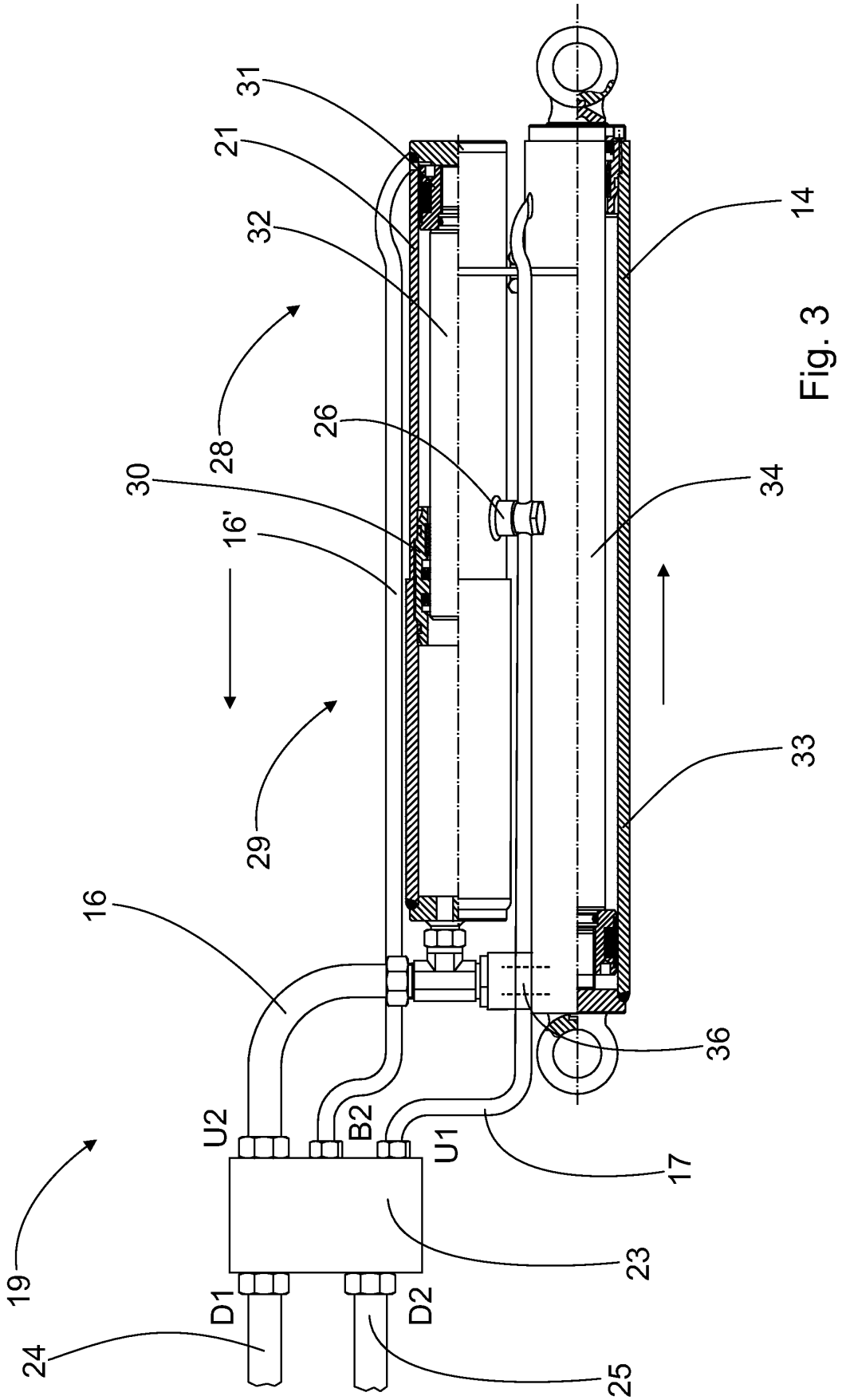


Fig. 3

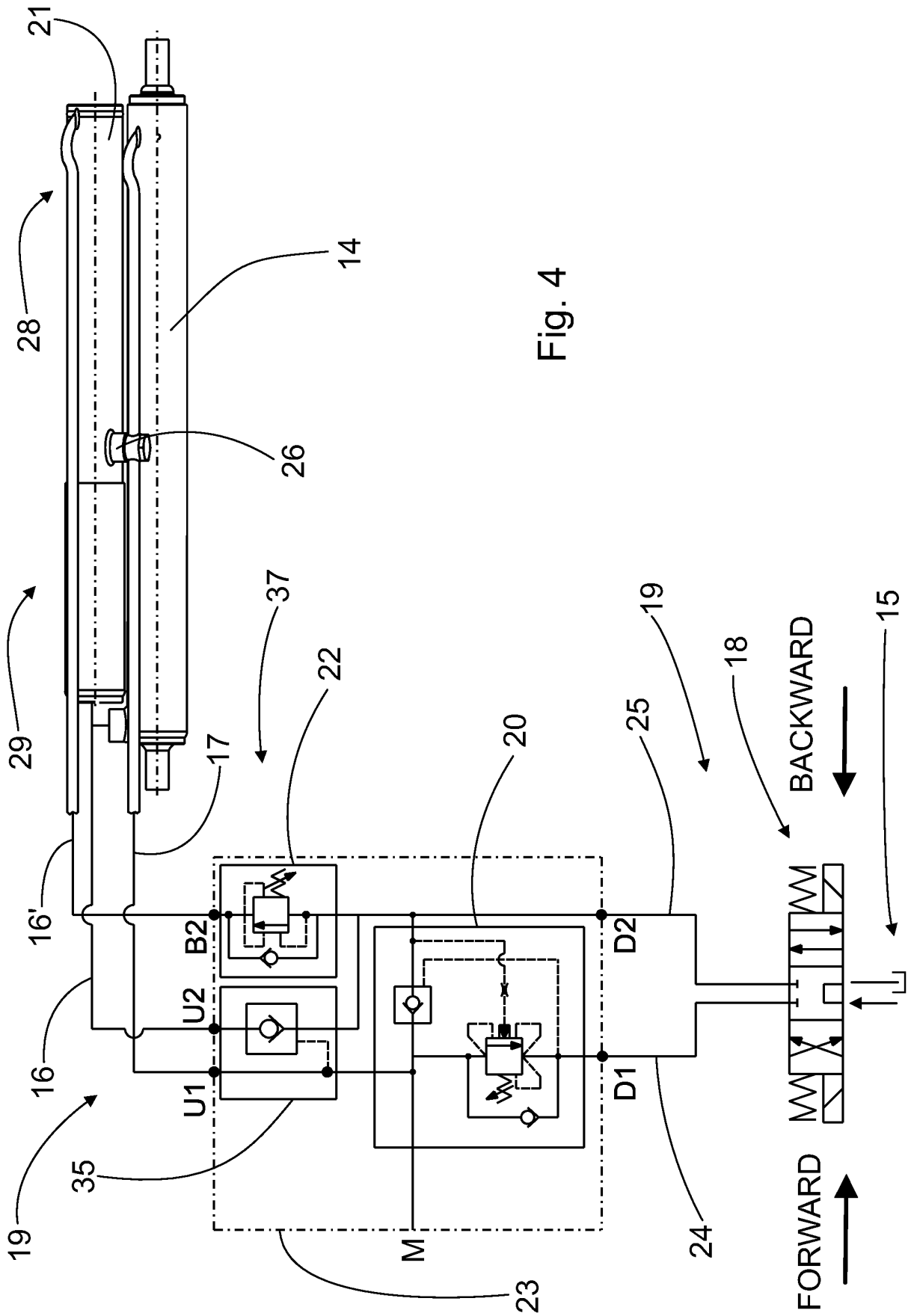

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Fig. 4

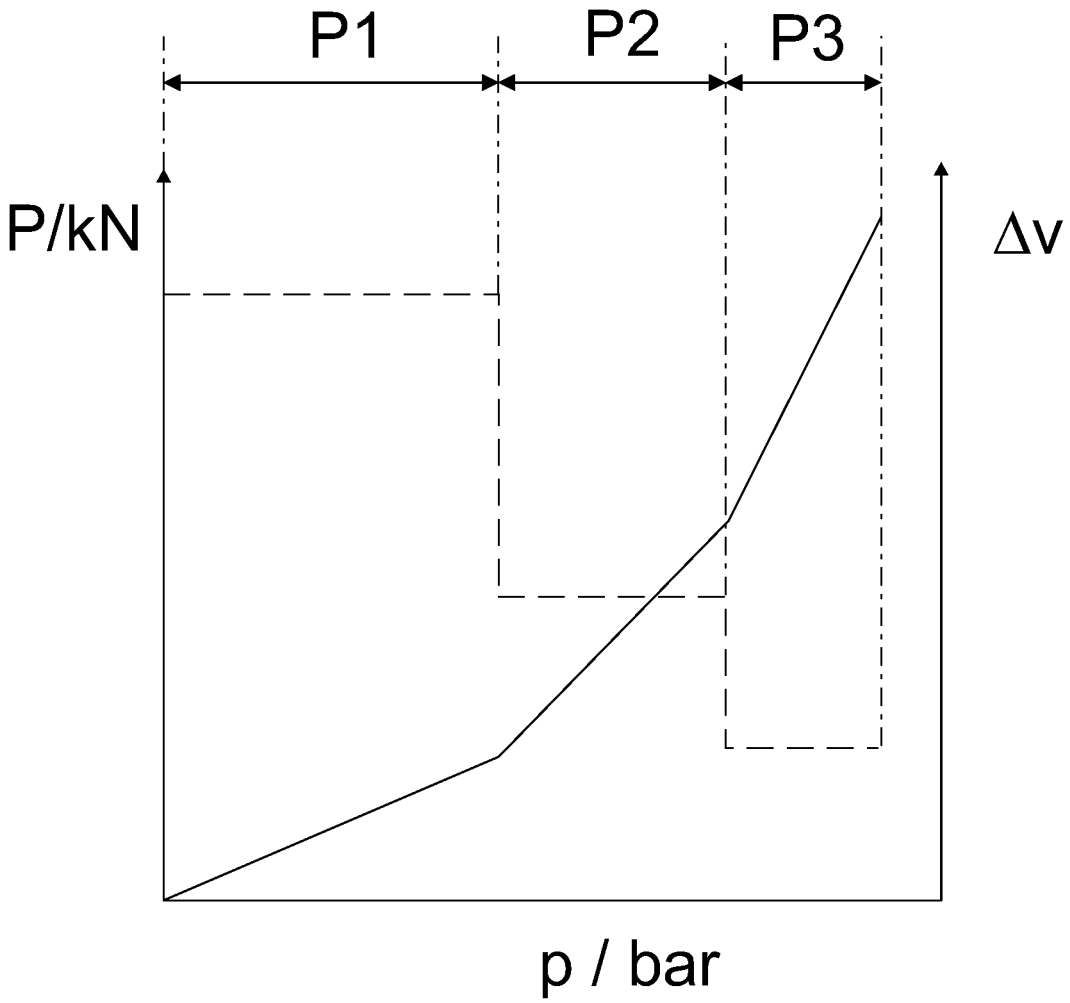


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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