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(54) **DEVICE FOR SEQUENTIAL OPERATION OF TWO OR MORE CYLINDERS**

(57) The present invention regards a device for sequential operation of two or more cylinders, comprising:
a first conduit (2), provided with a first branch (21), designed to be connected to a chamber of a first cylinder (10), and a second branch (22), designed to be connected to a chamber of a second cylinder (10);
a second conduit (3), provided with a first branch (31), designed to be connected to the other chamber of the first cylinder (10), and a second branch (32), designed to be connected to the other chamber of the second cylinder (11);
a first control valve (4), arranged along the second branch (22) of the first conduit (2), which is movable between an opening configuration, in which it allows flow along the second branch (22) of the first conduit (2), and a closing configuration, in which it prevents the flow along the second branch (22) of the first conduit (2);
an adjustment element (53), arranged along the first branch (31) of the second conduit (3), which is configured in such a way so as to allow an exhaust flow from the other chamber of said first cylinder (10) towards said second conduit (3) if the pressure in said other chamber of said first cylinder (10) exceeds a predetermined value and to prevent flow in the opposite direction;
a control valve (52), preferably a check valve, which is positioned parallel to said regulating element (53) and is configured so as to allow a flow towards said other chamber of said first cylinder (10) in case the pressure in said first branch (31) in the portion facing said other chamber of said first cylinder (10) is lower than the pressure in the remaining part of said first branch (31) and to prevent the flow in the opposite direction;
a first pilot conduit (41), which connects the first control valve (4) and the first branch (31) of the second conduit

(3) at an intermediate point between the connection to the first cylinder (10) and the adjustment element (53), and pilots the control valve (4) towards the closed configuration.

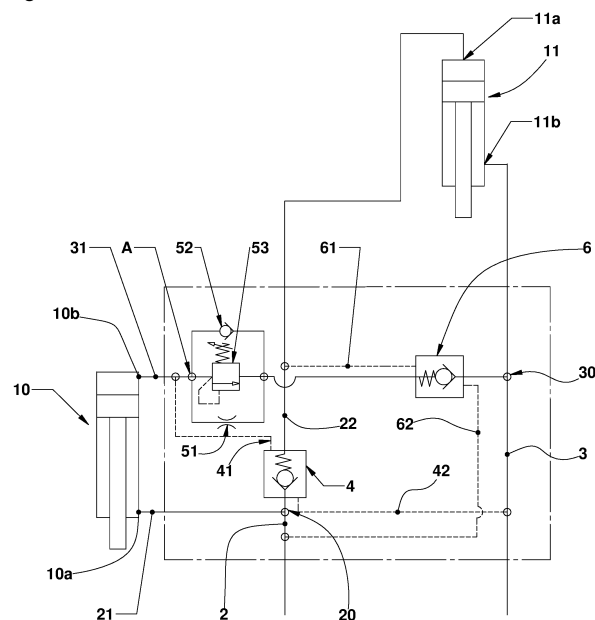


Fig. 1

Description

TECHNICAL FIELD

[0001] The present invention regards a device for sequential operation of two or more cylinders.

BACKGROUND

[0002] Operational examples in which it is necessary to operate two cylinders in sequence are represented by the control of the stabilizing feet of an operating vehicle or the operation in sequence of the extensions of the arms of cranes, for which it is required that the extension occurs according to a predetermined sequence.

[0003] Currently, there are systems on the market that use cylinders with special internal grooves through which this movement can be obtained. There is also another system that involves the use of valves called "mechanical end-strokes" that activate the supply valves to the various cylinders or extensions in succession. Mechanical limit switches are components whose cost is not negligible, and moreover they are not free from failures and damages. Alternatively, it is possible to use feeding circuits equipped with sequence valves that are designed to allow the feeding in succession of the different extensions when a certain pressure is exceeded. However, the use of such feed circuits requires a considerable expenditure of energy, which is necessary to overcome the calibration values of the sequence valves.

[0004] The purpose of the present invention is to provide a device for sequentially actuating two or more cylinders that overcomes the drawbacks of currently available devices.

SUMMARY

[0005] The present invention relates to a control system according to the features listed in claim 1.

[0006] An advantage of the device according to the present invention is that it is fully automatic, and thus does not require manual intervention by an operator.

[0007] Another advantage of the device according to the present invention is to be precise and reliable, always allowing the activation of the cylinders in the predetermined sequence.

[0008] Another advantage of the device according to the present invention is to greatly reduce the required energy expenditure.

[0009] A further advantage of the device according to the present invention is to allow reverse activation of the cylinders, again automatically.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The present invention will be described with reference to the appended figures in which the same numbers and/or reference marks indicate the same and/or

similar and/or corresponding parts of the system.

Figure 1 shows a schematic view of a device for sequentially actuating two or more cylinders according to a particular embodiment of the present invention

Figure 2 shows schematically a device for sequentially actuating multiple cylinders according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0011] Hereinafter, the present invention is described by reference to particular forms of embodiments as illustrated in the accompanying drawing plates. However, the present invention is not limited to the particular forms of embodiment described in the following detailed description and depicted in the figures, but rather the described forms of embodiment merely exemplify the various aspects of the present invention, the scope of which is defined by the claims. Further modifications and variations of the present invention will be apparent to the person skilled in the art.

[0012] Figure 1 shows the device according to the present invention used for sequential actuation of a first cylinder 10 and a second cylinder 11. The device may also be used for actuating more cylinders, as shown in Figure 2.

[0013] The device for sequentially actuating two or more cylinders according to the present invention comprises a first conduit 2 having a first branch 21 arranged to be connected to a chamber of a first cylinder 10 at a connection 10a. The first conduit 2 further includes a second branch 22, arranged to be connected to a chamber of a second cylinder 11 at a connection 11a. In the embodiment depicted, the first branch 21 is connected to the chamber of the first cylinder 10 which, when energized, produces piston re-entry, while the second branch 22 is connected to the chamber of the second cylinder 11 which, when energized, produces piston exit. A reverse connection would of course be possible, or a connection in which both branches 21, 22 are connected to the piston exit or re-entry chamber.

[0014] The device further comprises a second conduit 3 having a first branch 31 arranged to be connected to the other chamber of the first cylinder 10 at a connection 11a. The second conduit 3 further includes a second branch 32, arranged to be connected to the other chamber of the second cylinder 11 at a connection 11b.

[0015] In the embodiment shown, the first branch 31 is connected to the chamber of the first cylinder 10 which, when energized, produces the piston exit, while the second branch 32 is connected to the chamber of the second cylinder 11 which, when energized, produces the piston re-entry. A reverse connection would of course be possible, or a connection in which both branches 31, 32 are connected to the piston exit or re-entry chambers. In any case, the first branch 21 of the first conduit 2 and the first

branch 31 of the second conduit 3 are each connected to a chamber of the first piston 10, while the second branch 22 of the first conduit 2 and the second branch 32 of the second conduit 3 are each connected to a chamber of the second piston 10.

[0016] The device includes a first control valve 4 disposed along the second branch 22 of the first conduit 2. In a known manner, the control valve 4 is provided with a poppet, which is movable between an open position, in which it allows fluid to flow, and a closed position, in which it prevents fluid from flowing. When the poppet is in the open position, the control valve 4 assumes an open configuration, while, when the poppet is in the closed position, the control valve 4 assumes a closed configuration.

[0017] The first control valve 4 is therefore movable between an open configuration, in which it allows flow along the second branch 22 of the first conduit 2, and a closed configuration, in which it prevents flow along the second branch 22 of the first conduit 2.

[0018] An adjustment element 53 is disposed along the first branch 31 of the second conduit 3. The control element 53 is configured to allow a discharge flow from the other chamber of the first cylinder 10 into the second conduit 3 if the pressure in the other chamber of the first cylinder 10 exceeds a predetermined value. In particular, according to a particular embodiment of the present invention, the control element 53 is a pressure control valve, which is configured to allow a discharge flow from the other chamber of the first cylinder 10 if the pressure in the other chamber of the first cylinder 10 exceeds a predetermined value and to close the passage in the direction opposite to the discharge direction.

[0019] A control valve 52, preferably a check valve, is arranged parallel to the control element 53 and is configured to allow a flow to the other chamber of the first cylinder 10 if the pressure in the first branch 31 in the portion facing the other chamber of the first cylinder 10 (in the portion between the control element 53 and the connection 10b) is less than the pressure in the remaining portion of the first branch 31 and to prevent flow in the opposite direction.

[0020] A restriction 51 is also arranged parallel to the regulating element 53 so as to allow the pressure trapped between the restriction 51 and the other chamber of the first cylinder 10 to be discharged to the second conduit 3.

[0021] A first pilot conduit 41 connects the first control valve 4 and the first branch 31 of the second conduit, at an intermediate point A between the connection 10b to the first cylinder 10 and the control element 53. The first pilot conduit 41 drives the control valve 4 towards the closing configuration. In other words, the first pilot conduit 41 is connected to the first control valve 4 such that the pressure present in the first pilot conduit 41 exerts a thrust that tends to drive the poppet of the first control valve 4 toward the closed position, and thus toward the closed configuration of the first control valve 4.

[0022] The device according to the present invention

allows the cylinders 10, 11 to be activated sequentially in the following manner. Consider supplying pressurized fluid to the first conduit 2. The fluid, through the first branch 21 of the first conduit 2, feeds the chamber of the first cylinder 10 through the connection 10a, producing piston re-entry. The fluid contained in the other chamber of the first cylinder 10 discharges to the second conduit 3 through the first branch 31 of the second conduit 3, passing through the regulating element 53. The presence of the regulating element 53 provides a pressure in the first pilot conduit 41 that keeps the first control valve 4 in a closed configuration, so that the fluid cannot transit along the second branch of the first conduit 2 and cannot supply the second cylinder 11, which consequently remains inactive.

[0023] When the stem of the first cylinder 10 reaches an end position in retraction, the flow along the first branch 31 of the second conduit 3 ceases, and consequently the pressure in the first pilot conduit 41 decreases. Under such conditions, the control element 53 closes (the remaining pressure output is provided by the restriction 51) and the first control valve 4 moves into an open configuration, allowing flow along the second branch 22 of the first conduit 2 and, thus, feeding the second cylinder 11 which is activated subsequent to the first cylinder 10.

[0024] Advantageously, the device according to the present invention includes a second control valve 6 disposed along the first branch 31 between the control member 53 and the first conduit 3. In a known manner, the second control valve 6 is also provided with a poppet, movable between an open position, in which it allows the passage of fluid, and a closed position, in which it prevents the passage of fluid. When the shutter is in the open position, the control valve 6 assumes an open configuration, while, when the shutter is in the closed position, the control valve 6 assumes a closed configuration.

[0025] The second control valve 6 is then movable between an open configuration, in which it allows flow along the first branch 31 of the second conduit 3, and a closed configuration, in which it prevents flow along the first branch 31 of the second conduit 3.

[0026] A second pilot conduit 61 is provided to connect the second control valve 6 to the second branch 22 of the first conduit 2. The second pilot conduit 61 drives the second control valve 6 toward the closing configuration. In other words, the second pilot conduit 61 is connected to the second control valve 6 such that the pressure present in the second pilot conduit 61 exerts a thrust that tends to drive the poppet of the second control valve 6 toward the closed position, and thus toward the closed configuration of the second control valve 6.

[0027] A fourth pilot conduit 62 is also provided that connects the second control valve 6 to the second conduit 2. The fourth pilot conduit 62 drives the second control valve 6 toward an open configuration. In other words, the fourth pilot conduit 62 is connected to the second control valve 6 such that the pressure present in the fourth pilot

conduit 62 exerts a thrust that tends to drive the poppet of the second control valve 6 toward the open position, and thus toward the open configuration of the second control valve 6.

[0028] The fourth pilot conduit 62 allows the second control valve 6 to remain open to allow flow along the first branch 31 of the second conduit 3 out of the first cylinder 10. In essence, when pressurized fluid is fed to the first conduit 2, the pressure in the fourth pilot conduit 62 increases, moving the second control valve 6 to the open position.

[0029] Similarly, the second branch 32 of the second conduit 3 of a first cylinder 10 and connected to the second conduit 3 of a second cylinder 11, the second branch 32 of the second conduit 3 of the second cylinder 11 and connected to the second conduit 3 of a third cylinder 12, and cos1 so on.

[0030] The second control valve 6 allows the cylinders 10, 11 to be sequentially activated also for inverse movements to those described above, as follows. With the first cylinder 10 in the retracted position and the second cylinder 11 in the extended position, consider feeding pressurized fluid to the second conduit 3. The fluid feeds the chamber of the second cylinder 11 which activates the reentry of the piston. The fluid contained in the other chamber of the second cylinder 11 discharges through the second branch 22 of the first conduit 2 producing a pressure increase in the second pilot conduit 61. The pressure in the second pilot conduit 61 keeps the second control valve in a closed configuration, so that fluid cannot flow along the first branch of the second conduit 3 and thus cannot feed the first cylinder 10, which remains inactive.

[0031] The discharge of oil through the second branch 22 of the first conduit 2 is allowed by the first control valve 4 being driven open through a third pilot conduit 42, which connects the first control valve 4 to the second conduit 3. In other words, the third pilot conduit 42 is connected to the first control valve 4 such that the pressure present in the third pilot conduit 42 exerts a thrust that tends to drive the poppet of the first control valve 4 toward the open position, and thus toward the open configuration of the second control valve 4.

[0032] When the second cylinder 11 reaches the inner limit switch, the flow rate along the second branch 22 of the first conduit 2 is cancelled. This results in a drop in pressure in the second pilot conduit 61, and the consequent opening of the second control valve 6, which allows for the passage of the operator fluid and activation of the first cylinder 10.

[0033] Although the present invention has been described with reference to the forms of embodiment described above, it is clear to the skilled person in the art that various modifications, variations and improvements of the present invention are possible in light of the teaching described above and within the scope of the appended claims, without departing from the subject matter and scope of protection of the invention.

[0034] Finally, those areas that are believed to be known by those skilled in the art have not been described in order to avoid unduly overshadowing the described invention in an unnecessary manner.

[0035] Accordingly, the invention is not limited to the forms of embodiment described above, but is only limited by the scope of protection of the appended claims.

Claims

1. Device for sequential operation of two or more cylinders, comprising:

a first conduit (2), provided with a first branch (21), designed to be connected to a chamber of a first cylinder (10), and a second branch (22), designed to be connected to a chamber of a second cylinder (10);

a second conduit (3), provided with a first branch (31), designed to be connected to the other chamber of the first cylinder (10), and a second branch (32), designed to be connected to the other chamber of the second cylinder (11);

a first control valve (4), arranged along the second branch (22) of the first conduit (2), which is movable between an opening configuration, in which it allows flow along the second branch (22) of the first conduit (2), and a closing configuration, in which it prevents the flow along the second branch (22) of the first conduit (2);

an adjustment element (53), arranged along the first branch (31) of the second conduit (3), which is configured in such a way so as to allow an exhaust flow from the other chamber of said first cylinder (10) towards said second conduit (3) if the pressure in said other chamber of said first cylinder (10) exceeds a predetermined value and to prevent flow in the opposite direction;

a control valve (52), preferably a check valve, which is positioned parallel to said regulating element (53) and is configured so as to allow a flow towards said other chamber of said first cylinder (10) in case the pressure in said first branch (31) in the portion facing said other chamber of said first cylinder (10) is lower than the pressure in the remaining part of said first branch (31) and to prevent the flow in the opposite direction;

a first pilot conduit (41), which connects the first control valve (4) and the first branch (31) of the second conduit (3) at an intermediate point between the connection to the first cylinder (10) and the adjustment element (53), and pilots the control valve (4) towards the closed configuration.

2. Device according to claim 1, wherein said regulating

element (53) is a pressure control valve, which is configured to allow an exhaust flow from the other chamber of said first cylinder (10) if the pressure in said other chamber of said first cylinder (10) exceeds a predetermined value and to close the passage in the direction opposite to the discharge direction. 5

3. Device according to one of claims 1 or 2, wherein said device further comprises a restriction (51), which is positioned parallel to said regulating element (53) so as to allow the discharge of the pressure trapped between said restriction (51) and said other chamber of said first cylinder (10) towards said second conduit (3). 10

4. Device according to one of claims 1 to 3, comprising a third pilot conduit (42) which connects the first control valve (4) to the second line (3) and pilots the first control valve (4) towards an opening configuration. 15

5. Device according to one of claims 1 to 4, wherein the device further comprises: 20

a second control valve (6), arranged along the first branch (31) between said regulating element (53) and said first conduit (3), which is structured to allow a direct flow from the first conduit (3) along the first branch (31); 25

a second pilot conduit (61), which connects the second control valve (6) to the second branch (22) of the first conduit (2), which pilots the second control valve (6) towards a closing configuration. 30

6. Device according to claim 5, comprising a fourth pilot conduit (62) which connects the second control valve (6) to the first conduit (2) and pilots the second control valve (6) towards an opening configuration. 35

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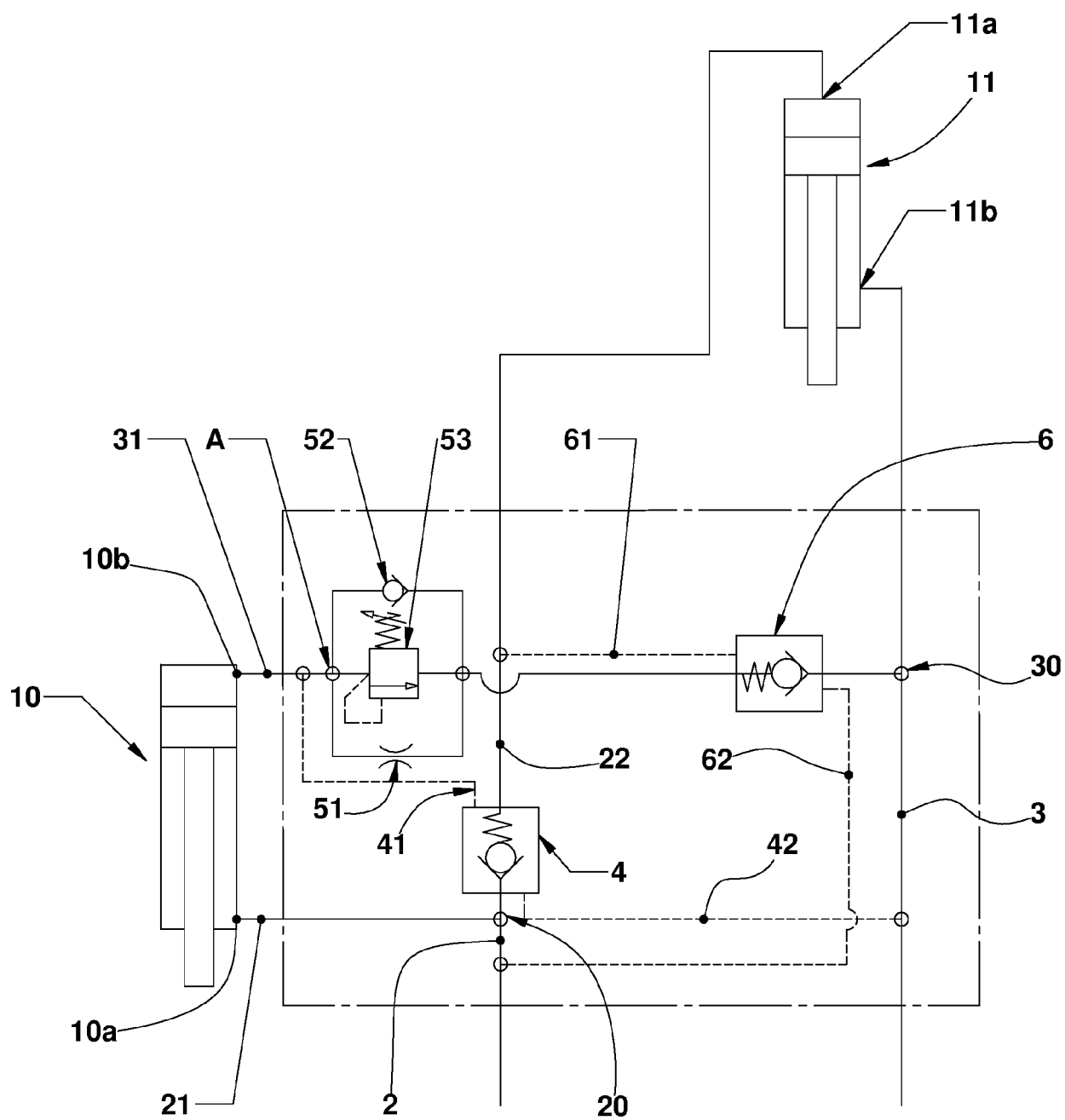


Fig. 1

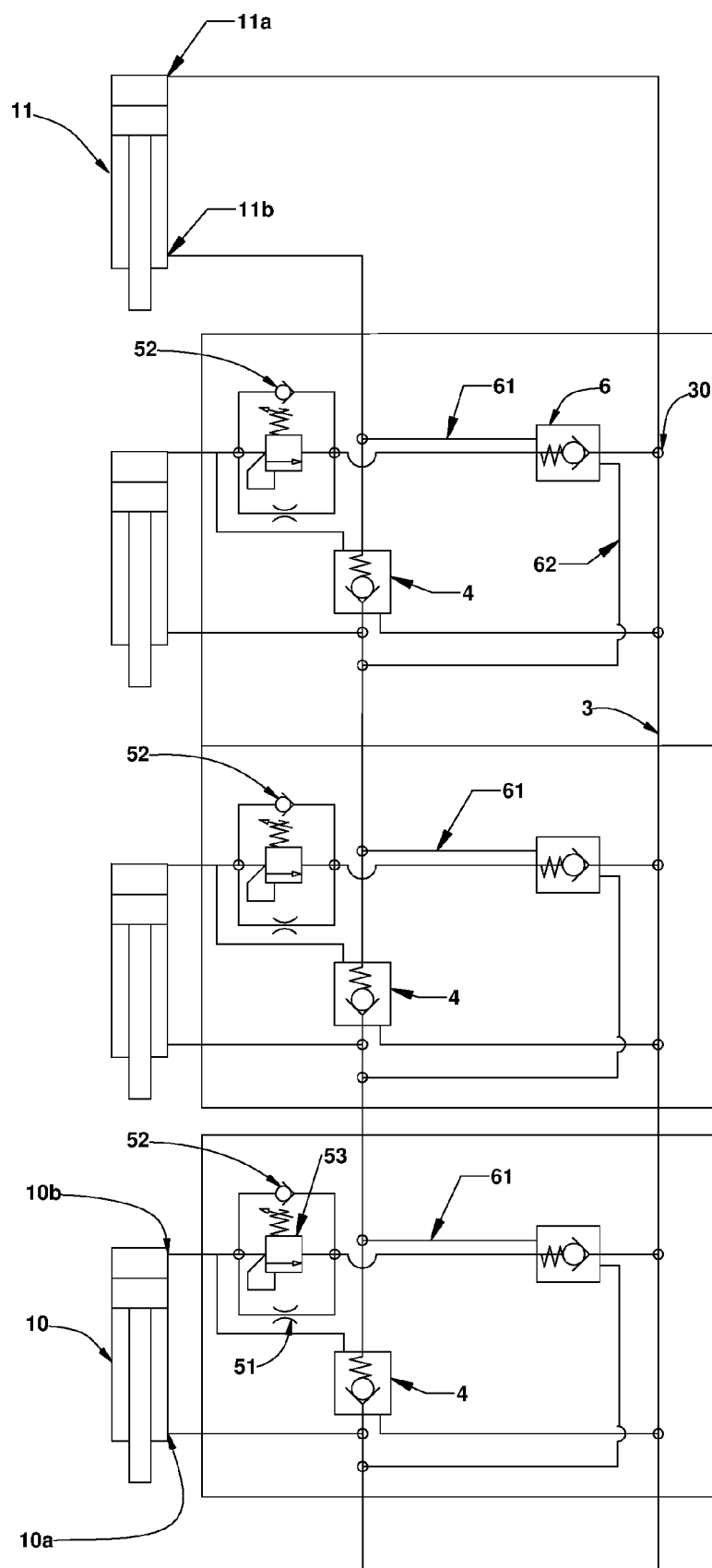


Fig. 2



EUROPEAN SEARCH REPORT

Application Number

EP 21 20 8158

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	DE 299 03 693 U1 (HOHENSTEIN VORRICHTUNGSBAU [DE]) 20 May 1999 (1999-05-20) * page 2, last paragraph - page 3 * -----	1-6	INV. F15B11/20
			TECHNICAL FIELDS SEARCHED (IPC)
			F15B

The present search report has been drawn up for all claims

1

EPO FORM 1503 03.82 (P04C01)

Place of search

Munich

Date of completion of the search

31 March 2022

Examiner

Toffolo, Olivier

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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 A : technological background
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.****EP 21 20 8158**

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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31-03-2022

10	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
15	DE 29903693	U1	20-05-1999	NONE
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