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(54) HYDRAULIC SYSTEM HOISTING AND AUTO-LEVELLING A TOOL

(57) Hydraulic system (1) for hoisting and auto-levelling a tool connected to a hoisting arm, comprising:
- a first supplying and unloading port/connection (2) and a second supplying and unloading port/connection (3) directly or indirectly connected or connectable to a storage reservoir and a pump for pressurizing a working fluid;
- a hoisting actuator group (4) connected or connectable by said hoisting arm to the tool for hoisting/lowering it, and having a first port/connection (6) for gaining access to a first chamber thereof, and a second first port/connection (7) for gaining access to a second chamber thereof;
- an aligning actuator group (5) connected or connectable to the tool and hoisting arm for holding the tool according to an orientation predefined during said hoisting/lowering steps and having a first port/connection (8) for gaining access to a first chamber thereof and a second port/connection (9) for gaining access to a second chamber thereof;
- a first flow divider (10) comprising an inlet (12), a first outlet (13) and a second outlet (14), configured to separate a flow rate entering the inlet (12) in a first and second predefined flow rates exiting the first (13) and second outlets (14), respectively;
- a second flow divider (11) comprising an inlet (21), a first outlet (22) and a second outlet (23), configured to separate a flow rate entering the inlet (21) in a first and second predefined flow rates exiting the first (22) and second outlets (23), respectively,
wherein:
- the inlet (12) of the first flow divider (10) is fluidically connected to the second port/connection (7) of the hoisting actuator group (4);
- the first outlet (13) of the first flow divider (10) is fluidically connected to the second supplying and unloading port/connection (3);
- the second outlet (14) of the first flow divider (10) is fluidically connected to the first port/connection (8) of the first aligning actuator (5);
- the inlet (21) of the second flow divider (11) is fluidically connected to the first port/connection (6) of the hoisting actuator group (4);
- the first outlet (22) of the second flow divider (11) is fluidically connected to the first supplying and unloading port/connection (2);
- the second outlet (23) of the second flow divider (11) is fluidically connected to the second port/connection (9) of the aligning actuator group (5).

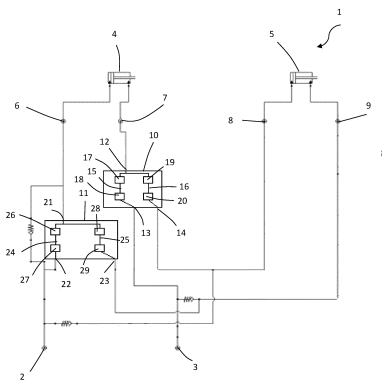

FIG. 1

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Description

Technical field of the invention

[0001] The present invention refers to a hydraulic system for hoisting and auto-levelling a tool. For example, the present invention is applied in loading and hoisting machines, which are required to hoist/lower a tool (a bucket or teeth of a shovel, for example), while maintaining it with a constant orientation from the ground, typically parallel to it, independently from the weight of the hoisted load.

[0002] Examples of machines wherein it is possible to find an application of the present system include: telehandlers, farming front-end loaders, front-end shovels, skid steer loaders, or similar.

Prior art

[0003] Different systems devised for maintaining the orientation of a tool in machines of the cited type are known.

[0004] According to a first kind, such effect is obtained by hydraulic systems wherein a slave cylinder is upwardly or downwardly dragged by a master cylinder and it pumps oil into a cylinder for orienting the tool, while maintaining the orientation of this latter. Unfortunately, these systems are difficult to be used in a medium/small sized machine.

[0005] According to a further kind, the orientation of the tool is maintained by a mechanical system, such as a four-bar linkage. Unfortunately, since these systems are bulky and heavy, they increase the overall weight of the machine and impair the field of view of an operator.

[0006] According to a further kind, the inclination is maintained by an electronic control of a dedicated cylinder commanded as a function of readings output by specific sensors.

[0007] Lastly, there are sophisticated hydraulic circuits devised for obtaining the object of holding the desired inclination of the tool. Generally, in these systems it is difficult to keep an accurate control and a correct alignment both during the hoisting step, and during the lowering step, independently from the hoisted load and/or supply flow rate.

Brief summary of the invention

[0008] Consequently, the object of the present invention consists of providing a hydraulic system for hoisting and auto-levelling a tool capable of at least partially overcoming the drawbacks of the prior art.

[0009] This and other objects are met by a hydraulic system for hoisting and auto-levelling a tool connected to a hoisting arm, comprising:

- a first supplying and unloading port/connection and a second supplying and unloading port/connection directly or indirectly connected or connectable to a storage reservoir and a pump for pressuring a working fluid;
- a hoisting actuator group connected or connectable by said hoisting arm to the tool for hoisting/lowering it, and having a first port/connection for gaining access to a first chamber thereof, and a second port/connection for gaining access to a second chamber thereof;
- an aligning actuator group connected or connectable to the tool and hoisting arm for holding the tool according to an orientation predefined during said hoisting/lowering steps and having a first port/connection for gaining access to a first chamber thereof and a second port/connection for gaining access to a second chamber thereof;
- a first flow divider comprising an inlet, a first outlet and a second outlet, configured to separate a flow rate entering the inlet in a first and second predefined flow rates exiting the first and second outlets, respectively;
- a second flow divider comprising an inlet, a first outlet and a second outlet, configured to separate a flow rate entering the inlet in a first and second predefined flow rates exiting the first and second outlets, respectively,

wherein:

- the inlet of the first flow divider is fluidically connected to the second port/connection of the hoisting actuator group;
- the first outlet of the first flow divider is fluidically connected to the second supplying and unloading port/connection;
- the second outlet of the first flow divider is fluidically connected to the first port/connection of the first aligning actuator;
- the inlet of the second flow divider is fluidically connected to the first port/connection of the hoisting actuator group;
- the first outlet of the second flow divider is fluidically connected to the first supplying and unloading port/connection;
- the second outlet of the second flow divider is fluidically connected to the second port/connection of the aligning actuator group.

[0010] Preferably, each of said first and second flow dividers comprise adjusting elements so that said first and second predefined outlet flow rates depend on the adjustments of the adjusting elements independently from the inlet flow rate. In other words, the flow dividers are configured so that the predefined outlet flow rates, which are adjustable or have an adjustable ratio for the same inlet flow rate, depend only on the adjustments of the adjusting elements themselves, and so that the ratio is held constant independently from the supplied flow rate, for example even though this latter is much lower

than the nominal flow rate value.

[0011] The dependent claims define possible advantageous embodiments of the invention.

Brief description of the drawings

[0012] In order to have a better comprehension of the invention and appreciate the advantages thereof, some exemplifying non-limiting embodiments of it will be described in the following with reference to the attached figures, wherein:

Figure 1 is a schematic illustration of a hydraulic system for hoisting and auto-levelling a tool according to a possible embodiment of the invention;

Figure 2 is a schematic illustration of a flow divider of the system of Figure 1 according to a possible embodiment of the invention.

Description of the embodiments of the invention

[0013] Referring to Figure 1, a hoisting/auto-levelling hydraulic system, implemented by a hydraulic circuit, is indicated by reference number 1. The system 1 can be for example applied to the machines discussed in the introductory part of the present description.

[0014] The system 1 comprises a first supplying and unloading port/connection 2 and a second supplying and unloading port/connection 3. The supplying and unloading ports/connections 2, 3 are preferably connected or connectable to a storage reservoir and a pump, by a group of valves or a hydraulic distributor for example (not shown in the figures), for storing, for circulating and pressurizing a pressurized working fluid in the system 1, for example a pressurized oil, which is made reference to as an example in the following description.

[0015] The system 1 comprises a first and second actuator groups. For example, such first and second actuator groups comprise a hoisting cylinder-piston group 4 and an aligning cylinder-piston group 5, preferably of the double acting type. In the present description, it is illustratively made reference to such hoisting cylinder-piston groups 4 and a hoisting cylinder-piston group 5. However, the first and second actuator groups can comprise any hydraulic and/or electronic actuating systems, for example a motor, a rotative actuator, a single acting cylinder, or similar.

[0016] The hoisting cylinder-piston group 4 is particularly adapted to hoist and lower a mechanical arm, possibly an extendable one, supporting a tool of a machine (not shown in the figures), while the aligning cylinder-piston group 5 is connected or connectable to the above cited mechanical arm and tool so that this latter can be both inclined by commands provided by an operator (for example during a loading/unloading operation) and automatically commanded during an upward/downward operation of the arm by the hoisting cylinder-piston group 4 for being maintained with a predefined orientation from the ground, for example horizontal. This implies the motions of the hoisting and aligning cylinder-piston groups 4, 5 are coordinated with each other. This also implies the speed of one is matched by an accurate speed of the other by a given ratio which is a function of the characteristics defined for the machine. Since this system is hydraulic, it is implied the pressurized fluid flow rates moving the two cylinder-piston groups can be accurately controlled and can maintain the desired values independently from the load hoisted by the tool and from the instantaneous supplying flow rate. The system according to the invention solves this drawback as it will be explained.

[0017] The hoisting cylinder-piston group 4 comprises a first port/connection 6 for gaining access to the first chamber, for example on the bottom side of the same, and a second port/connection 7 for gaining access to a second chamber, for example on the stem side of the same. The above-cited two chambers are the two portions of the varying volume cylinder, separated by the piston of the cylinder-piston group. For example, when the oil flows through the first port/connection 6 in the first chamber, the piston performs a movement hoisting the tool and, consequently, the stored oil in the second chamber flows out through the second port/connection 7. Viceversa, when the oil flows through the second port/connection 7 of the second chamber, the piston performs a movement lowering the tool and, consequently, the stored oil in the first chamber flows out through the first hydraulic port/connection 6. Obviously, it is possible to devise also an opposite arrangement, in other words so that the cited oil flows are matched by opposite motions for lowering or hoisting the tool.

[0018] The aligning cylinder-piston group 5, in turn, comprises a first port/connection 8 for gaining access to the first chamber and a second port/connection 9 for gaining access to the second chamber. The two above cited chambers are the two portions of the varying volume cylinder, separated by the piston of the cylinder-piston group. For example, when the oil flows through the first port/connection 8 of the first chamber, the piston performs a motion aligning the tool with a first direction and, consequently, the stored oil in the second chamber flows out through the second port/connection 9. Viceversa, when the oil flows through the second port/connection 9 in the second chamber, the piston performs a motion aligning the tool with a second direction (opposite to the first one) of the tool and, consequently, the stored oil in the first chamber flows out through the first port/connection 8. Obviously, also in this case an opposite arrangement can be provided, in other words the indicated oil flows are matched by aligning motions according to directions opposite to what was described.

[0019] System 1 comprises a first flow divider 10 and a second flow divider 11. As it will be described more specifically in the following, the function of the flow dividers 10 and 11 is of separating an inlet flow in two outlet flows, ensuring the ratio of the two outlet flows is constant

independently from the inlet supplying flow rate, and the outlet instantaneous flow rates remain constant independently from the hoisted load according to preset calibrations and adjustments.

[0020] The first flow divider 10 comprises an inlet 12, a first outlet 13 and a second outlet 14. Moreover, the first flow divider 10 comprises a first branch 15 connecting the inlet 12 to the first outlet 13 and a second branch 16 connecting the inlet 12 to the second outlet 14. The first branch 14 comprises an element 17 for adjusting the through opening and a compensator 18 configured so that the fluid pressure between the adjusting element 17 and compensator 18 is constantly set equal to the pressure maximum value between the two outlets 13 and 14, up to a calibration constant (corresponding to a calibration value of an elastic element of the compensator itself, as it will be described). Analogously, the second branch 16 comprises an element 19 for adjusting the through opening and a compensator 20 configured so that the fluid pressure between the adjusting element 19 and compensator 20 is constantly set equal to the pressure maximum value between the two outlets 13 and 14, up to a calibration constant (corresponding to the calibration value of an elastic element of the compensator itself, as it will be described in the following).

[0021] The second flow divider 11 has a shape analogous to the one of the first flow divider 10. Particularly, the second flow divider 11 comprises an inlet 21, a first outlet 22 and a second outlet 23. Further, the second flow divider 11 comprises a first branch 24 connecting the inlet 21 to a first outlet 22 and a second branch 25 connecting the inlet 21 to the second outlet 23. The first branch 24 comprises an element 26 for adjusting the through passage and a compensator 27 configured so that the fluid pressure between the adjusting element 26 and compensator 27 is constantly held equal to the maximum pressure value between the outlets 22 and 23, up to a calibration constant (corresponding to a calibration value of an elastic element of the compensator itself, as it will be described in the following). Analogously, the second branch 25 comprises an element 28 for adjusting the through opening and a compensator 29 configured so that the fluid pressure between the adjusting element 28 and compensator 29 is constantly held equal to a maximum pressure value between the two outlets 22 and 23, up to a calibration constant (corresponding to a calibration value of an elastic element of the compensator itself, as it will be described in the following).

[0022] Further details and possible alternative embodiments of the flow dividers 10 and 11 will be provided in the following.

[0023] The system 1 is configured so that:

- the inlet 12 of the first flow divider 10 is hydraulically connected to the second port/connection 7 of the hoisting cylinder-piston group 4;
- the first outlet 13 of the first flow divider 10 is hydraulically connected to the second supplying and unloading port/connection 3;
- the second outlet 14 of the first flow divider 10 is hydraulically connected to the first port/connection 8 of the aligning cylinder-piston group 5;
- the inlet 21 of the second flow divider 11 is hydraulically connected to the first port/connection 6 of the hoisting cylinder-piston group 4;
- the first outlet 22 of the second flow divider 11 is hydraulically connected to the first supplying and unloading port/connection 2;
- the second outlet 23 of the second flow divider 11 is hydraulically connected to the second port/connection 9 of the aligning cylinder-piston group 5.

[0024] It is observed that the system 1 is configured so that the flow dividers 10 and 11 are crossed only by the fluid flowing from the respective inlets to the respective outlets, and not the opposite. For this purpose, the system 1 can be provided with a plurality of non-return valves, illustratively shown in Figure 1. Obviously, alternative arrangements of the circuit underlying the system 1 are also possible, which result in the same effect, as it will be evident to a person skilled in the art.

[0025] Referring to the diagram in Figure 1, the ascending and descending operations will be now described.

[0026] With reference to the ascending operation, by supplying the supplying and unloading port/connection 2, the flow rate enters the first chamber of the hoisting cylinder-piston group 4 through the first port/connection 6. The flow rate exits the second chamber of the hoisting cylinder-piston group 4 through the second port/connection 7 and is divided by a preset percentage by the first flow divider 11, which distributes it between the second supplying and unloading port/connection 3 (in this case is connected to unload) and the first port/connection 8 which transfers the supply to the first chamber of the aligning cylinder/piston group 5, which will consequently maintain the same inclination of the tool from the ground.

[0027] Referring instead to the descending operation, by supplying the supplying and unloading port/connection 3, the flow rate supplies the second chamber of the hoisting cylinder-piston group 4 through the second port/connection 7.

[0028] The flow rate exits the first chamber of the hoisting cylinder-piston group 4 through the first port/connection 6 and is divided by a preset percentage by the second flow divider 11 between the first supplying and unloading port/connection 2 (in this case is connected to unload) and the second port/connection 9 which transfers the supply to the second chamber of the aligning cylinder-piston group 5, which will consequently maintain the same inclination of the tool from the ground.

[0029] Referring to Figure 2, a possible arrangement of a flow divider will be described.

[0030] According to an embodiment, the flow divider 100 comprises an inlet 112, a first outlet 113 and a second outlet 114. Moreover, the flow divider 10 comprises a first

branch 115 connecting the inlet 112 to the first outlet 113 and a second branch 116 connecting the inlet 112 to the second outlet 114. The first branch 115 comprises an element 117 for adjusting the through opening and a compensator 118 configured so that the fluid pressure between the adjusting element 117 and compensator 118 is constantly held equal to the maximum pressure value between the two outlets 113 and 114, up to a calibration constant of a first calibration elastic element 132.

[0031] Analogously, the second branch 116 comprises an element 119 for adjusting the through opening and a compensator 120 configured so that the fluid pressure between the adjusting element 119 and compensator 120 is constantly held equal to the maximum pressure value between the two outlets 113 and 114, up to a calibration constant of a second calibration elastic element 133.

[0032] According to a possible embodiment, the adjusting elements 117, 119 can comprise fixed or adjustable throttles, or proportional valves or similar, such to be capable of adjusting the through areas Ya and Yb respectively in the branches 115 and 116. Such adjustments can be performed by an operator, or automatically, as a function of the pressurized fluid flow rates which should be let flow in the first 115 and second branches 116.

[0033] Possible embodiments of the compensators 118 and 120 will be described in the following.

[0034] According to an embodiment, they comprise a first hydraulic proportional valve 121 in the first branch 115 and a second hydraulic proportional valve 122 in the second branch 116. Hydraulic proportional valves mean internally and/or externally piloted/commanded valves capable of continuously varying their opening. These proportional valves are designed so that the pressure upstream them is equal to pc between the respective branches, (wherein pc is equal to the maximum pressure between the outlets 113 and 114, which is added to the pressure pk of the calibration elastic elements 132 and 133 of the compensators themselves), independently from the two pressures pa and pb downstream them in the two branches 115 and 116 (which, in turn, depend on the users connected at the outlet, for example on the load supported by the tool).

[0035] For this purpose, it is possible to provide the following arrangement. According to an embodiment, the flow divider 100 comprises a connecting branch 123 downstream the first 121 and second proportional valves 122, hydraulically connecting the first branch 115 and second branch 116. This connecting branch 123 is provided with a three-way hydraulic valve 124 having a first inlet 126 connected to the first branch 115, a second inlet 127 connected to the second branch 116 and an outlet 128 hydraulically connected to a hydraulic pilot branch of the compensator 129 having a first end 130 so that the fluid inside it applies its pressure on the first proportional valve 121 and a second end 131 so that the fluid inside it applies its pressure on the second proportional valve 122. Moreover, on the first 121 and second proportional valves 122 respectively act the before cited first 132 and second elastic elements 133 which apply equal elastic forces on the respective proportional valve, schematically shown in Figure 2 by equivalent pressures pk. Advantageously, the three-way valve 124 is configured for keeping open the connection of the hydraulic pilot branch of the compensator 129 with the branch between the first 115 and second branches 116 of the divider 100 which is under the highest pressure condition. In other words, the three-way valve 124 is configured so that the pressure pis in the pilot branch of the compensators 129 is equal to the highest pressure between pa and pb.

[0036] Consequently, each proportional hydraulic valve 121 and 122 operate so that the pressure pc is equal to the sum of pressures pis and pk.

[0037] In this way, given an inlet flow rate Q at pressure p, the pressures in the two branches 115 and 116 upstream the proportional valves 121 and 122 are ensured to be always equal to pc. Consequently, the flow rates in the two branches Qa and Qb will depend only on the adjustments Ya and Yb of the adjusting elements 117 and 119, independently from the pressures pa and pb and from any supplying flow rate Q. In this way, the inlet flow rate Q can be accurately divided in two predefined outlet flow rates Qa and Qb.

[0038] Inserting such dividers in the system 1, as illustrated in Figure 1, makes, given a determined flow rate from the hoisting cylinder-piston group 4, a predefined part of it to be supplied to the aligning cylinder-piston group 5, both in the upward step and downward step. Since the flow rates are related to the speeds of pistons, it is possible to define the respective speeds required to keep the alignment of the tool and consequently to adjust the flow dividers 10 and 11 so that they provide the correct flow rate to the aligning cylinder-piston group 5.

[0039] Referring again to Figure 2, it is observed that, as an alternative, the adjusting valves 117 and 119 can be electronically and/or hydraulically and/or mechanically adjusted. For example, it is possible to provide pressure sensors upstream them and perform a closed-loop control of the opening of the valves so that the downstream pressure is kept constant and equal to pc. In this way, the functions of the proportional hydraulic valves 117 and 119 are incorporated in the adjusting elements 117 and compensator 118.

[0040] A person skilled in the art can introduce many additions, modifications, or substitutions of elements with other operatively equivalent ones to the described embodiments of the hydraulic system for hoisting and auto-levelling a tool, in order to meet specific contingent needs without falling out of the scope of the attached claims.

Claims

1. Hydraulic system (1) for hoisting and auto-levelling a tool connected to a hoisting arm, comprising:

- a first supplying and unloading port/connection (2) and a second supplying and unloading port/connection (3) directly or indirectly connected or connectable to a storage reservoir and a pump for pressurizing a working fluid;
- a hoisting actuator group (4) connected or connectable by said hoisting arm to the tool for hoisting/lowering it, and having a first port/connection (6) for gaining access to a first chamber thereof, and a second first port/connection (7) for gaining access to a second chamber thereof;
- an aligning actuator group (5) connected or connectable to the tool and hoisting arm for holding the tool according to an orientation predefined during said hoisting/lowering steps and having a first port/connection (8) for gaining access to a first chamber thereof and a second port/connection (9) for gaining access to a second chamber thereof;
- a first flow divider (10) comprising an inlet (12), a first outlet (13) and a second outlet (14), configured to separate a flow rate entering the inlet (12) in a first (Qa) and second predefined flow rates (Qb) exiting the first (13) and second outlets (14), respectively;
- a second flow divider (11) comprising an inlet (21), a first outlet (22) and a second outlet (23), configured to separate a flow rate (Q) entering the inlet (21) in a first (Qa) and second predefined flow rates (Qb) exiting the first (22) and second outlets (23), respectively,

wherein:

- the inlet (12) of the first flow divider (10) is fluidically connected to the second port/connection (7) of the hoisting actuator group (4);
- the first outlet (13) of the first flow divider (10) is fluidically connected to the second supplying and unloading port/connection (3);
- the second outlet (14) of the first flow divider (10) is fluidically connected to the first port/connection (8) of the first aligning actuator (5);
- the inlet (21) of the second flow divider (11) is fluidically connected to the first port/connection (6) of the hoisting actuator group (4);
- the first outlet (22) of the second flow divider (11) is fluidically connected to the first supplying and unloading port/connection (2);
- the second outlet (23) of the second flow divider (11) is fluidically connected to the second port/connection (9) of the aligning actuator group (5),

characterized in that each of said first (10) and second flow dividers (11) comprises adjusting elements (117, 119) so that said first (Qa) and second exiting predefined flow rates (Qb) depend on the adjustments (Ya, Yb) of the adjusting elements (117 and 119) independently from the inlet flow rate (Q).

2. System (1) according to claim 1, wherein the first flow divider (10) comprises a first branch (15) connecting the inlet (12) to the first outlet (13) and a second branch (16) connecting the inlet (12) to the second outlet (14), said first (15) and second branches (16) comprising respective elements (17, 19) for adjusting the passage opening and respective compensators (18, 20) configured so that the pressure of the fluid between the adjusting element and the compensator of one of said first (15) and second branches (16), is kept constantly equal to the pressure (pc) between the adjusting element and compensator of the other of said first (15) and second branches (16).

3. System (1) according to claim 1 or 2, wherein the second flow divider (11) comprises a first branch (24) connecting the inlet (21) to the first outlet (22) and a second branch (25) connecting the inlet (21) to the second outlet (23), said first (24) and second branches (25) comprising respective elements (26, 28) for adjusting the passage opening, and respective compensators (27, 29) configured so that the pressure of the fluid between the adjusting element and the compensator of one of said first (24) and second branches (25) is constantly kept equal to the pressure (pc) between the adjusting element and compensator of the other of said first (24) and second branches (25).

4. System (1) according to claim 2 or 3, wherein said adjusting elements (117, 119) of the first and/or second flow dividers comprise fixed or adjustable throttles, or proportional valves, capable of adjusting the passage areas (Ya, Yb) of the respective branches.

5. System (1) according to claim 2 or 3 or 4, wherein said compensators (118, 119) of the first and/or second flow dividers comprise:

- a first proportional hydraulic valve (121) in the first branch (115) and a second proportional hydraulic valve (122) in the second branch (116);
- a connecting branch (123) downstream the first (121) and second proportional hydraulic valves (122), fluidically connecting the first branch (115) and second branch (116) of the flow divider;
- a compensator pilot branch (129) having a first end (130) so that the fluid inside it exerts its pressure on the first compensator (121), and a second end (131) so that the fluid inside it exerts its pressure on the second compensator (122);
- a three-way selecting hydraulic valve (124) disposed in the connecting branch (123), having a

first inlet (126) fluidically connected to the first outlet (113) of the first branch (115), a second inlet (127) fluidically connected to the second outlet (114) of the second branch (116) and an outlet (128) fluidically connected to the compensator pilot branch (129).

6. System (1) according to claim 5, wherein the three-way valve (124) is configured to hold open the connection of the compensator pilot branch (129) to the branch between the first (115) and second branches (116) of the divider (100), which is at the highest pressure condition.

7. System (1) according to claim 5 or 6, wherein a first (132) and second elastic calibrating elements (133) act on the first (121) and second proportional hydraulic valves, respectively.

8. System (1) according to claim 2 or 3, wherein said adjusting elements (117, 119) comprise a first proportional valve in the first branch (115) and a second proportional valve in the second branch (116), wherein opening said first and second proportional valves is adjusted by a closed-loop control of the pressure upstream the proportional valves, so that the pressure downstream them is held constant and equal in the first (115) and second branches (116) and consequently said adjusting elements (117) implement said compensators (118, 120).

9. Machine for hoisting a tool, comprising a hoisting and auto-levelling hydraulic system according to any of the preceding claims.

10. Machine according to the preceding claim, selected in the group consisting in: loading and hoisting machines, telehandlers, farming front-end loaders, front-end shovels, skid steer loaders.

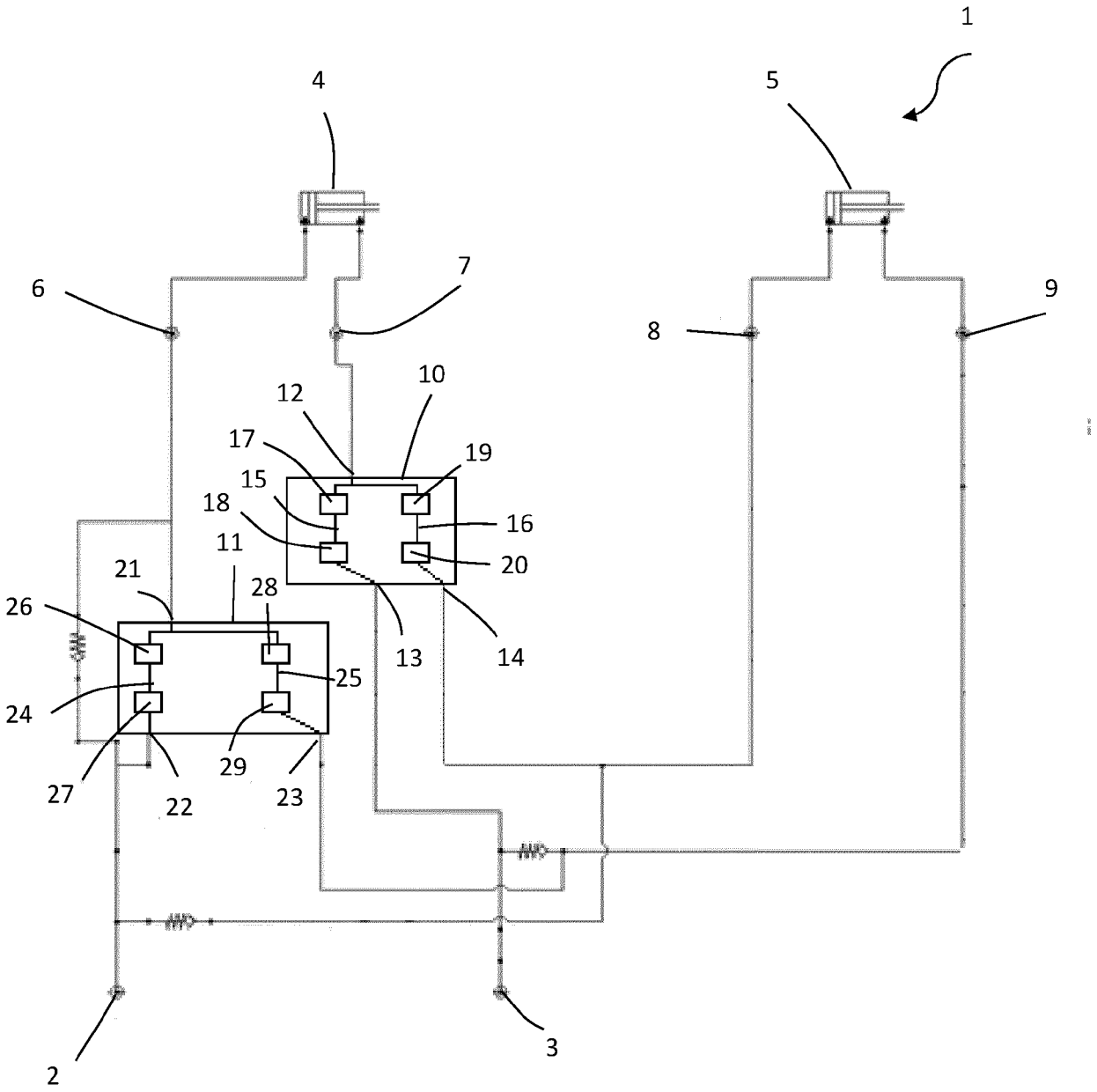

FIG. 1

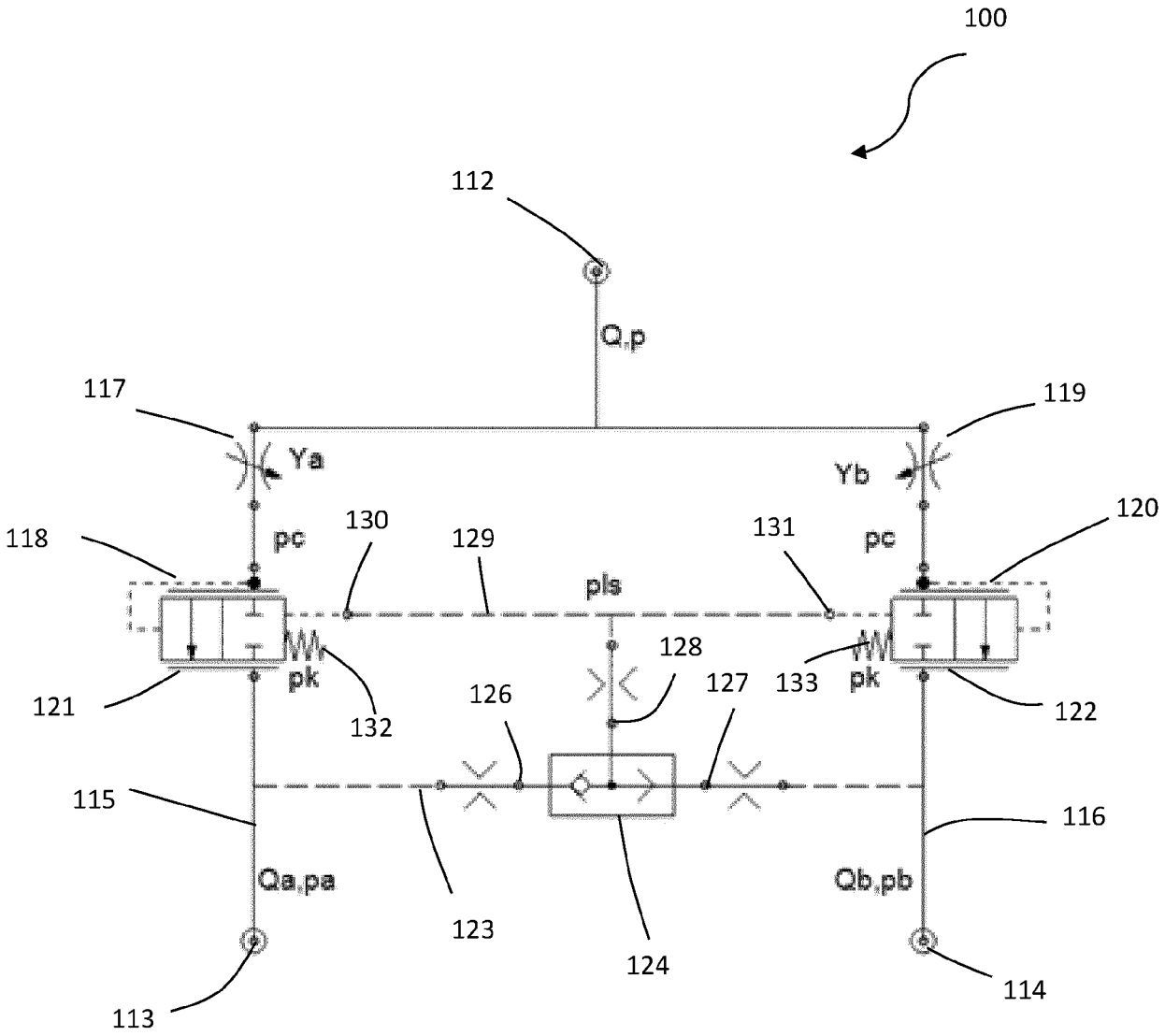
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FIG. 2

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 20 16 5275

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	US 6 308 612 B1 (EMANIE FARAIDOON FRED [US] ET AL) 30 October 2001 (2001-10-30) * figure 1 * -----	1-10	INV. F15B11/22 F15B11/20 F15B13/02
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TECHNICAL FIELDS SEARCHED (IPC)

F15B
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 July 2020	Bindreiff, Romain

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 16 5275

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US 6308612 B1	30-10-2001	NONE	
US 4815357 A	28-03-1989	NONE	
EP 3495565 A1	12-06-2019	NONE	

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