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(54) DESCENT CONTROL DEVICE FOR A HYDRAULIC CYLINDER, IN PARTICULAR FOR CONTROLLING THE DESCENT OF AN OPERATING ARM

(57) Descent control device for a hydraulic cylinder, comprising:
a first conduit (2), connectable to a first chamber (C1) of a cylinder (C);
a second conduit (3), connectable to a second chamber (C2) of the cylinder (C);
a control valve (4), arranged along the first conduit (2) and movable between a closed configuration and an open configuration;
a compensating valve (6), arranged along the first conduit (2) upstream of the control valve (4) with respect to the flow coming from the first chamber (C1);
wherein the compensating valve (6) comprises a control chamber (6a) and a chamber (6b);
a first driving conduit (61), connected to the first conduit (2), in a section downstream of the compensating valve (6) and upstream of the control valve (4) with respect to the flow coming from the first chamber (C1), and connected to the control chamber (6a).

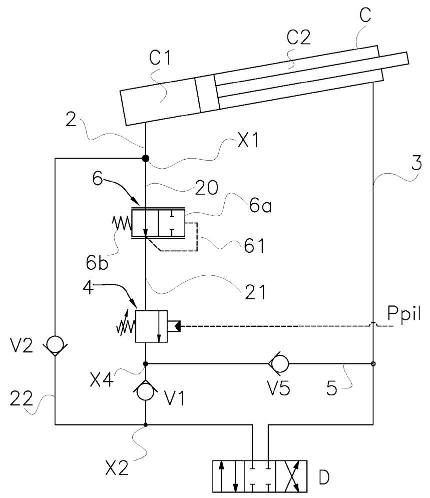

Fig.1

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Description

[0001] The present invention relates to a descent control device for a hydraulic cylinder. In particular, the invention relates to a descent control device which allows to make the descent speed of an operating arm independent of the load sustained.

[0002] The invention relates in particular to the field of operating machines arranged for lifting and lowering loads.

[0003] Machines of this type normally have one or more arms which can be lifted or lowered by means of hydraulic cylinders, to allow the handling of even very heavy loads, or to operate tools of various kinds.

[0004] As is known, hydraulic cylinders can be activated through the controlled feeding and discharge of a pressurised operating fluid, typically oil.

[0005] A hydraulic cylinder normally has two chambers, separated by a piston to which the stem is associated, which is connected in various ways to the load to be lifted or to a tool. A first chamber, typically the chamber located on the side of the bottom of the cylinder, is intended to receive pressurised oil to cause the exit of the stem and, for example, the lifting of the load. A second chamber, located on the side of the stem of the cylinder and, therefore, annular in shape, is arranged to receive oil and cause the re-entry of the stem and, for example, the lowering of the load.

[0006] A main distributor, usually four-way and with three positions, is arranged to cause the oil feed to the first chamber or to the second chamber and, simultaneously, to put the other chamber in communication with a discharge.

[0007] On the line feeding the chamber on the bottom side of the cylinder, there is a load control valve. This valve, when the arm is lifted or the cylinder is extended, allows the chamber on the bottom side of the cylinder to be freely fed, and it also carries out the function of sealing the load and controlling the emptying of the cylinder. In particular, this control valve is a normally closed valve which is actuated in opening by means of a specific command, connected to the load descent command. In the absence of a descent command, the valve remains closed and ensures support, preventing the uncontrolled descent of the load. In the presence of a descent command, the valve opens in a controlled manner, ensuring the possibility of carrying out a controlled descent of the load.

[0008] The control valve opening command can be of the hydraulic or electromechanical type. For example, the command to open the control valve occurs by means of a driving pressure, which can be taken from the line feeding the chamber on the stem side of the cylinder, or it can be taken from a driving line dedicated for the purpose.

[0009] Operating machines are normally provided with hydraulic or electric manipulators, comprising for example levers and/or buttons which can be actuated by an operator, which are arranged to activate the main distributor in the three operating positions. In hydraulically controlled systems, a load descent command, given by means of the manipulator, generates a driving pressure which is used both to activate the main distributor, moving it to the position corresponding to the descent of the load, and to drive the descent control valve. In the electromechanically controlled systems, a load descent command produces an electrical signal which, through an electronic control unit, is used both to command the main distributor and to generate the control current or pressure to bring the descent control valve to open.

[0010] In order to prevent the weight sustained by the operating arm, weighing on the cylinder, from influencing the descent speed of the operating arm itself, it is known to use compensating valves, arranged along the discharge line of the control valve. Such compensating valves basically have the feature of varying the oil passage cross-section, and thus the oil flow discharged, as a function of the pressure present in the bottom side chamber.

[0011] A compensating valve generally comprises a box which is progressively movable between an open position and a closed position. Moving between the open and closed positions, the box progressively changes the area of the oil passage cross-section from fully open to fully closed. In the compensating valves known in similar applications, the shutter is pushed towards the closed position by the pressure present in the bottom side chamber of the cylinder which acts upstream of the control valve, while it is pushed towards the open position by the thrust of a spring and the pressure present downstream of the control valve.

[0012] In particular, the compensating valve tends to maintain a constant pressure difference between the line upstream and the line downstream of the control valve. This allows to compensate for the effect of the weight of the load acting on the cylinder, which increases the pressure in the bottom side chamber of the cylinder, on the descent speed set by the operator. The devices currently available have a serious drawback. In fact, in the event of an incomplete closure of the control valve, for example due to a fault or the presence of impurities, the pressure induced by the load would tend to bring the shutter of the compensating valve to open, leaving the load free to descend in an uncontrolled manner, or to generate uncontrolled pressure increases in other parts of the circuit.

[0013] Furthermore, the devices currently available have complexities in terms of construction and related costs, working with two driving lines to be connected upstream and downstream of the valve which defines the control area; this factor also causes space and form factors which often make it difficult to apply such solutions in compact dimensions or which require special shapes to allow assembly on compact machines.

[0014] The object of the present invention is to solve the drawbacks summarised above and to introduce a different logic for compensating load-induced pressure.

[0015] An advantage of the present invention is that, when applied to closed-centre distributors, which constitute the vast majority of the applications in the field of the operating machines for lifting, it prevents uncontrolled load descent in the event of incomplete closure of the control valve.

[0016] Another advantage of the present invention is that it does not require any dedicated actuation systems, as the compensating valve is always active. A further advantage of the present invention is that it allows the load to descend without abrupt initial accelerations and jolting.

[0017] Additional features and advantages of the present invention will become more apparent from the following detailed description of an embodiment of the invention in question, illustrated by way of non-limiting example in the appended figures, in which:

- figure 1 schematically shows a first embodiment of the descent control device according to the present invention;
- figure 2 schematically shows a second embodiment of the descent control device according to the present invention;
- figures 3 and 4 show alternative embodiments of certain components of the device;
- figure 5 shows a further variant applicable in the presence of all embodiments shown in the other figures.

[0018] The descent control device according to the present invention is preferably used in a feed circuit for a hydraulic cylinder, which is intended to cause the lifting and lowering of a load.

[0019] In the following description, the term "valve" refers to a directly or automatically controlled device, arranged to regulate the flow of a fluid along a conduit. Although it will not be stated explicitly, it will be understood that a valve comprises at least one shutter, movable within a seat between a closed position, in which it prevents the flow through the valve and thus along the conduit in which the valve is installed, and at least one open position, in which it allows the flow through the valve and thus along the conduit in which the valve is installed.

[0020] Indicating an open position or configuration of a valve is intended as a configuration in which the shutter is in the open position.

[0021] Indicating a closed position or configuration of a valve is intended as a configuration in which the shutter is in the closed position.

[0022] Indicating an opening command is intended as an action which causes the shutter to move towards the open position.

[0023] Indicating a closing command is intended as an action which causes the shutter to move towards the closed position.

[0024] The expression "electromechanically driven valve" is intended as a valve with an electromechanical actuator acting on the shutter or on a control element which causes the shutter to move towards the open or closed position. An elastic means acts antagonistically to the electromechanical actuator to move the shutter in the opposite direction, in the absence of the action exerted by the electromechanical actuator.

[0025] The expression "hydraulically driven valve" is intended as a valve provided with at least a first driving conduit, i.e., a conduit which transmits a first driving pressure to the shutter which pushes it towards the open position or towards the closed position. An elastic means acts antagonistically to the thrust exerted by the driving pressure to move the shutter in the opposite direction, in the absence of the action exerted by the driving pressure. In combination with or as an alternative to the elastic means, the valve can comprise a second driving conduit, i.e., a conduit which transmits a second driving pressure to the shutter, which pushes it in the opposite direction with respect to the first driving pressure.

[0026] The lifting and lowering of the load is achieved by means of a cylinder (C) schematically illustrated in the figures. The cylinder (C) has two chambers (C1 ,C2) separated by a piston to which a stem is associated, which in turn is connected to the load. A first chamber (C1), located on the side of the bottom of the cylinder, is intended to receive the operating fluid to cause the lifting of the load. A second chamber (C2), located on the side of the stem of the cylinder (C) and, therefore, annular in shape, is arranged to receive the operating fluid and cause the lowering of the load. In an alternative embodiment, not illustrated, the lifting and lowering of the load occurs by inversely feeding the first and the second chamber (C1 ,C2).

[0027] Preferably, the operating fluid is mineral oil known in the art. In the following description, the operating fluid will be referred to either as "operating fluid" or "oil".

[0028] The oil intended for the first or the second chamber (C1 ,C2) comes from a special source. Preferably, the source comprises a pump, possibly connected to a supply tank. The pump is not shown in detail in the figures, but is simply indicated with "P".

[0029] A distributor (D), for example four-way and with three positions, is arranged to cause the oil feed to the first chamber (C1) or to the second chamber (C2) and, simultaneously, to put the chamber which is not fed with oil in communication with a discharge. In the embodiment illustrated, the distributor (D) is provided with a box which can take on a first position or ascent position, in which the first chamber (C1) is placed in communication with the pump (P) and the second chamber (C2) is placed in communication with a discharge. Such a first position is diagrammed on the left side of the distributor (D). The box can also take on a second position or descent position, diagrammed on the right side of the distributor (D), in which opposite connections are made with respect to those in the first position. The box can also take on a central position in which the first and the second chamber (C1 ,C2) are not in communication with the pump (P).

[0030] In a manner known in the art, the commands for lifting and lowering the load can be given through a manoeuvring member or an interface which can be activated by an operator. Such a manoeuvring member comprises, for example, a lever, one or more buttons or the like. The lifting or lowering command causes the distributor (D) to move to the position corresponding to the required action.

[0031] The descent control device according to the present invention comprises a first conduit (2), connectable to the first chamber (C1) of the cylinder (C). A second conduit (3) is connectable to the second chamber (C2) of the cylinder (C).

[0032] A control valve (4) is arranged along the first conduit (2).

[0033] The control valve (4) is arranged to take on a closed configuration, in which it prevents the flow along the first conduit (2), and to take on an open configuration in response to an opening command, in which it allows the flow of fluid out of the first chamber (C1).

[0034] That is, the control valve (4) is arranged to allow the free flow of oil being discharged from the first chamber (C1) only if it receives an opening command.

[0035] The control valve (4), known to the person skilled in the art, substantially has the function of preventing the discharge of the oil from the first chamber (C1), unless a precise opening command is given by an operator. In a possible embodiment, known in the art, the control valve (4) comprises a shutter, not shown in detail, which is pushed towards a closed position, in which it prevents the discharge of oil from the first chamber (C1), by means of a closing actuator, for example of an elastic type such as a spring. The shutter can be moved from the closed position towards an open position by exerting a thrust on the shutter which is opposite and greater than the thrust exerted by the elastic actuator.

[0036] In another possible embodiment, which is not illustrated but known in the art, the control valve (4) is driven in the open position by means of an electromechanical actuator which causes the opening of a driving stage which, in turn, causes the movement of a main shutter, and in which, when the command ceases, the return to the closed position of the driving stage causes, together with the action of the in-line pressure on the chambers of the main shutter, also a return of the main shutter to the closed position.

[0037] In the embodiments of figures 1 and 2, the control valve (4) is hydraulically driven. In particular, the opening thrust on the shutter is exerted by means of a driving pressure which, on command, can be fed to the shutter from a source in a known manner.

[0038] In the embodiment shown in figure 3, the control valve (4) is electromechanically driven. In such a case, the opening thrust is exerted by means of an electromechanical actuator acting on the shutter.

[0039] Preferably, the control valve (4) is a proportional valve, which allows to regulate the oil flow rate in response to a corresponding command from the operator. In other words, the descent command can be modulated so as to regulate the descent speed of the load. To this end, the shutter is configured to progressively increase the passage area available for oil flow, moving from the closed position to the open position. By regulating the descent command, it is possible to position the shutter in a certain intermediate position between the open and closed position, thereby regulating the oil passage area and, consequently, the flow rate of oil being discharged from the first chamber (C1) and the load descent speed. Advantageously, the descent control device according to the present invention comprises a compensating valve (6), arranged along the first conduit (2) upstream of the control valve (4) with respect to the flow coming from the first chamber (C1). The compensating valve (6) is connected at the inlet to a section (20) of the first conduit (2) directly connected to the chamber (C1) of the cylinder, and is connected at the outlet to the control valve (4) by an intermediate section (21) of the first conduit (2).

[0040] The compensating valve (6) can be activated between a closed configuration, in which it prevents the flow along the first conduit (2), and an open configuration, in which it allows the flow along the first conduit (2). The compensating valve (6) comprises a shutter, not shown, movable between a closed position, in which the compensating valve is in a closed configuration, and an open position, in which the compensating valve is in an open configuration.

[0041] The compensating valve (6) is hydraulically driven. To this end, the compensating valve (6) comprises a control chamber (6a), structured to receive a pressure which tends to bring the compensating valve (6) towards the closed configuration. The control chamber (6a) of the compensating valve (6) is fed by means of a driving conduit (61) connected to the intermediate section (21) of the conduit (2).

[0042] The compensating valve (6) can be activated in the closed configuration by the pressure present in the intermediate section (21) of the first conduit (2), i.e., by the pressure present between the control valve (4) and the compensating valve (6). This is possible by putting the control chamber (6a) of the compensating valve (6) in communication with the intermediate section (21) of the first conduit (2) by means of the first driving conduit (61).

[0043] Advantageously, the compensating valve (6) comprises an actuator (6b), arranged to exert an action which pushes the shutter towards the open position. The actuator (6b) is placed in a respective chamber. The actuator is preferably elastic. The shutter of the compensating valve (6) is thus pushed towards the open position by the thrust exerted by the actuator (6b), for example a spring.

[0044] In a manner known in the art, the chamber housing the actuator (6b) can be ventilated in the atmosphere, or it can be connected to a discharge line, or it can be connected to a driving line.

[0045] In the embodiments in which the chamber housing the actuator (6b) is connected to a driving line, the pressure present in the driving line contributes, together with the elastic means, to activating the valve towards the open position.

[0046] In the position sustaining an arm and a possible load weighing thereon, the pressure induced by the weight of the arm and the load causes the pressurisation of the first chamber (C1) and the conduit (2), including the intermediate section (21), up to the control valve (4), which, in the absence of an opening command, is in the closed position. **Advantageously,** in the device object of the present invention, in such a load-supporting condition, the compensating valve (6) is also pushed into the closed position by the load-induced pressure in the intermediate section (21), which is located upstream of the sealing and load control valve (4).

[0047] The operation of the descent control device according to the present invention occurs in the following modes.

[0048] A load descent command sent by the operator causes the control valve (4) to open and the compensating valve (6) to open. The opening command can be sent to the control valve (4) by means of a driving pressure along a driving line (Ppil), which can be connected to an external driving circuit or to the second chamber (C2) of the cylinder (C). Alternatively, if the valve (4) is electromechanically driven, the opening command could come from a control unit which generates a control current.

[0049] Following the opening command, the valve (4) is brought to the open position, allowing oil to flow out from the first chamber (C1) of the cylinder. In the absence of the compensating valve (6), such a flow rate would tend to increase in a consistent manner as the load and the consequent pressure induced in the first chamber (C1) increase, and this would cause very different load descent speeds, depending on the weight of the load. Furthermore, an abrupt acceleration could occur in the initial step of the downward movement, especially with high loads, which could cause the load to fall from the arm or the operating machine to overturn.

[0050] **Instead, in the present invention,** the compensating valve (6) is brought to an intermediate position between the closed position and the open position, such as to always cause a constant pressure in the intermediate section (21) upstream of the control valve (4). That is, the compensating valve (6) is capable of maintaining a constant pressure in the intermediate section (21) even with different loads to be sustained. This means that, as the load weighing on the arm increases and the pressure in the first chamber (C1) increases, the valve (6) tends to take on a more closed configuration, causing the decoupling or isolation of the pressure present in the section (20) of the first conduit, comprised between the compensating valve (6) and the first chamber (C1) of the cylinder (C), with respect to the pressure in the intermediate section (21), which the compensating valve (6) keeps constant.

[0051] In practice, for any configuration taken on by the control valve (4) in response to an opening command, the compensating valve (6) takes on an intermediate position between the open position and the closed position such that a constant pressure is maintained in the intermediate section (21). This occurs because the more the valve (6) moves towards the closed position, the greater the pressure induced by the load in the first chamber (C1).

[0052] Thereby, irrespective of the load acting on the arm, the control valve (4) always operates in the presence of a preset upstream pressure, and therefore allows the flow of an oil flow, and thus a re-entry speed of the cylinder (C) and load descent speed, which depends only on the position taken on in response to the opening command, while it is independent of the pressure induced by the load in the first chamber (C1).

[0053] A further advantage, given by the positioning of the compensating valve (6) upstream of the control valve (4), is as follows. Since the compensating valve (6), under load-supporting conditions, i.e., in the absence of an opening command, is in the closed position, it is possible to use the opening of the compensating valve (6) itself to obtain a load descent without initial accelerations or jolting. To this end, it is possible to configure the shutter of the compensating valve (6) so as to obtain a progressive opening as it moves from the closed position to the open position, always maintaining a constant pressure in the intermediate section (21) of the first conduit (2).

[0054] By cancelling the descent command, the control valve (4) is brought towards the closed configuration, and the compensating valve (6) also returns to the closed position.

[0055] The descent control device according to the present invention comprises a bypass line (22), arranged in parallel to the control valve (4) and to the compensating valve (6). The bypass line (22) is arranged to allow the flow of oil directed from the distributor (D) towards the first chamber (C1) and to prevent the opposite flow. To this end, the bypass line (21) comprises a one-way valve (V2), which is configured to allow oil to flow directly towards the first chamber (C1) and to prevent the opposite flow.

[0056] In a first embodiment, illustrated in figure 1, the first conduit (2) is connected to the distributor (D). The bypass line (22) is connected to the first conduit (2) at two intersections (X1,X2) arranged at the ends of the section of the first conduit (2) along which the control valve (4) and the compensating valve (6) are arranged. Thereby, the flow directed towards the first chamber (C1) passes through the bypass conduit (21) without crossing the compensating valve (6) and the control valve (4). In this first embodiment, a load ascent command envisages sending oil to the first chamber (C1) and is diagrammed with the left position of the distributor (D). The oil is directed towards the first conduit (2) and flows along the bypass line (21), given the closed configuration of the control valve (4) and compensating valve (6). The chamber (C1) thus receives the oil, increasing its volume at the expense of the second chamber (C2), which reduces its volume by discharging the oil through the second conduit (3). A load descent command envisages sending oil to the second chamber (C2), as diagrammed in the right position of the distributor (D). In this case, the second chamber (C2) receives the oil and increases its volume, while the first chamber (C1) discharges the oil through the first conduit (2). The load descent command is combined with a control valve (4) opening command.

[0057] In the embodiment of figure 2, the first conduit (2) is not connected to the distributor (D), but to a discharge (T). The bypass line (22) is connected to the distributor (D) and joins the first conduit (2) at an intersection (X1) interposed between the first chamber (C1) and the compensating valve (6).

[0058] Also in this second embodiment, a load ascent command envisages sending oil to the first chamber (C1) (distributor (D) in the left position). The oil is directed to the bypass line (22) which, as already indicated, is directly connected to the distributor (D). The chamber (C1) thus receives the oil, increasing its volume at the expense of the second chamber (C2), which reduces its volume by discharging the oil through the second conduit (3). Since the second conduit (3) is connected to the distributor (D), the oil discharge occurs through the latter.

[0059] A load descent command envisages sending oil to the second chamber (C2) (distributor (D) in the right position). In this case, the second chamber (C2) receives the oil and increases its volume, while the first chamber (C1) discharges the oil through the first conduit (2).

[0060] As in the solution of figure 1, the load descent command is combined with a control valve (4) opening command. In this second embodiment, for the purposes of increased safety, there is an enabling valve (7). The enabling valve (7) is arranged to take on a closed configuration, in which it prevents the flow along the first conduit (2), and to take on an open configuration in response to an opening command, in which it allows the flow of oil from the conduit (2) towards the discharge. That is, the enabling valve (7) is arranged to allow the free flow of oil being discharged from the conduit (2) only if it receives an opening command.

[0061] The enabling valve (7), known to the person skilled in the art, substantially has the function of preventing the discharge of the oil from the conduit (2) unless a precise opening command is given by an operator. In a possible embodiment, known in the art, the enabling valve (7) comprises a shutter, not shown in detail, which is pushed towards a closed position, in which it prevents the discharge of oil, by means of a closing actuator, for example of an elastic type such as a spring. The shutter can be moved from the closed position towards an open position by exerting a thrust on the shutter which is opposite and greater than the thrust exerted by the elastic actuator. In another possible embodiment, not illustrated but known in the art, the enabling valve (7) is driven in the open position by means of an electromechanical actuator. The enabling valve (7) is arranged to receive an opening command only in the presence of an opening command of the control valve (4).

[0062] The presence of the compensating valve (6) thus brings considerable advantages.

[0063] Firstly, the compensating valve (6) is a very high safety measure with respect to possible malfunctions or failed closures of the control valve (4). In fact, in the embodiment of figure 1 in which the distributor (D) has a rest position in which the connections to the first and the second conduit (2,3) are closed (a solution known in the art as a closed-centre distributor), if the valve (4) fails to close, the pressure induced by the load causes a pressure in the first conduit (2) such that the compensating valve (6) is brought towards the closed position. In such conditions, the load is supported by the closing of the valve (6) itself and the closed centre position of the distributor (D).

[0064] Also in the embodiment of figure (2), the safety advantage would be ensured by the presence of the enabling valve (7), which is normally closed in the absence of a descent command. As already emphasised, a load descent command is paired or combined with an opening command of the control valve (4) and, if present, to activate the enabling valve (7). In particular, the descent command, in addition to the movement of the distributor (D), also causes a signal or command to be sent to the activation system connected to the control valve (4) and, in the embodiment of figure 2, to the enabling valve (7). As already mentioned, the latter can be hydraulically driven or electromechanically driven. The distributor (D) can also be either hydraulically driven or electromechanically driven.

[0065] Merely by way of example, in the embodiment of figures 1 and 2 the control valve (4) is hydraulically driven.

[0066] In the embodiment shown in figure 3, both valves (4,7) are electromechanically controlled.

[0067] The electromechanical command is transmitted by a control module (ECU), arranged to detect the presence of a load descent command and to consequently activate the valves (4, 7) in the manner already described. In general, one among the control (4) and enabling (7) valves could be hydraulically driven and the other electromechanically driven, or both could be equally driven.

[0068] Preferably, but not necessarily, the descent control device according to the present invention further comprises a third conduit (5), which connects the second conduit (3) with the first conduit (2). In particular, the third conduit (5) connects the second conduit (3) with a section of the first conduit (2) placed downstream of the control valve (4) with respect to the flow exiting from the first chamber (C1). In the embodiment depicted, the third conduit (5) joins the first conduit (2) at a first intersection (X4) arranged downstream of the control valve (4) with respect to the flow exiting from the first chamber (C1). The third conduit (5) is arranged to allow the flow of oil from the first conduit (2) to the second conduit (3) and to prevent the opposite flow. To this end, the third conduit is provided with a one-way valve (V5), structured to allow oil to flow from the first conduit (2) towards the second conduit (3) and to prevent the opposite flow.

[0069] Thanks to the presence of the third conduit (5), at least a part of the flow discharged from the first chamber (C1), during the load descent, is recovered and fed to the second chamber (C2), so as to keep the second chamber (C2) adequately fed, without having to activate the pump (P) at full speed, but, at most, activating the pump (P) at reduced speed, for the supply of a minimum flow of oil. The part of the flow which is not fed to the second chamber (3) can be directed to the discharge.

[0070] In the embodiment of figure 1, to prevent the flow directed towards the first chamber (C1) from entering the third conduit (5), a one-way valve (V1) is arranged along the first conduit (2) between the distributor (D) and the intersection (X4) between the first conduit (2) and the third conduit (5).

[0071] An auxiliary descent control valve (8) is illustrated in the embodiment shown in figure 5. Such an auxiliary valve (8) could however also be adopted in the embodiments of figures 1 and 2.

[0072] The auxiliary valve (8) is arranged in parallel with the control valve (4) and the compensating valve (6), to allow the discharge of oil from the first chamber (2) even if the control valve (4) is blocked in the closed position, i.e., also in the event of a malfunction which prevents the control valve (4) from opening.

[0073] The auxiliary valve (8) is arranged along a conduit connecting the first chamber (2) with a discharge. Furthermore, the auxiliary valve (8) is normally closed, and is driven in opening by the load descent command. To this end, the auxiliary valve (8) is connected to the second conduit (3) by a driving conduit (81). Thereby, the pressure present in the second conduit (3) pushes the auxiliary valve (8) towards the open position, allowing the oil to be discharged from the first chamber (2). Preferably, the auxiliary valve (8) is an over center valve.

[0074] In the possible applications for the present invention, under certain operating conditions, it may be convenient or desirable for the operator to be able to vary the compensating capacity of the compensating valve (6). That is, instead of obtaining a load-independent, compensated descent speed with the same drive control as described in the previous paragraphs, it may be convenient to obtain a higher or lower speed with respect to that determined by the compensating valve (6) described above. For example, if certain machines are used in certain industries, geographical areas, or with certain tools mounted on the arm, it may be required, for a certain descent command, to be able to carry out uncompensated descent speeds, i.e., with mitigated effects of the compensating valve (6) so as to obtain higher speeds. To this end, advantageously, the compensating valve (6), as shown in figure 4, can be arranged to accommodate a driving line (Pil) in a control chamber (6b), which acts to bring the compensating valve (6) towards an open position. That is, for applications or operating conditions where a higher speed is desired under certain conditions following a command from the operator or machine control system, it is possible to send a driving pressure to a second driving chamber, i.e., the chamber which accommodates the actuator (6b) for opening the valve. Such a chamber can be fed by a driving conduit (Pil), which can be connected to a dedicated control line and fed by a dedicated circuit, or it can be connected to the same control line which drives the control valve (4) in opening.

Claims

1. A descent control device for a hydraulic cylinder, comprising:

   a first conduit (2), connectable to a first chamber (C1) of a cylinder (C);
   a second conduit (3), connectable to a second chamber (C2) of the cylinder (C);
   a control valve (4), arranged along the first conduit (2) and movable between a closed configuration and an open configuration;
   characterised in that:

      it comprises a compensating valve (6), arranged along the first conduit (2) upstream of the control valve (4) with respect to the flow coming from the first chamber (C1), which is movable between a closed configuration and an open configuration;
      the compensating valve (6) comprises a control chamber (6a), structured to receive a pressure causing the compensating valve (6) to move towards the closed configuration, and an actuator (6b), arranged to cause the compensating valve (6) to move towards the open configuration;
      the control chamber (6a) is connected by means of a first driving conduit (61) to an intermediate section (21) of the first conduit (2), placed between the compensating valve (6) and the control valve (4).

2. The device according to claim 1, comprising:

   a bypass line (22), arranged parallel to the control valve (4) and to the compensating valve (6);
   a first one-way valve (V2), arranged along the bypass line (22) and configured to allow the flow of oil directed to the first chamber (C1) and to prevent the opposite flow.

3. The device according to claim 2, comprising a distributor (D), connected to a source (P) of pressurised oil, to a discharge (T), to the bypass line (22) and to the second conduit (3), which is configured to take on at least a first position and at least a second position, wherein:

in the first position, the bypass line (22) is placed in communication with the source (P) and the second conduit (3) is placed in communication with the discharge (T);
in the second position, the bypass line (22) is placed in communication with the discharge (T) and the second conduit (3) is placed in communication with the source (P).

4. The device according to claim 3, wherein:

the first conduit (2) is connected to the distributor (D);
the bypass line (22) is connected to the first conduit (2) at two intersections arranged at the ends of the section of the first conduit (2) along which the control valve (4) and the compensating valve (6) are arranged.

5. The device according to claim 3, wherein:

the first conduit (2) is connected to a discharge (T) downstream of the control valve (4);
the bypass line (22) is connected to the first conduit (2) at an intersection interposed between the first chamber (C1) and the compensating valve (6).

6. The device according to claim 5, comprising an enabling valve (7) placed along the first conduit (2) between the control valve (4) and the discharge (T), wherein the enabling valve (7) is normally closed and is arranged to receive an opening command only in the presence of an opening command of the control valve (4).

7. The device according to any one of the preceding claims, wherein the control valve (4) and/or the enabling valve (7) are electromechanically driven valves.

8. The device according to one of the preceding claims, comprising a third conduit (5), which connects the second conduit (3) with the first conduit (2) at a section of the first conduit (2) placed downstream of the control valve (4) with respect to the flow exiting from the first chamber (C1);
wherein the third conduit (5) is provided with a one-way valve (V5) arranged to allow the flow from the first conduit (2) towards the second conduit (3), and to prevent the reverse flow.

9. The device according to one of the preceding claims, comprising an auxiliary descent control valve (8), arranged parallel to the control valve (4) and to the compensating valve (6), to allow the oil to be discharged from the first chamber (2) even in the event of a blockage in the closed position of the control valve (4).

10. The device according to one of the preceding claims, wherein the compensating valve (6) is provided with a driving chamber (6b) connected to a driving conduit (Pil) arranged to accommodate a driving pressure which causes the compensating valve to move in the open position.

11. The device according to claim 10, wherein the driving conduit (Pil) is arranged to receive a driving pressure in the presence of an opening command of the valve (4).

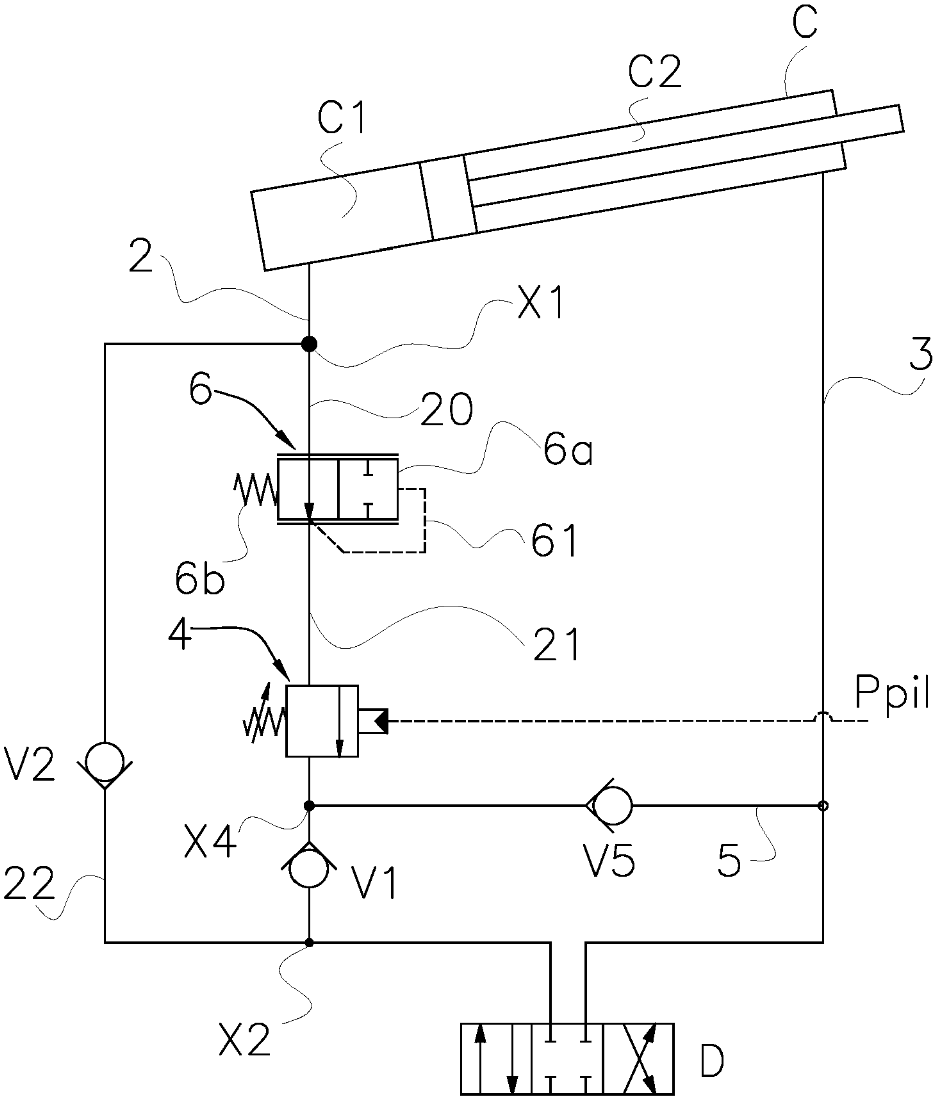

Fig.1

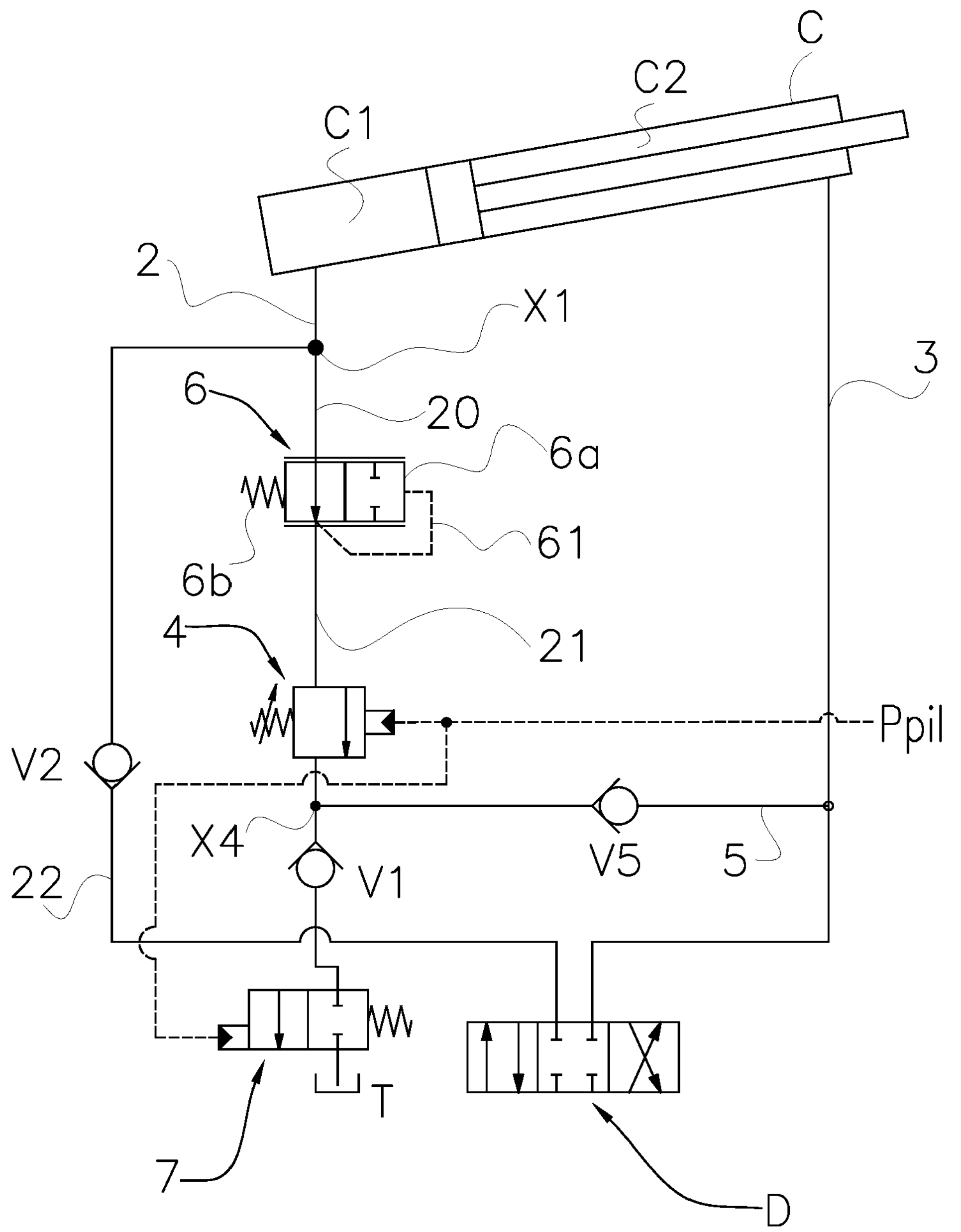

Fig.2

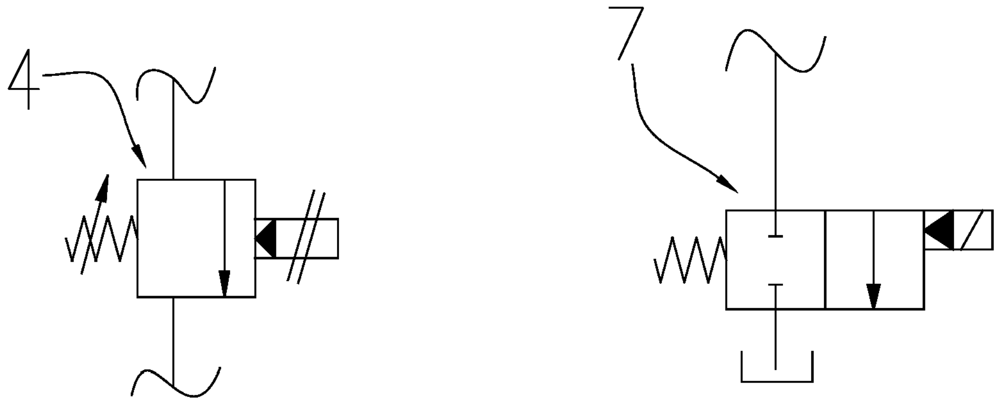

Fig.3

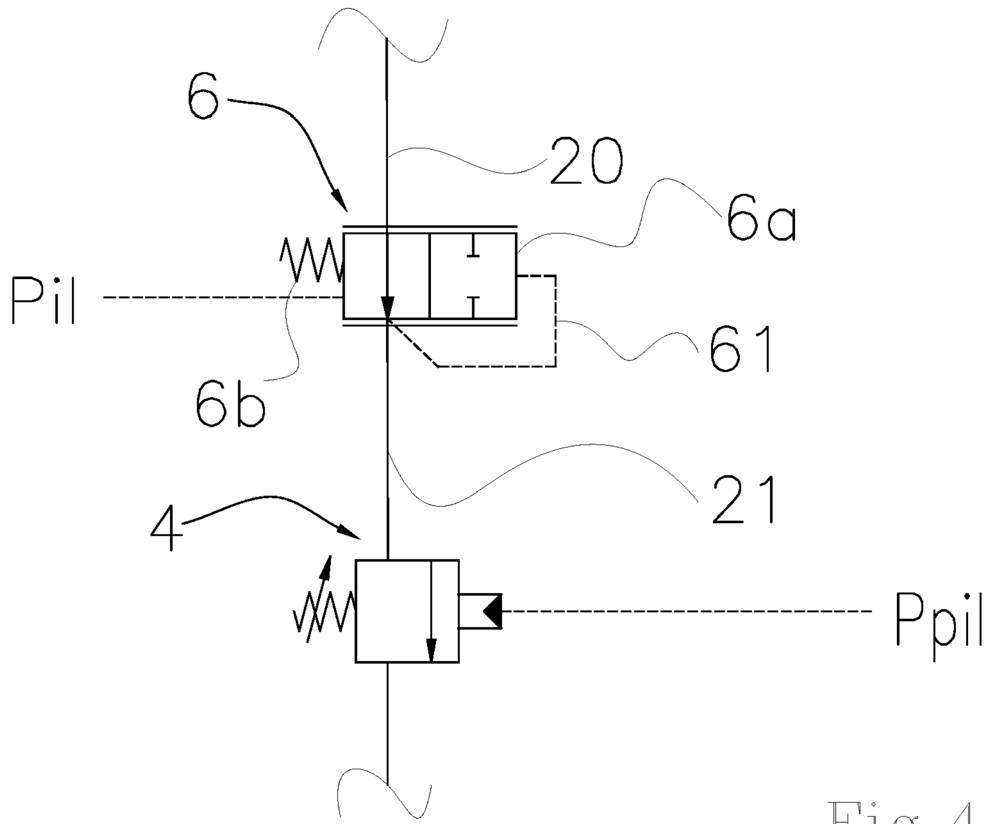

Fig.4

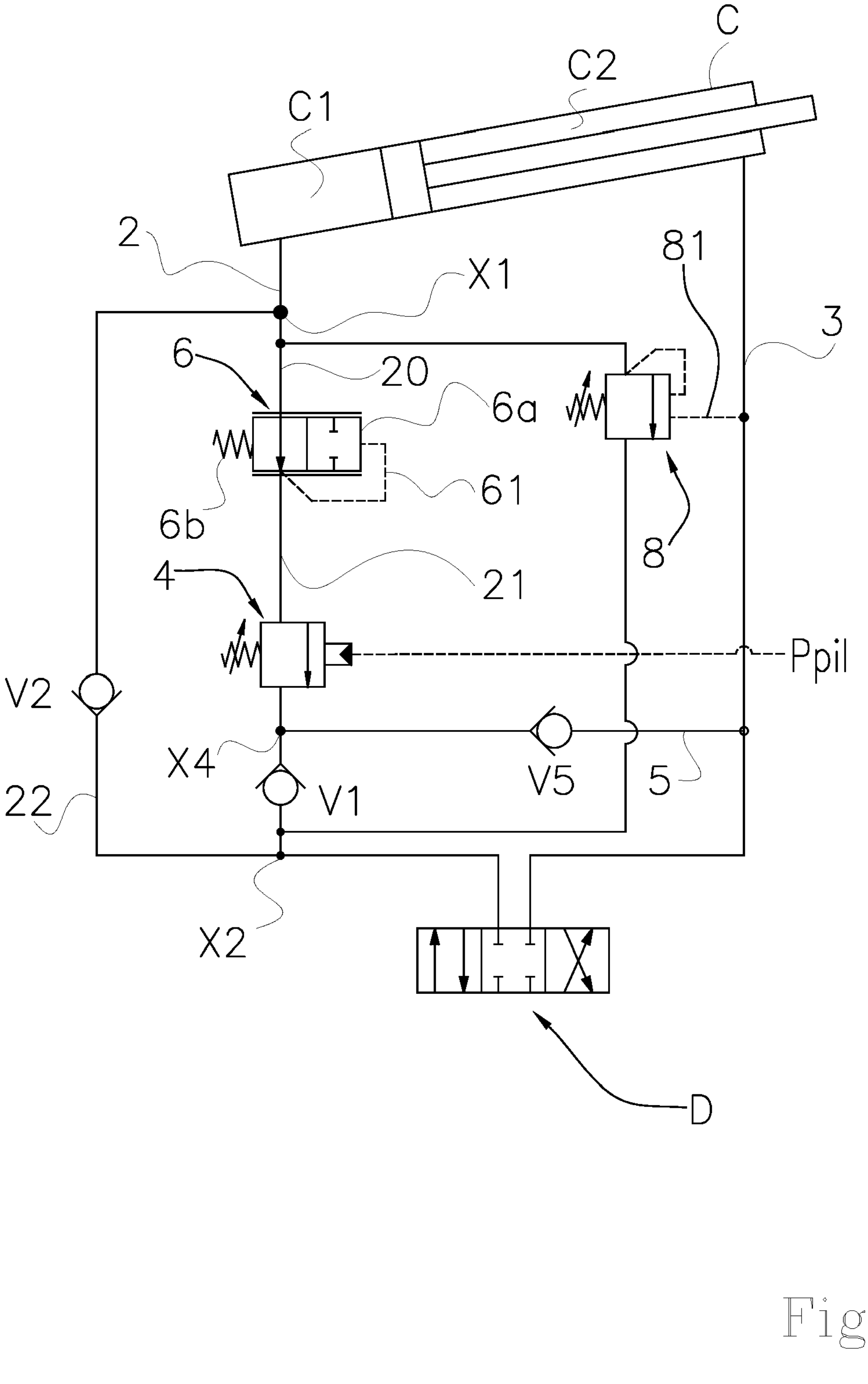

Fig.5

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	28 June 2024	Deligiannidis, N

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