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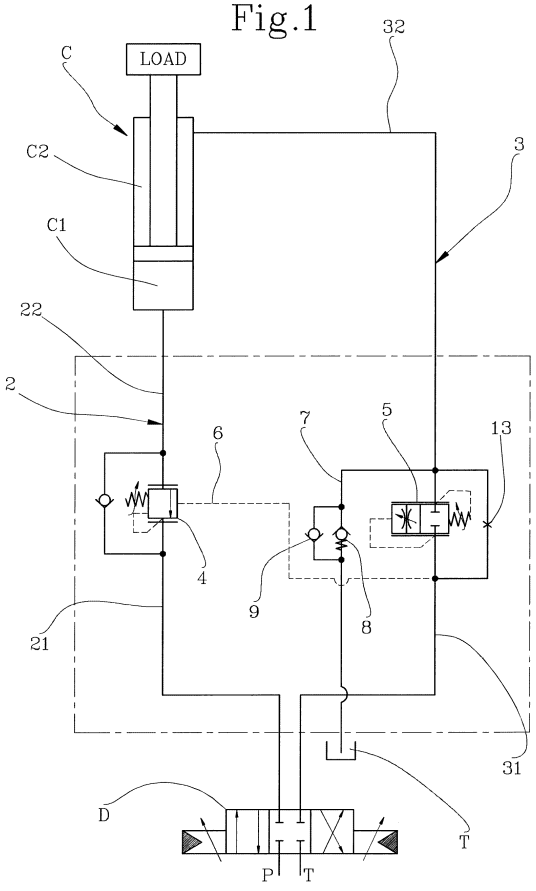
(54) Control device for the descent of a load

(57) A control device for the descent of a load, comprising: a first conduit (2), designed to connect a first chamber (C1) of a cylinder (C) with a directional control valve (D); a second conduit (3), designed to connect a second chamber (C2) of the cylinder (C) with the directional control valve (D); a control valve (4), disposed along the first conduit (2), which is designed to allow the flow of fluid from the directional control valve (D) toward the first chamber (C1) and to allow the flow of fluid from the first chamber (C1) toward the directional control valve (D) only if supplied with a pilot pressure that is greater than a minimum value; a shut-off valve (5), disposed along the second conduit (3), which is designed to take on a closed configuration, in which it prevents the flow of fluid along the second conduit (3), and an open condition, in which it enables the flow of fluid from the directional control valve (D) toward the second chamber (C2) only if the pressure present between the shut-off valve (5) and the directional control valve (D) exceeds a given minimum pressure; a pilot conduit (6), which connects the control valve (4) with the section of the second conduit (3) between the shut-off valve (5) and the directional control valve (D); a drainage conduit (7) which connects the section of the second conduit (3) between the shut-off valve (5) and the second chamber (C2) with a drain (T); a one-way valve (8), disposed along the drainage conduit, which prevents flow from the drain (T) toward the second conduit (3) and allows flow from the second conduit (3) toward the drain only if the pressure upstream of the one-way valve (8) exceeds a given minimum pressure; a choke (13), disposed in parallel with the shut-off valve (5).

Fig.1



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Description

[0001] The present invention relates to a control device for the descent of a load.

[0002] The invention relates in particular to the field of working machines designed to lift and lower a load.

[0003] Working machines of this type are normally equipped with a jib that can be actuated to lift or lower by means of a hydraulic cylinder. The cylinder can be supplied with working fluid under pressure, typically oil, on the base plate side, in order to cause the load to be lifted, or on the rod side, to cause the load to be lowered.

[0004] On the conduit which supplies the working oil to base plate side of the cylinder there is a control valve. The control valve has the function of allowing the free supply of working fluid to the base plate side of the cylinder, and of controlling or blocking the drainage of working fluid from the base plate side of the cylinder. In particular, the control valve is a normally closed pilot-operated valve. In the absence of a pilot pressure, the valve remains closed and prevents the working fluid from being drained, so as to ensure that the load is supported and prevent an uncontrolled descent of the load itself. In the presence of a pilot pressure, the valve opens in a controlled manner, allowing the drainage of the working fluid and the consequent controlled descent of the load. In this case the pilot pressure is drawn from the conduit that supplies the working oil to the rod side of the cylinder.

[0005] The supply of working fluid to the base plate side or rod side of the cylinder is normally established by means of a directional control valve which has a central position, in which it closes both cylinder supply conduits, a first position in which the working oil is supplied to the base plate side of the cylinder, while the rod side is connected to a drain, and a second position, in which the working oil is supplied to the rod side of the cylinder, while the base plate side is connected to the drain via the control valve.

[0006] Whenever possible, in order to save energy, the load is lowered by exploiting gravity, i.e. without generating a driving thrust on the rod side of the cylinder. It is necessary, however, to deliver a pilot pressure to the control valve which would otherwise remain closed, thereby preventing the lowering of the load. The pilot pressure must also be capable of being modulated so as to enable the operator to control the load lowering speed. A further condition to be met is that the rod side of the cylinder must in any case be supplied with a sufficient flow rate of oil to prevent the occurrence of cavitation phenomena.

[0007] At present the conditions briefly described above are ensured by means of rather complex, costly directional control valves, which must enable control of the pilot pressure delivered to the control valve. The use of such directional control valves, moreover, can result in an undesirable increase in the pressure on the rod side of the cylinder during lowering of the load, a condition that should absolutely be avoided in terms of both energy expenditure and mechanical stress on the cylinder, and because it can disrupt the continuity of the load lowering movement, which it is desirable to occur without swinging or jerking, especially in cases where the load consists of a car intended to accommodate people.

[0008] The object of the present invention is to provide a control device for the descent of a load which enables the drawbacks currently found in the art to be overcome.

[0009] One advantage of the device according to the present invention is that it enables precise, effective control of the descent of a load to be achieved irrespective of the technical features of the drive directional control valve.

[0010] Another advantage of the device according to the present invention is that of being particularly simple, while ensuring very safe conditions in the control of the descent of the load.

[0011] Additional features and advantages of the present invention will be more apparent from the following detailed description of one embodiment of the invention in question, illustrated by way of non-restrictive example in the appended figures in which:

- figure 1 shows a first embodiment of the control device according to the present invention;
- figure 2 shows a second embodiment of the control device according to the present invention;
- figure 3 shows a third embodiment of the control device according to the present invention;
- figure 4 shows a fourth embodiment of the control device according to the present invention;
- figure 5 shows a fifth embodiment of the control device according to the present invention.

[0012] The control device for the descent of a load according to the present invention is preferably used in a supply circuit for a hydraulic cylinder intended to bring about the lifting and lowering of a load.

[0013] The lifting and lowering of the load are achieved by means of a cylinder (C) schematically illustrated in the figures. The cylinder (C) normally has two chambers (C1, C2) separated by a piston associated with a rod which is connected in various ways to the load to be lifted. A first chamber (C1), typically the chamber that is on the cylinder base plate side, is intended to receive oil under pressure so as to cause the load to be lifted. A second chamber (C2), disposed on the rod side of the cylinder (C), and thus ringshaped, is designed to receive oil and cause the load to be lowered. The second chamber (C2) must always be full of oil.

[0014] A directional control valve (D), usually a four-way, three-position valve, is designed to cause oil to be supplied under pressure to the first chamber (C1) or the second chamber (C2) and, simultaneously, to place the chamber that is not being supplied with oil under pressure in communication with a drain. In the example embodiment schematically illustrated, the directional control valve (D) has a drawer which can take on a first position,

in which the first chamber (C1) is placed in communication with a source of fluid under pressure (P) and the second chamber (C2) is placed in communication with a drain (T). The first position is schematically shown on the left side of the directional control valve (D). The drawer can also take on a second position, schematically shown on the right side of the directional control valve (D), in which connections opposite to those of the first position are made. The drawer can also take on a central position in which the first and second chambers (C1, C2) are not in communication with the source of fluid under pressure (P).

[0015] The control device according to the present invention comprises a first conduit (2), designed to connect the first chamber (C1) of the cylinder (C) with a directional control valve (D). A second conduit (3) is designed to connect the second chamber (C2) of the cylinder (C) with the directional control valve (D).

[0016] A control valve (4), disposed along the first conduit (2), is designed to allow a free flow of fluid from the directional control valve (D) toward the first chamber (C1) and a free flow of fluid from the first chamber (C1) toward the directional control valve (D) only if supplied a pilot pressure exceeding a minimum value. The control valve (4), known to the person skilled in the art, substantially has the function of preventing drainage of the working fluid from the first chamber (C1), except in the presence of a precise command from an operator. This is necessary to prevent uncontrolled descents of the load, also in the event of malfunctions or leaks of fluid. The control valve (4) essentially comprises a shutter that is pushed toward a closed position, in which it prevents drainage of the fluid from the first chamber (C1), for example by means of a spring and/or pressure. The shutter can be moved from the closed position toward an open position by exerting on the shutter itself a counter-thrust that is greater than the closing thrust. This opening thrust is exerted by means of the working fluid which, on command, can be supplied to the shutter with a pressure that is sufficient to create the necessary thrust to overcome the closing pressure.

[0017] The supply of fluid for opening the shutter of the control valve (4) is drawn from the second conduit (3) by means of a pilot conduit (6). In this manner, the control valve (4) will open in the presence of a load lowering command, since in order to bring about the descent of the load, working oil is supplied to the second chamber (C2) through the second conduit (3).

[0018] The control device further comprises a shut-off valve (5), which is disposed along the second conduit (3) and is designed to take on a closed configuration, in which it prevents the flow of fluid along the second conduit (3), and an open configuration, in which it allows fluid to flow from the directional control valve (D) toward the second chamber (C2), only if the pressure present upstream of the shut-off valve (5), i.e. in a first section (31) of the second conduit (3), situated between the shut-off valve (5) and the directional control valve (D), exceeds a given minimum or set pressure of the valve itself. The pilot conduit (6) connects the control valve (4) with the first section (31) of the second conduit (3), situated between the shut-off valve (5) and the directional control valve (D).

[0019] In a preferred embodiment, the shut-off valve (5) is a sequence valve. As is well known, a sequence valve comprises a shutter that is pushed toward a closed position, in which it prevents the flow of fluid by means of a spring whose thrust can be regulated by defining the minimum or set pressure of the valve, i.e. the pressure below which the shutter will not move into the open position. When at rest, therefore, the shutter will be in a closed position. The shutter can be moved from the closed position toward an open position, in which it allows the flow of fluid, by exerting on the shutter itself a counter-thrust that is greater than the thrust exerted by the spring. In the device according to the present invention, the thrust that tends to bring the shutter into the open position is exerted by the oil present in the first section (31) of the second conduit (3), i.e. in the section of the second conduit (3) upstream of the shut-off valve (5), considering the flow directed by the directional control valve (D) toward the second chamber (C2).

[0020] The profile of the shutter of the shut-off valve (5) and the thrust exerted by the closing spring of the valve (5) itself can be determined in such a way as to produce a desired increase in pressure with increasing flow rates of the oil delivered to the second conduit (3) by the directional control valve (D). The pressure increase produced by the shut-off valve (5) in the first section (31) of the second conduit (3) brings about a corresponding increase in pressure along the pilot conduit (6). Consequently, the pressure along the pilot conduit (6) likewise varies in relation to the flow rate of the fluid delivered to the second conduit (3), so that the opening of the control valve (4) also varies in relation to the flow rate of the fluid delivered to the second conduit (3). In other words, if one desires to increase the load lowering speed, it is necessary to increase the flow rate of the fluid delivered to the second conduit (3). This brings about an increase in pressure in the first section (31) of the second conduit (3) and in the pilot conduit, the consequence being that the control valve (4) will increase its opening, allowing a greater flow rate of oil drained from the first chamber (C1). The opposite naturally occurs if it is desired to reduce the lowering speed. If it is desired to stop the load, it will be necessary to cut off the supply of fluid to the second conduit (3). This will bring about a pressure drop in the second conduit (3) and in the pilot conduit (6), so that the control valve (4) will go back into the closed position. In order to prevent the first section (31) of the second conduit (3) from remaining pressurized, the device comprises a choke (13) disposed in parallel with the shut-off valve (5). The choke (13) does not substantially influence the operation of the device and ensures that, on receipt of a command to stop the descent of the load, the pressure in the first section (31) of the second conduit (3) will decrease rapidly, enabling closure of the control

valve (4).

[0021] A drainage conduit (7) connects a second section (32) of the second conduit (3), situated between the shut-off valve (5) and the second chamber (C2), with a drain (T). In this manner, after passing through the shut-off valve (5), the oil will be drained without pressurizing the second chamber (C2), so that the load will be lowered substantially by gravity.

[0022] Owing to the presence of the shut-off valve (5), therefore, the operator is perfectly able to control the load lowering speed by acting on the directional control valve (D), i.e. on the flow rate of the oil that is delivered to the second conduit (3), even where the descent occurs by gravity.

[0023] In order to maintain a minimum level of pressure inside the second chamber (C2) and avoid cavitation phenomena, a one-way valve (8) is disposed along the drainage conduit (7). The one-way valve prevents flow from the drain toward the second conduit (3), while allowing flow from the second conduit (3) toward the drain only if the pressure in the second section (32) of the second conduit (3) - i.e. the pressure upstream of the one-way valve (8) relative to the flow directed toward the drain (T) - exceeds a predetermined set pressure of the one-way valve (8).

[0024] Preferably, a second one-way valve (9) is disposed along the drainage conduit (7) in parallel with the one-way valve (8). The second valve allows a free flow from the drain (T) toward the second chamber (C2) and prevents the opposite flow. The presence of the second one-way valve (9) can be useful for further reducing the risk of cavitation inside the second chamber (C2).

[0025] In a second embodiment of the device, illustrated in figure 2, the drainage conduit (7) connects the second section (32) of the second conduit (3) with a first section (21) of the first conduit (2), situated between the control valve (4) and the directional control valve (D). A one-way lowering valve (10) is disposed along the second conduit (3) in parallel with the shut-off valve (5) in order to allow flow from the second chamber (C2) toward the directional control valve (D). The one-way lowering valve (10) is necessary to allow oil to be drained from the second chamber (C2) during the upward travel of the load. This second embodiment of the device enables the necessary connections to be simplified, since it does not require a dedicated connection to the drain (T) for the drainage conduit (7). The second embodiment of the device is particularly useful in the event that, during the descent of the load, the pressure inside the first section (21) of the first conduit (2) is relatively low. This occurs when the descent is mainly controlled by the control valve (4), i.e. when the pressure decrease between the pressure present inside the first chamber (C1) and the drainage pressure occurs almost entirely in the control valve (4), without involving the directional control valve (D).

[0026] In a third embodiment, shown in figure 3, the control device comprises a normally closed shut-off valve (11) disposed along the drainage conduit (7) downstream of the one-way valve (8). In particular, the shut-off valve (11) comprises a shutter that is pushed toward the closed position, in which it closes the drainage conduit (7) under the action of a spring. The shut-off valve (11) can be actuated into an open position by means of a pilot pressure coming from a second section (22) of the first conduit (2), situated between the control valve (4) and the first chamber (C1). For this purpose, a pilot conduit (11a) connects the shut-off valve (11) with the second section (22) of the first conduit (2). The setting of the spring that pushes the shutter toward the closed position is relatively low, so that in the presence of a minimum pressure in the first chamber (C1), the shut-off valve (11) will remain open; in particular, it will remain open also during the descent of the load. In the case in which the pressure in the first chamber (C1) becomes null, as occurs, for example, when the load touches the ground, the shut-off valve (11) will go into the closed configuration. In such a situation it is possible to pressurize the second chamber (C2) by delivering oil to the second conduit (3), in order, for example, to exert pressure on the ground.

[0027] In this third embodiment, the shut-off valve (5) is actuated into a closed position by means of a spring placed in an environment at atmospheric pressure or at low pressure.

[0028] Advantageously, in the third embodiment of the device there can be provided a blocking valve (12), shown in figure 4, which prevents flow from the second chamber (C2) toward the directional control valve (D). The blocking valve can be actuated to open by means of a pilot pressure drawn from the first section (21) of the first conduit (2). The presence of the blocking valve (12) makes it possible, in case of need, to close the second chamber (C2), keeping the oil present inside it.

[0029] Figure 5 shows a fifth embodiment of the device, in which the shut-off valve (5) is in the form of a pressure-limiting valve. Also in the form of a pressure-limiting valve, the shut-off valve (5) is designed to assume a closed configuration, at rest, in which it prevents the flow of fluid along the second conduit (3), and an open configuration, in which it allows fluid to flow from the directional control valve (D) toward the second chamber (C2) only if the pressure present between the shut-off valve (5) and the directional control valve (D), i.e. in the first section (31) of the second conduit (3), exceeds a given minimum or set pressure of the valve itself.

[0030] Also in the form of a maximum pressure valve, the shut-off valve (5) comprises a shutter that is pushed toward a closed position, in which it prevents the flow of fluid by means of a spring whose thrust can be regulated by defining the minimum or set pressure of the valve, i.e. the pressure below which the shutter will not move into the open position. The shutter can be moved from the closed position toward an open position, in which it allows the flow of fluid, by exerting on the shutter itself a counter-thrust greater than the thrust exerted by the spring. In the device according to the present invention, the thrust that tends to bring the shutter into the open position is

exerted by the oil present in the first section (31) of the second conduit (3), i.e. in the section of the second conduit (3) upstream of the shut-off valve (5), considering the flow directed by the directional control valve (D) toward the second chamber (C2). Unlike a sequence valve, a maximum pressure valve does not allow the oil passage section to be adjusted, but nonetheless allows the relation between pressure and flow rate to be adjusted, for example by changing the elastic constant of the spring. Consequently, in the present invention the use of a pressure-limiting valve is substantially equivalent to that of a sequence valve.

[0031] Figure 6 shows a sixth embodiment of the device according to the present invention, in which the shut-off valve (5) is in the form of a pressure-limiting valve and a shut-off valve (11) is present on the drainage conduit (7), as in the case of the embodiment shown in figure 3. The operation and effects of the shut-off valve (11) are the same as described in relation to the embodiment of figure 3. The shut-off valve (5), in the form of a pressure-limiting valve, must be of the counterpressure-compensated type, i.e. it must be configured in such a way as to open at a given pressure present in the first section (31) of the second conduit (3), irrespective of the pressure present inside the second section (32). This is obtained, for example, by placing the closing spring of the valve (5) in an environment at atmospheric pressure or low pressure, or with hydraulic compensation devices.

[0032] The control device according to the present invention offers important advantages. Firstly, it enables a precise and effective control of the descent of a load to be achieved irrespective of the technical features of the directional control valve. In particular, the operator is able to control the load lowering speed with precision, a descent that takes place by gravity. Another advantage of the device according to the present invention is that of being particularly simple, while ensuring very safe conditions in the control of the descent of the load.

Claims

1. A control device for the descent of a load, comprising: a first conduit (2), designed to connect a first chamber (C1) of a cylinder (C) with a directional control valve (D); a second conduit (3), designed to connect a second chamber (C2) of the cylinder (C) with the directional control valve (D); a control valve (4), disposed along the first conduit (2), which is designed to allow the flow of fluid from the directional control valve (D) toward the first chamber (C1) and to allow the flow of fluid from the first chamber (C1) toward the directional control valve (D) only if supplied with a pilot pressure exceeding a minimum value; **characterized in that** it comprises a shut-off valve (5), disposed along the second conduit (3), which is designed to take on a closed configuration, in which it prevents the flow of fluid along the second conduit (3), and an open condition, in which it allows the flow of fluid from the directional control valve (D) toward the second chamber (C2), only if the pressure present between the shut-off valve (5) and the directional control valve (D) exceeds a given minimum pressure; a pilot conduit (6), which connects the control valve (4) with the section of the second conduit (3) between the shut-off valve (5) and the directional control valve (D); a drainage conduit (7) which connects the section of the second conduit (3) between the shut-off valve (5) and the second chamber (C2) with a drain (T); a one-way valve (8), disposed along the drainage conduit, which prevents flow from the drain (T) toward the second conduit (3) and allows flow from the second conduit (3) toward the drain only if the pressure upstream of the one-way valve (8) exceeds a given minimum pressure; a choke (13), disposed in parallel with the shut-off valve (5).

2. The control device for the descent of a load according to claim 1, comprising a second one-way valve (9), disposed along the drainage conduit (7) in parallel with the one-way valve (8), which enables a free flow from the drain (T) toward the second chamber (C2) and prevents the opposite flow.

3. The control device for the descent of a load according to claim 1, wherein the drainage conduit (7) connects the section of the second conduit (3) between the shut-off valve (5) and the second chamber (C2) with the section of the first conduit (2) between the control valve (4) and the directional control valve (D); a one-way lowering valve (10) is disposed along the second conduit (3) in parallel with the shut-off valve (5) to allow flow from the second chamber (C2) toward the directional control valve (D).

4. The control device for the descent of a load according to claim 1, comprising a normally closed shut-off valve (11) disposed along the drainage conduit (7) downstream of the one-way valve (8), which can be actuated into an open configuration by means of a pilot pressure coming from the section of the first conduit (2) between the control valve (4) and the first chamber (C1); the shut-off valve (5) is actuated into a closed position by means of a spring placed in an environment at atmospheric pressure or at low pressure.

5. The control device for the descent of a load according to claim 4, comprising a blocking valve (12), normally closed relative to the flow from the second chamber (C2) toward the directional control valve (D), which can be actuated to open by means of a pilot pressure drawn from the section of the first conduit (2) between the control valve (4) and the directional control valve (D).

6. The control device the descent of a load according to claim 1, wherein the shut-off valve (5) is in the form of a pressure-limiting valve (51) and is designed to take on a closed configuration, in which it prevents the flow of fluid along the second conduit (3), and an open configuration, in which it allows the flow of fluid from the directional control valve (D) toward the second chamber (C2), only if the pressure present between the shut-off valve (5) and the directional control valve (D), i.e. in the first section (31) of the second conduit (3), exceeds a given minimum pressure.

7. The control device for the descent of a load according to claim 6, comprising a normally closed shut-off valve (11) disposed along the drainage conduit (7) downstream of the one-way valve (8), which can be actuated into an open configuration by means of a pilot pressure coming from the section of the first conduit (2) between the control valve (4) and the first chamber (C1); the shut-off valve (5) is actuated into a closed position by means of a spring placed in an environment at atmospheric pressure or at low pressure.

Fig.1

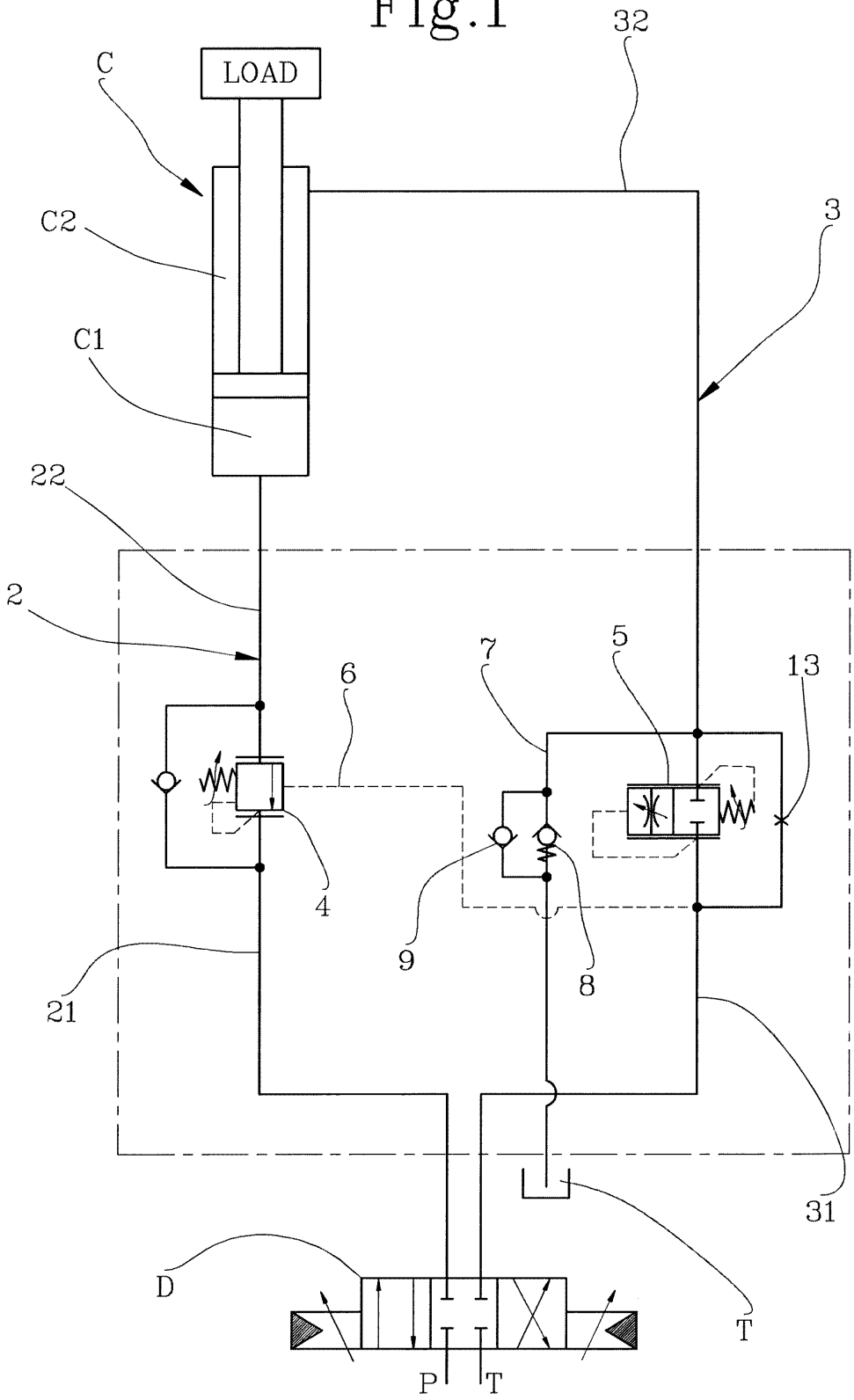


Fig.2

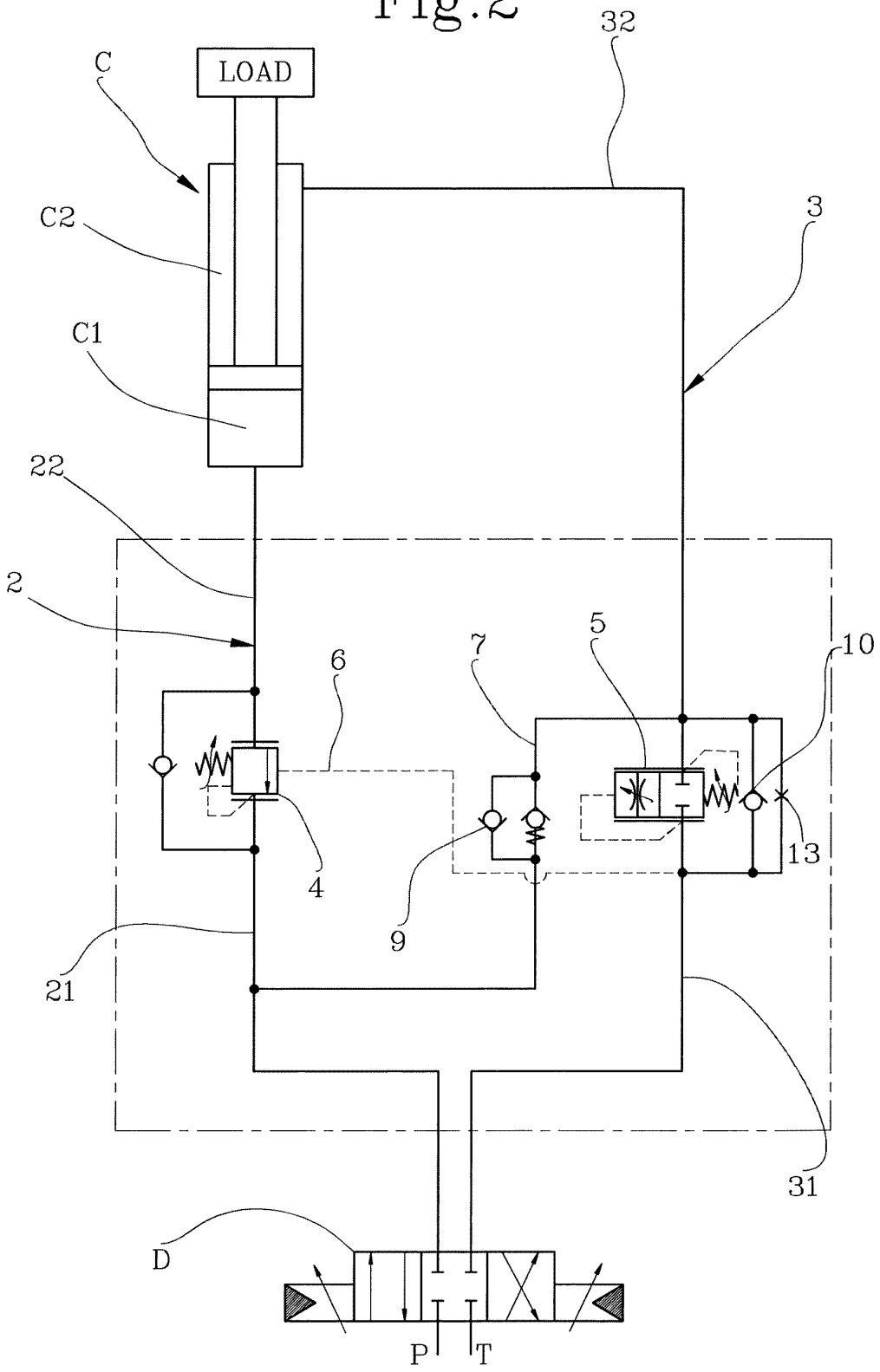


Fig.3

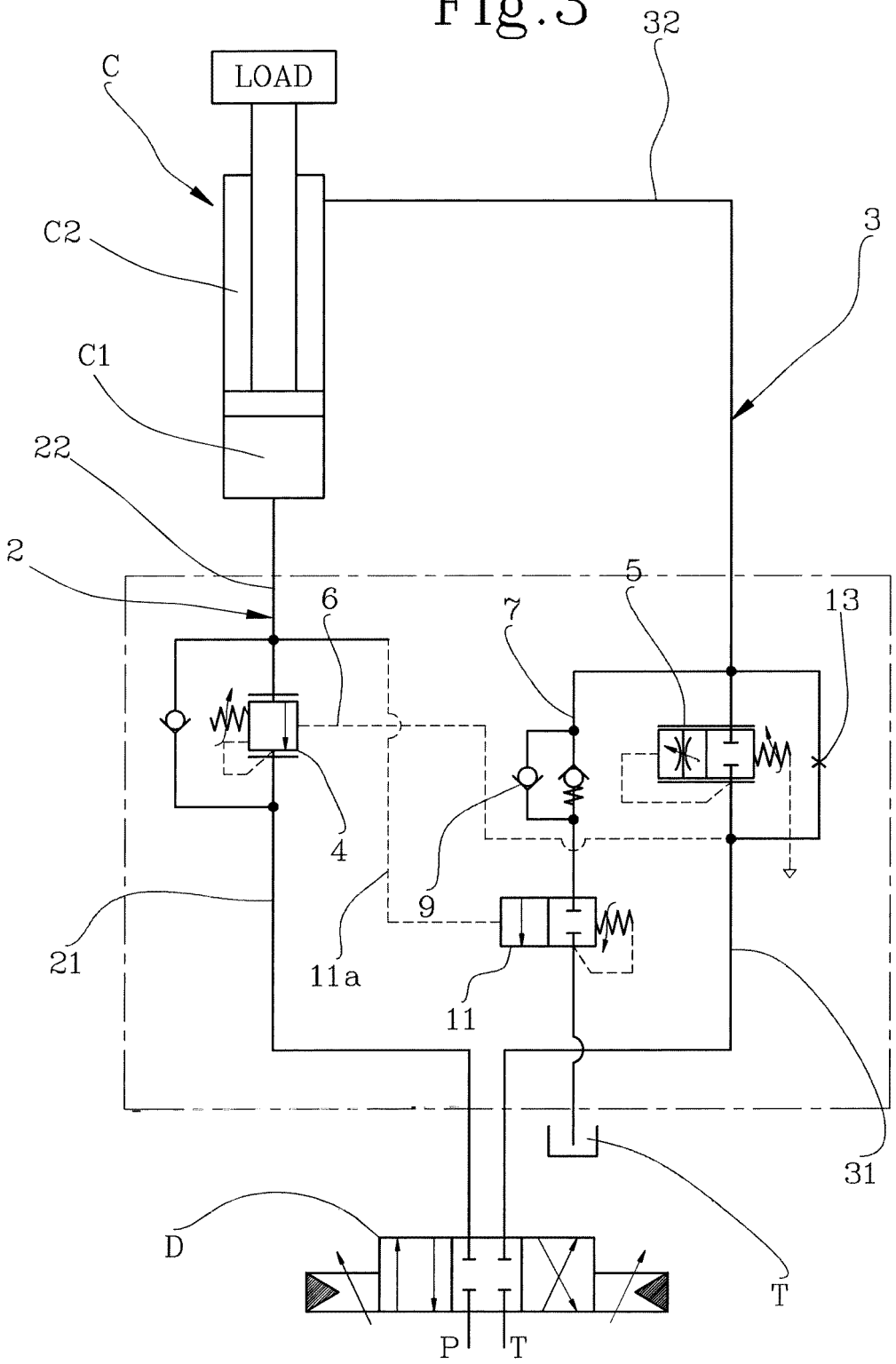


Fig.4

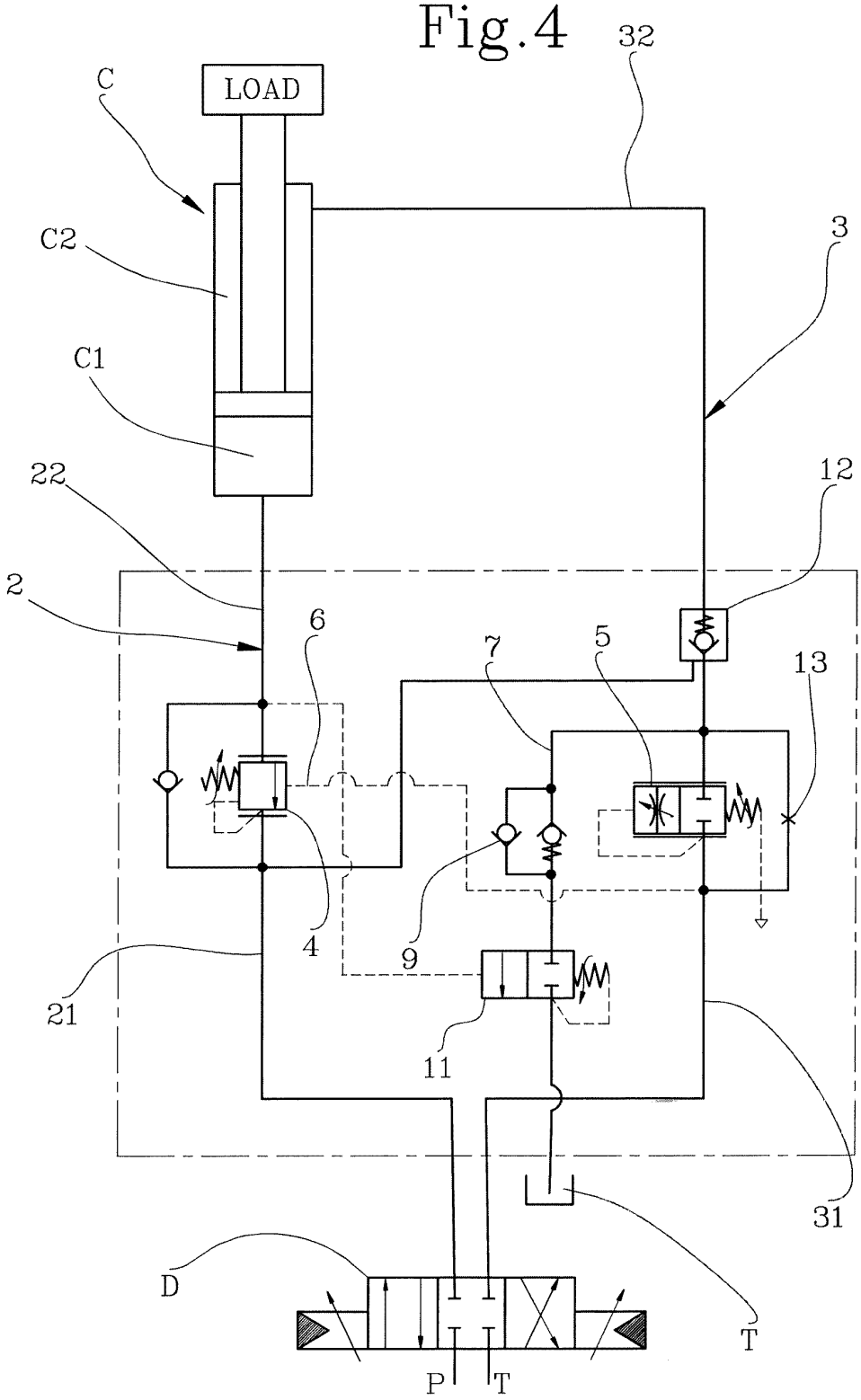


Fig.5

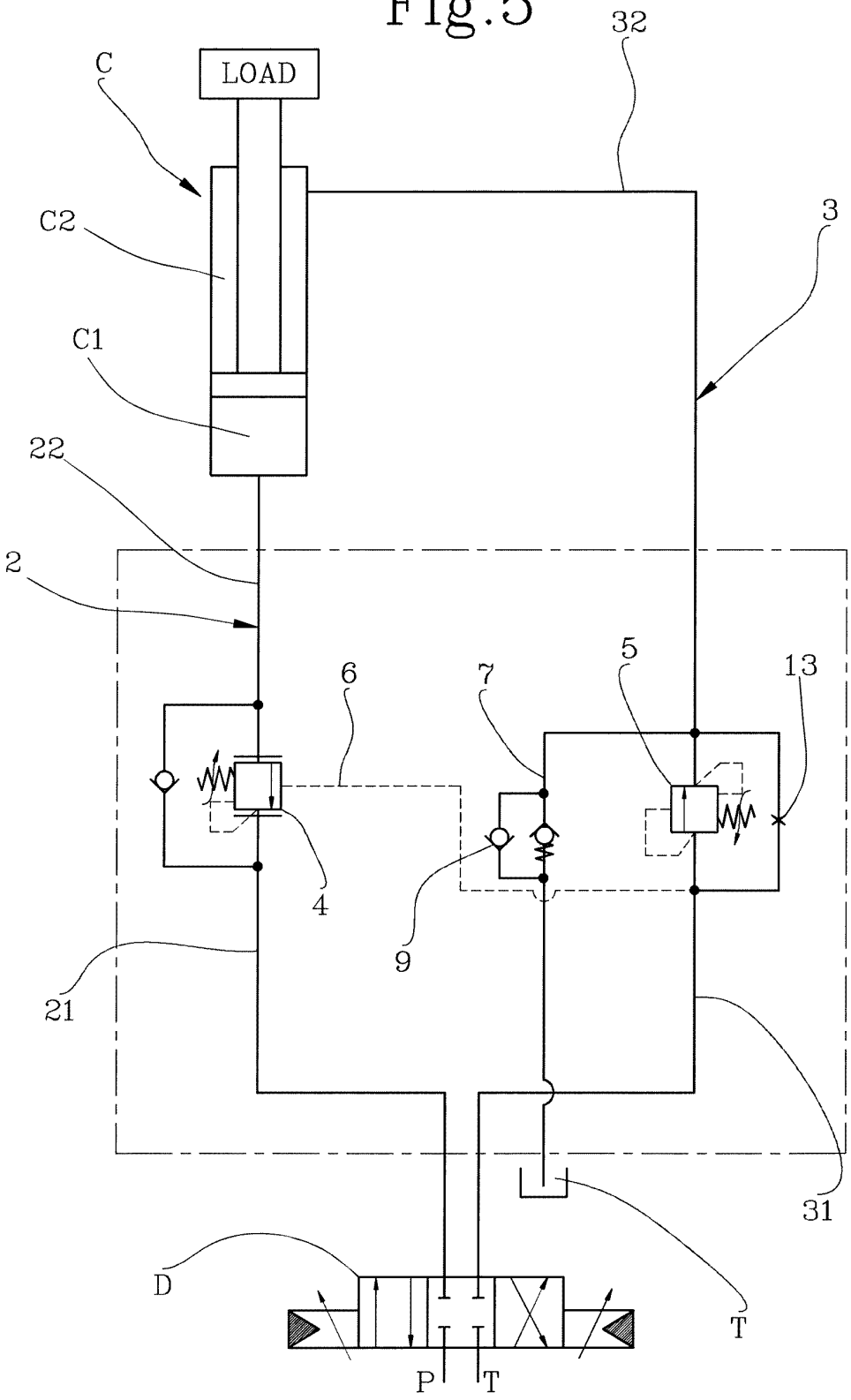
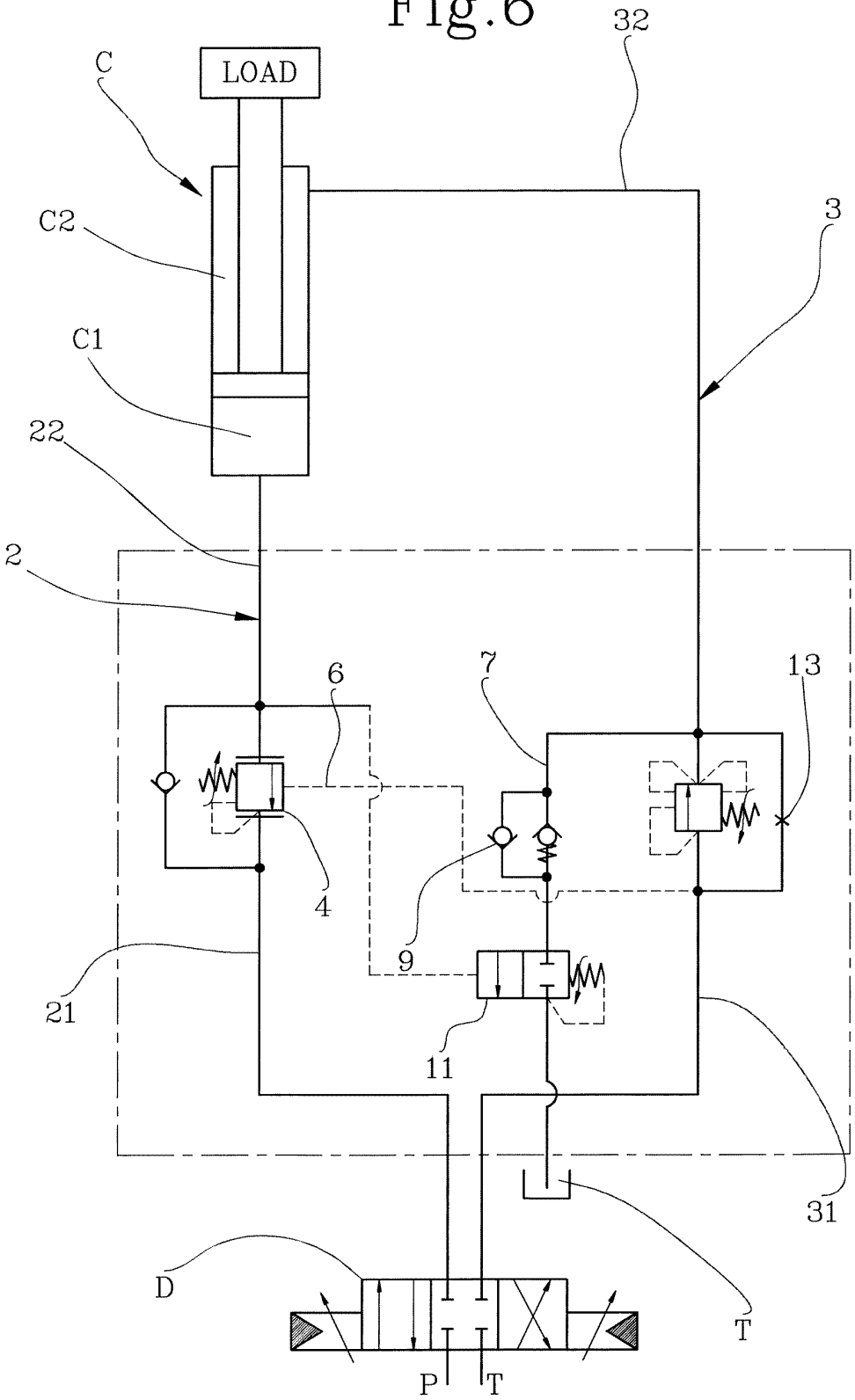


Fig.6



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EUROPEAN SEARCH REPORT

Application Number
EP 13 42 5048

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 372 167 A1 (BOSCH REXROTH OIL CONTROL S P A [IT]) 5 October 2011 (2011-10-05) * the whole document *	1-7	INV. B66F9/22
X	US 5 034 892 A (SAOTOME YOSHIMI [JP]) 23 July 1991 (1991-07-23) * the whole document *	1-7	
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TECHNICAL FIELDS SEARCHED (IPC)

B66F
F15B
B66C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 August 2013	Faymann, L

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 42 5048

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28-08-2013

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82