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(54) **A lifting device and s hydraulic system therfor, as well as a method for adapting the same**

(57) Lifting device (3) comprising a frame (2) as well as a movable lifting arm (4) provided with a connecting device at a free end thereof for connecting a hydraulically operable tool (5) to the lifting arm (4). The lifting device (3) is provided with a hydraulic system for controlling a hydraulic actuator (50) of the tool. The hydraulic system comprises a reservoir (32) for hydraulic fluid disposed on the frame as well as a pump unit (31) connected to the reservoir for pumping hydraulic fluid through the hydraulic system; a control valve unit (33), which is connected to the pump unit; a first line (41) and a second line (42), which extend from the control valve unit (33) to the connecting device (8). The control valve unit (33) is designed

for operatively connecting the first line (41) and the second line (42) at least alternately to the pump unit (31) for alternately pressurizing the first line (41) and the second line (42). The hydraulic system comprises a connecting line provided with a controllable connecting valve unit (33), which connecting line is connected to the first line (41) and the second line (42) in such a manner that the first line (41) and the second line (42) can be operatively connected to the pump unit (31) simultaneously for pressurizing the first line (41) and the second line (42) simultaneously.

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## Description

**[0001]** The invention relates to a lifting device according to the preamble of claim 1. The invention further relates to a hydraulic system for such a lifting device.

**[0002]** In the art, various vehicles provided with a lifting device comprising a hydraulic system are known. The known lifting device comprises a movable and pivotable (telescopic) lifting arm, which is mounted on the chassis of a truck. A hydraulic tool, such as a grab, a pallet hook, a brick grab, a tree clamp and the like, can be hydraulically connected to an end of the lifting arm. The hydraulic system of the lifting device comprises a hydraulic unit placed on the vehicle, which unit is provided with a reservoir with a pump. Two hydraulic lines are connected to the hydraulic unit, extending over the lifting arm in the direction of the end of the lifting arm, where, in a connected condition of the tool, they are connected to a double-acting cylinder provided on the tool. The hydraulic system further comprises a control valve by means of which the lines can be alternately pressurised for alternately extending or retracting the double-acting cylinder so as to thus operate the tool. The known hydraulic system further comprises two further lines which are connected to the unit, extending over the lifting arm and being connected to an actuator of the connecting device in order to thus effect a rotational movement of the tool. The four lines can thus be used for carrying out two functions of the tool, viz. rotation and actuation.

**[0003]** A drawback of the known lifting device is the fact that it is limited as regards the amount of hydraulic functions that can be performed at the location of the end of the lifting arm. It is of course possible, by adding two additional lines between the hydraulic unit and an additional actuator, to add an additional hydraulic function. However, this does not provide a solution for existing lifting devices, since the existing lifting arms hardly provide space for said additional lines, if at all. In addition to that, such an adaptation is relatively costly.

**[0004]** Accordingly it is an object of the present invention to provide a lifting device of the kind referred to in the introduction, which device is provided, in a relatively simple manner, with at least one additional hydraulic function.

**[0005]** It is furthermore an object of the present invention to provide lifting devices of the kind referred to in the introduction with at least one additional hydraulic function.

**[0006]** In addition to that it is an object of the present invention to provide a hydraulic system for such a lifting device, by means of which at least one additional hydraulic function can be obtained at the location of the tool.

**[0007]** According to one aspect thereof, the invention to that end provides a lifting device of the kind referred to in the introduction which is characterised by the features defined in the characterising part of claim 1. The hydraulic system is designed for alternately pressurising the first line and the second line. The hydraulic system

is furthermore designed for operatively connecting the first line and the second line simultaneously with the pump unit for simultaneously pressurizing the first line and the second line. Said simultaneous pressurization of the first line and the second line causes the actuator connected to the tool to block, so that the tool will undergo practically no movement due to the actuator. The hydraulic system further comprises an actuator line connected to one of said first line and said second line, which actuator line is connected to an additional actuator, which is disposed near the free end of the lifting arm. The actuator line comprises an adjustable valve unit. The valve unit can be opened in a condition in which the two lines are pressurized, such that the actuator line is pressurized as well. The opening and closing of the valve unit can take place automatically, but it may also be done semi-manually. The pressure on the actuator line provides pressure in the actuator, making it possible to operate the actuator. When the system is reset to a condition in which the line (the first line or the second line) connected to the actuator line is not pressurized, the actuator line will not be pressurized either, enabling the additional actuator to return to the condition of rest. In order to ensure that the additional actuator will at all times return to a condition of rest, the actuator line is further connected to the other of said first or said second line by means of a return line provided with an adjustable valve unit, for example a non-return valve unit. When the lifting device is returned to a normal operation mode, i.e. either the first or the second line is pressurized, and the other line is not pressurized, therefore, the pressure that may prevail in the actuator line can be released via the non-pressurized line. Thus an additional actuator is provided in a simple manner near the end of the lifting arm, which actuator can be controlled in a simple manner, making use of pressure prevailing in existing lines. The added lines can thus be provided locally, and no additional lines extending the entire length of the lifting arm need to be provided. Thus, a lifting device is realised which is provided with at least one additional hydraulic function in a relatively simple manner. The object of the present invention is thus accomplished.

**[0008]** The hydraulic system preferably comprises a connecting line provided with a controllable connecting valve unit, which connecting line is connected to the first and the second line. Such a connecting line comprising a valve unit is relatively easy to install. In a first condition, the first line and the second line can be alternately pressurized. In a second condition, the first line and the second line can be operatively connected to the pump unit simultaneously for pressurizing the first line and the second line simultaneously.

**[0009]** Further advantageous embodiments are the subject matter of the dependent claims. A few embodiments and their advantages will be explained in more detail hereinafter.

**[0010]** The additional actuator is preferably connected to the connecting device. In this way the additional function of the actuator can be used near the connecting de-

vice.

**[0011]** In one embodiment, the connecting device is detachably connectable to the tool. The connecting device can be alternately locked and unlocked. It is advantageous in that regard if the additional actuator is designed for alternately locking and unlocking the connecting device. The extra function obtained with the additional actuator is thus used for automatically effecting the locking and unlocking of the connecting device. As a result, a connection no longer needs to be effected manually, in contrast to the prior art. Such manual locking takes a great deal of time. The user must position himself near the end of the connecting device, subsequently connect the tool to the connecting device, and finally manually effect the locking engagement between the two, for example by manipulating a pin. The pin must be inserted into an opening intended for that purpose. If the opening is not perfectly aligned with the pin, the user must apply a great deal of force for correctly positioning the pin. The user is in that case engaged for some time. The user is positioned quite close to the tool and to the end of the arm. This is dangerous, since accidental movement of the lifting arm or the tool can lead to injury to the user. Furthermore, because the user must be present near the tool, he will in some cases have to work at dangerous locations, where there is for example a risk of falling. By using the lifting device according to the present invention and using the additional actuator for locking the connection, a lifting device is obtained which is safer and by means of which a gain in time can be realised.

**[0012]** The connecting device may comprise two hydraulic connecting elements for hydraulically connecting the first line and the second line to the tool. Since the lines to be connected and disconnected may be pressurized, the connecting elements are preferably designed to be connected and disconnected under pressure in order to thus prevent leakages upon connection and disconnection.

**[0013]** The additional actuator may be mechanically connected to at least one of the two hydraulic connecting elements for alternately connecting and disconnecting the same. The connecting device preferably also comprises a pressing device for moving at least one of the two hydraulic connecting elements to the connected condition. In this way an additional protection against the connection being disconnected is obtained. The additional actuator is designed for generating, in an operative condition thereof, a force which is greater than, and opposed to, the force delivered by the pressing device. The additional actuator is in that case mainly intended for disconnecting, in an operative condition thereof, the connecting device. The pressing device will place the connecting device in a locked condition upon placement of the additional actuator in an inoperative condition,

**[0014]** In one embodiment, the pressing device comprises a hydraulic cylinder. Said cylinder is operatively connected to the first line or the second line. As a result, the hydraulic cylinder will force the pressing device to the

connected condition in the pressurized condition of the first and/or the second line. In this way an additional protection against disconnection is obtained.

**[0015]** In a very simple embodiment, the pressing device comprises a spring element. Such a spring element is quite suitable for obtaining a reliable and safe force towards a locked position.

**[0016]** In one embodiment, the additional actuator comprises a hydraulic cylinder. Said hydraulic cylinder may be a single-acting cylinder or a double-acting cylinder.

**[0017]** According to another possibility, the hydraulic cylinders of at least one of the hydraulic connecting elements is/are a single-acting cylinder and/or double-acting cylinder. The advantage of a single-acting cylinder is that only one pressure line is required, which means a reduction of the number of lines required for the actuator.

**[0018]** The adjustable valve unit is preferably a non-return valve element. The adjustable valve unit is preferably controllably connected, via a control line, to the other of said first or said second line, in such a manner that the valve unit can be placed in an open condition under the influence of pressure on the other of said first or said second line. If the actuator line is connected to the first line, the control line will be connected to the second line, and vice versa. By pressurizing the two lines, the control line will cause the adjustable valve unit to be placed in an open condition. Because both lines are under pressure, also the actuator line will be pressurized. As a result, the additional actuator will be provided with pressure as well. The additional actuator can thus be driven.

**[0019]** According to one aspect of the invention, there is provided a vehicle, such as a truck, comprising a lifting device according to the present invention. Advantages of such a vehicle provided with such a lifting device have already been explained in the foregoing.

**[0020]** Another aspect of the invention relates to the use of a lifting device as described in the foregoing. The invention further relates to the use of a vehicle provided with a lifting device according to the present invention.

**[0021]** According to another aspect of the present invention, there is provided a method of the kind referred to in the preamble of claim 15 for adapting an existing lifting device. The method is characterised by the method steps defined in the characterising part of claim 15. An existing lifting device can be adapted in a very simple and inexpensive manner so as to thus add an additional function near the free end of the lifting arm. To that end, a connecting line provided with a controllable connecting valve unit must be provided. The connecting line and connecting valve unit must be connected to the first line and the second line in such a manner that the first line and the second line can be operatively connected to the pump unit simultaneously for pressurizing the first line and the second line simultaneously. Furthermore, an actuator line provided with an adjustable valve unit and an additional actuator must be provided. The actuator and

the adjustable valve unit must be connected to one of said first line or said second line. Furthermore, a return line provided with an adjustable valve unit must be provided, and these must be connected to the actuator line and to the other of said first line or said second line.

**[0022]** Further adaptations are realised by adding elements from the above-described embodiments of the lifting device.

**[0023]** Further advantages and embodiments of the present invention will now be explained by means of a description of the figures, in which:

Figure 1 is a side view of a truck comprising a load platform and a lifting device according to the present invention, which is mounted on the load platform;  
 Figures 2a and 2b are perspective views of a first part of a connecting device and a second part of a connecting device;  
 Figure 3 is a schematic view of the hydraulic system for the lifting device according to the present invention.

**[0024]** Figure 1 is a side view of a truck 1 comprising a load platform 2 and a lifting device 3 mounted on the load platform 2. The lifting device 3 is provided with a number of arms 4, which can be moved and pivoted relative to each other by means which are known per se, for example hydraulic means, so that one end of the lifting device 3 can be moved and pivoted in the x-, y- and z-directions. A tool in the form of a grab 5 is present on the load platform 2 of the truck 1. The grab 5 comprises a number of pivotally interconnected arms 6.

**[0025]** The end of the lifting device 3 is provided with a first part 7 of a connecting device 8, which can be connected to a second part 9 of the connecting device 8 that is connected to the grab 5, which connecting device is configured similarly to the connecting device described in EP 1 669 317 B1, which patent, and in particular the connecting device described therein, is incorporated herein by reference. The connecting device 8 will be explained in more detail hereinafter.

**[0026]** Figures 2a and 2b show the device 8 in more detail. The first part 7 (figure 2a) comprises a plate which is provided with a centring pin 10 and three pins 11, 12, 13 arranged symmetrically around said centring pin. The second part 9 (figure 2b) comprises a plate 15, which is provided with a number of openings 20, 21, 22, 23, which register with the centring pin 10 and the pins 11, 12, 13, respectively. The second plate may be connected to the tool by means of spacers, as is shown in figure 1.

**[0027]** As figure 2a clearly shows, the pins 11, 12, 13 comprise a widened portion spaced from the plate and a narrower portion extending between the plate and the widened portion. The widened portion has a spherical end on a side remote from the plate. The centring pin 10 is longer than the pins 11, 12, 13 and has a conical end on a side remote from the plate 10.

**[0028]** The openings 21, 22, 23 in the plate have a wid-

ened portion, into which the widened portion of the pins 11, 12, 13 can be positioned, and a narrower portion joining said widened portion. The narrower portion is so dimensioned that the narrower portion of the pin can easily move therethrough.

**[0029]** To connect the lifting device 3 to the tool 5, the operator of the truck 1 moves the lifting device 3 by means of the controls present on the truck 1 until the first part 7 connected to the end of the lifting device is positioned opposite the second part 9. Then the first part 7 is moved downwards until the conical end of the centring pin 10 is positioned in the centring opening 20. The conical shape of the end, the centring pin 10 allows easy insertion into the opening 20. Subsequently, the plate of the first part 7 of the connecting device is rotated about the centring pin 10 relative to the plate of the second part 9 of the connecting device until the widened portions of the pins 11, 12, 13 are positioned opposite the widened portions of the openings 21, 22, 23 and are inserted into said widened portions by subsequently moving the plate of the first part 7 in the direction of the plate. Once the plate of the first part 7 abuts against the plate of the second part 9, the widened portions of the pins 11, 12, 13 have passed through the widened portions of the openings 21, 22, 23 in their entirety. The plate is then rotated with respect to the plate of the second part by the operator of the lifting device 3, in such a manner that the narrower portions of the pins 11, 12, 13 are moved into the narrower portions of the openings 21, 22, 23. The plates are now interlocked. To prevent accidental rotation of the plates relative to each other during use of the tool 5, possibly causing the pins 11, 12, 13 to move out of the openings 21, 22, 23, the two hydraulic connecting elements 17 of the first part 7 of the connecting device are connected to corresponding hydraulic connecting openings 19 of the second part 9 of the connecting device. The plates are thus locked against movement relative to each other in a simple manner.

**[0030]** The hydraulic connection can also be locked mechanically, by using an additional actuator, as will be explained hereinafter with reference to a schematic survey of the hydraulic diagram shown in figure 3.

**[0031]** Figure 3 shows a schematic survey of the hydraulic diagram. The hydraulic system comprises a unit 30 provided on the frame 2, which unit comprises a reservoir 32 for hydraulic fluid and a pump unit 31 connected thereto. Downstream thereof, a control valve unit 33 is provided. Connected to said control valve unit 33 are a first line 41 and a second line 42. The control valve unit 33 is designed for alternately pressurizing the first and the second line 41, 42. The first line and the second line further extend to a part of the hydraulic system which is disposed substantially near or in the connecting device 8, which part is illustrated in a dotted square. In the right-hand part of the figure the first part 7 and the second part 9 of the connecting device 8 are schematically shown. In particular the hydraulic connecting openings 19 and the hydraulic connecting elements 17 are shown in sec-

tional view. A hydraulic connection 72 is effected by fully inserting the hydraulic connecting element 17 into the hydraulic connecting opening 19. The first line and the second line can subsequently be brought into operative contact with a hydraulic actuator 50 of the tool 5. In the illustrated embodiment said hydraulic actuator is a double-acting cylinder comprising a first chamber 51, a second chamber 52 and a cylinder 54 that is movable therein. Upon pressurization of the first line, i.e. the control valve unit 33 is moved fully to the left, fluid will flow into the second chamber 52, as a result of which the piston will move to the left. Upon pressurization of the second line 42, i.e. the control valve unit 33 is moved fully to the right, the first chamber 51 of the actuator 50 is pressurized and the cylinder 54 will move to the right again. Operation of the tool is now possible.

**[0032]** As is shown in the left-hand part of the figure, a connecting line 38 comprising a controllable connecting valve unit 36 is provided between the first line 41 and the second line 42. The connecting valve unit is the so-called 3/2 valve having three connections and two positions. In the position of rest, a passage for the second line is obtained. In the other position, the first line 41 is connected to the rear part of the second line 42, as a result of which the two lines can be pressurized. Downstream of the connecting valve unit 36, an actuator line 45 is furthermore connected to the second line 42. Said actuator line is provided with an adjustable valve unit 44, a non-return valve 44 in the illustrated example. The actuator line is further connected to an additional actuator 47. In the illustrated embodiment, said additional actuator is a single-acting cylinder 47 comprising a pressure chamber 46. The non-return valve can be opened by means of a control line 61. The actuator line 45 is further provided with an additional return line 62, which connects the first line 41 to the actuator line 45. The return line 62 further comprises a non-return valve 63.

**[0033]** Near the location of the hydraulic connection, the first line and the second line are both provided with a hydraulic cylinder 74, which functions to make it possible to move the hydraulic connecting elements 17. The hydraulic cylinders 74 are so-called single-acting cylinders, which means that when the first line and/or the second line is (are) pressurized, the pressure chamber of the cylinder 74 will fill, causing the hydraulic connecting element 17 to move downward. The hydraulic connecting element 17 is movably accommodated in the hydraulic cylinder, forming the piston of the hydraulic cylinder, as it were. The piston has a surface area so large that once the pressure chamber is pressurized, it will experience a force that causes the piston, and thus the hydraulic connecting element, to move downward. In other words, the hydraulic connection is in this way secured against being broken as a result of the pressure that occurs in the first and/or the second line.

**[0034]** It will be understood that the hydraulic connecting element 17 will also experience an upward force as a result of the pressure that prevails near the other con-

nection 72. Said upward force depends on the pressure-experiencing area at the location of the dividing plane of the connection 72. The area of the hydraulic connecting element 17 in the hydraulic cylinder 74 is therefore larger than the area of the dividing plane near the connection 72.

**[0035]** The additional actuator 47 is mechanically connected to the hydraulic connecting element 17 by means of a connecting plate 48. Two spring elements 49 are provided at an upper side of said connecting plate 48. Said spring elements force the hydraulic connecting elements 17 downward, i.e. to a locked position.

**[0036]** The additional actuator 47 is so designed that the additional actuator will move upward upon pressurization of the first line 41 and the second line 42 and the subsequent pressurization of the actuator line 45, because the pressure prevailing in the actuator chamber 46, and the resulting force exerted on the additional actuator 47, is larger than the combined forces that press the hydraulic connecting elements downward. The combined forces are in this case provided by a pressing device 80 comprising the hydraulic cylinders 74 and the spring elements 49.

**[0037]** Since the pressures prevailing in the lines are the same for all the lines once the first line 41 and the second line 42 are pressurized, the surface area of the piston 47 of the additional actuator 47 must be so large that the resulting upward force is greater than the combined downward forces. Given an unchanged pressure, a larger surface area will result in a larger force. The skilled person, starting from the selected pressing device, will be capable of realising an additional actuator having adequate dimensions.

**[0038]** When the pressure on one of the two lines 41, 42 is released, one of the two non-return valves 44, 63, or both, will be opened, as a result of which the pressure in the chamber 46 of the additional actuator 47 can escape and the pressing device 80 will lock the hydraulic connection again.

**[0039]** Those skilled in the art will appreciate that the invention is not limited to the embodiments described in the foregoing and that many variants are possible, which variants may fall within the scope of the appended claims.

## Claims

1. A lifting device (3) comprising a frame (2) as well as a movable lifting arm (4) extending from the frame, which lifting arm is provided with a connecting device (8) at a free end thereof for mechanically and hydraulically connecting a hydraulically operable tool (5) to the lifting arm, which lifting device (3) is provided with a hydraulic system for controlling a hydraulic actuator (50) of the tool (5), which hydraulic system comprises

- a reservoir (32) for hydraulic fluid disposed on the frame as well as a pump unit (31) connected

to the reservoir for pumping hydraulic fluid through the hydraulic system;

- a control valve unit (33), which is connected to the pump unit (31);
- a first line (41) and a second line (42), which extend from the control valve unit (33) to the connecting device (8);

said control valve unit (33) being arranged for operatively connecting the first line (41) and the second line (42) at least alternately to the pump unit (31) for alternately pressurizing the first line (41) and the second line (42), **characterised in that** the hydraulic system is arranged for operatively connecting the first line (41) and the second line (42) simultaneously to the pump unit (31), wherein the hydraulic system comprises an actuator line (45) provided with an adjustable valve unit (44), which is connected to one of said first line (41) or said second line (42), wherein the actuator line (45) is further connected to an additional actuator (47) disposed near the free end of the lifting arm (4) and wherein the actuator line (45) is further connected to the other of said first (41) or said second line (42) by means of a return line (62) provided with an adjustable valve unit (63).

2. A lifting device according to claim 1, wherein the hydraulic system comprises a connecting line (38) provided with a controllable connecting valve unit (36), which connecting line is connected to the first (41) and the second line (42) for pressurizing the first line (41) and the second line (42) simultaneously.
3. A lifting device according to claim 1 or 2, wherein the additional actuator (47) is connected to the connecting device (8).
4. A lifting device according to claim 1, 2 or 3, wherein the connecting device (8) is detachably connectable to the tool, wherein the connecting device (8) can be alternately locked and unlocked and wherein the additional actuator (47) is designed for alternately locking and unlocking the connecting device (8).
5. A lifting device according to one or more of the preceding claims, wherein the connecting device (8) comprises two hydraulic connecting elements (72) for hydraulically connecting the first line (41) and the second line (42) to the tool.
6. A lifting device according to claim 5, wherein the additional actuator (47) is mechanically connected to at least one of the two hydraulic connecting elements (72) for alternately connecting and disconnecting the same to/from the tool.
7. A lifting device according to claim 5 or 6, wherein the connecting device (8) comprises a pressing device

(80) for moving at least one of the two hydraulic connecting elements (72) to the connected condition.

8. A lifting device according to claims 6 and 7, wherein the additional actuator (47) is designed for generating, in an operative condition thereof, a force which is greater than, and opposed to, the force delivered by the pressing device (80).
9. A lifting device according to claim 7 or 8, wherein the pressing device (80) comprises a hydraulic cylinder (74) which is operatively connected to the first line (41) or the second line (42), and/or wherein the pressing device (70) comprises a spring element (49).
10. A lifting device according to one or more of the preceding claims, wherein the additional actuator (47) comprises a hydraulic cylinder, and/or wherein the hydraulic cylinder of the additional actuator and/or the at least one hydraulic cylinder of at least one of the hydraulic connecting elements is/are a single-acting cylinder.
11. A lifting device according to one or more of the preceding claims, wherein the adjustable valve unit (44) is controllably connected, via a control line (61), to the other of said first (41) or said second line (42), in such a manner that the valve unit can be placed in an open condition under the influence of pressure on the other of said first (41) or said second line (42).
12. A vehicle (1), such as a truck, provided with a lifting device (3) according to one or more of the preceding claims.
13. Use of a lifting device (3) according to one or more of the preceding claims 1 - 11, and/or use of a vehicle (1) according to claim 12.
14. A hydraulic system (100) for a lifting device (3) according to one or more of the preceding claims 1 - 11, wherein the hydraulic system (100) is configured as defined in one or more of the preceding claims 1 - 11.
15. A method for adapting a lifting device (3) comprising a frame (2) as well as a movable lifting arm (4) extending from the frame, which lifting arm is provided with a connecting device (8) at a free end thereof for mechanically and hydraulically connecting a hydraulically operable tool (5) to the lifting arm, which lifting device (3) is provided with a hydraulic system for controlling a hydraulic actuator (50) of the tool (5), which hydraulic system comprises
  - a reservoir (32) for hydraulic fluid disposed on the frame as well as a pump unit (31) connected

to the reservoir for pumping hydraulic fluid through the hydraulic system;

- a control valve unit (33), which is connected to the pump unit (31);
- a first line (41) and a second line (42), which extend from the control valve unit (33) to the connecting device (8);

said control valve unit (33) being designed for operatively connecting the first line (41) and the second line (42) at least alternately to the pump unit (31) for alternately pressurizing the first line (41) and the second line (42), wherein the method is **characterized** by the steps of:

- providing a connecting line (38) provided with a controllable connecting valve unit (36), and connecting the same to the first line (41) and the second line (42) in such a manner that the first line (41) and the second line (42) can be operatively connected to the pump unit (31) simultaneously for pressurizing the first line (41) and the second line (42) simultaneously,
- providing an actuator line (45) provided with an adjustable valve unit (44) and an additional actuator, and connecting the same to one of said first line (41) or said second line (42),
- providing a return line (62) provided with an adjustable valve unit (63), and connecting the same to the actuator line and to the other of said first line (41) or said second line (42) (42).

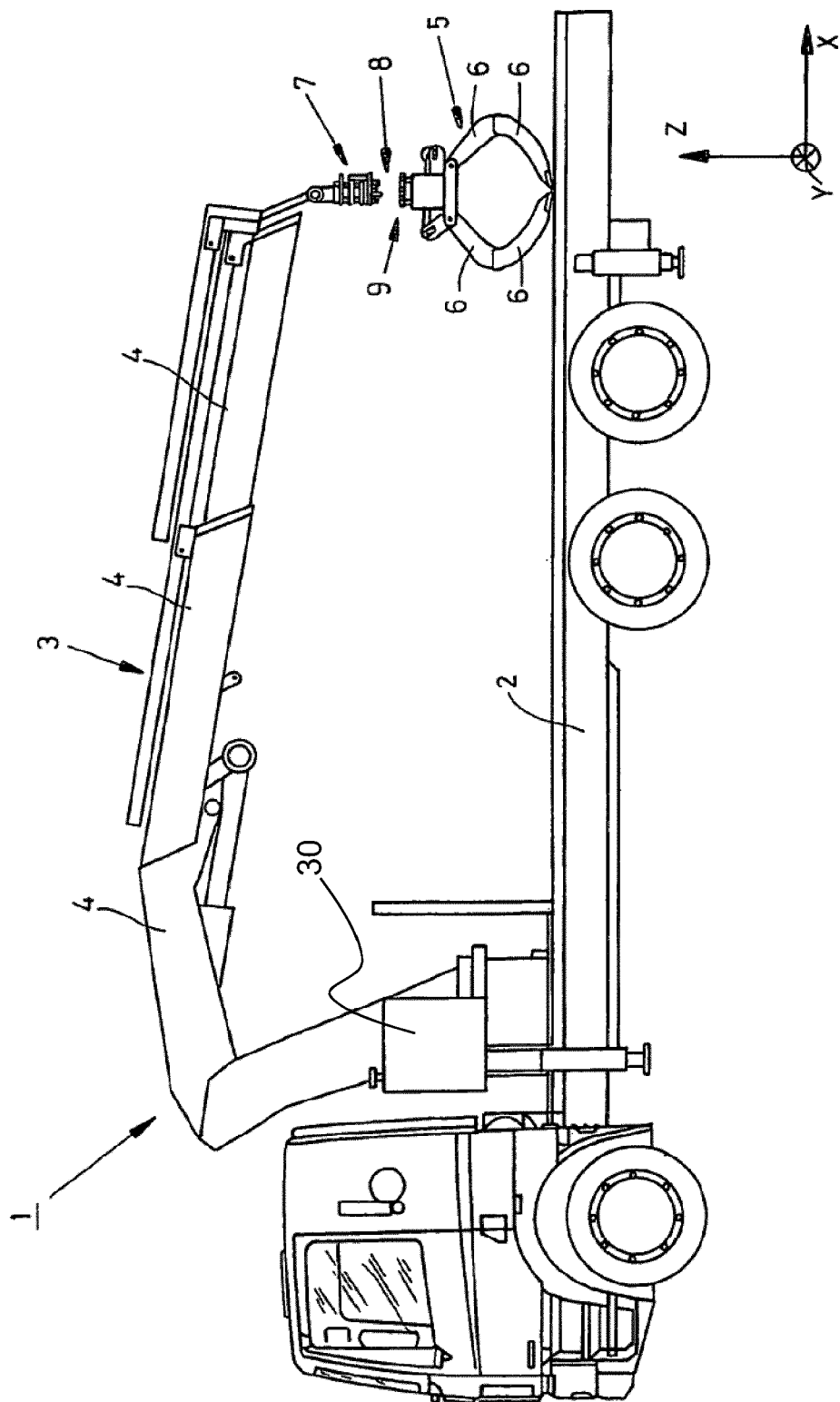
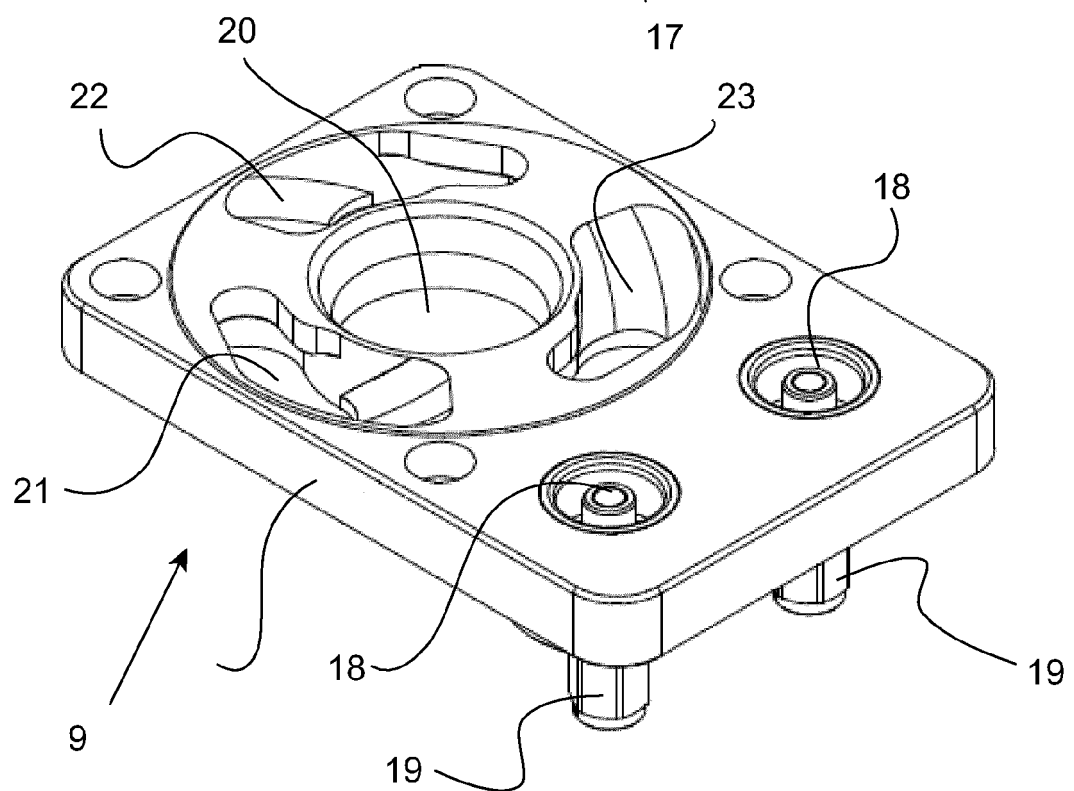
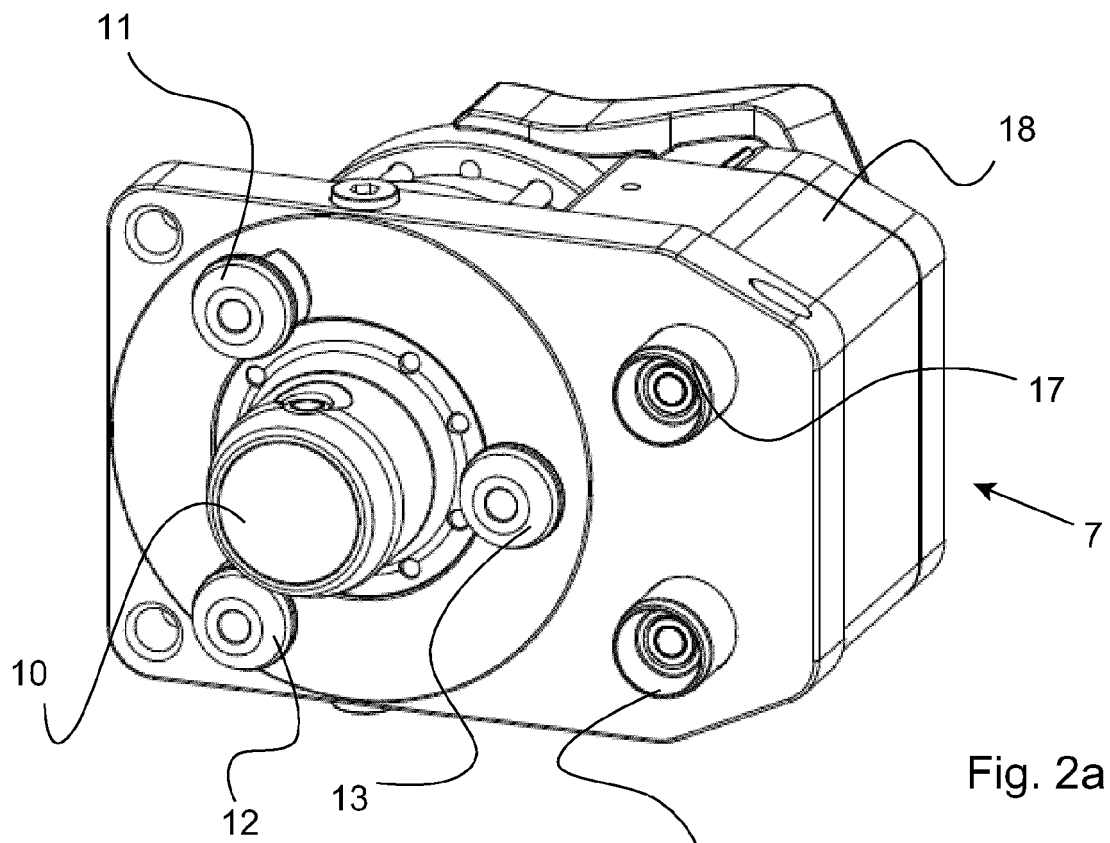
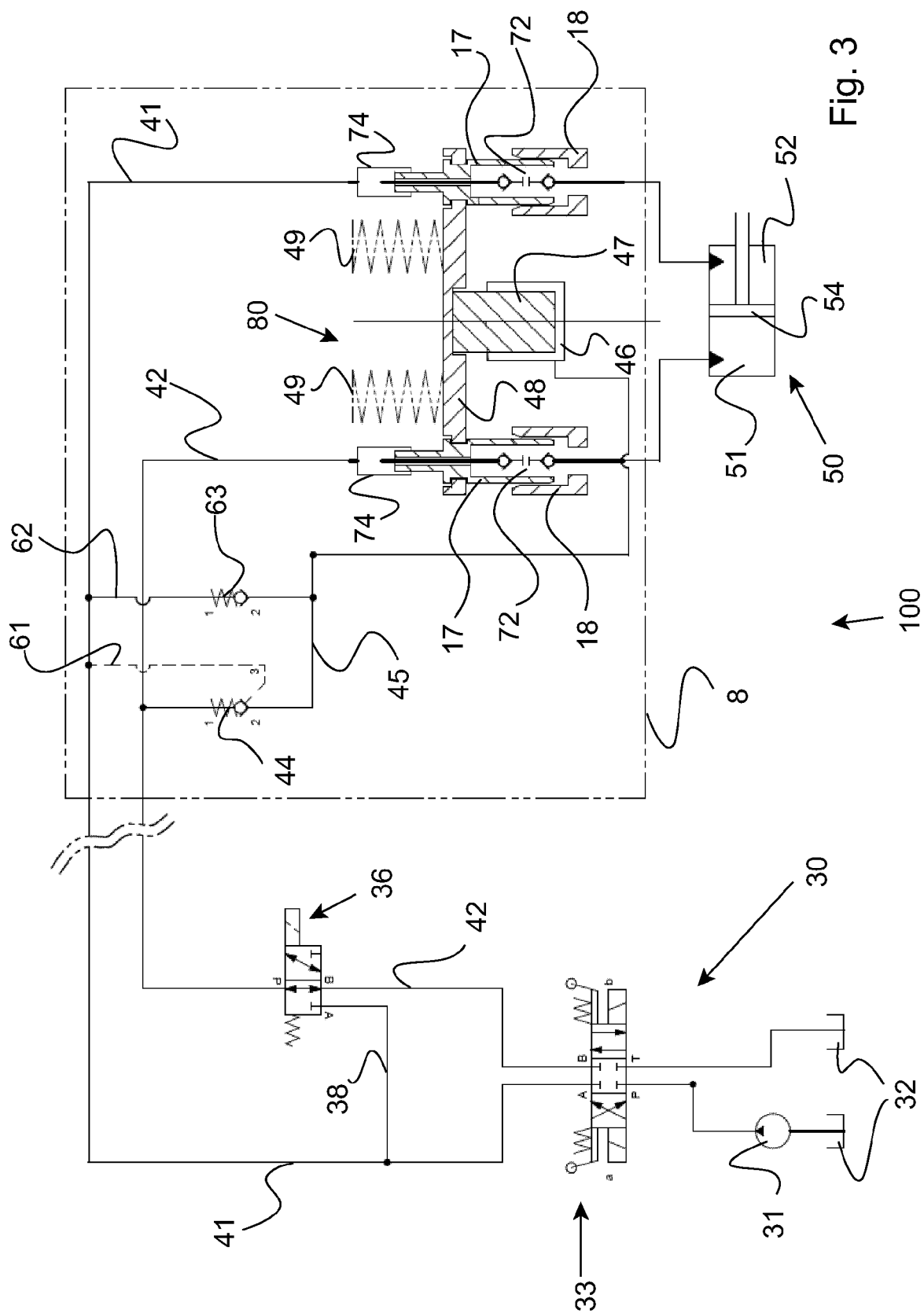


Fig. 1









## EUROPEAN SEARCH REPORT

Application Number  
EP 12 15 0891

| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | JP 2009 143705 A (CATERPILLAR JAPAN LTD)<br>2 July 2009 (2009-07-02)<br>* abstract; figures *<br>----- | 1,12,15                          | INV.<br>B66C13/14<br>E02F3/36<br>B66C1/42 |
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