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(54) **IMPROVED HYDRAULIC ARRANGEMENT FOR A WORK MACHINE, WORK MACHINE PROVIDED WITH SUCH HYDRAULIC ARRANGEMENT AND COMBINATION OF SUCH WORK MACHINE AND A COUPLING DEVICE**

(57) A hydraulic arrangement (4) for a work machine (1), configured to be fluidly connected to a quick coupler and comprising a source of pressurized hydraulic fluid (6); and a hydraulic circuit (10) configured to fluidly connect the source of pressurized hydraulic fluid (6) with a hydraulic actuator (270) of the quick coupler (200); the hydraulic circuit comprising: a first hydraulic line (12), which is configured to fluidly connect the source of pressurized hydraulic fluid (6) with the hydraulic actuator (270); a second hydraulic line (14) configured to fluidly connect a tank (7) with the hydraulic actuator (270); and a valve assembly (16), which is configured to be fluidly interposed between the first hydraulic line (12), the second hydraulic line (14) and the hydraulic actuator (270).

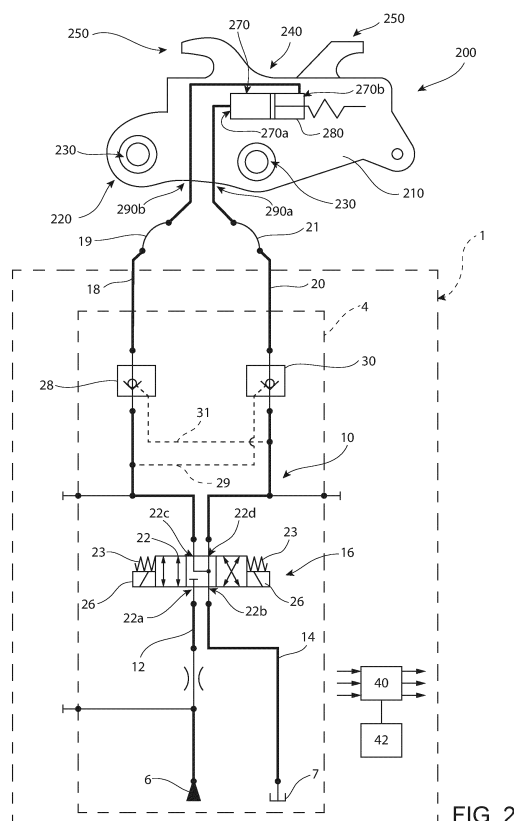


FIG. 2

Description

TECHNICAL FIELD

[0001] The present invention relates to an improved hydraulic arrangement for a work machine, in particular for an earth-moving machine such as an excavator, a digger, a mechanical shovel or the like. In addition, the present invention further relates to a work machine provided with such hydraulic arrangement, to a combination of such work machine and a coupling device and to a related control method.

[0002] The present invention finds its preferred, although not exclusive, application in a hydraulic arrangement for controlling a quick coupler adapted to be carried by a hydraulically actuated arm, of an excavator or the like. Reference will be made to this application by way of example below, without however losing in generality.

BACKGROUND OF THE INVENTION

[0003] As is known, work machines such as excavators, diggers and the like are provided with a hydraulically actuated work implement, which is carried by a body of the work machine and is configured to perform multiple earth-moving operations, such as digging, handling earth or gravel, loading trucks and/or similar operations.

[0004] Such hydraulically actuated work implement, in particular, comprises: a boom rotatably carried by the body of the work machine; a boom actuator configured to rotate the boom with respect to the body of the work machine; a stick or arm or dipper rotatably carried by the boom; an arm hydraulic actuator configured to rotate the arm with respect to the boom; a work tool, such as a bucket or the like, rotatably carried by the arm; and a bucket hydraulic actuator configured to rotate the bucket with respect to the arm.

[0005] In particular, a plurality of different types of work tools may be carried by the arm, depending on the specific operation to be carried out by the work machine, such as buckets, rakes, grapples, asphalt cutters or the like.

[0006] Hydraulically actuated quick couplers have been developed to allow such work tools to be quickly exchanged without the need for manual intervention by an operator or, for instance, without the driver of the working machine having to get out of the cab.

[0007] Such hydraulically actuated quick couplers are adapted to be rotatably carried by the free end of the arm of the work machine and are configured to allow the rapid exchange of buckets or similar tools.

[0008] A schematic example of such hydraulically actuated quick couplers is represented in Figure 1 and is denoted as a whole with reference number 100.

[0009] In particular, quick coupler 100 comprises a first coupling interface 110, which is configured to be mechanically connected to the free end of the arm of the

hydraulic machine.

[0010] In addition, quick coupler 100 comprises a second coupling interface 120 adapted to be selectively connected to the work tool to be attached to the arm of the work machine.

[0011] More in detail, second hydraulically actuated coupling interface 120 comprises a hydraulically actuated coupling member 130, such as one or more hook, which is carried in a movable manner by the body of the same quick coupler 100 and is selectively operable between an unlocking position and a locking position, in order to lock and unlock the attached work tool.

[0012] In addition, quick coupler 100 comprises a double effect hydraulic cylinder 140 configured to arrange the coupling member 130 in the locked and in the unlocked position.

[0013] In use, to operate the coupling member 130 between the locked and the unlocked position, a first chamber of the hydraulic cylinder 140 is fluidly connected to a source of pressurized hydraulic fluid, while the second chamber of the same hydraulic cylinder 140 is connected to tank.

[0014] In particular, hydraulic cylinder 140 is hydraulically connected to a hydraulic circuit 150 of the work machine via a pair of flexible hoses 160a and 160b, which are routed along the hydraulically actuated work implement, i.e. along the boom and the arm of the same work machine.

[0015] More in details, the two flexible hoses 160a and 160b are connected to hydraulic ports arranged on the body of the quick coupler 100, which in turn are fluidly connected to the two chambers of the hydraulic cylinder 140.

[0016] In addition, hydraulic circuit 150 comprises a valve arrangement 170 configured to selectively pressurize the first chamber of such hydraulic cylinder 140, in order to arrange the coupling member of quick coupler in the locking position.

[0017] Patent application US20230160172 A1 discloses a similar quick coupler, denoted with number 400. In particular, quick coupler 400 disclosed in US20230160172 A1 comprises a hydraulic cylinder 420, which is operatively connected to blocking members 430 and 440 and is configured to selectively arrange such blocking members 430 and 440 in a locking position or in an unlocking position.

[0018] In the locking position, blocking members 430 and 440 are configured to prevent a work tool 500 to separate from quick coupler 400 and an unlocking position.

[0019] Vice versa, in the unlocking position, blocking members 430 and 440 are configured to allow detachment of work tool 500 from quick coupler 400.

[0020] In addition, US20230160172 A1 discloses a hydraulic assembly 600 fluidly connected to hydraulic cylinder 420 and configured to control operation of the latter.

[0021] In particular, hydraulic assembly 600 comprises

a pump 601, a tank 602 and a directional assembly 610, in particular a directional control valve 610a, fluidly interposed between hydraulic cylinder 420, pump 601 and tank 602.

[0022] More in detail, directional control valve 610a is configured to be selectively and alternatively arranged in a first position, in which it arranges the hydraulic cylinder 420 in the locking position, in a second position, in which it arranges the hydraulic cylinder 420 in the unlocking position, and in a third floating position in which it fluidly connects both chambers of hydraulic cylinder 420 with tank 602.

[0023] Unfortunately, quick couplers of different manufacturers have different hydraulic interfaces, and sometimes the position of the two hydraulic ports configured to be hydraulic connected to the two flexible hoses 160a and 160b on the quick coupler 100 may be reversed with respect to the position of the respective flexible hose 160a or 160b.

[0024] In such cases, work machine manufacturers are forced to cross the two flexible hoses 160a and 160b along the boom or the arm, with the obvious drawbacks that this entails. Indeed, crossing the two flexible hoses may result in wear and damages to the same hoses during work machine operation, which may cause the failure of the same flexible hoses 160a and 160b, with the obvious drawbacks that this entails.

[0025] In view of the above, the need is felt to provide an improved hydraulic arrangement for a work machine able to overcome the aforementioned drawbacks.

[0026] Aim of the present invention is to satisfy the above-mentioned need in an optimized and cost-effective manner.

SUMMARY OF THE INVENTION

[0027] The aforementioned aims are reached by a hydraulic arrangement for a work vehicle, by a work vehicle by a combination of a work vehicle and a coupling device and by a method as claimed in the appended set of claims.

BRIEF DESCRIPTION OF DRAWINGS

[0028] For a better understanding of the present invention, a preferred embodiment is described in the following, by way of a non-limiting example, with reference to the attached drawings, wherein:

- Figure 1 is a schematic illustration of a hydraulic arrangement of a work machine, which is adapted to be connected to a quick coupler, as known in the art; and
- Figures 2 is schematic illustration of a hydraulic arrangement of a work machine, which is adapted to be connected to a quick coupler and is realized according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0029] With reference to Figure 2, number 1 denotes, as a whole, a work machine, in particular an earth-moving machine such as an excavator, a digger, a mechanical shovel or the like.

[0030] Work machine 1 comprises a body movable on the ground via ground engaging wheels or tracks.

[0031] In particular, as known, said body preferably comprises: a lower frame or undercarriage, which carries the ground engaging wheels or tracks to allow motion of the body with respect to the ground; and an upper frame or superstructure, which is carried in a rotatable manner by lower frame preferably about a rotation axis orthogonal to the advancing plane of work machine 1, i.e. orthogonal to the ground.

[0032] In addition, as always known, work machine 1 comprises a hydraulically actuated work implement or work arm, which is carried by the body and is configured to perform multiple earth moving operations, such as digging, handling earth or gravel, loading trucks and/or similar operations.

[0033] In particular, said work implement is rotatably carried by the upper frame of work machine 1.

[0034] As per se known, the hydraulically actuated work implement preferably comprises: a boom rotatably carried by the body; and a stick or arm or dipper, which is rotatably carried by the boom and, in turn, is configured to carry in a rotatable manner a work tool, such as buckets, rakes, grapples, asphalt cutters or the like.

[0035] In addition, work machine 1 preferably comprises a plurality of hydraulic cylinders, in particular double-acting hydraulic cylinders, configured to actuate the hydraulically actuated work implement.

[0036] More in detail, work machine 1 comprises at least one boom actuator, which is operatively interposed between the work machine body and the boom and is configured to rotate the boom with respect to said body.

[0037] In addition, work machine 1 further comprises at least one arm actuator, which is operatively interposed between the boom and the arm and is configured to rotate the arm with respect to the boom.

[0038] Preferably, work machine 1 further comprises also at least one bucket actuator, which is operatively interposed between the arm and the work tool and is configured to rotate the same work tool with respect to the arm.

[0039] In addition, with reference to the exemplary embodiment illustrated in Figure 2 number 200 indicates as a whole a coupling device, in the following referred to also as "quick coupler" or "quick hitch", which is configured to be rotatably carried by the work implement, in particular by the arm of work machine 1, and is further configured to allow the connection of the work tool to the same arm.

[0040] More in detail, as known, quick coupler 200 is configured to allow rapid exchange between different work tools without the need for manual intervention by

an operator.

[0041] In particular, quick coupler 200 is configured to be interposed between the arm of work vehicle 1 and the bucket or other similar work tools.

[0042] As known, quick coupler 200 comprises a first coupling interface 220 configured to be rotatably carried by the free end of the arm of work vehicle 1 opposite to the boom.

[0043] In particular, first coupling interface 220 is preferably configured to be mechanically connected to the free end of the arm of work machine 1.

[0044] For instance, first coupling interface 220 may comprise a pair of holes 230, which are realized on the body 210 of the quick coupler 200 and are configured to be engaged by respective pins carried by the arm of work machine 1, to securely attach the quick coupler 200 to the same arm.

[0045] In addition, as always known, quick coupler 200 comprises a second coupling interface 240, which is adapted to be mechanically connected to the work tools to be attached to the arm of work machine 1.

[0046] More in detail, the second coupling interface 240 comprises a hydraulically actuated coupling member 250, which is configured to be coupled to the work tool and is selectively arrangeable in a locking position, in which it is configured to firmly/securely attach the work tool to the same quick coupler 200, and an unlocking position, in which it allows detachment of the work tool from quick coupler 200 and work machine 1.

[0047] In particular, with reference to the exemplary embodiment illustrated in Figure 2, the coupling member 250 preferably comprises two hooks 250, which are adapted to engage respective pins carried by the work tool, in order to securely attach the same work tool to the arm of work machine 1.

[0048] Preferably, one of the two hooks 250 is fixedly/rigidly carried by the body 210 and the other one between the two hooks 260 is carried in a movable manner and is movable from and towards a locking position, in which it is configured to engage a respective pin of the work tool, in order to firmly attach the same work tool to the quick coupler 200.

[0049] In addition, with reference to the exemplary embodiment illustrated in Figure 2, quick coupler 200 comprises a hydraulic actuator 270, in particular a double-effect hydraulic actuator, which is operatively connected to the hydraulically actuated coupling member 250 and is configured to selectively operate the same hydraulically actuated coupling member 250 in the locking position or in the unlocking position.

[0050] In particular, preferably by pressurizing a first hydraulic port 270a of hydraulic actuator 270, coupling member 250 is arranged in the locking position, while by pressurizing the other hydraulic port 270b of hydraulic actuator 270, coupling member 250 is arranged in the unlocking position.

[0051] Clearly, the hydraulic port of the hydraulic actuator 270 to be pressurized to arrange the coupling

member 250 in the locking position may vary, for instance on the manufacturer and/or the model of the quick coupler 200.

[0052] Preferentially, the hydraulic actuator 270 comprises a double-effect hydraulic cylinder 280.

[0053] In use, one chamber of hydraulic cylinder 280 is configured to be connected to a source of pressurized hydraulic fluid and the other chamber of hydraulic cylinder 280 is configured to be connected to a tank, a reservoir or the like, in order selectively operate the hydraulically actuated coupling member 250 in the locking or in the unlocking position.

[0054] In addition, quick coupler 200 preferably comprises a first hydraulic port 290a and a second hydraulic port 290b, which are realized on the body 210 of the same quick coupler 200, are fluidly connected respectively to port 270a and to port 270b of the hydraulic actuator 270, and are configured to be fluidly connected, on command, to a source of pressurized fluid and to a tank of work machine 1, for instance by means of flexible hoses, to allow fluidly connecting the two chambers of the hydraulic actuator 270 to the source of pressurized of hydraulic fluid and to tank.

[0055] Preferably, the two hydraulic ports 290a and 290b are spaced apart to each other on opposite sides of the vertical midplane of the same quick coupler 200.

[0056] In addition, a first between hydraulic ports 290a and 290b is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the locking position.

[0057] The second one between hydraulic ports 290a and 290b is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the unlocking position.

[0058] In particular, depending on the model or make of the hydraulic coupler 200, the hydraulic port to be pressurized in order to arrange coupling member 250 in the locking or unlocking position may change.

[0059] With reference to the exemplary embodiment illustrated in Figure 2, work vehicle 1 further comprises a hydraulic arrangement 4, which is configured to be hydraulically connected to the quick coupler 200, in particular to the hydraulic actuator 270 via hydraulic ports 290a and 290b, and is configured to operate the same hydraulic actuator 270.

[0060] More in detail, hydraulic arrangement 4 comprises a source of pressurized hydraulic fluid 6. Source of pressurized hydraulic fluid 6, in particular, is configured to provide at outlet a pressurized flow of hydraulic fluid.

[0061] Preferably, source of pressurized hydraulic fluid 6 comprises a hydraulic pump, which is carried by an engine of work machine 1 and is adapted to be driven in rotation in order to suck hydraulic fluid from a tank 7 and to provide at outlet a pressurized flow of such hydraulic fluid.

[0062] With reference to the exemplary embodiment illustrated in Figure 2, hydraulic arrangement 4 further comprises a hydraulic circuit 10, which is configured to be fluidly connected to the quick coupler 200 in order to put

the hydraulic actuator 270 in fluid communication with the source of pressurized hydraulic fluid 6 and with a tank 7.

[0063] More in detail, hydraulic circuit 10 is preferably configured to be fluidly connected to ports 290a and 290b of quick coupler 200.

[0064] In particular, hydraulic circuit 10 comprises a first hydraulic line 12, in the following referred to as "high-pressure hydraulic line", which is configured to fluidly connect the outlet of the source of pressurized hydraulic fluid 6 with the quick coupler 200, particular with the hydraulic actuator 270.

[0065] In addition, hydraulic circuit 10 comprises a second hydraulic line 14, in the following referred to as "low pressure hydraulic line", which is configured to fluidly connect the quick coupler 200, in particular the hydraulic actuator 270 with tank 7.

[0066] With reference to the preferred embodiment illustrated in Figure 2, hydraulic circuit 10 further comprises a valve assembly 16, which is adapted to be fluidly interposed between the high-pressure line, the low-pressure line and the hydraulic actuator 270 of quick coupler 200 and is configured to control the flow of pressurized hydraulic fluid provided to the same hydraulic actuator 270.

[0067] More in detail, valve assembly 16 is preferably configured to be fluidly connected to the first port 290a and to the second port 290b of quick coupler 200, via a first hydraulic line 18 and via a second hydraulic line 20.

[0068] In particular, valve assembly 16 is configured to selectively fluidly connect, on command, a first one between first hydraulic port 290a and a second hydraulic port 290b with first hydraulic line 12, and a second one between first hydraulic port 290a and a second hydraulic port 290b with second hydraulic line 14.

[0069] First hydraulic line 18 and second hydraulic line 20 preferably comprise each a flexible hose 19 and 21 configured to connect the hydraulic arrangement 4 carried by work machine 1 body with the quick coupler 200 carried by the hydraulically actuated work implement, in particular by the arm.

[0070] Flexible hoses 19 and 21 are preferably routed along the boom and the arm and they preferably extend one aside, in particular substantially parallel, to the other.

[0071] In particular, flexible hoses 19 and 21 are preferably arranged one spaced aside the other on opposite sides of the vertical midplane of the hydraulically actuated arm of work vehicle 1.

[0072] With reference to the exemplary embodiment illustrated in Figure 2, flexible hose 19 is adapted to be fluidly connected to port 290b, and flexible hose 21 is adapted to be fluidly connected to port 290a, in order to avoid crossing of flexible hoses 19 and 21.

[0073] In addition, line 18 preferably connects valve assembly 16 with port 290b of quick coupler 200, while line 20 preferably connects valve assembly 16 with port 290a of quick coupler 200.

[0074] With reference to the exemplarity illustrated in Figure 2, valve assembly 16 preferably comprises a four-

ways three-positions valve 22, in particular solenoid-controlled valve.

[0075] A first port 22a of valve 22 is preferably fluidly connected to the high-pressure line 12 and to source 6 and a second port 22b of valve 22 is preferably fluidly connected to low-pressure line 14 and to tank 7.

[0076] Preferably, the two other ports 22c and 22d of valve 22 are configured to be fluidly connected to the hydraulic actuator 270.

[0077] More in detail, the two ports 22c and 22d of valve 22 are preferably configured to be fluidly connected to hydraulic ports 290 of quick coupler 200 via line 18 and line 20 respectively.

[0078] In a first position or neutral position, illustrated in Figure 2, valve 22 is preferably configured to put the two ports 270a and 270b of hydraulic actuator 270 in fluid communication with low-pressure line 14 and to fluidly isolate high-pressure line 12.

[0079] More in detail, in the first position, valve 22 is preferably configured to put the two ports 290a and 290b of hydraulic coupler and the two lines 18 and 20 in fluid communication with low-pressure line 14 and to fluidly isolate high-pressure line 12.

[0080] Preferably, valve 22 comprises biasing means 23 configured to bias valve 22 in the first position.

[0081] In the second position, valve 22 is preferably configured to put port 270a of hydraulic actuator 270, in particular port 290a, in fluid communication with high-pressure line 12 and port 270b of hydraulic actuator 27, in particular port 290b, in fluid communication with low-pressure line 14.

[0082] Vice-versa, in the third position, valve 22 is preferably configured to put port 270a of hydraulic actuator 270, in particular port 290a, in fluid communication with low-pressure line 14 and port 270b of hydraulic actuator 27, in particular port 290b, in fluid communication with high-pressure line 12.

[0083] In other words, in the second position, valve 22 is preferably configured to put port 290a and line 20 in fluid communication with high-pressure line 12 and a port 290b and line 18 in fluid communication with low-pressure line 14.

[0084] Vice-versa, in the third position, valve 22 is preferably configured to put port 290b and line 18 in fluid communication with high-pressure line 12 and a port 290a and line 20 in fluid communication with low-pressure line 14.

[0085] Preferably, valve assembly 16 further comprises two solenoids 26, which are operable to selectively arrange valve 22 in the second or in the third position.

[0086] With reference to the exemplary embodiment illustrated in Figure 2, hydraulic arrangement 4 preferably comprises two check valves 28 and 30, which are respectively arranged along line 18 and 20, advantageously downstream valve assembly 16.

[0087] Check valve 28 and 30 are preferably configured to allow unidirectional flow of the pressurized hydraulic fluid from the source 6 and valve assembly 22

towards the hydraulic coupler 200.

[0088] In addition, check valves 28 and 30 are preferably pilot operated check valves.

[0089] More in detail, hydraulic arrangement 4 preferably comprises a first pilot line 29, which fluidly connects port 22c with check valve 30, and is configured to open check valve 30 when valve 22 is arranged on the third position, i.e. when line 18 is pressurized, so as to open check valve 30 and allow to discharge the pressurized hydraulic fluid contained within line 20, between hydraulic coupler 200 and the same check valve 30.

[0090] Moreover, hydraulic arrangement 4 preferably comprises a second pilot line 31, which fluidly connects port 22d with check valve 28, and is configured to open check valve 28 when valve 22 is arranged on the second position, i.e. when line 20 is pressurized, so as to open check valve 28 and allow to discharge the pressurized hydraulic fluid contained within line 18, between hydraulic coupler 200 and the same check valve 28.

[0091] With reference to the exemplary embodiment illustrated in Figure 2, work machine 1 preferably further comprises an electronic control unit 40, which is operatively connected at least to valve assembly 16 and is provided with elaboration means configured to control the operation of the same valve assembly 16.

[0092] More in detail, electronic control unit 40 is preferably electronically connected to solenoids 26 and is configured to control its operation.

[0093] Preferentially, work machine 1 further comprises an input device 42, such as a knob, a button, a portion of a touch-sensitive screen or similar HMIs, which allow the operator to impart a command to control the operation of valve assembly 16.

[0094] Electronic control unit 40 is preferably electronically connected to input device 42 and is configured to control the operation of valve assembly 16, in particular of solenoids 26, as function of the commands imparted by the user via the input device.

[0095] In particular, input device 42 is preferably configured to output to electronic control unit 40 a first or locking command to arrange coupling member 250 in the locking position and a second or unlocking command to arrange coupling member 250 in the unlocking position.

[0096] In particular, input device 42 is configured to allow the user to operate valve assembly 16 in order to selectively arrange the coupling member 250 in the locking or in the unlocking position, to lock or unlock the work tool accordingly.

[0097] More in detail, electronic control unit 40, in response to the command received from input means 42, is configured to control operation of valve assembly 16 as function of the position of ports 290a and 290b of quick coupler 200, in order to avoid crossing of flexible hoses 19 and 21.

[0098] Input means 42 are preferably further configured to allow the user to impart commands associated to the relative position of the hydraulic ports 290a and 290b of quick coupler 200.

[0099] In particular, with reference to the exemplary embodiment illustrated in Figure 2, if hydraulic ports 290a is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the locking position, electronic control unit 40 may be configured to arrange valve 22 in its second position to arrange coupling member 250 in the locking position.

[0100] Vice-versa, if hydraulic port 290b is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the locking position, electronic control unit 40 may be configured to arrange valve 22 in its third position to arrange coupling member 250 in the locking position.

[0101] In addition, according to the preferred embodiment of the present invention, the electronic control unit 40 and the input device 42 are preferably configured to allow the user to control the operation of hydraulic arrangement 4 and therefore of quick coupler 200, in particular of coupling member 250, according to the ISO standard 13031:2013 (Earth moving machinery - Quick couplers - Safety).

[0102] The operation of the above-described work machine 1 is easy inferable from what above and is briefly the following.

[0103] In use, the operator attaches the quick coupler 200 to the arm of work machine 1 and then engages, with the same quick coupler 200, the work tool to be attached to the arm of work machine 1.

[0104] In particular, the operator connects the flexible hoses 19 and 21 to the respective ports 290b and 290a of quick coupler, avoiding crossing the same flexible hoses.

[0105] To lock the work tool to the quick coupler 200 and to arm of work machine 1, operator imparts command via input device 42 to arrange valve assembly in the second or in the third position, to pressurize the relative chamber of hydraulic actuator 270 and engage coupling member 250, thus safely and stably connecting the work tool to quick coupler 200.

[0106] Clearly, the position in which the valve has to be arranged depend on the chamber of the hydraulic actuator 270 to be pressurized to move the coupling member 250 in the locking position.

[0107] To disengage the quick coupler 200 from the work tool, on the other hand, valve assembly 16 is arranged in the opposite position with respect to the locking phase, i.e. respectively in the third or in the second position.

[0108] More in detail, the operator imparts command via user input means 42 related to the position/configuration of hydraulic ports 290a and 290b of quick coupler 200.

[0109] In particular, the operator imparts command via user input means 42 to indicate which one between hydraulic ports 290a and 290b is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the locking position.

[0110] Then, when operator imparts commands via user input means 42 to arrange coupling member 250 in the locking position, electronic control unit 40 controls valve assembly 22 depending on the position/configuration of hydraulic ports 290a and 290b.

[0111] More in detail, when operator imparts commands via user input means 42 to arrange coupling member 250 in the locking position and hydraulic port 290a is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the locking position, electronic control unit 40 arranges valve 22 in its second position.

[0112] Vice-versa, when operator imparts commands via user input means 42 to arrange coupling member 250 in the locking position and hydraulic port 290b is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the locking position, electronic control unit 40 arranges valve 22 in its third position.

[0113] In view of the foregoing, the present invention is further directed to a method for controlling hydraulic arrangement 4, which comprises the following steps:

- a) determining which one between hydraulic port 290a and 290b is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the locking position,
- b) receiving a control signal to arrange coupling member 250 in the locking position,
- c) if hydraulic port 290a is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the locking position, arranging valve 22 in its second position, or vice-versa,
- d) if hydraulic port 290b is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the locking position, arranging valve 22 in its third position.

[0114] The method may further comprise the following steps:

- e) receiving a control signal to arrange coupling member 250 in the unlocking position,
- f) if hydraulic port 290b is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the unlocking position, arranging valve 22 in its second position, or vice-versa,
- g) if hydraulic port 290a is configured to receive pressurized hydraulic fluid in order to control hydraulic cylinder 270 to arrange coupling member 250 in the unlocking position, arranging valve 22 in its third position.

[0115] In view of the foregoing, the advantages of a

hydraulic arrangement 4 according to the present invention are considerable and apparent.

[0116] In fact, it is apparent from the above that hydraulic arrangement 4 allows to connect quick couplers 200 having also hydraulic ports 290a and 290b and accordingly hydraulic actuators ports 270a and 270b in reversed position with respect to the corresponding ports of the same hydraulic arrangement 4, without the need to cross the flexible hoses 19 and 21. Indeed, such crossing is performed from valve assembly 16, which is configured to be able to pressurize selectively and alternatively both ends the same hydraulic cylinder depending on the position it is arranged.

[0117] By avoiding crossing the flexible hoses 19 and 21, the risk of their breakage is greatly reduced, with all the obvious benefits that this entails.

[0118] Lastly, the presence of the two check valves 28 and 30 securely closed when the valve assembly is in the first or neutral position allows to keep pressurized the branches of lines 18 or 20 comprised between the same check valve 28 or 30 and the quick coupler 200, in order to maintain the coupling member 250 securely arranged in the locking position and prevent accidental detachment of the work tool even if there are pressure drops in the hydraulic arrangement 4, thus increasing massively the safety associated with work machine 1. Un unwanted detachment of a bucket or a similar, work tool when the hydraulically actuated work implement of work machine 1 is lifted from the ground, indeed, might also result in a fatal accident.

[0119] It is clear that modifications can be made to the described hydraulic arrangement 4, to the related work machine 1 and to the quick coupler 200 which do not extend beyond the scope of protection defined by the claims.

Claims

1. A hydraulic arrangement (4) for a work machine (1), said work machine comprising a body movable on the ground via ground engaging means and a hydraulically actuated arm carried by said body;

said hydraulic arrangement (4) being configured to be fluidly connected to a coupling device (200), wherein said coupling device (200) is provided with:

- a first coupling interface (220), which is configured to be connected to said arm;
- a second coupling interface (240), which is configured to be selectively connected to a work tool, in order to allow connecting said work tool to said hydraulically actuated arm,
- a hydraulically actuated coupling member (250), which is configured to be coupled to said work tool and is selectively operable in

a locking position and in an unlocking position;

- a hydraulic actuator (270), which is operatively connected to said hydraulically actuated coupling member (250), is configured to be fluidly connected to said hydraulic arrangement (4) and is configured to selectively arrange said hydraulically actuated coupling member (250) in the locking position or in the unlocking position;
- a first hydraulic port (290a) and a second hydraulic port (290b), which are realized on a body (210) of said quick coupler (200) and are fluidly to a respective inlet (270a, 270b) of said hydraulic actuator (270),

said hydraulic arrangement (4) comprising:

- a source of pressurized hydraulic fluid (6); and
- a hydraulic circuit (10) configured to fluidly connect said source of pressurized hydraulic fluid (6) with said hydraulic actuator (270);

said hydraulic circuit comprising:

- a first hydraulic line (12), which is configured to fluidly connect said source of pressurized hydraulic fluid (6) with said hydraulic actuator (270);
- a second hydraulic line (14) configured to fluidly connect a tank (7) with said hydraulic actuator (270); and
- a valve assembly (16), which is configured to be fluidly interposed between said first hydraulic line (12), said second hydraulic line (14) and said hydraulic actuator (270), and is configured to selectively fluidly connect, on command, a first one between said first hydraulic port (290a) and a second hydraulic port (290b) with said first hydraulic line (12), and a second one between said first hydraulic port (290a) and a second hydraulic port (290b) with said second hydraulic line (14), and
- an electronic control unit (40), which is operatively connected to said valve assembly (16) and to said user input means (42) and comprises elaboration means configured to control the operation of said valve assembly (16) as function of the relative position of said first hydraulic port (290a) and a second hydraulic port (290b).

2. Hydraulic arrangement according to claim 1, further comprising user input means (42) configured to impart commands to arrange said coupling member

(250) on said locking position or said unlocking position, and commands associated to the relative position of said hydraulic ports (290a) and (290b), said electronic control unit (40) being configured to control the operation of said valve assembly (16) on the basis of the commands received by said user input means (42).

3. Hydraulic arrangement according to claim 1 or 2, wherein said valve assembly (16) comprises a solenoid-controlled valve (22).

4. Hydraulic arrangement according to any of claims 1 to 3, wherein said valve assembly (16) comprises a four-way three-position hydraulic valve (22).

5. Hydraulic arrangement according to claim 4, wherein:

a first port (22a) of said hydraulic valve (22) is configured to be fluidly connected to said first hydraulic line (12);
a second port (22b) of said hydraulic valve (22) is configured to be fluidly connected to said second hydraulic line (14); and
a third (22c) and a fourth (22d) ports of said hydraulic valve (22) is configured to be fluidly connected to respective ports (270b, 270a) of said hydraulic actuator (270).

6. Hydraulic arrangement according to claim 4 or 5, wherein said valve (22):

in a first position is configured to put the said first port (290a) and said second port (290b) in fluid communication with said low-pressure line (14) and to fluidly isolate said high-pressure line (12),
in a second position is configured to put said first port (290a) in fluid communication with high pressure line (12) and said second port (290b) in fluid communication with low pressure line (14), and
in a third position is configured to put said first port (290a) in fluid communication with low pressure line (14) and said second port (290b) in fluid communication with high pressure line (12).

7. Hydraulic arrangement according to claim 5 or 6, further comprising a first check valve (28) and a second check valve (30) arranged downstream said valve assembly (16), respectively along a third hydraulic line (18) configured to fluidly connect the third port (22c) of said hydraulic valve (22) to said second port (270b) of said hydraulic actuator (270) and along a fourth hydraulic line (19) configured to fluidly connect the fourth port (22d) of said hydraulic valve (22) to said first port (270a) of said hydraulic actuator (270).

8. Hydraulic arrangement according to claim 7, further comprising a first pilot line (31) configured to fluidly connect said first check valve (28) to said fourth line (20), in order to allow to open said first check valve (28) when said hydraulic valve (22) is arranged in said third position; and
 a second pilot line (29) configured to fluidly connect said second check valve (30) to said third line (18), in order to allow to open said second check valve (30) when said hydraulic valve (22) is arranged in said second position.
9. Hydraulic arrangement according to claim 6, 7 or 8, wherein if the first one between said first hydraulic port (290a) and said second hydraulic port (290b) is configured to receive pressurized hydraulic fluid to arrange said control member (250) in the locking position, electronic control unit (40) is configured to arrange said valve (22) in its second position, and if the second one between said first hydraulic port (290a) and said second hydraulic port (290b) is configured to receive pressurized hydraulic fluid to arrange said control member (250) in the locking position, electronic control unit (40) is configured to arrange said valve (22) in its third position.
10. Hydraulic arrangement according to claim 9, wherein user input means (42) are configured to output signals to said control unit (40) adapted to indicate which one between said first hydraulic port (290a) and said second hydraulic port (290b) is configured to receive pressurized hydraulic fluid in order to arrange coupling member 250 in said locking position.
11. A work machine (1) comprising a body movable on the ground via ground engaging means, a hydraulically actuated arm carried by said body, and a hydraulic arrangement (4) as claimed in any one of the preceding claims.
12. A combination comprising a work machine (1) as claimed in claim 11 and a coupling device (200) comprising:
- a first coupling interface (220), which is configured to be connected to said arm,
 - a second coupling interface (240), which is configured to be selectively connected to a work tool, in order to allow connecting said work tool to said hydraulically actuated arm, and comprises a hydraulically actuated coupling member (250), which is configured to be coupled to said work tool and is selectively operable in a locking position and in an unlocking position,
 - a hydraulic actuator (270), which is operatively connected to said hydraulically actuated coupling member (250), is configured to be fluidly connected to said hydraulic arrangement and is configured to selectively arrange said hydraulically actuated coupling member (250) in the locking position or in the unlocking position, and
 - a first hydraulic port (290a) and a second hydraulic port (290b), which are realized on a body (210) of said quick coupler (200) and are fluidly to a respective inlet (270a, 270b) of said hydraulic actuator (270).
13. A method of operation of a hydraulic arrangement realized according to any of claims 6 to 10, said method comprising the steps of:
- a) determining which one between said first hydraulic port (290a) and said second hydraulic port (290b) is configured to receive pressurized hydraulic fluid in order to arrange said coupling member (250) in said locking position,
 - b) receiving a control signal to arrange said coupling member (250) in said locking position,
 - c) if the first one between hydraulic port (290a) and second hydraulic port (290b) is configured to receive pressurized hydraulic fluid in order to arrange said coupling member (250) in said the locking position, arranging said valve (22) in its second position, or vice-versa,
 - d) if the second one between hydraulic port (290a) and second hydraulic port (290b) is configured to receive pressurized hydraulic fluid in order to arrange said coupling member (250) in said the locking position, arranging said valve (22) in its third position.

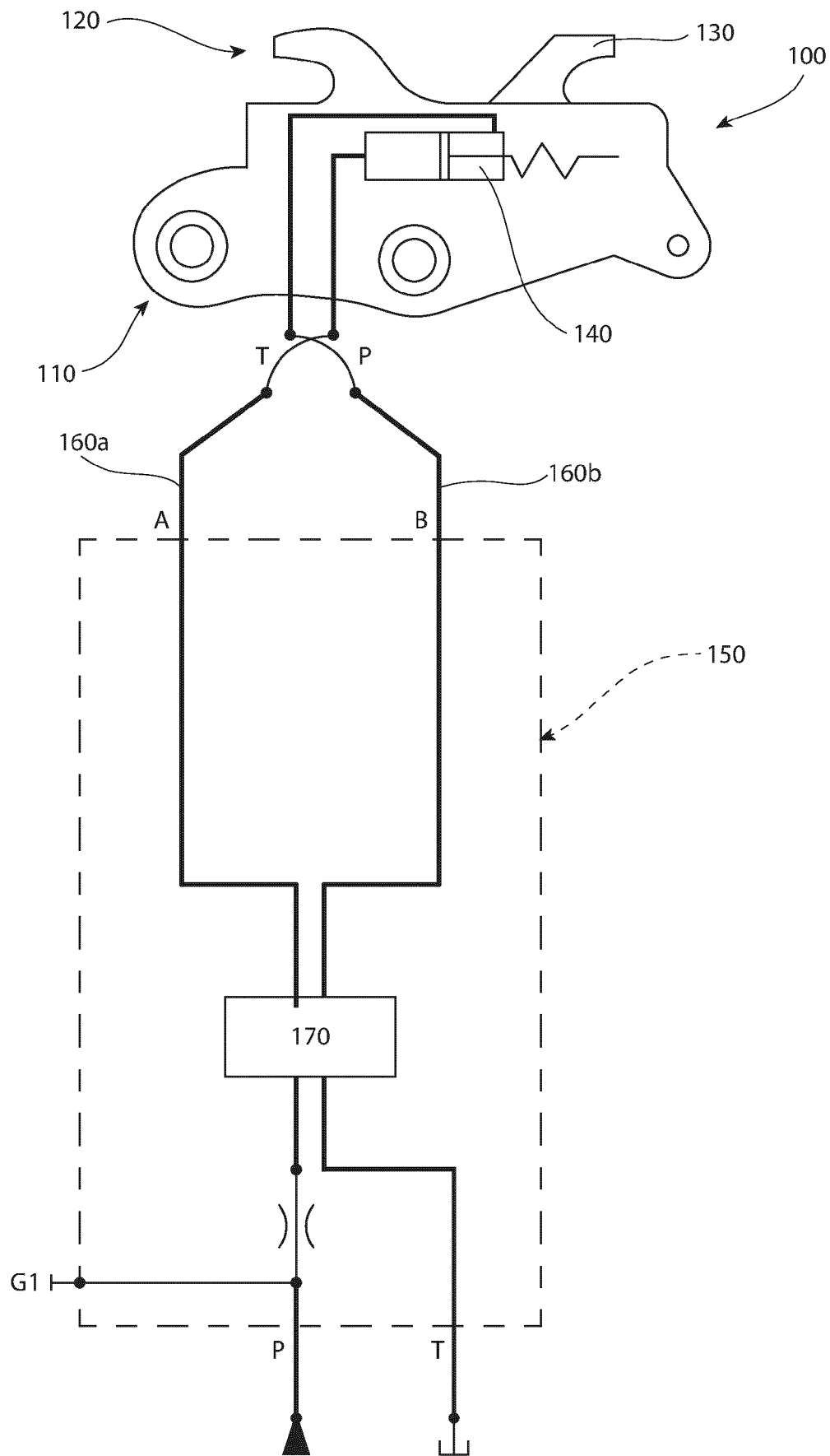
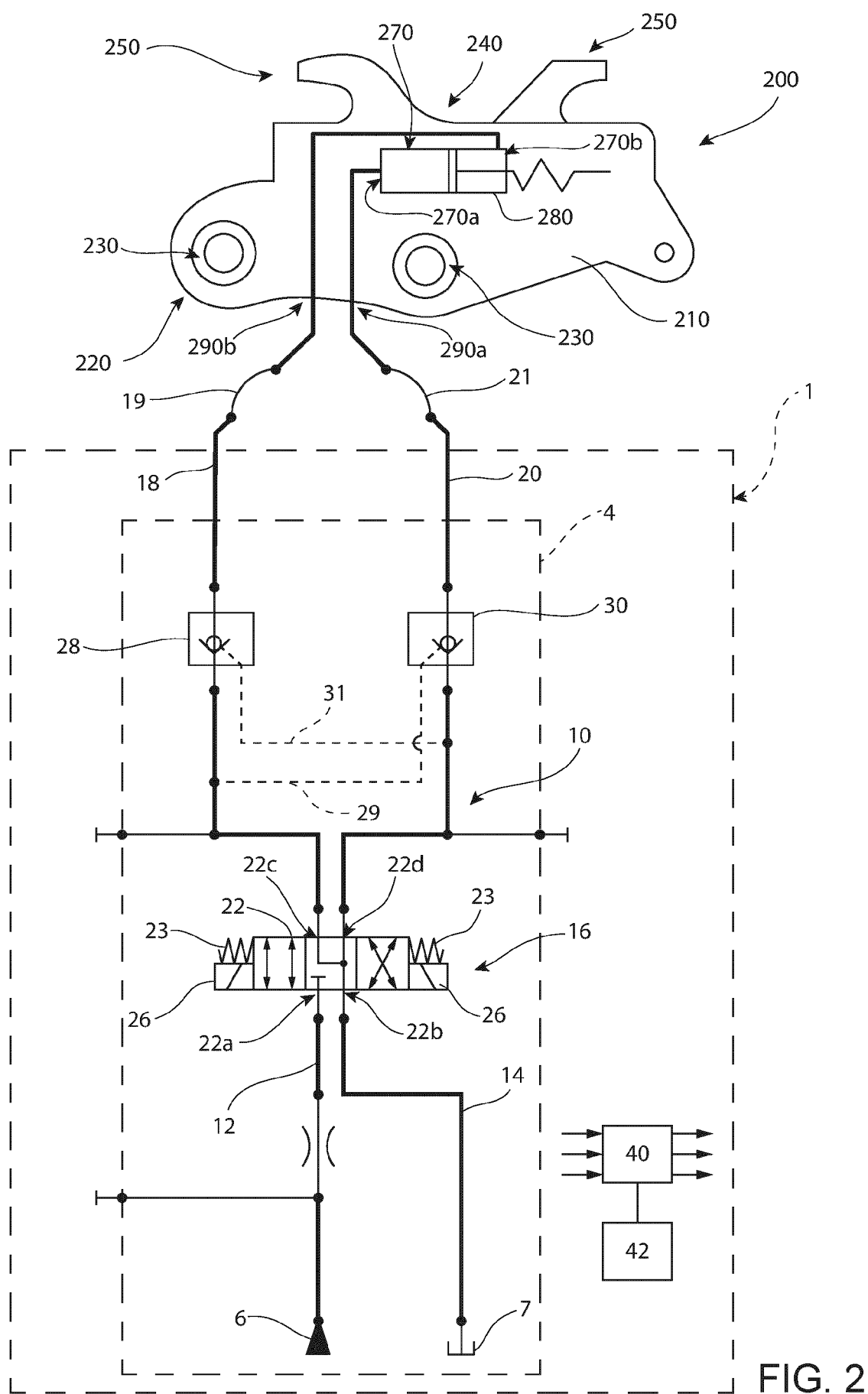


FIG. 1





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