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(54) IMPROVED WORK MACHINE

(57) A work machine (1) comprising a body, a hydraulically actuated work implement carried by the body; plurality of hydraulic actuators (4) configured to actuate the body and/or the hydraulically actuated work implement; and a hydraulic arrangement (12), which is fluidly connected to the hydraulic actuators (4);
said hydraulic arrangement (12) comprising: a source of pressurized hydraulic fluid (14), to provide at outlet a flow of the pressurized hydraulic fluid; a hydraulic circuit (18) to put the source of pressurized fluid (14) in fluid communication with the hydraulic actuators (4); and control valve arrangement (40), to selectively put said hydraulic circuit (18) in fluid communication with said hydraulic actuators (4); the hydraulic circuit comprises: a first hydraulic line (20), which fluidly connects the hydraulic actuators (4) with the tank (16); a first hydraulic line assembly (21), which fluidly connects the source of pressurized hydraulic fluid (14) with at least a first among said hydraulic actuators (4); and a second hydraulic line assembly (22), which fluidly connects the source of pressurized hydraulic fluid (14) with at least a second among said hydraulic actuators (4), different from said first hydraulic actuator (4).

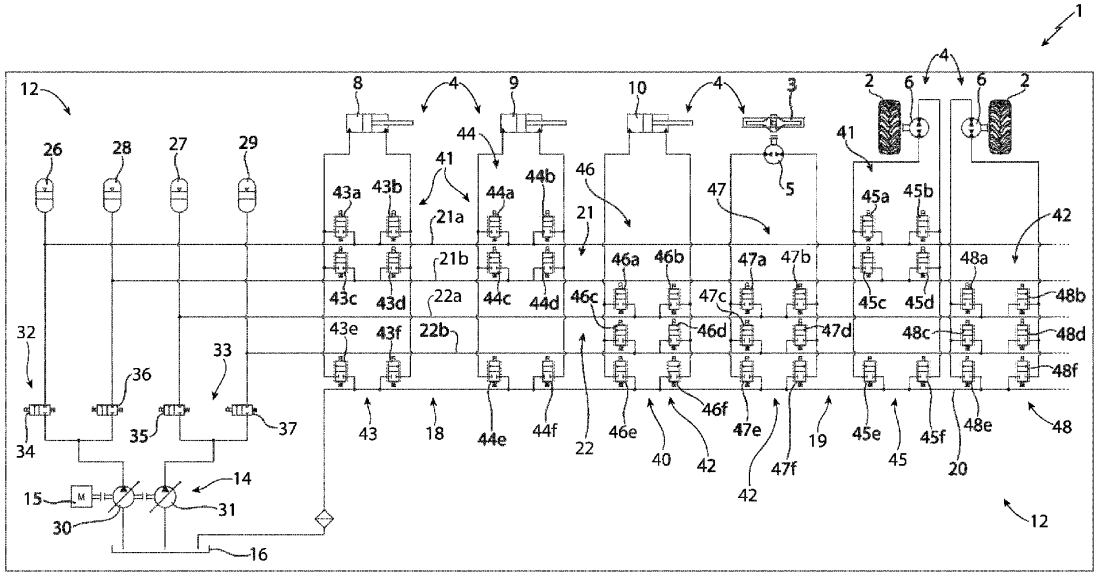


Fig. 2

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Description

TECHNICAL FIELD

[0001] The present invention relates to a work machine, in particular to an earth-moving machine such as an excavator, a digger, a mechanical shovel or the like.

[0002] The present invention finds its preferred, although not exclusive, application in a work machine, in particular an excavator, including a hydraulic arrangement provided with a common pressure rails (CPR) configuration and configured to operate the same work machine. Reference will be made to this application by way of the 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.

[0004] A simplified example of such hydraulic machine is illustrated in Figure 1 and is denoted as a whole with reference number 100.

[0005] Work machine 100 comprises a body movable on the ground via ground engaging wheels or tracks (not illustrated).

[0006] Such body in particular comprises: an undercarriage (not illustrated), which carries the ground engaging wheels or tracks to allow motion of the body with respect to the ground; and a superstructure 110, which is carried in a rotatable manner by the undercarriage.

[0007] Work machine 100 further comprises a hydraulic motor 120, also referred to swing motor which is configured to rotate the superstructure 110 with respect to the undercarriage.

[0008] In addition, work machine 100 comprises also at least two additional hydraulic motors 130, which are configured to drive the ground engaging wheels or tracks in rotation to allow motion of the body of the work machine 100 with respect to the ground.

[0009] Work machine 1 comprises a hydraulically actuated work implement, which is carried by said body and is configured to perform multiple earth moving operations, such as digging, handling earth or gravel, loading trucks and/or similar operations.

[0010] As known, said hydraulically actuated work implement comprises: a boom rotatably carried by the body; a boom actuator 140 configured to rotate the boom with respect to the body 110; a stick or arm or dipper rotatably carried by the boom; an arm hydraulic actuator 150 configured to rotate the arm with respect to the boom; a bucket and/or other similar tools rotatably carried by the arm; and a bucket hydraulic actuator 160 configured to rotate the bucket with respect to the arm.

[0011] In addition, work machine 100 comprises a hydraulic system, which is configured to provide pressurized hydraulic fluid towards at least one of the aforementioned hydraulic actuators, in order to operate the latter.

[0012] Traditionally, such hydraulic system comprises a source of pressurized hydraulic fluid and directional proportional control valves configured to throttle the flow of hydraulic fluid provided to each hydraulic actuator, to control its operation. This allows a precise control of the operation of each hydraulic actuator, but unfortunately results in a great deal of hydraulic fluid routed back to tank, with the waste in energy that this entails.

[0013] With reference to Figure 1, to reduce waste of energy and allow some energy recovery, some manufacturer recently developed a hydraulic system 170 including a source of pressurized hydraulic fluid 180 and a hydraulic circuit 190 comprising a set of common pressure rails (CPR) and a set of logic on-off hydraulic valve configured to selectively fluidly connect the source of pressurized hydraulic fluid with the aforementioned hydraulic actuators.

[0014] However, during operation, multiple hydraulic actuators are usually operated simultaneously, in particular at least two actuators at the same time. For instance, bucket and arm actuator are usually operated simultaneously during a digging operation, or boom actuator and swing motor are operated simultaneously when unloading the loaded earth/gravel within a truck.

[0015] However, hydraulic system 170 is not optimized for application in work machines provided with multiples hydraulic actuators to be powered simultaneously, as in excavators, diggers, mechanical shovels or the like.

[0016] In other words, it is not possible to independently adapt the hydraulic fluid pressures within each pressure rail according to the load demands of each hydraulic actuator, in order to power simultaneously a plurality of different actuators and thus minimize throttling losses.

[0017] 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.

[0018] Aim of the present invention is to satisfy the above-mentioned need in an optimized and cost-effective manner.

SUMMARY OF THE INVENTION

[0019] The aforementioned aims are reached by a work machine as claimed in the appended set of claims.

BRIEF DESCRIPTION OF DRAWINGS

[0020] 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 for a hydraulically actuated work im-

plement of a work machine as known in the art;

- Figures 2 is schematic illustrations of a work machine realized according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] 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.

[0022] Work machine 1 comprises a body movable on the ground via ground engaging wheels or tracks 2.

[0023] In particular, said body preferably comprises: a lower frame or undercarriage (not illustrated), which carries the ground engaging wheels or tracks 2 to allow motion of the body with respect to the ground; and an upper frame 3 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.

[0024] In addition, work machine 1 comprises a hydraulically actuated work implement (not illustrated), which is carried by body 2 and is configured to perform multiple earth moving operations, such as digging, handling earth or gravel, loading trucks and/or similar operations.

[0025] In particular, said work implement is rotatably carried by the upper frame 3 of work machine 1.

[0026] In addition, work machine 1 comprises a plurality of hydraulic actuators 4, which are configured to actuate said body and/or said hydraulically actuated work implement.

[0027] More in detail, said hydraulic actuators 4 comprise at least one hydraulic motor 5, in the following referred to as "swing motor 5", which is operatively interposed between the lower frame and the upper frame 3 and is configured to rotate the upper frame 3 with respect the lower frame.

[0028] With reference to the exemplary embodiment illustrated in Figure 1, said hydraulic actuators 4 further comprise at least one hydraulic motor 6, in particular a reversible hydraulic motor 6, in the following referred to as "drive motor 6" which is configured to drive the ground engaging wheels or tracks 2 in rotation to allow motion of the work machine body with respect to the ground.

[0029] Preferably, hydraulic actuators 4 comprises a pair of drive motors 6, each operatively coupled to a corresponding wheel or track 2.

[0030] As per se known, the hydraulically actuated work implement preferably comprises: a boom rotatably carried by the body; a stick or arm or dipper rotatably carried by the boom; and a bucket and/or other similar tools rotatably carried by the arm.

[0031] In addition, hydraulic actuator 4 preferably comprises a plurality of hydraulic cylinders, in particular double-acting hydraulic cylinder, configured to actuate the hydraulically actuated work implement.

[0032] With reference to the exemplary embodiment illustrated in Figure 2, in particular, hydraulic actuators 4 comprises at least one boom actuator 8, which is operatively interposed between the work machine body and the boom and is configured to rotate the boom with respect to said body.

[0033] In addition, hydraulic actuators 4 further comprises at least one arm actuator 9, which is operatively interposed between the boom and the arm and is configured to rotate the arm with respect to the boom.

[0034] Preferably, hydraulic actuators 4 further comprise also at least one bucket actuator 10, which is operatively interposed between the arm and the bucket and is configured to rotate the bucket with respect to the arm.

[0035] With reference to the preferred embodiment illustrated in Figure 2, work machine 1 further comprise a hydraulic arrangement 12, which is fluidly connected to the aforementioned hydraulic actuators 4 and is configured to actuate this latter, in order to operate said work implement accordingly.

[0036] More in detail, hydraulic arrangement 12 is fluidly connected to swing motor 5, to drive motor or motors 6, to boom actuator 8, to arm actuator 9 and to bucket actuator 10, and is configured to provide these latter with pressurized hydraulic fluid in order to actuate these latter.

[0037] Hydraulic arrangement 12 comprises a source of pressurized hydraulic fluid 14, which is configured to provide at outlet a flow of pressurized hydraulic fluid.

[0038] More in detail, the source of pressurized hydraulic fluid preferably comprises pumping means 14, which are carried by an internal combustion engine 15 of the work machine 1, and are configured to suck hydraulic fluid from a tank 16 and to provide at outlet a pressurized flow of such hydraulic fluid.

[0039] With reference to the exemplary embodiment illustrated in Figure 2, hydraulic arrangement 12 further comprises a hydraulic circuit 18 which is adapted to put the source of pressurized fluid, i.e. the outlet of pumping means 14, in fluid communication with the aforementioned hydraulic actuators 4.

[0040] More in detail, the hydraulic circuit 18 is preferably provided with a common pressure rails (CPR) configuration, i.e. it comprises a plurality of separate hydraulic lines/ pipes/rails/conduits 19, which are fluidly connected in parallel to each other and are each configured to be selectively fluidly connected between the source of pressurized fluid and one or more of the hydraulic actuators 4.

[0041] In other words, according to the common pressure rails (CPR) configuration, hydraulic circuit 18 preferably comprises a plurality of hydraulic lines, which are fluidly connected in parallel to each other and are each configured to set a different pressure level.

[0042] In particular, according to the CPR configuration, hydraulic lines 19 of hydraulic circuit 18 are preferably configured to operate with a pressure setting which

is constant and is different to each other, in order each to be able to provide pressurized hydraulic fluid to hydraulic actuator 4 with different pressure levels.

[0043] More in detail, hydraulic circuit 18 comprises a first hydraulic line 20, in the following referred to "low-pressure hydraulic line 20" or "discharge hydraulic line 20", which is configured to selectively fluidly connect hydraulic actuators 4 with tank 16.

[0044] In addition, hydraulic circuit 18 comprises a first hydraulic line assembly 21, which is arranged in parallel to the low-pressure hydraulic line 20, and is configured to selectively fluidly connect the source of pressurized hydraulic fluid 14 with at least a first one among the aforementioned hydraulic actuators 4.

[0045] Furthermore, hydraulic circuit 18 comprises a second hydraulic line assembly 22, which is arranged in parallel to the low-pressure hydraulic line 20 and to the first hydraulic line assembly 21, and is configured to selectively fluidly connect the source of pressurized hydraulic fluid 14 with at least a second one among the aforementioned hydraulic actuators 4.

[0046] Preferably, hydraulic line assemblies 21 and 22 each have a CPR (common pressure rail) configuration, i.e. they may comprise a plurality of separate hydraulic lines arranged in parallel to each other.

[0047] Preferably, hydraulic line assemblies 21 and 22 are fluidly separated from each other and/or from-low pressure line 20.

[0048] More in detail, hydraulic line assemblies 21 and 22 comprise each at least one hydraulic line 21a and 22a, which is arranged in parallel to the low-pressure hydraulic line 20, and is configured to selectively fluidly connect the source of pressurized hydraulic fluid 14 with the aforementioned hydraulic actuators 4. Hydraulic lines 21a and 22a in the following will be referred to as "high-pressure hydraulic lines". High-pressure hydraulic lines 21a and 22a preferably are arranged in parallel to each other. In use, high-pressure hydraulic lines 21a and 22a may operate with different pressure levels.

[0049] In addition, with reference to the exemplary embodiment illustrated in Figure 2, each hydraulic lines assemblies 21 and 22 preferably comprises a further hydraulic line 21b and 22b, which is arranged in parallel to the low-pressure hydraulic line 20 and to the high-pressure hydraulic lines 21a and 22a.

[0050] Preferably, hydraulic lines 21b and 22b are also arranged in parallel to each other.

[0051] Preferably, hydraulic lines 21b and 22b are configured to selectively fluidly connect the source of pressurized hydraulic fluid 14 with the aforementioned hydraulic actuators 4.

[0052] Preferably, hydraulic lines 21b and 22b are configured to operate in use with a pressure level lower than high-pressure hydraulic lines 21a and 22a, and in the following they will be referred to as "medium-pressure hydraulic lines". In use, medium-pressure hydraulic lines 21b and 22b may also with different pressure levels.

[0053] In addition, hydraulic circuit 18 preferably comprises at least two hydraulic accumulators 26 and 27.

[0054] Hydraulic accumulators 26 and 27 are fluidly connected respectively to hydraulic line assembly 21 and to hydraulic line assembly 22.

[0055] More in detail, hydraulic accumulators 26 and 27 are preferably fluidly connected to a respective high-pressure hydraulic line 21a or 22a. In the following, hydraulic accumulators 26 and 27 will be referred to as "high-pressure hydraulic accumulators".

[0056] In use, high-pressure hydraulic accumulators 26 and 27 are configured to store the pressurized hydraulic fluid provided by the source of pressurized hydraulic fluid 14, so as to fluidly decouple the same source of pressurized hydraulic fluid 14 from hydraulic actuators 4 and at the same time to be able to provide pressurized hydraulic fluid towards the hydraulic actuators 4.

[0057] In addition, by controlling the pressure of the hydraulic fluid contained within hydraulic high-pressure hydraulic accumulators 26 and 27 it is possible to control the pressure level of the corresponding high-pressure hydraulic line 21 and 22, as explained more in detail in the following.

[0058] In addition, with reference to the exemplary embodiment illustrated in Figure 2, hydraulic circuit 18 preferably comprises at least two additional hydraulic accumulators 28 and 29, each of them fluidly connected to a respective medium-pressure hydraulic line 21b and 22b. In the following, hydraulic accumulators 28 and 29 will be referred to as "medium-pressure hydraulic accumulators".

[0059] As far as the source of pressurized fluid is concerned, it preferably comprises a pair of hydraulic pumps 30 and 31, which are preferably carried by internal combustion engine 15 in order to be driven in rotation.

[0060] The outlet of hydraulic pumps 30 and 31 is fluidly connected respectively to hydraulic line assembly 21 and to hydraulic line assembly 22.

[0061] Hydraulic pumps 30 and 31 in use are adapted to suck hydraulic fluid from tank 16 and to provide at outlet a pressurized flow of hydraulic fluid, respectively within hydraulic line assembly 21 and within hydraulic line assembly 22.

[0062] More in detail, hydraulic pumps 30 and 31 in use are adapted to provide at outlet a pressurized flow of hydraulic fluid respectively within high-pressure hydraulic line 21a and high-pressure hydraulic accumulator 26 and within high-pressure hydraulic line 22a and high-pressure hydraulic accumulator 27.

[0063] In other words, hydraulic pumps 30 and 31 are arranged in parallel to each other and are each configured fluidly connected to a respective hydraulic line assembly 21 and to hydraulic line assembly 22.

[0064] With reference to the exemplary embodiment illustrated in Figure 2, hydraulic pump 30 is preferably fluidly connected also to medium-pressure hydraulic line 21b and to medium-pressure hydraulic accumulator 28.

[0065] Similarly, hydraulic pump 31 is preferably fluidly connected also to medium-pressure hydraulic line 22b

and to medium-pressure hydraulic accumulator 29.

[0066] With reference to the exemplary embodiment illustrated in Figure 2, hydraulic arrangement 12 preferably comprises a pair of valve means 32 and 33, which are operatively interposed between the outlet of pumping means 17, in particular respectively between the outlet of hydraulic pump 30 and hydraulic pump 31, and a respective hydraulic line assembly 21 and 22, and are configured to regulate the flow of pressurized hydraulic fluid fed towards the same hydraulic line assembly 21 and 22 by hydraulic pumps 30 and 31 respectively.

[0067] More in detail, valve means 32 and 33 preferably comprises respectively each a valve 34 and a valve 35, which is operatively interposed between the outlet of hydraulic pump 30 and 31 and high-pressure hydraulic line 21a and 22a.

[0068] Preferably, valves 34 and 35 are two-way two-position hydraulic valves, in particular solenoid-controlled two-way two-position hydraulic valves, operable between an open position and a closed position. Preferably, valves 34 and 35 are on/off hydraulic valves.

[0069] In addition, valve means 32 and 33 preferably comprises respectively each a further valve 36 and 37, which is operatively interposed respectively between the outlet of hydraulic pump 30 and 31 and medium-pressure hydraulic line 21b and 22b.

[0070] Preferably, valves 36 and 37 are two-way two-position hydraulic valves, in particular solenoid-controlled two-way two-position hydraulic valves, operable between an open position and a closed position. Preferably, valves 36 and 37 are on/off hydraulic valves.

[0071] With reference to the exemplary embodiment illustrated in Figure 2, hydraulic arrangement 12 further comprises a control valve arrangement 40, which is fluidly interposed between hydraulic circuit 18 and hydraulic actuators 4 and is configured to regulate the pressurized hydraulic fluid fed toward the same hydraulic actuators 4.

[0072] More in detail, control valve arrangement 40 configured to selectively put hydraulic line assemblies 21 and 22 in fluid communication with one or more of hydraulic actuators 4, in order to operate these latter.

[0073] With reference to the exemplary embodiment illustrated in Figure 2, control valve arrangement 40 comprises a first valve assembly 41, which is operatively interposed between hydraulic line assembly 21 and at least a first one among hydraulic actuators 4, and is configured to selectively put said first actuator 4 in fluid communication with hydraulic line assembly 21.

[0074] In addition, control valve arrangement 40 comprises a second valve assembly 42, which is operatively interposed between hydraulic line assembly 22 and at least a second one among hydraulic actuators 4, and is configured to selectively put said second actuator 4 in fluid communication with hydraulic line assembly 21.

[0075] First valve assembly 41 is operatively interposed also between low-pressure hydraulic line 20 and at least said first hydraulic actuator 4, and is configured to selectively put said first hydraulic actuator 4 in fluid communication with low-pressure hydraulic line 20.

[0076] Similarly, second valve assembly 41 is operatively interposed also between low-pressure hydraulic line 20 and at least said second hydraulic actuator 4, and is configured to selectively put said second hydraulic actuator 4 in fluid communication with low-pressure hydraulic line 20.

[0077] More in detail, with reference to the exemplary embodiment illustrated in Figure 2, first valve assembly 41 is preferably operatively interposed between hydraulic line assembly 21 and boom actuator 8 and/or arm actuator 9, and is configured to selectively put boom actuator 8 and/or arm actuator 9 in fluid communication with hydraulic line assembly 21.

[0078] In addition, first valve assembly 41 is also preferably operatively interposed between low-pressure hydraulic line 20 and at least boom actuator 8 and/or arm actuator 9, and is configured to selectively put boom actuator 8 and/or arm actuator 9 in fluid communication with low-pressure hydraulic line 20.

[0079] In addition, first valve assembly 41 is preferably fluidly interposed also between hydraulic line assembly 21 and a first drive motor 6 and is preferably configured to selectively put the same drive motor 6 in fluid communication with hydraulic line assembly 21.

[0080] Preferably, first valve assembly 41 is also operatively interposed between low-pressure hydraulic line 20 and the first drive motor 6 and is preferably configured to selectively put the same drive motor 6 in fluid communication with low-pressure hydraulic line 20.

[0081] With reference to the exemplary embodiment illustrated in Figure 2, first valve assembly 41 preferably comprises a first valve set 43, which is operatively interposed between the hydraulic line assembly 21 and boom actuator 8.

[0082] More in detail, first valve set 43 preferably comprises at least two hydraulic valves, which are operatively interposed between hydraulic line assembly 21 and the two chambers/ends of boom actuator 8.

[0083] More in detail, first valve set 43 preferably comprises at least as many valves as many lines there are provided within hydraulic line assembly 21.

[0084] With reference to the exemplary embodiment illustrated in Figure 2, first valve set 43 preferably comprises four hydraulic valves 43a-d fluidly respectively connecting high- and medium-pressure hydraulic lines 21a and 21b with the two ends/chambers of boom actuator 8.

[0085] In addition, first valve set 43 preferably comprises two additional valves 43e and 43f fluidly connecting low-pressure hydraulic line 20 with the two chambers/ends of boom actuator 8.

[0086] With reference to the exemplary embodiment illustrated in Figure 2, first valve assembly 41 preferably comprises a second valve set 44, which is operatively interposed between the hydraulic line assembly 21 and arm actuator 9.

[0087] More in detail, second valve set 44 preferably comprises at least two hydraulic valves, which are operatively interposed between hydraulic line assembly 21 and the two chambers/ends of arm actuator 9.

[0088] More in detail, second valve set 44 preferably comprises at least as many valves as many lines there are provided within hydraulic line assembly 21.

[0089] With reference to the exemplary embodiment illustrated in Figure 2, second valve set 44 preferably comprises four hydraulic valves 44a-d fluidly respectively connecting high- and medium-pressure hydraulic lines 21a and 21b with the two ends/chambers of arm actuator 9.

[0090] In addition, second valve set 44 preferably comprises two additional valves 44e and 44f fluidly connecting low-pressure hydraulic line 20 with the two chambers/ends of arm actuator 9.

[0091] With reference to the exemplary embodiment illustrated in Figure 2, first valve assembly 41 preferably comprises a third valve set 45, which is operatively interposed between the hydraulic line assembly 21 and the first drive motor 6.

[0092] More in detail, third valve set 45 preferably comprises at least two hydraulic valves, which are operatively interposed between hydraulic line assembly 21 and the two ends/ports of first hydraulic motor 6.

[0093] More in detail, third valve set 45 preferably comprises at least as many valves as many lines there are provided within hydraulic line assembly 21.

[0094] With reference to the exemplary embodiment illustrated in Figure 2, third valve set 45 preferably comprises four hydraulic valves 45a-d fluidly respectively connecting high- and medium-pressure hydraulic lines 21a and 21b with the two ends/ports of first hydraulic motor 6.

[0095] In addition, third valve set 45 preferably comprises two additional valves 45e and 45f fluidly connecting low-pressure hydraulic line 20 with the two ends ports of first hydraulic motor 6.

[0096] With reference to the exemplary embodiment illustrated in Figure 2, second valve assembly 42 is preferably operatively interposed between hydraulic line assembly 22 and at least bucket actuator 10 and/or swing motor 3, and is configured to selectively put bucket actuator 10 and/or swing motor 3 in fluid communication with hydraulic line assembly 22.

[0097] In addition, second valve assembly 42 is preferably operatively interposed also between low-pressure hydraulic line 20 and at least bucket actuator 10 and/or swing motor 3, and is configured to selectively put bucket actuator 10 and/or swing motor 3 in fluid communication with low-pressure hydraulic line 20.

[0098] In addition, second valve assembly 42 is preferably fluidly interposed also between hydraulic line assembly 22 and the second drive motor 6, and is preferably configured to selectively put the same second drive motor 6 in fluid communication with hydraulic line assembly 22.

[0099] Preferably, second valve assembly 42 is also operatively interposed between low-pressure hydraulic line 20 and the second drive motor 6, and is preferably configured to selectively put the same second drive motor 6 in fluid communication with low-pressure hydraulic line 20.

[0100] With reference to the exemplary embodiment illustrated in Figure 2, second valve assembly 42 preferably comprises a fourth valve set 46, which is operatively interposed between the hydraulic line assembly 22 and bucket actuator 10.

[0101] More in detail, fourth valve set 46 preferably comprises at least two hydraulic valves, which are operatively interposed between hydraulic line assembly 22 and the two chambers/ends of bucket actuator 10.

[0102] More in detail, fourth valve set 46 preferably comprises at least as many valves as many lines there are provided within hydraulic line assembly 22.

[0103] With reference to the exemplary embodiment illustrated in Figure 2, fourth valve set 46 preferably comprises four hydraulic valves 46a-d fluidly respectively connecting high- and medium-pressure hydraulic lines 22a and 22b with the two ends/chambers of bucket actuator 10.

[0104] In addition, fourth valve set 46 preferably comprises two additional valves 46e and 46f fluidly connecting low-pressure hydraulic line 20 with the two chambers/ends of bucket actuator 10.

[0105] With reference to the exemplary embodiment illustrated in Figure 2, second valve assembly 42 preferably comprises a fifth valve set 47, which is operatively interposed between the hydraulic line assembly 22 and swing motor 4.

[0106] More in detail, fifth valve set 47 preferably comprises at least two hydraulic valves, which are operatively interposed between hydraulic line assembly 22 and the two ports/ends of swing motor 4.

[0107] More in detail, fifth valve set 47 preferably comprises at least as many valves as many lines there are provided within hydraulic line assembly 22.

[0108] With reference to the exemplary embodiment illustrated in Figure 2, fifth valve set 47 preferably comprises four hydraulic valves 47a-d fluidly respectively connecting high- and medium-pressure hydraulic lines 22a and 22b with the two ends/ports of swing motor 4.

[0109] In addition, fifth valve set 47 preferably comprises two additional valves 47e and 47f fluidly connecting low-pressure hydraulic line 2 with the two ends/ports of swing motor 4.

[0110] With reference to the exemplary embodiment illustrated in Figure 2, second valve assembly 42 preferably comprises a sixth valve set 46, which is operatively interposed between the hydraulic line assembly 22 and the second drive motor 6.

[0111] More in detail, sixth valve set 48 preferably comprises at least two hydraulic valves, which are operatively interposed between hydraulic line assembly 22 and the two ends/ports of second hydraulic motor 6.

[0112] More in detail, sixth valve set 48 preferably comprises at least as many valves as many lines there are provided within hydraulic line assembly 22.

[0113] With reference to the exemplary embodiment illustrated in Figure 2, sixth valve set 48 preferably comprises four hydraulic valves 48a-d fluidly respectively connecting high- and medium-pressure hydraulic lines 22a and 22b with the two ends/ports of second hydraulic motor 6.

[0114] In addition, sixth valve set 48 preferably comprises two additional valves 48e and 48f fluidly connecting low-pressure hydraulic line 20 with the two ends ports of second hydraulic motor 6.

[0115] Preferably, valves of valve sets 43-48 are two-way two position solenoid-controlled hydraulic valves, in particular two-way two position solenoid-controlled on-off hydraulic valves.

[0116] The operation of the above-described work vehicle 1 is the following.

[0117] In use, both hydraulic pumps 30 and 31 are operated to provide pressurized hydraulic fluid within hydraulic line assembly 21 and hydraulic line assembly 22.

[0118] Valve sets 43-48 of control valve arrangement 40 are selectively actuated to operate the respective hydraulic actuator 4.

[0119] For instance, valve sets 43 and 47 may be operated simultaneously to actuate at the same time boom actuator 8 and swing motor 6, in order to rotate the boom upwards and at the same time swing the upper frame 3 with respect to the lower frame.

[0120] Moreover, valve sets 44 and 46 may be operated simultaneously, for instance during a digging operation, to actuate at the same time arm actuator 9 and bucket actuator 10, in order to operate at the same time arm and bucket of the hydraulically actuated work implement.

[0121] In view of the foregoing, the advantages of a hydraulic arrangement 12 according to the present invention are considerable and apparent.

[0122] In fact, it is apparent from the above that the proposed layout of hydraulic arrangement 12 is optimized for a work machine 1 provided with multiple hydraulic actuators 4 to be operated simultaneously.

[0123] More in detail, the provision of two separate hydraulic line assemblies 21 and 22 connected to different actuators 4, which are designed to be operated simultaneously allows to optimize the rail pressures to said different actuators 4, thus minimizing throttling losses.

[0124] In addition, the modularity and the flexibility of the system is increased, as it is possible to provide a different number of hydraulic line assemblies and/or pumps depending on the application.

[0125] Lastly, the proposed layout allows to employ smaller hydraulic pumps, which make it possible to obtain a better dynamic and to reduce fuel consumptions.

[0126] It is clear that modifications can be made to the described hydraulic arrangement 14, which do not extend beyond the scope of protection defined by the claims.

[0127] For instance, the connection between hydraulic actuators 4 and control valve arrangement 40 may be provided not with respect to the operation logic of such hydraulic actuators 4 but with reference to the operating pressures.

[0128] In particular, the number of different hydraulic lines, the number of different hydraulic line assemblies and/or the number of different accumulators may be varied, for instance it may be greater that the one described in the exemplary embodiment illustrated in Figure 2.

[0129] In addition, the layout of the source of pressurized fluid 14, for instance it may comprise only one hydraulic pump adapted to be fluidly connected to the different hydraulic line assemblies.

Claims

1. A work machine (1) comprising:

- a body movable on the ground by means of ground engaging means (2);
- a hydraulically actuated work implement carried by said body;
- plurality of hydraulic actuators (4) configured to actuate said body and/or said hydraulically actuated work implement; and
- a hydraulic arrangement (12), which is fluidly connected to said hydraulic actuators (4) in order to actuate said hydraulic actuators (4);

said hydraulic arrangement (12) comprising:

- a source of pressurized hydraulic fluid (14), which is configured to suck a hydraulic fluid from a tank (16) and to provide at outlet a flow of the pressurized hydraulic fluid;
- a hydraulic circuit (18) which is configured to put said source of pressurized fluid (14) in fluid communication with said hydraulic actuators (4), and is provided with a common pressure rails (CPR) configuration; and
- a control valve arrangement (40), which is operatively interposed between said hydraulic circuit (18) and said hydraulic actuators (4) and is configured to selectively put said hydraulic circuit (18) in fluid communication with said hydraulic actuators (4);

said hydraulic circuit (18) comprising:

- a discharge hydraulic line (20), which fluidly connects said hydraulic actuators (4) with said tank (16);
- a first hydraulic line assembly (21), which

is adapted to fluidly connect said source of pressurized hydraulic fluid (14) with at least a first among said hydraulic actuators (4);

• a first hydraulic accumulator (26) fluidly connected to said first hydraulic line assembly (21);

• a second hydraulic line assembly (22), which is adapted to fluidly connect said source of pressurized hydraulic fluid (14) with at least a second among said hydraulic actuators (4), different from said first hydraulic actuator (4), and is fluidly connected in parallel to said first hydraulic line assembly (21); and

• a second hydraulic accumulator (27) fluidly connected to said second hydraulic line assembly (22);

said control valve arrangement (40) comprising:

• a first valve assembly (41), which is operatively interposed between said first hydraulic line assembly (21) and said first hydraulic actuator (4), and is configured to selectively put said first actuator (4) in fluid communication with said hydraulic line assembly (21) ; and

• a second valve assembly (42), which is operatively interposed between said second hydraulic line assembly (22) and said second hydraulic actuator (4), and is configured to selectively put said second actuator (4) in fluid communication with said second hydraulic line assembly (22).

2. Work machine according to claim 1, wherein said first valve assembly (41) is operatively interposed also between said discharge hydraulic line (20) and at least said first hydraulic actuator (4), and is configured to selectively put said first hydraulic actuator (4) in fluid communication with said discharge hydraulic line (20); and
said second valve assembly (42) is operatively interposed also between said discharge hydraulic line (20) and at least said second hydraulic actuator (4), and is configured to selectively put said second hydraulic actuator (4) in fluid communication with said discharge hydraulic line (20).

3. Work machine according to claim 1 or 2, wherein said first hydraulic line assembly (21) comprises a plurality of first second hydraulic lines (21a, 21b), which are arranged in parallel to each other and fluidly connect said source of pressurized hydraulic fluid (14) at least with said first hydraulic actuator (4), and said second hydraulic line assembly (22) comprises a plurality of separate second hydraulic lines (22a, 22b), which are arranged in parallel to each other and fluidly connect said source of pressurized hydraulic fluid (14) at least with said second hydraulic actuator (4).

4. Work machine according to claim 3, wherein said hydraulic circuit (18) comprises a plurality of first hydraulic accumulators (26, 28), each fluidly connected to a respective first hydraulic line (21a, 21b) of said first hydraulic line assembly (21), and/or said hydraulic circuit (18) comprises a plurality of second hydraulic accumulators (27, 29), each fluidly connected to a respective second hydraulic line (22a, 22b) of said second hydraulic line assembly (22).

5. Work machine according to claim 3 or 4, wherein said first valve assembly (41) comprises a plurality of first valve sets (43, 44, 45), each of which is operatively interposed between said first hydraulic line assembly (21) and a correspondent first hydraulic actuator (4); and
said second valve assembly (42) comprises a plurality of second valve sets (46, 47, 48), each of which is operatively interposed between said second hydraulic line assembly (22) and a correspondent second hydraulic actuator (4).

6. Work machine according to claim 5, wherein each of said first valve sets (43, 44, 45) comprises a plurality of two-way two-position hydraulic valves, each of which is operatively interposed between a correspondent first hydraulic line (21a, 21b) and a correspondent first hydraulic actuator (4); and
each of said second valve sets (46, 47, 48) comprises a plurality of two-way two-position hydraulic valves, each of which is operatively interposed between a correspondent second hydraulic line (22a, 22b) and a correspondent second hydraulic actuator (4).

7. Work machine according to any of the preceding claims, wherein said source of pressurized hydraulic fluid (14) comprises a first hydraulic pump (30) operatively connected to said first hydraulic line assembly (21) and a second hydraulic pump (31), which is arranged in parallel to said first hydraulic pump (30) and is operatively connected to said second hydraulic line assembly (22).

8. Work machine according to claim 7, wherein said hydraulic arrangement (12) further comprises: first valve means (32) operatively interposed between the outlet of said first hydraulic pump (30) and said first hydraulic line assembly (21); and second valve means (33) operatively interposed between the outlet of said second hydraulic pump (31) and said second hydraulic line assembly (22).

9. Work machine according to any of the preceding

claims, wherein:

said body comprises: a lower frame, which carries said ground engaging means (2) to allow motion of said body with respect to the ground; and an upper frame (3), which is rotatably carried by said lower frame; and
said hydraulically actuated work implement comprises: a boom rotatably carried by said body; an arm rotatably carried by said boom; and a bucket or similar tool rotatably carried by said arm.

10. Work machine according to claim 9, wherein said hydraulic actuators (4) comprise:

• a first hydraulic motor (5), which is operatively interposed between said lower frame and said upper frame (3) and is configured to rotate said upper frame (3) with respect the lower frame;
• a second and a third hydraulic motors (6), each operatively interposed between said lower frame and a corresponding ground engaging means (2) and configured to drive the corresponding ground engaging means (2) in rotation;
• at least one boom actuator (8), which is operatively interposed between the said body and said boom and is configured to rotate said boom with respect to said body;
• at least one arm actuator (9), which is operatively interposed between said boom and said arm and is configured to rotate said arm with respect to said boom; and
• at least one bucket actuator (10), which is operatively interposed between said arm and said bucket and is configured to rotate said bucket with respect to said arm.

11. Work machine according to claim 10, wherein said first hydraulic actuator (4) comprises the first one between said boom actuator (8) and said first hydraulic motor (5) and/or said first hydraulic actuator (4) comprises the first one between said bucket actuator (9) and said arm actuator (10) and/or said first hydraulic actuator (4) comprises the first one between said second hydraulic motor (6) and said third hydraulic motor (6).

12. Work machine according to claim 11, wherein said second hydraulic actuator (4) comprises the second one between said boom actuator (8) and said first hydraulic motor (5) and/or said second hydraulic actuator (4) comprises the second one between said bucket actuator (9) and said arm actuator (10) and/or said second hydraulic actuator (4) comprises the second one between said second hydraulic motor (6) and said third hydraulic motor (6).

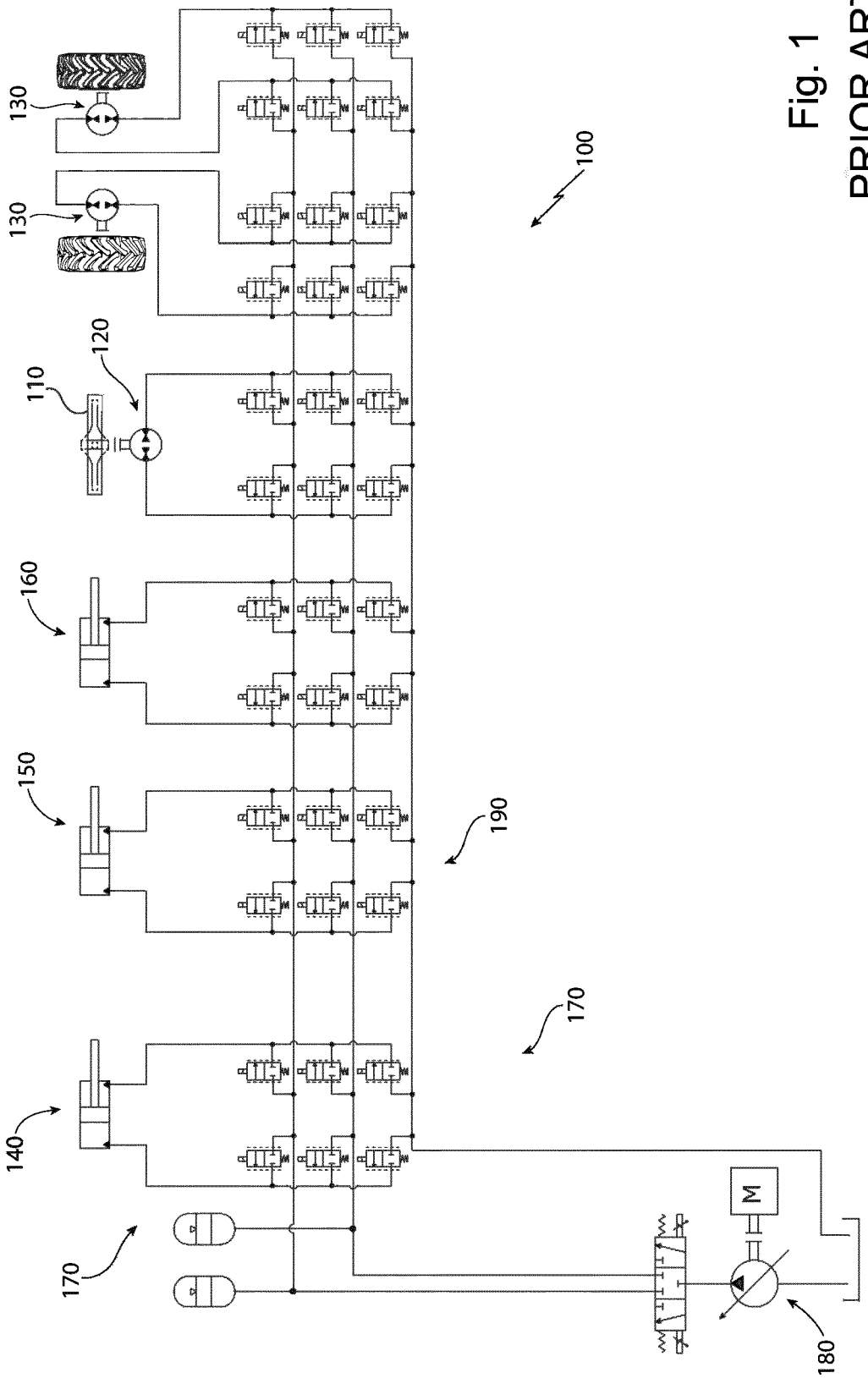


Fig. 1
PRIOR ART

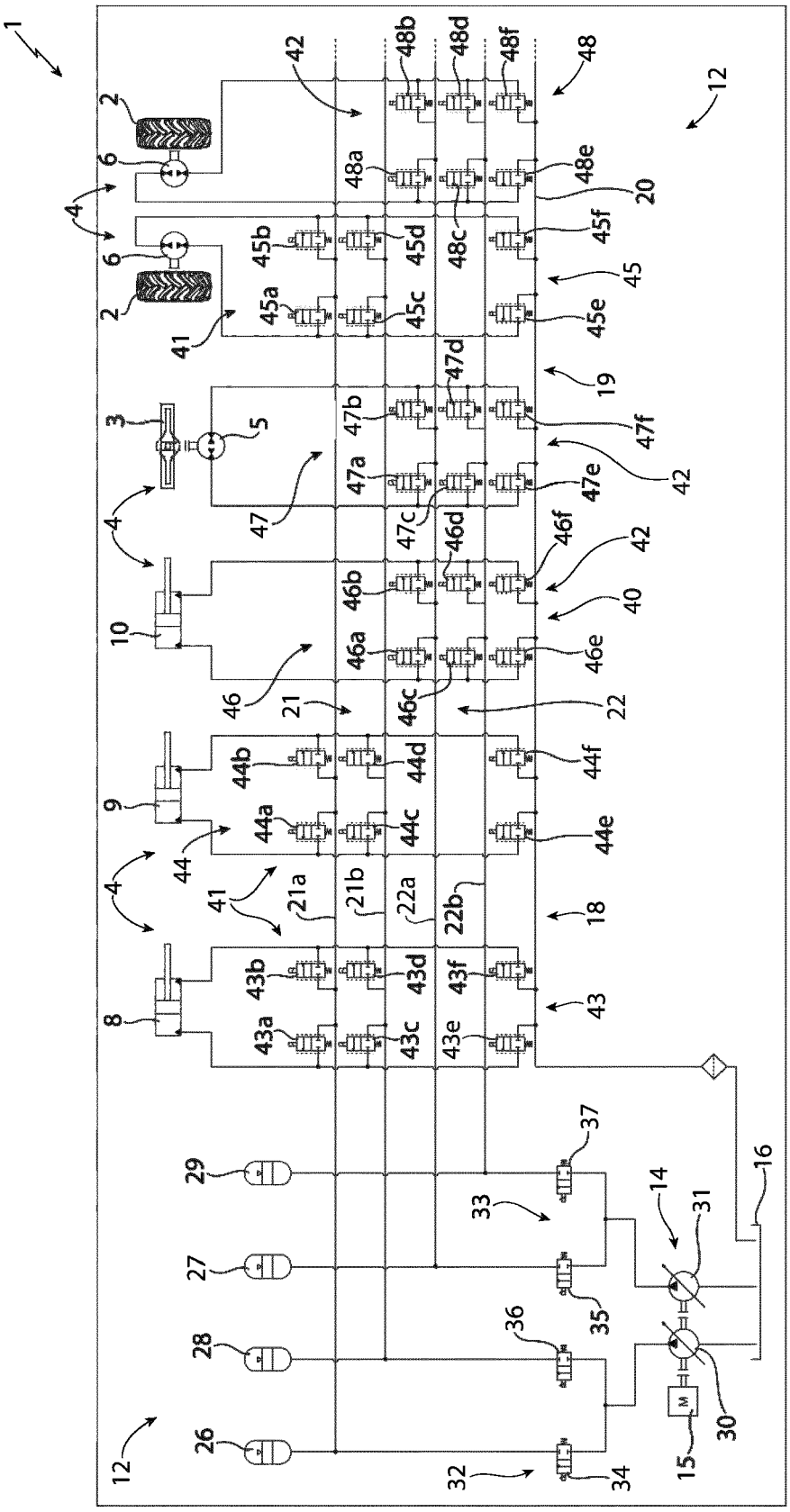

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Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 9457

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	CN 108 708 423 A (UNIV TAIYUAN TECHNOLOGY) 26 October 2018 (2018-10-26) * figure 5 * -----	1-12	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 November 2024	Rocabruna Vilardell

CATEGORY OF CITED DOCUMENTS

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