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(54) Fluid system and method of operating thereof.

(57) A fluid system (16) is disclosed for selectively fluidly connecting a first chamber (18) of a cylinder (14) to an accumulator (42) such that in a first position of a valve arrangement (26) the first chamber (18) is fluidly connected both to the accumulator (42) and a second chamber (20) of the cylinder (14). In a second position

of the first valve arrangement (26) the first chamber (18) is fluidly connected only with the accumulator (42). In a third position of the first valve arrangement (26), the first chamber (18) is connected neither with the accumulator (42) nor with the second chamber (20). Further disclosed is a machine (10) provided with such fluid system and a method of operating such machine (10).

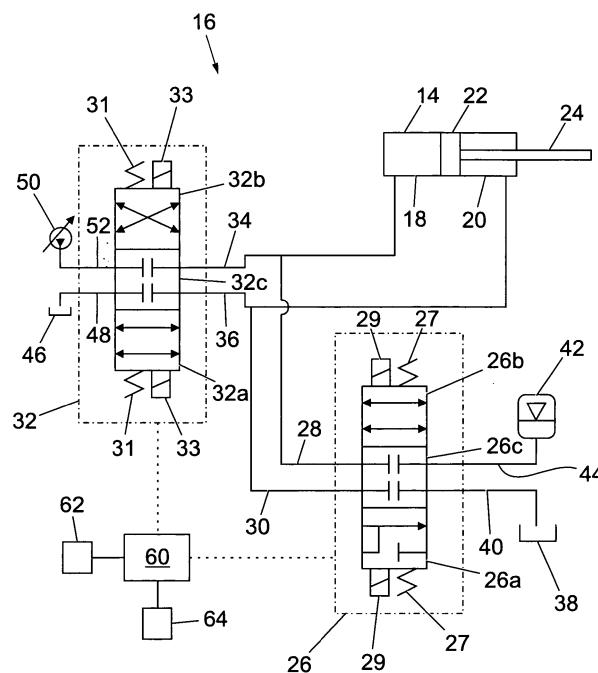


Fig. 2

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Description

Technical Field

[0001] The disclosure relates to fluid systems and in particular to fluid systems providing selective fluid connection between one or more cylinder chambers and an accumulator.

Background

[0002] In the prior art, two types of ride control systems are used for compensating shocks on the cylinders of load carrying machines, such as wheel loaders traveling with a loaded bucket. These shocks may be reduced by selectively connecting the load bearing cylinder to an accumulator. In a single setting ride control system the accumulator lay-out is optimized for a particular load. Multi-setting ride control systems can be set to suit many load applications. This is done with multiple accumulators with varying volumes and pre-charges to give ride damping that is suitable for different load conditions, such as traveling with a full and empty bucket. The multi-setting system is favorable in regard of operator comfort but requires additional components that take up additional space and increase the costs for such a system.

[0003] From US patent no. 5,992,146 a variable rate ride control system is known in which an accumulator arrangement is connected through a first valve mechanism to the loaded end of an actuator to provide a cushion or damping of the sudden changes in force. The first valve mechanism controls the magnitude of the damping in response to the rate of flow between the actuator and the accumulator arrangement via an infinitely variable flow control mechanism.

[0004] From US patent no. 5,802,847 a ride control system is known in which a control slide can hydraulically connect a rod end and a piston end of a cylinder to a hydraulic tank and an accumulator respectively for damping of pitching oscillations, and which can attach both cylinder ends to a hydraulic tank to provide a low-cost and space saving system with a "floating" function.

[0005] The disclosure aims to improve upon some or all of the disadvantages associated with the prior art.

Summary of the Invention

[0006] In a first aspect of the disclosure there is provided a fluid system (16) comprising at least one cylinder (14) having a first chamber (18) and a second chamber (20), an accumulator (42); and a first valve arrangement (26) fluidly connected to the first and second chambers (18, 20). The first valve arrangement (26) is configured to in a first position fluidly connect the first chamber (18) to both the accumulator (42) and the second chamber (20). The first valve arrangement (26) is further configured to in a second position fluidly connect the first chamber (18) to the accumulator (42) and fluidly disconnect

the second chamber (20) from the accumulator (42).

[0007] In a second aspect of the disclosure there is provided a machine (10) having a fluid system (16) as provided by the first aspect of the disclosure.

[0008] In a third aspect of the disclosure there is provided a method of operating a machine (10) including a work arm (12) operated by at least one cylinder (14), a first valve arrangement (26) for selectively enabling a fluid flow between the cylinder (14) and at least one of a low pressure area (38) and an accumulator (42). The method comprises controlling the first valve arrangement (26) so as to select a first position in which the first valve arrangement (26) fluidly connects the first chamber (18) of the cylinder (14) to both the accumulator (42) and the second chamber (20). The method further comprises controlling the first valve arrangement to select a second position in which the first valve arrangement (26) fluidly connects a first chamber (18) of the cylinder (14) to the accumulator (42) and fluidly disconnects a second chamber (20) of the cylinder (14) from the accumulator (42).

[0009] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0010] Fig. 1 is a diagrammatic representation of a portion of a machine.

[0011] Fig. 2 is a schematic representation of a fluid system for the machine of Fig. 1.

Detailed Description

[0012] Referring to Fig. 1 there is shown a machine generally designated with numeral 10 having a work arm 12. For clarity, the machine 10 and the work arm 12 are represented in a simplified form, but it is to be understood that the machine 10 and work arm 12 may be of any suitable kind. The machine 10 and the work arm 12 may for example be part of a construction machine such as a telehandler, a backhoe loader, a wheeled excavator, a skid steer loader or a wheeled loader.

[0013] At least one cylinder 14 may be configured to operate and hence raise and lower the work arm 12. The at least one cylinder 14 may be one or more cylinders and may be part of a fluid system generally designated 16 of which an exemplary embodiment is shown in Fig. 2.

[0014] The cylinder 14 may have a first chamber 18 and a second chamber 20 and may be provided with a piston 22 and a rod 24. The cylinder 14 may operate in a conventional manner such that when the first chamber 18 is pressurized the cylinder 14 is extended and when the second chamber 20 is pressurized the cylinder 14 is retracted. Although shown in Fig.1 as having the rod end of the cylinder 14 attached to the work arm 12, the cylinder 14 may also be arranged such that the head end of the cylinder 14 is attached to the work arm 12.

[0015] The first chamber 18 of the cylinder 14 may be

fluidly connected to a first valve arrangement 26 via a first fluid line 28. The second chamber 20 may be fluidly connected to the first valve arrangement 26 via a second fluid line 30. The first chamber 18 may further be connected to a second valve arrangement 32 via a third fluid line 34. The second chamber 20 may further be fluidly connected to a second valve arrangement 32 via a fourth fluid line 36. The first and third fluid lines 28 and 34 may be partially combined into a single fluid line as shown in Fig. 2, but they may also be run separately. Similarly, the second and fourth fluid lines 30 and 36 may be partially combined into a single fluid line as shown in Fig. 2, but they may also be run separately.

[0016] The first valve arrangement 26 may further be fluidly connected to a low pressure region 38 via a fluid line 40. The low pressure region 38 may be of any suitable type and may for example be a fluid reservoir. The first valve arrangement 26 may further be connected to an accumulator 42 via a fluid line 44. The accumulator 42 may be a conventional accumulator having a pre-charged and compressible gas chamber filled with a gas such as nitrogen. The accumulator 42 may also be an arrangement of multiple accumulators.

[0017] The first valve arrangement 26 may include a single valve or a combination of valves. The first valve arrangement 26 may be controlled in any suitable manner and may for example be biased to one position by springs 27 and actuated by actuators 29. The actuators 29 may be solenoids.

[0018] In the exemplary embodiment of Fig. 2 the first valve arrangement 26 may be configured to assume a plurality of positions and may therefore be provided with first, second and third portions 26a, 26b and 26c representing first, second and third valve positions. By selecting a first position of the valve arrangement 26 and thereby using the first portion 26a, the first chamber 18 is fluidly connected to both the accumulator 42 and the second chamber 20. In the second position, the active portion of the valve arrangement 26 is portion 26b. By selecting portion 26b, the valve arrangement 26 in the first position fluidly connects the first chamber 18 to the accumulator 42. Simultaneously the second chamber 20 is fluidly disconnected from the accumulator 42. The first valve arrangement 26 may be configured such that the second chamber 20 is fluidly connected to the low pressure region 38 when the first valve arrangement 26 is in the first position, but the first valve arrangement 26 may alternatively be configured to fluidly disconnect the second chamber 20 from the low pressure region 38.

[0019] By selecting a third position of the valve arrangement 26 and thereby using the third portion 26c, the first and second chambers 18 and 20 are both disconnected from the accumulator 42. In the third position the first and second chambers 18 and 20 may be either fluidly connected to one another or they may be fluidly disconnected from one another.

[0020] The second valve arrangement 32 may further be fluidly connected to a low pressure region 46 via a

fluid line 48. The low pressure region 46 may be of any suitable type and may for example be a fluid reservoir. The low pressure region 46 may be fluidly connected to the low pressure region 38. The second valve arrangement 32 may further be connected to a source of pressurized fluid 50 via a fluid line 52. The source of pressurized fluid 50 may for example be a fluid pump.

[0021] The second valve arrangement 32 may be configured to pressurize at least one of the first and second chambers 18 and 20 of the cylinder 14 to, for example, raise and lower the work arm 12.

[0022] The second valve arrangement 32 may include a single valve or a combination of valves. The second valve arrangement 32 may be controlled in any suitable manner and may for example be biased to one position by springs 31 and actuated by actuators 33. The actuators 33 may be solenoids.

[0023] In the exemplary embodiment of Fig. 2 the second valve arrangement 32 may be configured to assume a plurality of positions and may therefore be provided with first, second and third portions 32a, 32b and 32c representing first, second and third valve positions. The second valve arrangement 32 may be proportional such that the valve arrangement 32 can assume positions intermediate of the first, second and third valve positions. In the first position, the active portion of the valve arrangement 32 is portion 32a. By selecting portion 32a, the valve arrangement 32 in the first position fluidly connects the first chamber 18 to the source of pressurized fluid 50. Simultaneously the second chamber 20 may be fluidly connected to the low pressure region 46.

[0024] By selecting a second position of the valve arrangement 32 and thereby using the second portion 32b, the second chamber 20 is fluidly connected to the source of pressurized fluid 50 whilst the first chamber 18 may be fluidly connected to the low pressure region 46.

[0025] By selecting a third position of the valve arrangement 32 and thereby using the third portion 32c, the first and second chambers 18 and 20 may both be disconnected from both the source of pressurized fluid 50 and the low pressure region 46.

[0026] In one embodiment wherein the fluid system 16 is fitted onto the machine 10, the machine 10 may be configured to prevent pressurization of at least one of the first and second chambers 18 and 20 via the second valve arrangement 32 when the first valve arrangement 26 is in the first position. For example, the machine 12 may include an electrical or electronic control arrangement 60 for controlling the first and second valve arrangements 26 and 32. The control arrangement 60 may be configured to receive signals from input means 62 and 64 which may for example be operator controls such as a joystick or switch arrangements. The control arrangement 60 may for example be an electronic control unit or a relay bases system that is configured to provide for an interlock between the actuators 29 and 33. If for example one of the actuators 27 is actuated, the control arrangement 60 may be configured to prevent any of the actuators 27

from being actuated.

[0027] In one embodiment wherein the fluid system 16 is fitted onto the machine 10, the machine 10 may be configured to prevent at least one of the first and second chambers 18 and 20 to be fluidly connected with at least one of the low pressure region 38 or the accumulator 42 when the second valve arrangement 32 is in the first or the second position. This may again be achieved via the control arrangement 60 which can be configured to prevent or enable certain combinations of simultaneous actuation of any of the actuators 27 with any of the actuators 33.

[0028] In one embodiment wherein the fluid system 16 is fitted onto the machine 10, the machine 10 may be configured to enable pressurization of at least one of the first and second chambers 18 and 20 via the second valve arrangement 32 when the first valve arrangement 26 is in the first position. This may for example be achieved by enabling the second valve arrangement 32 to assume an intermediate position between the first and the third position, i.e. intermediate of the portions 32a and 32c, such that the fluid line 52 is fluidly connected with the third fluid line 34, but that the fluid line 48 is not yet fluidly connected with the fourth fluid line 36.

[0029] In one embodiment wherein the fluid system 16 is fitted onto the machine 10, the machine 10 may be configured to prevent pressurization of at least one of the first and second chambers 18 and 20 via the second valve arrangement 32 when the first valve arrangement 26 is in the second position. This may be achieved, for example, by the electrical or electronic control arrangement 60 described above.

[0030] In one embodiment wherein the fluid system 16 is fitted onto the machine 10, the machine 10 may be configured to enable pressurization of at least one of the first and second chambers 18 and 20 via the second valve arrangement 32 when the first valve arrangement 26 is in the second position. This may for example be achieved by placing the second valve arrangement 32 in the first or second position.

[0031] In one embodiment the second valve arrangement 32 may be configured such that it is able to influence the fluid pressure in the accumulator 42 when the first valve arrangement 26 is in the first position. When the first valve arrangement 26 is in the first position, the accumulator 42 is fluidly connected to both the first and second chambers 18 and 20. The second valve arrangement may be placed such that pressurized fluid may flow from the source of pressurized fluid 50 to the accumulator 42. The fluid pressure in the fluid accumulator 42 may therefore rise. This may for example be achieved by enabling the valve arrangement 32 to assume an intermediate position between the first and the third position, i.e. intermediate of the portions 32a and 32c, such that the fluid line 52 is fluidly connected with the third fluid line 34, but that the fluid line 48 is not yet fluidly connected with the fourth fluid line 36. When the first valve arrangement 26 is in the first position, the accumulator 42 is fluidly

connected to both the first and second chambers 18 and 20. The second valve arrangement 32 may be placed in a position such that fluid may flow from the accumulator 42 to the low pressure region 46. The fluid pressure in the fluid accumulator may therefore drop. This may for example be achieved by enabling the valve arrangement 32 to assume an intermediate position between the second and the third position, i.e. intermediate of the portions 32b and 32c, such that the fluid line 48 is fluidly connected with the third fluid line 34, but that the fluid line 52 is not yet fluidly connected with the fourth fluid line 36.

[0032] In one embodiment the second valve arrangement 32 may be configured such that it is able to influence the fluid pressure in the accumulator 42 when the first valve arrangement 26 is in the second position. When the first valve arrangement 26 is in the second position, the accumulator 42 is fluidly connected to the first chamber 18 and fluidly disconnected from the second chamber 20. The second valve arrangement 32 may be placed in its first position such that fluid may flow from the source of pressurized fluid 50 to the accumulator 42. The fluid pressure in the fluid accumulator may therefore rise. When the first valve arrangement 26 is in the second position, the accumulator 42 is fluidly connected to the first chamber 18 and fluidly disconnected from the second chamber 20. The second valve arrangement 32 may be placed in its second position such that fluid may flow from the accumulator 42 to the low pressure region 46. The fluid pressure in the fluid accumulator may therefore drop.

[0033] Industrial Applicability

[0034] During normal operation the fluid system 16 and the machine 10 may function as follows. The machine 10 may be used in a common operation such as for example a combined dig and transport cycle, wherein the machine uses a tool mounted on the work arm 12 to dig into a substance, load the tool and transport it to another place. One situation may for example include controlling the first valve arrangement 26 such that it is in its third position and neither of the first and second chambers 18 and 20 are fluidly connected to the accumulator 42 nor connected to one another. Controlling the second valve arrangement 32 such that the second valve arrangement assumes its first or second position selectively enables a fluid flow between the cylinder 14 and the source of pressurized fluid 50, and between the cylinder 14 and the low pressure region 46. This may then result in the cylinder 14 extending or retracting and hence the work arm 12 being raised or lowered.

[0035] In one situation the operation may involve controlling the first valve arrangement 26 so as to select the second position of the first valve arrangement 26 in which the valve arrangement fluidly connects the first chamber 18 with the accumulator 42 and fluidly disconnects the second chamber 20 from the accumulator 42. When at the same time the second valve arrangement 32 is in its third position such that the fluid lines 34 and 36 are not fluidly connected with the source of pressurized fluid 50

nor the low pressure region 46, the load on the cylinder 24 from the work arm 12, and any payload it may carry, is at least partially supported by the accumulator 42. This is a selection that may be chosen when the machine 10 is in, for example, a transport condition. During transport the machine may encounter uneven terrain that may induce a front-aft rocking motion. If the load of the cylinder 14 is supported by the accumulator 42, a limited flow of fluid can take place between the first chamber 18 and the accumulator due to the accumulator allowing the gaseous pre-charge being compressed. This may for example be the case when the work arm 12 is accelerated in a downwards fashion during a transport operation whereby for example the machine 12 encounters an obstacle. Fluid expelled from the first chamber 18 by the piston 22 may in that case flow to the accumulator 42.

[0036] In another situation the operation may involve controlling the first valve arrangement 26 so as to select the first position in which the first valve arrangement 26 fluidly connects the first chamber 18 of the cylinder 14 with both the accumulator 42 and the second chamber 20. When at the same time the second valve arrangement 32 is in its third position such that the fluid lines 34 and 36 are not fluidly connected with the source of pressurized fluid 50 nor the low pressure region 46 the load on the cylinder 24 from the work arm 12 and any payload it may carry is at least partially supported by the accumulator 42. This is a selection that may be chosen when the machine 10 is in, for example, a transport condition to reduce the effect of the fore-aft rocking motion. When the load of the cylinder 14 is supported by the accumulator 42 whilst the second chamber 20 is also fluidly connected to the first chamber 18, a limited flow of fluid may also take place between the first chamber 18 and the second chamber 20 and/or the second chamber 20 and the accumulator 42. Fluid expelled from the first chamber 18 by the piston 22 may in that case flow both to the second chamber 20 and the accumulator 42.

[0037] It is clear from the above that the behavioral characteristics of the fluid system 16 and the machine 12 may differ, depending whether the first valve arrangement 26 is in the first position or the second position. For example, with the second valve arrangement 32 in its second position and the first valve arrangement 26 in its second position such that the first chamber 18 is not fluidly connected with the second chamber 20 all fluid that is being displaced from the first chamber 18 will flow towards the accumulator 42. Pressure in the accumulator 42 may rise relatively fast in relation to the quantity of fluid displaced from the first chamber 26, hence the resistance to the flow of fluid from the first chamber 18 to accumulator will increase relatively fast. The damping provided may therefore feel relatively stiff to the operator as movement of the work arm 12 may be damped over a relatively short range of work arm movement.

[0038] With the second valve arrangement 32 in its second position and the first valve arrangement 26 in its first position such that the first chamber 18 is fluidly con-

nected with the second chamber 20, a portion of the fluid that is being displaced from the first chamber 18 may flow towards the accumulator 42, but another portion may flow towards the second chamber 20. The second chamber 20 which has a smaller fluid capacity than the first chamber 18 due to the presence of the cylinder rod 24, can take in a portion of the fluid displaced by the first chamber 18, but not the full quantity of displaced fluid. The excess displaced fluid from the first chamber 18 which is not taken in by the second chamber 20 can flow towards the accumulator 42. Pressure in the accumulator 42 may therefore rise relatively slowly in relation to the quantity of fluid displaced from the first chamber 18 as compared to the first and second chambers 18 and 20 not being fluidly connected, because not all fluid displaced from the first chamber 18 flows towards the accumulator 42. Hence the damping provided may feel relatively soft to the operator as movement of the work arm 12 may be damped over a relatively large range of work arm movement.

[0039] The machine 10 may be set up to include preventing the work arm 12 from being raised or lowered when either the first or second position of the first valve arrangement 26 is selected. This may be used if it is desirable to relatively accurately predict the behavior of the work arm during operation.

[0040] The machine 10 may be set up to include preventing the first valve arrangement from being in the first or second position when the work arm 12 is being raised or lowered. This may be used if it is desirable to relatively accurately predict the behavior of the work arm during operation.

[0041] The machine 10 may be set up to include controlling the second valve arrangement so as to influence the fluid pressure in the accumulator when the first valve arrangement is in the first or second position. By connecting the source of pressurized fluid 50 or the lower pressure region 46 briefly or for longer periods into the circuit when the accumulator is fluidly connected with at least the first chamber 18, the pressure in the accumulator may be influenced so as to stiffen or soften the suspensive effect of the accumulator 42 on the work arm 12.

[0042] Although the preferred embodiments of this invention have been described herein, improvements and modifications may be incorporated without departing from the scope of the following claims.

Claims

1. A fluid system (16) comprising:

- at least one cylinder (14) having a first chamber (18) and a second chamber (20);
- an accumulator (42);
- a first valve arrangement (26) fluidly connected to said first and second chambers (18, 20);

- said first valve arrangement (26) being configured to in a first position fluidly connect said first chamber (18) to both said accumulator (42) and said second chamber (20), and in a second position fluidly connect said first chamber (18) to said accumulator (42) and fluidly disconnect said second chamber (20) from said accumulator (42).
2. A fluid system (16) according to claim 1, wherein said first valve arrangement (26) is further configured to in a third position fluidly disconnect both said first and second chambers (18, 20) from said accumulator (42).
 3. A fluid system (16) according to any of the preceding claims wherein said fluid system (16) further includes a low pressure area (38) and said first valve arrangement (26) is configured to fluidly connect said second chamber (20) to said low pressure area (38) when said first valve arrangement (26) is in said second position.
 4. A fluid system (16) according to claim 1 to 2 wherein said fluid system (16) further includes a low pressure area (38) and said first valve arrangement (26) is configured to fluidly disconnect said second chamber (20) from said low pressure area (38) when said first valve arrangement (26) is in said second position.
 5. A machine (10) having a fluid system (16) according to any of the preceding claims.
 6. A machine (10) according to claim 5, wherein said at least one cylinder (14) is configured to raise and lower a work arm (12) of said machine (10), said fluid system (16) further including a second valve arrangement (32), said second valve arrangement (32) being configured to pressurize at least one of said first and second chambers (18, 20) so as to raise or lower said work arm (12).
 7. A machine (10) according to claim 6, wherein said machine (10) is configured such that said pressurization of at least one of said first and second chambers (18, 20) via said second valve arrangement (32) is prevented when said first valve arrangement (26) is in said first position.
 8. A machine according (10) to claim 6, wherein said machine (10) is configured such that said pressurization of at least one of said first and second chambers (18, 20) via said second valve arrangement (32) is enabled when said first valve arrangement (26) is in said first position.
 9. A machine according to any of claims 6 to 8, wherein said machine (10) is configured such that said pressurization of at least one of said first and second chambers (18, 20) via said second valve arrangement (32) is prevented when said first valve arrangement (26) is in said second position.
 10. A machine (10) according to any of claims 6 to 8, wherein said machine (10) is configured such that said pressurization of at least one of said first and second chambers (18, 20) via said second valve arrangement (32) is enabled when said first valve arrangement (26) is in said second position.
 11. A machine (10) according to any of claims 6 to 10, wherein said second valve arrangement (32) is configured such that it is able to influence the fluid pressure in said accumulator (42) when said first valve arrangement (26) is in said first position.
 12. A machine (10) according to any of claims 6 and 11, wherein said second valve arrangement (32) is configured such that it is able to influence the fluid pressure in said accumulator (42) when said first valve arrangement (26) is in said second position.
 13. A method of operating a machine (10), said machine (10) including a work arm (12) operated by at least one cylinder (14), a first valve arrangement (26) for selectively enabling a fluid flow between said cylinder (14) and at least one of a low pressure area (38) and an accumulator (42), said method comprising:
 - controlling said first valve arrangement (26) so as to select a first position in which said first valve arrangement (26) fluidly connects said first chamber (18) of said cylinder (14) to both said accumulator (42) and said second chamber (20); and
 - controlling said first valve arrangement to select a second position in which said first valve arrangement (26) fluidly connects a first chamber (18) of said cylinder (14) to said accumulator (42) and fluidly disconnects a second chamber (20) of said cylinder (14) from said accumulator (42).
 14. A method according to claim 13, further including controlling said first valve arrangement (26) so as to select a third position in which said first valve arrangement (26) fluidly disconnects said first chamber (18) of said cylinder (14) from both said accumulator (42) and said second chamber (20) of said cylinder (14).
 15. A method according to any of claims 13 to 14 wherein said machine (10) further includes a second valve arrangement (32), the method further including controlling said second valve arrangement (32) so as to

selectively enable a fluid flow between said at least one cylinder (14) and at least one of a low pressure area (46) and a source of pressurized fluid (50) so as to raise or lower said work arm (12).

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- 16.** A method according to claim 15, further including preventing said work arm (12) to be raised or lowered when said first position of said first valve arrangement (26) is selected.

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- 17.** A method according to any of claims 15 to 16, further including preventing said work (12) arm to be raised or lowered when said second position of said second valve arrangement (26) is selected.

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- 18.** A method according to any of claims 13 to 15 further including controlling said second valve arrangement (32) so as to influence the fluid pressure in said accumulator (42) when said first valve arrangement (26) is in said first position.

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- 19.** A method according to any of claims 13 to 15 further including controlling said second valve arrangement (32) so as to influence the fluid pressure in said accumulator (42) when said first valve arrangement (26) is in said second position.

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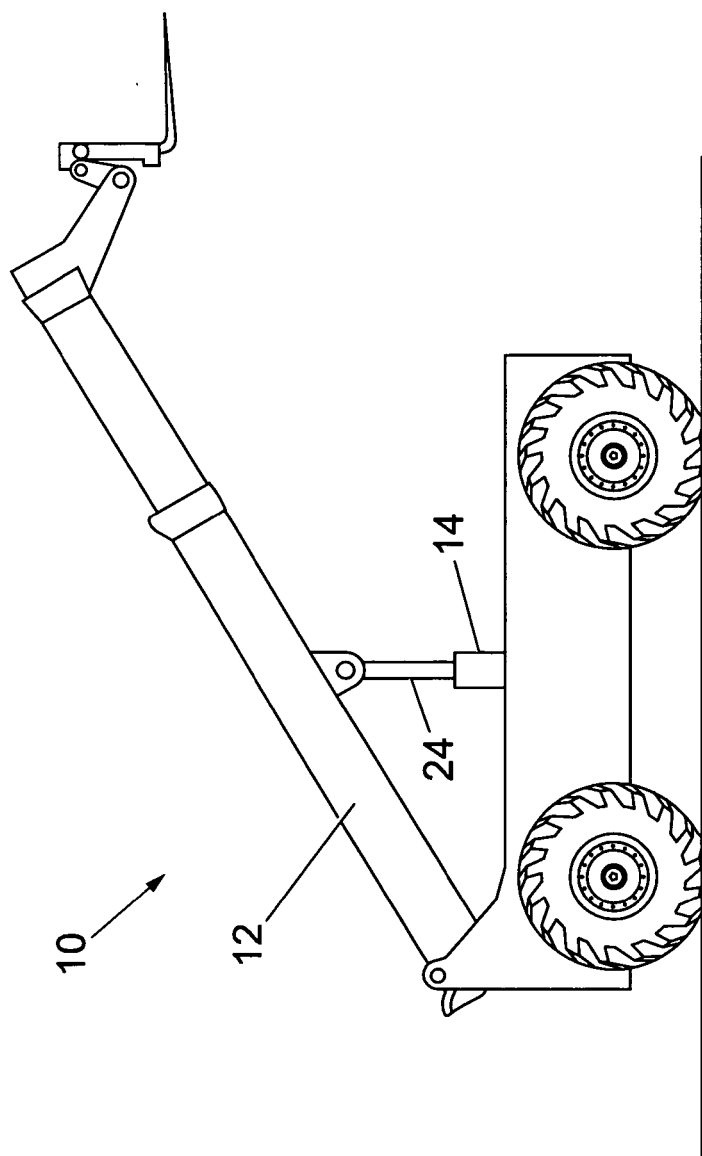


Fig. 1

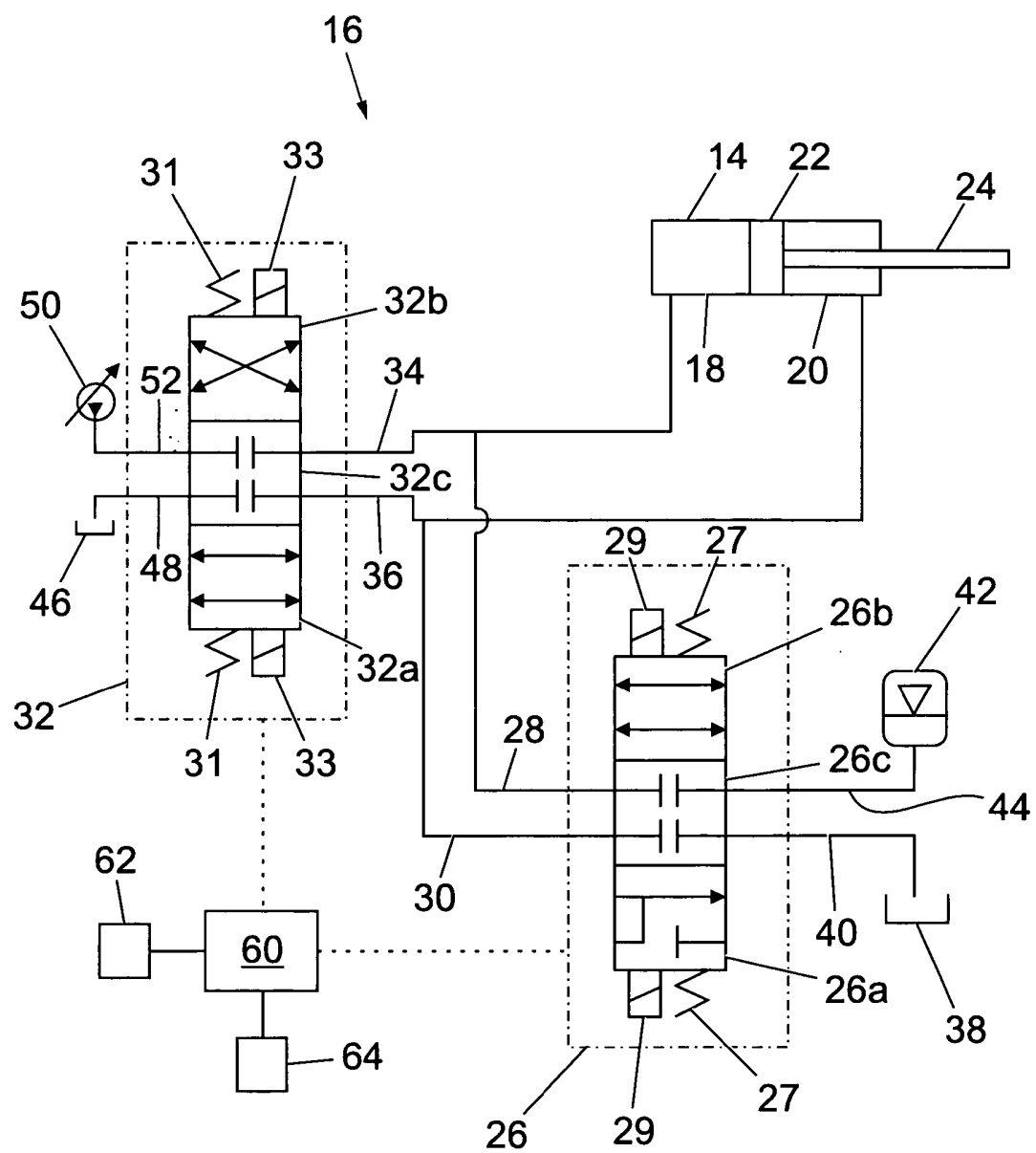


Fig. 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 10 3359

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 11 June 2007	Examiner Guthmuller, Jacques
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 07 10 3359

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