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(54) **Hydraulic leveling selection circuit for a work machine**

(57) A support system for a work machine (10) is provided that includes a front support assembly (22a) configured to perform one of stabilization and leveling control, a rear support assembly (22b) configured to perform the other of stabilization and leveling control, and a hydraulic circuit (30) configured to selectively switch leveling control between the front and rear support assemblies.

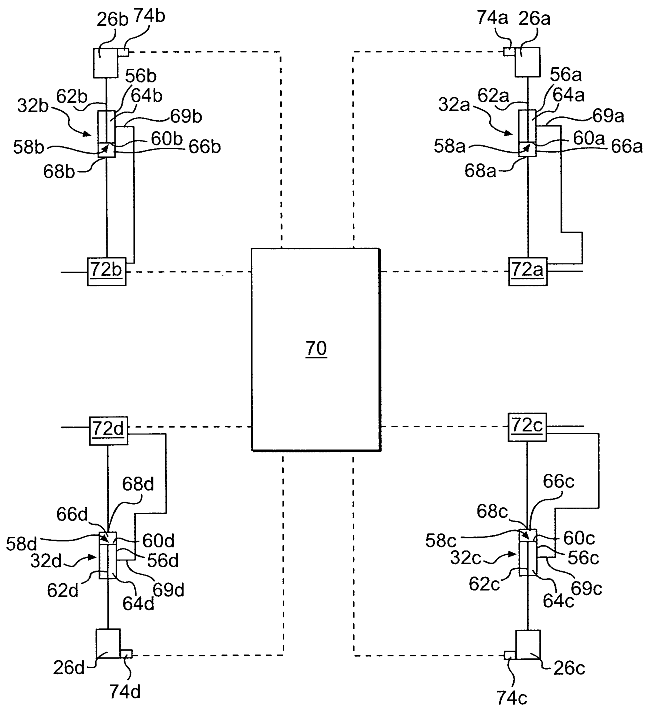


*FIG. 5*

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## Description

### Technical Field

**[0001]** The present disclosure relates to a work machine for the treatment of roadway surfaces, and more particularly to a cold planer for roadway surfacing operations.

### Background

**[0002]** Road milling machines, also known as cold planers, may be configured to scarify, remove, mix, or reclaim material from the surface of bituminous, concrete, or asphalt roadways and other surfaces using a rotatable planing tool mounted on a frame. The frame may be mounted on a plurality of tracks/wheels which support and horizontally transport the machine along the working surface.

**[0003]** Typically, cold planers may also include a plurality of lifting members positioned near the front and rear of the frame. The lifting members may be adjusted between extended and retracted positions to control the depth and shape of cut by raising or lowering the frame and rotatable planing tool. Actuation of the lifting members may be controlled by a machine operator or other suitable control mechanism.

**[0004]** One example of a leveling system for a cold planer is described in U.S. Patent No. 6,769,836 to Lloyd ("Lloyd"). Lloyd discloses an asphalt recycling machine. The machine includes front and rear axles that are raised and lowered by hydraulic cylinders. In order to stabilize the machine, the front axle's hydraulic cylinders are hydraulically connected in parallel. The rear axle's hydraulic cylinders are operated individually to control the height and tilt (slope) of the mainframe of the machine. Individual control of the rear axle's hydraulic cylinders, together with the front axle's hydraulic cylinders connected hydraulically, in parallel, form a three-point suspension, allowing the mainframe to ride over uneven surfaces. Also, stability is maintained as the rear wheels of the rear axle operate on a milled to grade surface.

**[0005]** The arrangement in Lloyd, wherein the front axle's hydraulic cylinders are connected while the rear axle's hydraulic cylinders are individually controlled, limits use of the machine to those job sites/situations in which such an arrangement is desired. For example, assigning individual control to the rear axle's hydraulic cylinders may be desirable in some instances because the rear axle's hydraulic cylinders run on the milled to grade surface and may be controlled and adjusted with better accuracy than the front axle's hydraulic cylinders that may run over uneven surfaces. However, assigning individual control to the front axle's hydraulic cylinders may be desirable in other situations, such as, for example, when milling/cutting irregularly shaped roadway surfaces or using high digging thicknesses that may cause high drum reaction that may create an upward force on the rear side of the machine. Because the machine in Lloyd only assigns individual control to the rear axle's hydraulic cylinders, it may not be used in jobs where assigning individual control on the front axle's hydraulic cylinders is desirable.

**[0006]** The disclosed system is directed towards overcoming one or more of the problems set forth above.

### Summary of the Invention

**[0007]** In one aspect, the present disclosure is directed to a support system for a work machine. The support system may include a front support assembly configured to perform one of stabilization and leveling control, a rear support assembly configured to perform the other of stabilization and leveling control, and a hydraulic circuit configured to selectively switch leveling control between the front and rear support assemblies.

**[0008]** In another aspect, the present disclosure is directed to a method of switching leveling control for a work machine. The method may include providing a front support assembly configured to perform one of stabilization and leveling control, providing a rear support assembly configured to perform the other of stabilization and leveling control, and selectively switching leveling control between the front and rear support assemblies.

**[0009]** In yet another aspect, the present disclosure may be directed to a work machine configured to perform work on a surface. The work machine may include a frame having a front portion and a rear portion. The work machine may also include a front support assembly including first and second hydraulic cylinders supporting the frame, with the front support assembly being configured to adjust the height of the front portion of the frame relative to the surface. The work machine may further include a rear support assembly including third and fourth hydraulic cylinders supporting the frame, with the rear support assembly being configured to adjust the height of the rear portion of the frame relative to the surface. Additionally, the work machine may include a first valve device operatively connected between the first and second hydraulic cylinders, and a second valve device operatively connected between the third and fourth hydraulic cylinders. When one of the first and second valves is in an open position, the other of the first and second valves is in a closed position.

### Brief Description of the Drawings

**[0010]**

FIG. 1 provides a diagrammatic top view of a work machine according to an exemplary disclosed embodiment.

FIG. 2 provides a diagrammatic side view of the work machine of FIG. 1.

FIG. 3 provides a schematic view of a hydraulic system according to an exemplary disclosed embodiment.

FIG. 4 provides another schematic view of the hydraulic system of FIG. 3.

FIG. 5 provides a schematic view of a hydraulic system according to another exemplary disclosed embodiment.

## Detailed Description

**[0011]** Work machines may be configured to perform work operations at job sites. Examples of work machines may include on and off highway vehicles, construction equipment, and earth-moving equipment. One particular type of work machine is a road milling machine or cold planer 10, as illustrated in FIG. 1. Cold planer 10 may be configured to scarify, remove, mix, or reclaim material from the surface of bituminous, concrete, or asphalt roadways and other surfaces. Elements of cold planer 10 may include a frame 12, a tool 14, and front and rear support assemblies 22a and 22b.

**[0012]** Front and rear support assemblies 22a and 22b may be configured to support frame 12 on work surfaces. Front support assembly 22a may include right and left front support assemblies 23a and 23b. Similarly, rear support assembly 22b may include right and left rear support assemblies 23c and 23d. Furthermore, right front support assembly 23a may include a traction device 24a and a column 26a. Traction devices 24b-24d and columns 26b-26d may be included in the remaining support assemblies.

**[0013]** Traction devices 24a-24d may perform the function of transporting the cold planer 10 across work surfaces. Traction devices 24a-24d may include tracks, wheels, and/or other known traction devices suitable for use on mobile work machines. At least one traction device may be powered by a drive assembly (not shown) for forward and rearward movement of cold planer 10. An example of a drive assembly may include an internal combustion engine or a hydraulic motor. It is further contemplated that traction devices 24a-24d may be attached to frame 12 by columns 26a-26d.

**[0014]** Columns 26a-26d may be selectively raised and lowered to cause upward, downward, and tilting movement of frame 12. In one embodiment, columns 26a-26d may include solid unitary elements that may be driven towards and away from frame 12 of cold planer 10 to raise and lower frame 12 with respect to roadway surface 16. In another embodiment, columns 26a-26d may include telescoping portions (not shown), such as, for example, overlapping cylindrical segments adapted to slide inward (retract) or outward (extend) with respect to each other. The inward and outward sliding of the overlapping cylindrical segments may raise and lower frame 12, and their movement may be actuated by pressurized hydraulic fluid that may be selectively supplied by the machine operator (pilot) and/or by an automated control mechanism.

**[0015]** Frame 12 may include one or more structural load carrying members adapted to support and/or protect components of cold planer 10. Elements of frame 12 may include, for example, housings, beams, and panels. Furthermore, tool 14 may be supported on or within frame 12.

**[0016]** Tool 14, shown in the side view depicted in FIG. 2, may include a rotatable planing tool, such as, for example, a rotatable drum 18 or cylinder. Drum 18 may include a plurality of replaceable bits (not shown) mounted thereon and may be lowered to engage a roadway surface 16. Upon engagement, the bits may cut and remove material from roadway surface 16. The removed material may enter conveyor 20 which may transfer the removed material into a dump truck (not shown) for transport off-site. The height of drum 18 relative to the roadway surface 16 may determine the shape and depth of cut made in the roadway surface 16 and may affect the amount of material being removed. Thus, in order to control the shape and depth of cut, drum 18 may be adjusted such that it may vertically move away from, towards, and into roadway surface 16.

**[0017]** An exemplary disclosed embodiment of a hydraulic system 28, configured to direct pressurized hydraulic fluid, is shown in FIG. 3. Hydraulic system 28 may cause movement of columns 26a-26d using the pressurized hydraulic fluid. Hydraulic system 28 may include a hydraulic circuit 30 for selectively supplying the pressurized hydraulic fluid to different areas of hydraulic system 28, and hydraulic cylinders 32a-32d to convert the hydraulic pressure into mechanical motion for actuating columns 26a-26d.

**[0018]** Hydraulic circuit 30 may include an assembly of components configured to regulate and control the flow of pressurized hydraulic fluid through hydraulic system 28. In one embodiment, hydraulic circuit 30 may include a valve manifold 34, cylinder valves 36a-36d, and two-way valves 38a and 38b. Exemplary sub-components of hydraulic circuit 30 will be discussed below, but it should be understood that hydraulic circuit 30 is not limited to these specific configurations.

**[0019]** Valve manifold 34 may be configured to selectively direct pressurized hydraulic fluid from apertures 40a-40f into the other parts of hydraulic circuit 30. Valve manifold 34 may include flow conduits 42a-42h, selector valves 44a-44c, a low pressure line 48, and a two-way valve 50. It should be understood that valve manifold 34 may include less, more, or different elements from those specified, and the structure of valve manifold 34 may depend on a host of factors, including, for example, the environment of the job site. Also, it should be understood that valve manifold 34 may be replaced by a plurality of valves, such as selector valves 44a-44c, that may be electrically actuated to perform substantially similar functions as those performed by valve manifold 34.

**[0020]** Each of apertures 40a-40f may be configured to permit pressurized hydraulic fluid to enter into and exit from valve manifold 34. Flow conduits 42c and 42d, operatively associated with right front support assembly 23a, may be selectively placed into fluid communication with apertures 40c-40f. Flow conduits 42a and 42b, operatively associated with left front support assembly 23b, may be selectively placed into fluid communication with apertures 40a and 40b. Flow conduits 42f and 42e, operatively associated with right rear support assembly 23c, may be selectively placed into fluid communication with apertures 40e and 40f. Flow conduits 42g and 42h, operatively associated with left rear support assembly 23d, may be selectively placed in fluid communication with apertures 40c and 40d or 40a and 40b. Flow conduits 42a, 42c, 42e, and 42g may carry input flow from a fluid source (not shown) into support assemblies 22a and 22b if colder planer 10 is to be raised, and/or they may carry output flow from support assemblies 22a and 22b to a tank (not shown) if cold planer 10 is to be lowered. Additionally, input flows from the fluid source (not shown) may pass through flow conduits 42b, 42d, 42f, and 42h, thus allowing these flow conduits to function as pilot lines to actuate cylinder valves 36a-36d.

**[0021]** Fluid communication between apertures 40a-40f and flow conduits 42a-42h may be determined by selector valves 44a-44c. Selector valves 44a-44c may each be configured to shift between a first position (FIG. 3) and a second position (FIG. 4). In the first position, selector valve 44a may direct the fluid flow from apertures 40a and 40b towards flow conduits 42a and 42b. In the second position, selector valve 44a may direct the fluid flow from apertures 40a and 40b towards flow conduits 42g and 42h. Similarly, selector valves 44b and 44c may also selectively direct the fluid flow. Each of selector valves 44a-44c may be biased by a spring 46a-46c towards the first position. Actuation of selector valves 44a-44c against the spring bias from the first position to the second position may be initiated by pressurized hydraulic fluid from low pressure line 48. Additionally or alternatively, it is also contemplated that selector valves 44a-44c may be actuated manually or by solenoid actuation upon recognition of an electrical signal.

**[0022]** Low pressure line 48 may direct a low pressure hydraulic fluid flow into valve manifold 34 of hydraulic circuit 30 from a tank and pump assembly (not shown). When low pressure line 48 and selector valves 44a-44c are placed into fluid communication, the low pressure hydraulic fluid flow may physically push each of selector valves 44a-44c into second position. Fluid communication between low pressure line 48 and selector valves 44a-44c may occur upon actuation of two-way valve 50, which may include, for example, a solenoid valve or a two-way pilot valve.

**[0023]** Cylinder valves 36a-36d may be operatively connected to flow conduits 42a-42h of valve manifold 34, and may control the fluid flow entering hydraulic cylinders 32a-32d. In one embodiment, cylinder valves 36a-36d may include counterbalance valves, each counterbalance valve having at least a check valve 52a-52d and a spring-biased pressure relief valve 54a-54d. Check valves 52a-52d and pressure relief valves 54a-54d may be configured to selectively prevent flow, restrict flow, and allow flow to enter into and exit from hydraulic cylinders 32a-32d. Thus, check valves 52a-52d and pressure relief valves 54a-54d may be configured to provide braking to hydraulic cylinders 32a-32d to slow down and/or smooth out their movements. It is also contemplated that cylinder valves 36a-36d may include double acting counterbalance valves for embodiments that may include double-acting, rather than single-acting, hydraulic cylinders.

**[0024]** Hydraulic cylinders 32a-32d may each include a housing 56a-56d and a piston 58a-58d slidably mounted therein. Each of housings 32a-32d may include a hollow bored interior, and each piston 58a-58d may include a piston plug 60a-60d configured to fit closely within the bore and a piston shaft 62a-62d operatively connected to plugs 60a-60d and columns 26a-26d. Pistons 58a-58d may divide their respective cylinder housings 56a-56d into upper chambers 64a-64d and lower chambers 66a-66d. Upper chambers 64a-64d may include outlets 69a-69d that may direct the pressurized hydraulic fluid out of upper chambers 64a-64d and into a tank (not shown) or the atmosphere. Lower chambers 66a-66d may include apertures 68a-68d to allow the pressurized hydraulic fluid passing through cylinder valves 36a-36d to enter lower chambers 66a-66d when extension of hydraulic cylinders 32a-32d may be desired, and also to allow the pressurized hydraulic fluid within lower chambers 66a-66d to escape back towards cylinder valves 36a-36d when retraction of hydraulic cylinders 32a-32d may be desired. It should be understood that extension and retraction of hydraulic cylinders 32a-32d may directly result in the raising and lowering of columns 26a-26d.

**[0025]** The operation of hydraulic cylinder 32a will now be described in more detail. In the state shown in FIG. 3, if extension of hydraulic cylinder 32a may be desired, pressurized hydraulic fluid supplied from a fluid supply (not shown) may enter flow conduit 42c from aperture 40f. As the pressurized hydraulic fluid travels through flow conduit 42, it may pass through check valve 52a, which may create a force on pressure relief valve 54a that may drive pressure relief valve 54a towards the open position (towards the left) allowing flow to travel through flow conduit 42c into aperture 68a of lower chamber 66a of hydraulic cylinder 32a. As the pressurized hydraulic fluid builds within lower chamber 66a, piston 58a may be driven upwards to an extended position. Any pressurized hydraulic fluid in upper chamber 64a may be forced out through outlet 69a by upward motion of piston 58a. If retraction of hydraulic cylinder 32a may be desired, the flow of pressurized hydraulic fluid entering flow conduit 42c from aperture 40f may cease. Pressurized hydraulic fluid may be supplied from a source (not shown) through inlet 40e into flow conduit 42d, wherein flow conduit 42d may act as a pilot line by driving pressure relief valve 54a towards the open position (left) allowing pressurized hydraulic fluid within lower chamber 66a to exit out through flow conduit 42c and aperture 40f as the force of gravity on cold planer 10 drives piston 58a in a downward direction.

Additionally or alternatively, hydraulic cylinder 32 may include a double-acting hydraulic cylinder that may retract and extend in ways known to those skilled in the art. While only the operation of hydraulic cylinder 32a has been described in detail, it should be understood that hydraulic cylinders 32b-32d may be operated in a similar manner.

**[0026]** Cylinder valves 36a and 36b may be selectively placed into fluid communication by two-way valve 38a, and a similar relationship may exist between cylinder valves 36c and 36d and two-way valve 38b. In FIG. 3, two-way valve 38a is shown in a closed state while two-way valve 38b is shown in an open state. In this condition of hydraulic circuit 30, hydraulic cylinders 32a and 32b may be individually controlled, while hydraulic cylinders 32c and 32d may move in unison. In FIG. 4, two-way valve 38a is shown in an open state, while two-way valve 38 b is shown in a closed state. In this condition of hydraulic circuit 30, hydraulic cylinders 32a and 32b may move unitarily, while hydraulic cylinders 32c and 32d may move independent of one another. In one embodiment, two-way valves 38a and 38b may include solenoid valves that may be actuated to move into open and closed positions, wherein if one valve is in open position the other will be in closed position. Additionally, two-way valves 38a and 38b, and any other of the valves described above, may include manually adjustable valves.

**[0027]** As shown in FIG. 5, it is further contemplated that one or more of the previously described valve devices may be replaced by an electronic controller 70. Controller may 70 include hardware and software elements adapted to selectively direct the desired amount of flow to hydraulic cylinders 32a-32d to simulate the function of one or more of the replaced valve devices. In one embodiment, controller 70 may control valve assemblies 72a-72d. Valve assemblies 72a-72d may include, for example, independent metering valve ("IMV") assemblies. Each IMV assembly may receive pressurized hydraulic fluid from a hydraulic pump (not shown) and may be in fluid communication with at least one of hydraulic cylinders 32a-32d. An IMV assembly may typically include four independently controllable valves, with one pair of the valves being coupled with a head end (upper chamber) of a hydraulic cylinder and the other pair of controllable valves being coupled with a rod end (lower chamber) of that hydraulic cylinder. Each pair of controllable valves in the IMV assembly may allow flow both to and from its corresponding hydraulic cylinder. The controllable valves may be electronically controlled using controller 70, depending upon various input signals received from one or more sensors 74a-74d.

**[0028]** In operation, controller 70 may monitor position sensors 74a and 74b associated with hydraulic cylinders 32a and 32b, and using readings from position sensors 74a and 74b as a reference, the controller may supply equal amounts of flow to hydraulic cylinders 32a and 32b to simulate the opening of two-way valve 38a. By simulating the opening of two-way valve 38a, the controller may assign leveling control to hydraulic cylinders 32c and 32d. Similarly, the controller may simulate the opening of two-way valve 38b by supplying equal amounts of flow to hydraulic cylinders 32c and 32d. By simulating the opening of two-way valve 38b, the controller may assign leveling control to hydraulic cylinders 32a and 32b.

<u>Industrial Applicability</u>

**[0029]** The disclosed hydraulic system 28 may be used to provide leveling control for work machines. An exemplary disclosed work machine may include, for example, a cold planer 10.

**[0030]** Hydraulic system 28 may provide the benefit of allowing a machine operator to switch leveling control from a front support assembly 22a to a rear support assembly 22b, and vice versa. Front and rear support assemblies 22a and 22b may include columns 26a-26d that may be raised and lowered by their respective hydraulic cylinders 32a-32d. In one embodiment, columns 26a and 26b may act as front columns, and columns 26c and 26d may act as rear columns. In a front leveling control state shown in FIG. 3, each of two-way valves 38a and 38b, two-way valve 50, and selector valves 44a-44c may be in a first position. In this first position, selector valves 44a-44c may direct the fluid flow from apertures 40a and 40b towards hydraulic cylinder 32b, and may also direct the fluid flow from apertures 40e and 40f towards hydraulic cylinder 32a. Additionally, two-way valve 38a may prevent fluid communication between flow conduits 42a and 42c. Thus, front columns 26a and 26b may be independently driven by fluid flow from apertures 40e and 40f, and 40a and 40b, respectively.

**[0031]** Also in the first position, selector valve 44c may direct the fluid flow from apertures 40c and 40d towards hydraulic cylinder 32d. In addition, two-way valve 38b may permit fluid communication between flow conduits 42g and 42e, and thus, hydraulic cylinder 32c associated with rear column 26c may be driven by the same fluid flow driving rear column 26d. Accordingly, rear columns 26c and 26d may move together unitarily or in unison.

**[0032]** Independently operated front columns 26a and 26b may perform leveling by being extended and retracted to control the depth and shape of cut. When equal fluid flow drives both of front columns 26a and 26b, then the front end of frame 12 may raise or lower accordingly. On the other hand, when greater fluid flow drives one of front columns 26a and 26b, then the front end of frame 12 may tilt and/or raise or lower accordingly. At the rear end of frame 12, operatively connected/linked rear columns 26c and 26d may provide for a three point machine configuration, with front telescoping columns 26a and 26b being two points, and rear telescoping columns 26c and 26d acting together as a third point. The three point machine configuration may provide cold planer 10 with the stability associated with using triangularly arranged support points, may provide both lifting, lowering, and tilting of frame 12, and may reduce stress in frame 12 as it passes over uneven roadway surface 16.

**[0033]** Switching leveling control from front columns 26a and 26b to rear columns 26c and 26d may be accomplished by signaling or actuating each of two-way valves 38a and 38b, into a rear leveling control state corresponding to FIG. 4. In this position, two-way valve 50 may allow low pressure fluid to flow through low pressure line 48 to actuate selector valves 44a-44c into a second position. In this second position, selector valves 44a-44c may direct the fluid flow from inlet ports 40a and 40b, and 40e and 40f, towards hydraulic cylinders 32c and 32d, respectively. Two-way valve 38b may block or prevent fluid communication between fluid conduits 42e and 42g, thus allowing rear columns 26c and 26d to move independently of one another. Selector valve 44c may direct the fluid flow from apertures 40c and 40d towards hydraulic cylinder 32a associated with front column 26a. Two-way valve 38a may permit fluid communication between fluid conduits 42a and 42c, thus linking the fluid flows driving columns 26a and 26b. Accordingly, independently operated rear columns 26c and 26d may perform leveling, while operatively connected/linked front columns 26a and 26b may provide for the stable three point machine configuration.

**[0034]** The ability to switch leveling control between front and rear support assemblies 22a and 22b, may be advantageous for several reasons. For example, setting leveling control on rear columns 26c and 26d of rear support assembly 22b may allow for a more precise cut in certain situations because traction devices 24c and 24d associated with rear columns 26c and 26d may run on a relatively flat (milled) roadway surface 16. Also, when cold planer 10 mills a small road thickness at high velocity, rear columns 26c and 26d and/or traction devices 24c and 24d may be less affected by roadway surface 16 unevenness than front columns 26a and 26b and/or traction devices 24a and 24b. However, giving leveling control to front columns 26a and 26b of front support assembly 22a may be desirable in other situations. Examples of such situations may include, milling/cutting irregularly shaped roadway surfaces 16, or using high digging thicknesses that may cause high drum reaction that may create an upward force on the rear side of cold planer 10. This force may cause leveling control on rear columns 26c and 26d to become imprecise and/or ineffective. For at least these reasons, the ability to switch leveling control between front support assembly 22a and rear support assembly 22b may be advantageous, by allowing the machine operator/controller to selectively determine where to assign leveling control based on roadway surface 16 conditions. The result may be an improvement in the flexibility of cold planer 10 because it may be used successfully in a wider variety of situations and job sites.

**[0035]** It will be apparent to those skilled in the art that various modifications and variations can be made in the disclosed protection system without departing from the scope of the disclosure. Additionally, other embodiments of the disclosed system will be apparent to those skilled in the art from consideration of the specification. It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims and their equivalents.

## Claims

**1.** A support system for a work machine (10), comprising:

a front support assembly (22a) configured to perform one of stabilization and leveling control;
a rear support assembly (22b) configured to perform the other of stabilization and leveling control; and
a hydraulic circuit (30) configured to selectively switch leveling control between the front and rear support assemblies.

**2.** The system of claim 1, wherein:

the front support assembly (22a) further includes first and second hydraulic cylinders (32a, 32b); and
the rear support assembly (22b) further includes third and fourth hydraulic cylinders (32c, 32d).

**3.** The system of claim 2, wherein the first and second hydraulic cylinders (32a, 32b) are operatively connected by a front valve device (38a) and the third and fourth hydraulic cylinders (32c, 32d) are operatively connected by a rear valve device (38b).

**4.** The system of claim 3, wherein when the front valve device (38a) is in an open position, the first and second hydraulic cylinders (32a, 32b) are hydraulically connected, and the third and fourth hydraulic cylinders (32c, 32d) perform leveling control.

**5.** The system of claim 3, wherein when the rear valve device (38b) is in an open position, the third and fourth hydraulic cylinders (32c, 32d) are hydraulically connected, and the first and second hydraulic cylinders (32a, 32b) perform leveling control.

**6.** A work machine (10) including the support system of any of claims 1-5.

**7.** A method of switching leveling control for a work machine (10), comprising:

providing a front support assembly (22a) configured to perform one of stabilization and leveling control;
providing a rear support assembly (23a) configured to perform the other of stabilization and lev-

eling control; and
selectively switching leveling control between the front and rear support assemblies.

**8.** The method of claim 7, wherein selectively switching leveling control further includes:

opening a first valve (38a) to assign leveling control to the rear support assembly (22b); and
closing the first valve (38a) to assign leveling control to the front support assembly (22a).

**9.** The method of claim 8, wherein opening the first valve (38a) permits a low pressure flow to actuate one or more selector valves (44a, 44b, 44c) to permit entry of first and second hydraulic flows into the rear support assembly (22b).

**10.** The method of claim 8, wherein closing the first valve (38a) permits the entrance of first and second hydraulic flows into the front support assembly (22a).

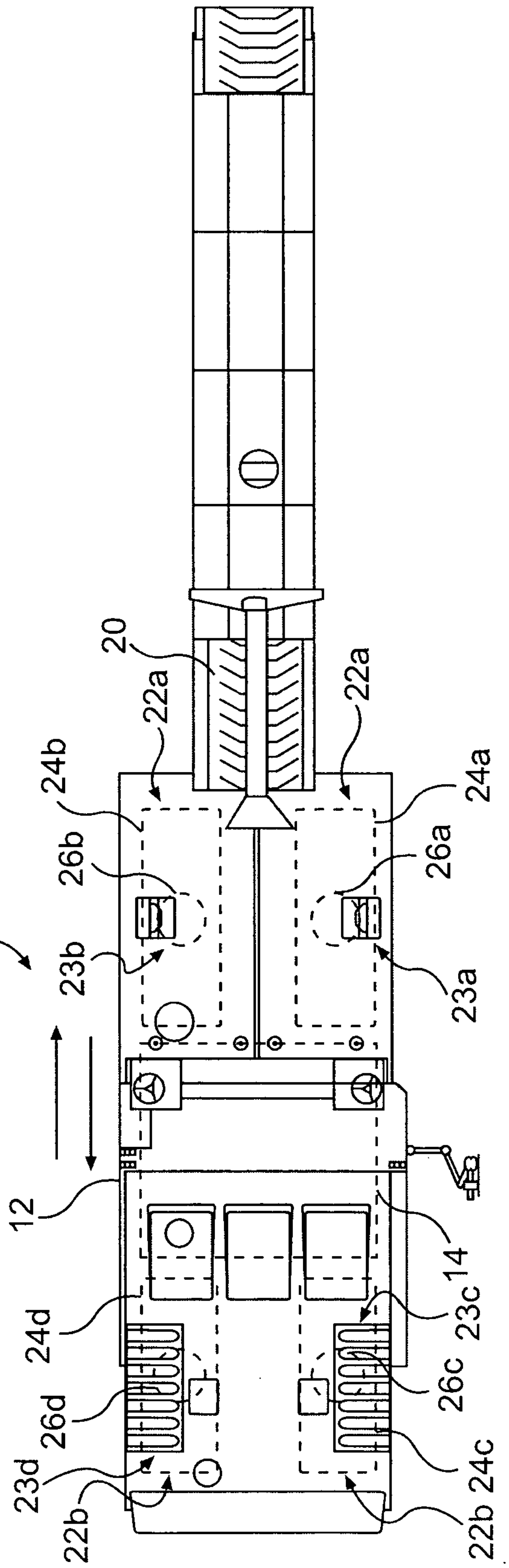
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FIG. 1

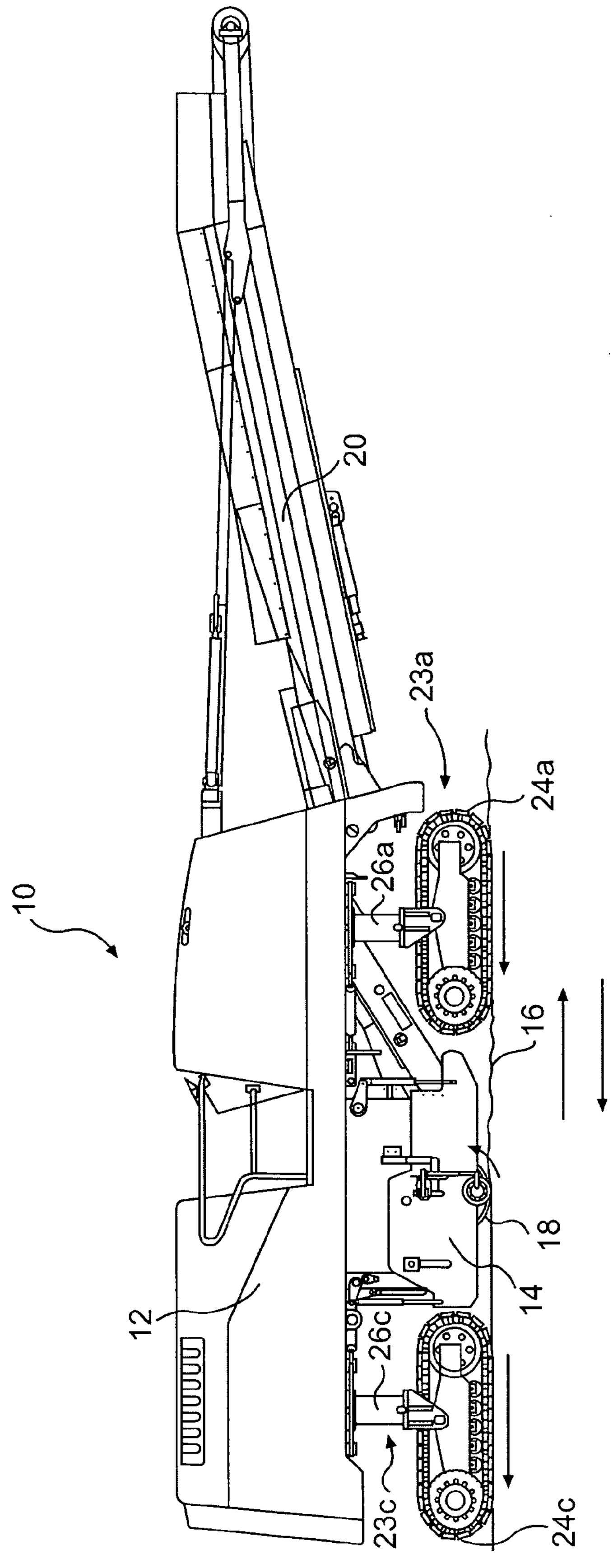


FIG. 2

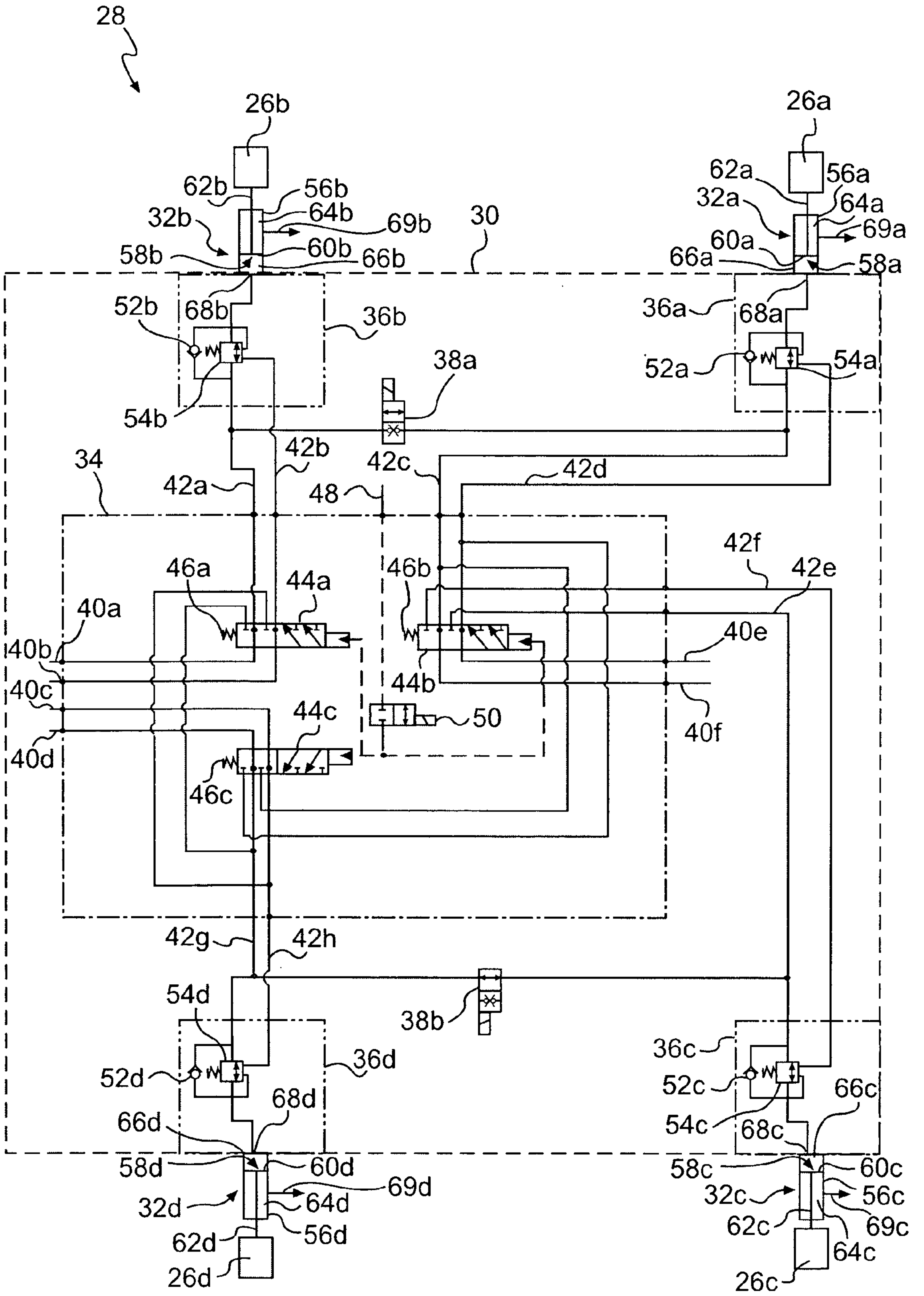
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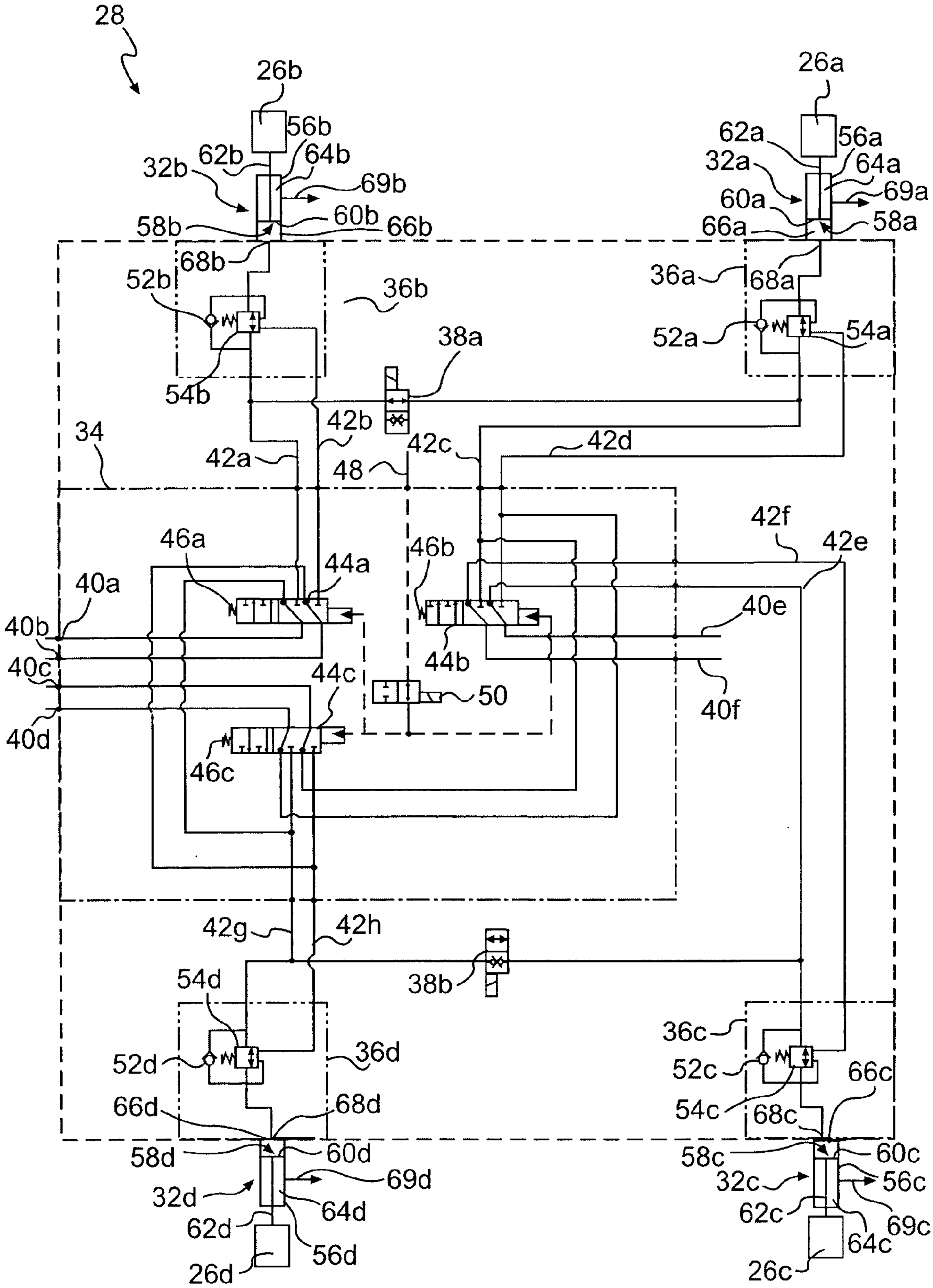
FIG. 3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26d
56d
36c
52c
54c
68c
66c
58c
60c
32c
56c
62c
69c
64c
26c

FIG. 4

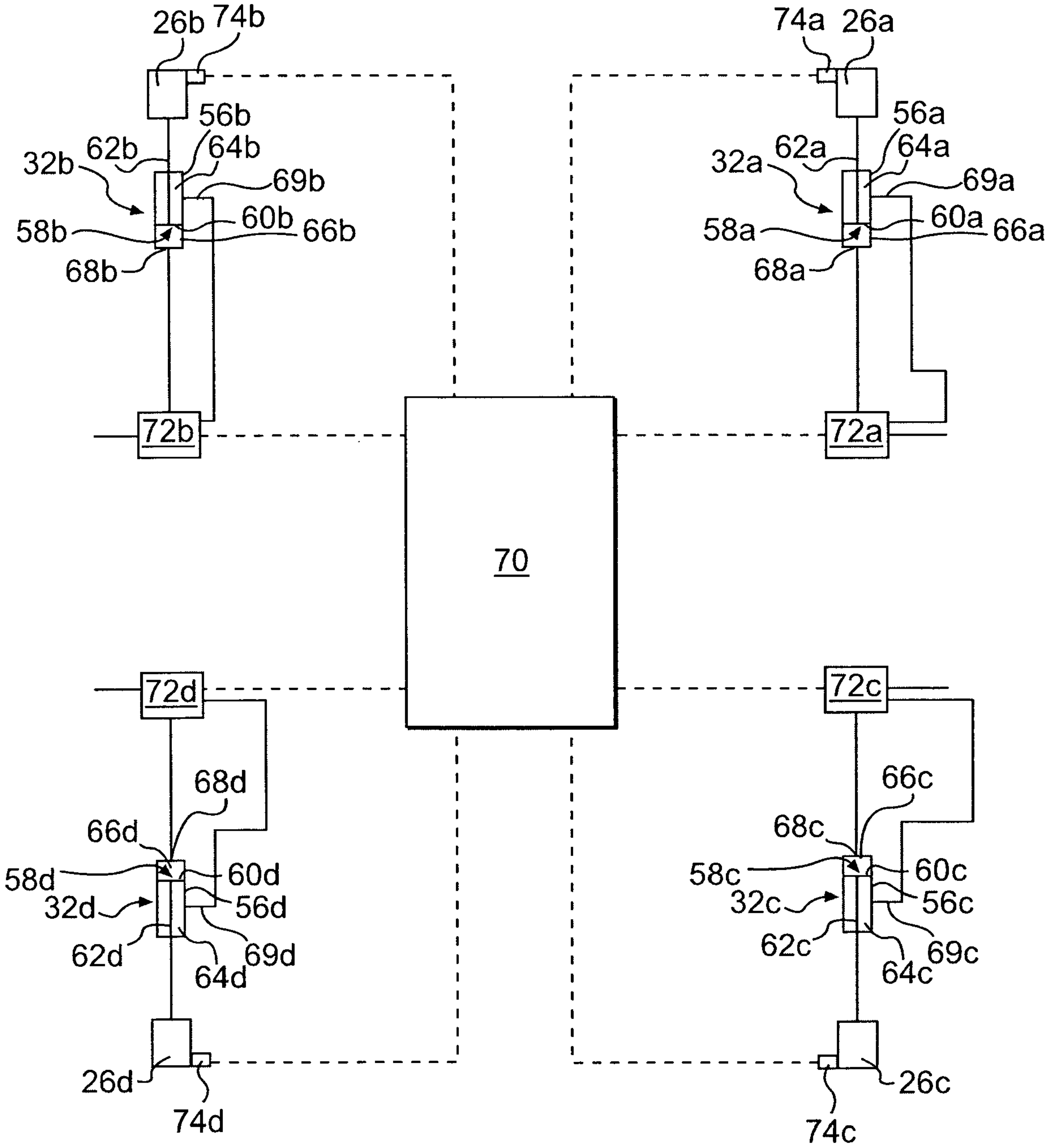
26b
74b
56b
32b
62b
64b
69b
60b
58b
66b
68b
72b
74a
26a
56a
32a
62a
64a
69a
60a
58a
66a
68a
72a
70
72d
68d
66d
58d
60d
32d
56d
62d
69d
64d
26d
74d
72c
66c
68c
58c
60c
32c
56c
62c
69c
64c
26c
74c

FIG. 5

## REFERENCES CITED IN THE DESCRIPTION



### Patent documents cited in the description

- US 6769836 B, Lloyd **[0004]**