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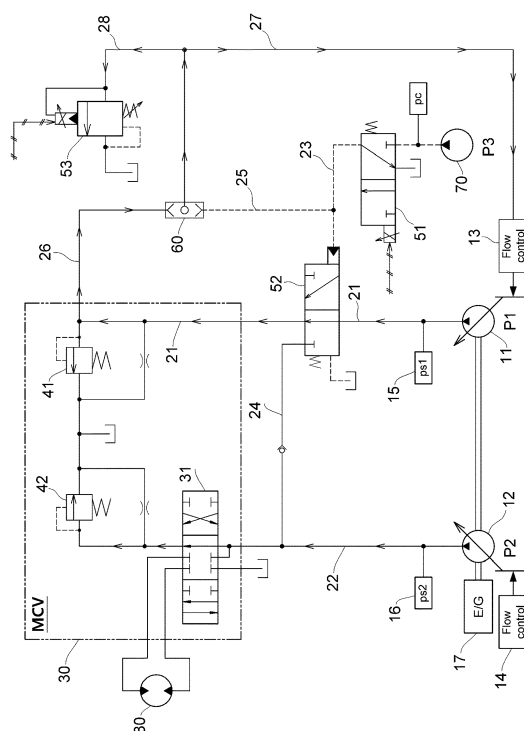
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(54) **HYDRAULIC SYSTEM FOR CONSTRUCTION MACHINERY**

(57) The present disclosure relates to a hydraulic system for construction machinery. According to the exemplary embodiment of the present disclosure, during a traveling mode, hydraulic oil discharged from a first main pump (11) merges with hydraulic oil discharged from a second main pump (12), and the merged hydraulic oil is provided to a traveling motor (80), thereby improving traveling performance. In addition, according to the hydraulic system for construction machinery according to the exemplary embodiment of the present disclosure, even in a situation in which the first and third control valve units (51, 53) cannot be normally controlled for an unknown reason, the overspeed traveling may be prevented by restricting a maximum discharge flow rate of the first main pump (11) in the traveling mode, thereby ensuring traveling performance and preventing durability of a traveling system from deteriorating.

FIG. 1



Description

FIELD OF THE DISCLOSURE

[0001] The Embodiments according to the present disclosure relates to a hydraulic system for construction machinery. More particularly, the present disclosure relates to a hydraulic system for construction machinery, including a first main pump and a second main pump, in which in a traveling mode, hydraulic oil discharged from the first main pump merges with hydraulic oil discharged from the second main pump, and the merged hydraulic oil is provided to a traveling motor, thereby improving traveling performance.

BACKGROUND OF THE DISCLOSURE

[0002] In general, a power source and a hydraulic system are provided in a construction machine. The power source may be an engine or an electric motor. The hydraulic system may include a main pump, a main control valve, an actuator, a sub-pump, and a joystick.

[0003] The main pump is operated by the power source, and discharges hydraulic oil at a predetermined pressure. A plurality of main pumps may be provided. In addition, the main pump may be a variable capacity type pump in which a discharge flow rate may be changed. The hydraulic oil discharged from the main pump may be supplied to the main control valve.

[0004] A plurality of control valves units may be disposed in the main control valve. The control valve units may be connected with a plurality of actuators through hydraulic lines, respectively.

[0005] The sub-pump is operated by the power source, and discharges pilot hydraulic oil. The sub-pump may be a fixed capacity type pump in which a discharge flow rate is fixed. The pilot hydraulic oil discharged from the sub-pump may be provided to the joystick.

[0006] The joystick may be manipulated by an operator. When the joystick is manipulated, a control signal is produced by the pilot hydraulic oil. The control signal is a signal that corresponds to manipulation displacement of the joystick. The control signal is applied to a pressure receiving part of a spool of the control valve unit. That is, when the operator manipulates the joystick, the spool of the control valve unit is moved corresponding to the manipulation of the joystick, and as a result, the high-pressure hydraulic oil supplied to the main control valve is provided to the actuator. The actuator is operated by the provided hydraulic oil, and performs desired work.

[0007] The actuator may be a linear actuator that is linearly operated, or may be a rotary actuator that is operated while rotating. The linear actuator may be a boom actuator, an arm actuator, a bucket actuator, or the like. In addition, the rotary actuator may be a traveling motor, a swing motor, or the like of the construction machine. In addition, the actuator may further include an option actuator, an outrigger, or a dozer that allows the con-

struction machine to perform additional functions.

[0008] Meanwhile, the main control valve has a first hydraulic line connected with a first main pump, and a second hydraulic line connected with a second main pump. Actuators, which mainly operate the first main pump and the second main pump, are determined. For example, an option control valve unit, a bucket control valve unit, a second boom control valve unit, a first arm control valve unit, and the like may be disposed in the first hydraulic line. In addition, a traveling control valve unit, an option control valve unit, a swing control valve unit, a first boom control valve unit, a second arm control valve unit, and the like may be disposed in the second hydraulic line.

[0009] However, a general hydraulic system for construction machinery has the following problems.

[0010] The construction machine may select either a working mode or a traveling mode. The working mode puts priority on working, and a boom, an arm, and a bucket and rotations of an upper body are mainly operated in the working mode. The traveling mode puts priority on traveling, and a traveling motor is mainly operated in the traveling mode. When an engine is operated, the first and second main pumps and the sub-pump are operated, and the hydraulic oil discharged from the second main pump is input to the traveling control valve unit. Since the second main pump and the traveling control valve unit are connected to each other in the general hydraulic system for construction machinery, there is a problem in that in a case in which the traveling mode is selected and the construction machine travels, the hydraulic oil discharged from the first main pump is not utilized to allow the construction machine to travel, but immediately discharged.

[0011] In another problem, in order to sufficiently supply the hydraulic oil to the traveling motor when the construction machine travels, the engine is sometimes operated at a higher rotational speed (rpm) of the engine, for example, 2,000 rpm than in the working mode. That is, the rotational speed of the engine in the traveling mode is relatively high in comparison with the working mode in which the rotational speed of the engine is set to 1,500 rpm to 1,800 rpm. Therefore, in the related art, an engine with high engine output, which may be operated at a high rotational speed, needs to be selected to satisfy traveling performance. Therefore, there is a problem in that when the engine is operated, a loss is increased, and fuel efficiency deteriorates.

[0012] In yet another problem, traveling performance and performance of a working machine all need to be considered when determining a capacity specification of the main pump, and as a result, it is difficult to determine a specification of the main pump. For example, when the capacity of the traveling motor is determined in consideration of traveling performance and traction force, a traveling speed may be designed based on the rotational speed of the engine and the capacity of the main pump. However, since the capacity of the main pump is deter-

mined based on performance of the working machine, the rotational speed of the engine for satisfying the traveling speed is inevitably determined regardless of a designer's intention. As a result, there is no performance factor by which a traveling system may be efficiently designed to satisfy target traveling performance (traction force and a traveling speed) of the construction machine, and as a result, there is a problem in that efficiency of the traveling system is inevitably much worse than efficiency of the working machine.

[0013] In still yet another problem, regarding the hydraulic system for construction machinery in the related art, there has been proposed a technology in which in the traveling mode, the hydraulic oil discharged from the first main pump merges with the hydraulic oil discharged from the second main pump, and the merged hydraulic oil is provided to the traveling motor, thereby improving traveling performance. The traveling is carried out by the traveling system, and the traveling system includes a number of constituent elements associated with the traveling in addition to the traveling motor. However, in the hydraulic system for construction machinery in the related art, for an unknown reason, there may be a problem with a control unit that is controlled by a current signal. When a problem occurs in the control unit, the first main pump may be abnormally controlled. In particular, when the hydraulic oil discharged from the first main pump merges with the hydraulic oil discharged from the second main pump, an excessive amount of hydraulic oil may be supplied to the traveling motor. That is, the construction machine may travel at a speed that is higher than a traveling speed designed by a manufacturer of the construction machine, thereby jeopardizing traveling safety. In addition, when an excessive amount of hydraulic oil is provided to the traveling motor, there may be a problem in view of durability of the traveling system.

[LITERATURE OF RELATED ART]

[Patent Literature]

[0014] (Patent Literature 1) Japanese Patent Application Laid-Open No. 2004-27706 (January 29, 2004)

SUMMARY

[0015] The present disclosure has been made in an effort to provide a hydraulic system for construction machinery, which is capable of improving traveling performance of construction machinery and preventing durability of a traveling system from deteriorating.

[0016] Technical problems to be solved by the present disclosure are not limited to the aforementioned technical problem, and other technical problems, which are not mentioned above, may be clearly understood from the following descriptions by those skilled in the art to which the present disclosure pertains.

[0017] An exemplary embodiment of the present dis-

closure provides a hydraulic system for construction machinery, including: first and second main pumps which discharge high-pressure hydraulic oil; a sub-pump which discharges pilot hydraulic oil; a first hydraulic line which is connected with the first main pump; a second hydraulic line which is connected with the second main pump; a traveling control valve unit which is disposed in the second hydraulic line, and controls a flow direction of the hydraulic oil that is supplied to a traveling motor; a first relief valve which is disposed in the first hydraulic line, and maintains pressure of the first hydraulic line to relief pressure or lower; a first control valve unit which is opened when a traveling mode is selected, and allows the pilot hydraulic oil to pass through the first control valve unit; a second control valve unit which is operated by the pilot hydraulic oil supplied via the first control valve unit, and connects the hydraulic oil discharged from the first main pump to the second hydraulic line; and a shuttle valve which allows the pressure of the pilot hydraulic oil and the relief pressure to compete at both ends of the shuttle valve, and connects relatively high-pressure hydraulic oil to a first regulator of the first main pump.

[0018] The relief pressure, which is set for the first relief valve, may be set to be equal to the pressure of the pilot hydraulic oil discharged from the sub-pump.

[0019] The hydraulic system for construction machinery may further include a third control valve unit which reduces the pressure of the hydraulic oil provided to the first regulator when pump pressure of any one of the first main pump and the second main pump is higher than a predetermined pressure.

[0020] The third control valve unit may be an electronic proportional control valve that reduces the pressure of the hydraulic oil provided to the first regulator in proportion to a difference between the pump pressure and the predetermined pressure.

[0021] When a working mode is selected, the first control valve unit may connect a pressure receiving part of a spool of the second control valve unit with a drain tank, and the second control valve unit may disconnect the first hydraulic line from the second hydraulic line.

[0022] Another exemplary embodiment of the present disclosure provides a hydraulic system for construction machinery, including: first and second main pumps which discharge high-pressure hydraulic oil; a sub-pump which discharges pilot hydraulic oil; a first hydraulic line which is connected with the first main pump; a second hydraulic line which is connected with the second main pump; a traveling control valve unit which is disposed in the second hydraulic line, and controls a flow direction of the hydraulic oil that is supplied to a traveling motor; a first relief valve which is disposed in the first hydraulic line, and maintains pressure of the first hydraulic line to relief pressure or lower; a first control valve unit which is opened when a traveling mode is selected, and allows the pilot hydraulic oil to pass through the first control valve unit; a second control valve unit which is operated by the pilot hydraulic oil supplied via the first control valve unit,

and connects the hydraulic oil discharged from the first main pump to the second hydraulic line; a third control valve unit which reduces pressure of the pilot hydraulic oil, and outputs the pilot hydraulic oil; and a shuttle valve which allows the pressure of the first hydraulic line and the output pressure of the third control valve unit to compete at both ends of the shuttle valve, and connects relatively high-pressure hydraulic oil to a first regulator of the first main pump.

[0023] In this case, the relief pressure, which is set for the first relief valve, may be set to be equal to the pressure of the pilot hydraulic oil discharged from the sub-pump.

[0024] When pump pressure of any one of the first main pump and the second main pump is higher than a predetermined pressure, the third control valve unit may reduce the pressure of the output hydraulic oil.

[0025] The third control valve unit may reduce the pressure of the output hydraulic oil in proportion to a difference between the pump pressure of the pump, which exceeds the predetermined pressure, and the predetermined pressure.

[0026] When a working mode is selected, the first control valve unit may connect a pressure receiving part of the second control valve unit with a drain tank, and the second control valve unit may disconnect the first hydraulic line from the second hydraulic line.

[0027] Other detailed matters of the exemplary embodiment are included in the detailed description and the drawings.

[0028] According to the hydraulic system for construction machinery according to the exemplary embodiment of the present disclosure, which is configured as described above, in a traveling mode, hydraulic oil discharged from a first main pump merges with hydraulic oil discharged from a second main pump, and the merged hydraulic oil is provided to a traveling motor, thereby improving traveling performance.

[0029] According to the hydraulic system for construction machinery according to the present disclosure, even in a situation in which the first and third control valve units cannot be normally controlled for an unknown reason, it is possible to restrict a maximum discharge flow rate of the first main pump in the traveling mode. Accordingly, it is possible to prevent overspeed traveling, ensure traveling stability, and prevent durability of a traveling system from deteriorating.

[0030] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

FIG. 1 is a hydraulic circuit diagram for explaining a

state in which a hydraulic system for construction machinery according to a first exemplary embodiment of the present disclosure is operated in a working mode.

FIG. 2 is a hydraulic circuit diagram for explaining a state in which the hydraulic system for construction machinery according to the first exemplary embodiment of the present disclosure is operated in a traveling mode.

FIG. 3 is a hydraulic circuit diagram for explaining a state in which the hydraulic system for construction machinery according to the first exemplary embodiment of the present disclosure is overloaded while being operated in the traveling mode.

FIG. 4 is a hydraulic circuit diagram for explaining a state in which a hydraulic system for construction machinery according to a second exemplary embodiment of the present disclosure is operated in a working mode.

FIG. 5 is a hydraulic circuit diagram for explaining a state in which the hydraulic system for construction machinery according to the second exemplary embodiment of the present disclosure is operated in a traveling mode.

DETAILED DESCRIPTION

[0032] In the following detailed description, reference is made to the accompanying drawing, which forms a part hereof. The illustrative embodiments described in the detailed description, drawing, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here.

[0033] Advantages and features of the present disclosure and methods of achieving the advantages and features will be clear with reference to an exemplary embodiment described in detail below together with the accompanying drawings.

[0034] Hereinafter, an exemplary embodiment of the present disclosure will be described in detail with reference to the accompanying drawings. It should be appreciated that the exemplary embodiments, which will be described below, are illustratively described to help understand the present disclosure, and the present disclosure may be modified to be variously carried out differently from the exemplary embodiments described herein. However, in the description of the present disclosure, detailed descriptions and specific drawings for publicly known related functions and constituent elements may be omitted when it is determined that the detailed descriptions and the specific drawings may unnecessarily obscure the subject matter of the present disclosure. In addition, to help understand the present disclosure, the accompanying drawings are not illustrated based on actual scales, but parts of the constituent elements may be exaggerated in terms of sizes.

[0035] Meanwhile, the terms used in the description

are defined considering the functions of the present disclosure and may vary depending on the intention or usual practice of a manufacturer. Therefore, the definitions should be made based on the entire contents of the present specification.

[0036] Like reference numerals indicate like elements throughout the specification.

[0037] Hereinafter, a hydraulic system for construction machinery according to a first exemplary embodiment of the present disclosure will be described with reference to FIG. 1.

[0038] FIG. 1 is a hydraulic circuit diagram for explaining a state in which the hydraulic system for construction machinery according to the first exemplary embodiment of the present disclosure is operated in a working mode.

[0039] The hydraulic system according to the first exemplary embodiment of the present disclosure may include first and second main pumps 11 and 12, a main control valve 30, and a sub-pump 70.

[0040] Each of the first and second main pumps 11 and 12 is operated by power output from an engine 17 and discharges hydraulic oil. Each of the first and second main pumps 11 and 12 may adjust a volume thereof by adjusting a swash plate angle. The swash plate angles of the first and second main pumps 11 and 12 may be adjusted by first and second regulators 13 and 14, respectively. As the swash plate angles of the first and second main pumps 11 and 12 are adjusted by the first and second regulators 13 and 14, a flow rate and pressure of hydraulic oil discharged from each of the first and second main pumps 11 and 12 may be adjusted. When pressure applied to the first and second regulators 13 and 14 is decreased, the first and second regulators 13 and 14 increase the swash plate angles of the first and second main pumps 11 and 12, respectively, thereby increasing flow rates of the first and second main pumps 11 and 12. In contrast, when pressure applied to the first and second regulators 13 and 14 is increased, the first and second regulators 13 and 14 decrease the swash plate angles of the first and second main pumps 11 and 12, respectively, thereby decreasing flow rates of the first and second main pumps 11 and 12.

[0041] Pump pressure of each of the first and second main pumps 11 and 12 may be measured and then provided to a control unit. The pump pressure may be detected by first and second pressure sensors 15 and 16. The first and second pressure sensors 15 and 16 may be disposed in a first hydraulic line 21 and a second hydraulic line 22, respectively.

[0042] The sub-pump 70 may be operated by the engine 17 or a separate electric motor. The sub-pump 70 discharges pilot hydraulic oil. Pressure p_c of the pilot hydraulic oil discharged from the sub-pump 70 may be detected. The pilot hydraulic oil may be provided by a joystick. When the joystick is manipulated, a control signal corresponding to a manipulation displacement of the joystick is produced. The control signal may be a pressure signal that corresponds to the manipulation displacement

of the joystick. The control signal is applied to spools of a plurality of control valves provided in the main control valve 30.

[0043] Meanwhile, the first hydraulic line 21 is connected to the first main pump 11. The second hydraulic line 22 is connected to the second main pump 12. The first and second hydraulic lines 21 and 22 are connected to the main control valve 30. The plurality of control valves may be provided in the main control valve 30. The plurality of control valves may be disposed in the first hydraulic line 21 one after another, and the plurality of control valves may also be disposed in the second hydraulic line 22 one after another. Each of the control valves is operated by the pilot hydraulic oil. When the pilot hydraulic oil is applied to the spool of the corresponding control valve, the spool of the corresponding control valve is moved, whereby hydraulic oil is supplied to an actuator, such that the corresponding actuator is operated.

[0044] A traveling control valve unit 31 may be one of the plurality of control valves disposed in the second hydraulic line 22. The traveling control valve unit 31 controls a flow direction of hydraulic oil supplied to a traveling motor 80.

[0045] Meanwhile, a first relief valve 41 may be disposed in the first hydraulic line 21, and a second relief valve 42 may be disposed in the second hydraulic line 22. The plurality of control valves is provided in the first hydraulic line 21, and the first relief valve 41 may be disposed at the most downstream side. The plurality of control valves is provided in the second hydraulic line 22, and the second relief valve 42 may be disposed at the most downstream side.

[0046] Relief pressure of the first and second relief valves 41 and 42 may be set. Therefore, if abnormally high pressure is formed in the first hydraulic line 21, the first relief valve 41 is opened, whereby pressure of the first hydraulic line 21 may be maintained to the relief pressure or lower. Similarly, if abnormally high pressure is formed in the second hydraulic line 22, the second relief valve 42 is opened, whereby pressure of the second hydraulic line 22 may be maintained to the relief pressure or lower. For example, the relief pressure may be 40 kgf/cm².

[0047] A first control valve unit 51 may be disposed in a pilot hydraulic oil discharge line of the sub-pump 70. The first control valve unit 51 may be operated by a first current signal. The pressure p_c of the pilot hydraulic oil discharged from the sub-pump 70 may be set to a value equal to a value of the relief pressure that is set for the first relief valve 41. In this case, when the relief pressure of the first relief valve 41 or pressure of the pilot hydraulic oil discharged from the sub-pump 70 is applied, the first regulator 13 may adjust a swivel angle of a swash plate of the first main pump 11 so as to minimize a discharge flow rate of the first main pump 11.

[0048] A second control valve unit 52 is provided in the first hydraulic line 21.

[0049] A third hydraulic line 23 connects the sub-pump

70 with a pressure receiving part of the second control valve unit 52. When the first current signal is not input, the first control valve unit 51 disconnects the pressure receiving part of the second control valve unit 52 from the sub-pump 70. On the contrary, when the first current signal is input, the first control valve unit 51 connects the pressure receiving part of the second control valve unit 52 and the sub-pump 70. That is, when the first control valve unit 51 is opened, the first control valve unit 51 allows the pilot hydraulic oil to pass through the first control valve unit 51, and the pilot hydraulic oil is applied to the pressure receiving part of the second control valve unit 52. The first current signal is a signal that determines whether to merge the hydraulic oil.

[0050] A fourth hydraulic line 24 connects the second control valve unit 52 and the second hydraulic line 22. The second control valve unit 52 is operated by the pilot hydraulic oil supplied via the first control valve unit 51. That is, when the pilot hydraulic oil is not applied to the pressure receiving part of the second control valve unit 52, the hydraulic oil discharged from the first main pump 11 flows toward the first relief valve 41 along the first hydraulic line 21. On the contrary, when the pilot hydraulic oil is applied to the pressure receiving part of the second control valve unit 52, a flow path from the first hydraulic line 21 to the main control valve 30 is blocked, and the hydraulic oil discharged from the first main pump 11 merges with the second hydraulic line 22 through the fourth hydraulic line 24.

[0051] Fifth and sixth hydraulic lines 25 and 26 are connected to both sides of a shuttle valve 60. The fifth hydraulic line 25 is connected with the third hydraulic line 23. The sixth hydraulic line 26 is connected to a downstream side of the first hydraulic line 21. That is, the sixth hydraulic line 26 is connected to an inlet of the first relief valve 41. In addition, the shuttle valve 60 is connected with the first regulator 13 through a seventh hydraulic line 27. Pressure of the fifth hydraulic line 25 and pressure of the sixth hydraulic line 26, which are input to the shuttle valve 60, compete, and the hydraulic oil with a higher pressure level between the two pressure levels is selected and then output from the shuttle valve 60. The hydraulic oil output from the shuttle valve 60 is applied to the first regulator 13.

[0052] Meanwhile, an eighth hydraulic line 28 is connected to the seventh hydraulic line 27. A third control valve unit 53 is provided in the eighth hydraulic line 28. The third control valve unit 53 may be opened by a second current signal or pressure of the eighth hydraulic line 28. The third control valve unit 53 is opened when pump pressure of any one of the first main pump 11 and the second main pump 12 is higher than a predetermined pressure. The level of the pump pressure is determined by the control unit, and the second current signal is applied to the third control valve unit 53 depending on the determination result. When the third control valve unit 53 is opened, the hydraulic oil of the seventh hydraulic line 27 is drained. When the third control valve unit 53 is opened, pressure

of the seventh hydraulic line 27 is decreased.

[0053] An increase in pump pressure means that a larger amount of hydraulic oil is required because of a high working load. Meanwhile, when pressure of the seventh hydraulic line 27 is decreased, pressure applied to the first regulator 13 is decreased, and as a result, the first regulator 13 increases the swivel angle of the swash plate of the first main pump 11. Therefore, a discharge flow rate of the first main pump 11 is increased. In addition, when pressure applied to the second regulator 14 is decreased, the second regulator 13 increases the swivel angle of the swash plate of the second main pump 12, and as a result, a discharge flow rate of the second main pump 12 is increased.

[0054] On the other hand, the third control valve unit 53 may be an electronic proportional control valve. The third control valve unit 53 decreases pressure of the eighth hydraulic line 28 in proportion to a difference between pump pressure p_{s1} of the first main pump 11 and the predetermined pressure of the first relief valve 41. When pressure of the eighth hydraulic line 28 is decreased, pressure of the seventh hydraulic line 27 is decreased, and as a result, pressure of the hydraulic oil provided to the first regulator 13 is decreased. Accordingly, as a first load is increased, a discharge flow rate of the first main pump 11 may be increased in proportion to the increase in first load.

<Working Mode>

[0055] Hereinafter, a state in which the hydraulic system according to the first exemplary embodiment of the present disclosure is operated in a working mode will be described with reference to FIG. 1.

[0056] When the working mode is selected by an operator, the first current signal is not applied to the first control valve unit 51. Therefore, a position of the first control valve unit 51 is not switched. Accordingly, the pilot hydraulic oil is blocked by the first control valve unit 51, and is not applied to the pressure receiving part of the second control valve unit 52, such that the second control valve unit 52 is not operated. Therefore, the hydraulic oil discharged from the first main pump 11 flows toward the first relief valve 41 via the first hydraulic line 21. When pressure formed in the first hydraulic line 21 is higher than the relief pressure, the first relief valve 41 is opened.

[0057] Meanwhile, the hydraulic oil flowing along the first hydraulic line 21 is supplied to the shuttle valve 60 via the sixth hydraulic line 26. In the shuttle valve 60, the pressure formed in the sixth hydraulic line 26 and the pressure formed in the fifth hydraulic line 25 compete. In this case, since the fifth hydraulic line 25 is connected with a drain tank, the pressure may be substantially atmospheric pressure. However, pressure, which is equal to or lower than the relief pressure, is formed in the sixth hydraulic line 26. Therefore, the pressure of the sixth hydraulic line 26 is selected and output between the pres-

sure of the sixth hydraulic line 26 and the pressure of the fifth hydraulic line 25, which are input to the shuttle valve 60. Accordingly, the maximum pressure, which may be formed in the sixth hydraulic line 26, is the relief pressure, and the pressure of the sixth hydraulic line 26 is applied to the first regulator 13 of the first main pump 11 via the seventh hydraulic line 27.

[0058] In this case, the hydraulic oil discharged from the second main pump 12 is provided to the respective control valve units that are provided in the second hydraulic line 22 and include the traveling control valve unit 31. That is, in the working mode, the spool of the control valve unit is operated corresponding to the manipulation of the joystick, such that high-pressure hydraulic oil is provided to the actuator, thereby performing desired work.

<Traveling Mode>

[0059] Hereinafter, an example in which a traveling mode is operated in the hydraulic system according to the first exemplary embodiment of the present disclosure will be described with reference to FIG. 2. FIG. 2 is a hydraulic circuit diagram for explaining an example in which the traveling mode is operated in the hydraulic system for construction machinery according to the first exemplary embodiment of the present disclosure.

[0060] The traveling mode may be selected by the operator. When the traveling mode is selected, the first current signal is input to the first control valve unit 51. Therefore, the position of the first control valve unit 51 is switched, such that the pilot hydraulic oil discharged from the sub-pump 70 is supplied to the pressure receiving part of the second control valve unit 52 and the shuttle valve 60.

[0061] As the second control valve unit 52 is switched by the pilot hydraulic oil applied to the pressure receiving part, a flow path from the first hydraulic line 21 to the main control valve 30 is blocked, and the first hydraulic line 21 is connected with the fourth hydraulic line 24, such that the hydraulic oil discharged from the first main pump 11 merges with the second hydraulic line 22 through the fourth hydraulic line 24. Therefore, a larger amount of hydraulic oil may be provided to the traveling motor 80, thereby improving traveling performance.

[0062] Meanwhile, the pressure of the sixth hydraulic line 26 and the pressure of the fifth hydraulic line 25 compete in the shuttle valve 60. However, because the hydraulic oil is not supplied to the sixth hydraulic line 26 as the first hydraulic line 21 is blocked, pressure is not formed or very low pressure is formed in the sixth hydraulic line 26. In contrast, pressure of the pilot hydraulic oil is formed in the fifth hydraulic line 25. Therefore, during the traveling mode, the pressure of the fifth hydraulic line 25 is output through the shuttle valve 60. Accordingly, the pilot hydraulic oil is supplied to the first regulator 13 via the fifth hydraulic line 25, the shuttle valve 60, and the seventh hydraulic line 27. Therefore, in a case in

which the hydraulic system according to the first exemplary embodiment of the present disclosure is operated in the traveling mode, the pressure of the pilot hydraulic oil is applied to the first regulator 13, and as a result, a discharge flow rate of the first main pump 11 is minimized. Therefore, a traveling speed of the construction machine is prevented from being abnormally and excessively increased, thereby improving traveling stability. In addition, since abnormal overspeed is prevented, it is possible to prevent durability of constituent elements associated with a traveling system from deteriorating.

[0063] The first control valve unit 51 is controlled by a current signal, and the pressure of the pilot hydraulic oil is applied to the first regulator 13 even if any unknown error occurs in the first control valve unit 51. Therefore, a discharge flow rate of the first main pump 11 may be maintained at a minimum level regardless of an abnormality in the first control valve unit 51.

<Traveling Mode - Overload>

[0064] Hereinafter, a state in which overload is applied to a traveling operation in the traveling mode will be described with reference to FIG. 3. FIG. 3 is a hydraulic circuit diagram for explaining a state in which the hydraulic system for construction machinery according to the first exemplary embodiment of the present disclosure is overloaded while being operated in the traveling mode.

[0065] For example, a larger amount of hydraulic oil may be required for the traveling motor 80 when the construction machine travels up a slope than when the construction machine travels on a flat ground. When a load is applied to the traveling motor 80, the pump pressure of the first main pump 11 or the second main pump 12 is increased. In this case, the pump pressure of the first main pump 11 may be detected as a ps1 pressure value by the first pressure sensor 15, and the pump pressure of the second main pump 12 may be detected as a ps2 pressure value by the second pressure sensor 16. When the pump pressure of the first main pump 11 or the second main pump 12 is increased, the third control valve unit 53 is opened by the control unit. When the third control valve unit 53 is opened, the hydraulic oil of the seventh and eighth hydraulic lines 27 and 28 is drained, and as a result, the pressure of the seventh and eighth hydraulic lines 27 and 28 is decreased. Therefore, pressure, which is lower than the pressure of the pilot hydraulic oil, is applied to the first regulator 13. As the pressure applied to the first regulator 13 is decreased, the swash plate angle of the first main pump 11 is increased. Therefore, a discharge flow rate of the first main pump 11 is increased, and the increased amount of hydraulic oil merges with the second hydraulic line 22 and then is provided to the traveling motor 80. Therefore, even in a case in which a traveling load is increased, such as when the construction machine travels up the slope, a larger amount of hydraulic oil may be provided to the traveling motor 80, thereby excellently maintaining traveling per-

formance.

[0066] Meanwhile, the third control valve 53 is controlled by a current signal, and the pressure of the pilot hydraulic oil output from the shuttle valve 60 may not be reduced by the third control valve 53 when any unknown error occurs in the third control valve 53. Even in this case, because the first regulator 13 is operated by the pilot hydraulic oil, a maximum discharge flow rate of the first main pump 11 is restricted. Therefore, a traveling speed of the construction machine is prevented from being abnormally and excessively increased, thereby improving traveling stability. In addition, since abnormal overspeed is prevented, it is possible to prevent durability of constituent elements associated with a traveling system from deteriorating.

[0067] As described above, according to the hydraulic system for construction machinery according to the first exemplary embodiment of the present disclosure, in the traveling mode, the hydraulic oil discharged from the first main pump 11 merges with the hydraulic oil discharged from the second main pump 12, and the merged hydraulic oil is provided to the traveling motor 80, thereby improving traveling performance.

[0068] According to the hydraulic system for construction machinery according to the present disclosure, even in a situation in which the first and third control valve units 51 and 53 cannot be normally controlled for an unknown reason, the overspeed may be prevented by restricting a maximum discharge flow rate of the first main pump 11 in the traveling mode. Accordingly, it is possible to ensure traveling stability, and to prevent durability of the traveling system from deteriorating.

[0069] FIG. 4 is a hydraulic circuit diagram for explaining a state in which a hydraulic system for construction machinery according to a second exemplary embodiment of the present disclosure is operated in a working mode. FIG. 5 is a hydraulic circuit diagram for explaining a state in which the hydraulic system for construction machinery according to the second exemplary embodiment of the present disclosure is operated in a traveling mode. Hereinafter, the hydraulic system for construction machinery according to the second exemplary embodiment of the present disclosure will be described with reference to FIGs. 4 and 5.

[0070] The hydraulic system according to the second exemplary embodiment of the present disclosure may include first and second main pumps 11 and 12, a main control valve 30, a sub-pump 70, a first control valve unit 51', a second control valve unit 52', a third control valve unit 53', a shuttle valve 60', and first, second, third, fourth, fifth, and sixth hydraulic lines 21, 22, 23, 24, 95, and 96.

[0071] Each of the first and second main pumps 11 and 12 is operated by power output from an engine 17 and discharges hydraulic oil. The swash plate angles of the first and second main pumps 11 and 12 may be adjusted by first and second regulators 13 and 14, respectively. As the swash plate angles of the first and second main pumps 11 and 12 are adjusted by the first and sec-

ond regulators 13 and 14, a flow rate and pressure of hydraulic oil discharged from each of the first and second main pumps 11 and 12 may be adjusted. When pressure applied to the first and second regulators 13 and 14 is decreased, the first and second regulators 13 and 14 increase the swash plate angles of the first and second main pumps 11 and 12, respectively, thereby increasing flow rates of the first and second main pumps 11 and 12. In contrast, when pressure applied to the first and second regulators 13 and 14 is increased, the first and second regulators 13 and 14 decrease the swash plate angles of the first and second main pumps 11 and 12, respectively, thereby decreasing flow rates of the first and second main pumps 11 and 12.

[0072] Pump pressure of each of the first and second main pumps 11 and 12 may be measured and then provided to a control unit. The pump pressure of the first and second main pumps 11 and 12 may be detected by first and second pressure sensors 15 and 16. The first and second pressure sensors 15 and 16 may be disposed in the first hydraulic line 21 and the second hydraulic line 22, respectively.

[0073] The sub-pump 70 may be operated by the engine 17 or a separate electric motor. The sub-pump 70 discharges pilot hydraulic oil. Pressure p_c of the pilot hydraulic oil discharged from the sub-pump 70 may be detected.

[0074] The first hydraulic line 21 is connected to the first main pump 11. The second hydraulic line 22 is connected to the second main pump 12. The first and second hydraulic lines 21 and 22 are connected to the main control valve 30. The plurality of control valves may be provided in the main control valve 30. The plurality of control valves may be disposed in the first hydraulic line 21 one after another, and the plurality of control valves may also be disposed in the second hydraulic line 22 one after another. Each of the control valves is operated by the pilot hydraulic oil. When the pilot hydraulic oil is applied to the spool of the corresponding control valve, the spool of the corresponding control valve is moved, whereby hydraulic oil is supplied to an actuator, such that the corresponding actuator is operated.

[0075] A traveling control valve unit 31 may be one of the plurality of control valves disposed in the second hydraulic line 22. The traveling control valve unit 31 controls a flow direction of hydraulic oil supplied to a traveling motor 80.

[0076] A first relief valve 41 may be disposed in the first hydraulic line 21, and a second relief valve 42 may be disposed in the second hydraulic line 22. The plurality of control valves is provided in the first hydraulic line 21, and the first relief valve 41 may be disposed at the most downstream side. The plurality of control valves is provided in the second hydraulic line 22, and the second relief valve 42 may be disposed at the most downstream side.

[0077] Relief pressure of the first and second relief valves 41 and 42 may be set. If abnormally high pressure

is formed in the first hydraulic line 21, the first relief valve 41 is opened, whereby pressure of the first hydraulic line 21 may be maintained to the relief pressure or lower. Similarly, if abnormally high pressure is formed in the second hydraulic line 22, the second relief valve 42 is opened, whereby pressure of the second hydraulic line 22 may be maintained to the relief pressure or lower.

[0078] The first control valve unit 51' may be disposed in a pilot hydraulic oil discharge line 90 of the sub-pump 70. The first control valve unit 51' may be operated by a first current signal. The pressure p_c of the pilot hydraulic oil discharged from the sub-pump 70 may be set to a value equal to a value of the relief pressure that is set for the first relief valve 41. In this case, when the relief pressure of the first relief valve 41 or pressure of the pilot hydraulic oil discharged from the sub-pump 70 is applied, the first regulator 13 may adjust a swivel angle of a swash plate of the first main pump 11 so as to minimize a discharge flow rate of the first main pump 11.

[0079] The second control valve unit 52' may be disposed in the first hydraulic line 21. The third hydraulic line 23 connects the sub-pump 70 and a pressure receiving part of the second control valve unit 52'. When the first current signal is not input, the first control valve unit 51' disconnects the pressure receiving part of the second control valve unit 52' from the sub-pump 70. On the contrary, when the first current signal is input, the first control valve unit 51' connects the pressure receiving part of the second control valve unit 52' and the sub-pump 70. That is, when the first control valve unit 51' is opened, the first control valve unit 51' allows the pilot hydraulic oil to pass through the first control valve unit 51', and the pilot hydraulic oil is applied to the pressure receiving part of the second control valve unit 52'.

[0080] The fourth hydraulic line 24 connects the second control valve unit 52' and the second hydraulic line 22. The second control valve unit 52' is operated by the pilot hydraulic oil supplied via the first control valve unit 51'. That is, when the pilot hydraulic oil is not applied to the pressure receiving part of the second control valve unit 52', the hydraulic oil discharged from the first main pump 11 flows toward the first relief valve 41 along the first hydraulic line 21. On the contrary, when the pilot hydraulic oil is applied to the pressure receiving part of the second control valve unit 52', a flow path from the first hydraulic line 21 to the main control valve 30 is blocked, and the hydraulic oil discharged from the first main pump 11 merges with the second hydraulic line 22 through the fourth hydraulic line 24.

[0081] The fifth hydraulic line 95 is connected to the pilot hydraulic oil discharge line 90. The third control valve unit 53' is connected to the fifth hydraulic line 95, and the sixth hydraulic line 96 is connected to the third control valve unit 53'. The third control valve unit 53' reduces pressure of the pilot hydraulic oil supplied through the fifth hydraulic line 95, and outputs the pilot hydraulic oil. The third control valve unit 53' may be operated by a second current signal. The third control valve unit 53'

may be an electronic proportional pressure reducing valve. The hydraulic oil output from the third control valve unit 53' is input to the shuttle valve 60' through the sixth hydraulic line 96. When pump pressure of any one of the first main pump 11 and the second main pump 12 is higher than a predetermined pressure, the third control valve unit 53' may reduce the pressure of the output hydraulic oil. In this case, the third control valve unit 53' may reduce the pressure of the output hydraulic oil in proportion to a difference between the pump pressure of the pump, which exceeds the predetermined pressure, and the predetermined pressure.

[0082] The first hydraulic line 21 and the sixth hydraulic line 96 are input to an input port of the shuttle valve 60'. An output port of the shuttle valve 60' may be connected with the first regulator 13. Pressure of the first hydraulic line 21 and pressure of the sixth hydraulic line 96, which are input to the shuttle valve 60', compete, and the hydraulic oil with a higher pressure level between the two pressure levels is selected and then output from the shuttle valve 60'. The hydraulic oil output from the shuttle valve 60' is applied to the first regulator 13.

<Working Mode>

[0083] Hereinafter, a state in which the hydraulic system according to the second exemplary embodiment of the present disclosure is operated in a working mode will be described with reference to FIG. 4.

[0084] When the working mode is selected by an operator, the first current signal is not applied to the first control valve unit 51'. Therefore, a position of the first control valve unit 51' is not switched. Accordingly, the pilot hydraulic oil is blocked by the first control valve unit 51', and is not applied to the pressure receiving part of the second control valve unit 52', such that the second control valve unit 52' is not operated. Therefore, the hydraulic oil discharged from the first main pump 11 flows toward the first relief valve 41 via the first hydraulic line 21. When pressure formed in the first hydraulic line 21 is higher than the relief pressure, the first relief valve 41 is opened.

[0085] Meanwhile, the hydraulic oil flowing along the first hydraulic line 21 is supplied to the shuttle valve 60'. In the shuttle valve 60', the pressure formed in the first hydraulic line 21 and the pressure formed in the sixth hydraulic line 96 compete. In this case, the pressure of the first hydraulic line 21 is equal to or higher than the pressure of the sixth hydraulic line 96. Therefore, the pressure of the first hydraulic line 21 is selected and output between the pressure of the first hydraulic line 21 and the pressure of the sixth hydraulic line 96, which are applied to the shuttle valve 60'.

<Traveling Mode>

[0086] Hereinafter, an example in which a traveling mode is operated in the hydraulic system according to

the second exemplary embodiment of the present disclosure will be described with reference to FIG. 5.

[0087] The traveling mode may be selected by the operator. When the traveling mode is selected, the first current signal is input to the first control valve unit 51'. Therefore, the position of the first control valve unit 51' is switched, such that the pilot hydraulic oil discharged from the sub-pump 70 is supplied to the pressure receiving part of the second control valve unit 52'.

[0088] The second control valve unit 52' is switched by the pilot hydraulic oil applied to the pressure receiving part. Therefore, a flow path from the first hydraulic line 21 to the main control valve 30 is blocked, and the first hydraulic line 21 is connected with the fourth hydraulic line 24, such that the hydraulic oil discharged from the first main pump 11 merges with the second hydraulic line 22 through the fourth hydraulic line 24. Accordingly, a larger amount of hydraulic oil may be provided to the traveling motor 80, thereby improving traveling performance.

[0089] Meanwhile, the pressure of the first hydraulic line 21 and the pressure of the sixth hydraulic line 96 compete in the shuttle valve 60'. However, because the first hydraulic line 21 is blocked by the second control valve unit 52', pressure is not formed or very low pressure is formed at the downstream side of the first hydraulic line 21. In contrast, pressure of the pilot hydraulic oil is formed in the sixth hydraulic line 96. Therefore, in the case of the traveling mode, the pressure of the sixth hydraulic line 96 is output through the shuttle valve 60'. The pressure of the sixth hydraulic line 96, which is output from the shuttle valve 60', is applied to the first regulator 13. Therefore, in a case in which the hydraulic system according to the second exemplary embodiment of the present disclosure is operated in the traveling mode, pressure, which is the same as the pressure of the pilot hydraulic oil, is applied to the first regulator 13, and as a result, a discharge flow rate of the first main pump 11 is minimized. Therefore, a traveling speed of the construction machine is prevented from being abnormally and excessively increased, thereby improving traveling stability.

[0090] The first control valve unit 51' is controlled by a current signal, and the pressure of the pilot hydraulic oil is applied to the first regulator 13 even if any unknown error occurs in the first control valve unit 51'. Therefore, a discharge flow rate of the first main pump 11 may be maintained at a minimum level regardless of an abnormality in the first control valve unit 51'.

<Traveling Mode - Overload>

[0091] Hereinafter, a state in which overload is applied to a traveling operation in the traveling mode will be described with reference to FIG. 5.

[0092] For example, when a load is applied to the traveling motor 80, such as when the construction machine travels up a slope, the pump pressure of the first

main pump 11 or the second main pump 12 is increased. In this case, the pump pressure of the first main pump 11 may be detected as a ps1 pressure value by the first pressure sensor 15, and the pump pressure of the second main pump 12 may be detected as a ps2 pressure value by the second pressure sensor 16. When the pump pressure of the first main pump 11 or the second main pump 12 is increased, the second current signal is applied to the third control valve unit 53' from the control unit. When the second current signal is applied to the third control valve unit 53', the pressure of the pilot hydraulic oil supplied through the fifth hydraulic line 95 is reduced, and as a result, the pressure of the sixth hydraulic line 96 is decreased. Therefore, pressure, which is lower than the pressure of the pilot hydraulic oil, is applied to the first regulator 13. As the pressure applied to the first regulator 13 is decreased, the swash plate angle of the first main pump 11 is increased. Therefore, a discharge flow rate of the first main pump 11 is increased, and the increased amount of hydraulic oil merges with the second hydraulic line 22 and then is provided to the traveling motor 80. Therefore, even in a case in which a traveling load is increased, such as when the construction machine travels up the slope, a larger amount of hydraulic oil may be provided to the traveling motor 80, thereby excellently maintaining traveling performance.

[0093] Meanwhile, the third control valve 53' is controlled by a current signal, and the pressure of the pilot hydraulic oil supplied through the fifth hydraulic line 95 may not be reduced by the third control valve 53' when any unknown error occurs in the third control valve 53'. Even in this case, because the pressure of the pilot hydraulic oil is applied to the first regulator 13, a discharge flow rate of the first main pump 11 is minimized. Therefore, a traveling speed of the construction machine is prevented from being abnormally and excessively increased, thereby improving traveling stability.

[0094] The hydraulic system for construction machinery according to the present disclosure may be used to improve traveling performance of the construction machine.

[0095] From the foregoing, it will be appreciated that various embodiments of the present disclosure have been described herein for purposes of illustration, and that various modifications may be made without departing from the scope and spirit of the present disclosure. Accordingly, the various embodiments disclosed herein are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

Claims

1. A hydraulic system for construction machinery, comprising:

first and second main pumps (11, 12) which discharge high-pressure hydraulic oil;

- a sub-pump (70) which discharges pilot hydraulic oil; (22).
 a first hydraulic line (21) which is connected with the first main pump (11);
 a second hydraulic line (22) which is connected with the second main pump (12);
 a traveling control valve unit (31) which is disposed in the second hydraulic line (22), and controls a flow direction of the hydraulic oil that is supplied to a traveling motor (80);
 a first relief valve (41) which is disposed in the first hydraulic line (21), and maintains pressure of the first hydraulic line (21) to relief pressure or lower;
 a first control valve unit (51') which is opened when a traveling mode is selected, and allows the pilot hydraulic oil to pass through the first control valve unit (51');
 a second control valve unit (52') which is operated by the pilot hydraulic oil supplied via the first control valve unit (51'), and connects the hydraulic oil discharged from the first main pump (11) to the second hydraulic line (22);
 a third control valve unit (53') which reduces pressure of the pilot hydraulic oil, and outputs the pilot hydraulic oil; and
 a shuttle valve (60') which allows the pressure of the first hydraulic line (21) and the output pressure of the third control valve unit (53') to compete at both ends of the shuttle valve (60'), and connects relatively high-pressure hydraulic oil to a first regulator (13) of the first main pump (11).
2. The hydraulic system of claim 1, wherein the relief pressure, which is set for the first relief valve (41), is set to be equal to the pressure of the pilot hydraulic oil discharged from the sub-pump (70).
 3. The hydraulic system of claim 1, wherein when pump pressure of any one of the first main pump (11) and the second main pump (12) is higher than a predetermined pressure, the third control valve unit (53') reduces the pressure of the output hydraulic oil.
 4. The hydraulic system of claim 3, wherein the third control valve unit (53') reduces the pressure of the output hydraulic oil in proportion to a difference between the pump pressure of the pump, which exceeds the predetermined pressure, and the predetermined pressure.
 5. The hydraulic system of claim 1, wherein when a working mode is selected, the first control valve unit (51') connects a pressure receiving part of the second control valve unit (52') with a drain tank, and the second control valve unit (52') disconnects the first hydraulic line (21) from the second hydraulic line

FIG. 1

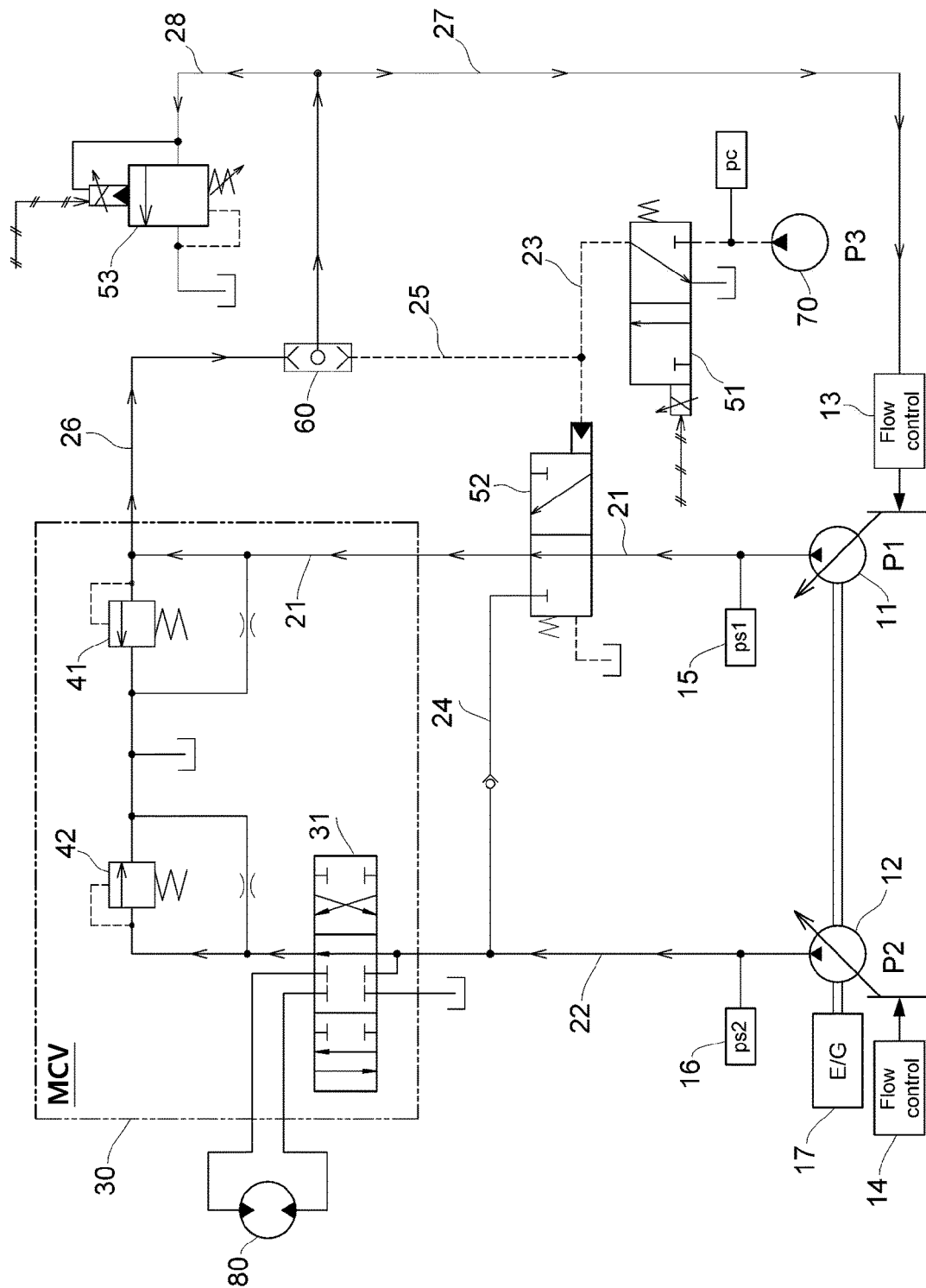


FIG. 2

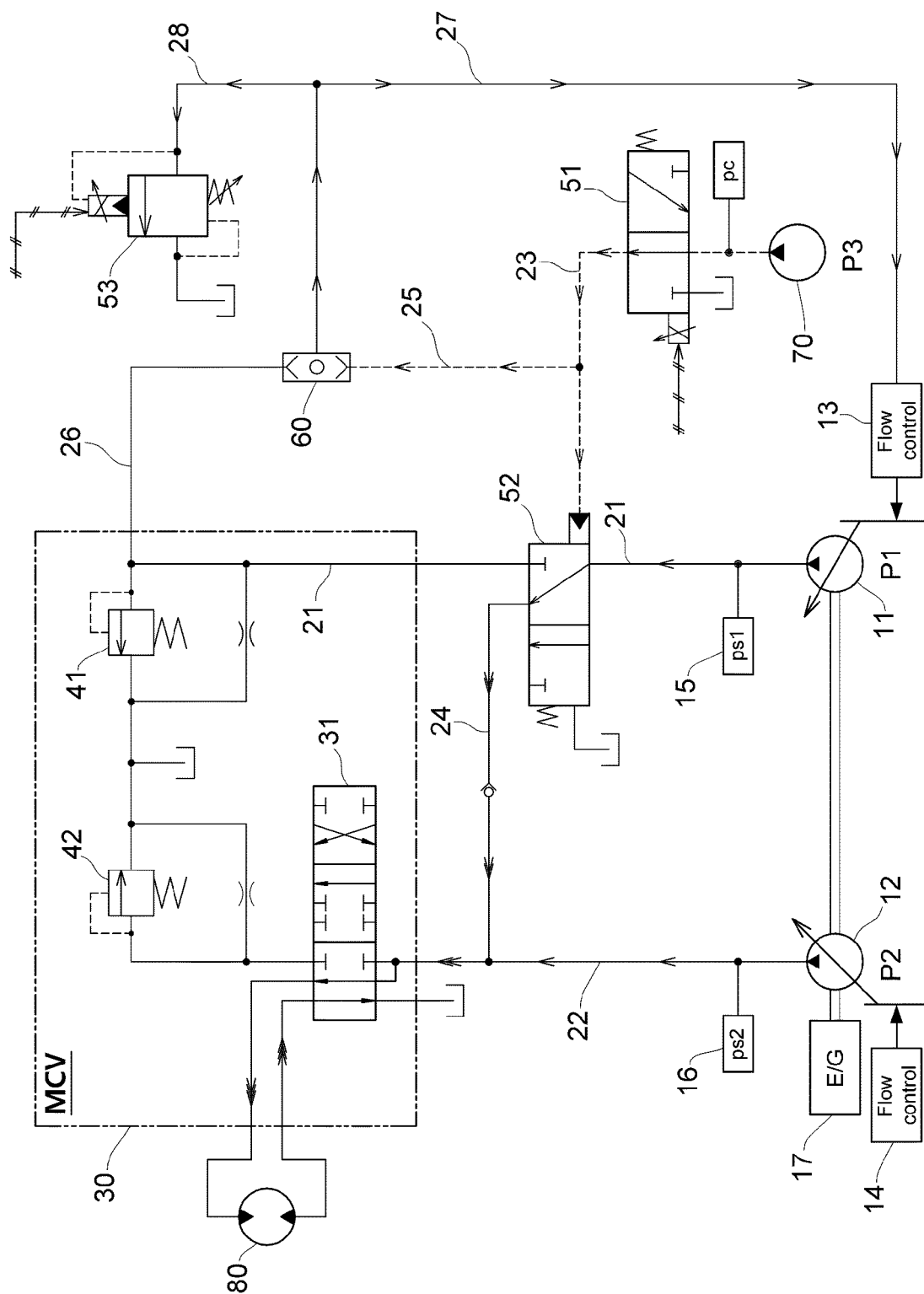


FIG. 3

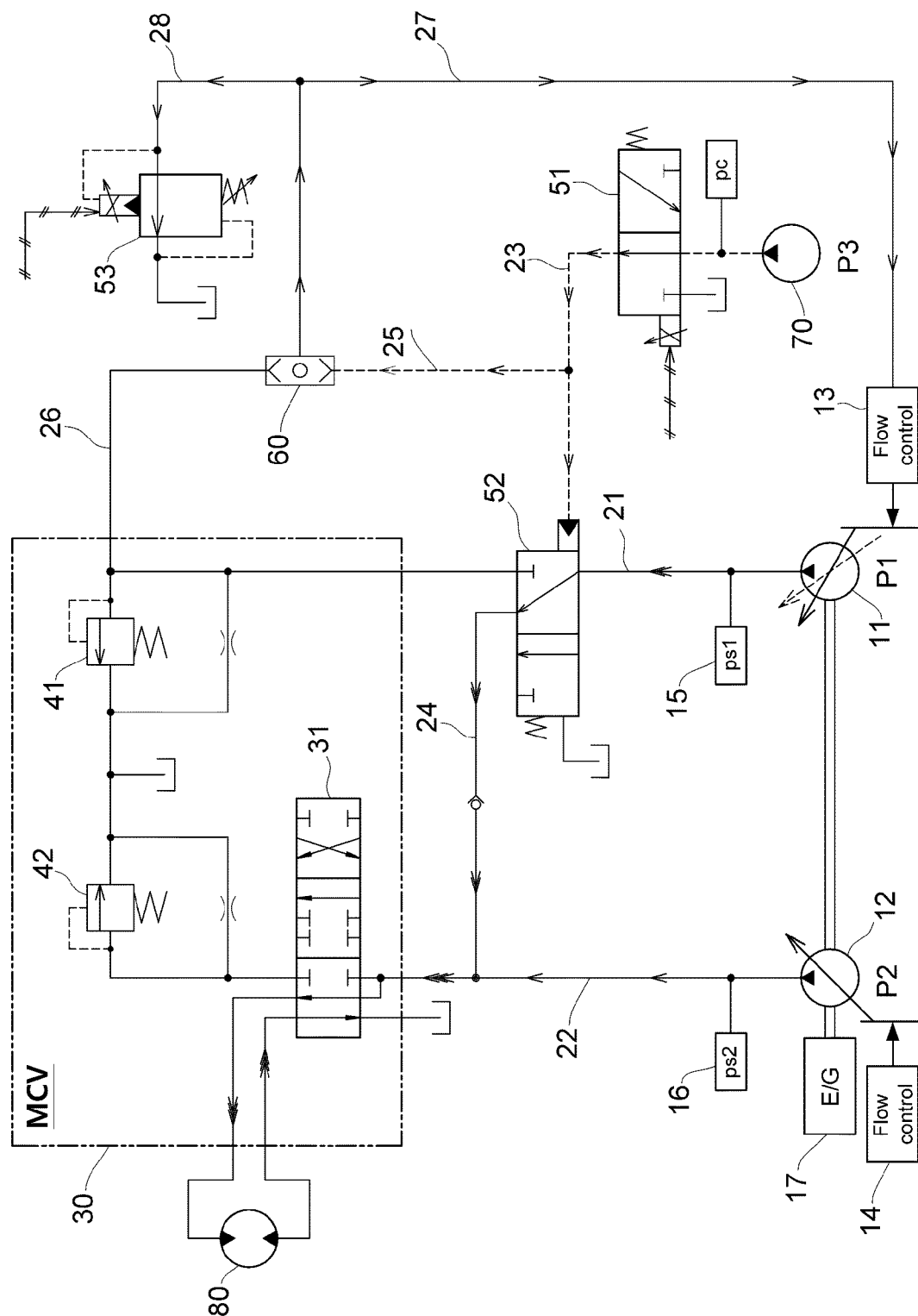


FIG. 4

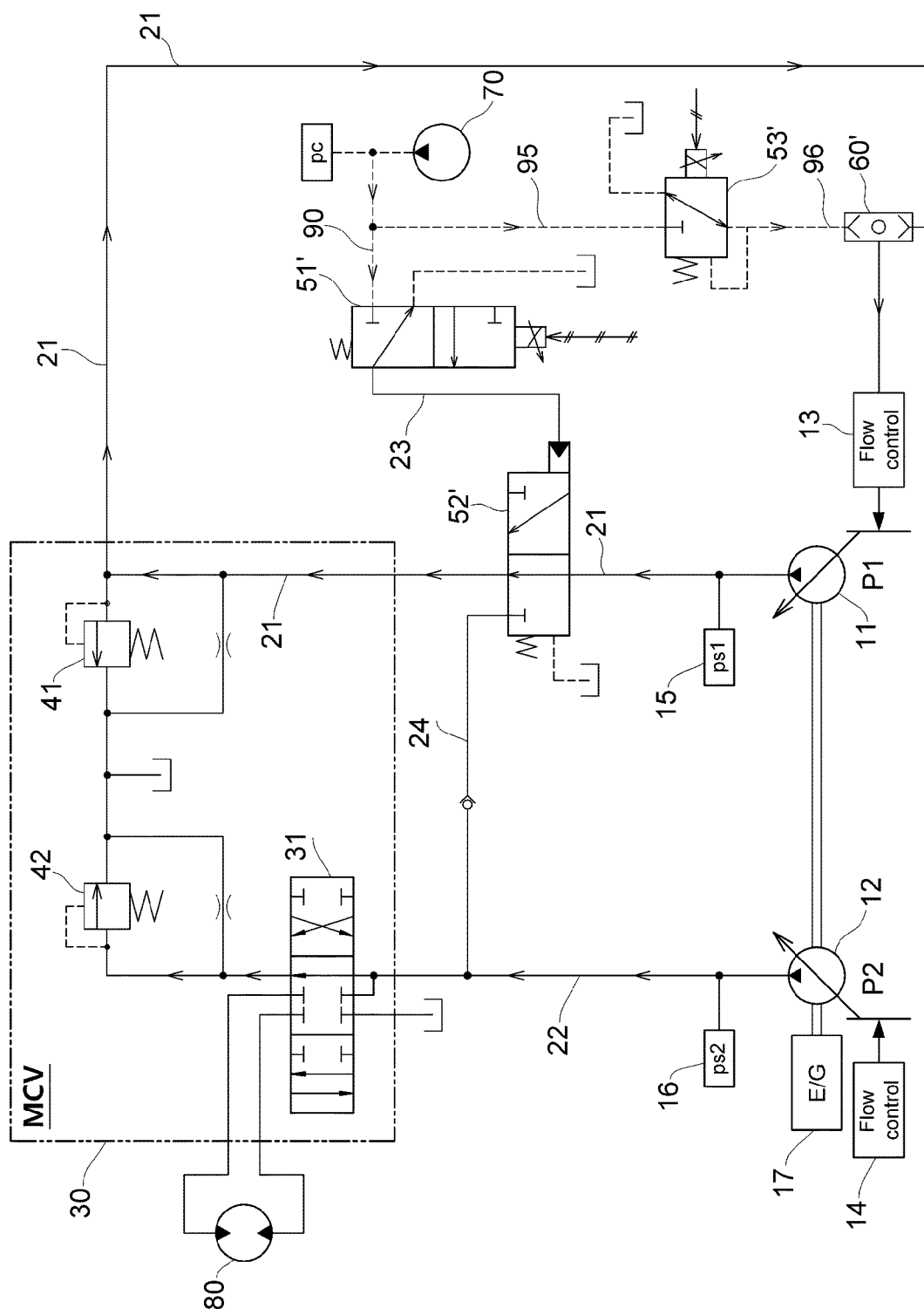
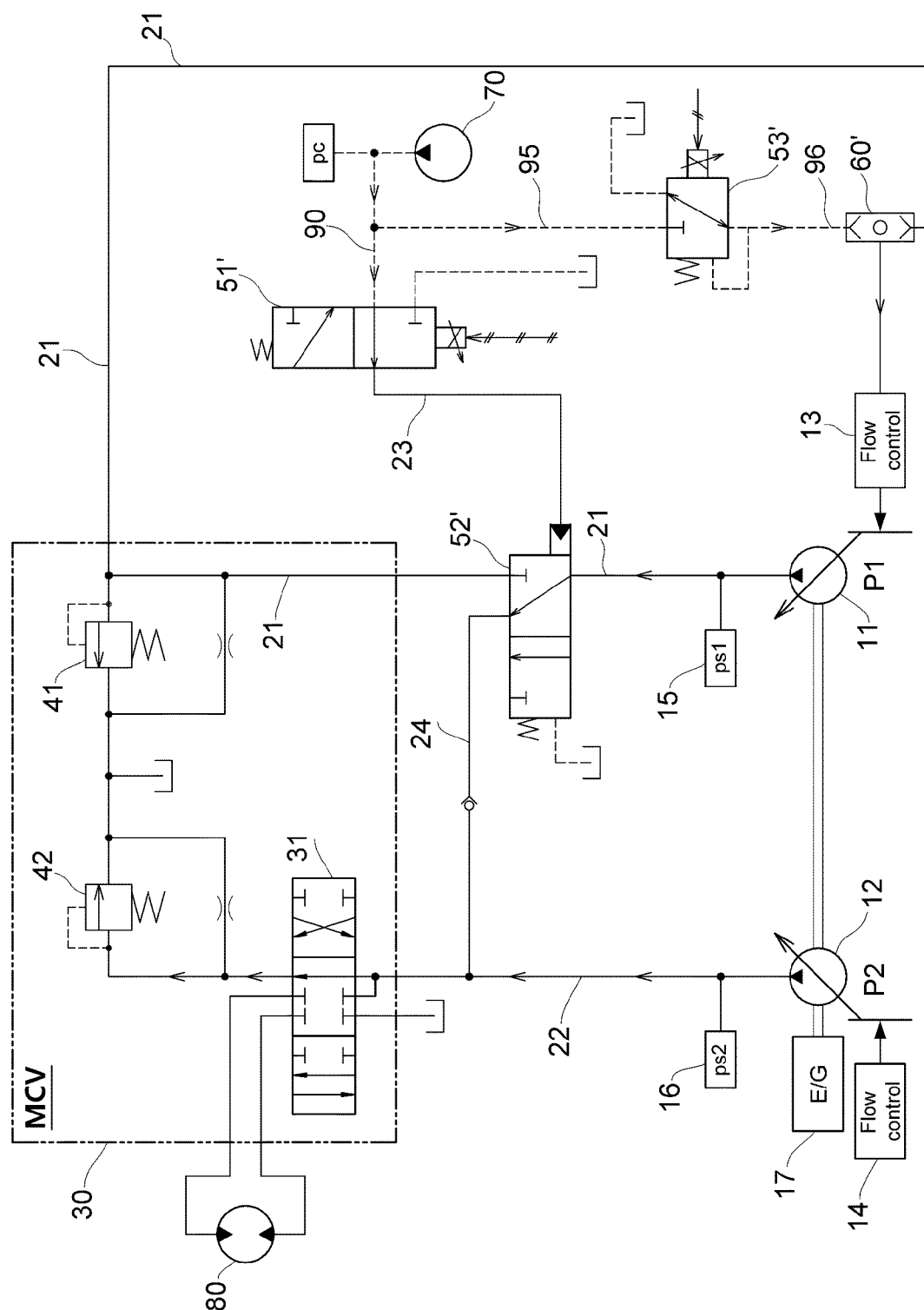


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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