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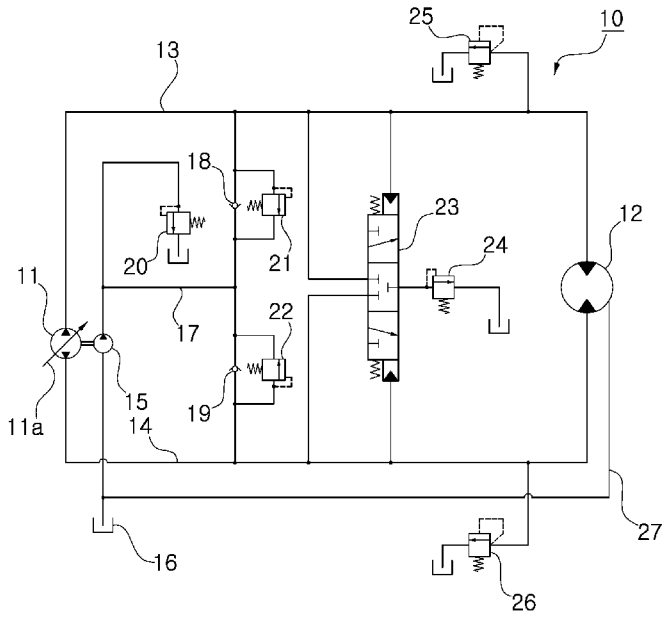


(57) Abstract: A closed loop hydrostatic transmission for a surface compactor is disclosed. The hydrostatic transmission dampens bouncing effect and protects an operator and machine elements from bouncing effect by providing relief for excessive pressure occurring together with bouncing effect in the high pressure supply line. The hydrostatic transmission has a variable displacement pump driven by a prime mover, a hydraulic motor connected to a drive train of the vehicle, first and second conduits interconnecting the pump and the motor, first and second high pressure relief valves connected to the first and second conduits with a relief pressure, at least one of first and second low pressure relief valves connected to the first and second conduits with a relief pressure which is lower than the relief pressure of the high pressure valves.

Description

Title of Invention: HYDROSTATIC TRANSMISSION FOR CONSTRUCTION VEHICLE

Technical Field

[1] The present invention relates to hydrostatic transmissions for a construction vehicle, and more particularly, to a closed loop hydrostatic transmission for a surface compactor dampening bouncing effect and protecting an operator and machine elements from bouncing effect.

[2]

Background Art

[3] Surface compactors, also known as road rollers, are mobile vehicles used to increase the density of soil and roadways and to seal and smooth asphalt surfaces. Such compactors are equipped with heavy drums and traveling relatively at low speeds. Thus, hydrostatic transmissions are typically chosen for their driving devices.

[4]

[5] Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common knowledge in the field.

[6]

[7] FIG. 1 shows a schematic diagram of a typical prior art hydrostatic transmission closed loop circuit 100 which includes a variable displacement hydraulic pump 101 driven by an internal combustion engine (not shown), and a fixed displacement hydraulic propulsion motor 102 connected to the drive train (not shown) of the vehicle. In a closed hydraulic circuit, pump 101 and motor 102 are fluidly coupled by a first conduit 103 and a second conduit 104. Pump 101 has a swash plate 101a the angle of which can be controlled either positive or negative from a neutral position. Changing the displacement of pump 101 by controlling the swash plate angle will change its output flow rate, which controls the speed of motor 102. Namely, the motor speed is zero when the fluid displacement of pump 101 is zero, which corresponds to a neutral position. Moving the swash plate angle negatively will reverse the flow out of pump 101, thus reversing the direction of motor 102. Depending upon the direction of the movement of swash plate 101a, the first conduit 103 (or the second conduit 104) of circuit 100 can be a high pressure supply line or a low pressure return line. Consequently, motor 102 is caused to rotate in forward and reverse directions, which corresponds to forward and backward travels of the vehicle. In this regard, it may be said that the hydrostatic transmission is in neutral state when the swash plate 101a is in

neutral position, in positive state when the swash plate 101a is in positive position and in negative state when the swash plate 101a is in negative position. The positive state corresponds to forward travel of the vehicle, and the negative state corresponds to backward travel of the vehicle.

[8]

[9] A charge pump 105, also driven via the engine, supplies additional hydraulic fluid to closed loop circuit 100 to replenish hydraulic losses in the closed loop circuit 100. Charge pump 105 draws fluid from a tank 106 and supplies this fluid into the circuit 100 through a conduit 107 by way of one-way check valves 108 and 109 to compensate for any possible loss, for example, due to internal leakage. A charge relief valve 110 is used to provide a relief path to the tank 106 so that more than the required flow from the charge pump 105 cannot enter circuit 100.

[10]

[11] High pressure relief valves 111 and 112 are provided between the conduits 103 and 104 and protect each conduit from pressure overload during operation. The high pressure relief valve 111 provides relief for the conduit 103 and the high pressure relief valve 112 provides relief for the conduit 104.

[12]

[13] Surface compactors adopting the closed loop circuit 100 are equipped with heavy drums driven by the motor 102, and the drums may be vibratory drums which have one or more of various kinds of eccentric rotation mechanism installed in them.

[14]

Disclosure of Invention

Technical Problem

[15] Vibratory drums are basically helpful in accomplishing more effective compaction with higher compaction energy. However, in case of over-compaction during which vibratory drums negotiating over-compacted patches, the compaction energy bounces back and causes an operator discomfort in addition to failure on some machine elements, which can be called as bouncing effect. There are some prior arts addressed to this problem. One of these is based on compaction gauge alarming or informing an operator of possible over-compaction so that the operator can adjust compaction energy before performing compaction. However, apart from the fact that compaction gauges are expensive, this cannot be a solution when too much energy is already in use and over-compaction happens.

[16]

Solution to Problem

[17] The present invention has been developed with attention paid to these problems en-

countered in the above-described related techniques, and the objects thereof include providing a hydrostatic transmission for a construction vehicle which is capable of dampening bouncing effect and protecting an operator and machine elements from bouncing effect.

[18]

[19] In order to achieve the aforementioned objects, the present invention employs the following arrangement.

[20]

[21] According to one aspect of the present invention, there is provided a hydrostatic transmission for a construction vehicle which comprises:

[22] a variable displacement pump driven by a prime mover;

[23] a hydraulic motor connected to a drive train of the vehicle;

[24] first and second conduits interconnecting said pump and said motor;

[25] first and second high pressure relief valves, said first high pressure valve being connected to said first conduit with a relief pressure, providing relief for said first conduit, and said second high pressure relief valve being connected to said second conduit with a relief pressure, providing relief for said second conduit; and,

[26] at least one of first low pressure relief valve and second low pressure relief valves, said first low pressure relief valve being connected to said first conduit with a relief pressure, providing relief for said first conduit, and said second low pressure relief valve being connected to said second conduit with a relief pressure, providing relief for said second conduit,

[27] wherein the relief pressure of said first low pressure relief valve is lower than the relief pressure of said first high pressure relief valve, and the relief pressure of said second low pressure relief valve is lower than the relief pressure of said second high pressure relief valve.

[28]

[29] It is preferable that the relief pressure of said first low pressure relief valve and said second low pressure relief valve is set 10 to 15 bar higher than a normal pressure encountered in relevant application.

[30]

[31] It is also preferable that said first low pressure relief valve and said second low pressure relief valve are remote pressure control valves having means for adjusting the relief pressure. Preferably, the means for adjusting the relief pressure is located near an operator's seat of the vehicle so that it can be readily accessible from the operator's seat.

[32]

[33] It is also preferable that said first low pressure relief valve is connected to said first

conduit at a position between said first high pressure relief valve and said motor, and said second low pressure relief valve is connected to said second conduit at a position between said second high pressure relief valve and said motor.

[34]

[35] It is also preferable that said first low pressure relief valve and said second low pressure relief valve relieve pressure from said conduits to a tank.

[36]

[37] It is also preferable that said first conduit is the conduit that becomes a high pressure supply line when the motor is caused to rotate in a forward direction, which corresponds to a forward travel of the vehicle.

[38]

[39] When vibratory drums having eccentric rotation mechanism negotiate over-compacted patches with unnecessarily high compaction energy, the compaction energy will bounce back and the pressure in the high pressure supply line will become higher than a normal pressure encountered in relevant application. When this happens, the first or second low pressure relief valve located in the high pressure supply line provides relief for the high pressure supply line, and thus, bouncing effect can be dampened and the operator and machine elements can be protected from bouncing effect.

[40]

Advantageous Effects of Invention

[41] The present invention is advantageous in that it provides hydrostatic transmissions for a construction vehicle which is capable of dampening bouncing effect and protecting an operator and machine elements from bouncing effect by providing relief for excessive pressure occurring together with bouncing effect in the high pressure supply line.

[42]

Brief Description of Drawings

[43] FIG. 1 is a schematic hydraulic circuit diagram showing a conventional hydrostatic transmission;

[44] FIG. 2 is a side view of the entire configuration of a surface compactor;

[45] FIG. 3 is a schematic hydraulic circuit diagram showing a hydrostatic transmission in neutral state according to one embodiment of the present invention;

[46] FIG. 4 is a schematic hydraulic circuit diagram showing a hydrostatic transmission in positive state according to the embodiment shown in Fig. 3; and

[47] FIG. 5 is a schematic hydraulic circuit diagram showing a hydrostatic transmission in negative state according to the embodiment shown in Fig. 3.

[48]

Best Mode for Carrying out the Invention

[49] Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings. While the present invention will be described in conjunction with the following embodiments, it will be understood that they are not intended to limit the present invention to these embodiments alone. On the contrary, the present invention is intended to cover alternatives, modifications, and equivalents which may be included within the spirit and scope of the present invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, embodiments of the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the present invention.

[50]

[51] FIG. 2 illustrates the schematic configuration of an entire surface compactor. As shown in FIG. 2, a compactor 1 is composed of a front drum 2, a rear drum 3, a front body 4 and a rear body 5. An operator's seat 6 is mounted either on the front body 4 or on the rear body 5. The two bodies 4, 5 are connected with each other by means of a pivot joint 7 so the vehicle 1 can be steered. The rear drum 3 can be replaced by wheels in certain applications.

[52]

[53] FIG. 3, Fig. 4 and Fig.5 show a schematic diagram of a hydrostatic transmission closed loop circuit 10 in neutral state, in positive state and in negative state according to one embodiment of the present invention, respectively. Referring to FIG. 3, the hydrostatic transmission closed loop circuit 10 has a variable displacement & reversible pump 11 driven by a prime mover (not shown) such as a diesel engine or an electrical motor, and a fixed displacement hydraulic motor 12 connected to the drive train (not shown) of the vehicle 1. The pump 11 and the motor 12 are fluidly coupled by a first conduit 13 and a second conduit 14.

[54]

[55] It should be noted that the number of the motor 12 is not restricted to only one. It is possible to use two or more motors in certain applications.

[56]

[57] The pump 11 can be an axial piston pump of which the fluid displacement can be determined by a tilted angle of a swash plate 11a. By changing the angle of the swash

plate 11a, the stroke of the pistons can be varied continuously. If the swash plate 11a is perpendicular to the axis of rotation, i.e., a zero angle, no fluid will flow and the motor speed is zero. If it is at a sharp angle, a large volume of fluid will be pumped and the motor speed is increased.

[58]

[59] The pump 11 allows the swash plate 11a to be moved in both directions from the zero or neutral position, pumping fluid in either direction without reversing the rotation of the pump 11. In other words, the swash plate angle can vary from a zero angle, i.e., a neutral position, to a positive angle and to a negative angle. Consequently, the motor 12 is caused to rotate in a forward direction and a reverse direction, which correspond to the intended forward or backward travels of the vehicle. For simplicity, the differences in swash plate angle among the three states are not depicted for the pump 11 in Fig. 3, Fig. 4 and Fig. 5.

[60]

[61] Depending upon the direction of the movement of the swash plate 11a, the first conduit 13 (or the second conduit 14) of the circuit 10 can be a high pressure supply line or a low pressure return line. In this embodiment, it is assumed that the first conduit 13 becomes a supply line and the second conduit 14 becomes a return line when the motor 12 rotates in forward direction, i.e., when the vehicle travels forward. In this regard, it may be said that the hydrostatic transmission closed loop circuit 10 is in neutral state as in Fig. 3 when the swash plate 11a is in neutral position, in positive state as in Fig. 4 when the swash plate 11a is in positive position, and in negative state as in Fig. 5 when the swash plate 11a is in negative position, and the positive state as in Fig. 4 corresponds to forward travel of the vehicle and the negative state as in Fig. 5 corresponds to backward travel of the vehicle.

[62]

[63] A charge pump 15, also driven via the prime mover, supplies additional hydraulic fluid to the closed loop circuit 10. The charge pump 15 draws fluid from a tank 16 and supplies this fluid into the circuit 10 through a conduit 17 by way of one-way check valves 18 and 19 to compensate for any possible loss, for example, due to internal leakage. A conduit 27 is connected between the motor 12 and the tank to provide a return line for fluid leakage from the motor 12 to the tank 16. A charge relief valve 20 is used to provide a relief path to the tank 16 so that more than the required flow from the charge pump 15 cannot enter the circuit 10.

[64]

[65] First high pressure relief valve 21 is connected to the first conduit 13 and protect the first conduit 13 from pressure overload during operation. Second high pressure relief valve 22 is connected to the second conduit 14 and protect the second conduit 14 from

pressure overload during operations. The first high pressure relief valve 21 provides relief for the first conduit 13 and the second high pressure relief valve 22 provides relief for the second conduit 14. The first high pressure relief valve 21 has a predetermined relief pressure P1 to open the path from the first conduit 13 to the second conduit 14, and the second high pressure relief valve 22 also has a predetermined relief pressure P1' to open the path from the second conduit 14 to the first conduit 13. In this embodiment, relief pressures P1 and P1' of both high pressure relief valves 21, 22 are set to a value sufficiently lower than a critical pressure causing destruction of the closed loop circuit 10, but high enough to provide sufficient compaction energy.

[66]

[67] The closed loop circuit 10 has a flushing valve 23 connected to the first conduit 13 and the second conduit 14 downstream of the high pressure relief valves 21, 22 and the check valves 18, 19. The flushing valve 23 is a pilot pressure operated three position, three port valve. The flushing valve 23 has opposite end positions and an intermediate position therebetween. The flushing valve 23 is pilot pressured centered, but is urged into one of the opposite end positions whenever a differential pressure exists between the first conduit 13 and the second conduit 14. In both of the opposite end positions of the flushing valve 23, one of the first and second conduits 13, 14 having the lower pressure at the time is connected to a purge relief valve 24 as shown in Fig. 4 and Fig. 5. However, when there is no differential pressure between the first conduit 13 and the second conduit 14, such as when the closed loop circuit 10 is in neutral state, the flushing valve 23 is in the intermediate position and is not connected to the purge relief valve 24 as shown in Fig. 3. The purge relief valve 24 has a predetermined relief pressure which is a little lower than that of the charge relief valve 20.

[68]

[69] First low pressure relief valve 25 with a relief pressure P2 is connected to the first conduit 13 providing relief for the first conduit 13. Second low pressure relief valve 26 with a relief pressure P2' is connected to the second conduit 14 providing relief for the first conduit 14. The relief pressure P2 of the first low pressure relief valve 25 is, as suggested from its name, lower than the predetermined relief pressure P1 of the first high pressure relief valve 21. Also, the relief pressure P2' of the second low pressure relief valve 26 is lower than the predetermined relief pressure P1' of the second high pressure relief valve 22.

[70]

[71] Although it is preferable that the closed loop circuit 10 comprises both the first and second low pressure relief valves 25, 26, there can be only one of the first and second low pressure relief valves 25, 26.

[72]

[73] As depicted, it is preferable that the first low pressure relief valve 25 and the second low pressure relief valve 26 relieve pressure from the first conduit 13 and second conduit 14 to the tank 16, respectively. However, other ways of relief, for example, from the first conduit 13 to the second conduit 14 and from the second conduit 14 to the first conduit 13, are possible.

[74]

[75] It should be noted that the relief pressures P1, P1' of the first and second high pressure relief valves 21, 22 are not necessarily set to a specific value, and likewise, the relief pressures P2, P2' of the first and second low pressure relief valves 25, 26 are not necessarily set to a specific value. Modifications for these pressure settings are available according to the requirements from the hydrostatic transmissions and the vehicles in use.

[76]

[77] However, it is required that the relief pressure P1 of the first high pressure relief valve 21 should be higher than the relief pressure P2 of the first low pressure relief valve 25, and the relief pressure P1' of the second high pressure relief valve 22 should be higher than the relief pressure P2' of the second low pressure relief valve 26.

[78]

[79] Each of the relief pressure P2 of the first low pressure relief valve 25 and the relief pressure P2' of the second low pressure relief valve 26 is set 10 to 15 bar higher than a normal pressure encountered in relevant application. It has been found out that this range provides sufficient compaction energy for relevant application in addition to sufficient dampening of bouncing effect.

[80]

[81] Although the first and second low pressure valves 25, 26 could have a fixed relief pressure, it is preferable that the first low pressure relief valve 25 and the second low pressure relief valve 26 are remote pressure control valves having means for adjusting the relief pressure P2, P2'. As remote pressure control valves are well-known components, they have not been described in detail so as not to unnecessarily obscure aspects of the present invention. Also, the means for adjusting the relief pressure, one of which can be exemplified to be a knob installed to a remote pressure control valve and configured to be able to adjust spring force exerted to a spool or poppet of the valve, has not been described in detail for the same reason.

[82]

[83] Although the means for adjusting the relief pressure could be located at any place of the vehicle 1, it is preferable that the means for adjusting the relief pressure is located near the operator's seat 6 of the vehicle 1 so that it can be readily accessible from the operator's seat 6. This will allow quick and fast adjustment of the relief pressure of the

first or second low pressure relief valves 25, 26, when an operator seated on the operator's seat 6 feels bouncing effect.

[84]

[85] The first low pressure relief valve 25 is connected to the first conduit 13 at any position. For example, the first low pressure relief valve 25 is connected to the first conduit 13 at a position between the first high pressure relief valve 21 and the motor 12. The second low pressure relief valve 26 is connected to the second conduit 14 at a position between the second high pressure relief valve 22 and the motor 12.

[86]

[87] The following description is now provided about the operation or function of the hydrostatic transmission described above.

[88]

[89] The construction vehicle 1 adopting the closed loop circuit 10 are equipped with heavy drums 2, 3 driven by the motor 12, and the drums 2, 3 may be vibratory drums which have one or more of various kinds of eccentric rotation mechanism installed in them.

[90]

[91] When compaction energy provided by the closed loop circuit 10 is adequate for the relevant application, the heavy drums 2, 3 having eccentric rotation mechanism negotiate and compact patches without bouncing back, and the pressure in the high pressure supply line (the first conduit 13 in case of forward travel and the second conduit 14 in case of backward travel) maintains normal pressure for relevant application. In this case, the first or second low pressure relief valves 25, 26 have no function.

[92]

[93] Problem occurs when heavy drums 2, 3 having eccentric rotation mechanism negotiate over-compacted patches. Over-compacted patches do not need additional input of compaction energy. Moreover, when unnecessarily high compaction energy is input, over-compacted patches bounce back compaction energy instead of being additionally compacted and this bouncing effect causes an operator discomfort in addition to failure on some machine elements.

[94]

[95] It is found out and noted that pressure in the high pressure supply line becomes a little higher than a normal pressure encountered in relevant application when compaction energy bounces back, and the first pressure relief valve 21 when the vehicle 1 travels forward (see Fig. 4) or the second pressure relief valve 22 when the vehicle 1 travels backward (see Fig. 5), which is located in the high pressure supply line, provides relief for this excessive pressure, and thus, bouncing effect can be

dampen and the operator and machine elements can be protected from bouncing effect. As the excessive pressure occurring with the bounce back effect is quite small comparing to the relief pressure of P1, P1' of the first and second high pressure relief valve, the closed loop circuit without the first and second low pressure relief valves 25, 26 will not be able to perform this kind of relief and dampening of bouncing effect cannot be expected.

[96]

[97] When the first and second low pressure valves 25, 26 are remote pressure control valves having means for adjusting the relief pressure P2, P2'. One operating the vehicle 1 (an operator) can adjust the relief pressure P2, P2' considering relevant application and condition of soil or asphalt. Moreover, when the means for adjusting the relief pressure is located near the operator's seat 6 of the vehicle 1, the means for adjusting the relief pressure can be readily accessible from the operator's seat 6 and the operator on the seat 6 can quickly adjusting the relief pressure of the first or second low pressure relief valves 25, 26 when he or she feels bouncing effect.

[98]

[99] The following explanation will disclose function and operation of the flushing valve 23. When the hydrostatic transmission closed loop circuit 10 is in neutral state, the flushing valve 23 has no function and the charge relief valve 20 maintains charge pressure from the charge pump 15. As shown in Fig. 4, when the closed loop circuit 10 is in positive state in which the first conduit 13 is a high pressure supply line and the second conduit is a low pressure return line, and the motor 12 rotates in forward direction and the vehicle travels forward, the second conduit 14, the low-pressure side of the loop, is connected to the purge relief valve 24 via the flushing valve 23. In this configuration, as the relief pressure of the purge relief valve 24 is a little lower than that of the charge relief valve 20, the volume of hot hydraulic fluid exiting the motor 12 and entering the second conduit 14 which is not required to maintain charge pressure is passing over the purge relief valve 24 to the tank 16, while relatively cool hydraulic fluid from the tank 16 is passing through the check valve 19 to the second conduit 14. Similarly, in the configuration shown in Fig. 5, the volume of hot hydraulic fluid exiting the motor 12 and entering the first conduit 13 which is not required to maintain charge pressure is passing over the purge relief valve 24 to the tank 16, while relatively cool hydraulic fluid from the tank 16 is passing through the check valve 18 to the first conduit 13.

[100]

[101] It should be noted that the hydrostatic transmissions according to the present invention are not limited to surface compactors shown in the embodiments, but can be widely used for various road machinery including, soil compactors, asphalt

compactors, and asphalt pavers.

[102]

[103] The present invention provides hydrostatic transmissions for a construction vehicle which is capable of dampening bouncing effect and protecting an operator and machine elements from bouncing effect by providing relief for excessive pressure occurring together with bouncing effect in the high pressure supply line.

[104]

[105] Although the invention has been described with reference to the preferred embodiments in the attached figures, it is noted that equivalents may be employed and substitutions made herein without departing from the scope of the invention as recited in the claims.

[106]

Industrial Applicability

[107] The present disclosure is applicable to a road construction machine, and more specifically, to a surface compactor.

[108]

Claims

[Claim 1] A hydrostatic transmission for a construction vehicle comprising:
a variable displacement pump driven by a prime mover;
a hydraulic motor connected to a drive train of the vehicle;
first and second conduits interconnecting said pump and said motor;
first and second high pressure relief valves, said first high pressure valve being connected to said first conduit with a relief pressure, providing relief for said first conduit, and said second high pressure relief valve being connected to said second conduit with a relief pressure, providing relief for said second conduit; and,
at least one of first low pressure relief valve and second low pressure relief valves, said first low pressure relief valve being connected to said first conduit with a relief pressure, providing relief for said first conduit, and said second low pressure relief valve being connected to said second conduit with a relief pressure, providing relief for said second conduit,
wherein the relief pressure of said first low pressure relief valve is lower than the relief pressure of said first high pressure relief valve, and the relief pressure of said second low pressure relief valve is lower than the relief pressure of said second high pressure relief valve.

[Claim 2] The hydrostatic transmission for a construction vehicle according to claim 1, wherein:
the relief pressure of said first low pressure relief valve and said second low pressure relief valve is set 10 to 15 bar higher than a normal pressure encountered in relevant application.

[Claim 3] The hydrostatic transmission for a construction vehicle according to claim 1, wherein:
said first low pressure relief valve and said second low pressure relief valve are remote pressure control valves having means for adjusting the relief pressure.

[Claim 4] The hydrostatic transmission for a construction vehicle according to claim 3, wherein:
the means for adjusting the relief pressure is located near an operator's seat of the vehicle so that it can be readily accessible from the operator's seat.

[Claim 5] The hydrostatic transmission for a construction vehicle according to claim 1, wherein:

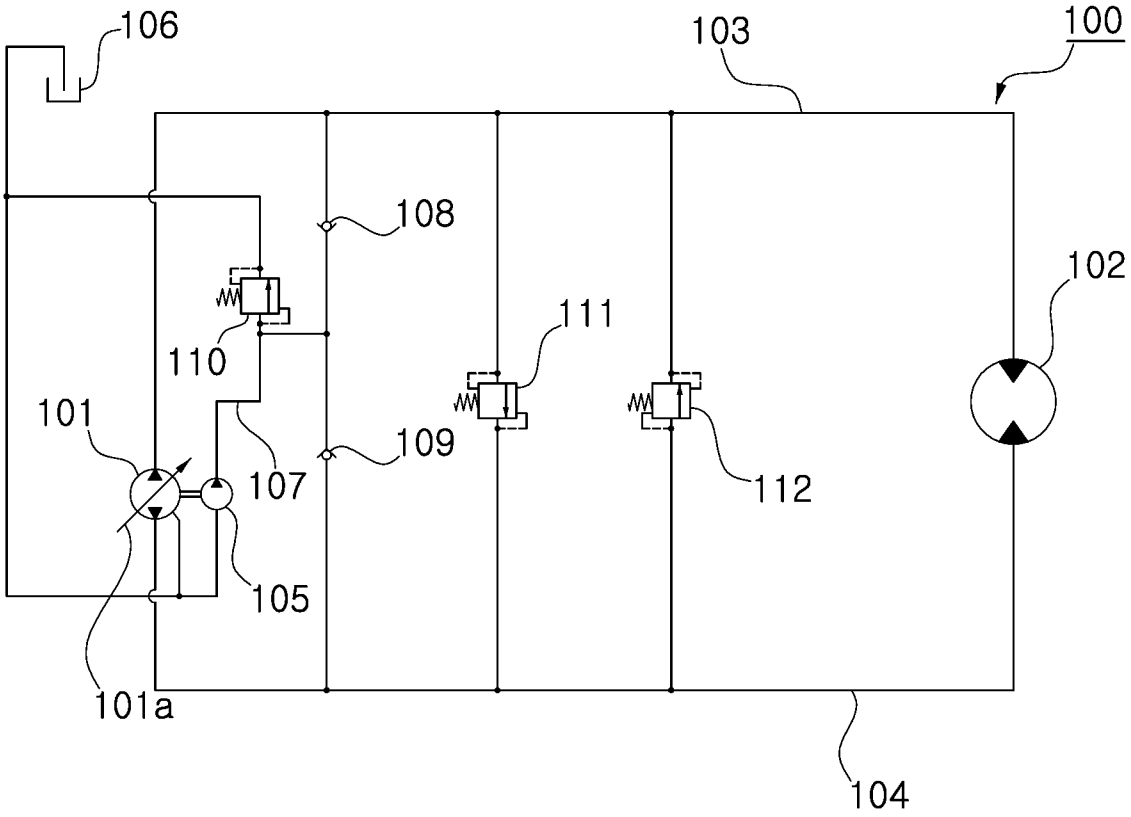
said first low pressure relief valve is connected to said first conduit at a position between said first high pressure relief valve and said motor, and said second low pressure relief valve is connected to said second conduit at a position between said second high pressure relief valve and said motor.

[Claim 6] The hydrostatic transmission for a construction vehicle according to claim 1, wherein:
said first low pressure relief valve and said second low pressure relief valve relieve pressure from said conduits to a tank.

[Claim 7] The hydrostatic transmission for a construction vehicle according to claim 1, wherein:
said first conduit is the conduit that becomes a high pressure supply line when the motor is caused to rotate in a forward direction which corresponds to a forward travel of the vehicle.

[Claim 8] The hydrostatic transmission for a construction vehicle according to claim 1, wherein:
said construction vehicle comprises a soil compactor, an asphalt compactor and an asphalt paver.

[Fig. 1]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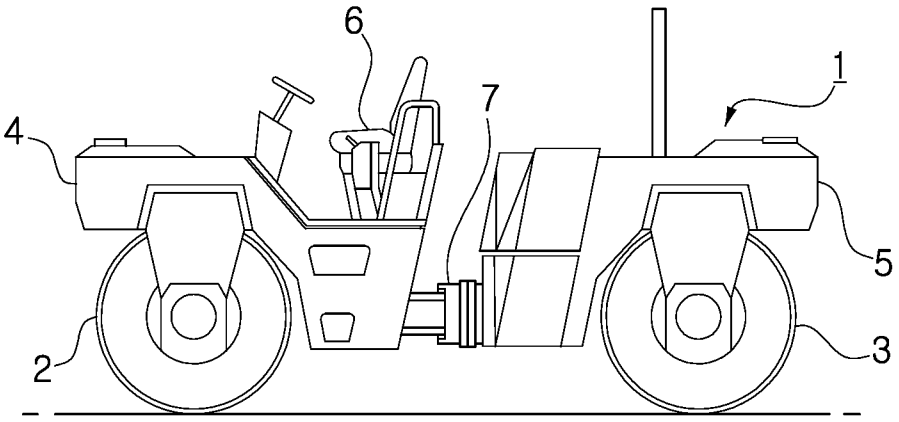
[Fig. 2]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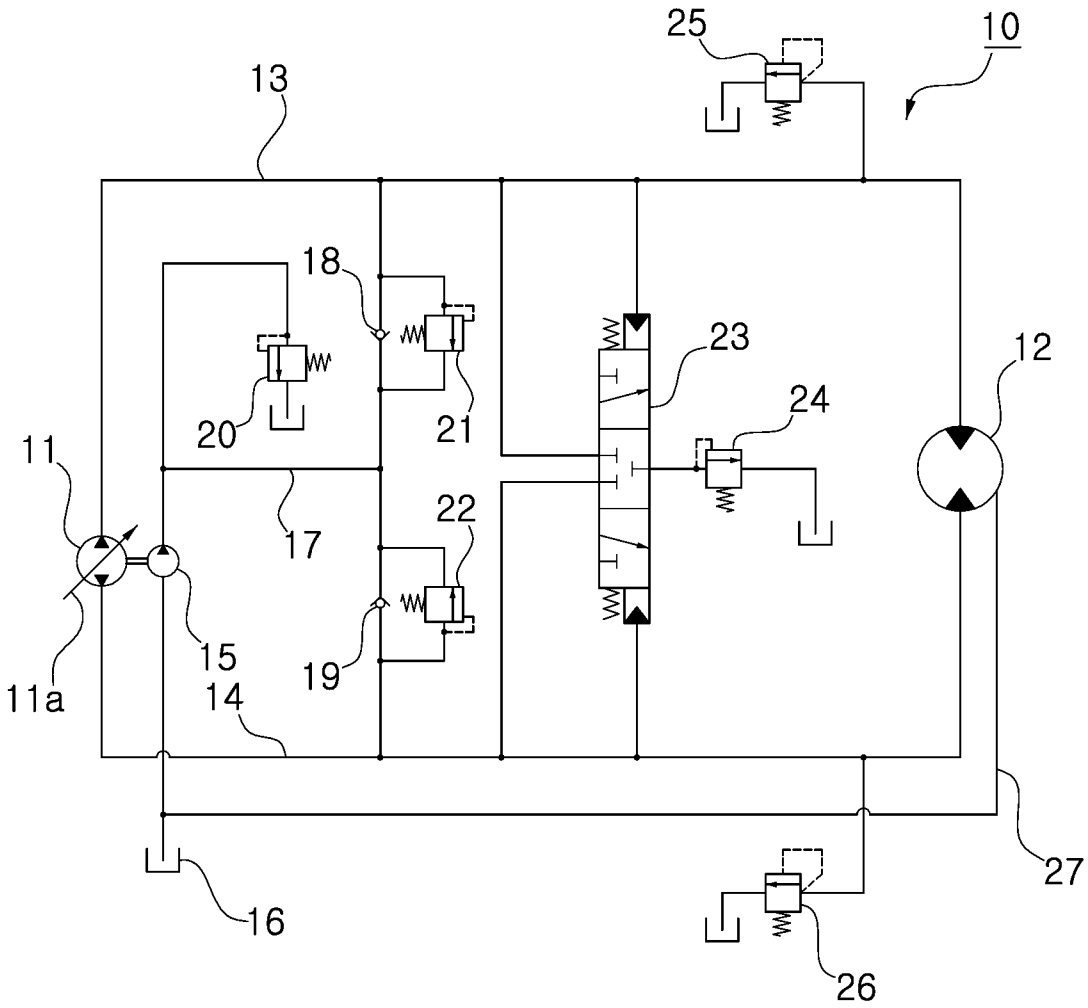
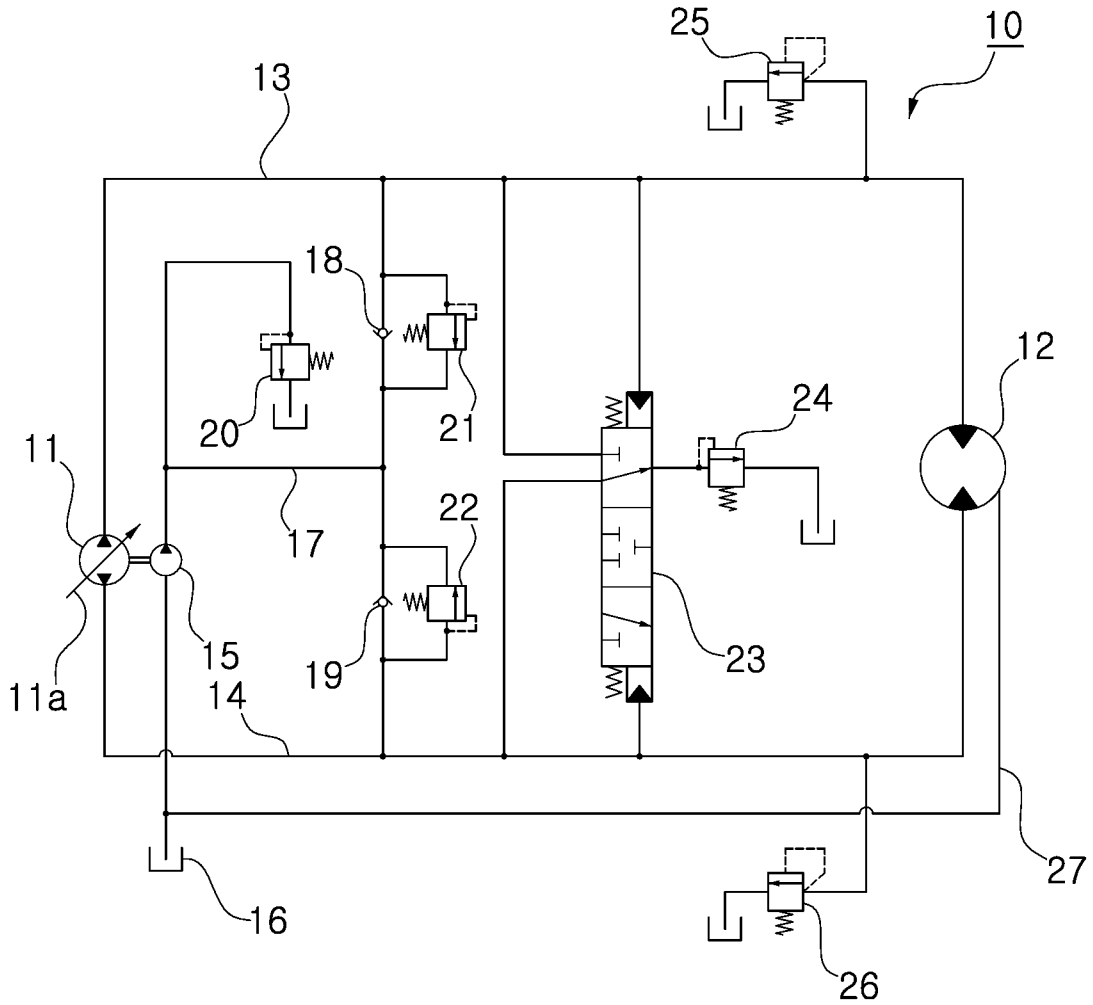
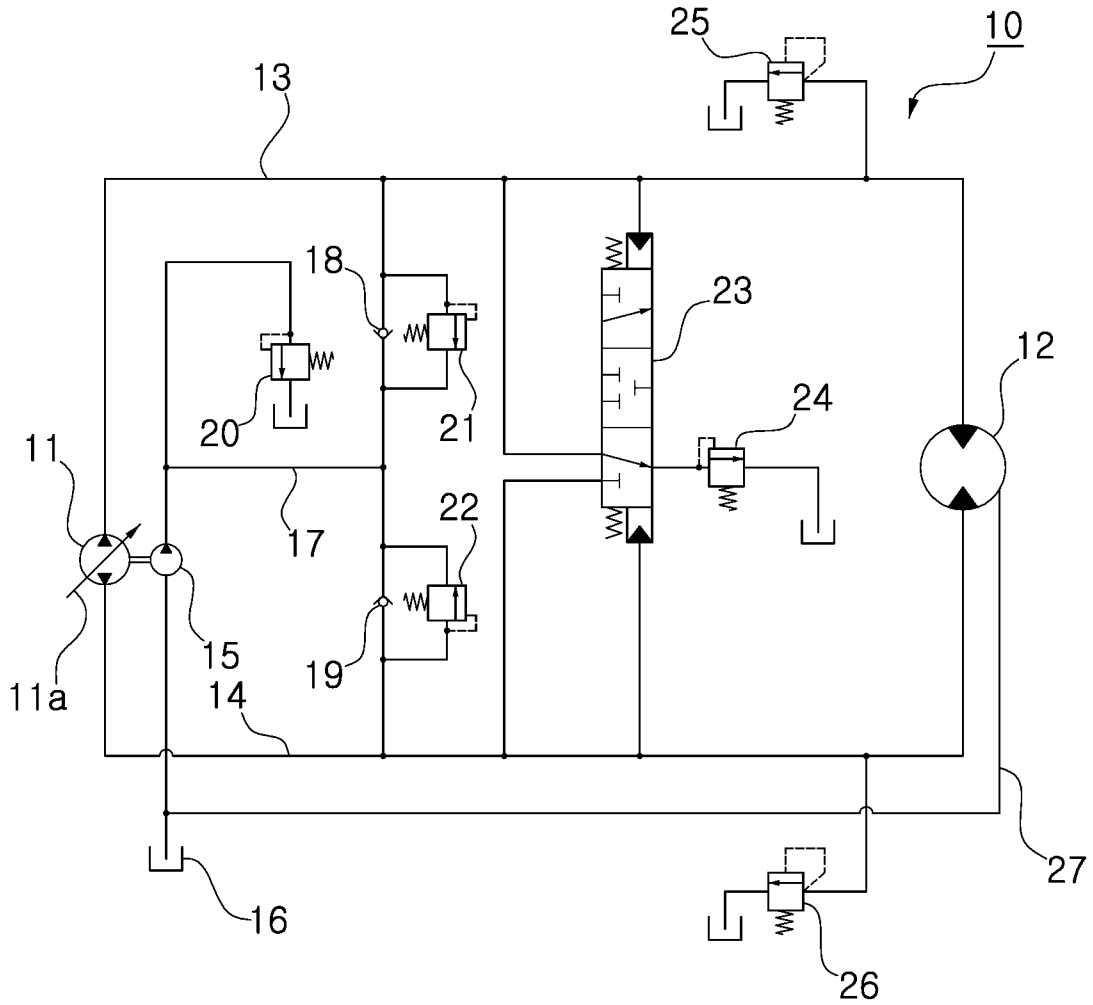
[Fig. 3]



[Fig. 4]



[Fig. 5]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/006376

A. CLASSIFICATION OF SUBJECT MATTER

B60K 17/10(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60K 17/10; F16H 37/08; F16D 31/02; E02F 9/22; F04B 1/107; F04B 49/02; B60K 17/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: construction, swash plate, transmission, motor, pump and relief valve

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011-0308879 A1 (SHIRAO et al.) 22 December 2011 See paragraphs [0011], [0037] and figure 2.	1-5,8
Y		6-7
Y	US 2007-0072728 A1 (ISHIMARU et al.) 29 March 2007 See paragraphs [0061], [0134], [0155] and figure 2.	6-7
A	US 2007-0102223 A1 (TATE et al.) 10 May 2007 See paragraphs [0022]-[0026] and figure 2.	1-8
A	WO 2014-048842 A1 (POCLAIN HYDRAULICS INDUSTRIE) 03 April 2014 See page 34, line 13 - page 35, line 29 and figures 15-16.	1-8
A	US 2007-0186549 A1 (SAKIKAWA, SIGENORI) 16 August 2007 See paragraphs [0062]-[0064], [0075] and figures 6, 10.	1-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 March 2016 (10.03.2016)	**10 March 2016 (10.03.2016)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR2015/006376

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