



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
11.09.2013 Bulletin 2013/37

(51) Int Cl.:
F15B 21/04 (2006.01) **E02F 9/22** (2006.01)
F15B 11/028 (2006.01)

(21) Application number: **11837981.7**

(86) International application number:
PCT/JP2011/075078

(22) Date of filing: **31.10.2011**

(87) International publication number:
WO 2012/060331 (10.05.2012 Gazette 2012/19)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **05.11.2010 JP 2010248558**

(71) Applicant: **Hitachi Construction Machinery Co., Ltd.**
Bunkyo-ku
Tokyo 112-8563 (JP)

(72) Inventors:
• **KODAKA Katsuaki**
Tsuchiura-shi
Ibaraki 300-0013 (JP)

- **NAKAMURA Yuta**
Tsuchiura-shi
Ibaraki 300-0013 (JP)
- **KAYANE Masahiro**
Tsuchiura-shi
Ibaraki 300-0013 (JP)
- **ICHIMURA Kazuhiro**
Tsuchiura-shi
Ibaraki 300-0013 (JP)

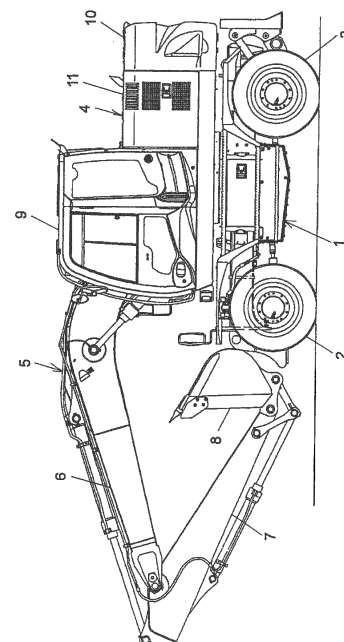
(74) Representative: **Beetz & Partner**
Patentanwälte
Steinsdorfstrasse 10
80538 München (DE)

(54) **HYDRAULIC DRIVE DEVICE FOR CONSTRUCTION MACHINE**

(57) [Problem] To permit guiding oil of a high pressure in an oil passage section, which communicates a valve device and a filter to each other, to a relief valve by a relatively inexpensive structure even when clogging occurs in a filter arranged in an oil passage communicating the valve device and the relief valve to each other.

[Solution] A hydraulic pump (20) and a charge valve (25), to which pressure oil is fed from the hydraulic pump (20) via an oil passage (26), are arranged. Arranged in the charge valve (25) are a valve device, for example, an on/off valve (33) switchable according to pressure oil delivered from the hydraulic pump (20), a relief valve (34) specifying a maximum of switching pressure for the on/off valve (33), and a filter (36) arranged in an oil passage (35) communicating the on/off valve (33) and the relief valve (34) to each other. In the oil passage (35), a check valve (37) is arranged in parallel with the filter (36) such that a flow of pressure oil from a side of the on/off valve (33) toward a side of the relief valve (34) is allowed but a flow of pressure oil from the side of the relief valve (34) toward the side of the on/off valve (33) is prevented.

FIG. 1



Description

Technical Field

[0001] This invention relates to a hydraulic drive system for a working machine such as a wheel excavator, which is to be arranged on the working machine and is provided with a filter for trapping dust mixed in oil flowing through an oil passage.

Background Art

[0002] As a conventional technology of this type, there is one described in Patent Document 1. The conventional technology disclosed in this Patent Document 1 is provided with a filter and a check valve. The filter is arranged in an upstream oil passage of a hydraulic circuit to which pressure oil delivered from a hydraulic pump is fed, and traps dust mixed in oil delivered from the hydraulic pump. The check valve is arranged in the oil passage such that the check valve is disposed in parallel with the filter, and allows a flow of oil from a side of the hydraulic pump to a side of the hydraulic circuit but prevents a flow of oil from the side of the hydraulic circuit to the side of the hydraulic pump.

[0003] According to this conventional technology, oil which has been cleaned through the filter is fed to the hydraulic circuit. When clogging occurs in the filter and oil becomes difficult to pass through the filter, a high pressure is produced on an upstream side of the filter so that the oil is fed to the hydraulic circuit via the check valve arranged in parallel with the filter. As a consequence, it has become possible to avoid a breakage of the entire circuit including the hydraulic pump, which would otherwise occur as a result of the clogging of the filter.

[0004] Although the filter is arranged on the upstream side relative to the hydraulic pump in the above-mentioned conventional technology, a technology with a filter arranged in a hydraulic circuit on a downstream side relative to a hydraulic pump has also been known conventionally. Described specifically, it has also been known for years to arrange a valve device and a relief valve, which specifies a maximum of switching pressure for the valve device, in a hydraulic circuit on a downstream side of a hydraulic pump, and in an oil passage communicating the valve device and the relief valve to each other, to arrange a filter for trapping dust that flows through the oil passage. The technology constructed as described above can realize the cleaning of oil that flows through the oil circuit on the downstream side of the hydraulic pump.

Prior Art Document

Patent Document

[0005] Patent Document 1: JP- A- 6- 35607 U

Disclosure of the Invention

Problem to Be Solved by the Invention

[0006] In a hydraulic drive system having the above-mentioned, conventionally known construction, specifically the conventional technology having the construction that a filter is arranged in an oil passage communicating a valve device and a relief valve to each other, there is a problem associated with clogging of the filter. Described specifically, when the degree of clogging of the filter increases, a restriction is imposed on a flow of oil from the side of the filter to the side of the relief valve. Accordingly, the pressure in an oil passage section that communicates the valve device and the filter to each other gradually rises to a high pressure. As this high pressure is confined to the oil passage section, there is a potential problem that an entire hydraulic circuit including the oil passage and valve device may be broken.

[0007] To avoid such a breakage of the hydraulic circuit, it may hence be contemplated to construct such that a relief valve is arranged between the valve device and the filter to release a high pressure when the pressure in the oil passage section, which communicates the valve device and the filter to each other, rises to the high pressure. However, a relief valve is generally expensive. The construction with a relief valve arranged as described above, therefore, involves an inconvenience that the hydraulic drive system requires higher manufacturing cost.

[0008] With the above-mentioned actual situation of the conventional technology in view, the present invention has as an object thereof the provision of a hydraulic drive system for a working machine, which can guide oil of a high pressure in an oil passage section, which communicates a valve device and a filter to each other, to the relief valve by a relatively inexpensive structure even when clogging occurs in a filter arranged in an oil passage communicating the valve device and the relief valve to each other.

Means for Solving the Problem

[0009] To achieve this object, a hydraulic drive system according to the present invention for a working machine is characterized in that in a hydraulic drive system for a working machine, said system being provided with a hydraulic pump, a valve device switchable according to pressure oil delivered from the hydraulic pump, a relief valve specifying a maximum of switching pressure for the valve device, and a filter arranged in an oil passage communicating the valve device and the relief valve to each other, a check valve is arranged in the oil passage and in parallel with the filter such that a flow of oil from a side of the valve device toward a side of the relief valve is allowed but a flow of oil from the side of the relief valve toward the side of the valve device is prevented.

[0010] According to the present invention constructed as described above, when clogging occurs in the filter

arranged in the oil passage communicating the valve device and the relief valve to each other and the pressure in the oil passage section communicating the valve device and the filter to each other rises to a high pressure, oil is guided to the relief valve via the relatively inexpensive check valve arranged in parallel with the filter, in other words, the check valve generally considered to be inexpensive compared with a relief valve or the like, and the pressure oil of the high pressure can be released by an actuation of the relief valve. As a consequence, no high pressure is confined to the oil passage section, thereby making it possible to avoid a breakage of the entire hydraulic circuit including the oil passage and valve device.

[0011] The hydraulic drive system according to the present invention may also be characterized in that in the above-described invention, a valve unit to which pressure oil delivered from the hydraulic pump is fed is provided, and in the valve unit, the valve device, relief valve, oil passage, filter and check valve are arranged.

[0012] The hydraulic drive system according to the present invention may also be characterized in that in the above-described invention, a brake valve and an accumulator, which can feed pressure oil to the brake valve, are arranged, the valve unit comprises a charge valve capable of feeding pressure oil to the accumulator, and the valve device comprises an on/off valve which, when an accumulated pressure in the accumulator becomes higher than a predetermined pressure, can release pressure oil of the higher pressure.

[0013] The hydraulic drive system according to the present invention may also be characterized in that in the above-described invention, the working machine is a wheel excavator, a priority valve and a steering valve, to which pressure oil delivered from the hydraulic pump is fed, are arranged, another oil passage for guiding pressure oil to the charge valve via the priority valve is arranged, and another filter is arranged in a further oil passage communicating the hydraulic pump and the priority valve to each other, and a check valve is arranged in the further oil passage and in parallel with the another filter such that a flow of oil from a side of the hydraulic pump toward a side of the priority valve is allowed but a flow of oil from the side of the priority valve toward the side of the hydraulic pump is prevented.

Advantageous Effects of the Invention

[0014] In the hydraulic drive system provided with the filter arranged in the oil passage communicating the valve device and the relief valve to each other, the check valve is arranged in the above-mentioned oil passage and in parallel with the filter to allow a flow of oil from the side of the valve device toward the side of the relief valve but to prevent a flow of oil from the side of the relief valve toward the side of the valve device. Even if clogging occurs in the filter, the present invention, therefore, can guide oil of a high pressure in the oil passage section,

which communicates the valve device and the filter to each other, to the relief valve via the relatively inexpensive check valve. As a consequence, a breakage of the entire hydraulic circuit can be avoided while suppressing an increase in the manufacturing cost of the hydraulic drive system including the oil passage and valve device, so that the excellent protection of the hydraulic circuit can be realized at low cost.

Brief Description of the Drawings

[0015]

FIG. 1 is a side view showing a wheel excavator exemplified as an example of the working machine on which the hydraulic drive system according to the present invention is arranged.

FIG. 2 is a hydraulic circuit illustrating a hydraulic drive system according to an embodiment, which can be arranged on the wheel excavator shown in FIG. 1.

Modes for Carrying out the Invention

[0016] An embodiment of the hydraulic drive system according to the present invention for the working machine will hereinafter be described based on the drawings.

[0017] The working machine on which the hydraulic drive system according to this embodiment can be arranged is, for example, a wheel excavator. As shown in FIG. 1, this wheel excavator is provided with a travel base 1 having front wheels 2 and rear wheels 3, an upperstructure 4 mounted on the travel base 1, and working equipment 5 attached tiltably in an up-and-down direction to the upperstructure 4. The working equipment 5 includes a boom 6 tiltably arranged on the upperstructure 4, an arm 7 tiltably arranged on a free end of the boom 6, and a bucket 8 tiltably arranged on a free end of the arm 7. An operator's cab 9 is arranged on the upperstructure 4 at a forward position thereof, and a counterweight 10 is arranged on the upperstructure 4 at a rear position thereof. An engine compartment 11 is arranged between the operator's cab 9 and the counterweight 11, and a main part of the hydraulic drive system according to this embodiment is accommodated in the engine compartment 11.

[0018] As illustrated in FIG. 2, the hydraulic drive system according to the present invention is provided with a hydraulic pump 20, a priority valve 21 communicated to the hydraulic pump 20, and a steering valve 22 arranged in continuation with the priority valve 21 to feed pressure oil to an unillustrated steering cylinder according to an operation of an unillustrated steering wheel. Also provided are a brake valve 23 for feeding pressure oil, which applies a brake on the front wheels 2 and rear wheels 3, to an unillustrated brake system according to a depression operation of a brake pedal 23a arranged in the operator's cab 9, accumulators 24 arranged in a pair,

one for the front wheels 2 and the other for the rear wheels 3, to accumulate pressure oil to be fed to the brake valve 23, and a charge valve 25 communicated to the above-mentioned priority valve 21 via an oil passage 26 to permit feeding pressure oil to the accumulators 24.

[0019] In an oil passage 38 that communicates the hydraulic pump 20 and the priority valve 21 to each other, a filter 28 and a check valve 29 are arranged in parallel with each other. The filter 28 traps dust mixed in pressure oil that flows through the oil passage 38. The check valve 29 allows a flow of pressure oil from a side of the hydraulic pump 20 toward a side of the priority valve 21, but prevents a flow of pressure oil from the side of the priority valve 21 toward the side of the hydraulic pump 20.

[0020] The above-mentioned priority valve 21 includes a directional control valve 21a and a relief valve 21b. The directional control valve 21a has a neutral position 21a1, which is a switched position where pressure oil can be fed to the accumulators 24, and an operated position 21a2, which is a switched position where pressure oil is fed to the steering valve 23 according to an operation of the unillustrated steering wheel. The relief valve 21b specifies a maximum of switching pressure for the directional control valve 21a. The relief valve 21b is connected to a reservoir 27.

[0021] The above-mentioned steering valve 22 includes a pump unit 22b for feeding pressure oil to the unillustrated steering cylinder, and a directional control valve 22a for controlling a flow of pressure oil to be fed to the pump unit 22b via the directional control valve 21a in the priority valve 21. The directional control valve 22a has a switched position 22a1 where pressure oil for allowing normal rotation of the pump unit 22b can be fed, another switched position 22a2 where pressure oil for allowing reverse rotation of the pump unit 22b can be fed, and a neutral position 22a3 where feeding of pressure oil to the pump unit 22b is prevented.

[0022] The above-mentioned charge valve 25 includes check valves 30,31 and a check valve 32. The check valves 30,31 allow feeding of pressure oil to the corresponding accumulators 24, but prevent flows of pressure oil from sides of the corresponding accumulators 24. The check valve 32 allows feeding of pressure oil in directions toward these check valves 30,31, but prevents flows of pressure oil from the sides of the check valves 30,31. The charge valve 25 also includes a valve device, specifically an on/off valve 33 and a relief valve 34. The on/off valve 33 is held in a closed position 33a when the pressure of the accumulators 24 is low, but is switched to an open position 33b when the pressure of the accumulators 24 has arisen to a predetermined pressure. The relief valve 34 specifies a maximum of switching pressure for the on/off valve 33. The on/off valve 33 and relief valve 34 are connected to the reservoir 27.

[0023] The charge valve 25 is arranged in an oil passage 35 that communicates the on/off valve 33 and the relief valve 34 to each other, and includes a filter 36 for trapping dust mixed in pressure oil that flows through the

oil passage 35. In this embodiment, the charge valve 25 also includes a check valve 37 in the above-mentioned oil passage 35 and in parallel with the filter 36 such that the check valve 37 allows a flow of pressure oil from a side of the on/off valve 33 toward a side of the relief valve 34 but prevents a flow of pressure oil from the side of the relief valve 34 toward the side of the on/off valve 33. The check valve 37 as described above is generally known to be inexpensive compared with a relief valve or the like. It is to be noted that the oil passage 26, which communicates the above-mentioned priority valve 21 and charge valve 25 to each other, is connected at an end thereof to an outlet port of the directional control valve 21a in the priority valve 21 and at an opposite end thereof to an oil passage that communicates the check valve 32 and the on/off valve 33 to each other in the charge valve 25.

[0024] When the unillustrated steering wheel is operated in this embodiment constructed as described above, the directional control valve 22a in the steering valve 22a tends to be switched to either one of the switched positions 22a1,22a2, and further, the directional control valve 21a in the priority valve 21 tends to be switched toward the operated position 21a. Therefore, a substantial portion of pressure oil delivered from the hydraulic pump 20 is fed to the pump unit 22b via the filter 28, the operated position 21a2 of the directional control valve 21a in the priority valve 21 and the switched position 22a1 or switched position 22a2 of the directional control valve 22a in the steering valve 22, and is further fed from the pump unit 22b to the unillustrated steering cylinder. As a consequence, the travelling direction of the travel base 1 is determined. When the switching pressure for the directional control valve 21a in the priority valve 21 exceeds the preset pressure for the relief valve 21b during the above-mentioned feeding of pressure oil, the relief valve 21b is actuated to release the pressure oil of high pressure, which exceeds the preset pressure, to the reservoir 27 via the relief valve 21b.

[0025] It is to be noted that even during an operation of the above-mentioned unillustrated steering wheel, a portion of pressure oil delivered from the hydraulic pump 20 may be fed, depending on the steering angle of the steering wheel, to the oil passage 26 from a side of the neutral position 21a1 of the directional control valve 21a in the priority valve 21. In such an instance, the accumulation of pressure to the accumulators 24 is feasible accordingly.

[0026] In a non-operated state of the unillustrated steering wheel, on the other hand, the directional control valve 21a1 in the priority valve 21 is held in the neutral position 21a1. Pressure oil delivered from the hydraulic pump 20 is, therefore, fed to the charge valve 25 via the switched position 21a1 of the directional control valve 21a1 in the priority valve 21 and the oil passage 26. In a state that the pressure accumulated in the accumulators 24 has not arisen to the predetermined pressure at this time, the on/off valve 33 is held in the closed position 33a so that pressure oil from the hydraulic pump 20 is fed to

the respective accumulators 24 via the check valve 32 and check valves 30, 31. When the pressure accumulated in both of the accumulators 24 has arisen to the predetermined pressure, the on/off valve 33 is switched to the open position 33b by a switching pressure applied to a section of the oil passage 35, said section being located between the on/off valve 33 and the filter 36. As a consequence, the pressure oil of a high pressure exceeding the predetermined pressure is released to the reservoir 27 via the open position 33b of the on/off valve 33. When the above-mentioned switching pressure exceeds the preset pressure for the relief valve 34, the relief valve 34 is actuated so that the pressure oil of a high pressure exceeding the preset pressure is released to the reservoir 26 via the filter 36 and relief valve 34.

[0027] It is to be noted that, when the brake pedal 23a is depressed while traveling is performed by the drive of the front wheels 2 and rear wheels 3 of the travel base 1, the pressure oil in the accumulators 24 is fed to the unillustrated brake system via the brake valve 23 and a braking force is applied to the front wheels 2 and rear wheels 3 to stop the travel base 1.

[0028] While such operations as described above are being performed, dust mixed in pressure oil flowing through the oil passage 38 is trapped by the filter 28 arranged in the oil passage 38 connected to the hydraulic pump 20, thereby performing the purification of pressure oil flowing on an upstream side of the hydraulic circuit including the hydraulic pump 20, priority valve 21, steering valve 22, charge valve 25, accumulators 24, brake valve 23 and the like. Further, dust mixed in pressure oil flowing through the oil passage 35 is trapped by the filter 36 arranged in the oil passage 35 that communicates the on/off valve 33 in the charge valve 25 and the relief valve 34 to each other, thereby performing the purification of pressure oil flowing on a downstream side of the relevant hydraulic circuit. By the filter 28 and filter 36, the pressure oil flowing through these hydraulic circuits is, therefore, kept clean so that the individual hydraulic devices including the priority valve 21, steering valve 22, charge valve 25, brake valve 23 and the like are allowed to maintain good operation performance.

[0029] When clogging occurs in the filter 28 arranged in the oil passage 38 connecting the hydraulic pump 20 and the priority valve 21 to each other and pressure oil becomes difficult to pass through the filter 28, pressure oil is fed from the hydraulic pump 20 to the priority valve 21 via the check valve 29 arranged in parallel with the filter 28. Desired operations can, therefore, be continuously performed while avoiding a breakage of the entire hydraulic circuit, although the cleaning function for pressure oil flowing through the oil passage 38 is reduced. When clogging occurs in the filter 36 arranged in the oil passage 35 communicating the on/off valve 33 and the relief valve 34 to each other in the charge valve 25 and pressure oil becomes difficult to pass through the filter 36, on the other hand, the pressure oil in the section of the hydraulic passage 35, said section being located be-

tween the on/off valve 33 and the filter 36, is fed to the relief valve 34 via the check valve 37 arranged in parallel with the filter 36. When the pressure of this pressure oil arises to a high pressure exceeding the preset pressure for the relief valve 34, the relief valve 34 is, therefore, actuated so that the pressure oil of the high pressure exceeding the preset pressure is released to the reservoir 27. It is, therefore, possible to surely avoid a breakage of the entire hydraulic circuit, which includes the passage 35, on/off valve 33, hydraulic pump 20 and the like, by pressure oil of a high pressure occurring in the section of the oil passage 35, said section being located between the on/off valve 33 and the filter 36, although the cleaning function for pressure oil flowing through the oil passage 35 is reduced.

[0030] As mentioned above, when clogging occurs in the filter 36 arranged in the oil passage 35 communicating the on/off valve 33 and the relief valve 34 to each other and the pressure in a section of the oil passage 35, said section communicating the on/off valve 33 and the filter 36 to each other, becomes high, this embodiment can guide the pressure oil to the relief valve 34 via the relatively-inexpensive check valve, specifically the check valve 37 arranged in parallel with the filter 36 and generally considered to be lower in price than a relief valve or the like, and owing to an actuation of the relief valve 34, can release the pressure oil of the high pressure. As a consequence, it is possible to avoid a breakage of the entire hydraulic circuit while preventing an increase in the manufacturing cost of the hydraulic drive system including the oil passage 35 and on/off valve 33, and therefore, to realize the excellent protection of the hydraulic circuit at low cost, although the cleaning function for pressure oil by the filter 36 is reduced as mentioned above.

[0031] In the above-described embodiment, the filter 36 and check valve 37 are arranged in parallel with each other in the oil passage 35 that communicates the on/off valve 33 and the relief valve 34 to each other in the charge valve 25. As an alternative, a filter and check valve may be arranged in parallel with each other in the oil passage that communicates the directional control valve 21a and the relief valve 21b to each other in the priority valve 21. This alternative construction can realize the cleaning of pressure oil flowing through the oil passage that communicates the directional control valve 33 and the relief valve 21b to each other, and upon occurrence of clogging in the filter, can also guide pressure oil of a high pressure in an oil passage section, which communicates the directional control valve 33 and the filter to each other, to the relief valve 21b via the check valve so that the relief valve 21b is actuated to release it to the reservoir 27. It is, therefore, possible to avoid a breakage of the entire hydraulic circuit, which includes the directional control valve 21a, hydraulic pump 20 and the like, by arranging the inexpensive check valve.

[0032] The above-described embodiment is configured to be applied to the wheel excavator. In the present invention, the working machine is, however, not limited

to such a wheel excavator. This embodiment may be configured to be applied, for example, to a wheel loader.

Legend

[0033]

- 1 Travel base
- 4 Upperstructure
- 5 Working equipment
- 20 Hydraulic pump
- 21 Priority valve
- 22 Steering valve
- 23 Brake valve
- 24 Accumulator
- 25 Charge valve (valve)
- 26 Oil passage
- 27 Reservoir
- 33 On/off valve
- 34 Relief valve
- 35 Oil passage
- 36 Filter (another filter)
- 37 Check valve (another check valve)
- 38 Oil passage (another oil passage)

Claims

1. A hydraulic drive system for a working machine, said system being provided with a hydraulic pump, a valve device switchable according to pressure oil delivered from the hydraulic pump, a relief valve specifying a maximum of switching pressure for the valve device, and a filter arranged in an oil passage communicating the valve device and the relief valve to each other, wherein:
 - a check valve is arranged in the oil passage and in parallel with the filter such that a flow of oil from a side of the valve device toward a side of the relief valve is allowed but a flow of oil from the side of the relief valve toward the side of the valve device is prevented.
2. The hydraulic drive system according to claim 1, wherein:
 - a valve unit to which pressure oil delivered from the hydraulic pump is fed is provided, and in the valve unit, the valve device, relief valve, oil passage, filter and check valve are arranged.
3. The hydraulic drive system according to claim 2, wherein:
 - a brake valve and an accumulator, which can feed pressure oil to the brake valve, are arranged,

the valve unit comprises a charge valve capable of feeding pressure oil to the accumulator, and the valve device comprises an on/off valve which, when an accumulated pressure in the accumulator becomes higher than a predetermined pressure, can release pressure oil of the higher pressure.

4. The hydraulic drive system according to claim 3, wherein:

the working machine is a wheel excavator, a priority valve and a steering valve, to which pressure oil delivered from the hydraulic pump is fed, are arranged, another oil passage for guiding pressure oil to the charge valve via the priority valve is arranged, and another filter is arranged in a further oil passage communicating the hydraulic pump and the priority valve to each other, and a check valve is arranged in the further oil passage and in parallel with the another filter such that a flow of oil from a side of the hydraulic pump toward a side of the priority valve is allowed but a flow of oil from the side of the priority valve toward the side of the hydraulic pump is prevented.

FIG. 1

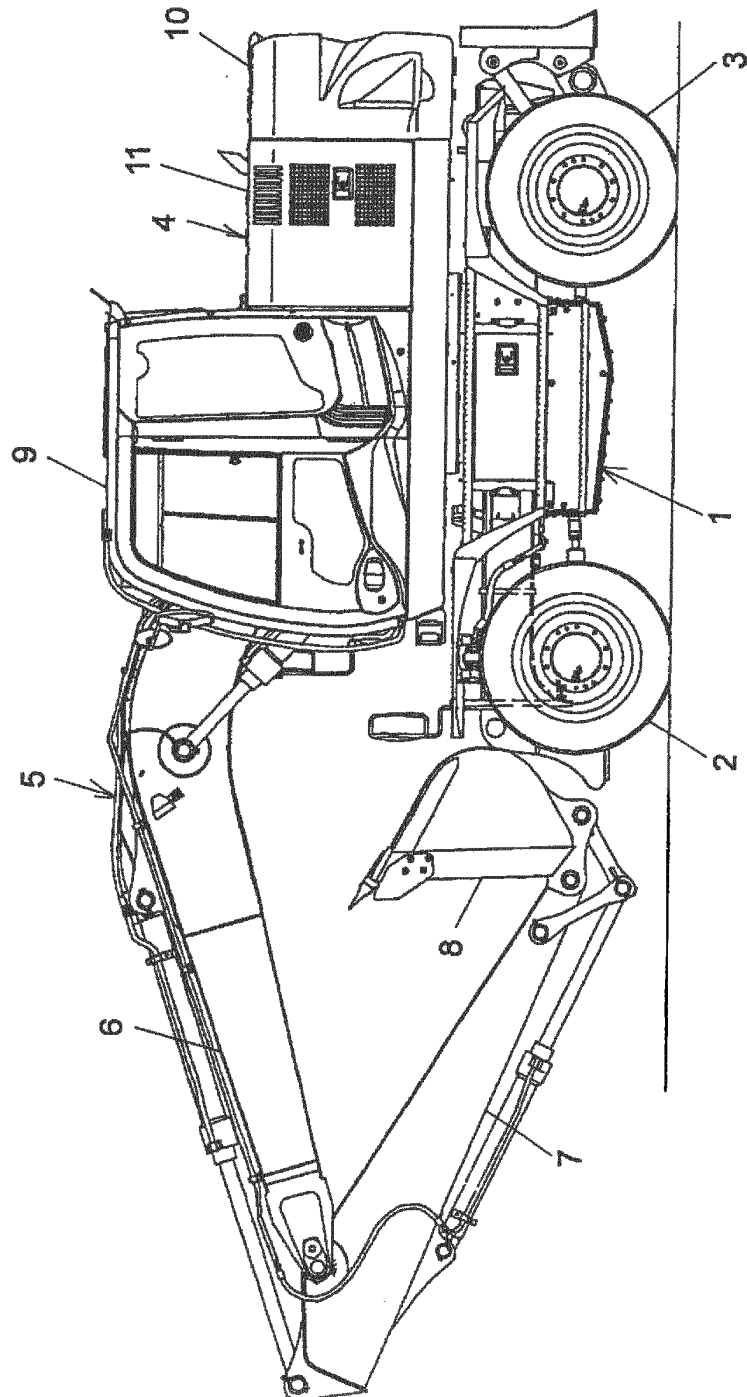
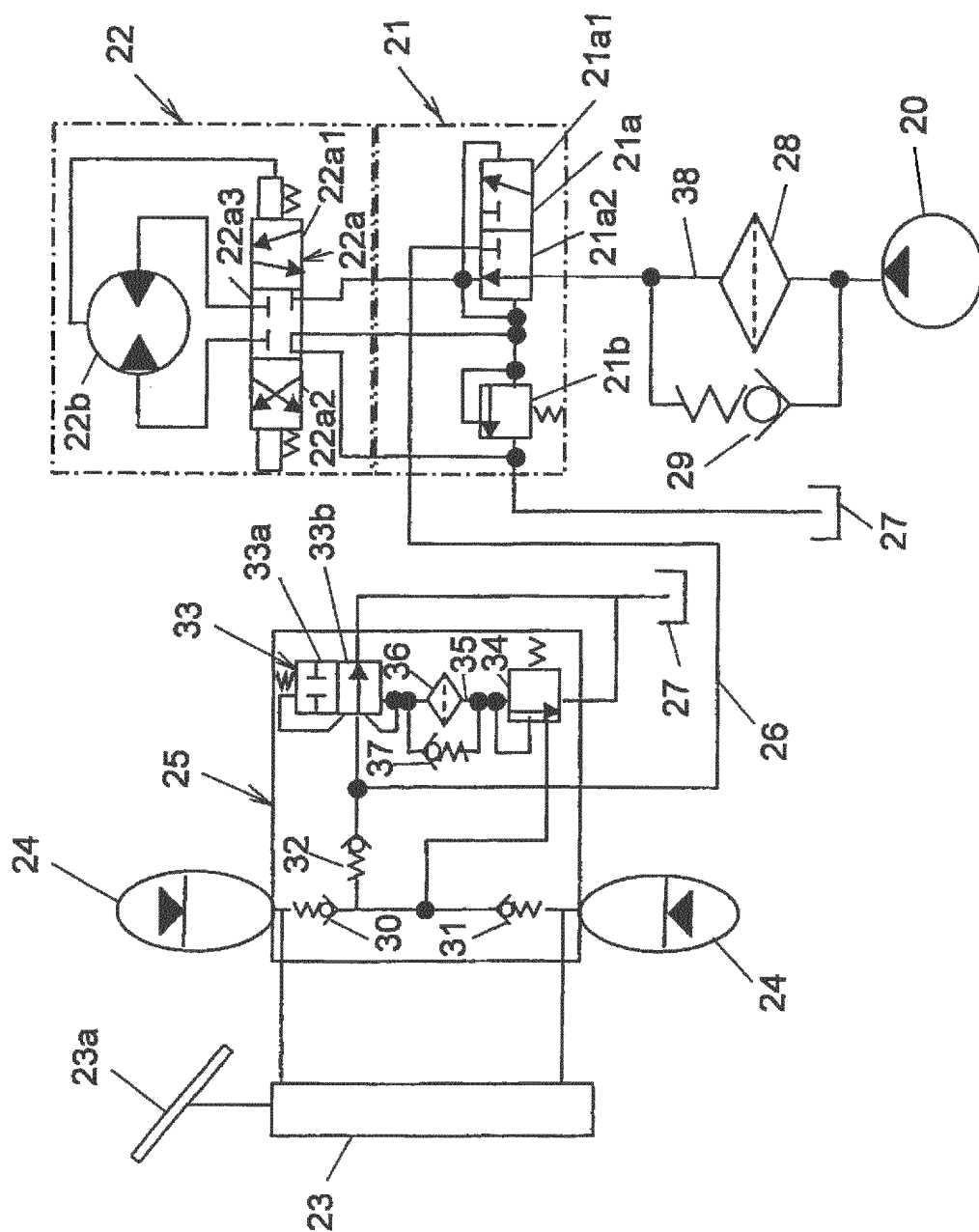


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/075078

A. CLASSIFICATION OF SUBJECT MATTER

F15B21/04 (2006.01) i, E02F9/22 (2006.01) i, F15B11/028 (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)

F15B21/04, E02F9/22, F15B11/028

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011

Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2006-036021 A (Hitachi Construction Machinery Co., Ltd.), 09 February 2006 (09.02.2006), paragraph [0021]; fig. 1 (Family: none)	1, 2 3, 4
Y	JP 2008-267395 A (Hitachi Construction Machinery Co., Ltd.), 06 November 2008 (06.11.2008), paragraph [0008]; fig. 1 (Family: none)	1, 2

☒ 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
16 November, 2011 (16.11.11)Date of mailing of the international search report
29 November, 2011 (29.11.11)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/075078

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 068629/1993 (Laid-open No. 037308/1995) (Niigata Engineering Co., Ltd.), 11 July 1995 (11.07.1995), paragraph [0021]; fig. 1 (Family: none)	1, 2
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 082703/1990 (Laid-open No. 039912/1992) (Honda Motor Co., Ltd.), 06 April 1992 (06.04.1992), page 10, line 19 to page 11, line 10; fig. 1 (Family: none)	1, 2
A	JP 2006-290236 A (Hitachi Construction Machinery Co., Ltd.), 26 October 2006 (26.10.2006), fig. 1 (Family: none)	1-4
P, A	JP 2011-080540 A (Hitachi Construction Machinery Co., Ltd.), 21 April 2011 (21.04.2011), fig. 2 (Family: none)	1-4

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 6035607 A [0005]