(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 610 409 A1**

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

(43) Date of publication:
03.07.2013 Bulletin 2013/27

(21) Application number: **10856458.4**

(22) Date of filing: **24.08.2010**

(51) Int Cl.:
E02F 9/22 *(2006.01)* ***F15C 3/02*** *(2006.01)*
F15B 21/02 *(2006.01)*

(86) International application number:
PCT/KR2010/005606

(87) International publication number:
WO 2012/026633 (01.03.2012 Gazette 2012/09)

(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 SE SI SK SM TR

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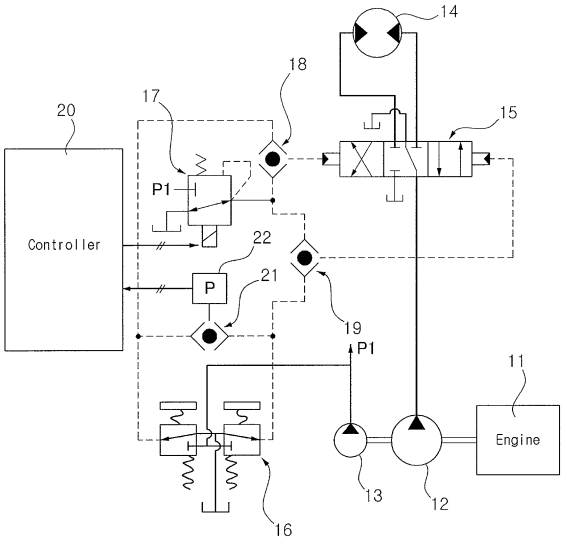
(54) DEVICE FOR CONTROLLING CONSTRUCTION EQUIPMENT

(57) Provided is a device for controlling construction equipment for controlling the spool of an MCV, which is directionally controllable, to control working fluid which is supplied to a hydraulic actuator. According to the present invention, provided is a device for controlling construction equipment, comprising: a remote control valve for outputting a secondary signal pressure which is proportionate to the amount calibrated by an operator; a calibrated amount detection means for detecting the secondary signal pressure of the remote control valve; an electro proportional pressure reducing valve for outputting the secondary signal pressure; first and second shuttle valves, each of the shuttle valves having an input portion on one side which connects to the secondary signal pressure of the remote control valve, and an input portion on the other side to which output-side ports of the electro proportional pressure reducing valve connect respectively; a directional control spool for controlling the actuation of the hydraulic actuator when exchanging by means of the signal pressure output from the first and second shuttle valves; and a controller for outputting a control signal to the electro proportional pressure reducing valve so as to correspond to the operation amount which is input by the operation amount detection means.

[Fig. 3]



EP 2 610 409 A1

Description

[Field of the Invention]

[0001] The present invention relates to a control apparatus for a construction machine. More particularly, the present invention relates to a control apparatus for a construction machine, which can control a spool of a main control valve (MCV) including a hydraulic remote control valve and a directional control spool so as to control a hydraulic fluid supplied to a hydraulic actuator.

[Background of the Invention]

[0002] In general, a technology is needed which controls a spool of the MCV, in which a controller can receive an operator's manipulation signal and achieve a preferred operation of a hydraulic actuator so as to improve manipulability of a work apparatus (including a boom, etc.) of a construction machine such as an excavator, preferentially control the work apparatus during the combined manipulation operation in which the work apparatus and the traveling apparatus are manipulated simultaneously, or improve fuel efficiency.

[0003] As shown in FIG. 1, a hydraulic MCV control circuit according to the prior art includes:

an engine 1;
a main hydraulic pump 2 (hereinafter, referred to as " hydraulic pump") connected to the engine 1 and a pilot pump 3;
a hydraulic actuator 4 (e.g. "hydraulic motor") connected to the hydraulic pump 2;
a spool 5 of a main control valve (MCV) installed in a flow path provided between the hydraulic pump 2 and the hydraulic actuator 4, and configured to be shifted to control a start, a stop, and a direction change of the hydraulic actuator 4; and
a remote control valve (RCV) 6 configured to output a secondary signal pressure for application to the spool 5 in proportion to an operator's manipulation amount.

[0004] When the operator manipulates the remote control valve 6 to operate the hydraulic actuator 4, a hydraulic fluid is discharged from the pilot pump 3 in proportional to the operator's manipulation amount and a secondary signal pressure passing through the remote control valve 6 is supplied to the spool 5. As a result, the spool 5 is displaced in proportional to the secondary signal pressure to cause the hydraulic fluid from the hydraulic pump 2 to pass through the spool 5 and to be supplied to the hydraulic actuator 4.

[0005] In this case, the control of the spool 4 depends on the manipulation amount of the remote control valve 6. Thus, there is a need for an apparatus that can restrict the abrupt opening of the spool 5 to smoothly accelerate the hydraulic actuator 4 even when the operator abruptly manipulates the remote control valve 6. That is, in the case where an orifice is installed in a pilot signal line provided between an output side of the remote control valve 6 and the spool 5, there occurs a disadvantage in that the function of the orifice may be performed limitedly by the temperature of the hydraulic fluid, and the like.

[0006] As shown in FIG. 2, an electro-hydraulic MCV control circuit according to the prior art includes:

an engine 1;
a main hydraulic pump 2 connected to the engine 1 and a pilot pump 3;
a hydraulic actuator 4 connected to the hydraulic pump 2;
a spool 5 of a main control valve (MCV) installed in a flow path provided between the hydraulic pump 2 and the hydraulic actuator 4, and configured to be shifted to control a start, a stop, and a direction change of the hydraulic actuator 4; an
electro proportional pressure reducing valves 7 and 8 configured to output a secondary signal pressure that is in proportion to an electric control signal from the outside;
a manipulation lever 9 configured to output a manipulation signal in proportional to an operator's manipulation amount; and
a controller 10 configured to calculate an electric control signal that corresponds to the manipulation amount outputted from the manipulation lever 9, and output the electrical control signal for application to the electro proportional pressure reducing valves 7 and 8.

[0007] When the operator manipulates the manipulation lever 9 to operate the hydraulic actuator 4, a manipulation signal that is proportional to the operator's manipulation amount is inputted to the controller 10. Then, the controller 10 calculates an output value that corresponds to the manipulation amount and outputs a control signal for application to the electro proportional pressure reducing valves 7 and 8 to control the spool 5. That is, the controller 10 can control

the spool 5 through the electro proportional pressure reducing valves 7 and 8 based on the manipulation amount of the manipulation lever 9 to control a hydraulic fluid supplied to the hydraulic actuator 4 in the optimum condition so that the operator's manipulation of the manipulation lever 9 can be calibrated.

[0008] In this case, a high-priced electronic joystick is used as the manipulation lever 9, which contributes to an increase in the manufacturing cost of the parts. In addition, there occurs a problem in that a pair of electro proportional pressure reducing valves 7 and 8 is used to control the directional control spool 5 of the MCV, and thus the number of parts is increased, leading to an increase in the manufacturing cost of the parts.

[Detailed Description of the Invention]

[Technical Problems]

[0009] Accordingly, the present invention was made to solve the aforementioned problem occurring in the prior art, and it is an object of the present invention to provide a control apparatus for a construction machine that is configured to be capable of controlling a directionally operable spool of the MCV to allow a hydraulic fluid to smoothly accelerate the hydraulic actuator even when an operator abruptly manipulates a remote control valve (RCV), and blocking an erroneous operation of the MCV upon the occurrence of an unexpected failure of a valve-driving electric circuit.

[Technical Solution]

[0010] To accomplish the above object, in accordance with a first embodiment of the present invention, there is provided a

A control apparatus for a construction machine including an engine, a hydraulic pump connected to the engine, and a hydraulic actuator configured to receive a supply of hydraulic fluid from the hydraulic pump and configured to be capable of being directionally operated to drive a work apparatus, the control apparatus including:

a remote control valve configured to output a secondary signal pressure in proportion to an operator's manipulation amount;
a manipulation amount detection means configured to detect the secondary signal pressure outputted from the output sides of the remote control valve;
an electro proportional pressure reducing valve configured to output a secondary signal pressure in proportion to an electric control signal from the outside;
first and second shuttle valves each having one input portion connected to a secondary signal pressure of the remote control valve and the other input portion connected to an output port of the electro proportional pressure reducing valve, the first and second shuttle valves being configured to output the higher signal pressure of signal pressures passing through the remote control valve and the electro proportional pressure reducing valve;
a directional control spool installed in a flow path provided between the hydraulic pump and the hydraulic actuator and configured to be shifted in response to the signal pressure output from the first and second shuttle valves to control a start, a stop, and a direction change of the hydraulic actuator; and
a controller configured to calculate a control signal that corresponds to the manipulation amount inputted thereto from the manipulation amount detection means, and output the control signal for application to the electro proportional pressure reducing valve.

[0011] In accordance with a more preferred embodiment, the manipulation amount detection means may include:

a third shuttle valve having an input portion connected to a secondary signal pressure of the remote control valve, and configured to output the higher signal pressure of the directional signal pressures passing through the remote control valve; and
a pressure sensor connected to the output side of the third shuttle valve to apply a detection signal to the controller.

[0012] In addition, the manipulation amount detection means may include:

a fourth shuttle valve having an input portion connected to a secondary signal pressure of the remote control valve and an output portion connected to an input port of the electro proportional pressure reducing valve, the fourth shuttle valve being configured to output the higher signal pressure of the directional signal pressures passing through the remote control valve; and
a pressure sensor connected to the output side of the fourth shuttle valve to apply a detection signal to the controller.

[Advantageous Effect]

[0013] The control apparatus for a construction machine according to embodiments of the present invention as constructed above has the following advantages.

[0014] A directionally operable spool of the MCV can be controlled while reducing the manufacturing cost of parts, and an erroneous operation of the MCV can be blocked upon the occurrence of an unexpected failure of a valve-driving electric circuit, thereby providing reliability.

[Brief Description of the Invention]

[0015] The above objects, other features and advantages of the present invention will become more apparent by describing the preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is a hydraulic MCV control circuit diagram in accordance with the prior art;
Fig. 2 is an electro-hydraulic MCV control circuit diagram according to the prior art;
Fig. 3 is an electro-hydraulic MCV control circuit diagram of a control apparatus for a construction machine according to a first embodiment of the present invention;
Fig. 4 is a graph illustrating the control of an electro proportional pressure reducing valve by a controller in a control apparatus for a construction machine according to a first embodiment of the present invention; and
Fig. 5 is an electro-hydraulic MCV control circuit diagram of a control apparatus for a construction machine according to a second embodiment of the present invention.

* Explanation on reference numerals of main elements in the drawings *

11:	engine
12:	hydraulic pump
13:	pilot pump
14:	hydraulic actuator
15:	spool
16:	remote control valve (RCV)
17:	electro proportional pressure reducing valve (PPRV)
18:	first shuttle valve
19:	second shuttle valve
20:	controller
21:	third shuttle valve
22:	pressure sensor
23:	fourth shuttle valve

[Preferred Embodiments of the Invention]

[0016] Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. The matters defined in the description, such as the detailed construction and elements, are nothing but specific details provided to assist those of ordinary skill in the art in a comprehensive understanding of the invention, and thus the present invention is not limited to the embodiments disclosed hereinafter.

[0017] As shown in Figs. 3 and 4, a control apparatus for a construction machine according to a first embodiment of the present invention includes an engine 11, a hydraulic pump 12 connected to the engine 11 and a pilot pump 13, and a hydraulic actuator (e.g. hydraulic motor) 14 configured to receive a supply of hydraulic fluid from the hydraulic pump 12 and configured to be capable of being directionally operated to drive a work apparatus (e.g. boom).

[0018] The control apparatus includes:

a remote control valve (RCV) 16 configured to output a secondary signal pressure in proportion to an operator's manipulation amount;
a manipulation amount detection means configured to detect the secondary signal pressure outputted from the output sides of the remote control valve 16;
an electro proportional pressure reducing valve 17 configured to output a secondary signal pressure in proportion to an electric control signal from the outside;

first and second shuttle valves 18 and 19 each having one input portion connected to a secondary signal pressure of the remote control valve 16 and the other input portion connected to an output port of the electro proportional pressure reducing valve 17, the first and second shuttle valves being configured to output the higher signal pressure of signal pressures passing through the remote control valve 16 and the electro proportional pressure reducing valve 17;

a directional control spool 15 installed in a flow path provided between the hydraulic pump 12 and the hydraulic actuator 14 and configured to be shifted in response to the signal pressure output from the first and second shuttle valves 18 and 19 to control a start, a stop, and a direction change of the hydraulic actuator 14; and

a controller 20 configured to calculate a control signal that corresponds to the manipulation amount inputted thereto from the manipulation amount detection means, and configured to output the control signal for application to the electro proportional pressure reducing valve 17.

[0019] Herein, the manipulation amount detection means may include a third shuttle valve 21 having an input portion connected to the output side of the remote control valve 16, and configured to output the higher signal pressure of the directional signal pressures passing through the remote control valve 16, and a pressure sensor 22 connected to a secondary signal pressure of the third shuttle valve 21 to apply a detection signal to the controller 20.

[0020] Hereinafter, the operation of the control apparatus for a construction machine according to a first embodiment of the present invention will be described.

[0021] As shown in Figs. 3 and 4, when an operator manipulates a left-side remote control valve 16 to operate the hydraulic actuator 14, a part of the hydraulic fluid from the pilot pump 13 is supplied to the first shuttle valve 18 via the left remote control valve, and a part of the hydraulic fluid from the pilot pump 3 is supplied to an inlet port of the electro proportional pressure reducing valve 17

[0022] Meanwhile, a secondary signal pressure having passed through the corresponding remote control valve is detected by the pressure sensor 22 installed in the output side of the third shuttle valve 21 and the detected signal pressure P is applied to the controller 20.

[0023] Even in the case where the operator manipulates the remote control valve 16 like a line "A" shown in a graph of Fig. 4 (i.e., in the case where the remote control valve 16 is abruptly manipulated to cause the hydraulic actuator 14 to be suddenly accelerated), when a work apparatus acceleration control characteristic like a line "B" is required in an actual construction machine (i.e., when the acceleration ratio of the hydraulic actuator 14 is equal to or smaller than a predetermined value), a secondary pressure of a line "C" is outputted to the electro proportional pressure reducing valve 17 so that the control characteristic of the line "B" can act as a drive force for the directional control spool 15.

[0024] In this case, the left and right ports of the spool 15 are connected to the output sides of the first and second shuttle valves 18 and 19, and the input portions of the first and second shuttle valves 18 and 19 are connected to the output side of the electro proportional pressure reducing valve 17 and the output sides of the remote control valve 16. As a result, in the case where a secondary signal pressure generated according to manipulation of the remote control valve 16 is supplied to the left port of the spool 15 via the first shuttle valve 18 (i.e., the case where the secondary signal pressure has a gradient value like the line "A"), a secondary signal pressure of the electro proportional pressure reducing valve 17 is supplied to the right port of the spool via the second shuttle valve 19 (i.e., the case where the secondary signal pressure has a gradient value like the line "C") in response to a control signal outputted to the electro proportional pressure reducing valve 17 from the controller 20.

[0025] In this case, the value of the secondary signal pressure supplied to one port of the spool 15 via the first shuttle valve 18 according to manipulation of the remote control valve 16 is relatively larger than that of the secondary signal pressure generated from the electro proportional pressure reducing valve 17 and supplied to the other port of the spool via the second shuttle valve 19.

[0026] Thus, the second signal pressure of the line "C" fluidically communicates with the spool 15 only in a direction where the remote control valve 16 is not manipulated and is connected to a corresponding port of the spool 15.

[0027] As such, when the operator manipulates the remote control valve 16, the signal pressure supplied to the spool 15 acts in an opposite direction to that of the secondary signal pressure generated from the output side of the remote control valve 16 according to the manipulation of the remote control valve 16, and thus the aperture ratio of the spool 15 can be limited to be equal to or smaller than a predetermined level.

[0028] As described above, according to the control apparatus for a construction machine of the first embodiment of the present invention, one manipulation amount detection means and one electro proportional pressure reducing valve are used to control the directionally operable spool, thereby reducing the manufacturing cost.

[0029] In the control apparatus for a construction machine according to a second embodiment of the present invention as shown in Fig. 5, the manipulation amount detection means for detecting the manipulation amount of the remote control valve 16 includes a fourth shuttle valve 23 having an input portion connected to a secondary signal pressure of the remote control valve 16 and an output portion connected to an input port of the electro proportional pressure reducing valve 17, the fourth shuttle valve being configured to output the higher signal pressure of the directional signal pressures

passing through the remote control valve 16 and a pressure sensor 22 connected to the output side of the fourth shuttle valve 23 to apply a detection signal to the controller 20.

[0030] In the second embodiment, the constitution of the control apparatus including the hydraulic pump 12, the hydraulic actuator 14, the spool 15, the remote control valve 16, the electro proportional pressure reducing valve 17, and the controller 20 is substantially the same as that of the control apparatus in the first embodiment of the present invention, and thus the detailed description of the constitution and operation thereof will be omitted to avoid redundancy and same reference numerals are used to designate the similar or same parts.

[0031] In the case where the operator manipulates the remote control valve 16, a hydraulic fluid discharged from the pilot pump 13 passes through the remote control valve 16 and is converted into a secondary signal pressure. Thus, a signal pressure P1 having passing through the output portion of the fourth shuttle valve 23 is supplied to the input port of the electro proportional pressure reducing valve 17. For this reason, reliability for failure of the valve-driving electric circuit is relatively increased.

[0032] As described above, according to the control apparatus for a construction machine of the first and second embodiments of the present invention, even in the case where an undesired output is generated from a valve due to the occurrence of an unexpected failure in a valve control circuit including the valve and an electric circuit, the same signal pressure is applied across the spool of the MCV to cause the spool to be maintained in a neutral position. Thus, the erroneous operation of the work apparatus is blocked, thereby securing safety.

[Industrial Applicability]

[0033] According to the present invention as constructed above, it is possible to control the directionally operable spool of the MCV to smoothly accelerate the hydraulic actuator even when the operator abruptly manipulates the remote control valve. In addition, an erroneous operation of the MCV can be blocked upon the occurrence of an unexpected failure of a valve-driving electric circuit.

Claims

1. A control apparatus for a construction machine including an engine, a hydraulic pump connected to the engine, and a hydraulic actuator configured to receive a supply of hydraulic fluid from the hydraulic pump and configured to be capable of being directionally operated to drive a work apparatus, the control apparatus comprising:

   a remote control valve configured to output a secondary signal pressure in proportion to an operator's manipulation amount;
   a manipulation amount detection means configured to detect the secondary signal pressure outputted from the output sides of the remote control valve;
   an electro proportional pressure reducing valve configured to output a secondary signal pressure in proportion to an electric control signal from the outside;
   first and second shuttle valves each having one input portion connected to a secondary signal pressure of the remote control valve and the other input portion connected to an output port of the electro proportional pressure reducing valve, the first and second shuttle valves being configured to output the higher signal pressure of signal pressures passing through the remote control valve and the electro proportional pressure reducing valve;
   a directional control spool installed in a flow path provided between the hydraulic pump and the hydraulic actuator and configured to be shifted in response to the signal pressure output from the first and second shuttle valves to control a start, a stop, and a direction change of the hydraulic actuator; and
   a controller configured to calculate a control signal that corresponds to the manipulation amount inputted thereto from the manipulation amount detection means, and configured to output the control signal for application to the electro proportional pressure reducing valve.

2. The control apparatus for a construction machine according to claim 1, wherein the manipulation amount detection means comprises:

   a third shuttle valve having an input portion connected to a secondary signal pressure of the remote control valve, and configured to output the higher signal pressure of the directional signal pressures passing through the remote control valve; and
   a pressure sensor connected to the output side of the third shuttle valve to apply a detection signal to the controller.

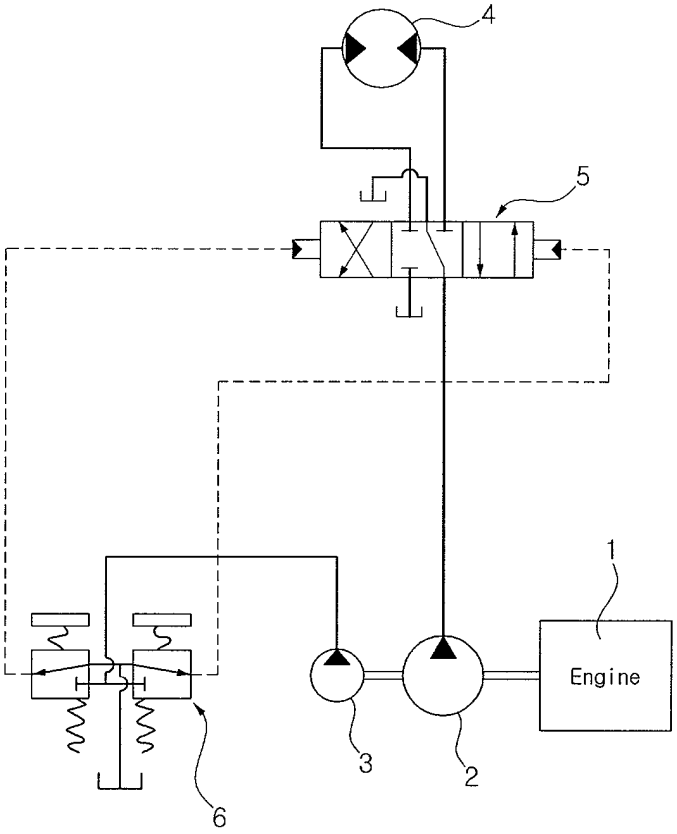
3. The control apparatus for a construction machine according to claim 1, wherein the manipulation amount detection

means comprises:

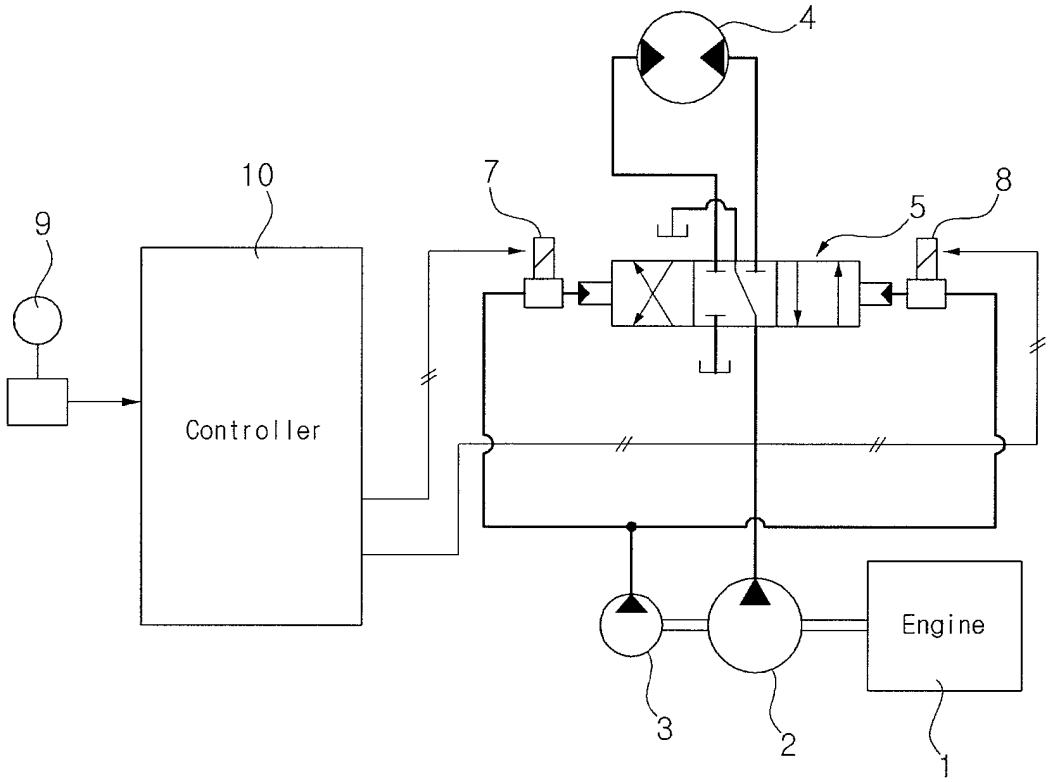
a fourth shuttle valve having an input portion connected to a secondary signal pressure of the remote control valve and an output portion connected to an input port of the electro proportional pressure reducing valve, the fourth shuttle valve being configured to output the higher signal pressure of the directional signal pressures passing through the remote control valve; and

a pressure sensor connected to the output side of the fourth shuttle valve to apply a detection signal to the controller.

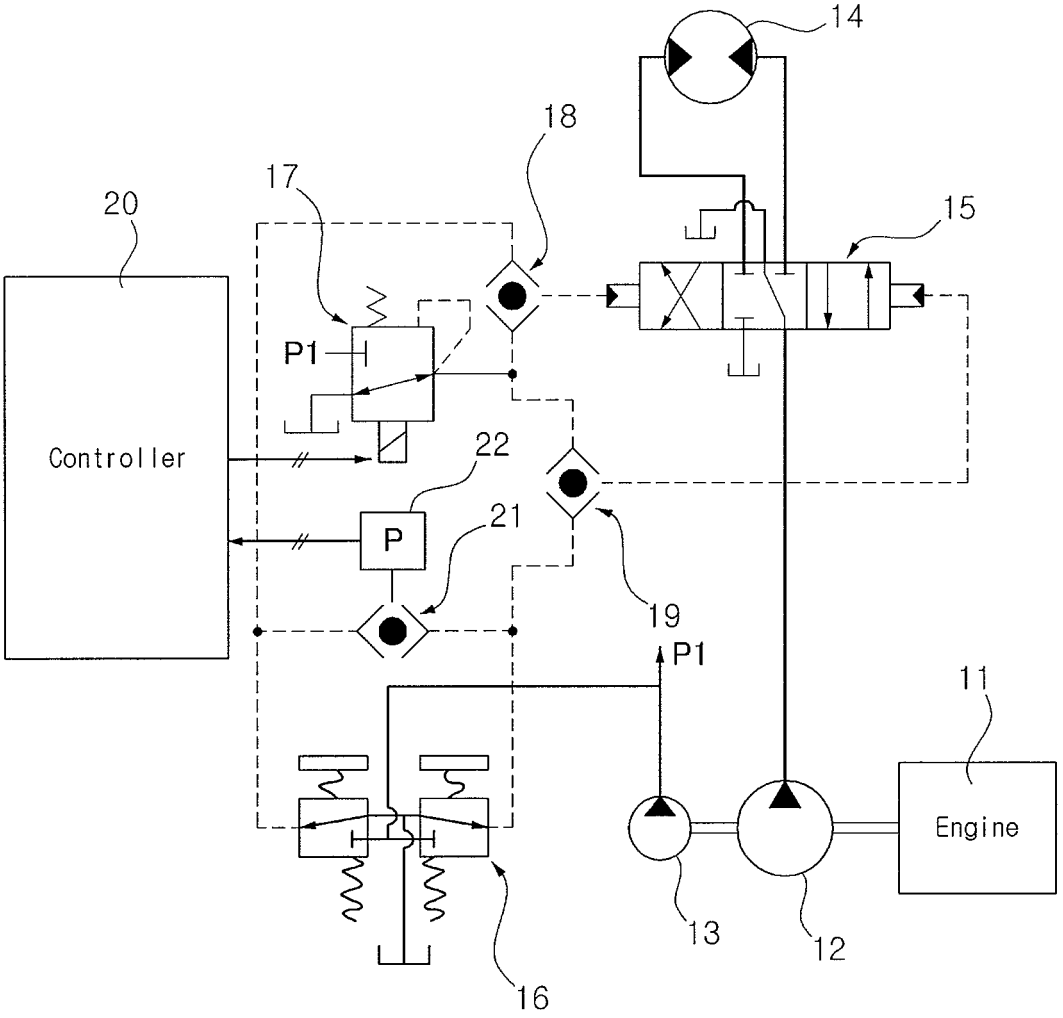
[Fig. 1]



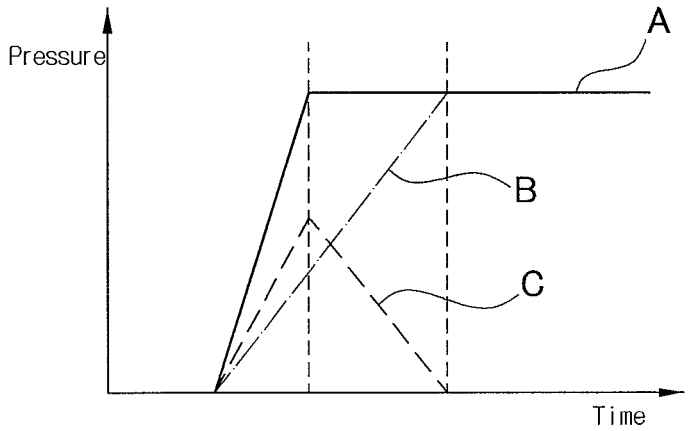
[Fig. 2]



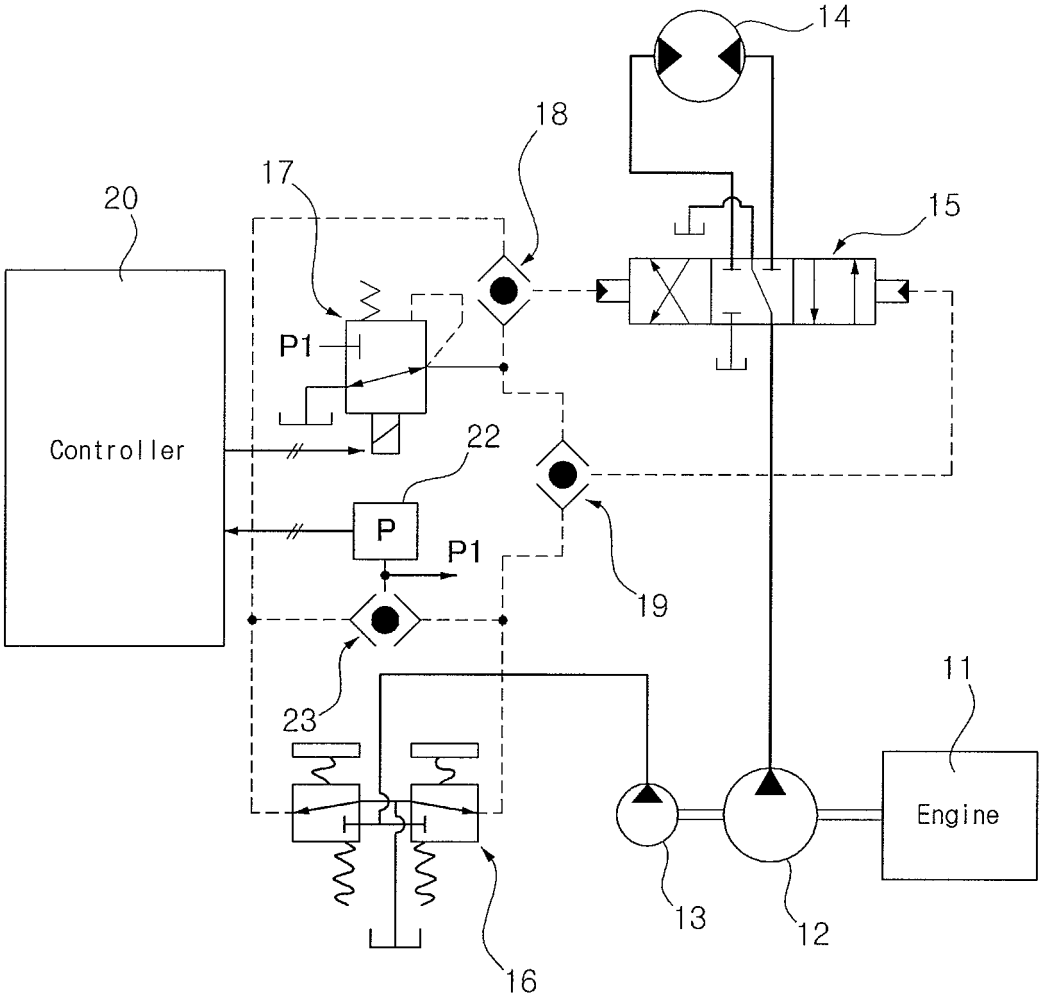
[Fig. 3]


14
18
17
20
15
P1
Controller
22
P
21
19
P1
11
Engine
13
12
16

[Fig. 4]


Pressure
A
B
C
Time

[Fig. 5]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2010/005606

A. CLASSIFICATION OF SUBJECT MATTER

E02F 9/22(2006.01)i, F15C 3/02(2006.01)i, F15B 21/02(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)

E02F 9/22; E02F 9/20; E02F 3/36

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: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

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

eKOMPASS (KIPO internal) & Keywords: remote control valve, manipulated variable detection unit, shuttle valve, electronic proportional pressure control valve, control spool, controller.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-0240090 B1 (VOLVO CONSTRUCTION EQUIPMENT KOREA CO., LTD.) 15 January 2000 Claims 1-4 and figures 1-2, 4	1-3
A	KR 10-0752115 B1 (DOOSAN INFRACORE CO., LTD.) 24 August 2007 Claims 1-5 and figures 1, 3, 5	1-3
A	JP 2000-213004 A (KOMATSU LTD) 02 August 2000 Claims 1-3 and figures 1-2, 6-7	1-3
A	KR 10-0240084 B1 (SAMSUNG HEAVY IND. CO.,LTD) 15 January 2000 Claims 1-3 and figures 1-2	1-3

☐ 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
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"P" document published prior to the international filing date but later than the priority date claimed
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"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
20 MAY 2011 (20.05.2011)	**23 MAY 2011 (23.05.2011)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2010/005606

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-0240090 B1	15.01.2000	NONE	
KR 10-0752115 B1	24.08.2007	CN 1824895 A	30.08.2006
		CN 1824895 B	08.09.2010
		CN 1824895 C0	30.08.2006
		EP 1676963 A2	05.07.2006
		EP 1676963 A3	31.12.2008
		US 2006-0147315 A1	06.07.2006
		US 7430859 B2	07.10.2008
JP 2000-213004 A	02.08.2000	JP 04-026969 B2	26.12.2007
		KR 10-0588285 B1	09.06.2006
		KR 10-0588285 B1	09.06.2006
		KR20000052452A	25.08.2000
		KR20000052452A	25.08.2000
KR 10-0240084 B1	15.01.2000	NONE	

Form PCT/ISA/210 (patent family annex) (July 2009)