



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

(43) Date of publication:
09.10.2013 Bulletin 2013/41

(51) Int Cl.:
F04B 9/115 (2006.01)

(21) Application number: **11871867.5**

(86) International application number:
PCT/CN2011/079520

(22) Date of filing: **09.09.2011**

(87) International publication number:
WO 2013/033915 (14.03.2013 Gazette 2013/11)

(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

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(54) **METHOD, APPARATUS, AND SYSTEM FOR CONTROLLING PUMPING DIRECTION-SWITCHING FOR USE IN PUMPING APPARATUS**

(57) A method, apparatus, and system for controlling pumping direction switching for use in a pumping apparatus. The system comprises at least two first proximity switches (110) used for detecting whether a first oil cylinder piston (61) has reached a predetermined position; at least one second proximity switch (120) used for detecting whether a second oil cylinder piston (62) has reached a predetermined position; and a controller connected to the at least two first proximity switches (110) and to the at least one second proximity switch (120), used for selecting a proximity switch combination, and,

when the selected proximity switch combination detects that the first oil cylinder piston (61) or the second oil cylinder piston (62) has reached the predetermined position, for controlling a direction-switching valve of the pumping apparatus to switch directions. The proximity switch combination comprises one of the at least two first proximity switches (110) and one of the at least one second proximity switch (120). When a proximity switch is damaged, another proximity switch is used to replace the damaged proximity switch, thereby ensuring that the control over direction-switching is maintained

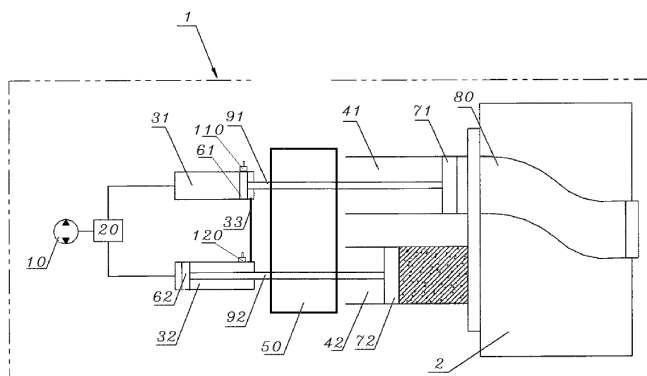


Figure 1

Description**Field of the Invention**

5 **[0001]** The present invention relates to concrete pumping domain, in particular to a method, an apparatus and a system for controlling pumping direction switching for use in a pumping apparatus.

Background of the Invention

10 **[0002]** Concrete pumping apparatuses are widely applied in building industry. Figure 1 is a schematic structural diagram of a concrete pumping apparatus. As shown in Figure 1, a concrete pumping apparatus comprises a concrete pumping unit 1 and a transfer pipeline (not shown) for transferring the concrete to a place of concrete placement.

15 **[0003]** The concrete pumping unit comprises: a hydraulic pump 10, a direction-switching valve 20, a first hydraulic oil cylinder 31, a second hydraulic oil cylinder 32, a first concrete cylinder 41, a second concrete cylinder 42, a water tank 50, a first oil cylinder piston 61 in the first hydraulic oil cylinder 31, a second oil cylinder piston 62 in the second hydraulic oil cylinder 32, a first concrete cylinder piston 71 in the first concrete cylinder 41, a second concrete cylinder piston 72 in the second concrete cylinder 42, a hopper 2, and a S-cylinder 80 in the hopper 2, wherein the first oil cylinder piston 51 and first concrete cylinder piston 71 are connected by a first piston rod 91 passing through the water tank 50, the second oil cylinder piston 62 and second concrete cylinder piston 72 are connected by a second piston rod 92 passing through the water tank 50.

20 **[0004]** The working process of the concrete pumping unit is as follows: the hydraulic pump 10 drives the first oil cylinder piston 61 to move forward, and thereby drives the first concrete cylinder piston 71 to move forward, so as to transfer away the concrete sucked into the first concrete cylinder 41 previously through the S-cylinder 80 and the transfer pipeline; at the same time, the movement of the first oil cylinder piston 61 causes the second oil cylinder piston 62 to move in the reverse direction (because a communicating cavity exists between the first hydraulic oil cylinder 31 and the second hydraulic oil cylinder 32; for example, the two hydraulic oil cylinders communicate with each other through a conduit 33), and thereby drives the second concrete cylinder piston 72 to move backward, so as to suck the concrete in the hopper into the second concrete cylinder 42. One end of the S-cylinder 80 is connected to the transfer pipeline, and the other end of the S-cylinder 80 can swing between the outlet of the first concrete cylinder 41 and the outlet of the second concrete cylinder 42. Before a concrete cylinder pumps the concrete, the other end of the S-cylinder 80 is connected to the outlet of that concrete cylinder, so that the concrete in that concrete cylinder is transferred away through the S-cylinder 80 and the transfer pipeline.

25 **[0005]** The pumping direction switching control system for such an existing concrete pumping apparatus usually comprises a controller and two proximity switches, wherein one proximity switch 110 is arranged on the first hydraulic oil cylinder 31 near the water tank side, and is configured to detect whether the first oil cylinder piston 61 reaches to a preset position; the other proximity switch 120 is arranged on the second hydraulic oil cylinder 32 near the water tank side, and is configured to detect whether the second oil cylinder piston 62 reaches to the preset position; the controller controls the direction-switching valve 20 to switch directions according to the output signals from the two proximity switches, so as to accomplish the pumping action of the pumping apparatus; for example, suppose the pumping apparatus pumps out the concrete sucked into the second concrete cylinder 42 previously while sucking the concrete into the first concrete cylinder 41, it will switch to use the second concrete cylinder 42 to suck concrete and at the same time pump out the concrete sucked into the first concrete cylinder 41 previously once it detects the signals from the proximity switches.

30 **[0006]** However, the signal sensing faces of the two proximity switches in the existing pumping direction switching control system are in the hydraulic oil cylinders; therefore, expensive highpressure proximity switches have to be used, and the high pressure in the hydraulic oil cylinders may cause damage to the proximity switches. Once either proximity switch is damaged, the pumping apparatus can't work any more because the pumping direction switching function is lost.

Summary of the Invention

35 **[0007]** The object of the present invention is to provide a method, an apparatus and a system for controlling pumping direction switching for use in a pumping apparatus, which have high robustness and can still accomplish pumping direction switching control in case either proximity switch fails.

40 **[0008]** To attain the purpose described above, the present invention provides a pumping direction pumping direction switching control system for a pumping apparatus, the pumping apparatus comprises a first hydraulic oil cylinder, a second hydraulic oil cylinder, a first concrete cylinder, a second concrete cylinder, a water tank, a first oil cylinder piston in the first hydraulic oil cylinder, a second oil cylinder piston in the second hydraulic oil cylinder, a first concrete cylinder piston in the first concrete cylinder, and a second concrete cylinder piston in the second concrete cylinder, wherein, the first oil cylinder piston and the first concrete cylinder piston are connected to each other by a first piston rod passing

through the water tank, the second oil cylinder piston and the second concrete cylinder piston are connected to each other by a second piston rod passing through the water tank, the system comprises: at least two first proximity switches configured to detect whether the first oil cylinder piston reaches to a preset position; at least one second proximity switch configured to detect whether the second oil cylinder piston reaches to a preset position; and, a controller, which is connected to the at least two first proximity switches and the at least one second proximity switch, and is configured to select a combination of proximity switches and control a direction-switching valve in the pumping apparatus to switch on the condition that the selected combination of proximity switches detects the first oil cylinder piston or the second oil cylinder piston reaches to the preset position; the combination of proximity switches comprises one of the at least two first proximity switches and one of the at least one second proximity switch.

[0009] Accordingly, the present invention further provides a pumping direction switching control method for the pumping apparatus, comprising: selecting a combination of proximity switches that comprises one of the at least two first proximity switches and one of the at least one second proximity switch, wherein the first proximity switches are configured to detect whether the first oil cylinder piston reaches to a preset position, and the second proximity switch is configured to detect whether the second oil cylinder piston reaches to a preset position; and, controlling a direction-switching valve in the pumping apparatus to switch on the condition that the selected combination of proximity switches detects the first oil cylinder piston or the second oil cylinder piston reaches to the preset position.

[0010] Accordingly, the present invention further provides a pumping direction switching control apparatus for the pumping apparatus, comprising: a selector, configured to select a combination of proximity switches that comprises one of the at least two first proximity switches and one of the at least one second proximity switch, wherein the first proximity switches are configured to detect whether the first oil cylinder piston reaches to a preset position, and the second proximity switch is configured to detect whether the second oil cylinder piston reaches to a preset position; and, an actuator, configured to control a direction-switching valve in the pumping apparatus to switch on the condition that the selected combination of proximity switches detects the first oil cylinder piston or second oil cylinder piston reaches to the preset position.

[0011] With the technical solution described above, in case either proximity switch fails, the other proximity switch can take the role of the failed proximity switch, so as to sustain the control over direction-switching, thereby the robustness of the pumping direction switching control system is improved.

[0012] Other features and advantages of the present invention will be further detailed in the embodiments hereunder.

Brief Description of the Drawings

[0013] The accompanying drawings are provided here to facilitate further understanding on the present invention, and are a part of this document. They are used together with the following embodiments to explain the present invention, but shall not be comprehended as constituting any limitation to the present invention. Among the drawings:

Figure 1 is a schematic structural diagram of a concrete pumping apparatus;

Figure 2 is a schematic structural diagram of the pumping direction switching control system provided in the present invention;

Figure 3 is a schematic diagram of mounting positions of the proximity switches in the pumping direction switching control system provided in the present invention; and

Figure 4 is a flow diagram of the pumping direction switch control method provided in the present invention.

Brief Description of the Symbols

[0014]

1	concrete pumping unit	2	hopper
10	hydraulic pump	20	direction-switching valve
31	first hydraulic oil cylinder	32	second hydraulic oil cylinder
41	first concrete cylinder	42	second concrete cylinder
50	water tank	61	first oil cylinder piston
62	second oil cylinder piston	71	first concrete cylinder piston
72	second concrete cylinder piston	80	S-cylinder
91	first piston rod	92	second piston rod
110	first proximity switch	120	second proximity switch
200	controller	300	input device

(continued)

400 pressure detector

Detailed Description of the Embodiments

[0015] Hereunder the embodiments of the present invention will be detailed, with reference to the accompanying drawings. It should be appreciated that the embodiments described here are only provided to describe and explain the present invention, but shall not be deemed as constituting any limitation to the present invention.

[0016] Figure 2 is a schematic structural diagram of the pumping direction switching control system provided in the present invention. As shown in Figure 2, the present invention provides a pumping direction switching control system for a pumping apparatus; the pumping apparatus comprises a first hydraulic oil cylinder 31, a second hydraulic oil cylinder 32, a first concrete cylinder 41, a second concrete cylinder 42, a water tank 50, a first oil cylinder piston 61 in the first hydraulic oil cylinder 31, a second oil cylinder piston 62 in the second hydraulic oil cylinder 32, a first concrete cylinder piston 71 in the first concrete cylinder 41, and a second concrete cylinder piston 72 in the second concrete cylinder 42, wherein the first oil cylinder piston 61 and the first concrete cylinder piston 71 are connected to each other by a first piston rod 91 passing through the water tank 50, the second oil cylinder piston 62 and the second concrete cylinder piston 72 are connected to each other by a second piston rod 92 passing through the water tank 50, the system comprises: at least two first proximity switches 110 configured to detect whether the first oil cylinder piston 61 reaches to a preset position; at least one second proximity switch 120 configured to detect whether the second oil cylinder piston 62 reaches to a preset position; and a controller 200, which is connected to the at least two first proximity switches 110 and the at least one second proximity switch 120, and is configured to select a combination of proximity switches and control a direction-switching valve 20 in the pumping apparatus to switch on the condition that the selected combination of proximity switches detects the first oil cylinder piston 61 or the second oil cylinder piston 62 reaches to the preset position; the combination of proximity switches comprises one of the at least two first proximity switches 110 and one of the at least one second proximity switch 120.

[0017] The combination of the proximity switches can comprise any combination including every first proximity switch 110 in the at least two first proximity switches 110 and every second proximity switch 120 in the at least one second proximity switch 120, as long as one first proximity switch 110 configured to detect whether the first oil cylinder piston 61 reaches to the preset position and one second proximity switch 120 configured to detect whether the second oil cylinder piston 62 reaches to the preset position exist in that combination.

[0018] Figure 3 is a schematic diagram of mounting positions of the proximity switches in the pumping direction switching control system provided in the present invention. As shown in Figure 3, the first proximity switches can be arranged in the first hydraulic oil cylinder 31 or in the water tank 50 near the second concrete cylinder 42, and the second proximity switch 120 can be arranged in the second hydraulic oil cylinder 32 or in the water tank 50 near the first concrete cylinder 41. Since there is a communicating cavity between the first hydraulic oil cylinder 31 and the second hydraulic oil cylinder 32 and hydraulic oil exists in the communicating cavity, the movement of the first oil cylinder piston 61 will cause the second oil cylinder piston 62 to move in the reverse direction to the same displacement, and the movement of the second oil cylinder piston 62 will cause the second concrete cylinder piston 72 to move in the same direction to the same displacement; therefore, by virtue of that relationship, the first proximity switches 110 can be arranged in the water tank 50 near the second concrete cylinder 42, to detect whether the second concrete cylinder piston 72 reaches to a preset position, and thereby detect indirectly whether the first oil cylinder piston 61 reaches to the preset position. Based on the same principle, the second proximity switch 120 can be arranged in the water tank 50 near the first concrete cylinder 41, to detect whether the first concrete cylinder piston 71 reaches to a preset position, and thereby detect indirectly whether the second oil cylinder piston 62 reaches to the preset position.

[0019] The at least two first proximity switches 110 can be arranged as follows: all first proximity switches 110 in the at least two first proximity switches 110 are arranged in the first hydraulic oil cylinder 31; or, all first proximity switches 110 in the at least two first proximity switches 110 are arranged in the water tank 50 near the second concrete cylinder 42; or, some first proximity switches 110 are arranged in the first hydraulic oil cylinder 31, while other first proximity switches 110 are arranged in the water tank 50 near the second concrete cylinder 42. The at least one second proximity switch 120 can also be arranged as described above. Preferably, one of the at least two first proximity switches 110 is arranged in the water tank 50 near the second concrete cylinder 42, and one of the at least one second proximity switch 120 is arranged in the water tank 50 near the first concrete cylinder 41. Since the pressure in the water tank 50 is low, the proximity switches arranged in the water tank 50 will not be damaged so easily as in the case they are arranged in the hydraulic oil cylinders; moreover, the proximity switches arranged in the water tank 50 can be ordinary proximity switches instead of highpressure proximity switches. Thus, the cost can be reduced.

[0020] Wherein, the pumping direction switching control system may further comprise an input device 300, which is configured to receive a command for selecting a combination of proximity switches and input the command to the

controller 200. The controller 200 receives the command and selects the combination of proximity switches according to the command. The input device 300 can be a device well known in the art, such as a switch, mouse, keyboard, or touch screen, etc.

[0021] Wherein, the pumping apparatus further comprises a hydraulic pump 10, an output of which is connected to the first hydraulic oil cylinder 31 and the second hydraulic oil cylinder 32 through a main oil- way. The system may further comprise a pressure detector 400, which is configured to detect the pressure of the main oil- way. The controller 200 is further connected with the pressure detector 400, and is configured to select another combination of proximity switches on the condition that the pressure change rate of the main oil- way exceeds a preset change rate and the pressure of the main oil- way exceeds a preset pressure value. On the condition that the pressure change rate of the main oil- way exceeds the preset change rate and the pressure of the main oil- way exceeds the preset pressure value, it indicates a suppressed cylinder phenomenon in the hydraulic oil cylinder. It is highly possible that the phenomenon is resulted from that the pumping apparatus doesn't accomplish direction switching timely due to failure of a proximity switch. Therefore, another combination of proximity switches can be selected to replace the current combination of proximity switches, so as to replace the failed proximity switch with a new proximity switch and thereby regain pumping direction switching control.

[0022] Wherein, on the condition that the pressure change rate of the main oil- way is still higher than the preset change rate and the pressure of the main oil- way is still higher than the preset pressure value after all combinations of proximity switches have been tried, the controller 200 may control the direction- switching valve 20 in the pumping apparatus to switch. Thus, on the condition that failed proximity switches exist in all combinations of proximity switches, emergent direction switching can be accomplished.

[0023] Figure 4 is a flow diagram of the pumping direction switching control method provided in the present invention. As shown in Figure 4, accordingly, the present invention further provides a pumping direction switching control method for the pumping apparatus, comprising: selecting a combination of proximity switches that comprises one of the at least two first proximity switches 110 and one of the at least one second proximity switch 120, wherein the first proximity switches 110 are configured to detect whether the first oil cylinder piston 61 reaches to a preset position, and the second proximity switch 120 is configured to detect whether the second oil cylinder piston 62 reaches to a preset position; and controlling a direction-switching valve 20 in the pumping apparatus to switch on the condition that the selected combination of proximity switches detects the first oil cylinder piston 61 or the second oil cylinder piston 62 reaches to the preset position.

[0024] Wherein, one of the at least two first proximity switches 110 may be arranged in the water tank 50 near the second concrete cylinder 42, and one of the at least one second proximity switch 120 may be arranged in the water tank 50 near the first concrete cylinder 41.

[0025] Wherein, the process of selecting the combination of proximity switches may comprise: receiving a command for selecting the combination of proximity switches; and selecting the combination of proximity switches according to the command.

[0026] Wherein, the pumping apparatus may further comprise a hydraulic pump 10, an output of which is connected to the first hydraulic oil cylinder 31 and the second hydraulic oil cylinder 32 through a main oil- way, wherein the process of selecting the combination of proximity switches may comprise: detecting the pressure of the main oil- way; and selecting another combination of proximity switches on the condition that the pressure change rate of the main oil- way exceeds a preset change rate and the pressure of the main oil- way exceeds a preset pressure value.

[0027] Wherein, the method may further comprise: controlling the direction- switching valve 20 in the pumping apparatus to switch, on the condition that the pressure change rate of the main oil- way is still higher than the preset change rate and the pressure of the main oil- way is still higher than the preset pressure value after all combinations of proximity switches have been tried.

[0028] For details and beneficial effects of the pumping direction switching control method, please see the description of the pumping direction switching control system in the above text. They will not be described further here.

[0029] Accordingly, the present invention further provides a pumping direction switching control apparatus for the pumping apparatus, comprising: a selector, configured to select a combination of proximity switches that comprises one of the at least two first proximity switches 110 and one of the at least one second proximity switch 120, wherein the first proximity switches 110 are configured to detect whether the first oil cylinder piston 61 reaches to a preset position, and the second proximity switch 120 is configured to detect whether the second oil cylinder piston 62 reaches to a preset position; and an actuator, configured to control a direction- switching valve 20 in the pumping apparatus to switch on the condition that the selected combination of proximity switches detects the first oil cylinder piston 61 or the second oil cylinder piston 62 reaches to the preset position.

[0030] Wherein, one of the at least two first proximity switches 110 may be arranged in the water tank 50 near the second concrete cylinder 42, and one of the at least one second proximity switch 120 may be arranged in the water tank 50 near the first concrete cylinder 41.

[0031] Wherein, the selector may comprise: a receiver, configured to receive a command for selecting the combination of proximity switches; and, a proximity switch combination selector, configured to select the combination of proximity

switches according to the command. Wherein, the pumping apparatus may further comprise a hydraulic pump 10, an output of which is connected to the first hydraulic oil cylinder 31 and the second hydraulic oil cylinder 32 through a main oil- way; the selector comprises: a pressure acquirer, configured to detect the pressure of the main oil- way; and, a proximity switch combination switcher, configured to select another combination of proximity switches on the condition that the pressure change rate of the main oil- way exceeds a preset change rate and the pressure exceeds a preset pressure value.

[0032] Wherein, the actuator may be configured to control the direction- switching valve in the pumping apparatus to switch, on the condition that the pressure change rate of the main oil- way is still higher than the preset change rate and the pressure is still higher than the preset pressure value after the proximity switch combination selector have tried all combinations of proximity switches.

[0033] For details and beneficial effects of the pumping direction switching control apparatus, please see the description of the pumping direction switching control system in the above text. They will not be described further here.

[0034] With the technical scheme described above, on the condition that either proximity switch fails, the other proximity switch can take the role of the failed proximity switch, so as to sustain the switching control function; in that way, the robustness of the pumping direction switching control system is improved. Moreover, since the proximity switches are arranged in the water tank near the concrete cylinders, the cost can be reduced, and the failure rate of the proximity switches can be decreased.

[0035] While some preferred embodiments of the present invention are described above with reference to the accompanying drawings, the present invention is not limited to the details in those embodiments. Those skilled in the art can make modifications and variations to the technical solution of the present invention, without departing from the spirit of the present invention. However, all these modifications and variations shall be deemed as falling into the protected domain of the present invention.

[0036] In addition, it should be appreciated that the technical features described in the above embodiments can be combined in any appropriate manner, provided that there is no conflict among the technical features in the combination.

To avoid unnecessary iteration, such possible combinations will not be described here in the present invention.

[0037] Moreover, the different embodiments of the present invention can be combined freely as required, as long as the combinations don't deviate from the ideal and spirit of the present invention. However, such combinations shall also be deemed as falling into the scope disclosed in the present invention.

Claims

1. A pumping direction switching control system for a pumping apparatus, wherein the pumping apparatus comprises a first hydraulic oil cylinder, a second hydraulic oil cylinder, a first concrete cylinder, a second concrete cylinder, a water tank, a first oil cylinder piston in the first hydraulic oil cylinder, a second oil cylinder piston in the second hydraulic oil cylinder, a first concrete cylinder piston in the first concrete cylinder, and a second concrete cylinder piston in the second concrete cylinder, the first oil cylinder piston and the first concrete cylinder piston are connected to each other by a first piston rod passing through the water tank, and the second oil cylinder piston and the second concrete cylinder piston are connected to each other by a second piston rod passing through the water tank, the system comprises:

at least two first proximity switches, configured to detect whether the first oil cylinder piston reaches to a preset position;

at least one second proximity switch, configured to detect whether the second oil cylinder piston reaches to a preset position; and

a controller, connected to the at least two first proximity switches and the at least one second proximity switch, configured to select a combination of proximity switches, and control a direction-switching valve in the pumping apparatus to switch on the condition that the combination of proximity switches detects the first oil cylinder piston or the second oil cylinder piston reaches to the preset position, wherein the combination of proximity switches comprises one of the at least two first proximity switches and one of the at least one second proximity switch.

2. The pumping direction switching control system according to claim 1, wherein one of the at least two first proximity switches is arranged in the water tank near the second concrete cylinder, and one of the at least one second proximity switch is arranged in the water tank near the first concrete cylinder.

3. The pumping direction switching control system according to claim 1 or 2, further comprising:

an input device, configured to receive a command for selecting the combination of proximity switches, and input the command to the controller,
the controller receives the command, and selects the combination of proximity switches according to the command.

- 5
4. The pumping direction switching control system according to claim 1 or 2, wherein the pumping apparatus further comprises a hydraulic pump, an output of which is connected to the first hydraulic oil cylinder and the second hydraulic oil cylinder through a main oil-way, the system further comprises:

10 a pressure detector, configured to detect the pressure of the main oil-way,
the controller is connected to the pressure detector, and is configured to select another combination of proximity switches on the condition that the pressure change rate of the main oil-way exceeds a preset change rate and the pressure of the main oil-way exceeds a preset pressure value.

- 15 5. The pumping direction switching control system according to claim 4, wherein the controller is configured to control the direction-switching valve in the pumping apparatus to switch, on the condition that the pressure change rate of the main oil-way is still higher than the preset change rate and the pressure of the main oil-way is still higher than the preset pressure value after all combinations of proximity switches have been tried.

- 20 6. A pumping direction switching control method for a pumping apparatus, wherein the pumping apparatus comprises a first hydraulic oil cylinder, a second hydraulic oil cylinder, a first concrete cylinder, a second concrete cylinder, a water tank, a first oil cylinder piston in the first hydraulic oil cylinder, a second oil cylinder piston in the second hydraulic oil cylinder, a first concrete cylinder piston in the first concrete cylinder, and a second concrete cylinder piston in the second concrete cylinder, the first oil cylinder piston and the first concrete cylinder piston are connected to each other by a first piston rod passing through the water tank, and the second oil cylinder piston and the second concrete cylinder piston are connected to each other by a second piston rod passing through the water tank, the method comprises:

30 selecting a combination of proximity switches that comprises one of the at least two first proximity switches and one of the at least one second proximity switch, wherein the first proximity switch is configured to detect whether the first oil cylinder piston reaches to a preset position, and the second proximity switch is configured to detect whether the second oil cylinder piston reaches to a preset position; and
controlling a direction-switching valve in the pumping apparatus to switch on the condition that the combination of proximity switches detects the first oil cylinder piston or the second oil cylinder piston reaches to the preset position.

- 35 7. The pumping direction switching control method according to claim 6, wherein one of the at least two first proximity switches is arranged in the water tank near the second concrete cylinder, and one of the at least one second proximity switch is arranged in the water tank near the first concrete cylinder.

- 40 8. The pumping direction switching control method according to claim 6 or 7, wherein the process of selecting the combination of proximity switches comprises:

45 receiving a command for selecting the combination of proximity switches; and
selecting the combination of proximity switches according to the command.

- 50 9. The pumping direction switching control method according to claim 6 or 7, wherein the pumping apparatus further comprises a hydraulic pump, an output of which is connected to the first hydraulic oil cylinder and the second hydraulic oil cylinder through a main oil-way, the process of selecting the combination of proximity switches comprises:

acquiring the pressure of the main oil-way; and
selecting another combination of proximity switches on the condition that the pressure change rate of the main oil-way exceeds a preset change rate and the pressure of the main oil-way exceeds a preset pressure value.

- 55 10. The pumping direction switching control method according to claim 9, further comprising:

controlling the direction-switching valve in the pumping apparatus to switch, on the condition that the pressure change rate of the main oil-way is still higher than the preset change rate and the pressure of the main oil-way

is still higher than the preset pressure value after all combinations of proximity switches have been tried.

- 5 11. A pumping direction switching control apparatus for a pumping apparatus, wherein the pumping apparatus comprises a first hydraulic oil cylinder, a second hydraulic oil cylinder, a first concrete cylinder, a second concrete cylinder, a water tank, a first oil cylinder piston in the first hydraulic oil cylinder, a second oil cylinder piston in the second hydraulic oil cylinder, a first concrete cylinder piston in the first concrete cylinder, and a second concrete cylinder piston in the second concrete cylinder, the first oil cylinder piston and the first concrete cylinder piston are connected to each other by a first piston rod passing through the water tank, and the second oil cylinder piston and the second concrete cylinder piston are connected to each other by a second piston rod passing through the water tank, the pumping direction switching control apparatus comprises:

15 a selector, configured to select a combination of proximity switches that comprises one of the at least two first proximity switches and one of the at least one second proximity switch, wherein the first proximity switches are configured to detect whether the first oil cylinder piston reaches to a preset position, and the second proximity switch is configured to detect whether the second oil cylinder piston reaches to a preset position; and an actuator, configured to control a direction-switching valve in the pumping apparatus to switch on the condition that the combination of proximity switches detects the first oil cylinder piston or the second oil cylinder piston reaches to the preset position.

- 20 12. The pumping direction switching control apparatus according to claim 11, wherein one of the at least two first proximity switches is arranged in the water tank near the second concrete cylinder, and one of the at least one second proximity switch is arranged in the water tank near the first concrete cylinder.

- 25 13. The pumping direction switching control apparatus according to claim 11 or 12, wherein the selector comprises:

a receiver, configured to receive a command for selecting the combination of proximity switches; and a proximity switch combination selector, configured to select the combination of proximity switches according to the command.

- 30 14. The pumping direction switching control apparatus according to claim 11 or 12, wherein the pumping apparatus further comprises a hydraulic pump, an output of which is connected to the first hydraulic oil cylinder and the second hydraulic oil cylinder through a main oil-way, the selector comprises:

35 a pressure acquirer, configured to acquire the pressure of the main oil-way; and a proximity switch combination switcher, configured to select another combination of proximity switches on the condition that the pressure change rate of the main oil-way exceeds a preset change rate and the pressure of the main oil-way exceeds a preset pressure value.

- 40 15. The pumping direction switching control apparatus according to claim 14, wherein the actuator is configured to control the direction-switching valve in the pumping apparatus to switch, on the condition that the pressure change rate of the main oil-way is still higher than the preset change rate and the pressure of the main oil-way is still higher than the preset pressure value after the proximity switch combination switcher has tried all combinations of proximity switches.

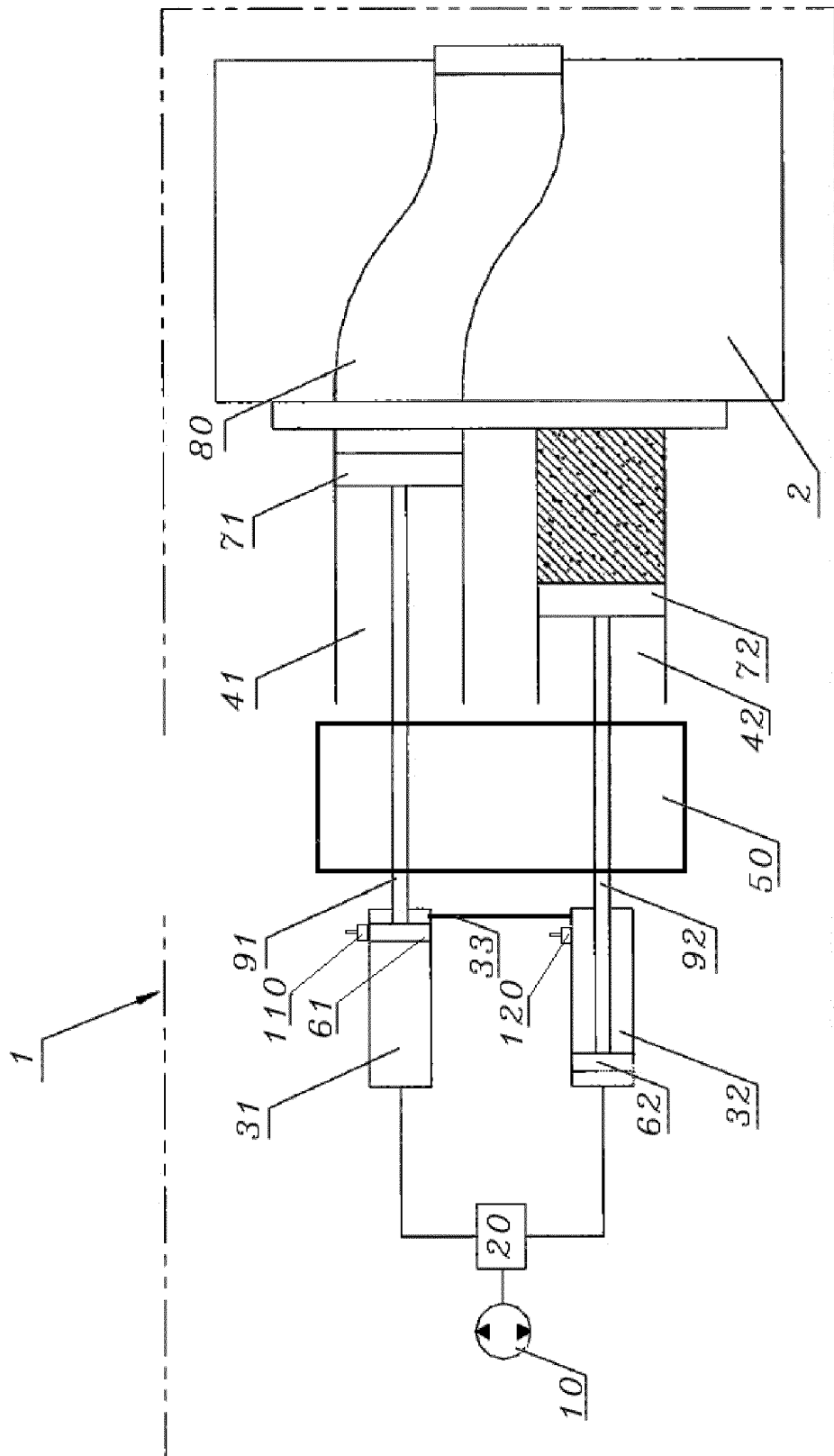


Figure 1

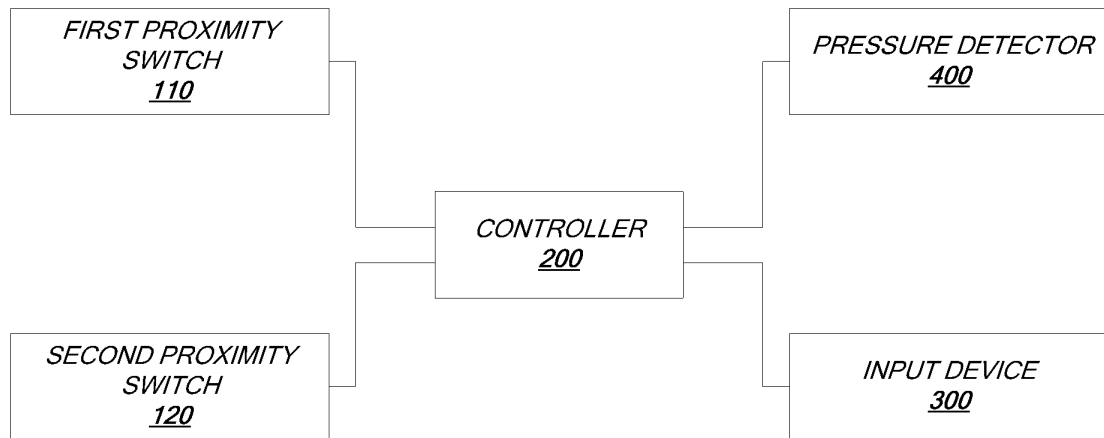


Figure 2

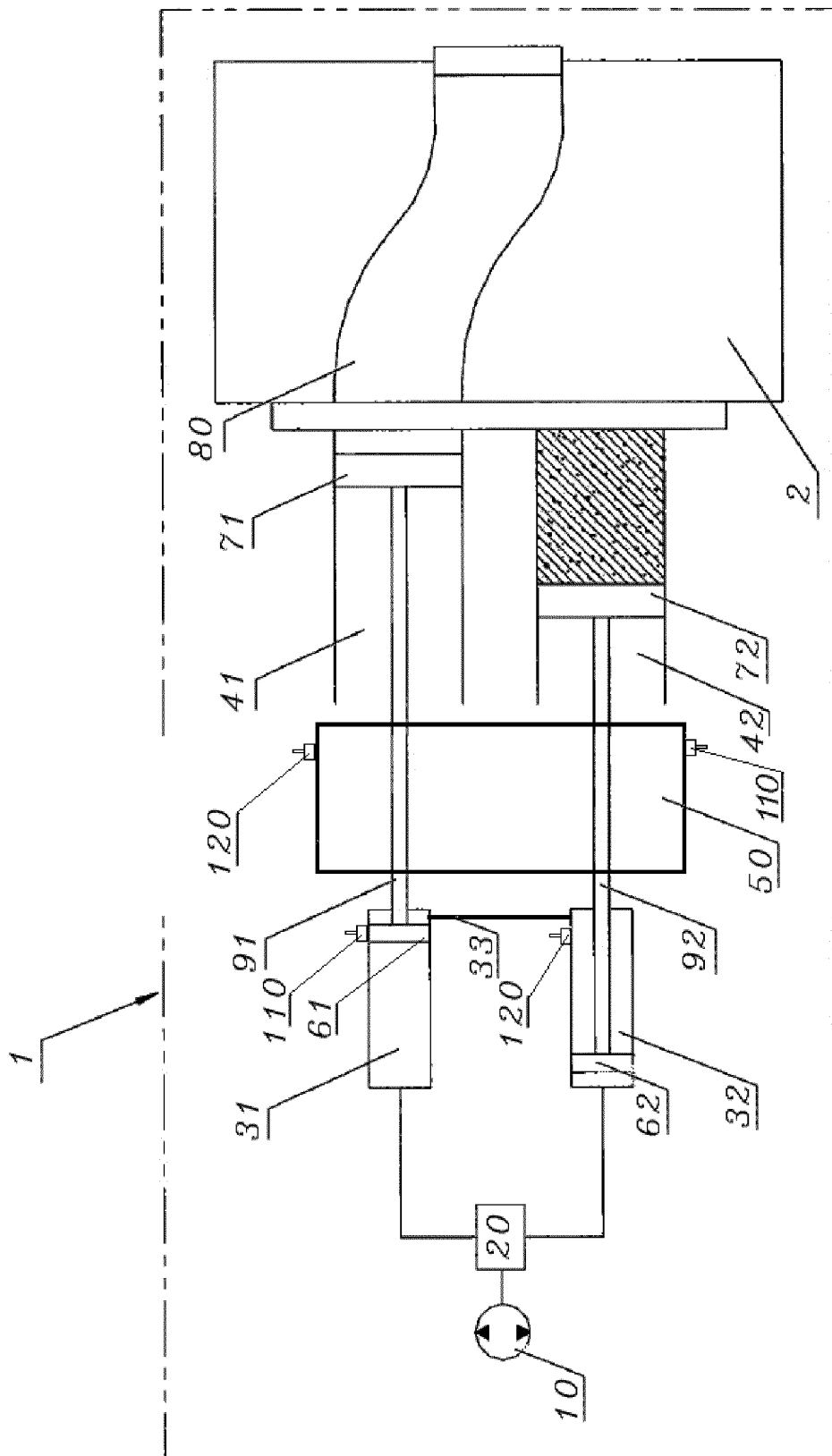


Figure 3

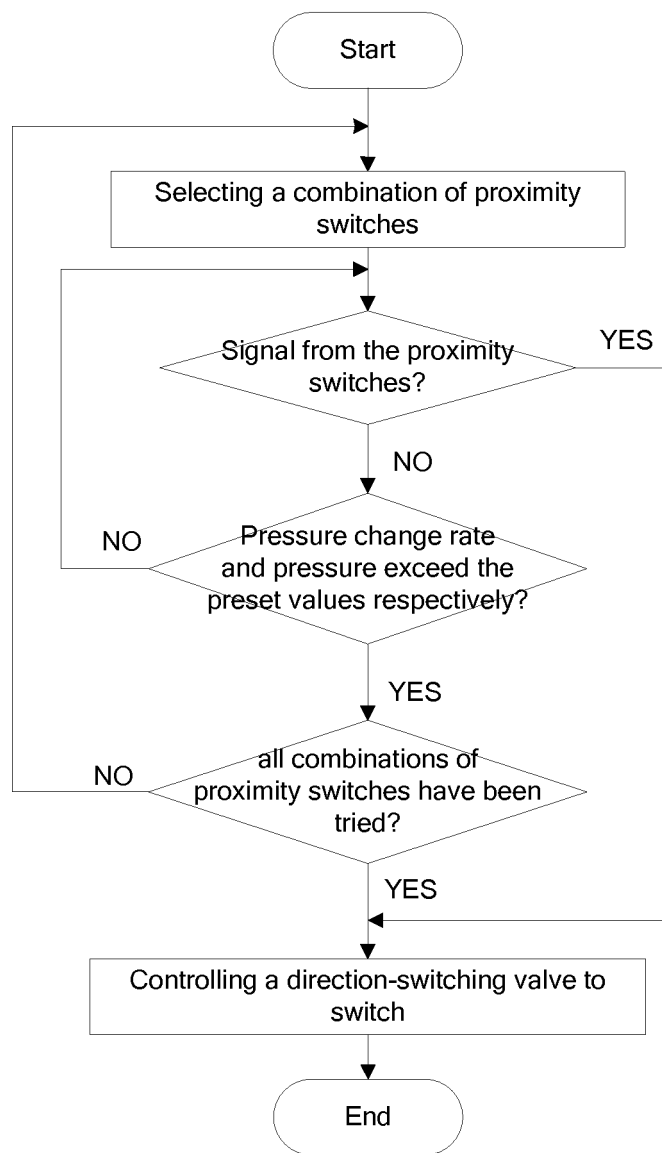


Figure 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/079520

A. CLASSIFICATION OF SUBJECT MATTER

F04B 9/115 (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)

IPC: F04B

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

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

CNPAT CNKI WPI EPODOC concrete, pump, commutation, reversing, direction d change, proximity d switch, approach d switch, cylinder, first, second, detect, control, test, position, location

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP10-331762 A (NIIGATA ENG CO LTD) 15 Dec. 1998 (15.12.1998) the whole document	1-15
A	JP3143772 B2 (KYOKUTO KAIHATSU KOGYO KK) 07 Mar. 2001 (07.03.2001) the whole document	1-15
A	JP9-112413 A (ISHIKAWAJIMA KENKI KK) 02 May 1997 (02.05.1997) the whole document	1-15
A	JP8-319938 A (TADANO LTD) 03 Dec. 1996 (03.12.1996) the whole document	1-15
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Date of the actual completion of the international search

01 Feb. 2012(01.02.2012)

Date of mailing of the international search report

01 Mar. 2012(01.03.2012)

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