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(54) WORKING LINK, VALVE PORT INDEPENDENT CONTROL TYPE MULTI-WAY VALVE, AND ENGINEERING MACHINE

(57) The invention relates to a working link, a valve port independent control type multi-way valve, and an engineering machine. The working link can realize independent control over an oil inlet and an oil outlet, and can use a manual control mode, an electro-hydraulic proportion control mode, and a CAN bus control mode. The problem of mechanical and fixed connection of an oil inlet and an oil outlet of a traditional multi-way valve is solved, and the degree of freedom of control is increased; the problem of complex and unstable control over an existing port-independent valve is solved; moreover, the structure is simple, the flow control precision is high, the cost is low, and switching between a port-independent valve and a traditional pre-compensation load-sensitive multi-way valve can be achieved. With the development of the sensor technology and the control technology, flow calculation control and pressure calculation control can be realized on the premise of not changing the structure of a valve body; moreover, a second main valve core is replaced with a plug, and the pattern of a throttling opening in a first main valve core is changed, such that the function of a pre-compensation load-sensitive multi-way valve of a traditional structure can be achieved by means of the working link, thereby improving the performance of the valve port independent control type valve and even the performance of the engineering machine.

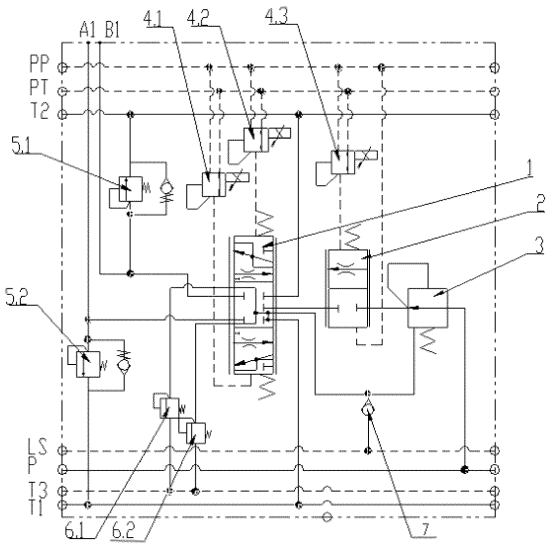

FIG. 2

EP 4 438 909 A1

Description

BACKGROUND OF THE INVENTION

1. Technical Field

[0001] The invention relates to the field of hydraulic techniques, in particular to a working link, a valve port independent control type multi-way valve and an engineering machine.

2. Description of Related Art

[0002] The main engine of engineering machines is developing towards intelligence and environmental friendliness. Existing engineering machines adopt multi-way valves of a traditional slide valve form to control an actuator, which has the defects of mechanical and fixed connection of an oil inlet and an oil outlet, control of the pressure or flow of only one cavity of the actuator, large pressure loss and poor state perception, and cannot meet the high-precision position/speed control requirements of electric control and intelligent assistance in the future, thus severely compromising the maneuverability, load adaptivity, operating stability and energy saving performance of the machine engine. The valve port independent control technique can realize separate control over the pressure/flow of two cavities of the actuator, has the advantages of flexible control, high load adaptivity, low power consumption and accurate control, and represents the development direction of high-end hydraulic valves.

[0003] The multi-way valve is a multi-functional integrated valve which mainly comprises two or more reversing valves and integrates reversing valves, check valves, overload valves, oil supplementing valves and braking valves, and as a key part of the hydraulic system of engineering machines, is located between a pump and an actuating element and used for controlling the flow rate and direction of hydraulic oil to control the movement direction and speed of the actuating element of the engineering machines.

[0004] At present, engineering machines generally adopt four types of multi-way valves: throttling-type multi-way valves, negative-flow multi-way valves, positive-flow multi-way valves and load-sensitive multi-way valves. The flow of the throttling-type multi-way valves, the negative-flow multi-way valves and positive-flow multi-way valves is affected by the change of the load pressure; and in case of a complex action, the flow flows to the actuating element with a small load, such that the flow cannot be distributed as expected. Therefore, the hydraulic system of engineering machines with a high control precision requirement generally adopts the load-sensitive multi-way valve.

[0005] CMA90 and CMA200 multi-way valves of the Eaton Cooperation are the best and mostly commonly used two-core valve port independent control type multi-way valves on the present market, the principle diagram of which is shown in FIG. 1. Wherein, 1' and 2' are main valve cores, the main valve core 1' controls oil to flow in via a port A, and the main valve core 2' control oil to flow out via a port B; and 3' and 4' are pilot valves, the pilot valve 3' controls the working state of the main valve core 1' and the pilot valve 4' controls the working state of the main valve core 2', such that separate control over the port A and the port B is realized.

[0006] Because the oil inlet and oil outlet of traditional multi-way valves are mechanically and fixedly connected, flow control of an oil inlet of the actuator and flow control of an oil outlet of the actuator are mutually influenced, and particularly, in a load condition, flow control cannot be realized, and resource waste will be caused. According to the CMA90 and CMA200 multi-way valves of the Eaton Cooperation, the port A and the port B are controlled separately, thus realizing the valve port independent control function; however, multiple temperature-pressure integrated sensors and displacement sensors are installed, control is realized based on flow calculation and pressure calculation, a control system is complex, and the control precision is affected by multiple parameters such as the viscosity of oil, leading to instability of the control system. In addition, the direction of oil ports of the CMA90 and CMA200 multi-way valves of the Eaton Cooperation is different from the direction of oil ports of traditional multi-way valves, and the cost of multiple sensors is high, so mass application of the CMA90 and CMA200 multi-way valves cannot be realized under the influence of multiple factors.

BRIEF SUMMARY OF THE INVENTION

[0007] In view of the defects existing in the prior art, the invention provides a working link, a valve port independent control type multi-way valve and an engineering machine.

[0008] In a first aspect, the invention provides a working line.

[0009] The working link comprises:

a valve body, formed with an oil supply port P, a working oil port A and a working oil port B;

a first main valve core, movably arranged in the valve body and used for controlling oil to flow out via the working oil port A and to return via the working oil port B or controlling oil to flow out via the working oil port B and to return via the working oil port A;

a second main valve core, movably arranged in the valve body and used for controlling the quantity of oil entering the working link from the oil supply port P; and

a pilot control module, comprising a first pilot control unit for controlling the first main valve core to move and a second pilot control unit for controlling the second main valve core to move.

[0010] Optionally, an oil return port T1, an oil return port T2, an oil supply line and working oil lines are arranged on the valve body;

the oil supply line is connected to the first main valve core from the oil supply port P via the second main valve core;
the working oil lines comprise a first working oil line and a second working oil line, the first working oil line is formed between the first main valve core and the working oil port A, and the second working oil line is formed between the first main valve core and the working oil port B;
when the first main control core controls oil to flow out via the working oil port A and to return via the working oil port B, the oil supply line is connected to the first working oil line, and the second working oil line is connected to the oil return port T2; when the first main valve core controls oil to flow out via the working oil port B and to return via the working oil port A, the oil supply line is connected to the second working oil line, the first working oil line is connected to the oil return port T1.

[0011] Optionally, a first port overflow valve is arranged in the first working oil line, and a second port overflow valve is arranged in the second working oil line.

[0012] Optionally, the working link further comprises a pressure difference control module, the pressure difference control module is arranged between the oil supply port P and the second main valve core and used for controlling a pressure difference between an oil inlet and an oil outlet of the second main valve core to be constant.

[0013] Optionally, the pressure difference control module is configured as a compensation valve core.

[0014] Optionally, the first pilot control unit has a first pilot control oil line and a second pilot control oil line, and the first pilot control oil line and the second pilot control oil line are connected to two control cavities of the first main valve core respectively; and the second pilot control unit has a third pilot control oil line, and the third pilot control oil line is connected to a spring cavity of the second main valve core.

[0015] Optionally, the first pilot control unit comprises a first electric proportional pressure reducing valve and a second electric proportional pressure reducing valve, the first pilot control oil line is led out from an outlet of the first electric proportional pressure reducing valve, and the second pilot control oil line is led out from an outlet of the second electric proportional pressure reducing valve; and the second pilot control unit comprises a third electric proportional pressure reducing valve, and the third pilot control oil line is led out from an outlet of the third electric proportional pressure reducing valve.

[0016] Optionally, the first pilot control unit comprises a first electric proportional reversing valve, and the first pilot control oil line and the second pilot control oil line are led out from two outlets of the first electric proportional reversing valve respectively; and the second pilot control unit comprises a second electric proportional reversing valve, and the third pilot control oil line is led out from an outlet of the second electric proportional reversing valve.

[0017] Optionally, the working link further comprises a control handle and a controller used for receiving a control signal from the control handle by means of a CAN bus, and the controller calculates a displacement of the first main valve core and/or the second main valve core according to the control signal and controls the first main valve core and/or the second main valve core to move by means of the corresponding first electric proportional reversing valve and/or second electric proportional reversing valve.

[0018] Optionally, an LS oil port and a load feedback oil passage are arranged on the first main valve core, the oil supply line is connected to the load feedback oil passage by means of the LS oil port, a first load-sensitive oil line and a second load-sensitive oil line are arranged on the valve body, a first LS overflow valve is arranged on the first load-sensitive oil line, and a second LS overflow valve is arranged on the second load-sensitive oil line;

when oil flows out via the working oil port A and returns via the working oil port B, the load feedback oil passage is connected to the first load-sensitive oil line;
when oil flows out via the working oil port B and returns via the working oil port A, the load feedback oil passage is connected to the second load-sensitive oil line.

[0019] Optionally, the working link further comprises an electric-control LS overflow valve, and an inlet of the electric-control LS overflow valve is connected to the load feedback oil passage, the first load-sensitive oil line or the second load-sensitive oil line.

[0020] Optionally, a first control and selection oil line, a second control and selection oil line and a third control and selection oil line are arranged on the valve body, the first control and selection oil line is used for connecting the inlet of the electric-control LS overflow valve and the first load-sensitive oil line, the second control and selection oil line is used for connecting the inlet of the electric-control LS overflow valve and the second load-sensitive oil line, and the third control and selection oil line is used for connecting the inlet of the electric-control LS overflow valve and the load feedback oil line.

[0021] Optionally, the second main valve core is replaced with a plug; an LSA oil port, an LSB oil port and a load feedback oil passage are arranged on the first main valve core, the oil supply line is connected to the load feedback oil passage by means of the LSA oil port or the LSB oil port, a first load-sensitive oil line and a second load-sensitive oil line are arranged on the valve body, a first LS overflow valve is arranged on the first load-sensitive oil line, and a second LS overflow valve is arranged on the second load-sensitive oil line;

when oil flows out via the working oil port A and returns via the working oil port B, the LSA oil port is connected to the first load-sensitive oil line by means of the load feedback oil passage;
when oil flows out via the working oil port B and returns via the working oil port A, the LSB oil port is connected to the second load-sensitive oil line by means of the load feedback oil passage.

[0022] In a second aspect, the application provides a valve port independent control type multi-way valve.

[0023] The valve port independent control type multi-way valve comprises one or more said working links as described above.

[0024] In a third aspect, the application provides an engineering machine.

[0025] The engineering machine comprises the valve port independent control type multi-way valve as described above.

[0026] Compared with the prior art, the technical solution of the invention has the following beneficial effects: the working link can realize independent control over an oil inlet and an oil outlet, and can use a manual control mode, an electro-hydraulic proportion control mode, and a CAN bus control mode. The problem of mechanical and fixed connection of an oil inlet and an oil outlet of a traditional multi-way valve is solved, and the degree of freedom of control is increased; the problem of complex and unstable control over an existing port-independent valve is solved; moreover, the structure is simple, the flow control precision is high, the cost is low, and switching between a port-independent valve and a traditional pre-compensation load-sensitive multi-way valve can be achieved by means of the combination of different accessories. With the development of the sensor technology and the control technology in the future, flow calculation control and pressure calculation control can be realized without changing the structure of the valve body; moreover, the second main valve core is replaced with a plug, and the pattern of a throttling opening in the first main valve core is changed, such that the function of a pre-compensation load-sensitive multi-way valve of a traditional structure can be achieved by means of the working link of this design.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0027]

FIG. 1 is a principle diagram of CMA90 and CMA200 multi-way valves of the Eaton Cooperation;
FIG. 2 is a principle diagram of Embodiment 1 of a working link according to the invention;
FIG. 3 is a schematic structural diagram of Embodiment 1 of the working link according to the invention;
FIG. 4 is a principle diagram of Embodiment 2 of the working link according to the invention;
FIG. 5 is a principle diagram of Embodiment 3 of the working link according to the invention;
FIG. 6 is a schematic structural diagram of Embodiment 4 of the working link according to the invention.

[0028] In FIGS: 1, first main valve core; 2, second main valve core; 3, compensation valve core; 4.1, first electric proportional pressure reducing valve; 4.2, second electric proportional pressure reducing valve; 4.3, third electric proportional pressure reducing valve; 5.1, first port overflow valve; 5.2, second port overflow valve; 6.1, first LS overflow valve; 6.2, second LS overflow valve; 7, check valve; 8.1, first control and selection oil line; 8.2, second control and selection oil line; 8.3, third control and selection oil line; 9, electric-control LS overflow valve; 10.1, first electric proportional reversing valve; 10.2, second electric proportional reversing valve; 11, manual end cover; 12, plug.

DETAILED DESCRIPTION OF THE INVENTION

[0029] Illustrative embodiments of the invention are explained below in conjunction with the accompanying drawings, with various details to facilitate understanding, and all these details should be construed as illustrative merely. Therefore, those ordinarily skilled in the art should understand that various transformations and modifications can be made to the embodiments described here without departing from the scope and spirit of the invention. Similarly, for the sake of clarity and brevity, commonly known functions and structures are not described below.

Embodiment 1

[0030] As shown in FIG. 2 and FIG. 3, a working link comprises a valve body, a first main valve core 1, a second main valve core 2 and a pilot control module, wherein an oil supply port P, a working oil port A and a working oil port B are arranged on the valve body, the first main valve core 1 is movably arranged in the valve body and used for controlling oil to flow out via the working oil port A and to return via the working oil port B or controlling oil to flow out via the working oil port B and to return via the working oil port A, the second main valve core 2 is movably arranged in the valve body and is used for controlling the quantity of oil entering the working link from the oil supply port P, and the pilot control module comprises a first pilot control unit used for controlling the first main valve core 1 to move and a second pilot control unit for controlling the second main valve core 2 to move.

[0031] Specifically, an oil return port T1, an oil return port T2, an oil supply line and working oil lines are arranged on the valve body, the oil supply line is connected to the first main valve core 1 from the oil supply port P via the second main valve core 2, the working oil lines comprise a first working oil line and a second working oil line, the first working oil line is formed between the first

main valve core 1 and the working oil port A, and the second working oil line is formed between the first main valve core 1 and the working oil port B; when the first main control core 1 controls oil to flow out via the working oil port A and to return via the working oil port B, the oil supply line is connected to the first working oil line, and the second working oil line is connected to the oil return port T2; when the first main valve core 1 controls oil to flow out via the working oil port B and to return via the working oil port A, the oil supply line is connected to the second working oil line, the first working oil line is connected to the oil return port T1; and a first port overflow valve 5.1 is arranged in the first working oil line, a second port overflow valve 5.2 is arranged in the second working oil line, and the first port overflow valve 5.1 and the second port overflow valve 5.2 are used for setting maximum working pressures of the working oil port A and the working oil port B to protect an actuator.

[0032] In some embodiments, the working line further comprises a pressure difference control module, which is arranged between the oil supply port P and the second main valve core 2 and used for controlling a pressure difference between an oil inlet and an oil outlet of the second main valve core 2 to be constant. In this embodiment, the pressure difference control module is configured as a compensation valve core 3.

[0033] In some embodiments, the first pilot control unit has a first pilot control oil line and a second pilot control oil line, and the first pilot control oil line and the second pilot control oil line are connected to two control cavities of the first main valve core 1 respectively; and the second pilot control unit has a third pilot control oil line, and the third pilot control oil line is connected to a spring cavity of the second main valve core 2.

[0034] In some embodiments, the first pilot control unit comprises a first electric proportional pressure reducing valve 4.1 and a second electric proportional pressure reducing valve 4.2, the first pilot control oil line is led out from an outlet of the first electric proportional pressure reducing valve 4.1, and the second pilot control oil line is led out from an outlet of the second electric proportional pressure reducing valve 4.2; and the second pilot control unit comprises a third electric proportional pressure reducing valve 4.3, and the third pilot control oil line is led out from an outlet of the third electric proportional pressure reducing valve 4.3.

[0035] Further, the first main valve core 1 is used for controlling an oil inlet direction and a return backpressure. The second main valve core 2 is used for controlling an oil inlet flow. A spring is arranged at one end of the compensation valve core 3, the pressure of an end, without the spring, of the compensation valve core 3 is an inlet pressure of the second main valve core 2, the pressure of the end, with the spring, of the compensation valve core 3 is an outlet pressure of the second main valve core 2, and the compensation valve core 3 is used for controlling the pressure difference between the oil inlet and the oil outlet of the second main valve core 2 to maintain the pressure difference between the oil inlet and the oil outlet of the second main valve core 2 approximately constant, thereby improving the control precision of the oil inlet flow. The first main valve core 1 and the second main valve core 2 work together to control the return backpressure and the oil inlet flow of the actuator separately so as to realize a valve port independent control function.

[0036] The compensation valve core 3 of the working link can be removed directly, pressure sensors are arranged at the oil inlet and the oil outlet, a displacement sensor is arranged on the second main valve core 2, and a flow-pressure difference control algorithm is used to control the flow of the actuator.

[0037] During the working process, the oil supply port P of the working link is connected to P1 by means of a throttling opening of the compensation valve core 3, P1 is connected to an oil inlet cavity of the second main valve core 2, the oil pressure from P1 reaches a spring-free cavity P3 of the compensation valve core 3 through an oil passage in the compensation valve core 3, P1 is connected to P2 by means of the second main valve core 2, the displacement of the second main valve core 2 is controlled by the third electric proportional pressure reducing valve 4.3, and the oil pressure from P2 reaches P4 through an oil passage in the first main valve core 1 and finally reaches a spring cavity of the compensation valve core 3, thus guaranteeing that the difference between the pressure of the second main valve core 2 in front of the throttling opening and the pressure of the second main valve core 2 behind the throttling opening is approximately constant. In this way, the flow passing through the second main valve core 2 is only related to the flow area of the second main valve core 2, the flow area of the second main valve core 2 depends on the displacement of the second main valve core 2, the displacement of the second main valve core 2 is determined by the third electric proportional pressure reducing valve 4.3, the third electric proportional pressure reducing valve 4.3 outputs a pilot control pressure in proportion to its control current to control the displacement of the second main valve core 2, and finally, the flow of the second main valve core 2 is controlled to be in proportion to the control current of the third electric proportional pressure reducing valve 4.3.

[0038] After hydraulic oil passes through P2, the first main valve core 1 reverses, and the hydraulic oil reaches the working oil port A/B through the first main valve core 1. The movement direction of the first main valve core 1 is controlled by the first electric proportional pressure reducing valve 4.1 and the second electric proportional pressure reducing valve 4.2. (1) When a current is applied to the first electric proportional pressure reducing valve 4.1, a generated pilot pressure reaches a spring cavity of a manual end cover 11 through an oil passage in the valve body, the first main valve core 1 moves towards a spring-free cavity, oil from P2 reaches the working oil port A, the working oil port B is connected to the return

port T2, and the displacement of the first main valve core 1 is set according to a pressure required by the working oil port B; in a load condition where the working oil port B requires a high pressure, the displacement of the first main valve core 1 is decreased to reduce the flow area from the working oil port B to the return port T2, thus increasing the pressure of the working oil port B. (2) When a current is applied to the electric proportional pressure reducing valve 4.2, a generated pilot pressure reaches the spring-free cavity of the first main valve core 1 through an oil passage in the valve body, the first main valve core 1 moves towards the spring cavity, oil from P2 reaches the working oil port B, the working oil port A is connected to the return port T1, and the displacement of the first main valve core 1 is set according to a pressure required by the working oil port A; in a load condition where the working oil port A requires a high pressure, the displacement of the first main valve core 1 is decreased to reduce the flow area from the working oil port A to the return port T1, thus increasing the pressure of the working oil port A.

[0039] When a large backpressure from the working oil port A/B to the return port T1/T2 is needed, in order to prevent a large pressure loss from P2 to the working oil port B/A, the overlap, from P2 to the working oil port A/B, of the first main valve core 1 is less than the overlap, from the working oil port A/B to the return port T1/T2, of the first main valve core 1, thus ensuring that the flow area from P2 to the working oil port B/A is still large in a case where the flow area from the working oil port A/B to the return port T1/T2 is small.

[0040] That is, the first main valve core 1 controls the oil inlet direction and the return restriction area, and the second main valve core 2 controls the oil inlet flow, thus realizing separate control over the oil inlet and the oil outlet. The compensation valve core 3 is arranged in front of the second main valve core 2, accurate flow control is realized based on the pre-compensation load-sensitive principle, and control is simple and stable.

Embodiment 2

[0041] As shown in FIG. 4, the working link further comprises an electric-control LS overflow valve 9, an inlet of the electric-control LS overflow valve 9 is connected to the load feedback oil passage, the first load-sensitive oil line or the second load-sensitive oil line, a first control and selection oil line 8.1, a second control and selection oil line 8.2 and a third control and selection oil line 8.3 are arranged on the valve body, the first control and selection oil line 8.1 is used for connecting the inlet of the electric-control LS overflow valve 9 and the first load-sensitive oil line, the second control and selection oil line 8.2 is used for connecting the inlet of the electric-control LS overflow valve 9 and the second load-sensitive oil line, the third control and selection oil line 8.3 is used for connecting the inlet of the electric-control LS overflow valve 9 and the load feedback oil line (a radial oil passage in the axis of the first main valve core), and a check valve 7 is arranged between the load feedback oil passage and an LS oil passage on the valve body. The first control and selection oil line 8.1, the second control and selection oil line 8.2 and the third control and selection oil line 8.3 are connected to an LSA oil passage, an LSB oil passage and an LS oil passage in a valve seat of the electric-control LS overflow valve 9, and the LSA oil passage, the LSB oil passage and the LS oil passage in the valve seat of the electric-control LS overflow valve 9 are connected to an oil inlet passage of the electric-control LS overflow valve 9. When the pressure of the LSA oil passage needs to be remotely controlled, the LSB oil passage and the LS oil passage in the valve seat of the electric-control LS overflow valve 9 can be blocked, only the LSA oil passage remains unblocked, and at this moment, the electric-control LS overflow valve 9 can remotely control the pressure of the LSA oil passage. The pressure of the LSB oil passage and the pressure of the LS oil passage can be remotely controlled in the same way.

Embodiment 3

[0042] As shown in FIG. 5, the first pilot control unit comprises a first electric proportional reversing valve 10.1, and the first pilot control oil line and the second pilot control oil line are led out from two outlets of the first electric proportional reversing valve 10.1 respectively; the second pilot control unit comprises a second electric proportional reversing valve 10.2, and the third pilot control oil line is led out from an outlet of the second electric proportional reversing valve 10.2; and the working link further comprises a control handle and a controller used for receiving a control signal from the control handle by means of a CAN bus, and the controller calculates the displacement of the first main valve core 1 and/or the second main valve core 2 according to the control signal and controls the first main valve core 1 and/or the second main valve core 2 to move by means of the corresponding first electric proportional reversing valve 10.1 and/or second electric proportional reversing valve 10.2. In the working process, an end cover of the control handle sends out a signal, the signal is transmitted to the controller by means of the CAN bus, the controller calculates the desired displacement of the first main valve core 1 and the desired displacement of the second main valve core 2 and outputs control current signals to the corresponding first electric proportional reversing valve 10.1 and second electric proportional reversing valve 10.2, the first electric proportional reversing valve 10.1 and the second electric proportional reversing valve 10.2 start to reverse to drive the first main valve core 1 and the second main valve core 2 to move, and the displacement of the valve cores is monitored in real time by means of displacement sensors; and when the desired displacement of the corresponding valve core is satisfied, the corresponding first electric proportional reversing valve 10.1 and/or second electric proportional reversing valve 10.2 is controlled to be powered off. When the first main valve

core 1 and the second main valve core 2 deviate from original positions due to leakage of the pilot oil lines of the first main valve core 1 and the second main valve core 2, the first electric proportional reversing valve 10.1 and the second electric proportional reversing valve 10.2 are powered on again. Therefore, the first electric proportional reversing valve 10.1 and the second electric proportional reversing valve 10.2 are power on and off frequently to maintain the first main valve core 1 and the second main valve core 2 at desired positions. The first electric proportional reversing valve 10.1 and the second electric proportional reversing valve 10.2 are both three-position four-way reversing valves.

[0043] An LS oil port and a load feedback oil passage are arranged on the first main valve core 1, the oil supply line is connected to the load feedback oil passage by means of the LS oil port, a first load-sensitive oil line and a second load-sensitive oil line are arranged on the valve body, a first LS overflow valve 6.1 is arranged on the first load-sensitive oil line, and a second LS overflow valve 6.2 is arranged on the second load-sensitive oil line; when oil flows out via the working oil port A and returns via the working oil port B, the load feedback oil passage is connected to the first load-sensitive oil line; when oil flows out via the working oil port B and returns via the working oil port A, the load feedback oil passage is connected to the second load-sensitive oil line; when the pressure of the working oil port A or the working oil port B exceeds the pressure of the corresponding LS overflow valve, the corresponding LS overflow valve is turned on, the pressure of the working oil port A or the working oil port B further rises, the pressure of the corresponding LS oil line will not rise anymore, the flow capacity of the compensation valve core 3 is reduced, and the flow of the actuator is decreased, thus fulfilling a safety protection effect; moreover, an LSA pressure measurement port and an LSB pressure measurement port can be arranged correspondingly to measure the pressure of corresponding LS oil lines.

[0044] In addition, a pressure measurement passage for the working oil port A, the working oil port B and P2 can be reserved on the valve body to measure the pressure of the working oil port A, the pressure of the working oil port B, the pressure of P and the pressure of P2, such that the flow and pressure of a main oil line are controlled by flow calculation control and pressure calculation control.

Embodiment 4

[0045] As shown in FIG. 6, the second main valve core 2 in the above embodiments is replaced with a plug 12; in a case where an LSA oil port, an LSB oil port and a load feedback oil passage are arranged on the first main valve core 1, the oil supply line is connected to the load feedback oil passage by means of the LSA oil port or the LSB oil port, a first load-sensitive oil line and a second load-sensitive oil line are arranged on the valve body, a first LS overflow valve 6.1 is arranged on the first load-sensitive oil line, and a second LS overflow valve 6.2 is arranged on the second load-sensitive oil line; when oil flows out via the working oil port A and returns via the working oil port B, the LSA oil port is connected to the first load-sensitive oil line by means of the load feedback oil passage; when oil flows out via the working oil port B and returns via the working oil port A, the LSB oil port is connected to the second load-sensitive oil line by means of the load feedback oil passage; a high pressure from the working oil port A or the working oil port B is guided to a spring cavity of a compensation valve as control oil, the compensation valve core 3 is provided with a spring, the pressure of a spring-free cavity is the same as the pressure of an oil inlet of the first main valve core 1, the pressure of a spring cavity is the same as the pressure of an oil outlet of the first main valve core 1, and a pressure difference between the oil inlet and the oil outlet of the first main valve core 1 is maintained approximately constant by means of the compensation valve, thus fulfilling the function of a traditional pre-compensation load-sensitive multi-way valve.

[0046] The working link provided by the invention is applied to a valve port impendent control type multi-way valve to realize separate control over an oil inlet and an oil outlet.

[0047] The valve port impendent control type multi-way valve provided by the invention is applied to an engineering machine to improve the overall performance of the machine.

[0048] Compared with the prior art, the working link, the valve port independent control type multi-way valve and the engineering machine provided by the embodiments of the invention have the following advantages: the working link can realize independent control over an oil inlet and an oil outlet, and can use a manual control mode, an electro-hydraulic proportion control mode, and a CAN bus control mode. The problem of mechanical and fixed connection of an oil inlet and an oil outlet of a traditional multi-way valve is solved, and the degree of freedom of control is increased; the problem of complex and unstable control over an existing port-independent valve is solved; moreover, the structure is simple, the flow control precision is high, the cost is low, and switching between a port-independent valve and a traditional pre-compensation load-sensitive multi-way valve can be achieved by means of the combination of different accessories. In addition, with the development of the sensor technology and the control technology in the future, flow calculation control and pressure calculation control can be realized on the premise of not changing the structure of the valve body; moreover, the second main valve core is replaced with a plug, and the pattern of a throttling opening in the first main valve core is changed, such that the function of a pre-compensation load-sensitive multi-way valve of a traditional structure can be achieved by means of the working link of this design, thereby improving the performance of the valve port independent control

type valve and even the performance of the engineering machine.

[0049] The above specific embodiments are not intended to limit the protection scope of the invention. Those skilled in the art should understand that, various amendments, combinations, sub-combinations and substitutions can be made depending on design requirements and other factors. Any amendments, equivalent substitutions and improvements made based on the spirit and principle of the invention should also fall within the protection scope of the invention.

Claims

1. A working link, comprising:

   a valve body, formed with an oil supply port P, a working oil port A and a working oil port B;
   a first main valve core, movably arranged in the valve body and used for controlling oil to flow out via the working oil port A and to return via the working oil port B or controlling oil to flow out via the working oil port B and to return via the working oil port A;
   a second main valve core, movably arranged in the valve body and used for controlling the quantity of oil entering the working link from the oil supply port P; and
   a pilot control module, comprising a first pilot control unit for controlling the first main valve core to move and a second pilot control unit for controlling the second main valve core to move.

2. The working link according to Claim 1, wherein an oil return port T1, an oil return port T2, an oil supply line and working oil lines are arranged on the valve body;

   the oil supply line is connected to the first main valve core from the oil supply port P via the second main valve core;
   the working oil lines comprise a first working oil line and a second working oil line, the first working oil line is formed between the first main valve core and the working oil port A, and the second working oil line is formed between the first main valve core and the working oil port B;
   when the first main control core controls oil to flow out via the working oil port A and to return via the working oil port B, the oil supply line is connected to the first working oil line, and the second working oil line is connected to the oil return port T2; when the first main valve core controls oil to flow out via the working oil port B and to return via the working oil port A, the oil supply line is connected to the second working oil line, the first working oil line is connected to the oil return port T1.

3. The working link according to Claim 2, wherein a first port overflow valve is arranged in the first working oil line, and a second port overflow valve is arranged in the second working oil line.

4. The working link according to Claim 1, further comprising a pressure difference control module, wherein the pressure difference control module is arranged between the oil supply port P and the second main valve core and used for controlling a pressure difference between an oil inlet and an oil outlet of the second main valve core to be constant.

5. The working link according to Claim 4, wherein the pressure difference control module is configured as a compensation valve core.

6. The working link according to Claim 1, wherein the first pilot control unit has a first pilot control oil line and a second pilot control oil line, and the first pilot control oil line and the second pilot control oil line are connected to two control cavities of the first main valve core respectively; and the second pilot control unit has a third pilot control oil line, and the third pilot control oil line is connected to a spring cavity of the second main valve core.

7. The working link according to Claim 6, wherein the first pilot control unit comprises a first electric proportional pressure reducing valve and a second electric proportional pressure reducing valve, the first pilot control oil line is led out from an outlet of the first electric proportional pressure reducing valve, and the second pilot control oil line is led out from an outlet of the second electric proportional pressure reducing valve; and the second pilot control unit comprises a third electric proportional pressure reducing valve, and the third pilot control oil line is led out from an outlet of the third electric proportional pressure reducing valve.

8. The working link according to Claim 6, wherein the first pilot control unit comprises a first electric proportional reversing valve, and the first pilot control oil line and the second pilot control oil line are led out from two outlets of the first electric proportional reversing valve respectively; and the second pilot control unit comprises a second electric proportional reversing valve, and the third pilot control oil line is led out from an outlet of the second electric proportional reversing valve.

9. The working link according to Claim 8, further comprising a control handle and a controller used for receiving a control signal from the control handle by means of a CAN bus, wherein the controller calcu-

lates a displacement of the first main valve core and/or the second main valve core according to the control signal and controls the first main valve core and/or the second main valve core to move by means of the corresponding first electric proportional reversing valve and/or second electric proportional reversing valve.

10. The working link according to Claim 1, wherein an LS oil port and a load feedback oil passage are arranged on the first main valve core, the oil supply line is connected to the load feedback oil passage by means of the LS oil port, a first load-sensitive oil line and a second load-sensitive oil line are arranged on the valve body, a first LS overflow valve is arranged on the first load-sensitive oil line, and a second LS overflow valve is arranged on the second load-sensitive oil line;

when oil flows out via the working oil port A and returns via the working oil port B, the load feedback oil passage is connected to the first load-sensitive oil line;
when oil flows out via the working oil port B and returns via the working oil port A, the load feedback oil passage is connected to the second load-sensitive oil line.

11. The working link according to Claim 10, further comprising an electric-control LS overflow valve, wherein an inlet of the electric-control LS overflow valve is connected to the load feedback oil passage, the first load-sensitive oil line or the second load-sensitive oil line.

12. The working link according to Claim 11, wherein a first control and selection oil line, a second control and selection oil line and a third control and selection oil line are arranged on the valve body, the first control and selection oil line is used for connecting the inlet of the electric-control LS overflow valve and the first load-sensitive oil line, the second control and selection oil line is used for connecting the inlet of the electric-control LS overflow valve and the second load-sensitive oil line, and the third control and selection oil line is used for connecting the inlet of the electric-control LS overflow valve and the load feedback oil line.

13. The working link according to Claim 1, wherein the second main valve core is replaced with a plug; an LSA oil port, an LSB oil port and a load feedback oil passage are arranged on the first main valve core, the oil supply line is connected to the load feedback oil passage by means of the LSA oil port or the LSB oil port, a first load-sensitive oil line and a second load-sensitive oil line are arranged on the valve body, a first LS overflow valve is arranged on the first load-sensitive oil line, and a second LS overflow valve is arranged on the second load-sensitive oil line;

when oil flows out via the working oil port A and returns via the working oil port B, the LSA oil port is connected to the first load-sensitive oil line by means of the load feedback oil passage;
when oil flows out via the working oil port B and returns via the working oil port A, the LSB oil port is connected to the second load-sensitive oil line by means of the load feedback oil passage.

14. A valve port independent control type multi-way valve, comprising one or more said working links according to any one of Claims 1-13.

15. An engineering machine, comprising the valve port independent control type multi-way valve according to Claim 14.

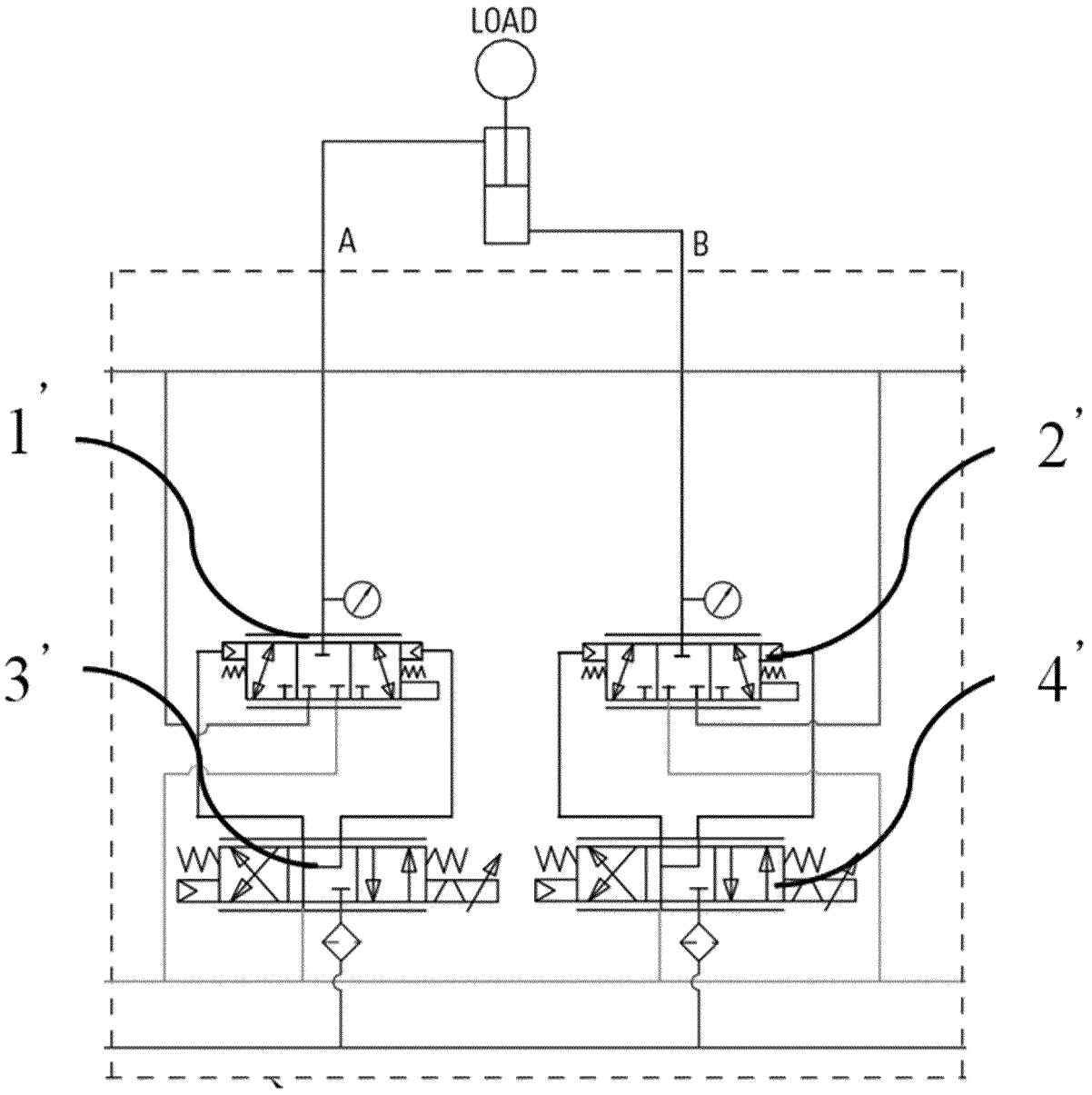

FIG. 1

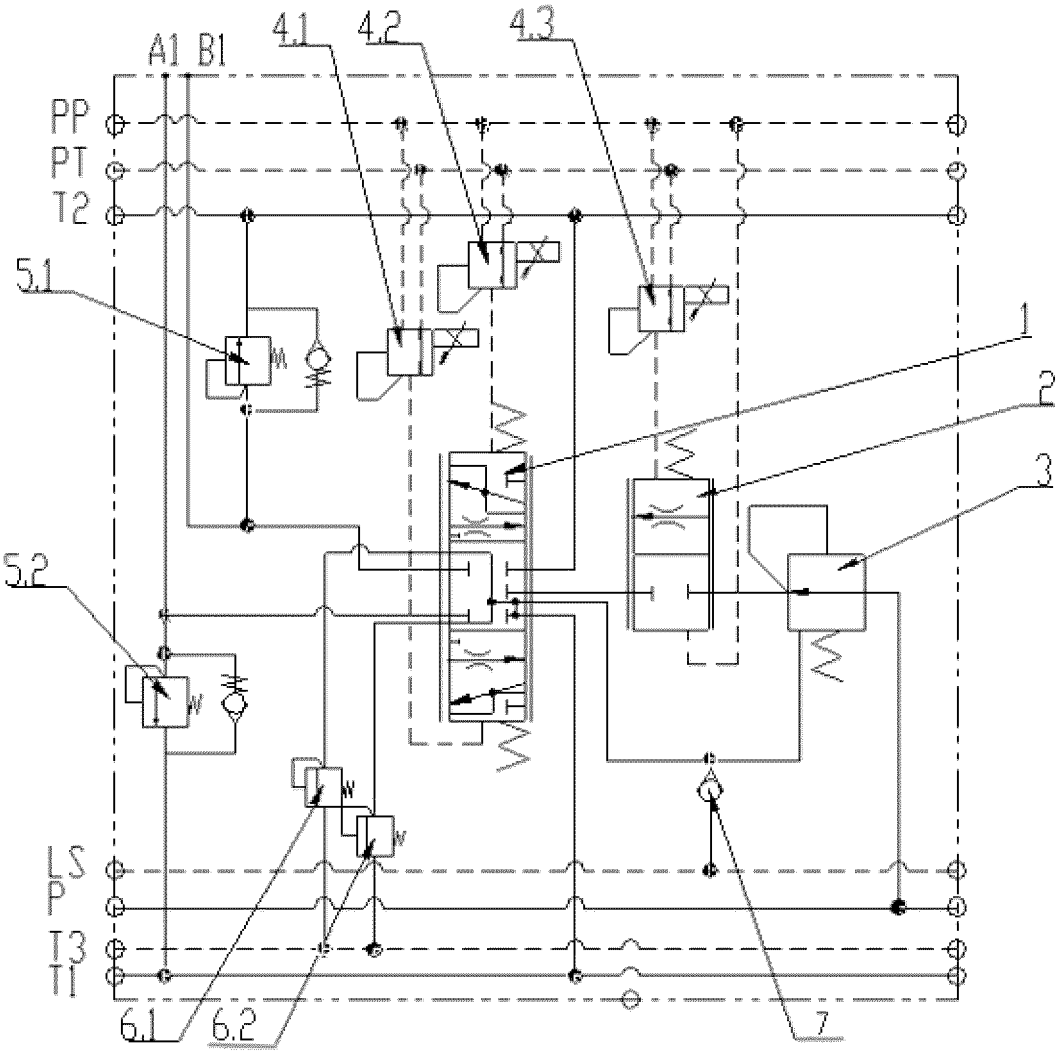

FIG. 2

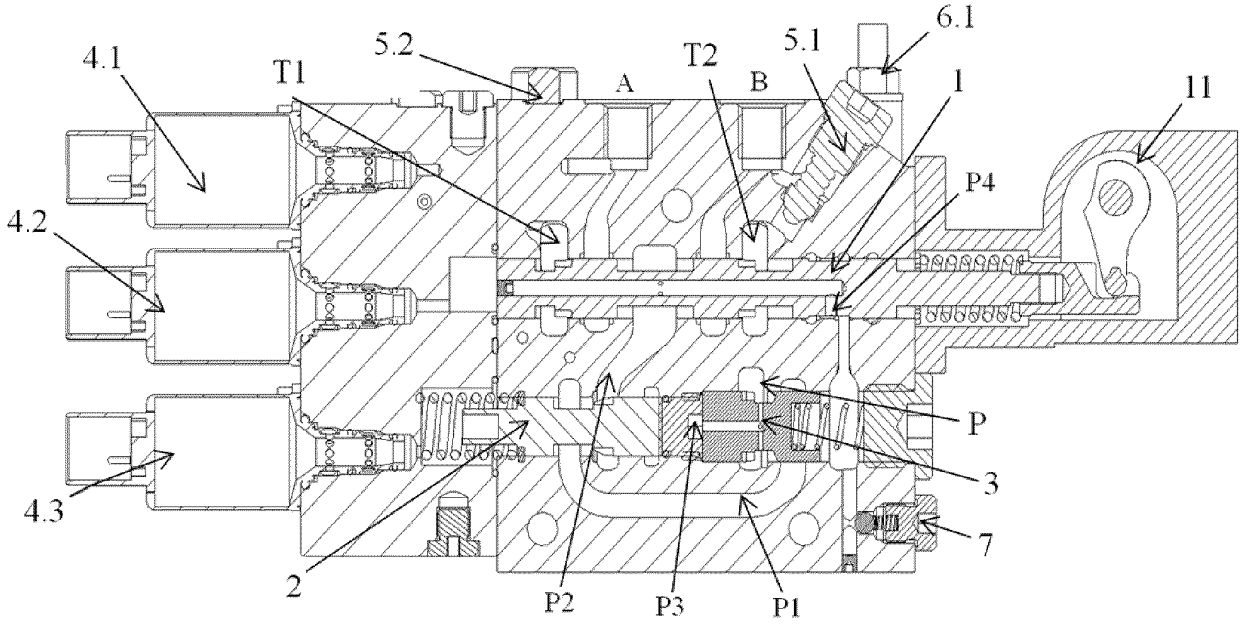

FIG. 3

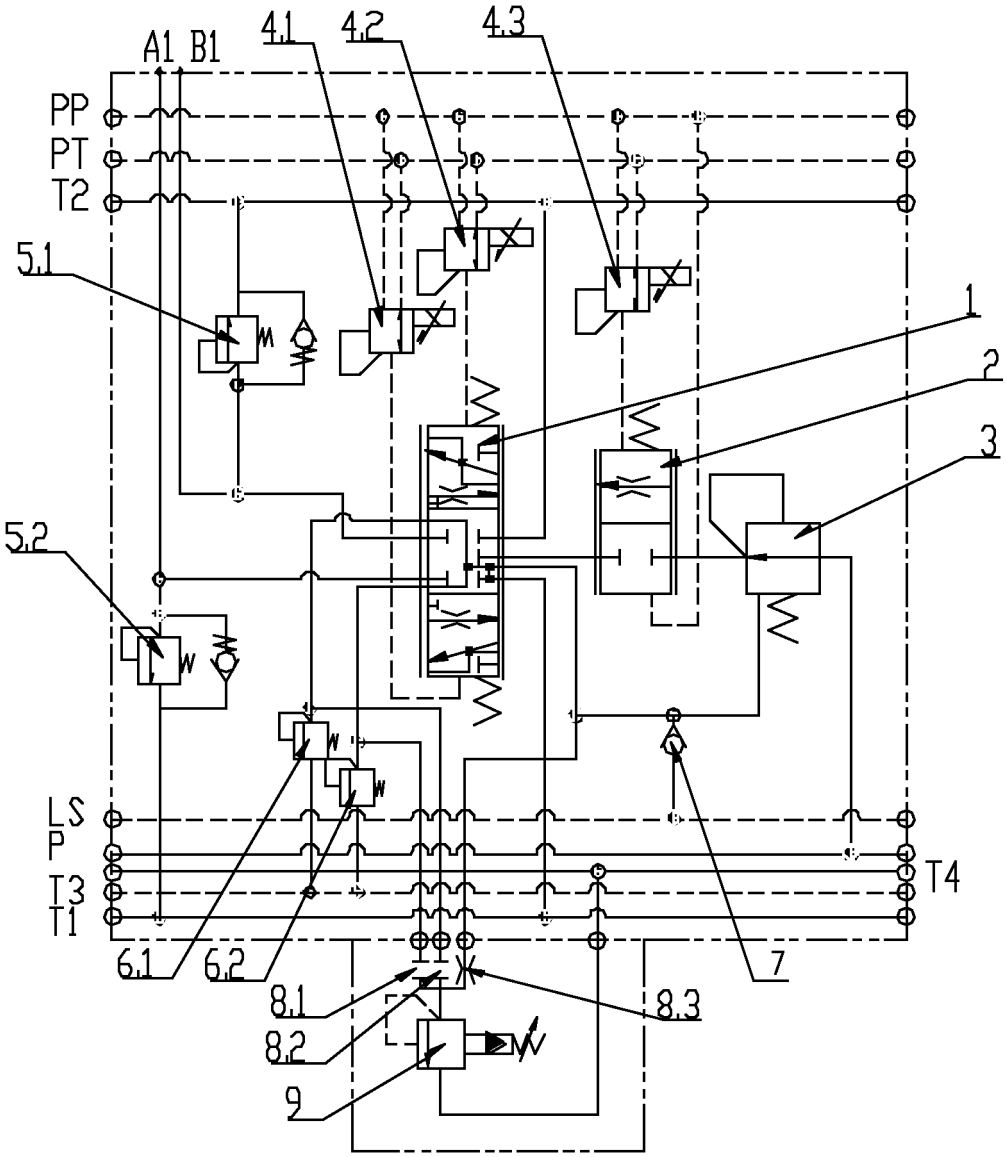

FIG. 4

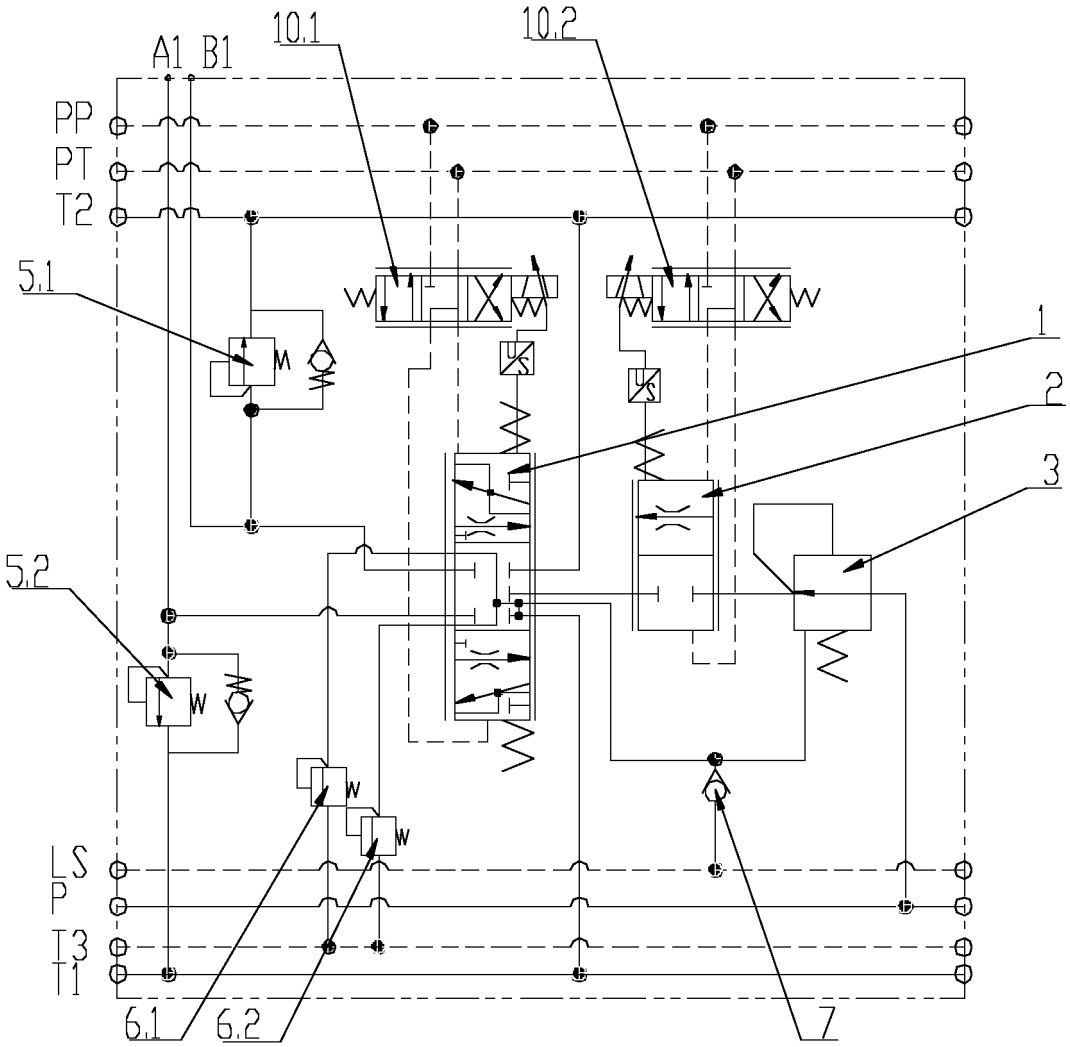

FIG. 5

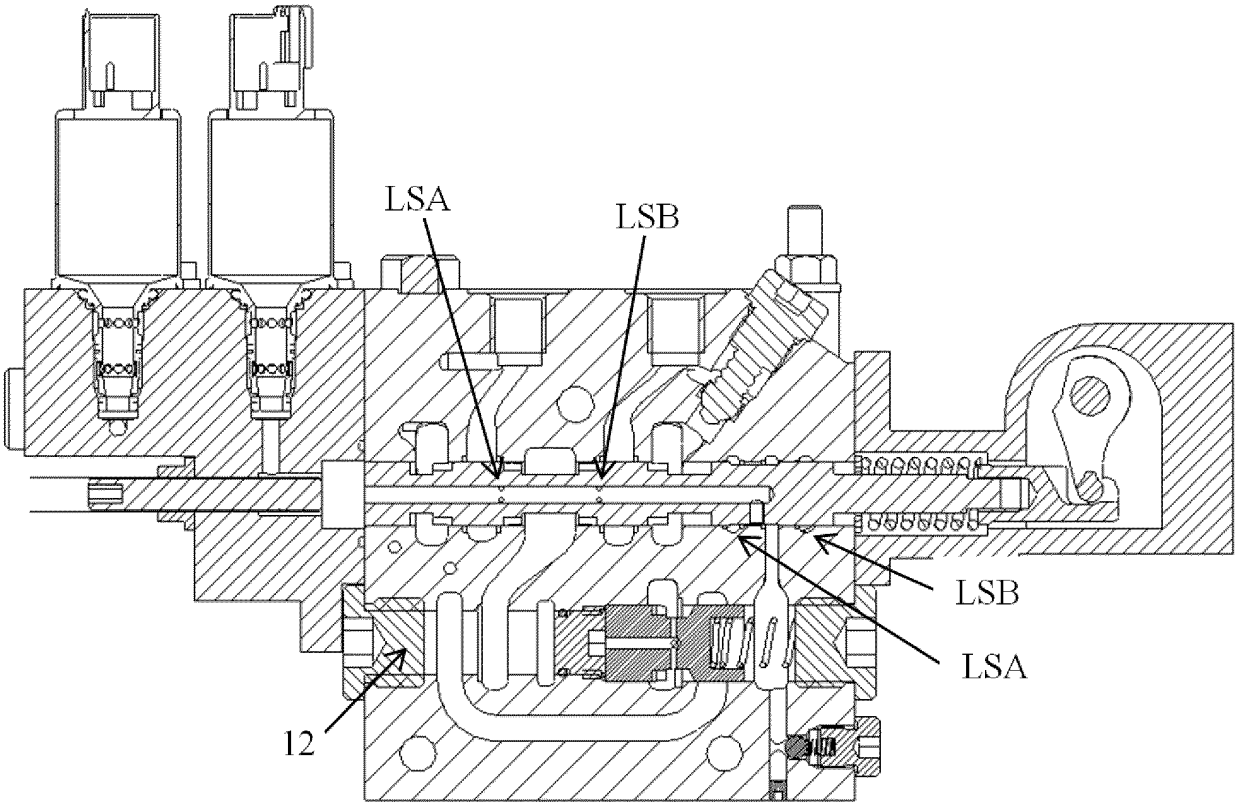

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/077059

A. CLASSIFICATION OF SUBJECT MATTER

F15B 13/02(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)

F15B

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, EPODOC, WPI: 工作联, 阀口, 控制, 多路, 阀芯, 出油, 回油, 压力, 补偿, work unit, valve, port, control, way, core, inlet, outlet, oil, pressure, compensation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 108252979 A (XCMG CONSTRUCTION MACHINERY CO., LTD.) 06 July 2018 (2018-07-06) description, paragraphs 23-62, and figures 1-6	1-9, 14-15
Y	CN 109441905 A (TAIYUAN UNIVERSITY OF TECHNOLOGY) 08 March 2019 (2019-03-08) description, paragraphs 25-50, and figure 6	1-9, 14-15
A	CN 106762916 A (XCMG CONSTRUCTION MACHINERY CO., LTD.) 31 May 2017 (2017-05-31) entire document	1-15
A	CN 105840574 A (XCMG CONSTRUCTION MACHINERY CO., LTD.) 10 August 2016 (2016-08-10) entire document	1-15
A	US 2020386245 A1 (PARKER HANNIFIN CORP.) 10 December 2020 (2020-12-10) entire document	1-15

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"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
04 July 2022	**17 August 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China**	Authorized officer
Facsimile No. **(86-10)62019451**	Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/077059

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CN 106762916 A	31 May 2017	None	
CN 105840574 A	10 August 2016	DE 102016200458 A1	21 July 2016
US 2020386245 A1	10 December 2020	EP 3752683 A1	23 December 2020
		WO 2019157429 A1	15 August 2019
		KR 20200105919 A	09 September 2020

Form PCT/ISA/210 (patent family annex) (January 2015)