

CIRCUIT SWITCHING VALVE, CHASSIS HYDRAULIC SYSTEM FOR CRAWLER CRANE, AND CRAWLER CRANE

TECHNICAL FIELD

[0001] The invention belongs to the technical field of crawler cranes, and particularly relates to a circuit switching valve, a chassis hydraulic system for a crawler crane, and a crawler crane.

BACKGROUND

[0002] At present, traveling, hoisting, and disassembly for transport of crawler cranes still rely on hydraulic drive. The crawler cranes have the function of hoisting, luffing, revolving and traveling. The chassis of small crawler cranes less than hundreds of tons has a wide-gauge mode and a narrow-gauge mode, wherein the narrow-gauge mode is suitable for operation in narrow places, the wide-gauge mode is suitable for spacious places and can improve the hoisting capacity, and switching between the wide-gauge mode and the narrow-gauge mode is realized by controlling a gauge-control hydraulic cylinder to stretch or retract. When a crawler crane is disassembled for transport, chassis outrigger cylinders are jacked up, then a crawler frame is disassembled to transport different parts respectively so as to reduce the maximum transport weight; or, the crawler crane is switched to the narrow-gauge mode by means of the gauge-control hydraulic cylinder to be directly driven onto a transport cart to reduce the transport width. Chassis traveling, switching between the wide-gauge mode and the narrow-gauge mode, and outrigger motions of the crawler cranes are realized by a hydraulic system.

[0003] To save resources and optimize costs when crawler cranes are manufactured and to save fuel in use of the crawler cranes, the weight, number and complexity of parts should be minimized and controlled in design, which is of great importance especially for technical research of parts of the hydraulic system which constitutes a large proportion of the value of the crawler cranes.

[0004] To effectively reduce the number and weight of hydraulic pumps and hydraulic valves in the hydraulic system of the crawler crane and reduce the connection complexity of the chassis and the turntable hydraulic system of the crawler crane, switching between a traveling circuit and a gauge control circuit or an outrigger cylinder circuit can be implemented by a circuit switching valve so as to save resources and optimize costs when the crawler crane is manufactured.

[0005] Existing crawler cranes typically adopt two types of chassis systems: an independent multi-circuit chassis hydraulic system and a circuit-switchable chassis hydraulic system.

[0006] The independent multi-circuit chassis hydraulic system comprises a chassis travel motor

circuit and a gauge control cylinder circuit or an outrigger cylinder circuit, which are respectively controlled by multiple groups of different pumps and control valves of a turntable of the crawler crane, two or three hydraulic pumps and a hydraulic circuit formed by two or three corresponding control valves are often configured on the turntable of the crawler crane, and a central revolving body has a large number of channels (eight channels).

[0007] Switching between a chassis travel motor circuit and a gauge control cylinder circuit or an outrigger cylinder circuit in the circuit-switchable chassis hydraulic system is realized by means of a circuit switching valve, and the circuit-switchable chassis hydraulic system is obviously superior to the independent multi-circuit chassis hydraulic system in reducing the number and weight of elements and lowering the complexity, and is widely applied to crawler cranes less than hundreds of tons, that have the maximum yield.

[0008] The circuit switching valve is a key component in the circuit-switchable chassis hydraulic system. The circuit-switchable chassis hydraulic system typically adopts multi-way reversing valves (hydraulic switches) imported from foreign countries or domestic hydraulic valves based on the same principle and structure. However, such hydraulic valves have the following drawbacks:

[0009] (1) The multi-way reversing valve cannot realize complete zero leakage due to a fit clearance between the valve rod and the valve body, and the fit clearance can only be controlled within 1-10 μ m; in case of a large clearance or an increase in the circuit pressure during the manufacturing process, internal leakage will be aggravated, and high-pressure oil in an operating circuit may flow to a non-operating circuit; an excessive pressure in the outrigger cylinder or the gauge control cylinder or slow and automatic stretching and retraction of the outrigger cylinder or the gauge control cylinder will be caused occasionally;

[0010] (2) A travel motor brake may be started and the travel motor may rotate slowly without an operation instruction, leading to a risk to some extent; such a risk will not be observed with naked eyes at the beginning, so measures cannot be taken in time, and the risk may occur occasionally;

[0011] (3) When the crawler crane suffers from a server change of the environmental temperature, for example, the crawler crane is exposed to the sun or transported from a low-temperature environment to a high-temperature environment, if the multi-way reversing valve in the chassis hydraulic system has good sealing performance, it is difficult for hydraulic oil in a non-operating circuit connected to the reversing valve to leak, a sealed cavity will be formed to some extent and will expand with the rise of the temperature in the sealed cavity, and the elasticity modulus of hydraulic oil is large, so an excessive pressure will be caused with the increase of the

pressure in the gauge control cylinder circuit or the outrigger cylinder circuit, leading to slow and automatic stretching of the cylinders in absence of an instruction or damage to sealing and structural parts of the cylinders, and these undesirable phenomena have been found in the long-term tracking process.

SUMMARY

[0012] To overcome the defects in the prior art, the invention provides a circuit switching valve, a chassis hydraulic system for a crawler crane, and a crawler crane, which solve the problems of leakage, oil flow to a non-operating circuit and excessive pressure of multi-way reversing valves in the prior art during circuit switching, and also solve the problems of excessive pressure, stretching and retraction of a gauge control cylinder and an outrigger cylinder and excessive pressure and rotation of travel motors of a chassis hydraulic system of a crawler crane in absence of an instruction caused by a circuit switching valve, thus greatly improving system reliability and reducing the requirements of equipment management staff and users for routine inspection and maintenance of equipment.

[0013] To fulfill the above purpose, the technical solution adopted by the invention is as follows:

[0014] In a first aspect, the invention provides a circuit switching valve, comprising a valve body and a valve spool arranged in the valve body, wherein the valve spool comprises a valve spool oil drain channel arranged in the valve spool, and the valve body comprises an oil drain port, a valve body oil drain channel arranged in the valve body, and a plurality of oil inlets and working ports; the oil inlets are connected to the corresponding working ports in an operating state, and the working ports in a non-operating state are connected to the oil drain port by means of the valve spool oil drain channel and the valve body oil drain channel to discharge hydraulic oil from the working ports in the non-operating state to prevent misoperation.

[0015] Further, the valve spool oil drain channel comprises valve spool oil drain ring-grooves connected to the working ports in the non-operating state, a plurality of valve spool radial oil drain holes connected to the valve spool oil drain ring-grooves, and a valve spool oil drain collection hole connected to the valve spool radial oil drain holes, and the valve spool oil drain ring-grooves are connected to the valve body oil drain channel.

[0016] Further, the valve body oil drain channel comprises a plurality of valve body radial oil drain holes connected to the valve spool oil drain ring-grooves, valve body oil drain ring-grooves connected to the valve body radial oil drain holes, and a valve body oil drain collection hole connected to the valve body oil drain ring-groove, and the valve body oil drain collection hole is connected to the oil drain port.

[0017] Further, the oil inlets comprise a first oil inlet and a second oil inlet, and the working ports comprises a first working port, a second working port, a third working port and a fourth working port; and the valve body is further provided with a control port (PX) used for controlling the valve spool to reverse.

[0018] Further, in absence of a control pressure at the control port, the first oil inlet is connected to the first working port, the second oil inlet is connected to the second working port, and the first working oil port and the second working port are in the operating state; and the third working port and the fourth working port are in the non-operating state and are connected to the oil drain port by means of the valve spool oil drain channel and the valve body oil drain channel.

[0019] Further, in presence of a control pressure at the control port, the first oil inlet is connected to the third working port, the second oil inlet is connected to the fourth working port, and the third working port and the fourth working port are in the operating state; and the first working port and the second working port are in the non-operating state and are connected to the oil drain port by means of the valve spool oil drain channel and the valve body oil drain channel.

[0020] In a second aspect, the invention provides a chassis hydraulic system for a crawler crane, comprising the circuit switching valve in the first aspect, wherein the first oil inlet, the second oil inlet, the control port and the oil drain port of the circuit switching valve are connected to a turntable hydraulic system; the first working port and the second working port of the circuit switching valve are connected to a first working device; and the third working port and the fourth working port of the circuit switching valve are connected to a second working device.

[0021] Further, the first working device is a left travel motor, and the second working device is a gauge control cylinder; or, the first working device is a left travel motor, and the second working device comprises a chassis outrigger multi-way valve, and the chassis outrigger multi-way valve is connected to an outrigger cylinder and a gauge control cylinder.

[0022] Further, in absence of a control pressure at the control port, the first working device is in an operating state; the second working device is in a non-operating state; and if hydraulic oil leaks from the first working device into the second working device by means of the circuit switching valve, the hydraulic oil leaking into the second working device is discharged by means of the valve spool oil drain channel, the valve body oil drain channel and the oil drain port in the circuit switching valve to prevent misoperation of the second working device.

[0023] Further, in presence a control pressure at the control port, the second working device in in an operating state; the first working device is in a non-operating state; and if hydraulic oil leaks from the second working device into the first working device by means of the circuit switching valve, the hydraulic oil leaking into the first working device is discharged by means of the valve

spool oil drain channel, the valve body oil drain channel and the oil drain port in the circuit switching valve to prevent misoperation of the first working device.

[0024] In a third aspect, the invention provides a crawler crane, comprising the chassis hydraulic system for a crawler crane in the second aspect.

[0025] Compared with the prior art, the invention fulfills the following beneficial effects: the circuit switching valve comprises a valve body and a valve spool arranged in the valve body, the valve spool comprises a valve spool oil drain channel arranged in the valve spool, the valve body comprises an oil drain port, a valve body oil drain channel arranged in the valve body, and a plurality of oil inlets and working ports; the oil inlets are connected to the corresponding working ports in an operating state, and the working ports in a non-operating state are connected to the oil drain port by means of the valve spool oil drain port and the valve body oil drain channel to discharge hydraulic oil from the working ports in the non-operating state to prevent misoperation. The invention solves the problems of leakage, oil flow to a non-operating circuit and excessive pressure of multi-way reversing valves in the prior art during circuit switching, and also solves the problems of excessive pressure, stretching and retraction of a gauge control cylinder and an outrigger cylinder and excessive pressure and rotation of travel motors of a chassis hydraulic system of a crawler crane in absence of an instruction caused by a circuit switching valve, thus greatly improving system reliability and reducing the requirements of equipment management staff and users for routine inspection and maintenance of equipment.

BRIEF DESCRIPTION OF DRAWINGS

[0026] FIG. 1 is a schematic structural diagram of a circuit switching valve in absence of a control pressure at a control end according to one embodiment of the invention;

[0027] FIG. 2 is a schematic structural diagram of the circuit switching valve in presence of a control pressure at the control end according to one embodiment of the invention;

[0028] FIG. 3 is a schematic structural diagram of a valve spool in the circuit switching valve according to one embodiment of the invention;

[0029] FIG. 4 is a schematic sectional view of the circuit switching valve in absence of a control pressure at the control end according to one embodiment of the invention;

[0030] FIG. 5 is a schematic sectional view of the circuit switching valve in presence of a control pressure at the control end according to one embodiment of the invention;

[0031] FIG. 6 is a first schematic diagram of a chassis hydraulic system for a crawler crane according to one embodiment of the invention;

[0032] FIG. 7 is a second schematic diagram of the chassis hydraulic system for a crawler crane

according to one embodiment of the invention;

[0033] In the FIGS: L, oil drain port; P1, first oil inlet; P2, second oil inlet; A1, first working port; A2, second working port; C1, third working port; C2, fourth working port; PX, control port; 11, valve spool oil drain ring-groove; 12, valve spool radial oil drain hole; 13, valve spool oil drain collection hole; 22, valve body radial oil drain hole; 23, valve body oil drain collection hole.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0034] The invention is described in further detail below in conjunction with accompanying drawings. The following embodiments are merely used for more clearly explaining the technical solutions of the invention and are not intended to limit the protection scope of the invention.

[0035] Embodiment 1:

[0036] As shown in FIGS. 1-5, a circuit switching valve comprises a valve body and a valve spool arranged in the valve body, wherein the valve spool comprises a valve spool oil drain channel arranged in the valve spool, and the valve body comprises an oil drain port L, a valve body oil drain channel arranged in the valve body, and a plurality of oil inlets and working ports; the oil inlets are connected to the corresponding working ports in an operating state, and the working ports in a non-operating state are connected to the oil drain port L by means of the valve spool oil drain port and the valve body oil drain port to discharge hydraulic oil from the working ports in the non-operating state to prevent misoperation.

[0037] In the invention, the oil inlets comprise a first oil inlet P1 and a second oil inlet P2, and the working ports comprise a first working port A1, a second working port A2, a third working port C1 and a fourth working port C2; and the valve body is further provided with a control port PX used for controlling the valve spool to reverse. The circuit switching valve provided by the invention has a two-position six-way reversing function and realizes multi-way reversing by means of a hydraulic pilot pressure.

[0038] As shown in FIG. 1, in absence of a control pressure at the control port PX, the first oil inlet P1 is connected to the first working port A1, the second oil inlet P2 is connected to the second working port A2, and the first working port A1 and the second working port A2 are in the operating state; and the third working port C1 and the fourth working port C2 are in the non-operating state and are connected to the oil drain port L1 by means of a damping channel in the valve spool (the valve spool oil drain channel) and a damping channel in the valve body (the valve body oil drain channel).

[0039] As shown in FIG. 2, in presence of a control pressure at the control port PX, the first oil inlet P1 is connected to the third working port C1, the second oil inlet P2 is connected to the fourth

working port C2, and the third working port C1 and the fourth working port C2 are in the operating state; and the first working port A1 and the second working port A2 are in the non-operating state and are connected to the oil drain port L by means of the valve spool oil drain channel and the valve body oil drain channel.

[0040] By means of a double-oil drain channel structure formed by the damping channel in the valve spool and the damping channel formed in the valve body, the defects in the prior art are fundamentally overcome; and the pressure in oil ports in the non-operating state is transmitted to the damping channel in the valve body by means of the damping channel in the valve spool and is finally released by means of the oil drain port L.

[0041] As shown in FIGS. 3-5, the double-oil drain channel structure is specifically as follows:

[0042] the valve spool oil drain channel comprises valve spool oil drain ring-grooves 11 connected to the working ports in the non-operating state, a plurality of valve spool radial oil drain holes 12 connected to the valve spool oil drain ring-grooves 11, and a valve spool oil drain collection hole 13 connected to the valve spool radial oil drain holes 12, and the valve spool oil drain ring-grooves 11 are connected to the valve body oil drain channel L2.

[0043] As shown in FIG. 3, the valve spool oil drain channel is formed by three valve spool oil drain ring-grooves 11, three valve spool radial oil drain holes 12 and a valve spool oil drain collection hole 13. The valve spool oil drain ring-grooves 11 located at two ends of the valve spool are connected to the valve body oil drain channel.

[0044] The valve body oil drain channel comprises a plurality of valve body radial oil drain holes 22 connected to the valve spool oil drain ring-grooves 11, valve body oil drain ring-grooves connected to the valve body radial oil drain holes 22, and a valve body oil drain collection hole 23 connected to the valve body oil drain ring-grooves, and the valve body oil drain collection hole 23 is connected to the oil drain port L.

[0045] The circuit switching valve provided with the double-oil drain channel structure has two states, as shown in Table 1:

[0046] Table 1 Comparison of two operating states of the circuit switching valve provided with the double-oil drain channel structure

Two states	PX control pressure	Connection state of working ports	Connection state of double-oil oil drain channel structure
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State 1	Existent	P1 is connected to C1 P2 is connected to C2	A1, A2 → valve spool oil drain ring-grooves → valve spool radial oil drain holes → valve spool oil drain collection hole → valve body radial oil drain holes → valve body oil drain ring-grooves → valve body oil drain collection hole → L
State 2	Non- existent	P1 is connected to A1 P2 is connected to A2	C1, C2 → valve spool oil drain ring-grooves → valve spool radial oil drain holes → valve spool oil drain collection hole → valve body radial oil drain holes → valve body oil drain ring-grooves → valve body oil drain collection hole → L

[0047] The circuit switching valve provided with the double-oil drain channel structure solves the problems of leakage, oil flow to a non-operating circuit and excessive pressure of multi-way reversing valves in the prior art during circuit switching, and also solves the problems of excessive pressure, stretching and retraction of a gauge control cylinder and an outrigger cylinder and excessive pressure and rotation of travel motors of a chassis hydraulic system of a crawler crane in absence of an instruction caused by a circuit switching valve, thus greatly improving system reliability and reducing the requirements of equipment management staff and users for routine inspection and maintenance of equipment.

[0048] Embodiment 2:

[0049] Based on the circuit switching valve in Embodiment 1, this embodiment provides a chassis hydraulic system for a crawler crane, wherein the first oil inlet P1, the second oil inlet P2, the control port PX and the oil drain port L of the circuit switching valve are connected to a turntable hydraulic system; the first working port A1 and the second working port A2 of the circuit switching valve are connected to a first operating device; and the third working port C1 and the fourth working port C2 of the circuit switching valve are connected to a second operating device.

[0050] As shown in FIG. 6, the first operating device is a left travel motor, and the second operating device is a gauge control cylinder. In absence of a working pressure at the control port PX, the left travel motor operates, and oil and pressure may be transmitted from a travel motor circuit A1/A2 to the gauge control cylinder, and in this case, the oil and pressure are transmitted to the oil drain port L by means of the double-oil drain channel structure of the circuit switching valve to be released to prevent misoperation of the gauge control cylinder. In presence of a working pressure of the control port PX, the crawler gauge control cylinder operates, oil and pressure may be transmitted from C1/C2 to A1/A2, and in this case, the oil and pressure are transmitted to the

oil drain port L by means of the double-oil drain channel structure of the circuit switching valve to be released to prevent misoperation of the left travel motor.

[0051] As shown in FIG. 7, the first working device is a left travel motor, and the second working device comprises a chassis outrigger multi-way valve, and the chassis outrigger multi-way valve is connected to an outrigger cylinder and a gauge control cylinder. In absence of a working pressure at the control port PX, the left travel motor operates, and oil and pressure may be transmitted from a travel motor circuit A1/A2 to the gauge control cylinder, and in this case, the oil and pressure are transmitted to the oil drain port L by means of the double-oil drain channel structure of the circuit switching valve to be released to prevent misoperation of the gauge control cylinder and the outrigger cylinder. In presence of a working pressure of the control port PX, the crawler gauge control cylinder or the outrigger cylinder operates, oil and pressure may be transmitted from C1/C2 to A1/A2, and in this case, the oil and pressure are transmitted to the oil drain port L by means of the double-oil drain channel structure of the circuit switching valve to be released to prevent misoperation of the left travel motor.

[0052] The circuit switching valve, the double-oil drain channel structure and the chassis hydraulic system for a crawler crane provided by the invention have the following advantages:

[0053] (a) The circuit switching valve solves in principle the problems caused by leakage, oil flow to a non-operating circuit and excessive pressure between oil ports of traditional multi-way reversing valves.

[0054] (b) The double-oil drain channel structure ingeniously realizes safe pressure and oil release of four oil ports by means of three oil drain ring-grooves, three radial oil drain holes and an oil drain collection hole in the valve spool, an oil drain channel in the valve body, and switching between two operating states.

[0055] (c) The chassis hydraulic system for a crawler crane provided by the invention solves the problems of excessive pressure, stretching and retraction of a gauge control cylinder and an outrigger cylinder and excessive pressure and rotation of travel motors of a chassis hydraulic system of a crawler crane in absence of an instruction caused by a circuit switching valve, thus greatly improving system reliability and reducing the requirements of equipment management staff and users for routine inspection and maintenance of equipment.

[0056] Embodiment 3:

[0057] Based on the circuit switching valve in Embodiment 1 and the chassis hydraulic system for a crawler crane in Embodiment 2, this embodiment provides a crawler crane, which is provided with the circuit switching valve in Embodiment 1 or the chassis hydraulic system for a crawler crane in Embodiment 2.

[0058] The above embodiments are merely preferred ones of the invention. It should be noted that those ordinarily skilled in the art can make some improvements and transformations without departing from the technical principle of the invention, and all these improvements and transformations should also fall within the protection scope of the invention.

What is claimed is:

1. A circuit switching valve, comprising a valve body and a valve spool arranged in the valve body, wherein the valve spool comprises a valve spool oil drain channel arranged in the valve spool, and the valve body comprises an oil drain port (L), a valve body oil drain channel arranged in the valve body, and a plurality of oil inlets and working ports;

the oil inlets are connected to the corresponding working ports in an operating state, and the working ports in a non-operating state are connected to the oil drain port (L) by means of the valve spool oil drain channel and the valve body oil drain channel to discharge hydraulic oil from the working ports in the non-operating state to prevent misoperation.

2. The circuit switching valve according to Claim 1, wherein the valve spool oil drain channel comprises:

valve spool oil drain ring-grooves (11) connected to the working ports in the non-operating state;

a plurality of valve spool radial oil drain holes (12) connected to the valve spool oil drain ring-grooves (11); and

a valve spool oil drain collection hole (13) connected to the valve spool radial oil drain holes (12);

the valve spool oil drain ring-grooves (11) are connected to the valve body oil drain channel (L2).

3. The circuit switching valve according to Claim 2, wherein the valve body oil drain channel comprises:

a plurality of valve body radial oil drain holes (22) connected to the valve spool oil drain ring-grooves (11);

valve body oil drain ring-grooves connected to the valve body radial oil drain holes (22); and

a valve body oil drain collection hole (23) connected to the valve body oil drain ring-groove;

the valve body oil drain collection hole (23) is connected to the oil drain port (L).

4. The circuit switching valve according to Claim 3, wherein the oil inlets comprise a first oil inlet (P1) and a second oil inlet (P2), and the working ports comprises a first working port (A1), a second working port (A2), a third working port (C1) and a fourth working port (C2); and the valve body is further provided with a control port (PX) used for controlling the valve spool to reverse.

5. The circuit switching valve according to Claim 4, wherein,

in absence of a control pressure at the control port (PX), the first oil inlet (P1) is connected to the first working port (A1), the second oil inlet (P2) is connected to the second working port (A2), and the first working oil port (A1) and the second working port (A2) are in the operating

state; and the third working port (C1) and the fourth working port (C2) are in the non-operating state and are connected to the oil drain port (L) by means of the valve spool oil drain channel and the valve body oil drain channel.

6. The circuit switching valve according to Claim 4, wherein,

in presence of a control pressure at the control port (PX), the first oil inlet (P1) is connected to the third working port (C1), the second oil inlet (P2) is connected to the fourth working port (C2), and the third working port (C1) and the fourth working port (C2) are in the operating state; and the first working port (A1) and the second working port (A2) are in the non-operating state and are connected to the oil drain port (L) by means of the valve spool oil drain channel and the valve body oil drain channel.

7. A chassis hydraulic system for a crawler crane, comprising the circuit switching valve according to any one of Claims 4-6, wherein,

the first oil inlet (P1), the second oil inlet (P2), the control port (PX) and the oil drain port (L) of the circuit switching valve are connected to a turntable hydraulic system; the first working port (A1) and the second working port (A2) of the circuit switching valve are connected to a first working device; and the third working port (C1) and the fourth working port (C3) of the circuit switching valve are connected to a second working device.

8. The chassis hydraulic system for a crawler crane according to Claim 7, wherein the first working device is a left travel motor, and the second working device is a gauge control cylinder;

or, the first working device is a left travel motor, and the second working device comprises a chassis outrigger multi-way valve, and the chassis outrigger multi-way valve is connected to an outrigger cylinder and a gauge control cylinder.

9. The chassis hydraulic system for a crawler crane according to Claim 7, wherein,

in absence of a control pressure at the control port (PX), the first working device is in an operating state; the second working device is in a non-operating state; and if hydraulic oil leaks from the first working device into the second working device by means of the circuit switching valve, the hydraulic oil leaking into the second working device is discharged by means of the valve spool oil drain channel, the valve body oil drain channel and the oil drain port (L) in the circuit switching valve to prevent misoperation of the second working device.

10. The chassis hydraulic system for a crawler crane according to Claim 7, wherein,

in presence a control pressure at the control port (PX), the second working device in in an operating state; the first working device is in a non-operating state; and if hydraulic oil leaks from the second working device into the first working device by means of the circuit switching valve, the hydraulic oil leaking into the first working device is discharged by means of the valve spool

oil drain channel, the valve body oil drain channel and the oil drain port (L) in the circuit switching valve to prevent misoperation of the first working device.

11. A crawler crane, comprising the chassis hydraulic system for a crawler crane according to any one of Claims 7-10.