

ROTARY HYDRAULIC SYSTEM, ENGINEERING MACHINERY, AND ROTARY CONTROL METHOD

TECHNICAL FIELD

[0001] The present application relates to the technical field of construction machines, and in particular to a slewing hydraulic system, a construction machine and a slewing control method.

BACKGROUND

[0002] The crane is mainly composed of four major moving parts: the boom telescopic mechanism, the boom derricking mechanism, the turntable slewing mechanism, and the hoisting mechanism. The turntable slewing mechanism is referred to as the slewing mechanism. The main function of the turntable slewing mechanism is to drive the turntable and the boom to rotate based on the center line of the turntable, thereby placing the hoisted weight in the required direction. The turntable slewing mechanism is mainly composed of a motor and a brake. By controlling the speed and steering of the motor, the slewing speed and direction of the turntable can be controlled.

[0003] With the development of small and medium tonnage cranes, the requirements for the stability and comfort of the slewing systems are getting higher and higher. In the related art, the flow and pressure are controlled by diverting the flow through the slewing control valve. However, there is a pressure overshoot during the slewing process, resulting in unstable starting and braking.

SUMMARY

[0004] The present application provides a slewing hydraulic system, a construction machine and a slewing control method, aiming to solve the problem that the pressure overshoot will occur in the slewing system of the related art during the slewing process, resulting in unstable starting and braking.

[0005] The present application provides a slewing hydraulic system, a construction machine and a slewing control method. The slewing hydraulic system includes: a first pipeline configured

to transport hydraulic oil; a second pipeline configured to transport hydraulic oil; a motor provided with a first oil port and a second oil port, the first oil port communicating with a first end of the first pipeline, and the second oil port communicating with a first end of the second pipeline; a proportional relief valve provided with an inlet and an outlet, the inlet of the proportional relief valve communicating with the first pipeline and the second pipeline respectively, and the outlet of the proportional relief valve communicating with the first pipeline and the second pipeline respectively; a first one-way valve provided between the outlet of the proportional relief valve and the first pipeline, the first one-way valve being configured to conduct the outlet of the proportional relief valve to the first pipeline; and a second one-way valve provided between the outlet of the proportional relief valve and the second pipeline, the second one-way valve being configured to conduct the outlet of the proportional relief valve to the second pipeline.

[0006] The slewing hydraulic system of the present application further includes a slewing reversing valve and a proportional pressure reducing valve. The slewing reversing valve is provided with a first inlet, a second inlet, a third inlet and a fourth inlet. A second end of the first pipeline communicates with the first inlet of the slewing reversing valve, a second end of the second pipeline communicates with the second inlet of the slewing reversing valve, the third inlet of the slewing reversing valve communicates with an oil supply pipeline, and the fourth inlet of the slewing reversing valve communicates with an oil return pipeline. The slewing reversing valve is provided with a first control end and a second control end. The proportional pressure reducing valves are respectively provided between the first control end and a pilot oil source and between the second control end and the pilot oil source, and the proportional pressure reducing valve is configured to push the slewing reversing valve to change direction.

[0007] The slewing hydraulic system of the present application further includes a first pressure measuring pipeline. A first end of the first pressure measuring pipeline communicates with the oil supply pipeline, and a second end of the first pressure measuring pipeline communicates with the outlet of the proportional relief valve.

[0008] In the slewing hydraulic system of the present application, the pressure measuring port further includes a second pressure measuring pipeline. An end of the second pressure measuring pipeline respectively communicates with a pipeline between the first control end of the slewing reversing valve and the pilot oil source and a pipeline between the second control end of the slewing reversing valve and the pilot oil source.

[0009] The slewing hydraulic system of the present application further includes a shuttle valve. An outlet of the shuttle valve communicates with the inlet of the proportional relief valve.

The shuttle valve is provided with two inlets, one of the two inlets of the shuttle valve communicates with the first pipeline, and another of the two inlets of the shuttle valve communicates with the second pipeline.

[0010] The slewing hydraulic system of the present application further includes a motor brake and a brake solenoid valve. A port of one end of the brake solenoid valve communicates with the motor brake via a motor brake oil port, and another end of the brake solenoid valve is provided with a first port and a second port. The first port respectively communicates with the two proportional pressure reducing valves, and the second port communicates with the pilot oil source.

[0011] The slewing hydraulic system of the present application further includes an oil drain pipeline, one end of the oil drain pipeline communicates with the two proportional pressure reducing valves respectively.

[0012] The slewing hydraulic system of the present application further includes a back pressure one-way valve. The back pressure one-way valve is provided at the oil return pipeline for conducting an end of the oil return pipeline communicating with the fourth inlet of the slewing reversing valve to another end of the oil return pipeline.

[0013] The present application further provides a construction machine including the slewing hydraulic system as mentioned above.

[0014] The present application further provides a slewing control method based on the slewing hydraulic system as mentioned above. The slewing control method includes: during a slewing start process, communicating a first oil port of a motor with a first pipeline, and determining a first set pressure of a proportional relief valve according to an actual working condition and a corresponding load;

[0015] during a slewing stop process, stopping feeding oil to the first pipeline, and communicating a second oil port of the motor with a second pipeline, and determining a second set pressure of the proportional relief valve according to the actual working condition and the corresponding load; and/or allowing an oil return of the second oil port of the motor to flow to the first pipeline via the proportional relief valve and communicate with the first oil port of the motor again.

[0016] The present application provides a slewing hydraulic system, a construction machine and a slewing control method. A first one-way valve is provided between the outlet of the proportional relief valve and the first pipeline, and a second one-way valve is provided between the outlet of the proportional relief valve and the second pipeline. According to the pressure in the pipeline, the proportional relief valve communicates with the first pipeline or the second

pipeline to adjust the oil pressure of the first pipeline or the second pipeline during the slewing process of the slewing hydraulic system. In this way, pressure overshoot during the slewing process can be avoided, thus improving the smoothness of the slewing start and braking process.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] To illustrate the technical solutions according to the present application or the related art more clearly, the accompanying drawings for describing the embodiments or the related art are introduced briefly in the following. Apparently, the accompanying drawings in the following description are only some embodiments of the present application. Persons of ordinary skill in the art can derive other drawings from the accompanying drawings without creative efforts.

[0018] FIG. 1 is a schematic structural view of a slewing hydraulic system according to the present application.

[0019] Description of reference numbers:

[0020] 1, left slewing proportional pressure reducing valve; 2, first one-way valve; 3, proportional relief valve; 4, shuttle valve; 5, motor; 51, first oil port; 52, second oil port; 6, second one-way valve; 7, brake solenoid valve; 8, slewing reversing valve; 9, right slewing proportional pressure reducing valve; 10, back pressure one-way valve; 11, motor brake; 12, second pressure measuring port; 13, pilot oil source; 14, oil return port; 15, oil supply port; 16, first pressure measuring port; 17, motor brake oil port; 18, oil drain port.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0021] In order to make the purpose, technical solutions and advantages of the present application clearer, the technical solutions in the present application will be clearly and completely described below in conjunction with the drawings of the present application. Obviously, the described embodiments are only some embodiments of the present application, and not all embodiments. Based on the embodiments in the present application, all other embodiments obtained by those of ordinary skill in the art without creative efforts shall fall within the scope of the present application.

[0022] The slewing hydraulic system, the construction machine and the slewing control method of the present application will be described in the following with reference to FIG. 1.

[0023] First, the technical terms involved in the present application will be explained.

[0024] Slewing braking. When the slewing control handle returns to the neutral position,

although there is no flow in the system, due to the inertia, the motor and the crane turntable will continue to rotate. In this case, in order to ensure that the motor stops rotating in time, as the slewing control handle returns to the neutral position, the brake will also timely achieve braking. Besides, in case of an emergency or hazardous situation, users can manually operate the brake to promptly close the brake, achieving emergency braking to prevent accidents.

[0025] Slewing buffering. When the crane stops slewing, due to the large weight of the slewing mechanism and the large moment of inertia, there will be a significant impact when the crane stops, causing the whole vehicle to shake. In severe cases, a security accident will occur. Therefore, the hydraulic system needs to have a slewing buffer function. On the one hand, the movement should be as smooth as possible when the slewing stops. On the other hand, the inertia force generated in the slewing process should be converted into the pressure release of the hydraulic system, thereby achieving a smooth and safe slewing stop.

[0026] Free sliding. When the crane is lifting, due to the different shapes and materials of the hoisted weights, it cannot be guaranteed that the center of gravity of the heavy object is directly below the hook (that is, the center of gravity of the heavy object is consistent with the center of gravity of the crane). In this case, unbalance load will occur. When the unbalanced load force reaches a certain value, it may cause the crane to tilt or even roll over in severe cases. In view of this, a free sliding function is designed. That is, when the crane is lifting, the brake starts and the oil inlet communicates with the oil return port of the motor, so that the motor is in a free sliding state and can rotate freely in this case. Under the unbalance load force, the center of gravity of the crane automatically coincides with the center of gravity of the heavy object on the same vertical line, thereby eliminating the unbalance load force and playing a safety protection role.

[0027] This embodiment provides a slewing hydraulic system including: a first pipeline configured to transport hydraulic oil; a second pipeline configured to transport hydraulic oil; a motor 5 provided with a first oil port 51 and a second oil port 52, the first oil port 51 communicating with a first end of the first pipeline, and the second oil port 52 communicating with a first end of the second pipeline; a proportional relief valve 3 provided with an inlet and an outlet, the inlet of the proportional relief valve 3 communicating with the first pipeline and the second pipeline respectively, and the outlet of the proportional relief valve 3 communicating with the first pipeline and the second pipeline respectively; a first one-way valve 2 provided between the outlet of the proportional relief valve 3 and the first pipeline, the first one-way valve 2 being configured to conduct the outlet of the proportional relief valve 3 to the first pipeline; and a second one-way valve 6 provided between the outlet of the proportional relief valve 3 and the second pipeline, the second one-way valve 6 being configured to conduct the outlet of the

proportional relief valve 3 to the second pipeline.

[0028] The cranes of the exiting medium and small tonnage truck generally adopt an open slewing system, which is composed of a fixed pump, a slewing control valve, a fixed motor and a pilot handle. The flow and pressure are controlled by diverting the flow through the slewing control valve, to control the slewing speed. In the related art, the slewing system is composed of two proportional relief valves and a remote control solenoid valve, only slewing stop buffering can be achieved, and slewing dynamic buffering cannot be achieved.

[0029] Based on this, this embodiment provides a slewing hydraulic system. As shown in FIG. 1, the slewing hydraulic system includes a first pipeline, a second pipeline and a motor 5. The motor 5 includes a first oil port 51 and a second oil port 52. The first oil port 51 communicates with the first end of the first pipeline. The second oil port 52 communicates with the first end of the second pipeline. The slewing hydraulic system also includes a proportional relief valve 3. The proportional relief valve 3 respectively communicates with the first pipeline and the second pipeline, that is, the inlet of the proportional relief valve 3 communicates with the first pipeline and the second pipeline respectively. In other words, the first oil port 51 communicates with the first end of the first pipeline, the proportional relief valve 3 communicates with the first oil port 51 via the first pipeline, the second oil port 52 communicates with the first end of the second pipeline, and the proportional relief valve 3 communicates with the second oil port 52 via the second pipeline 52. Through changing the control current, the proportional relief valve 3 changes the pressure set value of the proportional relief valve 3, to adjust the oil pressure of the first pipeline or the second pipeline, thereby realizing dynamic changes of buffering pressure of the proportional relief valve 3.

[0030] Further, the proportional relief valve 3 includes an inlet and an outlet. The outlet of the proportional relief valve 3 communicates with the first pipeline and is provided with a first one-way valve 2 for directing the flow direction from the outlet of the proportional relief valve 3 to the first pipeline, so that the hydraulic oil can flow from the outlet of the proportional relief valve 3 to the first pipeline. The outlet of the proportional relief valve 3 communicates with the second pipeline and is provided with a second one-way valve 6 for directing the flow direction from the outlet of the proportional relief valve 3 to the second pipeline, so that the hydraulic oil can flow from the outlet of the proportional relief valve 3 to the second pipeline. The one-way valve is configured to control the hydraulic oil that only flows in one direction and is blocked in the reverse direction, that is, the hydraulic oil can only flow in the forward direction and does not flow in the reverse direction.

[0031] In the embodiment of the present application, a first one-way valve 2 is provided

between the outlet of the proportional relief valve 3 and the first pipeline, and a second one-way valve is provided between the outlet of the proportional relief valve 3 and the second pipeline. According to the pressure in the pipeline, the proportional relief valve 3 communicates with the first pipeline or the second pipeline to adjust the oil pressure of the first pipeline or the second pipeline during the slewing process of the slewing hydraulic system. In this way, pressure overshoot during the slewing process can be avoided, thus improving the smoothness of the slewing start and braking process.

[0032] Based on the above embodiment, the slewing hydraulic system also includes a slewing reversing valve 8 and a proportional pressure reducing valve. The slewing reversing valve 8 includes a first inlet, a second inlet, a third inlet and a fourth inlet. The second end of the first pipeline communicates with the first inlet of the slewing reversing valve 8. The second end of the second pipeline communicates with the second inlet of the slewing reversing valve 8, and the third inlet of the slewing reversing valve 8 communicates with the oil supply pipeline. The oil supply pipeline is provided with an oil supply port 15 communicating with the oil supply equipment, so that the slewing reversing valve 8 can communicate with the oil supply equipment. The fourth inlet of the slewing reversing valve 8 communicates with the oil return pipeline. An oil return port 14 is provided at the oil return pipeline, so that the hydraulic oil in the slewing reversing valve 8 can return back to the oil tank via the fourth inlet of the slewing reversing valve 8 and the oil return port 14 of the oil return pipeline.

[0033] In an embodiment, the oil supply port 15 of the oil supply pipeline communicates with the first oil port 51 of the motor 5 via the slewing reversing valve 8 and the first pipeline, or the oil supply port 15 of the oil supply pipeline communicates with the second oil port 52 of the motor 5 via the slewing reversing valve 8 and the second pipeline. The first oil port 51 of the motor 5 communicates with the oil return port 14 at the oil return pipeline via the first pipeline and the slewing reversing valve 8, or the second oil port 52 of the motor 5 communicates with the oil return port 14 of the oil return pipeline via the second pipeline and the return slewing reversing valve 8. Further, the slewing reversing valve 8 includes a first control end and a second control end, and a proportional pressure reducing valve is provided between the first control end and the pilot oil source 13. A proportional pressure reducing valve is also provided between the second control end and the pilot oil source 13. The proportional pressure reducing valve is configured to push the slewing reversing valve 8 to change direction.

[0034] In this embodiment, when the slewing reversing valve 8 rotates to the left, the oil supply port 15 of the oil supply pipeline communicates with the first oil port 51 of the motor 5 via the slewing reversing valve and the first pipeline, so that the hydraulic oil can be transported

in the pipeline between the oil supply port 15 of the oil supply pipeline and the first oil port 51 of the motor 5. The second oil port 52 of the motor 5 communicates with the oil return port 14 of the oil return pipeline via the second pipeline and the slewing reversing valve 8, so that the hydraulic oil can be transported in the pipeline between the second oil port 52 of the motor 5 and the oil return port of the oil return pipeline. On the contrary, when the slewing reversing valve 8 rotates to the right, the oil supply port 15 of the oil supply pipeline communicates with the second oil port 52 of the motor 5 via the slewing reversing valve 8 and the second pipeline, so that the hydraulic oil can be transported in the pipeline between the oil supply port 15 and the second oil port 52 of the motor 5. The first oil port 51 of the motor 5 communicates with the oil return port 14 of the oil return pipeline via the first pipeline and the slewing reversing valve 8, so that the hydraulic oil can be transported in the pipeline between the first oil port 51 of the motor 5 and the oil return port 14 of the oil return pipeline.

[0035] In an embodiment, the slewing reversing valve 8 is configured to change the direction, and two control ends of the slewing reversing valve 8 control the left reversing and the right reversing respectively. The proportional pressure reducing valve is configured to reduce the pressure of the hydraulic oil in the pipeline. The proportional pressure reducing valve is divided into a left slewing proportional pressure reducing valve 1 and a right slewing proportional pressure reducing valve 9. Further, a left slewing proportional pressure reducing valve 1 is provided between the slewing reversing valve 8 and the pilot oil source 13. The left slewing proportional pressure reducing valve 1 receives the current signal inputted by the controller, and the hydraulic oil of the pilot oil source 13 flows to the left slewing proportional pressure reducing valve 1. After the pressure reaches a certain requirement, the left slewing proportional pressure reducing valve 1 pushes the slewing reversing valve 8 to change direction to the left. A right slewing proportional pressure reducing valve 9 is provided between the slewing reversing valve 8 and the pilot oil source 13. The hydraulic oil of the pilot oil source 13 flows to the right slewing proportional pressure reducing valve 9. After the pressure reaches a certain requirement, the right slewing proportional pressure reducing valve 9 pushes the slewing reversing valve 8 to change direction to the right.

[0036] The pilot oil source 13 is connected to the oil pump. The oil pressure required between the pilot oil source 13 and the slewing reversing valve 8 is small, so a proportional pressure reducing valve is provided between the pilot oil source 13 and the slewing reversing valve 8 to reduce the oil pressure between the pilot oil source 13 and the slewing reversing valve 8, and avoid affecting the normal operation of other systems due to too small oil pressure.

[0037] Further, when the slewing control handle returns to the neutral position, that is, the

slewing reversing valve 8 returns to the neutral position, both the first pipeline and the second pipeline are blocked, and pressure in the first oil port 51 and the second oil port 52 of the motor 5 will decrease rapidly, the proportional pressure reducing valve closes, and the oil supply port 15 of the oil supply pipeline communicates with the oil return port 14 of the oil return pipeline, and the pressure at the control port is slowly released according to the set value to achieve the buffering effect during slewing.

[0038] In this embodiment, by adopting the proportional pressure reducing valve to control the reversing direction of the valve core of the reversing valve, the proportional pressure reducing valve can slowly release the pressure of the control port according to the set value to achieve a buffering effect during the slewing process. In this way, when the flow rate changes greatly, the slewing smoothness can be improved.

[0039] Further, the slewing hydraulic system also includes a first pressure measuring pipeline. The first end of the first pressure measuring pipeline communicates with the oil supply pipeline, and the second end of the first pressure measuring pipeline communicates with the outlet of the proportional relief valve 3. In an embodiment, a first pressure measuring port 16 is provided at the first pressure measuring pipeline. The first pressure measuring port 16 is connected to an external pressure measuring equipment. The pressure measuring equipment is configured to detect the oil pressure in the pipeline. Further, the first end of the first pressure measuring pipeline communicates with the oil supply pipeline and is configured to detect the oil pressure of the oil supply pipeline. The second end of the first pressure measuring pipeline communicates with the outlet of the proportional relief valve 3 and is configured to detect the oil pressure at the outlet of the proportional relief valve 3, and the oil pressure may be the pressure of the oil flowing to the first pipeline or flowing to the second pipeline.

[0040] Furthermore, the slewing hydraulic system in this embodiment also includes a second pressure measuring pipeline. An end of the second pressure measuring pipeline respectively communicates with a pipeline between the first control end of the slewing reversing valve 8 and the pilot oil source 13 and a pipeline between the second control end of the slewing reversing valve 8 and the pilot oil source 13. In an embodiment, the second pressure measuring pipeline is provided with a second pressure measuring port 12, and the second pressure measuring port 12 is connected to an external pressure measuring device for detecting the oil pressure of the second pressure measuring pipeline. Further, a left slewing proportional pressure reducing valve 1 provided between the first control end of the slewing reversing valve 8 and the pilot oil source 13. One end of the second pressure measuring pipeline communicates with the pipeline between the left slewing proportional pressure reducing valve 1 and the pilot oil source 13. A right slewing

proportional pressure reducing valve 9 is provided between the second control end of the slewing reversing valve 8 and the pilot oil source 13, and one end of the second pressure measuring pipeline also communicates with the pipeline between the right slewing proportional pressure reducing valve 9 and the pilot oil source 13. That is, the external pressure measuring equipment connected to the second pressure measuring port 12 of the second pressure measuring pipeline can detect the oil pressure of the pipeline between the pilot oil source 13 and the left slewing proportional pressure reducing valve 1, and can also detect the oil pressure of the pipeline between the pilot oil source 13 and the right slewing proportional pressure reducing valve 9.

[0041] In an embodiment, the first pressure measuring port 16 of the first pressure measuring pipeline communicates with the oil supply pipeline, and can detect the pressure of the working oil port of the oil supply pipeline. In addition, the first pressure measuring port 16 of the oil supply pipeline communicates with the outlet of the proportional relief valve 3, and can detect the pressure of the oil flowing from the first pipeline to the second pipeline via the proportional relief valve 3, and can also detect the pressure of the oil flowing from the second pipeline to the second pipeline via the proportional relief valve 3. Further, the second pressure measuring port 12 of the second pressure measuring pipeline communicates with the left slewing proportional pressure reducing valve 1 and the right slewing proportional pressure reducing valve 9 synchronously. In this way, when direction is changed to the left or to the right, the second pressure measuring port 12 of the second pressure measuring pipeline can detect the electrical signal from the controller received at any proportional pressure reducing valve, then building pressure starts to be performed and the slewing reversing valve 8 is pushed to change direction.

[0042] Based on the above embodiment, the slewing hydraulic system also includes a shuttle valve 4. The outlet of the shuttle valve 4 communicates with the inlet of the proportional relief valve 3. The shuttle valve 4 includes two inlets, and one of the two inlets of the shuttle valve 4 communicates with the first pipeline. The other inlet of the shuttle valve 4 communicates with the second pipeline.

[0043] In an embodiment, as shown in FIG. 1, the shuttle valve 4 includes two inlets. One inlet of the shuttle valve 4 communicates with the first oil port 51 of the motor 5 via a first pipeline, and the other inlet of the shuttle valve 4 communicates with the second oil port 52 of the motor 5 via the second pipeline. The outlet of the shuttle valve 4 communicates with the inlet of the proportional relief valve 3, and the outlet of the proportional relief valve 3 communicates with the first pipeline and the second pipeline respectively. That is, the hydraulic oil flowing from the shuttle valve 4 to the proportional relief valve 3 can return to the first pipeline via the first one-way valve 2, or can also return to the second pipeline via the second one-way valve 6.

[0044] In this embodiment, the structure of the shuttle valve 4 is not specifically limited and may be composed of two one-way valves.

[0045] Further, the slewing hydraulic system also includes a motor brake 11 and a brake solenoid valve 7. The port of one end of the brake solenoid valve 7 communicates with the motor brake 11 via the motor brake oil port 17. The other end of the brake solenoid valve 7 is provided with a first port and the second port. The first port communicates with the two proportional pressure reducing valves respectively, and the second port communicates with the pilot oil source 13.

[0046] In an embodiment, the first port and the second port of the brake solenoid valve 7 respectively communicate with the left slewing proportional pressure reducing valve 1 and the right slewing proportional pressure reducing valve 9. When the left slewing proportional pressure reducing valve 1 or the right slewing proportional pressure reducing valve 9 receives the electrical signal from the controller, building pressure starts to be performed and the slewing reversing valve 8 is pushed to change direction. At the same time, the brake solenoid valve 7 is powered. Further, the hydraulic oil from the pilot oil source 13 communicates with the motor brake 11 via the working oil port of the brake solenoid valve 7 and the motor brake oil port 17. When the brake solenoid valve 7 receives an electrical signal, pressure of the motor brake 5 is added, and the brake is opened to facilitate the rotation of the motor 5.

[0047] Based on the above embodiment, the slewing hydraulic system further includes a drain pipeline. One end of the drain pipeline communicates with two proportional pressure reducing valves respectively. In an embodiment, a drain port 18 is provided at the oil drain pipeline. When the proportional pressure reducing valve does not receive an electrical signal, the brake solenoid valve 7 cannot be powered. In this case, the motor brake oil port 17 communicates with the drain port 18 of the oil drain pipeline via two proportional pressure reducing valves, so that the hydraulic oil in the pipeline between the motor brake oil port 17 and the proportional pressure reducing valve and the hydraulic oil in the proportional pressure reducing valve can return to the oil tank via the oil drain port 18 of the oil drain pipeline.

[0048] Further, the outlet of the proportional relief valve 3 communicates with the oil return pipeline. In an embodiment, the hydraulic oil flowing through the outlet of the proportional relief valve 3 flows to the first pipeline or the second pipeline via the one-way valve, or directly returns to the oil return pipeline and returns to the oil tank via the oil return port 14 of the oil return pipeline.

[0049] Based on the above embodiment, the slewing hydraulic system also includes a back pressure one-way valve 10. The back pressure one-way valve 10 is provided at the oil return

pipeline and is configured to conduct an end of the oil return pipeline communicating with the fourth inlet of the slewing reversing valve 8 to the other end of the oil return pipeline. The back pressure one-way valve 10 is mainly used to conduct the pipeline to allow the hydraulic oil to circulate when the oil pressure is greater than the set value of the back pressure one-way valve 10. In an embodiment, the back pressure one-way valve 10 is provided at the oil return pipeline. The oil outlet of the back pressure one-way valve 10 communicates with the oil return port 14 of the oil return pipeline. The oil inlet of the back pressure one-way valve 10 communicates with the outlet of the flow valve 3, the first oil port 51 of the motor 5 or the second oil port 52 of the motor 5. That is, the hydraulic oil in the pipeline must pass through the back pressure one-way valve 10 before flowing back to the oil tank via the oil return port 14 of the oil return pipeline, which can also prevent the hydraulic oil in the oil tank from flowing backward via the oil return port 14 of the oil return pipeline.

[0050] In this embodiment, the selection of the proportional relief valve 3 is not limited, which can be a direct proportional relief valve, or an inverse proportional relief valve, or a proportional speed regulating valve, as long as the pressure of the proportional relief valve can be adjusted according to the actual situation.

[0051] This embodiment also provides a construction machine, including the slewing hydraulic system of any embodiment as mentioned above. The construction machine may be a crane, and the crane includes the slewing hydraulic system of any embodiment as mentioned above and also includes a boom telescopic mechanism.

[0052] This embodiment also provides a slewing control method based on any above mentioned slewing hydraulic system. The slewing control method includes: during the slewing start process, communicating the first oil port of the motor with the first pipeline, determining the first set pressure of the proportion relief valve according to the actual working condition and the corresponding load, reducing the oil pressure at the first oil port of the motor through the proportion relief valve to achieve a smooth slewing start process.

[0053] When slewing to the left or right, the proportional pressure reducing valve receives the current signal inputted by the controller, building pressure starts to be performed according to the electrical signal, and the slewing reversing valve 8 is pushed to change direction. The hydraulic oil enters the motor 5 via the slewing reversing valve 8. The pressure set value will be set in the proportional relief valve 3 through the controller according to the hoisting working condition information and the corresponding load.

[0054] When the slewing starts, the slewing speed will slowly increase. When the increase of the slewing speed is lower than the increase of the slewing flow, the pressure will rise rapidly. In

this case, the pressure set in the proportional relief valve 3 will leave the excess flow to ensure a requirement that the speed rises stably, thereby making the slewing start smoothly.

[0055] In this embodiment, during the slewing start acceleration process, pressure overshoot will occur. In this case, the proportional relief valve will weaken the pressure overshoot to realize the buffer during the slewing start.

[0056] During the slewing stop process, the first pipeline stops feeding oil. The second set pressure of the proportional relief valve 3 is determined according to the actual working conditions and the corresponding load. The proportional relief valve is configured to return the oil of the second oil port 52 of the motor 5 back to the second pipeline to reduce the oil pressure of the second oil port 52 of the motor 5. And/or, the oil return of the second oil port 52 of the motor 5 flows to the first pipeline via the proportional relief valve 3, and then will communicate with the first oil port 51 again to increase the oil pressure of the first oil port 51, thereby achieving a stable slewing stop process. When operating in the opposite direction, the first oil port 51 and the second oil port 52 adjust the oil feeding direction and the oil return direction.

[0057] When the slewing stops, the current of the left slewing proportional pressure reducing valve 1 or the right slewing proportional pressure reducing valve 9 starts to decrease. When the current value is zero, the pressure of the proportional relief valve 3 will be set by the controller again according to the crane lifting condition. In this case, the pressure set by the inverse proportional relief valve will buffers the inertia of the turntable and structure to achieve buffering. The working principle of the inverse proportional relief valve is that the greater the current, the smaller the voltage.

[0058] In this embodiment, when the slewing stops, the slewing reversing valve is reset and the pressure at the oil return port will rise. By adjusting the braking pressure of the electric proportional valve, the pressure is released to achieve braking buffering.

[0059] Further, the pressure of the electric proportional relief valve can be automatically adjusted based on the load and working condition information of the crane. The greater the load, the greater the set pressure of the proportional relief valve 3. Under a small load condition, the set pressure of the electric proportional relief valve will be relatively small (1-2MPa greater than the starting pressure). As the load increases, the starting pressure will be adjusted accordingly.

[0060] During the free sliding process, the first oil port 51 of the motor 5 communicates with the second oil port 52 of the motor 5, and the proportional relief valve 3 and the brake solenoid valve 7 are opened to realize free sliding. The proportional relief valve 3 and the brake solenoid valve 7 operate simultaneously to achieve free sliding. When the electric proportional relief

valve 3 does not build pressure, the first oil port 51 of the motor 5 communicates with the second oil port 52 of the motor 5. In this case, the brake solenoid valve 7 is powered, and the reducer brake is opened to realize the free sliding.

[0061] In an embodiment, during the process of lifting heavy objects, the free sliding control switch during slewing is pressed, the brake solenoid valve 7 is opened, and the pilot oil source 13 is connected to the motor brake 11 via the brake solenoid valve 7 and the motor brake oil port 17. In this case, the motor brake 11 is opened, the proportional relief valve 3 is powered, but the proportional relief valve 3 does not build pressure, and the first oil port 51 communicates with the second oil port 52. In an embodiment, when a heavy object is unbalanced, the hydraulic oil from the pilot oil source 13 flows to the brake solenoid valve 7. The brake solenoid valve 7 is connected to the motor brake 11 via the motor brake oil port 17, and the motor brake 11 is opened to realize the rotation of the motor 5. The hydraulic oil of the first oil port 51 of the motor 5 flows to the motor 5, then flows to the proportional relief valve 3 via the second oil port 52 and the shuttle valve 4. After that, the hydraulic oil will flow back to the first oil port 51 via the first one-way valve 2 to achieve communication between the first pipeline and the second pipeline, thereby achieving free sliding of the slewing.

[0062] In another embodiment, when the weight is unbalanced, the hydraulic oil in the second oil port 52 of the motor 5 flows to the first oil port 51 of the motor 5, the shuttle valve 4 and the proportional relief valve 3. After that, the hydraulic oil will flow back to the second oil port 52 via the second one-way valve 6 to achieve communication between the first pipeline and the second pipeline, thereby achieving free sliding of the slewing.

[0063] The present application provides a slewing hydraulic system, a construction machine and a slewing control method, which uses an electric proportional relief valve to connect the first oil port 51 and the second oil port 52 of the motor 5 to directly control the pressure of the working port. Further, the shuttle valve 4 is used to connect the two working oil ports of the motor 5. That is, the outlet of the shuttle valve 4 is connected to the inlet of the electric proportional relief valve, and the outlet of the electric proportional relief valve is connected to the oil return of the slewing reversing valve 8. In an embodiment, the shuttle valve 4 is connected to the first oil port 51 and the second oil port 52 of the motor 5, the outlet of the shuttle valve 4 is connected to the inlet of the electric proportional relief valve, and the outlet of the electric proportional relief valve is connected to the oil return of the slewing reversing valve 8. This principle can adjust the pressure or control signal of the electric proportional relief valve according to different load conditions to achieve starting buffering and braking buffering of the slewing.

[0064] This embodiment provides a slewing hydraulic system, a construction machine and a slewing control method, which has fewer control components and can effectively improve the problems of pressure overshoot and unstable acceleration. When the buffer pressure is constant during braking, the pressure of the proportional relief valve can be adjusted according to the actual working conditions of the machine.

[0065] Finally, it should be noted that the above embodiments are only used to illustrate the technical solution of the present application, but not to limit the present application. Although the present application has been described in detail with reference to the foregoing embodiments, those of ordinary skill in the art should understand that the technical solutions described in the foregoing embodiments can still be modified equivalent substitutions can be made to some of the technical features. However, these modifications or substitutions do not cause the essence of the corresponding technical solutions to deviate from the spirit and scope of the technical solutions in the embodiments of the present application.

CLAIMS

What is claimed is:

1. A slewing hydraulic system, comprising:

a first pipeline configured to transport hydraulic oil;

a second pipeline configured to transport hydraulic oil;

a motor (5) provided with a first oil port (51) and a second oil port (52), wherein the first oil port (51) communicates with a first end of the first pipeline, and the second oil port (52) communicates with a first end of the second pipeline;

a proportional relief valve (3) provided with an inlet and an outlet, wherein the inlet of the proportional relief valve (3) communicates with the first pipeline and the second pipeline respectively, and the outlet of the proportional relief valve (3) communicates with the first pipeline and the second pipeline respectively;

a first one-way valve (2) provided between the outlet of the proportional relief valve (3) and the first pipeline, wherein the first one-way valve (2) is configured to conduct the outlet of the proportional relief valve (3) to the first pipeline; and

a second one-way valve (6) provided between the outlet of the proportional relief valve (3) and the second pipeline, wherein the second one-way valve (6) is configured to conduct the outlet of the proportional relief valve (3) to the second pipeline.

2. The slewing hydraulic system according to claim 1, further comprising a slewing reversing valve (8) and a proportional pressure reducing valve, wherein:

the slewing reversing valve (8) is provided with a first inlet, a second inlet, a third inlet and a fourth inlet;

a second end of the first pipeline communicates with the first inlet of the slewing reversing valve (8), a second end of the second pipeline communicates with the second inlet of the slewing reversing valve (8), the third inlet of the slewing reversing valve (8) communicates with an oil supply pipeline, and the fourth inlet of the slewing reversing valve (8) communicates with an oil return pipeline;

the slewing reversing valve (8) is provided with a first control end and a second control end;

and

the proportional pressure reducing valves are respectively provided between the first control end and a pilot oil source (13) and between the second control end and the pilot oil source (13), and the proportional pressure reducing valve is configured to push the slewing reversing valve (8) to change direction.

3. The slewing hydraulic system according to claim 2, further comprising a first pressure measuring pipeline, wherein a first end of the first pressure measuring pipeline communicates with the oil supply pipeline, and a second end of the first pressure measuring pipeline communicates with the outlet of the proportional relief valve (3).

4. The slewing hydraulic system according to claim 3, further comprising a second pressure measuring pipeline, wherein an end of the second pressure measuring pipeline respectively communicates with a pipeline between the first control end of the slewing reversing valve (8) and the pilot oil source (13) and a pipeline between the second control end of the slewing reversing valve (8) and the pilot oil source (13).

5. The slewing hydraulic system according to claim 1, further comprising a shuttle valve (4), wherein an outlet of the shuttle valve (4) communicates with the inlet of the proportional relief valve (3), the shuttle valve (4) is provided with two inlets, one of the two inlets of the shuttle valve (4) communicates with the first pipeline, and another of the two inlets of the shuttle valve (4) communicates with the second pipeline.

6. The slewing hydraulic system according to claim 2, further comprising a motor brake (11) and a brake solenoid valve (7), wherein:

a port of one end of the brake solenoid valve (7) communicates with the motor brake (11) via a motor brake oil port (17); and

another end of the brake solenoid valve (7) is provided with a first port and a second port, the first port respectively communicates with the two proportional pressure reducing valves, and the second port communicates with the pilot oil source (13).

7. The slewing hydraulic system according to any one of claims 2 to 6, further comprising an oil drain pipeline, wherein one end of the oil drain pipeline communicates with the two proportional pressure reducing valves respectively.

8. The slewing hydraulic system according to claim 2, further comprising a back pressure one-way valve (10), wherein the back pressure one-way valve (10) is provided at the oil return pipeline for conducting an end of the oil return pipeline communicating with the fourth inlet of the slewing reversing valve (8) to another end of the oil return pipeline.

9. A construction machine, comprising the slewing hydraulic system according to any one of claims 1 to 8.

10. A slewing control method based on the slewing hydraulic system according to any one of claims 1 to 8, comprising:

during a slewing start process, communicating a first oil port (51) of a motor (5) with a first pipeline, and determining a first set pressure of a proportional relief valve (3) according to an actual working condition and a corresponding load;

during a slewing stop process, stopping feeding oil to the first pipeline, and communicating a second oil port (52) of the motor (5) with a second pipeline, and determining a second set pressure of the proportional relief valve (3) according to the actual working condition and the corresponding load; and/or,

allowing an oil return of the second oil port (52) of the motor (5) to flow to the first pipeline via the proportional relief valve (3) and communicate with the first oil port (51) of the motor (5) again.