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DOUBLE-WINCH HYDRAULIC CONTROL SYSTEM, WORK MACHINE, AND CONTROL METHOD

TECHNICAL FIELD

This application relates to the field of winch control technologies, and in particular, to a double-winch hydraulic control system, a work machine, and a control method.

BACKGROUND

In the current field of work machines, for example, for a diaphragm wall grab, in a process of working and trenching, a double-winch diaphragm wall grab needs to use the weight of a work apparatus to keep impacting a ground layer, to implement the crushing of rock and soil. Subsequently, a grab oil cylinder pushes peels to close, to implement shearing and grabbing of rock and soil. After contacting the ground layer, the work apparatus generates a particular tilt, and winches are in a loose state. When the peels close to grab rock and soil, the rock and soil apply a reactive force to a grab body to push the grab body to move upward, and the work apparatus also generates a particular tilt. An operator needs to keep adjusting the posture of the work apparatus to ensure the trenching quality. Due to this phenomenon, the trenching quality severely depends on the personal experience of the operator, and construction efficiency is affected.

SUMMARY OF THE INVENTION

This application provides a double-winch hydraulic control system, a work machine, and a control method to resolve deficiencies in the prior art that a work apparatus tilts in a working process, adjustment difficulty is high, and working efficiency is affected, and implements comparison based on a first force value of a first steel wire rope and a second force value of a second steel wire rope, to control a first motor to tension the first steel wire rope, or control a second motor to tension the

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second steel wire rope, so that the automatic adjustment of a tilt of the work apparatus is implemented.

This application provides a double-winch hydraulic control system, including:

a first force measurement member, where the first force measurement member is configured to measure a first force value of a first steel wire rope;

a second force measurement member, where the second force measurement member is configured to measure a second force value of a second steel wire rope;

a first motor, where the first motor is connected to the first steel wire rope; and

a second motor, where the second motor is connected to the second steel wire rope,

where, when the first force value is less than the second force value, the first motor is controlled to tension the first steel wire rope, and when the first force value is greater than the second force value, the second motor is controlled to tension the second steel wire rope.

The double-winch hydraulic control system provided in this application further includes a first control circuit and a second control circuit, where

the first control circuit is connected to the first motor, and is configured to drive the first motor when the first force value is less than the second force value; and

the second control circuit is connected to the second motor, and is configured to drive the second motor when the first force value is greater than the second force value.

In the double-winch hydraulic control system provided in this application, the first control circuit includes a first hydraulic pump, a first reversing valve, and a first balancing valve, the first hydraulic pump is connected to the first reversing valve, the first reversing valve is connected to the first balancing valve, and the first balancing valve is connected to the first motor,

where the first reversing valve is configured to control forward and reverse rotation of the first motor by reversal switching; and

the first balancing valve is connected such that, when the first motor is controlled to rotate reversely to tension the first steel wire rope, hydraulic fluid provided by the

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first hydraulic pump sequentially passes through the first reversing valve and a one-way valve part of the first balancing valve to enter the first motor, and when the first motor is controlled to rotate forward to reel out the first steel wire rope, hydraulic fluid enters a pilot port of the first balancing valve to open a valve spool thereof, so as to cause hydraulic fluid returning from the first motor to pass through the first balancing valve to flow out.

In the double-winch hydraulic control system provided in this application, the second control circuit includes a second hydraulic pump, a second reversing valve, and a second balancing valve, the second hydraulic pump is connected to the second reversing valve, the second reversing valve is connected to the second balancing valve, and the second balancing valve is connected to the second motor,

where the second reversing valve is configured to control forward and reverse rotation of the second motor by reversal switching; and

the second balancing valve is connected such that, when the second motor is controlled to rotate reversely to tension the second steel wire rope, hydraulic fluid provided by the second hydraulic pump sequentially passes through the second reversing valve and a one-way valve part of the second balancing valve to enter the second motor, and when the second motor is controlled to rotate forward to reel out the second steel wire rope, hydraulic fluid enters a pilot port of the second balancing valve to open a valve spool thereof, so as to cause hydraulic fluid returning from the second motor to pass through the second balancing valve to flow out.

The double-winch hydraulic control system provided in this application further includes a first braking execution mechanism and a second braking execution mechanism, where

the first braking execution mechanism is configured to control rotation and stop of the first motor; and

the second braking execution mechanism is configured to control rotation and stop of the second motor.

The double-winch hydraulic control system provided in this application includes a first braking circuit, where the first braking circuit includes a third hydraulic pump

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and a third reversing valve, the third hydraulic pump is connected to the third reversing valve, and the third reversing valve is connected to a pilot port of the first reversing valve and a pilot port of the second reversing valve, where

the first reversing valve is connected to the first braking execution mechanism to provide hydraulic fluid to the first braking execution mechanism so as to control the first braking execution mechanism, and the second reversing valve is connected to the second braking execution mechanism to provide hydraulic fluid to the second braking execution mechanism so as to control the second braking execution mechanism.

In the double-winch hydraulic control system provided in this application, the first braking circuit further includes a first braking valve group and a second braking valve group, where

the first reversing valve is connected to the first braking valve group, the first braking valve group is connected to the first braking execution mechanism, and hydraulic fluid flowing out of the first reversing valve is depressurized by the first braking valve group and then supplied to the first braking execution mechanism; and

the second reversing valve is connected to the second braking valve group, the second braking valve group is connected to the second braking execution mechanism, and hydraulic fluid flowing out of the second reversing valve is depressurized by the second braking valve group and then supplied to the second braking execution mechanism.

This application further provides a double-winch hydraulic control system, where the double-winch hydraulic control system includes:

a first motor, where the first motor is configured to be connected to a first steel wire rope for reeling out and reeling in the first steel wire rope;

a second motor, where the second motor is configured to be connected to a second steel wire rope for reeling out and reeling in the second steel wire rope;

a first control circuit, where the first control circuit is configured to control forward and reverse rotation of the first motor, where, when a difference value between a first force value on the first steel wire rope and a second force value on the second steel wire rope is within a first preset range, the first control circuit controls

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the first motor to rotate reversely to reel in the first steel wire rope; and

a second control circuit, where the second control circuit is configured to control forward and reverse rotation of the second motor, where, when the difference value between the first force value on the first steel wire rope and the second force value on the second steel wire rope is within a second preset range, the second control circuit controls the second motor to rotate reversely to reel in the second steel wire rope.

In the double-winch hydraulic control system provided in this application, the first control circuit includes a first hydraulic pump, a first reversing valve, and a first balancing valve, the first hydraulic pump is connected to the first reversing valve, the first reversing valve is connected to the first balancing valve, and the first balancing valve is connected to the first motor, where the first reversing valve is configured to control forward and reverse rotation of the first motor by reversal switching; and

the first balancing valve is connected such that, when the first motor is controlled to rotate reversely to tension the first steel wire rope, hydraulic fluid provided by the first hydraulic pump sequentially passes through the first reversing valve and a one-way valve part of the first balancing valve to enter the first motor, and when the first motor is controlled to rotate forward to reel out the first steel wire rope, hydraulic fluid enters a pilot port of the first balancing valve to open a valve spool thereof, so as to cause hydraulic fluid returning from the first motor to pass through the first balancing valve to flow out.

In the double-winch hydraulic control system provided in this application, the second control circuit includes a second hydraulic pump, a second reversing valve, and a second balancing valve, the second hydraulic pump is connected to the second reversing valve, the second reversing valve is connected to the second balancing valve, and the second balancing valve is connected to the second motor, where the second reversing valve is configured to control forward and reverse rotation of the second motor by reversal switching; and

the second balancing valve is connected such that, when the second motor is controlled to rotate reversely to tension the second steel wire rope, hydraulic fluid provided by the second hydraulic pump sequentially passes through the second

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reversing valve and a one-way valve part of the second balancing valve to enter the second motor, and when the second motor is controlled to rotate forward to reel out the second steel wire rope, hydraulic fluid enters a pilot port of the second balancing valve to open a valve spool thereof, so as to cause hydraulic fluid returning from the second motor to pass through the second balancing valve to flow out.

In the double-winch hydraulic control system provided in this application, both the first hydraulic pump and the second hydraulic pump are controlled by a same engine.

In the double-winch hydraulic control system provided in this application, the double-winch hydraulic control system further includes a first braking execution mechanism and a second braking execution mechanism, where

the first braking execution mechanism is configured to control rotation and stop of the first motor; and

the second braking execution mechanism is configured to control rotation and stop of the second motor.

In the double-winch hydraulic control system provided in this application, the double-winch hydraulic control system further includes a first braking circuit, where the first braking circuit includes a third hydraulic pump and a third reversing valve, the third hydraulic pump is connected to the third reversing valve, and the third reversing valve is connected to a pilot port of the first reversing valve and a pilot port of the second reversing valve for feeding hydraulic fluid into the pilot ports to cause the first reversing valve to switch to control the first motor to rotate reversely and to cause the second reversing valve to switch to control the second motor to rotate reversely, where

the first reversing valve is connected to the first braking execution mechanism, and when the first reversing valve switches to control the first motor to rotate reversely, the first reversing valve supplies hydraulic fluid to the first braking execution mechanism, so as to cause the first braking execution mechanism to control rotation of the first motor; and

the second reversing valve is connected to the second braking execution

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mechanism, and when the second reversing valve switches to control the second motor to rotate reversely, the second reversing valve supplies hydraulic fluid to the second braking execution mechanism, so as to cause the second braking execution mechanism to control rotation of the second motor.

In the double-winch hydraulic control system provided in this application, the first braking circuit further includes a first braking valve group and a second braking valve group, where

the first reversing valve is connected to the first braking valve group, the first braking valve group is connected to the first braking execution mechanism, and hydraulic fluid flowing out of the first reversing valve is depressurized by the first braking valve group and then supplied to the first braking execution mechanism; and

the second reversing valve is connected to the second braking valve group, the second braking valve group is connected to the second braking execution mechanism, and hydraulic fluid flowing out of the second reversing valve is depressurized by the second braking valve group and then supplied to the second braking execution mechanism.

In the double-winch hydraulic control system provided in this application, the first braking circuit further includes a seventh reversing valve, a fluid inlet port of the seventh reversing valve is connected to the third hydraulic pump, and a fluid outlet port of the seventh reversing valve is connected to another pilot port of the first reversing valve and connected to another pilot port of the second reversing valve for feeding hydraulic fluid into the other pilot ports to cause the first reversing valve to switch to control the first motor to rotate forward and to cause the second reversing valve to switch to control the second motor to rotate forward.

In the double-winch hydraulic control system provided in this application, the double-winch hydraulic control system further includes a third control circuit, and the third control circuit is respectively connected to the first motor and the second motor;

when the difference value between the first force value on the first steel wire rope and the second force value on the second steel wire rope is within a third preset range, the third control circuit controls the first motor to rotate reversely to tension the

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first steel wire rope; and

when the difference value between the first force value on the first steel wire rope and the second force value on the second steel wire rope is within a fourth preset range, the third control circuit controls the second motor to rotate reversely to tension the second steel wire rope,

where reverse rotation speeds of the first motor and the second motor controlled by the third control circuit are less than a reverse rotation speed of the first motor controlled by the first control circuit, and are less than a reverse rotation speed of the second motor controlled by the second control circuit.

In the double-winch hydraulic control system provided in this application, the third control circuit includes a fourth hydraulic pump, an eighth reversing valve, and a pressure relief valve; and

the fourth hydraulic pump provides hydraulic fluid to the first motor and the second motor via the eighth reversing valve, and the pressure relief valve is connected for controlling hydraulic fluid pressure supplied from the fourth hydraulic pump to the first motor and the second motor.

This application further provides a work machine, including the foregoing double-winch hydraulic control system.

This application further provides a double-winch hydraulic control method, including:

acquiring a first force value of a first steel wire rope, and acquiring a second force value of a second steel wire rope;

determining a magnitude relationship between the first force value and the second force value; and

controlling a first motor connected to the first steel wire rope to rotate reversely, or controlling a second motor connected to the second steel wire rope to rotate reversely.

In the double-winch hydraulic control method provided in this application, before the step of determining a magnitude relationship between the first force value and the second force value, the method further includes:

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presetting a first threshold and a second threshold, where the first threshold is greater than the second threshold, where

when an absolute value of a difference between the first force value and the second force value is greater than the first threshold, the first motor and the second motor are controlled to rotate reversely in a first working mode; and

when the absolute value of the difference between the first force value and the second force value is less than the first threshold and is greater than the second threshold, the first motor and the second motor are controlled to rotate reversely in a second working mode.

In the double-winch hydraulic control system provided in this application, the first force measurement member and the second force measurement member are respectively disposed on the first steel wire rope and the second steel wire rope to acquire the first force value and the second force value respectively, and based on comparison data of the first force value and the second force value, the first motor is controlled to tension the first steel wire rope, or the second motor is controlled to tension the second steel wire rope, so that a tilt of the work apparatus is automatically adjusted, thereby improving working efficiency.

Further, in the work machine and the double-winch hydraulic control method provided in this application, because the foregoing double-winch hydraulic control system is provided, the foregoing various advantages are also provided.

BRIEF DESCRIPTION OF THE DRAWINGS

To describe the technical solutions in this application or the prior art more clearly, the following briefly introduces the accompanying drawings required for describing the embodiments or the prior art. Apparently, the accompanying drawings in the following description show some embodiments of this application, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

FIG. 1 is a diagram of a hydraulic principle of a double-winch hydraulic control system according to an implementation of this application;

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FIG. 2 is a schematic diagram of a state of a diaphragm wall grab impacting a trench bottom according to an implementation of this application;

FIG. 3 is a schematic diagram of a state of a diaphragm wall grab digging rock according to an implementation of this application;

FIG. 4 is a flowchart of a double-winch hydraulic control method according to an implementation of this application.

Reference numerals:

100: winch; 101: first force measurement member; 102: second force measurement member; 103: first steel wire rope; 104: second steel wire rope; and 105: work apparatus;

200: first motor; 201: first hydraulic pump; 202: first reversing valve; and 203: first balancing valve;

300: second motor; 301: second hydraulic pump; 302: second reversing valve; and 303: second balancing valve;

400: third hydraulic pump; 401: third reversing valve; 402: seventh reversing valve; 403: sixth reversing valve; 404: first shuttle valve; 405: first braking valve group; 406: second shuttle valve; 407: third shuttle valve; 408: fourth shuttle valve; 409: second braking valve group; 410: first brake cylinder; 411: fourth reversing valve; 412: second brake cylinder; and 413: fifth reversing valve; and

500: fourth hydraulic pump; 501: eighth reversing valve; and 502: pressure relief valve.

DETAILED DESCRIPTION

To make the objectives, technical solutions, and advantages of this application clearer, the following clearly and completely describes the technical solutions in this application with reference to the accompanying drawings in this application. It is clear that the described embodiments are merely some rather than all of embodiments of this application. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of this application without creative efforts fall within

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the protection scope of this application.

In the description of the embodiments of this application, it needs to be noted that orientation or location relationships indicated by terms "up", "down", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "inside", and "outside" are based on orientation or location relationships shown in the accompanying drawings, and are only used to facilitate description of the embodiments of this application and simplify description, but are not used to indicate or imply that the apparatuses or elements must have specific orientations or are constructed and operated by using specific orientations, and therefore, cannot be understood as a limitation to the embodiments of this application. In addition, the terms "first", "second", and "third" are used only for description, but are not intended to indicate or imply relative importance.

In the description of the embodiments of this application, it needs to be noted that unless otherwise expressly specified and defined, terms "connected" and "connection" should be understood in a broad sense, for example, fixedly connected, detachably connected, or integrally connected; or mechanically connected, or electrically connected; or connected directly or through an intermediate. For a person of ordinary skill in the art, specific meanings of the foregoing terms in embodiments of this application may be understood based on a specific situation.

In the description of the specification, the description with reference to terms "an embodiment", "some embodiments", "an example", "a specific example" or "some embodiments", and the like indicate that specific features, structures, materials or characteristics described with reference to the embodiments or examples are included in at least one embodiment or example of the embodiments of this application. In the specification, the schematic descriptions of the foregoing terms do not necessarily involve the same embodiments or examples. In addition, the described specific features, structures, materials or characteristics may be combined in an appropriate manner in any one or more embodiments or examples. In addition, a person skilled in the art may integrate and combine different embodiments or examples or features in different embodiments or examples in the specification without causing any

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contradictions.

The following describes embodiments of this application with reference to FIG. 1 to FIG. 4. It should be understood that the following description is only example implementations of this application, and does not constitute a limitation to this application.

As shown in FIG. 1, this application provides a double-winch hydraulic control system, including:

a first force measurement member 101 and a second force measurement member 102, where the first force measurement member 101 is configured to measure a first force value of a first steel wire rope 103, and the second force measurement member 102 is configured to measure a second force value of a second steel wire rope 104. The first force measurement member 101 and the second force measurement member 102 may be mounted on a pulley block of a winch 100, and for example, may be tensile force sensors, dynamometers, tensometers, or the like, which are configured to measure tensile forces of the first steel wire rope 103 and the second steel wire rope 104. The first steel wire rope 103 and the second steel wire rope 104 are two steel wire ropes of the winch 100. The two steel wire ropes are configured to be connected to a work apparatus 105. The work apparatus 105 may be, for example, a diaphragm wall grab, or another work apparatus may be used.

In addition, the system includes a first motor 200 and a second motor 300. The first motor 200 is connected to the first steel wire rope 103, and the second motor 300 is connected to the second steel wire rope 104. The first motor 200 and the second motor 300 may rotate forward and rotate reversely. For example, during actual use, when the first motor 200 and the second motor 300 rotate forward, the tensile forces of the first steel wire rope 103 and the second steel wire rope 104 decrease, and when the first motor 200 and the second motor 300 rotate reversely, the tensile forces of the first steel wire rope 103 and the second steel wire rope 104 increase.

Based on comparison between the first force value and the second force value, the first motor 200 is controlled to tension the first steel wire rope 103, or the second motor 300 is controlled to tension the second steel wire rope 104. That is, based on

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the first force value and the second force value, the first motor 200 and the second motor 300 are controlled to implement that only one motor can make an output. For example, when the first force value is greater than the second force value (in this case, the second steel wire rope 104 is looser than the first steel wire rope 103 to cause a tilt of the work apparatus), the second motor 300 is controlled to rotate reversely to reel in the second steel wire rope 104, to tension the second steel wire rope 104. When the first force value is less than the second force value (in this case, the first steel wire rope 103 is looser than the second steel wire rope 104 to cause a tilt of the work apparatus), the first motor 200 is controlled to rotate reversely to reel in the first steel wire rope 103, to tension the first steel wire rope 103.

In the technical solution provided in this application, based on the comparison between the first force value of the first steel wire rope 103 and the second force value of the second steel wire rope 104, the first motor or the second motor is controlled to rotate reversely to tension the first steel wire rope 103 or the second steel wire rope 104, so that a tilted state of the work apparatus 105 can be adjusted.

In an embodiment of this application, the double-winch hydraulic control system further includes a first control circuit and a second control circuit, where the first control circuit is connected to the first motor 200, and is configured to drive the first motor 200 when the first force value is less than the second force value; and the second control circuit is connected to the second motor 300, and is configured to drive the second motor 300 when the first force value is greater than the second force value.

Specifically, a first threshold F is preset.

In first comparison data, an absolute value of a difference between a first force value a_1 and a second force value a_2 is greater than the first threshold F , and the first force value a_1 is less than the second force value a_2 . In this case, the first motor 200 rotates reversely at a high speed, and the first steel wire rope 103 quickly generates a pre-tightening force, for example, the grab is in a state of being quickly unwound to impact a trench bottom. That is, in the first comparison data, the work apparatus 105 tilts, and the first steel wire rope 103 is looser than the second steel wire rope 104. In addition, a deviation between the first steel wire rope 103 and the second steel wire

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rope 104 is large, and the first motor 200 can be quickly driven to rotate reversely, to quickly tension the first steel wire rope 103.

In second comparison data, the absolute value of the difference between the first force value a_1 and the second force value a_2 is greater than the first threshold F , and the first force value a_1 is greater than the second force value a_2 . In this case, the second motor 300 rotates reversely at a high speed, and the second steel wire rope 104 quickly generates a pre-tightening force, for example, the grab is in a state of being quickly unwound to impact the trench bottom. That is, in the second comparison data, the work apparatus 105 tilts, and the second steel wire rope 104 is looser than the first steel wire rope 103. In addition, a deviation between the first steel wire rope 103 and the second steel wire rope 104 is large, and the second motor 300 can be quickly driven to rotate reversely, to quickly tension the second steel wire rope 104.

Further, in another embodiment of this application, the double-winch hydraulic control system further includes a third control circuit. The third control circuit is respectively connected to the first motor 200 and the second motor 300. In third comparison data, the third control circuit drives the first motor 200 to rotate, or in fourth comparison data, the third control circuit drives the second motor 300 to rotate.

Specifically, a second threshold f is preset, and the first threshold F is greater than the second threshold f . Based on the precision of control, values selected for the first threshold F and the second threshold f are different.

In the third comparison data, the absolute value of the difference between the first force value a_1 and the second force value a_2 is less than the first threshold F and is greater than the second threshold f , the first force value a_1 is less than the second force value a_2 . The first motor 200 rotates reversely at a low speed, to accurately adjust a tensioning force of the first steel wire rope 103, for example, adjust a tilted state generated when the grab digs rock and soil. That is, in the third comparison data, the work apparatus 105 tilts, and the first steel wire rope 103 is looser than the second steel wire rope 104. In addition, a deviation between the first steel wire rope 103 and the second steel wire rope 104 is small, and the first motor 200 can be slowly driven to rotate reversely, to slowly tension the first steel wire rope 103.

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Similarly, in the fourth comparison data, the absolute value of the difference between the first force value a_1 and the second force value a_2 is less than the first threshold F and is greater than the second threshold f , the first force value a_1 is greater than the second force value a_2 . The second motor 300 rotates reversely at a low speed, to accurately adjust a tensioning force of the second steel wire rope 104, for example, adjust a tilted state generated when the grab digs rock and soil. That is, in the fourth comparison data, the work apparatus 105 tilts, and the second steel wire rope 104 is looser than the first steel wire rope 103. In addition, a deviation between the first steel wire rope 103 and the second steel wire rope 104 is small, and the second motor 300 can be slowly driven to rotate reversely, to slowly tension the second steel wire rope 104.

Continuing to refer to FIG. 1, in an optional embodiment of this application, the first control circuit includes a first hydraulic pump 201, a first reversing valve 202, and a first balancing valve 203, the first hydraulic pump 201 is connected to the first reversing valve 202, the first reversing valve 202 is connected to the first balancing valve 203, and the first balancing valve 203 is connected to the first motor 200, where the first reversing valve 202 is configured to control forward and reverse rotation of the first motor 200 by reversal switching.

The first balancing valve 203 is connected such that, when the first motor 200 is controlled to rotate reversely to tension the first steel wire rope 103, hydraulic fluid provided by the first hydraulic pump 201 sequentially passes through the first reversing valve 202 and a one-way valve part of the first balancing valve 203 to enter the first motor 200, and when the first motor 200 is controlled to rotate forward to reel out the first steel wire rope 103, hydraulic fluid enters a pilot port of the first balancing valve 203 to open a valve spool thereof, so as to cause hydraulic fluid returning from the first motor 200 to pass through the first balancing valve 203 to flow out. When the first motor 200 reels out the first steel wire rope 103, return fluid is set to pass through the first balancing valve 203, so that a reeling speed of the first steel wire rope 103 can be effectively controlled, to keep the first steel wire rope from lowering at an excessive speed.

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Similarly, in another embodiment of this application, the second control circuit includes a second hydraulic pump 301, a second reversing valve 302, and a second balancing valve 303, the second hydraulic pump 301 is connected to the second reversing valve 302, the second reversing valve 302 is connected to the second balancing valve 303, and the second balancing valve 303 is connected to the second motor 300, where the second reversing valve 302 is configured to control forward and reverse rotation of the second motor 300 by reversal switching.

The second balancing valve 303 is connected such that, when the second motor 300 is controlled to rotate reversely to tension the second steel wire rope 104, hydraulic fluid provided by the second hydraulic pump 301 sequentially passes through the second reversing valve 302 and a one-way valve part of the second balancing valve 303 to enter the second motor 300, and when the second motor 300 is controlled to rotate forward to reel out the second steel wire rope 104, hydraulic fluid enters a pilot port of the second balancing valve 303 to open a valve spool thereof, so as to cause hydraulic fluid returning from the second motor 300 to pass through the second balancing valve 303 to flow out. When the second motor 300 reels out the second steel wire rope 104, return fluid is set to pass through the second balancing valve 303, so that a reeling speed of the second steel wire rope 104 can be effectively controlled, to keep the second steel wire rope from lowering at an excessive speed.

In addition, the first balancing valve 203 and the second balancing valve 303 are one-way balancing valves, the first reversing valve 202 and the second reversing valve 302 are three-position six-way reversing valves, and the first reversing valve 202 and the second reversing valve 302 may be solenoid reversing valves, or hydraulic control reversing valves.

Further, in an optional embodiment of this application, the double-winch hydraulic control system further includes a first braking execution mechanism and a second braking execution mechanism, where the first braking execution mechanism is configured to control rotation and stop of the first motor 200, and the second braking execution mechanism is configured to control rotation and stop of the second motor 300.

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In other words, in the first comparison data and the third comparison data, the first braking execution mechanism controls the first motor 200 to output a torque to tension the first steel wire rope 103, and when the absolute value of the difference between the first force value a_1 and the second force value a_2 is less than the second threshold f , the first braking execution mechanism controls the first motor 200 to stop rotation.

In the second comparison data and the fourth comparison data, the second braking execution mechanism controls the second motor 300 to output a torque to tension the second steel wire rope 104, and when the absolute value of the difference between the first force value a_1 and the second force value a_2 is less than the second threshold f , the second braking execution mechanism controls the second motor 300 to stop rotation.

Further, the first hydraulic pump 201 and the second hydraulic pump 301 may be driven by one engine. That is, the first hydraulic pump 201 and the second hydraulic pump 301 are connected in parallel. When the first motor 200 and the second motor 300 rotate forward, that is, when the first steel wire rope 103 and the second steel wire rope 104 are simultaneously controlled to be reeled out, one engine may be used to simultaneously control forward and reverse rotation of the first motor 200 and the second motor 300, to implement the synchronization of the reeling out of the first steel wire rope 103 and the second steel wire rope 104, thereby ensuring that the work apparatus 105 is stable. When the work apparatus 105 is in a tilted state, the first braking execution mechanism and the second braking execution mechanism are used to separately control a single output state of the first motor 200 and the second motor 300, to adjust the work apparatus 105.

In another embodiment of this application, the double-winch hydraulic control system includes a first braking circuit, where the first braking circuit includes a third hydraulic pump 400 and a third reversing valve 401, the third hydraulic pump 400 is connected to the third reversing valve 401, and the third reversing valve 401 is connected to a pilot port of the first reversing valve 202 and a pilot port of the second reversing valve 302 for feeding hydraulic fluid into the pilot ports to cause the first

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reversing valve 202 to switch to control the first motor 200 to rotate reversely and to cause the second reversing valve 302 to switch to control the second motor 300 to rotate reversely, where the first reversing valve 202 is connected to the first braking execution mechanism to provide hydraulic fluid to the first braking execution mechanism so as to control the first braking execution mechanism, and the second reversing valve 302 is connected to the second braking execution mechanism to provide hydraulic fluid to the second braking execution mechanism so as to control the second braking execution mechanism.

That is, the third reversing valve 401 is switched. Output hydraulic fluid of the third hydraulic pump 400 is used as pilot hydraulic fluid to control reversal of the first reversing valve 202 and the second reversing valve 302. When the first reversing valve 202 and the second reversing valve 302 respectively control the first motor 200 and the second motor 300 to rotate reversely, a part of hydraulic fluid flowing out of the first reversing valve 202 and a part of hydraulic fluid flowing out of the second reversing valve 302 respectively enter the first motor 200 and the second motor 300, and other parts respectively enter the first braking execution mechanism and the second braking execution mechanism, to control the first braking execution mechanism and the second braking execution mechanism to be turned on and turned off, to implement torque outputs to the first motor 200 and the second motor 300.

For example, the first braking execution mechanism includes a fourth reversing valve 411 and a first brake cylinder 410, and the second braking execution mechanism includes a fifth reversing valve 413 and a second brake cylinder 412. Hydraulic fluid flowing out of the first reversing valve 202 enters the fourth reversing valve 411, and after the reversal of the fourth reversing valve 411, the first brake cylinder 410 releases the braking of the first motor 200.

Similarly, hydraulic fluid flowing out of the second reversing valve 302 enters the fifth reversing valve 413, and after the reversal of the fifth reversing valve 413, the second brake cylinder 412 releases the braking of the second motor 300. The fourth reversing valve 411 and the fifth reversing valve 413 are separately switched in a process in which the first motor 200 and the second motor 300 rotate reversely.

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Continuing to refer to FIG. 1, in another optional embodiment of this application, the first braking circuit further includes a first braking valve group 405 and a second braking valve group 409. The first reversing valve 202 is connected to the first braking valve group 405, a fluid outlet port of the first braking valve group 405 is connected to the first braking execution mechanism, and hydraulic fluid flowing out of the first reversing valve 202 is depressurized by the first braking valve group 405 and then supplied to the first braking execution mechanism; and the second reversing valve 302 is connected to the second braking valve group 409, a fluid outlet port of the second braking valve group 409 is connected to the second braking execution mechanism, and hydraulic fluid flowing out of the second reversing valve 302 is depressurized by the second braking valve group 409 and then supplied to the second braking execution mechanism.

The first braking valve group 405 and the second braking valve group 409 may use a sequence valve and a pressure reducing valve to reduce pressures to respectively supply hydraulic fluid to the fourth reversing valve 411 and the fifth reversing valve 413.

A first shuttle valve 404 and a fourth shuttle valve 408 are respectively disposed at fluid inlet ports of the first braking valve group 405 and the second braking valve group 409. A first fluid inlet port of the first shuttle valve 404 is connected to a fluid path between the first balancing valve 203 and the first reversing valve 202, and a second fluid inlet port of the first shuttle valve 404 is connected to a fluid path between a first fluid port of the first motor 200 and the first reversing valve 202. The first balancing valve 203 is disposed on a fluid path between a second fluid port of the first motor 200 and the first reversing valve 202. It is similar to the fourth shuttle valve 408, and details are not described herein again.

In addition, in a specific embodiment of this application, the system further includes a second braking circuit. The second braking circuit includes a sixth reversing valve 403, and the third hydraulic pump 400 is connected to the sixth reversing valve 403. The sixth reversing valve 403 is respectively connected to the first braking execution mechanism and the second braking execution mechanism.

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Further, the first braking circuit further includes a seventh reversing valve 402, a fluid inlet port of the seventh reversing valve 402 is connected to the third hydraulic pump 400, a fluid outlet port of the seventh reversing valve 402 is connected to another pilot port of the first reversing valve 202 and another pilot port of the second reversing valve 302, and the seventh reversing valve 402 performs reversal to implement that the first reversing valve 202 and the second reversing valve 302 respectively control the first motor 200 and the second motor 300 to rotate forward simultaneously. In addition, hydraulic fluid is supplied to the first braking execution mechanism and the second braking execution mechanism respectively through the first braking valve group 405 and the second braking valve group 409, and the fourth reversing valve 411 and the fifth reversing valve 413 are simultaneously switched, to release the braking effect on the first brake cylinder 410 and the second brake cylinder 412.

Specifically, the double-winch hydraulic control system further includes a second shuttle valve 406 and a third shuttle valve 407. A first fluid inlet port of the second shuttle valve 406 is connected to the fluid outlet port of the first braking valve group 405, a second fluid inlet port of the second shuttle valve 406 is connected to a first fluid inlet port of the third shuttle valve 407, and a fluid outlet port of the second shuttle valve 406 is connected to the fourth reversing valve 411. A second fluid inlet port of the third shuttle valve 407 is connected to the second braking valve group 409, and a fluid outlet port of the third shuttle valve 407 is connected to the fifth reversing valve 413. The second fluid inlet port of the second shuttle valve 406 and the first fluid inlet port of the third shuttle valve 407 are connected to the sixth reversing valve 403.

In a state in which the third control circuit works, the second braking circuit is turned on to control the first braking execution mechanism and the second braking execution mechanism.

Specifically, the third control circuit includes a fourth hydraulic pump 500, an eighth reversing valve 501, and a pressure relief valve 502. The fourth hydraulic pump 500 provides hydraulic fluid to the first motor 200 and the second motor 300

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via the eighth reversing valve 501, and the pressure relief valve 502 is connected for controlling hydraulic fluid pressure supplied from the fourth hydraulic pump 500 to the first motor 200 and the second motor 300.

Specifically, as shown in FIG. 1, the fourth hydraulic pump 500 is connected to the eighth reversing valve 501, the eighth reversing valve 501 is connected to the first motor 200 and the second motor 300, and the pressure relief valve 502 is connected to a fluid inlet port of the eighth reversing valve 501 to accurately adjust a circuit pressure, thereby implementing the accurate adjustment of a pre-tightening force of the winch 100. Further, the pressure relief valve 502 may be a proportional pressure relief valve, and control a circuit pressure through a current input. Optionally, the pressure relief valve 502 may be connected to the first force measurement member 101 and the second force measurement member 102, and an opening degree of the pressure relief valve 502 is adjusted through a controller based on the first force value and the second force value, to adjust an output pressure of the fourth hydraulic pump 500, thereby implementing the accurate adjustment of the speeds of reverse rotation of the first motor 200 and the second motor 300.

In the third comparison data and the fourth comparison data, the eighth reversing valve 501 switches, to supply hydraulic fluid to the first motor 200 and the second motor 300. The sixth reversing valve 403 switches, to supply hydraulic fluid to the fourth reversing valve 411 and the fifth reversing valve 413. Switching of the fourth reversing valve 411 and the fifth reversing valve 413 is controlled for reversal, so that the first motor 200 or the second motor 300 is turned on to adjust a tensioning force.

This application further provides a double-winch hydraulic control system, where the double-winch hydraulic control system includes:

- a first motor 200, where the first motor 200 is configured to be connected to a first steel wire rope 103, configured to lift and reel out the first steel wire rope 103;

- a second motor 300, where the second motor 300 is configured to be connected to a second steel wire rope 104, configured to lift and reel out the second steel wire rope 104;

- a first control circuit, where the first control circuit is connected to the first motor

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200, to control the first motor 200 to rotate reversely when a difference value between a first force value a_1 on the first steel wire rope 103 and a second force value a_2 on the second steel wire rope 104 is within a first preset range to tension the first steel wire rope 103; and

a second control circuit, where the second control circuit is connected to the second motor 300, to control the second motor 300 to rotate reversely when the difference value between the first force value a_1 on the first steel wire rope 103 and the second force value a_2 on the second steel wire rope 104 is within a second preset range to tension the second steel wire rope 104.

The first preset range is that an absolute value of a difference between the first force value a_1 and the second force value a_2 is greater than the first threshold F , and the first force value a_1 is less than the second force value a_2 . The second preset range is that the absolute value of the difference between the first force value a_1 and the second force value a_2 is greater than the first threshold F , and the first force value a_1 is greater than the second force value a_2 .

In an implementation, the double-winch hydraulic control system further includes a third control circuit, and the third control circuit is respectively connected to the first motor 200 and the second motor 300;

the third control circuit controls the first motor 200 to rotate reversely to tension the first steel wire rope 103 when the difference value between the first force value a_1 on the first steel wire rope 103 and the second force value a_2 on the second steel wire rope 104 is within a third preset range; and

the third control circuit controls the second motor 300 to rotate reversely to tension the second steel wire rope 104 when the difference value between the first force value a_1 on the first steel wire rope 103 and the second force value a_2 on the second steel wire rope 104 is within a fourth preset range, where

the third preset range is that the absolute value of the difference between the first force value a_1 and the second force value a_2 is less than the first threshold F and is greater than a second threshold f , the first force value a_1 is less than the second force value a_2 .

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The fourth preset range is that the absolute value of the difference between the first force value a_1 and the second force value a_2 is less than the first threshold F and is greater than the second threshold f , the first force value a_1 is greater than the second force value a_2 . The first threshold F is greater than the second threshold f .

Reverse rotation speeds of the first motor 200 and the second motor 300 controlled by the third control circuit are less than a reverse rotation speed of the first motor 200 controlled by the first control circuit, and are less than a reverse rotation speed of the second motor 300 controlled by the second control circuit.

That is, when $|a_1 - a_2| > F$, the first motor 200 or the second motor 300 rotates reversely at a high speed (under the control of the first control circuit or the second control circuit), and the first steel wire rope 103 or the second steel wire rope 104 quickly generates a pre-tightening force. For example, in a diaphragm wall grab, a work apparatus 105 is lowered to contact a ground layer and a large tilt occurs, and the first motor 200 or the second motor 300 is controlled to implement quick reverse rotation, so that the loose first steel wire rope 103 or the loose second steel wire rope 104 can be quickly tensioned to ensure trenching quality.

When $F > |a_1 - a_2| > f$, through the control of the third control circuit, the first motor 200 or the second motor 300 rotates reversely at a low speed, to accurately adjust a tensioning force of the first steel wire rope 103 or the second steel wire rope 104. For example, the work apparatus 105 grabs rock and soil, the rock and soil applies a reactive force on the work apparatus 105 to push the work apparatus 105 to move upward, the work apparatus 105 generates a small tilt, and the first motor 200 or the second motor 300 is controlled to rotate reversely at a slow speed, that is, make a slight adjustment, to straighten the work apparatus 105, thereby ensuring trenching quality.

When $|a_1 - a_2| < f$, the first motor 200 and the second motor 300 stop rotation, and the adjustment is completed.

Arrangement manners of the first control circuit, the second control circuit, and the third control circuit may be the same as those in the foregoing implementation, and certainly circuits that can implement the same functions are also feasible.

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In an embodiment, the double-winch hydraulic control system further includes a first braking execution mechanism and a second braking execution mechanism, where the first braking execution mechanism is configured to control rotation and stop of the first motor 200, and the second braking execution mechanism is configured to control rotation and stop of the second motor 300.

The double-winch hydraulic control system may further include a first braking circuit and a second braking circuit. The arrangement of the first braking execution mechanism, the second braking execution mechanism, the first braking circuit, and the second braking circuit may be the same as that in the foregoing implementation, and details are not described herein again.

This application further provides a work machine, including the foregoing double-winch hydraulic control system in the foregoing embodiment.

As shown in FIG. 2 and FIG. 3, the work machine may be a diaphragm wall grab. When a tilt is generated because the diaphragm wall grab impacts a trench bottom or a tilt is generated during digging of rock, tensions of the first steel wire rope 103 and the second steel wire rope 104 are adjusted, to implement the straightening of the diaphragm wall grab.

As shown in FIG. 4, this application further provides a double-winch hydraulic control method, including the following steps.

S1: Acquire a first force value of a first steel wire rope 103, and acquire a second force value of a second steel wire rope 104.

S2: Determine a magnitude relationship between the first force value and the second force value.

S3: Control a first motor 200 connected to the first steel wire rope 103 to rotate reversely, or control a second motor 300 connected to the second steel wire rope 104 to rotate reversely.

Further, in an optional embodiment of this application, before the step of determining a magnitude relationship between the first force value and the second force value, the method further includes the following steps.

S11: Preset a first threshold F and a second threshold f , where the first threshold

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F is greater than the second threshold f.

S12: When an absolute value of a difference between the first force value and the second force value is greater than the first threshold F, the first motor 200 and the second motor 300 are controlled to rotate reversely in a first working mode; and

when the absolute value of the difference between the first force value and the second force value is less than the first threshold F and is greater than the second threshold f, the first motor 200 and the second motor 300 are controlled to rotate reversely in a second working mode.

Rotational speeds of the first motor 200 and the second motor 300 in the first working mode are different from rotational speeds of the first motor 200 and the second motor 300 in the second working mode.

Specifically, for example, the first force value is measured by the first force measurement member 101 of the first steel wire rope 103 in the foregoing embodiment, and the second force value is measured by the second force measurement member 102 of the second steel wire rope 104 in the foregoing embodiment. A controller compares and determines the first force value and the second force value, to feed back signals to a first control circuit, a second control circuit, and a third control circuit that control forward and reverse rotation of the first motor 200 and the second motor 300.

When the absolute value of the difference between the first force value and the second force value is greater than the first threshold F, the first control circuit and the second control circuit control the first motor 200 and the second motor 300 to rotate reversely, that is, in the first working mode, the first motor 200 and the second motor 300 implement quick reverse rotation. When the absolute value of the difference between the first force value and the second force value is less than the first threshold F and is greater than the second threshold f, the third control circuit controls the first motor 200 and the second motor 300 to rotate reversely, that is, in the second working mode, the first motor 200 and the second motor 300 implement slow-speed high-precision reverse rotation. In this way, stepwise control is implemented.

In the double-winch hydraulic control system provided in this application, the

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first force measurement member and the second force measurement member are respectively disposed on the first steel wire rope and the second steel wire rope to acquire the first force value and the second force value respectively, and based on comparison data of the first force value and the second force value, the first motor is controlled to tension the first steel wire rope, or the second motor is controlled to tension the second steel wire rope, so that a tilt of the work apparatus is automatically adjusted, thereby improving working efficiency.

Further, in the work machine and the double-winch hydraulic control method provided in this application, because the foregoing double-winch hydraulic control system is provided, the foregoing various advantages are also provided.

Finally, it should be noted that the foregoing embodiments are merely intended for describing the technical solutions of this application, but not for limiting this application. Although this application is described in detail with reference to the foregoing embodiments, a person of ordinary skill in the art should understand that they may still make modifications to the technical solutions described in the foregoing embodiments or make equivalent replacements to some technical features thereof, without departing from the spirit and scope of the technical solutions of embodiments of this application.

Claims

What is claimed is:

1. A double-winch hydraulic control system, comprising:

a first force measurement member, wherein the first force measurement member is configured to measure a first force value of a first steel wire rope;

a second force measurement member, wherein the second force measurement member is configured to measure a second force value of a second steel wire rope;

a first motor, wherein the first motor is connected to the first steel wire rope; and

a second motor, wherein the second motor is connected to the second steel wire rope,

wherein, when the first force value is less than the second force value, the first motor is controlled to tension the first steel wire rope, and when the first force value is greater than the second force value, the second motor is controlled to tension the second steel wire rope.

2. The double-winch hydraulic control system according to claim 1, further comprising a first control circuit and a second control circuit, wherein

the first control circuit is connected to the first motor, and is configured to drive the first motor when the first force value is less than the second force value; and

the second control circuit is connected to the second motor, and is configured to drive the second motor when the first force value is greater than the second force value.

3. The double-winch hydraulic control system according to claim 2, wherein the first control circuit comprises a first hydraulic pump, a first reversing valve, and a first balancing valve, the first hydraulic pump is connected to the first reversing valve, the first reversing valve is connected to the first balancing valve, and the first balancing valve is connected to the first motor,

wherein the first reversing valve is configured to control forward and reverse rotation of the first motor by reversal switching; and

the first balancing valve is connected such that, when the first motor is controlled to rotate reversely to tension the first steel wire rope, hydraulic fluid provided by the

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first hydraulic pump sequentially passes through the first reversing valve and a one-way valve part of the first balancing valve to enter the first motor, and when the first motor is controlled to rotate forward to reel out the first steel wire rope, hydraulic fluid enters a pilot port of the first balancing valve to open a valve spool thereof, so as to cause hydraulic fluid returning from the first motor to pass through the first balancing valve to flow out.

4. The double-winch hydraulic control system according to claim 3, wherein the second control circuit comprises a second hydraulic pump, a second reversing valve, and a second balancing valve, the second hydraulic pump is connected to the second reversing valve, the second reversing valve is connected to the second balancing valve, and the second balancing valve is connected to the second motor,

wherein the second reversing valve is configured to control forward and reverse rotation of the second motor by reversal switching; and

the second balancing valve is connected such that, when the second motor is controlled to rotate reversely to tension the second steel wire rope, hydraulic fluid provided by the second hydraulic pump sequentially passes through the second reversing valve and a one-way valve part of the second balancing valve to enter the second motor, and when the second motor is controlled to rotate forward to reel out the second steel wire rope, hydraulic fluid enters a pilot port of the second balancing valve to open a valve spool thereof, so as to cause hydraulic fluid returning from the second motor to pass through the second balancing valve to flow out.

5. The double-winch hydraulic control system according to claim 4, further comprising a first braking execution mechanism and a second braking execution mechanism, wherein

the first braking execution mechanism is configured to control rotation and stop of the first motor; and

the second braking execution mechanism is configured to control rotation and stop of the second motor.

6. The double-winch hydraulic control system according to claim 5, comprising

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a first braking circuit, wherein the first braking circuit comprises a third hydraulic pump and a third reversing valve, the third hydraulic pump is connected to the third reversing valve, and the third reversing valve is connected to a pilot port of the first reversing valve and a pilot port of the second reversing valve, wherein

the first reversing valve is connected to the first braking execution mechanism to provide hydraulic fluid to the first braking execution mechanism so as to control the first braking execution mechanism, and the second reversing valve is connected to the second braking execution mechanism to provide hydraulic fluid to the second braking execution mechanism so as to control the second braking execution mechanism.

7. The double-winch hydraulic control system according to claim 6, wherein the first braking circuit further comprises a first braking valve group and a second braking valve group, wherein

the first reversing valve is connected to the first braking valve group, the first braking valve group is connected to the first braking execution mechanism, and hydraulic fluid flowing out of the first reversing valve is depressurized by the first braking valve group and then supplied to the first braking execution mechanism; and

the second reversing valve is connected to the second braking valve group, the second braking valve group is connected to the second braking execution mechanism, and hydraulic fluid flowing out of the second reversing valve is depressurized by the second braking valve group and then supplied to the second braking execution mechanism.

8. A double-winch hydraulic control system, wherein the double-winch hydraulic control system comprises:

a first motor, wherein the first motor is configured to be connected to a first steel wire rope for reeling out and reeling in the first steel wire rope;

a second motor, wherein the second motor is configured to be connected to a second steel wire rope for reeling out and reeling in the second steel wire rope;

a first control circuit, wherein the first control circuit is configured to control forward and reverse rotation of the first motor, wherein, when a difference value

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between a first force value on the first steel wire rope and a second force value on the second steel wire rope is within a first preset range, the first control circuit controls the first motor to rotate reversely to reel in the first steel wire rope; and

a second control circuit, wherein the second control circuit is configured to control forward and reverse rotation of the second motor, wherein, when the difference value between the first force value on the first steel wire rope and the second force value on the second steel wire rope is within a second preset range, the second control circuit controls the second motor to rotate reversely to reel in the second steel wire rope.

9. The double-winch hydraulic control system according to claim 8, wherein the first control circuit comprises a first hydraulic pump, a first reversing valve, and a first balancing valve, the first hydraulic pump is connected to the first reversing valve, the first reversing valve is connected to the first balancing valve, and the first balancing valve is connected to the first motor, wherein the first reversing valve is configured to control forward and reverse rotation of the first motor by reversal switching; and

the first balancing valve is connected such that, when the first motor is controlled to rotate reversely to tension the first steel wire rope, hydraulic fluid provided by the first hydraulic pump sequentially passes through the first reversing valve and a one-way valve part of the first balancing valve to enter the first motor, and when the first motor is controlled to rotate forward to reel out the first steel wire rope, hydraulic fluid enters a pilot port of the first balancing valve to open a valve spool thereof, so as to cause hydraulic fluid returning from the first motor to pass through the first balancing valve to flow out.

10. The double-winch hydraulic control system according to claim 9, wherein the second control circuit comprises a second hydraulic pump, a second reversing valve, and a second balancing valve, the second hydraulic pump is connected to the second reversing valve, the second reversing valve is connected to the second balancing valve, and the second balancing valve is connected to the second motor, wherein the second reversing valve is configured to control forward and reverse rotation of the

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second motor by reversal switching; and

the second balancing valve is connected such that, when the second motor is controlled to rotate reversely to tension the second steel wire rope, hydraulic fluid provided by the second hydraulic pump sequentially passes through the second reversing valve and a one-way valve part of the second balancing valve to enter the second motor, and when the second motor is controlled to rotate forward to reel out the second steel wire rope, hydraulic fluid enters a pilot port of the second balancing valve to open a valve spool thereof, so as to cause hydraulic fluid returning from the second motor to pass through the second balancing valve to flow out.

11. The double-winch hydraulic control system according to claim 10, wherein both the first hydraulic pump and the second hydraulic pump are controlled by a same engine.

12. The double-winch hydraulic control system according to claim 10, wherein the double-winch hydraulic control system further comprises a first braking execution mechanism and a second braking execution mechanism, wherein

the first braking execution mechanism is configured to control rotation and stop of the first motor; and

the second braking execution mechanism is configured to control rotation and stop of the second motor.

13. The double-winch hydraulic control system according to claim 12, wherein the double-winch hydraulic control system further comprises a first braking circuit, wherein the first braking circuit comprises a third hydraulic pump and a third reversing valve, the third hydraulic pump is connected to the third reversing valve, and the third reversing valve is connected to a pilot port of the first reversing valve and a pilot port of the second reversing valve for feeding hydraulic fluid into said pilot ports to cause the first reversing valve to switch to control the first motor to rotate reversely and to cause the second reversing valve to switch to control the second motor to rotate reversely, wherein

the first reversing valve is connected to the first braking execution mechanism,

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and when the first reversing valve switches to control the first motor to rotate reversely, the first reversing valve supplies hydraulic fluid to the first braking execution mechanism, so as to cause the first braking execution mechanism to control rotation of the first motor; and

the second reversing valve is connected to the second braking execution mechanism, and when the second reversing valve switches to control the second motor to rotate reversely, the second reversing valve supplies hydraulic fluid to the second braking execution mechanism, so as to cause the second braking execution mechanism to control rotation of the second motor.

14. The double-winch hydraulic control system according to claim 13, wherein the first braking circuit further comprises a first braking valve group and a second braking valve group, wherein

the first reversing valve is connected to the first braking valve group, the first braking valve group is connected to the first braking execution mechanism, and hydraulic fluid flowing out of the first reversing valve is depressurized by the first braking valve group and then supplied to the first braking execution mechanism; and

the second reversing valve is connected to the second braking valve group, the second braking valve group is connected to the second braking execution mechanism, and hydraulic fluid flowing out of the second reversing valve is depressurized by the second braking valve group and then supplied to the second braking execution mechanism.

15. The double-winch hydraulic control system according to claim 13, wherein the first braking circuit further comprises a seventh reversing valve, a fluid inlet port of the seventh reversing valve is connected to the third hydraulic pump, and a fluid outlet port of the seventh reversing valve is connected to another pilot port of the first reversing valve and connected to another pilot port of the second reversing valve for feeding hydraulic fluid into said other pilot ports to cause the first reversing valve to switch to control the first motor to rotate forward and to cause the second reversing valve to switch to control the second motor to rotate forward.

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16. The double-winch hydraulic control system according to any one of claims 8 to 15, wherein the double-winch hydraulic control system further comprises a third control circuit, and the third control circuit is respectively connected to the first motor and the second motor;

when the difference value between the first force value on the first steel wire rope and the second force value on the second steel wire rope is within a third preset range, the third control circuit controls the first motor to rotate reversely to tension the first steel wire rope; and

when the difference value between the first force value on the first steel wire rope and the second force value on the second steel wire rope is within a fourth preset range, the third control circuit controls the second motor to rotate reversely to tension the second steel wire rope,

wherein reverse rotation speeds of the first motor and the second motor controlled by the third control circuit are less than a reverse rotation speed of the first motor controlled by the first control circuit, and are less than a reverse rotation speed of the second motor controlled by the second control circuit.

17. The double-winch hydraulic control system according to claim 16, wherein the third control circuit comprises a fourth hydraulic pump, an eighth reversing valve, and a pressure relief valve; and

the fourth hydraulic pump provides hydraulic fluid to the first motor and the second motor via the eighth reversing valve, and the pressure relief valve is connected for controlling hydraulic fluid pressure supplied from the fourth hydraulic pump to the first motor and the second motor.

18. A work machine, comprising the double-winch hydraulic control system according to any one of claims 1 to 17.

19. A double-winch hydraulic control method, comprising:

acquiring a first force value of a first steel wire rope, and acquiring a second force value of a second steel wire rope;

determining a magnitude relationship between the first force value and the

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second force value; and

controlling a first motor connected to the first steel wire rope to rotate reversely, or controlling a second motor connected to the second steel wire rope to rotate reversely.

20. The double-winch hydraulic control method according to claim 19, wherein, before the step of determining a magnitude relationship between the first force value and the second force value, the method further comprises:

presetting a first threshold and a second threshold, wherein the first threshold is greater than the second threshold, wherein

when an absolute value of a difference between the first force value and the second force value is greater than the first threshold, the first motor and the second motor are controlled to rotate reversely in a first working mode; and

when the absolute value of the difference between the first force value and the second force value is less than the first threshold and is greater than the second threshold, the first motor and the second motor are controlled to rotate reversely in a second working mode.