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(54) **Title**: ENERGY RECYCLING SYSTEM FOR WORKING DEVICE

(54) **发明名称**: 工作装置能量回收系统

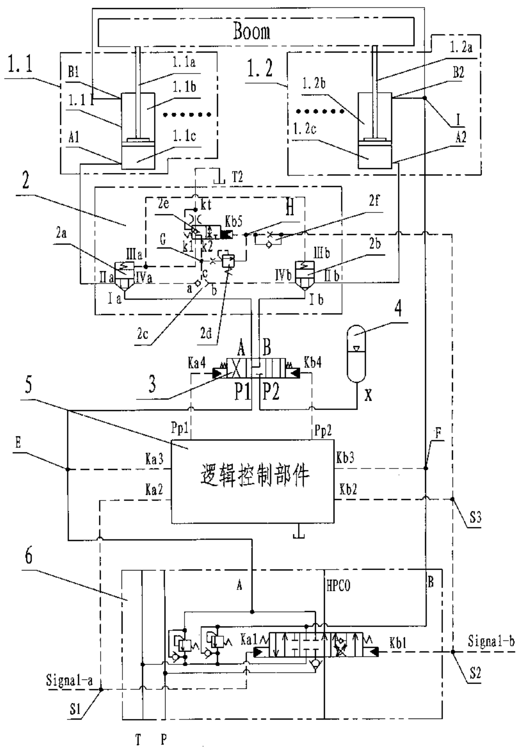


图1 / FIG. 1

5 LOGIC CONTROL UNIT

(57) **Abstract**: An energy recycling system for a working device comprises an energy converter, a pressure-retaining valve, a switching valve, an energy collector, a logic control unit, a main valve, a movable arm device and corresponding connecting components. By using this system, the potential energy generated during the lowering of the movable arm device can be controllably converted into hydraulic energy to be stored in the energy collector, and the potential energy can also be directly recycled for acting on the movable arm device in a balancing mode. The heat generated by the hydraulic system is thereby reduced, the input power of a prime motor is reduced, and the purpose of saving energy is achieved.

(57) **摘要**: 一种工作装置能量回收系统，包括能量转换器、压能保持阀、切换阀、能量收集器、逻辑控制部件、主阀、动臂装置及相应连接。通过使用本系统，不仅能可控地把动臂装置下降的势能转化成液压能存入能量收集器，而且还能直接进行循环利用，对动臂装置进行平衡做功，从而减小液压系统发热，减小原动机的输入功率，达到节能的目的。

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# WORKING DEVICE ENERGY RECOVERY SYSTEM

## BACKGROUND

### Technical Field

The present invention relates to a hydraulic system that can control liquid flow of an energy converter that can move mechanical components on a machine, and more particularly to a device that recovers energy from an energy converter and subsequently provides certain power for operation by using the recovered energy.

### Related Art

In engineering machinery and agricultural equipment, various mechanical components are often operated by means of fluid transmission. For example, an excavator is a common type of engineering machinery, and lifting and dropping of an excavator boom are often implemented by acting on an oil cylinder by hydraulic oil. The hydraulic oil cylinder includes a cylinder with a piston, the piston divides the cylinder into two chambers, a rod connected with the piston is connected to the boom, and the oil cylinder is connected with the main body of the excavator, to implement rise and drop of a support by extending the rod outwards from the oil cylinder and retracting the rod towards the oil cylinder. During operation of the excavator, for example, positions of working devices such as the boom, the stick, the bucket and the corresponding oil cylinder are often constantly adjusted, and especially the boom is often in a cyclic movement process of being lifted from a low position to a high position and then dropped from a high position to a low position, as the boom and the stick and the bucket that act on the boom are large in mass, in terms of the principle of energy conversion, the support can be only dropped under the action of gravity, and if dropping resistance is not provided, the dropping process is prone to weightlessness. In order to prevent weightlessness when the boom drops, a conventional solution is to keep the hydraulic oil cylinder having certain back pressure; as a result, a liquid flow return pipeline is often provided with a throttling device, where hydraulic oil flows back to an oil tank through the throttling device. Consequently, potential energy of the boom is converted to heat energy, which is wasted away. To prevent great increase in the temperature of hydraulic oil from bringing hazards to the system, it is further necessary to dispose a heat-dissipating device. An excavation device has been described in

JP2009275776, where an accumulator is implemented to collect overproduced energy in the form of oil pressure. However, the valve system in this device is basic and does not take into account situations when the device is not in action and where high pressure is some parts of the device, leading to leakages and damage of the components. Therefore, it is necessary to find out an effective technology to implement energy recovery and reuse in the hydraulic system.

## SUMMARY

A technical problem to be solved by the present invention is to provide a working device energy recovery system, which saves energy and reduces temperature rise of hydraulic oil in a hydraulic system.

To solve the foregoing problem, a working device potential energy recovery hydraulic system (working device energy recovery system) used in the present invention includes two energy converters that comprise at least an unit each, a main valve, a first control signal and a second control signal, where an inlet of a pressure energy retaining valve is connected with the main valve through a switchover valve, an outlet of the pressure energy retaining valve is connected with rodless cavities of the said units of the energy converters, the said switchover valve is connected with an energy collector, an input end of a logical control member is in communication connections with the said main valve, the said units of the energy converters, the said first control signal and the said second control signal, an output end of the logical control member is connected with a control end of the switchover valve,and is characterized in that the said pressure energy retaining valve comprises unit valves, a signal OR valve, a pressure overload protection valve, a direction valve and a one-way throttle control valve.

Each of the two energy converters at least comprises one or more units, the units of the two energy converter may be each respectively separated into corresponding working cavities by rod pistons, the working cavities may be respectively provided with oil ports and may be directly connected with an oil port of the main valve, and the working cavities, for example first-, second-, third- and fourth-working cavities, may be respectively provided with oil ports. A boom may act on the units of the energy converters.

The pressure energy retaining valve includes unit valves, a signal OR valve, a

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pressure overload protection valve, a direction valve and a one-way throttle control valve.

A unit valve may be provided with a first oil port, a second oil port, a third oil port and a fourth oil port, and the second oil port communicates with the fourth oil port; another unit valve may be provided with a fifth oil port, a sixth oil port, a seventh oil port and an eighth oil port, the sixth oil port may communicate with the eighth oil port, and the oil ports of the pressure energy retaining valve may be respectively connected with the first working cavity oil port and the second working cavity oil port of the first and second working cavities of the energy converters.

The direction valve may be provided with a first pressure input port, a second pressure input port, an oil return port and a reverse control port, the first pressure input port may communicate with the third oil port and the seventh oil port, the oil return port may be connected with an oil return path and may get oil back to an oil tank, and the reverse control port may connected to a second connecting point of the main valve at which the second control signal is input.

When there is no pressure on the reverse control port, the direction valve is at a normal position, the first pressure input port and the second pressure input port are switched on, but the oil return port is not switched on; when there is pressure on the reverse control port, the direction valve is reversed to the right position, the first pressure input port and the oil return port are resistively switched on, but the second pressure input port is not switched on.

The signal OR valve may include a third pressure input port, a fourth pressure input port and a pressure output port, the third pressure input port may be connected with the fourth oil port of the unit valve, the fourth pressure input port may be connected with the eighth oil port of the another unit valve, and the pressure output port may be connected with the second pressure input port of the direction valve and may take a high-pressure oil signal of the third pressure input port or the fourth pressure input port through logic OR.

An inlet of the pressure overload protection valve may be connected to an oil path from the second pressure input port to the pressure output port, and an output port may be connected to a control oil path of the reverse control port.

The one-way throttle control valve may be resistively connected to an output oil path of the pressure overload protection valve, and may be used to press the reverse control port to reverse the direction valve for overload protection, which may have no throttle control effects on the second control signal.

The switchover valve may include a first main oil port, a second main oil port, a third main oil port, a fourth main oil port, a first control port and a second control port, where the first main oil port and the second main oil port may be respectively connected with an oil port of the main valve and an oil port of the energy collector, the third main oil port and the fourth main oil port may be respectively connected with the first oil port and the fifth oil port of the pressure energy retaining valve, and the first control port and the second control port may be respectively connected with a third control port and a fourth control port of the logical control member.

For example, when the first control port has a signal function, the switchover valve is switched to the left position, and at this time, the first main oil port is connected with the fourth main oil port, and the third main oil port is connected with the second main oil port; when the second control port has a signal function, the switchover valve is switched to the right position, and at this time, the first main oil port is connected with the third main oil port, and the fourth main oil port is connected with the second main oil port; when both the first control port and the second control port have no signal function, the switchover valve is at the normal position (middle position), and at this time, the first main oil port is connected with the third main oil port and the fourth main oil port, but the second main oil port is not switched on.

The logical control member may be a hydraulic logical control member, an electric logical control member or an electro-hydraulic control logical member. The logical control member may include input and output connections which may include an input connected to a first connecting point of the main valve at which the first control signal is input, an input connected to a first main oil path from the oil port of the main valve to the first main oil port of the switchover valve, an input connected to a third connecting point of the main valve at which the second control signal is input, and an input connected to a second main oil path from the oil port of the main valve to a first rod end oil port and a second rod end oil port of the energy converter; and the third control port may be connected to the first control port of the switchover valve, and the fourth control port may be connected to the second control port of the switchover valve.

For example, when pressure oil is introduced into two working cavities and of the two units of the energy converters and the other two working cavities are reconnected to the oil tank, the units of the energy converters synchronously lift the boom through the rod pistons, and, at this time, input hydraulic energy is converted to potential energy of the boom; when pressure oil is introduced into the two working cavities of the two units of the energy converters and the other two working cavities are connected externally, the boom drives the rod pistons of the units of the energy converters to synchronously drop, and, at this time, potential energy of the boom is converted to hydraulic energy. When operations are not performed, the pressure energy retaining valve not only can prevent leakage of pressure oil in the two working cavities of the energy converters, to retain the boom in situ, but also can prevent the pressure oil in the two working cavities of the energy converters from having too high pressure. During a lifting operation, working oil can be respectively introduced into the second oil port and the sixth oil port unidirectionally from the first and fifth oil ports, and during a dropping operation, the second control signal acts on the reverse control port, the direction valve is reversed, and the pressure oil from the two working cavities of the energy converters is respectively introduced into the first oil port and the fifth oil port from the second oil port and the sixth oil port.

For example, when the first control port and the second control port have no signal function, the switchover valve is at the middle position, and conventional lifting and dropping operations of the boom without potential energy harvesting can be performed; when the first control port has a signal function and the switchover valve is at the left position, a loop connected to the third main oil port of the main valve, the first main oil port and the fourth main oil port, the fifth oil port and the sixth oil port of the pressure energy retaining valve, and the second working cavity oil port of an unit of the energy converter forms a passage, and a loop connected to the oil port of the energy collector, the second main oil port and the third main oil port, the first oil port and the second oil port of the pressure energy retaining valve, and the first working cavity oil port of an other unit of the energy converter also forms a passage. When the second control port has a signal function and the switchover valve is at the right position, a loop connected to the third main oil port of the main valve, the first main oil port and the third main oil port of the switchover valve, the first oil port and the second oil port of the pressure energy retaining valve, and the first working cavity oil port of an unit of the energy converter forms a passage, and a loop connected to the oil port of the energy collector, the second main oil port and the fourth main oil port of the switchover valve, the fifth oil port and the sixth oil port of the pressure energy retaining valve, and the second working cavity oil port of an other unit of the energy converter forms a passage.

Therefore, by changing signal functions of the first control port and the second control port, it is ensured that third main oil port of the main valve, the oil port of the energy collector, the first working cavity oil port of an unit of the energy converter and the second working cavity oil port of an other unit of the energy converter are alternately switched on, to achieve the objectives of harvesting and utilizing potential energy and exchanging and cooling hot oil of the energy collector.

The logical control member can respectively control the signal functions of the first control port and the second control port of the switchover valve according to the pressure of the first main oil path or the second main oil path, can directly or indirectly introduce the first control signal and the second control signal into the first control port and the second control port of the switchover valve when pressure of the first main oil path or the second main oil path does not reach a set value of the logical control member, and, otherwise, removes the signal functions of the first control port and the second control port of the switchover valve.

Preferably, the first control signal and the second control signal may be hydraulic pressure signals and/or electrical signals, and may be directly or indirectly taken from an operating handle.

Beneficial effects brought about by the present invention are as follows: the present invention is applied to recycling of potential energy of an excavator boom, charges the potential energy of the boom into an energy collector through corresponding control when the boom drops, and when an excavator is performing arm lifting and energy consumption operations, releases stored oil to directly do work by controlling the switchover valve, and reduces input power of a prime mover. The present invention has a simple principle, is easy to control, has reliable performance, and can automatically achieve exchange and cooling of hot oil in the energy collector, which not only can reduce heat generated by a hydraulic system and save energy, but also can reduce emissions of the prime mover.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic structural diagram of Embodiment 1.

## DETAILED DESCRIPTION

Embodiments of the Present Invention

The present invention is further described below in detail with reference to the accompanying drawing and specific embodiments.

Referring to FIG. 1, a working device potential energy recovery hydraulic system includes two energy converters that at least include a unit 1.1, 1.2 each, a main valve 6, a first control signal Signal-a and a second control signal Signal-b. An inlet of a pressure energy retaining valve 2 is connected with the main valve 6 through a switchover valve 3, an outlet of the pressure energy retaining valve 2 is connected with rodless cavities of the units 1.1, 1.2 of the energy converters, the switchover valve 3 is connected with an energy collector 4, an input end of a logical control member 5 is in communication connections with the main valve 6, the units 1.1, 1.2 of the energy converters, the first control signal Signal-a and the second control signal Signal-b, and an output end of the logical control member 5 is connected with a control end of the switchover valve 3.

Each of the units 1.1, 1.2 of the energy converters is separated into corresponding working cavities 1.1b, 1.1c, 1.2b, 1.2c by a rod piston 1.1a, 1.2a, the working cavities 1.1b,1.2b are each provided with an oil port B1, B2 and are directly connected with an oil port B of the main valve, and the working cavities 1.1c, 1.2c are each provided with an oil port A1, A2. The pressure energy retaining valve 2 includes: unit valves 2a, 2b, a signal OR valve 2c, a pressure overload protection valve 2d, a direction valve 2e and a one-way throttle control valve 2f, where the unit valve 2a is provided with a first oil port Ia, a second oil port IIa, a third oil port IIIa and a fourth oil port IVa, and the second oil port IIa communicates with the fourth oil port IVa; the unit valve 2b is provided with a fifth oil port Ib, a sixth oil port IIb, a seventh oil port IIIb and an eighth oil port IVb, the sixth oil port IIb communicates with the eighth oil port IVb, and the second oil port IIa and the sixth oil port IIb are respectively connected with the first working cavity oil port A1 and the second working cavity oil port A2 of 1.1c, 1.2c of the energy converters; the direction valve 2e is provided with a first pressure input port k1, a second pressure input port k2, an oil return port kt and a reverse control port Kb5, the input port k1 communicates with the third oil port IIIa and the seventh oil port IIIb, the oil return port kt is connected with an oil return path T2 and gets oil back to an oil tank, and the reverse control port Kb5 is connected to a second connecting point S2 of the main valve at which the second control signal Signal-b is input; the signal OR valve 2c includes: a third pressure input port a, a fourth pressure input port b and a pressure output port c, the third pressure input port a is connected with the fourth oil port IVa of the unit valve 2a, the fourth pressure input port b is connected with the eighth oil port IVb of the unit valve 2b, and the pressure output port c is connected with the oil port k2 of the direction valve and takes a high-pressure oil signal of the third pressure input port a or the fourth pressure input port b through logic OR; an inlet of the pressure overload protection valve 2d is connected to an oil path G from the oil port k2 to the pressure output port c, and an output port is connected to a control oil path H of the reverse control port Kb5; and the one-way throttle control valve 2f is resistively connected to an output oil path of the pressure overload protection valve 2d, and is used to press the reverse control port Kb5, to reverse the direction valve 2e for overload protection, which has no throttle control effects on the second control signal Signal-b. The switchover valve 3 includes: a first main oil port P1, a second main oil port P2, a third main oil port A, a fourth main oil port B, a first control port Ka4 and a second control port Kb4, where the first main oil port P1 and the second main oil port P2 are respectively connected with an oil port A of the main valve and an oil port X of the energy collector, the third main oil port A and the fourth main oil port B are respectively connected with the first oil port Ia and the fifth oil port Ib of the pressure energy retaining valve 2 and the first control port Ka4 and the second control port Kb4 are respectively connected with a third control port Pp1 and a fourth control port Pp2 of the logical control member 5. Input and output connections of the logical control member 5 include: input Ka2 is connected to a first connecting point S1 of the main valve at which the first control signal Signal-a is input, input Ka3 is connected to a first

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main oil path E from the oil port A of the main valve to the oil port P1 of the switchover valve, input Kb2 is connected to a third connecting point S3 of the main valve at which the second control signal Signal-b is input, and input Kb3 is connected to a second main oil path F from the oil port B of the main valve to a first rod end oil port B1 and a second rod end oil port B2 of the energy converter; and output Pp1 is connected to the first control port Ka4 of the switchover valve 3, and output Pp2 is connected to the second control port Kb4 of the switchover valve 3.

The logical control member 5 is a hydraulic logical control member, an electric logical control member or an electro-hydraulic control logical member.

Preferably, the signals Signal-a and Signal-b are hydraulic pressure signals and/or electrical signals, and are directly or indirectly taken from an operating handle.

Referring to FIG. 1, in terms of the units 1.1 and 1.2 of the energy converters: when pressure oil is introduced into the two working cavities 1.1c and 1.2c of the units 1.1 and 1.2 of the energy converters and the other two working cavities 1.1b and 1.2b are reconnected to the oil tank, the units 1.1 and 1.2 of the energy converters synchronously lift the boom through the rod pistons 1.1a and 1.2a, and at this time, input hydraulic energy can be converted to potential energy of the boom; when pressure oil is introduced into the two working cavities 1.1b and 1.2b of the units 1.1 and 1.2 of the energy converters and the other two working cavities 1.1c and 1.2c are connected externally, the boom drives the rod pistons 1.1a and 1.2a of the units 1.1 and 1.2 of the energy converters to synchronously drop, and at this time, potential energy of the boom is converted to hydraulic energy.

In terms of the pressure energy retaining valve 2: when lifting and dropping operations of the boom are not performed, the pressure energy retaining valve not only can prevent leakage of pressure oil in the two working cavities 1.1c and 1.2c of the energy converters, to retain the boom in situ, but also can prevent that the pressure oil in the two working cavities 1.1c and 1.2c of the energy converter has too high pressure and therefore damages components.

In terms of the switchover valve 3: by correspondingly controlling signals that act on the first control port Ka4 and the second control port Kb4, the following functions can be achieved: 1) oil paths from the oil port A of the main valve and the oil port X of the energy collector to the two cavities 1.1c and 1.2c of the energy converters are alternately switched on, which not only achieves the objective of harvesting and utilizing potential energy but also can achieve exchange and cooling of hot oil of the energy collector; 2) when lifting and dropping operations of the boom are performed, for example, the first main oil path E and the second main oil path F are in a state in which the pressure reaches a set pressure value of the logical control member, the logical control member removes a signal acting on the first control port Ka4 or the second control port Kb4, the switchover valve returns to the middle position, and conventional operations without energy conservation can be performed.

In terms of the energy collector 4: it not only can collect dropping potential energy of the boom, but also can provide power when the boom is lifted.

In terms of the logical control member 5: it is mainly used to detect pressure of the first main oil path E or the second main oil path ), for example, when the pressure does not reach the set value of the logical control member, it directly or indirectly introduces the first control signal Signal-a and the second control signal Signal-b into the first control port Ka4 and the second control port Kb4 of the switchover valve for reverse control, and otherwise, it removes acting signals of the first control port Ka4 and the second control port Kb4 of the switchover valve.

Referring to FIG. 1, in the lifting operation process: an operating handle inputs a signal to enable the first control signal Signal-a to be effective, the main valve is switched to the left position under the action of the first control signal Signal-a, pressure oil on an oil path P of the main valve can be introduced into the port A of the main valve, and return oil of the port B of the main valve can be introduced into an oil return path T. Herein, the switchover valve has the following two working states:

1) If pressure (determined by load) of the port A of the main valve does not reach the set value of the logical control member, the logical control member introduces the first control signal Signal-a into the first control port Ka4 of the switchover valve to switch the switchover valve to the left position. At this time, pressure from the main valve enters the working cavity 1.2c of the energy converter through the port A of the main valve, the first main oil port P1 and the fourth main oil port B of the switchover valve, the fifth oil port Ib and the sixth oil port IIb of the pressure energy retaining valve

and the port A2 of the energy converter. Besides, pressure oil of the energy collector enters the working cavity 1.1c of the energy converter through the X port, the second main oil port P2 and the third main oil port A of the switchover valve, the first oil port Ia and the second oil port IIa of the pressure energy retaining valve and the port A1 of the energy converter. At this time, return oil of the working cavities 1.1b and 1.2b of the energy converters can flow back to the oil tank through the port B of the main valve and the oil return path T of the main valve, and thus the energy converter does work on and lifts the boom under the action of the energy collector and the pressure oil from the main valve, and required power of the prime mover is automatically decreased due to assistant functions of the energy collector.

2) If pressure (determined by load) of the port A of the main valve reaches or exceeds the set value of the logical control member, the logical control member removes a signal function of the first control port Ka4 of the switchover valve, and the switchover valve works in the middle position. At this time, pressure oil from the main valve is divided into two channels after passing through the port A of the main valve and the first main oil port P1 of the switchover valve, one channel enters the working cavity 1.1c of the energy converter from the third main oil port A, the first oil port Ia and the second oil port IIa of the pressure energy retaining valve and the port A1 of the energy converter, and the other channel enters the working cavity 1.2c of the energy converter from the fourth main oil port B, the fifth oil port Ib and the sixth oil port IIb of the pressure energy retaining valve and the port A2 of the energy converter. Return oil of the working cavities 1.1b and 1.2b of the energy converters can flow back to the oil tank through the port B of the main valve and the oil return path T, and thus the energy converter does work on and lifts the boom without energy conservation under the action of the pressure oil from the main valve.

In the dropping operation process: the operating handle inputs a signal to enable the second control signal Signal-b to be effective, the main valve is switched to the right position under the action of the second control signal Signal-b, pressure oil on an oil path P of the main valve can be introduced into the port B of the main valve, return oil of the port A of the main valve can be introduced into the oil return path T. Herein, the switchover valve also has the following two working states:

1) If pressure (determined by load) of the port B of the main valve does not reach the set value of the logical control member, the logical control member introduces the second control signal Signal-b into the second control port Kb4 of the switchover valve to switch the switchover valve to the right position. At this time, pressure oil from the main valve enters the working cavities 1.1b and 1.2b of the energy converters through the port B of the main valve, oil of the working cavity 1.1c of the unit 1.) of the energy converter enters the energy collector through the second oil port IIa and the first oil port Ia of the pressure energy retaining valve, the third main oil port A and the second main oil port P2, and oil of the working cavity 1.2c of the unit 1.2 of the energy converter flows back to the oil tank through the sixth oil port IIb and the fifth oil port Ib of the pressure energy retaining valve, the third main oil port A, the first main oil port P1, the port A of the main valve and the oil return path T. As the port A of the main valve has small back pressure, the dropping back pressure of the boom is mainly generated by the energy collector, the dropping potential energy of the boom is mainly stored in the energy collector.

2) If pressure (determined by load) of the port B of the main valve reaches or exceeds the set value of the logical control member, the logical control member removes a signal function of the second control port Kb4 of the switchover valve, and the switchover valve is not reversed and works in the middle position. At this time, pressure oil from the main valve enters the working cavities 1.1b and 1.2b of the energy converters through the port B of the main valve, oil of the working cavities 1.1c and 1.2c of the energy converters each passes through the second oil port IIa, the first oil port Ia, the sixth oil port IIb and the fifth oil port Ib of the pressure energy retaining valve, and the third main oil port A and the fourth main oil port B of the switchover valve and then enters the oil return path T from the first main oil port P1 of the switchover valve and the port A of the main valve and flows back to the oil tank, and the boom can perform conventional dropping operations without energy storage.

The foregoing descriptions are merely preferred embodiments of the present invention, and do not limit the present invention in any way. For persons skilled in the art, the present invention can have various changes and variations.

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## CLAIMS

What is claimed is:

1. A working device energy recovery system, comprising two energy converters, that comprise at least a unit each, a main valve, a first control signal and a second control signal, wherein an inlet of a pressure energy retaining valve is connected with the main valve through a switchover valve, an outlet of the pressure energy retaining valve is connected with rodless cavities of the said unit of the energy converters, the said switchover valve is connected with an energy collector, an input end of a logical control member is in communication connections with the said main valve, the said units of the energy converters, the said first control signal and the said second control signal, an output end of the logical control member is connected with a control end of the switchover valve, wherein the said pressure energy retaining valve comprises unit valves, a signal OR valve, a pressure overload protection valve, a direction valve and a one-way throttle control valve.

2. The working device energy recovery system according to claim 1, wherein each of the two energy converters at least comprises one or more units, each unit is separated into corresponding working cavities by a rod piston, the working cavities are each provided with an oil port and are directly connected with an oil port of the main valve, and the working cavities are each provided with an oil port.

3. The working device energy recovery system according to claim 1 or claim 2, wherein a unit valve is provided with a first oil port, a second oil port, a third oil port and a fourth oil port, and the second oil port communicates with the fourth oil port.

4. The working device energy recovery system according to claim 1 to 3, wherein another unit valve is provided with a fifth oil port, a sixth oil port, a seventh oil port and an eighth oil port, the sixth oil port communicates with the eighth oil port, and the second oil port and the sixth oil port are respectively connected with the first working cavity oil port and the second working cavity oil port of the energy converters.

5. The working device energy recovery system according to claim 4, wherein the direction valve is provided with a first pressure input port, a second pressure input port, an oil return port and a reverse control port, the first pressure input port communicates

with the third oil port and the seventh oil port, the oil return port is connected with an oil return path and gets oil back to an oil tank, and the reverse control port is connected to a second connecting point of the main valve at which the second control signal is input.

6. The working device energy recovery system according to claim 4, wherein the signal OR valve comprises a third pressure input port, a fourth pressure input port and a pressure output port, the third pressure input port is connected with the fourth oil port of the unit valve, the fourth pressure input port is connected with the eighth oil port of the unit valve, and the pressure output port is connected with the second pressure input port of the direction valve and takes a high-pressure oil signal of the third pressure input port or the fourth pressure input port through logic OR.

7. The working device energy recovery system according to claim 5, wherein an inlet of the pressure overload protection valve is connected to an oil path from the second pressure input port to the pressure output port, and an output port is connected to a control oil path of the reverse control port.

8. The working device energy recovery system according to any one of the preceding claims 1 to 7, wherein the one-way throttle control valve is resistively connected to an output oil path of the pressure overload protection valve, and is used to press the reverse control port, to reverse the direction valve for overload protection, which has no throttle control effects on the second control signal.

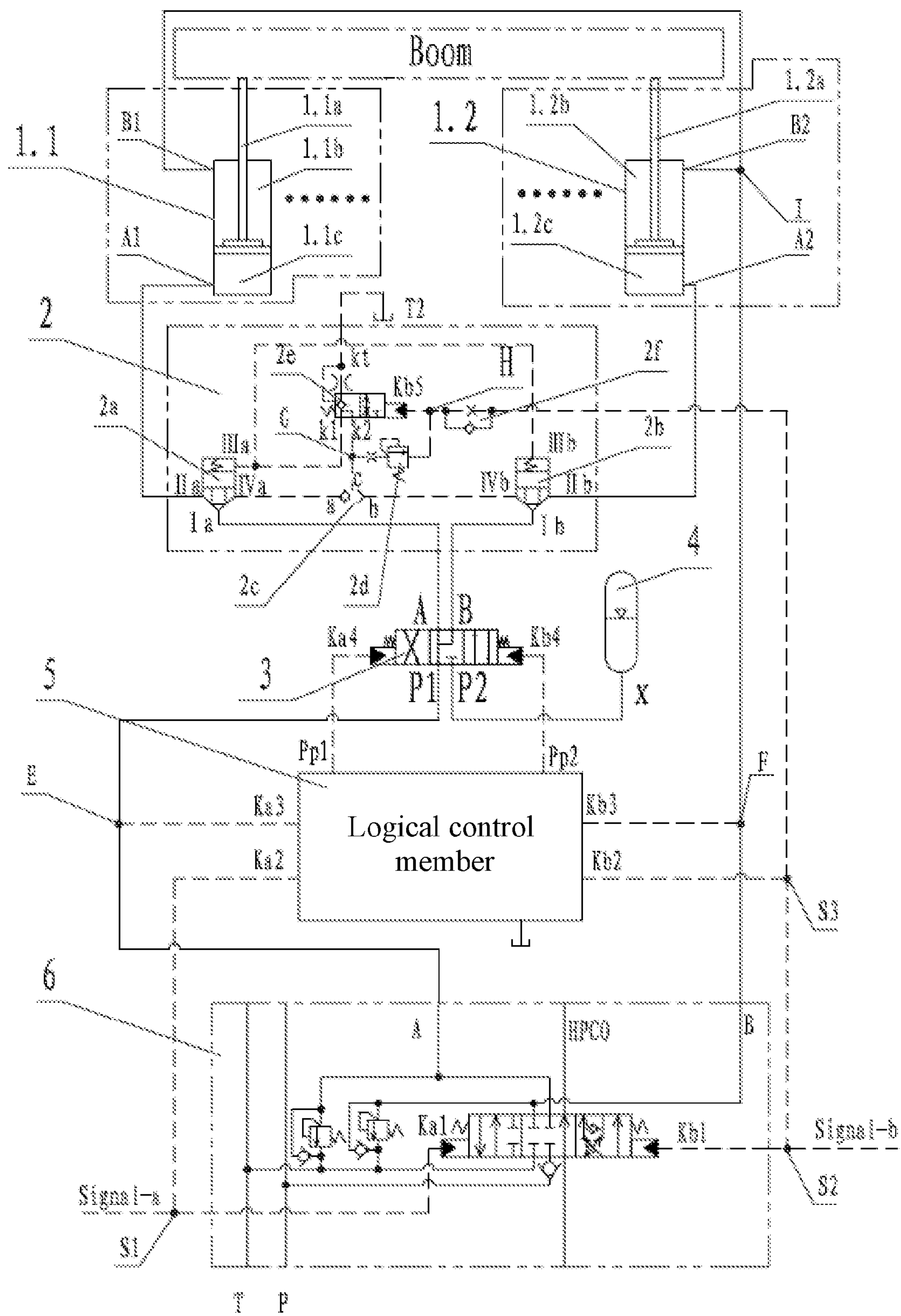
9. The working device energy recovery system according to any of the preceding claims 1 to 8, wherein the switchover valve comprises a first main oil port, a second main oil port, a third main oil port, a fourth main oil port, a first control port and a second control port, the first main oil port and the second main oil port are respectively connected with an oil port of the main valve and an oil port of the energy collector, the third main oil port and the fourth main oil port are respectively connected with the first oil port and the fifth oil port of the pressure energy retaining valve, the first control port and the second control port being respectively connected with a third control port and a fourth control port of the logical control member.

10. The working device energy recovery system according to claim 9, wherein input and output connections of the logical control member comprise an input

connected to a first connecting point of the main valve at which the first control signal is input, an input connected to a first main oil path from the oil port of the main valve to the first main oil port of the switchover valve, an input connected to a third connecting point of the main valve at which the second control signal is input, an input is connected to a second main oil path from the oil port of the main valve to a first rod end oil port and a second rod end oil port of the energy converter, the third control port being connected to the first control port of the switchover valve, and fourth control port being connected to the second control port of the switchover valve.

11. The working device energy recovery system according to any one of the preceding claims 1 to 10, wherein the logical control member is a hydraulic logical control member, an electric logical control member or an electro-hydraulic control logical member.

12. The working device energy recovery system according to any one of the preceding claims 1 to 11, wherein the first control signal and the second control signal are hydraulic pressure signals and/or electrical signals, and are directly or indirectly taken from an operating handle.


Boom
1.1
1.1a
1.1b
1.1c
B1
A1
1.2
1.2a
1.2b
1.2c
B2
A2
I
2
2a
2b
2c
2d
2e
2f
H
G
Kt
Kb5
K1
K2
IIIa
IIa
IVa
IIIb
IVb
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Ka4
Kb4
3
P1
P2
X
5
Pp1
Pp2
E
Ka3
Kb3
F
Ka2
Kb2
S3
Logical control member
6
HPCO
Ka1
Kb1
Signal-a
Signal-b
S1
S2
T
P

FIG. 1