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# (54) LOCOMOTIVE DRIVER CONTROLLER AND CONTROL METHOD THEREOF

(57) A locomotive driver controller and a control method thereof. The locomotive driver controller comprises a mechanical operation apparatus (10) and a digital operation apparatus (20), wherein the mechanical operation apparatus (10) comprises a mechanical traction brake unit (11), a mechanical direction unit (12) and a mechanical lock; the mechanical traction brake unit (11) and the mechanical direction unit (12) are respectively connected to the mechanical lock in an interlocked manner; the mechanical traction brake unit (11) comprises a zero bit and a non-zero bit; the digital operation apparatus (20) comprises a digital lock, a digital direction unit (21) and a digital traction brake unit (22); the digital direction unit (21) and the digital traction brake unit (22) are respectively connected to the digital lock in an interlocked manner; and the digital traction brake unit (22) comprises a zero bit and a non-zero bit. The locomotive driver controller further comprises an interlocking unit (30), the interlocking unit (30) comprising an interlocking cam (31), which is connected to the mechanical operation apparatus (10), and an interlocking button (32), which is connected to the digital operation apparatus (20), wherein the interlocking cam (31) and the interlocking button (32) have an interlocking switch release state and an interlocking switch compression state.

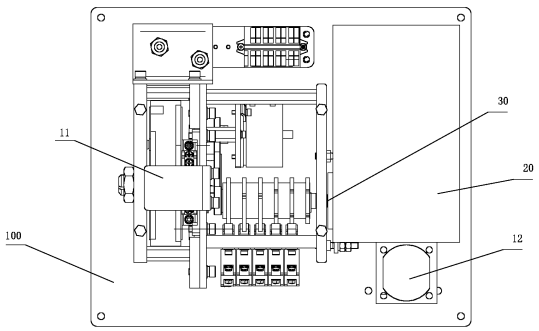

Fig. 1

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## Description

### FIELD OF THE INVENTION

**[0001]** The present disclosure relates to the technical field of driver controllers, in particular to a locomotive driver controller and a control method thereof.

### BACKGROUND OF THE INVENTION

**[0002]** Most locomotive driver controllers used at present are mechanical driver controllers. In prior art, a locomotive driver controller which integrates a digital and intelligent operation apparatus with a mechanical operation apparatus is rare. Product digitization and intelligence are inevitable trends in social development, and a driver controller with digital and intelligent operation is an inevitable trend in future development.

**[0003]** A multifunctional driver controller simulation system (Issue number of Chinese patent CN205750339) is constituted by serially connecting an electronic control unit to a rear stage of a universal driver controller. In different projects, by adjusting the software logic function of the electronic control unit, functional output of the driver controller for different projects is produced to reduce demands of different projects for different models of driver controllers, costs of system testing, and waste of resources. However, this solution does not integrate mechanical and digital operation functions.

### SUMMARY OF THE INVENTION

**[0004]** An objective of the present disclosure is to provide a new generation locomotive driver controller, which integrates a digital and intelligent operation apparatus with a mechanical operation apparatus, has digital and intelligent operation functions, conforms to the development trend of product digitization and intelligence, and also has stable and reliable mechanical operation.

**[0005]** To achieve the above objective, the present disclosure adopts the following technical solution:

A locomotive driver controller, including a mechanical operation apparatus, the mechanical operation apparatus having a working state and a non-working state, characterized in that the locomotive driver controller further includes a digital operation apparatus, the digital operation apparatus having a working state and a non-working state; the locomotive driver controller further includes an interlocking unit, the interlocking unit includes an interlocking cam connected to the mechanical operation apparatus and an interlocking button connected to the digital operation apparatus, and the interlocking cam and the interlocking button have an interlocking switch release state and an interlocking switch compression state, where when the mechanical operation apparatus is in the working state, the interlocking cam and the interlocking button are in the interlocking switch compression state, and the digital operation apparatus enters the non-working state; and when the mechanical operation apparatus is in the non-working state, the interlocking cam and the interlocking button are in the interlocking switch release state, and the digital operation apparatus is allowed to enter the working state. A locomotive driver controller integrating a mechanical operation apparatus and a digital operation apparatus is achieved. By setting the interlocking unit, the logic control signal level of the mechanical operation apparatus is higher than that of the digital operation apparatus.

**[0006]** As a further solution, the mechanical operation apparatus is mechanical; the mechanical operation apparatus includes a mechanical traction and brake unit, a mechanical direction unit, and a mechanical lock; and the mechanical traction and brake unit and the mechanical direction unit are respectively connected to the mechanical lock in a mechanical interlocking manner.

**[0007]** As a further solution, the digital operation apparatus is digital; the digital operation apparatus includes a digital lock, a digital direction unit, and a digital traction and brake unit; and the digital direction unit and the digital traction and brake unit are respectively connected to the digital lock in an electrical interlocking manner.

**[0008]** The mechanical operation apparatus is mechanical, and the digital operation apparatus is digital, so that the locomotive driver controller becomes a new generation locomotive driver controller integrating the digital operation apparatus and the mechanical operation apparatus.

**[0009]** As a further solution, the digital lock involves one of fingerprint unlocking, password unlocking, facial recognition unlocking, ID card unlocking, and iris unlocking.

**[0010]** As a further solution, output signals of the mechanical operation apparatus are hard wire signals, and the hard wire signals include a lock signal, a mechanical direction signal, and a traction and brake signal; an output signal of the digital operation apparatus is a communication signal, the communication signal is one of MVB network signal, CAN signal, and Ethernet signal, and the communication signal includes start information, direction information, and traction and brake rate.

**[0011]** As a further solution, the digital operation apparatus can be remotely controlled by a vehicle monitoring center; and preferably, the remote control is cloud control.

**[0012]** As a further solution, input of the digital operation apparatus includes one or more of touch screen input, keyboard input, mouse input, and voice input.

**[0013]** As a further solution, the digital traction and brake unit is used for performing operations according to collected vehicle information.

**[0014]** Preferably, the vehicle information includes command information from the vehicle monitoring center, environmental information on a travel path of the locomotive, and locomotive fault information; and the operations performed by the digital traction and brake unit include adjusting locomotive speed, adjusting locomotive

acceleration, and applying parking brake.

**[0015]** More preferably, the locomotive fault information includes information about abnormal locomotive speed/acceleration, abnormal temperature of locomotive components, and abnormal connection between a pantograph and a contact network.

**[0016]** A control method for a locomotive driver controller is provided corresponding to the locomotive driver controller.

**[0017]** A control method for a locomotive driver controller, tasks performed by the locomotive driver controller include a mechanical operation task and a digital operation task; the mechanical operation task includes a mechanical direction operation, a mechanical traction and brake operation, and a mechanical lock operation; the digital operation task includes a digital direction operation, a digital traction and brake operation, and a digital lock operation;

The response priority of the mechanical operation task is higher than that of the digital operation task; while the mechanical operation task is responded, the digital lock is in a locked state;

**[0018]** The control method for the locomotive driver controller includes:

determining whether the digital lock is locked before performing the digital direction operation or the digital traction and brake operation: and

if the digital lock is in the locked state, locking the digital operation task in an initial state, where the initial state is 0 position, indicating that the digital operation task is not performed; or

if the digital lock is in an unlocked state, performing the digital direction operation or the digital traction and brake operation.

**[0019]** In the above technical solution, the control method further includes:

determining whether the mechanical lock is in a locked state before performing the mechanical direction operation or the mechanical traction and brake operation: and

if the mechanical lock is in the locked state, locking the mechanical direction unit used for performing the mechanical direction operation and the mechanical traction and brake unit used for performing the mechanical traction and brake operation in an initial state, where the initial state is 0 position, indicating that the mechanical operation task is not performed; or

if the mechanical lock is in an unlocked state, performing the mechanical direction operation or the mechanical traction and brake operation.

**[0020]** In the above technical solution, both the mechanical operation task and the digital operation task have mark bits, and the mark bits include a zero bit and a non-zero bit;

When the mark bit of the mechanical operation task is zero, it indicates that the mechanical operation task is not performed, that is, the initial state; when the mark bit of the mechanical operation task is non-zero, it indicates that the mechanical operation task is being performed;

When the mark bit of the digital operation task is zero, it indicates that the digital operation task is not performed, that is, the initial state; when the mark bit of the digital operation task is non-zero, it indicates that the digital operation task is being performed;

When the mark bit of the mechanical operation task is non-zero, the digital operation task is not allowed to be performed; and when the mark bit of the mechanical operation task is zero, the digital operation task is allowed to be performed after the digital lock is unlocked.

**[0021]** In the above technical solution, the locomotive driver controller includes a mechanical operation apparatus and a digital operation apparatus; the mechanical operation apparatus includes a mechanical traction and brake unit used for performing the mechanical traction and brake operation, a mechanical direction unit used for performing the mechanical direction operation, and a mechanical lock; the mechanical traction and brake unit and the mechanical direction unit are respectively connected to the mechanical lock in a mechanical interlocking manner;

The digital operation apparatus includes a digital lock, a digital direction unit used for performing the digital direction operation, and a digital traction and brake unit used for performing the digital traction and brake operation; the digital direction unit and the digital traction and brake unit are respectively connected to the digital lock in an electrical interlocking manner;

The control method further includes:

when the network signal output by the digital traction and brake unit is a non-zero bit signal and the I/O signal output by the mechanical operation apparatus is a zero bit signal, performing traction and brake control on the entire vehicle according to the network signal;

when the I/O signal output by the mechanical traction and brake unit is a non-zero bit signal, performing, by the digital traction and brake unit, an operation of powering off or cutting off output signals or outputting determination signals according to preset settings, and determining a traction and brake state of the entire vehicle according to the I/O signal output by the mechanical traction and brake unit; and

after the mechanical traction and brake unit locks the digital operation apparatus, and after the mechanical traction and brake unit recovers

to the 0 position, and when the digital lock of the digital operation apparatus is not unlocked, determining a traction and brake state of the entire vehicle according to the I/O signal output by the mechanical traction and brake unit.

**[0022]** In the above technical solution, when the mechanical lock is in an unlocked position, the mechanical direction unit is allowed to switch to a forward or reverse position, output a corresponding I/O signal and perform a corresponding task, and the mechanical traction and brake unit is allowed to push to a traction position or a brake position from a 0 position, output a corresponding I/O signal and perform a corresponding task.

**[0023]** In the above technical solution, when the digital lock is in an unlocked position, the digital direction unit is allowed to switch to a forward or reverse position, output a corresponding network signal and perform a corresponding task, and the digital traction and brake unit is allowed to switch among a 0 position, a traction position, and a brake position, output a corresponding network signal and perform a corresponding task.

**[0024]** Beneficial effects achieved by the present invention are as follows:

By using the present invention, digital and intelligent operation of a driver controller for a rail transit vehicle can be implemented. Specific effects are as follows:

(1) The locomotive driver controller integrates a digital operation apparatus and a mechanical operation apparatus, so during the operation of the vehicle, any operation method can be used to control the vehicle;

(2) In any case, the output signal of the mechanical operation apparatus can cut off output signals of the digital operation apparatus; and

(3) In emergencies, a mechanical handle that is more intuitive and clearer in hand feel can be quickly operated to avoid braking or accelerating too quickly or too slowly.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0025]** In order to illustrate the technical solutions of the present invention more clearly, the accompanying drawings used in the description of the embodiments will be briefly introduced below. Apparently, the accompanying drawings in the following description show only one embodiment of the present invention, and those of ordinary skill in the art can obtain other drawings according to the accompanying drawings without any creative effort.

FIG. 1 is a bottom view of an embodiment of the present invention;

FIG. 2 is a front view of an embodiment of the present invention;

FIG. 3 is a top view of an embodiment of the present invention;

FIG. 4 shows that an interlocking cam and an interlocking button are in an interlocking switch release state according to an embodiment of the present invention;

FIG. 5 shows that the interlocking cam and the interlocking button are in an interlocking switch compression state according to an embodiment of the present invention; and

FIG. 6 shows input information that can be received by a digital operation apparatus according to an embodiment of the present invention.

**[0026]** In the figures: 100 - panel, 10 - mechanical operation apparatus, 11 - mechanical traction and brake unit, 12 - mechanical direction unit, 20 - digital operation apparatus, 21 - digital direction unit, 22 - digital traction and brake unit, 30 - interlocking unit, 31 - interlocking cam, 32 - interlocking button.

## DETAILED DESCRIPTION OF THE EMBODIMENTS

**[0027]** As shown in FIGs. 1-5, a locomotive driver controller includes a panel 100, as well as a mechanical operation apparatus 10 and a digital operation apparatus 20 integrated on the panel 100.

**[0028]** As shown in FIGs. 1-3, the mechanical operation apparatus 10 includes a mechanical traction and brake unit 11, a mechanical direction unit 12, and a mechanical lock (not shown in the figure). The mechanical traction and brake unit 11 and the mechanical direction unit 12 are respectively connected to the mechanical lock in a linkage manner. The connection in a linkage manner is mechanical interlocking connection of the mechanical traction and brake unit 11 and the mechanical direction unit 12 with the mechanical lock. The mechanical traction and brake unit 11 has a working state and a non-working state.

**[0029]** As shown in FIGs. 1-3, the digital operation apparatus 20 includes a digital lock (not shown in the figure), a digital direction unit 21, and a digital traction and brake unit 22. The digital direction unit 21 and the digital traction and brake unit 22 are respectively connected to the digital lock in a linkage manner. The connection in a linkage manner is electrical interlocking connection of the digital traction and brake unit 22 and the digital direction unit 21 with the digital lock. The digital traction and brake unit 22 has a working state and a non-working state.

**[0030]** The locomotive driver controller further includes an interlocking unit 30, the interlocking unit 30 includes an interlocking cam 31 connected to the mechanical operation apparatus 10 and an interlocking button 32 connected to the digital operation apparatus 20, and the interlocking cam 31 and the interlocking button 32 have an interlocking switch release state and an interlocking switch compression state. When the mechanical traction and brake unit 11 is in the working state, the interlocking cam 31 and the interlocking button 32 are in the inter-

locking switch compression state, and the digital traction and brake unit 22 enters the non-working state. When the mechanical traction and brake unit 11 is in the non-working state, the interlocking cam 31 and the interlocking button 32 are in the interlocking switch release state, and the digital traction and brake unit 22 enters the working state. In this way, the present invention can implement digital and intelligent operation of the driver controller for a rail transit vehicle. In addition to the digital and intelligent operation, the driver controller also has the mechanical operation apparatus, so during the operation of the vehicle, any operation method can be used to control the vehicle. In any case, output signals of the mechanical operation apparatus can cut off output signals of the digital operation apparatus.

**[0031]** The mechanical traction and brake unit includes a mechanical handle. In emergencies, the mechanical handle that is more intuitive and clearer in hand feel can be quickly operated to avoid braking or accelerating too quickly or too slowly.

**[0032]** As shown in FIG. 4, the interlocking cam 31 does not press the interlocking button 32, indicating that the interlocking cam 31 and the interlocking button 32 are in the interlocking switch release state.

**[0033]** As shown in FIG. 5, the interlocking cam 31 presses the interlocking button 32, indicating that the interlocking cam 31 and the interlocking button 32 are in the interlocking switch compression state.

**[0034]** Specifically, the logic control signal level of the mechanical operation apparatus 10 is higher than the logic control signal level of the digital operation apparatus 20. The mechanical operation apparatus 10 is mechanical, and its output signals are hard wire signals. The digital operation apparatus 20 is digital, and its output signals are communication signals. The communication signals include start information, direction information, and traction and brake rate. The output signals of the mechanical operation apparatus 10 are hard wire signals, which include a lock signal, a mechanical direction signal, and a traction and brake signal. There is mechanical and electrical interlocking between the mechanical operation apparatus and the digital operation apparatus. The output signals of the mechanical operation apparatus are prior to those of the digital operation apparatus. When the mechanical operation apparatus works, operation instructions of the digital operation apparatus for the locomotive may be cut off from mechanical, electrical, and communication aspects.

**[0035]** The digital operation apparatus 20 of the locomotive driver controller has functions of lock unit operation, direction operation, traction and brake operation, unmanned driving mode, etc. The digital lock of the digital operation apparatus 20 is only used for unlocking the digital operation apparatus in a manner of fingerprint unlocking, password unlocking, facial recognition unlocking, iris unlocking, etc., and the specific manner is determined by an actual interface. The digital direction unit 21 is a locomotive running direction selection portion, including forward, 0 position, and reverse. According to interface requirements, the digital direction unit may be a touch screen sliding control key or a touch screen button. The digital traction and brake unit 22 is a touch screen sliding control, which may display specific values of selected traction speed and brake rate. According to specific requirements of the driver controller, an automatic driving mode button may be added to the interface. The communication method of the output signal of the digital operation apparatus 20 involves MVB network signals, which may also be changed to CAN signals or Ethernet network signals according to a specific system.

**[0036]** In the entire vehicle system, the priority of the I/O signals output by the mechanical operation apparatus 10 of the driver controller is higher than that of the network signals such as MVB of the digital operation apparatus 20. When the mechanical operation apparatus of the driver controller inputs train driver control information, that is, outputs I/O signals, the system controls direction, traction and brake, etc. according to the I/O signals. The digital operation apparatus 20 of the driver controller consists of an information input and start unit, a digital direction unit 21, a digital traction and brake unit 22, etc, and each portion has an independent operation area with clear range on a display screen.

**[0037]** A control method for a locomotive driver controller is proposed corresponding to the locomotive driver controller. Tasks performed by the locomotive driver controller include a mechanical operation task and a digital operation task. The mechanical operation task includes a mechanical direction operation, a mechanical traction and brake operation, and a mechanical lock operation. The digital operation task includes a digital direction operation, a digital traction and brake operation, and a digital lock operation.

**[0038]** Specific steps of the mechanical operation task include that the mechanical traction and brake unit 11 and the mechanical direction unit 12 are respectively connected to the mechanical lock in a mechanical interlocking manner, and when the mechanical lock is in an unlocked position, the mechanical direction unit 12 is allowed to switch to a forward or reverse position, output a corresponding I/O signal and perform a corresponding task, and the mechanical traction and brake unit 11 is allowed to push to a traction or brake position from a 0 position, output a corresponding I/O signal and perform a corresponding task.

**[0039]** Specific steps of the digital operation task include that the digital direction unit 21 and the digital traction and brake unit 22 are respectively connected to the digital lock in an electrical interlocking manner, and when the digital lock is unlocked, the digital direction unit 21 is allowed to switch to a forward or reverse position, output a corresponding network signal and perform the corresponding task, and the digital traction and brake unit is allowed to switch among a 0 position, traction position, and brake position, output a corresponding network signal and perform a corresponding task.

**[0040]** By the design, the response priority of the mechanical operation task is higher than that of the digital operation task. While the mechanical operation task is responded, the digital lock is in a locked state.

**[0041]** The control method for the locomotive driver controller includes: determining whether the mechanical lock is in a locked state before performing the mechanical direction operation or the mechanical traction and brake operation, and interrupting the mechanical operation task if the mechanical lock is in the locked state, or performing the mechanical direction operation or the mechanical traction and brake operation when the mechanical lock is in an unlocked state; and determining whether the digital lock is in a locked state before performing the digital direction operation or the digital traction and brake operation, and interrupting the digital operation task if the digital lock is in the locked state, or performing the digital direction operation or the digital traction and brake operation if the digital lock is in an unlocked state.

**[0042]** Specifically, both the mechanical operation task and the digital operation task have mark bits, the mark bits include a zero bit and a non-zero bit, the zero bit represents a non-working state, and the non-zero bit represents a working state. When the mark bit of the mechanical operation task is zero, it indicates that the mechanical operation task is not performed. When the mark bit of the mechanical operation task is a non-zero, it indicates that the mechanical operation task is being performed. When the mark bit of the digital operation task is zero, it indicates that the digital operation task is not performed. When the mark bit of the digital operation task is non-zero, it indicates that the digital operation task is being performed. When the mark bit of the mechanical operation task is a non-zero, the digital operation task is not allowed to be performed. When the mark bit of the mechanical operation task is zero, the digital operation task is performed after the digital lock is unlocked.

**[0043]** As a further specific implementation solution, the control method further includes the following steps:

when the network signal output by the digital traction and brake unit is a non-zero bit signal and the I/O signal output by the mechanical operation apparatus is a zero bit signal, performing traction and brake control on the entire vehicle according to the network signal;

when the I/O signal output by the mechanical traction and brake unit is a non-zero bit signal, performing, by the digital traction and brake unit, an operation of powering off, or cutting off output signals, or outputting determination signals according to preset settings, and determining a traction and brake state of the entire vehicle according to the I/O signal output by the mechanical traction and brake unit; and

after the mechanical traction and brake unit locks the digital operation apparatus, after the mechanical traction and brake unit recovers to the 0 position, and when the digital lock of the digital operation apparatus 20 is not unlocked, determining a traction and brake state of the entire vehicle according to the I/O signal output by the mechanical traction and brake unit.

**[0044]** The digital operation apparatus 20 is allowed to be remotely controlled by a vehicle monitoring center. The remote control can be cloud control.

**[0045]** As shown in FIG. 6, the input of the digital operation apparatus 20 includes one or more of touch screen input, keyboard input, mouse input, and voice input. The digital operation apparatus 20 may further receive information collected by vehicle sensors and cameras.

**[0046]** The digital operation apparatus adopts a human-computer interaction system for operation and control, including but not limited to touch screen input and voice input. Input and display of the digital operation apparatus may be performed on a driver's console main control screen or HUD display (head-up display).

**[0047]** The digital traction and brake unit 22 is used for performing operations according to collected vehicle information;

**[0048]** The vehicle information includes command information from the vehicle monitoring center (for example, the vehicle monitoring center indicates the locomotive to accelerate, decelerate, or stop through remote control), environmental information on a travel path of the locomotive, and locomotive fault information. The operations performed by the digital traction and brake unit 22 include adjusting locomotive speed, adjusting locomotive acceleration, and applying parking brake.

**[0049]** The locomotive fault information includes information about abnormal locomotive speed/acceleration, abnormal temperature of locomotive components, and abnormal connection between a pantograph and a contact network.

**[0050]** The digital operation apparatus may recognize, analyze, and respond to the information collected by the vehicle sensors and cameras to achieve traction and brake control on the vehicle and the like. An internal control program of the digital operation apparatus can adjust the control state and change the current traction and brake state according to the external operating environment recognized by the vehicle (such as obstacles) and instructions sent by the vehicle monitoring center.

**[0051]** For example, the sensors mounted on a front pilot can collect information about obstacles on the travel path of the locomotive. When the information about obstacles on the travel path is collected, the digital traction and brake unit 22 can perform a parking operation. Similarly, the cameras mounted on the vehicle can capture environmental image information (such as obstacles), the vehicle controller can process the image information, and the digital traction and brake unit 22 can perform a corresponding operation (such as adjusting the vehicle speed or acceleration, or even parking) according to the processing results. When information about an abnor-

mality or fault of the vehicle, such as excessively high temperature rise at a point on the locomotive, abnormal vehicle speed or acceleration, or abnormal connection between the pantograph and the contact network, is collected, the digital traction and brake unit 22 can also perform a corresponding operation (such as adjusting the vehicle speed or acceleration, or even parking).

**[0052]** Finally, it should be noted that the contents illustrated by the above embodiments should be understood as these embodiments are merely used for illustrating the present invention more clearly, rather than limiting the scope of the present invention. Various equivalent modifications made to the present invention by those skilled in the art after reading the present invention all fall within the scope defined by the appended claims of the present application.

## Claims

1. A locomotive driver controller, comprising a mechanical operation apparatus (10), the mechanical operation apparatus (10) having a working state and a non-working state, **characterized in that** the locomotive driver controller further comprises a digital operation apparatus (20), the digital operation apparatus (20) having a working state and a non-working state;

   the locomotive driver controller further comprises an interlocking unit, the interlocking unit comprises an interlocking cam connected to the mechanical operation apparatus (10) and an interlocking button connected to the digital operation apparatus (20), and the interlocking cam and the interlocking button have an interlocking switch release state and an interlocking switch compression state, wherein
   when the mechanical operation apparatus (10) is in the working state, the interlocking cam and the interlocking button are in the interlocking switch compression state, and the digital operation apparatus (20) enters the non-working state; and
   when the mechanical operation apparatus (10) is in the non-working state, the interlocking cam and the interlocking button are in the interlocking switch release state, and the digital operation apparatus (20) is allowed to enter the working state.

2. The locomotive driver controller according to claim 1, **characterized in that** the mechanical operation apparatus (10) comprises a mechanical traction and brake unit (11), a mechanical direction unit (12), and a mechanical lock, wherein the mechanical traction and brake unit (11) and the mechanical direction unit (12) are respectively connected to the mechanical lock in a mechanical interlocking manner.

3. The locomotive driver controller according to claim 1, **characterized in that** the digital operation apparatus (20) comprises a digital lock, a digital direction unit (21), and a digital traction and brake unit (22), wherein the digital direction unit (21) and the digital traction and brake unit (22) are respectively connected to the digital lock in an electrical interlocking manner.

4. The locomotive driver controller according to claim 3, **characterized in that** the digital lock involves one of fingerprint unlocking, password unlocking, facial recognition unlocking, ID card unlocking, and iris unlocking.

5. The locomotive driver controller according to any one of claims 1-4, **characterized in that** output signals of the mechanical operation apparatus (10) are hard wire signals, and the hard wire signals comprise a lock signal, a mechanical direction signal, and a traction and brake signal; output signals of the digital operation apparatus (20) are communication signals, the communication signals are one of MVB network signals, CAN signals, and Ethernet signals, and the communication signals comprise start information, direction information, and traction and brake rate.

6. The locomotive driver controller according to any one of claims 1-4, **characterized in that** the digital operation apparatus (20) is allowed to be remotely controlled by a vehicle monitoring center; and preferably, the remote control is cloud control.

7. The locomotive driver controller according to any one of claims 1-4, **characterized in that** input of the digital operation apparatus (20) comprises one or more of touch screen input, keyboard input, mouse input, and voice input.

8. A control method for the locomotive driver controller according to claim 3, **characterized in that** the digital traction and brake unit (22) is used for performing operations according to collected vehicle information;

   preferably, the vehicle information comprises command information from the vehicle monitoring center, environmental information on a travel path of the locomotive, and locomotive fault information; and the operations performed by the digital traction and brake unit (22) comprise adjusting locomotive speed, adjusting locomotive acceleration, and applying parking brake; and
   more preferably, the locomotive fault information comprises information about abnormal lo-

comotive speed/acceleration, abnormal temperature of locomotive components, and abnormal connection between a pantograph and a contact network.

**9.** A control method for a locomotive driver controller, **characterized in that** tasks performed by the locomotive driver controller comprise a mechanical operation task and a digital operation task; the mechanical operation task comprises a mechanical direction operation, a mechanical traction and brake operation, and a mechanical lock operation; the digital operation task comprises a digital direction operation, a digital traction and brake operation, and a digital lock operation;

the response priority of the mechanical operation task is higher than that of the digital operation task; while the mechanical operation task is responded, the digital lock is in a locked state;
the control method for the locomotive driver controller comprises:
determining whether the digital lock is locked before performing the digital direction operation or the digital traction and brake operation:

if the digital lock is in the locked state, locking the digital operation task in an initial state, wherein the initial state is 0 position, indicating that the digital operation task is not performed; or
if the digital lock is in an unlocked state, performing the digital direction operation or the digital traction and brake operation.

**10.** The control method for the locomotive driver controller according to claim 9, **characterized in that** the control method further comprises:
determining whether the mechanical lock is in a locked state before performing the mechanical direction operation or the mechanical traction and brake operation:

if the mechanical lock is in the locked state, locking the mechanical direction unit (12) used for performing the mechanical direction operation and the mechanical traction and brake unit (11) used for performing the mechanical traction and brake operation in an initial state, wherein the initial state is 0 position, indicating that the mechanical operation task is not performed; or
if the mechanical lock is in an unlocked state, performing the mechanical direction operation or the mechanical traction and brake operation.

**11.** The control method for the locomotive driver controller according to claim 9, **characterized in that** both the mechanical operation task and the digital operation task have mark bits, and the mark bits comprise a zero bit and a non-zero bit;

when the mark bit of the mechanical operation task is zero, it indicates that the mechanical operation task is not performed; when the mark bit of the mechanical operation task is non-zero, it indicates that the mechanical operation task is being performed; and
when the mark bit of the digital operation task is zero, it indicates that the digital operation task is not performed; when the mark bit of the digital operation task is non-zero, it indicates that the digital operation task is being performed;
when the mark bit of the mechanical operation task is non-zero, the digital operation task is not allowed to be performed; and when the mark bit of the mechanical operation task is zero, the digital operation task is performed after the digital lock is unlocked.

**12.** The control method for the locomotive driver controller according to any one of claims 9-11, **characterized in that** the locomotive driver controller comprises a mechanical operation apparatus (10) and a digital operation apparatus (20);

the mechanical operation apparatus (10) comprises a mechanical traction and brake unit (11) used for performing the mechanical traction and brake operation, a mechanical direction unit (12) used for performing the mechanical direction operation, and a mechanical lock; the mechanical traction and brake unit (11) and the mechanical direction unit (12) are respectively connected to the mechanical lock in a mechanical interlocking manner;
the digital operation apparatus (20) comprises a digital lock, a digital direction unit (21) used for performing the digital direction operation, and a digital traction and brake unit (22) used for performing the digital traction and brake operation; the digital direction unit (21) and the digital traction and brake unit (22) are respectively connected to the digital lock in an electrical interlocking manner;
the control method further comprises:

when the network signal output by the digital traction and brake unit (22) is a non-zero bit signal and the I/O signal output by the mechanical operation apparatus is a zero bit signal, performing traction and brake control on the entire vehicle according to the network signal;
when the I/O signal output by the mechanical traction and brake unit (11) is a non-zero bit signal, performing, by the digital

traction and brake unit (22), an operation of powering off, or cutting off output signals, or outputting determination signals according to preset settings, and determining a traction and brake state of the entire vehicle according to the I/O signal output by the mechanical traction and brake unit; and after the mechanical traction and brake unit (11) locks the digital operation apparatus (20), after the mechanical traction and brake unit (11) recovers to the 0 position, and when the digital lock of the digital operation apparatus (20) is not unlocked, determining a traction and brake state of the entire vehicle according to the I/O signal output by the mechanical traction and brake unit (11).

**13.** The control method for the locomotive driver controller according to claim 12, **characterized in that** when the mechanical lock is in an unlocked position, the mechanical direction unit (12) is allowed to switch to a forward or reverse position, output a corresponding I/O signal and perform a corresponding task, and the mechanical traction and brake unit (11) is allowed to push to a traction or brake position from a 0 position, output a corresponding I/O signal and perform a corresponding task.

**14.** The control method for the locomotive driver controller according to claim 12, **characterized in that** when the digital lock is in an unlocked position, the digital direction unit (21) is allowed to switch to a forward or reverse position, output a corresponding network signal and perform a corresponding task, and the digital traction and brake unit (22) is allowed to switch among a 0 position, traction position, and brake position, output a corresponding network signal and perform a corresponding task.

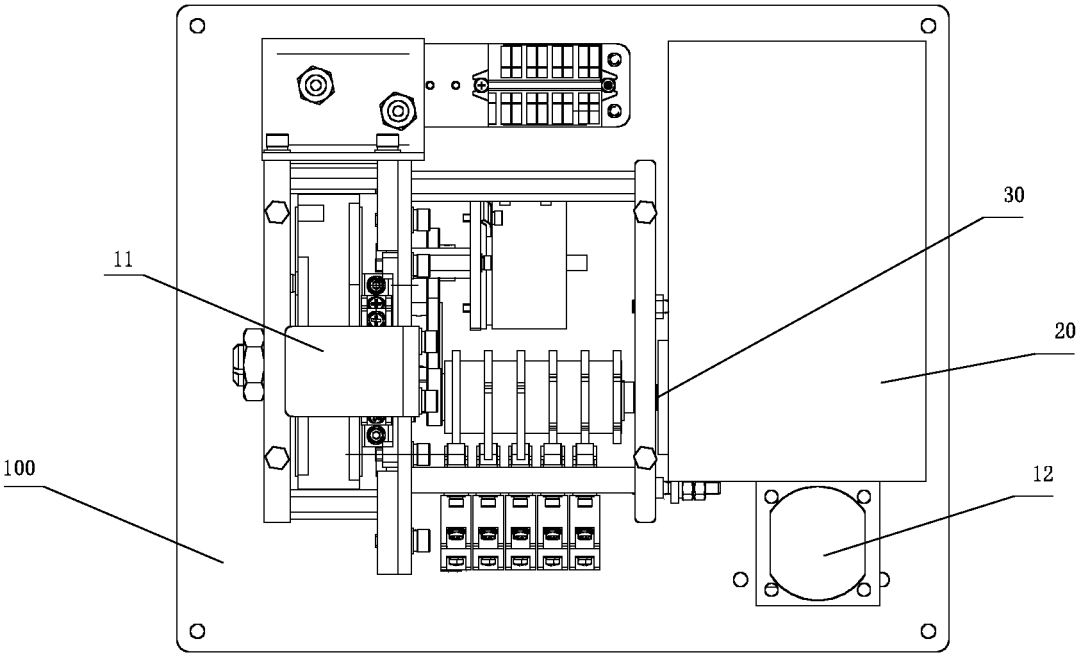


Fig. 1

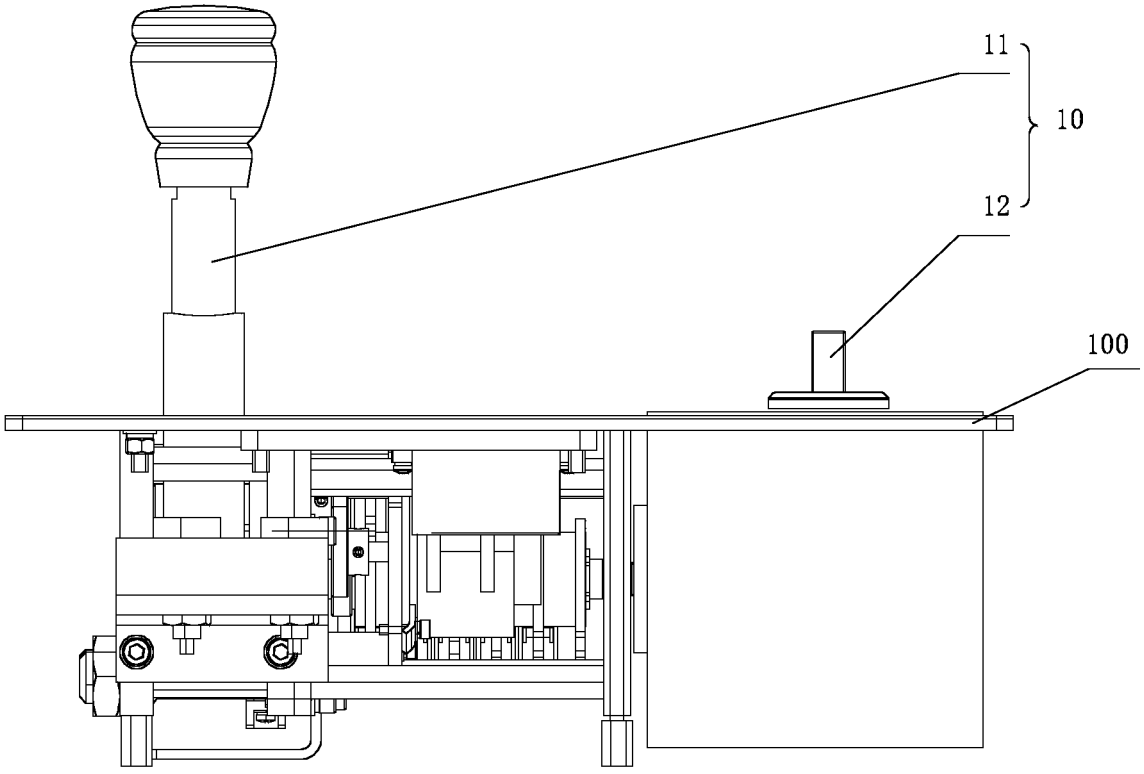


Fig. 2

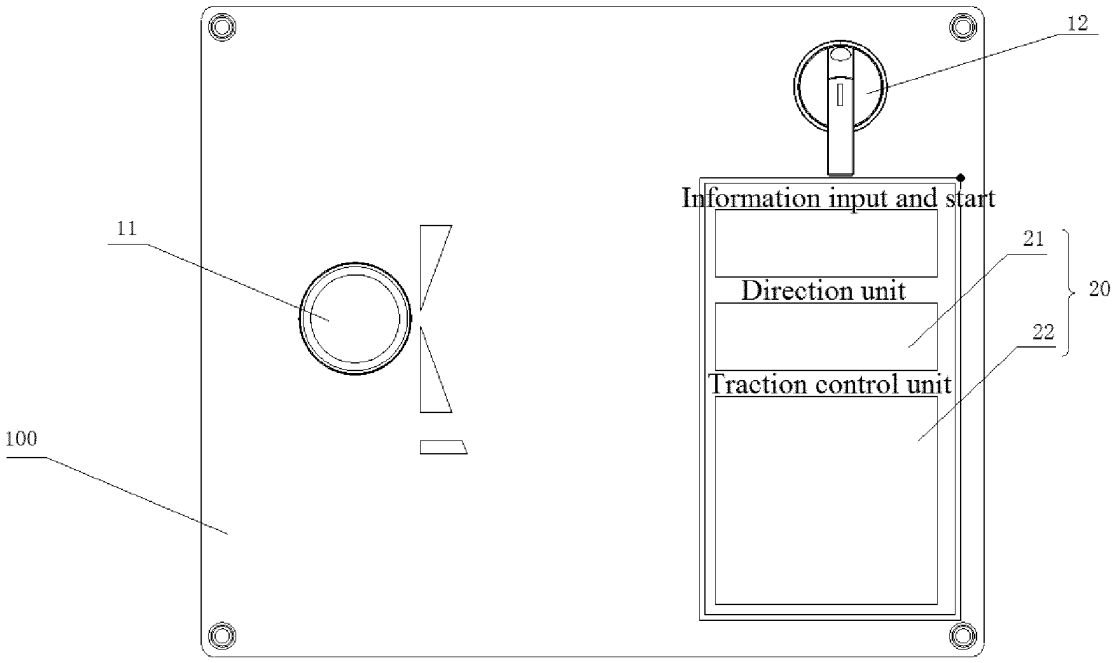
12
Information input and start
11
21
20
Direction unit
22
Traction control unit
100

Fig. 3

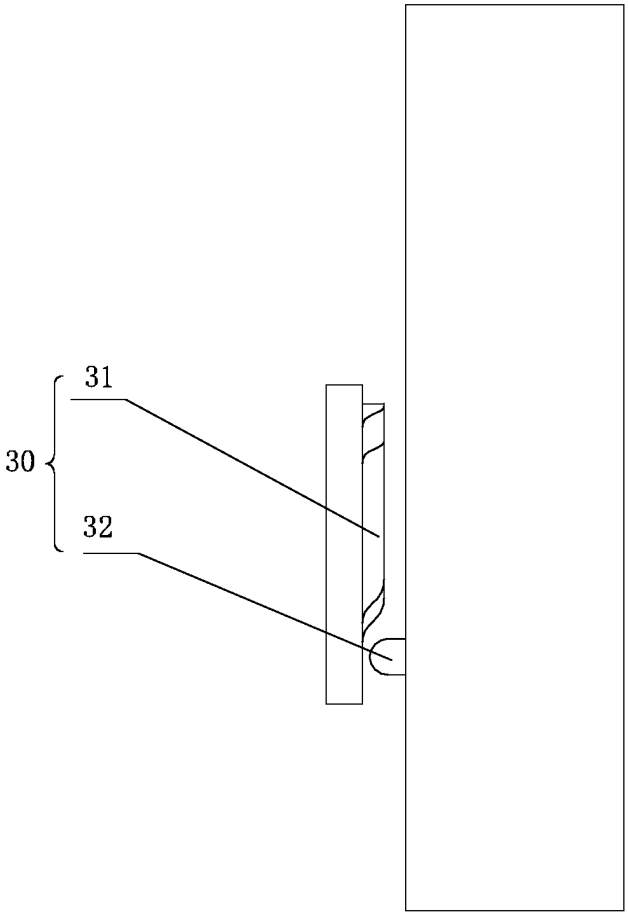
31
30
32

Fig. 4

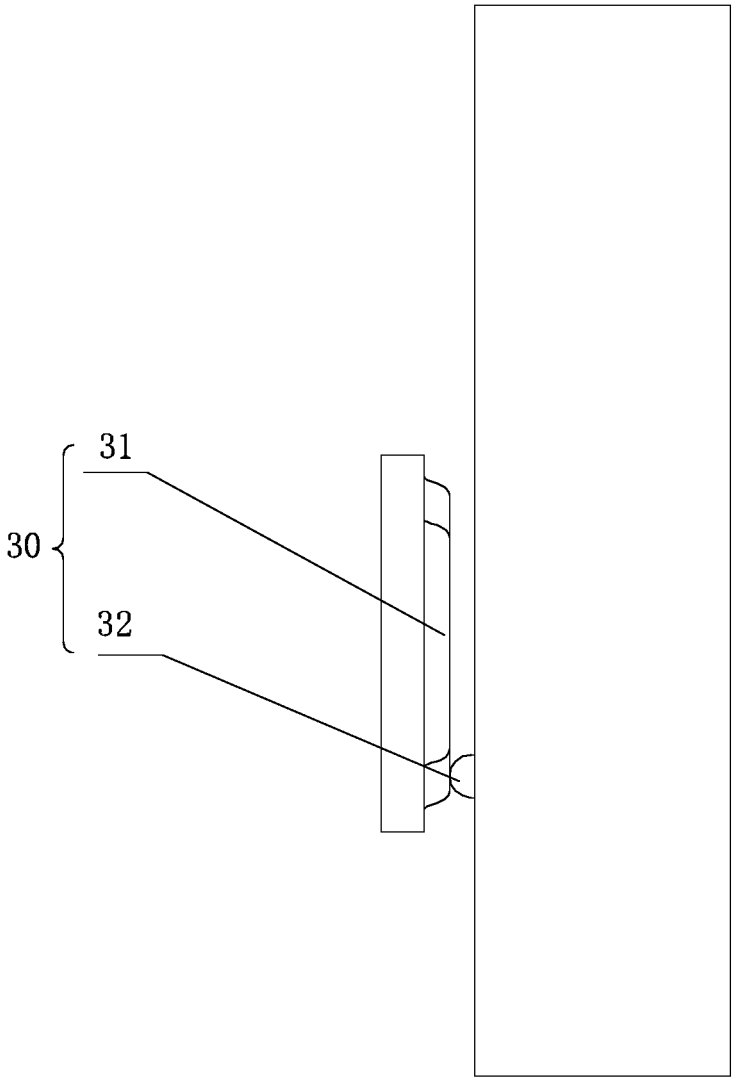


Fig. 5

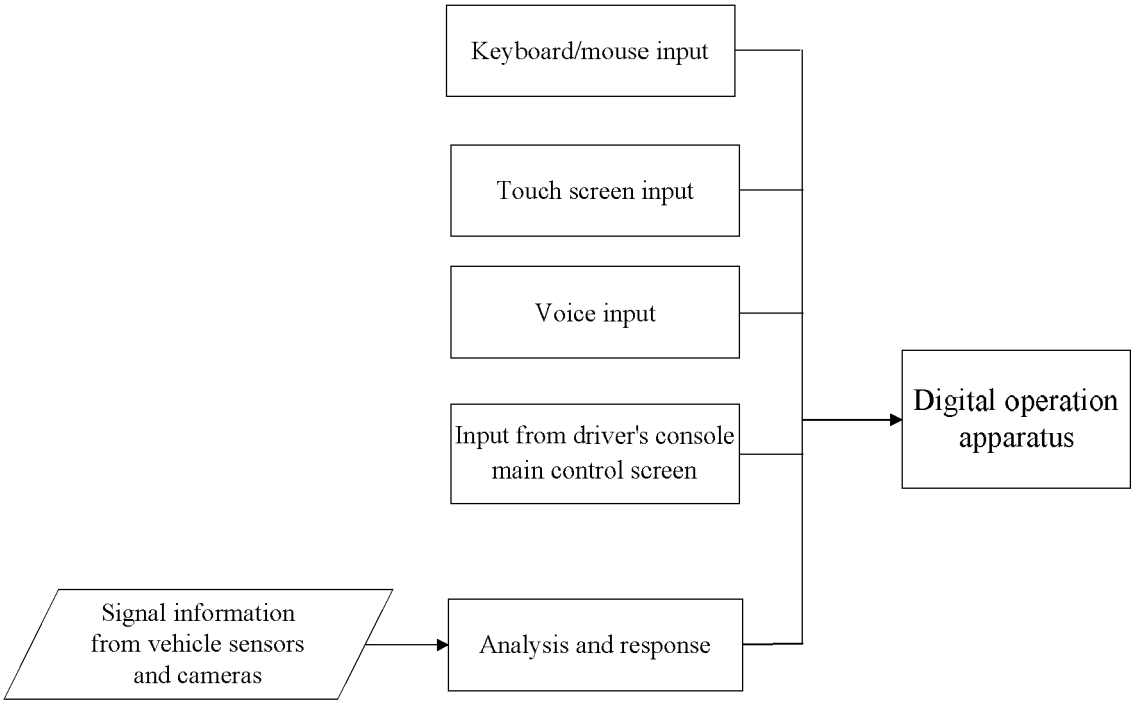
Keyboard/mouse input
Touch screen input
Voice input
Input from driver's console main control screen
Digital operation apparatus
Signal information from vehicle sensors and cameras
Analysis and response

Fig. 6

## INTERNATIONAL SEARCH REPORT

International application No.
**PCT/CN2022/126934**

**A. CLASSIFICATION OF SUBJECT MATTER**

B61C 17/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

B61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS; CNTXT; CNKI; VEN; USTXT; EPTXT; WOTXT: 株洲电力机车, 司机室控制, 手柄, 机械锁, 凸轮, 联锁, 数字, 电子, 人机交互, 触摸屏, 人工驾驶, 智能驾驶, 自动驾驶, control+, digit+, screen, intelligent driv+, auto+, lock+, cam

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| PX | CN 113879342 A (CRRC ZHUZHOU LOCOMOTIVE CO., LTD.) 04 January 2022 (2022-01-04)<br>description, paragraphs [0041]-[0052], and figures 1-5 | 1-14 |
| Y | CN 105365851 A (CRRC DALIAN INSTITUTE CO., LTD.) 02 March 2016 (2016-03-02)<br>description, paragraphs [0012]-[0021], and figure 1 | 1-11 |
| Y | CN 206179703 U (CRRC ZHUZHOU LOCOMOTIVE CO., LTD.) 17 May 2017 (2017-05-17)<br>description, paragraphs [0043]-[0069], and figures 1-18 | 1-11 |
| Y | CN 103863364 A (BEIJING THSOFT INFORMATION TECHNOLOGY CO., LTD.) 18 June 2014 (2014-06-18)<br>description, paragraphs [0017]-[0037], and figures 1-3 | 1-11 |
| Y | CN 104590333 A (CNR DALIAN LOCOMOTIVE RESEARCH INSTITUTE CO., LTD.) 06 May 2015 (2015-05-06)<br>description, paragraphs [0024]-[0038], and figures 1-3 | 1-11 |
| Y | CN 104875753 A (CSR ZHUZHOU ELECTRIC LOCOMOTIVE CO., LTD.) 02 September 2015 (2015-09-02)<br>description, paragraphs [0002] and [0021]-[0023], and figures 1-6 | 1-11 |

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

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| **18 November 2022** | **30 November 2022** |

| Name and mailing address of the ISA/CN | Authorized officer |
|---|---|
| **China National Intellectual Property Administration (ISA/CN)**<br>**No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** | |
| Facsimile No. **(86-10)62019451** | Telephone No. |

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/126934

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 6853890 B1 (BELTPACK CORP.) 08 February 2005 (2005-02-08)<br>entire document | 1-14 |

Form PCT/ISA/210 (second sheet) (January 2015)

**INTERNATIONAL SEARCH REPORT**
**Information on patent family members**

International application No.
**PCT/CN2022/126934**

| Patent document cited in search report | Publication date (day/month/year) | Patent family member(s) | Publication date (day/month/year) |
|---|---|---|---|
| CN 113879342 A | 04 January 2022 | None | |
| CN 105365851 A | 02 March 2016 | None | |
| CN 206179703 U | 17 May 2017 | None | |
| CN 103863364 A | 18 June 2014 | CN 103863364 B | 18 November 2015 |
| CN 104590333 A | 06 May 2015 | CN 104590333 B | 17 August 2016 |
| CN 104875753 A | 02 September 2015 | CN 104875753 B | 17 May 2017 |
| US 6853890 B1 | 08 February 2005 | WO 2005028273 A1 | 31 March 2005 |

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

## REFERENCES CITED IN THE DESCRIPTION

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