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(54) **WRENCH DEVICE AND METHOD FOR CONTROLLING SAME**

(57) A wrench device and a method for controlling the same are provided. The wrench device comprises: at least two wrenches, each wrench being provided with a control mechanism; a sliding assembly, all of the wrenches being assembled on the sliding assembly and sliding synchronously with the sliding assembly; and an online mechanism, wherein the control mechanisms of all the wrenches are in communication connection by means of the online mechanism, such that the control mechanism of one of the wrenches can control all the wrenches when the online mechanism is powered on. By using the present solution, the online control of two or more wrenches is realized, such that an operator can simultaneously control a plurality of wrenches to operate at one time, and the consistency of the torque outputs of the plurality of wrenches is guaranteed. Moreover, the wrenches can be driven to reach the next operation position by pushing the sliding assembly without manual carrying, thereby reducing the labor intensity of the operator, which facilitates a reduction in error rates. In addition, the present solution further enables functions such as automatic shutdown, automatic calculation, torque detection and display and automatic error reporting, such that the wrench device is more intelligent.

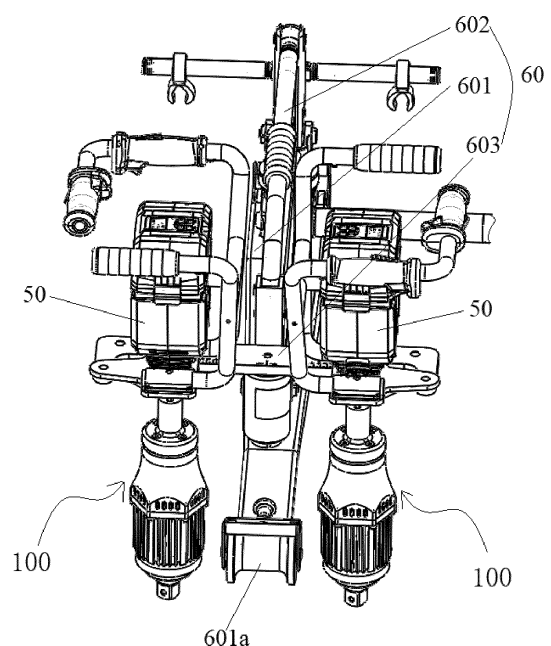


FIG. 1

Description

[0001] This application claims priority of the Chinese patent application No. 202111007455.2 filed with the Chinese Patent Office on August 30, 2021 and entitled "WRENCH DEVICE AND METHOD FOR CONTROLLING THE SAME", the entire contents of which are incorporated by reference in this application.

FIELD OF THE INVENTION

[0002] The present invention relates to the technical field of wrenches, in particular to a wrench device and a method for controlling the same.

BACKGROUND OF THE INVENTION

[0003] There are two main types of impact wrenches on the market. One is the direct-twist wrench, which has a reverse force arm, and can be easily installed with a torque sensor so as to meet the requirement of precise torsion. However, the direct-twist wrench has a large volume and heavy weight. Another type is the impact wrench, which is small in size, light in weight, and can provide a large torque, and thus is widely used in the current market.

[0004] In an operation scene, torques applied to the nuts need to be consistent for safety purpose, but the workload is large, resulting in high labor intensity so that operation errors occur easily. For example, in the maintenance and repair process of railways, the disassembly and replacement of track fasteners require a large number of nut installation, disassembly, and replacement operations, and torques applied to the nuts need to remain consistent to ensure driving safety.

[0005] In view of this, how to reduce labor intensity and more effectively ensure that the torques applied to the nuts remains consistent is a technical problem to be solved by those skilled in this field.

SUMMARY OF THE INVENTION

[0006] To solve the above technical problems, the present invention provides a wrench device, which comprises:

at least two wrenches, each wrench being provided with a control mechanism;
a sliding assembly, all of the wrenches being assembled on the sliding assembly and sliding synchronously with the sliding assembly; and
an online mechanism, wherein the control mechanisms of all the wrenches are in communication connection by means of the online mechanism, such that the control mechanism of one of the wrenches can control all the wrenches when the online mechanism is powered on.

[0007] In an embodiment, each wrench being provided with an input component for a user to input an instruction; the control mechanism is in communication connection to the input component so that the control mechanism can control the wrenches according to the instruction input by the user.

[0008] In an embodiment, each wrench being provided with a motor, an output mechanism driven by the motor, and a collection mechanism for collecting current operating data of the motor in real time; and the control mechanism is in communication connection to the collection mechanism so that the control mechanism can, according to the current operating data of the motor and/or the instruction input by the user, calculate a current output torque of the output mechanism, and/or determine a current operating status of the motor, and/or control the motor to turn on or off.

[0009] In an embodiment, each wrench being provided with an impact block driven by the motor and used to impact the output mechanism; and the collection mechanism comprises a current sensor and a rotational speed sensor.

[0010] In an embodiment, each wrench being provided with a display; and the control mechanism is in communication connection to the display so that the control mechanism can, according to the instruction input by the user, control the display to turn on or off, and/or control the display to display the calculated current output torque of the output mechanism, and/or display current operating information of the motor, and/or display the instruction input by the user, and/or display warning information.

[0011] In an embodiment, each wrench being provided with a torque detection mechanism for detecting the current output torque of the output mechanism; and the control mechanism is in communication connection to the torque detection mechanism so that the control mechanism can control the display to display the current output torque of the output mechanism detected by the torque detection mechanism.

[0012] In an embodiment, each wrench being provided with a lighting lamp; and the control mechanism is in communication connection to the lighting lamp so that the control mechanism can, according to the instruction input by the user, control the lighting lamp to turn on or off, and/or control the lighting lamp to emit warning light.

[0013] In an embodiment, the control mechanism comprises a power-off storage component for saving an instruction currently input by the user when the power is off.

[0014] In an embodiment, the control mechanism comprises a counter for recording the number of times that a single operation duration of the motor reaches a preset duration.

[0015] In an embodiment, the sliding assembly comprises: a sliding table, an elastic arm connected to the sliding table, and a connecting seat connected to the elastic arm; and

the wrenches being installed on the connecting seat, and the elastic arm can make use of its own elasticity to drive the connecting seat together with the wrenches to move to a target position and maintain the wrenches at the target position.

[0016] In an embodiment, the connecting seat comprises a fixed seat portion fixed to the elastic arm and a sliding seat portion that can slide along a sliding direction perpendicular to the sliding table, the wrench is connected to the sliding seat portion, and the fixed seat portion being provided with a scale used to indicate a position of the sliding seat and a sliding distance of the sliding seat relative to the fixed seat portion.

[0017] In an embodiment, a bottom of the sliding table being provided with a roller matchable with the track, a member to be screwed is a part of the track, at least one wrench is located on one side of the track, and at least one wrench is located on the other side of the track.

[0018] In addition, the present application also provides a method for controlling a wrench device, wherein the wrench device is any of the wrench devices stated above. The control method comprises: turning off the on-line mechanism, and each wrench is independently controlled by its own control mechanism; alternatively, turning on the online mechanism, and all wrenches are controlled by the control mechanism of one wrench.

[0019] In an embodiment, the control method comprises: controlling the wrench according to the instruction input by the user; the instruction input by the user include: an instruction indicating forward rotation or reverse rotation of the motor of the wrench, an instruction indicating a rotational speed gear of the motor of the wrench, and an instruction indicating turning on the motor of the wrench.

[0020] In an embodiment, the control method comprises: according to collected current operating data of the motor and/or the instruction input by the user, calculating a current output torque of an output mechanism of the wrench, and/or determining a current operating status of the motor, and/or controlling the motor to turn on or off.

[0021] In an embodiment, the collected current operating data of the motor includes a current and a rotational speed;

calculating the current output torque of the output mechanism of the wrench comprises: determining a starting moment when an impact block of the wrench impacts the output mechanism according to the current change; and calculating the current output torque of the output mechanism at a predetermined time interval starting from the starting moment according to a preset formula, until the control mechanism controls the motor to turn off; wherein the preset formula is: the current output torque of the output mechanism = a current rotational speed of the motor $\times$ a current impact duration $\times$ a speed gear coefficient $\times$ a constant $\times$ a feedback coefficient of power supply voltage, and the gear co-

efficient corresponding to different speed gear is different.

[0022] In an embodiment, controlling the motor to turn on or off comprising: controlling the motor to turn on according to the instruction indicating a rotational speed gear of the motor and/or the instruction indicating turning on of the motor; and controlling the motor to turn off when operating time of the motor reaches a preset duration.

[0023] In an embodiment, the control method comprises: controlling the display to turn on or off according to the instruction input by the user, and/or controlling the display to display the calculated current output torque of the output mechanism, and/or controlling the display to display current operating information of the motor, and/or controlling the display to display the instruction input by the user, and/or controlling the display to display warning information.

[0024] In an embodiment, controlling the display to display warning information comprises: controlling the display to display warning information when the operating time of the motor is less than a preset duration.

[0025] In an embodiment, the control method comprises: detecting the current output torque of the output mechanism; and controlling the display to display the detected current output torque of the output mechanism.

[0026] In an embodiment, the control method comprises: according to the instruction input by the user, controlling the lighting lamp to turn on or off, and/or controlling the lighting lamp to emit warning light.

[0027] In an embodiment, controlling the lighting lamp to emit warning light comprises: controlling the lighting lamp to emit warning light when the operating time of the motor is less than a preset duration.

[0028] In an embodiment, the control method comprises: recording the number of times that a single operation duration of the motor reaches a preset duration, and controlling the display of the wrench to display the recorded times.

[0029] In an embodiment, the control method comprises: saving an instruction currently input by the user when the power is off, until the user re-inputs an instruction.

[0030] The wrench device and the method for controlling the same according to the present invention, the on-line control of two or more wrenches is realized, such that an operator can simultaneously control a plurality of wrenches to operate at one time. Moreover, the wrenches can be driven to reach the next operation position by pushing the sliding assembly without manual carrying, thereby reducing the labor intensity of the operator, which facilitates a reduction in error rates. Meanwhile, communicative control also ensures consistency in torque outputs of multiple wrenches.

BRIEF DESCRIPTION OF DRAWINGS

[0031]

FIG. 1 is a schematic diagram of a wrench device according to an embodiment of the present invention;

FIG. 2 is a schematic diagram of a connecting seat in FIG. 1;

FIG. 3 is a schematic diagram of a wrench in FIG. 1;

FIG. 4 is a sectional view of an impact mechanism in FIG. 3;

FIG. 5 is a sectional view of a damping mechanism in FIG. 3;

FIG. 6 is a sectional view of a first elastic damping member and a fixing portion connected to it in FIG. 5; and

FIG. 7 is a sectional view of the first grip member in FIG. 3.

[0032] In the drawings:

01, track;

100, wrench;

10, impact mechanism; 101, motor; 102, deceleration component; 103, drive shaft; 104, elastic component; 105, impact block; 105a, first protrusion; 106, housing; 106a, groove; 107, guide rail pair; 20, output mechanism; 201, output shaft; 201a, second protrusion;

30, damping mechanism; 301, connecting piece; 301a, first connecting portion; 301b, second connecting portion; 301c, third connecting portion; 302, first elastic damping member; 303, fastener; 304, second elastic damping member;

40, operating mechanism; 401, operating mechanism body; 401a, first grip member; 401b, second grip member; B, anti-slip structure; 401c, protection button; 401d start button; 402, bracket; 402a, carrier; 402b, support shaft; 402c, support arm;

50, control mechanism;

60, sliding assembly; 601, sliding table; 601a, roller; 602, elastic arm; 603, connecting seat; 603a, fixed seat portion; 603b, positioning shaft; 603c, sliding seat portion.

DETAILED DESCRIPTION

[0033] In order to enable the skilled in the art to better understand the technical solutions of the present invention, detailed explanation of the technical solutions of the present invention will be further provided below in conjunction with the drawings and specific embodiments. The radial direction described herein refers to the radial direction of the drive shaft 103, the axial direction refers to the axial direction of the drive shaft 103, and the circumferential direction refers to the circumferential direction of the drive shaft 103.

[0034] As shown in FIG. 1, in an embodiment, the wrench device comprises two wrenches 100. Of course, in other embodiments, it may comprise more wrenches. The wrench device also comprises a sliding assembly

60, and all wrenches are assembled on the sliding assembly and sliding synchronously with the sliding assembly. Each wrench is provided with a control mechanism 50. The wrench device also comprises an online mechanism, and all control mechanisms of the wrenches are communicatively connected through the online mechanism. Specifically, the online mechanism may be an electrical connection line inserted into a plug port of the control mechanism, or a wireless transmission component assembled in the control mechanism.

[0035] When the online mechanism is powered on, all control mechanisms of the wrenches can share data by means of the online mechanism, so that the operator can operate one wrench to control all the wrenches to work simultaneously and synchronously. This not only reduces the labor intensity of the operator, but also ensures the consistency in torque output of all wrenches. Of course, the online mechanism can also choose to be powered off. After the online mechanism is powered off, each wrench is independently controlled by its own control mechanism without interfering with each other.

[0036] After the operation at one position is completed, the sliding assembly can be pushed to the next operating position, and all wrenches can be moved together with the sliding assembly to the next operating position without manual carrying, thereby further reducing the labor intensity of the operator and further facilitating a reduction in error rates.

[0037] As shown in FIG. 1, in this embodiment, the sliding assembly 60 comprises a sliding table 601, an elastic arm 602 connected to the sliding table 601, and a connecting seat 603 connected to the elastic arm 602. The wrenches 100 are connected to the connecting seat 603. The bottom of sliding 601 is provided with a roller 601a. The elastic arm 602 can make use of its own elastic deformation to swing forward, backward, leftward, rightward, upward and downward, thereby driving the connecting seat 603 to reach different positions, which can adapt to more work scenes. Moreover, the elastic value of the elastic arm 602 is designed to be able to remain in the deformation position after elastic deformation occurs, and thus the connecting seat 603 can remain in the target position after reaching the target position. One application scene is, it is used in the disassembly and replacement process of track fasteners to remove or install the nuts of track fasteners. In this application scene, the roller 601a of the sliding table is adaptively clamped on two sides of the track and can roll along the track. The two wrenches of the wrench device are respectively located on both sides of the track and are respectively used to disassemble or screw the nuts on both sides of the track fasteners. Of course, the present invention is not limited to this application scene.

[0038] As shown in FIG. 2, in this embodiment, the connecting seat 603 comprises a fixed seat portion 603a, a sliding seat portion 603c, and a positioning shaft 603b. The fixed seat portion 603a is connected to the elastic arm 602. The sliding seat portion 603c is connected to a

long circular hole of the fixed seat portion 603a through a fastener. After the fastener is loosened, the sliding seat portion 603c can slide in the long circular hole of the fixed seat portion. The sliding seat portion 603c can adopt a C-shaped plate structure. The wrench is connected to the sliding seat portion 603c, and the sliding seat portion 603c can drive the wrench to slide together relative to the fixed seat portion 603a. The sliding direction may be perpendicular to the sliding direction of the sliding table, so that the position of the wrench can be flexibly adjusted. For example, in the above application scene, the position of the sliding seat portion 603c can be adjusted to make the two wrenches closer to each other so as to adapt to narrower tracks, or to make the two wrenches farther apart so as to adapt to wider tracks. The fixed seat 603a is provided with a scale, through which the sliding distance of the wrench relative to the fixed seat 603c and the position of the wrench can be determined. The positioning shaft 603b is connected to the bottom of the fixed seat portion 603a to support and fix the fixed seat portion 603a.

[0039] It should be noted that the structure of the connecting seat and the overall structure of the sliding assembly are not limited to the above embodiment, as long as the structure can achieve the function of driving the wrench to slide and the function of assembling the wrenches.

[0040] In the illustrated embodiment, two wrenches are of the same structure. The structure of the wrenches will be described below by taking one wrench as an example. The wrench illustrated is an impact wrench. In practical implementation, a direct-twist wrench or other forms of impact wrench can also be used.

[0041] As shown in FIG. 3, in addition to the control mechanism 50 stated above, the wrench is also provided with an impact mechanism 10, an output mechanism 20, a damping mechanism 30, and an operating mechanism 40. These mechanisms will be described below in detail.

Impact Mechanism 10 and Output Mechanism 20

[0042] As shown in FIG. 4, the impact mechanism 10 comprises a housing 106 and components assembled in the housing 106 such as a motor 101, a deceleration component 102, a drive shaft 103, an elastic component 104, an impact block 105, a guide rail pair 107, etc. The motor 101 may be a brushless motor. A first protrusion 105a is provided on the impact block 105, and a second protrusion 201a is provided on an output shaft 201 of the output mechanism 20. When the impact block 105 is in its initial position, its first protrusion 105a overlaps with the second protrusion 201a of the output shaft 201 in the axial direction (as shown in FIG. 4), and its first protrusion 105a and the second protrusion 201a are spaced apart in the circumferential direction.

[0043] The working process of the impact mechanism 10 is as follows.

[0044] The power of the motor 101 is transmitted to

the drive shaft 103 through the deceleration component 102, which drives the drive shaft 103 to rotate around its own axis, then drives the impact block 105 to rotate, so that the impact block 105 rotates from the initial position to a position where it contacts the second protrusion 201a. At the moment of contact, it will impact the second protrusion 201a, thereby driving the output shaft 201 to rotate.

[0045] After the first protrusion 105a comes into contact with the second protrusion 201a, the impact block 105 will be subjected to a resistive force from the output shaft 201. Under the action of the resistive force, the impact block 105 cannot maintain synchronous rotation with the drive shaft 103 but will rotate relative to the drive shaft 103. Guided by the guide rail pair 107, the impact block 105 will rotate relative to the drive shaft 103 and also move in the direction approaching the elastic component 104 along the axial direction, thereby allowing the elastic component 104 to store energy.

[0046] After moving to a certain position, the first protrusion 105a of the impact block 105 and the second protrusion 201a of the output shaft 201 no longer overlap in the axial direction but are staggered from each other. At this point, the elastic component 104 will release its elastic energy and make the impact block 105 to return to the initial position, and thus repeat the above impact process again. This cycle repeats until the motor 101 is turned off.

[0047] The output shaft 201 rotates and thus drives the sleeve or cylinder that is connected to the end of output shaft 201 to rotate. The sleeve is disposed outside the nut, bolt, and other parts to be loosened or tightened. The cylinder extends into the counterbore of the nut, bolt, and other parts to be loosened or tightened, and thus drives the nut, bolt, and other parts to rotate, thereby realizing the loosening or tightening.

Damping Mechanism 30

[0048] The damping mechanism 30 is connected between the operating mechanism 40 and the impact mechanism 10, and can effectively block the transmission of vibration to the operating mechanism 40, thereby reducing the user's hand feeling of vibration.

[0049] As shown in FIG. 5, the damping mechanism 30 comprises a connecting member 301, a first elastic damping member 302, a fixing portion 303, and a second elastic damping member 304. The connecting piece 301 comprises a first connecting portion 301a, a second connecting portion 301b, and a third connecting portion 301c.

[0050] As shown in FIG. 5, the first connecting portion 301a is connected to the operating mechanism 40 (in FIG. 5, the supporting shaft 402b is a part of the operating mechanism 40). In the illustrated solution, the first connecting portion 301a adopts a sleeve structure, which is sleeved outside the supporting shaft 402b. One end of the inner hole of the sleeve is provided with a stopper for position limiting, and one end of the supporting shaft 402b abuts against the stopper to fix the position. Of course,

the first connecting portion 301a is not limited to the sleeve structure, as long as it can be connected to the operating mechanism 40.

[0051] As shown in FIG. 5, the second connecting portion 301b and the impact mechanism 10 are staggered axially from each other so that an axial spacing space is formed between the second connecting portion 301b and the impact mechanism 10. The first elastic damping member 302 is arranged in the axial spacing space. As shown in FIG. 6, two ends of the first elastic damping member 302 are connected with fixing portions 303, which are spaced apart and not in contact with each other. The fixing portions 303 may be made of metal material, the first elastic damping member 302 may be made of rubber material, and the fixing portions 303 and the first elastic damping member 302 can be vulcanized together. As shown in FIG. 5, one end of the first elastic damping member 302 is connected to the second connecting portion 301b through the fixing portion 303, and the other end is connected to the housing 106 of the impact mechanism 10 through the fixing portion 303. The connection may be achieved by fastening screws, fastening nuts, etc., or by threads on the fixing portion 303 itself. By adopting this structure, it can be ensured that there is only elastic contact, not rigid contact, between the connecting member 301 and the impact mechanism 10 through the first elastic damping member 302 in the axial direction, thereby effectively blocking the transmission of vibration from the impact mechanism 10 to the operating mechanism 40.

[0052] In the illustrated solution, the second connecting portion 301b adopts a flange plate, which facilitates the connection to the fixing portion 303. Of course, it is not limited to the flange plate, as long as it can be connected to the fixing portion 303. In the illustrated solution, the second connecting portion 301b is arranged above the top of the impact mechanism 10, and the axial spacing space is formed between the second connecting portion 301b and the top end face of the impact mechanism 10. Alternatively, a flange may be provided on the outer circumference of the impact mechanism 10, the second connecting portion 301b is arranged above the flange, and the axial spacing space is formed between the flange and the second connecting portion 301b.

[0053] As shown in FIG. 5, the third connecting portion 301c at least partially surrounds the outer circumference of the impact mechanism 10 and is staggered from the impact mechanism 10 in the radial direction, thereby forming a radial spacing space between the third connecting portion 301c and the impact mechanism 10. The second elastic damping member 304 is arranged in the radial spacing space and closely contacts the impact mechanism 10 and the third connecting portion 301c. The second elastic damping member 304 further blocks the transmission of vibration from the impact mechanism 10 to the operating mechanism 40, and can also further fix the position of the damping mechanism 30 to stabilize the radial position of the damping mechanism 30. The

second elastic damping member 304 may adopt a circular structure, or multiple block structures distributed uniformly in the circumferential direction.

[0054] It should be noted that if the radial stiffness of the first elastic damping member 302 is set sufficiently large, the second elastic damping member 304 may not be provided. However, the radial stiffness of the first elastic damping member 302 should not be too large, otherwise it will affect the damping performance. Preferably, both the first elastic damping member 302 and the second elastic damping member 304 are provided and set to have appropriate and moderate stiffness.

[0055] As shown in FIG. 5, a groove 1 matched with the shape and size of the outer surface of the second elastic damping member 304 is provided on the inner surface of the third connecting portion 301c and/or the outer surface of the impact mechanism 10 to accommodate the second elastic damping member 304. In the illustrated solution, a groove 106a is provided on the outer surface of the impact mechanism 10, and the second elastic damping member 304 is partially embedded in the groove 106a. In this way, the second elastic damping member 304 can be positioned and installed without using other connecting parts, thereby facilitating the simplification of structure.

[0056] In the illustrated solution, the third connecting portion 301c adopts a sleeve structure. Of course, it is not limited to the sleeve structure, as long as it can surround the outer circumference of the impact mechanism 10. In the illustrated solution, two sleeve structures are respectively connected to both ends of the flange plate, and the two sleeve structures may be integrated with the flange plate.

Operating Mechanism 40

[0057] As shown in FIG. 3, the operating mechanism 40 comprises an operating mechanism body 401. The operating mechanism body 401 comprises an input component for inputting an instruction by a user, a first grip member 401a, and a second grip member 401b with an anti-slip structure B on the surface. The input component may adopt a button structure. In FIG. 3, the input component comprises a start button 401d. Of course, the input component may also adopt a touch screen structure. In FIG. 3, the start button 401d is mounted on the surface of the first grip member 401a. The user will touch and press the start button 401d when holding the first grip member 401a. After the start button 401d is pressed, the control mechanism 50 receives an instruction indicating turning on the motor 101, thereby controlling the motor 101 to turn on. In the illustrated solution, two first grip members 401a are provided, and gripping directions of the two first grip members 401a are different. In this way, users can choose the first grip member 401a that is convenient to grip according to its orientation during use. During the operation of the wrench or during the movement of the wrench, the user can hold the second

grip member 401b.

[0058] It should be noted that the instructions input by the user through the input component are not limited to the turning-on instruction, for example, they may also include an instruction indicating the forward rotation or reverse rotation of the motor of the wrench. If the motor has multiple speed gears, they may also include an instruction indicating the speed gear of the motor of the wrench. If the wrench is provided with a lighting lamp, they may also include an instruction indicating turning on or off the lighting light of the wrench. If the wrench is provided with a display, they may also include an instruction indicating turning on or off the display of the wrench. Different instructions may be input through different input components, or input through the same input component by different operations.

[0059] As shown in FIG. 3, the operating mechanism 40 further comprises a bracket 402, and both the operating mechanism body 401 and the control mechanism 50 are connected to the bracket 402. Specifically, the bracket 402 comprises a carrier 402a, a support arm 402c connected to the carrier 402a, and a support shaft 402b connected to the carrier 402a. The control mechanism 50 is loaded on the carrier 402a, and the top of the support arm 402c bypasses the control mechanism 50 and extends over the control mechanism 50. The grip portions of the operating mechanism 401 are connected to the top of the support arm 402c. This design has a compact structure and saves space.

[0060] In this embodiment, besides the start button 401d, the first grip member 401a is also provided with a protective button 401c. As shown in FIG. 7, the first grip member 401a has an inner cavity, and one end of the protective button 401c is provided with an abutting portion. When the protective button 401c is not pressed, its abutting portion abuts against the start button 401d so that it cannot be pressed downward. After the protective button 401c is pressed, its abutting portion leaves the start button 401d so that it can be pressed as normal. By adopting this structure, the start button 401d can be pressed only after the protective button 401c is pressed, so the safety accidents caused by mistake turning on the wrench due to accidentally touching the start button 401d can be avoided.

[0061] The protective button 401c and the start button 401d are both assembled on the first grip member 401a. When the user holds the first grip member 401a, the protective button 401c and the start button 401d can be pressed together, thus overcoming the problem of making the user's operation more complicated due to providing the protective button 401c. Preferably, the protective button 401c is provided at a position of the first grip member 401a where it is held first, and the start button 401d is provided at a position of the first grip member 401a where it is held later, so that for each grip the protective button 401c can be pressed first and then the start button 401d is pressed. Usually, the upper part of the first grip member 401a is held first, and the lower part of the first

grip member 401a is held later. Therefore, the protective button 401c can be assembled on the upper part of the first grip member 401a, the start button 401d can be assembled on the lower part of the first grip member 401a, and the protective button 401c and the start button 401d are arranged to face each other.

[0062] Further, the wrench may also be provided with a collection mechanism. The collection mechanism is used to collect current operating data of the motor in real time. The control mechanism is communicatively connected to the collection mechanism so that the control mechanism can, according to the current operating data of the motor and/or the instruction input by the user, calculate a current output torque of the output mechanism, and/or determine a current operating status of the motor, and/or control the motor to turn on or off.

[0063] The collection mechanism includes but is not limited to a current sensor and a rotational speed sensor. The current sensor collects the current electrical current of the motor, while the rotational speed sensor collects the current rotational speed of the motor.

[0064] Specifically, the current output torque of the output mechanism of the wrench can be calculated by the following method. First, a starting moment when the impact block of the wrench impacts the output mechanism, more specifically, a moment when the current suddenly increases, can be determined according to the current change. Then, the current output torque of the output mechanism is calculated at a predetermined time interval starting from the starting moment according to a preset formula, until the control mechanism controls the motor to turn off. The preset formula is: the current output torque of the output mechanism = a current rotational speed of the motor $\times$ a current impact duration $\times$ a speed gear coefficient $\times$ a constant $\times$ a feedback coefficient of power supply voltage. The gear coefficient corresponding to different speed gear is different. In an embodiment, the predetermined time interval is 0.1 seconds.

[0065] Specifically, the motor can be controlled to turn on or off by the following method. First, the motor can be controlled to turn on according to the instruction indicating turning on the motor and/or the instruction indicating a rotational speed gear of the motor input by the user. Then, the motor is controlled to turn off when operating time of the motor reaches a preset duration. The preset durations corresponding to different rotational speed gears may be different.

[0066] Further, the wrench may also be provided with a display. The display may be a liquid crystal display, digital tube display, etc. The control mechanism is communicatively connected to the display so that the control mechanism can, according to the instruction input by the user, control the display to turn on or off, and/or control the display to display the calculated current output torque of the output mechanism and/or current operating information of the motor and/or the instruction input by the user and/or warning information. The current operating information of the motor includes speed, steering, speed

gear, start, stop, fault, and other information. The user can determine whether the wrench has reached the required torque for the operation by viewing the calculated current output torque. For the convenience of user, the display may be controlled to continue displaying the current output torque interface for a period of time after the motor is turned off, and then return to the main interface or other interfaces.

[0067] Specifically, the display can be controlled to display warning information through the following method: when the operation duration of the motor is less than the preset duration, the display is controlled to display warning information. Warning information may be text and/or pictures and/or sounds. After seeing the warning information, the user can try the operation again. If the warning information still appears, it indicates that the wrench is faulty.

[0068] Further, the wrench may also be provided with a torque detection mechanism to detect the current output torque of the output mechanism. The torque detection mechanism includes but is not limited to torque sensors. The control mechanism is communicatively connected to the torque detection mechanism so that the control mechanism can control the display to display the current output torque of the output mechanism detected by the torque detection mechanism. The user can determine whether the wrench is functioning properly by comparing the calculated current output torque of the output mechanism displayed on the monitor with the current output torque of the output mechanism detected by the torque detection mechanism to see if there is a significant difference.

[0069] Further, the wrench may also be provided with a lighting lamp. In an embodiment, the lighting lamp is installed outside the housing 106, and comprises multiple LED beads arranged along the circumferential direction. The focus point of the multiple LED beads is located at an end of the output shaft 201 that is connected to the sleeve or cylinder, thereby achieving better lighting effect. Of course, the structure and installation position of the lighting lamp can be flexibly adjusted according to actual needs. The control mechanism is communicatively connected to the lighting lamp so that the control mechanism can, according to the instruction input by the user, control the lighting lamp to turn on or off, and/or control the lighting lamp to emit warning light.

[0070] Specifically, the control mechanism can control the lighting lamp to turn on or off according to the instruction of turning on or off the lighting lamp input by the user, or according to a built-in time program or a built-in trigger program.

[0071] Specifically, the lighting lamp may be controlled to emit warning light by the following methods: when the operating time of the motor is less than the preset duration, the lighting lamp is controlled to emit warning light. The warning light may be light that flashes at a specific frequency, or light with a specific color, or light with a specific brightness. After seeing the warning light, the

user can try the operation again. If the warning light still appears, it indicates that the wrench is faulty.

[0072] Further, the control mechanism may be provided with a power-off storage component for saving an instruction currently input by the user when the power is off. When the power is on again, the control mechanism can directly use the instruction stored in the power-off storage component as the current instruction. However, if the user re-inputs an instruction, the control mechanism will control the power-off storage component to no longer store the instruction and instead use the user's re-input instruction as the current instruction.

[0073] Further, the control mechanism may be provided with a counter for recording the number of times that a single operation duration of the motor reaches the preset duration. The control mechanism controls the display to display the recorded times, and then further controls the display to return to the main interface. If the motor is turned on and operates, but the operation duration does not reach the preset duration, it will not be recorded. When the quantity of recorded times reaches a preset quantity of times, the display may display information reminding the user to perform maintenance.

[0074] In sum, the wrench device and the method for controlling the same according to the present invention realize the online control of two or more wrenches, so that the operator can simultaneously control multiple wrenches to operate at one time. Moreover, the wrenches can be driven to reach the next operating position by pushing the sliding assembly without manual carrying, thereby reducing the labor intensity of the operator which facilitates a reduction in error rates. Meanwhile, online control also ensures consistency in torque outputs of multiple wrenches, and realizes functions such as automatic shutdown, automatic calculation, torque detection and display, and automatic error reporting, thereby making the operation more intelligent.

[0075] The above provides a detailed description of the wrench device and the method for controlling the same according to the present invention. The principle and embodiments of the present invention are explained using specific examples, and the above examples are only used to help understand the methods and core ideas of the present invention. It should be pointed out that for a person of ordinary skill in the art, improvements and modifications can be made to the present invention without departing from the principle of the present invention, which also fall within the protection scope of the claims of the present invention.

Claims

1. A wrench device, **characterized in that** the wrench device comprises:

at least two wrenches (100), each wrench being provided with a control mechanism (50);

- a sliding assembly (60), all of the wrenches being assembled on the sliding assembly and sliding synchronously with the sliding assembly; and
 an online mechanism, wherein the control mechanisms of all the wrenches are in communication connection by means of the online mechanism, such that the control mechanism of one of the wrenches can control all the wrenches when the online mechanism is powered on.
2. The wrench device according to claim 1, **characterized in that** each wrench being provided with an input component for a user to input an instruction; the control mechanism is in communication connection to the input component so that the control mechanism can control the wrenches according to the instruction input by the user.
 3. The wrench device according to claim 2, **characterized in that** each wrench being provided with a motor (101), an output mechanism (20) driven by the motor, and a collection mechanism for collecting current operating data of the motor in real time; and the control mechanism is in communication connection to the collection mechanism so that the control mechanism can, according to the current operating data of the motor and/or the instruction input by the user, calculate a current output torque of the output mechanism, and/or determine a current operating status of the motor, and/or control the motor to turn on or off.
 4. The wrench device according to claim 3, **characterized in that** each wrench being provided with an impact block (105) driven by the motor and used to impact the output mechanism; and the collection mechanism comprises a current sensor and a rotational speed sensor.
 5. The wrench device according to claim 3, **characterized in that** each wrench being provided with a display; and the control mechanism is in communication connection to the display so that the control mechanism can, according to the instruction input by the user, control the display to turn on or off, and/or control the display to display the calculated current output torque of the output mechanism, and/or display current operating information of the motor, and/or display the instruction input by the user, and/or display warning information.
 6. The wrench device according to claim 5, **characterized in that** each wrench being provided with a torque detection mechanism for detecting the current output torque of the output mechanism; and the control mechanism is in communication connection to the torque detection mechanism so that the control mechanism can control the display to display the current output torque of the output mechanism detected by the torque detection mechanism.
 7. The wrench device according to claim 3, **characterized in that** each wrench being provided with a lighting lamp; and the control mechanism is in communication connection to the lighting lamp so that the control mechanism can, according to the instruction input by the user, control the lighting lamp to turn on or off, and/or control the lighting lamp to emit warning light.
 8. The wrench device according to any one of claims 2-7, **characterized in that** the control mechanism comprises a power-off storage component for saving an instruction currently input by the user when the power is off.
 9. The wrench device according to any one of claims 3-7, **characterized in that** the control mechanism comprises a counter for recording the number of times that a single operation duration of the motor reaches a preset duration.
 10. The wrench device according to any one of claims 1-7, **characterized in that** the sliding assembly comprises: a sliding table (601), an elastic arm (602) connected to the sliding table, and a connecting seat (603) connected to the elastic arm; and the wrenches being installed on the connecting seat (603), and the elastic arm can make use of its own elasticity to drive the connecting seat together with the wrenches to move to a target position and maintain the wrenches at the target position.
 11. The wrench device according to claim 10, **characterized in that** the connecting seat (603) comprises a fixed seat portion (603a) fixed to the elastic arm and a sliding seat portion (603c) that can slide along a sliding direction perpendicular to the sliding table, the wrench is connected to the sliding seat portion (603c), and the fixed seat portion being provided with a scale used to indicate a position of the sliding seat portion and a sliding distance of the sliding seat portion relative to the fixed seat portion.
 12. The wrench device according to claim 11, **characterized in that** a bottom of the sliding table being provided with a roller (601a) matchable with a track, a member to be screwed is a part of the track, at least one wrench is located on one side of the track, and at least one wrench is located on the other side of the track.
 13. A method for controlling a wrench device, wherein the wrench device is the wrench device of any one

of claims 1-12, **characterized in that**, the control method comprises:

turning off the online mechanism, and each wrench is independently controlled by its own control mechanism; alternatively, turning on the online mechanism, and all wrenches are controlled by the control mechanism of one wrench.

14. The method for controlling a wrench device according to claim 13, **characterized in that**, the control method comprises: controlling the wrench according to the instruction input by the user; the instruction input by the user include: an instruction indicating forward rotation or reverse rotation of the motor of the wrench, an instruction indicating a rotational speed gear of the motor of the wrench, and an instruction indicating turning on the motor of the wrench.

15. The method for controlling a wrench device according to claim 14, **characterized in that**, the control method comprises: calculating a current output torque of an output mechanism of the wrench, and/or determining a current operating status of the motor, and/or controlling the motor to turn on or off according to collected current operating data of the motor and/or the instruction input by the user.

16. The method for controlling a wrench device according to claim 15, characterized in that the "collected current operating data of the motor" includes a current and a rotational speed;

the "calculating the current output torque of the output mechanism of the wrench" comprises: determining a starting moment when an impact block of the wrench impacts the output mechanism according to the current change; and calculating the current output torque of the output mechanism at a predetermined time interval starting from the starting moment according to a preset formula, until the control mechanism controls the motor to turn off;

wherein the preset formula is: the current output torque of the output mechanism = a current rotational speed of the motor $\times$ a current impact duration $\times$ a speed gear coefficient $\times$ a constant $\times$ a feedback coefficient of power supply voltage, and the gear coefficient corresponding to different speed gear is different.

17. The method for controlling a wrench device according to claim 15, **characterized in that** the "controlling the motor to turn on or off" comprising: controlling the motor to turn on according to the "instruction indicating a rotational speed gear of the motor" and/or the "instruction indicating turning on the motor" input by the user; and controlling the motor to turn off when

operating time of the motor reaches a preset duration.

18. The method for controlling a wrench device according to claim 15, **characterized in that**, the control method comprises: controlling the display to turn on or off according to the instruction input by the user, and/or controlling the display to display the calculated current output torque of the output mechanism, and/or controlling the display to display current operating information of the motor, and/or controlling the display to display the instruction input by the user, and/or controlling the display to display warning information.

19. The method for controlling a wrench device according to claim 18, **characterized in that** the "controlling the display to display warning information" comprises: controlling the display to display warning information when the operating time of the motor is less than a preset duration.

20. The method for controlling a wrench device according to claim 18, **characterized in that**, the control method comprises: detecting the current output torque of the output mechanism; and controlling the display to display the detected current output torque of the output mechanism.

21. The method for controlling a wrench device according to claim 17, **characterized in that**, the control method comprises: according to the instruction input by the user, controlling the lighting lamp to turn on or off, and/or controlling the lighting lamp to emit warning light.

22. The method for controlling a wrench device according to claim 21, **characterized in that** the "controlling the lighting lamp to emit warning light" comprises: controlling the lighting lamp to emit warning light when the operating time of the motor is less than a preset duration.

23. The method for controlling a wrench device according to any one of claims 17-22, **characterized in that**, the control method comprises: recording the number of times that a single operation duration of the motor reaches a preset duration, and controlling the display of the wrench to display the recorded times.

24. The method for controlling a wrench device according to any one of claims 14-22, **characterized in that**, the control method comprises: saving an instruction currently input by the user when the power is off, until the user re-inputs an instruction.

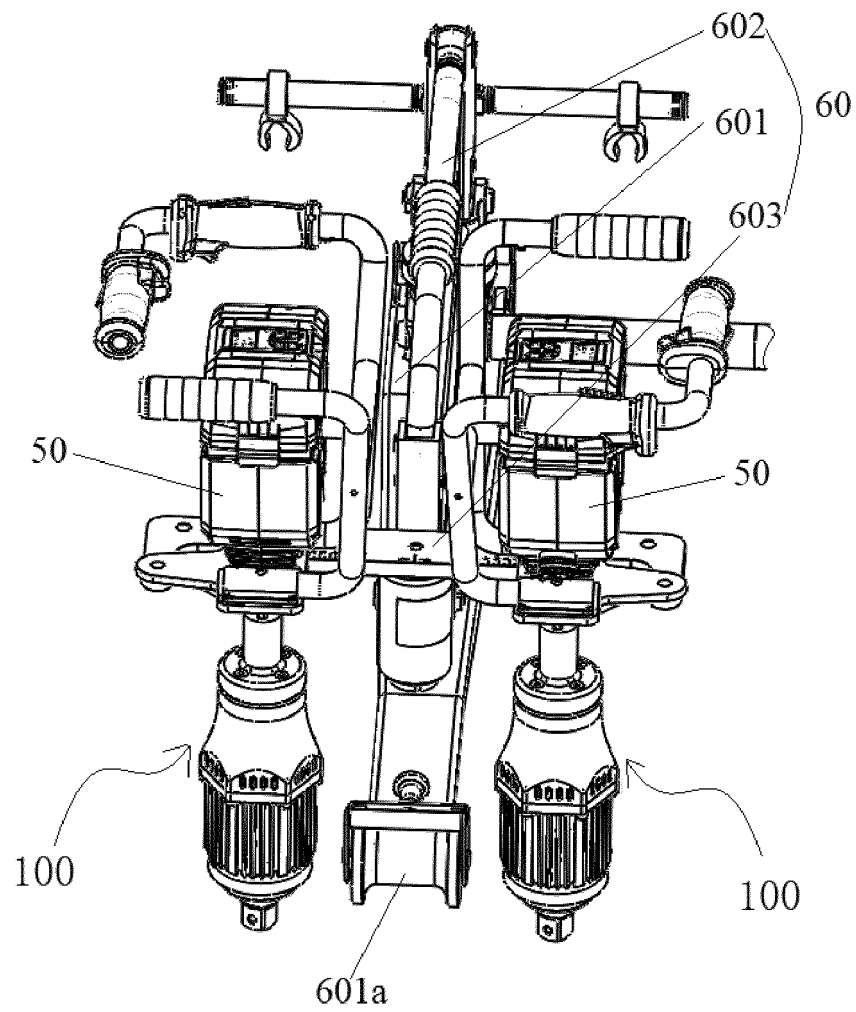


FIG. 1

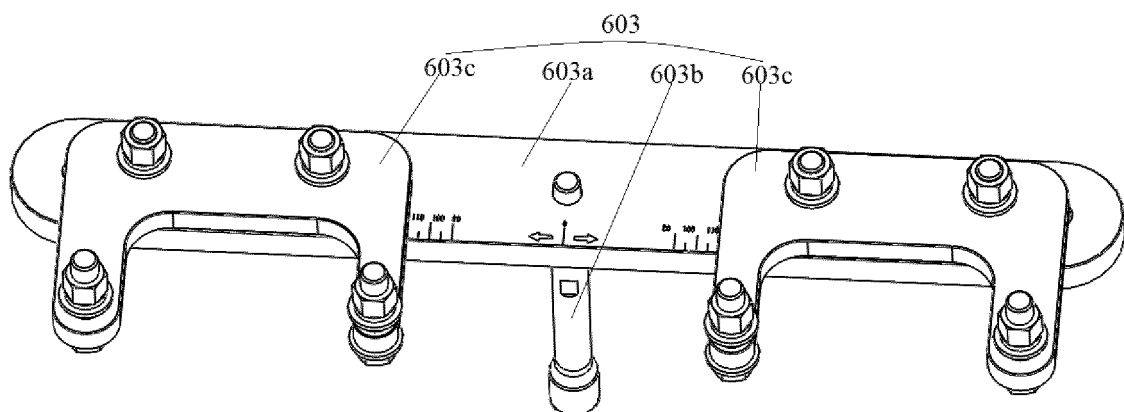


FIG. 2

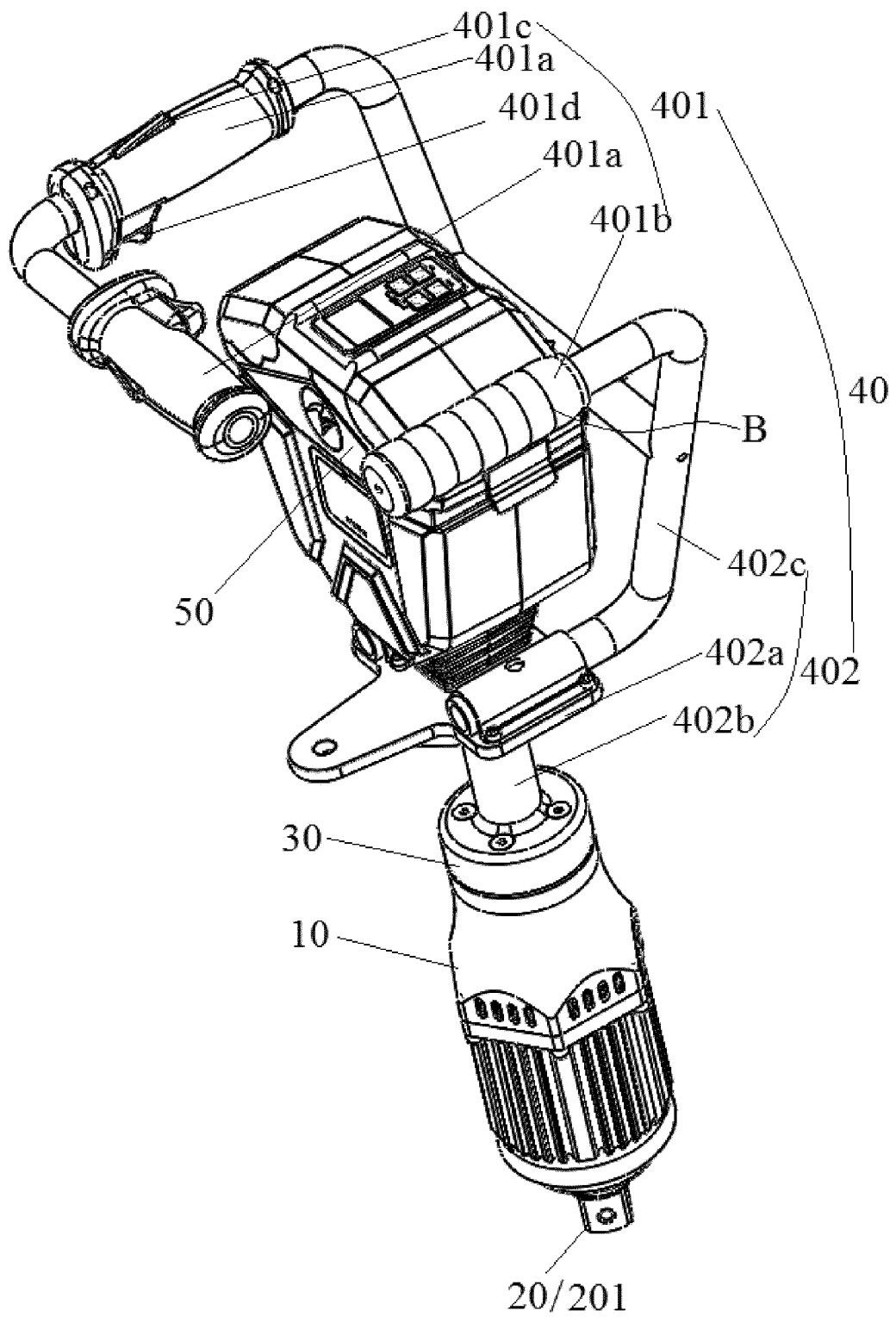


FIG. 3

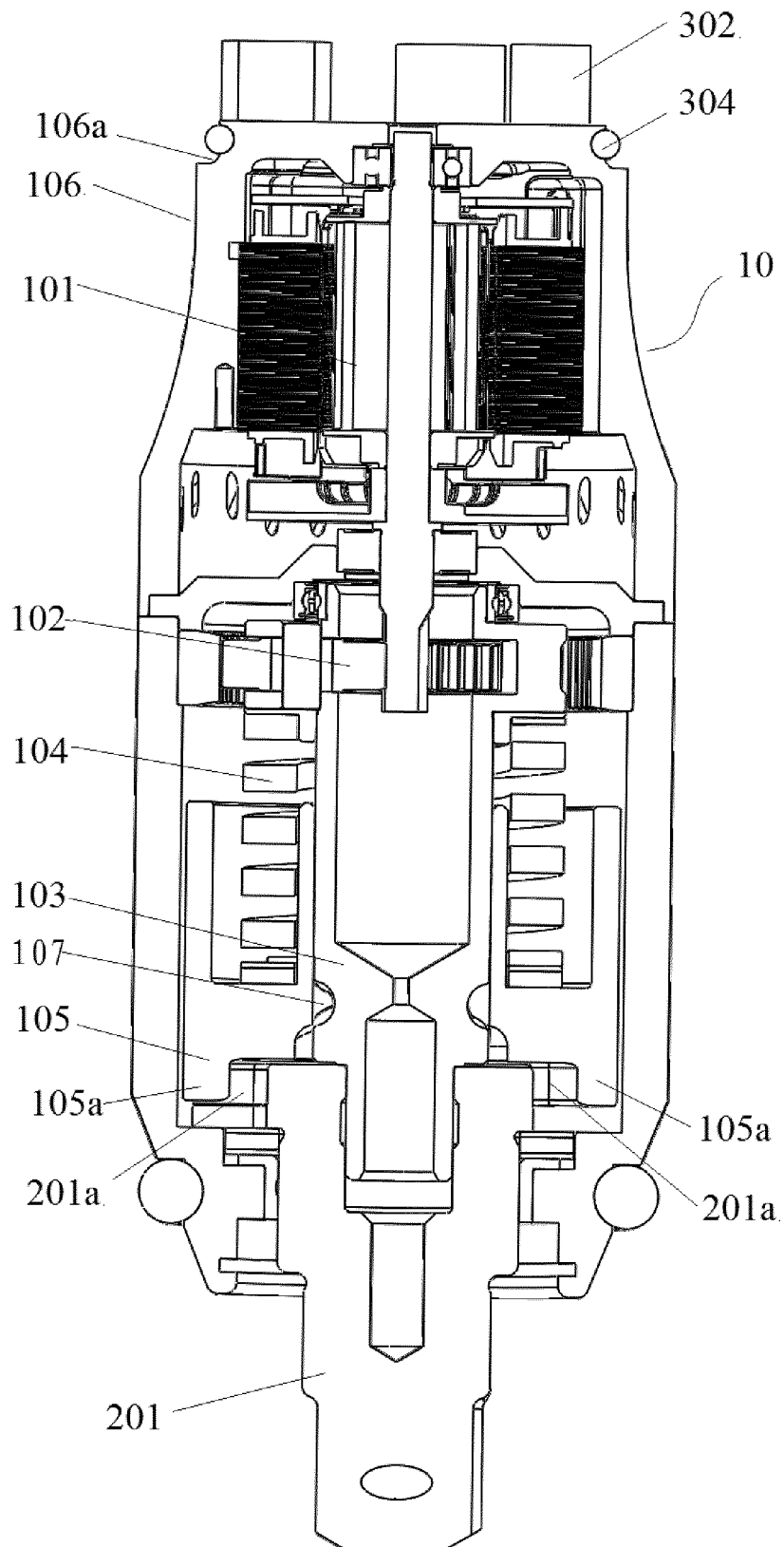


FIG. 4

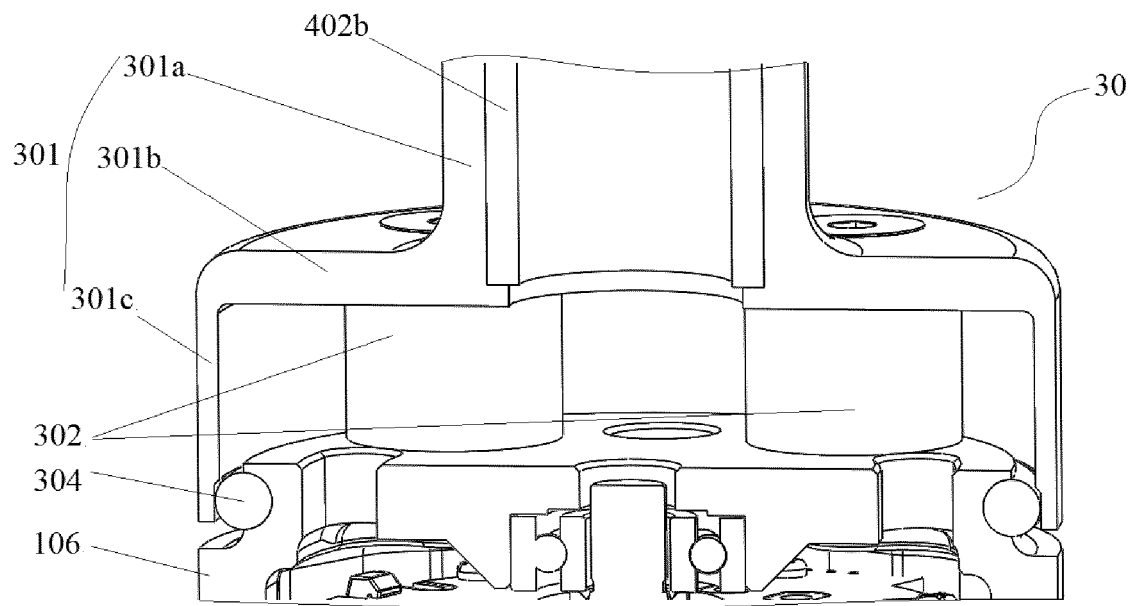


FIG. 5

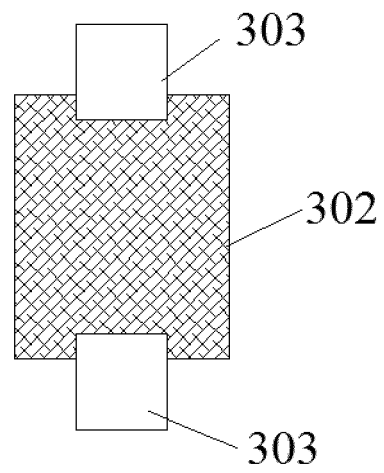


FIG. 6

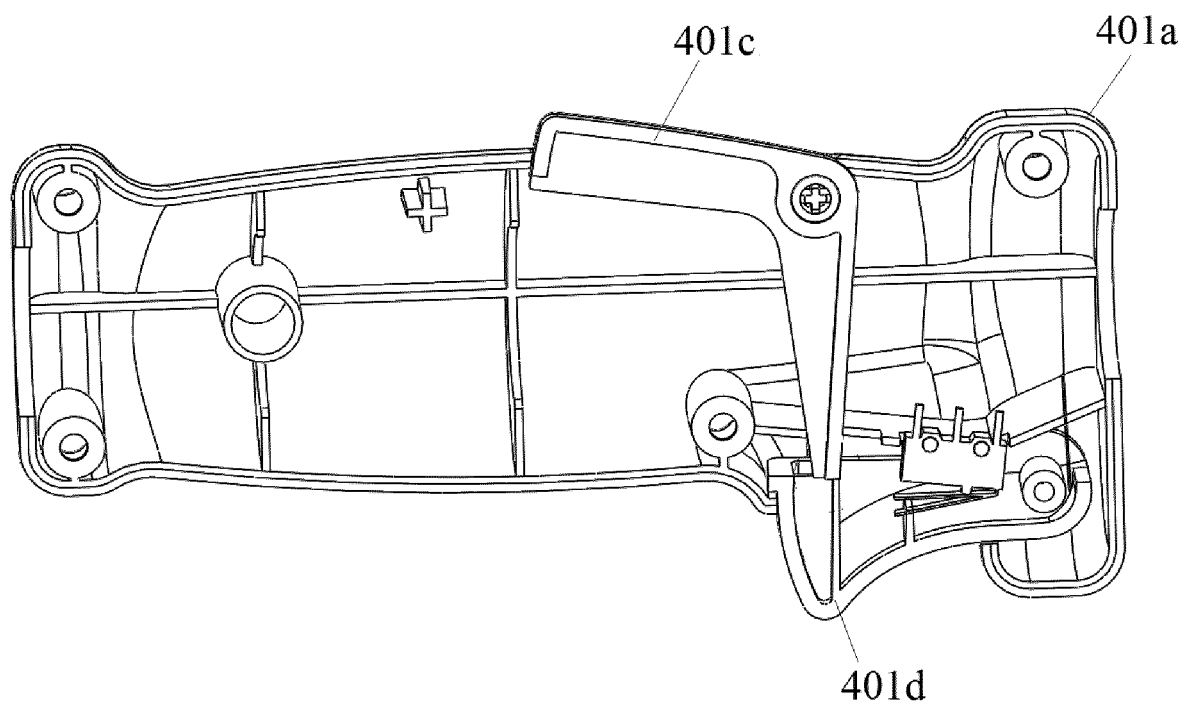


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/112103

A. CLASSIFICATION OF SUBJECT MATTER

B25B 23/147(2006.01)i; B25B 23/14(2006.01)i; B25B 23/18(2006.01)i; B25B 19/00(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)

B25B

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: 扳手, 螺丝刀, 电动工具, 控制机构, 控制部, 控制装置, 控制器, 控制单元, 控制模块, 控制, 两个, 多个, 双头, 通信, 无线, 实时, 扭矩, 力矩, 输入, 信号, 一次, 同时, 同步, 显示, 传感器, 电流, 转速. VEN, ENTXT: spanner, wrench, torque, unit, member, controller, display, control, wireless, communication, multiple, signal, sensor, electric, current, speed.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 215701284 U (TIANZE ELECTRIC POWER (TIANJIN) CO., LTD.) 01 February 2022 (2022-02-01) entire document	1-24
PX	KR 20220081011 A (BOLT-N BOLTING MASTER CO., LTD.) 15 June 2022 (2022-06-15) description, paragraphs 16-29, and figures 1-3	1-24
Y	CN 108367417 A (ATLAS COPCO INDUSTRIAL TECHNIQUE AB) 03 August 2018 (2018-08-03) description, paragraphs 13-17 and 26-32, and figures 1-2	1-24
Y	DE 202011004847 U1 (APEX-N APEX BRANDS INC.) 14 July 2011 (2011-07-14) description, paragraphs 27-41, figure 1	1-24
Y	CN 203804874 U (LU YIQUN) 03 September 2014 (2014-09-03) description, paragraphs 37-55, and figures 1-2	1-24
A	CN 104209914 A (CHANGSHU CITY DONGBANG TOWN XUSHI HONGLEI HARDWARE MACHINERY PLANT) 17 December 2014 (2014-12-17) entire document	1-24

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

11 October 2022

Date of mailing of the international search report

04 November 2022

Name and mailing address of the ISA/CN

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Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/112103

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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	CN 305007777 S (BEIJING TIANZE ELECTRIC POWER GROUP CO., LTD.) 22 January 2019 (2019-01-22) entire document	1-24

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/112103

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
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Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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