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POWER TOOL AND CONTROL METHOD THEREOF

- (57)

Provided are a power tool and a control method thereof. The power tool includes a controller. The controller is configured to acquire a first characteristic parameter when the motor receives an operation instruction to shut down, determine a compensation parameter of
- the motor according to the first characteristic parameter and control the motor to execute the compensation parameter, and limit a torque output of the motor or control the motor to shut down after the motor runs in place according to the compensation parameter.

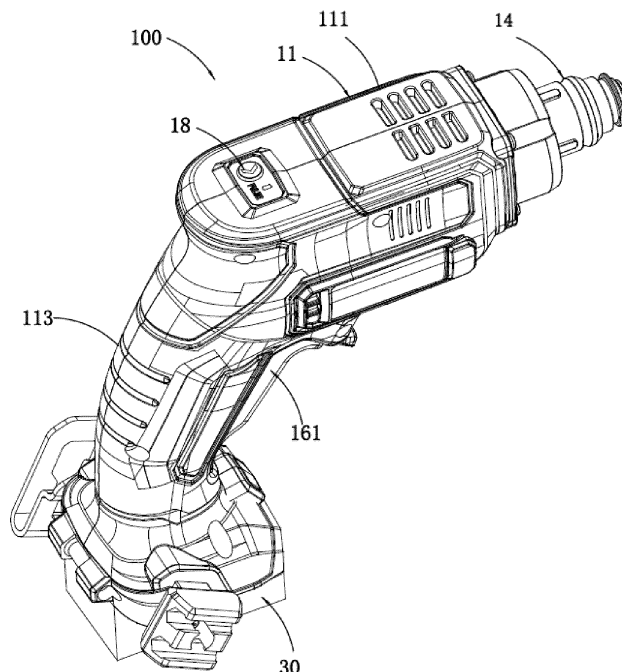


FIG. 1

Description

TECHNICAL FIELD

[0001] The present application relates to a power tool and, in particular, to a power tool and a control method thereof during dry construction.

BACKGROUND

[0002] During dry construction, it is commonly necessary to use a power tool to drive a fastener to mount a workpiece such as a gypsum board or a light panel to a wall or a ceiling, and the fastener is required to be flush with the workpiece.

[0003] A power tool in the related art brakes with a fixed braking force when receiving a shutdown instruction. However, when the power tool runs under different working conditions, the motor runs at different rotational speeds. Therefore, during the shutdown of the power tool, fasteners are screwed to inconsistent depths. As a result, it is difficult to control the output of the power tool to make the fastener flush with the workpiece.

[0004] This part provides background information related to the present application, and the background information is not necessarily the existing art.

SUMMARY

[0005] An object of the present application is to solve or at least alleviate part or all of the preceding problems. Therefore, an object of the present application is to provide a power tool and a control method thereof for screwing a fastener to a consistent depth during shutdown.

[0006] To achieve the preceding object, the present application adopts the technical solutions below.

[0007] In one aspect, the present application provides a power tool for drywall construction. The power tool includes a power switch and a controller.

[0008] The power switch is configured to receive an operation instruction of a user and control the current between a motor and a power supply according to the operation instruction.

[0009] The controller is configured to control the motor.

[0010] The controller is configured to acquire a first characteristic parameter when the motor receives an operation instruction to shut down, determine a compensation parameter of the motor according to the first characteristic parameter and control the motor to execute the compensation parameter, and limit a torque output of the motor or control the motor to shut down after the motor runs in place according to the compensation parameter.

[0011] In some examples, the power tool further includes: a housing; the motor at least partially disposed in the housing and including a drive shaft rotating about a first axis; the power supply configured to power the motor; and an output mechanism used for outputting torque and

including an output shaft rotating about an output axis.

[0012] In some examples, the power switch includes a first switch and a control switch, the first switch is configured to respond to a movement state of the output shaft, the output shaft moves back and forth along the direction of the output axis, and the control switch is configured to respond to a manual operation of the user.

[0013] In some examples, the controller is configured to send the operation instruction to shut down to the motor when at least one of the first switch and the control switch is in an inactive state.

[0014] In some examples, the controller is specifically configured to determine a load state of the motor according to the first characteristic parameter and determine a compensation parameter of the motor according to the load state of the motor.

[0015] In some examples, the first characteristic parameter includes at least one of a parameter related to a rotational speed of the motor and a parameter related to a current of the motor.

[0016] In some examples, the first characteristic parameter includes at least one of a rotational speed of the output shaft, a rotation angle of the output shaft, and rotational acceleration of the output shaft.

[0017] In some examples, the load state of the motor includes at least a light load state and a heavy load state.

[0018] In some examples, the controller is configured to, when a parameter value satisfies a first preset parameter value, determine that the load state of the motor is the light load state.

[0019] In some examples, the controller is configured to, when the parameter value does not satisfy the first preset parameter value, determine that the load state of the motor is the heavy load state, where a load value in the light load state is less than a load value in the heavy load state.

[0020] In some examples, the compensation parameter includes at least one of a compensation rotation number, compensation rotation time, and a compensation rotation angle.

[0021] In some examples, the power tool further includes a detection assembly configured to detect the first characteristic parameter.

[0022] In some examples, the compensation parameter is determined through the difference between a preset running parameter and a real-time running parameter.

[0023] In some examples, the preset running parameter is determined according to the first characteristic parameter through a query on a first calibration table.

[0024] In some examples, the real-time running parameter is determined according to the first characteristic parameter through fitting.

[0025] In some examples, the real-time running parameter is determined according to the first characteristic parameter through a query on a second calibration table.

[0026] In an aspect, the present application further provides a control method of a power tool. The control

method of the power tool includes the steps described below.

[0027] A first characteristic parameter is acquired when a motor receives an operation instruction to shut down.

[0028] A compensation parameter of the motor is determined according to the first characteristic parameter.

[0029] The motor is controlled to execute the compensation parameter.

[0030] A torque output of the motor is limited or the motor is controlled to shut down after the motor runs in place according to the compensation parameter.

[0031] In some examples, determining the compensation parameter of the motor according to the first characteristic parameter includes determining a load state of the motor according to the first characteristic parameter and determining the compensation parameter of the motor according to the load state of the motor.

[0032] In an aspect, the present application further provides a power tool for drywall construction. The power tool includes a control switch and a switching switch. The control switch is configured to send a start signal and a shutdown signal to a motor.

[0033] The switching switch is configured to switch a working mode of the power tool. The working mode includes at least a pulsed working mode. In the pulsed working mode, the control switch continuously sends the start signal, and the motor drives an output shaft to intermittently perform a rotational output.

[0034] In some examples, a controller is configured to control the motor. The controller is configured to, when the working mode of the power tool is switched to the pulsed working mode, control the motor to run with a first duty cycle, is configured to acquire a load value of the output shaft, and is configured to, when the load value of the output shaft is greater than a preset load value, control the motor to run with a second duty cycle. The second duty cycle is larger than the first duty cycle.

[0035] In some examples, the power tool further includes: a housing; the motor at least partially disposed in the housing and including a drive shaft rotating about a first axis; a power supply configured to power the motor; and an output mechanism used for outputting torque and including an output shaft rotating about an output axis.

[0036] In some examples, the controller is further configured to, when the motor runs with the second duty cycle, control the motor to continuously run with the second duty cycle until the shutdown signal is received.

[0037] In some examples, the controller is further configured to, if the load value of the output shaft is less than or equal to the preset load value, control the motor to continue running with the first duty cycle.

[0038] In some examples, the controller is configured to, when the output shaft is driven, acquire a load parameter of the output shaft and determine the load value of the output shaft according to the load parameter.

[0039] In some examples, the load parameter of the output shaft includes at least one of a rotational speed at

which the output shaft performs a rotational output, a rotation angle of the output shaft at the time of performing the rotational output, rotational acceleration of the output shaft at the time of performing the rotational output, a parameter related to a rotational speed of the motor, and a parameter related to a current of the motor.

[0040] In some examples, the load parameter of the output shaft includes the number of pulses. When the number of pulses is greater than a preset number of pulses, it is determined that the load value of the output shaft is greater than the preset load value.

[0041] In some examples, in the pulsed working mode, the motor drives, for the same amount of time every time, the output shaft to perform the rotational output, and the motor stops, for the same amount of time every time, driving the output shaft to perform the rotational output.

[0042] In some examples, the working mode of the power tool further includes a continuous working mode. In the continuous working mode, the motor drives the output shaft to perform the rotational output continuously.

[0043] In some examples, the switching switch is disposed on the housing.

[0044] In some examples, when the working mode of the power tool is the pulsed working mode, the control switch is in a locked state so that the control switch continuously sends the start signal.

[0045] In some examples, the output shaft moves back and forth along the direction of the output axis, and the control switch and the output shaft cooperate to control the start and shutdown of the motor.

[0046] In an aspect, the present application further provides a control method of a power tool for drywall construction. The control method of the power tool includes the steps described below.

[0047] A current working mode of the power tool is acquired, where a working mode includes at least a pulsed working mode, and in the pulsed working mode, a motor continuously receives a start signal and drives an output shaft to intermittently perform a rotational output.

[0048] The motor is controlled to run with a first duty cycle when the working mode of the power tool is switched to the pulsed working mode.

[0049] A load value of the output shaft is acquired.

[0050] The motor is controlled to run with a second duty cycle when the load value of the output shaft is greater than a preset load value, where the second duty cycle is larger than the first duty cycle.

[0051] In some examples, before acquiring the load value of the output shaft, the method further includes: acquiring a load parameter of the output shaft when the output shaft is driven; and determining the load value of the output shaft according to the load parameter.

[0052] In some examples, the method further includes: when the motor runs with the second duty cycle, controlling the motor to continuously run with the second duty cycle until the shutdown signal is received.

[0053] In some examples, the method further includes: controlling the motor to continue running with the first duty

cycle if the load value of the output shaft is less than or equal to the preset load value.

[0054] The present application has the benefit described below. When the motor receives the operation instruction to shut down, the first characteristic parameter is acquired so that the compensation parameter of the motor is determined according to the first characteristic parameter and the motor is controlled to execute the compensation parameter. The torque output of the motor is limited or the motor is controlled to shut down after the motor runs in place according to the compensation parameter so that shutdown time or a rotation number of the motor during the shutdown is consistent after the motor receives the operation instruction to shut down. Thus, during each shutdown of the power tool, the fastener is screwed to the consistent depth. Then, it can be ensured that the power tool is not affected by an external factor (for example, the variation of an electric quantity and a load variation) in a working process, and consistency in a whole running process is ensured.

BRIEF DESCRIPTION OF DRAWINGS

[0055]

FIG. 1 is a structural view of a power tool according to an example of the present application;

FIG. 2 is a sectional view of a power tool according to an example of the present application;

FIG. 3 is a sectional view of part of a power tool according to an example of the present application;

FIG. 4 is an enlarged view of a region J shown in FIG. 2.

FIG. 5 is a control circuit diagram of a power tool according to an example of the present application;

FIG. 6 is a flowchart of a control method of a power tool according to an example of the present application;

FIG. 7 is another flowchart of a control method of a power tool according to an example of the present application;

FIG. 8 is a flowchart of a control method of a power tool for a pulsed working mode according to an example of the present application; and

FIG. 9 is another flowchart of a control method of a power tool for a pulsed working mode according to an example of the present application.

DETAILED DESCRIPTION

[0056] Before any example of the present application is explained in detail, it is to be understood that the present application is not limited to its application to the structural details and the arrangement of components set forth in the following description or illustrated in the preceding drawings.

[0057] In the present application, the terms "comprising", "including", "having", or any other variation thereof are intended to cover an inclusive inclusion such that a process, method, article, or device comprising a series of elements includes not only those series of elements, but also other elements not expressly listed, or elements inherent in the process, method, article, or device. Without further limitations, an element defined by the phrase "comprising a..." does not preclude the presence of additional identical elements in the process, method, article, or device comprising that element.

[0058] In the present application, the term "and/or" is used for describing the association relationship between associated objects, which means that there can be three kinds of relationships. For example, A and/or B can indicate that A exists alone, A and B exist simultaneously, and B exists alone. In addition, the character "/" in the present application generally indicates the "and/or" relationship between the contextual associated objects.

[0059] In the present application, the terms "connection", "combination", "coupling", and "mounting" may be direct connection, combination, coupling, or mounting and may also be indirect connection, combination, coupling, or mounting. Among them, for example, direct connection means that two members or assemblies are connected together without intermediate members, and indirect connection means that two members or assemblies are separately connected to at least one intermediate member and the two members or assemblies are connected to each other by the at least one intermediate member. In addition, "connection" and "coupling" are not limited to physical or mechanical connections or couplings and may include electrical connections or couplings.

[0060] In the present application, it is to be understood by those of ordinary skill in the art that a relative term (such as "about", "approximately", and "substantially") used in conjunction with a quantity or a condition includes a stated value and has a meaning dictated by the context. For example, the relative term includes at least a degree of error associated with the measurement of a particular value, a tolerance caused by manufacturing, assembly, and use associated with the particular value, and the like. Such relative term should also be considered as disclosing the range defined by the absolute values of the two endpoints. The relative term may refer to that an indicated value is added or reduced by a certain percentage (such as 1%, 5%, 10%, or more). A value not modified by the relative term should also be disclosed as a particular value with a tolerance. In addition, when expressing a

relative angular position relationship (for example, substantially parallel or substantially perpendicular), "substantially" may refer to that a certain degree (such as 1 degree, 5 degrees, 10 degrees, or more) is added to or subtracted from the indicated angle.

[0061] In the present application, those of ordinary skill in the art will understand that a function performed by an assembly may be performed by one assembly, multiple assemblies, one member, or multiple members. Similarly, a function performed by a member may be performed by one member, one assembly, or a combination of members.

[0062] In the present application, the terms "up", "down", "left", "right", "front", and "rear", and other directional words are described based on the orientation or positional relationship shown in the drawings and should not be understood as limitations to the examples of the present application. In addition, in this context, it also needs to be understood that when it is mentioned that an element is connected "above" or "under" another element, it can not only be directly connected "above" or "under" the other element, but can also be indirectly connected "above" or "under" the other element through an intermediate element. It should also be understood that orientation words such as upper side, lower side, left side, right side, front side, and rear side do not only represent perfect orientations, but can also be understood as lateral orientations. For example, lower side may include directly below, bottom left, bottom right, front bottom, and rear bottom.

[0063] In the present application, the terms "controller", "processor", "central processing unit", "central processing unit (CPU)", and "microcontroller unit (MCU)" are interchangeable. Where a unit such as the "controller", the "processor", the "central processing unit", the "CPU", or the "MCU" is configured to perform specific functions, these functions may be performed by a single one of the preceding units or multiple preceding units unless otherwise indicated.

[0064] In the present application, the term "device", "module", or "unit" is used to implement a specific function in the form of hardware or software.

[0065] In the present application, the terms "computing", "judging", "controlling", "determining", "identifying", and the like refer to the operations and processes of a computer system or similar electronic computing device (for example, the controller, the processor, or the like).

[0066] To clearly illustrate technical solutions of the present application, an upper side, a lower side, a left side, a right side, a front side, and a rear side are defined in the drawings of the specification.

[0067] FIGS. 1 and 2 show a power tool in an example of the present application. The power tool 100 is an electric screwdriver. The electric screwdriver is a power tool for dry construction and is configured to screw a fastener such as a screw into a gypsum drywall, for example, a drywall screwdriver and a drywall driver.

[0068] As shown in FIGS. 1 to 4, the power tool 100

includes a power supply 30. In this example, the power supply 30 is a direct current power supply. The direct current power supply is configured to supply electrical energy to the power tool 100. The direct current power supply is a battery pack. The power tool 100 is powered by the battery pack cooperating with a corresponding power supply circuit. It is to be understood by those skilled in the art that the power supply 30 is not limited to the direct current power supply, and the corresponding components in the machine may be powered through mains electricity or an alternating current power supply in cooperation with corresponding rectifier, filter, and voltage regulation circuits.

[0069] In this example, the power supply 30 is specifically configured to be the battery pack. A battery pack 30 is used below instead of the power supply, which is not intended to limit the present application. The battery pack 30 may be a lithium battery pack, a solid-state battery pack, or a pouch battery pack. In some examples, the nominal voltage of the battery pack is higher than or equal to 8 V. In some examples, the nominal voltage of the battery pack is higher than or equal to 8 V and lower than or equal to 48 V.

[0070] The power tool 100 includes a housing 11, a motor 12, a transmission mechanism 13, and an output mechanism 14. The motor 12 includes a drive shaft 121 rotating about a first axis 101. In this example, the motor 12 is specifically configured to be an electric motor. The electric motor 12 is used below instead of the motor, and an electric motor shaft 121 is used below instead of the drive shaft, which is not intended to limit the present application.

[0071] The output mechanism 14 is used for driving a working accessory (not shown in the figure) to rotate and output torque. The output mechanism 14 includes an output shaft 141. A clamping assembly 142 is disposed at the front end of the output shaft 141. The clamping assembly 142 may clamp corresponding working accessories (not shown in the figure), for example, a screwdriver bit, a drill bit, and a socket, to implement different functions. Thus, the fastener such as the screw is screwed into cement or wood. In this example, the working accessory may be the screwdriver bit.

[0072] The output shaft 141 is rotatable about an output axis 102 so that the output shaft 141 moves back and forth along the direction of the output axis 102 to output power. In this example, the first axis 101 and the output axis 102 are configured to be parallel to each other instead of coinciding with each other. In this example, the output shaft 141 is approximately disposed on the upper side of the electric motor shaft 121. In other alternative examples, a certain included angle exists between the output axis 102 and the first axis 101. In other alternative examples, the first axis 101 coincides with the output axis 102.

[0073] The output shaft 141 subjected to a force can move back and forth along the direction of the output axis 102. When an external force is removed, the output shaft

141 can be restored to an original position.

[0074] The housing 11 includes a body housing 111 and a grip 113. The body housing 111 is configured to be a long hollow body. The electric motor 12 and part of the output mechanism 14 are accommodated in the body housing 111. The body housing 111 is further formed with or connected to the grip 113 for a user to operate. The grip 113 and the body housing 111 form a T-shaped or L-shaped structure to be convenient for the user to hold and operate. The battery pack 30 is connected to an end of the grip 113.

[0075] The transmission mechanism 13 is used for transmitting power outputted by the electric motor shaft 121 to the output shaft 141. The transmission mechanism 13 includes a first transmission member 131 and a second transmission member 132. The first transmission member 131 is fixedly connected to or integrally formed with the electric motor shaft. The second transmission member 132 and the output shaft 141 form synchronous transmission. The first transmission member 131 is in mesh with the second transmission member 132 constantly. The second transmission member 132 is at least partially in contact with the output shaft 141 constantly during the movement of the output shaft 141 subjected to the force along the output axis 102. The second transmission member 132 is formed with a sliding slot (not shown in the figure) in which the output shaft 141 can reciprocate. The output shaft 141 is fixedly connected to or integrally formed with a sliding portion (not shown in the figure). The sliding portion constantly mates with the sliding slot so that it is ensured that the second transmission member 132 synchronously rotates with the output shaft 141.

[0076] The power tool 100 further includes an elastic member 15. An input end 411 of the output shaft is subjected to the force to move along the direction of the output axis 102. Thus, when an output end 412 of the output shaft moves backwards along the direction of the output axis 102, the elastic member 15 is used for applying a force to the output shaft 141 to restore the output shaft 141 to the original position. The elastic member 15 is sleeved on the output shaft 141. One end of the elastic member 15 abuts against a protrusion portion formed by the output shaft 141, and the other end of the elastic member 15 abuts against the second transmission member 132. The output shaft 141 is subjected to the force to move backwards so that the elastic member 15 is subjected to elastic deformation and generates a deformation force. When the external force is removed, the output shaft 141 is restored to the original position due to the deformation force. Actually, it can be easily found that the original position of the output shaft 141 is often not fixed for mounting or operation reasons, which does not matter. As long as the output shaft 141 is not affected by any external force, the position of the output shaft 141 in this case can be regarded as the original position.

[0077] FIG. 5 is a control circuit diagram of the power

tool according to an example of the present application. As shown in FIG. 5, the electric motor 12 includes stator windings and a rotor. In some examples, the electric motor 12 is a three-phase brushless motor including a rotor with a permanent magnet and three-phase stator windings U, V, and W that are commutated electronically. In some examples, the three-phase stator windings U, V, and W adopt a star connection. In other examples, the three-phase stator windings U, V, and W adopt a delta connection. However, it is to be understood that other types of brushless motors are also within the scope of the present disclosure. The brushless motor may include less than or more than three phases.

[0078] The power tool 100 includes a control assembly. The control assembly includes a switching circuit 171 and a controller 17. The switching circuit 171 is electrically connected to the stator windings U, V, and W of the electric motor 12 and is configured to transmit a current from the battery pack 30 to the stator windings U, V, and W so as to drive the electric motor 12 to rotate. In an example, the switching circuit 171 includes multiple switching elements Q1, Q2, Q3, Q4, Q5, and Q6. A gate terminal of each switching element is electrically connected to the controller 17 and is configured to receive a control signal from the controller 17. The drain or source of each switching element is connected to the stator windings U, V, and W of the electric motor 12. The switching elements Q1 to Q6 receive control signals from the controller 17 to change their respective on states, thereby changing the current loaded by the battery pack 30 to the stator windings U, V, and W of the electric motor 12. In an example, the switching circuit 171 may be a three-phase bridge driver circuit including six controllable semiconductor power devices (such as field-effect transistors (FETs), bipolar junction transistors (BJTs), or insulated-gate bipolar transistors (IGBTs)). It is to be understood that the preceding switching elements may be any other types of solid-state switches such as the IGBTs or the BJTs.

[0079] In this example, the controller 17 is configured to control the electric motor 12. The controller 17 is disposed on a control circuit board. The control circuit board includes a printed circuit board (PCB) and a flexible printed circuit (FPC) board. The controller 17 uses a dedicated control chip, for example, a single-chip microcomputer or a microcontroller unit (MCU). Specifically, the controller 17 controls the on or off states of the switching elements in the switching circuit 171 through the control chip. In some examples, the controller 17 controls the ratio of an on time of a drive switch to an off time of the drive switch based on a pulse-width modulation (PWM) signal. It is to be noted that the control chip may be integrated into the controller 17 or may be disposed independently of the controller 17. The structural relationship between a driver chip and the controller 17 is not limited in this example.

[0080] The power tool 100 further includes a power switch 16 for the user to operate to control the energiza-

tion state of the electric motor 12. The power switch 16 includes a control switch 161 and a first switch 162. The control switch 161 is disposed near the grip 113 and is configured to send a start signal and a shutdown signal to the motor when manually operated by the user. The first switch 162 is disposed in the housing 111. A signal of the first switch 162 responds to a movement state of the output shaft 141. In this example, a signal of the control switch 161 and a signal of the first switch 162 are connected in series.

[0081] The control switch 161 includes an operation member 1611 and a switching element 1612 connected to the operation member 1611. The operation member 1611 is used for receiving an operation instruction of the user. Generally, when the operation member 1611 is activated, the switching element 1612 is on, and when the operation member 1611 is not activated, the switching element 1612 is off. In this example, the user inputs operation instructions by pressing and releasing the operation member 1611. In some alternative examples, the user inputs the operation instruction into the operation member 1611 through an operation action such as rotation, toggling, or a touch.

[0082] The first switch 162 includes a detection element 1621 and an activation element 1622. The detection element 1621 is coupled to the electric motor 12, and the activation element 1622 is configured to activate the detection element 1621. In this example, the activation element 1622 responds to the movement of the output shaft 141 to activate the detection element 1621. During the movement of the detection element 1621, the detection element 1621 has an active state in which the detection element 1621 is activated by the activation element 1622 and generates an activation signal and a sleep state in which the detection element 1621 is not activated by the activation element. In this example, when the detection element 1621 is in the active state and the control switch 161 is in the on state, the electric motor 12 starts. That is, the electric motor 12 cannot start when either the detection element 1621 is in the sleep state or the control switch 161 is in the off state. It is to be noted here that the output shaft 141 drives the detection element 1621 to move, which may be understood as follows: the output shaft 141 directly drives the detection element 1621 to translate, rotate, slide, or the like, or the output shaft 141 indirectly drives the detection element 1621 to translate, rotate, slide, or the like. In this example, the output shaft 141 drives the detection element 1621 to rotate about a first rotation axis 103. During the rotation, the detection element 1621 can be activated by the activation element 1622 so that the detection element 1621 is in the active state.

[0083] In this example, the output shaft 141 drives the detection element 1621 to rotate. For example, the input end 411 is subjected to the force to move along the direction of the output axis 102 so that the output end 412 can drive the detection element 1621 to rotate about the first rotation axis 103 when moving backwards along

the direction of the output axis 102.

[0084] As shown in FIG. 4, the first switch 162 further includes a rotary member 1623, a biasing member 1624, and a connector 1625. The rotary member 1623 is rotatably connected to a transmission housing 21 through the connector 1624. The rotary member 1623 is used for mounting the detection element 1621. The preceding description may be understood as follows: the output shaft 141 drives the rotary member 1623 to rotate about the first rotation axis 103, thereby driving the detection element 1621 to rotate. The biasing member 1624 is mounted on the rotary member 1623. For example, when the biasing member 1624 is mounted, the biasing member 1624 has a biasing force. The biasing force can keep the rotary member 1623 in an initial position when no external force is applied. In this example, the rotary member 1623 includes a connecting portion 1626 and a mounting portion 1627. The mounting portion 1627 is formed with an accommodation slot, and the detection element 1621 is mounted in the accommodation slot and rotates synchronously with the rotary member 1623. The connecting portion 1626 is fixedly connected to or integrally formed with the mounting portion 1627. For example, the connecting portion 1626 is integrally formed with the mounting portion 1627. The biasing member 1624 can provide the biasing force that keeps the detection element 1621 in the initial position without the drive of the external force. That is to say, the biasing member 1624 keeps the detection element 1621 in the initial position in the case where the output shaft 141 is driven by no external force. On the premise that the control switch 161 is always in the on state, the output end 412 can drive the detection element 1621 to switch from the sleep state to the active state when the input end 411 is subjected to the force to move towards the electric motor shaft 121 along the first axis 101. The output end 412 is at least partially in contact with the connecting portion 1626 when the detection element 1621 is in the sleep state. That is to say, when the detection element 1621 is in the active state, the detection element 1621 is at least partially in contact with the activation element 1622. A driving member 1411 is disposed on the output shaft 141. The driving member 1411 may drive the connecting portion 1626, thereby causing the detection element 1621 to rotate. The driving member 1411 may be a bearing. In this manner, damage to the connecting portion 1626 can be avoided when the electric motor 12 drives the output shaft 141 to run at a high speed, thereby prolonging the service life. In this example, the detection element 1621 is a Hall sensor, and the activation element 1622 is a permanent magnet. It is to be noted that the output end 412 described above may be formed by the driving member 1411.

[0085] As shown in FIGS. 1 and 2, the power tool 100 further includes a switching switch 18. The switching switch 18 is operated by the user to switch a working mode of the power tool. In this example, the electric screwdriver includes a continuous working mode. In

the continuous working mode, the electric motor drives the output draft to continuously perform a rotational output. For example, when the power switch controls the electric motor to be energized, the electric motor continuously runs to drive the output shaft to continuously output the power.

[0086] The working mode of the power tool further includes at least a pulsed working mode. In the pulsed working mode, the electric motor drives the output draft to intermittently perform the rotational output. For example, when the power switch controls the electric motor to be energized, the electric motor runs with a certain on/off ratio. When the electric motor rotates, the output shaft is driven to output the power. It is to be explained that the on/off ratio refers to the ratio of shutdown time of the electric motor or running time of the electric motor to total running time in the pulsed working mode. Thus, it is ensured that the electric motor drives the output shaft to perform the rotational output intermittently with some regularity.

[0087] The switching switch 18 is disposed on the housing and manually operated by the user. In this example, the switching switch 18 is disposed above the output axis. In this example, the user presses the switching switch 18 to input an operation instruction to switch the working mode. In some alternative examples, the user inputs, through an operation action such as rotation, toggling, or a touch, the operation instruction to switch the working mode.

[0088] In an example, the controller is configured to acquire a first characteristic parameter when the motor receives an operation instruction to shut down, determine a compensation parameter of the motor according to the first characteristic parameter and control the motor to execute the compensation parameter, and limit a torque output of the motor or control the motor to shut down after the motor runs in place according to the compensation parameter.

[0089] The first characteristic parameter refers to a parameter related to the motor 12 or a parameter related to the output shaft 141. The compensation parameter of the motor 12 refers to a parameter with which the motor 12 continues running from the time the motor 12 receives the operation instruction to shut down to the time the motor 12 shuts down or the torque output of the motor 12 is limited. Optionally, the compensation parameter includes at least one of a compensation rotation number, compensation rotation time, and a compensation rotation angle. The torque output of the motor 12 is limited, which may refer to that torque outputted by the motor 12 is controlled so that the output shaft 141 cannot drive, under a current working condition, the fastener to rotate.

[0090] In an optional example, the controller is further configured to send the operation instruction to shut down to the motor when at least one of the first switch 162 and the control switch 161 is in an inactive state.

[0091] In this example, when the user operates the control switch 161 to cause the control switch 161 to

be off or when the first switch 162 is caused to be off in response to the movement state of the output shaft 141, the controller sends the operation instruction to shut down to the motor 12. When the motor 12 receives the operation instruction to shut down, the controller 17 acquires the first characteristic parameter so that the compensation parameter of the motor 12 is determined according to the first characteristic parameter and the motor 12 is controlled to execute the compensation parameter. The controller 17 limits the torque output of the motor 12 or controls the motor 12 to shut down after the motor 12 runs in place according to the compensation parameter so that the output shaft 141 cannot drive, under the current working condition, the fastener to rotate. That is to say, after the motor 12 runs in place according to the compensation parameter, the electric motor starts braking, and the power tool stops screwing the fastener or screws the fastener at a fixed length.

[0092] In this example, when the motor 12 receives the operation instruction to shut down, the first characteristic parameter is acquired so that the compensation parameter of the motor 12 is determined according to the first characteristic parameter and the motor 12 is controlled to execute the compensation parameter. The torque output of the motor 12 is limited or the motor 12 is controlled to shut down after the motor 12 runs in place according to the compensation parameter so that after the motor 12 receives the operation instruction to shut down, shutdown time or a rotation number of the motor 12 during shutdown is consistent regardless of the magnitude of a rotational speed of the motor. Thus, during each shutdown of the power tool, the fastener is screwed to a consistent depth. In this manner, it is easy to control the output of the power tool to control the consistency with which the fastener is screwed. A depth adjuster is attached to the front of the power tool 100 for the drywall construction, for example, the drywall screwdriver. Therefore, the consistency with which the fastener is screwed is ensured so that it can be ensured that the fastener is flush with a workpiece. The case is avoided where an external factor (for example, the variation of an electric quantity and a load variation) affects the running of the electric motor, causing fasteners to be screwed to different depths.

[0093] Optionally, the controller is specifically configured to determine a load state of the motor according to the first characteristic parameter and determine the compensation parameter of the motor according to the load state of the motor.

[0094] The load state of the motor 12 includes at least a light load state and a heavy load state. It is to be understood that when the power tool is applied to different scenarios, the motor 12 has different load ranges. Therefore, the light load state and the heavy load state refer to a relatively light load and a relatively heavy load on the power tool in a current application scenario.

[0095] In this example, the first characteristic parameter includes at least one of a parameter related to a

current of the electric motor 12, a parameter related to the rotational speed of the electric motor 12, and a rotation parameter of the output shaft 141. In this example, the power tool further includes a detection assembly 18 configured to detect the first characteristic parameter.

[0096] It is to be explained that the parameter related to the current of the electric motor 12 includes the current of the electric motor 12 and a parameter obtained through the calculation of the current of the electric motor 12. The detection assembly 18 includes a first detection assembly. The current of the electric motor 12 is acquired through the first detection assembly. The first detection assembly includes a current sense resistor, a Hall current sensor, a metal-oxide-semiconductor field-effect transistor (MOSFET), or a turn-on resistor.

[0097] It is to be explained that the parameter related to the rotational speed of the electric motor 12 includes the rotational speed of the electric motor 12 and a parameter obtained through the calculation of the rotational speed of the electric motor 12, for example, torque of the electric motor 12. When the output shaft 141 bears a relatively heavy load, the rotational speed of the output shaft 141 decreases, and the rotational speed of the electric motor 12 also decreases. When the output shaft 141 bears a relatively light load, the rotational speed of the output shaft 141 increases, and the rotational speed of the electric motor 12 also increases. The rotational speed of the electric motor 12 is detected through a magnetic ring, a magnetic steel, a photoelectric code disk, an inductor, a Hall sensor, or a photoelectric sensor.

[0098] The rotation parameter of the output shaft 141 includes at least one of the rotational speed of the output shaft 141, a rotation angle of the output shaft 141, and rotational acceleration of the output shaft 141. The detection assembly 18 includes a second detection assembly. The second detection assembly is configured to detect the rotation parameter of the output shaft 141. The second detection assembly includes a position sensor. Specifically, the position sensor may be a photodiode sensor, a magnetic sensor, or a potentiometer. The second detection assembly may be a rotation sensor. Specifically, the rotation sensor is a gyroscope sensor. The gyroscope sensor may be a single-axis, dual-axis, or three-axis microelectromechanical system (MEMS) sensor or a rotation-type sensor.

[0099] Optionally, the controller is specifically configured to, when a parameter value satisfies a first preset parameter value, determine that the load state of the motor is the light load state. When the parameter value does not satisfy the first preset parameter value, it is determined that the load state of the motor is the heavy load state, where a load value in the light load state is less than a load value in the heavy load state.

[0100] In an illustrative example, when the rotational speed of the output shaft 141 is used as the parameter value, it is determined that the load state of the motor 12 is the light load state if the rotational speed of the output shaft 141 is greater than the first preset parameter, and it

is determined that the load state of the motor 12 is the heavy load state if the rotational speed of the output shaft 141 is less than or equal to the first preset parameter. Thus, when the load state of the motor 12 is the light load state, it is determined that the compensation parameter of the motor 12 is a first compensation parameter, and when the load state of the motor 12 is the heavy load state, it is determined that the compensation parameter of the motor 12 is a second compensation parameter.

[0101] In another illustrative example, when the current of the electric motor 12 is used as the parameter value, it is determined that the load state of the motor 12 is the light load state if the current of the electric motor 12 is less than the first preset parameter, and it is determined that the load state of the motor 12 is the heavy load state if the current of the electric motor 12 is greater than or equal to the first preset parameter. Thus, when the load state of the motor 12 is the light load state, it is determined that the compensation parameter of the motor 12 is a first compensation parameter, and when the load state of the motor 12 is the heavy load state, it is determined that the compensation parameter of the motor 12 is a second compensation parameter.

[0102] A specific value of the first preset parameter may be set according to actual detection requirements and is not specifically limited here. The value of the first preset parameter is adjusted according to power tools of different specifications including different output power and different output torque.

[0103] In this example, the compensation parameter is determined through the difference between a preset running parameter and a real-time running parameter. The preset running parameter is determined according to the first characteristic parameter through a query on a first calibration table. The first calibration table is calibrated in advance and stored in the controller. The real-time running parameter is determined according to the first characteristic parameter through fitting or a query on a second calibration table.

[0104] In an optional example, when the compensation running parameter of the motor 12 includes the compensation rotation number and the load state of the output shaft 141 is the light load state, the first compensation parameter = a first preset running parameter - a first real-time running parameter. The "first preset running parameter" refers to a braking rotation number at the maximum rotational speed in the light load state, which may be understood as the number of rotations performed, in the case where the electric motor bears the minimum load, the battery pack has the maximum electric quantity, and the electric motor runs at the maximum rotational speed, by the electric motor within a load range under a light load working condition from the reception of the shutdown signal by the electric motor to the completion of the shutdown. The "first real-time running parameter" refers to a braking rotation number of the electric motor at a current rotational speed. The braking rotation number of the electric motor at the current rotational speed = $(K1 *$

the rotational speed of the electric motor before braking), where K1 denotes the fitting coefficient of the rotational speed and the braking rotation number. In some examples, the braking rotation number of the electric motor at the current rotational speed = (K1 * the rotational speed of the electric motor before braking - B1), where B1 is a correction constant. K1 and B1 are each calculated through detection data in a laboratory. For example, the same fastener is controlled for performing a fastening test on the same workpiece, the rotational speed of the electric motor is changed, and the braking rotation number of the electric motor is detected. According to obtained values, fitting is performed on discrete points, thereby obtaining the values of K1 and B1.

[0105] Likewise, when the load state of the output shaft 141 is the heavy load state, the second compensation parameter = a second preset running parameter- a second real-time running parameter. The "second preset running parameter" refers to a braking rotation number at the maximum rotational speed in the heavy load state, which may be understood as the number of rotations performed, in the case where the electric motor bears the minimum load, the battery pack has the maximum electric quantity, and the electric motor runs at the maximum rotational speed, by the electric motor within a load range under a heavy load working condition from the reception of the shutdown signal by the electric motor to the completion of the shutdown. The "second real-time running parameter" refers to a braking rotation number of the electric motor at a current rotational speed. The braking rotation number of the electric motor at the current rotational speed = (K2 * the rotational speed of the electric motor before braking), where K2 denotes the fitting coefficient of the rotational speed and the braking rotation number. In some examples, the braking rotation number of the electric motor at the current rotational speed = (K2 * the rotational speed of the electric motor before braking - B2), where B2 is a correction constant.

[0106] Based on the same application concept, this example further provides a control method of a power tool. FIG. 6 is a flowchart of the control method of the power tool according to the example of the present application. Referring to FIG. 6, the control method of the power tool includes the steps described below.

[0107] In S110, the first characteristic parameter is acquired when the motor receives the operation instruction to shut down.

[0108] In S120, the compensation parameter of the motor is determined according to the first characteristic parameter.

[0109] In S130, the motor is controlled to execute the compensation parameter.

[0110] In S140, it is determined whether the motor runs in place according to the compensation parameter. If so, S150 is performed.

[0111] In S150, the torque output of the motor is limited or the motor is controlled to shut down.

[0112] Specifically, when the user operates the control

switch 161 to cause the control switch 161 to be off or when the first switch 162 is caused to be off in response to the movement state of the output shaft 141, the controller sends the operation instruction to shut down to the motor 12. When the motor 12 receives the operation instruction to shut down, the controller acquires the first characteristic parameter so that the compensation parameter of the motor 12 is determined according to the first characteristic parameter and the motor 12 is controlled to execute the compensation parameter. The controller limits the torque output of the motor 12 or controls the motor 12 to shut down after the motor 12 runs in place according to the compensation parameter so that the output shaft 141 cannot drive, under the current working condition, the fastener to rotate. That is to say, after the motor 12 runs in place according to the compensation parameter, the electric motor starts braking while running, and the power tool stops screwing the fastener.

[0113] Optionally, FIG. 7 is another flowchart of a control method of a power tool according to an example of the present application. In this example, based on the preceding example, the steps about how the compensation parameter of the motor is determined according to the first characteristic parameter are further provided. Referring to FIG. 7, the control method specifically includes the steps described below.

[0114] In S210, the first characteristic parameter is acquired when the motor receives the operation instruction to shut down.

[0115] In S220, the load state of the motor is determined according to the first characteristic parameter.

[0116] Optionally, the first characteristic parameter includes at least one of the rotational speed of the motor, the current of the motor, a commutation parameter of the motor, and freewheeling time of the motor. Determining the load state of the motor according to the first characteristic parameter includes determining that the load state of the motor is the light load state when the parameter value satisfies the first preset parameter value and determining that the load state of the motor is the heavy load state when the parameter value does not satisfy the first preset parameter value.

[0117] In S230, the compensation parameter of the motor is determined according to the load state of the motor.

[0118] The load state of the motor includes at least the light load state and the heavy load state.

[0119] In S240, the motor is controlled to execute the compensation parameter.

[0120] In S250, it is determined whether the motor runs in place according to the compensation parameter. If so, S260 is performed.

[0121] In S260, the torque output of the motor is limited or the motor is controlled to shut down.

[0122] In this example, when the motor receives the operation instruction to shut down, the first characteristic parameter is acquired so that the compensation parameter of the motor is determined according to the first

characteristic parameter and the motor is controlled to execute the compensation parameter. The torque output of the motor is limited or the motor is controlled to shut down after the motor runs in place according to the compensation parameter so that after the motor receives the operation instruction to shut down, the shutdown time or the rotation number of the motor during the shutdown is consistent. Thus, during each shutdown of the power tool, the fastener is screwed to the consistent depth. In this manner, it is easy to control the output of the power tool to make the fastener flush with the workpiece. In addition, the load state of the motor is determined according to the first characteristic parameter. When the parameter value satisfies the first preset parameter value, it is determined that the load state of the motor is the light load state. When the parameter value does not satisfy the first preset parameter value, it is determined that the load state of the motor is the heavy load state. Thus, when the load state of the motor is the light load state, it is determined that the compensation parameter of the motor is the first compensation parameter, and when the load state of the motor is the heavy load state, it is determined that the compensation parameter of the motor is the second compensation parameter. Therefore, it is unnecessary to determine one compensation parameter of the motor according to each load value. Thus, resources can be saved on the premise that the power tool satisfies requirements of a working condition.

[0123] As shown in FIGS. 7 and 8, in an example of the present application, when the working mode of the electric screwdriver is the pulsed working mode, the control switch 161 is in a locked state. In this example, the control switch 161 is activated and then kept in an always-on state. That is to say, the control switch keeps sending start signals, but the user does not need to input instructions continuously. For example, the user inputs the operation instructions by pressing and releasing the operation member 1611. When the user presses and releases the operation member once, the operation member is activated, the switching element is turned on, and the control switch sends the start signals to the controller or the electric motor 12 continuously. When the user presses and releases the operation member again, the operation member is not activated, and the switching element is turned off.

[0124] In an example, in the pulsed working mode, the electric motor 12 runs for the same amount of time every time. That is to say, the electric motor 12 drives the output shaft 141 to perform the rotational output for the same duration every time. The duration is preset according to laboratory data or through simulation or the like. The electric motor 12 runs at equal intervals. That is to say, the electric motor 12 stops, for the same amount of time every time, driving the output shaft 141 to perform the rotational output. For example, T1 denotes the time the electric motor 12 ends driving, for the n-th time, the output shaft 141 to perform the rotational output, and T2 denotes the time the electric motor 12 starts driving, for the

(n+1)-th time, the output shaft 141 to perform the rotational output. The difference between T2 and T1 is a preset fixed value. That is, the electric motor 12 stops, for the same amount of time every time, driving the output shaft 141 to perform the rotational output.

[0125] In an example, the control switch may be a travel switch. Travel magnitude of the travel switch corresponds to a turn-on degree of the travel switch. In the pulsed working mode, when the number of times the electric motor 12 runs is less than a preset number of times, a duty cycle with which the electric motor 12 runs is controlled according to a turn-on degree of the control switch 161 if the turn-on degree of the control switch 161 is lower than or equal to a preset turn-on degree. When the turn-on degree of the control switch 161 is equal to the preset turn-on degree, it is determined, according to the turn-on degree of the control switch 161, that the duty cycle with which the electric motor 12 runs is a preset duty cycle. When the turn-on degree of the control switch 161 is higher than the preset turn-on degree, the duty cycle with which the electric motor 12 runs is controlled to be the preset duty cycle. In an optional example, the number of times the electric motor 12 runs is determined by a counter. Every time the electric motor 12 starts driving the output shaft 141 to perform the rotational output until the electric motor 12 stops driving the output shaft 141 to perform the rotational output, the electric motor 12 is considered to run once. In an optional example, the preset number of times and the preset duty cycle are determined according to an application scenario of the electric screwdriver. When the electric screwdriver is applied to different application scenarios, the same preset number of times and the same preset duty cycle may be provided, or different preset numbers of times and different preset duty cycles may be provided. For example, the preset number of times may be 4, and the preset duty cycle may be 40%. That is, the electric motor 12 runs with a duty cycle of smaller than 40% when rotating for the first four times to satisfy working requirements under the light load working condition. When the number of times the electric motor 12 rotates is greater than a preset number of times, the duty cycle with which the electric motor 12 runs is controlled according to the turn-on degree of the control switch 161. If the turn-on degree of the control switch 161 is higher, the duty cycle with which the electric motor 12 runs is greater so that working requirements under the heavy load working condition are satisfied.

[0126] In some examples, when the time the electric motor 12 drives the output is less than preset time, the duty cycle with which the electric motor 12 runs is controlled according to the turn-on degree of the control switch 161 if the turn-on degree of the control switch 161 is lower than or equal to the preset turn-on degree. When the turn-on degree of the control switch 161 is equal to the preset turn-on degree, it is determined, according to the turn-on degree of the control switch 161, that the duty cycle with which the electric motor

12 runs is the preset duty cycle. When the turn-on degree of the control switch 161 is higher than the preset turn-on degree, the duty cycle with which the electric motor 12 runs is controlled to be the preset duty cycle.

[0127] In some examples, the controller is configured to, when the working mode of the power tool is switched to the pulsed working mode, control the motor to run with a first duty cycle, is configured to acquire a load value of the output shaft, and is configured to, when the load value of the output shaft is greater than a preset load value, control the motor to run with a second duty cycle. The second duty cycle is larger than the first duty cycle.

[0128] The preset load value is determined according to the application scenario of the electric screwdriver. For example, when the electric screwdriver is a low-torque electric screwdriver, the preset load value is set to a relatively small load value. When the electric screwdriver is a high-torque electric screwdriver, the preset load value is set to a relatively large load value. Specific values are set for different products. The load value of the output shaft acquired by the controller is compared with the preset load value so that it can be determined that the electric screwdriver bears a light load or a heavy load in the current application scenario.

[0129] Specifically, when the working mode of the power tool is switched to the pulsed working mode, the motor is controlled to run with the relatively small first duty cycle. The load value of the output shaft is acquired, and as the power tool continuously screws the fastener, the load value of the out shaft becomes greater and greater. When the output value of the output shaft is greater than the preset load value, the motor is controlled to run with the relatively large second duty cycle.

[0130] In this example, when the working mode of the power tool is switched to the pulsed working mode, the motor is controlled to run with the first duty cycle, and the load value of the output shaft is acquired. When the load value of the output shaft is greater than the preset load value, the motor is controlled to run with the second duty cycle. The second duty cycle is larger than the first duty cycle. Thus, when the load value of the output shaft increases to the preset load value, the duty cycle with which the motor runs is increased, thereby improving the output capability of the power tool. In this manner, when driving the output shaft to perform the rotational output, the motor can run at an output rotational speed suitable for the load so that the power tool automatically matches output performance with a load condition when driving the output shaft to perform the rotational output. In another aspect, since the output capability is matched with the load, it is easier to control the depth to which the power tool drives, per unit of time, the fastener to be screwed, and the consistency of the depth to which the fastener is screwed is improved. Thus, the user also can control, without use experience, the depth to which the fastener is screwed, thereby making the fastener flush with the workpiece and improving the universality of the power tool.

[0131] Optionally, the controller is further configured to, if the load value of the output shaft is less than or equal to the preset load value, control the motor to continue running with the first duty cycle and continuously acquire the load value of the output shaft. The controller is further configured to, when the motor runs with the second duty cycle, control the motor to continuously run with the second duty cycle until the shutdown signal is received.

[0132] When at least one of the first switch 162 and the control switch 161 is in the inactive state, the operation instruction to shut down is sent to the motor. The operation instruction to shut down received by the motor is the shutdown signal received by the motor.

[0133] In this example, when the load value of the output shaft is less than or equal to the preset load value, the motor is controlled to continue running with the first duty cycle and continuously acquire the load value of the output shaft, and when the load value of the output shaft is greater than the preset load value, the motor is controlled to run with the second duty cycle. As the power tool continuously screws the fastener, the load value of the out shaft becomes greater and greater. Therefore, when the load value of the output shaft is less than or equal to the preset load value, the motor is controlled to continue running with the relatively small first duty cycle. When the load value of the output shaft reaches the preset load value, it is unnecessary to continue acquiring the load value of the output shaft, and the motor is just directly controlled to continuously run with the second duty cycle until the shutdown signal is received. Thus, the resources can be saved on the premise that the power tool satisfies the requirements of the working condition.

[0134] In some examples, according to the requirements of the working condition, a third duty cycle or more duty cycles that are different from the first duty cycle and the second duty cycle may also be set. In this manner, more precise control is performed.

[0135] Optionally, the controller is specifically configured to, when the output shaft is driven, acquire a load parameter of the output shaft and determine the load value of the output shaft according to the load parameter.

[0136] In this example, the load parameter of the output shaft includes at least one of the parameter related to the current of the electric motor 12, the parameter related to the rotational speed of the electric motor 12, and the rotation parameter of the output shaft.

[0137] In this example, the load parameter of the output shaft includes the number of pulses. When the number of pulses is greater than a preset number of pulses, it is determined that the load value of the output shaft is greater than the preset load value. Optionally, the number of pulses may be determined by the counter. Every time the electric motor 12 starts driving the output shaft to perform the rotational output and stops driving the output shaft to perform the rotational output until the electric motor 12 starts driving the output shaft to perform the rotational output again, the electric motor 12 is considered to complete one pulse. Optionally, a pulsed running

duration, the variation of the current, a parameter related to the commutation of the electric motor 12, or freewheeling time may be detected such that the number of pulses is calculated. When the number of pulses of the power tool is less than the preset number of pulses, it may be indicated that the fastener is screwed to a relatively shallow depth. In this case, the output shaft generally bears a relatively light load. As the number of pulses increases, the depth to which the fastener is screwed also increases. In this case, the load borne by the output shaft increases.

[0138] In this example, when the parameter value satisfies the first preset parameter value, it is determined that the load value is a first load value, and when the parameter value does not satisfy the first preset parameter value, it is determined that the load value is a second load value. The first load value is less than the preset load value, and the preset load value is less than the second load value.

[0139] In an illustrative example, when a rotational speed at which the output shaft performs the rotational output is used as the parameter value, it is determined that the load value is the first load value if the rotational speed at which the output shaft performs the rotational output is greater than the first preset parameter. Thus, the motor is continuously controlled to run with the first duty cycle. It is determined that the load value is the second load value if the rotational speed at which the output shaft performs the rotational output is less than or equal to the first preset parameter. Thus, the motor is controlled to run with the second duty cycle.

[0140] In another illustrative example, when the current of the electric motor 12 during running is used as the parameter value, it is determined the load value is the first load value if the current of the electric motor 12 during running is less than the first preset parameter. It is determined that the load value is the second load value if the current of the electric motor 12 during running is greater than or equal to the first preset parameter.

[0141] In another illustrative example, when the number of pulses of the electric motor 12 during running is used as the parameter value, it is determined the load value is the first load value if the number of pulses of the electric motor 12 during running is less than the first preset parameter. It is determined that the load value is the second load value if the number of pulses of the electric motor 12 during running is greater than or equal to the first preset parameter.

[0142] Based on the same inventive concept, this example further provides a control method of a power tool. FIG. 7 is a flowchart of the control method of the power tool according to the example of the present invention. Referring to FIG. 7, the control method of the power tool includes the steps described below.

[0143] In S310, a current working mode of the power tool is acquired.

[0144] A working mode includes at least the pulsed working mode. In the pulsed working mode, the motor

continuously receives the start signal and drives the output shaft to intermittently perform the rotational output.

[0145] In S320, when the working mode of the power tool is switched to the pulsed working mode, the motor is controlled to run with the first duty cycle.

[0146] In S330, the load value of the output shaft is acquired.

[0147] In S340, when the load value of the output shaft is greater than the preset load value, the motor is controlled to run with the second duty cycle.

[0148] The second duty cycle is larger than the first duty cycle.

[0149] Optionally, FIG. 8 is another flowchart of a control method of a power tool according to an example of the present invention. In this example, based on the preceding example, the steps about how the load value of the output shaft is determined according to the first characteristic parameter are further provided. Referring to FIG. 8, the control method specifically includes the steps described below.

[0150] In S410, the current working mode of the power tool is acquired.

[0151] The working mode includes at least the pulsed working mode. In the pulsed working mode, the motor continuously receives the start signal and drives the output shaft to intermittently perform the rotational output.

[0152] In S420, when the working mode of the power tool is switched to the pulsed working mode, the motor is controlled to run with the first duty cycle.

[0153] In S430, when the output shaft is driven, the load parameter of the output shaft is acquired.

[0154] In S440, the load value of the output shaft is determined according to the load parameter.

[0155] In an optional example, the load parameter of the output shaft includes at least one of the rotational speed of the output shaft at the time of being driven, a rotation angle of the output shaft at the time of being driven, rotational acceleration of the output shaft at the time of being driven, a parameter related to the rotational speed of the motor during running, and a parameter related to the current of the motor during running. The load parameter of the output shaft further includes the number of pulses. S440 includes: when the parameter value satisfies the first preset parameter value, it is determined that the load value is the first load value, and when the parameter value does not satisfy the first preset parameter value, it is determined that the load value is a second load value. The first load value is less than the preset load value, and the preset load value is less than the second load value.

[0156] In S450, the load value of the output shaft is acquired.

[0157] In S460, it is determined whether the load value of the output shaft is greater than the preset load value. If yes, S470 is performed. If no, S480 is performed.

[0158] In S470, the motor is controlled to run with the

second duty cycle.

[0159] The second duty cycle is larger than the first duty cycle. When the motor runs with the second duty cycle, the motor is controlled to continuously run with the second duty cycle until the shutdown signal is received. 5

[0160] In S480, the motor is controlled to continue running with the first duty cycle.

[0161] Specifically, when the motor is controlled to continue running with the first duty cycle, S430 is performed so that when the load value of the output shaft is greater than the preset load value, the motor is controlled to run with the second duty cycle. 10

[0162] In this example, when the working mode of the power tool is switched to the pulsed working mode, the motor is controlled to run with the first duty cycle, and the load value of the output shaft is acquired. When the load value of the output shaft is greater than the preset load value, the motor is controlled to run with the second duty cycle. The second duty cycle is larger than the first duty cycle. Thus, when the load value of the output shaft increases to the preset load value, the duty cycle with which the motor runs is increased, thereby improving the output capability of the power tool. In this manner, during each rotational output, the power tool drives the fastener to be screwed to the consistent depth. Thus, the user also can control, without the use experience, the depth to which the fastener is screwed, thereby making the fastener flush with the workpiece and improving the universality of the power tool. In addition, when the load value of the output shaft is less than or equal to the preset load value, the motor is controlled to continue running with the relatively small first duty cycle. When the load value of the output shaft reaches the preset load value, it is unnecessary to continue acquiring the load value of the output shaft, and the motor is just directly controlled to continuously run with the second duty cycle until the shutdown signal is received. Thus, the resources can be saved on the premise that the power tool satisfies the requirements of the working condition. 20 25 30

[0163] The basic principles, main features, and advantages of the present application are shown and described above. It is to be understood by those skilled in the art that the preceding examples do not limit the present application in any form, and all technical solutions obtained through equivalent substitutions or equivalent transformations fall within the scope of the present application. 35 40 45

Claims

1. A power tool (100) for drywall construction, comprising: 50

a housing (11);
a motor (12) at least partially disposed in the housing and comprising a drive shaft (121) rotating about a first axis (101);
a power supply (30) configured to power the 55

motor;

an output mechanism (14) used for outputting torque and comprising an output shaft (141) rotating about an output axis (102);

a power switch (16) configured to receive an operation instruction of a user and control a current between the motor and the power supply according to the operation instruction; and
a controller (17) configured to control the motor; wherein the controller is configured to acquire a first characteristic parameter when the motor receives an operation instruction to shut down, determine a compensation parameter of the motor according to the first characteristic parameter, control the motor to execute the compensation parameter, and limit a torque output of the motor or control the motor to shut down after the motor runs in place according to the compensation parameter.

2. The power tool according to claim 1, wherein the power switch comprises a first switch (162) and a control switch (161), the first switch is configured to respond to a movement state of the output shaft, the output shaft moves back and forth along a direction of the output axis, and the control switch is configured to respond to a manual operation of the user.
3. The power tool according to claim 2, wherein the controller is configured to send the operation instruction to shut down to the motor when at least one of the first switch and the control switch is in an inactive state.
4. The power tool according to claim 1, wherein the controller is configured to determine a load state of the motor according to the first characteristic parameter and determine the compensation parameter of the motor according to the load state of the motor.
5. The power tool according to claim 4, wherein the first characteristic parameter comprises at least one of a parameter related to a rotational speed of the motor or a parameter related to a current of the motor.
6. The power tool according to claim 4, wherein the first characteristic parameter comprises at least one of a rotational speed of the output shaft, a rotation angle of the output shaft, or a rotational acceleration of the output shaft. 50
7. The power tool according to claim 4, wherein the load state of the motor comprises at least a light load state and a heavy load state.
8. The power tool according to claim 7, wherein the controller is configured to, when the first characteristic parameter satisfies a first preset parameter

value, determine that the load state of the motor is the light load state.

9. The power tool according to claim 8, wherein when the first characteristic parameter does not satisfy the first preset parameter value, it is determined that the load state of the motor is the heavy load state, wherein a load value in the light load state is less than a load value in the heavy load state. 5
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10. The power tool according to claim 1, wherein the compensation parameter comprises at least one of a compensation rotation number, compensation rotation time, or a compensation rotation angle. 15
11. The power tool according to claim 1, further comprising a detection assembly (18) configured to detect the first characteristic parameter. 20
12. The power tool according to claim 1, wherein the compensation parameter is determined through a difference between a preset running parameter and a real-time running parameter. 25
13. The power tool according to claim 12, wherein the preset running parameter is determined according to the first characteristic parameter through a query on a first calibration table, and the real-time running parameter is determined according to the first characteristic parameter through fitting. 30
14. The power tool according to claim 12, wherein the real-time running parameter is determined according to the first characteristic parameter through a query on a second calibration table. 35
15. A control method of the power tool (100) of the claim 1, comprising:
 - acquiring a first characteristic parameter when a motor receives an operation instruction to shut down; 40
 - determining a compensation parameter of the motor according to the first characteristic parameter; 45
 - controlling the motor to execute the compensation parameter; and
 - limiting a torque output of the motor or controlling the motor to shut down after the motor runs in place according to the compensation parameter. 50

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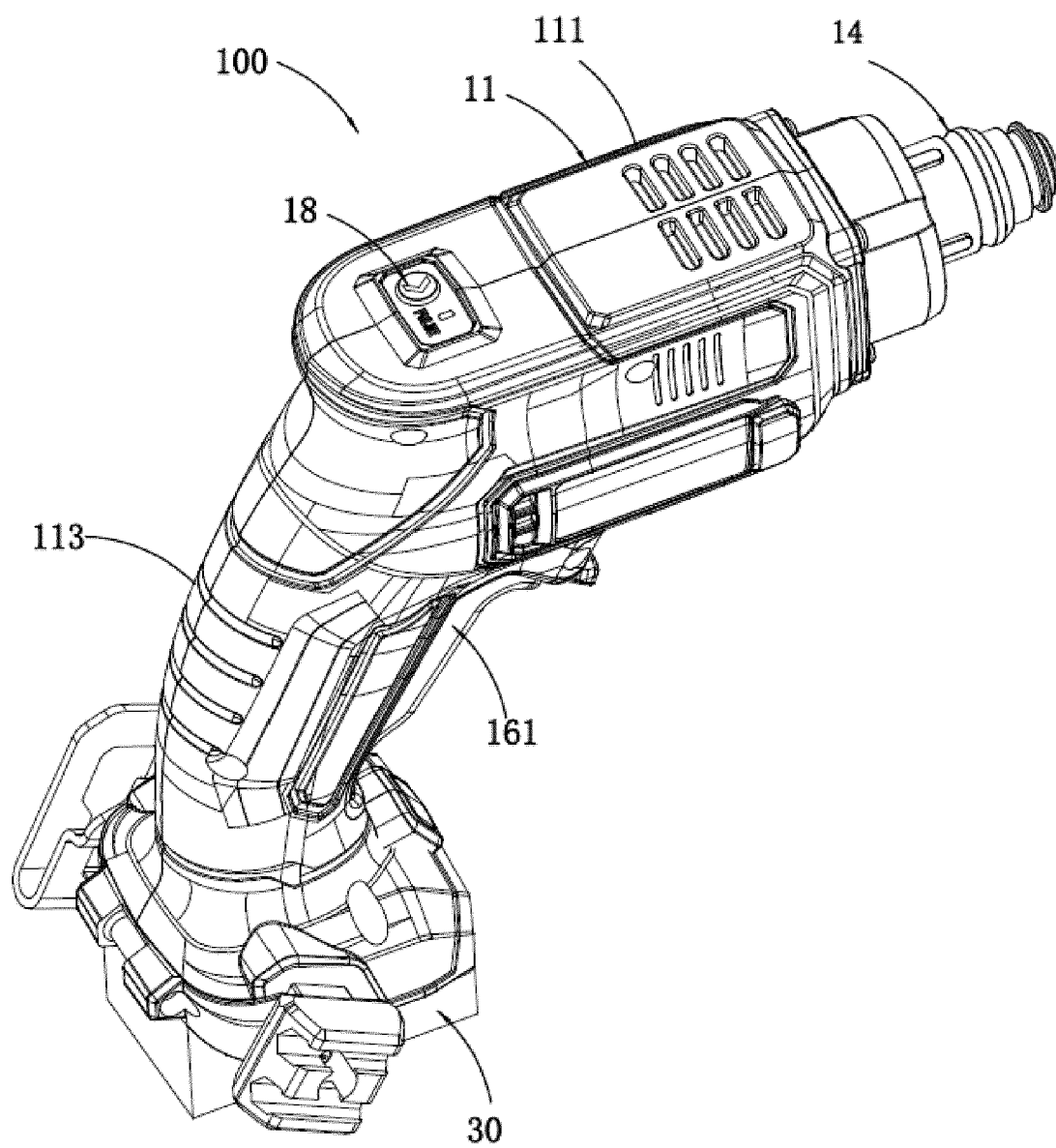


FIG. 1

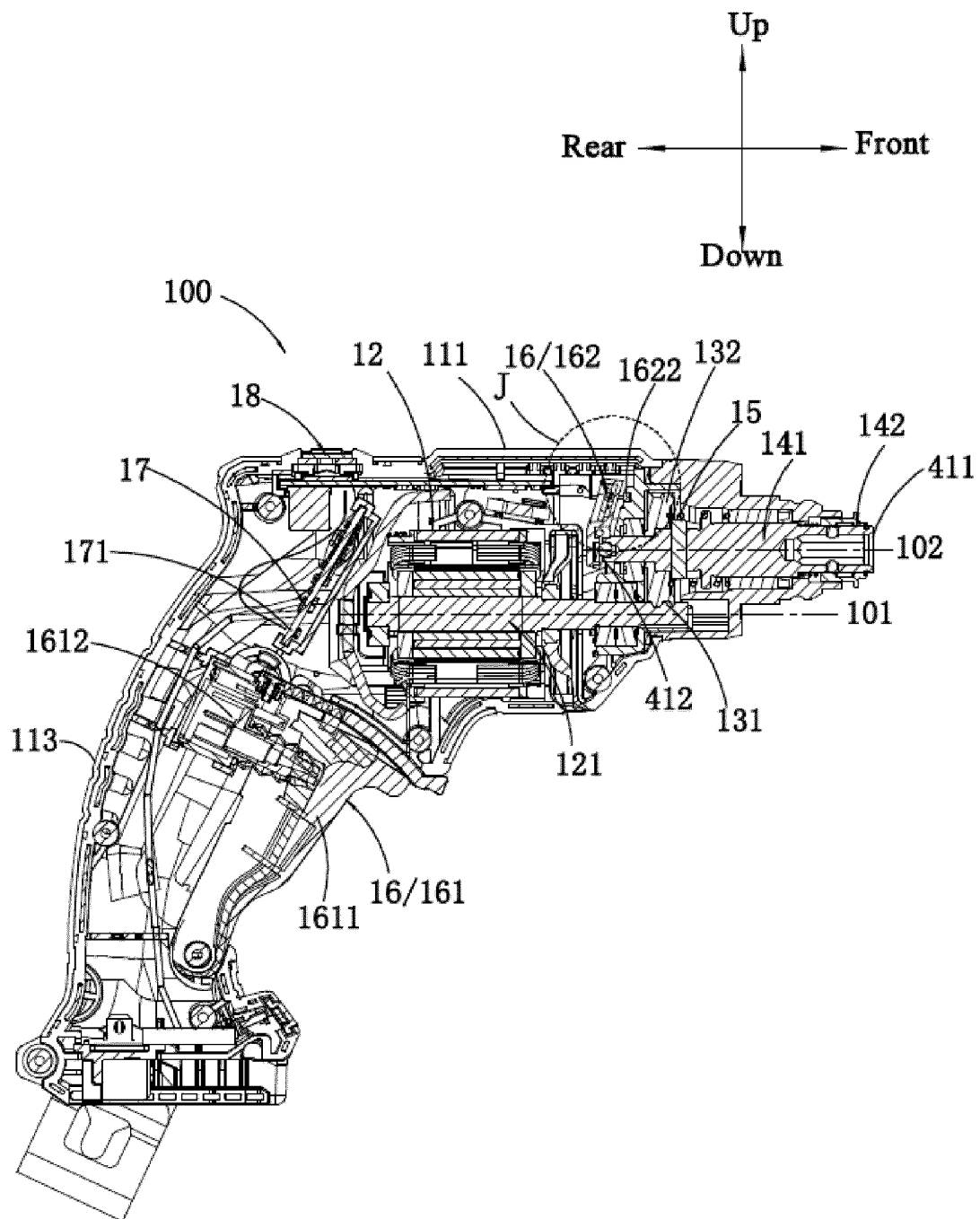


FIG. 2

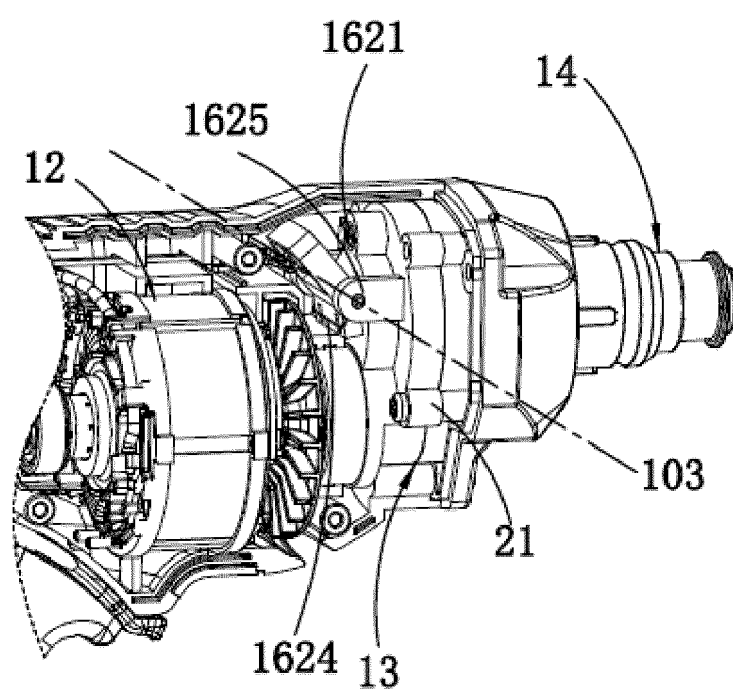


FIG. 3

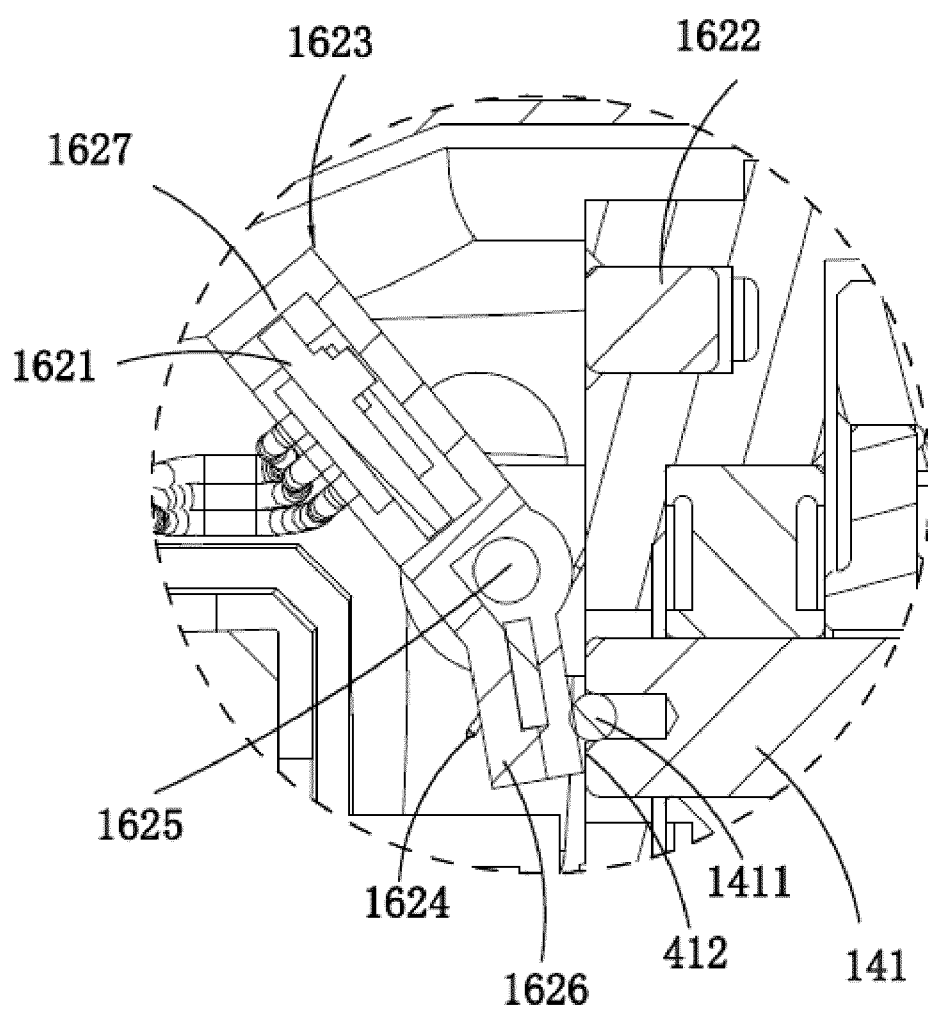


FIG. 4

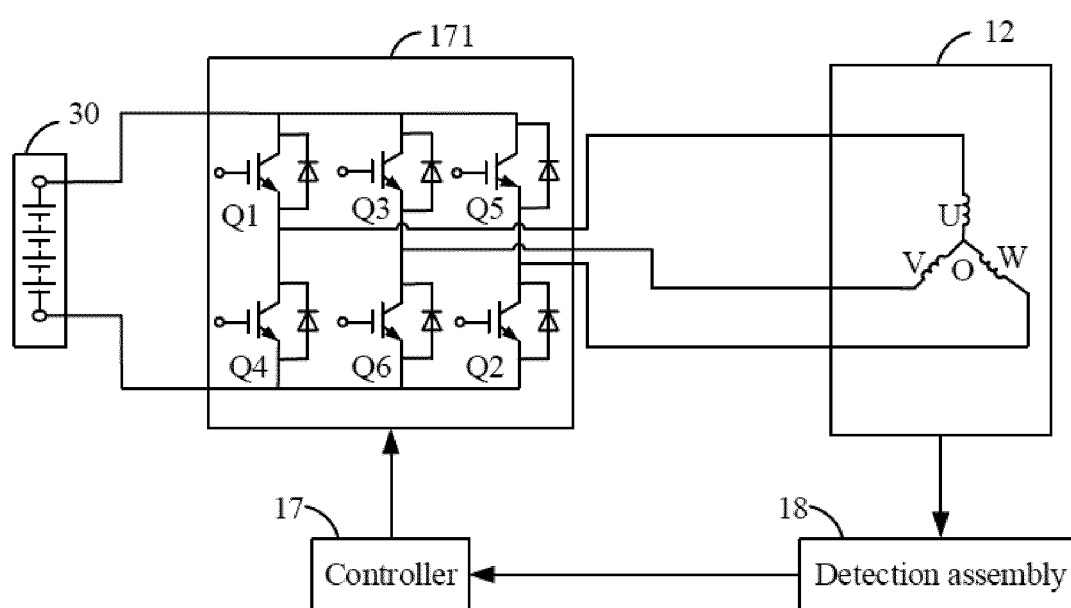


FIG. 5

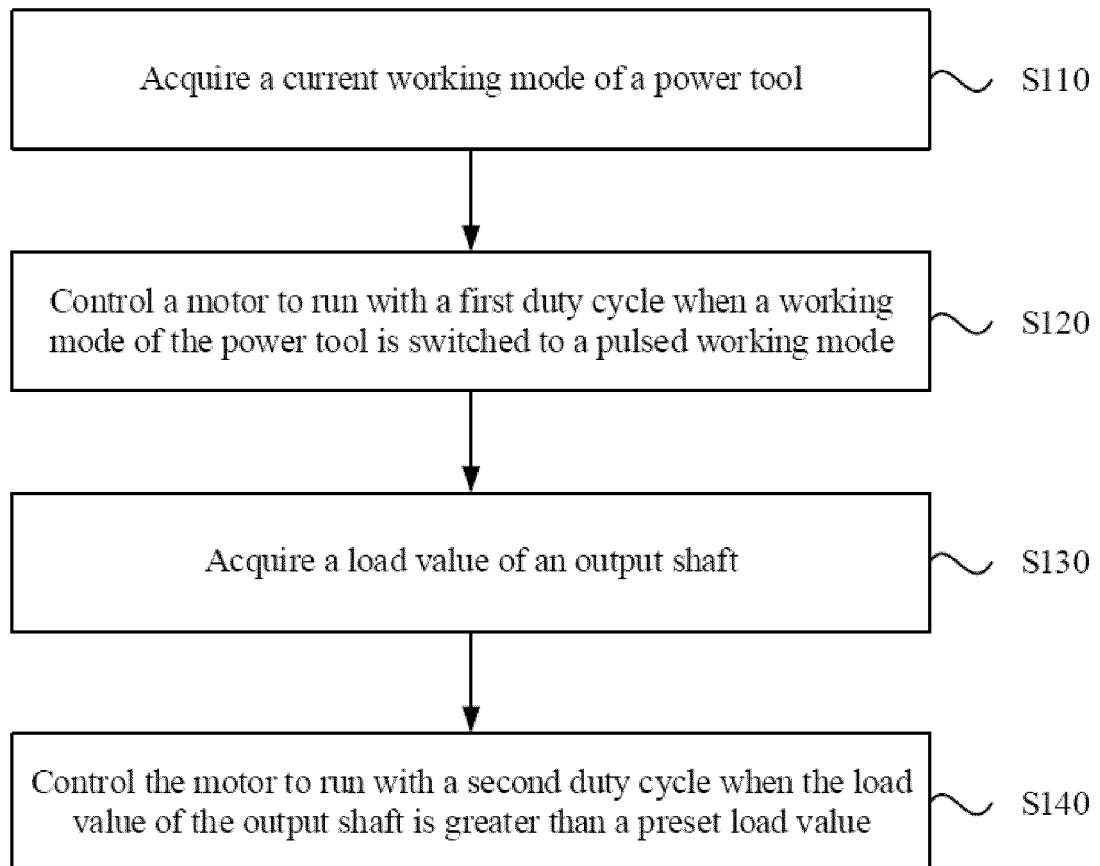


FIG. 6

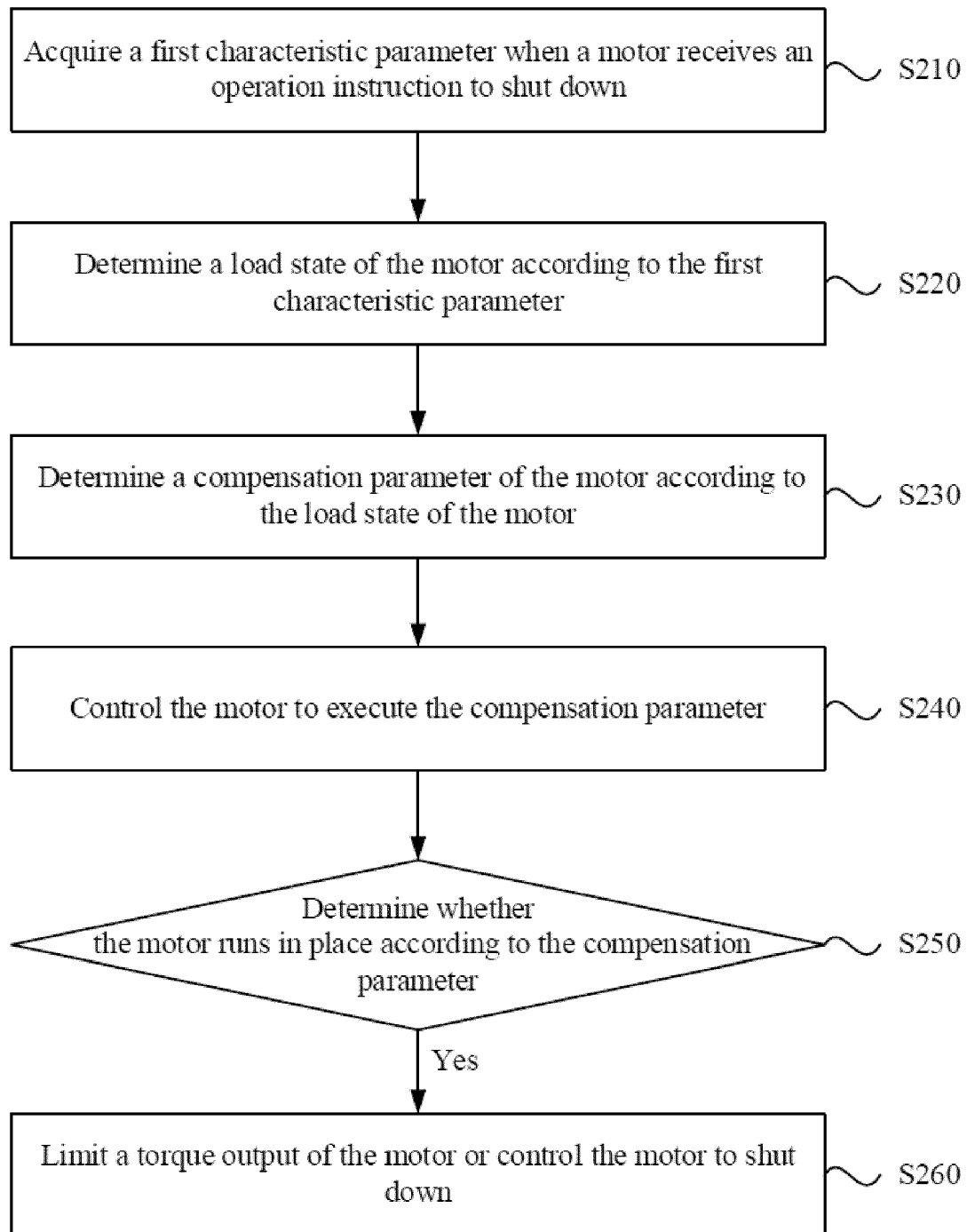


FIG. 7

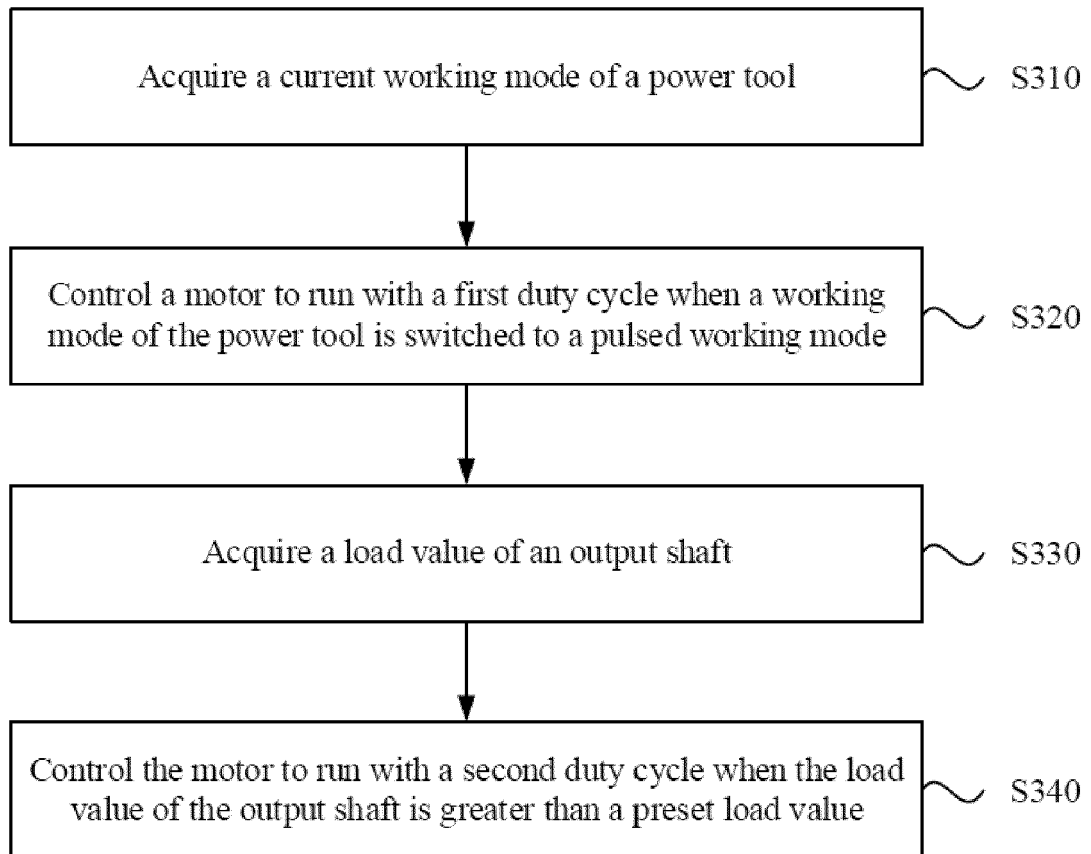


FIG. 8

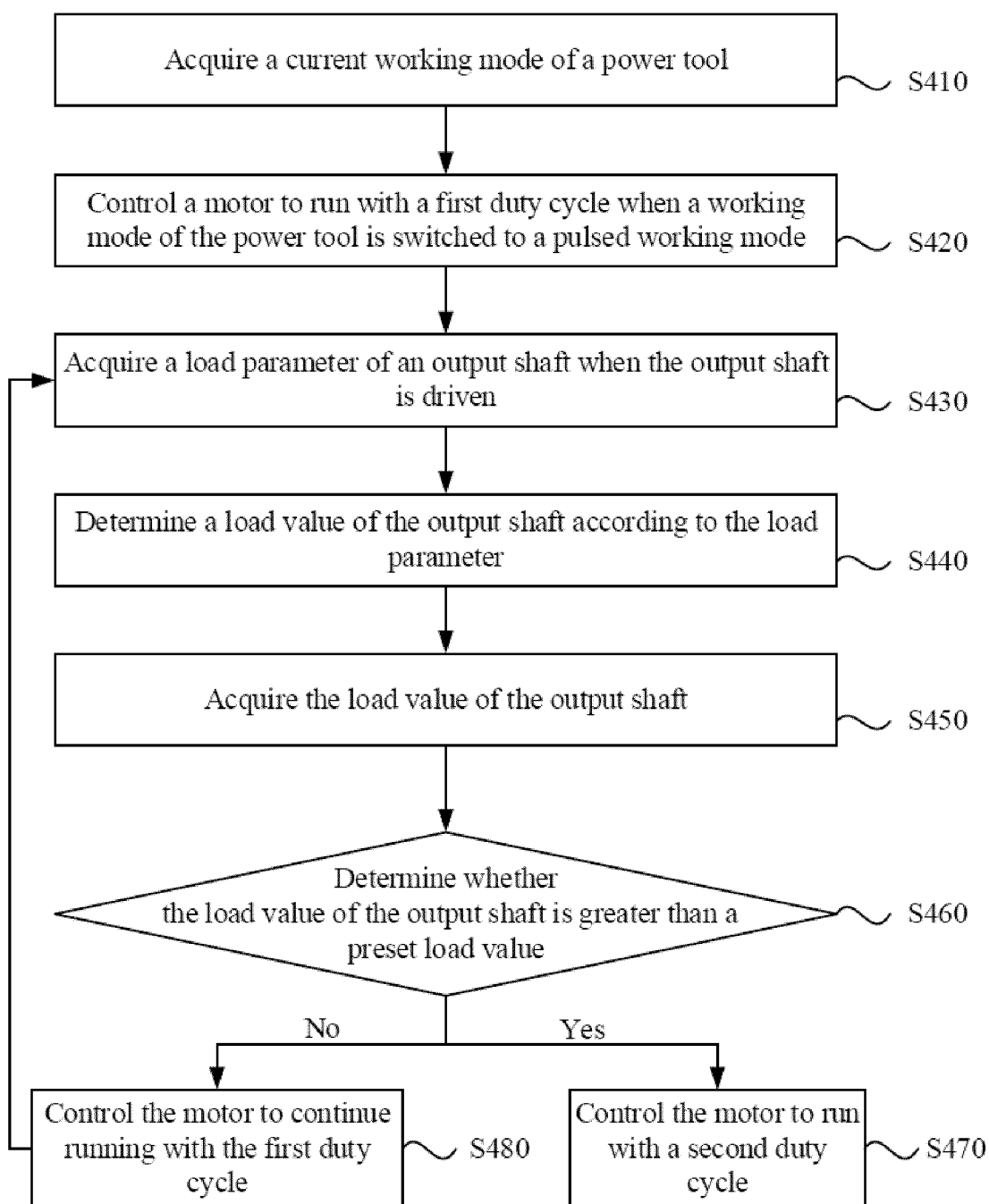


FIG. 9



EUROPEAN SEARCH REPORT

Application Number

EP 24 18 8497

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 969 105 A (GAENSSLE HEINZ [US]) 6 November 1990 (1990-11-06)	1,4-7, 10-15	INV. B25B21/00
A	* column 3, line 4 - column 7, line 2; figures 1,5-7 *	2,3,8,9	B25B23/147 B25F5/00
A	US 2008/289839 A1 (HRICKO PETER [CH] ET AL) 27 November 2008 (2008-11-27) * paragraphs [0022] - [0042]; figures 1-3 *	1-15	
A	US 9 707 671 B2 (SHI PINGBO [CN]) 18 July 2017 (2017-07-18) * column 1, line 16 - column 1, line 46 * * column 5, line 32 - column 7, line 30; figures 1-5 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			B25B B25H B25F
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		27 January 2025	Pastramas, Nikolaos
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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27 - 01 - 2025

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