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Ikuta et al.

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(54) **SCREW-TIGHTENING TOOL**

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(73) Assignee: **MAKITA CORPORATION**, Anjo (JP)

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(22) Filed: **Sep. 20, 2022**

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Oct. 14, 2021 (JP) 2021-168596

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B25F 5/00 (2006.01)

(52) **U.S. Cl.**
CPC ***B25B 21/00*** (2013.01); ***B25F 5/001*** (2013.01)

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See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Oliff PLC

(57) **ABSTRACT**

A screw-tightening tool includes a housing, a motor, a spindle, a first clutch and a second clutch. The first clutch is operably coupled to an output shaft and the spindle, and is configured to transmit power from the output shaft to the spindle only when the output shaft is rotationally driven in a first direction. The second clutch is operably coupled to the output shaft and the spindle, and is configured to transmit the power from the output shaft to the spindle only when the output shaft is rotationally driven in a second direction. An output rotation speed of the spindle when the power is transmitted via the first clutch is different from an output rotation speed of the spindle when the power is transmitted via the second clutch, in response to the same rotation speed of the output shaft of the motor.

19 Claims, 17 Drawing Sheets

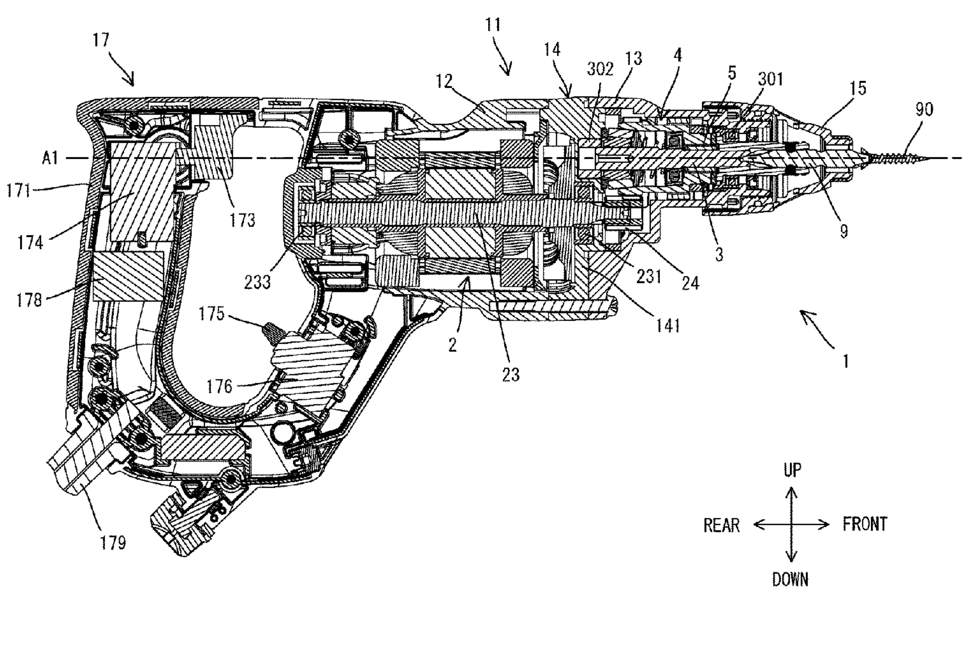
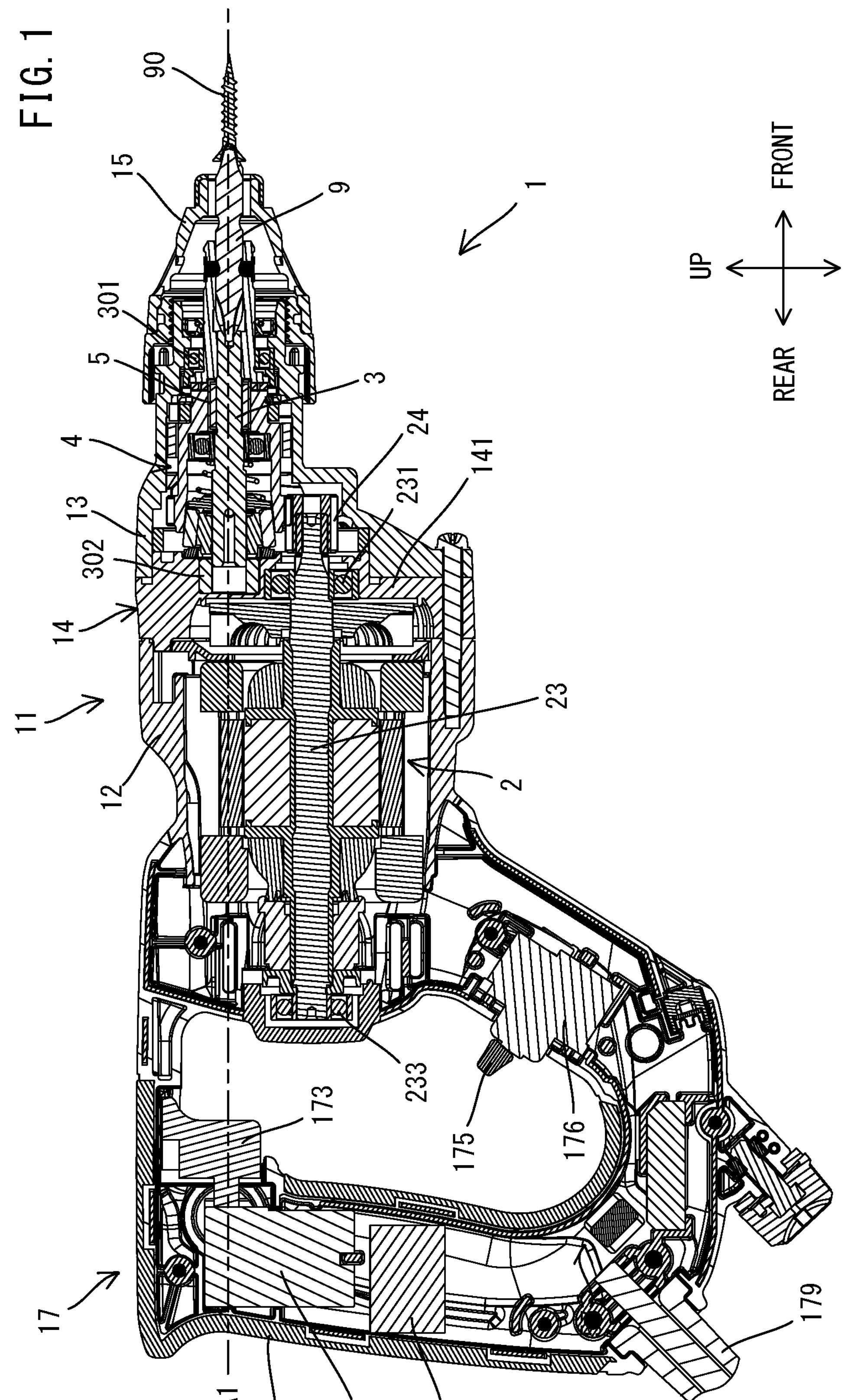


FIG. 1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179
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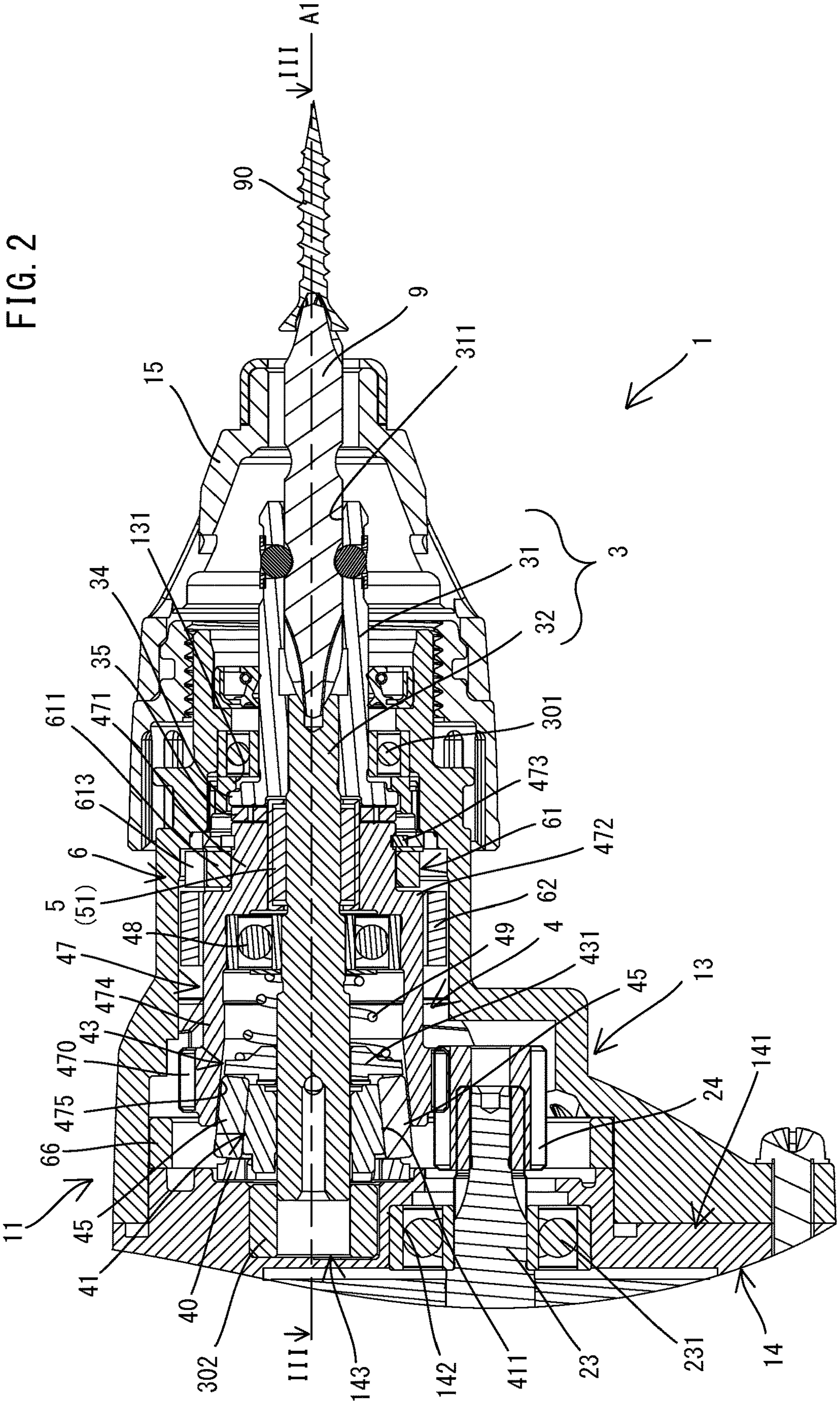
FRONT
UP
DOWN
REAR

FIG. 2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231
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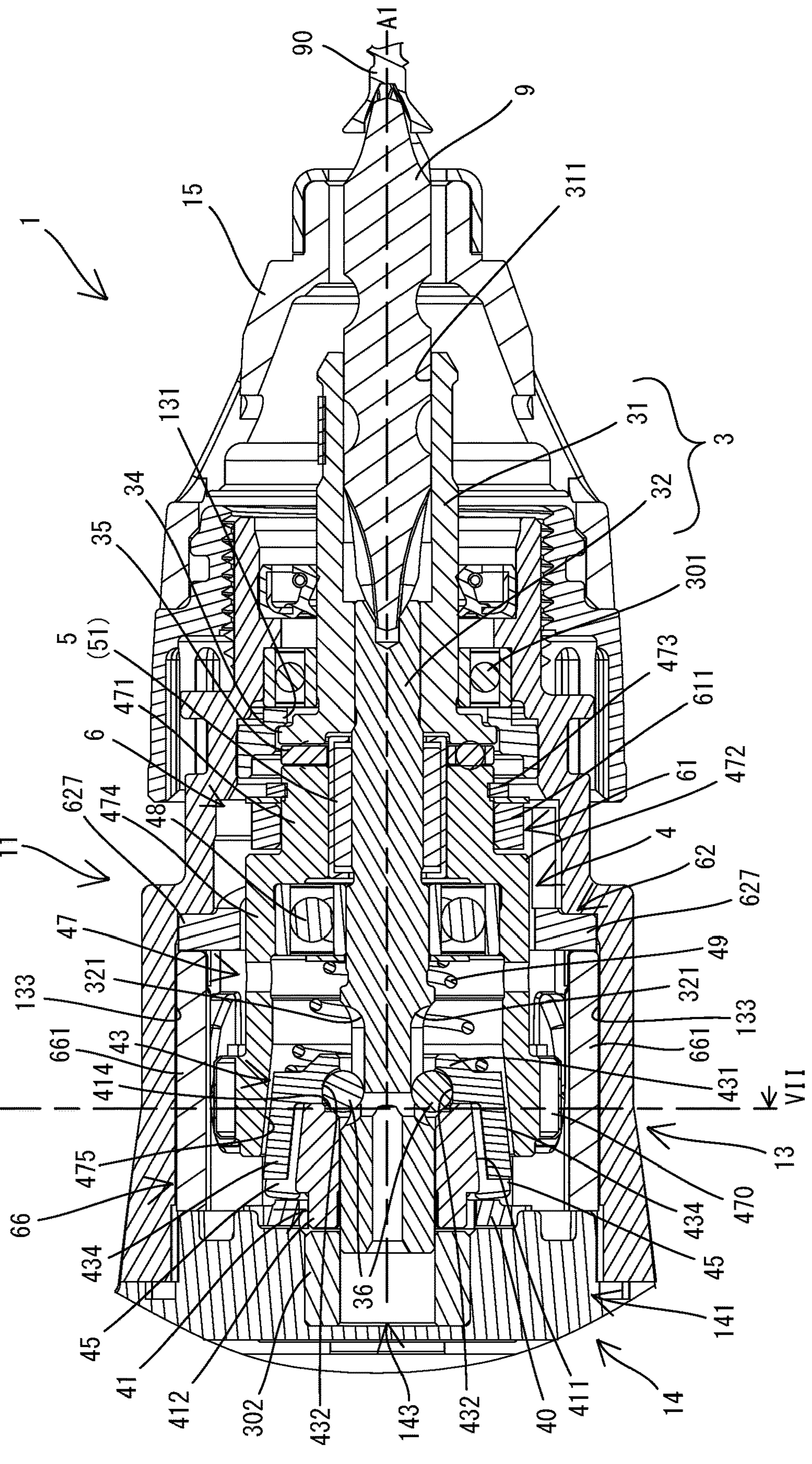
FIG. 3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48
4
11
62
627
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133
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VII
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FIG. 4

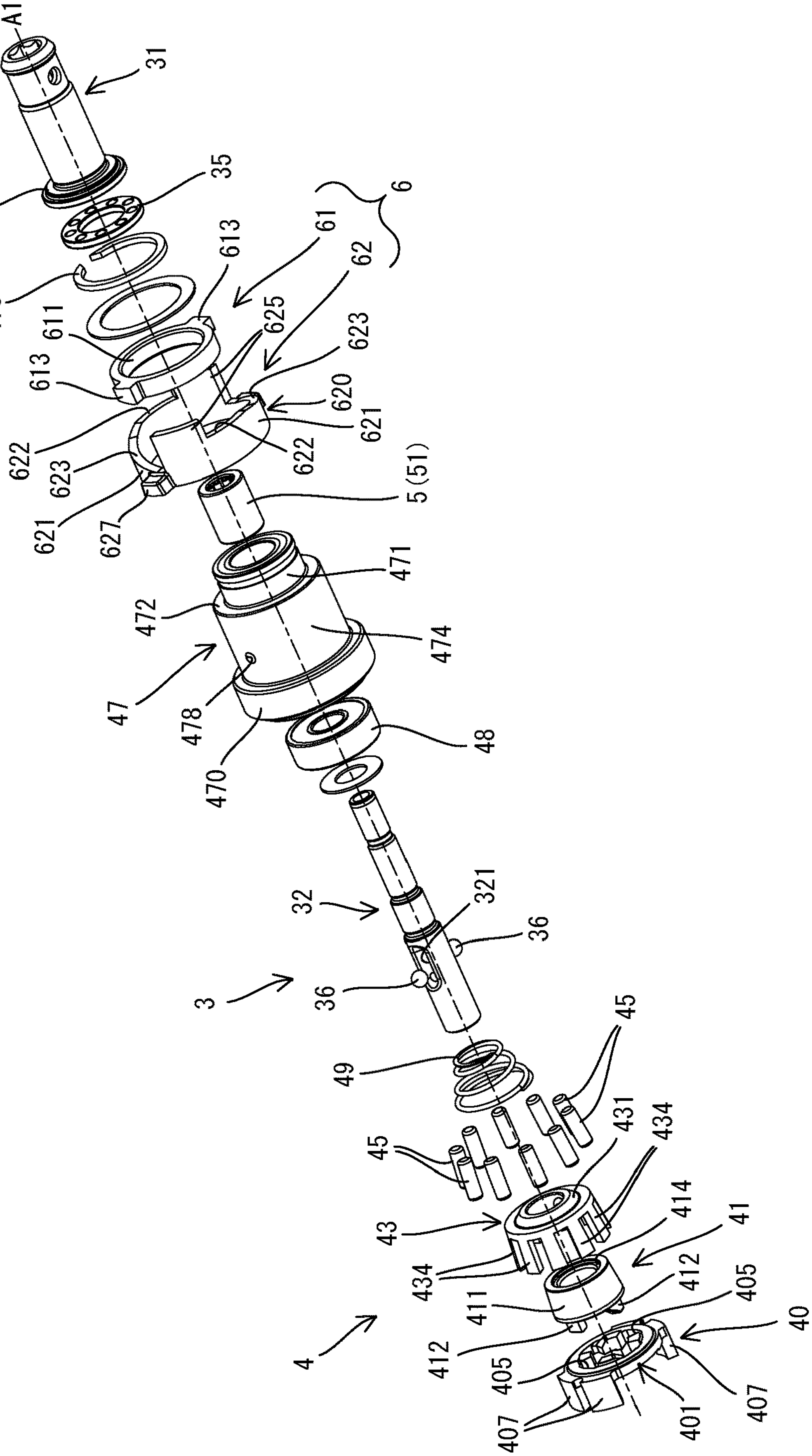
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FIG. 5

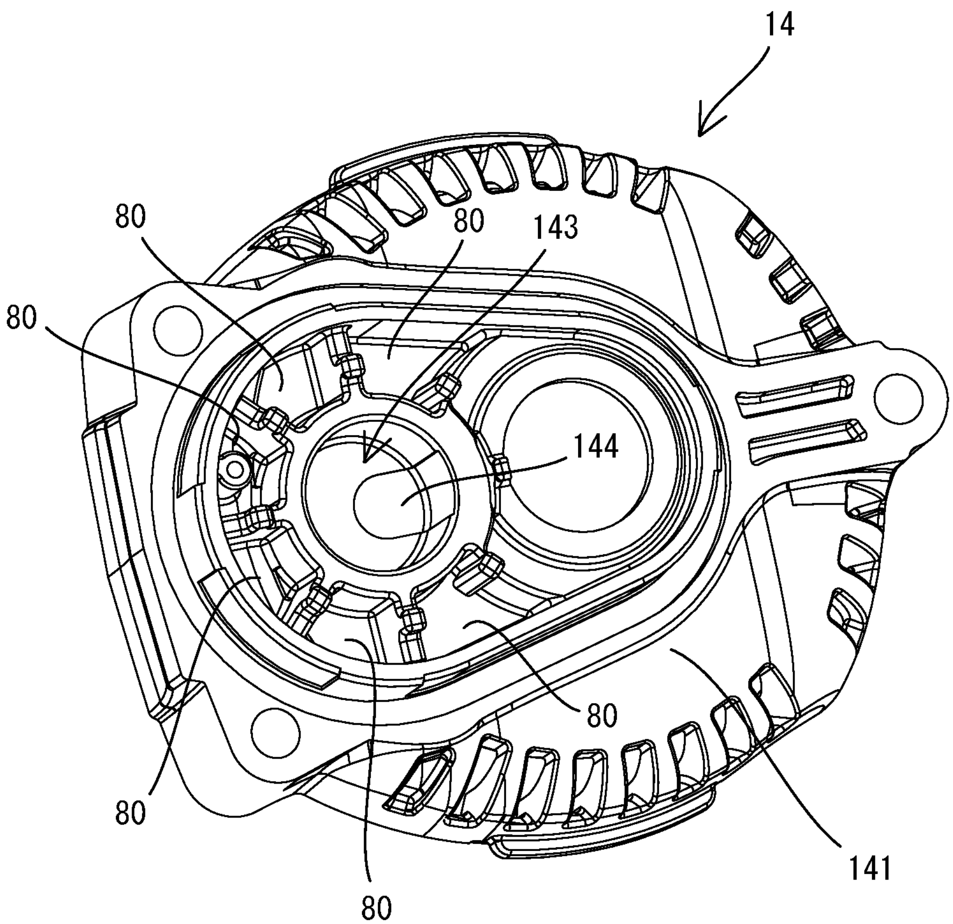

FIG. 6

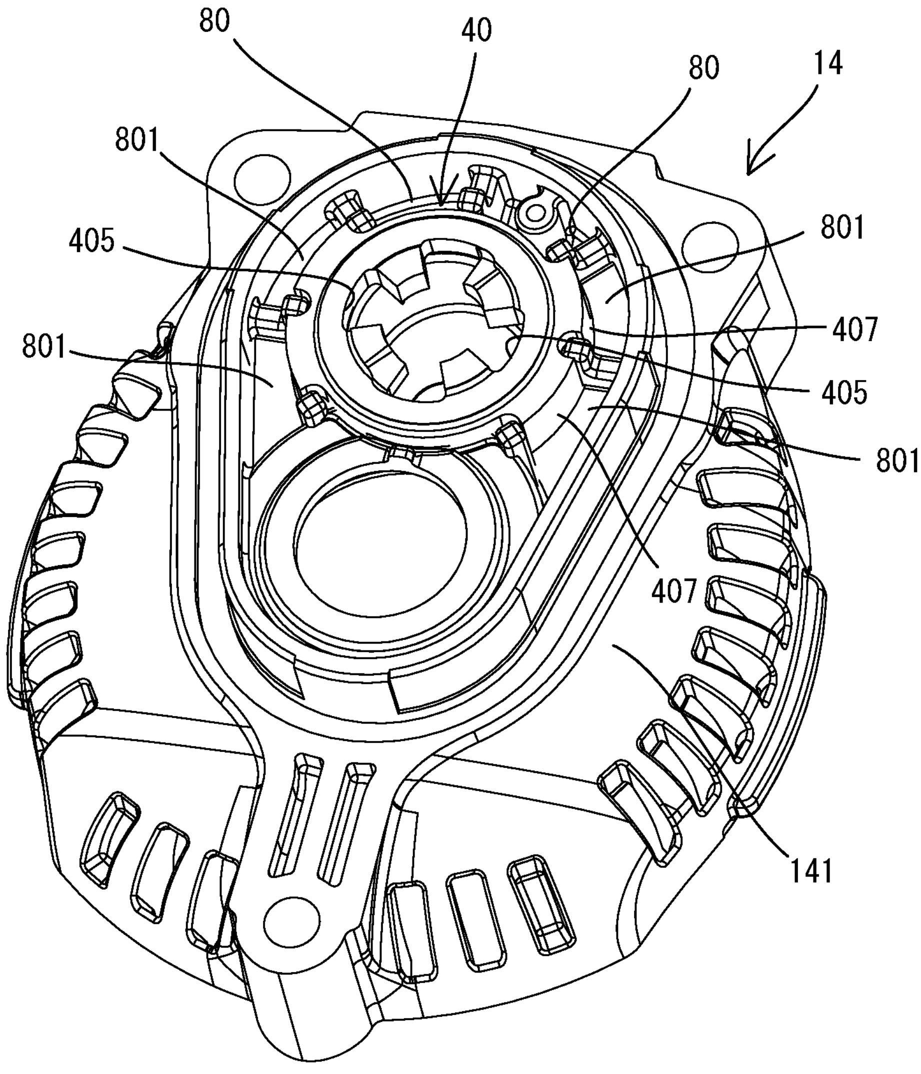

FIG. 7

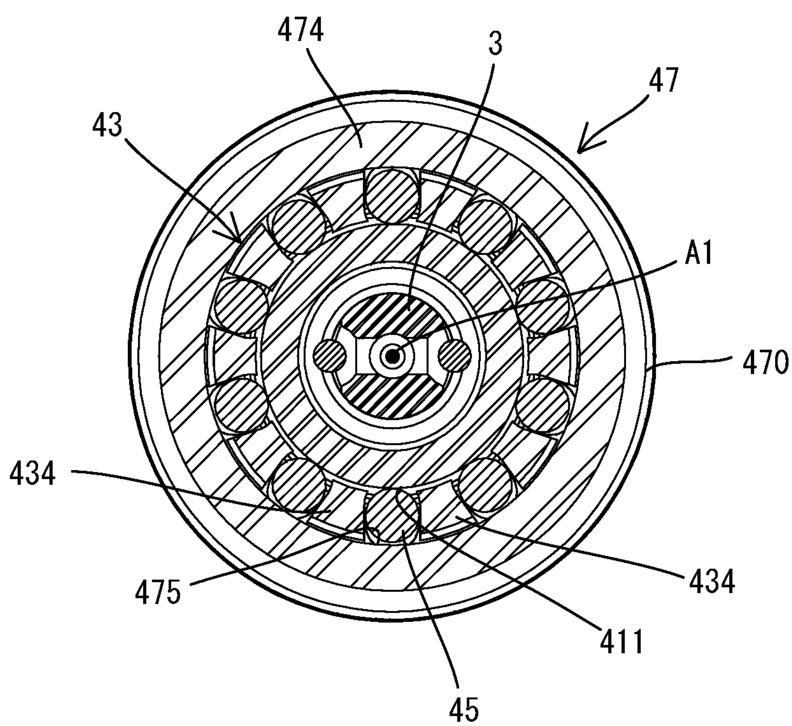

FIG. 8

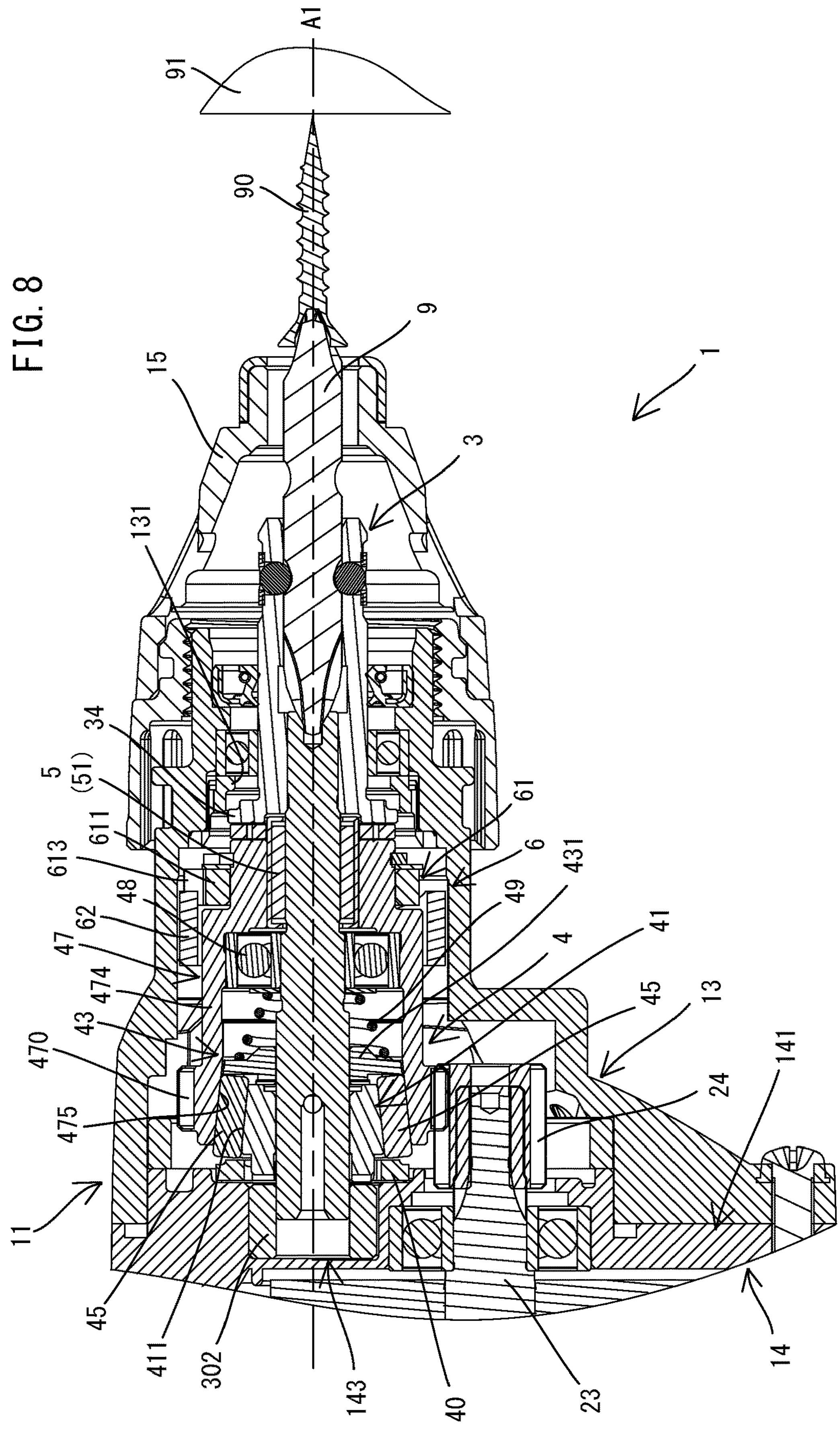
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FIG. 9

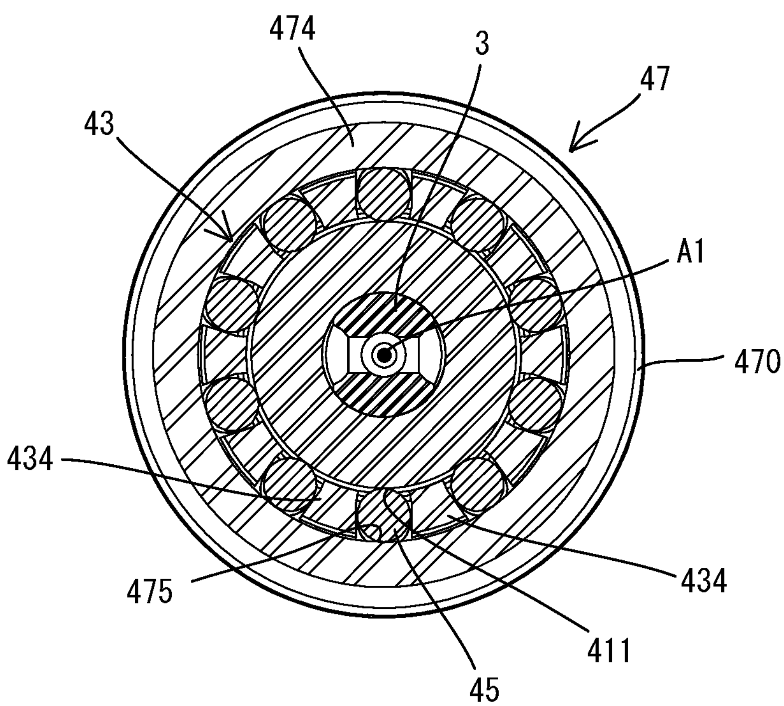

FIG. 10

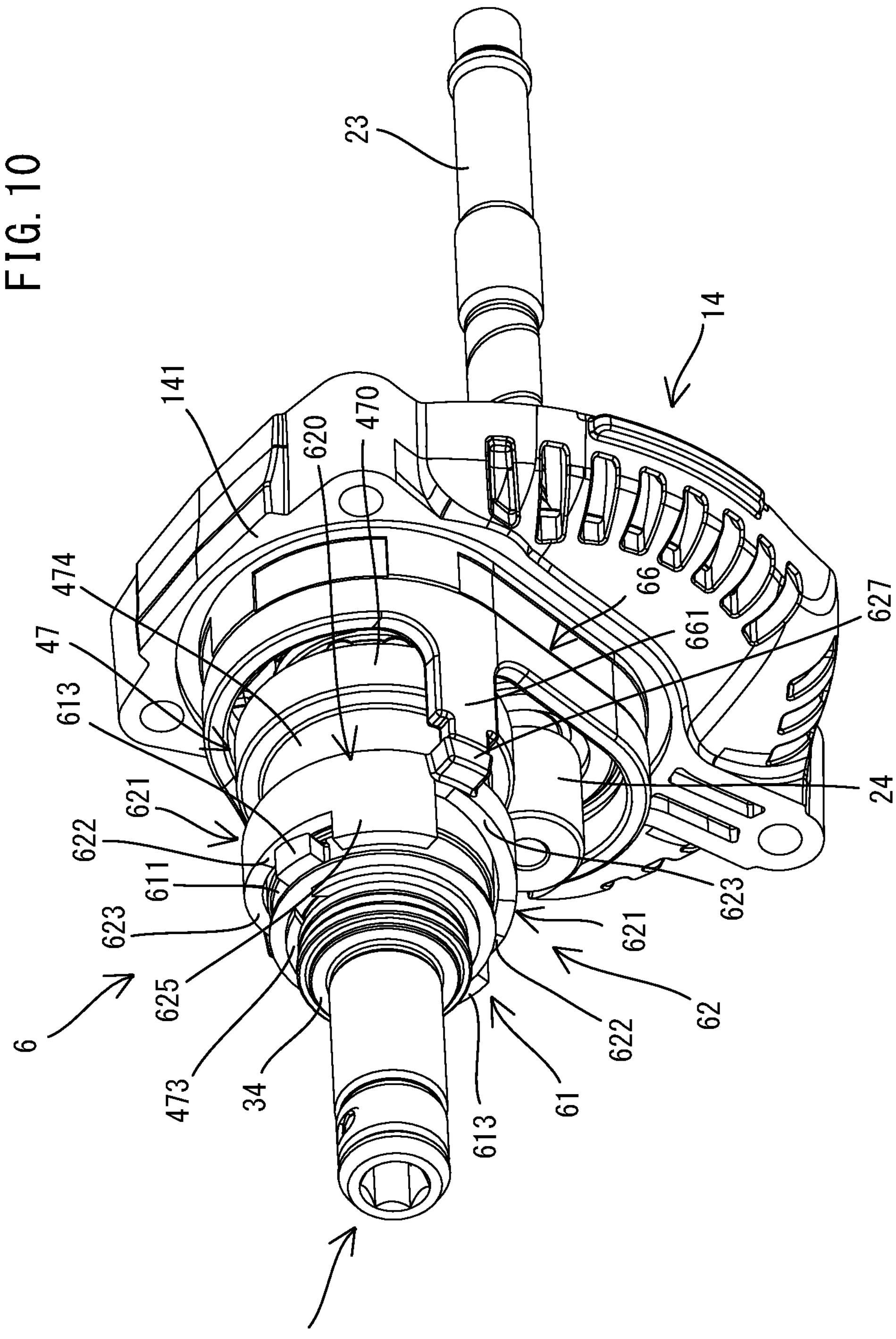
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FIG. 11

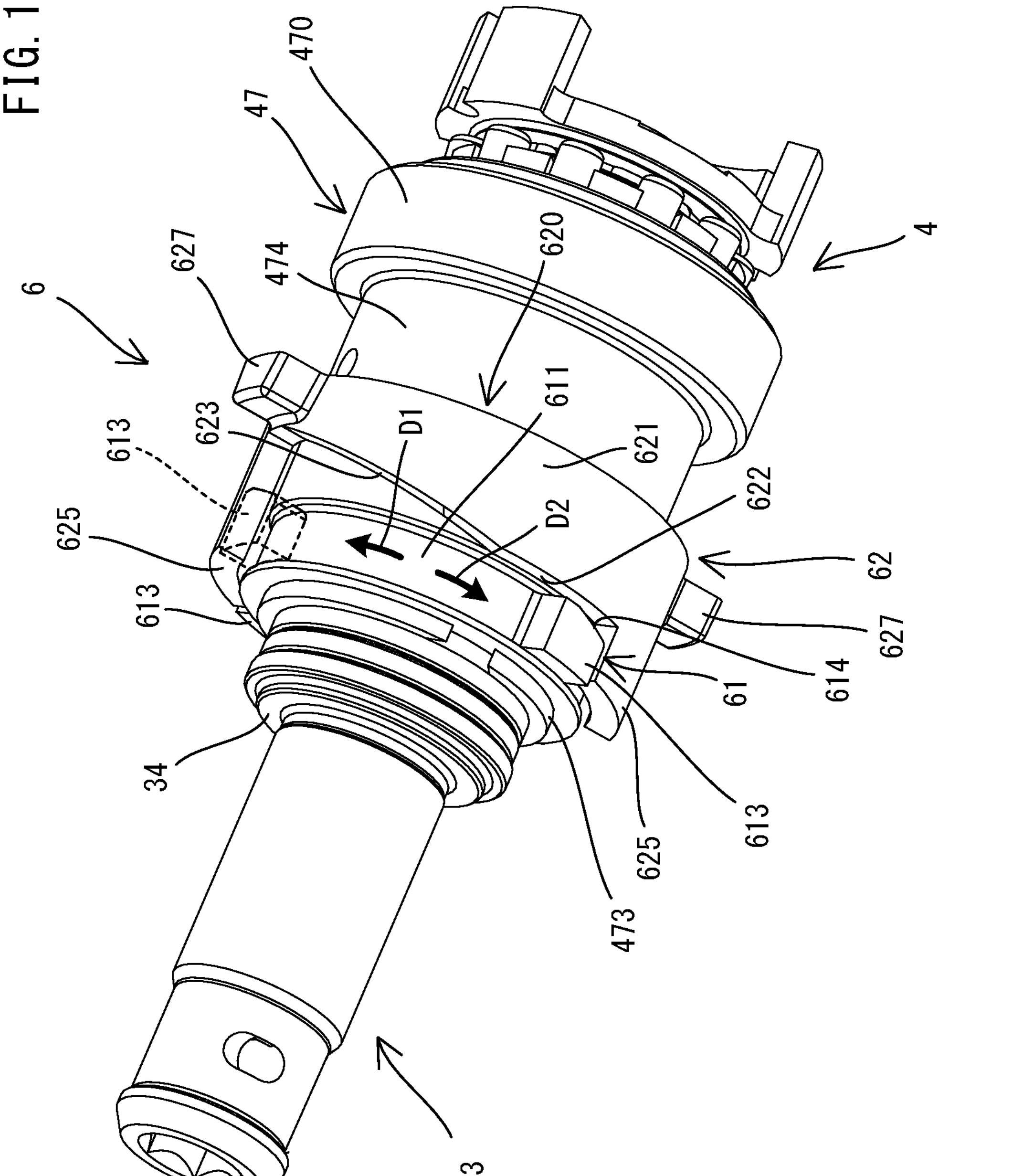
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FIG. 12

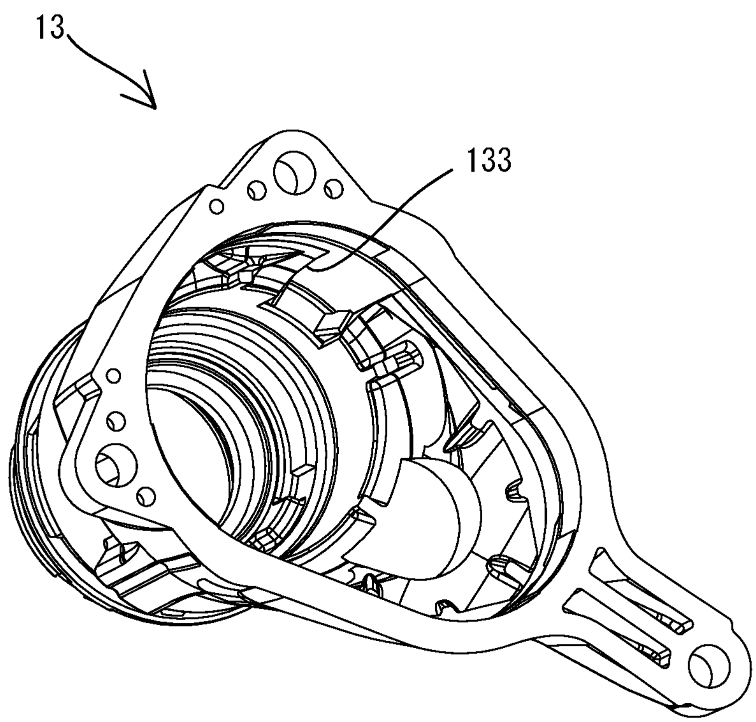

FIG. 13

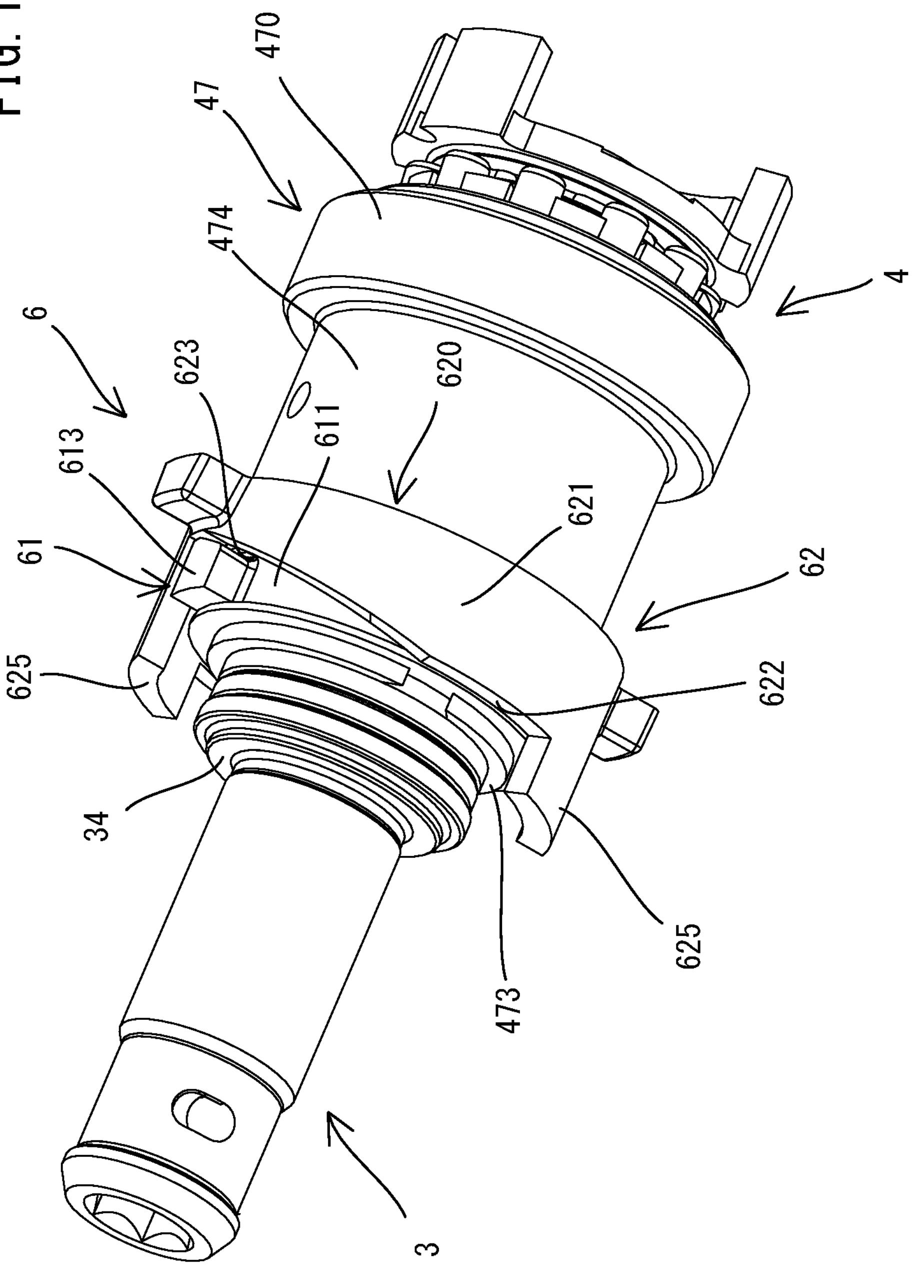

FIG. 14

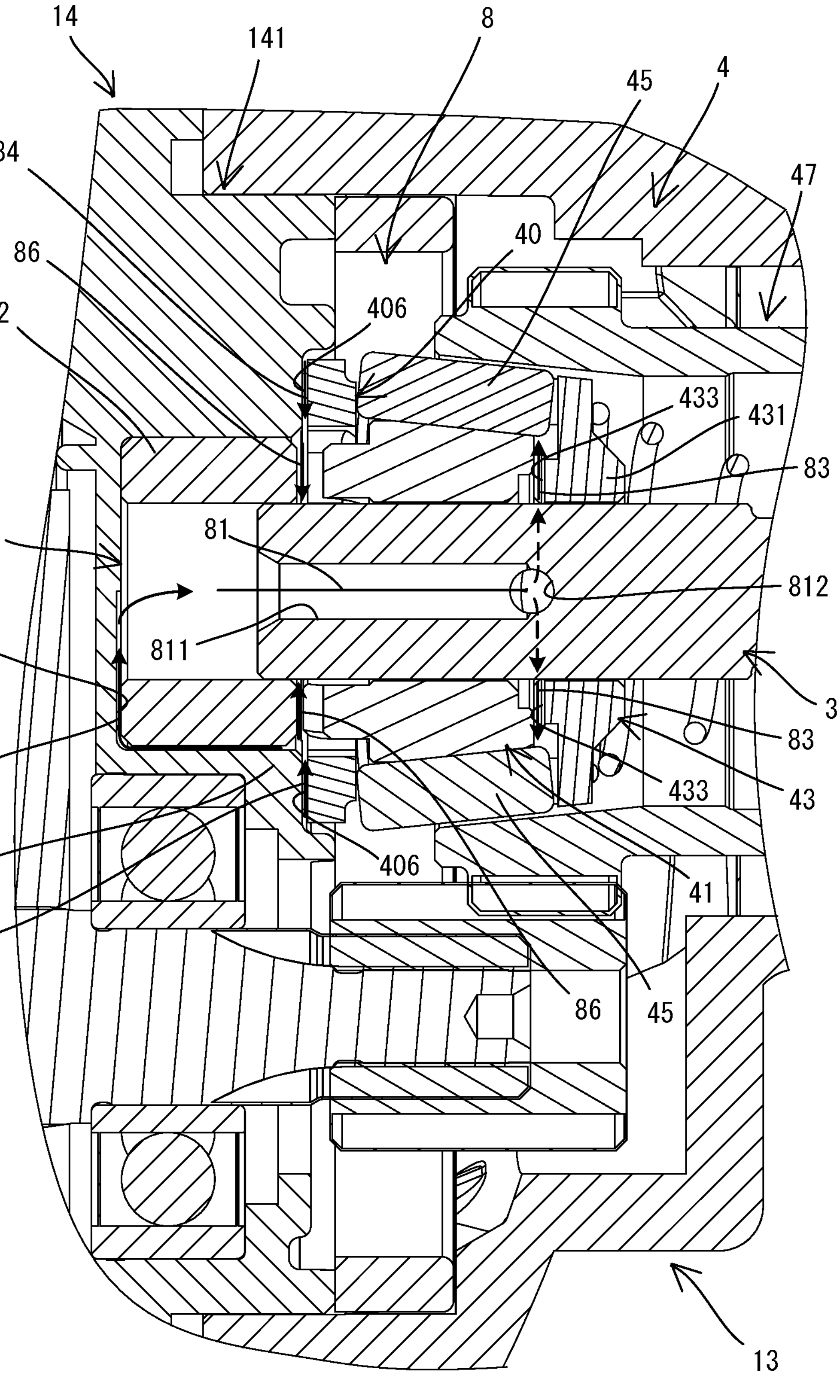
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FIG. 15

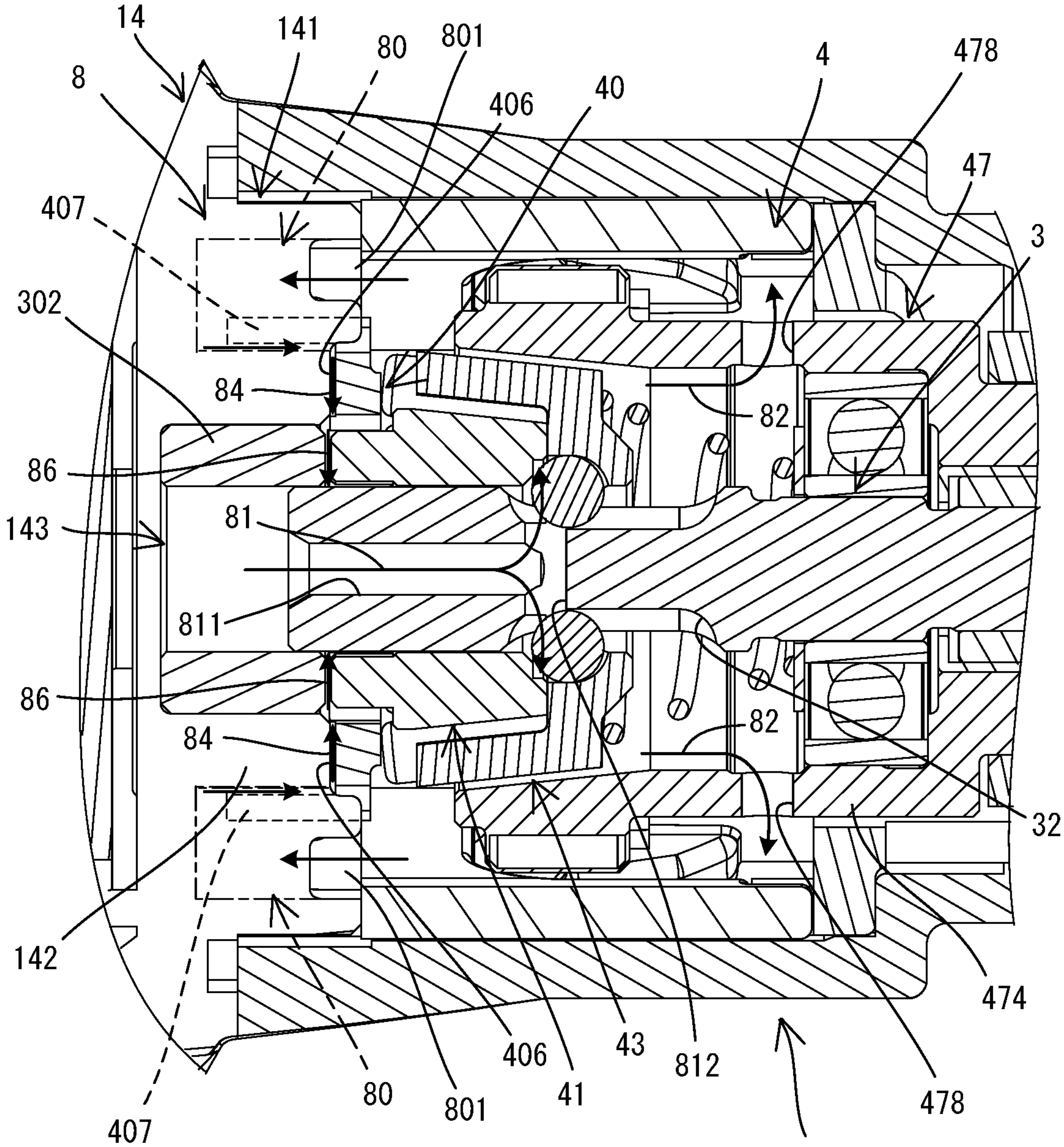

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FIG. 16

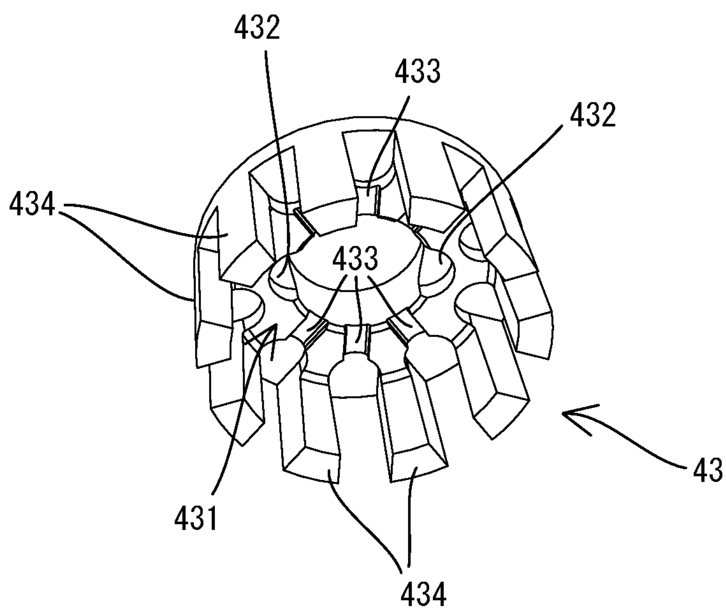
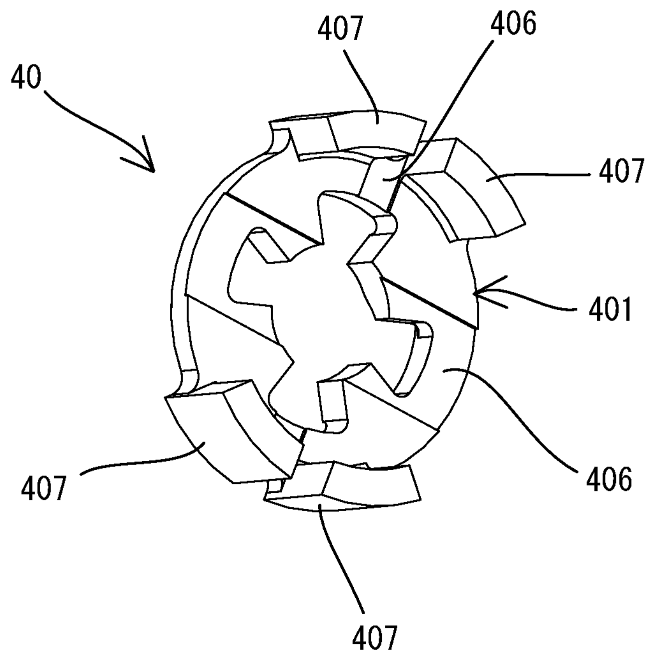


FIG. 17



SCREW-TIGHTENING TOOL

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority to Japanese patent application No. 2021-168596 filed on Oct. 14, 2021, the contents of which are hereby fully incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to a screw-tightening tool.

BACKGROUND

A screw-tightening tool is configured to rotationally drive a spindle in a normal direction in a screw-tightening operation and to rotationally drive the spindle in a reverse direction, which is opposite to the normal direction, in a screw-loosening operation. For example, Japanese Unexamined Patent Application Publication No. 2019-141945 discloses a screw-tightening tool configured to start rotation of a spindle in response to pushing of the spindle. In a screw-loosening operation, a smaller pushing force needs to be applied to a screw than that required in a screw-tightening operation. Thus, this screw-tightening tool is configured to start rotation of the spindle in the screw-loosening operation when the spindle is pushed by a smaller amount than that in the screw-tightening operation.

SUMMARY

The above-described screw-tightening tool can decrease the amount by which the spindle needs to be pushed in the screw-loosening operation. However, there is still room for improvement in such a screw-tightening tool.

Accordingly, it is one non-limiting object of the present disclosure to provide a screw-tightening tool that can achieve improved operating efficiency.

A non-limiting aspect of the present disclosure provides a screw-tightening tool including a housing, a motor, a spindle, a first clutch and a second clutch.

The motor is within the housing. The motor has an output shaft that is configured to be rotationally driven selectively in a first direction and a second direction that is opposite to the first direction. The first direction corresponds to a direction for tightening a screw. The second direction corresponds to a direction for loosening the screw. The spindle is supported by the housing to be movable along a driving axis and to be rotatable around the driving axis. The driving axis defines a front-rear direction of the screw-tightening tool. The spindle has a front end portion that is configured to removably receive a tool accessory.

The first clutch is operably coupled to the output shaft and the spindle. The first clutch is configured to transmit power from the output shaft to the spindle only when the output shaft is rotationally driven in the first direction. The second clutch is operably coupled to the output shaft and the spindle. The second clutch is configured to transmit power from the output shaft to the spindle only when the output shaft is rotationally driven in the second direction. Further, an output rotation speed of the spindle when the power is transmitted via the first clutch is different from an output rotation speed of the spindle when the power is transmitted via the second clutch, in response to a same rotation speed of the output shaft of the motor.

In the screw-tightening tool of the present aspect, the power is transmitted from the motor to the spindle via the first clutch in the screw-tightening operation, while the power is transmitted from the motor to the spindle via the second clutch in the screw-loosening operation. Thus, the power is transmitted via different paths between the screw-tightening operation and the screw-loosening operation. Further, the output rotation speed of the spindle when the power is transmitted via the first clutch is different from the output rotation speed of the spindle when the power is transmitted via the second clutch, in response to the same (identical) rotation speed of the output shaft of the motor. Thus, even if the output shaft of the motor is rotationally driven at the same speed in the screw-tightening operation and in the screw-loosening operation, the spindle (and the screw) can be rotated at different rotation speeds that are suitable to the screw-tightening operation and the screw-loosening operation, respectively. Consequently, operating efficiency of each operation can be optimized.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view of a screwdriver according to one embodiment of the present disclosure, wherein a spindle is at an initial position.

FIG. **2** is a partial, enlarged view of FIG. **1**.

FIG. **3** is a sectional view taken along line III-III in FIG. **2**.

FIG. **4** is an exploded perspective view showing the spindle, a first clutch and a second clutch.

FIG. **5** is a perspective view of a central housing as viewed from front.

FIG. **6** is a perspective view of the central housing with a base and a felt fitted therein as viewed from front.

FIG. **7** is a sectional view taken along line VII-VII in FIG. **3**, for illustrating an interruption state of the first clutch (wherein a front housing and a retainer are not shown).

FIG. **8** is a partial, sectional view that corresponds to FIG. **7**, wherein the spindle is at an activation position.

FIG. **9** is a sectional view that corresponds to FIG. **3**, for illustrating a transmission state of the first clutch.

FIG. **10** is a perspective view of a structure in the front housing.

FIG. **11** is a perspective view showing the spindle, the first clutch and a restricting mechanism, wherein the spindle is at the initial position.

FIG. **12** is a perspective view of the front housing as viewed from behind.

FIG. **13** is a perspective view showing the spindle, the first clutch and the restricting mechanism, wherein the spindle is at the activation position.

FIG. **14** is a partial, enlarged view of FIG. **2**, for illustrating a circulation passage of a lubricant.

FIG. **15** is a partial, enlarged view of FIG. **3**, for illustrating the circulation passage of the lubricant.

FIG. **16** is a perspective view of the retainer as viewed from behind.

FIG. **17** is a perspective view of the base as viewed from behind.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In the non-limiting embodiment of the present disclosure, the first clutch may be configured to selectively transmit the power, depending on a position of the spindle in the front-rear direction. The second clutch may be configured to transmit the power regardless of the position of the spindle in the front-rear direction. According to this embodiment, in the screw-tightening operation, the spindle can be selectively rotated, depending on the position of the spindle in the front-rear direction, i.e., depending on whether the screw is being pressed against a workpiece. On the other hand, in the screw-loosening operation, the spindle can be rotated even if the screw is not pressed against the workpiece, so that the screw-loosening operation can be started immediately.

In addition or in the alternative to the preceding embodiments, the screw-tightening tool may further include a restricting mechanism that is configured to restrict the spindle from moving in the front-rear direction only when the output shaft is rotationally driven in the second direction. According to this embodiment, the restricting mechanism can reliably prevent the first clutch from operating when the output shaft is rotationally driven in the second direction.

In addition or in the alternative to the preceding embodiments, the restricting mechanism may include a first restricting part and a second restricting part. The first restricting part may be rotatable between a first position and a second position in a circumferential direction around the driving axis. The first restricting part may be configured to be placed at the first position in response to rotation of the output shaft in the first direction, and to be placed at the second position in response to rotation of the output shaft in the second direction. The second restricting part may be configured to allow the spindle to move in the front-rear direction when the first restricting part is at the first position and to restrict the spindle from moving in the front-rear direction when the first restricting part is at the second position. According to this embodiment, the restricting mechanism having a simple structure can appropriately allow the spindle to move in the front-rear direction and can appropriately restrict the spindle from moving in the front-rear direction, depending on the rotational direction of the output shaft of the motor.

In addition or in the alternative to the preceding embodiments, the screw-tightening tool may further include a rotational member. The rotational member may be disposed between the output shaft and the spindle in a power transmission path and may be configured to be rotated by the output shaft. The first restricting part may be disposed around the rotational member to be selectively rotatable relative to the rotational member. The first restricting part may be configured to co-rotate with the rotational member only between the first position and the second position. The term "co-rotation" herein means that a second member that is in contact with a first member rotates together with the first member in response to rotation of the first member, due to a frictional force between contact surfaces of the first and second members. The second restricting part may be substantially immovable relative to the housing. The second restricting part may be formed as a member that is originally separate (discrete) from the housing and directly or indirectly fixed to the housing. Alternatively, the second restricting part may be a portion of the housing. According to this embodiment, the first restricting part that is rotatable between the first position and the second position in the circumferential direction can be easily embodied, utilizing the rotational member.

In addition or in the alternative to the preceding embodiments, the second restricting part may include a wall part that extends in the circumferential direction behind the first restricting part in the front-rear direction. A front end surface of the wall part may include a first surface that extends in a direction orthogonal to the driving axis, and a second surface that extends obliquely (diagonally) rearward from one end of the first surface in the circumferential direction. The first surface may be configured to come into contact with the front restricting part at the second position, from behind. The second surface may be configured to allow the spindle to move in the front-rear direction. According to this embodiment, the second restricting part having a simple structure can reliably prevent the first clutch from operating when the output shaft is rotationally driven in the second direction.

In addition or in the alternative to the preceding embodiments, the first clutch may be configured to function as a speed-reducing mechanism. According to this embodiment, since the screw-tightening tool does not need a speed-reducing mechanism separately from the first clutch, the screw-tightening tool can be made compact.

In addition or in the alternative to the preceding embodiments, the speed-reducing mechanism may include a sun member, a ring member and a carrier that are coaxial with the driving axis, and planetary rollers rollably retained by the carrier. The ring member may be configured to be rotated by the output shaft. The carrier may be configured to be rotated integrally with the spindle. The planetary rollers may be at least partially disposed between a tapered outer peripheral surface of the sun member and a tapered inner peripheral surface of the ring member in a radial direction of the ring member. The ring member may be configured to move integrally with the spindle in the front-rear direction relative to the sun member. The first clutch may be configured to transmit the power when the planetary rollers selectively come into frictional contact with the tapered outer peripheral surface of the sun member and the tapered inner peripheral surface of the ring member in response to rearward movement of the spindle from an initial position. According to this embodiment, the screw-tightening tool having a rational structure can be achieved that employs a so-called planetary-roller-type speed-reducing mechanism, as the first clutch, that is configured to operate (be activated) in response to the movement of the spindle in the front-rear direction.

In addition or in the alternative to the preceding embodiments, the screw-tightening tool may further comprise a circulation passage in the housing. The spindle may have a first hole that extends forward from a rear end of the spindle, and a second hole that communicates with the first hole. The second hole may extend in a direction intersecting with the first hole and may be open to an outer peripheral surface of the spindle. The circulation passage may be configured to return a lubricant, which has passed through the first hole and the second hole and has flowed outside the spindle, to the rear end of the spindle. According to this embodiment, the lubricant that has flowed outside the second hole due to the centrifugal force of the rotating spindle can be returned into the first hole to circulate within the housing. Consequently, the elements inside the housing can be efficiently lubricated.

In addition or in the alternative to the preceding embodiments, a reservoir for the lubricant may be disposed in the circulation passage. According to this embodiment, the lubricant can be stored or accumulated in the reservoir to be circulated efficiently. An element (for example, a felt) that is configured to absorb and retain the lubricant may be disposed in the reservoir.

A screwdriver **1** according to a representative, non-limiting embodiment of the present disclosure is now described in detail with reference to the drawings. The screwdriver **1** is an example of a screw-tightening tool that is capable of selectively performing a screw-tightening operation and a screw-loosening operation by rotationally driving a tool accessory (specifically, a driver bit **9**) removably coupled to a spindle **3**.

First, the general structure of the screwdriver **1** is described.

As shown in FIG. **1**, an outer shell of the screwdriver **1** is formed by an elongate body housing **11** (also referred to as a tool body) and a handle **17**.

The body housing **11** houses a motor **2** and the elongate spindle **3**. The spindle **3** is disposed such that a rotational axis of the spindle **3** (i.e., a driving axis A**1** of the driver bit **9**) extends along a longitudinal direction of the body housing **11**. One end portion of the spindle **3** is disposed in one end portion of the body housing **11** in its longitudinal direction. The driver bit **9** is removably coupled to this end potion of the spindle **3**.

The handle **17** is basically C-shaped and connected to the other end portion of the body housing **11** in its longitudinal direction, so that the body housing **11** and the handle **17** form a loop shape. The handle **17** includes a grip part **171** configured to be held by a user. The grip part **171** is spaced apart from the body housing **11** and linearly extends in a direction that is generally orthogonal to the driving axis A1. One end portion in a longitudinal direction of the grip part **171** is located on the driving axis A**1**. A trigger **173** is provided on this end portion. A power cable **179**, which is connectable to an external alternate current power source, is connected to the other end portion of the grip part **171**.

When the trigger **173** is depressed by the user, the motor **2** is driven and thus the spindle **3** is rotationally driven integrally with the driver bit **9**. Thus, a screw **90**, which is engaged with the driver bit **9**, is rotated.

In the following description, for the sake of convenience, an extension direction of the driving axis A**1** is defined as a front-rear direction of the screwdriver **1**. In the front-rear direction, the side on which the driver bit **9** is removably received is defined as a front side of the screwdriver **1**, and the other side on which the grip part **171** is disposed is defined as a rear side of the screwdriver **1**. A direction that is orthogonal to the driving axis A**1** and that generally corresponds to the extension direction of the grip part **171** is defined as an up-down direction of the screwdriver **1**. In the up-down direction, the side on which the trigger **173** is disposed is defined as an upper side of the screwdriver **1**, and the side on which the power cable **179** is connected to the grip part **171** is defined as a lower side of the screwdriver **1**. A direction that is orthogonal to the front-rear direction and the up-down direction is defined as a left-right direction of the screwdriver **1**.

The detailed structure of the screwdriver **1** is now described.

First, the detailed structure of the body housing **11** and elements or structures disposed within the body housing **11** are described.

As shown in FIG. **1**, the body housing **11** includes a tubular rear housing **12** that mainly houses the motor **2**, a tubular front housing **13** that mainly houses the spindle **3**, and a central housing **14** that is disposed between the rear housing **12** and the front housing **13**. A front end portion of the central housing **14** has a partition wall **141**. The driving axis A1 intersects the partition wall **141**. The central housing **14** and the front housing **13** are fixed to the rear housing **12** by screws, so that the three housings are integrated together as the body housing **11**.

The rear housing **12** mainly houses the motor **2**. An output shaft **23** of the motor **2** extends in parallel to the spindle **3** below the spindle **3**. Thus, a rotational axis of the output shaft **23** is parallel to the driving axis A**1**. Bearings **231** and **233** rotatably support front and rear end portions of the output shaft **23**, respectively. The front bearing **231** is supported by the partition wall **141**. The rear housing **233** is supported by a rear end portion of the rear housing **12**. A front end portion of the output shaft **23** protrudes forward into the front housing **13** through a through hole formed in the partition wall **141**. A pinion gear **24** is fixed around the front end portion of the output shaft **23**.

As shown in FIGS. **2** and **3**, the front housing **13** mainly houses the spindle **3**, a first clutch **4** and a second clutch **5**.

The spindle **3** is basically an elongate member (or a shaft) shaped like a solid circular cylinder (round bar/rod). The spindle **3** extends in the front-rear direction along the driving axis A**1**. In the present embodiment, two members (a front shaft **31** and a rear shaft **32**), which are separately formed, are fixedly connected to each other and integrated together to form the spindle **3**. The spindle **3** may, however, be constituted by a single shaft. A flange **34** is provided on a central portion of the spindle **3** in the front-rear direction.

Bearings **301** and **302** support front and rear end portions of the spindle **3**, so that the spindle **3** is rotatable around the driving axis A**1** and is movable (slidable) along the driving axis A**1** in the front-rear direction. The front bearing **301** is a ball bearing and is supported by a front end portion of the front housing **13**. The rear bearing **302** is a sliding bearing (also referred to as a plain bearing, or a bush). The bearing **302** is press-fitted into and thus supported in a recess (hereinafter, referred to as a bearing housing part **143**, see FIG. **5**) defined by a front surface of the partition wall **141** and a hollow cylindrical part **142** that protrudes forward from the front surface of the partition wall **141**.

The spindle **3** is always biased forward, as will be described in detail later. In an initial state in which an external rearward force is not applied to the spindle **3**, the spindle **3** is held in a position where a front end surface of the flange **34** is in contact with a stopper part **131** provided within the front housing **13**. The position of the spindle **3** at this time is a foremost position (also referred to as an initial position) within a movable range of the spindle **3**.

A tubular locator **15** is removably mounted around the front end portion of the front housing **13** so as to cover the front end portion of the front housing **13**. The front end portion of the spindle **3** protrudes from the front housing **13** into the locator **15**. A bit-insertion hole **311** is formed in the front end portion of the spindle **3**. The driver bit **9** is held such that a rear portion of the driver bit **9** is inserted into the bit-insertion hole **311**. The user can fix the locator **15** in any position by moving the locator **15** relative to the front housing **13** in the front-rear direction. Accordingly, an amount of protrusion of the driver bit **9** from the locator **15**, i.e., a tightening depth of the screw **90**, is set.

Each of the first clutch **4** and the second clutch **5** is configured to selectively transmit power from the output shaft **23** of the motor **2** to the spindle **3**. The details of the first clutch **4** and the second clutch **5** will be described later.

Next, elements or structures disposed within the handle **17** are described.

As shown in FIG. **1**, the handle **17** houses a main switch **174**, a reversing switch **176**, and a controller **178**.

The main switch **174** is a switch for starting the motor **2** and is disposed in an upper portion of the grip part **171** behind the trigger **173**. The main switch **174** is normally kept in an OFF state and switched to an ON state when the trigger **173** is depressed. The main switch **174** is connected to the controller **178** via wires, and configured to output a signal indicating the ON state or OFF state to the controller **178**.

A reversing switch lever **175** is provided in a portion of the handle **17** that connects a lower end portion of the grip part **171** and a lower rear end portion of the body housing **11** (the rear housing **12**). The reversing switch lever **175** is a manipulation member that is configured to switch a rotational direction of the motor **2** (more specifically, a rotational direction of the output shaft **23**) and is operably coupled to the reversing switch **176**. By manipulating the reversing switch lever **175**, the user can set the rotational direction of the motor **2** to either one of a normal direction (or a screw-tightening direction) and a reverse direction (or a screw-loosening direction). When the motor **2** is rotated in the normal direction, the driver bit **9** tightens the screw. When the motor **2** is rotated in the reverse direction, the driver bit **9** loosens the screw **90**. The reversing switch **176** is connected to the controller **178** via wires. The reversing switch **176** is configured to output a signal to the controller **178** that corresponds to the rotational direction set via the reversing switch lever **175**.

The controller **178** is disposed below the main switch **174** within the grip part **171**. The controller **178** includes a control circuit that is configured to control the driving of the motor **2**. When the main switch **174** is in the ON state, the controller **178** rotationally drives the motor **2** in the normal direction or in the reverse direction, according to the rotational direction indicated by the signal from the reversing switch **176**.

The detailed structure of the first clutch **4** is now described.

As shown in FIGS. **2** and **3**, the first clutch **4** is operably coupled to the output shaft **23** and to the spindle **3**. Thus, the first clutch **4** is disposed in a power-transmitting path between the output shaft **23** and the spindle **3**. The first clutch **4** is configured to selectively transmit power from the output shaft **23** to the spindle **3**, depending on the position of the spindle **3** in the front-rear direction.

The first clutch **4** of the present embodiment also functions (serves) as a speed-reducing mechanism. Specifically, the first clutch **4** is structured as a planetary-gear speed-reducing mechanism that includes a tapered sleeve **41**, a retainer **43**, a plurality of rollers **45** and a gear sleeve **47**.

The tapered sleeve **41**, the retainer **43** and the gear sleeve **47** are arranged coaxially with the spindle **3** (i.e., along the driving axis A**1**). The tapered sleeve **41**, the retainer **43**, the rollers **45** and the gear sleeve **47** correspond to a sun member, a carrier, planetary members and a ring member of the planetary-gear speed-reducing mechanism, respectively. In the first clutch **4**, the tapered sleeve **41**, the gear sleeve **47** and the retainer **43** serve as a fixed element, an input element and an output element, respectively. Thus, the gear sleeve **47** and the retainer **43** (and the spindle **3**) rotate in the same direction.

In the following description, the rotational direction of the gear sleeve **47**, the retainer **43** and the spindle **3** when the motor **2** (the output shaft **23**) is rotationally driven in the normal direction (the screw-tightening direction) is referred to as a normal direction (a screw-tightening direction) of the gear sleeve **47**, the retainer **43** and the spindle **3**. The rotational direction of the gear sleeve **47**, the retainer **43** and the spindle **3** when the motor **2** is rotationally driven in the reverse direction (the screw-loosening direction) is referred to as a reverse direction (a screw-loosening direction) of the gear sleeve **47**, the retainer **43** and the spindle **3**. The rotational direction of the output shaft **23** is always opposite to the rotational direction of the gear sleeve **47**, the retainer **43** and the spindle **3**.

As shown in FIGS. **2** to **4**, the tapered sleeve **41** is a tubular member. The tapered sleeve **41** is supported by the body housing **11** via a base **40**.

The base **40** is formed as a member that is originally separate (discrete) from the body housing **11**. The base **40** is coupled to the body housing **11** (specifically, the partition wall **141**) to be coaxial with the driving axis A**1**. More specifically, the base **40** includes an annular part **401** and four legs **407** that protrude rearward from a peripheral edge portion of the annular part **401**. As shown in FIG. **5**, recesses **80** that are defined by ribs are disposed around the cylindrical part **142** that surrounds (defines) the bearing housing part **143**. As shown in FIG. **6**, the legs **407** of the base **40** are fitted into the recesses **80**, respectively. Thus, the base **40** is held by the body housing **11** (the partition wall **141**) while rotation of the base **40** around the driving axis A1 is restricted.

In the present embodiment, the recess **80** also serves as a reservoir (oil reservoir) for lubricant (for example, grease or lubrication oil). A felt **801** that absorbs and retains the lubricant is fitted in each recess **80**. Gaps (see FIG. **15**) are formed within the recess **80** between a rear end (a protruding end) of the leg **407** and a bottom surface of the recess **80** and between a radially inner surface of the leg **407** and an outer peripheral surface of the cylindrical portion **407**, respectively. Portions of the felt **801** are disposed in the gaps, respectively.

As shown in FIGS. **2** to **4**, the rear end of the tapered sleeve **41** has protrusions **412**. The protrusions **412** are fitted into recesses **405** formed on an inner peripheral surface of the base **40**, respectively. Thus, the tapered sleeve **41** is held by the body housing **11** (the partition wall **141**) via the base **40** while rotation of the tapered sleeve **41** around the driving axis A1 is restricted. An outer peripheral surface of the tapered sleeve **41** is structured as a tapered surface **411** that is inclined (oblique) relative to the driving axis A1 by a specified angle. More specifically, the tapered sleeve **41** has a truncated conical outer shape that is tapered forward (having a diameter decreasing toward the front). The tapered surface **411** is thus structured as a conical surface that is inclined forward toward the driving axis A**1**.

The retainer **43** is configured to rotatably retain the rollers **45**. The retainer **43** in the present embodiment includes an annular part **431** and retaining arms **434**.

The annular part **431** is a wall part having a through hole at its center. The retaining arms **434** are spaced apart from each other in a circumferential direction and protrude generally rearward from a rear surface of a peripheral edge portion of the annular part **431**. Each of the retaining arms **434** extends substantially at the same inclination angle as the tapered surface **411** of the tapered sleeve **41** relative to the driving axis A1 (in other words, in parallel to the tapered surface **411**). A space between the retaining arms **434** adjacent to each other in the circumferential direction serves as a retaining space for the roller **45**. A front end of this space is closed by the peripheral edge portion of the annular part **431**.

In the present embodiment, the retainer **43** is supported by the spindle **3** not to be rotatable and to be movable in the front-rear direction relative to the spindle **3**, while the retaining arms **434** are disposed radially outward of the tapered sleeve **41**. More specifically, as shown in FIGS. **3** and **4**, two grooves **321** are formed across the driving axis A1 in a rear end portion of the spindle **3** (the shaft **32**). Each of the grooves **321** extends linearly in the front-rear direction. A ball **36** is rollably disposed in each of the grooves **321**. Further, two recesses **432** are formed across the driving axis A1 in an inner peripheral surface of the annular part **431** of the retainer **43**. A portion of the ball **36** disposed in the groove **321** is engaged with the recess **432**. Furthermore, an annular recess **414** is formed in the center of a front end surface of the tapered sleeve **41**. The retainer **43** is biased rearward by a biasing spring **49** and held such that the balls **36** are each arranged within a space defined by the recesses **414** and **432**, and a rear surface of the annular part **431** is in contact with the front end surface of the tapered sleeve **41**, as will be described in detail later.

Owing to such a structure, the retainer **43** is engaged with the spindle **3** via the balls **36** so as to be rotatable together with the spindle **3** (i.e., rotationally engaged with the spindle **3** via the balls **36**). Further, the balls **36** can roll within the annular recess **419** of the tapered sleeve **41**, and the retainer **43** can rotate around the driving axis A1 together with the spindle **3** relative to the tapered sleeve **41**. The spindle **3** can move in the front-rear direction relative to the retainer **43** and the tapered sleeve **41** within the range in which the balls **36** can roll within the corresponding grooves **321**.

As shown in FIGS. **2** to **4**, each of the rollers **45** is a circular columnar member. Each of the rollers **45** has a constant diameter and is rotatably retained between the adjacent retaining arms **434**. As shown in FIG. **7**, an outer peripheral surface of the roller **45** partially and slightly protrudes from inner and outer surfaces of the retaining arms **434** in the radial direction of the retainer **43**.

As shown in FIGS. **2** to **4**, the gear sleeve **47** is basically structured as a hollow cylindrical member with a stepped portion. More specifically, a front end portion of the gear sleeve **47** has an inner diameter and an outer diameter that are smaller than those of a portion of the gear sleeve **47** extending rearward from the front end portion. In the following description, the front end portion of the gear sleeve **47** is referred to as a small-diameter part **471**, and the portion of the gear sleeve **47** extending rearward from the front end portion is referred to as a large-diameter part **474**. Further, the stepped portion connecting the small-diameter part **471** and the large-diameter part **474** is referred to as a shoulder part **472**. Each of the small-diameter part **471** and the large-diameter part **474** is a cylindrical tubular wall having an inner diameter larger than the diameter of the spindle **3**.

An outer ring of a bearing (specifically, a ball bearing) **48** is fixed onto an inner peripheral surface of a front end portion of the large-diameter part **474** (a portion adjacent to the shoulder part **472**). The spindle **3** is inserted into an inner ring of the bearing **48**. Thus, the gear sleeve **47** is supported by the spindle **3** to be rotatable around the driving axis A1 relative to the spindle **3**.

A space is formed behind the bearing **48** and between the spindle **3** and the large-diameter part **474** (the tubular wall) in the radial direction. Portions of the tapered sleeve **41**, the retainer **43** and the rollers **45** are arranged in this space. Further, gear teeth **470** are integrally formed on an outer periphery of a rear end portion of the gear sleeve **47** (specifically, the large-diameter part **474**). The gear teeth **470** are always engaged with the pinion gear **24**. Thus, the gear sleeve **47** is rotationally driven in response to rotation of the output shaft **23**, in a direction opposite to the output shaft **23**.

As shown in FIGS. **2** and **3**, an inner peripheral wall of the rear end portion of the large-diameter part **474** of the gear sleeve **47** has a tapered surface **475**. The tapered surface **475** is inclined (oblique) relative to the driving axis A1, substantially at the same angle as the tapered surface **411** of the tapered sleeve **41** (in other words, extends in parallel to the tapered surface **411**). Thus, the tapered surface **475** is structured as a conical surface that is inclined rearward (toward the open end of the gear sleeve **47**) and away from the driving axis A1. A front portion of each of the rollers **45** retained by the retainer **43** is between the tapered surface **411** and the tapered surface **475** in the radial direction of the spindle **3** (in the direction orthogonal to the driving axis A1).

The first clutch **4** includes the biasing spring **49** that is disposed between the gear sleeve **47** and the retainer **43** (specifically, between the bearing **48** and the retainer **43**) in the front-rear direction. In the present embodiment, the biasing spring **49** is a conical coil spring. Alternatively, other type of spring may be employed. The biasing spring **49** always biases the retainer **43** and the gear sleeve **47** away from each other, that is, rearward and forward, respectively. Thus, movement of the tapered sleeve **41**, the retainer **43** and the rollers **45** in the front-rear direction is restricted, and thus the tapered sleeve **41**, the retainer **43** and the rollers **45** are held in their specified positions.

A thrust bearing **35** is disposed between a front surface of the gear sleeve **47** (the small-diameter part **471**) and the flange **34** of the spindle **3** in the front-rear direction. Since the gear sleeve **47** is biased forward by the biasing force of the biasing spring **49**, the spindle **3** is also biased forward via the thrust bearing **35**. Thus, in the initial state, the spindle **3** is held in the foremost position (the initial position). The gear sleeve **47** moves in the front-rear direction along with the movement of the spindle **3** in the front-rear direction. Thus, the gear sleeve **47** and the spindle **3** move integrally with each other in the front-rear direction relative to the body housing **11**.

The first clutch **4** having the above-described structure transmits the power using a frictional force between the rollers **45** and the tapered sleeve **41** (the tapered surface **411**) and a frictional force between the rollers **45** and the gear sleeve **47** (the tapered surface **475**). In other words, the first clutch **4** of the present embodiment is structured as a so-called planetary-roller-type frictional clutch.

Positions of the spindle **3** and the gear sleeve **47** in the front-rear direction and operation of the first clutch **4** are now described.

When the spindle **3** is held in the initial position, as shown in FIGS. **2** and **7**, the rollers **45** are loosely held between the tapered surface **411** of the tapered sleeve **41** and the tapered surface **475** of the gear sleeve **47** while the rollers **45** are allowed to move slightly. Thus, the first clutch **4** is incapable of transmitting the power of the motor **2** to the spindle **3** (this state is hereinafter referred to as an interruption state). Thus, even if the gear sleeve **47** is rotated in this state, the rotation of the gear sleeve **47** is not transmitted to the retainer **43**.

As shown in FIG. **8**, when the user presses the screw **90**, which is engaged with the driver bit **9**, against the workpiece **91**, the spindle **3** is pushed rearward relative to the body housing **11** against the biasing force of the biasing spring **49**. The gear sleeve **47** is also moved rearward integrally with the spindle **3** relative to the body housing **11**, the tapered sleeve **41**, the retainer **43** and the rollers **45**. The gear sleeve **47** moves rearward toward the tapered sleeve **41**, and the distance between the tapered surface **411** of the tapered sleeve **41** and the tapered surface **475** of the gear sleeve **47** in the radial direction gradually decreases.

Along with the rearward movement of the spindle **3** and the gear sleeve **47**, as shown in FIGS. **8** and **9**, the rollers **45** come into frictional contact with the tapered surface **411** and the tapered surface **475**. When the frictional force increases and reaches a threshold, the rollers **45** revolve while rotating in response to rotation of the gear sleeve **47**. The rollers **45** cause the retainer **43** and the spindle **3** to rotate in the same direction as the gear sleeve **47**. In this manner, the state of the first clutch **4** shifts from the interruption state to a transmission state, in which the first clutch **4** is capable of transmitting power to the spindle **3**. In the following description, the positions of the spindle **3** and the gear sleeve **47** in the front-rear direction at this time are referred to as their activation positions. Since the first clutch **4** is a speed-reducing mechanism, the rotation speed of the spindle **3** is slower than the rotation speed of the gear sleeve **47**.

The first clutch **4** of the present embodiment is configured to transmit the power from the output shaft **23** to the spindle **3** only when the motor **2** is rotationally driven in the normal direction (the screw-tightening direction). In other words, the first clutch **4** is incapable of shifting from the interruption state to the transmission state when the motor **2** is rotationally driven in the reverse direction (the screw-loosening direction), as will be described in detail later.

The detailed structure of the second clutch **5** is now described.

As shown in FIGS. **2** to **4**, the second clutch **5** is operably coupled to the output shaft **23** and to the spindle **3**. Thus, the second clutch **5** is disposed in the power-transmitting path between the output shaft **23** and the spindle **3**. Unlike the first clutch **4**, the second clutch **5** is configured to transmit the power from the output shaft **23** to the spindle **3** regardless of the position of the spindle **3** in the front-rear direction. Further, the second clutch **5** of the present embodiment is configured to transmit the power from the output shaft **23** to the spindle **3** only when the rotational direction of the motor **2** (the output shaft **23**) is the reverse direction (the screw-loosening direction).

The second clutch **5** of the present embodiment is formed by a one-way clutch **51**. The one-way clutch **51** is configured to transmit rotation only in one direction and to run idle (not to transmit rotation) in the other direction. The one-way clutch **51** of the present embodiment is a general one-way clutch that includes a hollow cylindrical outer ring and a plurality of rolling elements (clutch members) disposed inside the outer ring. Rollers (specifically, needle rollers) are employed as the rolling elements.

The one-way clutch **51** is disposed between the small-diameter part **471** of the gear sleeve **47** and the spindle **3** in the radial direction of the spindle **3**. More specifically, the outer ring of the one-way clutch **51** is press-fitted into and fixed to an inner peripheral surface of the small-diameter part **471** of the gear sleeve **47**. The spindle **3** is inserted into the one-way clutch **51**.

When the motor **2** (the output shaft **23**) is rotationally driven in the normal direction (the screw-tightening direction), the one-way clutch **51** rotates together with the gear sleeve **47**, but runs idle (slips) relative to the spindle **3**. In other words, when the motor **2** is rotationally driven in the normal direction, the one-way clutch **51** does not transmit the rotation of the gear sleeve **47** to the spindle **3**. On the other hand, when the motor **2** is rotationally driven in the reverse direction (the screw-loosening direction), the one-way clutch **51** is locked to the spindle **3** and thus rotates integrally with the gear sleeve **47** and the spindle **3**. In other words, when the motor **2** is rotationally driven in the reverse direction, the one-way clutch **51** transmits the rotation of the gear sleeve **47** to the spindle **3**. The rotation speed of the gear sleeve **47** is the same with the rotation speed of the spindle **3**.

Further, the screwdriver **1** includes a restricting mechanism **6** that is configured to selectively restrict movement of the spindle **3** and the gear sleeve **47** in the front-rear direction. More specifically, the restricting mechanism **6** allows the spindle **3** and the gear sleeve **47** to move in the front-rear direction when the motor **2** is rotationally driven in the normal direction (the screw-tightening direction), to thereby make the first clutch **4** operable. On the other hand, the restricting mechanism **6** restricts (blocks, prevents) the spindle **3** and the gear sleeve **47** from moving in the front-rear direction when the motor **2** is rotationally driven in the reverse direction (the screw-loosening direction), to thereby make the first clutch **4** inoperable. Thus, the restricting mechanism **6** is configured to switch the state of the first clutch **4** between an operable state and an inoperable state, depending on the rotational direction of the motor **2**. The detailed structure of the restricting mechanism **6** is described below.

As shown in FIGS. **2** to **4**, **10** and **11**, the restricting mechanism **6** includes a rotating sleeve **61** and a restricting frame **62**.

The rotating sleeve **61** is basically a hollow cylindrical (annular) member (i.e., a sleeve or a collar). More specifically, the rotating sleeve **61** includes a hollow cylindrical tubular wall **611** and two protrusions **613** that protrude radially outward from an outer peripheral surface of the tubular wall **611**. The tubular wall **611** is disposed around the small-diameter part **471** of the gear sleeve **47** (in other words, fitted onto the outer circumference of the small-diameter part **471**). The outer diameter of the tubular wall **611** is set such that the outer peripheral surface of the tubular wall **611** does not protrude from the outer peripheral surface of the large-diameter part **474** of the gear sleeve **47** in the radial direction. The two protrusions **613** are symmetrically arranged relative to an axis of the rotating sleeve **61** (i.e., the driving axis A**1**). Each of the protrusions **613** protrudes radially outward from the outer peripheral surface of the large-diameter part **474**. A rear end surface of each of the protrusions **613** includes an inclined (oblique) surface **614** that is slightly inclined (oblique) relative to the circumferential direction (see FIG. **11**).

The rotating sleeve **61** is configured such that, when an external force is not applied to the rotating sleeve **61** or the external force is small enough, the rotating sleeve **61** rotates together (co-rotates) with the gear sleeve **47** along with the rotation of the gear sleeve **47**. The rotating sleeve **61** of the present embodiment is configured to rotate together with the gear sleeve **47** around the driving axis A**1** relative to the body housing **11**, owing to a frictional force between an inner peripheral surface of the rotating sleeve **61** (the tubular wall **611**) and the outer peripheral surface of the gear sleeve **47** (the small-diameter part **471**). When an external force that exceeds the frictional force causing the co-rotation of the rotating sleeve **61** is applied to the rotating sleeve **61**, the rotating sleeve **61** and the gear sleeve **47** rotate relative to each other around the driving axis A**1**.

The rotating sleeve **61** is disposed between the shoulder part **472** of the gear sleeve **47** and a stopper ring **473** (and a washer) fixed around the gear sleeve **47** (the small-diameter part **471**) in the front-rear direction. Thus, the rotating sleeve **61** is restricted from moving in the front-rear direction relative to the gear sleeve **61**. Accordingly, the rotating sleeve **61** moves integrally with the gear sleeve **47** and the spindle **3** in the front-rear direction relative to the body housing **11**.

The restricting frame **62** is supported by the body housing **11**, such that the restricting frame **62** is substantially immovable relative to the body housing **11**. The restricting frame **62** is configured to selectively restrict (block, prevent) the rotating sleeve **61** (and thus the spindle **3** and the gear sleeve

47) from moving in the front-rear direction relative to the body housing **11**, depending on a rotational position of the rotating sleeve **61** (a circumferential position of the protrusion **613**) relative to the body housing **11**.

More specifically, the restricting frame **62** is basically a tubular member, having a diameter larger than that of the rotating sleeve **61**. More specifically, the restricting frame **62** has a hollow cylindrical tubular wall **620**, two protrusions **625** and two protrusions **627**. The tubular wall **620** is disposed around and coaxially with the gear sleeve **47**. The two protrusions **625** protrude forward from an front end of the tubular wall **620**. The two protrusions **627** protrude radially outward from an outer peripheral surface of the tubular wall **620**.

As shown in FIGS. **3** and **12**, two grooves **133** are formed in the front housing **13**, corresponding to the two protrusions **627** of the restricting frame **62**. Each of the grooves **133** extends in the front-rear direction and has a sectional shape that conforms to the protrusion **627**. The two protrusions **627** are fitted into the two grooves **133**, respectively. Each of the protrusions **627** is disposed between a surface that defines a front end of the groove **133** and a front end of an arm **661** of a holding member **66** (see FIG. **10**) that is disposed in front of the partition wall **141**. The protrusions **627** are thus held in position. Owing to this structure, the restricting frame **62** is held to be substantially immovable relative to the body housing **11**. However, the restricting frame **62** may be directly fixed to the body housing **11** (the front housing **13**) without the holding member **66**.

The two protrusions **625** are symmetrically arranged relative to the driving axis **A1**, and protrude forward from the front end of the tubular wall **620**. Thus, in the restricting frame **62**, the two protrusions **625** and two portions without the protrusion **625** of the tubular wall **620** alternate in the circumferential direction. The portion without the protrusion **625** of the tubular wall **620** (hereinafter referred to as a restricting part **621**) is positioned behind a rear end of the protrusions **613** of the rotating sleeve **61** in the front-rear direction when the spindle **3** and the gear sleeve **47** are at their initial positions. Each of the protrusions **625** of the restricting frame **62** protrudes forward of the rear end of the protrusion **613** of the rotating sleeve **61**.

The position of a front end surface of the restricting part **621** in the front-rear direction varies along the circumferential direction of the tubular wall **620**. More specifically, the front end surface of each restricting part **621** includes a first surface **622** (a flat surface) that is generally orthogonal to the driving axis **A1**, and a second surface **623** (an inclined (oblique) surface) that extends obliquely rearward (inclines/slopes rearward) in the circumferential direction from one end in the circumferential direction of the first surface **622**. More specifically, the second surface **623** is connected to a forward side end of the first surface **622** in the normal direction (a direction indicated by arrow **D1** in FIG. **11**) of the gear sleeve **47** and inclines/slopes rearward toward (along) the normal direction. Each of the protrusions **625** is disposed between the first surface **622** of one of the two restricting parts **621** and the second surface **623** of the other one of the two restricting parts **621** in the circumferential direction of the restricting frame **62**.

An inner diameter of the tubular wall **620** of the restricting frame **62** is larger than the outer diameter of the large-diameter part **474** of the gear sleeve **47**. Thus, an inner peripheral surface of the tubular wall **620** is always spaced apart from the large-diameter part **474**, and the gear sleeve **47** is rotatable around the driving axis **A1** relative to the body housing **11** and the restricting frame **62** without interfering with the tubular wall **620**. The inner diameter of the tubular wall **620** is smaller than a distance between protruding ends of the two protrusions **613** of the rotating sleeve **61** (i.e., smaller than the maximum diameter of the rotating sleeve **61**). Thus, when the rotating sleeve **61** rotates relative to the restricting frame **62** due to the co-rotation, the protrusion **625** may interfere with the protrusion **613** of the rotating sleeve **61**. Further, when the spindle **3** and the gear sleeve **47** move rearward from their initial positions, the restricting part **621** may interfere with the protrusion **613** of the rotating sleeve **61**.

Specifically, as shown in FIG. **11**, when the gear sleeve **47** rotates in the normal direction, which is indicated by arrow D**1**, the rotating sleeve **61** rotates in the same direction as the gear sleeve **47** due to the co-rotation, relative to the body housing **11** and the restricting frame **62**. The rotating sleeve **61** can rotate to a position where each protrusion **613** comes into contact with the protrusion **625** at the forward side of the protrusion **613** in the normal direction, as shown by dotted lines in FIG. **11**. The rotational position (the position in the circumferential direction) of the rotating sleeve **61** at this time is hereinafter referred to as a first position.

When the rotating sleeve **61** is at the first position, the protrusion **613** is directly in front of the forward side end portion of the second surface **623** of the restricting part **621** in the normal direction (the direction of arrow D**1**). When the spindle **3** is at the initial position, the protrusion **613** is spaced apart from the second surface **623** in the front-rear direction. Thus, as shown in FIG. **13**, the rotating sleeve **61** can move rearward relative to the restricting frame **62**. Accordingly, the restricting part **621** (specifically, the second surface **623**) of the restricting frame **62** allows the spindle **3** to move rearward from the initial position when the rotating sleeve **61** is at the first position. The restricting part **62** (the second surface **623**) is configured to allow the spindle **3** to move from the initial position to at least the activation position (i.e., to make the first clutch **4** operable).

When the gear sleeve **47** rotates in the reverse direction (the direction of arrow **D2** in FIG. **11**) while the spindle **3** is at the initial position, the rotating sleeve **61** rotates, due to the co-rotation, to a position where each protrusion **613** is in contact with the protrusion **625** at the forward side of the protrusion **613** in the reverse direction, as shown by solid lines in FIG. **11**. The rotational position of the rotating sleeve **61** at this time is hereinafter referred to as a second position.

When the rotating sleeve **61** is at the second position, the protrusion **613** is directly in front of the first surface **622** of the restricting part **621**. At this time, there is only a slight gap between the protrusion **613** and the first surface **622** in the front-rear direction. Thus, when the spindle **3** starts to move rearward from the initial position, the first surface **622** comes into contact with the protrusion **613** from behind, so that the rotating sleeve **61** prevents the spindle **3** from moving further rearward. In other words, when the rotating sleeve **61** is at the second position, the restricting part **621** (specifically, the first surface **622**) restricts (blocks, prevents) the spindle **3** from moving rearward from the initial position (i.e., makes the first clutch **4** inoperable).

Operations of the restricting mechanism **6**, the first clutch **4** and the second clutch **5** in the screw-tightening operation and in the screw-loosening operation are now described in detail.

First, the screw-tightening operation (i.e., an operation in which the motor **23** is rotationally driven in the normal direction (the screw-tightening direction)) is described.

As shown in FIG. **2**, when the spindle **3** is held in the initial position, the first clutch **4** is in the interruption state.

In this state, when the user presses the trigger **173**, the main switch **174** is turned ON and thus the controller **178** starts driving of the motor **2**. The gear sleeve **47** is rotationally driven in the normal direction (the screw-tightening direction). As described above, at this time, the second clutch **2** (the one-way clutch **51**) does not operate, so that the gear sleeve **47** runs idle relative to the spindle **3**.

As described above, the rotating sleeve **61** of the restricting mechanism **6** is placed at the first position due to the co-rotation. As shown by the dotted lines in FIG. **11**, since the protrusion **613** of the rotating sleeve **61** comes into contact with the protrusion **625** of the restricting frame **62**, the rotating sleeve **61** is prevented from further rotating in the normal direction and the rotating sleeve **61** is thus held in the first position. The gear sleeve **47** continues to run idle in the normal direction relative to the spindle **3** while also rotating relative to the rotating sleeve **61**.

Since the rotating sleeve **61** is held at the first position, the restricting part **621** (the second surface **623**) allows the spindle **3** to move rearward without interfering with the protrusions **613** of the rotating sleeve **61**. Thus, the first clutch **4** is operable. Accordingly, as shown in FIGS. **8** and **13**, when the user presses the screw **90** against the workpiece **91**, the spindle **3**, the gear sleeve **47** and the rotating sleeve **61** move rearward relative to the body housing **11** and the restricting frame **62**. When the spindle **3** reaches the activation position, the first clutch **4** shifts from the interruption state to the transmission state, thereby starting tightening the screw **90** into the workpiece **91**.

When the operation of tightening the screw **90** into the workpiece **91** proceeds and a front end of the locator **15** comes into contact with the workpiece **91**, a portion of the screwdriver **1** that is subjected to a pressing force shifts from the spindle **3** to the locator **15**. Consequently, the pressing force applied to the spindle **3** gradually decreases. Thus, a clamping force applied to the rollers **45** from the tapered surface **411** of the tapered sleeve **41** and the tapered surface **475** of the gear sleeve **47**, and thus the torque that is transmitted from the gear sleeve **47** to the spindle **3** also gradually decrease. When the torque that is transmitted from the gear sleeve **47** to the spindle **3** falls below the torque that is required for tightening the screw **90**, the rotation of the spindle **3** is stopped. In this manner, the screw-tightening operation is finished.

Next, the screw-loosening operation (i.e., an operation in which the motor **2** is rotationally driven in the reverse direction (the screw-loosening direction)) is described.

When the user depresses the trigger **173** while the spindle **3** is at the initial position, the main switch **174** is turned ON, and the controller **178** starts driving of the motor **2**. The gear sleeve **47** is rotationally driven in the reverse direction (the screw-loosening direction). As described above, the second clutch **5** (the one-way clutch **51**) operates and thus the spindle **3** starts to rotate integrally with the gear sleeve **47** substantially at the same time as the gear sleeve **47** starts to rotate, to thereby starting loosening the screw **90**. Thus, when the motor **2** is rotationally driven in the reverse direction, the user can loosen the screw **90** without pressing the screw **90** against the workpiece **91**. Consequently, the user can start the screw-loosening operation immediately, by simply depressing the trigger **173**.

The rotating sleeve **61** of the restricting mechanism **6** is placed at the second position as described above, due to the co-rotation. In a case in which the spindle **3** is pushed rearward and thus the protrusions **613** come into contact with the corresponding second surfaces **623** before the protrusions **613** reach their respective position directly in front of the first surfaces **622**, the rotating sleeve **61** is led to the second position by the effect of the inclined second surfaces **623** (and the inclined surfaces **614** of the protrusions **613**). As shown by the solid lines in FIG. **11**, when the rotating sleeve **61** is placed at the second position, the protrusions **613** of the rotating sleeve **61** come into contact with the protrusions **625** of the restricting frame **62**, respectively, so that the rotating sleeve **61** is prevented from further rotating in the reverse direction and thus the rotating sleeve **61** is held in the second position. The gear sleeve **47** continues to rotate integrally with the spindle **3** in the reverse direction while rotating relative to the rotating sleeve **61**.

The screw **90** moves rearward as the screw **90** is loosened. Accordingly, the spindle **3** is pushed rearward. However, since the rotating sleeve **61** is held in the second position, the restricting parts **621** (the first surfaces **622**) come into contact with the protrusions **613**, respectively, and restrict (block, prevent) the spindle **3** from moving rearward. Accordingly, the first clutch **4** is kept inoperable and cannot be activated during the operation of the second clutch **5**. Consequently, the power of the output shaft **23** is transmitted to the spindle **3** only via the second clutch **5**, and the screw **90** is loosened and removed from the workpiece **91**. As described above, since the first clutch **4** functions as a speed-reducing mechanism, if the first clutch **4** and the second clutch **5** operate at the same time, a slip may be caused in either one of the first clutch **4** and the second clutch **5**, which may lead to false operation. However, the present embodiment can appropriately eliminate such false operation.

As described above, the screwdriver **1** transmits the power from the motor **2** to the spindle **3** via the first clutch **4** in the screw-tightening operation. On the other hand, the screwdriver **1** transmits the power from the motor **2** to the spindle **3** via the second clutch **5** in the screw-loosening operation. Thus, the power is transmitted through different paths between the screw-tightening operation and the screw-loosening operation. Further, since the first clutch **4** also serves as a speed-reducing mechanism, even if the rotation speed of the output shaft **23** of the motor **2** is the same (identical), the rotation speed of the spindle **3** when the power is transmitted via the first clutch **4** in the screw-tightening operation is different from the rotation speed of the spindle **3** when the power is transmitted via the second clutch **5** in the screw-loosening operation. Specifically, when the motor **2** is rotationally driven at the same rotation speed, the screw **90** is rotated at a higher speed in the screw-loosening operation than in the screw-tightening operation. The torque that is required in the screw-loosening operation is smaller than the torque that is required in the screw-tightening operation. Thus, operating efficiency in each of the screw-tightening operation and the screw-loosening operation can be optimized by setting different output rotation speeds (i.e., the rotation speeds of the spindle **3**) with respect to the same input rotation speed (i.e., the rotation speed of the motor **2**), depending on the rotational direction of the motor **2**.

Further, since the first clutch **4**, which operates only when the motor **2** is rotationally driven in the normal direction (the screw-tightening direction), also serves as a speed-reducing mechanism, the screwdriver **1** does not need to have a speed-reducing mechanism that is independent from the first clutch **4**. Thus, the compact screwdriver **1** can be achieved. The torque that is required when the motor **2** is rotationally driven in the reverse direction (the screw-loosening direction) is relatively small. Thus, the second clutch **5** employs the one-way clutch **51** that simply transmits rotation without reducing the speed. Consequently, the second clutch **5** can be compact and relatively inexpensive.

The first clutch **4** starts to transmit the power in response to the rearward movement (push) of the spindle **3**. The restricting mechanism **6** restricts the spindle **3** from moving in the front-rear direction only when the motor **2** (the output shaft **23**) is rotationally driven in the reverse direction. Thus, the restricting mechanism **6** can reliably prevent activation of the first clutch **4** when the motor **2** (the output shaft **23**) is rotationally driven in the reverse direction.

In the present embodiment, in particular, the restricting mechanism **6** is structured by the rotating sleeve **61** that is rotatable between the first position and the second position, and the restricting frame **62** that is fixed to the body housing **11** and that restricts the spindle **3** from moving in the front-rear direction only when the rotating sleeve **61** is at the second position. Since the rotating sleeve **61** can be rotated between the first position and the second position due to the co-rotation with the gear sleeve **47** that is rotated by the output shaft **23**, the rotating sleeve **61** has a simple structure. Further, the restricting frame **62** (the restricting part **621**) with the simple first surface **622** that abuts on the rotating sleeve **61** from behind can reliably prevent the spindle **3** from moving rearward.

Further, in the present embodiment, the restricting frame **62** has the protrusions **625** that are configured to respectively abut the protrusions **613** of the rotating sleeve **61** in the circumferential direction. Owing to this structure, the rotating sleeve **61** is prevented from co-rotating beyond the first position and beyond the second position without interrupting the rotation of the gear sleeve **47**, and thus the rotating sleeve **61** can be held in the first position and the second position.

In the screwdriver **1**, since various mechanisms and elements that require lubrication are disposed within the front housing **13**, a lubricant (for example, grease or lubrication oil) is provided in the front housing **13**. In the present embodiment, a circulation passage **8** for effectively circulating the lubricant is defined in the front housing **13**. The circulation passage **8** is described in detail below.

As shown in FIGS. **14** and **15**, the circulation passage **8** includes a passage **81** that passes inside the spindle **3** and various passages **82** to **86** that are formed outside the spindle **3** to lead the lubricant to the rear end of the spindle **3**.

The passage **81** inside the spindle **3** is defined by a first hole **811** and a second hole **812**. The first hole **811** extends forward from the rear end of the spindle **3** along the axis of the spindle **3** (i.e., along the driving axis A1). The first hole **811** is a bottomed hole having a closed front end and an open rear end that opens at the rear end of the spindle **3**. The second hole **812** extends through the spindle **3** along the diameter of the spindle **3**. Both open ends of the second hole **812** are in the outer peripheral surface of the spindle **3** (into the grooves **321**). The open ends of the second hole **812** are radially inside the first clutch **4** regardless of the position of the spindle **3** in the front-rear direction. A central portion of the second hole **812** communicates with a front end portion of the first hole **811**. Thus, the first hole **811** and the second hole **812** together form a T-shape.

The lubricant that enters the first hole **811** from the rear end of the spindle **3** can flow out of the spindle **3** through the open ends of the second hole **812**. More specifically, the lubricant passes through the passage **81** and is discharged radially outside the spindle **3** owing to the centrifugal force caused by rotation of the spindle **3**. Consequently, the discharged lubricant can lubricate the elements (specifically, the first clutch **4**) disposed in a region surrounding the spindle **3**.

The passages **82** are configured to allow the lubricant, which has passed through the passage **81** and flowed outside the spindle **3**, to flow radially out of the gear sleeve **47**. Specifically, as shown in FIG. **15**, two communication holes **478** are formed in the large-diameter part **474** of the gear sleeve **47**. Each of the communication holes **478** extends through the large-diameter part **474** (the tubular wall) to communicate a space radially inside the large-diameter part **474** (an inner space of the gear sleeve **47**) with a space radially outside the large-diameter part **474** (an outer space of the gear sleeve **47**). Thus, the lubricant that has flowed out of the passage **81** and into the inner space of the gear sleeve **47** can flow radially outside the gear sleeve **47** through the communication holes **478**. In particular, when the gear sleeve **47** is rotated, flows of air are generated through the communication holes **478** by the centrifugal force, and thus the lubricant can be effectively discharged outside the gear sleeve **47**.

The passages **83** extend between the tapered sleeve **41** and the retainer **43** and are configured to lead the lubricant, which has passed through the passage **81** and flowed outside the spindle **3**, to peripheries of the rollers **48**. Specifically, as shown in FIG. **16**, shallow grooves **433** are formed in the rear surface of the annular part **431** of the retainer **43**. Each of the grooves **433** is between the adjacent retaining arms **434** and extends radially from an inner edge to an outer edge of the annular part **431**. As shown in FIG. **14**, the passages **83** are defined by the front surface of the tapered sleeve **41** and the grooves **433**. As described above, the retainer **43** is held such that the rear surface of the annular part **431** is in contact with the front surface of the tapered sleeve **41**. However, the lubricant that has flowed outside the spindle **3** can move to the peripheries of the rollers **45** through passages **83**, so that the lubricant can lubricate the rollers **45** and the tapered surfaces **411** and **475**.

The rollers **45** revolve while rotating in frictional contact with the tapered surface **411** of the tapered sleeve **41** and with the tapered surface **475** of the gear sleeve **47**. A difference in rotation between the front portion and the rear portion of each roller **45** causes slipping. The lubricant supplied by way of the passage **81** can effectively reduce wear of the rollers **45** and the tapered surfaces **411** and **475** and can improve the durability of the first clutch **4**.

The lubricant that has passed the passages **82** and **83** can move into the recess **80** (the oil reservoir) of the partition wall **141** and can be absorbed and retained by the felt **801** disposed in the recess **80**. In this manner, the lubricant can be stored in the recess **80** using the felt **801** to be efficiently circulated.

The passages **84** are configured to lead the lubricant from the recess **80** to an opening of the bearing housing part **143**. Specifically, as shown in FIG. **17**, two shallow grooves **406** are formed in the rear surface of the annular part **401** of the base **40**. The two grooves **406** orthogonally intersects with each other to form a cross shape. Each of the grooves **406** extends in the diametrical direction across the central portion of the annular part **401**. As shown in FIGS. **14** and **15**, the passages **84** are defined by the front surface of the cylindrical part **142** and the grooves **406**. As described above, the base **40** is held such that the rear surface of the annular part **401** is in contact with the front surface of the cylindrical part **142**. However, the lubricant that has been absorbed and retained by the felt **801** in the recess **801** can flow through the passages **84** and reach the opening of the bearing housing part **143**.

The passages **85** and **86** are configured to lead the lubricant from the opening of the bearing housing part **143** to the inside (specifically, a periphery of the rear end of the spindle **3**).

Specifically, as shown in FIG. **5**, a shallow groove **144** is formed in the surface that defines the bearing housing part **143**. The groove **144** extends from the front end (the protruding end, open end) of the cylindrical part **142** to the central portion of the bottom surface of the bearing housing part **143**. As shown in FIG. **14**, the passage **85** is defined by the outer surface of the bearing **302** and the groove **144**. The lubricant that has reached the opening of the bearing housing part **143** through the passages **84** can enter the bearing housing **143** and the inside of the bearing **302** through the passage **85** and then reach the periphery of the rear end of the spindle **3**. Thus, the lubricant can re-enter the passage **81** in the spindle **3**.

Further, as shown in FIGS. **14** and **15**, the front end of the bearing **302** (the sliding bearing) is positioned slightly rearward of the front end of the cylindrical part **142** of the partition wall **141** in the front-rear direction. The passage **86** is formed by a gap between the front end of the bearing **302** and the rear ends of the base **40** and the tapered sleeve **41**. The lubricant that has reached the opening of the bearing housing part **143** through the passages **84** can move to an area surrounding the outer peripheral surface of the spindle **3** through the passage **86** and then reach the periphery of the rear end of the spindle **3** through a gap between the bearing **302** and the spindle **3**. Thus, the lubricant can re-enter the passage **81** in the spindle **81**

In the present embodiment, the pressure inside the bearing **302** becomes lower than the pressure outside the bearing **302** due to the rotation of the spindle **3**. In the present embodiment, since the lubricant can be stored in the recess **80** using the felt **801**, the lubricant can be led into the bearing **302** from the recess **80** through the passages **84**, **85** and **86**, utilizing the pressure difference. Further, since the spindle **3** reciprocates in the front-rear direction relative to the bearing **302**, the lubricant can be led into the bearing **302** from the recess **80**, utilizing a pump effect.

As described above, in the present embodiment, the elements (in particular, the first clutch **4**) in the front housing **13** can be effectively lubricated by the circulation passage **8**, which includes the passage **81** inside the spindle **3** and the passages **82** to **86** outside the spindle **3**. The circulation passage **8** may include different passage(s) other than the passages in the above-described example. Further, the oil reservoir may be disposed at a position different from that in the above-described example.

Correspondences between the features of the above-described embodiment and the features of the present disclosure are as follows. However, the features of the above-described embodiments are merely exemplary, and therefore the features of the present disclosure are not limit thereto.

The screwdriver **1** is an example of a "screw-tightening tool". The body housing **11** is an example of a "housing". The motor **2** and the output shaft **23** are examples of a "motor" and an "output shaft", respectively. The normal direction (the screw-tightening direction) is an example of a "first direction". The reverse direction (the screw-loosening direction) is an example of a "second direction". The spindle **3** is an example of a "spindle". The driving axis A**1** is an example of a "driving axis". The first clutch **4** is an example of a "first clutch". The second clutch **5** is an example of a "second clutch".

The restricting mechanism **6** is an example of a "restricting mechanism". The rotating sleeve **61** (the protrusion **613**) is an example of a "first restricting part". The restricting frame **62** (the restricting part **621**) is an example of a "second restricting part". The gear sleeve **47** is an example of a "rotational member". The restricting part **621** is an example of a "wall part". The first surface **622** and the second surface **623** are examples of a "first surface" and a "second surface", respectively. The tapered sleeve **41** is an example of a "sun member". The gear sleeve **47** is an example of a "ring member". The retainer **43** is an example of a "carrier". The roller **45** is an example of a "planetary roller". The tapered surface **411** is an example of a "tapered outer peripheral surface of the sun member". The tapered surface **475** is an example of a "tapered inner peripheral surface of the ring member". The first hole **811** and the second hole **812** are examples of a "first hole" a the "second hole", respectively. The circulation passage **8** is an example of a "circulation passage". The recess **80** is an example of a "reservoir".

The above-described embodiment is merely exemplary, and a screw-tightening tool according to the present disclosure is not limited to t the screwdriver **1** of the above-described embodiment. For example, the following modifications may be made-. Further, any one or more of these modifications may be employed in combination with at least one of the screwdriver **1** of the above-described embodiment and the features recited in each claim.

For example, in the above-described embodiment, a so-called planetary-roller-type frictional clutch is employed as the first clutch **4**. Instead, a different type of clutch may be employed, as long as the clutch is in an interruption state when the spindle **3** is at the initial position and shifts to a transmission state in response to rearward movement of the spindle **3** from the initial position. For example, a single-plate friction clutch, a multiple-plate friction clutch, or a cone friction clutch may be employed. Alternatively, a positive clutch (e.g., a jaw clutch, a claw clutch) may be employed. Further, in a case in which a so-called planetary-roller-type frictional clutch is employed, the structures (shape, size, the number thereof, etc.) and arrangement of the sun member, the ring member, the carrier, and the planetary rollers may be appropriately changed.

Similarly, a different type of clutch (for example, a sprag type one-way clutch) other than the one-way clutch **51** in the above-described embodiment may be employed as the second clutch **5**. The position of the second clutch **5** may be appropriately changed in accordance with or regardless of the change of the first clutch **4**.

Further, any structure may be employed in the restricting mechanism **6**, as long as the restricting mechanism **6** is configured to restrict the spindle **3** from moving in the front-rear direction only when the motor **2** (the output shaft **23**) is rotationally driven in the normal direction.

For example, the rotating sleeve **61** may be operably coupled to a member that is different from the gear sleeve **47** and that is configured to be rotated by the output shaft **23**. Further, the number of the protrusions **613** of the rotating sleeve **61** may be one or three or more. Alternatively, a portion of the rotating sleeve **61** other than the protrusion **613** may be configured to abut on the restricting frame **62** (the restricting part **621**). The restricting part **621** of the restricting frame **62** or the number of the protrusions **625** may be changed in accordance with the change of the rotating sleeve **61**.

The structure that comes into contact with a portion of the rotating sleeve **61** from behind when the rotating sleeve **61** is at the second position to restrict (block, prevent) the rearward movement of the spindle **3** is not limited to the restricting frame **62** (the restricting part **621**). For example, such a structure may be formed integrally with the body housing **11** inside the body housing **11** (the front housing **13**). For example, at least one protrusion may protrude toward the rotating sleeve **61** from the inner surface of the body housing **11**. The protrusion may be configured such that the protrusion is placed directly behind the protrusion **613** of the rotating sleeve **61** and abuts the protrusion **613** from behind only when the rotating sleeve **61** is at the second position, so as to restrict the rearward movement of the spindle **3**.

Further, the structure that restricts (prevents) the rotating sleeve **61** from rotating beyond the first position and the second position due to its co-rotation is not limited to the protrusion **625** of the restricting frame **62**. For example, similarly to the above-described modification of the restricting part **621**, at least one protrusion may protrude from the inner surface of the body housing **11** (the front housing **13**) and abut a portion of the rotating sleeve **61** when the rotating sleeve **61** is at the first position or the second position, to thereby prevent the rotating sleeve **61** from further rotating.

The screwdriver **1** may be driven by electric power supplied from a direct current power source. In this case, for example, the body housing **11** may include a battery mounting part that is configured to removably receive a rechargeable battery. The shapes of the body housing **11** and the handle **17**, and/or the connection structure therebetween, a kind or the arrangement of the motor **2** may be appropriately changed. For example, the motor **2** may be a DC motor (for example, a brushless DC motor). Further, the motor **2** may be disposed such that the rotational axis of the output shaft **23** intersects with the driving axis **A1**.

In view of the nature of the present invention and the above-described embodiment, the following structures (aspects) are provided. Any one or more of the following structures may be employed in combination with the screwdriver **1** of the embodiment, the modifications thereof, or the invention recited in each claim.

(Aspect 1)

The output rotation speed of the spindle when the power is transmitted via the second clutch is higher than the output rotation speed of the spindle when the power is transmitted via the first clutch.

According to this Aspect, the rotation speed of the screw in the screw-loosening operation is higher than that in the screw-tightening operation, so that the screw-loosening operation can be optimized.

(Aspect 2)

The spindle is configured to be normally held in an initial position and to be moved to an activation position, which is located rearward of the initial position, in response to rearward pushing of the spindle, and

the first clutch is configured to interrupt the power transmission when the spindle is located forward of the activation position and to start to transmit the power when the spindle is placed at the activation position.

(Aspect 3)

The first restricting part is configured to move integrally with the spindle in the front-rear direction, and

the second restricting part is configured to prevent the spindle from moving rearward by abutting the first restricting part at the second position, from behind.

According to this Aspect, when the second restricting part is in contact with the first restricting part, the spindle can be reliably prevented from moving rearward.

(Aspect 4)

The screw-tightening tool further comprises:

a first contact part that is configured to come into contact with the first restricting part placed at the first position in response to rotation of the output shaft in the first direction to thereby restrict the first restricting part from rotating in the first direction; and

a second contact part configured to come into contact with the first restricting part placed at the second position in response to rotation of the output shaft in the second direction to thereby restrict the first restricting part from rotating in the second direction.

The protrusion **625** of the above-described embodiment is an example of each of the "first contact part" and the "second contact part" in this Aspect.

According to this Aspect, the first restricting part can be reliably prevented from rotating beyond the first position and the second position due to the co-rotation.

(Aspect 5)

The second surface is at a forward side of the first surface in a rotational direction of the first restricting part when the output shaft is rotationally driven in the first direction, and

the second surface is inclined rearward toward the rotational direction of the first restricting part when the output shaft is rotated in the first direction.

(Aspect 6)

The second clutch is a one-way clutch that is configured to transmit rotation in one direction and to run idle in a direction opposite to the one direction.

(Aspect 7)

The one-way clutch is disposed radially inside the ring member and radially outside the spindle, and

the one-way clutch is configured to transmit rotation of the ring member to the spindle only when the output shaft is rotationally driven in the second direction.

(Aspect 8)

The second hole is open to the outer peripheral surface of the spindle in the first clutch.

(Aspect 9)

The rear end portion of the spindle is supported by a bearing fixed to the housing to be slidable along the driving axis and rotatable around the driving axis, and

the reservoir is disposed radially outside the bearing.

(Aspect 10)

The circulation passage includes at least one first passage between the second hole and the reservoir, and at least one second passage between the reservoir and an inside of the bearing.

DESCRIPTION OF THE REFERENCE NUMERALS

1: screwdriver, **11**: body housing, **12**: rear housing, **13**: front housing, **131**, stopper part, **133**: groove, **14**: central housing, **141**: partition wall, **142**: cylindrical part, **143**: bearing housing part, **144**: groove, **15**: locator, **17**: handle, **171**: grip part, **173**: trigger, **174**: main switch, **175**: reversing switch lever, **176**: reversing switch, **178**: controller, **179**: power cable, **2**: motor, **23**: output shaft, **231**: bearing, **233**: bearing, **24**: pinion gear, **301**: bearing, **302**: bearing, **3**: spindle, **31**; shaft,

311: bit-insertion hole, **32**: shaft, **321**: groove, **34**: flange, **35**: thrust bearing, **36**: ball, **4**: first clutch, **40**: base, **401**: annular part, **405**: recess, **406**: groove, **407**: leg, **41**: tapered sleeve, **411**: tapered surface, **412**: protrusion, **414**: recess, **419**: recess, **43**: retainer, **431**: annular part, **432**: recess, **433**: groove, **434**: retaining arm, **45**: roller, **47**: gear sleeve, **470**: gear teeth, **471**: small-diameter part, **472**: shoulder part, **473**: stopper ring, **474**: large-diameter part, **475**: tapered surface, **478**: communication hole, **48**: bearing, **49**: biasing spring, **5**: second clutch, **51**: one-way clutch, **6**: restricting mechanism, **61**: rotating sleeve, **611**: tubular wall, **613**: protrusion, **614**: inclined surface, **62**: restricting frame, **620**: tubular wall, **621**: restricting part, **622**: first surface, **623**: second surface, **625**: protrusion, **627**: protrusion, **66**: holding member, **661**: arm, **8**: circulation passage, **80**: recess, **801**: felt, **81**: passage, **811**: first hole, **812**: second hole, **82**: passage, **83**: passage, **84**: passage, **85**:

passage, **86**: passage, **9**: driver bit, **90**: screw, **91**: workpiece, **A1** driving axis

What is claimed is:

1. A screw-tightening tool comprising:

a housing;

a motor within the housing, the motor having an output shaft configured to be rotationally driven selectively in a first direction that corresponds to a direction for tightening a screw and in a second direction that corresponds to a direction for loosening the screw and that is opposite to the first direction;

a spindle that is supported by the housing to be movable along a driving axis and to be rotatable around the driving axis, the driving axis defining a front-rear direction of the screw-tightening tool, the spindle having a front end portion configured to removably receive a tool accessory;

a first clutch that is operably coupled to the output shaft and the spindle and configured to transmit power from the output shaft to the spindle only when the output shaft is rotationally driven in the first direction, and is configured to not transmit power from the output shaft to the spindle when the output shaft is rotationally driven in the second direction; and

a second clutch that is operably coupled to the output shaft and the spindle and configured to transmit power from the output shaft to the spindle only when the output shaft is rotationally driven in the second direction, and is configured to not transmit power from the output shaft to the spindle when the output shaft is rotationally driven in the first direction,

wherein:

an output rotation speed of the spindle when the power is transmitted via the first clutch is different from an output rotation speed of the spindle when the power is transmitted via the second clutch, in response to a same rotation speed of the output shaft.

2. The screw-tightening tool as defined in claim **1**, wherein:

the first clutch is configured to selectively transmit the power depending on a position of the spindle in the front-rear direction, and

the second clutch is configured to transmit the power regardless of the position of the spindle in the front-rear direction.

3. The screw-tightening tool as defined in claim **2**, further comprising:

a restricting mechanism that is configured to restrict the spindle from moving in the front-rear direction only when the output shaft is rotationally driven in the second direction.

4. The screw-tightening tool as defined in claim **3**, wherein the restricting mechanism comprises:

a first restricting part that is rotatable between a first position and a second position in a circumferential direction around the driving axis, the first restricting part being configured to be placed at the first position in response to rotation of the output shaft in the first direction and to be placed at the second position in response to rotation of the output shaft in the second direction; and

a second restricting part that is configured to allow the spindle to move in the front-rear direction when the first restricting part is at the first position and to restrict the spindle from moving in the front-rear direction when the first restricting part is at the second position.

5. The screw-tightening tool as defined in claim **4**, wherein:

the first restricting part is configured to move integrally with the spindle in the front-rear direction, and

the second restricting part is configured to prevent the spindle from moving rearward by abutting the first restricting part at the second position from behind.

6. The screw-tightening tool as defined in claim **4**, further comprising:

a rotational member that is disposed between the output shaft and the spindle in a power transmission path and that is configured to be rotated by the output shaft,

wherein:

the first restricting part is disposed around the rotational member to be selectively rotatable relative to the rotational member and is configured to co-rotate with the rotational member only between the first position and the second position, and

the second restricting part is substantially immovable relative to the housing.

7. The screw-tightening tool as defined in claim **6**, further comprising:

a first contact part that is configured to come into contact with the first restricting part placed at the first position in response to rotation of the output shaft in the first direction to thereby restrict rotation of the first restricting part in the first direction; and

a second contact part that is configured to come into contact with the first restricting part placed at the second position in response to rotation of the output shaft in the second direction to thereby restrict rotation of the first restricting part in the second direction.

8. The screw-tightening tool as defined in claim **4**, wherein:

the second restricting part includes a wall part that extends in the circumferential direction behind the first restricting part in the front-rear direction,

a front end surface of the wall part includes:

a first surface that extends in a direction orthogonal to the driving axis and that is configured to come into contact with the first restricting part at the second position, from behind, and

a second surface that extends obliquely rearward from one end of the first surface in the circumferential direction and that is configured to allow the spindle to move in the front-rear direction.

9. The screw-tightening tool as defined in claim **1**, wherein the first clutch is configured to function as a speed-reducing mechanism.

10. The screw-tightening tool as defined in claim **9**, wherein:

the speed-reducing mechanism includes a sun member, a ring member and a carrier that are coaxial with the driving axis, and planetary rollers rollably retained by the carrier,

the ring member is configured to be rotated by the output shaft,

the carrier is configured to be rotated integrally with the spindle,

the planetary rollers are at least partially disposed between a tapered outer peripheral surface of the sun member and a tapered inner peripheral surface of the ring member in a radial direction of the ring member,

the ring member is configured to move integrally with the spindle in the front-rear direction relative to the sun member, and

the first clutch is configured to transmit the power when the planetary rollers selectively come into frictional contact with the tapered outer peripheral surface of the sun member and the tapered inner peripheral surface of the ring member in response to rearward movement of the spindle from an initial position.

11. The screw-tightening tool as defined in claim **10**, wherein the second clutch is a one-way clutch that is configured to transmit rotation in one direction and to run idle in a direction opposite to the one direction.

12. The screw-tightening tool as defined in claim **1**, further comprising:

a circulation passage in the housing,

wherein:

the spindle has a first hole that extends forward from a rear end of the spindle, and a second hole that communicates with the first hole, the second hole extending in a direction intersecting with the first hole and being open to an outer peripheral surface of the spindle, and

the circulation passage is configured to return a lubricant, which has passed through the first hole and the second hole and has flowed outside the spindle, to the rear end of the spindle.

13. The screw-tightening tool as defined in claim **12**, wherein a reservoir for the lubricant is disposed in the circulation passage.

14. The screw-tightening tool as defined in claim **2**, wherein:

the spindle is configured to be normally held in an initial position and to be moved to an activation position, which is located rearward of the initial position, when the spindle is pushed rearward,

the first clutch is a friction clutch or a positive clutch that is configured to interrupt the power transmission when the spindle is located forward of the activation position and to start to transmit the power when the spindle is placed at the activation position, and

the second clutch is a one-way clutch that is configured to transmit rotation in one direction and to run idle in a direction opposite to the one direction.

15. The screw-tightening tool as defined in claim **10**, wherein the first clutch is configured to function as a speed-reducing mechanism.

16. The screw-tightening tool as defined in claim **5**, further comprising:

a rotational member that is disposed between the output shaft and the spindle in a power transmission path and that is configured to be rotated by the output shaft,

wherein:

the first restricting part is disposed around the rotational member to be selectively rotatable relative to the rotational member and is configured to co-rotate with the rotational member only between the first position and the second position, and

the second restricting part is substantially immovable relative to the housing.

17. The screw-tightening tool as defined in claim **6**, wherein:

the second restricting part includes a wall part that extends in the circumferential direction behind the first restricting part in the front-rear direction,

a front end surface of the wall part includes:

a first surface that extends in a direction orthogonal to the driving axis and that is configured to come into contact with the first restricting part at the second position, from behind, and

a second surface that extends obliquely rearward from one end of the first surface in the circumferential direction and that is configured to allow the spindle to move in the front-rear direction.

18. The screw-tightening tool as defined in claim **1**, wherein the first clutch is a planetary roller speed-reducing mechanism, and the spindle having a rear end portion rotating integrally with a carrier of planetary roller speed-reducing mechanism.

19. A screw-tightening tool comprising:

a housing;

a motor within the housing, the motor having an output shaft configured to be rotationally driven selectively in a first direction that corresponds to a direction for tightening a screw and in a second direction that corresponds to a direction for loosening the screw and that is opposite to the first direction;

a spindle that is supported by the housing to be movable along a driving axis and to be rotatable around the driving axis, the driving axis defining a front-rear direction of the screw-tightening tool, the spindle having a front end portion configured to removably receive a tool accessory;

a first clutch that is operably coupled to the output shaft and the spindle and configured to transmit power from the output shaft to the spindle only when the output shaft is rotationally driven in the first direction;

a second clutch that is operably coupled to the output shaft and the spindle and configured to transmit power from the output shaft to the spindle only when the output shaft is rotationally driven in the second direction, and

a restricting mechanism that is configured to restrict the spindle from moving in the front-rear direction only when the output shaft is rotationally driven in the second direction, the restricting mechanism including:

a first restricting part that is rotatable between a first position and a second position in a circumferential direction around the driving axis, the first restricting part being configured to be placed at the first position in response to rotation of the output shaft in the first direction and to be placed at the second position in response to rotation of the output shaft in the second direction; and

a second restricting part that is configured to allow the spindle to move in the front-rear direction when the first restricting part is at the first position and to restrict the spindle from moving in the front-rear direction when the first restricting part is at the second position, wherein:

an output rotation speed of the spindle when the power is transmitted via the first clutch is different from an output rotation speed of the spindle when the power is transmitted via the second clutch, in response to a same rotation speed of the output shaft,

the first clutch is configured to selectively transmit the power depending on a position of the spindle in the front-rear direction,

the second clutch is configured to transmit the power regardless of the position of the spindle in the front-rear direction.

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