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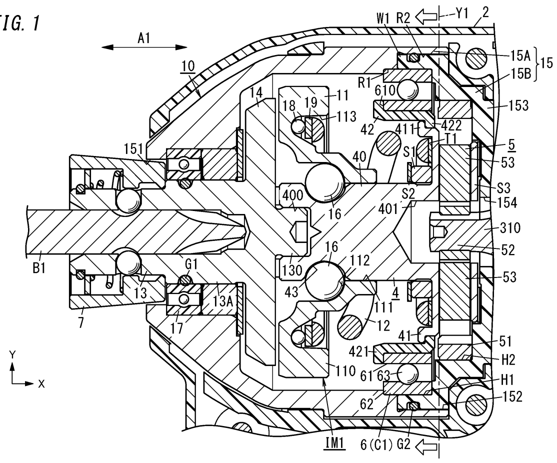
(54) IMPACT ROTARY TOOL

(57) An object of the present disclosure is to contribute to reducing the dimension of a tool along the axis of a drive shaft thereof. An impact rotary tool (1) includes a drive shaft (4), a speed reducer mechanism (5), an output shaft (13), a hammer (11), a spring (12), and a bearing member (6). The speed reducer mechanism (5) transmits rotational force of a shaft of a motor (31) to the drive shaft (4). The output shaft (13) receives rotational force from the drive shaft (4) and transmits the rotational force to a tip tool (B1). The hammer (11) is supported rotatably by the drive shaft (4) and strikes the output shaft (13). The spring (12) biases the hammer (11) toward the output shaft (13). The bearing member (6) supports the drive shaft (4) rotatably. The bearing member (6) is disposed closer to the output shaft (13) than the speed reducer mechanism (5) is along an axis (A1) of the drive shaft (4).

FIG. 1



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Description

Technical Field

[0001] The present disclosure generally relates to an impact rotary tool and more particularly relates to an impact rotary tool for generating impact torque.

Background Art

[0002] Patent Literature 1 discloses an impact rotary tool. The impact rotary tool includes an impact mechanism section. The impact mechanism section includes: a drive shaft connected to a motor via a speed reducer; an anvil; a hammer to strike the anvil; and a hammer spring to bias the hammer toward the anvil. The shaft portion of the drive shaft has its rear end held by a bearing, which is fixed in a case that houses the speed reducer, and has its front end held rotatably by a rear hole provided through the anvil.

Citation List

Patent Literature

Patent Literature 1: JP 2009-172732 A

Summary of Invention

[0003] There has been an increasing demand for further reducing the size of an impact rotary tool. Among other things, a demand for reducing the dimension of the tool along the axis of the drive shaft thereof has been on the rise.

[0004] In view of the foregoing background, it is therefore an object of the present disclosure to provide an impact rotary tool that would contribute to reducing the dimension of the tool along the axis of the drive shaft thereof.

[0005] An impact rotary tool according to an aspect of the present disclosure includes a drive shaft, a speed reducer mechanism, an output shaft, a hammer, a spring, and a bearing member. The speed reducer mechanism transmits rotational force of a shaft of a motor to the drive shaft. The output shaft receives rotational force from the drive shaft and transmits the rotational force to a tip tool. The hammer is supported rotatably by the drive shaft and strikes the output shaft. The spring biases the hammer toward the output shaft. The bearing member supports the drive shaft rotatably. The bearing member is disposed closer to the output shaft than the speed reducer mechanism is along an axis of the drive shaft.

Brief Description of Drawings

[0006]

FIG. 1 is a cross-sectional view of a main part of an impact rotary tool according to an exemplary embodiment;

FIG. 2 is a view illustrating the appearance of the impact rotary tool;

FIG. 3 a partially cutaway view illustrating the appearance of a main part of the impact rotary tool;

FIG. 4 is an exploded perspective view illustrating a drive shaft, an increased diameter portion, an extended portion, and a bearing member of the impact rotary tool;

FIG. 5 is a perspective view illustrating the drive shaft and increased diameter portion of the impact rotary tool;

FIG. 6A is a perspective view illustrating a main part of the impact rotary tool as viewed obliquely from in front of the impact rotary tool; and

FIG. 6B is a perspective view illustrating the main part of the impact rotary tool as viewed obliquely from behind the impact rotary tool.

Description of Embodiments

(1) Overview

[0007] The drawings to be referred to in the following description of embodiments are all schematic representations. Thus, the ratio of the dimensions (including thicknesses) of respective constituent elements illustrated on the drawings does not always reflect their actual dimensional ratio.

[0008] As shown in FIG. 1, an impact rotary tool 1 according to an exemplary embodiment includes a drive shaft 4, a speed reducer mechanism 5, an output shaft 13, a hammer 11, a spring 12, and a bearing member 6.

[0009] The speed reducer mechanism 5 transmits the rotational force of the shaft (rotary shaft 310) of a motor 31 to the drive shaft 4. In this embodiment, the speed reducer mechanism 5 is a planetary gear mechanism and transforms the rotational velocity and torque of the rotary shaft 310 of the motor 31 into a rotational velocity and torque required for the operation of turning a screw.

[0010] The output shaft 13 receives rotational force from the drive shaft 4 and transmits the rotational force to a tip tool B 1. The hammer 11 is supported rotatably by the drive shaft 4 and strikes the output shaft 13. Specifically, the hammer 11 strikes an impact receiver 14 (i.e., anvil) of the output shaft 13 as the drive shaft 4 rotates. The spring 12 biases the hammer 11 toward the output shaft 13. The bearing member 6 supports the drive shaft 4 rotatably. In this embodiment, the bearing member 6 is a bearing C1, for instance. In this embodiment, the bearing member 6 is disposed closer to the output shaft 13 than the speed reducer mechanism 5 is along an axis A1 of the drive shaft 4 as shown in FIG. 1.

[0011] According to this configuration, the bearing member 6 is disposed closer to the output shaft 13 than the speed reducer mechanism 5 is, and therefore, there is no need to leave a space for disposing the bearing member 6 on an opposite side from the output shaft 13 with respect to the speed reducer mechanism 5. This contributes to reducing the dimension of the tool along the axis A1 of the drive shaft 4.

(2) Details

(2.1) Overall configuration

[0012] Next, an overall configuration of an impact rotary tool 1 according to this embodiment will be described in detail.

[0013] In the following description, an exemplary embodiment will be described with the three axes that intersect with each other at right angles (namely, an X-axis, a Y-axis, and a Z-axis) defined as shown in FIGS. 1-4. Specifically, in the exemplary embodiment to be described below, an axis aligned with the axis A1 (refer to FIG. 1) of the drive shaft 4 of the impact rotary tool 1 is herein defined to be the "X-axis." Also, an axis aligned with an arrangement direction of a barrel 21 and a base 23 of a housing 2 (to be described later) of the impact rotary tool 1 is herein defined to be the "Y-axis." In the following description, the direction aligned with the X-axis will be hereinafter simply referred to as a "forward/backward direction." The negative side of the X-axis will be hereinafter referred to as "forward" and the positive side of the X-axis will be hereinafter referred to as "backward." Also, the direction aligned with the Y-axis will be hereinafter simply referred to as an "upward/downward direction." The positive side of the Y-axis will be hereinafter referred to as "upward" and the negative side of the Y-axis will be hereinafter referred to as "downward."

[0014] Note that the X-, Y-, and Z-axes are all virtual axes and the arrows indicating these X-, Y-, and Z-axes on the drawings are just shown there as an assistant to description and are insubstantial ones. It should also be noted that these directions do not define the direction in which the impact rotary tool 1 is supposed to be used.

[0015] The impact rotary tool 1 is a portable electric tool which may be gripped by the user with one of his or her hands. The impact rotary tool 1 includes a motor block 3 (refer to FIG. 3), a drive block 10 (transmission mechanism; refer to FIGS. 1 and 3), and the housing 2 (refer to FIG. 2). The drive block 10 transmits the rotational force of the rotary shaft 310 (refer to FIG. 1) of the motor 31 in the motor block 3 to the tip tool B1. The housing 2 houses the motor block 3 and the drive block 10.

[0016] The impact rotary tool 1 further includes a holder 7 (socket attachment; refer to FIGS. 1-3) to hold thereon a bit (such as a screwdriver bit) serving as the tip tool B1. The tip tool B1 is attached removably onto the holder 7. The drive block 10 drives the tip tool B1 using the rotational force generated by the motor 31. The drive block 10 according to this embodiment includes an impact mechanism IM1 (refer to FIG. 1). Note that the drive block 10 will be described in detail in the next section.

[0017] The impact rotary tool 1 according to this embodiment may be an impact screwdriver allowing the user to perform the work of fastening a screw B2 (refer to FIG. 2) with the impacting force applied by the impact mechanism IM1.

[0018] A rechargeable battery pack 9 (refer to FIG. 2) is attached removably to the impact rotary tool 1. The impact rotary tool 1 is powered by the battery pack 9. In this embodiment, the battery pack 9 is not a constituent element of the impact rotary tool 1. However, this is only an example and should not be construed as limiting. Alternatively, the impact rotary tool 1 may include the battery pack 9 as a constituent element. The battery pack 9 includes an assembled battery formed by connecting a plurality of secondary batteries (such as lithium-ion batteries) in series, and a battery pack case 90 that houses the assembled battery. The battery pack 9 includes a communications connector for transmitting battery information about the battery pack 9. Examples of the battery information include various pieces of information about the temperature, battery level, rated voltage, rated capacity, and number of times of charging.

[0019] As shown in FIG. 2, the housing 2 includes the barrel 21, a grip 22, and the base 23. The barrel 21 has the shape of a hollow cylinder. The grip 22 protrudes, in one direction (downward) aligned with the radius of the barrel 21, from an outer peripheral surface of the barrel 21. The grip 22 is formed in the shape of a hollow cylinder elongated in the one direction. The internal space of the grip 22 communicates with the internal space of the barrel 21. The barrel 21 is connected to one longitudinal end (i.e., upper end) of the grip 22 and the base 23 is connected to the other longitudinal end (i.e., the lower end) of the grip 22. The battery pack 9 is attached removably to the base 23.

[0020] As shown in FIG. 2, the impact rotary tool 1 further includes a switch circuit module 81, an operating member 82, a forward/reverse switch 83, and a control circuit module 84.

[0021] The switch circuit module 81 is disposed in the internal space of the grip 22. The switch circuit module 81 is electrically connected to the control circuit module 84. The control circuit module 84 is housed in the base 23.

[0022] The switch circuit module 81 includes a main switch. The main switch is used to open or close a power supply path for supplying power from the battery pack 9 to the motor 31. The operating member 82 is a trigger lever to be operated by the user of the impact rotary tool 1 with one of his or her fingers. The operating member 82 is operatively coupled to the switch circuit module 81. The operating member 82 is pulled toward the grip 22 when operated by the user with one of his or her fingers.

[0023] The switch circuit module 81 turns the main switch OFF when the operating member 82 is pulled to a depth equal to or less than a predetermined value but turns the main switch ON when the operating member 82 is pulled to a depth greater than the predetermined value. This allows the switch circuit module 81 to selectively supply or cut off power from the battery pack 9 to the motor 31. In addition, when the operating member 82 is pulled to a depth greater than the predetermined value, the switch circuit module 81 also transmits an operating signal, corresponding to the depth of the operating member 82 pulled, to the control circuit module 84. This causes the magnitude of the power supplied to the motor 31 to be varied according to the depth to which the operating member 82 has been pulled, thus changing the rotational velocity of the rotary shaft 310 of the motor 31.

[0024] In addition, the switch circuit module 81 is also connected to the forward/reverse switch 83. The forward/reverse switch 83 is a direction switch allowing the user to change the rotational direction of the rotary shaft 310 of the motor 31. The forward/reverse switch 83 is provided in the vicinity of the boundary between the barrel 21 and the grip 22.

[0025] The control circuit module 84 is connected to the switch circuit module 81 and the motor 31. With the battery pack 9 attached to the impact rotary tool 1, the control circuit module 84 is connected to a pair of power terminals and a communications connector of the battery pack 9. This allows the control circuit module 84 to be supplied with power from the battery pack 9 via the pair of power terminals. In addition, the control circuit module 84 acquires the battery information from the battery pack 9 via the communications connector. Furthermore, the control circuit module 84 controls the motor 31 in accordance with the operating signal supplied from the switch circuit module 81. More specifically, the control circuit module 84 controls the rotational velocity, rotational direction, and other parameters of the rotary shaft 310 of the motor 31.

[0026] The motor block 3 is housed in the internal space of the barrel 21 of the housing 2 to be located on the positive side of the X-axis. The motor block 3 is fixed to the housing 2. The barrel 21 has a plurality of ventilation holes 211, 212 (refer to FIG. 2) around the motor block 3.

[0027] As shown in FIG. 3, the motor block 3 includes the motor 31, a fan 32, and a driver circuit module 33.

[0028] The motor 31 is a brushless motor. The motor 31 includes a motor body 311 (refer to FIG. 3) and the rotary shaft 310 (refer to FIG. 1) held rotatably by the motor body 311.

[0029] The fan 32 has a plurality of blades. The fan 32 is coupled to the rotary shaft 310 of the motor 31. This allows the fan 32 to turn along with the rotary shaft 310 of the motor 31.

[0030] The driver circuit module 33 is controlled by the control circuit module 84 to drive the motor 31. The driver circuit module 33 includes a circuit board, a plurality of transistors mounted on the circuit board, and an encapsulant that encapsulates the circuit board and the plurality of transistors together.

[0031] The rotary shaft 310 of the motor 31 is supported by the drive block 10. The rotational force (driving force) generated by a rotor of the motor body 311 is transmitted from the rotary shaft 310 to the drive block 10.

(2.2) Drive block

[0032] Next, the drive block 10 will be described in detail. The drive block 10 is housed in the internal space of the barrel 21 of the housing 2 to be located on the negative side of the X-axis with respect to the motor block 3.

[0033] As shown in FIG. 1, the drive block 10 includes the drive shaft 4, the speed reducer mechanism 5, the bearing member 6, the hammer 11, the spring 12, the output shaft 13, a case 15, two steel spheres 16, and a tip-side bearing member 17.

[0034] The output shaft 13 is configured to receive the rotational force of the drive shaft 4 and transmit the rotational force to the tip tool B1. The output shaft 13 is disposed in front of the drive shaft 4 (i.e., provided on the negative side of the X-axis with respect to the drive shaft 4) to have the center axis thereof substantially aligned with the center axis of the drive shaft 4. As shown in FIG. 1, the output shaft 13 is formed such that a spindle 13A and an impact receiver 14 (anvil) are continuous and integral with each other. In the impact rotary tool 1, the tip of the spindle 13A also serves as a part of the holder 7, thus allowing the tip tool B1 to be fixed on the tip of the spindle 13A.

[0035] The tip-side bearing member 17 is configured as a bearing. The spindle 13A is supported rotatably by the tip-side bearing member 17. The outer peripheral surface of the spindle 13A has a groove to which an O-ring G1 is fitted. The spindle 13A is held stably by an inner ring of the tip-side bearing member 17 via the O-ring G1. In addition, the spindle 13A is also coupled to the drive shaft 4. Thus, the spindle 13A rotates along with the drive shaft 4. Note that the drive shaft 4 is supported rotatably by the bearing member 6 (to be described later).

[0036] The rotary shaft 310 of the motor 31 is coupled to the speed reducer mechanism 5. The rotational force of the rotary shaft 310 of the motor 31 is transmitted to the drive shaft 4 via the speed reducer mechanism 5. In the drive block 10, the impact mechanism IM1 is formed by the drive shaft 4, the hammer 11, the spring 12, the output shaft 13, and the two steel spheres 16. The rotational force of the rotary shaft 310 of the motor 31 is transmitted by the impact mechanism IM1 to the spindle 13A of the output shaft 13.

[0037] The speed reducer mechanism 5 transmits the rotational force of the rotary shaft 310 of the motor 31 to the drive shaft 4. Specifically, the speed reducer mechanism 5 is a planetary gear mechanism for transforming the rotational velocity and torque of the rotary shaft 310 of the motor 31 into a rotational velocity and torque required for performing the operation of turning a screw. The speed reducer mechanism 5 includes a ring gear 51, a sun gear 52, and three planetary gears 53. As shown in FIG. 1, the sun gear 52 is formed continuously and integrally with the rotary shaft 310 of the motor 31. The three planetary gears 53 mesh with the sun gear 52 outside of the sun gear 52. As shown in FIG. 6B, the ring gear 51 meshes with, and supports, the three planetary gears 53.

[0038] The hammer 11 is supported rotatably by the drive shaft 4 and strikes the impact receiver 14 of the output shaft 13. The hammer 11 includes a substantially circular columnar hammer body 110, which is compressed in the X-axis direction as a whole. The hammer body 110 has a through hole 1 1 1 to pass the drive shaft 4 therethrough in the X-axis direction. The hammer body 110 has a groove 112 on an inner peripheral surface of the through hole 111. The two steel spheres 16 are interposed between the groove 112 and a groove 43 provided on the outer peripheral surface of the body 40 of the drive shaft 4.

[0039] The groove 112, the groove 43, and the two steel spheres 16 together form a cam mechanism. As the two spheres 16 roll inside the groove 43, the hammer 11 is not only movable along the axis A1 of the drive shaft 4, but also rotatable, with respect to the drive shaft 4. In the drive block 10, as the hammer 11 rotates with respect to the drive shaft 4, the hammer 11 moves along the axis A1 of the drive shaft 4 either toward the spindle 13A of the output shaft 13 (i.e., moves forward) or away from the spindle 13A of the output shaft 13 (i.e., moves backward) according to the angle of the rotation of the hammer 11.

[0040] Note that a lubricant is applied to, for example, the speed reducer mechanism 5 and other members. The lubricant is used to reduce the friction and abrasion, for example, of the drive block 10. The lubricant has electrical insulation properties. The lubricant may be a synthetic hydrocarbon oil grease, for example.

[0041] As shown in FIGS. 1, 4, 6A, and 6B, the drive shaft 4 includes a body 40, an increased diameter portion 41, and an extended portion 42.

[0042] The body 40 supports the hammer 11 rotatably. The body 40 is formed in the shape of a circular column having a longitudinal axis aligned with the X-axis direction. The body 40 may be a metallic part, for example. The body 40 has an insert recess 400, which is provided through an end surface thereof on the negative side of the X-axis (i.e., a frontend surface) and which is recessed in the positive direction of the X-axis. A projection 130 (refer to FIG. 1) protruding backward from a rear end surface of the output shaft 13 (i.e., a rear end surface of the impact receiver 14) is inserted into the insert recess 400, thereby coupling the output shaft 13 to the drive shaft 4. This allows the output shaft 13 to rotate along with the drive shaft 4. In addition, the body 40 has the groove 43 to allow the two steel spheres 16 to roll therein as described above.

[0043] The increased diameter portion 41 is a part which protrudes radially outward from the body 40 to position the spring 12 between the hammer 11 and the increased diameter portion 41 itself. The center axis of the increased diameter portion 41 is aligned with the center axis of the body 40. The increased diameter portion 41 may be a metallic part, for example. Furthermore, in this embodiment, the increased diameter portion 41 may be formed continuously and integrally with the body 40, for example. In addition, the increased diameter portion 41 has a protrusion 411 (refer to FIGS. 1 and 4) which protrudes outward along the radius thereof. The protrusion 411 may be a flange-shaped part.

[0044] Specifically, the increased diameter portion 41 includes a first part 41A, a second part 41B, and three pillars 41C.

[0045] The first part 41A has a disklike shape when viewed in the X-axis direction. A peripheral edge portion 415 (refer to FIG. 5) thereof protrudes in the negative direction of the X-axis along the entire circumference thereof. The first part 41A is a cuplike part as a whole. In other words, the first part 41A has a backwardly depressed, positioning recess 410 (refer to FIG. 4). The first part 41A has the shape of a circle, centered around the body 40, when viewed from the negative side of the X-axis. In addition, the protrusion 411 described above is provided for the first part 41A. That is to say, the peripheral edge portion 415 of the first part 41A, which protrudes in the negative direction of the X-axis along the entire circumference, has the shape of a flange protruding radially outward. The flange-shaped protruding portion is the protrusion 411.

[0046] The first part 41A is formed continuously and integrally with a rear end portion of the body 40 and protrudes radially outward from the rear end portion of the body 40. On the bottom of the positioning recess 410, placed is an annular sheet member T1 (refer to FIGS. 1 and 6A). An end portion of the spring 12 on the positive side of the X-axis is housed in the positioning recess 410 to be in contact with the front surface of the sheet member T1. That is to say, the spring 12 applies biasing force to the bottom of the first part 41A via the sheet member T1. This allows the end portion of the spring 12 on the positive side of the X-axis to be positioned stably with respect to the drive shaft 4.

[0047] As shown in FIGS. 4 and 5, the first part 41A has three shaft insert holes 412, which are provided through the bottom thereof. The frontend portions of three shafts 530 (refer to FIG. 6B) of the three planetary gears 53 are respectively inserted into the three shaft insert holes 412. The sheet member T1 is disposed to cover the three shaft insert holes 412 from the negative side of the X-axis. The sheet member T1 may be made of felt, for example. The sheet member T1 catches the lubricant applied to the speed reducer mechanism 5 and substantially prevents the lubricant from flowing outside of the speed reducer mechanism 5. In addition, the sheet member T1 reduces the chances of the shafts 530 coming into contact with, and scratching, surrounding parts thereof while the planetary gear 53 is turning.

[0048] In addition, on the bottom of the positioning recess 410, an annular elastic member S1 and an annular sheet member S2, covering the front surface of the elastic member S1, are arranged inside the sheet member T1 as shown in FIG. 1. If the hammer 11 moved in the positive direction of the X-axis by overcoming the elastic force applied by the spring 12, then the rear end portion of the hammer 11 would come into contact with the sheet member S2, thus allowing the elastic member S1 to absorb the shock.

[0049] The second part 41B is a disklike part, of which the thickness is aligned with the X-axis direction. The second part 41B is disposed such that its front surface faces the rear surface of the first part 41A. The three pillars 41C are parts that couple the first part 41A and the second part 41B to each other with a predetermined gap distance left between the first part 41A and the second part 41B. That is to say, the first part 41A is formed continuously and integrally with the second part 41B via the three pillars 41C. The three planetary gears 53 are housed in a gap SP1 (refer to FIG. 5) surrounded with the first part 41A and the second part 41B. Note that the three planetary gears 53 are housed in the gap SP1 with their outer peripheral portion partially sticking out of the gap SP1 to allow the three planetary gears 53 to mesh with the ring gear 51. The gap SP1 is divided by the three pillars 41C approximately evenly into three spaces in which the three planetary gears 53 are respectively housed.

[0050] The second part 41B has three shaft insert holes 413 (refer to FIG. 5), which are provided through the second part 41B to respective face one to one the three shaft insert holes 412 of the first part 41A in the X-axis direction. The respective rear end portions of the three shafts 530 of the three planetary gears 53 are inserted into the three shaft insert holes 413.

[0051] Thus, the three planetary gears 53 are supported rotatably by the increased diameter portion 41 by having the three shafts 530 thereof inserted into the three shaft insert holes 412 of the first part 41A and the three shaft insert holes 413 of the second part 41B.

[0052] As shown in FIG. 5, the second part 41B has an insert hole 414 as a center hole thereof. Also, the body 40 formed continuously and integrally with the first part 41A has an undercut recess 401, which is provided through a central area of the rear end surface thereof to face the insert hole 414, as shown in FIG. 5. The rotary shaft 310 of the motor 31 is inserted and passed through the insert hole 414. In addition, the sun gear 52, formed continuously and integrally with the rotary shaft 310, has a tip portion thereof inserted into the undercut recess 401 without contacting with the inner peripheral surface thereof, while meshing with the three planetary gears 53.

[0053] Note that an annular sheet member (made of felt, for example), covering the three shaft insert holes 413 from the positive side of the X-axis, is also disposed on the rear surface of the second part 41B. The annular sheet member as well as the sheet member T1, substantially prevents the lubricant from flowing out of the speed reducer mechanism 5. In addition, the annular sheet member also reduces the chances of the shafts 530 coming into contact with, and scratching, surrounding parts thereof while the planetary gears 53 are turning.

[0054] The extended portion 42 is an annular part. Specifically, the extended portion 42 has the shape of a circular cylinder, which is compressed in the X-axis direction and of which both ends are opened. The extended portion 42 may be a metallic part, for example. The extended portion 42 is provided separately from at least the body 40. In this embodiment, the increased diameter portion 41 is formed continuously and integrally with the body 40. Thus, the extended portion 42 is provided separately from both the body 40 and the increased diameter portion 41. The body 40 and the increased diameter portion 41 are fitted and fixed into the extended portion 42 from the negative side of the X-axis (i.e., from in front of the extended portion 42). In this case, the first part 41A is inserted to reach the rear opening of the extended portion 42 and fixed there to close the rear opening. Meanwhile, the second part 41B, the three pillars 41C, and the three planetary gears 53 housed in the gap SP1 are arranged behind the rear opening of the extended portion 42. In such a state, the three planetary gears 53 mesh with the ring gear 51. As a result, the extended portion 42 is extended from the edge portion of the increased diameter portion 41 toward the hammer 11 as shown in FIG. 1. The center axis of the extended portion 42 is aligned with the center axis of the body 40.

[0055] The extended portion 42 is fitted and fixed into the bearing member 6. In this embodiment, the bearing member 6 is configured as a bearing C1 as will be described later. Thus, the extended portion 42 is disposed inside the inner ring 61 of the bearing C1 and supported by the bearing C1 to rotate along with the inner ring 61 as shown in FIGS. 1, 6A, and 6B. Thus, the body 40 is supported rotatably by the bearing member 6 via the increased diameter portion 41 and the extended portion 42.

[0056] As the sun gear 52, which is continuous and integrated with the rotary shaft 310 of the motor 31, turns, the three planetary gears 53 also turn inside the ring gear 51 along the circumference of the ring gear 51. As a result, the body 40, the increased diameter portion 41, and the extended portion 42 rotate along with each other.

[0057] As shown in FIGS. 1 and 4, the extended portion 42 has an outer projection 421, which protrudes outward along the radius thereof. The outer projection 421 is a flange-shaped part. Specifically, the outer projection 421 protrudes outward from the front peripheral edge portion of the extended portion 42 along the entire circumference thereof. In addition, the extended portion 42 is positioned by hooking the outer projection 421 onto the end surface 610, facing the output shaft 13, of the inner ring 61 from one side where the output shaft 13 is located (i.e., from in front of the extended portion 42). This makes it easier to regulate the movement of the extended portion 42 away from the output shaft 13 (i.e., its backward movement) with respect to the bearing member 6.

[0058] In addition, the extended portion 42 also has an inner projection 422, which protrudes inward along the radius thereof, as shown in FIGS. 1 and 4. Specifically, the inner projection 422 protrudes inward from the rear peripheral edge portion of the extended portion 42 along the entire circumference thereof. The increased diameter portion 41 is positioned by hooking the protrusion 411 onto the inner projection 422 from the side where output shaft 13 is located (i.e., from in front of the extended portion 42). This makes it easier to regulate the movement of the increased diameter portion 41 away from the output shaft 13 (i.e., its backward movement) with respect to the extended portion 42.

[0059] The bearing member 6 supports the drive shaft 4 rotatably. Particularly, the bearing member 6 supports the drive shaft 4 rotatably in contact with the extended portion 42. In this embodiment, the bearing member 6 is disposed closer to the output shaft 13 than the speed reducer mechanism 5 is along the axis A1 of the drive shaft 4. In this embodiment, the bearing member 6 is configured as the bearing C1. As shown in FIGS. 1, 4, and 6B, the bearing member 6 includes the inner ring 61, an outer ring 62, and a plurality of rolling elements (balls) 63 held between the inner ring 61 and the outer ring 62. Note that in the example illustrated in FIGS. 1, 4, and 6B, illustration of a holder for holding the plurality of rolling elements 63 between the inner ring 61 and the outer ring 62 is omitted.

[0060] The bearing member 6 supports the drive shaft 4 rotatably with at least a part of the spring 12 (e.g., an end portion thereof on the positive side of the X-axis in this example) disposed inside the bearing member 6. In other words, the bearing member 6 is arranged outside of the spring 12 to surround the spring 12 with its inner ring 61.

[0061] In addition, the bearing member 6 is interposed between the hammer 11 and the speed reducer mechanism 5 along the axis A1 of the drive shaft 4.

[0062] The spring 12 biases the hammer 11 toward the output shaft 13. Specifically, the spring 12 is configured as a conical coil spring, of which the diameter slightly decreases in the positive direction of the X-axis. With the body 40 of the drive shaft 4 inserted and passed therethrough, the spring 12 is interposed between the hammer 11 and the increased diameter portion 41 of the drive shaft 4.

[0063] As shown in FIG. 1, the impact mechanism IM1 further includes a plurality of steel spheres 18 (only two of which are shown in FIG. 1) and a ring member 19, all of which are interposed between the hammer 11 and the spring 12. The hammer body 110 has, on end surface thereof on the positive side of the X-axis (i.e., on a rear end surface), a recess 113 to house an end portion of the spring 12 on the negative side of the X-axis (refer to FIG. 1). The recess 113 is an annular recess which is depressed in the negative direction of the X-axis when viewed from the positive side of the X-axis. The plurality of steel spheres 18 are arranged inside the annular recess 113 along the circumference thereof. In addition, the ring member 19 is further arranged inside the recess 113 to cover the plurality of steel spheres 18 from behind the steel spheres 18. The end portion of the spring 12 on the negative side of the X-axis is housed in the recess 113 while biasing the ring member 19 forward. This makes the hammer 11 rotatable with respect to the spring 12. The hammer 11 receives the biasing force applied from the spring 12 toward the impact receiver 14 of the output shaft 13 in the direction aligned with the axis A1 of the drive shaft 4.

[0064] The case 15 houses the drive shaft 4, the speed reducer mechanism 5, the bearing member 6, the hammer 11, the spring 12, the output shaft 13, the two steel spheres 16, and other members inside. The case 15 has substantially the same shape as an end portion of the barrel 21 of the housing 2 on the negative side of the X-axis (i.e., a frontend portion of the barrel 21). The case 15 is formed in a slightly smaller size than the frontend portion of the barrel 21 so that the case 15 is fitted into the frontend portion of the barrel 21 with almost no gap left between the case 15 and the barrel 21.

[0065] As shown in FIG. 1, the case 15 includes a cover 15A and an attachment base 15B.

[0066] The cover 15A may be made of an alloy, for example. The cover 15A has the shape of a cylinder, both ends of which in the X-axis direction are opened. As shown in FIG. 1, the cover 15A has a first opening 151 (as a front opening) and a second opening 152 (as a rear opening) at both ends thereof in the X-axis direction. The cover 15A is formed to have its diameter gradually decreased from a middle in the X-axis direction toward the first opening 151 such that the shorter the distance to the first opening 151 is, the smaller the diameter of the cover 15A is. The aperture area of the first opening 151 is smaller than the aperture area of the second opening 152.

[0067] The cover 15A houses the hammer 11 to surround the hammer 11 entirely. In addition, the cover 15A also houses the drive shaft 4 and the spring 12 to surround the drive shaft 4 and the spring 12 entirely. Furthermore, the cover 15A also houses the output shaft 13 to surround the output shaft 13 with a part of the output shaft 13 (i.e., its tip on the negative side of the X-axis) sticking out of the first opening 151.

[0068] The attachment base 15B has electrical insulation properties. The attachment base 15B may be made of a synthetic resin, for example. The attachment base 15B substantially has the shape of a circular cylinder which is compressed in the X-axis direction as a whole. One end portion of the attachment base 15B on the negative side of the X-axis is opened. A bottom portion 153 (refer to FIG. 1) of the attachment base 15B has a shaft hole 154, which penetrates through the bottom portion 153 in the X-axis direction. The rotary shaft 310 of the motor 31 is disposed with its tip portion protruding through the shaft hole 154 from the bottom portion 153 toward the negative side of the X-axis.

[0069] The attachment base 15B has an inner peripheral surface, of which the inside diameter decreases stepwise toward the bottom portion 153. Such a stepwise inner peripheral surface defines a first housing portion H1 and a second housing portion H2, of which the inside diameter is smaller than that of the first housing portion H1. In other words, the attachment base 15B includes the first housing portion H1 and the second housing portion H2 inside.

[0070] The first housing portion H1 is configured to house the bearing member 6. The second housing portion H2 is configured to house the speed reducer mechanism 5. The first housing portion H1 is a spatial region, which is defined inside the attachment base 15B closer to the opening thereof. The second housing portion H2 is a spatial region, which is defined inside the attachment base 15B closer to the bottom portion 153. That is to say, the first housing portion H1, the second housing portion H2, and the bottom portion 153 are arranged side by side in this order in the positive direction of the X-axis.

[0071] The attachment base 15B holds the ring gear 51 of the speed reducer mechanism 5 in the second housing portion H2. The ring gear 51 may be insert-molded with respect to the attachment base 15B, for example. That is to say, the ring gear 51 is fixed to the attachment base 15B.

[0072] The attachment base 15B also holds the bearing member 6 in the first housing portion H1. The bearing member 6 is arranged such that an end portion thereof on the negative side of the X-axis slightly protrudes in the negative direction of the X-axis with respect to the first housing portion H1 (refer to FIG. 1). The protruding portion of the bearing member 6 is held by the cover 15A.

[0073] Specifically, the cover 15A is formed such that the inside diameter of the inner peripheral surface thereof adjacent to the second opening 152 (i.e., the rear opening) decreases stepwise toward the front end thereof. In other words, the cover 15A has, on its inner peripheral surface adjacent to the second opening 152, a first recess R1 and a second recess R2, of which the inside diameter is larger than the inside diameter of the first recess R1. The second recess R2 is located on the positive side of the X-axis with respect to the first recess R1.

[0074] The cover 15A is assembled onto the attachment base 15B by fitting an outer peripheral wall W1 of the attachment base 15B (refer to FIG. 1) into the second recess R2. The outer peripheral surface of the outer peripheral wall W1 has a groove, into which an O-ring G2 is fitted. Providing the O-ring G2 allows the cover 15A to be assembled with good stability onto the attachment base 15B while reducing the chances of foreign matter (such as powder dust or water) entering the case 15 through the gap between the outer peripheral wall W1 and the inner peripheral surface of the second recess R2.

[0075] In addition, the cover 15A and the attachment base 15B hold the bearing member 6 to sandwich the outer ring 62 of the bearing member 6 between the first recess R1 and the first housing portion H1 as shown in FIG. 1. Consequently, the bearing member 6 may be positioned with good stability inside the case 15.

(2.3) Advantages

[0076] In this embodiment, the bearing member 6 is disposed closer to the output shaft 13 than the speed reducer mechanism 5 is (i.e., disposed forward of the speed reducer mechanism 5; stated otherwise, located on the negative side of the X-axis with respect to the speed reducer mechanism 5) as indicated by the virtual line Y1 (one-dot chain) and the open arrows in FIG. 1. Thus, there is no need to leave a space for disposing the bearing member 6 on an opposite side from the output shaft 13 with respect to the speed reducer mechanism 5 (i.e., behind the speed reducer mechanism 5; stated otherwise, on the positive side of the X-axis with respect to the speed reducer mechanism 5). In addition, this makes it easier to dispose the bearing member 6 at the same position as the spring 12 along the axis A1. This contributes to reducing the dimension of the tool along the axis A1 of the drive shaft 4.

[0077] Particularly when work needs to be performed above the ceiling or when a built-in kitchen, a toilet, or a modular bath needs to be installed, for example, the workspace tends to be relatively narrow. Thus, there has been a significantly increasing demand, among installers who often have to perform the work of fastening screws using an impact rotary tool in such a narrow workspace, for reducing the dimension of the tool along the axis of the drive shaft. The impact rotary tool 1 according to this embodiment adopts the above-described arrangement and structure for the bearing member 6, thus reducing the dimensions of the tool and thereby immensely contributing to meeting such a demand.

[0078] In addition, according to this embodiment, the bearing member 6 supports the drive shaft 4 rotatably with at least a part of the spring 12 disposed inside the bearing member 6. That is to say, the bearing member 6 is arranged outside of the spring 12 to surround the spring 12. Thus, disposing the bearing member 6 in the space surrounding the spring 12, which often tends to be a vacant space in the drive block 10, enables making effective use of the space surrounding the spring 12, thus making it easier to reduce the dimension of the tool along the axis A1. Furthermore, according to this embodiment, the bearing member 6 is interposed between the hammer 11 and the speed reducer mechanism 5 along the axis A1 of the drive shaft 4, thus enabling making more effective use of the space surrounding the spring 12 and thereby making it easier to reduce the dimension of the tool along the axis A1.

[0079] Furthermore, the drive shaft 4 includes the body 40, the increased diameter portion 41, and the extended portion 42, thus making it easier to provide such a configuration in which the bearing member 6 is disposed closer to the output shaft 13 than the speed reducer mechanism 5 is.

[0080] In particular, according to this embodiment, the extended portion 42 is provided separately from the body 40, thus achieving the following advantage. Specifically, in the manufacturing process of an impact rotary tool 1, the hammer 11 needs to be smoothly slid (moved with thrusting force) with respect to the body 40 by subjecting the surface of the body 40 to surface treatment (such as polishing treatment). If the extended portion 42 and the body 40 were formed continuously and integrally with each other, then the extended portion 42 would impede the surface treatment being conducted on the body 40. In contrast, providing the extended portion 42 separately from the body 40 as in this embodiment makes it easier to conduct the surface treatment on the body 40, for example.

[0081] In addition, according to this embodiment, the extended portion 42 includes the flange-shaped outer projection 421 and is positioned by hooking the outer projection 421 onto the end surface 610 of the inner ring 61 from the front. Furthermore, the extended portion 42 includes the inner projection 422 and the increased diameter portion 41 is positioned by hooking the flange-shaped protrusion 411 onto the inner projection 422 from in front of the extended portion 42.

[0082] In short, the two parts of the drive shaft 4, namely, the increased diameter portion 41 formed continuously and integrally with the body 40 and the extended portion 42, may be coupled to each other in this order in the same direction (in the backward direction) with respect to the bearing member 6. This enables having the assembling work done more efficiently during the manufacturing process.

[0083] Furthermore, the two parts of the drive shaft 4, namely, the increased diameter portion 41 formed continuously and integrally with the body 40 and the extended portion 42, are coupled to each other with their backward movement regulated with respect to the bearing member 6. While the work of fastening a screw is performed using the impact rotary tool 1, the impact rotary tool 1 receives a load applied in the positive direction of the X-axis (i.e., in the backward direction) from the target of the screw fastening work. In this respect, the impact rotary tool 1 has a coupling structure for regulating the backward movement of the increased diameter portion 41 and the extended portion 42, thus enabling providing an exceptionally reliable tool.

(3) Variations

[0084] Note that the embodiment described above is only an exemplary one of various embodiments of the present disclosure and should not be construed as limiting. Rather, the exemplary embodiment may be readily modified in various manners depending on a design choice or any other factor without departing from the scope of the present disclosure.

[0085] Next, variations of the exemplary embodiment will be enumerated one after another. In the following description, the exemplary embodiment described above will be hereinafter sometimes referred to as a "basic example." Note that each of the variations to be described below may be adopted as appropriate in combination with either the basic example or any other variation.

[0086] In the basic example described above, the body 40 and the increased diameter portion 41 are formed continuously and integrally in the drive shaft 4. However, this is only an example and should not be construed as limiting. Alternatively, the body 40 and the increased diameter portion 41 may be provided separately from each other. For example, the increased diameter portion 41 and the extended portion 42 may be formed continuously and integrally with each other but provided separately from the body 40. Still alternatively, the body 40, the increased diameter portion 41, and the extended portion 42 may be all formed continuously and integrally with each other.

[0087] In the basic example described above, the outer projection 421 of the extended portion 42 is formed along the entire circumference of the peripheral edge portion thereof. However, this is only an example and should not be construed as limiting. Alternatively, a plurality of outer projections 421 may be formed intermittently along the circumference of the peripheral edge portion.

[0088] Likewise, in the basic example described above, the inner projection 422 of the extended portion 42 is formed along the entire circumference of the peripheral edge portion thereof. However, this is only an example and should not be construed as limiting. Alternatively, a plurality of inner projections 422 may be formed intermittently along the circumference of the peripheral edge portion.

[0089] Likewise, in the basic example described above, the protrusion 411 of the increased diameter portion 41 is formed along the entire circumference of the peripheral edge portion thereof. However, this is only an example and should not be construed as limiting. Alternatively, a plurality of protrusions 411 may be formed intermittently along the circumference of the peripheral edge portion.

[0090] In the basic example described above, the impact rotary tool 1 is an impact screwdriver as an example. However, the impact rotary tool 1 does not have to be an impact screwdriver but may also be an impact wrench, for example.

(4) Recapitulation

[0091] As can be seen from the foregoing description, an impact rotary tool (1) according to a first aspect includes a drive shaft (4), a speed reducer mechanism (5), an output shaft (13), a hammer (11), a spring (12), and a bearing member (6). The speed reducer mechanism (5) transmits rotational force of a shaft (rotary shaft 310) of a motor (31) to the drive shaft (4). The output shaft (13) receives rotational force from the drive shaft (4) and transmits the rotational force to a tip tool (B1). The hammer (11) is supported rotatably by the drive shaft (4) and strikes the output shaft (13). The spring (12) biases the hammer (11) toward the output shaft (13). The bearing member (6) supports the drive shaft (4) rotatably. The bearing member (6) is disposed closer to the output shaft (13) than the speed reducer mechanism (5) is along an axis (A1) of the drive shaft (4). According to the first aspect, the bearing member (6) is disposed closer to the output shaft (13) than the speed reducer mechanism (5) is, thus contributing to reducing the dimension of the tool along the axis (A1) of the drive shaft (4).

[0092] In an impact rotary tool (1) according to a second aspect, which may be implemented in conjunction with the first aspect, the bearing member (6) supports the drive shaft (4) rotatably with at least a part of the spring (12) disposed inside the bearing member (6). The second aspect makes it easier to reduce the dimensions of the tool.

[0093] In an impact rotary tool (1) according to a third aspect, which may be implemented in conjunction with the first or second aspect, the bearing member (6) is interposed between the hammer (11) and the speed reducer mechanism (5) along the axis (A1) of the drive shaft (4). The third aspect makes it easier to reduce the dimensions of the tool.

[0094] In an impact rotary tool (1) according to a fourth aspect, which may be implemented in conjunction with any one of the first to third aspects, the drive shaft (4) includes a body (40) supporting the hammer (11) rotatably, an increased diameter portion (41), and an extended portion (42) having an annular shape. The increased diameter portion (41) protrudes radially outward from the body (40) and is arranged to position the spring (12) between the hammer (11) and the increased diameter portion (41) itself. The extended portion (42) is extended from an edge portion of the increased diameter portion (41) toward the hammer (11). The bearing member (6) is in contact with the extended portion (42) to support the drive shaft (4) rotatably. The fourth aspect makes it easier to provide an arrangement in which the bearing member (6) is disposed closer to the output shaft (13) than the speed reducer mechanism (5) is.

[0095] In an impact rotary tool (1) according to a fifth aspect, which may be implemented in conjunction with the fourth aspect, the increased diameter portion (41) is provided continuously and integrally with the body (40). The fifth aspect may reduce an increase in the number of parts required.

[0096] In an impact rotary tool (1) according to a sixth aspect, which may be implemented in conjunction with the fourth or fifth aspect, the extended portion (42) is provided separately from at least the body (40). The sixth aspect makes it easier to conduct surface treatment (such as polishing treatment) on the body (40), for example, than in an arrangement in which the extended portion (42) is formed continuously and integrally with the body (40).

[0097] In an impact rotary tool (1) according to a seventh aspect, which may be implemented in conjunction with any one of the fourth to sixth aspects, the bearing member (6) is configured as a bearing (C1). The extended portion (42) is disposed inside an inner ring (61) of the bearing (C1) and supported by the bearing (C1) to rotate along with the inner ring (61). The seventh aspect makes it easier to provide an arrangement in which the bearing member (6) is disposed closer to the output shaft (13) than the speed reducer mechanism (5) is.

[0098] In an impact rotary tool (1) according to an eighth aspect, which may be implemented in conjunction with the seventh aspect, the extended portion (42) includes an outer projection (421) protruding outward along a radius thereof. The extended portion (42) is positioned by hooking the outer projection (421) thereof onto an end surface (610), facing the output shaft (13), of the inner ring (61) from one side where the output shaft (13) is located. The eighth aspect makes it easier to regulate the movement of the extended portion (42) away from the output shaft (13) with respect to the bearing member (6).

[0099] In an impact rotary tool (1) according to a ninth aspect, which may be implemented in conjunction with any one of the fourth to eighth aspects, the extended portion (42) is provided separately from the increased diameter portion (41). The extended portion (42) includes an inner projection (422) protruding inward along a radius thereof. The increased diameter portion (41) includes a protrusion (411) protruding outward along a radius thereof. The increased diameter portion (41) is positioned by hooking the protrusion (411) thereof onto the inner projection (422) from one side where the output shaft (13) is located. The ninth aspect makes it easier to regulate the movement of the increased diameter portion (41) away from the output shaft (13) with respect to the extended portion (42).

[0100] Note that the constituent elements according to the second to ninth aspects are not essential constituent elements for the impact rotary tool (1) but may be omitted as appropriate.

Reference Signs List

[0101]

1	Impact Rotary Tool
4	Drive Shaft
40	Body
41	Increased Diameter Portion
411	Protrusion
42	Extended Portion
421	Outer Projection
422	Inner Projection
5	Speed Reducer Mechanism
6	Bearing Member
61	Inner Ring
610	End Surface
11	Hammer
12	Spring
13	Output Shaft
31	Motor

310 Rotary Shaft
A1 Axis
B1 Tip Tool
C1 Bearing

Claims

1. An impact rotary tool comprising:

a drive shaft;
a speed reducer mechanism configured to transmit rotational force of a shaft of a motor to the drive shaft;
an output shaft configured to receive rotational force from the drive shaft and transmit the rotational force to a tip tool;
a hammer supported rotatably by the drive shaft and configured to strike the output shaft;
a spring biasing the hammer toward the output shaft; and
a bearing member supporting the drive shaft rotatably,
the bearing member being disposed closer to the output shaft than the speed reducer mechanism is along an axis of the drive shaft.

2. The impact rotary tool of claim 1, wherein the bearing member supports the drive shaft rotatably with at least a part of the spring disposed inside the bearing member.

3. The impact rotary tool of claim 1 or 2, wherein the bearing member is interposed between the hammer and the speed reducer mechanism along the axis of the drive shaft.

4. The impact rotary tool of any one of claims 1 to 3, wherein
the drive shaft includes:

a body supporting the hammer rotatably;
an increased diameter portion protruding radially outward from the body and arranged to position the spring between the hammer and the increased diameter portion itself; and
an extended portion having an annular shape and extended from an edge portion of the increased diameter portion toward the hammer, and
the bearing member is in contact with the extended portion to support the drive shaft rotatably.

5. The impact rotary tool of claim 4, wherein the increased diameter portion is provided continuously and integrally with the body.

6. The impact rotary tool of claim 4 or 5, wherein the extended portion is provided separately from at least the body.

7. The impact rotary tool of any one of claims 4 to 6, wherein

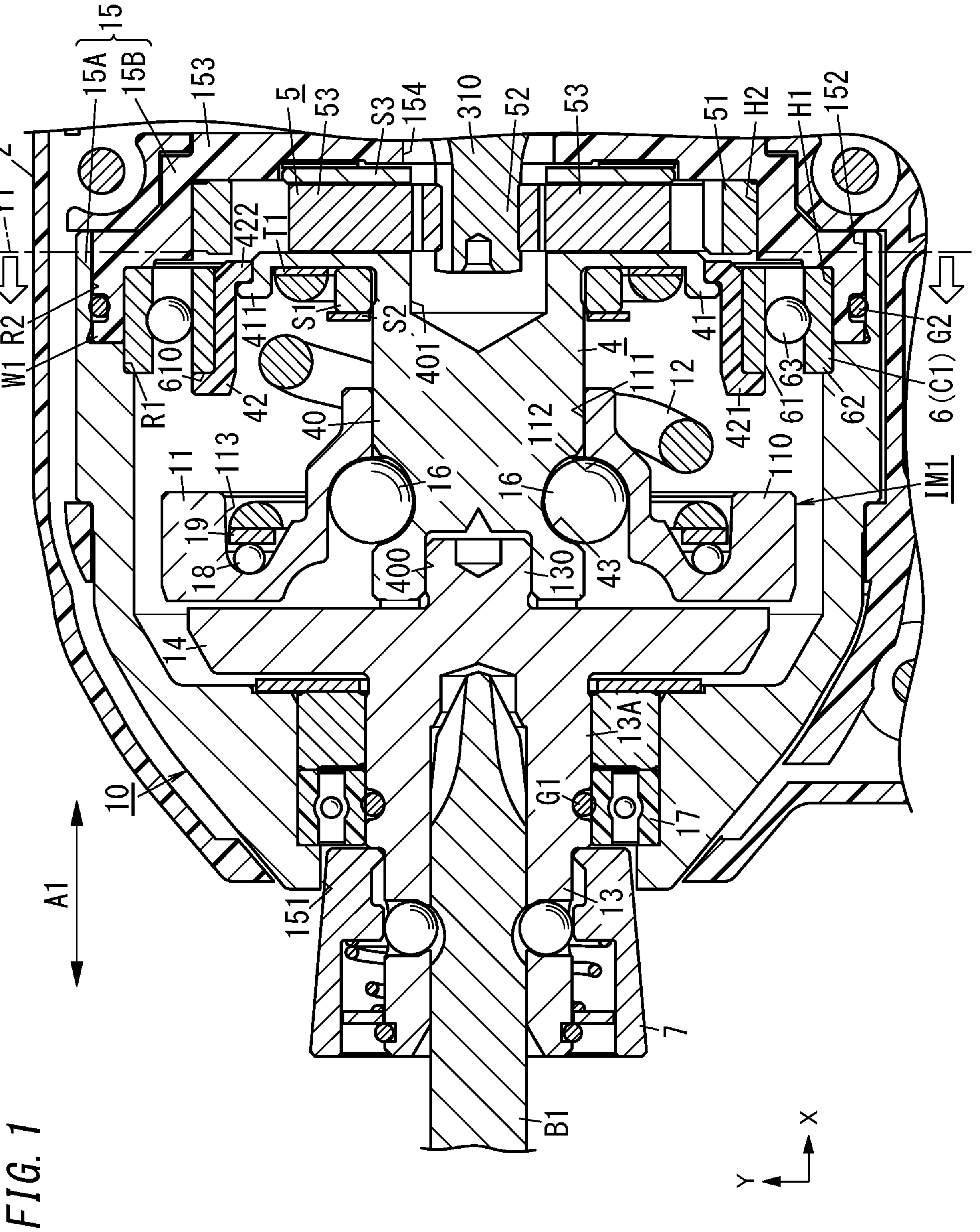
the bearing member is configured as a bearing, and
the extended portion is disposed inside an inner ring of the bearing and supported by the bearing to rotate along with the inner ring.

8. The impact rotary tool of claim 7, wherein

the extended portion includes an outer projection protruding outward along a radius thereof, and
the extended portion is positioned by hooking the outer projection thereof onto an end surface, facing the output shaft, of the inner ring from one side where the output shaft is located.

9. The impact rotary tool of any one of claims 4 to 8, wherein

the extended portion is provided separately from the increased diameter portion,
the extended portion includes an inner projection protruding inward along a radius thereof,
the increased diameter portion includes a protrusion protruding outward along a radius thereof, and
the increased diameter portion is positioned by hooking the protrusion onto the inner projection from one side where the output shaft is located.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15A
15B
153
5
53
S3
154
310
52
53
51
H2
H1
152
2
Y1
422
T1
411
S1
S2
401
4
41
W1
R2
R1
610
42
40
111
12
112
421
61
63
62
G2
6(C1)
11
113
19
18
16
16
110
IM1
400
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13A
G1
17
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151
13
7
A1
B1
X
Y

FIG. 1

FIG. 2

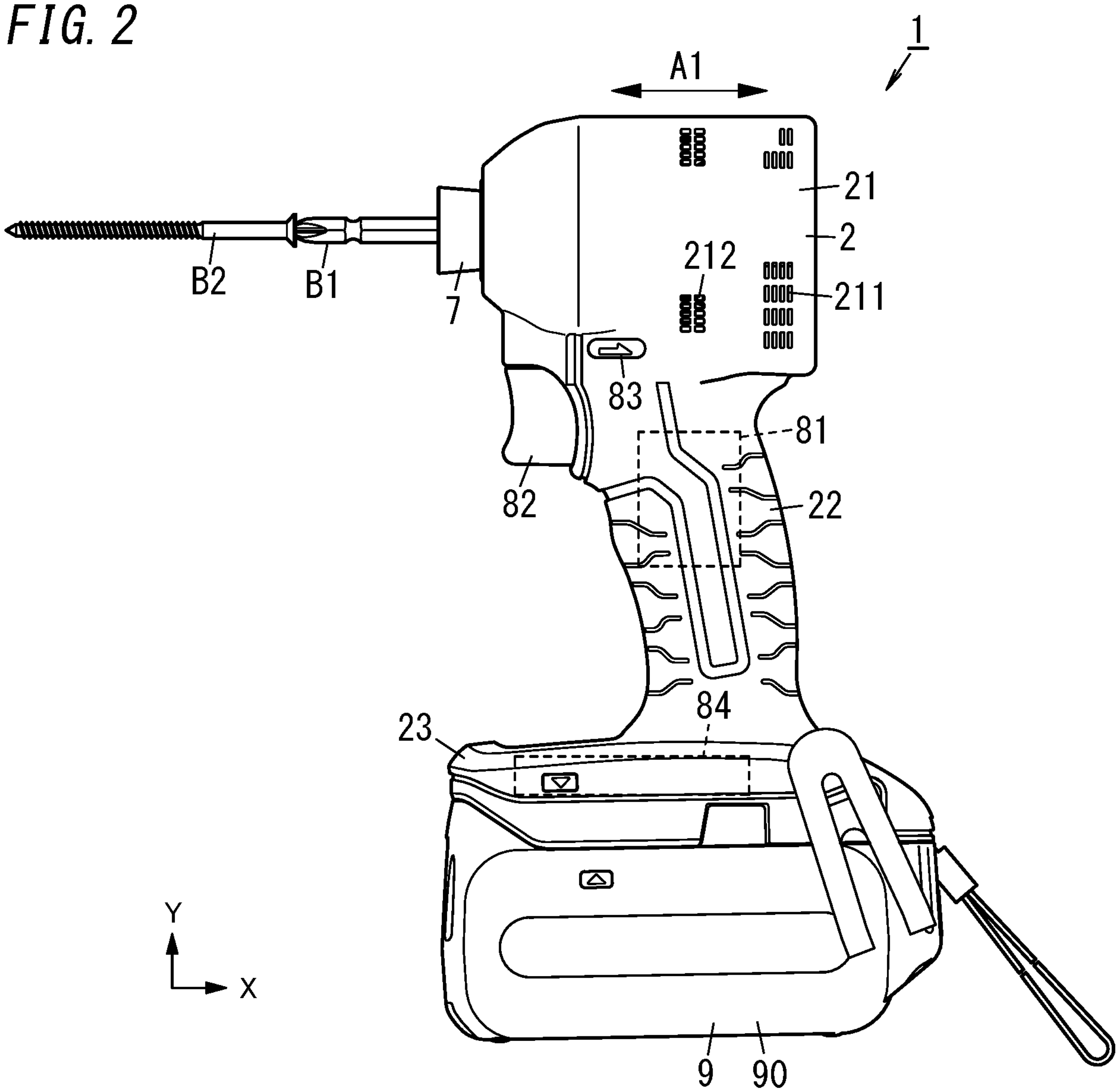


FIG. 3

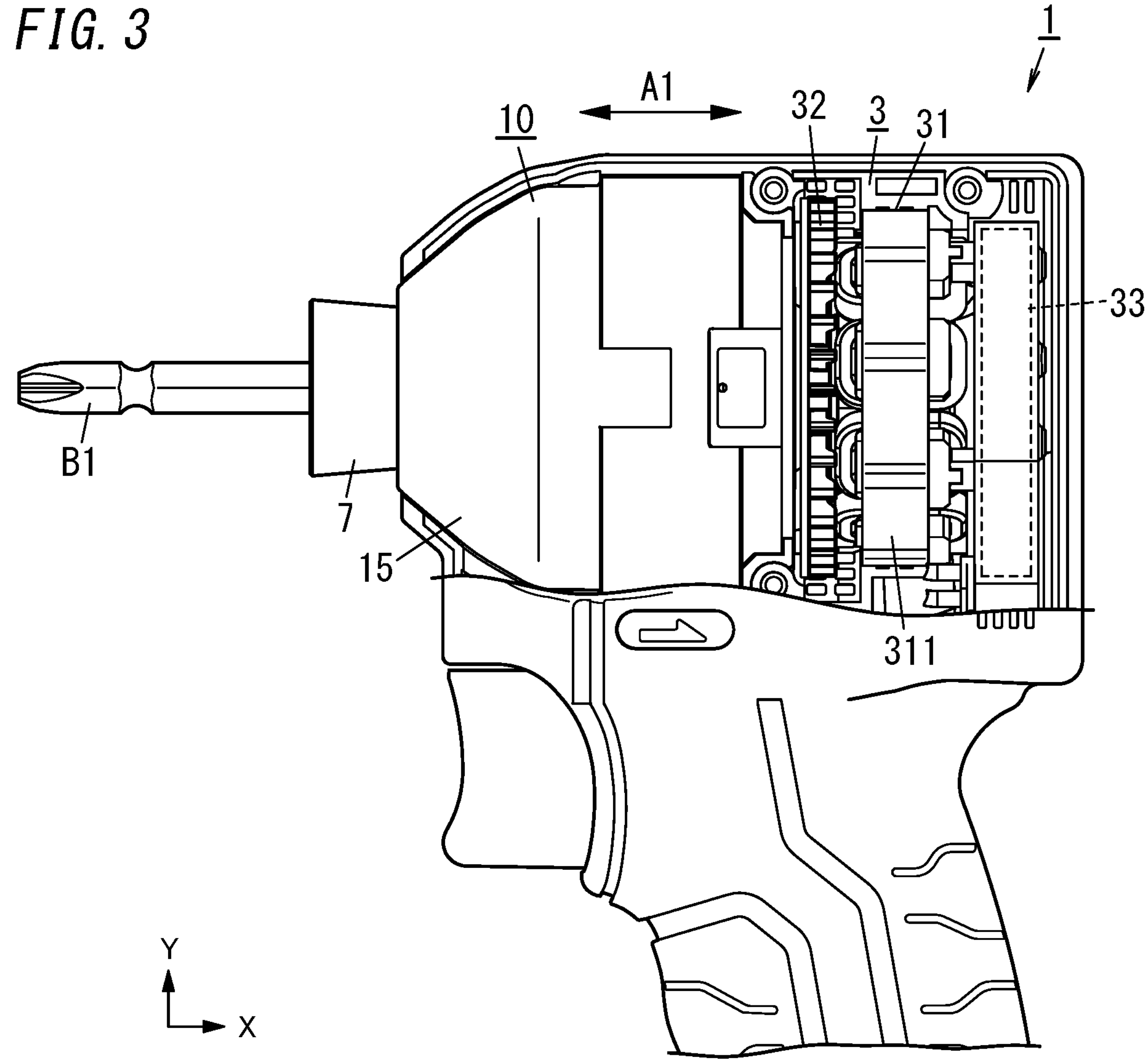


FIG. 4

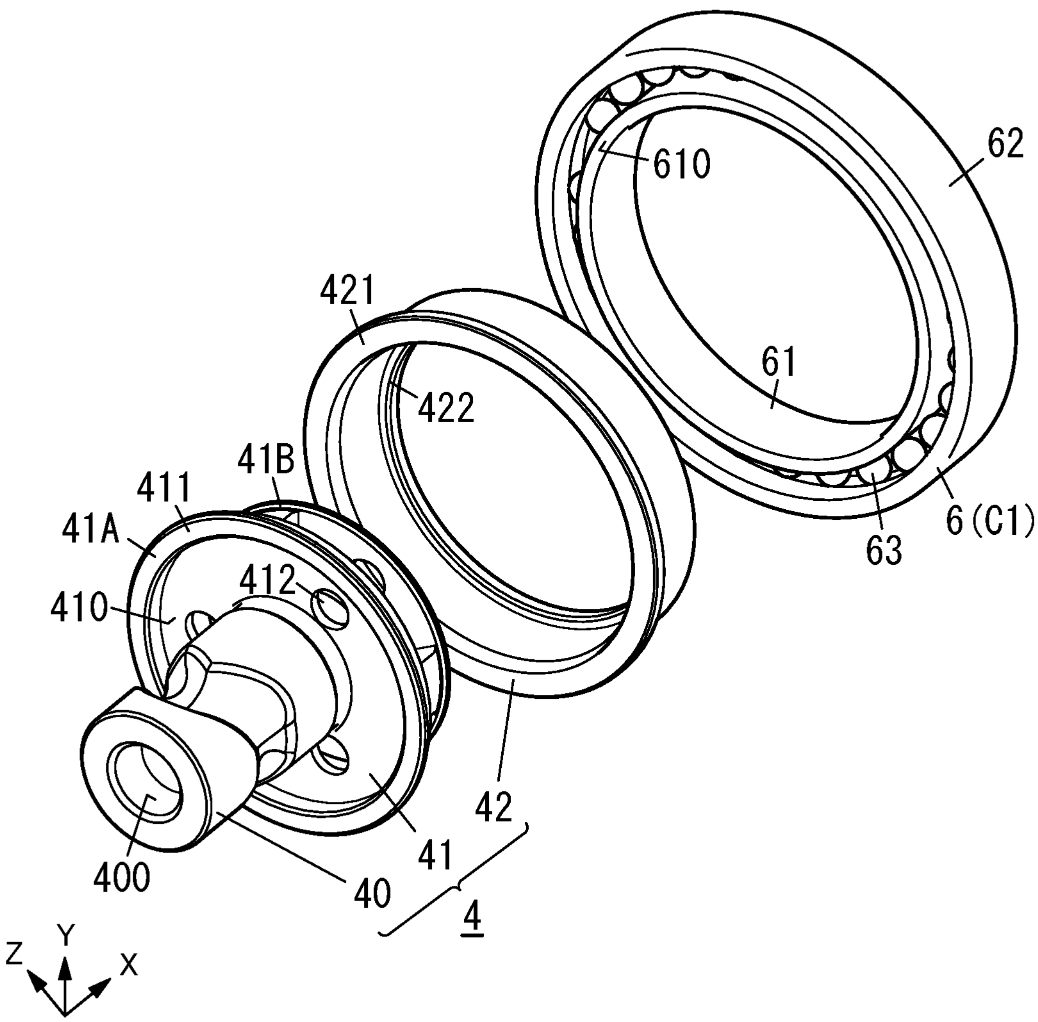


FIG. 5

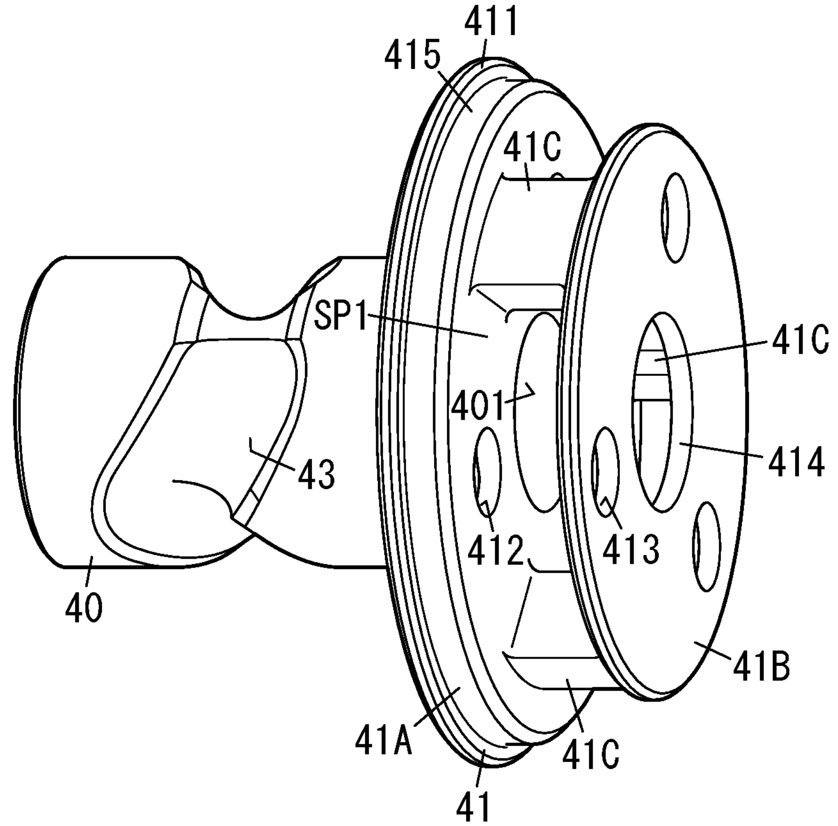


FIG. 6A

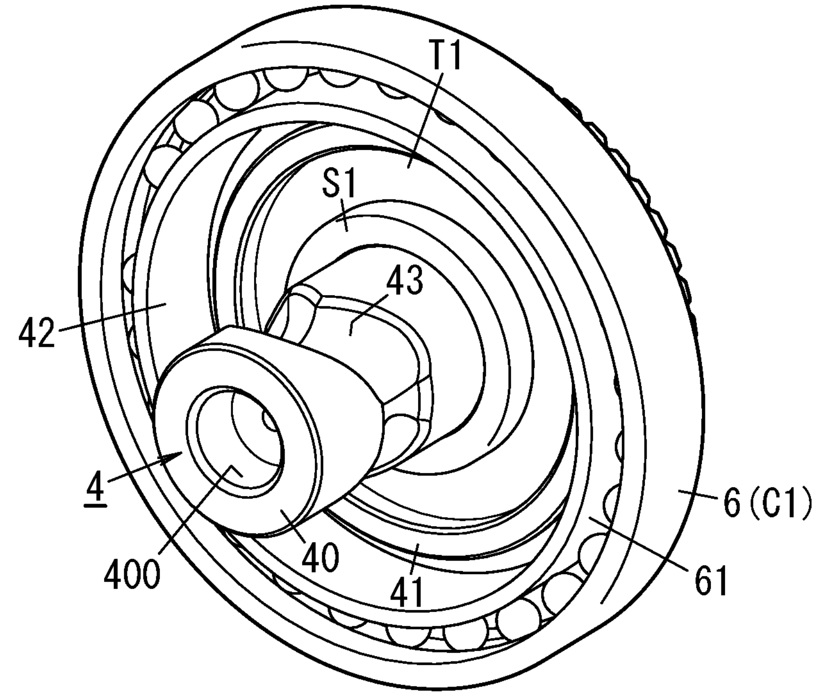
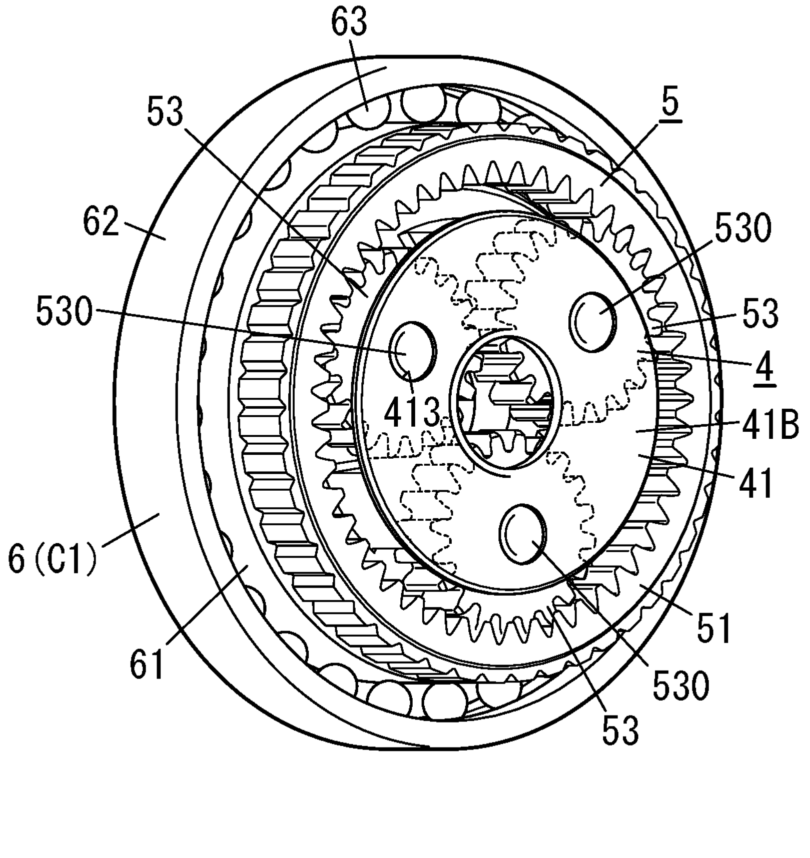

T1
S1
43
42
4
400
40
41
6(C1)
61

FIG. 6B


63
53
5
62
530
530
53
4
413
41B
41
6(C1)
51
61
530
53

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2021/023979

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. B25B21/02(2006.01)i
FI: B25B21/02G

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. B25B21/00-21/02

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2019-98450 A (MAKITA CORPORATION) 24 June 2019 (2019-06-24), paragraphs [0009], [0013], [0014], [0016], fig. 3, 4	1-9 2
X Y	JP 4457170 B1 (KUKEN CO., LTD.) 28 April 2010 (2010-04-28), paragraphs [0032]-[0042], [0048]-[0050], [0089], [0091], fig. 1, 2, 5	1-9 2
X Y	US 2010/0071923 A1 (RUDOLPH, S. M.) 25 March 2010 (2010-03-25), paragraphs [0053]-[0055], [0071], fig. 1-4, 13, 14	1-9 2
X Y	JP 2014-200884 A (MAKITA CORPORATION) 27 October 2014 (2014-10-27), paragraphs [0022]-[0024], fig. 2	1, 3-9 2

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
27 August 2021	07 September 2021

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/023979

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2010-504220 A (ROBERT BOSCH GMBH) 12 February 2010 (2010-02-12), paragraphs [0014], [0016], fig. 1, 2	1, 3-9 2
X Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 98703/1991 (Laid-open No. 49267/1993) (RYOBI LTD.) 29 June 1993 (1993-06-29), paragraph [0008], fig. 1	1, 3-9 2

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/023979

JP 2019-98450 A	24 June 2019	US 2019/0160636 A1 paragraphs [0029]-[0031], [0037]-[0039], [0042], fig. 3, 4 DE 102018130309 A1 CN 109909956 A
JP 4457170 B1	28 April 2010	US 2012/0073845 A1 paragraphs [0046]-[0056], [0062]-[0064], [0108], [0110], fig. 1, 2, 5 WO 2010/140268 A1 EP 2439021 A1 CN 102458772 A
US 2010/0071923 A1	25 March 2010	EP 2168724 A1 CN 201808050 U
JP 2014-200884 A	27 October 2014	US 2015/0364972 A1 paragraphs [0079]-[0087], fig. 2 WO 2014/162772 A1 DE 212014000099 U1 CN 205184693 U
JP 2010-504220 A	12 February 2010	US 2010/0224033 A1 paragraphs [0015], [0017], fig. 1, 2 WO 2008/037530 A1 DE 102006045842 A1 CN 101516577 A
JP 5-49267 U1	29 June 1993	US 5361853 A column 4, line 40 to column 5, line 5, fig. 1 DE 4239799 A1

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