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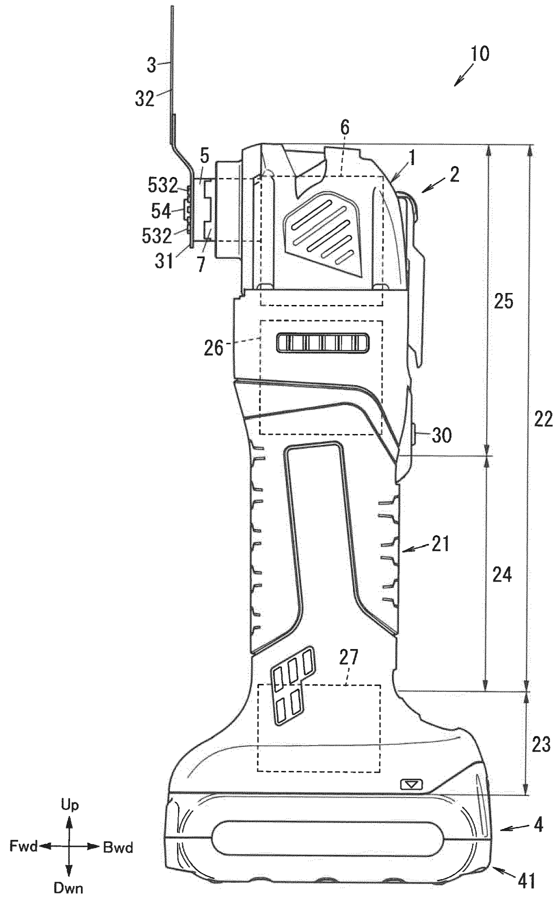
(54) **TOOL AND TOOL SYSTEM**

(57) The present disclosure provides a tool and tool system that allows the user to change the orientation of a bit held by the tool even without removing the bit from the tool. A tool (1) according to an embodiment includes: a housing (21) having a grip (24); a holder (5) with the ability to hold a bit (3); an oscillating rotary mechanism (6) to generate power that imparts an oscillating rotary motion to the holder (5); and an adjustment mechanism (70). The adjustment mechanism (70) switches the state of the holder (5) between a prohibited state and a permitted state. The prohibited state is a state in which the holder (5) is prohibited from rotating around a virtual axis with respect to the grip (24) unless the holder (5) is supplied with the power. The permitted state is a state in which the holder (5) is permitted to rotate around the axis with respect to the grip (24) even when the holder (5) is not supplied with the power.

FIG. 1



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Description

Technical Field

[0001] The present disclosure generally relates to a tool and a tool system, and more particularly relates to a tool with the ability to impart an oscillating rotary motion to a bit and a tool system including the bit and the tool.

Background Art

[0002] An electric power tool as disclosed in JP 2017-127943 A is an exemplary electric power tool for producing an oscillating rotary motion of a bit. According to JP 2017-127943 A, after a cutting edge is temporarily attached onto the electric power tool, a pin is inserted into respective holes of the cutting edge and a tip of the electric power tool such that the cutting edge is clamped between the pin and the tip of the electric power tool. This allows the cutting edge to be secured onto the electric power tool.

[0003] The electric power tool of JP 2017-127943 A requires, when the user needs to change the orientation of the cutting edge with respect to the electric power tool for the sake of convenience of machining, for example, the user to remove the cutting edge once from the electric power tool, change the orientation of the cutting edge, and then attach the cutting edge to the electric power tool all over again. Thus, the electric power tool does not allow him or her to change the orientation of the cutting edge easily.

[0004] It is therefore an object of the present disclosure to provide a tool and tool system that allows the user to change the orientation of a bit held by the tool even without removing the bit from the tool.

Summary

[0005] A tool according to an aspect of the present disclosure includes: a housing having a grip; a holder with the ability to hold a bit; an oscillating rotary mechanism to generate power that imparts an oscillating rotary motion to the holder; and an adjustment mechanism. The adjustment mechanism switches a state of the holder between a prohibited state and a permitted state. The prohibited state is a state in which the holder is prohibited from rotating around a virtual axis with respect to the grip unless the holder is supplied with the power. The permitted state is a state in which the holder is permitted to rotate around the axis with respect to the grip even when the holder is not supplied with the power.

[0006] A tool system according to another aspect of the present disclosure includes: the tool described above; and the bit described above.

Brief Description of Drawings

[0007]

FIG. 1 is a side view of a tool and tool system according to an embodiment of the present disclosure;
FIG. 2 is a rear view of the tool and tool system;
FIG. 3 is a cross-sectional view illustrating an upper portion of the tool and tool system;
FIG. 4A is a side view illustrating a supporting member, a holder, and a bit of the tool and tool system;
FIG. 4B is a partially cutaway side view of the mechanism shown in FIG. 4A;
FIG. 5A is a bottom view of the supporting member shown in FIG. 4A;
FIG. 5B is a plan view of the holder and bit shown in FIG. 4A;
FIG. 6A is an exploded perspective view of the supporting member shown in FIG. 4A;
FIG. 6B is an exploded perspective view of the holder and bit shown in FIG. 4A;
FIG. 7A is a side view illustrating how the supporting member, holder, and bit shown in FIG. 4A operate;
FIG. 7B is a partially cutaway cross-sectional view of the mechanism shown in FIG. 5A;
FIG. 8A is a bottom view of a supporting member according to a first variation;
FIG. 8B is a plan view of a holder and bit according to the first variation;
FIG. 9 is a side view of the supporting member, holder, and bit according to the first variation;
FIG. 10A is a side view of a supporting member, a holder, and a bit according to a second variation;
FIG. 10B is a cross-sectional view taken along the plane X-X shown in FIG. 10A;
FIG. 11 is a side view illustrating the mechanism shown in FIG. 10A with a locking member thereof removed;
FIG. 12A is a cross-sectional view illustrating the appearance of the mechanism shown in FIG. 10B when its locking member is loosened;
FIG. 12B is a side view illustrating how the supporting member, holder, and bit according to the second variation operate;
FIG. 13A is a bottom view of a supporting member according to a third variation;
FIG. 13B is a plan view of a holder according to the third variation;
FIG. 14A is a side cross-sectional view of a holder and a supporting member according to a fourth variation;
FIG. 14B is a cross-sectional view of the holder and supporting member according to the fourth variation when viewed in plan; and
FIG. 14C is a partial cross-sectional view when viewed in plan illustrating how the holder and supporting member according to the fourth variation operate.

Description of Embodiments

[0008] An overview of a tool 1 and tool system 10 according to the present disclosure will be described.

[0009] A tool 1 includes: a housing 21 having a grip 24; a holder 5 with the ability to hold a bit 3; an oscillating rotary mechanism 6 to generate power that imparts an oscillating rotary motion to the holder 5; and an adjustment mechanism 70. The adjustment mechanism 70 switches the state of the holder 5 between a prohibited state and a permitted state. The prohibited state is a state in which the holder 5 is prohibited from rotating around a virtual axis with respect to the grip 24 unless the holder 5 is supplied with the power transmitted from the oscillating rotary mechanism 6. The permitted state is a state in which the holder 5 is permitted to rotate around the virtual axis with respect to the grip 24 even when the holder 5 is not supplied with the power transmitted from the oscillating rotary mechanism 6. A tool system 10 includes: the tool 1; and a bit 3.

[0010] Thus, the present disclosure allows, when the adjustment mechanism 70 switches the state of the holder 5 to the prohibited state, the user to fix the orientation of the bit 3 with respect to the grip 24 in the tool system 10. This allows him or her to perform machining using the tool system 10 in such a state. In addition, the present disclosure also allows, when the adjustment mechanism 70 switches the state of the holder 5 to the permitted state, the user to change the orientation of the bit 3 with respect to the grip 24 in the tool system 10 with the bit 3 still held by the holder 5 by rotating the holder 5 with respect to the grip 24. This allows him or her to change the orientation of the bit 3 held by the tool 1 even without removing the bit 3 from the tool 1.

[0011] This saves, when the user needs to insert the bit 3 into a narrow gap or press the bit 3 obliquely against the wall while using the tool system 10, him or her a lot of trouble of removing the bit 3 from the tool 1 once, changing the orientation of the bit 3, and then attaching the bit 3 to the tool 1 all over again.

[0012] Next, a more specific embodiment of the present disclosure will be described with reference to FIGS. 1-7C. Note that the exemplary embodiment to be described below is only one of various embodiments of the present disclosure and should not be construed as limiting. Rather, the embodiment may be readily modified in various manners, depending on a design choice or any other factor, without departing from a true spirit and scope of the present disclosure. In addition, various directions, including a forward/backward direction, a rightward/leftward direction, and an upward/downward direction to be referred to in the following description, are mentioned just for the sake of convenience and are insubstantial ones. That is to say, those directions should not be construed as defining in what directions the tool 1 according to the exemplary embodiment should be used.

[0013] As shown in FIGS. 1 and 2, a tool system 10 according to this embodiment is implemented as a handheld multi-purpose tool including a tool 1 and a bit 3. As used herein, the "multi-purpose tool" refers to a tool 1 which has the ability to impart an oscillating rotary motion to the bit 3 around an axis of rotation X and of which the bit 3 is replaceable. Note that the axis of rotation X is a virtual axis and the "oscillating rotary motion" refers herein to an axial rotation, of which the rotational direction inverts sequentially.

[0014] The tool 1 includes a holder 5, a tool body 2, and a battery pack 4. The tool body 2 is a part for producing an oscillating rotary motion of the holder 5 with power supplied from the battery pack 4, i.e., a part for producing an oscillating rotary motion of the bit 3 held by the holder 5. The tool body 2 includes a housing 21 for housing various constituent members of a mechanism for producing an oscillating rotary motion of the holder 5 and the bit 3. The constituent members include an oscillating rotary mechanism 6 and a drive source 26. The housing 21 is formed in the shape of a bar, which is thick enough for the user to grip the tool 1. That is to say, the housing 21 may serve as a grip 24 for the user of the tool 1.

[0015] The oscillating rotary mechanism 6 is a mechanism for generating power that imparts an oscillating rotary motion to the holder 5 around the axis of rotation X. The drive source 26 is an electric motor for driving the oscillating rotary mechanism 6. The oscillating rotary mechanism 6 is housed in an upper internal part of the housing 21. The drive source 26 is housed under the oscillating rotary mechanism 6 inside of the housing 21, and a control circuit 27 is housed under the drive source 26 inside of the housing 21.

[0016] The housing 21 has a generally cylindrical shape, and may have a generally circular or rectangular cross section when taken on a plane perpendicular to the axis (upward/downward direction) of the housing 21. The housing 21 includes a barrel 22 and a pedestal 23.

[0017] The barrel 22 has the shape of a cylinder with a generally circular cross section and extends in the upward/downward direction. A roughly lower half of the barrel 22 serves as a grip 24 allowing the user to hold the tool 1 with his or her hand. The grip 24 is formed to be somewhat thinner than an upper part 25, which is roughly an upper half of the barrel 22.

[0018] The pedestal 23 is provided at the lower end along the length (upward/downward direction) of the barrel 22 and protrudes outward from the outer peripheral portion of the barrel 22. More specifically, the pedestal 23 is formed in the shape of a rectangular parallelepiped elongated in the forward/backward direction. The front and rear side surfaces of the pedestal 23 protrude outward in the forward/backward direction with respect to the front and rear side surfaces of the upper part 25 of the barrel 22 (see FIG. 1). The right and left side surfaces of the pedestal 23 protrude outward in the rightward/leftward direction with respect to the right and left side surfaces of the grip 24 of the barrel 22 and protrude approximately to the same degree as the right and left side surfaces of the upper part 25 of the barrel 22 (see FIG. 2).

[0019] The battery pack 4 is attached removably to a lower surface 231 of the pedestal 23. Attaching the battery pack 4 onto the lower surface 231 of the pedestal 23 connects the battery pack 4 to the pedestal 23 (and therefore, to the tool body 2) both mechanically and electrically.

[0020] The holder 5 is arranged on a front surface of the upper part 25 of the housing 21. More specifically, inside of the upper part 25 of the housing 21, housed in the forward/backward direction is a rotary shaft member 61 for producing an oscillating rotary motion of the holder 5. The tip (i.e., the front end) of the rotary shaft member 61 protrudes forward from the front surface of the upper part 25 of the housing 21. The supporting member 7 is arranged at the tip of the rotary shaft member 61. The holder 5 is held by the supporting member 7. The bit 3 may be held by the holder 5. The structures of the supporting member 7 and the holder 5 will be described in further detail later.

[0021] On the outer peripheral surface of the housing 21, provided are a power switch 30 and a shift dial 40.

[0022] The power switch 30 is a switch for switching the operation mode of the tool 1 from a driving state to a non-driving state, and vice versa. The power switch 30 is a sliding switch, which may be turned both upward and downward. The power switch 30 is provided, for example, over the grip 24 on the outer peripheral surface of the housing 21 (e.g., at a position on which the user putting his or her hand on the grip 24 is able to put his or her thumb). The shift dial 40 is a dial switch for use to adjust the rotational frequency of the bit 3 in oscillating motion. The rotational frequency in oscillating motion may be adjusted by turning this shift dial 40. The shift dial 40 may be provided, for example, under the grip 24 on the outer peripheral surface of the housing 21.

[0023] The battery pack 4 is a part for supplying power to the tool body 2. The battery pack 4 includes a plurality of batteries and a battery case 41.

[0024] The batteries may be lithium-ion batteries, for example. Those batteries are electrically connected together. The battery case 41 forms the shell of the battery pack 4 and houses the plurality of batteries therein. The battery pack 4 is able to change the performance of the batteries (such as the rated output voltage and capacity of the batteries) according to the number of the batteries connected together and the type of electrical connection (i.e., series or parallel) between the batteries. For example, a battery pack with a rated output voltage of 14.4 V and a battery pack with a rated output voltage of 18 V may be provided as the battery packs 4.

[0025] The tool 1 with such a configuration is activated or deactivated by the turn of the power switch 30. Turning the shift dial 40 while the tool 1 is up and running allows the rotational frequency of the bit 3 in oscillating motion to be changed. For example, the user may strip a tile easily just by holding the tool 1 on the grip 24 and inserting the tip of the bit 3 in oscillating motion into the gap between the tile and the underlying material (such as a wall). Changing the bits 3 according to the type of the machining to do allows this tool 1 to be used in various types of machining.

[0026] Next, the oscillating rotary mechanism 6 will be described with reference to FIG. 3.

[0027] The oscillating rotary mechanism 6 is arranged in the upper internal part of the housing 21. Under the oscillating rotary mechanism 6 (i.e., over the grip 24), housed is the drive source 26. The drive source 26 is arranged along the length of the housing 21. The shaft 261 of the drive source 26 extends upward (i.e., toward the upper part of the housing 21). The shaft 261 outputs the rotative power of the drive source 26. The shaft 261 starts to rotate around an axis of rotation extending in the upward/downward direction when the drive source 26 starts running.

[0028] The oscillating rotary mechanism 6 includes the rotary shaft member 61, an actuating arm 63, and a coupling shaft member 64. Part of the rotary shaft member 61, the actuating arm 63, and the coupling shaft member 64 are housed in the housing 21.

[0029] The rotary shaft member 61 supports the supporting member 7 and imparts an oscillating rotary motion to the supporting member 7 by transmitting power to the supporting member 7. The rotary shaft member 61 is arranged in an upper internal part of the housing 21. The rotary shaft member 61 is rotatable around the axis of rotation X extending in the forward/backward direction (i.e., perpendicularly to the shaft 261). The tip of the rotary shaft member 61 protrudes forward from the front surface of the housing 21.

[0030] The supporting member 7 is fixed to one end (front end) in the direction aligned with the axis of rotation X (i.e., the forward/backward direction) of the rotary shaft member 61. Optionally, the supporting member 7, provided separately from the tool 1, may be attached to the rotary shaft member 61. Alternatively, the rotary shaft member 61 and the supporting member 7 may form respective integral parts of the same member. The holder 5 is held at one end (front end) in the direction aligned with the axis of rotation X (i.e., forward/backward direction) of the supporting member 7.

[0031] The actuating arm 63 includes an actuating portion 631 fixed to an outer peripheral surface of the rotary shaft member 61 and an arm portion 632 extending perpendicularly to the axis of rotation X from the actuating portion 631 toward the shaft 261 (i.e., downward). The arm portion 632 has a U-shape with right and left branch portions.

[0032] The coupling shaft member 64 is coupled to the tip (upper end) of the shaft 261. The coupling shaft member 64 includes a coaxial portion 64a and an eccentric portion 64b located over the coaxial portion 64a (i.e., located opposite from the shaft 261 with respect to the coaxial portion 64b). The coaxial portion 64a is coupled to the shaft 261. The center axis of the eccentric portion 64b is parallel to, but does not agree with, the axis of rotation of the shaft 261 . That is to say, the center axis of the eccentric portion 64b is eccentric with respect to the axis of rotation of the shaft 261. The eccentric portion

64b is surrounded with the U-arm portion 632 of the actuating arm 63. A bearing 65 is fitted onto the eccentric portion 64b so as to surround the outer periphery of the eccentric portion 64b. The outer peripheral surface of the bearing 65 is in contact with, and clamped between, the legs of the U-arm portion 632. That is to say, the arm portion 632 of the actuating arm 63 clamps the bearing 65 and the eccentric portion 64b is fitted into the center hole of the bearing 65.

[0033] In this oscillating rotary mechanism 6, when the shaft 261 starts to be driven in rotation by the drive source 26, the coupling shaft member 64 also starts to rotate. The eccentric portion 64b of the coupling shaft member 64 rotates around an axis that is offset with respect to its own center axis. As the eccentric portion 64b rotates, the bearing 65 also sets up a rotary motion such that the center of the bearing 65 moves around the axis of rotation of the shaft 261. This makes the bearing 65 swing, to the right and to the left, the arm portion 632 of the actuating arm 63 in contact with the bearing 65, thus making the actuating portion 631 of the actuating arm 63 impart an oscillating rotary motion to the rotary shaft member 61 around the axis of rotation X aligned with the forward/backward direction. The rotary shaft member 61 transmits the power to the supporting member 7 to impart an oscillating rotary motion to the supporting member 7 around the axis of rotation X. The supporting member 7 also imparts an oscillating rotary motion to the holder 5 around the axis of rotation X by transmitting power to the holder 5 in the prohibited state. This oscillating rotary motion of the rotary shaft member 61 in turn imparts an oscillating rotary motion to the holder 5, fixed to the rotary shaft member 61, around the axis of rotation X. The bit 3 is held by the holder 5. As the holder 5 sets up an oscillating rotary motion, the bit 3 held by the holder 5 also sets up an oscillating rotary motion.

[0034] An example of the bit 3 will be described. The bit 3 may be made of a metallic material, for example. The bit 3 may have a thin plate shape, for example, and has its thickness aligned, in a state where the bit 3 is held by the holder 5, with the axis of rotation X. The bit 3 includes a base end portion 31 and a machining part 32 extending from the base end portion 31 in one direction perpendicular to the axis of rotation X. The machining part 32 is located forward of the base end portion 31 (i.e., more distant from the tool 1 than the base end portion 31 is). One end, connected to the machining part 32, of the base end portion 31 is bent toward the machining part 32. Thus, the bit 3 is formed in a step shape. The other end, located opposite from the base end portion 31, of the machining part 32 is a cutting edge for machining. The base end portion 31 has a hole running through the base end portion 31 (attachment hole 33) and a plurality of holes 34 arranged to surround the attachment hole 33. The plurality of holes 34 correspond one to one to the plurality of projections 532 on a holding surface 53. As used herein, the orientation of the bit 3 may be an orientation from the base end portion 31 toward the machining part 32.

[0035] Note that the machining part 32 does not have to have the shape described above, but may also have any other appropriate shape according to the type of machining to be performed using the bit 3. For example, the machining part 32 may also be implemented as a grinder.

[0036] The user may put, in the state where the bit 3 is held by the holder 5, his or her hand on the grip 24 of the tool 1 and insert the tip of the bit 3 in oscillating motion into the gap between a tile and the underlying material such as a wall, for example. This allows the user to strip the tile easily. Alternatively, the user may also drill a hole through a given member such as plasterboard by pressing the tip of the bit 3 in oscillating motion against the surface of the member. Still alternatively, the user may also use this tool 1 for multiple types of machining by changing the bits 3 according to the type of the machining to do.

[0037] As described above, the tool 1 includes an adjustment mechanism 70. The adjustment mechanism 70 switches the state of the holder 5 between a prohibited state and a permitted state. The prohibited state is a state in which the holder 5 is prohibited from rotating around a virtual axis with respect to the grip 24 unless the holder 5 is supplied with the power transmitted from the oscillating rotary mechanism 6. The permitted state is a state in which the holder 5 is permitted to rotate around the virtual axis with respect to the grip 24 even when the holder 5 is not supplied with the power transmitted from the oscillating rotary mechanism 6. In this embodiment, the virtual axis is the axis of rotation X.

[0038] In this embodiment, the adjustment mechanism 70 includes the supporting member 7, a biasing member 73, and a receiving surface 51 of the holder 5 as shown in FIGS. 4A-7B.

[0039] The supporting member 7 is fixed at the front end of the rotary shaft member 61. The supporting member 7 may be made of a metallic material, for example. The supporting member 7 may have the shape of a cylinder, of which the center axis is aligned with the axis of rotation X, for example. The supporting member 7 has a transmission surface 71, facing forward, at the front end thereof.

[0040] As shown in FIGS. 4A-6B, the holder 5 includes a holder body 50 and a securing member 54. The holder body 50 is fixed to the front end of the supporting member 7. The holder body 50 may be made of a metallic material, for example. The holder body 50 may have the shape of a cylinder, of which the center axis is aligned with the axis of rotation X, for example. The holder body 50 has, at the front end thereof, a holding surface 53 facing forward. Thus, in this embodiment, the axis of rotation X is perpendicular to the holding surface 53. The holder body 50 also has, at the rear end thereof, a receiving surface 51 facing backward toward the transmission surface 71 of the supporting member 7. The holder body 50 further has a female screw hole 55 cut open through the holding surface 53. The holding surface 53 includes a plurality of projections 532, which protrude toward the facing direction of the holding surface 53 and which are arranged in a circle at predetermined intervals around the female screw hole 55. The securing member 54 includes a leg 542 with a male screw thread corresponding in shape to the female screw hole 55 and a screw head 541 with a diameter larger than the inner diameter of the female screw hole 55.

[0041] Next, it will be described how to attach the bit 3 onto the holder 5. First, when the bit 3 is not held by the holder 5 yet, the base end portion 31 is placed in position to face the holding surface 53. In this state, the attachment hole 33 of the base end portion 31 is aligned with the female screw hole 55 of the holder 5 and the plurality of holes 34 of the base end portion 31 are aligned with the plurality of projections 532 on the holding surface 53 of the holder 5. In such a state, the base end portion 31 is brought into contact with the holding surface 53 such that the plurality of projections 532 are respectively fitted into the plurality of holes 34. Also, the leg 542 of the securing member 54 is screwed into the female screw hole 55 to clamp the base end portion 31 between the screw head 541 of the securing member 54 and the holding surface 53. This allows the bit 3 to be held by the holder 5.

[0042] The transmission surface 71 has, in its central region, a first arrangement recess 76, of which the opening faces the direction that the transmission surface 71 faces (see FIGS. 5A and 6A). The receiving surface 51 has, in its central region, a second arrangement recess 56, of which the opening faces the direction that the receiving surface 51 faces (see FIGS. 5B and 6B). The first arrangement recess 76 and the second arrangement recess 56 face each other. A biasing member 73 for applying elastic force directed toward the transmission surface 71 to the holder 5 is provided in the space formed by placing the first arrangement recess 76 on top of the second arrangement recess 56. In this embodiment, the biasing member 73 is implemented as a tensile spring that generates elastic force in the direction aligned with the axis of rotation X. As used herein, the "tensile spring" refers to a spring that generates, when receiving a tensile load, elastic force in a direction opposite from the direction in which the tensile spring is pulled. The tensile spring may a coil spring, for example. One end of the tensile spring is attached to the supporting member 7 at the bottom of the first arrangement recess 76, while the other end of the tensile spring is attached to the holder 5 at the bottom of the second arrangement recess 56. The tensile spring may be attached to the supporting member 7 so as to be rotatable around the axis of rotation X. Alternatively, the tensile spring may also be attached to the holder 5 so as to be rotatable around the axis of rotation X. Optionally, the tensile spring may even be attached to both of the supporting member 7 and the holder 5 so as to be rotatable around the axis of rotation X. A tensile load, directed away from the transmission surface 71, is applied along the axis of rotation X from the holder 5 to the tensile spring. This causes the tensile spring to apply elastic force, directed toward the transmission surface 71, to the holder 5.

[0043] The transmission surface 71 has an uneven surface pattern, so does the receiving surface 51. The respective uneven surface patterns of the transmission surface 71 and receiving surface 51 are fitted into each other only when the holder 5 is rotated around the axis of rotation X with respect to the supporting member 7 sequentially 1/N of full rotation in each step, but are not fitted into each other otherwise, where N is an integer equal to or greater than two.

[0044] Specifically, the transmission surface 71 has an uneven surface pattern in which a plurality of (N) protrusions 77 and a plurality of (N) depressions 78 are alternately arranged so as to surround the first arrangement recess 76. In this embodiment, N is four. When viewed from a direction opposite from the facing direction of the transmission surface 71 (i.e., when view in plan), each protrusion 78 has a generally fan shape (more exactly, a shape formed by removing a smaller fan from a vertex portion of another larger fan, where the smaller fan has the same center angle as, and a shorter radius than, the larger fan; this statement applies to the rest of the description) (see FIG. 5A). Likewise, each depression 78 also has a generally fan shape in a plan view. Each and every protrusion 77 and each and every depression 78 have their vertex of the fan (more exactly, the respective vertices of the smaller fans removed, each having the same center angle as, and the shorter radius than, the larger fans; this statement applies to the rest of the description) located at the same point on the axis of rotation X. The respective planar shapes of the plurality of protrusions 77 are congruent with each other, so are the respective planar shapes of the plurality of depressions 78. Nevertheless, the planar shape of each protrusion 77 and the planar shape of each depression 78 may or may not be congruent with each other. The respective arcs of those protrusions 77 and depressions 78 are all located on the outer peripheral surface of the transmission surface 71, thus allowing the respective arcs of the depressions 78 to communicate with the space outside of the supporting member 7.

[0045] The receiving surface 51 has an uneven surface pattern in which a plurality of (N) protrusions 57 and a plurality of (N) depressions 58 are alternately arranged so as to surround the second arrangement recess 56. When viewed from a direction opposite from the facing direction of the receiving surface 51 (i.e., when view in plan), each protrusion 57 has a generally fan shape (see FIG. 5B). Likewise, each depression 58 also has a generally fan shape in a plan view. Each and every protrusion 57 and each and every depression 58 have their vertex of the fan located at the same point on the axis of rotation X. The respective planar shapes of the plurality of protrusions 57 are congruent with each other, so are the respective planar shapes of the plurality of depressions 58. Nevertheless, the planar shape of each protrusion

57 and the planar shape of each depression 58 may or may not be congruent with each other. The respective arcs of those protrusions 57 and depressions 58 are all located on the outer peripheral surface of the receiving surface 51, thus allowing the respective arcs of the depressions 58 to communicate with the space outside of the holder 5.

[0046] The number of the protrusions 77 and depressions 78 of the transmission surface 71 and the number of the protrusions 57 and depressions 58 of the receiving surface 51 are all equal to N. The planar shape of each protrusion 77 of the transmission surface 71 and the planar shape of a corresponding depression 58 of the receiving surface 51 are congruent with each other. The planar shape of each depression 78 of the transmission surface 71 and the planar shape of a corresponding protrusion 57 of the receiving surface 51 are also congruent with each other.

[0047] Each protrusion 77, 57 has two outer side surfaces. The axis of rotation X is present on a virtual plane including the respective outer side surfaces. Optionally, the respective outer side surfaces of each protrusion 77, 57 may be regarded as the inner side surfaces of a depression 78, 58 adjacent to the protrusion 77, 57.

[0048] It can be said that the uneven surface pattern of the transmission surface 71 has N-fold rotational symmetry with respect to the axis of rotation X and the uneven surface pattern of the receiving surface 51 also has N-fold rotational symmetry with respect to the axis of rotation X.

[0049] When the transmission surface 71 and the receiving surface 51 have such uneven surface patterns, the N protrusions 77 of the transmission surface 71 are able to be respectively fitted into the N depressions 58 of the receiving surface 51 (see FIGS. 4A and 4B). In addition, the N depressions 78 of the transmission surface 71 are also able to be respectively fitted into the N protrusions 57 of the receiving surface 51. This allows the transmission surface 71 and the receiving surface 51 to be fitted into each other. Thus, even if the holder 5 is sequentially rotated around the axis of rotation X with respect to the supporting member 7 1/N of full rotation in each step, the transmission surface 71 and the receiving surface 51 are still able to be fitted into each other.

[0050] In the embodiment described above, the planar shape of the protrusions 77, 57 and the planar shape of the depressions 78, 58 are supposed to be a fan shape. However, this is only an example and should not be construed as limiting. Alternatively, the protrusions 77, 57 and the depressions 78, 58 may also have any other planar shape as long as the protrusions 77 of the transmission surface 71 are able to be fitted into the depressions 58 of the receiving surface 51 and as long as the depressions 78 of the transmission surface 71 and the protrusions 57 of the receiving surface 51 are able to be fitted into each other. Optionally, the transmission surface 71 may have one type of surface pattern elements selected from the protrusions and depressions to be fitted into each other, and the receiving surface 51 may have the other, opposite type of surface pattern elements. Furthermore, as long as the transmission surface 71 and the receiving surface 51 may be fitted into each other, neither the transmission surface 71 nor the receiving surface 51 needs to have clear-cut protrusions and depressions.

[0051] The state where the transmission surface 71 and the receiving surface 51 are fitted into (i.e., engaged with) each other as shown in FIGS. 4A and 4B corresponds to the prohibited state. In this state, the holder 5 is unable to rotate around the axis of rotation X with respect to the supporting member 7. Application of the elastic force directed toward the transmission surface 71 from the tensile spring serving as the biasing member 73 to the holder 5 reduces the chances of releasing the receiving surface 51 from the transmission surface 71. When the supporting member 7 sets up an oscillating rotary motion in such a state by being supplied with power transmitted from the oscillating rotary mechanism 6 to the supporting member 7, the supporting member 7 transmits the power to the holder 5 and thereby imparts an oscillating rotary motion to the holder 5 around the axis of rotation X as well, because the transmission surface 71 and the receiving surface 51 are tightly fitted with each other. This imparts an oscillating rotary motion to the bit 3 held by the holder 5.

[0052] In this embodiment, the power is transmitted from the supporting member 7 to the holder 5 by application of force from an outer side surface of each protrusion 77 of the transmission surface 71 to the adjacent outer side surface of an associated protrusion 57 of the receiving surface 51. Since the axis of rotation X is present on a virtual plane including the respective side surfaces as described above, an outer side surface of each protrusion 77 and an adjacent outer side surface of an associated protrusion 57 face, and are in contact with, each other along the circumference of a virtual circle drawn around the axis of rotation X. The transmission surface 71 and the receiving surface 51 suitably have a pair of surfaces facing toward, and coming into contact with, each other along the circumference of a virtual circle drawn around the axis of rotation X in the prohibited state just like these outer side surfaces of the protrusions 77, 57. This significantly reduces the chances of the holder 5 rotating unexpectedly around the axis of rotation X with respect to the supporting member 7, thus transmitting power efficiently from the supporting member 7 to the holder 5.

[0053] Meanwhile, when the holder 5 moves away from the supporting member 7 along the axis of rotation X, then the tensile spring extends to the point of releasing the holder 5 from the transmission surface 71 and disengaging the receiving surface 51 from the transmission surface 71 as shown in FIGS. 7A and 7B. This state corresponds to the permitted state. Specifically, the holder 5 in the prohibited state switches to the permitted state by moving away from the supporting member 7 along the axis of rotation X. In this state, the holder 5 is allowed to rotate around the axis of rotation X with respect to the supporting member 7 while being still coupled to the supporting member 7 via the tensile spring. In this state, the holder 5 is allowed to rotate n/N around the axis of rotation X and then move toward the transmission surface 71 along the axis of rotation X, where n is an integer falling within the range from 1 to N - 1. This makes the transmission surface 71 and the receiving surface 51 fitted into each other and the holder 5 switches to the prohibited state again.

[0054] That is to say, according to this embodiment, the holder 5 is allowed in the permitted state to rotate around the axis of rotation X. On the other hand, in the prohibited state, the holder 5 is in any one of N arrangement states defined by sequentially rotating the holder 5 around the axis of rotation X 1/N of full rotation in each step. Thus, this embodiment allows, by rotating the holder 5 n/N, the bit 3 held by the holder 5 to have an orientation corresponding to the angle of the rotation that the holder 5 has made.

[0055] According to this embodiment, the adjustment mechanism 70 allows the power to be transmitted from the supporting member 7 to the holder 5 by making the transmission surface 71 and the receiving surface 51 fitted into each other in the prohibited state. On the other hand, in the permitted state, the holder 5 moves away from the transmission surface 71 along the axis of rotation X to bring the receiving surface 51 out of engagement with the transmission surface 71, and therefore, the adjustment mechanism 70 allows no power to be transmitted from the supporting member 7 to the holder 5. That is to say, the adjustment mechanism 70 is configured to allow power to be transmitted from the oscillating rotary mechanism 6 to the holder 5 in the prohibited state and to allow no power to be transmitted from the oscillating rotary mechanism 6 to the holder 5 in the permitted state. This allows the bit 3 to set up an oscillating rotary motion in the prohibited state by transmitting power to the bit 3 via the holder 5 and also allows the holder 5 to rotate without the oscillating rotary mechanism 6 in the permitted state by transmitting no power to the holder 5.

[0056] In particular, in this embodiment, the adjustment mechanism 70 includes the supporting member 7, to which power is transmitted from the oscillating rotary mechanism 6, and the supporting member 7 has the transmission surface 71 facing the holder 5. In addition, in this embodiment, the supporting member 7 and the holder 5 are coupled together via the tensile spring, thus allowing the supporting member 7 to hold the holder 5 such that the holder 5 is movable between a position where the holder 5 is in contact with the transmission surface 71 (i.e., a supported position) and a position where the holder 5 is out of contact with the transmission surface 71 (i.e., a non-supported position). The holder 5 is located at the supported position in the prohibited state and is located at the non-supported position in the permitted state. Furthermore, when the holder 5 is located at the supported position, the transmission surface 71 and the receiving surface 51 are fitted into each other, and therefore, the supporting member 7 allows power to be transmitted from the supporting member 7 itself to the holder 5. On the other hand, when the holder 5 is located at the non-supported position, the transmission surface 71 and the receiving surface 51 are not fitted into each other, and therefore, the supporting member 7 allows no power to be transmitted from the supporting member 7 itself to the holder 5. Thus, the user may keep power from being transmitted to the holder 5 by releasing the holder 5 located at the supported position from the transmission surface 71 and moving the holder 5 to the non-supported position. In this state, the user may rotate the holder 5 and then move the holder 5 to the supported position so that power is transmitted to the holder 5 again.

[0057] In addition, the adjustment mechanism 70 includes the tensile spring serving as a biasing member 73 that applies elastic force directed toward the transmission surface 71 to the holder 5. Thus, even when the user has moved the holder 5 from the supported position to the non-supported position, the holder 5 is still allowed to easily go back to the supported position again with the elastic force applied by the biasing member 73 to the holder 5. In addition, the biasing member 73 pressing the holder 5 against the transmission surface 71 while the tool 1 is being used reduces the chances of the holder 5 being released from the transmission surface 71. This allows the power to be kept transmitted to the holder 5 more easily in the prohibited state. According to the embodiment described above with such a configuration, when the holder 5 is located at the supported position, the transmission surface 71 and the receiving surface 51 are in contact with each other with the holder 5 prohibited from rotating around the axis of rotation X with respect to the supporting member 7, thus realizing the permitted state. In the permitted state, as the supporting member 7 rotates around the axis of rotation X with the power transmitted from the oscillating rotary mechanism 6, the power is also transmitted to the holder 5, thus making the holder 5 rotatable around the axis of rotation X as well. That is to say, the power is allowed to be transmitted from the oscillating rotary mechanism 6 to the holder 5. On the other hand, when the holder 5 is located at the non-supported position, the transmission surface 71 and the receiving surface 51 are out of contact with each other, thus realizing the prohibited state. In the prohibited state, even when the supporting member 7 rotates around the axis of rotation X with the power transmitted from the oscillating rotary mechanism 6, the power is not transmitted to the holder 5. That is to say, no power is allowed to be transmitted from the oscillating rotary mechanism 6 to the holder 5. In the prohibited state, the holder 5 is freely rotatable around the axis of rotation X with respect to the supporting member 7. When located at the supported position, the holder 5 is in any one of a plurality of arrangement states. The plurality of arrangement states are defined such that rotating the holder 5 in one arrangement state predetermined degrees around the axis of rotation X switches the arrangement state of the holder 5 to another arrangement state. In any of the plurality of arrangement states, the transmission surface 71 and the receiving surface 51 can be fitted into each other such that the holder 5 is prohibited from rotating around the axis of rotation X with respect to the supporting member 7. Therefore, when the holder 5 is located at the supported position, the permitted state is realized, no matter which of the arrangement states the holder 5 is in.

[0058] Note that the exemplary embodiment described above is only an example of the present disclosure and should not be construed as limiting. Rather, the exemplary embodiment may be readily modified in various manners in terms of specifics. Some of those numerous variations of the exemplary embodiment will be enumerated one after another. In the following description, any constituent element of the variations, having the same function as a counterpart of the embodiment described above, will be designated by the same reference numeral as that counterpart's, and a detailed description thereof will be omitted herein.

[0059] In the foregoing description of embodiments, N is supposed to be four. However, this is only an example and should not be construed as limiting. Alternatively, N may be any other integer as long as N is at least equal to two. For example, in a first variation of the present disclosure illustrated in FIGS. 8A and 9, N is eight.

[0060] FIGS. 10A-12B illustrate a second variation of the present disclosure. As in this second variation, the tool 1 may include a locking mechanism 80. The locking mechanism 80 selectively allows the adjustment mechanism 70 to switch the state of the holder 5 between the prohibited state and the permitted state. Providing the locking mechanism 80 for the tool 1 and making the locking mechanism 80 prohibit the adjustment mechanism 70 from switching the state of the holder 5 between the prohibited state and the permitted state reduces the chances of the state of the holder 5 happening to switch from the prohibited state to the permitted state and thereby changing the orientation of the bit 3 unintentionally. When the orientation of the bit 3 needs to be changed, the locking mechanism 80 may allow the adjustment mechanism 70 to switch the state of the holder 5 between the prohibited state and the permitted state.

[0061] A configuration for the adjustment mechanism 70 and locking mechanism 80 according to this second variation will be described in more detail. The locking mechanism 80 includes a groove 81 provided for the supporting member 7 and the holder 5, and a locking member 82.

[0062] The groove 81 will be described. As shown in FIG. 11, the surface, facing away from the axis of rotation X, of each protrusion 57 of the holder 5 and the surface, also facing away from the axis of rotation X, of each protrusion 77 of the supporting member 7 (such surfaces will be hereinafter referred to as "arc surfaces") each have a groove 83 along the outer periphery of the holder 5 and the supporting member 7 (hereinafter referred to as a "circumferential direction"). The groove 83 of each protrusion 57 of the holder 5 is connected in the circumferential direction to the groove 83 of the adjacent protrusion 77 of the supporting member 7. Connecting the grooves 83 of the respective protrusions 57 of the holder 5 and the grooves 83 of the respective protrusions 77 of the supporting member 7 together allows a single ringlike groove 81 to be formed.

[0063] The locking member 82 includes a fastener 84 and an adjustor 85. The fastener 84 may be implemented as a type of chord such as a wire. The adjustor 85 is fixed onto the arc surface of one of the protrusions 57 of the holder 5. Alternatively, the adjustor 85 may also be fixed onto the arc surface of one of the protrusions 77 of the supporting member 7, not the holder 5. Still alternatively, the adjustor 85 may be fixed to neither the supporting member 7 nor the holder 5. The adjustor 85 holds one end and the other end of the fastener 84, thus making the fastener 84 a loop. Optionally, the fastener 84 itself may be formed in the shape of a loop and part of the fastener 84 may be held by the adjustor 85. The adjustor 85 has a press button 86 and has the capability of switching the state of the fastener 84 between a fastening state and a non-fastening state every time the press button 86 is pressed. The fastening state is a state where the fastener 84 fastens both of the holder 5 and the supporting member 7 at a time as shown in FIGS. 10A and 10B. In this embodiment, in the fastening state, the fastener 84 fastens the groove 81, thereby fastening the holder 5 and the supporting member 7 at the same time. The non-fastening state is a state where the fastener 84 does not fasten the holder 5 or the supporting member 7. In this second variation, in the non-fastening state, the fastener 84 is looser than in the fastening state as shown in FIG. 12A , thus making the fastener 84 stop fastening the groove 81. The adjustor 85 may reel a part of the fastener 84 in itself to make the fastener 84 shorter outside of the adjustor 85 and thereby switch the state of the fastener 84 from the non-fastening state to the fastening state. Alternatively, the adjustor 85 may reel out a part of the fastener 84 out of itself to make the fastener 84 longer outside of the adjustor 85 and thereby switch the state of the fastener 84 from the fastening state to the non-fastening state. In this embodiment, the adjustor 85 includes an appropriate mechanism for reeling a part of the fastener 84 either in or out of itself when the press button 86 is pressed. For example, the adjustor 85 may have an appropriate mechanism for loosening or tightening the fastener 84 when the press button 86 is pressed. Alternatively, the adjustor 85 may also have a mechanism for winding or unwinding a part of the fastener 84 in itself when the press button 86 is pressed.

[0064] The tool 1 provided with such a locking member 82 makes, when the fastener 84 is in the fastening state while the holder 5 is in the prohibited state, the fastener 84 fasten the respective protrusions 57 of the holder 5 and the respective protrusions 77 of the supporting member 7 at a time, thus allowing the fastener 84 to fasten the holder 5 and the supporting member 7 at the same time. This reduces the chances of the holder 5 being released from the transmission surface 71 of the supporting member 7 unintentionally. Thus, the locking member 82 prohibits the adjustment mechanism 70 from switching the state of the holder 5 from the prohibited state to the permitted state.

[0065] When the press button 86 of the adjustor 85 is pressed while the fastener 84 is in the fastening state, the fastener 84 switches to the non-fastening state. Then, the fastener 84 stops fastening the respective protrusions of the holder 5 and the respective protrusions of the supporting member 7. Then, the fastener 84 no longer restricts the movement of the holder 5, thus allowing the holder 5 to be released from the transmission surface 71 of the supporting member 7 as shown in FIG. 12B. Thus, the locking member 82 allows the adjustment mechanism 70 to switch the state of the holder 5 between the prohibited state and the permitted state.

[0066] Note that as long as the fastener 84 realizes the fastening state and the non-fastening state, the fastener 84 does not have to have the configuration described above. For example, the fastener 84 does not have to be a wire but also be implemented as a belt. In addition, the fastener 84 does not have to be a chord, either, but may also be any other member with an appropriate structure as long as the fastener 84 is able to fasten the holder 5 and the supporting member 7 at a time. For example, the fastener 84 may also be a member which is slidable on the outer peripheral surface of the holder 5 and the supporting member 7 between a position where the fastener 84 fastens the holder 5 and the supporting member 7 at a time and a position where the fastener 84 no longer fastens the holder 5 and the supporting member 7.

[0067] Furthermore, as long as the fastener 84 is able to fasten the holder 5 and the supporting member 7 sufficiently tightly at a time in the fastening state, the locking mechanism 80 may have no grooves 81. Optionally, the arc surface of each of the protrusions 57, 77 may have an uneven surface pattern and the surface of the fastener 84 may have a matching uneven surface pattern to be fitted into the uneven surface pattern of the arc surface. This also allows the fastener 84 to fasten the holder 5 and the supporting member 7 sufficiently tightly by fitting the respective uneven surface patterns of the arc surface and the fastener 84 into each other in the fastening state.

[0068] Optionally, the arc surface of each of the protrusions 57, 77 may have a hole and the fastener 84 may have pins to be fitted into the respective holes of the protrusions 57, 77 in the fastening state. In that case, fitting the pins of the fastener 84 in the fastening state into the respective holes of the protrusions 57, 77 at the same time significantly reduces the chances of the holder 5 being released from the transmission surface 71.

[0069] In the exemplary embodiment described above, the fastener 84 fastens the respective arc surfaces of the protrusions 57, 77. However, this is only an example and should not be construed as limiting. Alternatively, the fastener 84 may also fasten any other part of the holder 5 and supporting member 7 depending on their structure or any other parameter, as long as the holder 5 and the supporting member 7 may be fastened at a time.

[0070] In the exemplary embodiment described above, in the prohibited state, the holder 5 may be in any one of N arrangement states defined by sequentially rotating the holder 5 1/N of full rotation in each step. That is to say, whenever sequentially changing from one arrangement state to another, the holder 5 always rotates to the same degree (i.e., its angle of rotation is always the same). However, this is only an example and should not be construed as limiting. Alternatively, the angle of rotation of the holder 5 when sequentially changing from one arrangement state to another may sometimes be different from the previous one. That is to say, as long as the holder 5 may have two or more arrangement states, the transmission surface 71 and the receiving surface 51 may have any other shapes and the angle of rotation to let the holder 5 change from one arrangement state to another does not have to be always the same.

[0071] For example, the holder 5 may be allowed to change to the next arrangement state by making 1/6, 1/6, and 4/6 rotations in this order. Specifically, in a third variation illustrated in FIGS. 13A and 13B, the transmission surface 71 has six depressions 781, 782, all of which have the shape of a fan in a plan view. These six depressions 781, 782 include two groups of depressions. Each group consists of three depressions 781 or 782 that have the same center angle, and the center angle of three depressions 781 that form one group (hereinafter referred to as "first depressions 781" for convenience sake) is smaller from that of three depressions 782 that form the other group (hereinafter referred to as "second depressions 782" for convenience sake). The three first depressions 781 are arranged one after another around the center of the transmission surface 71, and then the three second depressions 782 are arranged one after another around the center of the transmission surface 71. These depressions 781, 782 are arranged so as to be shifted by 30 degrees from each other around the axis of rotation X. Thus, each of the first depressions 781 faces any of the second depressions 782 with respect to the center of the transmission surface 71. Meanwhile, the receiving surface 51 has two protrusions 571, 572, consisting of a first protrusion 571 having the same center angle as the first depressions 781 and a second protrusion 572 having the same center angle as the second depressions 782. The first protrusion 571 and the second protrusion 572 also face each other with respect to the axis of rotation X.

[0072] In this third variation, as the holder 5 makes 1/6, 1/6, and 4/6 rotations in this order, the first and second protrusions 571, 572 of the receiving surface 51 are each fitted into any of the first and second depressions 781, 782 of the transmission surface 71, thus making the transmission surface 71 and the receiving surface 51 fitted into each other. Otherwise, the transmission surface

71 and the receiving surface 51 are not fitted into each other. This allows the holder 5 to change to the next arrangement state by making 1/6, 1/6, and 4/6 rotations in this order.

[0073] Furthermore, the adjustment mechanism 70 does not have to have the structure described above as long as the adjustment mechanism 70 is able to switch the state of the holder 5 between the prohibited state and the permitted state.

[0074] For example, in a fourth variation shown in FIGS. 14A-14C, the adjustment mechanism 70 includes a supporting member 7 to which power is transmitted from the oscillating rotary mechanism 6 and a stopper 74. The holder 5 is rotatable around an axis (axis of rotation X) with respect to the supporting member 7. The supporting member 7 includes a first receiver 72 and the holder 5 includes a second receiver 52. The first receiver 72 and the second receiver 52 switch, as a relative position of the second receiver 52 with respect to the first receiver 72 changes with the rotation of the holder 5, between a fitted state and a non-fitted state. As used herein, the "fitted state" refers to a state in which the stopper 74 is able to be fitted into both of the first receiver 72 and the second receiver 52 at a time. The "non-fitted state" refers to a state in which the stopper 74 is unable to be fitted into both of the first receiver 72 and the second receiver 52 at a time. According to this variation, the prohibited state is realized by making the stopper 74 fitted into both of the first receiver 72 and the second receiver 52 at a time in the fitted state, and the permitted state is realized by making the stopper 74 non-fitted into at least one of the first receiver 72 or the second receiver 52 in the non-fitted state.

[0075] A configuration according to this fourth variation will be described more specifically. The transmission surface 71 of the supporting member 7 includes a protrusion 79, while the receiving surface 51 of the holder 5 includes a depression 59. In a plan view, the protrusion 79 has the shape of a circle, of which the center is defined by the axis of rotation X. In a plan view, the depression 59 also has the shape of a circle, of which the center is defined by the axis of rotation X and of which the diameter is as large as that of the protrusion 79. Fitting the protrusion 79 into the depression 59 makes the transmission surface 71 and the receiving surface 51 fitted into each other. The receiving surface 51 includes a circumferential wall 591, which surrounds the depression 59 and of which the inner peripheral surface defines the inner side surface of the depression 59. The inner peripheral surface of the wall 591 (i.e., the inner side surface of the depression 59) is in contact with the outer peripheral surface of the protrusion 79. This allows the holder 5 to rotate around the axis of rotation X with respect to the supporting member 7. In this state, the holder 5 and the supporting member 7 are coupled together by a coupling mechanism 75, including a shaft and a bearing, for example, so as to be rotatable around the axis of rotation X.

[0076] The supporting member 7 includes a plurality of (N) first receivers 72, which are provided for the protrusion 79, where N is an integer equal to or greater than two and may be four in this fourth variation. Each of the first receivers 72 is a non-through hole, which is cut open on the outer peripheral surface of the protrusion 79. Each of the first receivers 72 extends from the outer peripheral surface perpendicularly to the axis of rotation X. These N first receivers 72 are arranged to surround the axis of rotation X. These first receivers 72 are arranged such that rotating one of the first receivers 72 1/N of full rotation around the axis of rotation X leads to the position where the next one of the first receivers 72 is located.

[0077] The holder 5 includes a plurality of (N) second receivers 52, which are as many as the first receivers 72 of the supporting member 7 and which are provided for the wall 591. Each of the second receivers 52 is a through hole, which is cut open through the outer and inner peripheral surfaces of the wall 591. Each of the second receivers 52 extends perpendicularly to the axis of rotation X. These N second receivers 52 are arranged to surround the axis of rotation X. These second receivers 52 are arranged such that rotating one of the second receivers 52 1/N of full rotation around the axis of rotation X leads to the position where the next one of the second receivers 52 is located.

[0078] The first receivers 72 and the second receivers 52 changes their states alternately between the fitted state and the non-fitted state as the holder 5 rotates around the axis of rotation X. In the specific structure illustrated in FIGS. 14A-14C, the "fitted state" can be regarded as a state where a change in the relative positions of the second receivers 52 with respect to the first receivers 72 makes the first receivers 72 and the second receivers 52 communicate with each other in either a direction intersecting with the axis (axis of rotation X) or a direction torsional to the axis of rotation X. Likewise, the "non-fitted state" can be regarded as a state where the first receivers 72 and the second receivers 52 do not communicate with each other. In this fourth variation, in the fitted state, each of the first receivers 72 communicates with any of the second receivers 52 perpendicularly to the axis of rotation X. In the non-fitted state, the first receivers 72 and the second receivers 52 do not communicate with each other. Also, in this fourth variation, every time the holder 5 rotates 1/N of full rotation, the first receivers 72 and the second receivers 52 are fitted into each other. Otherwise, the first receivers 72 and the second receivers 52 are not fitted with each other.

[0079] The adjustment mechanism 70 further includes N stoppers 74. Each of the stoppers 74 is implemented as a pin including a head 741 and a leg 742 protruding from the head 741. The leg 742 has a diameter which is small enough to be inserted into an associated pair of first and second receivers 72, 52 and has a length which is greater than the depth of the first receiver 72 but is equal to or less than the total depth of the first and second receivers 72, 52.

[0080] When the first receivers 72 and the second receivers 52 are in the fitted state, the respective stopper 74 are inserted at a time into the first and second receivers 72, 52 such that their legs 742 point toward the axis of rotation X with respect to their heads 741, thus making the holder 5 and the supporting member 7 fitted into each other and realizing the prohibited state. In this prohibited state, the rotation of the holder 5 with respect to the supporting member 7 is prevented by the stoppers 74. Thus, the holder 5 is prohibited from rotating around the axis of rotation X with respect to the grip 24 unless the holder 5 is supplied with the power transmitted from the oscillating rotary mechanism 6. Also, in this prohibited state, the power transmitted from the oscillating rotary mechanism 6 to the supporting member 7 is further transmitted to the holder 5 via the stoppers 74. Thus, in the prohibited state, the adjustment mechanism 70 allows the power to be transmitted from the oscillating rotary mechanism 6 to the holder 5.

[0081] Moving the stoppers 74 away from the axis of rotation X as shown in FIG. 14C while the holder 5 is in the prohibited state makes the respective legs 742 of the stoppers 74 disengaged out of the first receivers 72, thus realizing the permitted state. In this case, the respective legs 742 of the stoppers 74 may be either still fitted into the second receivers 52 as shown in FIG. 14C or no longer fitted into the second receivers 52. In this permitted state, the rotation of the holder 5 with respect to the supporting member 7 is not prevented by the stoppers 74. Thus, the holder 5 is allowed to rotate around the axis of rotation X with respect to the grip 24 even when the holder 5 is not supplied with the power transmitted from the oscillating rotary mechanism 6. In addition, in this permitted state, no power is transmitted via the stoppers 74. Therefore, in this permitted state, the adjustment mechanism 70 does not allow the power to be transmitted from the oscillating rotary mechanism 6 to the holder 5. When the holder 5 is allowed to rotate n/N (where n is an integer falling within the range from 1 to N - 1) around the axis of rotation X with respect to the supporting member 7 in the permitted state, the first receivers 72 and the second receivers 52 turn into a different fitted state from the one before the rotation. Inserting the respective stoppers 74 into the first and second receivers 72, 52 at the same time in this state such that their legs 742 point toward the axis of rotation X with respect to their heads 741 realizes the prohibited state.

[0082] As can be seen, according to the fourth variation, the adjustment mechanism 70 is configured to allow the power to be transmitted from the oscillating rotary mechanism 6 to the holder 5 in the prohibited state, and allow no power to be transmitted from the oscillating rotary mechanism 6 to the holder 5 in the permitted state as in the exemplary embodiment described above.

[0083] In this fourth variation, the transmission surface 71 and the receiving surface 51 do not have to have the shape described above as long as the holder 5 is rotatable with respect to the supporting member 7. For example, the receiving surface 51 may have a protrusion and the transmission surface 71 may have a depression and a wall instead. Likewise, the first receivers 72 and the second receivers 52 do not have to be arranged as described above and do not have to have the shapes described above as long as the first receivers 72 and the second receivers 52 switch their states between the fitted state and the non-fitted state as the holder 5 rotates. For example, when the receiving surface 51 has a protrusion, the protrusion may have the second receivers. When the transmission surface 71 has a depression and a wall, the wall may have the first receivers. In that case, the relationship between the first and second receivers described above is reversed.

[0084] Furthermore, in the fourth variation, the adjustment mechanism 70 may also include a locking mechanism 80. In that case, the locking mechanism 80 is a mechanism for switching the state of the stoppers 74 in the permitted state between a state where the movement of the stoppers 74 with respect to the first and second receivers 72, 52 is regulated and a state where their movement is not regulated. Specifically, the locking mechanism 80 may have the same configuration as the locking mechanism 80 according to the third variation. In that case, fastening the fastener 84 of the locking member 82 causes the fastener 84 to press the respective heads 741 of the stoppers 74 toward the axis of rotation X, thus regulating the movement of the stoppers 74. On the other hand, loosening the fastener 84 causes the fastener 84 to stop pressing the respective heads 741 of the stoppers 74, thus deregulating the movement of the stoppers 74. Alternatively, the locking mechanism 80 may also be implemented as a stopper with an appropriate structure for switching the state of the stoppers 74 between the movement regulated state and the movement deregulated state.

[0085] Furthermore, in the fourth variation, the number of the stoppers 74 provided may fall within the range from 1 to less than N. That is to say, the prohibited state may be realized by inserting the stopper 74 into at least one pair of first and second receivers 72, 52. If the number of the stoppers 74 falls within the range from 1 to less than N, then the number of the second receivers 52 may be less than N, as long as the number of the second receivers 52 is equal to or greater than that of the stoppers74.

[0086] Furthermore, in the fourth variation, in the prohibited state, the holder 5 may be any one of N arrangement states which are defined by sequentially rotating the holder 5 1/N of full rotation in each step. That is to say, whenever sequentially changing from one arrangement state to another, the holder 5 always rotates to the same degree (i.e., its angle of rotation is always the same). However, this is only an example and should not be construed as limiting. Alternatively, the angle of rotation of the holder 5 when sequentially changing from one arrangement state to another may sometimes be different from the previous one. That is to say, as long as the holder 5 may have two or more arrangement states, the angle of rotation to let the holder 5 change from one arrangement state to another does not have to be always the same. For example, the holder 5 may be allowed to change to the next arrangement state by making 1/6, 1/6, and 4/6 rotations in this order. For that purpose, in the example shown in FIGS. 14A-14C, the locations, numbers, and inside diameters of the first and second receivers 72, 52 and the diameter of the respective legs 742 of the stoppers 74 may be changed appropriately.

[0087] In the exemplary embodiment described above, in the state where the bit 3 is held by the holder 5, fitting the plurality of projections 532 on the holding surface 53 into the respective holes 34 of the bit 3 prevents the bit 3 from rotating with respect to the holder 5. However, this is only an example and should not be construed as limiting. Alternatively, the rotation of the bit 3 with respect to the holder 5 may also be prevented by any other structure that makes the holder 5 and the bit 3 fitted into each other, not just the combination of the projections 532 and the holes 34. For example, contrary to the exemplary embodiment described above, the holding surface 53 may have a plurality of holes and the bit 3 may have a plurality of projections 532 to be fitted into the respective holes. Note that this alternative structure is just an example and any other fitting structure may also be adopted for the bit 3 and the holder 5 to prevent the bit 3 from rotating with respect to the holder 5 unexpectedly.

[0088] Furthermore, in the exemplary embodiment and variations described above, the holder 5 may also be attachable to, and removable from, the tool body 2. Alternatively, the combination of the holder 5 and the supporting member 7 may also be attachable to, and removable from, the tool body 2. That is to say, the tool 1 according to the present disclosure may be formed by attaching the combination of the holder 5 and the supporting member 7 to a tool without any holder 5 or supporting member 7.

[0089] Furthermore, in the exemplary embodiment described above, the adjustment mechanism 70 is provided outside of the housing 21. However, this is only an example and should not be construed as limiting. Alternatively, the adjustment mechanism 70 may also be provided inside of the housing 21. Optionally, the adjustment mechanism 70 may be built in the oscillating rotary mechanism 6. In any case, the adjustment mechanism 70 does not have to have the structure described above but may also have any other structure as long as the adjustment mechanism 70 is able to switch the state of the holder 5, which is a member for holding the bit 3, between the prohibited state and the permitted state.

[0090] Furthermore, in the embodiment described above, the tool 1 is implemented as an electric power tool (electric tool) including an electric motor as its drive source 26. However, the tool 1 does not have to be such an electric power tool. That is to say, the tool 1 may also be a hydraulic power tool or an air power tool as well.

[0091] Note that embodiments and their variations described above are only examples of the present disclosure and should not be construed as limiting. Rather, those embodiments and variations may be readily combined in various manners depending on a design choice or any other factor without departing from a true spirit and scope of the present disclosure.

[0092] As can be seen from the foregoing description of embodiments and variations, a tool (1) according to a first aspect of the present disclosure includes: a housing (21) having a grip (24); a holder (5) with the ability to hold a bit (3); an oscillating rotary mechanism (6) to generate power that imparts an oscillating rotary motion to the holder (5); and an adjustment mechanism (70). The adjustment mechanism (70) switches a state of the holder (5) between a prohibited state and a permitted state. The prohibited state is a state in which the holder (5) is prohibited from rotating around a virtual axis with respect to the grip (24) unless the holder (5) is supplied with the power. The permitted state is a state in which the holder (5) is permitted to rotate around the axis with respect to the grip (24) even when the holder (5) is not supplied with the power.

[0093] The first aspect allows the user to change the orientation of a bit (3) held by the tool (1) even without removing the bit (3) from the tool (1).

[0094] A tool (1) according to a second aspect of the present disclosure, which may be implemented in conjunction with the first aspect, further includes a locking mechanism (80) that selectively allows the adjustment mechanism (70) to switch the state of the holder (5) between the prohibited state and the permitted state.

[0095] The second aspect reduces the chances of the state of the holder (5) happening to switch from the prohibited state to the permitted state to change the orientation of the bit (3) unintentionally.

[0096] In a tool (1) according to a third aspect of the present disclosure, which may be implemented in conjunction with the first or second aspect, the adjustment mechanism (70) allows, in the prohibited state, the power to be transmitted from the oscillating rotary mechanism (6) to the holder (5), and allows, in the permitted state, no power to be transmitted from the oscillating rotary mechanism (6) to the holder (5).

[0097] The third aspect imparts, in the prohibited state, an oscillating rotary motion to the bit (3) by transmitting power to the bit (3) via the holder (5) and also allows, in the permitted state, the holder (5) to rotate without the oscillating rotary mechanism (6) by transmitting no power to the holder (5).

[0098] In a tool (1) according to a fourth aspect of the present disclosure, which may be implemented in conjunction with the third aspect, the adjustment mechanism (70) includes a supporting member (7) to which the power is transmitted from the oscillating rotary mechanism (6). The supporting member (7) has a transmission surface (71) facing the holder (5). The supporting member (7) holds the holder (5) while allowing the holder (5) to move between a supported position where the holder (5) is in contact with the transmission surface (71) and a non-supported position where the holder (5) is out of contact with the transmission surface (71). The holder (5) is located at the supported position in the prohibited state and located at the non-supported position in the permitted state. The supporting member (7) allows, when the holder (5) is located at the supported position, the power to be transmitted from the supporting member (7) to the holder (5), and also allows, when the holder (5) is located at the non-supported position, no power to be transmitted from the supporting member (7) to the holder (5).

[0099] The fourth aspect allows, when the holder (5) located at the supported position goes out of contact with the transmission surface (71) and moves to the non-supported position, no power to be transmitted to the holder (5). If the holder (5) moves to the supported position after having rotated in this state, then no power may be transmitted to the holder (5).

[0100] In a tool (1) according to a fifth aspect of the present disclosure, which may be implemented in conjunction with the fourth aspect, the adjustment mechanism (70) further includes a biasing member (73) to apply elastic force directed toward the transmission surface (71) to the holder (5).

[0101] The fifth aspect allows, even when the holder (5) has moved from the supported position to the non-supported position, the holder (5) to easily go back to the supported position again with the elastic force applied by the biasing member (73) to the holder (5). In addition, the biasing member (73) pressing the holder (5) against the transmission surface (71) reduces the chances of the holder (5) being released from the transmission surface (71). This allows the power to be transmitted to the holder (5) more easily in the prohibited state.

[0102] In a tool (1) according to a sixth aspect of the present disclosure, which may be implemented in conjunction with the third aspect, the adjustment mechanism (70) includes the supporting member (7) to which the power is transmitted from the oscillating rotary mechanism (6) and a stopper (74). The holder (5) is rotatable around the axis with respect to the supporting member (7). The supporting member (7) includes a first receiver (72) and the holder (5) includes a second receiver (52). The first receiver (72) and the second receiver (52) switch, as a relative position of the second receiver (52) with respect to the first receiver (72) changes with rotation of the holder (5), between a fitted state in which the stopper (74) is able to be fitted into both of the first receiver (72) and the second receiver (52) at a time and a non-fitted state in which the stopper (74) is unable to be fitted into both of the first receiver (72) and the second receiver (52) at a time. The prohibited state is realized by making the stopper (74) fitted into both of the first receiver (72) and the second receiver (52) at a time in the fitted state, and the permitted state is realized by making the stopper (74) non-fitted into at least one of the first receiver (72) or the second receiver (52).

[0103] The sixth aspect allows, by making the stopper (74) non-fitted into at least one of the first receiver (72) or the second receiver (52) in the prohibited state, no power to be transmitted to the holder (5) and realizes the permitted state. If the stopper (74) is fitted into the first receiver (72) and the second receiver (52) at a time in the fitted state after the holder (5) has rotated in this state, then power is allowed to be transmitted to the holder (5) and the prohibited state is realized.

[0104] In a tool (1) according to a seventh aspect of the present disclosure, which may be implemented in conjunction with any one of the first to sixth aspects, in the permitted state, the holder (5) is rotatable around the axis. In the prohibited state, the holder (5) is in any one of N arrangement states, each of which is defined by sequentially rotating the holder (5) around the axis 1/N of full rotation in each step, where N is an integer equal to or greater than two.

[0105] The seventh aspect allows the bit (3) to have an orientation corresponding to the angle of rotation of the holder (5) by rotating the holder (5) in the permitted state n/N (where n is an integer falling within the range from 1 to N - 1) of full rotation and then switching the state of the holder (5) to the prohibited state.

[0106] A tool system (10) according to an eighth aspect of the present disclosure includes: the tool (1) of any one of the first to seventh aspects; and the bit (3).

[0107] The eighth aspect allows the user to change the orientation of a bit (3) held by the tool (1) even without removing the bit (3) from the tool (1).

Reference Signs List

[0108]

1	Tool
10	Tool System
21	Housing
24	Grip
3	Bit
5	Holder
51	Receiving Surface
52	Second Receiver
6	Reciprocating Rotary Mechanism
70	Adjustment Mechanism
7	Supporting Member
71	Transmission Surface
72	First Receiver
73	Biasing Member
74	Fastener
80	Locking Mechanism

Claims

1. A tool (1) comprising:

a housing (21) having a grip (24);
a holder (5) configured to hold a bit (3);
an oscillating rotary mechanism (6) configured

to generate power that imparts an oscillating rotary motion to the holder (5); and
an adjustment mechanism (70) configured to switch a state of the holder (5) between a prohibited state in which the holder (5) is prohibited from rotating around a virtual axis with respect to the grip (24) unless the holder (5) is supplied with the power and a permitted state in which the holder (5) is permitted to rotate around the axis with respect to the grip (24) even when the holder (5) is not supplied with the power.

2. The tool (1) of claim 1, further comprising a locking mechanism (80) configured to selectively allow the adjustment mechanism (70) to switch the state of the holder (5) between the prohibited state and the permitted state.

3. The tool (1) of claim 1 or 2, wherein
the adjustment mechanism (70) is configured to allow, in the prohibited state, the power to be transmitted from the oscillating rotary mechanism (6) to the holder (5), and allow, in the permitted state, no power to be transmitted from the oscillating rotary mechanism (6) to the holder (5).

4. The tool (1) of claim 1, wherein
the adjustment mechanism (70) includes a supporting member (7) to which the power is transmitted from the oscillating rotary mechanism (6),
the supporting member (7) has a transmission surface (71) facing the holder (5),
the supporting member (7) is configured to hold the holder (5) while allowing the holder (5) to move between a supported position where the holder (5) is in contact with the transmission surface (71) and a non-supported position where the holder (5) is out of contact with the transmission surface (71),
the holder (5) is located at the supported position in the prohibited state and located at the non-supported position in the permitted state, and
the supporting member (7) is configured to allow, when the holder (5) is located at the supported position, the power to be transmitted from the supporting member (7) to the holder (5), and also allow, when the holder (5) is located at the non-supported position, no power to be transmitted from the supporting member (7) to the holder (5).

5. The tool (1) of claim 4, wherein
the adjustment mechanism (70) further includes a biasing member (73) configured to apply elastic force directed toward the transmission surface (71) to the holder (5).

6. The tool (1) of claim 3, wherein
the adjustment mechanism (70) includes the supporting member (7) to which the power is transmitted from the oscillating rotary mechanism (6) and a stopper (74),
the holder (5) is rotatable around the axis with respect to the supporting member (7),
the supporting member (7) includes a first receiver (72) and the holder (5) includes a second receiver (52),
the first receiver (72) and the second receiver (52) are configured to switch, as a relative position of the second receiver (52) with respect to the first receiver (72) changes with rotation of the holder (5), between a fitted state in which the stopper (74) is able to be fitted into both of the first receiver (72) and the second receiver (52) at a time and a non-fitted state in which the stopper (74) is unable to be fitted into both of the first receiver (72) and the second receiver (52) at a time, and
the prohibited state is realized by making the stopper (74) fitted into both of the first receiver (72) and the second receiver (52) at a time in the fitted state, and the permitted state is realized by making the stopper (74) non-fitted into at least one of the first receiver (72) or the second receiver (52) in the non-fitted state.

7. The tool (1) of any one of claims 1 to 6, wherein
in the permitted state, the holder (5) is rotatable around the axis,
in the prohibited state, the holder (5) is in any one of N arrangement states, each of which is defined by sequentially rotating the holder (5) around the axis 1/N of full rotation in each step, where N is an integer equal to or greater than two.

8. A tool system (10) comprising:

the tool (1) of any one of claims 1 to 7; and
the bit (3).

FIG. 1

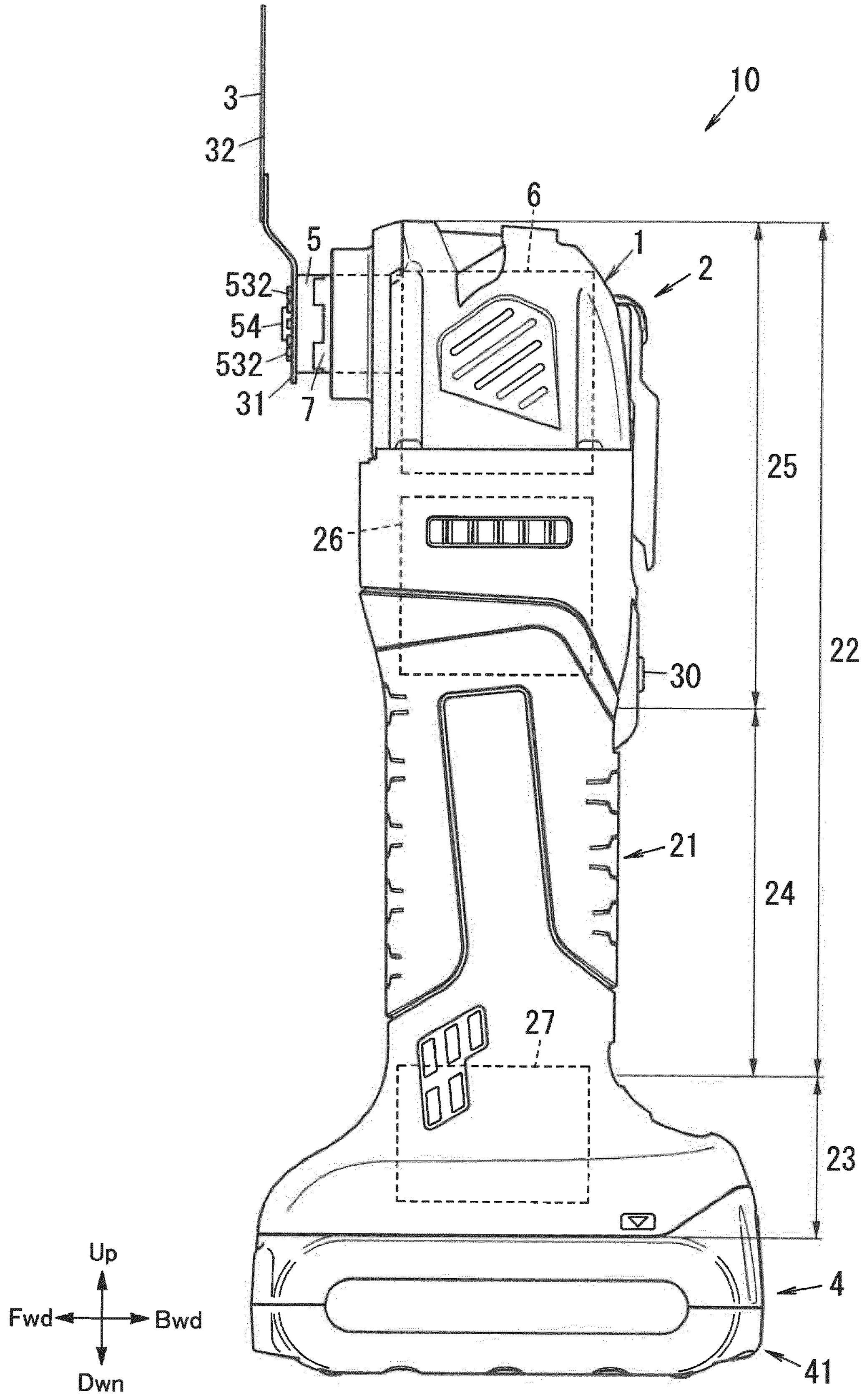

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FIG. 2

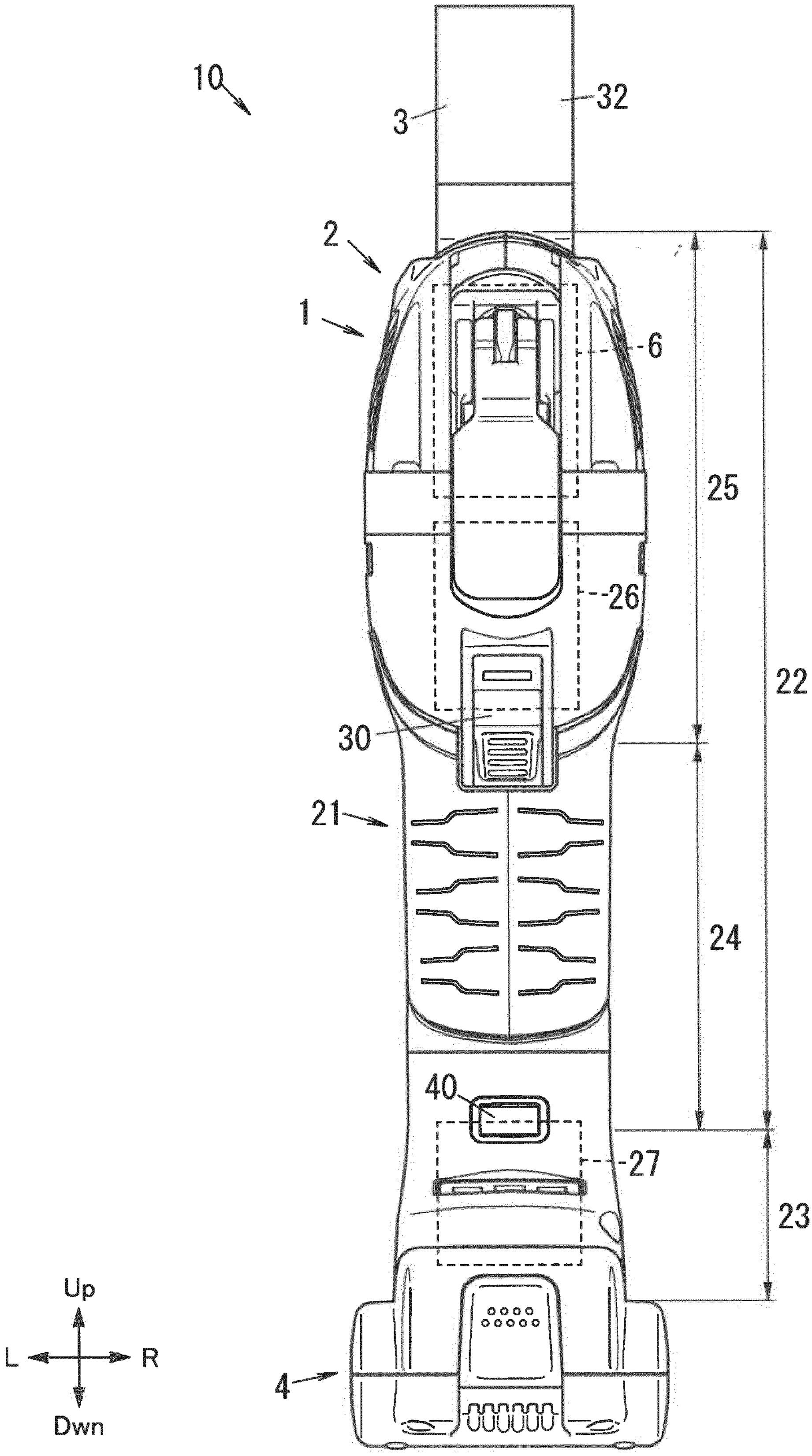

FIG. 3

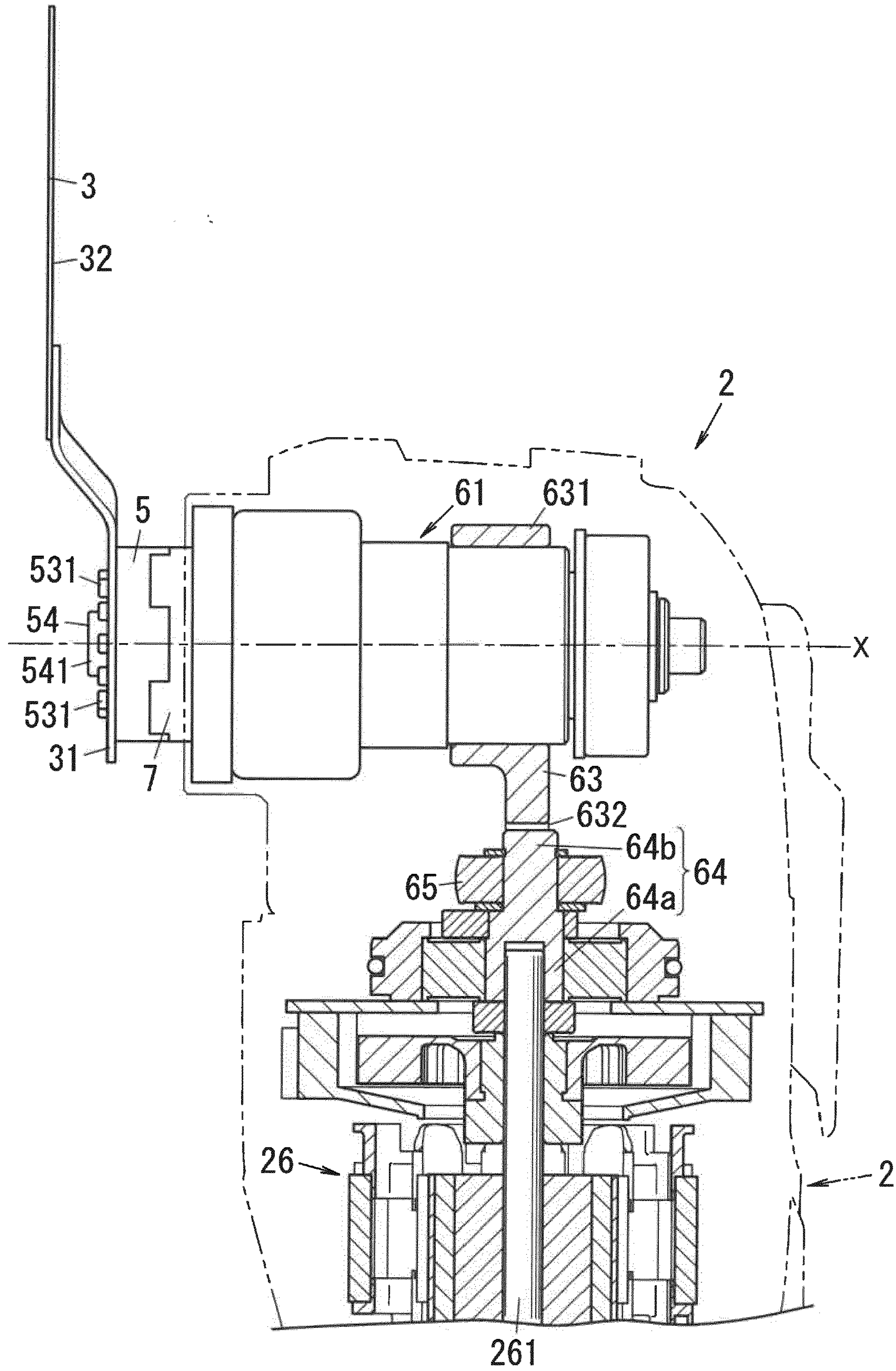

FIG. 4A

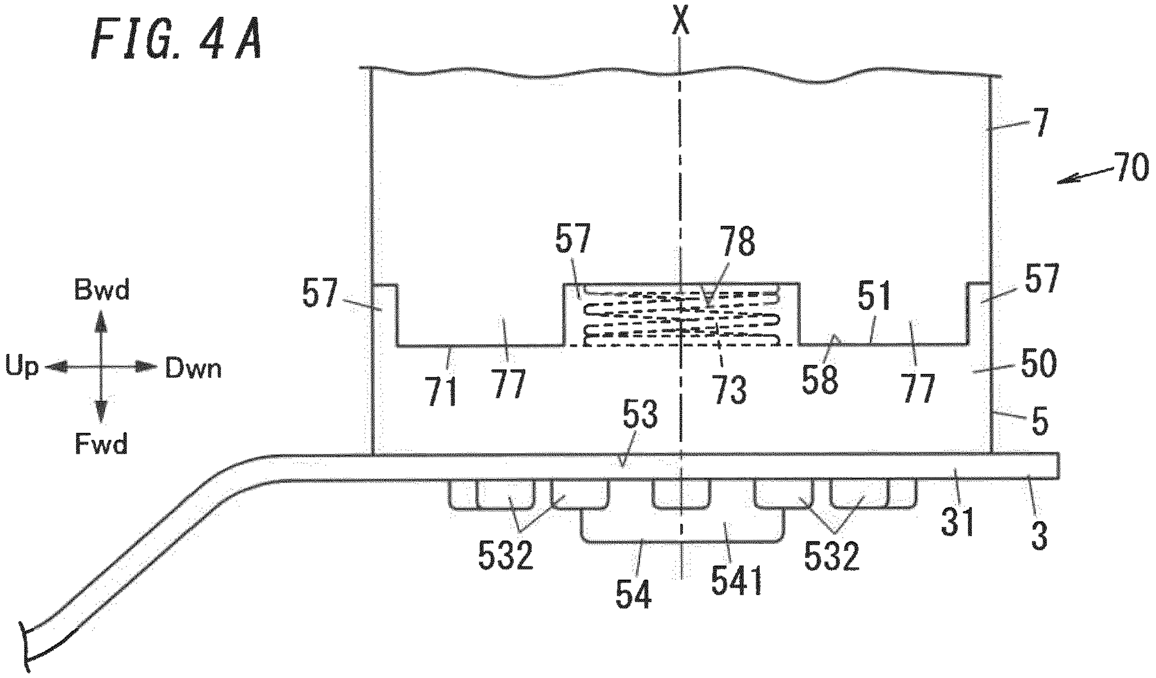
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FIG. 4B

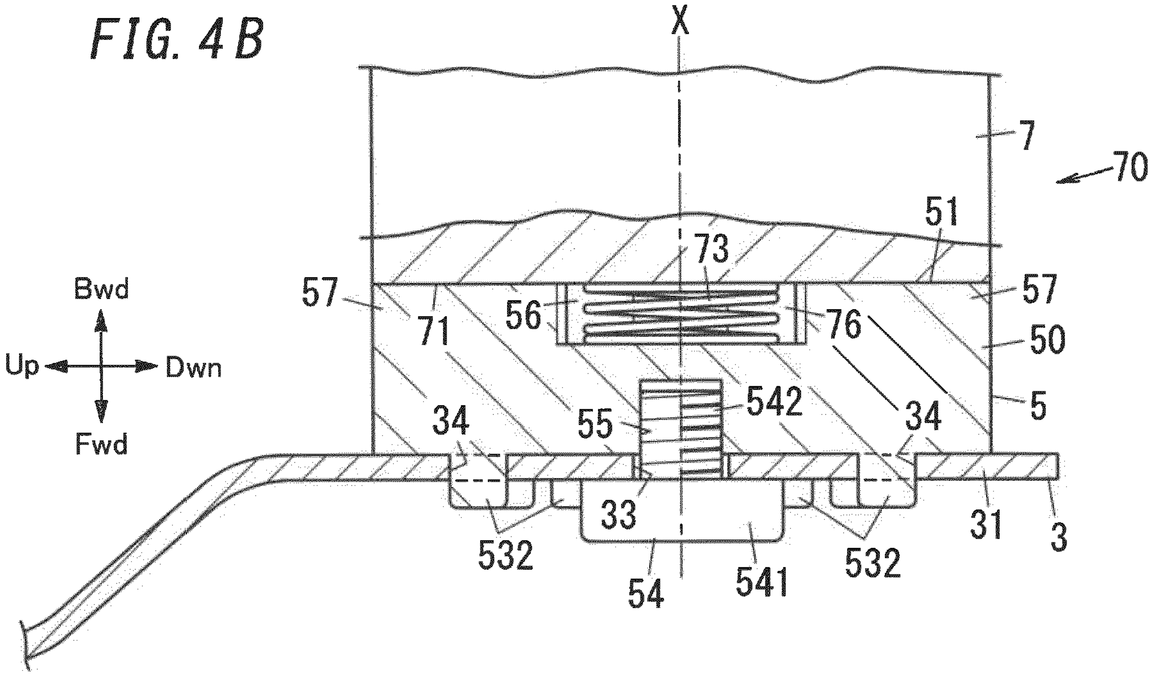
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FIG. 5A

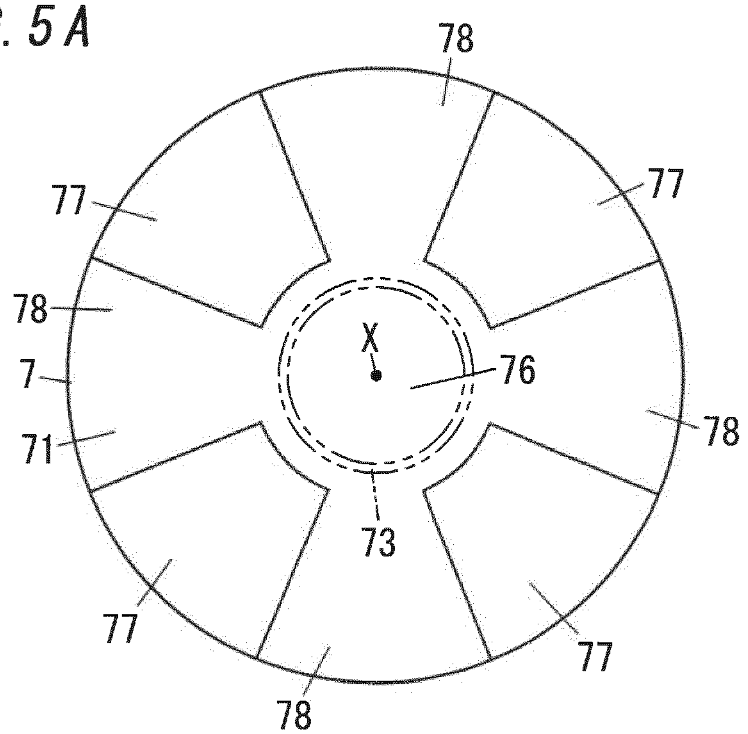
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FIG. 5B

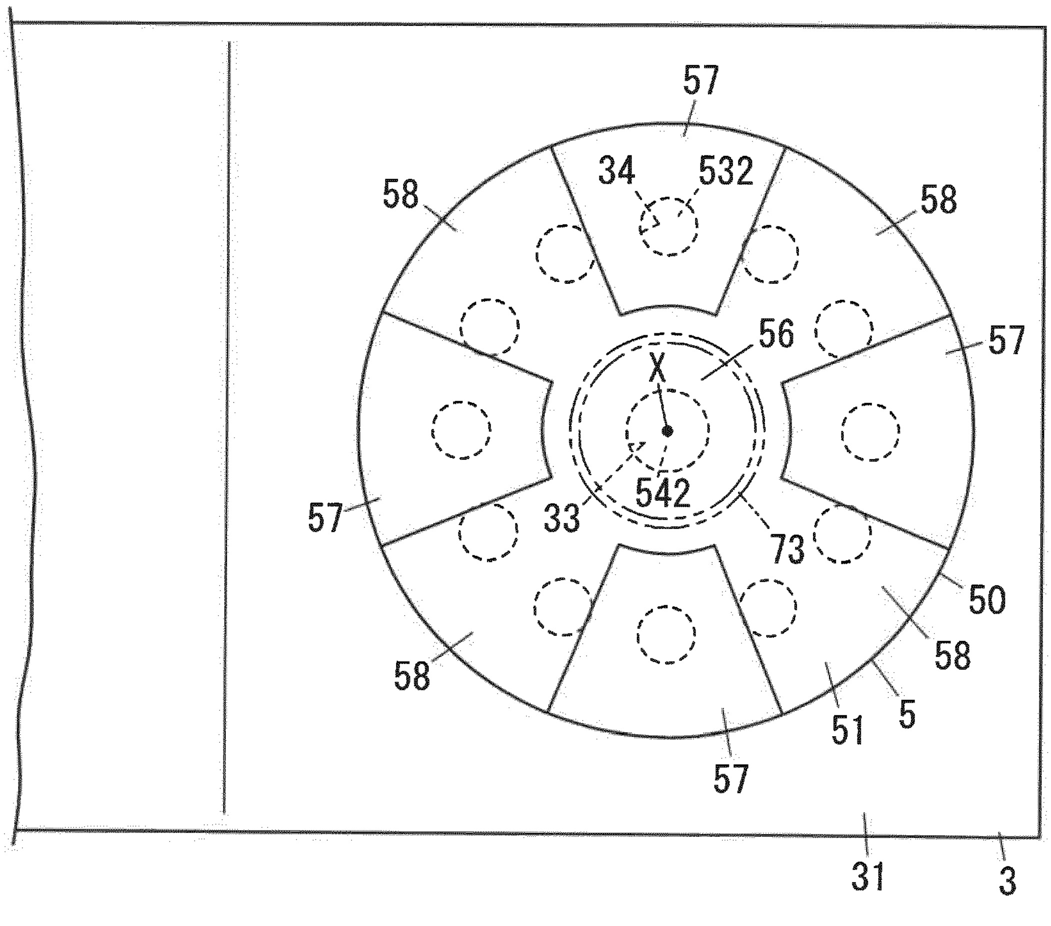
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FIG. 6A

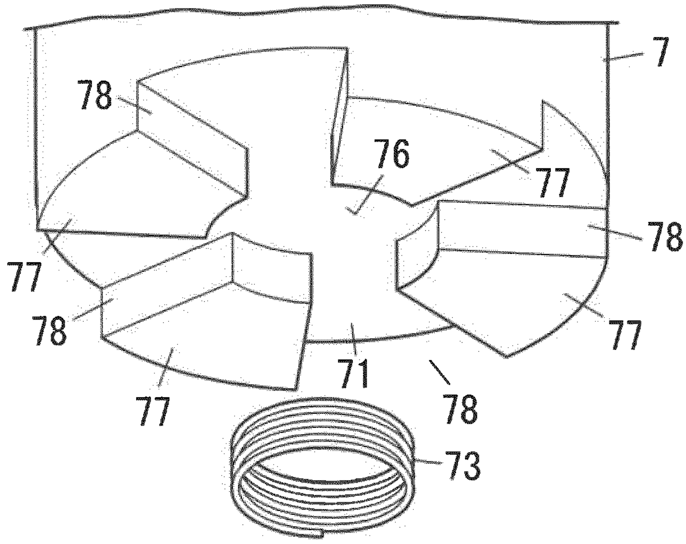
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FIG. 6B

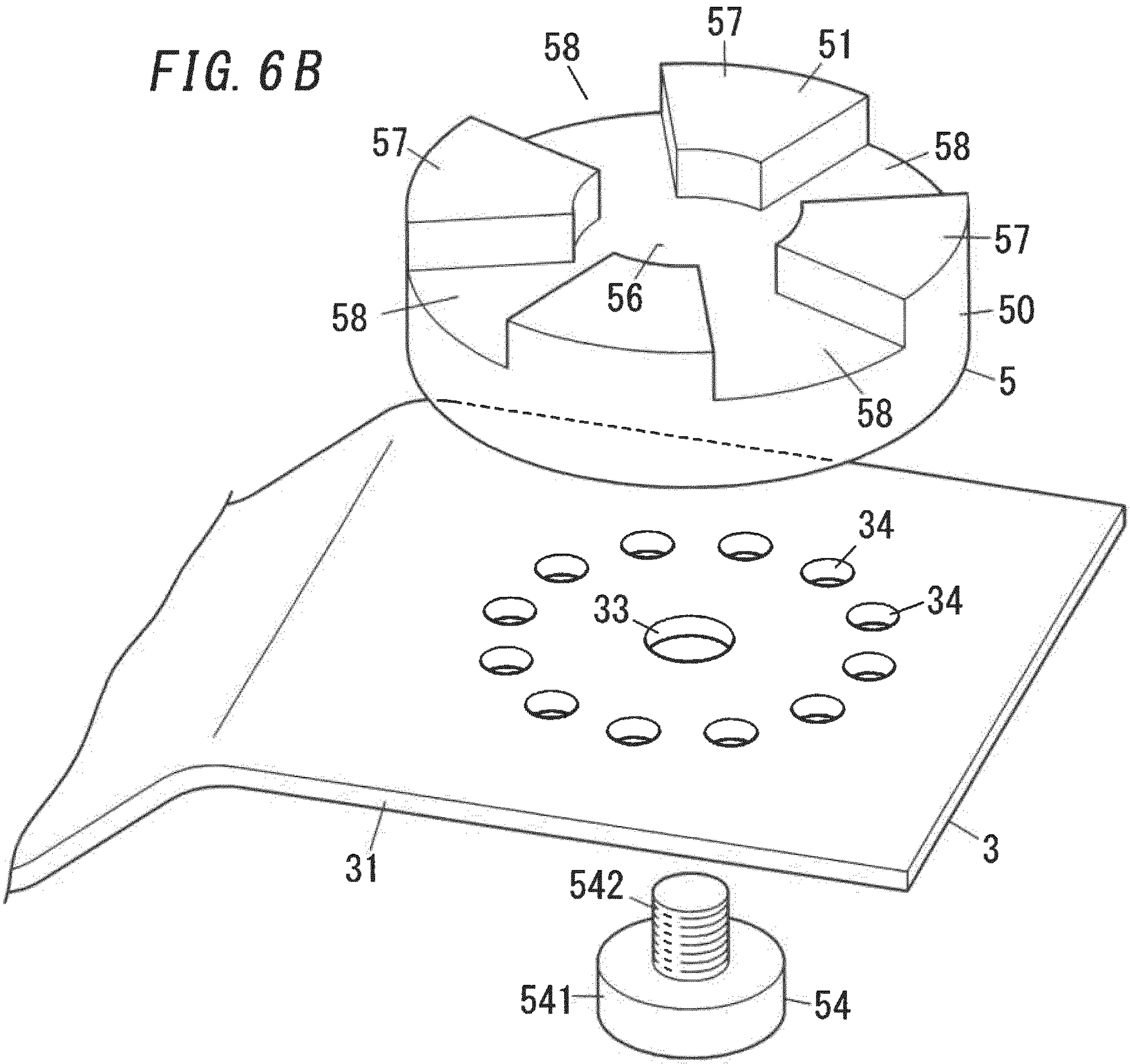
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FIG. 7A

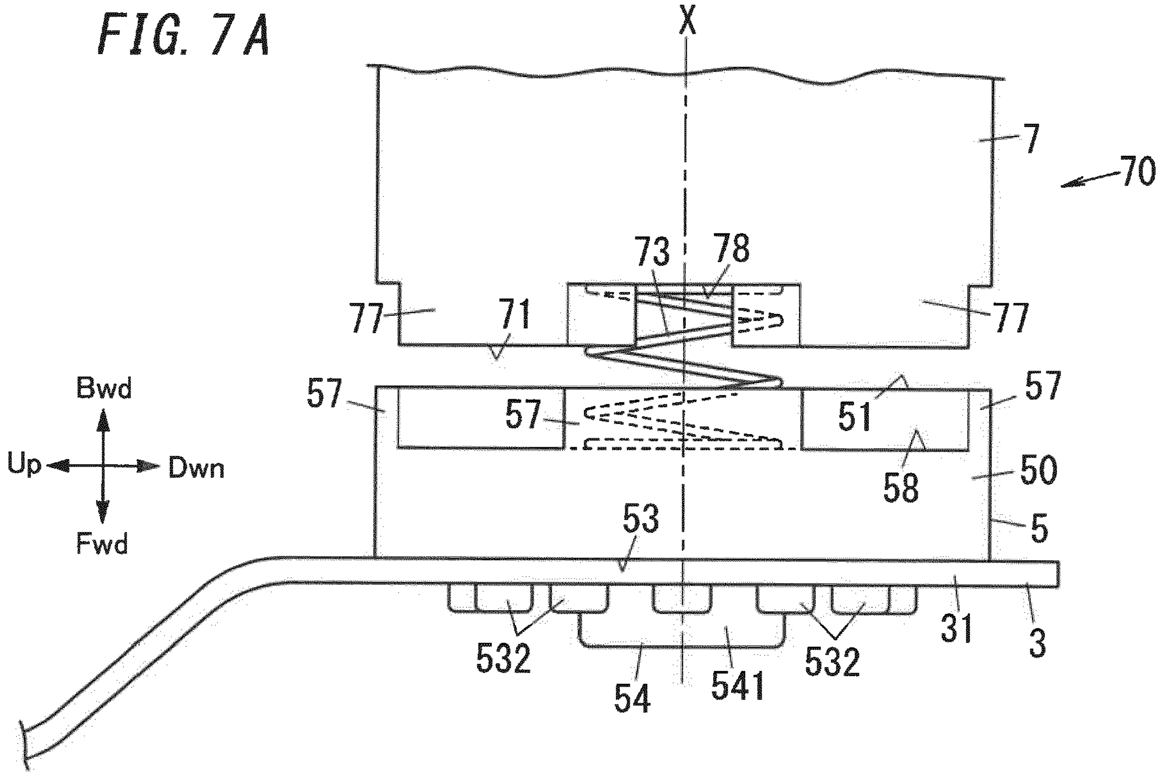
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FIG. 7B

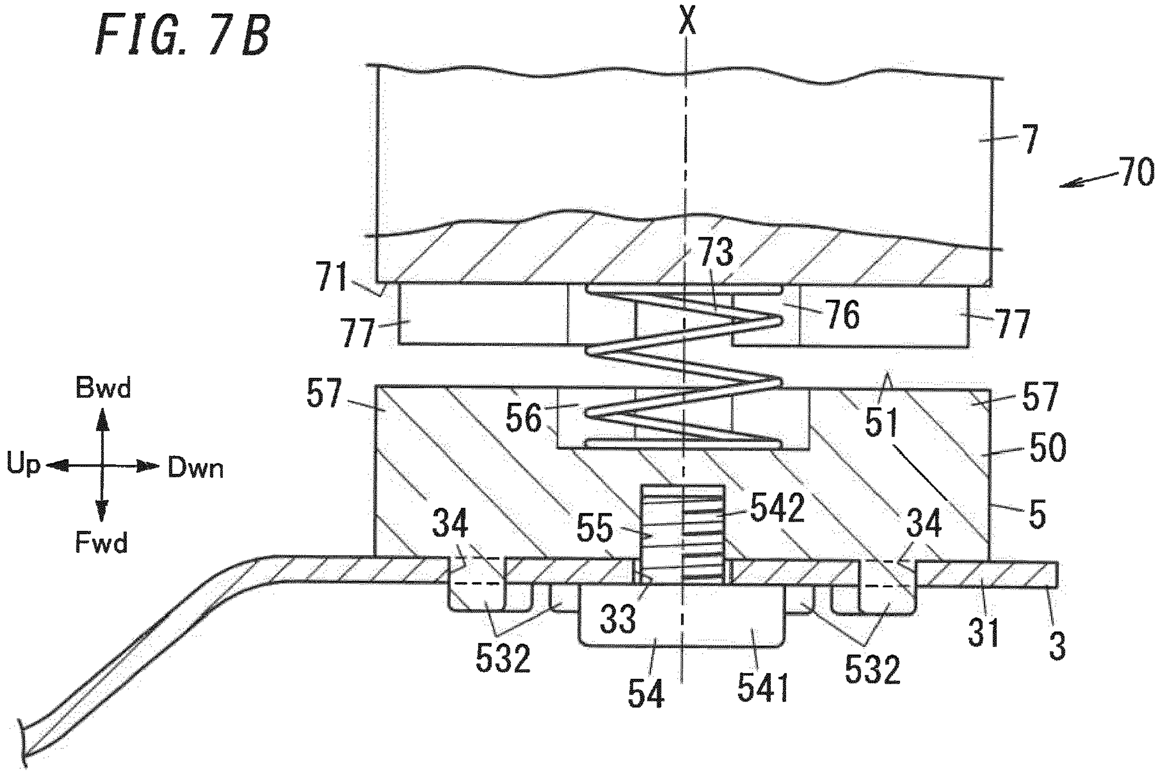
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FIG. 8A

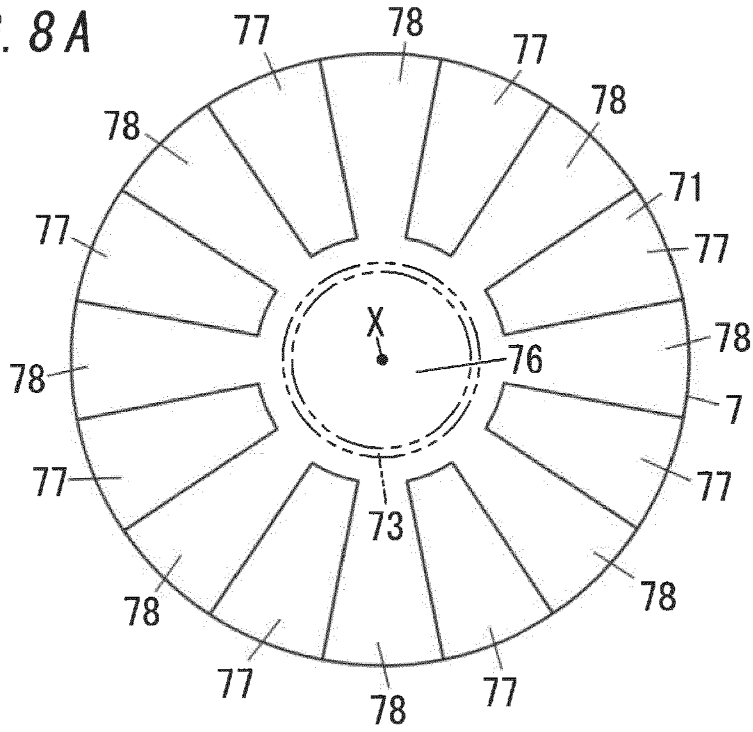
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FIG. 8B

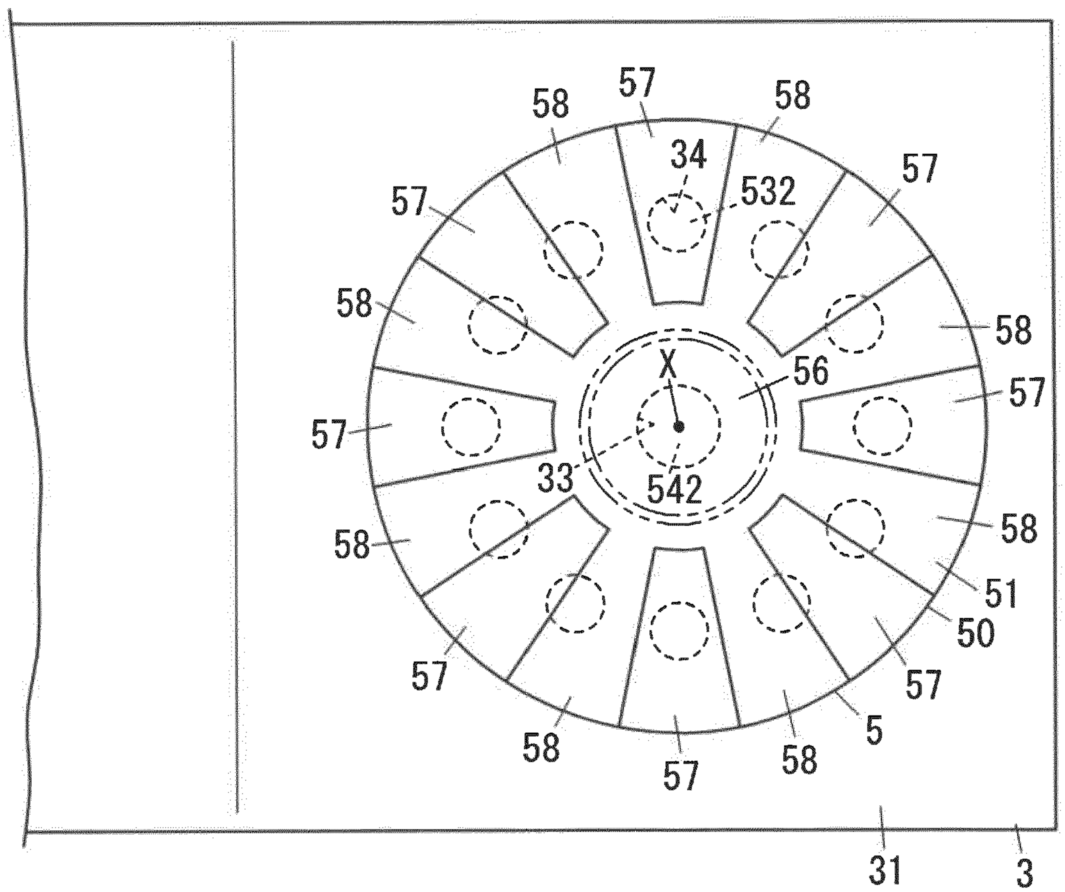
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FIG. 9

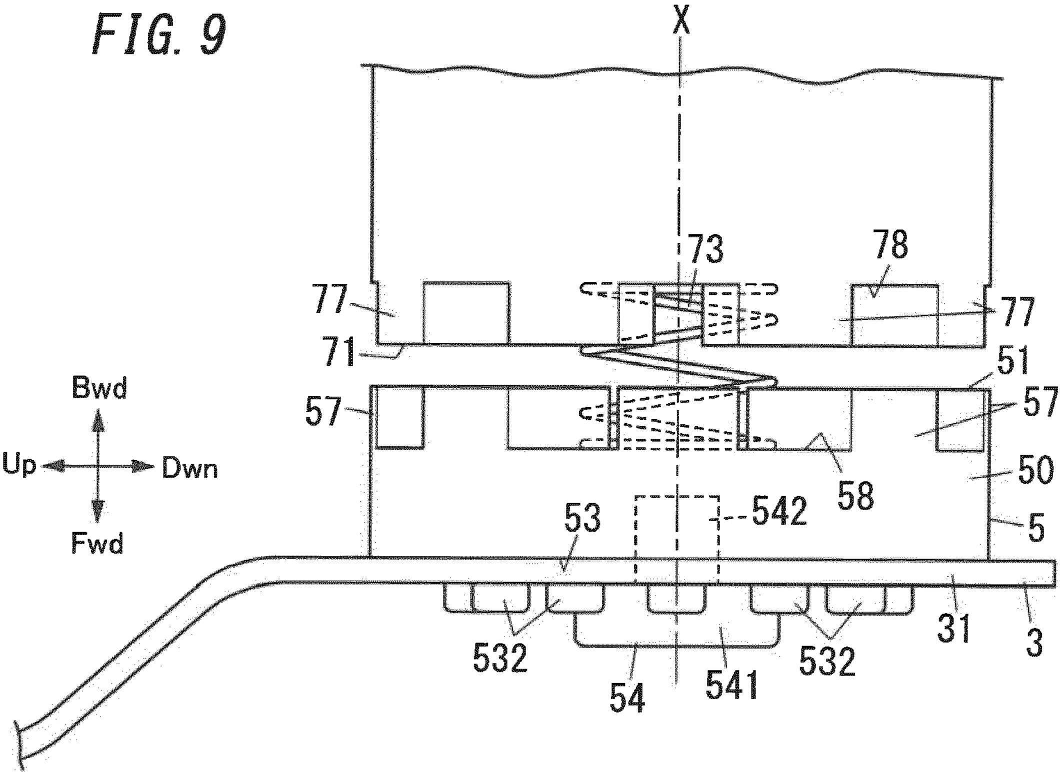
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FIG. 10A

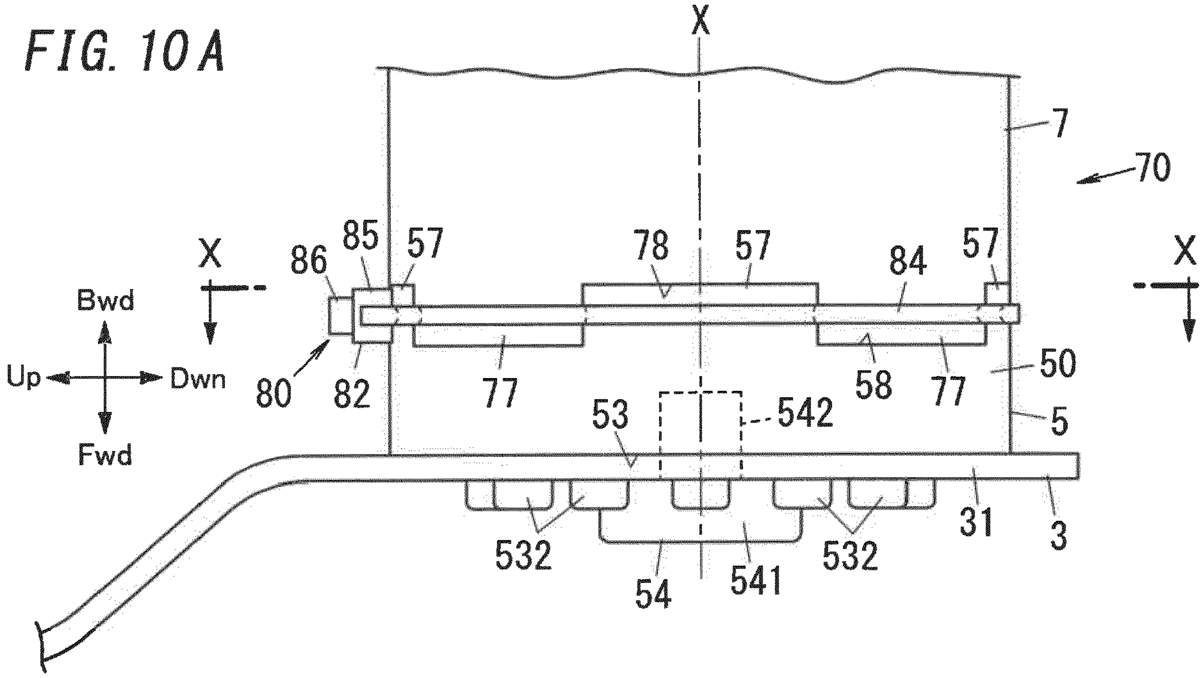

FIG. 10B

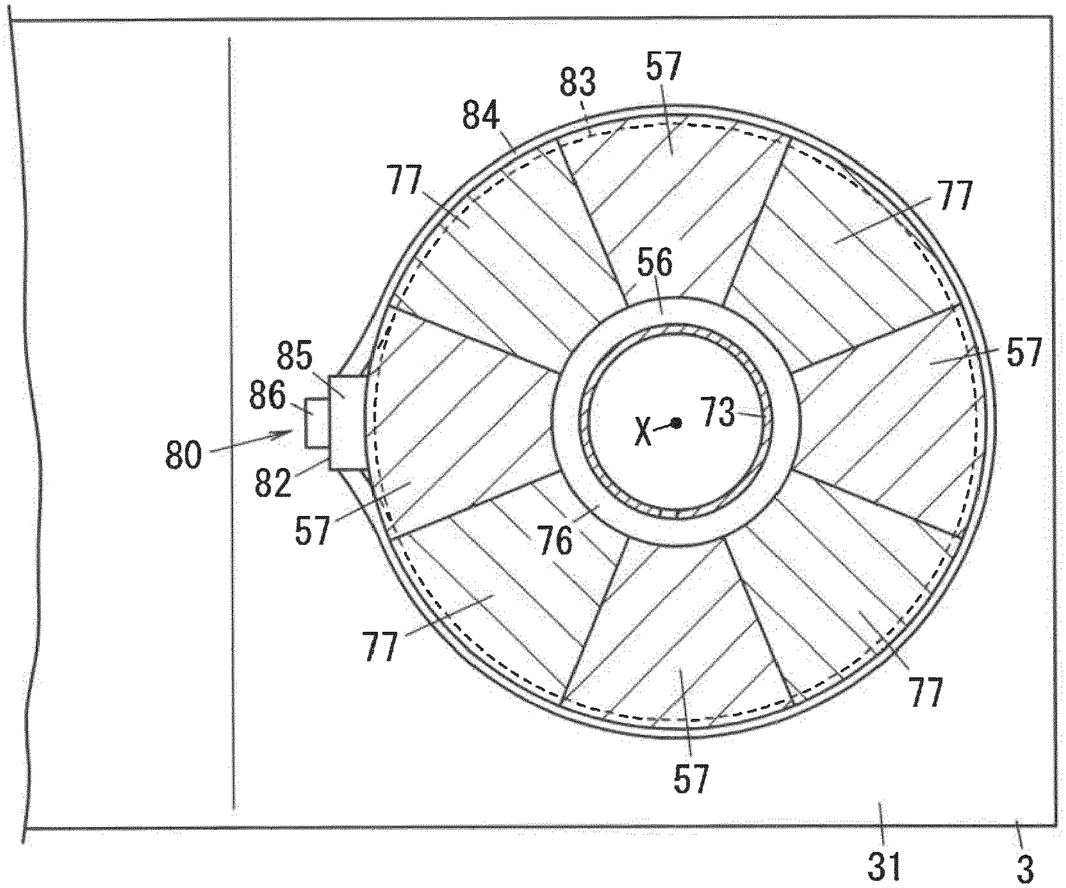

FIG. 11

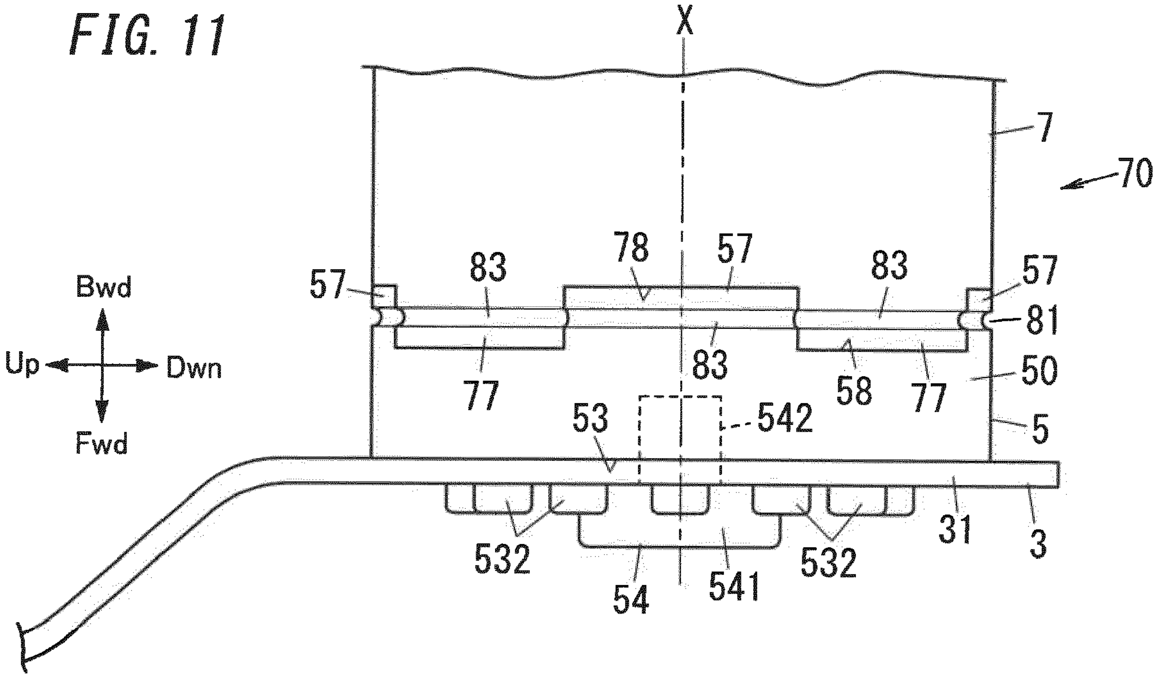
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FIG. 12A

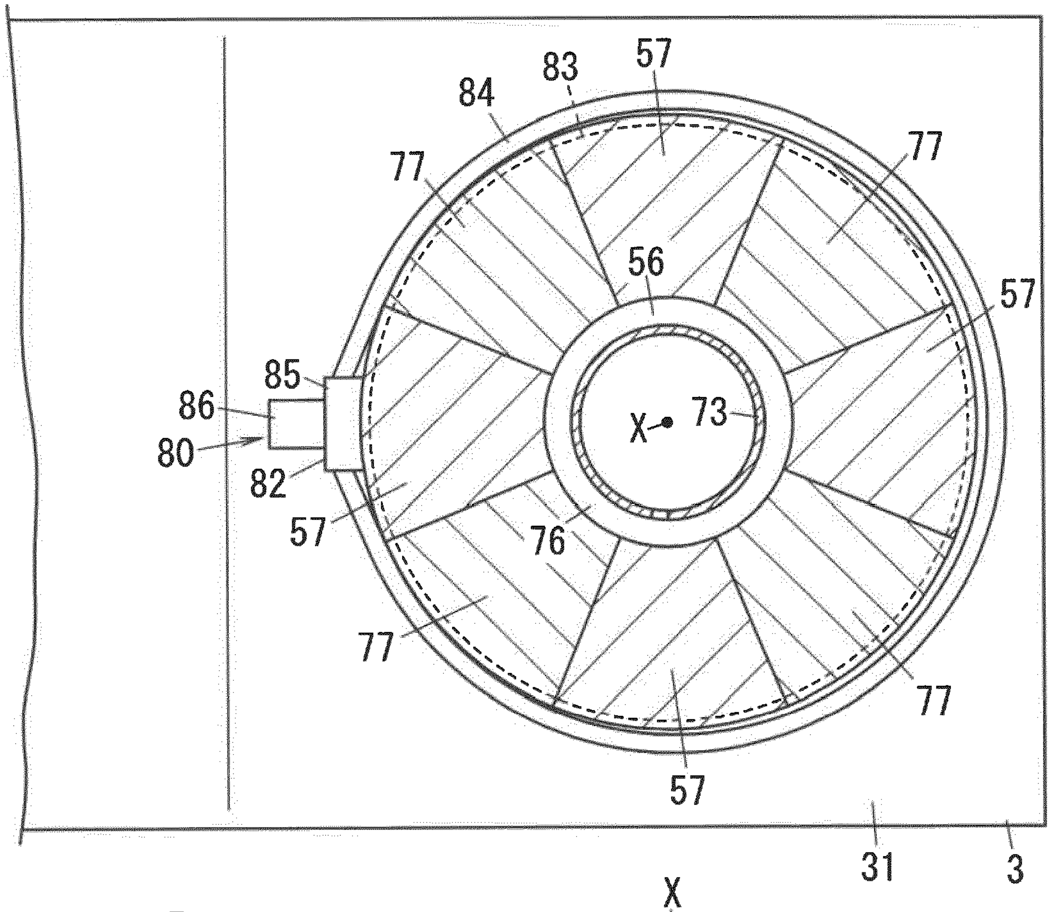


FIG. 12B

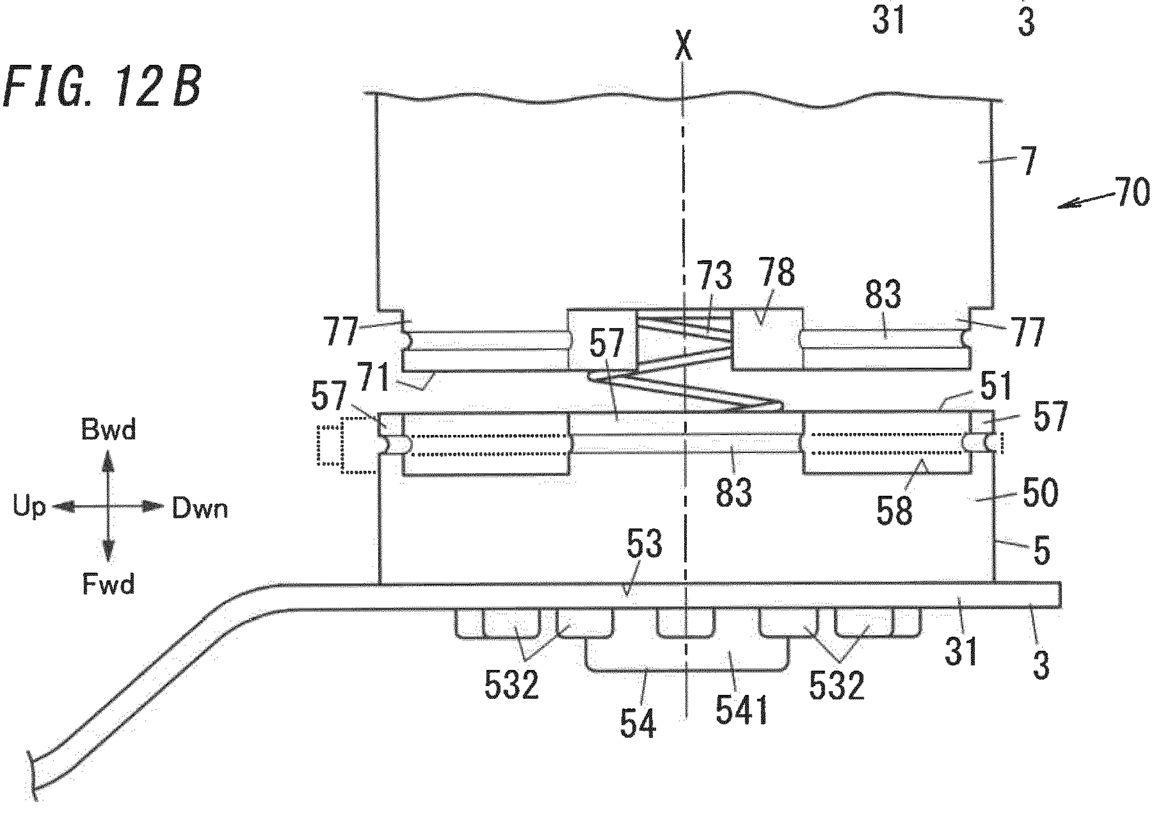


FIG. 13A

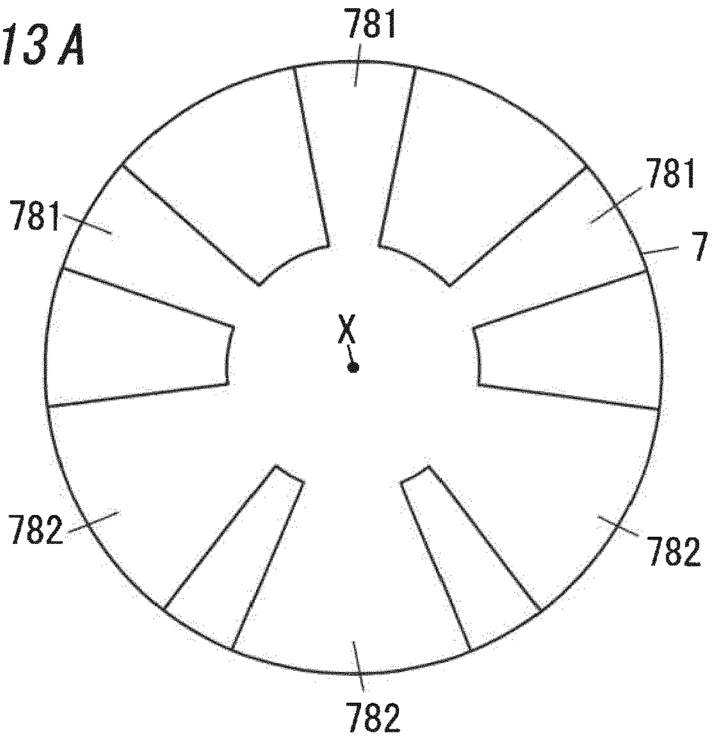


FIG. 13B

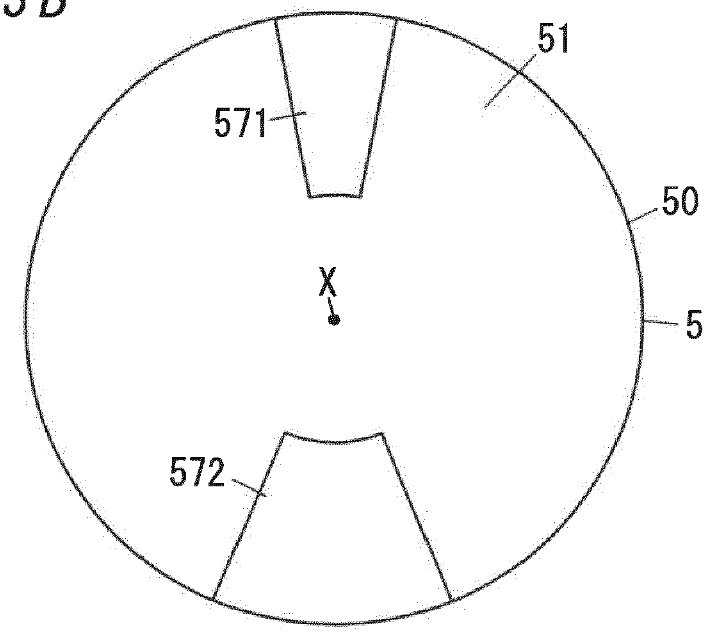


FIG. 14A

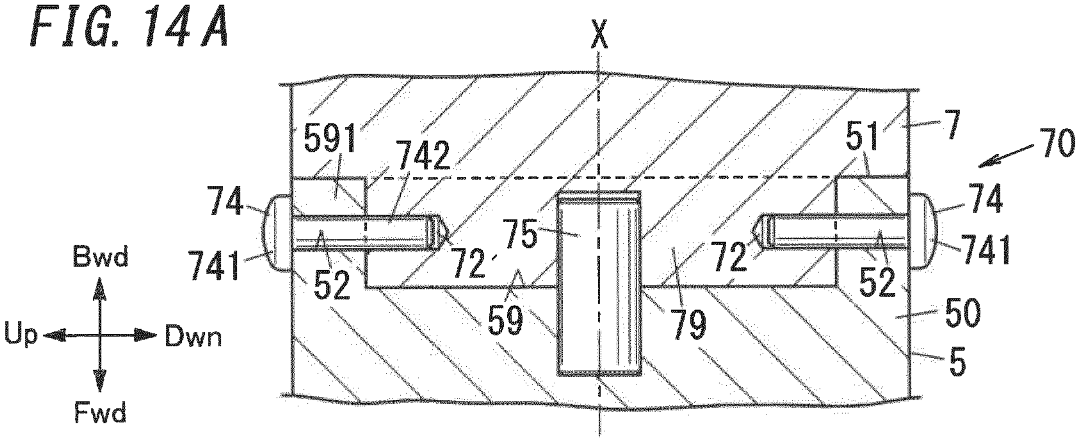


FIG. 14B

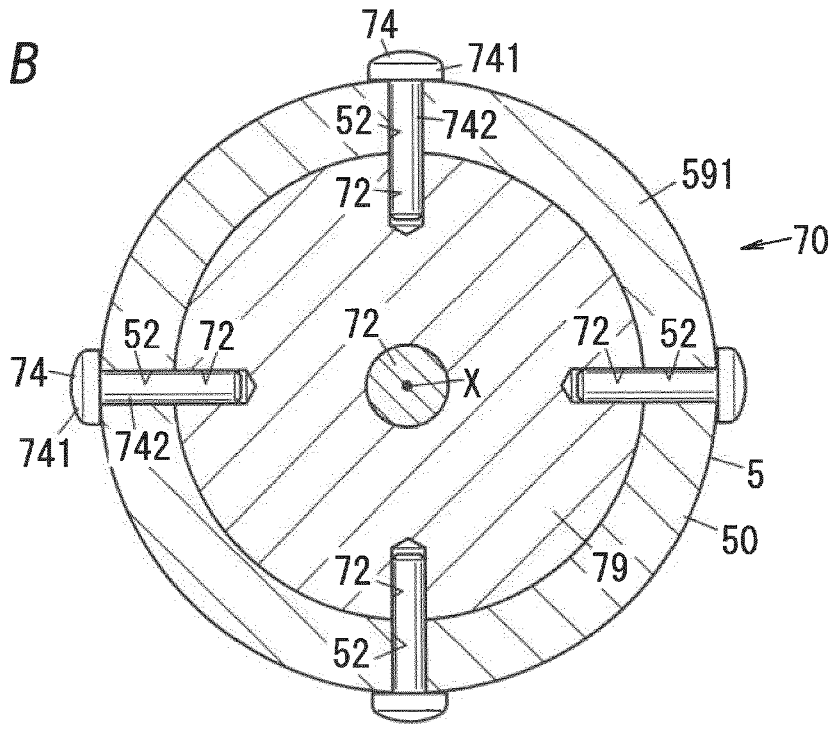
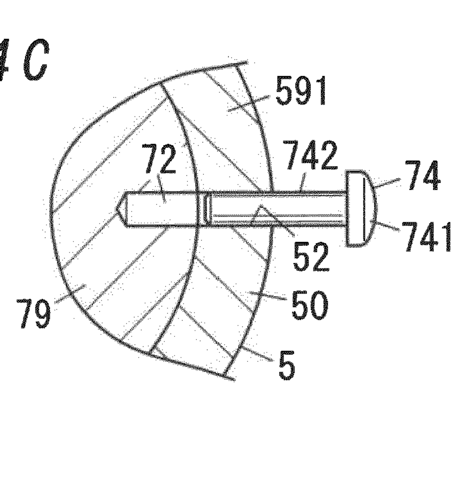


FIG. 14C



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EUROPEAN SEARCH REPORT

Application Number
EP 19 19 5385

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2016/045998 A1 (ZHOU HONGTAO [CN]) 18 February 2016 (2016-02-18) * paragraphs [0033] - [0039] * * figures 1-4 *	1-8	INV. B25F5/00 B24B23/04 B24B45/00 B27B19/00
X	US 2018/056414 A1 (RUBENS JEREMY [US] ET AL) 1 March 2018 (2018-03-01) * paragraphs [0021], [0022], [0033], [0035] * * figures 1,9,10 *	1-8	
A	US 9 242 347 B2 (KRAUSE AARON C [US]; TITOVS ALEKSANDRS [LV] ET AL.) 26 January 2016 (2016-01-26) * column 5, line 39 - column 6, line 25 * * figure 7 *	6	

TECHNICAL FIELDS SEARCHED (IPC)

B25F
B24D
B28D
B24B
B27B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	17 February 2020	Bonnin, David

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17-02-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016045998 A1	18-02-2016	DE 202012101783 U1	08-08-2012
		FR 2975324 A3	23-11-2012
		GB 2491032 A	21-11-2012
		US 2012292864 A1	22-11-2012
		US 2016045998 A1	18-02-2016
US 2018056414 A1	01-03-2018	US 2018056414 A1	01-03-2018
		WO 2018041598 A1	08-03-2018
US 9242347 B2	26-01-2016	BR PI1007756 A2	06-02-2018
		CN 102458764 A	16-05-2012
		EP 2429764 A1	21-03-2012
		ES 2539681 T3	03-07-2015
		RU 2011145348 A	20-06-2013
		US 2012051832 A1	01-03-2012
		WO 2010132620 A1	18-11-2010

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2017127943 A **[0002] [0003]**