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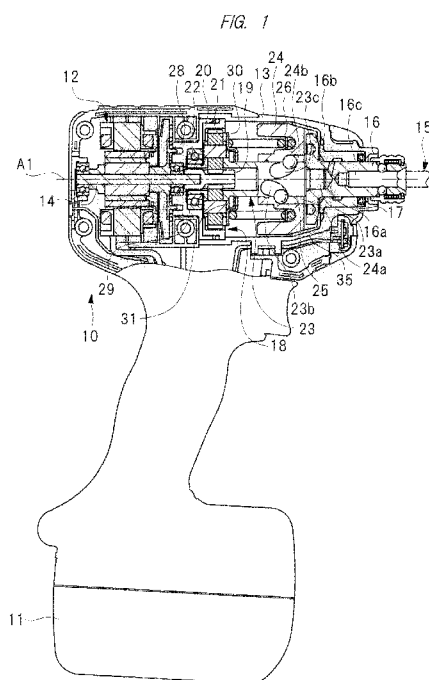
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(54) Title: STRIKING TOOL



(57) Abstract: A striking tool which can increase a striking force of a hammer is provided. The striking tool includes: a spindle 23; and a hammer 24 which is attached to an outer peripheral surface of the spindle 23 and which converts a torque of the spindle 23 into a striking force in a rotation direction. The striking tool includes: a first outer cam groove 23b and a second outer cam groove 23c which are provided on the outer peripheral surface of the spindle 23 and are arranged in a circumferential direction around an axis A1 of the spindle 23; a first inner cam groove 24a and a second inner cam groove 24b which are provided on an inner peripheral surface of the hammer 24 and are arranged in the circumferential direction around the axis A1; and a plurality of balls 25 each of which is held by each of a plurality of paired cam grooves formed of a pair of the first outer cam groove 23b and the first inner cam groove 24a and a pair of the second outer cam groove 23c and the second inner cam groove 24b. The first outer cam groove 23b and the second outer cam groove 23c are arranged at positions different from each other in a direction along the axis A1.

Description

Title of Invention: STRIKING TOOL

Technical Field

[0001] The present invention relates to a striking tool that converts a torque of a rotating member into a striking force in a rotation direction.

Background Art

[0002] Conventionally, a striking tool that converts a torque of a power source into a striking force in a rotation direction has been known, and an example of such a striking tool is described in Patent Literature 1. The striking tool described in Patent Literature 1 includes: an electric motor serving as a power source; a spindle to which a torque of the electric motor is transmitted via a speed reducer; a first outer cam groove and a second outer cam groove that are formed on an outer peripheral surface of the spindle; a hammer attached to outer periphery of the spindle so as to be axially movable; a first inner cam groove and a second inner cam groove that are formed on an inner peripheral surface of the hammer; balls each of which is held separately by such paired cam grooves as a pair of the outer cam groove and the inner cam groove; a nail formed on the hammer; and an anvil arranged to be coaxial with the spindle and to be rotatable.

[0003] A screwdriver bit serving as a tip tool is supported by the anvil. The first and second outer cam grooves are formed along a circumference direction of the spindle, and are formed into an axially-deformed V shape. Also, when the outer peripheral surface of the spindle is developed on a plane, each of the first and second outer cam grooves is bent at two points.

[0004] The torque of the electric motor is transmitted through the spindle, balls, hammer, and anvil to the screwdriver bit, and a load is applied to the anvil when an object is tightened, so that the balls roll along the outer cam grooves and the inner cam grooves. Also, the hammer is moved in the axial direction and a direction in which the hammer moves away from the anvil, against a spring force, and then, is moved toward the anvil by the spring force, and besides, the balls move along the outer cam grooves and the inner cam grooves, so that the hammer applies a striking force in the rotation direction to the tip tool.

Citation List

Patent Literature

[0005] PTL 1: Japanese Patent Application Laid-Open Publication No. 2003-181774

Summary of Invention

Technical Problem

[0006] However, in the striking tool described in the above-described Patent Literature 1, each of the first and second outer cam grooves is bent at two points, and therefore, a resistance generated when the balls roll along the first and second cam grooves increases, and a problem of insufficient striking force in the rotation direction generated by the hammer arises.

[0007] A preferred aim of the present invention is to provide a striking tool that can increase a striking force in a rotation direction generated by a hammer.

Solution to Problem

[0008] A striking tool according to one embodiment is a striking tool including: a rotating member; and a hammer that is attached to an outer peripheral surface of the rotating member and that converts a torque of the rotating member into a striking force in a rotation direction. The striking tool includes: a plurality of outer cam grooves that are formed on the outer peripheral surface of the rotating member and that are arranged in a circumferential direction around an axis of the rotating member; a plurality of inner cam grooves that are formed on the inner peripheral surface of the hammer and that are arranged in a circumferential direction around the axis; and a plurality of rolling elements each of which is held by each of a plurality of paired cam grooves formed of a pair of any one of the plurality of outer cam grooves with any one of the plurality of inner cam grooves. The plurality of outer cam grooves are arranged at different positions from each other in a direction along the axis.

[0009] A striking tool according to another embodiment is a striking tool including: a rotating member; a hammer that can move in a direction along an axis of the rotating member; an outer cam groove formed on an outer peripheral surface of the rotating member; an inner cam groove formed on an inner peripheral surface of the hammer; and a rolling element housed in the outer cam groove and the inner cam groove. A plurality of the outer cam grooves are arranged at different positions from each other in the direction along the axis.

[0010] A striking tool according to still another embodiment is a striking tool including: a rotating member; a hammer that can move in a direction along an axis of the rotating member; a plurality of outer cam grooves formed on an outer peripheral surface of the rotating member; a plurality of inner cam grooves formed on an inner peripheral surface of the hammer; and a plurality of rolling elements that are housed in the plurality of outer cam grooves and the plurality of inner cam grooves. The plurality of outer cam grooves include a first outer cam groove and a second outer cam groove, each of the first outer cam groove and the second outer cam groove has the first distal end and the second distal end that are positioned at both ends in a circumferential direction of the rotating member, and the first distal end of the first outer cam groove

and the second distal end of the second outer cam groove are arranged at a position at which both distal ends overlap each other in the circumferential direction of the rotating member.

Advantageous Effect of Invention

[0011] According to a striking tool of one embodiment, a plurality of outer cam grooves can be made longer as much as possible in a circumferential direction around an axis, so that a striking force in a rotation direction generated by a hammer can be increased.

Brief Description of Drawings

[0012] [fig.1]FIG. 1 is a side cross-sectional view of a striking tool of the present invention; [fig.2]FIG. 2 is an enlarged view illustrating a spindle and a hammer provided in the striking tool of FIG. 1; [fig.3]FIG. 3 is a perspective view of the hammer provided in the striking tool of FIG. 1; [fig.4A]FIG. 4A is a development view of the outer peripheral surface of the spindle of FIG. 2; and [fig.4B]FIG. 4B is a development view of the outer peripheral surface of the spindle and the outer peripheral surface of the hammer of FIG. 2.

Description of Embodiments

[0013] Hereinafter, one embodiment of the present invention will be described in detail with reference to FIGs. 1 to 3. A striking tool 10 illustrated in FIG. 1 is an impact screwdriver. The striking tool 10 includes: a battery pack 11 housing a battery cell which can be charged and discharged; and an electric motor 12 driven with power supplied thereto from the battery pack 11. The electric motor 12 is a power source that converts electric energy into kinetic energy. The striking tool 10 includes a casing 13, and the electric motor 12 is housed inside the casing 13.

[0014] The electric motor 12 has a rotating shaft 14, and the rotating shaft 14 rotates around an axis A1. The electric motor 12 can switch the rotation direction of the rotating shaft 14 between a forward direction and a backward direction. The striking tool 10 includes an anvil 16 serving as a support member that supports a tip tool 15, and the anvil 16 is supported by a sleeve 17 attached to the casing 13 so as to freely rotate. The anvil 16 can rotate around the axis A1, and the tip tool 15 is attached to/detached from the anvil 16.

[0015] Meanwhile, a speed reducer 18 is provided inside the casing 13. The speed reducer 18 is arranged between the electric motor 12 and the anvil 16 in a direction along the axis A1. The speed reducer 18 is a power transmission device that transmits the torque of the electric motor 12 to the anvil 16, and is configured of a single-pinion type planetary gear mechanism. The speed reducer 18 includes: a sun gear 19 arranged to be

coaxial with the rotating shaft 14; a ring gear 20 provided so as to surround an outer peripheral side of the sun gear 19; and a carrier 22 that supports a plurality of pinion gears 21 engaged with the sun gear 19 and with ring gear 20 so that the pinion gears 21 can rotate and revolve. The ring gear 20 is fixed to the casing 13, and therefore, cannot rotate.

[0016] Also, a spindle 23 which rotates together with the carrier 22 around the axis A1 is provided. That is, the rotating shaft 14 of the electric motor 12, the speed reducer 18, the spindle 23, and the anvil 16 are provided around the axis A1. The spindle 23 is arranged between the anvil 16 and the speed reducer 18 in a direction along the axis A1, and a shaft 23a protruding in the direction along the axis A1 is formed on an end of the spindle 23 on the anvil 16 side. A cylindrical holder 28 is attached to inside of the casing 13, and an end of the spindle 23 in a longitudinal direction is supported by the holder 28 via a bearing 29 so as to freely rotate. Further, a plurality of outer cam grooves are arranged on the outer peripheral surface of the spindle 23. Specifically, the first outer cam groove 23b and the second outer cam groove 23c are provided on the outer peripheral surface.

[0017] Meanwhile, a holding hole 16a coaxial with the axis A1 is provided on an end of the anvil 16 on the spindle 23 side, and the shaft 23a is inserted into the holding hole 16a so as to freely rotate. That is, the anvil 16 and the spindle 23 can rotate relative to each other around the axis A1. Further, an attachment hole 16c coaxial with the axis A1 is provided on the anvil 16. The attachment hole 16c is opened on a part of the anvil 16 which is exposed to outside of the casing 13, and the attachment hole 16c is provided so as to attach to and detach from the tip tool 15.

[0018] Also, an annular hammer 24 is attached to the outer periphery of the spindle 23. The hammer 24 is arranged between the speed reducer 18 and the anvil 16 in the direction along the axis A1. The hammer 24 can rotate relative to the spindle 23, and besides, can move relative to the spindle 23 in the direction along the axis A1. On an inner peripheral surface of the hammer 24, the first inner cam groove 24a and the second inner cam groove 24b which are extended in the direction along the axis A1 are formed.

[0019] And, one ball 25 is held by a pair of the first outer cam groove 23b and the first inner cam groove 24a, and one ball 25 is held by a pair of the second outer cam groove 23c and the second inner cam groove 24b. That is, one ball 25 is held by each of the plurality of the pairs of the cam grooves. The ball 25 is a metal rolling element. Therefore, the hammer 24 can move in the direction along the axis A1 in a range in which the ball 25 can roll relative to the spindle 23. Also, the hammer 24 can move around the axis A1 in a circumferential direction in the range in which the ball 25 can roll relative to the spindle 23.

[0020] Further, an annular plate 30 is attached between the first and second outer cam

grooves 23b and 23c and the carrier 22 in the direction along the axis A1 in the outer periphery of the spindle 23. Also, a compression spring 26 in a compressed state is provided between the hammer 24 and the plate 30 in the direction along the axis A1. The movement of the carrier 22 in the direction along the axis A1 is regulated by its contact with the bearing 29 and with the holder 28, and the pressing force of the compression spring 26 is applied to the hammer 24. The hammer 24 is pushed by the pressing force of the compression spring 26 toward the anvil 16 in the direction along the axis A1. Also, an annual stopper 31 is provided inside the plate 30 on the outer periphery of the spindle 23. The stopper 31 is integrally made of a rubber elastic material, and the stopper 31 regulates a range of the movement of the hammer 24 in the direction along the axis A1.

[0021] On an end of anvil 16 on the hammer 24 side, a protruding portion 16b which protrudes in a radial direction is provided. Two protruding portions 16b are provided so as to separate from each other by 180 degrees in the circumference direction of the anvil 16. On the other hand, on an end of the hammer 24 on the anvil 16 side, a protruding portion 35 which protrudes in the direction along the axis A1 is provided. Two protruding portions 35 are provided so as to separate from each other by 180 degrees in the circumference direction of the hammer 24. The protruding portions 16b and 35 are arranged on the same circumference around the axis A1, and the protruding portions 16b and 35 can be engaged with and be released from each other.

[0022] Next, a characteristic structure of the striking tool 10, that is, a shape and a structure of each of the first outer cam groove 23b and the second outer cam groove 23c will be described with reference to FIGs. 4A and 4B. As illustrated in FIG. 4A, each of the first outer cam groove 23b and the second outer cam groove 23c is formed into a V shape. The first outer cam groove 23b and the second outer cam groove 23c are protruded in a direction of approaching the anvil 16. Since planar shapes of the two first and second outer cam grooves 23b and 23c are the same as each other, the first outer cam groove 23b will be explained below.

[0023] The first outer cam groove 23b is a continuous body formed of two linear portions 32 and 33, and the linear portions 32 and 33 are extended in the circumferential direction of the spindle 23, and besides, are inclined in the direction along the axis A1. An acute-angle-side striking angle a_1 is set between a straight line C1 and a centerline B1 of one linear portion 32 in a width direction. An acute-angle-side striking angle a_2 is set between the straight line C1 and a centerline B2 of the other linear portion 33 in the width direction. The straight line C1 passes through an intersection D1 between the centerline B1 and the centerline B2, and besides, lies at right angles to the axis A1. Also, the striking angle a_1 and the striking angle a_2 are identical with each other, and the striking angle a_1 and the striking angle a_2 are set as, for example, similar to each

other within a range of 30 to 35 degrees.

[0024] Also, a centerline A2 passes through a connection portion between the linear portion 32 and the linear portion 33. The linear portions 32 and 33 are the same as each other in a width, and besides, in a length in directions along the centerlines B1 and B2. Further, the centerlines B1 and B2 intersect at the intersection D1 between the centerline A2 and the straight line C1. In this manner, in a plan view obtained by developing the outer peripheral surface of the spindle 23, the linear portions 32 and 33 are linear symmetric about the centerline A2.

[0025] Further, the first outer cam groove 23b includes: the first end 40 occupying a predetermined position in the circumferential direction of the spindle 23; and the second end 41 arranged at a position different from the position of the first end 40 in the circumferential direction of the spindle 23. The first end 40 and the second end 41 are both ends of the first outer cam groove 23b in the circumferential direction of the spindle 23. Also, the first outer cam groove 23b also has a top portion 42 arranged between the first end 40 and the second end 41 in the circumferential direction of the spindle 23. The top portion 42 is the most protruding part of the first outer cam groove 23b in the direction along the axis A1. Since the first outer cam groove 23b is formed into the V shape, the top portion 42 is arranged at a position different from the positions of the first and second ends 40 and 41 in the direction along the axis A1 of the spindle 23.

[0026] On the other hand, in the plan view obtained by developing the outer peripheral surface of the spindle 23, the second outer cam groove 23c is the same as the first outer cam groove 23b in a shape and a structure. Further, the second outer cam groove 23c has the first end 43 occupying a predetermined position in the circumferential direction of the spindle 23, and the second end 44 arranged at a position different from the position of the first end 43 in the circumferential direction of the spindle 23. The first end 43 and the second end 44 are both ends of the second outer cam groove 23c in the circumferential direction of the spindle 23. Also, the second outer cam groove 23c has a top portion 45 arranged between the first end 43 and the second end 44 in the circumferential direction of the spindle 23. The top portion 45 is the most protruding part of the second outer cam groove 23c in the direction along the axis A1. Since the second outer cam groove 23c is formed into a V-shape, the top portion 45 is arranged at a position different from the positions of the first and second ends 43 and 44 in the direction along the axis A1 of the spindle 23.

[0027] And, the first outer cam groove 23b and the second outer cam groove 23c are provided at positions different from each other in the direction along the axis A1 on the outer peripheral surface of the spindle 23. Specifically, the intersection D1 on the first outer cam groove 23b and the intersection D1 on the second outer cam groove 23c are arranged at positions different from each other in a direction along the centerline A2.

The centerline A is parallel with the axis A1. FIG. 4A illustrates an example in which the intersection D1 on the second outer cam groove 23c is positioned closer to the anvil 16 than the intersection D1 on the first outer cam groove 23b.

[0028] Also, as illustrated in FIG. 4B, the first outer cam groove 23b and the second outer cam groove 23c are the same as each other in a length H1 in the direction along the centerline A2. Therefore, the first outer cam groove 23b and the second outer cam groove 23c are different from each other in an arrangement range of the first outer cam groove 23b and an arrangement range of the second outer cam groove 23c in the direction along the centerlines A2. Specifically, in the direction along the centerline A2, the arrangement range of the first outer cam groove 23b and the arrangement range of the second outer cam groove 23c are partially the same to overlap each other but partially different from each other. Further, the top portion 42 of the first outer cam groove 23b and the top portion 45 of the second outer cam groove 23c are arranged at positions different from each other in the direction along the axis A1 and at positions different from each other by 180 degrees in the circumference direction of the spindle 23.

[0029] Note that the arrangement range of the first outer cam groove 23b and the arrangement range of the second outer cam groove 23c in the direction along the axis A1 are within an arrangement range of the hammer 24 when the hammer 24 is in contact with the anvil 16 and is therefore stopped.

[0030] Further, in the circumferential direction of the spindle 23, the arrangement ranges of the first outer cam groove 23b and second outer cam groove 23c exceed a range of 360 degrees. The first outer cam groove 23b and the second outer cam groove 23c are arranged at the positions different from each other in the direction along the axis A1. Therefore, an end of the linear portion 32 of the first outer cam groove 23b and an end of the linear portion 33 of the second outer cam groove 23c overlap each other in a range E1 in the circumferential direction of the spindle 23. In addition, an end of the linear portion 33 of the first outer cam groove 23b and an end of the linear portion 32 of the second outer cam groove 23c overlap each other in a range in the circumferential direction of the spindle 23. A size of the range E1 in which the linear portion 32 and the linear portion 33 overlap each other is determined by a length of the linear portion 32 in the direction of the centerline B1 and a length of the linear portion 33 in the direction of the centerline B2.

[0031] Here, the end of the linear portion 32 of the first outer cam groove 23b and the end of the linear portion 33 of the second outer cam groove 23c are ends in the circumferential direction of the spindle 23, and correspond to the first end 40 and the second end 44 described later, respectively. Also, the end of the linear portion 33 of the first outer cam groove 23b and the end of the linear portion 32 of the second outer cam

groove 23c are ends in the circumferential direction of the spindle 23, and correspond to the second end 41 and the first end 43 described later, respectively.

[0032] In addition to the provision of the first outer cam groove 23b and the second outer cam groove 23c at the positions different from each other in the direction along the axis A1, the first inner cam groove 24a and the second inner cam groove 24b are provided at positions different from each other in a direction along centerline A3 as illustrated in FIG. 4B. The centerline A3 is parallel with the centerline A2 and the axis A1, and FIG. 4B illustrates a state in which the centerline A2 and the centerline A3 are arranged at the same place as each other for convenience. In FIG. 4B which is a plan view obtained by developing the inner peripheral surface of the hammer 24, each of the first inner cam groove 24a and the second inner cam groove 24b is formed into a substantially pentagonal shape, and the first inner cam groove 24a and the second inner cam groove 24b are arranged at positions different from each other in the circumferential direction of the hammer 24.

[0033] The first inner cam groove 24a is provided in a predetermined range in the circumference direction around the centerline A3, and the second inner cam groove 24b is provided in a predetermined range in the circumference direction around the centerline A3. The centerline A3 of the first inner cam groove 24a is parallel with the centerline A3 of the second inner cam groove 24b, and the centerline A3 is parallel with the axis A1. The centerline A3 of the first inner cam groove 24a and the centerline A3 of the second inner cam groove 24b are arranged to be separated from each other by 180 degrees in the circumference direction of the hammer 24. A distal end 38 of the first inner cam groove 24a is arranged to be separated from the anvil 16 further than the distal end 38 of the second inner cam groove 24b in the direction along the centerline A3.

[0034] Note that FIG. 4A is the plan view illustrating to develop the spindle 23, and FIG. 4B is the plan view illustrating to develop the spindle 23 and the hammer 24. Therefore, the direction along the centerlines A2 and A3 is equivalent to the direction along the axis A1 of FIG. 1.

[0035] Next, the operation of the striking tool 10 will be described. When the electric motor 12 is stopped, the hammer 24 pressed by the compression spring 26 is in contact with the anvil 16, and is therefore stopped. When power is supplied to the electric motor 12 so as to rotate the rotating shaft 14, the torque of the rotating shaft 14 is transmitted to the sun gear 19 of the speed reducer 18. When the torque is transmitted to the sun gear 19, the ring gear 20 becomes a reaction element, and the carrier 22 becomes an output element. That is, when the torque of the sun gear 19 is transmitted to the carrier 22, a rotation speed of the carrier 22 is lower than a rotation speed of the sun gear 19, which results in increase in the torque.

- [0036] When the torque is transmitted to the carrier 22, the spindle 23 rotates together with the carrier 22. The torque of the spindle 23 is transmitted to the hammer 24 via the balls 25. The torque of the hammer 24 is transmitted to the anvil 16 through force of engagement between the protruding portion 35 and the protruding portion 16b, so that the anvil 16 rotates. A torque of the anvil 16 is transmitted to a bolt via the tip tool 15, and the bolt is screwed into an object such as a wood material.
- [0037] In a state in which a torque required for rotating the tip tool 15 is low, that is, in a low-load state, the center of the ball 25 is positioned on the centerline A3, and besides, the centerline A2 and the centerline A3 overlap each other as illustrated in FIG. 4B.
- [0038] Then, the bolt is screwed into the wood material, a frictional resistance between the bolt and the wood material increases, and the torque required for rotating the tip tool 15 increases, so that the anvil 16 stops, the balls 25 roll inside the first outer cam groove 23b and the first inner cam groove 24a and inside the second outer cam groove 23c and the second inner cam groove 24b by the reaction force generated at the contact surfaces between the balls 25 and the first and second inner cam grooves 24a and 24b, and the hammer 24 moves away from the anvil 16.
- [0039] Here, the hammer 24 moves along the axis A1 and against the pressing force of the compression spring 26. Then, the protruding portion 35 and the protruding portion 16b are released from each other, so that the torque of the hammer 24 is not transmitted to the anvil 16. Further, an end of the hammer 24 in a reciprocating direction comes into collision with the stopper 31, and the stopper 31 absorbs the kinetic energy generated when the hammer 24 moves away from the anvil 16. The stopper 31 regulates a range of the movement of the hammer 24 away from the anvil 16 along the axis A1.
- [0040] Further, when the rotation of the hammer 24 is continued so that the protruding portion 35 climbs over the protruding portion 16b, the pressing force applied by the compression spring 26 to the hammer 24 becomes larger than the force acting in the direction in which the hammer 24 moves away from the anvil 16. Then, the balls 25 roll along the inside of the first outer cam groove 23b and the first inner cam groove 24a and the inside of the second outer cam groove 23c and the second inner cam groove 24b, so that the hammer 24 and the spindle 23 rotate relative to each other, and besides, the hammer 24 moves closer to the anvil 16.
- [0041] Then, the protruding portion 35 of the rotated hammer 24 comes into collision with the protruding portion 16b of the stopped anvil 16, so that a striking force in the rotation direction is applied to the anvil 16 and to the tip tool 15. Note that the bolt is loosened by reverse of the rotation direction of the rotating shaft 14 of the electric motor 12.
- [0042] In the striking tool 10 according to the present embodiment, the first outer cam groove 23b and the second outer cam groove 23c are arranged at positions different

from each other in the direction along the axis A1. The first end 40 of the first outer cam groove 23b and the second end 44 of the second outer cam groove 23c overlap each other in the range E1 in the circumferential direction of the spindle 23. In this manner, in the circumferential direction of the spindle 23, that is, the direction along the straight line C1, the length L1 of each of the linear portions 32 and 33 provided on the first outer cam groove 23b and the second outer cam groove 23c can be increased as much as possible. This length L1 affects the striking force.

[0043] That is, when the hammer 24 strikes the anvil 16, a magnitude of the movement of the hammer 24 in the circumferential direction of the spindle 23 can be increased as much as possible. Therefore, the striking force transmitted from the hammer 24 to the tip tool 15 can be increased. Also, by increasing the length L1, impact to the stopper 31 generated by the reaction generated when the hammer 24 strikes the anvil 16 can be suppressed. Therefore, damage to an inner mechanism of the casing 13 such as the stopper 31 can be suppressed, so that a longer service life of the stopper 31 can be achieved.

[0044] As described above, by setting the striking angles $\alpha 1$ and $\alpha 2$ as small as possible in order to increase the length L1 of each of the linear portions 32 and 33 each provided to the first outer cam groove 23b and the second outer cam groove 23c as large as possible, the length H1 of each of the first and second outer cam grooves 23b and 23c in the direction along the centerline A2 can be decreased as small as possible. Therefore, increase in a total length of the spindle 23 in the direction along the axis A1 can be suppressed, and therefore, the suppression contributes to downsize the striking tool 10, and besides, to increase the striking force.

[0045] Also, the length H1 affects an axial force, i.e., a force acting in the axial direction. The axial direction means the direction along the axis A1. By decreasing the length H1, a movement speed of the hammer 24 when the hammer 24 collides with the stopper 31 can be reduced. Further, by setting the striking angles $\alpha 1$ and $\alpha 2$ as small as possible, the force in the axial direction transmitted from the hammer 24 to the anvil 16 can be reduced, and therefore, noise of the striking tool 10 can be reduced.

[0046] Further, in the hammer 24, the distal end 38 of the first inner cam groove 24a and the distal end 38 of the second inner cam groove 24b are provided at positions different from each other in the direction along the centerline A3. That is, in FIG. 4B obtained by developing the inner peripheral surface of the hammer 24, an area of the first inner cam groove 24a is larger than an area of the second inner cam groove 24b. Accordingly, in order to prevent the hammer 24 from being dynamically unbalanced in the radial direction around the axis A1, means for adjusting the balance of the hammer 24 are treated.

[0047] Specifically, as illustrated in FIG. 3, a balance portion 39 is provided so that a part of

the outer peripheral surface of the hammer 24 is protruded outward in a direction of a radius of a circle around the axis A1. The balance portion 39 is provided in a region where the first inner cam groove 24a is provided in the circumferential direction of the hammer 24. In this manner, the gravity center of the hammer 24 is pair on the axis A1. Therefore, when the hammer 24 rotates around the axis A1, the dynamic balance of the hammer 24 is maintained in the radial direction around the axis A1 so as to prevent the hammer 24 and the spindle 23 from oscillating in the radial direction around the axis A1.

[0048] The spindle 23 described in the present embodiment corresponds to the rotating member of the present invention, the electric motor 12 corresponds to the power source of the present invention, the first ends 40 and 43 correspond to the first distal ends of the present invention, and the second ends 41 and 44 correspond to the second distal ends of the present invention.

[0049] It is needless to say that the present invention is not limited to the foregoing embodiment and various modifications and alterations can be made within the scope of the present invention. For example, the striking tools of the present invention include an impact screwdriver, a screwdriver drill, and an impact wrench. Also, the striking tools of the present invention include a structure in which power from an alternating-current power supply can directly be supplied to an electric motor without using a battery pack. Further, the striking tools of the present invention also include a structure in which power from a battery pack or power from an alternating-current power supply can be supplied to an electric motor through switching between the battery pack and the alternating-current power supply.

[0050] Still further, the power sources of the present invention include not only the electric motor but also an engine, a pneumatic motor, a hydraulic motor, and others. The engine is a power source that converts thermal energy generated by burning a fuel into kinetic energy, and the engines include, for example, a gasoline engine, a diesel engine, and a liquid petroleum gas engine. The electric motor includes a brush motor and a brushless motor. Further, the striking tools of the present invention also include a structure in which the tip tool is attached directly to the anvil and a structure in which the tip tool is attached to the anvil via a socket or an adaptor. Still further, the first and second ends of the first outer cam groove are positioned on both ends in the circumferential direction of the rotating member, and either one may be the first end or the second end.

Industrial Applicability

[0051] The present invention can be used for a striking tool that converts a torque of a rotating member into a striking force in a rotation direction, such as an impact

screwdriver, a screwdriver drill, and an impact wrench.

Claims

- [Claim 1] A striking tool including: a rotating member; and a hammer which is attached to an outer peripheral surface of the rotating member and which converts a torque of the rotating member into a striking force in a rotation direction,
the striking tool characterized by:
a plurality of outer cam grooves which are provided on an outer peripheral surface of the rotating member and are arranged in a circumferential direction around an axis of the rotating member;
a plurality of inner cam grooves which are provided on an inner peripheral surface of the hammer and are arranged in the circumferential direction around the axis; and
a plurality of rolling elements each of which is held by each of a plurality of paired cam grooves formed of a pair of any one of the plurality of outer cam grooves and any one of the plurality of inner cam grooves,
wherein the plurality of outer cam grooves are arranged at positions different from each other in a direction along the axis.
- [Claim 2] The striking tool according to claim 1,
wherein some of the plurality of outer cam grooves are arranged at the same position as each other in the circumferential direction around the axis.
- [Claim 3] The striking tool according to claim 1,
wherein the hammer includes a balance portion which maintains dynamic balance of the hammer in a radial direction around the axis.
- [Claim 4] The striking tool according to claim 1, comprising:
a power source which transmits a torque to the rotating member; and
a speed reducer which reduces a rotation speed of the rotating member to be lower than a rotation speed of the power source when the torque of the power source is transmitted to the rotating member.
- [Claim 5] The striking tool according to claim 4,
wherein the power source includes an electric motor which converts electric energy into kinetic energy to generate the torque.
- [Claim 6] A striking tool characterized by:
a rotating member;
a hammer which can move in a direction along an axis of the rotating member;

an outer cam groove which is provided on an outer peripheral surface of the rotating member;
an inner cam groove which is provided on an inner peripheral surface of the hammer; and
a rolling element which is housed in the outer cam groove and the inner cam groove,
wherein a plurality of the outer cam grooves are arranged at positions different from each other in the direction along the axis.

[Claim 7]

The striking tool according to claim 6,
wherein each of the plurality of outer cam grooves includes:
a first end in a circumferential direction of the rotating member;
a second end which is arranged at a position different from a position of the first end in the circumferential direction of the rotating member;
and
a top portion which is arranged between the first end and the second end in the circumferential direction of the rotating member, and,
in each of the plurality of outer cam grooves, the top portion is arranged at a position different from the positions of the first end and the second end in the direction along the axis.

[Claim 8]

The striking tool according to claim 7,
wherein the plurality of outer cam grooves include the first outer cam groove and the second outer cam groove, and
the first end of the first outer cam groove is arranged at a position at which the first end overlaps the second end of the second outer cam groove in the circumferential direction.

[Claim 9]

The striking tool according to claim 7,
wherein the plurality of outer cam grooves include the first outer cam groove and the second outer cam groove, and
a top portion of the first outer cam groove and a top portion of the second outer cam groove are arranged at positions different from each other by 180 degrees in the circumference direction of the rotating member.

[Claim 10]

A striking tool characterized by:
a rotating member;
a hammer which can move in a direction along an axis of the rotating member;
a plurality of outer cam grooves which are provided on an outer peripheral surface of the rotating member;

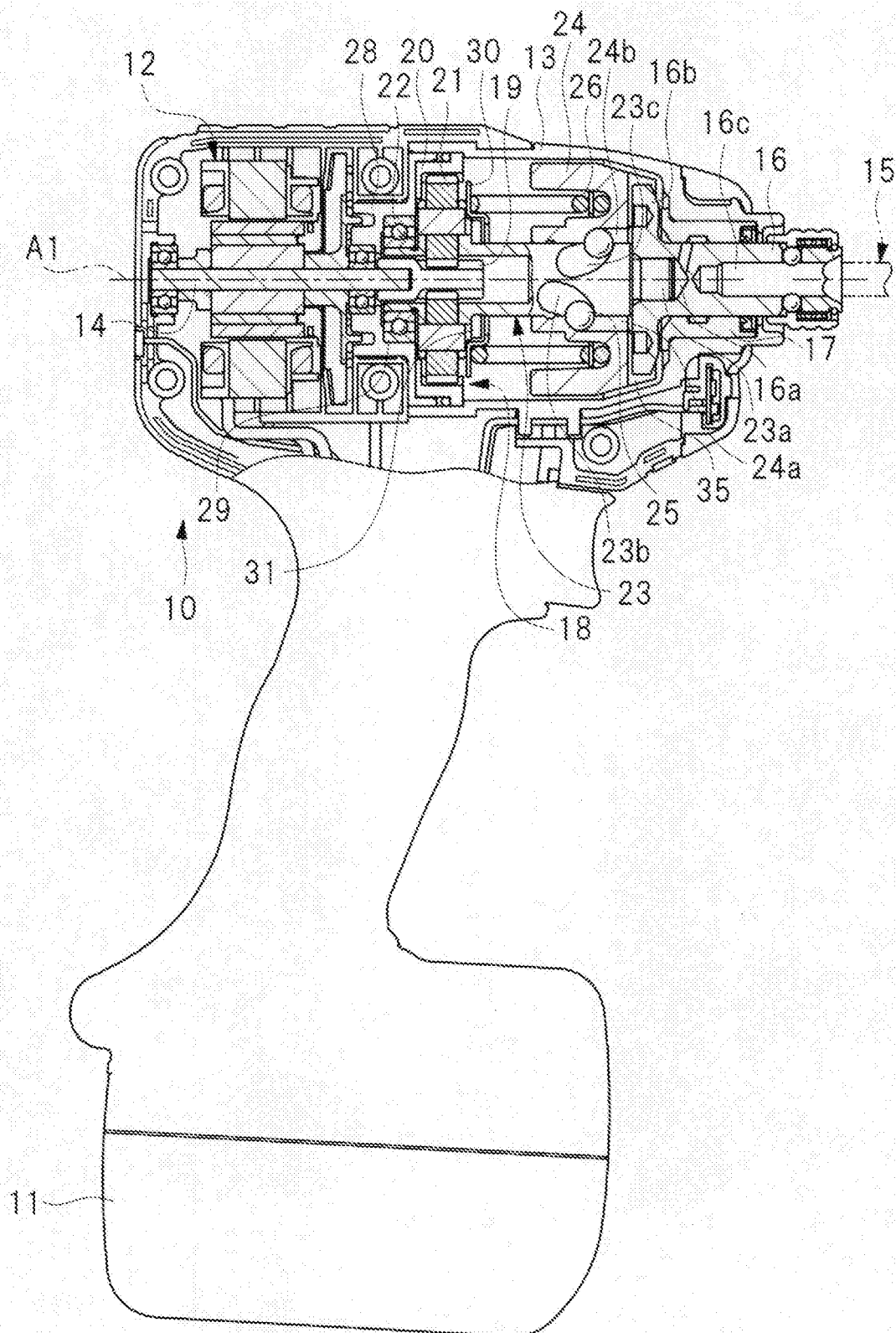
a plurality of inner cam grooves which are provided on an inner peripheral surface of the hammer; and
a plurality of rolling elements which are housed in the plurality of outer cam grooves and the plurality of inner cam grooves,
wherein the plurality of outer cam grooves include the first outer cam groove and the second outer cam groove,
each of the first outer cam groove and the second outer cam groove has the first distal end and the second distal end which are positioned at both ends in a circumferential direction of the rotating member, and
the first distal end of the first outer cam groove and the second distal end of the second outer cam groove are arranged at a position at which both distal ends overlap each other in the circumferential direction of the rotating member.

[Claim 11] The striking tool according to claim 10,
wherein the first outer cam groove and the second outer cam groove are arranged at positions different from each other in the direction along the axis.

[Claim 12] The striking tool according to claim 11,
wherein each of the first outer cam groove and the second outer cam groove has a top portion which is arranged between the first distal end and the second distal end in the circumferential direction, and
the top portion of the first outer cam groove and the top portion of the second outer cam groove are arranged at positions different from each other in the direction along the axis.

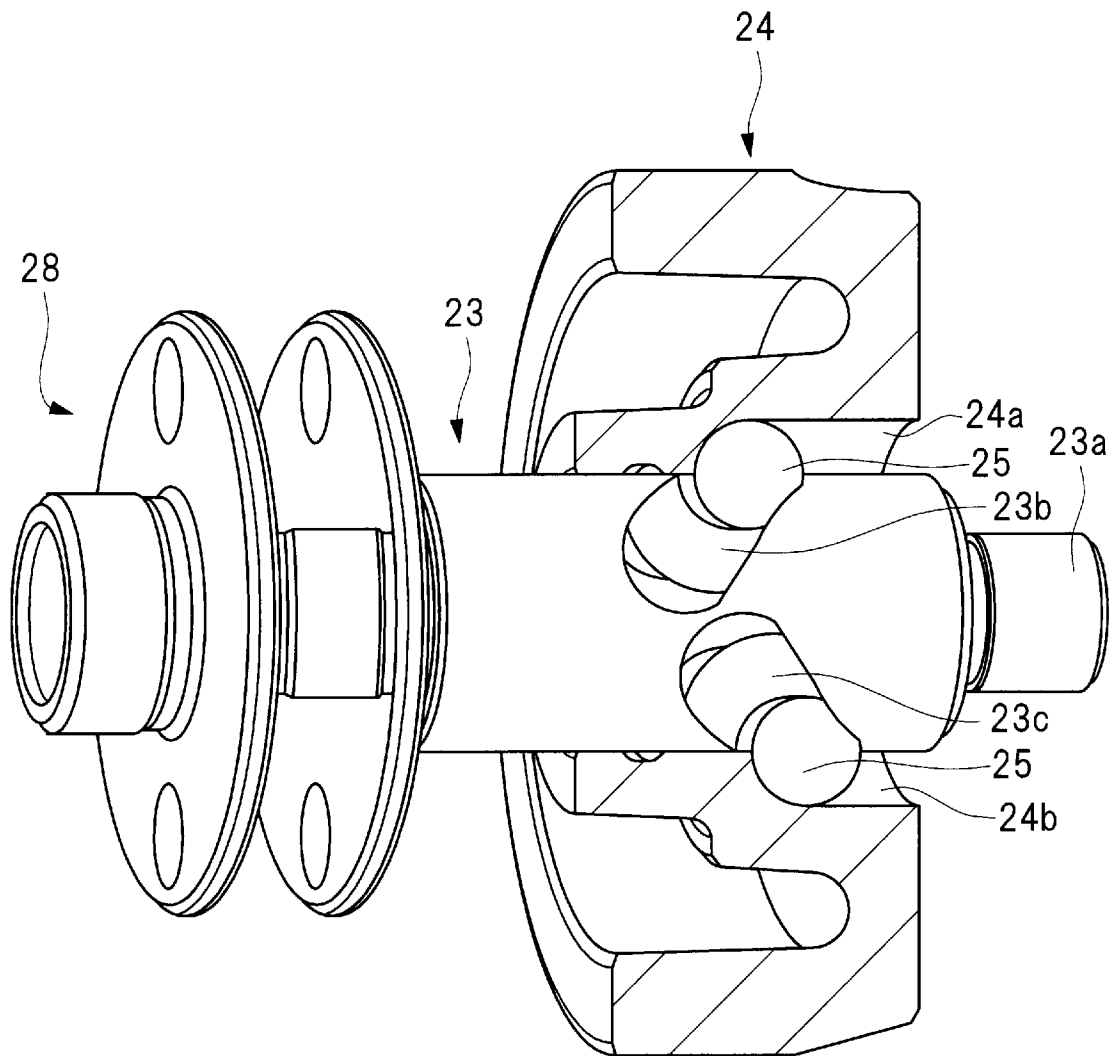
[Fig. 1]

FIG. 1



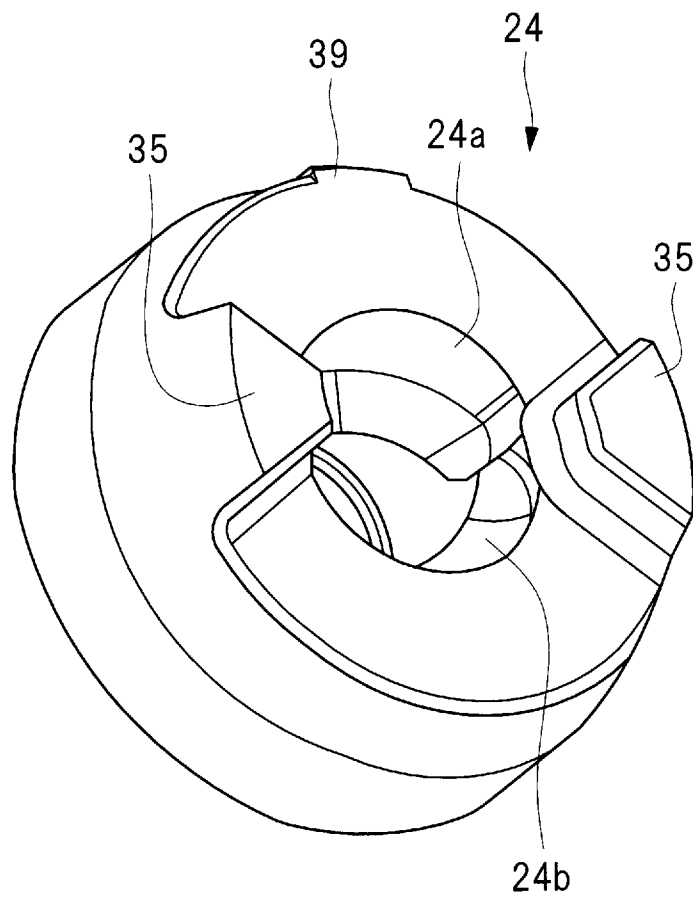
[Fig. 2]

FIG. 2



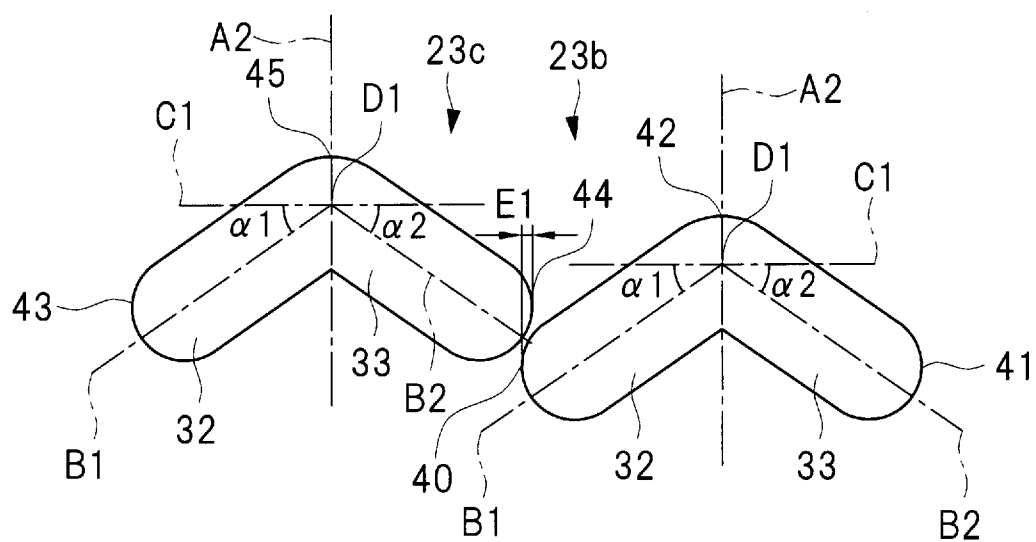
[Fig. 3]

FIG. 3



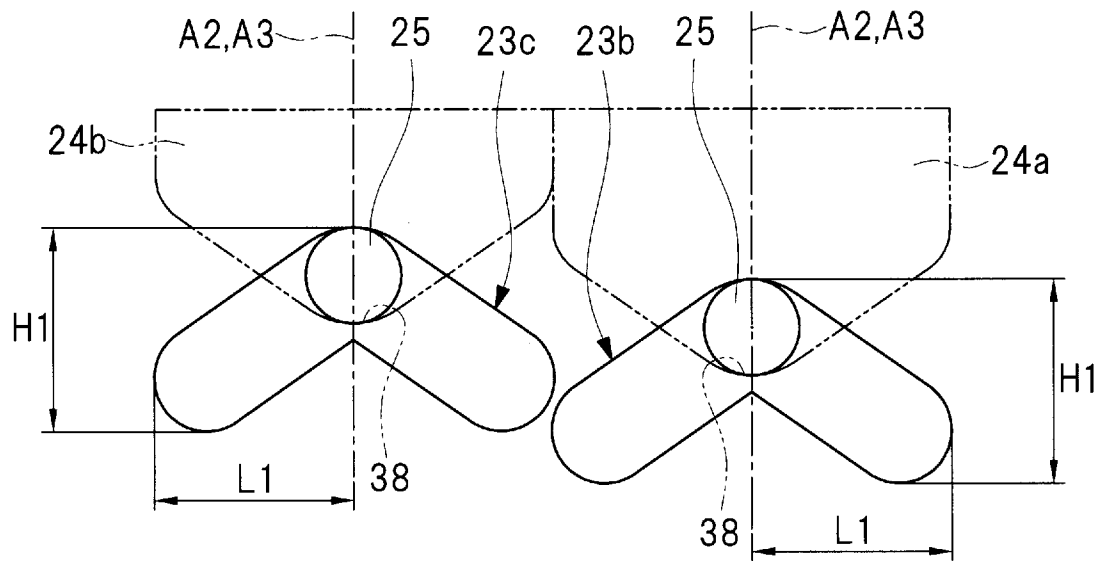
[Fig. 4A]

FIG. 4A



[Fig. 4B]

FIG. 4B



INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2014/003279

A. CLASSIFICATION OF SUBJECT MATTER
INV. B25B21/02
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B25B

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/094907 A1 (ELGER WILLIAM A [US]) 18 July 2002 (2002-07-18)	10
A	paragraphs [0032], [0042], [0044], [0049], [0051] figures 4,6	1,6,11

X	US 3 207 237 A (KARL WANNER) 21 September 1965 (1965-09-21)	10
A	figures 1,5	1,6,11

A	DE 10 2011 089914 A1 (BOSCH GMBH ROBERT [DE]) 27 June 2013 (2013-06-27)	1,6,10
	paragraphs [0035], [0037], [0038], [0040] figure 2	

A	GB 531 797 A (CHICAGO PNEUMATIC TOOL CO) 10 January 1941 (1941-01-10)	1,6,10
	the whole document	

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

16 September 2014

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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