(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 712 708 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.04.2014 Bulletin 2014/14

(51) Int Cl.:
B25B 21/02 *(2006.01)* ***B25B 21/00*** *(2006.01)*

(21) Application number: **13184680.0**

(22) Date of filing: **17.09.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **28.09.2012 JP 2012216027**

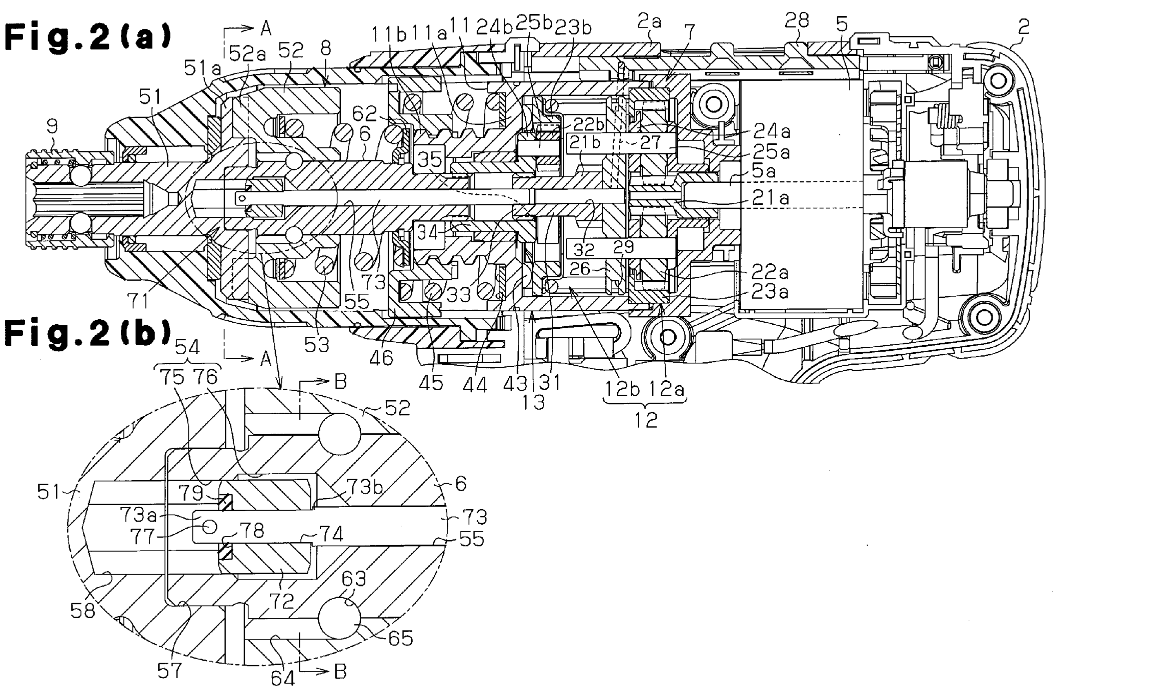
(71) Applicant: **Panasonic Corporation**
Kadoma-shi
Osaka 571-8501 (JP)

(72) Inventors:
- **Tanaka, Naotake**
Chuo-ku, Osaka 540-6207 (JP)
- **Tsubakimoto, Hiroyuki**
Chuo-ku, Osaka 540-6207 (JP)

(74) Representative: **Appelt, Christian W.**
Boehmert & Boehmert
Pettenkoferstrasse 20-22
80336 München (DE)

(54) **Impact rotation tool**

(57) An impact rotation tool (1) includes a switching shaft (73) (73), which extends through a drive shaft (6), and a coupling member (72), which is coupled to the switching shaft (73). The switching shaft (73) moves the coupling member (72) to a position where the coupling member (72) is engaged with the wall of only the drive shaft hole (54) to switch the impact rotation tool (1) to an impact mode. The switching shaft (73) moves the coupling member (72) to a position where the coupling member (72) is engaged with the walls of both of the drive shaft hole (54) to switch the impact rotation tool (1) to a drill mode. The wall of the drive shaft hole (54) includes an engagement portion (75), which is engaged with the coupling member (72) in the impact mode, and a relief (76), which does not contact the outer circumferential surface of the coupling member (72) in the impact mode.



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Description

[0001] The present invention relates to an impact rotation tool.

[0002] An impact rotation tool includes a hammer coupled to a drive shaft, which is rotated and driven by a motor. The hammer impacts an anvil to generate an impact torque used by the impact rotation tool to tighten a screw. Japanese Patent No. 3911905 describes an impact rotation tool that is switched between an impact mode, in which the hammer impacts the anvil, and a drill mode, in which the anvil is rotated integrally with the drive shaft.

[0003] Referring to Fig. 7, the '905 patent describes an impact rotation tool 81 that includes an anvil 82, which is coaxial with and rotatable relative to a drive shaft 83. A hammer 84, which includes a hook 84a, is coupled to the drive shaft 83. When the hammer 84 is rotated, the hook 84a is engaged with a portion of an arm 82a of the anvil 82. A hammer spring 85 urges the hammer 84 toward the anvil 82. When the load torque transmitted to the anvil 82 by the hammer 84 exceeds a predetermined value, the drive shaft 83 and the hammer 84 (anvil) rotate relative to each other. This moves the hammer 84 away from the anvil 82 against the urging force of the hammer spring 85. Then, when the hook 84a moves over the arm 82a as the hammer 84 rotates, the urging force of the hammer spring 85 moves the hammer 84 toward the anvil 82, and the hook 84a impacts the arm 82a. This rotates the anvil 82 again. Such an impact action is repeated as the drive shaft 83 rotates.

[0004] The drive shaft 83 includes a drive shaft hole 91 having a hexagonal cross-section. The drive shaft hole 91 faces the anvil 82 at a distal end of the drive shaft 83. The anvil 82 includes an anvil hole 92 having a hexagonal cross-section and facing toward the drive shaft 83. A hexagonal coupling member 93 is arranged in the drive shaft hole 91. The coupling member 93 is movable in the axial direction inside the drive shaft hole 91. Further, the coupling member 93 is engaged with one or both of the drive shaft hole 91 and the anvil hole 92. The coupling member 93 is rotatably coupled to a switching shaft 94. The switching shaft 94 moves in the axial direction in cooperation with the movement of a switch (not shown). A stopper 95 is fixed to a distal end of the switching shaft 94 to restrict axial movement of the switching shaft 94 relative to the coupling member 93. The axial movement of the switching shaft 94 axially moves the coupling member 93 in the drive shaft hole 91. For example, when the coupling member 93 is engaged with the wall of the drive shaft hole 91 but not with the wall of the anvil hole 92, the rotation tool 81 is in the impact mode, which permits relative rotation of the drive shaft 83 and the anvil 82 (hammer 84). When the coupling member 93 is engaged with the walls of both of the drive shaft hole 91 and the anvil hole 92, the rotation tool 81 is in the drill mode, which restricts relative rotation of the drive shaft 83 and the anvil 82 (hammer 84).

[0005] When, for example, the drive shaft 83 is inclined due to manufacturing or assembling errors of components, a portion of the coupling member 93 may be strongly forced against the wall of the drive shaft hole 91. A regulated clearance is provided between the drive shaft 83 and the anvil 82. When the hammer 84 moves in the axial direction during an impact action, the drive shaft 83 moves within the range of the clearance. If a portion of the coupling member 93 is forced strongly against the wall of the drive shaft hole 91, friction would occur where the coupling member 93 contacts the wall of the drive shaft hole 91. This would push the coupling member 93 with a strong force toward the anvil 82. Further, the stopper 95 would repetitively receive a strong force from the coupling member 93. This may shorten the life of the stopper 95.

[0006] It is an object of the present invention to provide an impact rotation tool that does not shorten the stopper life.

[0007] One aspect of the present invention is an impact rotation tool including a drive shaft rotated and driven by a rotational power source. The drive shaft includes a drive shaft hole. An anvil is coaxial with the drive shaft and rotatable relative to the drive shaft. The anvil includes an anvil hole. A hammer is rotated by the drive shaft and engaged with the anvil. The hammer is coupled to the drive shaft so that the hammer moves away from the anvil in an axial direction of the drive shaft when the hammer rotates relative to the drive shaft. An urging member urges the hammer toward the anvil. A switching mechanism switches the impact rotation tool between an impact mode that impacts the anvil with the hammer and a drill mode that integrally rotates the drive shaft and the anvil. The switching mechanism includes a coupling member movable between a position where the coupling member is engaged with a wall of only one of the drive shaft hole and the anvil hole and a position where the coupling member is engaged with the walls of both of the drive shaft hole and the anvil hole. A switching shaft supports the coupling member to be rotatable and moves the coupling member in the axial direction. A stopper restricts axial movement of the coupling member relative to the switching shaft. The switching shaft moves the coupling member to the position where the coupling member is engaged with the wall of only the drive shaft hole to switch to the impact mode. The switching shaft moves the coupling member to the position where the coupling member is engaged with the walls of both of the drive shaft hole and the anvil hole to switch to the drill mode. The wall of the drive shaft hole includes an engagement portion engaged with the coupling member in the impact mode, and a relief formed so as not to contact an outer circumferential surface of the coupling member in the impact mode.

[0008] Preferably, the impact rotation tool further includes an elastic member arranged between the coupling member and the stopper.

[0009] Preferably, the relief of the drive shaft hole is formed to form a clearance between the coupling member and the drive shaft.

[0010] Preferably, the coupling member includes a distal portion and a basal portion; in the drill mode, the distal portion of the coupling member engages with the inner surface of the anvil hole, and the basal portion of the coupling member is engaged with the engagement portion of the drive shaft hole, and the basal portion of the coupling member is engaged with the engagement portion of the drive shaft hole; and in the impact mode, the distal portion of the coupling member is engaged with the engagement portion of the drive shaft hole, and the basal portion of the coupling member is separated from the relief of the drive shaft hole in a radially inner direction.

[0011] Preferably, the engagement portion includes an inner diameter substantially equal to an outer diameter of the coupling member, and the relief has an inner diameter that is substantially larger than the outer diameter of the coupling member.

[0012] Preferably, the drive shaft includes a distal end supported to be rotatable by the anvil, and the relief is located in the drive shaft hole at a position that is farther from the distal end of the drive shaft than the engagement portion.

[0013] The present invention provides an impact rotation tool that does not shorten the stopper life.

[0014] Other aspects and advantages of the present invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

[0015] The novel features which are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself and additional objects and advantages thereof will best be understood from the following description of embodiments thereof when read in connection with the accompanying drawings, in which:

Fig. 1 is a perspective view showing one embodiment of an impact rotation tool;
Fig. 2(a) is a schematic partial cross-sectional view of the impact rotation tool in an impact mode;
Fig. 2(b) is a partially enlarged view of Fig. 2(a);
Fig. 3(a) is a schematic partial cross-sectional view of the impact rotation tool in a drill mode;
Fig. 3(b) is a partially enlarged view of Fig. 3(a);
Fig. 4 is a cross-sectional view of the impact rotation tool taken along line A-A in Fig. 2(a);
Fig. 5 is a cross-sectional view of the impact rotation tool taken along line B-B in Fig. 2(b);
Fig. 6 is a cross-sectional view showing another example a drive shaft including a relief; and
Fig. 7 is a partial cross-sectional view showing an impact rotation tool of the prior art.

[0016] One embodiment of an impact rotation tool will now be described.

[0017] In the example shown in Fig. 1, an impact rotation tool 1 is hand-held and may be used as, for example, an impact driver and a drill driver. In the illustrated example, the impact rotation tool 1 has a T-shaped housing 2 including a cylindrical barrel 2a and a grip 2b, which extends from a lower side of the barrel 2a. The lower end of the grip 2b forms a battery pack seat 2c. A battery pack 3 is attached in a removable manner to the battery pack seat 2c. The grip 2b includes a trigger switch 4 that activates and deactivates the impact rotation tool 1. In the description hereafter, the longitudinal direction of the barrel 2a is referred to as a front-to-rear direction.

[0018] Referring to Figs. 2(a) and 3(a), a rear portion of the barrel 2a accommodates a motor 5, which serves as a rotational power source. The motor 5 is coupled to a power transmission unit 7, which reduces the speed of the rotation generated by the motor 5 and transmits the rotation to a drive shaft 6. An impact generator 8 is arranged in front of the power transmission unit 7 to generate pulsed torque from the rotation of the drive shaft 6. A chuck 9 that holds a tip tool (not shown) in a removable manner is arranged on the front end of the barrel 2a.

[0019] The power transmission unit 7 will now be described.

[0020] The power transmission unit 7 includes a gear case 11, which is fixed to the inner side of the barrel 2a, a speed reduction unit 12, which is accommodated in the gear case 11, and a clutch mechanism 13, which regulates the torque of the motor 5 transmitted to the drive shaft 6 by the speed reduction unit 12. The gear case 11 is cup-shaped and includes an open rear end. A support tube 11b projects toward the front from a front end 11a of the gear case 11.

[0021] In the illustrated example, the speed reduction unit 12 is a planetary gear unit including first and second speed reduction mechanisms 12a and 12b arranged in order from the rear, that is, from the motor 5. The motor 5 includes a rotation shaft 5a. The first speed reduction mechanism 12a includes a first sun gear 21a rotated integrally with the rotation shaft 5a of the motor 5. Further, the first speed reduction mechanism 12a includes a plurality of first planet gears 22a engaged with the first sun gear 21a, a first ring gear 23a engaged with the first planet gears 22a, and a first carrier 24a rotatably supporting the first planet gears 22a. The first ring gear 23a is fixed to the gear case 11 so that rotation about the axis of the rotation shaft 5a is prohibited. Each first planet gear 22a is rotatably supported by a first coupling pin 25a on the first carrier 24a. Rotation of the rotation shaft 5a rotates each first planet gear 22a about the axis of the corresponding first coupling pin 25a as the first planet gear 22a orbits about the first sun gear 21a.

[0022] The first carrier 24a holds a movable carrier 26 with the first coupling pins 25a. The movable carrier 26 is rotatable integrally with the first carrier 24a and movable axially relative to the first carrier 24a. A link 27 connects the movable carrier 26 to a switch 28, which is arranged on the housing 2. The switch 28 is slidable toward the front and rear. The movable carrier 26 moves toward the front and rear in the axial direction in cooperation with the movement of the switch 28. The link 27 is, for example, an arcuate wire spring extending in the circumferential direction. The link 27 is coupled to an annular groove 29 formed in the outer circumferential surface of the movable carrier 26.

[0023] The second speed reduction mechanism 12b includes a second sun gear 21b arranged integrally with the front surface of the movable carrier 26. The second speed reduction mechanism 12b includes a plurality of second planet gears 22b arranged around and engaged with the second sun gear 21b when the movable carrier 26 (second sun gear 21b) is moved toward the front (refer to Fig. 3). Further, the second speed reduction mechanism 12b includes a second ring gear 23b, which is engaged with the second planet gears 22b, and a second carrier 24b, which rotatably supports the second planet gears 22b with second coupling pins 25b. A coupling shaft 31 projecting toward the front is formed integrally with the second sun gear 21b. A through hole 32 axially extends through the coupling shaft 31. The coupling shaft 31 has a front end forming a gear-shaped direct coupling portion 33. A coupling tube 34, which projects toward the front, is formed integrally with the second carrier 24b. The coupling tube 34 includes a rear end that forms a direct coupling portion 35 engaged with the direct coupling portion 33 so as to rotate integrally with the direct coupling portion 33. In one example, the second ring gear 23b is rotatably arranged in the gear case 11. When the coupling tube 34 is arranged in the support tube 11b of the gear case 11, the second carrier 24b is supported to be rotatable relative to the gear case 11.

[0024] Referring to Fig. 2(a), when the movable carrier 26 is located at the rear of the gear case 11 in the speed reduction unit 12, the direct coupling portion 33 of the second sun gear 21b is engaged with the direct coupling portion 35 of the second carrier 24b, and the second sun gear 21b rotates integrally with the second carrier 24b. Thus, only the first speed reduction mechanism 12a transmits the rotation generated by the motor 5 to the drive shaft 6. Referring to Fig. 3(a), when the movable carrier 26 is located at the front of the gear case 11, the direct coupling portions 33 and 35 are disengaged from each other, and the second sun gear 21b is engaged with the second planet gears 22b. Thus, the first and speed reduction mechanism 12a and 12b transmit the rotation generated by the motor 5 to the drive shaft 6.

[0025] When the second sun gear 21b is engaged with the second planet gears 22b as shown in Fig. 3 (drill mode), the clutch mechanism 13 restricts rotation of the second ring gear 23b when the load torque applied to the second ring gear 23b is less than or equal to a predetermined torque. When the load torque is greater than the predetermined torque, the second ring gear 23b rotates freely.

[0026] More specifically, a plurality of projections (not shown) axially project from the front surface of the second ring gear 23b at equal angular intervals. Balls 43 engaged with the projections are received in insertion holes (not shown) arranged in the front end 11a of the gear case 11. The clutch mechanism 13 includes a clutch plate 44, a clutch spring 45, and an adjustment member 46. The clutch spring 45 urges the balls 43 toward the second ring gear 23b with the clutch plate 44. The adjustment member 46 is fastened to the support tube 11b of the gear case 11 and allows for adjustment of the compression amount of the clutch spring 45. Accordingly, when the load torque applied to the second ring gear 23b is lower than the engagement force between the projections and the balls 43, which are urged by the clutch spring 45, the clutch mechanism 13 restricts rotation of the second ring gear 23b. This rotates the second carrier 24b and transmits the output of the speed reduction unit 12 to the drive shaft 6. When the load torque applied to the second ring gear 23b is higher than the engagement force between the projections and the balls 43, the second ring gear 23b pushes back the balls 43 and rotates freely. Thus, the second carrier 24b is not rotated, and the output of the speed reduction unit 12 is not transmitted to the drive shaft 6.

[0027] The impact generator 8 will now be described.

[0028] The impact generator 8 includes the drive shaft 6, an anvil 51, a hammer 52, and a hammer spring 53 serving as an urging member. The anvil 51 is coaxial with the drive shaft 6 and rotatable relative to the drive shaft 6. The hammer 52 is coupled to the drive shaft 6. The hammer spring 53 urges the hammer 52 toward the anvil 51. The axis of the drive shaft 6 extends in the front-to-rear direction. As shown in Figs. 2(b) and 3(b), the drive shaft 6 includes a drive shaft hole 54 that opens toward the front, that is, toward the anvil 51. An insertion hole 55 axially extends through the drive shaft 6 and is in communication with the drive shaft hole 54.

[0029] The axis of the anvil 51 extends in the front-to-rear direction. The anvil 51 includes a front end that receives the basal end of a tip tool. The chuck 9 holds a tip tool so that the tip tool rotates integrally with the anvil 51.

[0030] The anvil 51 includes a plurality of arms 51a that extend toward the outer side in the radial direction. In the example of Fig. 4, two arms 51a are arranged at an interval of 180°. As shown in Figs. 2(b) and 3(b), the anvil 51 includes a support hole 57 that is open at the rear side toward the drive shaft 6. The support hole 57 is coaxial with the drive shaft 6. The anvil 51 includes an anvil hole 58 that is in communication with the support hole 57 and coaxial with the drive shaft hole 54. The front end of the drive shaft 6 is fitted into the support hole 57 and rotatably supported by the anvil 51. An axial clearance is provided between the front end of the drive shaft 6 and the anvil 51 to permit slight axial movement of the drive shaft 6.

[0031] The hammer 52 is engaged with the anvil 51 when rotated by the drive shaft 6. In the example shown in Fig. 4, the hammer 52 is annular. Hooks 52a project toward the front from the front surface of the hammer 52.

The rotation of the hammer 52 engages the hooks 52a with the arms 51a of the anvil 51. In the illustrated example, the two hooks 52a, which are trapezoidal, are arranged at an interval of 180°. As shown in Figs. 2(a) and 3(a), the hammer spring 53 is held in a compressed state and arranged between the anvil 51 and an annular spring seat 62, which is fixed to the drive shaft 6. The hammer spring 53 is, for example, a coil spring.

[0032] When the hammer 52 and the drive shaft 6 rotate relative to each other, the hammer 52 moves away from the anvil 51. The hammer 52 is cam-coupled to the drive shaft 6. For example, the outer circumferential surface of the drive shaft 6 includes a cam groove 63 having an inclination angle (lead angle) relative to the axis of the drive shaft 6. The inner circumferential surface of the hammer 52 includes a linear cam groove 64. Balls 65 are held between the cam grooves 63 and 64. The hammer 52 is coupled to the drive shaft 6 with the balls 65 arranged in between.

[0033] Due to the cam coupling, in the impact generator 8, the hammer 52 rotates relative to the drive shaft 6. Further, when the balls 65 roll between the cam grooves 63 and 64, the hammer 52 moves away from the anvil 51 against the urging force of the hammer spring 53. When the hooks 52a move over the arms 51a, the hammer 52 is moved toward the anvil 51 by the urging force of the hammer spring 53 while rotating, and the hammer 52 impacts the arms 51a with the hooks 52a. Such an impact action is intermittently repeated as the drive shaft 6 rotates.

[0034] The impact generator 8 includes a switching mechanism 71 that switches between an impact mode, in which the hammer 52 impacts the anvil 51, and a drill mode, in which the anvil 51 is rotated integrally with the drive shaft 6. The switching mechanism 71 includes a coupling member 72, a switching shaft 73, and a stopper pin 77. The coupling member 72 is engageable with the walls of one or both of the drive shaft hole 54 and the anvil hole 58. The switching shaft 73 supports the coupling member 72 in a relatively rotatable manner. The switching shaft 73 moves in the axial direction in cooperation with the movement of the switch 28. The stopper pin 77 restricts the axial movement of the coupling member 72 relative to the switching shaft 73. The switching shaft 73 moves the coupling member 72 in the axial direction in accordance with the movement of the switch 28. For example, the switch shaft 73 switches to the impact mode by moving the coupling member 72 to a location where the coupling member 72 is engaged with only the wall of the drive shaft hole 54. In the impact mode, relative rotation is permitted between the drive shaft 6 and the anvil 51 (hammer 52). Further, the switch shaft 73 switches to the drill mode by moving the coupling member 72 to a location where the coupling member 72 is engaged with the walls of both of the drive shaft hole 54 and the anvil hole 58. In the drill mode, relative rotation is restricted between the drive shaft 6 and the anvil 51 (hammer 52).

[0035] In the example shown in Figs. 2(b) and 3(b), the coupling member 72 is hexagonal. A fitting hole 74 axially extends through the coupling member 72. The coupling member 72 has an axial length set to be shorter than the drive shaft hole 54, and the coupling member 72 may be completely accommodated in the drive shaft hole 54.

[0036] As shown in Fig. 2(b), the wall of the drive shaft hole 54 includes an engagement portion 75, which is engaged with the coupling member 72 in the impact mode, and a relief 76, which does not contact the outer surface of the coupling member 72 in the impact mode. As shown in Fig. 4, the engagement portion 75 has a hexagonal cross-section of which inner diameter is substantially the same as the outer diameter of the coupling member 72 (diameter of inscribed circuit of the hexagon formed by the cross-section of the coupling member 72). As shown in Fig. 5, the relief 76 has a hexagonal cross-section with an inner diameter that is larger than the outer diameter of the coupling member 72. For example, the relief 76 is an annular groove extending in the circumferential direction of the drive shaft 6 and formed in a wall surface of a rear side of the engagement portion 75. The engagement portion 75 is formed in an axial range that allows for the engagement portion 75 to receive the front end of the coupling member 72 during the impact mode and prevent the rear end of the coupling member 72 from entering the relief 76 during the drill mode. Further, the entire anvil hole 58 has a hexagonal cross-section in the axial direction and an inner diameter that is generally the same as the outer diameter of the coupling member 72.

[0037] The front end of the switching shaft 73 includes a small diameter portion 73a having a smaller diameter than the rear side of the switching shaft 73. The coupling member 72 is rotatably fitted to the small diameter portion 73a. The stopper pin 77 is fixed to the front end of the small diameter portion 73a (end facing the anvil 51). The stopper pin 77 serves as a stopper that is adjacent to the front surface of the coupling member 72. For example, the stopper pin 77 is fixed to the switching shaft 73 in a direction perpendicular to the switching shaft 73. The coupling member 72 is held between a step 73b of the switching shaft 73 and the stopper pin 77 to restrict axial movement of the coupling member 72 relative to the switching shaft 73.

[0038] The front surface of the coupling member 72 includes a recess 78. An elastic member 79 made of rubber or the like is arranged in the recess 78. As shown in Fig. 4, the recess 78 is a round hole having a larger diameter than the axial length of the stopper pin 77. Thus, the coupling member 72 does not directly contact the stopper pin 77, and the elastic member 79 is arranged between the coupling member 72 and the stopper pin 77.

[0039] As shown in Figs. 2(a) and 3(a), the switching shaft 73 is inserted through the insertion hole 55 of the drive shaft 6 so that the rear end of the switching shaft 73 projects from the drive shaft 6 toward the rear. The rear end of the switching shaft 73 is fitted under pressure into the through hole 32 of the second sun gear 21b.

Thus, the switching shaft 73 is fixed to the second sun gear 21b to be rotatable integrally with the second sun gear 21b and immovable in the axial direction relative to the second sun gear 21b. As a result, the switching shaft 73 moves in the axial direction integrally with the second sun gear 21b (movable carrier 26) in cooperation with the movement of the switch 28.

[0040] The operation of the impact rotation tool in the present embodiment will now be described.

[0041] When using the impact rotation tool 1 as an impact driver, the switch 28 is moved toward the rear to move the coupling member 72 with the switching shaft 73 toward the rear. As a result, the coupling member 72 engages with the wall of only the drive shaft hole 54, and the rotation tool 1 enters the impact mode. In the example shown in Fig. 2(b), during the impact mode, the coupling member 72 is completely accommodated in the drive shaft hole 54 and does not enter the anvil hole 58. In the impact mode, the impact torque generated by impact actions rotates the anvil 51 and tightens a screw or the like.

[0042] When using the impact rotation tool 1 as a drill driver, the switch 28 is moved toward the front to move the coupling member 72 with the switching shaft 73 toward the front. As a result, the coupling member 72 engages with the walls of both of the drive shaft hole 54 and the anvil hole 58, and the rotation tool 1 enters the drill mode. As shown in Fig. 3(b), in the drill mode, the boundary between the drive shaft 6 and the anvil 51 lies along the coupling member 72. In the drill mode, the torque of the motor 5 is reduced in speed by the speed reduction mechanisms 12a and 12b and transmitted to the drive shaft 6 in order to rotate the anvil 51 and tighten a screw or the like.

[0043] A regulated clearance in the axial direction is provided between the drive shaft 6 and the anvil 51. Thus, the drive shaft 6 moves toward the anvil 51 whenever an impact action is produced. Further, frictional force is produced where the coupling member 72 contacts the drive shaft 6. This pushes the coupling member 72 against the stopper pin 77 in accordance with the frictional force. Due to errors in assembled components or the like, the frictional force produced between the drive shaft 6 and the coupling member 72 may strongly force a portion of the coupling member 72 against the wall of the drive shaft hole 54.

[0044] In this regard, the wall of the drive shaft hole 54 in the present embodiment includes the relief 76. This decreases the area of the coupling member 72 that contacts the wall of the drive shaft hole 54 in comparison to when there is no relief. Thus, even when frictional force is produced between the drive shaft 6 and the coupling member 72 during an impact action due to errors in assembled components or the like, the coupling member 72 is not pushed by a strong force. As a result, a large force is not applied to the stopper pin 77 by the coupling member 72. Further, the force applied to the stopper pin 77 from the coupling member 72 is absorbed by the elastic deformation of the elastic member 79, which is arranged between the coupling member 72 and the stopper pin 77. In addition, the wall of the drive shaft hole 54 includes the engagement portion 75. Thus, in comparison with when the diameter of the drive shaft hole 54 is entirely larger in the axial direction than the outer diameter of the coupling member 72, the coupling member 72 is not rotated relative to the drive shaft 6 in the drive shaft hole 54. Thus, the edge of the coupling member 72 does not contact the wall of the drive shaft hole 54, and the application of excessive load to the drive shaft 6 is suppressed.

[0045] The present embodiment has the advantages described below.

(1) The wall of the drive shaft hole 54 includes the relief 76 so that there is no contact with the coupling member 72 during the impact mode. Thus, a large force is not applied by the coupling member 72 to the stopper pin 77, and the life of the stopper pin 77 is prolonged. Further, the wall of the drive shaft hole 54 includes the engagement portion 75 that is engaged with the coupling member 72. This suppresses the application of excessive force to the drive shaft 6 and prolongs the life of the drive shaft 6.

(2) The elastic member 79 is arranged between the coupling member 72 and the stopper pin 77. The elastic member 79 absorbs the force applied to the stopper pin 77 by the coupling member 72. This decreases the force applied to the stopper pin 77 and further prolongs the life of the stopper pin 77.

[0046] It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or scope of the invention. Particularly, it should be understood that the present invention may be embodied in the following forms.

[0047] In the above embodiment, a coil spring is used as the hammer spring 53 serving as an urging member that urges the hammer 52 toward the anvil 51. The hammer spring 53 may be a Belleville spring or the like.

[0048] In the above embodiment, the stopper does not have to be the stopper pin 77 and may instead be a snap ring or the like.

[0049] In the above embodiment, the elastic member 79, which is made of rubber or the like, may be arranged between the coupling member 72 and the stopper pin 77.

[0050] In the above embodiment, the relief 76 is an annular groove extending in the circumferential direction of the drive shaft 6 and formed at the rear side of the inner circumferential surface of the engagement portion 75. Thus, the entire outer circumferential surface of the rear end of the coupling member 72 does not contact the relief 76. Instead, for example, as shown in Fig. 6, the relief 76 may be formed by a linear groove extending in the axial direction. In the example shown in Fig. 6, a plurality of (six) reliefs 76 are formed at equal angular intervals in the circumferential direction.

[0051] In the above embodiment, the drive shaft hole 54, the anvil hole 58, and the coupling member 72 have hexagonal cross-sections. However, the drive shaft hole 54, the anvil hole 58, and the coupling member 72 may have any non-circular cross-section as long as the rotation of the coupling member 72 may be transmitted to the drive shaft hole 54 and the anvil hole 58. For example, the cross-section may be square, elliptic, or D-shaped.

[0052] In the above embodiment, the rotational power source is not limited to the motor 5 and may be, for example, a hydraulic or pneumatic rotational power source.

[0053] The present examples and embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

Claims

1. An impact rotation tool (1) including:

    a drive shaft (6) rotated and driven by a rotational power source (5), wherein the drive shaft (6) includes a drive shaft hole (54);
    an anvil (51) that is coaxial with the drive shaft (6) and rotatable relative to the drive shaft (6), wherein the anvil (51) includes an anvil hole (58);
    a hammer (52) rotated by the drive shaft (6) and engaged with the anvil (51), wherein
    the hammer (52) is coupled to the drive shaft (6) so that the hammer (52) moves away from the anvil (51) in an axial direction of the drive shaft (6) when the hammer (52) rotates relative to the drive shaft (6);
    an urging member (53) that urges the hammer (52) toward the anvil (51); and
    a switching mechanism (71) that switches the impact rotation tool (1) between an impact mode that impacts the anvil (51) with the hammer (52) and a drill mode that integrally rotates the drive shaft (6) and the anvil (51), wherein the switching mechanism (71) includes
    a coupling member (72) movable between a position where the coupling member (72) is engaged with a wall of only one of the drive shaft hole (54) and the anvil hole (58) and a position where the coupling member (72) is engaged with the walls of both of the drive shaft hole (54) and the anvil hole (58),
    a switching shaft (73) that supports the coupling member (72) to be rotatable and
    moves the coupling member (72) in the axial direction, and
    a stopper (77) that restricts axial movement of the coupling member (72) relative to the switching shaft (73); and
    wherein the switching shaft (73) moves the coupling member (72) to the position where the coupling member (72) is engaged with the wall of only the drive shaft hole (54) to switch to the impact mode, and
    wherein the switching shaft (73) moves the coupling member (72) to the position where the coupling member (72) is engaged with the walls of both of the drive shaft hole (54) and the anvil hole (58) to switch to the drill mode,
    the impact rotation tool (1) being **characterized in that**
    the wall of the drive shaft hole (54) includes
    an engagement portion (75) engaged with the coupling member (72) in the impact mode, and
    a relief (76) formed so as not to contact an outer circumferential surface of the coupling member (72) in the impact mode.

2. The impact rotation tool (1) according to claim 1, further including an elastic member (79) arranged between the coupling member (72) and the stopper (77).

3. The impact rotation tool (1) according to claim 1 or 2, wherein the relief (76) of the drive shaft hole (54) is formed to form a clearance between the coupling member (72) and the drive shaft (6).

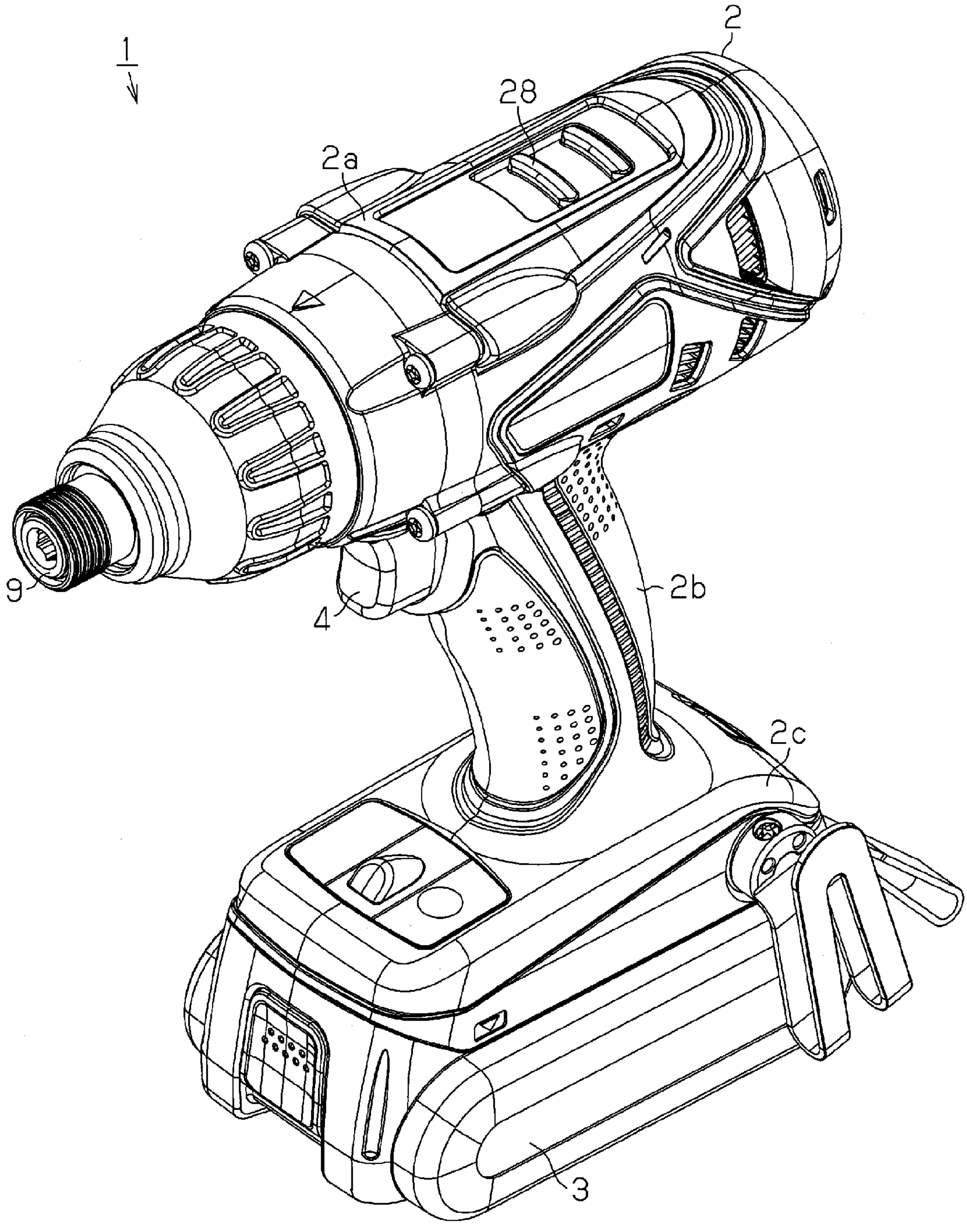
4. The impact rotation tool (1) according to any one of the preceding claims, wherein the coupling member (72) includes a distal portion and a basal portion;
    in the drill mode, the distal portion of the coupling member (72) engages with the inner surface of the anvil hole (58), and the basal portion of the coupling member (72) is engaged with the engagement portion (75) of the drive shaft hole (54), and the basal portion of the coupling member (72) is engaged with the engagement portion (75) of the drive shaft hole (54); and
    in the impact mode, the distal portion of the coupling member (72) is engaged with the engagement portion (75) of the drive shaft hole (54), and the basal portion of the coupling member (72) is separated from the relief (76) of the drive shaft hole (54) in a radially inner direction.

5. The impact rotation tool (1) according to any one of the preceding claims, wherein the engagement portion (75) includes an inner diameter substantially equal to an outer diameter of the coupling member (72), and
    the relief (76) has an inner diameter that is substantially larger than the outer diameter of the coupling member (72).

6. The impact rotation tool (1) according to any one of the preceding claims, wherein the drive shaft (6) includes a distal end supported to be rotatable by the

anvil (51), and
the relief (76) is located in the drive shaft hole (54) at a position that is farther from the distal end of the drive shaft (6) than the engagement portion (75).

Fig.1



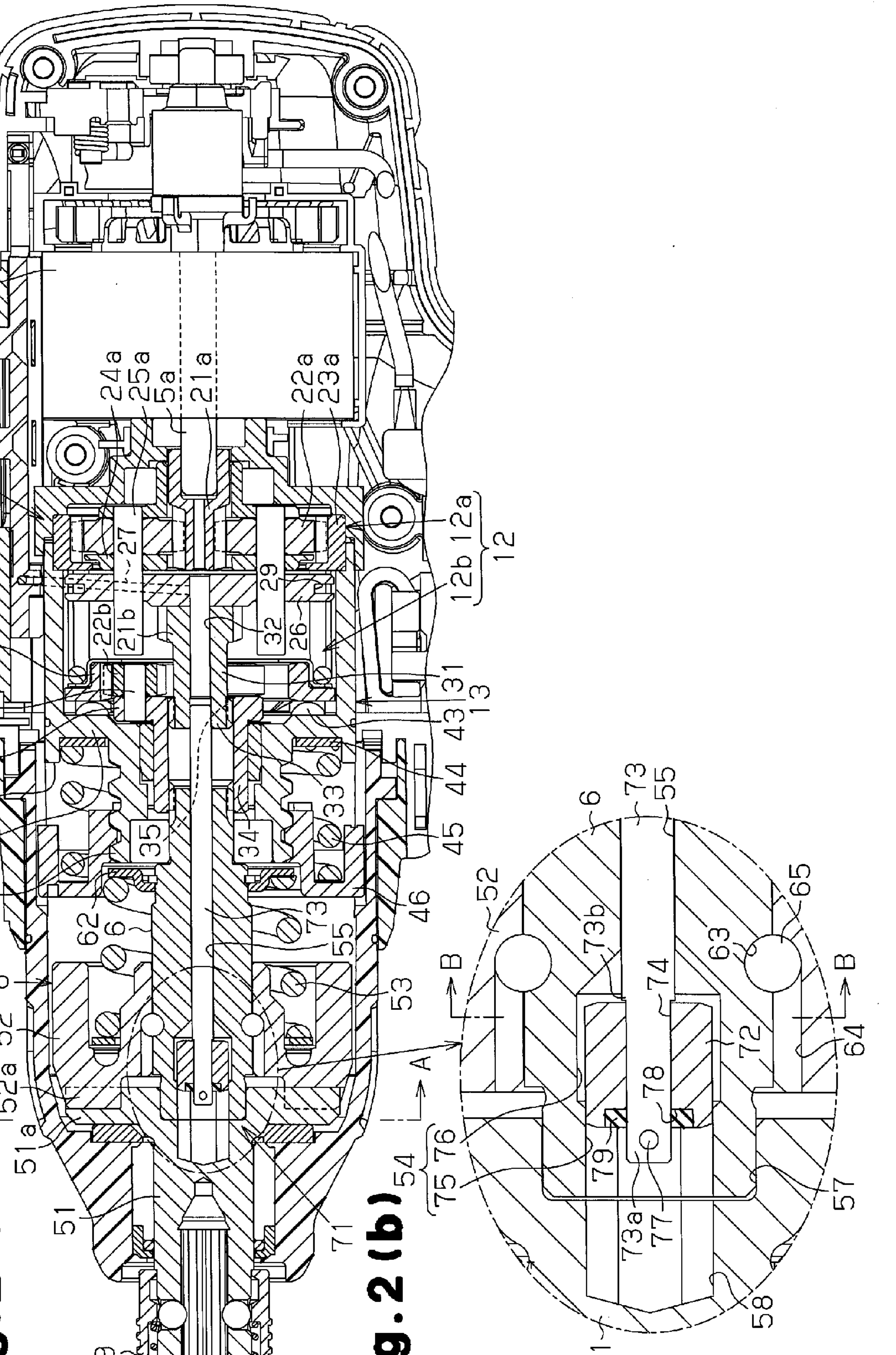


Fig.2(a)

Fig.2(b)

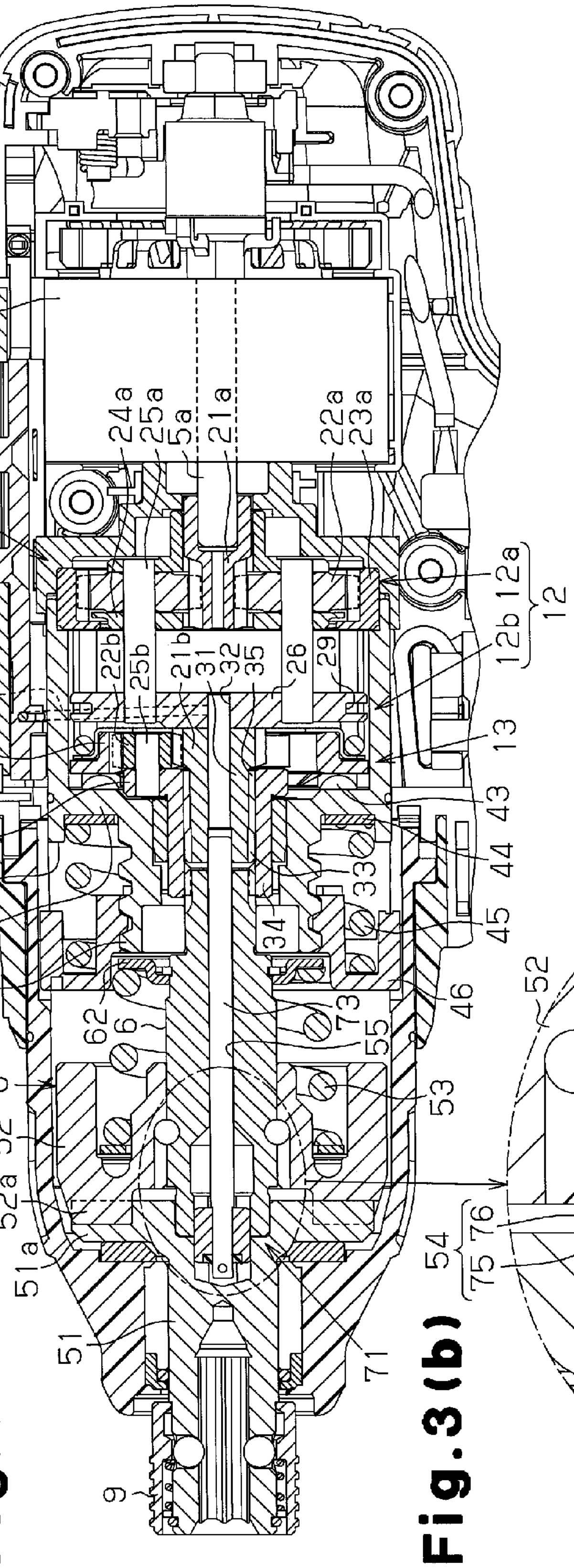

2
5
28
7
2a
27
23b
24b
11
11a
11b
8
52
52a
51a
51
9
24a
25a
5a
21a
22a
23a
12a
12b
12
22b
25b
21b
31
32
35
26
29
13
43
44
33
34
45
46
62
6
73
55
53
71

Fig.3(a)

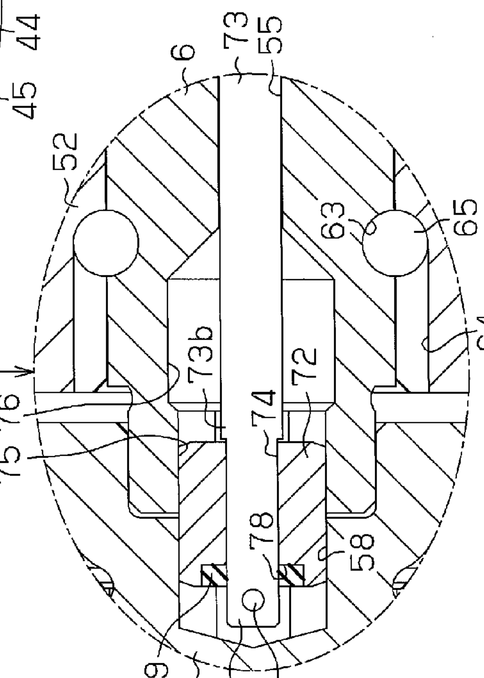

6
73
55
52
63
65
64
54
76
75
73b
74
72
78
58
79
51
73a
77

Fig.3(b)

Fig.4

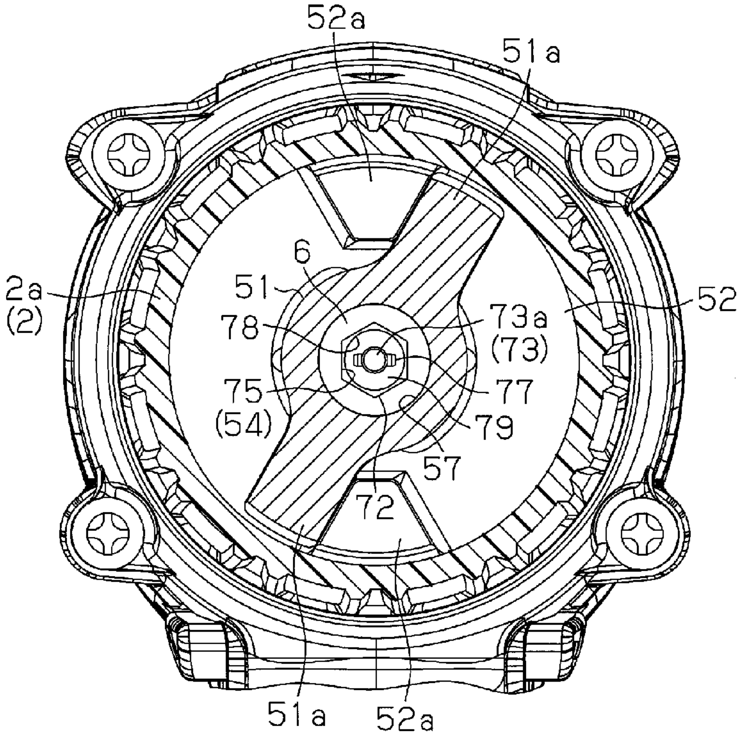

52a
51a
6
51
2a
(2)
78
73a
(73)
52
75
(54)
77
79
57
72
51a
52a

Fig.5

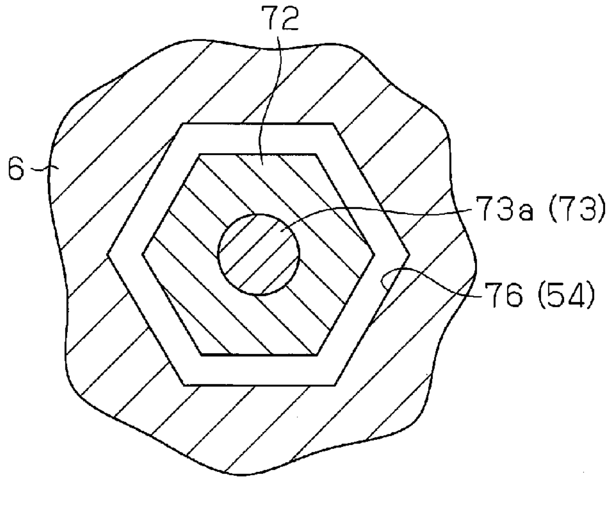

72
6
73a (73)
76 (54)

Fig.6

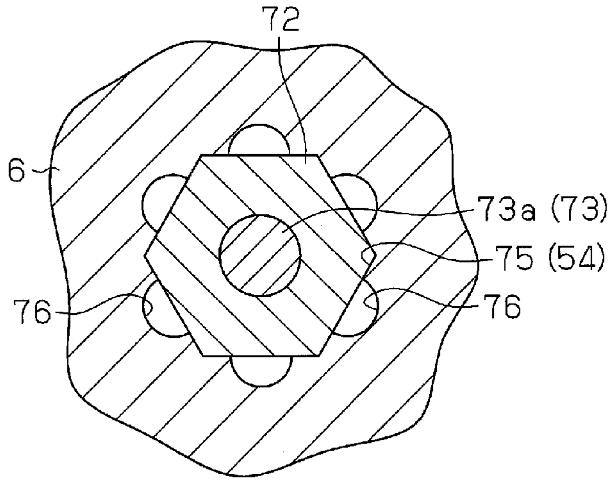
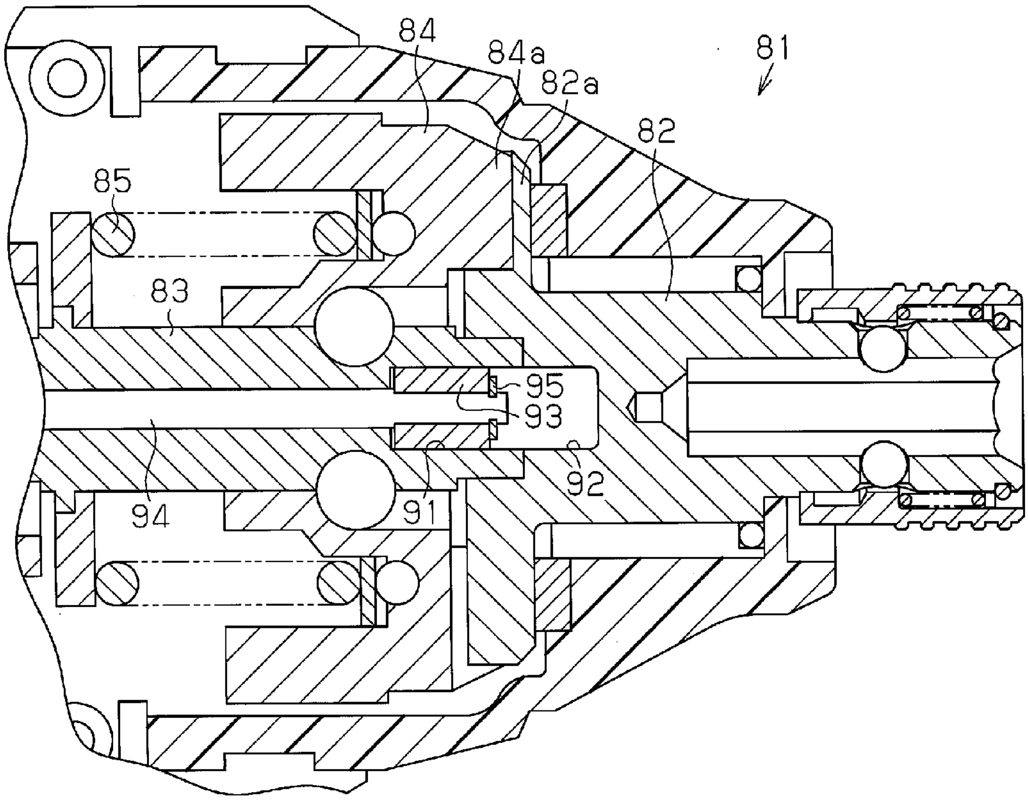


Fig.7



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3911905 B **[0002]**