



(11) EP 1 666 182 B9

## (12) CORRECTED EUROPEAN PATENT SPECIFICATION

(15) Correction information:

**Corrected version no 1 (W1 B1)****Corrections, see****Description Paragraph(s) 12, 27, 32, 33, 35**

(51) Int Cl.:

**B23D 49/16 (2006.01)****B25D 17/04 (2006.01)****B25F 5/00 (2006.01)**

(48) Corrigendum issued on:

**22.09.2010 Bulletin 2010/38**

(45) Date of publication and mention

of the grant of the patent:

**30.06.2010 Bulletin 2010/26**(21) Application number: **05026037.1**(22) Date of filing: **29.11.2005**(54) **Reciprocating power tool**

Hin- und herbewegbares Kraftwerkzeug

Outil motorisé animé d'un mouvement alternatif

(84) Designated Contracting States:

**DE FR GB**(30) Priority: **02.12.2004 JP 2004350015**

(43) Date of publication of application:

**07.06.2006 Bulletin 2006/23**

(60) Divisional application:

**09006843.8 / 2 090 393**(73) Proprietor: **Makita Corporation****Anjo-shi, Aichi-ken 446-8502 (JP)**

(72) Inventors:

**Oki, Sadaharu****Anjo****Aichi 446-8502 (JP)****• Hirabayashi, Shinji****Anjo****Aichi 446-8502 (JP)****• Kobayashi, Kenji****Anjo****Aichi 446-8502 (JP)**(74) Representative: **Kramer - Barske - Schmidtchen****European Patent Attorneys****Landsberger Strasse 300****80687 München (DE)**

(56) References cited:

**EP-A- 0 561 473 EP-A- 1 510 298****DE-A- 19 503 526 GB-A- 714 300**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

**[0001]** The present invention relates to a reciprocating power tool such as a reciprocating saw and more particularly, to a technique for reducing vibration in cutting a workpiece and a cutting technique when the reciprocating power tool is in operation.

#### Description of the Related Art

**[0002]** Japanese non-examined laid-open Patent Publication No. 2001-9632 (hereinafter referred to as "D1") discloses an electric reciprocating saw as an example of a reciprocating power tool. The known reciprocating saw includes a motion converting mechanism for causing a slider to reciprocate in the longitudinal direction. A counter weight is provided in the motion converting mechanism. When the slider reciprocates, the counter weight reciprocates in a direction opposite to the reciprocating direction of the slider, with a 180° phase shift with respect to the slider. As a result, vibration of the reciprocating saw caused by the reciprocating movement of the slider can be reduced.

**[0003]** Further, Japanese non-examined laid-open Patent Publication No.06-79701 (hereinafter referred to as "D2") discloses an electric reciprocating saw having a first motion converting mechanism for converting the rotating output of a motor into reciprocating linear motion in the longitudinal direction of the slider and a second motion converting mechanism for converting the rotating output of the motor into swinging motion in the vertical direction of the slider. In the reciprocating saw having such a construction, the tool bit or the blade supported by the slider not only linearly reciprocates in the longitudinal direction, but swings in the vertical direction, whereby the cutting efficiency can be increased.

**[0004]** In the reciprocating saw as disclosed in D1, because the counter weight is additionally provided for vibration reduction in the motion converting mechanism, the weight of the reciprocating saw itself is increased by the weight of the counter weight. Therefore, further improvement is desired in this respect. On the other hand, in the reciprocating saw disclosed in D2, the actuating mechanism for the blade includes the first motion converting mechanism for causing the blade to linearly reciprocate and the second motion converting mechanism for causing the blade to swing in the vertical direction. Therefore, the actuating mechanism is complicated in structure, the weight of the entire reciprocating saw is increased, and the size of the entire housing for housing these mechanisms is increased. Therefore, further improvement is also desired in this respect.

**[0005]** EP-A-0 561 473, from which the preamble of appended claim 1 starts, discloses a power operated re-

ciprocal saw comprising a plunger assembly swingably supported in a casing for mounting a saw blade and a drive mechanism contained within the casing and connected to a motor and the plunger assembly for imparting oscillatory movement to it. The drive mechanism includes a gear driven by the motor, first cam means including first and second cam elements mounted on said gear, wherein the plunger assembly includes first and second cam following surfaces in respective engagement with the first and second cam elements such that rotation of the gear imparts orbital movement to at least a portion of said plunger assembly. The drive mechanism further comprises second cam means mounted on said gear and a counterweight having a mass substantially the same as the mass of the plunger assembly and mounted for a movement independent of the plunger assembly. The counterweight includes cam following means in engagement with said second cam means, whereby at least a portion of said counter weight is actuated to move in an orbital path upon rotation of said gear. The plunger assembly and the counter weight move in planes parallel with the plane of rotation of the gear.

**[0006]** EP 1 510 298 A1 discloses a reciprocating power tool with its actuating mechanism including a driving motor, the rotating output of which is converted into a reciprocating movement of a piston via a crank mechanism. When the piston linearly moves, a striker linearly moves forward at a high speed by the action of a so-called air spring and collides with an impact bolt as an intermediate element. The impact bolt linearly moves forward at high speed and collides with a hammer bit, which is the tool bit of the power tool and linearly moves forward at a high speed. Thus, the hammer bit performs a hammering (striking) movement and as a result, hammering operation is performed to a workpiece. For dampening the strong vibration caused by the hammer, a handgrip of the power tool is connected to the power tool body at its lower part by a pivot and at its upper part via an elastic element and a dynamic vibration reducer.

**[0007]** GB 714 300 A discloses a control device for a motor driven hand tool, wherein a handgrip is fixed to the body via a pivot at the lower part of the handgrip and a guide pin fixed to the body and protruding into an opening in the upper part of the body. A motor-controlling switch is accommodated in the handgrip and adapted to be operated by the pin as the handgrip is rotated in one direction about the pivot. Resilient means are interposed between the upper part of the handgrip and the body and urge the handgrip in one direction. Stop means on the body cooperate with the handgrip and limit the rotational movement of the grip about the pivot in both directions. The motor-controlling switch starts the motor when the hand tool is pushed against a workpiece and shuts the motor down when the hand tool is pulled away from a workpiece. During operation of the hand tool, when the hand tool is pressed against a workpiece the resilient member does not dampen any vibration of the handgrip, for the handgrip is rotated relative to the body until its

rotational movement is limited by the stop means.

**[0008]** DE 195 03 526 A discloses an impact drilling machine with a vibration dampening means and a detachable handgrip. The handgrip has a general U-shape, wherein the vibration dampening means is located in the region of the legs of the handgrip at the transition to a mounting body, which can be detachably mounted to the body of the impact drilling machine.

### Summary of the Invention

**[0009]** It is an object of the invention to provide a reciprocating power tool with its tool bit being a saw blade, which power has an improved cutting efficiency and wherein the vibrations of the handgrip are reduced.

**[0010]** A solution of this object is achieved with the reciprocating power tool according to appended claim 1.

**[0011]** Sub claims 2 to 9 are directed towards advantageous improvements and embodiments of the inventive power tool.

**[0012]** According to the invention, a representative reciprocating power tool is provided to comprise a body, an actuating mechanism disposed within the body to cause the tool bit to linearly reciprocate, a handgrip disposed on the rear end of the body on the side opposite to the tool bit. The "reciprocating power tool" according to the invention may include various power tools such as a reciprocating saw and a jig saw, to be used to cut a workpiece of various materials such as wood and metal. The "tool bit" typically comprises a blade which is formed of a steel sheet and has teeth continuously formed on the edge of the steel sheet.

**[0013]** According to the invention, the handgrip and the body are coupled to each other such that the handgrip and the body can rotate with respect to each other via a pivot in a direction crossing the direction of reciprocating linear motion of the tool bit. The tool bit swings together with the body with respect to the handgrip being held by a user of the power tool, while the tool bit linearly reciprocates with respect to the body via the actuating mechanism. When the tool bit linearly reciprocates with respect to the body with the handgrip held by a user, an inertial force acts upon the body. By this inertial force, the tool bit swings on the pivot together with the body with respect to the handgrip. The angle of inclination of the reciprocating tool bit is changed by the combined motion of the tool bit that swings while reciprocating. Such change of the inclination angle of the tool bit can increase the cutting efficiency.

**[0014]** The swinging motion of the tool bit is realized with a simple construction in which the body is coupled to the handgrip via the pivot. Therefore, compared with the prior arts in which a combination of several functional components driven by a motor is used as a motion converting mechanism in order to cause the tool bit to swing, the construction can be simpler and lighter in weight. Thus, the weight reduction of the reciprocating power tool can be achieved. Further, the body can be made

thinner. Therefore, ease of use can be enhanced in performing a cutting operation while holding the handgrip by one hand and holding the tip end region of the body by the other hand.

**[0015]** According to the invention, an elastic element is disposed between the handgrip and the body and serves to absorb vibration transmitted from the body to the handgrip by elastically receiving the relative rotation of the handgrip and the body. The "elastic element" comprises a rubber or a spring. The manner in which the "elastic element is disposed" suitably includes both the manner in which the elastic element is disposed apart from the pivot and the manner in which the elastic element is disposed on the axis of the pivot. The elastic element disposed between the handgrip and the body absorbs and reduces vibration caused in the body and transmitted to the handgrip, by elastic deformation of the elastic element. Such vibration reduction by using the elastic element is more effective for weight reduction of the reciprocating power tool, compared with the known art that uses a counter weight.

**[0016]** Thus, according to the invention, vibration in the handgrip can be reduced and the cutting efficiency can be improved without complicating the construction.

**[0017]** Other objects, features and advantages of the present invention will be readily understood after reading the following detailed description together with the accompanying drawings and the claims.

### 30 BRIEF DESCRIPTION OF THE DRAWINGS

#### [0017]

FIG. 1 is a sectional view showing an entire reciprocating saw having a vibration-proof handgrip according to an embodiment of the invention.

FIG. 2 is a sectional view showing a rotatable connection between a fixed part and a moving grip part.

FIG. 3 is a sectional view taken along line III-III in FIG. 1.

FIG. 4 is a view showing the inclination of a blade when a slider is in the bottom dead center.

FIG. 5 is a view showing the inclination of the blade when the slider is in the upper dead center.

FIG. 6 is a sectional view showing an entire reciprocating saw having a normal handgrip according to the state of the art.

### DETAILED DESCRIPTION OF THE INVENTION

**[0018]** Each of the additional features and method steps disclosed above and below may be utilized separately or in conjunction with other features and method steps to provide and manufacture improved reciprocating power tools and method for using such reciprocating power tools and devices utilized therein. Representative examples of the present invention, which examples utilized many of these additional features and method steps

in conjunction, will now be described in detail with reference to the drawings. This detailed description is merely intended to teach a person skilled in the art further details for practicing preferred aspects of the present teachings and is not intended to limit the scope of the invention. Only the claims define the scope of the claimed invention. Therefore, combinations of features and steps disclosed within the following detailed description may not be necessary to practice the invention in the broadest sense, and are instead taught merely to particularly describe some representative examples of the invention, which detailed description will now be given with reference to the accompanying drawings.

**[0019]** A representative embodiment of the present invention will now be described with reference to the drawings. As shown in FIG. 1, a reciprocating saw 101 as a representative embodiment of a reciprocating power tool according to the invention comprises a body 103, a slider 107, a blade 111 and a handgrip 105. The slider 107 projects from the body 103 and the blade 111 is detachably mounted to a chuck 109 on the end of the slider 107 and cuts a workpiece (not particularly shown). The blade 111 is a feature that corresponds to the "tool bit" according to the invention. The body 103 includes a motor housing 103a and a gear housing 103b connected to the front end of the motor housing 103a. In the present embodiment, for the sake of convenience of explanation, the side of the blade 111 is taken as the front side and the side of the handgrip 105 as the rear side in the following description.

**[0020]** The motor housing 103a of the body 103 houses a driving motor 113. The driving motor 113 is driven when the user depresses a trigger switch 115. The blade 111 then reciprocates in the longitudinal direction together with the slider 107 and the chuck 109 and can cut a workpiece. The slider 107, the chuck 109 and the blade 111 form a moving part. The slider 107 is supported via a bearing 108 in the gear housing 103b such that the slider 107 can reciprocate in its longitudinal direction. The slider 107 is connected to a motor shaft 117 via a motion converting mechanism 121 disposed within the gear housing 103b. The motion converting mechanism 121 is a feature that corresponds to the "actuating mechanism" according to the invention.

**[0021]** The motion converting mechanism 121 converts the rotational motion of the motor shaft 117 into the reciprocating motion in the longitudinal direction of the slider 107. The motion converting mechanism 121 comprises a bevel gear 123, a crank pin 129 and a slider block 131. The bevel gear 123 engages with a pinion 119 of the motor shaft 117. The bevel gear 123 is mounted to a fixed shaft 125 that is fixed to the gear housing 103b, via a bearing 127 and can rotate within a horizontal plane. The crank pin 129 is mounted on the upper surface of the bevel gear 123 at a position shifted a predetermined distance from the center of rotation of the bevel gear 123. The lower end of the crank pin 129 is fixedly mounted by press-fitting into a pin mounting hole that is formed in the

bevel gear 123. The upper end of the crank pin 129 is fitted in the slider block 131 that is formed in the slider 107, via a bearing 133. Thus, the crank pin 129 can rotate with respect to the slider 107.

**5 [0022]** The slider block 131 has a guide groove 131a extending in a direction crossing the longitudinal direction of the slider 107. The crank pin 129 can move with respect to the slider block 131 along the guide groove 131a via the bearing 133 that is fitted in the guide groove 131a. **10** With respect to the revolving motion of the crank pin 129 around the fixed shaft 125, components of the motion in the direction crossing the longitudinal direction of the slider 107 within a horizontal plane escape into the guide groove 131a and only components of the motion in the **15** longitudinal direction of the slider 107 are transmitted to the slider 107. The slider 107 is thus allowed to reciprocate only in its longitudinal direction. Further, a shoe 106 is mounted on the end of the body 103. The user presses the shoe 106 against the workpiece while holding the handgrip 105 during cutting operation.

**[0023]** The construction of the handgrip 105 and the construction for mounting the handgrip 105 to the body 103 will now be explained with reference to FIGS. 1 to 3. Vibration is caused in the body 103 during operation **25** of cutting a workpiece with the reciprocating saw 101. According to the representative embodiment, in order to reduce transmission of this vibration to the handgrip 105, the handgrip 105 is constructed as follows. The handgrip 105 is a D-type handgrip which is generally D-shaped in **30** side view. The handgrip 105 is hollow and generally rectangular in section. An opening 141 is formed in the front upper region of the handgrip 105 and opens to the front. In order to mount the handgrip 105 to the motor housing 103a, the opening 141 is fitted on the rear end of the body **35** 103 or a grip mounting portion 143 formed in the rear end portion of the motor housing 103a.

**[0024]** The handgrip 105 has a two-part structure which is divided into halves along a vertical plane parallel to the axis of the slider 107. Specifically, the handgrip **40** 105 includes right and left halves 105a, 105b (see FIGS. 2 and 3). The right and left halves 105a, 105b are butted against each other from the sides in such a manner that the region of the opening 141 covers the grip mounting portion 143. In this state, the halves 105a, 105b are joined **45** by clamping screws 144 (see FIG. 1) at several points on the edge portions of the halves 105a, 105b. Thus, the handgrip 105 is fixedly mounted on the grip mounting portion 143. The handgrip 105 can be detached from the grip mounting portion 143 by unscrewing the clamping **50** screws 144 so as to disjoin the halves 105a, 105b from the grip mounting portion 143. Specifically, the handgrip 105 is constructed to be detachably mounted to the body 103. Further, as shown in FIG. 1, an engaging portion 142 is formed on the engagement surfaces between the **55** opening 141 and the grip mounting portion 143. The respective engaging portions 142 have projections and depressions and engage with each other. By the engagement of the engaging portions 142, the handgrip 105 is

prevented from falling off rearward from the body 103.

**[0025]** Further, the handgrip 105 is partitioned into two forward and rearward parts. The forward part comprises a fixed part 145a mounted to the motor housing 103a, and the rearward part comprises a moving grip part 145b that a user grips. The fixed part 145a is mounted to the motor housing 103a in such a manner as mentioned in the preceding paragraph. One end (lower end) of the moving grip part 145b is rotatably connected to one end (lower end) of the fixed part 145a via a pivot 147. The other end (upper end) of the moving grip part 145b is elastically connected to the other end (upper end) of the fixed part 145a via a compression coil spring 149. The compression coil spring 149 is a feature that corresponds to the "elastic element" in the present invention. With the above-mentioned construction, the moving grip part 145b and the body 103 can rotate vertically or in a direction crossing the direction of the reciprocating movement of the blade 111 about the pivot 147 with respect to each other. Thus, the vibration-proof handgrip 105 is formed with a construction in which the moving grip part 145b is rotatably connected at its lower end to the fixed part 145a via the pivot 147 and connected at its upper end to the fixed part 145a via the compression coil spring 149.

**[0026]** FIG. 2 shows a rotatable connection between the fixed part 145a and the moving grip part 145b. As shown, the right and left halves 105a, 105b of the handgrip 105 are butt-joined to each other, and the side lower end portion of the fixed part 145a is fitted over the side lower end portion of the moving grip part 145b. In this state, the side end portion of the fixed part 145a is fastened to the side end portion of the moving grip part 145b via a bush 147a by a mounting screw 147b. In this manner, the fixed part 145a and the moving grip part 145b are rotatably connected to each other. The bush 147a and the mounting screw 147b form the pivot 147.

**[0027]** Further, as shown in FIG. 1, the compression coil spring 149 is disposed forward of the pivot 147 and on the axis of the slider 107 and arranged such that the biasing direction of the compression coil spring 149 is tangential to the rotation around the pivot 147. Specifically, the compression coil spring 149 is disposed on the forward decline between the fixed part 145a and the moving grip part 145b in the handgrip 105. FIG. 3 is a sectional view showing the mounting portion for mounting the compression coil spring 149. As shown in FIGS. 1 and 3, a rectangular tubular portion 151 having a circular bore is formed in the front upper portion of the moving grip part 145b and receives the compression coil spring 149. The tubular portion 151 projects forward on the decline and is movably inserted into a space 153 that is formed in the fixed part 145a. A circular projection (pin) 151a is formed on the right and left sides of the tubular portion 151 and is slidably engaged with a guide groove 153a in the space 153. (The guide groove 153a is formed in a portion of the fixed part 145a which defines and faces the space 153.) The guide groove 153a extends to a predetermined length in the inclining direction of the tubular portion 151.

Thus, the fixed part 145a and the moving grip part 145b are allowed to pivot within the length range of the guide groove 153a with respect to each other. Further, one end of the compression coil spring 149 rests on the bottom of the bore of the tubular portion 151, while the other end rests on the bottom of the space 153.

**[0028]** A dynamic vibration reducer 161 is disposed rearward of the compression coil spring 149 within the hollow portion of the moving grip part 145b and serves to reduce vibration of the moving grip part 145b. The dynamic vibration reducer 161 is positioned so as to reduce vibration in the reciprocating direction (longitudinal direction) of the blade 111, which vibration is transmitted from the body 103 to the moving grip part 145b. The dynamic vibration reducer 161 includes a guide rod 163, a weight 165 and a biasing spring 167. The guide rod 163 extends in the longitudinal direction of the slider 107. The weight 165 is mounted on the guide rod 163 and can move in the axial direction. The biasing spring 167 is disposed on the both sides of the weight 165 in the axial direction. The biasing spring 167 applies a spring force to the weight 165 between the weight 165 and the moving grip part 145b (rod mounting portion) when the weight 165 moves in the axial direction of the guide rod 163.

**[0029]** Further, in the reciprocating saw 101 according to the representative embodiment, the above-mentioned vibration-proof handgrip 105 can be integrally replaced with a normal handgrip of standard specification which does not have a vibration reducing function. FIG. 6 shows the reciprocating saw 101 in which a normal handgrip 205 is attached to the body 103. The vibration-proof handgrip 105 and the normal handgrip 205 have a construction for mounting to the motor housing 103a in common such that the handgrips 105, 205 can be integrally replaced with each other. Specifically, the handgrip 205 has a two-part structure which is divided into halves along a vertical plane parallel to the axis of the slider 107 and thus includes right and left halves 205a, 205b. The right and left halves 205a, 205b are butted against each other from the sides in such a manner that the front upper portion of the handgrip 205 covers the grip mounting portion 143. In this state, the halves 205a, 205b are joined by clamping screws 244 at several points on the edge portions of the halves 205a, 205b. Thus, the handgrip 205 is detachably mounted on the grip mounting portion 143.

**[0030]** Operation and usage of the reciprocating saw 101 constructed as described above will now be explained. When the user depresses the trigger switch 115 disposed on the moving grip part 145b of the handgrip 105 of the reciprocating saw 101 as shown in FIG. 1, the driving motor 113 is driven, and the bevel gear 123 is rotated around the fixed shaft 125 within a horizontal plane via the motor shaft 117 and the pinion 119. Then, the crank pin 129 revolves around the fixed shaft 125. As a result, the slider 107 reciprocates in the longitudinal direction between the top dead center and the bottom dead center via the slider block 137. Thus, the blade 111 that is coupled to the chuck 109 on the end of the slider

107 reciprocates and is allowed to cut the workpiece.

**[0031]** The user presses the shoe 106 against the workpiece to be cut and cuts the workpiece in this state from above by the reciprocating blade 111. At this time, the blade 111 can be smoothly operated even if the user obliquely presses the moving grip part 145b against the tool body 103, because the fixed part 145a and the moving grip part 145b are rotatably connected to each other via the pivot 147.

**[0032]** During actuation of the blade 111 or during operation of cutting a workpiece by the blade 111, vibration is caused in the reciprocating saw 101. The handgrip 105 is segmented into the fixed part 145a and the moving grip part 145b. The lower end of the moving grip part 145b is rotatably connected to the fixed part 145a via the pivot 147, and the upper end of the moving grip part 145b is elastically connected to the fixed part 145a via the compression coil spring 149. With such construction, vibration caused in the body 103 and transmitted to the moving grip part 145b can be absorbed and reduced by the spring force of the compression coil spring 149. The compression coil spring 149 is disposed generally on the line of reciprocating movement of the blade 111 and tangentially to the rotation around the pivot 147. Therefore, the compression coil spring 149 can efficiently absorb the longitudinal vibration which is transmitted from the body 103 to the moving grip part 145b of the handgrip 105.

**[0033]** Amount of vibration was measured in each of the longitudinal, vertical and lateral directions of the handgrips 105, 205 and in the three-axis resultant, using the reciprocating saw 101 with the vibration-proof handgrip 105 as shown in FIG. 1 and the reciprocating saw 101 with the normal handgrip 205 of standard specification without a vibration reducing function as shown in FIG. 6. As a result, the vibration values of the vibration-proof handgrip 105 (the moving grip part 145b) were lower than the normal handgrip 205 in all the measurements other than in the vertical direction, i.e. in the longitudinal and lateral directions and in the three-axis resultant. Thus, the vibration-proof handgrip 105 was proved to have a vibration reducing effect. Further, it was also confirmed that the same vibration reducing effect can be achieved whether under unloaded or loaded conditions and whether in woodworking or in metalworking. Thus, according to the embodiment, the vibration-proof handgrip 105 was proved to have an adequate vibration reducing effect as a whole.

**[0034]** Further, according to this embodiment, during cutting operation, when the blade 111 linearly reciprocates together with the slider 107 and the chuck 109 in the longitudinal direction between the top dead center and the bottom dead center, the blade 111 vertically swings on the pivot 147 together with the body 103. Specifically, when the blade 111 linearly reciprocates, an inertial force acts upon the body 103 and the compression coil spring 149 receives this inertial force. The blade 111 then vertically swings on the pivot 147 while deforming the compression coil spring 149. As a result, the blade

111 performs a combined motion of the reciprocating linear motion and the vertical swinging motion on the pivot 147, or a circular arc motion in the cutting direction (longitudinal direction). Such circular arc motion of the blade 111 causes a change in the angle of inclination of the reciprocating blade 111. By virtue of the angle change of the blade 111, the cutting efficiency is enhanced.

**[0035]** When the slider 107 moves from the top dead center to the bottom dead center or when the blade 111

retracts to be drawn leftward as viewed in FIG. 1 to cut the workpiece, the angle of inclination of the blade 111 defined by the angle between the horizontal axis and the axis of the slider 107 gradually increases. In other words, the tip end of the blade 111 is oriented upward. By such increase in the blade inclination, the number of teeth of the blade 111 which touch the workpiece during cutting operation is reduced compared with the case in which the blade 111 is moved linearly. Therefore, the teeth of the blade 111 can readily dig into the workpiece, so that the cutting efficiency can be improved. On the other hand, when the slider 107 moves from the bottom dead center to the top dead center (the blade 111 is pushed), the angle of inclination of the blade 111 gradually decreases. FIG. 4 shows the blade 111 inclined at an angle of  $\theta_1$  (for example,  $1^\circ$ ) when the slider 107 is in the bottom dead center. FIG. 5 shows the blade 111 inclined at an angle of  $\theta_2$  (for example,  $-5^\circ$ ) when the slider 107 is in the top dead center. Thus, according to the embodiment, when the blade 111 linearly reciprocates, the blade 111 is caused to vertically swing together with the body 103, so that the angle of inclination of the blade 111 changes. As a result, the cutting efficiency can be improved. The angle of inclination of the blade 111 tends to vary in a greater degree as the load during cutting operation increases.

**[0036]** The reciprocating saw 101 according to the embodiment is configured to achieve vibration reduction of the handgrip 105 and greater cutting efficiency by improving the construction for mounting the handgrip 105.

Therefore, in contrast to the known arts in which a functional component is additionally provided in the blade actuating mechanism in order to reduce vibration and/or improve the cutting efficiency, the reciprocating saw 101 can be simpler in construction and lighter in weight. Further, the motor housing 103a and the gear housing 103b which form the body 103 can be made thinner. Therefore, ease of use can be enhanced in performing a cutting operation while holding the moving grip part 145b by one hand and holding the tip end region of the body 103 by the other hand.

**[0037]** Further, because each of the vibration-proof handgrip 105 and the normal handgrip 205 of standard specification can be detachably mounted to the body 103 and can be replaced with the other, the reciprocating saw 101 can be provided in high-efficiency mode and in standard-efficiency mode.

**[0038]** Further, the dynamic vibration reducer 161 is provided within the moving grip part 145b of the handgrip

105. Therefore, the dynamic vibration reducer 161 in the moving grip part 145b performs a vibration reducing function with respect to vibrations of the moving grip part 145b which cannot be absorbed any more by the compression coil spring 149. Specifically, vibration reducing elements in the dynamic vibration reducer 161, i.e. the weight 165 and the biasing springs 167 cooperate to passively reduce vibration of the moving grip part 145b of the reciprocating saw 101 on which a predetermined external force (vibration) is exerted. Thus, the vibration of the reciprocating saw 101 can be effectively alleviated or reduced. Further, when vibrations caused when the blade 111 reciprocates have a low frequency at the source so that the compression coil spring 149 can not appropriately absorb such vibrations, the dynamic vibration reducer 161 can alleviate such vibrations. Thus, provision of the dynamic vibration reducer 161 can further reduce the vibration of the moving grip part 145b, so that the ease of use of the reciprocating saw 101 can be further enhanced. In this case, the dynamic vibration reducer 161 is disposed on the line of reciprocating movement of the blade 111. Therefore, the dynamic vibration reducer 161 can efficiently perform the vibration reducing function, and generation of vibration by actuation of the dynamic vibration reducer 161 can be avoided. Thus, the dynamic vibration reducer 161 can effectively perform the vibration reducing function.

**[0039]** Further, rubber may be used instead of the compression coil spring 149 as an elastic element according to the representative embodiment. Further, according to the embodiment, the reciprocating saw 101 has been described as an example of the reciprocating power tool, but this invention may be applied to tools, such as a jigsaw, which performs a cutting operation on a workpiece by reciprocating. Further, in this embodiment, the handgrip 105 has been described as having a D-shape, but it is not limited to this shape.

**[0040]** It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the purpose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges.

#### Description of Numerals

#### **[0041]**

101	reciprocating saw (reciprocating power tool)
103	body
103a	motor housing
103b	gear housing

105	handgrip
105a	left half
105b	right half
106	shoe
5 107	slider
108	bearing
109	chuck
111	blade (tool bit)
113	driving motor
10 115	trigger switch
117	motor shaft
119	pinion
121	motion converting mechanism (actuating mechanism)
15 123	bevel gear
125	fixed shaft
127	bearing
129	crank pin
131	slider block
20 131a	guide groove
133	bearing
141	opening
142	engaging portion
143	grip mounting portion
25 144	clamping screw
145a	fixed part
145b	moving grip part
147	pivot
147a	bush
30 147b	screw
151	tubular portion
151a	projection
153	space
153a	guide groove
35 161	dynamic vibration reducer
163	guide rod
165	weight
167	biasing spring
205	normal handgrip
40 205a	left half
205b	right half
244	clamping screw

#### **45 Claims**

1. A reciprocating power tool comprising a body (103), a tool bit disposed in the tip end region of the body, an actuating mechanism (121) disposed within the body, the actuating mechanism causing the tool bit to linearly reciprocate, a handgrip (105) disposed on the rear end of the body on the side opposite to the tool bit, wherein said tool bit is a saw blade (111) detachably mounted to a chuck (109) at one end of a slider (107), which is linearly reciprocatingly movably driven along its longitudinal direction by said actuating mechanism

(121),

**characterized in that**

said handgrip (105) is coupled to the body (103) via a pivot (147) disposed at a lower end portion of said handgrip and an elastic element (149) disposed at an upper end portion of said handgrip forward of the pivot (147) and downwardly declined towards the body (103) such that the handgrip and the body can rotate with respect to each other via the pivot (147) in a direction crossing the direction of the reciprocating linear motion of the tool bit, wherein the tool bit swings together with the body with respect to the handgrip held by a user of the power tool, while the saw blade (111) linearly reciprocates with respect to the body via the actuating mechanism and wherein the elastic element absorbs vibration transmitted from the body to the handgrip by elastically receiving the relative rotation of the handgrip and the body, whereby, when the saw blade linearly reciprocates with the power tool held by a user, the saw blade vertically swings on the pivot together with the body by an inertial force acting upon the body such that an angle of inclination of the reciprocating saw blade is changed.

2. The reciprocating power tool as defined in claim 1, wherein the elastic element (149) is arranged such that the biasing direction of the elastic element is tangential to the rotation around the pivot (147).
3. A reciprocating power tool as defined in claim 1 or 2, wherein the elastic element (149) is disposed substantially on the axis of the slider (107).
4. The reciprocating power tool as defined in claim 3, wherein the elastic element is formed by a compression coil spring (149) accommodated in a tubular portion (151) formed in a front upper portion of the moving grip part (145) and downwardly declined towards the body (103), which tubular portion is movably inserted into a space (153) formed in the fixed part (145a), wherein the movability of the tubular portion within the space is restricted by projections (151a) formed at the tubular portion and engaging with guide grooves (153) formed in the wall of the space.
5. The reciprocating power tool as defined in any of claims 1 to 4, wherein, when the tool bit linearly moves in a direction to cut workpiece, the angle of inclination of the tool bit gradually increases.
6. The reciprocating power tool according to any of claims 1 to 5, wherein said handgrip (105) comprises a fixed part (145a) mounted to said body (103) and a moving grip part (145b) to be gripped by a user, which moving grip part is disposed at the side of the fixed part opposite to the tool bit and is rotatably

mounted to the fixed part via said pivot (147) and said elastic element is disposed between the fixed part (145a) and the moving grip part (145b).

- 5 7. The reciprocating power tool as defined in any of claims 1 to 6, wherein the handgrip (105) is detachably coupled to the body (103) and can be integrally replaced with a normal handgrip of standard specification integrally detachably coupled to the body.
- 10 8. The reciprocating power tool as defined in any one of claims 1 to 7, wherein a dynamic vibration reducer (161) is disposed in the handgrip (105), the dynamic vibration reducer reduces vibration transmitted from the body (103) to the handgrip during cutting operation.
- 15 9. The reciprocating power tool as defined in claim 8, wherein at least one of the elastic element (149) and the dynamic vibration reducer (161) is disposed substantially on the line of reciprocating movement of the tool bit (111).

**25 Patentansprüche**

1. Hin- und herbewegbares Kraftwerkzeug mit einem Körper (103), einem Werkzeugbit, das an dem Spitzendbereich des Körpers angeordnet ist, einem Betätigungsmechanismus (121), der in dem Körper angeordnet ist, wobei der Betätigungsmechanismus das Werkzeugbit zu einer linearen Hin- und Herbewegung veranlasst, einem Handgriff (105), der auf dem hinteren Ende des Körpers auf der Seite angeordnet ist, die dem Werkzeugbit gegenüberliegt, wobei das Werkzeugbit ein Sägeblatt (111) ist, das lösbar an einem Spannfutter (109) an einem Ende eines Gleiters (107) montiert ist, der entlang seiner Längsrichtung durch den Betätigungsmechanismus (121) linear hin- und herbewegbar angetrieben wird, dadurch gekennzeichnet, dass der Handgriff (105) an den Körper (103) über ein Gelenk (147) gekoppelt ist, das an einem unteren Endbereich des Handgriffs angeordnet ist, und über ein elastisches Element (149) das an einem oberen Endbereich des Handgriffs vor dem Gelenk (147) und in Richtung Körper (103) nach unten geneigt derart angeordnet ist, das der Handgriff und der Körper über das Gelenk (147) bezüglich zueinander in eine Richtung drehen können, die die Richtung der linearen Hin- und Herbewegung des Werkzeugbits kreuzt, wobei das Werkzeugbit zusammen mit dem Körper bezüglich des von einem Benutzer des Kraftwerkzeugs gehaltenen Handgriffs schwingt, während sich das Sägeblatt (111) über den Betätigungsmechanismus

bezüglich des Körpers linear hin- und herbewegt, und wobei das elastische Element eine Vibration, die von dem Körper an den Handgriff übertragen wird, durch elastisches Aufnehmen der relativen Drehung des Handgriffs und des Körper absorbiert, wodurch, 5

wenn sich das Sägeblatt linear hin- und herbewegt, wobei das Kraftwerkzeug von einem Benutzer gehalten wird, das Sägeblatt zusammen mit dem Körper vertikal auf dem Gelenk durch eine Trägheitskraft, die auf den Körper wirkt, so schwingt, dass ein Neigungswinkel des sich hin- und herbewegenden Sägeblatts geändert wird. 10

2. Hin- und herbewegbares Kraftwerkzeug nach Anspruch 1, bei dem das elastische Element (149) derart angeordnet ist, dass die Vorbelastungsrichtung Richtung des elastischen Elements tangential zu der Drehung um das Gelenk (147) ist. 15

3. Hin- und herbewegbares Kraftwerkzeug nach Anspruch 1 oder 2, bei dem das elastische Element (149) im wesentlichen auf der Achse des Gleiters (107) angeordnet ist. 20

4. Hin- und herbewegbares Kraftwerkzeug nach Anspruch 3, bei dem das elastische Element durch eine Druckspiralfeder (149) gebildet ist, die in einem Röhrenbereich (151) untergebracht ist, der in einem vorderen oberen Bereich des bewegbaren Griffteils (145) gebildet ist und in Richtung des Körpers (103) nach unten geneigt ist, wobei der Röhrenbereich bewegbar in einen Raum (153) eingeführt ist, der in dem fixierten Teil (145a) gebildet ist, wobei die Bewegbarkeit des Röhrenbereichs innerhalb des Raums durch Vorsprünge (151a) begrenzt ist, die an dem Röhrenbereich gebildet sind und mit Führungsrollen (153), die in der Wand des Raums gebildet sind, in Eingriff stehen. 25

5. Hin- und herbewegbares Kraftwerkzeug nach einem der Ansprüche 1 bis 4, bei dem, wenn sich das Werkzeugbit linear in eine Richtung zum Schneiden des Werkstücks bewegt, der Neigungswinkel des Werkzeugbits allmählich zunimmt. 30

6. Hin- und herbewegbares Kraftwerkzeug nach einem der Ansprüche 1 bis 5, bei dem der Handgriff (105) ein fixiertes Teil (145a), das am Körper (103) montiert ist, und ein bewegbares Griffteil (145b), das von einem Benutzer zu ergreifen ist, enthält, wobei das bewegbare Griffteil an der Seite des fixierten Teils, dem Werkzeugbit gegenüberliegend angeordnet ist, und über das Gelenk (147) drehbar an dem fixierten Teil montiert ist, und das elastische Element zwischen dem fixierten Teil (145a) und dem bewegbaren Griffteil (145b) angeordnet ist. 35

7. Hin- und herbewegbares Kraftwerkzeug nach einem der Ansprüche 1 bis 6, bei dem der Handgriff (105) abnehmbar an den Körper (103) gekoppelt ist und durch einen normalen Handgriff einer Standardspezifikation, der ganzheitlich abnehmbar an den Körper gekoppelt ist, ganzheitlich ersetzt werden kann. 40

8. Hin- und herbewegbares Kraftwerkzeug nach einem der Ansprüche 1 bis 7, bei dem ein dynamischer Vibrationsreduzierer (161) in dem Handgriff (105) angeordnet ist, wobei der dynamische Vibrationsreduzierer eine Vibration reduziert, die von dem Körper (103) an den Handgriff während eines Schneidebetriebs übertragen wird. 45

9. Hin- und herbewegbares Kraftwerkzeug nach Anspruch 8, bei dem von dem elastischen Element (149) und dem dynamischen Vibrationsreduzierer (161) mindestens einer im wesentlichen auf der Hin- und Herbewegungslinie des Werkzeugbits (111) angeordnet ist. 50

## Revendications

1. Outil motorisé à mouvement alternatif, comprenant : un corps (103),  
une mèche d'outil disposée dans la région d'extrémité de pointe du corps,  
un mécanisme d'actionnement (121) disposé à l'intérieur du corps, le mécanisme d'actionnement provoquant un mouvement alternatif linéaire de la mèche d'outil,  
une poignée (105) disposée à l'extrémité arrière du corps, du côté opposé de la mèche d'outil, dans lequel :  
ladite mèche d'outil est une lame de scie (111) montée de manière amovible sur un mandrin (109) à une extrémité d'un coulisseau (107), qui est entraîné dans un mouvement alternatif linéaire le long de sa direction longitudinale par ledit mécanisme d'actionnement (121),  
**caractérisé en ce que**  
ladite poignée (105) est couplée au corps (103) via un pivot (147) disposé sur une partie d'extrémité inférieure de ladite poignée et un élément élastique (149) disposé sur une partie d'extrémité supérieure de ladite poignée en avant du pivot (147) et penché vers le bas en direction du corps (103) de sorte que la poignée et le corps puissent tourner l'un par rapport à l'autre via le pivot (147) dans une direction transversant la direction du mouvement alternatif linéaire de la mèche d'outil, dans lequel :  
la mèche d'outil pivote conjointement avec le corps par rapport à la poignée tenue par un utilisateur de l'outil motorisé, tandis que la lame de

scie (111) effectue un mouvement alternatif linéaire par rapport au corps via le mécanisme d'actionnement et dans lequel l'élément élastique absorbe les vibrations transmises du corps à la poignée par réception élastique de la rotation relative de la poignée et du corps, de sorte que, lorsque la lame de scie effectue un mouvement alternatif linéaire avec l'outil électrique tenu par un utilisateur, la lame de scie pivote verticalement sur le pivot conjointement avec le corps sous l'effet d'une force d'inertie agissant sur le corps de sorte que l'angle d'inclinaison de la lame de scie effectuant un mouvement alternatif soit modifié.

5

2. Outil motorisé à mouvement alternatif selon la revendication 1, dans lequel l'élément élastique (149) est aménagé de sorte que la direction de sollicitation de l'élément élastique soit tangentielle par rapport à la rotation autour du pivot (147).

10

3. Outil motorisé à mouvement alternatif selon la revendication 1 ou 2, dans lequel l'élément élastique (149) est disposé sensiblement sur l'axe du coulisseau (107).

15

4. Outil motorisé à mouvement alternatif selon la revendication 3, dans lequel l'élément élastique est formé par un ressort hélicoïdal de compression (149) logé dans une partie tubulaire (151) formée dans une partie supérieure frontale de la partie de préhension mobile (145) et penchée vers le bas en direction du corps (103), laquelle partie tubulaire est insérée mobile dans un espace (153) formé dans la partie fixe (145a), dans lequel la mobilité de la partie tubulaire à l'intérieur de l'espace est restreinte par des saillies (151a) formées dans la partie tubulaire et s'engageant sur des rainures de guidage (153) formées dans la paroi de l'espace.

20

25

30

35

40

5. Outil motorisé à mouvement alternatif selon l'une quelconque des revendications 1 à 4, dans lequel, lorsque la mèche d'outil effectue un déplacement linéaire dans une direction pour couper une pièce, l'angle d'inclinaison de la mèche d'outil augmente de manière graduelle.

45

6. Outil motorisé à mouvement alternatif selon l'une quelconque des revendications 1 à 5, dans lequel ladite poignée (105) comprend une partie fixe (145a) montée sur ledit corps (103) et une partie de préhension mobile (145b) à saisir par un utilisateur, laquelle partie de préhension mobile est disposée sur le côté de la partie fixe opposé à la mèche d'outil et est montée à rotation sur la partie fixe via ledit pivot (147) et ledit élément élastique est disposé entre la partie fixe (145a) et la partie de préhension mobile (145b).

50

55

7. Outil motorisé à mouvement alternatif selon l'une quelconque des revendications 1 à 6, dans lequel la poignée (105) est couplée de manière amovible au corps (103) et peut être remplacée d'une seule pièce par une poignée normale de spécification standard couplé d'une seule pièce amovible au corps.

8. Outil motorisé à mouvement alternatif selon l'une quelconque des revendications 1 à 7, dans lequel un réducteur de vibrations dynamique (161) est disposé dans la poignée (105), le réducteur de vibrations dynamique réduisant les vibrations transmises du corps (103) à la poignée pendant l'opération de coupe.

9. Outil motorisé à mouvement alternatif selon la revendication 8, dans lequel au moins un élément parmi l'élément élastique (149) et le réducteur de vibrations dynamique (161) est disposé sensiblement sur la ligne du mouvement alternatif de la mèche d'outil (111).

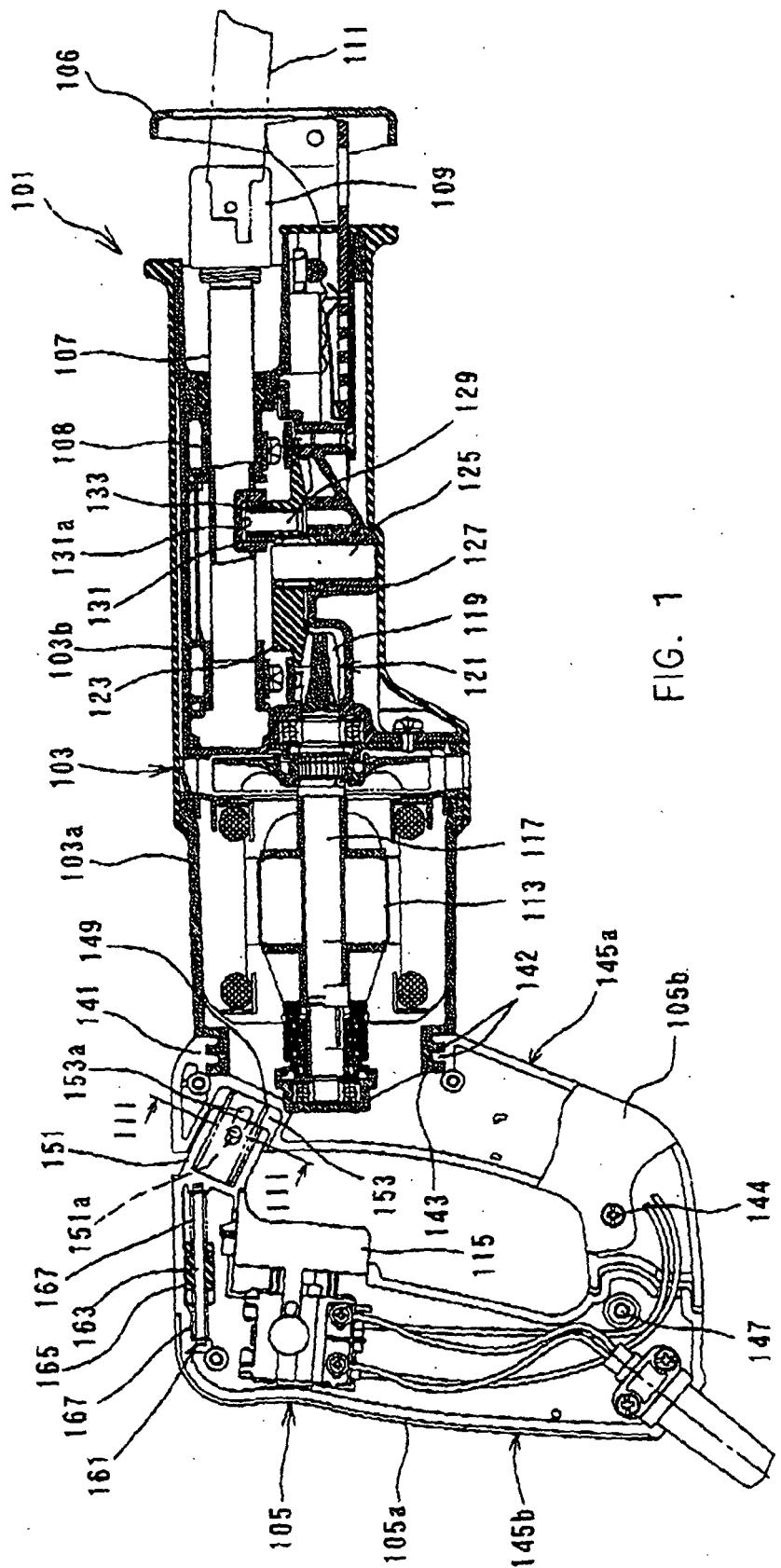


FIG. 1

FIG. 2

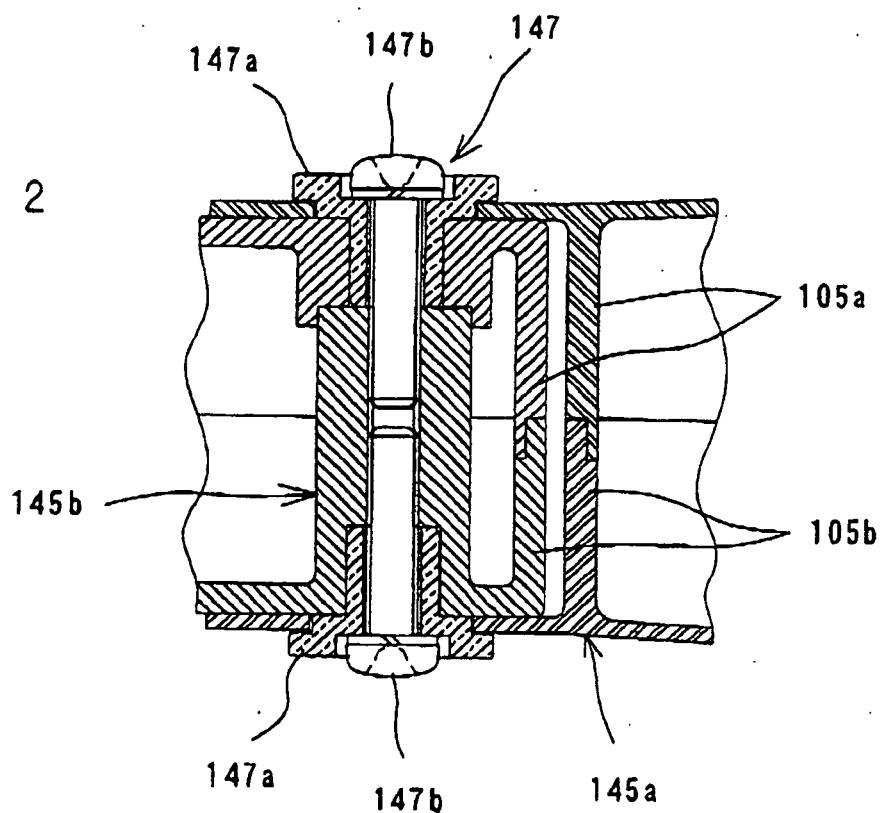
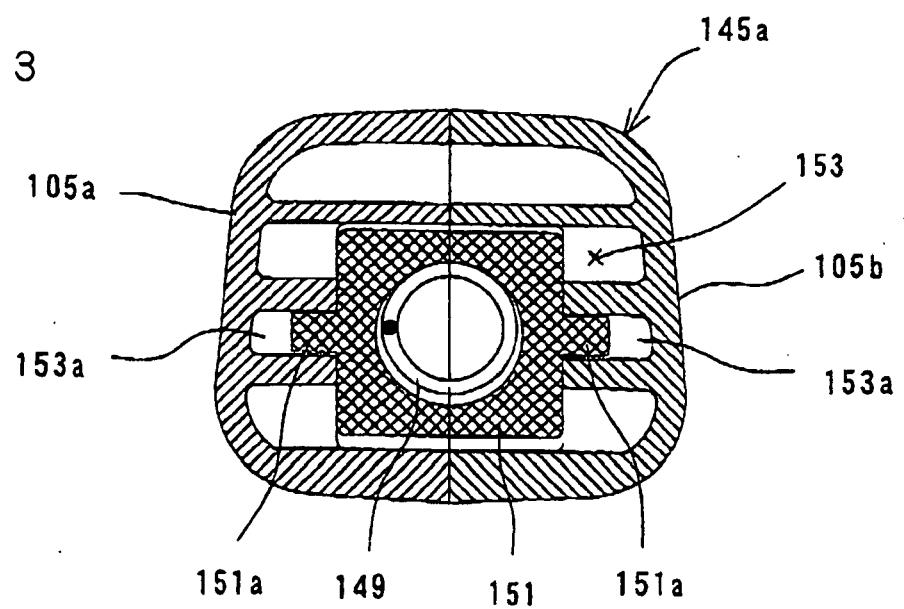


FIG. 3



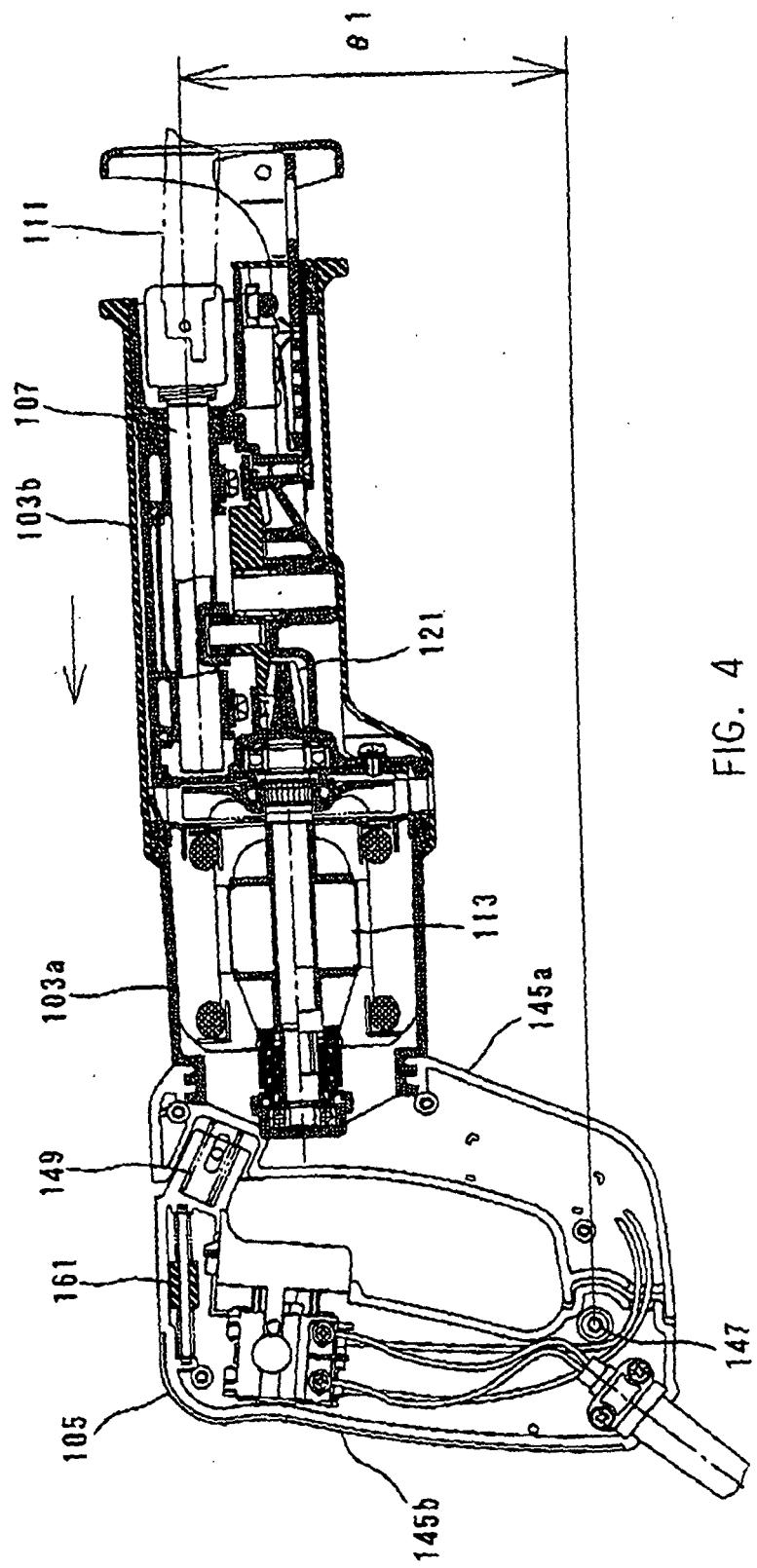


FIG. 4

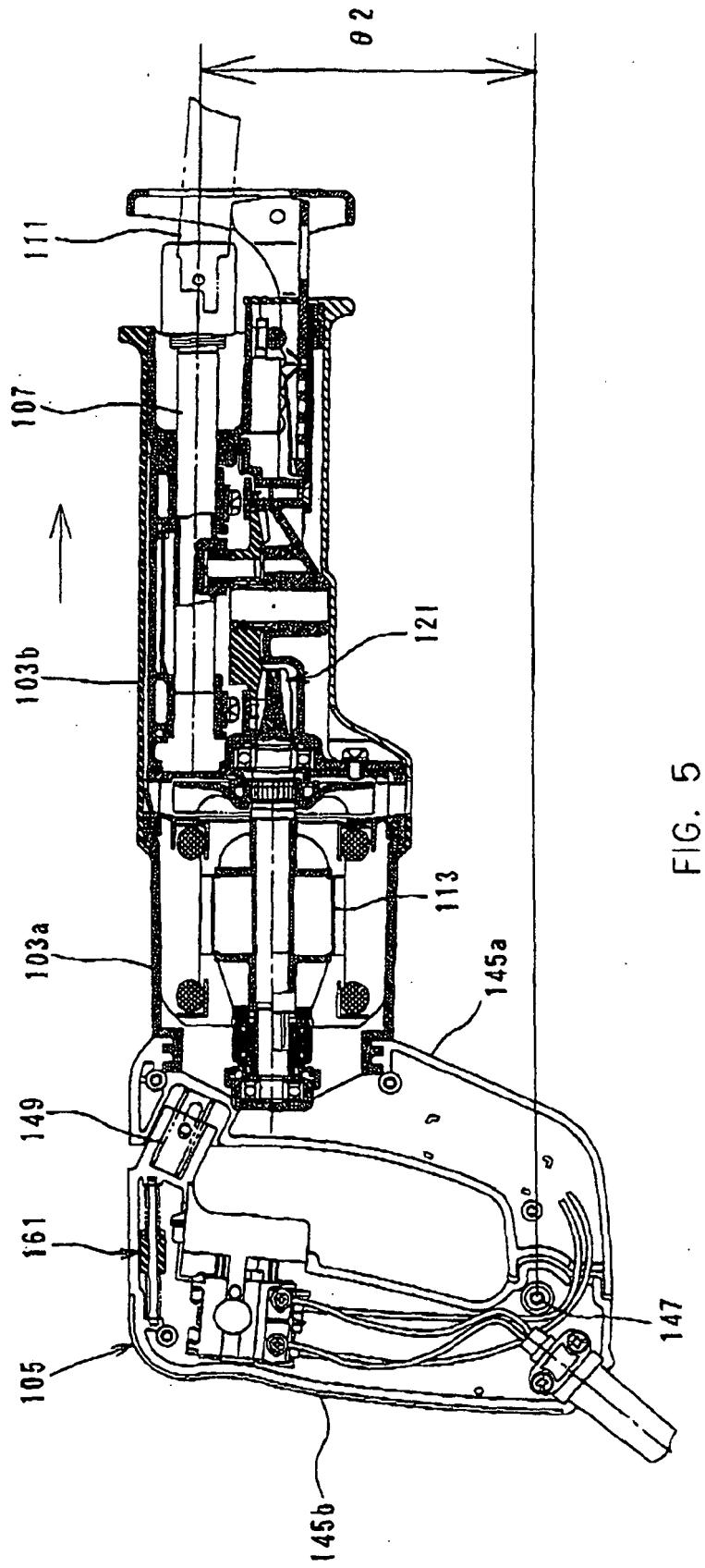


FIG. 5

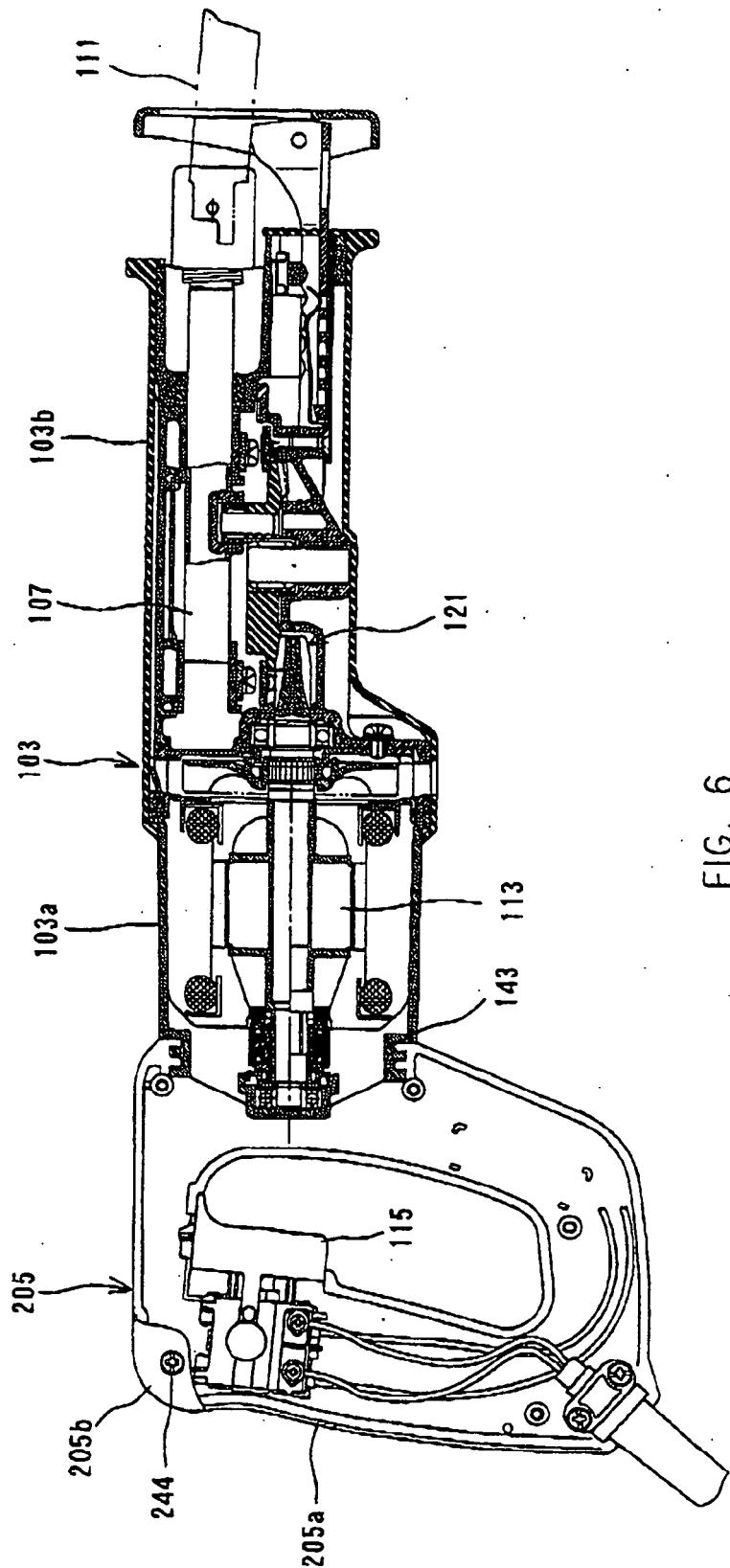


FIG. 6

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- JP 2001009632 A [0002]
- JP 6079701 A [0003]
- EP 0561473 A [0005]
- EP 1510298 A1 [0006]
- GB 714300 A [0007]
- DE 19503526 A [0008]