

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
27 November 2008 (27.11.2008)

PCT

(10) International Publication Number
WO 2008/142971 A1

(51) International Patent Classification:
B25B 21/02 (2006.01)

(21) International Application Number:
PCT/JP2008/058293

(22) International Filing Date: 23 April 2008 (23.04.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2007-127101 11 May 2007 (11.05.2007) JP

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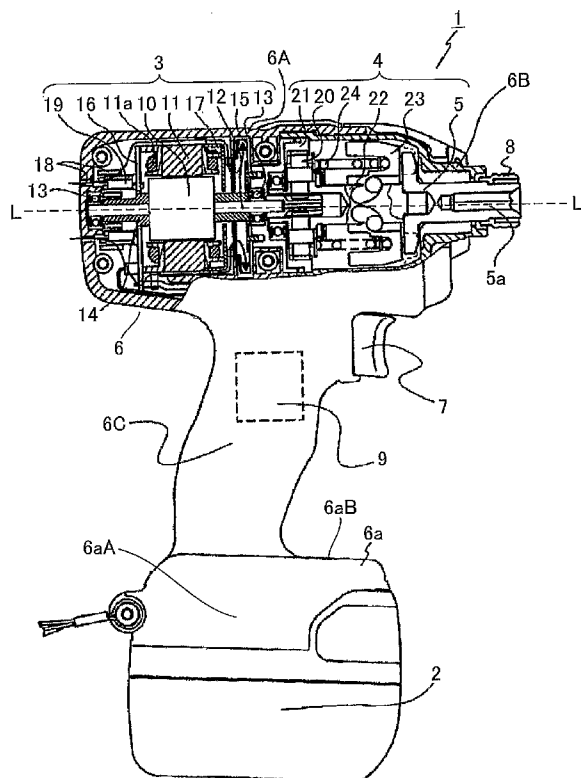
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL,

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(54) Title: ELECTRIC TOOL COMPRISING A STRIKING FORCE CHANGING UNIT AND A STRIKING FORCE DISPLAY UNIT

FIG.1



(57) Abstract: An electric tool (1) has a housing (6), a motor (3), a rotary striking unit (4), a striking-force changing unit (25), and a striking-force display unit (27). The housing includes a first face and a second face. The motor (3) is provided in the housing to generate a torque. The rotary striking unit (4) is configured to convert the torque of the motor (3) to a rotary striking force having a strength and transmit the rotary striking force to a distal-end tool. The striking-force changing unit (25) changes the strength of the rotary striking force. The striking-force display unit (27) displays the rotary striking force. The striking-force changing unit (25) is provided on the first face. The striking-force display unit (27) is provided on the second face. Accordingly, the striking-force display unit (27) is not hidden by a user's hand and/or finger manipulating the striking-force changing unit (25).



PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA,
ZM, ZW.

European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
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NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG,
CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

Published:

— *with international search report*

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DESCRIPTION

ELECTRIC TOOL COMPRISING A STRIKING FORCE CHANGING UNIT AND A STRIKING FORCE
DISPLAY UNIT

Technical Field

5 The present invention relates to an electric tool such
as an impact driver.

Background Art

10 Impact drivers having a rotary striking mechanism are
well-known. The impact driver has a motor, a decelerating
mechanism, and a battery-pack holder in addition to the
rotary striking mechanism. The motor is used as a drive
source. The decelerating mechanism is designed to
15 decelerate the rotation of the motor shaft. The rotary
striking mechanism converts a torque of the motor to a
rotary striking force, which is transmitted to a distal-end
tool. The battery-pack holder includes a battery to feed
electric power to the motor.

20 Some impact drivers can change a striking force
(rotational speed of the motor shaft) in accordance with a
screw size, the material and desired finish of the workpiece
to which the impact driver fastens a screw, in order to
prevent cutting the head of the screw or excessively
fastening the screw to the workpiece. To change the
striking force to a desired strength, a user operates a
25 striking-force changing switch provided on the impact driver,
thereby changing the strength of force. The desired
strength is displayed as a digital value on a striking-force
display unit provided on the impact driver. This structure
enables the user to set the striking force to the desired
30 strength by operating the striking-force changing switch and
to confirm that the predetermined strength has been set at
the striking force, while looking at the screen of the

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display unit.

Japanese Patent Application Publication No. 2005-144564 discloses an electric tool that has a striking-force changing switch and a display unit therefor, both of which are arranged very closely to each other. The display unit is generally hidden when the user operates the striking-force changing switch. Accordingly, it is difficult for the user to reliably confirm the actual striking-force strength.

Disclosure of Invention

An object of the present invention is to provide an electric tool having a striking-force display unit and a striking-force changing unit in which a user can easily and reliably manipulate the striking-force changing unit, while monitoring the strength of a striking force which is displayed on the striking-force display unit.

The present invention provides an electric tool having: a housing, a motor, a rotary striking unit, a striking-force changing unit, and a striking-force display unit. The housing includes a first face and a second face. The motor is provided in the housing to generate a torque. The rotary striking unit is configured to convert the torque of the motor to a rotary striking force having a strength and transmit the rotary striking force to a distal-end tool. The striking-force changing unit changes the strength of the rotary striking force. The striking-force display unit displays the rotary striking force. The striking-force changing unit is provided on the first face. The striking-force display unit is provided on the second face.

According to the above structure, the striking-force display unit is not hidden by a user's finger and/or hand manipulating the striking-force changing unit. The user can easily and reliably look at the display unit without

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changing the manner to grip the housing, while fastening a screw. The user can use the impact driver efficiently, while manipulating the striking-force changing unit to change the striking force to a desired strength, if
5 necessary.

Preferably, the housing has a periphery. And the striking-force changing unit is provided on the periphery of the housing. The user can operate the striking-force changing unit to change the striking force, looking at the striking-force strength displayed on the striking-force
10 display unit, while the user is operating the electric tool.

Preferably, the housing has a trunk portion having a longitudinal axis, a handle portion, and a battery-pack holder portion. The trunk portion accommodates the motor and the rotary striking unit. The handle portion has a first end and a second end. The first end is connected to the trunk portion. The handle portion extends in a direction substantially perpendicular to the longitudinal axis. The battery-pack holder has an upper face and a
15 periphery. The upper face is detachably mounted to a second end of the handle portion. The striking-force changing unit is provided on the periphery of the battery-pack holder.

The user can manipulate the striking-force changing unit reliably and quickly with one hand, while gripping the handle unit with the other hand and monitoring the striking-force strength displayed on the striking-force display unit.
25

Preferably, the striking-force display unit is provided on the upper face of the battery-pack holder. The striking-force display unit is not hidden with the user's finger and/or hand, while the user is manipulating the striking-force changing unit. Thus, the user can reliably and directly look at the striking-force strength displayed
30

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on the striking-force display unit.

Brief Description Of The Drawings

FIG. 1 is a partially sectional right-side view of an impact driver according to the present invention;

5 FIG. 2 is a partially sectional left-side view of the impact driver;

FIG. 3 is a sectional view taken along the line A-A shown in FIG. 2; and

10 FIG. 4 is a partially sectional side view of the lower part of the impact driver.

Brief Explanation of Reference Numerals

1 impact driver
3 motor
4 rotary striking mechanism
15 5 anvil
6A motor housing
6B drive-force transmitting housing
6C handle housing
6a battery-pack holder
20 6aA lateral face
6aB upper face
25 striking-force changing switch
27 striking-force display panel

Best Mode for Carrying Out the Invention

25 An embodiment of the present invention will be described with reference to the accompanying drawings.

Referring to FIG. 1, an impact driver 1 has a battery pack 2, a motor 3, a rotary striking mechanism 4, and an anvil 5. The battery pack 2 is a power source. The motor 3
30 is a drive source to drive the rotary striking mechanism 4 to strike the anvil 5. Thus, the impact driver 1 transmits a striking torque to a driver bit (not shown) as a distal-

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end tool intermittently to perform screw-fastening.

The motor 3 is provided in a motor housing 6A made from synthetic resin. The motor housing 6A communicates with a drive-force transmitting housing 6B to form a trunk portion having a longitudinal axis L-L. The drive-force transmitting housing 6B accommodates the rotary striking mechanism 4. A handle housing 6C has one end fixed to the motor housing 6A and the drive-force transmitting housing 6B. The handle housing 6C extends substantially perpendicularly to the longitudinal axis L-L of the trunk portion 6. A trigger switch 7 to turn on and off the motor 3 is provided in the upper part of the handle housing 6C. Note that the motor housing 6A, the drive-force transmitting housing 6B, and the handle housing 6C constitute a housing unit that is shaped like a letter "T" as viewed from either side.

The anvil 5 has one end protruding from the distal end of the drive-force transmitting housing 6B (i.e., the right end as seen in FIG. 1). The anvil 5 has an anvil-corner hole 5a at one corner. The driver bit (not shown) is inserted and fixed to the anvil-corner hole 5a by a fastening member 8. A bolt-fastening bit as another distal-end tool may be fitted in the anvil-corner hole 5a instead of the driver bit.

The battery pack 2 is removably attached to a battery-pack holder 6a which is attached to the lower part, i.e., the other end of the handle housing 6C. The battery pack 2 contains a battery-pack unit composed of a lithium-ion secondary battery or a nickel-cadmium secondary battery.

The motor 3 is a brushless DC motor. The motor 3 includes a rotor 10 and a stator 11 surrounding the rotor 10. Bearings 13 support both ends of the shaft 12 of the rotor 10, allowing the shaft 12 to rotate. A sleeve 14 and a

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cooling fan 15 are mounted to the shaft 12. An inverter circuit 16 and a cover 17 are coupled to the stator 11. The cover 17 seals the rotor 10.

5 A motor-drive circuit device 9 and the inverter circuit 16 are used to drive the motor 3. The inverter circuit 16 has a well-known type of bridge circuit which supplies a current to the stator coil 11a that is wound around the stator 11. The motor-drive circuit device 9 includes a CPU for controlling the inverter circuit 16. The
10 inverter circuit 16 need to supply a large amount of drive current to the stator coil 11a and is required to have an output transistor such as an insulated-gate bipolar transistor (IGBT).

The battery pack 2 is electrically connected to the
15 motor-drive circuit device 9 via the trigger switch 7. The output transistor has inevitably a large power loss and generates heat. In the present embodiment, a heat-radiating plate is arranged near exhaust ports 18 made in the motor housing 6A to radiate the heat from the output transistor.
20 The motor-drive circuit device 9 is electrically connected to the stator coil 11a of the motor 3 to drive the rotor 10 of the motor 3. The stator coil 11a is, for example, a star-connected three-phase coil.

The rotary striking mechanism 4 converts the torque of
25 the motor 3 to a rotary striking force and transmits the rotary striking force to the anvil 5. The rotary striking mechanism 4 includes a reduction mechanism, an impact mechanism, and the anvil 5. The reduction mechanism is composed of a planetary gear 20 and a ring gear 21. The
30 impact mechanism is composed of a rotatable spindle 22 and a hammer 23. The hammer 23 can apply a rotary striking force to the anvil 5. The spindle 22 supports the hammer 23,

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allowing the hammer 23 to swing back and forth around the spindle 22. A spring 24 applies a striking force to the hammer 23.

How the impact driver 1 operates to fasten a screw to a workpiece will be explained as follows. When the user pulls the trigger switch 7, while gripping the handle housing 6C, the trigger switch 7 is turned on. Then, the impact driver 1 starts operating.

At this time, the battery pack 2 supplies a current flow to the motor 3 so that the motor 3 starts rotating. The reduction mechanism reduces the rotation speed of the shaft 12 of the motor 3. The torque of the motor 3 is transmitted to the spindle 22. If the force exerted on the anvil 5 (more precisely, driver bit) exceeds a predetermined strength while the screw is being fastening to the workpiece, the hammer 23 converts the torque of the motor 3 to a striking force by virtue of the spring 24. Thus, the hammer 23 applies a rotary striking force to the drive bit secured to the anvil 5, thereby fastening the screw to the workpiece.

In order to prevent cutting the head of the screw or excessively fastening the screw to the workpiece, the impact driver 1 is configured to change the striking force (actually, the rotation speed of the motor 3) in accordance with the screw size, the material and desired finish of the workpiece. Therefore, the impact driver 1 has a striking force changing switch 25 to change the striking force strength. The striking force changing switch 25 is secured to a circuit board 31 in the battery-pack holder 6a and exposed on the lateral side of the battery-pack holder 6a. The circuit board 31 is electrically connected to the motor-drive circuit device 9. The user can select the strength of the striking force generated by the impact driver 1 through

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the striking force changing switch 25. As shown in FIGS. 3 and 4, the striking force changing switch 25 is provided on a lateral face or a periphery 6aA of the battery-pack holder 6a.

5 In the present embodiment, the striking force strength can be changed in ten levels "0" to "9", i.e., from the minimum to the maximum in this order. The impact driver 1 has a striking-force display panel 27 for digitally displaying the strength of the striking force selected by
10 operating the striking-force changing switch 25. The striking-force display panel 27 is provided on a flat upper face 6aB of the battery-pack holder 6a, in particular, on a panel sheet 26 attached to the upper face 6aB. The striking-force display panel 27 is electrically connected to
15 the circuit board 31.

As shown in FIG. 3, the battery-pack holder 6a further has a light switch 28 for turning on and off a light, a battery-capacity display panel 30 for displaying the remaining amount of the battery, and a battery-capacity
20 display switch 29 for turning on and off the battery-capacity display panel 30, which are arranged in series on the panel sheet 26 on the upper face 6aB of the battery-pack holder 6a. The light switch 28, the battery-capacity display switch 29, and the battery-capacity display panel 30
25 are also electrically connected and fixed to the circuit board 31 and exposed on the upper face 6aB of the battery-pack holder 6a, which is different face from the lateral face 6aA.

As described above, the striking-force changing switch
30 25 and the striking-force display panel 27 are provided on different faces of the battery-pack holder 6a. More precisely, the striking-force changing switch 25 is provided

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on the lateral face 6aA of the battery-pack holder 6a, whereas the striking-force display panel 27 is provided on the upper face 6aB of the battery-pack holder 6a. In other words, the striking-force changing switch 25 and the striking-force display panel 27 are not provided on the same face of the battery-pack holder 6a.

According to the above structure, when the user operates the striking-force changing switch 25, while fastening a screw to the workpiece, either of the striking-force display panel 27 and the battery-capacity display panel 30 is not hidden by the user's finger or hand. The user can always easily and reliably look at the striking-force display panel 27 without changing the manner to grip the handle housing 6C. Thus, the user can look at the striking-force display panel 27, while manipulating the striking-force changing switch 25 to change the striking force to a desired level, if necessary.

Both of the striking-force changing switch 25 and the battery-capacity display switch 29 may be arranged on the lateral face of the battery-pack holder 6a. In this case, either the striking-force display panel 27 or the battery-capacity display panel 30 is not hidden by the user's finger or hand. This structure helps the user to use the impact driver 1 more efficiently.

In the present embodiment, the striking-force changing switch 25 is arranged on the lateral face of the battery-pack holder 6a. This structure enables the user to manipulate the striking-force changing switch 25 efficiently and quickly with one hand, while looking at the striking-force strength displayed on the striking-force display panel 27 and simultaneously maintaining gripping the handle housing 6C with the other hand. Moreover, since the

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striking-force display panel 27 is arranged on the upper face of the battery-pack holder 6a, the striking-force display panel 27 is not hidden with the user's finger or hand, while the user is manipulating the striking-force changing switch 25. Thus, the operator can reliably confirm the striking-force strength displayed on the striking-force display panel 27.

In another embodiment, if the striking-force changing switch 25 is arranged on the different face of the battery-pack holder 6a from the face on which the striking-force display panel 27 is arranged, the light switch 28, the battery-capacity display switch 29, the striking-force display panel 27, and the battery-capacity display panel 30 can be arranged at any faces of the battery-pack holder 6a.

In the above embodiment, the striking force can be changed in ten levels. However, the number of striking-force levels is not limited to ten.

It is understood that the foregoing description and accompanying drawings set forth the embodiments of the invention at the present time. Various modifications, additions and alternative designs will, of course, become apparent to those skilled in the art in light of the foregoing teachings without departing from the spirit and scope of the disclosed invention. Thus, it should be appreciated that the invention is not limited to the disclosed embodiments but may be practiced within the full scope of the appended claims.

Industrial Applicability

The present invention is applicable to any electric tool for generating a rotary striking force for a specific, such as a hammer drill, as well as an impact driver.

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CLAIMS

1. An electric tool (1) comprising:

5 a housing (6) including a first face and a second face;

a motor (3) provided in the housing to generate a torque;

10 a rotary striking unit (4) configured to convert the torque of the motor to a rotary striking force having a strength and transmit the rotary striking force to a distal-end tool;

a striking-force changing unit (25) that changes the strength of the rotary striking force; and

15 a striking-force display unit (27) that displays the rotary striking force, wherein

the striking-force changing unit is provided on the first face, and the striking-force display unit is provided on the second face.

20 2. The electric tool according to claim 1, wherein the housing has a periphery, and the striking-force changing unit is provided on the periphery.

25 3. The electric tool as claimed in claim 2, wherein the housing has a trunk portion (6A, 6B) having a longitudinal axis, a handle portion (6C), and a battery-pack holder portion (6a),

the trunk portion accommodating the motor and the rotary striking unit,

30 the handle portion having a first end and a second end, the first end being connected to the trunk portion, the handle portion extending in a direction substantially perpendicular to the longitudinal axis, and

the battery-pack holder having an upper face and a

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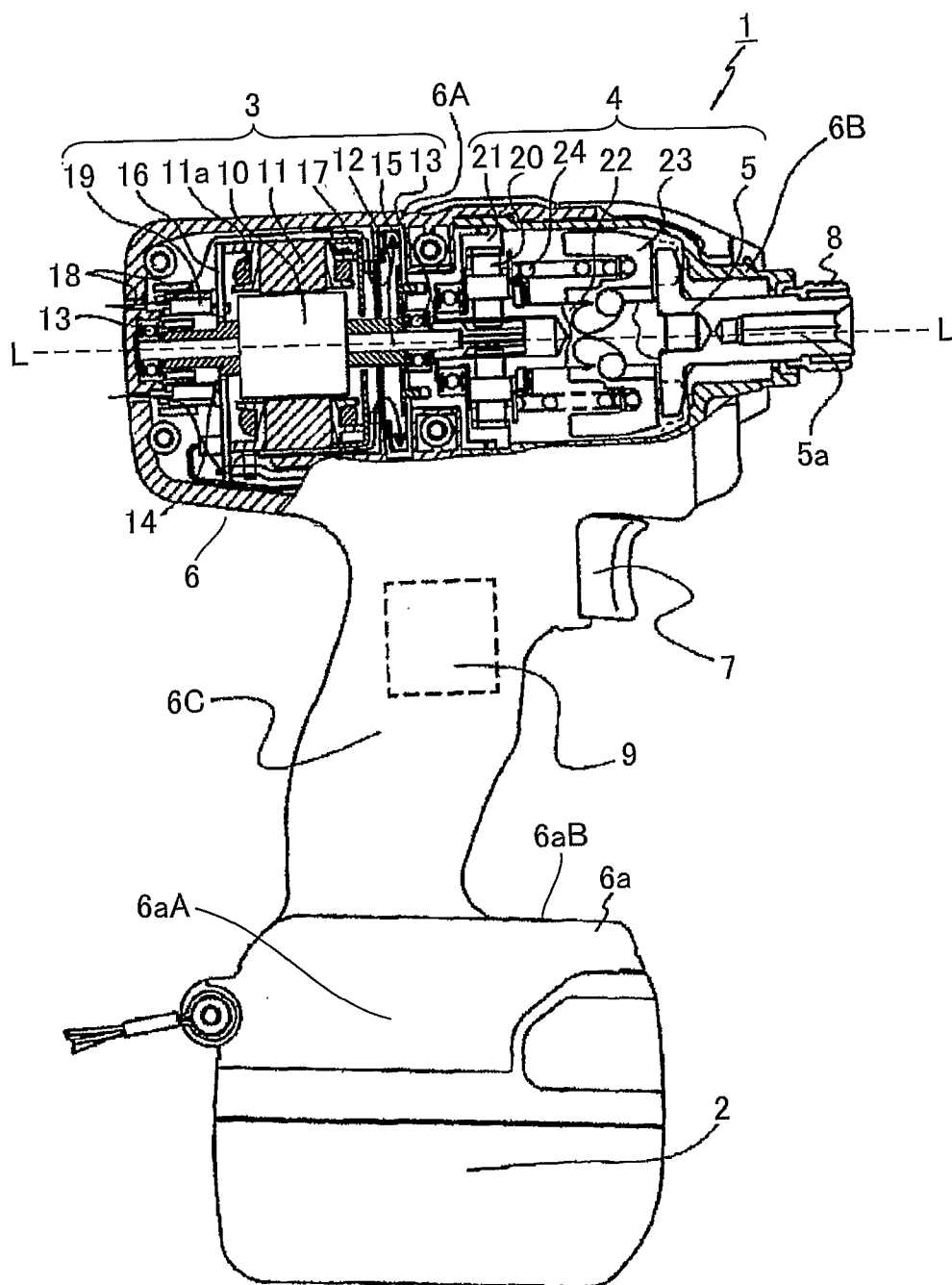
periphery, the upper face being detachably mounted to a second end of the handle portion, wherein

the striking-force changing unit is provided on the periphery of the battery-pack holder.

- 5 4. The electric tool as claimed in claim 3, wherein the striking-force display unit is provided on the upper face of the battery-pack holder.

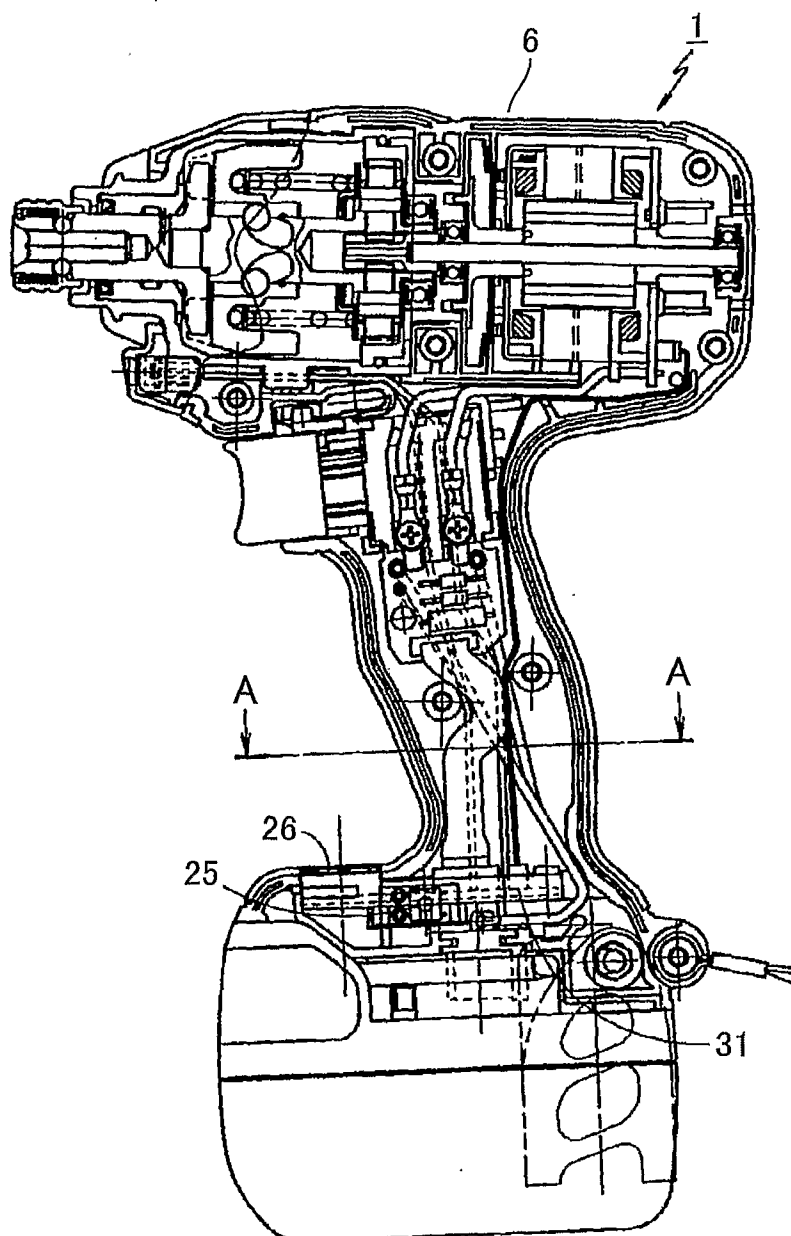
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FIG. 1



2/3

FIG.2



3/3

FIG.3

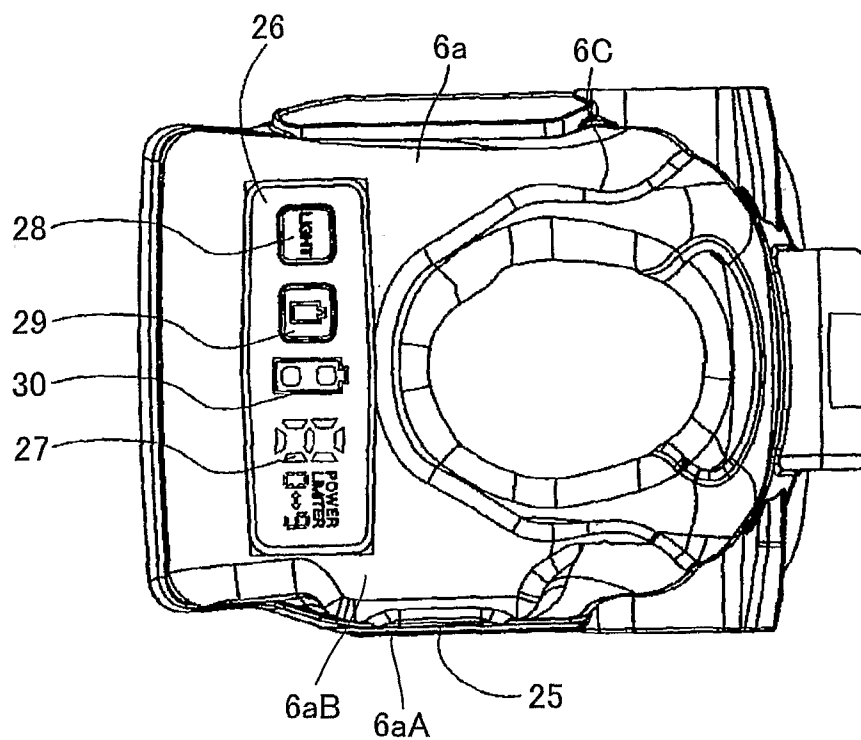
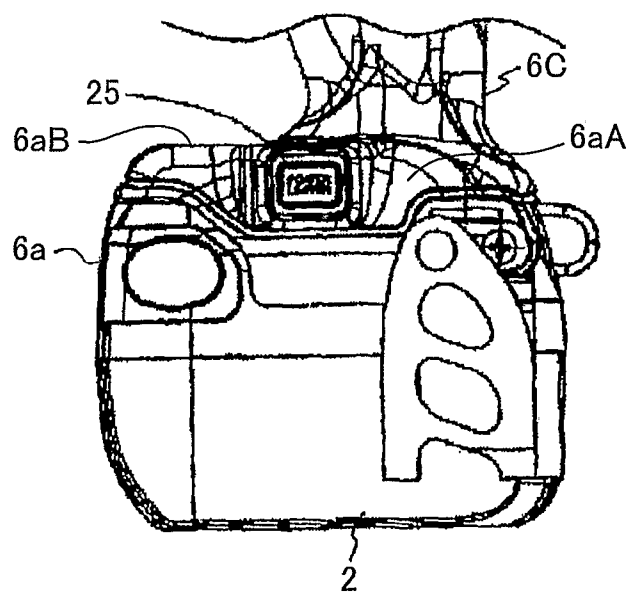


FIG.4



INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2008/058293

A. CLASSIFICATION OF SUBJECT MATTER
INV. B25B21/02

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 B25F

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ 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

31 July 2008

Date of mailing of the international search report

04/09/2008

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2008/058293

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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