

ELECTRIC HAND TOOL

This invention relates to electric hand tools adapted in use to drive rotatably a bit for fastening, drilling and like operations by an electric motor incorporated therein.

5 Electric hand tools of this type, as disclosed in US patent Nos. 2,789,597 and 3,687,179, comprise a single housing in which an electric motor rotatably drives a suitable bit locked in the chuck. These tools are utilized by grasping the housing to perform an
10 intended driving operation. However, these tools with a single housing of a relatively bulky mass to be grasped by the hand of an operator may sometimes be inconvenient to use because the housing itself constitutes a hindrance when the driving operation
15 needs to be performed in a limited space and the housing requires a relatively large storage space.

In GB patent No. 1,484,694 is disclosed an electric hand tool in which the housing is in two separable parts, but, in use, the two parts are locked
20 together to form a single housing.

The above disadvantages of the prior electric hand tools are obviated by the present invention which

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provides a novel and improved construction of an electric hand tool, allowing an operator to handle the tool in two different operating positions depending upon the operation spot. An electric tool in accordance with the present invention, comprises an elongate housing having a first longitudinal axis, an electric motor mounted in the housing and connected to drive a chuck for holding the bit, the chuck projecting from the forward end of the housing, and an elongate grip having a second longitudinal axis, the grip accommodating an electric battery which is electrically connected to the motor, the housing and grip each being constructed as a pair of two halves in the direction of the respective longitudinal axis, and the halves of the housing having inwardly projecting hollow hubs to receive an inwardly projecting post on one of the halves of the grip to form a pivotal connecting means between the forward end of the grip and the rearward end of the housing to permit swinging movement of the grip between a straight position where the second longitudinal axis is in line with the first longitudinal axis and an angled position where the two longitudinal axes are inclined and cross each other.

This enables the tool to be manipulated by the hand in the form of the straight construction or the

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angled construction in order to be brought into the proper and easy handling position for use at different operation spots and against workpieces. Also, the tool can be arranged or packed within a relatively small
5 space as in a toolbox and the like by selecting between the straight and angled positions depending upon the dimensional requirements of the storage space.

With the motor mounted in the housing and the electric battery in the grip, it is easy to properly
10 balance the tool for one-hand operation.

Preferably, the connecting means has a pivot axis which is perpendicular to the first and second longitudinal axes, and the tool including a retractable cover which telescopes to close a gap opened at the
15 portion adjacent to the pivot axis and formed between the rearward end of the housing and the forward end of the grip, when the grip is in the straight position. This feature may be used to prevent the finger of the operator from being inadvertently nipped in the gap and
20 provides a smooth fit between the tool and the hand grasping it. Besides the above, the retractable cover may have means for retaining the grip in both straight and angled positions to prevent its shaky movement unless a force is applied to shift the position of the
25 grip.

There follows a description by way of example of a specific embodiment of the present invention, reference being made to the accompanying drawings in which:

5 Fig. 1 is a perspective view showing a hand-held electric tool with the grip arranged in the angled position in accordance with the present invention;

Fig. 2 is a perspective view showing the tool with the grip extended in the straight position;

10 Fig. 3 is a side view showing a partial cross section of the electric tool;

Fig. 4 is an exploded perspective view showing the parts interconnecting the housing and the grip of the tool;

Fig. 5 is a transverse sectional view taken along a line substantially corresponding to the line X-X in Fig. 3;

Figs. 6(a) and 6(b) are enlarged longitudinal sectional views showing the portion interconnecting the housing and the grip respectively in its straight position and angled position;

Fig. 7 is a fragmentary enlarged longitudinal section showing the interior construction of the speed reduction means employed in the electric tool in which the torque limiting clutch is engaged;

Fig. 8 is an exploded perspective view showing the parts constructing the above speed reduction means;

Fig. 9 is a perspective view of the internal gear composing the above speed reduction means;

Fig. 10(a) is an exploded fragmentary perspective view showing a part of the retainer ring composing the speed reduction means and the ball to be retained thereby;

Fig. 10(b) is a fragmentary sectional view of the above retainer ring and the ball seated therein;

Fig. 11 is a fragmentary perspective view showing parts of the speed reduction means half assembled with the retainer ring kept in position by the sleeve; and

Fig. 12 is a fragmentary enlarged longitudinal section showing the interior construction of the speed reduction means in which the torque limiting clutch is disengaged.

Referring now to the drawings and particularly to Figs. 1 to 3, there is shown a hand-held electric screwdriver as a preferred embodiment of the present invention including an elongated cylindrical housing 1 having a first longitudinal axis and an elongated cylindrical grip 2 having a second longitudinal axis and pivotally connected at its forward end to the backward end of the housing 1.

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Within the housing 1 are mounted an electric motor 5 and speed reduction means the details of which will be hereinafter explained. A chuck 4 for holding a screwdriver bit (not shown) projects coaxially from the forward end of the housing 1 and is operatively connected to the motor 5 so as to be rotatably driven thereby. The housing 1 also carries an electric slide switch 6 for electrically connecting the motor 5 to an electric battery 7 disposed within the grip 2 and disconnecting it therefrom. The battery 7 consists of a series of rechargeable battery cells and is supplied with electricity when required through a pair of terminals 8 provided at the rear of the grip 2 which are adapted to be detachably connected to a battery charger (not shown). Both housing 1 and grip 2 are made of synthetic resin and have approximately equal diameter and length. As is shown in Fig. 4, the housing 1 is constructed by a pair of the two halves 1a, each of which has one part of a pair of cooperating projections 10 at its backward end, such projections being held together to form a pivot tang 11. The grip 2 is also constructed by a pair of halves 2a each having at its forward upper side a yoke 20 projecting longitudinally to leave the forward lower side thereof a recessed portion 21. Formed integrally with one of the yokes 20 is a hollow post 22 projecting inwardly thereof and in a direction perpendicular to said second longitudinal axis. Each projection 10 forming the pivot tang 11 has an inwardly projecting hub 12 with a bore 13 extending therethrough. These hubs 12 are combined when two halves 1a are held together to form a pivot bearing through which said hollow post 22 extends to pivotally connect grip 2 to housing 1, and grip 2 is permitted to pivot in a plane including said first and second longitudinal axes about the hollow post 22 which defines a pivot axis. A screw 23 engages threadedly into the hollow

post 22 to unite the two halves 2a into the grip 2 while retaining the hollow post 22 in the rotatable engagement within said pivot bearing as well as overlapping the pivot tang 11 with the yokes 20. At the upper and lower forward ends of the grip 2 are formed respectively first and second stops 24 and 25 which are circumferentially spaced apart along a circle having the coincident center with the hollow post 22 so that the grip 2 can be rotated relative to the housing 1 in one direction until the first stop 24 abuts against a first seat 14 on the upper backward end of the housing 1 to assume a straight position where said first and second longitudinal axes are in line with each other and that the grip 2 can be rotated in the opposite direction until the second stop 25 abuts against the second seat 15 on the lower backward end of the housing 1 to assume an angled position where said first and second longitudinal axes cross one another at approximately right angles. Thus, the grip 2 is limited to swing about the pivot axis relative to the housing 1 between such straight and angled positions.

Disposed between the lower backward end of the housing 1 and the lower forward end of the grip 2 is a retractable cover 3 which telescopes internally of the grip 2, that is, the cover 3 is to be disposed on the side which will constitute an inner corner formed by the housing 1 and the grip 2 when in said angled position. The retractable cover 3 has at its forward end a pair of outwardly projecting pins 30 which are slidably and pivotally received within the corresponding grooves 18 respectively formed on the interior of the halves 1a and elongated along an oblique axis inclined at approximately 45 deg to said first longitudinal axis. The rear portion of the retractable cover 3 is slidably received within a longitudinally and circumferentially elongated channel 26 provided within the

lower forward portion of the grip 2 with its opening exposed at said recessed portion 21. Accordingly, as shown in Fig. 6(a), the cover 3 will extend from the channel 26 to close a gap between the lower portions of the housing 1 and the grip 2 when the tool extended in said straight position, such gap being largely defined by said recessed portion formed at the lower forward end of the grip 2. As the grip 2 is moved from the straight position to the angled position, the cover 3 will gradually retract into the channel 26 and be received within the grip 2 when the grip 2 is in the angled position, as shown in Fig. 6(b). In the straight position as shown in Fig. 6(a), the laterally opposed edges of the cover 3 abut intermediate its longitudinal ends against a rib 16 projecting radially from said respective hubs 12 so as to prevent the accidental inward movement of the cover 3 due to the external force which may be applied thereto by the finger of an operator grasping the tool. Also, in this position, the lower extremity of the forward end of the grip 2 snaps into the cut 32 formed at the outer rear end of the cover 3 to retain the cover 3 in position, which in turn prevents inadvertent swinging or rotating movement from the angled position of the grip 2 relative to the housing 1. The cover 3 is further provided with a hook 34 projecting upwardly from the rear end thereof which snappedly engages with a node 28 projecting inwardly of the rear portion of the channel 26 when the grip 2 is in the angled position, as seen in Fig. 6(b), such that the cover 3 locks the grip 2 to likewise prevent inadvertent and unnecessary swinging movement thereof from this position. As is apparent from the above arrangement of the retractable cover 3, the cover 3 acts not only to prevent the finger of the operator from accidentally being nipped in when the tool is in the straight position but also to restrict inadvertent movement

of the grip 2 to retain it both in the straight and the angled positions.

Referring now to Fig. 7 through Fig. 12, there is shown the detailed structure of said speed reduction means which, composed of a double planetary gear train and a torque limiting clutch for protecting the motor 5 against overload, provides a driving connection between the motor 5 and the drive spindle 9 carrying the chuck 4. The double planetary gear train includes a first sun gear 41 fixed on the output shaft 40 of the motor 5, a coaxial internal gear 42 which is axially slidable, a set of circumferentially spaced first planet gears 43 supported on a first planet carrier 44, a second sun gear 45 formed centrally of and integrally with the first planet carrier 44, a set of circumferentially spaced second planet gears 46 intermeshing with the gears 45 and said internal gear 42 and supported on a second planet carrier 47 from the center of which projects forward said drive spindle 9 which is rotatably journaled in the bearing received in a concentric hub 48 projecting forwardly from the gear casing 49 fixedly and coaxially mounted within the housing 1 forwardly of the motor 5. Disposed on the hub 48 is an intermediate ring 50 which is axially slidable and rotatively fixed with respect to the gear casing 49 and which threadedly engages with a torque adjusting ring 51 rotatably attached to the front end of the housing 1. Between the intermediate ring 50 and said internal gear 42 are disposed a set of circumferentially spaced apart pins 52 which extend through the front face of the gear casing 49 with their respective front ends abutting against the rear end of the intermediate ring 50 and their respective rear ends ~~abutting through a washer 53 against the front end of the~~ internal gear 42 so as to convert the rotational movement of the torque adjusting ring 51 into the longitudinal or

axial movement of the internal gear 42. As shown in Figs. 8 and 9, said internal gear 42 has on its rear end a plurality of axially projecting teeth 54 which are angularly spaced about the axis of the internal gear 42.

5 The internal gear 42 with these teeth 54 is connected by means of a series of circumferentially spaced balls 55 to a clutch plate 57 which is rotatably and slidably mounted on a boss 61 coaxially projecting from a base 60 secured to the front end of the motor 5. The balls 55 are seated

10 respectively in the circumferentially spaced sockets 63 formed in a retainer ring 56 located between the internal gear 42 and the clutch plate 57, such balls 55 cooperating with said teeth 54 on the internal gear 42 to provide the torque-limiting clutch. The clutch plate 57 is biased

15 against the internal gear 42 by means of compression springs 59 which are seated at their respective rear ends in the holes 62 formed in the base 60 and engage at their respective front ends with a washer ring 58 which is rotatively fixed and slidably mounted on the boss 61 so as

20 to be arranged in frictional engagement with the clutch plate 57. The compression force exerted by the springs 59 tends to keep the balls 55 in engagement with the teeth 54 so as to arrest or lock the internal gear 42 in non-rotatory position wherein the output shaft 40 of the

25 motor 5 drives the first and second planet gears 43 and 46 to revolve along the stationary internal gear 42 in order to rotate the drive spindle 9 about its axis, whereby the drive torque of the output shaft 40 is transmitted to the drive spindle 9 via the double planetary gear train. When

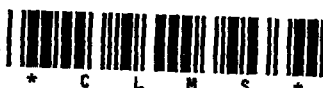
30 the torque load on the internal gear 42, during the driving operation of the tool such as for tightening the screw, reaches a predetermined magnitude which is determined by the load on the springs 59, the teeth 54 of the internal gear 42 thrusts the balls 55 rearward, as shown in Fig. 12,

and at the same time roll over the balls 55 so that the internal gear 42 starts rotating about its axis in the opposite direction to the rotating direction of the drive spindle 9, breaking the drive connection between the drive
5 spindle 9 and the output shaft 40 to protect the motor from being overloaded. The magnitude of torque at which the teeth 54 roll over the balls 55 to permit the rotational movement of the internal gear 42 is adjusted by varying the compression load on the springs 59. This adjustment is
10 effected by turning said torque adjusting ring 51 at the front end of the housing 1, that is, turning the ring 51 moves said intermediate ring 50 axially, which in turn, moves the internal gear 42 axially by the pins 52 and the washer 53 to vary the tension load on the springs 59. Each
15 socket 63 for retaining the ball 55 is shaped in the form of a tapered bore having at the front face of the retainer ring 56 the smaller opening with a diameter slightly smaller than that of the ball 55, so that the balls 55 can be retained in and thus prevented from springing out of the
20 respective sockets 63 when the parts are half assembled as shown in Fig. 11, wherein a stop member 64 is pressed fixedly into the base 60 with its flange resting on the inner periphery of the front face of the retainer ring 56.

25 The above description and particularly the drawings are set forth for purposes of illustration only. It will be understood that many variations and modifications of the embodiment herein described will be obvious to those skilled in the art, and may be carried out without
30 departing from the spirit and scope of the invention.

CLAIMS:

1. An electric tool adapted in use to rotate a bit for fastening, drilling and like operations, comprising an elongate housing having a first longitudinal axis, an electric motor mounted in the housing and connected to drive a chuck for holding the bit, the chuck projecting from the forward end of the housing, and an elongate grip having a second longitudinal axis, the grip accommodating an electric battery which is electrically connected to the motor, the housing and grip each being constructed as a pair of two halves in the direction of the respective longitudinal axis, and the halves of the housing having inwardly projecting hollow hubs to receive an inwardly projecting post on one of the halves of the grip to form a pivotal connecting means between the forward end of the grip and the rearward end of the housing to permit swinging movement of the grip between a straight position, where the second longitudinal axis thereof is in line with the first longitudinal axis and an angled position where the two longitudinal axes are inclined and cross each other.



2. A tool according to claim 1, wherein the connecting means has a pivot axis which is perpendicular to the first and second longitudinal axes, and the tool including a retractable cover which
5 telescopes to close a gap opened at the portion adjacent to the pivot axis and formed between the rearward end of the housing and the forward end of the grip, when the grip is in the straight position.

10 3. A tool according to claim 2, wherein the retractable cover has means for restricting the swinging movement of the grip about the pivot axis to retain it in the straight position or the angled position.

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4. An electric tool as hereinbefore described with reference to Figs. 1 to 6 of the accompanying drawings.

5. An electric tool as hereinbefore described with
20 reference to Figs. 7 to 12 of the accompanying drawings.

