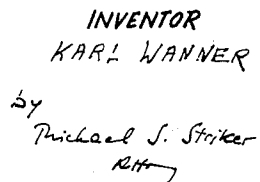


K. WANNER
APPARATUS FOR APPLYING OR DISLODGING SCREWS
AND SIMILAR THREADED FASTENERS
 Filed June 28, 1963

APPARATUS FOR APPLYING OR DISLODGING SCREWS
AND SIMILAR THREADED FASTENERS
Filed June 28, 1963



1

3,207,237

APPARATUS FOR APPLYING OR DISLODGING SCREWS AND SIMILAR THREADED FASTENERS

Karl Wanner, Echterdingen, Wurttemberg, Germany, assignor to Robert Bosch G.m.b.H., Stuttgart, Germany

Filed June 28, 1963, Ser. No. 291,493

Claims priority, application Germany, July 3, 1962, B 67,890

5 Claims. (Cl. 173—93)

The present invention relates to an apparatus for applying and dislodging screws, nuts, bolts and similar threaded fasteners. More particularly, the invention relates to a power-driven torque transmitting and impacting apparatus which may be used as a screw driver or nut fastener.

It is an important object of the invention to provide an improved power-driven tool which may be used for applying or dislodging of threaded fasteners and which is constructed and assembled in such a way that its operation remains quiet and that it may be held by exertion of a comparatively small force even if a threaded fastener offers great resistance to rotation.

Another object of the invention is to provide a torque transmitting and impacting apparatus of the just outlined characteristics which is constructed and assembled in such a way that its parts are not subjected to excessive wear even if the apparatus is used to drive home or to dislodge hard-to-turn screws, nuts and similar threaded fasteners.

A further object of the invention is to provide a power-driven apparatus which may be connected with all or nearly all conventional screw drivers, nut drivers and similar tools which come into direct motion transmitting engagement with a threaded fastener.

An additional object of the invention is to provide an improved torque transmitting and impacting assembly for use in an apparatus of the above outlined characteristics.

With the above objects in view, one feature of the present invention resides in the provision of a torque and impulse transmitting apparatus which may be used as a screw driver or nut fastener. The apparatus comprises a driver shaft which is rotatable by a reversible electric motor or the like, a rotary anvil which is coaxial with the shaft and is arranged to offer variable resistance to rotation when it carries a tool which engages a nut or another threaded fastener, an annular hammer or fly-wheel mass disposed about and movable axially and angularly of the shaft between a first position nearer to and a second position more distant from the anvil, a V-shaped groove provided in the periphery of the shaft and having two legs of different length which diverge from the apex of the groove in a direction away from the anvil, a spherical coupling element received in an internal channel of the hammer and extending into the apex of the groove when the hammer assumes its first position into which it is biased by a helical return spring or a similar resilient member, and a clutch arranged to couple the hammer with the anvil in the first position of the hammer but to permit independent rotation of the hammer when the latter assumes its second position. The arrangement is such that the hammer is automatically detached from the anvil when the latter offers a predetermined resistance to rotation whereupon the spring automatically accelerates the hammer and returns it into engagement with the anvil so that the hammer transmits a strong impulse to the anvil in a sense to drive home or to unscrew a threaded fastener, depending on the direction in which the shaft is driven by its motor.

The length of that groove section in which the coupling element travels when a threaded fastener is being

2

driven home preferably exceeds the length of the other groove section to insure that the hammer may rebound without actually braking the driver shaft when it is disengaged from the anvil. This reduces the shocks and enables the teeth of the clutch between the hammer and the anvil to reengage to the same extent whenever the hammer moves under the bias of the return spring.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved apparatus itself, however, both as to its construction and its method of operation, together with additional features and advantages thereof, will be best understood from the following detailed description of a specific embodiment with reference to the accompanying drawings, in which:

FIG. 1 is a partly elevational and partly axial sectional view of a torque transmitting and impacting apparatus which embodies the invention and which may be used as a screw driver or as a means for driving home or unscrewing nuts, bolts and similar threaded fasteners;

FIG. 2 is an enlarged axial section through an annular hammer which constitutes a component part of the apparatus shown in FIG. 1;

FIG. 3 is a fragmentary end elevational view of the hammer as seen from the left-hand side of FIG. 2;

FIG. 4 is an enlarged side elevational view of a driver shaft which serves to rotate the hammer;

FIG. 5 is a fragmentary developed view of the central portion of the peripheral surface on the driver shaft, showing the configuration of V-shaped cam grooves for spherical coupling elements which establish a driving connection between this shaft and the hammer; and

FIG. 6 is a fragmentary developed view of the internal surface of the hammer and illustrates specially configured channels which cooperate with the V-shaped cam grooves to guide the coupling elements.

Referring to FIG. 1, the apparatus of my invention comprises a first housing 10 which consists of hard insulating material and which serves as a handle to be grasped by one or both hands when the apparatus is in use. The internal space 10a of this housing accommodates a reversible electric motor 10b of any known design, for example, a short-circuited winding rotor motor which may be connected to a source of 200-Hz three-phase current. The open end of the housing is connected with one end of a substantially tubular gear box 11, and the other end of this gear box carries a transversely extending cover 12 which abuts against the open end of a second housing 13, the latter serving to accommodate the component parts of the motion transmitting and impacting assembly. The housings 10, 13 and the gear box 11 with its cover 12 constitute three aligned sections of a composite housing and are held together by a series of axially parallel bolts 10c (only one shown).

The bottom wall 11a of the gear box 11 accommodates an antifriction bearing 11b for the output shaft 14 of the motor 10b, and this output shaft carries at its free end a pinion 15 which meshes with a gear 16 mounted on an intermediate shaft 17 whose ends are journaled in the bottom wall 11a and in the cover 12. The shaft 17 carries a pinion 18 which meshes with a gear 20 fixed to the rear end of a shaft 21 which is rotatable in an antifriction bearing 22 provided in the cover 12. The axis of the shaft 21 is parallel to but need not coincide with the axis of the output 14. The shaft 17 and the gears 15, 16, 18, 20 constitute a transmission which establishes a driving connection between the output shaft 14 and the shaft 21 so that the latter rotates at a predetermined speed as soon as the circuit of the motor 10b is completed.

A driver shaft 32 which is coaxial with the shaft 21 and which forms part of the impacting assembly serves

to drive a specially constructed mass or weight 26 (see also FIGS. 2 and 3) which constitutes a hammer and which serves to transmit torque to an anvil 29 whose spindle 29a is provided with a non-circular end portion 48 so that it may be attached to a screw driver, to a nut tightener or to a similar tool. The anvil 29 is formed with a central bore 38 which receives a stub 39 provided at the outer end of the driver shaft 32, and the rear or inner end of this shaft is formed with a blind bore 36 to receive the front end portion of the shaft 21. Thus, the driver shaft 32 is movable axially between the shaft 21 and anvil 29, and the latter is movable axially with respect to the housing 13. This housing accommodates a bearing sleeve 13a for the spindle 29a and the anvil is formed with a shoulder 29b which co-operates with the sleeve 13a to limit axial movements of the anvil in a direction away from the driver shaft 32. A comparatively weak spring 47 which is inserted into the blind bore 36 operates between a ball 47a and the end face of the shaft 21 so as to normally bias a shoulder 39a of the driver shaft 32 into abutment with anvil 29 whereby the shoulder 29b abuts against the bearing sleeve 13a to maintain the spindle 29a in the axial portion of FIG. 1 when the apparatus is not in use.

The shaft 21 carries a hub 24 which is rigid with radially extending clutch elements or teeth 23 adapted to cooperate with complementary clutch elements or teeth 49 at the rear end of the driver shaft 32. When the spring 47 is free to expand, the clutch elements 49 are disengaged from the clutch elements 23 so that the shaft 21 may be driven without rotating the shaft 32. However, only a small force is necessary to move the anvil 29 axially of the sleeve 13a and to thereby displace the shaft 32 so that the clutch elements 49 engage with clutch elements 23. Such small axial force is produced when a screw driver secured to the spindle 29a engages a bolt or screw and when the operator applies against the housing 10 a small pressure in the direction indicated by an arrow 10d.

The hammer 26 carries a pair of axially extending clutch elements or claws 27, 28 which are arranged to cooperate with clutch elements or claws 30, 31, provided at the rear end of the anvil 29. These claws are normally held in the position of FIG. 1 because the hammer 26 is biased by a resilient element in the form of a strong helical spring 33 which operates between a cylindrical portion 40 of the hammer and an annular retainer 42 which is slidable along the driver shaft 32 and whose flange 44 serves as a guide for a cylindrical shell 40a which is integral with and which extends rearwardly from the cylindrical portion 40. The periphery of the flange 44 is in sliding engagement with the internal surface 40b of the shell 40a. The retainer 42 rotates on an antifriction bearing 42a and its flange 44 abuts against a collar 43 of the driver shaft 32. The collar 43 is integral with the teeth 49, see FIG. 4.

The coupling means which transmits rotation of the driver shaft 32 to the hammer 26 comprises two spherical coupling elements 34 which extend into V-shaped cam grooves 35 provided in the periphery of the shaft 32 and into channels 46 provided in the precision-finished internal surface 41 of the cylindrical hammer portion 40. The arrangement is such that the spherical coupling elements 35 allow for limited axial and angular displacements of the hammer with respect to the driver shaft or vice versa. Each groove 35 comprises two mutually inclined sections or legs including a longer section 35a and a shorter section 35b. These sections diverge from the apex 45 of the respective groove 35 in a direction away from the anvil 29. When the impacting assembly in the housing 13 assumes the position of FIG. 1, i.e., when the hammer 26 is coupled to the anvil 29, the coupling elements 34 are located at the apices 45 of the respective cam grooves.

The channels 46 are inclined with reference to the axis of the hammer 26 and their rear ends are adjacent

to the shoulder 40c which separates the internal surfaces 40b, 41 from each other. When the coupling elements 34 assume the positions shown in FIG. 2 or 6, they prevent axial movements of the driver shaft 32 or hammer 26 under the bias of the spring 33.

It is now assumed that the spindle 29a is connected with a conventional nut tightener or a similar tool T (shown in phantom lines) and that the nut which is to be driven home by the tool T is provided with right-hand threads so that the output shaft 14 must be rotated in a clockwise direction. The circuit of the motor 10b is completed so that the transmission 15-20 drives the shaft 21. This shaft will start to rotate the driver shaft 32 as soon as the operator connects the operating end of the tool T with the non-illustrated nut and as soon as the operator applies a force (arrow 10d) which is sufficient to overcome the bias of the spring 47 so that the clutch elements 49 engage with the clutch elements 23. When the spring 47 is compressed, the parts 29, 26, 32, 42 move as a unit because the other spring 33 is strong enough to prevent axial movements of the hammer 26 with respect to the driver shaft 32 or vice versa. The motor 10b drives the shafts, 14, 17, 21, 32 at constant speed and the hammer 26 drives the anvil 29 at the speed of the shaft 32. In other words, the hammer serves as a means for transmitting motion the shaft 32 to the anvil 29 through the intermediary of coupling elements 34 and clutch elements 27, 28, 30, 31. The anvil 29 causes the tool T to rotate the nut at the speed of the driver shaft 32, but there is no relative movement between the anvil and the hammer so that the tool does not receive any axial impulses other than the pressure exerted by the hand or hands grasping the composite housing 10, 11, 13.

When the tool T begins to offer greater resistance to rotation (i.e., when the nut engaged by this tool meets increasing resistance to axial movement), the rotational speed of the spindle 29 decreased to brake the hammer 26 which begins to move axially and in a direction counter to the bias of the spring 33 so that the claws 27, 28 are disengaged from the claws 30, 31. During such axial movement of the hammer 29, the coupling elements 34 roll along the walls bounding the longer sections 35a of the respective cam grooves 35 so that the movement of the hammer relative to the driver shaft 32 is a composite axial and angular movement. As soon as the claws 27, 28 are disengaged from the claws 30, 31, the hammer 29 is free to rotate independently of the anvil and is accelerated to rotate at the speed of the driver shaft 32. The hammer receives an additional impulse from the spring 33 so that the claws 27, 38 impact against the claws 30, 31 and impart to the anvil 29 a very strong impulse which causes rotation of the tool T. The arrow 50 in FIG. 5 indicates the direction of rotation of the driver shaft 32 at the time this shaft rotates with respect to the hammer 26 whereby the coupling elements 34 roll from the apices 45 toward the opposite ends of the groove sections 35a (arrow 51).

Of course, when the spring 33 is free to expand (namely, when the extent of axial movement of the claws 27, 28 is sufficient to disengage these claws from the claws 30, 31), the hammer 26 receives an impulse which causes it to move axially of and to change its angular position with respect to the shaft 32. This is due to the inclination of the groove sections 35a so that the hammer is accelerated angularly and axially and its claws 27, 28 engage the claws 30, 31 with a force which is sufficient to cause at least some angular displacement of the nut. The flange 44 serves as a guide and engages the internal surface 40b when the hammer 26 is caused to move axially under or against the bias of the spring 33. The internal surface 41 of the cylindrical portion 40 is finished with such degree of precision that the hammer receives the drive shaft 32 with minimal play.

The exact position of the cam grooves 35 is preferably selected in such a way that the clutch elements 27, 28

5

reengage the elements 30, 31 shortly before the coupling elements 34 return to the apices 45. Thus, the spring 33 will accelerate the hammer within a very short interval of time so that the hammer again rotates at the speed of the constantly driven shaft 32.

It will be readily understood that the tool T may include an elastically deformable protecting device which will be twisted in response to impulses of predetermined magnitude so that the threads of the nut connected with the tool will not be damaged if the nut is driven home and if the operator fails to arrest the motor 10b. However, if the tool does not include such a protecting device, the nut will be compelled to share all rotary movements of the anvil 29.

As a rule, the hammer 26 will strike the anvil several times before the nut is driven home, and each such striking or impacting action is preceded by an axial displacement of the hammer against the bias of the spring 33. As the nut continues to offer increasing resistance to rotation, the impulses which the hammer 26 transmits to the anvil 29 begin to resemble elastic shocks because the hammer actually rebounds as soon as its clutch elements 27, 28 impact against the elements 30, 31. This will explain the presence of comparatively long groove sections 35a because it is advisable to prevent the coupling elements 34 from striking against the end walls of these groove sections. It will be readily understood that the apparatus would be hard to handle and that the parts of the impacting assembly would undergo excessive wear if the sections 35a were so short that the coupling elements 34 would reach the outer ends of these sections prior to expansion of the spring 33.

The shorter legs or sections 35b of the grooves 35 will accommodate the coupling elements 34 when the motor 10b is caused to drive the shaft 14 in the opposite direction, i.e., when the operator desires to unscrew a nut, a bolt, a screw or a similar threaded member. In such instances, the force of impact between the hammer 26 and the anvil 29 decreases very rapidly as soon as the nut is loose and, consequently, there is no need for a long cam groove when the resistance which a nut or another threaded member offers to rotation diminishes rather than increases.

In the illustrated embodiment, the circumferential length of the shorter groove sections 35b is only about one-eighth of the circumference of the driver shaft 32, whereas the circumferential length of the longer groove sections 35a is between 110°-135°, preferably about 118°. Thus, when the tool T begins to offer greater resistance to rotation of the spindle 29a, the hammer 26 is free to complete about one-third of a complete revolution relative to the driver shaft 32. At the same time, the coupling elements 34 may roll along the walls bounding the inclined channels 46 so that the hammer 26 may travel through an additional angle of about 65°, this being the circumferential length of the walls bounding the channels 46. In other words, the maximal angular displacement of the hammer 26 may approximate $118^\circ + 65^\circ = 183^\circ$ before the coupling elements 34 prevent further rotation of the hammer with respect to the shaft 32. The reference character W in FIG. 6 indicates the length of angular movement of the coupling elements 34 as a result of the inclination of the channels 46.

Such large angular displacement of the hammer 26 relative to the driver shaft 32 is sufficient in all or nearly all situations, that is, also in instances when a nut, a bolt or a screw must be driven home with a great force. In other words, the just described configuration of the grooves 35 and channels 46 prevents sudden entrainment of the hammer 26 by the driver shaft 32 when the hammer is disconnected from the anvil 29. This is of particular importance when the tool T comprises a twistable protecting device, such as a package of torsion springs or the like, which enables the tool to turn with respect to a nut when the latter is driven home and cannot rotate

6

any more. The elements of such protecting device take up and are deformed by impulses which the anvil 29 receives from the hammer 26. This protecting device is shown schematically in FIG. 1 and is identified by a reference character P. Of course, when the tool T is equipped with this protecting device, the springs of which the device P consists are deformed in response to impulses received from the anvil 29 and thereupon recoil to transmit oppositely directed impulses to the hammer 26. Therefore, the apparatus of my invention is preferably constructed in such a way that the coupling elements 34 have sufficient room to travel in the longer groove sections 35a regardless of whether the tool includes or is without a torsion spring or a similar protecting device. When, however, the device P is attached to the anvil, it is considered as constituting a part thereof.

When the apparatus of my invention is used for dislodging a screw, a bolt, a nut or a similar threaded member, the tool need not comprise a protecting device because the resistance which the tool offers to rotation will diminish very rapidly as soon as the screw or nut is loosened. Therefore, the length of the groove sections 35b may be much less than the length of sections 35a without any danger that parts of the apparatus will be subjected to excessive stresses or that the operator must withstand excessive shocks such as could arise if the coupling elements 34 were permitted to reach the ends of the sections 35b before the spring 33 expands. It goes without saying that the motor 10b must be reversed when the apparatus is used for loosening of nuts, bolts, screws or the like.

FIG. 5 shows that the shorter section 35b of one groove 35 terminates in immediate proximity of the longer section 35a which forms part of the other groove 35. As a rule, the length of sections 35a is 1.5-2.5 times the length of the sections 35b.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A torque and impulse transmitting apparatus, particularly an electric screw driver or nut fastener, comprising rotary shaft means; a motor for selectively rotating said shaft means in a clockwise or anticlockwise direction; a rotary anvil coaxial with and located at one end of said shaft means, said anvil being arranged to offer variable resistance to rotation thereof; annular hammer means coaxially surrounding and movable axially and angularly with respect to said shaft means between a first position nearer to and a second position more distant from said anvil, one of said means having a cylindrical surface with closely arranged V-shaped grooves therein arranged transverse to the axis of said cylindrical surface each of said V-shaped grooves having an apex and a longer and a shorter elongated section diverging from said apex in a direction away from said anvil, said shorter section of each groove underlapping in axial direction and terminating in immediate proximity of the side face of said longer section of an adjacent groove; a clutch arranged to drivingly connect said hammer means with said anvil in the first position of said hammer means and to permit rotation of said hammer means independently of said anvil in the second position of said hammer means; resilient means arranged to bias said hammer means to said first position; and a follower extending into each of said grooves and arranged to rotate with the other of said means so as to move into the corresponding one of said sections of each of the respective grooves and to shift

said hammer means to said second position against the bias of said resilient means in response to a predetermined resistance offered by said anvil such as will tend to reduce the rotational speed of the hammer means.

2. An apparatus as set forth in claim 1, wherein said grooves are provided in the periphery of said shaft means and wherein said longer section of each of said grooves extends through an angle of at least 100° as seen in the circumferential direction of said shaft means.

3. An apparatus as set forth in claim 2, wherein each of said longer sections extends through an angle of 115°-120°.

4. A torque and impulse transmitting apparatus, comprising rotary shaft means; a motor for selectively rotating said shaft means in a clockwise or anticlockwise direction; a rotary anvil coaxial with and located at one end of said shaft means, said anvil being arranged to offer variable resistance to rotation thereof; annular hammer means coaxially surrounding and movable axially and angularly with respect to said shaft means between a first position nearer to and a second position more distant from said anvil, one of said means having a cylindrical surface with a pair of V-shaped grooves therein arranged transverse to the axis of said cylindrical surface and located diametrically opposite each other and each including an apex and a longer and a shorter elongated section diverging from the respective apex in a direction away from said anvil, said shorter section of each groove overlapping in axial direction and terminating in immediate proximity of said longer section of the other of said pair of grooves, the other of said means having a pair of elongated channels located diametrically opposite each other and inclined with reference to the axis of said shaft means; a clutch arranged to drivingly connect said hammer means with said anvil in the first position of said hammer means and to permit rotation of said hammer means independently of said anvil in the second position of said hammer means; resilient means arranged to bias said hammer means to said first position; and a pair of spherical coupling elements each having a first portion received in one of said grooves and a second portion received in one of said channels so as to move in one section of the respective groove and to shift said hammer means to said second position against the bias of said resilient means in response to a predetermined resistance offered by said anvil such as will tend to reduce the rotational speed of the hammer means, said anvil having a deformable portion which is deformed to store energy during rotation of said anvil in one direction and to release such energy to urge said clutch to rotate said hammer in the opposite direction in response to movement of said hammer means toward said second position so as to provide additional energy for moving said hammer means against the bias of said resilient means and to move said follower even further along said longer section but short of that end thereof which is spaced from said apex.

5. A torque and impulse transmitting apparatus, particularly an electric screw driver or nut fastener, comprising a housing defining an internal space; a reversible motor mounted in said housing and having an output shaft; a second shaft rotatably mounted in said housing and parallel with said output shaft; a transmission drivingly connecting said output shaft with said second shaft a driver shaft coaxial with and movable axially of said second shaft between an operative position nearer to and an idle position more distant from said second shaft; a comparatively weak spring operating between said driver shaft and said second shaft for biasing said driver shaft to said idle position; first clutch means arranged to couple said second shaft with said driver shaft in the operative position

of said driver shaft; a rotary anvil coaxial with and located at that end of said driver shaft which is distant from said second shaft, said anvil having an end portion rotatably and axially movably mounted in and projecting in part from said housing, said anvil being arranged to offer variable resistance to rotation thereof when it is used to rotate a screw or the like and said driver shaft being moved to said operative position against the bias of said spring in response to axial movement of said anvil in a direction toward said second shaft when the anvil is used to transmit axial pressure to a screw or the like; a rotary hammer coaxially surrounding and movable axially and angularly with respect to said driver shaft between a first position near to and a second position more distant from said anvil, said driver shaft having a pair of V-shaped peripheral grooves disposed diametrically opposite each other and each including an apex and a pair of elongated groove sections diverging from the respective apex in a direction away from said anvil, said hammer having a pair of internal channels, one for each of said grooves and each inclined relative to the axis of said driver shaft; a second spring stronger than said first mentioned spring and arranged to operate between said driver shaft and said hammer so as to bias the hammer to said first position; a second clutch arranged to couple said hammer with said anvil in the first position of said hammer and to permit the hammer to rotate independently of said anvil in the second position thereof; and a pair of spherical coupling elements, one for each of said grooves, each coupling element having a first portion received in the respective groove and a second portion received in the corresponding channel so as to automatically shift the hammer to said second position in response to a predetermined resistance offered by said anvil to rotation with the hammer such as tends to reduce the rotational speed of the hammer when the driver shaft assumes said operative position and drives the hammer, said coupling elements being located at the apices of the respective grooves when the hammer assumes said first position and said coupling elements travelling in one section of the respective grooves to thereby change the angular and axial position of said hammer with respect to said driver shaft when the resistance which the anvil offers to rotation with the hammer increases and when the second shaft is driven by said transmission in a clockwise direction, said coupling elements travelling in the other sections of the respective grooves when the resistance which the anvil offers to rotation with the hammer increases while said second shaft rotates in a counterclockwise direction, said one section of each groove being longer than the other section of the respective groove and each coupling element being arranged to travel in said one section of the respective groove when the resistance which the anvil offers to rotation in a clockwise direction exceeds the resistance to rotation in a counterclockwise direction, said one section of each groove extending through an angle of at least 100 degrees as seen in the circumferential direction of the driver shaft.

References Cited by the Examiner

UNITED STATES PATENTS

2,100,522	11/37	Ripsch	81—52.3
2,160,150	5/39	Jimerson et al.	192—30.5
2,219,865	10/40	Fitch	192—30.5
2,717,672	9/55	Maurer	192—30.5
2,745,528	5/56	Amtsberg	192—30.5
2,907,240	10/59	Schwenk et al.	192—30.5
3,006,446	10/61	Harrison et al.	192—30.5

BROUGHTON G. DURHAM, *Primary Examiner.*