

Dec. 27, 1966

R. H. RILEY, JR., ET AL

3,294,183

POWER DRIVEN TOOLS

Filed Sept. 30, 1964

4 Sheets-Sheet 1

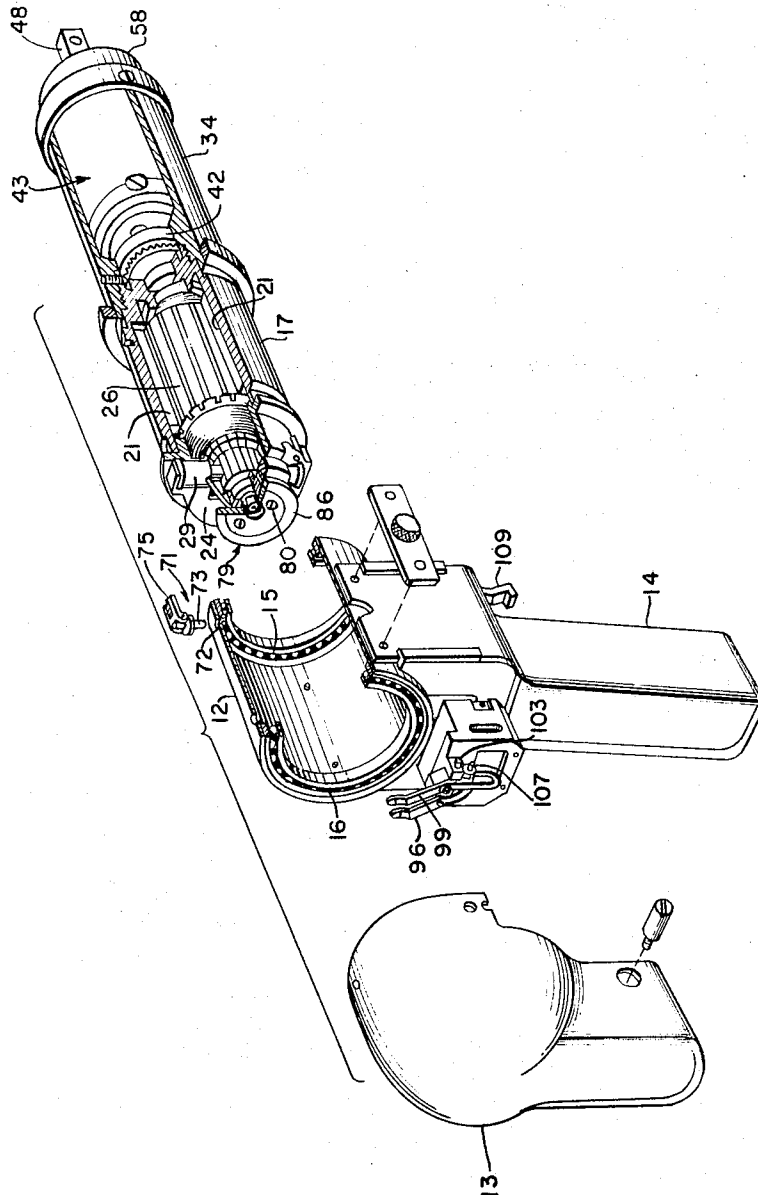


FIG. 1.

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4 Sheets-Sheet 2

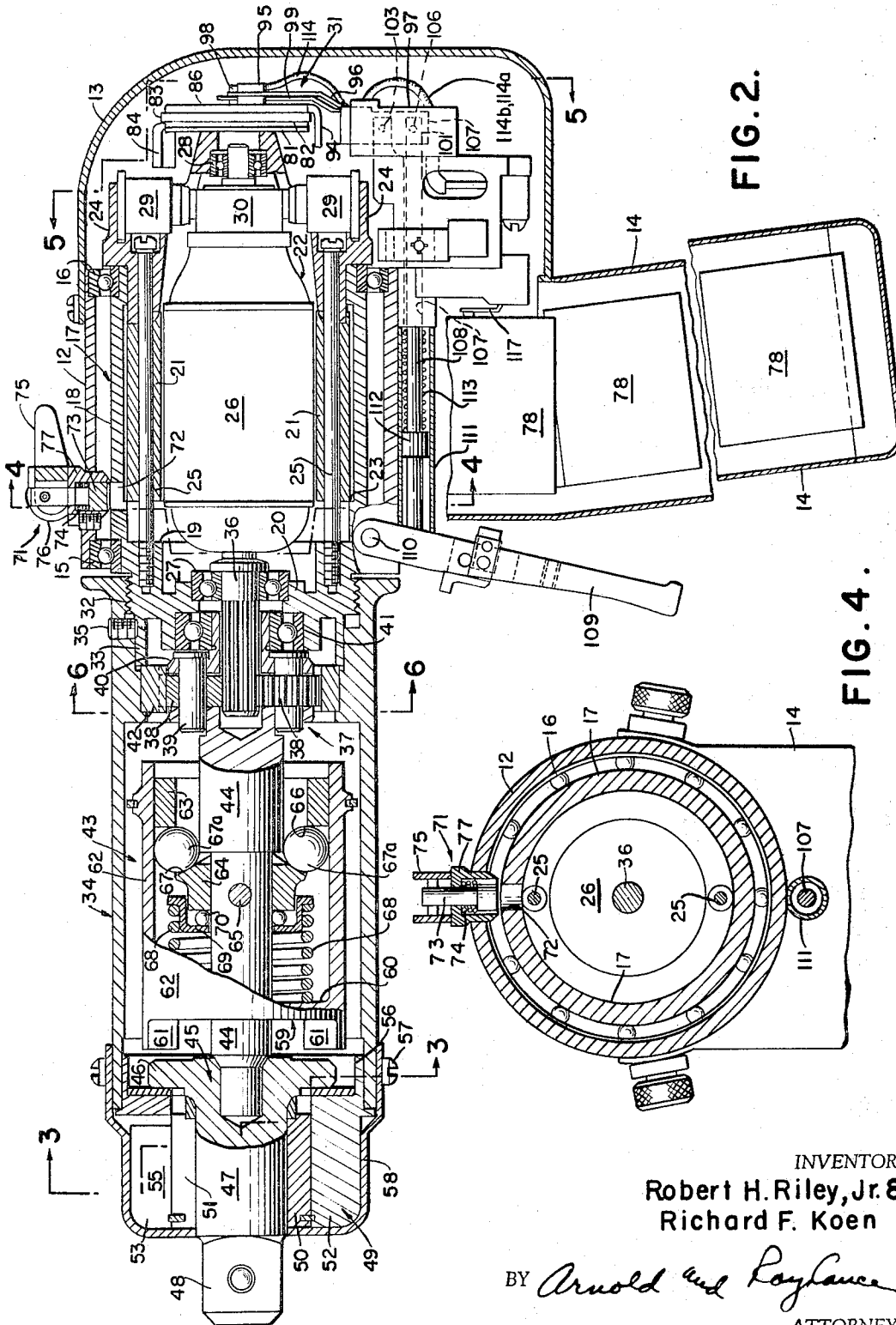


FIG. 2.

FIG. 4.

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4 Sheets-Sheet 4

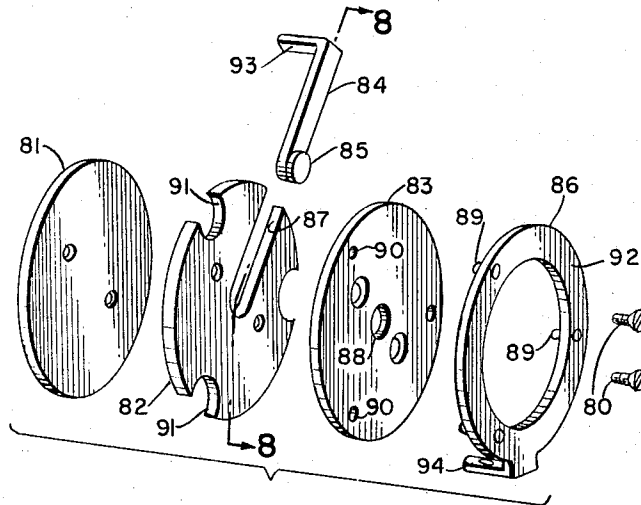


FIG. 7.

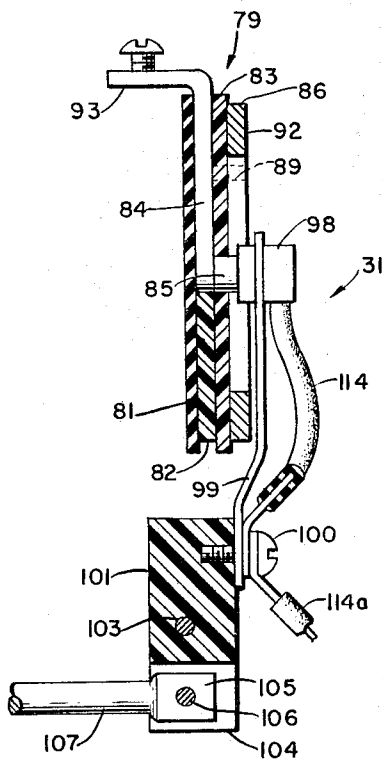


FIG. 8.

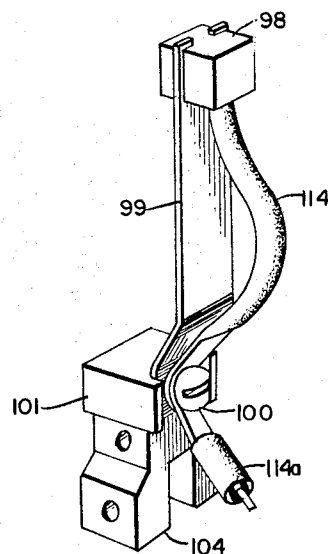


FIG. 9.

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3,294,183

POWER DRIVEN TOOLS

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Filed Sept. 30, 1964, Ser. No. 400,438

17 Claims. (Cl. 173-162)

This invention relates to portable, hand-manipulated, power-driven tools and, more particularly, to such tools wherein the reaction forces encountered by the operator during use of the tool are minimized or substantially eliminated.

Under circumstances now commonly encountered in the construction trades, the installation and maintenance of systems operated by electric and telephone utilities, the installation and repair of television and like towers, etc., the reaction forces applied to the person operating a portable power-driven tool represent a danger to the safety of the operator. Thus, when a high-powered drill, hammer-drill, rotary hammer, or similar tool is used on a scaffold or on a utility pole, for example, strong reaction torques acting on the person operating the tool can cause the operator to lose his footing and fall.

Under the more unusual "weightless" conditions of zero gravity, such as are encountered in outer space, the lack of gravity precludes a suitable anchor for persons attempting to operate power tools, and reaction torques applied to the person by the tool accordingly tend to cause the person to spin about the axis of the tool. Thus, man's conquest of outer space has generated a new demand, quite aside from questions of safety, for power tools in which reaction forces applied to the operator are at least minimized.

Finally, in high-powered tools now commonly employed, sudden and strong reaction forces tend to result in damage to gears, pinions, shafts and other components of the tool itself, and elimination or reduction of the reaction forces is accordingly actively needed in the high-power tool industry.

The primary object of the invention, therefore, is to provide a power-driven tool in which the torque reaction experienced by the operator who holds and manipulates the tool is minimized or substantially eliminated.

Another object is to provide a portable, hand-manipulated, power-driven tool especially suitable for use under conditions of zero gravity.

In this condition, tools constructed in accordance with the invention, when employed by a human operator, apply to the operator only such minimal torques that the use of the tool in accomplishing general space maintenance tasks is entirely feasible.

A further object is to devise a hand-manipulated, portable, power-driven tool which can be used for such operations as tightening nuts, driving screws and caps, operating tool elements (such as drills) which are required both to rotate and reciprocate, applying driven fasteners, and the like, yet exhibit only minimal reaction forces applied to the person operating the tool, even though the tool be one employing a high-powered motor.

Yet another object is to provide a power-driven hand tool which is convertible from a substantially zero-reaction force mode of operation to a conventional mode of operation in which the reaction forces are generally minimized, with the conversion being accomplished by operating a single movable control element.

Broadly considered, the invention is based on the concept of providing, in addition to the rotary output member of the tool, a rotary member which is arranged to turn relative to the driven tool element (e. g., the usual socket element driven by the tool and engageable with a

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nut or bolt), and incorporating in the tool means for applying to the additional rotary member a torque which is opposite to the driving torque of the power device which drives the tool element, so that the additional rotary member and the driven tool element tend to counter-rotate relative to each other, a slip clutch or equivalent restraint means being connected to the additional rotary member to restrain the same against rotation.

Though the invention is more broadly applicable, unusually advantageous results are attained when the power device is a motor having a driving structure (such as the field structure of an electric motor) and a driven structure (such as the armature), the driving and driven structures being mounted for rotation both relative to each other and relative to the tool housing, and the tool element is driven from the armature shaft via a rotary impacting mechanism. The driving structure of the motor then constitutes the rotary member which is to rotate in opposition to the tool element, and the restraint means can then be provided as a slip clutch connected between the tool element and a barrel member, for example, carried by the rotatably mounted driving structure of the motor. In such an arrangement, the only reaction force applied to the tool housing, and hence to the operator, is that which occurs because of frictional drag in the bearings which mount the motor on the housing, and also, the frictional drag of the brushes which engage the slip ring structure.

In order that the manner in which the foregoing and other objects are achieved in accordance with the invention can be understood in detail, one advantageous embodiment of the invention will be described with reference to the accompanying drawings, which form a part of this specification, and wherein:

FIG. 1 is an exploded perspective view of a minimum-reaction rotary power tool constructed in accordance with the invention;

FIG. 2 is a longitudinal sectional view of the tool of FIG. 1;

FIG. 3 is a transverse sectional view taken on line 3-3, FIG. 2;

FIG. 4 is a transverse sectional view taken on line 4-4, FIG. 2;

FIG. 5 is a transverse sectional view taken generally on line 5-5, FIG. 2;

FIG. 6 is a transverse sectional view taken on line 6-6, FIG. 2;

FIG. 7 is an exploded perspective view of a slip ring unit employed in the device of FIG. 1;

FIG. 8 is a transverse sectional view, taken generally on line 8-8, FIG. 7, of the slip ring unit in its assembled condition and also showing the movable contact assembly associated therewith; and

FIG. 9 is a perspective view of a switching contact assembly employed in the device of FIG. 1.

Turning now to the drawings in detail, the illustrated embodiment of the invention comprises a rigid cylindrical housing member 12 closed at one end by shroud 13 and provided with a hollow handle 14 by which the tool can be held and manipulated. Journalled in housing member 12 by ball bearings 15 and 16 is a rigid member 17 having a cylindrical body portion 18 which is open at its end adjacent bearing 16 and, at the other end, includes a first transverse annular inwardly extending portion 19 and a second such portion 20. Bearings 15 and 16 support member 17 for rotation about the central axis of housing member 12, and annular portions 19 and 20 are concentric with that axis.

The cylindrical body portion 18 of member 17 embraces and supports the field structure 21 of an electrical driving motor indicated generally at 22. One end of the field structure abuts an internal transverse annular

shoulder 23 provided on body portion 18, and the other end of the field structure is engaged by the closure member 24 secured to member 17, as by the longitudinally extending screws 25. The motor 22 includes a rotor structure or armature 26, the shaft of the armature being journaled at one end in a ball bearing 27 supported by portion 20 of member 17 and, at the other end, in a ball bearing 28 supported by the central portion of closure member 24. The motor is completed by conventional brush assemblies 29, carried by closure member 24 and disposed with the brushes engaging commutator 30, current being supplied to the armature via a combination switch and slip ring device indicated generally at 31 and described in detail hereinafter.

At its end including annular portions 19 and 20, member 17 projects forwardly beyond housing member 12 and includes an exteriorly threaded portion 32 and a plain cylindrical tubular portion 33, FIG. 2. A cylindrical barrel member 34 is rigidly secured to member 17, one end of member 34 being interiorly threaded for engagement with exteriorly threaded portion 32. Member 34 embraces portion 33 of member 17 and a set screw 35 is provided to assure that there will be no relative rotation between members 17 and 34.

At the left or forward end of motor 22, the driven shaft of the motor is extended in the form of a toothed spindle 36 which provides the input to a speed-reduction gearing indicated generally at 37. Gearing 37 includes two planet gears 38 carried by stub shafts 39 and a rotatable carrier or cage 40 which is supported by a ball bearing 41 for rotation about the axis of armature 26. The speed reduction gearing also comprises a ring gear 42 fixedly secured to barrel member 34, as by being clamped between an internal transverse shoulder on the bearing member and the tip of cylindrical tubular portion 33 of member 17. The planet gears 38 mesh with both the internal teeth of the ring gear and the external teeth of spindle 36, in conventional fashion for planetary gearing.

Forwardly of the speed reduction gearing, barrel member 34 encloses a conventional rotary impacting mechanism, indicated generally at 43. The impacting mechanism can, for example, be constructed in accordance with U.S. Patent 2,792,732, issued May 21 1957, to W. S. Brucker. Typically, the impacting mechanism comprises a central spindle 44 having one end provided with shoulders engaged by the forwardly projecting end portions of stub shafts 39, so that the speed reduction gearing 37 serves to rotate spindle 44 continuously at a speed substantially lower than the speed of rotation of the armature of motor 22. At its other end, spindle 44 has a tip portion of reduced diameter which is journaled within an axially extending recess in an anvil member 45. The anvil member includes radially displaced impact portions 46, a cylindrical shaft portion 47, and a portion 48 which is of polygonal transverse cross section and adapted to be secured to a tool element (not shown), such as a socket wrench element, in conventional fashion.

The anvil member 45 is supported for rotation, about the common axis of the motor and spindle 44, by an adjustable friction clutch indicated at 49 and generally of the type disclosed in U.S. Patent 3,127,202, issued March 31, 1964, to Richard F. Koen. The clutch 49 comprises a plain cylindrical sleeve bearing 50, of bronze or the like, provided with an axially extending slot 51, bearing 50 directly engaging the shaft portion 47 of the anvil member and being itself embraced by a heavy spring collar 52. Collar 52 is provided with a slot 53 and, when properly sprung, provides a strong spring force which clamps bearing 50 against shaft portion 47 of the anvil member, so that there is a marked frictional effect tending to oppose rotation of the anvil member. The frictional effect of the clutch is manually adjusted by means of a screw 54 which is engaged in a threaded bore extending chordally with respect to collar 52 in such fashion

that the tip of the screw engages the flat surface 55 presented by slot 53. Accordingly, it will be understood that rotation of screws 54 in one direction will tend to open collar 52, reducing the clamping force which is applied to bearing 50, while rotation in the opposite direction will allow the spring collar to close, increasing the frictional force applied to the bearing, and thus to the shaft portion of the anvil member.

Spring collar 52 includes a tubular extension 56, substantially larger in diameter than the anvil member, extension 56 being telescopically engaged within the front end portion of barrel member 34 and secured thereto in any suitable fashion, as by screws 57. The screws 57 also serve to mount a generally cup-shaped nose or cover portion 58 which completely encloses the friction clutch.

Surrounding spindle 44 of the impacting mechanism is a cylindrical hammer member indicated generally at 59. At its forward end, hammer member 59 includes a transverse wall 60 provided with a central opening through which spindle 44 freely projects. On the side of wall 60 adjacent the anvil, member 59 includes hammer lugs 61 adapted to cooperate with the impact portions 46 of the anvil member, as later described in more detail. The main cylindrical body portion 62 of the hammer member projects from the other side of wall 60 concentrically with respect to spindle 44.

At its end opposite wall 60, body portion 62 encloses a hammer lift camming mechanism comprising an annular hammer cam element 63 which is rigidly secured to the hammer member and spaced outwardly from spindle 44. The camming mechanism also includes a spindle cam element 64 which is secured to spindle 44, as by a pin 65. Cam elements 63 and 64 present opposed cam surfaces 66 and 67, respectively, which can be considered as portions of cylindrical surfaces each having its axis extending transversely with respect to the axis of spindle 44, as described in detail in aforementioned Patent 2,792,732. Hardened cam balls 67a are engaged between cam surfaces 66 and 67.

The axial position of spindle 44 is fixed, one end of the spindle being engaged with the adjacent faces of the planet gears 38, the other end of the spindle being provided with a forwardly facing shoulder which engages a cooperating shoulder on anvil member 45. Accordingly, since spindle cam element 64 is rigidly secured to spindle 44, the axial position of the spindle cam element is also essentially fixed. The hammer member 59, on the other hand, is capable of shifting axially relative to spindle 44 and anvil member 45. The hammer member is biased toward the anvil member by a heavy prestressed helical compression spring 68 which surrounds spindle 44 and is itself surrounded by body portion 62 of the hammer member. The forward end of spring 68 directly engages the transverse wall 60 of the hammer member. The opposite end of the spring engages the outer flange of a bearing cup member 69, FIG. 2, which loosely surrounds the hub of spindle cam element 64 and bears against thrust bearing balls 70. The arrangement is such that, when there is relative rotation between hammer member 59 and spindle 44, cam surfaces 66 and 67 will be displaced to shift the hammer member axially along the spindle, either forwardly or rearwardly of the tool, depending on the direction of the relative motion.

Considering housing member 12 as being held stationary, and assuming that motor 22 is energized, it is to be noted that the combination of member 17, the permanent magnet field structure 21 of the motor, barrel member 34, and the spring collar and slotted bearing of friction clutch 49 constitute one assembly capable of rotating about the axis of the tool defined by bearings 15 and 16 and coincident with the longitudinal central axis of the driven shaft of the motor. The armature and toothed spindle of the motor constitute a second assembly capable of rotating relative to housing member 12,

and the rotation of this assembly is imparted, via speed reduction gearing 37 and rotary impacting mechanism 43, to the tip portion 48 of the anvil member 45, and to whatever tool element is attached thereto.

The assembly including member 17 and barrel member 34 can be locked to housing member 12 by the manually operated locking device indicated generally at 71. Thus, member 17 is provided with a radially extending opening 72, FIG. 2, and the locking device 71 includes a radially shiftable locking pin 73 which is normally biased inwardly, to engage in opening 72, by a spring 74. An operating handle 75, in the nature of a lever, is pivotally connected to the outer end portion of the locking pin 73 and carried thereby. Handle 75 has identical cam edges 76 disposed to engage the exposed surface of the lock housing 77, the cam edges of the handle being urged into such engagement by the action of spring 74. The arrangement is such that, when the handle is pivoted in a clockwise direction, as viewed in FIG. 2, locking pin 73 is cammed radially outwardly, so as to be disengaged from opening 72 in order to free member 17 for rotation relative to housing member 12. On the other hand, when the handle is pivoted in a counterclockwise direction, as viewed in FIG. 2, the shape of the cam edges allows the locking pin 73 to be forced inwardly by spring 74, so that, when opening 72 comes into alignment with the locking pin, the locking pin can enter the opening and lock member 17 to housing member 12.

Though the motor 22 can be energized from any suitable power source, the illustrated embodiment of the invention is in the nature of a self-contained unit and employs rechargeable batteries 78, contained within handle 14, to supply energizing current to the motor via the switch and slip ring device 31. Described and claimed in copending application Serial No. 406,955, filed October 19, 1964, by Harry L. Beam and Michael J. Pedone, Jr., device 31 includes a slip ring unit 79 which is rigidly secured to closure member 24, as by screws 80, FIGS. 5 and 7, so as to rotate with the assembly comprising member 17, field 21 and barrel member 34 when that assembly rotates. The slip ring unit 79 is flat and lies in a plane extending at right angles to the rotational axis defined by bearings 15 and 16. The unit includes a thin, flat backing disc 81 of electrical insulating material, an insulating spacer disc 82, an insulating slip ring supporting disc 83, an arm 84 which carries a cylindrical central contact 85, and an annular contact ring 86, all as illustrated in detail in FIGS. 7 and 8.

Disc 82 is provided with a radially extending slot 87, FIG. 7, closed at its inner end and opening through the periphery of the disc, to accommodate arm 84, the relative shapes of the arm and slot being such that, when the arm is fully inserted in the slot, contact 85 is disposed at the center of the slip ring unit. Disc 83 is flat, circular, and provided with a circular central opening 88, FIG. 7, which snugly embraces contact 85, as seen in FIG. 8. Contact ring 86 has an outer diameter slightly smaller than that of disc 83, an inner diameter markedly greater than the diameter of contact 85 and a plurality of equally spaced openings each accommodating a rivet 89, the rivets being fixed to the contact ring and projecting rearwardly therefrom. Disc 83 is provided with apertures 90 through which rivets 89 extend, and disc 82 has peripheral notches 91 to accommodate the ends of the rivets when the same have been upset or otherwise deformed to secure ring 86 to disc 83. Discs 81, 82 and 83 are each provided with apertures to accommodate screws 80. The heads of rivets 89 lie in the plane of the exposed flat circular face 92 of contact ring 86. The outer end of arm 84 is bent at right angles to provide a lug 93 to which a conductor (not shown) is connected, the conductor extending to and being connected to one of the brushes of the motor 22. Similarly, a lug 94 is provided, integral with contact ring 86, for connection to the other brush of the motor.

A brush contact 95, carried by a spring arm 96 secured to an insulating support 97 carried by housing member 12, is disposed for constant sliding contact with face 92 of contact ring 86. A second brush contact 98 is carried by a spring arm 99 and constitutes the movable contact of the combined switch and slip ring unit. Arm 99 is secured by screw 100, FIG. 8, to a block 101 of electrical insulating material, block 101 is mounted on a stationary support 102 for pivotal movement about the axis defined by pin shaft 103, support 102 being secured to housing member 12. The lower end portion 104 of block 101 is bifurcated, accommodating the flat end portion 105 of a push rod 106. The end portion 105 of the rod is pivotally connected to block 101 by pin shaft 107, FIG. 8.

Push rod 106 is disposed below housing member 12 and is constrained by a bore 108, FIG. 2, in support 102. Rod 106 extends parallel to the axis of rotation of armature 26 and is so positioned that its longitudinal axis passes directly below central contact 85 of the slip ring unit. The forward end of rod 106 engages a trigger 109 which is mounted on housing member 12 to swing about the transverse axis indicated at 110, FIG. 2, axis 110 and the axes determined by pin shafts 103 and 107 all being parallel to each other and at right angles to the axis of rotation defined by bearings 15 and 16. Forwardly of support 102, the push rod extends through a tube 111 and is provided with an enlargement 112 presenting a shoulder directed toward support 102. A helical compression spring 113 surrounds the push rod and is engaged between enlargement 112 and support 102 to bias the push rod toward trigger 109.

Assuming trigger 109 to be free, spring 113 moves push rod 106 forwardly, causing block 101 and arm 99 to pivot clockwise, as viewed in FIG. 2, so that brush contact 98 is moved out of engagement with the central contact 85 of the slip ring unit. When the operator actuates the trigger toward handle 14, push rod 106 is forced rearwardly, compressing spring 113, and block 101 and arm 99 are pivoted counterclockwise, as viewed in FIG. 2, swinging brush contact 98 into engagement with central slip ring contact 85. When the trigger 109 is released, spring 113 urges the push rod forwardly, returning it to its initial position, so that the combination of block 101 and arm 99 is again pivoted in a clockwise direction, as viewed in FIG. 2, to disengage brush contact 98 from contact 85. Any suitable releasable lock mechanism (not shown) can be provided on support 102 to retain the push rod in its rearwardly actuated position, so the operator need not hold trigger 109 in its rearwardly actuated position.

Contact arm 99 is shunted by an insulated conductor 114 extending between and connected electrically to brush contact 98 and screw 100 to provide a low resistance connection to contact 98. Similarly, contact arm 96 is shunted by an insulated conductor 115 extending between brush contact 95 and the screw 116, FIG. 5, by which the arm 96 is secured to support 97. Screws 100 and 116 are connected by suitable wiring, including insulated conductors 114a and 114b, FIG. 5, to the respective contacts 117, FIG. 2, which engage the terminals of the uppermost batteries 78, it being understood that the several batteries are interconnected to constitute a unitary power supply. Accordingly, when brush contact 98 is pivoted into engagement with the center contact 85 of the slip ring unit as a result of actuation of the trigger, the batteries are connected to energize motor 22, and such energization is maintained even though member 17, and therefore the slip ring unit, be rotating as a result of operation of the tool. When the trigger is released, and the push rod is allowed to move forwardly under the biasing action of spring 113, arm 99 is again pivoted in a clockwise direction to disengage brush contact 98 from contact 85 so that motor 22 is deenergized.

Advantageously, the free ends of arms 96 and 99 are bifurcated, and brush contacts 95 and 98 are in the form of polygonal blocks having grooves in which the bifur-

cated end portions of the arms are engaged to retain the brush contacts.

When the tool illustrated in FIGS. 1-8 is to be used, a suitable tool element, such as a socket to engage a nut or bolt, is first fitted to portion 48 of anvil member 45. The operator then manipulates the trigger to complete the energizing circuit between batteries 78 and motor 22. Lock mechanism 71 is operated to withdraw pin 73 from opening 72 so as to free member 17 for rotation relative to housing member 12. With the motor energized, the field and armature structures of the motor tend to counter-rotate, that is, the armature tends to turn in one direction while the field structure tends to rotate in the opposite direction. Accordingly, the assembly comprising member 17, field 21, closure member 24, barrel member 34, and the spring collar 52 of clutch 49 tends to rotate in one direction, while the assembly comprising armature 26, spindle 44, hammer member 59, and anvil member 45, with the tool element attached thereto, tends to rotate in the opposite direction. If clutch 49 is so adjusted that anvil member 45 is completely free to turn, free counter-rotation of the two assemblies just mentioned will result. However, frictional engagement between the anvil member and sleeve 50 of clutch 49 affects the impacting mechanism 43 in the same manner as does the resistance against turning offered by a nut or other fastener being driven by the tool element attached to shank 48. Accordingly, assuming that adequate frictional force is applied by clutch 49, the counter-rotational tendency results in "cocking" of impact mechanism 43, so that energy is first stored in spring 68 and then released to accelerate the hammer to impact against the anvil member. With the motor energized, but the tool element not engaged with the nut or the like to be driven by the tool, screw 54 can be adjusted to provide the desired frictional restraint consistent with proper tool operation.

This having been accomplished, the operator manipulates the tool to engage the tool element carried by shank 48 operatively with the nut or the like to be driven. With motor 22 energized, impacting mechanism 43 will operate to apply to anvil member 45, and thus to the tool element and the fastener, successive driving impulses of short duration and relatively high amplitude, the amplitude of the driving impulses being significantly greater than that required to overcome the frictional forces between the driven nut and the bolt or the like with which the same is engaged. Accordingly, the tool acts to tighten the nut in what is essentially the usual fashion for impact wrenches.

The major reaction torque developed in the impacting mechanism is that which results from disengagement of the lugs 61 of the hammer member from the cooperating anvil lugs of member 45, this occurring at a time during development of each driving impulse when a substantial amount of energy has been stored in spring 68. This reaction torque is transferred from spindle 44 to barrel member 34 through speed reduction gearing 37 and also through the motor 22. In this regard, it is to be noted that the driving torque of the motor tends to prevent the motor spindle 36 from turning in that direction urged by the reaction torque. Accordingly, insofar as the reaction torque is concerned, it can be considered that the spindle 44 provides an input to the speed reduction gearing 37 and tends to cause the planet gears 38 to translate about spindle 36. This tendency in turn is imparted to ring gear 42 and, therefore, to the barrel member 34. The combination of the barrel member and friction clutch 49 acts to transfer the reaction torque to the anvil member and, therefore, to the nut or the like with which the tool element carried by shank 48 is engaged. So transferred, the reaction torque is in a direction tending to loosen the fastener.

Because of the inherent characteristics of the impacting mechanism, the reaction torque just referred to is of relatively long duration and low amplitude, as compared to the driving impulse which results when the ham-

mer impacts on the anvil member. The amplitude of the reaction torque is sufficiently low that the torque does not exceed that value which would be necessary to rotate the nut or the like against the frictional force between the nut and the bolt or other element with which the same is engaged. Accordingly, though the reaction torque is transferred to the tool element, and thus to the nut or other element being driven by the tool, in a direction tending to loosen the nut, the reaction torque is simply absorbed without causing any movement of the nut.

Since the assembly including barrel member 34 and the field structure of the motor is free to rotate relative to housing member 12, by virtue of bearings 15 and 16, the only reaction torque imparted to the housing, and thus to the operator, is that which results from frictional drag in bearings 15 and 16, and also, the frictional drag of the brushes which engage the slip ring structure. Employing antifriction bearings of reasonable quality, this frictional drag is minimal and there is, in effect, no significant reaction torque observable by the operator. Thus, under conditions of zero gravity, as encountered in outer space, the tool illustrated in FIGS. 1-9 will operate to tighten nuts and accomplish like functions even though the handle 14 is not held by an operator. Though substantially reaction-free operation under zero gravity conditions is a paramount advantage of the invention, it will be clear that the tool is equally useful under normal gravity conditions, as encountered on earth, for example. Under conditions of normal gravity, it is of course necessary for the operator to support the weight of the tool, but the advantage of low or substantially zero reaction torque is still attained.

The tool is also useful to accomplish operations, such as drilling, of such character that the impact mode of operation normally afforded by impacting mechanism 43 is not desirable. In such cases, screw 54 is adjusted to fully release the friction clutch 49, and the locking mechanism 71 is actuated to engage the locking pin 73 in opening 72, so that member 17 and the motor field structure are locked to stationary housing member 12. Assuming that the drill or like tool element being driven does not encounter especially high resistance, the tool now functions in normal fashion, as if shank 48 were directly coupled to the driven shaft of the motor 22, the lugs 61 of hammer member 59 remaining in constant engagement with the lugs 46 of the anvil member. Under these circumstances, a reaction torque is imparted to the housing member 12, and thus to the person operating the tool, but this reaction force is tolerable under many conditions in which the tool can be employed. The reaction torque is relatively low because of the inherent characteristics of impacting mechanism 43. Further, the reaction torque is limited to a definite value predetermined by reason of the fact that the impacting mechanism will commence normal impacting operation in the event that the torque increases unduly. Under low gravity conditions, it is necessary that the operator achieve some anchoring or bracing, when using the tool with the lock mechanism 71 operated to lock member 17 to the housing, since the reaction torque imparted to the housing will be significant and the operator will experience a slight tendency to spin.

Though one particularly advantageous embodiment of the invention has been chosen for illustrative purposes, it will be obvious that the invention can be practiced in various other ways than that described. Thus, while the tool of FIGS. 1-9 is designed to drive rotary elements, such as nuts, screws, bolts, and the like, the fundamental principles involved are equally applicable to tools adapted for linear action, as in the driving of nails or the like. The particular embodiment of the invention illustrated and described can be applied to any tool for driving an element which is associated with other structure in such fashion as to present frictional forces, acting on the driven element, of such magnitude as to be capable

of absorbing the reaction forces developed during operation of the tool. As will be recognized by those skilled in the art, various changes and modifications can be made in the disclosed embodiment of the invention, without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a low torque-reaction portable power-driven rotary tool, the combination of
 - housing means adapted to be grasped and manipulated by the operator;
 - power means mounted in said housing and having a rotary driven element;
 - output means mounted to rotate about an axis;
 - said output means being driven by said driven element of said power means;
 - a member mounted for rotation relative to said output means;
 - means interconnecting said driven element and said member and operative to impart rotary movement to said member in a direction opposite to the direction of rotation of said driven element when said power means operates to rotate said driven element; and
 - restraining means connected to said member, tending to control the same against said opposite rotation.
2. A tool according to claim 1, wherein
 - said member is tubular and concentric with said axis; and
 - said restraining means is a friction clutch interconnecting said member and said output means.
3. A tool according to claim 2, wherein
 - said power means is a motor having a driving structure and a driven structure,
 - said structures being mounted for rotation about a common axis relative to each other and to said housing means,
 - said tubular member being concentric with respect to said common axis and secured to said driving structure.
4. A tool according to claim 2, and further comprising
 - rotary impacting mechanism including
 - rotary anvil means connected to said output means;
 - rotary hammer means;
 - rotary input means driven from said driven elements of said power device, and
 - means for converting continuous rotation of said input means into periodic impacting motion of said hammer when rotation of said output means is opposed;
 - said friction clutch being effective to transfer to said output means torque tending to oppose rotation of said output means by said impacting mechanism.
5. In a low torque-reaction portable power-driven tool, the combination of
 - housing means adapted to be grasped and manipulated by the operator;
 - power means mounted in said housing and having a rotary driven element;
 - planetary speed reduction gearing including a ring gear, planet gears and an input gear,
 - said rotary driven element of said power means driving said input gear;
 - rotary output means;
 - driving means rotated by rotary translation of said planet gears and arranged to drive said output means;
 - a member mounted for rotation relative to said output means,
 - said member being rigidly connected to said ring gear; and
 - restraining means connected to said member to restrain the same against rotation.
6. A tool according to claim 5, wherein
 - said member is tubular and surrounds said speed reduction gearing and said driving means, and

- said restraining means is a friction clutch.
- 7. A tool according to claim 6, wherein
 - the axes of rotation of said output means, said driven element of said power means, and said tubular member are coincident, and
 - said clutch interconnects said tubular member and said output means.
- 8. A tool according to claim 6, wherein
 - the axes of rotation of said output means, said driven element of said power means, and said tubular member are coincident, and
 - said tubular member surrounds said speed reduction gearing and said driving means.
- 9. In a low torque-reaction portable power-driven rotary tool, the combination of
 - housing means adapted to be grasped and manipulated by the operator;
 - a power device comprising a driving structure and a rotary-driven structure;
 - bearing means mounting said driving and driven structures on said housing means for rotation about a common axis relative to each other and to said housing means;
 - rotary output means;
 - means connecting said driven structure of said power device to said output means comprising
 - speed reduction gearing having an input connected to said driven structure of said power device, planet gear means, and a ring gear;
 - a member mounted for rotation relative to said output means and secured to both said driving structure of said power device and said ring gear; and
 - restraint means operatively arranged to restrain the combination of said member and said driving structure of said power device against rotation.
- 10. A tool according to claim 9, wherein
 - said member is tubular and encloses said speed reduction gearing, and
 - said restraint means is a friction clutch coupled to said tubular member.
- 11. A tool according to claim 10, wherein
 - said friction clutch interconnects said tubular member and said rotary output means.
- 12. In a low torque-reaction portable power-driven tool, the combination of
 - housing means adapted to be grasped and manipulated by the operator;
 - a motor disposed in said housing and comprising a driving structure and a driven structure;
 - anti-friction bearing means mounting said driving and driven structures on said housing means for rotation relative to each other and relative to said housing means about a common axis;
 - a rotary tool element; and
 - means connecting said tool element to be driven by the driven structure of said motor.
- 13. A tool according to claim 12, and further comprising
 - means for selectively locking said driving structure to and freeing said driving structure from said housing means.
- 14. In a low torque-reaction portable power-driven tool, the combination of
 - housing means adapted to be grasped and manipulated by the operator;
 - a motor disposed in said housing means and comprising a driving structure and a driven structure;
 - anti-friction bearing means mounting said driving and driven structures for rotation about a common axis relative to each other and to said housing means;
 - rotary impacting mechanism connected to said driven structure of said motor to be driven thereby;
 - said impacting mechanism having a rotary output member adapted to be coupled to a tool element to be driven; and

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restraint means secured to said driving structure of said motor and coupled to said rotary output member to restrain the same against rotation and thereby enable said impacting mechanism to operate in an impacting mode.

15. In a low torque-reaction portable power tool, the combination of

a housing;

a motor disposed in said housing and comprising a driving structure and a driven structure;

anti-friction bearing means mounting said driving and driven structures for rotation relative to each other and to said housing;

impacting mechanism driven by said driven structure of said motor and comprising

rotary anvil means connectable to a tool element to be driven, and

rotary hammer means normally engaged with said anvil means to drive the same but releasable, when said anvil means is restrained against rotation, to accelerate and impact said anvil means; and

restraint means coupled to said anvil means to restrain the same against rotation.

16. A tool according to claim 15 and further comprising

planetary speed reduction gearing having an input and an output,

the input of said gearing being driven by said driven structure of said motor,

the output of said gearing being connected to drive said hammer means; and

a member mounted for rotation relative to said anvil,

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said member being connected to said anvil means by said restraint means and also being connected to said gearing to receive reaction torque generated by said impacting mechanism.

17. In a tool of the type described, the combination of a housing;

a motor carried by said housing;

a speed reduction gearing comprising an input, a planetary output, and a ring gear;

10 rotary output means;

a member mounted for rotation relative to said output means,

the input of said gearing being connected to said motor to be driven thereby,

said output means being driven by the planetary output of said gearing,

said member being connected to said ring gear; and

controlled restraint means connected to said member to restrain the same against rotation.

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