United States Patent

Koehler

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[45] **Mar. 21, 1972**

[54] POWER DRIVEN DEVICE

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[22] Filed: **May 5, 1970**

[21] Appl. No.: **34,844**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 847,294, Aug. 4, 1969.

[52] **U.S. Cl.**.....**173/110**, 173/116, 173/139

[51] **Int. Cl.**.....**B25d 11/00**

[58] **Field of Search**.....173/110, 111, 139, 116

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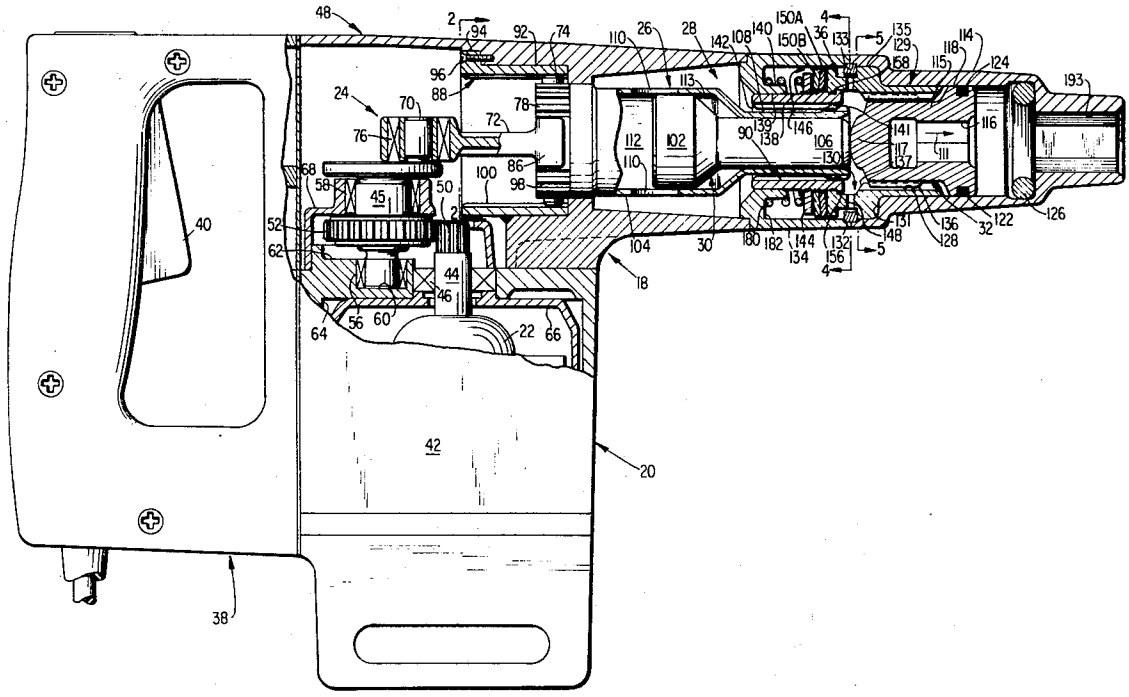
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[57] **ABSTRACT**

Power driven devices in which a closed type, cushioned tool holder is axially impacted by a free-floating driver mounted in a reciprocably driven, non-rotatable piston and also intermittently rotated and in which the mechanism producing intermittent rotation has two components which slip relative to each other when a rotation restraining force of a predetermined magnitude is exerted on the tool holder.

21 Claims, 11 Drawing Figures



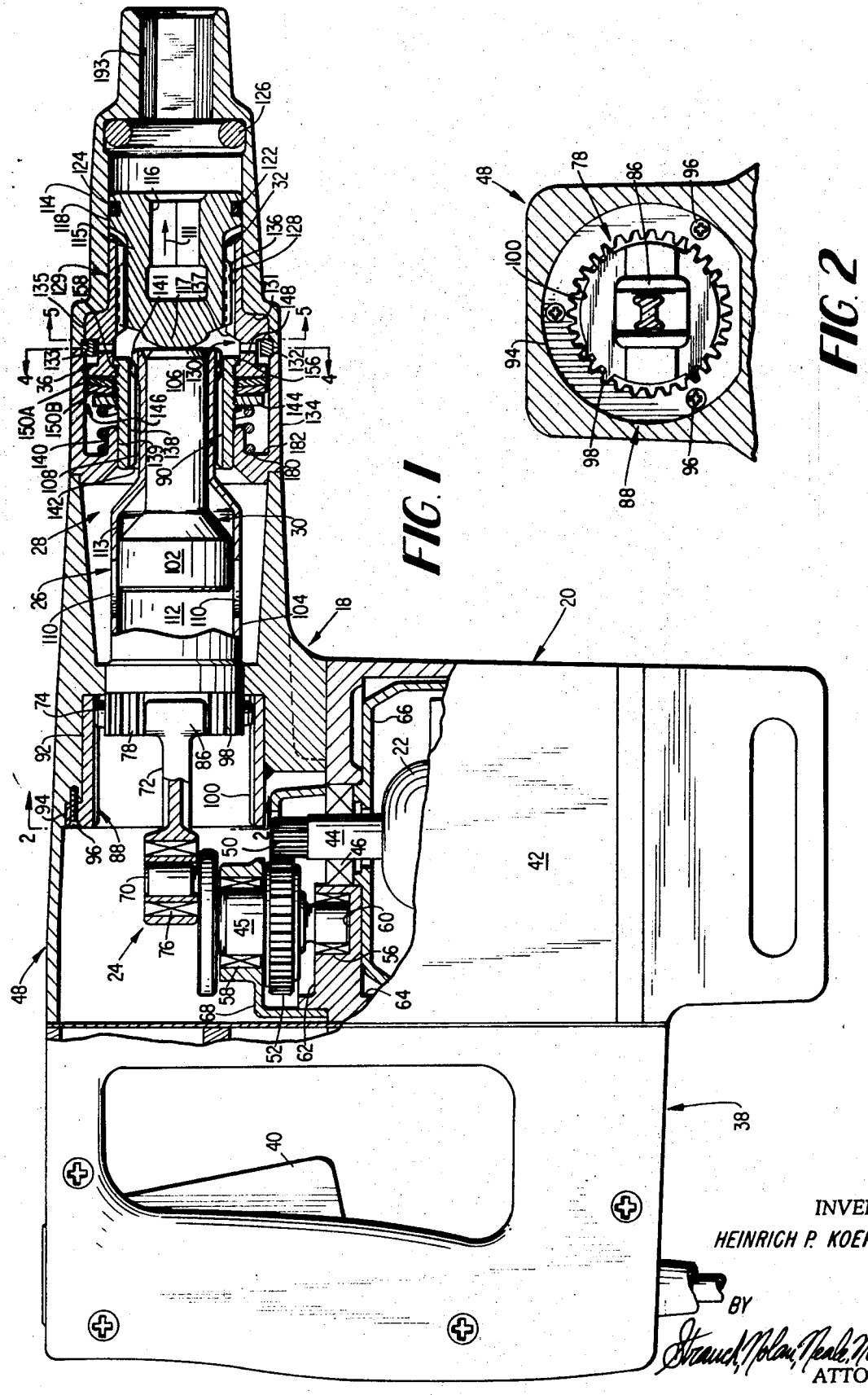


FIG. 1

FIG. 2

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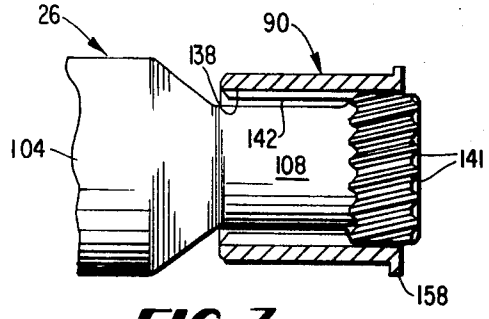


FIG. 3

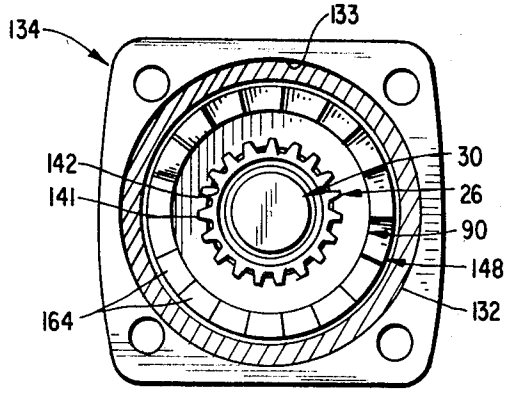


FIG. 4

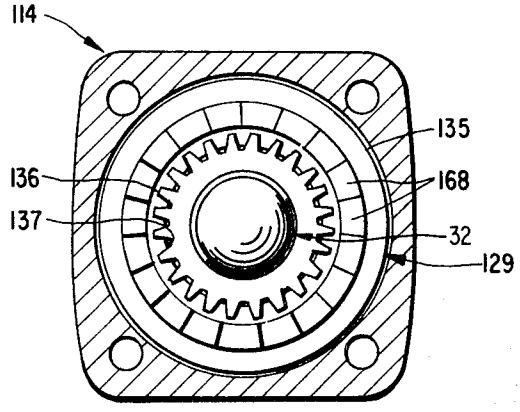


FIG. 5

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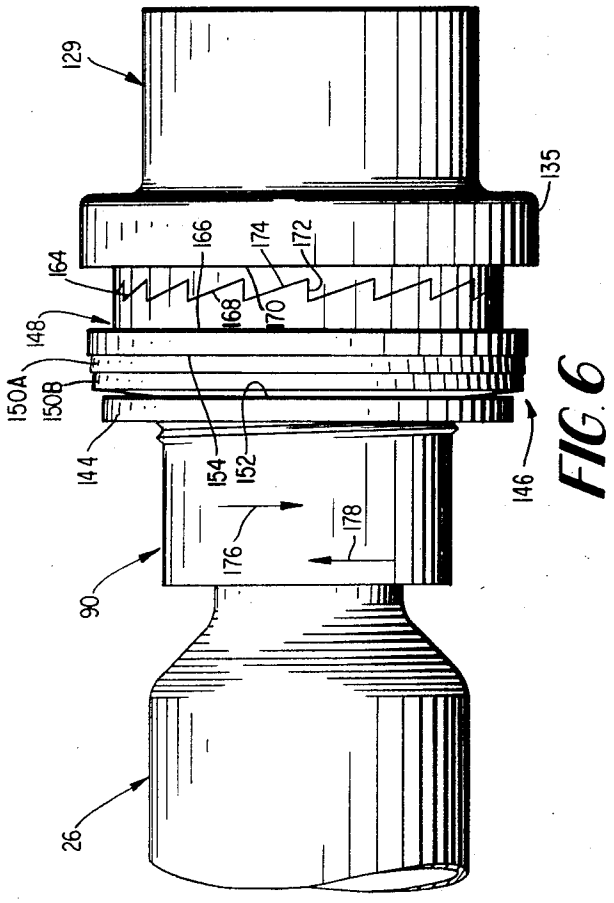


FIG. 6

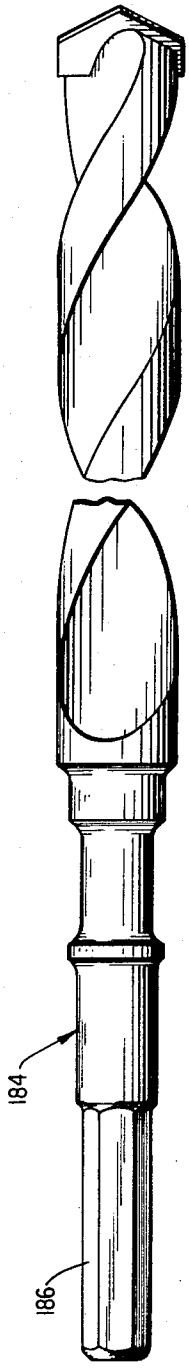


FIG. 10

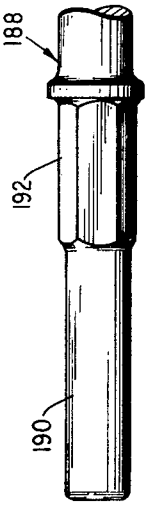
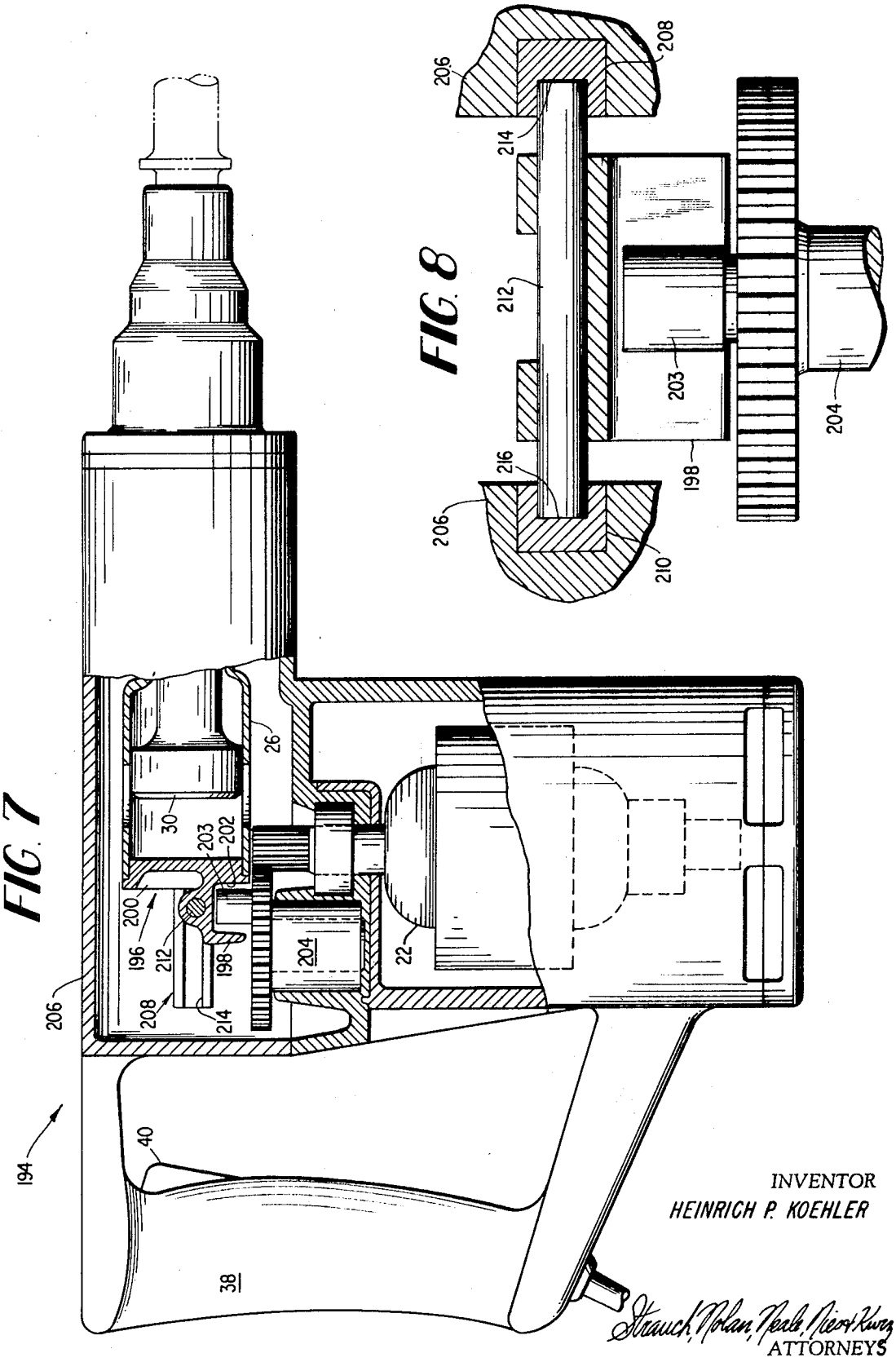


FIG. 11

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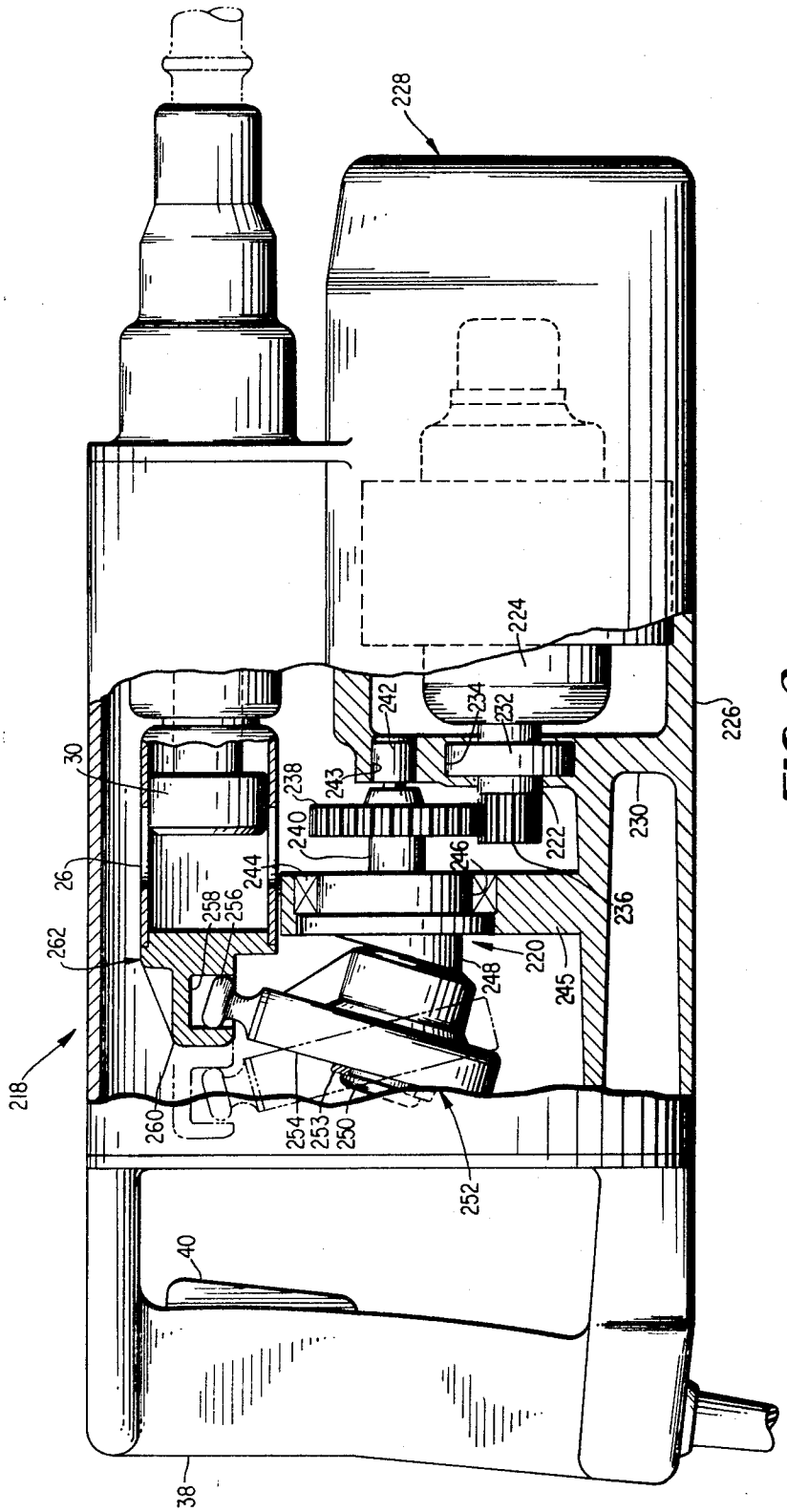


FIG. 9

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POWER DRIVEN DEVICE

RELATION TO OTHER APPLICATIONS

This application is a continuation-in-part of copending application Ser. No. 847,294 filed Aug. 4, 1969.

The present invention relates to power driven devices and, more particularly, to power driven devices for drilling holes in or otherwise working concrete, masonry, and the like by axially impacting a tool against the workpiece, either with or without intermittent rotation of the tool, depending upon the task and the material involved.

One primary object of the present invention resides in the provision of novel, improved power driven devices of the type just described.

Another primary object of the present invention resides in the provision of power driven devices which are improvements on those disclosed in the copending application identified above.

A number of tools for drilling holes in or otherwise working concrete, masonry, rock, and similar materials have heretofore been proposed, including those described in U.S. Pat. Nos. 1,191,148; 1,601,644; 2,283,292; 2,533,481; 2,558,165; 3,256,944; 3,334,693; 3,456,740; 3,456,743; and 3,463,246; in German Pat. Nos. 121,394; 153,320; and 306,148; in Robert Bosch GmBH Spare Parts List No. EW–EWV 2/302/IX (11.64); and in Metabo Elektrowerkzeuge Spare Parts List for Bohrhammer 1130 dated Feb. 1969. However, in each instance, these previously proposed devices had drawbacks such as undue complexity, unwieldiness, excessive size and/or weight, poor balance, inadequate protection against the penetration of foreign matter to the interior of the device, and similar factors. In addition many such tools heretofore proposed operate less than satisfactorily and/or make no provision for protecting the operator from injury or the device against damage if the tool sticks.

The foregoing and other deficiencies of heretofore available devices of the type in question are eliminated in the power driven hammers disclosed in copending application, Ser. No. 847,294. In the devices described and illustrated in this copending application the motor of the device, which is preferably disposed at right angles to the longitudinal axis of the hammer, is connected through a rotary-to-reciprocating motion converting mechanism to an impact producing mechanism consisting of a reciprocable piston in which a free-floating driver is slidably mounted. The driver is dimensioned to strike a closed type tool holder to impart axial impacts to a tool in the holder. Controlled flow of air into and out of the piston on opposite sides of the driver produces positive forces for propelling the driver through its working and return strokes and provides cushions which prevent the driver from striking the ends of the piston as it moves back-and-forth therein.

During each cycle of the impact imparting mechanism the tool socket is rotatably advanced through an angle of preselected magnitude by a novel motion transmitting mechanism driven by the piston. This mechanism is also torque responsive and interrupts the rotary drive connection between the piston and tool socket if the tool binds or sticks.

Depending upon the operation involved, the intermittent rotary motion of the tool socket may or may not be transmitted to the tool itself. This provides a choice between axial hammering alone or axial hammering plus intermittent rotation of the tool.

In the novel power driven hammers just described, the rotary motion producing mechanism includes a drive member which is connected to the reciprocable piston by helical splines so that the drive member rotates back-and-forth as the piston reciprocates. This motion of the drive member of the rotary motion producing mechanism, which is of the ratchet type, is converted to intermittent unidirectional rotary motion by an arrangement which has as its input the drive member just described. The output member of the ratchet arrangement consequently rotates or advances only as the drive member rotates in one of its two opposite directions.

A spring biases ratchet teeth on the input and output members of the intermittent motion producing mechanism together, and the biased members accordingly separate and permit the ratchet teeth on the two members to ride over each other when the input member rotates in the direction in which rotary motion of the output member is not wanted. This biasing arrangement also provides torque responsive interruption of the drive connection in that the ratchet teeth are configured so that separation of the input and output members will occur and allow the teeth on the two members to ride over each other if a restraining torque of a predetermined magnitude is exerted on the tool holder, even though the input member is rotating in the output member advancing direction.

I have now discovered that more positive and effective interruption in the drive train to the tool can be obtained by replacing the ratchet mechanism input member just described with a drive member which is rotatable by the reciprocating piston and a ratchet input member rotatable relative to the drive member and frictionally drive-connecting these two components by a frictional drive providing element disposed between them since this arrangement eliminates any defects in performance attributable to separation inhibiting forces which may in some operational circumstances be imposed on the ratchet members employed in the devices disclosed in copending application Ser. No. 847,294. That is, in the present invention, overload release does not require separation of the ratchet members, but only slippage between the frictional drive connecting element and/or the drive member and the ratchet input member; and the point at which such slippage will occur can be accurately controlled by the design of the frictional drive connection, and by a novel arrangement which allows the devices of the present invention to be individually calibrated so that slippage will occur at the proper point.

That an effective torque responsive overload release feature is incorporated in the intermittent rotary motion producing mechanism is of considerably importance. This feature prevents a binding or sticking tool from causing damage to the hammer or injury to its operator as it keeps the motor from driving the hammer about a stuck tool and also prevents the motor from being burned out if a tool sticks.

Due to the novel features they share in common with the power driven devices disclosed in copending application, Ser. No. 847,294, the novel power hammers of the present invention also have a number of advantages.

Specifically, they are compact and relatively light and have good balance due to the manner in which the motor is positioned with respect to the rotary-to-reciprocatory motion converting mechanism. They are also rugged, providing a long service life, and uncomplicated, making them comparatively inexpensive to manufacture and maintain.

Furthermore, the novel power hammers of the present invention are highly effective in drilling and like operations because of the intermittent rotation imparted to the tool in conjunction with axial impacts.

Further, the novel closed type tool holder employed in the hammers of the present invention has been found highly effective in preventing foreign matter from penetrating to the interior of the hammer casing. This also contributes to proper operation of the hammer and to long service life.

The primary objects of the present invention have been identified above. Another important but more specific object of the present invention resides in the provision of novel, improved power driven devices in which there is a reciprocating to intermittent, unidirectional, rotary motion converting mechanism connected between a driving motor and a tool holder and in which such mechanism includes a frictional drive providing an interruption of the connection between the motor and tool holder when a restraining force of predetermined magnitude is exerted on the tool holder.

Other important, specific objects of the present invention reside in the provision of novel, improved power driven hammers, which:

1. are particularly effective for drilling holes in concrete, masonry, rock, and the like.

2. are compact and relatively light and well balanced.

3. are rugged and uncomplicated and therefore have a long service life and are relatively inexpensive to manufacture and service.

4. are versatile.

5. are constructed to minimize the penetration of foreign matter to the interior of the hammer.

6. have various combinations of the desirable attributes just discussed.

Other objects and features and additional advantages of the invention will become apparent from the appended claims and as the ensuing detailed description and discussion proceeds in conjunction with the accompanying drawing, in which:

FIG. 1 is a side view of a power driven hammer constructed in accord with the principles of the present invention, part of the hammer casing being broken away to show certain of its internal components;

FIG. 2 is a section through the hammer of FIG. 1 taken substantially along line 2—2 of FIG. 1, showing the driver and reciprocating piston of an axial impact producing mechanism employed in the hammer and the member in the piston is mounted;

Flg. 3 is a fragmentary side view of the piston and the input member of the intermittent rotary motion producing mechanism with the latter sectioned to show the manner in which it is drive-connected to the piston;

FIG. 4 is a section through the hammer taken substantially along line 4—4 of FIG. 1, showing the piston of the impact imparting mechanism and the input member of an intermittent rotary motion producing and torque responsive overload release mechanism which is driven by the piston as the latter reciprocates in the hammer casing;

FIG. 5 is a section through the hammer taken substantially along line 5—5 of FIG. 1, showing the output member of the rotary motion producing mechanism, a tool socket which is driven by the output member, and the forward end of the hammer casing;

FIG. 6 is a side view of the input and output members of the intermittent rotary motion producing mechanism illustrating the drive connection therebetween;

FIG. 7 is a view similar to FIG. 1 of another embodiment of the invention;

FIG. 8 is a transverse section through a Scotch yoke mechanism employed in the hammer of FIG. 8;

FIG. 9 is a view similar to FIG. 1 of yet another form of the invention;

FIG. 10 is a side view of one form of tool which may be used in the hammers of the present invention; and

FIG. 11 is a fragmentary side view of a second type of tool which may be employed in the hammers of the present invention when axial hammering without rotary motion of the tool is desired.

Referring now to the drawing, FIG. 1 depicts a power driven hammer 18 constructed in accord with the principles of the present invention. The major components of hammer 18 include a casing 20 housing a motor 22 drive-connected through rotary-to-reciprocable motion converting mechanism 24 to the piston 26 of an impact imparting mechanism 28 which also includes a free-floating driver 30 slidably mounted in the piston. Driver 30 is adapted to periodically strike and impart axial impacts to an axially movable tool holder 32 mounted in the forward end of casing 20 and thence to a tool (not shown) in holder 32. The tool may also be intermittently rotated or advanced during each working stroke of piston 26 by the piston, which is drive-connected to tool holder 32 through a reciprocable to intermittent, unidirectional rotary motion converting drive mechanism 36. Drive mechanism 36 is also designed to serve an overload function, i.e., to interrupt the drive connection between piston 26 and tool holder 32 if the rotation resisting torque exerted by the tool on the tool holder rises above a predetermined magnitude.

Hammer 18 also includes a pistol grip 38 supporting a witch 40 for controlling the operation of motor 22. The details of these components are not part of the present invention and will accordingly not be described further herein.

Considering now the novel hammer 18 just described in more detail, motor 22 is supported in depending casing section 42 in a conventional manner at a right angle to the longitudinal axis of hammer 18, an arrangement which is preferred as it eliminates the need for comparatively expensive bevel gears in drive train mechanism 24. Also, as shown in FIG. 1, the motor shaft 44 is located forwardly of a crankshaft 45 incorporated in drive train 24. This shortens the hammer, making it more compact. Also, it places the center of gravity of the hammer closer to its grip 38, thereby improving the balance of the hammer and making it easier to handle. The output shaft 44 of the motor extends vertically through a bearing 46 in the upper end of casing section 42 into the interior of a casing section 48 where a pinion 50 fixed to or integral with its upper end meshes with a gear 52 fixed to the crankshaft 45 just mentioned.

Referring still to FIG. 1, crankshaft 45 is rotatably supported in casing section 48 in bearings 56 and 58. Lower bearing 56 is seated in a recess 60 formed in a boss 62 which protrudes from the rear wall 64 of casing section 42. Upper bearing 58 is supported from the top wall 66 of lower casing section 42 by a conventional bearing holder 68 of the configuration illustrated in FIG. 1.

Rotary motion of crankshaft 45 produced through the arrangement just described is translated into longitudinal, rectilinear movement of piston 26 by crankpin 70, connecting rod 72, and wrist pin 74. Crankpin 70 is fixed to or made integral with crankshaft 45 and is located at the periphery thereof in conventional fashion. One end of connecting rod 72 is fixed to the crankpin with a bearing 76 being disposed between the crankpin and connecting rod to permit the elements to rotate freely with respect to each other.

The opposite end of connecting rod 72 is pivotally fixed to the rear wall member 78 of piston 26 by wrist pin 74, which extends through apertures (not shown) in member 78 and an aperture (likewise not shown) through a boss 86 on the forward end of the connecting rod.

Referring now to FIGS. 1 and 2, piston 26 is supported for rectilinear movement in casing section 48 by a piston guide 88 and by a rotatably mounted motion converting component 90 in previously mentioned drive mechanism 36. Piston guide 88 has a cylindrical main portion 92 and a radial flange 94 and is fixed in casing section 48 by fasteners 96 which extend through flange 94 and are threaded into the casing section. Cooperating external splines 98 on piston wall member 78 and internal splines 100 in the cylindrical portion 92 of piston guide 88 keep piston 26 from rotating or twisting in the guide as it is reciprocated by motor 22 acting through motion converting mechanism 24.

The free-floating driver 30 referred to above, which is the other component of the axial impact producing mechanism, has a head 102 dimensioned for a sliding fit in the main body portion 104 of piston 26 and a smaller diameter stem 106 dimensioned for a sliding fit in the necked down forward portion 108 of the piston. Driver 30 is propelled into engagement with tool holder 32 as piston 26 moves forwardly[1](1. By forward and rearward as used herein (unless specified otherwise) are meant toward the nose end of the hammer and toward the grip end of the hammer, respectively.) in casing 20 and displaced toward the rearward end of the piston during the return stroke of the latter by the controlled ingress of air into piston 26 on opposite sides of driver head 102 and the controlled egress of air therefrom through ports 110 in the piston.

More specifically, with reference to FIG. 1, piston 26 is shown in its forwardmost position with driver 30 moving forwardly in the piston to impart an axial blow to tool holder 32 and thereby drive a tool mounted therein in the direction indicated by arrow 111. At this point ports 110 in piston 26 are partly uncovered. Accordingly, there is no pressure differential between the exterior of the piston and the chamber 112 between driver head 102 and piston rear wall member 78.

Upon rebound and approximately as piston 26 changes direction and moves rearwardly, drive 30 rebounds toward the

rear of the hammer drill. This movement is initially relatively unimpeded because of the comparatively low pressure in chamber **112** and the force exerted by air trapped in the chamber **113** between the forward end of driver head portion **102** and the reduced diameter portion **108** of piston **26**. As the piston and driver continue to travel rearwardly, the forward portions of ports **110** are uncovered. This permits compressed air to escape from chamber **113** and seals chamber **112** in which the pressure therefore begins to increase.

Next, the piston reaches its rearwardmost position; reverses direction while driver **30** is still travelling toward the rear end of hammer **18**; and moves forwardly, further increasing the pressure in chamber **112** until the air is sufficiently compressed to overcome the inertia of the still rearwardly moving driver. This compressed air expands, propelling driver **30** forwardly into impacting engagement with tool holder **32**. The air compressed in chamber **112** also provides a cushion which keeps the driver from striking and possibly damaging the piston during its rearward movement in the portion of the impact mechanism operating cycle just described.

As the driver is driven forward toward tool holder **32** by the expansion of air in chamber **112**, the forward ends of ports **110** are closed, sealing chamber **113** from the ambient atmosphere. Thus the pressure in chamber **113** increases as the driver approaches the forward end of the piston. This provides a cushion which keeps the driver from striking the forward part of the piston, even if there is no tool in the holder or the hammer is idling with the tool holder forward in casing member **114** and out of contact with driver **30**.

The double-acting air cushion arrangement just discussed can, of course, be replaced by other types of impact mechanisms, if desired. The double-acting type is preferred, however, because positive pressures are available to effect both the forward and rearward motion of the driver in contrast to other types in which a negative pressure or vacuum is at least in part utilized to effect movement of the driver or striker. Also, the air cushions produced in the preferred arrangement are highly effective in preventing the driver from striking and damaging the piston. This is a significant factor in long service life.

Turning now to FIGS. **1** and **6**, the tool holder **32** against which driver **30** impacts includes a cylindrical main body portion **115** in which a tool receiving socket **116** is formed and a closed rear wall **117**, which prevents foreign matter from penetrating through the tool socket to the interior of casing **20**.

Tool holder **32** is mounted for rectilinear movement in the forward section **114** of tool casing **20** with a flange **118** at its nose slidingly engaging the interior of the casing section. An O-ring **122** disposed in a recess **124** formed in the tool holder nose portion prevents foreign matter from penetrating to the interior of the tool casing around the tool holder.

A ring **126** of resilient material is preferably disposed in the forward end of casing section **114** in spaced relation to tool holder **32**. This ring keeps tool holder **32** from striking and damaging the casing with motor **22** running and hammer **18** idling or with no tool in the tool holder.

Referring now to FIGS. **1** and **5**, the main body portion **115** of the tool holder extends into a bore **128** through the output or driven member **129** of a ratchet type, intermittent rotary motion producing mechanism **130** incorporated in motion converting drive mechanism **36**. Output member **129** is rotatably mounted in casing section **114**, but is fixed against axial movement by an annular ledge **131** in casing section **114** and a retainer **132** fitted in a recess **133** spanning the joint between forward casing section **114** and intermediate casing section **134**. Ledge **131** and retainer **132** engage opposite sides of a flange **135** on member **129**. External splines **136** on the main body portion **115** of toolholder **32** and cooperating internal splines **137** in the bore **128** of driven member **129** connect the tool holder to output member **129** for rotation therewith.

Turning next to FIgS. **1** and **3**, the motion converting component or drive member **90** of mechanism **36** referred to previously has an internal bore **138** through which the forward end portion **108** of piston **26** extends. Member **90** is rotatably and axially movable in a bore **139** through an annular boss **140** in intermediate casing section **134**.

As shown in FIG. **3**, helical external splines **141** are formed on the forward end portion **108** of piston **26**, and cooperating, internal, helical splines **142** are formed in the bore **138** of driven member **90**. Accordingly, as piston **26** is reciprocated by the mechanism described above, it effects an oscillatory or to-and-fro rocking movement of drive member **90** through an angle determined by the configuration of cooperating splines **141** and **142**.

Referring now to FIGS. **1** and **6**, the cylindrical input member **144** of a friction clutch **146** incorporated in motion producing mechanism **36** is journaled on and fixed to member **90** for rotation therewith in a manner which will be described hereinafter. The output member **148** of clutch **146** is similarly journaled on member **90**, but is free to rotate relative to this member.[2] (2. As will become apparent shortly, clutch output member **148** is also the input or drive member of ratchet mechanism **130**.)

Clutch members **144** and **148** are frictionally drive connected by Belleville washers **150A** and **150B**. As shown in FIG. **1**, the Belleville washers are journaled on motion converting drive component **90** between the clutch elements and frictionally engage the forward face **152** of input member **144** and the rear face **154** of output member **148**.

The maximum force which clutch **146** is capable of transmitting is determined by the design of the Belleville washers and clutch faces **152** and **154** and by the distance between the clutch faces[3]. (3. These factors determine the coefficient of friction between and the normal forces on the engaging surfaces. This distance is determined by the engagement of cooperating internal and external shoulders **156** and **158** on output member **148** and drive member **90**, which limit the forward movement of the clutch output member, and by input member **144** which is a nut **160** threaded on and spot welded to member **90** after calibration[4](4. This arrangement is of considerable practical importance as it allows for individual calibration of devices of the type described herein.)

Referring now to FIGS. **1** and **6**, the forward end of clutch output member **148** faces the annular flange **135** at the rear end of ratchet mechanism driven member **129**. Ratchet teeth **164** are formed on the forward face **166** of output member **148**, and cooperating ratchet teeth **168** are formed on the face **170** provided by the flange **135** at the rear end of output-input member **129**.

As shown in FIG. **6**, the teeth **164** on clutch member **148** have a steep leading edge **172** and a trailing edge **174** with a relatively gentle slope. The teeth on member **129** are similarly configured but face in the opposite direction.

Accordingly, with teeth **164** and **168** in engagement as shown in FIG. **6**, clutch member **148** drives ratchet mechanism output member **129** when motion converting component **90** is oscillated or rotated by piston **26** in the direction shown by arrow **176**. However, when output-input member **148** is oscillated in the opposite direction as shown by arrow **178**, teeth **164** slide over the teeth **168** on member **129**; and no rotary motion is imparted to the latter.

Thus, depending upon the inclination of the cooperating helical splines **141** and **142** on the piston and motion converting member **90**, respectively, the piston is effective upon its forward or return stroke to rotate member **90** in a direction in which it will rotatably advance output member **129**, driving through clutch **146** and ratchet mechanism **130**. This rotary advance is transmitted to tool holder **32** by the cooperating external splines **136** on the tool holder and **137** in the bore through the output member. This incremental advance is in turn transmitted to a tool mounted in the tool socket by employing matching configurations in the tool socket **116** and on the shank of the tool. Typically, this configuration will be hex-

agonal (see FIG. 10) although any configuration which will drive connect the tool to the tool socket may be employed.

Referring now to FIG. 1, clutch output member 148 and ratchet mechanism output member 129 are normally maintained in the driving relationship shown in FIG. 6 by a compression spring 180 having one end which abuts clutch input member 144. The other rear end of this spring engages an annular ledge 182 formed at the rear end of the intermediate casing section 134 in which the input member is disposed.[5] (5. As an alternate, motion converting member 90 and clutch 146 can be axially fixed in intermediate casing section 134 and the compression spring relocated to bias tool holder rotating member 129 toward the rear of the hammer (see application Ser. No. 847,294 in which this type of arrangement is illustrated and described in detail). The arrangement described above is preferred, however, as it is the more effective in keeping the ratchet mechanism input and output members 148 and 129 in firm driving engagement, even under the vibration produced by the rebounding driver and tool holder. Moreover, eccentricities in and cocking of the tool are more satisfactorily accommodated in the axially fixed output member 129 than in alternate arrangements in which the output member is axially movable.) However, spring 180 allows clutch 146 to move to the rear and teeth 164 to slide over teeth 168 in the manner described above when motion converting component 90 is oscillated in the direction indicated by arrow 178[6]. (6. It was indicated above that the intermittent rotary advance of the tool can be effected on either the working or the return stroke of piston 26. It is preferred, however, that this motion be provided during the forward stroke. In this case friction between the helical splines on the piston and those in member 90 biases member 90 and the elements of clutch 146 forwardly, assisting spring 180 in keeping the teeth on clutch output member 148 in engagement with the teeth on ratchet mechanism driven member 129 while the driving part of the ratcheting motion occurs. Also, the frictional force between the helical splines tends to keep the driving and driven members 148 and 129 from separating due to rebound under impact. Moreover, on the return stroke the frictional force acts in the opposite direction to retract the driving member and facilitate the ratcheting of output-input member 148 relative to output member 129.)

The novel intermittent rotation just described has proven to contribute significantly to the operation of the present invention, especially in drilling operations in which spiral fluted bits of the type illustrated in FIg. 10 are employed. This particular mechanism produces high acceleration rates, making the illustrated type of bit highly effective in breaking off chips in the borehole, and also facilitates the movement of the chips up the bit and out of the borehole.

As indicated above, clutch 146 constitutes a torque responsive overload release as well as a motion transmitting link in the mechanism 36 provided for intermittently rotatably advancing tool holder 32. More specifically, if a tool mounted in socket 116 becomes stuck or an excessive rotation restraining torque is other wise exerted upon it, this restraint will be transmitted through tool holder 32 to ratchet mechanism output member 129 through the drive connection discussed above.

With the output member thus restrained against rotation, motion converting member 90 will still be rotatably oscillated by piston 26 as it reciprocates in casing 20. However, as the input member rotates in the direction indicated by arrow 176 in FIG. 6, one or both of the clutch members 144 and 148 will slip relative to Belleville washers 150A and 150B.

Such slippage will continue until the rotation restraining force is removed from ratchet mechanism output member 129. This is an important safety feature as it keeps motor 22 from driving hammer 18 around a stuck tool and hitting the operator or damaging the hammer and also prevents the motor from stalling and suffering damage if a tool sticks.

As discussed above, the novel torque overload release just described affords accurate control over the point at which interruption of the application of driving force to a stuck or otherwise restrained tool will occur. Accordingly, tools constructed in accord with the principles of the present invention are highly effective in effecting release if an overload occurs and, accordingly, highly effective in preventing the damage or injury which can result if torque overload release does not properly occur.

Another unique advantage of the novel mechanism 36 just described is that a stuck bit may be freed by shutting off the power to motor 22 and then rotating hammer 18 about the tool in the drilling direction to impart torque to and thereby free the tool. In heretofore available hammers such procedure merely spins the hammer motor, and no torque is exerted on the stuck bit.

The foregoing description of an exemplary embodiment of the invention was concerned with applications of the invention in which it is desired to impart both axial impact and intermittent rotary movement to a tool mounted in tool holder 32. In this type of application tools like those illustrated in FIG. 10 and identified by reference character 184 are employed. As indicated previously, this type of tool has a shank 186 which matches the configuration of the socket 116 in tool holder 32 and fixes the tool to the tool holder for intermittent unidirectional rotation therewith.

However, the exemplary impact hammer described above may equally well be employed for applications where axial impact without rotary movement is desired. For such applications, tools with the shank configuration discussed above are replaced with a tool of the type identified by reference character 188 in FIG. 11 in which the rearward portion 190 of the tool shank is cylindrical and the forward portion 192 has a hexagonal or other noncircular configuration configured for sliding fit in a socket 193 formed in the forward end of casing member 114.

The connection between shank portion 192 and socket 193 keep tool 188 from rotating in the housing member. And, as the rear shank portion 190 extending into the socket 116 in tool holder 32 is circular, there is no driving connection between the tool socket and the tool. Thus, while motion transmitting mechanism 36 continues to rotatably advance tool socket 32 in the manner previously discussed, this rotary motion is not imparted to the tool. Axial blows are, however, imparted to the shank of the tool by driver 30 through the tool holder in the manner described above.

As mentioned previously, hammers constructed in accord with the principles of the present invention may take forms other than that discussed above and illustrated in FIGS. 1–6. For example, FIGS. 7 and 8 illustrate an embodiment of the present invention which involves the substitution of a Scotch yoke for the crank and connecting rod employed in hammer drill 18 to convert the rotary motion of the hammer motor to reciprocatory motion of the piston of the impact imparting mechanism. For the most part the components of the hammer 194 illustrated in these figures may be like those of hammer 18. Such like components have been identified by the same reference characters as in FIGS. 1–6.

The Scotch yoke motion converting mechanism 196 of hammer 194 includes a transversely extending crosshead 198 integrally formed on the rear wall member 200 of piston 26. Crosshead 198 is provided with a downwardly opening recess 202 into which the eccentric crankpin 203 on crankshaft 204 extends.

Crosshead 198 and piston 26 are mounted for but confined to axial longitudinal movement in casing member 206 by guides 208 and 210 which extend longitudinally in casing member 206 on opposite sides thereof and a pin 212, which extends through crosshead 198 into recesses 214 and 216 in guides 208 and 210, respectively. Accordingly, as crankshaft 204 rotates, crankpin 203 moves laterally in the recess 202 of crosshead 198, causing piston 26 to reciprocate longitudinally in casing section 206 in the same manner as in hammer 18 to produce axial impact and intermittent rotary motion.

The Scotch yoke modification just discussed may prove advantageous in many applications of the present invention. It

may permit a reduction of the overall length of the hammer drill, has a small number of components, is of light weight, and is not expensive to build.

FIG. 9 depicts yet another hammer **218** constructed in accord with the principles of the present invention. In this hammer the mechanism **220** provided to convert the rotary motion of motor output shaft **222** into reciprocable motion of piston **26** is of the wobble plate type. Also, in this embodiment of the invention, motor **224** is mounted in a lower section **226** of hammer casing **228** with its output shaft **222** extending rearwardly parallel to the longitudinal axis of the hammer through casing partition **230** and a bearing **232** disposed in aperture **234** in the partition. Integral with or attached to the rear end of output shaft **222** is a pinion **236**, which meshes with a gear **238** fixed on a shaft **240**. Shaft **240** is supported from partition **230** in a bearing **242** fitted into an aperture **243** in the partition and is also supported by a bearing **244** fitted into holder **245**.

Fixed to the rear end of shaft **240** is a member **247** carrying a wedge-shaped disc or plate **248**. Extending at an angle from plate **248** is a crankpin **250** on which a wobble plate structure **252** is journaled. The wobble plate is retained on the crankpin by a retaining ring **253** or the like.

The wobble plate includes a pin **254** having a head **256** disposed in a hole **258** which is formed in a boss **260** integral with the rear wall member **262** of piston **26**, which is restrained against rotation by an arrangement (not shown) of the type described above in conjunction with the embodiment of FIG. 1.

As shaft **240** is rotated by motor **224**, wobble plate **252** imparts the same reciprocatory motion to piston **26** as do the other forms of motion converting mechanism described above. Hammer **218** accordingly operates in the same manner as the previously described embodiments to produce axial impacts on and intermittent rotation of tool holder **32**.

It will be apparent to those skilled in the relevant arts that power driven hammers employing the principles of the present invention may assume forms other than those illustrated and described above. To the extent that they are not expressly excluded from the appended claims, such forms of the invention are fully intended to be covered therein.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of therefore intended to be embraced therein.

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

1. A power driven device, comprising: a casing; an impact imparting mechanism; means mounting said impact imparting mechanism in said casing; a motor; motion transmitting and converting means drive-connecting said motor to said impact imparting mechanism for cycling said mechanism through working and return strokes; a rotatably mounted tool holder; and means so drive-connecting said impact imparting mechanism to said tool holder that said mechanism rotatably advances said tool holder during one of the strokes in each cycle thereof but does not effect rotation of the tool holder in the other stroke of each cycle thereof, said drive connecting means including a unidirectionally acting rotatable drive means having an input member and an output member with the output member being operatively connected to said tool holder and a frictional drive connection providing means capable of transmitting only forces up to a selected maximum magnitude operatively connected between said impact imparting mechanism and the input member of said unidirectionally acting drive means, whereby the drive connection between the impact imparting mechanism and the tool holder is effectively interrupted while there is a rotation restraining force on said tool holder which exceeds the magnitude of the force which said frictional drive connection is capable of transmitting.

2. The power driven device of claim **1**, wherein the means drive-connecting the impact imparting mechanism to the tool holder includes a rotatably mounted driven member connected to said tool holder for rotation therewith, said tool holder being axially movable relative to said driven member; a rotatably mounted drive member axially aligned with said driven member; and first and second means so drive-connecting said impact imparting mechanism to said drive member through said frictional drive connection and said drive member to said driven member that, during one of said working and return strokes in each cycle of said impact imparting mechanism, the rectilinear movement of said mechanism causes a rotary advance of said drive member and said drive member rotatably advances said driven member and therefore said tool holder.

3. The power driven device of claim **2**, wherein said imparting mechanism includes a rectilinearly reciprocable piston; said drive member has a bore therein into which said piston extends; and the means drive-connecting the impact imparting mechanism to said drive member comprises external helical splines on said piston and internal helical splines in the bore of said drive member.

4. The power driven device of claim **1**, wherein said impact imparting mechanism comprises a cylindrical piston having one closed end and a driver slidable in said piston and extending through the other end of the piston, said driver being engageable with said tool holder and said piston being so ported as to permit the formation of air cushions in the opposite ends of said piston as said driver moves back and forth therein.

5. The power driven device of claim **4**, wherein the motion transmitting and converting means drive-connecting said motor to said impact imparting mechanism comprises means for reciprocating the piston of the impact imparting mechanism which includes a rotatably mounted crank having an eccentric crankpin thereon; a connecting rod pivotally fixed to said crankpin; means pivotally fixing said connecting rod to said piston; and means drive-connecting said motor to said rotatably mounted crank.

6. The power driven device of claim **5**, wherein said motor has an output shaft and wherein the means drive-connecting the motor output shaft to said crank is gear teeth on said shaft and gear teeth around the periphery of said crank intermeshing with those on the motor output shaft.

7. The power driven device of claim **4**, wherein the motion transmitting and converting means drive-connecting the motor to the impact imparting mechanism comprises means for reciprocating the piston of the impact imparting mechanism and wherein said piston reciprocating means includes a rotatably mounted crank; an eccentrically mounted crankpin; a crosshead having a slot extending at right angles to the direction of reciprocating of said piston, said crankpin extending into said slot; guides confining said crosshead to rectilinear, reciprocal movement in the same direction as said piston; and means fixing said crosshead to said piston.

8. The power driven device of claim **7**, wherein said casing has means for retaining the tool holder therein and an opening in the nose end thereof through which a tool can be inserted for connection to said tool holder, said tool holder having a blind tool receiving bore therein with the closed end of the bore being the furtherest from the nose end of the casing, and there being a sealing member extending completely around and engaging the periphery of the tool holder and the inside of the casing, whereby foreign matter is prevented from penetrating beyond the work holder into the interior of the casing.

9. A power driven device according to claim **8**, wherein the opening in the nose end of the casing has a noncircular configuration, whereby said casing will restrain against rotation a tool inserted therethrough which has a matching external configuration.

10. The device of claim **9**, wherein the tool receiving bore in the tool holder has a noncircular configuration, whereby a tool inserted into said bore and having a matching external configuration is connected to said tool holder for rotation therewith.

11. The power driven device of claim 1, wherein the means drive-connecting the impact imparting mechanism to the tool holder comprises ratchet means including axially aligned, rotatable input member and output members; means connecting said output member to said tool holder for rotation therewith; and means rotating said input member back and forth as said impact imparting mechanism moves in opposite directions, there being cooperating first and second means on said input and output members engageable when said input member is rotated in one direction only to rotatably advance said output member and said tool holder.

12. A power driven device, comprising: a tool holder; a rectilinearly reciprocable impact imparting mechanism having a working stroke in which it axially impacts said tool holder and a return stroke; a first rotatably driven member, said tool holder being fixed to said first driven member for rotation therewith; a rotatable driving member disposed between said first driven member and said impact imparting mechanism, there being cooperating means on said impact imparting mechanism and said driving member for converting the rectilinear movement of said impact imparting mechanism during its working and return strokes into alternately oppositely directed rotary movements of said driving member; a rotary motion transmitting component fixed to said driving member for rotation therewith; a second driven member; means frictionally drive-connecting said second driven member to said rotary motion transmitting component; means on said second driven member engageable with cooperating means on said first driven member to rotatably advance said first driven member and therefore said tool holder as said driving member is rotated in one of said opposite directions, said means being constructed to permit the driving member to rotate relative to the driven member as it rotates in the other of said opposite directions; and means biasing into engagement the cooperating means on said first and second driven members.

13. A power driven device, comprising: a casing; a tool holder rotatably supported by said casing; an impact imparting mechanism comprising a cylindrical piston having one closed end and a driver slidable in said piston and extending through the other end of the piston, said driver being engageable with said tool holder and said piston being so ported as to permit the formation of air cushions in the opposite ends of said piston as said driver moves back and forth therein; means mounting said impact imparting mechanism for reciprocable rectilinear movement in said casing; a motor; motion transmitting and converting means drive-connecting said motor to said impact imparting mechanism for cycling said mechanism through oppositely directed working and return strokes, said last-mentioned means comprising means for reciprocating the piston of the impact imparting mechanism and said piston reciprocating means including a wobble plate operatively connected to said piston; and means so drive-connecting said impact imparting mechanism to said tool holder that, during one of the strokes in each cycle thereof, said mechanism rotatably advances said tool holder, said mechanism not effecting rotation of the tool holder in the other stroke of each cycle thereof, and said drive-connecting means including a frictional drive connection capable of transmitting only forces up to a selected maximum magnitude, whereby the drive connection between the impact imparting mechanism and the tool holder is effectively interrupted while there is a rotation restraining force on said tool holder which exceeds the magnitude of the force which said frictional drive connection is capable of transmitting.

14. A power driven device, comprising: a tool holder; a rectilinearly reciprocable impact imparting mechanism having a working stroke in which it axially impacts said tool holder and a return stroke; a first rotatably driven member, said tool holder being fixed to said first driven member for rotation therewith; a rotatable driving member disposed between said first driven member and said impact imparting mechanism, there being cooperating means on said impact imparting mechanism and said driving member for converting the rectilinear movement of said impact imparting mechanism during its working and return strokes into alternately oppositely directed rotary movements of said driving member; a rotary motion transmitting component fixed to said driving member for rotation therewith, said rotary motion transmitting component being disposed in surrounding relationship to said driving member; a second driven member disposed in surrounding relationship to said driving member; means frictionally drive-connecting said second driven member to said rotary motion transmitting component which includes a component disposed between and frictionally engaging said rotary motion transmitting component and said second driven member; means on said second driven member engageable with cooperating means on said first driven member to rotatably advance said first driven member and therefore said tool holder as said driving member is rotated in one of said opposite directions, said means being constructed to permit the driving member to rotate relative to the driven member as it rotates in the other of said opposite directions; and means biasing into engagement the cooperating means on said first and second driven members.

15. The power driven device of claim 14, wherein said driving member includes means limiting the movement of the second driven member in one direction and including means fixing the motion transmitting component to the driving member to thereby determine the maximum force transmitting capability of the component disposed between said rotary motion transmitting component and said second driven member.

16. The power driven device of claim 14, wherein the component frictionally engaging the rotary motion transmitting component and the second driven member comprises at least one Belleville washer.

17. The power driven device of claim 16, wherein there are cooperating threads on said driving member and said motion transmitting component, whereby said motion transmitting component may be displaced axially along said driving member to vary the bias on the Belleville washer(s) and thereby preselect the frictional drive force which the motion transmitting component is capable of transmitting to said second driven member.

18. The power driven device of claim 13, wherein the means biasing the cooperating means on said first and second driven engagement comprises a compression spring means disposed between said casing and said rotary motion transmitting means and biasing said motion transmitting means and said second driven member toward said first driven member.

19. A power driven device, comprising: a rotatably mounted tool holder; a rectilinearly reciprocable impact imparting mechanism; means for cycling said mechanism through a working stroke in which it imparts an axial impact to said tool holder and an oppositely directed return stroke; and a reciprocable to intermittent, unidirectional rotary motion converting mechanism including a friction type torque overload release drive-connected between said impact imparting mechanism and said tool holder for rotatably advancing said tool holder, said overload release including calibration means for presetting the torque at which interruption of the drive connection between the impact imparting mechanism and the tool holder will occur.

20. A power driven device, comprising: an impact imparting mechanism; means for cycling said mechanism through an impact imparting working stroke and a return stroke; a rotatably mounted tool holder; and means drive-connecting said impact imparting mechanism to said tool holder which includes means so drive-connecting said impact imparting mechanism to said tool holder that said mechanism rotatably advances said tool holder during one of the strokes in each cycle thereof but does not effect rotation of the tool holder in the other stroke of each cycle thereof, said drive-connecting means including means having cooperating annular surfaces providing a frictional drive connection between said impact imparting mechanism and said tool holder which is capable of trans-

mitting only forces up to a selected maximum magnitude, whereby the drive connection between the impact imparting mechanism and the tool holder is effectively interrupted while there is a rotation restraining force on said tool holder which exceeds the magnitude of the force which said frictional drive connection is capable of transmitting.

21. A power driven device, comprising: an impact imparting mechanism; means for cycling said mechanism through an impact imparting working stroke and a return stroke; a rotatably mounted tool holder; and means drive-connecting said impact imparting mechanism to said tool holder which includes a first means so drive-connecting said impact imparting mechanism to said tool holder that said mechanism rotatably advances said tool holder during one of the strokes in each cycle thereof but does not effect rotation of the tool holder in the other stroke of each cycle thereof, said drive-connecting means including a second means providing a frictional drive connection between said impact imparting mechanism and said tool holder capable of transmitting only forces up to a selected maximum magnitude, whereby the drive connection between the impact imparting mechanism and the tool holder is effectively interrupted while there is a rotation restraining force on said tool holder which exceeds the magnitude of the force which said frictional drive connection is capable of transmitting.

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