United States Patent [19]

Koehler

[11] **3,850,255**

[45] **Nov. 26, 1974**

[54] **POWER DRIVEN HAMMERS OR THE LIKE**

[75] Inventor: **Heinrich P. Koehler,** Camillus, N.Y.

[73] Assignee: **Rockwell International Corporation,** Pittsburgh, Pa.

[22] Filed: **Aug. 4, 1969**

[21] Appl. No.: **847,294**

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

[51] **Int. Cl.** **E21c 3/04,** B25d 9/04, B25d 9/06

[58] **Field of Search** 173/47, 110, 111, 139

[56] **References Cited**

UNITED STATES PATENTS

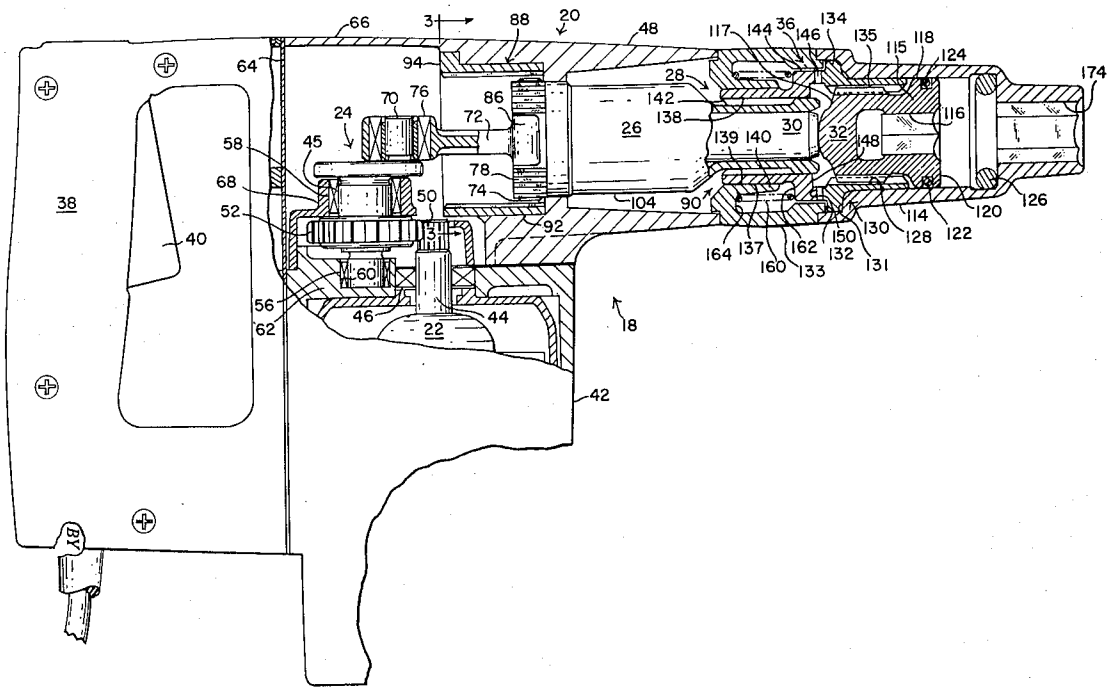
1,100,071	6/1914	Greve	173/139
1,141,650	6/1915	Oldham	173/111
1,934,252	11/1933	Baker	173/110
2,019,163	10/1935	Slater	173/111
2,955,573	10/1960	Feucht	173/139
3,463,246	8/1969	Bronnert	173/111

Primary Examiner—James A. Leppink

[57] **ABSTRACT**

Power driven hammers or the like 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 is of the ratchet type and has input and output members which are biased into driving engagement but disengage when a rotation restraining force of a predetermined magnitude is exerted on the tool holder. The input member is drive-connected to and rotated back-and-forth by the piston as the piston reciprocates.

21 Claims, 13 Drawing Figures



PATENTED NOV 26 1974

3,850,255

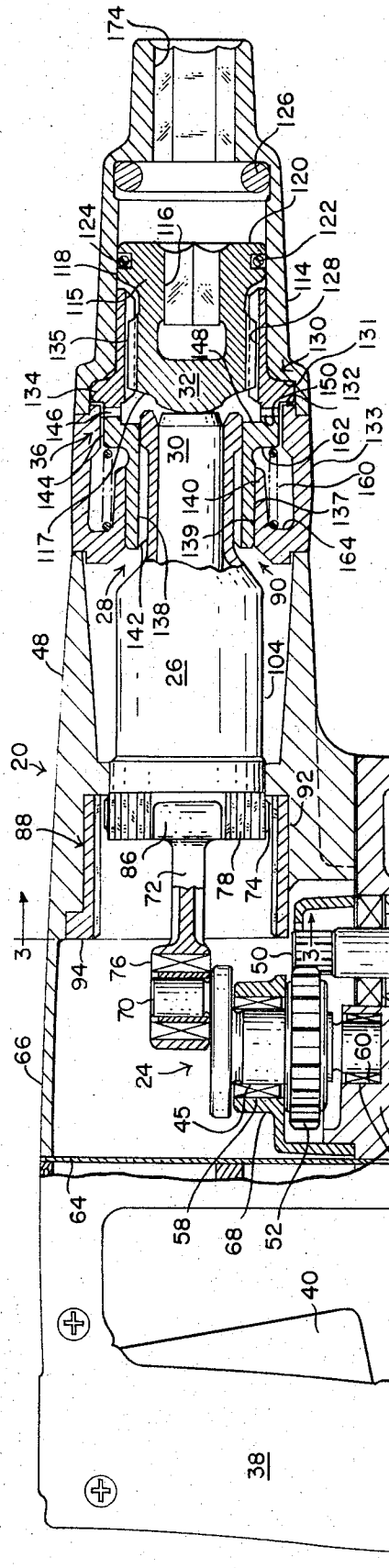


FIG. 1

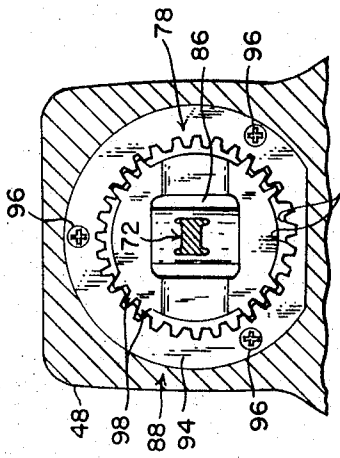


FIG. 3

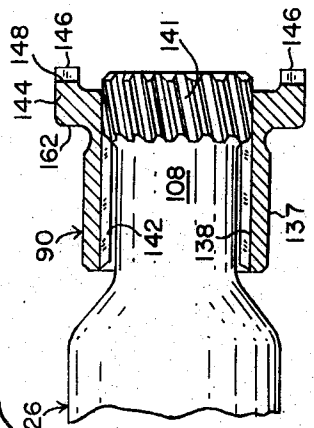


FIG. 5

INVENTOR.
HEINRICH
P. KOEHLER

BY

Strauch, Nolan, Neale,
Nies & Kurz
ATTORNEYS

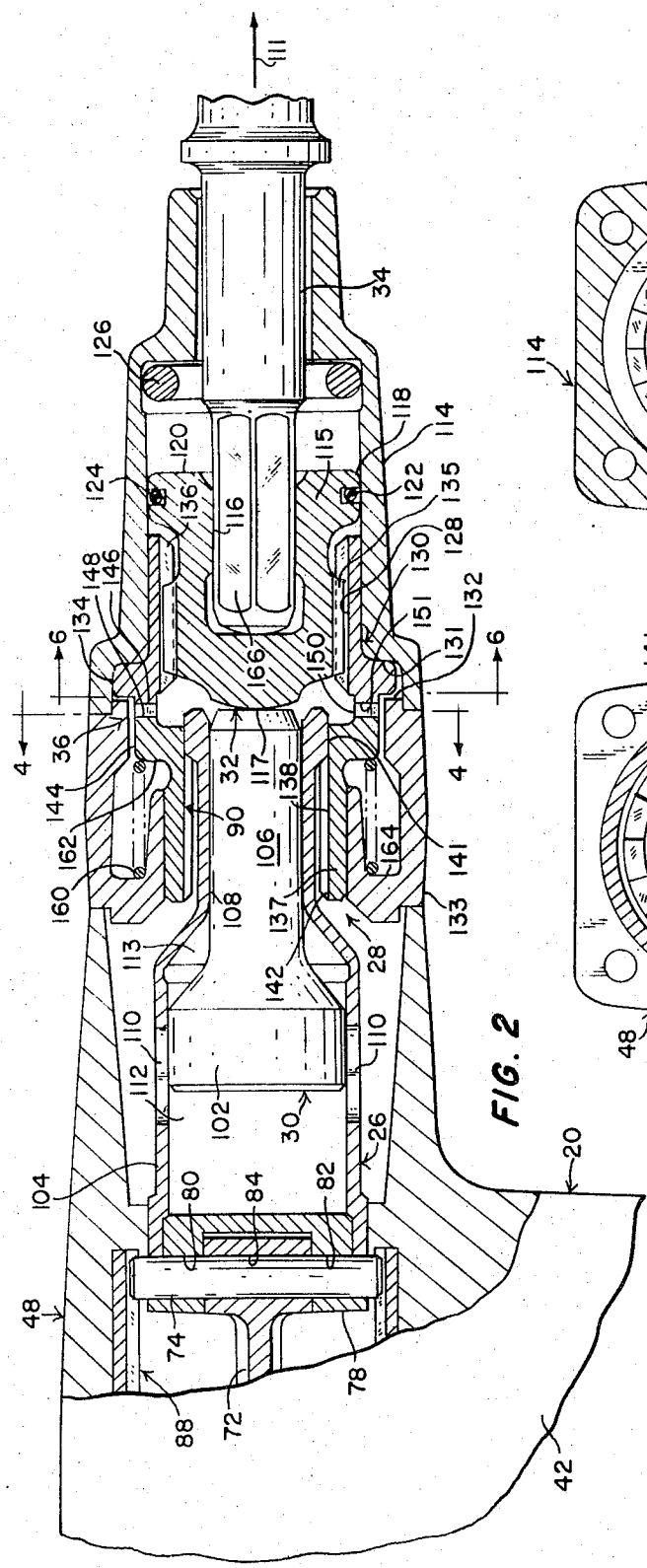


FIG. 2

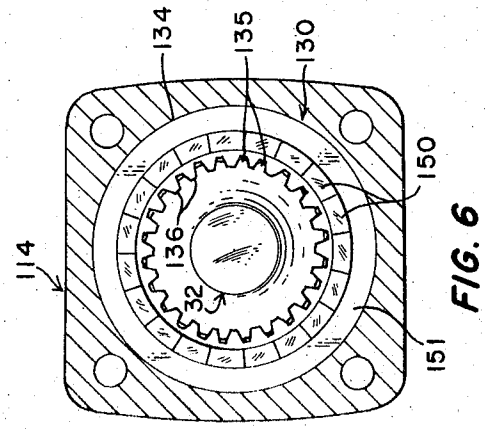


FIG. 6

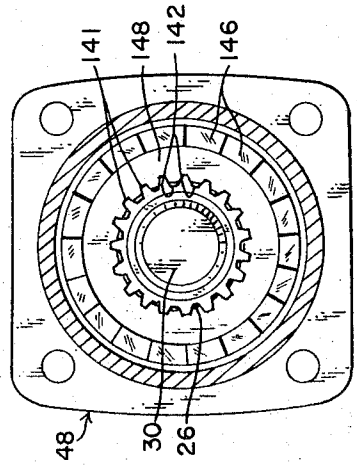


FIG. 4

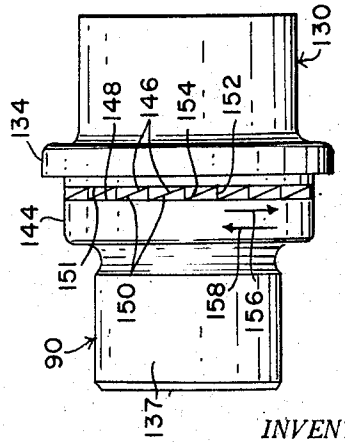


FIG. 7

INVENTOR.
HEINRICH P. KOEHLER

BY

Strauch, Nolan, Neale, Nies & Kurtz

ATTORNEYS

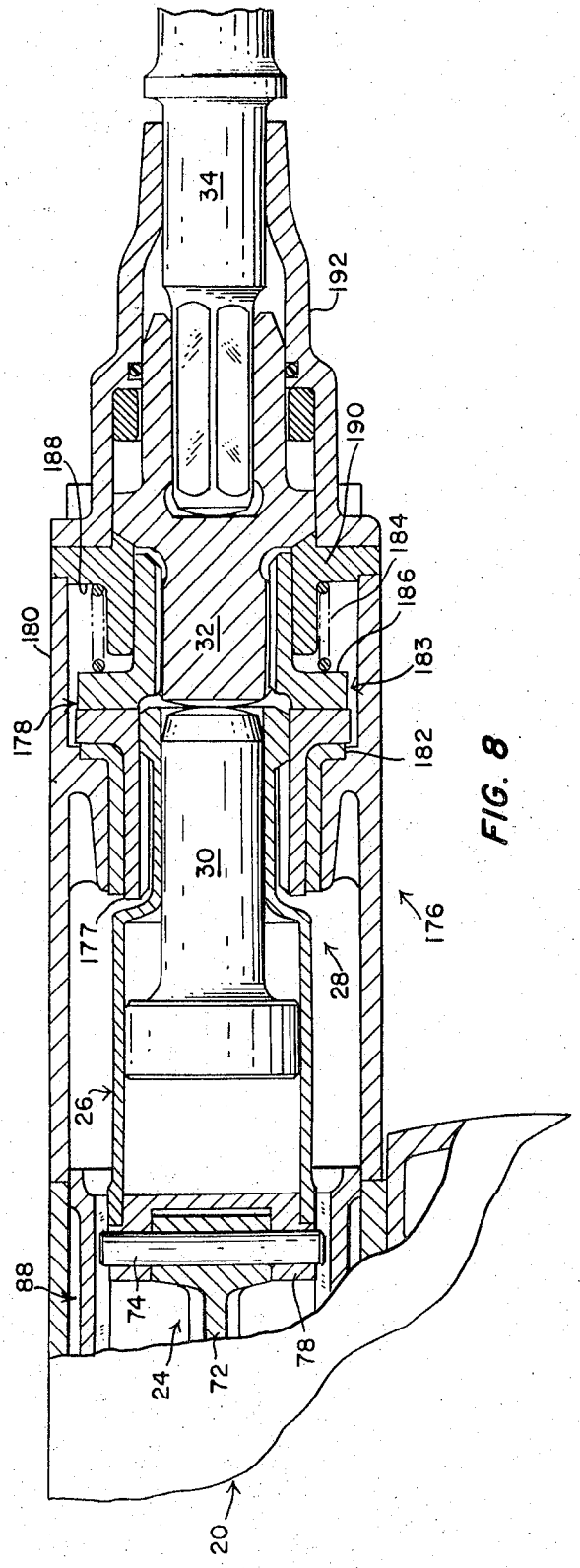


FIG. 8

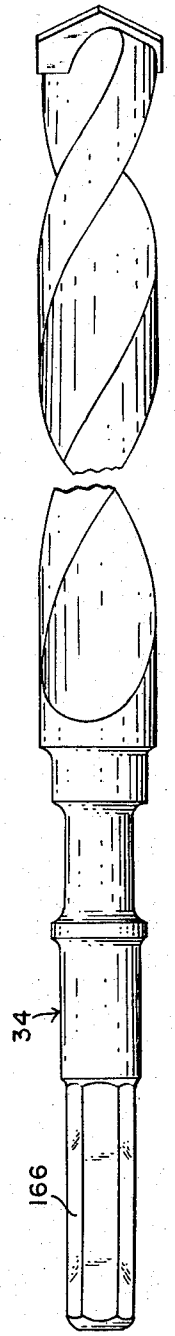


FIG. 12

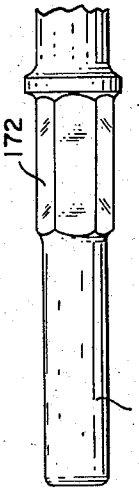
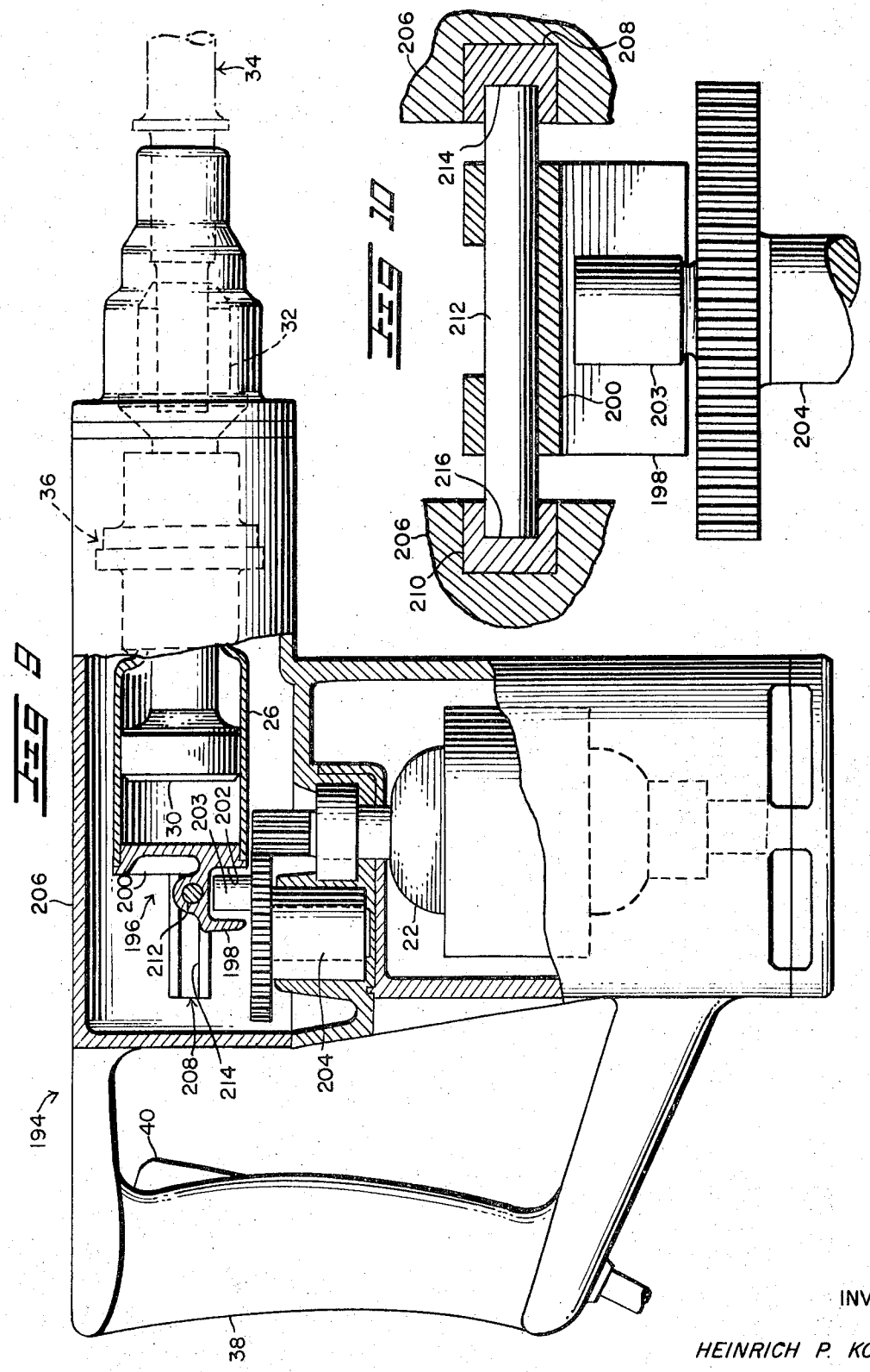


FIG. 13

INVENTOR.
HEINRICH P. KOEHLER
BY
Strauch, Nolan, Neale,
Nies & Kurz,
ATTORNEYS



INVENTOR

HEINRICH P. KOEHLER

BY Strauch, Nolan, Neale, Nies & Kurz

ATTORNEYS

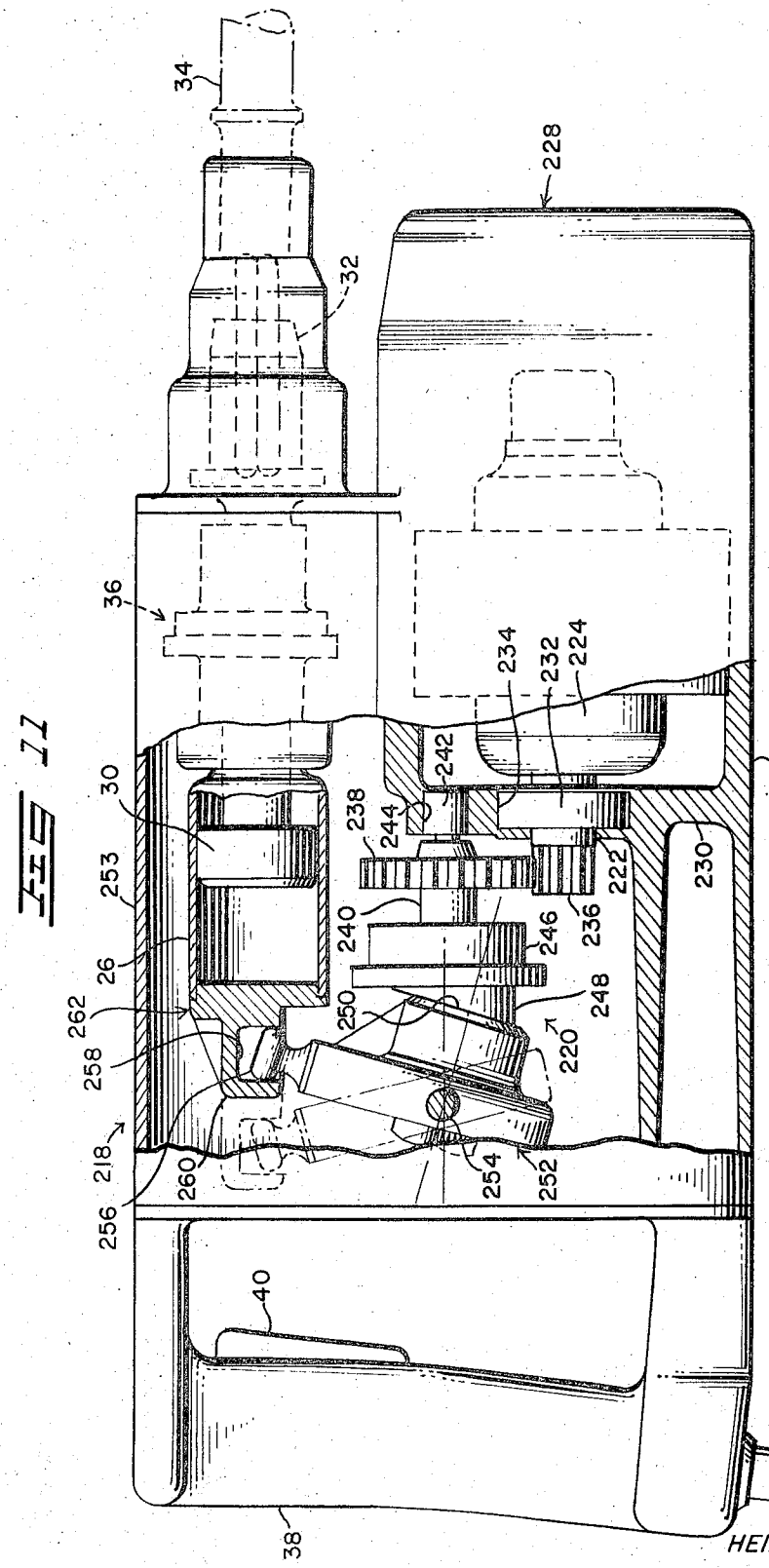


FIG 11

INVENTOR

HEINRICH P. KOEHLER

BY Strauch, Nolan, Neale, Nies & Kurz

ATTORNEYS

POWER DRIVEN HAMMERS OR THE LIKE

This 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.

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; and 3,456,743; in German Patents 121,394 153,320; and 306,148 and in Robert Bosch GmBH Spare Parts List No. EW-EWV 2/302/IX (11.64) and Metabo Elektrowerkzeuge Spare Parts List For Bohrhammer 1130 dated February 1969. However, in each instance, the previously proposed devices have drawbacks which it would be desirable to eliminate. Among these are 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.

In the novel power driven hammers of the present invention by which the foregoing and other deficiencies of the heretofore available devices are remedied, 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 side 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.

The novel power hammer just described is compact and relatively light and has good balance due to the manner in which the motor is positioned with respect to the rotary-to-reciprocatory motion converting mechanism. It is also rugged, providing a long service life, and uncomplicated, making it 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. And, as will be discussed in more detail later, the specific impacting mechanism and intermittent rotary motion producing mechanism of the present invention contribute to positive operation and improved performance.

Also, the torque responsive overload release feature incorporated in the intermittent rotary motion producing mechanism is of considerable 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.

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.

One primary object of the present invention has been identified above. Another important and primary object of the invention resides in the provision of novel, improved power driven hammers which do not have the above-discussed disadvantages of previously available devices of this type.

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

1. are compact and relatively light and well balanced.
2. are rugged and uncomplicated and therefore have a long service life and are relatively inexpensive to manufacture and service.
3. are versatile.
4. are particularly effective for drilling holes in concrete, masonry, rock, and the like.
5. include a mechanism for producing both axial impacts on and intermittent rotation of a tool or bit.
6. have a torque responsive overload release mechanism for preventing damage to the hammer and/or injury to the operator in case of a struck bit or the like.
7. are constructed to minimize the penetration of foreign matter to the interior of the hammer.
8. 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 portion of the hammer of FIG. **1** to an enlarged scale with the casing and part of the internal components in section;

FIG. **3** is a section through the hammer of FIG. **1** taken substantially along line **3—3** 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;

FIG. **4** is a section taken substantially along line **4—4** of FIG. **2**, 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 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. 6 is a section through the hammer taken substantially along line 6—6 of FIG. 2, 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 hammer casing;

FIG. 7 is a side view of the input and output members of the intermittent rotary motion producing mechanism illustrating the drive connection therebetween;

FIG. 8 is a view similar to FIG. 2 of an alternate form of intermittent rotary motion producing mechanism which may be employed in the hammers of the present invention.

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

FIG. 10 is a transverse section through a Scotch yoke mechanism employed in the hammer of FIG. 9;

FIG. 11 is a view similar to FIG. 1 of yet another form of the invention.

FIG. 12 is a side view of one form of tool which may be used in the hammers of the present invention; and

FIG. 13 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 34 (see FIG. 2) in holder 32. Tool 34 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 ratchet type drive arrangement 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 34 rises above a predetermined magnitude.

Tool 18 also includes a pistol grip 38 supporting a switch 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 tool 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 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 48. 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 in 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 80 and 82 in member 78 and an aperture 84 through a boss 86 on the forward end of the connecting rod.

Referring now to FIGS. 1–3, piston 26 is supported for rectilinear movement in casing section 48 by a piston guide 88 and by the input or drive member 90 of the ratchet type motion transmitting 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.

As best shown in FIG. 2, 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 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 FIGS. 1 and 2, 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 tool 34 in the direction indicated by arrow 111 in FIG. 2. 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, driver **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 doubling-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, 2** 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 section **48.**

Tool holder **32** is mounted for rectilinear movement in the forward section **114** of tool casing **20** with a flange **118** at its nose **120** slidingly engaging the interior of casing section **114.** An O-ring **122** disposed in a recess **124** formed in tool holder nose portion **120** 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, 2** and **6,** the main body portion **115** of the tool holder extends into a bore **128** through the output or driven member **130** of ratchet type rotary motion transmitting mechanism **36.** Member **130** is rotatably mounted in casing section **114,** but is fixed against axial movement by an annular ledge **131** in casing section **114** and a similar ledge **132** at the forward end of intermediate casing section **133,** which engage opposite sides of a flange **134** on member **130.** External splines **135** on the main body portion **115** of the tool holder and cooperating internal splines **136** in the bore **128** of driven member **130** connect the tool holder to output member **130** for rotation therewith.

Turning next to FIGS. **1, 2, 4** and **6,** the drive or input member **90** of intermittent rotary motion producing mechanism **36** mentioned briefly above includes a main body section **137** provided with an internal bore **138** through which the forward end portion **108** of piston **26** extends. Input member **90** is rotatable and axially movable in a bore **139** through an annular boss **140** in intermediate casing section **133.**

As shown in FIG. **5,** 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 drive 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 mechanism input member **90** through an angle determined by the configuration of cooperating splines **141** and **142.**

Referring now to FIGS. **1, 2** and **7,** the forward end of input member **90** terminates in an annular flange **144,** which faces the annular flange **134** at the rear end of driven member **130.** Ratchet teeth **146** are formed on the face **148** of drive member **90** provided by flange **144,** and cooperating ratchet teeth **150** are formed on the face **151** provided by the flange **134** at the rear end of output member **130.**

As shown in FIG. **7,** the teeth **146** on input member **90** have a steep leading edge **152** and a trailing edge **154** with a relatively gentle slope. The teeth on output member **130** are similarly configured but face in the opposite direction.

Accordingly, with teeth **146** and **150** in engagement as shown in FIG. **7,** input member **90** drives output member **130** when it is oscillated by piston **26** in the direction shown by arrow **156.** However, when it is oscillated in the opposite direction as shown by arrow **158** in FIG. **7,** teeth **146** slide over the teeth **150** on output member **130;** and no rotary motion is imparted to the output member.

Referring now to FIGS. **1** and **2,** input member **90** and output member **130** are normally maintained in the driving relationship shown in FIG. **7** by a compression spring **160,** which abuts an annular ledge **162** on input member **90** at its forward end. The rear end of this spring engages an annular ledge **164** formed at the rear end of the intermediate casing section **133** in which the input member is disposed.

Thus, depending upon the inclination of the cooperating helical splines **141** and **142** on the piston and input member, respectively, the piston is effective upon its forward or return stroke to rotate input member **90** in a direction in which it will rotatably advance output member **130.** This rotary advance is transmitted to tool holder **32** by the cooperating external splines **135** on the tool holder and **136** in the bore through the output

member. This incremental advance is in turn transmitted to tool **34** because of the matching configurations of the tool socket **116** and the shank **166** of the tool. Typically, this configuration will be hexagonal although any configuration which will drive connect the tool to the tool socket may be employed.

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 **34** of the type illustrated in FIG. **12** 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, the driving and driven members **90** and **130** of rotary motion transmitting mechanism **36** constitute a torque responsive overload release as well as a mechanism for intermittently rotatably advancing tool **34.** More specifically, as discussed above, compression spring **160** normally maintains the input and output members in driving engagement as shown in FIG. **7.** However, if tool **34** becomes stuck or a rotation restraining torque is otherwise exerted upon it, this restraint will be transmitted through tool holder **32** to output member **130** through the drive connections discussed above.

With the output member thus restrained against rotation, input 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 **156** in FIG. **7,** its teeth **146** will simply ride up the leading edges of the teeth **150** on output member **130** despite their rather steep inclination. This forces input member **90** away from output member **130** against the bias exerted by spring **160** and allows it to slip relative to the driven member.

Such slippage continues until the rotation restraining force is removed from output member **130.** 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 toool sticks.

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 a rotary impact to and thereby free the tool. In heretofore available hammers such procedure turns the hammer motor, and no impact is exerted on the stuck bit.

As will be discussed hereinafter, the arrangement of the components in mechanism **36** can be varied, if desired. The arrangement just described is preferred, however, as it has proven the most effective in keeping the input and output members **90** and **130** of mechanism **36** in firm driving engagement, even under the vibration produced by the rebounding driver and tool holder. Moreover, eccentricities in and cocking of tool **34** are accommodated in the axially fixed output member **130.** This has proven more satisfactory than in alternate arrangements in which the output member is axially movable.

Also, in conjunction with the foregoing, 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 effected during the forward stroke. In this case friction between the helical splines on the piston and those in driving member **90** biases the teeth on the driving member into and keeps them in engagement with the teeth on the drive member 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 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 member **90** relative to output member **130.**

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 the tool **34.** However, this exemplary impact hammer 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 **168** in FIG. **13** in which the rearward portion **170** of the tool shank is cylindrical and the forward portion **172** has a hexagonal or other non-circular configuration configured for sliding fit in a socket **174** formed in the forward end of casing member **114.**

The connection between shank portion **172** and socket **174** keeps tool **168** from rotating in the housing member. And, as the rear shank portion **170** 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, FIG. **8** illustrates a hammer **176** which is similar to that just discussed except that the input member **177** of intermittent rotary motion producing mechanism **178** is fixed against axial rearward movement in casing section **180** by thrust bearing **182,** and the output or driven member **183** of mechanism **178** is axially movable and is biased into engagement with the driving member by a compression spring **184.** This spring extends between annular flange **186** at the rear of the output member and an annular flange **188** on a support member **190** fixed between casing sections **180** and **192.** While this arrangement is satisfactory for many applications of the invention, it may prove inferior to the alternate arrangement employed in tool **18** as far as maintaining the inpput and output members of the intermittent motion producing arrangement in driving engagement is concerned.

Another modification of the present invention, incorporated in the hammer **194** illustrated in FIGS. **9** and **10,** 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 hammer **194** may be like those of hammer **18.** Such

like components have been identified by the same reference characters as in FIGS. 1–6.

As shown in FIGS. 9 and 10, 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 results in 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. 11 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 244 in the partition.

Fixed to the rear end of shaft 240 is a member 246 carrying a wedge-shaped wobble plate 248. The wobble plate is adapted to engage the forward face 250 of a connecting member 252 mounted for pivotable movement in upper casing section 253 by a laterally extending pin 254 secured at its ends to opposite sides of casing section 253. The head 256 of pin 254 is disposed in a slot 258 which is formed in a boss 260 integral with the rear wall member 262 of piston 26.

As shaft 240 is rotated by motor 224, wobble plate 248 rocks connecting member 252 back-and-forth about the axis of pin 254. This imparts the same reciprocatory motion to piston 26 as 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 imparts 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 the claims are 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; a tool holder; means mounting said tool holder for rotation in said casing; a cyclically operable impact imparting mechanism for imparting axial impacts to said tool holder; means for reciprocating said impact imparting mechanism in said casing; and means so drive-connecting said impact imparting mechanism to said tool holder that, in each cycle of operation of said impact imparting mechanism, said mechanism rotatably advances said tool holder, said drive connecting means comprising rotatably mounted, axially aligned input and output means; first means so drive-connecting said impact imparting mechanism to said input means that said input means is rotatively oscillated as said impact imparting mechanism reciprocates; second means for so drive-connecting said input means to said output means that said output means is rotatively advanced by said input means as said input means moves in one of its directions of movement only; and third means connecting said tool holder to said output means for rotation therewith, all of the first means connecting the impact imparting mechanism to said input means and said input means being rectilinearly movable in said casing along the axis along with said input and output means are aligned.

2. The device of claim 1, wherein said impact imparting mechanism includes a rectilinearly reciprocable piston, said input means includes a rotatable drive member having a bore therein into which said piston extends, said input means being integral with said drive member, and said first means comprises external helical splines on said piston and internal helical splines in the bore of said drive member.

3. The device of claim 1, wherein the third means connecting said tool holder to said output means comprises external splines on one of these components and co-operating internal splines on the other of said components.

4. The device of claim 3, wherein said casing has an internal annular shoulder therein for retaining said tool holder in said casing, the device also including an annular shock absorbing member in said casing between said shoulder and the end of the tool holder facing said shoulder.

5. The device of claim 1, wherein said second drive-connecting means comprises co-operating drive elements on said input and output means and including means biasing said elements into driving engagement, said co-operating elements being configured to allow the elements on the input means to ride out of engagement with the elements on the output means despite the force exerted by said biasing means while a rotation restraining force of a predetermined magnitude is exerted on said output means.

6. The device of claim 1, together with means mounting said tool holder for rectilinear movement in the

nose portion of said casing, said casing having 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 furthermost 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.

7. A power driven device according to claim **6,** wherein the opening in the nose end of the casing has a non-circular configuration, whereby said casing will restrain against rotation a tool inserted therethrough which has a matching external configuration.

8. The device of claim **6,** wherein the tool receiving bore in the tool holder has a non-circular configuration, whereby a tool inserted into said bore and having a matching external configuration is connected to said tool holder for rotation therewith.

9. 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 rotatable driven member, said tool holder being fixed to said driven member for rotation therewith; a rotatable, unitary, axially movable driving member disposed between said driven member and said impact imparting mechanism, there being co-operating 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 and means on said driving member engageable with co-operating means on said driven member to rotatably advance said 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 co-operating means on said driving and driven members.

10. The device of claim **9,** wherein the rectilinearly reciprocable impact imparting mechanism includes a cylindrical piston having one closed end and an impact producing driver slidable in said piston and extending through the other end of the piston, 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.

11. The device of claim **10,** together with drive means for reciprocating the piston of the impact imparting mechanism comprising a rotatably mounted crank having an eccentric crankpin thereon; a connecting rod pivotally fixed to said crankpin; and means pivotally fixing said connecting rod to said piston.

12. The device of claim **10,** together with drive means for reciprocating the piston of the impact imparting mechanism comprising a rotatably mounted crank; an eccentrically mounted crankpin; a crosshead having a slot extending at right angles to the direction of reciprocation of said piston, said crankpin extending through 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.

13. A power driven device, comprising: a casing having a nose portion; a tool holder rectilinearly movable in the nose portion of said casing; a rectilinearly reciprocable impact imparting mechanism having a working stroke in which it imparts an axial impact to said tool holder and a return stroke and including a piston and a driver mounted in said piston and engageable with said tool holder; drive means for reciprocating said piston; and a component mounted in and restrained against rotation relative to said casing, said piston being rectilinearly movable in said component and said component and said piston having co-operating means for restraining said piston against rotation relative to said component.

14. The device of claim **13,** wherein said co-operating means comprise external splines on said piston and internal splines in the component in which said piston is rectilinearly movable.

15. A power driven device, comprising: a casing having a nose portion; a tool holder rectilinearly movable in the nose portion of said casing: a rectilinearly reciprocable impact imparting mechanism in said casing for producing axial impacts on said tool holder; a motor; and a motion transmitting and converting means drive-connecting the motor to the impact imparting mechanism, said last-mentioned means comprising a crank mounted with its axis of rotation at right angles to the axis of reciprocation of the impact imparting mechanism and means connecting said crank to said mechanism, said motor having a rotatable output shaft and being mounted with the axis of rotation of said shaft in parallel, spaced relationship to the axis of rotation of said crank and between said last-mentioned axis and the nose portion of said casing, and said motion transmitting and converting means further comprising means drive-connecting said motor output shaft to said crank.

16. The device of claim **15,** wherein the means connecting said crank to the impact imparting mechanism comprises an eccentrically mounted crankpin on said crank, a connecting rod pivotally fixed to said crank, and a wrist pin pivotally fixing said connecting rod to said impact imparting mechanism.

17. The device of claim **15,** 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.

18. A power driven device, comprising: a rectilinearly reciprocable impact imparting mechanism; a motor; motion transmitting and converting means drive-connecting said motor to said impact imparting mechanism; a rotatably mounted tool holder; and means so drive-connecting said impact imparting mechanism to said tool holder that rectilinear movement of said mechanism produces rotary movement of the tool holder, said last-mentioned means including a torque responsive clutch for effectively interrupting the drive connection between the impact imparting mechanism and the tool holder while rotation resisting forces of at least a predetermined magnitude are exerted on said tool holder which comprises a rotatable, axially fixed output member connected to said tool holder for rotation therewith, a rotatable, axially movable input means, and cooperating first and second means on said

input means and output member, respectively, for providing a drive connection therebetween, said co-operating means being so configured as to permit those on the input means to override those on the output member when said rotation restraining force of predetermined magnitude is reached to thereby permit said input means to rotate relative to said output member, and the means for drive-connecting the impact imparting mechanism to the tool holder also including an axially movable, rotary drive means which is integral with said rotatable input means and rotatable by said impact imparting mechanism as the latter reciprocates and means biasing said rotary drive means and said clutch input means toward said clutch output member to engage the drive connection providing means on the input means with the co-operating drive connection providing means on the output member so that the drive connection providing means on the input means will override the co-operating means on the output member only upon the rotation resisting force reaching said predetermined magnitude and overcoming the clutch engaging force exerted by said biasing means.

19. 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 rotatable driven member, said tool holder being fixed to said driven member for rotation therewith; a rotatable, axially movable, unitary driving member disposed between said driven member and said impact imparting mechanism, there being co-operating means on said impact imparting mechanism sand 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 and means on said driving member engageable with co-operating means on said driven member to rotatably advance said 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; means biasing into engagement the co-operating means on said driving and driven members; and means fixing said driven member against axial movement, there being an annular flange on said driving member and said biasing means comprising a compression spring surrounding said driving member, one end of said spring bearing against said flange and the other end of said spring being axially fixed.

20. A power driven device, comprising: a casing having a nose portion; a tool holder; means mounting said tool holder for rectilinear and rotary movement in the nose portion of said casing; a rectilinearly reciprocable impact imparting mechanism having a working stroke in which an axial impact is produced on said tool holder and a return stroke and including 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; drive means for reciprocating said piston which comprises a wobble plate, means mounting said wobble plate for pivotal movement about a pivot axis extending at right angles to the direction of movement of the piston of the impact imparting mechanism, means pivotally fixing said wobble plate to said piston, a cam engageable with said wobble plate for pivoting said plate about its pivot axis, and means mounting said cam for rotation about an axis disposed at right angles to said pivot axis; and means having rotatably mounted input element and output elements drive-connected between said piston and said tool holder for converting the rectilinear movement of said piston into intermittent rotary motion of said tool holder and for permitting said input member to slip relative to said output member while rotation restraining forces of at least a predetermined magnitude are exerted on said tool holder.

21. A power driven device, comprising: an impact imparting mechanism, means mounting said impact imparting mechanism for reciprocable rectilinear movement; 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; a rotatably mounted tool holder; 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, the means drive-connecting the impact imparting mechanism to the tool holder comprising ratchet means including axially aligned, rotatable input 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 co-operating first and second means on said input and output members, respectively, which are engageable when said input member is rotated in one direction only to rotatably advance said output member and said tool holder and the means for rotating the input member back and forth including one means incorporated in the rotatable input member and a co-operating means incorporated in the impact imparting mechanism, said rotatable input member, said co-operating first means on said input member and said one means incorporated in the rotatable input member comprising a one piece, integral member.

* * * * *