

Aug. 30, 1966

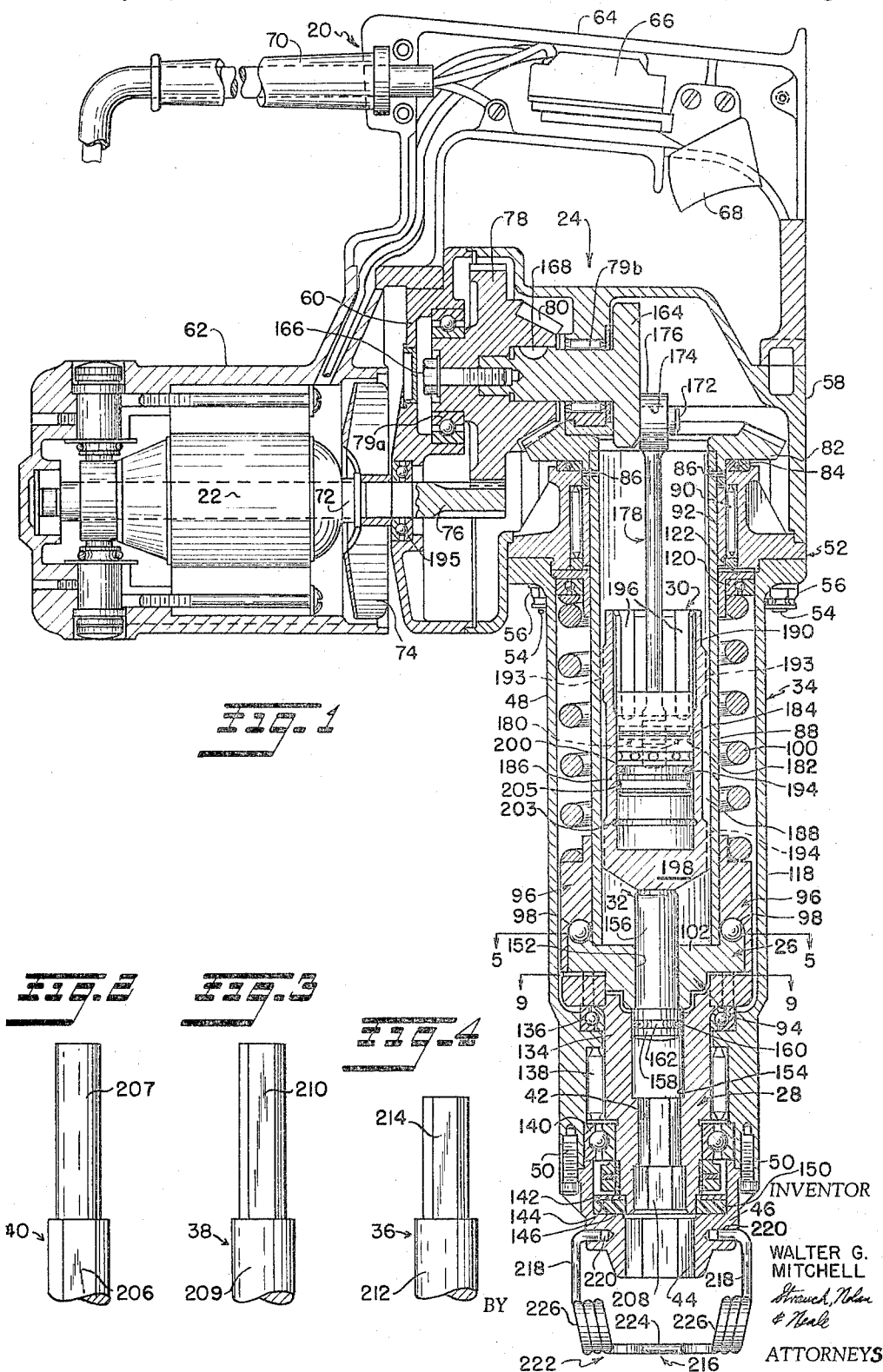
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3,269,466

IMPACT TOOL

Filed July 17, 1964

3 Sheets-Sheet 1



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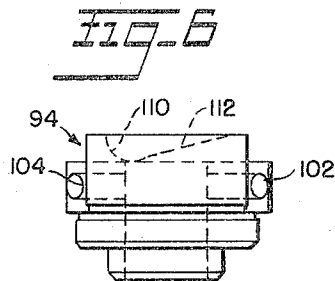
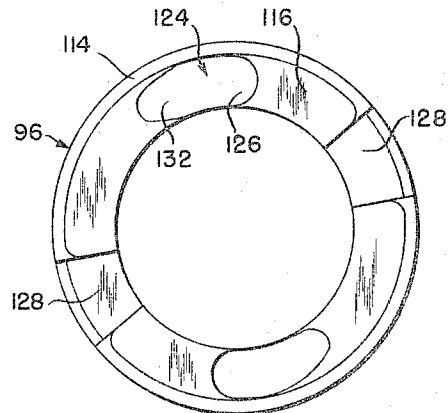
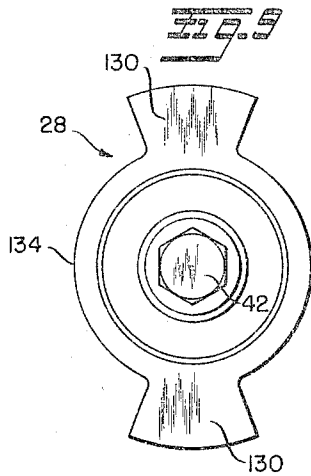
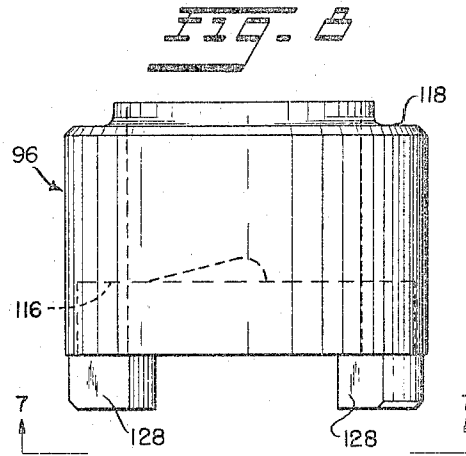
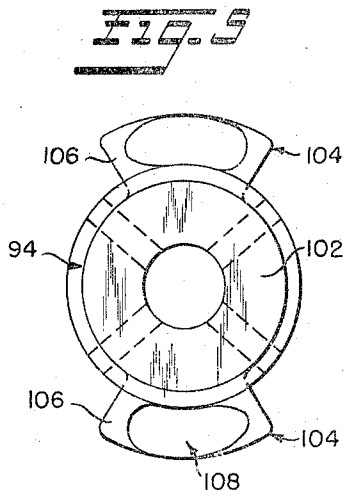
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

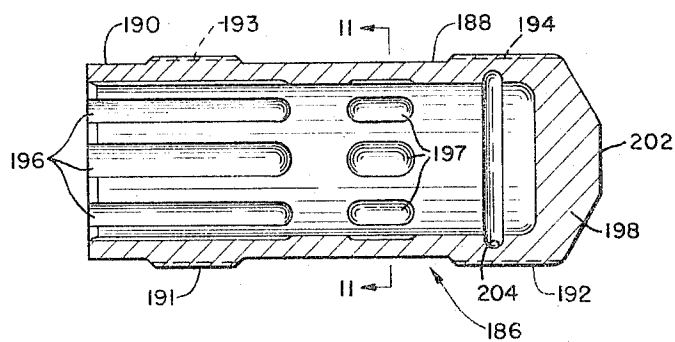


FIG. 10

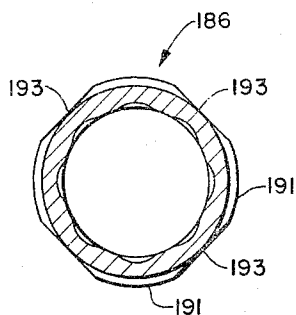


FIG. 11

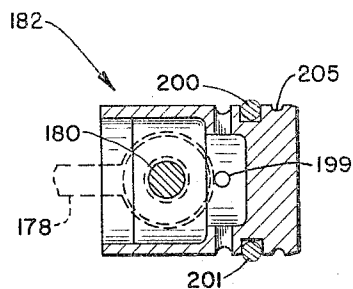


FIG. 12

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3,269,466

IMPACT TOOL

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17 Claims. (Cl. 173-93.6)

This invention relates to power tools and, more particularly, to power driven, hand supported, hammer drills.

By "hammer drill" is meant a power driven device for imparting hammering or rotary action or combined rotary and hammering action to a drill, chisel, or other tool. Such devices are highly versatile and are used for such diverse functions as masonry drilling, chiseling, chipping, riveting, and drilling wood and metal.

Several different versions of hammer drills have heretofore been proposed. Exemplary of the prior art hammer drills are those shown in United States Letters Patent No. 3,114,423 issued December 17, 1963, to L. V. Naslund, for Rotary-Hammer Device. The Naslund hammer drill provides combined axial hammering action and rotation of the tool or axial hammering or rotation of the tool separately. Naslund's hammer drill, however, has no provision for protecting the operator from injury or for preventing the motor from stalling when a rotating tool sticks or jams. Consequently, the motor may burn out when this occurs or the operator may be injured by wrenching reaction forces on the hand held tool since the motor will tend to drive the hammer drill with considerable force around the stuck tool until stalling occurs.

Furthermore, the Naslund hammer drill employs a striker which is driven by a reciprocating piston acting on a column of air between the striker and piston serving as a cushion. As the device becomes worn, air will leak past the striker; and the required cushion will not form. Consequently, the striker will rebound and hit the piston sharply, causing damage to it and/or the mechanism provided for reciprocating the piston.

The hammer drills provided by the present invention differ from the most advanced hammer drills heretofore known in that, in addition to straight axial hammering and rotary actions and combined axial hammering and rotary action, they provide a novel arrangement for automatically disrupting the motor drive if the rotating tool bit encounters excessive resistance and jams or sticks and for then producing rotary impacts on the tool to free it. In addition, the novel hammer drills disclosed herein embody a novel arrangement which prevents the striker from repeatedly rebounding against the piston and damaging the piston and/or the piston reciprocating drive mechanism if the air cushion normally present between these components fails.

Another novel feature of the present invention is an operating chamber which is sealed off from the exterior air. Hammer drills are frequently used in areas where the air is heavily laden with abrasive particles such as may be encountered in concrete drilling. In prior art hammer drills such as disclosed in the Naslund patent, an opening to atmosphere is necessary for the intake and exhaust of air as the striker reciprocates. In the instant invention, the working parts are enclosed in a sealed operating chamber, isolating them from abrasive or corrosive materials in the atmosphere and allowing a mist-type lubricating atmosphere to be maintained inside the operating chamber.

Because of the foregoing and other novel features, the hammer drills provided by the present invention are more versatile than those of the prior art, are safer to use, and provide superior performance, especially when drilling in materials with high or variable resistance to rota-

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tion of the drill bit. In addition, because of the novel protective features discussed above and hereinafter and their simple and rugged construction, the hammer drills of the present invention are less susceptible to damage in operation and have a longer service life than prior art hammer drills. Hammer drills produced in accordance with the principles of the present invention, moreover, are economical to manufacture and maintain.

From the foregoing, it will be apparent that one object of the present invention resides in the provision of novel, improved hammer drills.

Additional objects of the present invention include the provision of hammer drills which:

(1) Are more versatile and safer to use than those of the prior art;

(2) Have novel protective features for preventing damage to the hammer drill motor and drive mechanism and/or the operator if the tool bit sticks or malfunctions;

(3) Have novel mechanism providing a rotary hammering action on the tool when the latter is subjected to a restraining torque of predetermined magnitude;

(4) In conjunction with the preceding object, are capable of selectively providing axial hammering action or rotary action alone or combined axial hammering and rotary action;

(5) Have operating components which are isolated from abrasive and other deleterious materials in the atmosphere; and

(6) Are of simple and rugged construction and economical to manufacture and maintain.

Additional objects and further novel features of the present invention will become more fully apparent from the appended claims and as the ensuing detailed description and discussion proceeds in conjunction with the accompanying drawings in which:

FIGURE 1 is a section through a hammer drill constructed in accordance with the principles of the present invention;

FIGURE 2 is a side view of the shank end of one form of tool bit for the hammer drill of FIGURE 1;

FIGURE 3 is a view similar to FIGURE 2 of a second form of tool bit for the hammer drill of FIGURE 1;

FIGURE 4 is a view similar to FIGURES 2 and 3 of a third form of tool bit for the hammer drill of FIGURE 1;

FIGURE 5 is a top view of a cylinder head employed in the hammer drill of FIGURE 1, looking in the direction of arrows 5-5 of the latter figure;

FIGURE 6 is a side view of the cylinder head;

FIGURE 7 is a bottom view of a hammer employed in the hammer drill of FIGURE 1, looking in the direction of arrows 7-7 of FIGURE 8;

FIGURE 8 is a side view of the hammer;

FIGURE 9 is a top view of an anvil employed in the hammer drill of FIGURE 1, looking substantially in the direction of arrows 9-9 of the latter figure;

FIGURE 10 is a section through a striker utilized in the hammer drill of FIGURE 1;

FIGURE 11 is a section through the striker, taken along line 11-11 of FIGURE 10; and

FIGURE 12 is a section through a piston employed in the hammer drill of FIGURE 1 and a portion of an associated connecting rod.

Referring now to the drawing, FIGURE 1 illustrates a hammer drill 20 constructed in accord with the principles of the present invention. This device includes a motor 22 drive connected through a drive train 24 including a novel torque responsive rotary impact device 26 to a rotatably supported anvil 28. Motor 22 also operates a hammer mechanism 30 arranged to repeatedly drive a tappet 32 against a tool bit received in anvil 28

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to provide an axial hammering action. The foregoing components are housed in a casing 34.

One of the features of the present invention is that it provides hammering action or rotary action alone or a combination of rotary and hammering action. The particular type of action provided by hammer drill 20 depends upon the configuration of the shank of the tool bit 36, 38, or 40 (FIGURES 2-4) used with the drill. The selected tool bit 36, 38, or 40 is inserted in a hexagonal socket 42 in anvil 28 or a hexagonal socket 44 in the nose piece 46 of casing 34.

In addition to nose piece 46, hammer drill casing 34 includes a cylindrical barrel 48 to which the nose piece is fixed by screws 50. At its opposite end, barrel 48 supports a hammer centerplate 52 which is assembled to barrel 48 by studs or bolts 54 and nuts 56 and forms part of the external portion of the housing.

Fixed to hammer centerplate 52 in any suitable manner is a gear housing 58 which substantially surrounds the centerplate. Gear housing 58 extends laterally beyond barrel 48 and supports a motor centerplate 60 to which a field case 62 extending at right angles to barrel 48 and housing motor 22 is attached in any convenient manner.

The external configuration of hammer drill 20 is completed by a grip type handle 64 fixed to gear housing 58 and motor centerplate 60. Handle 64 is hollow and houses a switch 66 operated by a conventional trigger 68. Switch 66 is wired to a grounded power cable 70 and to motor 22 and controls the application of operating voltage to the motor.

Motor 22 is mounted in field case 62 in a manner which is not part of the present invention and which it is therefore deemed not necessary to describe herein. The output shaft 72 of motor 22 supports the conventional cooling fan 74 and a spur gear type motor pinion 76 which may be fixed to or formed as an integral part of the motor output shaft. Motor pinion 76 is the input for both the drive mechanism 24 which rotates anvil 28 and the hammer mechanism 30 which drives tappet 32.

The drive train 24 for rotating anvil 28 includes a drive gear 78 meshed with pinion 76 and rotatably supported from motor centerplate 60 in bearings 79a and 79b. Integral with drive gear 78 is a bevel pinion 80 meshed with a bevel gear 82 rotatably supported by bearing 84 from hammer centerplate 52. Bevel gear 82 is rotatably fixed, as by pins 86, to an elongated cylinder 88 which extends downwardly through hammer centerplate 52 and the barrel 48 of hammer drill casing 34 and terminates in spaced relation to anvil 28. The upper end of cylinder 88 is rotatably supported from hammer centerplate 52 by bearing 90 and a sleeve 92 interposed between the bearing and the cylinder.

Cylinder 88 is an imperforate cylindrical tube. The upper end of cylinder 88, at which bevel gear 82 is mounted, is open. The other lower end of cylinder 88 is closed by a cylinder head 94, the input member of the torque responsive rotary impact mechanism 26, which also includes a hammer 96, cam balls 98, and compression spring 100.

Referring now to FIGURE 5, cylinder head 94 has a flat central portion 102 of substantially the same diameter as the inside of cylinder 88 and two integral flanges 104 extending radially from opposite sides of the cylinder head's central portion. Flanges 104 (see FIGURES 1 and 5) have flat surfaces 106 which are parallel to, but spaced from, the surface of the cylinder head's central portion 102.

As is best shown in FIGURE 5, a cam track 108 subtending approximately a 40° angle is formed in each of the two cylinder head flanges 104 and opens onto the flat surface 106. Each of the cam tracks 108 has a maximum depth portion 110, in which cam balls 98 are normally seated, and an inclined portion 112, up which cam balls 98 can roll. This inclined track portion extends

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from the maximum depth portion 110 to the surface 106 of the flange in which the cam track is formed. The maximum depth portion 110 of each cam track 108 is equal in diameter to cam balls 98 and has a depth equal to one-half the diameter of the cam balls.

Referring now to FIGURE 1, cam balls 98 normally drive connect cylinder head 94 to hammer 96 which is a generally cylindrical component surrounding and axially and rotatably movable relative to cylinder 88 and which has a depending flange 114 extending over the flanges 104 of cylinder head 94.

Referring now to FIGURES 7 and 8, hammer 96 has a flat annular surface 116 which, when hammer drill 20 is assembled, is held against the surfaces 106 of cylinder head flanges 104 by compression spring 100 which (see FIGURE 1), at its lower end, bears against an annular ledge 118 formed adjacent the end of hammer 96 opposite flanges 114. The upper end of spring 100 bears against a bearing 120 which surrounds cylinder 88 and is pressed by spring 100 against an L-sectioned sleeve 122. Sleeve 122 abuts hammer centerplate 52 and thereby exerts a reactive force against spring 100.

Referring now to FIGURES 1, 7, and 8, cam tracks 124, identical to the cam tracks 108 in cylinder head 94, are formed in hammer 96 and open onto its annular surface 116. In normal operation, the maximum depth portions 110 of cam tracks 108 and 126 of cam tracks 124 are opposite each other and cam balls 98 lie in these portions of the associated cam tracks so that they afford a drive connection between the cylinder head 94 (the driving member) and hammer 96 (the driven member).

The rotary motion thus imparted to hammer 96 is transmitted to anvil 28 by two integral lugs 128 on hammer 96 which are oriented at right angles to surface 116 of the hammer and engage two cooperating, radially extending lugs 130 formed at the upper end of anvil 28. Normally, therefore, energization of motor 22 is effective, through the drive train mechanism described above, to rotate anvil 28.

However, it is a novel and important feature of the present invention that, if a tool bit inserted in the socket 42 in anvil 28 and being rotated by motor 22 sticks, or encounters a resistance to rotation of more than a predetermined magnitude, the novel torque responsive rotary impact mechanism 26 just described will disconnect motor 22 from anvil 28 to prevent the motor from burning out and, in addition, will repeatedly impart rotary hammer blows or impacts to the tool bit through anvil 28 to free it or to assist in overcoming the increased resistance. Specifically, if a rotation resisting torque of more than a predetermined magnitude is exerted on anvil 28, cylinder head 94 will begin to rotate relative to and faster than hammer 96 since the latter is forced to rotate at the same rate as anvil 28 by the cooperating lugs 128 on the hammer and 130 on the anvil. This will cause cam balls 98 to ride up the cooperating inclined surface portions 112 and 132 of the cam tracks 108 and 124 in cylinder head 94 and hammer 96, respectively. Since cylinder head 94 cannot move longitudinally in barrel 48, this movement of the cam ball forces hammer 96 away from cylinder head 94, drawing hammer lugs 128 out of engagement with anvil lugs 130 and thereby relieving the strain on motor 22.

Cam balls 98 remain out of the cooperating cam tracks 108 and 124 until cylinder head 94 has rotated through an angle of approximately 140°, at which point the cam balls start rolling down the inclined portions of cam tracks 108 and 124, permitting lugs 128 to drop down and reengage the cooperating lugs 130 of anvil 94. As lugs 128 begin to move into reengagement with lugs 130, they are given an impetus in the direction in which the tool is being rotated by cam balls 98 rolling down the inclined portions 112 and 132 of the cooperating cam tracks 108 and 124, which imparts a rotational velocity exceeding that of cylinder 88 to hammer 96. Conse-

quently, lugs 128 exert a sharp rotary hammer blow on lugs 130 as they reengage to free the sticking tool bit or to overcome the increased resistance it has encountered.

Referring now to FIGURE 1, the main portion 134 of anvil 28 has a generally cylindrical configuration and is rotatably supported in the barrel 48 of hammer drill casing 34 by bearings 136, 138, and 140. Adjacent the end opposite lugs 130, anvil 28 is surrounded by a flat annular member or plate 142, which abuts an annular shoulder 144 on the anvil. Disposed between plate 142 and a flat annular internal shoulder 146 on hammer drill casing nose piece 46 is an annular seal 150 which prevents lubricant from leaking past anvil 28 to the exterior of hammer drill 20.

Referring still to FIGURE 1, the tappet 32 which strikes the upper end of the tool inserted in anvil 28 to provide axial hammering action, is guided in a bore 152 in cylinder head 94 and an axially aligned bore 154 in anvil 28 which communicates with socket 42. Tappet 32 has a shank 156 which extends into the interior of cylinder 88 and a head 158 in the bore 154 in anvil 28. An O ring 160 in an annular groove 162 in head 158 serves a dual purpose. It prevents lubricant from leaking past tappet 32 to the exterior of hammer drill 20, and also seals the internal mechanism of the hammer drill from abrasive and corrosive materials in the atmosphere.

With continued reference to FIGURE 1, the hammer mechanism 30 by which tappet 32 is driven against the tool in socket 42 includes a crank 164 rotatably fixed as by a cap screw 166 and a half moon key 168 to the drive gear 78 meshed with motor pinion 76. Crank 164 is rotatably supported from gear housing 58 by bearing 79b.

Fixed to and extending normally from crank 164 adjacent its periphery is a crank pin 172 which extends through an aperture 174 formed in a boss 176 at one end of a connecting rod 178. Connecting rod 178 extends into cylinder 88, and the end thereof opposite boss 176 is connected as by a pin 180 to a piston 182 which is reciprocable in a generally cylindrical bore 184 formed in a striker 186. The striker is slidably mounted in cylinder 88 and is provided with annular recesses 188 and 190 in its periphery to reduce sliding friction between it and cylinder 88.

FIGURES 10 and 11 show the arrangement for allowing air passage between striker 186 and cylinder 88. Cylindrical bearing surfaces 191 and 192 are relieved by flat surfaces 193 and 194 respectively to permit the free passage of air from one end of striker 186 to the other end thereof within cylinder 88. This free movement of air between opposite ends of the striker permits reciprocation of the striker without the necessity of exhausting and drawing air into the cylinder as the striker reciprocates. Thus, the interior of cylinder 88 may be sealed off from the external atmosphere to prevent abrasive laden air from being drawn into the internal mechanism.

As best seen in FIGURE 1, gear housing 58, hammer centerplate 52, barrel 48, and nose piece 46 comprise a housing sealed at the end of motor shaft 72 at motor 22 and around anvil 28 and the upper end of tappet 32 to prevent the entry of foreign substances into the interior of the tool. A seal 195 around motor shaft 72 seals the motor shaft at its point of entry into gear housing 58.

Referring now specifically to FIGURE 10, striker 186 has two sets of internal, axially extending, circumferentially spaced grooves 196 and 197. One set of grooves 196 provides a bypass for air around the reciprocating piston when rotary motion only is desired and a tool bit as shown in FIGURE 4 is therefore used. The function of grooves 197 will be described in detail hereinafter.

During the hammering action, small amounts of air may escape from between piston 182 and striker 186. The cumulative effect of this would be to allow piston 182 to move further and further toward the closed end wall 198 of striker 186 without sufficient compression of

entrapped air for effective operation. To prevent this, grooves 197 are provided adjacent the end of striker 186. These grooves cooperate with holes 199 in piston 182 (see FIGURE 12) to provide "makeup" air to and thereby maintain the air cushion between piston 182 and striker 186. As piston 182 moves downwardly in striker 186, an O ring 200 in an annular groove 201 adjacent the closed end of piston 182 passes the inner ends of grooves 197, thereby sealing off the remainder of the interior of striker 186 to provide an air cushion. On the return stroke of piston 182, O ring 200 moves away from end wall 198 of striker 186 until communication is established between both ends of the piston 182 through a passage consisting of holes 199 and grooves 197 so that, on each stroke, the air between the piston and the end wall 198 of striker 186 is replenished. As the piston 182 continues on its return stroke the piston reaches a position with respect to striker 186 (depending on the amount of rebound of the striker) where O ring 200 passes the opposite outer ends of grooves 197. At this point, the space between the piston and end wall 198 of the striker are sealed off because of a lack of communication between grooves 197 and holes 199, and the piston pulls the striker with it towards the end of its return stroke. O ring 200 prevents quantities of air from leaking from the portion of bore 184 between the closed end 198 of striker 186 and piston 182 past the piston when the piston is operating in a normal fashion.

The closed end 198 of the striker has a generally frusto-conical configuration and terminates in a planar surface 202 of substantially the same diameter as the juxtaposed end of tappet 32.

The operation of hammer mechanism 20 can best be understood by beginning with its components in the position shown in FIGURE 1. As illustrated in this figure, piston 182 is in its lowest position (terms relating to orientation such as lowest and highest, up and down, etc., as hereinbefore and hereinafter employed, are with reference to the figure of the drawing only and do not refer to the orientation of hammer drill 20 in actual operation since it will, in the course of its use, be oriented in many different positions). From the illustrated position, piston 182 moves upwardly relative to cylinder 88, increasing the distance between it and the closed end 198 of striker 186. This creates a vacuum in the space between the piston and the closed end 198 of striker 186 after O ring 200 passes grooves 197, and air pressure acting on the closed end of the striker forces it upwardly toward piston 182. However, piston 182 completes its upward stroke and begins its succeeding downward stroke while striker 186 is still moving upwardly. This compresses the air in the space between the piston and striker head 198 to an extremely high pressure. The compressed air then expands, as piston 182 and striker 186 move downwardly, driving striker 186 with great force against tappet 32 and imparting an axial hammer blow to the tool bit in socket 42.

In addition to providing the motive force for driving striker 186 against tappet 32, the air trapped between piston 182 and the striker provides a cushion which prevents striker 186 from rebounding off tappet 32 and striking piston 182. This would be highly undesirable as such impact would damage piston 182 and/or the drive train components described above by which it is reciprocated.

After continued use, piston ring 200 may become worn to such an extent that it will be unable to prevent air from leaking past the piston and will not, therefore, be effective to maintain the air cushion. To prevent striker 186 from rebounding and striking piston 182 in these circumstances, a ring 203 of flexible material is disposed in annular groove 204 adjacent the closed end 198 of striker 186; and a cooperating annular groove 205 is formed adjacent the juxtaposed end of piston 182. If piston ring 200 is worn to the extent that it cannot maintain an air cushion, striker 186 will rebound toward pis-

ton 182; and ring 203 will engage in groove 205, preventing the striker from hitting piston 182. In this case, striker 186 and piston 182 move as a unit; and the striker is unable to move sufficiently far down cylinder 88 to strike tappet 32 so that there is no hammering action. This, provides an indication to the operator that piston ring 200 is worn and needs to be replaced.

As will be apparent from the foregoing, anvil 28 is continuously rotated and piston 182 of hammer mechanism 30 is continuously reciprocated when motor 22 is energized. To provide a choice between hammering action or rotation (by rotation or rotary action is meant both continuous rotary movement and the torque responsive rotary hammering action provided by the rotary hammer mechanism 26 described above) only or a combination of hammering and rotation, tool bits having shanks of different configurations are employed, as mentioned briefly above. Specifically, if hammering action only is desired, a bit 40 having the shank configuration illustrated in FIGURE 2 is employed. Tool bit 40 (which could be, for example, a chisel, riveting tool, or chipping or pointing tool) has a first shank portion 206 of substantially the same dimensions and configuration as the hexagonal socket 44 in casing nose piece 46 and a second shank portion 207 of smaller diameter than the hexagonal socket 42 in anvil 28 and of sufficient length that it extends upwardly through a bore 208 in the lower end of anvil 28, socket 42, and the bore 154 in the upper end of anvil 28 into engagement with the head 158 of tappet 32.

When hammer drill 20 is operated, shank portion 207 of tool bit 40 is repeatedly impacted as tappet 32 is driven against it by hammer mechanism 30; but there is no drive connection between anvil 28 and tool bit 40, and anvil 28 rotates freely around the second shank portion 207 of tool bit 40, which is maintained non-rotary by its engagement with socket 44.

For combined rotary and hammering action, a tool bit 38 having the shank configuration illustrated in FIGURE 3 is employed. Referring now to the latter figure, tool bit 38 has a first circular shank portion 209 of smaller diameter than the socket 44 in casing nose piece 46 so that bit 38 can rotate freely in the nose piece. Extending axially from shank portion 209 is a second portion 210 which has a hexagonal configuration matching that of the socket 42 in anvil 28 and is of substantially the same length as shank portion 207 of tool bit 40. Therefore, the shank end of tool bit 38 extends into abutment with the head 158 of tappet 32. Like bit 40, therefore, tool bit 38 has an axial hammering action. And, as its second shank portion 210 is drive engaged with socket 42 of anvil 28, it is continuously rotated by anvil 28 to provide a combination of hammering and rotary action. Tool bit 38 would typically be a carbide drill for drilling concrete and the like in which combined hammering and rotary action is necessary for effective drilling.

Tool bits having the shank configuration illustrated in FIGURE 4 are employed if pure rotary reaction is desired. The bit 36 illustrated in this figure may be, for example, a drill chuck adapter which, when inserted in hammer drill 20, permits hammer drill 20 to be used for the same purposes as a conventional electric drill.

Referring now to FIGURE 4, tool bit 36 has a first shank portion 212 identical to the shank portion 209 of tool bit 38 so that tool 36 can rotate in hammer drill casing nose piece 46; and a second shank portion 214 having a hexagonal configuration matching that of the socket 42 in anvil 28 so that, when bit 36 is inserted in the hammer drill, it is drive connected to the anvil. However, unlike the corresponding shank portion 210 of tool bit 38, shank portion 214 does not extend into the upper bore 154 in anvil 28 but is so dimensioned that its upper end is coterminous with the upper end of socket 42.

Tool bit 36 is rotated by anvil 28 when motor 22 is energized. However, the short shank 214 of tool bit 36 permits tappet 32 to move downwardly until its head

158 reaches the bottom of the bore 154 in anvil 28. As striker 186 is supported by tappet 32, it also moves downwardly. Consequently, piston 182 reciprocates in the upper end of the striker rather than the lower. With piston 182 in the upper end of the striker, axially extending exhaust passages or grooves 196 in bore 184 provide fluid communication between the two sides of the piston; and air cannot be compressed between the piston and striker to provide the motive force for driving the striker against tappet 32.

Referring now to FIGURE 1, the various bits which may be employed with hammer drill 20 are retained in the hammer drill by a tool retainer 216 formed from steel or other spring wire. As shown in FIGURE 1, tool retainer 216 is pivotally connected to hammer drill 20 by two L-shaped legs 218 which extend into blind bores 220 on opposite sides of the nose piece. Legs 218 are connected by a transversely extending integral portion 222 in which a bit retaining loop 224 is formed. When a tool bit is inserted into the hammer drill, tool retainer 216 is pressed against it until the tool shank snaps into retaining loop 224. Coil springs 226 formed in transverse portion 222 between tool retaining loop 224 and legs 218 prevent vibrations of the bit from jarring it out of the tool retaining loop.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is 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. In a power driven hammer drill or the like:

- (a) a rotatably mounted cylinder;
- (b) a striker slidable in said cylinder and having a bore formed therein from one end;
- (c) a piston reciprocable in said bore;
- (d) drive means for simultaneously (i) reciprocating said piston to effect reciprocation of the striker in the cylinder and (ii) rotating said cylinder;
- (e) an anvil formed with a tool bit receiving socket for receiving a rotatable tool bit, said anvil being mounted for rotation about the same axis as said cylinder;
- (f) means including a cylinder head fixed to said cylinder for drive connecting said cylinder and said anvil;
- (g) aligned bores in said cylinder head and said anvil;
- (h) a communicating bore formed between the one of said aligning bores and said socket in said anvil;
- (i) a tappet reciprocably mounted in said aligned bores and having one end extending into said cylinder head whereby said tappet is adapted to be struck by said striker as it reciprocates in said cylinder head and to impart hammer blows to a tool bit having an end extending through said socket and said communicating bore and into the one of said aligning bores in said anvil; and
- (j) means for preventing axial displacement of said tappet into said communicating bore whereby said tappet is incapable of striking ends of tool bits therein.

2. The hammer drill of claim 1, wherein the means drive connecting said cylinder and anvil further includes:

- (a) a hammer surrounding said cylinder and movable longitudinally of said cylinder;
- (b) said hammer and said cylinder head having facing cooperating surfaces with equidistantly spaced apart cam grooves formed therein;
- (c) rollable cam elements in said grooves, each of said grooves having a cam surface inclined relative to the cooperating surface of the component in which it is formed, whereby rotary motion of said hammer relative to said cylinder head will cause said cam elements

- to roll up said inclined surfaces and thereby move said hammer away from said cylinder head;
- (d) means biasing said hammer toward said cylinder head; and
- (e) cooperating, normally engaged lugs formed on said hammer and said anvil, the lugs on said hammer being so dimensioned as to be disengaged from the cooperating lugs on the anvil by the aforesaid movement of said hammer away from said cylinder head.
3. The hammer drill of claim 1, together with:
- (a) a ring of resilient material supported by said striker and protruding into the bore thereof adjacent the closed end of said bore; and
- (b) an annular groove in said piston adjacent the end thereof nearest said bore, whereby excessive rebound of said striker will cause said ring to seat in said groove, preventing said striker from hammering said piston and thereby damaging the drive means therefor.
4. The hammer drill of claim 1, wherein said drive means comprises:
- (a) a motor having an output pinion;
- (b) a drive gear in mesh with said pinion;
- (c) a crank rotatably fixed to said drive gear;
- (d) a crank pin fixed to said crank;
- (e) a connecting rod fixed to said crank pin and to said piston;
- (f) a bevel pinion rotatably fixed to said drive gear; and
- (g) a bevel gear meshed with said bevel pinion and rotatably fixed to said cylinder.
5. The hammer drill of claim 1, together with means providing a substantially air tight seal between said piston and the walls of the bore in said striker.
6. The hammer drill of claim 1, together with at least one external recess having a substantial axial dimension in said striker to reduce the area of contact between said striker and said cylinder.
7. The hammer drill as defined in claim 1, together with air exhaust passages in one end portion of the bore of said striker.
8. The hammer drill as defined in claim 1, together with a casing surrounding said cylinder, said casing having a tool bit receiving bore for non-rotatably receiving a tool bit in axial alignment with the tool bit receiving socket in said anvil.
9. In a power driven hammer drill:
- (a) an axially fixed anvil having a tool bit receiving socket formed therein;
- (b) a tappet reciprocable relative to said anvil and positioned to engage a tool bit received in said socket;
- (c) means for imparting axial hammer blows to said tappet to repeatedly drive it against said tool bit;
- (d) means for continuously rotating said anvil when the rotation restraining torque exerted on said anvil is below a predetermined magnitude; and
- (e) means actuated by the exertion of a rotation restraining torque of predetermined magnitude on said anvil for imparting rotary hammer blows to said anvil.
10. In a power driven rotary impact hammer drill or the like:
- (a) a rotatably mounted anvil having a tool bit receiving socket formed therein;
- (b) a rotatably mounted hammer adjacent one end of said anvil, said anvil and said hammer having normally engaged cooperating lugs drive connecting said hammer and said anvil;
- (c) means actuated by the exertion of a restraining torque of predetermined magnitude on said anvil for alternately drawing the hammer lugs out of engagement with the cooperating lugs on said anvil to thereby permit rotation of said hammer relative to said anvil and then reengaging said lugs to cause the hammer to impart a rotary blow to said anvil; and

- (d) means for imparting axial hammer blows to a tool bit received in the socket in said anvil.
11. In a power driven hammer drill or the like:
- (a) a rotatably mounted anvil;
- (b) means for imparting successive and repeated axial hammer blows to a tool bit mounted in said anvil;
- (c) means for continuously rotating said anvil when rotation restraining torque exerted on said anvil is below a predetermined magnitude; and
- (d) means for imparting rotary hammer blows to said anvil when said restraining torque exerted on said anvil exceeds said predetermined magnitude.
12. In a power driven hammer drill or the like:
- (a) a reciprocably mounted tappet adapted to strike and thereby impart axial hammer blows to a tool bit received in said hammer drill;
- (b) means for rotating said tool bit; and
- (c) means for repeatedly driving said tappet against said tool bit comprising:
- (1) a striker having a blind bore opening through one end and being reciprocable along the same axis as said tappet for axially impacting said tappet;
- (2) a piston reciprocable in said bore for imparting reciprocable movement to said striker; and
- (3) means for reciprocating said piston;
- (d) said means for rotating said tool bit including a clutch having drive and driven members rotatable about axes aligning with that of said striker and piston.
13. In a power driven rotary tool:
- (a) a rotatable tool bit;
- (b) motor means;
- (c) drive means operatively connected to said motor means for rotatably driving said tool bit and for imparting a rotary impact to said tool bit when the torque resisting rotation of said tool exceeds a predetermined magnitude;
- (d) said drive means including clutch means normally drivingly connecting said tool bit and said motor means and adapted to disengage said tool bit from said motor means when the torque resisting rotation of said tool bit exceeds said predetermined magnitude;
- (e) a reciprocably mounted striker for imparting axial impacts to said tool bit; and
- (f) means including components of said drive means for reciprocating said striker.
14. In a power driven impacting tool:
- (a) an imperforate cylinder, one end of which is closed by an end wall;
- (b) impact receiving means having an element extending through said end wall;
- (c) a striker reciprocably received in said cylinder for imparting a succession of axial impacts to said impact receiving means;
- (d) means for reciprocating said striker;
- (e) said striker having passage means connecting the space in said cylinder on one side of said striker to the space on the other side thereof, whereby at least a part of the air trapped within said cylinder may pass from one side of said striker to the other as said striker reciprocates;
- (f) means for continuously rotating said impact receiving means when rotation restraining torque exerted thereon is below a predetermined magnitude; and
- (g) means for imparting rotary hammer blows to said impact receiving means.
15. In a power driven impacting tool:
- (a) an imperforate cylinder, one end of which is closed by an end wall;
- (b) impact receiving means extending through said end wall;
- (c) a cylindrical striker having a generally cylindrical bore therein and an end wall closing one end of said

- bore, said striker being reciprocally received in said cylinder for imparting a succession of axial impacts to said impact receiving means;
- (d) said striker having passage means connecting the space in said cylinder on one side of said striker to the space on the other side thereof, whereby at least a part of the air trapped within said cylinder may pass from one side of said striker to the other as said striker reciprocates;
- (e) a piston disposed in the bore in said striker and being reciprocable to impart reciprocating movement to said striker;
- (f) means for reciprocating said piston;
- (g) recess means formed in the interior surface of said striker which delimits the bore therein at a point displaced a predetermined distance from the end wall of said striker; and
- (h) radial passage means formed in said piston adapted to connect with said recess means when said piston is displaced said predetermined distance from said end wall, whereby the volume on one side of said piston is connected with the volume on the other side of said piston when said piston is displaced said predetermined distance from said end wall.
16. In a power driven rotary tool:
- (a) an anvil adapted to non-rotatably receive a tool bit;
- (b) a rotatable cylinder;
- (c) means including a striker received in said cylinder and being reciprocable to impart axial impacts to said tool bit;
- (d) power means for simultaneously rotating said cylinder and reciprocating said striker; and
- (e) means drive connecting said anvil to said cylinder for rotation therewith and including clutch means operable (i) to momentarily disengage said anvil

from said cylinder when the torque resisting rotation of said tool bit and said anvil exceeds a predetermined magnitude and (ii) to impart a rotary hammer blow to said anvil upon reengagement.

17. In a power driven rotary tool, means for mounting a tool bit for rotational and axial displacement, a striker, means reciprocally mounting said striker for imparting axial impacts to said tool bit, a drive member, drive means for rotating said drive member and reciprocating said striker, a releasable clutch comprising a hammer operatively connected to said drive member, and an anvil having a non-rotatable drive connection to said tool bit, said hammer and anvil being normally engaged to operatively connect said drive member to rotate said tool bit, and means for sequentially disengaging and reengaging said hammer and anvil when the torque resisting rotation of said tool bit exceeds a predetermined amount, said last mentioned means imparting a rotational velocity to said hammer in excess of the rotational velocity of said drive member when said hammer and anvil are disengaged.

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