The present invention relates to a compact rotary hammer, and more particularly, to a portable electric hammer or similar power-operated device, wherein a rotation of the tool is facilitated together with a simultaneous impacting against the end of the tool shank.

It is an object of the present invention to provide a compact rotary hammer wherein both ends of the motor shaft are utilized, one end to drive the percussive mechanism, and the other end to drive the mechanism which rotates the tool.

It is another object of the present invention to provide a portable electric hammer, suitable for masonry drilling, concrete slotting, wood cutting, and for general demolition work, wherein the hammer is compact, considerably shorter than prior art devices, relatively lightweight, and convenient for the operator to use.

It is yet another object of the present invention to provide a compact rotary hammer which uses readily-available components and is easy to assemble and economical to produce, yet out-performs competitive devices and is rugged and reliable for continuous service over extended periods of time.

In accordance with the general teachings of the present invention, there is herein illustrated and described, a compact rotary hammer comprising a housing, one preferably including an end handle provided with a trigger-type of switch, and further comprising a motor energized through the switch and having a shaft journal bored and at in the housing. A floating ram is guided for reciprocation within the housing to one side of the motor and is disposed on an axis which is substantially parallel to the axis of the motor shaft; and means are provided, driven by the end of the motor shaft, to reciprocate the ram. The housing is provided with means to receive the shank of a tool, the end of which is struck repeatedly and directly by the ram; and means are further provided, driven by the fore end of the motor shaft, to rotate the tool.

In accordance with the specific teachings of the present invention, there is herein illustrated and described, a compact rotary hammer comprising a housing and a motor having a shaft journalered in respective bearings fore and aft in the housing. A floating ram is disposed within the housing directly above the motor and is guided for reciprocation along an axis which is substantially parallel to the axis of the motor shaft. Means are provided to reciprocate the ram, including a crank shaft journalered in the housing anteriorly of the motor on an axis which is transverse to the axis of the motor shaft, the crank shaft being driven by the aft end of the motor shaft. A gear or other rotatable member is journeled in the forward portion of the housing; and the gear is provided with a socket formed therein to receive the shank of the tool, the end of which is struck repeatedly and directly by the ram. The gear is constantly rotated through gearing driven by the fore end of the motor shaft; and preferably, but not necessarily, the shank formation of the particular tool bit determines the type of motion developed by the hammer, namely, hammering only, rotation only, or a combination of both hammering and rotation.

These and other objects of the present invention will become apparent from a reading of the following specification, taken in conjunction with the enclosed drawings, in which:

"FIGURE 1 is a side elevation of the compact rotary hammer of the present invention;"  
"FIGURE 2 is an enlarged longitudinal section of the compact rotary hammer; and"  
"FIGURES 3a, 3b and 3c are views of the forward portion of the hammer and respective tools used therewith, showing the development of both hammering and rotation, "pure" rotation, and "pure" hammering, respectively."

With reference to FIGURES 1 and 2, the compact rotary hammer 10 of the present invention has a housing which comprises an end housing 11, a motor housing 12, a gear case 13 and a gear case cover 14, and an end handle 15, the latter being provided with a trigger switch 16 and a conventional line cord 17. As desired, each of the housing portions 11-15 may be die-cast from a suitable aluminum alloy or may be molded from a suitable glass fiber material.

With particular reference to FIGURE 2 the motor housing 12 has an electric motor (or other power source) which is conventional and comprises a pair of field windings 18 and a rotating armature 19. The armature 19 is provided with a motor shaft 20 which is journeled in respective bearings 21 and 22 disposed fore and aft in the housing. Bearing 21 is retained within a boss 21a formed in the forward portion of the motor housing 12, while bearing 22 (on the aft end of the motor shaft 20) is retained within a boss 22a formed in the gear case cover 14. A fan 23 is mounted upon the aft end of the motor shaft 20, and a fan blithe 24 is disposed between the fan 23 and the motor for diverting the airflow through suitable openings 23a in a well-known manner.

The bearing 23 is retained by means of a cone lock washer 25 and lock nut 26 which engages the threaded portion 27 of the shaft 20, and also, by means of a retainer plate 28 which is secured to the gear case cover 14 by a plurality of screws, one of which is shown in Fig. 3c as 29.

A bevel pinion 30 is formed on the aft end of the motor shaft 20, and preferably but not necessarily, the pinion 30 is of the well-known hypoid type gear for reasons of strength and compactness. The pinion 30 is designed to engage a bevel gear 31 (of like formation) which has a loose splined connection 32 with respect to a crankshaft 33. The crankshaft 33 is disposed within the gear case 13 anteriorly of the motor and along an axis which is substantially transverse to the axis of the motor shaft 20. The crankshaft 33 is journeled in a ball bearing 34 and in a closed needle bearing 35, which are retained within respective bosses 34a and 36 formed in the gear case 13. The bevel gear 31 is secured on the crankshaft 33 by means of a cone lock washer 37 and a pair of locking nuts 38, the latter engaging respective threads 39 formed on the crankshaft. The ball bearing 34 is retained by means of a retainer plate 40 which is secured to the gear case 13 by means of a plurality of screws, one of which is shown in section as at 41.

The crankshaft 33 has an integral crank body 42 within which a crank pin 43 is secured on an eccentric axis. A connecting rod 44 is mounted upon the crank pin 43, and a sleeve bearing 45, preferably of the "Graphite" type (made and sold by Timken Roller Bearing Co.) is disposed therebetween. If desired, the crank pin 43 and the connecting rod 44 may be suitably lubricated, such as is illustrated and described in the coming-pending Short application S.N. 218,678 filed August 23, 1963, entitled "Lubricator for a Motion-Translating Mechanism," and assigned to the assignee of the present invention. The other end of the connecting rod 44 is pivotedly mounted to a reciprocating cross...
head 46 through a wrist pin 47, and the cross-head 46 is guided within a sleeve 48 which is retained within the motor housing 11. A tubular piston rod 49 is formed integrally with the cross-head 46, and a relatively-short disc-shaped piston 50 is formed integrally on the forward end of the piston rod 49. The piston 50 is disposed within a floating ram 51 which is guided on rails 52 within the sleeve 48. Preferably, the ram 51 is of the hollow cylinder type, and a chamber 53 is formed between the piston 50 and the ram 51 for trapping a quantity of air therein. The air entrapped in the chamber 53 exhibits alternate compression and rarefaction effects and thus comprises an "air spring" which has a two-fold purpose: to advance or accelerate the ram 51 ahead of the reciprocating piston 50 by means of a compression of the entrapped air, and secondly, to withdraw or retract the ram 51 within the sleeve 48 by means of a suction effect which may be aided by the rebound of the hammer blow struck by the ram. Some type of momentary venting means is provided for the entrapped air chamber 53 so that the mass of entrapped air may adjust itself to a substantially constant working level during the operation of the tool, and a preferred embodiment of the momentary venting means comprises an internal annular recess 54 formed within the ram 51, the recess having a greater axial width than the corresponding height of the relatively-short disc-shaped piston 50; consequently, the entrapped air chamber 53 communicates with the atmosphere whenever the piston 50 passes by the internal annular recess 54 formed in the ram 51, it being noted that the piston 50 and ram 51 reciprocate (not in unison) but relative to one another. Further details of the structural and operating venting means, in particular, and of the reciprocating piston and ram in general, are described in the Ackerman Patent 3,034,302 issued May 15, 1962, entitled "Momentary Venting Means for Power-Operated Percussion Tool," and assigned to the assignee of the present invention. However, it will be understood by those skilled in the art that any suitable means for reciprocating the floating ram 51 may be employed in conjunction with the teachings of the present invention. Moreover, an external annular groove 55 is formed on the piston 50, and a sealing ring 56 is disposed within the annular groove 55; preferably, the sealing ring 56 has an axial clearance with respect to the width of the groove 55, measured axially, and also has a radial clearance with respect to the inner diameter of the piston measured at the trough of the annular groove 55, such that the sealing ring 56 has a certain fit with respect to the piston 50. The concurrent usage of the load-flushing assignee of the present invention further enhances the cycling and smooth operation of the tool, as described more particularly in the Ackerman Patent 3,067,584 issued on December 11, 1962, entitled "Sealing Ring Means for Reciprocating Piston Used in Power-Operated Percussion Tool," and assigned to the assignee of the present invention. Furthermore, the forward portion of the piston 50 is provided with a cylindrical protrusion 57 which is designed (at times) to cooperate with a cylindrical recess 58 formed in the closed forward portion of the ram 51. At certain times over the extended life of the mechanism, more particularly when the sealing ring 56 has become somewhat deteriorated, the piston 50 may tend to "bottom" or impact against the closed end of the ram 51; and in order to preclude a continuous impacting or "bottoming" of the piston 50, the protrusion 57 is received within the recess 58 and acquires a positive location, such that the force being imparted by the reciprocating piston 50 and further impacting therebetween is prevented. Further details of this particular structure and is mode of operation may be obtained in the Ackerman Patent 3,032,998 issued on May 8, 1962, entitled "Ram Catcher for Piston-Ram Assembly," and assigned to the assignee of the present invention. However, it will be appreciated by those skilled in the art that any suitable type of power-operated means may be employed to reciprocate the ram 51 insofar as the means employed is driven by the aft end of the motor with the ram 51 reciprocating in accordance with the teachings of the present invention.

With further reference to FIGURE 2, a nose piece comprising a flanged bushing 59 is secured to the forward portion of the motor housing 11 by means of a plurality of screws 60 and respective lock washers 61, the screws being received within corresponding threaded recesses 62 formed in the housing, and a cone lock washer 63 being disposed between the flanged portion of the nose piece 59 and the motor housing 12. Between the nose piece 59 and the end of the sleeve 48, there is disposed an O-ring 64, a bypass plate comprising a ring 65, and a split-coilet 66, the purpose of which is to prevent the ram 51 from impacting against the nose piece 59 and the adjacent elements of the mechanism. A bearing sleeve 67 is pressed within the nose piece 59 so as to journal the integral tubular neck portion 68 of a gear 69 or other rotatable member. A washer 70 is disposed between the bearing sleeve 67 and the real face of the gear 69. The forward face of the gear 69 engages a bearing bushing 71 which is pressed within the end housing 11. The gear 69 is driven by a pinion 72 which is formed on a jack shaft 73, and the jack shaft 73 is journaled in the housing; consequently, as viewed in FIGURE 2) within respective closed needle bearings 74 and 75 fore and aft in the housing. The bearing 74 is retained within a boss 76 formed in the end housing 11 while the other bearing 75 is retained within a boss 77 formed in the motor housing 12. A pair of the nutary tappets 78 are mounted on the jack shaft 73 adjacent the bearings 74 and 75, respectively, and the jack shaft carries an intermediate gear 79. The gear 79 engages a pinion 80 which is loosely mounted on the fore end of the motor shaft 20. The fore end of the shaft 20 carries a pair of keyed washers 82, a pair of thrust washers 83, and a pair of cone lock washers 84, all of which are retained by means of a lock nut 85 engaging the threaded portion 86 of the shaft 20, thereby forming a friction-actuated "slip" clutch between the pinion 80 and the motor shaft 20. The extreme forward portion of the motor shaft 20 is provided with a hexagonal socket 87 and a removable cap plug 88 is carried by the end housing 11 forwardly of the shaft 20. Consequently, the plug 88 may be removed, and a pair of suitable wrenches applied, one to the hexagonal socket 87 and the other to the nut 85, so as to adjust the degree of torque at which the clutch will "slip" to a predetermined level. The structural details of the slip clutch and its mode of operation, as well as the nature and purpose of the rotating gear 69, are provided in the pending Short application S.N. 213,363, filed July 30, 1962, entitled "Rotary Hammer," and assigned to the assignee of the present invention. A commutator 89 is carried by the armature 19, and a collar 90 is disposed between the commutator 89 and the bearing 21. The commutator 89 engages suitable electrical brushes mounted in the forward portion of the tool housing in respective brush holder, one of which is shown as at 101 in FIGURE 1, means of bringing the electrical wires from the cord 17 into the end handle 15 and through the motor housing 12 to the brushes which engage the commutator 89, form no part of the present invention and hence are omitted herein for ease of illustration.

With reference again to FIGURE 2, and with further reference to ram 51 is "S", "Sa", "Sb", and "Sc", the application and inherent utility of the present invention is described with reference to a number of conventional tools, each of which is readily available in the commercial market. As shown in FIGURE 2, the structure of the compact rotary hammer 10 includes the rotating gear 69 which (together with its integral neck portion 68) is provided with a round axial bore 90, a counterbore 91, and a
hexagonal (or other polygonal) socket 92. In FIGURE 3a, a conventional tool 93 (preferably of the carbide type) is inserted within the hammer 10, such that the hexagonal shank portion 94 of the tool 93 is received within the socket 92 of the gear 69, and such that the end of the shank will be repeatedly struck by the ram 51. Consequently, both hammering and a simultaneous rotation is obtained. In FIGURE 3b, another standard tool 95 is inserted within the hammer 10, and the tool 95 (which again may be of the carbide type) is similar to the tool 93 but has a shorter hexagonal shank portion 96 than that of the tool 93. Consequently, the tool 95 is continuously rotated, but being shorter, is not engaged by the impacting ram 51; and thus a "pure" rotation is obtained without any hammering action. Each of the tools 93 and 95 are used primarily for drilling in masonry, such as concrete, or for similar operations. In FIGURE 3c, still another standard tool 97 (referred to in the art as a "bull point" and used primarily for demolition work) is inserted within the hammer 10, and the tool 97 has a round shank portion 98 which is received loosely within the hexagonal socket 92 and which is sufficiently long so as to be struck by the ram 51. Consequently, a "pure" hammering or percussive action is obtained without any simultaneous rotation of the tool; and indeed, rotation is altogether precluded by means of the hexagonal shank portion 99 of the tool 97, which is received within the hexagonal socket 100 formed within the stationary bearing bushing 71. Consequently, it will be appreciated that the type of motion desired by the user, namely, pure hammering, pure rotation, or a combination of both hammering and rotation, may be obtained by use of the proper type of conventional tool, and more particularly, the shank formation thereof; and further details on the particular structure of the tools and their mode of operation, which are well-known in the art, are given in the aforesaid Short co-pending application.

The compactness of the rotary hammer of the present invention is achieved first, by having the motor beneath (or above or to one side of) the reciprocating ram 51, and secondly, by using both ends of the motor shaft 20, the aft end driving the crankshaft 33 and other elements of the percussive mechanism, and the fore end driving the gear 69 and other elements of the rotary mechanism. This structural arrangement results in a considerably shorter tool than competitive prior art devices, yet still retains the desirable features of striking a very hard blow and (at the same time) rotating the shank of the tool.

Obviously, many modifications may be made without departing from the basic spirit of the present invention; and accordingly, within the scope of the appended claim, the invention may be practiced other than as has been specifically described herein.

We claim:
A compact rotary-hammer tool, comprising:
(a) a housing having a rearwardly-disposed end handle provided with a trigger-type of switch for manually actuating the tool;
(b) an electric motor in the housing connected to said switch;
(c) said motor including an armature having an armature shaft journal ed in bearings forwardly and rearwardly in said housing; the rearward portion of said armature shaft being of larger diameter than the forward portion, and the respective bearing for said rearward portion being correspondingly larger than the respective forward bearing;
(d) a commutator carried on the forward portion of said armature shaft between said armature and the respective forward bearing for the armature shaft, and electrical brushes mounted in the forward portion of said housing for engaging said commutator;
(e) said housing having a longitudinal barrel parallel to said motor and spaced laterally therefrom, and said barrel having a floating ram guided for reciprocation therein;
(f) means including a reciprocating mechanism and a vertically-journalled crankshaft driven by the rearward end of said armature shaft, through cooperating bevel gears, one gear on said rearward end of said armature shaft, and the other gear on said crankshaft, for reciprocating said ram, whereby the larger diameter rearward bearing for the armature shaft accommodates the relatively-higher mechanical loads occasioned by the crankshaft and the reciprocating mechanism;
(g) a gear journalled for rotation in the housing forwardly of said barrel; said gear having integral socket means formed therein for receiving the shank of a tool bit, the end of which is struck repeatedly and directly by said ram;
(h) gearing means driven by the forwardmost end of said armature shaft, forwardly of the respective forward bearing for the armature shaft, for driving said gear; and
(i) a torque-responsive slip clutch means in said gearing means.

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