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COMPACT ROTARY HAMMER

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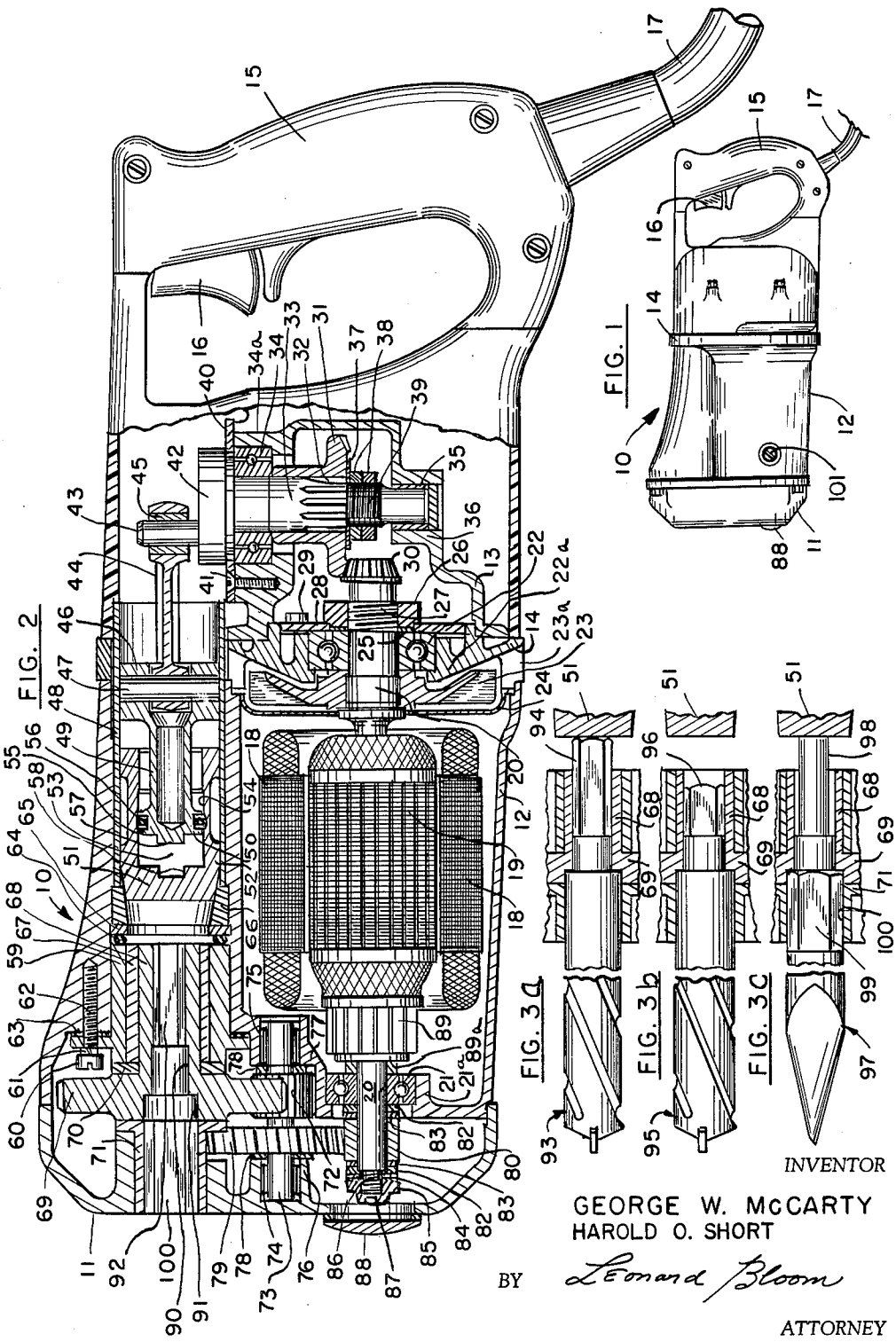


FIG. 1

FIG. 3a

FIG. 3b

FIG. 3c

INVENTOR

GEORGE W. McCARTY

HAROLD O. SHORT

BY Leonard Bloom

ATTORNEY

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COMPACT ROTARY HAMMER

George W. McCarty and Harold O. Short, Towson, Md., assignors to The Black and Decker Manufacturing Company, Towson, Md., a corporation of Maryland

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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 gouging, 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 journaled fore and aft 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 aft 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 journaled 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 journaled 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 journaled 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 3*a*, 3*b* and 3*c* 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 journaled in respective bearings **21** and **22** disposed fore and aft in the housing. Bearing **21** is retained within a boss **21***a* 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 **22***a* formed in the gear case cover **14**. A fan **23** is mounted upon the aft end of the motor shaft **20**, and a fan baffle **24** is disposed between the fan **23** and the motor for diverting the cooling air through suitable openings **23***a* in a well-known manner. The bearing **22** 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 elevation as at **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 journaled in a ball bearing **34** and in a closed needle bearing **35**, which are retained within respective bosses **34***a* 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 "Graphmo" type (manufactured 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 co-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 pivotably 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 cylindrical 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: one 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 vending 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 structure and operation of the momentary venting means, in particular, and of the reciprocating piston and ram in general, are described in the Akerman Patent 3,034,302 issued May 15, 1962, entitled "Momentary Venting Means for Power-Operated Percussive 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 loose fit with respect to the piston 50. The concurrent usage of the loose-fitting sealing ring 56 further enhances the cycling and smooth operation of the tool, as described more particularly in the Atkinson 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 press-fit therein, such that the floating ram 51 is "caught" by the reciprocating piston 50 and further impacting therebetween is precluded. Further details of this particular structure and is mode of operation may be obtained in the Atkinson 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 shaft 20 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 washer 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 bumper plate comprising a ring 65, and a split-collet 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 (below the longitudinal midplane of the tool 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 thrust washers 78 are mounted on the jack shaft 73 adjacent the bearings 74 and 75, respectively, and the jack shaft carriers 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 copending 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 89*a* 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; the manner 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 FIGURES 3*a*, 3*b*, and 3*c*, the application and inherent utility of the present invention may be 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 3*a*, 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 a hammering and a simultaneous rotation is obtained. In FIGURE 3*b*, 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 3*c*, 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 journaled 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-journaled 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 journaled 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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BROUGHTON G. DURHAM, *Primary Examiner.*