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[54] **IMPACT TOOL**
 9 Claims, 11 Drawing Figs.

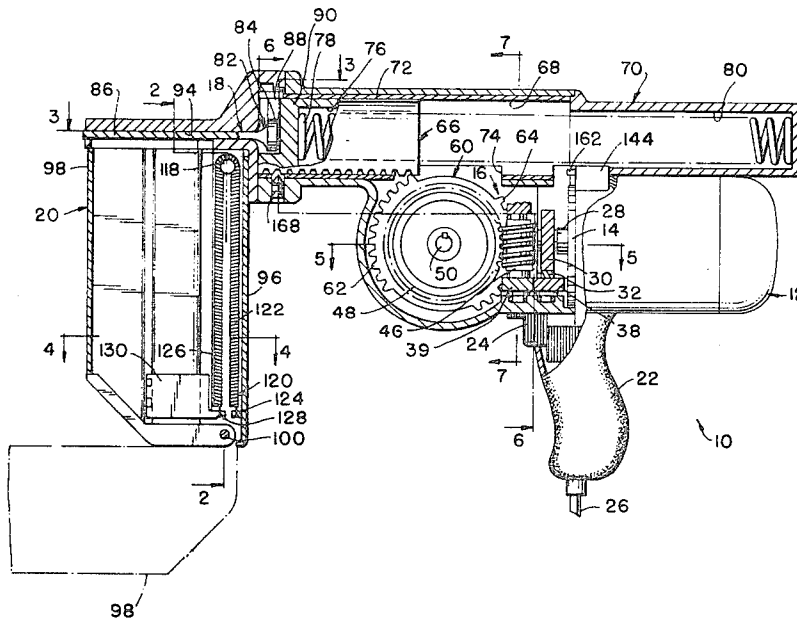
[52] U.S. Cl. 227/132,
 227/131
 [51] Int. Cl. B25c 1/06
 [50] Field of Search. 227/109,
 131, 132, 146

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ABSTRACT: A hand-held impact tool usable, for example, as a nailing machine is disclosed. The tool includes a hammer which is retracted by means of an electric motor to compress a spring. A gear, driven by the motor, is caused to disengage from the hammer upon retraction thereof to permit forward movement of the hammer under the pressure of the compressed spring. Switch means are provided to prevent a repeat of the operating cycle except upon manual release and depression of a trigger. A fastener-feeding structure is detachably secured to the impact tool. Provision is made for changing the hammer and fastener-feeder magazine to permit use of different size and shape fasteners such as nails and staples.



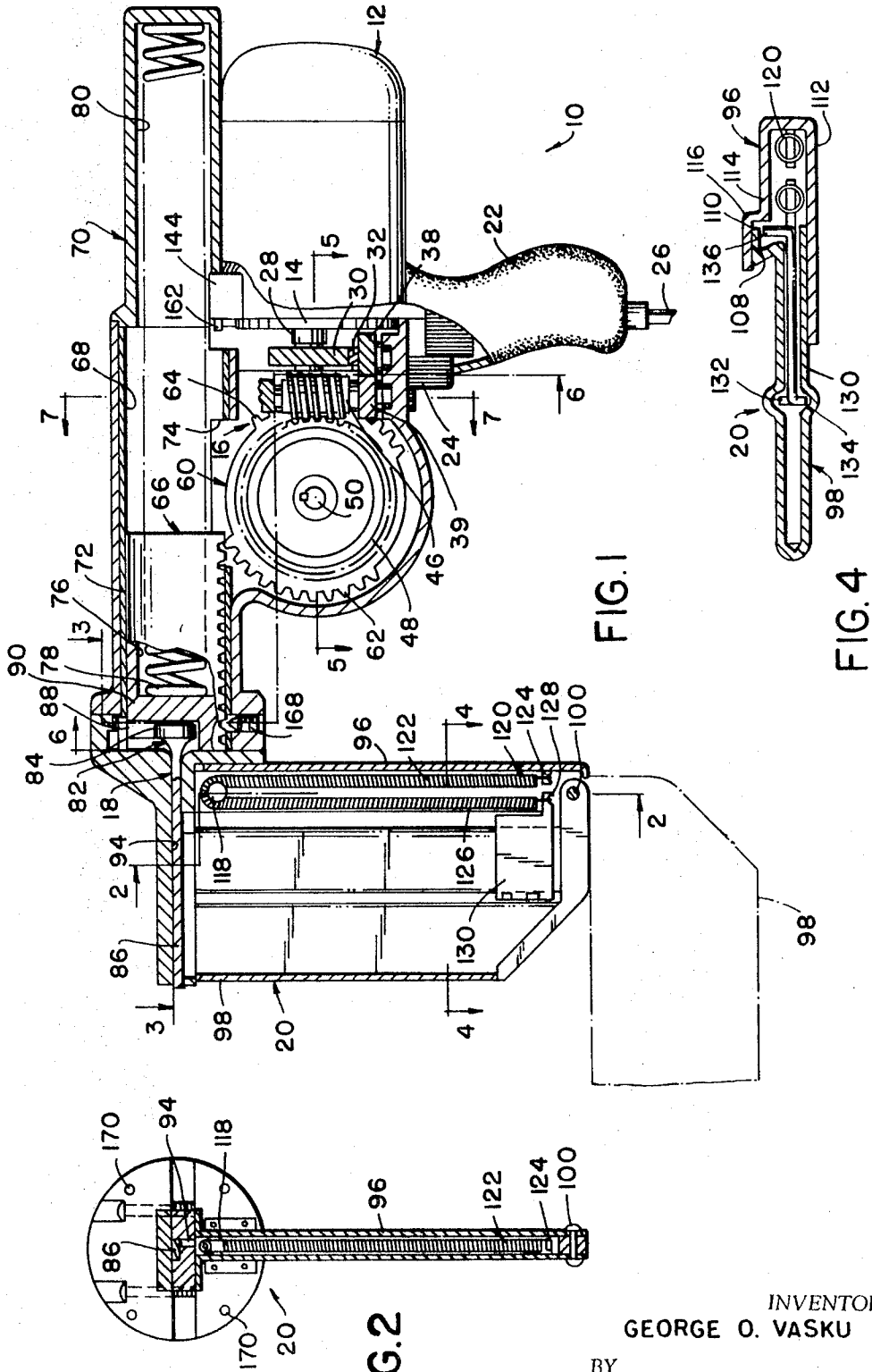


FIG. 1

FIG. 2

FIG. 4

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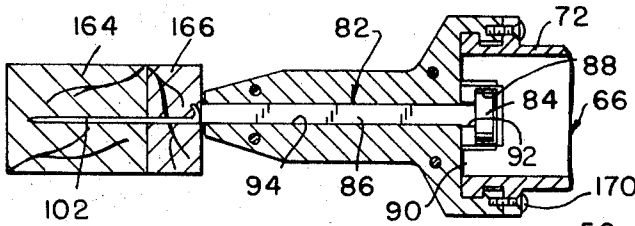


FIG. 3

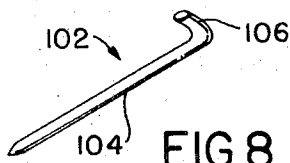


FIG. 8

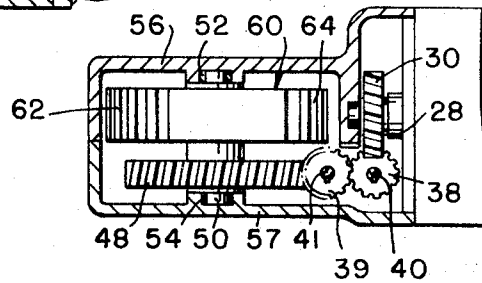


FIG. 5

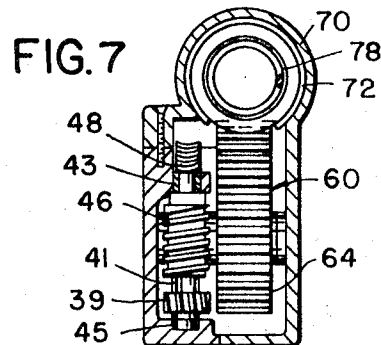


FIG. 7

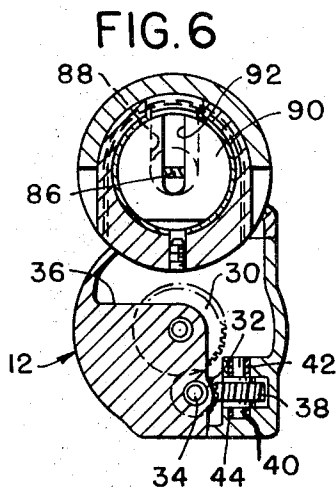


FIG. 6

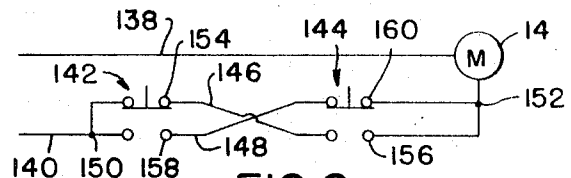


FIG. 9

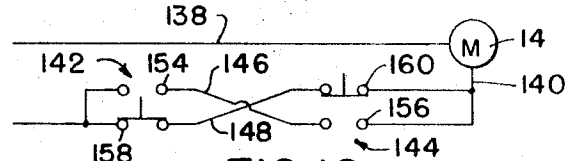


FIG. 10

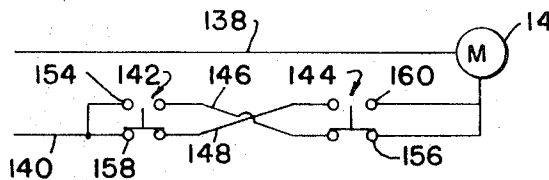


FIG. 11

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IMPACT TOOL

BACKGROUND OF THE INVENTION

Numerous impact tools for use in driving nails, staples and for providing impact on workpieces, have been proposed in the past. There has been a need for a versatile, safe and efficient all-around impact tool which has not been supplied by the prior art. One problem in the prior art has been repeat hammering, that is, the hammer of the impact tool has operated continuously upon actuation of switch means. The present invention provides a device which avoids hammer repeat for the purpose of safety.

Another problem with prior art devices has been their complexity. The present invention provides a structure which comprises a simplified operating mechanism. The device is electrically powered and is reliable in use.

One additional feature lacking in some prior art devices is provision for change in the type of fastener-feeding structure utilized with the device. The present invention provides a casing structure and hammer head and magazine structure which permits interchanging of different hammer head and magazine structure to permit the impact tool to operate on nails and staples and the like having different sizes, shapes and weights.

SUMMARY OF THE INVENTION

The impact tool comprises a hammer which is reciprocally mounted to deliver an operating blow. An electric motor is operably connected to a drive train which in turn is operably connected to the hammer to move the hammer in one direction upon energization of the motor. Spring means are compressed by the hammer upon movement of the hammer in said one direction. Means are provided to disconnect the hammer from the drive train at the end of the predetermined hammer movement in said one direction, whereupon the hammer is driven in the other direction by the spring means to deliver an operating blow. Switch means are provided to deenergize the motor immediately after the hammer is driven in said other direction.

The drive train includes a gear having teeth over only a portion of the periphery thereof which mesh with the teeth of a rack connected to the hammer. The gear teeth disengage the rack at the end of hammer retraction to permit forward movement of the hammer under the power of the spring means. Switching means are provided to deenergize the motor immediately after the termination of hammer movement and to prevent reenergization of the motor until positive manual switching action has taken place. A fastener-feeding structure is detachably secured to the impact tool. Various feeding structures may be used depending upon the shape and size of the fasteners to be driven.

IN THE DRAWINGS

FIG. 1 is a side elevational view partly in section of an impact tool forming one embodiment of the present invention;

FIG. 2 is a sectional view taken substantially along the line 2-2 of FIG. 1 looking in the direction of the arrows illustrating the nail-feeding structure of the impact tool;

FIG. 3 is a sectional view taken substantially along the line 3-3 of FIG. 1 looking in the direction of the arrows illustrating the hammer of the impact tool after it has driven a nail into a pair of wooden members;

FIG. 4 is an enlarged sectional view taken substantially along the line 4-4 of FIG. 1 looking in the direction of the arrows illustrating the nail-feeding structure;

FIG. 5 is a sectional view taken substantially along the line 5-5 of FIG. 1 looking in the direction of the arrows illustrating the drive train of the impact tool;

FIG. 6 is a view taken substantially along the line 6-6 of FIG. 1 looking in the direction of the arrows illustrating the hammer structure and drive train;

FIG. 7 is a view taken substantially along the line 7-7 of FIG. 1 looking in the direction of the arrows illustrating the drive train;

FIG. 8 is a view in perspective of the type of nail utilized in the present embodiment of the impact tool;

FIG. 9 is a schematic view of the electrical switch system illustrated in one open position;

FIG. 10 is a schematic view of the electrical switching system illustrating one closed position to supply power to the driving motor; and

FIG. 11 is a schematic view illustrating the electrical switching system in a second open position.

The impact tool 10 comprises a casing 12 which encloses an electric motor 14, drive train 16 and hammer structure 18. A nail-feeding structure 20 is detachably fastened to the forward end of the casing 12.

The lower portion of the casing 12 is fashioned in the shape of a pistol, having a hand-engageable pistol grip 22 with a trigger 24 for closing a circuit through the motor 14 to energize the motor and actuate the device. An electric cord 26 is provided for connection to a source of electric power. The cord 26 extends through the grip 22 and is ultimately connected, through a switching system, to the motor 14.

The output shaft 28 of the motor has secured thereto a helical gear 30. The gear 30 meshes with a gear 32 of smaller diameter which is rotatably mounted on a shaft 34. As will be noted in FIG. 6, an interior projection 36 is provided within the casing 12 for mounting of the shafts which support the gears 30, 32.

The gear 32 meshes with a similar gear 38 fixedly secured to a shaft 40 which is journaled for rotation between bearing structures 42, 44. The gear 38 meshes with a gear 39 fixedly mounted on a shaft 41 journaled in bearings 43, 45. The shaft 41 has fixedly mounted thereon a worm 46 which engages and drives worm wheel 48. The worm wheel 48 is fixedly mounted on a shaft 50 which is journaled in bearing structures 52, 54 provided on oppositely disposed casing sidewalls 56, 57 as may be noted in FIG. 5.

The shaft 50 also fixedly carries a spur-type gear 60 adjacent to the worm wheel 48. The gear 60 has a set of oppositely disposed teeth 62, 64 each of which sets extends over an arc of approximately 90°. The sets of teeth 62, 64 are designed to alternately engage the teeth of a slidable rack 66 as the shaft 50 is rotated. The rack 66 is slidably mounted in a bore 68 provided in the upper barrel-like portion 70 of the casing 12. A cylindrical metallic sleeve 72 is provided to line the interior of the bore 68 and acts as a bearing surface. A notch 74 is cut into the portion 70 to provide access for contact of the rack 66 and teeth 62, 64.

The rack 66 has a central recess 76 therein to receive one end of a coil spring 78. The other end of the spring 78 is received in bore portion 80 which is of reduced diameter with respect to the bore 68. When the rack 66 is driven rearwardly of the device as viewed in FIG. 1, the spring 78 is compressed to store energy for forward driving of the rack-and-hammer structure 18.

The hammer structure 18 includes a hammer 82 comprising an enlarged circular or round head 84 having extending therefrom an elongated flat strip element 86 of rectangular cross section as shown in FIG. 2. The head 84 is received in a reentrant groove 88 provided in the forward wall 90 of the rack 66. As will be noted in FIGS. 3 and 6, the strip 86 which is of rectangular cross section engages the sidewalls of slot portion 92 formed in the forward wall of rack 66. The strip 86 extends from the rack 66 into an elongated rectangular-shaped slot 94 formed in the feeding structure 20, as illustrated in FIGS. 2 and 3, with the surfaces of the strip 86 in contact with the surfaces defining the slot 94. As will be appreciated, upon movement of the rack 66 rearwardly, the strip 86 is moved rearwardly in the slot 94 to permit loading of a nail thereinto for driving purposes. Upon completion of the rearward movement of rack 66, the strip 86 of hammer 82 is still in engagement with the surfaces defining slot portion 92 and slot 94 thereby preventing rack 66 from turning.

The nail-feeding structure 20 is best illustrated in FIGS. 1, 2 and 4. The nail-feeding structure 20 comprises a fixed substantially U-shaped casing portion 96 which is secured to the forward portion of the casing 12 and a pivotal casing portion 98 which is also substantially U-shaped. The pivotal casing portion 98 is secured to the fixed casing 96 by means of a pin 100. The pivotal casing portion 98 may be pivoted downwardly as shown in FIG. 1 for loading of nails thereinto.

The pivotal casing portion 98 is configured to receive a nail such as the nail 102 shown in FIG. 8. The nail 102 comprises an elongated portion 104 which is driven into a wood piece by means of the impact tool 10. A bentover portion 106 forms the nail head. The nails 102 are received in the pivotal portion 98 with the elongated portion 104 extending for substantially the width of the casing and the head 106 oriented to be received within the recess defined by angular walls 108, 110 provided along the rearward side of the pivotal casing portion 98.

The fixed casing portion 96 has one relatively wide sidewall 112 which overlaps the pivotal casing portion 98. The other sidewall 114 extends up to the angular wall 110. A right-angle portion 116 extends therefrom to overlap the wall 110.

A roller 118 is provided within the casing portion 96 adjacent to the upper end thereof. An elongated tension-spring element 120 extends around the roller 118. One leg 122 of the spring 120 is fixedly attached to a projection 124 provided adjacent the lower end of the casing. The other leg 126 is attached to a projection 128 which extends from a pusher element 130 which is slidably received within the pivotal casing portion 98. As will be noted in FIG. 4, oppositely disposed grooves are provided in the sidewalls of the casing portion 98 to receive projections 132, 134 of the pusher element 130 to guide the pusher element up and down within the casing. A front wall portion 136 of the pusher element is bent over to be received in the same recess as the nail heads for the purpose of guiding the pusher element. In operation, the spring 120 constantly urges the pusher element 130 upwardly to position nails within the slot 94 for action thereupon by the hammer 82.

FIG. 9, 10 and 11 illustrate the electrical circuitry for energizing and deenergizing the electric motor 14 in operation of the impact tool 10. A pair of leads 138, 140 extend from the motor 14 to a source of electrical power. Two double-throw, double-pole switches 142, 144 are placed in parallel in leads 146, 148 having common connection points 150, 152 to lead 140. One set of contacts 154 of the switch 142 is placed in series with one set of contacts 156 of the switch 144 in the lead 146. The other set of contacts 158 of the switch 142 is placed in series with the other set of contacts 160 of the switch 144 in lead 148. The switch 142 is operated by the trigger 24. The switch 144, which is a limit switch, is actuated by the rack 66 immediately after reaching the end of its rearward stroke. As will be noted in FIG. 1, the plunger 162 is in registry with the rack 66 and is depressed thereby at the end of the rearward stroke of the rack at which time the last tooth 62 of gear 60 is disengaged from the rack 66. As a result the rack 66 is urged by spring 78 in its forward stroke and the plunger 162, previously depressed, is released upon the forward movement or stroke of rack 66 to actuate the switch 144.

In operation, when the motor 14 is deenergized, the contacts of the switches 142, 144 which are in series are not closed. For example, as shown in FIG. 9, the contacts 154 of switch 142 are closed while the contacts 160 of switch 144 are closed. As a consequence, one side of the motor 14 is not connected to power and the motor is deenergized. Upon actuation of the trigger 24, the contacts 158 of the switch 142 will be closed (FIG. 10) thus completing a circuit through the motor 14 to energize the motor. The motor, upon being energized, will cause the rack 66 to be moved rearwardly as a result of the rotation of the gear 60. Upon rearward movement of the rack, the spring 78 is compressed. At the same time, the hammer 82 is moved rearwardly in the slot 94 as explained previously thereby permitting a nail to be injected into the slot 94 from the nail-feeding structure 20.

The rack 66, upon reaching the end of its stroke, will depress the plunger 162. Simultaneously, with depression of the plunger 162, the last tooth of the set of teeth 62 will disengage from the rack 66, leaving the rack free for forward travel. The spring 78 will then drive the rack forwardly with great power. Immediately after the rack starts its forward stroke, the plunger 162 is released thereby opening the contacts 160 and closing the contacts 156 of the switch 144 (FIG. 11). This causes deenergization of the motor 14. The hammer 82 will drive the nail 102 out of the slot 94 and into the parts 164, 166 to be nailed together as illustrated in FIG. 3.

In order to repeat the process, the trigger 24 must be released and depressed again in order to close the contacts 154 of switch 142 which are in series with the closed contacts 156 of the switch 144.

Means are provided for quickly and efficiently changing the nail-feeding structure 20 so that different sizes of nails or staples may be utilized with the impact tool 10. In order to remove the nail-feeding structure illustrated, a setscrew 168, as shown in FIG. 1, which is provided in a threaded opening in the forward portion of the casing portion 70, is threaded into engagement with the teeth of the rack 66 thus holding the rack in place. The screws 170 (FIG. 2) are then unthreaded. The nail-feeding structure 20 (including the hammer 82) may then be slid out of engagement with the casing 12. A new feeding structure is then engaged and the screws 170 rethreaded to secure the unit in place. The setscrew 168 is then unthreaded to disengage the rack 66. The impact tool 10 is then ready for use with the new feeding structure.

The impact tool 10 has been described specifically in connection with use as a means for automatically driving nails. However, the impact tool may be used to drive other fastening devices. Alternately, the hammer portion of the impact tool may be used for any purpose in which it is desired to strike a powerful hammer blow on a workpiece.

What I claim as my invention is:

1. An impact tool comprising a hammer reciprocally mounted to deliver an operating blow, an electric motor, a drive train between the motor and the hammer to move the hammer in a predetermined hammer movement in one direction upon energization of the motor, said drive train being disconnected from said hammer upon completion of the movement of said hammer in said one direction, spring means compressed by the hammer upon movement in said one direction and effective to drive said hammer in the other direction to deliver an operating blow when said drive train is disconnected from said hammer, and switch means interposed between said hammer and said motor and responsive to the movement of said hammer in said other direction to deenergize the motor.

2. An impact tool as defined in claim 1, and further characterized in that said drive train includes a gear having teeth for only a portion of the periphery thereof, a gear rack connected to said hammer and having teeth engageable with the teeth of said gear, said gear being driven by said electric motor when the motor is energized to engage the gear rack and move the hammer in said one direction, the teeth of said gear disengaging the gear rack at the end of said predetermined hammer movement in said one direction.

3. An impact tool as defined in claim 2, and further characterized in that said gear has two sets of diametrically opposed teeth on the periphery thereof, a space being provided on said gear between the beginning and end of each set of teeth.

4. An impact tool as defined in claim 2, and further characterized in that said switch means comprises a limit switch placed in the path of said rack, the limit switch having a plunger engageable with said rack near the end of said predetermined hammer movement and to be actuated to operate said limit switch and deenergize the motor when said hammer is moved in said other direction.

5. An impact tool as defined in claim 4, and further characterized in that said limit switch has a pair of sets of contacts, one set of said contacts being closed by actuation of said

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plunger and the other set of said contacts being opened thereby, a manually actuatable switch having a pair of sets of contacts and means to manually open one set of said contacts and close the other set of said contacts, one of each of said sets of contacts of each of said switches being in series with one set of contacts of the other switch and in parallel with the other set of contacts of said other switch, and in series with said electric motor whereby said electric motor is energized by closure of two sets of said contacts which are in series and deenergized by opening the closed contacts of the limit switch.

6. An impact tool as defined in claim 2, and further characterized in the provision of a casing having a portion with a longitudinal bore therethrough, said hammer, rack and spring being positioned in said bore, said casing including a portion enclosing the motor and gear train, opening means between said casing portions for ingress of the teeth of said gear for engagement with the rack.

7. An impact tool as defined in claim 2 wherein a fastener feeder structure is detachably connected thereto, said fastener

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feeder structure including means to feed a fastener into the path of movement of said hammer upon movement thereof in said one direction and for driving contact with said hammer when the latter is moved in said other direction.

8. An impact tool as defined in claim 7, and further characterized in the provision of a casing enclosing said hammer and associated structure, said fastener-feeding structure including a casing, and detachable fastening means securing the two casings together.

9. An impact tool as defined in claim 8, and further characterized in that said fastener casing includes an elongated storage chamber positioned at substantially right angles to the path of movement of said hammer, a slot in said fastener casing in alignment with the hammer to receive the hammer upon movement thereof towards the slot to drive a fastener out of the fastener structure, and spring-urged means to move fasteners contained within the storage chamber into the slot.

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