United States Patent

De Caro

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[54] **FASTENER DRIVE TOOL FOR CASELESS LOADS**

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[52] **U.S. Cl.** **227/10**

[51] **Int. Cl.** **B25c 1/14**

[58] **Field of Search** 227/7, 8, 9, 10, 11, 147

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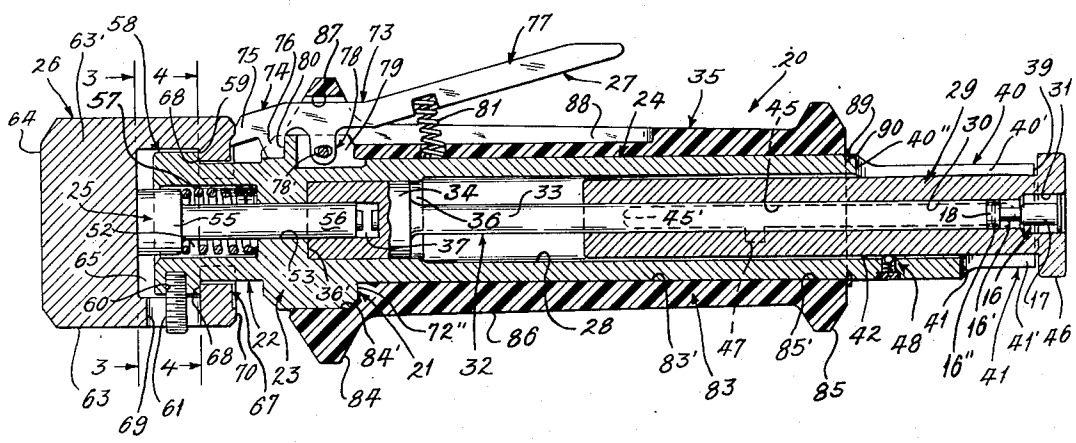
[57] **ABSTRACT**

A powder actuated tool utilizing caseless powder loads and having a hammer anvil in driving relationship with a firing pin and a safety lever normally preventing anvil movement from its non-firing position; and a fastener driving ram with an ignition chamber for a caseless powder load cooperable with the firing pin and being engaged with a fastener carried by a ram guide member slidable in the tool housing. The ram and its guide member forming fastener drive means extendable from the muzzle end and being non-axially movable into reloading and disconnecting positions.

28 Claims, 11 Drawing Figures



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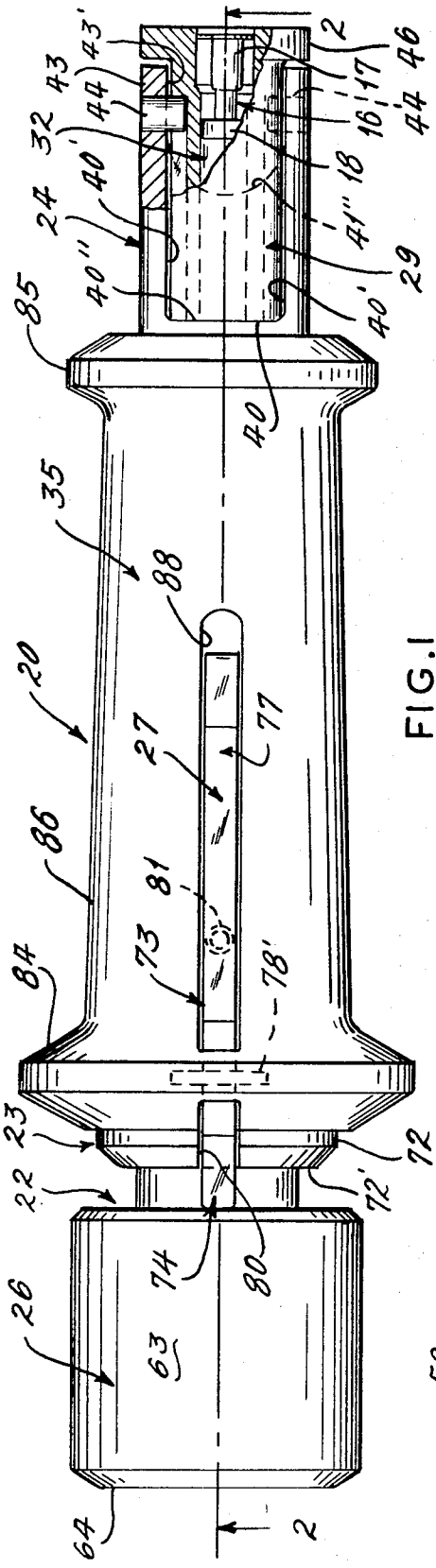

FIG. 1

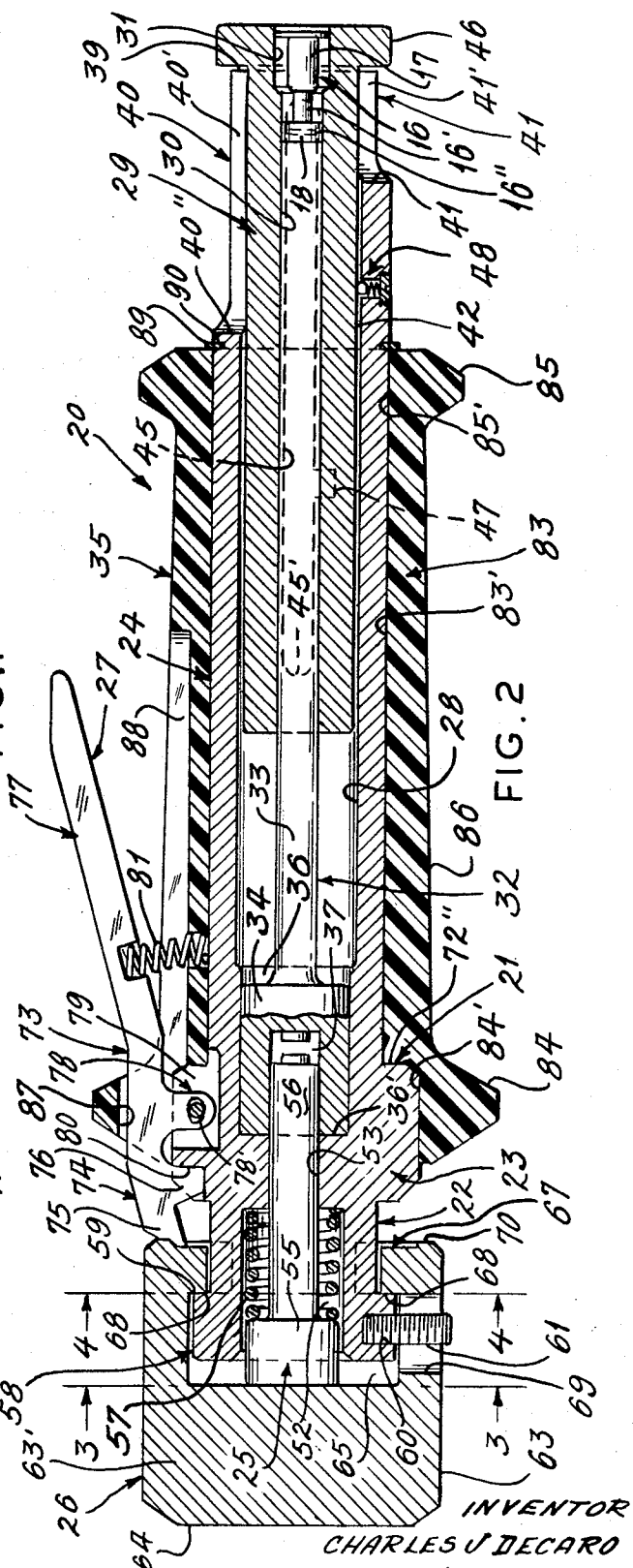

FIG. 2

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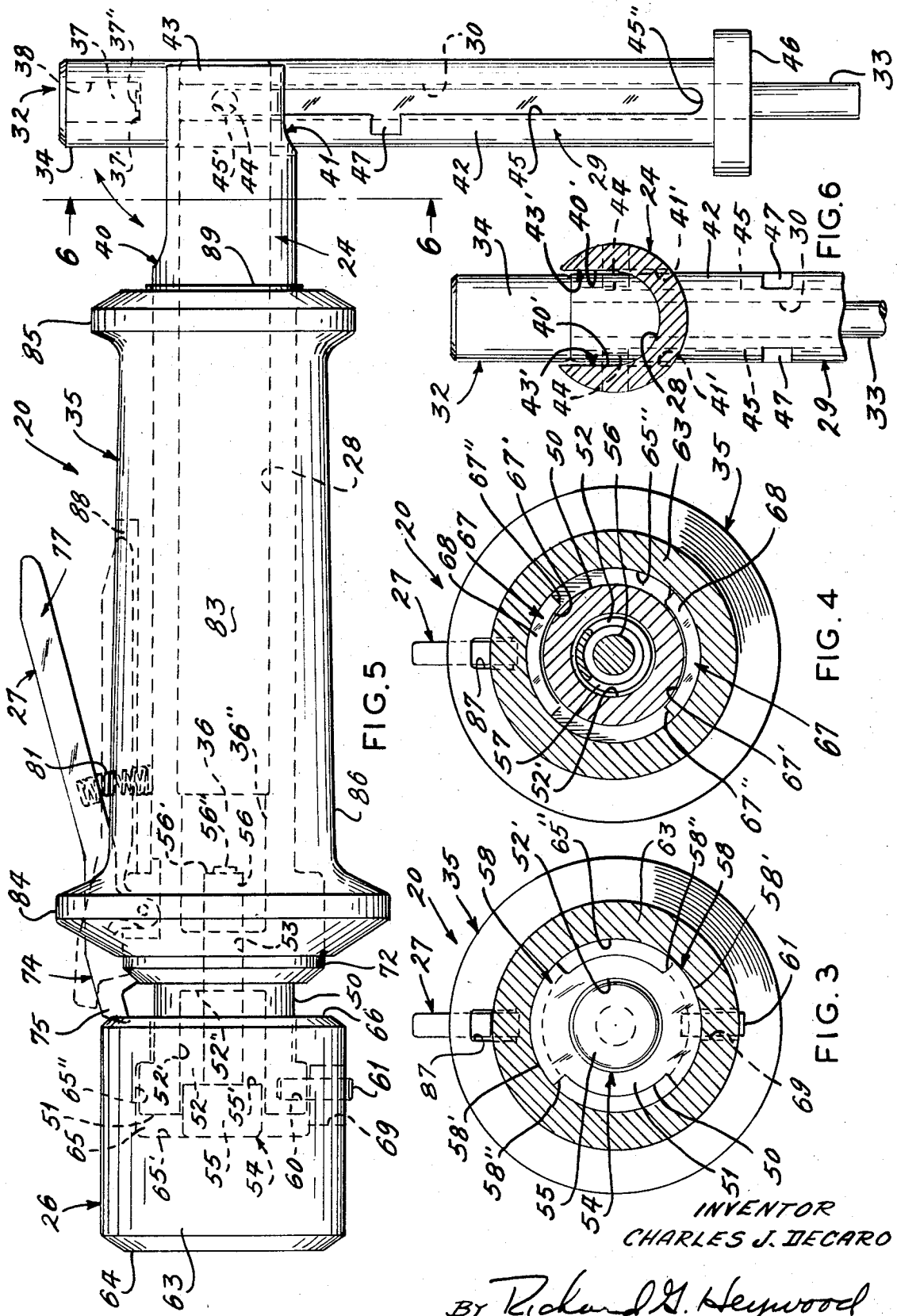

FIG. 5

FIG. 6

FIG. 4

FIG. 3

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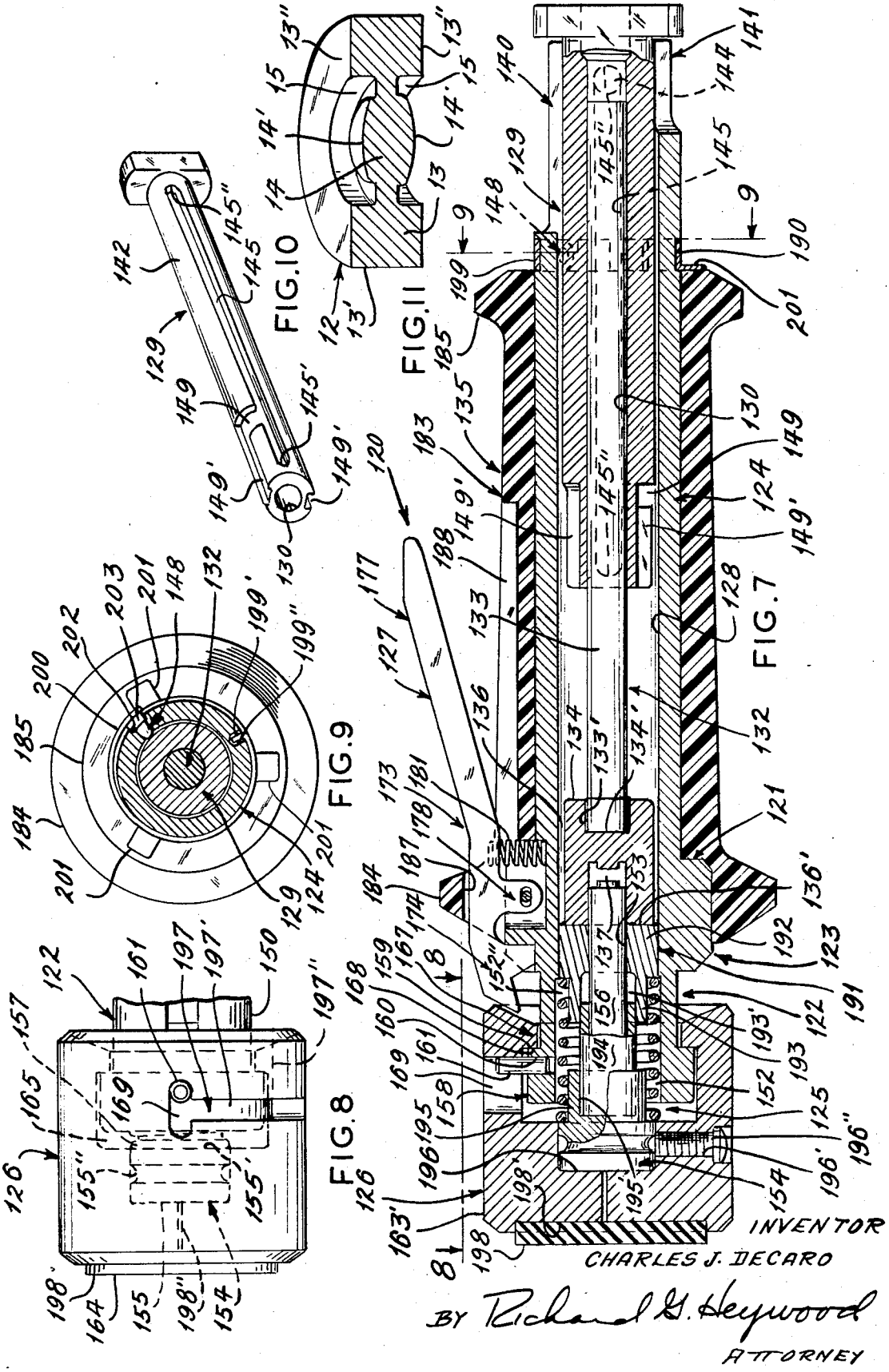

FIG. 8

FIG. 9

FIG. 10

FIG. 11

FIG. 7

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FASTENER DRIVE TOOL FOR CASELESS LOADS

BACKGROUND OF THE INVENTION

The invention relates generally to fastener driving tools, and more particularly to an anvil-type or hammer actuated tool utilizing caseless powder loads.

Many types of fastener driving tools and like explosively actuated equipment have been developed over the years, and such tools have utilized conventional cased ammunition or cartridges with the cost, weight and packaging problems incidental thereto as well as the requirements for such tools of complex mechanisms for ejecting or extracting spent cartridge cases and for meeting safety standards. More recently, stable caseless explosive charges or pelletized powder loads have been developed and made commercially available. Caseless powder loads, as the term implies, do not have the usual metal or like cartridge casing or shell and are formed entirely by the compaction into desired configuration of a suitable fibrous smokeless powder, such as nitrocellulose, although such powder loads may be formed with or without primers. The development of acceptable fastener drive tools for utilizing such caseless loads has naturally lagged behind the provision of acceptable powder loads, and various caseless tools have been attempted by modifying prior tools for cased ammunition as well as development efforts utilizing similar principles or features of such prior art tools.

SUMMARY OF THE INVENTION

The present invention comprises a powder actuated tool of the type for driving fasteners and the like as utilized in construction and other trades, and adapted particularly for the use of caseless powder loads that are now or may become commercially available.

The principal object of the present invention is to provide a novel fastener drive tool of simple construction eliminating the need for complex closure, trigger, sear, firing pin, cartridge holding, cartridge ejection and like mechanisms of present day tool design.

Another object is to provide a powder actuated tool that is efficient in operation, provides exceptional safety standards against drop-fire and like incidents, has "quick opening" and "quick disconnect" features for rapid reloading of the tool and interchange of different assemblies for accommodating different types of powder loads and various types of fasteners or to provide a configuration compatible to the requirements of certain applications.

Another object is to provide a powder actuated tool of simple one-piece configuration that may be dismantled and re-assembled manually without the use of tools.

A still further object of the invention is to provide a tool adapted for the use of multiple powder loads and a range of different fastener sizes and types.

These and still other objects and advantages will become apparent hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

For purposes of illustration and disclosure, the invention is embodied in the parts and in the arrangements and combinations of parts hereinafter described and claimed.

In the accompanying drawings which form part of the specification and wherein like numerals refer to like parts wherever they occur:

FIG. 1 is a top plan view of a fastener drive tool embodying the present invention;

FIG. 2 is a longitudinal cross-sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 2;

FIG. 5 is a side elevational view of the tool showing the open extended position of the barrel means for loading;

FIG. 6 is a fragmentary view taken along line 6—6 of FIG. 5;

FIG. 7 is a longitudinal cross-sectional view, similar to FIG. 2, showing a modified embodiment of the tool;

FIG. 8 is a fragmentary elevational view of the modified tool as seen from line 8—8 of FIG. 7;

FIG. 9 is a cross-sectional view taken substantially along line 9—9 of FIG. 7;

FIG. 10 is a perspective view of the barrel member of the modified tool shown in FIG. 7; and

FIG. 11 is a greatly enlarged sectional perspective view illustrating a typical caseless powder load adapted for use with a fastener drive tool of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 11 which illustrates a typical caseless powder load 12 adapted for use with fastener drive tools embodying the invention, such a powder load 12 may also be referred to in the trade as a "powder charge," a "capsule" or a "pellet." The caseless powder load 12 shown in FIG. 11 does not have a primer, and comprises an annular main body portion 13 having a peripheral outer wall 13' and outwardly facing annular lands or shoulders 13'' and a central web 14 having spherical or convex outer surfaces 14' inset from the annular lands 13'' by recesses 15.

Referring now to FIG. 2, a typical fastener 16 adapted to be actuated into a workpiece (not shown) by operation of fastener drive tools embodying the invention is illustrated for disclosure purposes and such a fastener may be referred to in the trade as a "pin," a "nail" or a "stud." The fastener 16 comprises a shank 16' having a pointed end provided with a sleeve-type disc 17 to function as a washer and a head 16'' provided with an expendable cup-shaped cap 18 to hold the fastener 16 in position in the tool preparatory to operation. Use of the powder load 12 and fastener 16 will be described more fully hereinafter with reference to the operation of the fastener drive tool.

Referring now to FIGS. 1–6 of the drawings, wherein one embodiment of a fastener driving tool 20 embodying the invention is illustrated, the tool 20 comprises a main housing member 21 having a head section 22, a breech block or intermediate section 23 and a cylindrical barrel housing section 24. A firing pin assembly 25 is housed in the head section 22 and an anvil head member 26 is mounted on this section for limited axial movement relative to the main housing member 21 to drive the firing pin from a normally retracted position to an actuated firing position. A safety lever assembly

27 is pivotally mounted on the breech block section 23 to normally maintain the anvil head member 26 in the retracted non-firing position as shown in FIG. 2. The barrel section 24 of the housing member 21 has a longitudinal axial bore wall 28 in which a sleeve-type ram guide member 29 is slidably mounted, the guide member 29 having an axial guide bore 30 and may have a counterbore 31 at its muzzle end for positioning the fastener 16. A ram member 32 has an axially-extending cylindrical ram or piston rod 33 slidably positioned in the ram guide bore 30 and an enlarged head 34 slidable in said housing bore 28, the ram and guide members 32 and 29 comprising fastener drive means for positioning and driving the fastener 16 into a workpiece (not shown) in a conventional manner readily apparent to those skilled in the art. The housing member 21 is also provided with an outer covering or handle grip member 35.

An important feature of the invention resides in the construction and operation of the barrel assembly, including the barrel section 24, the ram guide member 29 and the ram member 32. The cylindrical barrel section 24 may be formed integral with the breech section 23, and a breech chamber or cavity 36 is formed at the breech or first end of the barrel member bore 28 at which ignition takes place for operation of the tool 20. The breech chamber 36 extends axially into the breech block 23 and is defined by an end wall 36' and side wall 36'' in which the head 34 of the ram member 32 has a close tolerance sliding fit. Ignition means are provided at or adjacent to the breech chamber 36 and, in the embodiment of the invention illustrated, the ram head 34 is provided with an axial bore forming an ignition cavity 37 with a stepped end wall having an annular shoulder 37' and axial central protrusion 37'', FIGS. 2 and 5, substantially complementary to the configuration of the annular land 13'' and recess 15 of the powder load 12, and the cavity side wall 38 having a predetermined diameter or circumferential size to snugly receive and may frictionally hold the outer periphery 13' of the powder load 12. It will be noted that the ignition cavity 37 has a substantial axial length, which represents the high pressure ignition stroke that may be varied to accommodate different or multiple powder loads 12, as will be described.

The tool 20 is provided with a "quick opening" or "swing away" feature adapted to facilitate loading the tool and with a "quick disconnect" feature for substitution of ram guide and ram members 29 and 32, i.e., fastener drive means, with different powder loads of different energy magnitude or with fasteners for different types of powder actuated work. Referring especially to FIGS. 1, 2, 5 and 6, the barrel housing section 24 extends axially from the breech section 23 to its muzzle or second end 39. The upper wall portion of the barrel section 24 is relieved by an elongated first or upper slot or major channel 40 extending from the muzzle end 39 a predetermined distance and delimited by side walls 40' formed tangentially from the diameter of the barrel bore 28 and by squared-off end wall 40''. Similarly, the lower wall portion of the barrel section 24 is relieved by a milling cut or the like forming an elongated second or lower slot or minor channel 41 extending from the muzzle end 49 a predetermined distance and delimited by side walls 41' formed tangentially from the diameter of the barrel bore 28 and by a rounded end wall 41'' substantially complementary to the outer cylindrical wall 42 of the ram guide member 29. As seen best in FIGS. 5 and 6, it will be apparent that the muzzle end 39 of the barrel section 24 is bifurcated by the opposed major and minor channels 40 and 41 and formed as laterally spaced wall segments 43 having opposed flat parallel wall surfaces, designated generally by the numeral 43' in FIG. 6, and such channel means 40, 41 accommodate the free sliding and swinging action of the fastener drive means 29 and 32 as will now be described.

A pair of guide and hinge pins 44 are press fit into the spaced wall segments 43 adjacent to the muzzle end 39 and project in opposed relation from the side wall surfaces 43' into the barrel bore 28. The sleeve-type ram guide member 29 comprises the cylindrical outer wall 42 slidable in the barrel section bore 28, and having elongated slots 45 formed intermediate its ends and on opposite sides in the outer wall surface 42 and being slidably received on the guide pins 44 in a last-motion connection therewith for movement between a first or inner breech end 45' and a second or outer muzzle end 45'' or positions intermediate thereto. The muzzle end of the ram guide member 29 has an enlarged head or flange 46 for abutment against the barrel muzzle 39 in the fully telescoped position and for abutment against a workpiece (not shown) in any ready-to-fire position of the tool 20, with the guide pins 44 being adjacent to the muzzle end 45'' of the slots 45, FIG. 2. The axial extent of the slots 45 is predetermined to permit the ram guide and ram members 29 and 32 to be withdrawn axially of the barrel section 24 to an extended position in which the guide pins 44 are positioned at the breech end 45' of the slots 45. In this extended position, with the ram head 34 in abutment with the guide member 29, the distance to the breech end of the head 34 is shorter than the distance to the end wall 40'' of the major channel 40 whereby the guide and ram members 29 and 32 are free to pivot or swing in the channels 40 and 41 on the pins 44 to a transverse or non-axial open position in which the ignition chamber 38 in the ram head 34 is fully exposed for loading a powder load 12 therein, FIG. 5. In addition, a pair of milling cuts are made in the outer cylindrical wall 42 intermediate to the ends 45' and 45'' of the slots 45 to form notches or passageways 47 extending tangentially from and conterminous with the bottom of the slots 45 to define a disconnect position whereby the guide and ram members 29 and 32 can be disassembled from or reassembled with the tool 20 by moving these members from the fully extended and non-axial open position shown in FIG. 5 to locate the notches 47 in alignment with the guide pins 44 and slipping the members outwardly off the pins 44.

It will be apparent that the ram and ram guide members 32 and 29 are freely slidable relative to each other and to the barrel housing section 24 in that no spring means or the like are provided for biasing either member in an axial direction. However, spring-loaded detent or friction means 48 are provided in the barrel section wall to act radially inwardly against the outer wall 42 of the ram guide member 29 to frictionally restrain it against completely free axial movement in the barrel bore 28 in order to maintain the position of the guide member 29 in loaded condition for firing.

Still referring to FIGS. 2, 3, 4 and 5, the head section 22 extends axially from the breech block section 23 of the barrel member 21 and may be formed integral therewith. The head section 22 has a cylindrical outer wall 50 and an end wall 51, and an axial bore in the head section 22 forms a firing pin chamber 52 having a side wall 52' and end wall 52'', FIG. 5. An axial bore having a cylindrical wall 53 is formed through the breech block section 23 between the end wall 52'' of the firing pin chamber 52 and the end wall 36' of the breech cavity 36. The firing pin assembly 25 comprises a firing pin 54 with a head portion 55 in sliding engagement with the side wall 52' of the chamber 52 and a shank portion 56 of reduced diameter forming an annular shoulder 55' with the head portion 55. The shank portion 56 has a close tolerance sliding fit with the cylindrical wall 53 of the breech block section 23 and with the side wall 38 of the ignition cavity 37 formed in the ram head 34. The working end of the firing pin 54 has an annular shoulder 56' and a central protrusion 56'' substantially complementary to the configuration of the annular land 13'' and recess 15 of the powder load 12. It will be noted that the firing pin shank 56 extends axially into the ignition cavity bore 38 a substantial depth in the ready-to-fire position shown in FIG. 2, and the ignition cavity 37 will be reduced to an axial size accommodating one or two powder loads 12 between the opposed annular shoulders 37' and 56' and the opposed protrusions 37'' and 56''. The firing pin assembly 25 also includes a firing pin spring 57 positioned in the chamber 52 between the end wall 52'' and firing pin shoulder 55' and biasing the firing pin 54 toward the remote or non-fire position.

The head section 22 is also provided with means for assembly of the anvil member 26 thereon, comprising a pair of key-stone shaped quadrant mounting lugs 58 formed on opposite sides at the outer end 51 of the cylindrical outer wall 50 and extending radially outwardly therefrom. The lugs 58 have arcuate outer surfaces 58' concentric with the cylindrical wall 50 and radial side walls 58'' defining the key-stone configuration, FIG. 3. Abutment surfaces 59 are formed on the side of the lugs 58 away from the end wall 51, and one of the lugs 58 is tapped, at 60, to secure a radially extending mounting pin 61.

The anvil member 26 comprises a cylindrical body 63 forming an impact head 63' of substantial mass with an outer end anvil surface 64 to receive a hammer blow to actuate the tool 20. The anvil member body 63 has a central socket or cavity 65 extending from its other end 66 and defined by inner end wall 65' and cylindrical side wall 65''. A pair of opposed quadrant mounting lugs 67 project radially inwardly from the cylindrical wall 65'' and are of key-stone configuration similar to the lugs 58 on the head section 22. The lugs 67 have arcuate inner wall surfaces 67' and radial side margins 67'', and abutment surfaces 68 are formed on the socket side of the lugs 67. An elongated axially extending slot 69 is formed through the side wall 65'' to receive the mounting pin 61. An annular axially projecting ridge 70 may be provided on the end surface 66 of the anvil body 63 for positive engagement by the safety lever member 27.

It will be readily apparent that the diameter of the central cavity side wall 65'' accommodates the diametral dimension between the arcuate outer margins 58' of the lugs 58 on the housing head section 22, FIG. 3, and the diametral dimension between the arcuate inner surfaces 67' of the lugs 67 on the anvil member 26 accommodates the diameter of the cylindrical outer wall 50 on the head section 22, FIG. 4. Furthermore, the central socket 65 is accessible through the peripheral opening formed at the end wall 66 and defined by the opposed quadrants of the cylindrical wall 65'' and by the margins 67' and 67'' of the opposed quadrant lugs 67, which opening is complementary to the end configuration of the head section 22. Accordingly, the anvil member 26 is assembled on the head section 22 by aligning the head section with the complementary opening to the anvil socket 65 and axially interfitting the two parts by compressing the firing pin spring 57 by pressure exerted through the anvil 26 and firing pin 54. The anvil member 26 is then rotated 90° to align the slot 69 with the tapped opening 60 in the head section lug 58 and threading the mounting pin 61 into the opening 60. The rotation of the anvil 26 relative to the head section 22 aligns the quadrant lugs 58 and 67 for firm abutment between the opposed arcuate segment abutment surfaces 59 and 68 thereof in the normal retracted non-firing position under pressure of the firing pin spring 57.

The breech block section 23 of the housing member 21 is formed with a cylindrical wall or collar 72 extending radially outwardly from the outer surfaces of the head and barrel sections 22 and 24 and forming annular shoulders 72' and 72'' therewith. The safety lever assembly 27 is mounted on the collar 72 of the housing member 21 and comprises an elongated bell crank lever 73 having a safety latch portion 74 formed with an anvil engaging lug or pawl 75 and a housing abutting lug or pawl 76. The lever 73 also has an elongated handle portion 77 extending from the double latch or pawl means 75 and 76, and a fulcrum mounting lug 78 is provided intermediate to the latch and handle portions 74 and 77. A milling cut or the like is made in the housing collar 72 and shoulder 72'' to form a mounting groove 79 in which the mounting lug 78 is pivotally secured by a press fit cross pin 78', and an abutment notch 80 is formed in the wall 72 and shoulder 72' opposite to the anvil shoulder 70 for engagement by the housing pawl 76. Spring means 81 is provided for biasing the safety lever 73 toward its operative position in which the anvil pawl 75 engages the ridge or shoulder 70 of the anvil 26 and the housing pawl 76 is seated in the housing abutment notch 80 to prevent relative axial movement between the anvil and the housing members 26 and 21.

The outer casing member 35 is formed of suitable plastic material and comprises a sleeve-type body portion 83 having a cylindrical bore 83'. A larger first annular conical end portion 84 is formed on one end of the body portion 83 for positioning at the breech section 23, and an enlarged counterbore 84' offset from the bore 83' abuts the collar 72 and shoulder 72''. A smaller second annular conical end portion 85 is formed on the other end for positioning adjacent to the muzzle end of the barrel housing section 24 and has a bore 85' conterminous with the cylindrical bore 83'. The outer surface 86 of the body portion 83 tapers inwardly from the larger conical portion 84 to the small conical portion 85. A tunnel opening 87 is formed through the large conical portion 84 and connects with

an elongated surface groove **88** formed axially in the tapering surface **86** of the body portion **83** to receive the safety lever assembly **27** and permit the handle portion **77** to be depressed into the groove **88** to a recessed relationship with the casing member **35** to fully disengage the anvil latching lug **75** from the anvil shoulder **70** for operation of the tool **20**, as shown in broken lines in FIG. **5**. The casing member **35** is retained in assembled position on the housing member **21** by a radially extending snap ring **89** received in an annular groove **90** formed in the outer surface of the barrel housing section **24** and forming a radial surface abutment with the end of said second conical end portion **85**.

The operation of the fastener drive tool **20** will be set out hereinafter also with reference to the fastener drive tool embodiment shown in FIGS. **7–10** inasmuch as the basic operation of both embodiments is the same. In addition, many components of the FIGS. **7–10** embodiment are identical or similar to the FIGS. **1–6** embodiment and such components will be correspondingly numbered in the one hundred series.

The fastener drive tool **120** comprises a main housing member **121** having head, breech block and barrel housing sections **122**, **123** and **124**, respectively, with a firing pin assembly **125** housed in the head section **122** and an anvil member **126** mounted thereon and with fastener drive means including a ram guide member **129** and ram member **132** being relatively axially slidable in the barrel bore **128**, a safety lever assembly **127** and handle grip casing **135** also being provided.

The ram guide member **129** has a bore **130** slidably receiving the piston rod or ram **133** of the ram member **132**, which is provided with an enlarged head **134** formed with an ignition cavity **137** on its breech and communicating with the breech chamber **136** formed at the inner end of the bore **128**. The ram **133** and head **134** may be formed separately to obviate concentration of stresses, that may be developed at the juncture of a one-piece unit, with the ram **133** having a head assembly end **133'** larger than the piston rod diameter and being press fit into an axial opening **134'** in the head **134**.

The muzzle end of the barrel housing section **124** is provided with a major channel **140** and a minor channel **141** formed on diametrally opposite sides and opposed guide and hinge pins **144** project into the bore **128** from the muzzle end wall segments defined by the major and minor channels **140** and **141**. Referring to FIG. **10**, the side wall **142** of the ram guide member **129** is provided with elongated slots **145** on opposite sides thereof, the ram guide member **129** being slidably positioned in the barrel bore **128** for rectilinear axial movement relative to the hinge pins **144** between the inner breech end **145'** and outer muzzle end **145''** of the slots **145**. The ram guide member **129** is provided with an alternate non-axial disconnect movement from the barrel housing **124**, although notches **47** similar to the FIGS. **1-6** embodiment may also be provided. Intermediate to the ends **145'** and **145''**, grooves **149** extend in a circumferential or lateral direction from the slot **145** to connect with axially extending grooves **149'** extending to the end of the ram guide member **129**. The grooves **149** and **149'** form a bayonet-type channel means adapted to facilitate dismantling the fastener drive means (**129** and **132**) from the barrel housing **124** in a non-axial movement, but without first swinging or pivoting the fastener drive means to a perpendicular or angular position relative to the axis of the barrel bore. The disconnect or dismantling operation is accomplished by moving the ram guide member **129** to an axial position in the barrel bore **128** in which the lateral grooves **149** are located in alignment with the hinge pins **144**, the ram guide **129** is then rotated in the bore **128** to move the hinge pins **144** to the grooves **149'** thereby permitting axial withdrawal of the ram and ram guide members **132** and **129** from the barrel housing **124**. Friction means **148** are provided to restrain the ram guide **129** in the barrel bore **128**, as will be described more fully hereinafter.

It will be noted that the main housing **121** of the tool **120** is formed with a through bore extending from the breech block section **123** to the muzzle end and principally forming the barrel bore **128**, and the head section **122** is counterbored to from a larger chamber **152** for the firing pin assembly **125**. The breech section **123** includes a breech plug **191** having a circular base portion **192** which is press fit into the through bore (**128**) and its end wall **136'** defines the end of breech chamber **136**. The breech plug **191** also has an annular wall **193** extending axially into the firing pin chamber **152** of the head section **122** in spaced relation with the side wall **152'** to form an annular recess **152''** for the firing pin spring **157**, and the central chamber **193'** defined by annular wall **193** accommodates the firing pin **154**. An axial bore **153** extends through the base portion **192** of the breech plug **191** in communication with the central chamber **193'** and the breech chamber **136**. The firing pin member **154** comprises a head portion **155**, a shank portion **156** and a sleeve **194** formed separately and press fit together to form a unitary pin member pre-stressed in tension to overcome opposing forces developed during ignition. The head portion **155** has an annular radial shoulder **155'** to seat the end of the firing pin spring **157**, and a circumferential groove **155''** is provided for assembly of the firing pin **154** with the anvil member **126**. An annular wall **195** defines an axial opening **195'** in which the shank **156** and sleeve **194** are press fit, the end of annular wall **195** being in opposed spaced relation with the end of annular wall **193** of the breech plug **191** for relative axial movement during actuation. The sleeve **194** is slidably positioned in the central chamber **193'** and the shank **156** is slidable in the breech plug bore **153** for guiding relative axial movement of the firing pin **154** during actuation. The working end of the firing pin shank **156** is positioned in the ignition chamber **137** adjacent to the powder load **12**.

The head section **122** also includes quadrant mounting lugs **158** positioned in the central socket **165** of the anvil member **126** in assembled relation and having abutment surfaces **159** engaged against abutment surfaces **168** formed on quadrant lugs **167** of the anvil **126** in the non-fire position. The head **155** of the firing pin **154** is seated in an axial cavity **196** and a threaded radial porthole **196'** is formed through the anvil wall for receiving a bolt **196''** having an inner end surface complementary to and aligned with the circumferential groove **155''** of the firing pin head **155**.

A feature of the invention is to provide a quick assembly or dis-assembly of the anvil member **126** on the housing head section **122** without tools. A pin **161** may be press fit into an opening **160** in one mounting lug **158** on the head section **122** and extends radially outwardly into an elongated slot **169** formed in the anvil side wall to permit relative axial movement during actuation. A mounting or assembly channel **197** is formed in the anvil to provide communication between the slot **169** and the open end of the anvil socket **165** intermediate to the quadrant lugs **167**, the channel **197** including an arcuate slot **197'** extending from intermediate the ends of the elongated slot **169** circumferentially around the anvil **126** substantially 90° to communicate with an axial slot **197''** extending to the open end. It will now be apparent that the anvil member **126** is assembled on the head section **122** by aligning the pin **161** with the axial slot **197''** and the quadrant lugs **158** with the complementary access opening to the anvil socket **165**, as previously described, and moving the members **122** and **126** axially together to compress the firing pin spring **157** and then rotating one of the members **122, 126** 90° relative to the other to move the pin **161** along the arcuate slot **197'** to the elongated slot **169**. The abutment surfaces **159** and **168** will thus be aligned, and the spring **157** will bring the lugs **158** and **167** together and move the pin **161** to one end of the slot **169** in the normally retracted non-fire position as shown in FIGS. **7** and **8**. It will be apparent that location of the pin **161** in the bayonet slot **197'** will hold the anvil **126** on the head section **122**, but relative movement to provide ignition of the tool can only take place when the pin **161** is positioned in the elongated slot **169**.

The anvil member **126** is also provided with a mallet or hammer cushion **198** to substantially reduce the high noise level incident to metal to metal striking contact normally produced in hammer actuation of anvil-type tools heretofore. The cushion **198** is seated in a recess **198'** on the anvil and secured by a suitable epoxy-type adhesive, a pinhole port **198''** being formed between the recess **198'** and axial cavity **196** to prevent air entrapment during assembly. The cushion **198** is preferably formed from a plastic material selected to provide an impact face **164** and yieldable mass having a predetermined co-efficient of restitution to most effectively impart energy from the hammer blow through the anvil mass **163'** to the firing pin **154**.

The safety lever assembly **127** is similar to the lever assembly **27** previously described and includes the bell crank lever **173** having a bifurcated latch portion **174**, handle portion **177** and mounting portion **178**, and a spring **181**.

The outer casing member **135** is also similar to the casing **35** described and includes a body portion **183** and large and small conical end portions **184** and **185**, with a tunnel opening **187** and connecting body groove **188**. However, referring to FIGS. **7** and **9**, the retainer means for the muzzle end of the casing member **135** comprises an annular groove **190** positioned adjacent to the muzzle end and at the end of smaller end portion **185** of the casing **135**, and an open-end annular band spring **199** circumscribes the annular groove **190** through an arc of substantially 270° and has one end **199°** engaged in a retainer slit **199''** with the spring end **200** yieldably engaging the friction means **148**. A plurality of spaced radially extending abutment tabs **201** are provided on the band spring **199** for surface abutment with the casing member **135**. The friction means comprises a radial stepped bore **202** having a larger outer portion communicating with the annular groove **190**, and a stepped detent **203** is positioned in the bore **202** and biased inwardly by the band spring **199** for frictional engagement with the ram guide member **129**.

In the operation of the tools **20, 120**, FIGS. **2** and **7** illustrate the respective positions of the components preparatory to actuation. The anvil member **26, 126** and firing pin **54, 154** are biased by the firing pin spring **57, 157** away from the main housing member **21, 121** to the remote non-fire position and are maintained in this spaced away position by the safety latch member **73, 173**. The anvil pawl **75** engages the anvil rim **70** and the housing pawl **76** abuts the housing shoulder **80**, the angularity of the face of pawl **75** and position of the latch member **73, 173** being such that relative axial movement of the anvil **26, 126** toward the housing **21, 121** would wedge the bifurcated latch portion **74, 174** more firmly between the members to prevent axial movement of the firing pin **54, 154** into its actuated firing or ignition position.

In the ready-to-fire position of FIGS. **2** and **7**, a powder load **12** is positioned in the ignition chamber **37, 137** between the working end (**56', 56''**) of the firing pin **54, 154** and the ram head **34, 134**. Telescoping of the firing pin shank **56, 156** in the ignition chamber bore comprises one method of confining the gases evolved during ignition for effective displacement of the ram member **32, 132**, but other ignition chamber means for obturation and effective actuation may be provided. It may be noted that the breech end of the ram head is shown abutting the end wall **36', 136'** of the breech chamber **36, 136** in condition for a single powder load **12** as usually employed, thereby defining a fully telescoped first position of the ram member **32, 132** in ready-to-fire condition and preventing further relative axial movement of the ram member toward the firing pin **54, 154** which might inadvertently ignite the powder load **12** as when the tool **20, 120** might be dropped accidentally on its muzzle end. However, under such circumstances as when a double powder load **12** might be required, the axial depth of the ignition chamber **37, 137** accommodates two loads and the end of the ram head **34, 134** may be spaced from the breech chamber end wall **36', 136'**.

Automatic relative axial adjustment of the fastener drive means to accommodate multiple powder loads **12** and fasteners **16** of varying length is a feature of the invention. The ram portion **33, 133** is slidable in the ram guide bore **30, 130** and, likewise, the ram guide member **29, 129** slides in the barrel housing bore **28, 128** for rectilinear axial movement provided by the longitudinal guide slots **45, 145** on the hinge pins **44, 144**. Accordingly, the ram guide member **29, 129** can hold different length fasteners **16** in its muzzle end and will be telescoped into the barrel bore **28, 128** only until the muzzle **46** abuts a workpiece (not shown) with the ram member **32, 132** being in contact with the fastener **16** at its muzzle or working end and with the breech end of the ram abutting the end wall **36', 136'** of the breech chamber with the firing pin being in proximity to the

powder load 12. In the event a fastener 16 is not inserted in the tool 20, 120 the ram member 132 will not be returned to the ready-to-fire position so that ignition cannot take place and damage to the ram will be prevented.

Actual operation of the tool 20, 120 is accomplished by holding the handle grip casing member 35, 135 with the large conical end portion 84, 184 being positioned against the thumb and index finger and the taper of the body portion 83, 183 accommodating a firmer grasp by the smaller fingers. The handle 77, 177 of the safety lever 73, 173 is depressed by the palm into a recessed position in the casing groove 88, 188 to pivot the lever and disengage the anvil pawl 75 from the anvil member 26, 126, the housing pawl 76 sliding upwardly on the housing shoulder 80, FIG. 5. The muzzle end of the ram guide member 29, 129 is pressed firmly against the workpiece to effect a solid abutting relationship between the workpiece, the fastener 16, the ram 32, 132 and the powder load 12, and the anvil surface 64, 164 is struck sharply with a heavy mallet (not shown) to drive the anvil 26, 126 and firing pin 54, 154 inwardly relative to the housing 21, 121 and fastener drive means thereby rapidly compressing and deflagrating or detonating the charge 12. Rapid evolution of gases from the burning powder load 12 initially develops a high pressure ignition actuation of the ram member 32, 132 toward the muzzle end to drive the fastener 16 into the work surface while the firing pin 54, 154 remains in the ignition chamber 37, 137 and, as the ram member 32, 132 moves away from the firing pin, the gases expand into the larger volume of the barrel bore 28, 128 and provide a low pressure stroke exerted against the larger surface area of the ram head 34, 134.

Referring to FIG. 5, the tool 20, 120 is reloaded by moving the fastener drive means, i.e., ram guide 29, 129 and ram 32, 132, to an extended second position in which the breech ends 45'', 145'' of the slots 45, 145 engage the hinge pins 44, 144, moving the fastener drive means non-axially through the major and minor channels 40, 140 and 41, 141 of the barrel housing 24, 124 in a swinging or pivoting action (referred to as a "quick open" or "swing away" feature) to expose the barrel bore 28, 128 and the ignition cavity 37, 137 for reloading. The caseless load 12 is fully expended and no ejection problem exists, so the ignition cavity 37, 137 is clear for placing another powder load therein and the fastener drive means is realigned axially with the housing and telescoped into the barrel bore to its first or ready-to-fire position. Another fastener 16 is then applied in the ram guide bore 30, 130.

If it is desired to replace or substitute fastener drive means, the ram and ram guide members are dismantled from the pins 44, 144 through the notches 47 or channel means 149, 149' as previously described.

From the foregoing description it will be readily apparent that the present fastener drive tool 20, 120 meets the various objectives and that various changes and modifications may be made by those skilled in the art to adapt the inventive concept to accommodate other applications, such as the use of cased loads instead of caseless loads as previously discussed. Accordingly, the invention is only limited by the scope of the claims which follow.

What is claimed is:

1. A fastener drive tool adapted to use caseless powder loads for implanting fastener devices, comprising a main housing member having head, breech and barrel sections, said barrel section having a barrel bore with an open muzzle end and a breech end accessible through said muzzle end, fastener drive means in said barrel bore in a first ready-to-fire position and including relatively axially slidable ram guide and ram members with means for receiving a powder load at the breech and of one member and means for receiving a fastener device at the muzzle end of the other member, said ram guide and ram members being movable from said first position to an axially extended and non-axial position relative to said barrel section for access at said muzzle end to said powder load receiving means, and other means operative in the non-axial position of said fastener drive means permitting it to be disengaged from said housing member, an anvil member mounted on said head section for axial movement relative thereto between a remote non-firing position and an actuated ignition position, firing pin means housed by said anvil member and head section and movable in concert with said anvil member, said firing pin means extending through said breech section with a working end operatively associated with said powder load receiving means in said first position of said fastener drive means, safety latch means normally engaged between said anvil and housing members for preventing said axial movement therebetween, and casing means for said housing member.

2. A fastener drive tool comprising a barrel housing having a barrel bore with an open muzzle end and an inner breech chamber end accessible through said muzzle end, fastener drive means axially slidable in said barrel bore from a first ready-to-fire position to a second position extending from said open muzzle end, and means for providing relative non-axial movement between said fastener drive means and said barrel housing for loading a powder charge at said open muzzle end of said barrel housing.

3. The fastener drive tool according to claim 2, in which said last mentioned means includes means for providing relative non-axial movement between said fastener drive means and said barrel housing for separating the former from the latter.

4. The fastener drive tool according to claim 2, in which said fastener drive means includes a breech chamber end having an ignition cavity therein and a muzzle end for accommodating a fastener, and said last mentioned means including means for pivoting said fastener drive means to an angular position relative to said housing member for access to said ignition cavity.

5. The fastener drive tool according to claim 2, in which said last mentioned means comprises channel means at said muzzle end of said barrel housing and a pivotal connection between said barrel housing adjacent to said muzzle end and said fastener drive means in the second position thereof whereby said non-axial movement comprises angular rotation of said fastener drive means relative to said barrel housing.

6. The fastener drive tool according to claim 5, wherein said pivotal connection comprises opposed pin means secured to said barrel housing and projecting radially into said barrel bore and longitudinal grooves on said fastener drive means slidably received on said pin means, and said channel means being formed nor-

mal to the axis of said pin means to accommodate rotation of said fastener drive means on said pins to said non-axial angular position.

7. The fastener drive means according to claim 6, in which said fastener drive means comprises a ram guide member slidable in said barrel bore and having a bore with a muzzle end to hold a fastener, said longitudinal grooves being formed on opposite sides of said ram guide member in diametral alignment and having first and second ends delimiting axial movement of said ram guide member on said pin means, a ram member having a breech end with an ignition cavity therein and a working end slidable in said ram guide bore and adapted for driving a fastener from the muzzle end.

8. The fastener drive means according to claim 7, in which said ram guide member includes other groove means in communication with said longitudinal grooves adapted to slide on said pin means in a non-axial movement of said ram guide member relative to said barrel housing to permit said ram guide member to be separated from said housing member.

9. The fastener drive means according to claim 8, in which said other groove means comprises lateral notches formed tangentially from said longitudinal grooves intermediate to the first and second ends thereof for accommodating separation of said ram guide member from said barrel housing in the non-axial angular position of the former.

10. The fastener drive means according to claim 8, in which said other groove means comprises lateral grooves extending circumferentially from said longitudinal grooves and in diametral alignment, and axial grooves extending from said lateral grooves to one end of said ram guide member for accommodating separation of said ram guide member from said barrel housing in an axial direction and in which said non-axial movement comprises a relative rotation component provided by said lateral grooves.

11. A fastener drive tool comprising a barrel housing having a barrel bore with an open muzzle end and an inner breech end accessible through said muzzle end, fastener drive means including first and second members axially slidable relative to each other and to said barrel bore, first means for normally maintaining said members in said slidable relationship with said barrel housing and preventing separation thereof, and second means for providing relative non-axial movement between said fastener drive means and said barrel housing for separating the former from the latter.

12. The fastener drive tool according to claim 11, in which said first means comprises a lost-motion connection between at least one of said first and second members and said barrel housing, and said other means includes non-axial groove means in one of said barrel housing and said one member in communication with said lost-motion connection.

13. The fastener drive tool according to claim 11, in which said first means comprises guide pins secured to said barrel housing and projecting radially into said barrel bore and longitudinal grooves formed on opposite sides of one of said first and second members delimiting relative axial movement of said one member on said guide pins, and said second means comprises lateral grooves extending circumferentially from said longitudinal grooves and axial grooves extending from said lateral grooves to one end of said one member from said barrel housing in an axial direction and in which said non-axial movement comprises a relative rotation component provided by said lateral grooves.

14. A fastener drive tool comprising a housing having barrel and head sections, a barrel bore formed in said barrel section having an open muzzle end and an inner breech chamber end adjacent to said head section and being accessible through said muzzle end, fastener drive means in said barrel bore including ignition chamber means for a powder load positioned in said breech chamber end in ready-to-fire position, means carried by said head section for firing a powder load in said ignition chamber, said fastener drive means being relatively axially slidable in said barrel bore from said ready-to-fire position to a position extending from said open muzzle end, and means for providing relative non-axial movement between said fastener drive means and said barrel section for accessibility to said ignition chamber means.

15. A fastener drive tool comprising a barrel housing member having a muzzle end, an outer wall surface extending longitudinally from said muzzle end, and an abutment extending outwardly from said outer wall surface in spaced relation with said muzzle end; and an integral handle grip casing member for said housing member including a body portion with an internal wall complementary to said outer wall surface and positioned between said abutment and said muzzle end, a first end portion having an internal opening offset from said internal wall of said body portion and engaged against said housing member abutment, and a second end portion positioned adjacent to said muzzle end and having an internal opening conterminous with said internal wall of said body portion; retainer means engaging said outer wall surface of said housing member and said second end portion of said casing member, safety lever means pivotally mounted on said barrel housing member and having an elongated handle, and said casing member having a tunnel opening formed in said first end portion and an elongated groove formed in said body portion to accommodate said safety lever means.

16. A fastener drive tool comprising a barrel housing member having a muzzle end, an outer wall surface extending longitudinally from said muzzle end, and an abutment extending outwardly from said outer wall surface in spaced relation with said muzzle end; and an integral handle grip member for said housing member including a body portion with an internal wall complementary to said outer wall surface and positioned between said abutment and said muzzle end, a first end portion having an internal opening off set from said internal wall of said body portion and engaged against said housing member abutment, and a second end portion positioned adjacent to said muzzle end and having an internal opening conterminous with said internal wall of said body portion; retainer means engaging said outer wall surface of said housing member and said second end portion of said casing member, said barrel housing member having a barrel bore extending from said muzzle end, fastener drive means slidable in said barrel bore, an opening formed in said housing member adjacent to said muzzle end and extending between said outer wall surface and said bore, friction means

positioned in said housing member opening for frictional engagement with said fastener drive means, and said retainer means being engaged against said friction means.

17. The fastener drive tool according to claim 16, in which an annular groove is formed in said outer wall surface of said housing member adjacent to said muzzle end, and said retainer means comprises an annular band spring disposed in said annular groove and having spaced radially extending abutment means formed on said band spring and in surface abutment with said casing member.

18. The fastener drive tool according to claim 16, in which an annular groove is formed in said outer wall surface of said housing member adjacent to said muzzle end, and said housing member opening is formed radially through said housing member and comprises a stepped bore with a larger outer portion communicating with said annular groove, and said friction means comprises a stepped detent adapted for limited radial movement in said housing member opening.

19. The fastener drive tool according to claim 18, in which said retainer means comprises an annular band spring circumferentially disposed in said annular groove and having an end portion biasing said stepped detent radially inwardly for frictional engagement with said fastener drive means.

20. A fastener drive tool having relatively axially movable housing and anvil members and powder ignition means actuated by said axial movement in one direction, said housing and anvil members have opposed abutment surfaces movable toward each other upon said axial movement in one direction, and rigid safety latch means mounted on one of said members and including spaced abutment engaging means normally engaged against said abutment surfaces for preventing said axial movement and ignition means actuation, and manually operable means for releasing said rigid safety latch means.

21. The fastener drive tool according to claim 20, in which said safety latch means extends axially of said housing and anvil members, and said abutment engaging means comprises a bifurcated latch portion having oppositely facing abutment margins normally disposed between and in axial alignment with said opposed abutment surfaces of said housing and anvil members.

22. The fastener drive tool according to claim 21, in which said safety latch means includes a fulcrum portion pivotally mounted on the exterior of said housing member and said bifurcated latch portion extends radially inwardly between said housing and anvil members from one end of said fulcrum portion, and said manually operable means being provided on the other end of said fulcrum portion and being movable radially inwardly toward said housing member to displace at least one of said abutment margins radially outwardly and out of axial alignment between said members.

23. The fastener drive tool according to claim 21, in which said safety latch means is pivotally mounted on said one member, and one of said abutment margins extends angularly relative to the direction of said axial movement and its adjacent cooperable abutment surface for effecting positive engagement of said latch portion between said member and preventing radial latch means displacement.

24. A fastener drive tool comprising a main housing member having head, breech and barrel sections, said barrel section having a barrel bore with an open muzzle end in direct axial communication with a breech end adjacent to the breech section, anvil member means including a firing pin having a powder ignition end extending into said breech end of said barrel bore and being axially movable relative to said main housing member, and means for releasably mounting said anvil member on said head section of said housing member, said last means comprising spaced locking lugs formed on said housing and anvil members and adapted for opposed abutting engagement in assembled relationship, and socket means formed in one of said members accessible through spaced keyways to receive the spaced lugs on the other member into said socket means during assembly.

25. The fastener drive means according to claim 24, in which said tool is hammer actuated, and cushion means are provided on said anvil member for receiving a hammer blow for actuation thereof.

26. The fastener drive tool according to claim 24, in which said one member includes an elongated axial slot and lateral and axially connecting channel means, and said other member has pin means adapted to traverse said channel means during assembly and be engaged in said elongated slot in assembled relationship to maintain the axial position of said members.

27. The fastener drive tool according to claim 26, in which said elongated axial slot delimits said relative axial movement of said housing and anvil members, and said lateral channel means intersects said elongated slot intermediate to its ends whereby said axial movement of said anvil member and powder ignition means actuation will be prevented during assembly and upon incomplete assembly of said members.

28. A fastener drive tool comprising a barrel housing member having a barrel bore with an open muzzle end and an inner breech end accessible through the muzzle end, fastener drive means including first and second telescoped members movably positioned in said barrel bore, ignition means for a powder load adjacent to the inner end of one of said first and second members, fastener holding means for a fastener defined by the other ends of said first and second members, and said first and second telescoped members being relatively axially movable in said barrel bore to adjust their relative axial positions to accommodate fastener means of different lengths.

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