March 9, 1965 J. F. HELDERMAN ETAL 3,172,123

EXPLOSIVE ACTUATED TOOL AND METHOD FOR DRIVING A FASTENING STUD OR SIMILAR ELEMENT

Filed Oct. 3, 1962 4 Sheets-Sheet 1

Fig. 1

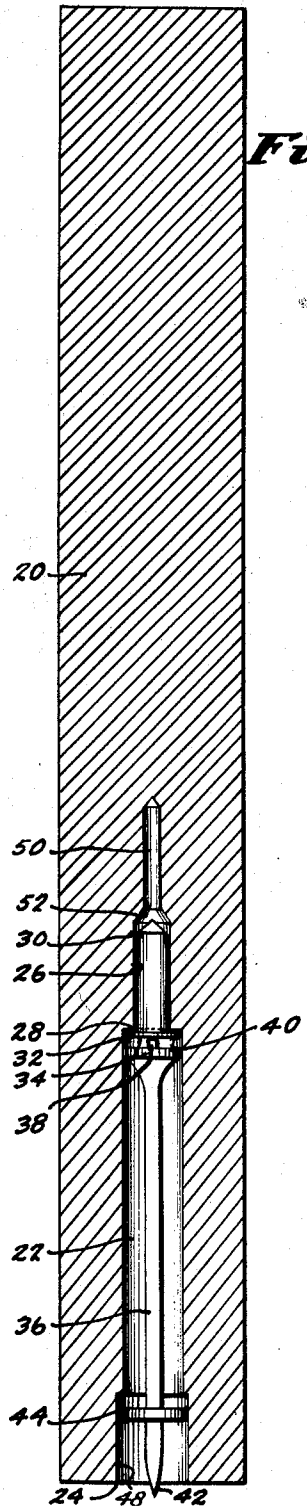
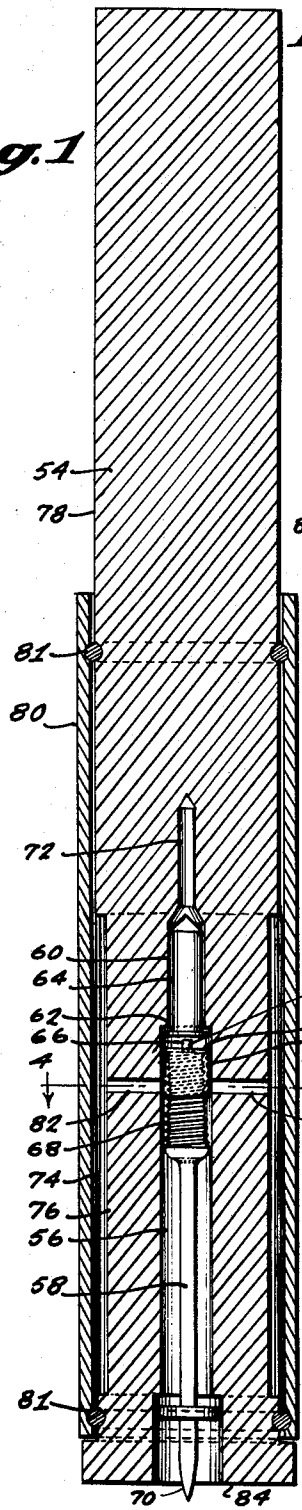


Fig. 2



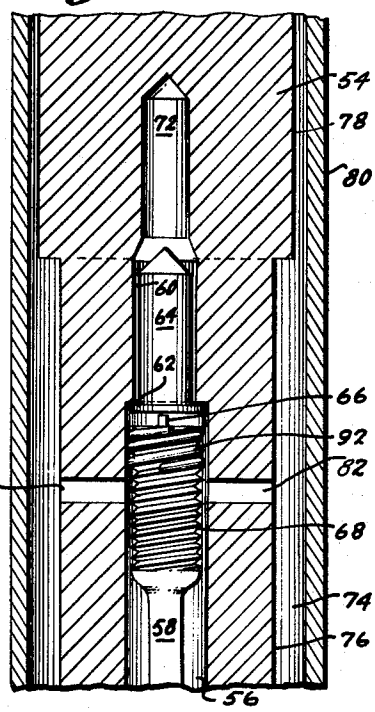


Fig. 3

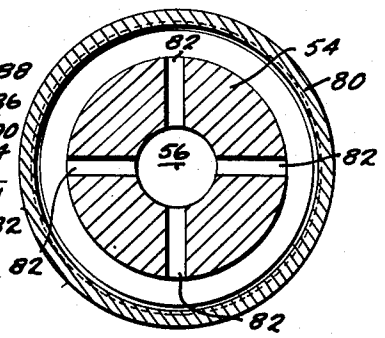


Fig. 4

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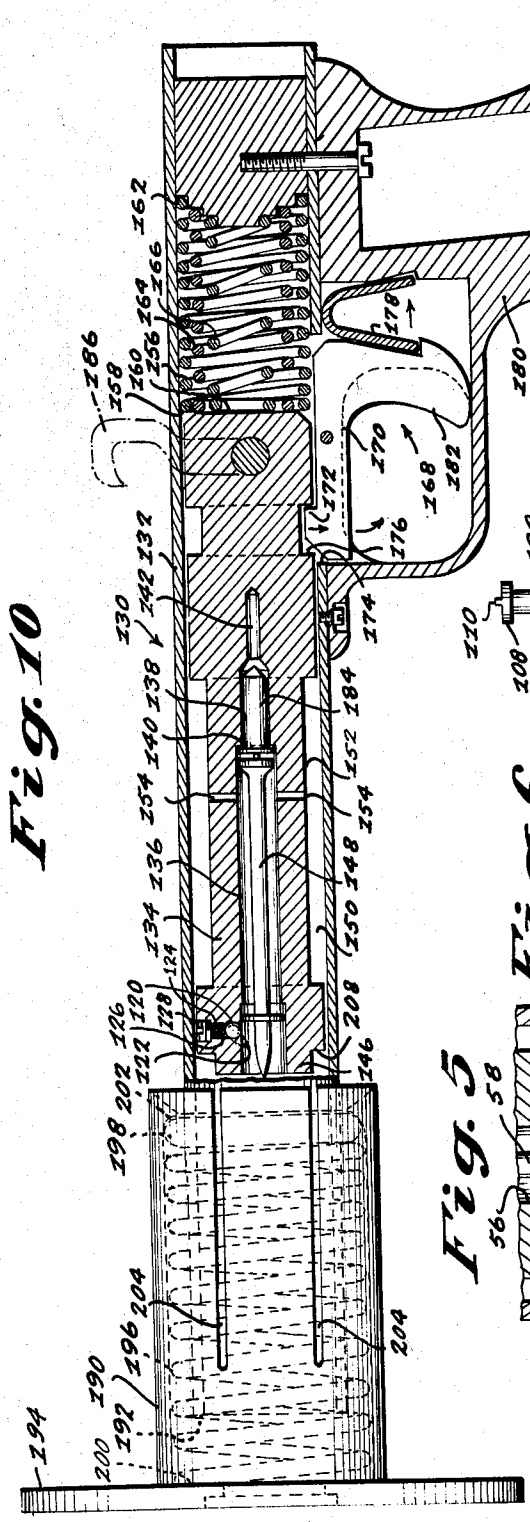


Fig. 10

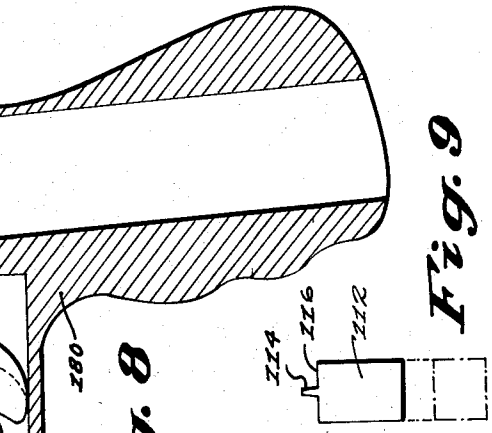


Fig. 9

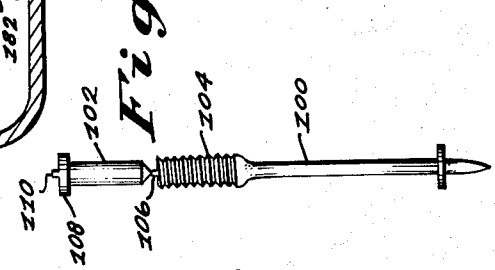


Fig. 8

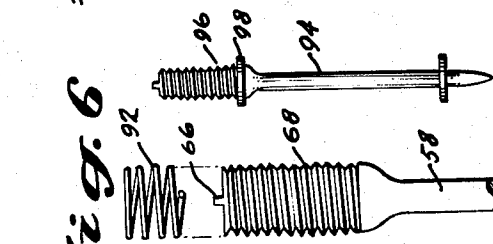


Fig. 7

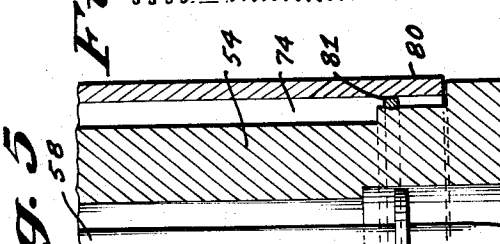


Fig. 6

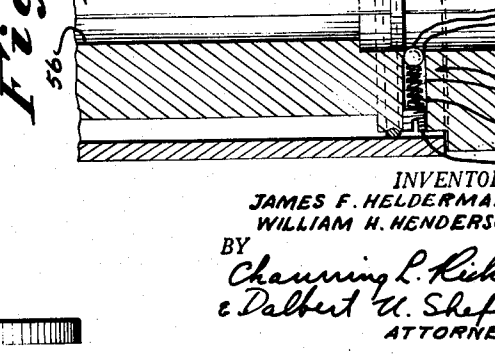


Fig. 5

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Fig. 11

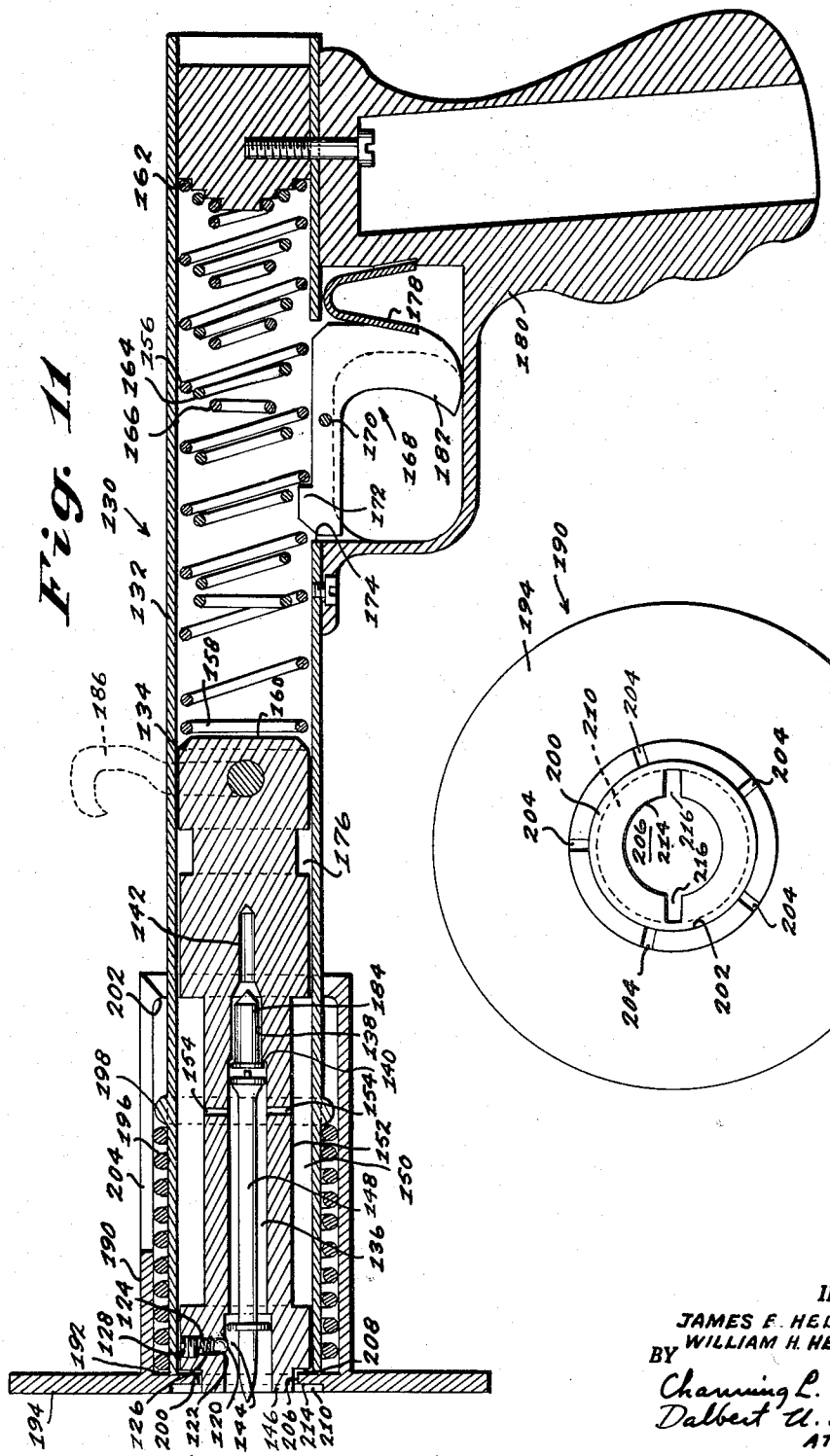


Fig. 12

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EXPLOSIVE ACTUATED TOOL AND METHOD FOR DRIVING A FASTENING STUD OR SIMILAR ELEMENT

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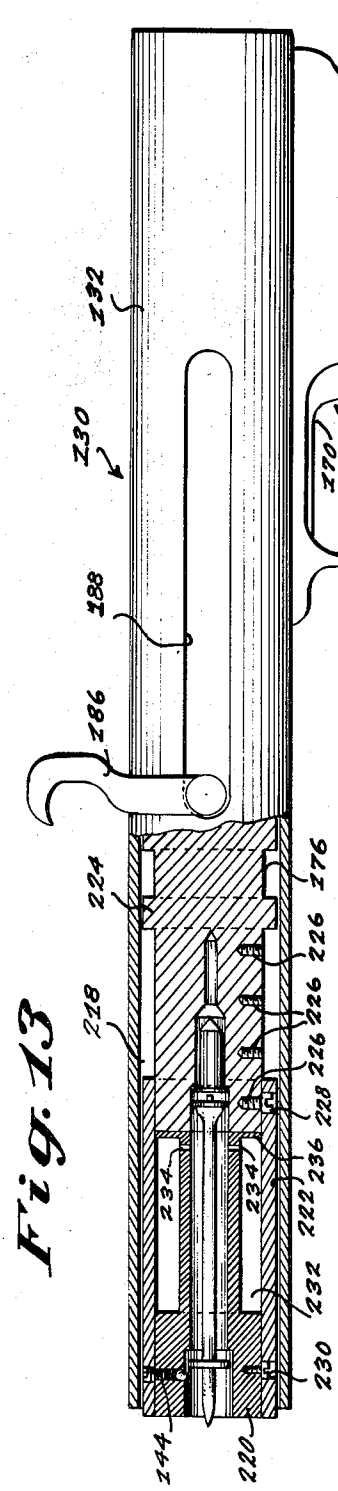


Fig. 13

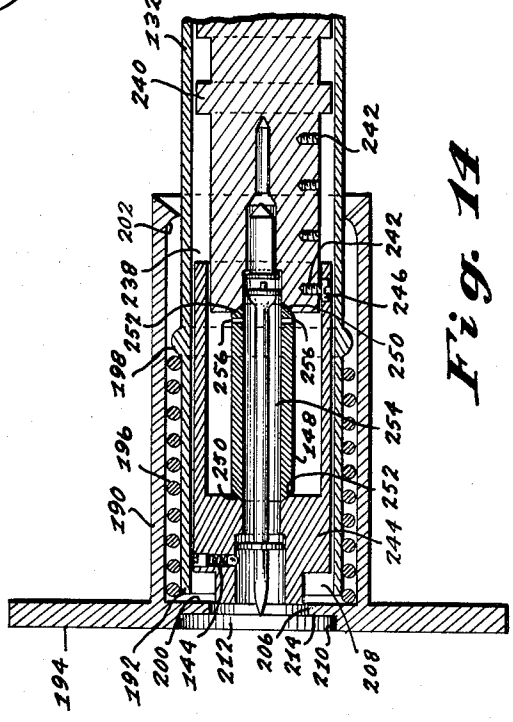


Fig. 14

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United States Patent Office 3,172,123 Patented Mar. 9, 1965

3,172,123

EXPLOSIVE ACTUATED TOOL AND METHOD FOR DRIVING A FASTENING STUD OR SIMILAR ELEMENT

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Filed Oct. 3, 1962, Ser. No. 228,080
20 Claims. (Cl. 1—60)

The present invention relates to the driving of elements, such as fastening studs, by an explosive actuated tool in which an explosive charge is uniquely positioned for simplified firing of the charge to drive a stud or other element, with the unique positioning and simplified firing of the charge permitting the tool to be simply and compactly constructed and yet be substantially safe from inadvertent firing as well as from the hazards inherent in firing high velocity type tools.

Briefly described, the explosive actuated tool of the present invention comprises a barrel member that has a bore in which an element to be driven by the tool is positioned prior to firing, and has a chamber extending inwardly from the bore for receiving a percussion ignitible explosive charge. This chamber is shaped so that the explosive charge will be positioned for ignition by an inwardly directed impact, such as produced by an inward movement of an element in the bore.

For example, the chamber may be formed with a shoulder at the end of the bore for seating the rim of a blank cartridge with the body of the cartridge extending inwardly in the chamber and the firing surface facing outwardly at the shoulder, and the bore formed of a length slightly less than the length of a stud to be driven therefrom so that the tip of the stud extends out of the bore. With this arrangement the tool is fired simply by striking the top of the stud against the work piece into which the stud is to be driven, as by hitting the rear end of the barrel member with a hammer as the tool is held in place against the work piece, or by impelling the barrel member against the work piece from an initial position spaced therefrom. When the tip of the stud strikes the work piece, the stud acts as the firing pin of the tool to transmit a force inwardly through the stud, causing an impact against the firing surface of by utilizing a protective shield that is shitable between resulting explosion driving the stud into the work piece.

This simplified firing of the charge by an inward movement of the stud eliminates the need for any firing mechanism as such, and permits the tool to be made in a simple and compact one-piece construction having only a stud bore and an explosive charge chamber, with the stud itself or means associated with the stud, such as a protuberance on the stud, efficiently serving as the firing pin of the tool.

Also, the firing by movement of the stud provides a positive means of firing at the proper time and minimizes inadvertent firing as there is no firing mechanism that can be accidentally triggered, and even inadvertent striking of the stud will not fire the tool unless it is a firm and strong blow.

In addition, the initial positioning of the stud against the work piece eliminates the ricochet problem common to prior tools where the stud is fired from the rear of the bore and strikes the work piece at a high velocity.

The safety of the tool can be even further enhanced by utilizing a protective shield that is shiftable between a projected position in which it extends beyond the tip of the stud to protect against inadvertent striking of the stud and a retracted position at which the tip of the stud is exposed for striking. This shield may be formed with a lateral flange at its outer end for abutting a work

piece to align the tool therewith for proper driving of the element and to space the stud from the work piece when not properly aligned so that the tool will not fire.

In a preferred embodiment of the present invention the above described barrel member with its stud bore and explosive charge chamber is incorporated in a stud gun for sliding within an outer barrel sleeve between a retracted cocked position and a projected firing position, with spring means for impelling the barrel member from cocked to firing position upon actuation of a trigger. With this embodiment the outer sleeve is positioned against a work piece and the trigger actuated to permit the spring to impel the barrel member, carrying a cartridge and stud through the outer sleeve and against the work piece so that the tip of the stud strikes the work piece, with the stud acting as a firing pin to create an inwardly directed impact against the explosive charge for firing the charge and driving the stud.

The stud driving force of the exploding charge may be controlled, after the driving of the stud is initiated, to reduce the recoil force by incorporating ports in the barrel member communicating with the bore and spaced from the inner end of the bore. These ports allow the expanding gas to escape, as into an expansion chamber, and thereby substantially reduce the force available to cause recoil. The expansion chamber may be easily formed by an exterior recess in the barrel member covered by an outer sleeve, such as the outer barrel sleeve of the aforementioned stud gun embodiment.

The present invention also provides advantageous means for expelling spent charges, such as cartridges, which would normally be difficult to remove because of their position in the substantially inaccessible explosive charge chamber inwardly of the bore, thus, an explosion chamber may be provided inwardly of and communicating with the explosive charge chamber and of a reduced cross-section so that upon firing of the charge the explosion enters the explosion chamber in back of the charge and as the explosion progresses it is directed forwardly and shaped by the explosion chamber to facilitate expulsion of the spent charge.

Other and further features and advantages of the present invention will be apparent from the following description and accompanying drawings, in which:

FIG. 1 is a vertical sectional view taken through an explosive actuated tool according to one embodiment of the present invention;

FIG. 2 is a view similar to FIG. 1 showing the explosive actuated tool modified to include additional features of the present invention;

FIG. 3 is an enlarged vertical sectional view of a portion of an explosive actuated tool similar to FIG. 2;

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

FIG. 5 is an enlarged vertical sectional view of the lower portion of an explosive actuated tool similar to the tool of FIG. 2 and incorporating yieldable detent means;

FIG. 6 is an enlarged elevational view of the threaded end of a fastening stud and a helical adapter coil for adapting the stud for use in an explosive actuated tool of the present invention;

FIG. 7 is an elevational view of a modified embodiment of a threaded fastening stud for use in the present invention;

FIG. 8 is an elevational view of a threaded fastening stud with an extender shank extending therefrom to adapt the stud to a particular bore length of an explosive actuated tool;

FIG. 9 is an enlarged elevational view of an extender or spacer plug for insertion in the bore of an explosive actuated tool to adapt a fastening stud to the length of the bore of the tool;

FIG. 10 is a side elevational view, partially in section, of a stud gun embodying the present invention, and showing the elements in cocked position prior to firing;

FIG. 11 is a vertical sectional view of the stud gun of FIG. 10 showing the elements in firing position;

FIG. 12 is an end elevational view of the protective shield of the stud gun of FIG. 10 as viewed from the right of FIG. 10;

FIG. 13 is a side elevational view, partially in section, of a modified embodiment of the stud gun of FIGS. 10 and 11; and

FIG. 14 is a vertical sectional view of the muzzle end of a further modification of the stud gun of FIGS. 10 and 11.

In the embodiment illustrated in FIG. 1, the explosive actuated tool of the present invention comprises simply a cylindrical barrel member **20** formed with a bore **22** extending inwardly from the muzzle **24** of the tool and with a chamber **26** extending inwardly from and communicating with the bore **22** from an inner shoulder **28** at the inner end of the bore **22**, with the chamber **26** being of a smaller diameter than the bore **22** as reduced by the shoulder **28**. The bore **22** is provided for positioning therein of a fastening stud **36** or other element to be driven by the tool, and the chamber **26** is provided for receipt of an explosive charge, such as a blank cartridge **30**, with the inner shoulder **28** providing a seat for the rim **32** of the cartridge **30** for positioning of the firing surface **34** facing outwardly and the body of the cartridge **30** extending within the chamber **26**.

The stud **36** is provided with a firing pin protuberance **38** extending from the head **40** of the stud for contact with the firing surface **34** of the cartridge **30**, with the head **40** being of a diameter only slightly less than the diameter of the bore **22** so that upon firing of the cartridge the head **40** will serve as a piston to drive the stud **36** from the bore **22**. The tip **42** or outer end of the stud **36** is pointed for driving into a work piece, such as a concrete floor or wall or any other type of material or structure.

The stud **36** is of an overall length slightly greater than the length of the bore **22** so that when the cartridge **30** and the stud **36** are positioned in the barrel member **20** the tip **42** of the stud will extend slightly beyond the muzzle **24** of the barrel member. In this manner the tool is actuated simply by striking the extending tip **42** of the stud **36**, which transmits the impact to the firing pin protuberance **38** and against the firing surface **34** of the cartridge **30**, to ignite the cartridge by percussion with the pursuant explosion driving the stud **36** into the work piece.

This firing by striking the tip **42** of the stud **36** against the work piece can be accomplished in any desired manner as by first placing the tool against the work piece and then striking the end of the tool with a hammer, or by striking the entire barrel member unit **20** against the work piece, which can be facilitated by forming a hammer handle on the barrel member **20**.

In most instances it is desirable to provide some means of aligning the stud **36** in the bore **22** for straight driving of the stud into the work piece. This can be accomplished as illustrated in FIG. 1 by affixing a guide washer **44** adjacent the tip **42** of the stud **36**. This guide washer **44** is slidable on the stud **36** and is initially positioned by a friction fit. This washer **44** serves as a laterally extending flange of a diameter slightly less than the diameter of the adjacent bore portion, thereby centering the tip **42** of the stud **36** within the bore. When the stud **36** is driven, it slides through the washer **44**, which remains against the work piece as a washer for the head **40** of the stud.

As illustrated in FIG. 1, the muzzle end **48** of the bore **22** is slightly enlarged and the diameter of the guide washer **44** is slightly less than the diameter of this enlarged muzzle end **48** of the bore **22**, this enlargement will permit the incorporation of a yieldable detent to initially engage the washer **44** and hold the stud **36** in the bore **22** prior to firing, but without extending into the path of the head **40** of the stud **36**. Such a yieldable detent is shown in FIGS. 5, 10, 11, 13 and 14, and will be described in detail below.

As the cartridge chamber **26** is relatively inaccessible, opening only at the inner end of the bore **27**, it would be difficult to remove a spent cartridge that has become lodged in the chamber **26**. To facilitate expulsion of spent cartridges, an explosion chamber **50** is provided inwardly of and communicating with the cartridge chamber **26**. This explosion chamber **50** tapers at the juncture **52** with the cartridge chamber **26** to a substantially reduced cross-section so that upon firing of the cartridge **30** the force of the explosion will expand into the explosion chamber **50** and be shaped by the reduced cross section to collapse the cartridge **30** and expel it from the chamber **26** for ready removal from the bore **22**.

From the above description it is apparent that the embodiment illustrated in FIG. 1 is a simple and compact construction requiring no movable parts, such as a firing mechanism, and can be made of a one-piece construction. In addition, the tool is efficiently fired by direct action of the stud itself. This firing by inward movement of the stud provides a safety feature as there is no mechanism that can fire the tool accidentally when the stud is not in place against a work piece.

A modification of the embodiment of FIG. 1 is illustrated in the tool of FIG. 2, which is similar to the tool of FIG. 1 in that it has a cylindrical barrel member **54** having a bore **56** for positioning of a stud **58** therein, for a cartridge chamber **60** defined by an inner shoulder **62** for positioning of a cartridge **64** for firing by a protuberance **66** of the head **68** of the stud **58** upon striking of the tip **70** of the stud against a work piece. This embodiment also includes an explosion chamber **72** extending inwardly from the cartridge chamber **60**.

In addition to the above elements similar to the embodiment of FIG. 1, the embodiment of FIG. 2 includes an expansion feature for allowing the explosive force to dissipate and thereby reduce recoil. This is accomplished by arranging ports **82** in the barrel member **54** communicating between the bore **56** and an expansion chamber **74**, which is formed by an exterior recess **66** in the surface **78** of the barrel member **54** and an outer cylindrical sleeve **80** positioned over the barrel member **54** completely covering exterior recess **76**. There are four symmetrically arranged ports **82**, and they are spaced from the inner end of the bore **56** so that upon explosion of the cartridge **64** the explosive charge drives the head of the stud without expansion of the force until the head of the stud passes the ports **82** to expose the ports and permit the explosive force to expand through the ports **82** into the expansion chamber **74**.

The cylindrical sleeve **80** of this embodiment is positioned on the barrel member **54** with O-rings that not only position the sleeve **80** but also seal the expansion chamber **74** and are formed of resilient material, such as rubber, to minimize vibrations and sound resulting from the explosion, and particularly the expansion of the explosive force into the expansion chamber **74**. To insure retention of the sleeve **80** in proper position on the tool even during recoil, the barrel member **54** is provided with a slightly enlarged muzzle end **84** so that upon recoil of the tool the muzzle end **84** will prevent the sleeve **80** from sliding forwardly on the barrel member **54**.

It will be noted that the stud **58** in the embodiment of FIG. 2 differs from the stud **36** of the embodiment of FIG. 1 in that the heads **68** of the stud **58** of FIG. 2 is threaded. These threads would normally permit at least part of the explosive force to escape without the full force of the explosion being directed to driving the stud.

To compensate for this, a driver cap 86 is positioned over the head 68 and is provided with a slot 88 to permit extension of the firing pin protuberance 66 of the stud 58. This driver cap 86 has a cylindrical wall 90 of a diameter slightly less than the diameter of the bore 56 so that it acts as a piston to drive the stud upon explosion of the cartridge 64.

An alternate form of a closure for the threaded head 68 of the stud 58 is illustrated in the enlargement of FIG. 3. In this alternate embodiment a helical coil 92, such as a coil spring, is threaded onto the thread of the head 68 of the stud 58 and serves the function of a piston ring in the same manner as the driver cap 86 illustrated in FIG. 2. This helical piston ring 92 is shown separated from the threaded stud head 68 in FIG. 6.

A further construction for forming a piston seal with a threaded stud is illustrated in FIG. 7, wherein the stud 94 has a threaded head 96 and is provided with a laterally extending flange 98 at the base of the head of a diameter slightly less than the diameter of the bore in which the stud is to be positioned, thereby substantially sealing the head 96 for driving as a piston by the explosion of the charge within the tool.

As mentioned previously, the length of the stud 36 of the embodiment of FIG. 1 is slightly longer than the length of the bore 22 of the barrel member 20 so that the tip 42 of the stud extends slightly beyond the muzzle 24 for firing engagement of the work piece. However, it is not necessary to use a standard length stud, as it is often desirable for a particular purpose to use a shorter stud. To accommodate such shorter studs, extender means may be used with the studs so that a single tool can be used for many stud length applications. Such extender means are shown in FIGS. 8 and 9. In FIG. 8 the stud 100 has an extender shank 102 extending from the head 104 of the stud and separated therefrom by a reduced diameter portion 106 so that after driving the stud 100, the extender shank 102 can be broken off at the reduced diameter portion 106. The extender shank 102 is provided with a piston rim 108 and a firing pin protuberance 110 similar to the corresponding elements of the previously described studs.

The extender means illustrated in FIG. 9 is a solid cylindrical plug 112 having a firing pin protuberance 114 extending from one end 116 thereof. This plug 112 is intended to be inserted in the bore of the tool after positioning of the cartridge and before positioning of the stud and is of a length sufficient to combine with the length of the stud to position the tip of the stud outwardly of the muzzle of the barrel member so that the tip of the stud can be struck and the impact transmitted through the plug to fire the cartridge. Representative plug lengths are indicated in dot-dash lines in FIG. 9.

As a stud is loaded into the tool through the muzzle and the tool is fired by placing the muzzle against a work piece, it is apparent that the tool must be moved from a loading position to a firing position and in so doing it may be difficult to retain the stud in the tool. Accordingly, a tool of the present invention may be provided with the aforementioned detent means. Such detent means are illustrated clearly in the enlargement of FIG. 5, which shows the muzzle end 84 of the barrel member 54 of the embodiment of FIG. 2. These detent means 118 consist of a ball detent 120 partially protruding through an opening 122 in the enlarged muzzle end of the bore 56. The opening 122 is of a diameter less than the diameter of the ball so that the ball cannot completely pass therethrough. The ball is held in a yieldable protruding position by a spring 124 compressed within a channel 126 extending laterally from the opening 122 to the outer surface of the barrel member 54 and held therein by a threaded plug 128. Thus the ball detent 120 yields to permit the guide washer 44 on the stud 58 to pass therebeyond into the bore 56 and retains the stud by engagement with the guide washer to prevent the stud from falling out of the bore until the cartridge is fired, at which time the force of the explosion will cause the washer to engage and retract the ball detent 120, permitting the washer and stud 58 to pass thereby.

The present invention may be advantageously incorporated in a stud gun construction such as that illustrated in FIGS. 10–14. In this embodiment the stud gun 130 has an outer barrel sleeve 132 within which an inner barrel member 134 is slidable between a retracted or cocked position as shown in FIG. 10 and a projected or firing position as shown in FIG. 11.

The inner barrel member 134 is preferably of a construction substantially the same as the cylindrical barrel member 20 of the embodiment of FIG. 1 or the cylindrical barrel member 54 of the embodiment of FIG. 2. Thus this inner barrel member 134 is provided with a stud bore 136, a cartridge chamber 138 extending inwardly from the stud bore 136 and defined at its outer end by a shoulder 140, and an explosion chamber 142 extending inwardly from and at a reduced diameter with respect to the cartridge chamber 138. The inner barrel member 134 is also similarly provided with detent means 144 at the muzzle end 146 thereof for retaining a stud 148 in the stud bore 136. An expansion chamber 150, serving the same purpose as the expansion chamber 74 of the embodiment of FIG. 2 is defined by an exterior recess 152 in the outer surface of the inner barrel member 134 and the outer barrel sleeve 132. This expansion chamber 150 communicates with the interior of the stud bore 136 by means of four equally spaced ports 154 positioned similar to the ports 82 of the embodiment of FIG. 2.

The inner barrel member 134 is impelled from its retracted cocked position (FIG. 10) to its projected firing position (FIG. 11) by a coil spring 156 that has one end 158 seated in the end 160 of the outer barrel sleeve 132 and its other end 162 biased against the inner barrel member 134. When the inner barrel member 134 is in its cocked or retracted position, the spring 156 is compressed. A second spring 164 is positioned within the first spring 156 and is similarly mounted to bias the inner barrel member forwardly. However, as seen in FIG. 11, this second spring 164 is substantially shorter than the first spring 156 and does not remain in contact with the inner barrel member 134 throughout the entire firing stroke thereof, but does serve to add to the initial impelling force and to add to the spring means available to absorb the recoil of the inner barrel member 134 after firing. To further reduce the effect of recoil, a third spring 166 is mounted within the second spring 164, but extending only a relatively short distance from the end 160 of the outer barrel sleeve 132. This third spring 166 is relatively stiff and is provided for stopping the rearward movement of the inner barrel member 134 on recoil thereof.

The inner barrel member 134 is retained in its cocked or retracted position by means of a trigger mechanism 168 comprising a pivoted trigger element 170 having a trigger latch 172 extending through a trigger recess 174 in the outer barrel sleeve 132 for engagement in a latching recess 176 in the inner barrel member 134 to lock the inner barrel member 134 in cocked position. The trigger element 170 is normally retained in latching position by a U-shaped spring 178 biased between the handle portion 180 of the stud gun and the finger portion 182 of the trigger 170.

The stud gun 130 is fired simply by squeezing the finger portion 182 of the trigger element 170 against the biasing of the spring 178, thereby pivoting the trigger latch 172 out of the latching recess 176 of the inner barrel member 134, which releases the inner barrel member to be impelled forwardly by the springs 156 and 164. When the inner barrel member 134 reaches its projected or firing position, the extending end of the stud 148 will strike the work piece against which the outer barrel sleeve 132 is positioned prior to firing, thereby transmitting an inwardly

directed impact against the cartridge **184**, which impact fires the cartridge to drive the stud by the resulting explosion into the work piece. The repercussion from the explosion drives the inner barrel member **134** backwardly against the springs **156**, **164** and **166**, which absorb this recoil and return the inner barrel member **134** to its projected position for reloading.

The inner barrel member **134** is provided with a hand lever **186** that extends through a slot **188** in the outer barrel sleeve **132** for engagement by the operator to retract the inner barrel member **134** to its cocked position against the urging of the springs **156** and **164** after reloading.

Although the stud gun **130** of the embodiments of FIGS. 10 through 14 includes a trigger mechanism **168**, this trigger mechanism does not itself fire the cartridge **184**. If the trigger is accidentally actuated, the inner barrel member **134** will be impelled to its firing position but the cartridge will be fired only if there is a work piece or other object against which the tip of the stud **148** can strike. If there is no object at the muzzle end of the gun the cartridge will not fire. Thus the present invention incorporates a very significant safety feature.

A further safeguard, as well as beneficial means for positioning and aligning the stud gun **130**, are provided by a tubular protective shield **190** that is shiftably mounted at the muzzle end **192** of the outer barrel sleeve **132**. This protective shield **190** has a laterally extending outer flange **194** and is shiftable from a projected position at which the outer flange **194** is spaced from the muzzle end **192** of the outer barrel sleeve **132** and an inner retracted position at which the outer flange **194** abuts the muzzle end **192** of the outer barrel sleeve **132**. This tubular protective shield **190** has an inner diameter slightly greater than the outer diameter of the outer barrel sleeve **132** so that a coil spring can be mounted therebetween. This coil spring **196** is biased between a collar **198** secured to the exterior of the outer barrel sleeve **132** inwardly of the muzzle end **192** thereof and the inner surface **200** of the outer flange **194** of the shield **190**. Thus this spring **196** normally urges the protective shield **190** to its projected position as seen in FIG. 10. The shield **190** is prevented from moving off of the outer barrel sleeve **132** by an inturned ridge **202** of lesser diameter than the diameter of the collar **198** so that the ridge **202** will engage the collar **198** and prevent the shield **190** from passing therebeyond. However, the shield **190** is provided with a plurality of longitudinal slots **204** that permit it to expand and allow the ridge **202** to pass over the collar **198** for removal of the shield **190** by a force greater than that of the spring **196**.

The outer flange **194** of the tubular shield **190** has a central opening **206** of a diameter less than the major diameter of the inner barrel member **134**, and the muzzle end **146** of the inner barrel member **134** is provided with an annular recess **208** that permits the unrecessed portion of the end of the inner barrel member **134** to extend through the central opening **206** of the outer flange **194** of the shield **190** and be positioned flush therewith for firing while the recessed portion abuts the inner surface **200** of the shield flange **194**.

In use the protective tubular shield **190** is normally positioned in its projected position by the spring **196**, thereby preventing objects from being close enough to the muzzle end **192** of the outer barrel sleeve **132** to be struck by the end of the stud should the trigger mechanism **168** be accidentally actuated, thus preventing inadvertent firing of the tool. When it is desired to drive a stud with this stud gun **130** the outer flange **194** of the shield **190** is placed against the work piece and the handle **180** is forced forwardly to force the outer barrel sleeve **132** into the shield **190** for retraction of the shield with respect to the sleeve so that when the inner barrel member **134** is impelled by the spring **156** upon actuation of the trigger mechanism **168** to its firing position the end of the stud **148** will strike the work piece and fire the cartridge **184** to drive the stud **148** into the work piece.

The outer flange **194** of the shield **190** serves as a positioning and aligning element that automatically positions the gun for proper firing simply by placing the flange **194** flush against the work piece. If the flange is not flush against the work piece, but is tilted with respect thereto, the resulting tilting will cause the muzzle end **146** of the inner barrel member **134** to be spaced from the work piece when in firing position so that the stud **148** will not strike the work piece and the cartridge **184** will not be fired.

In some instances the material into which it is desired to drive the stud will not be hard enough to produce a firing impact when the stud strikes the object. Thus when it is desired to drive a stud into soft wood the stud tip will penetrate the wood rather than moving inwardly in the barrel, with the result that the stud will not fire the cartridge. To provide for firing of studs into soft material, the stud gun **130** of the present embodiment provides a circular recess **210** surrounding the central opening **206** of the outer flange **194** of the protective shield **190**, for mounting of a firing disc **212** of metal or other hard material across the opening to provide a striking surface for the end of the stud when the stud is to be fired into soft material. The mounting shoulder **214** formed by the circular recess **210** for mounting of the firing disc **212** may be diametrically split as at **216** and the halves oppositely magnetized so that a metallic disc will be retained in the recess prior to placing of the stud gun against a work piece. The above described protective shield **190** is clearly illustrated in FIGS. 10, 11, 12 and 14, with FIG. 14 also showing the firing disc **212**.

As illustrated in FIGS. 13 and 14, the stud gun **130** of this embodiment can be modified to drive studs of various lengths by using alternate inner barrel member constructions. However, the stud length adapter of FIGS. 8 and 9 could also be used in this embodiment.

In FIG. 13 the inner barrel member **218** is formed with an interchangeable muzzle portion **220**, a tubular connecting portion **222**, and a rear base portion **224**. The rear base portion **224** is constructed similar to the inner barrel member **134** of FIG. 10 rearwardly of the ports **154** and has its similar elements numbered the same as in FIG. 10. In addition, longitudinally spaced threaded recesses **226** are formed in the outer surface of the rear base portion **224** for receipt of the set screw **228** used to position the tubular connecting portion **222** in an adjusted length position with respect to the rear base portion **224**. The tubular connecting portion **222** is also connected by a set screw **230** to the muzzle portion **220**, which is of a selected length and is interchangeable with similar muzzle portions of different lengths to accommodate different length studs. The muzzle portion **220** has a recessed surface **232** for defining an expansion chamber in combination with the interior of the tubular connecting portion **222**. Ports **234** communicate between this expansion chamber and the bore of the barrel member **218**. The recessed surface **232** terminates rearwardly in a flange **236** that abuts the rear base portion **224** to firmly position the portions in place.

In the modified barrel construction of FIG. 14, the barrel member **238** is formed with a rear base portion **240** substantially identical to the rear base portion **222** of the barrel member **218** of FIG. 13, having similar threaded recesses **242** for adjustable positioning of a forward muzzle portion **244** by means of a set screw **246**. The muzzle portion **244** extends from the rear base portion **240** to the muzzle of the barrel member **238**, and is hollow for a substantial length from the inner end thereof. An interchangeable tubular member **248** is seated in the hollow area of the muzzle portion **244**, and has tapered ends **250** that seat in complementary tapered surfaces **252** of the muzzle portion **244** and rear bore

portion 240 to mate firmly with these portions and combine therewith to form a continuous bore 254. This tubular member 248 is provided with ports 256 for communication between the bore 254 and the space within the muzzle portion 244 outwardly of the tubular member 248, which space forms an expansion chamber. To accommodate studs of different length, different length tubular members 248 are interchangeable with the muzzle portion 244 accommodating the change by selective positioning with respect to the threaded recesses 242 of the rear base portion 240.

The present invention has been described in detail above for purposes of illustration only and is not intended to be limited by this description or otherwise except as defined in the appended claims.

We claim:

1. An explosive actuated tool for driving an element, such as a fastening stud, by an explosive charge, said tool comprising a barrel member having a bore for positioning therein of an element to be driven by said tool and a chamber communicating with said bore inwardly of the position of said element for receipt of a percussion ignitible explosive charge, said chamber being shaped for positioning said charge for ignition by an inwardly directed impact producible by an inward relative movement of an element in said bore.

2. An explosive actuated tool according to claim 1 and characterized further in that the length of said bore outwardly of said chamber is such that an element positioned therein will extend outwardly of the barrel member for striking against an object, such as a workpiece into which said element is to be driven, to produce said inwardly directed impact.

3. An explosive actuated tool according to claim 1 and characterized further in that said barrel member has an explosion chamber communicating with the explosive charge receiving chamber inwardly of the position of the charge for directing the explosion to facilitate expulsion of the spent charge from said bore upon firing.

4. An explosive actuated tool according to claim 1 and characterized further in that said barrel member has an expansion chamber spaced laterally from said bore with ports connecting said bore and expansion chamber intermediate the ends of the bore for expansion of the explosion into the expansion chamber after the element to be driven has been driven past said ports.

5. An explosive actuated tool according to claim 4 and characterized further in that said expansion chamber is formed by an exterior recess in said barrel member and a sleeve member covering said recess.

6. An explosive actuated tool according to claim 2 and characterized further in that a protective shield is mounted on said barrel member and is shiftable between a projected position in which it extends beyond the outward extension of an element positioned in the bore of the barrel member to protect against unintentional firing of the tool and a retracted position exposing said extending end of the element for firing.

7. An explosive actuated tool according to claim 6 and characterized further in that said protective shield has a laterally extending flange for abutting a workpiece to align the tool prior to driving of the element.

8. An explosive actuated tool according to claim 6 and characterized further in that said protective shield is provided with a recess surrounding the end of said bore, and a firing disc is seatable in said recess across said bore for firing engagement with the end of the element when the protective shield is in retracted position.

9. An explosive actuated tool for driving an element, such as a fastening stud, by an explosive charge, said tool comprising a barrel member having a muzzle and a bore extending from said muzzle to an inner shoulder for positioning in the bore of an element to be driven by said tool, said barrel member having a cartridge chamber extending inwardly from said inner shoulder for positioning of an explosive cartridge in said chamber with the rim of the cartridge seated against said inner shoulder for firing of the cartridge by an inwardly directed impact producible by an inward relative movement of an element in said bore.

10. An explosive actuated tool according to claim 9 and characterized further in that said barrel member has an explosion chamber communicating with and extending inwardly from said cartridge chamber at a reduced cross-section for directing the explosion to facilitate expulsion of the spent cartridge from said bore upon firing.

11. An explosive actuated tool for driving an element, said tool comprising a barrel member having a muzzle and a bore extending from said muzzle to an inner shoulder and a cartridge chamber extending inwardly from said inner shoulder, an explosive cartridge having a rimmed firing end, said cartridge being positioned in said cartridge chamber with the rim of the firing end seated against said shoulder and said firing end facing outwardly for firing by an inwardly directed impact, a firing pin element positioned in said bore outwardly of said cartridge having an inner end in contact with said firing end of said cartridge and an outer end extending beyond said muzzle for striking against an object into which said element is to be driven to impart through said element a firing impact to said cartridge.

12. An explosive actuated tool for driving an element according to claim 11 and characterized further in that said element inner end has a protuberance integral with and extending inwardly from said element inner end for contact with said firing end of said cartridge.

13. An explosive actuated tool for driving an element, said tool comprising a barrel member having a bore and a chamber extending inwardly of said bore, an explosive charge positioned in said chamber for firing by an impact directed inwardly through said bore, a firing pin element positioned in said bore movable inwardly to produce a firing impact to explode said charge, said bore having an enlarged muzzle end, a flange member associated with said element in said enlarged muzzle end of said bore, and yieldable detent means in said barrel member at said enlarged muzzle end of the bore yieldably engageable with said flange member to retain said element in said bore prior to firing of said tool.

14. A stud gun for driving a fastening stud or the like comprising an outer barrel sleeve having a muzzle end, an inner slidable barrel in said outer barrel sleeve and slidable therein between a retracted position and a firing position at said muzzle end of the outer barrel sleeve, said inner slidable barrel having a bore for positioning therein of a stud or the like to be driven by said gun and a chamber extending inwardly from said bore for receipt of an explosive charge ignitible when said inner barrel is in firing position to drive said stud, means operable to impel said inner slidable barrel from retracted to firing position.

15. A stud gun according to claim 14 and characterized further in that said inner slidable barrel has ports extending laterally from said bore and an exterior recess communicating with said ports and forming with said outer barrel sleeve an expansion chamber for expansion of the explosion within the bore.

16. A stud gun for driving a fastening stud or the like comprising an outer barrel sleeve having a muzzle end, an inner slidable barrel in said outer barrel sleeve and slidable therein between a cocked position within said outer barrel sleeve and a firing position at said muzzle end of the outer barrel sleeve, said inner slidable barrel having a bore for positioning therein of a stud or the like to be driven by said gun and a chamber extending inwardly from said bore for receipt of an explosive charge ignitible to drive said stud when the inner slidable barrel is in firing position, resilient means for impelling said inner slidable barrel from cocked to firing position and for absorbing the recoil of the inner slidable barrel upon firing, trigger means for retaining said inner slidable bar-

rel in cocked position against the urging of said resilient means and operable to release said inner slidable barrel for impelling to firing position by said resilient means.

17. A stud gun according to claim 16 and characterized further in that an explosive charge is positioned in said chamber for ignition by an impact directed inwardly of said inner slidable barrel and a stud is positioned in said bore for extension outwardly of the inner slidable member for striking a work piece upon sliding of the inner slidable member to firing position, said stud having an inner firing pin end for firing said charge to drive the stud into the work piece when the stud strikes the work piece.

18. A stud gun according to claim 17 and characterized further in that a protective shield is shiftably mounted on said outer barrel sleeve and is shiftable between a projected position outwardly of the muzzle of said outer barrel sleeve beyond the position of the stud when the inner slidable barrel is in firing position and thereby protecting against inadvertent firing, and a retracted position substantially flush with the muzzle of said outer barrel sleeve, and means for releasably positioning said protective shield in projected position.

19. A method of driving a stud or similar element by an explosive charge comprising loading a cartridge in the bore of a barrel member with the firing surface thereof facing outwardly of the bore, positioning a stud in the bore with an end extending outwardly beyond the barrel member, striking the extending end of the stud against a work piece to cause the stud to move inwardly to produce an impact against said cartridge to ignite the cartridge with the resulting explosion driving the stud into the work piece.

20. A method of driving a stud or similar element by an explosive charge comprising loading a cartridge in the bore of a barrel member with the firing surface thereof facing outwardly of the bore, positioning a stud in the bore outwardly of said cartridge with an end facing outwardly, striking said end of the stud against a work piece to cause the stud to move inwardly to produce an impact against said cartridge to ignite the cartridge with the resulting explosion driving the stud into the work piece.

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