

May 26, 1970

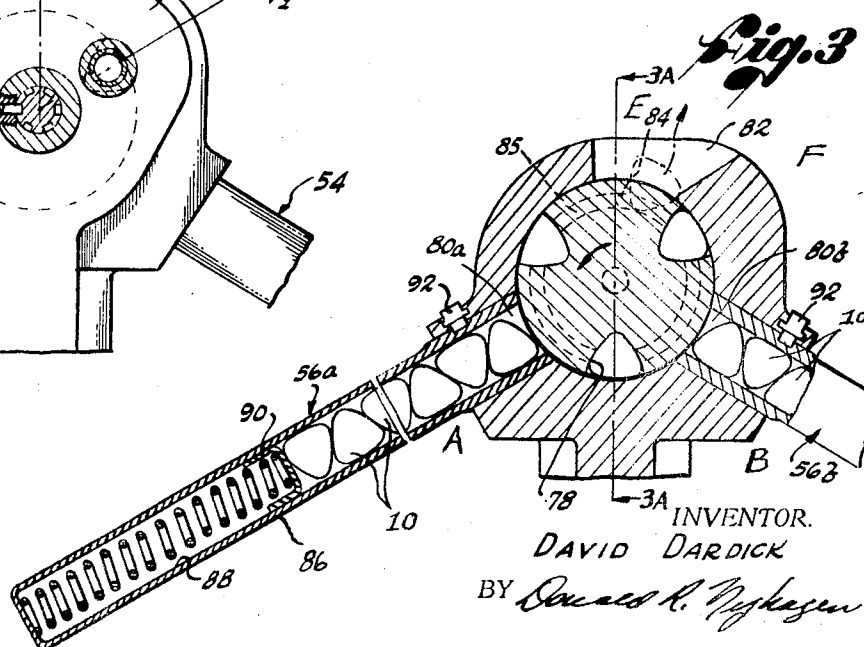
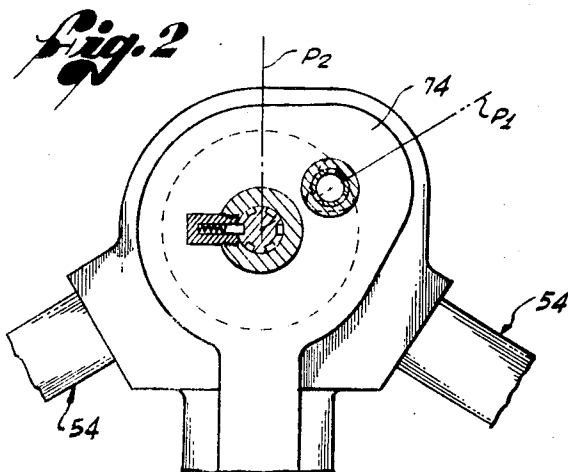
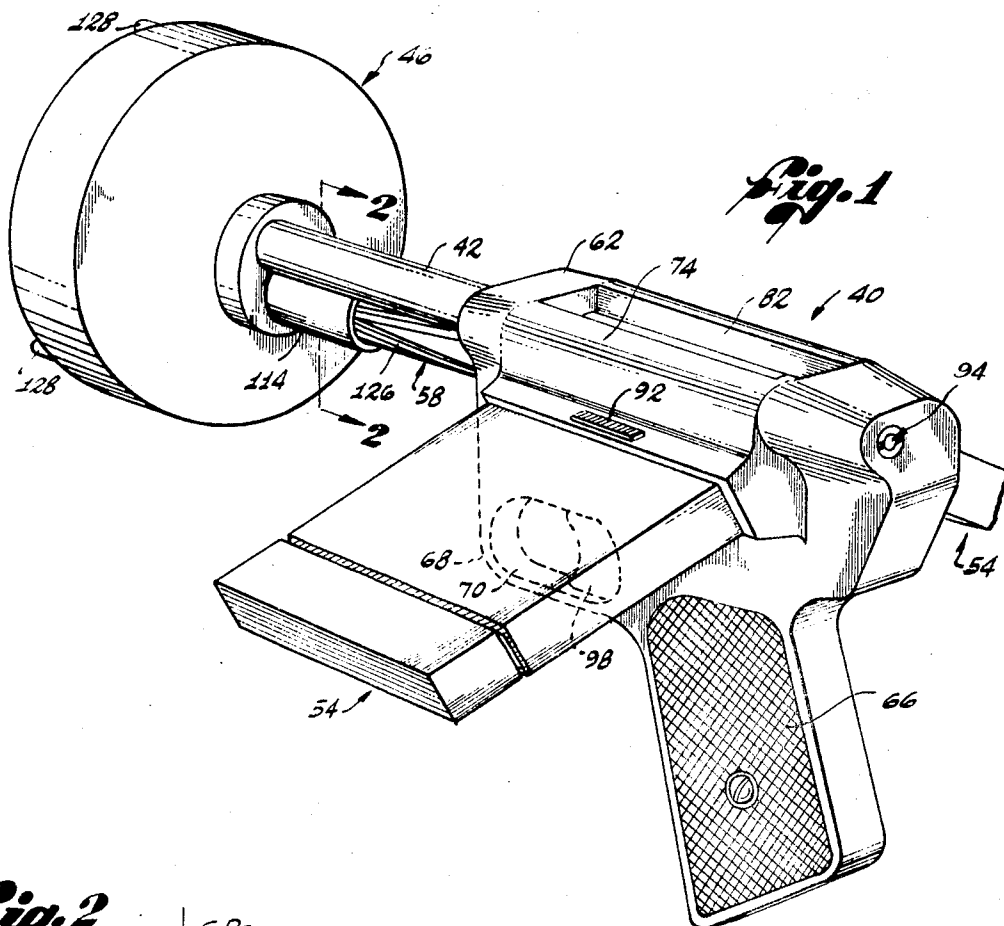
D. DARDICK

3,514,026

REPEATING PROPELLANT GAS POWERED DRIVING TOOL

Filed Sept. 1, 1967

5 Sheets-Sheet 1



INVENTOR.
DAVID DARDICK
BY *Donald R. Nykogen*
ATTORNEY

May 26, 1970

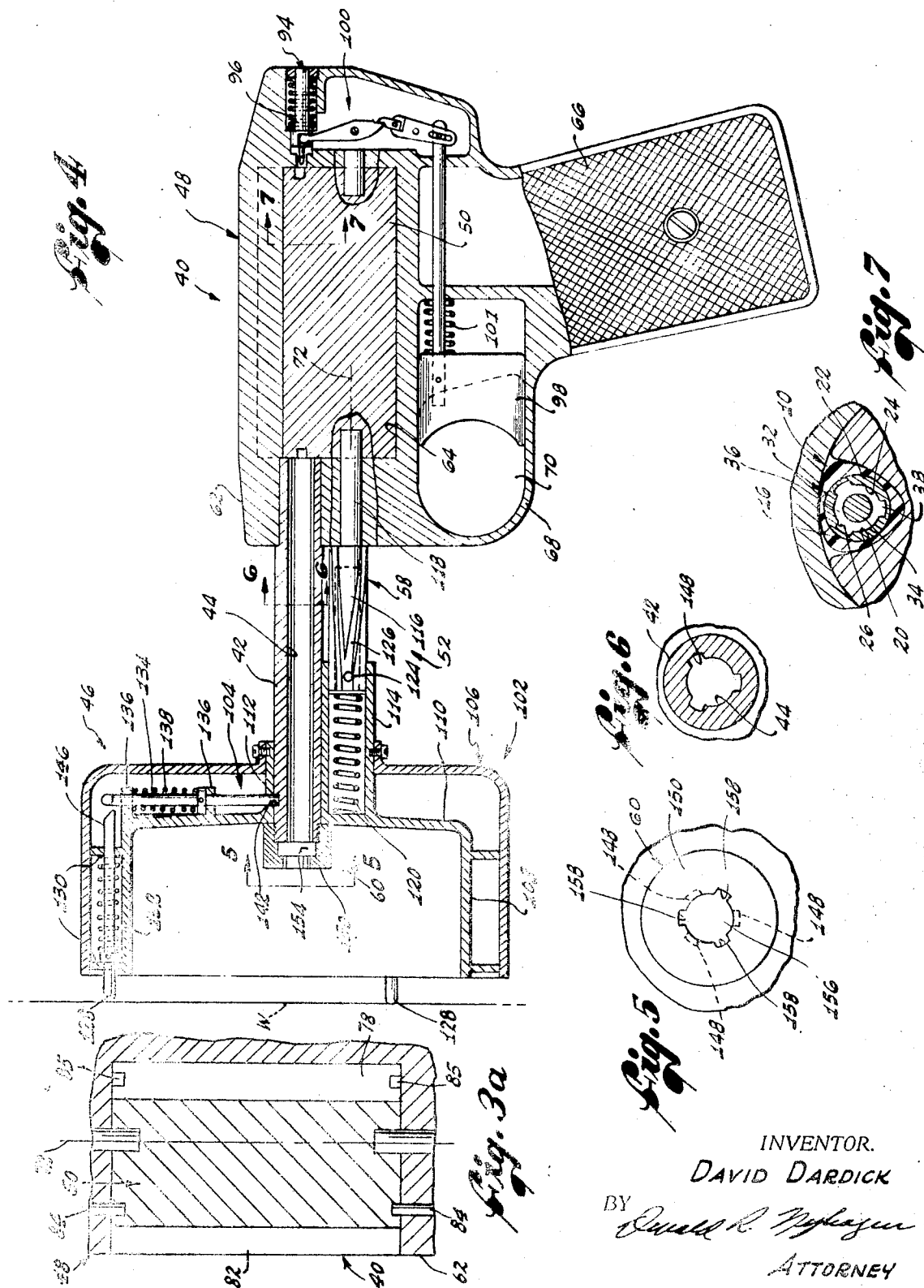
D. DARDICK

3,514,026

REPEATING PROPELLANT GAS POWERED DRIVING TOOL

Filed Sept. 1, 1967

5 Sheets-Sheet 2



May 26, 1970

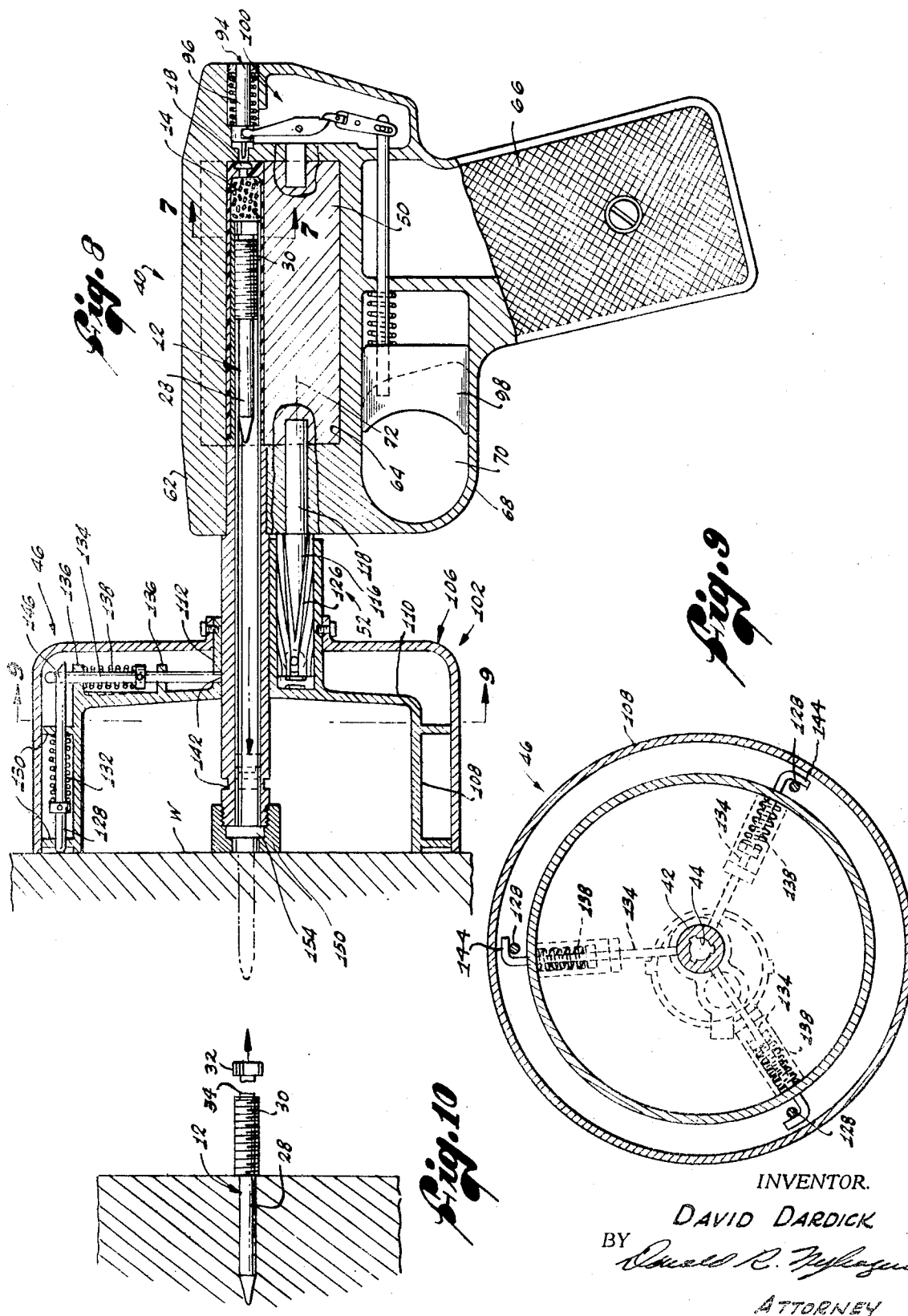
D. DARDICK

3,514,026

REPEATING PROPELLANT GAS POWERED DRIVING TOOL

Filed Sept. 1, 1967

5 Sheets-Sheet 3



May 26, 1970

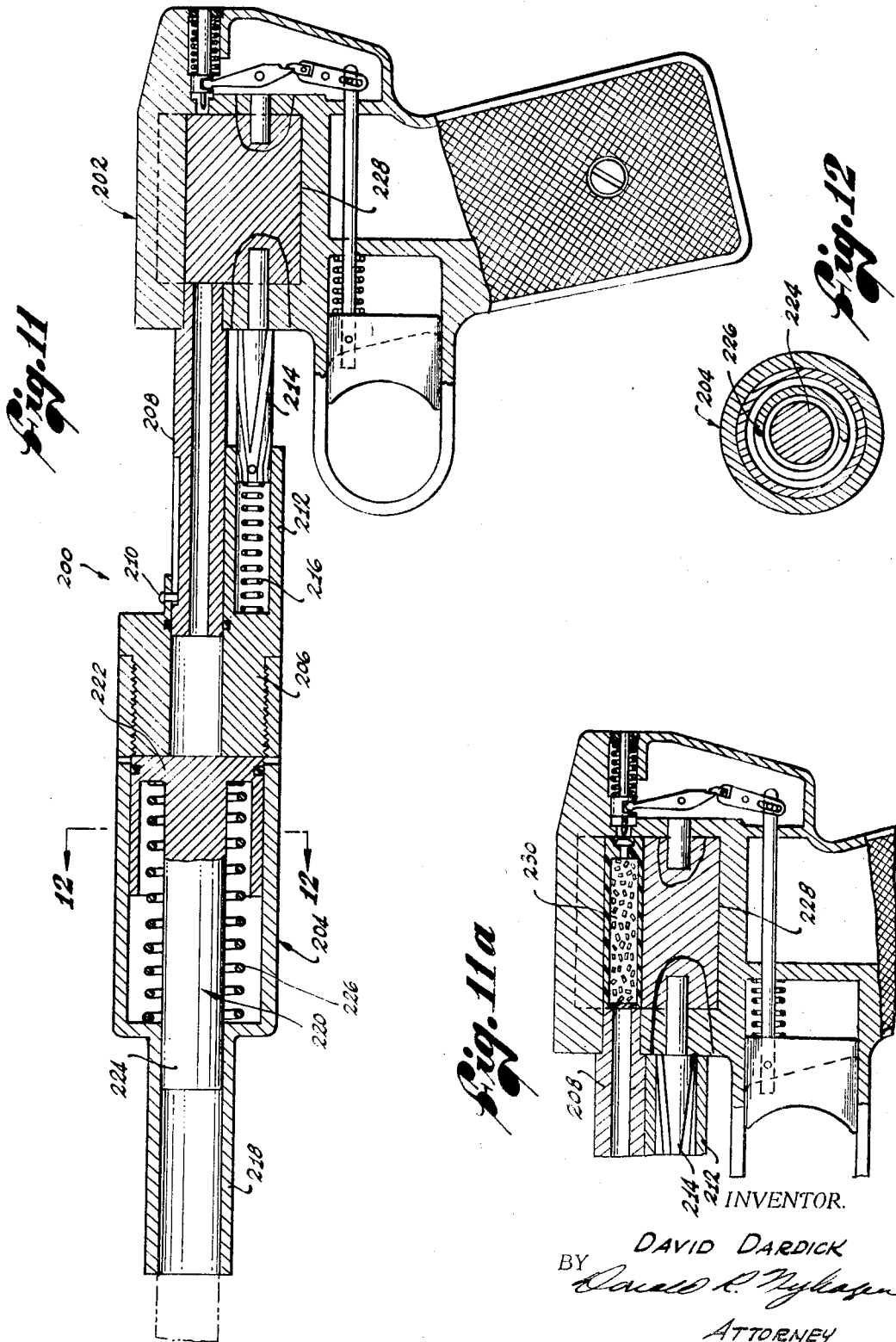
D. DARDICK

3,514,026

REPEATING PROPELLANT GAS POWERED DRIVING TOOL

Filed Sept. 1, 1967

5 Sheets-Sheet 4



May 26, 1970

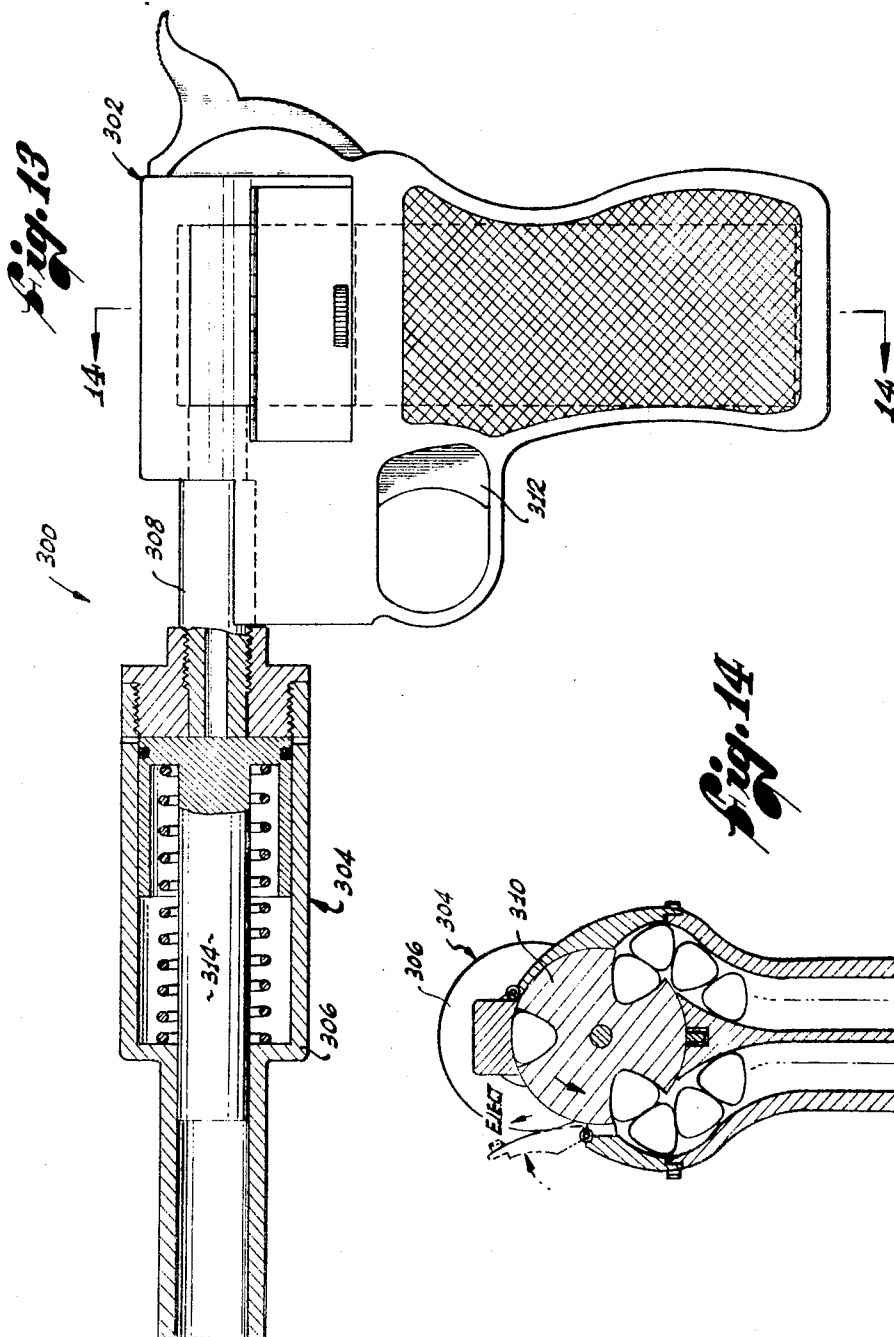
D. DARDICK

3,514,026

REPEATING PROPELLANT GAS POWERED DRIVING TOOL

Filed Sept. 1, 1967

5 Sheets-Sheet 5



INVENTOR.
DAVID DARDICK
BY
Donald R. Nykopen
ATTORNEY

1

3,514,026

REPEATING PROPELLANT GAS POWERED DRIVING TOOL

David Dardick, Palos Verdes Peninsula, Calif., assignor
to TRW Inc., Redondo Beach, Calif., a corporation of
Ohio

Filed Sept. 1, 1967, Ser. No. 665,133

Int. Cl. B25c 1/18

U.S. Cl. 227—11

21 Claims

ABSTRACT OF THE DISCLOSURE

A repeating propellant gas powered tool and ammunition therefor containing a propellant charge, the tool having a barrel and a breech mechanism at the breech end of the barrel for initially transporting an ammunition round from an ammunition magazine to firing position, selectively firing the round in firing position to drive a fastener into a workpiece, deliver a high energy impact to the workpiece, or perform some other propellant gas powered operations, and finally ejecting the spent cartridge case of the fired round, or the entire round in the event that the round is not fired.

CROSS-REFERENCES TO RELATED APPLICATION

Reference is made herein to copending applications Ser. No. 671,910, filed Sept. 1, 1967, and entitled "Sealed Open Chamber Breech Mechanism and Caseless Ammunition Therefor," and Ser. No. 665,136, filed Sept. 1, 1967, and entitled "Semicombustible Ammunition for Open Chamber Breech Mechanism."

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates generally to power operated hand tools. The invention relates more particularly to a repeating propellant gas powered tool for driving fasteners into a workpiece, delivering high intensity impacts to a workpiece, or performing various other propellant gas powered operations.

As will appear from the ensuing description, the present tool may be constructed and arranged to perform any one of several different propellant gas powered operations. One disclosed embodiment of the tool, for example, is designed to drive fasteners into a workpiece. Illustrative of such fasteners, for example, are studs including both internally and externally threaded studs, drive pins, nails and the like. Accordingly, it will be understood that the expression "fastener," as used in this disclosure, is intended to encompass all of the above and other similar fasteners, and the like. Other disclosed embodiments of the invention are designed to function as percussion tools. These percussion tools have general utility in any application requiring the transmission of high energy blows or impacts to a workpiece or other object.

Prior art

Propellant gas powered fastener driving tools of the general class to which the invention pertains are well-known in the art and are commonly referred to as "stud drivers." Generally speaking, the existing tools of this type are characterized by a barrel, a work engaging means at the muzzle end of the barrel, and a breech mechanism at the breech end of the barrel. Within the breech mechanism at the breech end of the barrel. Within the breech mechanism is a firing chamber which is exposed by opening the mechanism to permit insertion into the chamber of a stud or other fastener to be driven and a propellant charge. After loading, the breech mechanism is reclosed to condition the tool for firing. In use, the tool is placed against a workpiece, after which the breech is actuated

2

in some way to fire the propellant charge in the firing chamber. A high pressure propellant gas is thereby generated within the firing chamber which propels the fastener forwardly through the barrel into the workpiece. In this type of tool, the work engaging means is a shield which provides expansion space for and confines the propellant gas exhausting from the barrel after firing and confines any fragments created by impact of the fastener with the workpiece, thus to prevent injury to the operator. Most commercial drivers of this type are equipped with various other safety features, including interlocks. These interlocks are intended to prevent firing of the tools unless pressed firmly against the workpiece with the axis of the barrel at the proper angle, typically perpendicular, relative to the work surface to prevent ricocheting of the fastener. Some tools also have means for captivating each fired fastener to limit its penetration into the workpiece. This captive fastener feature prevents travel of the fastener completely through and beyond the workpiece which, obviously, would present a serious safety hazard. A typical propellant gas powered percussion tool contains a weighted plunger or hammer which is driven forwardly by propellant gas pressure to deliver a high energy blow to an object.

The existing tools of the kind under discussion are characterized by various deficiencies which this invention seeks to overcome. One of the major deficiencies of the existing tools, for example, resides in the fact that they are effectively single shot devices which must be manually reloaded after each use. This manually reloading requirement is obviously undesirable per se for the reason that it inherently involves waste time and labor which increase in direct proportion to the number of shots to be fired. Moreover, the reloading procedure utilized in most, if not all, of the existing tools are involved and time consuming. Thus, in most cases, each reloading operation involves initial opening and final reclosing of the breech mechanism. In addition, the existing stud drivers employ discrete or separate propellant charges and fasteners which must be inserted separately into the breech firing chamber. Such separate propellant charges and fasteners are time consuming and laborious to load. Moreover, their use introduces the undesirable and often hazardous possibility of inadvertently loading a tool with a propellant charge which is either too small or too large for the particular job at hand. Many of these drivers which fire so-called captive fasteners or studs are particularly difficult and time-consuming to reload for the reason that their loading procedures involve various additional and often involved steps to recondition and mate each fastener with the fastener captivating means of the drivers.

Most, if not all, of the existing tools of this kind are also subject to a serious safety hazard in spite of the safety features embodied in such tools. This safety hazard results from the fact that the existing drivers, when readied for use, contain a propellant charge and fastener in firing position. Although the interlock features of such a tool are intended to prevent firing of the propellant charge until the tool is disposed in proper firing relation to a workpiece, numerous serious accidents have occurred as a result of accidental dropping of a loaded driver in such a way that the interlock and firing mechanism are actuated. Accidental firing of the existing drivers has also occurred in various other ways. In any event, the fact that the existing drivers, when readied for use, contain a propellant charge and fastener in firing position creates a serious potential safety hazard.

SUMMARY OF THE INVENTION

This invention provides improved propellant gas powered tools of the character described and ammunition

therefor which obviate most, if not all, of the above noted and other deficiencies of the existing tools of this type. According to one of its aspects, for example, the invention provides novel ammunition for a fastener driving tool which is characterized by an integrated or unitized fastener and a propellant charge. Thus, each firing cycle of a tool for firing the ammunition involves placement in firing position of only a single ammunition element, or ammunition round as it is referred to herein, which contains both the fastener to be driven and the propellant charge for driving the fastener. As will appear from the ensuing description, the ammunition may be either cased or uncased ammunition.

According to another of its aspects, the invention provides gas powered tools of the character described embodying a repeating breech action which permits a relatively large number of ammunition rounds to be initially loaded into and successively fired in the tools in automatic repeating fashion before manual reloading of the tools is again necessary. Thus, a relatively large number of shots may be fired in minimum time and virtually as fast as the tools can be located in firing position and operated. Depending upon the type of tool, the ammunition may comprise a propellant charge only or a fastener and a propellant charge for driving the fastener. In this regard, it will be recalled that one disclosed tool embodiment is a fastener driving tool, while other disclosed embodiments are percussion tools.

Another important aspect of the invention involves certain safety features and interlocks to prevent firing of the tool except when properly positioned in firing relation to a workpiece. These safety features and interlocks, however, unlike those of the existing tools, are uniquely constructed and arranged to prevent accidental discharge of the tool in the event the latter is dropped or subjected to other abnormal conditions which may cause accidental firing of the existing drivers. One unique safety feature of the present invention, for example, is associated with the automatic breech action referred to above. According to this feature, the tool is equipped with means for effectively sensing when the tool is properly positioned in firing relation with a workpiece and operating the breech mechanism to transport an ammunition round to firing position when, and only when, the tool is thus properly positioned. Accordingly, even though the present tool is readied for use by loading it with a number of ammunition rounds, a live round is not actually located in firing position within the breech mechanism until the tool is placed in proper firing relation to a workpiece. Another unique safety feature is that each round which is transported to firing position as a result of proper engagement of the tool with a workpiece is automatically ejected from the tool upon removal of the tool from the workpiece without firing. Thus, an ammunition round is never in firing position unless the tool is actually disposed in proper engagement with a workpiece. The possibility of accidental discharge of the tool is thus virtually eliminated. As will appear from the ensuing description, the above described breech action also serves to eject the spent cartridge cases of fired cased ammunition rounds.

The present fastener driving tool also embodies a unique fastener captivating action whereby a fired stud or other fastener remains captivated by the driver until deliberately released. As in the existing drivers, this captivating action limits penetration of each driven fastener into the workpiece to prevent travel of the fastener completely through and beyond the workpiece. According to this aspect, the invention provides a driver and ammunition therefor wherein the fastener of each ammunition round is equipped with a rear safety head and the driver is equipped with a forward safety stop which engages the safety head of a driven fastener to arrest and captivate the latter in the event of excessive penetration of the fastener into the workpiece. The safety stop is uniquely configured to per-

mit rapid disengagement of the tool from each driven fastener.

At this point, attention is directed to the fact that a propellant gas powered tool according to the invention may employ either a conventional closed chamber breech action or a so-called open chamber breech action. A closed chamber action is the breech action which has been and still is employed in most guns. An open chamber breech action is a relatively recent development in the gun art. Typical open chamber breech mechanisms, for example, are disclosed in Pats. Nos. 3,046,890; 2,831,141; 2,865,126; 2,983,223; 3,041,939; and 2,847,784. However, the open chamber breech action offers many benefits, is uniquely adapted for use in the present stud driver, and is thus the preferred breech action so far as the present invention is concerned. For this reason, the invention will be disclosed in connection with such an open chamber breech mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a perspective view of a fastener driving tool according to the invention;

FIG. 2 is a section taken on line 2—2 in FIG. 1;

FIG. 3 is a transverse section through the breech mechanism of the driving tool in FIG. 1, showing the breech cylinder in firing position;

FIG. 3A is a section taken on line 3A—3A in FIG. 3;

FIG. 4 is a longitudinal section through the driving tool showing the various parts of the tool in the positions which they occupy when the tool is in its normal inoperative condition;

FIG. 5 is an enlarged view looking in the direction of the arrows on line 5—5 in FIG. 4;

FIG. 6 is an enlarged section taken on line 6—6 in FIG. 4;

FIG. 7 is an enlarged section taken on line 7—7 in FIG. 8;

FIG. 8 is a longitudinal section through the driving tool showing the various parts of the tool in the positions which they occupy when the tool is conditioned for firing;

FIG. 9 is a section taken on line 9—9 in FIG. 8;

FIG. 10 illustrates a stud which has been driven into a workpiece by the fastener driving tool of FIGS. 1 through 9;

FIG. 11 is a longitudinal section through a percussion tool according to the invention illustrating the various parts of the tool in the positions which they occupy in the normal inoperative condition of the tool;

FIG. 11a is a fragmentary longitudinal section through the percussion tool illustrating certain parts of the tool in the positions which they occupy when the tool is conditioned for firing;

FIG. 12 is a section taken on line 12—12 in FIG. 11;

FIG. 13 is a side elevation, partly in section, of a modified percussion tool according to the invention; and

FIG. 14 is a section taken on line 14—14 in FIG. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It will be recalled that according to one of its aspects, the invention provides composite ammunition, represented in the drawings by the ammunition round 10, for use in a propellant gas powered fastener driving tool. The present ammunition includes a fastener 12 and a propellant charge 14 for driving the fastener into a workpiece. As noted earlier, the present ammunition may be either cased or uncased. The particular ammunition of the invention which has been selected for illustration in the drawings is cased ammunition and includes an outer cartridge case 16 which contains the fastener 12 and its propellant charge 14. Mounted in the rear end of the case is a primer 18. At this point, attention is directed to the fact that composite ammunition according to the invention may be

5

designed for use in other drivers than the present automatic driver.

The illustrated ammunition 10 of the invention is intended for use in the present open chamber fastener driving tool. To this end, the cartridge case 16 of each ammunition round has the same generally triangular round shape in transverse cross-section as the open chamber ammunition disclosed in the aforementioned prior art patents. The cartridge case is constructed of a suitable yieldable, non-combustible material, preferably one of the non-combustible plastics referred to in the patents. As will appear from the ensuing description, the cartridge case of the present ammunition serves the same breech sealing function as does the cartridge case of the ammunition disclosed in the patents. Extending longitudinally into the front end of the cartridge case 16 is an opening 20. Fixed within and externally complementing this opening is a sleeve or liner 22 having a central bore 24 opening through its ends. The wall of this bore has a number, in this instance three, of uniformly spaced longitudinal grooves 26. Liner 22 is constructed of a suitable non-combustible material which may comprise the same plastic material as the cartridge case. The liner has a length somewhat less than that of the cartridge case opening 20 and is positioned with its front end flush with the front end of the cartridge case. Accordingly, the rear end of the liner is spaced from the rear end of the cartridge case to define therebetween a chamber for containing the propellant charge 14.

As noted earlier, and as will become evident from the ensuing description, ammunition according to the invention may comprise fasteners of various sizes, types, and shapes, depending upon each particular job application. The particular fastener 12 illustrated is an externally threaded stud including a forward pointed shank 28, an intermediate externally threaded body 30, and a rear safety head 32. The safety head is joined to the stud body by a relatively slender connecting stem 34. The rear safety head 32 has a central cylindrical portion 36 of the same diameter as the threaded stud body 30 and a number of uniformly spaced, radially projecting, longitudinally extending ribs 38. These ribs are equal in number to and slidably engaged in the grooves 26 in the cartridge case liner 22. The stud body 30 and cylindrical safety head portion 36 are sized to fit closely but slidably within the liner bore 24. The stud has the same overall length as and is positioned with its ends flush with the ends of the liner 22.

According to another of its aspects, the invention provides a propellant gas powered fastener driving tool, represented in the drawings by the tool 40, for firing the ammunition rounds 10. Since the fastener 12 which is embodied in the illustrated ammunition is a stud, the tool 40 is referred to in the following description as a stud driver. As noted earlier, among the unique and highly beneficial features of the stud driver is its repeating action, whereby the driver may be initially loaded with a number of ammunition rounds and then operated to rapidly fire the rounds in succession before the tool must be again manually reloaded. Other unique and highly beneficial features of the stud driver are its safety features, whereby a live ammunition round is located in firing position when, and only when, the tool is properly engaged with a workpiece, and each fired stud is captivated by the tool until deliberately released. Accidental discharge of the present stud driver is thus virtually if not actually impossible, and penetration of a fired stud completely through and beyond the workpiece is prevented.

In general terms, the present stud driver comprises a barrel 42 containing a bore 44 and mounting forward work engaging means 46, and a breech mechanism 48 at the breech end of the barrel for transporting the present ammunition rounds 10 in succession to and firing each round in firing position at the breech end of the bore. The

6

contained stud 12 of each fired round is propelled, by propellant gas pressure, into the workpiece with which the tool is currently engaged. According to the repeating feature, just referred to, the breech mechanism 48 includes an ammunition carrier 50 for receiving the ammunition rounds 10 to be fired, and means 52 for driving the carrier in such a way as to successively transport the rounds to firing position in semiautomatic fashion. Conceivably, the breech mechanism may be arranged to permit manual loading of each ammunition round into the ammunition carrier 50. Even in this case, the present stud driver would be significantly easier and faster to operate than a conventional stud driver. According to the preferred practice of the invention, however, the present stud driver is equipped with ammunition storage and infeed means 54 for containing a number of ammunition rounds 10 to be fired and automatically feeding the contained rounds in succession to the ammunition carrier 50. The ammunition storage and infeed means of the illustrated stud driver, for example, comprise two ammunition magazines 56a, 56b each capable of holding several ammunition rounds.

According to the first of the aforementioned safety features of the present stud driver, whereby an ammunition round 10 is located in firing position when, and only when, the tool is properly engaged with a workpiece W, the carrier drive means 52 comprises a coupling 58 between the work engaging means 46 and the ammunition carrier 50. This coupling is arranged in such a way that the carrier is driven through the coupling to transport an ammunition round 10 from the ammunition storage means 54 to firing position in response to pressure of the work engaging means against the workpiece with the axis of the barrel 42 at the proper angle, in this instance normal, relative to the work surface. In the event that the tool is removed from the workpiece without firing, the carrier is again automatically driven through the coupling 58 to eject the unfired round. Subsequent re-engagement of the work engaging means with a workpiece transports the next ammunition round from the storage means to firing position. Accordingly, a live ammunition round is never located in firing position in the stud driver except when the latter is properly engaged with a workpiece. According to the earlier mentioned captive stud feature of the present stud driver, the muzzle end of the barrel 42 is provided with a safety ring or collar 60 which cooperates with the safety head 32 of each fired stud 12 to prevent penetration of the stud completely through a workpiece. As will appear from the ensuing description, the safety head of each stud and the safety collar of the stud driver are uniquely constructed and arranged to accomplish this safety function while permitting rapid and easy separation of the driver from each driven stud.

Referring now in greater detail to the stud driver 40 of the invention which has been selected for illustration in the attached drawings, the breech mechanism 48 of the tool is an open chamber breech mechanism of the general type disclosed in the earlier mentioned prior art patents. In this regard, it is significant to recall that a stud driver according to the invention may employ a conventional closed chamber breech action, but that an open chamber breech action is the preferred breech action, for reasons which will become readily evident as the description proceeds. The illustrated open chamber breech mechanism 48 has an elongated breech frame 62 containing a carrier or cylinder receiving chamber 64. Formed integrally with and extending laterally from one side of this frame is a hand grip 66 with a forward trigger guard 68 containing a trigger opening 70. The illustrated ammunition carrier 50 is a cylinder which is rotatably mounted within the chamber 64 for turning on a longitudinal axis 72 of the breech frame 62. The chamber 64 is cylindrical in cross-section and is sized to receive the breech cylinder 50 with a relatively close sliding fit.

Thus, the confronting cylinder and chamber surfaces are disposed in close proximity or mutual sliding contact.

Barrel 42 is threaded at its rear end and extends forwardly from the front end of the breech frame 62 in laterally spaced parallel relation to the cylinder axis 72. It is significant to note here that the breech frame 62 has a radially projecting, longitudinally extending enlargement or rib 74 which is centered relative to a plane P_1 containing the cylinder axis and the axis of the barrel 42. This enlargement forms the firing strap of the breech frame. For reasons which will appear presently, the plane P_1 is disposed at an acute angle relative to the longitudinal plane P_2 of symmetry of the breech frame and hand grip 66 containing the cylinder axis.

Breech carrier or cylinder 50 has at least one, and in this instance three, longitudinal firing chambers 78. Each firing chamber opens laterally through the circumference and longitudinally through the ends of the cylinder. The illustrated firing chambers are uniformly spaced about the cylinder and have the same triangular round shape in transverse cross-section as the ammunition rounds 10. In accordance with conventional open chamber breech practice, the ammunition rounds 10 and firing chambers 78 are so sized that the rounds complement the chambers. Accordingly, when an ammunition round is positioned in a firing chamber, the curved side of the round which is exposed at the open side of the chamber is flush with cylinder circumference. As will appear from the ensuing description, the breech cylinder 50 of the present stud driver, like the cylinder of a conventional open chamber breech mechanism, may be driven in oscillation or unidirectional rotation. In the particular stud driver illustrated, the cylinder is rotatable in the counterclockwise direction in FIG. 3 to sequentially locate each firing chamber 78 in ammunition infeed, firing, and ejection positions. Each firing chamber, when in infeed position, has its open side in registry with an ammunition infeed opening in the breech frame 62. Since the illustrated stud driver has a pair of ammunition magazines 56a, 56b, the breech frame 62 has two ammunition infeed openings 80a, 80b, and each firing chamber has two infeed positions. In the drawings, these infeed positions are identified as A and B respectively. As shown best in FIG. 3, the infeed opening 80a is located in the plane P_1 and opens laterally and downwardly through one side of the breech frame 62. The infeed opening 80b opens laterally and downwardly at the same angle through the opposite side of the frame. Each firing chamber 78, when in firing position, is coaxially aligned with and opens forwardly to the bore 44 in the stud driver barrel 42. The open side of the firing chamber is then closed by the breech frame firing strap 74. This firing position is identified in the drawings by the reference character F. When in ejection position, the open side of each firing chamber registers with an ejection opening 82 in the top of the breech frame 62. This ejection position is represented by the reference character E. Mounted within and on the end walls of the ejector opening 82 are ejector pins 84 which project into concentric grooves 85 into the ends of breech cylinder 50 for camming cartridges from the cylinder firing chambers through the ejector opening after firing, as will be explained presently.

The ammunition storage magazine 56a, 56b are essentially identical and each comprises a magazine or clip 86 containing an ammunition chamber 88 which opens through one end of the slip. The chamber is sized to receive a number of ammunition rounds 10 in the manner shown in FIG. 3. It will be observed in this Fig. that the contained rounds are disposed in side by side relation within the magazine with the axes of the rounds extending normal to the longitudinal axis of the magazine. Contained within the magazine chamber is a spring loaded follower 90 for urging the contained rounds toward the open end of the magazine.

The ammunition infeed openings 80a, 80b in the breech frame 62 are surrounded by rectangular, laterally projecting shoulders on the frame which define sockets for receiving the open ends of the ammunition magazines 56a, 56b. The magazines are releasably secured to the breech frame in any convenient way, as by spring loaded detents 92.

As noted earlier, and hereinafter described in detail, the ammunition carrier or cylinder 50 is driven in rotation to feed an ammunition round 10 from one of the magazines 56a, 56b to firing position in response to engagement of the work engaging means 46 with a work-piece W. The breech mechanism 48 is equipped with firing means 94 for firing each round which is thus transported to firing position. The illustrated firing means is a conventional trigger actuated firing pin mechanism. This mechanism includes a spring loaded firing pin 96, a trigger 98, and a snap action linkage 100 connecting the trigger and firing pin. Firing pin 96 is mounted in the rear end of the breech frame 62 so as to register with the rear primer 18 of each ammunition round 10 when the latter occupies firing position F. The trigger 98 is slidably mounted within the trigger opening 70 and is urged forwardly to its normal position by a spring 101. The trigger may be retracted rearwardly against spring pressure by finger pressure on the trigger. The trigger linkage 100 is a conventional snap action linkage train which operatively connects the trigger 98 to the firing pin 96 in such a way that depression of the trigger initially retracts the firing pin against spring pressure and then abruptly releases the pin for spring propulsion of the pin into percussive contact with the primer 18 of the ammunition round 10 currently in firing position, thus to fire the round.

The work engaging means 46 of the illustrated stud driver 40 includes a safety shield 102 and shield interlock means 104. Safety shield 102 has a hollow, generally cylindrical cup 106 with a cylindrical side wall 108 and a rear end wall 110. The front side of the cup is open. Secured to and projecting axially from the rear side of the rear cup wall 110 is a bearing sleeve 112 which slidably receives the stud driver barrel 42. Also secured to the rear cup wall 110 and the bearing sleeve 112, and extending rearwardly from the rear wall in laterally spaced relation to the barrel sleeve is a second bearing sleeve 114. This latter sleeve slidably receives a spindle 116 having a rear shaft 118. Shaft 118 extends rotatably through the front end of the breech frame 62 on the axis 72 of the breech cylinder 50 and is secured at its rear end to the cylinder. Disposed within the forward end of the spindle sleeve 114 is a compression spring 120. This spring acts between the rear safety shield wall 110 and the front end of the spindle 116 to yieldably urge the safety shield 102 forwardly along the barrel 42 to its fully extended position of FIG. 4. Forward spring extension or travel of the shield is limited by engagement of the front end of the barrel sleeve 112 with the rear end of the safety collar 60 on the barrel. The safety shield 102 is retractable rearwardly along the barrel 42 to its fully retracted position of FIG. 8 against the action of the shield spring 120. In its fully retracted position, the annular front end face of the safety collar 60 and the annular front edge of the safety shield are located substantially in a common plane normal to the axis of the barrel.

The safety shield spindle sleeve 114 and the breech cylinder spindle 116 form a part of the cylinder drive coupling 58. This drive coupling further comprises motion translating means for converting axial motion of the safety shield 102 into intermittent, unidirectional rotation of the breech cylinder 50. To this end, the illustrated motion translating means comprises a spring loaded cam follower pin 124 carried by the spindle sleeve 114. Follower pin 124 is disposed with its axis normal to the axis of the spindle 116 and slidably engages in a double helix

groove 126 formed in the outer surface of the spindle. The follower pin 124 and helix screw 126 are constructed and arranged in the well-known manner so that retraction of the safety shield 102 from its fully extended position to its fully retracted position drives the breech cylinder 50 in the counterclockwise direction in FIG. 3 through an angle equal to one-half the angular spacing between the adjacent cylinder firing chambers 78, in this instance through an angle of 60°. Spring return of the shield to its fully extended position drives the cylinder in the same direction through the same angle. It will be understood by those versed in the art that the helix mechanism described is a conventional mechanism for converting reciprocating motion to unidirectional rotation, wherein the floor of the helix groove is stepped to prevent reverse rotation of the cylinder.

According to the present invention, the breech frame firing strap 74, the cylinder firing chambers 78, and the breech frame infeed and ejection openings 80a, 80b, 82 are so located that when the safety shield 102 is in its fully extended position of FIG. 4 one firing chamber is located in infeed position A, wherein the chamber registers with the ammunition infeed opening 80a, the following firing chamber (in the direction of cylinder rotation) is located in infeed position B, wherein the chamber registers with the ammunition infeed opening 80b, and the third firing chamber is located in ejection position E, wherein the chamber registers with the ejection opening 82.

Movement of the shield to its fully retracted position of FIG. 8 drives the cylinder 50 to rotate the firing chamber currently in infeed position A to a position midway between infeed positions A and B, the firing chamber currently in infeed position B to firing position F, and the firing chamber currently in ejection position E to a position midway between the ejection position and infeed position A. Subsequent spring return of the shield to its fully extended position drives the cylinder in the same direction to rotate the firing chamber currently in firing position F to ejection position E, the following firing chamber to infeed position A, and the remaining firing chamber to infeed position B. It is evident at this point, therefore, that each full retraction stroke of the safety shield 102 rotates a cylinder firing chamber 78 from infeed position B to firing position F, and each full extension stroke of the shield rotates the latter firing chamber from firing position to ejection position E, and the following firing chamber to infeed position B.

According to the present invention, the safety shield 102 is retracted by engaging the shield with a workpiece W and the pressing forwardly on the tool. The shield is returned to extended position by its spring 120 when the tool is removed from the workpiece. Thus, the present stud driver 40 is effectively armed or conditioned for firing when, and only when, the shield is retracted by pressing the tool against the workpiece. That is to say, an ammunition round 10 is transported to and located in firing position F only when the tool is pressed against a workpiece with sufficient force to fully retract the shield. If the tool is removed from the workpiece without firing, the unfired round is rotated from firing position F to ejection position E and is then ejected through the breech frame ejection opening 82. In this regard, attention is directed to FIGS. 3 and 3A, wherein it will be observed that the ejector pins 84 are arranged to engage a scoping side of and cam through the ejection opening each unfired round (as well as the cartridge case 16 of each fired round) rotated to ejected position.

The safety shield interlock means 104 prevent retraction of the safety shield 102 to arm the stud driver 40, and thereby prevent firing the driver, unless the tool is pressed against a workpiece with the axis of the barrel 42 normal to the work surface. This eliminates the possibility of firing of the tool with the barrel canted relative to the work surface which might permit ricocheting of the

fired stud 12. The illustrated interlock means 104 comprise a number, in this instance three, of work engaging or position sensing pins 128 which extend parallel to the axis of the barrel 42 and are uniformly spaced about the interior of the safety shield cup 106. Each pin is slidably mounted in brackets 130 secured to the outer surface of the cup side wall 108 and is urged forwardly to an extended position (FIG. 4) by a spring 132. In this fully extended position, the forward end or tip of the pin projects forwardly a distance beyond the front edge of the cup, as shown. Associated with each work engaging or position sensing pin 128 is the latch pin 134. Each latch pin extends from the rear end of its corresponding work engaging pin radially in toward the barrel 42 and is slidably supported in brackets 136 secured to the rear side of the rear cup wall 110. The latch pins are urged inwardly toward the barrel by springs 138. The inner ends of the latch pins extend slidably through bores in the front end of the barrel sleeve 112. Formed in the outer surface of the barrel 42, so as to receive the inner ends of the latch pins 134 when the safety shield 102 is fully extended, is a locking groove 142. Engagement of the latch pins in this groove obviously lock the safety shield against rearward retraction relative to the barrel. The outer end of each latch pin 134 is bent at right angles to form an arm 144 which engages the rear end of the corresponding work engaging pin 128. The rear end of each work engaging pin is beveled to form a cam 146 for camming the respective latch pin 134 radially out of engagement with the barrel latching groove 142 when the work pin is retracted rearwardly to its position of FIG. 8. In this retracted position, the front end of each work engaging pin is flush with the front edge of the safety shield cup 106.

It is now evident, therefore, that the safety shield 102 is released for retraction relative to the stud driver barrel 42 when, and only when, all of the latch pins 134 are simultaneously retracted. Simultaneous retraction of the latch pins, in turn, requires engagement of the tool against a workpiece W with the axis of the barrel 42 normal to the work surface, such that all of the work engaging pins 128 will be simultaneously fully retracted upon forward pressure of the tool toward the workpiece. When, and only when, this condition exists, the stud driver can be pressed forwardly against the workpiece to retract the safety shield 102 and thereby drive the breech cylinder 50 to transport a live ammunition round 10 to firing position F. Thereafter, and again only when the shield is fully retracted, the trigger 98 can be depressed to fire the round currently in firing position and thereby effect forward propulsion or driving of its contained stud 12 into the workpiece.

It will be recalled that the stud 12 of each present ammunition round 10 has a rear safety head 32 including a cylindrical portion 36 with radially projecting safety ribs 38. These safety ribs slidably engage within the longitudinal grooves 26 in the cartridge case liner 22. The wall of the bore 44 in the stud driver barrel 42 is formed with similar longitudinal grooves 148 which register with the liner grooves 126 of each ammunition round 10 when the latter is located in firing position. These barrel grooves are sized to slidably receive the safety head ribs 38 of each fired stud 12. In this regard, it is significant to note that because of the triangular round shape of the illustrated ammunition, each ammunition round 10 may occupy any one of three different angular positions in the breech cylinder firing chambers 78. That is to say, each round may be positioned in a firing chamber with any one of the three curved sides of the round exposed at the open side of the chamber. The liner grooves 26 and barrel grooves 148 are automatically aligned in each position of the round. Accordingly, when an ammunition round is fired in the present stud driver, its contained stud 12 will be propelled forwardly through the bore 44 in such a way

11

that the safety head ribs 38 of the stud engage in and slide along the barrel grooves 148.

Under normal conditions, each fired stud 12 will penetrate the workpiece W until the forward end of the threaded stud body 30 engages the work surface. In this regard, it should be noted a significant feature of the present stud driver ammunition resides in the fact that each ammunition round 10 will contain the proper propellant charge 14 for its particular stud size and type and the particular work material in which the stud is driven for driving the stud to the correct depth.

Accordingly, the possibility, which exists in a conventional stud driver, of mating an improper propellant charge with a stud to be driven is greatly minimized if not virtually eliminated in the present stud driver. As noted earlier, however, and as is well-known to those skilled in the art, there always exists the possibility of firing a stud into a workpiece or workpiece area which is softer than anticipated and which would permit travel of the fired stud completely through the work unless the stud were restrained or captivated by the tool. The safety collar 60 of the present stud driver and the safety head 32 on the stud 12 of each present ammunition round 10 cooperate to provide this stud-captivating action.

In connection with this stud-captivating action, attention is directed to FIG. 4 wherein it will be observed that the safety collar 60 has a front wall 150 which is spaced from the front end of the barrel 42 to define therebetween an internal annular groove or recess 154. This recess has an outside diameter slightly greater than the diameter of a circle centered on the axis of each stud 12 and circumscribing the safety head ribs 38 of the stud. Opening through the front safety collar wall 150, on the axis of the barrel bore 44, is a circular opening 156 of about the same diameter as the bore. Wall 150 also has three uniformly spaced notches 158 of about the same cross-section as the barrel grooves 148. These notches open radially into the front collar wall opening 156 and are angularly displaced from the barrel grooves 148. It is now evident, therefore, that in the event of excessive penetration of a fired stud 12 into a workpiece W, the stud will be finally arrested by engagement of its safety head ribs 38 with the front wall 150 of the safety collar 60. The stud is thus captivated by the stud driver until deliberately released. Such release is accomplished by rotating the tool relative to the driven stud to a position wherein the safety collar notches 158 are lined with the safety head ribs on the driven stud and then retracting the tool rearwardly from the stud.

The operation of the illustrated stud driver 40 is now believed to be obvious. Briefly reviewing this operation, the stud driver is conditioned for firing by removing the ammunition magazines 56a, 56b from the breech frame 52 and loading each magazine with the proper number of ammunition rounds 10. The magazines are then reinstalled on the tool, whereupon the tool is readied for use.

During such use, the stud driver is pressed forwardly against a workpiece W with the axis of the barrel 42 normal to the work surface. This action initially retracts the work-engaging pins 128 relative to the safety shield 102 and thereby retracts the latch pins 134 out of interlocking engagement with the barrel 42 to release the safety shield 102 for retraction relative to the barrel. Continued forward pressure of the tool against the workpiece now results in forward extension of the barrel relative to the shield, and hence relative retraction of the shield relative to the barrel, until the front end of the safety collar 60 bottoms against the work surface. This relative retraction of the safety shield 102 along the barrel 42 drives the breech cylinder 50 to transport an ammunition round 10 from one of the ammunition magazines 56a or 56b to firing position. At this point, the trigger 98 of the tool is depressed

12

to fire the round currently in firing position and thereby effect the forward propulsion of its contained stud 12 into the workpiece. In the event that the tool is pressed against the workpiece with the axis of the barrel 42 at an angle other than perpendicular relative to the work surface, at least one of the three work-engaging pins 128 will not be fully retracted to release the safety shield 102 for retraction relative to the barrel. Accordingly, an ammunition round 10 will not be transported to firing position. Moreover, even though the tool is pressed forwardly against the workpiece with the axis of the barrel 42 normal to the work surface, the tool cannot be fired until the ammunition round is transported all the way to its firing position, wherein the primer 18 of the round is aligned with the firing pin 96, by bottoming of the safety collar 60 against the work surface. Accordingly, there is no possibility of firing a round in the present stud driver unless the round is properly positioned in firing relation relative to the bore 44.

When the stud driver is removed from the workpiece W, the safety shield spring 120 returns the safety shield 102 to its fully extended position and thereby drives the breech cylinder 50 to rotate the cylinder-firing chamber 78 currently in firing position from this position to ejection position. The spent cartridge case 16 of the just-fired round is then ejected through the breech frame ejection opening 82. In the event that the tool is removed from the workpiece without firing, the unfired round is ejected from the tool.

The above action or rotation of the breech cylinder 50 occurs in response to each engagement of the stud driver with and subsequent removal of the driver from a workpiece. Thus, each engagement of the tool with a workpiece transports a live ammunition round 10 from one of the ammunition magazines 56a, 56b to firing position. Subsequent removal of the tool from the workpiece results in ejection of the spent cartridge case of the fired round or the unfired live round, as the case may be. In connection with infeed movement of the ammunition rounds 10 from the ammunition magazines 56a, 56b into the cylinder-firing chambers 78, it is significant to note that successive firing of the stud driver will result first in emptying of the magazine 56a and subsequent emptying of magazine 56b. This is obvious from FIG. 3, wherein it will be observed that each cylinder-firing chamber 78 undergoes initial rotation past the magazine 56a and subsequent rotation past the magazine 56b. Accordingly, each firing chamber will receive an ammunition round from the magazine 56a so long as this magazine contains at least one round. The round which thus enters each firing chamber from the magazine 56a blocks the entrance, into that firing chamber, of an ammunition round from magazine 56b. As a consequence, ammunition rounds will not commence feeding from magazine 56b until magazine 56a is completely empty. It should be noted here that the illustrated magazine arrangement is purely illustrative and that a present stud driver may be equipped with only one or with more than two magazines. For example, a stud driver according to the invention may comprise a single ammunition magazine contained within the handgrip 66, thus to provide a relatively compact tool.

Returning now to the operation of the illustrated stud driver, it will be recalled that excessive penetration of a fired stud 12 into the workpiece W is prevented or limited by engagement of the stud safety ribs 38 with the front wall 150 of the safety collar 60. The tool is removed from such a fired stud by rotating the tool to a position wherein the front safety wall notches 158 are aligned with the stud ribs and then withdrawing the tool rearwardly from the stud. After each stud is driven into the workpiece, the safety head of the stud may be easily removed by merely snapping or breaking the slender connecting stem 34 between the head and the stud proper.

Reference is not made to FIGS. 11 through 14, which illustrate propellant gas powered percussion tools according to the invention. These tools may be used for various purposes, such as stunning animals preparatory to slaughtering (i.e., as slaughter guns), splicing cables by percussive welding, driving stakes, fasteners and the like, and other applications which require transmission of high energy blows or impacts to a workpiece or other object.

The percussion tool 200 illustrated in FIGS. 11 and 12 has a breech mechanism 202 which is identical to that embodied in the earlier stud driver. In this case, however, the safety shield of the stud driver is replaced by a cylinder 204 containing a rear threaded collar 206 which slides on the tool barrel 208. Stop means 210 are provided for limiting forward movement of the cylinder along the barrel to its forward extended position of FIG. 11. Extending rearwardly from the collar 206 is a bearing sleeve 212 which slidably receives the helix spindle 214 of the breech mechanism 202 and contains the spindle spring 216. The front end of the cylinder 204 has a reduced diameter extension 218.

Slidably within the cylinder 204 is a weighted plunger or hammer 220. This hammer has a rear piston 222 which slides within the cylinder and a front shank 224 which slides in the cylinder extension 218. The hammer is urged rearwardly in the cylinder by a spring 226.

In this percussion tool, the breech mechanism 202 is armed by engaging the front end of the cylinder 204 against a workpiece or other object and then pressing forwardly on the tool to effect relative rearward retraction of the cylinder with respect to the tool barrel 208. The breech cylinder 228 is thereby rotated through the spindle 214 to transport an ammunition round 230 to firing position (FIG. 11a) in the breech mechanism 202, all in the same manner as described earlier in connection with the stud driver. In this case, of course, each ammunition round will contain a propellant charge only but will be otherwise essentially the same as the ammunition rounds that are fired in the stud driver.

When an ammunition round 230 is fired in the percussion tool 200, the resulting propellant gas drives the hammer 220 forwardly in the cylinder 204 to deliver a high intensity blow or impact to the workpiece or other object with which the tool is currently engaged. When the tool is removed from the work or object, the cylinder 204 is returned forwardly by the spindle spring 216 and the hammer spring 226 to effect ejection of the spent cartridge case of the fired round (or the unfired round in the event the tool is removed without firing). The hammer 220 is returned rearwardly in the cylinder 204 by the hammer spring 226.

The modified percussion tool 300 illustrated in FIGS. 13 and 14 has an open chamber breech mechanism 302 like that described in the aforementioned Pat. No. 2,865,126 and a cylinder and hammer assembly 304 similar to that embodied in the percussion tool 200, just described. In this case, however, the hammer cylinder 306 is rigidly secured to the tool barrel 308.

The modified percussion tool 300 is used and operates in much the same way as the earlier percussion tool 200. In the modified tool, however, the breech cylinder 310 is rotated from one firing position to the next actuation of the trigger 312 rather than by pressing of the tool against the workpiece or other object which receives the blow or impact by the tool hammer 314.

At this point, attention is directed to the fact that while the invention has been disclosed in connection with cased open chamber ammunition, the ammunition features of the invention may be embodied in both caseless and semicombustible ammunition similar to that disclosed in the aforementioned copending applications.

While the invention has been disclosed in what is presently conceived to be its preferred and most practical embodiments, it should be understood that various

modifications of the invention are possible in the spirit and scope of the following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A propellant gas powered fastener driving tool for use with ammunition rounds each containing a fastener and a propellant charge comprising:

a barrel containing a bore;

a breech mechanism at the breech end of said bore including a carrier for receiving and transporting said rounds in succession to a firing position, wherein each round is disposed in coaxial alignment with the breech end of said bore to permit firing of the round, thereby to effect propulsion of its contained fastener forwardly through said bore into a workpiece by propellant gas pressure, and means for firing each round in firing position;

work engaging means at the muzzle end of said barrel engageable with said workpiece for positioning said tool relative to said workpiece; and

ammunition storage means on said breech mechanism for containing a number of said ammunition rounds and feeding said rounds in succession to said breech mechanism.

2. A propellant gas powered fastener driving tool for use with open chamber ammunition rounds each containing a fastener and a propellant charge comprising:

a barrel containing a bore;

an open chamber breech mechanism at the breech end of said bore including a breech frame secured to said breech and containing a carrier receiving chamber, a rotary carrier supported on said frame within said chamber for turning on an axis parallel to and spaced laterally from said bore, said carrier containing a firing chamber opening laterally through the circumference and longitudinally through the front end of said carrier, and said carrier being rotatable to locate said firing chamber in an ammunition infeed position, wherein the open side of said firing chamber registers with an ammunition infeed opening in said frame to permit lateral infeed movement of an ammunition round into said firing chamber through said opening, and a firing position, wherein the open side of said firing chamber is closed by said frame and said firing chamber is coaxially aligned with and opens forwardly to said bore to permit firing of an ammunition round in said firing chamber, thereby to effect propulsion of its contained fastener forwardly through said bore into a workpiece;

work engaging means at the muzzle end of said barrel engageable with said workpiece for positioning said tool relative to said workpiece; and

ammunition storage means on said breech mechanism for containing a number of said ammunition rounds and feeding said round laterally in succession through said infeed opening.

3. A propellant gas powered tool for use with ammunition rounds each containing a propellant charge, comprising:

a barrel containing a bore;

a breech mechanism at the breech end of said barrel including a breech frame, a carrier containing a firing chamber, means mounting said carrier on said frame for movement through an ammunition infeed position wherein said firing chamber is disposed to receive an ammunition round, a firing position wherein said firing chamber is coaxially aligned with and opens forwardly to the breech end of said bore to permit firing of an ammunition round contained in said firing chamber, and an ejection position wherein said firing chamber is disposed for ejection of the spent cartridge case of a fired ammunition round as well as an unfired round from said firing chamber and means for firing each round in firing position;

15

work engaging means at the muzzle end of said barrel;
and

carrier driving means operatively connecting said work engaging means and carrier for driving said carrier from said ring position to said ejection position in response to disengagement of said work engaging means from said workpiece and thereafter driving said carrier to said infeed position and then back to said firing position in response to subsequent re-engagement of said work engaging means with a workpiece.

4. A propellant gas powered fastener driving tool for use with ammunition rounds each containing a fastener and a propellant charge, comprising:

a barrel containing a bore;

a breech mechanism at the breech end of said barrel including a breech frame secured to said barrel and containing a carrier receiving chamber, a rotary carrier supported on said frame within said chamber for turning on an axis parallel to and laterally spaced from said bore, said carrier containing a firing chamber and being rotatable to locate said firing chamber in an ammunition infeed position, wherein said firing chamber is disposed to receive an ammunition round to be fired, a firing position, wherein said firing chamber is coaxially aligned with an opening forwardly to the breech end of said bore to permit firing of an ammunition round in said firing chamber, thereby to effect propulsion of its contained fastener forwardly through said bore into a workpiece, and an ejection position wherein said firing chamber is disposed for ejection of the spent cartridge case of a fired ammunition round as well as an unfired round from said firing chamber, and means for firing each round in firing position;

a work engaging shield mounted on the muzzle end of said barrel for movement along said barrel between a forward extended position and a rear retracted position in response to pressure of said tool against said workpiece;

a spring for urging said shield to said extended position; and

motion translating means operatively connected between said shield and carrier for driving said carrier in rotation to rotate said firing chamber from firing position to ejection position in response to movement of said shield from retracted position to extended position and thereafter to rotate the firing chamber from ejection position to infeed position and then back to firing positioning in response to subsequent extension and retraction strokes of said shield.

5. A propellant gas powered fastener driving tool for use with ammunition rounds each containing a fastener and a propellant charge, comprising:

a barrel containing a bore;

a breech mechanism at the breech end of said barrel including a breech frame secured to said barrel and containing a carrier receiving chamber, a rotary carrier supported on said frame within said chamber for turning on an axis parallel to and laterally spaced from said bore, said carrier containing a firing chamber and being rotatable to locate said firing chamber in an ammunition infeed position, wherein said firing chamber is disposed to receive an ammunition round to be fired, and a firing position, wherein said firing chamber is coaxially aligned with an opening forwardly to the breech end of said bore to permit firing of an ammunition round in said firing chamber, thereby to effect propulsion of its contained fastener forwardly through said bore into a workpiece, and means for firing each round in firing position;

a work engaging shield mounted on the muzzle end

16

of said barrel for movement along said barrel between a forward extended position and a rear retracted position in response to pressure of said tool against said workpiece;

a spring for urging said shield to said extended position;

motion translating means operatively connected between said shield and carrier for driving said carrier in rotation to rotate said firing chamber from said infeed position to said firing position in response to movement of said shield from said extended position to said retracted position and to rotate said firing chamber from said firing position toward said infeed position in response to movement of said shield from said retracted position to said extended position; and

ammunition storage means on said breech mechanism for containing a number of said ammunition rounds and feeding a round to said firing chamber in response to each rotation of said firing chamber to said infeed position.

6. A propellant gas powered fastener driving tool for use with open chamber ammunition rounds each containing a fastener and a propellant charge, comprising:

a barrel containing a bore;

an open chamber breech mechanism at the breech end of said barrel including a breech frame secured to the breech end of said barrel and containing a carrier receiving chamber, a rotary carrier supported on said frame within said chamber for turning on an axis parallel to and spaced laterally from said bore, said carrier containing a firing chamber opening laterally through the circumference and longitudinally through the front end of said carrier, said carrier being rotatable to locate said firing chamber in an ammunition infeed position, wherein the open side of said chamber registers with an ammunition infeed opening in said frame to permit lateral infeed movement of an ammunition round into said firing chamber, a firing position, wherein the open side of said firing chamber is closed by said frame and said firing chamber is coaxially aligned with an opens forwardly to the breech end of said bore to permit firing of an ammunition round in said firing of said bore to permit firing of an ammunition round in said firing chamber, thereby to effect forward propulsion of its contained fastener through said bore into a workpiece, and an ejection position wherein the open side of said firing chamber registers with an ejection opening in said breech frame to permit lateral ejection of the spent cartridge case of a fired ammunition round as well as an unfired round from said firing chamber, and means for firing each ammunition round in said firing chamber when in firing position;

a work engaging shield mounted on the muzzle end of said barrel for movement lengthwise of said barrel between a forward extended position and a rear retracted position in response to pressure of said tool against said workpiece;

a spring for urging said shield to said extended position; and

motion translating means operatively connected between said shield and carrier for driving said carrier to rotate said firing chamber from firing position to ejection position in response to movement of said shield from retracted position to extended position and thereafter to rotate said firing chamber from ejection position to infeed position and then back to firing position in response to subsequent extension and retraction strokes of said shield.

7. A propellant gas powered fastener driving tool for use with open chamber ammunition rounds each containing a fastener and a propellant charge, comprising:

a barrel containing a bore;

an open chamber breech mechanism at the breech end of said barrel including a breech frame secured to the breech end of said barrel and containing a carrier receiving chamber, a rotary carrier supported on said frame within said chamber for turning on an axis parallel to and spaced laterally from said bore, said carrier containing a firing chamber opening laterally through the circumference and longitudinally through the front end of said carrier, said carrier being rotatable to locate said firing chamber in an ammunition infeed position, wherein the open side of said chamber registers with an ammunition infeed opening in the said frame to permit lateral infeed movement of an ammunition round into said firing chamber, and a firing position, wherein the open side of said firing chamber is closed by said frame and said firing chamber is coaxially aligned with and opens forwardly to the breech end of said bore to permit firing of an ammunition round in said firing chamber, thereby to effect forward propulsion of its contained fastener through said bore into a workpiece, and means for firing each ammunition round in said firing chamber when in firing position;

a work engaging shield mounted on the muzzle end of said barrel for movement lengthwise of said barrel between a forward extended position and a rear retracted position in response to pressure of said tool against said workpiece;

a spring for urging said shield to said extended position;

motion translating means operatively connected between said shield and carrier for driving said carrier to rotate said firing chamber from infeed position to firing position in response to movement of said shield from extended position to retracted position and to rotate said shield from firing position toward infeed position in response to movement of said shield from retracted position to extended position; and

ammunition storage means on said breech mechanism for containing a number of said ammunition rounds and feeding said rounds laterally in succession to said carrier through said infeed opening.

8. In a propellant gas powered tool, the combination comprising:

a barrel containing a bore;

a breech mechanism at the breech end of said bore including ammunition storage means for containing a number of ammunition rounds, carrier means containing a firing chamber and movable to locate said firing chamber in an ammunition infeed position wherein said chamber is disposed to receive an ammunition round from said infeed means, a firing position wherein said chamber is disposed to locate an ammunition round contained in said chamber in said firing position, and an ejection position wherein said chamber is disposed for ejection of an unfired round as well as the spent cartridge case of a fired round from said chamber, and means for firing each ammunition round in firing position; and

breech operating means including work engaging means at the muzzle end of said barrel for driving said carrier means to move said firing chamber from said infeed position to firing position in response to each engagement of said work engaging means with said workpiece from firing position to ejection position in response to disengagement of said work engaging means from said workpiece, whereby engagement of said work engaging means with subsequent disengagement of said work engaging means from said workpiece without actuation of said firing means results in initial infeed movement of an ammunition round from said storage means to firing position and

subsequent ejection of the unfired round from said firing chamber.

9. A propellant gas powered fastener driving tool for use with an open chamber ammunition round including a cartridge case of generally triangular round cross-section having a central opening of non-circular cross-section containing a fastener with a rear safety head of the same non-circular cross-section as said opening and a propellant charge, comprising:

a barrel containing a bore of the same non-circular cross-section as said cartridge case opening;

an open chamber breech mechanism at the breech end of said bore including a rotary cylinder having a firing chamber opening forwardly through the front end and laterally through the circumference of said cylinder for receiving said ammunition round and transporting the round to firing position wherein said chamber and the contained round are aligned with said bore, said firing chamber having a triangular round shape in transverse cross-section which orients the contained round in a position wherein its cartridge opening registers in aligned relation with said bore to permit unrestricted passage of its fastener into said bore in firing position;

safety stop means at the front end of said barrel including a stop shoulder engageable with the safety head of said fastener to limit penetration of the fastener into a workpiece; and

said stop means having an opening of generally the same cross-section as but rotated relative to said bore through which the safety head of said fastener may pass to permit removal of said tool from the fastener, and a recess between said shoulder and the front end of said barrel to permit rotation of said tool relative to said fastener to align said safety head with the latter opening for passage of the heat through the latter opening.

10. A propellant gas powered fastener driving tool for use with open chamber ammunition rounds of generally triangular round shape in transverse cross-section, each containing a fastener having a rear safety head with radially projecting ribs and a propellant charge, comprising:

a barrel containing a bore;

an open chamber breech mechanism at the breech end of said bore, including a breech frame containing a carrier receiving chamber;

a carrier rotatably supported in said chamber for rotation on an axis parallel to and laterally spaced from the axis of said bore, said carrier having a firing chamber opening laterally through the circumference and forwardly through the front end of said carrier and being rotatable between an ammunition infeed position wherein the open side of said firing chamber registers with an ammunition infeed opening in said frame, a firing position wherein the open side of said firing chamber is closed by said frame and said firing chamber is coaxially aligned with and opens forwardly to the breech end of said bore, and an ejection position wherein the open side of said firing chamber registers with an ejection opening in said breech frame, and firing means for firing each ammunition round in firing position;

a hollow forwardly opening work engaging shield mounted on the muzzle end of said barrel for movement along said barrel between a forward extended position and a rear retracted position;

spring means for urging said shield to said extended position;

means operatively connecting said shield and carrier for driving said carrier to said infeed, firing, and ejection positions in succession in response to successive retraction and extension strokes of said shield relative to said barrel, in such manner that said carrier is driven from said infeed position to said firing position in response to movement of said shield from said

19

extended position to said retracted position, said carrier is driven from said firing position to said ejection position in response to following return of said shield to said extended position, and said carrier is driven from said ejection position back to said in-

5 extended position in response to subsequent retraction and extension strokes of said shield;
interlock means on said shield normally disposed in interlocking engagement with said barrel for locking said shield against retraction relative to said barrel;
10 position sensing means on said shield engageable with said workpiece and operatively connected to said interlock means for releasing said interlock means to release said shield for retraction relative to said barrel in response to initial pressured engagement of
15 said tool against the workpiece with the axis of said bore disposed at a predetermined angle relative to said workpiece, whereby pressured engagement of said tool against said workpiece initially releases said shield for retraction relative to said barrel and there-
20 after retracts said shield relative to said barrel to rotate said firing chamber to firing position, and subsequent disengagement of said tool from said workpiece releases said shield for spring extension thereof to rotate said firing chamber from said firing
25 position to said ejection position;

said firing chamber having a generally triangular round shape in transverse cross-section, complementing each
30 ammunition round, whereby an ammunition round in firing position is positively angularly oriented about the axis of said bore;

the wall of said bore having longitudinal grooves which are axially aligned with the ribs on the fastener of each ammunition round in firing position and which are sized to slidably receive said ribs, whereby when
35 an ammunition round is fired in said tool, the ribs of its contained fastener slide along said grooves during forward propulsion of the fastener through said bore; and

a safety collar on the muzzle end of said barrel including
40 a wall disposed in a plane transverse to said bore and having a central opening with radial notches opening through its edge which are sized to pass the safety head and ribs of a driven fastener, said notches being angularly displaced relative to said grooves, and an annular recess between said wall and the
45 muzzle end of said bore for permitting rotation of said tool relative to each driven fastener to a position wherein said notches are aligned with said ribs of the driven fastener, thereby to permit rearward re-
50 traction of said tool from the driven fastener.

11. A propellant gas powered percussion tool for use with open chamber ammunition rounds of generally tri-
angular round shape in transverse cross-section contain-
ing a propellant charge, comprising:

an open chamber breech mechanism including a breech
55 frame having a firing strap, a cylindrical carrier having firing chambers of generally triangular round shape in transverse cross-section spaced about and opening laterally through the circumference of said
60 carrier for receiving and transporting said rounds in succession to firing position wherein the open side of each firing chamber is closed by a surface of said firing strap, and means for firing each round in firing
65 position to generate a high pressure propellant gas within said chamber;

a cylinder mounted on said breech mechanism and con-
taining a chamber which communicates rearwardly to
70 said firing chamber when in firing position and opens forwardly through the front end of said cylinder;

a caged hammer slidable within said cylinder and adapted to be propelled forwardly by propellant gas
75 pressure into impact with a workpiece; and

20

a spring acting between said cylinder and hammer for urging said hammer rearwardly in said cylinder.

12. A percussion tool according to claim 11, including: work engaging means associated with said cylinder sup-
ported for forward extension and rearward retraction
relative to said breech mechanism;

spring means for urging said work engaging means to
extended position;

said work engaging means being retracted against spring
pressure in response to pressure engagement of said
tool against said workpiece; and

motion translating means on said work engaging means
and carrier which undergo relative movement along
a path of relative movement disposed in non-inter-
secting relation to the open sides of said firing cham-
bers and said firing strap surface to drive said carrier
to firing position in response to retraction of said
work engaging means and from firing position in
response to extension of said work engaging means.

13. A propellant gas powered tool comprising:

a barrel containing a bore;

an open chamber breech mechanism at the breech end
of said barrel including a breech frame having a
firing strap, a cylinder containing a firing chamber
of generally triangular round shape in transverse
cross-section opening laterally through the circum-
ference of said cylinder, means supporting said cylin-
der within said frame for rotation through a firing
position wherein said firing chamber registers with
said bore and the open side of said chamber is closed
by a surface of said firing strap;

retractable work engaging means at the front end of
said barrel adapted to be pressed against a work-
piece to retract said work engaging means rearwardly
toward said breech mechanism;

resilient means for urging said work engaging means
forwardly to extended position upon disengagement
of said work engaging means from said workpiece;

coacting motion translating means on said cylinder and
work engaging means for rotating said cylinder to
firing position upon rearward retraction of said work
engaging means and rotating said cylinder from said
firing position upon subsequent forward extension of
said work engaging means; and

said coacting motion translating means undergoing rela-
tive movement during extension and retraction of
said work engaging means and along a path of rela-
tive movement disposed in non-intersecting relation
with the open side of said firing chamber and said
firing strap surface.

14. A tool according to claim 13, wherein:

said motion translating means comprises a spindle
member coaxially secured to and extending for-
wardly from said cylinder, a member secured to
and extending rearwardly from said work engaging
means, a helix groove in one member, and a cam
follower on the other member engaging in said
groove, whereby relative axial movement of said
members occasioned by extension and retraction
movement of said work engaging means drives said
carrier in rotation.

15. A tool according to claim 14, wherein:

said cylinder contains a number of firing chambers
spaced about and opening laterally through the cir-
cumference of said cylinder; and

said motion translating means comprises means for
rotating said cylinder in one direction of rotation to
rotate said firing chambers to and from firing posi-
tion in succession upon successive rearward retraction
and forward extension strokes of said work
engaging means.

16. A propellant gas powered tool comprising:

a barrel containing a bore;

an open chamber breech mechanism at the breech end
of said barrel including a breech frame having a

21

firing strap, a cylinder containing a number of firing chambers of generally triangular round shape in transverse cross-section spaced about and opening laterally through the circumference of said cylinder, means rotatably supporting said cylinder within said frame for rotation of said firing chambers in succession through a firing position wherein each chamber registers with said bore and the open side of the respective chamber is closed by a surface of said firing strap;

retractable work engaging means at the forward end of said barrel adapted to be pressed against a workpiece to retract said work engaging means rearwardly toward said breech mechanism;

resilient means for urging said work engaging means forwardly to extended position upon disengagement of said work engaging means from said workpiece;

coacting motion translating means on said cylinder and work engaging means for rotating said cylinder in one direction to locate said firing chambers in firing position successively upon successive rearward retraction and forward extension strokes of said work engaging means; and

said coacting motion translating means undergoing relative movement during extension and retraction of said work engaging means and along a path of relative movement disposed in non-intersecting relation with the open sides of said firing chambers and said firing strap surface.

17. A propellant gas powered tool comprising:

a barrel containing a bore;

an open chamber breech mechanism at the breech end of said barrel including a breech frame having a firing strap, a cylinder containing a firing chamber of generally triangular round shape in transverse cross-section opening laterally through the circumference of said cylinder, means supporting said cylinder within said frame for rotation through an infeed position wherein the open side of said firing chamber is exposed through an infeed opening in said frame and a firing position wherein said firing chamber registers with said bore and the open side of said chamber is closed by a surface of said firing strap;

retractable work engaging means at the forward end of said barrel adapted to be pressed against a workpiece to retract said work engaging means rearwardly toward said breech mechanism;

resilient means for urging said work engaging means forwardly to extended position upon disengagement of said work engaging means from said workpiece;

coacting motion translating means on said cylinder and work engaging means for rotating said cylinder from infeed position to firing position upon rearward retraction of said work engaging means and rotating said cylinder from firing position toward infeed position upon subsequent forward extension of said work engaging means; and

said coacting motion translating means undergoing relative movement during extension and retraction of said work engaging means and along a path of relative movement disposed in non-intersecting relation with the open side of said firing chamber and said firing strap surface.

18. A tool according to claim 17, wherein:

said frame has an ejection opening; and

said cylinder is rotatable from firing position to infeed position through an ejection position wherein the open side of said firing chamber registers with said ejection opening.

22

19. A tool according to claim 16, wherein:

said frame has an ammunition infeed opening; and

each firing chamber is rotatable from firing position back to firing position through an intervening infeed position wherein the open side of the respective chamber registers with the infeed opening.

20. A tool according to claim 19, wherein:

said breech frame has an ejection opening; and

each firing chamber is rotatable from firing position to infeed position through an intervening ejection position wherein the opening side of the respective chamber registers with said ejection opening.

21. In combination:

an open chamber ammunition round including a cartridge case of generally triangular round shape in transverse cross-section having a central opening of non-circular cross-section, a fastener within said opening having a rear safety head of the same non-circular cross-section as said opening whereby said fastener may be driven forwardly through said opening but is restrained against rotation within said opening, and a propellant charge at the rear of said fastener; and

a propellant gas powered fastener driving tool including a barrel containing a bore of the same non-circular cross-section as said cartridge case opening, an open chamber breech mechanism at the breech end of said bore including a rotary cylinder having a firing chamber opening forwardly through the front end and laterally through the front end and laterally through the circumference of said cylinder for receiving said ammunition round and transporting the round to firing position wherein said chamber and round are aligned with said bore, said firing chamber having the same triangular round shape in transverse cross-section as said cartridge case and orienting said round in a position wherein said cartridge case opening registers in aligned relation with said bore in firing position to permit unrestricted passage of said fastener from said cartridge case into said bore, safety stop means at the front end of said barrel including a stop shoulder engageable with said fastener safety head to limit penetration of the fastener into a workpiece, said safety stop means having an opening of generally the same cross-section as, but rotated relative to, said bore through which said fastener safety head may pass to permit removal of the tool from said fastener, and a recess between said shoulder and the front end of said barrel to permit rotation of said tool relative to said fastener to align said safety head with the latter opening for removal of said tool from said fastener.

References Cited

UNITED STATES PATENTS

2,395,354	2/1946	Temple	227—9
2,575,079	11/1951	Temple	227—9
2,770,194	11/1956	Kopf et al.	227—10 XR
2,780,812	2/1957	Landa et al.	227—8
2,930,041	3/1960	Massacrier	227—11
3,048,850	8/1962	Schilling	227—11
3,181,760	5/1965	Catlin et al.	227—10

FOREIGN PATENTS

211,511	3/1967	Sweden.
---------	--------	---------

GRANVILLE Y. CUSTER, JR., Primary Examiner

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,514,026 Dated May 26, 1970

Inventor(s) DAVID DARDICK

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, lines 65 and 66	delete "Within the breech mechanism at the breech end of the barrel."
Column 6, line 34	correct "berrel" to read -- <u>barrel</u> --.
Column 13, line 1	correct "not" to read -- <u>now</u> --.
Column 14, line 26	correct "oepn" to read -- <u>open</u> --.
Column 15, line 5	correct "ring" to read -- <u>firing</u> --.
Column 16, lines 44 and 45	delete "of said bore to permit firing of an ammunition round in said firing".
Column 17, line 13	delete "the".
Column 18, line 23	correct "permt" to read -- <u>permit</u> --.
Column 19, line 3	correct "followng" to read -- <u>following</u> --.
Column 22, lines 30 and 31	delete "front end and laterally through the".

Signed and sealed this 1st day of April 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks