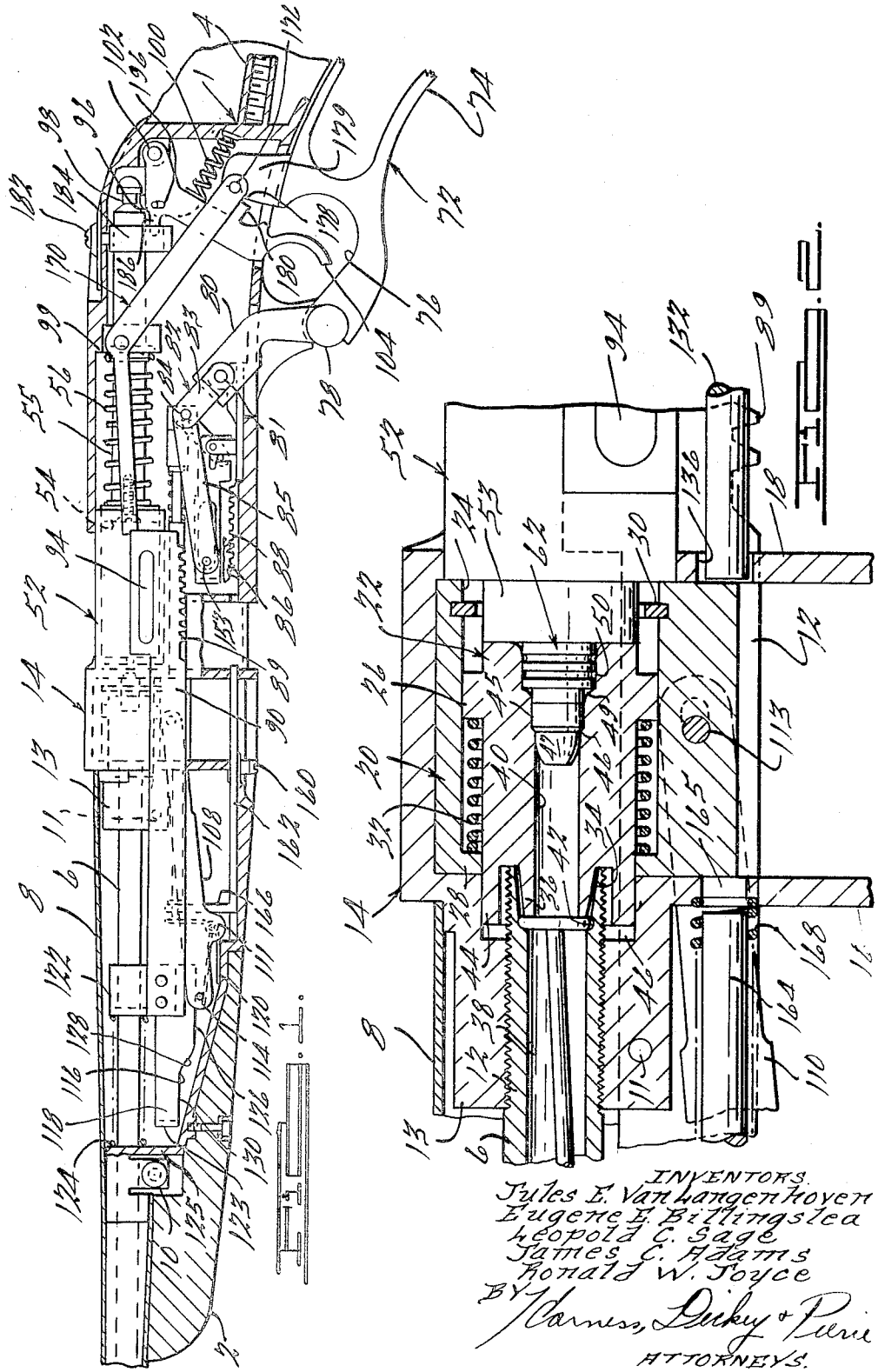
Feb. 7, 1967 J. E. VAN LANGENHOVEN ETAL 3,302,523

AIR OPERATED PROJECTILE FIRING APPARATUS

Filed July 7, 1965 4 Sheets-Sheet 1



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AIR OPERATED PROJECTILE FIRING APPARATUS

Filed July 7, 1965 4 Sheets-Sheet 2

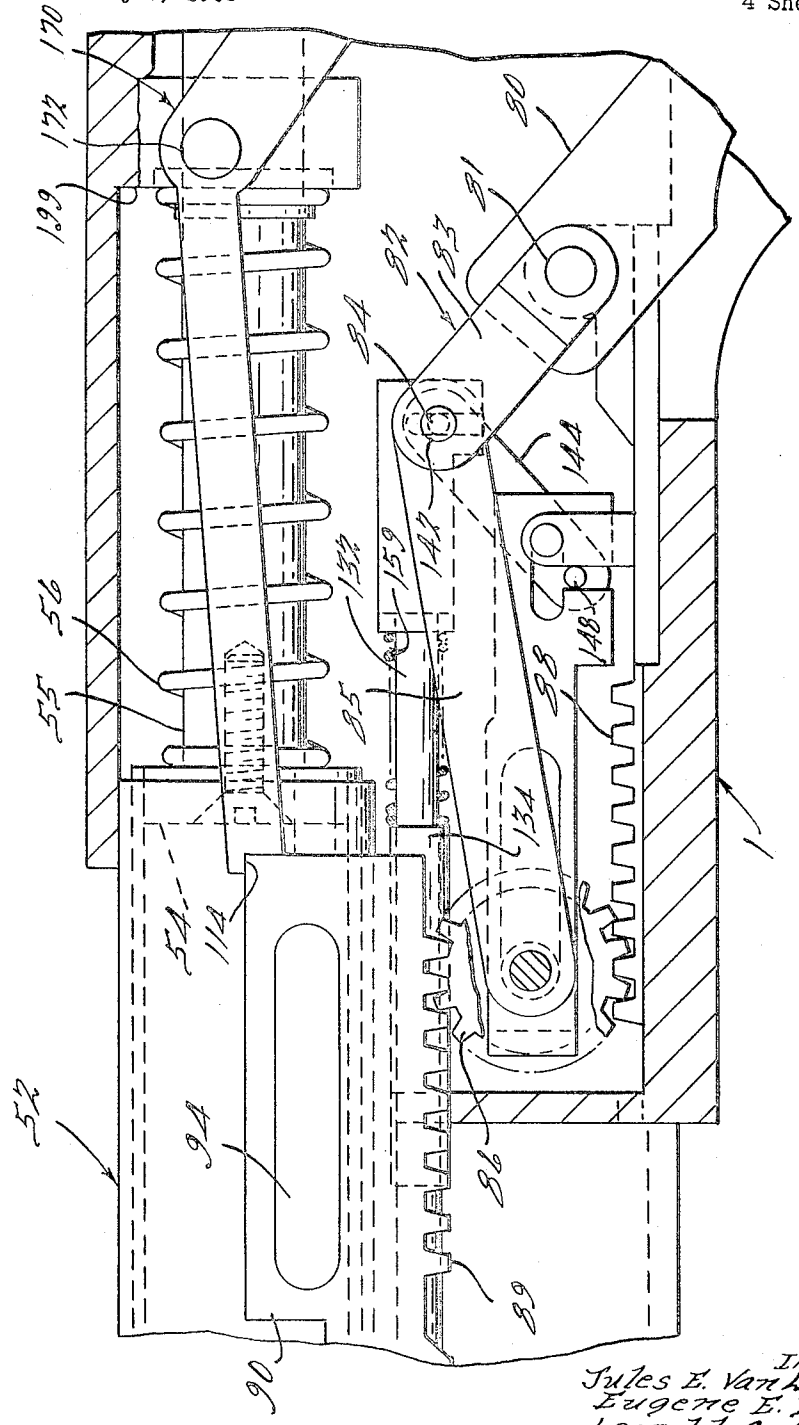


FIG. 2

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AIR OPERATED PROJECTILE FIRING APPARATUS

Filed July 7, 1965 4 Sheets-Sheet 3

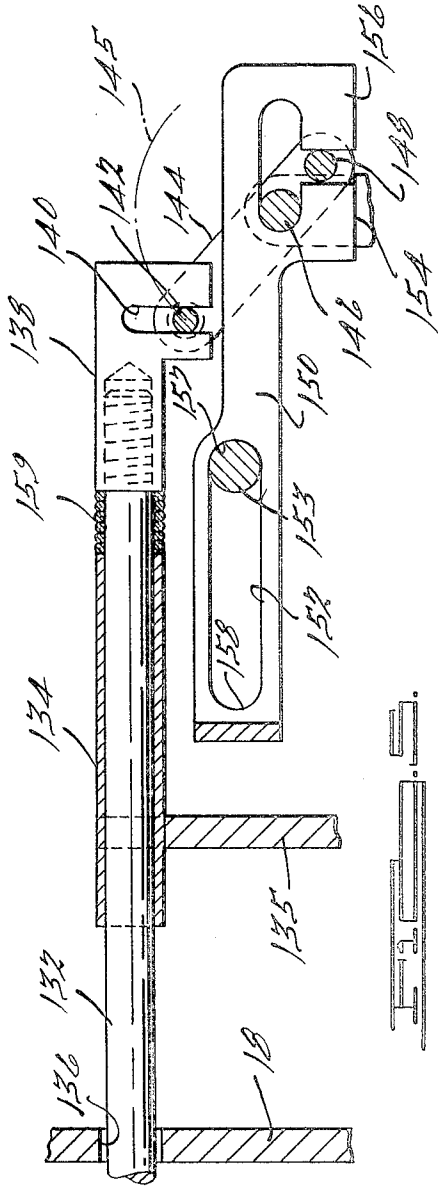


Fig. 5.

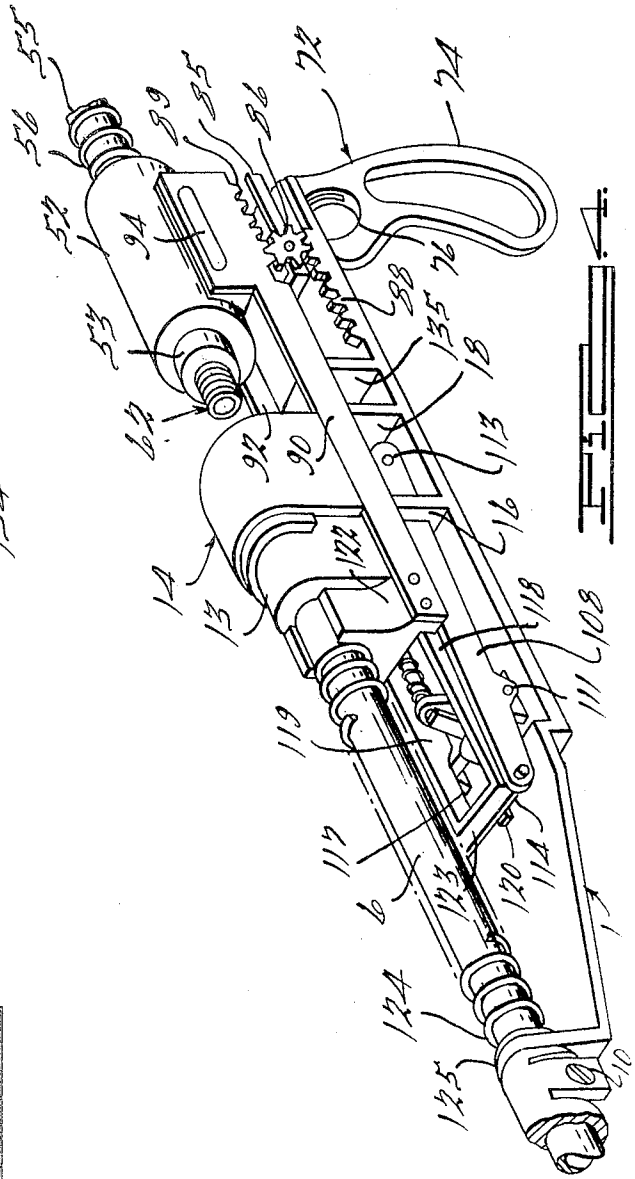


Fig. 4.

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AIR OPERATED PROJECTILE FIRING APPARATUS

Filed July 7, 1965 4 Sheets-Sheet 4

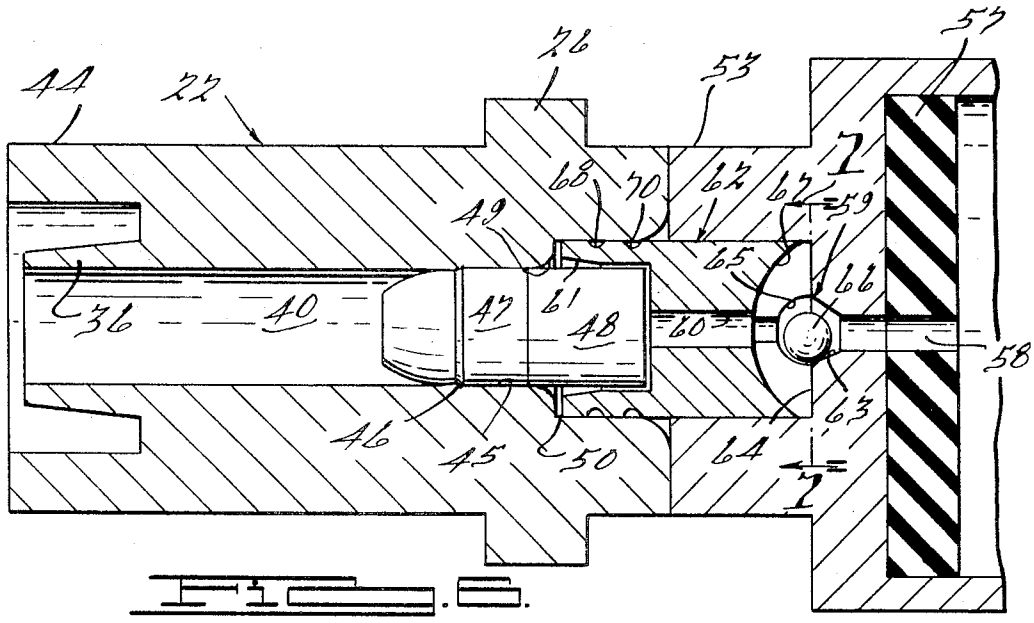


FIG. 6.

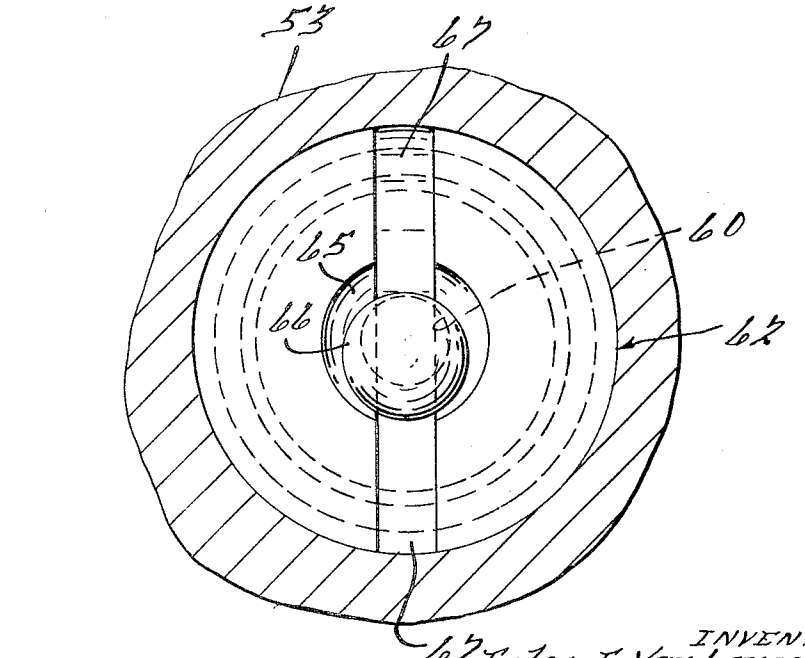


FIG. 7.

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AIR OPERATED PROJECTILE FIRING APPARATUS

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Filed July 7, 1965, Ser. No. 470,028

16 Claims. (Cl. 89—7)

This invention relates to air operated projectile firing apparatus and more particularly to a gun for firing caseless ammunition of the type comprising a projectile and an associated propellant ignitable by surface contact with high temperature air.

Air operated projectile firing apparatus and caseless ammunition of the type to which this invention relates is further described in copending application Serial No. 473,556 for Air Operated Projectile Firing Apparatus filed herewith.

The purpose and objects of this are to provide new and improved air operated projectile firing apparatus and the inventive principles have been illustratively embodied in a shoulder arm for firing a projectile having an associated propellant capable of being ignited by surface contact with high temperature air comprising: barrel means for guiding the projectile from the arm after ignition of the propellant; movable ammunition holding means for receiving the projectile and the propellant in a loading position and for carrying the projectile and the propellant from the loading position to the firing position, and for holding the projectile and the propellant in the firing position in alignment with the barrel means prior to ignition of the propellant; a source of high temperature air having a temperature at which the propellant is ignitable by surface contact therebetween, firing chamber means formed about the propellant in the firing position, air delivery means connecting the source to the firing chamber means to deliver high temperature air from said source to the firing chamber means at a temperature at which the propellant is ignitable by surface contact therebetween; obturation means effective in the firing position between the barrel means and the ammunition holding means and between the air delivery means and the ammunition holding means, and flow control means associated with the air delivery means to close the firing chamber means relative to the source after delivery of the high temperature air to prevent flow of fluid from the firing chamber means to the source after ignition of the propellant.

FIGURE 1 is a side elevational view of a presently preferred embodiment of certain of the inventive principles in a gun;

FIGURE 2 is an enlarged partial sectional view of a portion of the apparatus shown in FIG. 1;

FIGURE 3 is an enlarged partial sectional view of another portion of the apparatus shown in FIG. 1;

FIGURE 4 is a schematic perspective view of portions of the operating mechanism of the apparatus shown in FIG. 1;

FIGURE 5 is an enlarged sectional view of another portion of the apparatus shown in FIG. 1;

FIGURE 6 is an enlarged sectional view of a portion of the apparatus shown in FIG. 1 illustrating a round of ammunition in firing position;

FIGURE 7 is a sectional view of a portion of the apparatus shown in FIG. 6.

While certain features of the present invention are particularly well adapted for use in air guns, it will be readily appreciated by those skilled in the art to which this invention relates that the inventive principles are also applicable to other devices such as powder actuated tools. Also,

while certain forms of the ammunition are particularly advantageous in certain applications, the projectile design and the manner of attaching the propellant thereto may be varied as necessary and desirable depending upon such factors as the velocities required, breech pressures attained, the type of gun, and the projectile propellant characteristics.

Referring now to FIGS. 1–7, a presently preferred embodiment of the inventive features in a gun is shown. A receiver casting, or the like 1 (FIG. 1) mounts a forearm support 2 and the stock (not shown) is adapted to be mounted on a threaded rearwardly extending stock sleeve 4. A barrel 6 and a barrel shroud 8 are mounted on the receiver as by clamping screw means 10, 11. The rear end 12 of the barrel means (FIG. 2) is threadably received in a hub portion 13 of a housing 14 mounted on the receiver. Parallel vertically extending front and rear guideplates 16, 18 form part of the housing and define a guideway for ammunition transfer means in the form of vertically movable elevator member 20 operable by associated elevator means. Ammunition holding means in the form of a tubular firing chamber member 22 provides firing chamber forming means and is reciprocably mounted in the elevator member 20 for axial movement between a firing position and a loading position. As shown in FIG. 2, a central bore 24 in the elevator member slidably receives a centrally located guide flange portion 26 extending radially outwardly from the firing chamber member and confined between a flange abutment 28 at one end of the bore and a retaining ring 30 at the other end. Compression spring 32 biases the firing chamber member toward the loading position (not shown) whereat the firing chamber member is centrally located in the elevator member between the side surfaces of the guide plates 16, 18.

In the raised position of the elevator member, shown in FIG. 2, the firing chamber member provides breech means axially aligned with and forming a continuation of the rear end of the barrel means. A conically tapered chamber 34, at the rear of the barrel, is adapted to snugly receive a correspondingly tapered nose portion 36 on the front end of the firing chamber member to connect and align the barrel bore 38 with a corresponding bore 40 in the firing chamber member. An enlarged groove 42 is provided at the end of the tapered chamber 34 between the barrel bore 38 and the firing chamber bore 40, and serves to collect lead from the projectiles being fired. Obturation means for sealing the firing chamber member relative to the barrel means during firing of a projectile are provided by the conical chamber 34, conical nose portion 36, and lead collecting groove 42. A sleeve portion 44 surrounds the tapered nose 36 and defines a groove into which the end of the barrel is received in the firing position. A counterbore 46 in the hub portion 13 accommodates the firing chamber member in the firing position.

The rear portion of the bore 40 terminates in an enlarged portion 45 providing a shoulder 46 for receiving and holding the ammunition in the firing chamber member in the manner shown in FIG. 6. The metallic (lead) bullet portion 47 is seated and sealed on the shoulder 46 with a cylindrical central portion in bore 45. The propellant portion 48 extends from the enlarged bore portion 45 and terminates forwardly of a shoulder 49 formed by an enlarged obturation chamber 50 in the rear end of the firing chamber member.

Referring now to FIGS. 1 and 3, ignition means for igniting the propellant comprises an air compression cylinder 52 having a piston 54, attached to a rearwardly extending piston rod 55, reciprocably mounted therein to compress and heat air to a temperature sufficiently high to ignite the propellant by surface contact therewith. A

compression spring 56 is provided to drive the piston from a retracted cocked position (shown in FIG. 1) to an extended position bottomed on a cushion disk 57 (FIG. 6) in the front end of the cylinder. Referring now to FIGURE 6, the cylinder head is provided with a restricted passage 58 which is connected through valve means 59, in breech means defined by a forwardly projecting hub portion 53, and passage means 60 to firing chamber means 61 formed by a cylindrical cavity in obturation means 62 which may be fixedly secured in place by a press fit or the like. A valve cavity is formed between a conical valve seat 63 in the bottom of an obturation cavity 64 and a hollow 65 in the rear of the obturation means 62. A valve, in the form of a ball valve 66, is floatingly mounted in the valve chamber and is movable onto the valve seat 63, facing the firing chamber, to close the passage 58 when the pressure on the firing chamber side of the valve seat exceeds the pressure on the compression chamber side of the valve seat and forms a rigid reaction wall. The obturator may be slotted, 67 FIGURE 7, to provide for adequate communication between passages 58, 60. The valve operates as hereinbefore described.

The obturation means 62 is provided with a cylindrical projection adapted to be snugly received in the obturation chamber 50. Sealing grooves 68, 70 are provided around the periphery of the cylindrical projection to prevent escape of high pressure fluids from the firing chamber. The obturation means is preferably made of a material, such as beryllium copper, which will expand and contact rapidly under pressure to aid in forming the seal. The spring 32 (FIGURE 1) biases the firing chamber toward the obturation means during engagement of the obturation means as hereinafter described in detail.

Referring now to FIGURES 1 and 3, cocking means are provided to condition the gun for firing of the ammunition and include a cocking lever 72, having a handle portion 74 and a trigger portion 76, pivotally mounted on the receiver at 78. A connecting lever portion 80 extends into the receiver and is pivotally connected at 81 to a bifurcated connecting yoke 82. Each leg 83 of the yoke is pivotally connected at 84, on opposite sides of the lever portion 80, to a link 85 having a pinion 86 rotatably journaled thereon. Each pinion 86 is rotatably mounted between a lower rack element 88 fixed to the receiver and an upper rack portion 89 of spaced parallel actuating bar means 90, 92 which are fixedly secured to projections 94 on the compression cylinder 52 and form carriage means therefor. Consequently, as the cocking lever is pivoted downwardly, the lever portion 80, the yoke 82, the links 85, and the pinions 86 are moved rearwardly. Rotation of the pinions on the fixed racks 88 causes rearward movement of the upper rack portions 89 to move the compression cylinder 52 and the piston rod 55 rearwardly to the position shown in FIG. 4 whereat a sear 96 (FIG. 1) is retainingly received in a notch 98 in the rod. Compression spring 56 is compressed against the receiver abutment 99 through which the piston rod slidably extends. A sear spring 100 biases the sear to the latched position about the pivot 102. A trigger 104 pivotally mounted at 102, releasably engages the sear by means of a pin and slot connection 106 so that rearward movement of the trigger against the bias of the sear spring 100 pivots the sear 96 downwardly and releases the piston rod for forward movement during the urging of the compression spring 56.

Return upward pivotal movement of the cocking lever moves the lever portion 80, the yoke 82, the links 85, and the pinions 86 forwardly. Rotation of the pinions on the fixed racks 88 causes forward movement of the upper rack portions 89 to return the compression cylinder to the firing position shown in FIGS. 1, 2, and 3.

Ammunition loading means are provided to load the firing chamber member while the gun is being cocked and the compression cylinder is being moved from the firing position to the loading position and back to the firing position. In order to load a round of ammunition in the firing chamber, the firing chamber member is displaced to a loading position by actuation of transfer means 20 through elevator means mechanism actuated simultaneously with the compression cylinder by the cocking means. The elevator means comprises spaced parallel links 108, 110 (FIG. 4) pivotally mounted on the receiver at 111. Each link is pivotally connected to the transfer means 20 at one end by a suitable pin and slot connection 113 (FIG. 2) so that, as the links are pivotally moved upwardly and downwardly, the transfer means is reciprocated vertically along guide plates 16, 18 between a raised firing position (FIG. 2) and a lowered loading position (FIG. 4).

Pivotal movement of the elevator means links is attained by engagement of cam follower means attached to the links with cam means operated by the cocking lever. In the illustrative embodiment, the cam follower means is in the form of roller means 114 (FIG. 4) mounted between the ends of the links 108, 110 and biased into engagement with cam surfaces 116 (FIG. 1), 117 (FIG. 4) on cam plates 118, 119 by spring means 120. A slide 122 is slidably mounted along the bottom of the barrel and fixedly supports the forward extending cam plates 118, 119 which are also interconnected by a cross brace 123. Actuating bars 90, 92 extend forwardly through guide slots formed in the guide plates 16, 18 and are connected to the slide 122 so that the slide is reciprocably actuated along the barrel as the gun is cocked. An assist spring 124 is mounted on the barrel between a receiver abutment 125 and the front face of the slide. The cam surfaces (FIG. 1) are provided with a first horizontally extending straight portion 126, an intermediate curved portion 128, and a terminal horizontally extending straight portion 130. Thus, during the first portion of the cocking operation, the cam follower travels along the straight portion 126 of the cam surface with no pivotal movment being imparted to the elevator levers 108, 109 and no vertical movement being imparted to the elevator member 20. The length of the straight portion 126 is sufficient to enable the obturation means 62 on the compression cylinder to be withdrawn from the obturation chamber 50 in the firing chamber element 22 and to clear the elevator member 20. As the obturation means are withdrawn, the compression spring 32 in the elevator member also releases the obturation means between the firing chamber member 22 and the barrel and positions the firing chamber member within the confines of the elevator member. When the cam follower means 114 reaches the curved portion 128 of the cam surface, the cam follower spring is effective to cause pivotal movement of the elevator levers resulting in lowering movement of the elevator member in its guideway. The elevator member bottoms before the end of the cocking action and the straight cam portion 130 at the top of the curved portion permits continued movement of the cam plates 118, 119 without imparting additional movement to the elevator member.

The loading mechanism, shown in detail in FIG. 5, is operative only after the elevator means mechanism has lowered the elevator member. A reciprocably mounted loading rod 132 is slidably journaled in a tubular support 134 in the receiver for movement between an extended position and a retracted position. In the extended position, the loading rod extends through clip type magazine means (not shown), which may be provided with rotary or axial feed mechanism, mounted between the guide plate 18 and a guide plate 135 through a suitable opening in the bottom of the gun. The loading rod slidably removes a round of ammunition from the magazine and pushes the round into the firing chamber member through a loading port 136 in the guide plate 18. Actuating mechanism is connected to the loading rod by a clevis member 138 having a vertically extending slot 140 in each leg. A crosspin 142, supported on each side by actuating links 144, is mounted in the slots 140 and rotated along an arc 145 between axially spaced positions. The slots permit straight line reciprocating movement to be imparted to the

loading rod by pivotal movement of the links 144. Each link is pivoted on the receiver at an intermediate point 146. Cross-pin 148 extends between the lower ends of the links 144 for engagement with an actuator link 150. An elongated slot 152, at one end of the actuator link, is adapted to receive a cross-shaft 153 extending between the pinions. Downwardly depending lug portions 154, 156 are provided at the other end of the actuating link for driving engagement with the cross-pin means 148. The arrangement is such that the cross-shaft 153 does not engage the end 157 of the slots 152 until after the elevator has been lowered. When the cross-shaft 153 does engage the end 157 of the slots, the actuator link 150 is moved rearwardly causing lug 154 to move the cross-pin means 148 rearwardly and rotate the links 144 about their pivots 146 to drive the loading rod forwardly through the magazine clip and carry a round of ammunition to the firing chamber member in the elevator member during the terminal portion of the movement of the cocking lever from its retracted position (FIG. 1) to its extended position (FIG. 4). A return spring means 159 is provided to immediately withdraw the loading rod at the beginning of the return movement of the cocking lever from the extended position to the retracted position. During reverse movement at the end of the cocking operation, the cross-shaft means 153 engages the other end 158 of the slots and pulls the rear lug 156 and the cross-pin means 148 forwardly to complete rotation of the actuating links 144 in the opposite direction which returns the loading rod to the retracted position enabling another round of ammunition to be fed into alignment with the loading rod in the magazine.

In order to eject a round from the gun, if necessary, the magazine clip is removed and manually operable ejector mechanism is provided to clear the firing chamber member. Referring again to FIGS. 1 and 2, a knob 160 is connected to a slide 162 slidably mounted on the receiver and having an ejector rod 164 (FIG. 2) mounted on an upwardly extending flange 166 (FIG. 1). Rod 164 is aligned with an opening 165 in the front guide plate 116 aligned with the loading port 136 in the guide plate 18. A compression spring 168 may be mounted between flange 166 and plate 16 to bias the ejection rod to the retracted position. By pulling the knob 160 rearwardly, the ejection rod is moved rearwardly through the plate 16 and, when the elevator mechanism is down, into the bore 40 of the firing chamber member whereat a round in the firing chamber will be engaged and driven rearwardly through the loading port 136 for discharge through the magazine cavity.

Referring now to FIGS. 1 and 3, lock bar means 170 for locking the compression cylinder in the firing position are pivotally mounted on the receiver at 172. A notch 174, at the plates 90, 92 while a cross-pin 176 at the other end engages a cam surface 178 on a projection 179 of the cocking lever which is operative to cam the lock bar means into locking position in the closed position of the cocking lever. When the cocking lever is open, cross-pin 176 on the lock bar means engages the trigger abutment 180 and prevents release of the sear until the cocking lever has been closed.

A conventional safety including a manually operable slide 182 and a locking ring 184 may be provided to selectively prevent release of the sear by positioning the ring about a projection 186 on the sear.

In the broadest aspects of the present invention it is contemplated that other types of propellant may be used and that other propellant ignition means may also be provided. However, particularly advantageous results are obtained by the use of the particular propellant and the particular means of ignition the propellant disclosed.

Obviously, the details of construction and the arrangement of the parts may be varied without departing from the principles herein disclosed. Since the inventive principles disclosed herein have obvious application in alternative combinations, it is intended that the scope of this invention as defined by the appended claims include those alternative embodiments which utilize the inventive principles herein disclosed.

What is claimed is:

1. A repeating gun for firing rounds of ammunition, said ammunition comprising a projectile having an associated propellant capable of being ignited by surface contact with high temperature air, said gun comprising:
- receiver means for supporting the projectile mechanism of the gun;
- barrel means for guiding the projectile from the gun after ignition of the propellant;
- a separate axially slidable ammunition holding means for holding a round of ammunition in a firing position in alignment with said barrel means and for receiving a round of ammunition in a loading position and for holding the round of ammunition during transfer from the loading position to the firing position;
- a separate transfer means slidably supporting said ammunition holding means for axial movement between the firing position and a transfer position and being reciprocably transversely movable between a firing position and a loading position;
- a source of high temperature air having a temperature at which the propellant is ignitable by surface contact therewith;
- breech means for connecting said source to said ammunition holding means in the firing position;
- a firing chamber formed by firing chamber means in said breech means and adapted to surround said propellant in the firing position;
- air delivery means connecting said source to said firing chamber and comprising passage means extending from said source to said firing chamber;
- elevator means for moving said transfer means between the firing position and the loading position;
- ammunition loading means mounted adjacent said elevator means and being movable axially between an extended position and a retracted position and adapted to move a round of ammunition from storage into said ammunition holding means during movement from the retracted position to the extended position;
- and cocking means movable from a retracted position to an extended position and back to the retracted position during a cocking cycle and being connected to said elevator means and said ammunition loading means for moving said transfer means between the firing position and the loading position and for moving said ammunition loading means between the extended position and the retracted position during a cocking cycle.

2. The invention as defined in claim 1 and wherein said elevator means comprises a transversely extending guideway mounted on said receiver means and adapted to slidably receive said transfer means, pivotally mounted elevator link means pivotally connected to said receiver means, lost motion connecting means between said transfer means and said elevator link means at one end for for causing said transfer means to be reciprocally moved along said guideway as said elevator link means are pivotally actuated.

3. The invention as defined in claim 1 and wherein said ammunition loading means comprises reciprocable rod means movable axially between the extended position and the retracted position, and actuating mechanism comprising pivotally mounted loading link means driveably connected to said loading rod means by a lost motion connection causing pivotal movement of said loading link means to impart reciprocable movement to said loading rod means, pivotal support means pivotally supporting said loading link means relative to said receiver means, reciprocable drive link means connected to said loading link means and being reciprocably operable between a retracted position and extended position to im-

part pivotal movement to said loading link means, loading spring means biasing said drive link means to the retracted position, a lost motion driving connection between said actuating mechanism and said cocking means whereby during movement of said cocking lever from the retracted position to the extended position driving engagement between said cocking means and said reciprocable drive link means is effected only after said transfer means and said ammunition holding means are located in the loading position to extend the loading rod means and move a round of ammunition from storage into the ammunition holding means during the terminal portions of the movement of the cocking lever from the retracted position to the extended position, and whereby during movement of said cocking lever from the extended position to the retracted position said loading spring means is immediately effective to return said loading rod from the extended position to the retracted position during the initial portion of the movement of the cocking lever from the extended position to the retracted position enabling said ammunition holding means to be returned to the firing position.

4. The invention as defined in claim 2 and having elevator means actuating mechanism comprising reciprocably movable cam means; cam follower means mounted on said elevator link means for engagement with said cam means and being operative to cause pivotal movement of said elevator link means during portions of the movement of said cocking means, a portion of said cam means being arranged to prevent actuation of said elevator link means during an initial portion of the movement of the cocking lever from the retracted position to the extended position during the cocking cycle sufficient to enable said breech means to be disassociated from said ammunition holding means and for said ammunition holding means to be disassociated from said barrel means, and a portion of said cam means being arranged to be effective to actuate said elevator link means and move said transfer means and said ammunition holding means along said guideway from the firing position to the loading position during an intermediate portion of the cocking lever movement from the retracted position to the extended position during a cocking cycle, and a portion of said cam means being arranged to be effective to prevent actuation of said elevator relative means during the terminal portions of cocking lever movement from the retracted position to the extended position and the initial portion of the movement of the cocking lever from the extended position to the retracted position to maintain said transfer means and said ammunition holding means in the loading position until a round of ammunition is loaded.

5. A repeating gun for firing rounds of ammunition, said ammunition comprising a projectile having an associated propellant capable of being ignited by surface contact with high temperature air, said gun comprising:

receiver means for supporting the operational mechanism of the gun;

barrel means for guiding the projectile from the gun after ignition of the propellant;

ammunition holding means for holding a round of ammunition in a firing position in alignment with said barrel means and for receiving a round of ammunition in a loading position and for holding the round of ammunition during transfer from the loading position to the firing position; said ammunition holding means comprising a sleeve member having a central bore, barrel obturation means formed circumjacent the central bore in said sleeve member adjacent the barrel means, barrel connecting means formed by a terminal portion of said central bore next adjacent said barrel means and corresponding to said barrel means and forming a continuation thereof, a projectile supporting chamber formed by an intermediate portion of the central bore in said sleeve member being enlarged and being connected to said barrel connecting means bore portion by shoulder means forming an ammunition engaging abutment for holding the ammunition in place until the propellant is ignited, firing chamber obturation means formed by a further enlarged terminal portion of said central bore opposite said barrel connecting means bore portion;

transfer means supporting said ammunition holding means and being movable between a firing position and a loading position, said transfer means comprising a reciprocable housing having a central bore, said sleeve member being slidably mounted in the central bore of said housing for movement between a firing position with said barrel obturation means in engagement with said barrel means and a transfer position centrally located in said housing with said barrel obturation means spaced from said barrel means, spring means in said housing biasing said sleeve member toward the centrally located transfer position, and abutment means confining and centrally locating said sleeve member within said housing;

a source of high temperature air having a temperature at which the propellant is ignitable by surface contact therewith comprising movable air compression cylinder means movably supported for movement between an extended firing position in association with said ammunition holding means and a retracted loading position separated therefrom, separately and concurrently movable piston means mounted in said air compression cylinder means and being movable therewith from an extended position after a compression stroke to a retracted cocked position ready for a compression stroke and being movable relative thereto from the retracted position to the extended position during a compression stroke, piston drive spring means associated with said piston means to drive said piston means from the retracted cocked position to the extended position during a compression stroke;

sear means for releasably holding said piston means in a retracted cocked position;

trigger means for selectively actuating said sear means and releasing said piston means for a compression stroke;

breech means for connecting said air compression cylinder means to said ammunition holding means, said breech means comprising a plug formed on the end of said air compression cylinder means next adjacent said ammunition holding means, said plug having a protruding portion adapted to be received in said firing chamber obturation means portion of said central bore in said sleeve member;

a firing chamber formed by firing chamber means in said plug and adapted to surround the propellant in the firing position;

air delivery means connecting said source to said firing chamber and comprising passage means extending from said air compression chamber means to said firing chamber;

flow control means mounted in said passage means and being movable between an open position permitting flow of high temperature air from said compression cylinder means to said firing chamber during a compression stroke and a closed position preventing flow of high pressure fluids from said firing chamber to said compression cylinder means after ignition of the propellant, said flow control means comprising a conical valve seat formed in a rigid reaction wall and facing said firing chamber, an enlarged valve chamber next adjacent said valve seat, and a ball valve retainingly movably mounted in said valve chamber for movement between the open position and the closed position and forming a continuation of said rigid reaction wall in the closed position;

elevator means for moving said transfer means between the firing position and the loading position comprising a transversely extending guideway mounted on said receiver means and adapted to slidably receive said housing, pivotally mounted elevator link means pivotally connected to said receiver means, lost motion connecting means between said housing and said elevator link means at one end for causing said housing to be reciprocably moved along said guideway as said elevator link means are pivotally actuated;

ammunition loading means mounted adjacent said elevator means and comprising reciprocable rod means movable axially between an extended position and a retracted position and adapted to move a round of ammunition from storage into said ammunition holding means during movement from the retracted position to the extended position;

cocking means movable from a retracted position to an extended position and back to the retracted position during a cocking cycle and comprising a manually operable cocking lever and pivotal support means therefor mounted on said receiver means;

carriage means reciprocably supporting said air compression cylinder means comprising longitudinally extending guide bar means, guide slot means on said receiver means and guidably receiving said guide bar means, yoke means mounted on said guide bar means and cooperatively slidably engaging said barrel means, assist spring means mounted between said yoke means and said receiver means and biasing said carriage means toward the retracted position, movable rack means attached to said carriage means and being movable therewith, stationary rack means mounted on said receiver means, pinion means rotatably supported on said stationary rack and being drivably engaged with said movable rack means, shaft means rotatably supporting said pinion means, pinion actuating link means connecting said cocking lever to said pinion shaft means whereby during movement of the cocking lever from the retracted position to the extended position said pinion means is moved rearwardly along said stationary rack means and drives said movable rack means and said carriage means and said compression cylinder means and said piston means and said breech means rearwardly from the extended firing position to the retracted loading position against the bias of said piston drive spring means, and whereby during movement of the cocking lever from the extended position to the retracted position said pinion means is moved forwardly along said stationary rack means and drives said movable rack means and said carriage means and said compression cylinder means and said breech means forwardly from the retracted loading position to the extended firing position, said piston means being latched and held in the retracted position by said sear means;

elevator means actuating mechanism comprising cam means attached to said carriage means and being movable therewith, cam follower means mounted on said elevator link means for engagement with said cam means and being operative to cause pivotal movement of said elevator link means during portions of the movement of said carriage means, a portion of said cam means being arranged to prevent actuation of said elevator link means during an initial portion of the movement of the cocking lever from the retracted position to the extended position during the cocking cycle sufficient to enable said breech means on said compression cylinder means to be disassociated from said ammunition holding means and for said ammunition holding means to be centrally positioned in said transfer means, and a portion of said cam means being arranged to be effective to actuate said elevator link means and move said transfer means and said ammunition holding means along said guideway from the firing position to the loading position during an intermediate portion of the cocking lever movement from the retracted position to the extended position during a cocking cycle, and a portion of said cam means being arranged to be effective to prevent actuation of said elevator link means during the terminal portions of the cocking lever movement from the retracted position to the extended position and the initial portion of the movement of the cocking lever from the extended position to the retracted position to maintain said transfer means and said ammunition holding means in the loading position until a round of ammunition is loaded, and a portion of said cam means being arranged to be effective to reversely actuate said elevator link means and move said transfer means and said ammunition holding means along said guideway from the loading position to the firing position during an intermediate portion of the cocking lever movement from the extended position to the retracted position, and a portion of said cam means being arranged to prevent actuation of said elevator link means during the terminal portions of the cocking lever movement from the extended position to the retracted position to maintain the transfer means and the ammunition holding mean in the firing position and to enable association with said breech means on said compression cylinder means during the terminal portion of the cocking lever movement from the extended position to the retracted position;

ammunition loading rod means actuating mechanism comprising pivotally mounted loading link means drivably connected to said loading rod means by a lost motion connection causing pivotal movement of said loading link means to impart reciprocable movement to said loading rod means, pivotal support means pivotally supporting said loading link means relative to said receiver means, reciprocable drive link means connected to said loading link means and being reciprocably operable between a retracted position and an extended position to impart pivotal movement to said loading link means, loading spring means biasing said drive link means to the retracted position, a lost motion driving connection between said shaft means rotatably supporting said pinion means and said reciprocable drive link means whereby during movement of said cocking lever from the retracted position to the extended position driving engagement between said shaft means and said reciprocable drive link means is effected only after said transfer means and said ammunition holding means are located in the loading position to extend the loading rod means and move a round of ammunition from storage and into the ammunition holding means during the terminal portions of the movement of the cocking lever from the retracted position to the extended position, and whereby during movement of said cocking lever from the extended position to the retracted position said loading spring means is immediately effective to return said loading rod from the extended position to the retracted position during the initial portion of the movement of the cocking lever from the extended position to the retracted position enabling said transfer means and said ammunition holding means to be returned to the firing position before said breech means and said air compression cylinder means are engageable therewith during return to the firing position.

6. A repeating gun for firing rounds of ammunition, said ammunition comprising a projectile having an asso-

ciated propellant capable of being ignited by surface contact with high temperature air, said gun comprising:

receiver means for supporting the operational mechanism of the gun;

barrel means for guiding the projectile from the gun after ignition of the propellant;

axially movable ammunition holding means for holding a round of ammunition in a firing position in alignment with said barrel means and for receiving a round of ammunition in a loading position and for holding the round of ammunition during transfer from the loading position to the firing position;

a separate transfer means supporting said ammunition holding means for axial movement between a firing position and a transfer position and being transversely reciprocably movable between a firing position and a loading position;

a source of high temperature air having a temperature at which the propellant is ignitable by surface contact therewith comprising movable air compression cylinder means movable between a firing position and a loading position and piston means mounted in said air compression cylinder means and being movable therewith from an extended position after a compression stroke to a retracted cocked position ready for a compression stroke and being movable relative thereto from the retracted position to the extended position during a compression stroke, piston drive spring means associated with said piston means to drive said piston means from the retracted cocked position to the extended position during a compression stroke;

sear means for releasably holding said piston means in a retracted cocked position;

trigger means for selectively actuating said sear means and releasing said piston means for a compression stroke;

breech means for connecting said air compression cylinder means to said ammunition holding means;

a firing chamber formed by firing chamber means in said breech means adapted to surround the propellant in the firing position;

air delivery means connecting said source to said firing chamber and comprising passage means extending from said air compression chamber means to said firing chamber;

flow control means mounted in said passage means and being movable between an open position permitting flow of high temperature air from said compression cylinder means to said firing chamber during a compression stroke and a closed position preventing flow of high pressure fluids from said firing chamber to said compression cylinder means after ignition of the propellant;

actuator means for moving said transfer means between the firing position and the loading position;

ammunition loading means mounted adjacent said actuator means movable between an extended position and a retracted position and adapted to move a round of ammunition from storage into said ammunition holding means during movement from the retracted position to the extended position; and

cocking means operably connected to said piston means, said actuator means, and said ammunition loading means and being movable from a retracted position to an extended position and back to the retracted position during a cocking cycle.

7. The invention as defined in claim 6 and said transfer means comprising a reciprocable housing having a central bore, barrel obturation means formed on said ammunition holding means adjacent said barrel means, said ammunition holding means being slidably mounted in the central bore of said housing for movement between a firing position with said barrel obturation means in engagement with said barrel means and a transfer position centrally located in said housing with said barrel obturation means spaced from said barrel means, spring means in said housing biasing said ammunition holding means toward the centrally located transfer position, and abutment means confining and centrally locating said ammunition holding means within said housing.

8. The invention as defined in claim 6 and said actuator means comprising a transversely extending guide way mounted on said receiver means and adapted to slidably receive said transfer means, pivotally mounted elevator link means pivotally connected to said receiver means, and lost motion connecting means between said transfer means and said elevator link means at one end for causing said transfer means to be reciprocably moved along said guideway as said elevator link means are pivotally actuated.

9. A repeating gun for firing rounds of ammunition, said ammunition comprising a projectile having an associated propellant capable of being ignited by surface contact with high temperature air, said gun comprising:

receiver means for supporting the operational mechanism of the gun;

barrel means for guiding the projectile from the gun after ignition of the propellant;

ammunition holding means for holding a round of ammunition in a firing position in alignment with said barrel means and for receiving a round of ammunition in a loading position and for holding the round of ammunition during transfer from the loading position to the firing position; said ammunition holding means comprising a sleeve member having a central bore, barrel obturation means formed circumjacent the central bore in said sleeve member adjacent the barrel means, barrel connecting means formed by a terminal portion of said central bore next adjacent said barrel means and corresponding to said barrel means and forming a continuation thereof, a projectile supporting chamber formed by an intermediate portion of the central bore in said sleeve member being enlarged and being connected to said barrel connecting means bore portion by shoulder means forming an ammunition engaging abutment for holding the ammunition in place until the propellant is ignited, firing chamber obturation means formed by a further enlarged terminal portion of said central bore opposite said barrel connecting means bore portion;

transfer means supporting said ammunition holding means and being movable between a firing position and a loading position, said transfer means comprising a reciprocable housing having a central bore, said sleeve member being slidably mounted in the central bore of said housing for movement between a firing position with said barrel obturation means in engagement with said barrel means and a transfer position centrally located in said housing with saaid barrel obturation means spaced from said barrel means, spring means in said housing biasing said sleeve member toward the centrally located transfer position, and abutment means confining and centrally locating said sleeve member within said housing;

a source of high temperature air having a temperature at which the propellant is ignitable by surface contact therewith comprising movable air compression cylinder means movably supported for movement between an extended firing position in association with said ammunition holding means and a retracted loading position separated therefrom, separately and concurrently movable piston means mounted in said air compression cylinder means and being movable therewith from an extended position after a compression stroke to a retracted cocked position ready for a compression stroke and being movable relative thereto from the retracted position to the

extended position during a compression stroke, piston drive spring means associated with said piston means to drive said piston means from the retracted cocked position to the extended position during a compression stroke;

sear means for releasably holding said piston means in a retracted cocked position;

trigger means for selectively actuating said sear means and releasing said piston means for a compression stroke;

breech means for connecting said air compression cylinder means to said ammunition holding means, said breech means comprising a plug formed on the end of said air compression cylinder means next adjacent said ammuntion holding means, said plug having a protruding portion adapted to be received in said firing chamber obturation means portion of said central bore in said sleeve member;

a firing chamber formed by firing chamber means in said plug and adapted to surround the propellant in the firing position;

air delivery means connecting said source to said firing chamber and comprising passage means extending from said air compression chamber means to said firing chamber;

flow control means mounted in said passage means and being movable between an open position permitting flow of high temperature air from said compression cylinder means to said firing chamber during a compression stroke and a closed position preventing flow of high pressure fluids from said firing chamber to said compression cylinder means after ignition of the propellant;

elevator means for moving said transfer means between the firing position and the loading position comprising a transversely extending guide way mounted on said receiver means and adapted to slidably receive said housing, pivotally mounted elevator link means pivotally connected to said receiver means, lost motion connecting means between said housing and said elevator link means at one end for causing said housing to be reciprocably moved along said guideway as said elevator link means are pivotally actuated;

ammunition loading means mounted adjacent said elevator means and comprising reciprocable rod means movable axially between an extended position and a retracted position and adapted to move a round of ammunition from storage into said ammunition holding means during movement from the retracted position to the extended position;

and cocking means operatively connected to said elevator means and said ammunition loading means and being movable from a retracted position to an extended position and back to the retracted position during a cocking cycle and comprising a manually operable cocking lever and pivoted support means therefor mounted on said receiver means.

10. The invention as defined in claim **9** and having carriage means reciprocably supporting said air compression cylinder means comprising longitudinally extending guide bar means, guide slot means on said receiver means and guideably receiving said guide bar means, yoke means mounted on said guide bar means and cooperatively slideably engaging said barrel means, assist spring means mounted between said yoke means and said receiver means and biasing said carriage means toward the retracted position, movable rack means attached to said carriage means and being movable therewith, stationary rack means mounted on said receiver means, pinion means rotatably supported on said stationary rack and being drivably engaged with said movable rack means, shaft means rotatably supporting said pinion means, pinion actuating link means connecting said cocking lever to said pinion shaft means whereby during movement of the cocking lever from the retracted position to the extended position said pinion means is moved rearwardly along said stationary rack means and drives said movable rack means and said carriage means and said compression cylinder means and said piston means and said breech means rearwardly from the extending firing position to the retracted loading position against the bias of said piston drive spring means, and whereby during movement of the cocking lever from the extended position to the retracted position said pinion means is moved forwardly along said stationary rack means and drives said movable rack means and said carriage means and said compression cylinder means and said breech means forwardly from the retracted loading position to the extended firing position, said piston means being latched and held in the retracted position by said sear means.

11. The invention as defined in claim **10** and having elevator means actuating mechanism comprising cam means attached to said carriage means and being movable therewith, cam follower means mounted on said elevator link means for engagement with said cam means and being operative to cause pivotal movement of said elevator link means during portions of the movement of said carriage means, a portion of said cam means being arranged to prevent actuation of said elevator link means during an initial portion of the movement of the cocking lever from the retracted position to the extended position during the cocking cycle sufficient to enable said breech means on said compression cylinder means to be disassociated from said ammunition holding means and for said ammunition holding means to be centrally positioned in said transfer means, and a portion of said cam means being arranged to be effective to actuate said elevator link means and move said transfer means and said ammunition holding means along said guideway from the firing position to the loading position during an intermediate portion of the cocking lever movement from the retracted position to the extended position during a cocking cycle, and a portion of said cam means being arranged to be effective to prevent actuation of said elevator link means during the terminal portions of the cocking lever movement from the retracted position to the extended position and the initial portion of the movement of the cocking lever from the extended position to the retracted position to maintain said transfer means and said ammunition holding means in the loading position until a round of ammunition is loaded, and a portion of said cam means being arranged to be effective to reversely actuate said elevator link means and move said transfer means and said ammunition holding means along said guideway from the loading position to the firing position during an intermediate portion of the cocking lever movement from the extended position to the retracted position, and a portion of said cam means being arranged to prevent actuation of said elevator link means during the terminal portions of the cocking lever movement from the extended position to the retracted position to maintain the transfer means and the ammunition holding means in the firing position and to enable association with said breech means on said compression cylinder means during the terminal portion of the cocking lever movement from the extended position to the retracted position.

12. The invention as defined in claim **11** and having ammunition loading rod means actuating mechanism comprising pivotally mounted loading link means drivably connected to said loading rod means by a lost motion connection causing pivotal movement of said loading link means to impart reciprocable movement to said loading rod means, pivotal support means pivotally supporting said loading link means relative to said receiver means, reciprocable drive link means connected to said loading link means and being reciprocably operable between a retracted position and an extended position to impart pivotal movement to said loading link means, loading spring means biasing said drive link means to the retracted posi-

tion, a lost motion driving connection between said shaft means rotatably supporting said pinion means and said reciprocable drive link means whereby during movement of said cocking lever from the retracted position to the extended position driving engagement between said shaft means and said reciprocable drive link means is effected only after said transfer means and said ammunition holding means are located in the loading position to extend the loading rod means and move a round of ammunition from storage and into the ammunition holding means during the terminal portions of the movement of the cocking lever from the retracted position to the extended position, and whereby during movement of said cocking lever from the extended position to the retracted position said loading spring means is immediately effective to return said loading rod from the extended position to the retracted position during the initial portion of the movement of the cocking lever from the extended position to the retracted position enabling said transfer means and said ammunition holding means to be returned to the firing position before said breech means and said air compression cylinder means are engageable therewith during return to the firing position.

13. A device for firing a projectile having a propellant associated therewith capable of being ignited by surface contact with high temperature air comprising:

barrel means having a bore for discharging the projectile from said device, an obturator chamber provided at the rear end of said barrel means;

elevator guide means adjacent the end of said barrel means;

transfer means guideably mounted in said guide means for reciprocable movement between a firing position located immediately behind said barrel means and a loading position spaced transversely therefrom;

elevator actuator means for moving said transfer means between said firing position and said loading position;

separate ammunition holding means carried by said transfer means and being axially reciprocable movable relative thereto between a firing position and a transfer position;

a central bore extending through said ammunition holding means, the front end of said bore adjacent said barrel means being dimensioned and arranged to form a continuation of the bore in said barrel means, an intermediate portion of said bore providing a seat for said ammunition, and the other rear end of said bore having an enlarged loading port formed therein;

an obturator plug provided on the front end of said ammunition holding means circumjacent said central bore and being dimensioned and arranged to be received within said obturation chamber in the rear end of said barrel means in the firing position;

an obturator chamber provided at the other rear end of said ammunition holding means circumjacent said central bore;

slide means slidably supporting said ammunition holding means within said transfer means;

spring means biasing said ammunition holding means toward the transfer position;

axially reciprocable air compression cylinder means mounted in line with said barrel means and the ammuntion holding means in the firing position and the transfer position and being movable between a loading position and a firing position;

piston means reciprocably mounted in said cylinder means for compressing air therein and being movable between a cocked position and an uncocked position;

cylinder actuating means for imparting reciprocable movement to said cylinder means and causing movement thereof between the loading position and the firing position and for imparting reciprocable movement to said piston means and causing movement thereof from the uncocked position to the cocked position during movement of the cylinder means from the firing position to the loading position;

compression spring means associated with said piston means to drive the piston means from the cocked position to the uncocked position and being compressed by said piston means during movement from the uncocked position to the cocked position;

sear means for releasably holding said piston means in the cocked position;

trigger means operatively connected to said sear means to release said piston means for movement from the cocked pisition to the uncocked position to compress air in said cylinder means;

cocking means operably connected to said cylinder actuating means for selectively moving said cylinder means from the firing position to the loading position and back to the firing position;

linkage means connecting said cocking means to said elevator actuator means to cause movement of said transfer means between the firing position and the loading position;

an obturator plug provided on the front end of said cylinder means and being dimensioned and arranged to be received within the obturator chamber at the rear end of said ammunition holding means;

an air passage means extending through the front wall of said cylinder means and said obturator plug and being connectable with the central bore in said ammunition holding means in the firing position to conduct high temperature air from said cylinder means to said central bore during movement of said piston means from said cocked position to said uncocked position;

valve means in said air passage means closeable after delivery of high temperature air from said cylinder means to said central bore to close said air passage means to flow of propellant gases after ignition of said propellant;

and said cocking means being operative to move said compression cylinder means forwardly and rearwardly into and out of obturating engagement with said ammunition holding means resulting in movement of said ammunition holding means into and out of obturating engagement with said barrel means and to move said transfer means between the firing position and the loading position after the obturator plug on said cylinder means is moved out of engagement with the obturation chamber in the rear of said ammunition holding means and after the obturation plug on the front of said ammunition holding means has been moved out of engagement with the obturation chamber at the rear end of said barrel means with movement of said cylinder means causing said piston to be cocked.

14. A device for firing a projectile having a propellant associated therewith capable of being ignited by surface contact with high temperature air comprising:

barrel means having a bore for discharging the projectile from said device;

ammunition transfer means mounted for transverse reciprocable movement between a firing position located immediately behind said barrel means and a loading position spaced transversely therefrom;

actuator means for moving said transfer means between said firing position and said loading position;

separate ammunition holding means carried by said transfer means and being axially repicrocable movable relative thereto between a firing position and a transfer position;

a central bore extending through said ammunition holding means, the end of said bore adjacent said barrel means being dimensioned and arranged to form a continuation of the bore in said barrel means, an intermediate portion of said bore providing a seat

for said ammunition, and the other end of said bore having an enlarged loading port formed therein;

axially reciprocable air compression cylinder means mounted in line with said barrel means and the ammunition holding means in the firing position and the transfer position and being movable between a loading position and a firing position;

piston means reciprocably mounted in said cylinder means for compressing air therein and being movable between a cocked position and an uncocked position;

cylinder actuating means for imparting reciprocable movement to said cylinder means between the loading position and the firing position and to said piston means from the uncocked position to the cocked position during movement of the cylinder means from the firing position to the loading position;

compression spring means associated with said piston means to drive the piston means from the cocked position to the uncocked position and being compressed by said piston means during movement from the uncocked position to the cocked position;

sear means for releasably holding said piston means in the cocked position;

trigger means operatively connected to said sear means to release said piston for movement from the cocked position to the uncocked position to compress air in said cylinder means;

and cocking means operably connected to said cylinder actuating means for selectively moving said cylinder means from the firing position to the loading position and back to the firing position.

15. The invention as defined in claim **14** and said actuator means comprising elevator means to cause sliding movement of said transfer means between the firing position and the loading position.

16. The invention as defined in claim **14** and having an obturator plug provided at the front end of said cylinder means and being dimensioned and arranged to be received with an obturator chamber at the rear end of said ammunition holding means;

an air passage means extending through the front wall of said cylinder means and said obturator plug and being connectable with the central bore in said ammunition holding means in the firing position to conduct high temperature air from said cylinder means to said central bore during movement of said piston means from said cocked position to said uncocked position;

valve means in said air passage means closeable after delivery of high temperature air from said cylinder means to said central bore to close said air passage means to flow of propellant gases after ignition of said propellant;

and said cocking means being operative to move said compression cylinder means forwardly and rearwardly into and out of obturating engagement with said ammunition holding means resulting in movement of said ammunition holding means into and out of obturating engagement with said barrel means and to move said transfer means between the firing position and the loading position after the obturation plug on said cylinder means is moved out of engagement with the obturation chamber in said ammunition holding means and after said ammunition holding means has been moved out of engagement with said barrel means with movement of said cylinder means causing said piston means to be cocked.

No references cited.

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