United States Patent

[11] 3,561,319

[72] Inventors **Ronald W. Joyce**
Springdale;
Jules Edmond Van Langenhoven, Rogers, Ark.

[21] Appl. No. **469,992**
[22] Filed **July 7, 1965**
[45] Patented **Feb. 9, 1971**
[73] Assignee **Victor Comptometer Corporation**
Chicago, Ill.
a corporation of Illinois

---

[54] **AIR-OPERATED PROJECTILE FIRING APPARATUS**
22 Claims, 12 Drawing Figs.

[52] **U.S. Cl.** 89/7; 42/59; 124/15, 124/48
[51] **Int. Cl.** **F41f 1/00**
[50] **Field of Search** ..... 124/15, 12, 13, 14, 45, 48; 89/7, 1, 155, 156, 157; 42/1, 59, 14; 102/1 (CD)

[56] **References Cited**

UNITED STATES PATENTS

338,760	3/1886	Merritt	42/59
946,351	1/1910	Haeghen	42/59
1,869,600	8/1932	Loomis	124/15
1,045,373	11/1912	Cook	124/15
1,049,106	12/1912	Key	42/59
1,509,257	9/1924	Randall	124/15
2,572,176	10/1951	Mihalyi	124/15
2,574,147	11/1951	Hobbs	89/7
2,938,513	5/1960	Giss	124/15
2,972,286	2/1961	Marquardt	89/155X
1,850,196	3/1932	Bardsley	102/81
2,705,921	4/1955	Moseman, Jr.	102/78
3,007,412	11/1961	Kipfer	102/71
3,264,995	8/1966	Libbey et al.	102/79

FOREIGN PATENTS

1,321,746	2/1963	France	102/(CD)

Primary Examiner—Samuel W. Engle
Attorney—Harness, Dickey & Pierce

CLAIM: 4. 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 ammuni- during transfer from the loading position to the firing 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 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 from the retracted position to the extended position during a compression stroke. piston spring drive 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 the 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 in the firing position;

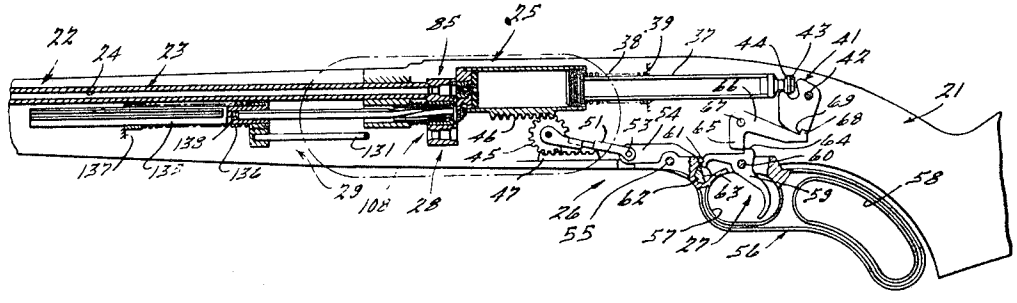
a firing chamber formed by firing chamber means in said breech means adapted to surround said propellant in the firing position;

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

transfer means supporting said ammunition holding means and being movable between a firing position and a transfer position and between the transfer position and a loading position to move said ammunition holding means between a firing position and a loading position; and

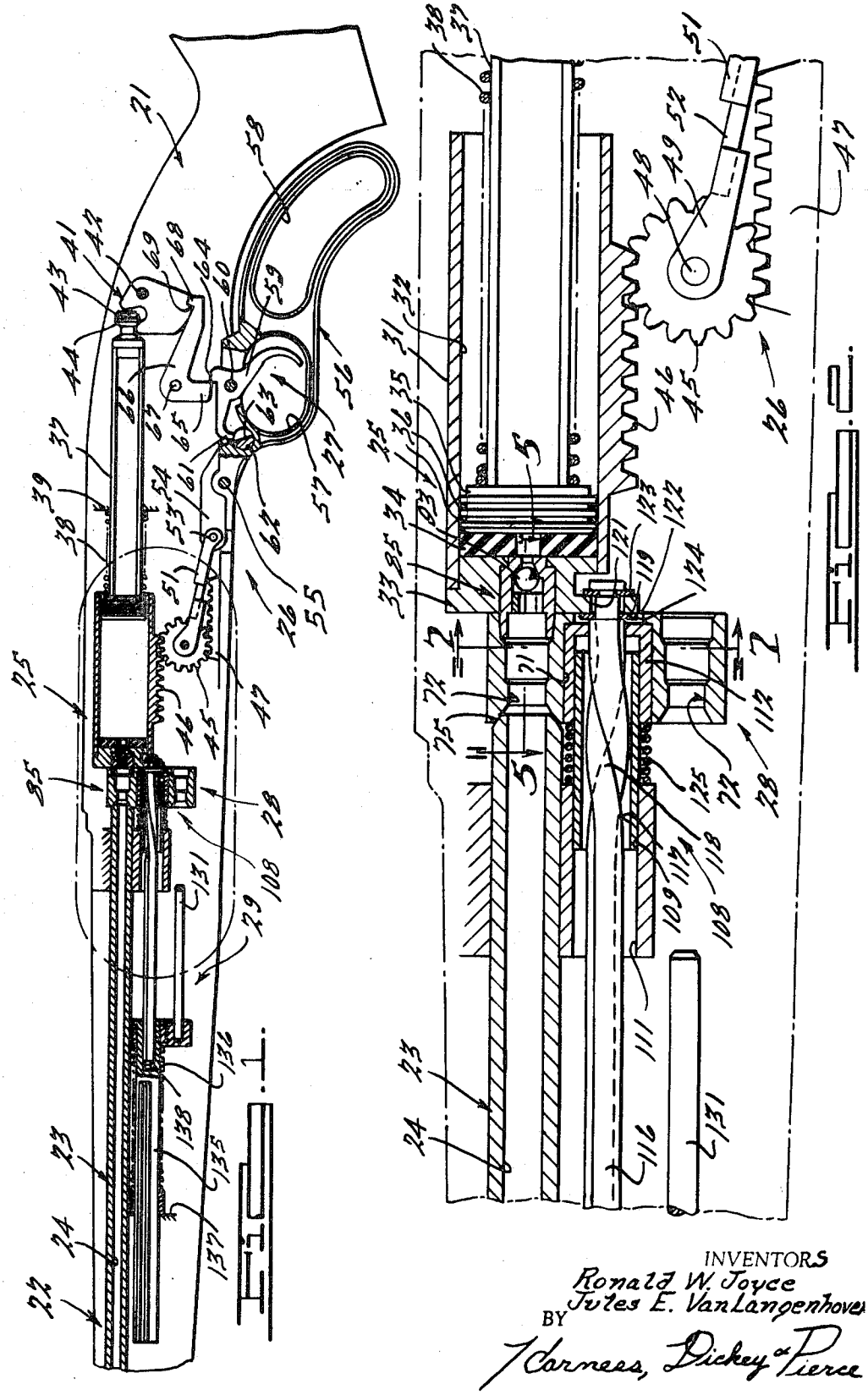
actuator means for moving said transfer means between the firing position and the transfer position and between the transfer position and the loading position.



PATENTED FEB 9 1971

3,561,319

SHEET 1 OF 4



INVENTORS
Ronald W. Joyce
Jules E. VanLangenhove
BY
Carneas, Dickey & Pierce
ATTORNEYS.

PATENTED FEB 9 1971

3,561,319

SHEET 2 OF 4

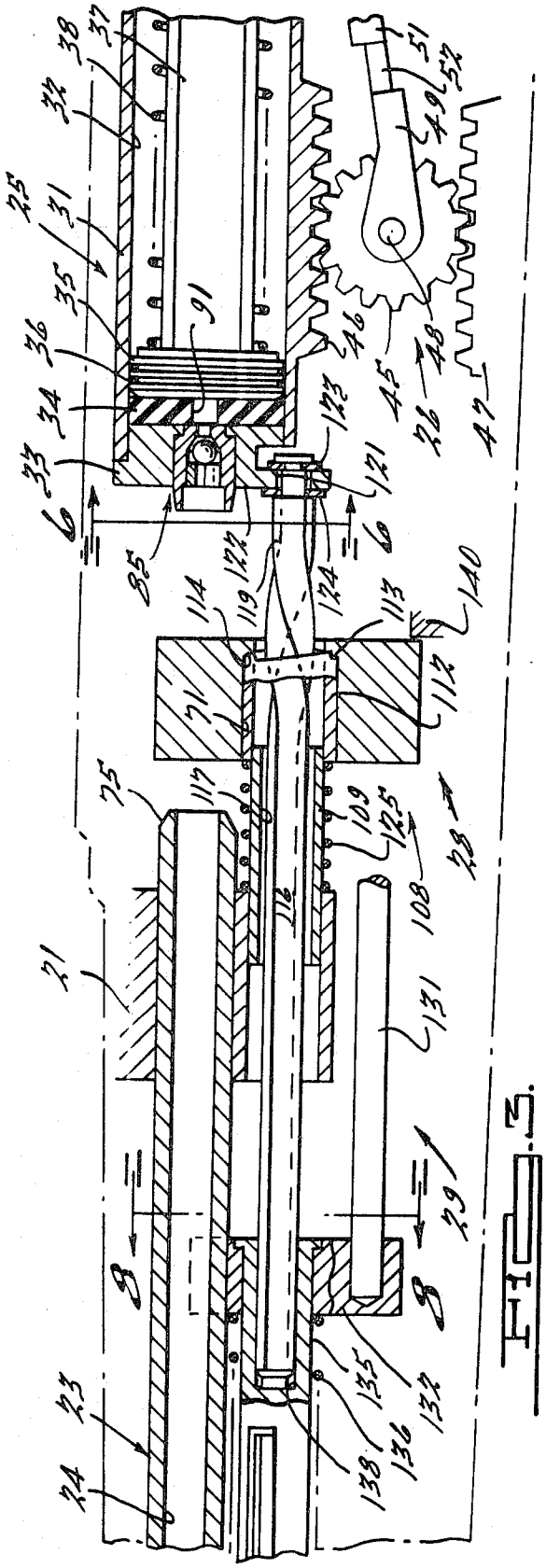


FIG. 3.

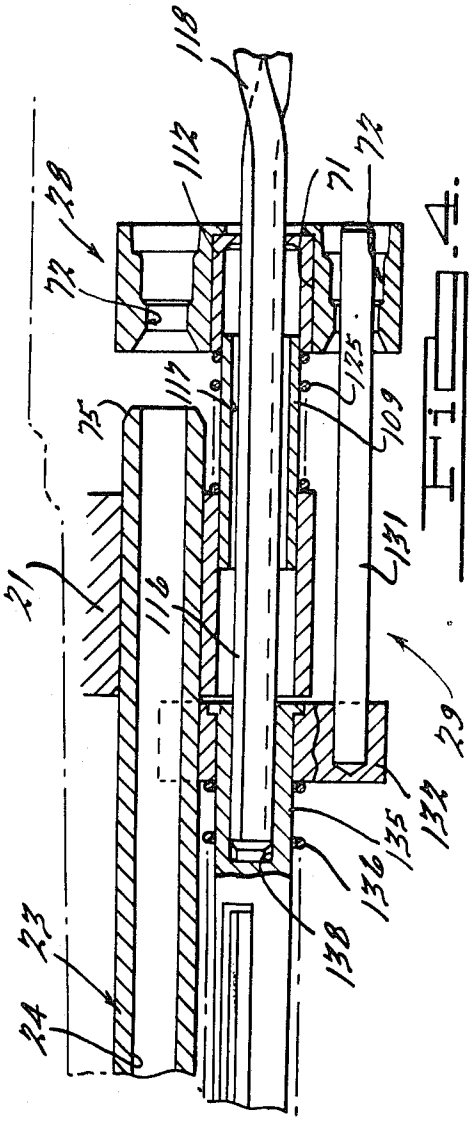


FIG. 4.

INVENTORS
Ronald W. Joyce
Jules E. VanLangenhoven
BY
J. Carness, Dickey & Pierce.
ATTORNEYS.

PATENTED FEB 9 1971

3,561,319

SHEET 3 OF 4

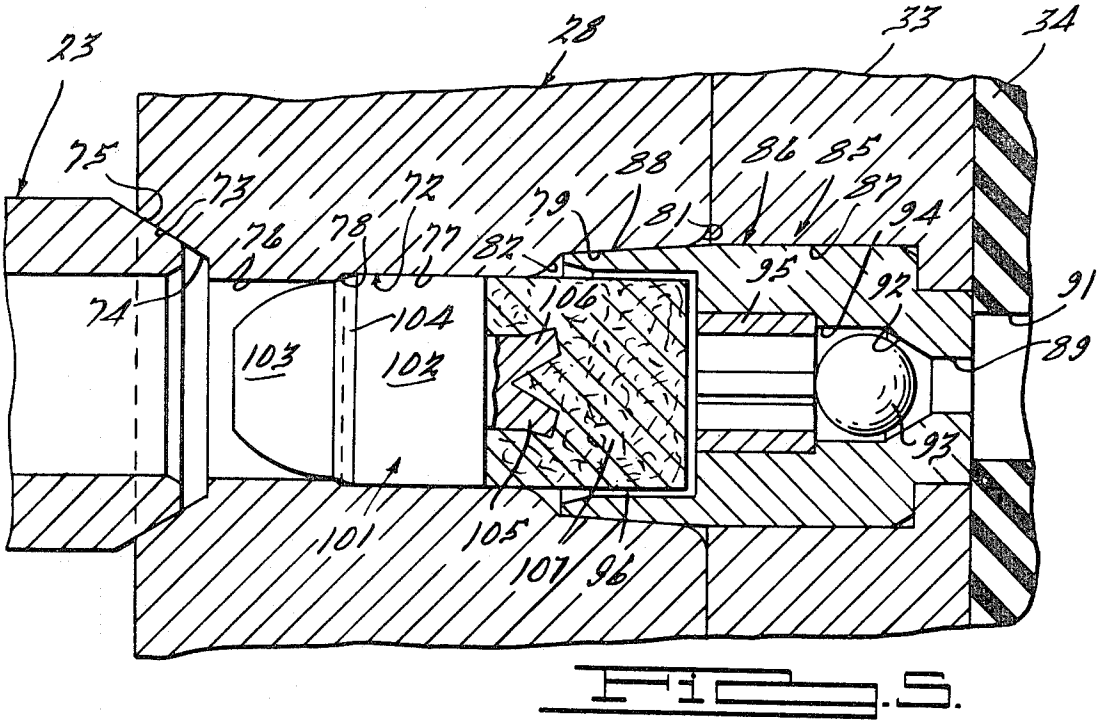


FIG. 5.

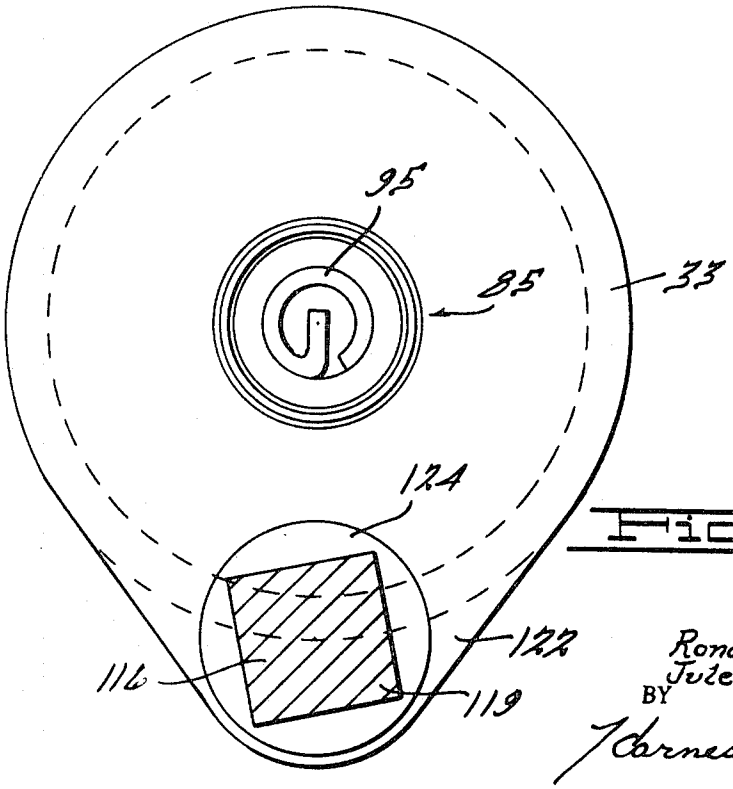


FIG. 6.

INVENTORS
Ronald W. Joyce
Jules E. VanLangenhoven
BY
Harness, Dickey & Pierce
ATTORNEYS

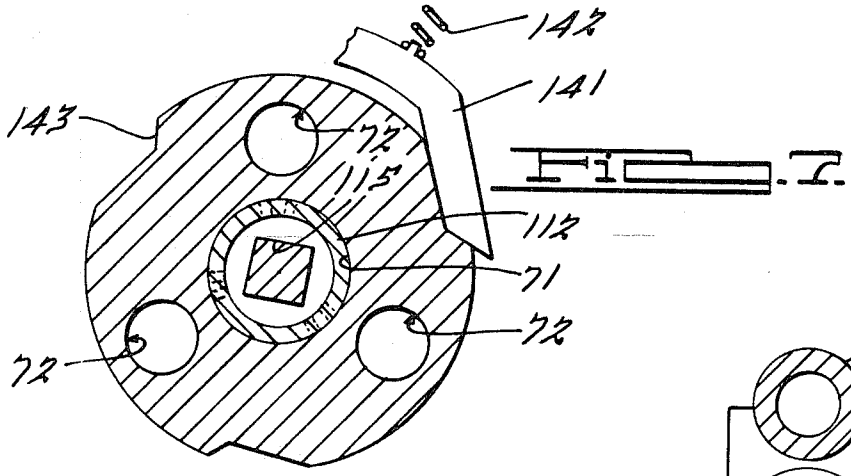


FIG. 7.

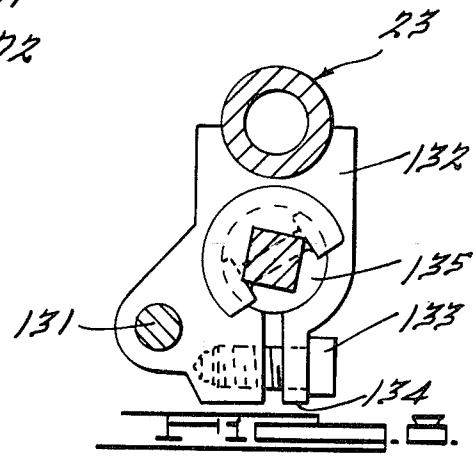


FIG. 8.

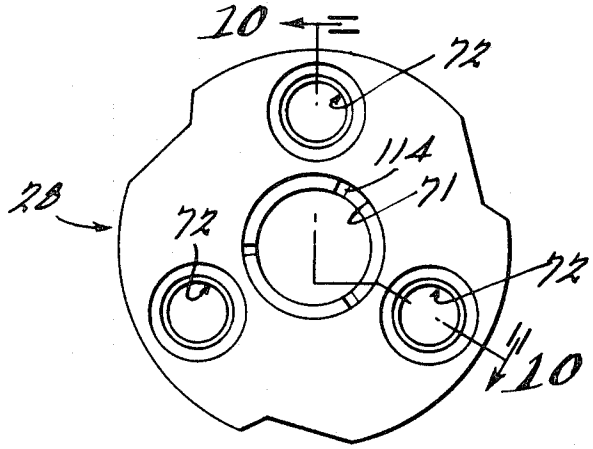


FIG. 9.

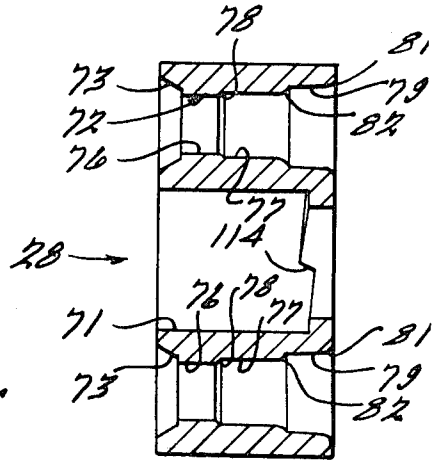


FIG. 10.

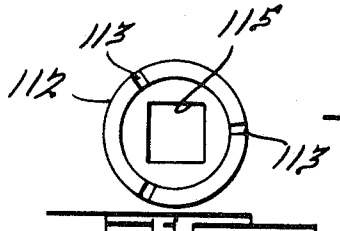


FIG. 11.

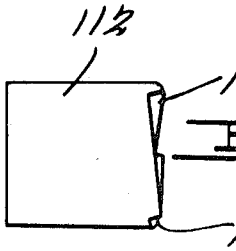


FIG. 12.

INVENTORS
Ronald W. Joyce
Jules E. VanLangenhoven
BY
Carness, Dickey & Pierce
ATTORNEYS

AIR-OPERATED PROJECTILE FIRING APPARATUS

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 Ser. 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 there between, firing chamber means formed about the propellant in the firing position, air 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.

FIG. 1 is a schematic side sectional view, with parts removed, of air gun structure embodying the inventive principles and shown in a cocked operational position;

FIG. 2 is an enlarged sectional view of a portion of the apparatus of FIG. 1 shown in an uncocked operational position;

FIG. 3 is an enlarged sectional view of a portion of the apparatus of FIG. 1 shown in an intermediate operational position during a cocking operation;

FIG. 4 is an enlarged sectional view of a portion of the apparatus shown in FIG. 3 in another intermediate operational position during a cocking operation;

FIG. 5 is an enlarged sectional view of a portion of the apparatus in FIG. 1 shown loaded with a round of ammunition of presently preferred form and in a firing position;

FIG. 6 is an enlarged cross-sectional view taken along the line 6–6 in FIG. 3;

FIG. 7 is a cross-sectional view taken along the line 7–7 in FIG. 2;

FIG. 8 is a cross-sectional view taken along the line 8–8 in FIG. 3;

FIG. 9 is an enlarged end view of a portion of the apparatus shown in FIG. 1;

FIG. 10 is a cross-sectional view of the part shown in FIG. 9;

FIG. 11 is an enlarged end view of another portion of the apparatus shown in FIG. 1; and

FIG. 12 is a side elevational view of the part shown in FIG. 11.

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 in detail to FIGS. 1—12, alternative embodiments of certain of the inventive features are shown in connection with a repeating type air operated rifle comprising, in general, a body portion or receiver 21 that supports a barrel means assembly 22. The barrel assembly includes a barrel 23 having a bore 24 for guiding a projectile. A source of high temperature fluid is provided by air compression means 25 positioned within the receiver 21 at the rear of the barrel 23. A cocking means 26 is provided for cocking the air compression unit. A trigger means 27, positioned toward the rear of the receiver, is actuable to operate the compression unit which results in a projectile being propelled from the barrel 23. Breech means connect the air compression unit to the barrel means and comprise ammunition transfer means in the form of a revolving cylinder assembly 28 interposed between the air compression unit and the barrel for delivering rounds of ammunition from a loading position adjacent suitable magazine means (not shown) in rapid succession to a firing position adjacent the barrel 23. Ammunition support means and firing chamber defining means are integrally formed in the ammunition transfer means for holding the ammunition in the firing position in alignment with the barrel means. The breech means further comprises obturation means provided to close the firing chamber in the firing position. An ejection means 29 is positioned adjacent the revolving cylinder assembly to clear the ammunition chambers of the cylinder assembly at certain times, as will be hereinafter described, during operation of the gun.

Referring now to FIGS. 1 through 3, the air compression means 25 comprises relatively movable compression chamber means and volume varying means with the chamber means being formed by a movably mounted cylinder means and the volume varying means being formed by movably mounted piston means. The cylinder means is movable between an ammunition loading position (FIG. 3) and an ammunition firing position (FIG. 1), and the piston means is movable between a cocked position (FIG. 1) ready for firing of the gun and an uncocked position (FIG. 2). The cylinder means and the piston means are movable relative to one another at certain times, with first one and then the other being fixedly retained, and are movable together at other times during operation of the gun.

Air cylinder 31 has an axially extending bore 32 formed therein. The air cylinder is supported for reciprocation relative to the receiver for a reason which will become apparent as this description proceeds. The end of the air cylinder 31 adjacent to the barrel 23 is closed by a head 33 which may be affixed in any suitable manner to the air cylinder. A resilient disc 34 is positioned adjacent the head 33 to provide a seal between the air cylinder and head and a cushion for a piston head, as will become more apparent as this description proceeds. A conventional type air compression piston 35 having a plurality of grooves that may receive sealing rings 36, forming a labyrinth type seal, is supported for reciprocation within the bore 32. In the preferred embodiment, the seal is formed by the grooves themselves without the sealing rings. The piston is integrally connected to an elongated piston rod 37.

Actuating means in the form of a coil spring 38 engages the piston 35 at one of its ends and a fixed abutment 39 at its other end. The coil spring 38 normally urges the piston toward the cylinder head. Trigger means are provided to release the piston in the cocked position and includes a sear 41 pivotally supported on a pivot pin 42. The sear 41 has a groove 43 that is adapted to receive a protuberance 44 formed at the inner end of the piston rod 37, when the piston is in the cocked position (FIG. 1).

The cocking mechanism 26 includes a pinion gear 45 that engages a rack 46 formed integrally on the underside of the air cylinder 31 and a rack 47 that is fixed in the receiver 21 below the cylinder 31. The pinion gear 45 is journaled upon a pin 48 carried at the forward end of a lever 49 which may be a one-piece member or connected to intermediate links 51, 52. The rear end of the lever is pivotally connected, as by a pin 53,

(FIG. 1), to a forwardly extending arm 54 of a cocking lever assembly pivoted at 55 and having a rearwardly extending portion 56 in which a trigger finger hole 57 and a cocking handle 58 are provided.

The trigger mechanism includes trigger 59 pivotally supported upon a pin 60 and extending into the trigger finger hole 57. The forward end of the trigger has a depending projection 61 adapted to contact a manually operable safety in the form of a shaft 62 having a segmented portion 63. An upstanding projection 64 of the trigger 59 contacts a depending arm 65 of a lever 66 pivotally supported upon a pivot pin 67. A detent 68 is adapted to be received in a notch 69 formed in the sear 41.

Referring now additionally to FIGS. 4, 5, 9, and 10, the revolving cylinder assembly 28 is a unitary piece formed with a centrally located generally cylindrical bore 71 around which are positioned a plurality of equally spaced ammunition chambers, indicated generally by the reference numeral 72. In the illustrated embodiment, three chambers 72 are provided. It is to be understood that any desired number of cavities may be provided.

Each of the ammunition chambers are provided with barrel obturation means comprising a chamfered section 73, formed at the end of the cylinder 28 adjacent to the barrel 23, which is adapted to form a lead collecting groove 74 and receive a beveled end 75 of the barrel when the gun is in the firing position. A first cylindrical bore 76, corresponding to the barrel bore 24, is provided adjacent the chamfered section 73 and the opposite end of the bore 76 terminates next to a larger diameter bore 77 jointed by a beveled section 78 which form projectile holding means as hereinafter described in detail. Firing chamber obturation means are provided and comprise a tapering obturation chamber 79 extending to the rear face of the revolving cylinder 28, adjacent the air compression unit, and terminating at its end in a round 81 and a round 82.

The firing chamber obturation means further comprises obturator plug means 85 (FIG. 5) interposed between the air compression means and the ammunition chambers 72. The obturator plug means comprises a generally cylindrically shaped housing 86 press fitted within a bore 87 formed in the cylinder head 33. The end of the obturator housing adjacent the rotating cylinder assembly 28 is formed with a tapered portion 88 that is complementary to the tapering bore 79 in the revolving cylinder 28. An air passage 89 is formed in the obturator housing and connects to a larger passage 91 formed in resilient disc 34 to provide air passage delivery means by which high temperature air is delivered from the compression chamber. Obturator air passage 89 merges into a chamfered section 92 forming a seat for flow control means in the form of a ball check valve 93. In the presently preferred form of the invention, the check valve 93 is floatingly supported for movement within a bore 94 extending from the chamfered section 92 through the obturator housing 86. A coiled retaining member 95 (FIG. 6) is positioned at the outer end of the bore 94 to floatingly retain the ball check valve 93 within the bore. An enlarged chamber 96 is formed at the mouth of the bore 94 adjacent the retaining member 95.

Caseless rounds of ammunition, indicated generally by the reference numeral 101, and shown in detail in FIG. 5, are adapted to be positioned within the ammunition chambers 72 of the revolving cylinder 28. In the presently preferred form of the invention, each round 101 comprises a metallic (e.g. lead) slug having a generally cylindrical section 102, complementary in diameter to the bore 77, and an end section 103 adapted to extend into the bore 76. A beveled section 104, connecting sections 102 and 103, is adapted to abuttingly engage the beveled section 78 of the projectile cavity 72 formed between the bore 76 and 77 to axially position the round within the revolving cylinder 28. The diameter of the cylindrical portion 102 is sufficiently larger than the diameter of the bore 76 so as to form a seal between the shoulders 78 and 104 and to hold the projectile in place in the ammunition chamber until the propellant has been ignited and sufficient force is obtained to compress the lead projectile and force it past the shoulder 78 and into the bore 76 and down the barrel bore 24. It is desirable to have an arrangement providing a shot start force greater than the force obtained by compression of the air alone so that the projectile will not start to move until after the propellant has been ignited. If a propellantless air driven round of ammunition is to be sued, the amount of frictional retention between the projectile and the ammunition chamber is reduced greatly so that the ammunition is merely supported in the ammunition chamber and is driven into the bores 24, 76 as soon as or shortly after the compression stroke begins. In this manner, the gun may be used as a high velocity weapon with a round of ammunition having propellant associated therewith and a high shot start force, and may be used as a low velocity air gun with a modified round of propellantless ammunition having a low shot start force.

Propellant attaching means are provided in the form of a stub shaft portion 105, integrally connected to the cylindrical section 102, and terminating in a radially displaced upset portion 106. In the presently preferred embodiment of the invention, a disc of solid propellant 107, corresponding in diameter to a cylindrical section 102, is fixed to the stub shaft portion and held in place by upset portion 106. While the presently preferred manner of associating the propellant with the projectile provides particularly advantageous results, it is contemplated that the propellant might be otherwise attached such as by directly bonding the propellant to the rear of the projectile without utilizing the post 105. In the preferred embodiment, the length of the propellant portion is approximately equal to the length of the main portions of the projectile. The diameter and depth of the chamber 96 are chosen so as to provide a minimum air gaP and a minimum air volume. In the firing position, the high temperature ignition air will be confined in a ignition chamber defined by the ammunition, the walls of the ammunition chamber, the walls of the chamber 96, and the air passage means extending from the valve seat 92. It will be apparent that the "ignition" chamber is in effect also at least part of the "firing" chamber. The propellant 107 may be of any type, which is sufficiently porous to be ignitable by surface contact with high temperature air such as compressed within the firing chamber 96 by the air compression unit 25, as will become more apparent as this description proceeds. The propellant 107 may be made up of a homogenous mass of propellant material or of several layers of different propellant material each of which may be molded, extruded, or otherwise mounted on the projectile. The layers may have successively higher ignition points progressing toward the projectile to provide a greater thrust if so desired or may be otherwise varied and modified to attain particular ignition and firing characteristics.

Referring again to FIG. 2, the rotating cylinder 28 is sequentially indexed to present a new round and projectile cavity 72 in line with the barrel 23 upon cocking of the gun by a ratchet drive mechanism indicated generally by the reference numeral 108. The ratchet drive mechanism includes a cylinder 109 press fitted within a bore 111 formed in a part of the receiver 21. A generally cup-shaped ratchet drive 112 (FIG. 11 and 12) is journaled upon the cylinder 109 for both rotary and axial movement. The axial bore 71 of the rotating cylinder 28 also slidably receives the ratchet drive 112 so that the rotating cylinder also is rotatably supported upon the cylinder 109 through the ratchet drive 112. A plurality of teeth or serrations 113 (FIG. 3) are formed at one end of the ratchet drive and cooperate with complementary serrations 114 formed in the face of the revolving cylinder 28 at the base of the bore 71.

Serrations 113 surround a square aperture 115 (FIG. 11) formed in the end of the ratchet drive. A ratchet actuator shaft 116 (FIGS. 2—4) is supported beneath the barrel 23 and extends coaxially through a bore 117 in the cylinder 109 and through the square aperture 115 in the ratchet drive 112. The shaft 116 has a generally square cross section and is formed with a twisted portion 118. An outer straight end portion 119 of the ratchet actuator shaft is affixed within a bore 121 formed in a depending projection 122 of the cylinder head 33

by a snap ring 123 and a thrust washer 124. A coil spring 125 is interposed between the ratchet drive 112 and the receiver 21 around the cylinder 109 to urge the ratchet drive 112 and rotating cylinder 28 in a rearward direction toward the cylinder 31.

The ejector mechanism 29 comprises an ejector rod 131 affixed to an adjustable mounting bracket 132 (FIG. 8). A screw 133 is threaded to a split end 134 of bracket 132 to tighten the bracket onto a shaft 135 supported for reciprocation in the receiver beneath the barrel. A coil spring 136 (FIGS. 3 and 4) engages the bracket 132 and fixed abutment 137 (FIG. 1) to normally urge the bracket and ejection rod 131 in a rearward direction toward an ejection position. The front end of the ratchet actuator shaft 116 is received in a complementary cavity 138 formed in the rear end of the shaft 135. Normally, the end of the shaft 116 abuts the bottom of the cavity 138 to urge the ejector rod 131 in a forward direction and compresses spring 136.

FIG. 1 illustrates the gun in its cocked position ready for firing. To fire the gun, the trigger 59 is pulled causing it to pivot in a counterclockwise direction about the pivot pin 60. Projection 64 contacts depending arm 65 of lever 66 to rotate it in a clockwise direction whereby detent 68 moves free of the notch 69 in sear 41. The force of the coil spring 38 upon the piston 35 overcomes the action of the latch 41 and the piston may be driven into the cylinder 31 by the spring to compress the air therein. Air under increased pressure and temperature enters the ignition chamber through the passages 89, 91. The ball valve depending upon its initial position, is either forced away from the valve seat or maintained away from the valve seat by the high pressure air and the flow passage between the ignition chamber and the compression chamber is kept open until the pressure in the ignition chamber becomes greater than the pressure in the passages 89, 91 due to leakage of air past the piston at the end of the compression stroke When the pressure differential is attained, the ball valve 93 is moved onto the valve seat 92 and the passage 89 is closed. A rigid reaction wall is thus provided. It has been found that ignition of the propellant will ordinarily occur after the valve is closed due to an ignition time delay apparently equal to the time necessary to transfer heat from the air to the propellant and raise the temperature of the propellant to the ignition temperature. The front of the ammunition round 101 provides a seal in the bore 77 and on the shoulder 78 so that the high temperature ignition air cannot leak past the round. When the round begins to move, lead on the projectile portion 102 is compacted as it moves by shoulder 78 and, as the projectile moves into the barrel, it has been found that some of the lead will be removed from the projectile and forced into the lead collecting groove 74. Consequently, upon subsequent firings, there will be an accumulation of lead in the groove and a lead seal will be established between the barrel and the cylinder. The high temperature of the air within the ignition chamber ignites the propellant 107 and the projectile 101 is driven out of the barrel bore 24 at a high velocity. The ball check valve 93 is driven against its seat 92 so that the products of ignition will not enter the air compression cylinder 31 through passages 89, 91.

To prepare the gun for the next firing operation, the cocking lever 56 and pivot pin 53 are rotated in a clockwise direction about pivot 55 causing link 51 to be drawn rearwardly and exerting a rearward force upon the supporting pin 48 of pinion gear 45. Pinion 45 then walks along the stationary rack 47 and causes the rack 46, that is integral with the cylinder 31, to be driven in a rearward direction. The cylinder 31 is moved rearwardly and forces the head of the piston 35 rearwardly through contact with the resilient disc 34. Thus, rotation of the cocking lever 56 causes the piston 35 and cylinder 31 to be moved rearwardly simultaneously.

When the piston 35 reaches its cocked position the sear 41 engages with protuberance 44 and retains the piston 35 in its cocked position. The cocking lever 56 will then have reached the end of its pivotal movement in a clockwise direction. It is returned to its normal position by rotating it in a counterclockwise direction and cylinder 31 will again be returned to the firing position.

As rotation been previously noted, revolving cylinder 28 is held from rotation by the contact of the obturator portion 88 with the tapered bore 79 and contact of the chamfered end 75 of the barrel with the chamfer 73. When the gun is being cocked, air compression unit 25, the cylinder 31, and obturator 85 are moved to an ammunition loading position away from the revolving cylinder 28. The coil spring 125 acting through the ratchet drive 112 then urges the revolving cylinder 28 away from its firing position in engagement with the barrel 23 toward a loading position until it contacts a suitable stop 140 (FIG. 3). As the cylinder head 33 draws rearwardly, the shaft 116 passes through the square aperture 115 in the ratchet drive 112. Once the revolving cylinder 28 contacts its stop, the obturator portion 88 will move away from the tapered bore 79 freeing the revolving cylinder for rotation. Then the twisted portion 118 of the shaft 116 enters the aperture 115 and the ratchet drive 112 is rotated. The rotary motion of the ratchet drive is transmitted through the ratchet teeth 113 to cause rotation of the rotatable cylinder 28.

The configuration of the ratchet teeth 113 and the twisted secton 118 of the shaft 116 is such that the revolving cylinder 28 will be indexed sufficiently to bring the next ammunition chamber 72 into alignment with the barrel 23.

A pivotally supported locking pawl 141 (FIG. 7) is biased by a coil spring 142 into engagement with serrations 143 formed around the periphery of the revolving cylinder 28. The spring 142 and direction of the serrations 143 is such that the revolving cylinder 28 may rotate freely under the action of the pawl 112 when it is being indexed. The indexing also occurs during the portion of the cocking of the air compression unit 25 that positions the piston 35 in its cocked position. When the cylinder 31 is being returned to the firing position, the shaft 116 will again traverse the rectangular aperture 115 of the ratchet drive 112. The locking pawl 141, however, will prevent rotation of the cylinder 28 at this time due to its locking action. The ratchet teeth 113 then disengage from the serrations 114 in the cylinder 28 to permit relative rotation.

Rotation of cylinder 28 terminates before the end of the cocking action and the forwardmost straight portion of the actuator rod 116 enables the rod to be further pulled through the ratchet mechanism. At the end of the cocking movement, the ejector rod is forced into the ammunition chamber 72 (FIG. 4) which chamber has just previously been in registry with the barrel 23 and indexed from a firing position to an ejection position during the cocking movement. When the actuating shaft 116 is being moved rearwardly, the coil spring 136 urges the lever 132 and ejector rod 131 into the chamber 72. In the event that the previous round was not fired, the ejector rod 131 will drive any unspent round or portion thereof from the ammunition chamber to prevent jamming of the gun to allow for unloading the gun. When the cylinder 31 is returned to the firing position, the forward end of the shaft 116 will abut the bottom of the cavity 138 formed in the shaft 135 to return the ejector rod 131 to its inactive position.

When the cocking lever 56 is returned to its normal position and the cylinder 31 is returned to the firing position, the tapered portion 88 of the obturator 85 will again reenter the tapered bore 79 of the next successive projectile cavity in the revolving cylinder 28. This operation will serve to center the cylinder 28 with respect to the barrel 23 and obturator 85. The axial movement of the cylinder 31 again compresses the spring 125 and returns the transfer mechanism to the firing position ready for discharge as shown in FIG. 2.

Any suitable axially discharging loading mechanism (not shown) may be provided within the receiver of the gun to insert a new round into the next succeeding projectile cavity 72 of the rotating cylinder 28 during return movement of the cylinder 31 to the firing position. The loading mechanism, which may be similar to the ejection mechanism previously described but reversely operating, may take the form of a rod

movable with the compression cylinder 31 through a spring operated magazine of conventional design.

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.

We claim:

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 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 ammunition receiving bore means having barrel obturation means formed circumjacent the ammunition receiving bore means in said member, barrel connecting means formed by a terminal portion of said ammunition receiving bore means next adjacent said barrel means and corresponding to said barrel means and forming a continuation thereof, an ammunition supporting chamber formed by an intermediate portion of said ammunition receiving bore means being enlarged relative to and being connected to said barrel connecting means bore portion by shoulder means forming an ammunition engaging abutment for holding the ammunition in place and obturating said ammunition receiving bore means with the ammunition in place therein, firing chamber obturation means formed by a further enlarged terminal portion of said ammunition receiving bore means opposite said barrel connecting means bore portion;

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 spring drive 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 the 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 in the firing position, 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 ammunition receiving bore;

a firing chamber formed by firing chamber means in said plug adapted to surround said propellant in the firing position, said firing chamber obturating means being effective with said plug to close said firing chamber;

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

transfer means supporting said ammunition holding means and being movable to move said ammunition holding means between a firing position and a loading position, said transfer means comprising a member movable axially between a firing position with said barrel obturation means in engagement with said barrel means and a transfer position axially spaced from said firing position with said barrel obturation means axially spaced from said barrel means;

actuator means for moving said transfer means between the firing position and the transfer position and between the transfer position and the loading position said actuator means comprising spring means biasing said transfer means toward the transfer position and rod means connected to said air compression means and being movable therewith between an extended position and a retracted position, said spring means being effective to move said transfer means from the firing position to the transfer position during movement of said air compression cylinder means from said firing position to said retracted position, cam means on said rod means to cause transverse motion of said member, cam follower means associated with said member engageable with said cam means on said rod means to impart transverse motion to said member during movement of said air compression means from the firing position to the retracted position, a portion of said cam means being arranged to move relative to said cam follower means without imparting transverse motion to said member during an initial portion of the movement of said air compression cylinder means from the firing position to the retracted position to enable said barrel obturation means and said firing chamber obturation means to be separated by said spring means, another portion of said cam means being arranged to move relative to said cam follower means and impart transverse motion to said member during an intermediate portion of the movement of said air compression cylinder means from the firing position to the retracted position to cause said ammunition holding means to move from the transfer position to the loading position, another portion of said cam means being arranged to move relative to said cam follower means without imparting further movement to said member during the final portion of the movement of said air compression cylinder means from the firing position to the retracted position to enable ammunition to be associated and disassociated from certain ones of said ammunition holding means; cylinder means being engageable with said transfer means by engagement of said firing chamber obturation means with said breech means and said transfer means being movable with said air compression cylinder means from the transfer position to the firing position against the bias of said spring means and said barrel obturation means being engaged with said barrel means during return movement of said air compression cylinder means from the retracted position to the firing position; and

ammunition moving means for moving ammunition relative to one of said ammunition receiving bores comprising: ammunition moving means movable between a retracted position disassociated from said bore means and an extended position associated with said bore means, said ammunition moving means being operable in conjunction with said air compression cylinder means and arranged to

be associated with said bore means in the extended position to place a round of ammunition in said bore means during the terminal portion of the movement of said air compression cylinder means from the firing position to the retracted position after the transfer means has been moved transversely and arranged to be removed from said bore means during the return movement of said air compression cylinder means from the retracted position to the firing position.

2. The invention as defined in claim 1 and having actuating means for said air compression cylinder means comprising movable rack means;

slide means for said air compression cylinder means comprising a first guideway formed in said receiver means on one side of said transfer means and a second guideway formed in said receiver means on the other side of said transfer means;

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

actuating means for said air compression cylinder means comprising movable rack means attached to said air compression cylinder means and being movable therewith, stationary rack means mounted on said receiver means, pinion means rotatably supported between said stationary rack means and 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 said 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 air compression cylinder means and said piston means and said breech means and said actuating rod 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 air compression cylinder means and said breech means and said actuating rod 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.

3. The invention as defined in claim 1 and wherein said ammunition holding means comprises a member having a plurality of ammunition receiving bores, one of said bores being movable from the transfer position to the loading position while another of said bores is being moved from the loading position to the transfer position, and ratchet means to hold said ammunition holding means in the transversely displaced position attained during movement of said air compression cylinder means from the firing position to the retracted position during return movement of said air compression cylinder means from the retracted position to the firing position, the cam means being movable relative to said cam follower means and ineffective to impart transverse movement to said ammunition holding means during the return movement.

4. 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;

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 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 from the retracted position to the extended position during a compression stroke, piston spring drive 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 the 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 in the firing position;

a firing chamber formed by firing chamber means in said breech means 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 air compression cylinder 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;

transfer means supporting said ammunition holding means and being movable between a firing position and a transfer position and between the transfer position and a loading position to move said ammunition holding means between a firing position and a loading position; and

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

5. The invention as defined in claim 4 and said actuator means comprising rod means movable between an extended position and a retracted position, spring means being effective to move said transfer means from the firing position to the transfer position, cam means on said rod means, cam follower means associated with said transfer means engageable with said cam means on said rod means, a portion of said cam means being arranged to move relative to said cam follower means without imparting motion to said transfer means during an initial portion of the movement of said rod means, another portion of said cam means being arranged to move relative to said cam follower means and impart motion to said transfer means during an intermediate portion of the movement of said rod means, and another portion of said cam means being arranged to move relative to said cam follower means without imparting further movement to said transfer means during the final portion of the movement of said rod means.

6. The invention ad defined in claim 5 and wherein said rod means being connected to and movable with said air compression cylinder means.

7. 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 an ammunition receiving bore comprising barrel obturation means formed circumjacent the ammunition receiving bore in said member, barrel connecting means formed by a terminal portion of said ammunition receiving bore next adjacent said barrel means and corresponding to said barrel means and forming a continuation thereof, an ammunition supporting chamber formed by an intermediate portion of said ammunition receiving bore being enlarged relative to and being connected to said barrel connecting means bore portion by shoulder means forming an ammunition engaging abutment for holding the ammunition in place and obturating said ammunition receiving bore with the ammunition in place therein, firing chamber obturation means formed by a further enlarged terminal portion of said ammunition receiving bore opposite said barrel connecting means bore portion;

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 spring drive 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 the 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 in the firing position, 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 ammunition receiving bore;

a firing chamber formed by firing chamber means in said plug adapted to surround said propellant in the firing position, said firing chamber obturating means being effective with said plug to close said firing chamber;

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

transfer means supporting said ammunition holding means and being movable between a firing position and a transfer position and between the transfer position and a loading position to move said ammunition holding means between a firing position and a loading position, said transfer means comprising a member movable axially between a firing position with said barrel obturation means in engagement with said barrel means and said firing chamber obturation means in engagement with said breech means and a transfer position axially spaced from said firing position with said barrel obturation means axially spaced from said barrel means and said firing chamber obturation means axially spaced from said breech means;

actuator means for moving said transfer means between the firing position and the transfer position and between the transfer position and the loading position, said actuator means comprising spring means biasing said member toward the transfer position and rod means connected to said air compression means and being movable therewith between an extended position and a retracted position, said spring means being effective to move said member from the firing position to the transfer position during movement of said air compression cylinder means from said firing position to said retracted position, cam means on said rod means to cause motion of said transfer means, cam follower means associated with said transfer means engageable with said cam means on said rod means to impart motion to said transfer means during movement of said air compression means from the firing position to the retracted position, a portion of said cam means being arranged to move relative to said cam follower means without imparting motion to said transfer means during an initial portion of the movement of said air compression cylinder means from the firing position to the retracted position to enable said barrel obturation means and said firing chamber obturation means to be separated from said barrel means and said breech means by axial movement of said transfer means by said spring means, another portion of said cam means being arranged to move relative to said cam follower means and impart motion to said transfer means during an intermediate portion of the movement of said air compression cylinder means from the firing position to the retracted position to cause said ammunition holding means to be moved from the transfer position to the loading position, another portion of said cam means being arranged to move relative to said cam follower means without imparting further movement to said transfer means during the final portion of the movement of said air compression cylinder means from the firing position to the retracted position to enable ammunition to be associated and disassociated from said ammunition holding means.

8. The invention as defined in claim 7 and wherein the air compression cylinder means being engageable with said transfer means by engagement of said firing chamber obturation means with said breech means and said transfer means being movable with said air compression cylinder means from the transfer position to the firing position against the bias of said spring means and said barrel obturation means being engaged with said barrel means during return movement of said air compression cylinder means from the retracted position to the firing position.

9. The invention as defined in claim 7 and having ammunition moving means for moving ammunition relative to said ammunition receiving bore comprising: means movable between a retracted position preventing movement of ammunition relative to said ammunition receiving bore and an extended position causing movement of ammunition relative to said bore, said means being operably associated with said air compression cylinder means and arranged to be positioned in the extended position during the terminal portion of the movement of said air compression cylinder means from the firing position to the retracted position after the transfer means has been transferred and arranged to be positioned in the retracted position during the return movement of said air compression cylinder means from the retracted position to the firing position.

10. The invention as defined in claim 7 and having cocking means movable from a retracted position to an extended position and back to a retracted position during a cocking cycle and comprising a manually operable cocking lever and pivotal support means therefor mounted on said receiver means; and actuating means for said air compression cylinder means comprising movable rack means attached to said air compression cylinder means and being movable therewith, stationary rack means mounted on said receiver means, pinion means rotatably supported between said stationary rack means and 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 said 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 air compression cylinder means and said piston means and said breech means and said actuating rod 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 air compression cylinder means and said breech means and said actuating rod 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 7 and having means to hold said transfer means in the transferred position attained during movement of said air compression cylinder means from the firing position to the retracted position during return movement of said air compression cylinder from the retracted position to the firing position, the cam means being movable relative to said cam follower means and ineffective to impart movement to said transfer means during the return movement.

12. 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;

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 spring drive 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 the retracted cocked position;

movable breech means for connecting said air compression cylinder means to said ammunition holding means in the firing position;

a firing chamber formed by firing chamber means in said breech means 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 air compression cylinder 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 air 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;

transfer means supporting said ammunition holding means and being movable between a firing position and a transfer position and a loading position to move said ammunition holding means between a firing position and a loading position;

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

ammunition moving means for moving ammunition relative to said ammunition holding means in the loading position;

cocking means movable from a retracted position to an extended position and back to a retracted position during a cocking cycle; and

connecting means for connecting said cocking means to said air compression cylinder means and to said actuator means whereby during movement of said cocking lever from the retracted position to the extended position said air compression cylinder means and said breech means are moved rearwardly from the extended firing position to the retracted loading position, and said transfer means is moved from the firing position to the transfer position to the loading position, and whereby during movement of the cocking lever from the extended position to the retracted position said air compression cylinder means and said breech means are moved forwardly from the retracted loading position to the extended firing position and the transfer means is moved from the loading position to the firing position.

13. The invention as defined in claim 12 and wherein said transfer means comprises a member movable axially between a firing position and a transfer position axially spaced from said firing position.

14. The invention as defined in claim 13 and wherein said actuator means comprises rod means connected to said air compression cylinder means and being movable therewith between an extended position and a retracted position, spring means being effective to move said transfer means from the firing position to the transfer position during movement of said air compression cylinder means from the firing position to the retracted position, cam means on said rod means to transversely displace said member, follower means associated with said member engageable with said cam means on said rod means to impart motion to said member during movement of said air compression cylinder means from the firing position to the retracted position.

15. The invention as defined in claim 12 and wherein a portion of said cam means being arranged to move relative to said cam follower means without imparting motion to said member during an initial portion of the movement of said air compression cylinder means from the firing position to the retracted position, another portion of said cam means being arranged to move relative to said cam follower means and impart motion to said member during an intermediate portion of movement of said air compression cylinder means from the firing position to the retracted position to move said member from the firing position to the transfer position to the loading position, and another portion of said cam means being arranged to move relative to said cam follower means without imparting further movement to said member during the final portion of the movement of said air compression cylinder means from the firing position to the retracted position.

16. The invention as defined in claim 13 wherein said ammunition moving means comprises means movable between a retracted position and an extended position, said means being operative conjointly with said air compression cylinder means and arranged to cause movement of a round of ammunition in said ammunition holding means during the terminal portion of the movement of said air compression cylinder means from the firing position to the retracted position after the transfer means has been moved and arranged to be disassociated from the ammunition holding means during the return movement of the air compression cylinder means from the retracted position to the firing position.

17. The invention as defined in claim 13 and having slide means for said air compression cylinder means comprising a first guideway formed in said receiver means on one side of said transfer means and a second guideway formed in said receiver means on the other side of said transfer means.

18. The invention as defined in claim 13 and wherein said actuator means comprises a reciprocable rod attached to said air compression means and being movable therewith from the firing position to the retracted position and back to the firing position, a bore provided in said transfer means and slidably receiving said rod, said rod and said bore having a corresponding peripheral configuration, a first portion of said rod being straight and adapted to slide in said bore without causing movement of said transfer means, a second portion of said rod being twisted to cause movement of said transfer means as said rod is drawn through said bore, and a terminal portion of said rod being straight to enable said rod to be drawn through said bore without imparting movement to said transfer means.

19. The invention as defined in claim 18 and wherein said bore in said transfer means being formed in sleeve means mounted in said transfer means, said sleeve means having driving engagement with said transfer means during movement of said twisted portion of said rod through said bore as said air compression means moves from said firing position to said retracted position and said sleeve being movable relative to said transfer means without imparting motion to said transfer means during movement of the twisted portion of said rod through said bore as said air compression means moves from the retracted position to the firing position.

20. The invention as defined in claim 19 and wherein ratchet means are provided to hold said transfer means after movement imparted thereto during movement of the air compression means from the firing position to the retracted position and during return movement of the air compression means from the retracted position to the firing position.

21. The invention as defined in claim 13 and wherein said actuator means comprises a reciprocable rod attached to said air compression means and being movable therewith, said reciprocable rod extending through said transfer means, the end portion of said reciprocable rod opposite said air compression means being slidably supported in said receiver means.

22. The invention as defined in claim 21 and wherein said ammunition moving means being attached to said reciprocable rod and movable therewith.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,561,319 Dated February 9, 1971

Inventor(s) Ronald W. Joyce and Jules Edmond Van Langenhoven

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

Column 1, line 27, after "air" insert --delivery means connecting the source to the firing chamber means to--; line 39, after "side" insert --elevational--. Column 4, line 6, "sued" should be --used--; line 32, "gaP" should be --gap--. Column 6, line 4, "rotation" should be --has- line 33, "112" should be --141--. Column 10, line 63, "ad" should be --as--. Column 13, line 74, after "said" (second occurrence) insert --air--. Column 14, line 47 (claim 15), "12" should be --14--.

Signed and sealed this 29th day of June 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents