Sept. 7, 1965 K. J. J. McGOWAN 3,204,530

ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM

Filed Oct. 15, 1963 8 Sheets-Sheet 1

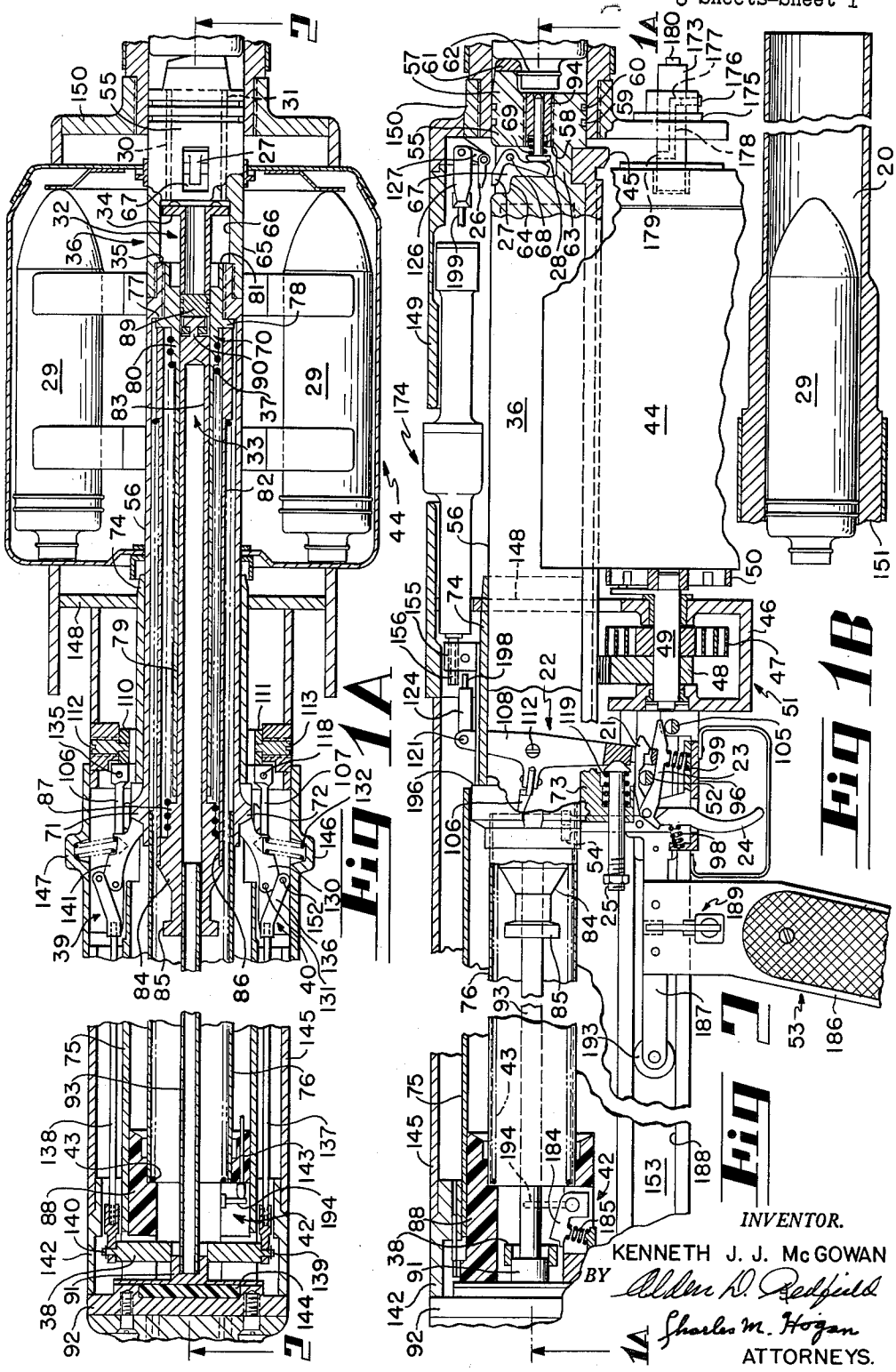

Fig 1A

Fig 1B

Fig 7

Fig 1A

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ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM

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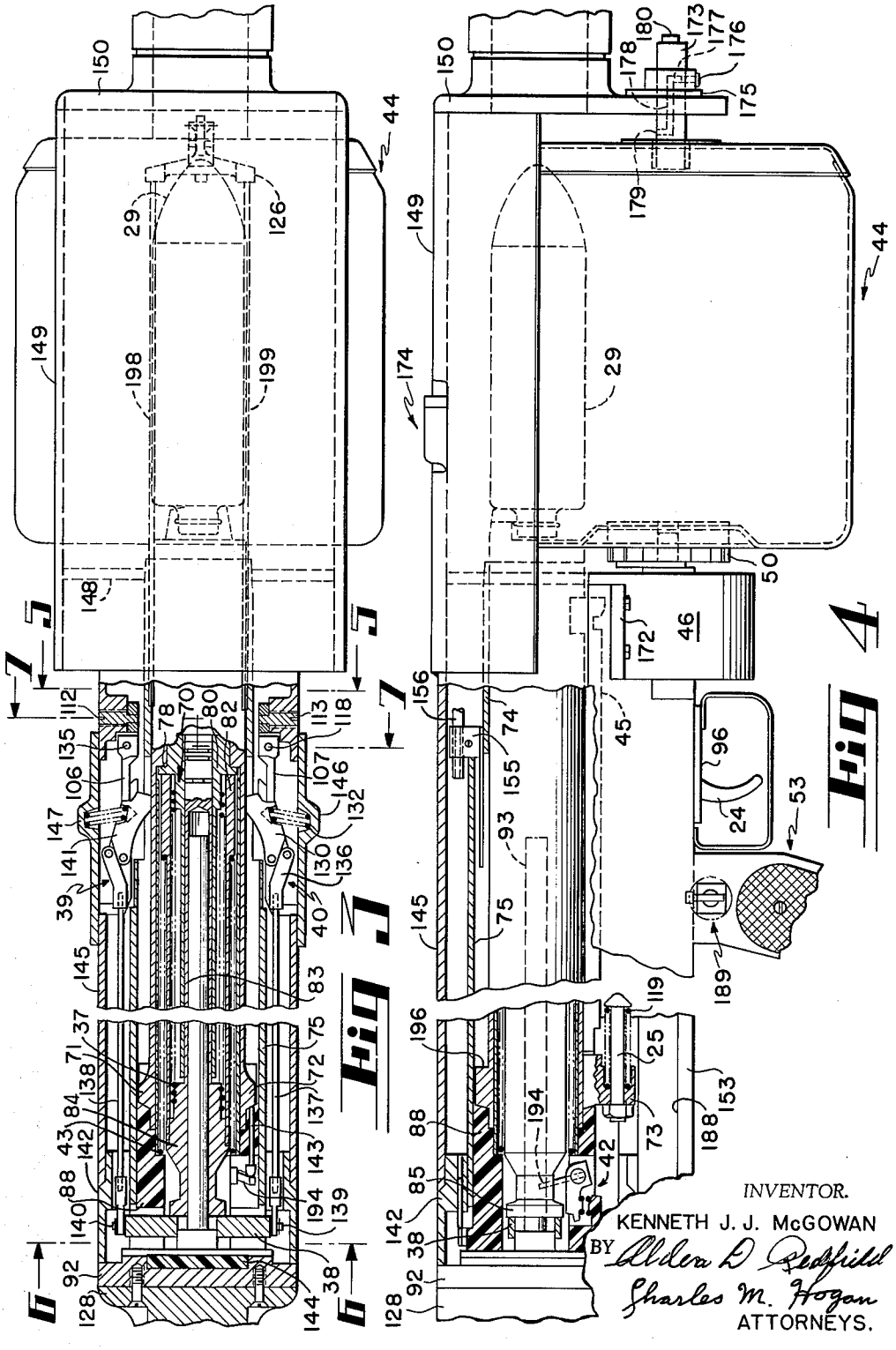

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ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM

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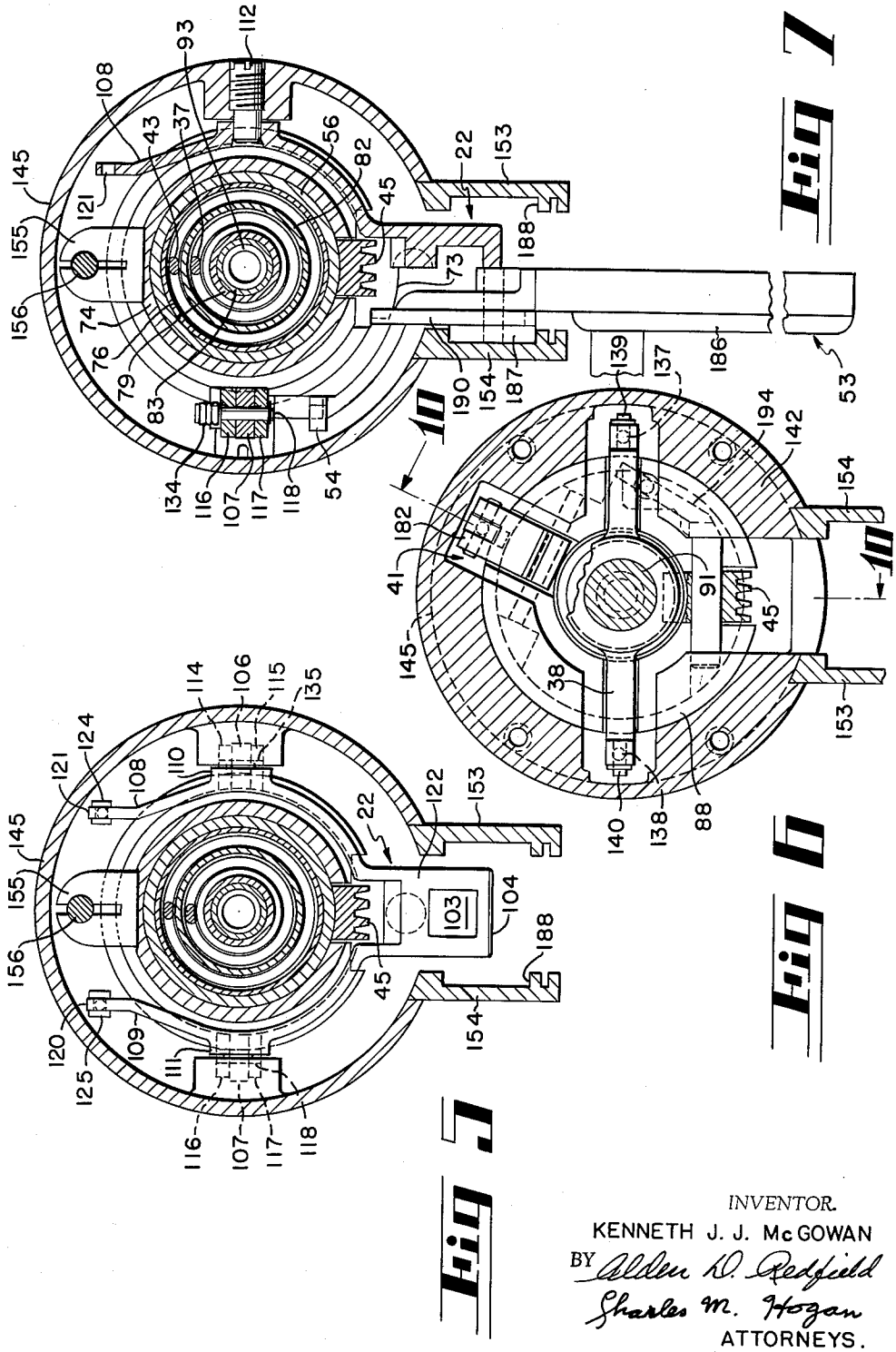

Fig. 7

Fig. 6

Fig. 5

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ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM

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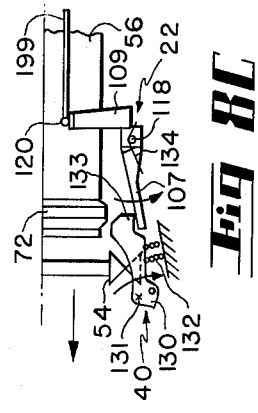

Fig 8C

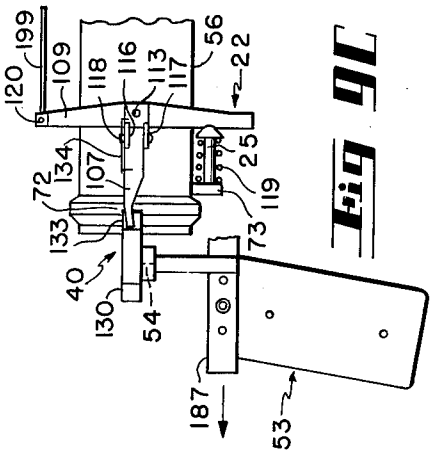

Fig 9C

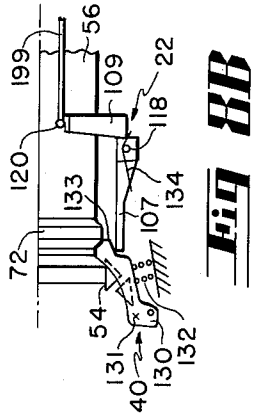

Fig 8B

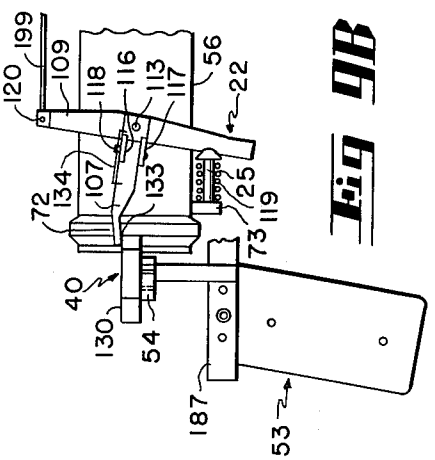

Fig 9B

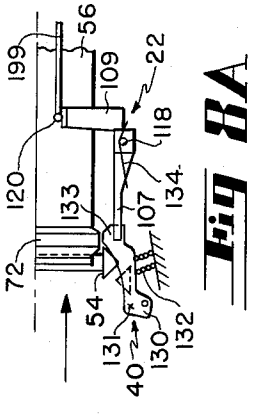

Fig 8A

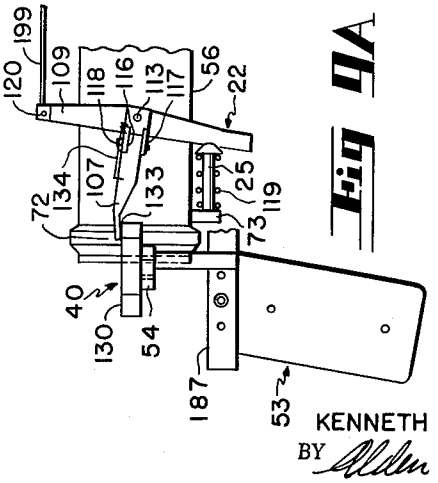

Fig 9A

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ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM

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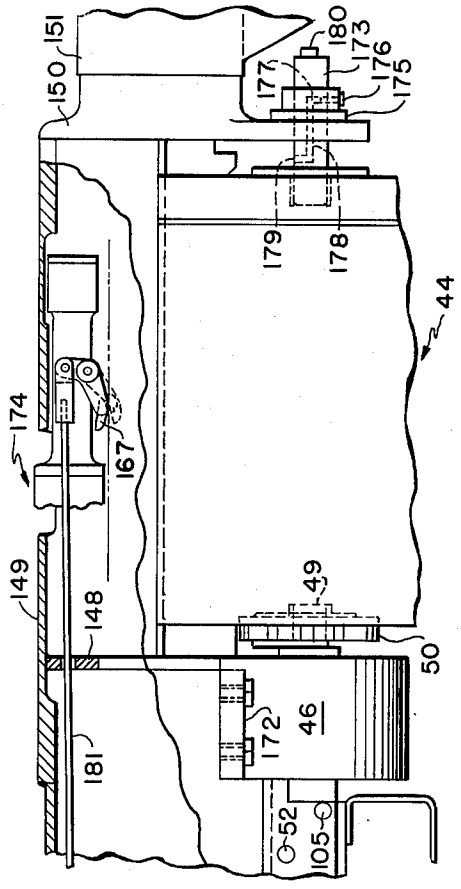
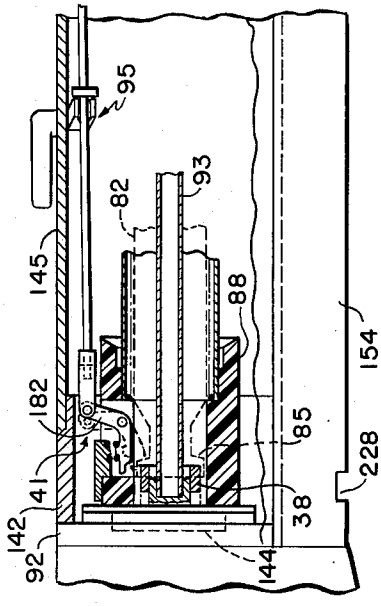


Fig 10



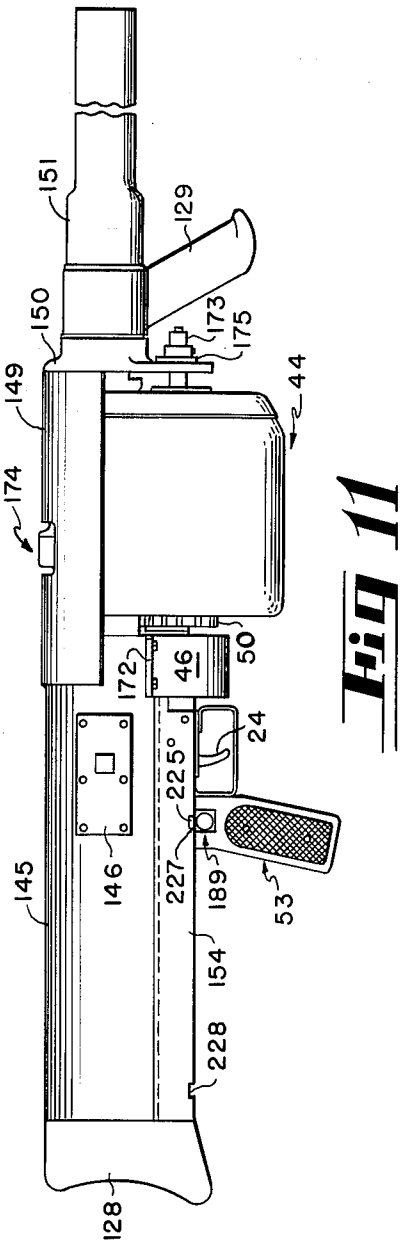


Fig 11

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ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM

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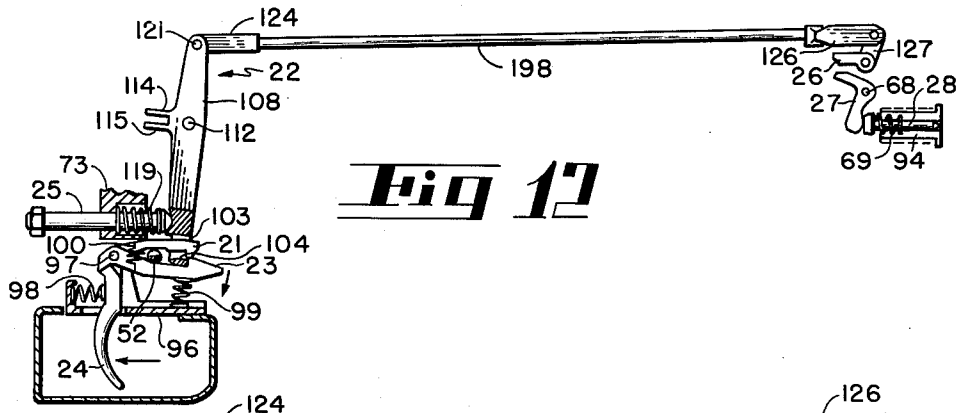

Fig 12

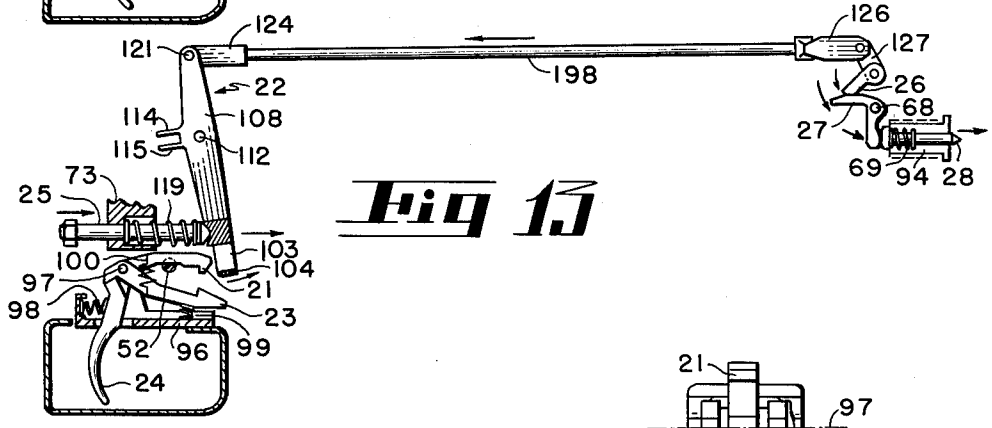

Fig 13

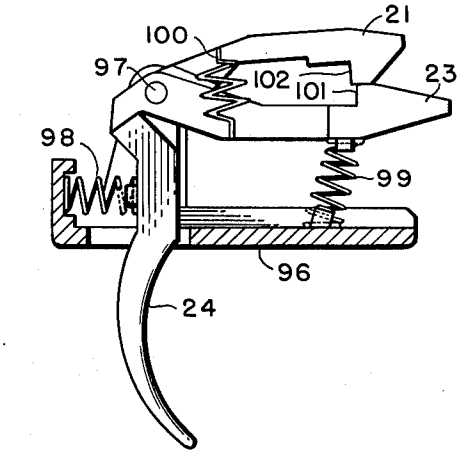

Fig 14

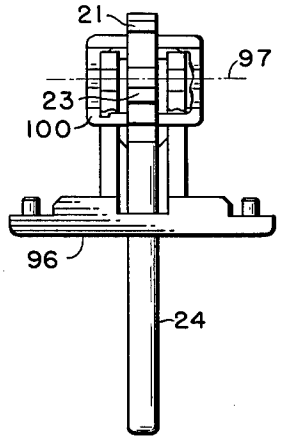

Fig 15

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ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM

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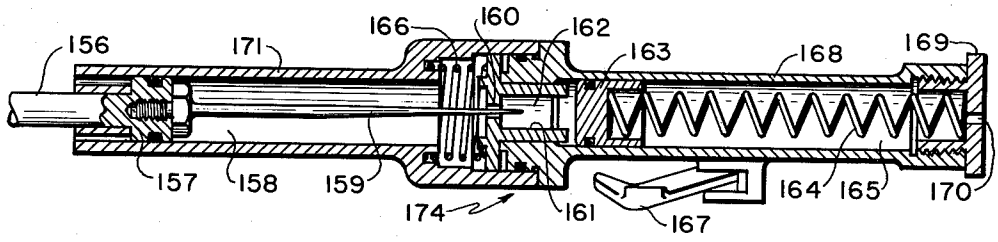

Fig 16

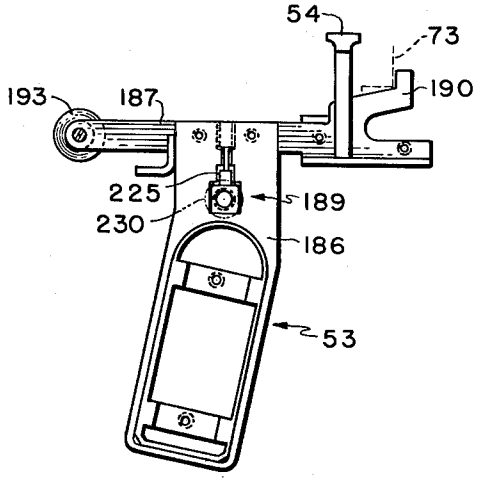

Fig 17

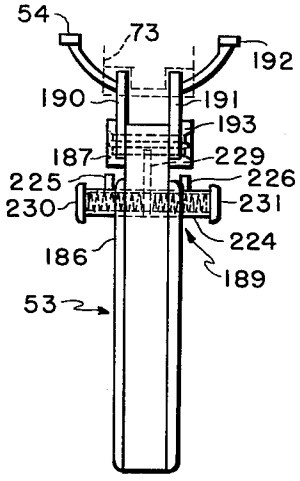

Fig 18

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ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM

Filed Oct. 15, 1963 8 Sheets-Sheet 8

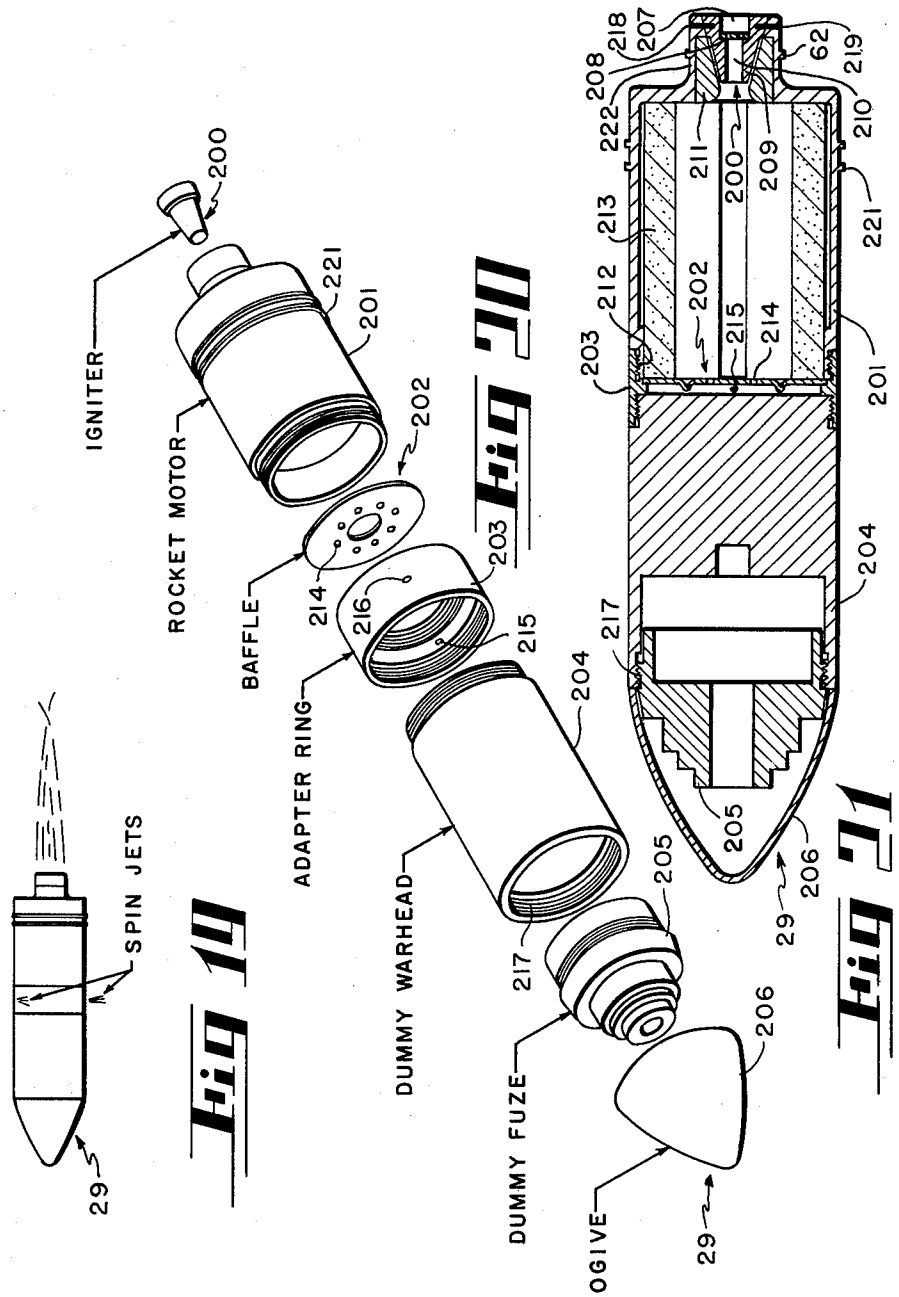

Fig 10

Fig 11

Fig 1

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United States Patent Office

3,204,530
Patented Sept. 7, 1965

3,204,530

ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM

Kenneth J. J. McGowan, Richmond, Ind., assignor to Avco Corporation, Richmond, Ind., a corporation of Delaware

Filed Oct. 15, 1963, Ser. No. 316,224
47 Claims. (Cl. 89—183)

The present invention is directed generally to ordnance and it resides in the field of automatic weapons systems. It is addressed more particularly to the provision of caseless, rocket-type ammunition and an automatic weapon for firing the same.

Ammunition for automatic weapons of the general type under consideration has heretofore been characterized by the presence of a cartridge case, which presents numerous problems relating to the ejection of the case of a fired round and the feeding of a new round into the firing chamber. Such ammunition is further characterized by problems of precision in manufacture and disposition of expended cases.

Problems pertaining to case ammunition have complicated the construction of automatic repeating weapons and required that the bolt action of gas-operated guns and the like be controlled by complex offset cams and linkages displaced from the line of fire.

Prior art rocket launching devices are generally fired by electrical ignition.

The present invention constitutes a radical departure from the three above-mentioned approaches, and is presented as a solution of the problems which they involve, in that the automatic weapon provided in accordance with the present invention percussively fires caseless rocket-type ammunition, and in that the bolt action of the weapon is controlled by a simplified operating mechanism in the line of fire.

The objects of the present invention, not enumerated in the precise order of emphasis, are to provide:

First—A lightweight, portable, rapid-fire, artillery defense system;

Second—A system particularly suitable for tactical operations in the field;

Third—A system including caseless percussion-fired rocket-type ammunition;

Fourth—A system featuring an automatic rocket-launching weapon having an unusually high ratio of fire power to weight;

Fifth—A shoulder-fired, low-recoil, automatic launcher;

Sixth—A launcher readily adapted to magazine or belt feed and to mounted, dismounted or platform use;

Seventh—An automatic repeating weapon comprising a bolt, and operating means disposed directly behind the line of fire for the purpose of exercising control over bolt unlocking, bolt advancement and retraction;

Eighth—An automatic weapon characterized by a high firing rate, the bolt being retracted by the forces of a tension spring—i.e., by "pulling" action;

Ninth—An automatic weapon incorporating various safety features in addition to the usual manually operated safety lever, such features including a mechanism assuring that the weapon cannot be fired unless the bolt is in battery position, and a mechanism assuring that the hammer cannot be armed unless the bolt is locked;

Tenth—A weapon including trigger and sear features providing a choice of automatic or semi-automatic fire;

Eleventh—A weapon which may readily be assembled and disassembled in the field;

Twelfth—A weapon which combines both passive and positive safety controls in that no force is exerted to arm the hammer linkage unless the bolt approaches battery and in that the hammer linkage is restrained against arming unless the bolt is locked;

Thirteenth—A compact rocket-launching weapon which requires the same order of space as the present .50 caliber machine gun;

Fourteenth—A relatively flashless, noiseless and smokeless weapon system, providing the individual combat infantryman with anti-tank assault capabilities; and

Fifteenth—A portable one-man automatic weapon system fully effective against armored vehicles at ranges in excess of one mile.

In considering the means by which these objects are sought to be attained, emphasis has, in the conception of the invention, been directed to the operating means or rod, the composite of the safety features, the ammunition, and the adaptation of the weapon features to the ammunition.

For a better understanding of the present invention together with other and further objects, advantages and capabilities thereof, reference is made to the following description of the accompanying drawings in which there is illustrated a complete weapons system employing an automatic weapon and ammunition in accordance with the present invention.

Description of drawings

FIGS. 1A and 1B together are a longitudinal sectional view of a preferred form of automatic weapon in accordance with the invention, taken along section line **1A—1A** of FIG. 2 and looking in the direction of the arrows, the conditions being those which prevail when the weapon is set for semi-automatic fire and is ready to fire in response to a pull on the trigger, FIG. 1B being a continuation of the right side of FIG. 1A so far as the weapon is concerned;

FIG. 2 is a longitudinal sectional view of said automatic weapon, generally as taken along the section line **2—2** of FIG. 1A, looking in the direction of the arrows, with certain parts shown in elevation and not in section for purposes of emphasis;

FIGS. 3 and 4 are, respectively, top and side views, with parts broken away for clarity in exposition, showing the conditions which prevail after a round has been fired and the operating rod and unlocked bolt have completely retracted;

FIGS. 5, 6, and 7 are fragmentary sectional views taken along the section lines **5—5**, **6—6**, and **7—7** of FIG. 3, in each case looking in the directions of the arrows, these figures emphasizing, respectively: the rocker arm; the end piece and bolt-unlocking yoke; and the composite of the rocker arm and the handgrip-operated lugs and arms;

FIGS. 8A and 9A, 8B and 9B, 8C and 9C are pairs of top and side views of the bolt lock and rocker arm release devices showing the positions of the parts under the following conditions, respectively: bolt not yet locked, bolt locked, and bolt being manually retracted from battery;

FIG. 10 is a fragmentary longitudinal sectional view of the weapon, as taken along the section line **10—10** of FIG. 6, emphasis being directed to the round-sensing pawl and is associated latch;

FIG. 11 is a pictorial outline or silhouette of said automatic weapon;

FIG. 12 is a side elevational view of the trigger, rocker arm, and hammer mechanisms under the conditions of semi-automatic fire, before the trigger is pulled, the upper hammer being safe;

FIG. 13 is a view generally similar to FIG. 12 but show-

ing the parts in the positions assumed after the trigger has been pulled and at the instant of firing;

FIGS. 14 and 15 are side and end elevational views of the trigger and sear mechanism;

FIG. 16 is a longitudinal sectional view of the front buffer, taken along its central axis;

FIGS. 17 and 18 are side and front views of the handgrip and slide subassembly;

FIG. 19 is a side view of a round of rocket ammunition in accordance with the system concepts of the invention;

FIG. 20 is an exploded perspective view of such round showing the parts disassembled; and

FIG. 21 is a longitudinal sectional view taken along the central axis of the round of ammunition of FIGS. 19 and 20.

Cycle of operation

The description at this point of a cycle of operation will facilitate understanding of the construction of the novel weapon. The assumed conditions are: First, semi-automatic fire; Second, a round in the chamber **20** (FIG. 1B); Third, bolt groups **36** locked in battery position.

The parts referred to in this section of the specification are generally shown in FIGS. 1A, 1B, and 2, but references to additional figures are made as necessary. The cycle of operation is as follows:

First—The upper sear **21** (see also FIGS. 12–15) is not engaging the rocker arm **22**, but the rocker arm is held back (in its counterclockwise position) by the lower sear **23**.

Second—The trigger **24** is pulled, and both sears **23** and **21** are urged, sear **23** turning slightly clockwise, freeing the rocker arm **22**.

Third—Spring-biased pusher **25** pushes the rocker arm **22** counterclockwise, and this motion is transmitted to upper hammer **26**, causing it to rotate counterclockwise and to strike lower hammer **27**.

Fourth—The lower hammer strikes the firing pin **28**, causing the round **29** to fire.

Fifth—Gases flow rearwardly through ports **30** and **31**, driving major piston **32** rearwardly, piston **32** driving minor piston **89** and operating rod group **33** rearwardly.

Sixth—The annular flange **34** on the piston **32** strikes annular shoulder **35** on the bolt group **36** so that the piston **32** is arrested, but the momentum of the operating rod group **33** is such that it continues to move rearwardly.

Seventh—As the operating rod **33** moves rearwardly, it stretches tension spring **37**.

Eighth—The operating rod strikes yoke **38**, and this motion is transmitted to bolt locks **39** and **40**, unlocking the bolt group **36**. The operating rod is latched in rearward position by two independent latches **41** (see also FIG. 10) and **42**.

Ninth—The bolt group **36** flies back, retracted by the force of tension spring **37**.

Tenth—As the bolt group retracts it resests the hammer linkage, lower hammer **27** striking upper hammer **26**, causing rocker arm **22** to be rotated to its clockwise position.

Eleventh—If the trigger **24** is still being held back, upper sear **21** engages the rocker arm **22**. If the trigger is not being held back, the lower sear **23** engages the rocker arm **22**.

Twelfth—As the operating rod group **33** is retracted, it compressed spring **43**.

Thirteenth—The bolt group so controls a spring-powered intermittent motion mechanism as to cause the magazine **44** to turn to align a fresh round of ammunition with the firing chamber **20**, as soon as the rearward displacement of the bolt allows sufficient clearance. The magazine **44**, bolt rack **45**, housing **46** for the intermittant feed mechanism, spiral spring **47**, spring-winding gear **48**, driving member **49**, and driven member **50** of this intermittent feed mechanism correspond in structure and function to the similarly named elements disclosed in my copending United States patent application entitled "Intermittent Feed Mechanism for High-Inertia Load," filed in the United States Patent Office on September 30, 1963. Serial No. 312,670, and assigned to the same assignee as the present application and invention. Said copending patent application is hereby incorporated herein by reference, and reference is made thereto for a full description of the construction and operation and interrelationships of the magazine here designated **44** and the intermittent feed mechanism here designated **51**.

Fourteenth—The new round actuates the sensing pawl **167** and unlocks latch **41** (see also FIG. 10).

Fifteenth—The bolt group **36** unlocks latch **42**.

Sixteenth—Now the bolt group reverses direction (see also FIGS. 3 and 4), driven forward by the operating rod group **33**, which is driven by compressed spring **43**. If for some reason no new round were in position, the latch **41** would not be opened and operating rod group **33** and bolt group **36** would remain in their rearward positions.

Seventeenth—As the bolt group **36** flies forward, it causes the magazine feed mechanism to be reset or readied for another feed operation.

Eighteenth—The bolt group **36** rams the fresh round into the firing chamber.

Nineteenth—The bolt group **36** is locked in battery position by bolt locks **39** and **40**.

The firing of the first round of automatic fire corresponds generally to the first round of semi-automatic fire. In semi-automatic fire the upper sear **21** assures that the rocker arm **22** will be held in its clockwise position as the bolt group returns to battery, de-activating the upper hammer **26** so that the gun does not fire as the bolt group returns to battery. In automatic fire the rocker arm automatically so positions the upper hammer **26** that lower hammer **27** is impacted by upper hammer **26** and fires the weapon as the bolt group is locked in battery position. That is, plunger **25** automatically rearms the hammer **26** as the bolt group goes into battery—i.e., plunger **25** turns rocker arm **22** counterclockwise. This operation implies no restraint by the sears, and both sears **21** and **23** are "out of the way" of the rocker arm. Parenthetically, the invention includes another safety feature which requires that the bolt group be locked by locks **39** and **40** before rocker arm **22** moves counterclockwise, but this is discussed in detail later. Selector shaft **52** has been set for automatic fire, de-activating upper sear **21**. The trigger is being held back, de-activating sear **23**. Thus the gun fires as the bolt group returns to battery. The automatic fire cycle continues as long as ammunition is supplied and the trigger **24** is held back.

The above discussion assumes that the weapon has been set up for operation and provided with a full magazine. Suppose now that the weapon is being set up for firing, and that a full magazine is being supplied to it. Under those circumstances it is necessary to retract the bolt so that a round can be aligned with the firing chamber **20**. This retraction of bolt **36** is accomplished by a handgrip mechanism **53** and immediately associated parts. Suffice it for the present to say that the handgrip is unlocked and manually pulled to the rear—i.e., toward the gunner. This manual operation draws rearwardly a slide **187**, the function of which is two-fold: (1) to unlock the bolt locks **39** and **40**; and (2) to retract the bolt group **36** rearwardly, the operating rod **33** then being engaged by latch **41** (see also FIG. 10) to lock the bolt group in its rearward position. It has already been stated that the bolt group opens latch **42** as it approaches the fully retracted position. Then the fresh magazine is put in place and a round aligned with the firing chamber. In order to prevent the opening of latch **41** by the sensing of the presence of a round under these circumstances,

an independent manual control **95** for the latch **41** is provided in order to override the action of the sensing pawl—that is to say, the control **95** can be set in such manner either as to permit or to prevent control of the latch **41** by the round-sensing pawl **167**. Obviously when the magazine is being installed, control by the element **95** must be exercised as a safety feature.

The handgrip **53** is similarly retracted to extract a round from chamber **20** in the event of a misfire.

The bolt and operating rod groups

In the weapon in accordance with the invention, the bolt **36** (called "bolt group" because it comprises several interfitted components) performs these functions:

First, it chambers the ammunition (i.e., advances to ram the successive rounds of ammunition into the firing chamber **20**);

Second, it provides, when locked, a closure (FIGS. 1A and 2) for the rear end of the firing chamber;

Third, it controls the magazine feed mechanism **51** in such a way that that mechanism feeds a fresh round as the bolt group completes retraction, the feed mechanism being readied for such operation as the bolt group advances into battery;

Fourth, it provides a housing for the piston **32** and is in concentric relation to the operating rod group, and in these and other respects the bolt feature of the present invention is radically different from the prior art;

Fifth, it provides means for manually extracting an unexpended round, when desired;

Sixth, it carries pusher means **25** which, on advance stroke, causes the hammer mechanism to be armed;

Seventh, it carries lower hammer **27** and firing pin **28** means, which cannot be actuated unless the bolt group advances into battery position; and

Eighth, on retract stroke it opens the operating rod latch **42**.

The bolt group **36** (FIGS. 1A and 2) comprises: the forward bolt member or bolt proper **55**; the bolt extension **56**; the operating rod guide tube **70**; and the rack **45** (which controls the magazine feed mechanism). The rearwardly extending bore **66** in the bolt proper houses major piston **32**.

The forward bolt member **55** is generally cylindrical in section. It comprises a solid face piece **57**, axially bored at **58**, annularly grooved at **59**, **60**, forwardly projecting to provide a mounting for an extractor **61**, the latter being provided with a downwardly extending lip which slides forwardly over rim **62** of the round **29**.

The bolt proper **55** is formed with an integral intermediate section **63** and an integral solid rear piece **64**, formed with a rearwardly extending cylinder portion having a wall **65** and a bore **66**. The bolt proper is formed with a vertically extending well **67**, within which is mounted the crank-shaped lower hammer **27**, the latter being rotatably mounted on a pivot **68**. Laterally of the well **67** are formed in the bolt proper the axially extending gas ports **30** and **31**. Within the forwardly extending bore **58** is a retainer **94**, on which is slidably mounted the firing pin **28**, normally biased rearwardly by a compression spring **69**, seated in retainer **94**.

The rear portion of bore **66** into the bolt extension **56** extends is enlarged to provide a shoulder-limited fit for the bolt extension.

The bolt extension **56** is a rearwardly extending tubular member formed as follows:

At its front, with a reduced portion which tightly and securely telescopes into the bolt proper **55**;

Near its rear exterior, with an annular ring including locking shoulders **71** and **72**;

With suitable outer diameter so that the annular ring slides within rear bolt guide **75**, and the main portion of the bolt extension slides within forward bolt guide **74**;

With a suitable inner diameter to slide over the cylindrical sleeve **76**, which guides spring **43**.

With a forwardly located annular interior shoulder **77** against the rear surface of which the front surface to flange **78** of operating rod guide tube **70** abuts;

And with a frontal face **35** which arrests travel of major piston **32**.

The bolt extension **56** and the bolt proper **55** are suitabily shaped on the lower portions thereof to provide a longitudinally extending mounting for the bolt rack **45**, which, as stated above, controls the intermittent feed mechanism **51** for the magazine. The rear of the bolt rack is formed with a downwardly extending lug **73** through which the pusher **25** slidably projects, the pusher being normally biased forwardly by a compression spring **119**. The force of the spring **119** against the pusher is sufficient to turn rocker arm **22** counterclockwise unless the rocker arm is restrained.

Now, as to the operating rod guide **70**, a part of the bolt group, it is cylindrical and hollow throughout, and is formed as follows:

With a rearwardly extending bore **79** for slidably receiving the long inner sleeve portion **83** of the operating rod group **33** and also the reduced portion of major piston **32**, as well as minor piston **89**;

With an enlarged exterior diameter portion **80**, grooved to secure the forward end of tension spring **37**;

With an annular flange **78**, the front face of which abuts against the rear face of flange **77** of the bolt extension **56**;

And with a forwardly extending section **81** terminating in alignment with shoulder **35**.

It is now pointed out that the entire bolt group **36**, comprising bolt proper **55**, extractor **61**, bolt extension **56**, operating rod guide **70**, and rack **45** is advanced and retracted as a unit, which is therefore referred to as the "bolt group."

Referring now to the operating rod **33** (FIGS. 1A and 2), its functions are:

First, to be retracted by gas-operated major piston **32** to strike yoke **38** and unlock the bolt group;

Second, to tension spring **37** and draw the unlocked bolt group back;

Third, to compress spring **43** to store power to drive the operating rod and bolt groups forwardly to battery position;

Fourth, to be held retracted by latch **41** (FIG. 10) and to hold the bolt retracted until a fresh round is in place; and

Fifth, to be held retracted by latch **42** until the bolt opens latch **42**.

The operating rod group **33** comprises: an outer sleeve **82**, enlarged forwardly securely to seat the front end of compression spring **43**, and slidably mounted within bolt extension **56** with sufficient clearance to guide compression spring **43**; a concentric inner sleeve **83**, slidably mounted within operating rod guide portion **79**; and a rear body portion **84**, integral with sleeve **83**. The body **84** has these formations:

An annular shoulder **85** for engagement with latches **41** and **42**;

An annular ring portion **86** for securely fitting outer sleeve **82**; and

A reduced frontal portion **87** providing security for the rear end of tension spring **37**.

Note that a portion of tension spring **37** is in the circular space between element **82** of the operating rod group and element **70** of the bolt group. Also that a portion of compression spring **43** is in the circular space between element **82** and element **76**. Also, the tension spring **37** is connected between the operating rod group **33** (at **87**) and bolt group (at **80**), and that the compression spring **43** is connected between the operating rod group (the enlarged front portion of **82**) and the rear buffer **88**.

The elements **82**, **83**, and **84** are parts of the operating

rod 33, and such parts are therefore referred to herein as the "operating rod group."

Reference is now made to the gas-operated piston arrangement which drives the operating rod group to the rear when the weapon is fired. The chamber pressure increases, moves the round forwardly and outwardly, and the pressure is such that gases escape rearwardly through the ports 30 and 31 and drive the outer or major piston 32 rearwardly until flange 34 strikes shoulder 35. The outer piston impact and the continually escaping gases drive rearwardly a cylindrical inner minor piston 89, which is suitably grooved and ringed and provided with a connecting rod portion secured at 90 to the integral solid frontal portion of inner sleeve 83 of the operating rod 33.

It is reiterated that the piston 32 moves rearwardly relative to the bolt under the force of the gases mentioned above, until it strikes shoulder 35 of the bolt extension, whereupon the piston 89 and the operating rod continue to retract relative to the bolt.

Note is now made of the fact that, at the time when the retracted operating rod group 33 is released by the opening of latches 41 and 42, so that the compression spring 43 drives the operating rod forward, the operating rod at the same time drives the bolt forward, the forward surface of the outer sleeve 82 of the operating rod group bearing against the rear surface of the flange 78 on the bolt guide 70. The point is that the bolt group and the operating rod group always advance together.

Secured to the forwardly extending boss of a stand member 91, fixed to the end cap 92, is a forwardly extending tubular guide member 93 which fits into the interior bore of the operating rod group 33 so that the operating rod group is guided thereby.

The trigger and hammer mechanisms

In the weapon in accordance with the invention it is essential to firing that the rocker arm 22 (FIG. 2) be placed in a counterclockwise position. When the rocker arm is in this position it causes the upper hammer 26 to be positioned counterclockwise—i.e., in an armed position. For reasons which will be explained in a later portion of this specification, the rocker arm cannot be moved counterclockwise by pusher 25 unless the bolt locks 39 and 40 are locked.

Considering the second round of automatic fire, the pusher 25 positions rocker arm 22, when unrestrained, counterclockwise as the bolt group advances into and is locked in battery position, so that hammer 26 is also positioned counterclockwise and causes the weapon to fire as the bolt reaches battery position. As the bolt is retracted, the rocker arm 22 is moved clockwise as lower hammer 27 strikes upper hammer 26. When termination of automatic fire is desired, the trigger 24 is released so that the rocker arm 22 engages the lower sear 23.

It will be noted that, during automatic fire, the selector lever 52 is so positioned as to lift or turn upper sear 21 slightly counterclockwise so that the upper sear cannot engage the rocker arm 22. On the other hand, termination of semi-automatic fire is accomplished by upper sear 21, the selector lever 52 being positioned for semi-automatic fire to lower the end of upper sear 21. That is, the selector lever enables the upper sear for semi-automatic fire and disables it for automatic fire.

The discussion now proceeds to the details of the trigger and sears (as shown in FIGS. 12–15 and FIG. 2), and particularly to the conditions pertaining to the initiation of firing.

Pivotally secured in relation to vertical lugs on a trigger housing 96, as by a pivot 97, are a trigger 24, a lower sear 23, and an upper sear 21. The trigger and the lower sear are biased into their normal positions, as shown in FIG. 12, by compression springs 98 and 99, respectively. The trigger and lower sear are so formed and arranged that, when the trigger is pulled (i.e., turned clockwise) against the force of compression spring 98, the lower sear is lowered, or turned clockwise, against the force of compression spring 99, disengaging the lower sear 23 from the rocker arm 22 and permitting the pressure of spring 119 (FIG. 2), acting on pusher 25, to turn rocker arm 22 counterclockwise (if the bolt group is locked).

Parenthetically, at this point it should be noted that during automatic fire, when the bolt advances, assuming the trigger to be still pulled, there is no sear restraint on rocker arm 22, and the force of pusher 25 is sufficient to position rocker arm 22 counterclockwise (if the bolt group is locked). On the other hand, if the trigger has been released during automatic fire, or if a round of semi-automatic fire has been ordered and fired, there will be sear restraint on rocker arm 22 when the bolt advances, and the rocker arm 22 will remain in clockwise position, the force of the pressure of spring 119 on pusher 25 not being adequate to overcome such restraint.

It will be observed that firing of this weapon is always initiated by removing the restraint of the lower sear 23 from the rocker arm 22.

During semi-automatic fire, if the trigger has been released after the firing of a single round, then the lower sear 23 will restrain the rocker arm. To assure such restraint and to conclude semi-automatic fire, whether or not the trigger has been released, there is provided the upper sear 21. That is, if the trigger has not been released, the upper sear (surface 102) will hold the rocker arm portion 104 until the trigger is released, whereupon the lower sear (surface 101) holds the rocker arm at 104. The upper and lower sears are coupled together by a tension spring 100, the function of which is to maintain in or close to abutment the free ends of the two sears 21 and 23, except under those conditions when the setting of the selector lever 52 for automatic fire dictates that the upper sear 21 be maintained in a counterclockwise position.

The selector lever 52 is a simple shaft with a flattened or semi-cylindrical section extending transversely of the upper sear. For automatic fire it is desired to position the upper sear 21 out of the way of the rocker arm latching section or bight 104. Accordingly, the selector shaft is turned so that its round surface cams the upper sear counterclockwise. For semi-automatic fire, on the other hand, the selector shaft 52 is so turned as to present its flat surface to upper sear 21, permitting the end of the upper sear to drop.

While both sears are urged, and sear 23 turns clockwise (FIG. 13) as the trigger 24 is pulled to initiate semi-automatic fire, so that the lower sear 23 releases the rocker arm 22, the upper sear does not under that circumstance restrain the rocker arm, the cam formations of the lower and upper sears, particularly their cam surfaces 101 and 102, respectively (the former being ahead of the latter), being such that the upper sear does not engage the rocker arm under that circumstance. The weapon is always initially fired from the lower sear 23.

The rocker arm 22 is formed with a rectangular aperture at 103 (FIGS. 5 and 13) to provide a latching section or bight 104, and it is this section with which the sears engage.

A safety lever 105 (FIG. 2), similar in construction to selector lever 52, is provided for the purpose of preventing any firing at all unless the operator affirmatively desires firing. To this end a shaft 105, transverse to sear 23, is formed with a flattened or semi-cylindrical section which can be turned to two positions: one (safe) in which the round surface locks lower sear 23 against any clockwise movement at all, thus locking the rocker arm 22 in clockwise position; the other position in which the flat surface of shaft 105 is turned toward lower sear 23, permitting free clockwise movement thereof.

The keystone of the arming and safety arrangements of this gun is the rocker arm 22. Emphasis is directed to the fact that, when the rocker arm is in its clockwise position, the gun is safe. When the rocker arm is pushed

counterclockwise, the weapon is fired (if the bolt group is in battery on semi-automatic fire, or when it comes into battery on automatic fire). A passive safety feature, therefore, resides in the fact that lower hammer **27** cannot be impacted unless the bolt group is in or finally going into battery position.

Another important safety feature of the weapon resides in the fact that, on automatic fire, the upper hammer **26** cannot be placed in firing or armed position unless the bolt group, when advancing, is locked in battery position. Let it be assumed that the bolt is traveling forward to the point where the shoulder portions **71** and **72** of the bolt group are pressing the bolt lock pieces **130** and **141** outwardly (FIGS. 8A, 9A). Under this condition the spring-biased plunger **25** tends to turn rocker arm **22** counterclockwise to place the upper hammer in firing position. Now this weapon is provided with an additional safety feature to assure that this counterclockwise turning action of the rocker arm **22** cannot occur until the bolt locking action is complete (i.e., until the locking pawls **141** and **130** swing inwardly again—see FIGS. 8B, 9B). In other words, a safety feature of this weapon resides in the fact that the upper hammer **26** cannot be placed in firing position until the advancing bolt is locked in battery. To this end (see FIGS. 1A and 5) there are provided two rocker arm release devices **106** and **107** (pivotally mounted on lug pairs **114–115** and **116–117** on the rocker arm), the function of which release devices is to sense that the bolt locking pawls have been pushed outwardly (FIGS. 8A, 9A) by the forward-moving bolt, and to be restrained and in turn to restrain the rocker arm until those pawls swing inwardly (FIGS. 8B, 9B) to lock the bolt group. When the bolt group is locked, as it comes into battery, the locking pawls **141** and **130** are not in the path of the ends of the release devices **106** and **107**, and the rocker arm **22** is turned counterclockwise by pusher **25**.

The rocker arm member **22** (FIGS. 2, 5, and 7) is a generally wishbone-shaped member formed as follows:

First, with generally vertically extending arms **108** and **109**;

Second, with laterally extending and diametrically opposed integral bosses **110** and **111** bored to receive the stub shafts **112** and **113** on which the rocker arm is pivotally mounted;

Third, with a narrow bight portion **104** which constitutes the portion engageable with the sears;

Fourth, with a wider bight portion **122** formed with a central depression against which the pusher **25** abuts;

Fifth, with two pairs of rearwardly extending spaced lugs **114–115** and **116–117**, each pair being vertically bored to receive a pivot, such as the pivot **118**, on which the rocker arm release device **107** is mounted—similarly, rocker arm release device **106** is pivotally mounted on pivot **135** between rearwardly extending lugs **114** and **115**;

Sixth, with upwardly located apertures **120** and **121**, providing the pivotal points to which the connector portions of the linkages which actuate the upper hammer are individually attached.

Now, as to the linkages which have just been mentioned, these include connectors **124** and **125** (FIGS. 2 and 5), utilized to control the hammer positioning. Connector **124** is pivoted at **121**, and connector **125** is pivoted at **120**. The forward ends of the connectors **124** and **125** are secured to the upper hammer yoke **126** by rods **198** and **199** (FIG. 3). The upper hammer yoke **126** is slidably mounted in such fashion that, when the weapon is armed, yoke **126** is in its rearward position, and when the weapon is not armed, it is in its forward position. The hammer yoke **126** (FIG. 2) actuates upper hammer **26** through a link **127** in such manner that, when the rocker arm **22** is clockwise, the upper hammer **26** is in its unarmed, or upper, position. When the rocker arm is counterclockwise, the hammer **26** is in its armed or lower position, whereat it strikes lower hammer **27**. As has already been stated, the bolt retracts after firing, so that the lower hammer **27** strikes the upper hammer **26** and causes the rocker arm **22** to be restored to its clockwise position.

A comment on the composite of the various safety features is now in order. Note that no adequate force tends to move arm **22** counterclockwise unless the bolt group is in battery. This is a passive safety feature. Note further that the arm **22** is restrained against counterclockwise movement unless the bolt group is locked. This is an active safety feature. Note still further that the hammer **27** cannot strike the hammer **26** unless the bolt group is achieving battery position. It will be perceived that, in addition to the manual safety lever **105**, safety is assured by the composite of the three just-mentioned features.

As to the firing mechanism, the lower hammer **27** is pivoted within the recess **67** (FIG. 2), the pivot being horizontal. The lower hammer **27**, when it strikes the upper hammer **26**, drives the firing pin **28** forwardly so that the round is percussively fired. The firing pin **28** is normally held in its rearward position by compression spring **69**.

On semi-automatic fire, of course, the upper hammer **26** strikes the lower hammer **27** to drive firing pin **28** forwardly to fire the round.

Bolt locking and unlocking mechanisms

Reference is made to the bolt lock **40** illustrated in locking condition in FIGS. 8B and 9B, and in not-yet-locked condition in FIGS. 8A and 9A. It comprises a locking pawl **130** pivotally mounted at **131** at a point near its rear. Its swinging end is biased toward locking position by a compression spring **132**. When the bolt group is locked, pawl **130** is in its counterclockwise, or inner, position (FIGS. 8B, 9B). Just before the bolt group is locked, during its forward travel, the bolt group shoulder **72** pushes pawl **130** into a clockwise position (FIGS. 8A, 9A). When in the latter position, a surface **133** on the free end of the pawl **130** has moved sufficiently outwardly of the bolt to be in the counterclockwise path of rocker arm release lever **107** (FIG. 9A), and it is this relationship which prevents rocker arm **22** from turning counterclockwise. On the other hand, when the bolt is locked (FIGS. 8B, 9B), the lug **133** on pawl **130** clears the free end of the rocker arm release member **107**, so that the rocker arm **22** is free to be turned counterclockwise by pusher **25** (from the FIG. 9B position to the FIG. 9C position). A torsion spring **134** is mounted on the pivot **118** for the rocker arm release device in such manner as normally to urge the free end of that device inwardly, for a purpose which will be described later herein.

Parenthetically, it will be understood that the construction and operation of bolt locks **39** and **40** and rocker arm release devices **106** and **107** and their associated controlling linkages are similar, the bolt locks and rocker arm release devices being symmetrically constructed and arranged. Therefore, the detailed description of the bolt lock **40** and associated members need not be repeated with reference to bolt lock **39** and its associated parts.

Bolt lock **40** is released by a link **136** (FIG. 1A), pivotally secured to pawl **130** at **152**, and the rear end of this link **136** is rigidly secured to a rod **137**, which in turn is secured by a connector to the bolt-unlocking yoke **38**. As previously indicated, it will be understood that rods **137** (for releasing **40**) and **138** (for releasing **39**) are identical and cooperate in performing the same function, these rods being secured to the bolt-unlocking yoke **38** at **139** and **140**, respectively.

It has already been stated that, at the end of its rearward travel, the operating rod group **33**, specifically portion **85** thereof, strikes the bolt-unlocking yoke **38**, causing rods **137** and **138** to be drawn rearwardly, thereby

drawing the free ends of pawls 130 and 141 outwardly away from the bolt shoulders 72 and 71, respectively, thus unlocking the bolt group.

Now considering how the bolt group is locked, when the bolt advances into battery, its shoulder portions 71 and 72 simply slip under the free ends of the pawls 141 and 130, and, those ends being spring-biased, the pawls are pressed into engagement with the rear surfaces on shoulders 71 and 72, respectively, of the bolt. The rods 137 and 138 and bolt-unlocking yoke 38 are accordingly drawn forwardly as the bolt group is locked.

FIGS. 8C and 9C are discussed later herein, in the section relating to the handgrip.

The buffers

The forward buffer is designated generally in FIG. 2 by the reference numeral 174. This buffer is purely conventional and need not be described in detail. It decelerates the bolt and operating rod groups as they travel forwardly, and it is of the viscous type.

The forward buffer comprises an impact piston extension 155 (FIG. 2) which is slidably mounted and guided for translatory motion along the top of portion 74 of the bolt guide. The arrangements are such that, as the bolt group comes forward, the upper arcuate portion of the enlarged ring portion 196 of the bolt group strikes the impact piston extension 155 and moves it forwardly. Shoulders 71 and 72 are formed in this annular ring portion 196.

Referring now to FIG. 16, the following actions then occur: The impact piston extension 155 moves rod 156 forwardly, and that rod in turn drives impact piston 157 forwardly within the oil compression chamber reservoir 158. Secured to the forward face of the impact piston 157 is a throttle needle which, as it moves forward, progressively narrows the oil flow aperture 160 on throttle plate 161. As oil flows from chamber 158 into chamber 162, it drives piston 163 forwardly against the force of return spring 164, disposed within the bleed chamber 165. The throttle plate is biased into its normal forward position by a compression spring 166.

Parenthetically, for purposes of convenience, the round-sensing pawl 167 is pivotally mounted on the bleed chamber housing 168. The bleed chamber is provided with a suitable cap 169, which is formed with a port at 170 to release the air compressed in buffing.

O-rings are provided to seal surfaces against leakages, as shown, all in a conventional manner. The compression chamber reservoir is housed in cylinder 171, which is enlarged at its forward end to receive in oil-tight fit the rear end of bleed chamber housing 168.

When the bolt retracts, the rearward movement of piston 163 forces oil back into reservoir 158, forcing piston 157 rearwardly and driving the impact piston extension 155 back to its rearward position (FIG. 4).

The rear buffer 88 is a plastic plug (FIGS. 1A, 2, 3, and 4) generally cylindrical in shape and interiorly longitudinally bored. Near the fore portion the bore has an enlarged section to interfit with the spring guide 76, followed by a still more enlarged section terminating in a bevel so as to provide a complementary bumper surface for the enlarged ring portion 196 of the bolt group. The rear buffer aids in arresting the rearward movement of the bolt group and absorbs the shock incident to the arrest of the bolt group.

The housing and frame

Before concluding this specification with a description of the operating rod latches 41 and 42, magazine replacement, extraction, and handgrip retraction of the bolt, it is in order to discuss briefly the housing and frame arrangements.

The housing is formed at the rear with a suitable butt stock 128 (FIG. 11), and at the front with a grasp handle 129. The rear of the housing for the operating parts is closed by a generally circular rear cap member 92 (FIG. 1A), countersunk on its forward face to provide a recess for a wafer-shaped shock absorber 144. Secured on the forward face of this wafer 144 is the stand member 91 which supports the inner tubular guide 93 for the operating rod group. Positioned forwardly of the wide flanged portion of stand 91 is the end piece 142, best illustrated in FIGS. 1A and 6. This end piece is circular but is formed with a generally cruciform cutout to provide room for the bolt unlocking yoke 38 and other parts presently described. The main portion of the housing comprises a generally tubular cylindrical jacket 145 which is provided with windows on each side, those windows providing access to the bolt locks and being closed by plates 146 and 147 (FIG. 3) screwed onto cylinder 145. Cylinder 145 terminates adjacent a forward transverse partition 148, to the upper edge of which is secured a semi-cylindrical hood 149. The latter serves as a top cover for the magazine, and it terminates adjacent a front cap 150 which is bored and provided with suitable fittings to secure the removable barrel 151 (FIG. 11), the latter being screw-threaded at its rear exterior for that purpose.

The rear cap 92 and rear end piece 142 and the cylinder 145 are cut out at the bottom to provide room and security for channel members 153 and 154 (FIGS. 6 and 11), the purposes of which will be discussed in connection with the description of the handgrip 53.

As best seen in FIGS. 11, 4, and 2, the cylinder 145 is further formed, immediately aft of partition 148, with a pair of laterally extending lugs (see element 172), only one of which is illustrated, to which lugs the housing 46 for the intermittent feed mechanism for the magazine is bolted. One of these lugs is on each side of the cylinder.

The magazine 44 is mounted between shaft 49 and pin 173 (FIG. 2). Pin 173 is slidably secured within a retainer 175. The retainer is fitted with a screw 176 which projects into a groove formed in pin 173. When the magazine is in place, screw 176 projects into forward transverse portion 177 of this groove. When the operator desires to remove the magazine, he turns pin 173 counterclockwise, retracts pin 173 away from the magazine by approximately the length of longitudinal groove portion 178, and then turns pin 173 counterclockwise so that screw 176 fits into the rear groove portion 179. The pin is turned as by a manually operable crank handle 180. When the pin 173 is retracted, as aforesaid, the magazine 44 is simply removed from shaft 49 and pin 173, and a new full magazine is installed, whereupon, by reverse manipulation of crank handle 180, the pin 173 is pushed toward the new magazine and the new magazine is locked into place.

The operating rod latches

The round-sensing pawl 167 (FIGS. 10 and 16) is pivotally mounted with reference to housing 168 of the forward buffer 174, this being simply a convenient location. It displaces a rod 181 (FIG. 10), which in turn positions the pivotally mounted pawl 182 of latch 41 in such a manner that when a round is in position, ready to be chambered by the forward movement of the bolt group, the operating rod is unlatched. However, when there is no round in this position, ready to be rammed into battery, then the linkage 167, 181, 182 operates in such a manner that the operating rod is latched to the rear, pawl 182 locking with portion 85 of the operating rod for that purpose.

The action of the sensing pawl may be overridden, if desired, by manual control 95, the function of which is to grip the rod 181 and position the latching mechanism 41 to hold the operating rod in retracted position even though there is a new round in the chamber.

The other operating rod latch 42 comprises a pawl 184 (FIG. 2) pivotally mounted in a recess formed in the rear buffer 88, and this pawl is normally biased into latch-

ing position by a compression spring **185**. This latch is so constructed and arranged as to engage and hold the operating rod (at **85**), and to hold the operating rod until the bolt flies rearwardly and disengages pawl **184** from portion **85** of the operating rod. The bolt accomplishes this by pushing pin **143** (FIG. 1A) to the rear, turning arm **194** on pawl **184** counterclockwise (FIG. 2).

The handgrip subassembly

The handgrip comprises a downwardly projecting, manually manipulable handle **186** which is secured to a horizontally extending slide or carriage member **187** (FIGS. 2, 17, 18). The slide member is adapted to slide within the channel members **153** and **154** (see also FIG. 6) on track formations **188**. A conventional catch **189** locks the handgrip mechanism in its forward position, and the catch is released to permit retraction of the handgrip mechanism. Wheels **193** are mounted on each side of the rear of the carriage **187** to facilitate its translatory motion.

The purpose of the carriage member **187** is to withdraw the bolt to the rear. Accordingly, there is attached to the slide a bolt-withdrawal yoke device comprising a pair of forwardly and upwardly extending arms **190** and **191**, so spaced and located (slightly in front of lateral projections on member **73** when the bolt is in battery) that they can be moved rearwardly to engage with the front of said lateral projections (FIGS. 7, 17 and 18) on the bolt. As the handgrip is drawn to the rear, after sufficient motion of the slide member or carriage **187** to unlock the bolt locks, these arms **190** and **191** draw the bolt group and operating rod group to the rear.

Also attached to the carriage **187**, to the rear of the bolt-engaging portions of arms **190** and **191**, are a pair of vertically and outwardly extending arms **54** and **192**, triangularly cam-surfaced at their tops to strike similar cam surfaces on pawls **130** and **141** and to cam outwardly the pawls **130** and **141**, therefore unlocking the bolt group. Note the triangular cam surfaces at the top of **54** and on the inner under surface of locking pawl **130** (FIGS. 8A, 8B, 8C).

Before discussing further handgrip retraction action, let the bolt lock construction be further considered.

FIGS. 8A and 9A show the bolt group advancing forwardly but not far enough to be locked. The bolt lock pawl **130** is thus cammed out by shoulder **72** and prevents counterclockwise motion of the rocker arm release device **107**, because the bolt lock pawl **130** rides under the rocker arm release **107**. Note that the compression spring **119** which offers the motive power for the rocker arm's rotation is only partly compressed. When the bolt group advances further and is locked, locking pawl **130** swings inwardly and the rocker arm **22** swings counterclockwise, the free end of release device **107** dropping below the plane of the top surface of pawl **130** (i.e., from the FIG. 9B to the FIG. 9C position).

FIGS. 8C and 9C show the rocker arm **22** after a round has been fired. If a misfire occurs, there is no automatic impact of lower hammer **27** against upper hammer **26** to bring the rocker arm back toward its clockwise position as in FIGS. 8A and 9A. In order to manually open the bolt, the handgrip **53** is pulled to the rear, as has been stated. This causes the arms **54** and **192** to cam the bolt-locking pawls **130** and **141** out, thereby releasing the bolt. Again considering FIGS. 8C and 9C, it is necessary for the rocker arm releases **106** and **107** to be able to swing outward as the bolt-locking pawls swing outwardly. Therefore, they are pivoted at **135** and **118** and spring-loaded toward their normal inner positions. They are constructed in such a way that they cannot swing inward any more than the position shown in FIGS. 8B and 9B. They are free to move outward (against bias), but not inward.

Referring further to the catch for the hindgrip, reference is made to FIG. 18. The catch comprises a transverse slide member **224** which is formed with upstanding lugs **225** and **226**. When the handgrip assembly is in its normal forward position, the lugs **225** and **226** engage notches on the underside of the members **153** and **154**. For example, referring to FIGS. 11 and 18, the lug **225** engages the notch **227** when the handgrip is in its normal forward position. On the other hand, when the handgrip is retracted, the lug **225** engages the notch **228** (FIG. 11). Lug **226** similarly engages with notches (not shown) on member **153**.

The transverse slide member **224** is spring-biased into its normal central position by a central barrier **229** and compression springs as shown in FIG. 18. The slide **224** is manually movable to either side, for purposes of disengaging the handgrip assembly from the members **153** and **154**, by spring-retaining buttons **230** and **231**.

Ammunition

Referring now to FIGS. 19, 20, and 21, there is shown a round of ammunition **29** provided in accordance with the present invention and suitable for use with the weapon fully described above and also so provided. The ammunition here disclosed for purposes of illustration is 40 millimeters in diameter, approximately 8 inches long, weighing 0.86 pound. It is powered by a solid propellant star-shaped grain approximately 70 grams in weight. It is spin stabilized and reaches a peak velocity at burn-out on the order of 1500 feet per second.

Basically the round here shown has four phases of operation during firing and flight toward a target:

(1) Ignition;

(2) Acceleration in the barrel **151**;

(3) Acceleration to peak velocity outside the barrel; and

(4) Free flight following burn-out of the propellant.

The ammunition comprises the following principal parts mechanically coupled in cascade, from rear to front: igniter **200**, rocket motor **201**, baffle **202**, adapter ring **203**, war head **204**, fuze **205**, all generally cylindrical in contour, and ogival cap **206**.

The igniter is of the percussion type. It comprises a primer **207**, a metallic baffle member **208** formed with ports, and a body **209**, the latter being suitably bored to provide a stem **210**. It will be understood that in firing, the firing pin strikes the primer **207**, igniting it by percussion; the primer projects a flame which causes ignition of of a charge in the bore **201**; and the ignition train then ignites the rocket propellant **213**; resulting in the generation of propellant gases which accelerate the rocket outwardly through the barrel and then in flight.

An igniter suitable for use in this ammunition is shown in the copending patent application of Anthony C. DeMatthew, Serial No. 248,564, filed in the United States Patent Office on December 31, 1962, entitled "Simplified Rocket Propellant Charge Igniter," and assigned to the same assignee as the present application and invention. A nozzle insert **211** is inserted in the rearwardly extending boss **222** provided on the rocket motor body **201**. The rocket motor body **201** is hollow and cylindrical in contour and is provided on its fore portion with a screw-threaded extension **212**. A star-shaped propellant grain **213** is placed within the rocket motor body.

The rocket motor body and the war head are connected by an adapter ring or bulkhead **203**, the latter being interiorly threaded to fit the rocket motor body **201** and the war head **204** and being provided with an annular shoulder, the rear surface of which supports the main baffle member **202**. The baffle member **202** has transverse ports **214** which permit gases to escape from the rocket motor through angled transverse ports **215** and **216** formed in the adapter ring for purposes of spin stabilization.

The cylindrical war head **204** is provided with a threaded reduced portion at its rear and is accordingly screwed into the adapter ring **203**. The ogive **206** is of

the conventional bluntly frontally pointed formation, and it is press-fitted onto a dummy fuze **205**. The dummy fuze is screw-threaded at **217** into the fore part of the war head, such fore part being interiorly bored to receive the rearwardly projecting parts of the dummy fuze. It will be understood that the dummy fuze and the war head here shown may be replaced by any suitable time-delay fuze and war head for anti-personnel, anti-tank, incendiary, tracer, or pyrotechnic tasks.

Now going through a cycle of operation of the ammunition, the primer **207** is struck by the firing pin **28** (FIGS. 13, 19–21), hot gases from the primer pass through baffle **208**, and they ignite a boron potassium nitrate ignition mix, for example, in stem **210**. The burning ignition mix passes into the rocket motor chamber and starts the surface of propellant **213** burning. Gases generated by the burning propellant build up pressure. When sufficient pressure is achieved, the shear pins **218** and **219**, holding the igniter housing **209** to the rocket motor body, are broken and the housing is expelled rearwardly.

At this point the throat of nozzle insert **211** is fully opened, and the rocket motor beings to initiate flight. While the gases build up pressure in the rocket chamber, the gases are also passed through the strainer **202** into the spin jets **215** and **216**, so that the round is caused to rotate rapidly around its axis, or to spin. Initial spin sufficient to stabilize the round at launching is achieved by reason of standard rifling in the barrel **151** and the use of rotating bands such as **221** on the round.

In considering the relationship of the ammunition to the operation of the gun, let it be observed that the gases expelled from the nozzle **211** build up pressure in the firing chamber **20**. This pressure build-up continues until the round moves outwardly in the barrel, at which time chamber pressure decreases. Simultaneous with the pressure build-up in the firing chamber, gases are passed through the ports **30**, **31** on the face of the bolt (FIG. 1A), impelling piston **32** backwards and forcing the operating rod group **33** rearwardly. This action begins immediately, so that energy for feeding the next round is stored before the fired round leaves the barrel.

Conclusion

An additional word with reference to FIGS. 3 and 4 may be helpful at this point. FIG. 3 shows the condition of the operating parts after the trigger has been pulled and semi-automatic fire has occurred. The bolt has been unlocked and is in its fully retracted position. In FIG. 4 the bolt is fully retracted and has unlatched latch **42**, freeing the operating rod group.

While the specific embodiment of weapon in accordance with the invention and herein shown is a 40 millimeter portable weapon which approximates 15 pounds in weight unloaded and 23 pounds fully loaded with an eight-round magazine, it will be understood that the invention is applicable to other calibers of ammunition and to tactical warfare on land, sea, or in the air. The embodiment herein shown is accordingly presented by way of illustration and not of limitation. In the specific embodiment, the rear buffer **88** and the shock absorber **144** are made of a suitable plastic, such as Delrin; aluminum is used for the housing generally, and liberally among the moving parts. Many of the moving and operating parts are preferably constructed of steel. The selection of appropriate materials is well within the capability of those of ordinary skill in the art, with the disclosure before them.

While there has been shown and described what is at present considered to be the preferred embodiment of the invention, it will be understood by those skilled in the art that various changes and modifications may be made therein without departing from the proper scope of the invention as defined in the appended claims. Accordingly, it is intended in such claims to cover all modifications and changes as fall within the scope of the invention there defined.

What is claimed is:

1. In an automatic weapon of the type which includes a firing chamber and means for firing a round disposed in the chamber, the improvement which comprises, in combination:

a bolt mounted for reciprocal movement relative to said firing chamber, the bolt advancing forwardly into battery to chamber a round of ammunition and retracting rearwardly to permit a new round to be placed in position to be rammed;

means selectively operable to release the bolt or to lock the bolt in battery position;

operating means mounted in reciprocal movable relation to, and having a center of mass located substantially on the central longitudinal axis of said bolt;

said operating means retracting rearwardly to actuate said selectively operable means to unlock said bolt;

and elastic means mechanically secured between said bolt and said operating means to store bolt-retract energy as the operating means is retracted,

2. In an automatic weapon of the type which includes a firing chamber and means for firing a round disposed in the chamber, the improvement which comprises, in combination:

bolt means mounted for reciprocal movement relative to said firing chamber, the bolt means advancing forwardly into battery to chamber a round of ammunition and retracting rearwardly to permit a new round to be placed in position to be rammed;

releasable locking means for locking the bolt means in battery position;

operating means mounted in reciprocal movable relation to said bolt means;

means for releasing the locking means, said operating means retracting rearwardly to actuate said releasing means to unlock said bolt means;

and a tension spring disposed between said operating means and said bolt means, said tension spring being stretched by rearward movement of the operating means relative to the bolt means so that it retracts the bolt means when the bolt means is unlocked.

3. In an automatic weapon of the type which includes a firing chamber and means for firing a round disposed in the chamber, the improvement which comprises, in combination:

bolt means mounted for reciprocal movement relative to said firing chamber, the bolt means advancing forwardly into battery to chamber a round of ammunition and retracting rearwardly to permit a new round to be placed in position to be rammed;

releasable locking means for locking the bolt means in battery position;

operating means mounted in reciprocal movable relation to, and on substantially a common axis with, said bolt means;

means for releasing the locking means, said operating means retracting rearwardly to actuate said releasing means to unlock said bolt means;

a tension spring disposed between said operating means and said bolt means, said tension spring being stretched by rearward movement of the operating means relative to the bolt means so that it retracts the bolt means when the bolt means is unlocked;

and compression spring means for advancing said bolt means and said operating means forwardly.

4. The improvement in accordance with claim **3** in which said compression spring is disposed between said operating means and a reference point, said compression spring being compressed when the operating means retracts relative to the bolt means, to supply energy to advance both the operating means and the bolt means forwardly upon arrest of the rearward motion of the operating means.

5. The improvement in accordance with claim 4 in which the bolt means is formed in concentric relation to the operating means.

6. The improvement in accordance with claim 5 in which the bolt means is apertured and adapted to be traversed by high pressure gases generated by firing of the round in the firing chamber and in which the bolt means is further formed to house and to permit limited movement of piston means, and piston means within said bolt means and adapted to be actuated by said gases to drive the operating means rearwardly.

7. The improvement in accordance with claim 6 and including a first latching means for holding the operating means in its rearward position, said bolt means being so constructed and arranged as to open said first latching means when the bolt means reaches its rearward position.

8. The improvement in accordance with claim 7 in which the firing means includes a firing pin carried by the bolt means, and which improvement further includes hammer means adapted to be armed to activate the firing pin when the bolt means is in battery position.

9. The improvement in accordance with claim 8, and arming means comprising a rocker arm connected to the hammer means and movable between safe and arming positions.

10. The improvement in accordance with claim 9, and pusher means carried by the bolt means for moving the rocker arm into armed position.

11. The improvement in accordance with claim 10 and including bolt-lock sensing means between the rocker arm and the bolt-locking means for preventing movement of the rocker arm into armed position until the bolt means is locked in battery position as it advances into battery.

12. The improvement in accordance with claim 11 and including trigger and sear means for restraining the rocker arm from moving into armed position until the trigger is pulled.

13. In a weapon of the type having a firing chamber, the combination of:

bolt means having an interior bore and a frontal portion formed with at least one gas passage therethrough,

and bolt-retracting means including gas-operated means mounted in said interior and responsive to gases, which develop while firing a round and traverse said passage, to be displaced rearwardly to initiate retraction of said bolt means.

14. The combination in accordance with claim 13 in which the bolt-retracting means comprises operating rod means and in which the gas-operated means comprises a piston,

said bolt means being formed to arrest the piston after a limited rearward travel of the piston relative to the bolt means,

said operating rod means being formed to travel further rearwardly relative to the bolt means in response to impact of the piston.

15. The combination in accordance with claim 14 in which the bolt-retracting means further comprises a first strainable elment secured between the bolt means and the operating rod means and adapted to be strained as the operating rod means moves rearwardly, thereby to store enregy used for retracting the bolt means.

16. The combination in accordance with claim 15, and releasable means for locking the bolt means in battery position.

17. The combination in accordance with claim 16 in which the operating rod means is formed to unlock said releasable means at the end of the rearward travel of the operating rod means.

18. The combination in accordance with claim 17, and a second strainable element between the operating rod means and a fixed reference point,

said second strainable element being strained as the operating rod means retracts, wherby to supply energy to advance the operating rod means and the bolt means into battery position.

19. The combination in accordance with claim 18 wherein the first strainable element is a tension spring and the second strainable elment is a compression spring.

20. The combination in accordance with claim 19, and first latch means released by retraction of the bolt for holding the operating rod means rearwardly.

21. The combination in accordance with claim 20,

round-sensing means,

and second latch means released by the round-sensing means for holding the operating rod means rearwardly, but responsive to the presence of a round in alignment with the firing chamber to release the operating rod means.

22. The combination in accordance with claim 21, and manually operable overriding means for holding the second latch means in latching position at the option of the gunner.

23. In an automatic weapon for firing rockets by precussion, the combination of:

a housing and frame including a tubular bolt guide and a barrel having a firing chamber;

a bolt group reciprocally movable within said bolt guide and comprising three principal parts:

First, a bolt member having a front face portion and an intermediate portion and a rearwardly extending tubular portion defining a piston chamber, said intermediate portion being formed with a vertically extending recess, said bolt member being formed with transverse gas passages in communication with said piston chamber, and said face portion being formed with a transverse bore;

Second, a tubular extension member projecting rearwardly from said bolt member; and

Third, a rearwardly extending tubular operating rod guide member in concentric relation to said extension member;

gas-operated piston means slidably mounted in said piston chamber;

an operating rod group in reciprocally movable relationship to said bolt group and adapted to be driven rearwardly by said piston means and comprising three principal parts:

First, an inner sleeve in concentric relation to and movable within said operating rod guide member;

Second, an outer sleeve in concentric relation to and movable within said extension member; and

Third, an intermediate body interconnecting said inner and outer sleeves at their rears;

a tension spring disposed between said body and said operating rod guide member;

a compression spring between said outer sleeve and a fixed refrence point;

a forwardly extending post mounted on said frame and extending forwardly into said inner sleeve to aid in guiding the operating group, the respective diameters of the concentric elements increasing in this sequence:

First, said post;

Second, said inner sleeve;

Third, said operating rod guide member;

Fourth, said outer sleeve; and

Fifth, said tubular extension member;

firing pin means mounted in said transverse bore in the bolt face portion;

and hammer means mounted in said vertically extending recess.

24. In a weapon, the combination of:

a barrel having a firing chamber;

a housing and frame including a bolt guide;

a rotary magazine including an intermittent feed drive;

a bolt formed for reciprocal movement relative to said

guide, the bolt being further formed to advance forwardly to ram a round of ammunition into battery position and to retract rearwardly to permit the magazine to place a new round in position to be rammed;
said bolt being formed with a rearwardly extending longitudinal bore;
an operating member within said bore;
said bolt and operating member being formed for reciprocal movement relative to each other;
means for locking the bolt in battery position;
means responsive to the firing of a round for driving the operating member rearwardly relative to the bolt;
a first spring connected between the operating member and bolt, said first spring being tensioned when the operating member is driven rearwardly relative to the bolt;
means actuated by said operating member, when moving rearwardly, for opening the locking means to permit the bolt to be pulled rearwardly by said first spring;
means for latching said operating member in its rearward position;
a second spring connected effectively between said operating member and said frame, said second spring being compressed when said operating member is driven rearwardly;
the latching means being opened when the bolt reaches its rearward position;
means carried by the bolt for controlling said intermittent feed drive to place a fresh round in position when the bolt retracts;
means carried by the bolt for firing a round when the bolt advances into battery;
and means for controlling the operation of the last-named means.

25. In an automatic weapon having a firing chamber, the combination of:
reciprocally movable bolt means formed with at least one gas pasage therethrough,
a gas generator in said chamber,
means carried by the bolt means for activating said generator,
means for locking said bolt in battery position,
and bolt-unlocking and retracting means including a gas-operated member positioned in the line of fire and adapted to be displaced rearwardly in response to gases developed in said chamber.

26. In an automatic weapon of the type which includes a firing chamber, the combination of:
a reciprocally movable bolt;
bolt-locking means;
firing means carried by the bolt;
a swingably mounted rocker member adapted to be turned to armed and safe positions, respectively, for activating or de-activating the firing means at the will of the gunner;
yieldable pusher means carried by the bolt for turning the rocker member into armed position as the bolt advances into battery;
bolt-lock sensing means between the rocker member and the bolt-locking means for preventing the rocker member from being turned to armed position unless the bolt is locked;
and hammer means mechanically coupled to said rocker member to be turned selectively into either a safe or an armed position;
said hammer means and firing means impacting to fire a round;
said hammer means being so constructed and arranged that the rocker member is turned to safe position when the bolt retracts.

27. In an automatic weapon, the combination of:
a reciprocally movable bolt formed with locking shoulders;
bolt-locking means comprising a pair of generally forwardly extending pawls individually pivotally symmetrically mounted on each side of the bolt and swingable toward each other and toward the locking shoulders to lock the bolt, said pawls also being swingable outwardly away from the locking shoulders to unlock the bolt;
firing means carried by the bolt;
a wishbone-shaped rocker arm member for firing control, said member being swingably mounted about a horizontal axis transverse to and forwardly of the bolt-locking means and comprising a lower portion and upwardly extending bifurcations formed with generally rearwardly extending pairs of lugs, said member having two terminal positions designated as "armed" and "safe" positions, the armed position being characterized by less forward inclination of said bifurcations;
yieldable means carried by the bolt for abutting against the lower portion of the rocker arm member to push the rocker arm member into armed position as the bolt advances into battery;
bolt-lock sensing means comprising a pair of generally rearwardly extending release devices individually mounted on said pairs of lugs, said release devices being underridden by surfaces on said pawls when the bolt shoulders, in advancing, swing the pawls outwardly, whereby said surfaces then block said devices to prevent turning movement of the rocker arm member toward armed position;
said surfaces being moved inwardly to clear said devices as the pawls lock the bolt, whereby to free the rocker arm member so that it may be pushed into armed position by said yieldable means;
and hammer means mechanically coupled to said rocker arm member and positioned in relation to the firing means so that the firing means is impacted by the hammer means to fire the weapon as the bolt is locked in battery, and so that the firing means impacts the hammer means to restore the rocker arm to safe position when the bolt retracts.

28. In an automatic weapon, the combination in accordance with claim **27** in which the hammer means is pivotally mounted upwardly of the bolt and coupled to the bifurcations of the rocker arm member by links, and in which the firing means is formed to be impacted by the hammer means when the hammer means is depressed by placement of the rocker member in armed position.

29. In an automatic weapon, the combination in accordance with claim **27**, and a handgrip mechanism for retracting the bolt manually, comprising a manually operated carriage formed with vertically extending lugs which engage said bolt to retract the same,
said carriage being formed further with upstanding arms having cammed surfaces which unlock the bolt,
said release devices being pivotally mounted on axes parallel to the rocker arm member so that they are pushed outwardly as the bolt locks are released.

30. In an automatic weapon of the type including a reciprocally movable bolt, firing control means comprising:
a rocker arm member swingably mounted about an axis transverse to the bolt;
yieldable means synchronized in movement with the bolt for biasing the rocker arm member toward armed position as the bolt advances into battery, said rocker arm member being turnable into an armed position and a safe position;
means controlled by said rocker arm member, when it is in armed position, for firing the weapon when the bolt is in battery;
means carried by the bolt for restoring the rocker arm member to its safe position when the bolt retracts;
and restraining means for precluding movement of the rocker arm member into armed position.

31. The combination in accordance with claim 30 in which the restraining means comprises sensing means responsive to unlocked condition of the bolt, when the bolt is advancing, to preclude movement of the rocker arm member until the bolt is locked.

32. The combination in accordance with claim 31,

a second restraining means comprising a first sear engageable with the rocker arm as it is restored to safe position,

and trigger means operable to place said first sear in or out of position to engage said rocker arm member.

33. The combination in accordance with claim 32, and a third restraining means comprising a second sear which is engageable with said rocker arm when it is restored to a safe position.

34. The combination in accordance with claim 33, and selector means for disabling said second sear.

35. The combination in accordance with claim 34 in which the means for firing includes an upper hammer linked to the rocker arm member, and in which the means carried by the bolt includes a lower hammer and a firing pin.

36. The combination in accordance with claim 35, and a manual safety lever for locking said first sear into engagement with said rocker arm.

37. In a weapon, the combination of:

a pivotally mounted rocker member having an upper end and a lower end and adapted to be positioned in a safe position by thrust on its upper end and in an armed position by thrust on its lower end, said rocker member being formed with a bight on its lower end;

a pivotally mounted lower sear having an upwardly extending projection adapted to latch onto said bight to restrain said rocker member against movement to the armed position;

and a pivotally mounted trigger for disengaging said sear from said rocker member to permit the rocker member to be moved into armed position.

38. The improvement in accordance with claim 37, and a pivotally mounted upper sear having a downwardly extending projection adapted to engage said bight.

39. In an automatic weapon of the type which includes a firing chamber, a reciprocally movable bolt, and bolt-locking means, the improvement which comprises:

firing means carried by the bolt;

and firing control means, said firing control means including a swingably mounted rocker arm adapted to be turned to armed and safe positions, respectively, for activating or de-activating the firing means at the will of the gunner;

the firing control means further including swingably mounted hammer means mechanically linked to said rocker arm to be positioned selectively in either a safe or an armed position, said hammer means and firing means impacting to fire a round.

40. In an automatic weapon of the type which includes a firing chamber, a reciprocally movable bolt, and bolt-locking means, the improvement which comprises:

firing means carried by the bolt;

firing control means including a swingably mounted rocker arm adapted to be turned to armed and safe positions, respectively, for activating or de-activating the firing means at the will of the gunner;

the firing control means further including hammer means mechanically coupled to said rocker arm to be positioned selectively in either a safe or an armed position, said hammer means and firing means impacting to fire a round;

and yieldable pusher means carried by the bolt for turning the rocker arm into armed position as the bolt advances into battery.

41. The improvement in accordance with claim 40 in which the firing control means further includes a first sear engageable with the rocker arm to hold it in safe position and releasable from the rocker arm to permit the pusher means to function.

42. The improvement in accordance with claim 41, and trigger means manually operable to a firing position to disengage said first sear from said rocker arm to permit the yieldable pusher means to move the rocker arm into armed position,

said firing means and hammer means being so constructed and arranged that the rocker arm is turned to safe position when the bolt retracts,

said first sear being so formed as then to re-engage the rocker arm and hold the rocker arm in safe position unless positively held out of engagement with said rocker arm by holding of said trigger means in firing position.

43. The improvement in accordance with claim 42, and a second sear for holding the rocker arm in safe position after a round has been semi-automatically fired until said trigger means is released from firing position.

44. The improvement in accordance with claim 43, and selector means for disabling said second sear when automatic fire is desired, or enabling said second sear when semi-automatic fire is desired.

45. In an automatic weapon of the type which includes a firing chamber and means for firing a round disposed in the chamber, the improvement which comprises, in combination:

a bolt mounted for reciprocal movement relative to said firing chamber, the bolt advancing forwardly into battery to chamber a round of ammunition and retracting rearwardly to permit a new round to be placed in position to be chambered;

selectively operable means for locking the bolt in battery position or releasing the bolt;

operating means mounted in reciprocal movable relation to and symmetrically disposed relative to said bolt, said operating means retracting rearwardly to actuate said selectively operable means to unlock said bolt;

and a strainable element mechanically intercoupling said bolt and said operating means, said strainable element being strained when the operating means retracts rearwardly whereby to store energy to retract the bolt when the bolt is released.

46. In an automatic weapon of the type which includes a firing chamber and means for firing a round disposed in the chamber, the improvement which comprises, in combination:

a bolt mounted for reciprocal movement relative to said firing chamber, the bolt advancing forwardly into battery to chamber a round of ammunition and retracting rearwardly to permit a new round to be placed in position to be chambered;

selectively operable means for locking the bolt in battery position or releasing the bolt;

operating means mounted in reciprocal movable relation to and symmetrically disposed relative to said bolt, said operating means retracting rearwardly to actuate said selectively operable means to unlock said bolt;

and an energy storage means connected between said bolt and said operating means, said energy storage means being mechanically energized when the operating means retracts rearwardly whereby to store energy to retract the bolt when the bolt is released.

47. In an automatic weapon of the type which includes a firing chamber and means for firing a round disposed in the chamber, the improvement which comprises, in combination:

a bolt mounted for reciprocal movement relative to said firing chamber, the bolt advancing forwardly

into battery to chamber a round of ammunition and retracting rearwardly to permit a new round to be placed in position to be chambered;

selectively operable means for locking the bolt in battery position or releasing the bolt;

operating means mounted with its gravitational center of mass in the boreline and in reciprocal movable relation to said bolt, said operating means retracting rearwardly to actuate said selectively operable means to unlock said bolt;

and an energy storage means connected between said bolt and said operating means, said energy storage means being mechanically energized when the operating means retracts rearwardly whereby to store energy to retract the bolt when the bolt is released.

References Cited by the Examiner

UNITED STATES PATENTS

783,770	2/05	Young et al.	89—183
1,157,750	10/15	Young	89—183
1,293,776	2/19	Hillman	89—183
2,380,024	7/45	Chandler	89—1.7
2,386,205	10/45	Garand	89—142
2,965,001	12/60	Bobco et al.	89—1.7
2,988,961	6/61	Berg	89—1.7
3,104,613	9/63	Rice et al.	102—49
3,118,377	1/64	Davies et al.	102—49

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