Aug. 1, 1967 G. R. KRUZELL 3,333,508

CLOSED BREECH GUN UTILIZING A HOLLOW BOLT AND A FIRING PIN AS A GAS CYLINDER AND A PISTON, RESPECTIVELY

Filed Jan. 30, 1967 2 Sheets-Sheet 1

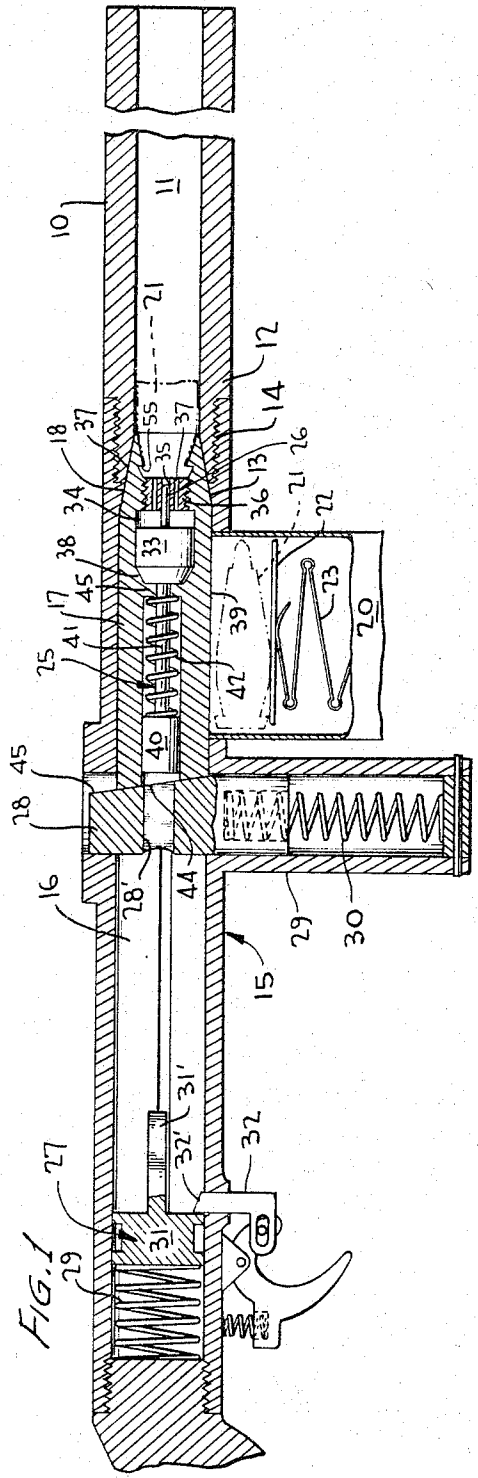

FIG. 1

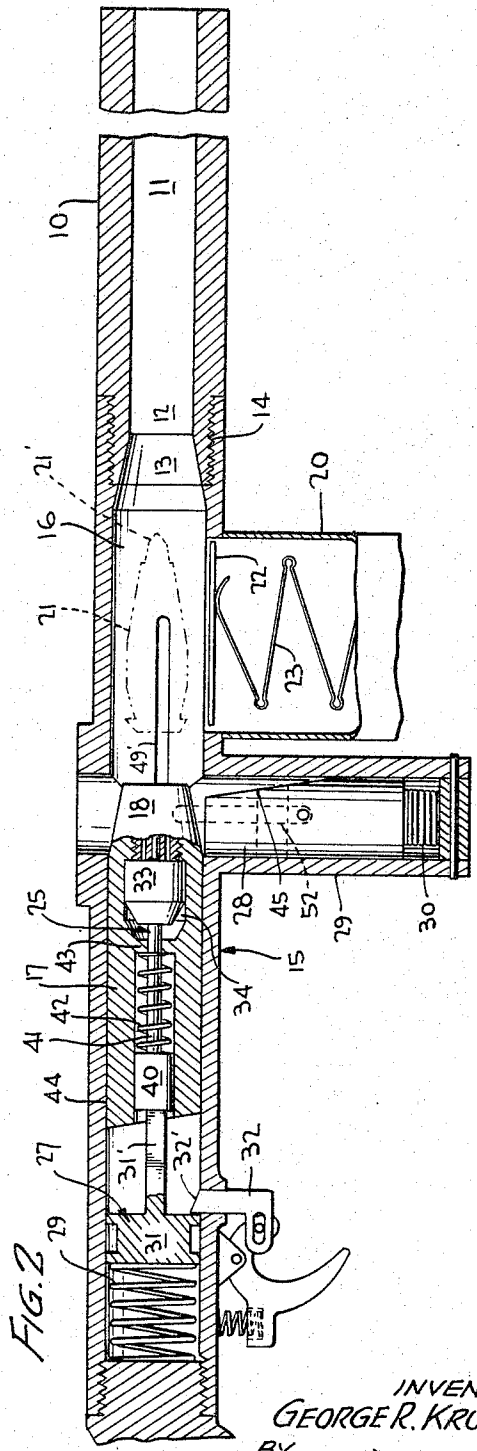

FIG. 2

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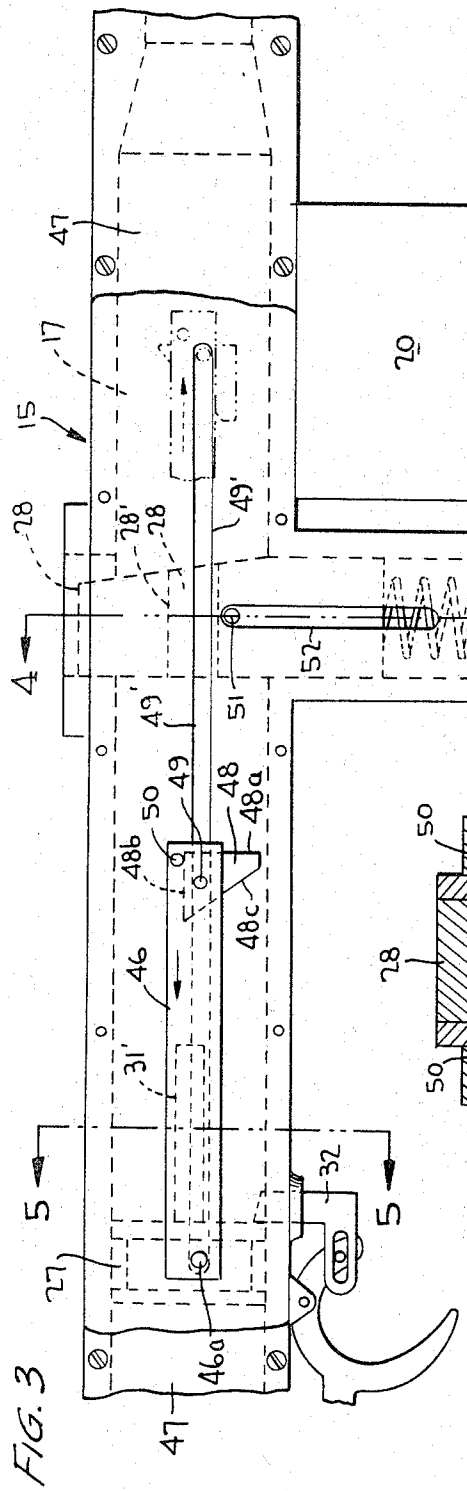

FIG. 3

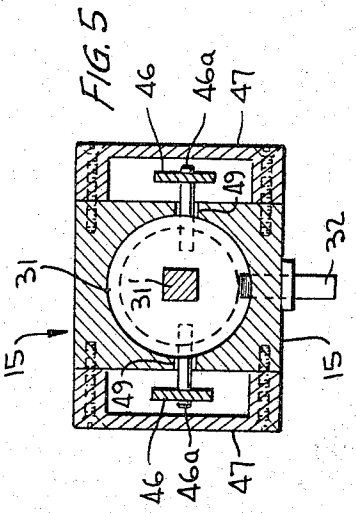

FIG. 5

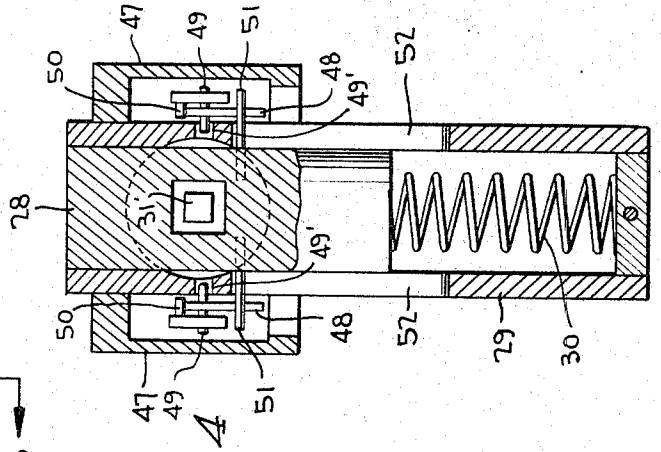

FIG. 4

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3,333,508

CLOSED BREECH GUN UTILIZING A HOLLOW BOLT AND A FIRING PIN AS A GAS CYLINDER AND A PISTON, RESPECTIVELY

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Filed Jan. 30, 1967, Ser. No. 612,376
10 Claims. (Cl. 89—179)

ABSTRACT OF THE DISCLOSURE

The gun here disclosed utilizes the hollow bolt and firing pin as a gas cylinder and piston for automatic cocking and loading.

With the bolt locked, recoil movement of the firing pin responsive to gas pressure in the firing chamber initiates retraction of the hammer, and a linkage between the hammer and bolt lock disengages the latter to permit recoil of the bolt by residual gas pressure in the firing chamber, and its subsequent spring return, for automatic loading and firing.

The firing pin spring is compressed by abutment between the firing pin and hammer near the end of the bolt recoil movement, and its subsequent expansion insures closing of the bolt well in advance of the hammer movement to permit operative positioning of the bolt lock between them.

If the bolt is not fully closed, this prevents operative positioning of the lock which, in turn, intercepts the hammer to prevent firing.

Brief summary of the invention

This application is a continuation-in-part of my prior application, Ser. No. 495,964, filed Oct. 14, 1965, which, in turn, is a continuation-in-part of my prior application, Ser. No. 382,864, filed July 15, 1964, now U.S. Patent No. 3,225,657.

The invention relates to improvements in a closed breech gun of the type generally disclosed in my prior application, Ser. No. 495,964, filed Oct. 14, 1965. In the disclosure of such application, as in the present invention, the firing pin is carried for operative movement within and through a bolt which is mounted in the receiver for operative movement in alignment with the barrel, and a bolt lock is automatically spring projected across the path of the bolt each time the latter is closed, the gas pressure from the firing chamber being admitted to a cylinder within the bolt to react against the firing pin so as to urge same through a limited retraction movement toward a fully retracted and sealed position.

In accordance with such prior application, movement of the bolt lock to its operative position is relied upon for actuating the firing pin. For retracting the bolt lock to permit recoil movement of the bolt after each firing, there is provided externally of the barrel a piston and cylinder unit suitably linked to the bolt lock and actuated by gas through a bleed passage communicating with the barrel medially of its length.

In the present invention, such an external unit is eliminated, while the firing pin and the firing pin striker or hammer are associated with each other and with the other parts to assume this function.

In accordance with a further important feature, the bolt lock, when operatively positioned, is interposed between the hammer and the firing pin to prevent firing of the gun except when the bolt is fully closed and the lock is fully projected.

A further important feature consists in utilizing recoil action of the firing pin under gas pressure for imparting retraction movement to the hammer with sufficient momentum to withdraw the latter from the bolt lock and

thereafter to utilize a portion of its inertia during continued retraction for actuating a linkage through which hammer retraction movement is imparted to the bolt lock to retract the lock and thus to permit subsequent retraction of the bolt itself by the action of residual gas pressure within the barrel.

In accordance with a further feature of the invention, engagement between the firing pin and the hammer is utilized for cushioning and arresting the recoil movement of the bolt as well as for projecting the bolt toward closing position sufficient in advance of the hammer as to permit operative positioning of the bolt lock rearwardly of the bolt without interference from the hammer.

The invention further contemplates as an optional feature the provision of a novel extractor mechanism particularly adapted for use with ammunition of the type in which the case is consumable, to facilitate removal of faulty rounds of ammunition.

In this application, I have shown and described only the preferred embodiment of my invention, together with one specific modification, and have used rather precise language to describe the invention and its several components.

It will be appreciated, however, that the invention is capable of various further modifications; and accordingly, the drawings and description herein are not to be construed as limitative in nature, but merely as exemplary.

Description of drawings

In the accompanying drawings:

FIGURE 1 is a fragmentary sectional view in a vertical longitudinal plane through a closed breech gun incorporating the invention, with the gun loaded and cocked for firing;

FIGURE 2 is a view similar to FIGURE 1, but with the bolt and firing pin in their retracted positions immediately after firing a round of ammunition;

FIGURE 3 is a fragmentary side elevation of the structure shown in FIGURE 1;

FIGURE 4 is a section on line **4**—**4** of FIGURE 3; and

FIGURE 5 is a section on line **5**—**5** of FIGURE 3.

In the form herein specifically disclosed, the gun of the invention is capable of automatic firing, and is especially adapted for use with ammunition of the consumable casing type.

Referring now in detail to the accompanying drawings, the gun of the invention includes a barrel **10** of generally conventional structure formed with a bore **11** therethrough which is formed at its rear end to define a firing chamber **12** and which terminates rearwardly in a breech opening. Preferably, the breech opening is defined by a conical annular sealing surface **13**. By suitable coupling means, such as the threaded coupling **14** shown in the drawing, the barrel is affixed to the forward end of the generally tubular receiver **15**. The boltwell **16** defined within the interior of the receiver, is elongated and aligned with the barrel to receive and guide the bolt **17** itself for movement between a rearwardly retracted open position and a forwardly projected closed position. The bolt **17** is suitably adapted at its forward end for sealing engagement with the breech opening, preferably being provided with an external conical surface **18** for sealing engagement with the interior conical surface **13** which defines the breech opening.

A generally conventional magazine **20** has its delivery end communicating with the interior of the receiver to deliver a fresh round of ammunition **21** thereinto in advance of the bolt each time the latter is fully retracted, whereby the return and closing movement of the bolt will

feed the round into the firing chamber in a generally conventional manner.

The magazine may be of a generally conventional type in which the several rounds of ammunition rest upon and are propelled outwardly by a follower plate **22** under the action of a compression spring **23**.

The firing pin **25** is housed within the generally tubular bolt **17** for a limited degree of actuating movement so that the striker **26** may be projected forwardly by its associated hammer **27** to operatively engage and detonate the primer of a round of ammunition **21** in the firing chamber. The gas pressure from the firing chamber **12** is then utilized to retract the firing pin to a sealed position within the bore of the hollow bolt.

In addition to its usual function of detonating the rounds of ammunition, the firing pin **25** in the instant invention performs the highly important function of functioning as a plunger, actuated by gas pressure from the barrel and firing chamber, to thrust against the hammer **27** and to commence the latter on its return or retraction movement with sufficient force and momentum that the latter will be fully retracted even though disengaged from the firing pin after but a short length of travel of the two together.

The bolt lock **28** is guided in a transversely disposed portion **29** of the receiver **15** for movement to and from a predetermined locking position across the path of retraction of the bolt, and resilient means such as the spring **30** is employed for moving it toward its operative locking position. It is to be noted, of course, that the bolt lock **28** is so positioned that it is capable of movement to its locking position rearwardly of the bolt only when the bolt is fully closed.

As thus far generally described, the parts and their mode of cooperation correspond with the disclosure of my earlier application, Ser. No. 495,964.

Referring in somewhat more detail to the various parts, the hammer **27** comprises a generally piston-like mass **31** having substantial inertia which is guided in the receiver for operative movement independently of the bolt and in alignment with the barrel from a retracted position on the remote side of the bolt lock from the barrel. The hammer may be retained in its retracted position by a conventional sear **32** under control of a trigger, which, though not illustrated, may be arranged in the same manner disclosed in my prior application, Ser. No. 495,964.

In order that it might actuate the firing pin without having its movement arrested by the intervening bolt lock, the hammer is formed with a probe or extension **31'** projecting toward and in alignment with the firing pin **25**, and the bolt block **28** in turn is formed with an opening or aperture **28'** which is positioned for free passage of the hammer extension **31'** only in the operative locking position of the bolt lock. If, for any reason, the bolt lock **28** is not fully projected to its operative position, the mis-alignment of the bolt lock opening with the hammer extension will cause the bolt lock to intercept and arrest the movement of the hammer and to bar same from contact with the firing pin.

As in the parent application earlier referred to, the firing pin **25** is provided with a piston **33** which is disposed in the gas cylinder **34** adjacent the forward end of the bolt for snug sliding movement within limits relative to the bolt. The striker **26** of the firing pin is carried by and projects forwardly from the piston, being slidably disposed through an opening **35** in a bearing plug **36** which is threaded or otherwise secured at the forward end of the cylinder. The gas pressure arising from the firing of each round of ammunition is communicated to the cylinder in advance of the piston to react against the forward face thereof. To this end, in the instant embodiment, the striker **26** has sufficient clearance with the opening **35** through the plug to permit such communication, and/or the plug is provided with a gas port such as **37**.

Forward movement of the firing pin **26** when struck by the hammer is limited by engagement between the firing pin piston **33** and the threaded plug **36**. Retraction movement of the firing pin within the bolt is limited by engagement of the piston **33** with a stop **38** within the cylinder, such stop preferably being in the form of a generally conical sealing surface which is adapted for sealing engagement with a similar conical surface **39** around the rear end portion of the piston. With this arrangement, it is possible to prevent any leakage of actuating gas beyond the piston.

For transmitting the retraction or recoil movement of the firing pin **25** to the hammer **31**, as well as for receiving the impact of the hammer, the firing pin terminates rearwardly in an anvil **40** which is slidably disposed in the rearward bore portion of the bolt and is connected to the piston by means of the rigid rod **41**. A spring **42**, which is coiled about the rod, is compressed between the anvil and an annular spring seat **43** to exert a resilient rearward thrust upon the firing pin tending to maintain it in its inoperative or retracted position.

In the preferred embodiment of the invention, the rear end of the bolt **17** and the forward face of the bolt lock **28** are formed with similarly upwardly and rearwardly inclined but opposed cam faces **44** and **45** arranged for wedging engagement with each other incident to upward projection of the bolt lock to its operative position. This arrangement, which is generally similar to that employed in my prior application, Ser. No. 495,964, and in my Patent No. 3,225,657, utilizes the projecting force of the bolt lock to effect the full closing of the bolt in the event same is not completely closed prior to engagement by the bolt lock. But if the bolt **17** is not fully closed, then the engagement of the cam faces **44** and **45** of the bolt lock and bolt will prevent full or complete projection of the bolt lock to its operative position. In such event, the opening **28'** through the bolt lock will be misaligned with the hammer extension **31'** to prevent actuation thereby of the firing pin **25**.

It will have been perceived from the foregoing that, before the retraction of the bolt **17** can commence after each firing, the hammer **27** and more particularly its extension **31'** must be fully withdrawn and disengaged from the bolt lock **28**, following which the bolt lock itself must be withdrawn against the action of its spring to an inoperative position out of the path of retraction of the bolt.

The necessary withdrawal and/or retraction of the hammer **27** is produced by the impact thereagainst of the rearwardly moving firing pin **17** as earlier mentioned. The hammer **27**, in turn, by virtue of the momentum imparted thereto by the firing pin, stores sufficient energy both to return it fully to its retracted position after disengagement from the firing pin and also to actuate a linkage subsequent to its disengagement from the bolt lock for retracting the latter.

A linkage appropriate for that purpose may assume any of various forms as will be readily apparent.

In the particular embodiment here illustrated and as best shown in FIGURES 3, 4 and 5, the linkage comprises rigid arms **46** affixed to the hammer portion **31** by pins **46*a*** which project outwardly from the hammer through slots **49'** in the receiver. The arms **46** project forwardly from the hammer for movement on opposite sides of the bolt lock **28**, through passages (FIGURE 4) provided between the receiver **15** and the cover plates **47** on opposite sides of the receiver.

Carried by each arm **46** adjacent its free end is a generally triangular cam **48** which is pivotally connected thereto at **49** for swinging, in a vertical plane, within predetermined limits, governed by an engagement of its respective edges **48*a*** and **48*b*** with a stop pin **50**, also carried by the arm.

Preferably the pivot pins **49** project inwardly for guiding reception in slot **49'** through the receiver walls to

prevent vertical deflection of such pins **49** on the free ends of their supporting arms, incident to the vertical forces imparted thereon incident to the camming function hereinafter described.

For cooperation with the cams **48**, the bolt lock **28** has affixed thereto follower pins **51** which project from opposite sides thereof, for movement with the bolt lock through vertical slots **52** in the opposite sides of the receiver, in position for engagement by the depending portions of the cams **48**, incident to operative movement of the hammer **27**.

Thus, when the hammer is projected forwardly, with the parts positioned as in FIGURE 3, the arms **46** will be projected forwardly on opposite sides of the bolt lock **28** to substantially the broken line position shown fragmentarily near the right-hand end of FIGURE 1. In so doing, the forward vertical edge **48***a* of each cam will strike its associated follower pin **51**, and will thereby be rocked rearwardly about its pivot **49** to ride forwardly over the pin **51**.

Upon abrupt termination of its forward movement by impact of the forward extension or hammer striker **31'** with the firing pin, and on its ensuing rearward return movement, the depending pendulum-like portion of each cam, below its pivot **49**, will be swung downwardly by its inertia to its operative position (limited by engagement of its edge **48***b* with the stop **50**) in which its diagonal cam edge will strike sharply against the follower pin of the bolt lock, to impart a rapid retraction movement to the lock.

Obviously, the vertical extent of the cams **48** need not coincide fully with the retroactive movement of the bolt lock, since the rapidity of the movement initially imparted to the bolt lock will be such that the retraction thereof may be completed by the momentum initially imparted to the lock, even though the camming action is discontinued before the lock is fully retracted.

An extractor for removal of unfired ammunition from the firing chamber is provided by an undercut recess in the forward end of the bolt in which the overhanging rearwardly-presented face **55** of the recess functions in the manner of hooks to engage behind the rear end rim of the cartridge casing. It will be understood that the cartridge casing, in such event, will be of a somewhat resilient plastic consumable material in which the rear end rim is adapted to be cammed inwardly or radially compressed by the forwardly-diverging surface at the mouth of the bolt to then expand after moving past the rear faces.

Operation

In the operation of the invention, when a round **21** of ammunition is loaded into the firing chamber **12** and the various parts are in readiness for firing, they will be positioned as illustrated in FIGURE 1. Thus, the bolt **17** is locked in its forwardly-projected operative position by the bolt lock **28** which has been projected by its spring **30** across the path of retraction of the bolt **17**. Incident to the operative projection of the bolt lock, its inclined cam face **45** will have engaged the cooperating cam face **44** of the bolt and urged the bolt forward to a fully-seated position in which its sealing surface **18** fully engages the conical sealing surface **13** to seal the breech opening defined by the latter.

The round of ammunition will have been moved into the firing chamber **12** in advance of the bolt **17**; and where the bolt is provided with an extractor **55**, same will have grippingly engaged the rim of the round of ammunition, as shown.

If the bolt should not have fully closed, the interengagement between the bolt **17** and bolt lock **28** will have prevented the latter from being fully projected to its operative position. If, for this or any other reason, the lock is not fully projected, the opening through the bolt lock will be misaligned with the path of movement of the hammer extension, so that the lock will interrupt the movement of the hammer toward the firing pin **25**, and the weapon thus cannot fire.

At this time, the hammer **27** will have been cocked and retained in position by its sear **32**. Upon disengaging the sear **32** from the hammer, by suitable actuation of a trigger or other mechanism, the hammer is immediately projected forwardly by its spring **29**; and, assuming that the lock **28** has been fully projected to its operative position, will move freely through the apertured bolt lock to impact against the rear end of the firing pin, and thus to project the firing pin forwardly so that its striker will engage and ignite the primer of the round of ammunition.

On firing of the round ammunition, the missile portion **21'** thereof will be forced forwardly through the barrel by the resulting gas pressure. The remainder of the ammunition will be instantly consumed by the ignition of the propellant charge, since the cartridge casing is of the combustible or consumable type. The gas pressure from the explosion is, therefore, free to enter the forward end of the gas cylinder **34** through the clearance between the firing pin striker and its opening **35**, or through other suitable ports **37**, to then react against the piston portion **33** of the firing pin.

Thus, with the bolt **17** still locked in its closed position, the gas pressure from the barrel will impel the firing pin **25** rearwardly within the locked bolt **17** for a limited distance, until relative movement of the firing pin and bolt is arrested by engagement of the firing pin with the sealing surface **38** within the bolt. As earlier noted, the interengaged stop surfaces **38**, **39** of the bolt and the firing pin establish a seal to prevent leakage of the gas between them, and to cause the entire gas pressure thereafter to react against the bolt.

At this time, the gas pressure will be substantially at a maximum; but throughout the maximum pressure phase, the hammer extension **31'** will be disposed through the apertured lock **28** to positively prevent displacement or retraction of the lock and/or the bolt.

The rapid, though limited, degree of firing pin retraction within the locked bolt is imparted to the hammer. The mass and momentum of the hammer **27** are such that it will complete its full retraction stroke after movement of the firing pin has been arrested. After a sufficient degree of such retraction movement of the hammer to fully retract or withdraw its projection **31'** from the bolt lock aperture, the hammer **27** is coupled to the bolt lock through the lock retracting mechanism **46–52** which utilizes a portion of the continuing hammer movement for retracting the bolt lock **28**.

In the form of lock retracting mechanism herein specifically illustrated, the swingable cam plates will have been swung rearwardly and upwardly by contact with the follower pins **51**, so as to pass freely thereover during the forward stroke of the hammer.

On the ensuing rearward or recoil stroke of the hammer, the cams **48** will be locked by the stops **50** against forward swinging or yielding, so that their cam edges **48***c* will impact sharply against the follower pins **51** of the bolt lock **28** to retract the latter only after the hammer striker **31'** has been fully withdrawn from the bolt lock opening **28'**.

The timing of the foregoing movements is such that the bolt **17** will be unlocked after the pressure of the ignited gas has passed its maximum, but while sufficient residual gas pressure still remains in the firing chamber to react against and retract the bolt, so that the ensuing retraction and return of the bolt will effect an automatic reloading of an additional round of ammunition from the magazine **20** into the firing chamber **12** in well known manner.

As the hammer nears the completion of its retraction stroke, it passes over and temporarily depresses the sear **32**, through engagement with the cam edge **32'** of the sear, providing the weapon is being operated as a semi-automatic or as a single-shot weapon. The sear, in such event,

will be then automatically spring projected in front of the hammer to retain the latter in its cocked and retracted position against the force of its spring until the sear is again released. If the sear is retained in its retracted or inoperative position, the firing will then occur automatically.

Throughout the retraction movement of the bolt **17**, a portion of same will extend across the path of projection of the bolt lock **28** to retain the latter retracted until the bolt is again closed.

As the bolt is retracted rearwardly beyond the mouth of the magazine **20**, a fresh charge of ammunition is delivered into the receiver **15** in front of the bolt **17** to be urged forwardly by the bolt and into the firing chamber upon subsequent closing of the bolt.

Where the firearm is to be fired automatically, the extent of the bolt retraction movement is such as the movement nears completion, the firing pin will re-engage the hammer **27**, through its extension **31'**, the hammer at this time being substantially at the end of its retraction stroke, and any continued retraction movement of the bolt thereafter will compress and store energy in the firing pin spring **42**. Such stored energy in the firing pin spring will supplement that of the bolt return spring **19** and will result in projecting the bolt forwardly on its return or closing stroke, sufficiently in advance of the hammer, that the bolt will reach its fully closed position, and the bolt lock **28** will have been automatically projected into operative position rearwardly thereof, before the hammer has advanced sufficiently on its return stroke that its extension **31'** might interfere with operation of the lock **28**. In other words, such cooperation serves to effect a sufficient delay of the return movement of the hammer relative to that of the bolt to allow ample time for actuation of the bolt lock.

While such timing is essential to the operation of the gun as a fully automatic firearm, it is of course not essential to operation of the gun as a single shot or semi-automatic firearm.

Having thus described my invention, I claim:

1. In a closed breech gun, including a barrel formed with a bore therethrough having its rear end connected to a receiver, a tubular open ended bolt guided in the receiver for movement in alignment with said barrel, resilient means urging said bolt to a forwardly-projected operative position in which it closes the rear end of said bore, a firing pin guided in the bolt for a predetermined range of operative projection and retraction movement through the forwardly opening end thereof in alignment with the bore, a bolt lock guided on said receiver for operative movement transversely to the bolt movement between a predetermined locking position across the path of retraction of the bolt and a retracted position in which it is out of the path of retraction of the bolt, and means for urging said bolt lock to its operative position, the improvements which include a hammer guided in said receiver for movement in alignment with said firing pin and resilient means normally urging the hammer toward and into engagement with the firing pin, the bolt lock including a portion positioned to intercept and arrest the movement of the hammer when the bolt lock is in other than its operative or retracted positions, said firing pin being exposed to the gas pressure within said barrel for rearward retraction movement through the bolt to thrust against and retract the hammer, and means establishing a coupling between the hammer and the bolt lock after withdrawal of the hammer from the path of retraction of said portion of the bolt lock, for then retracting the bolt lock incident to continuing retraction of the hammer, whereby to permit subsequent retraction of the bolt by residual gas pressure in the barrel.

2. In a closed breech gun as defined in claim **1**, the further improvement wherein said means for establishing a coupling between the hammer and the bolt lock comprises a cam means, together with means for rendering said cam means operative on the retraction stroke of the hammer and inoperative on the operative forward movement of the hammer.

3. In a closed breech gun as defined in claim **1**, the further improvement wherein said bolt is formed to define a gas cylinder therein normally communicating with the barrel, said firing pin including a piston disposed for movement in said cylinder under the influence of gas pressure entering same from the barrel, the rear end of said firing pin being adapted for engagement with the hammer, for actuation thereby on each forward stroke of the hammer and to abut against and retract the hammer on each retraction of the bolt.

4. In a closed breech gun as defined in claim **3**, the further improvement comprising spring means for urging said firing pin rearwardly and for cushioning and storing energy resulting from engagement of the firing pin with the hammer near the end of each retraction of the firing pin, whereby to initiate forward movement of the bolt substantially in advance of the hammer during automatic firing of the gun.

5. In a closed breech gun as defined in claim **4**, the further improvement wherein the predetermined range of movement of the firing pin is such as to arrest the retraction movement of the firing pin before the hammer is fully retracted, said hammer having sufficient mass and inertia to continue and complete its retraction movement under the impetus imparted to it by the firing pin.

6. In a closed breech gun as defined in claim **4**, the further improvement wherein said means establishing a coupling between the hammer and the bolt lock is disengaged prior to complete retraction of the bolt lock, the latter having sufficient mass to complete its retraction movement after such disengagement under the impetus transmitted to it through said coupling.

7. In a closed breech gun as defined in claim **4**, the further improvement which includes a selectively-releasable sear mounted on the housing for cooperation with the hammer to releasably retain the hammer in its retracted position.

8. In a closed breech gun as defined in claim **4**, the further improvement wherein said means for urging the bolt lock to its operative position is a resilient means.

9. In a closed breech gun as defined in claim **4**, the further improvement wherein the bolt lock is formed with an opening positioned to permit passage therethrough of the hammer only when the bolt lock is operatively positioned with respect to the bolt.

10. In a closed breech gun as defined in claim **9**, the further improvement wherein said bolt is formed at its forward end with an undercut recess, adapted for snap fitting reception and gripping of the rim of a shell case to extract the latter from the barrel.

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