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[54] **IMPEDER FOR A GUN FIRING MECHANISM WITH AMMUNITION FEEDER AND MODE SELECTOR**

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[51] **Int. Cl.**[6] **F41B 11/02**; F41A 9/61

[52] **U.S. Cl.** **124/76**; 124/72; 124/48; 124/51.1; 221/24; 221/266

[58] **Field of Search** 124/76, 74, 72, 124/70, 48, 49, 50, 51.1, 52, 53; 188/302, 303, 311, 314, 267, 224; 24/2; 89/190, 189, 181, 131, 33.17; 221/24, 263, 266

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Assistant Examiner—Thomas A. Beach
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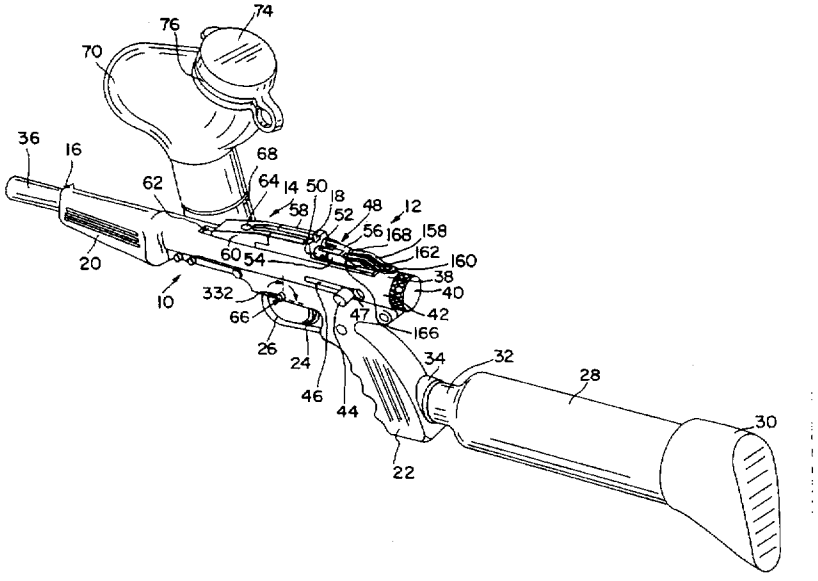
[57] **ABSTRACT**

An ammunition feed mechanism for an automatic or semi-automatic weapon which includes a mechanism for retarding the cyclic feeding of ammunition into the chamber of the weapon. The mechanism for retarding the cyclic feeding of ammunition includes an impeder which engages the bolt of the weapon. The ammunition feed mechanism also includes a magazine having a ramped bottom which directs ammunition projectiles to an exit therein where the ammunition projectiles are fed into the chamber of the weapon. The magazine includes a plurality of curved projections in the bottom which define a plurality of spaces into which the ammunition projectiles are received. The plurality of curved projections also guide the ammunition projectiles through the exit.

33 Claims, 7 Drawing Sheets



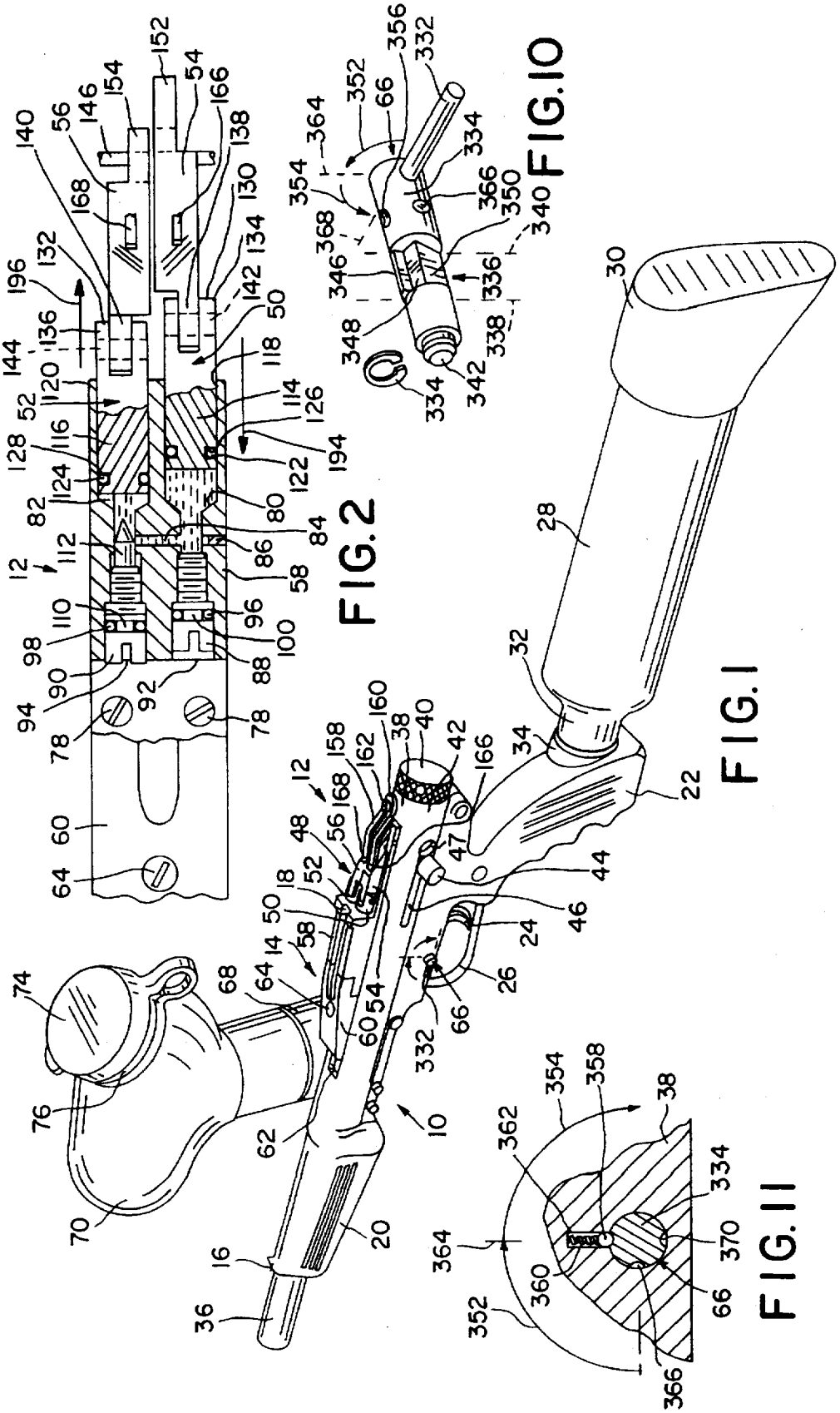


FIG. 1

FIG. 2

FIG. 10

FIG. 11

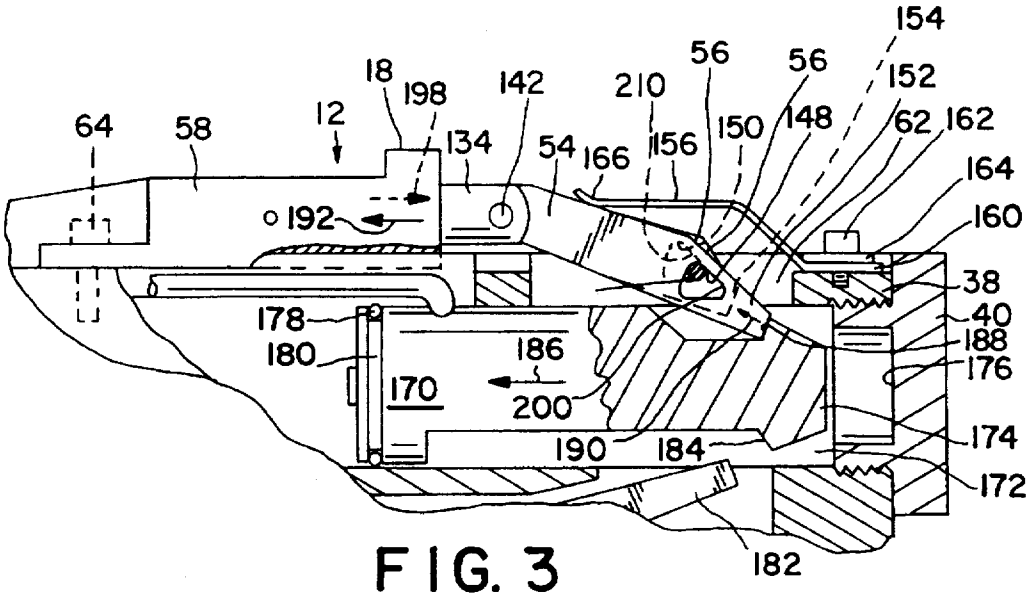
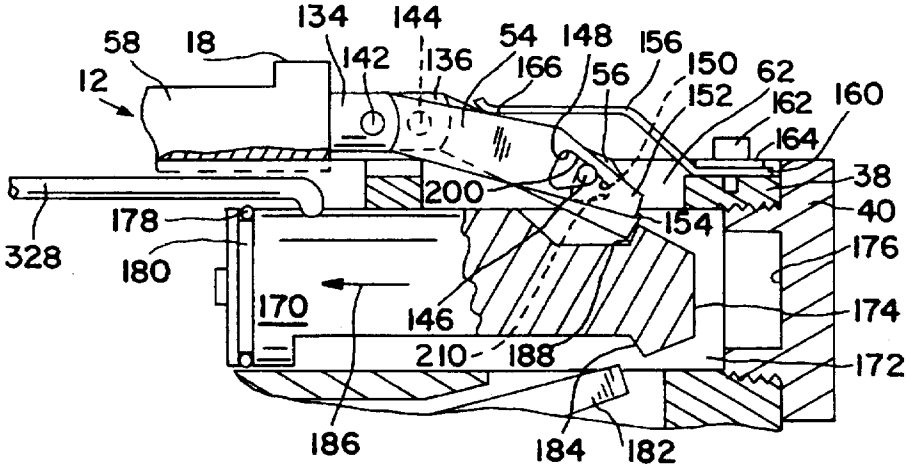


FIG. 3



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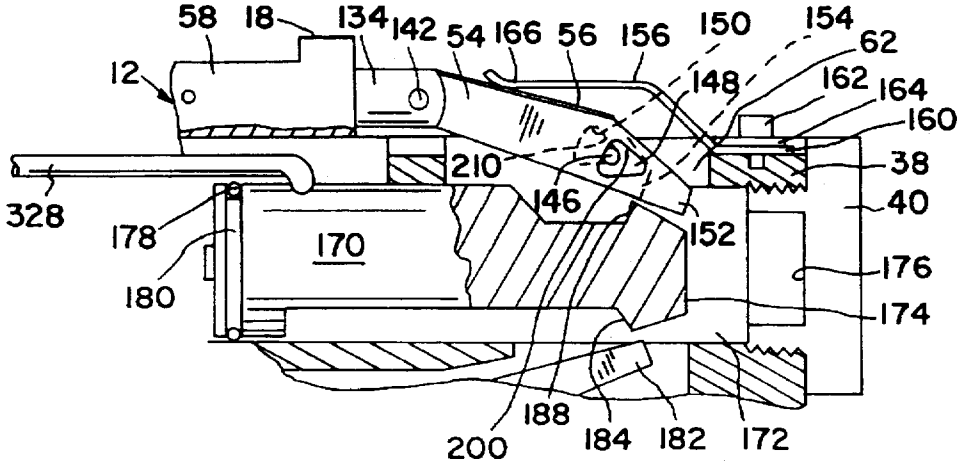

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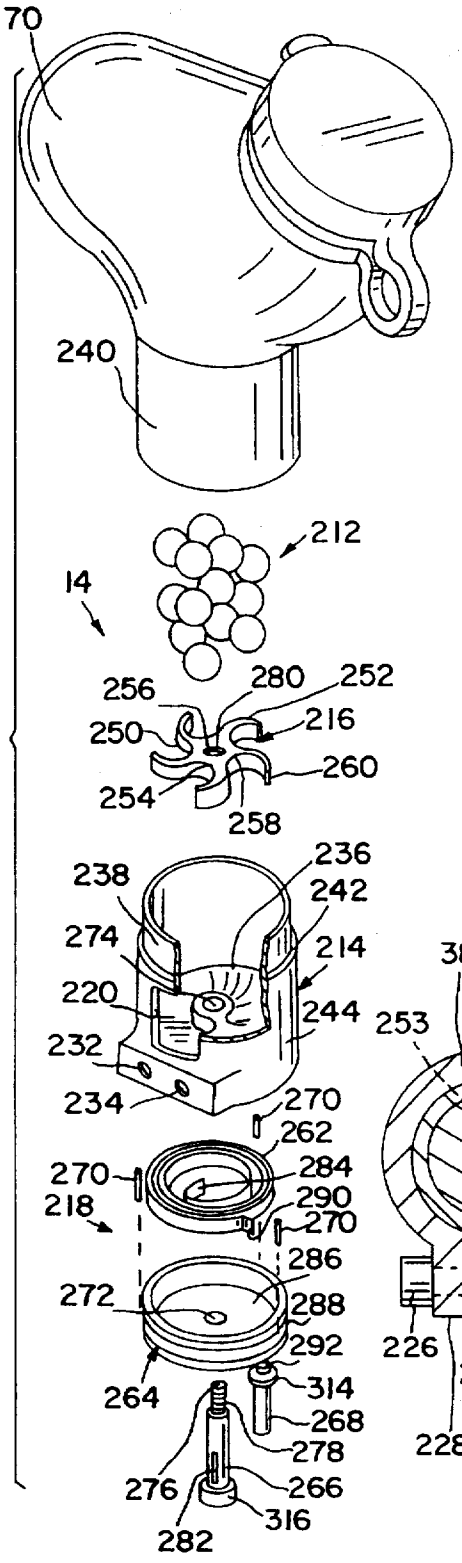
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FIG. 6

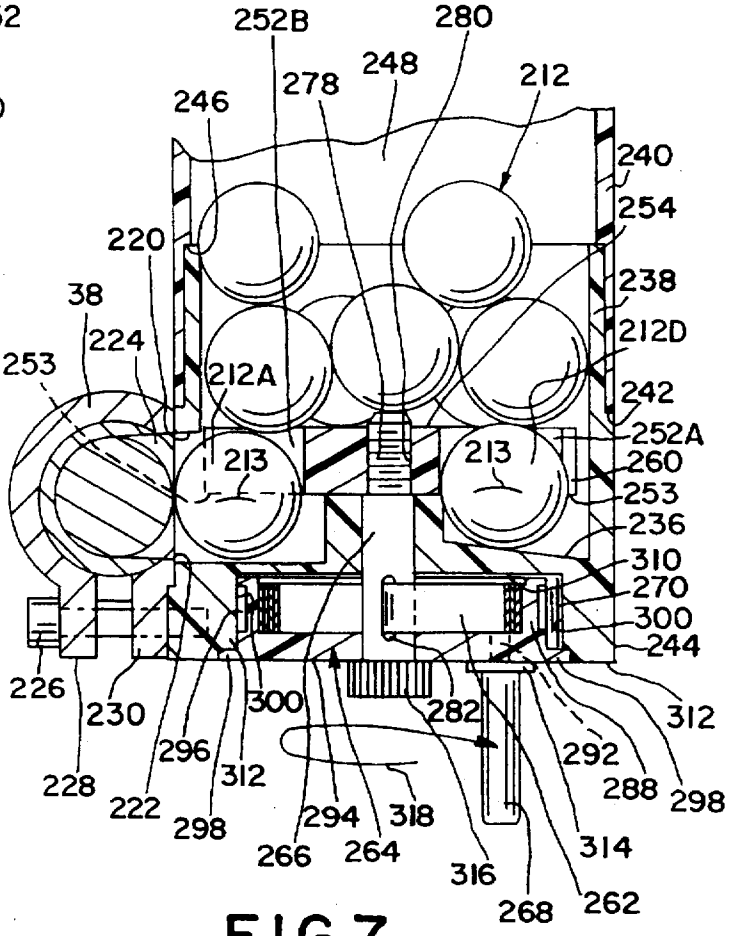
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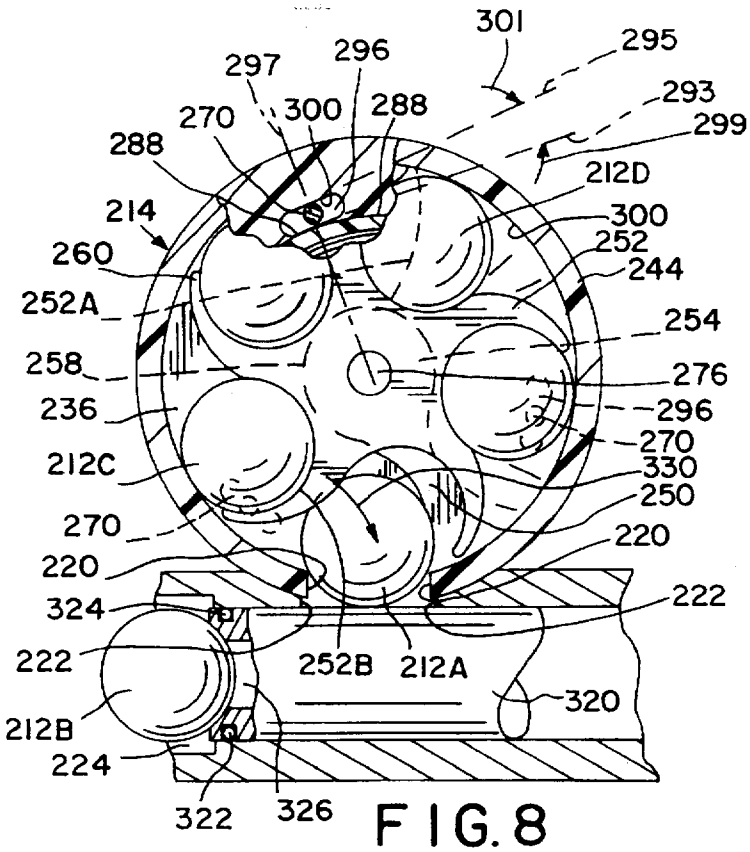
FIG. 7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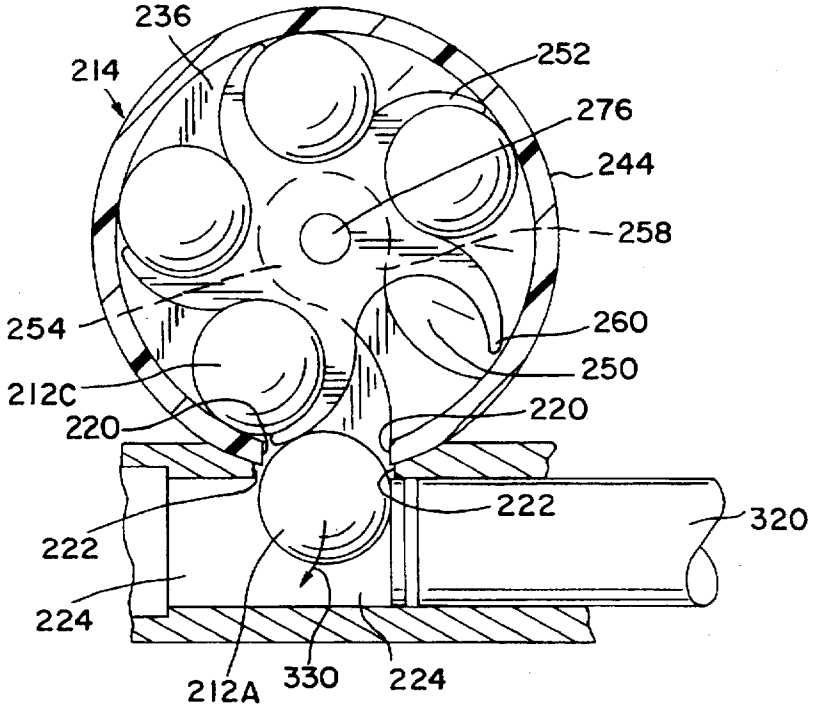
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FIG. 9

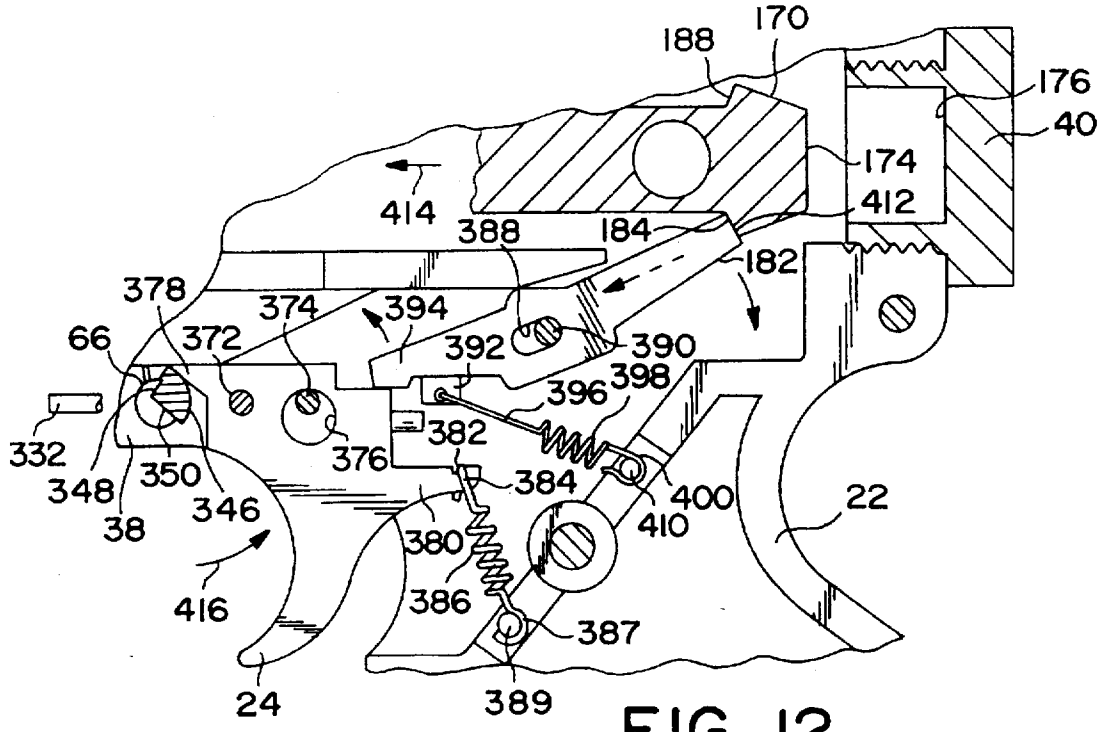
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FIG. 12

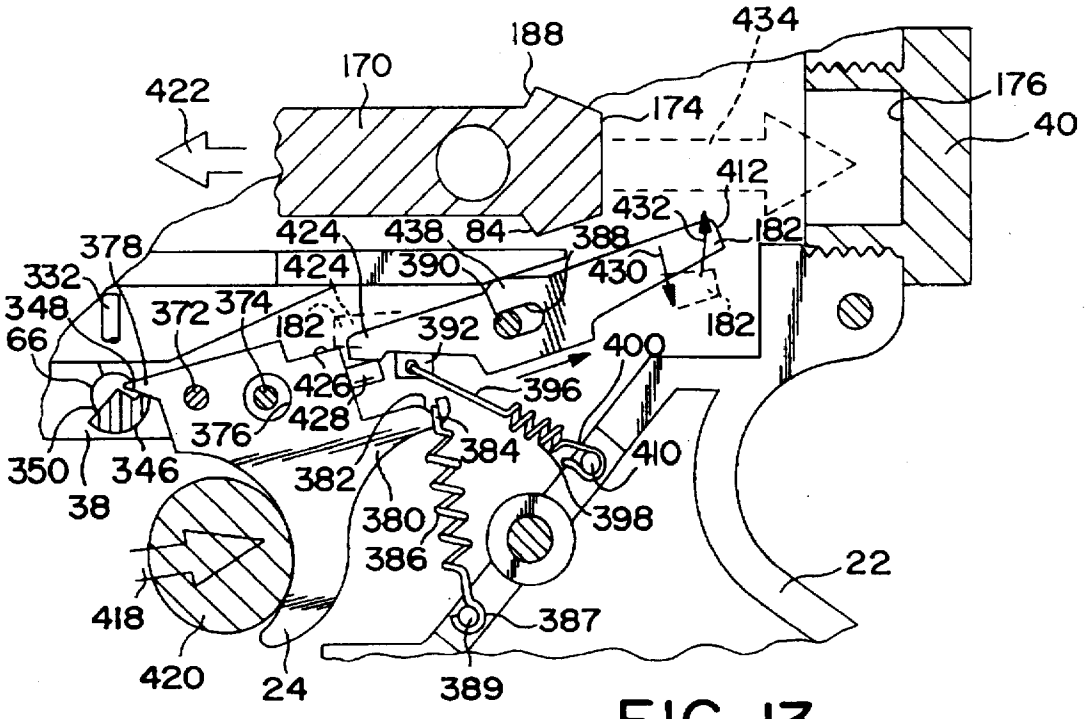
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FIG. 13

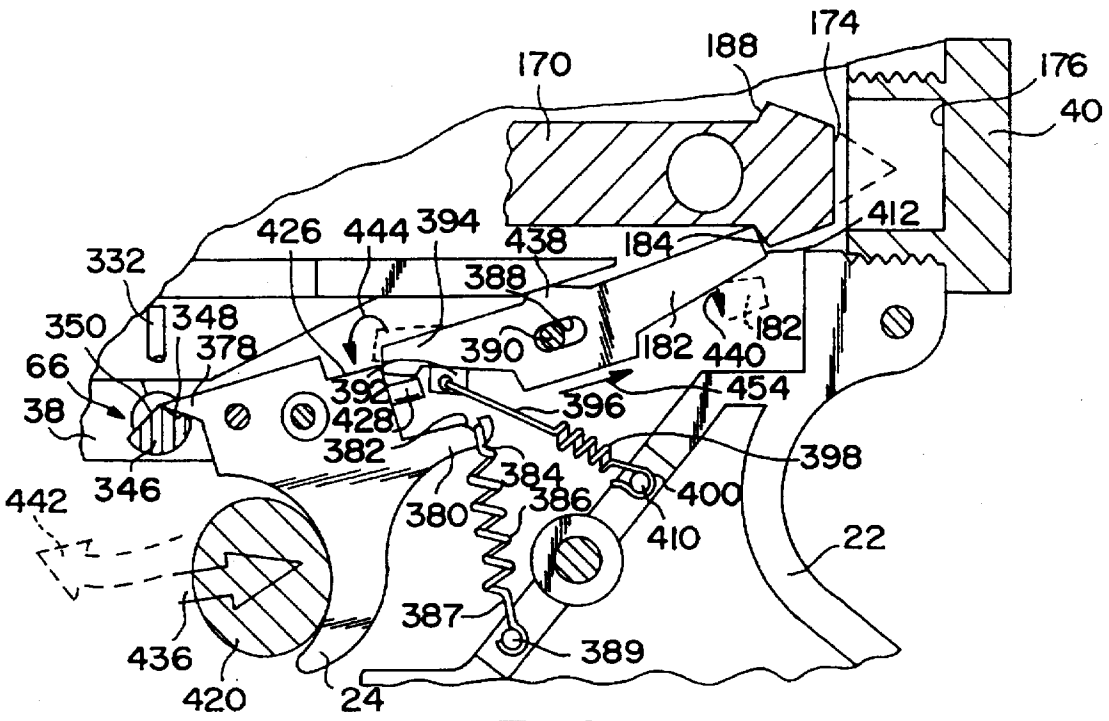
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FIG. 14

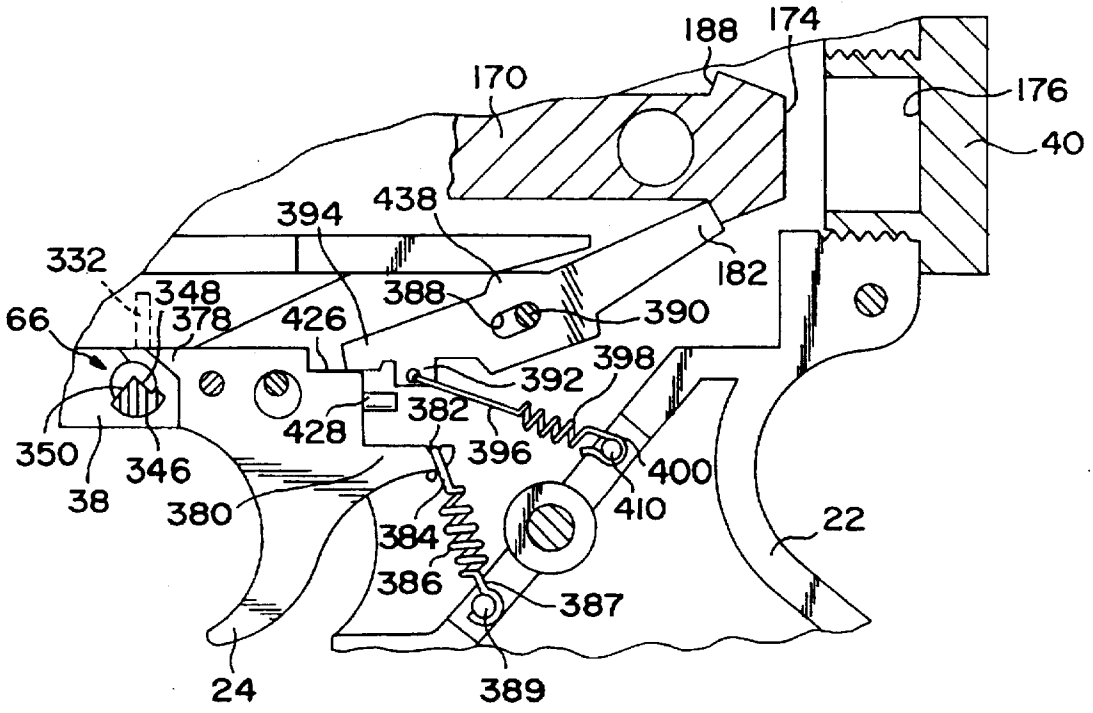
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FIG. 15

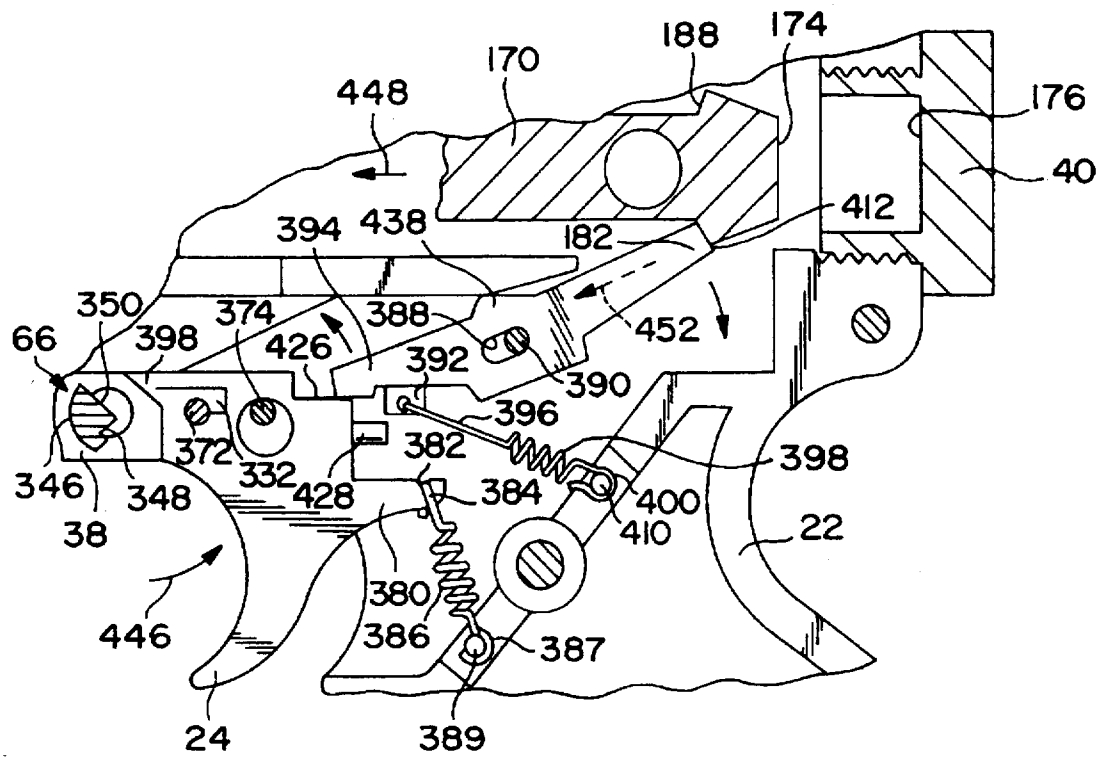
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FIG. 16

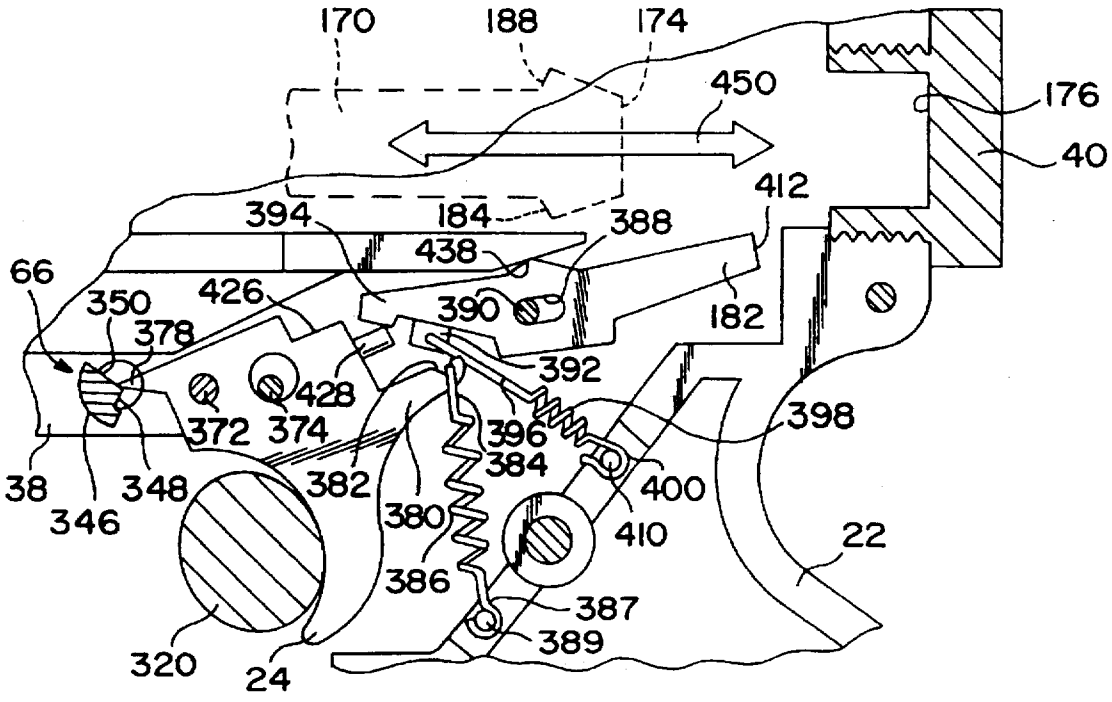
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FIG. 17

IMPEDER FOR A GUN FIRING MECHANISM WITH AMMUNITION FEEDER AND MODE SELECTOR

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to guns. More particularly, the present invention relates to an apparatus for retarding movement of a cyclically reciprocating member of the gun firing mechanism during each reciprocating cycle of the member, an ammunition feed mechanism for feeding a projectile into a chamber of the gun at a same point during each reciprocating cycle of the member, and a mode selector switch for selecting a rate of fire of the gun.

Ammunition power feeds supply projectiles to a chamber of a gun for firing by a firing mechanism. Ammunition power feeds should be designed to correctly feed a projectile into the gun chamber for firing by the firing mechanism. Misfeeds, such as loading a projectile only partially into the gun chamber or loading a projectile in backwards, can cause the gun to "jam" and require the chamber to be cleared, which is time consuming. Such misfeeds may additionally damage the gun. Furthermore, such misfeeds may be dangerous, causing injury to an operator of the gun when struck by the projectile or causing injury to the operator by failing to operate when needed for protection.

Ammunition power feeds should also be designed to positively feed or force a projectile into the chamber each time the firing mechanism is actuated. This is particularly true for semi-automatic and fully-automatic guns where firing rate is important. Malfunctions of this type can significantly reduce the firing rate, effectiveness, and reliability of a gun. The design of an ammunition power feed should additionally be "simple" to decrease manufacturing costs and operational breakdown, as well as to increase reliability, ease of use, and ease of servicing.

Firing mechanism retarders are designed to reduce the speed of the firing mechanism used to fire projectiles from the gun. One application for these mechanisms is conversion of a gun from semi-automatic firing to fully-automatic firing. This conversion requires reduction in the speed of the firing mechanism during a portion or all of its reciprocating cycle to allow sufficient time for loading of projectiles. If firing mechanism speed is not reduced, gun malfunctions such as jamming, breaking, or misfiring can occur.

Firing mechanism retarders should be designed to ensure that movement of the firing mechanism is properly impeded each reciprocating cycle of the firing mechanism. For example, with those retarders that only reduce the speed of the firing mechanism for a portion of each reciprocating cycle, correct and reliable engagement and subsequent disengagement with the firing mechanism each reciprocating cycle is a design goal. Additionally, the design of a firing mechanism retarder should be "simple" to decrease manufacturing costs and operational breakdown, as well as to increase reliability, ease of use, and ease of servicing.

A firing mechanism retarder of the present invention directed to these above-described design goals includes an apparatus for retarding movement of a cyclically reciprocating member during each reciprocating cycle of the member. The apparatus includes an impeder, a reset, and a release. The impeder is engaged with the member during a first portion of the reciprocating cycle of the member. The impeder resists displacement of the member during the first portion of the cycle. The impeder is disengaged from the member during a second portion of the reciprocating cycle.

The reset is engaged with the member during a third portion of the reciprocating cycle of the member to position the impeder for engagement with the member during the first portion of the reciprocating cycle. The release disengages the impeder from the member during the second portion of the reciprocating cycle.

The impeder may be displaced along an axis of reciprocation of the member. The first and third portions of the reciprocating cycle may occur during movement of the member in a same direction. The member may be a bolt of a firing mechanism.

The impeder may include an impeder sear engaged with a surface of the member and a sear movement retarder impeding displacement of the impeder sear and the member during engagement between the impeder sear and the member. The impeder sear may include a cam-shaped surface and the release may interact with the cam-shaped surface of the impeder sear to disengage the impeder sear from the member. The cam-shaped surface of the impeder sear may include an edge that defines an opening and the release may include a pin disposed within the opening and interacting with the edge to lift the sear out of engagement with the member. The sear movement retarder may include a piston assembly coupled to the impeder sear. The piston assembly may include a piston displaced by the impeder sear during engagement between the impeder sear and the member.

The reset may include a reset sear and the sear movement retarder may include a piston assembly coupled to the impeder sear and the reset sear. In this embodiment, the piston assembly may include first and second pistons in fluid communication with one another, the first piston assembly being coupled to the impeder sear and the second piston assembly being coupled to the reset sear. The reset sear engages the member during the third portion of the reciprocating cycle, is displaced by the member, and positions the impeder sear for engagement with the member during the first portion of the reciprocating cycle.

The sear movement retarder may be resistive to compressive forces. In addition, the sear movement retarder may be resistive to tensile forces. The sear movement retarder may include a piston disposed within a housing that is at least partially filled with a fluid medium.

The sear movement retarder may include an adjuster for controlling the rate by which fluid displacement of the member is impeded.

The apparatus may additionally include an ammunition feed mechanism of the present invention directed to the above-described design goals. The ammunition feed mechanism may include a body having an exit and a projectile carrier mechanism having a plurality of spaces each of which receives a projectile of the ammunition. The projectile carrier mechanism forces one of the projectiles out of the exit each reciprocating cycle of the member.

Another embodiment of the ammunition feed mechanism is for an apparatus, such as a gun, including a chamber having a projectile entrance that cyclically opens and closes. This embodiment of the ammunition feed mechanism includes a magazine, an ammunition carrier, and an ammunition carrier advancing mechanism. The magazine has an exit and the ammunition carrier has a plurality of spaces each of which receives a projectile of ammunition. The ammunition carrier advancing mechanism actuates the ammunition carrier to positively force one projectile out of the exit each time the projectile entrance is open.

A bottom of the magazine may be formed to include a ramp directing projectiles to the exit of the magazine. The

ammunition carrier may include a plurality of projections that define the spaces. These projections of the ammunition carrier may be curved for guiding each projectile through the exit and into the chamber. The ammunition carrier may include a wheel having a hub coupled to the ammunition carrier advancing mechanism. The projectiles of the ammunition carrier may radiate from the hub and curve from a proximate end of each projection to a distal end of each projection. The curving of the projections may be away from a direction of movement of the ammunition carrier.

The ammunition carrier advancing mechanism may include spring that releases stored energy to move the ammunition carrier. The ammunition carrier advancing mechanism may also include a crank for storing energy in the spring when the crank is moved in a first direction and at least one anti-reversing roller coupled to the crank that engages the magazine to help prevent the crank from moving in a second direction so that energy stored in the spring is used to move the ammunition carrier. In another embodiment, the ammunition carrier advancing mechanism includes a motor.

The exit of the magazine may be located at a bottom of the magazine and the magazine may be mounted to the apparatus so that ammunition in the magazine is gravity fed toward the bottom of the magazine during operation of the apparatus. Alternatively, a bottom of the magazine may be actuated in a direction of force applied by such means as a spring or compressed air to force projectiles into the spaces of the ammunition carrier.

An embodiment of a gun constructed in accordance with the preset invention includes a chamber, a cyclically reciprocating member, an ammunition feed mechanism, and a retarder. The chamber has a projectile entrance and the cyclically reciprocating member is used to fire projectiles from the gun. The ammunition carrier includes a magazine having an exit mounted adjacent the projectile entrance of the chamber. The ammunition feed mechanism also includes an ammunition carrier having a plurality of spaces each of which receives one projectile from the magazine. The projectile carrier positively feeds one projectile into the chamber via the exit and the projectile entrance at a same point during each reciprocating cycle of the member. The retarder includes an impeder engaged with the member during a first portion of the reciprocating cycle of the member to resist displacement of the member during the first portion of the reciprocating cycle of the member. The impeder is disengaged from the member during a second portion of the reciprocating cycle of the member.

The first portion of the reciprocating cycle may be prior to firing one projectile from the gun. At least a part of the second portion of the reciprocating cycle of the member may be after firing one of the projectiles from the gun.

The gun may additionally include structure for selecting a rate of fire of the gun. The selecting structure may include a mode selector switch positionable in one of a plurality of positions. These positions may include a locked position and an automatic firing position. The positions may also include a semi-automatic firing position.

The mode selector switch may include a pin having one or more surfaces for interacting with a firing mechanism of the gun, in one or more of the mode selector switch positions, to control displacement of the firing mechanism. The firing mechanism may include a trigger.

The selecting structure may also include structure for releasably securing the selector switch in each mode selector switch position. The selecting structure may include a plurality of recessed portions formed in a body of the selector switch and a detent disposable in one of the recessed portions in each selector switch position.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a gun equipped with an embodiment of a retarder mechanism and an embodiment of an automatic feed mechanism constructed in accordance with the present invention.

FIG. **2** is a top, partial cross-sectional view of the retarder mechanism shown in FIG. **1**.

FIG. **3** is a side view of a stage of operation of the retarder mechanism shown in FIG. **1**.

FIG. **4** is a side view of the retarder mechanism shown in FIG. **3** during a different stage of operation of the retarder mechanism.

FIG. **5** is a side view of the retarder mechanism shown in FIG. **3** during a different stage of operation of the retarder mechanism.

FIG. **6** is an exploded perspective view of an embodiment of an automatic feed mechanism constructed in accordance with the present invention.

FIG. **7** is an assembled, cross-sectional side view of the automatic feed mechanism shown in FIG. **6**.

FIG. **8** is a top, cross-sectional view of the automatic feed shown in FIG. **6** illustrating operation of the automatic feed mechanism.

FIG. **9** is a top, cross-sectional view of the automatic feed mechanism shown in FIG. **8** during a different stage of operation of the automatic feed mechanism.

FIG. **10** is a perspective view of a mode selector switch constructed in accordance with the present invention.

FIG. **11** is a cross-sectional view of the mode selector switch shown in FIG. **10** installed in the gun of FIG. **1**.

FIG. **12** is a cross-sectional view of the gun of FIG. **1** showing the mode selector switch positioned so that the gun is locked.

FIG. **13** is a cross-sectional view, like that shown in FIG. **12**, with the mode selector switch in a semi-automatic position so that a projectile may be fired from the gun each time the firing mechanism is actuated.

FIG. **14** is a cross-sectional view, like that shown in FIG. **13**, showing the mode selector switch in the semi-automatic position after a projectile has been fired from the gun but before the firing mechanism has been reset.

FIG. **15** is a cross-sectional view, like that shown in FIG. **14**, showing the mode selector switch in the semi-automatic position after a projectile has been fired from the gun and after the firing mechanism has been reset so another projectile may be fired.

FIG. **16** is a cross-sectional view, like that shown in FIG. **13**, illustrating the mode selector switch in the fully automatic position so that projectiles may be continuously fired from the gun.

FIG. **17** is a cross-sectional view, like that shown in FIG. **16**, illustrating the mode selector switch in the fully automatic mode and the firing mechanism actuated for continuous firing of projectiles from the gun.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a perspective view of a gun **10** equipped with an embodiment of a retarder mechanism **12** constructed

in accordance with the present invention and an embodiment of an automatic feed mechanism **14** also constructed in accordance with the present invention. Gun **10** includes a front sight **16** and a rear-notched sight **18** which are used together to aim gun **10**. Gun **10** additionally includes a front hand grip or forestock **20** and a pistol grip **22** both of which are used to hold gun **10** in a firing position. Gun **10** additionally includes a firing mechanism, such as trigger **24**, used to manually fire projectiles from gun **10**. Trigger **24** is partially surrounded by a trigger guard **26**. Gun **10** additionally includes a shoulder stock **28** and a buttplate **30**. A CO_2 or other compressed gas canister forms shoulder stock **28** and is used as a propellant to fire projectiles from gun **10** and also operate the firing mechanism thereof, as discussed more fully below. As can be seen in FIG. **1**, canister **28** includes a neck portion **32** that is received in a socket portion **34** of pistol grip **22** by such means as a threaded engagement between neck **32** and socket **34**.

Gun **10** further includes a barrel **36** from which projectiles are fired and a frame **38** to which components of gun **10**, such as retarder mechanism **12** and automatic feed mechanism **14**, are attached. A cap **40** is received within an end **42** of frame **38** by such means as threaded engagement between cap **40** and end **42** of frame **38**. Cap **40** helps seal a chamber of gun **10**. In other embodiments of gun **10**, a compressed gas canister may be received in end **42** of frame **38** instead of at socket portion **34**.

Gun **10** additionally includes a handle **44** connected to a cyclically reciprocating member (e.g., a bolt) of gun **10** used to fire projectiles therefrom. Handle **44** cyclically reciprocates within slot **46** formed in frame **38** of gun **10**. Slot **46** includes an end **47** that receives handle **44** when the reciprocating member of gun **10** is in a "cocked" or ready position for firing a projectile.

Retarder mechanism **12** includes an impeder **48** that engages a cyclically reciprocating member of a firing mechanism during a portion of its reciprocating cycle, as discussed more fully below. Impeder **48** includes a pair of piston assemblies **50** and **52** that are connected to sears **54** and **56** that engage the cyclically reciprocating member as discussed more fully below. Piston assemblies **50** and **52** are housed within a block **58** that is connected to frame **38** of gun **10**. As can be seen in FIG. **1**, rear-notched sight **18** is integrally formed as a part of block **58**. However, other embodiments of retarder mechanism **12** may not include an integrally formed rear-notched sight **18**. That is, rear-notched sight **18** is separately connected to block **58** or another portion of gun **10**.

A cover **60** is secured over part of an opening **62** in which retarder mechanism **12** is disposed via a fastener **64**.

Gun **10** may additionally include a mode selector switch **66** movable between safe, semi-automatic, and fully automatic settings, as described in U.S. Pat. No. 4,819,609. Mode selector switch **66** may operate in the manner described in U.S. Pat. No. 4,819,609.

Automatic feed mechanism **14** includes a magazine **68** to which a hopper **70** is coupled. Hopper **70** includes an opening (not shown) that is removably covered by a cover **74** that fits over and engages a lip **76** defining the opening. Projectiles, such as paint balls, are loaded into hopper **70** via this opening. These projectiles travel from hopper **70** into magazine **68** of automatic feed mechanism **14** where they are positively fed or forced into a chamber (not shown in FIG. **1**) of gun **10** as more fully discussed below.

A top, partial cross-sectional view of retarder mechanism **12** is shown in FIG. **2**. The above-described piston assemblies **50** and **52**, sears **54** and **56**, and block **58** are shown, as is a part of cover **60**. Block **58** is shown as being secured to frame **38** via a pair of fasteners **78**. As can be seen in FIG. **2**, block **58** is formed to include a pair of chambers **80** and **82** that are fluidly coupled together via a channel or port **84**. Channel or port **84** is substantially sealed via a plug or seal **86** to help prevent escape of fluid, such as air, within chambers **80** and **82** and channel or port **84**. Threaded fasteners **88** and **90** seal respective ends **92** and **94** of respective chambers **80** and **82**. Each threaded fastener **88** and **90** is fitted with a seal, such as O-ring seals **96** and **98**, that are seated about neck portions **100** and **110** of fasteners **88** and **90**. A needle or adjuster **112** may be formed on fastener **90** and used to adjustable control the rate of fluid flow between chambers **80** and **82** by blocking part or all of channel or port **84**.

Each piston assembly **50** and **52** also includes a piston **114** and **116** disposed within respective chambers **80** and **82** via respective ends **118** and **120**. Seals, such as O-ring seals **122** and **124**, are seated about respective grooves **126** and **128** of respective pistons **114** and **116** to substantially seal ends **118** and **120** of respective chambers **80** and **82**.

Ends **130** and **132** of respective pistons **114** and **116** are formed to include forked portions **134** and **136**. Forked portions **134** and **136** receive respective reduced portions **138** and **140** of sears **54** and **56** as shown. Forked portion **134** and **136** and reduced portions **138** and **140** are each formed to include openings therein that receive pins **142** and **144** to connect sears **54** and **56** to respective pistons **114** and **116**.

Retarder mechanism **12** additionally includes a release **146**, that may be a pin, as shown in FIG. **2**, disposed within openings **148** and **150** formed in respective sears **54** and **56** as shown in FIGS. **3–5**. Release **146** helps disengage sears **54** and **56** from the cyclically reciprocating member of gun **10** used to fire projectiles therefrom as more fully discussed below.

Sears **54** and **56** include respective members **152** and **154** that engage the cyclically reciprocating member as more fully discussed below. As can be seen in FIG. **2**, member **152** is slightly longer than member **154**.

Retarder mechanism **12** additionally includes springs **156** and **158** (see FIG. **1**) that are connected together end **160** which is attached to a portion of frame **38** of gun **10** via fastener **162** and washer **164** (see FIGS. **3–5**). Ends **166** and **168** are respectively engaged with sears **54** and **56** to resiliently bias them in a direction toward cyclically reciprocating member **170**, as shown in FIGS. **3–5**.

FIGS. **3–5** illustrate different stages of operation of retarder mechanism **12**. Cyclically reciprocating member **170** is shown disposed within an open section **172** of gun **10** defined by frame **38**. Cap **40** is shown as being threadably secured to frame **38** adjacent the point of connection of springs **156** and **158**. Although not shown, an actuator is used to impart cyclically reciprocating motion to member **170**. This actuator may include a spring disposed between end **174** of member **170** and, for example, inside portion **176** of cap **40**. An example of such an actuator mechanism is shown in U.S. Pat. No. 4,819,609. A seal, such as O-ring seal **178**, is seated in groove or notch **180** of member **170** to substantially seal open portion **172**.

A firing mechanism sear **182** engages a notch or shoulder portion **184** of member **170** to hold member **170** in place against movement caused by the urging of the actuator adjacent end **174**, as discussed above. Sear **182** is moved out of engagement with notch or shoulder **184** upon actuation of

trigger **24**. In the embodiment illustrated, trigger **24** is manually pulled rearwardly toward grip **22** to pivot or move sear **182** out of engagement with notch or shoulder **184**.

With sear **182** out of engagement with notch **184**, member **170** moves forwardly under the urging of the actuator (not shown) toward barrel **36**, as generally indicated by arrow **186**, until member **152** engages notch or shoulder **188** of member **170**, as shown in FIG. **3**. Engagement between member **152** and notch or shoulder **188** causes sear **54** and piston **114** to move forwardly, being axially displaced along with member **170**, as generally indicated by arrows **190** and **192** in FIG. **3** and arrow **194** in FIG. **2**. Movement of piston **114** within chamber **80** displaces fluid medium therein. Fluid within chamber **80** is displaced through channel or port **84** into chamber **82** at a rate controlled by such factors as the size of channel or port **84** and chamber **82**, as well as the depth of insertion of needle **112**. Displacement of fluid into chamber **82** moves piston **116** and sear **56** in a direction generally opposite movement of piston assembly **52** and sear **54**, as generally indicated by arrow **196** in FIG. **2** and arrow **198** in FIG. **3**. The amount of displacement of piston assembly **52** and sear **56** is proportional to the displacement of piston assembly **50** and sear **54**. In one or more embodiments of retarder mechanism **12**, displacement of piston assembly **52** and sear **56** may be directly proportional to displacement of piston assembly **50** and sear **54**. However, in other embodiments of retarder mechanism **12**, displacement of piston assembly **52** and sear **56** may be more or less than that of piston assembly **50** and sear **54**.

The engagement between member **152** and notch or shoulder **188** impedes movement of member **170** thereby reducing the firing rate of gun **10**. The rate at which the firing rate of gun **10** is reduced is dependent upon one or more factors such as the size of piston chambers **80** and **82**, the size of channel or port **84**, the depth of insertion of needle **112** into chamber **82**, the fluid medium disposed within chambers **80** and **82**, and the shape of pistons **114** and **116**.

Sear **54** is engaged with member **170** and axially displaced thereby until disengaged therefrom by release **146** as shown in FIG. **4**. Edge **200**, which defines opening **148**, interacts with release **146** to lift or disengage member **152** from notch or shoulder **188** of member **170**. As can be seen in FIGS. **3** and **4**, the portion of edge **200** that interacts with release **146** is angled with respect to the direction of axial displacement of member **170**, generally indicated by arrow **186**, so that this angled surface cammingly engages release **146** to lift or disengage member **152** from notch or shoulder **188**.

As shown in FIG. **3**, member **154** is initially disengaged from notch or shoulder **188** as a result of a portion of edge **210**, that defines opening **150**, cammingly engaging release **146** to lift member **154** out of engagement with notch or shoulder **184**. As can be seen in FIGS. **3–5**, the portion of edge **210** that engages release **146** is also generally angled with respect to the direction of movement of member **170**, generally indicated by arrow **186**. The amount of angling of edge portion **210** is shown as being greater than the amount of angling of edge portion **200** in FIGS. **3–5**. However, it is to be understood that other embodiments of retarder mechanism **12** of the present invention may angle edge portions **200** and **210** differently. For example, edge portion **200** may be angled to a greater amount then edge portion **210**. Alternatively, edge portions **200** and **210** may be angled approximately the same. Some factors, not necessary the only ones, which determine this amount of angling include such things as the length of members **152** and **154** and the relative positioning of release **146** within openings **148** and **150**.

Piston assembly **50** and sear **54** act as a reset when engaged with member **170** during a portion of its reciprocating cycle to position member **154** of sear **56** for engagement with notch **188** of member **170**. The engagement between member **154** and member **170** resists displacement of member **170** in a direction generally indicated by arrow **186**. When member **154** is engaged with notch **188**, member **170** displaces fluid out of chamber **82** and into chamber **80** via channel or port **84**. As discussed above, the rate at which fluid is displaced is controlled by a variety of factors such as the depth of insertion of needle **112** into chamber **82**. The impeding of movement of member **170** reduces the firing rate of projectiles from gun **10** as discussed above.

Eventually, member **170** displaces sear **56** and member **154** thereof to the position shown in FIG. **5**. At this point, member **154** of sear **56** is lifted up and disengaged from notch **188** of member **170** by camming engagement between edge portion **210** of opening **150** and release **146** as discussed above in connection with edge portion **200** and release **146**. Subsequent to disengagement of member **154** from notch **188**, member **170** is free to travel, unimpeded by retarder mechanism **12**, for the remainder of its forward movement and rearward movement back to the position shown in FIGS. **3** upon completion of one reciprocating cycle. At this point, member **170** is either stopped by engagement between sear **182** and notch or shoulder **184** or, if trigger **24** is still actuated, until engagement again between member **152** and notch or shoulder **188** which has been moved back into position for this engagement as a result of the displacement of sear **56** and piston assembly **52**.

Ends **166** and **168** of respective springs of **156** and **158** bias respective sears **54** and **56** downwardly, in a direction generally towards member **170**, facilitate engagement therewith and proper camming action between release **146** and edge portions **200** and **210** of respective openings **148** and **150**.

The embodiment of retarder mechanism **12** disclosed in FIGS. **1–5** utilizes two piston assemblies and sears. As discussed above, one sear and piston assembly engages the cyclically reciprocating member and is displaced thereby to reset the other piston assembly and sear in a position for engagement with the firing member to further impede its rate of displacement. The second piston assembly and sear reduce the rate of travel of the firing member and are displaced thereby to reposition the reset piston assembly and sear for reengagement with the cyclically reciprocating member on its next cycle. It is to be understood, however, that other embodiments of retarder mechanism **12** may utilize a different structure, such as a single piston assembly, and a single sear, from gun **10**. One factor controlling whether a single piston assembly and sear can be used is the rate of cyclical reciprocation of member **170**. For guns having higher rates of cyclical reciprocation, the dual disclosed assembly may work more effectively and help better insure impeding engagement during a portion of the cyclical reciprocation of member **170**. For such faster guns, a single sear may not drop downwardly under the urging of a spring quickly enough to reengage a shoulder or notch of the member subsequent to being disengaged therefrom by a release. It is to also be understood that impeding mechanisms other than piston assemblies may be used in other embodiments of retarder mechanism **12**. For example, one or more piston assemblies of retarder mechanism **12** may be replaced by spring assemblies or assemblies including elastomeric members that are resistive to compressive and/or tensile forces.

An exploded perspective view of an embodiment of automatic feed mechanism **14** of FIG. **1** is shown FIG. **6**.

The above-described hopper **70** is also shown. Also shown are a plurality of projectiles **212**, in the form of paint balls, that are fired from barrel **36** of gun **10**.

Automatic feed mechanism **14** includes a magazine **214**, an ammunition carrier **216**, and an ammunition carrier advancing mechanism **218**. Magazine **214** includes an exit **220** that is mounted to frame **38** of gun **10** adjacent an entrance **222** of chamber **224** of gun **10** via a plurality of fasteners **226** that are disposed through members **228** and **230** of frame **38** and openings **232** and **234** of magazine **214**, as shown in FIGS. **6** and **7**.

Magazine **214** additionally includes a ramped bottom surface **236**. Ramped bottom surface **236** helps direct projectiles **212** toward exit **220** and into chamber **224** via entrance **222**. As can be seen in FIG. **7**, ramped bottom surface **236** is angled so that center **213** of projectile **212D** is above bottom edge **253** of projection or arm **252A** and center **213** of projectile **212A** is below bottom edge **253** of projection or arm **252B**.

Magazine **214** is further formed to include an upstanding portion **238** that is received within an opening **248** of hopper **70**, defined by depending portion **240**, to couple hopper **70** to ammunition feed mechanism **14** as shown in FIGS. **1** and **7**. The depth of insertion of upstanding portion **238** into opening **248** is limited by a shoulder **242** formed on body **244** of magazine **214** which is engaged by depending portion **240** as shown in FIGS. **6** and **7**. Depending portion **240** may also be formed to include a shoulder **246** engaged by upstanding portion **238** as an alternative or additional means for limiting the depth of insertion of portion **238** within opening **248** as shown in FIG. **7**.

Ammunition carrier **216** includes a plurality of spaces **250** defined by a plurality of radiating projections or arms **252**. Ammunition carrier **216** includes a hub **254**, to which radiating projections or arms **252** are either attached or integrally formed, and an opening **256**. As can be seen in FIGS. **6**, **8**, and **9**, projections or arms **252** are curved. This curving helps direct or guide projectiles **212** out of exit **220** and into chamber **224** via entrance **222**. As can also be seen in FIGS. **6**, **8**, and **9**, projections or arms **252** are curved from a proximate end **258** to a distal end **260**.

Ammunition carrier advancing mechanism **218** includes a spring **262**, a plate **264**, an axle **266**, a pin **268**, and one or more anti-reversing rollers **270**. Axle **266** is disposed through opening **272** in plate **264** and opening **274** in magazine **214**. End **276** of axle **266** is also disposed within opening **256** and includes a plurality of threads **278** that threadably engage wall **280** that defines opening **256** to secure ammunition carrier **216** to axle **266**. Axle **266** also includes a slot **282** that receives an end **284** of spring **262** therein. Spring **262** is disposed within a recess **286** of plate **264** defined by upstanding wall **288**. End **290** of spring **262** is disposed within a slot (not shown) formed in plate **264** or against a projecting rib (not shown) formed on upstanding wall portion **288**. An end **292** of pin **268** is disposed within an opening (not shown) formed on bottom **294** of plate **264**. One or more anti-reversing rollers **270** are positioned in recesses **296** formed in upstanding wall portion **288** of plate **264** so that anti-reversing rollers **270** are disposed between a lip **298** of plate **264** and a wall **300** of magazine **214** that defines recess **310** into which plate **264** is disposed when axle **266** is coupled to hub **254** of ammunition carrier **216**. Shoulders **312** formed on magazine **214** engage lip **298** of plate **264** to control the depth of insertion of plate **264** within recess **310**.

A washer **314** may be formed on pin **268** to control the depth of insertion of end **292** within the opening formed in bottom **294** of plate **264**. Axle **266** may include a head **316** thereon to limit the depth of insertion of axle **266** within openings **272** and **274**.

Energy is stored within spring **262** of ammunition carrier advancing mechanism **218** by manually actuating pin **268** thereof to turn mechanism **218** in a direction generally indicated by arrow **318**. Energy stored within spring **262** is used to turn ammunition carrier **216** as discussed more fully below.

Anti-reversing rollers **270** engage wall **300** of magazine **214** and upstanding wall **288** of plate **264** to help prevent uncoiling of spring **262** while, at the same time, allowing energy to be stored therein by rotating pin **268** in a counterclockwise direction indicated by arrow **318**, as discussed above. This is accomplished by angling each recess or slot **296** a predetermined number of degrees, as generally indicated by lines **293**, **295**, and **297**, and arrows **299** and **301**. This angling causes each anti-reversing roller **270** to move to the right when plate **264** is turned in a counterclockwise direction and to the left, wedging against walls **288** and **300**, if plate **264** attempts to move in a clockwise direction under the urging of spring **262**. This wedging locks plate **264** against such clockwise movement. In one or more embodiments of ammunition feed mechanism **14**, the predetermined number of degrees is approximately between six and seven degrees.

Although ammunition carrier advancing mechanism **218** is shown as being driven by a spring **262**, it is to be understood that other embodiments of ammunition carrier advancing mechanism **218** are possible. For example, ammunition carrier advancing mechanism **218** may include a motor as a source for energy rather than spring **262**.

As shown in FIGS. **8** and **9**, the firing mechanism of gun **10** includes an additional cyclically reciprocating member **320** that axially moves within chamber **224** of gun **10**. Cyclically reciprocating member **320** cyclically opens and closes chamber entrance **222** as shown in FIG. **8** where entrance **222** is closed by member **320** to prevent a projectile **212A** from entering and FIG. **9** where entrance **222** is open so that projectile **212A** can be positively fed or forced into chamber **224**. Member **320** includes a groove **322** on which a seal, such as O-ring seal **324**, is seated to line to substantially seal chamber **224** so that projectiles **212** may be fired pneumatically therefrom via pneumatic fluid traveling opening **326** in member **320**.

As can be seen in FIG. **8**, a projectile **212** is disposed within each space **250** between a pair of radiating projections or arms **252**. Spaces **250** are sized so that only a single projectile **212** is disposed therein at any given time to prevent misfeeds such as multiple projectiles **212** from being positively fed or forced into chamber **224** via exit **220** and entrance **222**.

In the embodiment of automatic feed mechanism **14** shown, projectiles **212** fall into spaces **250** under the influence of gravity. However, it is to be understood that other means may be used to dispose a projectile **212** within each space **250** of ammunition carrier **216**. For example, automatic feed mechanism **14** may be mounted in an upside down position (i.e., rotated 180 degrees with respect to the position of mechanism **14** shown in FIG. **1**). In this embodiment, bottom surface **236** may be urged upwardly toward gun **10** by means such as a spring or compressed air so that a projectile **212** is disposed within each of spaces **250** of ammunition carrier **216**.

Member **312** is coupled to member **170** by a rigid member, such as a rod **328** shown in FIGS. **3–5** so that

cyclical reciprocating motion of member **170** causes cyclical reciprocating motion of member **320**. As discussed above, FIG. **8** shows chamber entrance **222** closed by member **320** so that projectile **212A** in magazine **214** is prevented from entering chamber **224**. Another projectile **212B** is adjacent member **320** for pneumatic firing. Upon firing of projectile **212B** from chamber **224**, member **170** is driven rearwardly toward cap **40**, by pneumatic fluid or other means, which causes member **320** to move sufficiently rearwardly to open chamber entrance **222**. Once open, a new projectile **212A** is positively fed or forced into chamber **224**, as generally indicated by arrow **330**, upon rotation of ammunition carrier **216** in a counterclockwise direction. Arrow **330** may indicate a spinning of projectile **212A**, caused by center **213** being below bottom edge **253** of projection or arm **252B**, as discussed above. Projectile **212C** is stopped from leaving exit **220** and entering chamber **224** via entrance **222** initially by the presence of projectile **212A** and subsequently by member **320** when it resumes the position shown in FIG. **8**. Advancement of ammunition carrier **216** in a counterclockwise direction is halted until projectile **212A** is fired from chamber **224** and member **320** clears entrance **222** as shown in FIG. **9**. In this way, ammunition carrier **216** helps insure that only a single projectile **212** is loaded in chamber **224** during each reciprocating cycle of members **170** and **320** of the firing mechanism of gun **10**. Additionally, ammunition carrier **216** and ammunition carrier advancing mechanism **218** are designed to advance any number of spaces **250**, if one or more of such spaces lack a projectile **212** disposed therein, until a space **250** having a projectile **212** therein is presented to exit **220** and entrance **222** and positively fed or forced into chamber **224**. In this way, ammunition feed mechanism **14** helps ensure that a projectile is always available for firing during the firing stroke of the firing mechanism, regardless of the rate of firing, should at least one projectile be within hopper **70**.

A perspective view of a mode selector switch **66** constructed in accordance with the present invention is shown in FIG. **10**. As can be seen, mode selector switch **66** includes a lever **332** coupled to a body **334**. Body **334** is formed to include a firing mechanism engagement portion **336** located between lines **338** and **340** in FIG. **10**. Body **334** is also formed to include a reduced end **342** that receives a lock washer **334**. Body **334** is disposed in a portion of frame **38** of gun **10** and secured thereto via placement of lock washer **344** on reduced end **342**.

As can be seen in FIG. **10**, firing mechanism engagement portion **336** includes a plurality of surfaces **346**, **348**, and **350**. Surfaces **346**, **348**, and **350** are selectively positionable adjacent a portion of trigger **24**, as discussed more fully below, to control the rate of firing of projectiles from gun **10**. Surfaces **346**, **348**, and **350** are selectively positionable via movement of lever **332** in the directions generally indicated by arrows **352** and **354** in FIG. **10**.

Mode selector switch **66** is releasably held in the position shown in FIG. **10** via engagement between recessed portion **356** and detent or ball **358** urged into recessed portion **356** under the influence of spring **360** disposed within cavity **362** of frame **38**, as shown in FIG. **11**. Lever **332** may be moved along the direction of arrow **352** to position **364** as shown in FIGS. **10** and **11**. In position **364**, surface **348** of firing mechanism engagement portion **336** engages trigger **24**, as discussed more fully below. Mode selector switch **66** is held in position **364** via engagement between detent **358** and recessed portion **366** formed in body **334**. When in position **364**, lever **332** may be moved back to the position shown in FIG. **10** in a direction generally opposite that of arrow **352** shown in FIG. **10**. When in position **364**, lever **332** may also be moved in the direction generally indicated by arrow **354** in FIGS. **10** and **11** to position **368**. In position **368**, detent **358** engages recessed portion **370**, shown in FIG. **11**, to releasably secure mode selector switch **66** in position **368**. When in position **368**, lever **332** may be returned to either position **364** or that shown in FIG. **10** by movement of lever **332** in a direction generally opposite that of arrow **354** and arrow **352**.

FIG. **12** is a cross-sectional view through a portion of gun **10** illustrating mode selector switch **66** in a locked position preventing firing of projectiles from gun **10**. Components of gun **10** visible in FIG. **12** include trigger **24**, mode selector switch **66**, cyclically reciprocating firing member **170**, and firing mechanism sear **182**. Trigger **24** is pivotally secured to frame **38** of gun **10** via pin **372** and pin **374**, which is disposed within opening **376** formed in trigger **24**. Trigger **24** is formed to include an end **378** that engages a portion of mode selector switch **66**, as more fully discussed below. Trigger **24** is also formed to include an extending member **380** having a notch **382** formed therein that receives an end **384** of a spring **386**. An opposing end **387** of spring **386** attaches to pin **389** of frame **38**.

As can be seen in FIG. **12**, firing mechanism sear **182** includes a longitudinal or elongated hole **388** in which a pivot pin **390** is disposed. Pivot pin **390** is free to translate in hole **388**, as more fully discussed below. A spring attachment member **392** is located near an end **394** of firing mechanism sear **182**. An end **396** of spring **398** is disposed within an opening in spring attachment member **392**. An opposing end **400** of spring **398** is attached to pin **410** of frame **38**. As can be seen in FIG. **12**, spring **386** urges trigger **24** into the position shown in FIG. **12** and spring **398** urges firing mechanism sear **182** into the position shown in FIG. **12** so that notch **184** of reciprocating member **170** engages end **412** of sear **182**. In this position, member **170** is prevented from moving forward in a direction generally indicated by arrow **414** and firing a projectile **212**.

As discussed above, mode selector switch **66** includes a firing mechanism engagement portion **336** formed to include a plurality of surfaces **346**, **348**, and **350**. Surface **346** of firing mechanism engagement portion **336** is shown as engaging end **378** of trigger **24** in FIG. **12**. In this position, gun **10** is prevented from firing a projectile because a force directed generally along arrow **416** in FIG. **12** will not displace trigger **24** to remove end **412** of firing mechanism sear **182** from notch **184** of member **170**.

Operation of gun **10** in a semi-automatic mode is illustrated in FIGS. **13–15**. In this mode, surface **348** of firing mechanism engagement portion **336** engages end **378** of trigger **24** to limit firing of projectiles from gun **10** to one projectile each time trigger **24** is actuated. Trigger **24** is displaced to the position shown in FIG. **13** upon application of a forced generally directed along large arrow **418** by such means as a finger **420**. This displacement of trigger **24** initially moves sear **182** to the position generally indicated by dashed lines in FIG. **13**. Sear **182** moves to this position by pivoting about raised portion **438** of sear **182**. This allows firing member **170** to move forward in the direction generally indicated by large arrow **422** to fire a projectile **212** from gun **10**. End **424** of sear **182** eventually clears ledge **426** of trigger **24** and comes to rest on extended portion **428** of trigger **24** to assume the position shown by solid lines in FIG. **13**. Movement of sear **182** from an initial position engaging member **170** to the position shown by dashed lines is indicated by arrow **430**. Movement from this position to the position wherein end **424** of sear **182** engages extended

portion **428** of trigger **24** is generally indicated by arrow **432** in FIG. **13**. As can be seen in FIG. **13**, spring **386** is in tension as a result of movement of trigger **24** to the position shown and spring **398** is pulling end **424** of sear **182** against extended portion **428**.

As discussed above, after moving a predetermined distance in the direction generally indicated by arrow **422**, cyclically reciprocating member **170** returns in the direction generally indicated by large dashed arrow **434** in FIG. **13** to the position shown in FIG. **14** where end **412** of sear **182** engages notch **184** of member **170**. End **412** of sear **182** is pulled against notch **184** of member **170** by spring **398**, as generally indicated by arrow **454**. Sear **182** is free to move in this manner by pin **390** translating in hole **388**. Gun **10** cannot be fired again upon application of a force in a direction generally indicated by arrow **436**, by means such as finger **420**, because sear **182** will not pivot downwardly about raised portion **438** thereof in a direction generally indicated by arrow **440** to release member **170** to fire another projectile. Such movement is blocked by engagement between end **378** of trigger **24** and surface **348** of mode selector switch **66**. In order to again fire a projectile, trigger **24** must be released so that spring **386** can exert a force thereon to move trigger **24** in a direction generally indicated by dashed arrow **442** in FIG. **13** so that trigger **24** assumes the position shown in FIG. **15**. Movement of trigger **24** in a direction generally indicated by arrow **442** moves end **394** of sear **182** onto ledge **426** of trigger **24** as generally indicated by arrow **444** in FIG. **14** and also shown in FIG. **15**. Repositioning of end **394** of sear **182** on ledge **426** of trigger **24** causes pin **390** to translate within hole **388** from the position shown in FIG. **14** to that shown in FIG. **15** under a force provided by member **170**. Another projectile may be fired from gun **10** by again actuating or moving trigger **24** in the direction of arrow **418** shown in FIG. **13**.

Mode selector switch **66** may also be moved to a position that allows for automatic firing of projectiles from gun **10**. This position of mode selector switch **66** is illustrated in FIGS. **16** and **17**. In this position of mode selector switch **66**, trigger **24** may be actuated by a force, generally indicated by arrow **446**, again by means such as finger **420**. Such movement of trigger **24** releases end **412** of sear **182** from notch or shoulder **184** of member **170** allowing for automatic firing of projectiles from gun **10** as member **170** reciprocates forward and backward in directions generally indicated by arrows **448** in FIG. **16** and large double headed arrow **450** in FIG. **17**. During movement of trigger **24** in the direction generally indicated by arrow **446**, end **378** thereof eventually contacts surface **350** of mode selector switch **66** to limit further movement of trigger **24**. End **412** of sear **182** is prevented from reengaging shoulder or notch **184** of member **170** after a single full reciprocating cycle because extended portion **428** engages end **394** of sear **182** to pivot it about raised portion **438** a sufficient amount to clear the path of cyclically reciprocating member **170** as shown in FIG. **17**. As can be seen from FIGS. **16** and. **17**, pin **390** translates within hole **388** as indicated by arrow **452** in FIG. **16** to remove sear **182** from the path of cyclically reciprocating member **170**. Upon release of trigger **24**, spring **386** will move trigger **24** to the position shown in FIG. **16** so the end **394** moves onto ledge **426** and sear **182** reengages notch **184** of cyclically reciprocating member **170** to prevent further firing of projectiles from gun **10**.

Although embodiments of the present invention have been shown and described for use with paint ball projectiles, it is to be understood that the present invention may find application for other types of projectiles as well. For example, a retarder mechanism constructed in accordance with the present invention may be used to impede cyclical reciprocatory motion of a member used to fire bullets or shells. Additionally, an automatic feed mechanism constructed in accordance with the present invention may be used to positively feed those bullets or shells to a firing chamber.

From the preceding description of the preferred embodiments, it is evident that the objects of the invention are attained. Although the invention has been described and illustrated in detail, it is to be clearly understood that the same is intended by way of illustration and example only and is not to be taken by way of limitation. The spirit and scope of the invention are to be limited only by the terms of the appended claims.

What is claimed:

1. An apparatus for retarding movement of a cyclically reciprocating member during each reciprocating cycle of the member, comprising:

an impeder engaged with the member during a first portion of the reciprocating cycle of the member, the impeder resisting displacement of the member during the first portion of the cycle, and disengaged from the member during a second portion of the reciprocating cycle, said impeder being displaced along an axis of the reciprocation member;

a reset engaged with the member during a third portion of the reciprocating cycle of the member to position the impeder for engagement with the member during the first portion of the reciprocating cycle; and

a release for disengaging the impeder from the member during the second portion of the reciprocating cycle.

2. The apparatus of claim **1**, wherein the first and third portions of the reciprocating cycle occur during movement of the member in a same direction.

3. The apparatus of claim **1**, wherein the member is a bolt of a firing mechanism.

4. The apparatus of claim **1**, further comprising an ammunition feed mechanism including a body having an exit and a projectile carrier mechanism having a plurality of spaces each of which receives a projectile, the projectile carrier mechanism forcing one of the projectiles out of the exit each reciprocating cycle of the member.

5. The apparatus of claim **1**, wherein the impeder includes an impeder sear engaged with a surface of the member and a sear movement retarder impeding displacement of the impeder sear and the member during engagement between the impeder sear and the member.

6. The apparatus of claim **5**, wherein the impeder sear includes a cam-shaped surface and the release interacts with the cam-shaped surface of the impeder sear to disengage the impeder sear from the member.

7. The apparatus of claim **6**, wherein the cam-shaped surface of the impeder sear includes by an edge that defines an opening and the release includes a pin disposed within the opening and interacting with the edge to lift the impeder sear out of engagement with the member.

8. The apparatus of claim **5**, wherein the sear movement retarder includes a piston assembly coupled to the impeder sear and having a piston displaced by the impeder sear during engagement between the impeder sear and the member.

9. The apparatus of claim **5**, wherein the reset includes a reset sear and the sear movement retarder includes a piston assembly coupled to the impeder sear and the reset sear.

10. The apparatus of claim **9**, wherein the piston assembly includes first and second pistons in fluid communication

with one another, the first piston assembly being coupled to the impeder sear and the second piston assembly being coupled to the reset sear, and further wherein the reset sear engages the member during the third portion of the reciprocating cycle, is displaced by the member, and positions the impeder sear for engagement with the member during the first portion of the reciprocating cycle.

11. The apparatus of claim **5**, wherein the sear movement retarder is resistive to compressive forces.

12. The apparatus of claim **11**, wherein the sear movement retarder is additionally resistive to tensile forces.

13. The apparatus of claim **11**, wherein the sear movement retarder includes a piston disposed with a housing, the housing being at least partially filled with a fluid medium.

14. The apparatus of claim **5**, wherein the sear movement retarder includes an adjuster controlling the rate by which displacement of the member is impeded.

15. An ammunition feed mechanism for an automatic or semiautomatic weapon, including a chamber having a projectile entrance that cyclically open and closes, comprising:

a magazine having an exit, a ramped bottom which directs projectiles to the exit, and a central hub extending from the ramped bottom for supporting an ammunition carrier;

an ammunition carrier having a plurality of curved projections which define a plurality of spaces, each of which receives a projectile of ammunition; and

an ammunition carrier advancing mechanism that actuates the ammunition carrier to positively force one projectile out of the exit each time the projectile entrance is open.

16. The ammunition feed mechanism of claim **15**, where the ammunition carrier includes a wheel having a hub coupled to the ammunition carrier advancing mechanism, the projections radiate from the hub, and the projections are curved from a proximate end of each projection to a distal end of each projection.

17. The ammunition feed mechanism of claim **15**, wherein the projections curve away from a direction of movement of the ammunition carrier.

18. The ammunition feed mechanism of claim **15**, wherein the ammunition carrier advancing mechanism includes a spring that releases stored energy to move the ammunition carrier.

19. The ammunition feed mechanism of claim **18**, wherein the ammunition carrier advancing mechanism includes a crank for storing energy in the spring when the crank is moved in a first direction and at least one anti-reversing roller coupled to the crank and engaging the magazine to help prevent the crank form moving in a second direction so that energy stored in the spring is used to move the ammunition carrier.

20. A gun, comprising:

a chamber having a projectile entrance;

a cyclically reciprocating member used in firing projectiles from the gun;

an ammunition feed mechanism including a magazine having an exit mounted adjacent the projectile entrance of the chamber and an ammunition carrier having a plurality of spaces each of which receives one of a plurality of projectiles positioned randomly in the magazine, the projectile carrier positively feeding one projectile into the chamber via the exit and projectile entrance at a same point during each reciprocating cycle of the member; and

a retarder including an impeder engaged with the member during a first portion of the reciprocating cycle of the member, the impeder resisting displacement of the member during the first portion of the reciprocating cycle of the member, and disengaged from the member during a second portion of the reciprocating cycle of the member.

21. The gun of claim **20**, wherein the first portion of the reciprocating cycle of the member is prior to firing one of the projectiles from the gun.

22. The gun of claim **20**, wherein at least a part of the second portion of the reciprocating cycle of the member is after firing one of the projectiles from the gun.

23. The gun of claim **20**, further comprising means for selecting a rate of fire of the gun.

24. The gun of claim **23**, wherein the selecting means includes a mode selector switch positionable in one of a plurality of positions.

25. The gun of claim **24**, wherein the positions include a locked position and an automatic firing position.

26. The gun of claim **25**, wherein the positions further include a semi-automatic firing position.

27. The gun of claim **24**, wherein the mode selector switch includes a pin having one or more surfaces for interacting with a firing mechanism of the gun in one or more of the mode selector switch positions to control displacement of the firing mechanism.

28. The gun of claim **27**, wherein the firing mechanism includes a trigger.

29. The gun of claim **24**, wherein the selecting means also includes means for releasably securing the selector switch in each mode selector switch position.

30. The gun of claim **29**, wherein the selecting means includes a plurality of recessed portions formed in a body of the selector switch and a detent disposable in one of the recessed portions in each mode selector switch position.

31. An ammunition feed mechanism for an automatic or semiautomatic weapon, including a chamber having a projectile entrance that cyclically opens and closes, comprising:

a magazine having an exit, a spiral ramped bottom which directs projectiles to the exit, and a central hub extending from the ramped bottom for supporting an ammunition carrier;

an ammunition carrier having a plurality of spaces, each of which receives a projectile of ammunition; and

an ammunition carrier advancing mechanism that actuates the ammunition carrier to positively force one projectile out of the exit each time the projectile entrance is open.

32. The ammunition feed mechanism of claim **31**, wherein the ammunition carrier advancing mechanism includes a motor.

33. The ammunition feed mechanism of claim **31**, wherein the exit of the magazine is located at a bottom of the magazine and the magazine is mounted to the apparatus so that ammunition in the magazine is gravity fed toward the bottom of the magazine during operation of the apparatus.

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