July 21, 1964 R. BUTTERWORTH 3,141,377

ROUND-TO BARREL SEALING MECHANISM

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FIG. 1

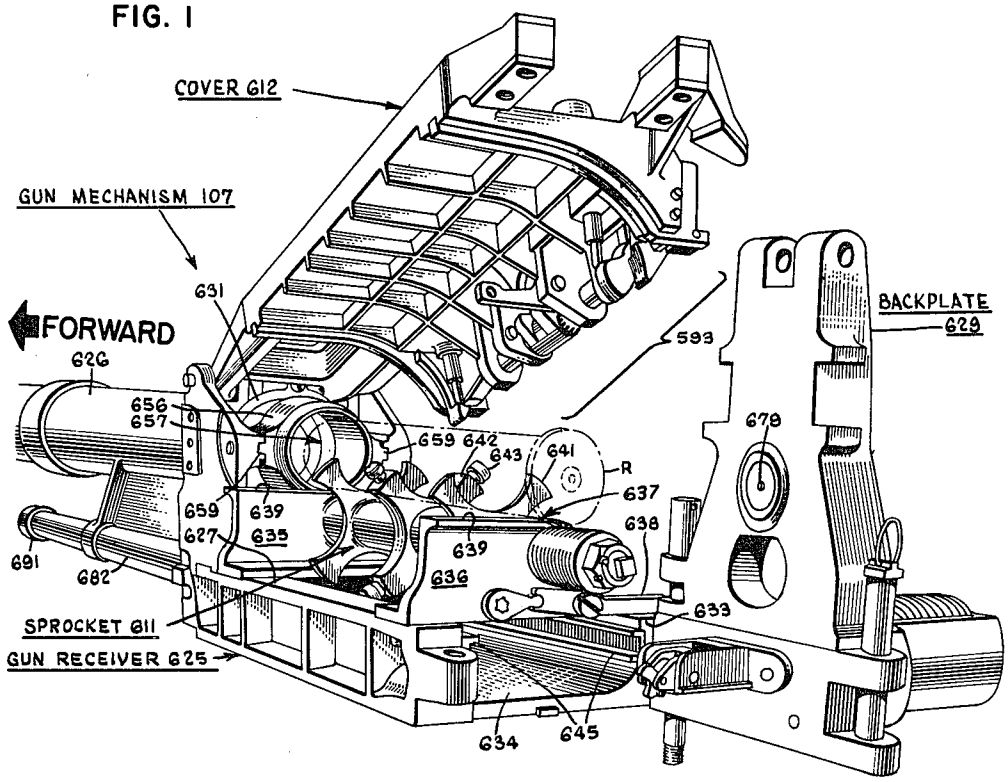

FIG. 2

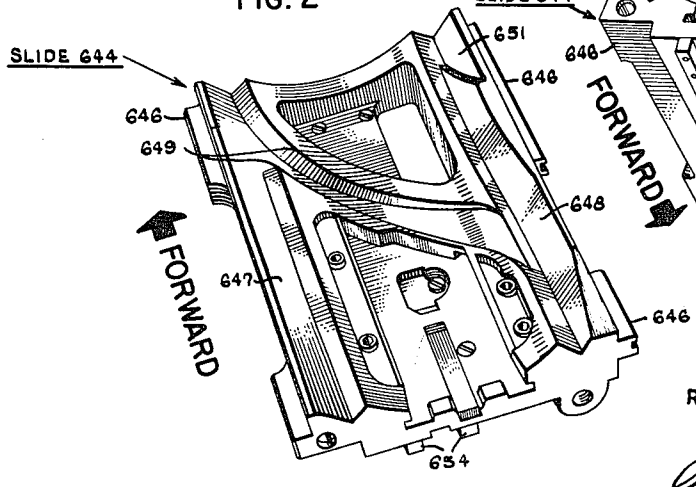

FIG. 3

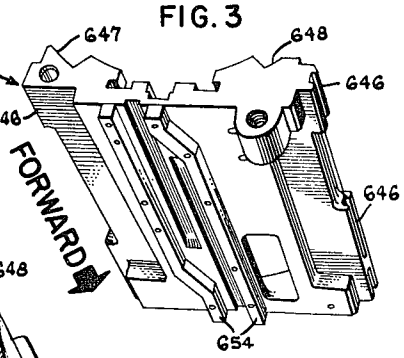

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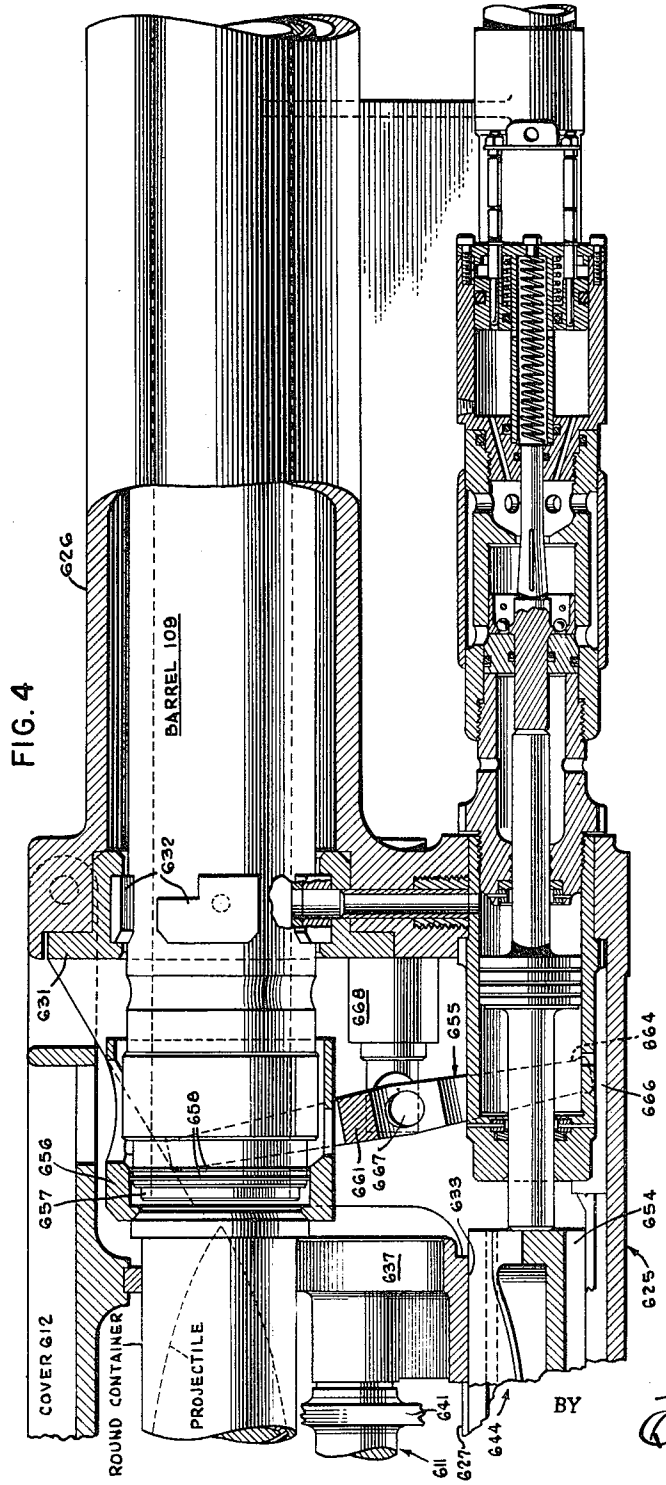
FIG. 4



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ROUND-TO BARREL SEALING MECHANISM

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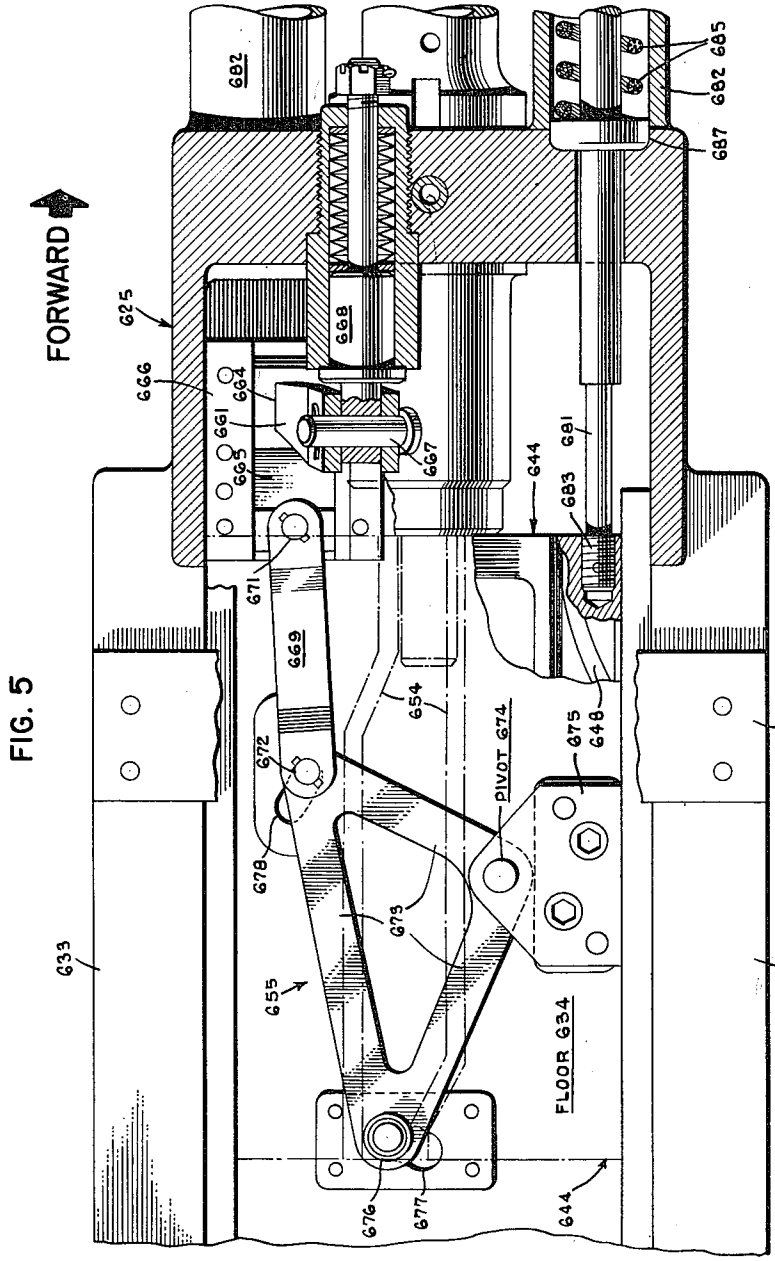

FIG. 5

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FIG. 6

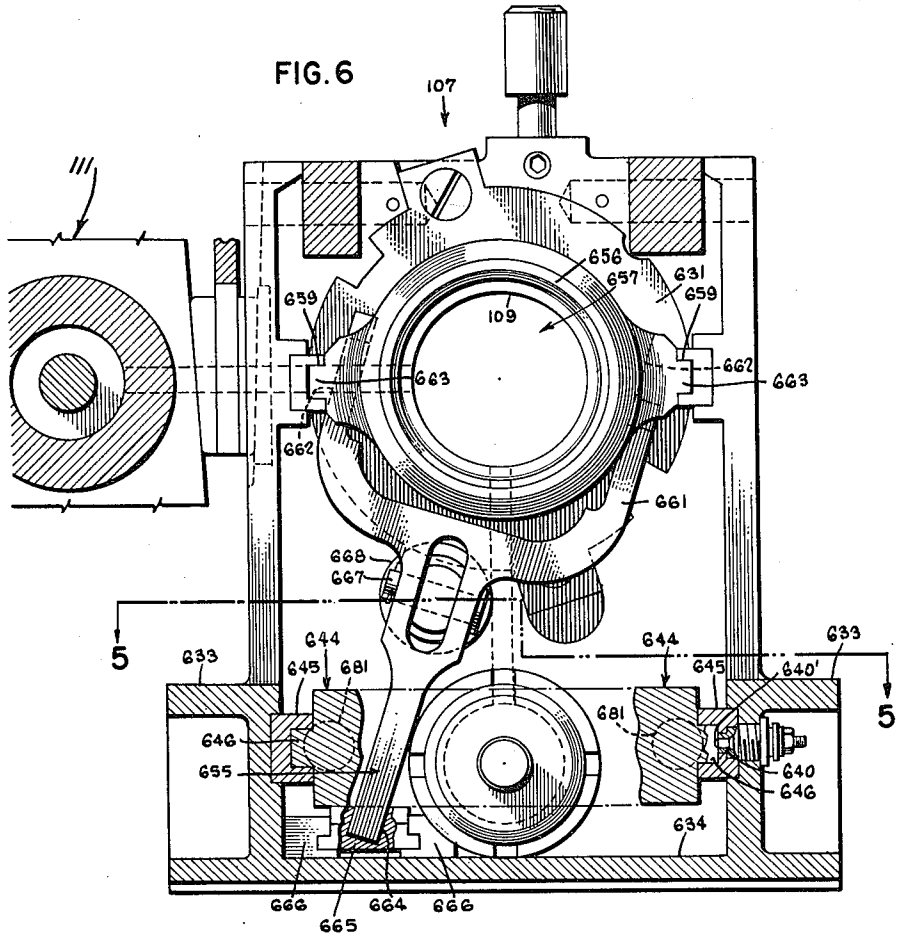
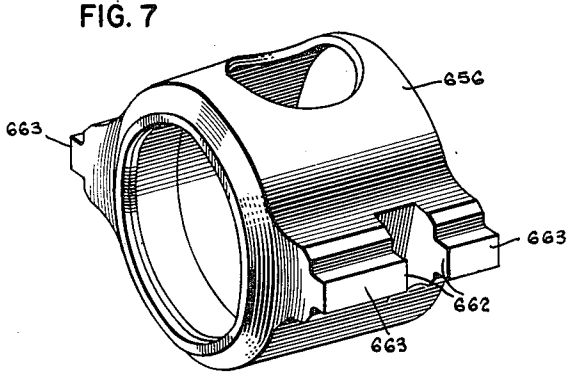


FIG. 7



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United States Patent Office

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ROUND-TO-BARREL SEALING MECHANISM

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Filed June 3, 1957, Ser. No. 663,326
4 Claims. (Cl. 89—17)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This application discloses and claims a mechanism which forms a portion of the system disclosed and claimed in applicaiton Serial No. 663,319, filed June 3, 1957, for Rapid Fire Gun System.

The present invention relates to a mechanism for sealing a round to a gun barrel in a projectile directing and firing system which includes a low velocity, rapid fire gun and mount therefor. More particularly, this invention is directed to such a weapon suitable for a saturation zone type of protective or assault fire and which is especially well adapted for shipboard antiaircraft use.

Heretofore, antiaircraft guns of both large and small calibers have been devised for employment against high and low altitude attacking planes. Although the large caliber guns are effective at high altitudes when properly used, these guns are generally ineffective at low altitudes and short ranges because, among other reasons, of their slow rate of fire and the more effective evasive action taken by aircraft at low altitudes. Consequently, guns generally in use against low flying aircraft have been of a small caliber and in the machine gun class in order to obtain a rapid rate of fire and cope with the evasive action of aircraft attempting to avoid the zone of fire. However, the use of armor around the vital parts of aircraft has increased considerably and it has been found that the smaller caliber guns could make a number of hits without reaching a vital part, and, therefore, the attacking aircraft would, in many cases, still continue the attack.

With conventional guns, as the caliber increases, the weight of the many gun components as well as the gun itself increases greatly. Heavier structural members are needed to load and transfer ammunition. The recoil forces generated require heavier mounting and driving structures. Consequently, aboardship the number of guns that can be installed is limited by the weight factor alone. Furthermore, the handling of large caliber case ammunition presents problems because of its size and weight, such ammunition not being adapted to belt or clip type feeding as used in the machine gun class weapons.

The use of large guns and mounts generally prohibits the stowage of ammunition or maintenance of magazines on the same level on which the gun is mounted because of space requirements. Thus, the ammunition stowage is at a lower level, often employing three or more decks of the ship to contain all the necessary equipment. Location below decks complicates the problem of feeding ammunition to large caliber guns and necessitates the installation of elaborate ammunition hoists with associated large gains in overall weight and complexity of the ammunition handling equipment.

The present invention overcomes many of the disadvantages of the prior art in that it provides an automatic, rapid fire, lightweight, mechanism for sealing a rocket assisted projectile of relatively large caliber to a gun barrel when the projectile is moved into the firing position. The gun employed with the present invention

may be of the type disclosed in copending application Serial No. 663,319, afore-mentioned, which fires a spin-stabilized, rocket-propelled projectile. The projectile enclosed in a symmetrical container or case which functions both as a storage case and as an expendable gun chamber when the projectile is fired. The projectile is fired by the ignition of a reduced powder charge within the container and is propelled through the barrel at a relatively low velocity. While within the rifled gun barrel, the rocket propellant motor is ignited by the hot gases of the reduced powder charge and thereafter the projectile accelerates to a much higher velocity comparable to conventional projectiles during flight. Sufficient spin is imparted by the rifled tube of the launcher and the canted nozzles of the rocket to make the rocket stable as it emerges from the tube. The canted nozzles of the rocket provide additional spin during flight. The usual recoil is substantially reduced in the present invention because of the low firing pressures produced in the system.

Machine gun rates of fire are obtained by the use of expendable gun chambers made feasible by the low powder pressure created when each round is fired. The employment of the expendable gun chambers makes possible the moving of rocket assisted ammunition laterally into and out of axial alignment with the gun barrel without the necessity of ramming and extracting operations common with conventional cased ammunition.

Conventional rocket launching devices are generally provided with short, smooth bore barrels and are incapable of the accuracy achieved by rifled barrels. The present invention, however, is particularly well adapted for employment with a rifled gun barrel through which is fired the projectile on an accurately directed line of fire.

It is, therefore, an object of the present invention to provide a round-to-barrel sealing mechanism capable of operating at a high cyclic rate to seal, gas-tight, each of a number of large caliber rocket assisted projectiles to the barrel of a gun, the projectiles being presented to the gun in rapid sequence.

Another object of the present invention is to provide a round-to-barrel sealing device for use with breechless gun mechanism adapted to fire a case enclosed projectile wherein the case is employed as a one shot chamber for the gun mechanism when the projectile is fired through the gun barrel.

Another object resides in the provision of a round-to-barrel sealing mechanism for use with case enclosed projectiles in which the projectile case functions as an expendable gun chamber which is pressure sealed to the gun barrel to prevent the escape of propellent gases at the moment of firing of the projectile and which is unsealed prior to and after firing.

Still another object of the present invention is to provide a round-to-barrel sealing mechanism which includes a collar for assisting in the alignment of ammunition with the gun bore and for providing a gas seal between the ammunition and the gun tube.

Another purpose is to provide a round-to-barrel sealing mechanism which includes a collar for thrusting the base of each ammunition case against the backplate to insure proper firing pin contact with the primer.

An additional object of this invention is to provide for a gun a round-to-barrel sealing mechanism which includes control linkages for sequentially actuating a gas sealing collar into sealed and unsealed positions in response to the firing of the gun.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a rear perspective view of the gun mechanism with the top cover raised, the backplate opened and the drive slide removed and illustrating the relative locations of the gas sealing collar of the present invention and some of the other components of the gun mechanism;

FIG. 2 is a top perspective view of the drive slide removed from the gun mechanism;

FIG. 3 is a bottom perspective view of the drive slide of FIG. 2;

FIG. 4 is a vertical longitudinal view, partially in section and partially in elevation as viewed from a line substantially corresponding to the center line of a gun mechanism and disclosing, among other elements, the gun barrel, sealing collar, and actuating means for moving the collar into and out of sealing engagement with the gun barrel;

FIG. 5 is a view from above the control linkages for actuating the gas sealing collar of the present invention and taken along a line substantially corresponding to line 5—5 of FIG. 6;

FIG. 6 is a vertical sectional view of the receiver adjacent the gas sealing collar and its forked operating arm; and FIG. 7 is a perspective view of the gas sealing collar removed from the gun mechanism.

Gun Mechanism

The gun mechanism with which the present invention has been advantageously employed will be described briefly before proceeding to the detailed description of the round-to-barrel sealing mechanism so that the purpose, structure and operation of the present invention will be better understood. Referring now to FIGS. 1 and 4 gun mechanism receiver **625** has a forward tubular barrel receiving portion **626**, a flattened rear floor portion **627**, a pivotable top cover **612** overlying the floor portion and forming a support for round engaging pawls **593**. Thus pawls **593** and the floor **627** define a round entry door. A rear, readily removable backplate **629** joins the floor and the cover. As best shown in FIGS. 4 and 6, a barrel **109** is locked in the receiver by means of a retaining plate **631** engageable with a series of quick disconnect keys **632** formed on the gun barrel.

The flattened rear floor portion **627** lies between a pair of inner and outer integrally cast, longitudinally extending side rails **633** which are raised from the main floor portion **634** and support forward and rearward drive sprocket bearing supports **635** and **636**, respectively.

Each of the bearing supports **635** and **636** is bolted at its base to the rails **633** of the receiver **625**, and the top of each support is flattened to form forward and rearward lower round entry guide rails **637**. Looking forward, the rails have a reversed S-shaped configuration, the round entry rail ends **638** being on the same plane with the rounds feeding into the gun mechanism from the transfer mechanism, not shown. The round exit rail ends **639** are raised to a height so as to place the moving round in axial alignment with gun barrel **109** and an adjacent ejection mechanism **111**.

As shown in FIG. 1, located centrally and above the receiver main floor **634**, a feed sprocket assembly **611** is rotatably mounted in and between the forward and rearward bearing supports **635** and **636**, respectively. The feed sprocket assembly **611** comprises identical shaft-mounted forward and rearward, relatively thin, cross-shaped feed star wheels **641**, and a thicker, centrally fixed drive star wheel **642** having four identical lobes, each lobe mounting a drive roller **643** at its outer end.

Now referring to FIGS. 2 and 3, located below the sprocket assembly **611** and in engagement with a pair of the drive rollers **643** is a feed sprocket operating slide **644**, movable forwardly and rearwardly in slide guides **645** formed in the inner and outer side rails **633** of the floor portion of the receiver.

The upper surface of the slide **644** is generally concave to provide clearance for the feed star wheels **641** during the radial sweeps of the star wheels as forward and rearward motion of the slide is effected. Laterally extended lugs **646** are formed on the left and right sides of the slide and move in the slide guides **645**, aforementioned. A switch **640** (FIG. 6) engages a contact **640'** formed in a lug **646** on the forward right hand side of slide **644** and serves to permit firing only when the slide **644** is in the full forward posiiton. As viewed looking forwardly (FIG. 2), relatively straight left and right drive roller grooves **647** and **648**, respectively, are provided on each upper and outer side of the slide in which two of the drive rollers **643** are engaged when the slide is in battery or counter battery. A central, elongated S-shaped, drive roller cam groove **649** communicates with the forward portion of the left roller groove **647** and the rearward portion of the right roller groove **648**. This cam groove provides the means for converting straight line motion of slide **644** to rotary motion of feed sprocket **611**. As the slide moves rearwardly in recoil, a drive roller **643** in the right groove **648** drops into a recessed portion **651** in the forward portion of that groove so that on forward motion of the slide, the right drive roller will then be displaced sideways thereby leading the left drive roller into the curved path of the cam groove **649**, thus rotating the feed sprocket in a counterclockwise direction. At the moment the left roller **643** begins to move laterally in the cam groove **649**, the right roller in the recessed portion **651** swings clear of the slide. Sprocket rotation is decelerated during the final 25 degrees of rotation of its 90 degree movement by means of a spring loaded, stepped cam, not shown, situated adjacent the rear feed star wheel **641**.

Gas Sealing Collar

Referring now to FIGS. 4, 5, 6, and 7 an additional cam groove **654** is formed on the undersurface of the slide **644** for the purpose of operating a linkage **655** that controls the gas sealing collar **656** mounted adjacent the breech end **657** of the gun barrel. The tubular gas sealing collar **656** encircles the breech end of a gun barrel **109** mounted in the barrel receiving portion **626** of the receiver **625**. The interior of collar **656** engages a pair of barrel sealing rings **658** to provide a gas-tight seal during axial movement of the collar between forward and rearward limits of movement, as will more fully appear as the description proceeds. The seal is enhanced because of the creation of a differential gas pressure which forces the sealing collar against the rim of the round case.

The collar is guided forwardly and rearwardly in horizontal guideways **659** formed in vertical side walls of the receiver. One end of a collar shifting fork or yoke **661**, engages slots **662** formed on each side of the collar in laterally extending guide lugs **663**. The opposite end of the fork engages a recess **664** formed in a reciprocable link block **665** secured in a fixed bracket **666** mounted on floor **634**. The fork **661** is pivoted intermediate its ends at **667** to a buffer spring piston **668** which urges the gas sealing collar **656** toward the round container when the link block **665** is in its forwardmost position as shown in FIGS. 4 and 5.

The rear end of the link block has a connecting link **669** pivotally attached thereto as at **671**, the other end of the link **669** being pivotally connected at **672** to a floor mounted bell crank **673**. The bell crank is in the form of a cutout triangle, a corner being pivoted at **674** to a fixed bracket **675** and the other end carrying a slide cam engaging roller **676** that cooperates with cam **654** on the underside of the operating slide block **644** (FIG. 5). In order to prevent deflection of the bell crank **673**, the link end of the bell crank which carries pivot pin **672** and the end of the bell crank which carries cam roller **676** are guided by a downward extension (not shown) of pin **672** and roller **676**. These downward extensions are guided by suitable grooves **677** and **678** formed in

the floor 634, these grooves having a configuration corresponding to the desired motion of the bell crank.

As shown partially in phantom in FIG. 5, the slide 644 is in its forward position. Hence, the rearward end of the cam 654 is shown as having urged the bell crank 673 in a clockwise direction, this action causing the link 669 and link block 665 to be moved in a forward direction. The link block simultaneously urges the upper end of collar shifting fork 661 rearwardly and seals the face of the collar 656 against the open end of the round container R and also urges the round container against backplate 629 to insure proper contact of firing pin 679 with the primer of the round container. As the slide 644 moves rearwardly, cam roller 676 moves bell crank 673 in a counterclockwise direction, thus reversing the action and moving the gas sealing collar 656 forwardly and out of the ejection path of the round container about to be ejected.

Briefly summarizing, the gas sealing collar 656 is operated by means of linkage 655 which coacts with the additional cam groove 654 formed on the undersurface of the gun slide 644. During axial movement of the collar 656 between the forward and rearward limits of movement thereof, the interior of the collar engages a pair of barrel sealing rings 658 to provide a gas-tight seal between the barrel and the round. The fork 661 is urged toward the round container by the buffer spring piston 668. As the collar 656 is moved into sealing engagement with the round the round is also urged by the collar rearwardly against backplate 629 to insure proper contact of the firing pin 679 with the primer of the round. As soon as the round is fired and the slide 644 commences its rearward movement, the cam roller 676 (FIG. 5) moves bell crank 673 in a clockwise direction and thereby moves the gas sealing collar 656 forwardly and away from the ejection path of the round container which is about to be ejected. The slide 644 is moved to its forward position by the pair of springs 685.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In an automatic weapon having a fixed barrel, a receiver, and feed means for successively moving loaded round containers into and empty round containers out of barrel alignment and firing rounds from the containers when in barrel alignment, a round-to-barrel sealing mechanism comprising, a reciprocating drive means operable upon round firing for actuating the feed means, sealing means for successively sealing each round container to the barrel when in barrel alignment and prior to firing of the round then sealed, said sealing means being movably mounted adjacent the breech end of the barrel, said sealing means including a slidable sealing collar successively engageable with one end of each round container, sealing rings carried by the barrel engageable with the inner surface of the collar, and supporting means for said collar carried by the receiver, yoke means engageable at one end with said collar, resilient pivot means for biasing said yoke means in one direction, bell crank linkage means connected to an opposite end of said yoke means, and means engageable in driven relationship with said drive means and carried by said bell crank linkage means whereby reciprocation of said drive means moves said collar between round-to-barrel sealed and unsealed positions.

2. In an automatic weapon having a fixed barrel, a receiver, and feed means for successively moving loaded round containers into and empty round containers out of barrel alignment and firing rounds from the containers when in barrel alignment, a round-to-barrel sealing mechanism comprising, a reciprocating drive means operable upon round firing for actuating the feed means, a sealing collar for successively sealing each round container to the barrel when in barrel alignment and prior to firing of the round then sealed, said collar being movably mounted adjacent the breech end of the barrel, a plurality of sealing rings mounted within and cooperating with said collar to provide a gas tight seal between the barrel and the round, yoke means engageable at one end with said collar, resilient pivot means for biasing said yoke means in one direction, bell crank linkage means connected to said opposite end of said yoke means, a series of projections on said drive means defining a longitudinal recess arranged substantially parallel to the axis of the gun barrel, one of said projections having an offset portion at one end laterally to one side of the gun barrel axis and another projection having an offset portion at the end opposite said first offset portion laterally to the opposite side of the gun barrel axis, and means in driven engagement with the walls of said recess and carried by said bell crank linkage means for reciprocating said collar between round-to-barrel sealed and unsealed positions in accordance with the position of the drive means.

3. In an automatic weapon having a fixed barrel, a receiver, and feed means for successively moving loaded round containers into and empty round containers out of barrel alignment and firing rounds from the containers when in barrel alignment, a round-to-barrel sealing mechanism comprising, a reciprocating drive means operable upon round firing for actuating the feed means, a sealing collar for successively sealing each round container to the barrel when in barrel alignment and prior to firing of the round then sealed, said sealing collar being slidably mounted adjacent the breech end of the barrel for successive engagement with one end of each round container, sealing rings carried by the barrel and engageable with the inner surface of the collar, supporting means for said collar carried by the receiver, linkage means connected to said sealing means, and means drivenly engaged by said drive means and engageable with said linkage means for moving the collar between sealing and nonsealing positions in accordance with reciprocation of the drive means.

4. In an automatic weapon having a fixed barrel, a receiver, and feed means for successively moving loaded round containers into and empty round containers out of barrel alignment and firing rounds from the containers when in barrel alignment, a round-to-barrel sealing mechanism comprising, a reciprocating drive means operable upon round firing for actuating the feed means, sealing means for successively sealing each round container to the barrel when in barrel alignment and prior to firing of the round then sealed, said sealing means being movably mounted adjacent the breech end of the barrel, a plurality of sealing rings mounted within and cooperating with said collar to provide a gas tight seal between the barrel and the round, linkage means connected to said sealing means, a series of projections on said drive means forming a longitudinal recess arranged substantially parallel to the axis of the gun barrel, one of said projections having an offset portion in one end laterally to one side of said axis and another projection having an offset portion at the end opposite to said first offset portion laterally to the opposite side of said axis, and means drivenly engaged by the walls of said recess and engageable with said linkage means for moving said sealing means between sealing and nonsealing positions in accordance with the reciprocating movement of said drive means.

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