SELF-POWERED IMPULSE AVERAGING RECOIL OPERATED MACHINE GUN WITH A ROTARY LOCK BOLT DRIVEN BY BIMODAL CAMS

Inventors: David L. Steimke, Burlington, VT (US); Parke R. Warner, Burlington, VT (US)

Correspondence Address:
HUNTON & WILLIAMS LLP
INTELLECTUAL PROPERTY DEPARTMENT
1900 K STREET, N.W., SUITE 1200
WASHINGTON, DC 20006-1109 (US)

Assignee: General Dynamics Armament and Technical Products

File No.: 12/334,880

Filed: Dec. 15, 2008

Related U.S. Application Data
Continuation of application No. 11/531,340, filed on Sep. 13, 2006.
Provisional application No. 60/821,310, filed on Aug. 3, 2006.

Publication Classification
Int. Cl. F41A 19/06
U.S. Cl. 89/132

ABSTRACT
A weapon system comprising a receiver, a barrel, a bolt, a barrel extension, a bolt carriage, and a toggle assembly. The barrel may have a longitudinal axis. The bolt may be spaced a distance from a rearward end of the barrel along the longitudinal axis of the barrel. The barrel extension may be attached to the bolt and connecting the barrel with the bolt. The barrel extension and bolt may be adapted to move linearly with respect to the receiver in a direction parallel to the longitudinal axis of the barrel. The bolt carriage may be movable relative to the bolt between an ammunition loading position and a firing position. The toggle assembly may be adapted to drive the bolt carriage between the loading position and the firing position in response to movement of the barrel extension and bolt relative to the receiver.
SELF-POWERED IMPULSE AVERAGING RECOIL-OPERATED MACHINE GUN WITH A ROTARY LOCK BOLT DRIVEN BY BIMODAL CAMS

[0001] This application is a continuation of, claims priority to, and incorporates by reference in its entirety, the following U.S. patent application Ser. No. 11/531,340, entitled "SELF-POWERED IMPULSE AVERAGING RECOIL-OPERATED MACHINE GUN WITH A ROTARY LOCK BOLT DRIVEN BY BIMODAL CAMS" filed Sep. 13, 2006, which claims priority from U.S. provisional patent application Ser. No. 60/821,310, filed on Aug. 3, 2006, which is incorporated herein by reference in its entirety.

GOVERNMENT LICENSE RIGHTS

[0002] The U.S. Government has a paid-up license in this invention and the right to limited circumstances to require the patent owner to license others on reasonable terms as provided for by the terms of W15QKN-04-C-1093 awarded by the Department of Defense.

FIELD OF THE INVENTION

[0003] Embodiments of the invention relate to an automatic weapon. More specifically, embodiments of the invention relate to a recoil operated automatic weapon with a rotary lock bolt.

BACKGROUND OF THE INVENTION

[0004] Throughout history, military forces have been employed in offensive, defensive, and peace-keeping roles. In all roles, these military forces have required the use of weapons, and more particularly, firearm weapons. The present invention is directed to a machine gun with a rotary lock bolt driven by bimodal cams.

SUMMARY OF THE INVENTION

[0005] One aspect of the present invention provides a weapon system comprising a receiver having at least one side plate with a bimodal cam way formed therein. The bimodal cam has an upper surface and a lower surface. A barrel extension is provided with at least a first end and at least one side plate with a cam way formed into the at least one side. A barrel is provided with a longitudinal axis and mounted to the barrel extension first end. A spring and buffer assembly is provided with a first end and a second end, wherein the first end is mounted to the barrel extension and the second end is mounted to the receiver. The mounted spring and buffer assembly are generally parallel to the barrel longitudinal axis. A bolt carriage is provided with a first end, a second end and at least one side plate, and a spring and buffer way formed in the side plate. The weapon system further comprises a firing pin assembly fixed to the bolt carriage and having a bolt cam way. A rotary lock bolt having a first end, a second end, and a hollow pass-through is provided with the first end comprises a generally flat forward facing surface and a plurality of lugs radially arranged about the forward facing surface. The hollow pass-through extends through both first and second ends, and is shaped to telescopically receive the firing pin assembly.

A bolt cam pin is adapted to be fixedly attached to the rotary lock bolt and simultaneously capable of sliding in and along the firing pin assembly bolt cam way. The relative movement of the bolt cam pin is relative movement along the longitudinal axis between the firing pin assembly and the rotary lock bolt causes the rotary lock bolt to rotate about the longitudinal axis due to the bolt cam pin riding in the bolt cam way. A toggle assembly having a toggle arm, a carriage cam way roller that rides in the carriage cam way, a barrel extension cam way roller that rides in the barrel extension cam way, and a receiver bimodal cam way roller to ride in the receiver bimodal cam way, the carriage cam way roller, barrel extension cam way roller and receiver cam way roller being collinear. The receiver roller rides on at least a portion of the bimodal cam way upper surface during a forward stroke of a firing cycle of the weapon system, and the receiver roller rides on at least a portion of the bimodal cam way lower surface during a rearward stroke of a firing cycle of the weapon system.

BRIEF DESCRIPTION OF THE FIGURES

[0006] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

[0007] FIG. 1A is a preferred embodiment of the present invention shown in a perspective view from the right and rear of the invention.

[0008] FIG. 1B is a preferred embodiment of the present invention shown in a perspective view from the left and rear of the invention.

[0009] FIG. 2 is a perspective view the receiver of the present invention.

[0010] FIG. 3 illustrates a side view of the bimodal cam of the present invention.

[0011] FIG. 4 depicts the operating group of the present invention.

[0012] FIG. 5 is a perspective view of the barrel extension of the present invention.

[0013] FIG. 6 is a perspective view of the rotary lock bolt assembly of the present invention.

[0014] FIG. 7A illustrates the rotary lock bolt of the present invention.

[0015] FIG. 7B shows the components used in conjunction with the rotary lock bolt of the present invention.

[0016] FIG. 7C depicts the round extractor of the present invention.

[0017] FIG. 7D is a side view of the round retainer of the present invention.

[0018] FIG. 7E illustrates the round ejector of the present invention.

[0019] FIG. 7F illustrates the round rammer of the present invention.

[0020] FIG. 8A illustrates the firing pin assembly of the present invention.

[0021] FIG. 8B shows the extraction buffer of the present invention.

[0022] FIG. 8C depicts the cam pin and cam pin retainer of the present invention.

[0023] FIG. 8D illustrates the firing pin of the present invention.

[0024] FIG. 9A depicts the rotary lock bolt assembly installed in the carriage.

[0025] FIG. 9B depicts the toggle assembly.

[0026] FIG. 10A is a top view of the operating group in the sear position.
FIG. 10B is a cross-sectional view of the present invention showing the position of the rollers in the rear position.

FIG. 11A is a top view of the operating group at the start of the firing cycle.

FIG. 11B is a cross-sectional view of the present invention showing the position of the rollers at the start of the firing cycle.

FIG. 12A is a top view of the operating group at a position of the firing cycle.

FIG. 12B is a cross-sectional view of the present invention showing the position of the rollers at a position of the firing cycle.

FIG. 12C is a cross-sectional view showing the bolt assembly aligning the round from the link with the rammer.

FIG. 13A is a top view of the operating group closing the chamber.

FIG. 13B is a cross-sectional view of the present invention showing the position of the rollers when the chamber is closed.

FIG. 14A is a top view of the operating group with the firing pin contacting the round.

FIG. 14B is a cross-sectional view showing the position of the rollers when the firing pin contacts the round.

FIG. 15A is a top view of the operating group at the start of recoil.

FIG. 15B is a cross-sectional view showing the position of rollers at the start of recoil.

FIG. 16A is a top view of the operating group ejecting a spent cartridge.

FIG. 16B is a cross-sectional view showing the position of the rollers when a spent cartridge is ejected.

FIG. 16C is a cross-sectional view showing the bolt assembly ejecting the round after firing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description is intended to convey a thorough understanding of the invention by providing a number of specific embodiments and details involving an automatic weapon system 100. It is understood, however, that the invention is not limited to these specific embodiments and details, which are exemplary only. It is further understood that one possessing ordinary skill in the art, in light of known systems and methods, would appreciate the use of the invention for its intended purposes and benefits in any number of alternative embodiments. Throughout the specification, the use of the terms “front” or “forward” refer to or toward the weapon system muzzle, and the terms “rear” or “rearward” refer to or toward the end of the weapon system 100 opposite the muzzle.

Referring to FIGS. 1A and 1B, a recoil operated gun system 100 is provided as an exemplary embodiment of the invention. The gun system 100 comprises a receiver 200 and an operating group 300. The gun system 100 comprises a feeder 102, a cartridge guide 104, an ejector port 106, and a trigger 108. These components are generally known in the art.

Referring now to FIGS. 2 and 3, the receiver 200 is adapted to at least partially house the internal operating group 300 (see FIGS. 1A, 1B, and 4). The receiver 200 comprises a horizontal member and two parallel vertical sidewalls. The cradle 202 is a mounting platform for parallel left 204 and right 206 side plates. The two side plates 204, 206 are mounted on the vertical sidewalls of the cradle 202. The cradle 202 further provides a mounting surface for a left cartridge guide mount 208 on the left side of the weapon 100, and a sector gear 210. The sector gear 210 interfaces with a pinion (not shown) to allow for precise control over the elevation or depression of the weapon system, such sector gears are generally known in the art.

A bimodal cam way 212 is formed in each side plate 204, 206. The two bimodal cam ways 212 are parallel to each other. Each side plate 204, 206 further comprises barrel extension rails 214 to guide the movement of the barrel extension 302 and toggles of the operating group 300, these features are discussed in greater detail herein. The side plates 204, 206 also comprise mounting surfaces for a forward feeder mount 216 for mounting the ammunition feeder 102. The left side plate 204 supports an active firing cam 220, and the right side plate supports a right cartridge guide mount 218. The active firing cam 220 is spring-loaded and biases the receiver rollers 382 to the upper surface of the bimodal cam way 212. The left and right cartridge guide mounts 208, 218 provide a platform to mount the cartridge guide 104 (see FIGS. 1A-1B).

Together, the side plates 204, 206 comprise mounting surfaces for left 222 and right 224 rear mounting plates for mounting a rear 226 and mounting surfaces for a rear side plate support 228. Both the rear 226 and rear side plate support 228 are mounted transverse to the longitudinal axis of the cradle 202. The right rear mounting plate 224 also supports the trigger 108 and trigger axial (not shown) which extends transversely across to the left 222 rear mounting through holes in plate.

Referring to FIG. 3, the bimodal cam way 212 can generally be described as having an upper flat portion, a sloped portion, and a lower portion. An active cam gate 213 is attached to the receiver below the lower portion of the bimodal cam 212. The cam gate 213 is spring loaded to be biased toward the tip of the slots in the cam plate. The cam way 212 further has upper and lower surfaces. The function and use of the cam way 212 and its sections are discussed herein with respect to the weapon system operating cycle.

With reference to FIG. 4, the operating group 300 comprises a barrel extension 302, a barrel 304, a chamber 305, a bolt assembly 306, a toggle assembly 308, a detachable feed post 309, an impulse averaging buffer assembly 400, and a barrel lock 311. Referring now to FIG. 5, the barrel extension 302 comprises two forward 312 (one not shown) and two rear 314 bearings to guide the barrel extension 302 along the length of the side plates 204, 206, a forward barrel opening 316, toggle track openings 318 on either side, barrel extension cam ways 320 on either side, carriage extractor slots 321, an ejector post slot 322, a carriage rail 323, an eject window 324, and a buffer mount 325. The barrel 304 is preferably manufactured from Cr-Mo steel with a chromium-plated bore. However, the barrel 304 could be manufactured of other materials known in the art. The barrel 304 is also preferably 0.50 caliber and has a twist ratio of 1 turn per 9 inches of barrel length. The barrel may also be provided with a quick release feature, such as by rotating the barrel lock counterclockwise until the lock clears the barrel then pull the barrel forward through the barrel extension opening.

Referring now to FIGS. 6-9, the bolt assembly 306 comprises a carriage 326 with 4 bearings 328 and a cam way 330, a rotary lock bolt 332 with a rammer 334, rammer spring 335, a round extractor 336, a round retainer spring (not
shown), an ejector 338 in the bolt 332, and an ejector spring 340 and a fixed firing pin assembly 342.

[0049] Referring now to FIGS. 7A-7F, the rotary lock bolt 332 has a generally cylindrical body with a face on a forward surface. The face of the bolt 332 closes the rear of the chamber 305 during firing of the weapon system 100. A hollow cylinder runs the length of the bolt 332 to telescopically receive the firing pin assembly 342. The cylinder extends the entire length of the bolt 332 to allow the firing pin 343 to extend forward of the bolt head 331 and into the chamber 305 to impact the primer during firing of the weapon system 100.

[0050] The round ejector 338 lies generally parallel with the axis of the barrel 304 and comprises a body 350, a longitudinal finger 352, and an ejector stop post 354. The ejector finger 352 extends through and beyond the face of the bolt 332. The ejector stop post 354 is formed at the base of the finger 352, and the ejector body 350 is formed rearward of the post 354. The body 350 is elongated and generally flat, it rides in a groove along the left circumferential side of the bolt 332. The ejector spring 340 is circumferentially arranged about the finger 352 and is compressed between the bolt and the stop post 354, biasing the finger 352 rearward keeping the finger clear of the forward surface of the bolt head 331.

[0051] The round rammer 334 is mounted in a groove formed in the top circumferential side of the bolt 332. A pin (not shown) extends through an opening 333 in the bolt 332 and through the rammer pivot 356. The rammer 334 is mounted to the bolt 332 so as to pivot about an axis that is perpendicular to the bolt axis and along a vertical plane. The rammer torsion spring 335 biases the rammer 334 in an up-pivoting position.

[0052] The round extractor 336 comprises a claw-like edge 357, a pivot 360, and a hole 362. The round extractor 336 is mounted in a groove formed in the face of the bolt 332. A pin (not shown) extends through an opening 337 in the bolt 332 and through the extractor pivot 360. The extractor 336 is mounted to the bolt 332 so as to pivot about an axis that is perpendicular to the bolt axis. A compression retainer spring (not shown) biases the extractor 336 so that it pivots in toward the bolt face 329. The claw-like edge 357 facilitates gripping a cartridge 110 when it pivots into the bolt face 329. The pivot 360 is inboard of the claw-like edge 357 thereby providing a moment about the pivot 360 to close the claw-like edge 357 against the round 110 if it pulls away from the bolt face 329. The face of the claw-like edge 357 has an angled surface 359 thereby allowing the round extractor 336 to be forced open when a round 110 is pushed toward the bolt face 329, allowing the round 110 into the bolt face 329.

[0053] With reference now to FIGS. 8A-8D, the firing pin assembly 342 comprises a firing pin 343, a bolt cam pin 344, a cam pin retainer 346, and an extraction buffer 348. The firing pin 343 extends from a forward surface of a firing pin body 366. The firing pin body 366 comprises a hollow cylinder with two helix bolt cams 368 in which the bolt cam pin 344 rides and a cylindrical rear opening 367. The bolt cams 368 are openings in the circumferential surface of the firing pin body 366 with a width slightly wider than the circumferential face of the bolt cam pin 344. The forward end of the cams 368 generally follow helical path generally 30° relative to a longitudinal axis of the firing pin body 366. The rearward end of the cams 368, however, are generally parallel to the same longitudinal axis. The firing pin body 366 comprises torsion restricting lugs 370. The firing pin body 366 further comprises threads at the rearward end of the opening 367 to threadedly secure the cam pin retainer 346.

[0054] The cam pin retainer 346 comprises a cylindrical body 349 with lug 351 attached at the rear. A cam pin retainer shaft 347 extends from a forward surface of the cam pin retainer body 349 to retain the cam pin 344 in the bolt cam 368 by extending into an opening in the circumferential side of the cam pin 344. The cam pin 344 is free to slide and rotate about the cam pin retainer shaft 347. The cam pin retainer 346 forward end is threadedly received within the firing pin rear opening 367 so that the shaft 347 extends into the firing pin body 366 and the cam pin 344 is free to slide through the twisting bolt cams 368. An extraction buffer 348 is retained on the cam pin retainer body 349 between the firing pin body 366 and the lug 351.

[0055] Referring now to FIGS. 4 and 9, the forward end of the carriage 326 comprises a bolt opening 364 to telescopically receive both the firing pin 343 and the bolt 332. The torsion restricting lugs 370 fit in recesses at the rear end of the carriage 326 to prevent the firing pin 343 from rotating about the axis of the bolt 332. The bolt 332 is then inserted into the opening 364 and the cam pin 344 is inserted through the cam pin openings 333 and the bolt cams 368. The cam pin retainer 346, with the extraction buffer 348 already attached, is then inserted into a retainer opening 372 at the rear of the carriage 326 and threaded into the firing pin rear opening 367. The firing pin 343 is now axially fixed to the carriage 326. The carriage 326 holds the firing pin 343 and bolt 332 collinear. The bolt 332 is now able to slide along the length of the firing pin 343 and rotate about the firing pin 343, following the bolt cams 368 through the cam pin 344. The carriage 326 is inserted into the barrel extension 302 through the carriage extraction slots 321. The barrel extension 302 now retains the firing pin 343, bolt 332, chamber 305, and barrel 304 collinear. The bolt cam pin 344 rides in the bolt cams 368 thereby defining both the rotational and axial position of the bolt 332. A bolt lug is restrained from rotation by a bolt side rail (not shown) in the barrel extension 302 thereby retaining the bolt 332 and bolt face 329 forward of the firing pin during the first half of the firing cycle.

[0056] The toggle assembly 308 comprises left 374 and right 375 toggles, a toggle shaft 376, a carriage roller 378, barrel extension rollers 380, a receiver roller 382, and rear rollers 384. The toggle shaft 376 connects the two toggles 374, 375. A rear roller 384 is positioned between the shaft 376 and each toggle 374, 375 and allows the toggle assembly 308 to ride in the toggle track openings 318 on the barrel extension 302. The left toggle 374 extends forward and connects to a barrel extension roller 380. The right toggle 375 extends forward parallel to the left toggle 374. The right toggle 375 is attached to a collarlock stack of rollers, the carriage roller 378, a barrel extension roller 380, and the receiver roller 382. The carriage roller 378 rides in the carriage cam way 330, the barrel extension rollers 380 rides in the barrel extension cam ways 320, and the receiver roller 382 rides in the receiver’s bimodal cam way 212. Because these rollers are collinear, the carriage cam way, the barrel extension cam way 320 and the bimodal cam way 212 will always share an intersecting point. These rollers and cams work together to adjust the position and speed of the carriage 326 relative to the barrel extension 302 as the barrel extension 302 moves through the receiver 200 during the operating cycle. An ejector bar 390 is attached to the side of and is collinear with and free to rotate about the toggle shaft 376. The front of the ejector bar 390 is supported
by a groove in the ejector 338 and the front of the ejector bar 390 rests on the ejector post 354 pushing the round ejector 338 forward.

[0057] Embodiments of the recoil system are described in U.S. Pat. No. 6,343,536 which is incorporated herein by reference.

[0058] With reference to FIGS. 10A-17, the cycle of the weapon system 100 will now be discussed in detail. With the weapon 100 in a neutral position [?], the operator first charges the weapon 100, as is known in the art.

[0059] Referring to FIGS. 10A-10B, with the weapon 100 charged with the barrel extension 302 located at the rear of the receiver 200 where it is held back by a hook on the rear 226 (see FIG. 11B). The bolt carriage 326 is positioned to the rear of the barrel extension 302 and held in place by the rollers 378, 380, 382 located at the top of their respective cam ways 330, 320, 212. The round ejector finger 352 extends forward of the bolt head 331 and is held in this position by the ejector stop post 354. A cartridge 110 is in the strip position in the cartridge guide 104.

[0060] With reference to FIG. 11, the operator initiates the firing sequence by carefully aiming the weapon system 100 and pulling the trigger 108. The trigger 108 moves the rear 226 out of the way, releasing the barrel extension 302, allowing the buffer main spring 402 to push the barrel extension 302 forward. The receiver roller 382 moves along the upper portion of the bimodal cam way 212. With the barrel extension 302 0.25 inches from the rear position, the rammer 334 engages the cartridge 110 and pushes it through a link (not shown).

[0061] Referring now to FIGS. 12A-12C, the barrel extension 302 continues forward, the receiver roller 382 engages the down-sloping portions of the bimodal cam way 212, pushing the receiver roller 382, barrel extension roller 380, and cartridge roller 378 through a downward changing slope. Moving through the changing slope, the barrel extension roller 380 begins to move downward and decelerate the barrel extension 302. At the same time, the carriage roller 378 pushes the cartridge cam way 330 to increase the carriage 326 acceleration relative to that of the barrel extension 302. With the barrel extension 302 2.57 inches from the rear position, the rammer 334 begins to push the cartridge 110 into the barrel chamber 305. At 3.1 inches from the rear position, the bolt assembly 306 and bolt carriage 326 have traveled farther than the ejector bar 390. This relieves the ejector stop 354 of the ejector bar 390 and allows the ejector spring 340 to push the ejector 338 rearward, clearing the ejector from the bolt face 329.

[0062] With reference now to FIGS. 13A and 13B, the barrel extension 302 continues forward with enough momentum to drive the ammunition feeder 102, which indexes the next cartridge into position. Such feed systems are generally known in the art, such as, for example, that disclosed by U.S. Pat. No. 6,343,536, which is incorporated herein by reference. As the barrel extension 302 continues forward, the receiver roller 382 moves through the relieved portion of the bimodal cam way (see FIG. 13B). The carriage 326 is slowed down relative to the receiver and barrel extension and the receiver roller 382 is forced to the upper surface of the bimodal cam by the active cam gate 213. With the barrel extension 7.2 inches from the rear position, the bolt head 331 closes the chamber 305 and its forward motion stops. As the chamber 305 closes, the forward motion of the ammunition round 110 is stopped by the barrel and it is forced into the round extractor 336. The carriage 326 however continues forward relative to the bolt 332. Moving forward, the carriage 326 pushes the firing pin forward, which cause the bolt cam pin 344 to move through the bolt cam ways 368 forcing the bolt 332 to rotate clockwise.

[0063] Referring now to FIGS. 14A and 14B, the barrel extension 302 continues forward, driving the receiver roller 382 further through the bimodal cam 212, accelerating the carriage 326. The firing pin assembly 342 continues forward, rotating the bolt 332 until it locks with the chamber 305. With the barrel extension 8.0 inches from the rear position, the carriage 326 drives the firing pin 343 into the cartridge primer, causing the propelling train to ignite and push the bullet out of the barrel 304. At this time, the barrel extension 302 forward movement is stopped and it is driven rearward from the impulse of the fired round.

[0064] Referring now to FIGS. 15A-16C, the unlocking of the bolt will now be explained. Due to the impulse of the fired round, the barrel extension 302 moves rearward, driving the receiver roller 382 into the lower surface of the bimodal cam 212. The carriage 326 then accelerates rearward by the receiver roller 382 moving through the upward slope of the bimodal cam 212 (see FIG. 16B). At the same time, the barrel extension rollers 380 and carriage roller 378 move upward in their respective cam ways 330, 320. As the carriage 326 moves rearward, the bolt 332 is initially still held in the chamber 305 as the cam pin 344 moves through the straight portion of the bolt cam 368. When the carriage 326 proceeds rearward, the cam pin 344 enters the helical portion of the bolt cam 368 and the bolt 332 rotates counterclockwise and is unlocked from the chamber 305 and pulled rearward by the carriage 326.

[0065] With reference to FIGS. 16A-16C, the barrel extension 302 continues rearward driving the rollers 378, 380, 382 upward and along their respective cam ways 330, 320, 212. The forward claw-like edge 357 of the round extractor 336 grips the rim of the cartridge 110 and pulls the cartridge 110 out of the chamber 305. The receiver roller now enters the upward sloped portion of the bimodal cam 212 and accelerates the rearward moving carriage 326. The ejector stop post 354 then engages the ejector stop 354 (See FIG. 16C) causing the ejector finger 352 to extend forward of the bolt head 331, impacting the back of the cartridge 110 near its circumferential edge, pushing the cartridge 110 off the bolt head 331, and out of the grip of the round extractor 336 and rotating the cartridge 110 laterally clear of the weapon through the eject port 106.

[0066] The barrel extension 302 continues rearward driving the receiver roller 382 into top portion of the bimodal cam 212 to clear the barrel 326. The barrel extension 302 continues rearward until the buffer assembly 400 stops it. The barrel extension 302 will then rear up or continue forward to repeat the firing cycle, depending on the operating mode and the orientation of the trigger 108. The rear position is illustrated in FIGS. 10A and 10B.

[0067] While the firing cycle has been described at 7 discrete points relating to FIGS. 10A-103, these 7 discrete positions have been described merely for illustrative purposes only. It should be understood that, in operation, the present invention’s firing cycle comprises a smooth and continuous sequence of motion, taking the operating group 400 from rear position, to firing the round, and back to rear position.

[0068] Other embodiments of the invention will be apparent to those skilled in the art from consideration of the spec-
fication and practice of the invention disclosed herein. It is intended that the specification be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

1. A weapon system comprising:
   a receiver;
   a barrel having a longitudinal axis;
   a bolt spaced a distance from a rearward end of the barrel along the longitudinal axis of the barrel;
   a barrel extension attached to the bolt and connecting the barrel with the bolt, the barrel extension and bolt adapted to move linearly with respect to the receiver in a direction parallel to the longitudinal axis of the barrel;
   a bolt carriage movable relative to the bolt between an ammunition loading position and a firing position; and
   a toggle assembly adapted to drive the bolt carriage between the loading position and the firing position in response to movement of the barrel extension and bolt relative to the receiver.

2. The weapon system of claim 1, wherein the bolt is spaced a fixed distance from a rearward end of the barrel.

3. The weapon system of claim 2, wherein and the barrel is adapted to move relative to the receiver in conjunction with the bolt and barrel extension.

4. The weapon system of claim 1, wherein the bolt assembly moves linearly relative to the bolt in a direction parallel to the longitudinal axis of the barrel.

5. The weapon system of claim 4, wherein when the bolt assembly is in the firing position, the bolt assembly overrides the space between bolt and the rearward end of the barrel, capturing a round of ammunition in the space between the bolt and the rearward end of the barrel.

6. The weapon system of claim 4, wherein when the bolt assembly is in the ammunition loading position, the bolt assembly overrides at least a portion of the bolt, opening the space between the bolt and the rearward end of the barrel.

7. The weapon system of claim 6 further comprising a load pawl and a load pawl cam surface that drives the load pawl through a range of movement in response to movement of the bolt and barrel extension.

8. The weapon system of claim 7 wherein the movement of the load pawl includes lifting a round of ammunition into the space between the bolt and the rearward end of the barrel as the bolt assembly moves from the ammunition loading position to the firing position.

9. The weapon system of claim 7 wherein the movement of the load pawl includes sweeping the opening between the bolt and the rearward end of the barrel to remove a spent ammunition cartridge as the bolt assembly moves from the firing position to the ammunition loading position.

10. The weapon system of claim 1, wherein the toggle comprises a cam follower, and the firearm further comprises a cam surface for guiding movement of the cam follower.

11. The weapon system of claim 10, wherein the cam surface is attached to an interior surface of the receiver.

12. The weapon system of claim 10, wherein the cam surface is integrally formed with an interior surface of the receiver.

13. The weapon system of claim 1, wherein the toggle comprises a forward toggle and a rearward toggle.

14. A recoil operated firearm comprising:
   a barrel having a longitudinal bore axis;
   a bolt being collinear with the bore axis;
   a bolt assembly comprising an ammunition-holding cavity having a longitudinal axis collinear with the bore axis;
   the bolt assembly being adapted for linear movement between a charged position and a firing position, wherein the linear bolt assembly movement is relative to the barrel and collinear with the bore axis, wherein, when in the bolt assembly charged position:
   the bolt assembly is positioned rearward end of the barrel, the forward end of the bolt assembly is spaced a distance away from the rearward end of the barrel, and
   the bolt assembly overrides at least a portion of the bolt such that the bolt occupies at least a portion of the ammunition-holding cavity; and
   wherein, when in the bolt assembly firing position:
   a forward surface of the bolt assembly sealingly contacts a rearward surface of the barrel, and
   a forward end of the bolt sealingly contacts a rearward end of the bolt assembly.

15. The firearm of claim 14 wherein, when in the bolt assembly charged position, a forward surface of the bolt is generally coplanar with a forward surface of the bolt assembly.

16. The firearm of claim 14 further comprising a barrel extension, wherein the barrel is removably attached to the barrel extension.

17. The firearm of claim 16 further comprising a receiver, wherein:
   the receiver at least partially houses the barrel extension,
   the barrel extension being adapted for linear movement relative to the receiver between a charged position and a firing position.

18. The firearm of claim 17 wherein, the receiver further comprises one or more barrel extension rails to guide movement of the barrel extension relative the receiver.

19. The firearm of claim 17 further comprising a toggle assembly.

20. The firearm of claim 19 wherein, the toggle assembly comprises:
   a first toggle arm; and
   a second toggle arm;
   wherein the first toggle arm is pivotally connected to the bolt assembly, the second toggle arm is pivotally connected to the barrel extension; and the first toggle arm is pivotally connected to the second toggle arm.

* * * * *