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A. MILLER

3,618,457

ROTARY AND SLIDING FIREARM BOLT WITH EXTERNAL CAM

Filed Nov. 25, 1969

2 Sheets-Sheet 1

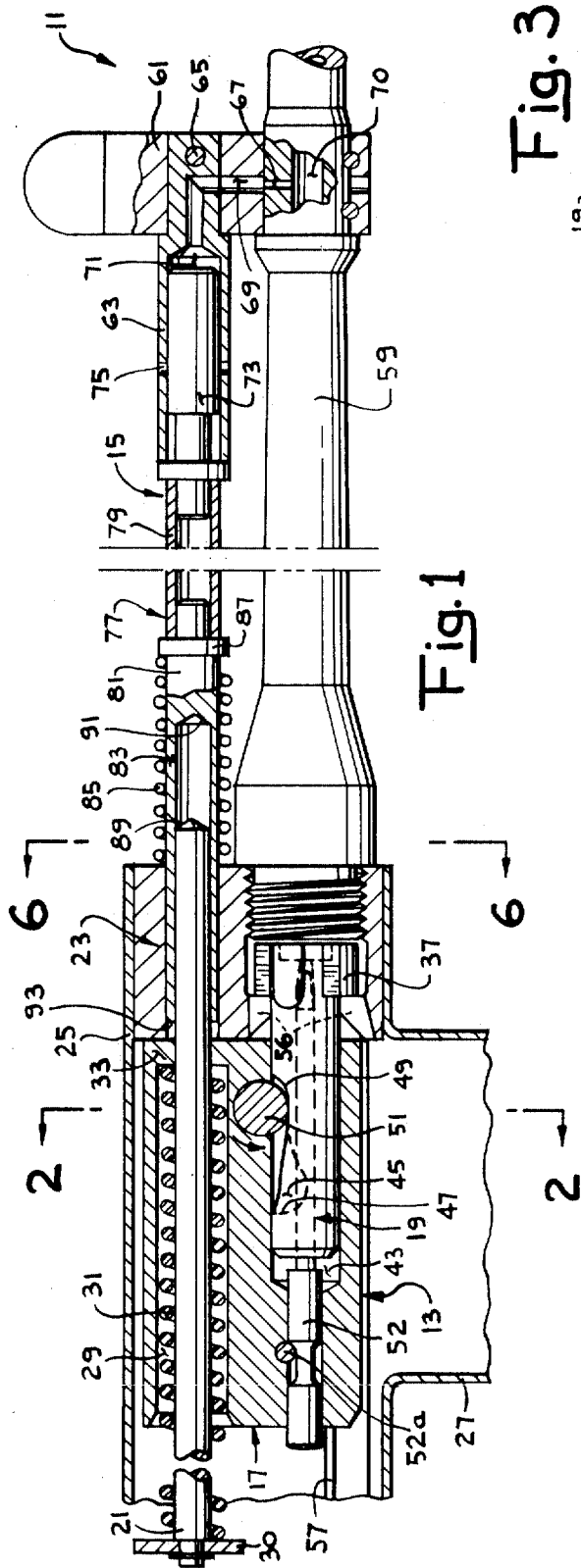


Fig. 1

Fig. 3

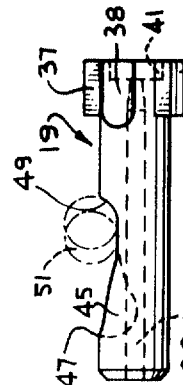
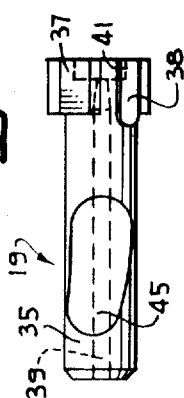


Fig. 4

Fig. 6

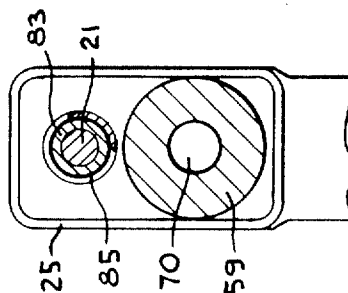
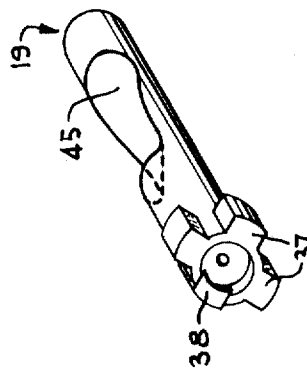


Fig. 7



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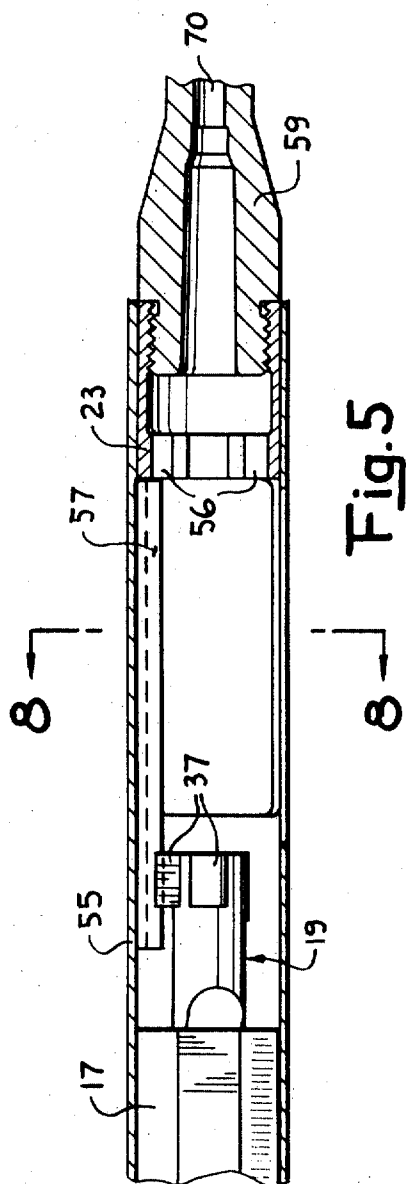


Fig. 8

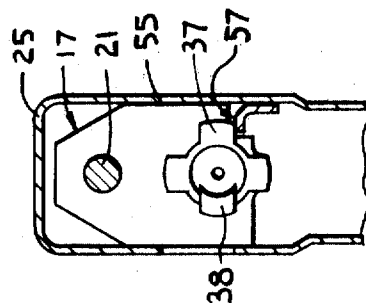
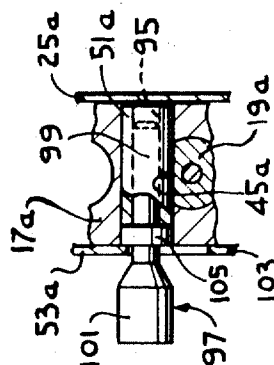
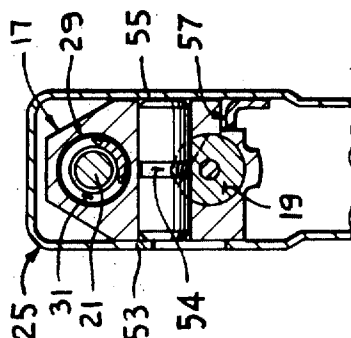


Fig. 2a



**Fig. 2**



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3,618,457  
**ROTARY AND SLIDING FIREARM BOLT WITH  
ETERNAL CAM**

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U.S. Cl. 89—185

17 Claims

## ABSTRACT OF THE DISCLOSURE

A firearm comprising a bolt having an external cam and a bolt carrier having a cam follower drivingly connected thereto for cooperating with the cam. The cam follower is mounted for rotation relative to the bolt carrier so that it can roll along the external cam. The firearm may also include a push rod assembly including a push rod and a guide rod having end portions mounted in slidable, telescoping relationship.

## BACKGROUND OF THE INVENTION

Many bolt groups for firearms utilize a rotating bolt and a bolt carrier with the bolt being carried by the bolt carrier. The bolt is rotated relative to the bolt carrier and moves axially therewith to lock and unlock the action, to feed a round into the chamber and to cause ejection of the spent cartridge case from the weapon.

A cam and cam follower are used to impart the desired rotary motion to the bolt. Cams of prior art firearms have been internal and are typically in the form of a slot in a tubular portion of the bolt carrier or a slot in the bolt. In both instances, the cam surface faces generally circumferentially. Such internal cams are undesirable in that they are difficult to cut and it is difficult to provide a good surface finish thereon. It is usually desirable to plate the cam surface, and internal cam surfaces are difficult to plate. In the slot type internal cam surface, the side walls of the slot form the cam and both of these side walls must be precisely cut and finished. Finally, the internal cams are not easily accessible and for this reason, they are difficult to clean.

The cam follower is rigidly mounted on the bolt or bolt carrier and it cannot rotate with respect to the member on which it is mounted. When the cam follower is on the bolt, the firing pin extends therethrough. This is necessary or desirable because of the rotary motion that the bolt undergoes.

As the cam follower is rigid, it slides along the cam and may cause galling, especially under adverse operating conditions such as when the weapon is exposed to mud, sand, etc. Galling causes still higher friction between the cam and cam follower and eventual binding of the cam and cam follower and ultimate failure of the weapon. In those weapons in which the firing pin extends through a hole in the cam follower, the hole weakens the cam follower and may produce cracks near the rim of the hole which ultimately cause fatigue failure of the cam follower.

In prior art short stroke push rod systems, one or more guide rods guide the reciprocatory movement of the bolt carrier. The guide rod or guide rods and push rod are usually axially offset and, therefore, take up substantial space. In addition, it is difficult to vary the length of

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stroke of the push rod. Such variation in length of the push rod stroke may be necessary or desirable when the weapon is to be used under adverse conditions.

## SUMMARY OF THE INVENTION

The present invention provides a firearm which solves all of the above noted problems. The concepts of this invention are applicable to a weapon which is capable of manual, semi-automatic or automatic operation.

The present invention is particularly adapted for use on a firearm of the type which includes a bolt and a member for mounting the bolt for movement relative thereto. The mounting member is usually a bolt carrier; however, it could be another member such as the receiver of the weapon.

According to the present invention, an external cam is used to impart the desired motion to the bolt. Although the external cam can be mounted at any location which will permit it to form this function, the cam is usually provided on, or is drivingly connected to, either the bolt or the bolt mounting member. The external cam is configured to impart the desired motion, which is usually rotary motion, to the bolt.

A cam follower is mounted on or drivingly connected to the other of the bolt or the bolt mounting member or elsewhere for cooperation with the cam. Cooperation between the cam and the cam follower impart the desired motion to the bolt. Although other orientations are possible, it is preferred to provide the external cam on the bolt and to mount the cam follower on the bolt carrier.

The external cam surface faces radially outwardly and has no side walls to thereby facilitate obtaining access to the cam. A preferred manner of forming the cam surface is to move the rotary cutter axially of the bolt while rotating the bolt with the axis of rotation of the cutter being transverse to the axis of the bolt. The portion of the external cam surface thus formed is a helicoid.

Because the cam surface is external, it is easy to form and to polish. The external cam surface can be easily plated and cleaned. The cam surface can advantageously terminate in suitable abutments which cooperate with the cam follower to permit the cam follower to move the bolt with the bolt carrier.

Another feature of the present invention is that the cam follower is mounted for rolling movement along the cam. This reduces the friction between the cam and the cam follower. Rolling friction is, of course, substantially less than sliding friction so that operation of the weapon is facilitated and the likelihood of galling is substantially reduced. The relative reduction in friction is even more pronounced when the weapon is operated in adverse conditions such as mud, sand and water.

In order to mount the cam follower for rotation, the present invention provides for offsetting the firing pin and the cam follower so that the firing pin does not extend through the cam follower in a manner which would prevent rotation of the cam follower. Preferably, the firing pin is spaced from the cam follower so that no holes or recesses for accommodating the firing pin are necessary. This reduces or eliminates the likelihood of cracking of the cam follower and consequent fatigue failure thereof.

The cam follower may be rotatably mounted by the bolt carrier or other appropriate member of the weapon.

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The mounting member for the cam follower preferably surrounds a substantial portion of the cam follower to thereby substantially prevent dirt or other matter from collecting on the surface of the cam follower. The cam follower may be provided with a circumferentially extending recess to provide a reservoir for accumulating any dirt which may get between the cam follower and the mounting member therefor.

Some weapons have a charging handle to permit manual movement of the bolt. According to the present invention, construction of such a firearm is simplified in that the cam follower is a standard bushing and the charging handle is mounted within the bushing.

The present invention provides a push rod assembly in which the push rod and guide rod have slidable telescoping end portions. This construction reduces the space required for these elements of the weapon and also causes these rods to be mutually supporting. Preferably the push rod telescopically cooperates with the barrel extension and the guide rod to provide very firm support. The two rods can telescope over relatively long distances to thereby provide firm support even when the barrel extension is short. In addition, the guide rod can be used to limit the stroke of the push rod, and the length of the push rod stroke can be varied by varying the length and/or the position of the guide rod.

The invention, both as to its organization and method of operation, together with further features and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying illustrative drawing.

#### BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary sectional view through a portion of a firearm constructed in accordance with the teachings of this invention with the bolt group and push rod assembly being illustrated.

FIG. 2 is a fragmentary sectional view taken along line 2—2 of FIG. 1.

FIG. 2a is a fragmentary sectional view taken along line 2—2 of FIG. 1 and illustrating a modification of the present invention.

FIG. 3 is a plan view of the bolt.

FIG. 4 is a side elevational view of the bolt.

FIG. 5 is a fragmentary sectional view taken from above of the bolt and barrel extension with the bolt moved to the rear.

FIG. 6 is a fragmentary sectional view taken along line 6—6 of FIG. 1.

FIG. 7 is a perspective view of the bolt.

FIG. 8 is a fragmentary sectional view taken along line 8—8 of FIG. 5.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing and in particular to FIG. 1 thereof, reference numeral 11 designates a firearm constructed in accordance with the teachings of this invention. The portions of the firearm 11 shown in FIG. 1 generally include a bolt group 13 and a push rod assembly 15. Portions of the firearm 11 not shown or described herein may be of conventional design. In the embodiment illustrated, the firearm 11 is adapted for automatic or semi-automatic firing.

Generally the bolt group 13 includes a bolt carrier 17 and a bolt 19 mounted in the bolt carrier for movement relative thereto. The bolt carrier 17 is mounted on a guide rod 21 for axial movement therealong. A barrel extension 23 and the bolt carrier 17 are housed within a receiver 25. A magazine guide 27 opens into the receiver 25 beneath the bolt 19.

The bolt carrier 17 has an upper passage 29 extending therethrough for receiving the guide rod 21. The left end of the guide rod 21 is slidably received in a plate 30 which in turn is mounted on the receiver (not shown) in a con-

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ventional manner to thereby support the left end of the guide rod. The guide rod 21 mounts the bolt carrier for sliding movement therealong. A coil spring 31 surrounds the guide rod 21 within the passage 29 and bears against an annular shoulder 33 to thereby urge the bolt carrier 17 to the right as viewed in FIG. 1 into engagement with the barrel extension 23.

The bolt 19 (FIGS. 1-4 and 7) includes a shank 35 and a plurality of circumferentially spaced, radially extending lugs 37 at one end of the shank. A conventional extractor 38 is carried by the bolt 19 in between a pair of the lugs 37. The bolt 19 is formed with an axial bore 39 and a counter bore 41. The bolt 19 is generally cylindrical and is mounted within a bore 43 of the bolt carrier 17 for axial and rotational movement relative to the bolt carrier.

The bolt 19 has an external cam 45 formed thereon. The shape of the cam 45 can be varied depending upon the type of movement which is to be imparted to the bolt 19. In the embodiment illustrated, a substantial portion of the cam 45 is in the form of a right helicoid.

As best seen in FIGS. 1, 3 and 4, the external cam surface 45 faces generally radially outward of the bolt 19. In addition, the cam surface 45 is not bounded by side walls which extend axially of the bolt. The cam surface 45 terminates at the opposite axial ends thereof in abutments 47 and 49 which extend generally circumferentially of the bolt. The cam surface 45 may be polished and plated as necessary. The cam surface 45 extends axially and circumferentially of the bolt 19. Specifically, the cam 45 has a relatively straight or axial portion near the right end thereof followed by a helicoid section which imparts rotation to the bolt. The relatively straight portion of the cam surface 45 is provided to allow a buildup of momentum of the bolt carrier 17 prior to initiating rotation of the bolt.

The helicoid portion of the cam 45 can be cut by advancing a rotary cutter axially of the bolt 19 while rotating the bolt about its axis with the axis of rotation of the cutter being perpendicular to the axis of the bolt. The precise shape of the cam surface thus formed will depend upon the relative rate of axial advance of the cutter, and the rate of rotation of the bolt as well as the depth of cut. The straight portion of the cam 45 can be formed in the same way except the bolt 19 is not rotated.

A cam follower 51 is mounted on the bolt carrier 17 for rotation relative thereto about an axis which extends generally transverse to the axis of the bolt 19. In the embodiment illustrated, the cam follower 51 is in the form of a pin, a large portion of the periphery of which is snugly engaged by the bolt carrier 17. However, any suitable means including ball bearings, needle bearings and other kinds of bearings may be utilized to mount the cam follower 51 for low friction rotary movement. As shown in FIG. 1, the periphery of the cam follower 51 engages the external cam 45 for cooperation therewith. The cam follower 51 has a circumferentially extending recess 54 extending completely around the cam follower to provide a reservoir and/or a means of escape for any dirt or particles which may get between the cam follower and the bolt carrier 17.

A firing pin 52 is mounted for axial sliding movement in the bore 39. The firing pin 52 performs the usual firing pin function and is retained in the bore 43 by a firing pin retaining pin 52a.

In the operation of the bolt group, the bolt carrier 17 is moved to the rear, i.e. to the left as viewed in FIG. 1 by the push rod assembly 15 in a manner more fully described hereinabove. As the bolt carrier 17 is moved to the rear, the cam follower 51 rolls along the external cam 45 and the bolt carrier 17 slides within the side walls 53 and 55 (FIG. 2) of the receiver 25. The rolling movement of the cam follower 51 along the cam surface 45 is accomplished with a minimum amount of friction.

In the straight portion of the cam 45 there is substan-

tially no resistance to movement of the bolt carrier 17 so that the latter builds up substantial momentum before entering the helicoid portion of the cam. The bolt 19 remains stationary while the cam follower 51 is on the straight portion of the cam 45. As the bolt carrier 17 is held against rotation by the side walls 53 and 55, movement of the cam follower 51 along the helicoid portion of the cam 45 results in imparting rotary motion to the bolt 19 while the bolt remains axially in the position shown in FIG. 1. In the embodiment illustrated, the bolt turns counter-clockwise as viewed from the right end of FIG. 1 when moving to the rear. Ultimately the cam follower 51 engages the abutment 47 of the bolt 19 whereupon further movement of the bolt carrier causes corresponding axial movement of the bolt 19 therewith.

The rotary motion of the bolt 19 is necessary to rotate the lugs 37 so that they come into alignment with the grooves between corresponding conventional splines or lugs 56 (FIG. 1) formed in the barrel extension 23. With the lugs 37 in registry with the grooves between the lugs 56 of the barrel extension, the bolt can be moved axially to the rear upon further movement of the bolt carrier 17. This is conventional firearm structure and is disclosed, for example, in U.S. Pat. No. 3,318,192 issued to Miller et al. Such movement of the bolt to the rear causes the extractor 38 carried by the bolt 19 to extract and a conventional ejector (not shown) to eject a spent cartridge case from the chamber in conventional fashion.

Movement of the bolt carrier 17 to the rear compresses the spring 31 and is ultimately stopped by a suitable abutment (not shown) in a conventional manner. The compressed spring 31 is then operative to return the bolt carrier 17 and the bolt 19 to the position shown in FIG. 1. During the return movement, the bolt 19 feeds a new cartridge from the magazine (not shown) within the magazine guide 27 into the chamber in conventional fashion. During firing of the cartridge the bolt retains the cartridge in the chamber in conventional fashion.

During the return movement of the bolt carrier 17, the cam follower 51 remains closely adjacent the abutment 47. The cam follower 51 cannot roll forwardly along the cam 45 and impart clockwise rotation because of a longitudinally extending tab 57 (FIGS. 2, 5 and 8) mounted, for example, on the receiver 25 and one of the lugs 37 on the bolt 19 engages the top side of the tab 57 during axial return movement of the bolt. Because the tab 57 prevents the bolt 19 from rotating clockwise, the engagement between the cam 45 and the cam follower causes the bolt 19 to return with the bolt carrier without rotating the bolt 19. The tab 57 extends longitudinally from the lugs 56 of the barrel extension rearwardly for the full length of stroke of the bolt (FIG. 8) so that the lugs 37 can enter and pass through the grooves between the lugs 56 in proper angular relationship. Once the lugs 37 have passed through the grooves between the lugs 56, the bolt 19 is no longer retained against clockwise rotation so that further movement of the bolt carrier 17 to the right results in rolling of the cam follower 51 along the cam 45 to rotate the bolt 19 to a locked position in which the lugs 37 are out of registry with the grooves between the lugs 56.

A barrel 59 (FIG. 1) is connected to the barrel extension 23 and a bracket 61 is mounted on the barrel near the outer end thereof. A tube 63 is mounted in a bore in the bracket 61 and retained therein by a pin 65. A radial gas port 67 in the barrel 59 and a passage 69 in the bracket 61 provide communication between the bore 70 through the barrel and a gas passage 71 within the tube 63. A piston 73 is slidably mounted in the tube 63, and the tube has a plurality of radial exhaust ports 75 therein. The piston 73 is connected to a push rod 77 which, in the embodiment illustrated, includes push rod segments 79 and 81. The tube 63 supports one end of the push rod 77. The push rod segment 79 is in the form of a tube and is joined at one end to the piston 73 and

at the other end to the push rod segment 81. The push rod segment 81 has a sleeve portion 83 which is slidably received in the barrel extension 23 and which slidably receives an end portion of the guide rod 21. The push rod 77 and the guide rod 21 are concentric. A coil spring 85 acts between the barrel extension 23 and a collar 87 on the push rod segment 81 to urge the push rod to the right as viewed in FIG. 1. The telescoping relationship between the push rod 77 and the guide rod 21 provides mutual support for these rods and reduces the space occupied by these two rods.

In operation of the push rod assembly 15, gases from a fired cartridge (not shown) pass through the gas port 67, the bore 69 and the gas passage 71 to act on the piston 73 to urge the latter and the push rod 77 to the left as viewed in FIG. 1. Movement of the push rod 77 to the left compresses the spring 85 and continues until end surfaces 89 and 91 of the rods 21 and 77, respectively, engage, at which time the spring 85 causes the push rod 77 to return to the right to the position illustrated in FIG. 1. After the piston 73 has moved to the left a predetermined amount, the ports 75 are uncovered to allow venting of gases in the passage 71 through ports 75.

As the end surface 89 serves as an abutment or stop for the push rod 77, the length of stroke of the push rod can be varied by changing the position of the end surface 89. The end surface 89 may be caused to assume a different position by using a guide rod of a different length or by suitably adjusting the position of the guide rod.

Movement of the guide rod 77 to the left as described hereinabove causes the end 93 of the push rod 77 to strike the bolt carrier 17 and move the latter to the left as viewed in FIG. 1. Such movement of the bolt carrier 17 to the left imparts, in sequence, rotational and axial movement to the bolt 19 in the manner described hereinabove.

FIG. 2a shows a modified firearm which may be identical to the firearm 11 in every respect not specifically shown or described herein. Parts in FIG. 2a corresponding to parts in FIGS. 1-6 are designated by corresponding reference characters followed by the letter *a*.

In the embodiment shown in FIG. 2a, the cam follower 51a is in the form of a bushing having a passage 95 extending therethrough. A charging handle 97 is mounted within the passage 95. Specifically, the charging handle 97 includes an inner shaft portion 99 within the passage 95 and a handle portion 101 which projects through an opening 103 in the side wall 53a. The charging handle 97 has a collar 105 intermediate the wall 53a and an end of the cam follower 51a to thereby retain the charging handle 97 in the position shown in FIG. 2a. The shaft 99 fits loosely within the passage 95 to facilitate disassembly.

An advantage of the embodiment of FIG. 2a is that a charging handle is provided without the need for drilling or otherwise forming additional holes in the bolt carrier 19. With the embodiment shown in FIG. 2a, the cam follower 51a can be a standard bushing and as such can serve to mount the charging handle 97. In the embodiment of FIG. 2a, there is no recess such as the recess 54 of FIG. 2.

Although exemplary embodiments of this invention have been shown and described, many changes, modifications and substitutions may be made by one having ordinary skill in the art without necessarily departing from the spirit and scope of this invention.

I claim:

1. A bolt group for a firearm comprising:
  - a bolt carrier;
  - means for mounting said bolt carrier for movement in both directions along a predetermined path;
  - a bolt mounted on said bolt carrier for movement therewith and relative thereto;

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a cam formed on the exterior surface of said bolt, said cam having first and second ends and first and second sides, said cam being open at both of said sides;

a cam follower drivingly connected to said bolt carrier and movable along said cam generally in the direction from the first end toward the second end in response to a first increment of movement of said bolt carrier along said path to cause said cam to impart a predetermined amount of rotation to said bolt relative to the bolt carrier; and

means on said bolt carrier and said bolt responsive to a second increment of movement of said bolt carrier along said path to move said bolt along said path with said bolt carrier.

2. A bolt group as defined in claim 1 including means for mounting said cam follower for rotation relative to the bolt carrier whereby said cam follower rolls along said cam to thereby reduce friction between the cam and the cam follower.

3. A bolt group as defined in claim 1 including a firing pin extending through said bolt, said firing pin being spaced from said cam follower.

4. A bolt group as defined in claim 1 wherein at least a portion of said cam is in the form of a helicoid.

5. A bolt group as defined in claim 1 wherein said cam includes an external surface of said bolt, said external surface facing generally radially outwardly away from said bolt, said external surface being substantially flat in radial cross section.

6. A bolt group as defined in claim 1 wherein said cam extends both axially and circumferentially of said bolt, and said last mentioned means including abutments adjacent the ends of said cam, said abutments cooperating with said cam follower to permit the cam follower to move the bolt along said path with said bolt carrier.

7. A bolt group as defined in claim 6 including means for mounting said cam follower on the bolt carrier for rotation relative thereto whereby the cam follower rolls along said cam to thereby reduce friction between the cam and the cam follower, said bolt group also including a firing pin extending through said bolt, said firing pin being spaced from said cam follower.

8. A firearm comprising:

a barrel;

a bolt member for feeding a round into registry with the barrel;

a mounting member for mounting said bolt for movement along a path to cause the round to be fed into registry with the barrel by said bolt;

a cam formed on the peripheral surface of one of said members, said cam having generally opposed sides, said cam being open at said sides;

a cam follower drivingly connected to the other of said members; and

means for imparting relative motion to said members to cause said cam and said cam follower to move relative to each other, said cam follower being engageable and cooperable with said cam to impart movement to said bolt member along at least a portion of said path.

9. A firearm as defined in claim 8 wherein the cam is on said one member and the cam follower is mounted on the said other member, said cam facing generally outwardly away from said one member.

10. A firearm as defined in claim 8 including means partially surrounding the cam follower for mounting the cam follower for rotation relative to said other member whereby said cam follower can roll along said external cam.

11. A firearm as defined in claim 8 wherein said last mentioned means includes a push rod for driving said one of said cam and said cam follower and a guide rod for guiding the movement of said push rod, one of said rods having a sleeve-like end portion for telescopically

and slidably receiving an end portion of the other of said rods whereby said rods are mutually supported.

12. A firearm as defined in claim 11 including means for mounting the cam follower for rotation relative to said other member whereby said cam follower can roll along said external cam.

13. A bolt group for a firearm comprising:

a bolt carrier member;

means for mounting said bolt carrier member for movement in both directions along a predetermined path;

a bolt member mounted on said bolt carrier member for movement therewith and relative thereto;

one of said members having a cam drivingly connected thereto;

a cam follower;

means for mounting said cam follower for movement with the other of said members and for rotation relative to said other member;

said cam follower cooperating with said cam and rolling therealong in response to a first increment of movement of said bolt carrier member to rotate said bolt member a predetermined amount relative to said bolt carrier member;

means on said bolt carrier member and said bolt member responsive to a second increment of movement of said bolt carrier member along said path to move said bolt member along said path with said bolt carrier member; and

said cam follower having a circumferentially extending recess therein.

14. A bolt group as defined in claim 13 including a firing pin, said firing pin not extending through said cam follower whereby said firing pin does not prevent rotation of said cam follower relative to said other member.

15. A bolt group for a firearm comprising:

a bolt carrier member;

means for mounting said bolt carrier member for movement in both directions along a predetermined path;

a bolt member mounted on said bolt carrier member for movement therewith and relative thereto;

one of said members having a cam drivingly connected thereto;

a cam follower;

means for mounting said cam follower for movement with the other of said members and for rotation relative to said other member;

said cam follower cooperating with said cam and rolling therealong in response to a first increment of movement of said bolt carrier member to rotate said bolt member a predetermined amount relative to said bolt carrier member;

means on said bolt carrier member and said bolt member responsive to a second increment of movement of said bolt carrier member along said path to move said bolt member along said path with said bolt carrier member; and

said cam follower being mounted on said bolt carrier member and said bolt group including a charging handle attached to said cam follower to permit manual movement of said bolt carrier along said path.

16. A bolt group as defined in claim 1 wherein the cam follower extends completely across the cam along a line which is transverse to the bolt, said cam follower projecting outwardly along said line beyond said sides.

17. A bolt group for a firearm comprising:

a bolt carrier;

means for mounting said bolt carrier for movement in both directions along a predetermined path;

a bolt mounted on said bolt carrier for movement therewith and relative thereto;

an exterior cam on the exterior of said bolt, said cam having first and second ends axially spaced along

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said bolt and first and second sides circumferentially spaced in a radial plane, said cam extending axially and circumferentially of said bolt from said first end to said second end;

a cam follower;

means for drivingly connecting said cam follower to said bolt carrier, said cam follower being movable along said cam in response to a first increment of movement of said bolt carrier along said path to cause said cam to impart a predetermined amount of rotation to said bolt relative to said bolt carrier; and said bolt having first and second abutments adjacent said first and second ends, respectively, said abutments being cooperable with the cam follower to permit the cam follower to move the bolt along said

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path with said bolt carrier, said cam being open between said abutments along said sides.

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S. C. BENTLEY, Assistant Examiner

U.S. Cl. X.R.

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