

Forward Ejection System Of Casing

Field of Invention

[001] The present invention relates to a casing ejection system for a firearm which is configured with a bolt assembly. In particular, the casing is ejected both forward and to one side of the firearm, this is, at a safe distance away from the shooter of the firearm. The bolt assembly is also configured with a latch cam pin to prevent accidental assembling of a firing pin without an associated cam pin (234) during assembling of the bolt assembly and casing ejection system.

Background

[002] A bolt assembly **10** for a firearm includes a bolt carrier **20** and a bolt **30** for moving inside the bolt carrier **20**. A front end of the bolt **30** has an extractor **34** and a plurality of lugs **36**. The lugs **36** are matched with cooperating slots at the rear of the barrel, for locking the bolt during firing and for unlocking the bolt after firing. After firing a cartridge, the high-pressure gas in the cartridge chamber is used to drive a piston assembly **50** which, in turn, moves the bolt carrier **20** rearward; as the bolt carrier is moved rearward, the bolt **30** is also rotated; rotation of the bolt **30** unlocks the lugs from the cooperating slots at the barrel rear-end and then allows the extractor **34** to pull the casing **12** of the spent cartridge from the cartridge chamber. In US Patent No. 6,625,917, issued to Heckler & Koch GmbH, the rearward moving casing hits an ejector rod; this causes the casing **12** to be tilted laterally and become dislodged from the extractor **34**; the kinetic energy of the casing then causes the casing to eject out of the firearm.

[003] Conventionally, most firearms are designed for right-hand use and the hot casings **12** are ejected to the right hand side. A left hand shooter using such a right-handed firearm faces the hazard of being struck by the hot casings. This problem is more serious when the firearm is of the bullpup design in that the hot casings **12** are ejected closer to the arm or face of the shooter.

[004] It can thus be seen that there exists a need for another type of mechanism to eject the hot casings a safe distance away from the shooter.

Summary

[005] The following presents a simplified summary to provide a basic understanding of the present invention. This summary is not an extensive overview of the invention, and is not intended to identify key features of the invention. Rather, it is to present some of the inventive concepts of this invention in a generalised form as a prelude to the detailed description that is to follow.

[006] The present invention seeks to provide a casing ejection system for a firearm, especially that of a bullpup design. Preferably, the firearm incorporating the casing ejection system is usable by both right-handed and left-handed users. A latch cam pin is provided at the bolt assembly to prevent accidental assembling of a firing pin without assembling an associated cam pin (234) during assembling of the bolt assembly and casing ejection system.

[007] In one embodiment, the present invention provides a casing ejection system for a firearm employing a bolt carrier assembly, with the system comprising: an elongate bolt disposed to move along and rotate about a longitudinal axis in a bolt carrier, with a front face of the bolt having an extractor for holding a casing thereon; an elongate actuator rod disposed parallel to the longitudinal axis of the bolt and bolt carrier, with a front end of the actuator rod having a L-shaped deflector, and a rear end having a cam pin and an engaging cam slot in a sleeve disposed around the rear end, wherein the L-shaped deflector is at a home position that is forward and clear from the front face of the bolt; an ejection chute that is parallel to the actuator rod and having a longitudinal opening for receiving a casing held by the extractor at the front face; and an ejector extends from the bolt carrier into the ejection chute near a rear end of the longitudinal opening and is movable to a front end of the longitudinal opening according to a longitudinal stroke of the cam pin in the cam slot; wherein, after an initial predetermined rearward motion, further rearward motion of the cam pin in the engaging cam slot causes the actuator rod to rotate and to strike the casing laterally into the ejection chute through the longitudinal opening. The return stroke of the

piston subassembly moves the bolt carrier forward via a recoil spring, and the casing in the ejection chute is pushed by the ejector out of the firearm to a safe distance forward and to one side of the firearm.

[0008] In an embodiment of the ejection system, the initial predetermined rearward motion of the actuator rod is accompanied by a combined longitudinal motion and rotation of the bolt, with the combined longitudinal and rotation of the bolt being generated by a transverse pin on the bolt engaging with a curved slot formed in the bolt carrier. The initial predetermined rearward motion of the actuator rod is generated by the cam pin traveling in an initial straight longitudinal section of the cam slot.

[0009] Preferably, the bolt carrier is driven by a piston subassembly. The piston subassembly and the ejection chute are located on opposite sides of the bolt carrier.

[0010] Preferably, a torsion spring is disposed around the actuator rod to rotationally return the L-shaped deflector to the home position from an actuated position. A dog clutch limiter may be used to rotationally define or adjust the home and actuated positions of the L-shaped deflector.

[0011] Preferably, a tension spring is located adjacent to the longitudinal opening of the ejection chute such that the contact force on the casing is operable to deflect the tension spring as the casing enters the ejection chute and the tension spring then retains the casing inside the ejection chute.

[0012] Preferably, a latch cam pin latch is provided along a side of the bolt to obstruct a central bore cavity. The latch cam pin is spring-loaded and the central bore cavity is normally obstructed until a cam pin (234) is inserted into the bolt. The normally obstructed central bore cavity ensures that the firing pin is blocked during assembling of the bolt assembly and the casing ejection system.

[0013] This invention will be described by way of non-limiting embodiments of the present invention, with reference to the accompanying drawings, in which:

[0014] FIG. 1A illustrates a top, left and rear perspective view of a firearm incorporating a bolt carrier and a casing ejection system according to an embodiment of the present invention; FIG. 1B illustrates a right hand view of the firearm shown in FIG. 1A; FIG. 1C illustrates a left hand side of the firearm shown in FIG. 1A without the hand guard, upper receiver and magazine;

[0015] FIG. 2A illustrates a gas-driven bolt carrier assembly and the casing ejection system, with a bolt and a deflector of the casing ejection system in their home positions, whilst FIG. 2B illustrates the bolt carrier and casing ejection mechanisms. FIG. 2C illustrates the bolt in a locked position during use; FIG. 2D illustrates the deflector being actuated and the casing being pushed into an ejector chute; and FIG. 2E illustrates a plan view of the firearm with a spent casing being ejected at the ejection port; and

[0016] FIG. 3A illustrates the bolt assembly, whilst FIG. 3B shows exploded parts of the bolt assembly.

Detailed Description

[0017] One or more specific and alternative embodiments of the present invention will now be described with reference to the attached drawings. It shall be apparent to one skilled in the art, however, that this invention may be practised without such specific details. Some of the details may not be described at length so as not to obscure the invention. For ease of reference, common reference numerals or series of numerals will be used throughout the figures when referring to the same or similar features common to the figures.

[0018] FIG. 1A shows a bullpup firearm that incorporates a gas-driven bolt carrier assembly **100** and a casing ejection system **300** according to the present invention. As shown, the firearm has a barrel **1**, a hand guard **2**, an upper receiver **3**, a lower receiver **4**, a magazine **5** and a stock **6**. FIG. 1B is a right hand view and shows an ejection port **600** from which spent casings **12** are ejected from the firearm. The ejection port **600** is forward with respect

to the trigger of the firearm; the ejection port 600 is also shown in FIG. 2E. FIG. 1C shows a left hand view of the firearm and parts of the bolt carrier assembly **100** and casing ejection system **300**.

[0019] FIG. 2A shows a top and front closed-up view of the bolt carrier assembly **100** and the casing ejection system **300**. FIG. 2B shows assemblies of the bolt carrier and casing ejection system when separated from the firearm. FIG. 2C shows a plan view of the bolt carrier assembly **100** and casing ejection system **300** with an L-shaped deflector **350** in the bolt carrier's locked position, whilst FIG. 2D shows the L-shaped deflector **350** in its actuated position. The bolt carrier assembly **100** and casing ejection system **300** are generally made of high-strength alloy steel. As shown in FIGs. 2A-2D, the gas-driven bolt carrier assembly **100** includes a gas-piston subassembly **50** that is connected to a bolt **230** and a bolt carrier **200**.

[0020] In FIG. 2A, the bolt **230** is partially visible. The bolt **230** is more clearly shown in FIGs. 3A-3B. The bolt **230** is elongate and is disposed to both translate and rotate in a longitudinal bore **220** in the bolt carrier **200**. The bore **220** has a longitudinal axis **221** (more clearly shown in FIG. 2C) that is co-axial with a longitudinal axis of the barrel **1**. The rear end of the bore **220** houses a firing pin **235**.

[0021] As seen from FIGs. 3A-3B, the front end of the bolt **230** has an extractor **34** and a plurality of lugs **36**. The lugs **36** are shaped and dimensioned to rotationally cooperate with slots or grooves (not shown in the figures) at the rear of the barrel **1**, so that a front face **230a** of the bolt **230** is in contact with the rear of the casing or cartridge **12**. The extractor **34** is elongate and is pivoted about an axis transverse (about pin **40**) to the longitudinal axis **221** of the bolt **230** so that a proximal claw-like tooth **35** is operated to latch onto a rim of the casing or cartridge **12**. The extractor **34** is biased by a spring **41** so that the claw-like tooth **35** is normally in the latched position. Preferably, a rubber insert **42** is provided inside the spring **41** to keep the spring in position. Preferably, the extractor **34** is at a 12 o'clock position. The extractor's **34** position is not so restricted and the claw-like tooth **35** can be in another position at the front face **230a** of the bolt **230**.

[0022] At a distal end of the bolt **230** is a cam pin **234**. The cam pin **234** extends transverse to the longitudinal axis **221** of the bolt **230** and is arranged to slide along a curved slot **224** formed along part of the cylindrical bore **220**. After a cartridge **12** is fired, high-pressured gas in the cartridge chamber is tapped out to drive the piston subassembly **50**; the high-pressured gas then pushes both the bolt **230** and bolt carrier **200** rearward. The twisting motion of the cam pin **234** along the curved slot **224** causes the bolt **230** to rotate and the lugs **36** to unlock from the slots at the rear of the barrel **1**; after moving an initial or first predetermined rearward motion, the L-shaped deflector **350** becomes aligned in front of the front face **230a** of the bolt **230** just clear from the extractor **34** and lugs **36**. Further rearward motions of the bolt **230** and bolt carrier **200** are accompanied by a rearward motion of an actuator rod **305** that drives the L-shaped deflector **350**. The actuator rod **305** is disposed above and substantially parallel to the bolt **230**; the centerline of the actuator rod **305** is indicated by numeral **306**. A distal end of the actuator rod **305** has a transverse cam pin **310** that cooperates with a cylindrical sleeve **320**. The cam pin **310** is constrained to slide in a cam slot **324** formed along a longitudinal axis the cylindrical sleeve **320**, thereby causing the actuator rod **305** to rotate anticlockwise (as seen from the rear in FIG. 2A) through an angle of substantially 110 degree. The cam slot **324** has an initial slot **324a** that is straight and parallel to the cylindrical sleeve's longitudinal axis, with a length of the initial slot **324a** corresponding to the initial or first predetermined rearward motion of the bolt **230**. When a casing **12** is held onto the front face **230a** of the bolt by the extractor **34**, rotation of the actuator rod **305** (subsequent to the initial predetermined rearward motion) causes the L-shaped deflector **350** to strike a lateral side of the casing **12** and to push the casing to the right hand side to enter an ejector chute **500**. The side of the ejector chute **500** adjacent the L-shaped deflector and bolt carrier has a longitudinal opening **502** for the casing to enter therethrough. As seen in FIGs. 2A-2C, the actuator rod **305** is disposed above and parallel to the bolt **230**, so that a contact area or contact line **352** along a contact face of the L-shaped deflector **350** with the casing **12** is substantially at a radius **R** of swing about the actuator rod's axis **306**. Preferably, the contact area **352** at the L-shaped deflector **350** is profiled, so that a contact force is in a direction to push the casing through the longitudinal opening **502** and into the ejection chute **500**. Also as seen in FIGs. 2C and 2D, a torsion spring **360** returns the L-shaped deflector **350** to its angular home position after the piston subassembly **50** springs back, and the actuator rod **305** and bolt **230** return to

their locked positions. An ejector **370** extends from the bolt carrier **200** into the ejector chute **500** through the longitudinal opening **502**; the forward return movement of the bolt carrier **200** causes the ejector **370** to push the casing **12** forward along the ejector chute **500**. The casing **12** is finally driven out through an ejection port **600** disposed at the right hand side of the firearm, as seen in FIG. 2E.

[0023] After a casing **12** is ejected, the cam pin **310** is moved back along the initial longitudinal portion **324a** of the cam slot **324**, and the bolt **230** is then returned to its home position so that the front bolt face **230a** comes into contact with the rear of the next casing **12**. This cycle of motions of the piston subassembly **50**, bolt carrier **200**, bolt **230**, L-shaped deflector **350** and actuator rod **305** allow spent casings **12** to be extracted automatically from the barrel chamber and be ejected through the ejection port **600**.

[0024] A convention approach in solving the right-handed and left-handed shooter issue is to make the conventional casing ejection mechanism laterally reversible. However, in the present invention, the casings **12** are ejected a safe distance forward with respect to the trigger or the barrel **1**, through the forward ejection port **600** in the hand guard **2**; the hot spent casings **12** are thus ejected safely away from the shooter and therefore there is no need to make the casing ejection system **300** of the present invention laterally reversible.

[0025] Also as seen in FIG. 2A, the bolt carrier **200**, at which the actuator rod **305** is journaled in, has a forward end that has dog clutch limiter **380**. The dog clutch limiter **380** is made up of an angular recess **381** at a forward end face of the bolt carrier and a cogged collar **382**. The angular recess **381** allows substantially 110 degree of rotation of the cogged collar **382**. The cogged collar **382** is angularly fixed onto the actuator rod **305**, for example, with a set screw. The dog clutch limiter **380** thus allows the actuator rod **305** to be assembled into the bolt carrier **200** and allows the angular position of the L-shaped deflector **350** to adjust with respect to the actuator rod **305** during assembly. The torsion spring **360** acting on the actuator rod **305** keeps the two components of the dog clutch limiter **380** always in contact with each other.

[0026] Preferably, a tension spring 364 is disposed adjacent to the longitudinal opening 502. In use, when the L-shaped deflector 350 sweeps a casing 12 into the ejection chute 500, the force on the casing deflects the body of the tension spring 364 as the casing is moved into the ejection chute 500; once a casing is pushed over the body of the tension spring 364, the tension spring 364 ensures that the casing 12 remains inside the ejection chute 500.

[0027] In the above description, the piston subassembly 50 is located to the left hand side of the bolt carrier assembly 100 as seen in FIG. 2A, whilst the ejection chute 500 is located to the right hand side. The principle of the present invention remains true even if the piston subassembly is located to the right hand side of the bolt carrier assembly and the ejection chute is located to the left hand side; thus, there is no further need to describe this alternate arrangement of the bolt carrier assembly and ejection chute.

[0028] Referring back to FIGs. 3A-3B, the bolt assembly is also configured with a latch cam pin 250, which is elongate and has a distal end and a proximal end; a distal (rear) end terminates with a claw 254, to prevent accidental inserting of the firing pin 235 without assembling the latch cam pin 250 during assembling of the bolt assembly and casing ejection system. When installed in the recess 252, the latch cam pin 250 is held in place by a pivot pin 257 with a compression spring 258 exerting a bias force on the proximal end, so that the claw 254 obstructs a central bore that receives the firing pin 235 in the bolt. When the bolt 230 is assembled correctly, the proximal end is depressed by the bolt carrier and the claw 254 becomes tilted out and the central bore becomes un-obstructed. During the process of assembling or dismantling (for example, for cleaning of the firearm) and when the bolt 230 is not received in the bolt carrier, the central bore is obstructed by the claw 254, thereby preventing the firing pin 235 from extending inside the bolt 230. In this way, the latch cam pin 250 provides a safety feature to prevent incomplete assembly of the bolt 230; in the same way, this prevents accidental firing of a cartridge without proper assembling of latch cam pin 250.

[0029] While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations and combinations thereof could be made to the present invention without departing from the scope of the invention. For example, the

longitudinal axis **306** of the actuator rod **305** is described as being above the longitudinal axis **221** of the bolt **230**; the longitudinal axis **306** of the actuator rod **305** can be offset laterally to the left or right hand side of the longitudinal axis **221** of the bolt **230**, as long as the radial swing **R** of the L-shaped deflector **350** is relative to the position of the longitudinal opening **502** at the ejection chute and the angle of rotation of the actuator rod **305**.

CLAIMS:

1. A casing ejection system for a firearm employing a bolt carrier assembly, the system comprising:

an elongate bolt disposed to move along and rotate about a longitudinal axis in a bolt carrier, with a front face of the bolt having an extractor for holding a casing thereon;

an elongate actuator rod disposed above and parallel to the longitudinal axis of the bolt and bolt carrier, with a front end of the actuator rod having a L-shaped deflector, and a rear end having a cam pin and an engaging cam slot in a sleeve disposed around the rear end, wherein the L-shaped deflector is at a home position that is forward and clear from the front face of the bolt;

an ejection chute that is parallel to the actuator rod and having a longitudinal opening for receiving a casing held by the extractor at the front face; and

an ejector extends from the bolt carrier into the ejection chute near a rear end of the longitudinal opening and is movable to a front end of the longitudinal opening according to a longitudinal stroke of the cam pin in the cam slot;

wherein, after an initial predetermined rearward motion, further rearward motion of the cam pin in the engaging cam slot causes the actuator rod to rotate and to strike and to push the casing laterally into the ejection chute, therethrough the longitudinal opening, so that the casing in the ejection chute is pushed forward by the ejector to eject a safe distance forward and to one side of the firearm.

2. The casing ejection system according to claim 1, wherein the initial predetermined rearward motion of the actuator rod is accompanied by a combined longitudinal motion and rotation of the bolt, with the combined longitudinal and rotation of the bolt being generated by a transverse pin on the bolt engaging with a curved slot formed in the bolt carrier.

3. The casing ejection system according to claim 2, wherein the initial predetermined rearward motion of the actuator rod is generated by the cam pin traveling in an initial straight longitudinal section of the cam slot.

4. The casing ejection system according to any one of claims 1-3, further comprising a piston subassembly to drive the bolt carrier rearward, and a recoil spring in the piston subassembly drives the bolt carrier forward.

5. The casing ejection system according to claim 4, wherein the piston subassembly and the ejection chute are located on opposite sides of the bolt carrier.
6. The casing ejection system according to any one of claims 1-5, further comprising a torsion spring disposed around the actuator rod to rotationally return the L-shaped deflector to the home position from an actuated position.
7. The casing ejection system according to claim 6, further comprising a dog clutch limiter to rotationally define the home and actuated positions of the L-shaped deflector.
8. The casing ejection system according to any one of claims 1-7, wherein a radial swing R of the L-shaped deflector is relative to a distance of the actuator rod longitudinal axis from the bolt longitudinal axis.
9. The casing ejection system according to any one of claims 1-8, wherein a contact face of the L-shaped deflector is profiled so that a contact force with the casing directs the casing into the ejection chute.
10. The casing ejection system according to claim 7, wherein the torsion spring ensures two components of the dog clutch limiter are always in contact with each other.
11. The casing ejection system according to any one of claims 1-10, further comprises a tension spring disposed adjacent and substantially parallel to the longitudinal opening of the ejection chute such that the contact force on a casing is operable to deflect the tension spring as the casing is deflected into the ejection chute, and the tension spring then retains the casing inside the ejection chute.
12. The casing ejection system according to any one of claims 1-11, wherein the bolt comprises a latch cam pin pivotedly connected thereto and a compression spring biases a proximal end of the latch cam pin so that a distal jaw end of the latch cam pin obstructs a central bore inside the bolt and prevents accidental assembling of a firing pin inside the central bore.

13. A firearm configured with a casing ejection system as defined by claims 1-11.