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Firing Rate Regulating Mechanism



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Field of the Invention

The present invention relates to a firing rate regulating mechanism and refers particularly, though not exclusively, to a firing rate regulating mechanism for use with weapons.

Reference to Related Application

The mechanism of the present invention may be used with a weapon to which is fitted a recoil mitigation mechanism the subject of our co-pending Singapore patent application number 200201721-8 for "Recoil Mitigation Mechanism" filed on 13 March 2002 ("our related application"), the contents of which are hereby incorporated by reference.

Background to the Invention

With normal weapons having a repeating function (as distinct from manually operated weapons such as, for example, bolt action rifles, mortars, and so forth) there are two distinct modes of operation:

- (a) semi-automatic/single shot – only one projectile is fired each time the trigger is depressed no matter for how long the trigger is depressed; and
- (b) fully automatic – for as long as the trigger is depressed the weapon will continue to fire until its ammunition is exhausted.

These have the problem that the operator of the weapon doesn't have any flexibility in the speed of operation of the weapon so that he can determine the optimum speed of delivery of the rounds for maximum effect, and for maximum efficiency in the use of the ammunition. For large caliber weapons, the rate of usage of the ammunition is an important factor as the weight and bulk of the ammunition may make delivery of further supplies difficult, particularly under battle conditions. A single shot operation may not be sufficiently speedy to achieve a satisfactory result, and fully automatic may be so wasteful of ammunition so that the ammunition supply is exhausted before the mission has been successfully concluded.

It is therefore the principal object of the present invention to provide a firing rate regulating mechanism, particularly for use on automatic weapons.

A further object of the present invention is to provide a firing rate regulating mechanism for weapons that is relatively easily adjustable by an operator during a mission.

A final object of the present invention is to provide a firing rate regulating mechanism for weapons and which can be adjusted between single shot and fully automatic.

Summary of the Invention

With the above and other objects in mind the present invention provides a firing rate regulating mechanism including a firing rate cylinder having at least one wall and a cylinder bore, a piston mounted for axial movement relative to the firing rate cylinder and substantially sealingly engaging the cylinder bore, the piston moving from a first position to a second position as a result of a firing, and moving from the second position to the first position to enable a further firing; the at least one wall having an air passage therethrough and being operatively connected to an air flow rate control means such that upon the piston moving axially from the first position to the second position it acts to force air in the firing rate cylinder through the air passage, the air flow rate control means being able to be adjusted to vary the air flow rate through the air passage and thus the rate of movement of the piston.

Preferably, the air flow rate control means includes an end block mounted to an end wall of the cylinder, and an air bleed rate cylinder to vary an opening of the air passage. The air bleed rate cylinder may have an inner end that is angled relative to a longitudinal axis of the air bleed rate cylinder. The angle may be in the range of from 30° to 60°, preferably 45°.

The piston may have an elongate rod mounted for reciprocal movement within a frame bore through a frame, the elongate rod having a disc at a rear end thereof, the disc

locating within the firing rate cylinder. The disc may be eccentric relative to ~~the~~ elongate rod.

A connector may be attached to a forward end of the elongate rod, the connector having a generally U-shaped body and a stem connected to the elongate rod; there being a sear pivotally mounted within the body and having a biasing means to bias the sear upwardly, the sear having a flat portion for sliding under a cam pin, the flat portion having a length substantially the same as the movement of the piston.

The elongate rod may have a lock pin extending transversely therethrough and beyond an outer surface of the elongate rod, the lock pin engaging in at least one groove in the frame bore to prevent rotational movement of the elongate rod about its longitudinal axis. There may be provided a rod biasing means to forwardly bias the elongate rod, preferably the rod biasing means being a compression spring mounted around the elongate rod at the forward end thereof; the compression spring at its forward end contacting the connector, and at its rear end contacting the frame to bias the elongate rod forwardly.

A trigger lever may be pivotally mounted to the frame, the trigger lever having a projection at its upper end for engaging in a step in the elongate rod. The disc may include an annular piston seal and a piston washer attached to the disc, the piston seal having a central opening of a diameter sufficient to enable the piston seal to move radially relative to the disc to enable the piston seal to compensate for any axial misalignment of the disc within the firing rate cylinder.

The firing rate cylinder may have an end wall including a rearwardly extending extension, the air passage allowing air to pass from an interior of firing rate cylinder to a hollow interior of the rearwardly extending extension. The end block is preferably mounted to the firing rate cylinder such that the rearwardly extending extension locates in a central opening of the end block, the central opening and the rearwardly extending extension each having a side wall with a first transverse opening, the first opening in the

side wall of the central opening being operatively connected to an interior passage to enable air to pass to atmosphere.

The end block may have a control passage in which is mounted the air bleed rate cylinder, the control passage being operatively connected to the hollow interior by a second transverse opening in the side wall of each of the central opening and the rearwardly extending extension. The air passage may have an opening to the hollow interior, the opening being able to be selectively closed, fully opened, or partially closed, by rotation of the air bleed rate cylinder, the closed opening corresponding to single shot firing, and the fully open opening corresponding to fully automatic firing.

The firing rate regulation may be during the firing stroke of the elongate rod.

Description of the Drawings

In order that the invention may be clearly understood and readily put into practical effect, there will now be described a preferred embodiment of the present invention, the description being with reference to the accompanying illustrative drawings, in which:

Figure 1 is a perspective view of the firing rate regulating mechanism for use with a weapon (not shown in full);

Figure 2 is a top plan view of the mechanism of Figure 1;

Figure 3 is a cross-sectional view along the lines and in the direction of arrows 3-3 on Figure 2;

Figure 4 is an enlarged perspective view of the firing rate cylinder of Figures 2 and 3;

Figure 5 is a longitudinal cross-sectional view of the cylinder of Figure 4;

Figure 6 is a perspective view of an air bleed rate cylinder of Figures 2 and 3;

Figure 7 is a longitudinal cross-sectional view of the air bleed rate cylinder of Figure 5;

Figure 8 is a perspective view of the end block of Figures 2 and 3; and

Figure 9 is a cross-sectional view along the lines and in the direction of arrows 9-9 on Figure 8.

Description of the Preferred Embodiment

The firing rate regulating mechanism as illustrated is for use with a 40 mm automatic grenade launcher ("launcher"), although it is suitable for use with any automatic weapon or other apparatus using explosive gasses for operation.

To refer to Figures 1 to 3 of the drawings, there is shown a frame 1 for mounting onto a receiver body (not shown) of a launcher. Mounted within cylindrical bore of frame 1 for reciprocating, axial movement relative thereto is a piston 2. The piston 2 has an elongate rod 17 with a disc 18 at a rear end 26 of rod 17, and a connector 4 at a forward end 27 of rod 17. As shown, the disc 18 is integral with rod 17, but it may be a separate component securely attached to rear end 26. The disc 18 is eccentric relative to the rod 17.

The connector 4 is securely attached to forward end 27 of rod 17 and has a generally U-shaped body 28 and a threaded stem 29 that engages in a correspondingly threaded blind hole 38 axially extending into rod 17 from forward end 27 and being concentric with rod 17. A sear 3 is pivotally mounted within body 28 by a pin 20. The principal function of sear 3 is described more fully in our related application. A front torsion spring 5 mounted to pin 20 and around body 28 engages sear 3 and biases sear 3 upwardly. Sear 3 has a flat portion 39 that is of a length substantially the same as the axial length of travel of piston 2.

Rod 17 has a lock pin 12 extending transversely therethrough and beyond the outer surface of the rod 17 so that the lock pin 12 engages in at least one groove (not shown) in the wall of frame 1. In this way the only movement of rod 17 relative to frame 1 is axial, and rotational movement about the longitudinal axis of rod 17 is prevented. Preferably, there are two diagonally opposite grooves. Extending around rod 17 at its front end 27 is a compression spring 13 that, at its front end, pushes on connector 4, and at its rear end presses on frame 1 to bias rod 17 toward the front.

A lock screw 6 secures an annular piston seal 7 and piston washer 8 to disc 18. Piston seal 7 has a central opening 21 of a diameter larger than the diameter of the shank of washer 8 so that the piston washer 8 can move radially relative to the shank to compensate for any axial misalignment of the disc 18 within a firing rate cylinder 9. Figure 3 shows lock screw 6 before it is fully tightened. Firing rate cylinder 9 has a cylinder wall 30 with a bore 31. Piston seal 7 provides a substantially air tight seal with bore 31 and thus prevents air from passing between seal 7 and bore 31 and thus escaping through the open end 22 of the firing rate cylinder 9. Due to the action of spring 13, seal 7 is biased towards the open end 22.

Firing rate cylinder 9 also has an end wall 25 that includes a rearwardly extending extension 32. An air passage 24 allows air to pass from the interior of firing rate cylinder 9 into a hollow interior 33 of extension 32.

The end block 11 has a number (five as illustrated) of holes 23 for attachment of the rear sight (not shown). It also has a central opening in which extension 32 locates in a substantially air tight manner. Extension 32 has with a first transverse opening 52 that aligns with a corresponding first transverse opening 34 in side wall 51 of central opening 35. Opening 35 is operatively connected to an internal passage 40 that, in turn, is open to the atmosphere at its bottom 41. In this way air can pass from cylinder 9, through passage 24 to hollow interior 33, through openings 52, 34, interior air passage 40, and out to atmosphere through bottom 41.

End block 11 has a control passage 42 that is operatively connected to hollow interior 33 by a second transverse opening 35 in side wall 51. Located in control passage 42 in a generally air tight manner is an air bleed rate cylinder 43. Cylinder 43 is able to rotate relative to end block 11 about the longitudinal axis of cylinder 43. At its axial outer end the cylinder 43 has a selection lever 10 securely attached thereto.

Cylinder 43 is of a maximum axial extent such that it can enter hollow interior 33 and completely cover the opening 52 of passage 24 into interior 33. In the form shown,

cylinder 43 may have an interior 44 that is hollow, or solid, as desired. Its inner end 45 is at an angle to the longitudinal axis of between 30° and 60°, preferably 45°. In this way the cylinder 43 has a different wall length, from a largest wall portion 46 to a shortest wall portion 47. When longest wall portion 46 is over opening 53 of passage 24 the opening 53 is completely blocked. Therefore, no air can flow from cylinder 9 into hollow interior 33 and then to atmosphere. This equates to a single shot (a semi-automatic) setting. However, no air seal will be perfect so there will be a slow leakage of air. If the operator maintains their finger on the trigger for an extended period, the loss of air may be such as to cause a further firing. The time taken for this to happen will depend the quality of the air seal, and the rate of air leakage.

When shortest wall portion 47 is over opening 53 of air passage 24, air can freely pass through passage 24, into hollow interior 33, out through openings 52, 34, through interior passage 40, and to atmosphere through bottom 41. This corresponds to a fully automatic setting of the weapon. By rotating cylinder 43 between the two extremes 46, 47 an operator can control the flow of air, and therefore the firing rate. There may be one or more settings between the two extremes 46, 47.

As an alternative rather than angled end 45, there may be a variable opening or openings in cylinder 43 to align with passage 24, air passing through hollow interior 44.

Cylinder 43 may have a groove 48 therein to align with opening 49. Groove 48 may be “notched” to provide a “click” feel to an operator upon the rotation of cylinder 43. An appropriate spring-loaded mechanism may be located in opening 49. This may also assist in retaining cylinder 43 in position in passage 33. A further opening 50 may be provided to allow for lubricant to pass therethrough to assist the ease of rotation of cylinder 43.

In this way the rate of air flow through the passage 24 is controlled – by the selection of the rotational position of cylinder 43 to have the opening 53 of passage 24 of the appropriate size.

Upon an operator selecting the appropriate position for cylinder 43, and upon the weapon being fired, piston 2 is moved axially rearwardly as a result of the firing process and during the initial stages of the firing process. In consequence, disc 18 moves rearwardly in cylinder 9. Due to seal 7, air in cylinder 9 is forced through air passage 24, through interior 33, and then to atmosphere. By selecting the required rotational position of cylinder 43, the bleed rate of air through the passage 24 can be determined. This therefore determines the rate of travel of piston 2 in cylinder 9. When the seal 7 moves axially forwardly during the next stage of the firing process, air can reenter the cylinder 9 in the reverse order. The spring 13 is of sufficient strength to return the piston 2 to its default position and to overcome the air resistance in entering the cylinder 9.

A trigger lever 14 is provided to operate the firing mechanism (not shown) and is biased to the rest position by a rear torsion spring 15. At its upper end the trigger lever has a projection 36 that engages in a step 37 in rod 17 when in its rest or neutral position, as shown.

Upon the weapon's trigger being operated, trigger lever pivots about spindle 38 so that projection 36 disengages from step 37. At this time the compression spring 13 is at its neutral or rest position. The recoil spring from our related application will act on compression spring 13 to force piston 2 towards the rear so that rod 17 and seal 7 will approach end wall 25. This compresses the air inside cylinder 9 and forces it out through air passage 24 and hollow interior 33. As is stated above, the rate of movement of piston 2 is controlled by the size (cross-sectional area) of the opening 53 of passage 24 due to the rotational position of cylinder 43 selected by the operator.

As a result of the rearward movement of rod 17, connector 4 is pulled rearwardly. Sear 3 therefore moves rearwardly until a cam pin 16 attached to the receiver body (not shown) forces sear 3 downwardly to disengage from a recoil inertia rack (not shown, but shown and described in our related application). As the piston 2 and the recoil inertia rack are linked due to the operation of the sear 3, as long as the trigger is activated, the firing will continue at a rate determined by the rotational position of cylinder 43 selected. Upon the

trigger being released, the projection 36 will engage step 37 to prevent further movement of piston 2, and thus firing will cease. The flat portion 39 is substantially the same length as the length of travel of piston 2 so that as piston 2 reaches its innermost position in cylinder 5, cam pin 6 will force sear 3 downwardly. This means the control over firing rate is on the firing stroke. Therefore, the rate of movement of flat 39 under pin 16 is that which is controlled.

Whilst there has been described in the foregoing description a preferred embodiment of the present invention it will be understood by those skilled in the technology that many variations or modifications in details of design or construction may be made without departing from the present invention.

The present invention extends to all features disclosed either individually, or in all possible permutations and combinations.

The Claims:

- 1 A firing rate regulating mechanism including a firing rate cylinder having at least one wall and a cylinder bore, a piston mounted for axial movement relative to the firing rate cylinder and substantially sealingly engaging the cylinder bore, the piston moving from a first position to a second position as a result of a firing, and moving from the second position to the first position to enable a further firing; the at least one wall having an air passage therethrough and being operatively connected to an air flow rate control means such that upon the piston moving axially from the first position to the second position it acts to force air in the firing rate cylinder through the air passage, the air flow rate control means being able to be adjusted to vary the air flow rate through the air passage and thus the rate of movement of the piston.
- 2 A firing rate regulating mechanism as claimed in claim 1, wherein the air flow rate control means includes an end block mounted to an end wall of the cylinder.
- 3 A firing rate regulating mechanism as claimed in claim 2, wherein the air flow rate control means includes an air bleed rate cylinder to vary an opening of the air passage.
- 4 A firing rate regulating mechanism as claimed in claim 3, wherein the air bleed rate cylinder has an inner end that is angled relative to a longitudinal axis of the air bleed rate cylinder.
- 5 A firing rate regulating mechanism as claimed in claim 4, wherein angle is in the range of from 30° to 60°.
- 6 A firing rate mechanism as claimed in claim 4 or claim 5, wherein the angle is 45°.

- 7 A firing rate regulating mechanism as claimed in any one of claims 1 to 6, wherein the piston has an elongate rod mounted for reciprocal movement within a frame bore through a frame, the elongate rod having a disc at a rear end thereof, the disc locating within the firing rate cylinder.
- 8 A firing rate regulating mechanism as claimed in claim 7, wherein the disc is eccentric relative to the elongate rod.
- 9 A firing rate regulating mechanism as claimed in claim 7 or claim 8, wherein a connector is attached to a forward end of the elongate rod, the connector having a generally U-shaped body and a stem connected to the elongate rod; there being a sear pivotally mounted within the body and having a biasing means to bias the sear upwardly, the sear having a flat portion for sliding under a cam pin, the flat portion having a length substantially the same as the movement of the piston.
- 10 A firing rate regulating mechanism as claimed in any one of claims 7 to 9, wherein the elongate rod has a lock pin extending transversely therethrough and beyond an outer surface of the elongate rod, the lock pin engaging in at least one groove in the frame bore to prevent rotational movement of the elongate rod about its longitudinal axis.
- 11 A firing rate regulating mechanism as claimed in any one of claims 7 to 10, wherein there is provided a rod biasing means to forwardly bias the elongate rod.
- 12 A firing rate regulating mechanism as claimed in claim 11, wherein the rod biasing means is a compression spring mounted around the elongate rod at the forward end thereof; the compression spring at its forward end contacting the connector, and at its rear end contacting the frame to bias the elongate rod forwardly.

- 13 A firing rate regulating mechanism as claimed in any one of claims 7 to 12, wherein a trigger lever is pivotally mounted to the frame, the trigger lever having a projection at its upper end for engaging in a step in the elongate rod.
- 14 A firing rate regulating mechanism as claimed in any one of claims 7 to 13, wherein the disc includes an annular piston seal and a piston washer attached to the disc, the piston seal having a central opening of a diameter sufficient to enable the piston seal to move radially relative to the disc to enable the piston seal to compensate for any axial misalignment of the disc within the firing rate cylinder.
- 15 A firing rate regulating mechanism as claimed in any one of claims 3 to 6, or any one of claims 7 to 14 when appended to claim 3, wherein the firing rate cylinder has an end wall including a rearwardly extending extension, the air passage allowing air to pass from an interior of the firing rate cylinder to a hollow interior of the rearwardly extending extension.
- 16 A firing rate regulating mechanism as claimed in claim 15, wherein the end block is mounted to the firing rate cylinder such that the rearwardly extending extension locates in a central opening of the end block, the central opening having a side wall, the side wall and the rearwardly extending extension each having aligned first transverse openings, the aligned first transverse openings being operatively connected to an interior passage to enable air to pass to atmosphere.
- 17 A firing rate regulating mechanism as claimed in claim 15 or claim 16, wherein the end block has a control passage in which is located the air bleed rate cylinder, the control passage being operatively connected to the hollow interior by a second transverse opening in each of the side wall and the rearwardly extending extension.

- 18 A firing rate regulating mechanism as claimed in any one of claims 15 to 17, wherein the air passage opening is able to be selectively closed, fully opened, or partially closed, by rotation of the air bleed rate cylinder.
- 19 A firing rate regulating mechanism as claimed in claim 18, wherein the closed opening corresponds to single shot firing, and the fully open opening corresponds to fully automatic firing.
- 20 A firing rate regulating mechanism as claimed in any one of claims 1 to 19, wherein the firing rate regulation is during the firing stroke.