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KENZO IWASHITA
MECHANISM FOR REDUCING THE RATE OF FIRE IN
AUTOMATIC FIRING ARMS

3,236,154

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4 Sheets-Sheet 1

FIG. 1

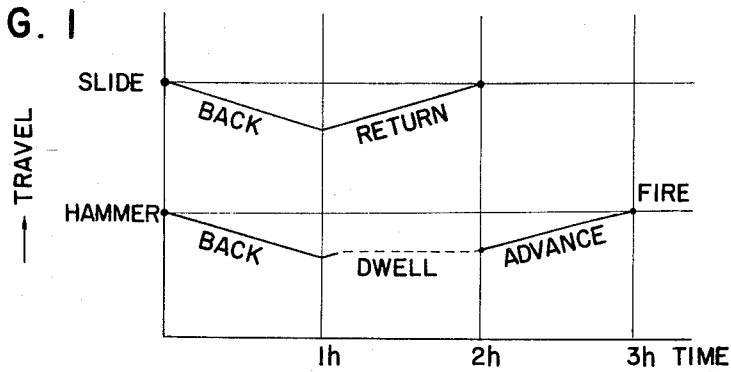


FIG. 2

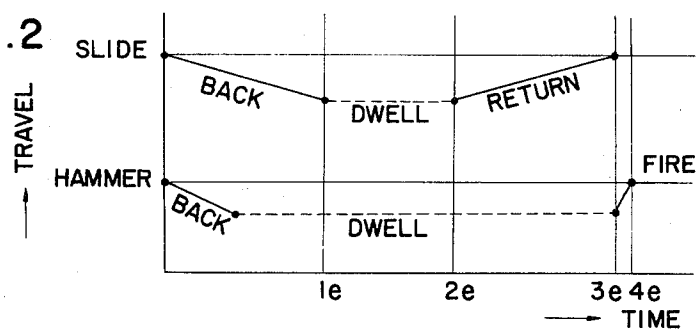
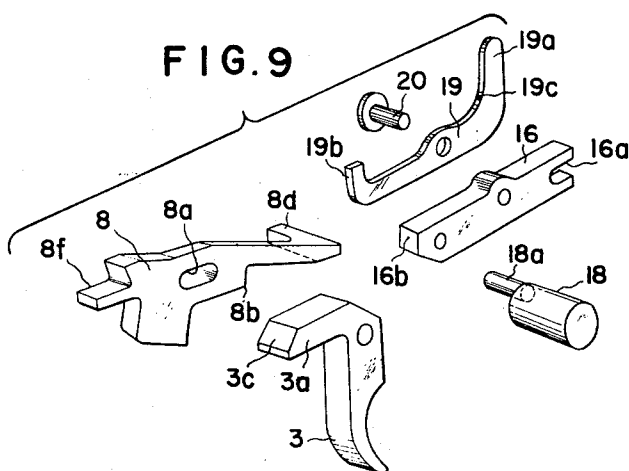


FIG. 9



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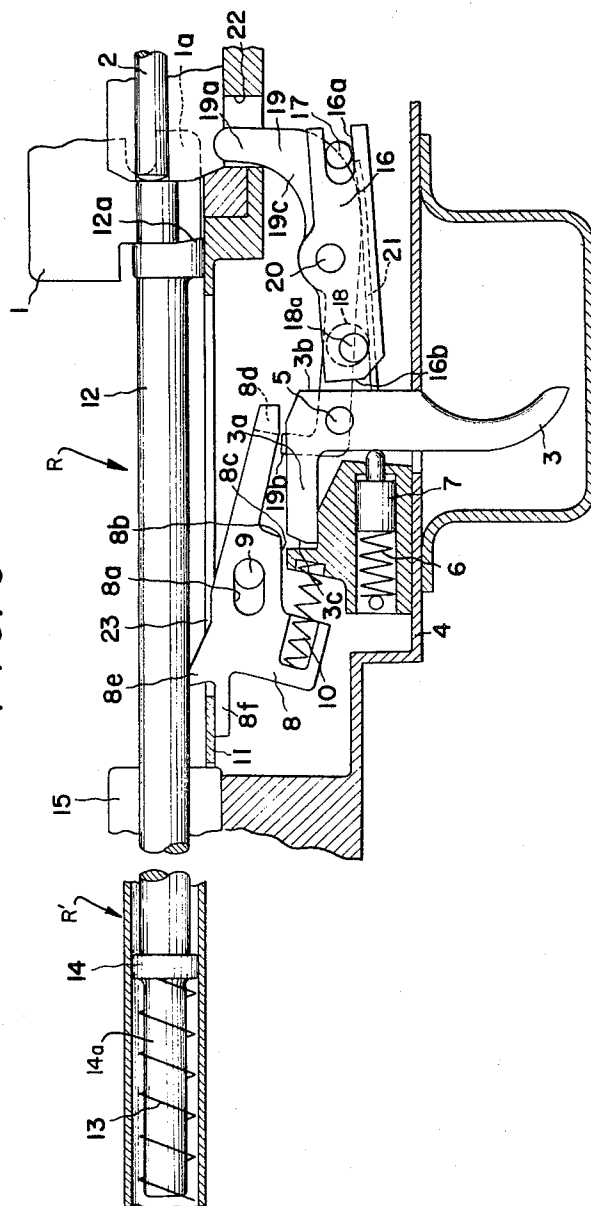
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FIG. 3



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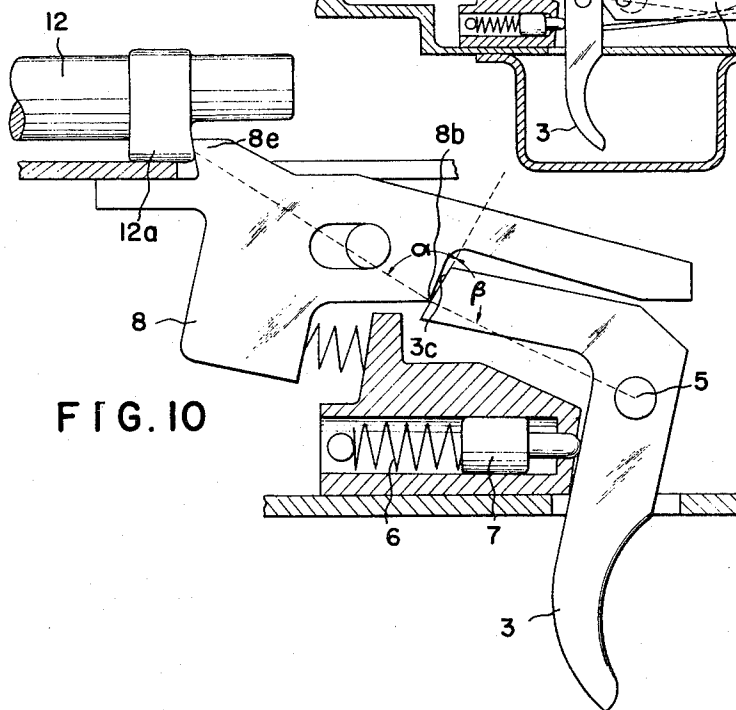
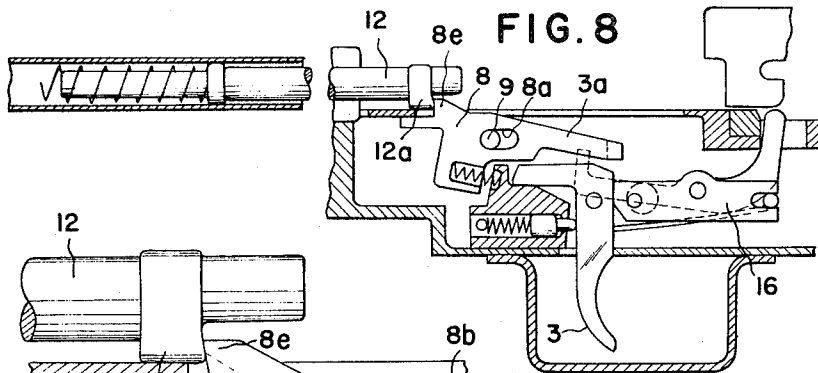
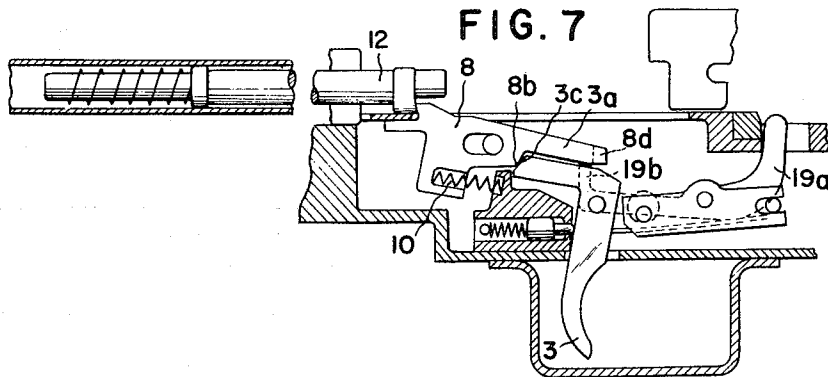
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MECHANISM FOR REDUCING THE RATE OF FIRE IN AUTOMATIC FIRING ARMS

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3 Claims. (Cl. 89—128)

The present invention relates to mechanism for reducing the rate of fire in automatic rifles and more particularly to an improved arrangement of trigger, sear and hammer components, as well as additional mechanism for adjustably selecting one of fully automatic firing, short or single firing and no firing operations.

In automatic arms, it is most important to provide them with excellent automatic firing accuracy so that these arms are required to be equipped with mechanisms which can provide such a feature. This is necessary for arms constructed for firing both single shot and a number of shots in rapid succession as well as for those constructed for only sustained fire, but the following factors, are considered to be important in designing arms which have excellent firing accuracy as well as other desirable characteristics.

Firstly, it is necessary to prolong insofar as possible the interval between the first shot and the second shot. Thus, for example, in a conventional fully automatic rifle having a normal rate of fire of from 700 to 800 shots or rounds per minute, it is desirable to reduce this rate as low as possible, for example to 400 to 500 shots per minute. If this reduction is possible, better firing accuracy can be attained.

Secondly, the mechanism should be so constructed that the motions of a reciprocating member, such as a slide, and a firing mechanism, such as a hammer, etc., may be well balanced and smooth and that these components can reciprocate in as straight a line as possible. With this construction, any moment that is caused by the mechanism itself and which tends to deflect the barrel axis can be eliminated, thereby resulting in excellent firing accuracy.

Thirdly, it is necessary to utilize a mechanism which can reduce the recoil energy of the weapon itself. This feature can be satisfactorily attained by increasing the weight of the rifle or by applying a muzzle brake.

It is one of the objects of this invention to provide a novel mechanism which can fulfil the above mentioned first and second features by a single mechanism.

A further object of this invention is to provide a novel mechanism which is quite simple, but can operate accurately without any trouble, reduce the rate of fire, and eliminate any moment that tends to disturb the maintenance of the aim.

The above and other objects and advantages of the present invention have been attained by a mechanism for reducing the rate of fire in automatic rifles of the type comprising a firing pin, a hammer, a chamber for the hammer, a hammer spring associated therewith for actuating the hammer to strike the firing pin, a slide, a recoil spring for said slide, said slide together with said hammer being guided in the hammer chamber for advance movement in a straight line towards the firing pin, means for retracting the hammer together with the slide

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until a dead point is reached, a receiver in which said hammer, slide, firing pin and recoil spring are arranged, a receiver tail containing the hammer spring, a hammer stop and being capable of having inserted therethrough substantially all of said hammer when the same is retracted, a sear adapted to lock the hammer in the retracted position, a trigger for triggering the hammer at said retracted position, a sear lock mounted for pivotal movement, a front projection on the sear lock adapted to be displaced downwardly at the termination of the return of said slide, a rear projection on said sear lock adapted to displace upwardly the forward end of said sear when the front projection is displaced downwardly thereby releasing the hammer, a sear lock spring urging said sear lock to normally displace said front projection upwardly, a connector pivoted to the sear lock at the pivotal mounting for the sear lock for adapting the fire arm to any state of continuous shot, single shot and safety, means defining a trigger chamber in which chamber is enclosed said trigger, sear lock, sear lock spring and connector, the arrangement being such that when the hammer retracts together with the slide by firing, the recoil spring returns the slide upon the same reaching its rear end with the hammer being locked by the sear and the sear lock actuated by the slide when the slide reaches its forward breech locking location for releasing the locking of the hammer whereby the hammer is urged toward the firing pin by the force of the hammer spring to strike the firing pin, the locking end of the sear being positioned at the rear portion of the receiver so as to make a substantial portion of the hammer retract into the receiver tail thereby lengthening the advancing distance of the hammer between the releasing position of the hammer from the sear and the striking position and the weight of the hammer being such as to decrease the advance velocity of the hammer between the position where the hammer is released from the sear and the position where the hammer strikes the firing pin.

The characteristic features of the present invention will become apparent from the following description taken in connection with the accompanying drawings, in which drawings like members are designated by like reference characters, and in which:

FIG. 1 shows an operation diagram of a mechanism embodying this invention;

FIG. 2 shows an operation diagram of a mechanism employed in the conventional weapon for reducing the rate of firing thereof;

FIG. 3 is a view in longitudinal section, partly broken away, illustrating the arrangement of all members of a mechanism constructed according to this invention;

FIGS. 4 and 5 are sectional views respectively showing relative positions of the respective members for automatic firing operations with FIG. 4 showing the state of readiness before the trigger is actuated by the shooter, and FIG. 5 the state wherein the trigger has been actuated;

FIGS. 6 and 7 are sectional views respectively showing the relative positions of the respective members for single shot firing operation with FIG. 6 showing the state of readiness, and FIG. 7 the state wherein the trigger has been actuated;

FIG. 8 is a similar view illustrating the safety condition of the mechanism of FIG. 3;

FIG. 9 is an exploded view of a trigger and its associated members of the mechanism of FIG. 3; and

FIG. 10 is a side view partly in elevation and partly in cross section illustrating the mutual relation of a trigger and a sear when they are engaged in the mechanism of FIG. 3.

In order to indicate fully the features of this invention, it seems necessary to describe them in comparison with those of the conventional mechanism by referring to the operation diagrams illustrated in FIGS. 1 and 2 of the accompanying drawing.

Referring now FIG. 2, in the conventional mechanism a slide is pushed backwardly by gas pressure or other motive force after one shot has been fired. Near the end of the backward stroke, the slide strikes the head of an actuator to cause it to retract while compressing a spring positioned behind the actuator until it stops at a balance point. Thereafter, the spring acts to push the actuator in the forward direction.

On the other hand, the slide begins its forward movement from the stroke end thereof under the action of a recoil spring, but it is locked by a slide lock at the initial stage of its forward movement. However, as the actuator advances to release the slide lock at the end of its forward stroke the slide again begins to advance forwardly to charge the succeeding cartridge into the firing chamber just before the end of its stroke, thus completing the breech lock.

It will be understood by those skilled in the art that the periods of the above described forward and rearward motions of the actuator have the effect of prolonging the interval between successive shots. In the mechanism of the type described above, a hammer is generally pivotally mounted in a trigger housing so that the hammer will be pushed back at its head by the slide at the initial stage of the retracting stroke thereof to be rotated around a pivot pin while moving backwardly until it is locked by a sear. As the slide advances, the hammer is released from the sear immediately after completion of the breech locking operation and then advances over a relatively short distance while rotating under the action of a hammer spring until it strikes the rear end of a firing pin to effect the next firing.

In contrast, as can be clearly noted from FIG. 1, with the mechanism of this invention, as soon as the slide reaches the dead point of its backward movement the slide is returned to the original position by the recoil spring thus completing the charging of the next cartridge.

The hammer which is pushed back by this slide to move linearly at the same speed as the slide is held by a sear near the dead point of its backward stroke, thus being prevented from returning. When the forward movement of the slide caused by the recoil spring and the breech locking operation are completed, the action of the sear is interrupted, whereby the hammer becomes free to move. Thus, the hammer is advanced from the position 2*h* to the position 3*h* (FIG. 1) along a relatively long straight distance until, finally, the position 3*h* is reached, at which point the hammer strikes a firing pin, thus resulting in the next firing. Thus, it will be obvious that, with this construction, increase in the firing interval should be obtained by the interval of travel 2*h*–3*h*. This is a distinct difference in comparison with the operation provided by the conventional mechanism, described in connection with FIG. 2.

A further outstanding feature of the mechanism of this invention is that the motion of the hammer is rectilinear. This means that a mechanism incorporating the first feature involves the second feature also. It will be clear that the construction in which the hammer is adapted to strike a firing pin during its motion along a straight line can greatly minimize any moment that may cause disturbance of the aim of the weapon when compared with the conventional construction wherein the hammer is rotated to hit the firing pin.

In various weapons, a more important objective is to minimize any tendency for functional failures. In the

case as described in connection with FIG. 2, although the extent of the rearward movement of the actuator is determined by the velocity of the slide at the time when it strikes the actuator, the rearward strokes of the slide are not always the same in the practical firing operation. Thus, the velocity of the slide at the time when it strikes the actuator varies substantially. Accordingly, the reciprocating time of the actuator and the force imparted to the slide lock by the actuator also vary substantially, thereby causing irregularities in the firing intervals. In some cases the slide lock fails to release the slide.

In accordance with this invention, since the forward movement of the slide causes the hammer to move freely in the forward direction, there is no possibility of functional failure as described hereinbefore. Moreover, as the time necessary for the hammer to advance is constant due to constant stroke of the hammer and constant force of the hammer spring, the firing intervals are very regular.

Another outstanding feature of the mechanism constructed according to the principle of this invention is that the respective members thereof are completely free from any disarrangement even when the rifle is subjected to an abnormal shock. In conventional mechanism, however, there are frequent cases in which the safety lock is caused by such shock to become ineffective even when it is originally set to operate. According to this invention such a defect is obviated by designing the sear so as to minimize the tendency to affect the locking function thereof or to rotate it about the axis of its pivot pin even when an impact from the outside is applied to the weapon in any direction and by interlocking the hammer and the sear in a hook fashion.

In addition to providing such a reliable safety mechanism, it is a further feature of this invention to provide a novel single shot mechanism.

In order to provide this single shot feature the mechanism is constructed so that actuation of the trigger by finger will cause firing of the first cartridge, and immediately thereafter the slide will retract and then advance to charge the next cartridge into the firing chamber. Even if the shooter continues to hold the trigger, subsequent firing is prevented, and when the shooter releases the trigger it is permitted to return to its initial position, so that only when the shooter actuates the trigger again, the next shot is fired.

In the mechanism of this invention only two members, namely, trigger and a sear, are utilized for this purpose, and the above mentioned objects can be attained by using a special contact position between the sear and the trigger.

Referring now to FIG. 3 which illustrates one embodiment of this invention, there is shown a reciprocating mass 1 including a slide and a bolt (not shown) adapted to charge and remove a cartridge, not shown, in the manner well known in the art. A firing pin 2 is arranged in a conventional manner. Within a trigger housing 4, a trigger 3 is pivotally mounted by a pivot pin 5, said trigger being biased in the counterclockwise direction, as viewed in the drawing, by a trigger spring 6 acting thereupon through a trigger pusher 7. Also, a sear 8 is mounted within the housing 4 by means of an elongated slot 8*a* and a pin 9 passing therethrough. The sear 8 is biased toward the left upper side by a sear spring 10 disposed below the pin 9, so that the rear extension 8*f* of the sear 8 will be rotated in the clockwise direction until it is engaged by the lower surface 11 of the receiver R.

A hammer 12 is constructed so that it will retract together with the slide 1 but will advance independently of the forward movement of the slide. In the receiver tail R', between the hammer 12 and a hammer spring 13 is interposed a hammer spring stop 14 provided with a shaft 14*a* about which the spring 13 is wound. The stop and shaft are inserted in the receiver tail R' so as to slide therethrough. A hook shaped projection 12*a* is formed on the fore end of the hammer 12.

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of the sear and the inclined surface 3c of the trigger 3, and the angle β between a line passing through the latter point of contact and through the axis of the pin 5 which supports the trigger and the inclined surface 3c so that these angles satisfy the following equations,

$$\begin{aligned} 90^\circ &\leq \alpha \leq 90^\circ + \text{angle of friction} \\ 90^\circ &\leq \beta + \phi \leq 90^\circ + \text{angle of friction} \end{aligned}$$

where ϕ represents the angle of rotation of the trigger around the pin 5 when actuated by the shooter. By so selecting these angles the shock imparted to the trigger 3 through the rear end of the sear can be greatly reduced, so that only a very small impact is transmitted to the finger of the shooter while the sear 8 is maintained in the automatic firing position. It was found that best results can be obtained by making

$$\begin{aligned} \alpha &= 93^\circ \\ \beta &= 88^\circ \\ \phi &= 7^\circ \end{aligned}$$

Finally, it is necessary to maintain the safety condition even when the mechanism is subjected to an unexpected shock from the outside, for example, hard knocking. Of course, such a shock will impart moments in abnormal directions to various members constituting the mechanism, and it is the best approach to maintain the safety condition to decrease to a minimum this effect caused by said shock.

According to this invention the slot 8a is so machined as to position the pin 9 substantially at the center of gravity of the sear 8 when it is displaced to the right under the bias of the hammer spring 13. By this construction the sear 8 is positively prevented from rotating about the pin 9 by an impact imparted thereto by unexpected strong outside shock. Even the slightest tendency for such a rotation can be precluded by providing slightly inclined engaging surfaces between the projection 12a on the hammer 12 and the projection 8e of the sear as best shown in FIG. 10. These inclined engaging surfaces can positively prevent not only unexpected firing in the case of the trigger being slightly pulled inadvertently, but also accidental firing caused by impact due to dropping of the rifle and other causes.

In addition to the various features described hereinabove, it can be easily observed from the drawing that the stroke of the hammer 12 is very long and is rectilinear, which is an important factor in reducing the firing rate, because a longer stroke requires a longer time for traverse. Moreover, with reference to the hammering mass, the effective hammering mass is the sum of the mass of the hammer 12, that of the hammer spring stop 14 including that of shaft 14a since the hammer stop and shaft advance as a unitary component in the firing operation. Furthermore, it is possible to design the dimensions of the hammer spring 13 and its biasing force with ample surplus margin, which insures more reliable firing operations.

With a rotatably hinged hammer commonly utilized in conventional arms, the force acting upon it will act in a direction to create a torque tending to swing the weapon, whereas according to the construction according to this invention the hammer is arranged to travel along a straight line. For this reason, not only the firing accuracy of the automatic firing weapons can be remarkably improved, but also damage to the firing pin can also be effectively prevented.

The various outstanding features of this invention described hereinabove are contributed by the fact that the mechanism is constituted by a very small number of component members, that the respective members are disposed in ample spaces to give them sufficient rigidity, that the striking function of the hammer is made positive by the travel hereof along a straight line, that the interval of firing is prolonged due to a relatively long hammer, and that the respective members are mounted in well-balanced condition to be free of adverse effect due to any abnormal

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shock from the outside. Thus, this invention provides a novel mechanism of high utility without the possibility of any trouble, which mechanism is also capable of reducing the rate of fire and greatly improving the firing accuracy.

Although a specific embodiment has been disclosed to illustrate the invention, it will be evident that various modifications and variations can be made within the scope of this invention. It, therefore, is to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A mechanism for reducing the rate of fire in automatic fire arms, particularly automatic rifles of the type comprising a firing pin, a hammer, a chamber for the hammer, a hammer spring associated therewith for actuating the hammer to strike the firing pin, a slide, a recoil spring for said slide, said slide together with said hammer being guided in the hammer chamber for advance movement in a straight line towards the firing pin, means for retracting the hammer together with the slide until a dead point is reached, a receiver in which said hammer, slide, firing pin and recoil spring are arranged, a receiver tail containing the hammer spring, a hammer stop and being capable of having inserted therethrough substantially all of said hammer when the same is retracted, a sear adapted to lock the hammer in the retracted position, a trigger for triggering the hammer at said retracted position, a sear lock mounted for pivotal movement, a front projection on the sear lock adapted to be displaced downwardly at the termination of the return of said slide, a rear projection on said sear lock adapted to displace upwardly the forward end of said sear when the front projection is displaced downwardly thereby releasing the hammer, a sear lock spring urging said sear lock to normally displace said front projection upwardly, a connector pivoted to the sear lock at the pivotal mounting for the sear lock for adapting the fire arm to any state of continuous shot, single shot and safety, means defining a trigger chamber in which chamber is enclosed said trigger, sear lock, sear lock spring and connector, the arrangement being such that when the hammer retracts together with the slide by firing, the recoil spring returns the slide upon the same reaching its rear end with the hammer being locked by the sear and the sear lock actuated by the slide when the slide reaches its forward breech locking location for releasing the locking of the hammer whereby the hammer is urged toward the firing pin by the force of the hammer spring to strike the firing pin, the locking end of the sear being positioned at the rear portion of the receiver so as to make a substantial portion of the hammer retract into the receiver tail thereby lengthening the advancing distance of the hammer between the releasing position of the hammer from the sear and the striking position and the weight of the hammer being such as to decrease the advance velocity of the hammer between the position where the hammer is released from the sear and the position where the hammer strikes the firing pin.

2. The mechanism as claimed in claim 1, in which the assemblage including the sear and trigger combined with the sear lock includes a sear lock pin constituting the pivotal mounting for the sear lock, said connector having at one end thereof an open slot, a fixed pin received in said open slot, said sear lock spring being defined by a leaf spring, and an eccentric pin carried by said connector for being positioned at any desired angle whereby adjusting of such latter pin adapts the fire arm for continuous firing, single shot firing and safety.

3. The mechanism as claimed in claim 1, in which the assemblage including the sear and trigger combined with the sear lock further includes a sear pin, a sear spring biasing the sear, a trigger pin pivotally supporting the trigger, a trigger pusher element operably associated with the trigger and a trigger spring, said trigger and sear having contacting portions so designed that during squeezing

For making possible automatic firing, a sear lock 19, having a projection 19a disposed to be pushed down by the returning motion of the slide 1, is connected, by a pin 20, to a connector 16 which in turn is supported in the trigger housing 4 by a pivot pin 18, a projection 19b on the end opposite to said projection 19a being normally urged in the counterclockwise direction by a leaf spring 21.

When this projection 19b and the fore end projection 8d of the sear 8 are in the same phase, the rotation of the sear lock 19 in the clockwise direction induces the rotation of the sear 8 in the counter-clockwise direction, which, of course, is induced by contact between the projection 19b against the projection 8d. When these projections are out of phase, or when the sear 8 is displaced to the right, as viewed in the drawing, along the elongated opening 8a such a transmission of motion does not occur. The sear 8 is formed to have a pointed edge 8b and a lower surface 8c, and the trigger 3 is provided with an inclined surface 3c, the purpose of which will be described later.

In FIG. 4, the hammer 12 is shown in its position when it is locked by the sear 8. This state of locking is quite stable, owing to a lock fashioned joint between the rear projection 8e of the sear 8 and the projection 12a on the hammer 12, which cannot be disengaged by any abnormal shock imparted from the outside.

When actuated by finger, the arm 3a of the trigger 3 engages the lower surface 8c of the sear 8 to push it upwardly, thereby to rotate the sear 8 in the counter-clockwise direction around the pivot pin 9 to release the hammer 12. Thus, the hammer 12 is advanced rapidly under the bias of the hammer spring 13 to strike the firing pin 2, thereby firing cartridge, not shown, at the end of its forward stroke.

Gas pressure produced as a result of firing causes the slide 1 and the hammer 12 to retract until the hammer 12 is locked by the sear 8, as shown in FIG. 5. It will be understood that the slide 1 is returned by a recoil spring, not shown. As the slide 1 depresses the projection 19a of the sear lock 19, the opposite projection 19b, which is now in the same phase as the projection 8d of the sear 8 as shown in FIG. 5, rotates the sear 8 in the counter-clockwise direction to release again the hammer 12, thus repeating the firing in the same manner as above described. At this stage of the firing operation, the pivot pin 9 of the sear 8 is at the righthand end of the slot 8a, but, upon release of the trigger 3, the edge 8b disengages from the inclined face 3c, whereby the hammer 12 pushes the sear 8 to the right until the pin 9 reaches the lefthand end of the slot 8a, thus bringing the projections 8d and 19b into an out-of-phase relation. As a result, even when the projection 19a is depressed by the slide 1, the projection 19b does not raise the projection 8d, thus assuring continuous locking of the hammer to prevent further firing operation.

Since the mechanism of this invention is constructed as described hereinabove, after the slide 1 and the hammer 12 have retracted to their dead points, only the hammer 12 is prevented from advancing forwardly at a point 1h, FIG. 1, whereas the slide 1 is permitted to advance to a point 2h. At this point 2h, where this advance is terminated, the sear 8 unlocks the hammer 12. It will be noted that a relatively long time interval is required to permit the hammer 12 to reach a point 3h in order to reduce the rate of fire.

As can be clearly observed from the accompanying drawings, a relatively large space is provided for the strokes of the hammer 12 which is constructed to reciprocate linearly along the longitudinal axis of the firearm. This contributes to providing a recoiling effect with almost no effect with respect to the center of gravity of the firearm, thus effectively improving the firing accuracy.

As shown in FIGS. 6 and 7, for single shot operation, the projection 19a of the sear lock 19 is kept in a position such that the projection is not affected in any way by

any movement of the slide 1, as can be clearly understood by comparing FIGS. 4 and 6. Means for providing this feature will be described hereinbelow by referring to FIG. 9.

More specifically, this means comprises a connector 16 having an open slot 16a at its one end for receiving a transversal pin 17 secured to the trigger housing 4. The opposite end of the connector 16 is held by an eccentric pin 18 forming an extension of a pin 18a journaled in the side walls of the trigger housing 4. Thus, by manipulating the pin 18, the connector 16 can be positioned at any desired angle. When the eccentric pin 18 is positioned in the extreme righthand position (FIGS. 4 and 5), the mechanism is set for the continuous automatic firing operation, whereas, when it is positioned in the extreme lefthand position (FIG. 8), the vertical end face 16b of the connector 16 abuts the front vertical surface of the trigger 3, thus causing it to become inoperative. In other words, such an abutment serves as a safety device.

In intermediate positions, that is, when the pin 18 is adjusted to position the connector 16 in a slightly inclined position with its lefthand end depressed downwardly as shown in FIGS. 6 and 7, the pin 20 is shifted to the left together with the sear lock 19. This brings the curved surface 19c on the left side of the projection 19a into contact with the left side wall of an opening 22 of the receiver. By suitably selecting the configuration of the surfaces of these engaging members, the projection 19a can be prevented from deeply entering into the opening 22. In other words, the projection 19a can be maintained out of contact with the slide 1. Concurrently therewith, the projections 19b and 8d are brought into out-of-phase relation so that they will not engage each other.

This renders completely inactive the sear lock 19 which operates for the automatic firing operation, and firing can be carried out only by the trigger 3. This is the condition for the single shot operation.

As shown in the drawing, a suitable buffer 15 is provided at the upper left side of the trigger housing 4 and as has been pointed out hereinabove, it will be understood that the slide 1 is returned to its righthand position by a conventional recoil spring, not shown.

Another feature of the mechanism embodying this invention is the capability of holding the sear 8 in a state for automatic firing operation without relying upon any additional mechanism, this feature being provided by suitably shaping the trigger 3 and the sear 8 so as to come into direct contact. More particularly, the sear 8 is biased to rotate clockwise around the pin 9 by a spring 10 while the hammer spring 13 urges the sear 8 to the right. Of course, the force of the hammer spring 13 is much greater than that of the spring 10. This means that unless a suitable means is used to prevent the sear from moving to the right, it is impossible to provide automatic firing operation. Accordingly, in this invention, it is necessary for designing the trigger 3 so that the sear is positively held against the strong hammer spring 13, the shooter is permitted to hold the trigger in its actuated position, and when released by the shooter, the trigger is positively returned to its released position under the action of the trigger spring 6 transmitted thereto through the trigger pusher 7. These requirements conflict with each other, so that, if the trigger is shaped to fully satisfy the former requirement the latter requirements cannot be fulfilled. On the contrary, if the trigger 3 is shaped to satisfy the latter requirement, there will be caused a dangerous condition wherein the sear 3 is displaced to the right, as shown in FIG. 3, even when the trigger 3 is maintained in its actuated state.

Accordingly, in order to simultaneously satisfy said conflicting requirements, this invention contemplates selecting the angle α (FIG. 10) between a line passing through the point of contact between the hook 8e on the sear 8 and the projection 12a of the hammer 12, and through the point of contact between the pointed edge 8b

of the trigger the sear is kept in continuous firing position with the trigger returning to idle position upon the release of the trigger.

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