April 9, 1963 R. M. KLINE ETAL 3,084,833

VALVE OPERATOR TENSION MECHANISM

Original Filed Oct. 6, 1955 3 Sheets-Sheet 1

FIG. 1.

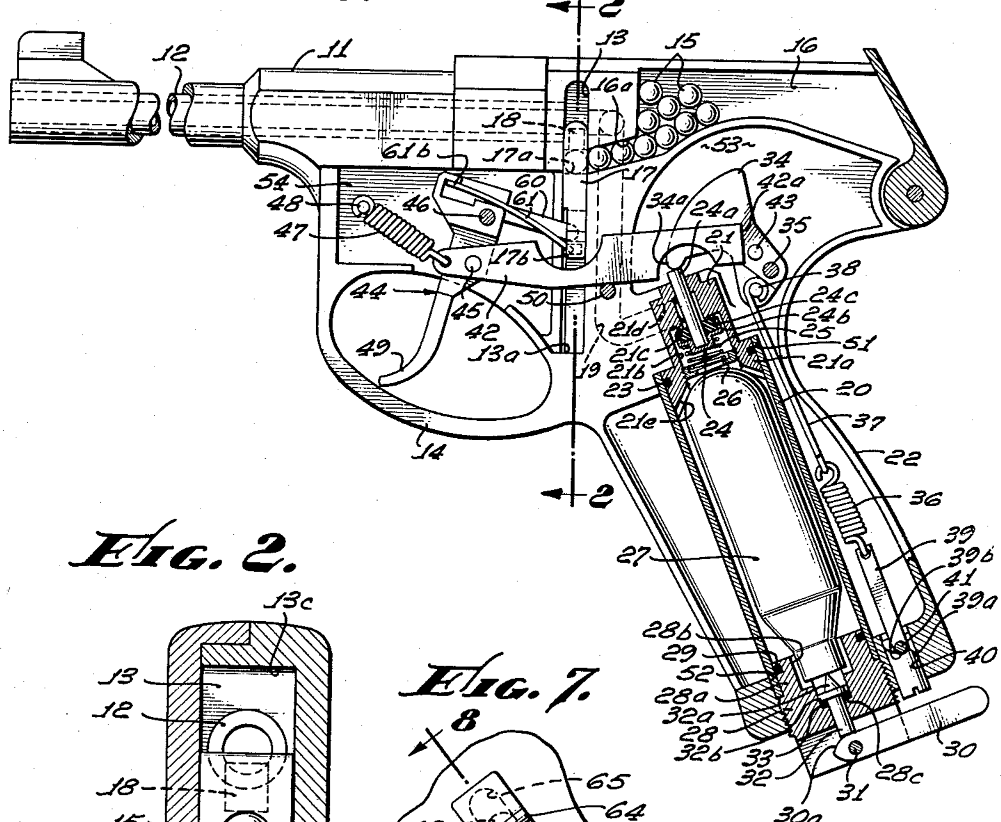


FIG. 2.

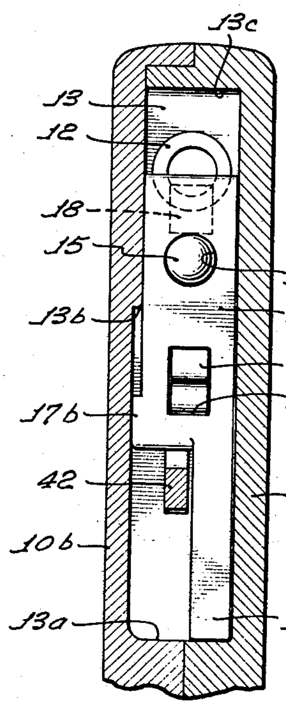


FIG. 7.

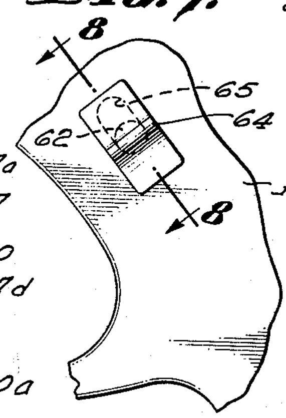
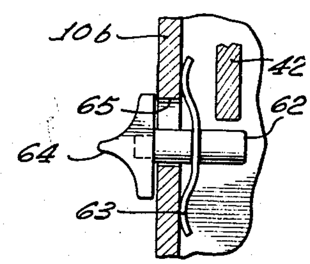


FIG. 8.



INVENTORS.
RICHARD M. KLINE
KENNETH R. PITCHER
BY
Flam and Flam
ATTORNEYS.

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FIG. 3.

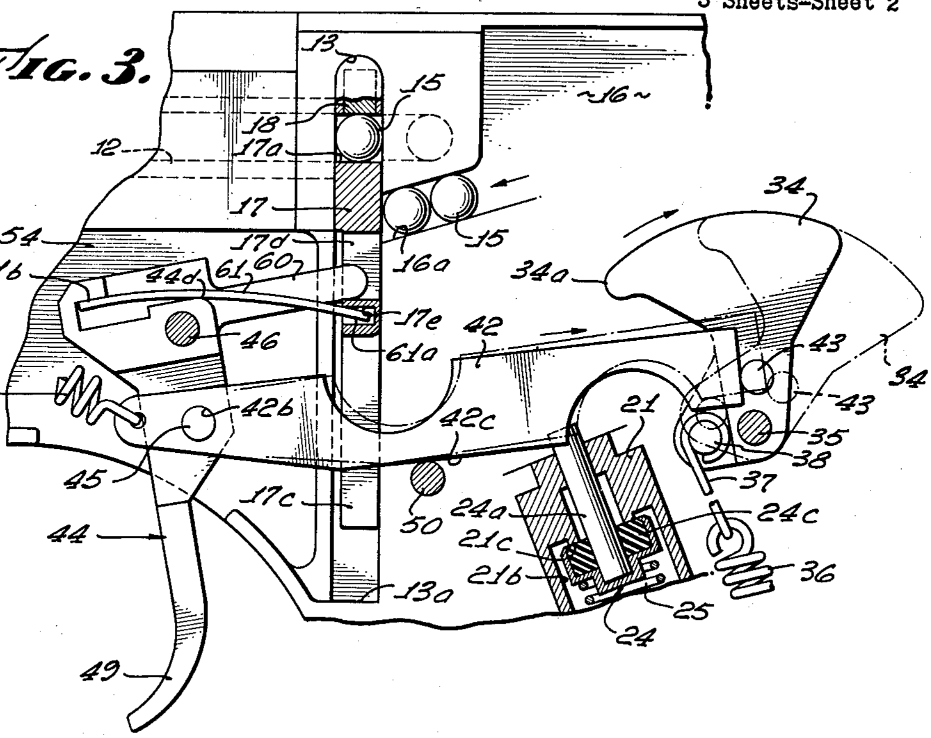
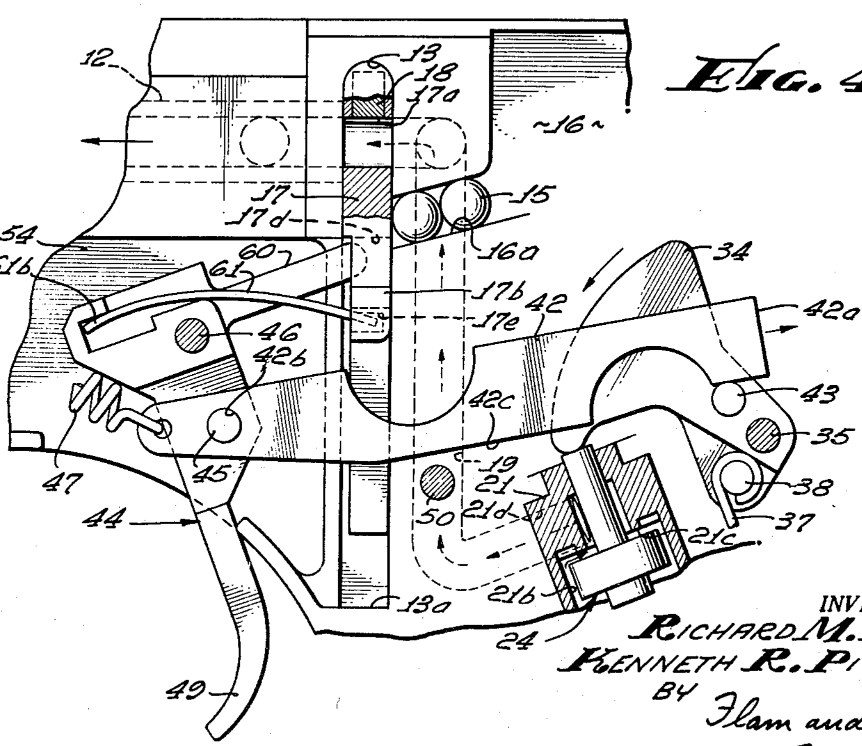


FIG. 4.



INVENTORS.
RICHARD M. KLINE
KENNETH R. PITCHER
BY Flam and Flam
ATTORNEYS.

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FIG. 5.

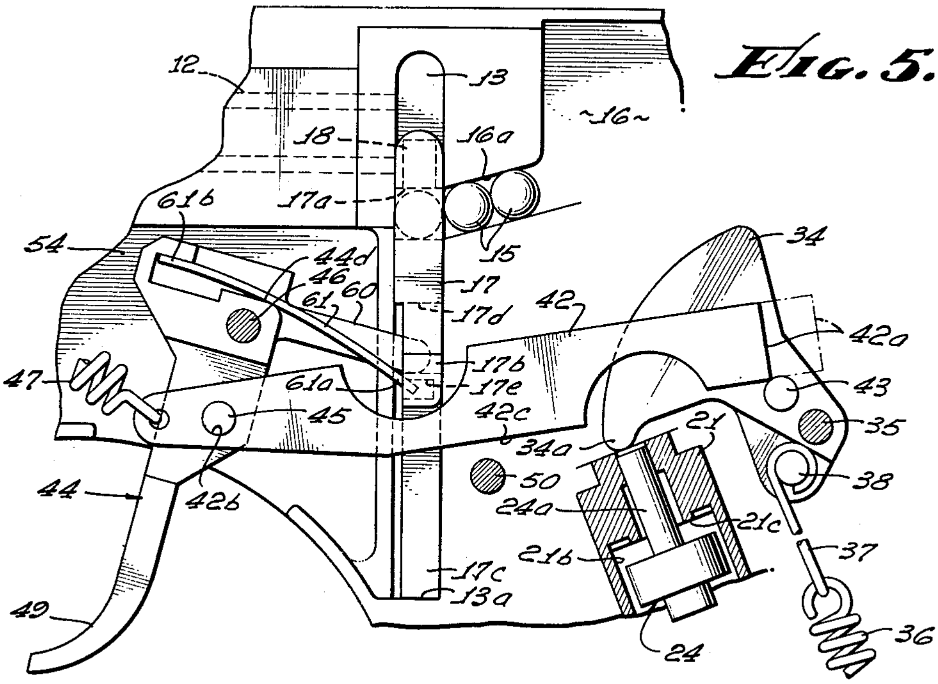
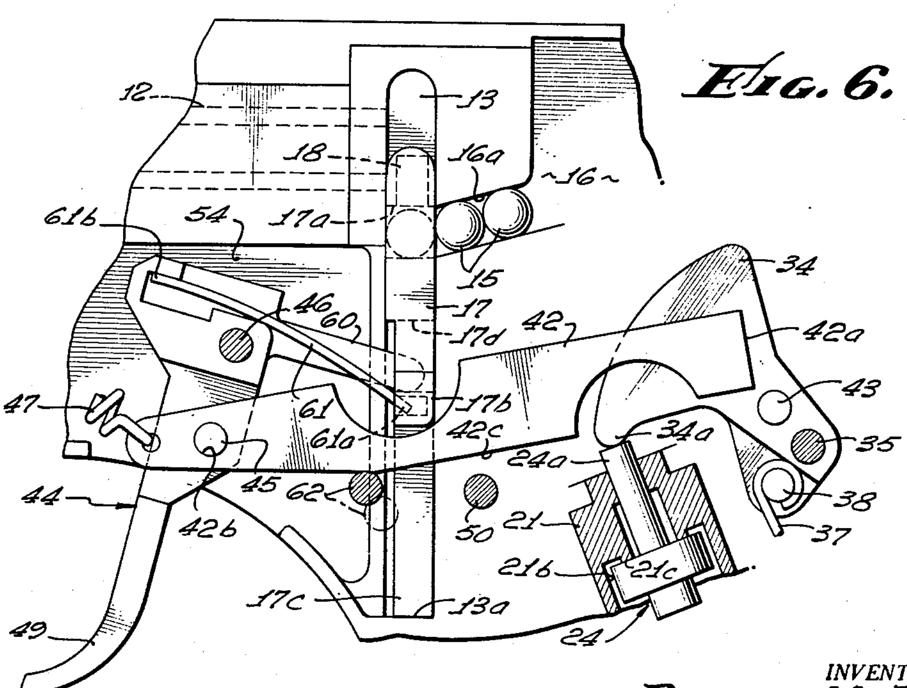


FIG. 6.



INVENTORS.
RICHARD M. KLINE
KENNETH R. PITCHER
BY
Flam and Flam
ATTORNEYS

3,084,833

VALVE OPERATOR TENSION MECHANISM

Richard M. Kline, 9413 Sawyer St., Los Angeles, Calif., and Kenneth R. Pitcher, 5001 Odessa, Encino, Calif.

Application June 27, 1958, Ser. No. 744,968, which is a continuation of application Ser. No. 538,858, Oct. 6, 1955. Divided and this application July 14, 1961, Ser. No. 124,125
2 Claims. (Cl. 222—509)

This invention relates to small arms, and particularly to pistols and rifles in which a valve is momentarily opened by an impact hammer for passing a predetermined quantity of pressurized gas from a cartridge to the barrel.

One of the objects of this invention is to provide a device of this character in which the operating parts of the mechanism are conveniently and compactly arranged, and in which the number of operating parts is quite small. Accordingly, an air pistol or rifle as compact and as attractive as a comparably sized firearm is provided.

Another object of this invention is to provide a novel and simple arrangement of parts that, without locking any parts, immobilizes the hammer when the charge of compressed fluid is exhausted or when a simple safety device is operable. This is made possible by a cocking and tripping link for the hammer, the hammer and link having normally engageable parts that are moved out of operative alignment either when the supply of compressed fluid is exhausted or when a safety lug moves the link away from its biased operative position.

Another object of this invention is to provide novel automatic mechanism for feeding missiles from the magazine to the barrel and for holding the missile in place when the hammer is tripped.

Another object of this invention is to provide feeding mechanism that picks up a missile from the magazine only if the preceding missile has been propelled or dislodged.

Still another object of this invention is to provide simple mechanism for ensuring against damaging any of the parts of the device if, for any reason, the missiles are not properly fed to the barrel.

Still another object of this invention is to ensure accurate positioning of the missile in the barrel at the time the hammer is tripped, all without requiring precise manufacturing tolerances.

Still another object of this invention is to provide a mechanism of this character in which the missiles are held in place without requiring any gaskets or other parts subject to wear or deterioration.

These objects are made possible by a novel slider structure that incorporates magnetic means for holding the missile in place until dislodged, either by the force of the compressed fluid or by a sharp tap. A novel resilient structure ensures that the missile is properly in place when the hammer is tripped without requiring precise manufacturing tolerances. The resilient structure also stores energy that would otherwise damage the parts in the event that missiles are not properly fed.

Still another object of this invention is to provide a device of this character in which the force of propulsion of the missile can be easily and accurately adjusted by discrete steps, whereby uniformly predictable operation can be achieved for any of the adjusted position.

This application is a division of our prior application Serial No. 744,968, filed June 27, 1958, and entitled Compressed Fluid-Operated Small Arms Weapon, which was a continuation of our abandoned prior application Serial No. 538,858, filed October 6, 1955, and entitled Compressed Fluid-Operated Small Arms Weapon.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention, but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a plan view of one of the complementary halves of a pistol body, some of the parts being shown in section;

FIG. 2 is an enlarged fragmentary sectional view, taken along the plane indicated by the line 2—2 of FIG. 1;

FIGS. 3 and 4 are diagrammatic enlarged fragmentary views, some of the parts being shown in section, showing the operation of the actuating mechanism in successive positions, FIG. 3 illustrating the hammer being cocked, the phantom-line position illustrating the critical position; FIG. 4 illustrates the tripped position of the hammer;

FIG. 5 is an enlarged fragmentary view showing the position of the actuating mechanism and hammer when the supply of compressed gases is exhausted;

FIG. 6 is a view similar to FIG. 5, showing the position of the actuating mechanism and hammer when a safety lug is in operative position;

FIG. 7 is an enlarged fragmentary view of that portion of the other complementary half of the gun body mounting the safety lug; and

FIG. 8 is a sectional view, taken along the plane indicated by the line 8—8 of FIG. 7.

The small arm illustrated in the drawings, in this instance, is a pistol. The pistol body comprises a main body part **10***a*, providing cavities for the elements of the apparatus, and a cover plate **10***b* (FIG. 2), cooperating with the main body part to enclose the elements.

The body **10***a* has a barrel **11** accommodating a barrel insert or liner **12**.

Missiles in the form of round pellets or shots **15**, normally contained in a magazine **16** at the lower end of the body **10**, are passed to the rear end of the barrel bore through the upper portion of an elongate body cavity or recess **13**. A small passage **16***a*, of such size and shape as to permit passage of the pellets **15** one by one, extends from the left-hand end of the magazine **16**, as viewed in FIG. 1, into the body cavity **13**. The passage **16***a* slopes downwardly at its opening into the recess **13** when the barrel is nearly horizontal. The opening of the passage **16***a* is located beneath the barrel bore.

In order to lift the pellets **15** one by one from the end of the passage **16***a* into registry with the barrel bore, a slider **17** is provided. The slider **17** generally conforms to the configuration of the cavity or recess **13**, and is slidable longitudinally therein. The lower end **13***a* of the recess **13**, which is located adjacent the base of the trigger guard **14**, forms a stop, determining the downward limited position of the slider **17**. The slider **17** has a through circular opening **17***a* that registers with the end of the magazine passage **16***a* when the slider is in this lower limited position. That pellet at the end of the magazine passage **16***a* falls by gravity into the slider aperture **17***a*. The wall of the body cavity **13** opposite the magazine passage **16***a* stops movement of the pellet. Assisting in drawing the pellet into the slider aperture **17***a* is a small permanent magnet **18** extending inwardly from the upper end of the slider **17**. The magnet **18** has a polar area located adjacent the center of the slider aperture **17***a*.

When the slider is moved upwardly, the pellet **15** is carried therewith into registry with the barrel liner **12**. The magnet **18** holds the pellet in place. During upward movement of the slider **17**, the next pellet at the end of the magazine passage 16*a* remains in place, the width of the slider 17 and the recess 13 both being substantially equal to the diameter of the pellet 15.

The upper limited position of the slider 17 corresponding to registry of the slider aperture 17*a* with the barrel liner is determined by a lateral lug 17*b* (FIG. 2) of the slider, engaging a shoulder 13*b* provided on the cover plate 10*b*, as well as by the upper end of the slider 17 engaging the upper end 13c of the recess 13.

Opening behind the slider 17 and in alignment with the barrel bore is a passage or port 19 (FIG. 4) provided in th body 10*a* for conducting compressed gases to the firing chamber formed at the upper end of the recess 13.

A space formed by a sleeve 20 (FIG. 1), located in the grip or handle portion 22 of the device, contains compressed fluid that is passed to the body passage through a valve body 21. The valve body 21 has an enlarged flange 21*a* telescopically received in the upper end of the sleeve 20 for closing this end of the sleeve. An O-ring 23 establishes a sealing relationship between the valve body 21 and the cylinder 20.

Opposite ends of the sleeve are accommodated in spaced circular recesses 51 and 52, each formed by the complementary body parts. The reduced upper portion of the valve body 21 projects through the reduced upper end of the circular recess 51 into a rear body cavity 53 beneath the magazine 16.

The valve body 21 (FIG. 1) has a through passage 21*b* in which inlet and outlet ends are formed, respectively, at the lower and upper ends thereof by a raised, downwardly directed valve seat 21*c*. A lateral port 21*d* of the body connects the outlet end of the valve with the conducting passage 19, the conducting passage 19 opening into the reduced end of the recess 51 in which the valve body 21 is accommodated.

For controlling the flow through the valve passage, a valve closure assembly 24 that momentarily opens the valve is provided.

A cup 24*b*, mounted on one end of the valve stem 24*a*, carries a resilient closure 24*c* cooperable with the seat 21*c*. The stem 24*a* projects through the outlet end of the body passage 21*b* and into the rear body cavity 53. The end of the valve body passage 21*b* guides the closure assembly for axial movement, whereby the closure 24*c* may be moved toward or away from the seat 21*c*.

The valve stem 24*a* has suitable clearance at that port of the valve body 21 at which the connecting port 24*d* opens.

One end of a light coil spring urges the valve 24 upwardly and toward closing position. A ported nut 26, threadedly accommodated in the lower end of the valve body opening, seats the other end of the spring 25.

The container sleeve 20 for the compressed or liquefied fluid is supplied with a charge by a carbon dioxide cartridge 27, or the like, that is removably accommodated in the sleeve 20. The cartridge 27 is inserted and removed through the lower end of the sleeve 20 and the apertured butt end of the handle 22. This opening is closed by a removable plug 28 that has a reduced extension 28*a* telescopically received in the lower end of the sleeve 20. The outer end of the plug 28 threadedly engages the apertured butt end of the body. An O-ring 29, carried in a recess or extension 28*a*, establishes a sealing relationship between the plug 28 and the cylinder 20.

The lower end of the plug 28 pivotally mounts a lever 30, to be described more fully hereinafter, that facilitates turning of the plug 28. One end of the lever 30 is located midway of a transverse slot in the end of the plug 28, and has an aperture through which a pin 31 extends. The other end of the lever is accessible for manipulation when it extends beyond either end of the end slot of the plug 28.

In FIG. 1, the cartridge 27 has been pierced, and carbon dioxide, having both a liquid and a gaseous phase, is contained in the sleeve 20. In a manner to be described more fully thereinafter, only a small quantity of the fluid originally in the container space is permitted to pass through the valve at one time. The pressure in the space is substantially constant until the contents are exhausted. This follows since an equilibrium condition between gaseous and liquid phases exists in the space.

A recess 28*b* on the inner side of the plug 28 loosely receives the neck end of the cartridge 27. Spacers or ribs in the recess 28*b* ensure communication between the sleeve proper and the cartridge opening at the end of the cartridge neck. A series of generally radially extending grooves 21*e* on the inner end of the valve body ensures communication between the sleeve 20 proper and the valve inlet 21*b*.

When the charge in the cylinder 20 is exhausted, the plug 28 is removed by manipulation of the lever 30 and a new cartridge 27 is inserted. The plug 28 is then tightened down.

For opening the cartridge 27, a piercing pin 32 is provided. This pin is slidably mounted in a through opening of the plug 28. The inner end of the pin has a piercing projection 32*a* extending upwardly into the plug recess 28*b* for cooperation with the soft closure of the cartridge 27 at its neck. The other end of the piercing pin extends into the cross slot of the plug toward the lever mounting pin 31. The piercing pin 32 is advanced by angular movement of the lever 30 toward an axial position relative to the pin and the plug 28. Advancement of the pin 32 is caused by a cam surface 30*a* provided on the end of the lever 30 adjacent the pin 31, successive portions of which engage the end of the pin 32 as the lever 30 is rotated.

After the soft cartridge closure is pierced, the lever 30 is returned to the transverse orientation illustrated.

An O-ring 33, located between an annular flange 32*b* of the piercing pin 32 and a shoulder 28*c* located intermediate the end of the plug opening, establishes a seal between the piercing pin 32 and the plug 28 for all positions of the piercing pin.

In order to release a quantity of compressed fluid, the valve 24 is momentarily opened by a hammer 34 located in the rear body cavity 53. The hammer 34 is provided with a projection 34*a* engageable with the projecting end of the valve stem 24*a*. A pin 35 carried by the body 10*b* mounts the hammer 34 for pivotal movement so that the valve stem 24*a* is in the path of movement of the projection 34*a*. A coil spring 36, located within the hollow portion of the grip 22, exerts a spring force on the hammer 34, tending to move it in a counterclockwise or engaging direction about its pivotal mounting. The spring 36 also stores energy when the hammer 34 is retracted, which energy, when suddenly released, is used to create a substantial impact necessary to unseat the valve against the seating force of the compressed fluid.

A link 37 connects one end of the coil spring 36 to a projection 38 on the hammer 34. This link 37 extends between the outer wall of the sleeve 20 and the rear wall of the body 10*b* at the grip portion thereof.

The opposite end of the spring 36 is connected to a post 39, the position of which may be adjusted to vary the amount of energy stored in the spring before the energy is released, and hence the extent of opening of the valves.

For this purpose, the lower enlarged end 39*a* of the post 39 is slidably receivable in a through opening 40 at the butt end of the grip portion 22 of the body. A pin 41 carried by the body 10*b* extends radially inwardly of the recess 40 to form a stop engageable with the enlarged headed end 39*a* of the post 39. When the hammer 34 is moved away from the valve stem 24*a*, the coil spring 36 expands, the pin 41 preventing inward movement of the post 39.

In order to provide definite adjusted positions of the post, that surface of the post head 39*a* engageable with the pin 41 is formed as a continuous cam surface provided with discontinuities forming distinct angularly spaced seats 39*b*, any one of which may be positioned for cooperation with the pin 41 by rotation of the post 39. The seats 39*b* are located at different axial positions along the length of the post 39, and accordingly determine discrete adjusted positions of tension of the spring 36. Rotation of the post 39 for the purpose of positioning any one of the seats is facilitated by a slotted outer end of the post 39. The pin 41 and head 39*a* form cam and cam follower structures urged to engage each other by the spring 36.

The cam arrangement ensures rapid adjustment that accurately controls the spring tension. Operation of the device is accurately predictable since the adjusted positions of the post are definite and since the pressure in the space is substantially uniform irrespective of the amount of fluid remaining.

The hammer is moved away from the valve stem 24*a* to store energy in the spring 36 by a longitudinally reciprocable link 42. One end of the link 42 extends into the rear body cavity 54 beneath the rear end of the barrel. The link 42 extends across the open side of the slider recess 13. The link 42 also clears the narrowed lower end 17*c* of the slider 17, as shown in FIG. 2.

The hammer 34 has an eccentric projection or cocking pin 43 in the path of movement of the end surface 42*a* of the link 42. By movement of the link 42 rearwardly or toward the right, as viewed in FIGS. 1 and 3, the hammer 34 is rotated and its valve-engaging projection 34*a* is retracted.

For moving the link 42, a pivoted trigger 44 is provided in the forward body cavity 54. The trigger 44 is pivotally mounted about an axis transverse to the body 20 by a pin 46 passing through an aperture in the upper portion of the trigger 44.

For mounting the link for operation by the trigger 44, the left-hand or forward end of the link 42 is pivotally connected eccentrically of the trigger 44. For this purpose, an aperture 42*b* of the link 42 engages a pin 45 projecting from the trigger 44.

By counterclockwise movement of the trigger 44, as by manipulation of a depending fingerpiece 49, the link is moved and the hammer cocking pin 34*a* is rotated.

For normally retracting the link 42 and for moving the fingerpiece 49 forwardly, a coiled tension spring 47 is provided. One end of the spring is fastened to a pin 48 of the body 10*b*, and its other end is secured to the left-hand or forward terminal portion of the link 42.

The pin 48, mounting the fixed end of the link-biasing spring 47, is located so that a clockwise torque is exerted on the link 42 about the trigger pin 46. This causes an intermediate portion of the lower edge 42*c* of the link to move into engagement with an abutment 50 formed on the body 10*b*. In this position, the end surface 42*a* of the link 42 is so located that it will engage the cocking pin 43 upon retraction of the link 42.

In the position shown in full lines in FIG. 3, the link 42 is partially retracted and the hammer 34 is lifted from the valve stem 24*a*. In this position, the direction of movement of the cocking pin 43 corresponds to the direction of movement of the operating link 42. Upon further movement, the cocking pin 43 moves downwardly in a path diverging from that of the link 42; the reaction between the cocking pin 43 and the end surface 42*a* of the link 42 is then so directed as to cause the link to rotate upwardly away from the abutment 50 against the force of the spring 47.

In the phantom-line position shown in FIG. 3, the cocking pin 43 is located at the end edge of the link surface 42*a*. Further movement of the link 42 will cause the link to clear the cocking pin 43. The hammer 34 is then tripped (FIG. 4) and the energy stored in the spring 36 is suddenly released. The impact is sufficient momentarily to open the valve closure assembly 24 against the high force of the compressed fluid in the space. A definite quantity of compressed gas, depending upon the

adjustment of the spring 36, is passed through the conducting passage 19 of the body to the barrel. When the energy of the spring 36 is spent, the pressure of the liquid in the sleeve 20 returns the closure and the hammer 34 to the position shown in FIG. 1.

After the hammer has been tripped, the cocking pin 43 slides along the lower edge 42*c* of the link 42. By releasing the fingerpiece 49, the link 42, under the action of the spring 47, will move forwardly until the end of the link 42 clears the cocking pin 43, and the mechanism is again in condition for operation by manipulation of the trigger.

In order to ensure that the slider 17 positions a pellet 15 in the barrel before the link 42 is moved to the critical tripping position, an overriding connection between the trigger 44 and the slider 17 is provided.

The trigger 44 has a rearwardly extending lug 60 entering an elongate slot or opening 17*d* of the slider 17 (see FIGS. 1, 2 and 3). The trigger-biasing spring 47 causes the end of the lug 60 to engage the bottom surface of the slider recess 17*d*, ensuring retraction of the slider 17 upon retraction of the link 42 and trigger 44.

When the slider 17 reaches its lower limit of travel in the recess 13, forward movement of the trigger 44 and link 42 is correspondingly limited by virtue of the interengagement of the lug 60 and the slider 17. In this position, there is a definite spacing between the end surface 42*a* of the link 42 and the cocking pin 43.

A bow spring 61 (FIG. 1) maintains the lower end of the slider slot 17*d* in engagement with the lug 60. The right hand end 61*a* of the bow spring 61 extends into a small recess 17*e* immediately beneath the recess 17*d* into which the lug 60 projects. The opposite end 61*b* of the bow spring 61 projects beneath an overhanging wall of a recess in the upper portion of the trigger 44. An upwardly extending surface 44*d* near the axis of the trigger engages the lower side of the bow spring 61 and imparts a suitable upwardly bowed configuration to the spring 61 so that the end 61*a* thereof exerts an upward thrust on the slider 17.

When the trigger 44 reaches the intermediate position shown in FIG. 3, the slider 17 has moved to its upper limited position. The hammer, however, has not yet been tripped. Further retraction of the trigger 44 causes the lug 60 to move away from the lower surface of the recess 17*d*. The slider 17 is, however, held in its upper limited position by the bow spring 61, the end 61*a* of the bow spring exerting an upward thrust thereon.

Retraction of the fingerpiece 49 past the position shown in FIG. 3 to the tripping position shown in FIG. 4 causes increased flexure of the bow spring 61. This follows since the overhanging wall anchoring the opposite end 61*b* of the spring 61 is moved downwardly about the relatively stationary fulcrum surface 44*d*. An increasing force is thereby applied to the slider 17 to maintain it in its upper limited position for firing.

By fixing one end of the bow spring on the trigger, a positive holding thrust is applied to the slider 17.

The slot or recess 17*d*, lug 60 and the bow spring 61 provide the overriding connection between the trigger 44 and slider 17. On release of the trigger 44, these elements form a lost motion connection.

When the trigger is released, the lug 60 moves downwardly until it engages the lower end of the recess 17*d*. Thereafter, the slider is retracted through positive engagement between the lug 60 and the slider 17.

The resilient connection ensures against damage of the parts in the event that the pellets 15 are not properly fed. If the feeding mechanism tends to jam, the lug 60 immediately will move away from the end surface of the slider slot as the trigger is retracted. Noticeably high resistance will be encountered by virtue of immediate increased flexure of the bow spring 61. The increased resistance will warn that the apparatus is jammed, and appropriate remedial measures can be taken before damage to any of the parts occurs.

As the available pressurized fluid is exhausted, the hammer loading spring 36 will overpower the very slight seating force exerted by the retainer spring 23, and will move the valve 24 to open position, as shown in FIG. 5. In this position, the cocking pin 43 is rotated forwardly toward the link 42 to an extent in excess of the usual spacing between the link and the pin. The link 42 will be prevented from dropping over the end of the cocking pin 43 as the trigger is released. Should the fingerpiece 49 thereafter be manipulated, the end of the link 42 will pass over the upper surface of the cocking pin 43. Operation of the hammer 34, when the charge in the sleeve 20 is exhausted, is accordingly prevented, avoiding unnecessary wear on the parts.

When a new cartridge 27 is inserted and opened, the pressure will urge the closure 24 to seat, and the stem **24a** will lift the hammer 34, thereby permitting the link 42 to return to the initial operating position illustrated in FIG. 1 under the influence of the biasing spring 47.

In order to provide a safety position for the apparatus, the link 42 is lifted so that it clears the cocking pin. For this purpose, a safety lug 62 is provided. The lug 62 projects inwardly through an elongate slot 65 in the cover plate 10*b* beneath the link 42. A bow spring 63 on the inside of the plate 10*b* engages a surface intermediate the length of the lug 62 to urge it inwardly and hold it in place. A fingerpiece 64 fastened to the outer end of the lug limits inward movement.

By moving the fingerpiece 64 upwardly in the slot 65 from the position shown in FIG. 8, the lug 62 rotates the link 42 to the position shown in FIG. 6. In this position, the end surface 42*a* and the lug will clear the cocking pin 43 of the hammer 34 whenever the trigger is retracted.

By moving the fingerpiece 64 downwardly in the slot 65, the link 42 is permitted to rotate back to operative position in which the link engages the abutment 50. The safety device ensures against operation of the apparatus without physically restraining any of the parts.

The inventors claim:

1. In a small arms weapon: a body; means forming a chamber for containing fluid under pressure; a valve

having a valve operating member accessible exteriorly of the chamber; a movable impact member engageable with the valve operating member for opening the valve only upon sufficient impact between the valve operating member and the impact member; a spring for urging the impact member toward engaging position, one end of the spring being connected to the impact member; and a pair of relatively rotatable and axially movable cam and follower elements mounted respectively on the body and the other end of the spring; one of the elements having a series of discontinuities forming steps; the spring urging the cam and follower elements into engagement; the elements being operable longitudinally to move the spring mounted element upon rotation of one of the elements.

2. In a small arms weapon: means forming a chamber for containing fluid under pressure; a valve having a valve operating member accessible exteriorly of the chamber; the pressure of fluid in the chamber normally maintaining the valve operating member in valve closing position; a movable impact member engageable with the valve operating member for opening the valve only upon sufficient impact between the valve operating member and the impact member; a spring for urging the impact member toward engaging position, one end of the spring being connected to the impact member; a post connected to the other end of the spring; a guide for the post, and permitting longitudinal movement of the post, corresponding to changed flexure of the spring, and also permitting rotation of the post about the longitudinal axis; the post having a head provided with a surface having a plurality of angularly spaced concavities at different axial positions along the post; and a pin carried by the guide and cooperable with any one of the concavities upon rotation of the post to form a limit to axial movement of the post.

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