

May 22, 1956

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2,746,643

LIQUID EJECTION DEVICES

Filed Nov. 17, 1952

3 Sheets-Sheet 1

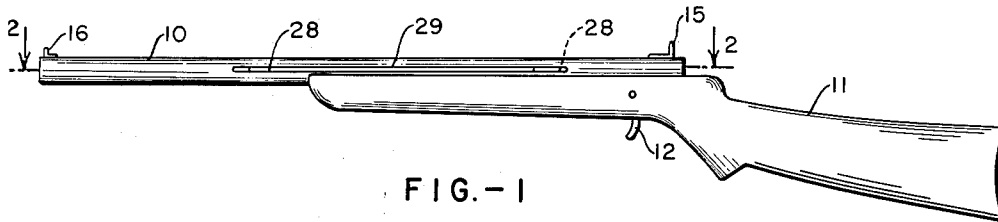


FIG. -1

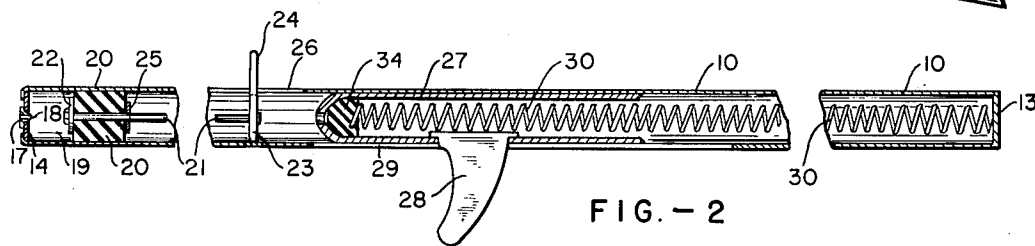


FIG. -2

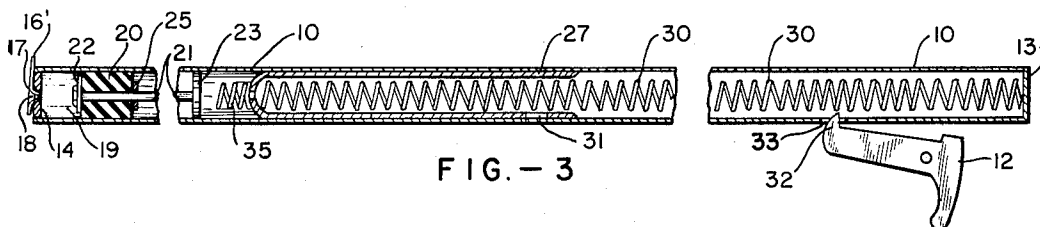


FIG. -3

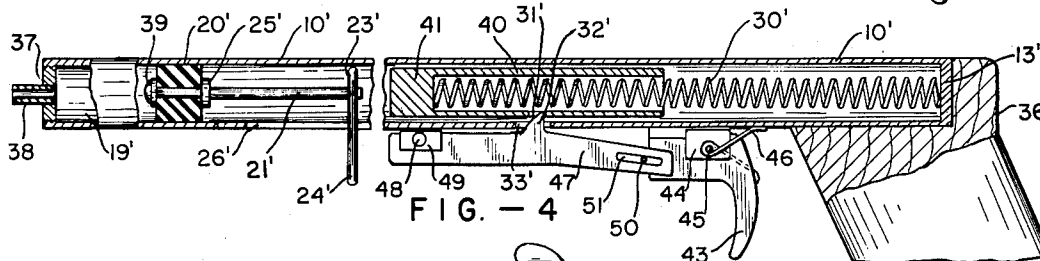


FIG. -4

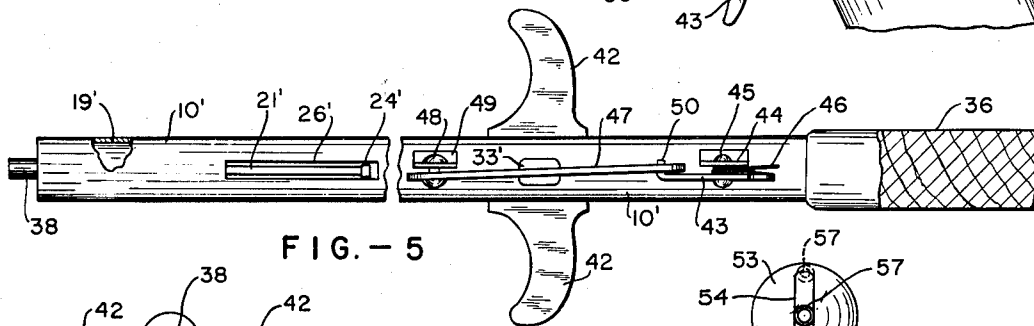


FIG. -5

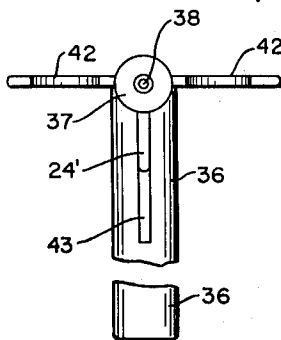


FIG. -6

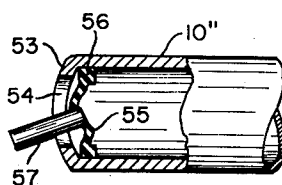


FIG. -7

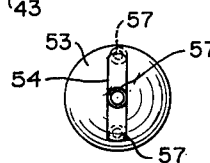


FIG. -8

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3 Sheets-Sheet 2

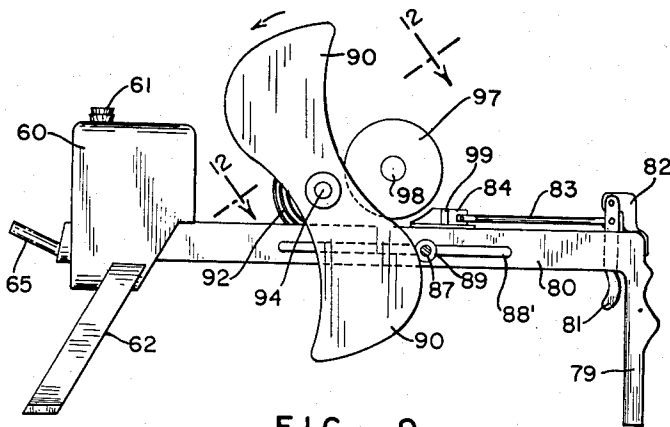


FIG.- 9

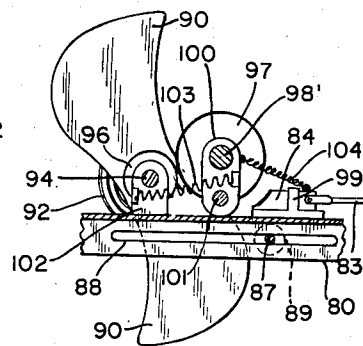


FIG.-14

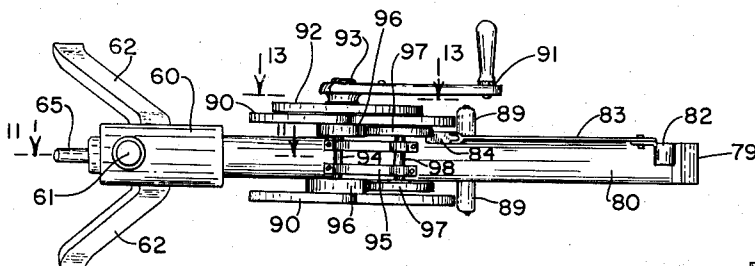


FIG.- 10

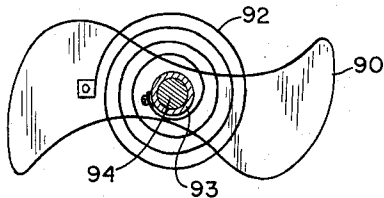


FIG. - 13

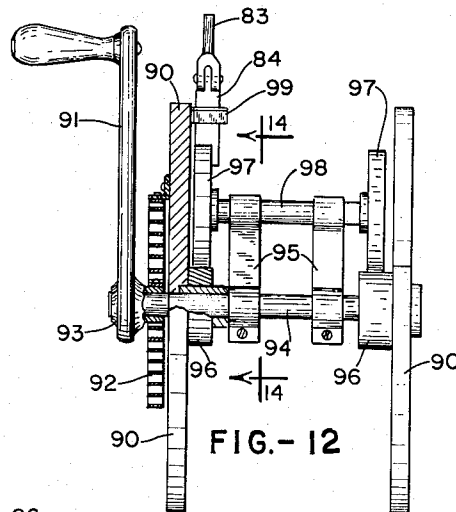


FIG.- 12

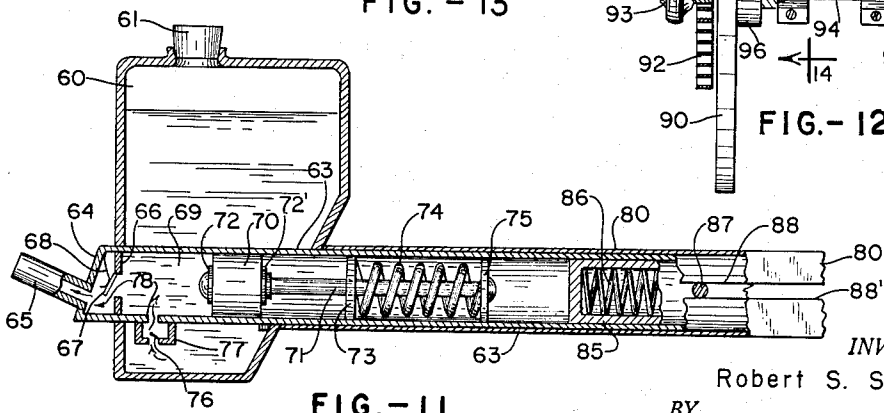


FIG.- 11

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3 Sheets-Sheet 3

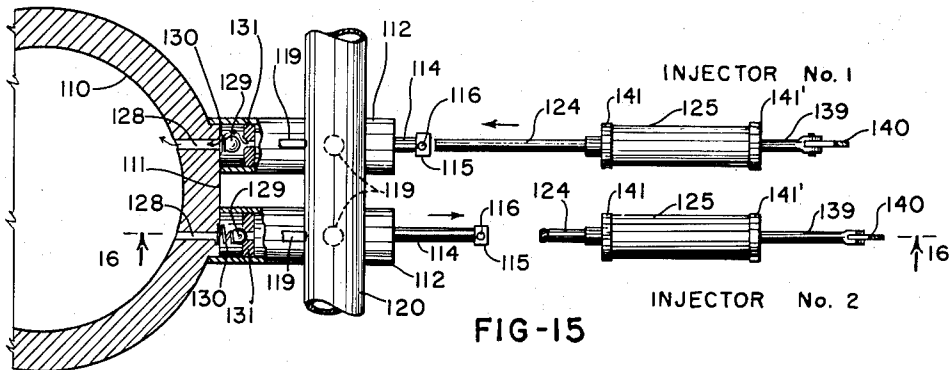


FIG-15

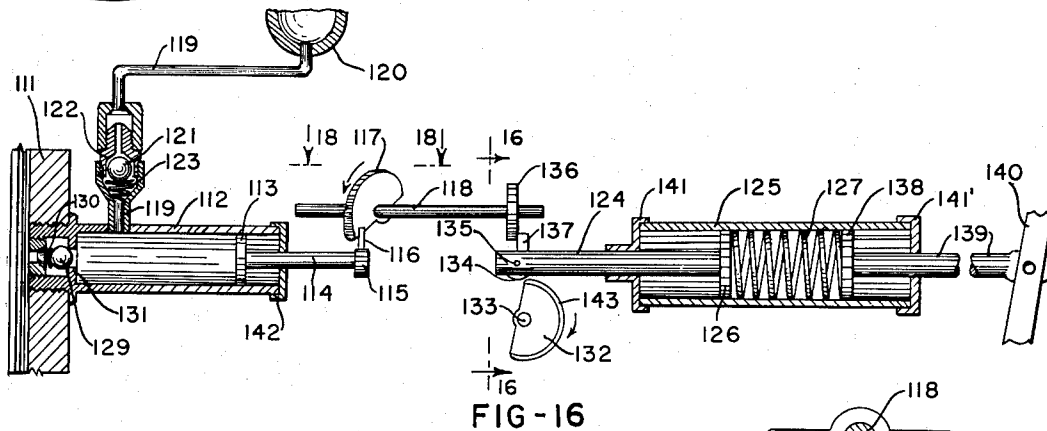
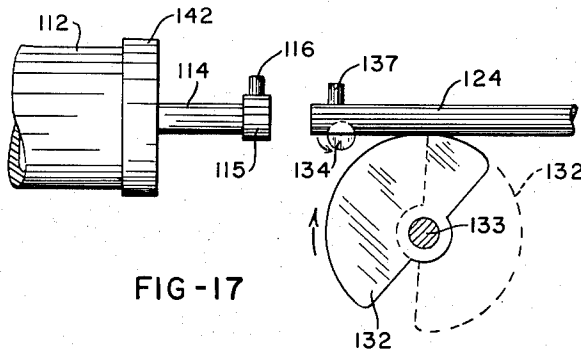


FIG-16



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2,746,643

LIQUID EJECTION DEVICES

Robert S. Spalding, Denver, Colo.

Application November 17, 1952, Serial No. 321,004

27 Claims. (Cl. 222—79)

This invention relates to liquid ejection devices such as water guns, water pistols, water rifles, diesel engine fuel injection devices, and the like.

Among the objects of the present invention are to provide a liquid ejection device which will project a small amount of liquid with considerable force; to provide such an ejection device which will operate effectively to eject liquid from a confined chamber; to provide such an ejection device which, in one form, may be a gun for ejecting a stream of liquid, such as water, with considerable force; to provide such a water ejection gun in which a number of small streams of liquid, such as water, may be ejected with relative rapidity; to provide such an ejection device which, in another form, may be a water ejection gun of the machine gun type, in which a number of small streams of water may be ejected in comparatively rapid succession; to provide another form of liquid ejection device which is adapted to inject liquid fuel into a cylinder of an internal combustion engine of the diesel type; to provide a diesel engine fuel injector in which the relative amount of liquid may be controlled; to provide such an ejection device which may include two injectors for each cylinder, with one injector supplying the fuel while an ejection chamber of the other injector is being filled; and to provide such injectors which may be operated at relatively high rates of speed.

Additional objects and the novel features of this invention will become apparent from the description which follows, taken in connection with the accompanying drawings, in which:

Fig. 1 is a side elevation of a water rifle forming one embodiment of this invention;

Fig. 2 is a condensed longitudinal section, on an enlarged scale, taken horizontally through the barrel, along the line 2—2 of Fig. 1, but showing a modified form of outlet;

Fig. 3 is a vertical longitudinal section, taken through the barrel and perpendicularly to the section of Fig. 2;

Fig. 4 is a condensed side elevation, principally in vertical longitudinal section, of a water pistol forming another embodiment of this invention;

Fig. 5 is a plan view, taken from the underside, of the water pistol of Fig. 4;

Fig. 6 is a front end elevation of the water pistol of Fig. 4;

Fig. 7 is a fragmentary side elevation, partly in vertical section, illustrating an alternative construction of the discharge end of the water gun of Figs. 1—3 or the water pistol of Figs. 4—6;

Fig. 8 is a front end view of the alternative discharge end construction of Fig. 7;

Fig. 9 is a side elevation of a water machine gun forming another embodiment of this invention;

Fig. 10 is a top plan view of the water machine gun of Fig. 9;

Fig. 11 is an enlarged, partial vertical longitudinal section taken along line 11—11 of Fig. 10;

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Fig. 12 is an enlarged, fragmentary, oblique view, partly in section, taken along line 12—12 of Fig. 9;

Fig. 13 is an enlarged, fragmentary vertical section taken along line 13—13 of Fig. 10;

Fig. 14 is a side elevation of a portion of the parts shown in Fig. 12, with a slight variation in construction, and taken generally from the position of line 14—14 of Fig. 12;

Fig. 15 is a top plan view, with certain parts omitted and other parts broken away for clarity of illustration, of a dual diesel engine fuel injection device forming a further embodiment of this invention;

Fig. 16 is a vertical section taken along line 16—16 of Fig. 15, showing certain alternative parts;

Fig. 17 is an enlarged fragmentary side elevation, illustrating primarily the action of a cam and a roller on an impact member, shown also in Fig. 16;

Fig. 18 is an enlarged top plan view of a plunger return cam, taken from the position of line 18—18 of Fig. 16; and

Fig. 19 is a transverse vertical section, on an enlarged scale, taken along line 19—19 of Fig. 16.

In general, a liquid ejection device constructed in accordance with this invention may comprise a container for liquid having an outlet at the end, a plunger extending within the container which is adapted to force liquid through the outlet, an impact member which is movable to a position spaced from the plunger and into engagement with the plunger, and resilient means, such as a spring, which opposes movement of the impact member to the spaced position, but upon release of the impact member causes the impact member to move into engagement with the plunger. The impact spring is preferably compressed by a suitable movement of the impact member, and the distance which the impact member moves is preferably such that the force of the spring may be largely expended by the time the impact member engages the plunger, but the inertia of the impact member provides sufficient force to strike a sharp blow, with a resultant, sharp ejection of liquid through the outlet. The embodiments of this invention illustrated in the drawings each operate in accordance with the principle of the inertia of the impact member producing sufficient force to produce a comparatively sudden ejection of liquid through the container outlet, although they may vary considerably in actual structure and the operation of the various parts. Thus, the impact member may be moved rearwardly by a cam, so that ejections will occur in rapid succession, depending upon the speed of rotation of the cam, as in the water machine gun of Figs. 9—14 or the diesel engine fuel injection device of Figs. 15—19; or the impact member may be moved rearwardly each time ejection is desired, as in the water rifle of Figs. 1—3 and the water pistol of Figs. 4—8. In the latter case, a releasable latch, such as actuated by a trigger, may be provided, but when a cam is utilized to move the impact member rearwardly ejection may occur automatically when the cam moves the impact member rearwardly to a predetermined position. However, at desired times, the impact member may be held in a rear position, as by a brake or by a suitable cam or the like. The container may be provided with an inlet which permits liquid to flow into the container when the plunger is removed rearwardly, or the discharge outlet may also form the inlet. Thus, the plunger may be moved rearwardly manually, as in the case of a water rifle or pistol, in which case the discharge outlet may serve also as an inlet; the plunger may be moved rearwardly automatically each time the impact member is withdrawn, as in the case of a water machine gun; or it may be moved rearwardly by mechanical means, such as a cam, at predetermined

times, as in the case of a diesel engine fuel injection device.

In the water rifle illustrated in Figs. 1-3 and constructed in accordance with this invention, a tubular barrel 10 may be mounted on a conventional stock 11, having a trigger 12 pivotally mounted therein at a conventional location. The barrel 10 may be closed by its rear end 13 being integral therewith, or closed by a circular plate which may be welded or brazed in place, or detachably connected, as by threads. The closed front end of the barrel may be formed integrally therewith, or may comprise a circular plate 14 attached to the end of the barrel 10 in a suitable manner, as by welding, brazing, or the like, as in Fig. 3, or may be attached thereto by crimping over the end of the barrel, as in Fig. 2, or in any other suitable manner, such as detachably connected by threads. The barrel 10 may also be provided with a rear sight 15 and a front sight 16, as in Fig. 1, while the front sight, as in Figs. 2 and 3, may be formed by an extension 16' of an outlet plate 17 having a discharge hole 18 disposed centrally of the barrel and formed so that the liquid discharged will tend to be directed slightly upwardly.

The front end of the barrel 10 forms a liquid containing space 19, as in Figs. 2 and 3, into which liquid may be drawn through the discharge hole 18 by rearward movement of a plunger which includes a piston 20, illustrated as a cylindrical plug of rubber, plastic, or the like, although a conventional plate and washer construction may be utilized. The piston 20 is mounted on a rod 21 which extends longitudinally and centrally of the barrel between a washer 22 at its front end, for piston 20, and a circular plate 23, at its rear end, adapted to guide rod 21 for movement in the barrel and provided with a laterally extending handle 24 for moving the piston 20 rearwardly to fill the liquid space 19, while a second washer 25 may be attached to rod 21 for the rear end of piston 20. Handle 24 may extend to either side, as through a longitudinal slot 26 in the barrel 10 on the left side. As will be evident, the piston 20 and rod 21, and parts attached thereto, comprise a plunger which is adapted to force liquid through the outlet 18 upon engagement by an impact member, the latter including a tube 27 to which a handle 28 is attached, the handle 28 extending laterally through a slot 29 in the barrel 10, as on the left hand side, and the handle 28 being movable between the full and dotted positions of Fig. 1. Tube 27 is closed or substantially closed at its front end, and encloses a portion of a compression spring 30, which bears at its rear end against the rear end 13 of barrel 10. The tube 27 may also be provided with a short slot 31 in the bottom thereof, adapted to engage a latch point 32 of trigger 12, to hold the tube 27 in rear position and the spring 30 compressed until release by pivotal movement of trigger 12. The latch point 32 of trigger 12 is adapted to extend through a slot 33 in the bottom of barrel 10, the latch point being beveled or curved on its front side, so that when tube 27 is moved rearwardly by handle 28, the latch point will automatically engage slot 31. As will be evident, when the tube 27 is released by trigger 12, the tube will be moved forwardly by spring 30 to impact against the plunger. This impact will cause the plunger to force liquid through the outlet 18, as a sudden spurt or jet. Tube 27 is preferably sufficiently heavy that its weight will provide sufficient inertia to produce a comparatively heavy impact, so that the jet of liquid thus discharged through outlet 18 will be shot through the air for a comparatively great distance. The free length of spring 30 is preferably such that substantially all of its stored energy will have been transferred to tube 27 by the time the plunger is impacted, when the last portion of the liquid is being ejected from space 19. Of course, for positions of the plunger rearwardly thereof, some of the stored energy of the spring

will not have been transferred to the tube 27 when the latter strikes the plunger. Thus, a block 34 of rubber may be placed in the front end of tube 27, as in Fig. 2, or a small spring 35 may be attached to the front end of the tube 27, as in Fig. 3, so that the impact will be cushioned slightly when spring 30 is less fully extended, and all impacts will tend to be more uniform.

The handle 28 is pulled back manually after each impact or "firing" of the rifle, and this is conveniently done with the left hand, while the right hand remains on trigger 12. Successive operations can be relatively fast, in much the same manner as in use of a "pump" shotgun. The handle 24, of course, need be pulled back only for filling, and the capacity of chamber 19 is preferably such that a large number of "shots" may be made without reloading the liquid. As will be evident, at each impact, the plunger and handle 24 will move forward a slight distance, and the position of handle 24 will indicate when the necessity for refilling is approaching.

In the water pistol, illustrated in Figs. 4-6, and forming another embodiment of this invention, a cylindrical barrel 10' may be mounted on a pistol-grip handle 36, the rear end 13' of the barrel being formed integrally therewith as shown, or formed by a separate part attached to the barrel. The front end of the barrel may be closed by a circular plate 37, detachably secured to the barrel by threads, as shown, or formed integrally with the barrel or permanently attached thereto. The plate 37 may be provided with a short tube 38 adapted to act as a discharge outlet, and also provide a filling opening, for the liquid space 19' in the front end of the barrel. As before, a plunger is engaged by an impact member, to force successive increments of fluid in the space 19' through the outlet 38. The plunger may comprise a piston 20', such as formed by a cylindrical plug of rubber or the like, mounted between a head 39 of a rod 21' and a washer 25', the rear end of rod 21' being provided with a guide disc 23' and a handle 24', the latter extending downwardly and being movable along a slot 26' in the barrel 10', to move the plunger rearwardly when filling the space 19'. The impact member may comprise a tube 40 having a relatively heavy or weighted front end 41, the tube 40 being adapted to partially surround a compression spring 30', bearing at its rear end against the rear end 13' of the barrel. The tube 40 may be provided with a handle 42 extending laterally on each side and adapted to extend through a suitable slot in the barrel 10', for movement of the tube, after each impact, back to locked position in which the spring 30' is compressed. A trigger 43 may be pivoted on a bracket 44, on the underside of barrel 10', as by a pin 45, and maintained in normal position by a torsion spring 46. A latch 47 is pivotally mounted by a pin 48 on a bracket 49, attached to the underside of barrel 10' at the forward end of lever 47. Centrally thereof, the lever 47 is also provided with a latch point 32', adapted to extend through a slot 33' on the underside of barrel 10' and to engage a slot 31' in tube 40, to lock the tube with the spring 30' in compressed position. Trigger 43 is pivotally connected to the rear end of lever 47 by a laterally extended portion 50 of the trigger, acting as a pin in a slot 51 of lever 47, to move the lever between catch and release positions. As before, the front end of latch point 32' is preferably rounded or beveled so that the rear end of tube 40 will slide thereover, and the lever 47 will move upwardly with latch point 32' in slot 31', when the corresponding position of tube 40 is reached. Torsion spring 46 presses the trigger 43 and lever 47 normally in a direction to cause latch point 32' to move into and be held in slot 31'.

As will be evident, each time a handle 42 is pulled rearwardly, spring 30' will be compressed and will be locked by latch point 32'; and when trigger 43 is pressed,

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tube 40 will be released and the impact member will move into engagement with the plunger, causing an amount of liquid, normally proportional to the force of the impact, to be ejected through the outlet tube 38. While a handle 42 must be moved rearwardly between each shot, the movement can be made rather rapidly, so that a number of shots can be fired in succession. As before, the position of plunger handle 24' will indicate the approaching necessity for refilling, and the liquid space 19' is preferably sufficiently large to provide liquid for a comparatively large number of shots.

In the alternative construction, illustrated in Figs. 7 and 8, of the discharge end of either the water gun of Figs. 1-3 or the water pistol of Figs. 4-6, the front end 53 of the barrel 10" may be integral therewith, as shown, or otherwise suitably attached thereto, preferably being arcuately conventional in shape and provided with a vertical slot 54. A flexible disc 55, made of rubber or other suitable material, is provided with a flange 56, extending around its periphery, to provide stability and retention in the end of the barrel, and also provided centrally with a discharge tube 57 which may be moved to any desired position within the slot 54, so as to direct the liquid discharge in any desired direction, either up or down, or laterally by holding the pistol or water gun tipped, such as around a corner. The slot 54 may also be angular or horizontal rather than vertical, and preferably has just sufficient clearance for tube 57 that the tube tends to be held in position by friction. The front end 53 of the barrel may also be made adjustable in position, so that the discharge tube 57 may be moved around to other various positions. As will be evident, an adjustable discharge tube at the end of a water pistol or water gun enables the user to shoot around corners, and at other various angles.

The water machine gun of Figs. 9-14, also constructed in accordance with this invention, has additional capacity and also a faster rate of discharge of successive shots than would normally be possible with the manually-activated water gun or water pistol previously described. This water machine gun may comprise a water tank 60, having a filling opening normally closed by a plug 61 and supported by a pair of legs 62, extending outwardly and downwardly from each side thereof. Tank 60, as in Fig. 11, surrounds a barrel 63 whose front end 64 may be provided with a discharge tube 65, which may be pointed upwardly, to secure greater distance of the ejected liquid, while slightly rearwardly therefrom, a partition 66 has a central opening normally closed by a flap valve 67, maintained in normally closed position by a spring 68. A plunger for ejecting the liquid from a liquid space 69 may comprise a piston plug 70 mounted on a rod 71 between washers 72 and 72', the rod 71 passing through a partition 73 within the barrel and providing a bearing for a compression spring 74, the opposite end of which bears against a disc 75, mounted on the rear end of rod 71, the spring 74 returning the piston 70 to rear position after each ejection. During such rearward movement by spring 74, additional fluid is pulled into the liquid space 69 from the water tank 60, such fluid flowing through a one-way flap valve 76 mounted over an opening in the underside of a box 77, the latter being attached to the underside of barrel 63 and communicating with the liquid space 69 through a hole 78. A rubber sack, closed at the rear end, may be substituted for the plunger and spring 74 as the equivalent thereof, the resiliency of the sack causing the discharge space to be filled with liquid after each impact. Also, an inlet valve may be provided by a flap in the side of such a sack.

Partitions 66 and 73 may be formed by discs mounted in the interior of the barrel 63 and held in position by screws extending through the barrel, by engaging interior threads of the barrel or an insert fastened in the

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barrel, or in any other suitable manner. As will be evident, the inlet flap valve 76 is closed during ejection through the outlet tube 65, while the valve 67 is closed while the inlet valve 76 is open. As will also be evident, in this embodiment the liquid discharge space 69 is automatically refilled after each ejection, and the plunger is automatically returned by spring 74 to the same position after each impact. Thus, the distance which the impact member is moved rearwardly, and also through which it moves forwardly, will be substantially identical for each stroke.

The rear end of the machine gun may be supported by a leg 79, formed if desired with a hand-grip, and attached to or integral with a frame 80, extending forwardly to the tank 60 and rectangular or inverted U-shape in section so as to enclose the barrel 63. The machine gun may be started and stopped by means of a trigger 81 mounted on a bracket 82 in a position convenient to the leg 79, the trigger 81 being connected by a rod 83 with a brake-shoe 84, the operation of which will be described later. The impact member may comprise a tube 85 which is slidable within the barrel 63 and closed at its front end to receive a compression spring 86, the tube 85 being provided at each side with a laterally extending pin 87, movable along a slot 88 in barrel 63 and a slot 88' in the side of frame 80. Each pin 87 may be provided with a cam roller 89, as in Figs. 9 and 10.

The operating means for the impact member may include a pair of "flywheel" cams 90 whose peripheral edges are shaped so as to move the pins 89 rearwardly twice during each complete rotation of the cams. As will be evident from Fig. 9, in the position shown, the pins 87 are being moved rearwardly during rotation of the cams 90 in the direction of the arrow of Fig. 9. When the pins reach a rear position, the tip of each cam moves past the corresponding pin, and the cams will leave the pins and the pins will be free to move forwardly, along with the tube 85, urged by the compression spring 86, to impact the plunger. As will be evident, the cam may be rotated continuously until all of the water in the tank 60 is exhausted, as by turning a crank 91 while the brake-shoe 84 is released by trigger 81. Also, the device may be "wound up" by means of a coil spring 92 whose inner convolution is connected to a hub 93 for crank 91 and whose outer convolution is connected to the adjacent cam 90, as in Fig. 14. Thus, the spring 92 may be coiled while the brake-shoe 84 is engaged, and then the device operated without turning the crank 91 (at least until spring 92 is run down), merely by pulling on the trigger 81.

As illustrated in Fig. 12, the cams 90 may be rotatable with a shaft 94, in turn journaled in dual bearing brackets 95, which are mounted atop the frame 80. The hub 93 for crank 91 may be journaled for free rotation on shaft 94, and a roller 96 is attached to or formed integrally with each of the cams 90, for engagement with a pair of inertia wheels 97, mounted on a rotating countershaft 98, in turn journaled in the bearing brackets 95. The brake-shoe 84 is adapted to engage one of the inertia wheels 97, and is guided in its movement toward and away from the wheel by a guide strip 99. As will be evident, the inertia wheels 97 tend not only to store energy during movement of the cams 90, while out of engagement with the pins 87, and return this energy while the cams are engaging the pins 87, but also tend to slow down the cams while out of engagement so as to give the impact member sufficient time to move forwardly to the plunger.

A modification in which the inertia wheels 97 are resiliently urged into contact with the rollers 96 is illustrated in Fig. 14, in which the inertia wheels 97 are mounted on a countershaft 98', journaled in bearing brackets 100, pivoted at their lower ends on a laterally extending pin 101, the shaft 94 being journaled in fixed bearing brackets 102 and each of the pivoted bearing brackets 100 being connected by a spring 103 with one of the fixed bearing

brackets 102. Urging inertia wheels 97 continuously into engagement with the corresponding rollers 96 insures that any wear of a roller 96 or a wheel 97 will be taken up. In addition, a spring 104 may extend between one of the bearing brackets 100 and the brake-shoe 84, so as to maintain the brake-shoe in engagement with the corresponding inertia wheel 97, except when the trigger 81 is pulled. Of course, a small compression spring may be placed behind the trigger 81 for the same purpose.

In addition to its use as a water machine gun, for the edification and amusement of youngsters (and perhaps to the consternation and discomfiture of adults), the device may be utilized as a fire extinguisher, particularly in its larger sizes. Other uses will also be evident, such as for stunning and catching butterflies, insects and the like, or for discharging a solution utilized for horticultural purposes, such as weed spraying, insecticidal, nematocidal, or parasiticidal solutions. In addition, the water rifle or water piston may be incorporated in a novelty cane or the like.

In the embodiment illustrated in Figs. 15-19, inclusive, the principles of this invention have been applied to a device for injecting fuel into a diesel engine. In a diesel engine, fuel is not drawn into the cylinder on an intake stroke along with air, but the intake air is first compressed, and the fuel then injected. The compression pressure may range between 200 and 700 lb. per sq. in., depending upon the compression ratio, and as the first portion of the fuel introduced ignites, pressure in addition to the compression pressure may be produced, so that fuel is usually injected into a diesel engine cylinder at a considerable pressure, such as 1,500 to 7,000 lb. per sq. in. In order to inject liquid fuel satisfactorily into the cylinder, it is necessary not only to produce the desired pressure, but also to introduce a regulated amount of fuel, the amount being dependent upon the speed of the engine and the load involved. In the apparatus of Figs. 15-19, there are two injectors for each cylinder, only one cylinder being shown and it being understood that the other cylinders of the engine will be similarly equipped. One injector, such as injector No. 1, operates to inject fuel into the engine cylinder 110 while the other injector, such as injector No. 2, is being filled with a supply of fuel for the next series of operations, the injectors being connected to the engine cylinder at a boss 111. At a predetermined time, such as when the fuel supply in the discharge chamber 112 of injector No. 1 approaches exhaustion, injector No. 2 is operated to produce successive injections of fuel while injector No. 1 is being filled. Thus, injector No. 1 and injector No. 2 are alternately operated, the one being filled while the other is discharging, and vice versa. Each injector, as in Fig. 16, may include a piston 113 mounted on a guide rod 114 for movement into and out of discharge chamber 112 from the rear end thereof. A block 115 at the rear end of piston rod 114 may be provided with a cam pin 116 so that the piston may be moved rearwardly for filling by a cam 117, inclined with respect to a shaft 118, as shown in Fig. 18, and rotated relatively slowly by the shaft 118, in the direction of the arrow of Fig. 18. As the piston 113 moves rearwardly, liquid fuel is drawn into the chamber 112 through an inlet line 119 leading from a supply pipe 120 and provided with a non-return valve, such as a ball 121, normally pressed against a seat 122 by a spring 123, but moved away from its seat during filling, as in Fig. 16. The pressure of fuel in supply pipe 120 should be maintained at a sufficient value, such as 100 to 500 lb. per sq. in., so that the fuel will flow readily into the chamber 112 when the piston 113 is withdrawn.

The fuel in chamber 112 is injected into the engine cylinder 110 at an appropriate time by the impact, against block 115, of an impact member or rod 124 which extends into a compression tube 125 and is provided with a flange 126 at its rear end, the flange forming a seat for one end of a compression spring 127. At each successive impact, the piston 113 causes an amount

of liquid, in proportion to the force of the impact, to be injected into the engine cylinder 110 through an injection hole 128 leading to the interior of cylinder 110. Hole 128 may be closed between impacts in a suitable manner, as by a ball 129 held by the pressure of a spring 130 against its seat, at a hole in a partition 131 adjacent the forward end of chamber 112. The fuel, during discharge, flows past the ball 129 and through the spring 130 and outlet hole 128 into engine cylinder 110, as indicated by the flow arrows for injector No. 1 in Fig. 15.

For successive impacts, the impact rod 124 is periodically withdrawn by a 180° cam 132, which is rotated continuously by a shaft 133 in the direction of the arrows of Figs. 16 and 17 and at a rate such that the impact member will deliver a desired number of impacts, such as between five and ten, while the piston 113 is free to be moved due to the free side of cam 117 being adjacent pin 116. Since the position of block 115 will vary slightly in accordance with the number of impact strokes of each series, the rod 124 is returned to the same position after each stroke, but is carried a slightly greater distance by the cam 132 on each successive stroke of a series. For this purpose, a roller 134, as in Figs. 16, 17, and 19, may be mounted for rotation on a pin 135 and disposed within a slot near the forward end of rod 124, but with a portion of the periphery of roller 134 extending below rod 124. As soon as cam 132 reaches the roller 134, the cam will merely rotate the roller, in the direction of the arrow of Fig. 17 without moving rod 124 any further. However, until the terminus of the solid portion of cam 132 is reached, as until cam 132 reaches the dotted position of Fig. 17, when rotating in the direction of the arrow, the rod 124 will be prevented from moving forwardly. But when cam 132 reaches the dotted position, rod 124 will be moved forwardly automatically, to impact block 115, such forward movement being produced while the free side of cam 132 is adjacent rod 124; and as soon as the solid portion of cam 132 again engages rod 124, rod 124 will be moved rearwardly for the next impact. The slight difference between the position of block 115 for successive impacts of a series will not materially affect the amount of liquid ejected, since the amount of compression of spring 127 will determine the impact force, and this compression will be constant for each of a series of impacts. The impacts are continued until rod 124 is arrested in a rear position by a 180° cam 136, extending perpendicularly to and mounted on the shaft 118, and adapted to engage a pin 137 mounted adjacent the forward end of impact rod 124, opposite roller 134. The radial edges of the solid portions of the perpendicular cam 136 and the inclined cam 117 are preferably in longitudinal alignment, and cam 136 is synchronized with cam 132, so that the leading edge of cam 136 will engage pin 137 at a time that rod 124 has been moved to its extreme rear position by cam 132, and cam 136 will hold the impact rod 124 in a rear position while the piston rod 114 is being withdrawn by the inclined cam 117, as will be evident from Fig. 16. While the impact rod 124 is held in rear position by cam 136, i. e., as the solid portion of the cam 136 moves around past the pin 137, the impact cam 132 will continue to rotate but will engage only roller 134. Thus, the impact cam 132 may be rotated continuously but will be inoperative to produce successive impacts, as long as cam 136 engages pin 137. For each engine cylinder, the cams 117 and 136 for injector No. 1 are preferably set at 180° with respect to the corresponding cams for injector No. 2; thus, injector No. 1 will produce fuel injection impacts during the time that the chamber 112 of injector No. 2 is being filled, and vice versa, as will be evident from Fig. 15.

To change the amount of fuel injected into the engine cylinder at each stroke of the impact rod 124, the rear end of spring 127 may bear against a flange 138

mounted on a rod 139 within tube 125, the compression of spring 127 being changed by adjustment of the position of flange 138 through an adjusting lever 140 which is pivotally connected to rod 139 at the rear end of the latter. As will be evident, a change in the position of lever 140 will change the position of flange 138 and thereby change the amount of compression of spring 137, which will in turn determine the relative amount of fuel injected at each impact, i. e., in accordance with the compressive force exerted by the spring 127.

The spring tube 125 may be provided with caps 141 and 141', and the chamber 112 may be provided at its rear end with a cap 142, these caps being provided with suitable apertures for guiding impact rod 124, spring adjusting rod 139 and piston rod 114, respectively. The cams 132 may be provided with a surface 143 (indicated only in Fig. 16), which will produce sufficient friction on the surface of rod 124 that the rod 124 is readily moved by the cam; or the rod 124 may be provided with a friction surface. Such a friction surface may be formed of a material different from that of the rod 124, or may be friction particles in or on a matrix. The position of the various cams may also be adjusted so that the cam 132 will leave the roller 134 at a time sufficiently ahead of the desired time of injection, to compensate for the time delay in the movement of rod 124 forwardly and the projection of the fluid through the engine cylinder hole 128.

The shaft 133 for the impact cams 132 may extend longitudinally of the engine cylinders, so that all of the cams 132 may be driven by the same shaft, while each shaft 118 for cams 117 and 136 may be driven individually by a countershaft (not shown) extending parallel to the impact cam shaft 133. This countershaft and shaft 133 may be driven by suitable gearing from the crankshaft of the engine, in any suitable manner. The levers 140, for adjusting the compression pressure of springs 127, may be connected to a throttle lever, for instance (not shown), for operating all of the levers 140 in unison, so that the amount of fuel to be injected will be adjusted simultaneously for each engine cylinder. Of course, for a substantially constant-speed diesel engine, i. e., one operating an air compressor or the like, the levers 140 may be connected to a suitable load responsive mechanism or governor arrangement, so that as the load increases or decreases, a corresponding increase or decrease in the amount of fuel injected will be obtained to maintain the engine speed at the desired constant rate.

From the foregoing, it will be evident that the liquid ejection devices of this invention fulfill to a marked degree the requirements and objects hereinbefore set forth. By the use of an impact member which periodically engages a plunger, successive portions of liquid may be ejected with considerable force. Resilient means, such as a spring, which opposes movement of the impact member to a position spaced from the plunger, stores energy during the return movement of the impact member, and this energy is converted in large part to inertia energy, which is capable of producing a comparatively sharp blow on the plunger. Due to the normal inertia of liquid, the sharper the blow, the more forcible will be the resulting ejection. The impact member may be moved rearwardly manually, as in the case of the water rifle and water pistol, illustrated and described, or substantially automatically by a cam, as in the case of the water machine gun and diesel engine fuel ejection device described. While the relative amount of liquid ejected at each impact will be substantially the same in the case of the water gun, water pistol, and water machine gun, it may be varied in accordance with the requirement of the engine in the case of the diesel engine fuel ejector. By the use of two injectors for each cylinder, one being filled while the other is ejecting fuel, the impact member may be moved rearwardly and permitted to move forwardly quite quickly,

so that the cam or other device for moving the impact member rearwardly may be operated at a sufficiently high rate of speed to accommodate the usual engine requirements.

Although the preferred constructional details of the various embodiments of this invention have been described with particularity, it will be understood that numerous variations therein may be made and also that other embodiments of this invention may exist, all without departing from the spirit and scope thereof.

What is claimed is:

1. In a liquid ejection device, a relatively fixed container for liquid having an outlet; plunger means within said container for relative movement thereto and adapted to force liquid through said outlet upon forward movement thereof, said container having a sufficient capacity that a succession of forward movements of said plunger will each force liquid through said outlet; an impact member movable between a rear position spaced from said plunger and a forward position in engagement with said plunger, successive forward movements of said impact member producing an impact against said plunger causing said plunger to move forwardly upon each impact; resilient means opposing movement of said impact member to said rear position and adapted to move said impact member forwardly into engagement with said plunger; and means for moving said impact member from a forward position engaging said plunger to said rear position.

2. In a liquid ejection device, as defined in claim 1, including means for holding said impact member in said rear position and for releasing the same.

3. In a liquid ejection device, as defined in claim 1, wherein said means for moving said impact member is periodic in operation.

4. A liquid ejection device comprising a relatively fixed container for liquid having an inlet and an outlet; plunger means within said container for relative movement thereto and adapted to force liquid through said outlet upon movement forwardly and to cause liquid to be drawn through said inlet upon movement rearwardly, said container having a sufficient capacity that a succession of forward movements of said plunger will each force liquid through said outlet; an impact member movable between a rear position spaced from said plunger and a forward position in engagement with said plunger, successive forward movements of said impact member producing an impact against said plunger causing said plunger to move forwardly upon each impact; resilient means opposing movement of said impact member rearwardly to said spaced position and adapted to move said impact member forwardly into engagement with said plunger; and means for moving said impact member rearwardly from said forward position engaging said plunger to said rear position.

5. In a liquid ejection device, as defined in claim 4, wherein said outlet is provided with a valve permitting flow of fluid only outwardly through said outlet.

6. In a liquid ejection device, as defined in claim 4, including resilient means for moving said plunger means rearwardly following rearward movement of said impact means.

7. A liquid ejection device comprising a container for liquid having an inlet and an outlet; a plunger extending within said container for relative movement thereto and adapted to force liquid through said outlet upon forward movement and to cause liquid to be drawn through said inlet upon rearward movement; an impact member movable between a rear position spaced from said plunger and a forward position in engagement with said plunger; resilient means opposing movement of said impact member to said rear position and adapted to move said impact member forwardly into engagement with said plunger; means for moving said impact member from a forward position engaging said plunger to said rear position; means

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for restraining movement of said impact member; and means for moving said plunger rearwardly.

8. In a liquid ejection device, as defined in claim 7, wherein said means for moving said impact member rearwardly includes a cam.

9. In a liquid ejection device, as defined in claim 7, wherein said means for moving said impact member rearwardly comprises a rotating cam engageable with said impact member and a roller mounted on said impact member to limit rearward movement thereof to a position in which said cam engages said roller.

10. In a liquid ejection device, a relatively fixed container for liquid having an outlet; a plunger extending within said container for relative movement thereto and adapted to force liquid through said outlet upon forward movement thereof, said container having a sufficient capacity that a succession of forward movements of said plunger will each force liquid through said outlet; an impact member movable between a rear position spaced from said plunger and a forward position in engagement with said plunger, successive forward movements of said impact member producing an impact against said plunger causing said plunger to move forwardly upon each impact; resilient means opposing movement of said impact member to said rear spaced position and adapted to move said impact member forwardly into engagement with said plunger; means for moving said impact member from said forward position engaging said plunger to said rear position; and a releasable latch device for holding said impact member in said rear position.

11. In a liquid ejection device, a container for liquid having an outlet; a plunger extending within said container for relative movement thereto and adapted to force liquid through said outlet upon forward movement thereof; an impact member movable between a rear position spaced from said plunger and a forward position in engagement with said plunger; resilient means opposing movement of said impact member to said rear position and adapted to move said impact member forwardly into engagement with said plunger; means for moving said impact member from a forward position engaging said plunger to said rear position; and a rotating cam for holding said impact member in said rear position, said impact member having means co-operating with said cam.

12. A liquid ejection device comprising a container for liquid having an inlet and an outlet; a plunger extending within said container for relative movement thereto and adapted to force liquid through said outlet upon forward movement and to cause liquid to be drawn through said inlet upon rearward movement; an impact member movable between a rear position spaced from said plunger and to a forward position in engagement with said plunger; resilient means opposing movement of said impact member to said rear position and adapted to move said impact member forwardly into engagement with said plunger; means, including a rotating cam, for moving said impact member from a forward position engaging said plunger to said rear position; and rotating means associated with said cam means for storing energy for said rotating cam.

13. A liquid ejection device comprising a container for liquid having an inlet and an outlet; a plunger extending within said container for relative movement thereto and adapted to force liquid through said outlet upon forward movement and to cause liquid to be drawn through said inlet upon rearward movement; an impact member movable between a rear position spaced from said plunger and to a forward position in engagement with said plunger; resilient means opposing movement of said impact member to said rear position and adapted to move said impact member forwardly into engagement with said plunger; at least one rotating cam for moving said impact member from a forward position engaging said plunger to said rear position; a crank for effecting rotation of said

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cam; and means associated with said crank and rotating cam for storing energy for said rotating cam.

14. In a liquid ejection device, a container for liquid having an outlet; plunger means within said container for movement relative thereto and adapted to force liquid through said outlet upon forward movement thereof; an impact member movable between a rear position spaced from said plunger and a forward position in engagement with said plunger; a compression spring opposing movement of said impact member to said rear position and adapted to move said impact member forwardly into engagement with said plunger; means for adjusting the compression of said spring; and means for moving said impact member from a forward position engaging said plunger to said rear position.

15. A liquid ejection device comprising a tubular barrel having closed front and rear ends and at its front a space for liquid and an outlet in its front end; a plunger disposed within said barrel for movement relative thereto and adapted to force liquid through said outlet upon forward movement and to cause liquid to be drawn through said inlet upon rearward movement, said plunger including a plug mounted on a rod having a guide flange at the rear end, said flange having a handle extending laterally therefrom and said barrel having a longitudinal slot accommodating movement of said handle; an impact tube having a substantially closed front end and movable within said barrel between a rear position spaced from said plunger and a forward position in engagement with said plunger; a coil spring at least partly received within said impact tube and bearing at its rear against the rear end of said barrel for opposing movement of said impact member to said rear position and adapted to move said impact member forwardly into engagement with said plunger; a handle attached to said tube and extending laterally therefrom, for moving said impact member from a forward position engaging said plunger to said rear position, said barrel having a longitudinal slot to accommodate movement of said tube handle; a rear stock on which said barrel is mounted; and a trigger on said stock for holding said impact tube in a rear position and releasing the same.

16. In a liquid ejection device, as defined in claim 15, wherein said barrel and stock form a rifle; said front and rear ends of said barrel are closed by discs attached thereto; said trigger is provided with a latch point and said impact tube and barrel are each provided with a slot for respectively engaging and accommodating movement of said latch point; and said outlet is formed by a hole in a plate attached to said front disc and extending upwardly to form a front sight.

17. In a liquid ejection device, as defined in claim 15, wherein said barrel outlet is provided with a flexible seal and a tube extending through said seal and movable to different angular positions relative to said barrel.

18. In a liquid ejection device, as defined in claim 15, wherein said barrel and stock form a pistol; the rear end of said barrel is integral therewith; the front end of said barrel is closed by a disc attached thereto by threads and provided with a tube extending therefrom and forming said outlet; said impact tube having a closed front end considerably greater in thickness than the remainder thereof; said impact tube is provided with a handle extending laterally to each side; said trigger includes a lever pivoted at its front end on the underside of said barrel and having a latch point extending upwardly from the central portion thereof, and a trigger member pivotally mounted rearwardly of said lever and pivotally connected to the rear of said lever; and said impact tube and barrel are each provided with a slot for respectively engaging and accommodating movement of said latch point.

19. In a liquid ejection device, a container for liquid having an outlet including a flexible seal and a tube extending through said seal and movable to different angular positions relative to said container; plunger means ex-

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tending in said container for movement relative thereto and adapted to force liquid through said outlet upon forward movement thereof; an impact member movable between a rear position spaced from said plunger and a forward position in engagement with said plunger; resilient means opposing movement of said impact member to said rear position and adapted to move said impact member forwardly into engagement with said plunger; and means for moving said impact member from a position engaging said plunger to said rear position.

20. A water machine gun comprising a container for liquid; a barrel having a water discharge space at the forward end thereof, an inlet communicating with said container, and a discharge outlet at the forward end thereof; a plunger disposed within said barrel for movement relative thereto and adapted to force liquid through said outlet upon forward movement and to cause liquid to be drawn through said inlet upon rearward movement; an impact member within said barrel and movable between a rear position spaced from said plunger and to a forward position in engagement with said plunger; a spring for moving said plunger rearwardly after each impact; a spring in the rear end of said barrel opposing movement of said impact member to said rear position and adapted to move said impact member forwardly into engagement with said plunger; a pair of rotating cams for moving said impact member from a forward position engaging said plunger to said rear position; a crank for rotating said cams; a coil spring connected between said crank and said cams; a rotating inertia wheel associated with each said cam for storing energy for said rotating cams; and a brake engaging one said inertia wheel.

21. A water machine gun, as defined in claim 20, wherein said barrel extends through said container; said inlet includes a flap valve; said outlet includes a spring pressed flap valve and a tube pointed upwardly; said cams are mounted on a shaft disposed above said barrel with one cam on each side of said barrel; said impact member is provided with a pin extending laterally at each side and each said pin is provided with a cam engaging roller; said barrel is mounted in a frame having a rear leg and extending to said container and said barrel and frame are provided with side slots to accommodate movement of said pins; said container is provided with a pair of legs; said cam shaft is provided with a fixed roller inwardly of each cam for engaging a rotating inertia wheel; and a shaft for said inertia wheels is disposed parallel to said shaft for said cams.

22. A water machine gun, as defined in claim 21, wherein said inertia wheel shaft is mounted on pivoted bearing elements; and a spring extends to said bearing elements for urging said inertia wheels against said rollers.

23. A fuel injection device for an internal combustion engine cylinder, comprising a pair of liquid ejection devices, each including a container for liquid fuel having an inlet and an outlet leading to said cylinder, a plunger extending within said container for movement relative thereto and adapted to force liquid through said outlet and into said cylinder upon forward movement and to cause liquid to be drawn through said inlet upon rearward movement, an impact member movable between a rear position spaced from said plunger and to a forward position in engagement with said plunger, resilient means opposing movement of said impact member to said rear

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position and adapted to move said impact member forwardly into engagement with said plunger, means for moving said impact member from a forward position engaging said plunger to said rear position, and means for moving said plunger rearwardly to fill said container; and means for controlling the operation of said ejection devices so as to cause the impact member of one ejection device to execute a plurality of strokes while the container of the other ejection device is being filled, said ejection devices thereby operating alternately to inject fuel into said cylinder.

24. In a fuel injection device for an internal combustion engine, as defined in claim 23, wherein each said ejection device includes a first cam shaft, an inclined cam on said shaft for moving said plunger rearwardly, said plunger being mounted on a rod and said rod having a cam engaging pin, a perpendicular cam on said first cam shaft for holding said impact member in a rear position, said cams extending for substantially 180° peripherally; and said injection device includes a second cam shaft and a pair of cams thereon for engaging said impact members and moving the said impact members rearwardly, and means for rotating said first cam shafts so that the said cams thereon for the respective ejection devices will operate 180° apart.

25. In a fuel injection device for an internal combustion engine, as defined in claim 24, wherein each said impact member comprises a rod having a pin engageable by said perpendicular cam and a roller opposite said pin and engageable by said cam on said second cam shaft when said impact rod is moved rearwardly to a predetermined position; said resilient means each comprises a spring bearing at the front against an impact member and at the rear against a movable element; and said device includes, for each spring, a lever and a rod pivoted thereto and connected with said movable element for adjusting the compression of said spring.

26. A trigger for a water pistol or the like having a barrel, comprising a lever pivoted at its front end on the underside of said barrel and having a latch point extending upwardly from the central portion thereof; and a trigger member pivotally mounted rearwardly of said lever and pivotally connected to the rear of said lever.

27. A trigger for a water pistol or the like, as defined in claim 26, wherein said lever is provided with a longitudinal slot adjacent its rear end, and a latch point disposed centrally thereof and extending upwardly, said latch point having an inclined front edge; said trigger member is provided with a projection engaging said lever slot; said trigger member is pivoted on a pin; and a coil spring extends around said pin and one end thereof engages said trigger member to urge said trigger member in a direction to move said lever upwardly.

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