March 26, 1940. V. R. PETTY 2,195,037

FUEL METERING AND INJECTING DEVICE FOR INTERNAL COMBUSTION ENGINES

Filed April 6, 1937 2 Sheets-Sheet 1

FIG. 1.

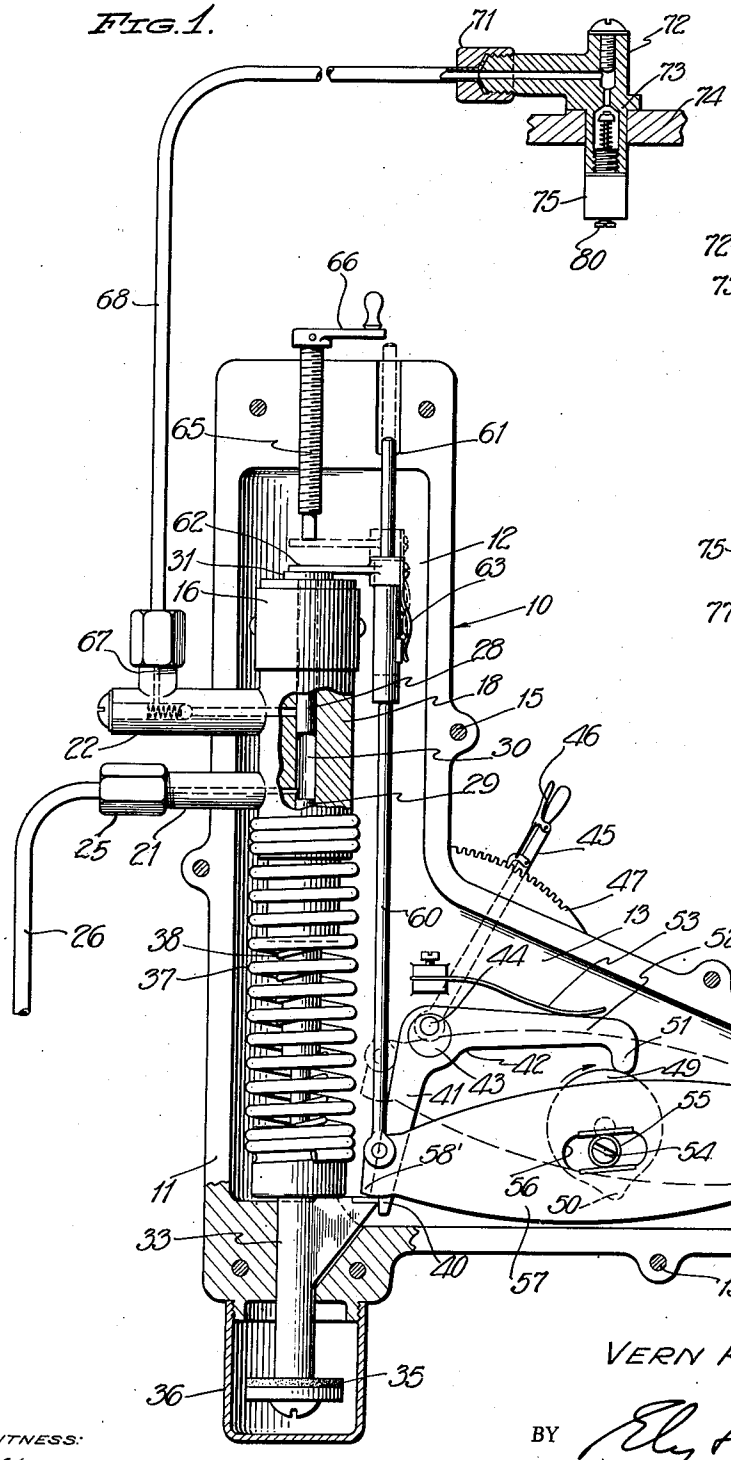
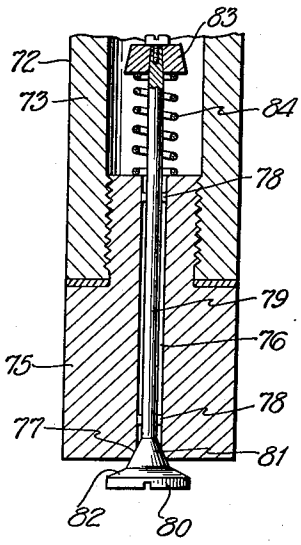


FIG. 4.



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FIG. 2.

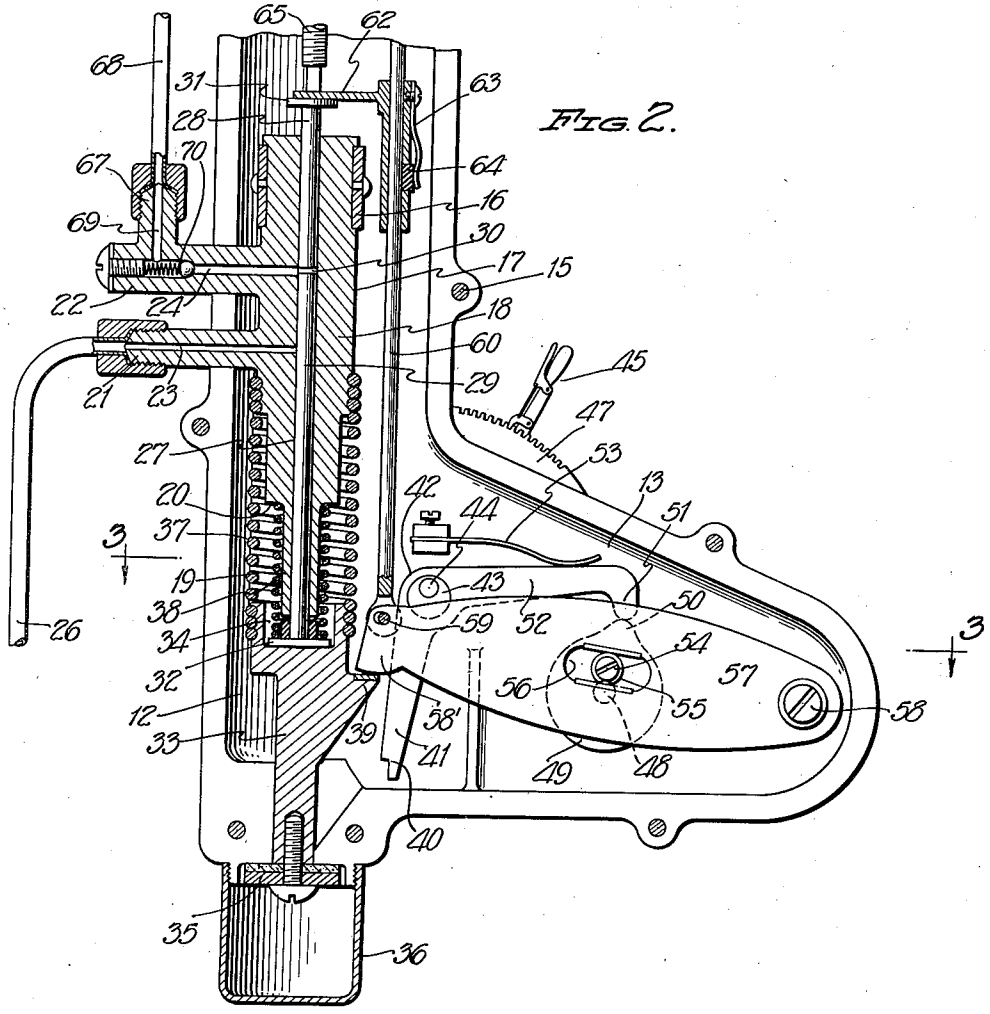
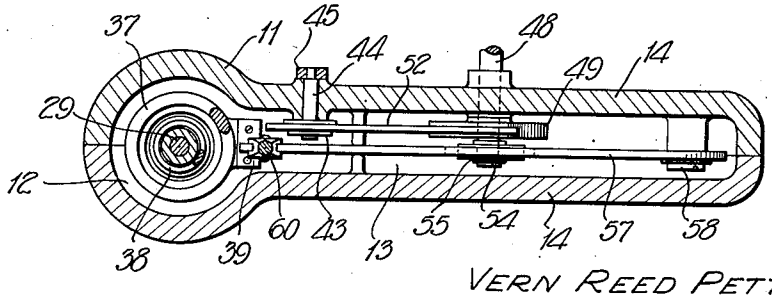


FIG. 3.



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2,195,037

UNITED STATES PATENT OFFICE

2,195,037

FUEL METERING AND INJECTING DEVICE FOR INTERNAL COMBUSTION ENGINES

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Application April 6, 1937, Serial No. 135,254

5 Claims. (Cl. 103—37)

This invention relates to improvements in fuel injectors in general and more particularly to a device for injecting and atomizing fuel at high pressure directly into the combustion chamber of compression ignition engines.

Whereas the fuel injectors of the kind to which my invention relates may be employed for use with various types of internal combustion engines, the same is primarily designed for use upon Diesel type engines wherein high pressure fuel injection in accurate intermittent predetermined quantities is essential to the efficient and economical operation of the engine, and it is with these features in mind that my improved fuel injector has been designed.

Another feature of the invention is to provide a high velocity engine fuel injector in which the control of the volume of fuel injected on each operation may be varied and the timing operation proportionately regulated to assure efficient operation of the engine.

A further feature of the invention is the provision of an engine fuel injector which is novel and compact of construction, inexpensive of manufacture, which renders the same adaptable for building in relatively small sizes for operation in connection with miniature Diesel engines, as well as in proportionate larger sizes for conventional size Diesel engines.

With these and other objects in view, the invention consists in the novel construction, combination, and arrangement of parts, the essential features of which will be hereinafter fully described in the following annexed specification, pointed out in the appended claims, and illustrated in the accompanying drawings, in which:

Figure 1 is a sectional side elevational view of the invention illustrating the parts in non-fuel injecting position.

Figure 2 is a fragmentary vertical sectional view through the fuel injector device with parts in fuel injecting position.

Figure 3 is a horizontal sectional view on the line 3—3 of Figure 2.

Figure 4 is an enlarged detail vertical sectional view through the fuel atomizing element.

Referring to the drawings by reference characters, the numeral 10 designates my improved fuel injector device in its entirety which includes a housing 11 having a vertically disposed cylindrical compartment 12 and an outwardly extending compartment 13 communicating with the lower end of said cylindrical compartment 12. The housing 11 is preferably formed of two housing sections 14—14 secured together by bolts or other fastening elements 15.

Suspended within the cylindrical compartment 12 by a bracket or collar 16 carried by the side wall of the said compartment is a metering element 17 which comprises a cylindrical body 18 having a reduced portion 19 at its lower end defining a shoulder 20. Spaced parallel horizontally disposed nipples 21 and 22 extend from the body 18 adjacent its upper end and which nipples are provided with fuel inlet and outlet passages 23 and 24 respectively. The inlet nipple 21 is connected by a coupling nut 25 to one end of a suction fuel supply pipe 26, the other end of the same being connected to a source of fuel supply, which is in the form of oil for Diesel type engines and other liquids for other type internal combustion engines.

The inlet and outlet passages 23 and 24 respectively connect with a bore 27 extending centrally and for the full length of the body 18. The bore 27 is of a uniform diameter throughout its length and freely slidable therein is an upper floating plunger 28 and a longer lower force plunger 29, the inner end of the plungers 28 and 29 being spaced apart to provide a variable metering chamber 30 therebetween. The upper end of the plunger 28 extends beyond the top of the body 18 and terminates in a flat stop head 31. The lower end of the plunger 29 extends below the reduced end of the body 18 and terminates in a flat stop head 32.

Slidably mounted in the bottom of the cylindrical compartment 12 in axial alinement with the plunger 29 is a tappet member 33 having a recessed seat 34 in its top which receives the flat stop head 32. The lower end of the tappet member is provided with a flat stop head 35 which abuts against the bottom of the housing when the tappet member is at the limit of its upward movement for the purpose of limiting such upward movement. A cup shaped cap 36 is threaded to the bottom of the housing and encloses the lower head end of the tappet member. A contractile spring 37 has its upper end secured to the metering body 18 while its lower end is secured to the upper end of the tappet member which places a tension upon the tappet member to normally urge the same and the plunger 29 upwardly. An expansion spring 38 of a tension less than the springs 37 encircles the reduced extension 19 and has its upper end seated against the shoulder 20 and its lower end against the flat stop head 32 to yieldably hold the lower end of the plunger 29 against the tappet member 33.

Extending from the tappet member 33 in the direction of the compartment 13 is a shoulder 39 the same adapted to be engaged by the notched end 40 of one arm 41 of a bell crank lever 42 to hold the tappet member 33 "cocked" in a down position against the tension of the spring 37 as shown in Figure 1 of the drawings. The bell crank lever 42 is pivoted on an eccentric 43 fixed to a stub shaft 44 mounted in one side wall of the compartment 13. Fixed to the outer end of the stub shaft 44 is a lever 45 provided with a releasable catch means 46 at its handle end which engages teeth upon a fixed tooth segment 47. By actuation of the lever 45, the eccentric 43 may be turned to laterally adjust the pivotal axis of the bell crank lever 42 for timing purposes hereinafter to be described.

Journaled in one side wall of the compartment 13 is a driven shaft 48 on which a cam 49 is fixedly mounted and which is disposed in the same plane but below that of the bell crank lever 42. The cam 49 is provided with a high spot or nose 50 which engages the downwardly extending finger 51 provided on the arm 52 of the bell crank lever for the purpose of actuating the bell crank lever to release the notched end 40 thereof from the shoulder 39 on each revolution of the cam 49. A flat spring 53 has one of its ends fixed to a wall of the housing 11 and its other end bearing against the arm 52 of the bell crank lever to hold the finger 51 against the peripheral surface of the cam 49.

Extending from one side of the cam 49 and offset from the axis thereof is an eccentric pin 54 which carries a roller 55, the same being disposed within an elongated slot 56 provided in a rocker arm 57, one end of which is pivoted to the housing as at 58. The other or nose end 58' of the rocker arm 57 terminates in the path of the shoulder 39 of the tappet member 33 for engagement therewith and has pivoted thereto as at 59, the lower bifurcated end of a push rod 60. The push rod 60 rises vertically in the cylindrical compartment 12 and its upper end has free sliding movement in a bearing 61 in the top of said compartment.

Carried by the push rod 60 adjacent its upper end is a floating plunger return tappet 62, the same being yieldably held to the push rod by a spring 63 carried by the tappet 62 and which presses against a friction brake shoe 64 which has direct bearing contact with the push rod 60. It is essential that the push rod 60 have relative movement with respect to the tappet 62 as will be hereinafter explained.

Upon the upstroke of the push rod 60, the tappet 62 is engaged with an adjustable control stop in the form of a screw 65 threaded in the top of the cylindrical compartment 12, the outer extending end being provided with a crank handle 66.

The outlet nipple 22 is provided with an upstanding nipple 67 to which one end of a high pressure fuel outlet pipe 68 is connected. Interposed between the outlet pasage 24 and the duct 69 passing through the nipple extension is a spring actuated resistance valve 70, which normally closes the outlet passage 24 to prevent the back flow of fuel oil from the outlet pipe 68 into the outlet passage 24 and metering chamber 30, and to resist the outward flow of fuel through the outlet passage until the plunger 28 is forced completely up against the stop 65.

The other end of the high pressure outlet pipe 68 is connected by a coupling 71 to a fuel atomizer 72, having a sleeve body 73 secured within the top of an engine cylinder 74. Threaded to the body 73 is an atomizer tip 75 having a central bore 76 passing vertically therethrough. The lower end of the bore 76 terminates in an outwardly beveled seat 77 while formed in the bore adjacent opposite ends are radial bearing elements 78 for slidably guiding a stem 79. The stem 79 is of a diameter less than the bore 76 to provide a passage for the fuel to be atomized and carried by the lower end of the stem is a deflector head 80. The head 80 is provided with an inverted cone shaped portion 81 for seating engagement with the beveled seat 77, and an exposed deflector surface 82, the angle of which is greater than that of the cone shaped portion 81 for the purpose of spreading and thinning of the film of fuel passing through the discharge end of the duct 76. The upper end of the stem 79 extends above the top of the tip 75 into the body 73 and carries a head 83. Interposed between the head 83 and the top of the tip 75 is an expansion spring 84 which tends to hold the cone shaped valve 81 against the seat, but the tension of this spring is such that it will yield by pressure impulses imparted to the head end 80 of the stem by the fuel oil forced through the duct 76.

In operation of the device, assume that the pipe line 26 is connected with a source of fuel oil supply and the outlet pipe 68 to the atomizer 72 is primed with fuel oil, the valve 81 being in engagement with the seat 77, and the parts being in the position shown in Figure 1 of the drawings wherein the eccentric roller 55 is at approximately its lowest position. The movement of the eccentric roller 55 from its high position to the low position has caused the nose end 58' of the rocker arm 57 to engage the shoulder 39, and caused the tappet member 33 to move downwardly against the action of the spring 37. On the down stroke of the tappet member 33, the contractile spring 37 is placed under greater tension due to the stretching action imparted to the spring while the lower plunger has followed and kept up with the downward movement of the tappet member by reason of the expansion spring 38. At the same time the push rod 60 is moved downward carrying with it the floating tappet 62 by reason of the friction means 63 which releasably connects the tappet member 62 with the rod 60. The floating tappet member 62 by reason of its overlapping of the stop head 31 on the floating plunger 28, moves the said plunger 28 downwardly until the flat stop head 31 abuts the top of the metering body 18 at the extreme lower position of the tappet member 33, the arm 52 of the bell crank lever 42 is in its lowermost position by engagement of the finger 51 with the plane surface of the cam 49, thus the spring 53 has moved the depending arm 41 of the bell crank lever into a position where the notched end 40 of the arm 41 is engaged with the shoulder 39 of the tappet member 33, thus locking the tappet member in lowered position against the tension of the spring 37. During the down stroke of the push rod 60, the floating plunger 28 has moved to its lowermost position, the inner end of the said plunger extending inwardly beyond the outlet passage 24 to shut off said passage from the bore 27, during which operation, the plunger 29 continues its downward stroke creating a partial vacuum in the metering chamber 30 due to the relative movement of the lower plunger 29 with respect to the floating plunger 28. The lower plunger 29 continues downward until it is moved below the

plane of the fuel inlet passage 23 and the vacuum which has been created in the chamber 30 between the adjacent ends of the plungers 28 and 29 causes a suction in the fuel supply pipe 26, which suction causes the chamber 30 to fill up with oil preparatory to the return upward movement of the lower plunger 29. By reference to Figure 1 of the drawings, it will be appreciated that the distance between the adjacent ends of the plungers 28 and 29 predetermines the amount of fuel to be injected under presure upon each operation of the device. Continuing with the sequence of operation, it follows that as the cam 45 continues to turn, the eccentric roller 55 will move the rocker arm 20 to its raised position at which time the push rod 60 is moved upwardly carrying with it the floating tappet 62 by reason of the latter's releasable friction connection 63 with the push rod. The floating tappet 62 moves upwardly until it engages the inner end of the adjustable control stop 65, which engagement stops the upward movement of the floating tappet 62, but by reason of the friction device 63, the push rod 60 is permitted to continue upwardly to the limit of its full stroke. At or near the extreme limit of upward movement of the rocker arm 57, the nose 50 of the cam 49 engages the finger 51 of the arm 52 of the bell crank 42, causing the arm 41 of the bell crank lever to move inwardly away from its engagement with the shoulder 39 of the tappet member 33, thus releasing the tappet member for upward movement under the built up pressure of the contractile spring 37. As the tappet member 33 moves upwardly under the pressure of the tension spring 37, the lower plunger 29 also moves upwardly under this pressure until the flat top head 35 engages beneath the bottom of the housing 11. As the plunger 29 moves upwardly under the tension of the spring 37, it causes a pressure rise in the fuel trapped in the space or chamber 30 causing the plunger 28 to move upwardly to uncover the fuel outlet passage 24 as clearly illustrated in Figure 2 of the drawings. The floating plunger 28 will rise upwardly until the flat stop head 31 engages the tappet 62, while the lower plunger 29 continues its upward movement toward the now stationary plunger 28, thus forcing the trapped fuel oil in the chamber 30 out through the passage 23, causing the valve 70 to open and enabling the pressure to rise in the outlet pipe 68, atomizer 72, and causing a charge of fuel oil to enter the cylinder of the engine through the duct 76 in the tip 75, the charge of fuel oil being broken up as it enters the cylinder by reason of the differential in the angular surfaces of the valve 81 and deflector surface 82. Upon the discharging of a predetermined amount of fuel into the combustion chamber, the spring 84 returns the head 80 to its original closed position. This same cycle of operation occurs during each rotation of the cam 49 carried by the driven shaft 48.

It is to be noted that the stroke of the floating plunger 28 may be varied in any degree by adjusting the stop 65, the adjustment which is possible being from a zero point up until the stroke of the plunger 28 is equal to the stroke of the lower pressure plunger 29. It will be undestood that when the stop 65 is adjusted at zero point, the movement of the two plungers is identical, but that under such conditions the necessary pressure for the charge of fuel could not be built up for it is the differential in stroke of the two plungers which builds up the pressure necessary to inject a predetermined charge of fuel into the discharge pipe 68.

By actuation of the control lever 45, the eccentric pivot 43 for the bell crank lever 42 may be so adjusted that the notched end 40 of the bell crank lever releases the tappet member 33 earlier or later in relation to the turning movement of the cam 49, thereby causing injection and combustion at the atomizer tip 75 to take place earlier or later in relation to the position of an engine piston. It is also pointed out that the spring actuated retard valve 70 is not in reality a check valve but acts in a capacity to resist the flow of fuel through the discharge passage 24 until the plunger 28 is forced completely up against the stop 65. Without the valve 70, the inertia of the plunger 28 would cause a slight flow of fuel through the outlet passage and atomizer tip 75 before the stop was reached with the effect of preignition and a lesser sharp injection and cut off of the fuel.

When the upward movement of the plunger 29 raises the pressure in the outlet pipe 68, the spring 84 of the atomizer is slightly compressed, thus forcing the fuel to flow down through the duct 76 around the stem 79 past the seat 77 at a relatively high velocity, it being understood that this pressure has caused the unseating of the valve portion 81 with the seat 77. The thin film of fuel oil traveling in high velocity and at an angle with respect to the seat 77, comes in contact with the increased angle 82 of the deflector head 80, causing the fuel to break up into finely divided particles as it leaves the edge of the deflector head 80. While certain deflecting angles have been shown in the drawings, I do not wish to limit myself thereto for penetration of the combustion chamber of an engine can be controlled by the difference in angles between the seat 71 and the deflector surface 82 of the deflector head 80.

Having shown and described what I consider to be the most practical embodiment of my invention, I wish it to be understood that such changes and alterations as come within the scope of the appended claims may be resorted to if desired.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. A device for injecting fuel at high pressures into the combustion chamber of an internal combustion engine comprising an elongated body having a bore of a uniform diameter extending longitudinally therethrough, a fuel inlet, a fuel outlet disposed above said fuel inlet, both said fuel inlet and said fuel outlet opening into said bore, a check valve in said outlet, a floating plunger slidably mounted in the top of said bore and closing said outlet when in lowered position, a compression plunger slidably mounted in the lower end of said bore and having its inner end disposed below the plane of said fuel inlet when said compression plunger is in lowered position, the inner ends of said plungers being disposed in spaced relation to provide a fuel measuring and compression chamber, spring means tending to move said compression plunger upwardly to close said inlet and compress a charge of fuel taken into said fuel chamber, releasable means acting to secure said compression plunger in lowered position against the tension of said spring means, adjustable stop means for limiting the upward movement of said free floating plunger to a position clear of said outlet during the upward com-

pression movement of said compression plunger, stop means for limiting the upward movement of said compression plunger after it has traveled upward a distance to close said inlet and for a distance relatively greater than said floating plunger to compress a charge of fuel within said compression chamber, actuating means for operating said releasable means to enable said spring means to move said compression plunger upwardly, means for subsequently returning said compression plunger to lowered position against the action of said spring means to be engaged and held by said releasable means for subsequent release by said actuating means, and adjustable means for regulating the operation of said releasable means in variable timed relation to said actuating means.

2. In a fuel injector for internal combustion engines, a body having a bore therein, an upper floating plunger, a lower compression plunger, said plungers sliding in said bore through the respective opposite ends of said body and movable simultaneously in the same direction but for different distances relative to each other, inlet and outlet passages communicating with said bore, a slidable push rod, a tappet, friction means securing said tappet to said push rod for holding the same in the path of upward movement of said floating plunger, stop means in the path of upward movement of said tappet, spring means tending to move said lower compression plunger upwardly, means acting to move said compression plunger downwardly against the action of said spring means and simultaneously move said push rod downwardly to cause the tappet to press downwardly upon said floating plunger, releasable means for holding said compression plunger down against the action of said spring means, and intermittent means for operating said releasable means and push rod in timed relation.

3. In a fuel injector for internal combustion engines, a body having a bore therein, an upper floating plunger, stop means for limiting the downward movement of said upper floating plunger, a lower compression plunger, said plungers being slidable in said bore, superposed inlet and outlet passages communicating with said bore, a slidable push rod, a tappet, means for mounting said tappet upon said push rod in the path of upward movement of said upper plunger for normal movement therewith and for sliding movement relative thereto, means for limiting the upward sliding movement of said tappet relative to the upward movement of said push rod, means for imparting reciprocation to said lower compression plunger, and means for imparting reciprocation to said push rod in timed relation to the reciprocating movement of said lower compression plunger.

4. In a fuel injector for internal combustion engines of the Diesel type, a body having a bore therein, an upper floating plunger, stop means for limiting the downward movement of said upper floating plunger, a lower compression plunger, said plungers sliding in said bore and movable simultaneously in the same direction but for different distances relative to each other, inlet and outlet passages communicating with said bore, a slidable push rod, a tappet, tensioned means securing said tappet to said push rod for movement with said push rod and to permit said push rod to slide relative to said tappet, said tappet being disposed in the path of upward movement of said floating plunger, stop means in the path of upward movement of said tappet, and means adapted to be driven by an engine with which the fuel injector is associated for controlling and imparting reciprocating movement to said compression plunger and said push rod in timed operative relation.

5. In a fuel injector for internal combustion engines of the Diesel type, a body having a bore therein, an upper floating plunger, stop means for limiting the downward movement of said upper floating plunger, a lower compression plunger, said plungers sliding in said bore and movable simultaneously in the same direction but for different distances relative to each other, inlet and outlet passages communicating with said bore, a slidable push rod, a tappet, tensioned means securing said tappet to said push rod for movement with said push rod and to permit said push rod to slide relative to said tappet, said tappet being disposed in the path of upward movement of said floating plunger, stop means in the path of upward movement of said tappet, spring means tending to move said lower compression plunger upwardly, means acting to move said compression plunger downwardly against the action of said spring means and simultaneously move said push rod downwardly to cause the tappet to press downwardly upon said floating plunger, releasable means for holding said compression plunger down against the action of said spring means, intermittent means for operating said releasable means, and manually actuated means for regulating the operation of said releasable means in varied timed relation to the operation of said intermittent means.

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