

March 22, 1960

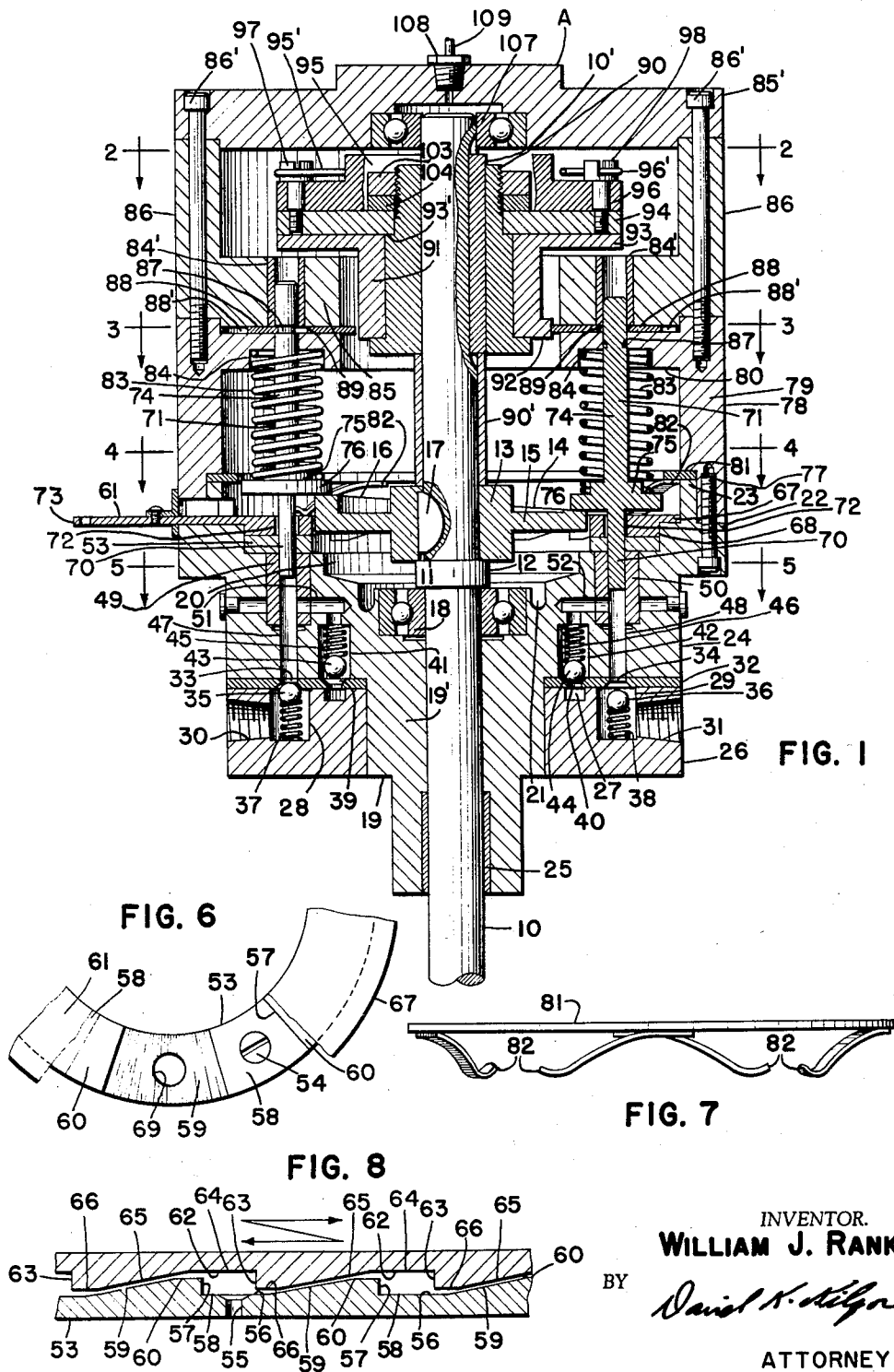
W. J. RANK

2,929,371

FUEL INJECTOR FOR AN INTERNAL COMBUSTION ENGINE

Filed April 30, 1958

3 Sheets-Sheet 1



INVENTOR.
WILLIAM J. RANK

BY

David H. Hilgore

ATTORNEY

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W. J. RANK

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FIG. 2

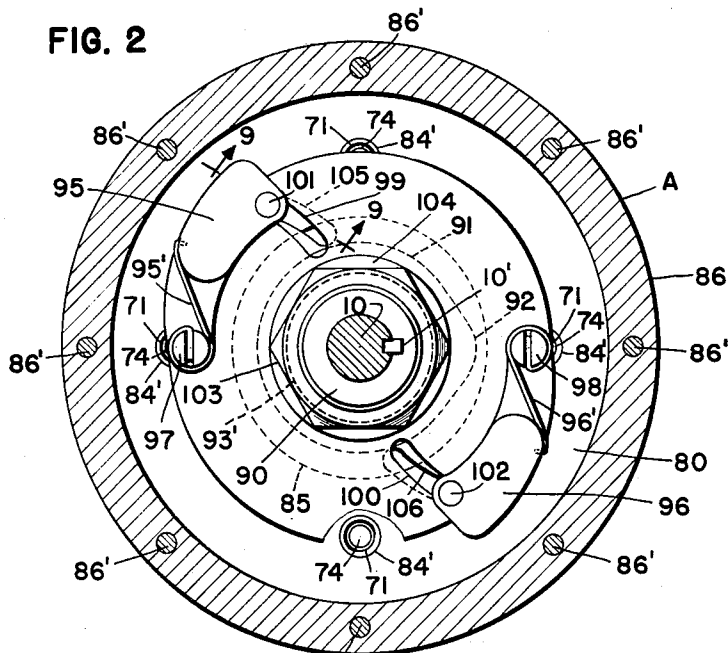
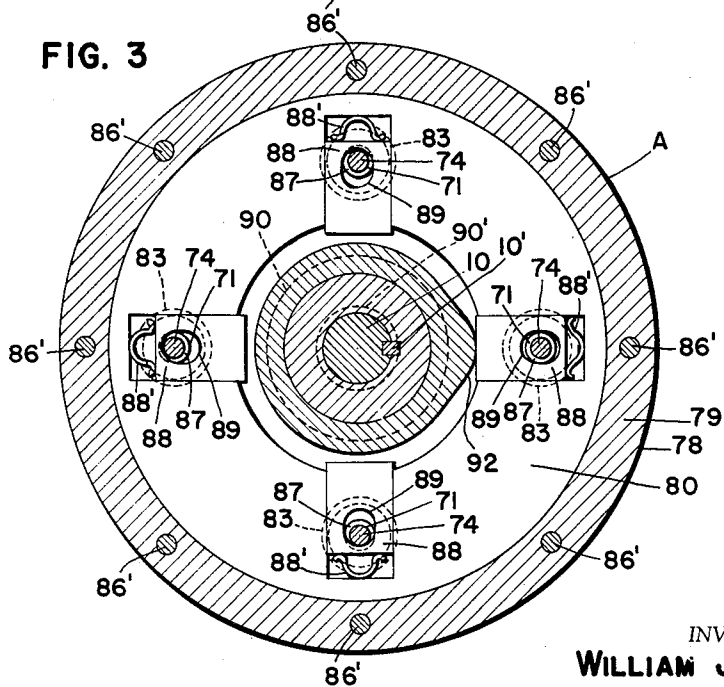


FIG. 3



INVENTOR.

WILLIAM J. RANK

BY

David H. Kelyne

ATTORNEY

March 22, 1960

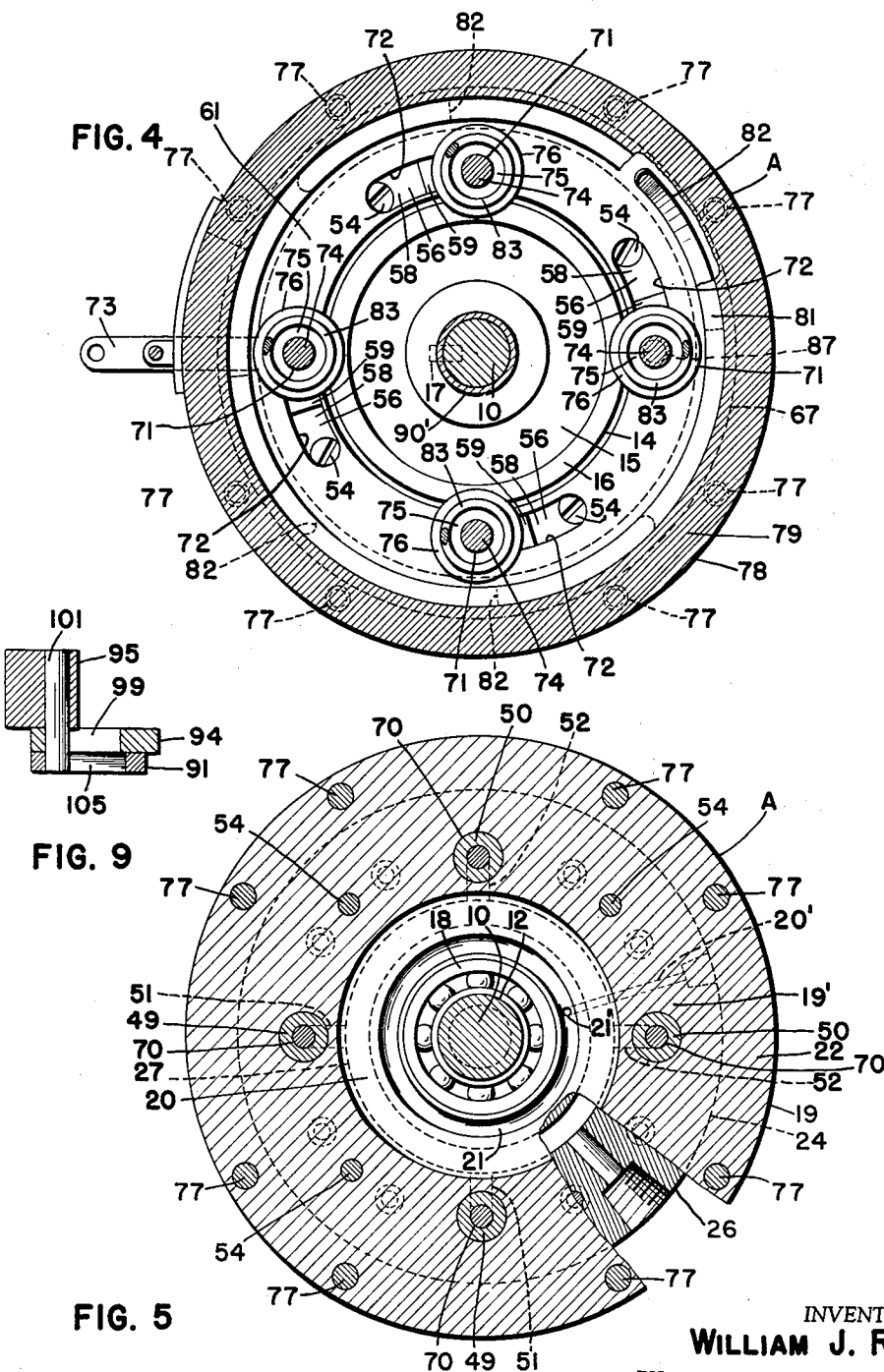
W. J. RANK

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FUEL INJECTOR FOR AN INTERNAL COMBUSTION ENGINE

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3 Sheets-Sheet 3



INVENTOR.
WILLIAM J. RANK
BY *David K. Kilgore*
ATTORNEY

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FUEL INJECTOR FOR AN INTERNAL COMBUSTION ENGINE

William J. Rank, Minneapolis, Minn.

Application April 30, 1958, Serial No. 731,911

7 Claims. (Cl. 123—139)

My invention relates to an improvement in a fuel injector for an internal combustion engine.

It is an object of my invention to provide a fuel injector unit having means for metering fuel to the engine in the required amounts for maximum efficiency. It is also an object to provide means for maintaining a constant velocity of the fuel entering each cylinder of the engine. It is a further object to provide means which controls the time of injection and supplies fuel in equal amounts to each cylinder. It is a still further object to provide means for maintaining combustion so that detonation will not take place.

It is an additional object to provide a fuel injector having delivery pump means having a reciprocating piston means the length of the stroke of which may be varied at will to control the operating speed of the engine.

I shall not here attempt to set forth and indicate all of the various objects and advantages incident to my invention but other objects and advantages will be referred to in or else will become apparent from that which follows.

The invention will appear more clearly from the following description when taken in connection with the accompanying drawings, showing by way of example a preferred embodiment of the inventive idea wherein like numerals refer to like parts throughout.

In the drawings forming part of this application:

Figure 1 is a vertical sectional view taken through my fuel injector.

Figure 2 is a sectional view taken on the line 2—2 of Figure 1.

Figure 3 is a sectional view taken on the line 3—3 of Figure 1 showing three of the four pistons in locked position.

Figure 4 is a sectional view taken on the line 4—4 of Figure 1.

Figure 5 is a sectional view taken on the line 5—5 of Figure 1.

Figure 6 is a fragmentary top plan view of the stationary cam member.

Figure 7 is an elevational view of a pressure member removed from my fuel injector.

Figure 8 is a fragmentary sectional detail taken through the contacting stationary and rotating cam member in a partially open position.

Figure 9 is a fragmentary sectional view, taken on the line 9—9 of Fig. 2.

Referring to the drawings in detail, my fuel injector A is illustrated as including means for supplying fuel to four cylinders which may be varied within the concept of the invention. The injector includes the driven distributor shaft 10 formed with a keyway 11 and the collar 12 on which rests the hub portion 13 of the circular loading cam 14. The cam 14 also includes the circular plate portion 15 formed integral with the hub 13 and on the outer periphery of which is formed the circular ramp 16. The cam 14 is keyed to the shaft 10 by means of the key 17 positioned in the keyway 11. The collar

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12 of the shaft 10 rests on the bearing 18 mounted in a recess formed in the cylindrical lower shaft support 19 having the main portion 19', the shaft 10 extending axially and rotatably through the support 19. The upper central portion of the support 19 is formed with circular recess 20 terminating in the annular groove or oil sump 21 from which oil drains through the outlet hole 21' and through the passageway 20' to suitable collecting and return means not shown.

The support 19 includes the outer flange portion 22 from which extends the upright annular wall portion 23. The support 19 also includes the reduced cylindrical portion 24 and the bushing 25. Securely fitted to the reduced cylindrical portion 24 is the annular fuel manifold body 26 which is formed with the annular fuel supply channel 27. The manifold body is also formed with the four exhaust chambers, only two of the same being shown as 28 and 29. The ports 30 and 31 are formed in the manifold body 26 leading from each of the chambers 28 and 29 respectively.

Interposed between the main shaft support portion 19' and the manifold body 26 is the check valve seat spacer 32 which has formed in the under surface thereof and in axial alignment with the chambers 28 and 29, the exhaust valve seats and openings 33 and 34 respectively which receive the check valve balls 35 and 36 respectively. The balls 35 and 36 are urged into contact with the seats 33 and 34 respectively by means of the check valve coil springs 37 and 38 respectively positioned within the chambers 28 and 29. Formed in the upper surface of the spacer 32 adjacent the seats 33 and 34 are the intake valve seats and openings 39 and 40 in axial alignment with the intake chambers 41 and 42 respectively formed in the main shaft support portion 19'. The check valve balls 43 and 44 are positioned within the chambers 41 and 42 and urged upon the seats 39 and 40 respectively by means of the check valve springs 45 and 46.

Formed within the body portion 19' and in axial alignment and connection with the valve seat openings 33 and 34 are the bores 47 and 48 respectively, which extend through the body 19' and the cylinder sleeves 49 and 50 mounted in the body portion 19'. The intake chambers 41 and 42 are connected to the bores 47 and 48 respectively by means of the conduits 51 and 52 respectively. Positioned within an annular recess formed axially within the upper portion of the support body 19' is the circular lower stationary throttle cam 53 having a central opening and secured in position by means of the bolts 54 extended through the holes 55 formed in the cam 53.

The stationary cam 53 has formed in the upper surface thereof the notches 56 which include the vertical shoulder 57, the flat lower depressed portion 58 extending from the shoulder 57 and the inclined ramp portion 59 extending from the portion 58 and terminating in the upper flat portion 60 parallel to the depressed portion 58 and the bottom surface of the cam. As a part of the cam unit, I provide the upper circular movable throttle cam 61 which is formed with notches 62 identical with those of the stationary cam 53 and having the vertical shoulder 63, the depressed portion 64 extending from the shoulder, and the inclined ramp portion 65 extending from the portion 64 and terminating in the flat portion 66. The inclined ramp portions 65 of the movable cam 61 overlap and coact with the inclined ramp portions 59 of the stationary throttle cam 53.

The upper movable cam 61 is the same diameter and width as the lower cam but has an annular lip portion 67 extending from the outer periphery thereof. Both cam members 53 and 61 are positioned in a circular recess 68 formed in the flange portion 22. The lower stationary cam 53 is formed with holes 69 through which each of the lower portions 70 of the injection pistons

71 freely extend. The upper movable cam 61 is formed with the slots 72 through which the plunger portions 70 of the piston 71 extend, and as a result the upper cam 61 may be rotatively moved upon and relative to the lower cam and the piston plunger portion 70.

The upper throttle cam 61 has extending therefrom the throttle arm 73 whereby the cam 61 may be moved. The injection piston 71 includes the main cylindrical body portion 74, and formed on the lower portion thereof is the annular shoulder 75 and the outstanding larger annular stop shoulder 76 as a part thereof and terminating in the piston plunger portion 70 which operates in a sleeve such as 49.

Mounted on the flange 22 by means of the bolts 77 and adjacent the upright annular wall 23 is the annular intermediate housing portion 78 formed of the outer wall portion 79 and the top circular flange portion 80. Secured between a portion of the wall 79 and the top of the annular wall 23 is the circular flat ring plate 81 having the spring fingers 82 secured to the under side thereof which suppress the upper throttle cam 61 upon the lower cam 53. It will be seen that the ramp 16 of the loading cam rotates in a position under the annular shoulder 76 and in contact therewith whereby the pistons 71 are raised and lowered.

The pistons 71 are urged downwardly by the coil springs 83 positioned in a recess 84 formed in the circular flange portion 80 and on the shoulder 75 and upon the stop shoulder 76. The upper end of the piston portion 74 is slidably positioned in a piston guide sleeve 84' secured in the annular flange portion 85 of the upper housing body 86. The upper housing 86 is secured to the housing portion 78 by means of the bolts 86' extending through the cap 85'. In addition, the upper end of the piston portion 74 is formed with an annular slot 87. Slidably positioned between the flange portion 89 of the intermediate housing 78 and the flange portion 85 are the flat injection piston-locking slides 88 which are generally rectangular in form and have formed therethrough the slightly elongated slots 89 through which the piston portion 74 movably extends. The slides 88 are urged inwardly of the unit by means of the springs 88', and in such position the slide 88 engages the annular slot 87 thereby holding the piston 71 in its upward or outer position relative to the bore or cylinder 47.

Keyed to the upper end of the shaft 10 by means of the key 10' is the cylindrical timing cam holder 90 and mounted on the holder 90 is the timing cam sleeve 91 formed with the single lobe 92 and the upper circular flange portion 93, the lobe 92 traveling in the plane of the slides 88. The timing cam 91 rotates within the axial opening formed in the flange portion 85. A spacer sleeve 90' is positioned on the shaft 10 between the cam holder 90 and the hub 13 of the loading cam 14.

Mounted on the flange portion 93 of the timing cam 91 and the shoulder 93' portion of the cam holder 90 is the circular fly-weight holder plate 94 which therefore rotates with the shaft 10. The fly-weights 95 and 96 are pivotally mounted on the pins 97 and 98 respectively which are secured into the plate 94 and the weights 95 and 96 are urged inwardly by the springs 95' and 96' respectively. The plate 94 has formed therein the arcuate slots 99 and 100 which receive the pins 101 and 102 extending downwardly from the weights 95 and 96 respectively. The fly-weight holder plate 94 is secured in position on the flange 93 by means of the large nut 103 upon the washer 104, the nut 103 threadedly engaging the upper end of the timing cam holder 90. The flange portion 93 of the timing cam 91 is formed with the arcuate slots 105 and 106 positioned below the slots 99 and 100 respectively, and the pins 101 and 102 extend into the slots 105 and 106. The timing cam 90 is rotated by the pins 101 and 102 engaging the slots 105 and 106 of the flange 93, part of the timing cam 90.

As the r.p.m. of the driven shaft 10 increases the r.p.m.

of the plate 94 increases and the weights 95 and 96 fling outwardly due to centrifugal force thereby moving the pins 101 and 102 through the slots 99 and 100 and bearing against the sides of the slots 105 and 106 thus advancing the flange 93 and the lobe 92, a part thereof, whereby the injection of fuel by the piston 71 is injected at an earlier point of time relative to shaft 10 rotation. The upper end of the shaft 10 is mounted in the bearing 107 which is mounted in the cap 85'. Mounted axially in the top of the cap 85' is the fitting 108 to which is connected the oil supply line 109 whereby the moving internal parts may be lubricated. The lubricating oil passes down to the sump 21 and out of the hole 21' and away from the unit by any suitable means well known in the art.

The operation of my pump for one cycle is as follows: Fuel is supplied to the fuel supply channel 27. As the annular ramp 16 of the loading cam 14 rotatively bears against the under side of the circular stop shoulder 76 the piston 71 is raised against an action of the spring 83 and the annular recess 87 is brought to register with the slide plate 88. The slide plate 88 is forced into engagement with the slot 87 due to the action of the spring 88' and the piston 71 is locked at the top of the stroke. As the piston 71 moves upwardly, as above, the ball 43 is raised off the seat 39 against the action of the spring 45 and fuel is drawn in through the conduit 51 into the bore 47, the ball valve 35 remaining on the seat 33. As the lobe 92 of the timing cam 90 contacts the slide-plate 88 it forces the same outwardly and out of engagement with the recess 87 of the piston 71 and the piston is released and travels downwardly at the correct velocity due to the action of the spring 83 thereby forcing fuel from the bore 47, unseating the ball valve 35 and out the port 30 to the cylinder of the engine.

As heretofore stated, the lower throttle cam 53 is stationary, and the upper cam 61 rotates through about ten degrees. In rotating, the upper cam 61 by varied registration of the ramps 65 with the ramps 59 of the lower cam 53 raises and lowers and in so doing limits the downward travel of the piston 71, for the cam ring 61 contacts the underside of the stop shoulder 76 of the piston 71. The extent of the downward movement of the piston determines the quantity of fuel metered out the port such as 30.

The invention is not to be understood as restricted to the details set forth, since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

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

1. In a fuel injector for an internal combustion engine, a housing having a pump cylinder bore for each cylinder of the engine, a piston having a plunger portion working in the cylinder bore and an outstanding portion, a valve controlled fuel inlet line in communication with said cylinder, a valve controlled fuel outlet line in communication with said cylinder, a shaft, timed means operatively engaged with said shaft for intermittently moving the piston to its outer position, releasable means for holding the piston in said outer position, cam means associated with said shaft for forcing said releasable means from holding said piston, an expandable member bearing against the outstanding part of the piston for moving said plunger portion of said piston inwardly of said cylinder upon said releasable means becoming ineffective, and adjustable means contacted by the outstanding portion of the piston for varying the extent of inward or compression movement of the plunger portion of the piston.

2. The device of claim 1 in which said adjustable means includes cooperating cam rings mounted in said housing.

3. In a fuel injector for an internal combustion engine, a housing having a pump cylinder bore for each cylinder

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of the engine, a piston having a plunger portion working in the cylinder bore and an outstanding portion, a valve controlled fuel inlet line in communication with said cylinder, a shaft, timed means operatively engaged with said shaft for intermittently moving the piston to its outer position, releasable means for holding the piston in said outer position, cam means associated with said shaft for forcing said releasable means from holding said piston, an expansible member bearing against the outstanding part of the piston for moving said plunger portion of said piston inwardly of said cylinder upon said releasable means becoming ineffective, a stationary cam member mounted in said housing, a movable cam member rotatably mounted and overlying said stationary cam member, the opposed faces of said movable and stationary cam members having coacting cam surface means for moving the movable member away from the stationary member upon rotatively moving the movable cam member, means for rotatively moving the movable member, said movable member having a portion extending in the path of travel of said outstanding portion of said piston whereby contact of said outstanding portion of said piston with said movable member limits the extent of the inward movement of said plunger portion within said cylinder bore.

4. The device of claim 3 including yieldable means for constantly urging said movable cam member toward said stationary member.

5. The device of claim 4 including means for rotatively moving said movable cam member exteriorly of said housing.

6. In a fuel injector for an internal combustion engine, a housing having a pump cylinder bore for each cylinder of the engine, a piston having a plunger portion working in said cylinder bore and an outstanding portion, a valve controlled inlet line in communication with said cylinder bore, a valve controlled fuel outlet line in communica-

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tion with said cylinder bore, a shaft, timed means for rotating said shaft, means operatively engaged with said shaft for intermittently moving said piston to its outer position, a plate within the housing mounted for endwise movement, said plate having a slot through which said piston freely extends, means for constantly urging said plate in a direction toward said piston, said plate when at the limit of such movement and said piston is in its outer position engages said piston to hold said piston against movement in said cylinder bore, and means operated from said shaft for moving said plate to release said piston for movement in said cylinder bore, and means for moving said piston inwardly immediately upon release.

7. In a fuel injector for an internal combustion engine, a housing having a pump cylinder bore for each cylinder of the engine, a piston having a plunger portion working in the cylinder and an outstanding portion, a valve controlled fuel inlet line in communication with said cylinder, a shaft, a valve controlled fuel outlet line in communication with said cylinder, timed means operatively engaged with the shaft for intermittently moving said piston to its outer position relative to said cylinder, releasable means for holding said piston in said outer position, means associated with said shaft for forcing said releasable means from holding said piston, an expansible member bearing against the outstanding portion of said piston for moving said plunger portion inwardly of said cylinder upon said releasable means becoming ineffective, said releasable means being in the form of a plate having a slot through which the piston freely extends.

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