

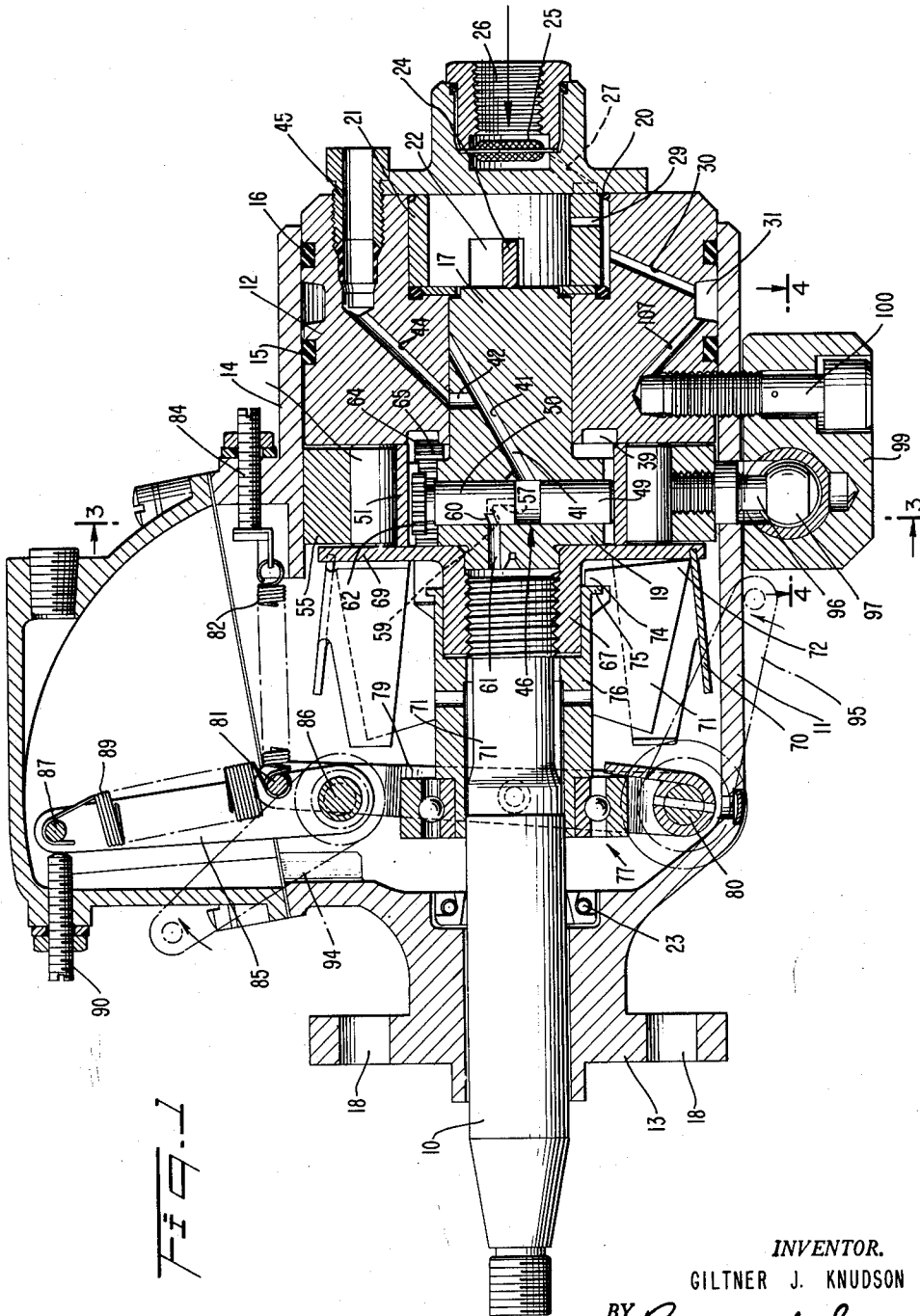
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FUEL INJECTION PUMP

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FUEL INJECTION PUMP

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This invention relates to fuel pumps of the type adapted to be utilized with internal combustion engines. The invention relates more particularly to distributor-type fuel injection pumps adapted to deliver charges of fuel under high pressure to internal combustion engines.

The invention has among its objects the provision of a new and improved fuel pump for internal combustion engines and the like.

Another object of the invention is the provision of a fuel pump of the type described which is relatively simple in construction and operation.

Yet another object of the invention is to provide a fuel pump incorporating novel means for varying the amount of fuel delivered under pressure at its successive fuel injecting operations.

Still a further object of the invention is to provide a fuel pump embodying a new and improved pumping device which may be adjusted to vary the amount of fuel injected by the pump in the successive injecting operations thereof.

The above and further objects and novel features of the invention will more fully appear from the following description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is a view in longitudinal axial section through the illustrative embodiment of fuel pump, the parts of the pump and the controls therefor being shown in the position which they assume when the pump is at rest, certain of the parts being shown in elevation;

FIG. 2 is a view in longitudinal axial section of the inner rotatable portion of the pump and of the inner housing part associated therewith, certain of the parts being shown in elevation;

FIG. 3 is a fragmentary view in transverse section showing the high pressure, fuel injecting pump and the generally stationary annular cam associated therewith, the section being taken along the line 3—3 of FIG. 1, certain of the parts being shown in elevation; and

FIG. 4 is a view in section through the mechanism for varying the timing of the fuel injecting operations of the pump, the section being taken along the line 4—4 of FIG. 1, certain of the parts being shown in elevation.

The pump of the invention is of particular advantage when employed to inject measured quantities of fuel such as oil directly into the cylinders of an internal combustion engine. The particular pump shown is one designed for use with a four-cylinder solid injection diesel engine. It will be understood, however, that pumps within the scope of the invention are not thus limited, and are capable of use to advantage in a variety of applications.

As shown in FIG. 1, the illustrative fuel injection pump has a longitudinally extending main shaft 10 which extends into and is rotatably mounted within a casing generally designated by the character 11. The casing 11 is adapted to be secured to the engine through the medium of a flange 13 on the housing, the casing being capable of limited adjustment about the axis of shaft 10 through the medium of arcuate slots 18 in flange 13 through which mounting studs (not shown) threadably secured to the

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engine block extend. The shaft 10 is driven in synchronism with the crank shaft of the engine, in a four-cycle engine being driven at half crank shaft speed, so as to deliver fuel charges to the engine in the proper timed relationship.

The casing or housing 11 has a cylindrical outer portion 14 within which is sealingly mounted a removable inner housing part 12. O rings 15 and 16, mounted in axially spaced peripheral grooves in housing part 12, provide a seal between parts 12 and 14. Rotatably mounted within an axially extending bore in housing part 12, and closely interfitted therewith, is a rotatable distributor 17 in the form of an extension on shaft 10. Between the rotatable distributor 17 and the shaft, the shaft extension is radially enlarged at 19 to provide a high pressure pump portion, to be described.

The outer end of rotatable distributor 17 drives a low pressure or transfer pump, generally designated 20, by means of which fuel is forwarded from a fuel source such as a tank under moderate pressure to the high pressure, fuel-injecting pump. The transfer pump 20 includes a longitudinally extending eccentrically bored casing 21 which is non-rotatably mounted in a bore at the outer end of casing part 12. The outer end of rotatable member 17 is cross slotted at 22, the cross slots carrying a first and a second slidable vane, 24 and 25, respectively, which are disposed transversely of each other. Transfer pump 20 is supplied with fuel through an inlet fitting 26 which forms a part of a cap member secured to the outer end of casing part 12 by studs, one of which is shown in FIG. 2. Fuel entering at fitting 26 travels into the transfer pump through passage 27 and after having been subjected to pressure in such pump is discharged therefrom through a passage 29. From passage 29 the discharged fuel flows under pressure through a further passage 30 into an annular groove 31 which extends peripherally of casing part 12 and is disposed between O rings 15 and 16.

Connected to annular groove 31 is a pressure relief valve 32 which prevents the pressure of the fuel delivered by the transfer pump to the high pressure fuel-injecting pump from exceeding a desired value. The pressure relief valve 32, shown more particularly in FIG. 2, is connected to annular groove 31 by means of the passages 35 and 34 which lead to the pressure relief valve proper. When the pressure of the fuel in groove 31 exceeds a predetermined value, the spring pressed ball 36 is thrust from its seat, thereby allowing the escape of excess fuel through passage 37 in casing part 12 to an annular groove 39 therein. From groove 39 the excess oil flows into the free space within housing 11, which is generally filled with fuel during its operation, from which it is returned to the fuel tank by means not shown.

Casing part 12 is provided with four equally angularly spaced passages 40, one of which is shown in FIG. 2, which lead from annular groove 31 inwardly to the central bore through part 12. Rotatable distributor 17 has an annularly directed passage 41 therein, passage 41 having its outer (right hand, FIG. 2) end connected to the inner end of each of passages 40 at predetermined times during rotation of member 17, and having its inner (left hand) end connected at all times to the space between the opposed pistons of the high pressure fuel-injecting pump, to be described. Passage 41 is provided with a short branch passage 42 intermediate its length, the outer end of branch passage 42 communicating at predetermined times during the rotation of element 17 with each of four equally angularly spaced high pressure fuel discharge passages 44 in casing part 12. Communicating with the outer end of each of passages 44 is a discharge fitting 45 (one shown in FIG. 1) from which conduits lead to injection nozzles connected to the respective cylinders of the engine. As is

evident in FIGS. 1 and 2, the outer end of passage 41 is closed by an imperforate portion of the wall of the bore in casing part 12 when branch passage 42 is connected to a discharge passage 44, and the outer end of branch passage 42 is closed by an imperforate wall portion of casing part 12 when the outer end of passage 41 communicates with an inlet passage 40. Thus the rotatable distributor 17 and the surrounding casing part 12 co-operating therewith function as a timing distributor for both the feeding of low pressure fuel from the transfer pump to the high pressure pump, and for the discharge of fuel under high pressure from the high pressure pump.

The high pressure fuel-injecting pump, generally designated 46, includes two opposed pistons 49 and 50 accurately fitting within a transverse bore 47 in the enlarged portion 19 of the member which forms an extension of shaft 10. The piston 49 is of completely circular cylindrical shape, and merely reciprocates in the bore of the pump under the action of the generally stationary timing cam, to be described. The other piston 50 not only reciprocates in the bore, but its angular position about its axis is controlled whereby selectively to vary the quantity of fuel injected by the pump at each active stroke thereof. The outer end of each of pistons 49 and 50 abuts the inner end of a shoe 51, the shoes being reciprocably mounted within guideways 52 and 53 at the right and left hand sides, respectively, of rotatable member 19 as it is shown in FIG. 3. Each shoe 51 has a longitudinally extending part-cylindrical seat in its outer end. Within each such seat there is rotatably mounted a short longitudinally extending roller 54 which engages and rolls upon the inner surface of a four-lobed generally stationary annular cam 55 which surrounds rotatable member 19. The four lobes 56 on the inner surface of cam 55 are located 90° apart and function as member 17, 19 rotates with respect to the cam alternately to thrust the pistons 49 and 50 together at the same time and to allow them to separate somewhat from each other under the action of centrifugal force and with the fuel fed between them under moderate pressure by the transverse bore.

Piston 50 is provided with a short axially extending bore 57 which is open to the forward or inner end thereof. Communicating with the inner end of bore 57 is a transverse bore 59 which extends outwardly to a helically disposed slot 60 in the surface of piston 50. A spill passage 61 extends longitudinally in rotatable member 19 from a zone at its inner end generally at the location of slot 60 to a free space between the inner end of shaft 10 and its extension 19, 17, whereby the fuel discharged through passage 61 is returned to the fuel sump provided by the free space within the casing 11. The parts are so arranged that in the initial portion of the fuel discharging stroke of piston 50, slot 60 is out of communication with spill port 61, communication between slot 60 and the spill port begins at a predetermined time in the operative stroke of the piston 50.

The angular position of piston 50, whereby the relationship between slot 60 and spill port 61 may be varied as desired, is under the control of the following mechanism. A pinion 62 secured to the outer end of piston 50 reciprocates therewith in the guideway 53. A longitudinally reciprocable plunger 64 is mounted in rotatable part 19 of the pump. Plunger 64 carries a rack gear 65 on its inner face, such rack gear meshing with pinion 62. The parts are so constructed and arranged that pinion 62 maintains its meshing engagement with rack gear 65 despite its reciprocation with piston 50 with respect thereto. It will be seen that by suitable adjustment of plunger 64 piston 50 may be angularly positioned so that the high pressure pump begins to spill at a predetermined time in its operative stroke, thereby delivering a desired quantity of high pressure fuel at the initial portion of such stroke.

In the pump of the illustrative embodiment the position of the plunger 64 is made responsive to the speed of rota-

tion of the engine and thus of shaft 10. The control mechanism is so arranged that when the engine is idling at low speed the fuel charges injected by the pump are of small volume and that when the speed of the engine increases the volume of such injected charges increases. There is thus provided in the pump a speed responsive mechanism which governs the positioning of plunger 64.

The speed responsive mechanism includes a cage, generally designated 66, which is affixed to and rotates with the extension 19, 17 of shaft 10. The cage includes a flanged sleeve 67, the flange portion 69 of which is affixed to portion 19 of the shaft extension as by rivets, as shown. The cage has a plurality of similar pocket-forming enclosure members 70 within each of which there is positioned a weight 71 having a sharp outer corner 72 at the junction of its inner transverse and longitudinally outer surfaces. Such surfaces are disposed at an angle of somewhat less than 90° with respect to each other so that the weights rock about edges 72 in their respective pockets as they are subjected to varying centrifugal force. Each of weights 71 has a radially inwardly projecting flange 74 which overlies an annular flange 75 on the inner end of a sleeve 76 which is keyed to shaft 10 so as to be slidable therealong and rotatable therewith. The outer end of sleeve 76 is affixed to the inner race of a ball bearing 77. It will be apparent that as shaft 10 increases its speed the weights 71 are impelled to turn outwardly around edges 72 and thus to thrust sleeve 76 axially of shaft 10 with a force which bears a predetermined relationship to the speed of rotation of the shaft.

The outer race of ball bearing 77 is affixed to a lever 79 in the form of a yoke which embraces shaft 10 and which is pivotally mounted at one end to casing 11 by pivot pin or axle 89. The other ends of the arms forming the yoke-shaped lever 79 are connected by a cross pin 81. A coil tension spring 82 extends from cross pin 81 to a bracket rotatably secured to the inner end of an adjusting stud 84 which extends through and has screw threaded engagement with a portion of the housing 11 of the pump. The spring 82 biases lever 79 in a clockwise direction against the thrust imposed thereon by the weights 71 acting through sleeve 76. Spring 82 and adjusting stud 84 permit the adjustment of such biasing force so as to adjust the idling speed of the engine.

The speed of the engine under other than idling conditions is under the control of mechanism now to be described. A second yoke-like lever 85 is pivoted at one end on a pair of aligned stub shafts connected to casing 11 at the opposite sides thereof. One such stub shaft is shown at 86 in FIG. 1. A cross pin 87 connects the outer or free ends of the arms making up the lever 85. A second coil tension spring 89 extends between cross pin 81 of lever 79 and the cross pin 87 of lever 85. The terminal position of lever 85 at the low speed end of the operating range of the engine is determined by the adjusted position of an adjusting stud 90 which extends through and has screw threaded engagement with the housing 11 at a position aligned with the outer end of lever 85. In the idle or "at rest" position of the pump shown in FIG. 1 the spring 89 extends somewhat rearwardly of the longitudinal axis of lever 79, the spring 89 then being in substantially its relaxed condition so that it has little or no effect upon the adjusted idling speed of the engine. When, however, lever 85 is rotated clockwise from the position shown in FIG. 1, the spring 89 exerts a biasing effect upon lever 79 which varies with the degree of angularity of the spring 89 past the axis of lever 79. As a consequence, the biasing force exerted upon sleeve 76 in opposition to the force exerted thereon by weights 71 may be changed by changing the angular position of lever 85. A lever 94 positioned externally of the pump casing 11 and connected to lever 85 by one of the pivot pins 86 permits lever 85 to be angularly adjusted by a throttle linkage, not shown. With lever 85 adjusted to a given position, the speed of the engine

remains substantially constant regardless of changes in the load thereon. To accomplish this result, weights 71 cause a shifting of sleeve 76 thereby to adjust plunger 64 and the spill ports 60, 61 of piston 50 so as to maintain the engine at the desired speed. The pump also includes an externally mounted lever 95, connected to pivot shaft 80 of lever 79, whereby the latter shaft may be turned so that the slot 60 of piston 59 remains in communication with spill port 61 throughout the entire stroke of piston 50. When lever 79 is thus moved, the delivery of fuel under high pressure to the engine is cut off, and the engine stops.

The pump shown also includes means whereby the timing of the injection strokes of the high pressure pump 46 is automatically changed in response to changes in the speed of rotation of the engine. A timing control arm 96 extends radially from an edge portion of the annular cam 55 and outwardly through a slot in pump housing 11 which permits the cam and its attached arm to rotate about the axis of the cam through a small angle. The outer end of arm 96 carries a rounded knob 97 which is operatively connected to a hollow piston 102 reciprocably mounted within a bore 101 in a sub-housing 99 affixed to casing 11 by a stud 100. As shown in FIG. 4, the knob 97 on arm 96 is held between a seat 104 on the inner end surface of the hollow piston 102 and a coil compression spring 105, the outer end of which abuts a plug member 106 which closes the end of the bore in housing 99.

Fuel under transfer pump pressure in annular groove 31 is led through angular passage 107 (FIG. 1) to an annular space 109 surrounding the stud 100 (FIG. 4). From passage 109 the fuel travels through passage 110 through a one-way valve 11 and thence through a further passage 112 into bore 101 at the location of a longitudinal groove 114 in piston 102. Fuel flows to the right through groove 114 into the space 115 between the outer end of the piston and the cylinder.

The pressure of the fuel delivered by the transfer pump varies generally in accordance with the speed of the transfer pump and thus of the engine. Accordingly, as the speed of the engine increases the pressure of the fuel in space 115 increases, thereby thrusting piston 102 to the left (FIG. 4) to advance the timing of the operative fuel injecting strokes of the pump 46. The coil compression spring 105 maintains knob 97 in contact with seat 104, and rotates cam 55 through arm 96 in a retarding direction when the speed of the engine decreases.

Although only one embodiment of the invention has been illustrated in the accompanying drawings and described in the foregoing specification, it is to be especially understood that various changes, such as in the relative dimensions of the parts, materials used, and the like, as well as the suggested manner of use of the apparatus of the invention, may be made therein without departing from the spirit and scope of the invention as will now be apparent to those skilled in the art.

What is claimed is:

1. In a device of the character described, a housing having a longitudinal bore, a rotor mounted for rotation in said longitudinal bore, said rotor having a pumping portion and a distributing portion whereby fuel pumped by said pumping portion will be delivered to said distributing portion, said distributing portion being adapted to communicate with a plurality of outlets successively upon rotation of said rotor, said pumping portion of said rotor having a radial bore, a plunger mounted for reciprocation in said radial bore, cam means adjacent the periphery of said pumping portion for effecting the pumping stroke of said plunger upon rotation of said rotor, said plunger having fuel spill control means, and means operable while the rotor is rotating for effecting rotation of said plunger to thereby adjust said fuel spill control means, whereby the quantity of fuel delivered by said

pumping portion to said distributing portion may be varied.

2. In a device of the character described, a housing having a longitudinal bore, a rotor mounted for rotation in said longitudinal bore, said rotor having a pumping portion and a distributing portion whereby fuel pumped by said pumping portion will be delivered to said distributing portion, said distributing portion being adapted to communicate with a plurality of outlets successively upon rotation of said rotor, said pumping portion of said rotor having a radial bore, a plunger mounted for reciprocation in said radial bore, cam means adjacent the periphery of said pumping portion for effecting the pumping stroke of said plunger upon rotation of said rotor, said plunger having fuel spill control means, and means operable while the rotor is rotating for effecting rotation of said plunger to thereby adjust said fuel spill control means, said fuel spill control means comprising a slot in said plunger and a fuel spill port adapted to communicate with said slot.

3. In a device of the character described, a housing having a longitudinal bore, a rotor mounted for rotation in said longitudinal bore, said rotor having a pumping portion and a distributing portion whereby fuel pumped by said pumping portion will be delivered to said distributing portion, said distributing portion being adapted to communicate with a plurality of outlets successively upon rotation of said rotor, said pumping portion of said rotor having a radial bore, a plunger mounted for reciprocation in said radial bore, cam means adjacent the periphery of said pumping portion for effecting the pumping stroke of said plunger upon rotation of said rotor, said plunger having fuel spill control means, and means operable while the rotor is rotating for effecting rotation of said plunger to thereby adjust said fuel spill control means, said fuel spill control means comprising a helical slot in said plunger and a fuel spill port adapted to communicate with said slot.

4. In a device of the character described, a housing having a longitudinal bore, a rotor mounted for rotation in said longitudinal bore, said rotor having a pumping portion and a distributing portion whereby fuel pumped by said pumping portion will be delivered to said distributing portion, said distributing portion being adapted to communicate with a plurality of outlets successively upon rotation of said rotor, said pumping portion of said rotor having a radial bore, a plunger mounted for reciprocation in said radial bore, cam means adjacent the periphery of said pumping portion for effecting the pumping stroke of said plunger upon rotation of said rotor, said plunger having fuel spill control means, and means on said rotor operable while the rotor is rotating, for effecting rotation of said plunger to thereby adjust said fuel spill control means.

5. In a device of the character described, a housing having a longitudinal bore, a rotor mounted for rotation in said longitudinal bore, said rotor having a pumping portion and a distributing portion in communication with said pumping portion, whereby fuel pumped by said pumping portion will be delivered to said distributing portion, said distributing portion being adapted to distribute fuel pumped by said pumping portion to each of a plurality of outlets successively upon rotation of said rotor, said pumping portion having a radial bore, opposed plungers mounted for reciprocation in said radial bore, cam means adjacent the periphery of said pumping portion for effecting the pumping stroke of said plungers upon relative rotation of said rotor and cam means, one of said plungers having fuel spill control means, and means for rotating said one plunger to adjust said fuel spill control means, said means for rotating said plunger comprising means on said rotor movable longitudinally thereof while the rotor is rotating, and means operatively connecting said movable means and said plunger, whereby upon movement of said movable means

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said plunger will be rotated to thereby effect adjustment of said fuel spill control means.

6. A device as claimed in claim 5, wherein the movable means is an annular member on the rotor, the annular member being slidable along the rotor and rotatable therewith.

7. A device as claimed in claim 6, comprising a further means movable along the rotor and having thrusting relationship with the annular member, and means for holding the further means from rotation with the rotor and for adjusting the further means and thus the annular member longitudinally of the rotor.

8. In a device of the character described, a housing having a longitudinal bore, a rotor mounted for rotation in said longitudinal bore, said rotor having a pumping portion and a distributing portion in communication with said pumping portion, whereby fuel pumped by said pumping portion will be delivered to said distributing portion, said distributing portion being adapted to distribute fuel pumped by said pumping portion to each of a plurality of outlets successively upon rotation of said rotor, said pumping portion having a radial bore, opposed plungers mounted for reciprocation in said radial bore, cam means adjacent the periphery of said pumping portion for effecting the pumping stroke of said plungers upon relative rotation of said rotor and cam means, one of said plungers having fuel spill control means, and means for rotating said one plunger to adjust said fuel spill control means, said means for rotating said plunger comprising means on said rotor movable longitudinally thereof while the rotor is rotating, and a rack operatively connected to said movable means and engaging said plunger, whereby upon movement of said rack by said movable means said plunger will be rotated to thereby effect adjustment of said fuel spill control means.

9. In a device of the character described, a housing having a longitudinal bore, a rotor mounted for rotation in said longitudinal bore, said rotor having a pumping portion and a distributing portion whereby fuel pumped by said pumping portion will be delivered to said distributing portion, said distributing portion being adapted to communicate with a plurality of outlets successively upon rotation of said rotor, said pumping portion of said rotor having a radial bore, a plunger mounted for reciprocation in said radial bore, cam means adjacent the periphery of said pumping portion for effecting the pumping stroke of said plunger upon rotation of said rotor, said plunger having fuel spill control means and means actuated upon rotation of said rotor for effecting rotation of

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said plunger to thereby adjust said fuel spill control means, and means on said rotor for actuating said means for rotating said plunger upon rotation of said rotor.

10. In a device of the character described, a housing having a longitudinal bore, a rotor mounted for rotation in said longitudinal bore, said rotor having a pumping portion and a distributing portion whereby fuel pumped by said pumping portion will be delivered to said distributing portion, said distributing portion being adapted to communicate with a plurality of outlets successively upon rotation of said rotor, said pumping portion of said rotor having a radial bore, a plunger mounted for reciprocation in said radial bore, cam means adjacent the periphery of said pumping portion for effecting the pumping stroke of said plunger upon rotation of said rotor, said plunger having fuel spill control means and means actuated upon rotation of said rotor for effecting rotation of said plunger thereby to adjust said fuel spill control means, said fuel spill control means comprising a slot in said plunger and a fuel spill port adapted to communicate with said slot, the slot in the plunger and the fuel spill port being so disposed that the fuel spill means becomes operative only at the end portion of the pumping stroke of the plunger.

11. In a device of the character described, a housing having a longitudinal bore, a rotor mounted for rotation in said longitudinal bore, said rotor having a pumping portion and a distributing portion whereby fuel pumped by said pumping portion will be delivered to said distributing portion, said distributing portion being adapted to communicate with a plurality of outlets successively upon rotation of said rotor, said pumping portion of said rotor having a radial bore, a plunger mounted for reciprocation in said radial bore, cam means adjacent the periphery of said pumping portion for effecting the pumping stroke of said plunger upon rotation of said rotor, said plunger having fuel spill control means and means actuated upon rotation of said rotor for effecting rotation of said plunger to thereby adjust said fuel spill control means, said fuel spill control means comprising a helical slot in said plunger and a fuel spill port adapted to communicate with said slot, the slot in the plunger and the fuel spill port being so disposed that the fuel spill means becomes operative only at the end portion of the pumping stroke of the plunger.

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