Feb. 12, 1946. G. E. DAVIDSON 2,394,668

FUEL INJECTION PUMP

Filed Sept. 19, 1942

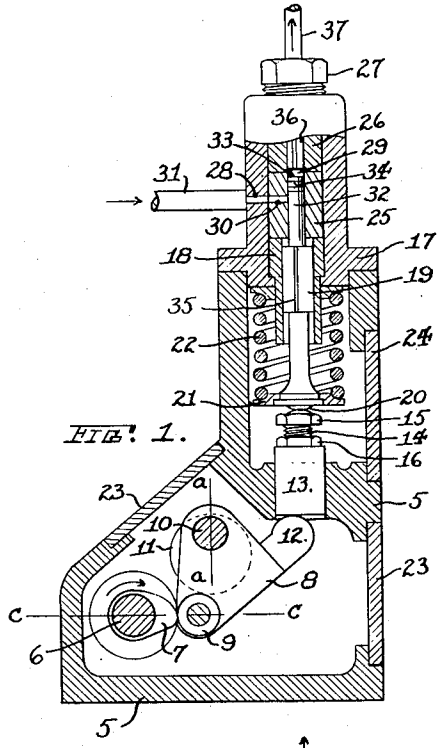


FIG. 1.

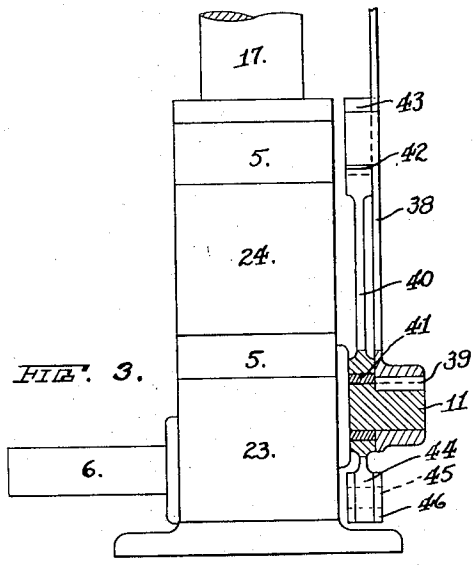


FIG. 3.

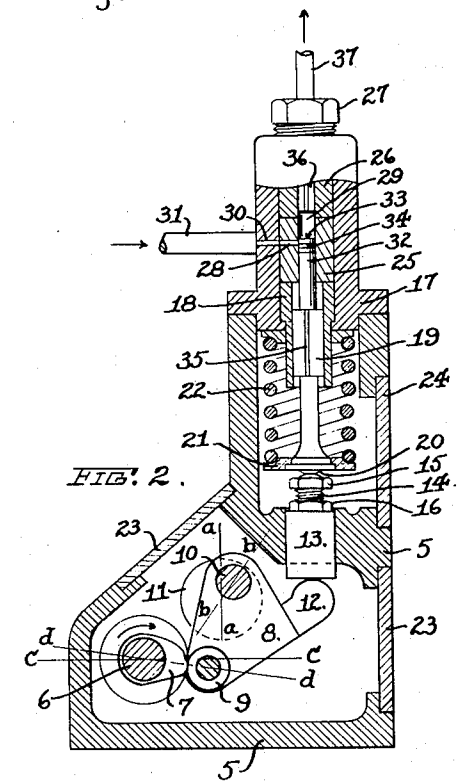


FIG. 2.

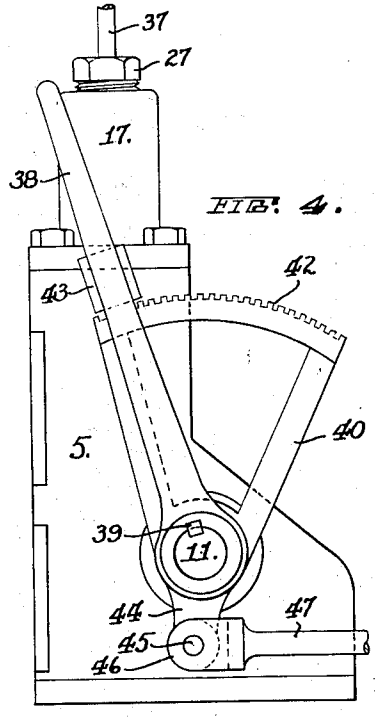


FIG. 4.

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FUEL INJECTION PUMP

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1 Claim. (Cl. 103—38)

The present invention relates to a plunger pump of the type used to inject fuel into the cylinder of a Diesel engine.

It is common practice to vary the amount of fuel injected into the Diesel cylinder at each stroke, in order to control the power developed by the engine, and at the same time to vary the timing of the injection, which should occur a few degrees earlier in the cycle at full power output than at minimum or idling output. These two variables, viz: quantity of fuel and timing, are commonly controlled by different mechanical means.

The principal object of the present invention is to provide a single means, operated by a single control, to vary both the amount of fuel injected at each stroke and the timing of the injection. Other objects are to provide a simple fuel injection pump having the dual functioning control means incorporated as an integral part of its mechanism; to provide a pump in which the amount of fuel injected is controlled by varying the effective length of stroke of the plunger; to provide means whereby the injections into the several cylinders of a multi-cylinder engine can be equalized, and to provide simple control means adapted either to manual or governor operation.

Other objects and advantages of the invention will be apparent from the following description, which should be read with the understanding that changes within the scope of the claim hereto appended, may be made in the form, construction and arrangement of the several parts herein illustrated and described, without departing from the spirit of the invention, and with the further understanding that the invention may be embodied in pumps for purposes other than that described herein.

Reference will be made to the accompanying drawing, wherein

Fig. 1 is a vertical section of a single cylinder fuel injection pump embodying a preferred form of the invention, showing the adjustable control means in position for full fuel delivery and advanced timing.

Fig. 2 is a similar view showing the control means in position for minimum fuel delivery and retarded timing.

Fig. 3 is a side elevation, partly in section, of the pump.

Fig. 4 is an end elevation thereof.

The pump herein shown and described has one cylinder and one plunger or piston, and is adapted for use with a single cylinder engine. It will be apparent, however, that any number of pump cylinders and plungers, one for each cylinder of a multi-cylinder engine, may be operated from one cam shaft and controlled by one control shaft.

In the drawing, the reference numeral 5 designates a casing, within which is a rotatable shaft 6 carrying a cam 7 of suitable profile, which rotates in the direction of the arrow, i. e. clockwise. The cam operates a lifter in the form of a bell crank 8 provided with a follower roller 9 traveling upon said cam. The bell crank 8 is pivoted upon a stud 10 eccentrically positioned in a shaft 11 which is rotatably mounted for rocking movement in the casing 5, the axis of said rock shaft 11 being parallel with the axis of the cam shaft 6. The free end 12 of the bell crank is rounded, and bears against a vertically reciprocable lifter 13 mounted in a guide in the casing 5. The lifter 13 has an adjustable tappet at its upper end, comprising a threaded stem 14 screwed into the lifter and provided with a head 15 and a lock nut 16.

A barrel 17 is secured in the upper portion of the casing 5, and contains a guide bushing 18 in which operates a plunger 19. The lower end of said plunger has a head 20 in contact with the tappet head 15, and a washer 21. A spring 22, compressed between said washer and the end of the barrel 17, moves the plunger on its downward stroke, and keeps the roller 9 of the bell crank in contact with the cam 7. Removable cover plates 23 and 24 provide access respectively to the cam shaft chamber and the tappet chamber of the casing 5.

A cylinder bushing 25 is fitted closely within the barrel 17 above the guide bushing 18, and a valve bushing 26 lies above said cylinder bushing. All three bushings are held in the barrel by a threaded plug 27 in its upper end, and can be removed by unscrewing said plug. The cylinder bushing 25 has an inlet port 28 leading into its interior cylinder 29, which port is in line with a passage 30 in the wall of the barrel communicating with an inlet pipe 31 leading from the fuel supply system. A piston 32, formed as a reduced diameter extension of the plunger 19, fits closely within the cylinder 25, and is preferably provided, just below its head 33, with a series of circumferential sealing grooves indicated at 34. The plunger guide portion 19 is provided with vertical grooves, one shown at 35, to relieve pressure above it. A discharge check valve of standard form, the lands of which are shown at 36, is housed within the valve bushing 26. A discharge passage, not shown, extends upward from said check valve through the plug 27 to a dis-

charge pipe 37 which leads to the injection nozzle, not shown, in the engine cylinder.

It will be seen from Figs. 1 and 2 that changing the position of the bell crank fulcrum 10, by turning the rock shaft 11 through a few degrees, changes the vertical position of the plunger 19 with respect to the cam 7. This changes the effective pumping stroke of the piston 32, by making it rise more or less above the inlet port 28 when it reaches the top of its stroke. In Fig. 1 the position of the bell crank fulcrum 10 is vertically above the center of the rock shaft 11, as indicated by the line *a*—*a*, and is such that the piston head 33 rises to its maximum distance above the inlet port 28 when reaching the top of its stroke, as shown, thereby injecting the maximum amount of fuel. At the bottom of its stroke, not shown, the piston head will be just below the port 28. In Fig. 2 the position of the bell crank fulcrum has been shifted by turning the rock shaft 11 clockwise through about 35 degrees, as indicated by the angle between lines *a*—*a* and *b*—*b*, with the result that the piston head 33 rises only slightly above the inlet port 28 at the top of its stroke, thereby injecting a minimum amount of fuel. The total travel of the piston, in both positions of the bell crank fulcrum, is the same, but its effective pumping stroke, i. e. that portion of its upward stroke that lies above the inlet port 28, is greater in the position of Fig. 1 than in the position of Fig. 2.

It will also be seen from Figs. 1 and 2 that the upward or injection stroke of the piston occurs later in the cycle with the rock shaft in the position of Fig. 2 than in the position of Fig. 1. In Fig. 1, with the bell crank in position for maximum injection, the end of the injecting stroke of the piston occurs when the high point of the cam 7 is approximately on the horizontal line *c*—*c* through the center of the cam shaft 6. In Fig. 2, the shifting of the bell crank to the position for minimum injection has also shifted the end of the injection stroke a few degrees in the direction of rotation of the cam 7, as indicated by the angle between the lines *c*—*c* and *d*—*d*. Thus, shifting the position of the bell crank fulcrum 10, by turning the rock shaft 11 clockwise, not only reduces the amount of fuel injected, but also retards the timing of the injection.

The relation between the rate of change in amount of fuel injected and the rate of change in timing depends upon the initial design and dimensions of the several parts. For example, by making the diameter of the piston and cylinder larger, and by providing less angular movement of the rock shaft, there will be less retarding of the injection as its amount decreases. The various parts must be designed, therefore, with the particular service characteristics of the engine in mind. A proper relation must also be established between the degree of eccentricity of the fulcrum 10 and the extent of angular movement of the rock shaft 11; less eccentricity of the fulcrum will require greater angular movement of the rock shaft, and vice versa.

Turning of the rock shaft 11, to change the amount of fuel injected and the timing of the injection, is preferably accomplished by the mechanism shown in Figs. 3 and 4. The rock shaft 11 projects outwardly from the casing 5, and a lever 38 is secured to its end by a key 39. Between the lever and the casing, a quadrant 40 is rotatably mounted upon the shaft 11, preferably with a bushing 41. The upper portion of the quadrant is provided with rack teeth 42, engageable by a suitable movable latch on the lever, indicated at 43. At the lower end, the quadrant has an integral ear 44 pivotally connected by a pin 45 with the clevis 46 of a rod 47.

If the engine with which the pump is associated is to be controlled manually, the rod 47 is either fixed to some part of the engine frame, or is omitted and quadrant fixed in position in any convenient manner not shown, as for example by bolting the ear 44 directly to the pump casing 5. The lever 38 then becomes the throttle lever for the engine, and is held in any desired position by its latch 43 engaging the teeth 42 of the stationary quadrant. If remote manual control is desired, the rod 47, connected with the movable quadrant as illustrated, is connected at its other end with a suitable throttle lever, not shown. The lever 38 is held in fixed relation to the quadrant 40 by its latch 43, and both quadrant and lever 38 are moved by the remote throttle lever to turn the rock shaft 11.

If the engine is controlled by a governor, not shown, the rod 47 is connected with and operated by said governor. The lever 38 is used in starting, and can be set at any position on the quadrant to provide the desired engine speed.

I claim:

A fuel injection pump comprising a plunger, a piston operated thereby, a cylinder in which said piston operates, a cam, a pivoted lifter interposed between said cam and said plunger, a rock shaft upon which the pivot of said lifter is eccentrically mounted, an operating lever secured upon said rock shaft for shifting the position of said pivot, a quadrant freely mounted upon said rock shaft adjacent said lever, cooperating latch means on said lever and said quadrant, and means connected with said quadrant for moving the same about the axis of said rock shaft.

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