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LIQUID FUEL INJECTION PUMPS

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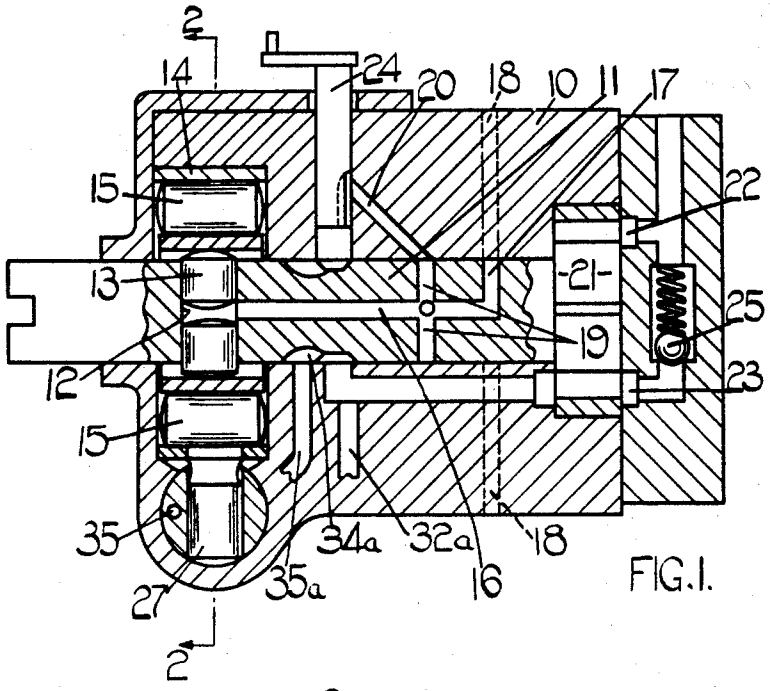

FIG.1.

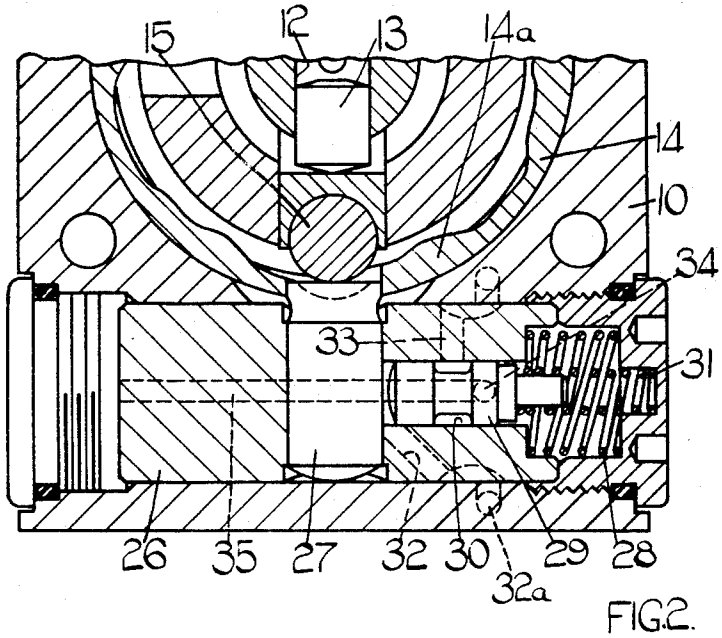

FIG.2.

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LIQUID FUEL INJECTION PUMPS

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ABSTRACT OF THE DISCLOSURE

A device for adjusting the timing of the delivery of fuel in a fuel injection pump having a reciprocable plunger and an adjustable cam, the device comprising a fluid pressure operable piston which is spring loaded, the piston being provided with a bore in which is mounted a slidable spring loaded valve member, the valve member being acted upon in opposition to its spring by a fluid control pressure and the valve member upon movement by the control pressure being arranged to open a port in the wall of the bore to permit fluid under pressure to act on one end of the piston in opposition to the spring.

This invention relates to a liquid fuel injection pump of the kind intended to supply fuel to an internal combustion engine. The pump is of the type which is provided with a rotary distributor member mounted in a body part of the pump and the distributor member in use, is driven in timed relationship with the engine with which the pump is associated. The distributor member is provided with a bore in which is mounted a plunger and through the intermediary of a roller at its outer end, the plunger is moved inwardly to effect an injection stroke by cam lobes formed on the internal periphery of an annular cam ring surrounding the distributor member. In order to vary the timing of injection of fuel the angular setting of the cam ring is adjustable. In known pumps this is effected by a fluid pressure operable piston and the application of fluid pressure to the piston is controlled by a valve member. The setting of the valve member is also controlled by a fluid control pressure which is applied to one end of the valve member to move the member in opposition to the force exerted by a spring. The fluid control pressure in known arrangements, is derived from the outlet of a feed pump which forms part of the injection pump and which has its outlet pressure controlled in such a manner that it varies in accordance with the speed at which the injection pump and the associated engine are driven. The pressure which is applied to the aforesaid piston may also be derived from the outlet of the feed pump although it can be derived from any convenient source such for instance as the lubrication system of the engine. It is desirable that the aforesaid piston should be spring loaded in order that the cam ring assumes a predetermined position when the injection pump is at rest and in addition the valve member should also be spring loaded so that the force exerted on the valve member by the fluid control pressure is balanced.

For reasons of compactness it has been proposed to mount the valve member within a bore formed in the piston and the arrangement described in the present application follows this suggestion. It has also been proposed to use a single spring to load both the piston and the

valve member but this arrangement has a number of disadvantages. One of these is that the force exerted by the spring particularly on the valve member is dependent upon the position of the piston and another disadvantage is the fact that intermittent loading of the piston by the cam as the roller engages the cam lobes can produce undesirable oscillation of the piston and valve member thereby leading to inaccuracy in the timing of delivery of fuel.

My prior specification No. 3,051,154 discloses an arrangement wherein the piston and valve member are not spring loaded relative to each other however, this arrangement has the serious disadvantage that the valve member whilst controlling flow through passages formed in the piston nevertheless is partially mounted and is slidable in a bore or the equivalent formed in the body. This leads to serious manufacturing difficulties since it is necessary to ensure the concentricity of the bore or the equivalent in the body and the remaining portion of the bore formed in the piston.

It is an object of the present invention to provide a construction in which the disadvantages outlined above are minimised.

In the arrangement forming the subject of this application the valve member is located and is slidable within a bore defined in the piston and two springs are provided to load the valve member and piston respectively. The piston is provided with two passages through one of which the control pressure is applied to the end of the valve member and through the other of which the fluid pressure is applied to the piston under the control of the valve member.

In the accompanying drawings:

FIGURE 1 is a sectional side elevation of one example of a liquid fuel injection pump in accordance with the invention and

FIGURE 2 is a section on the line 2—2 of FIGURE 1.

Referring to the drawings there is provided a body part **10** in which is mounted a rotary cylindrical distributor **11** which is adapted to be driven in timed relationship with the engine with which the injection pump is associated. At one end of the distributor there is provided a transversely extending bore **12** in which is mounted a pair of pumping plungers **13** which are arranged to be moved inwardly during an injection stroke of the pump, by a plurality of pairs of cams **14***a* formed on the internal periphery of a cam ring **14** which surrounds the distributor at this point. The cam ring is mounted within the body part and is permitted limited angular movement about the axis of rotation of the distributor and interposed between the plungers and the cams are rollers **15** respectively. The bore is in communication with a longitudinal passage **16** formed in the distriubtor and which at one point is in communication with a radial delivery passage **17** which is adapted to register in turn, as the distributor rotates with a plurality of outlet ports **18** formed in the body part. The outlet ports are in communication with the injection nozzles of the engine respectively and the communication between the delivery passage **17** and one of the outlet ports **18** occurs whilst the plungers **13** are being moved inwardly by the cams.

At another point the longitudinal passage **16** is in communication with a plurality of radial inlet passages **19**

which are adapted to register in turn, as the distributor rotates, with an inlet port **20** formed in the body part and to which liquid fuel is arranged to be supplied by a feed pump **21**. The feed pump is located within the body part and its rotary member is arranged to be driven by the distributor. The inlet **22** of the feed pump is connected to a source of fuel and the outlet **23** thereof is arranged to delivery fuel to the inlet port by way of any convenient throttling means e.g. a throttle **24**. Communication between one of the inlet passages **19** and the inlet port **20** occurs whilst the plungers are permitted outward movement by the cams and whilst this communication is established a quantity of fuel flows to the transverse bore **12** and this quantity of fuel is delivered to the appropriate nozzle during the next inward movement of the plungers. The output pressure of the feed pump is controlled by a valve **25** so that the pressure varies as a function of the speed of the engine.

As has previously been stated the cam ring **14** is angularly movable within the body part and by this means the timing of the commencement of delivery of fuel to the engine can be varied. In order to move the cam angularly a fluid pressure operable piston **26** is provided and this is located within a tangentially disposed cylinder defined in the body part. The piston is connected to the cam ring **14** by means of a peg **27** so that when axial movement is imparted to the piston angular movement will be imparted to the cam ring. The piston is loaded towards one end of the cylinder by means of a spring **28** which is disposed intermediate the piston and a closure for the cylinder at the other end.

For controlling the admission of fluid under pressure to said one end of the cylinder a valve member **29** is provided and this is located within a blind bore **30** extending inwardly from the end of the piston remote from said one end of the cylinder. Conveniently the inner end of the bore is defined by the aforementioned peg. The valve member is axially slidable within this bore and is in the form of a spool having a single circumferential groove. Moreover, the spool is loaded towards the inner end of the bore by a spring **31** which is located between the outer end of the spool and the aforementioned closure of the cylinder.

Formed in the piston is a passage **32** which is in communication with the inner end of the bore **30** and which also is in constant communication with a passage defined in the body part and through which a control pressure can be applied to the inner end of the spool. In the present example the control pressure is the speed controlled output pressure of the feed pump which is applied to the passage **32** by way of a passage **32*a*** in the body part. In another example (not shown) it is this pressure which is modified by means of the throttling means so that the control pressure varies in accordance with the load on the engine.

Also formed in the piston is a passage **33** which is arranged to communicate with the annular space defined by the groove on the valve member and the surrounding wall of the bore. The second passage is arranged to be in communication with any suitable source of fluid pressure conveniently and as shown this is the outlet **23** of the feed pump, but only during the time when the pumping plungers are permitted outward movement. This is achieved by a plurality of axial slots **34*a*** formed in the periphery of the distributor and which are in constant communication with the outlet of the feed pump, and a co-operating port **35*a*** formed in the body part and in communication with the passage **33**. Formed in the wall of the bore **30** is a port **34** which when the piston and spool are in equilibrium, as will be described, is arranged to be covered by the outer land of the valve member. The port is in communication by way of a passage **35** formed in the piston, with said one end of the cylinder and the other end of the cylinder is arranged to be in communication with a drain.

In use, as the control pressure increases the valve member **29** will be moved against the action of the spring **31** and in so doing will uncover the port **34** to the aforesaid groove. Fuel can then flow through the passage **33** and the passage **35** to said one end of the cylinder and will thereby cause the piston **26** to be moved against the action of the spring **28**. As the piston moves the port **34** will be re-covered by the outer land of the valve member and a new equilibrium position will be established and the cam ring will have been moved to vary the timing of the commencement of delivery of fuel to the engine. If the control pressure decreases, then the valve member will be moved by the spring **31** in a direction towards the inner end of the bore and in so doing the port **34** will be exposed to the drain with the result that fuel from said one end of the cylinder will flow down the passage **35** thereby permitting the piston to be moved by the spring **28** in the opposite direction to that described above. As the piston so moves the port will be re-covered by the outer land of the valve member and a new equilibrium position will be established. The purpose of permitting the passage **33** to be in communication with the outlet of the feed pump only during the time when the pumping plungers **13** are permitted outward movement is that during the inward movement of the plungers the reaction on the cam ring tends to move the piston towards said one end of its cylinder. If this occurs there is a risk that the port **34** will be exposed to the circumferential groove in the valve member and thereby fuel could escape for an instant from said one end of the cylinder through the passage **35** and the passage **33** to the outlet of the feed pump. By interrupting the communication between the passage **33** and the outlet of the feed pump a hydraulic lock is formed and the difficulty is overcome in a convenient manner.

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

1. A liquid fuel injection pump for supplying fuel to an internal combustion engine and of the kind comprising a body part, a rotary distributor member mounted in the body part and which is arranged to be driven in timed relationship to the engine with which in use the pump is associated, the distributor member being provided with a bore in which is mounted a plunger, an annular cam ring having cam lobes formed on the internal periphery thereof and which as the distributor member is rotated effect inward movement to the plunger, a cylinder formed in the body part, a fluid pressure operable piston slidable in the cylinder and operatively connected to said cam ring whereby movement of the piston will vary the angular setting of the cam within the body part and thereby to enable the instant at which the plunger is moved inwardly to be varied, a valve member for controlling the application of fluid under pressure to one end of the piston, a bore formed in the piston and in which said valve member is slidably mounted, the valve member being subjected to a fluid control pressure and wherein the improvement comprises a pair of springs acting to load the piston and valve member in opposition to the fluid pressure and the fluid control pressure respectively, a first passage in the piston and through which the control pressure can act on the inner end of the valve member, a groove formed in the valve member intermediate its ends, a second passage in the piston and through which fluid under pressure can flow to said groove, a port in the wall of the bore and which is arranged to be covered by a part of the valve member lying intermediate the outer end of the valve member and said groove, said port being arranged to be uncovered by said part as the valve member moves in accordance with variations in said control pressure, a third passage in the piston and through which said port is in communication with one end of the cylinder containing the piston and the arrangement being such that when the control pressure increases, the valve member will be moved to allow fluid under pressure to flow to said one end of the cylinder as the port is exposed to the

groove and thereby to cause the piston to be moved away from said one end of the cylinder and thereby to reclose said port.

2. A liquid fuel injection pump according to claim 1 including co-operating ports and grooves on the distributor member and body part and arranged to prevent flow of fluid through said second passage when the plunger is being moved inwardly by a cam lobe.

3. A liquid fuel injection pump according to claim 2 including a feed pump for supplying fuel under pressure to said transverse bore during the filling stroke of the injection pump, a relief valve serving to control the outlet pressure of the feed pump so that it varies in accordance with the speed at which the associated engine is driven,

said fluid control pressure being derived from the outlet of the feed pump.

References Cited

UNITED STATES PATENTS

2,784,708	3/1957	Hill et al.	103—2.1
3,051,154	8/1962	Kemp	123—139.13
3,101,078	8/1963	Evans	123—139

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U.S. Cl. X.R.

123—139; 346—112