United States Patent [19]

Jackson

[11] **3,811,799**

[45] **May 21, 1974**

[54] **LIQUID FUEL PUMPING APPARATUS**

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[22] Filed: **Oct. 12, 1972**

[21] Appl. No.: **297,066**

[30] **Foreign Application Priority Data**

Oct. 15, 1971 Great Britain 48019/71

[52] **U.S. Cl.** **417/221,** 417/462

[51] **Int. Cl.** **F04b 1/06**

[58] **Field of Search** 417/221, 218, 462, 249, 417/250

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Attorney, Agent, or Firm—Holman & Stern

[57] **ABSTRACT**

A fuel pumping apparatus includes a member adjustable to vary the timing of injection of fuel to the engine and which is operated by a fluid pressure operable device which comprises a first piston of cup-shaped form and having its open end subjected to a speed dependent pressure which moves it against a first spring and the apparatus also includes a second piston located within the first piston and connected to said member. The second piston is also subjected to said speed dependant pressure but is capable of limited movement relative to the first piston. Means is provided to control the pressure in the space between the two pistons in accordance with the setting of the throttle member of the apparatus.

3 Claims, 2 Drawing Figures

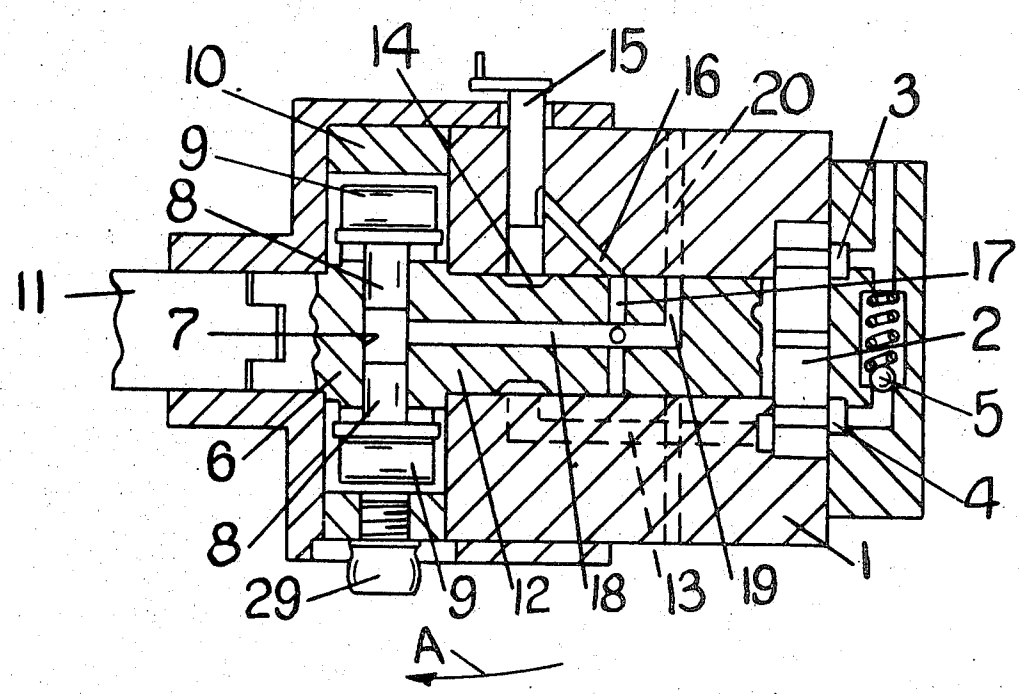

FIG.1.

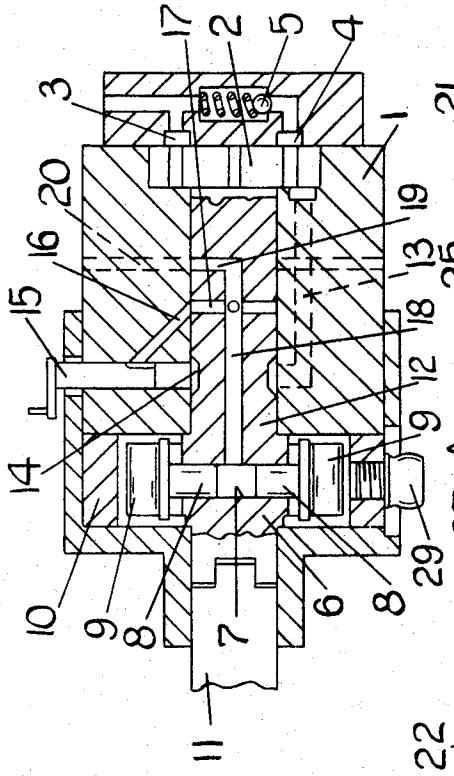
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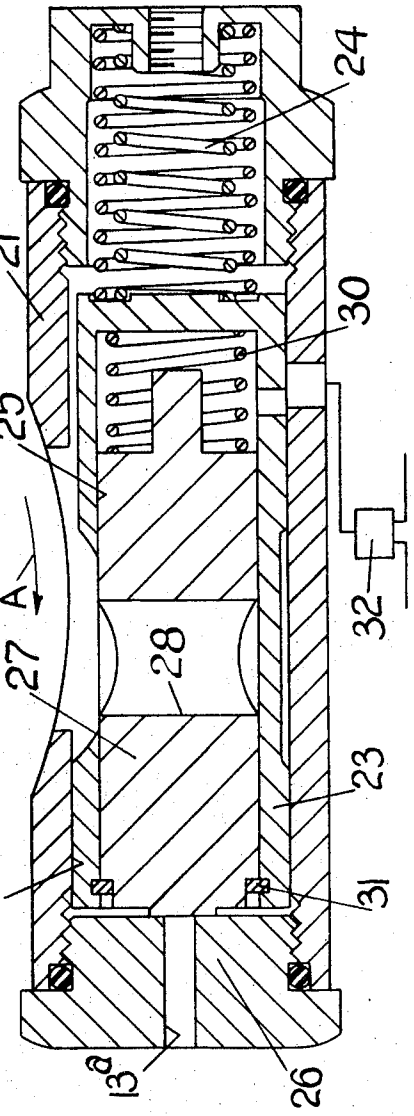
FIG.2.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LIQUID FUEL PUMPING APPARATUS

This invention relates to liquid fuel pumping apparatus for supplying fuel to internal combustion engines and of the kind comprising an injection pump driven in timed relationship with the associated engine, a feed pump for supplying fuel under pressure to the injection pump at a pressure which varies in accordance with the speed at which the apparatus is driven, a throttle member for controlling the quantity of fuel supplied to the injection pump and thereby controlling the quantity of fuel supplied to the associated engine and fluid pressure operable means for controlling the timing of delivery of fuel by the injection pump.

The object of the invention is to provide such an apparatus in a simple and convenient form.

According to the invention said fluid pressure operable means comprises in combination, a cup shaped piston mounted within a first cylinder, first resilient means for urging said piston towards one end of said cylinder, said cup shaped piston defining a second cylinder having its closed end remote from said one end of said first cylinder, a second piston mounted in said second cylinder, second resilient means for urging said second piston away from the closed end of said second cylinder, said second piston being connected to a part of the injection pump whereby movement of the piston will effect variation in the timing of injection of fuel, conduit means for connecting said one end of the first cylinder with the feed pump and control means for admitting fluid under pressure to the closed end of said second cylinder depending upon the setting of said throttle member, said control means acting to lower the pressure of fluid in the closed end of said second cylinder when the throttle member is set to reduce the amount of fuel supplied by the feed pump to the injection pump whereby the pistons will move relative to each other against the action of the second resilient means.

One example of a liquid fuel pumping apparatus in accordance with the invention will now be described with reference to the accompanying drawing in which:

FIG. 1 is a sectional side elevation showing one form of pumping apparatus to which the invention can be applied, and

FIG. 2 shows to enlarged scale a portion of the apparatus not seen in FIG. 1.

With reference to the drawings there is provided a body part 1 which at one end contains a feed pump 2 of the kind comprising a rotary impeller provided with vanes. The inlet 3 and outlet 4 of this pump are interconnected through a relief valve 5 which regulates the pressure of fuel delivered to the rest of the apparatus in a manner dependent upon the speed of this pump. At the other end of the body part is contained a fuel injection pump which comprises a rotary head 6 formed at one end of a distributor 12 which serves to interconnect the rotary parts of the feed and injection pumps. Formed in the head is a transverse bore 7 containing a pair of reciprocable plungers 8 which through rollers 9 at their outer ends co-operate with a surrounding annular cam 10. Furthermore, the distributor is adapted to be driven in synchronism with an engine with which it is associated, through a drive shaft 11.

Fuel from the feed pump 2 is fed through a passage 13 in the body part to an annular groove 14 in the periphery of the distributor and thence by way of a throttle valve 15 to a passage 16 in the body part which registers in turn as the distributor rotates, with a plurality of radially disposed passages 17 formed in the distributor. The passages 17 are in communication with an axial passage 18 in the distributor which opens at one end into the bore 7 in the head. Also extending from the axial passage 18 is a radial passage 19 which is adapted to register in turn and as the distributor rotates with a plurality of outlet ports 20 formed in the body part and which are adapted for connection to the injection nozzles respectively of the cylinders of the associated engine.

The apparatus so far described is well known and operates in the following manner. Fuel from the feed pump is fed intermittently by way of the throttle valve to the axial passage 18 in the distributor and thus serves to move the plungers of the injection pump outwardly. At appropriate instants in the cycle the plungers are moved inwardly by the action of the cam and thereby serve to discharge fuel in turn to the engine cylinders.

Connected to the body part is an extension 21 in which is formed a first cylinder 22 and slidable within this cylinder is a cup shaped piston 23. The piston 23 is loaded towards one end of the cylinder by a pair of coiled compression springs 24 and is movable in the opposite direction by fuel under pressure which is derived from the passage 13 and flows to the cylinder by way of a passage 13*a* formed in an end closure in the in the form of a plug 26.

The piston 23 defines a second cylinder 25 the closed end of which is remote from said one end of the cylinder 22, the latter being closed by the plug 26. Located within the cylinder 25 is a second piston 27 and this is provided with a centrally disposed recess 28 in which is engaged a projection 29 extending outwardly from the cam 10. In order to allow the projection 29 to enter into the recess 28 the first piston 23 is provided with a longitudinal slit in its wall. The second piston 27 is loaded towards the plug 26 by means of a second coiled compression spring 30 and the extent of relative movement of the pistons under the action of the spring 30 is limited by a stop which is in the form of a circlip 31 mounted within a groove formed in the inner peripheral wall of the piston 23. The extent of relative movement of the pistons against the action of the spring 30 is determined by a projection on the piston 27 and which abuts against the end wall of the cylinder 25.

The closed end of the cylinder 25 communicates by way of registering ports in the piston 23 and the casing 21, with a valve 32. The valve 32 is a selector valve whereby the closed end of the cylinder may be brought into communication with the passage 13 or alternatively with a drain. Conveniently the valve 32 is constituted by the throttle valve 15 and the arrangement of the valve is such that when the throttle valve is set to provide the maximum amount of fuel then the closed end of the cylinder 25 will communicate with the passage 13. When the throttle valve is moved to reduce the quantity of fuel supplied to the associated engine then the closed end of the cylinder 25 is placed in communication with the drain.

In use, when the throttle valve is fully open the closed end of the cylinder is filled with fuel at the outlet pressure of the feed pump and similarly said one end of the cylinder 22 is filled with fuel at this pressure. As the speed of operation of the engine increases therefore

and the pressure of fuel increases the two pistons will move towards the right as seen in the drawing, against the action of the springs **24.** This will have the effect of advancing the timing of injection of fuel since the direction of rotation of the plungers is indicated by the arrow A in FIG. **2.** It will be noted that the two pistons are maintained in the position shown by the action of the coiled spring **30.** If now the throttle member is closed then the pressure in the closed end of the cylinder falls to the drain pressure and the piston **27** moves under the action of the unbalanced pressures acting on it, relative to the piston **23** and further advancement of the timing of injection of fuel occurs. If now the throttle member is fully opened again then the fuel pressures acting on the piston **27** will be balanced and the two pistons will move relative to each other under the action of the spring **30.** The srping **30** is a light spring so that relative movement of the pistons **23** and **27** can occur even at low engine speeds when the output pressure of the feed pump is relatively low.

I claim:

1. A liquid fuel pumping apparatus for supplying fuel to internal combustion engines the apparatus being of the kind comprising an injection pump adapted to be driven in timed relationship with an associated engine, the injection pump including a rotary body in which is defined a bore, a fuel transfer passage communicating with said bore, reciprocable plunger in the bore, cam means surrounding said body and operable to effect inward movement to the plunger to displace fuel through said transfer passage as the body rotates, a feed pump for supplying fuel under pressure through said fuel transfer passage to the injection pump, valve means for varying the outlet pressure of the feed pump so that it varies in accordance with the speed of the associated engine, a throttle member for controlling the quantity of fuel supplied to the injection pump and thereby controlling the quantity of fuel supplied to the associated engine, and fluid pressure operable means for controlling the setting of said cam means thereby to adjust the timing of delivery of fuel by the injection pump, said fluid pressure operable means comprising in combination, a cup shaped piston mounted within a first cylinder, first resilient means for urging said piston towards one end of said cylinder, said cup shaped piston defining a second cylinder having its closed end remote from said one end of said first cylinder, a second piston mounted in said second cylinder, second resilient means for urging said second piston away from the closed end of said second cylinder, means connecting said second piston to said cam means whereby movement of the piston will effect variation in the timing of injection of fuel, conduit means for connecting said one end of the first cylinder with the feed pump and control means for admitting fluid under pressure to the closed end of said second cylinder depending upon the setting of said throttle member, said control means acting to lower the pressure of fluid in the closed end of said second cylinder when the throttle member is set to reduce the amount of fuel supplied by the feed pump to the injection pump whereby the pistons will move relative to each other against the action of the second resilient means.

2. An apparatus as claimed in claim **1** including means for limiting the relative movement of said pistons.

3. An apparatus as claimed in claim **2** in which said means comprises a circlip carried by the first piston in a position to co-operate with the end of the second piston to limit the extent of relative movement under the action of the second spring and a projection on the second piston for co-operation with the end wall of said second cylinder to limit the extent of relative movement against the action of the spring.

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