

Aug. 20, 1963

F. M. EVANS

3,101,079

LIQUID FUEL PUMPS FOR INTERNAL COMBUSTION ENGINES

Filed April 13, 1962

2 Sheets-Sheet 1

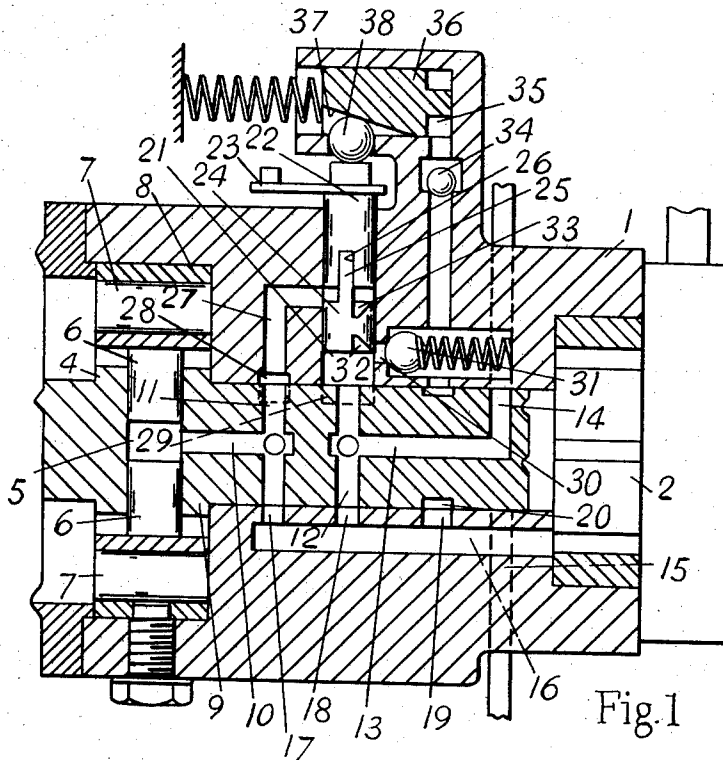


Fig. 1

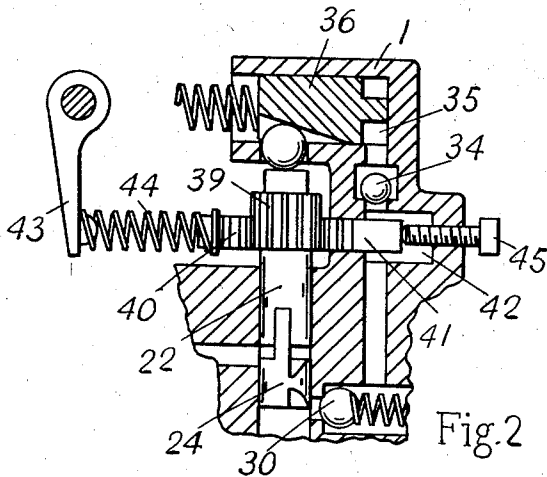


Fig. 2

Aug. 20, 1963

F. M. EVANS

3,101,079

LIQUID FUEL PUMPS FOR INTERNAL COMBUSTION ENGINES

Filed April 13, 1962

2 Sheets-Sheet 2

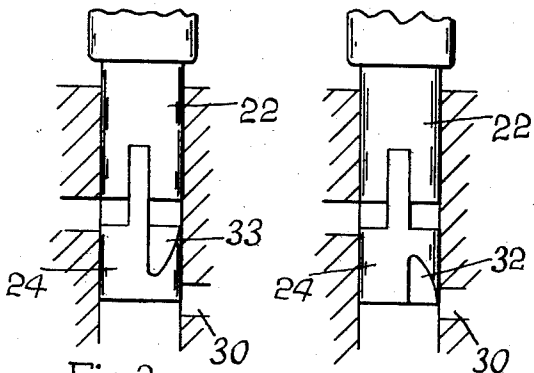


Fig.3

Fig.4

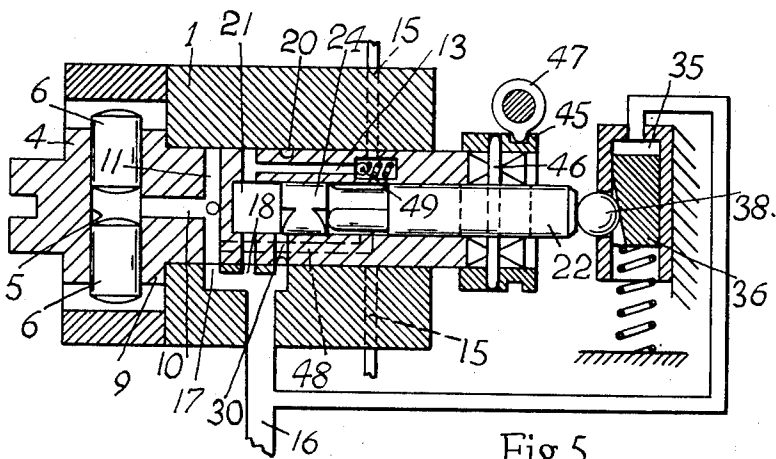


Fig.5

1

3,101,079

LIQUID FUEL PUMPS FOR INTERNAL COMBUSTION ENGINES

Fraser Mackie Evans, Uxbridge, Middlesex, England,
assignor to C.A.V. Limited, London, England

Filed Apr. 13, 1962, Ser. No. 188,615

Claims priority, application Great Britain Apr. 17, 1961

7 Claims. (Cl. 123—140)

The object of this invention is to provide in a convenient form a liquid fuel injection pump for internal combustion engines.

A pump according to the invention comprises in combination a body part, a rotary distributor in the body part, a rotary head at one end of the distributor, said head and distributor being adapted to be rotated by the engine with which the pump is associated, a transverse bore in the head, at least one plunger in the bore, and an annular cam surrounding the head for imparting radially inward movements to the plunger as the head rotates, a first series of angularly spaced passages in the distributor, said first series of passages being in communication with the bore in the head, a second series of angularly spaced passages in the distributor, a discharge passage in the distributor in communication with the second series of passages, a plurality of angularly spaced discharge ports in the body part with which the discharge passage is arranged to register in turn as the distributor rotates, said discharge ports being adapted for connection respectively to injection nozzles associated with the cylinders of the engine respectively, a cylindrical chamber one end of which is in communication with the passages of the first series, and the other end of which is in communication with the passages of the second series a pair of inlet ports adapted to register respectively with the passages of the first and second series in turn as the distributor rotates, means for feeding fuel to the pair of inlet ports, a spill passage in the wall of the chamber, an axially movable shuttle in the chamber, means for moving the shuttle angularly about its axis, means for limiting axial movement of the shuttle towards said one end of the chamber and at least one slot in the shuttle having a helical or inclined edge whereby the angular setting of the shuttle will determine at what axial position of the shuttle spill port will be uncovered, and the arrangement being such that fuel fed to the second series of passages will be discharged to the discharge ports in turn through the discharge passage by the displacement of the shuttle by the fuel fed to said one end of the chamber by the inward movements of the plunger, the timing of the commencement and/or cessation of discharge being determined by the covering and/or uncovering of the spill passage.

In the accompanying drawings.

FIGURE 1 is a sectional side view of an example of the invention as applied to a pump for supplying fuel to a four cylinder compression ignition engine.

FIGURE 2 is a fragmentary sectional side view of a modification.

FIGURES 3 and 4 respectively illustrate alternative forms for the shuttle, and

FIGURE 5 is a diagrammatic sectional side view of a further modification of the invention as applied to a pump for supplying fuel to a four cylinder compression ignition engine.

Referring first to FIGURE 1 of the drawings, there is provided a body part 1 which at one end contains a feed pump 2 of the vane type. This pump has an inlet and an outlet formed in the body part, the inlet and outlet being interconnected by a spring loaded relief valve (not shown) which limits the maximum pressure which can be generated by the pump, the outlet pressure of the pump

2

below this maximum varying with the speed of the engine.

At the other end of the body part is contained an injection pump which includes a rotary head 4 having formed in it a transverse bore 5. The bore extends diametrically through the head and contains a pair of reciprocable plungers 6. As the head rotates each plunger is moved inwardly at appropriate timing by the interaction of a roller 7 at its outer end with a surrounding annular cam 8.

The rotary parts of the feed and injection pumps are interconnected by a cylindrical distributor 9, and are adapted to be driven as a unit by the engine with which the pump is associated. In the distributor 9 is formed an axial passage 10 which at one end is in communication with the bore 5 in the head at a position between the pair of plungers 6, and at its other end is in communication with four equiangularly spaced radially extending passages 11 (i.e. there are as many radial passages as there are cylinders in the engine with which the pump is to be associated). Also in the distributor 9 are formed four equiangularly spaced radially extending passages 12 which are disposed at the same angles as the passages 11. The radial passages 12 are in communication with one end of an axial passage 13 which at its other end is in communication with a radially extending discharge passage 14 which is adapted to register in turn, as the distributor rotates, with each of four discharge ports 15 formed in the body part 1 and adapted for connection to the four injectors (not shown) of the cylinders of the engine respectively, the ports 15 being angularly displaced relative to the ports 17 and 18.

The feed pump 2 is adapted to deliver fuel to an inlet passage 16 formed in the body part 1, and from this inlet passage extend three inlet ports 17, 18, 19. The first inlet port 17 is arranged to register in turn with each of radial passages 11 as the distributor rotates. The second inlet port 18 simultaneously is arranged to register in turn with each of the radial passages 12 as the distributor rotates, whilst the third inlet port 19 is in communication with a circumferentially extending groove 20 formed in the periphery of the distributor.

In the body part 1 is formed a cylindrical chamber 21 which extends radially relative to the distributor 9. The outer end of this chamber is closed by an axially and angularly movable plug 22 having a radial arm 23 which is adapted to be linked to a mechanical governor (not shown) whereby it may be angularly set. At the inner side of the plug 22 there is disposed within the chamber a reciprocable shuttle 24 having a tongue 25 which engages in a slot 26 in the plug in a manner to prevent relative angular movement of the plug and shuttle whilst permitting the shuttle to reciprocate independently of the plug. The inner end 29 of the chamber 21 is extended angularly so as to be always in communication with at least one of the radial passages 12, whilst opening into the chamber 21 at a position between the plug 22 and shuttle 24 is a passage 27 which at its other end 28 is extended angularly so as to be always in communication with at least one of the radial passages 11. Moreover, opening from the chamber 21 at a position between its inner end 29 and the pump passage 27 is a spill passage 30 incorporating a spring loaded relief valve 31 through which it is connected to the inlet passage 16 by means of the circumferentially extending groove 20 and the inlet port 19.

Assuming the plug 22 to be fixed, then the operation of the pump as so far described is as follows. When the inlet ports 17, 18 are in register respectively with the passages 11, 12 the discharge passage 14 is out of register with the discharge ports 15. As a result fuel flowing through the inlet port 17 serves to move the plungers 6

in the head 4 apart whilst fuel flowing through the inlet port 18 serves to move the shuttle 24 outwardly in the chamber 21 to the limit of its travel as permitted by the setting of the plug 22. When the distributor 9 has moved through a predetermined angle, such for example, as 45°, the passages 11, 12 will be out of register with the inlet ports 17, 18 and the discharge passage 14 will be in register with one of the discharge ports 15. At this instant the plungers 6 will be moved inwardly by the action of the surrounding annular cam 8. As a result fuel will be delivered through the passage 27 to the chamber 21 thereby moving the shuttle 24 inwardly. During the initial inward movement of the shuttle 24 fuel from the inner end of the chamber 21 will be discharged through the spill passage 30 until the latter is covered by the shuttle 24, whereafter fuel will be injected to the appropriate engine cylinder through the discharge port 15 until the spill passage 30 is again uncovered by the trailing end of the shuttle 24. The inner and outer ends of the shuttle 24 incorporate a pair of slots 32, 33 having helically shaped edges respectively whereby the covering and uncovering of the spill passage 30 can be effected at different axial settings of the shuttle 24 by varying its angular setting by angular movement of the plug 22. If desired, the slot 32 can be omitted as shown in FIGURE 3, or alternatively the slot 33 can be omitted as shown in FIGURE 4. It will be understood that where, as shown in FIGURE 4, a slot 32 is provided only at the inner end of the shuttle the angular adjustment of the shuttle 24 will determine the commencement of injection, whilst where the slot 33 is provided only at the outer end of the shuttle 24 (as shown in FIGURE 3) the angular setting of the latter will determine the timing of the cessation of injection. However, where both slots 32, 33 are provided as shown in FIGURE 1, the angular setting of the shuttle will determine both the instant and commencement and termination of injection.

The circumferential groove 20 in the distributor 9 is connected through a non-return valve 34 to one end of a cylinder 35 formed in the body part 1 at the outer side of the chamber 21 and extending at right angles to the axis of the chamber. In the cylinder is a spring loaded piston 36 having an inclined face 37 co-operating with a ball 38 adapted to bear upon the outer end of the plug 22, the arrangement being such that an increase in pressure in the inlet passage 16, due to an increase in engine speed, will cause the piston 36 to move in a direction to move the plug 22 inwardly in the chamber 21 thereby advancing the instant of injection, for a given angular setting of the plug 22. A clearance is provided between the piston 36 and the cylinder 35 to admit of escape of fuel from the cylinder so as to allow the piston to be moved by its spring when the pressure falls.

In the modification illustrated in FIGURE 2 instead of the plug 22 incorporating a radial arm 23 connected to the governor, the outer end of the plug may take the form of a pinion 39 in mesh with a rack bar 40 one end of which is shaped to form a piston 41 occupying a second cylinder 42 in the body part 1 to which fuel is admitted from the inlet passage 16. A throttle actuated lever 43 acts on the opposite end of the rack bar through a balancing spring 44 and within the second cylinder is an adjustable maximum fuel stop 45. In this construction the delivery pressure of the feed pump 2, which is a function of engine speed, is caused to act on the rack bar in opposition to the balancing spring and thereby hydraulic governing may be obtained.

In a further modification as illustrated in FIGURE 5 of the drawings the shuttle 24 and plug 22 are located in an axial cylindrical chamber 21 in the distributor 9 and are permitted axial and angular movement relative thereto. The angular setting of the shuttle 24 and plug 22 relative to the distributor is controlled by means of an axially movable sleeve 45 surrounding a portion of the distributor and engaged by a pin 46 passing through heli-

cal slots in the distributor and a straight slot in the plug 22, the axial setting of the sleeve 45 being determined by a part 47 movable angularly by the governor. The axial setting of the plug 22 is determined as in the previous example by the position of a piston 36.

In this modification the feed pump is a separate unit driven in synchronism with the distributor and connected to the inlet passage 10. The four equi-angularly spaced radially extending passages 11 are in communication with the end of the chamber 21 remote from the head 4 by means of an axial passage 43 within the distributor. Within the longitudinal extending passage 13 is a non-return delivery valve 49. Moreover, communicating with the circumferentially extending groove 20 is a spill passage 30 extending into the chamber 21.

In use when the plungers 6 are moved inwardly fuel passes via one of the radial passages 11 and the axial passage 43 into the chamber 21 to force the shuttle 24 towards the head. Fuel is spilled to the inlet passage 16 via the passage 30 until the latter is closed by the shuttle 24, thereafter the fuel flows via the longitudinal passage 13, the non-return delivery valve 49, and one of the discharge ports 15 to the appropriate engine cylinder until the passage 30 is again opened by the shuttle 24. As the distributor rotates fuel flows from the inlet passage 16, the inlet port 17, one of the four equi-angularly spaced passages 11 to move the plungers 6 outwardly. At the same time fuel passes from the inlet passage 16 by way of the port 18 and one of the four equi-angularly spaced passages 12 to the chamber 21 to move the shuttle 24 into contact with the plug 22. As in the previous example, angular movement of the shuttle 24 varies the quantity of fuel injected into the engine whilst the longitudinal setting of the plug 22 determines the timing of the injection into the engine.

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

1. For use with a multi-cylinder internal combustion engine provided with a plurality of fuel injection nozzles in communication respectively with the cylinders of the engine, a liquid fuel injection pump comprising in combination a hollow body part, a cylindrical distributor mounted in a complementary portion of said hollow body part, and adapted to be rotated by the engine, a head which is rigidly united with one end of said distributor so as to be rotatable therewith, and which is provided with a transverse bore, at least one plunger slidably mounted in said transverse bore, an annular cam surrounding said head for imparting radially inward movements to said plunger during rotation of said head, a first series of angularly spaced radial passages formed in said distributor, an axial passage which is formed in said distributor, and which establishes communication between said first series of radial passages and the transverse bore in said head, a second series of angularly spaced radial passages formed in said distributor, a radial discharge passage formed in said distributor, another passage which is formed longitudinally in said distributor, and through which said second series of radial passages are communicable with said radial discharge passage, a plurality of angularly spaced discharge ports formed in said hollow body part at positions in which said discharge passage registers in turn with said discharge ports during rotation of said distributor, said discharge ports being adapted for connection respectively to the fuel injection nozzles of the engine, a cylindrical chamber which at one end communicates with said first series of angularly spaced radial passages, and at the other end communicates with said second series of angularly spaced radial passages, a pair of fuel inlet ports in said hollow body part at positions in which, during rotation of said distributor, one of said fuel inlet ports registers in turn with said first series of angularly spaced radial passages, and the other of said fuel inlet ports registers in turn with said second series

5

of angularly spaced radial passages, means for feeding fuel to said pair of fuel inlet ports, spill passage in the wall of said cylindrical chamber, an axially movable shuttle in said cylindrical chamber, means for adjusting said shuttle angularly about its axis, means for limiting axial movement of said shuttle towards the end of said cylindrical chamber in communication with said first series of angularly spaced radial passages, and means for adjusting said shuttle axially, said shuttle having in at least one end thereof a slot shaped so that angular adjustment of said shuttle will determine at what axial position said shuttle will uncover said spill passage, and the arrangement being such that fuel fed to said second series of angularly spaced radial passages will be delivered through said discharge passage to said discharge ports in turn by displacement of said shuttle in response to fuel fed by inward movements of said plunger to the first mentioned end of said cylindrical chamber.

2. A liquid fuel injection pump according to claim 1, wherein said means for limiting axial movement of said shuttle towards the end of said cylindrical chamber in communication with said first series of angularly spaced radial passages, comprises an axially movable plug, and means responsive to the speed of the pump for determining the axial setting of said plug.

3. A liquid fuel injection pump according to claim 2, wherein said axially movable plug is in non-rotatable engagement with said shuttle, and is angularly movable about its axis.

4. A liquid fuel injection pump according to claim 1,

6

and including a spring-loaded relief valve in said spill passage.

5. A liquid fuel injection pump according to claim 1, and including a spring-loaded delivery valve between said discharge passage and the end of said cylindrical chamber in communication with said second series of angularly spaced radial passages.

6. A liquid fuel injection pump according to claim 2, wherein said means responsive to the speed of the pump for determining the axial setting of said plug comprises a spring-loaded piston which is mounted in a cylinder extending transversely relative to said plug, and which is movable against its spring-loading by fuel at a pressure dependent upon the speed of the pump, said piston having an inclined surface through the medium of which the axial position of said piston determines the axial position of said plug.

7. A liquid fuel injection pump according to claim 2, wherein said cylindrical chamber is axially disposed within said distributor, a pin extends through a slot in said plug and engages helical slots in said distributor, and means are provided for moving said pin longitudinally relative to said distributor so as to vary the angular setting of said plug relative to said distributor.

References Cited in the file of this patent

UNITED STATES PATENTS

2,406,239	Morgenroth	Aug. 20, 1946
2,922,371	Bischoff	Jan. 26, 1960
3,035,523	Kemp et al.	May 22, 1962