Sept. 9, 1969 M. G. MOWLE 3,465,678

LIQUID FUEL PUMPING APPARATUS

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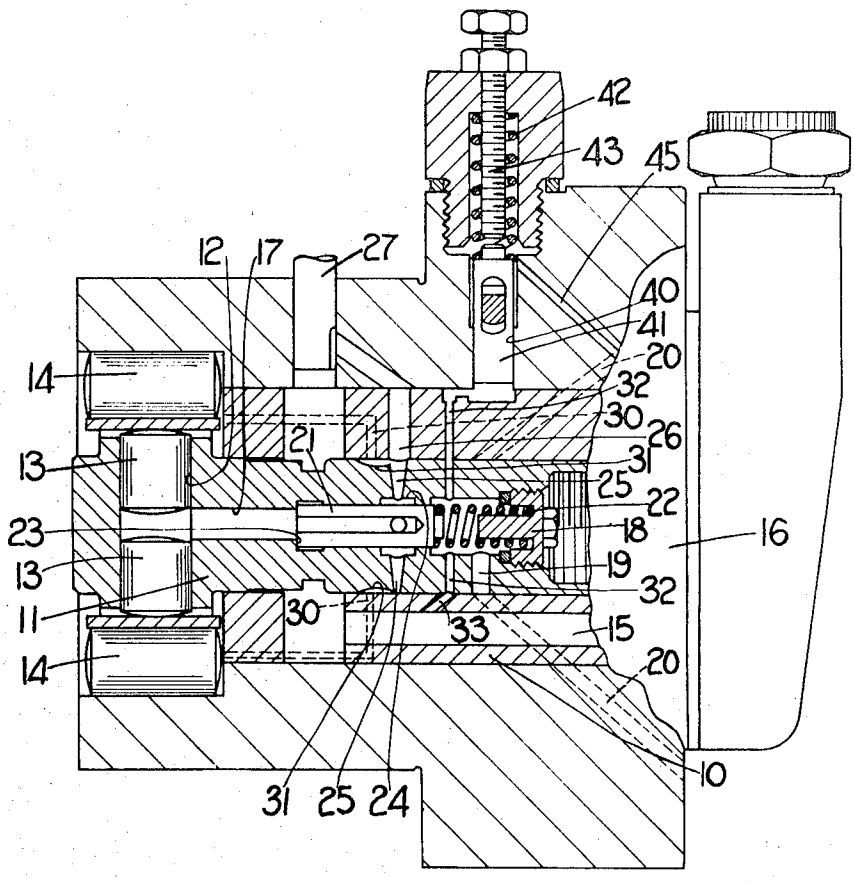



FIG. 1.

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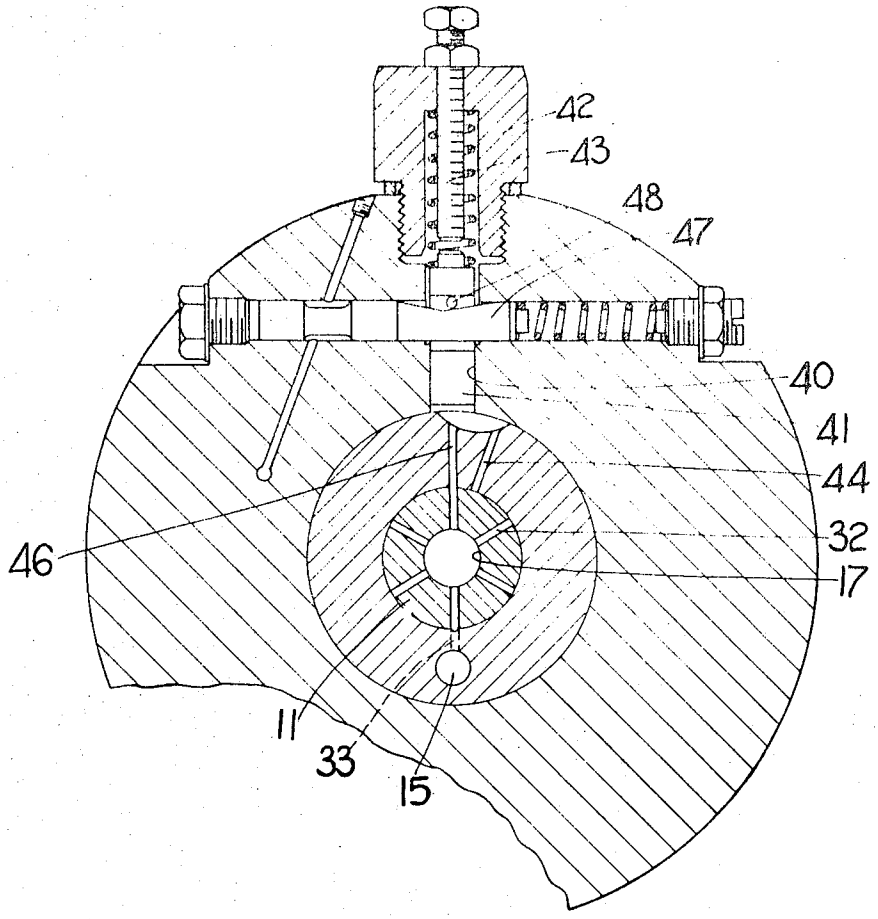



FIG. 2

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# LIQUID FUEL PUMPING APPARATUS

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U.S. Cl. 103—2 10 Claims

## ABSTRACT OF THE DISCLOSURE

A liquid fuel pumping apparatus for supplying fuel to an internal combustion engine and including an injection pump driven in timed relationship with the engine, the injection pump being arranged to deliver fuel to an outlet port during an injection stroke thereof and a one way valve disposed intermediate the injection pump and said port, the valve being arranged to be closed after the delivery of fuel to the port has ceased and means for relieving the pressure on the opposite sides of said valve after injection has ceased.

This invention relates to liquid fuel pumping apparatus for supplying fuel to internal combustion engines and has for its object to provide such an apparatus in a simple and convenient form.

A liquid fuel pumping apparatus in accordance with the invention comprises in combination, an injection pump arranged to be driven in timed relationship with the engine with which the apparatus is associated, the injection pump being arranged to deliver fuel to an outlet port during an injection stroke thereof, a one way valve disposed intermediate the injection pump and said port, said valve being arranged to be closed after the delivery of fuel to the port has ceased, and means for relieving the pressure on the opposite sides of said valve after injection has ceased, to a pressure or pressures below the pressure which is attained during an injection stroke of the injection pump.

In the accompanying drawings:

FIGURE 1 is a sectional side elevation of one example of a liquid fuel pumping apparatus in accordance with the invention, and

FIGURE 2 is a section through the apparatus of FIGURE 1.

The apparatus comprises a body part **10** in which is mounted a rotary cylindrical distributor **11** which is adapted to be driven in timed relationship with an engine with which the apparatus is associated. At one end of the distributor member there is provided a transverse bore **12** in which is mounted a pair of pumping plungers **13** which are arranged to be moved inwardly as the distributor member rotates by means of an annular cam **14** surrounding the distributor member at this point. For this purpose, the annular cam is provided with a plurality of inwardly extending and diametrically disposed pairs of cam lobes which are arranged to be contacted by rollers which are mounted at the outer ends of the pumping plungers respectively.

At the opposite end of the distributor member is mounted the rotary part of a vane-type fuel feed pump **16** which is provided with an inlet and an outlet in the body part. The outlet is in communication with an axially disposed feed passage **15** formed within the body part and the inlet is in communication with an inlet port formed on the exterior of the body part. The inlet port in use, is arranged to be connected to a source of liquid fuel. Moreover, the inlet and outlet of the fuel feed pump are interconnected by a relief valve (not shown) which is so arranged that



the outlet pressure of the feed pump varies in accordance with the speed at which the distributor member is driven.

Formed in the distributor member is a stepped axial passage **17** which at one end is in communication with the transverse bore **12**. At its other end the passage is closed by a plug **18** and furthermore this end of the passage is enlarged. From the enlarged end of the passage extends a radially disposed delivery port **19** which is arranged to register in turn and as the distributor member rotates, with a plurality of equi-angularly spaced delivery passages **20** formed in the body part. The delivery passages in use, are connected respectievly to the injection nozzles of the associated engine. The registration of the delivery port **19** with one of the delivery passages **20** is arranged to occur before the plungers are moved inwardly by the cam lobes and for a period after the plungers have moved inwardly to their maximum extent.

The stepped axial passage **17** accommodates a cylindrical valve member **21** which is urged in a direction away from the enlarged end of the passage, by means of a coiled compression spring **22** which is located in said enlarged end. The extent of movement of the valve member under the action of its spring is limited by a step **23** defined in the periphery of the axial passage. The valve member is provided with a blind bore which extends from its end which is directed towards the transverse bore **12** and this blind bore is provided with a transverse drilling which breaks out onto the periphery of the valve member. When the valve member is in contact with the step **23**, the transverse drilling is in communication with a groove **24** formed in the periphery of the axial passage at this point. Moreover, the groove is in communication with a plurality of equi-angularly spaced and radially extending inlet ports **25** formed in the distributor member, and which are arranged to register in turn and as the distributor rotates with an inlet port **26** formed in the body part. The axial position of the transverse drilling in the valve member is so chosen that during the initial inward movement of the pump plungers **13**, the cylindrical valve member **21** will be moved axially against the action of its spring thereby to displace fuel from the enlarged end of the axial passage through the delivery port **19**, and subsequently the transverse drilling will be exposed to the enlarged end of the axial passage so that further flow of fuel from the transverse bore takes place by way of the blind bore formed in the valve member and the transverse drilling.

The inlet port is in communication with the feed passage **15** formed in the body part by way of a groove on the distributor member and a throttle valve **27** is provided to control the rate at which fuel can flow through the inlet port. The throttle valve is movable angularly by a governor (not shown) which is responsive to the speed at which the distributor member is driven and an operator adjustable member is provided to control the setting of the governor. The throttle member has a groove formed in its periphery, the degree of exposure of which to a port in the wall of the body part determines the quantity of fuel which passes to the inlet port.

The operation of the apparatus thus far described will now be explained assuming that the delivery port **19** has just opened to one of the delivery passages **20** and the pumping plungers **13** are just starting to move inwardly under the influence of the cam lobes. Initially, the valve member **21** is moved axially against the action of its spring by the fuel which is being driven from the transverse bore **12** by the plungers. The axial movement of the valve member displaces fuel from the enlarged end of the axial passage through the delivery port to the delivery passage which is in register therewith and to the appropriate injection nozzle of the engine. It should be

mentioned that during this movement the inlet passages **25** are out of register with the inlet port **26**. Continued axial movement of the valve member places the transverse drilling thereof in communication with the enlarged end of the axial passage and the remainder of the fuel which is to be displaced from the transverse bore passes by way of the blind bore in the valve member and the transverse drilling to the enlarged end of the axial passage. When the rollers reach the crests of the cam lobes no further inward movement of the pumping plungers takes place and consequently the supply of fuel to the engine ceases. As the rollers roll over the crests of the cam lobes, the plungers move outwardly and the valve member under the action of the spring **22** and the fuel flowing to the transverse bore, is moved in the reverse direction to the closed position. By this means a predetermined amount of relief of the pressure in the enlarged end of the axial passage occurs. The cam lobes are shaped to provide a period of dwell in the outward movement of the plungers so that such further outward movement is temporarily halted. However, the amount of outward movement permitted to the plungers is always sufficient to ensure that the transverse drilling in the valve member is brought back into register with the groove formed in the axial passage and which is in communication with the inlet passages. Subsequently, the delivery port **19** moves out of register with the delivery passage **20** and before this occurs one of the inlet passages **25** is brought into register with the inlet port **26**.

In order to ensure that the valve member **21** seats against the step **23** and in order to stabilise the pressure existing in the transverse bore **12** and the portion of the axial passage **17** downstream of the valve member, together with the bore in the valve member and the groove, whilst the plungers are temporarily halted, it is arranged that these volumes are placed in communication with a low pressure. Conveniently, this low pressure is the pressure pertaining in the space surrounding the annular cam, and this space is normally in communication with a drain port provided on the external surface of the apparatus. In order to achieve this, drain passages **30** are provided in the body part of the pump and for registration in turn with a plurality of axially extending drain grooves **31** formed in the periphery of the distributor member. The drain grooves are respectively in communication with the inlet passages **25**, and the registration of the drain grooves with the drain passages is arranged to occur at the same time as the inlet port **26** registers with one of the inlet passages **25**. Moreover, the drain grooves move out of communication with the drain passages before the delivery port moves out of communication with one of the delivery passages. During the time that the drain grooves are open to the drain passages, fuel flows by way of the inlet port to drain, but nevertheless, the pressure in the aforesaid volumes is stabilised to drain pressure and this stabilisation occurs whilst the plungers are held against outward movement by the dwell period of the cam lobes. High pressure in the enlarged end of the axial passage **17** ensures that at this point of operation the valve member **21** assisted by the spring is moved into contact with the step **23**. As soon as the aforesaid dwell period is over and when the drain grooves have moved out of register with the drain passages, fuel flows to the transverse bore **12** to move the plungers outwardly, the amount of fuel being controlled by the setting of the throttle.

In order to ensure that the pressure in the enlarged end of the axial passage after the delivery port has closed, and during the filling period, is always at a predictable and relatively low pressure, the enlarged end of the axial passage is arranged to be placed in communication with the outlet of the feed pump. For this purpose extending from the enlarged end of the axial passage are a plurality of radially extending and equiangularly spaced dump ports **32** which are arranged to register with a dump passage **33** in communication with



the feed passage **15**, whilst the delivery port **19** is out of register with a delivery passage **20**.

By the arrangements described, the high pressures which exist at the end of the injection period in conventional pumps of this type and which have a tendency to cause irregularities within the pump now no longer exist.

In order to be able to shape the delivery curve of the fuel output of the apparatus with respect to the speed at which the apparatus is driven, an adjustable quantity of fuel is allowed to escape from the enlarged end of the axial passage at the commencement of the inward movement of the pumping plungers. For this purpose there is provided in the body part a cylindrical chamber **40** in which is mounted a shuttle **41** which is loaded towards one end of the chamber by means of a coiled compression spring **42** located at the other end of the chamber. The extent of movement of the shuttle towards said other end of the chamber is limited by an adjustable stop **43** which can be adjusted from the exterior of the body part of the apparatus. Said one end of the chamber **40** is brought into communication with the enlarged end of the axial passage at the same time as the delivery port **19** is brought into register with one of the delivery passages **20**. For this purpose a spill passage **44** is provided in the body part and which is in communication with said one end of the cylinder. The other end of the spill passage is positioned so that it registers with one of the aforesaid dump ports **32** at the appropriate time. By this means the initial quantity of fuel which is delivered through the axial passage **17** when the plungers are moved inwardly flows to said one end of the chamber and the shuttle therein is moved against the action of its spring into contact with the adjustable stop **43**. When the movement of the shuttle is halted by the stop, injection of fuel to the engine proceeds as described previously. The other end of the chamber which contains the shuttle **41** is in communication with the inlet of the feed pump by way of a passage **45** and consequently fuel is displaced to the inlet of the feed pump when the shuttle is moved against the action of its spring. The period of registration of the spill passage with one of the dump ports occurs for only a portion of the time during which the delivery port is open to a delivery passage. When the delivery port has closed and whilst one of the dump ports **32** is in communication with the dump passage **33** it is arranged that fuel can flow from said one end of the chamber into the enlarged end of the axial passage and for this purpose a return passage **46** is provided which is in communication with said one end of the chamber **40**. This return passage communicates with one of the dump ports **32** at the appropriate time and the shuttle moves under the action of its spring towards said one end of the chamber.

The extent of movement of the shuttle towards said one end of the chamber is controlled by a stop, the setting of which depends upon the speed at which the apparatus is driven. The stop comprises a fluid pressure operable piston **47** which is spring loaded in one direction and which is urged in opposition to the loading of its spring by fuel under pressure from the outlet of the feed pump. The shuttle **41** is provided with a transverse drilling through which the valve member extends and an abutment is provided in the drilling **48** which co-operates with a cam surface formed on the periphery of the piston **47** remote from said one end of the chamber. The cam surface is shaped in any convenient manner so that the extent of movement of the shuttle **41** towards said one end of the chamber under the action of its springs is limited. By shaping the cam surface any desired fuel output curve can be attained.

The variation in the timing of injection of fuel to the engine can be obtained in the usual manner with this type of pump by varying the angular setting of the annular cam within the body part. For this purpose a fluid

pressure operable piston may be provided which is coupled to the annular cam, the piston being resiliently loaded in one direction and movable in the opposite direction by fuel under pressure derived from the outlet of the feed pump.

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

1. A liquid fuel pumping apparatus for supplying liquid fuel to an internal combustion engine and comprising in combination, an injection pump arranged to be driven in timed relationship with the engine with which the apparatus is associated, the injection pump being arranged to deliver fuel to an outlet port during an injection stroke thereof, a one way valve disposed intermediate the injection pump and said port, said valve being arranged to be closed after the delivery of fuel to the port has ceased, means for relieving the pressure on the opposite sides of said valve after injection has ceased, to a pressure or pressures below the pressure which is attained during an injection stroke of the injection pump, and a rotary valve adapted to be driven in timed relationship with the injection pump, said rotary valve serving to control communication between the upstream side of said valve and said outlet port, the means for relieving the pressure upstream of the valve being inoperative until said rotary valve has closed.

2. A liquid fuel pumping apparatus as claimed in claim 1 in which said one way valve during its movement towards the closed position, allows a predetermined volume of fuel to be displaced from the upstream side thereof, the means for relieving the pressure downstream of the valve being operative before said rotary valve has closed.

3. A liquid fuel pumping apparatus as claimed in claim 2 in which a plurality of said outlet ports are provided equal in number to the number of cylinders of the engine to which fuel is to be supplied, said rotary valve having a delivery port in communication with the upstream side of said one way valve, the delivery port registering in turn, and during successive injection strokes of the injection pump with passages communicating respectively with said outlets, the means for relieving pressure upstream of the one way valve comprising a plurality of dump ports formed in the rotary valve and which register in turn, with a dump passage thereby to relieve the pressure upstream of the one way valve after the delivery passage has moved out of register with a delivery port.

4. A liquid fuel pumping apparatus as claimed in claim 3 in which the means for relieving pressure downstream of the one way valve comprises a plurality of ports formed in the rotary valve which are brought into register with a spill passage before the delivery port has closed to a delivery passage.

5. A liquid fuel pumping apparatus as claimed in claim 4 in which fuel is supplied to the downstream side of the one way valve during the filling strokes of the injection pump from a source of fuel under pressure, throttle means being provided to control the quantity of fuel supplied to the injection pump.

6. A liquid fuel pumping apparatus as claimed in claim 5 including a shuttle movable within a chamber, means biasing said shuttle towards one end of the chamber, the rotary valve acting to place said one end of the chamber in communication with the upstream side of said valve during the initial portion of the injection stroke of the injection pump, so that a quantity of fuel is displaced into said chamber, and a stop for limiting the movement of the shuttle away from said end of the chamber the shuttle returning to said end of the chamber when said dump passages and ports are brought into communication with each other.

7. A liquid fuel pumping apparatus as claimed in claim 6 including stop means for limiting the extent of movement of the shuttle towards said end of the chamber.

8. A liquid fuel pumping apparatus as claimed in claim 7 in which the setting of said stop means is dependent upon the speed at which the apparatus and the associated engine are driven.

9. A liquid fuel pumping apparatus as claimed in claim 8 including a feed pump for supplying fuel to the injection pump, valve means for controlling the output pressure of the feed pump so that the pressure varies in accordance with the speed at which the apparatus is driven, said stop means comprising a fluid pressure sensitive piston which is subjected to the output pressure of said feed pump.

10. A liquid fuel pumping apparatus as claimed in claim 9 in which the shuttle is biased towards said end of the chamber by a coiled compression spring.

**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,006,281 | 10/1961 | Delaney | 103—41 X |
| 3,331,327 | 7/1967 | Roosa. | |
| 3,352,245 | 11/1967 | Wolff | 103—2 |
| 3,364,863 | 1/1968 | Olszewski et al. | |


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