United States Patent

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[33] **Great Britain**
[31] **54,304/68**

[54] **LIQUID FUEL PUMPING APPARATUS**
3 Claims, 9 Drawing Figs.

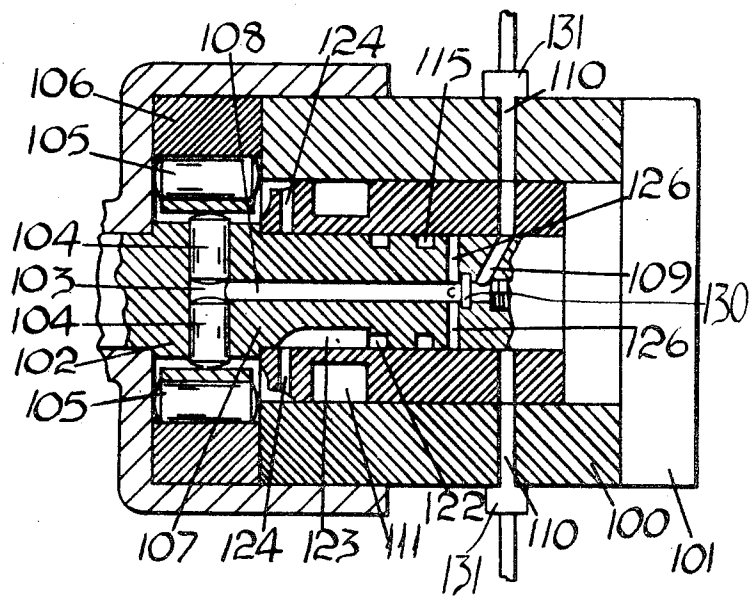
[52] **U.S. Cl.** **417/458,** 417/462, 137/614.2
[51] **Int. Cl.** **F04b 21/02,** F04b 39/08, F04b 19/02
[50] **Field of Search** 417/456, 458, 462; 137/538, 614.2, 625.11

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ABSTRACT: A fuel injection pump of the rotary distributor type and which includes a distributor in which is provided a passage having a delivery valve which closes at the end of an injection stroke and after a predetermined quantity of fuel has flowed back towards the injection pump, and the pump also includes in each outlet, a pressurizing valve which includes a valve member which is spring loaded to maintain the column of fuel intermediate the pressurizing valve and the delivery valve under the pressure thereby to prevent the formation of cavities within the column of fuel.



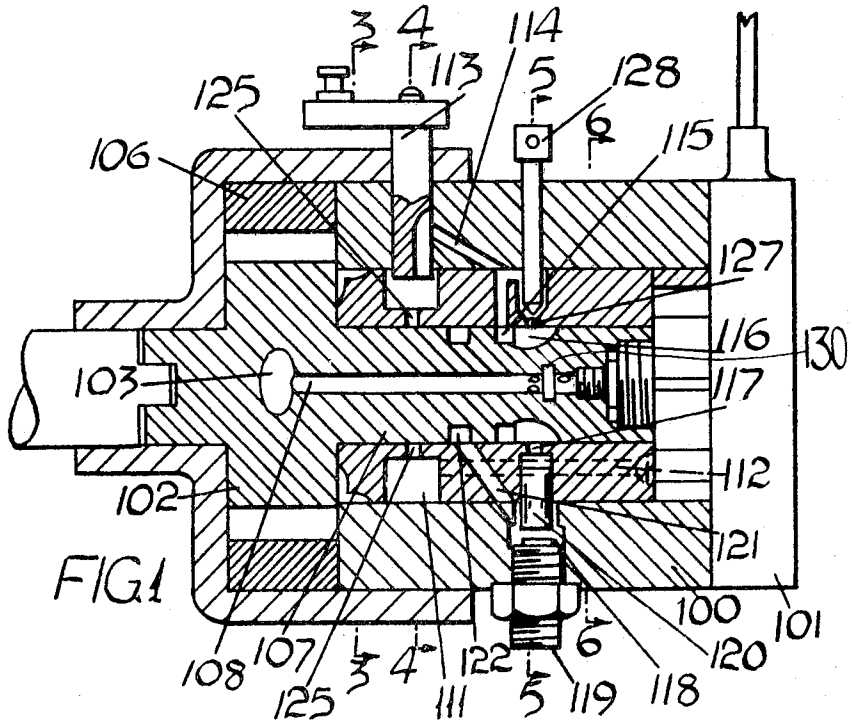


FIG 1

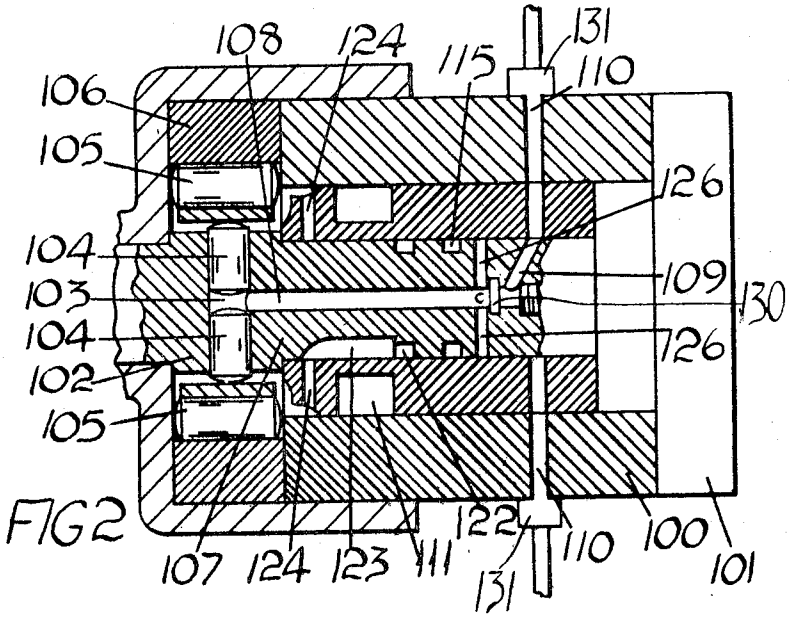


FIG 2

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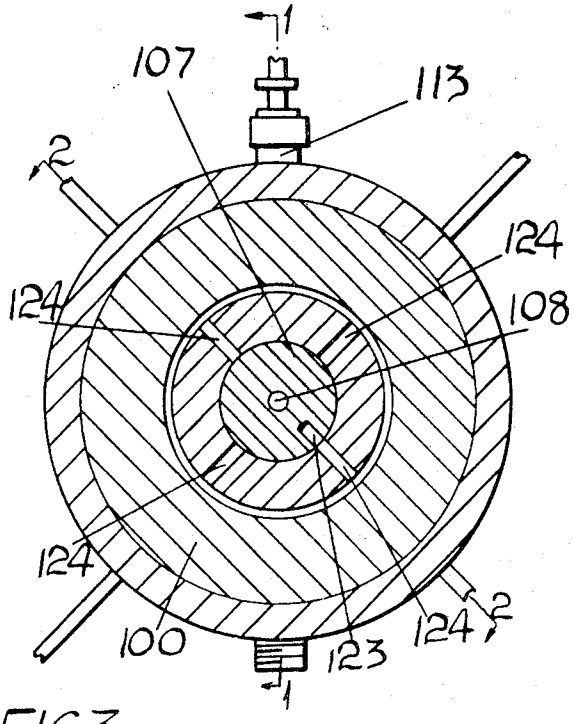


FIG. 3

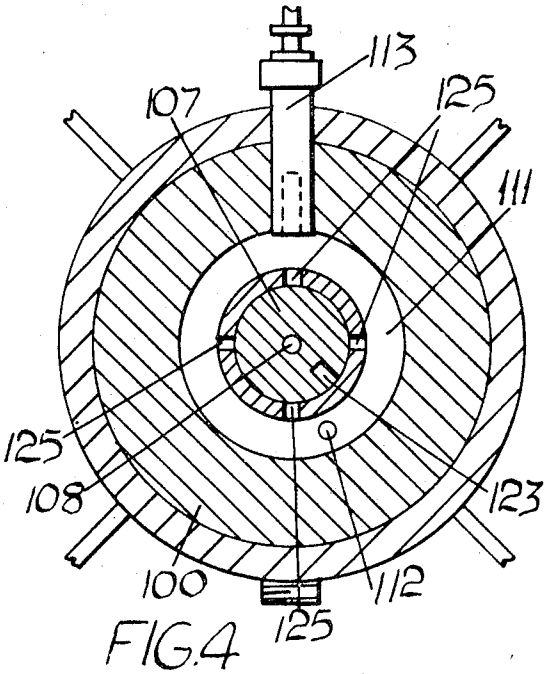


FIG. 4

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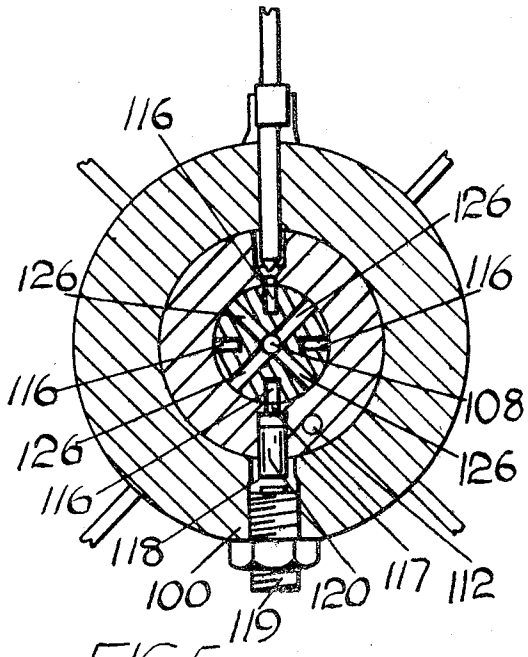


FIG. 5

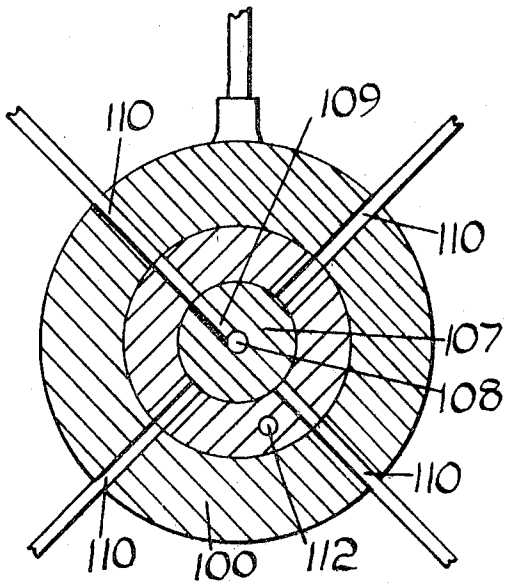


FIG. 6

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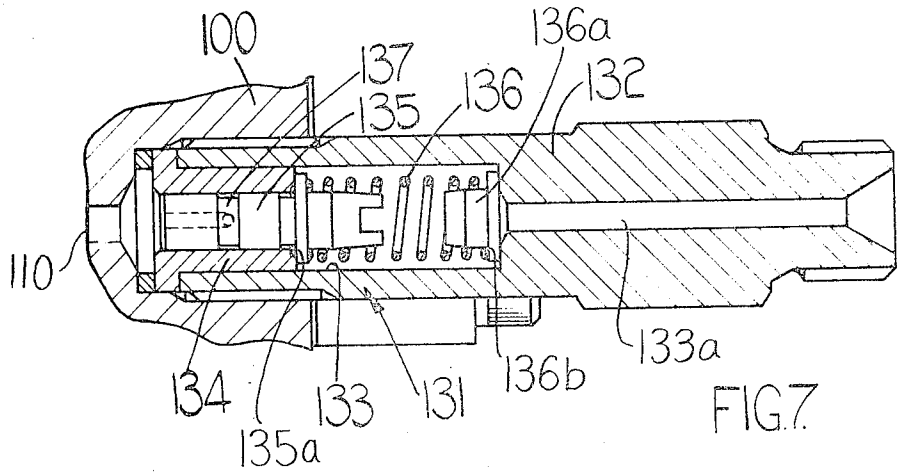


FIG.7

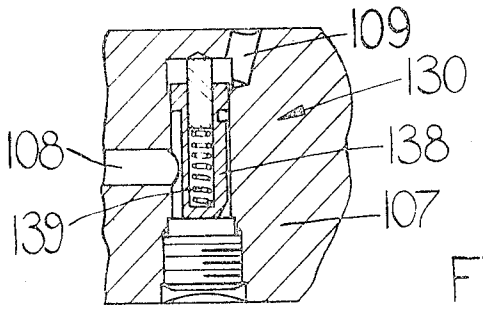


FIG.8

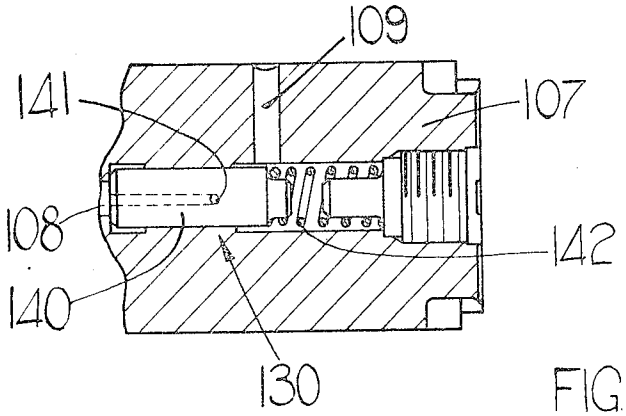


FIG.9

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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 in combination an injection pump adapted to be driven in timed relationship with the associated engine, a rotary distributor member including a delivery passage connected to the outlet of the injection pump, the distributor member being driven in timed relationship with the engine, a plurality of outlet ports being formed in a body surrounding the distributor member and with which the delivery passage registers in turn during successive delivery strokes of the injection pump.

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

According to the invention in a pumping apparatus of the kind specified there is provided in the delivery passage a delivery valve which is closed at the end of a delivery stroke of the injection pump and the outlet ports are provided with pressurizing valves respectively which act to maintain fuel contained in the portions of the delivery passage and the associated outlet port at the end of the delivery stroke of the injection pump, under pressure at least until the delivery passage has been moved out of register with the outlet port.

In the accompanying drawings:

FIG. 1 is a sectional side view of one example of an apparatus in accordance with the invention, showing the apparatus during an injection stroke, the section being on the line 1—1 of FIG. 3;

FIG. 2 is a further sectional side view of the apparatus taken on the line 2—2 of FIG. 3;

FIG. 3 is a section on the line 3—3 of FIG. 1;

FIG. 4 is a section on the line 4—4 of FIG. 1;

FIG. 5 is a section on the line 5—5 of FIG. 1;

FIG. 6 is a section on the line 6—6 of FIG. 1;

FIG. 7 is a side elevation to an enlarged scale of a portion of the apparatus shown in block form only in FIG. 2;

FIG. 8 is a side elevation to an enlarged scale of a further portion of the apparatus shown in block form only in FIGS. 1 and 2, and

FIG. 9 shows an alternative arrangement of the portion of the apparatus of FIG. 8.

Referring firstly to FIGS. 1–6 of the drawings there is shown a pumping apparatus which is intended to supply fuel to a four-cylinder engine. The apparatus comprises a body part 100 which at one end contains a feed pump 101. The feed 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 pressure which can be generated by the feed pump.

At the other end of the body part there is provided an injection pump which includes a rotary head 102 in which is formed a transverse bore 103. The bore extends diametrically through the head and contains a pair of reciprocable plungers 104. As the head rotates each plunger is moved inwardly at an appropriate timing by the interaction of a roller 105 at its outer end, with a surrounding annular cam 106 on the internal periphery of which are formed inwardly extending cam lobes.

The rotary parts of the feed and injection pumps are connected by a cylindrical distributor 107 and are arranged to be driven as a unit by the engine with which the apparatus is associated. In the distributor 107 is formed an axial passage 108 which at one end is in communication with the bore 103 and which at its opposite end is in communication with an outlet passage 109. The outlet passage communicates as the distributor rotates, with each in turn of four equiangularly spaced outlet ports 110 formed in the body part. The outlet ports in use, are connected to injection nozzles respectively mounted on the associated engine in a position to direct fuel into the combustion spaces thereof. Moreover, the injection nozzles contain spring-loaded valve members for controlling the flow of fuel therethrough.

In the body part is an annular chamber 111 to which fuel is supplied from the feed pump through a feed pump passage 112. Fuel can flow from this chamber through an adjustable throttle valve 113 to a first passage 114 which is in communication with a circumferentially extending groove 115 formed in the distributor. In communication with the groove 115 there formed in the periphery of the distributor, four equiangularly spaced and longitudinally extending grooves 116. These grooves are arranged to register in turn as the distributor rotates with a port 117 formed in the body part and in communication with the inner end of a cylinder 118 also formed in the body part and extending substantially radially relative to the distributor. In the outer end of the cylinder 118 is a screw stop 119 which can be adjusted from the exterior of the body part to determine the degree of outward movement allowed to a shuttle 120 slidably mounted within the cylinder. The outer end of the cylinder is also in communication through a passage 121 in the body part, with a second circumferential groove 122 formed in the periphery of the distributor. Extending from the groove 122 is a single longitudinally extending groove 123 and this groove is arranged to register as the distributor rotates, with each in turn of a first series of four equiangularly spaced passages 124 which are in communication with the space surrounding the head 102 with this space in turn being in communication with the fuel reservoir. The groove 123 is also arranged to communicate in turn and as the distributor rotates, with a second series of four equiangularly spaced passages 125 in the body part communicating with the annular chamber 111; the first and second series of passages 124, 125 in the body part being displaced from one another by 45°.

There is also formed in the distributor a third series of four equiangularly spaced passages 126 which at their inner ends are in communication with the axial passage 108. The third series of passages 126 are angularly displaced from the grooves 116 by 45° and are adapted to register in turn as the distributor rotates, with the port 117 in the body part and which communicates with the inner end of the cylinder 118. In operation, as the plungers 104 are moved inwardly fuel is displaced from the axial passage in the distributor through the outlet passage 109 and to the appropriate outlet port 110. At the same time fuel is fed by the feed pump to the inner end of the cylinder 118 by way of the annular chamber 111, the throttle valve 113, the first passage 114, the circumferential groove 115 and one of the longitudinally extending grooves 116. As a result the shuttle 120 is moved outwardly towards the stop 119 thereby displacing fuel from the outer end of the cylinder by way of the second passage 121 in the body part, the circumferential groove 122 the second longitudinal groove 123 and one of the first series of passages 124 to the reservoir. It will be understood that when the throttle valve 113 is partially closed the shuttle will not necessarily be moved into contact with the stop.

At a position 45° subsequently fuel is fed to the outer end of the cylinder 118 by way of the annular chamber 111, one of the second series of passages 125, the single longitudinally extending groove 123, the circumferential groove 122 and the second passage 121 in the body part. As a result the shuttle 120 is moved inwardly thereby displacing fuel from the inner end of the cylinder 118 by way of one of the third series of passages 126 to the axial passage 108 thereby moving the plungers 104 apart ready for the next injection stroke.

In order to permit a quantity of fuel in excess of the maximum for which the stop 119 has been set, the first passage 114 communicates with a bypass passage 127 incorporating a manually operable valve 128. The end of the passage 127 at the downstream side of the valve is disposed to register in turn with the passages 126 as the distributor rotates and at the instant when the passages 126 are in register with the port 117. When the valve 128 is open additional fuel can be fed through it to the axial passage 108 thereby ensuring that the plungers 104 are moved outwards to the limit of their travel even though the stop 119 has been set to provide a maximum fuel setting below the maximum capacity of the apparatus.

Such forms of pumping apparatus as described above are very well known and it is known that the injection nozzles incorporate valves which open only when the pressure applied to the nozzle attains a predetermined value. Furthermore, these valves close rapidly at the end of the delivery of fuel by the injection pump thereby to cause rapid termination of the supply of fuel to the engine. With such an arrangement it has been found that the closure of the valves in the injection nozzles causes pressure waves which travel backwards and forwards within the pipeline connecting the nozzle to the pumping apparatus and within the open outlet port **110**, delivery passage **109**, axially extending passage **108** and the pumping chamber of the injection pump. In some instances at the point when communication between the delivery passage **109** and outlet **110** is cut off, it is possible for the fuel within the distributor member to be under considerable pressure while in other cases its pressure may be below that which might normally be expected. This can lead to undesirable variations in the delivery of the apparatus to each outlet.

In order to overcome these difficulties there is provided in the delivery passage **109**, a delivery valve **130** which closes under the action of a spring and the return flow of fuel as the rollers **105** roll over the crests of the cam lobes. Furthermore, there is provided in each outlet port **110** a pressurizing valve **131** which acts to pressurize the fuel contained within the portions of the delivery passage **109** and outlet **110** intermediate the pressurizing valve and the delivery valve until the delivery passage **109** moves out of register with the appropriate outlet port **110**. In this manner the fuel in the rotor upstream of the delivery valve is isolated at the end of the injection period from the pressure waves created due to the closure of the valves of the injection nozzles. The action of the pressurizing valve is to minimize the risk of cavities forming in the passages of the distributor due to overshoot of fuel on the pumping stroke of the plungers **104** and to refill any cavities formed between the pressurizing valves and delivery valve. The delivery valve is positioned to leave as small a volume as possible for pressurization by reflected pressure waves.

With reference to FIG. 7 the pressurizing valve **131** is located within an adapter **132** which is engaged within the body **100** of the apparatus. The adapter is provided with a cylindrical bore **133** which forms a continuation of the outlet port **110**. Located within the end of the bore is a flanged cylindrical member **134** which defines a cylinder and slidable within the cylinder is a valve member **135**. A stop member **136***a* is positioned within the bore **133** at the end of passage **133***a*. The stop is provided with a flange **136***b* and a coiled compression spring **136** is located between the flange and a head **135***a* on the valve member **135** to limit the extent of movement of the valve member. In addition, intermediate its ends, the valve member is provided with a groove **137** which by way of an internal passage in the valve member, is in constant communication with the outlet port **110**. In use, during an injection stroke of the injection pump the valve member **135** is moved against the action of the spring **136** and fuel is displaced from the bore **133**. When the groove **137** is exposed beyond the end of the member **134** fuel flows through the internal passage of the valve member. The flange **136***b* is recessed at spaced intervals on its face remote from the spring **136** to allow fuel in the bore **133** to flow into the passage **133***a*. At the end of the injection stroke the valve member returns towards the position in which it is shown in FIG. 7. Initially the return motion is due to the flow of fuel towards the injection pump as the rollers ride over the cam lobes and before the delivery valve has closed, but when the delivery valve has closed the additional stroke of the valve member **135** pressurizes the fuel as described to close any cavities which may have formed.

Two forms of delivery valve **130** are shown in FIG. **8** and **9**. The valve of FIG. **8** has a valve member **138** slidable within a radially disposed stepped bore in the distributor **107**. The wider end of the bore communicates with the delivery passage **109** and the passage **108** opens into the bore intermediate its ends. The valve member **138** is provided with a head which is exposed beyond the step in the bore during an injection stroke to permit the flow of fuel to the delivery passage **109**. Moreover, the valve member is spring loaded by a coiled spring **139** accommodated within a bore in the valve member. When at the end of an injection stroke the plungers are allowed outward movement the valve member returns to the position in which it is shown under the action of the spring **139** and the fuel pressure. The delivery valve seats before the pressurizing valve has completed its stroke and the quantity of fuel required to displace the delivery valve is less than the displacement of the pressurizing valve.

The delivery valve shown in FIG. **9** has a valve member **140** disposed in an axially extending stepped bore formed in the distributor **107**. The valve member is of plain cylindrical form and is loaded by a coiled compression spring **142**. The passage **108** opens into the narrower end of the cylinder and the passage **109** extends from the wider end thereof. Moreover, the valve member **140** is provided with a port **141** in its periphery which by way of an internal passage communicates with the passage **108**. In use, the valve member is moved at the start of an injection stroke against the action of the spring **142** until the port **141** is exposed beyond the step in the cylinder.

The valve members **135** and **140** have limited movement against the action of their springs, stops being provided for this purpose. The movement of the valve member of the delivery valve of FIG. **8** being limited by the abutment of the valve member with the end of the cylinder in which it is located.

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

1. A liquid fuel pumping apparatus of the kind intended to supply fuel to an internal combustion engine and comprising in combination an injection pump adapted to be driven in timed relationship with the associated engine, a rotary distributor member including a delivery passage connected to the outlet of the injection pump, the distributor member being driven in timed relationship with the engine, a plurality of outlet ports being formed in a body surrounding the distributor member and with which the delivery passage registers in turn during successive delivery strokes of the injection pump, a delivery valve located in said delivery passage and which is closed at the end of a delivery stroke of the injection pump and pressurizing valves located in the outlet ports respectively, said pressurizing valves acting to maintain fuel contained in the portions of the delivery passage and the associated outlet port and the end of the delivery stroke of the injection pump, under pressure at least until the delivery passage has been moved out of register with the outlet port.

2. The apparatus as claimed in claim 1 in which the valves each include a valve member loaded by a coiled compression spring.

3. The apparatus as claimed in claim 2 in which the quantity of fuel displaced by the delivery valve is less than that displaced by the pressurizing valve thereby ensuring that the valve member of the delivery valve completes its movement at the end of an injection stroke before the valve member of the pressurizing valve.

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