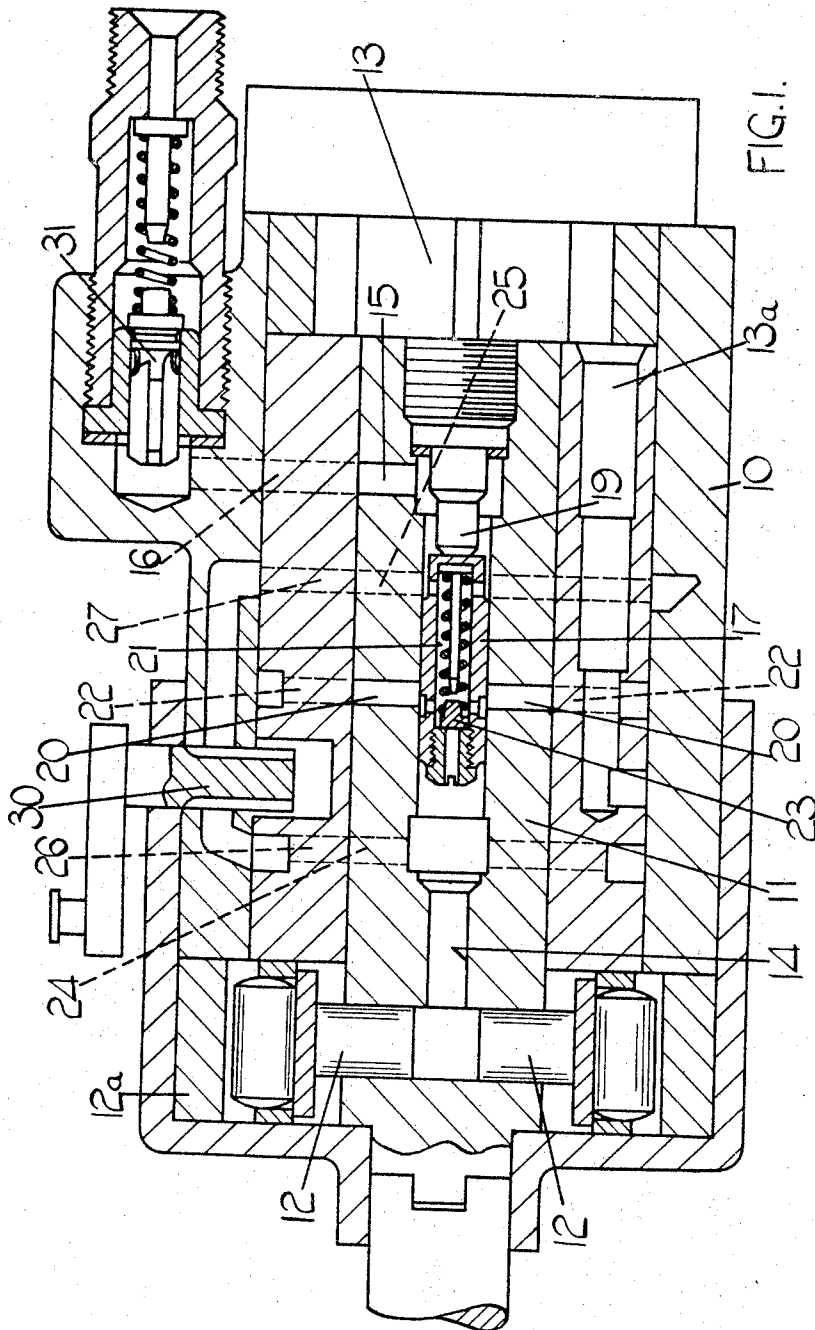


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LIQUID FUEL PUMPING APPARATUS FOR SUPPLYING FUEL TO
INTERNAL COMBUSTION ENGINES
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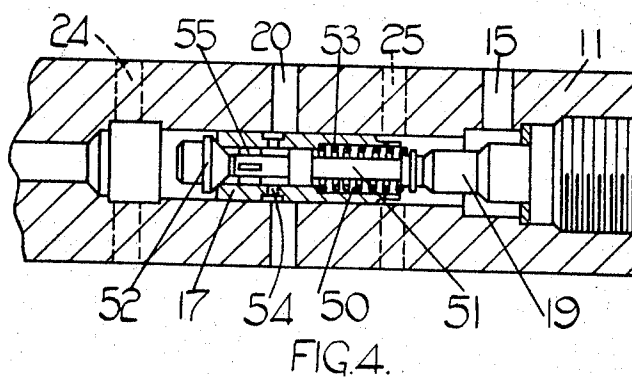
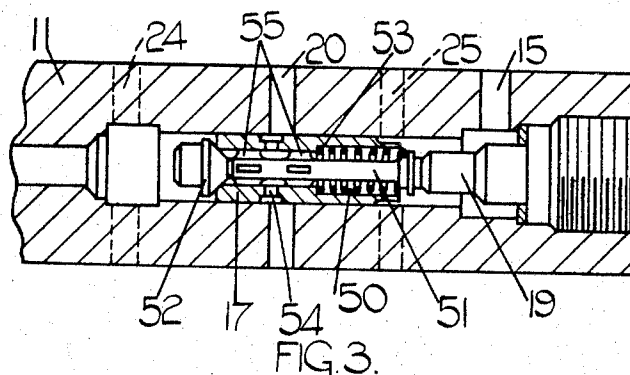
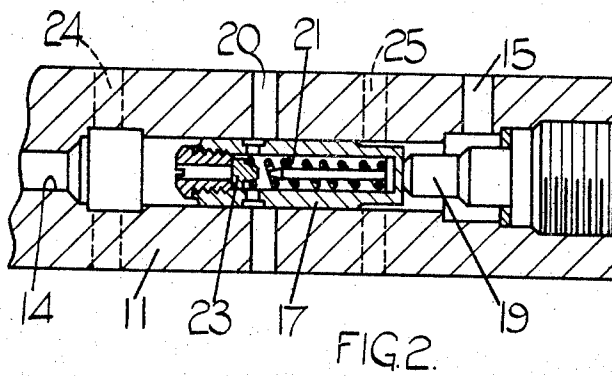
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LIQUID FUEL PUMPING APPARATUS FOR SUPPLYING FUEL TO INTERNAL COM- BUSTION ENGINES

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8 Claims

ABSTRACT OF THE DISCLOSURE

A pumping apparatus including an injection pump which supplies liquid fuel to an outlet by way of a bore, the bore having a shuttle slidable therein, the movement of the shuttle due to fuel leaving the injection pump being limited by a stop, and valve means being provided which opens when the shuttle hits the stop to permit excess fuel to escape from the injection pump.

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.

An apparatus in accordance with the invention comprises in combination, an injection pump which is arranged to be driven in timed relationship with an engine with which the apparatus is associated, the injection pump having a pumping chamber which is in communication with one end of a bore, an outlet passage extending from the other end of said bore and through which fuel can flow to the engine during a pumping stroke of the injection pump, a shuttle slidable within said bore, the shuttle being arranged to be moved towards said other end of the bore by fuel expelled from the pumping chamber during a pumping stroke of the injection pump, a stop for limiting the movement of the shuttle towards said other end of the bore, said spill path being arranged to be opened to permit surplus fuel from the pumping chamber to escape from said one end of the bore when the shuttle contacts the aforesaid stop.

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

FIGURES 2, 3 and 4 show modifications of part of the apparatus of FIGURE 1.

Referring to the drawings there is shown a body part 10 having mounted therein a rotary distributor member 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 is provided a transverse bore in which are mounted a pair of reciprocable pumping plungers 12. Surrounding the pumping plungers is an annular cam ring 12a on which are formed inwardly directed pairs of cam lobes, the lobes of each pair being diametrically opposed to each other. The cam lobes together with the pumping plungers define an injection pump having a pumping space defined between the plungers. At the other end of the distributor and driven thereby is a feed pump 13 which in use supplies fuel under pressure to a feed conduit 13a formed in the body part.

Extending longitudinally within the distributor is a bore 14 one end of which communicates with the pumping chamber of the injection pump and the other end of which communicates with a delivery passage 15. The lat-

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ter passage is arranged to communicate with each in turn of a plurality of equiangularly spaced delivery ports 16 (only one of which is shown) as the distributor rotates, the delivery ports in use, being connected respectively to the injection nozzles of the associated engine. Within the bore 14 is a movable shuttle 17 and for limiting the movement of the shuttle towards the other end of the bore there is provided a stop 19.

Within the shuttle 17 there is formed an axially extending bore 21 which is in communication at its opposite ends with the adjacent ends of the bore 14. Moreover, formed in the shuttle is a transverse drilling which communicates with the bore 21 and which as the shuttle moves towards the stop 19 communicates with a plurality of spill passages 20 formed in the distributor. The spill passages 20 register during the time when the plungers 12 are moving inwardly, with spill ports 22 formed in the body part 10 and in communication with the feed conduit 13a. The communication of the end of the bore 21 with the end of the bore 14 which is in communication with the pumping chamber is controlled by a spring loaded valve 23, the operation and purpose of which will be described.

For supplying fuel to the opposite ends of the bore 14 two series of feed passages 24, 25 are provided in the distributor 11 and each of these series of passages is arranged to communicate during the time when the plungers 12 are permitted to move outwardly by the cam lobes, with two series of feed ports 26, 27 respectively. The feed ports are supplied with fuel from the feed conduit 13a and for controlling the relative amount of fuel which flows through the feed ports a proportioning valve 30 such as is described and illustrated in the specification of our British Patent No. 956,561 is provided. By this means the amount of fuel delivered by the pump can be controlled.

The operation of the apparatus will now be described starting from the position in which the parts of the apparatus are as shown in FIGURE 1. As shown the delivery of fuel to the engine has just finished and as the distributor rotates the delivery passage 15 moves out of register with the delivery port 16 and the feed passages 24, 25 move into register with the feed ports 26, 27 respectively thereby allowing fuel to flow into the opposite ends of the bore 14. Whilst this is taking place the shuttle 17 will be moved in a direction towards the pumping chamber by an amount determined by the volume of fuel admitted through the feed passages 25. At the end of the filling period the bore 14 and the pumping chamber of the injection pump will be completely filled with fuel. As the distributor further rotates the feed passages 24, 25 will move out of register with the feed ports 26, 27 and the delivery passage 15 will register with one of the delivery ports 16. Shortly after this registration is established the plungers 12 will commence their inward movement under the action of the cam lobes and fuel will be expelled from the pumping chamber into the bore 14. This fuel will force the shuttle 17 away from the pumping chamber thereby causing fuel to be expelled from the other end of the bore 14 through the delivery passage 15 and to the appropriate injection nozzle of the engine. During the final part of the movement of the shuttle away from the pumping chamber the transverse drilling in the shuttle registers with the spill passages 20, the latter being arranged so as to be brought into communication with the spill ports 22 during if not before the start of the inward movement of the plungers. As a result fuel is spilled from the other end of the bore 14 to the feed conduit 13a. Under the action of the fuel leaving the pumping chamber the shuttle will be moved to contact the stop 19 whereupon the valve 23 will open to permit surplus fuel from the

pumping chamber to flow through the spill passages 20 and spill ports 22 to the feed conduit 13a. In this manner owing to the spring loading of the valve a residual pressure higher than the pressure in the feed conduit 13a is maintained in the pumping chamber and the risk of the pumping plungers 12 contacting each other at the end of their inward movement by the cam lobes owing to their inertia is minimised. In this manner also the risk of cavitation occurring within the pumping chamber is minimised.

The opening of the spill ports and spill passages to the other end of the bore 14 besides serving to accurately terminate the end of delivery of fuel to the engine also permits unloading of the pressure in the pipe lines interconnecting the outlet ports 16 and injection nozzles. In order to control the unloading an unloading valve such as is shown at 31 in FIGURE 1 may be provided in each outlet port or alternatively a single unloading delivery valve may be provided in the bore 14 or in the outlet passage 15.

In an alternative arrangement a modified form of shuttle is used which is shown in FIGURE 2. The bore 21 in the shuttle is not in communication with the other end of the bore 14 and the valve 23 is arranged so that the pressure at which it opens is greater than the maximum injection pressure encountered whilst the apparatus is in use. In this manner spill from said other end of the bore 14 does not occur but the shuttle moves into contact with the stop 19 thereby terminating the injection of fuel to the engine and subsequently the valve 23 opens to permit surplus fuel within the pumping chamber to escape through the transverse drilling in the shuttle and the spill passages 20.

In a further modification (not shown) the shuttle is solid and the valve 23 is mounted in an extended portion of the bore 14 on the remote side of the pumping chamber. As in the last modification the valve is loaded so that it only opens when the pressure in the pumping chamber is in excess of the maximum injection pressure which is encountered when the apparatus is in use. Alternatively the valve 23 may be disposed in the body part and in this case the spill passages 20 are in constant communication with the end of the bore 14 which is connected to the pumping chamber. In a further modification the valve is positioned within one of the pumping plungers 12 and again the loading of this valve is such that it will not open until the pressure within the pumping chamber exceeds the maximum injection pressure which can be attained during normal use of the apparatus.

In a further modified form of the apparatus the shuttle which is shown in FIGURE 3 is used.

In this embodiment the shuttle 17 is provided with a stepped axial bore 50 therein and within this bore is the stem 51 of a valve member having a head 52 formed at its end thereof which is directed towards the pumping chamber. The stem is spring loaded by means of a coiled compression spring 53 in a direction so that the head 52 contacts a seating defined on the shuttle. Moreover, the stem extends beyond the valve member and is adapted to contact the stop 19. The bore in the shuttle is in communication with a transverse drilling 54 which can communicate with the spill passages 20 as will be described. Furthermore, two sets of longitudinal flutes 55 are defined on the stem 51 and these serve to place the transverse drilling 54 in communication with the portion of the bore 14 adjacent the stop as well as to guide the movement of the stem.

In use, as the shuttle is moved towards the stop by the action of the pumping plungers moving inwardly, fuel will be displaced from the end of the bore 14 by way of the delivery passage 15 to a delivery port 16. At some point during this movement the transverse drilling 54 is brought into communication with the spill passages 20 and when this occurs further delivery of

fuel to the outlet port 16 ceases and the fuel which is contained within the end of the bore 14 remote from the pumping chamber flows by way of the passages defined by the flutes 55 and the transverse drilling 54 to the spill passages. Further movement of the shuttle causes the stem 51 of the valve member to strike the stop 19 and when this occurs the continued movement of the body of the shuttle opens the valve to allow surplus fuel from the pumping chamber to flow by way of the transverse drilling 54, to the spill passages 20. As in the first example the fact that the fuel from the end of the bore 14 remote from the pumping chamber is spilled to the spill passage 20 permits relief of the pipe line connecting the outlet port or ports with the injection nozzle or nozzles. The amount of relief can be controlled by any suitable form of valve provided in the pipe line or the outlet port. In an alternative construction shown in FIGURE 4 the right hand set of flutes 55 are omitted and in this case no fuel is spilled from the end of the bore 14 remote from the pumping chamber however, the movement of the shuttle is arrested by the fact that the valve stem contacts the stop 19 and in this manner injection of fuel to the engine ceases and surplus fuel from the pumping chamber is spilled to the spill passages 20.

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 fuel to an internal combustion engine and comprising in combination, an injection pump which is arranged to be driven in timed relationship with an engine with which the apparatus is associated, the injection pump having a pumping chamber which is in communication with one end of a bore, an outlet passage extending from the other end of said bore and through which fuel can flow to the engine during a pumping stroke of the injection pump, a shuttle slidable within said bore, the shuttle being arranged to be moved towards said other end of the bore by fuel expelled from the pumping chamber during a pumping stroke of the injection pump, a stop for limiting the movement of the shuttle towards said other end of the bore, a spill path in communication with said one end of the bore, and spring loaded valve means which is opened to permit surplus fuel from the pumping chamber to escape from said one end of the bore through the spill path, when the shuttle contacts the aforesaid stop.

2. A liquid fuel pumping apparatus according to claim 1 in which a portion of said spill path is defined in the shuttle, said spring loaded valve means also being located in said shuttle.

3. A liquid fuel pumping apparatus according to claim 2 in which said spring loaded valve means is a pressure relief valve which is set to withstand the maximum pressure encountered during the delivery of fuel by the apparatus.

4. A liquid fuel pumping apparatus according to claim 2 in which said spring loaded valve means comprises a seating defined about the portion of the flow path in the shuttle, a valve head loaded into sealing engagement with said seating to prevent the flow of fuel through the flow path, a stem connected to said valve head, the stem forming part of the shuttle and being arranged to lift the valve head from the seating when it contacts said stop.

5. A liquid fuel pumping apparatus according to claim 2 in which said portion of the spill path is defined in part by an axial drilling formed in the shuttle, one end of the drilling being in communication with said one end of the bore, a port extending from said bore, said port defining the remaining portion of the spill path, the drilling being brought into communication with said port as the shuttle approaches said stop.

6. A liquid fuel pumping apparatus according to claim 5 in which said drilling is open to the other end

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of the bore, so that as soon as the drilling registers with said port, the delivery of fuel through the outlet passage will cease, the shuttle continuing its movement until it contacts the stop.

7. A liquid fuel pumping apparatus according to claim 4 in which said portion of the spill path is defined in part by an axial drilling formed in the shuttle, one end of the drilling being in communication with said one end of the bore, a port extending from said bore, said port defining the remaining portion of the spill path, the drilling being brought into communication with said port as the shuttle approaches said stop.

8. A liquid fuel pumping apparatus according to claim 7 in which said drilling is open to the other end of the bore so that as soon as the drilling registers with the port, the delivery of fuel through the outlet passage

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will cease, the shuttle continuing its movement until it contacts the stop.

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