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(12) # EUROPEAN PATENT APPLICATION

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(54) **Fuel pumping apparatus.**

(57) A reciprocable plunger fuel injection pump has a pumping plunger (13) reciprocable within a bore (11) from which extends an outlet (12). A control port (15) is formed in the wall of the bore for registration with a helical groove (23) on the plunger. The control port communicates with one end of a cylinder (16) containing a spring biased piston (21) coupled to a valve member (20) which closes a spill passage (19) communicating with the one end of the bore.

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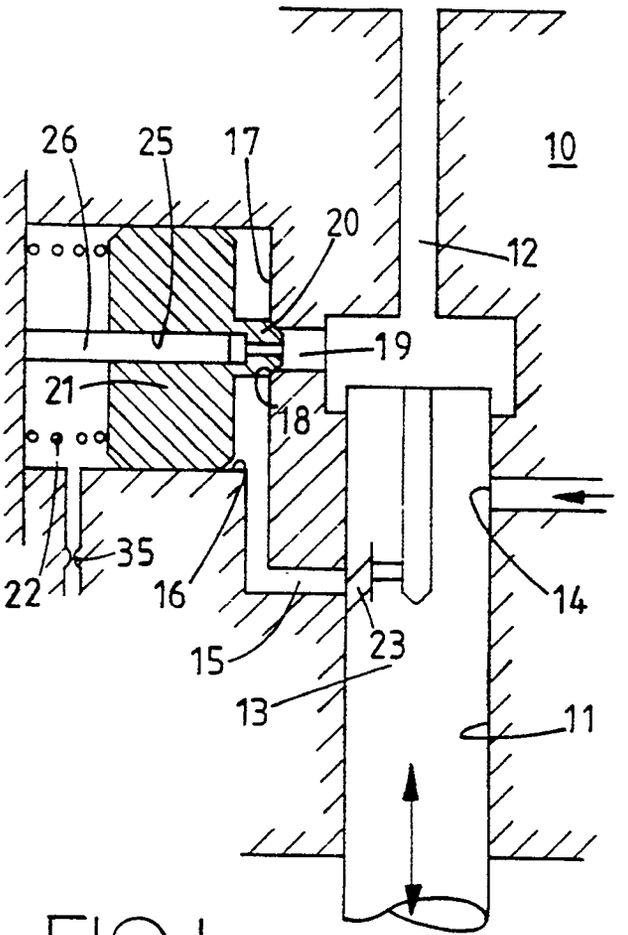

FIG.1.

This invention relates to a fuel pumping apparatus of the kind comprising a plunger reciprocable within a bore, an outlet from one end of the bore, a port formed in the wall of the bore and a groove formed on the plunger, the groove communicating with said one end of the bore and having an inclined control edge whereby the angular setting of the plunger within the bore determines the instant during the inward movement of the plunger at which the port is placed in communication with the one end of the bore to terminate flow of fuel through the outlet.

Such pumping apparatus is well known in the art and in order to achieve a rapid reduction in the pressure in the one end of the cylinder so that the flow of fuel through the outlet is terminated quickly, the port has to be large to achieve a high rate of flow of fuel as the port is progressively uncovered. Increasing the size of the port to achieve the required rate of flow of fuel leads to an increase in the leakage of fuel along the working clearance between the wall of the bore and the plunger. The rate of leakage of fuel also increases as the pressure at which fuel delivered through the outlet is increased.

It is known in such apparatus to provide a separate valve which can be opened to allow fuel to escape from the one end of the bore. The separate valve can be operated electrically but this involves a complex electronic control system or it may be operated mechanically or hydraulically. Mechanical actuation of the valve can possibly involve the addition of a further cam in addition to that which is required to actuate the pumping plunger and in the case of hydraulic operation examples of apparatus are known in which an additional plunger is provided which produces a control pressure specifically to actuate the valve.

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

According to the invention an apparatus of the kind specified comprises a cylinder having an end wall, an actuating piston slidable in said cylinder and resiliently biased towards said end wall, a spill passage extending from said one end of the bore into the cylinder through said end wall, a valve member movable by the piston for controlling the flow of fuel through said spill passage and passage means connecting said port with said cylinder whereby when during the inward movement of the pumping plunger, the port is uncovered by the control edge, fuel will flow into the cylinder to effect movement of the piston and valve member thereby allowing fuel flow through said spill passage into said cylinder.

In the accompanying drawings:-

Figure 1 is a diagrammatic sectional side elevation of one example of an apparatus in accordance with the invention and

Figure 2 is a view similar to Figure 1 showing a further modification.

Referring to Figure 1 of the drawings the apparatus comprises a housing 10 in which is formed a bore 11. Communicating with one end of the bore is an outlet 12 which in use is connected to an injection nozzle of an associated engine. A conventional form of delivery valve may be incorporated in the outlet.

Slidable within the bore 11 is a pumping plunger 13 which is driven inwardly towards the one end of the bore by means of an engine driven cam not shown. The plunger is moved outwardly by means of a return spring and the angular setting of the plunger within the bore can be adjusted in known manner.

Formed in the wall of the bore is a filling port 14 which in use, is connected to a source of fuel at low pressure. The port 14 is uncovered to the one end of the bore towards the end of the outward movement of the plunger 13. Also formed in the wall of the bore is a control port 15 which is connected to one end of a cylinder 16 formed in the housing 10. Formed in the end wall 17 of the cylinder at said one end thereof, is a seating 18 which is located about a spill passage 19 extending into the cylinder from the one end of the bore and for engagement with the seating there is provided a valve member 20 which is mounted on a piston 21 slidable in the cylinder. The piston is biased towards the one end of the cylinder by means of a coiled compression spring 22 and the end of the cylinder which contains the spring, is vented.

In known manner there is formed in the plunger 13 a groove 23 which is provided with an inclined control edge. The groove 23 communicates with the one end of the bore by way of a passage in the plunger.

In operation, and starting from the outer most position of the plunger, the initial inward movement of the plunger will displace fuel from the bore through the filling port 14 however, as soon as this port is covered by the plunger the fuel in the one end of the bore will be pressurised and displaced through the outlet 12 to the associated engine. This flow of fuel continues until the inclined control edge of the groove 23 uncovers the control port 15 and as soon as this occurs, fuel at the high pressure in the one end of the bore 11 flows into the cylinder to effect an initial displacement of the piston 21 against the action of its spring. The displacement of the piston lifts the valve member 20 from the seating and fuel can then flow from the one end of the bore through the spill passage 19 into the cylinder and this flow of fuel continues until the plunger has completed its inward movement. The rapid flow of fuel from the one end of the bore means that the pressure of fuel supplied to the associated injection nozzle falls very quickly and the valve member in the nozzle can therefore close quickly. In some instances it may be desirable to restrict the rate at which the pressure of fuel falls and this can be achieved by providing a restriction 35 in the passage through which the end of the cylinder 16 containing the spring 22 is vented.

As the plunger starts its outward movement, the fuel previously displaced into the cylinder 16 will be returned to the bore by way of the spill passage and to a certain extent by way of the control port 15 and the groove 23. Since however, some fuel will have been displaced to the associated engine, as soon as the filling port 14 is uncovered by the plunger fuel will flow into the bore from the source of fuel under pressure. The piston and valve member will therefore assume the position shown in the drawing ready for the next inward movement of the plunger. By moving the plunger angularly in known manner, the amount of fuel which is supplied to the associated engine can be varied and the conventional mechanism for controlling the angular setting of the plunger can still be utilised. At the same time however since the control port 15 is small, the leakage of fuel is kept to a minimum.

As described above it is the force exerted by the spring 22 which maintains the valve member in engagement with the seating 18 and therefore the spring must exert a considerable force. In order to reduce the force which is exerted by the spring, the piston is provided with an axial bore 25 which communicates with the spill passage 19 by way of a central drilling in the valve member 20. The bore 25 is occupied by a reaction plunger 26 and the diameter of the bore 25 is chosen so that it is slightly smaller than the effective seat diameter of the seating 18. The pressure of fuel in the bore 25 acts upon the valve member to substantially pressure balance the valve member so that the force which requires to be exerted by the spring 22 can be reduced.

No provision is made in the example of Figure 1 for adjusting the timing of the commencement of fuel delivery which takes place as soon as the filling port 14 is covered by the plunger. If variation in the timing of fuel delivery is required, this can be achieved in known manner using a mechanical arrangement which adjusts the relationship between the actuating cam for the plunger and the associated engine. Alternatively and as shown in Figure 2, provision can be made to adjust the timing by varying the position during the inward movement of the plunger at which the filling port is covered.

Referring to Figure 2, there is provided about the lower portion of the plunger 27 an axially adjustable sleeve 28. The sleeve defines a control port 29 which is the equivalent of the control port 15 in the example of Figure 1 and in addition, on its internal surface it defines a circumferential groove 30 which is the equivalent of the filling port 14, the groove 30 being in constant communication with a fuel supply passage 31. The plunger 27 is modified by an extension of the axial drilling 32 which is connected to the groove 23, the extended portion of the drilling being connected by cross drillings 33 to the exterior surface of the piston. The drillings 33 communicate with the groove 30 towards the end of the outward movement of the plunger, to replenish the fuel which has flowed to the associated engine. A mechanism not shown, is provided for moving the sleeve 28 axially and it will be appreciated that as the sleeve is moved towards the one end of the bore the instant of delivery of fuel to the associated engine will be delayed and vice-versa. The space defined between the sleeve 28 and the underside of the enlarged portion of the plunger is vented through a passage 34.

As described the outlet 12 is connected to a fuel injection nozzle of an associated engine. The apparatus can however be utilised to supply fuel to a multi cylinder engine in which case a distributor member is interposed between the outlet 12 and the injection nozzles of the engine. The fact that the spilled fuel is returned to the pumping chamber defined by the plunger and the bore is particularly useful in this case since it eases the problem of refilling the pumping chamber with fuel.

In the case where the outlet 12 is connected directly to a fuel injection nozzle the usual form of delivery valve can be omitted and the pressure in the pipeline connecting the outlet 12 with the nozzle controlled using the trailing flank of the cam lobe which actuates the pumping plunger.

Claims

1. A fuel pumping apparatus for supplying fuel to an internal combustion engine comprising a plunger (13, 27) reciprocable within a bore (11) an outlet (12) from one end of the bore, a control port (15, 29) formed in the wall of the bore (11) and a groove (23) formed on the plunger, the groove communicating with said one end of the bore and defining an inclined control edge whereby the angular setting of the plunger within the bore determines the instant during the inward movement of the plunger at which the control port (15, 29) is placed in communication will the one end of the bore (11) to terminate fuel flow through the outlet (12) characterised by a cylinder (16) having an end wall (17), an actuating piston (21) slidable in the cylinder and resiliently biased towards said end wall (17) of the cylinder, a spill passage (19) extending from said one end of the bore (11) into the cylinder (16) through said end wall (17), a valve member (20) movable by the actuating piston (21) for controlling the flow of fuel through said spill passage (19) and passage means connecting said port (15, 29) with said cylinder (16) whereby when during the inward movement of the plunger (13, 27), the control port (15, 29) is uncovered by the control edge, fuel will flow into the cylinder to effect movement of the piston (21) and valve member (20) thereby allowing fuel flow through said spill passage (19) into said cylinder

(16).

2. A pumping apparatus according to Claim 1, characterised by a spring (22) which biases the actuating piston (21) towards said end wall (17) of the cylinder.

3. A pumping apparatus according to Claim 2, characterised by a further bore (25) formed in the piston, one end of said further bore (25) communicating with said one end of the plunger bore (11) and a reaction plunger (26) located in said further bore, the diameter of said further bore and said reaction plunger being slightly less than the effective seat diameter of a seating (18) with which said valve member (20) cooperates to prevent fuel flow through spill passage (19).

4. A pumping apparatus according to any one of Claims 1, 2 or 3, including a restriction (35) for controlling the movement of the piston (21) away from said end wall (17) of the cylinder.

5. A pumping apparatus according to Claim 1, characterised by a sleeve (28) slidable in the bore (11) about said plunger (27), said port (29) being formed in said sleeve, a groove (30) in the internal surface of said sleeve in communication with a source of fuel, and a drillings (33) in the plunger (27) communicating with said one end of the bore (11), said sleeve (28) being axially movable within the bore to adjust the instant during inward movement of the plunger at which the drillings (33) are moved out of communication with said groove (30) to cause delivery of fuel through said outlet (12).

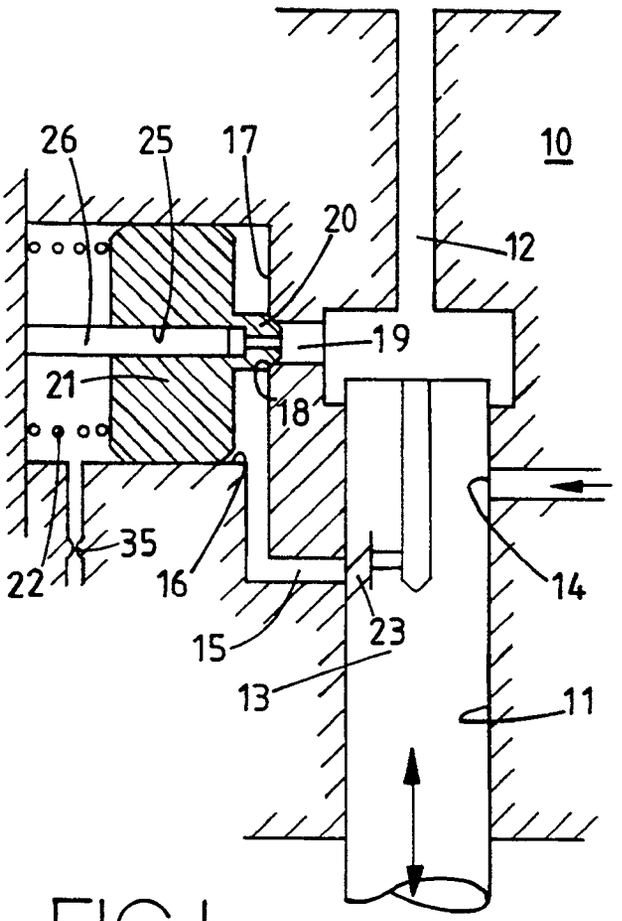
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FIG.1.

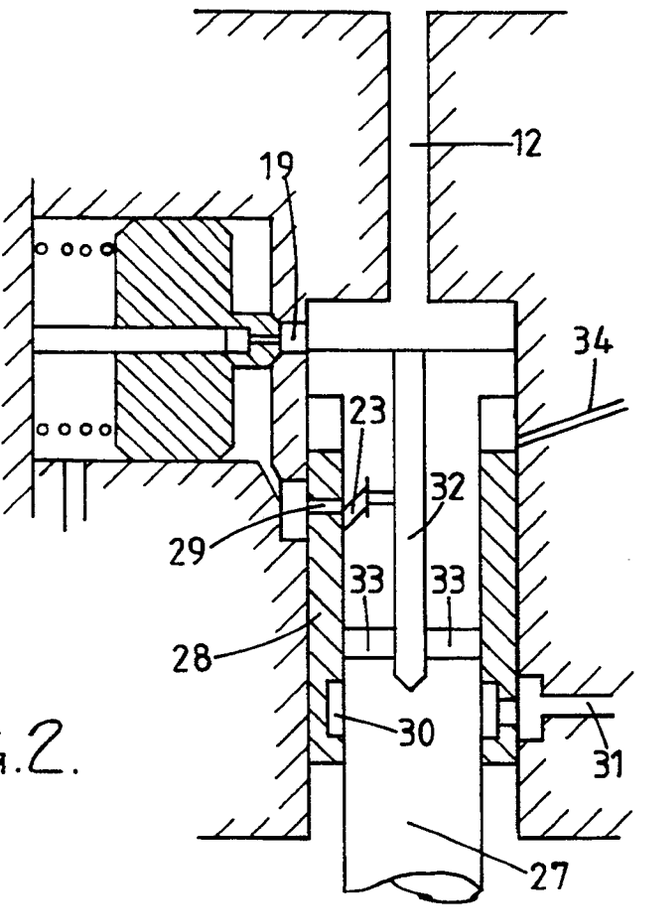
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FIG.2.

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EUROPEAN SEARCH REPORT

Application Number

EP 91 30 4424

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	WO-A-8802068 (NOVA-WERKE AG) * page 13, lines 4 - 21; figure 2 * ---	1, 2	F02M59/36 F02M59/26 F02M59/24
A	EP-A-121689 (ROBERT BOSCH GMBH) * page 15, line 18 - page 18, line 34; figures 1, 6 * -----	1, 2	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04 SEPTEMBER 1991	HAKHVERDI M.

CATEGORY OF CITED DOCUMENTS

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