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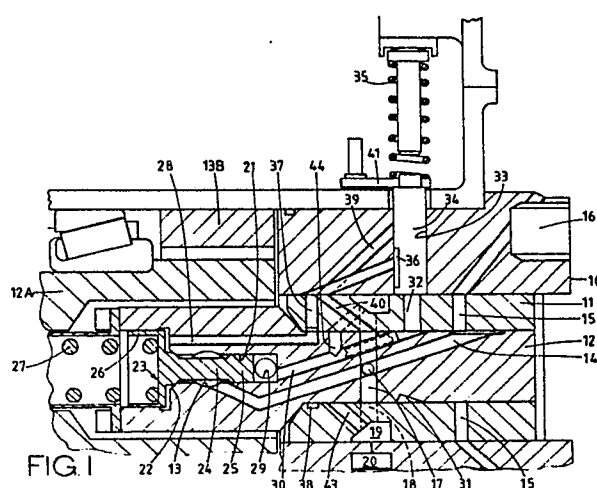
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54 **Fuel pumping apparatus.**

57 A fuel pumping apparatus of the rotary distributor type comprises a distributor member 12 rotatable in a body 10 in timed relationship with an associated engine, a pumping plunger housed within a bore 13 and movable inwardly to displace fuel to the associated engine, by means of a cam 13B and a valve member 23 which is spring biased to the closed position and which can be moved to an open position to allow fuel to escape from the bore 13, by means of fluid pressure applied to a piston 26 which is coupled to the valve member. Fluid under pressure is applied to the piston under the control of a slidable shuttle 34 which is actuated by a further plunger in timed relationship with the first mentioned plunger. The extent of movement of the shuttle before fluid under pressure is applied to the piston 26 can be controlled so as to determine the amount of fuel supplied to the associated engine.



FUEL PUMPING APPARATUS

This invention relates to fuel pumping apparatus of the rotary distributor type and comprising a distributor member rotatable in a body in timed relationship with an associated engine, a pumping plunger located in a bore in the distributor member, cam means for imparting inward movement to the plunger as the distributor member rotates, means for feeding fuel from the bore to a plurality of outlet ports in turn during successive inward movements of the plunger, further means for feeding fuel to the bore to achieve outward movement of the plunger during the filling stroke of the apparatus and valve means for controlling the quantity of fuel delivered by the apparatus.

In known forms of apparatus of the kind specified fuel flow to the bore is throttled to provide a control of the quantity of fuel delivered by the apparatus.

With this form of apparatus the fuel is delivered the whole time the plunger is moved inwardly by cam lobes constituting the cam means. As a result the final rate of fuel delivery and the rate at which the pressure in an outlet falls following delivery, is determined in part by the profiles of the crests of the cam lobes and the size of the roller which forms part of a cam follower located between the cam lobes and the plunger.

If the cam profile or the roller are modified to increase the final rate of fuel delivery and the rate at which the pressure falls, increased stress occurs in the material forming the roller and the cam lobes.

British Patent specification 990695 shows a apparatus of the aforesaid kind having a pair of plungers and which includes the throttle in the fuel supply to the bore and also has provision for lowering the pressure in the bore before the rollers reach the crests of the cam lobes. The lowering of the pressure which terminates delivery of fuel to the associated engine is achieved by constructing the plungers so that they form a spill path which is opened when during their inward movement, the plungers attain a fixed relative axial position. The construction of the plungers is not without difficulty, moreover, with the aforesaid form of apparatus the timing of the commencement of fuel delivery depends upon the quantity of fuel supplied to the bore and the timing adjustment besides having to cope with variation of timing as required by changes in engine speed, also has to correct for the variation of timing which occurs as the quantity of fuel supplied by the apparatus is varied.

Another form of apparatus is known from United States specification 2922370 in which one of the plungers is provided with a helical spill groove

which during the inward movement of the plunger can register with a spill port formed in the bore. Mechanical means is provided to adjust the angular setting of the plunger so that the instant during the inward movement of the plunger at which the spill port is opened, can be adjusted to enable the quantity of fuel delivered by the apparatus to be varied. This form of apparatus provides for a constant start of fuel delivery with a consequent simplification of the timing mechanism.

However, since the spill path is defined by one plunger only variations in the point of spill will occur due to any eccentricity of the cam ring. In addition the provision of mechanical means to effect adjustment of the angular setting of the plunger within its bore is not easy particularly as the plunger is mounted in a rotary part.

In both forms of pump described the spill path is constituted by the plungers and very careful construction of the plungers is required, moreover, the area of the spill path may not be sufficient to ensure the required rate of spill of fuel.

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 in an apparatus of the kind specified said valve means comprises a valve member biased into engagement with a seating to close a spill path from said bore, a fluid pressure operable member which can be subjected to a control pressure when it is required to lift the valve member from the seating, a shuttle slidable in a shuttle bore and biased towards one end thereof, pump means communicating with said one end of the shuttle bore and delivering fluid to said one end of the shuttle bore during the inward movement of the pumping plunger thereby to cause movement of the shuttle away from said one end of the shuttle bore, said shuttle and the shuttle bore defining a control valve for communicating said control pressure to said fluid pressure operable member and means for adjusting the position of the shuttle within its bore at which said control pressure is communicated to said fluid pressure operable member.

Examples of fuel pumping apparatus in accordance with the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a diagrammatic side elevation of one example of the apparatus,

Figure 2 is a view similar to Figure 1 showing a second example of the apparatus and

Figure 3 is a view similar to Figure 1 showing a third example of the apparatus.

Referring to Figure 1 of the drawings the ap-

paratus comprises a body 10 in which is located a fixed sleeve 11. The sleeve mounts a rotary distributor member 12 which is coupled by means (not shown), to a drive shaft which is driven in timed relationship with the associated engine.

Formed in the distributor member is a transverse extending pumping bore 13 in which is mounted a pair of pumping plungers (not shown). The pumping plungers at their outer ends are engaged by cam followers which in turn engage the internal peripheral surface of an annular cam ring 13B having pairs of cam lobes on its internal peripheral surface.

Formed in the distributor member is a passage 14 which communicates with the bore 13 and which opens on to the periphery of the distributor member at a position to register in turn with a plurality of outlet ports 15 which are connected respectively to outlets 16 in the body, the outlets 16 being connected in use, to the injection nozzles of the associated engine. The passage 14 also communicates with a plurality of radially disposed and outwardly extending inlet passages 17 which as will be explained, can communicate with inlet ports 18 formed in the sleeve and connected at their outer ends to a circumferential groove 19 formed in the sleeve and which is in constant communication with the outlet of a low pressure fuel supply pump shown diagrammatically at 20. The low pressure supply pump in practice will be a vane type pump the rotary part of which is coupled to the distributor member. The portion of the apparatus thus far described constitutes a more or less conventional form of distributor type pump with the exception that there is no fuel quantity control adjustment. In operation, when the plungers are driven inwardly by the cam lobes fuel will be displaced from the bore 13 to an outlet port 15 and thence by way of the respective outlet 16, to an injection nozzle of the associated engine. As the distributor member rotates the passage 14 moves out of register with an outlet 15 and two of the inlet passages 17 move into register with the inlet ports 18. Fuel can now flow to the bore 13 to effect outward movement of the plungers to their maximum extent as determined either by stop rings or by the engagement of the cam followers with the cam ring 13B.

The cycle is repeated and fuel is delivered to the injection nozzles of the engine in turn. Extending at right angles to the bore 13 is a cylinder 21 having a narrower end which traverses the bore 13. At the junction of the narrower and wider portions of the cylinder 21 there is formed a seating 22 and provided for cooperation with the seating is a valve member 23 which has a reduced diameter stem portion 24 traversing the bore 13 and connecting with a balance piston 25 which is of substantially

the same diameter as the narrower portion of the cylinder 21.

Connected to the stem portion 24 is a fluid pressure operable member 26 which is slidable in the wider portion of the cylinder 21 and the fluid pressure operable member is acted upon by a spring 27 to urge the valve member into contact with the seating 22. A passage 28 communicates with the wider end of the cylinder and through the passage 28 a control pressure can be applied to the fluid pressure operable member 26 to lift the valve member from the seating. When this occurs during inward movement of the plungers, spillage of fuel from the bore 13 takes place into the wider end of the cylinder and the fluid pressure operable member 26 together with the valve member 23 are displaced axially against the action of the spring 27 thus rapid spillage of fuel occurs and the pressure in the pumping chamber defined by the bore 13 and the plungers therein, drops quickly. Moreover, the fuel which spills into the wider end of the cylinder is retained and is returned to the pumping chamber as the plungers are allowed to move outwardly.

An actuating pressure is generated by a pair of auxiliary plungers (not shown) which are accommodated in a transverse bore 29 and the balance piston 25 is for convenience, subject to the pressure generated by the auxiliary plungers.

In communication with the bore 29 is a passage 30 which is in constant communication with an annular groove 31 formed on the periphery of the distributor member and the groove through a passage 32, communicates with one end of a shuttle cylinder 33 which contains an axially slidable shuttle 34. The shuttle 34 is biased towards the one end of the cylinder by the action of a coiled compression spring 35. The plungers which are contained in the bore 29 are actuated by the same cam lobes which actuate the pumping plungers and during inward movement of the pumping plungers, movement of the auxiliary plungers takes place which displaces fuel to the inner end of the shuttle cylinder 33 thereby to effect outward movement of the shuttle 34 against the action of the spring 35.

The shuttle 34 is provided with a helical groove 36 which by way of a passage 37 formed in the sleeve, communicates with a second circumferential groove 38 about the periphery of the distributor member and this is in constant communication with the passage 28. The groove 36 at a predetermined position during outward movement of the shuttle 34 against the action of its spring, is brought into communication with a passage 39. The passage 39 by way of a further passage 40 in the sleeve communicates with one of the inlet passages 17 during the time when the pumping plungers are

moved inwardly. The effect therefore is that as the shuttle 34 moves outwardly, a position will be reached at which the passage 39 is placed in communication with the passage 37 and fuel at the high pressure developed during inward movement of the pumping plungers flows by way of the groove 36 and the passages 37 and 28 to the wider end of the cylinder 21 to effect movement of the fluid pressure operable member 26 against the action of its spring. As soon as this occurs fuel is spilled from the bore 13 and the supply of fuel to the associated engine ceases.

The shuttle 34 is angularly adjustable by means of a lever 41 which is coupled to a governor mechanism having an engine operator controlled input member. The governor mechanism acts as a speed governor and it may be of the two speed or all speed variety.

During outward movement of the auxiliary plungers, the fuel in the shuttle cylinder 33 is returned to the bore 29 as the shuttle moves under the action of the spring 35. Any additional fuel required to make up for leakage is supplied by way of one of a series of fuel supply ports 43 formed in the sleeve and which communicate with the groove 19. The supply ports during this time communicate with a filling passage 44 which is connected to the passage 30. At the end of the filling stroke therefore the auxiliary plungers will have been moved outwardly their maximum extent and the shuttle 34 will be in contact with the inner end of its cylinder. As soon as the distributor member rotates communication between the port 43 and the passage 44 will cease and the cycle of operation as described is repeated.

By adjusting the angular setting of the shuttle 34, the position during its outward movement at which the groove 36 is brought into register with the passage 39 can be controlled and hence the amount of fuel which is supplied to the associated engine can be controlled. Spillage of fuel therefore takes place before the cam followers move over the crests of the cam lobes and furthermore, irrespective of the quantity of fuel which is supplied to the associated engine, the start of delivery of fuel to the associated engine remains constant.

Referring now to Figure 2 identical reference numerals are used wherever possible to those used in Figure 1. In the apparatus of Figure 2 there are two main differences the first being that the auxiliary plungers which are incorporated into the example of Figure 1, are omitted and the main pumping plungers which occupy the bore 13 of Figure 1 are modified. Referring to Figure 2 the distributor member 12 is provided with a diametrically disposed bore 50 and mounted in the bore 50 is a pair of telescopically engaged pumping plungers 51, 52. The plunger 51 defines a blind bore 53

which extends outwardly from its inner face and slidable within the bore 53 is a piston 54 formed integrally with the plunger 52. The inner end portion of the bore 53 is of slightly enlarged diameter as compared with the piston and it communicates with a pair of radial ports 55 which in turn communicate with a circumferential groove 56 formed in the bore 50. The groove 56 communicates with the passage 30 which as in the example of Figure 1, communicates with the inner end of the shuttle cylinder 33.

The pumping chamber 57 from which fuel is delivered to the associated engine when the plungers are moved inwardly, is of annular form and is defined by the inner end portions of the plungers 51 and 52 the bore 50 and the piston 54. The pumping chamber, communicates with an axial passage 58 in the distributor member this passage communicating with the passages 14 and 17. During inward movement of the plungers fuel will be expelled from the pumping chamber 57 and will flow to an outlet 15. In addition, fuel will be displaced from the inner end of the bore 53 to effect outward movement of the shuttle 34A in the manner described with reference to Figure 1. The shuttle conveniently is of similar construction to that of Figure 1 but in this case the groove 36A extends about the shuttle. When the shuttle has moved outwardly by a predetermined amount depending upon its angular setting, the passage 39 will be connected to the passage 28 to admit fuel under pressure to act upon the fluid pressure operable member which in this case is in the form of a piston 59 slidable within a cylinder 60. The cylinder 60 is defined in a part which is in screw thread engagement with the distributor member 12 and the piston supports a central locating rod 61 which is slidable within an aperture formed in a top hat section spring abutment 62. The rod serves to prevent tilting of the piston under the action of the springs 63 and 64. The valve member 65 is formed separately from the piston this being the second difference as compared with the example of Figure 1, and is engaged by the end of the rod 61 to urge it into engagement with a seating defined about a short passage 66 which communicates with the pumping chamber 57. The valve member 65 is fluted to permit fuel to flow into the cylinder 60 when the valve member is lifted from the seating.

During the inward movement of the plungers 51 and 52 the control pressure is admitted to the cylinder 60, the piston 59 will move against the action of the springs permitting the high pressure fuel within the pumping chamber to lift the valve member 65 from its seating thereby allowing the main quantity of fuel from the pumping chamber to be spilled into the cylinder 60 to cause further displacement of the piston.

When the plungers are permitted to move outwardly, at least some of the fuel contained in the cylinder 60 will be returned to the pumping chamber 57 past the valve member 65 and any further fuel which is necessary to complete the filling of the pumping chamber will be supplied by way of one of the inlet passages 17 and an inlet port 18. In order to be absolutely certain that the valve member 65 seats correctly on the seating the cylinder 60 is vented to the interior of the housing by way of a passage 67 which is formed in the distributor member and opens to the periphery thereof, the passage 67 communicating with the passage 28. The sleeve 11 is provided with appropriately positioned slots 68 one of which communicates with the passage 67 near the end of the filling period of the pumping chamber. The cylinder 60 is therefore depressurised thus ensuring that the total force exerted by the springs 63 and 64 is available to maintain the valve member 65 in engagement with its seating.

It should be pointed out that the valve member 23 of the example of Figure 1 is substantially pressure balanced so far as the high pressure fuel is concerned but this is not the case with the valve member 65 of the example of Figure 2.

In the example of Figure 3 the longitudinal passage 70 which conveys fuel to and from the pumping chamber 57 is inclined to the axis of rotation of the distributor member 12 and it is drilled from the end of the distributor member remote from the plungers 51, 52. At this end the passage is plugged using a screw in the conventional manner. The passage intersects the bore 50 and extends by a short distance beyond the bore.

Moreover, the spill valve 71 is of a slightly different construction to those shown in Figures 1 and 2. The valve is a balanced valve and the valve member is slidable within a blind bore 72, the inner end of which communicates with the interior of the pump housing and is therefore at a low pressure. The valve member has a cylindrical portion 73 slidable in the bore with an integral head 74 which can cooperate with a seating formed about the open end of the bore. Beneath the head the valve member is of reduced diameter to define an annular chamber which is connected by a short drilling 75 with the extended portion of the drilling forming the passage 70. The rod 61 passes through the piston 59 and defines a head which is engaged beneath a lip defined on the head 74 of the valve member. The piston as in the example of Figure 2, is biased by a spring but in this case since the valve member is substantially pressure balanced, the spring 76 is lighter than the spring 63. The passage 28 is not shown in Figure 3.

The operation of the apparatus shown in Figure 3 is identical to that of Figure 2 with the exception

that the valve member instead of being urged off its seating by the fuel pressure in the pumping chamber 57, is lifted from its seating by the fuel under pressure applied to the piston 59. A further difference although this is mainly for illustration, is the use of a slot 77 on the distributor member to replace the passage 67 of the example shown in Figure 2.

Figure 3 also demonstrates how the passage 30 is constructed by drilling inwardly from the end of the distributor member adjacent the plungers. The drilling intersects the bore 50 at a position to register with the ports 55 in the plunger 51. The open end of the drilling is closed by a washer 78 which is secured against the end of the distributor member by the housing 79 for the piston 59.

Claims

1. A fuel pumping apparatus of the rotary distributor type comprising a distributor member (12) rotatable in a body (10, 11) in timed relationship with an associated engine, a pumping plunger (51, 52) located in a bore (13, 50) in the distributor member, cam means (13B) for imparting inward movement to the plunger as the distributor member rotates, means (14) for feeding fuel from the bore to a plurality of outlet ports (15) in turn during successive inward movements of the plunger, further means (17, 18) for feeding fuel to the bore (13, 50) to achieve outward movement of the pumping plunger (51, 52) during the filling stroke of the apparatus and valve means for controlling the quantity of fuel delivered by the apparatus, characterised in that said valve means comprises a valve member (23, 65, 74) biased into engagement with a seating (22) to close a spill path from said bore (13, 50), a fluid pressure operable member (26, 59) which can be subjected to a control pressure when it is required to lift the valve member from the seating, a shuttle (34, 34A) slidable in a shuttle bore (33) and biased towards one end thereof, pump means (53, 54) communicating with said one end of the shuttle bore and delivering fluid to said one end of the shuttle bore during the inward movement of the pumping plunger (51, 52) thereby to cause movement of the shuttle away from said one end of the bore (33) said shuttle (34, 34A) and a port in said shuttle bore (33) defining a control valve for communicating said control pressure to said fluid pressure operable member (26, 59) and means (41) for adjusting the position of the shuttle within its bore at which said control pressure is communicated to said fluid pressure operable member.

2. An apparatus according to Claim 1 characterised in that said pump means comprises a fur-

ther plunger located in a further bore (29) formed in the distributor member said further plunger being actuated by said cam means (13B) in synchronism with said pumping plunger.

3. An apparatus according to Claim 1 characterised in that said pump means comprises a blind bore (53) formed in the pumping plunger (51) and a piston (54) slidable in said blind bore, said piston (54) being integrally formed with a further pumping plunger (52). 5 10

4. An apparatus according to Claim 1 characterised in that said shuttle is formed with a groove (36, 36A) which is in permanent communication with a cylinder containing said fluid pressure operable member (26, 59) and a port (39) in the shuttle bore (33) said port being uncovered to said groove during the movement of the shuttle away from said one end of the shuttle bore (33), said port (39) during inward movement of the pumping plunger (51, 52) communicating with the bore (13, 50). 15 20

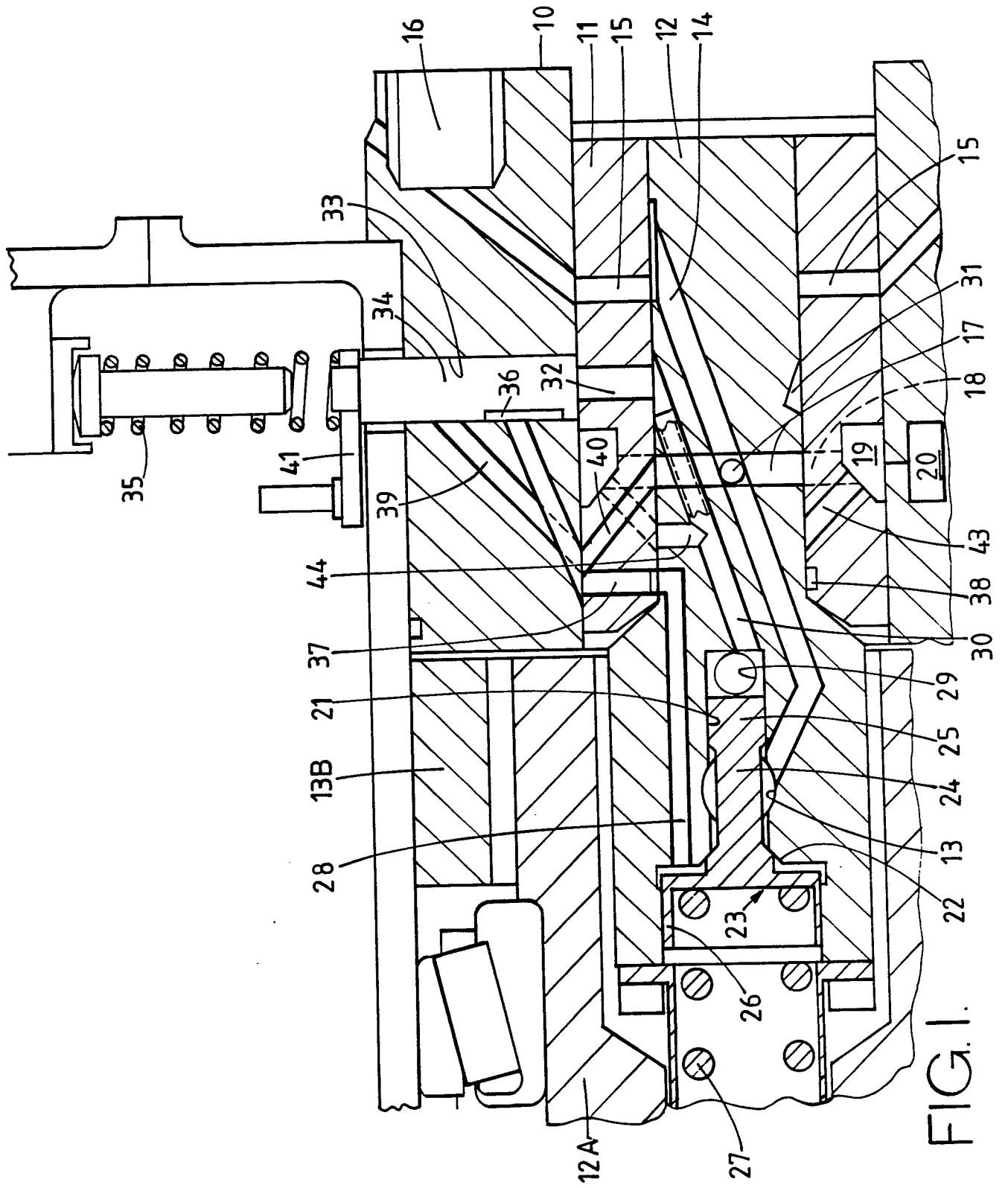
5. An apparatus according to Claim 4 characterised in that said shuttle (34, 34A) is angularly adjustable and said groove (36, 36A) has an inclined edge. 25

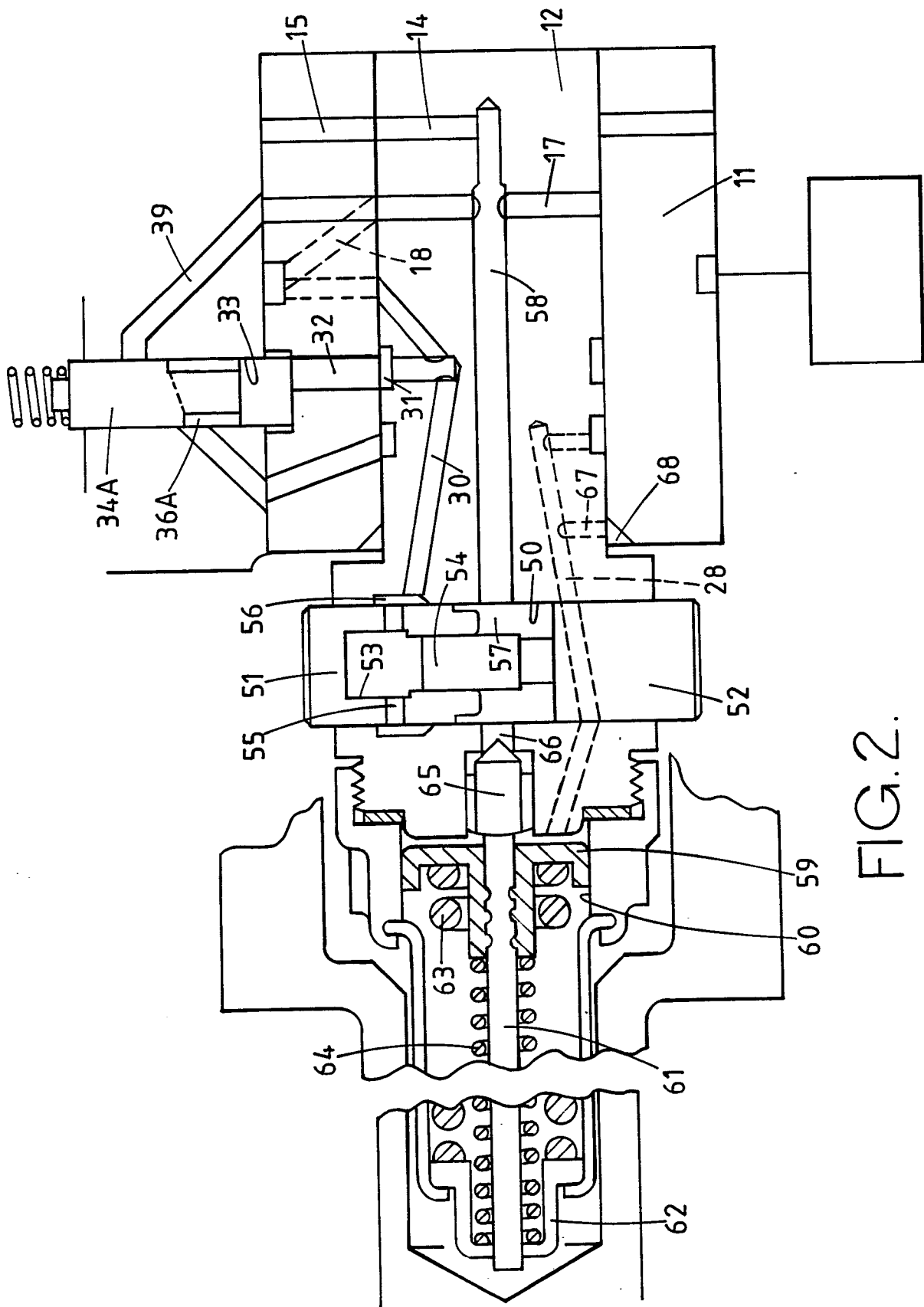
6. An apparatus according to Claim 1 characterised in that said valve member (23, 74) is pressure balanced in the closed position and said fluid pressure operable member (26, 59) is connected to the valve member. 30

7. An apparatus according to Claim 1 characterised in that said valve member (65) is lifted from its seating by the fuel under pressure developed in the bore (50).

8. An apparatus according to Claim 6 or Claim 7 characterised by spring means (27, 63, 64, 76) biasing said fluid pressure operable member (26, 59) the force exerted by said spring biasing the valve member into contact with the seating. 35 40

9. An apparatus according to Claim 1 characterised in that said spill path extends into a cylinder containing said fluid pressure operable member (26, 59). 45 50 55





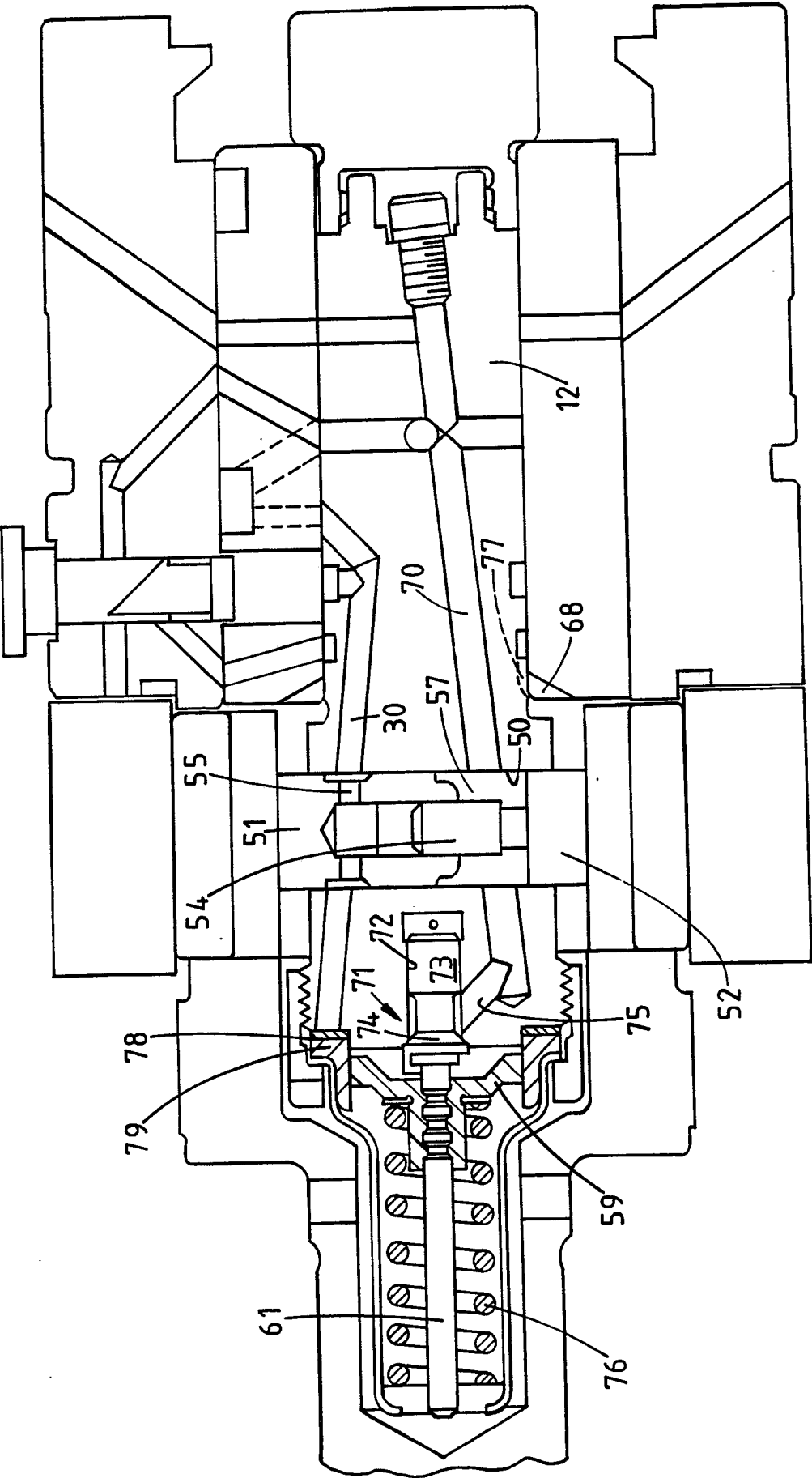


FIG.3.