March 23, 1954 W. FRIEDLANDER 2,672,817

FUEL INJECTION PUMP FOR INTERNAL-COMBUSTION ENGINES

Filed April 3, 1951 5 Sheets-Sheet 1

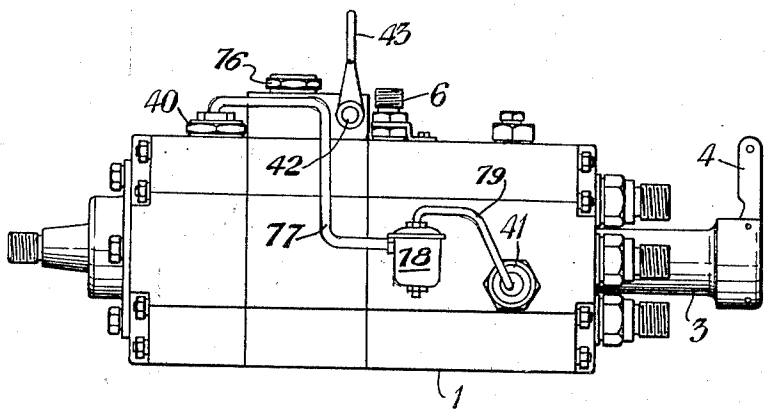


FIG. 1.

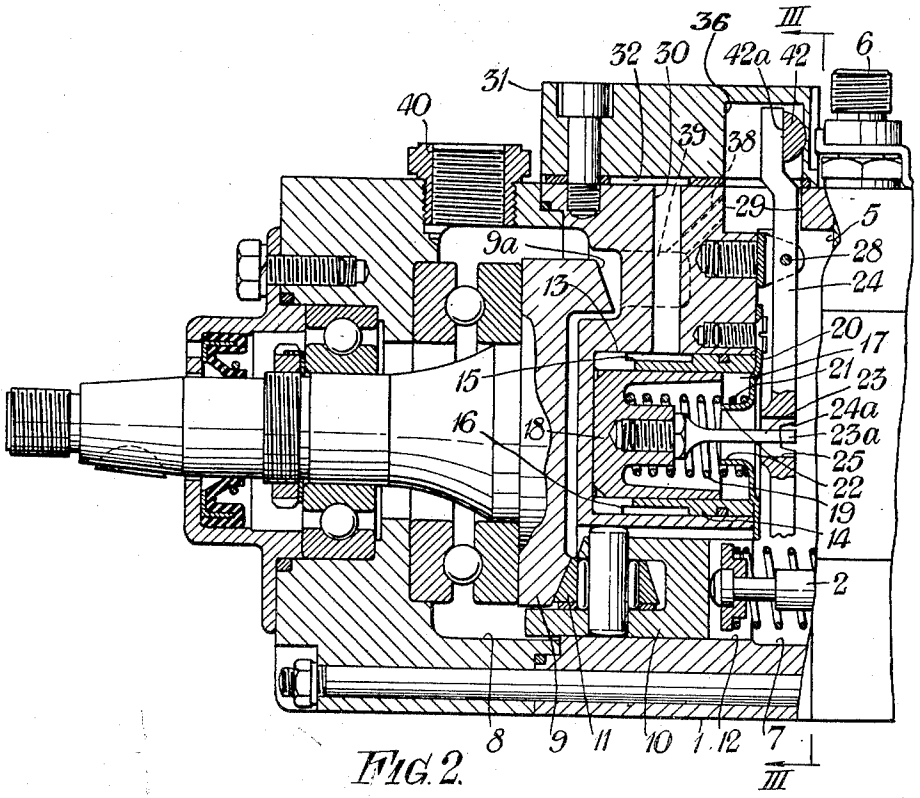


FIG. 2.

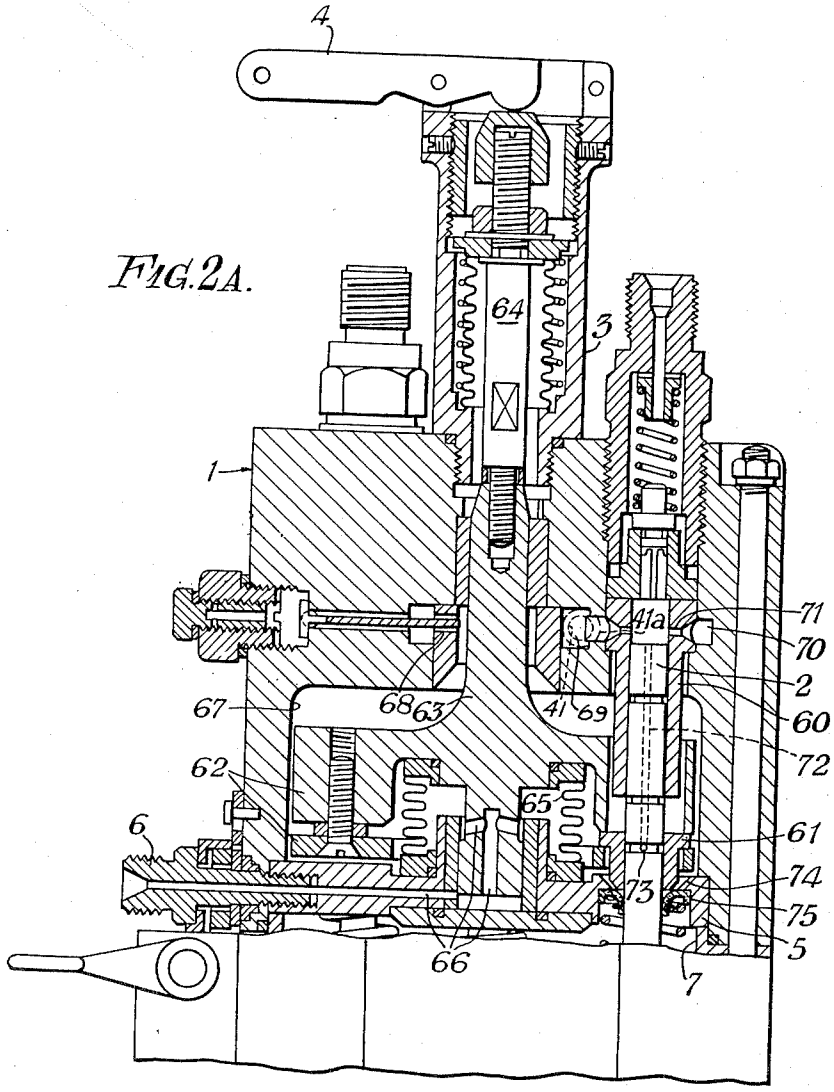
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FUEL INJECTION PUMP FOR INTERNAL-COMBUSTION ENGINES

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FIG. 2A.



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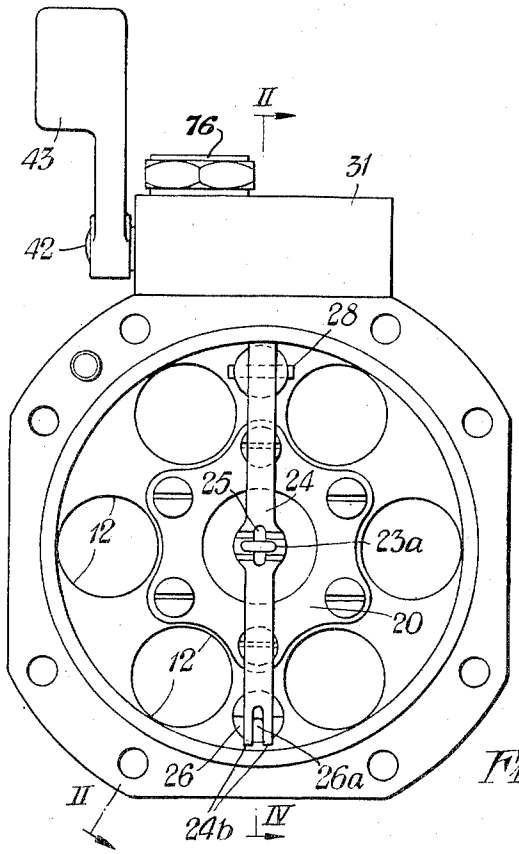


FIG. 3.

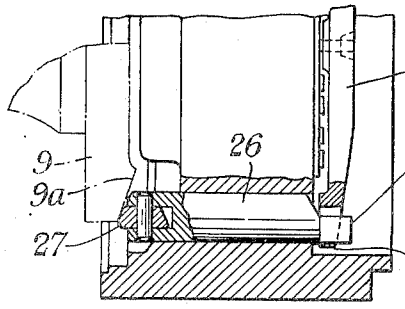


FIG. 4.

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FUEL INJECTION PUMP FOR INTERNAL-COMBUSTION ENGINES

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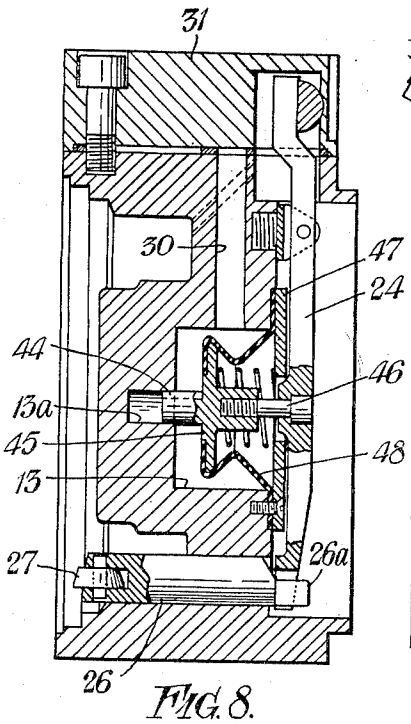


FIG. 8.

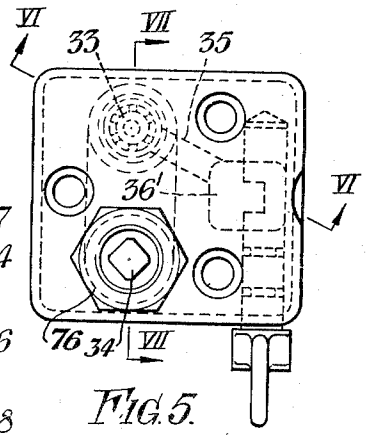


FIG. 5.

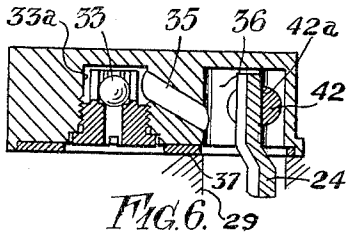


FIG. 6.

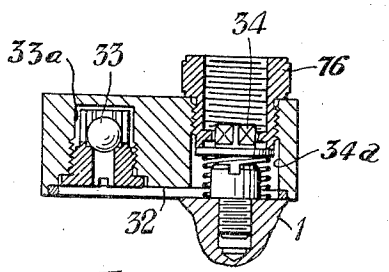


FIG. 7.

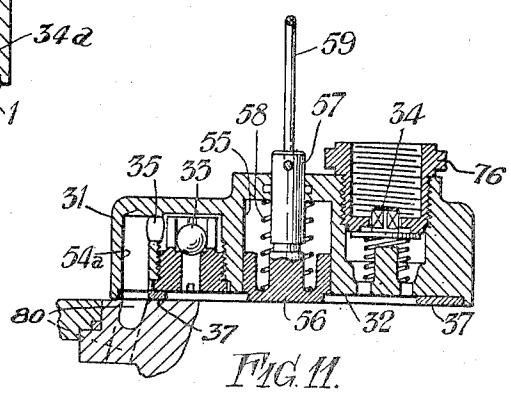


FIG. 11.

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FUEL INJECTION PUMP FOR INTERNAL-COMBUSTION ENGINES

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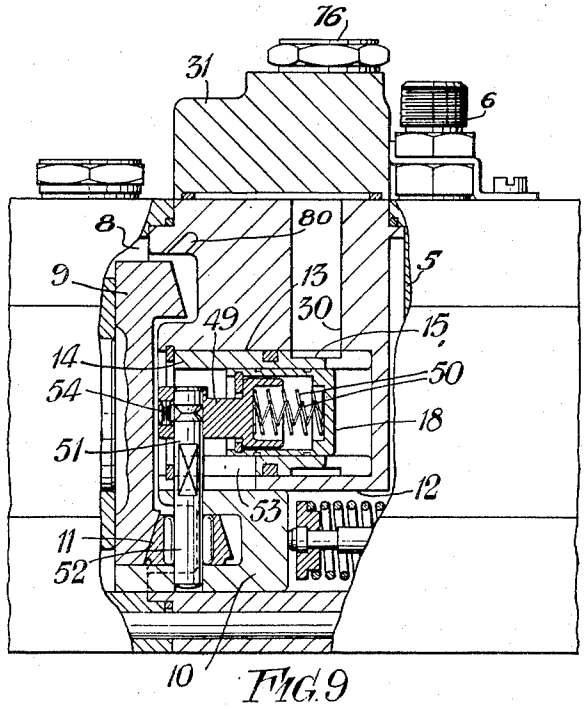


FIG. 9

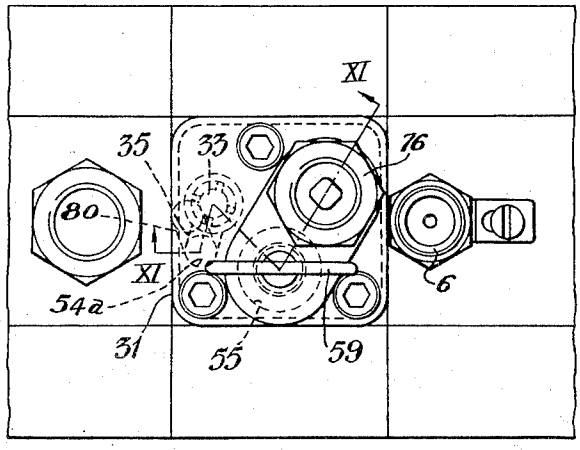


FIG. 10.

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2,672,817

UNITED STATES PATENT OFFICE

2,672,817

FUEL INJECTION PUMP FOR INTERNAL-COMBUSTION ENGINES

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Application April 3, 1951, Serial No. 218,932

Claims priority, application Great Britain April 5, 1950

9 Claims. (Cl. 103—5)

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This invention relates to fuel injection pumps for internal combustion engines and is concerned with pumps of the type (referred to herein as the "type specified") comprising a housing within which rotates a common face cam adapted to cause reciprocation of pump plungers in respective cylinders having their axes parallel with, and disposed around and equidistant from, the axis of the cam.

An example of such a pump is described, for example, in the specification of Patent No. 2,517,483, in which example the length of the effective delivery part of the stroke is adjusted for all the plungers uniformly with the aid of a common member arranged to adjust the axial position of sleeves engaged over the respective plungers and co-operating with by-pass or spill passages formed in the plunger themselves. The common adjusting member referred to may be arranged to be operated substantially in accordance with a pressure variation which may be that occurring in the induction or exhaust system of the engine fed by the pump or that arising in the interior of the pump housing due to the spill of fuel from the pump cylinders. Constructions embodying these features are described in the specifications of co-pending applications Ser. Nos. 168,359 and 168,508.

In combination with fuel injection pumps of the type specified, it is generally necessary to provide a fuel lift or feed pump which will serve to bring fuel from a tank, which may be at a lower level than the fuel injection pump, to the inlet connection of the latter. It is the object of the present invention to provide an improved and compact construction of fuel injection pump of the type specified having an internally disposed fuel feed pump.

According to the invention, in a fuel injection pump of the type specified, a fuel feed pump is disposed within the housing substantially centrally of the ring of pump plungers and means is provided for operating the feed pump from the common face cam which actuates these plungers.

With advantage, manually operable means is provided whereby fuel may be lifted from the fuel tank to the injection pump while the latter is not in operation. For example, the means for operating the feed pump from the cam may include an element which is operable manually from the exterior of the housing, when desired.

The invention will be understood from the following description of some ways in which it may be carried into effect as applied to a fuel injection pump constructed substantially as described in the specification of one of the co-pending applications referred to above. In this description reference will be made to the accompanying drawings, wherein:

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Fig. 1 is a side elevation (on a smaller scale than the other figures) of the fuel injection pump with a fuel feed pump incorporated therein in accordance with this invention, some parts being broken away for the sake of clearness,

Fig. 2 is a fragmentary view mainly in section taken on the line II—II of Fig. 3,

Fig. 2A is a similar view of the right-hand end of the pump,

Fig. 3 is an end view of the left-hand end of the pump taken on the line III—III of Fig. 2, with some parts omitted,

Fig. 4 is a fragmentary view with some parts in section, the section being taken on the line II—IV of Fig. 3,

Fig. 5 is a plan view of a valve housing mounted exterenally on the main pump body,

Fig. 6 is a section taken on the line VI—VI of Fig. 5,

Fig. 7 is a section taken on the line VII—VII of Fig. 5, part of the main pump body also being shown,

Fig. 8 is a fragmentary section substantially corresponding to part of Fig. 2 but showing an alternative form of fuel feed pump,

Fig. 9 is a fragmentary sectional elevation illustrating another form of fuel feed pump according to this invention,

Fig. 10 is a plan view thereof, and

Fig. 11 is a section taken on the line XI—XI of Fig. 10.

In all these figures like reference numerals indicate corresponding parts.

In the fuel injection pump shown in the several figures, see particularly Fig. 2A, the housing 1 is of substantially cylindrical form and has the pump barrel 60 secured in the right-hand end thereof with their axes parallel with and equiangularly spaced around the axis of the housing. Pump plungers 2, the outer end of one of which is also visible in Fig. 2, are arranged in the respective barrels 60 and pass through control sleeves 61 which are mounted in a common adjusting member 62 capable of being actuated manually by means of a central axial extension 63 carrying a rod 64 which is located within a tubular extension 3 of the housing and is operable by the lever 4. The common adjusting member 62 is located within the housing 1 close to a transverse partition 5 between which and the member is disposed a collapsible bellows 65

secured at its ends to the respective parts. The space within the bellows 65 is placed in communication, through suitable passages 66 and a connection 6, with the space within the induction manifold of the engine supplied by the pump, and the space 67 surrounding the bellows 65 within the housing 1 is provided with a restricted outlet an annular chamber 69 which is supplied with fuel through a passage 41a (shown as a circle in broken line in Fig. 2A) leading from an inlet connection 41 (Fig. 1) on the exterior of the housing 1. The chamber 69 is in communication with annular sub-chambers 70 which encircle the respective pump barrels 60 and supply the inlets 71 of these with fuel. The chamber 69 is also in communication, through a return pipe (not shown), with the fuel tank so that excess fuel will flow back to the fuel tank. Each plunger 2 is formed with an axial bore 72 extending from that end which works within the corresponding pump barrel 60 to about the location of the respective control sleeve 61, at which point it opens to the cylindrical surface of the plunger through a radial bore 73 therein. Due to this arrangement, the delivery of the pump plungers 2 is varied in accordance with the position of the respective control sleeves 61 axially of the plungers, the bores 72, 73 in the plungers being placed in communication with the space 67 surrounding the bellows 65 at an earlier or a later period in the strokes of the plungers whereby some of the fuel in the respective pump cylinders will be spilled into the said space. It will be understood that owing to the restricted outlet 68 from this space, the pressure of the fuel within the latter will vary in accordance with the amount of fuel spilled from the cylinders in a unit of time, the bellows 65 being influenced by these changes in pressure to adjust the position of the control sleeves 61 automatically so that a governing action is exerted upon the operation of the fuel injection pump. All these details of construction of the pump proper are fully described and illustrated in the specification of co-pending application Ser. No. 168,359, and require no further illustration here.

The outer ends of the pump plungers 2 pass through respective clearance apertures 74 in the partition 5 within the housing 1 into a further chamber 7 which is in free communication with a chamber 8 (Fig. 2) that contains a common face cam 9 having its axis coincident with that of the housing 1 and adapted to operate the plungers 2 through sliding members 10 carrying rollers 11 for contacting the operative cam face 9a. The annular gap between a plunger 2 and the edge of the aperture 74 in the partition 5 is sealed in a substantially oil-tight manner by means of a suitable packing 75 (Fig. 2A). In this way, the two chambers 7 and 8 within the housing 1 are effectively isolated from the chamber 67 containing the common regulating member 62.

The sliding members 10 for actuating the plungers 2 are mounted in guides 12 in a portion of the housing 1 which is formed centrally with a pump cylinder 13 having its axis coincident with that of the housing and having an open end directed towards the partition 5 in the latter. Within this cylinder is disposed a cylindrical liner 14 having an annular groove 15 around its exterior and formed at its inner end with slots 16 for establishing communication between the groove 15 and the cylindrical space 17 enclosed by the liner. Within the latter is slidably arranged a pump piston 18 which is normally urged towards the closed end of the cylinder by a spring 19 located between the piston and an annular pressure plate 20 secured over the open end of the cylinder. This pressure plate, which also serves to retain the liner in position, has an inwardly extending flange 21 around its central aperture 22 which serves to stiffen the plate and also to position the adjacent end of the spring 19. Centrally secured in the piston 18 is an axially extending rod 23 having a T-shaped free end 23a, the projecting arms of which are adapted to be received in notches 24a formed in an actuating lever 24 at either side of a rectangular slot 25 within which is accommodated the adjacent shank portion of the rod 23. The dimensions of the slot 25 are such that the T-end 23a of the rod may be passed through the slot as a reasonably close fit whereupon, upon being rotated about its axis through 90°, the projecting arms of the T-portion are moved over the longer edges of the slot to engage in the notches 24a.

The actuating lever 24 extends substantially diametrically of the housing 1 and parallel with the partition 5 and at one end 24b (Fig. 3) is bifurcated to embrace a flat-sided pin-like extension 26a from the end of a sliding member 26 (see also Fig. 4) corresponding to, but smaller than, those used for transmitting movement to the pump plungers 2 from the cam 9, 9a. This sliding member 26 bears by its one end on the lever 24 and has an appropriate roller 27 at its opposite end to run on the operative face 9a of the cam 9, the correct disposition of the roller being ensured by the engagement of the pin-like extension 26a with the bifurcated end 24b of the actuating lever 24. Towards its opposite end, the actuating lever is pivotally mounted at 28 on that portion of the housing which affords the guides for the sliding members 10, 26, and this extremity of the lever passes with clearance through an aperture 29 formed in the housing of the pump. Closely adjacent to this aperture, there opens into the external surface of the housing a substantially radial bore 30 which communicates at its inner end with the space defined between the annular groove 15 in the liner 14 and the wall of the cylindrical recess 13 within which this is received.

On the external surface of the pump housing is mounted a valve housing 31 which covers both the aperture 29 and the end of the radial bore 30. The inner face of the valve housing is recessed to a small depth at 32 and there open into the base of the recess two passages 33a and 34a (Fig. 7) fitted with non-return valves 33 and 34, respectively, which are adapted to close in opposite directions. That valve 33 which opens away from the shallow recess in the valve housing has the passage 33a in which it works connected by a bore 35 in the housing to a deep recess 36 (Fig. 6), the open end of which registers with the aperture 29. The recess 36 is deep enough to accommodate the projecting end of the lever 24 with adequate clearance. That valve 34 which opens towards the shallow recess 32 in the inner face of the valve housing 31 has the passage 34a in which it works connected to the supply pipe from a fuel tank at the inlet connection 76. The portion of the shallow recess 32 in the valve housing into which the valve-controlled passages open is isolated from the other portion into which the deep recess 36 opens by a suitable packing or gasket 37.

It will be seen that as the front cam 9, 9a rotates, the actuating lever 24 will be oscillated about its pivot 28 and will thus cause reciprocation of the piston 18 within the liner 14. On each outward stroke of the piston, fuel will be drawn into the cylindrical space within the liner 14 from the inlet connection 76 by way of the opened valve 34, passage 34a, recess 32, bore 30, groove 15 and slots 16. As the piston moves back on each inward stroke, the fuel in the cylindrical space within the liner 14 will be expelled through the slots 16, groove 15, bore 30 and recess 32 but as the valve 34 will now be closed and the valve 33 will now be open, the fuel then proceeds by way of the passage 33a, bore 35, recess 36, and aperture 29 into the compartment 7 of the pump housing. This compartment is in free communication (by way of the passages 38, 39) with the chamber 8 which is provided with an outlet 40 at which is connected (as shown somewhat diagrammatically in Fig. 1) a pipe 77 leading to a filter 78 from which a return pipe 79 is connected to the inlet 41 provided at another point in the pump housing 1 to supply fuel from the chamber 8 through the outlet 40, through filter 78, inlet 41 and passage 41a to the chamber 69. Fuel is supplied from the chamber 69 through the annular sub-chamber 70 to the inlets 71 of the respective pump barrel 60, as above described. If desired the filter 78 may be omitted and the chamber 8 can be connected directly to the inlet side of the pump housing by means of a passage or passages formed in the housing.

There is rotatably arranged within the valve housing 31 a shaft 42 which extends across the projecting end of the actuating lever 24 and is formed adjacent to the latter with a diametral flat face 42a upon which the lever bears when the piston 18 connected to the lever is at the inner end of its stroke. The shaft 42 extends externally of the valve housing 31 to have secured thereon a short arm 43 suitably shaped for ease of operation by the thumb. Depression of this arm will cause partial rotation of the shaft 42 and thereby cam the end of the actuating lever 24 in the direction for drawing the piston 18 out of the cylinder. Release of the arm 43 enables the spring 19 to return the piston and it will be seen that by operating the arm a number of times in quick succession, the pump may be caused to lift fuel from the tank and supply it to the inlet to the fuel injecting pumps.

It will be appreciated that other types of feed pump than that specifically described may be employed. For example, see Fig. 8, the cylindrical recess 13 may be shallower than in the foregoing example and be formed with a central axial recess 13a in its closed end to serve as a guide for a central stud 44 projecting from a disc member 45 which is in turn provided with an axially extending rod 46 whereby it may be engaged with the actuating lever 24. Between the disc member 45 and an annular clamping ring 47 secured around the mouth of the cylindrical recess 13 is provided a flexible diaphragm or bellows 48. The radial bore 30 leading to the valve housing 31 is, in this construction, arranged to open into the space between the diaphragm or bellows 48 and the wall of the cylindrical recess 13. It will be appreciated that this arrangement constitutes a diaphragm or bellows pump which will operate in exactly the same manner as the piston pump already described.

Another construction of feed pump is illustrated in Figs. 9 to 11. In this form the cylindrical recess 13 is closed at the end adjacent to the partition 5 and is open towards the face cam 9. The liner 14 is inserted into the recess through the open end and is formed with an annular groove 15 with which is adapted to register the passage 30 which leads from the recess 13 to the valve housing 31. Within the liner 14 is disposed a piston 18 which has a lost-motion connection to a piston rod 49, the rod and piston being normally maintained in the separated condition by means of springs 50 located within the piston 18. In this arrangement the piston is actuated by means of an extension 51 formed on the pin 52 which constitutes the support for the cam engaging roller 11 on one of the sliding members 10. A longitudinal slot 53 is formed both through the liner 14 and the wall separating the recess 13 from the bore 12 within which the respective sliding member 10 is adapted to reciprocate. The extension 51 of the pin 52 passes through this slot and is secured in a transverse bore in the piston rod 49 by means of a grub screw 54.

It will be appreciated that as the sliding member 10 is reciprocated due to the rotation of the cam 9 the piston rod 49 will be similarly reciprocated and will displace the piston 18 through the intermediary of the springs 50 on the pressure strokes unless there is a tendency for the pressure of the fuel to build up to an excessive value determined by the strengths of the springs 50, in which case the springs will be compressed during the stroke of the piston rod 49.

The valve arrangements in this construction of pump are slightly different from those illustrated in Figs. 5, 6 and 7. As can be seen from Figs. 10 and 11 the non-return inlet valve 34 and the non-return delivery valve 33 are arranged in substantially the same manner as before although in somewhat different locations. However, the port 35, instead of leading to the deep recess 36 as shown in Fig. 6, is now arranged to open into a bore 54a formed in the valve body 31. The mouth of the bore 54a is surrounded by a portion of the packing 37 (see Fig. 11) so that there will be no possibility of the fuel which is being delivered escaping into the recess 32. The mouth of the bore 54a registers with a passage 80 (Figs. 9 and 10) formed through the body portion of the pump to open into the recess 8 within which operates the rise of the cam 9. It will be appreciated that the pump arrangement illustrated in Figs. 9 to 11 will operate in exactly the same manner as those constructions previously described.

It should be noted that in the arrangement last described the lever 24 has been omitted and it is not possible therefore to use the priming means which have been illustrated in Figs. 1 to 8. Since it is desirable to be able to prime the pump while the cam is stationary, a small priming pump is provided in the valve housing 31 as can be seen most clearly in Fig. 11. From the inner face of the valve housing there is formed a cylindrical bore 55 within which is arranged as a close fit a piston 56, the rod of which extends at 57 through the outer face of the valve housing 31. A spring 58 is provided as shown to encircle the piston rod and urge the piston 56 outwardly of the bore 55 into contact with the outer surface of the main pump body. The projecting end of the piston rod 57 is provided with a loop handle 59 by means of which the piston 56 may be operated when it is desired to prime the main fuel injection pump. It will be appre-

ciated that reciprocation of the priming piston 56 will cause fuel to be sucked in through the valve 34 and delivered via the shallow recess 32 and non-return delivery valve 33 to the bore 54.

It will, of course, be understood that the volumetric displacement of the piston or diaphragm of the feed pump in all the arrangements described is considerably greater than the total maximum volumetric displacement of all the fuel injection pump plungers, for each revolution of the cam, the excess fuel pumped to the inlet to the fuel pump proper being allowed to return to the fuel tank in known manner.

The pump constructed according to the invention is particularly compact and occupies very little more space than the pumps described in the earlier specifications referred to herein in which no provision was made for a feed pump. The detachability of the valve housing makes it possible to adjust or clean the valves and/or their seatings without a major dismantling operation. Furthermore the fuel supplied by the feed pump to the main pump is passed through the chamber in the latter containing the face cam and the associated working parts which carry relatively heavy loads and prevents these parts being overheated even under loads in excess of those normal for pumps of this type.

What I claim is:

1. A fuel injection pump comprising a casing containing a fuel chamber, a plurality of piston-and-cylinder pumping assemblies arranged in a ring about said chamber with their axes parallel to a given axis, means for conveying fuel from said chamber to said pumping assemblies, a fuel-inlet passage in said casing communicating at one of its ends with said chamber, a cam element mounted in said casing for rotation about said given axis, means for rotating said cam element, elements actuatable by said cam element during each of its rotations to operate each of the pistons of said pumping assemblies in turn, a second chamber arranged within said casing substantially centrally of the ring of pumping assemblies, a second passage in said casing leading from said second chamber to the exterior of the casing, a valve housing mounted on the exterior of said casing, a fuel-supply connection on said housing, a suction passage in said housing leading from the fuel-supply connection to said second passage, a non-return valve located in said suction passage to open towards said second passage, a delivery passage in said housing communicating at one of its ends with said second passage, a non-return valve located in said delivery passage to open away from said second passage, means for conveying fuel from the other of said ends of the delivery passage to the other of said ends of said fuel-inlet passage, a pumping element displaceable within said second chamber between an end position in which said chamber can only accommodate a minimum volume of fuel and another end position in which said chamber can accommodate a maximum volume of fuel, an actuating element reciprocable by said cam element, during its rotation, in a direction substantially parallel with said given axis, and means operatively connecting said pumping element to said actuating element so that reciprocation of the latter will displace said pumping element to-and-fro between its said end positions.

2. A pump as claimed in claim 1, in which the means operatively connecting said pumping element to said actuating element comprises a rocking lever and a connection from a point on the lever intermediate its extremities to said pumping element, and in which said actuating element is a sliding member arranged to engage said lever near one of its extremities.

3. A pump as claimed in claim 2, including manually operable means for displacing the rocking lever and arranged to act upon the latter near the other of its extremities.

4. A pump as claimed in claim 1, in which the second chamber is a cylinder and the pumping element is a piston working as a close fit in said cylinder.

5. A pump as claimed in claim 1, in which the pumping element is a flexible diaphragm.

6. A pump as claimed in claim 1, in which the means for conveying fuel from the delivery passage to the fuel-inlet passage comprises a chamber formed in the casing to enclose the cam element.

7. A pump as claimed in claim 1, including a cylinder formed in the valve housing to communicate with said second passage, a piston displaceable within said cylinder, and means operable from the exterior of the casing to displace said piston within its cylinder in order to prime the pump.

8. A pump as claimed in claim 1 in which the actuating element is a pin secured to one of the elements actuatable by the cam element to operate the pistons of the pumping assemblies.

9. A pump as claimed in claim 1, in which the second chamber is a cylinder, the pumping element is a piston working as a close fit in said cylinder, and the connection between the actuating element and said piston includes a piston rod resiliently connected with some lost motion to said piston.

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