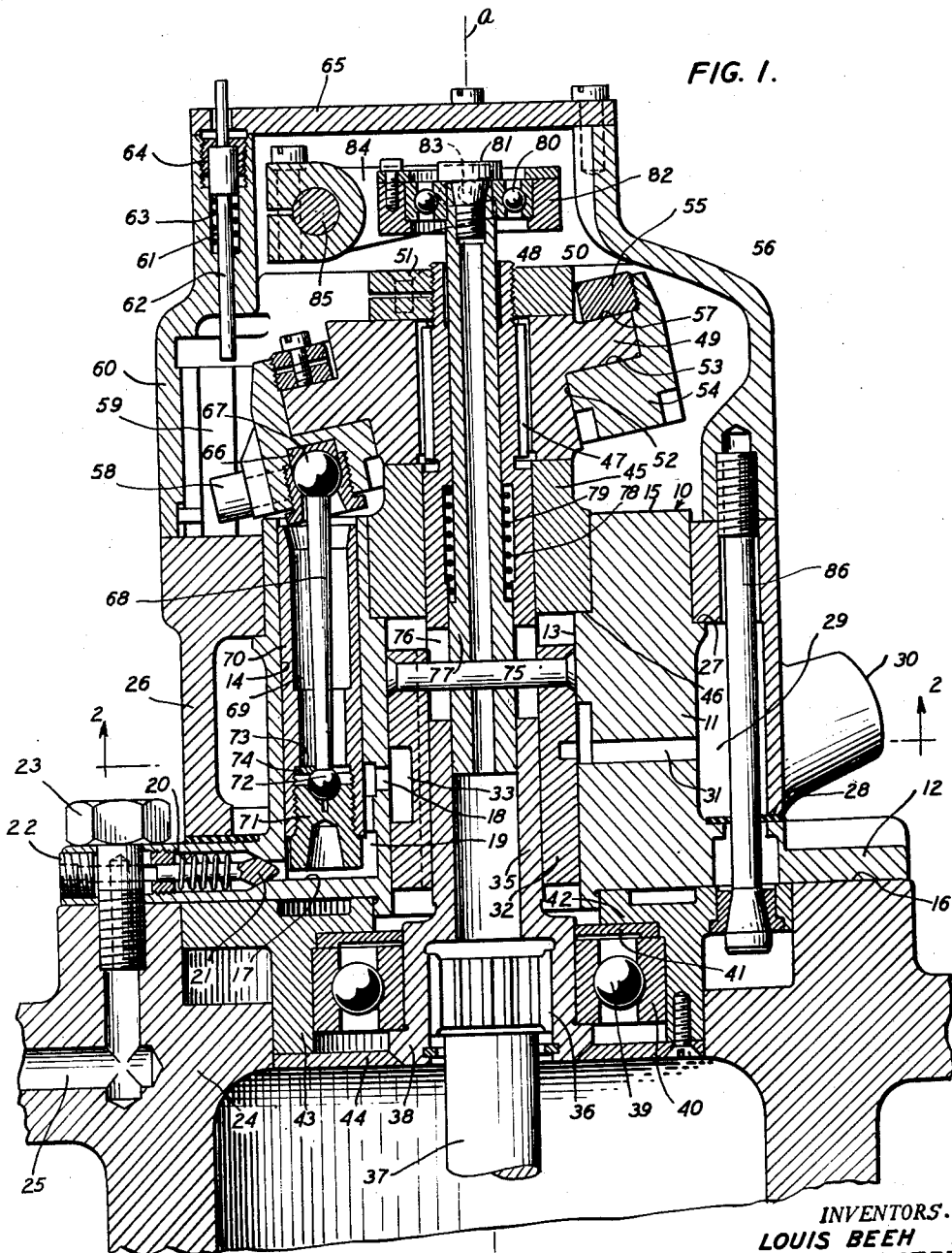


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L. BEEH ET AL
FUEL INJECTION PUMP
Filed Sept. 27, 1944

2,380,574

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 2.

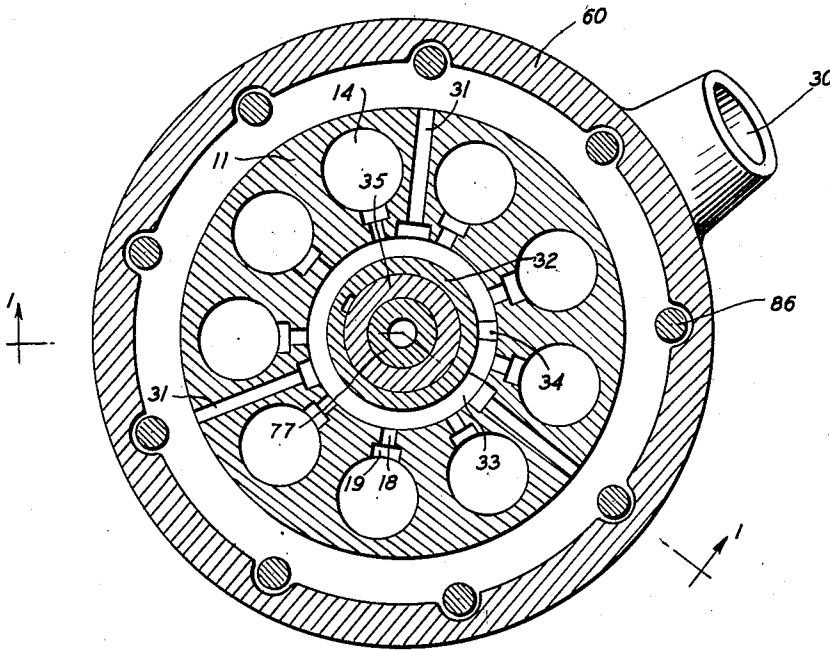
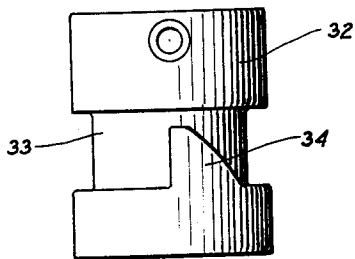


FIG. 3.



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FUEL INJECTION PUMP

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Application September 27, 1944, Serial No. 555,974

10 Claims. (Cl. 103—173)

The invention relates to a multiple pump, and more in particular, to a fuel injection pump for multiple cylinder engines, and contemplates the provision of certain improvements applicable with particular advantages to that type of pumps in which a plurality of units essentially comprising each a plunger movable in a barrel, are arranged parallel to and equidistant from a main axis, and in which a common drive reciprocates each plunger with a phase displacement in relation to the preceding one, once per each revolution of the drive shaft, as disclosed e. g. in the application for U. S. Patent, Serial No. 543,445 filed by Louis Beeh on July 4, 1944. However, it will be understood that the invention is not limited in its application to that particular type of pumps.

The invention aims to provide means whereby the main driving forces are taken up by a block containing the barrels, without transmitting such forces to a housing or casing encompassing the barrel block. The invention also aims to provide means whereby the discharge of the fuel from the pump takes place very close to the engine to which the pump is intended to be applied.

The invention further aims to provide means whereby the barrel block can be secured with its lower portion to an engine to be charged by the pump, whereas the means for reciprocating the plungers are arranged on top of the barrels so as to allow for a direct connection of the pump discharge with said engine.

Further objects and details of the invention will be apparent from the description given hereinafter and the accompanying drawings showing embodiments thereof by way of example. In the drawings:

Fig. 1 is a longitudinal section of an embodiment of the invention, the section being taken along line 1—1 of Fig. 2;

Fig. 2 is a cross-section along line 2—2 of Fig. 1;

Fig. 3 is a side elevation of the metering valve of the pump of Fig. 1.

Referring now to the drawings, the illustrated embodiment of a pump according to the invention is destined for use with a nine cylinder engine. The pump comprises a block in general denoted by 10 which consists of a substantially cylindrical portion 11 with a flange 12 at its lower end, and which has an axial bore 13 throughout its length. Nine other bores 14 are provided parallel to and equidistant from the main pump axis a—a. They reach from the top face 15 of

the block not quite to the other end face 16 which is the lower face of the flange 12 so that each bore 14 constitutes a barrel with a bottom 17. At a distance upward from the bottom 17, a radial port 18 opens from the barrel into the space of the bore 13, and a groove 19 in the interior of the barrel reaches from the port 18 downward to the bottom 17. The flange 12 is provided with radial bores 20, one for each barrel, and communicating with the bottom end of the latter. Each bore 20 is so formed as to constitute a chamber for a spring biased delivery valve 21. The outer end of each bore 20 is closed by a plug 22, and a hollow screw bolt 23 crosses the bore 20 and serves the dual purpose of securing the pump to a flange or other portion 24 of an engine, and of connecting the bore 20 to a conduit 25 leading to the nozzle (not shown) of an engine cylinder.

A substantially cylindrical jacket or housing 26 bears on an outer shoulder 27 of the block 10 and also on a gasket ring 28 on top of flange 12. An annular fuel chamber 29 with an inlet 30 is formed between the housing 26 and block 10, and radial conduits 31 in the block 10 intermediate said barrels connect said chamber and the inner bore 13 of the block 10. Interiorly of the bore 13, a valve 32 shaped as a hollow piston is arranged so as to be rotatable and axially shiftable for a purpose and by means to be described hereinafter. The valve, the side view of which is shown in Fig. 3 has a peripheral recess 33 with a land 34 therein to close the ports 18, one after the other during its rotation, for a shorter or longer part of each revolution depending on whether a narrower or wider part of the land is in registry with the ports. However, it is to be noted that the recess 33 is in permanent communication with chamber 29 through at least some of the conduits 31.

Coaxially with the block 10 and extending through valve 32, a hollow drive shaft 35 is arranged which is interiorly splined in its lower end portion at 36 in order to be coupled with a shaft 37 of the engine to which the pump is to be applied. The shaft 35 is provided with an end collar or flange 38 and journaled in a bearing 39 which in the illustrated embodiment is a ball bearing acting as a collar bearing as well as a thrust bearing. The latter quality is of importance from the viewpoint of the invention, as it will be apparent from the description hereinafter. The outer race 40 of bearing 39 engages a thrust ring 41 which in turn bears on an inner flange 42 of a casing 43 secured to the lower face

16 of the block 13. The casing is closed by a lower cover plate 44. Shaft 35 is journaled in a second bearing or bushing 45 which rests on an inner shoulder 46 of the block 10. The shaft portion above the bearing 45 is externally splined at 47, and the topmost end 48 is screw-threaded. To the splined portion, a shaft head 49 is secured by means of a slitted nut 50 screwed on the threading 48 and locked in position by a screw 51 which forces the slitted nut portions apart or together so as to deform a portion of the nut threading. The shaft head 49 has an outer cylindrical bearing surface 52 inclined with respect to the main axis $a-a$, and another thrust bearing surface 53 at right angles to the surface 52. A cup-shaped wobble or swash plate 54 engages both said bearing surfaces and is held in engaging position by a slitted nut 55 screwed into an interior threading 56 of the swash plate 54 and being supported by an upper bearing surface 57 of the shaft head. The swash plate 54 is provided with a projection 58 which engages a stationary guide face 59 arranged parallel to the axis $a-a$ interiorly of a housing top part 60. Thus, when shaft 35 rotates, the swash plate will not participate in the rotation owing to the engagement of the projection 58 with the guide faces 59 but will accomplish a cyclical up and down motion.

In order to facilitate adjustments necessary to insure correct operation of the pump parts as it will be described hereinafter, indicator means may be provided in order to ascertain when a predetermined point of the swash plate is in its topmost position. For this purpose, the housing top 60 is provided with a bore 61 in which a pin 62 is movable. A spring 63 tends to push the pin upward against a cap nut 64 screwed into the upper portion of the bore 61. The upper end of the pin projects through a cover plate 65 of the housing portion 60. When pin 62 is pressed down by an operator the lower end of the pin will be in the path of the projection 58 and it can be noticed by finger pressure when the highest position of the projection is reached. When the pin is released it will be lifted by spring 63 into the illustrated position in which it cannot be contacted by the projection.

The swash plate is provided with nine ball sockets 66, i. e. as many as there are barrels in the block 10, so as to receive therein the upper ball heads 67 of connecting rods 68 of plungers 69 which are reciprocable in the barrels 14. Each plunger consists of a tubular body 70 with a lower head 71 screwed into the body end. The plungers are omitted in Fig. 2 but one plunger is clearly shown in Fig. 1. The lower ball end 72 of each connecting rod is secured to an accordingly shaped recess of the head 71 of the associated plunger by a slotted washer 73 bearing against an inner shoulder 74 of the plunger tube 70. This washer is so dimensioned as to yield or break when the plunger gets stuck. However, it will be noted that the design avoids, as far as possible, the occurrence of any dangerous lateral stresses which might be the cause of the plungers freezing in their barrels.

In order to rotate the metering valve while the plungers are reciprocated, a pin 75 is secured in the valve body and engages the drive shaft 35 in slots 76 which permit axial adjustment of the valve relatively to the ports 18.

For the purpose of metering the quantity of fuel delivered by the pump, a tubular rod 77 is arranged interiorly of shaft 35 and the pin 75 is secured to said rod so that the valve and the rod

will rotate in conjunction and will be axially shiftable together in relation to the shaft 35. A recess 78 is formed between the shaft and the tubular rod and a compression spring 79 in that recess tends to shift the rod and valve downward. On the end of the tubular rod 77, projecting upwardly from the drive shaft 35, an antifriction bearing 80 is mounted so as to abut against the flanged head of a plug 81 screwed into the tubular rod 77. The bearing 80 is encased in a ring 82 having two diametrically opposite trunnions 83 which are engaged by a forked lever 84. The latter is mounted on a shaft 85 projecting outwardly of the housing part 60 so as to be turned by suitable means not shown. Thus, by turning shaft 85 the tubular rod 77 together with valve 32 can be raised against the restraint of spring 79 or lowered while being free to rotate together with the drive shaft 40. The housing part 60 which encloses the swash plate mechanism and the adjustment control, is connected to the lower housing 26, the block flange 12, and the casing 43 by means of a number of screw bolts 86 as clearly shown in Fig. 1. All conventional lubrication ducts have been omitted in the drawing in order to avoid overcrowding of the latter. However, any suitable lubrication system for the movable parts of the pump may be applied as well known in the art.

The pump operates in the following manner: if the drive shaft is turned by the engine shaft 37, the plungers will be reciprocated according to the cyclical oscillation of the swash plate, i. e. each plunger lagging in phase in respect to the preceding one and the phase lag being equal to 360° divided by the number of plungers. While the plungers are thus reciprocated the metering valve 32 rotates uniformly with the shaft 35. It is so adjusted in relation to the inclination of the shaft head 49 that each port 18 will be covered by the land 34 of the valve during a portion of the compression stroke of the coordinate plunger 69 and the length of such stroke portion will be determined by the width which the land has according to its axial adjustment between its edges on the level of the ports 18. During the suction stroke of a plunger, fuel may therefore enter the coordinate barrel from space 29 through conduits 31, valve recess 33 and port 18. While the latter is closed during a portion of the compression stroke a corresponding quantity of fuel will be expelled by the plunger from its barrel through the delivery valve 21, and during the remainder of the compression stroke a corresponding quantity of fuel will be returned on the same way as that on which fuel entered during the suction stroke. As to the axial forces occurring during the operation of the pump, the action during the compression stroke of a plunger is downward as to the connecting rod. Consequently, an upward reaction between the shaft head 49 and nut 50 will tend to raise the drive shaft. This tendency is counteracted by the thrust bearing arrangement at the lower end of the shaft, whereby the upward force is transmitted to the lower face 16 of block 10. On the other hand, the downward pressure of the connecting rod and plunger, acting on the fuel in the barrel is taken up by the barrel side walls and the bottom 17 which as well as the barrel walls is part of the block 10. The forces occurring during the suction stroke take a similar way but are considerably smaller and in the opposite direction. Hence, all pumping forces are directly transmitted to and taken up by the block 10 so that in particular all housing parts are relieved

from stresses. Furthermore, the arrangement of the swash plate mechanism above the pump barrels renders it possible to provide the delivery ports in close proximity of the engine to which the pump is applied, thereby avoiding all external conduits except those required to feed the pump.

Many alterations and modifications of the illustrated forms will be apparent to those skilled in the art, without departing from the spirit and essence of the invention which shall be limited only by the scope of the appended claims.

We claim:

1. In a pump of the type described a substantially tubular block including a flange at one of its ends and embodying in its wall a plurality of pump barrels parallel to the block axis and closed at their ends adjacent said flange, plungers reciprocable in said barrels, a drive including a shaft extending coaxially through said block and means attached to said shaft outside the other block end to reciprocate said plungers, and means in connection with said shaft outside the flanged block end and bearing upon said flanged block end to transmit thereto axial reactions of plunger pressures.

2. In a pump of the type described, a substantially tubular block including a flange at one of its ends and embodying in its wall a plurality of pump barrels parallel to the block axis and closed at their ends adjacent said flange, plungers reciprocable in said barrels, a drive including a shaft extending coaxially through said block and a swash plate device attached to said shaft outside the other barrel end and connected to the plungers so as to reciprocate the latter upon rotation of said shaft, and a thrust bearing between said shaft and the outside of said flanged barrel end.

3. A device as claimed in claim 2 further comprising a housing encasing at least the major portion of said block and said swash plate, and an indicator means attached to the housing and operative from the outside so as to engage said swash plate thereby to indicate the swash plate position relatively to a predetermined point of said block.

4. In a pump of the type described, a substantially tubular block including a flange at one of its ends and embodying in its wall a plurality of pump barrels parallel to the block axis, said flange being provided with a plurality of substantially radial delivery conduits, one for each barrel and communicating therewith, valve-controlled conduits in said block to admit fuel to said barrels, plungers reciprocable in said barrels, a drive including a shaft extending coaxially through said block and a swash plate attached to said shaft outside the other barrel end and connected to the plungers so as to reciprocate the latter upon rotation of said shaft, and a thrust bearing between said shaft and the outside of said flanged barrel end.

5. A device as claimed in claim 4, further comprising a plurality of delivery valves, one in each of said radial conduits.

6. In a pump of the type described a block including a substantially cylindrical portion and a flange at its one end, said block being provided with an axial bore throughout its length and with a plurality of other bores parallel to its axis and closed at their bottoms so as to constitute pump barrels, said flange being provided with radial bores, one for each barrel and communicating therewith, so as to constitute delivery conduits, other conduits connecting each of said barrels

to said axial bore, a rotatable valving means in said axial bore so as to control said other conduits, means to supply fuel to said valving means for admission to said other conduits one after the other, reciprocable plungers in said barrels, a drive shaft coaxial with and extending through said valve and connected therewith, and means outside the other end of said block and connected to said shaft and said plungers to reciprocate the latter once per each shaft revolution and with equal phase displacements as to one another.

7. A device as claimed in claim 6, said valving means comprising a substantially cylindrical, metering valve body, a control rod, and a connecting pin, said valve body being adjustable in axial direction and provided with an axial bore, said shaft being hollow and extending through said axial bore of said valve body, said control rod being axially shiftable interiorly of said shaft and projecting therefrom with one of its ends, and said pin extending in substantially radial direction through longitudinal slots in said shaft and being secured to said valve body and the other end portion of said rod.

8. A fuel injection pump for multiple cylinder engines comprising a block including a substantially cylindrical portion and a flange at its lower end, said block being provided with an axial bore throughout its length and with a plurality of other bores parallel to its axis and closed at their bottoms so as to constitute pump barrels, said flange being provided with radial bores, one for each barrel and communicating therewith, so as to constitute delivery conduits, a housing member secured to the top of said flange and encasing the cylindrical block portion so as to form a fuel chamber between said member and said cylindrical block portion, a set of passages in said block between said chamber and said axial bore, a second set of passages between said barrels respectively and said axial bore, a rotatable valve in said axial bore so as to control the passages of said second set one after the other, reciprocable plungers in said barrels, a drive shaft coaxial with and extending through said valve and connected therewith, and means on top of said block and connected to said shaft and said plungers to reciprocate the latter once per each shaft revolution and with equal phase displacements as to one another.

9. A pump as claimed in claim 8, further comprising a bearing, and said shaft embodying a collar at its lower end portion, said bearing being located between said collar and the lower face of said flanged block end and adapted to transmit axial forces from said shaft to said block.

10. A fuel injection pump for multiple cylinder engines comprising a block including a substantially cylindrical portion and a flange at its lower end, said block being provided with an axial bore throughout its length and with a plurality of other bores parallel to its axis and closed at their bottoms so as to constitute pump barrels, said flange being provided with radial bores, one for each barrel and communicating therewith so as to constitute delivery conduits, a housing member secured to the top of said flange and encasing the cylindrical block portion so as to form a fuel chamber between said member and said cylindrical block portion, conduits in said block from said chamber and from said barrels to said axial bore, a rotatable and axially adjustable metering valve in said axial bore so as to control said conduits, reciprocable plungers in said barrels, a hollow drive shaft coaxial with and ex-

tending through said valve and connected therewith for common rotation, a swash plate device on top of said block and connected to said shaft and said plungers to reciprocate the latter, a rod axially shiftable interiorly of said shaft and upwardly projecting therefrom and connected to said valve through slots in said shaft, means in operative connection with said rod and arranged

on top of said swash plate to shift said rod and said valve axially, and a cover for said housing so as to encase said swash plate and said shifting means.

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