May 16, 1967 P. E. GLIKIN 3,319,616

LIQUID FUEL PUMPS FOR USE WITH INTERNAL COMBUSTION ENGINES

Filed Jan. 26, 1965 3 Sheets-Sheet 1

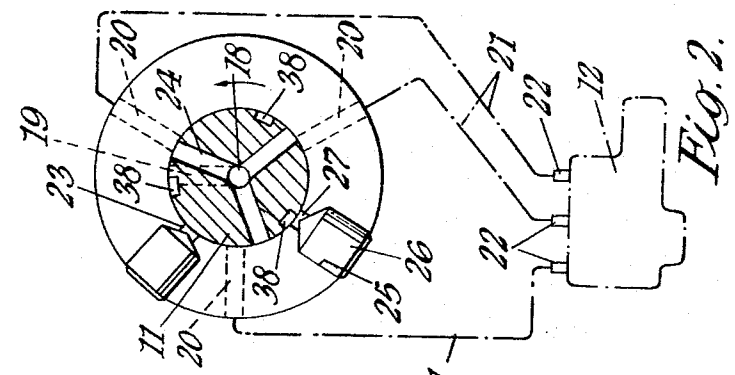
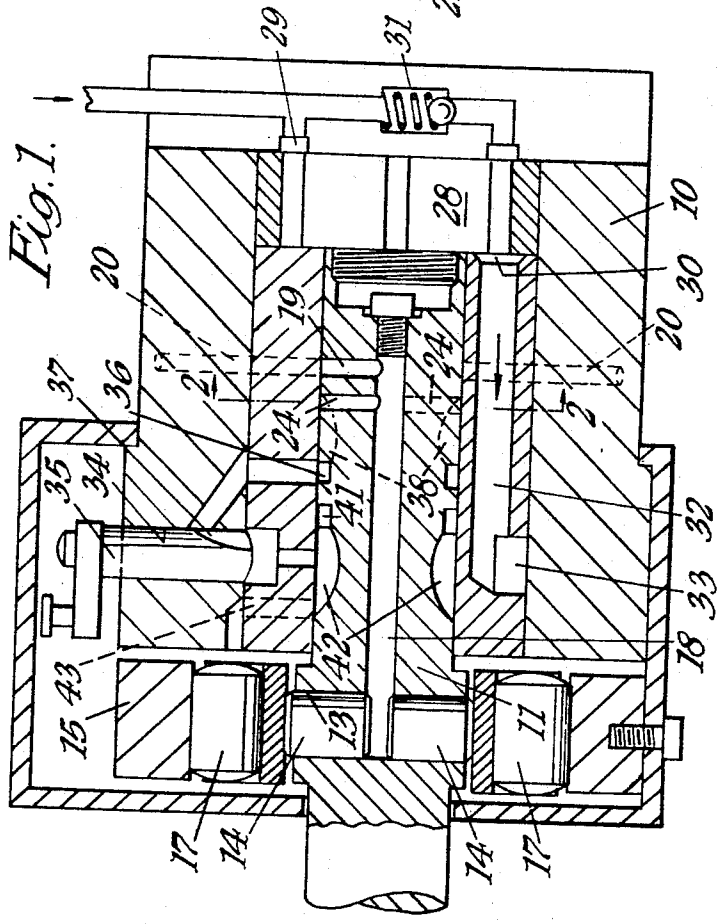


Fig. 2.

Fig. 1.



May 16, 1967 P. E. GLIKIN 3,319,616

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Filed Jan. 26, 1965

3 Sheets-Sheet 2

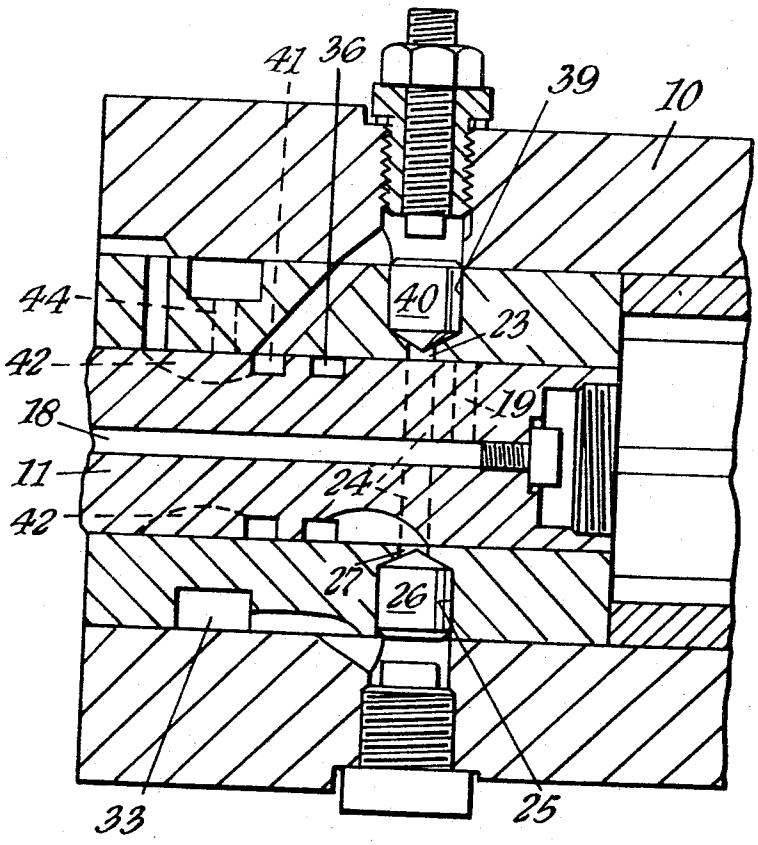


Fig. 3.

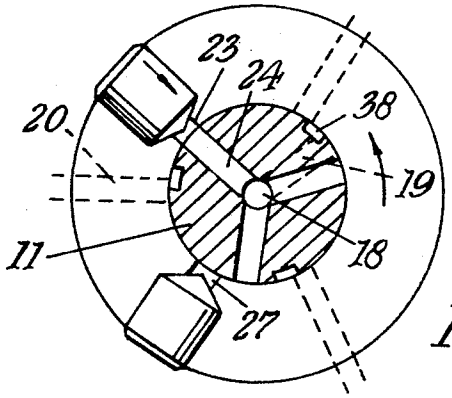


Fig. 4.

May 16, 1967 P. E. GLIKIN 3,319,616

LIQUID FUEL PUMPS FOR USE WITH INTERNAL COMBUSTION ENGINES

Filed Jan. 26, 1965 3 Sheets-Sheet 3

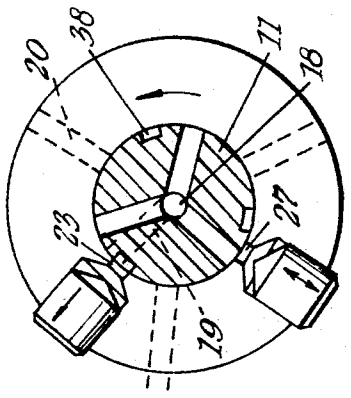


Fig. 6.

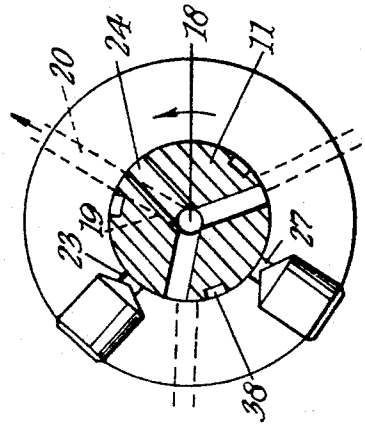


Fig. 5.

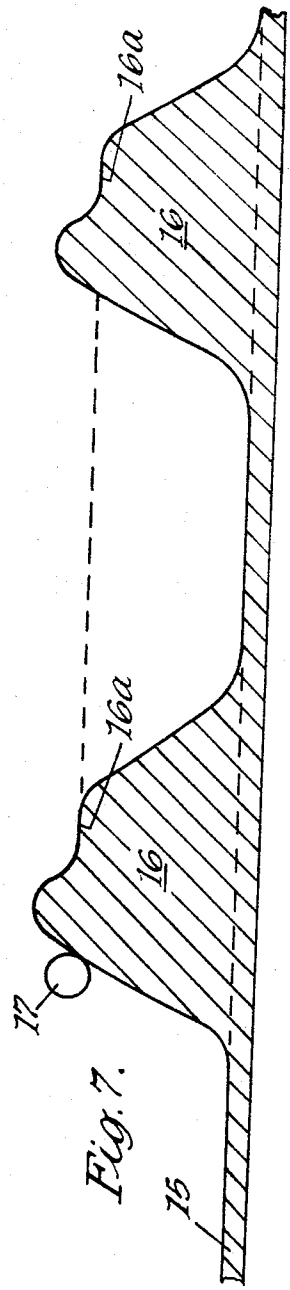


Fig. 7.

United States Patent Office

3,319,616

Patented May 16, 1967

3,319,616

LIQUID FUEL PUMPS FOR USE WITH INTERNAL COMBUSTION ENGINES

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Claims priority, application Great Britain, Feb. 25, 1964, 7,753/64

5 Claims. (Cl. 123—139)

This invention relates to liquid fuel pumps for supplying fuel to internal combustion engines, the pumps being of the kind comprising a body part, a rotary distributor mounted within the body part, an injection pump rotor mounted on the distributor, a pumping chamber defined within the rotor, a plurality of pairs of equiangularly spaced cam lobes mounted within the body part, the lobes of each pair being diametrically opposed to one another, a pair of diametrically disposed plungers slidably mounted in the rotor, said plungers being arranged to be moved inwardly by the action of the cam lobes as the distributor rotates to reduce the volume of the pumping chamber, and longitudinal bore formed in the distributor in communication with the pumping chamber, a plurality of equiangularly spaced delivery ports formed in the body part and adapted for communication through a plurality of pipe lines with the cylinders of the engine respectively, a delivery passage extending from the longitudinal bore in the rotor, said delivery passage being arranged to communicate as the distributor rotates, with each of the outlet ports in turn during an injection stroke of the pump, said delivery passage being arranged to remain in communication with the delivery port after the completion of the injection stroke to permit the plungers to move outwardly by a small amount to relieve the pressure in the pipe line, a plurality of equiangularly spaced inlet passage formed in the distributor, said inlet passages being in communication at their inner ends with the longitudinal passage, a fuel inlet port in the body part and with which the inlet passages register, in turn, as the distributor rotates during a part of the time when the delivery passage is out of register with the delivery ports, and means for feeding fuel under pressure to said inlet port so that as the inlet passages register therewith fuel will be fed to the pumping chamber to move the plungers outwardly.

When such a pump is used for supplying fuel to a three cylinder engine, difficulty arises in that after an injection period has taken place the distributor must rotate through approximately 120° before the start of the next injection period and during this time the cam followers must pass an intermediate pair of cam lobes. Because the plungers are allowed to move outwardly by a small amount after the end of each injection stroke the plungers will be moved inwardly by the aforesaid intermediate pair of cam lobes thereby attempting to displace fuel from the pumping chamber during a time when the delivery passage and the inlet passages are out of register with their associated ports.

This would result in extremely high liquid pressures and mechanical stresses in the pump and the object of this invention is to provide a pump of the aforesaid kind for supplying fuel to a three cylinder engine in which the aforesaid difficulties are overcome in a convenient manner.

A pump of the kind specified for supplying fuel to a three cylinder internal combustion engine and comprising a recuperation chamber which is placed in communication with the longitudinal bore during the time when the plungers are being moved inwardly by cam lobes during the time when the delivery passage is out of register with a delivery port; and which receives fuel discharged from the longitudinal bore during that time, the chamber being arranged to deliver the fuel back to the longitudinal bore before the next injection stroke of the pump.

In the accompanying drawings:

FIGURE 1 is a sectional side view of one example of a liquid fuel pump in accordance with the invention and for supplying fuel to a three cylinder internal combustion engine,

FIGURE 2 is a sectional view on the line 2—2 of FIGURE 1,

FIGURE 3 is a sectional side view of the pump taken on the line 3—3 of FIGURE 2,

FIGURES 4, 5 and 6 are views similar to FIGURE 2 with parts of the pump in different positions, and

FIGURE 7 is a developed view of part of the pump shown in FIGURE 1.

Referring to the drawings there is provided a body part **10** within which is rotatably mounted a cylindrical distributor **11** which is adapted to be driven in timed relationship with an engine **12**. Formed at one end of the distributor is a rotary head in which is provided a transverse bore **13** accommodating a pair of reciprocatory plungers **14**. Surrounding the head is a ring **15** on the internal periphery of which are formed six equiangularly spaced inwardly extending cam lobes **16**, shown in FIGURE 7, which cooperate through a pair of rollers **17** respectively, with the aforesaid plungers. Within the distributor is formed a longitudinal passage **18** which communicates at one end, with the transverse bore **13** and which, at its other end communicates with a radially disposed delivery passage **19**. The delivery passage communicates, in turn as the distributor rotates with three equiangularly spaced delivery ports **20** formed in the body part and which communicate respectively by way of pipe lines **21**, with fuel injection nozzles **22** mounted so as to direct fuel into the cylinders of the engine respectively.

Formed in the body part adjacent the distributor is a fuel inlet port **23** and this communicates, in turn as the distributor rotates, and as shown in FIGURE 4, with three equiangular spaced inlet passages **24** formed in the distributor and in communication at their inner ends with the longitudinal passage **18**. This communication only being established during part of the time when the delivery passage **19** is out of register with the delivery port **20**. Fuel is delivered under pressure to the inlet port by means which will be described later in the specification and the operation of the pump so far described is as follows. Consider that the distributor **11** is in such a position that injection of fuel to one of the engine cylinders is about to begin, in this position the plungers **14** are about to be moved inwardly by one pair of cam lobes **16** and the delivery passage **19** will already be in communication with one of the delivery ports **20**. As the distributor rotates the plungers will be moved inwardly and fuel will be displaced from the transverse bore to an engine cylinder.

The next injection stroke takes place after the distributor has moved through approximately 120° and during this movement the rollers must pass an intermediate pair of cam lobes, as the lobes are angularly spaced by 60° with the result that the transverse bore **13** cannot be refilled with fuel until the plungers have passed the aforesaid intermediate pair of cam lobes. As soon as this

has happened the inlet port **23** communicates with one of the inlet passages **24** and a fresh quantity of fuel is delivered to the bore **13** after which, as the distributor further rotates fuel is injected to another cylinder of the engine as previously described.

With such pumps it has been found necessary in practice to relieve the pressure in the passages of the pump and the particular pipe line at the end of an injection stroke and for this purpose the delivery passage **24** is arranged to remain in communication with the delivery port **20** after the inward movement of the plungers has finished.

Furthermore it is desirable that only a predetermined amount of relief should occur and for this purpose the cam lobes **16** are shaped to give a dwell period, indicated by the portion **16a** in FIGURE 7, during which period the delivery passage moves out of register with the delivery port. As a result of this a small quantity of fuel enters the transverse bore **13** with a result that the plungers will not pass the intermediate lobes without the rollers coming into contact therewith and very high liquid pressures and mechanical stresses would be generated in the pump if suitable precautions were not taken.

In the body of the pump is formed a recuperation chamber which comprises a radially disposed cylindrical chamber **25** in which is mounted a cylindrical shuttle **26**, the inner end of the chamber communicates with a relief port **27** which is at the same axial position as the inlet port **23** but is angularly spaced by 97° therefrom, and the outer end of the chamber is in constant communication with a source of fuel under pressure. The relief port **27** communicates in turn as the distributor rotates and as shown in FIGURE 6, with the inlet passages **24** during the time when the rollers **17** are riding over the intermediate cam lobes with the result that fuel is displaced from the transverse bore **13** into the inner end of the chamber by the plungers as the rollers are moved inwardly by the lobes, and is then allowed to flow in the reverse direction back to the bore **13** when the plunger pass the intermediate lobes. Thus by this means the excessive pressures and stresses are avoided.

For supplying fuel to the inlet port **23** there is provided a feed pump **28** of the vane type the rotor of which is mounted on the opposite end of the distributor to the bore **13** and which is provided with an inlet **29** and an outlet **30** in the body part, moreover, the inlet and outlet are interconnected by a relief valve **31** which controls the pressure at the outlet of the feed pump. The inlet of the feed pump is connected to a source of fuel and the outlet of the pump communicates with a fuel supply passage **32** extending in an axial direction within the body part. This passage communicates with the outer end of the chamber **25** and further communicates with an annular gallery **33** also formed in the body part.

Extending from the gallery is a cylindrical bore **34** which accommodates an angularly movable throttle valve **35** and in the wall of this bore is a port which is in constant communication with a first circumferential groove **36** formed in the periphery of the distributor. In the periphery of the throttle valve is formed a groove **37**, which communicates with the gallery **33**, and which has an edge which, as the throttle valve is moved angularly varies the effective size of the port, thereby varying the rate at which fuel can flow through the port. The circumferential groove **36** communicates with a first series of three equiangularly spaced longitudinal grooves **38** formed in the periphery of the distributor and which are of a length such, that, as the distributor rotates, they will communicate in turn with the inlet port **23**. Moreover the angular position of the grooves **38** is such that one of the grooves will communicate with the inlet port **23** as shown in FIGURE 6 during part of the time when the inlet passages **24** are out of register with the inlet port. In the present example the grooves register with the inlet port approximately 30° before the inlet passages register

therewith. As soon as one of the grooves registers with the inlet port fuel will flow, at a rate dependent upon the setting of the throttle valve **35**, to the inner end of a cylindrical chamber **39** formed in the body part, and which contains a cylindrical metering shuttle **40**. Fuel entering the inner end of the chamber **39** moves the metering shuttle **40** outwardly and fuel displaced from the outer end of this chamber flows to a second circumferential groove **41** formed in the periphery of the distributor. In communication with this groove is a second series of three equi-angularly spaced longitudinal grooves **42** formed in the periphery of the distributor and one of these grooves communicates with a drain passage **43** formed in the body part during the time when the metering shutting **40** is being moved outwardly. A further port **44** is provided which is in constant communication with the gallery **33** and which communicates with the second series of grooves **42**, in turn, at least during the time when the inlet port **23** is in register with one of the inlet passages **24**. During this time the metering shuttle will be moved inwardly and the previously metered quantity of fuel contained in the inner end of the chamber will be displaced into the longitudinal passage, and the transverse bore, ready to be delivered to the engine during the next injection stroke of the pump.

By a construction of pump as above described the difficulties of supplying fuel to a three cylinder engine have been overcome in a simple and convenient manner.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. A liquid fuel pump for supplying fuel to internal combustion engines and comprising a body part, a rotary distributor within the body part, a transverse bore formed within the distributor, a pair of plungers mounted in the opposite ends of said bore respectively, a cam ring having three pairs of cam lobes equiangularly disposed about the distributor and positioned to cause inward movement of the plungers during rotation of the distributor, the lobes of each pair of cam lobes being diametrically disposed relative to each other, the lobes being shaped to permit a limited outward movement to the plungers after the inward movement has taken place, a delivery passage in the distributor, three equiangularly spaced delivery ports formed in the body part and with which the delivery passage registers in turn as the distributor rotates during the full inward movement of the plungers, the limited outward movement of the plungers taking place whilst the delivery passage is still in register with a delivery port and serving to partially relieve liquid pressure in said delivery port, a recuperation chamber and means for placing said recuperation chamber in communication with the transverse bore during the time when the plungers are moved inwardly by the cam lobes and when the delivery passage is not in register with a delivery port.

2. A liquid fuel pump as claimed in claim **1** including a relief port in communication with said recuperation chamber, three equiangularly disposed passages in the distributor and which register in turn with said relief port during the time when the plungers are moved inwardly by the cam lobes and when the delivery passage is not in register with a delivery port, said passages being in communication with the transverse bore.

3. A liquid fuel pump as claimed in claim **2** including an inlet port in the body part with which said equiangularly disposed passages register in turn as the distributor rotates and through which liquid fuel can flow to the transverse bore.

4. A liquid fuel pump as claimed in claim **3** in which said recuperation chamber comprises a cylinder formed in the body part, one end of said cylinder being in communication with said relief port, a shuttle movable within said cylinder said shuttle being displaced away from said one end of the cylinder when fuel flows into said cylinder through said relief port, a feed pump mounted

within the body part and having an inlet and an outlet, the outlet of the pump being in communication with the other end of said cylinder.

5. A liquid fuel pump as claimed in claim 4 in which the relief port remains open to the transverse bore after the partial inward movement of the plungers has taken place, so that the fuel which is discharged to said cylinder during the partial inward movement of the plungers is returned to the transverse bore.

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