March 3, 1970 D. F. MOWBRAY 3,498,226

LIQUID FUEL PUMPING APPARATUS

Filed Oct. 31, 1968 2 Sheets-Sheet 1

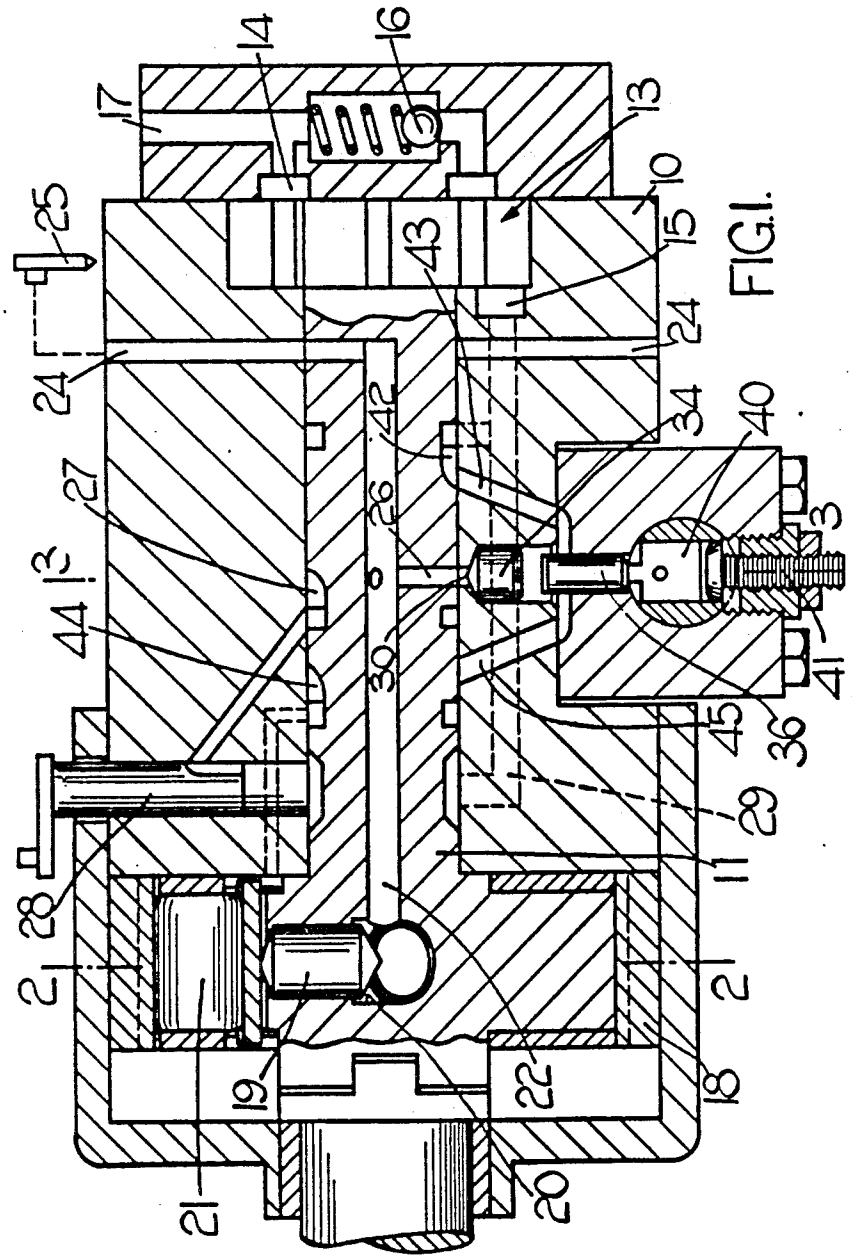


FIG. 1.

INVENTOR
Dorian Farrar Mowbray
BY Pennie, Edmonds, Downing & Lucas
ATTORNEYS

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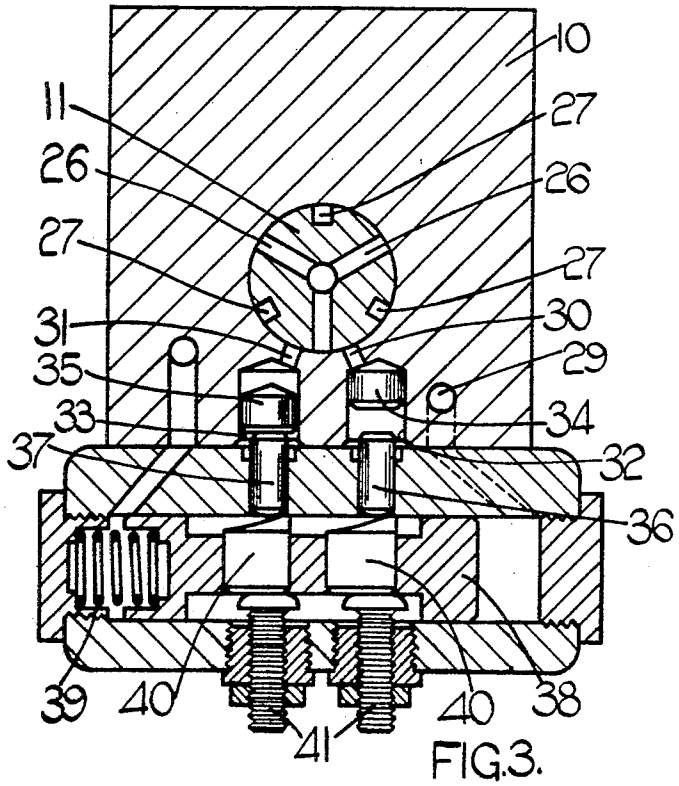


FIG.3.

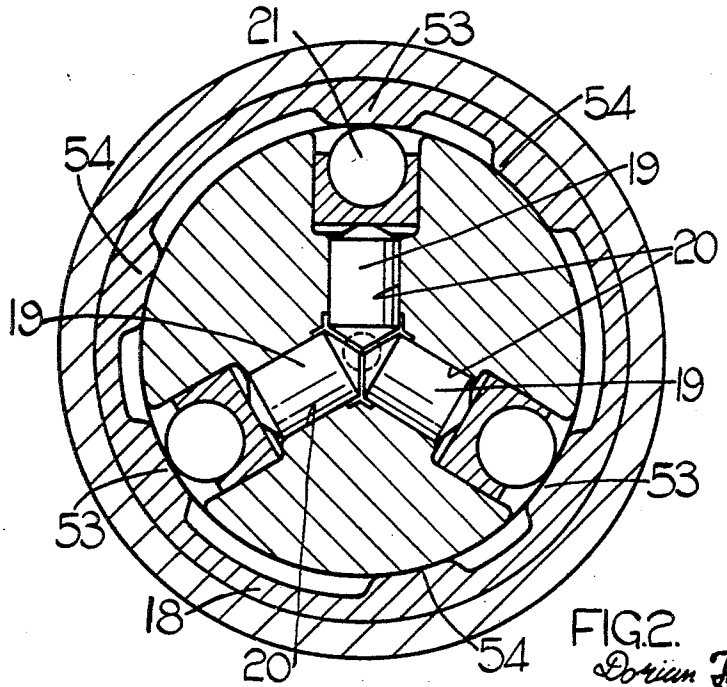


FIG.2.

INVENTOR

Dorian Harrison Mowbray

BY Glascock Downing & Seebold

ATTORNEYS

United States Patent Office

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LIQUID FUEL PUMPING APPARATUS

Dorian Farrar Mowbray, Burnham, England, assignor to C.A.V. Limited, London, England, a British company

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Int. Cl. F04b *1/00, 1/04;* F02m *39/00*
U.S. Cl. 103—2 1 Claim

ABSTRACT OF THE DISCLOSURE

A liquid fuel pumping apparatus for supplying fuel to a six-cylinder compression ignition engine having unequal firing angles and including a rotary distributor member in which are mounted three radially movable but equi-angularly spaced pumping plungers, there being provided a cam ring having two sets of cam lobes, formed on its internal periphery for imparting inward movement to the plungers, the sets of cam lobes being displaced angularly relative to each other by the required firing angle of the engine.

This invention relates to liquid fuel pumping apparatus for supplying liquid fuel to a six-cylinder compression ignition internal combustion engine having unequal firing angles, and the object of the invention is to provide such apparatus in a simple and convenient form.

Apparatus in accordance with the invention comprises in combination, a body part, a rotary distributor mounted within the body part and adapted to be driven in timed relationship with the engine with which the apparatus is associated, six outlet ports formed in the body part and through which fuel flows in turn to the combustion spaces of the engine respectively, the outlet ports opening onto the periphery of the distributor member at angularly spaced points, the spacing of which corresponds to the required firing angle, a delivery passage formed in the distributor member for registration with the outlet ports in turn, three equiangularly spaced radial bores formed in the distributor member, the inner ends of said bores communicating with said delivery passage, three pumping plungers located within said bores respectively, a cam surrounding the distributor member, two sets of cam lobes formed on the internal periphery of the cam each set comprising three equiangularly spaced cam lobes and the lobes of each set being spaced by the required firing angle, the cam lobes acting to impart movement to the plungers during the time when the delivery passage is in register with an outlet port, three inlet passages formed in the distributor member and opening out onto the pheriphery thereof at equiangularly spaced points, said inlet passages communicating with the inner ends of said bores, a pair of ports formed in the body part for registration with said inlet passages, said bores being angularly spaced by an amount so as to be placed in communication with the bores by way of said inlet passages alternately and during the time when the plungers are permitted to move outwardly by the cam lobes, a pair of cylinders formed in the body part in communication at one end with said ports respectively, a pair of reciprocable shuttles respectively mounted in said cylinders, means for feeding fuel to said ends of the cylinders in turn whilst they are out of communication with said inlet passages, throttle means for controlling the quantity of fuel fed to said

ends of the cylinders, thereby to control the extent of movement of the shuttles therein, and means for feeding fuel to the opposite ends of said cylinders to move the shuttles therein towards said ends thereof during the time when an inlet passage is in communication with one of the ports.

In the accompanying drawings:

FIGURE 1 is a sectional side elevation on the line **1—1** of FIGURE 3 of one example of liquid fuel pumping apparatus in accordance with the invention,

FIGURE 2 is a section on the line **2—2** of FIGURE 1 and

FIGURE 3 is a section on the line **3—3** of FIGURE 1.

The drawings show a liquid fuel pumping apparatus capable of supplying fuel to a six-cylinder compression ignition engine of the V-type. The angle between the two banks of cylinders of the engine is 90°, and the particular engine requires fuel to be supplied to it at unequal intervals of pump rotation of 45°, 75°, 45°, 75°, etc. It will be appreciated however that the apparatus is equally able to supply fuel to engines having 60° or 120° V angles, and to a conventional six cylinder engine having its cylinders in line provided various angles within the apparatus are altered accordingly.

The apparatus comprises a body part **10** in which is mounted a rotary cylindrical distributor **11** which is adapted to be driven in timed relationship with the engine with which the apparatus is associated. At one end of the disributor is formed three radially extending equi-angularly spaced bores **20** which accommodate pumping plungers **19** respectively. Bearing against the outer ends of the pumping plungers are shoe pieces respectively, each of which mounts a roller **21** which cooperates to effect inward movement of the associated pumping plunger, with cam lobes formed on the internal periphery of an annular cam ring **18** which surrounds the distributor at this point. The cam ring is formed with two sets **53, 54** of lobes and each set comprises three lobes which are equi-angularly spaced relative to each other about the axis of rotation of the distributor. Moreover, the two sets of cam lobes are angularly spaced from each other by 45°. The effect of this spacing is that all three pumping plungers **50** are moved inwardly simultaneously to deliver fuel at 45°, 75°, 45°, etc., intervals of pump rotation.

The inner ends of the bores **20** which accommodate the pumping plungers are in communication with each other, and also with a longitudinal passage **22** formed in the distributor. At one point, the longitudinal passage is in communication with a radially disposed delivery passage **23**, and this is arranged to register in turn, as the distributor rotates, with six outlet ports **24** which are formed in the body part. The circumferential spacing of the outlet ports **24** corresponds with the spacing of the sets of cam lobes and the delivery passage **23** is arranged to register with an outlet port during the time when the pumping plungers are being moved inwardly by the cam lobes. In use, the outlet ports are connected to the fuel injection nozzles **25** of the associated engine.

The longitudinal passage **22** is also in communication with three inlet passages **26** which extend to points on the periphery of the distributor member, the points being equiangularly spaced relative to each other. Moreover, formed in the body part are a pair of inlet ports **30, 31** for communication with the inlet passages **26**, the ports being spaced by an angle of 45°. The ports are in communica-

tion respectively with the inner ends of a pair of cylinders **32, 33** defined in the body part and which contains reciprocable shuttles **34, 35**, respectively. The inlet passages **26** and the inlet ports **30, 31** are positioned that an inlet passage is brought into register with one inlet port during the time when the plungers are permitted to move outwardly by the cam lobes and during this time fuel flows through this inlet port in a manner which will be described, to the bores **20** containing the pumping plungers **19** thereby to move the latter in an outward direction. This part of the cycle of operation of the apparatus is described as a filling stroke, and the next filling stroke occurs after an injection stroke, and during the time when the aforesaid inlet passages move into register with the other inlet port.

Also mounted within the body part is a feed pump **13** of the vane type, the rotary parts of the feed pump being secured to the end of the distributor remote from the bores. The feed pump is provided with an inlet **14** for connection to a source of fuel, and an outlet **15**, and the inlet and outlet are in communication with each other by way of a relief valve **16** which controls the outlet pressure of the feed pump.

Also formed on the periphery of the distributor member are three grooves **27** which are equiangularly spaced relative to each other and which are positioned at 60° intervals relative to the inlet passages **26**. The grooves **27** are in communication with a circumferential groove which is formed in the periphery of the distributor and which is in communication with the outlet **15** of the feed pump by way of the throttle valve **28** which can be adjusted to determine the rate at which the fuel flows from the outlet of the feed pump through passage **29** to the circumferential groove. The aforesaid grooves **27** register with the inlet ports **30, 31** in turn, during the time when the inlet passages **26** are out of register therewith. Considering the inlet port **30** and the associated shuttle **34**, during delivery of fuel to the bores **20**, the shuttle **34** is moved towards the inner end of the cylinder **32**. After the inlet passage **26** has moved out of register with the inlet port, one of the aforesaid grooves **27** is brought into register therewith, and fuel flows to the inner end of the cylinder **32** thereby moving the shuttle outwardly. The quantity of fuel which flows to the inner end of the cylinder is determined by the setting of the throttle valve **28**, and it is this quantity of fuel which is subsequently passed to the aforesaid bores for injection to the associated engine.

During the outward movement of the shuttle **34**, fuel is displaced from the outer end of its cylinder and for this purpose there is provided in communication with the outer end of the cylinder a drain passage **45**. The drain passage **45** opens onto the periphery of the distributor member at a point axially removed from but angularly aligned with the port **30**. This is illustrated in FIGURE 1 and a similar passage is provided for the cylinder **33** which contains the other shuttle. For registration with the drain passages at the appropriate time there are provided in the periphery of the distributor member three drain grooves **44**. These are angularly aligned with the grooves **27** respectively and communicate with a circumferential groove formed in the periphery of the distributor member which is in constant communication with a drainage space defined in the body part of the apparatus. Thus, when fuel flows through a groove **27** to the inner ends of the cylinders to move the shuttles outwardly, fuel flows from the outer ends of the cylinders by way of the appropriate drain passage and a drain groove **44**.

In order to effect inward movement of the shuttles **34, 35** during a filling stroke fuel under pressure from the outlet **15** of the feed pump is supplied to the outer ends of the cylinders containing the shuttle. For this purpose the outer ends of the cylinders are in communication respectively with a pair of supply passages which open out onto the periphery of the distributor member at

a point axially removed from but angularly aligned with the respective inlet ports. As shown in FIGURE 2 the supply passage associated with the cylinder containing the shuttle **34** is referenced **43**. For registration with the supply passages there are provided in the periphery of the distributor member three equiangularly spaced supply grooves **42** which are angularly aligned with the inlet passages **26**, and which communicate with a circumferential groove which is in constant communication with the outlet **15** of the feed pump by way of the passage **29**. Thus during a filling stroke when a passage **26** is in communication with an inlet port fuel is supplied to the outer end of the associated cylinder to move the shuttle inwardly.

At the outer ends of the cylinders **32, 33** are mounted a pair of stops **36, 37**, respectively, the setting of which can be varied by means of a fluid pressure operable piston **38**. This piston is loaded by means of a coiled compression spring **39** in one direction, and is moved in opposition to the spring by fuel under pressure derived directly from the outlet of the feed pump through passage **29**. The piston has mounted therein a pair of members **40** which have cam surfaces defined on their sides which are presented to the stops. Moreover, the members are adjustably mounted within the piston, and can be adjusted by means of a pair of adjustors **41** respectively operable from the exterior of the apparatus. In the particular example, the cam surfaces are shaped so that as the output pressure of the feed pump increases, the permitted extent of movement of the shuttles within their cylinders is reduced.

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

1. A liquid fuel pumping apparatus for supplying fuel to a six-cylinder compression ignition internal combustion engine having unequal firing angles the apparatus comprising in combination, a body part, a rotary distributor mounted within the body part and adapted to be driven in timed relationship with the engine with which the apparatus is associated, six outlet ports formed in the body part and through which fuel flows in turn to the combustion spaces of the engine respectively, the outlet ports opening onto the periphery of the distributor member at angularly spaced points, the spacing of which corresponds to the required firing angle, a delivery passage formed in the distributor member for registration with the outlet ports in turn, three equiangularly spaced radial bores formed in the distributor member, the inner ends of said bores communicating with said delivery passage, three pumping plungers located within said bores respectively, a cam surrounding the distributor member, two sets of cam lobes formed on the internal periphery of the cam, each set comprising three equiangularly spaced cam lobes and the lobes of each set being spaced by the required firing angle, the cam lobes acting to impart inward movement to the plungers during the time when the delivery passage is in register with an outlet port, three inlet passages formed in the distributor member and opening out onto the periphery thereof at equiangularly spaced points, said inlet passages communicating with the inner ends of said bores, a pair of ports formed in the body part for registration with said inlet passages, said bores being angularly spaced by an amount so as to be placed in communication with the bores by way of said inlet passages alternately and during the time when the plungers are permitted to move outwardly by the cam lobes, a pair of cylinders formed in the body part in communication at one end with said ports respectively, a pair of reciprocable shuttles respectively mounted in said cylinders, means for feeding fuel to said ends of the cylinders in turn whilst they are out of communication with said inlet passages, throttle means for controlling the quantity of fuel fed to said ends of the cylinders, thereby to control the extent of movement of the shuttles therein, and means for feeding fuel to the opposite ends of

said cylinders to move the shuttles therein towards said ends thereof during the time when an inlet passage is in communication with one of the ports.

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DONLEY J. STOCKING, Primary Examiner

W. J. KRAUSS, Assistant Examiner

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103—174; 123—139