May 6, 1958 F. M. EVANS 2,833,263

LIQUID FUEL PUMPS FOR INTERNAL COMBUSTION ENGINES

Filed May 4, 1956 2 Sheets-Sheet 1

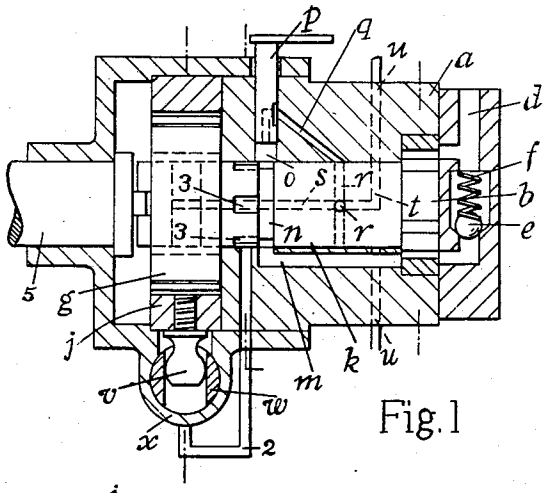

Fig.1

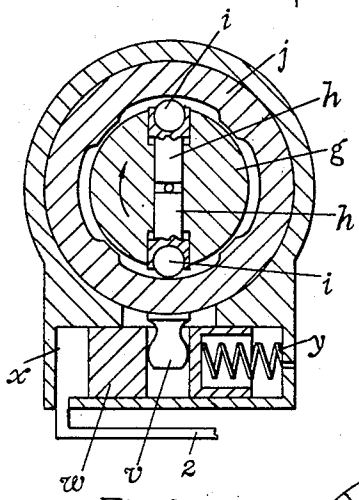

Fig.2

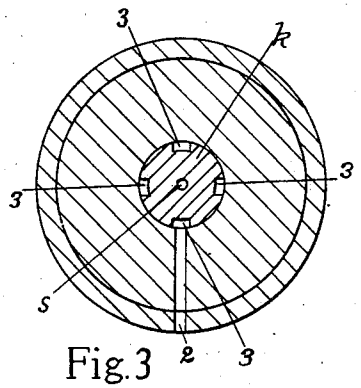

Fig.3

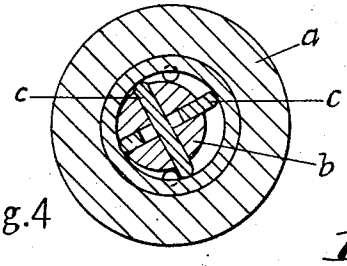

Fig.4

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LIQUID FUEL PUMPS FOR INTERNAL COMBUSTION ENGINES

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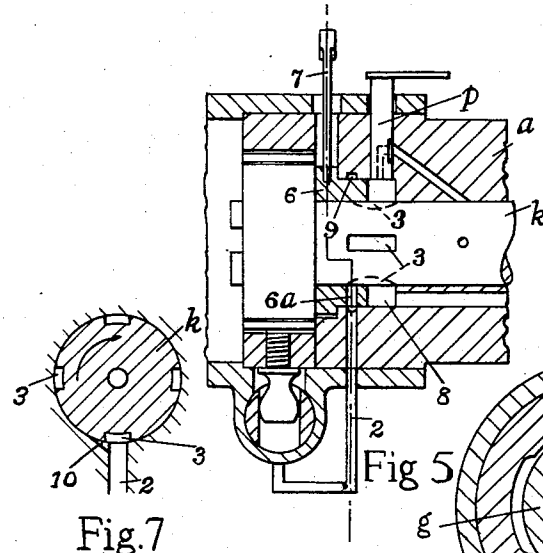

Fig.7

Fig 5

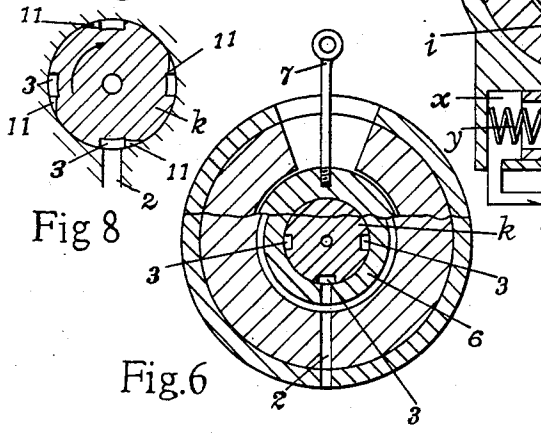

Fig 8

Fig.6

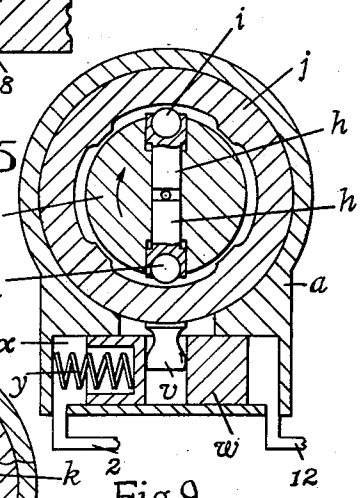

Fig.9

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LIQUID FUEL PUMPS FOR INTERNAL COMBUSTION ENGINES

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7 Claims. (Cl. 123—139)

This invention relates to liquid fuel pumps for internal combustion engines of the kind comprising a feed pump, an injection pump, an adjustable throttle for controlling the rate of supply of fuel from the feed pump to the injection pump, and a distributor for conveying successive discharges from the injection pump to each in turn of the engine cylinders.

A disadvantage of a pump of the kind aforesaid as hitherto constructed, is that the instant at which each discharge to the engine is initiated varies with the rate of supply of fuel from the feed to the injection pump, a diminished rate being accompanied by a delay of the commencement of the discharge.

The object of the present invention is to provide a pump of the kind above specified, in a form which obviates the said delay, and may also be adapted to vary the instant of discharge.

The invention comprises a pump of the kind aforesaid having combined with it an adjustable cam for actuating the injection pump, and a hydraulic lock for the cam supplied with liquid from the feed pump under the control of the distributor for determining the instant of commencement of each discharge of the injection pump.

In the accompanying drawings:

Figure 1 is a sectional side elevation of a pump embodying the invention.

Figure 2 is a cross section through the injection pump, Figure 3 a cross section through the distributor, and Figure 4 a cross section through the feed pump.

Figure 5 is a fragmentary sectional side elevation illustrating a modification of the construction shown in Figure 1, and Figure 6 is a cross section through the distributor.

Figures 7 and 8 are fragmentary views illustrating further modifications of construction associated with the distributor port.

Figure 9 is a fragmentary view illustrating an alternative embodiment of the invention.

Referring to Figures 1–4 the pump there shown comprises a body part *a* which at one end contains (as hitherto) a feed pump of the kind comprising a rotary impeller *b* provided with vanes *c*. Fuel is conveyed to this pump through a passage *d* and the inlet and outlet ports may be interconnected through a relief valve *e* loaded by a spring *f* which limits the pressure which can be generated in this pump. At the other end of the body part is contained the fuel injection pump. This comprises a rotary body part *g* having a transverse bore containing reciprocatory plungers *h* which through rollers *i* co-operate with a cam ring *j*. The parts *b*, *g* are interconnected by a spindle *k* which has formed in it axial and radial passages and which serves as a fuel distributor. The arrangement is such that liquid fuel entering at *d* is discharged from the feed pump along the passage *m* and around a groove *n* in the spindle *k* to a cavity *o* which contains a manually adjustable throttle *p*. From the throttle the fuel passes along a passage *q* to each in turn of the radial ports *r* in the spindle and thence along the bore *s* to the injection pump. During the inward movements of the plungers

h the fuel is returned along the bore *s* to a single radial port *t* by which it is discharged through each in turn of the passages *u* connected to the different cylinders of the engine. It will be understood that the radial ports *r*, *t* are so disposed that when any one of the ports *r* is open to the passage *q* the port *t* is closed to the passages *u*, and when the port *t* is open to a passage *u*, the ports *r* are all closed.

According to the invention, the plunger-actuating cam *j* which surrounds the rotary body *g* of the injection pump is angularly movable. From one side of it extends a short radial arm *v* which at its outer end occupies a gap in a reciprocatory plunger *w* contained in a cylinder *x*. The plunger is movable in one direction by a spring *y* contained in one end of the cylinder, and in the opposite direction by fuel supplied by the feed pump to the other end of the cylinder along a passage **2**. Also on the distributor spindle *k* are formed longitudinal grooves **3** which successively convey liquid fuel from the groove *n* to the passage **2**. When the injection pump is provided with two plungers as shown and the cam with four equispaced lobes, four such grooves **3** are provided, the number and positions of the grooves being similar to the ports *r*.

The rotary part *g* of the pump is driven in the direction of the arrow through a spindle **5** by motion derived from the engine.

The mode of action is such that while the outer ends of the injection pump plungers *h* occupy a position between the cam lobes as shown in Figure 2 and are therefore free, liquid is admitted through one of the distributor grooves **3** and the passage **2** to the left hand end of the cylinder *x*, causing the cam actuating plunger *w* to move the cam in the anti-clockwise direction to an advanced position against the resistance of the spring *y*. As soon as the pump plungers encounter the cam lobes the effect is to impart a return movement to the cam so long as the passage **2** is open, and cause some of the liquid to be displaced from the cylinder. But when the passage **2** is closed by the distributor this movement of the cam is locked by the entrapped liquid, and the cam then causes the pump plungers to perform their discharge movement.

It follows that by means of the device above described, the instant at which the discharge of the injection pump is initiated is fixed, this instant being determined by the closing of the passage **2** by the distributor.

When it is required to be able to vary the instant at which the injection pump commences its action the construction shown in Figures 5 and 6 is employed. In this construction, the distributor *k* is surrounded by a ring **6** which is angularly movable by an arm **7**, the latter being operable by any convenient means responsive to the speed of the engine. For example a centrifugal governor may be used for actuating the ring **6** or a hydraulic device operable by pressure of the fuel supplied by the feed pump. In the ring is formed a port **6***a* which receives fuel from each in turn of the grooves **3**, the latter being open at one end to an annular recess **8** through which fuel from the feed pump can pass to the throttle *p*. Also the ring is surrounded by an annular groove **9** which communicates with the passage **2**.

Alternatively either of the devices shown in Figures 7 and 8 may be used. As shown by the fragmentary view in Figure 7, there is formed at the forward edge of the entrance to the passage **2** a tapering notch **10**. Or, and as shown in the similar view at Figure 8, there is formed at the trailing edge of each of the distributor grooves **3**, a tapering notch **11**.

These tapering notches produce a so-called wire drawing effect which causes the pressure of the liquid entrapped in the cylinder, and thus the operative position of the cam ring *j*, to vary automatically with the speed of the engine.

In the modified form of the invention illustrated by the fragmentary view shown in Figure 9, the position of the spring *y* acting on the reciprocatory plunger *w* is reversed. The left hand end of the cylinder *x* containing the plunger is connected by the passage **2** to the part of the distributor provided with the grooves **3** (Figure 1) and the right hand end of the cylinder is connected by a passage **12** to the passage *m* (Figure 1) leading from the feed pump to the distributor.

In this arrangement, the plunger *w* is moved to the right by the spring *y* when the pump plungers *h* occupy positions between the lobes of the cam *j* so causing the said ring to be moved in the anti-clockwise direction. But as soon as the pump plungers *h* encounter the cam lobes which they are approaching, they impart an opposite angular movement to the cam against the action of the spring, this movement being arrested when the distributor closes the passage **2**.

The invention is not, however, limited to the particular form of combined feed and injection pump above described, as it may be applied in essentially the same manner to other equivalent pumps.

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

1. Means for supplying liquid fuel to a multi-cylinder internal combustion engine, comprising in combination a feed pump, an injection pump, an adjustable throttle for controlling the rate of supply of liquid fuel from the feed pump to the injection pump, a rotary distributor for conveying successive discharges from the injection pump to the engine cylinders in turn, an adjustable cam for effecting discharge of the injection pump, a spring-loaded cam-adjusting plunger having an operative connection with the cam, a cylinder containing the plunger, a passage for conveying liquid fuel from the feed pump to one end of the cylinder, and means operable by the distributor for interrupting fuel flow through the passage prior to each discharge of the injection pump for entrapping liquid fuel in the said end o fthe cylinder, and thereby determining the angular position of the cam at the instant of commencement of each discharge of the injection pump.

2. Means for supplying liquid fuel to a multi-cylinder internal combustion engine, comprising in combination a feed pump, a rotary injection pump, an adjustable throttle for controlling the rate of supply of liquid fuel from the feed pump to the injection pump, a rotary distributor for conveying successive discharges from the injection pump to the engine cylinders in turn, an angularly adjustable cam for effecting discharge of the injection pump, a spring-loaded cam-adjusting plunger having an operative connection with the cam, a cylinder containing the plunger, a passage for conveying liquid fuel from the feed pump to one end of the cylinder for imparting angular movement to the cam against the spring-loading of the plunger in a direction opposite to the direction of rotation of the injection pump, and ported means operable by the distributor for interrupting fuel flow through the passage prior to each discharge of the injection pump for entrapping liquid fuel in the said end of the cylinder, and thereby determining the angular position of the cam at the instant of commencement of each discharge of the injection pump.

3. Means for supplying liquid fuel to a multi-cylinder internal combustion engine, comprising in combination a feed pump, a rotary injection pump, an adjustable throttle for controlling the rate of supply of liquid fuel from the feed pump to the injection pump, a rotary distributor for conveying successive discharges from the injection pump to the engine cylinders in turn, an angularly adjustable cam for effecting discharge of the injection pump,

a cam-adjusting plunger having an operative connection with the cam, a cylinder containing the plunger, a spring arranged in one end of the cylinder and urging the plunger to impart angular movement to the cam in a direction opposite to the direction of rotation of the injection pump, a first passage for conveying liquid fuel from the feed pump to the end of the cylinder containing the spring, a second passage for conveying liquid fuel from the feed pump to the other end of the cylinder, and ported means operable by the distributor for interrupting fuel flow through the first passage prior to each discharge of the injection pump, and thereby determining the angular position of the cam at the instant of commencement of each discharge of the injection pump.

4. Means according to claim 1, in which the distributor and the means operable thereby comprise a rotary stem having a plurality of angularly spaced radial ports for successively receiving from the feed pump liquid fuel to be supplied to the injection pump, and also having thereon a plurality of spaced grooves corresponding in number and angular disposition to the ports, the grooved portion of the stem being arranged to control fuel flow through the passage for conveying liquid fuel from the feed pump to one end of the cylinder.

5. Means according to claim 1, in which the distributor and the means operable thereby comprise a rotary stem having a plurality of angularly spaced radial ports for successively receiving from the feed pump liquid fuel to be supplied to the injection pump, and also having thereon a plurality of spaced grooves corresponding in number and angular disposition to the ports, the grooved portion of the stem being arranged to control fuel flow through the passage for conveying liquid fuel from the feed pump to one end of the cylinder, and having mounted thereon an angularly adjustable ported control sleeve for varying the instant at which the fuel flow through the passage is interrupted.

6. Means according to claim 1, in which the distributor and the means operable thereby comprise a rotary stem having a plurality of angularly spaced radial ports for successively receiving from the feed pump liquid fuel to be supplied to the injection pump, and also having thereon a plurality of spaced grooves corresponding in number and angular disposition to the ports, the grooved portion of the stem being arranged to control fuel flow through the passage for conveying liquid fuel from the feed pump to one end of the cylinder, and each of the grooves being formed at one side with a tapering notch for causing the angular position of the cam at the instant of commencement of each discharge of the injection pump to be varied with the speed of the distributor.

7. Means according to claim 1, in which the distributor and the means operable thereby comprise a rotary stem having a plurality of angularly spaced radial ports for successively receiving from the feed pump liquid fuel to be supplied to the injection pump, and also having thereon a plurality of spaced grooves corresponding in number and angular disposition to the ports, the grooved portion of the stem being arranged to control fuel flow through the passage for conveying liquid fuel from the feed pump to the injection pump, and the portion of the passage adjacent to the grooved portion of the stem being formed at one side with a tapering notch for causing the angular position of the cam at the instant of commencement of each discharge of the injection pump to be varied with the speed of the distributor.

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