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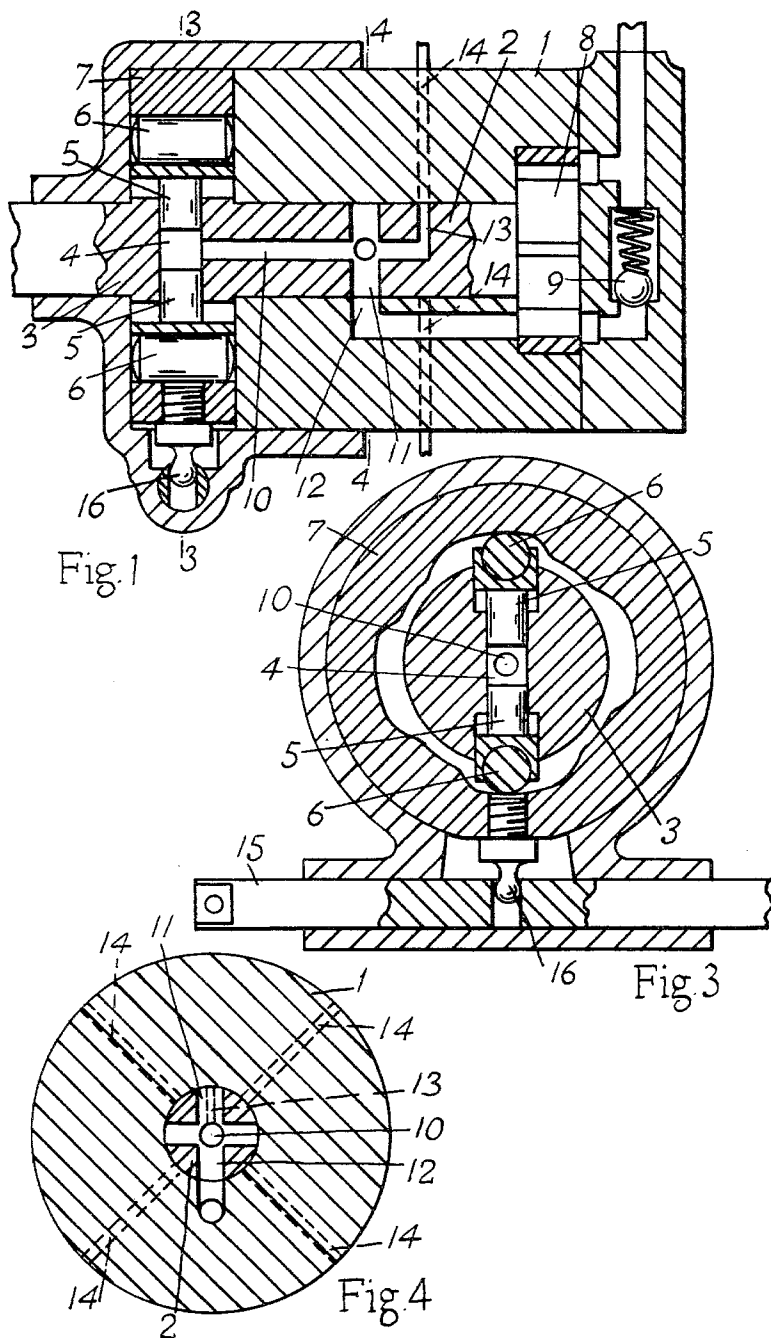
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LIQUID FUEL PUMPS

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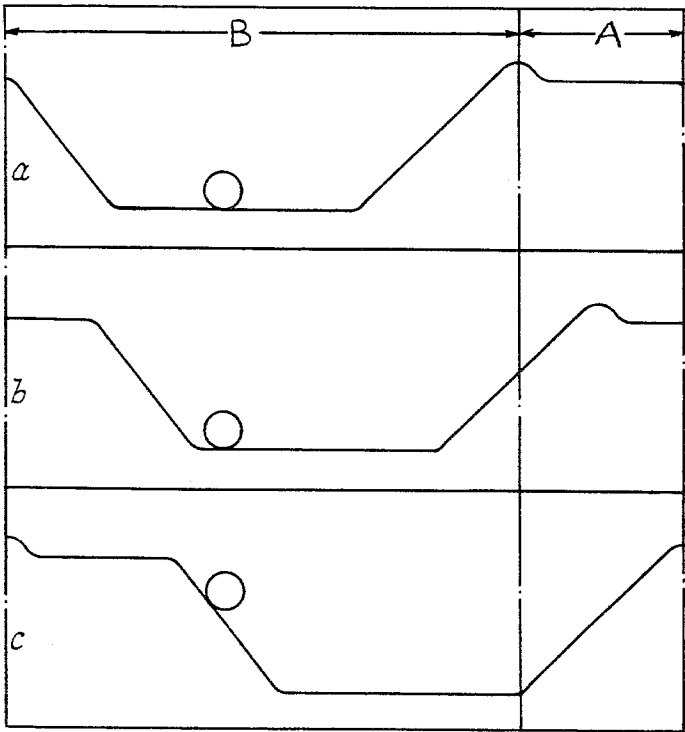


Fig. 2

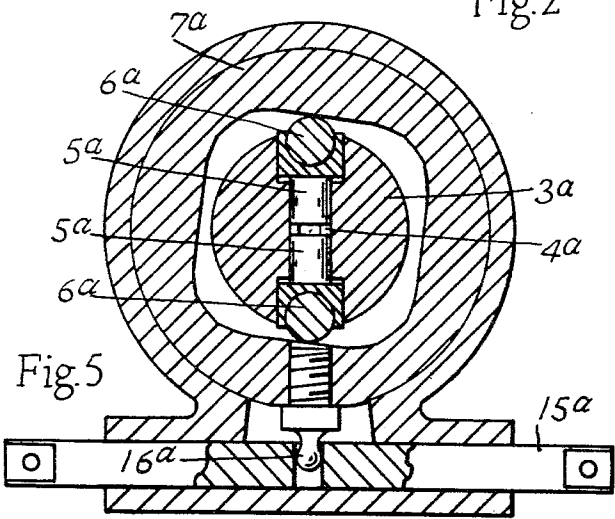


Fig. 5

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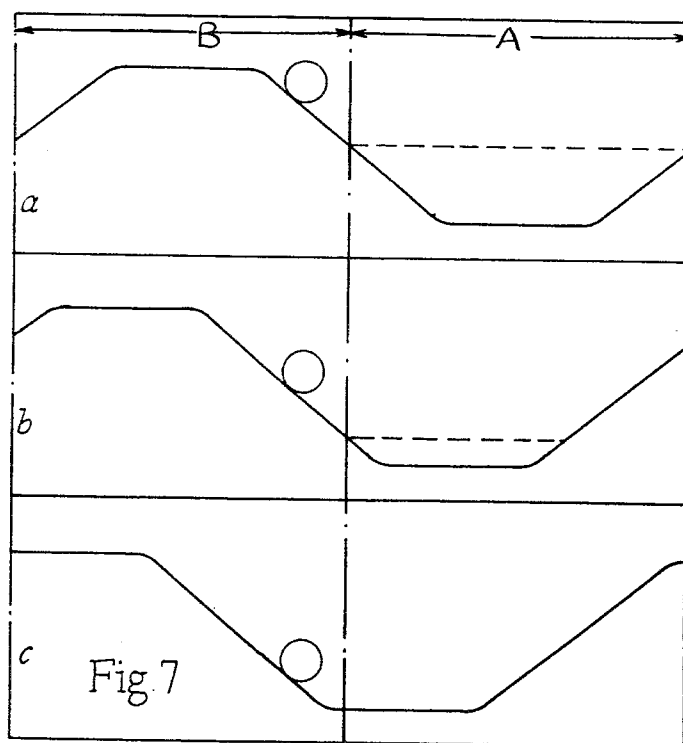
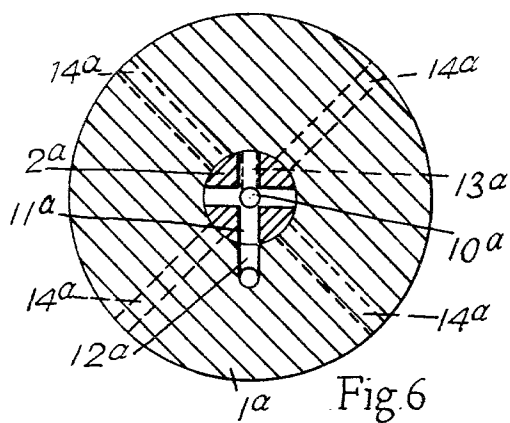
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LIQUID FUEL PUMPS

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4 Claims. (Cl. 103—2)

This invention relates to liquid fuel pumps for internal combustion engines, and more particularly of the kind comprising a rotor having formed therein a transverse bore, at least one reciprocable plunger in the bore, an annular cam surrounding the rotor for imparting inward movements to the plunger as the rotor is rotated, and a distributor having passages whereby the bore in the rotor is placed in communication alternately with an inlet port and with successive outlet ports in timed relationship to the rotation of the rotor.

The object of the invention is to provide in such a pump convenient means for varying the quantity of liquid fed to the outlet ports.

According to the invention in a pump of the kind specified, the annular cam is adjustable about its axis through an angle such, in relation to the positions of the passages in the distributor, that the quantity of fuel fed to the outlets can be determined by varying the proportions of the inward strokes of the plunger which are effected while the bore is in communication with the outlet ports.

In the accompanying drawings:

FIGURE 1 is a sectional side elevation of a liquid fuel pump in accordance with the invention.

FIGURE 2 is a timing diagram showing a developed view of a quarter of the cam at three alternative settings of the pump shown in FIGURE 1.

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

FIGURE 4 is a section on the line 4—4 of FIGURE 1.

FIGURES 5 and 6 respectively are views similar to FIGURES 3 and 4 of a modified pump and FIGURE 7 is a timing diagram showing a developed view of a quarter of the cam at three alternative settings of the pump shown in FIGURES 5 and 6.

Referring to FIGURES 1, 3, and 4 there is provided a body part 1 in which is mounted a rotary cylindrical distributor 2. At one end of the distributor is a head 3 which constitutes the rotor of an injection pump. In the head is a diametrically disposed bore 4 in which are accommodated a pair of reciprocable plungers 5 arranged to be moved inwardly at the same time by the interaction of rollers 6 at their outer ends with a surrounding annular cam 7 in the body part.

At the other end of the distributor is a supply pump 8 of the vane type. The rotary part of the supply pump, and the rotor of the injection pump are interconnected by the distributor and are adapted to be driven as a unit by the engine with which the pump is associated. Moreover, the inlet and outlet of the supply pump 8 are interconnected by a relief valve 9 which limits the pressure which can be generated by this pump to the required speed/pressure characteristic.

In the distributor is an axial passage 10 in communication with the bore 4 between the plungers 5. Extending from the axial passage is a plurality of equi-angularly spaced radial inlet passages 11 (i.e. four radial passages in a pump for a four cylinder engine) which are adapted to register in turn as the distributor rotates with an inlet port 12 in the body part in communication with the supply pump outlet. Also extending from the axial passage is a radial passage 13 which, as the distributor

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rotates, is adapted to register in turn with a plurality of equi-angularly spaced outlet or delivery ports 14 in the body part, the outlet ports being adapted for connection respectively to the injection nozzles (not shown) associated with the engine cylinders. The angular relationship of the inlet passages 11 and the radial passage 13 are such in relation to the positions of the inlet port 12 and outlet ports 14, that when the bore 4 is closed to the inlet port it is open to the outlet ports, and when closed to an outlet port the inlet port is open. Moreover, the inlet port, which opens alternately with the opening of each outlet port, is arranged to remain open throughout larger angular movements of the distributor than the outlet ports, and for this purpose the inlet port 12 and passages 11 may be of larger diameter than the outlet ports 14 and radial passage 13.

The annular cam 7 is annularly adjustable about its axis by means of a control rod 15 which extends parallel to a tangent to the cam and which engages a peg 16 secured to the cam. The rod is axially movable by manually or governor operable means (not shown) in order to vary the quantity of fuel delivered to the engine.

Referring to FIGURE 2, there is shown a timing diagram illustrating the position of one of the rollers 6 and therefore its associated plunger 5 in relation to the periods of registration of the inlet ports 12 with one of the inlet passages 11 and one of the outlet ports 14 and the radial passage 13 during one quarter of a revolution of the distributor. The period A represents the time during which the radial passage 13 is in communication with one of the outlet ports 14 and the period B the time during which the inlet port 12 is in communication with one of the inlet passages 11. Considering FIGURE 2 portion a, during period B, the roller is first permitted outward movement (i.e. in the downward direction in the diagram) and the bore 4 is filled with fuel. However, after a period of dwell, inward movement is imparted to the roller and the fuel in the bore is discharged back to the inlet. During period A a slight outward movement of the roller takes place and then a dwell for the rest of the period. Thus no fuel is delivered to the outlet port. Considering now portion b of FIGURE 2, in which the cam is displaced from the extreme position in portion a, during period B the roller is permitted to move outwardly, thus filling the bore with fuel, and after a dwell period the roller is moved inwardly discharging a portion of the fuel back to the inlet. All the fuel is not however returned to the inlet and the excess is delivered to the appropriate outlet port during the period A. In portion c of FIGURE 2, the cam is shown in the other extreme position and following the above reasoning it will be seen that all the fuel drawn in to the bore during period B is delivered to the engine during period A.

The modification shown in FIGURES 5 and 6 is similar to the example shown in FIGURES 1 to 4 except that the profile of the cam 7a is regular, and the duration of opening of the inlet port 12a is arranged to be the same as that of the opening of the outlet ports 14a. For the latter purpose, the inlet port 12a and each passage 11a is of the same diameter as the outlet ports 14a and passage 13a. Moreover, the ports and passages are arranged so that the axial bore 10a is open at all times to either an outlet port or the inlet port. Referring to FIGURE 7, the period during which the inlet port 12a is open to one of the inlet passages 11a is designated B and the period during which the radial passage 13a is open to one of the outlet ports 14a in the injection period is designated A. Portion a shows the cam 7a at one extreme position and the initial movement of the roller 6a is inward and any fuel in the bore 4a is displaced back to the

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inlet. After a period of dwell, the roller is permitted outward movement and a quantity of fuel equal to that expelled at the beginning of the period is drawn into the bore. During the initial part of the period A, the roller is still moving outwardly but no fuel is drawn into the bore and cavitation tends to occur. After a period of dwell, the roller is urged inwardly by the cam an amount sufficient to remove the cavitation only. Thus no fuel is delivered to the outlet port. Portion *b* of FIGURE 7 shows the cam at an intermediate position and during period B a small quantity of fuel is displaced to the inlet from the bore and after a period of dwell a greater quantity of fuel is drawn into the bore as the roller is permitted outward movement. During the initial portion of period A the roller is still moving outwardly so cavitation will occur and after a period of dwell, the roller is urged inwardly to remove the cavitation and then deliver fuel by way of the appropriate delivery port to the engine. In portion *c* of FIGURE 7, the full outward movement of the roller takes place during period B and the full inward movement during period A so at this extreme position of the cam the maximum quantity of fuel is fed to the engine.

Pumps as above described therefore provide a convenient means of varying the quantity of fuel delivered by the pump without resorting to any throttle valves or the like.

The invention is not to be confined to any strict conformity to the showings in the drawings but changes or modifications may be made therein so long as such changes or modifications mark no material departure from the spirit and scope of the appended claims.

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

1. A fuel injection pump for supplying fuel to an internal combustion engine, comprising a body having a cylindrical bore extending longitudinally thereof, a rotary distributor located in said bore, a rotor at one end of said distributor and rotatable therewith, means for supplying fuel under pressure at the other end of said distributor and having an inlet and an outlet, said distributor being provided with an axial passage, a plurality of equi-angularly spaced fuel inlet passages and a delivery passage spaced axially from said inlet passages in the direction of said fuel supplying means with said fuel inlet passages and delivery passage extending outwardly from said axial passage to the periphery of said distributor, said body having a fuel inlet port communicating with said outlet of said fuel supplying means and a plurality of equi-angularly spaced delivery ports adapted to be placed into registry in turn with said fuel inlet passages and said delivery passage, respectively, upon rotation of said distributor, the relative angular relationship of said delivery ports with respect to said inlet passages being such that said axial passage communicates with a delivery port via said delivery passage at all times except when said axial passage communicates with said inlet port through an inlet passage, said rotor having a transverse bore communicating with said axial passage, at least one plunger mounted in said transverse bore, an annular cam surrounding said rotor with said plunger being moved outwardly as permitted by said cam by fuel under pressure when said inlet port is in registry with an inlet passage, said cam being provided with surfaces cooperable with said plunger for moving said plunger inwardly upon rotation of said rotor whereby the inward movement of said plunger forces fuel into said axial passage and thence through either the inlet port or one of the delivery ports dependent upon the angular position of the rotor, and means operably connected with said cam for adjusting the angular position of the cam to determine the proportions of fuel introduced through said inlet port and delivery ports when said plunger moves inwardly.

2. The fuel injection pump as claimed in claim 1 in which said inlet port and inlet passages are of larger

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diameter than the delivery ports and delivery passage so that the inlet port remains open throughout larger angular movements of said distributor than said delivery ports.

3. A fuel injection pump for supplying fuel to an internal combustion engine, comprising a body having a cylindrical bore extending longitudinally thereof, a rotary distributor located in said bore, a rotor at one end of said distributor and rotatable therewith, means for supplying fuel under pressure at the other end of said distributor and having an inlet and an outlet, said distributor being provided with an axial passage, a plurality of equi-angularly spaced fuel inlet passages and a delivery passage spaced axially from said inlet passages in the direction of said fuel supplying means with said fuel inlet passages and delivery passage extending outwardly from said axial passage to the periphery of said distributor, said body having a fuel inlet port communicating with said outlet of said fuel supply means and a plurality of equi-angularly spaced delivery ports adapted to be placed into registry in turn with said fuel inlet passages and said delivery passage, respectively, upon rotation of said distributor, the relative angular relationship of said delivery ports with respect to said inlet passages being such that said axial passage communicates with a delivery port via said delivery passage at all times except when said axial passage communicates with said inlet port through an inlet passage, said rotor having a transverse bore communicating with said axial passage, at least one plunger mounted in said transverse bore, an annular cam surrounding said rotor with said plunger being moved outwardly as permitted by said cam by fuel under pressure when said inlet port is in registry with an inlet passage, said cam being provided with surfaces cooperable with said plunger for moving said plunger inwardly upon rotation of said rotor whereby the inward movement of said plunger forces fuel into said axial passage and thence through either the inlet port or one of the delivery ports dependent upon the angular position of the rotor, and means for adjusting the angular position of the cam between extreme positions in one of which positions the plunger moves inwardly only when said axial passage communicates with a delivery port and in the other position said plunger moves inwardly only when the axial passage communicates with said inlet port, said cam in positions intermediate the extreme positions serving to move the plunger inwardly so that during the initial portion of the inward movement of the plunger, fuel is fed through the inlet port and during the final portion of the inward movement of the plunger the fuel is fed through a delivery port.

4. A fuel injection pump for supplying fuel to an internal combustion engine, comprising a body having a cylindrical bore extending longitudinally thereof, a rotary distributor located in said bore, a rotor at one end of said distributor and rotatable therewith, means for supplying fuel under pressure at the other end of said distributor and having an inlet and an outlet, said distributor being provided with an axial passage, a plurality of equi-angularly spaced fuel inlet passages and a delivery passage spaced axially from said inlet passages in the direction of said fuel supplying means with said fuel inlet passages and delivery passages extending outwardly from said axial passage to the periphery of said distributor, said body having a fuel inlet port communicating with said outlet of said fuel supplying means and a plurality of equi-angularly spaced delivery ports adapted to be placed into registry in turn with said fuel inlet passages and said delivery passage, respectively, upon rotation of said distributor, the relative angular relationship of said delivery ports with respect to said inlet passages being such that said axial passage communicates with a delivery port via said delivery passage at all times except when said axial passage communicates with said inlet port through an inlet passage, said rotor having a transverse bore communicating with said axial passage, at least one plunger

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mounted in said transverse bore, an annular cam surrounding said rotor with said plunger being moved outwardly as permitted by said cam by fuel under pressure when said inlet port is in registry with an inlet passage, said cam being provided with surfaces cooperable with said plunger for moving said plunger inwardly upon rotation of said rotor whereby the inward movement of said plunger forces fuel into said axial passage and thence through either the inlet port or one of the deliver ports dependent upon the angular position of the rotor, means for adjusting the angular position of the cam between extreme positions in one of which positions said plunger moves inwardly only when said axial passage communicates with the delivery port and in the other position said plunger moves outwardly and inwardly by an equal amount during the period when the axial passage communicates with the inlet port and also during the period when the axial passage communicates with the delivery port, said cam in positions intermediate said extreme positions serving for varying the proportion of inward to outward movement occurring during the period when the axial passage communicates with the inlet port and dur-

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ing the period when the axial passage communicates with the delivery port.

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