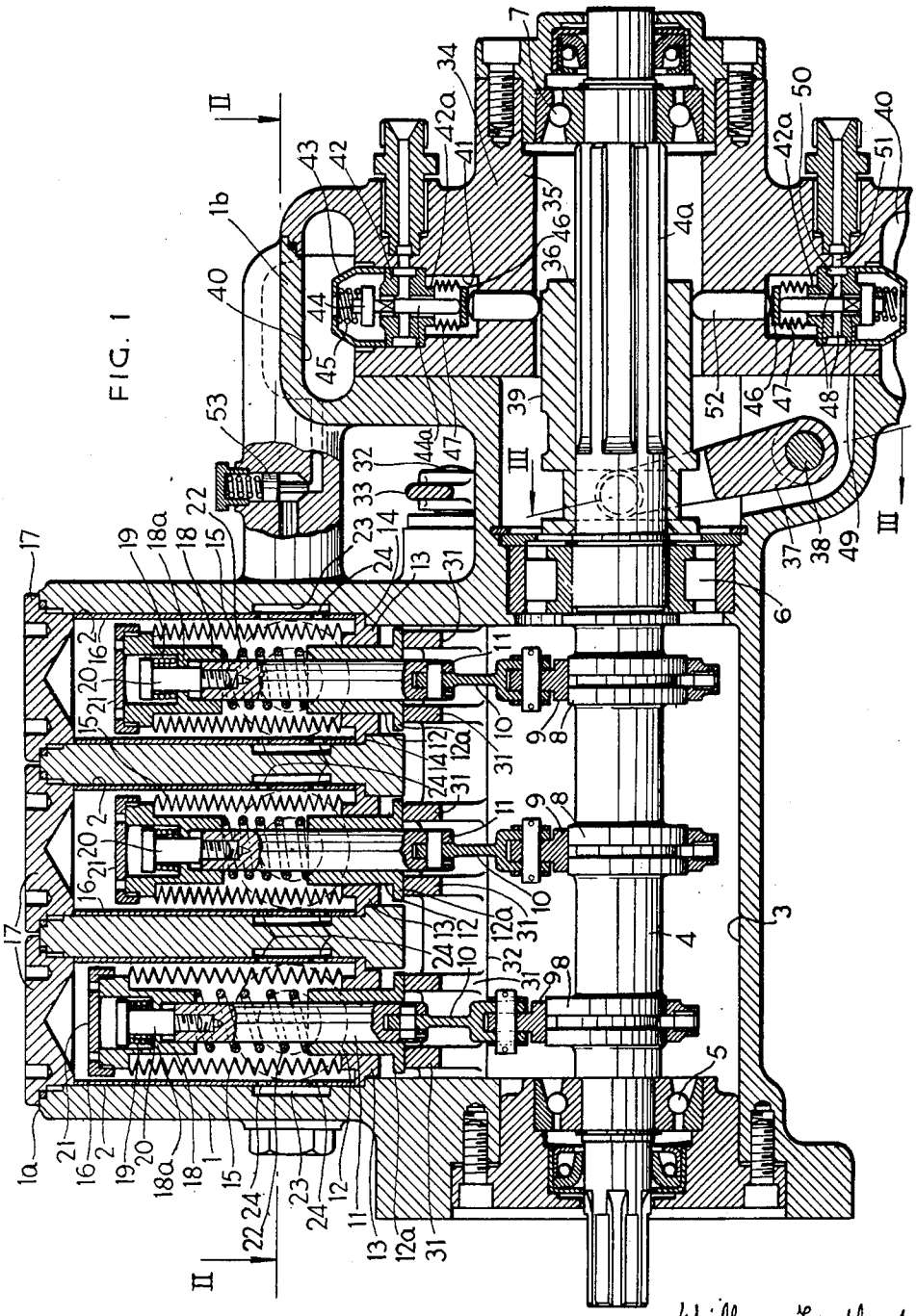
Feb. 12, 1952 W. FRIEDLANDER 2,585,544

FUEL PUMP

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FIG. 1



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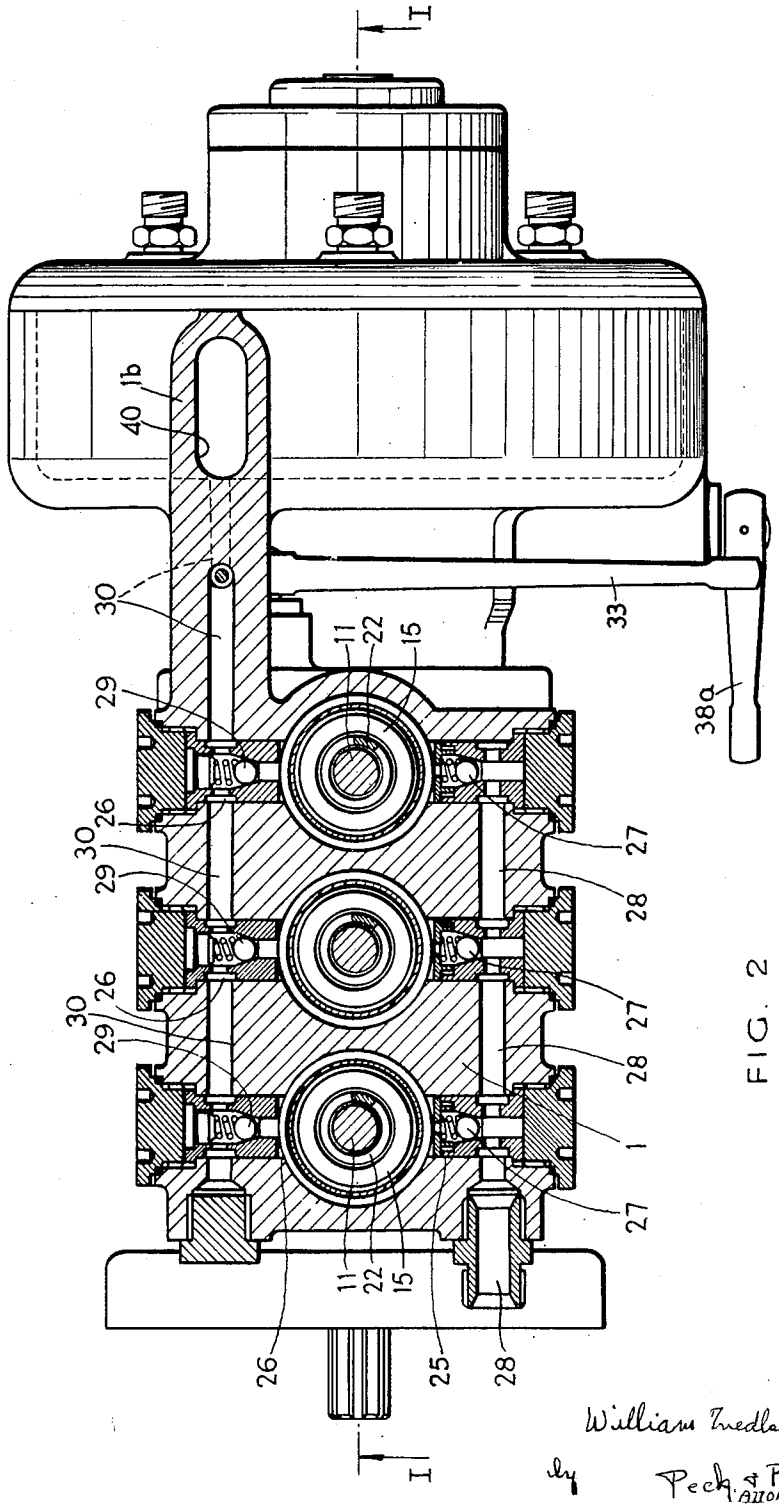


FIG. 2

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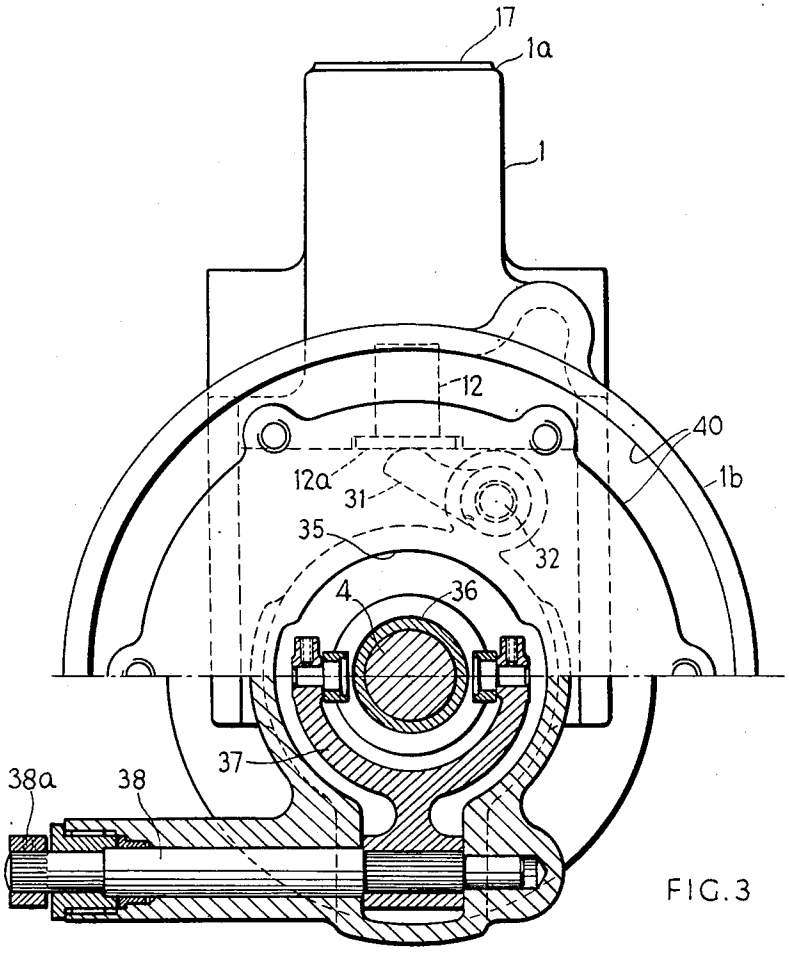


FIG. 3

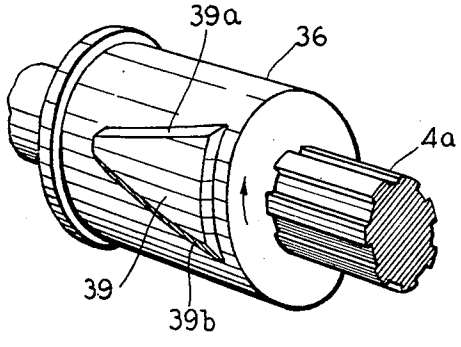


FIG. 4

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UNITED STATES PATENT OFFICE

2,585,544

FUEL PUMP

William Friedlander, London, England, assignor to Mono-Cam Limited, London, England, a company of Great Britain

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In Great Britain December 18, 1946

5 Claims. (Cl. 103—38)

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This invention relates to fuel pumps and distributors for petrol-injection internal combustion engines in which an accurately measured small dose of petrol (or other volatile fuel hydrocarbon) is injected into each cylinder during the suction and/or part of the compression stroke of the piston working therein.

It is one object of the present invention to provide an improved fuel pump for such engines which shall be of a simple and robust construction effectively isolating the fuel from the working parts which requires lubrication and which shall be capable of adjustment while running in order to vary the delivery pressure of the fuel as required. Another object is to improve the fuel distributor associated with the pump so that the quantity of fuel injected into each cylinder of the engine may be varied in an improved and simple manner.

According to one feature of the invention, a fuel pump for an engine of the kind referred to comprises a plurality of closed pumping chambers, a suction and a delivery valve for each chamber, a common petrol supply to all the suction valves, a common petrol delivery means leading from all the delivery valves, a collapsible bellows located within each chamber, resilient means normally holding each bellows in expanded condition, reciprocable elements driven from the engine and adapted alternately to collapse the bellows against the action of their resilient means and to permit the latter to expand the bellows, each reciprocable element having a lost motion connection to its associated bellows for permitting the latter to remain in a collapsed or partially collapsed condition when the delivery pressure tends to exceed that capable of being produced by the resilient means, and means capable of operation for simultaneously varying the pressure exerted by the resilient means during the reciprocation of the engine-driven elements.

The means for varying the pressures exerted by the resilient means preferably comprises a movable abutment for each resilient means and mechanism for simultaneously adjusting the movable abutments by equal amounts.

Another feature of the invention is a fuel distributor for use with a fuel pump of the character indicated, comprising a chamber for receiving fuel under pressure, delivery pipes leading one to each engine cylinder, valves for controlling communication between the chamber and the delivery pipes, rotary cam means for opening each valve in turn, and means for adjusting the cam means along its axis of rotation to vary the period for which each valve is kept open at each operation thereof.

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With advantage, the chamber is of annular shape and the valves are arranged around a common central cam. The latter preferably has a single rise the length of which in the direction of rotation varies throughout the axial length of the cam.

The nature of the invention will be clearly understood from the following description taken in conjunction with the accompanying drawings which illustrate one example of the way in which it may be carried into effect.

In the drawings:

Fig. 1 is a longitudinal section, taken substantially on the line I—I of Fig. 2, showing the complete assembly of fuel pump and distributor,

Fig. 2 is a section taken substantially on the line II—II of Fig. 1, some parts being omitted,

Fig. 3 is a view taken from the right-hand end of Fig. 1, the upper part being in elevation with the valve block of the distributor removed and the lower part being a section taken substantially on the line III—III of Fig. 1, and

Fig 4 is a fragmentary perspective view showing a cam sleeve employed in the distributor.

In the example (see Fig. 1) a housing 1 is formed with three parallel open-ended pumping chambers 2 leading from one face 1*a* thereof into a common larger bore 3 disposed at right-angles and containing an axially disposed shaft 4. The parts disposed in any one of the chambers 2 being the same and functioning in the same manner as the parts in any other of the chambers 2, the following description will refer more particularly to one only of the chambers but the same reference numerals will be used for identical parts in the figures of the drawings. The shaft 4 is mounted in bearings 5, 6 and 7 and is formed with three eccentrics 8 each carrying a strap 9 which is connected by a short connecting rod 10 to one end of a reciprocable rod 11 axially disposed in the appropriate pumping chamber 2. On each rod 11 is slidable, as a close fit, a sleeve 12 having a flanged outer end 12*a* and having its inner end also slidable as a close fit in an annulus 13 which rests on an internal shoulder 14 in the chamber 2. The annulus 13 has secured thereto the one end of a metal bellows 15 and is held against the shoulder 14 by a liner 16 fitting into the chamber 2 and engaged at its other end by a plug 17 screwed into the open end of the chamber. The other end of the bellows 15 is secured to an annular member 18

which is slidable on the end of the appropriate reciprocable rod 11 and is permitted a limited degree of movement relative thereto (in the direction for collapsing the bellows 15) due to the fact that a compression spring 19 is interposed between an internal flange 18a of the member 18 and the head of a stud 20 screwed into the rod 11. In the normal position, the spring 19 is fully compressed and the top faces of both the rod 11 and the stud 20 are spaced by a distance equal to the full stroke of the rod 11 from, respectively, the under face of the flange 18a and the under face of a cap 21 which closes the free end of the annular member 18. The cap 21 in the expanded condition of the bellows 15, is disposed close to the plug 17 at the end of the chamber 2. Encircling each reciprocable rod 11 between the annulus 12 and the annular member 18 thereon, is a helical compression spring 22 tending to expand the bellows, this spring being stronger than the spring 19.

The wall of each pumping chamber 2 is formed with an annular groove 23 (see also Fig. 2) and the part of the corresponding liner 16 lying over the groove is apertured at one or more points as shown at 24 (Fig. 1). At diametrically opposite points of each groove (see Fig. 2) there open radial passages 25 and 26, the passage 25 containing a spring-pressed ball valve 27 opening towards the groove 23 and controlling communication between the latter and a petrol supply passage 28, and the passage 26 containing a spring-pressed ball valve 29 opening away from the groove 23 and controlling communication between the latter and a petrol delivery passage 30.

Referring to Figs. 1 and 3, it will be seen that the flanged ends 12a of the annuli 12 supporting the one ends of the compression springs 22 are themselves each supported by a pair of arms 31 extending radially from a common rocking shaft 32 on one end of which is secured an adjusting arm 33 connected to suitable control means (not shown).

In the operation of the pump thus far described, the rotation of the shaft 4 carrying the eccentrics 8 causes reciprocation of the rods 11 within the pumping chambers 2, the outward stroke of a rod being transmitted through the fully compressed spring 19 disposed between the stud 20 and the annular member 18 to displace the latter to collapse the bellows 15 against the action of the main spring 22. The free volume within the pumping chamber 2 is thereby increased and petrol is drawn in through the appropriate ball valve 27. The inward stroke of the rod 11 permits the main spring 22 to expand the bellows 15, thereby decreasing the free volume within the pumping chamber 2 and expelling the petrol therefrom through the appropriate ball valve 29. Should the pressure in the delivery passage 30 build up, due to consumption of petrol by the engine at a low rate, the main spring 22 will be insufficiently strong to cause full expansion of the bellows 15 and delivery of petrol will be reduced accordingly. The reciprocable rod 11 will however execute its full inward stroke, moving relative to the annular member 18 and permitted the spring 19 between the latter and the stud 20 to expand.

Angular adjustment of the rocking shaft 32 about its axis will cause all the annuli 12 to be moved into or out of their respective pumping chamber 2 to the same extent, thereby increasing or reducing the loading of the main springs 22 and correspondingly varying the pressure at which petrol is delivered by the pump.

It will be seen that the working parts requiring lubrication are effectively isolated from contact with the petrol by the bellows arrangement adopted.

In the example chosen, the fuel distributor for an engine equipped with a pump as described above has a valve block 34 fitted into a part 1b of the pump housing 1 and arranged substantially concentrically with the pump shaft 4. The latter is extended through an axial bore 35 in the block 34 as a splined shaft 4a upon which is slidable, but not rotatable, a sleeve member 36 which has some clearance in the bore 35 and is actuated by a forked arm 37 on a rocking shaft 38. The latter may be rocked by actuation of an arm 38a secured thereon.

The sleeve member 36 has a cam rise 39 formed thereon which (see Fig. 4) would be of triangular shape when developed flat, i. e. the width of which (considered in the direction of rotation of the sleeve shown by the arrow in Fig. 4) progressively increases from one end of the sleeve to the other.

Around the outer part of the distributor (see Fig. 1) is formed (partly in the housing part 1b and partly in the block 34) an annular chamber 40 receiving petrol under pressure from the pump delivery passage 30, and a number of equiangularly spaced radial bores 41 is formed in the block 34 to lead from the chamber 40 to the central bore 35 accommodating the cam sleeve 36. Each bore 41 is stepped to three diameters, the largest diameter part being adjacent the chamber 40 and accommodating an annular valve seat 42 held in position by an apertured cap 43 screwed into the mouth of the bore. Within the cap is located a valve member 44 normally held against the seat 42 by a spring 45 and formed with a stem 44a which bears at its inner end against a disc 46 forming the closure of one end of a metal bellows 47 having its other end secured to an annular projection 42a on the valve seat member 42. The latter has radial bores 48 leading from an axial bore 49 (through which the stem 44a passes with play) into an annular groove 50 with which registers a passage 51 leading to a pipe (not shown) connected to a petrol injection device in the appropriate engine cylinder.

The portion of the radial bore 41 in the block 34 which is of intermediate diameter receives the bellows 47 with some clearance and the smallest diameter portion of the bore 41 contains, as a close sliding fit, a rod 52 which bears at its outer end on the closure disc 46 of the bellows and at its inner end on the cam sleeve 36. The inner end is rounded off (as shown) so that it will ride up the leading edge of the cam rise 39 as the cam sleeve rotates.

It will be understood that the bringing of the cam rise 39 beneath one of the rods 52 will cause it to be moved outwards to lift the corresponding valve 44 from its seat and thus establish communication between the annular petrol chamber 40 and the respective petrol injection device on the engine. The duration of the period for which the valve is open is dependent upon the speed of rotation of the cam sleeve 36 and the width of the cam rise 39 in the circumferential direction at the zone where the rod contacts therewith.

In the operation of the distributor, the cam sleeve 36 is rotated to cause the opening of each

valve 44 in succession and the axial position of the sleeve in relation to the valve-actuating rods 52 is varied by operation of the arm 38a as desired in order to increase the durations of the periods for which the valves are open as the engine speed increases.

The means (arm 38a) controlling the cam sleeve 36 may be inter-connected with the means (arm 33) controlling the delivery pressure of the pump so that the fuel pressure is also increased as the engine speed increases. Alternatively the means controlling the delivery pressure of the pump may be connected with pressure sensitive devices in the air intake manifold making the pump pressure and therefore delivery a function of the air intake.

Here, again, the parts requiring lubrication are isolated from the petrol passages by the bellows devices 47 interposed between the valve stems 44a and the valve-actuating rods 52.

The cam rise 39 on the cam sleeve 36 may have its leading and trailing edges shaped as required, for example, so that the points in the suction strokes of the engine pistons at which the respective distributor valves 44 open and close may be varied as the sleeve is displaced axially. In the example shown in Fig. 4 the leading edge 39a of the cam rise is inclined in relation to the axis of the sleeve 36 so that the valves 44 will be opened progressively earlier in the suction strokes as the sleeve is moved to the left in Figs. 1 and 4. Additionally, the trailing edge 39b of the cam rise is oppositely and more steeply inclined so that the periods for which the valves 44 are open will increase in length as the sleeve 36 is so moved to the left.

It is preferred to provide a spring-loaded needle-type valve 53 (Fig. 1) in the delivery passage 30 leading from the pump to the petrol chamber 40 of the distributor and to arrange that this valve will only open when a predetermined delivery pressure is exceeded but will be held open by a lower pressure of the fuel. This may be achieved by arranging that the area of the valve acted upon by the fuel is increased by the lifting of the valve from its seat, in a known manner. Such provision facilitates the starting of the engine from the cold.

In the preceding description, the elements which are expanded and collapsed within the pumping chambers 2 have been referred to throughout as "bellows." It is to be understood, however, that they may also take the form of a flexible diaphragm the periphery of which is secured to an axial extension of the annulus 13 and the centre of which is secured to the annular member 18 slidable on the appropriate rod 11. The rods 11 and pumping chambers 2 may then be considerably shorter in axial length. In the appended claims, therefore, the term "bellows" is to be understood as including a flexible diaphragm.

What I claim is:

1. A fuel pump for an engine of the kind referred to comprising a plurality of closed pumping chambers, a suction and delivery valve for each chamber, a common petrol supply to all the suction valves, a common delivery means leading from all the delivery valves, a collapsible bellows located within each chamber, resilient means normally holding each bellows in an expanded condition, reciprocable elements driven from the engine and adapted alternately to collapse the bellows against the action of their resilient means to increase the free volume of their respective chambers and to permit the resilient means to expand the bellows to decrease said free volume, each reciprocable element being connected to its associated bellows by spring means weaker than said resilient means for permitting the bellows to remain in an at least partially collapsed condition when a pressure exceeding that capable of being produced by the resilient means tends to arise in the common delivery means, and means capable of operation for simultaneously varying the pressures exerted by the resilient means during the reciprocation of the engine-driven elements in order to vary the pressure at which petrol is delivered by the pump.

2. A fuel pump according to claim 1, wherein the means for varying the pressure at which petrol is delivered comprises a movable abutment for each resilient means and mechanism for simultaneously adjusting the movable abutments by equal amounts.

3. A fuel pump for an engine of the kind referred to comprising a plurality of closed pumping chambers, a suction and delivery valve for each chamber, a common petrol supply to all the suction valves, a common delivery means leading from all the delivery valves, a collapsible bellows located within each chamber, resilient means normally holding each bellows in an expanded condition, reciprocable elements driven from the engine and adapted alternately to collapse the bellows against the action of their resilient means to increase the free volume of their respective chambers and to permit the resilient means to expand the bellows to decrease said free volume, each reciprocable element being connected to its associated bellows by spring means weaker than said resilient means for permitting the bellows to remain in an at least partially collapsed condition when a pressure exceeding that capable of being produced by the resilient means tends to arise in the common delivery means, a movable abutment for each resilient means, mechanism for simultaneously adjusting the movable abutments by equal amounts to vary the pressures exerted by the resilient means during the reciprocation of the engine-driven elements, and a fuel distributor including a chamber for receiving fuel under pressure, delivery pipes leading one to each engine cylinder, valves for controlling communication between the chamber and the delivery pipes, rotary cam means for opening each valve in turn, and means for adjusting the cam means along its axis of rotation to vary the period for which each valve is kept open at each operation thereof.

4. A fuel pump and distributor combination according to claim 3, wherein the fuel-receiving chamber is of annular shape and the valves are arranged around a common central cam having a single rise the length of which in the direction of rotation varies throughout the axial length of the cam.

5. For an engine of the kind referred to, a fuel pump comprising a fuel supply, a distributor, and means for pumping said fuel to the distributor said means including collapsible bellows and moving parts requiring lubrication, wherein the collapsible bellows constitutes an impermeable wall isolating the fuel passages from the moving parts requiring lubrication and the distributor comprises a chamber for receiving fuel under pressure from the pumping means, bores leading from the chamber to a central bore, delivery outlets leading one to each of said bores, valves mounted

within said bores for controlling communication between the chamber and the delivery outlets, cam means mounted within said central bore to operate said valves through moving parts which together with the cam means require lubricating and a collapsible bellows mounted within each bore between the valve and the respective moving parts to isolate the parts requiring lubrication from the fuel within the distributor.

WILLIAM FRIEDLANDER.

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