Jan. 3, 1939. C. R. ALDEN 2,142,086

FUEL PUMP

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Fig. 1.

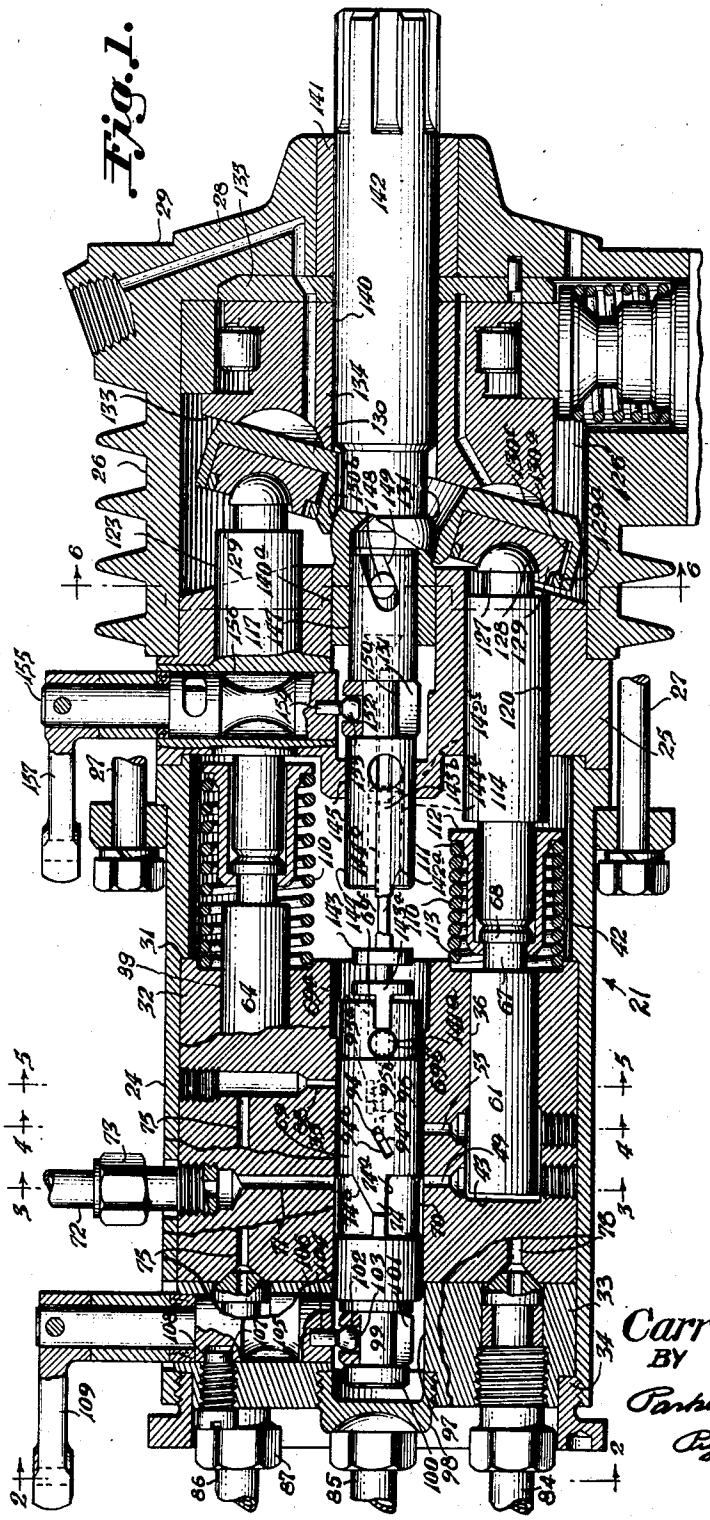


Fig. 8.

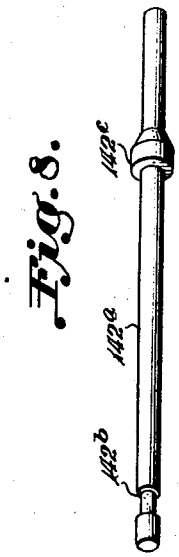
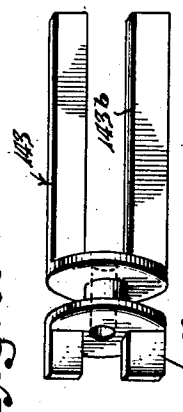


Fig. 7.



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Fig. 2.

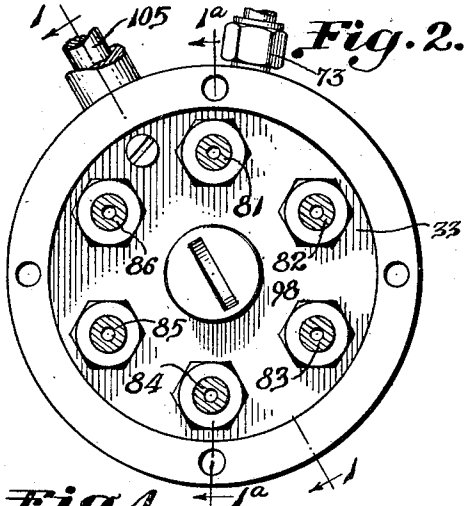


Fig. 3.

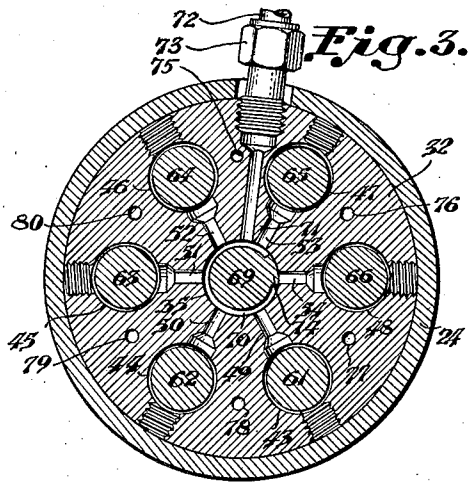


Fig. 4.

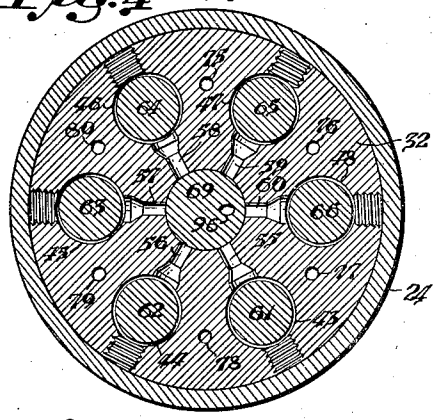


Fig. 5.

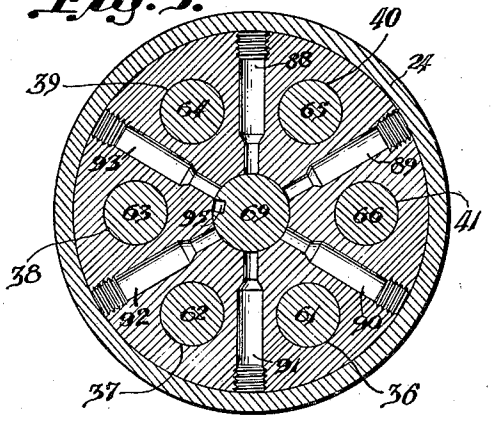
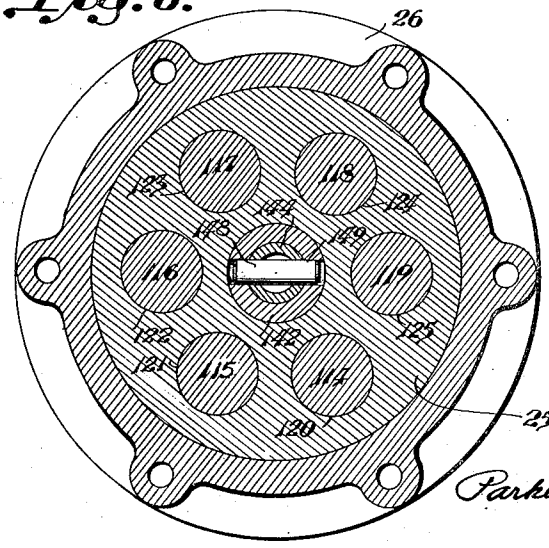


Fig. 6.



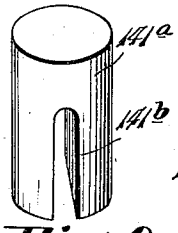


Fig. 9.

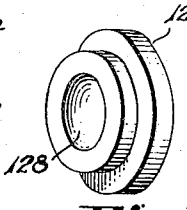


Fig. 10.

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UNITED STATES PATENT OFFICE

2,142,086

FUEL PUMP

Carroll R. Alden, Detroit, Mich., assignor to Ex-Cell-O Corporation, a corporation of Michigan

Application September 9, 1933, Serial No. 688,815

9 Claims. (Cl. 103—173)

The present invention relates generally to fuel pumps and more particularly to improvements in metering and distributing pumps such as are used to supply fuel to internal combustion engines.

One object of the present invention is to provide a novel form of fuel metering and distributing pump which is adapted for effective and efficient operation throughout a wide range of both capacity and timing adjustment.

Another object is to provide a pump of the type described which may be readily disassembled and reassembled for purposes of inspection and repair.

A further object resides in the provision of a novel fuel metering and distributing pump which avoids the use of spring actuated valves, and which has a novel arrangement of control ports and coacting areas effective to prevent inter-leakage.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings, Figure 1 is a longitudinal sectional view of a pump embodying the invention, the view being taken mainly along line 1—1 of Fig. 2 and in fragment along line 1a—1a of Fig. 2.

Fig. 2 is a transverse sectional view taken along line 2—2 of Fig. 1 and showing the pump in end elevation.

Fig. 3 is a transverse sectional view taken along line 3—3 of Fig. 1.

Fig. 4 is a transverse sectional view taken along line 4—4 of Fig. 1.

Fig. 5 is a transverse sectional view taken along line 5—5 of Fig. 1.

Fig. 6 is a transverse sectional view taken substantially along broken line 6—6 of Fig. 1.

Figs. 7, 8, and 9 illustrate details of the drive connection for the rotor.

Fig. 10 is a perspective view of one of the elements in the pump drive.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring more particularly to the drawings, the invention is shown herein as embodied in a fuel metering and distributing pump 21 (Fig. 1) adapted for use in connection with various kinds of internal combustion engines, and particularly suited for multiple cylinder engines. In general, the fuel metering and distributing device or pump 21 receives fuel, such as naphtha or gasoline, from a suitable source and delivers it in metered or measured charges for use in respective engine cylinders. The delivery is timed by the pump in relation to the sequential operation of each engine piston, a charge of fuel being delivered for each cycle of each piston. The capacity of the pump, that is the measured quantity of fuel delivered in each charge, may be varied by adjustment of the pump as hereinafter described. Both the timing and capacity of the pump may be adjusted by suitable automatic mechanisms (not shown) or manually as desired.

In the preferred embodiment of the invention, the fuel metering and distributing device or pump 21 (see Fig. 1) may be driven by an associated engine, and is adjustable in capacity and also in phase relation to the engine. More particularly, the pump 21 comprises an outer casing which is formed of two end sections 24 and 26 and an intermediate section 25 in end abutting engagement. The sections have interlocking ends to secure accurate registration, and are suitably held in assembled relation by means of a plurality of tie bolts 27. One of the sections, namely the section 26, is adapted to be mounted on a suitable support, and to this end is provided with an outer end wall 28 defining a peripheral shoulder 29 which may be secured against a suitable support such as a gear housing on the engine block.

Mounted in the section 24 and abutting at its inner end against an annular shoulder 31 therein is a cylindrical pump body 32. A circular end plate 33 is disposed in the outer end of the section 24 to close the latter, and abuts against the outer end of the body 32. The body 32 and the plate 33 are secured in position by means of a lock ring 34 threaded into the outer end of the section 24 against the plate.

The pump body 32 is formed with an axial bore 35 opening therethrough, and with a plurality of parallel bores, six bores 36 to 41 in the present instance, constituting pump cylinders arranged in parallel to and uniformity spaced relation about the axial bore. The bores 36 to 41 open at their outer ends to a closed chamber 42 within the inner end of the casing section 24 and between the intermediate casing section 25 and the pump body 32, and at their inner ends are

closed and peripherally enlarged to define pressure chambers 43 to 48 respectively. Opening from the periphery of the axial bore 35 in a common transverse plane (see Fig. 3) respectively to the inner ends of the pump chambers 43 to 48 are a plurality of inlet passages or ports 49 to 54. Similarly, a plurality of delivery passages or ports 55 to 60 open in a common transverse plane (see Fig. 4) respectively from the other ends of the pump chambers 43 to 48 to the periphery of the axial bore 35. The inlet and delivery ports for each pump chamber, for example the ports 49 and 55 opening from the chamber 43, preferably are located in a common longitudinal plane.

Mounted respectively for reciprocation in the cylinders 36 to 41 are a plurality of pump pistons 61 to 66. Each of the pistons is cylindrical in form, and has a reduced axial extension 67 with an enlarged head 68 on its free end projecting into the chamber 42. In operation, the pistons 61 to 66 are reciprocated harmonically in uniformly timed sequence.

A valve member 69, in the form of an elongated and generally cylindrical rotor, extends through and is rotatable in the axial bore 35 in timed relation to the reciprocation of the pistons 61 to 66. The rotor 69 is formed with a shallow peripheral groove 70 of substantial width which defines a low pressure fluid area or belt projecting through the transverse plane of the cylinder inlet ports 49 to 54. Fluid from a suitable low pressure source (not shown) is adapted to be supplied to the area 70 through an inlet passage 71 formed in the pump body 32. Preferably, the passage 71 is located in the same plane as the inlet ports 49 to 54, and intermediate two of the ports. A fluid supply conduit 72 is connected to the body 32 by means of a hollow screw fitting 73, and communicates with the outer end of the passage 71.

The rotor 69 is formed with a land area 74 projecting longitudinally into one side of the fluid area 70, and adapted for movement successively across the inlet ports 49 to 54 to interrupt communication thereof with the fluid area. The phase relation of the revolution of the land area 74 to the reciprocation of the pistons 61 to 66 is such that each inlet port will be closed during a predetermined period of the pressure stroke of the associated piston, and will be in communication with the fluid area 70 during the remaining portion of the cycle. Preferably, the foregoing period is timed to occur at or near the middle of the pressure stroke when by reason of the simple harmonic drive the rate of piston displacement is the greatest.

The rotor 69 is axially adjustable and the land area 74 is tapered in width so that the period of cut-off may be varied in duration. Preferably, the land area 74 tapers uniformly toward its free end, and has a leading edge 74^a parallel to the axis of rotation, and a trailing edge 74^b inclined thereto.

Formed longitudinally in the pump body 32 in staggered relation to the two sets of ports 49 to 54 and 55 to 60 are a plurality of discharge passages 75 to 80, one for each of the pump cylinders 36 to 41. These passages are in communication respectively with a plurality of conduits 81 to 86 (see Figs. 1 and 2) attached by means of hollow screw fittings 87 to the end plate 33, and leading to the engine cylinders (not shown). The inlet ends of the passages 75 to 80 terminate in radial ports 88 to 93 which open in a common transverse plane to the periphery of the axial bore 35, and which are staggered in relation to the ports 55 to 60.

The rotor 69 is formed with means for connecting the cylinder outlet ports 55 to 60 in timed sequence to the respective discharge ports 88 to 93 during cut-off of the associated cylinder inlet ports 49 to 54. In its preferred form, this means comprises two elongated slots 94 and 95 formed in the periphery of the rotor 69 and extending longitudinally thereof. A passage 96 formed within the rotor 69 serves to connect the slots 94 and 95.

The slot 94 extends through the plane of the outlet ports 55 to 60 for communication therewith in all axial positions of the rotor 69, and has leading and trailing side edges 94^a and 94^b inclined to the axis of rotation. The relation between the land area 74 and the slot 94 on one hand to the respective sets of inlet and outlet ports 49 to 54 and 55 to 60 on the other hand is such that the leading edge 94^a will move onto any one of the outlet ports just before or at the same time the leading edge 74^a cuts off the associated inlet port, and that the trailing edges 94^b and 74^b will leave the respective ports simultaneously. To insure cut-off of the outlet port simultaneously with relief of the inlet port in all axial positions of the rotor 69, the trailing edges 74^b and 94^b are made parallel. The slot 95 has leading and trailing side edges 95^a and 95^b parallel to the axis of rotation, and is so related to the discharge ports 88 to 93 and to the land area 74 that the leading edge 95^a will move onto any one of the discharge ports at the same time that the leading edge 74^a cuts-off the associated cylinder inlet port.

It will be evident that the land area 74 determines the duration of each period of fuel injection, and hence the volume of each fuel charge. Referring for example to cylinder 36, when the inlet port 49 is cut-off from the fluid area 70 by the leading edge 74^a of the land area 74, the pump piston 61, which is moving along its pressure stroke, forces the trapped fuel from the pressure chamber 43 through the outlet port 55, the slot 94, the passage 96, the slot 95, the discharge port 88 and the passage 75 to the conduit 81. Thus, the start of injection is determined by the leading edge 74^a, and is constant in relation to the engine cycle. Upon relief of the pressure chamber 43 through the inlet port 49 past the trailing edge 74^b to the fluid area 70, injection ceases. Thus, the end point of injection is determined by the trailing edge 74^b, and is variable depending on the axial position of the rotor 69. Simultaneously with the opening of the inlet port 49, the trailing edge 94^b of the slot 94 cuts-off the outlet port 55 so that return flow from the discharge passage 75 is prevented. By providing the three port arrangement herein described, narrow land areas between different pressure sources are avoided, and hence leakage is effectively eliminated. Since the discharge conduits 81 to 86 are not connected directly to the pump cylinders 36 to 41, no check valves need be provided.

In some instances it may be desirable to place the fuel under compression immediately before the start of injection. In this event, the leading edge 94^a of the slot 94 is timed to move onto the outlet port 55 a short time after the leading edge 74^a of the land 74 leaves the inlet port 49. Thus, the fuel in the chamber 43 is trapped for a short time so that the energy stored up therein by movement of the piston 61 will create a pressure surge at the start of injection.

It may also be desirable in some instances to vent the fuel line to the low pressure area 70 a short time before cut-off of injection. In this event, the trailing edge 74b of the land 74 is timed to uncover the inlet port 49 a short time before the trailing edge 95b of the slot 95 leaves the discharge port 88.

It will be evident that the rotor 69 constitutes a fuel throttle which is adjustable axially to vary the capacity of the pump 21. To facilitate such adjustment, a bore 97 in axial alignment with the bore 35 and adapted to receive the outer end of the rotor 69 is formed in and opens through the end plate 33. The outer end of the bore 97 is closed by means of a cap screw 98. The outer end of the rotor 69 has a reduced axial extension 99 with an enlarged head 100 on its free end. Rotatably embracing the extension 99 between the body of the rotor 69 and the head 100 is a split sleeve 101 formed in the periphery with a socket or recess 102. A ball 103 on the end of a pin 104 engages in the recess 102. The pin 104 is secured eccentrically to the inner end of a transverse shaft 105 journaled in a bore 106 opening from the bore 97 radially through the plate 33 and the casing section 24. A spline pin 107 threaded into the outer end of the plate 33 engages in a peripheral groove 108 formed in the shaft 105 to hold the latter in axial position. Fixed on the outer end of the shaft 105 is a crank arm 109 which affords means whereby the rotor 69 may be adjusted.

Any suitable means may be provided for driving the pistons 61 to 66 and the rotor 69. In the present instance, the pistons 61 to 66 are urged outwardly by a plurality of compression springs 110. Referring to the piston 61, the spring 110 is seated at one end against the body 32, and abuts at its other end against an outer peripheral flange 111 on the outer end of an annular spring retainer 112. The latter is coaxial with the piston 61, and has an inner peripheral flange 113 on its inner end embracing the extension 67 and abutting against the inner side of the head 68. A like construction is provided for each of the other pistons.

The pistons 61 to 66 are moved positively through their working strokes against the action of the springs 110. The means for this purpose comprises a plurality of plungers 114 to 119 respectively aligned axially with the pistons 61 to 66, and abutting against the heads 68 within the retainers 112. The plungers extend reciprocably through a plurality of spaced parallel bores 120 to 125 which are formed in the intermediate casing section 25 and open therethrough from the chamber 42 to a chamber 126 defined by the casing section 26. It will be evident that the plungers 114 to 119 in effect constitute continuations of the pistons 61 to 66, but by reason of their separation from the pistons require less accuracy in construction than do the latter for efficient operation.

To provide means for driving the plungers 114 to 119 in uniformly timed sequence and preferably harmonically, the outer ends in the chamber 126 are provided respectively with semi-spherical heads 127 in bearing engagement with complementary sockets 128 formed in a plurality of shoes 129 (see Fig. 10). These shoes 129 are loosely retained, as by means of removable snap rings 129a, in a plurality of sockets 130a formed in one side of an annular follower plate 130. Preferably, the shoes 129 and the sockets 130a are circular in form, and of sufficiently different diameters to permit independent movement of the shoes relatively to the plate 130 as necessitated by changing angularity of the latter. It will be evident that the follower plate 130 is restrained against rotation by the heads 127 and the shoes 129. The other side of the follower plate 130 bears slidably against an inclined end face 133 on a rotary drive member or wobble plate 134. A drive shaft 142 extends through and is fixed in an axial bore 140 in the wobble plate 134, and serves to rotate the latter. Preferably, an end bearing plate 135 is interposed between the end wall 28 and the wobble plate 134.

The inner end of the drive shaft 142 extends through the follower plate 130, and is formed with a spherical enlargement 131 which engages with a complementary surface 130b in the latter to locate same in a central position. The outer end of the shaft 142 is journaled in a bushing 141 fixed in the end wall 28 of the housing section 26, and is adapted to be connected by means (not shown) to the engine crank shaft. It will be evident that as the wobble plate 134 is rotated, a wobble motion will be imparted to the follower plate 130 to drive the pistons 61 to 66 harmonically in uniformly timed and overlapping sequence.

The rotor 69 may be driven by any suitable means, and is herein shown as connected to the drive shaft 142. Thus, the inner end of the rotor 69 is connected by a driver 143 (Fig. 7), for joint rotary motion and independent axial adjustment, to an intermediate shaft 144 slidably and rotatably mounted in an axial bore 145 having different diameters along its length, and opening through the intermediate casing section 25. The inner end of the drive shaft 142 extends from the follower plate 130 into the adjacent end of the bore 145, and is formed with axial bore 147 slidably receiving the adjacent end of the shaft 144. A pin 148 and slot 149 serve to connect the shafts 142 and 144.

The inner end of the rotor 69 is formed with an axial bore 69a intersected by a transverse bore 69b, and with two diametrically spaced longitudinal slots 69c in the side walls of the bore 69a. A cylindrical plug 141a (see Fig. 9) is inserted in the bore 69b, and is formed with a longitudinal diametrical slot 141b in one end portion. An elongated pin 142a extends at one end axially into the bore 69a and is formed with a peripheral groove 142b loosely engaged with the sides of the slot 141b. Thus, the pin 142a has a loose connection through the medium of the plug 141a with the rotor 69. At the other end, the pin 142a extends into an axial bore 144a in the adjacent end of the intermediate shaft 144, and is formed therein with a peripheral flange or shoulder 142c. The driver 143 is axially disposed on the pin 142a, and at one end has two parallel spline keys 143a disposed in the slots 69c and engaging at their ends against the plug 141a. On the other end, the driver 143 has two parallel spline keys 143b which extend slidably in longitudinal slots 144b in the shaft 144 and which abut against the shoulder 142c. Hence, the pin 142a serves to hold the driver in assembled relation with the rotor 69 for axial sliding spline connection with the shaft 144.

The slot 149 is inclined longitudinally to the axis of rotation so that axial adjustment of the shaft 144 will effect adjustment of the angular phase relation between the rotor 69 and the pistons 61 to 66. To provide means for adjusting

the shaft 144, it is formed with a peripheral groove 150. A split sleeve 151 is rotatably secured in the groove 150, and has a socket or recess 152 in its periphery. A ball 153 on the end of a pin 154 bears in the recess 152. The pin 154 is secured eccentrically to the inner end of an adjusting shaft 155 which is journaled in and extends outwardly through a bore 156 in the casing section 25, and which is keyed in axial position. A crank arm 157 secured to the outer end of the shaft 155 affords means for angularly adjusting the shaft 155.

From the foregoing it will be apparent that the pump 21 is adapted to perform both timing and metering functions. As to its timing function, the phase of the pistons 61—66 can be adjusted with respect to the phase of the engine crank shaft, and hence the phase of the engine pistons, by shifting the adjustment lever 157. Similarly, the capacity of the pump, or in other words the quantity of fuel in each metered charge delivered, can be adjusted through the medium of the lever 109 as heretofore described.

I claim as my invention:

1. A pump comprising, in combination, a pump body formed with a pump cylinder, a fluid supply, an inlet and a spaced outlet opening respectively to and from said cylinder, and a discharge passage, a piston reciprocable in said cylinder, and means including a valve member driven in timed relation to said piston for interrupting communication between said supply and said inlet and for simultaneously connecting said outlet to said discharge passage for a selected variable portion of each pressure stroke of said piston, said valve member being adjustable to vary the duration of said portion.

2. A pump comprising, in combination, a plurality of pump cylinders, a plurality of pistons mounted respectively for reciprocation in said cylinders, means for driving said pistons in timed sequence, a plurality of separate discharge passages one for each cylinder and piston unit, each cylinder having an inlet port and a delivery port, and a single rotary valve member driven in timed relation to said pistons, said valve member having a coacting axially tapered land and a recess portion operable for each cylinder to close the associated inlet port and to connect the associated delivery port to the associated discharge passage for a predetermined period during the pressure stroke of the associated piston, said member being axially adjustable to vary the duration of said period.

3. A pump comprising, in combination, a pump body, said body being formed with a cylinder closed at one end, and with a bore parallel to said cylinder, the closed end of said cylinder being peripherally enlarged to define a pressure chamber, said body being formed with an inlet port opening from said bore to the inner end of said chamber, with a delivery port in the same axial plane as said inlet port and opening from the other end of said chamber to said bore, and with a discharge port opening from said bore, a piston reciprocable in said cylinder and having a pressure stroke and a return stroke, means for driving said piston with a simple harmonic motion, a cylindrical valve member mounted for rotation and axial adjustment in said bore, means for adjusting said member axially, and drive means for rotating said member continuously in one direction at a constant speed in timed relation to said piston, said valve member having a low pressure peripheral fluid area normally open to said inlet port, a raised longitudinal land area on said member projecting into one side of said fluid area for movement across said inlet port to interrupt communication thereof with said fluid area over a predetermined portion of each pressure stroke of said piston, said land area having a leading edge parallel to the axis of rotation and a trailing edge inclined thereto, said rotor having two longitudinally spaced elongated first and second slots movable respectively across said delivery and discharge ports, and a passage in said rotor connecting said slots, said first slot having an inclined trailing edge parallel to said first mentioned trailing edge and timed to leave said delivery port at the same time that said first mentioned trailing edge moves onto said inlet port, said second slot having a leading edge parallel to the axis of rotation and timed to move onto said discharge port at the same time that said first mentioned leading edge leaves said inlet port.

4. A pump comprising, in combination, a plurality of parallel annularly spaced cylinders, a plurality of pistons one reciprocable in each cylinder, spring means tending to urge said pistons outwardly, a rotary drive member having an inclined end face, a drive shaft connected to said member, a disk bearing at one side on said face, said disk being formed in the other side with a plurality of annularly spaced individual circular sockets, a plurality of circular shoes freely disposed respectively in said sockets, said shoes being formed respectively with a plurality of recesses in bearing engagement respectively with the outer ends of said pistons, and removable snap rings retaining said shoes in place in said sockets.

5. A pump comprising, in combination, a pump body, said body being formed with a cylinder closed at one end, and with a bore parallel to said cylinder, said body being formed with an inlet port opening from said bore to the inner end of said cylinder, with a delivery port opening from the other end of said cylinder to said bore, and with a discharge port opening from said bore, a piston reciprocable in said cylinder and having a pressure stroke and a return stroke, means for driving said piston, a cylindrical valve member mounted for rotation in said bore, and drive means for rotating said member continuously in one direction in timed relation to said piston, said valve member having a low pressure peripheral fluid area normally open to said inlet port, a raised land area on said member interrupting said fluid area for movement across said inlet port to break communication thereof with said fluid area over a predetermined portion of each pressure stroke of said piston, said rotor having first and second slots movable respectively across said delivery and discharge ports, and a passage connecting said slots, said slots being timed to be in communication respectively with said delivery and discharge ports at the same time that the inlet port is closed by said land area.

6. A pump comprising, in combination, a pump body, said body being formed with a cylinder closed at one end, and with a bore parallel to said cylinder, said body being formed with an inlet port opening from said bore to the closed end of said cylinder, with a delivery port opening from said cylinder to said bore and spaced longitudinally from said inlet port, and with a discharge port opening from said bore, a piston reciprocable in said cylinder and having a pressure stroke

and a return stroke, means for driving said piston, a cylindrical valve member mounted for rotation and axial adjustment in said bore, and drive means for rotating said member continuously in one direction in timed relation to said piston, said valve member having a low pressure peripheral fluid area normally open to said inlet port, a raised longitudinal land area on said member projecting into one side of said fluid area for movement across said inlet port to interrupt communication thereof with said fluid area over a predetermined portion of each pressure stroke of said piston, said land area being variable in width and having a leading edge and a trailing edge, said rotor having two longitudinally spaced elongated first and second slots movable respectively across said delivery and discharge ports, and a passage in said rotor connecting said slots, said slots being arranged for simultaneous communication respectively with said delivery and discharge ports to establish a flow connection therebetween for a period of said predetermined portion of said pressure stroke, and having relatively inclined controlling edges for varying the duration of said period in accordance with variable cut-off of said inlet port by said land area upon axial adjustment of said valve member.

7. A pump comprising, in combination, a plurality of parallel annularly spaced cylinders, a plurality of pistons one reciprocable in each cylinder, means including a rotary drive shaft for reciprocating said pistons in timed sequence, an intermediate shaft telescoping at one end axially with said drive shaft and having a pin and inclined slot connection therewith to effect relative rotation therebetween upon relative axial movement, a collar peripherally splined to said intermediate shaft and formed in one side with a socket, a rock shaft extending transversely of said intermediate shaft and having a crank pin eccentrically mounted on one end and in engagement in said socket, a rotary valve member for controlling the inlet and discharge of fluid to and from said cylinders, and an axial spline drive connection between said intermediate shaft and said valve member.

8. A pump comprising, in combination, a plurality of parallel annularly spaced cylinders, a plurality of pistons one reciprocable in each cylinder, means including a rotary drive shaft for reciprocating said pistons in timed sequence, an intermediate shaft having a generally longitudinal pin and inclined slot spline connection with said drive shaft for rotation with respect thereto upon axial adjustment thereof and formed in one end with longitudinal keyways and an axial bore, a rotary valve member for controlling the supply and discharge of fluid to and from said cylinders and formed in one end with an axial bore in alignment with said first mentioned bore, a transverse bore and longitudinal spline keyways, an elongated pin extending axially into said aligned bores and provided in said first mentioned bore with a peripheral shoulder, a plug in said transverse bore for securing said pin to said valve member, a driver disposed on said pin and having spline keys on one end engaging in said first mentioned keyways and abutting against said shoulder and having spline keys on the other end engaging in said last mentioned keyways and abutting against said plug, and means for adjusting said intermediate shaft axially.

9. A pump comprising, in combination, means providing a pump cylinder, a fluid supply, an inlet and a spaced outlet opening respectively to and from said cylinder, and a spaced bore having a discharge passage, a piston reciprocable in said cylinder, driving means for said piston, a valve member in said bore including a driving connection with said driving means permitting relative adjustment of said member and being effective to actuate the latter in timed relation to said piston, said valve member being operable during a predetermined portion of each pressure stroke of said piston simultaneously to interrupt communication between said supply and said inlet and to connect said outlet to said discharge passage, and means for adjusting said valve member to vary the duration of said portion.

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