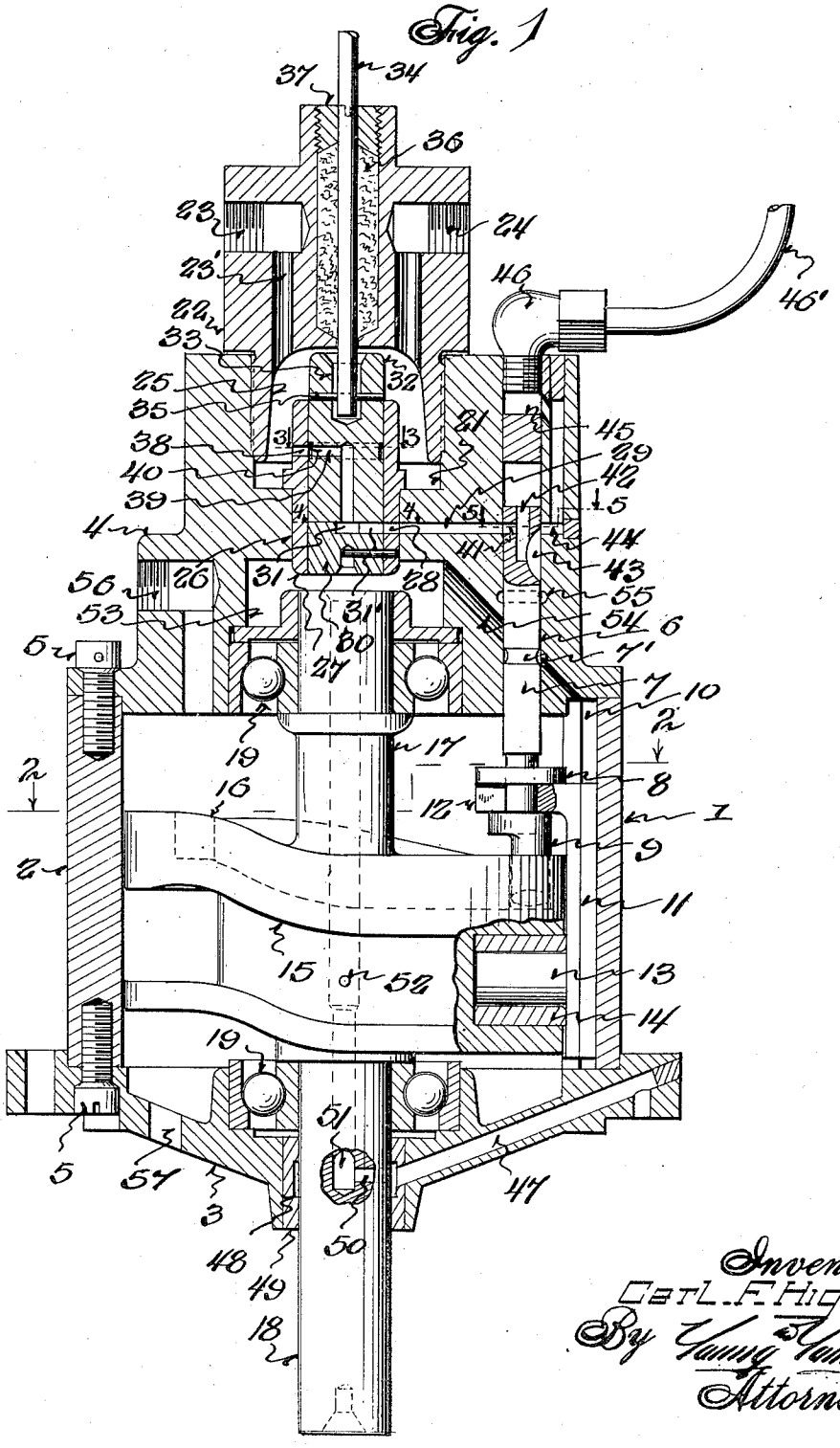
June 8, 1937. C. F. HIGH 2,083,020

FUEL PUMP

Original Filed June 25, 1931 3 Sheets-Sheet 1

Fig. 1



Inventor
Carl F. High
By Young & Young
Attorneys

June 8, 1937. C. F. HIGH 2,083,020

FUEL PUMP

Original Filed June 25, 1931 3 Sheets-Sheet 2

Fig. 5

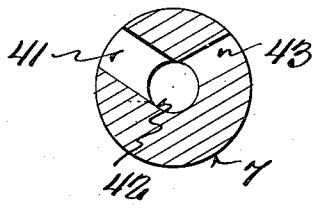


Fig. 3

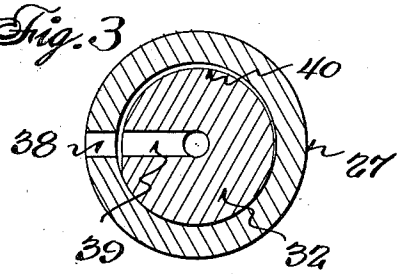


Fig. 4

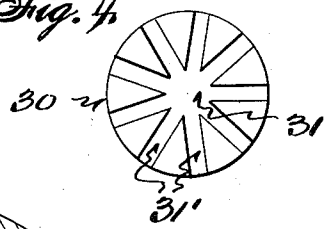
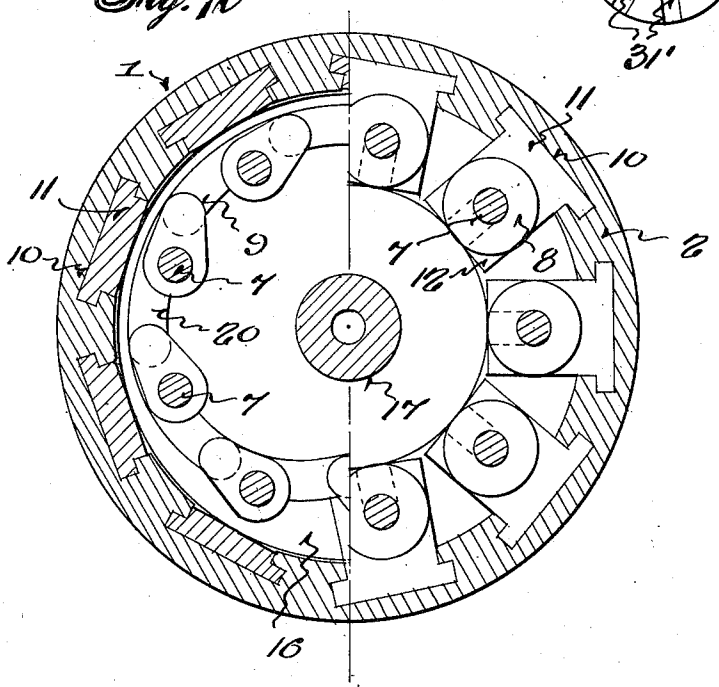


Fig. 2



Inventor
Carl F. High
By Young & Young
Attorneys

June 8, 1937. C. F. HIGH 2,083,020

FUEL PUMP

Original Filed June 25, 1931 3 Sheets-Sheet 3

Fig. 8

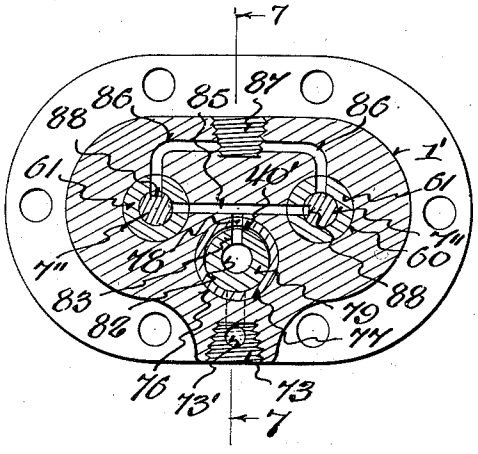


Fig. 7

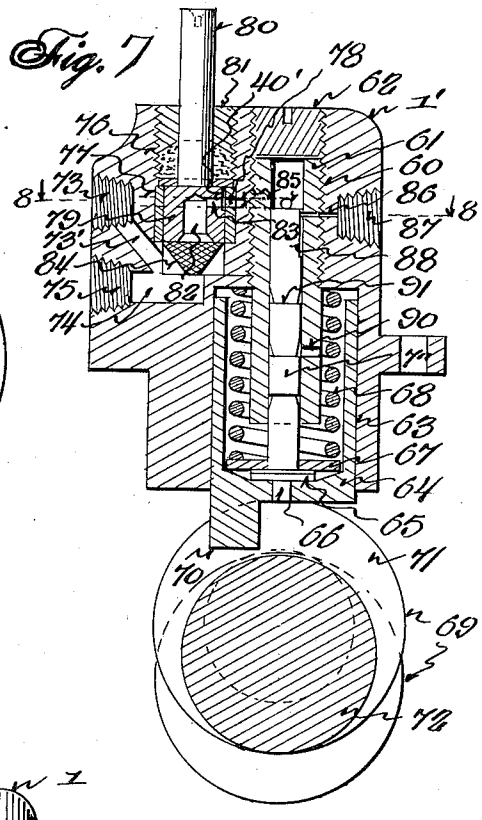
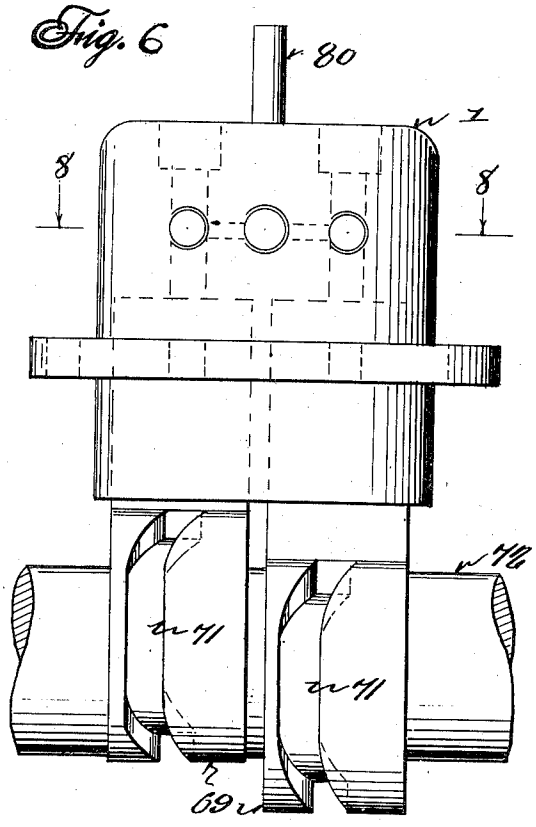


Fig. 6



Inventor
Carl F. High
By Young & Young
Attorneys

Patented June 8, 1937 2,083,020

UNITED STATES PATENT OFFICE

2,083,020

FUEL PUMP

Carl F. High, Flint, Mich.

Application June 25, 1931, Serial No. 546,797
Renewed May 9, 1934

5 Claims. (Cl. 103—157)

This invention pertains to fuel pumps, and has primarily for its object to further improve the pump structure as disclosed in patent application Serial No. 475,791, filed August 16, 1930.

Incidental to the foregoing, a more specific object resides in the provision of a fueling mechanism of the foregoing character, in which a plurality of pumps are annularly arranged about a common fuel distributing chamber, the pump units being actuated by a common member, and in which check valves, with their inherent objections, are eliminated, thus materially simplifying the structure and providing dependable operation.

Another object resides in the provision of an improved mechanism for metering fuel to an extremely minute degree, and more specifically to provide a rotary metering valve provided with an annularly tapered groove cooperating with the fuel inlet port to uniformly and gradually vary the fuel supply to the pump units.

A still further object resides in the provision of a reciprocative and oscillatory pump plunger for effecting the desired discharge of fuel without the use of check valves, each plunger being automatically reciprocated and rotated by a single member to effect the desired discharge of fuel without the use of check valves.

Another object is to provide a pump mechanism of the foregoing character, in which a plurality of pump units are so connected as to provide a constant spray of fuel through a single discharge port.

With the above and other objects in view, which will appear as the description proceeds, the invention resides in the novel construction, combination, and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the herein disclosed invention may be made as come within the scope of the claims.

In the accompanying drawings is illustrated one complete example of the physical embodiment of the present invention constructed according to the best mode so far devised for the practical application of the principles thereof.

In the drawings, Figure 1 is a vertical section through a fuel pump unit constructed in accordance with the present invention;

Figure 2 is a transverse section taken on the line 2—2 of Figure 1;

Figure 3 is a detailed section through the metering valve, taken on the line 3—3 of Figure 1.

Figure 4 is a detailed section through the distributing portion of the metering valve taken on the line 4—4 of Figure 1;

Figure 5 is a detailed section taken through the head of one of the pump plungers, as indicated by the line 5—5 of Figure 1.

Figure 6 is an elevation of a modified form of the invention;

Figure 7 is a vertical section taken on the line 7—7 of Figure 8; and

Figure 8 is a transverse section taken on the line 8—8 of Figure 6.

Referring now more particularly to the accompanying drawings, and especially that form of the invention illustrated in Figures 1 to 6 inclusive, the numeral 1 designates a pump casing which is preferably annular in shape and constructed in sections to facilitate manufacture and assembly of the working units. To this end, an intermediate cylindrical housing 2 is provided with a lower cap 3 and a top head 4, both of which are secured to the housing 2 by the bolts 5, or any other suitable means, and form closures for the top and bottom of the housing 2.

The head 4 is provided with a plurality of vertical bores 6, concentrically arranged about its axis and having slidably mounted therein pump plungers 7, the lower ends of which project below the bottom face of the head 4, and are provided with flanges 8 and cranks 9, which serve to effect reciprocative and oscillatory action of the plungers, as will be hereinafter explained.

As best shown in Figures 1 and 2, the inner face of the housing 2 is provided with a plurality of spaced vertical guideways 10 having the flanged slides 11 mounted therein for reciprocative movement. The upper end of each slide 11 is provided with a laterally disposed forked head 12, which straddles the lower end of the plunger 7 between its flange 8 and crank 9, thus imparting reciprocative movement to the plunger, as the slide is actuated. The lower end of each slide 11 carries a stud 13 having mounted thereon a roller 14, positioned in an annular cam track 15 provided in a cam 16.

The cam 16, which is positioned within the housing 2, has its upper and lower stub shafts 17 and 18, respectively, journalled in anti-frictional bearings 19, the upper bearing being carried by the head 4, while the lower bearing is mounted in the cap 3. The stub shaft 18 projects through the cap 3 to provide for any suitable driving connection with the motor to be fuelized.

As best shown in Figure 2, the depending cranks 9, carried by the pump plunger 7, project into

an annular cam track 20 formed in the top face of the cam 16.

In operation, it will be quite obvious that as the cam 16 is rotated, the slides 11 will be vertically reciprocated through the action of the rollers 14 travelling in the annular cam track 15, causing the pump plunger 7 to be correspondingly reciprocated, at the same time oscillatory movement is imparted to the plungers through the cranks 9 travelling in the cam track 20.

Considering now the method of metering and fuel distribution to the various pump plungers, it will be noted in Figure 1 that the head 4 is provided at its top end with a central recess 21 forming a fuel pocket and having a plug 22 threaded therein to form a closure for the pocket. The plug 22 is provided with a fuel inlet port 23 and an outlet port 24, the inlet port being connected with any suitable source of fuel supply, while the outlet port is provided with a suitable connection for venting the fuel chamber to hasten the priming of the pump when starting out from dry.

From the port 23, the fuel passes downwardly through a duct 23' into the fuel pocket, it being noted that the plug 22 is provided with a recess 25 in its lower end to further increase the size of the fuel pocket and also allow for the positioning of the metering mechanism within the fuel pocket.

In order to meter and uniformly distribute the fuel from the central fuel pocket to the various pump units, the recess 21 is provided with a central bore 26, in which a shouldered sleeve 27 is tightly fitted to prevent its rotation. The sleeve 27 is provided with a plurality of annularly spaced ports 28 which are aligned with a plurality of radial ports 29 communicating with the plunger bores 6. The lower end of the sleeve 27 is closed by a plug 30 provided with a central recess 31 formed in its top face, and a plurality of radial ducts 31' extending from the central recess to the outer periphery of the plug in alignment with the ports 28 provided in the sleeve 26.

Rotatably mounted within the sleeve 27, and seated upon the plug 30, is a valve 32 provided with a recess 33 in its upper end for reception of an actuating rod 34 secured to the valve 32 by a pin 35, or in any other suitable manner. The actuating rod 34 extends through the plug 22, and is sealed by the usual packing 36 and the packing nut 37.

That portion of the sleeve 27 projecting into the fuel pocket or recess 21 is provided with a fuel inlet port 38 aligned horizontally with a duct 39 that communicates with the central recess 31 formed in the plug 30. Thus, when the duct 39 is in communication with the fuel inlet port 38, fuel is admitted to the distributing plug 31 from which it passes through the ports 28 and the ducts 29 to the plunger bores 6.

In order to provide for metering or graduating the fuel supply to the plunger bores, the valve plug 32 is provided with an annularly tapered groove 40 in horizontal alignment with the inlet port 38 and the duct 39, as best shown in Figure 3. Thus, as the valve plug 32 is rotated through actuation of the rod 34, the communication between the inlet port 38 and the duct 39 is gradually varied to provide for variation of the fuel supply to a high degree of nicety, very essential to the successful operation of a fuel injection pump of the present character.

Obviously, as fuel is distributed to the various pump bores 6, and the plungers 7 are reciprocated through the action of the cam 16, fuel will be drawn into the bores and discharged either to the manifold or independent cylinders of the engine, as may be desired, it being understood that the manner of injecting the fuel into the engine forms no particular part of the present invention, it being contemplated that this may be accomplished in several different ways.

As set forth in the preceding objects, the present invention eliminates the use of check valves, which are found to present many objections in a device of the present character, due to the high speed at which the plungers are actuated, and the fact that the fuel to be discharged from the pump units must be accurately measured under all conditions.

In order to avoid the use of check valves, the present invention provides a novel construction of plunger, which serves to both discharge the fuel under high pressure, and also regulate the period of induction, without the use of a check valve. This is accomplished by providing the plunger with a radial inlet port 41 positioned closely adjacent its head and adapted to align with its corresponding duct 29 in one position of the plunger. The port 41 communicates with a central recess 42 provided in the head of the plunger, and communicating with an elongated vertical slot 43 formed in one side of the plunger below its head, the slot 43 being formed to align with a discharge duct 44 formed in the head of the casing during a portion of the discharge stroke of the plunger 7. The bore 6 is closed by a plug 45 suitably secured within the bore above the working stroke of the plunger 7, while the duct 44 communicates with that portion of the bore 6 above the plug 45. A conventional fitting 46, threaded into the upper end of the bore 6, serves to connect a pipe or piece of tubing 46', which delivers the fuel to the engine, as heretofore explained.

Lubrication of the various working parts is accomplished much in the same manner as in the aforesaid pending application, the oil being supplied either by gravity or under pressure to a duct 47 formed in the lower cap 3 of the housing 1. The duct 47 communicates with an annular groove 48 formed in the bushing 49 carried by the cap 3 and surrounding the lower stub shaft 18, which shaft is provided with a radial port 50 communicating with a vertical bore 51 extending upwardly through the cam and top stub shaft 17. An orifice 52, communicating with the central bore 51, serves to distribute oil to the cam track 15 and the rollers and slide actuated thereby, as well as to the other working parts contained within the central cam compartment. From the central bore 51, oil is delivered through the top of the stub shaft 17 into a compartment formed by the recess 53 provided in the bottom face of the head 4, while ducts 54 form communications between the recess 53 and the various plunger bores 6 to effect lubrication of the plungers 7.

As set forth in the aforesaid application, lubrication of the various plungers is accomplished by means of an annular groove 7' provided in the plunger adjacent the lower end of the bore 6, and as lubricant is forced through the ducts 54, and the plungers 7 are reciprocated to carry the grooves 7' past the ducts 54, oil will be picked up and carried along the surface of the bores.

In practice, the result of the foregoing action has been found to progressively feed the oil upwardly upon the walls of the bores, and while it

is true that a certain amount of pressure is developed above the head of the piston during its compression stroke, which has some tendency to oppose the upward feed of lubricant, it has been found in actual practice that such compression, rather than forcing itself down between the bore and plunger, which is closely fitted, will build up in the recess **42**, and exert itself through the intake port **41**, thus avoiding tendency to obstruct the upward feed of lubricant.

Furthermore, upon the downward or suction stroke of the piston the reduced pressure above its head will have a tendency to draw the oil upwardly within the bore, thus serving to properly lubricate the plunger throughout its entire length. In some instances, where it may be desired to provide a greater amount of lubrication for the piston, an annular groove **55** may be provided in the face of the bore **6**, above the duct **54**, in alignment with the upper position of the groove **7'**. Thus, oil carried upwardly by the groove **7'** will be deposited and stored within the groove **55**, from which point it is fed upwardly by the action of the piston, and the reduced pressure above the same on the suction stroke, as hereinbefore described.

It may also be desired to have the lower extremity of slot **43** overlap the annular groove **55**, so that there is provided a passage to facilitate the pumping action from the groove, this pumping being caused by the reduced pressure formed above the plunger on each down stroke.

When the pump is mounted in a vertical position, lubricant fed thereto is drained through the opening **57** formed in the cap **3**, and the drain outlet **56** formed in the head **4** is plugged, but should the apparatus be mounted in an inverted position, then a suitable drain is communicated with the outlet **56**.

From the foregoing explanation taken in connection with the accompanying drawings, it is believed that the operation of the pump will be quite apparent, in that fuel introduced through the port **23** and duct **23'** into the fuel chamber formed by the recess **21**, will be delivered through the port **38** in the bushing **26** to the annular tapered groove **40** formed in the valve plug **32**. The fuel then travels through the duct **39** into the central recess **31** formed in the plug **30**, from whence it is delivered through the radial ports and ducts to the bore **6**.

As best shown in Figure 5, the radial inlet port **41**, formed in the plunger **6**, is positioned at an angle of less than 180 degrees with relation to the slot **43**, while the ducts **29** and **44** are disposed at 180 degrees. Consequently, when the port **41** is in alignment with the duct **29** to receive fuel, the slot **43** is out of alignment with the discharge duct **44**. During the suction stroke of a plunger the port **41** is vertically above the corresponding duct **29** so that the inlet duct **29** is closed, thus creating a reduced pressure above the plunger until such time as the port **41** opens the duct **29**, thus admitting fuel to the bore **6** above the head of the plunger. Before the compression stroke of the plungers, the cam track **20**, actuating the cranks **9**, rotates the plungers to bring the slots **43** into alignment with the discharge ducts **44**, causing the fuel to be expelled through the plungers and discharge ducts, from which it is delivered to the engine through the tubing **46'**.

Obviously, the foregoing structure has many advantages, in that lubrication of moving parts is positively provided for, and check valves, with their inherent objections, are eliminated.

It will also be appreciated that by means of the annularly tapered groove **40** provided in the valve plug, an extremely gradual and definite metering of the fuel is provided for, which feature is highly essential in the injection of liquid fuel.

It will also be noted that fuel to the various pump units is delivered from a common central source, namely, the recess **31**, which is positioned between the bores and the metering portion of the valve, thus insuring a uniform supply to the various pump units under all conditions.

Attention is also directed to the fact that an extremely simple structure has been provided for eliminating the use of check valves in connection with the pump units, this being accomplished in the present instance by both reciprocating and oscillating plungers by a single element, namely, the cam **16**, which structure and operation is permitted by the annular arrangement of the plunger units about a common axis.

An inherent advantage of the present pump, which meters by throttling the common intake of the several pumping units, lies in the fact that TIME is one of the factors affecting the metering. This factor operates when the engine speed is reduced by the application of increased load. Under this condition, and without a change of throttle setting, the time element enters, and more fuel is allowed to pass the metering orifice. This extra fuel is comparable to the extra air, which passes the throttle valve in the engine's induction system under similar conditions, and serves to carry the increased load.

Taking up the modification of the present invention, as disclosed in Figures 6 to 8 inclusive, wherein it is proposed to provide a continuous discharge spray of fuel through a single outlet common to a plurality of pump plungers, the numeral **1'** designates a casing adapted to be mounted upon an engine in any suitable manner and provided with a pair of spaced threaded orifices **60** having bushings **61** threaded therein, and closed at their upper ends by the threaded plugs **62**. The lower portion of the casing **1'** is provided with enlarged central bores **63**, aligned with the threaded orifices **60** for reception of the sleeves **64**, slidably and rotatably mounted within said bores, it being noted that the bushings **61** project downwardly within the sleeves **64**. Slidably and rotatably mounted within the sleeves **61** are the plungers **7''**, provided with flanges **65** adjacent their lower ends, and squared shanks **66** projecting through squared openings in the bottom of the sleeves **64**.

Washers **67** are mounted on the plungers above the flanges **65**, and coil springs **68**, disposed between the washers **67**, and the upper ends of the bores **63**, serve to frictionally hold the plungers into engagement with the sleeves **64**, and also urge the sleeves downwardly into engagement with their respective cams **69**. As best shown in Figures 6 and 7, the sleeves **64** are provided with depending offset lugs **70**, which serve as cranks, and are engaged in the annular cam tracks **71** provided in the peripheral faces of the cams **69**.

From the foregoing, it will be readily seen that as the cam shaft **72** is rotated, the peripheral camming surface of the cams **69** will cause the sleeves **65** to be reciprocated, which in turn imparts reciprocative movement to the pump plungers **7''**, and at the same time oscillatory movement is imparted to the plungers by means

of the cam tracks 71 actuating the cranks 70 to rotate the sleeves 64, it being understood that the plungers are held in engagement with the sleeves by means of the springs 68.

The foregoing reciprocative and oscillatory action of the pump plungers is similar to that as explained in connection with the preferred form of the invention, the only distinction residing in the structural means employed to accomplish the same.

Metering of the fuel is also obtained by means equivalent to that embodied in the preferred structure, in that fuel is introduced through an inlet port 73, from whence it passes through a duct 73' to a fuel chamber 74, said fuel chamber being provided with a vent outlet 75 for the same purpose heretofore explained in connection with the preferred form of the invention.

Communicating with the fuel chamber, the casing is provided with a recess 76, in which is seated a bushing 77 provided with an outlet port 78. A metering valve 79 is rotatably mounted within the bushing 77, and has its shank 80 projecting upwardly beyond the casing and sealed by means of conventional packing and packing nut 81, threaded into the recess 76.

The valve 79 is provided at its lower end with a central recess 82, the upper end of which communicates with a radial outlet port 83 in horizontal alignment with the outlet port 78 formed in the bushing 77, while the periphery of the valve 79 is provided with an annularly tapered groove 40' similar to the groove 40 in the preferred form, and horizontally aligned with the ports 83 and 78. A screen or mesh 84, positioned below the recess 82, serves to strain out heavy particles from the fuel passing through the valve.

As best shown in Figure 8, the outlet 78 is in communication with the duct 85 which extends to both of the plunger chambers, which chambers are provided with discharge ducts 86 communicating with a common outlet 87. Here, it will be noted that the ducts 85 and 86 are positioned at 90 degrees respectively in each plunger chamber, and inasmuch as each plunger 7'' is provided with a single valving groove 88, the plungers must be rotated 90 degrees in order to effect the proper valving, that is, intake and discharge of fuel.

Inasmuch as it is desired in this form of the invention to provide a constant discharge through the common outlet 87, naturally the plungers are set with their valving grooves at 90 degrees to each other, as shown in Figure 8. In this position of the plungers, that plunger having its groove 88 in alignment with the duct 85 is drawing fuel, while the opposite plunger is discharging fuel, and inasmuch as actuation of the plungers is so timed by the cams as to provide for continuous alternating discharge from the respective plungers, the discharge of fuel from the common outlet 87 is continuous.

From the foregoing it will be readily seen that the principle of operation involved in the modified form of the invention is identical with the mechanical operation embodied in the preferred form, and to this end produces the same advantageous results. The primary distinction between the two forms resides only in the fact that in the preferred form a plurality of plungers are provided for independent injection of fuel into either the manifold of a multiple cylinder engine or to the individual cylinders, as may be desired, while in the present instance the device is adapted to provide a constant spray into a manifold to replace the conventional carburetor.

In the modified form of the invention, lubrication is accomplished in a manner similar to that of the preferred form, in that lubricant is supplied to the pocket formed by the bore 63, from which it passes through a port 90 formed in the bushing 61, and is picked up by the grooves 91 formed on the plungers. The structure of the plungers 91 is similar to that disclosed in the aforesaid application, and therefore distribution of the lubricant throughout the plunger bore is the same.

I claim:

1. A fuel pump comprising a casing provided with a central fuel distributing chamber and a plurality of pump cylinders concentrically arranged around said fuel distributing chamber, and provided with inlet and outlet ports, said inlet ports communicating with said distributing chamber, a valve for metering fuel to said distributing chamber, plungers operable in said pump cylinders, cranks carried by said plungers, a concentric rotary member provided with independent cam faces for respectively reciprocating said plungers and actuating said cranks to oscillate said plungers.

2. A fuel pump comprising a casing provided with a central fuel distributing chamber and a plurality of pump cylinders concentrically arranged around said fuel distributing chamber and provided with inlet and outlet ports, said inlet ports communicating with said distributing chamber, a valve for regulating the fuel to said distributing chamber, plungers operable in said pump cylinders, cranks carried by said plungers, a concentric rotary member provided with a peripheral cam track for reciprocating said plungers, and an annular track in one of its end faces for actuating said cranks to oscillate said plungers.

3. A pump for supplying liquid fuel under pressure to internal combustion engines comprising, in combination, a casing provided with a common fuel distributing chamber closed to atmosphere and having an inlet orifice in one of its walls, and a plurality of pump cylinders provided with side wall inlet ports communicating with said distributing chamber and outlet ports spaced circumferentially from said inlet ports, manually operable means for positively varying said orifice to meter fuel entering said distributing chamber, plungers in said cylinders having end portions for completely emptying the cylinders on the discharge strokes and a longitudinal port and connecting transverse port functioning to control the opening and closing of the inlet and outlet ports in proper sequence when the plungers are oscillated, means driven in timed relation with the engine for reciprocating said plungers, and means for oscillating said plungers in predetermined timed relation to the reciprocation thereof to control said inlet and outlet ports.

4. A pump for supplying liquid fuel under pressure to internal combustion engines comprising, in combination, a casing provided with a common liquid fuel distributing chamber closed to atmosphere and having an inlet orifice in one of its walls, means for supplying liquid fuel to said orifice, manually operable means for positively varying said orifice to meter fuel entering said distributing chamber, a plurality of pump cylinders provided with inlet ports communicating only with said distributing cham-

ber so as to exclude air, and outlet ports, plungers operable in said cylinders and having portions effective to empty completely the cylinders on the discharge strokes and a fuel passage therein to connect with said inlet and outlet ports when the plungers are oscillated, cranks carried by said plungers, and a rotary member provided with independent cam faces for respectively reciprocating said plungers and actuating said cranks to oscillate said plungers, in timed relation.

5. A pump for discharging liquid fuel under pressure to internal combustion engines comprising, in combination, a casing having a common fuel distributing chamber closed to atmosphere and provided with a single inlet orifice, means for supplying fuel in liquid form to said orifice, means for positively varying said orifice to meter fuel entering said distributing chamber, a plurality of parallel circumferentially spaced pump cylinders in said casing closed at one end and provided with inlet and outlet ports adjacent said end, ducts connecting said inlet ports with said chamber, plungers operable in said pump cylinders having end portions provided with longitudinal ports and connecting transverse ports functioning to connect with the inlet and outlet ports in proper sequence when the plungers are oscillated, a drive shaft extending centrally of said cylinders, and means on said drive shaft for reciprocating and oscillating said plungers in predetermined timed relation.

CARL F. HIGH.