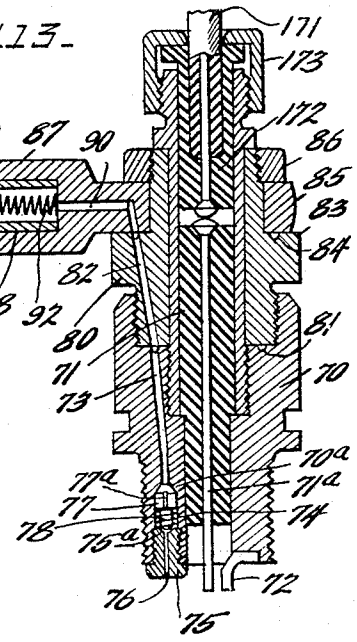
Dec. 16, 1947. J. A. CIVITARESE 2,432,507

FUEL INJECTING PUMP

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FIG. 13.



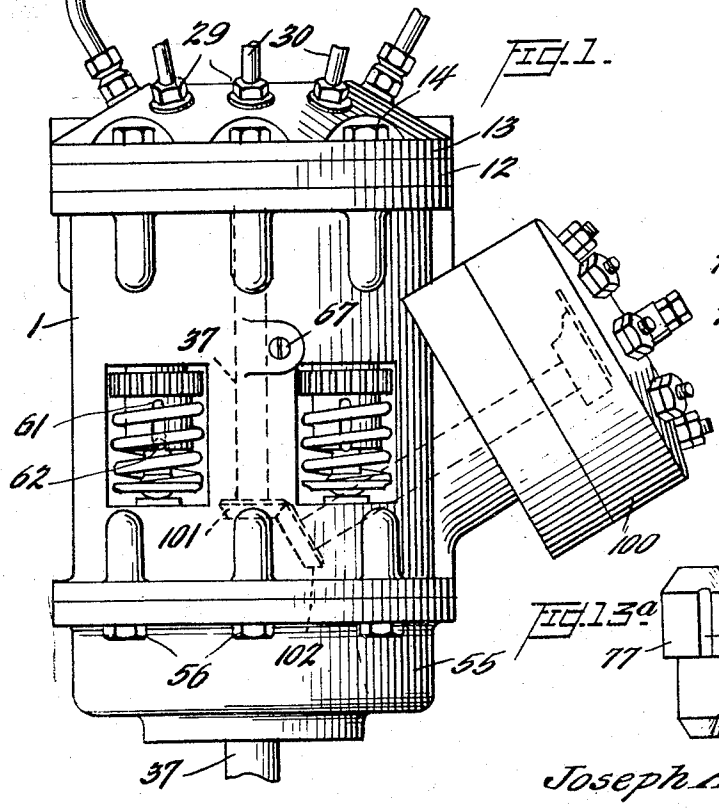


FIG. 1.

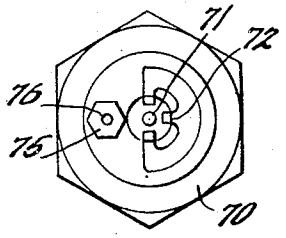


FIG. 14.

FIG. 13a.

FIG. 13b.



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FUEL INJECTING PUMP

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FIG. 3.

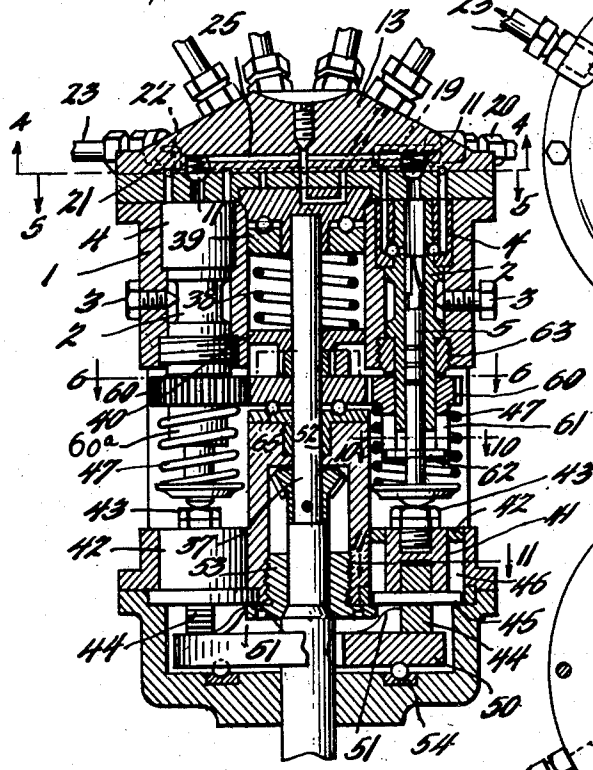


FIG. 2.

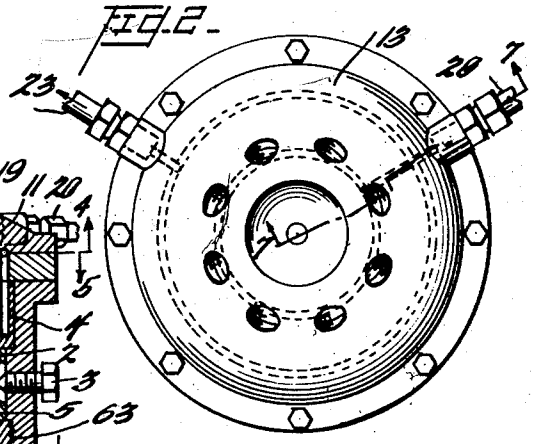


FIG. 4.

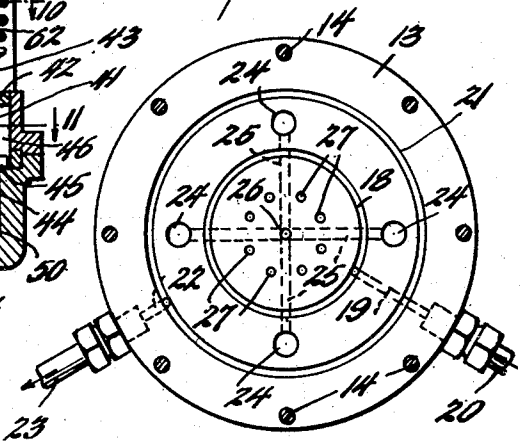


FIG. 6.

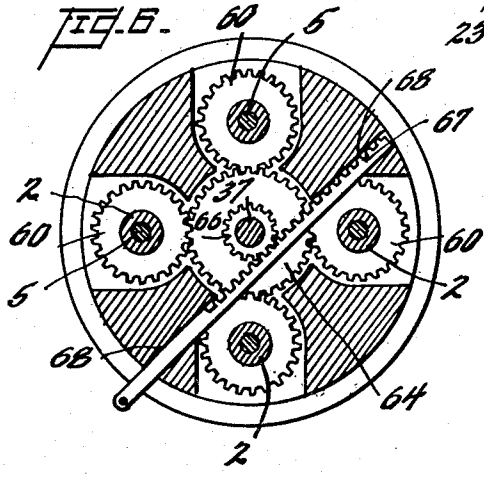
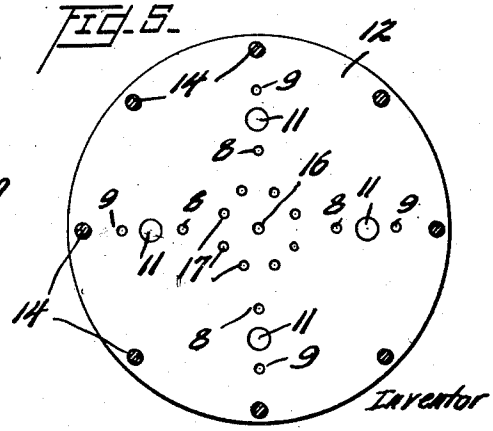


FIG. 5.



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FIG. 7.

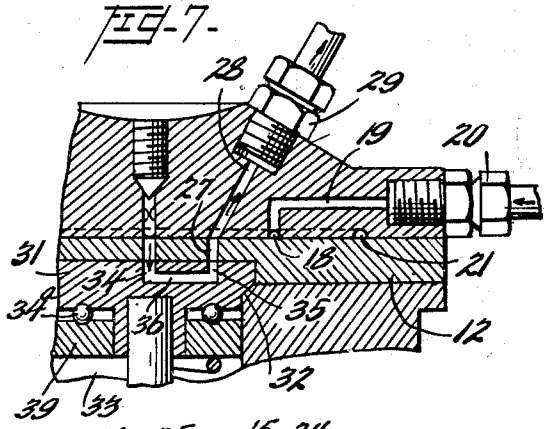


FIG. 8.

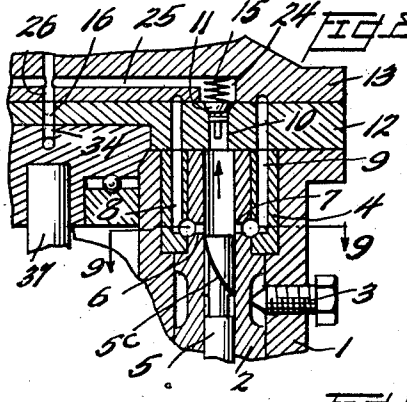


FIG. 9.

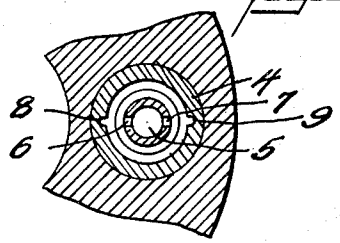


FIG. 10.

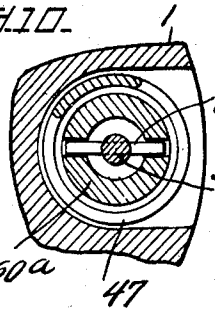


FIG. 11.

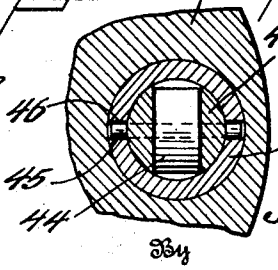


FIG. 12.

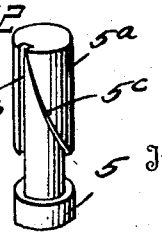
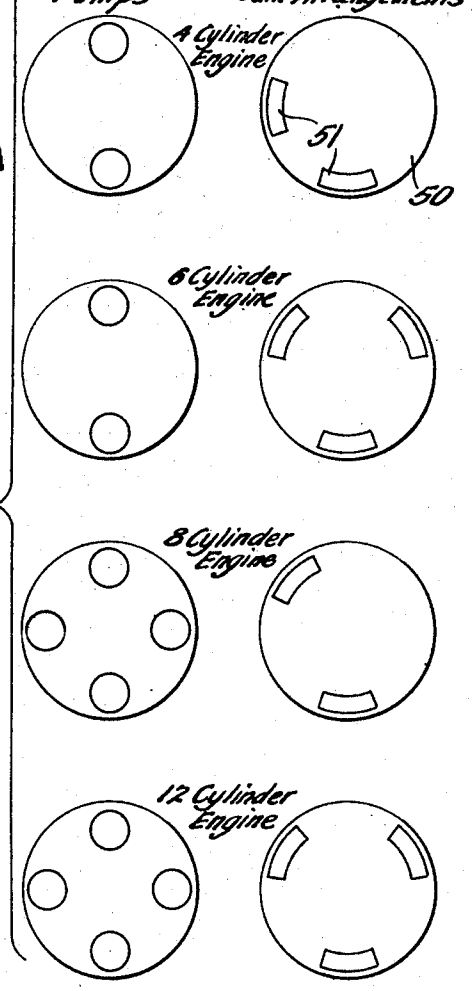


FIG. 15



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FUEL INJECTING PUMP

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FIG. 16.

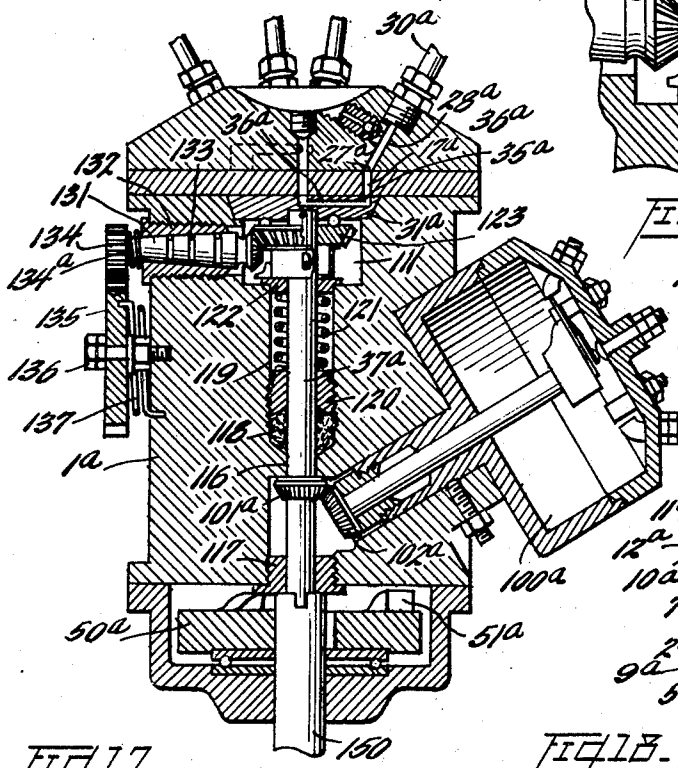


FIG. 19.

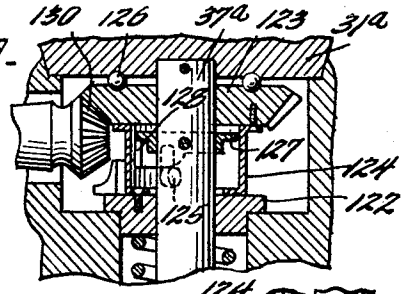


FIG. 20.

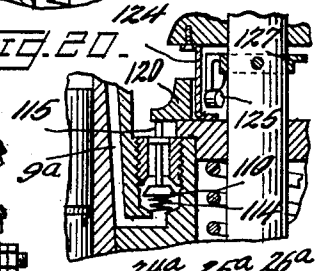


FIG. 17.

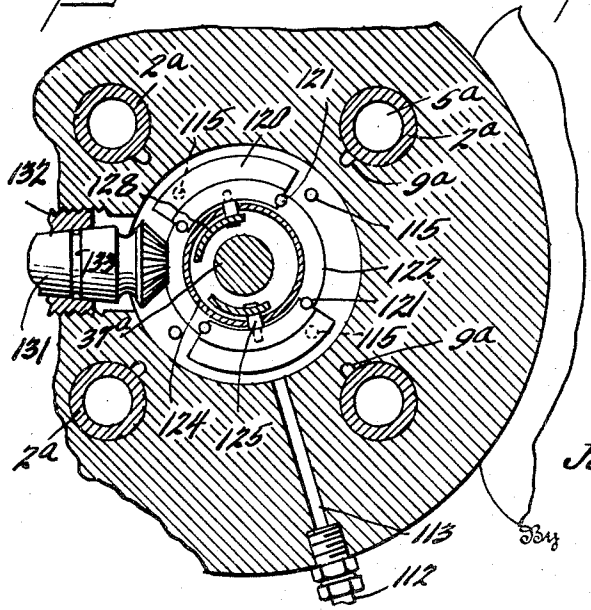
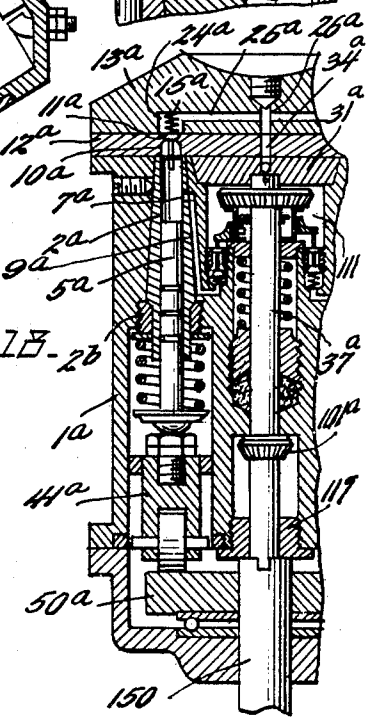


FIG. 18.



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FIG. 24.

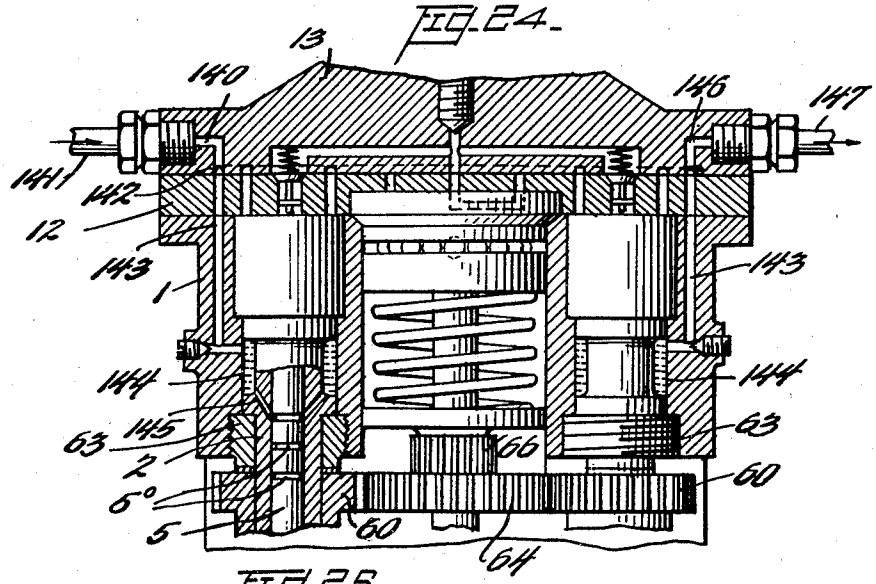


FIG. 25.

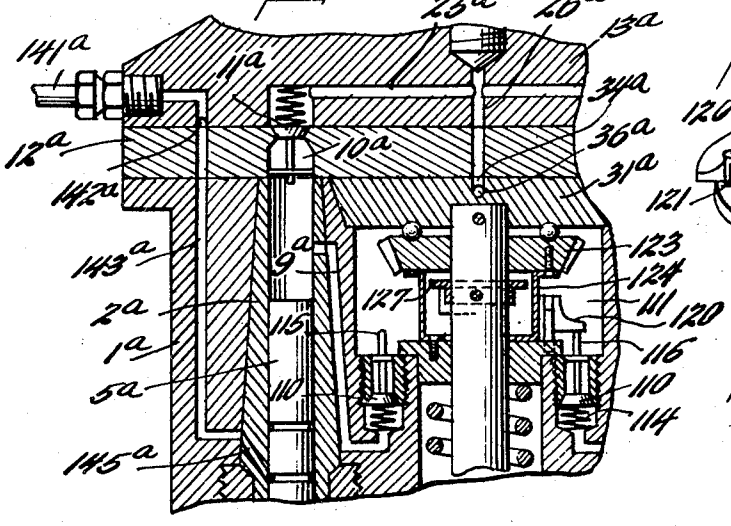


FIG. 21.

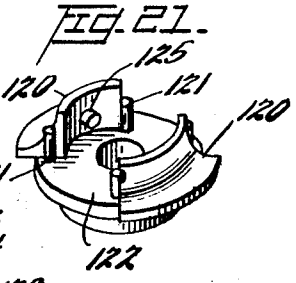
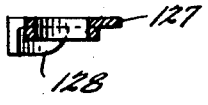


FIG. 22.



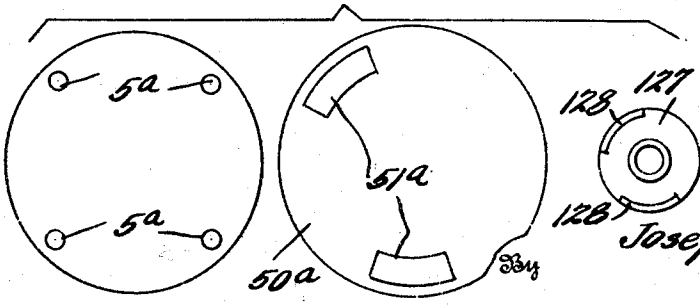


FIG. 23.

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Patented Dec. 16, 1947 2,432,507

UNITED STATES PATENT OFFICE

2,432,507

FUEL INJECTING PUMP

Joseph Anthony Civitarese, Lodi, N. J.

Application January 21, 1944, Serial No. 519,173

9 Claims. (Cl. 103—173)

1

The present invention relates to fuel injecting pumps, and more especially to those of the class employed for injecting fuel into the cylinders of internal combustion engines.

One of the primary objects of the invention is to provide a novel and improved liquid fuel injecting pump whereby the amount of fuel injected into the engine cylinders may be readily adjusted to control the power developed by the engine, and in which the fuel is distributed to the engine cylinders by a single rotating valve.

A more particular object is to provide a multiple pump for feeding liquid fuel, the pump units being simultaneously and uniformly adjustable during their operation to vary the amount of fuel supplied by each pump unit, and a single distributor valve which receives the fuel from each pump unit and distributes it to the engine cylinders.

Another object is to provide a multi-pump feed for multi-cylinder engines in which the pump units are actuated by a single cam member having cams arranged thereon to time the operations of the pump units properly in relation to the cylinders to which the fuel is being fed, the arrangement of the cams enabling a multiple number of engine cylinders to be fed from a smaller number of pump units.

A further object of the invention is to provide a combined fuel injecting and ignition plug for the engine cylinders which not only provides a unitary structure for these functions but which introduces the fuel into the engine cylinder adjacent to the point of fuel ignition, thus rendering ignition of the rejected fuel charges more certain, effective and uniform.

In the accompanying drawings, which disclose the preferred embodiments of the invention:

Fig. 1 is an elevation of one form of fuel injecting means, comprising the improved multi-pump and distributor valve, and showing the improved fuel injecting and ignition plug for one of the engine cylinders.

Fig. 2 is a top plan view of the pump and distributor.

Fig. 3 is a vertical section of the pump and distributor valve, taken through two of the pump units.

Fig. 4 is a horizontal section, taken on the line 4—4 in Fig. 3 and looking in the direction of the arrows.

Fig. 5 is a horizontal section, taken on the line 5—5 in Fig. 3 and looking in the direction of the arrows.

Fig. 6 is a horizontal section, taken on the line 6—6 in Fig. 3.

Fig. 7 is an enlarged detail section, taken on the line 7—7 in Fig. 2.

Fig. 8 is an enlarged detail section of the upper

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portion of one of the pump units and adjacent parts.

Fig. 9 is a transverse section, taken on the line 9—9 in Fig. 8.

Fig. 10 is a detail section, taken on the line 10—10 in Fig. 3.

Fig. 11 is a detail section, taken on the line 11—11 in Fig. 3.

Fig. 12 is a perspective view of the upper end of one of the pump plungers.

Fig. 13 is an enlarged detail section taken longitudinally through one of the fuel injecting and ignition plugs, and Figs. 13*a* and 13*b* are detail views of the check valve.

Fig. 14 is a bottom plan of the plug shown in Fig. 13.

Fig. 15 is a diagram illustrating the number and arrangement of pump units and cams employed for feeding fuel to different numbers of engine cylinders.

Fig. 16 is a vertical section of a modified form of fuel pump and distributor according to the present invention.

Fig. 17 is a section, on an enlarged scale, taken horizontally through the pump structure shown in Fig. 16.

Fig. 18 is a vertical section of one of the pump units employed in Fig. 16.

Fig. 19 is a detail view of the cams for regulating the fuel feed from the pump units.

Fig. 20 is a detail view, illustrating the by-pass valve for one of the pump units, and showing the controlling cam in cooperation therewith.

Figs. 21 and 22 are detail perspective views of the cam elements for regulating the fuel feed from the pump units.

Fig. 23 is a diagrammatic view showing the relative timing of the pump actuating and fuel regulating cams employed in the arrangement shown in Fig. 16.

Fig. 24 is a section taken vertically through the upper portion of the multiple pump shown in Fig. 1, illustrating a lubricating system therefor.

Fig. 25 is a section taken vertically through the upper portion of the multiple pump shown in Fig. 16, illustrating a lubricating system therefor.

The preferred embodiments of the invention are shown in the drawings and are hereinafter described in detail, but it is to be understood that the invention is not restricted to the precise details shown, as equivalent structures are contemplated and such will be included within the scope of the claims at the end of this specification.

Referring first to the embodiment of the invention shown in Figs. 1 to 15 inclusive, the multiple pump comprises a casing 1 which contains the pump units and distributor valve and their actuating and controlling means. Different num-

bers of pump units may be employed, a group of four of such units being shown, for example, in the present instance, the fuel outputs of which are distributed to the respective engine cylinders by a single or common distributor valve. The pump units are grouped concentrically and spaced at equal angles around the center of the casing.

Each pump unit comprises a cylinder 2 fitted in a bore in the casing and secured adjustably therein by a locking screw 3, the cylinder having an enlarged head 4 which fits closely in an enlarged portion of the bore, and a plunger 5 which fits and reciprocates in the cylinder. The upper portion of the cylinder is provided with a fuel inlet port 6 and a fuel outlet port 7, these ports being uncovered by the plunger when it approaches the end of its downward or intake stroke, the port 6 communicating with an inlet passage 8 in the head 4 and the port 7 communicating with an outlet port 9 in said head. The upper or discharge end of the cylinder is open and communicates with a discharge port 10 controlled by a check valve 11 which permits discharge of fuel from the pump but prevents return flow of fuel thereto. The port 10 and continuations of the passages 6 and 7 are formed in a head plate 12 which is surmounted by a cap 13, said plate and cap being firmly secured together and to the top of the casing as by cap screws 14 or other suitable means. Each valve 11 is urged toward its seat on the plate 12 by a spring 15 which is compressed between the valve 11 and cap 13. The plate 12, as shown in Fig. 5, is also provided with a central port 16, and an annular series of ports 17 which are concentric therewith and are of a number corresponding with the number of cylinders of the engine to which the fuel is to be fed.

The underside of the cap 13, as shown in Fig. 4, is provided with an inner annular groove 18 which communicates, by a passage 19, with a fuel supply pipe 20, and is provided with an outer annular groove 21 which communicates, by a passage 22, with a fuel outlet pipe 23 which may be connected to return fuel therefrom to the source of fuel supply. The underside of the cap 13 is also formed with chambers 24 for the springs 15 of the check valves 11, and these chambers are connected by radial passages 25 to a central port 26 which registers with the central port 16 in the head plate 12. The cap 13 is also provided on its underside with an annular series of ports 27 which are concentric with the port 26 and are of a number and arrangement to register with the ports 17 in the head plate 12. The ports 27 communicate with passages 28 which lead to fittings 29 to which are attached pipes 30 for conducting the fuel to the respective cylinders of the engine. The head plate 12 is provided in its underside with a recess in which a circular valve 31 is fitted, the top of this valve seating against the top of the recess in the plate 12 and the valve having a bevelled flange 32 which rests on a corresponding seat formed on the surrounding upper end of a cylindrical bore 33 formed centrally within the pump casing. The top of the valve 31 is provided with a central port 34, which registers and is in constant communication with the central ports 16 and 26, and with a port 35 which, during rotation of this valve, communicates successively with the ports 17 in the head plate, the ports 34 and 35 being connected by a radial passage 36 formed within the valve 31. This valve is connected to the upper end of a shaft 37 to be rotated thereby, and is pressed against the head plate 12 to maintain a fluid tight fit therewith by a spring 38 the upper end of which presses a bearing ring 39 upwardly, an antifriction bearing 39a being preferably interposed between this bearing ring and the valve, the lower end of the spring resting on a collar 40 carried by the shaft 37.

The plunger 5 of each pump unit is of the type having an upper cylindrical portion 5a which has a fluid-tight fit in its respective cylinder, and this portion of the plunger is formed with a tapered groove 5b the narrow end of which communicates with the top thereof, one side of this groove having a helically extending edge 5c which extends around one-half of the circumference of the plunger, said groove being adapted to communicate with the port 7 earlier or later in the upward or discharge stroke of the plunger, according to the position into which the plunger is rotated, thereby regulating or metering the amount of fuel injected at each working stroke. Each plunger is actuated on its working stroke by a tappet 41 which is mounted slidably in a guide sleeve 42 fixed in the casing and carrying a screw 43 which is engageable with the lower end of the plunger, the tappet carrying a roller 44 rotatable on a pin 45 the ends of which project into slots 46 in the guide sleeve to prevent rotation of the tappet in its guide sleeve. The return strokes of each plunger are effected by a spring 47, which maintains the respective tappet roller in operative relation with an actuating cam 50, the latter being provided on its upper face with cam projections 51 of a number and arrangement according to the number of cylinders of the engine supplied with fuel from the pump. The cam 50 is keyed or otherwise fixed to the lower portion of the shaft 37, which latter is driven from the engine in proper timed relation therewith, as at cam shaft speed when used with an internal combustion engine of the conventional four-cycle type. The shaft 37 is supported rotatably in the pump casing by upper and lower bearings 52 and 53, and by a bearing 54, preferably of the antifriction type, interposed between the cam 50 and a cap 55 which is removably secured, as by the cap screws 56, to the bottom of the casing.

Means is provided for simultaneously and uniformly rotating the plungers of the pump units to regulate or meter the fuel injected by the group of pump units, such means comprising a pinion 60 mounted rotatably on the lower end of the cylinder 2 of each unit and having a sleeve 60a extending downwardly therefrom and provided with a pair of diametrically opposite slots 61 in which the ends of a pin 62 extending diametrically through the respective plunger reciprocate, this pin connecting the pinion to the respective plunger so that rotation of the pinion causes corresponding rotation of the plunger. The pinion is held in position against a bushing 63 by the spring 47 which effects the return strokes of the plunger. The pinions 60 of all of the pump units mesh with a central gear 64 which is mounted loosely on the shaft 37 and may be supported by an antifriction bearing 65 interposed between this gear and the bearing 52, and the gear 64 has a pinion 66 fixed thereto, this pinion meshing with a reciprocatory rack 67 which is slidable in bearings 68 in opposite sides of the casing and adapted to be connected to any suitable control means which functions as a throttle for the engine.

When the pump is constructed with four pump units, as shown in the present instance, it may be adapted for use with an eight cylinder engine by employing a cam 50 having two cam projections 51 thereon spaced apart through an angle

of 135 degrees, as indicated in the lower portion of Fig. 15, and such a pump may be adapted to a twelve cylinder engine by employing a cam 50 having three cam projections 51 spaced apart through equal angles of 120 degrees, as indicated at the bottom of Fig. 15. When the pump comprises two pump units in diametrically opposite relation, as indicated in the upper portion of Fig. 15, such a pump may be adapted for injecting fuel for a four-cylinder engine by employing a cam 50 having two cam projections spaced apart through an angle of 90 degrees, and may be adapted for use with a six cylinder engine by employing a cam 50 having three cam projections 51 spaced apart through equal angles of 120 degrees. Similarly, by employing a pump having three pump units spaced around the central actuating shaft 37 through equal angles of 120 degrees, the pump may be employed for injecting fuel for a nine cylinder engine by employing an actuating cam having three cam projections spaced apart through angles of 80 degrees.

The fuel injecting and ignition plug provided by the present invention comprises a body 70 which may be threaded like a conventional spark plug for insertion into the cylinder of the engine, the plug body containing a core 71 of insulating material through which a central electrode 71a extends to a position to cooperate with one or more electrodes 72 grounded on the plug body, as usual, for igniting fuel in the engine cylinder, this electrode contacting with a lead wire 171 for supplying ignition current to the plug, the lead wire being secured in the top of the plug in any suitable may, as by an insulating sleeve 172 and retaining cap 173. The plug body is bored to provide a passage 73 which leads downwardly to a chamber 74 the lower end of which is provided with a plug 75 having an orifice 76 immediately adjacent to the plug electrodes, and through which the fuel is injected into the engine cylinder.

Means is preferably employed for preventing after-drip of any fuel after injection has ceased. Such means, as shown in the present instance, comprises a check valve 77 having a plurality of grooves 77a in its periphery and extending from its upper to its lower end. This valve is movable axially within the cylindrical chamber 74, and is tapered or otherwise suitably formed on its upper and lower ends to seat on either an upper valve seat 70a or a lower valve seat 75a, a spring 78 being provided which surrounds a reduced portion of the valve and acts on the valve to engage it with the upper seat. The surface of the lower tapered end of the valve is provided with a suitable number of grooves 77b which extend inwardly from its periphery toward and in tangential relation to its center where these grooves communicate with the upper end of the orifice 76 in the plug. In operation, the upper end of the valve 77 is held seated against its upper seat 70a by the spring, but as the fuel is forced downwardly in the passage 73 it forces the valve downwardly, thereby disengaging it from its upper seat and permitting the fuel to pass down through the grooves 77a and into the portion of the chamber 74 containing the reduced portion of the valve and the surrounding spring 78. This downward movement of the valve continues until its lower end seats on the lower valve seat 75a on the upper end of the plug 75, but the flow of the fuel continues through the tangential grooves 77b which communicate with the orifice 76, the consequent tangential flow of the fuel producing a turbulent motion thereof as it enters the orifice. When the pressure on the fuel in the fuel line ceases, the spring 78 returns the valve to its upper seat 70a, thereby preventing any pressure due to compression or combustion in the engine cylinder from producing back pressure against the fuel in the line leading to the fuel injecting plug. The valve 77 thus acts as a pre-check valve in advance of the ball check valves 91 and 95 of the fuel injecting plug unit, to effectively prevent back-pressure on the fuel in the fuel line, the movement of the valve 77 being relatively small or minute.

A bushing 80 is threaded or otherwise secured in the body 70 of the plug so that it seats on the bottom of a recess therein having an annular fuel supply groove 81 which communicates with the passage 73, this bushing having a passage 82 therein which communicates with the fuel supply groove 81. The bushing is formed with a seat 83 which is provided with an annular fuel supply groove 84, and said seat is adapted to receive a fitting 85 which is clamped thereon as by a nut 86 threaded on the upper end of the bushing. The fitting 85 has a lateral extension 87 provided with a chamber 88 into which a plug 89 is fitted, said chamber being provided with a passage 90 which communicates with the fuel supply groove 84. The plug 89 contains a check valve 91 having a spring 92 for normally holding it on its seat to prevent return of fuel from the engine cylinder. A pipe fitting 93 is attached to the end of the extension 87, as by a nut 94 threaded thereon, and this fitting is also preferably provided with a check valve 95 and spring 96. The fitting 93 is connected to one of the pipes 30 to receive fuel from the pump and supply it to the respective cylinder of the engine.

The present invention also provides as a single unit a combined fuel pump and ignition timer and distributor, which enables the same shaft to be utilized for the operation of both the fuel pump and the timer and distributor. As shown, the timer and distributor 100, which may be of usual or conventional form, is arranged at an oblique angle to the axis of the pump casing, its shaft being connected to and driven from the shaft 37 by a bevel gear 101 thereon which meshes with a similar bevel gear 102 on the shaft of the timer and distributor.

The operation of the pump and distributor as shown in Figs. 1 to 15 inclusive is as follows: Assuming that liquid fuel is supplied to the pump through the pipe 20, and that the shaft 37 is driven from an appropriate part of the engine in proper timed relation therewith, the liquid fuel will be fed through the passage 19 to the inner groove 18 and from this groove to the inlet passages 8 leading to the intake ports 6 of the pump units. Each time one of the cam projections 51 is brought beneath a pump unit by rotation of the cam 50, the plunger 5 of such unit will be lifted by its tappet 41. During the initial part of the upstroke of the plunger, the fuel in the cylinder above it will be forced upwardly, opening the valve 11 and entering one of the passages 25 and flowing to the central port 26. The fuel then passes to the central port 34 and through the radial passage 36 to the port 35 in the valve 31. As the valve 31 is rotated in timed relation with the pump units through the shaft 37 which drives it and the cam 50, the port 35 in the valve will register with one of the dis-

tributor ports 17 from which the fuel is conducted through the port 27 and passage 28 and by the respective pipe 30 to the injector and ignition plug of the corresponding engine cylinder, the fuel unseating the check valves 95 and 91 and flowing through the passages 90 and 82 and chamber 74 and discharging into the cylinder through the orifice 76, where it is ignited by the spark passing at the appropriate time between the electrodes 71a and 72.

The amount of fuel injected into each cylinder by each pump unit is controlled by adjustment of the rack bar 67 which rotates the pump plungers simultaneously to alter the relation of the helical edge 5c of the groove 5b of each plunger to the by-pass port of the respective cylinder. When this helical edge of the groove comes into communication with the respective by-pass port 7 during the upward or working stroke of each plunger, the fuel in the respective cylinder flows from the upper side of the plunger through the groove 5b and discharges into the by-pass port 7, thereby terminating the discharge of fuel past the check valve 11, thereby metering or regulating the amount of fuel injected into the engine cylinders by the respective pump units. When the cam projections 51 each pass from beneath each pump plunger, the latter is lowered by its spring 47, the respective check valve 11 then being closed, so that fuel is drawn from the inlet port 7 of the respective pump unit when it is uncovered by the descending plunger. As the ignition timer and distributor is driven in synchronism with the pump, the fuel charges will be ignited simultaneously with their introduction into the respective engine cylinders. Adjustment of the rack bar 67 operates through the pinion 66 and gears 64 and 60 to rotate the pump plungers simultaneously and to equal extents to vary the relation of the helical groove 5c of each plunger to its port 7, causing fuel above the plunger to by-pass into said port at an earlier or later point in its discharge stroke, thereby metering the fuel injected into the engine cylinders, according to the position of the rack bar.

In the modified form of the pump shown in Figs. 16 to 20 inclusive, the pump plungers 5a, four of which are shown, are fitted to reciprocate in cylinders 2a fixed in the pump casing 1a, as by bushings 2b threaded into the casing and forcing the cylinders into the casing with a taper fit. The pump plungers are reciprocated by tappets 41a actuated by a cam 50a fixed on an extension 150 of the shaft 37a and having cam projections 51a thereon for actuating the plungers. The cylinder of each pump unit is open at its upper end and communicates with a port 10a in a plate 12a and provided with a check valve 11a and spring 15a in chambers 24a in a cap 13a, these chambers being connected by radial passages 25a in the cap leading to a central passage 26a, the latter communicating with a central port 34a in a circular bevelled valve 31a mounted rotatably between the upper end of the casing 1a and the plate 12a. The valve 31a has a radial passage 36a leading from its central port to a port 35a which communicates successively with ports 17a arranged in an annular series in the head plate 12a, which register with a corresponding annular series of ports 27a in the cap 13a, the latter having passages 28a leading from the latter ports for connection by pipes 30a to the respective cylinders of the engine. The passages, ports and distributing valve in this embodiment of the invention are thus similar in arrangement to Figs. 1 to 15 inclusive, and they function in a similar manner to distribute the liquid fuel to the different cylinders of the engine, but the means for metering or regulating the amount of fuel injected by the pumps is somewhat different.

As shown in Fig. 18, the cylinder of each pump unit is provided, near its upper or discharge end, with a port 7a which communicates, through a passage 9a, and check valve 110 with a central chamber 111 in the upper portion of the casing below the valve 31a, and which is connected to receive liquid fuel through a feed pipe 112 and passage 113. The valve 110 is pressed toward its seat by a spring 114, and is provided with an upwardly projecting stem 115. The shaft 37a to which the valve 31a is fixed, is mounted in bearings 116 and 117 located centrally in the casing, a suitable packing 118 being inserted in a chamber 119 surrounding the shaft and retained by a nut 120 to prevent leakage of fuel from the chamber 111.

A set of tappets 120 is mounted for vertical movement on a disk 122, mounted rotatably in the upper end of the chamber 119, the tappets corresponding in number to the number of pump units, and being arranged in an annular series and guided for individual vertical movements by vertical pins 121 secured in the disk 122, one of these tappets overlying the stem 115 of each valve 110. The disk 122 is connected to a gear 123 for rotation therewith, as by a hub 124 through which pins 125 fixed to the tappets extend, an antifriction bearing 126 being preferably interposed between the gear 123 and the valve 31a, against which said gear is pressed by a spring 122a. The shaft 37a carries a cam 127 which rotates therewith and is provided with a suitable number of cam projections 128 arranged to engage and depress successively the pins 125 which project inwardly from the tappets. When, as shown in the present instance, the pump comprises four pump units, and the pump actuating cam 50a is provided with two cam projections 51a spaced apart through an angle of 135 degrees, two cam projections 128 spaced apart through a similar angle of 135 degrees and synchronized with the cam projections 51a will be sufficient for an eight cylinder engine, and three cam projections 128 equidistantly spaced apart through angles of 120 degrees will be sufficient for a twelve cylinder engine.

The tappets 120 are normally held in raised position by the springs 114 of the respective valves 110 the upwardly projecting stems 115 of which engage the undersides of the respective tappets, but as the cam 127 is rotated by the shaft 37a, it successively engages the pins 125 on the tappets and lowers the latter, thereby pushing open the respective valves 110, thus permitting liquid fuel to be by-passed or returned from the respective pump units to the supply chamber 111. The cam 127 is so timed on the shaft 37a in relation to the cam 50a that its projection 128 will depress each valve 110 during the fuel discharge stroke of the plunger of the respective pump unit, thereby permitting fuel to be by-passed from the upper side of each pump plunger through the respective port 7a, passage 9a and valve 110 into the chamber 111.

In order to enable the amount of fuel by-passed from each pump unit during the working strokes of its plunger, and to thereby meter or regulate the amount of fuel injected during the working strokes of the pump plungers, the gear 123 is

rotatable into different positions by means located exteriorly of the pump casing, it being preferable to employ a bevel pinion 130 which meshes with the gear 123, this pinion being formed on the inner end of a stem 131 which is preferably of tapered form and fitted rotatably in a bushing 132 threaded in the pump casing, the stem being shown provided with circumferential grooves 133 to provide circular air pockets which serve as seals to prevent leakage of liquid fuel from the chamber 111. The outer end of the stem 131 is provided with means for rotating it, as for example, a pinion 134 which is fixed thereon and meshes with a gear segment 135 which is pivoted on a screw 136 secured in the pump casing and adapted to be connected to a suitable throttle control member. A spring 134a is preferably interposed between the pinion 134 and the bushing 132 to maintain a fluid-tight fit between the tapered stem 131 and its correspondingly tapered bushing 132, and a spring 137 may be interposed between the segment 135 and the pump casing, this spring serving to return the cam 127 to its normal closed throttle position.

As previously stated, the number of cam projections 128 provided on the cam 127 may be varied according to the number of pump units employed and the number of engine cylinders to be supplied thereby with fuel. For example, in the present instance, in which the pump embodies four pump units spaced apart through angles of 90 degrees around the central shaft 37a, two cam projections 128 spaced apart through an angle of 135 degrees will be employed for an eight cylinder engine, such cam projections being timed to correspond with the timing of the cam projections 51a which actuate the pump plungers, as indicated in Fig. 23, but by employing two diametrically opposite pump units and two cam projections 128 and two cam projections 51a each spaced apart through an angle of 90 degrees, the fuel can be injected at proper intervals to a four cylinder engine, and by employing a cam 50a provided with three cam projections 51a spaced apart through angles of 120 degrees, and a cam 127 having three cam projections 128 spaced apart through angles of 120 degrees, a pump having two diametrically opposite pump units will be sufficient for a six cylinder engine, and a pump having four pump units spaced apart through angles of 90 degrees around the central shaft, will be sufficient for a twelve cylinder engine.

The operation, in the embodiment of the invention disclosed in Figs. 16 to 23 inclusive, is as follows: Assuming that liquid fuel is supplied to the chamber 111 from a tank or other suitable source through pipe 112 and passage 113 and that the shaft 37a is driven from the engine in appropriately timed relation therewith, liquid fuel will be drawn into the upper end of each pump cylinder, during the down-stroke of its respective plunger 5a, through the respective valve 110 by the unseating of this valve, and through the passage 9a and port 7a. As a cam projection 51a on the cam 50a lifts the tappet 41a of each pump plunger, the latter is forced upwardly on its working stroke, and simultaneously therewith, the tapept 120 above the valve 110 for such plunger will be depressed by a cam projection 128 on the cam 127 acting on the pin 125 of the tappet, thereby opening the valve 110 and permitting fuel drawn into the respective pump unit to flow back into the supply chamber 111 and thus by-passed. The amount of fuel thus by-passed depends upon the adjustment of the disk 122 by the gear 123 and its controlling means. As soon as the cam projection 128 passes off the pin 125, the tappet is free to rise under the action of the spring 114 of the valve 110, thereby permitting closing of this valve. By-passing of the fuel from the pump unit is then terminated, and the remaining upward or working stroke of the pump plunger is effective to eject a metered amount of fuel into the engine cylinder. The fuel from the pump units is distributed to the appropriate cylinders by the rotating valve 31a, the fuel from the different pump units being conducted by the radial passages 25a to the central passage 26a, whence it flows through central passages 24a and 34a and radial passage 36a to a port 35a in the valve 31a, the rotation of this valve bringing this port into communication successively with the ports 28a which communicate with the pipes 30a which are connected to the fuel injectors in the respective engine cylinders.

The pump shown in Figs. 16 to 23 inclusive may be utilized to drive the conventional form of ignition timer and distributor 100a for the engine, the shaft 37a having a bevel gear 101a fixed thereon and meshing with a similar bevel gear 102a fixed on the shaft of the distributor, as in the embodiment shown in Fig. 1.

The present invention provides means for effectively lubricating the pump plungers, especially when a fuel lighter than the heavier grades of fuel oil is used. Fig. 24 shows a lubricating system for a pump constructed as shown in Figs. 1 to 14 inclusive, the cap 13 having a passage 140 therein connected to receive a suitable grade of lubricating oil from a suitable reservoir, pump and filters through a pipe 141. The oil introduced into the passage 140 is conducted to a circular groove 142 formed in the under-side of the cap 13, and the oil flows from this groove into passages 143 which lead to the respective pump units, the oil filling chambers 144 surrounding each pump cylinder 2. From each chamber, passages 145 lead to the respective plunger 5 and through which the oil flows to the plungers and fills the circumferential grooves 5c, thus forming seals between the plunger and its cylinder and also lubricating the plunger and cylinders. The surplus lubricating oil introduced into the distributing groove 141, and which is under pressure, is returned to the reservoir or source of supply through an outlet passage 146 which leads from said groove to an oil return pipe 147. A similar lubricating system for the pump shown in Figs. 16 to 23 inclusive is shown in Fig. 25, with the exception that the lubricating oil entering through the pipe 141a, groove 142a and passage 143a enters the passages 145a in the pump cylinders directly, the surplus oil being returned to the oil reservoir as in Fig. 24.

The present invention provides a multiple unit fuel injecting pump in combination with a distributing valve which enables fuel to be injected into engine cylinders which are of a greater number than the pump units used, thereby simplifying and reducing the cost of manufacture of the pump, and providing a compact unitary structure which may be accommodated in relatively small space, which is a desideratum particularly in engines for aircraft.

By grouping the pump units in circumferentially spaced relation around a central actuating shaft, the fuel distributing valve and pump actuating cam may be conveniently operated from such shaft, and these parts will be maintained in

proper timed relation. This concentric relationship of the pump units, distributor valve and actuating cam also enables the pump to be built of a standardized general structure, and to be adapted for the injection of fuel for engines having different numbers of cylinders by equipping the pump with a cap having an appropriate number of fuel distributing ports and passages, and cams having appropriate number and arrangement of cam projections thereon.

I claim as my invention:

1. A fuel injecting pump comprising a group of pump units, a cam mounted concentrically of said units and having portions thereon spaced angularly to actuate the units successively, and a fuel distributing valve mounted coaxially with the cam and connected to receive fuel from the pump units and having outlets of a number which is a multiple of the number of pump units.

2. A fuel injecting pump comprising a group of pump units, a shaft mounted concentrically of said units, a cam fixed to said shaft for rotation therewith and having projections thereon spaced angularly to cooperate in succession with said units for actuating them at successive intervals, and a valve fixed to said shaft for rotation therewith and embodying means for receiving fuel from the pump units and for distributing it successively to a plurality of outlets.

3. A fuel pump comprising a casing, a group of pump units embodying reciprocatory plungers mounted in the casing, a shaft mounted in the casing parallel to the plungers, a cam fixed on the shaft to rotate therewith and having projections thereon spaced angularly to cooperate in succession with the plungers to actuate them successively, and a distributor valve fixed on the shaft to rotate therewith and connected to receive fuel from the pump units and having discharge ports of a number which is a multiple of the number of pump units and a distributing port cooperative with said discharge ports in synchronism with the actuations of the plungers by the cam projections for discharging the fuel successively to a plurality of outlets.

4. A fuel injecting pump for internal combustion engines, comprising a casing, a group of pump units in the casing, a shaft mounted in the casing centrally of the group of pump units, a cam on said shaft having a plurality of projections thereon spaced angularly to cooperate in succession with the pump units for actuating them at successive intervals, a distributing valve on said shaft having a distributing part connected to the pump units to receive fuel therefrom, and means fixed on the casing and having discharge ports which register with said distributing port synchronously with the actuations of the pump units by the cam projections, and having passages leading from said discharge ports for distributing fuel to the respective cylinders of the engine.

5. A fuel injecting pump for internal combustion engines, comprising a casing, a group of pump units in the casing, a shaft mounted in the casing, a cam on said shaft having a plurality of portions spaced angularly thereon to cooperate in succession with the pump units for actuating them, means providing a common outlet from the pump units, a distributing valve rotatable by said shaft and having a port arranged to receive fuel from said common outlet and having a fuel distributing port, and means on the casing having a series of discharge ports of a number which is a multiple of the number of pump units and with which the distributing port in the distributing valve communicates synchronously with the actuations of the pump units, and having passages leading from said series of ports for distributing fuel to the respective cylinders of the engine.

6. A fuel injecting pump for internal combustion engines, comprising a casing, a group of pump units in the casing having reciprocatory plungers, tappets for actuating the plungers, a shaft mounted in the casing, a cam on said shaft having a plurality of actuating portions spaced angularly to cooperate in succession with the tappets for operating said plungers, a distributing valve rotatable by said shaft and having fuel receiving and distributing ports, and means on the casing having a series of ports to receive fuel from the distributing port of said valve synchronously with the actuations of said plungers and having passages leading from said series of ports for distributing fuel to the respective cylinders of the engine.

7. A fuel injecting pump for internal combustion engines, comprising a casing, a group of pump units mounted in the casing, a shaft mounted rotatably in the casing, a cam fixed to said shaft and having a plurality of cam projections thereon spaced angularly to cooperate in succession with the pump units for actuating them at successive intervals, a distributing valve rotatable by said shaft, means on the casing for conducting fuel from the pump units to said valve, means for regulating simultaneously the amount of fuel delivered by the pump units to the distributing valve, and means on the casing for receiving fuel from the distributing valve synchronously with the actuations of the pump units and directing it to the respective cylinders of the engine.

8. A fuel injecting pump for internal combustion engines, comprising a group of pump units, a single distributing valve connected to receive fuel from said units and operative to distribute the fuel to the cylinders of the engine, and a cam having actuating projections thereon for said units, the number of said projections being coordinated with the number of pump units and the number of engine cylinders to which the fuel is distributed by said valve.

9. A fuel injecting pump according to claim 8, wherein said cam projections are of a number and arrangement to produce a number of operations of the pump units which is a multiple of the number of said units.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,631,185	Anibal	June 7, 1927
1,807,650	Chryst et al.	June 2, 1931
2,050,392	Starr	Aug. 11, 1936
2,142,086	Alden	Jan. 3, 1939
2,280,875	Wahlmark	Apr. 28, 1942
1,966,911	Stephan	July 17, 1934
2,243,995	Alden	June 3, 1941
2,255,203	Wiegand	Sept. 9, 1941
1,603,228	Woerner	Oct. 12, 1926
1,971,601	Dilg	Aug. 28, 1934
2,060,076	High	Nov. 10, 1936
2,160,735	Hoffer	May 30, 1939