

June 9, 1953

V. D. ROOSA

2,641,238

FUEL PUMP

Filed Aug. 11, 1947

5 Sheets-Sheet 1

Fig. 1

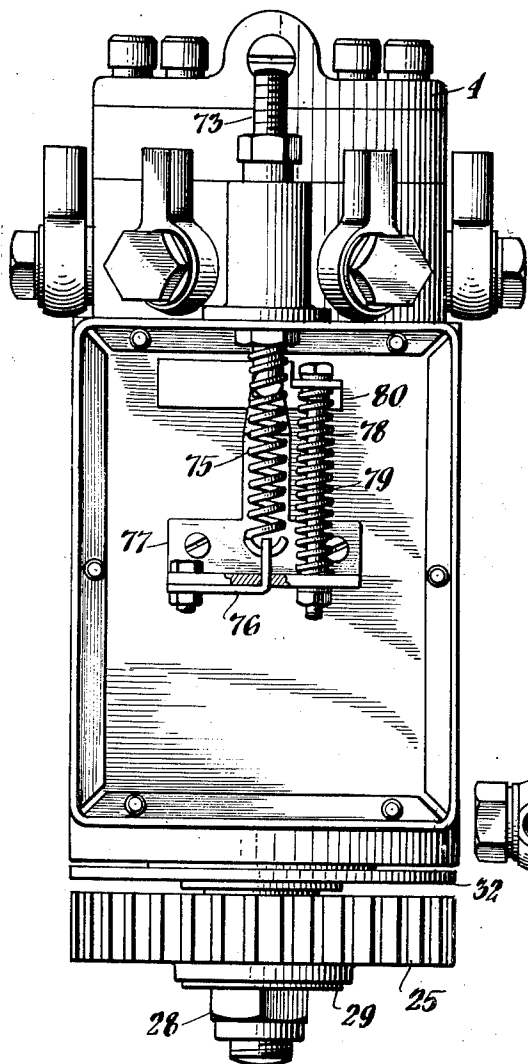


Fig. 7

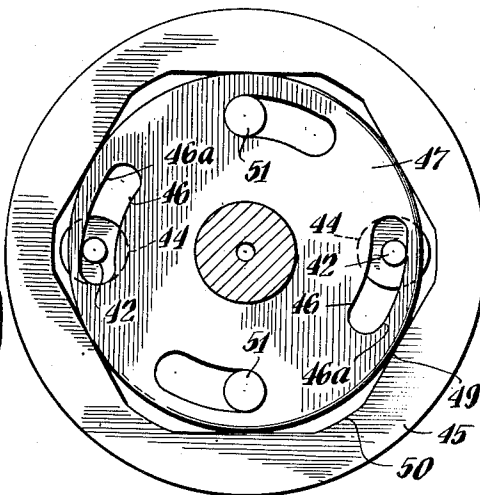
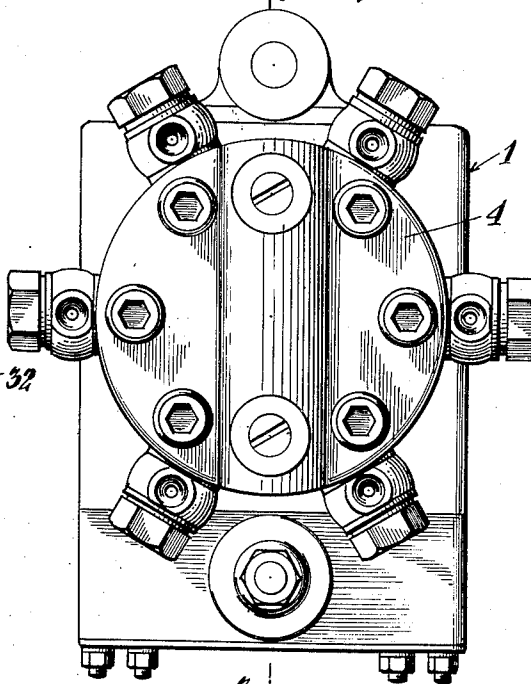


Fig. 2



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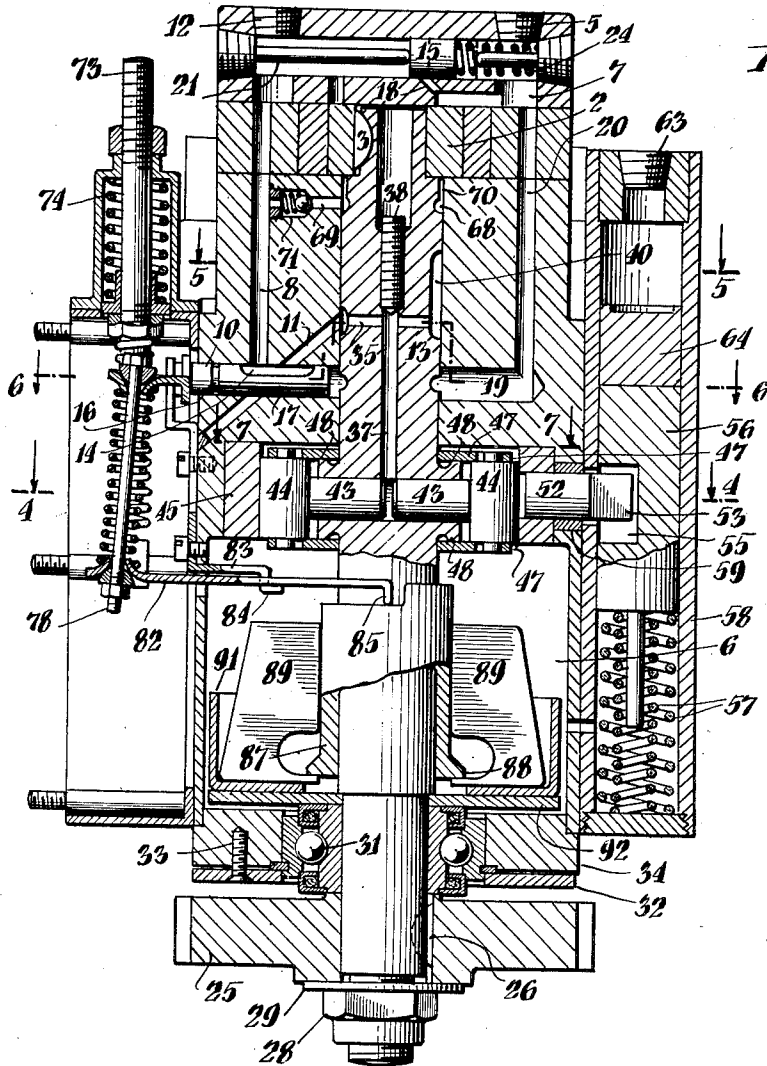


Fig. 3

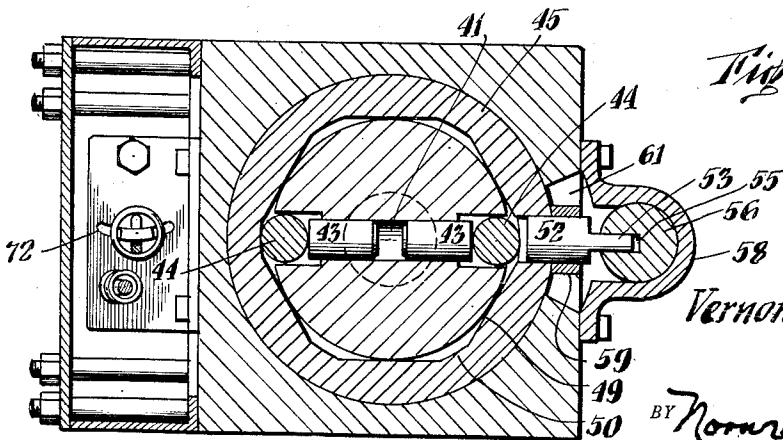


Fig. 4

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Fig. 5

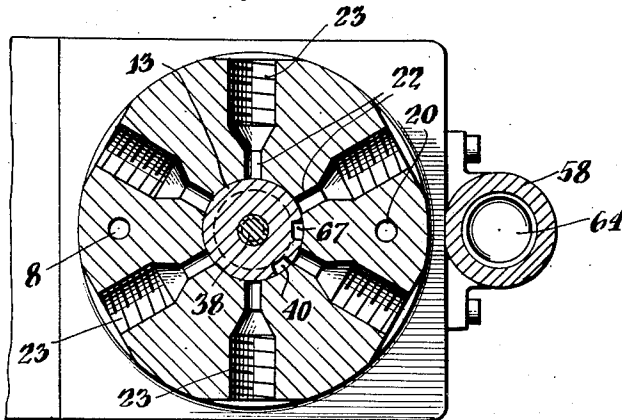


Fig. 6

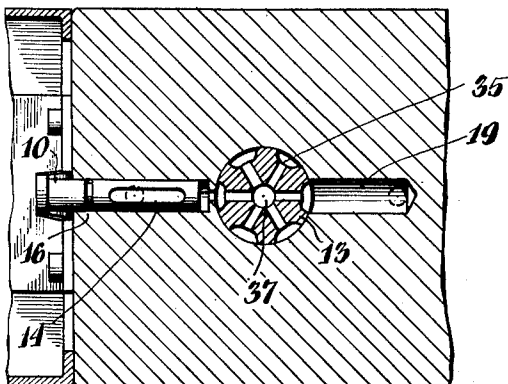


Fig. 8

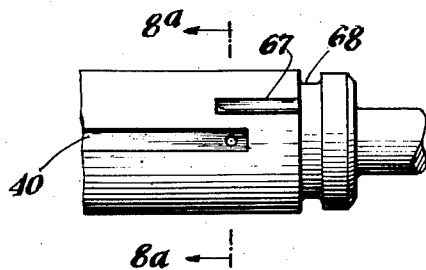


Fig. 9b

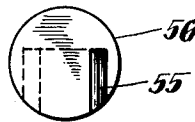


Fig. 9a

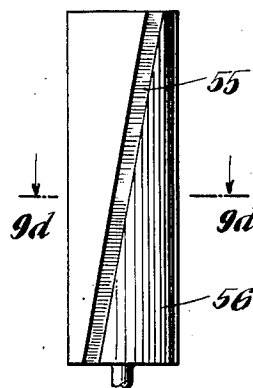


Fig. 9c



Fig. 9d

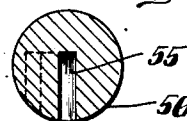
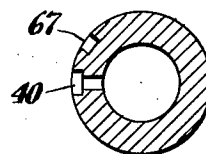


Fig. 8a



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Fig. 10

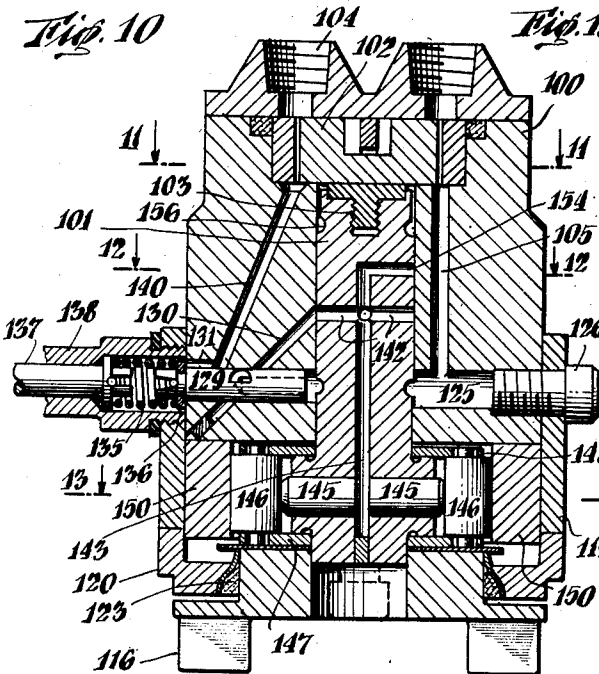


Fig. 13

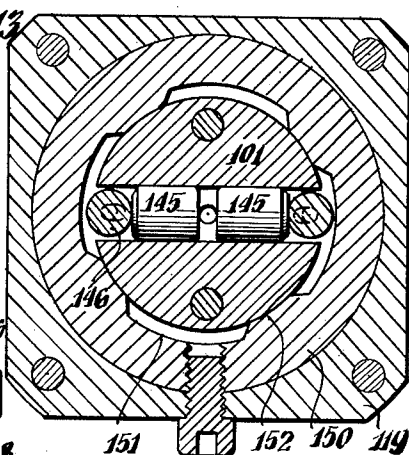


Fig. 14

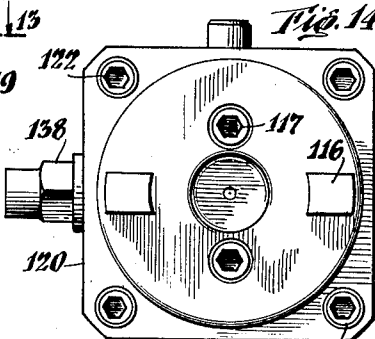


Fig. 11

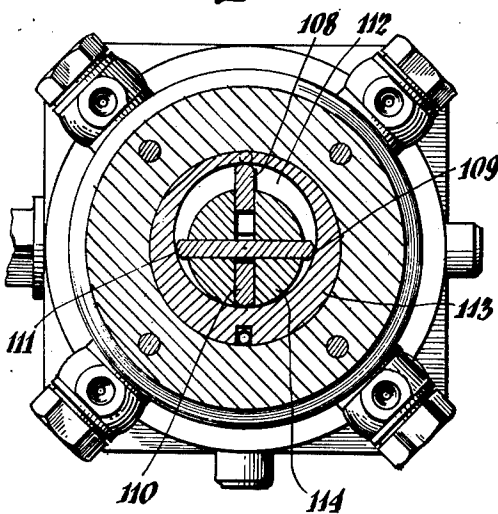
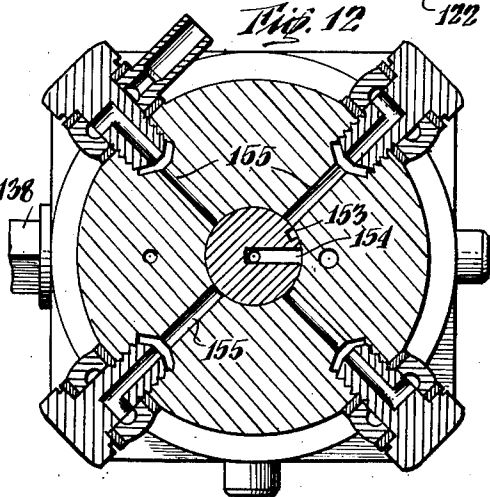


Fig. 12



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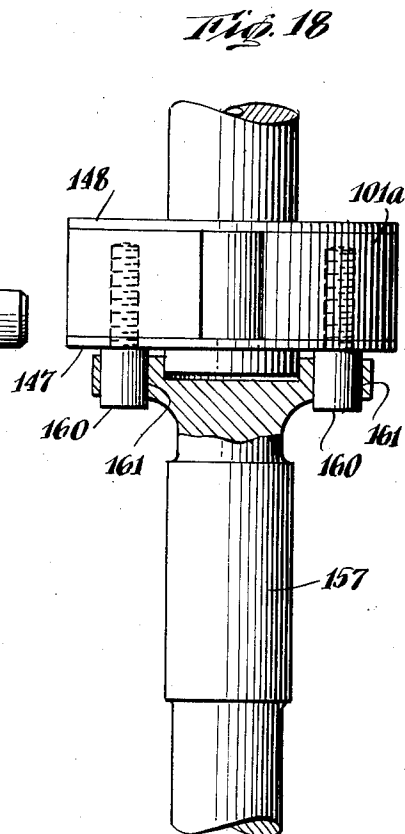
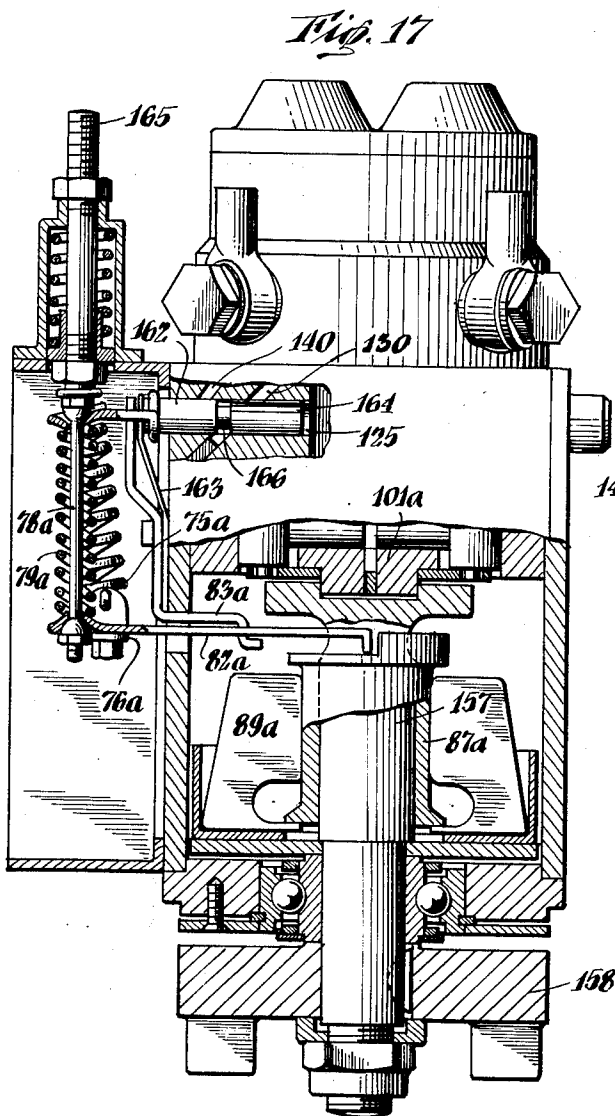
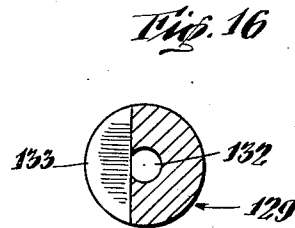
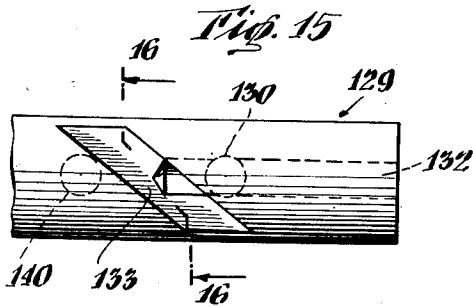
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5 Sheets-Sheet 5



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2,641,238

FUEL PUMP

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Application August 11, 1947, Serial No. 767,939

27 Claims. (Cl. 123—140)

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The present invention relates to fuel pumps of the type adapted to be utilized with internal combustion engines. The present pump is an improvement over previous pumps and over the pumps disclosed in my co-pending application, United States Serial Number 602,476, filed in the United States Patent Office on June 30, 1925, now Patent No. 2,538,982, granted January 23, 1951.

Manufacturers and users of fuel pumps are continually seeking to obtain a fuel pump adapted to be used with internal combustion engines which is relatively simple in construction and operation, inexpensive to manufacture, and adapted to operate efficiently over relatively long periods of time with little or no inspection or maintenance. The point of ease of maintenance is quite important as it is desirable that the ordinary garage mechanic be able to adjust or make minor repairs to such pumps. Where the number of parts is at a minimum the wearing surfaces are few and simplicity of operation is enhanced.

An object of the present invention is to provide a new and improved fuel pump for internal combustion engines and the like.

Another object of the invention is to provide a fuel pump which is relatively simple in construction and operation.

Another object of the invention is to provide a fuel pump embodying a new and improved pumping device.

Another object of the invention is to provide new and improved means for timing fuel injection.

A further object of the invention is to provide new and improved means for relieving excess pressure in a fuel conduit.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

A preferred embodiment of the invention has been chosen for purposes of illustration and description and is shown in the accompanying drawings, forming a part of the specification, wherein:

Fig. 1 is an elevational view showing one form of the present invention;

Fig. 2 is an end view of the pump shown in Fig. 1;

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 3;

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Fig. 5 is a fragmentary sectional view taken along line 5—5 of Fig. 3;

Fig. 6 is a fragmentary sectional view taken along line 6—6 of Fig. 3;

Fig. 7 is a fragmentary sectional view taken along line 7—7 of Fig. 3;

Fig. 8 is a fragmentary view of a fuel distributor;

Fig. 8a is a sectional view along the line 8a—8a of Fig. 8;

Figs. 9a, 9b, 9c and 9d are, respectively, plan, top end, bottom end and sectional views showing one form of time controlling member;

Fig. 10 is a sectional view through a modified form of fuel pump;

Fig. 11 is a sectional view taken along line 11 of Fig. 10;

Fig. 12 is a sectional view taken along line 12 of Fig. 10;

Fig. 13 is a sectional view taken along line 13 of Fig. 10;

Fig. 14 is an end view of the fuel pump shown in Fig. 10;

Fig. 15 is an enlarged fragmentary view of the metering valve shown in Fig. 10;

Fig. 16 is a sectional view along line 16—16 of Fig. 15;

Fig. 17 is a sectional view showing another modified form of the invention; and

Fig. 18 is a fragmentary sectional view showing a portion of the fuel pump of Fig. 17.

The pump of the present invention may be located in any position, that is, horizontally, vertically or otherwise, the positions shown in the drawings being chosen merely for purposes of convenience in description.

Referring more particularly to Figs. 1 through 9 of the drawings, there is shown a fuel pump comprising a casing, housing or stator 1 having a relatively large opening or bore and various smaller passageways or conduits (8, 11, 19, 20). An enlarged opening or chamber 6 is shown adjacent the lower part of the casing.

The upper part of the casing 1 is provided with a cover 4 bolted or otherwise secured thereto and beneath the cover 4 is shown a fuel transfer pump 2 adapted to supply fuel to the feeding and distributing portion of the pump. The transfer pump 2 may be of the rotary gear type, one example of which is disclosed in my referred to pending application and may be secured by a key 3 to a rotor or distributor which will be hereinafter described. While any suitable type of fuel transfer pump may be utilized, rotary gear or

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vane types have proven quite satisfactory in actual operation.

The cover 4 is provided with an inlet opening or passage 5 adapted to receive one end of an oil conduit (not shown) for conveying fuel to the transfer pump 2. Fuel entering the cover 4 through the threaded opening 5 may pass inwardly through the inlet passage 7 into the gear pump 2. The cover 4 also includes a pressure relief feature which will be later described. The exit or discharge side of the gear pump 2 communicates with a fuel conduit or pasageway 8 and another fuel passage 11 through a metering valve 10. The metering valve 10 may be moved to control the effective size of opening through the conduits 8 and 11 and hence the quantity of fuel passing through these conduits. The passageway 11 in turn is in communication with the fuel distributing means or rotor 13.

The metering valve 10 shown comprises a substantially cylindrical member having a recessed or cut away portion 14 at one side thereof; rotation of the metering valve is thus effective to vary the size of opening by which the discharge passage or conduit 8 communicates with the fuel passage 11. In order to minimize leakage of fuel outwardly along the metering valve 10, the valve may have an annular recess or channel 16 and a longitudinally extending channel or recess 17; fuel which tends to leak outwardly along the metering valve 10 enters the annular recess 16 and flows from this recess into the longitudinal recess or slot 17, from which it may pass into a transversely extending passage 19 that communicates with an additional return passage or conduit 20. The return conduit 20 leads back to the inlet passage 7 and hence such fuel may return to the transfer pump 2.

In order to pump or feed fuel charges to the cylinders of an internal combustion engine it is necessary that fuel which enters through the passageway 11 be conducted to discharge ports 22 (Fig. 5) of the pump; the discharge ports 22 may be connected by suitable conduits with the various cylinders of an engine. The ends of fuel conveying conduits may be secured with the stator or casing 1 in any suitable manner, preferably by threaded openings 23 (Fig. 5).

As shown in Fig. 3 a distributor or rotor 13 is adapted to successively connect the discharge openings or ports 22 with suitable pumping means for forcing fuel out of the discharge ports 22 and through the conduits to the cylinders of the engine.

The particular number of outlet or discharge ports 22 will be determined by the number of cylinders of the engine with which the fuel pump is used. For purposes of illustration and description the pump of Figs. 1-7 is shown adapted to feed fuel to an internal combustion engine having six cylinders.

The distributor 13 fits relatively closely against the walls of the central bore of the casing or housing 1 and adjacent its upper end is connected with the fuel transfer pump by the key 3 or other suitable means. Adjacent its lower end the rotor is shown secured to a gear or coupling 25 by a key 26; a nut 28 and washer 29 serve to retain the gear 25 in position on the distributor 13. The lower end of the distributor is retained in position by a ball bearing 31, the ball bearing being maintained in position by a plate 32 secured by screws 33 to a collar or mem-

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ber 34 bolted, force-fitted or otherwise attached to the lower end of the casing 1.

As the distributor 13 turns, due to rotation of the gear or coupling 25 keyed to the lower end thereof, the transfer pump 2 will be rotated to force fuel through the conduits 8 and 11 as described. The distributor or rotor 13 has a plurality of radially extending conduits therein adjacent the outlet end of the passage 11, the number depending upon the number of cylinders in the engine; in the present instance six radially extending distributor conduits 35 are utilized. As the distributor or rotor 13 turns, the radial openings 35 connect in consecutive order with the inlet pasageway 11 so that fuel may feed through the various radial openings 35 to a chamber or opening 37 at the interior of the distributor. The chamber or opening 37 may be formed within the rotor by drilling the rotor longitudinally and thereafter closing the upper portion or one end of the formed opening by a threaded plug or screw 38.

When the distributor has rotated to a position where an inlet conduit 35 is out of registry with the inlet port 11, a slot or opening 40 in the wall of the distributor may be in registry with one of the discharge ports 22 that connects with a cylinder of an engine. In this latter position it is desirable to eject the fuel from the chamber or the opening 37 of the distributor and to force it through a suitable conduit into the particular engine cylinder with which the slot 40 is in communication. Ejection of the fuel charge at this position may be achieved by the pumping means shown adjacent the lower part of the centrally disposed chamber 37.

The construction of the fuel pumping or ejection means may be best observed in Figs. 3, 4 and 7. The distributor 13 is provided with a laterally or transversely extending chamber or opening 41 into which is fitted one or more plungers or pumping members 43. The plungers 43 are shown freely mounted within the chamber or bore 41 so that they may slide or reciprocate toward and away from the central portion of the chamber 41. As shown in Figs. 3 and 4, the outer end of a plunger 43 rests against a roller 44 and the latter roller contacts a cam 45.

Retaining plates 47 fitted about the distributor 13 and resting against shoulders 48 thereof provide two desirable features; they serve to maintain the rollers 44 against endwise movement and they are also effective to limit the maximum outward positions of the rollers, and hence of the plungers or pistons 43. This limitation in outermost position of a roller 44 and plunger 43 may be achieved by pins or extensions 42 of the rollers which project into slots 46 of the retaining plates. It will be noted (Fig. 7) that the slots 46 are inclined or so disposed that circumferential shifting of the retaining plates serves to position different locations along the length of the outer edge 46a of a slot into operative relationship with the roller. Thus the stroke of the plungers' pistons may be adjusted by angularly shifting the plates 47 so as to obtain optimum pumping conditions. The retaining plates 47 may be held in an adjusted position by bolts (not shown) which extend through adjustment slots and thread into openings 51 in the shoulder of the distributor. As the distributor rotates, under the influence of the coupling or gear 25, the rollers 44 travel around or along the operating surface of the cam 45. Lobes or high and low points on the cam 45 tend to move the rollers inward radially so as to

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likewise move the plungers 43 inwardly when the rollers 44 are affected by a high point of the cam 45; when the rollers 44 are opposite low points 50 of the cam the plungers 43 may move radially outwardly.

Outward movement of the plungers 43 obtains due to rotation of the distributor 13, which tends to urge the plungers outwardly due to centrifugal force, and also due to fuel being forced into the cavity or chamber 37 of the distributor by the transfer pump 2 during intervals when a radial inlet passage 35 of the distributor is in registry with the inlet port 11. Fuel thus forced into the cavity 37 urges the plungers 43 outwardly due to the hydraulic pressure or force exerted by the entering fuel, the outermost position being determined by the adjacent portion of the outer slot edge 46a.

From the foregoing description it will be seen that the pumping members or plungers 43 are urged outwardly due to centrifugal force and also due to the incoming fuel; inward or pumping motion of the plungers 43 is achieved by cam means during intervals when the discharge slot or opening 40 of the distributor 13 is in communication with a particular discharge port 22.

In the event the fuel transfer pump 2 should tend to feed fuel to the distributor faster than the latter removes it, excess pressure will start to build up in the casing conduit 11. Any excess pressure will generally be relieved by passing outwardly through an opening 12 in the cover 4, this opening 12 being joined by a return conduit (not shown) with a fuel supply tank; the return conduit may be throttled by a valve to control the return flow.

In addition to relieving pressure by flow of fuel out through the opening 12 of the cover 4, there is also shown in the cover a pressure relief means adapted to facilitate "by-passing" of fuel. In the event of excess pressure at the discharge side of the transfer pump 2 the pressure is effective upon one end of a piston or member 15, normally retained in position over a port 18 and against a limiting pin 21 by a spring 24. A sufficient increase in pressure moves the member 15 away from the end of the pin 21 and in opposition to the spring 24 and uncovers the port 18. Fuel may then pass through the port 18 to a position adjacent the inlet of the fuel transfer pump 2. The pressure relief means is thus effective to by-pass fuel and relieve excess pressure within the pump.

For most efficient operation of an internal combustion engine it is desirable to provide means for varying the timing of the fuel injection into the engine cylinders. When an internal combustion engine connected with the present fuel pump is operating under given conditions, the plungers 43 are effective to deliver fuel charges to the cylinders at a certain time or "instant" with respect to the positions of the pistons in the engine; in the event that the speed of the engine is increased it is desirable to cause injection of fuel to the cylinder at a slightly earlier instant than occurred prior to speeding up of the engine.

With the present pump variation of the time of fuel injection may be achieved by shifting the position of the cam 45 so that the high points 48 thereof may be effective to actuate the rollers 44 and plungers 43 at a slightly earlier instant.

Movement or shifting, here shown as circumferential rotation, of the cam 45 may be achieved by the mechanism illustrated more particularly at the right side of Figs. 3 and 4 and in Fig. 9

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of the drawings. An operating pin 52 fitting into an aperture in the cam 45 and projecting through an opening 61 of the casing 1 has an extension 53 projecting into a slot 55 of a movable operating member 56; the operating member 56 may be yieldably mounted upon one or more springs 57 so that the member may move with respect to the cam 45. The operating member 56 is preferably mounted in a guide chamber or cylinder 58 and as it moves vertically (as shown in Figs. 3 and 4 of the drawings) the slot 55 therein which projects over the extension 53 of the operating pin 52 causes the operating pin 52 to move the cam 45 circumferentially to shift the positions of the high and low points of the cam with respect to the plungers 43 and operating rollers 44. The slot 55 is preferably diagonally disposed and has straight side walls (Figs. 9a-9d) so that longitudinal movement of the operating member 56 permits the pin 52 to move circumferentially and the pin extension 53 and pin itself to freely shift without jamming or binding. Preferably the operating pin 52 is mounted in a suitable bushing or bearing 59 to facilitate smoothness of operation thereof.

Movement of the operating member 56 is achieved by connecting the guide chamber of the cylinder 58 with a conduit in communication at any suitable location with the outlet side of the fuel transfer pump 2. Pressure created at the outlet or discharge side of the transfer pump 2 is thus effective at the interior of the guide cylinder or chamber 58. Pressure existing within the guide chamber 58 is effective upon a hydraulic piston 64 within the guide chamber 58, the latter hydraulic piston normally resting against the operating member or plunger 56. The operating piston 56 may be normally retained in upper position by the compression of springs 57 resting against the lower end of the guide chamber 58. When the operating member 56 is in upper or outward position (Fig. 3) the cam 45 is effective to deliver oil charges to the cylinders of an engine at a certain instant with respect to the positions of the pistons in the engine. As the speed of the engine increases, the pressure of fuel forced into the pump by the transfer pump 2 also increases; this pressure is communicated to the interior of the guide cylinder 58 and is effective upon the hydraulic piston 64 and adjacent operating member 56. When increased fuel pressure moves the hydraulic piston 64 and operating member 56 downwardly or inwardly the inclined slot in the latter member changes the position of the operating pin 52 and the latter shifts the position of the cam 45 in circumferential direction to automatically change the instant of injection of fuel into the cylinders of the engine. As the slotted operating member 56 moves upwardly or downwardly, different portions of the slot 55 become effective upon the extension 53 of the operating pin which actuates the circumferentially movable cam 45.

The pumping mechanism, including the pistons or plungers 43 which deliver fuel to the cylinders of an engine, cause ejection of the fuel at a higher pressure than that created by the fuel transfer pump 2. Upon delivery of a fuel charge to an engine cylinder there may remain in the conduits leading to the engine cylinder an excess or residual pressure. It is desirable to relieve this pressure immediately subsequent to completion of delivery of a desired charge to an engine cylinder. In the present fuel pump this relieving of pressure is achieved by providing a pressure

relief slot or opening 67 in the distributor or rotor 13, the pressure relief slot being positioned slightly rearwardly or "in retard" of the discharge port or slot 40 (Fig. 8). In Figs. 8 and 8a the relief opening is shown approximately 36° in retard of the discharge opening, but any suitable amount of "offsetting" may be utilized.

The discharge slot 40 comes into registry with and hence is effective to conduct fuel under pressure to discharge port in communication with a line leading to an engine cylinder. The discharge slot 40 thereafter passes out of registry with the discharge port during the interval while a pumping roller 44 is on a dwell portion of the cam 45; the pressure relief opening 67 moves into registry with the same discharge port very shortly thereafter (this may occur while the rollers 44 are on the dwell portion of the cam or, in some instances, while they are moving toward a low area of the cam). Fuel under pressure in a discharge or injection conduit may thus be relieved by the registration of the relief opening 67 therewith.

The pressure relief opening 67 may communicate with an annular groove 68 formed in the distributor 13 and the annular groove 68 may communicate through a portion 70 of reduced diameter, with the transfer pump 2. Fuel which passes from the relief aperture 67 into the relief groove 68 may flow gradually through the portion of reduced section and to the fuel pump 2 or other low pressure part of the pump. It has been found that utilizing a diameter 70 which is about one-one thousandth of an inch less than adjacent distributor portions is satisfactory.

Instead of utilizing a distributor portion of reduced diameter, the relief groove 68 may communicate with a passage 69 having a relief valve mechanism therein. The relief valve may be set to unseat at a suitable pressure to allow relief or passage of fuel into the fuel passage 8 leading to the metering valve 10. In some instances there may be used other means such as a needle valve or a fixed orifice.

The mechanism for controlling the position of the metering valve 10 and thus controlling the quantity of fuel fed to the distributor 13 may be similar to that described in my application previously referred to. A throttle rod may be connected with the threaded member 73 to facilitate moving the member 73 up or down (Fig. 3). A spring 74 normally urges the member 73 in one direction. Shifting the position of the throttle rod connecting member 73 is effective to change the force or tension of the tension spring 75 which is connected adjacent the lower end thereof with a resilient L-shaped member 76, the latter member being secured adjacent one end thereof by a nut to a lever 82. As described in connection with my previous application, the L-shaped bracket or connecting member may be changed with respect to an opening or slot 72 through which it passes; thus the same spring may be utilized for different installations and the desired spring strength obtained by changing the leverage of the spring.

The lever 82 is connected with the metering valve 10 through the intermediation of a rod 78, spacer spring 79 and cross arm 80. Operating lever 82 is pivotally supported intermediate its ends upon an arm or bracket 83 at a supporting portion 84. The free end 85 of the lever 82 rests upon one end of a sleeve 87 shown extending about a portion of the distributing member or rotor 13. The lower end of the sleeve 87 is provided with a shoulder 88 which extends into

recesses or openings of weights 89 of a governor.

The governor comprises a series of weights housed in suitable pockets or openings 91 secured to the member 92, the member 92 being keyed or otherwise secured to the rotor 13 in such manner as to rotate with it. Preferably a plurality of weights are utilized. As the rotor 13 turns and carries with it the governor weights 89, centrifugal force tends to throw the weights outwardly and the lower inner ends of the weights tend to lift the extension 83 of the sleeve member 87. Longitudinal or upward movement of the sleeve 87 lifts the inner end 85 of the lever 82 and is effective to shift the position of the metering valve 10 through the rod 78 and cross arm 80. When a state of equilibrium is reached the centrifugal force of the weights 89 is balanced against the tension of the spring or resilient member 75 and when the two forces are equal the speed of the engine is fixed.

A solenoid or electromagnet construction (not shown), similar to that of my referred to pending application, may be utilized to shut off the supply of fuel when a cut-off switch is actuated to stop the engine.

While the member 25 is shown as a gear, any other suitable means for coupling the pump to a driving means may be utilized. By connecting the gear or coupling member 25 with the engine, the distributor or rotor 13 may be caused to rotate at a speed determined by the speed of the engine on which the pump is mounted.

In Figs. 10 through 16 there is shown a modified form of the present fuel pump which is particularly adapted for use with internal combustion engines subjected to variable speeds. Examples of such uses are engines used in automobiles, tractors and also in marine installations.

The pump shown in these figures comprises a casing 100 having various fuel passages (105, 125, 130) therein adapted to convey fuel during movement to the cylinders of an engine. In addition, an opening is adapted to contain a fuel distributor 101.

A transfer pump 102 is shown attached to the upper portion of the distributor 101 by a threaded or other suitable connection 103. The fuel transfer pump is adapted to receive fuel, from a source of supply (not shown), through an inlet conduit 104 and to discharge it, under increased pressure, to a passage 105. The transfer pump 102 shown in Figs. 10 through 16 is of the rotary vane type and may comprise a plurality of radially extending vanes 108, 109, 110 and 111 (Fig. 11) adapted to rotate within the chamber 112 of an outer appropriately shaped member 113. Fuel fed into the rotary vane pump is discharged therefrom into passage 105 upon rotation of the vanes and the actuating or driving member 114. Vane pumps of this general type are known and hence a further detailed description of such a transfer pump is believed unnecessary. While a vane type pump is shown, a rotary gear type pump similar to that disclosed in connection with Figs. 1 through 9 may be used.

The fuel distributor 101 and the transfer pump 102 are simultaneously rotated by a suitable coupling or driving member 116 shown connected with the lower part of the distributor by suitable socket head screws or bolts 117. While any suitable type of coupling 116 may be utilized the type shown, which is generally referred to as an "Oldham" coupling, is preferred since it facilitates ready assembly and disassembly of the fuel pump with a driving means.

The pumping mechanism which is adapted to eject fuel from the pump to the cylinders of an engine is generally similar to that described in connection with the embodiment of Figs. 1 through 9 and is shown enclosed within a substantially cylindrical housing member 119 bolted or otherwise secured to the casing 100. A housing extension 120 is bolted or otherwise secured to the housing 119 by socket head screws or bolts 122. A suitable flexible or resilient sealing member 123 is shown intermediate the housing extension 120 and a rotating portion of the coupling member 116; the utilization of such a sealing member of "neoprene" rubber or any other suitable material tends to seal the interior of the pump against contamination by dirt or other impurities.

During operation of the pump of Fig. 10 fuel enters the inlet conduit 104 and passes into the transfer pump 102, from which it is discharged into the fuel passage 105. From passage 105 fuel passes into an additional passage 125. The passage 125 is shown extending substantially laterally or transversely through the casing 100 and may be drilled or otherwise suitably formed in the casing. One end of the passage 125 is closed by a plug 126 and the opposite end contains a controlling or metering valve 129 which will be fully described hereinafter. After passage beyond the metering valve 129 the fuel enters a fuel feeding passage 130 which terminates at the outlet end thereof adjacent the distributor 101.

The metering valve 129 is adapted to control the passage or flow of fuel from the transverse passage 125 into the fuel feeding passage 130. The metering valve is shown more particularly in Figs. 10, 15 and 16. As shown in these figures it comprises a rod-like member having a longitudinally disposed opening or aperture 132 therein which is in communication with a diagonally disposed slot or cut-away portion 133. The slot or opening 133 is preferably positioned at an angle with respect to the longitudinal axis of the metering valve and, while any appropriate angle may be utilized, an angle of forty five degrees has proven satisfactory in actual usage.

When the metering valve is so positioned that the slot 133 is opposite a solid or imperforate portion of the casing wall fuel is cut off and does not flow from the slot 133 into the feed passage 130. Suitable rotation of the valve 129 serves to move the slot into registry with the lower end of the feed passage 130. The valve may be rotated so as to place the discharge slot 133 into partial or complete registry with the lower end of the feed passage 130. The lower end of the feed passage 130 is indicated diagrammatically in Fig. 15; when the metering valve is turned the discharge slot 133 will gradually move into registry with the end of the feed passage 130 (Fig. 15). When the valve is rotated to place the discharge slot only partially into registry with the outlet passage 130 the cross sectional discharge area of the opening through which fuel may pass is relatively small and hence only a relatively small amount of fuel may feed through the valve and into the passage 130. As the valve is rotated more fully into registry with the feed aperture 130 a greater amount of fuel may pass through the passage 130 to the distributor 101. Hence the quantity of fuel passing to the distributor 101 may be controlled by suitably positioning the metering valve 129.

The metering valve 129 may be retained in the "inward" position of Fig. 10 by a spring or other

resilient means 135 which presses against a shoulder 136 of the valve. The opposite end of the spring may be connected with a control rod 137, the end of the rod 137 and the spring 135 being enclosed within a cap 138 secured into a threaded opening of the housing 119.

Opposite ends of the spring 135 are shown turned inwardly and extending substantially diametrically across the spring 135 to provide one means of attachment of the spring with the metering valve 129 and the control rod 137. The spring 135 thus serves to maintain the metering valve seated with the shoulder 136 thereof resting against a side wall portion of the casing 100. As the control rod 137 is rotated the spring or resilient means 135 likewise rotates and the metering valve 129 turns to control the flow of fuel.

A small opening 131 preferably connects the passage 140 with the interior of the cap or housing 138 to minimize the possibility of "hydraulic lock" whereby desired operation of the valve 129 might be interfered with.

In addition to performing the fuel control functions the metering valve 129 serves to provide governing and pressure relief features. In the event an engine tends to speed up excessively, due to an excess quantity of fuel reaching the engine cylinders, the coupling 116 connected with the engine serves to turn the distributor 101 and the fuel transfer pump at higher speed. Turning the transfer pump at higher speed tends to increase the fuel pressure at the discharge side of the transfer pump, namely in the passages or conduits 105 and 125. Increased pressure in conduit 125 is effective upon the metering valve 129 and tends to move the valve longitudinally in opposition to the effect of the resilient means 135. Movement of the valve 129 longitudinally in opposition to the spring 135 moves the valve discharge slot 133 so as to vary the amount of registry thereof with the lower end of the fuel passage 130; this may be seen more particularly in Fig. 15 of the drawings. Moving the diagonally disposed discharge slot 133 away from the lower end of the passage 130 decreases the effective discharge area of the slot 133 and passage 130 and hence serves to decrease the amount of fuel going to the fuel distributor 101. As a result the engine tends to slow down and slowing down the engine decreases the speed of the transfer pump 102; fuel pressure in the conduit 125 decreases and the metering valve 129 gradually moves back toward its initial inner position. The construction and operation tends to maintain a "balanced" condition until the throttle control rod 137 is intentionally actuated.

In the event an engine speeds up to an undesirable extent, pressure in the conduit 125 increases sufficiently to move the discharge slot or opening 133 into registry with the lower end of a pressure relief passage 140 and fuel may then pass through the central opening 132 of the valve, through the opening 133, and into the relief passage 140. The relief passage 140 communicates with the inlet side of the fuel transfer pump 102 and therefore serves to by-pass fuel through the pump to provide a very desirable pressure relief feature.

The distributor 101 is provided with a plurality of laterally extending passages 142 adapted to receive fuel from the feed passage 130 and conduct it into a centrally disposed opening or chamber 143 of the distributor 101. With the pump of Fig. 10 four passages 142 are utilized but any suitable number may be utilized, for example

six or eight. When a passage 142 is in communication or registry with the passage 130 fuel may enter the chamber 143. When the passages 142 are out of registry with the feed passage 130 fuel may be ejected from the chamber 143 by the pumping mechanism shown adjacent the lower part of the distributor.

The pumping mechanism shown adjacent the lower part of the pump of Fig. 10 is similar to that described in connection with Figs. 1 through 9 and comprises plungers or pumping members 145 adapted to be actuated by rollers 146 carried intermediate retaining plates 147 and 148. Actuation of the rollers 146 and plungers 145 during rotation of the distributor 101 may be achieved by a cam 150 having low and high points 151 and 152, respectively. Operation of the pumping means to force fuel out of the chamber 143 is similar to that already described in connection with Figs. 1 through 9.

Oil pumped out of the chamber 143 by the pumping means may emerge through a passage 154 adjacent the upper part of the distributor 101 and enter into laterally extending casing passages 155 (Fig. 12), which will be connected by suitable conduits (not shown) with the cylinders of an internal combustion engine. The discharge port 154 connects in consecutive order with the casing passages 155.

The distributor 101 is preferably provided with a pressure relief opening 153, pressure relief groove 156, and a reduced diameter portion similar to those described in connection with Figs. 1 through 9, whereby undesirable excess or residual pressure in a fuel discharge conduit may be relieved. This feature was brought out more particularly in connection with Figs. 3, 8 and 8a.

In addition, the pump of Figs. 10 through 16 is preferably provided with means for automatically varying the timing of injection of fuel into the cylinders of an engine. This feature has already been described in detail herein wherein it has been pointed out how movement of the operating cam (45 of Figs. 3 and 4) 150 serves to vary the instant of fuel injection.

In Figs. 17 and 18 there is shown a pumping mechanism similar to that of Figs. 10 through 16 embodied in and modified for use with a governing mechanism similar to that of Figs. 1 through 9. The utilization of such a governing mechanism is desirable in those instances where closer speed regulation is important. Examples of such use requiring closer speed regulation are in connection with electricity generating units.

When the pump of Fig. 10 is embodied in such a unit the housing extension 120 and coupling member 116 are removed from the pump and the distributor connected with a distributor extension 157, the outer end of the extension 157 being provided with suitable coupling means 158.

The drive connection between distributor 101a of Figs. 17 and 18 with the distributor extension 157 may be obtained by socket head screws or bolts 160 which serve to hold in assembled relationship the retaining plates 147 and 148 of the pumping mechanism. The heads of the socket screws 160 may project into suitable openings 161 in the member 157.

Adjacent the lower portion of Fig. 17 is shown a governing mechanism substantially similar to that of Fig. 3, wherein governor weights 89a are operatively connected with a sleeve 87a to move the sleeve in instances where the speed of the pump tends to reach an excessive value. Movement of the sleeve 87a serves to actuate the lever

82a and control movement of a metering valve 162. Pivotal movement of the lever 82a on a supporting bracket 83a and operation of the connecting rods 73a, connecting spring 79a and spring 75a is similar to that described in connection with Fig. 3.

The metering valve 162 is shown provided with a longitudinally extending slot 164 communicating with a circumferential groove 166, the valve being normally retained in "inner" position by a leaf spring 163. Manual control or rotation of the metering valve 162 for adjustment of fuel feed may be obtained by a throttle rod attached to connecting member 165; the governor mechanism adjacent the lower part of the pump also is effective to rotate the valve 162. In the event of sufficiently increased pressure in the passage 125 the valve 162 is urged toward the left (Fig. 17) in opposition to the effect of spring 163 to place the groove 166 into communication with the return passage 140; thus the valve 162 also acts as a pressure relief valve and tends to maintain a constant pressure in the passage 125 leading from the transfer pump.

It will be seen that the present invention provides a new and improved fuel pump comprising a minimum number of parts which may be readily manufactured at comparatively low cost. The relative simplicity of the pump insures low maintenance costs and continuity of operation over relatively long periods of time.

Ejection of fuel from the pump into the cylinders of an engine is obtained in positive manner by the pumping plungers, the plungers being freely mounted within suitable cylinders or chambers. Variation of the injection of timing may be automatically obtained by varying the position of an operating cam which controls the movement of the plungers.

Relief of excessive pressures within a discharge conduit leading to an engine cylinder subsequent to injection is facilitated by pressure relief means of relatively simple construction incorporated with the distributor and the pump.

The pump is relatively simple in construction and is well adapted to withstand any rough usage to which it may be subjected.

As various changes may be made in the form, construction and arrangement of the parts herein without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. In a fuel pump adapted to be used for internal combustion engines and the like, the combination of a casing having fuel discharge ports, a rotatable fuel distributing member disposed in said casing and having a fuel discharge opening for communication with said discharge ports in sequence as the distributing member is rotated, pumping means including a chamber in said distributing member communicating with the discharge opening and a piston mounted for reciprocal movement in said chamber, a normally stationary cam disposed about the axis of rotation of the distributing member and supported by the casing for intermittently actuating the plunger in timed relationship with the rotation of the distributing member to cause injections of fuel while the opening is in communication with a fuel discharge port, and means for adjustably moving the cam about the axis of the distributing mem-

ber to adjust the timing of the pumping means relative to the distributing member.

2. In a fuel pump adapted to be used for internal combustion engines and the like, the combination of a fuel pick-up pump having a rotatable pumping member, a casing having fuel discharge ports, a rotatable fuel distributing member disposed in said casing and having a fuel discharge opening for communication with said discharge ports in sequence as the distributing member is rotated, means for simultaneously rotating the distributing member and the rotatable pumping member of the pick-up pump, pumping means including a chamber in said distributing member communicating with the discharge opening and a piston mounted for reciprocal movement in said chamber, cam means for intermittently actuating the piston in timed relationship with the rotation of the distributing member to cause injections of fuel while the opening is in communication with a fuel discharge port, and means responsive to pressure created by the fuel pick-up pump for adjusting the position of the cam whereby the timing of the pumping means is varied relative to the distributing member as the speed of rotation of the distributing member is varied.

3. In a fuel pump adapted to be used for internal combustion engines and the like, the combination of a fuel pick-up pump having a rotatable pumping member, a casing having fuel discharge ports, a rotatable fuel distributing member disposed in said casing and having a fuel discharge opening for communication with said discharge ports in sequence as the distributing member is rotated, means for simultaneously rotating the distributing member and the rotatable pumping member of the pick-up pump, pumping means including a chamber in said distributing member communicating with the discharge opening and a piston mounted for reciprocal movement in said chamber, a normally stationary cam disposed about the axis of rotation of the distributing member for intermittently actuating the piston in timed relationship with the rotation of the distributing member, means providing a chamber in communication with the fuel pick-up pump, a plunger in said chamber operatively connected to the cam for revolving the cam about the axis of the distributing member in response to the pressure of fuel from the pick-up pump whereby the timing of the pumping means relative to the distributing member is adjusted in response to the speed of the distributing member.

4. In a fuel pump, the combination of a casing having fuel exit ports, a rotatable fuel distributing member in said casing having a fuel discharge opening movable along a portion of said casing when the distributing member is rotated for communication with said fuel exit ports in sequence and having a relief opening disposed in retard of said fuel discharge opening for communication with said fuel exit ports following communication of said fuel discharge opening therewith, a charge pump communicating with said fuel discharge opening, a fuel pick-up pump communicating with said charge pump, and means forming a passageway between said relief opening and the discharge side of the fuel pick-up pump.

5. In a fuel pump for an internal combustion engine, the combination of a member having a plurality of discharge ports, a rotatable fuel distributing device associated with said member having a fuel discharge opening and having a

pressure relief opening disposed in retard relationship with respect to said fuel discharge opening for communicating sequentially with the fuel discharge ports during rotation of the fuel distributing device, pumping means for supplying fuel under pressure to said discharge opening, and a restricted passage communicating with said pressure relief opening adapted to conduct fuel away from the pressure relief opening and means for maintaining pressure in said passage.

6. In a fuel pump, the combination of a housing having a fuel conducting passage, a fuel distributor associated with said housing and communicating with said housing passage, a fuel transfer pump adapted to supply fuel to said housing passage, a control valve in the housing passage between the fuel distributor and the transfer pump, said valve including a valve body mounted for translational movement in a direction to vary the flow of fuel through said housing passage, and means for moving the valve in said one direction including a surface on the valve subjected to the pressure of fluid in the said housing passage.

7. In a fuel pump, the combination of a housing having a fuel conducting passage, a fuel distributor associated with said housing, a fuel transfer pump adapted to supply fuel through said fuel conducting passage to said distributor, a fuel control valve in said fuel conducting passage, means for mounting the valve for movement in a first direction for varying the flow of fuel through said fuel conducting passage and for movement in a second direction for varying the flow of fuel through said fuel conducting passage, manually operable means for moving the valve in said first direction, means on the valve subjected to fuel pressure in said fuel conducting passage for urging the valve in said second direction, and spring means opposing movement of the valve in said second direction.

8. In a fuel pump, the combination of a housing, a fuel distributing means associated with said housing, a fuel transfer pump associated with said housing for supplying fuel under pressure, a fuel control valve movably positioned in an opening of said housing, means forming a passageway between the fuel transfer pump and the valve and between the valve and the distributing means, said valve having a recess adjacent an outer surface thereof for varying the flow of fuel through the passageway depending upon the size of registering opening between said recess and the fuel passageway, and said valve having a portion exposed to pressure existing within the fuel passageway and resilient positioning means for the valve to permit the valve to move in a direction for varying the size of registering opening between said recess and the fuel passageway upon delivery by the fuel transfer pump of fuel at a predetermined pressure.

9. In a fuel pump, the combination of a casing having a fuel feed passage, a fuel distributor passage and a fuel relief passage, a feed pump for supplying fuel under pressure to the fuel feed passage, a control valve between the fuel feed passage and the fuel distributor and fuel relief passages having a valve body movable in one direction through a range of positions for decreasing the effective opening between the fuel feed passage and the distributor passage to a position for discontinuing admission of fuel to the fuel distributor passage and directing the fuel to the fuel relief passage, means on the valve

subject to fuel pressure existing in said fuel feed passage for urging the valve in said one direction, and means yieldingly urging the valve in the opposite direction.

10. In a fuel pump, the combination of a casing having a fuel feed passage and a fuel distributor passage and a fuel relief passage, a fuel tributor passage and a fuel relief passage, a fuel transfer pump for supplying fuel under pressure to the fuel feed passage, a control valve in the fuel feed passage having an area subject to fuel pressure created in said fuel feed passage by said transfer pump, manually operable means for rotating said valve to control the quantity of fuel passing from said fuel feed passage to said fuel distributor passage, and means yieldably maintaining said valve in position against axial movement, a predetermined fuel pressure in said fuel feed passage being effective to move the valve axially to vary the size of effective opening between the fuel feed passage and the distributor passage, and a predetermined additional pressure being effective to move the valve axially an additional distance to discontinue admission of fuel to the fuel distributor passage and to direct fuel to the fuel relief passage.

11. In a fuel pump, the combination of a casing provided with a cylindrical chamber having a fuel inlet and a plurality of fuel outlet ports, means for pumping fuel under pressure to said fuel inlet, a fuel receiving and distributing member rotatably mounted in said chamber having a longitudinal fuel passageway therein provided with opening means for communicating alternately with said inlet and an outlet port as the member is rotated and having a transverse chamber communicating with said passageway, a plunger freely mounted in said chamber for movement in an outward direction to admit said fuel to the transverse chamber and in an inward direction to force the fuel from the transverse chamber, and a cam surrounding said member having a plurality of raised portions for moving the plunger inwardly each time the member is rotated to place said passageway in communication with an outlet port.

12. In a fuel pump, the combination of a rotatable fuel distributor having an axial fuel passageway provided with fuel inlet and outlet ports, a radial bore in said distributor communicating with said passageway, a pair of plungers in said radial bore adapted to be moved apart to receive a charge of fuel therebetween from the axial passageway, and cam means for intermittently moving the plungers together during rotation of the distributor to alternately return the fuel charge to the axial passageway under pressure.

13. In a fuel pump, the combination comprising a pump body having a chamber therein and a fuel inlet and fuel outlet passages leading from the chamber, a fuel distributor rotatably mounted in said chamber having an axially disposed fuel passageway provided with an outlet and inlet ports for communicating with said passages in sequence as the distributor is rotated, a radial chamber in said distributor communicating with said passageway, a pair of opposed plungers freely mounted in said radial chamber forming a charging pump, and cam means for intermittently actuating said plungers inwardly during rotation of the distributor.

14. In a fuel pump, the combination of a pump body having a cylindrical cavity therein, a fuel

inlet and fuel outlet passageways communicating with said cavity, a cylinder rotatably mounted in said cavity, said cylinder having an axial fluid passageway provided with ports for communicating with said inlet and outlet passageways in sequence as the cylinder is rotated and having a transverse chamber communicating with said passageway, a plurality of free plungers slidably mounted in said chamber, and cam means for periodically moving said plungers inwardly toward said passageway as the cylinder is rotated to eject fuel through said outlet passageways, said plungers being movable outwardly to receive the fuel charge entering through said inlet passageway.

15. A fuel pump comprising a tubular pump body, a fuel pick-up pump member rotatably mounted in one end of said body, a rotary valve member mounted in an intermediate section of said body, pumping means comprising a rotatable member having radially disposed pistons therein at the other end of said body, means forming a driving connection between the pick-up pump member, rotary valve member and rotatable member, means for driving one of said members, and cam means in said other end of said body for periodically actuating said pistons as the members are rotated.

16. A fuel pump comprising a continuous pump body, a fuel pick-up pump rotatably mounted in one end of said body, a rotary distributor mounted in an intermediate section of said body, a fuel passageway extending within said body from the fuel pick-up pump to the rotary distributor, a metering valve in said passageway, a piston charging pump forming a part of the fuel distributor comprising a plurality of radially disposed pistons, a cam mounted in said body about said piston charging pump to intermittently move the piston inwardly as the distributor is rotated, and single driving means for the distributor and fuel pick-up pump.

17. A fuel pump comprising, in combination, a fuel pick-up pump having a rotatable pumping member, a rotary distributor rigidly connected at one end to said member, a charging pump comprising a piston mounted for transverse movement in the opposite end of the distributor, a cam for periodically actuating the piston as the distributor is rotated, and a single unitary pump body providing a head for the fuel pick-up pump, a casing for the distributor and a housing for said cam.

18. A fuel pump comprising, in combination, a fuel pick-up pump having a rotatable pumping member, a rotary distributor rigidly connected at one end to said member, a charging pump comprising a piston mounted for transverse movement in the opposite end of the distributor, a cam for periodically actuating the piston as the distributor is rotated, and a single unitary pump body providing a head for the fuel pick-up pump, a casing for the distributor and a housing for said cam, said distributor and rotatable member of the fuel pick-up pump being radially supported solely by engagement of the distributor with the said casing.

19. A fuel pump comprising, in combination, a fuel pick-up pump having a rotatable pumping member, a rotary distributor rigidly connected at one end to said member, a charging pump comprising a piston mounted for transverse movement in the opposite end of the distributor, a cam for periodically actuating the piston as the distributor is rotated, and a single unitary

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pump body providing a head for the fuel pick-up pump, a casing for the distributor and a housing for said cam, said body being provided with outlet openings for connection to engine cylinders and internal fuel passageways of short length extending between the pick-up pump and the distributor and the distributor and said openings.

20. In a fuel pump, the combination comprising a pump body having a chamber therein, a fuel distributor rotatably mounted in said chamber, a fuel charging pump forming a part of said distributor comprising a plurality of transversely reciprocable pistons, cam means for actuating the pistons, rollers situated between the outer ends of the pistons and the cam means and adjustable stop means separate from the cam for limiting outward movement of the pistons.

21. In a fuel pump, the combination comprising a pump body having a chamber therein, a fuel distributor rotatably mounted in said chamber, a fuel charging pump forming a part of said distributor comprising transverse passageways in the distributor and pistons freely mounted therein, a cam for periodically actuating said pistons inwardly as the distributor is rotated, rollers between the cam and the outer ends of the pistons, and an adjustable cage for limiting the outward movement of the rollers.

22. In a fuel pump, the combination of a housing having fuel conducting passages, a fuel transfer pump adapted to supply fuel to one housing passage, a fuel distributor associated with said housing for receiving fuel from a second of said passages, and a control valve movably mounted in said housing for controlling the flow between said passages, said valve being movable axially in one direction to decrease the flow and in an opposite direction to increase the flow and having its end portion exposed to pressure created by the transfer pump whereby the valve is urged in a flow diminishing direction responsive to transfer pump pressure.

23. In a fuel pump, the combination of a fuel pick-up pump, a fuel distributor, a piston charging pump comprising a piston freely mounted in said distributor, a fuel passageway between said fuel pick-up pump and the distributor, a manually operable metering valve in said passageway having a portion thereof exposed to the pressure of fuel in said passageway and means for mounting the valve for movement in response to said pressure for varying the flow of fuel from the pick-up pump to the distributor.

24. In a fuel pump, the combination of a fuel pick-up pump, a fuel distributor, a piston charging pump comprising a piston freely mounted in said distributor, a fuel passageway between said fuel pick-up pump and the distributor, a metering valve in said passageway for varying the flow of fuel from the pick-up pump to the distributor, said valve comprising a plunger exposed to fuel pressure in said passageway, spring means acting on said plunger in opposition to said fuel pressure, and manually operable means connected to the spring means for varying the metering of the valve in response to fuel pressure.

25. In a fuel pump, the combination of a fuel

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transfer pump, a fuel distributor, a piston charging pump comprising a piston freely mounted in said distributor, a fuel passageway between the transfer pump and distributor, a manually adjustable valve in said passageway having a portion exposed to the pressure of fuel in said passageway for varying the flow of fluid from the transfer pump to the distributor, and spring means acting on said valve in opposition to said fuel pressure.

26. In a fuel pump, the combination of a fuel transfer pump, a fuel distributor, a piston charging pump comprising a piston freely mounted in said distributor, a fuel passageway between the transfer pump and the distributor, a metering valve in said passageway movable to vary the flow of fuel through the passageway, manually adjustable spring means for urging the valve in an opening direction, means for rotating the fuel transfer pump and the fuel distributor, a governor operated by the last named means for urging the valve in a closing direction, and means on the valve opposite from the spring means and exposed to fuel pressure in the passageway for urging the valve in a closing direction upon increasing fuel pressure.

27. In a fuel pump, the combination of a housing having fuel conducting passages, a fuel transfer pump adapted to supply fuel to one housing passage, a fuel distributor associated with said housing for receiving fuel from a second of said passages, and a control valve mounted in said housing comprising a cylindrical member rotatably and longitudinally movable to vary the flow of fuel between said passages, said member having an end portion exposed to pressure created by the transfer pump to render the valve movable longitudinally by said pressure and having means for permitting the member to be rotated manually.

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