July 28, 1931. P. L. SCOTT 1,816,157

INJECTOR

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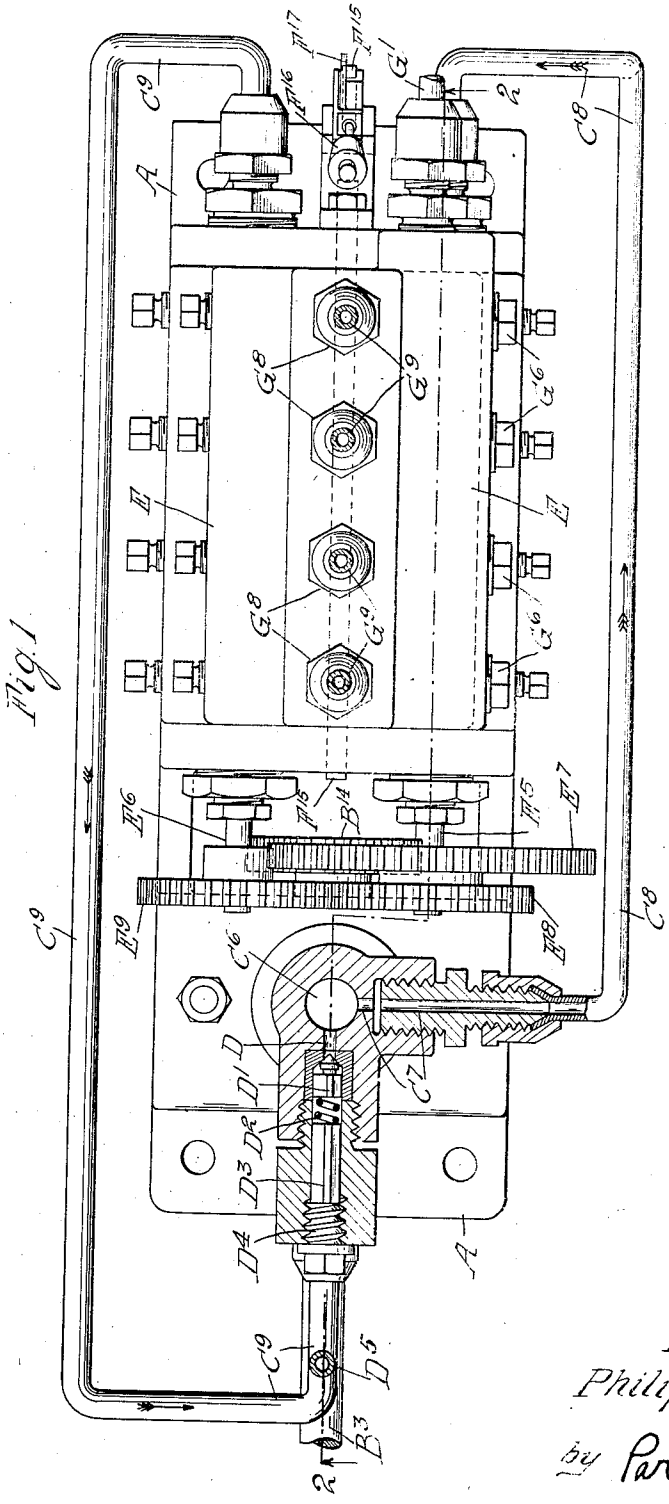


Fig 1

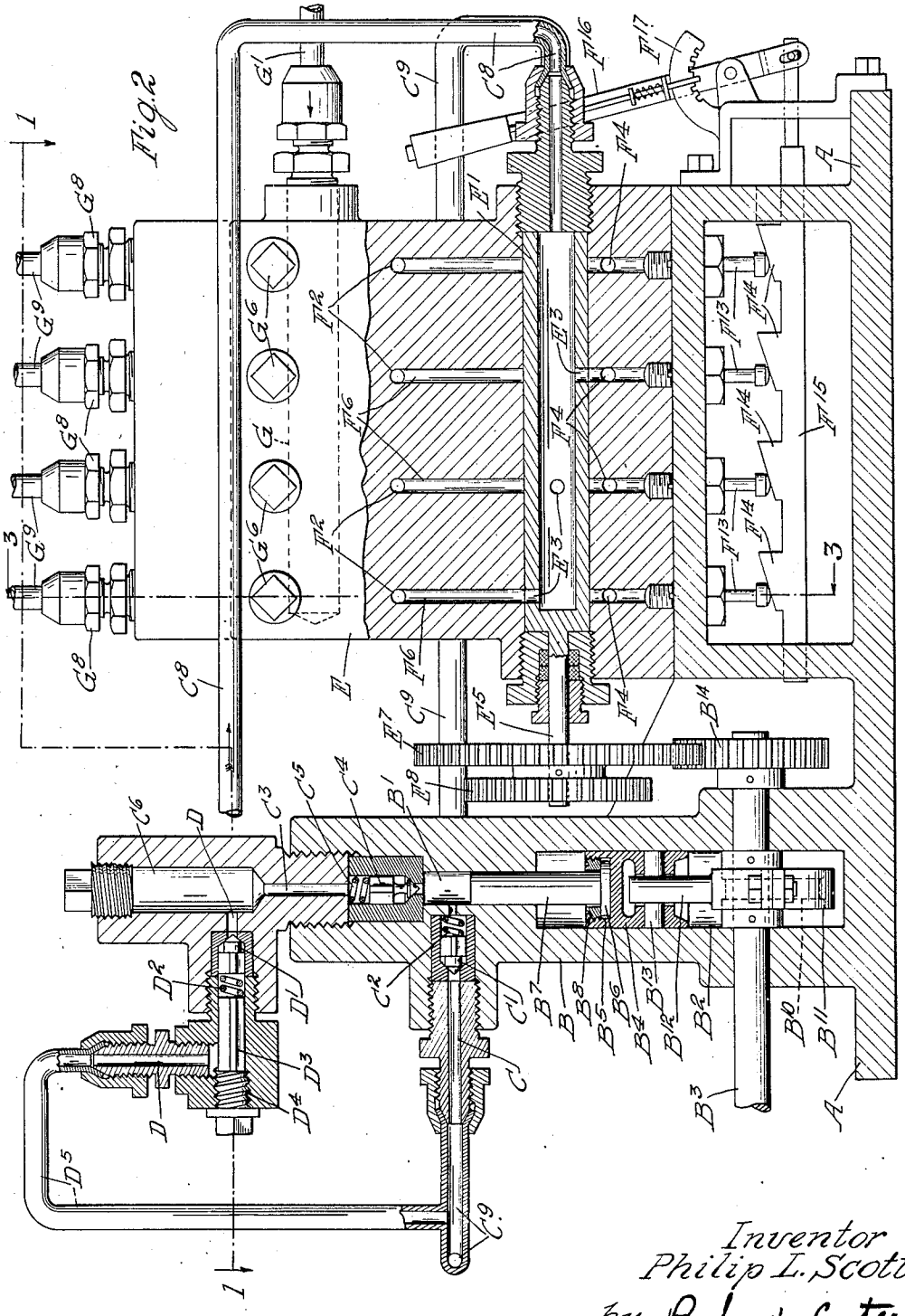
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Fig. 2



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Fig. 3

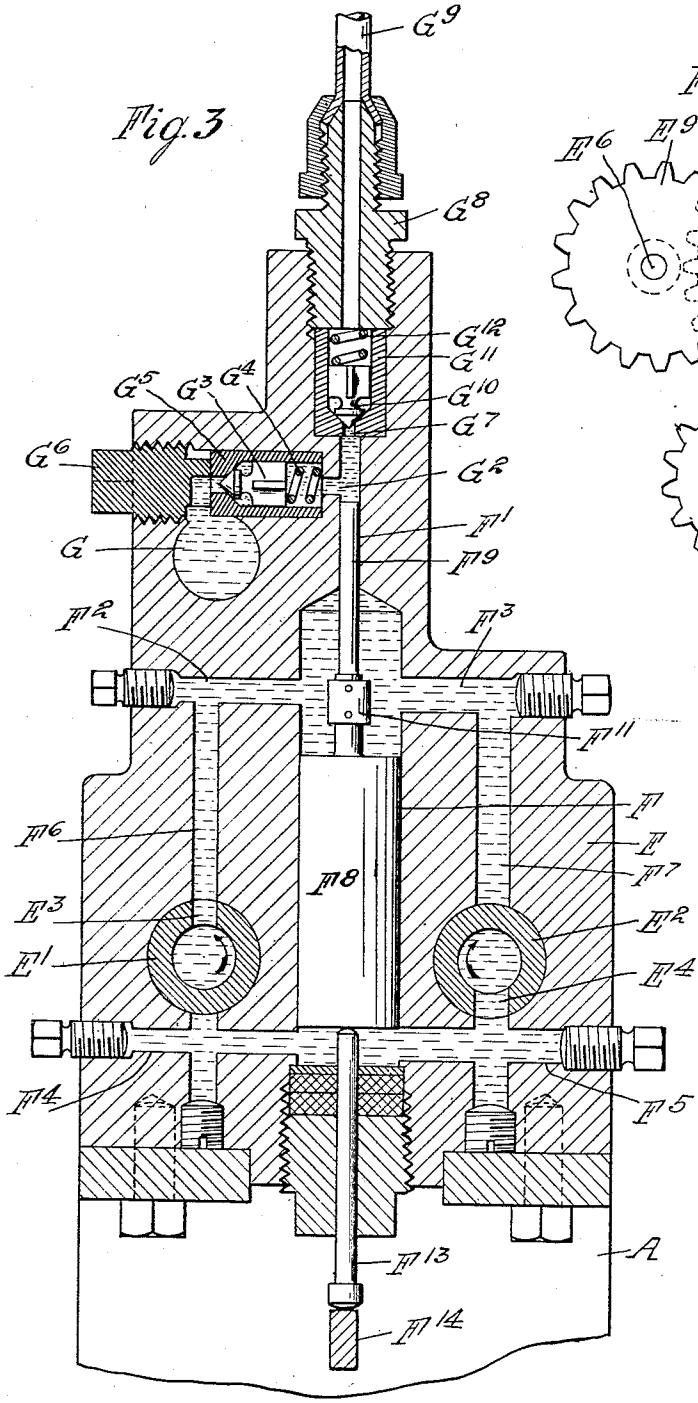


Fig. 4

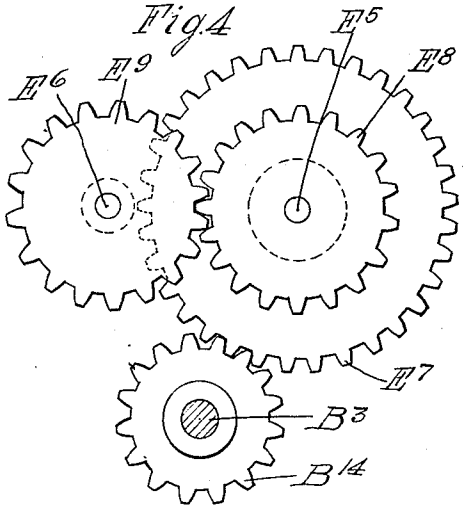
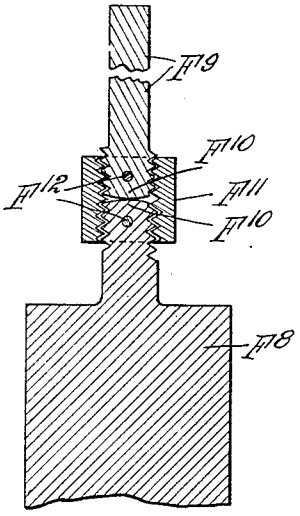


Fig. 5



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Fig. 6

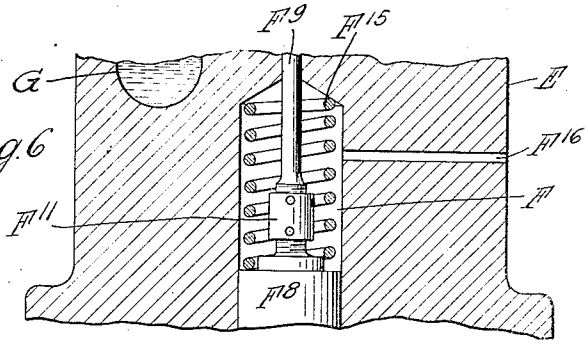
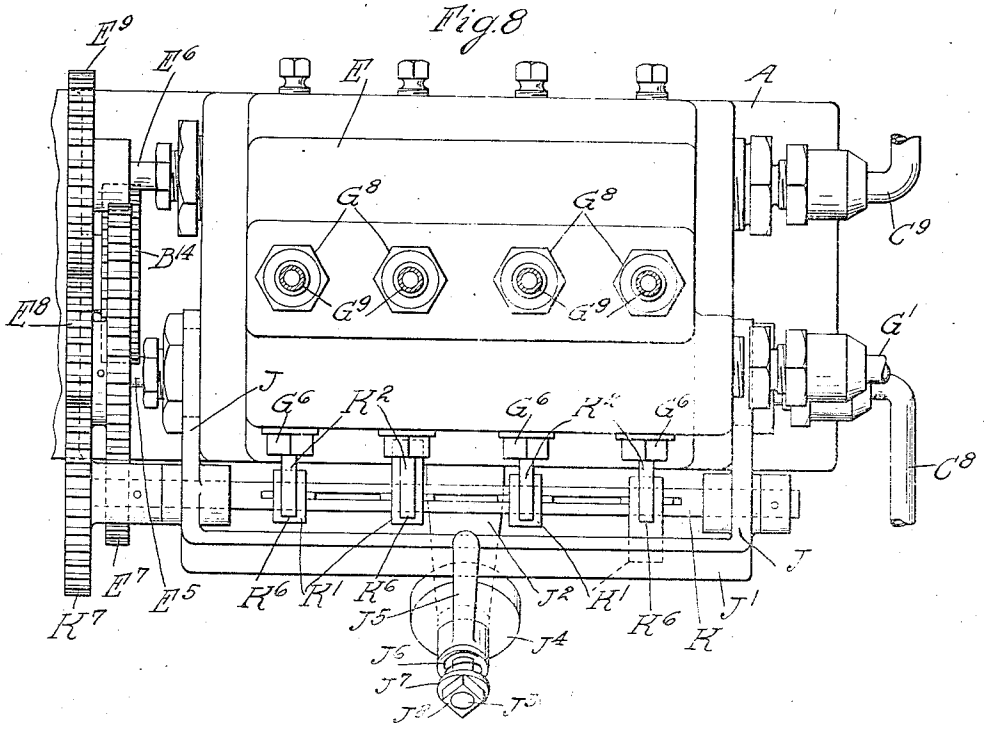


Fig. 8



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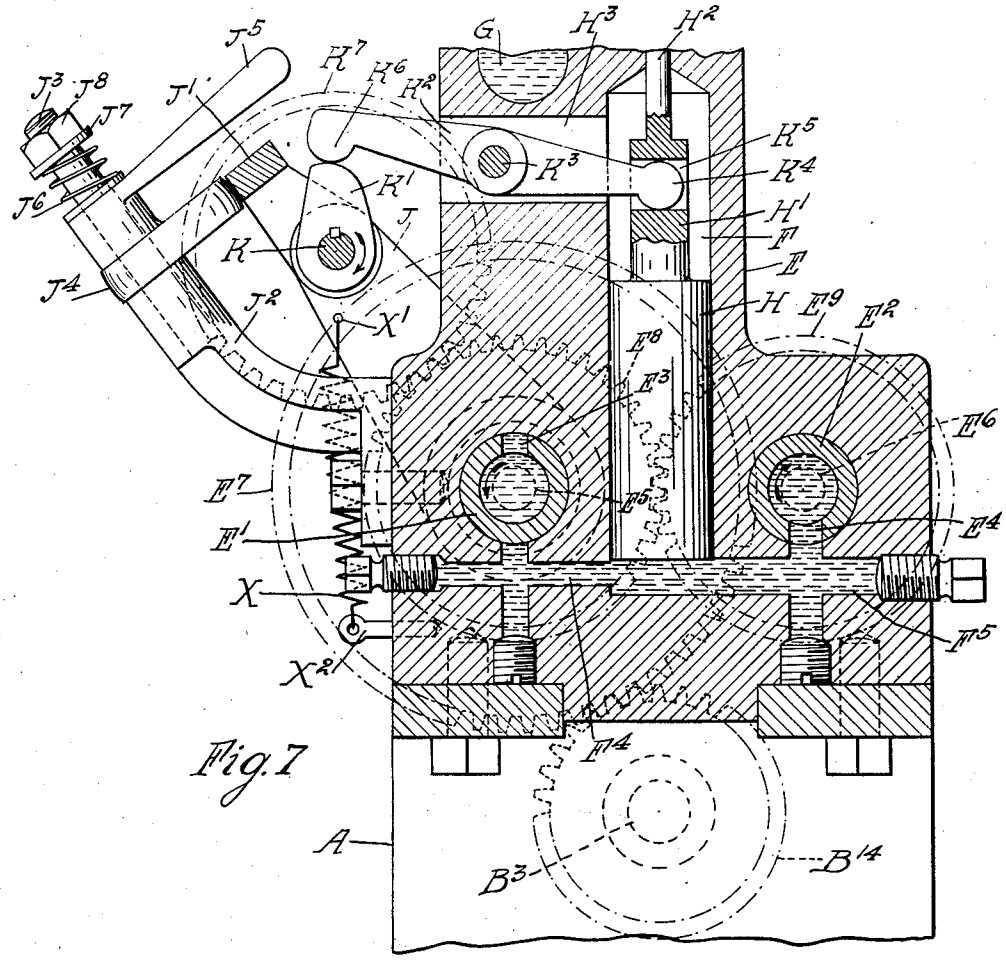


Fig. 7

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Patented July 28, 1931 1,816,157

UNITED STATES PATENT OFFICE

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INJECTOR

Application filed June 16, 1926. Serial No. 116,272.

This invention relates to means for delivering liquid under high pressures and, if desired, intermittently at very high frequency and particularly for doing so without the use of mechanical drives and especially without the use of such heavily loaded drives. While the invention has many applications, it is illustrated here particularly in several forms adapted for use in connection with internal combustion engines of the injection type. By this is meant engines of the Diesel and the modified Diesel cycle in which the fuel is injected into the engine.

One object of the invention is to provide means for delivering liquid under very high pressure, intermittently at high frequency without any metal to metal driving contact at the delivery end. Another object is to provide means for supplying such liquid in very small controlled quantities with great accuracy. Another object is to provide means for delivering such liquid in very small controlled quantities with great accuracy. Another object is to provide means for delivering such liquid to the separate cylinders of an engine while using a single main pressure creating unit irrespective of the number of cylinders. Another object is to provide an apparatus of the type above suggested in which a single main pressure creating unit may be used to operate a plurality of final injection units which may be located at a considerable distance from such main unit. Other objects will appear from time to time throughout the specification and claims. The method may be used to "step up" liquid pumping pressures.

The invention is illustrated more or less diagrammatically in the accompanying drawings in which:

Fig. 1 is a plan view of the combined pump and injection;

Figure 2 is a vertical cross section taken on line 2—2 of Figure 1, with parts in elevation;

Figure 3 is a transverse cross section on an enlarged scale, taken on line 3—3 of Figure 2 and illustrating in detail a number of the injection units;

Figure 4 is a diagrammatic elevation illustrating the driving gearing connection;

Figure 5 is a fragmentary vertical cross section on a further enlarged scale illustrating the connection between the two plungers in the injection unit;

Figure 6 is a modified form generally similar to Figure 3 showing the detail of a spring return;

Figure 7 is a similar view showing a mechanical return;

Figure 8 is a plan view of Figure 7.

A is a bed upon which the parts of the device as shown in Figures 1 to 5 inclusive, are mounted. The main operating pump unit is formed of a member B which is provided with a central cylindrical bore B^1, an enlarged lower bore B^2. B^3 is a driving shaft for the pump driven from any suitable power source. Where the apparatus is used in connection with an engine, this pump will preferably be driven by such engine. B^4 is a cross head provided with an upward depression B^5 within which the enlarged head B^6 of a pump plunger B^7 is located. It is held therein by a retaining gland B^8. The shaft B^3 is provided with an eccentric B^{10} about which a collar B^{11} is mounted. The collar is joined by means of a connecting rod B^{12} to a wrist pin B^{13} positioned in the cross head B^4.

C is an intake or suction passage within which is mounted a suction valve C^1 normally held seated by a spring C^2. C^3 is a discharge passage within which the discharge or outlet valve C^4 is seated and normally held on its seat by a spring C^5. It communicates with a chamber C^6 from which an outlet connection C^7 leads to a high pressure pipe or conduit C^8. C^9 is a low pressure or return pipe or conduit which communicates with the intake passage C. Thus, the circuit of fluid is into the pump, out through the pipe C^8, through the injection unit or units in the manner described below and back through the conduit C^9 into the pump again and the driving fluid is thus circulated about in a closed circuit.

D is an overflow connection which communicates with the chamber C^6. It is con-

trolled by an outlet valve D^1 normally seated by a spring D^2 which spring is held in place for a fluted follower D^3 which is itself adjustably held in place by a screw D^4. When for any reason severe pressure is developed in the chamber C^6 the valve D^1 is operated and fluid is thereby permitted to pass through the pipe D^5 and from the high pressure side of the pump, back to the low pressure side.

In the form shown in Figures 1, 2 and 3, the injector units are four in number. They are all grouped together in a single housing E. Rotated within this housing are two tubular distributor rotors located in a cylindrical passage formed in the housing E. E^1 is the high pressure rotor and the conduit C^8 communicates with it through a suitable fitting and supplies it with the liquid under pressure. E^2 is a corresponding low pressure rotor and it discharges into the conduit C^9. Each of the rotors is provided with four openings or perforations spaced progressively about the rotor 90° apart. The rotor E^1 is provided with the several perforations or ports E^3 and the rotor E^2 is provided with the perforations or ports E^4. One of the ports in each rotor is effective for one injector unit which acts upon one engine cylinder. A description of one such unit will suffice for all. The housing E is provided with one or more central bores F, each of which has a reduced portion F^1. Communicating with the upper part of the bore F are two lateral passages F^2 and F^3, the latter preferably being larger than the former. Communicating with the lower part of the bore F are two similar lateral passages F^4 F^5 the latter being larger than the former. Connecting the passages F^2 and F^4 is a vertical passage F^6, which is preferably of the same size as these two passages. Connecting the passage F^5 and F^3 is a vertical passage F^7 preferably of the same size as the two last mentioned lateral passages. Each of the vertical passages passes through the cylindrical chamber in which one of the rotors lies and flow of liquid through the various passages is thus controlled and limited by the position of the rotors. F^8 is the larger portion of a differential plunger and it lies within the bore F and reciprocates therein. F^9 is the smaller end of the differential plunger and it lies within the bore F^1. The two are provided at their contacting ends with rounded portions F^{10} and are held together by a loose collar F^{11} and pins F^{12}. The collar F^{11} making a loose fit with the abutted threaded ends of the differential plunger permits slight relative movement of the parts without setting up undue strains and without binding of the parts. F^{13} is an adjusting plug which may be raised or lowered to limit the downward movement of the plunger. In one form, this plug is controlled by a cam F^{14} on a rod F^{15} which may be moved in and out by a lever F^{16} which may be locked in position upon a quadrant F^{17}. What has been described above relates wholly to the driving of the injection means and the driving fluid alone is circulated through the passages, chambers and conduits described. The actual fuel supply is wholly independent from these conduits and passages and it will now be described.

Running longitudinally through the upper part of the housing E is a fuel supply chamber G to which fuel is supplied by means of a pipe G^1. From the supply chamber G a passage G^2 runs to each of the reduced bores F^1. The opening of the passage is controlled by an intake valve G^3 which is normally held seated by a spring G^4. The valve is mounted in a cage G^5 which is removably held in position by a plug G^6. G^7 is a discharge passage which through a fitting G^8 and a conduit G^9 communicates with the injector or other point where the injected liquid is to be treated. Located within this passage is a valve G^{10} seated within a valve cage G^{11} and normally held seated by a spring G^{12}. A downward reciprocation of the plunger lifts the intake valve G^3 and draws fuel from the chamber G into the bore F^1. The upward reciprocation of the piston closes the valve G^3 and after pressure is built up opens the discharge valve G^{10} and fluid is forced outward to its point of use or further treatment.

I shall now describe the driving mechanism for the rotors.

Each of the rotors is provided at its closed end with an extending stem, the rotor E^1 having the stem E^5 and the rotor E^2 having the stem E^6. Mounted on the shaft B^8 is the driving pinion B^{14}. It meshes with a larger E^7 on the shaft E^5. This shaft carries a small driving pinion E^8. It meshes with another pinion E^9 on the shaft E^6. Thus the two rotors are driven in opposite directions at the same speed.

While in the forms shown the rotors and injector units are in the same housings, that it in the same main block, for some purposes it might be preferable to have a single housing in which the rotors are mounted and have separate injector units located elsewhere, possibly each one adjacent the engine cylinder which it serves, and in that case, of course the rotors and the injector units would not be in the same housing. My invention is therefore not limited specifically to a structure in which the rotors and injectors are in the same housing.

In Figure 6 which shows merely a detail of the return mechanism for a device generally similar to that shown in Figure 3. The passages F^2 F^3 and F^6 F^7 are omitted for each injector unit. The return of the mem-

ber F^8 is accomplished therefore not by fluid pressure but by a spring F^{15} which is located above the plunger F^8 and at one end bears upon it and at the other end upon the upper end of the bore F within which the plunger F^8 is located. The spring being compressed when the plunger is forced upward by fluid pressure, returns the plunger when it is free to do so by the reduction or withdrawal of the pressure beneath the plunger. F^{16} is an air vent communicating with the interior of the bore F and above the piston. This vent serves to equalize the air pressure within the bore above the piston with that of the outside air.

In Figure 7 a further modified form for returning the plunger is shown. This form of the device differs from the form shown in Figure 3 in that the passages F^2 F^3 and F^6 F^7 are omitted and further in that the upper part of the bore F is open to the air. The limiting device shown in Figure 3 and including the parts F^{13} and F^{14} is also omitted.

In place of the piston or plunger F^8 a generally similar piston H is used. It is positioned within the bore F in the same manner. It is provided at its top with a reduced extension H^1 which carries preferably a reduced piston or plunger H^2. An opening H^3 is formed in the side of the housing E opposite each of the bores.

J J are bracket arms pivoted concentrically with the shaft E^5. These bracket arms are joined by a longitudinal member J^1 and they are thus held in the same position and may be moved together. J^2 is a bracket fastened to the housing E and located generally centrally of the longitudinal member J^1. J^3 is a stud projecting from the bracket upon which is mounted for rotation a cam J^4 which is joined to an arm J^5 by means of which it may be moved. The cam J^4 bears against the longitudinal member J^1 and as it is rotated, moves the member rotating it and the bracket arms J about a point concentric with the shaft E^5.

K is a cam shaft pivoted on the arms J. J. In the form here shown there are on the cam shaft four cams K^1. They are preferably placed 90° apart. This arrangement, of course, would be different if a different type of engine were used or if an engine with a different number of cylinders were used. K^2 is a rocker arm projecting inwardly through the opening H^3 and pivoted therein on a shaft K^3. One of the said rocker arms is provided for each of the pistons H and in the form here shown a single rod K^3 would extend through the casting and furnish the bearing for each of said rocker arms. At one end of the rocker arm K^2 is provided with a rounded part K^4 which is positioned within a cavity K^5 in the member H^1. At its other end the rocker arm K^2 carries a nose K^6 which is contacted by the cam K^1 in their rotation. It is obvious from the construction shown that as the cam shaft rotates the cams upon it contact the noses K^6 and thus rock the rocker shafts K^2 and so return the piston H. The upward movement of the piston is brought about by hydraulic pressure in the same manner as that described above in connection with the other forms of the invention. The mechanism for forcing the piston upward and the process by which this is done is the same in all forms of the invention, and the function of the cam and rocker arm assembly shown in Figures 7 and 8 is merely to return the piston in lieu of the hydraulic return shown in Figure 3.

On the shaft K is a driven gear K^7. It is in mesh with the driving gear E^8 and driven by it.

Although I have shown an operative device, still it will be obvious that many changes might be made in size, shape and arrangement of parts without departing materially from the spirit of my invention; and I wish, therefore, that my showing be taken as in sense diagrammatic.

J^6 is a helical spring mounted about the stud J^3 and bearing against a washer J^7 and a nut J^8 on said stud. The spring thus bears against the top of the cam hub J^5 and holds it against accidental movement.

X is a tension spring fastened at X^1 to the arm J and fastened to the projection X^2 fixed on the housing E. The tension of the springs tends to rotate the cam shaft and frame which carries it downwardly and to hold it against the cam J^4 to prevent accidental movement away from its adjusted position.

The use and operation of my invention are as follows:

In the form shown in Figures 1 to 5 inclusive, the operation of the device in connection with an internal combustion engine is as follows: The driving shaft is connected with the engine and is driven thereby in timed relation thereto. The liquid in the primary pump unit is circulated about in a closed circuit. Oil will preferably be used for this purpose. This oil is forced from the high pressure side of the pump to the rotor E^1 which is always full of high pressure oil. As one of the perforations of the rotor E^1 registers with a passage F^6, high pressure oil is discharged from the rotor, moves through communicating passages and is admitted to the upper end of the large bore F. The timing of the rotors with relation to each other is such that at this time the rotor E^2 is closing the passage F^7 and since this high pressure oil cannot escape into the low pressure rotor it forces the plunger down into the position shown in Fig. 3, thereby drawing fuel into the chamber G^2 from the supply port. As the rotors

continue their rotation, the port E^3 is moved out of register with the passage F^6 and the port E^4 finally moves into register with the passage F^7, thereby being in position to permit the escape of oil from above the plunger. Since the passage F^7 is larger than the passage F^6, the port E^4 will partially register with the passage F^7 ahead of the time E^3 registers with F^4. The port E^4 will then be pointed approximately upward. Thus the port E^4 will be in full register with the passage F^7 by the time the rotor E^2, having completed approximately one-half a revolution, is pointed down and in full register with the passage F^4. Thus a high pressure oil is again discharged from the rotor E^1. This time, however, it is discharged on the under side of the plunger F^8 and fills the passages F^4 and F^5. Escape upward through the passage F^7 is barred by the position of the rotor E^2 and therefore this high pressure oil forces the plunger upward and since the passages communicating with the upper part of the bore F are open through the port E^4 to the interior of the low pressure rotor E^2, the oil is forced from above the plunger into this rotor and out through it along the conduit C^9, back to the intake or low pressure side of the main pumping unit. As the injector plunger rises, it closes the intake valve G^3, opens the valve G^{10} and forces out a charge of fuel to the engine injector nozzle or other point of use for further treatment.

While the operation of a single unit has been described, it is clear that the other units operate in exactly the same manner following each other in regular order. In the form shown, the ports in the rotors are spaced 90° apart, running progressively from one end to the other of each rotor and thus the injector units operate, one after the other, in the order indicated. The amount of travel of the injector plunger is determined by the seating of the governing or adjusting plugs. The adjustment or seating of these parts may be carried out manually, as in the form shown in Figures 2 and 3, or it may be governor controlled.

The operation of the device as shown in the modified forms of Figures 6, 7 and 8 is generally the same as that described in connection with the forms of Figures 1 and 3. The rotors are driven by the same mechanism and operate in the same manner. The piston is forced upwardly in the same manner by hydraulic pressure and distributed and controlled by the rotors, and the injector units operate in the same manner as that described above in connection with Figures 1 and 3. In the return movement occurs the only difference. In the form shown in Figure 6 return movement is by a spring. In the form shown in Figures 7 and 8 return movement is mechanical and is caused by rocker arms which are rocked by the cam shafts which are themselves driven in phase with the driving mechanism of the rotor. The rocker arms thus at approximately the time that the pistons have completed their full upward stroke, are actuated by the cam to depress them. The length of the excursion of the plunger is variably adjusted in the form shown in Figures 7 and 8, just as it is in the form shown in Figure 6. In the latter case, however, the adjustment is carried out by adjusting the cam shaft. Since the cam shaft is mounted on the frame which can be rotated, this frame is rotated up and down and by its rotation the amount of movement of the rocker arms is varied and thus the amount of downward movement of the plunger caused by the rocker arms in their motion is also varied, and thus a governing effect is provided.

I claim:

1. In an injecting system for internal combustion engines and the like the combination of a main pumping unit, a plurality of fuel injecting pump units, ported hollow rotor valves, one connected with the high pressure side of the main pump and the other with the low pressure side thereof, a series of ducts between each injector pump and the two hollow rotor valves respectively, one duct of each set communicating with the injector pump on one side of the operating piston thereof and the other on the opposite side thereof, the said ducts being arranged to communicate with the rotor valves through the ports thereof as the valve is rotated, and means for operating the valves in proper timed relationship.

2. The combination stated in claim 1, wherein the intermediate ducts between the rotor valve that is connected with the high pressure side of the main pump are of larger size than are the intermediate ducts communicating with the low pressure rotor valve.

3. The combination stated in claim 1 having the pumping units arranged in a single housing in line with each other and the rotor valves arranged upon opposite sides of the injector pumps on lines parallel with the line of pumps.

4. The combination stated in claim 1 including as a further element unitary adjusting means for limiting the movements of a plurality of the operating pistons of the respective injector pumps.

5. In an injection system for internal combustion engines and the like, a combination of a main pumping unit, a plurality of fuel injecting pump units, rotary valves, one connected with the high pressure side of the main pump and another with the low pressure side thereof, ducts from each injector to the rotary valves, one duct leading to the injector pump, on one side of its op-

erating piston, and another on the opposite side, said ducts arranged to be controlled by the operation of the rotary valves, and means for driving the valves in timed relation.

6. In an injection system for internal combustion engines and the like, a combination of a main pumping unit, a plurality of fuel injecting pump units, rotary valves, one connected with the high pressure side of the main pump and another with the low pressure side thereof, ducts from each injector to the rotary valves, one duct leading to the injector pump, on one side of its operating piston, and another on the opposite side, said ducts arranged to be controlled by the operation of the rotary valves, and means for driving the valves in timed relation with each other and with the main pumping unit.

Signed at Chicago, county of Cook and State of Illinois, this 1st day of June, 1926.

PHILIP LANE SCOTT.