My present invention relates to an improved fuel metering and distributing means and more particularly to a unitary structure operable in conjunction with a fuel pump, and comprises a timer and cooperating valve structure operating to measure and distribute fuel under pressure to a plurality of fuel lines connected with cylinders of a fuel injection engine, and preferably an engine of the compression ignition type.

An object of my present invention is to construct an improved fuel metering and distributing means by providing an electrically operated solenoid actuated valve for controlling the distribution of measured amounts of fuel to a plurality of outlets, each of which outlets are controlled by separate valve means actuated in timed relation with respect to said first mentioned valve.

Additional objects of my invention relate to improved construction by providing means preventing undue leakage of fuel into the fuel lines, for accurate timing of fuel injection supplied under pressure from a suitable fuel pumping means, all operating from a common shaft.

For a more detailed understanding of my invention, reference may be had to the accompanying drawings illustrating a preferred embodiment thereof, in which like characters throughout the several views refer to like parts, and in which:

Fig. 1 is a plan view of the improved fuel metering and distributing structure associated with a pumping structure.

Fig. 2 is a vertical sectional view therethrough taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is a horizontal sectional view through the timer taken substantially on the line 3—3 of Fig. 4.

Fig. 4 is a vertical sectional view of the timer taken substantially on the line 4—4 of Fig. 3.

Fig. 5 is another sectional view through the timer taken substantially on the line 5—5 of Fig. 4.

Fig. 6 is a horizontal view of the device taken substantially on the line 6—6 of Fig. 2 and showing the fuel pumping means, the pump drive and the timer drive, and

Fig. 7 is a wiring diagram of the timer.

My fuel distributing and metering means comprises a structure formed of a plurality of casing parts, one, designated 10, which houses the pump, pump drive and timer drive as well as some of the valve actuating mechanism, 11 which houses the valves and fuel inlet, and outlet means and 12 which houses the solenoid actuating valve means.

The casing 10 supports a reciprocating pump 13 which is reciprocated by means of a cup-shaped actuator 14 that is in turn actuated by the actuating cam 15. A spring 16 wedges the actuator against the cam 15. This pump discharges fuel through a one way valve 16 into a fuel line 17 which is connected with a second fuel line 18 connected with a fuel inlet 19 in casing 11.

Referring more particularly to Figs. 1, 2 and 6, it will be observed that the casing 10 carries a pair of pumps radially associated with the drive shaft 20 and angularly spaced 90° apart. The cam 15 is secured to shaft 20 and carries equally angularly spaced cam portions 21, and is operated to alternately thrust against the pumps. It will be observed that as one pump ends its pressure stroke, the other pump is just beginning its pressure stroke. The cams 21 are angularly spaced 120° apart, and thus serve to provide a continuous flow of fuel under substantially constant pressure into the fuel inlet 19. The shaft 20 also carries a gear 25 which meshes with gear 26 carried by the timer drive shaft 21, and this shaft is preferably supported in casing 10 by bearings 28 of standard construction.

In the casing 12, there is mounted a solenoid, which receives current through the electric conductor 31, and when energized actuates the core 32 which supports a valve stem 33. Thus as the solenoid is energized it will lift the core 32 and valve stem 33 thus lifting the valve 34 off its seat and permitting the fuel in the inlet 19 to enter the radial fuel passages 35 connected with the annular groove 36 in the valve guide 37. An adjustable stop pin 38 is supported by casing 12 and serves to limit the opening movement of this valve, the springs 39 which abut the nut 40 acting to urge the solenoid core inwardly of the device and this urges the valve towards its seat, so that when the solenoid is de-energized the valve 34 will seat and close the connection between inlet passage 19 and fuel passages 35.

The casing 11 is provided with a plurality of fuel passages 41 connected with the annular groove or primary fuel chamber 36 in the valve guide 37 and these passages are preferably equal in number to the number of engine cylinders for which the distributor valve is designed, and each of these passages 41 terminates into a chamber 42, each chamber having an outlet 43 controlled by a valve 44. A spring 45 urges the valve 44 on its seat and same is mechanically lifted off its seat, when the valve tappet 46 is engaged with a cam roller 47 carried by a rotating member 48 secured or fastened by any suitable means to the drive shaft 20. When the valve 44 is seated, the valve tappet 46 rides on the plane surface 49.
of member 48 and said tappet is preferably slightly spaced from the valve 44. The contacting faces of valve 44 and tappet 48 are conical so as to permit the conical edge of the tappet to tightly seat in the conical recess of the valve when the valve is lifted. The tappet 48 is provided with an axial bore or passage 50 extending lengthwise clear through the tappet so as to vent the discharge passages 41 which is in open communication with the outlet 43. This vent also serves to vent discharge or outlet passage 51 if there is any leakage past valves 44 and 48.

There are a plurality of these valves and tappets 44 and 46 respectively all constructed identically and successively opened as the roller 47 successively engages the tappets. In one complete revolution of the shaft 20 all the valves 44 will be successively opened and thus it will be noted that the valves 44 are all opened in timed relation with engine operation, since the shaft 20 is connected by a suitable driving connection with the engine cam shaft in the usual manner.

The timing of the electrically controlled valve 34 is had by means of an electrical timing device housed within casing 56 and driven by means of the cam driving shaft 27 which is connected as at 61 to a power drive shaft 62. The gears 26 and 28 are preferably constructed with a one to one (1:1) ratio so that the shaft 62 preferably has the same R. P. M. as the shaft 20. The shaft 62 drives a distributor plate 63 which carries the oscillating arm 64 mounted on shaft 65, this arm 64 carrying a contact 66 arranged to make and break with the contact 67. Referring more particularly to Fig. 7 it will be seen that the current from the source of power such as the battery 70 flows into a variable rheostat 91 into line 72 thence to ring 73 molded into the timing casing 60. A plurality of contacts 75 are carried by the engine and electrically connected with the ring 73 by an adjustable resistance connector 76 preferably composed of laminated disks or other suitable variable resistance means. The laminated resistors 76 may each separately be adjusted by means of an adjusting nut 77. As the timer is rotated the arms 64 successfully contact with these contacts 75 and thus provide for flow of current through the arm 64 into the post 65 and thus to ring 73 to post 69 to the condenser 80. As the arm 64 leaves the contact 75 a cam 81, which is adjustable by means of the thread and nut 82, thus actuates arm 64 to cause contacts 66 and 67 to engage thus discharging the condenser into the central post 83 which is connected with an outlet connection or post 84 to which the solenoid connection 31 may be connected.

This timer is of standard construction and it will be observed that it is useful to time the actuation of the solenoid valve. The variable rheostat 71 is actuated to vary the amount of current flowing to line 72 and it will be readily seen that as the adjusting arm 85 of the rheostat is moved the amount of energy which enters the condenser 80 is varied, and thus the energizing of the solenoid is controlled in such a way as to vary the time in which said solenoid is energized, thus varying the opening period of valve 34, and thus controlling the amount of fuel under pressure supplied to the passages 41, chamber 42 and fuel discharge line 51.

Preferably the valve 44 is timed for operation with respect to the solenoid operated valve, so that when valve 34 opens there is an immediate discharge of fuel into a fuel discharge line 51.

It will be observed that these valves are timed together and with the engine operation, and the central distributing and metering valve is timed to successfully open the plurality of chambers 42 with the source of fuel under pressure supplied to fuel inlet line 53 and thus when the valve 44, associated with the chambers 42 are successively opened there is an immediate discharge of fuel into the fuel discharge line.

Careful study of the principles involved in the present invention will reveal that the preferred construction produces an injection system which is free of the necessity of manufacturing the machined parts with extreme accuracy, as is usually required with such mechanisms. Since small leakages, such as will occur under high injection pressure of fuel supplied through normally fitted machined parts, will not occur in the present construction and adversely affect fuel distribution, substantially equal quantities of fuel to all engine cylinders is thereby provided for whether leakage occurs or not.

Although I have illustrated but one form of my invention and have described in detail but a single application thereof, it will be apparent to those skilled in the art to which my invention pertains, that various modifications and changes may be made without departing from the spirit of my invention or from the scope of the appended claims.

I claim:

1. A fuel distributing valve structure comprising a primary fuel chamber and a plurality of secondary fuel chambers each connected directly with said primary fuel chamber, fuel discharge lines respectively connected with each of said secondary fuel chambers, a source of fuel supply under pressure, a regulable electrically actuated solenoid control valve metering fuel from said source of fuel supply under pressure to said primary fuel chamber, and mechanically operable valves respectively associated with each of said secondary fuel chambers and successively operable to control the discharge of fuel to said discharge lines, valve operating means for said valves and timed to successively open for a period said mechanically operable valves and to open and close said electrically actuated solenoid control valve once during the open period for each successive operation of said plurality of mechanically operated valves.

2. A fuel distributing valve structure comprising a primary fuel chamber and a plurality of secondary fuel chambers each connected directly with said primary fuel chamber, fuel discharge lines respectively connected with each of said secondary fuel chambers, a source of fuel supply under pressure, a regulable electrically actuated solenoid control valve metering fuel from said source of fuel supply under pressure to said primary fuel chamber, and mechanically operable valves respectively associated with each of said secondary fuel chambers and successively operable to control the discharge of fuel to said discharge lines, valve operating means for said valves and timed to successively open for a period said mechanically operable valves and to open and close said electrically actuated solenoid control valve once during the open period for each successive operation of said plurality of mechanically operated valves.
fuel chamber associated therewith so constructed and arranged as to vent the fuel discharge line associated therewith when said valve is seated.

A fuel distributing valve structure comprising a primary fuel chamber and a plurality of secondary fuel chambers each connected directly with said primary fuel chamber, fuel discharge lines respectively connected with each of said secondary fuel chambers, a source of fuel supply under pressure, a regulatable control valve metering fuel from said source of fuel supply under pressure to said primary fuel chamber, and mechanically operable valves respectively associated with each of said secondary fuel chambers and successively operable to control the discharge of fuel to said discharge lines, valve operating means for said valves and timed to successively open for a period said mechanically operable valves and to open and close said regulatable control valve once during the open period for each successive operation of said plurality of mechanically operated valves, said means for operating said regulatable control valve comprising an electric circuit including a condenser, a variable rheostat and a timer constructed and arranged to selectively vary the electrical energy discharged from said condenser to energize the rheostat, and thereby selectively vary the time period said solenoid is energized to vary the open period of said regulatable control valve.

4. A fuel distributing valve structure comprising a primary fuel chamber and a plurality of secondary fuel chambers each connected directly with said primary fuel chamber, fuel discharge lines respectively connected with each of said secondary fuel chambers, a source of fuel supply under pressure, a regulatable control valve metering fuel from said source of fuel supply under pressure to said primary fuel chamber, and mechanically operable valves respectively associated with each of said secondary fuel chambers and successively operable to control the discharge of fuel to said discharge lines, valve operating means for said valves and timed to successively open for a period said mechanically operable valves and to open and close said regulatable control valve once during the open period for each successive operation of said plurality of mechanically operated valves, and means for operating said regulatable control valve comprising an electric circuit, a solenoid operable to actuate said valve, said circuit including a condenser and a variable rheostat constructed and arranged to selectively vary the electrical energy discharged from said condenser to energize the solenoid, and thereby selectively vary the time period said solenoid is energized to the open period of said solenoid operated valve.

6. A fuel distributing valve structure comprising a casing having a fuel inlet connected with a source of fuel supply under pressure, a primary fuel chamber and a plurality of secondary fuel chambers each connected directly with said primary fuel chamber, and a plurality of fuel discharge ducts each respectively associated with each of said secondary fuel chambers, a solenoid operated fuel metering valve controlling flow of fuel under pressure from said fuel inlet to said primary fuel chamber, mechanically operated valve means controlling the discharge of the fuel from said secondary fuel chambers to said discharge ducts, means successively actuating said mechanically operated valve means, and means actuating said solenoid operated valve to open and close the same once during the open period for each operation of said mechanically operated valve means and comprising an electric circuit including a condenser, a variable rheostat and a timer constructed and arranged to selectively vary the electrical energy discharged from said condenser to energize the solenoid, and thereby selectively vary the time period said solenoid is energized to vary the open period of said solenoid operated valve.

7. A fuel distributing valve structure comprising a casing having a fuel inlet connected with a source of fuel supply under pressure, a primary fuel chamber and a plurality of secondary fuel chambers each connected directly with said primary fuel chamber, and a plurality of fuel discharge ducts each respectively associated with each of said secondary fuel chambers, a solenoid operated fuel metering valve controlling flow of fuel under pressure from said fuel inlet to said primary fuel chamber, mechanically operated valve means controlling the discharge of the fuel from said secondary fuel chambers to said discharge ducts, means successively actuating said mechanically operated valve means, and means actuating said solenoid operated valve once for each operation of said mechanically operated valve means and comprising an electric circuit including a condenser, a variable rheostat and a timer constructed and arranged to selectively vary the electrical energy discharged from said condenser to energize the solenoid, and thereby selectively vary the time period said solenoid is energized to vary the open period of said solenoid operated valve.

5. A fuel distributing valve structure comprising a casing having a fuel inlet connected with a source of fuel supply under pressure, a primary fuel chamber and a plurality of secondary fuel chambers each connected directly with said primary fuel chamber, and a plurality of fuel discharge ducts each respectively associated with each of said secondary fuel chambers, a solenoid operated fuel metering valve controlling flow of fuel under pressure from said fuel inlet to said primary fuel chamber, mechanically operated valve means controlling the discharge of the fuel from said secondary fuel chambers to said discharge ducts, means successively actuating said mechanically operated valve means, and means actuating said solenoid operated valve to open and close the same once during the open period for each operation of said mechanically operated valve means and comprising an electric circuit including a condenser, a variable rheostat and a timer constructed and arranged to selectively vary the electrical energy discharged from said condenser to energize the solenoid, and thereby selectively vary the time period said solenoid is energized to vary the open period of said solenoid operated valve.

8. A fuel distributing valve structure comprising a casing having a fuel inlet connected with a source of fuel supply under pressure, a primary fuel chamber and a plurality of secondary fuel chambers each connected directly with said primary fuel chamber, and a plurality of fuel discharge ducts each respectively associated with each of said secondary fuel chambers, a solenoid operated fuel metering valve controlling flow of fuel under pressure from said fuel inlet to said primary fuel chamber, mechanically operated valve means controlling the discharge of the fuel from said secondary fuel chambers to said discharge ducts, means successively actuating said mechanically operated valve means, and means actuating said solenoid operated valve to open and close the same once during the open period for each operation of said mechanically operated valve means and comprising an electric circuit including a condenser, a variable rheostat and a timer constructed and arranged to selectively vary the electrical energy discharged from said condenser to energize the solenoid, and thereby selectively vary the time period said solenoid is energized to vary the open period of said solenoid operated valve.
energized to vary the open period of said solenoid operated valve, said timer being adjustable with respect to the actuation of said mechanically operated valves so as to open said solenoid operated valve immediately subsequent to the opening of each of said mechanically operated valves, said means actuating said mechanically operated valves being operable to maintain same open at all times when said solenoid operated fuel metering valve is open, and to close immediately subsequent to the closing of said solenoid operated fuel metering valve and prior to the opening of the next mechanically operated valve to open and the reopening of said solenoid operated fuel metering valve.

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