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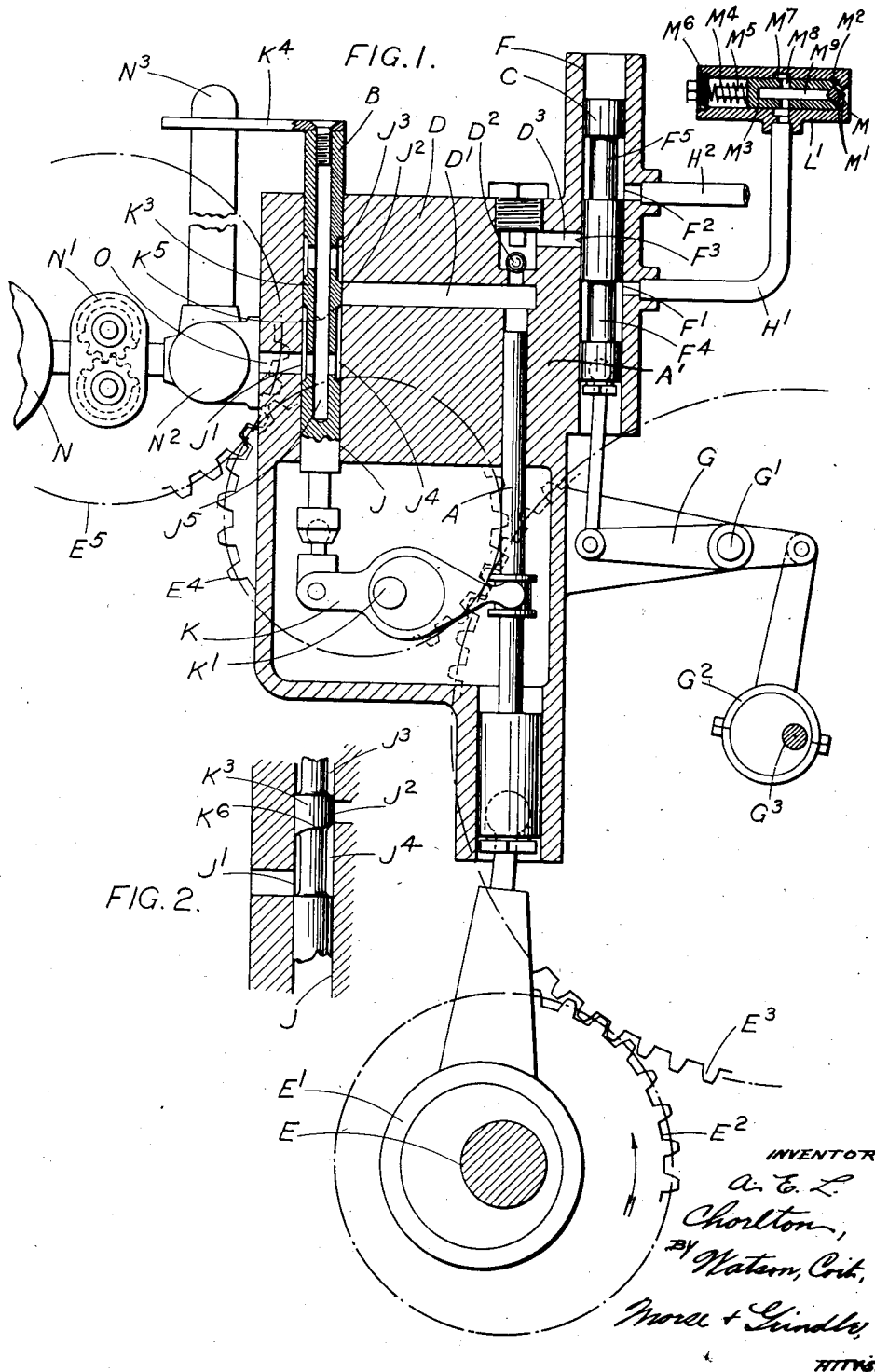
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LIQUID FUEL ADMISSION DEVICE FOR INTERNAL COMBUSTION ENGINES

Filed Sept. 24, 1924

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

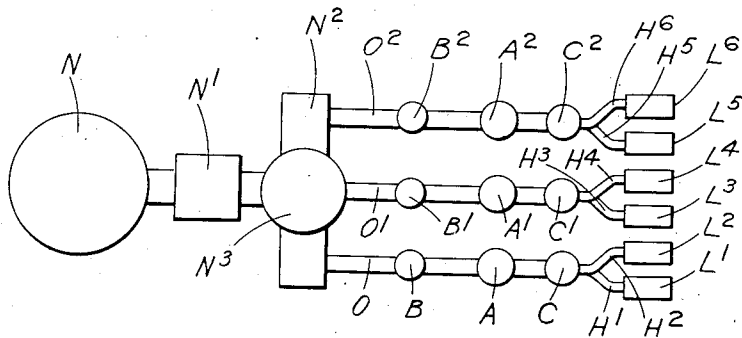


FIG. 3.

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LIQUID-FUEL-ADMISSION DEVICE FOR INTERNAL-COMBUSTION ENGINES.

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This invention relates to liquid fuel admission devices for high speed internal combustion engines and is more especially applicable to high speed multicylinder engines operating on the four-stroke cycle.

The primary object of the invention is to ensure that the fuel will be mixed with the air in the combustion chamber in a more homogeneous manner than hitherto. For this purpose it is important that the fuel sprayer in the wall of each working cylinder shall deliver a fine spray with high penetrative power.

A further object of the invention is therefore to provide means for controlling the fuel sprayers so that they shall be very sharp in action to prevent initial inefficiency when the spray starts and also dribbling or dropping as the spray ceases.

Another object is to provide an improved arrangement of the fuel pumps and of the means for controlling these pumps.

Further objects of the invention will be apparent from the following description of the accompanying drawings and from the appended claims.

The invention may be carried into practice in various ways but a preferred arrangement showing the application thereof to a four-stroke six-cylinder internal combustion engine is illustrated somewhat diagrammatically in the accompanying drawings, in which

Figure 1 is a vertical section through a fuel pump,

Figure 2 shows a detail modification, and

Figure 3 is a diagrammatic plan showing the arrangement of the fuel supply passages.

For the purpose of the fuel supply the six cylinders of the engine are grouped in pairs, the firing angle of the two cylinders of a pair being 180° . Each pair of cylinders is supplied with liquid fuel from a fuel pump, and there are thus three fuel pumps in all.

Each fuel pump is constructed in the manner shown in Figure 1 and comprises broadly a pump plunger A, a suction valve B and a distributing valve C, all of which are preferably mounted within a single casing D. The plunger A is reciprocated by means of an eccentric E' on the engine crankshaft E. The casing D contains a pump pressure chamber D' from which the liquid fuel is forced at each delivery stroke of the plunger A past an automatic delivery valve D² into a passage D³ leading to the distributing valve C.

The distributing valve C is reciprocated

within a cylindrical chamber F having three ports F' F² F³ in its wall by means of a lever G pivoted at G'. This lever G is rocked about its pivot G' by means of an eccentric G² on a shaft G³, which is driven at half the speed of the crankshaft E by means of the gear wheels indicated at E² E³. Of the three ports F' F² F³, one F³ communicates with the passage D³ whilst the other two F' F² communicate respectively with two delivery pipes H' H². The body of the distributing valve C has two portions F⁴ F⁵ of restricted diameter, so arranged that they will place the port F³ in communication alternately with the two ports F' and F² as the valve C is reciprocated. Thus during a delivery stroke of the plunger A, the passage D³ communicates with one or other of the two delivery pipes H' H², and liquid fuel is delivered alternately to these two pipes.

Since it is necessary for the pump to supply fuel at high pressure, it is further desirable to employ only the middle portion of the plunger stroke, that is when it is travelling at its highest speed. This is effected by means of the suction valve B which controls the supply of fuel into the pump pressure chamber D'. The suction valve B is reciprocated within a cylindrical chamber J having ports J' J² in its wall by means of a lever K eccentrically pivoted at K'. The other end of the lever K is formed as a yoke engaging with a collar K² on the pump plunger A. The body of the valve B has two portions of restricted diameter, one above and one below a central portion K³ which fits closely within the chamber J, thus forming two annular spaces J³ J⁴ which are permanently connected together through an internal passage J⁵ in the valve body. The space J⁴ always registers with the inlet port J' through which liquid fuel is supplied. The port J² communicates with the pump pressure chamber D' and constitutes the outlet port from the cylindrical chamber J. The central portion K³ of the valve body is of such a length as completely to close the outlet port J² during the middle portion of the stroke, but the port J² is open to one or other of the spaces J³ or J⁴ during the earlier and later portions of the stroke. Thus during the earlier and later portions of each delivery stroke of the plunger A the port J² is open, and fuel is only forced through the delivery valve D² during the middle portion of the stroke when the port J² is closed. The injection period

thus lasts only for a comparatively short portion of each stroke when the plunger A is moving at its highest speed.

In order to be able to control the length of the injection period, the valve B is made rotatable within the cylinder J by means of a lever K⁴, and the central portion K³ of the valve body is arranged to have varying lengths as indicated at K⁵, so that the port J² is closed for a longer or shorter period during the middle of each stroke according to the angular position of the body of the valve B. Alternatively the central portion K³ may have a helical upper or lower edge as shown at K⁶ in Figure 2, so that by rotating the valve B through a small angle the length of the central part K³ which covers the port J² may be varied. The moment of beginning and of ending of the injection period may also be varied by adjusting the eccentrically mounted lever K about its pivot K'.

The deliverly pipes H' H² lead respectively to fuel sprayers L' L², one in the wall of each of the two cylinders supplied by the fuel pump. Only one of these sprayers L' is shown in Figure 1 of the drawings. The fuel sprayers may be of any suitable form but a preferred form is illustrated in Figure 1. As shown the sprayer consists of a casing L' which is mounted in the wall of the working cylinder in a known manner so as to inject liquid fuel into the combustion chamber. The end wall M of the casing L' is provided with two or more (as shown four) spraying orifices M' so arranged that the fuel jets therefrom will impinge on one another in the combustion chamber close to the sprayer. This impingement of the jets, which are discharged at high velocity, ensures that the liquid fuel will be thoroughly atomized and effectively distributed throughout the combustion chamber. The orifices M' are arranged in a ring and are controlled by the annular edge M² of a hollow piston-shaped valve member M³ which can move longitudinally within the casing M. The valve member M³ is normally pressed against the orifices M' by means of a spring M⁴, which is coiled round an extension M⁵ of the valve member. This extension M⁵, when the valve member M³ is in its open position, abuts against the end wall M⁶ of the casing L' remote from the orifices M' and thus limits the travel of the valve member within the casing.

The pump delivery pipe H' opens into an annular recess M⁷ in the casing L' which surrounds the valve member M³, and openings M⁸ are provided through the wall of the valve member, so that the delivery pipe H' is permanently in communication with the hollow interior of the valve member. The internal end wall M⁹ of the valve member thus acts as a piston face subjected to the pressure in the delivery pipe. When this pressure exceeds the pressure of the spring

M⁴, the valve member M³ moves and opens the orifices M' which discharge their jets of liquid fuel into the combustion chamber. Owing to the arrangement and operation of the fuel pump and its valves, rapidly alternating high and low pressures are produced in the delivery pipe, and this results in a very sudden action of the valve member M³ both in opening and in closing the orifices M'. The suddenness of action of the sprayer and the very high pressure in the delivery passage discharge the liquid fuel in a very finely atomized condition and prevent initial inefficiency and dribbling or dropping as the spray ceases, thus ensuring a thorough distribution of the fuel particles throughout the combustion chamber.

The general arrangement of the fuel supply passages to the engine is shown partly on the left-hand side of Figure 1 but more fully in the diagrammatic plan in Figure 3. The six working cylinders of the engine are not shown, but the six fuel sprayers therefor are indicated at L' L² L³ L⁴ L⁵ L⁶ in Figure 3, the corresponding pump delivery pipes H' H² H³ H⁴ H⁵ H⁶ being also shown. As already mentioned three fuel pumps are employed, each supplying two delivery pipes. The order in which the fuel injections into the various cylinders take place is as usual from the sprayers L' L³ L⁵ L² L⁴ L⁶, and two cylinders having a firing angle of 180° are supplied from each pump. Thus the sprayers L' L² are supplied through the delivery pipes H' H² from the pump having a plunger A, a suction valve B and a distributing valve C. The sprayers L³ L⁴ are supplied through the delivery pipes H³ H⁴ from the pump having a plunger A', a suction valve B' and a distributing valve C', and the pump with plunger A², suction valve B², and distributing valve C² supplies the sprayers L⁵ L⁶ through the pipes H⁵ H⁶.

The fuel is supplied under pressure from a tank indicated at N by means of an auxiliary pump N', which is conveniently of the gear wheel type, driven through suitable gearing E² E³ E⁴ E⁵ from the engine crankshaft E, into a chamber N² common to the three pumps. This chamber N² has an air expansion column N³, and the pumps are supplied from this chamber N² through passages O O' O² respectively. The connection between the passage O and the cylindrical chamber J containing the suction valve B is shown clearly in Figure 1, and it will be understood that the three pumps are each arranged similarly to the pump shown in Figure 1.

From the foregoing, it will be apparent that I have devised injection apparatus consisting of a delivery or booster pump N' connected by passageways or conduits to the atomizer nozzles or orifices M. One such passageway or conduit is shown in Fig. 1 made

up of the passage O, chamber or passage J, chamber or passage D', passage D³, and either of the delivery pipes H' or H². Pressure-producing means is associated with each conduit or passage to secure the requisitely high pressure for satisfactory atomization and injection in a high-speed Diesel engine, the pressure-producing means consisting of the plunger A and the valve J. The plunger A is arranged in a cylinder A' which has its most remote portion at one end in communication with the chamber D', forming a part of said conduit or passage. In operation, the conduit or passage is supplied by the booster pump N' with liquid fuel when the valve means is open, particularly during the out-stroke of the plunger; and, when the valve means closes, and for the interval of closure thereof during the working stroke of the plunger, injection takes place. The booster pump N' insures that at least that portion of the conduit connecting it with the plunger cylinder A', as well as the latter, shall be maintained filled with liquid fuel. While, under some conditions, the portion of the conduit between the plunger cylinder and the atomizer, this portion being aptly termed the delivery passage, may also be maintained filled directly by the booster pump N'; generally, in operation, the check valve D² prevents this, so that maintaining the delivery passage beyond the check valve is due directly to the plunger A, although of course, indirectly to the booster pump. In operation, as soon as the high or injection pressure ceases due to opening of the valve means of the pressure-producing means, the check valve D² closes due to the back-flow tendency, the atomizer valve also closing as soon as a pressure lower than its opening pressure is reached; and liquid fuel under a fairly high pressure is entrapped beyond the check valve. The latter high pressure is advantageous in that it reduces the lag of injection with respect to the apparatus. Hence, due to this entrapped pressure, supplying of liquid fuel to the portion of the conduit beyond the check valve may be said to be directly due to the plunger A and indirectly due to the booster pump. Therefore, the conduit is maintained under pressure at all times, the pressure being greatly increased periodically by the operation of the injection pressure-producing means; and the maintenance of pressure is due both to the booster pump and to the plunger of the pressure-producing means, although during non-injection periods, if the check valve should be omitted or if it should not entrap liquid fuel under sufficiently high pressure, maintenance of the conduit filled with liquid fuel would be due to the booster pump. In any event, the booster pump functions primarily as the means for maintaining the conduit filled so that the plunger

may act effectively to impart a hammer-blow on a body of liquid fuel to develop therein a high pressure very quickly or practically instantaneously.

While I have shown pressure-producing means incorporating separate valve means, it will be obvious that any suitable valve means may be used so long as the operative principles are preserved.

The particular construction described and illustrated has been given by way of example only and modifications may be made without departing from the scope of the invention.

What I claim as my invention and desire to secure by Letters Patent is:—

1. In apparatus of the character described, the combination of a pair of inlet and outlet valve cylinders and a pump cylinder communicating therewith, a supply passage communicating with the inlet cylinder, an outlet passage communicating with the outlet cylinder, piston valves in the valve cylinders, a pump piston in the pump cylinder, and means for operating the pump piston and the valve pistons in timed relation so that the inlet valve piston interrupts communication of the supply passage with the pump cylinder and the outlet valve piston establishes communication of the pump cylinder with the outlet passage during a portion of the working stroke of the pump piston.

2. In apparatus of the character described, the combination of a pair of inlet and outlet valve cylinders and a pump cylinder communicating therewith, said cylinders being arranged substantially parallel, a supply passage communicating with the inlet cylinder, an outlet passage communicating with the outlet cylinder, piston valves in the valve cylinders, a pump piston in the pump cylinder, and means for operating the pump piston and the valve pistons in timed relation so that the inlet valve piston interrupts communication of the supply passage with the pump cylinder and the outlet valve piston establishes communication of the pump cylinder with the outlet passage during a portion of the working stroke of the pump piston.

3. In a fuel feeding device, the combination of a casing member provided with inlet and outlet valve chambers communicating with a pump chamber, a supply passage communicating with the inlet valve chamber, an outlet passage communicating with the outlet chamber, movable valve members in the valve chambers, a movable abutment member in the pump chamber, engine operated means, and means for operating the valve and abutment members from the engine operated means and in timed relation so that, when the pump abutment member is diminishing the volume of the pump chamber at approximately its highest rate, the inlet valve member interrupts communication of the pump chamber with the supply passage and the

outlet valve member establishes communication of such chamber with the outlet passage.

4. In a fuel feeding device, the combination of a casing member provided with inlet and outlet valve cylinders communicating with a pump cylinder, a supply passage communicating with the inlet valve cylinder, an outlet passage communicating with the outlet valve cylinder, cylindrical valve members movable in said valve cylinders, a piston in the pump cylinder, engine operated means, and means for operating the valve members and the pump piston from the engine operated means and in timed relation so that, when the pump piston is moving most rapidly in its working stroke the inlet valve member interrupts communication of the pump cylinder with the supply passage and the outlet valve member establishes communication of the pump cylinder with the outlet passage.

5. In apparatus of the character described, the combination of a pump cylinder, a valve guide chamber, a passage connecting the cylinder and the valve guide chamber, a supply passage communicating with the valve guide chamber, the openings of said passages into the valve guide chamber being offset, a valve member in the valve guide chamber, said valve member having a valve portion for covering the opening of the passage communicating with the pump cylinder and provided with means for placing said openings in communication, a pump piston in the pump cylinder, and means for operating the pump piston and the valve member in timed relation.

6. In apparatus of the character described, the combination of pump cylinder, a valve guide chamber, a passage connecting the pump cylinder and the valve guide chamber, a supply passage communicating with the valve guide chamber, the openings of said passages into the valve guide chamber being offset, a valve member slidably arranged within said valve guide chamber, said valve member having a valve portion of variable lap for covering the opening of the passage communicating with the pump cylinder and provided with means for placing said openings in communication, means for adjusting the valve member to change the extent of lap of the valve portion, a pump piston in the pump cylinder, and means for operating the piston and valve member in timed relation.

7. In apparatus of the character described, the combination of a pump cylinder, a valve cylinder, a passage connecting the cylinders, a supply passage communicating with the valve cylinder, the openings of said passages into the valve cylinder being offset, a piston valve member in the valve cylinder, said piston valve member having a piston valve portion of variable lap for covering the opening

of the passage connecting the valve cylinder and the pump cylinder and having a passage for affording communication between the supply passage and the connecting passage when said piston valve portion uncovers the opening of the connecting passage into the valve cylinder, means for adjusting the valve member to change the extent of lap of the piston valve portion, a pump piston in the pump cylinder, and means for operating the pump piston and the valve piston in timed relation.

8. In apparatus of the character described, the combination of a pump cylinder; a valve cylinder; a passage connecting the cylinders; a supply passage communicating with the valve cylinders; the openings of said passages into the valve cylinder being offset; a piston member in the valve cylinder having a piston portion for covering and uncovering the opening of said connecting passage into the valve cylinder, a portion of reduced diameter providing a space adapted to communicate with the opening of said connecting passage after the latter is uncovered by the piston portion upon movement of the piston member in one direction, a portion of reduced diameter providing a space communicating with the opening of said supply passage into the valve cylinder and adapted to communicate with the opening of said connecting passage into the valve cylinder when the piston valve portion uncovers the latter opening when moving in the other direction, and having a passage for affording communication between said spaces; a pump piston in the pump cylinder; and means for operating the piston valve member in timed relation with respect to the pump piston so that during a working stroke of the pump piston the piston valve member moves in a single direction and during the first part of such movement one of its spaces affords communication between the supply passage and the connecting passage, during the next part of said movement the piston portion covers the opening of said communicating passage into the valve cylinder, and during the last part of said movement the other space is brought into communication with said opening of the communicating passage with the valve cylinder to provide communication between said supply and communicating passages.

9. In apparatus of the character described, the combination of inlet and outlet valve cylinders, a pump cylinder communicating with the inlet and outlet valve cylinders, a supply passage communicating with the inlet valve cylinder, an outlet passage communicating with the outlet valve cylinder, a piston valve in the inlet valve cylinder, a piston valve in the outlet valve cylinder, a pump piston in the pump cylinder, means for operating the piston valves in timed relation with respect to the pump piston so that, upon a working stroke of the pump piston, the inlet

valve piston first affords communication between the supply passage and the pump cylinder, then interrupts such communication with concurrent operation of the outlet piston to establish communication of the pump cylinder with the outlet passage, and lastly re-establishes such communication upon movement of the inlet piston valve member in a single direction, said inlet piston valve having a piston valve portion of variable lap for interrupting communication between the supply passage and the pump cylinder, means for adjusting the inlet valve piston to vary the extent of lap, and means for varying the timing of the inlet valve piston with respect to the pump piston.

10. In a fuel feeding apparatus for an internal combustion engine, the combination of a plurality of conduits leading to engine cylinders and provided with injection nozzles, an auxiliary pump having its outlet in communication with all of said conduits, displacement members associated with the respective conduits for developing pressure of liquid fuel therein to secure injection, and valve means operated in timed relation with respect to each displacement member for interrupting communication of the associated conduit with the outlet of the auxiliary pump during an intermediate portion of the working stroke of the associated displacement member.

11. In a device for securing solid injection and atomization of liquid fuel in a high-speed Diesel engine, the combination of a working cylinder, an automatic fuel atomizer mounted in the wall of the cylinder, a conduit communicating with the atomizer, means for maintaining the conduit filled with liquid fuel under pressure insufficient to secure operation of the atomizer, and means including a reciprocating plunger device and a reciprocating valve both cooperating with the delivery conduit and serving to impart impulses to the column of liquid fuel therein to develop a sufficiently high pressure to operate the fuel atomizer and to secure a degree of atomization of the liquid fuel suitable for combustion in accordance with the Diesel cycle.

12. In a liquid fuel admission device for high speed internal combustion engines, in combination, a liquid fuel conduit having a discharge orifice of relatively small size, a valve controlling said discharge orifice and adapted to be opened by the pressure of liquid fuel in said conduit when said pressure exceeds a predetermined value, means for supplying liquid fuel under pressure to said conduit at a pressure insufficient to open said discharge valve, and means for momentarily increasing the pressure of the liquid fuel in said conduit to a value sufficient to operate said discharge valve, said last-named means including a rapidly moving valve adapted to intermittently close and open a relief port

from said conduit while moving in one direction.

13. In a solid injection fuel feeding system for a high speed internal combustion engine, the combination of a liquid fuel conduit provided with a pressure-opened nozzle for injecting fuel into the engine cylinder, pumping means for supplying and maintaining fuel in said conduit at a pressure which is positive but insufficient to open the nozzle, reciprocating plunger means operated in timed relation with the engine and communicating with the conduit for displacing liquid fuel during its entire working stroke, valve means for restricting discharge of liquid fuel from the conduit except through said nozzle during a portion of the working stroke of said plunger, and means for positively opening and closing said valve means in timed relation with the engine.

14. In a liquid fuel admission device for high speed internal combustion engines, in combination a liquid fuel conduit, a pressure-opened injection nozzle connected to the conduit, means for supplying liquid fuel to said conduit at a pressure insufficient to open said nozzle, a displacement pump communicating with said conduit, a rapidly moving valve constructed and arranged to abruptly close and open said conduit while moving in one direction and during each working stroke of the displacement pump in order that pressure sufficient for injection may be rapidly built up and such injection pressure quickly relieved to terminate injection, and actuating means for said pump and said valve designed and constructed to move the valve with great rapidity to close and open said conduit while the pump is moving in a pressure-producing direction.

15. In a liquid feeding device for an internal combustion engine, in combination, a liquid conduit having a pressure-opened discharge nozzle, means for supplying liquid to said conduit at a pressure insufficient to open said nozzle, a device for putting the liquid in the conduit under greatly increased pressure, and a member moving at all times under control of the engine for intermittently blocking the egress of the liquid from the conduit to any point save the nozzle when the pressure producing means is active, to place the liquid in the conduit under sufficient pressure to cause discharge from the nozzle of a measured quantity of liquid, said member being positioned intermediate said high pressure producing device and the liquid supply means and effecting the blocking and the reopening of the conduit without change in the direction of its movement.

16. In a liquid fuel feeding device for an internal combustion engine, in combination, a pressure-opened discharge nozzle, an auxiliary pump, a conduit connecting said nozzle

and said auxiliary pump and supplied with liquid fuel by the latter at a pressure insufficient to open said nozzle, a valve arranged to establish communication between the conduit and the auxiliary pump during initial and final stages and to interrupt such communication during an intermediate stage of movement of the valve in a single direction, a displacement member cooperating with the conduit and operated concurrently with the valve to develop pressure of liquid fuel in said conduit between the valve and the nozzle sufficient to open said nozzle to secure injection when said valve is in interrupting position, and mechanism operated in timed relation with respect to the engine for operating said valve and displacement member in properly timed relation.

17. In a liquid fuel feeding device for an internal combustion engine, in combination, a pressure-opened discharge nozzle, an auxiliary pump, a conduit connecting said nozzle and said auxiliary pump and supplied with liquid fuel by the latter at a pressure insufficient to open said nozzle, a valve for establishing communication between the auxiliary pump and the conduit in order that the latter may be supplied with liquid fuel under pressure and movable in a single direction to provide for escape of fuel from the conduit other than through said nozzle and to interrupt the escape of fuel save through said nozzle, a displacement member cooperating with the conduit and operated concurrently with the valve to develop pressure of liquid fuel in said conduit between the valve and the nozzle sufficient to secure injection when said valve is in position to prevent escape of liquid fuel save through the nozzle, means for adjusting the timing of said valve with respect to the displacement member, and mechanism operated in timed relation with respect to the engine for operating the valve and displacement member in properly timed relation.

18. In a liquid fuel feeding device for an internal combustion engine, in combination, a pressure-opened discharge nozzle, an auxiliary pump, a conduit connecting said nozzle and said auxiliary pump and supplied with liquid fuel by the latter at a pressure insufficient to open said nozzle, a valve for establishing communication between the auxiliary pump and the conduit in order that the latter may be supplied with liquid fuel under pressure and movable in a single direction to provide for escape of fuel from the conduit other than through said nozzle and to interrupt the escape of fuel save through said nozzle, a displacement member cooperating with the conduit and operated concurrently with the valve to develop pressure of liquid fuel in said conduit between the valve and the nozzle sufficient to secure injection when said valve is in interrupting position, means for varying the extent of the interrupting phase

of said valve, and mechanism operated in timed relation with respect to the engine for operating the valve and displacement member in properly timed relation.

19. In a liquid fuel feeding device for an internal combustion engine, in combination, a pressure-opened discharge nozzle, an auxiliary pump, a conduit connecting said nozzle and auxiliary pump and supplied with liquid fuel by the latter at a pressure insufficient to open said nozzle, a reciprocable valve having spaced recesses to establish communication between the auxiliary pump and said conduit during initial and final stages of its movement in a single direction, and having a slide valve portion separating the recesses and serving to interrupt communication during an intermediate stage of said movement, a displacement member cooperating with the conduit between the valve and the nozzle and operated concurrently with the valve to develop pressure of liquid fuel in said conduit sufficient to secure injection when said valve is in interrupting position, and mechanism operated in timed relation with respect to the engine for operating the valve and displacement member in properly timed relation.

20. In a liquid fuel feeding device for an internal combustion engine, in combination, a pressure-opened discharge nozzle, an auxiliary pump, a conduit connecting said nozzle and said auxiliary pump and supplied with liquid fuel by the latter at a pressure insufficient to open said nozzle, a piston valve having spaced recesses to establish communication between the auxiliary pump and said conduit during initial and final stages of its movement in a single direction and having a piston valve portion with divergent edges separating the recesses and serving to interrupt communication during an intermediate stage of said movement, a displacement member cooperating with the conduit between the valve and the nozzle and operated concurrently with the valve to develop pressure of liquid fuel in said conduit sufficient to open the nozzle to secure injection when said valve is in interrupting position, means for adjusting said piston valve about its axis in order to vary the duration of said interrupting stage, and mechanism operated in timed relation with respect to the engine for operating the valve and displacement member in properly timed relation.

21. In a device for securing solid injection and atomization of liquid fuel in a high-speed Diesel engine, the combination of a liquid fuel conduit having a discharge orifice of relatively small size, a cylinder having its most remote portion at one end directly communicating with the conduit, means for maintaining the interior space of the conduit and of the portion of the cylinder communicating therewith filled with liquid fuel, and means for developing injection pressure and inject-

ing a predetermined amount of liquid fuel including a reciprocatory plunger having its displacement portion fitting the bore of said cylinder and movable toward said cylinder end during its working stroke and valve means providing for the escape, other than through said orifice, of liquid fuel displaced by the plunger except during a portion of the working stroke of the latter when discharge is restricted to the orifice and high-pressure injection through the latter takes place.

22. In a device for securing solid injection and atomization of liquid fuel in a high-speed Diesel engine, the combination of a liquid fuel conduit having a discharge orifice of relatively small size, a cylinder having one end opening directly into the conduit, means for maintaining the interior space of the conduit and of the portion of the cylinder communicating with the conduit filled with liquid fuel, and means for developing injection pressure and metering liquid fuel injected including a reciprocatory plunger having its displacement portion fitting the bore of said cylinder and movable toward said cylinder end during its working stroke and valve means providing for the escape, other than through said orifice of liquid fuel displaced by the plunger except during an intermediate portion of the plunger working stroke when discharge is restricted to the orifice and high-pressure injection through the latter results.

23. In a device for securing solid injection and atomization of liquid fuel in a high-speed Diesel engine, the combination of a liquid fuel conduit, a pressure-opened injection nozzle connected to the conduit, a cylinder having its most remote portion at one end directly communicating with the conduit, means for maintaining the interior space of the conduit and of the portion of the cylinder communicating therewith filled with liquid fuel at a pressure insufficient to open said nozzle, and means for developing injection pressure and injecting a predetermined amount of liquid fuel including a reciprocatory plunger having its displacement portion fitting the bore of said cylinder and movable toward said cylinder end during its working stroke and valve means providing for the escape, other than through said nozzle, of liquid fuel displaced by the plunger except during a portion of the working stroke of the latter when discharge is restricted to the nozzle and high-pressure injection through the latter takes place.

24. In a device for securing solid injection

and atomization of liquid fuel in a high-speed Diesel engine, the combination of a liquid fuel conduit having a discharge orifice of relatively small size, a cylinder having its most remote portion at one end directly communicating with the conduit, means for maintaining the interior space of the conduit and of the portion of the cylinder communicating therewith filled with liquid fuel, and means for developing injection pressure and metering a predetermined amount of liquid fuel injected including a reciprocatory plunger having its displacement portion fitting the bore of said cylinder and movable toward said cylinder end during its working stroke and valve means providing for the escape, other than through said orifice, of plunger-displaced liquid fuel during initial and final portions of motion of the valve means in a single direction and limiting escape of liquid fuel to said orifice during the intermediate portion of motion of the valve means in the same direction.

25. In a device for securing solid injection and atomization of liquid fuel in a high-speed Diesel engine, the combination of a liquid fuel conduit having a discharge orifice of relatively small size, a cylinder having its most remote portion at one end directly communicating with the conduit, means for maintaining the interior space of the conduit and of the portion of the cylinder communicating therewith filled with liquid fuel, means for developing injection pressure and metering liquid fuel injected including a reciprocatory plunger having its displacement portion fitting the bore of said cylinder and movable toward said cylinder end during its working stroke and valve means providing for the escape, other than through said orifice, of plunger-displaced liquid fuel during initial and final portions of motion of the valve means in a single direction and limiting escape of liquid fuel to said orifice during the intermediate portion of motion of said valve means, and means providing for variation in the extent of the intermediate portion of motion of said valve means.

26. In the combination claimed in claim 23, a check valve in said conduit between said injection nozzle and said plunger, and disposed adjacent said plunger, for preventing the return of liquid toward said plunger.

In testimony whereof I have signed my name to this specification.

ALAN ERNEST LEOFRIC CHORLTON.