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MEANS FOR INJECTING LIQUID FUEL INTO INTERNAL COMBUSTION ENGINES

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Fig. 1.

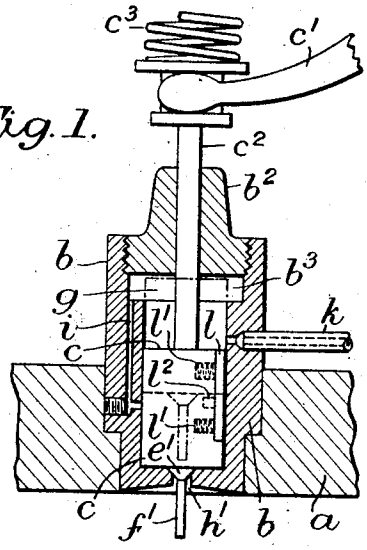


Fig. 2.

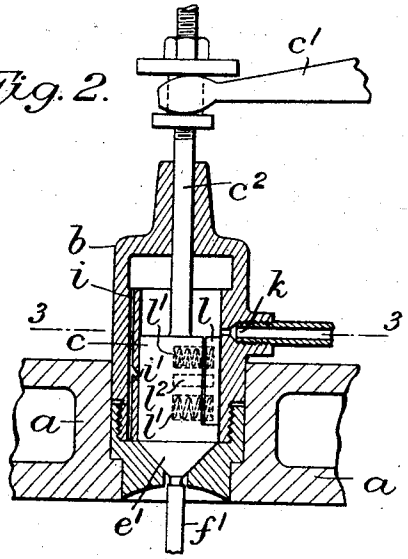
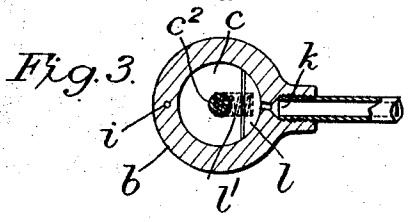


Fig. 3.



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UNITED STATES PATENT OFFICE.

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MEANS FOR INJECTING LIQUID FUEL INTO INTERNAL-COMBUSTION ENGINES.

Application filed July 25, 1925, Serial No. 46,147, and in Great Britain April 30, 1924.

This invention has reference to means for injecting liquid fuel into internal-combustion engines of the type in which an explosive charge is formed in a small injector cylinder connected with the working cylinder, and is forced into the latter by a spring-pressed plunger which is retracted by a cam after each injection stroke.

The invention relates more particularly to arrangements of this kind in which a portion of the air compressed in the working cylinder enters the injector cylinder and after mixing with the liquid fuel or oil to form the charge, is driven back into the engine cylinder by the plunger.

The invention is intended primarily for use with two-stroke engines to obviate the waste in the latter due to the unavoidable carrying away of fuel-oil spray or vapour along with the exhaust. It may however be applied to four-stroke engines if desired, and may be used both with light-oil, paraffin or spirit, and also with heavy oil. It may be used with either low or high compression and with spark-plug ignition, or in engines having self-ignition on the Diesel principle.

A further object of the invention is to ensure more perfect formation or atomization of the charge, and more efficient distribution and ignition thereof in the working cylinder, this being attained by a "double action," as set out in the specification of my co-pending patent application Serial Number 16,457 filed 18th March, 1925.

In other words, the charge in the injector cylinder is formed in two stages as it were, one stage during the backward stroke of the plunger, and the other during its forward stroke.

According to one example or construction, the injector cylinder is double-ended, the oil or liquid fuel being taken into the space above the piston and then forced from there into the space below the piston as the latter rises, through a suitable port or by-pass. This by-pass and also the oil inlet are so arranged that the piston itself covers and uncovers them at the proper times after the manner of a piston valve.

As the oil is discharged into the lower part of the cylinder, it mixes with the air therein which has just come already compressed from the engine cylinder, and the mixture is forced out as the piston descends, being sprayed or injected into the engine cylinder for ignition as the working charge in the usual way. The injection takes place through a restricted orifice with thin edges to promote dispersion or scattering of the charge, and the piston carries a short rod, plug or finger, and a valve part which co-operate with this orifice.

In the accompanying diagrammatic drawings:

Fig. 1 illustrates in longitudinal section, a double-ended injector for a two-stroke engine.

Fig. 2 illustrates a modification thereof.

Fig. 3 is a section on the line 3—3 of Fig. 2.

Referring more particularly to Fig. 1:

a represents the top or rear end of the engine cylinder, and b the double-ended injector cylinder which is in the form of a hollow block or plug firmly secured in the engine cylinder.

c represents the injector piston or plunger.

c^1 represents a cam-actuated lever for working said plunger.

c^2 represents the rod or stem of the plunger, on which are collars c^x engaged by the forked end of the lever c^1 in the usual way.

At the lower or forward end of the piston or plunger is a valve e^1 and a plug or finger f^1. These serve to control the injection orifice h leading from the injector chamber or cylinder b into the engine cylinder a.

The injector cylinder b being double-ended, the space above and below the plunger or piston c both take part in the formation of the charge. The injector piston or plunger c consists of a cylindrical block rather more than half the depth of the injector cylinder b in which it works freely or fairly easily. The rod or stem c^2 of the piston passes out through a closed conical cover or gland b^2. It is acted on by a powerful spring c^3 which tends to force the plunger c downward or forward whereas the cam-actuated lever c^1 moves it backward or retracts it counter to the spring. The operating cam may be of any suitable shape, as even a pear-shaped cam will allow the piston or plunger c to work sharply enough when the engine is running at full speed.

In one side of the cylinder b is the oil-inlet orifice k which just clears the top of the plunger c when the latter is in its lowest position. In the opposite side, but lower

down, is the outlet i^1 of a by-pass i, which is cleared and uncovered by the bottom of the plunger when the latter is fully raised, (see dotted lines). The ends of the plunger or piston may be made slightly inclined or askew so that by turning it round, the exact degree of clearance at the orifice can be regulated or adjusted with great nicety. The side of the plunger c has a groove or recess in which is fitted a short piece or strip l which is pressed against the cylinder wall near the oil inlet k by springs l^1. It serves (like a slide valve) to ensure proper closing of the inlet k as the piston moves up and down, so that the closure is complete notwithstanding that the piston is an easy fit in the cylinder. It has a pin or projection l^2 to prevent it moving endwise in its seat in the side of the plunger c.

The fuel oil inlet may also be graduated or controlled by a needle valve in any convenient way.

The injection orifice h^1 is situated centrally in the lower end of the injector cylinder, its bottom edge being rather thin or narrow, so that the spray passing through it will spread out fanwise or diverge freely all round.

The top of this orifice h^1 resembles a small valve-seat, and the plunger carries opposite to it, the central pin or finger f^1 which can enter it freely and acts as the restricting plug. The plunger also has a conical or valve-like portion e^1 to fit the valve seat.

Thus when the piston or plunger c is right down, the valve-like injection opening or orifice h^1 is closed entirely, by the valve e^1, whereas when the piston is drawn right up or backward, the pin or plug f^1 is withdrawn clear out of the said orifice (see dotted lines) and it is left fully open.

In intermediate positions the pin f^1 is in the opening and almost closes it, so giving a very restricted annular passage around the pin f^1 and ensuring good atomizing.

In practice the area of this narrow annular passage should be about equal to a circle whose diameter is one percent of the bore of the engine cylinder.

The by-pass i extends down through the wall of the cylinder. It opens into the top space of the latter, and also at i^1 into the bottom space thereof just below the raised position of the piston (see dotted line) as stated.

As the piston c starts descending, a small quantity of air passes up the by-pass i into the space above it, which is enlarged as at b^3. When the piston is right down, a small charge of oil enters through the side inlet k.

As the piston or plunger c is drawn back or rises, its slide-piece l first covers and closes the oil inlet k. The piston then carries the oil charge up to the top and forces it into the by-pass i partly mixed with air. The said oil charge then passes down i to the under side of the piston c and is sprayed into the lower chamber of the injector, this finishes the first stage of the double action in the formation of the mixture.

In the meantime the lower space of the injector has become filled with compressed air from the engine cylinder, and when the piston or plunger c again descends or makes its next forward stroke, it completes the mixture of oil-spray and air as it forces it back under heavy pressure into the engine cylinder, into which it spreads out fan-wise and gives a very efficient combustion.

In its descent the plunger c also covers and closes the lower end of the by-pass i, so that as it continues to descend, a partial vacuum is formed at the top of the injector ready to receive (or suck in) the next charge of oil through the inlet pipe or port k.

The proper formation of the charge is assisted by the heat of the walls of the device and of the surface of the pin or plug f^1, whilst overheating of the latter is prevented by the impact of the fuel spray.

The pin may have an annular groove as shown at its upper end to assist the dispersal action on the charge.

It may be mentioned that the injector piston need only have a rather slack or easy fit in the cylinder, a fair amount of clearance being an advantage in fact in many cases. Thus the inconvenience of a very tightly fitting or packed piston is avoided, and the wear and tear are correspondingly reduced. The only part which requires to be really tight is the slide-piece l controlling the oil inlet k.

In the arrangement shown in Figs. 2 and 3 the same letters refer to corresponding parts, and the same principles of construction are followed. The plunger c is however made conical instead of flat at its lower end, the injector cylinder being correspondingly shaped. The tip of the cone forms the valve part (corresponding to e^1) for closing the injection orifice. The injector cylinder is formed in two parts screwed together as shown. The slide l is a segment of the piston, whilst the by-pass i is drilled right down, its bottom end being closed however by the lower part of the injector. These arrangements facilitate manufacture and the conical shape of the plunger avoids any necessity for a clearance space between it and the bottom of the cylinder.

Obviously the above arrangements may be modified in various ways in carrying the invention into practice without departing from the general nature thereof.

I claim:

1. In a liquid-fuel injector, the combination of a double-ended injector chamber halv-

ing an injection orifice directly between it and the engine cylinder, a plunger in said chamber, means for admitting compressed air from the engine into said chamber as the plunger retires, means for forming a mixture of air and fuel at one side of the plunger and completing such mixture at the other side, and a device for restricting said orifice during the injection, substantially as described.

2. In a liquid fuel injector the combination of a double-ended injector chamber having an injection orifice between it and the engine cylinder, a plunger working pistonwise in said chamber, a valve for closing the injection orifice when the plunger is at the lower end of its stroke, and a device for restricting said orifice at the moment the injection is taking place, substantially as described.

3. In a liquid-fuel injector, the combination of a double-ended injector cylinder, an injection plunger working in said cylinder and acting also as a piston valve, an oil-supply to the space behind the plunger, a by-pass passage leading from said space to that below the plunger, means for restricting the injection orifice during the injection of the charge, and valve-like means for closing said orifice at the end of the injection stroke, substantially as described.

4. In a liquid fuel injector, the combination of a double-ended cylinder, a plunger working therein, means for supplying fuel to the space above said plunger, a by-pass in the wall of said cylinder through which the fuel is discharged as spray into the air space below said plunger, and means carried by said plunger for restricting, during the actual injection, the orifice leading into the engine cylinder substantially as described.

5. In a liquid-fuel injector, the combination of a double-ended cylinder, an oil-supply inlet to the space at one end, a by-pass from said space to that at the other end, a piston which uncovers the oil inlet and the by-pass alternately, a valve part carried by said piston for temporarily closing the fuel orifice leading to the engine cylinder, and a projection on said piston for restricting said orifice during injection of the charge, substantially as described.

6. In a liquid-fuel injector, the combination of a double-ended cylinder, an injection plunger which is retracted by a cam and driven forward for the injection stroke by a spring, a fuel-supply inlet which is closed by the plunger when in its retracted position, a by-pass in the wall of said cylinder which is closed by the plunger when in its forward position, and means for restricting the inlet orifice leading to the engine cylinder during the actual injection, substantially as described.

7. In a liquid fuel injector, the combination of a double-ended cylinder made conical at its forward end, a plunger which is also correspondingly conical at its forward end, a liquid fuel inlet admitting fuel to the rear end of the injector, and a by-pass for transferring said fuel to the forward part of the injector, said inlet and by-pass being alternately opened and closed by the plunger, substantially as described.

8. In a liquid fuel injector, the combination of a double-ended cylinder made conical at its forward end, a plunger which is also correspondingly conical at its forward end, a liquid fuel inlet admitting fuel to the rear end of the injector, and a by-pass for transferring said fuel to the forward part of the injector, an orifice between said forward part and the engine cylinder, and a pin carried by the plunger for restricting said orifice due to the actual injection of the charge, substantially as described.

In testimony whereof I affix my signature.

SIMON DOKK OLSEN.