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 A. R. F. RAVEN
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 WITH AN INTERNAL COMBUSTION ENGINE
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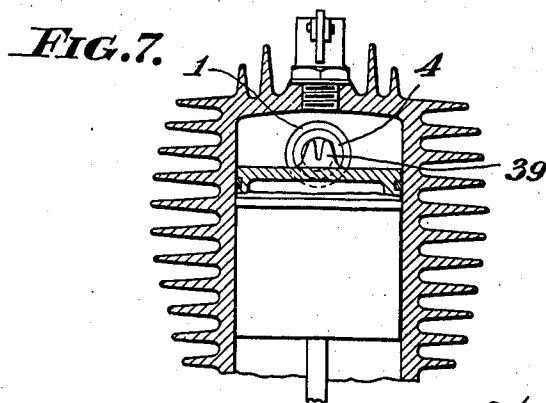
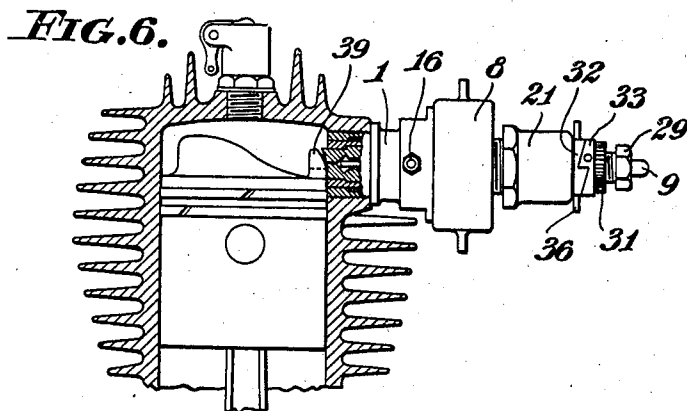
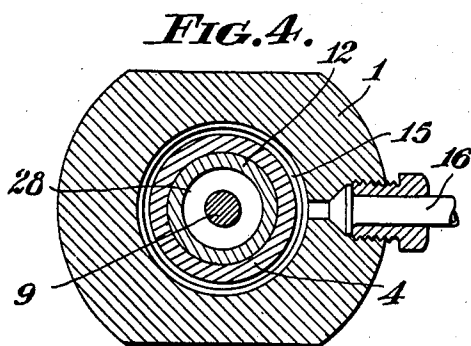
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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COMBINED FUEL PUMP, INJECTION AND
SPRAY JET FOR USE WITH AN INTERNAL
COMBUSTION ENGINE

Arthur Robert Fenton Raven, Hong Kong, China

Application June 20, 1939, Serial No. 280,147
In Great Britain September 13, 1937

5 Claims. (Cl. 123—139)

This invention relates to a self-contained combined fuel pump and injector, operating with a solid or airless injection compression ignition system, and applicable for use with an internal combustion engine designed normally for operating on petrol, so that the petrol engine can be converted into a solid injection compression ignition engine.

The invention is particularly applicable to operating with "solid" injection on a two-stroke cycle and by way of example, a self-contained combined fuel pump and injector suitable for use on a petrol engine will be hereinafter described with reference to the accompanying drawings, wherein:

Figure 1 is an axial section through one embodiment of the injector.

Figures 2 to 5 transverse sections on lines II—II; III—III; IV—IV and V—V respectively of Figure 1; and,

Figures 6 and 7 are side and end views respectively, showing the application of the embodiment of Figure 1 to the cylinder in horizontal disposition instead of vertical.

In accordance with the embodiment of the invention shown, a hollow plug 1 is provided which has its lower end extremity screw-threaded at 2 to engage a screw-threaded opening in the cylinder head, such as the existing opening for the sparking plug. The lower end of the bore of the hollow plug 1 is narrower than the upper end and forms, together with the bore of a gland nut 3 in the upper end of the plug bore, a cylindrical seating for a pump barrel 4 which has a comparatively large flange 5 with a screw-threaded periphery 6 near its upper end. The periphery of the enlarged upper end of the plug is also screw-threaded at 7, the threads of the barrel flange and of the plug top being of different "hand," i. e. one a right-hand thread and the other a left-hand thread, so that the rotation of a collar 8 screwed internally to engage the barrel flange and plug top threads 6 and 7, effects movement of the barrel 4 axially in relation to the plug 1. In this way the "timing" of the valve is altered, that is, the pump barrel and with it the pump plunger contained therein may be adjusted in relation to the position of the engine piston and thus effect earlier or later opening of the needle valve 9 for delivery of the fuel, to be hereinafter referred to. The collar 8 is partially rotated by the vehicle driver through the medium of any suitable remote control means connected to the said collar. Means are provided to prevent rotation of the barrel 4 relative to the plug 1; in the embodiment there is employed for this purpose a series of pins 10 projecting outwardly from the plug and slidable within holes in the barrel flange 5. In the lower end of the pump barrel 4 is slidably housed the pump plunger

11 consisting of a hollow cylindrical rod having both ends reduced in diameter, the bottom reduced portion being accommodated as a snug sliding fit in the constricted lower end of the pump barrel bore. The bottom end of the plunger normally projects down below the bottom of the barrel 4, which, in turn, normally projects down below the plug 1. In the upper part of the pump barrel 4 and projecting up beyond the top thereof is a fuel regulating sleeve 12 whose lower end extends into the annular space existing between the upper reduced portion of the plunger 11 and the surrounding barrel 4. The remaining part of the annular space below the bottom extremity of the sleeve 12 constitutes a fuel chamber 13 in which oil is admitted through a ring of orifices 14 provided in the barrel wall from a concentric annular space 15 existing between the barrel 4 and the plug 1, admission of fuel to the space 15 being through an inlet nipple 16. The oil from the fuel chamber 13 enters through the bore of the hollow pump plunger 11 through another series of orifices 17. The capacity of the fuel chamber 13 is varied by relative longitudinal movement between the plunger 11 and the regulating sleeve 12. The regulating sleeve 12 is normally held in its lower position (in which it is seated on a shelf 18 in the barrel interior) by means of a coil spring 19 encircling said sleeve 12 and interposed between a flange 20 thereon and the roof of a cap 21 which is screw-threaded on to a hollow boss 22 provided on the barrel 4 above the flange 5 thereof. Means are provided to prevent relative rotation between the pump barrel 4 and the regulating sleeve 12, such as a pin-and-slot connection 12a. Extending centrally through the appliance is the needle valve 9 whose tapered point 23 normally rests on a conical seating 24 provided at the bottom of the bore of the pump plunger 11, the tip of the needle closing a fine-diameter oil injecting jet or orifice 25 which extends down from the plunger bore to a conical recess 26 on the bottom face of the plunger 11. The lower end of the valve 9 is of lesser diameter than the bore of the plunger 11, or other suitable provision is made so that the ducts 17 are in communication as indicated at 27, through said bore with the jet orifice 25 under the control of the valve 23, for the flow of fuel oil between the orifices 17 in the plunger wall and the jet or orifice 25 at the tip of the plunger. The needle valve 9 projects up from the plunger bore into the interior of the regulating sleeve 12 and is provided above the top of the plunger with a flange or collar 28 between which and an adjustable through-bore nut 29 screwed into the top of the regulating sleeve is a coil spring 30 which encircles the needle valve 9. Between the top face of the roof of the spring cap 21 and a nut 31

on the top end of the regulating sleeve 12 are a pair of collars 32 and 33 having opposed ratchet faces 34, one of which (32) is loose and the other (33) anchored by the grip screw 35 to the regulating sleeve. The loose ratchet collar 32 is provided with lugs 36 by which it can be coupled to a remotely situated handle by cables or other linkage so that by partially rotating the loose collar 32 the complementary fixed collar 33 is lifted and the regulating sleeve 12 displaced axially.

In use of the device, filtered fuel is supplied by gravity to the annular fuel reservoir 15 between the barrel 4 and plug 1 and from thence is drawn by suction through the orifices 14 in the barrel wall into the annular fuel chamber 13 around the plunger 11. The pressure of injection imposed on the fuel is regulated by the adjustment of the regulating sleeve spring 19 and of the valve spring 30, the tension or pressure of these two springs being adjustable by manipulating respectively the cap 21 screwed on to the boss 22 of the barrel and the nut 29 screwed in the upper end of the regulating sleeve 12. The upward or pressure stroke of the plunger is effected by the contact therewith of an abutment 37 on the piston which takes place when the piston is very near the top of its stroke and accordingly when its motion is slow and decelerating. The timing of the moment of contact is regulated by partial rotation of the collar 8 which mutually connects with the plug 1 and the barrel flange 5 and the quantity of the fuel charge is regulated by partial rotation of the loose ratchet collar 32 which imparts axial movement to the fuel regulating sleeve 12. As the sleeve spring 19 is stiffer than the valve spring 30, the pressure exerted on the oil overcomes that exerted on the valve 9, so that the valve lifts to uncover the spray jet or orifice 25 in the plunger tip. The valve 9 is returned to its seating under the pressure of its spring 30 when the plunger 11 ceases to contact with the piston abutment 3 and the plunger is then returned by the spring 30 to the suction stroke and intake of a new oil charge. It will be observed that the piston abutment 37 is grooved radially to provide channels 38 along which the fuel can flow whilst the abutment is in contact with its seating 26 in the end of the plunger 11.

In the foregoing description a vertically disposed appliance attached to the crown of the cylinder head has been described and in this case the abutment on the piston takes the form of an adjustable stud on the piston crown, as shown, the channels serving to "spread" the oil spray. A V split lug 39 on the piston crown adjoining the piston wall would be employed, for example, when the appliance is horizontally disposed, as shown in Figures 6 and 7.

In the event of chokage of the jet of the plunger, relief is provided by a series of auxiliary orifices 40 (see Figure 1) normally covered by the regulating sleeve 12 but uncovered when the resistance of the sleeve spring 19 is overcome, the auxiliary orifices 40 feeding the oil from the pump chamber 13 back to the reservoir 15.

I claim:

1. A combined fuel pump and injector for internal combustion engines of the compression ignition type comprising a barrel, a pump plunger within said barrel and reciprocable relative thereto, means limiting inward movement of said

plunger relative to said barrel, said pump plunger, when at its limit of inward movement in said barrel, being disposed to be engaged and to be moved outwardly in said barrel by an abutment on the engine piston during the final portion of the outward stroke of the piston, the inner end portion of said plunger having a liquid tight relationship to said barrel, the outer end portion of said plunger being spaced from said barrel, a sleeve extending into the space between the outer end portion of said plunger and said barrel and cooperating with said barrel and plunger to provide therebetween a liquid fuel chamber the outer end of which is defined by the inner end of said sleeve, means for the supply of fuel to said chamber when said plunger is at its limit of inward movement in said barrel and for the cutting off of the fuel supply to said chamber when said plunger is moving outwardly in said barrel, said plunger having an axial bore and a transverse duct providing constant communication between said bore and the inner end of said fuel chamber, said plunger also having a fuel outlet orifice and an outwardly facing valve seat disposed inwardly with respect to said duct and in constant communication through said bore with said duct, a valve cooperating with said valve seat to control flow of fuel from said bore through said orifice, said valve having a stem disposed in said bore and liquid tightly fitting said bore outwardly with respect to said duct so that under the influence of a predetermined pressure of the liquid fuel when the valve is seated and the plunger is held against inward movement the valve is moved outwardly relative to the plunger and thereby is unseated, spring means resisting outward movement of said valve, and other spring means resisting outward movement of said sleeve, said spring means being of strengths relative to each other such that the pressure of the liquid fuel developed by outward movement of the plunger in the barrel is effective to impart outward opening movement to the valve prior to outward movement of the sleeve.

2. A combined fuel pump and injector as set forth in claim 1 including means for adjusting the sleeve inwardly and outwardly relative to the barrel to vary the volume of the fuel chamber.

3. A combined fuel pump and injector as set forth in claim 1 including means for adjusting the barrel inwardly and outwardly to vary the position of the plunger relative to the engine cylinder when said plunger is at its limit of inward movement within the barrel, thus to vary the time at which the plunger is engaged and moved outwardly by the piston abutment.

4. A combined fuel pump and injector as set forth in claim 1 in which the plunger and the piston abutment are formed to cooperate when engaged with each other to provide therebetween a series of small passageways radiating from the fuel outlet orifice for distributing the fuel into the engine cylinder.

5. A combined fuel pump and injector as set forth in claim 1 including a plug to be fastened to the engine and in which the barrel is inwardly and outwardly adjustable, and a rotatably adjustable collar having threaded connections with said plug and barrel so that by rotation of said collar the barrel may be adjusted inwardly or outwardly relative to said plug.

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