

Aug. 18, 1931.

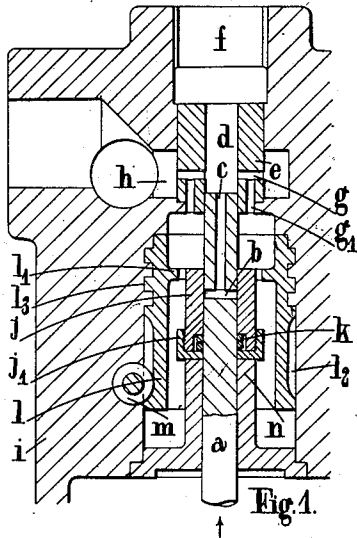
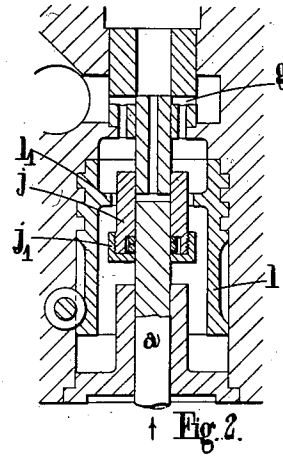
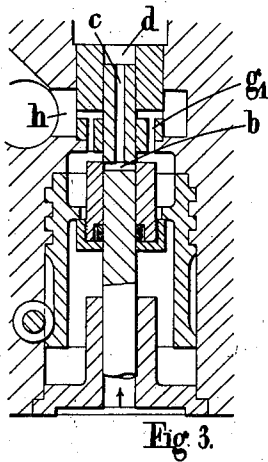
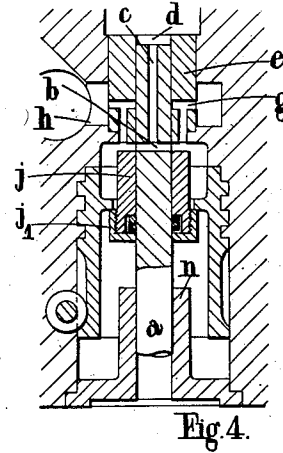
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1,819,015

LIQUID FUEL PUMP FOR INTERNAL COMBUSTION ENGINES

Filed March 18, 1930

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

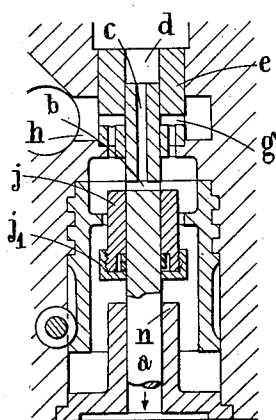


Fig. 5.

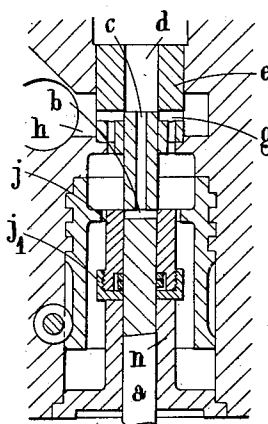


Fig. 6.

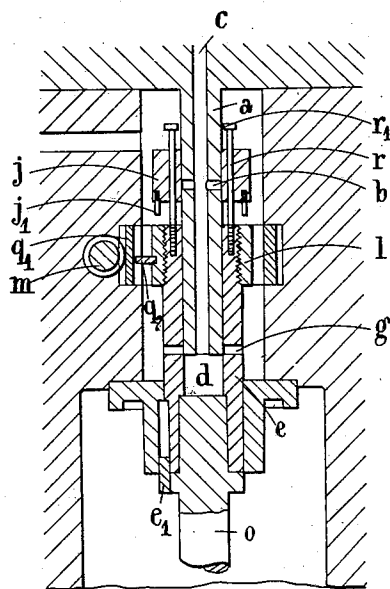


Fig. 7

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UNITED STATES PATENT OFFICE

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LIQUID FUEL PUMP FOR INTERNAL COMBUSTION ENGINES

Application filed March 18, 1930, Serial No. 436,864, and in Great Britain December 16, 1929.

This invention relates to an improved liquid fuel pump for internal combustion engines, more particularly high speed Diesel engines, designed to deliver variable quantities of fuel to the reservoir connected with the injection nozzle.

The invention is more particularly directed to the kind of fuel pump in which a piston is provided with a longitudinal hole and with radial holes communicating therewith, whereby communication is established between the working space in front of the piston and a suction chamber during the reciprocation of the piston in and relatively to a fixed cylinder provided with an opening which communicates with the suction chamber and is controlled by the piston, and in and relatively to a sleeve mounted on the piston and capable of being adjusted relatively thereto to control the end of the injection.

The main object of the present invention is to provide an improved fuel pump of the kind referred to which will be especially efficient more particularly in the case of high speed Diesel engines.

The invention broadly consists in arranging that the adjustable sleeve shall also be automatically displaced during the inward and outward strokes of the piston in such a manner as to ensure, in conjunction with the opening provided in the fixed cylinder and controlled by the piston, a supply of fuel to the working space during the entire outward stroke of the piston without the use of an inlet valve in the head of the fixed cylinder, in addition to its function of ensuring the end of the injection by the adjustment of the sleeve.

According to a modification, the cylinder is made movable and the piston above referred to stationary, in which case the adjustable sleeve on the piston is automatically displaced during the inward and outward strokes of the movable cylinder.

The invention also consists in the constructions hereinafter more particularly described by way of example.

Referring to the accompanying drawings illustrating the invention diagrammatically and by way of example,

Figure 1 is a sectional elevation of one form of construction,

Figures 2-6 showing different portions of the movable parts, and

Figure 7 illustrating a modified form of construction.

The piston *a* is provided with a radial hole or holes *b* and with an axial or longitudinal hole or holes *c* communicating with the said radial holes and with the working space *d* of the pump. The piston is associated with a fixed cylinder *e*, the working space *d* of which communicates with the reservoir *f* connected with the injection nozzle and by means of radial holes *g* controlled by the piston also with the suction chamber *h*, which is provided in the casing or frame *i* of the pump, preferably in the form of an annular space. In addition to the communication referred to between the suction chamber *h* and the working space *d* of the pump, communication is established between the suction chamber and the working space through the holes *b*, *c* provided in the piston, this communication being controlled by the radial holes *b* provided in the piston through the intermediary of an adjustable sleeve *j* mounted on the piston *a*.

The adjustable sleeve *j* is mounted on the piston *a* in such a manner as to be taken along with the piston owing to the friction existing between them. The sleeve *j* may be partly slit in the longitudinal direction and forced against the piston by means of a resilient ring surrounding a portion of the sleeve, or as shown in the drawing by means of a split ring *k* sprung on the piston *a* and mounted between the sleeve *j* and a flanged member *l* screw-threaded on the sleeve *j* and forming an abutment thereof. The adjustable sleeve *j*, *j*₁ is used in conjunction with a longitudinally displaceable member *l* provided with an abutment *l*₁ for the sleeve *j*, *j*₁, such abutment coming into action during the inward stroke of the piston. The longitudinally displaceable member *l* is preferably in the form of a cylinder surrounding the sleeve *j* without making contact therewith and provided with an internal flange *l*₁ forming an abutment intended to co-operate with the flanged mem-

ber j_1 provided at the end of the sleeve j facing away from the fixed cylinder e . The said longitudinally displaceable member l , l_1 may be adjusted in the longitudinal direction by means of a lever engaging in a transverse recess provided therein and rocked by a rotary bar mounted in the case or frame of the pump or as shown in the drawing by a helical displacement effected by means of a sliding toothed rack m mounted in the pump casing or frame i and engaging with teeth l_2 formed on the longitudinally displaceable member l , which is also in helical engagement with the casing i as shown at l_3 .

According to a further form of construction, the longitudinally displaceable member is provided on its outer surface with a rack engaging with a hand-operated pinion.

The operation of the construction hereinbefore described is as follows:—

At the beginning of the inward stroke (see Fig. 1) the sleeve j mounted on and in frictional contact with the piston a abuts against the end n of the pump casing, the longitudinally displaceable member l having previously been set at the desired distance from the fixed cylinder e . The working space d of the pump is in communication with the suction chamber h through the radial holes g provided in the fixed cylinder e , whilst the radial holes b in the piston are covered by the sleeve j . As the piston a advances during its inward stroke carrying the sleeve j with it, the injection commences at the moment the front end of the piston covers the radial holes g provided in the fixed cylinder (see Fig. 2). During the injection, the flange j_1 on the sleeve j comes against the flange l_1 of the longitudinally displaceable member l , whereby the friction between the piston and the sleeve is overcome and the piston a continues to move inwards, leaving the sleeve j behind it (see Fig. 3). At the moment the radial holes b in the piston start to be uncovered at the end of the sleeve (see Fig. 3), the injection terminates and part of the fuel remaining in the working space d is forced into the suction chamber h past the longitudinal and radial holes c , b , provided in the piston a and the holes g_1 . As soon as the outward stroke starts from the highest position of the piston shown in Figure 4, the sleeve j is taken along with the piston as shown in Figure 5 until the outer end of the sleeve j comes against the end n of the pump casing, as shown in Figure 6. The whole construction is such that at this moment the working space d is just placed in communication with the radial holes g provided in the cylinder e and communicating with the suction chamber h , the radial holes b in the piston still being wholly or partly in communication with the suction chamber. The piston a now continues to move relatively to the sleeve j mounted thereon, whereby the radial holes

b in the piston are closed and the fuel is continued to be drawn into the working space through the radial holes g provided in the fixed cylinder. After the piston reaches the end of its outward stroke, the cycle of operations above referred to is repeated.

It will be seen that in this way the suction of the fuel into the working space is ensured during the whole outward stroke of the piston without any inlet valve being provided at the head of the working space. It will also be seen that the sleeve j mounted on the piston in frictional contact therewith controls the end of the injection and in addition thereto, in conjunction with the radial holes provided in the fixed cylinder, allows the suction to be continued during the entire outward stroke without interrupting the delivery of the fuel to the working space during the outward stroke.

Referring to the modification illustrated in Figure 7, the piston a is made stationary, b and c being the radial and longitudinal holes provided therein, and the cylinder e is made movable, being reciprocated on the stationary piston a by the rod o , its rotation being prevented by a key e_1 . A sleeve l screw-threaded on the reciprocating cylinder e is adapted to be longitudinally displaced thereon under the control of a toothed rack m through the intermediary of an internal slot formed on the externally toothed sleeve g_1 and pins g_2 secured to the sleeve l and engaging with the said slot. The sleeve j intended to be moved during the operation is mounted on the stationary piston a and is traversed by rods r secured to the sleeve l , the said rods being provided with heads r_1 and the said movable sleeve j being provided with abutments j_1 against which the sleeve l comes to lie in order to move the sleeve j in one direction, its movement in the opposite direction being effected by the heads r_1 on the rods r .

The operation of this form of construction is as follows: When the cylinder e moves upwards from its lowermost position, the liquid fuel present in the space d is forced through the radial holes g in the cylinder e into the suction space h until the end of the stationary piston a covers the said holes g . Thereupon the fuel is forced through the axial hole c and the injection takes place. As the forward movement of the cylinder is continued, its upper end strikes against the abutments j_1 on the sleeve j and takes the latter along with it. As soon as the lower inner edge of the sleeve j uncovers the radial holes b in the piston a , the pressure is released and the injection is terminated. The cylinder e starts on its return stroke, leaving the sleeve j in its uppermost position, and the radial holes uncovered, so that suction commences through these holes. Upon the heads r_1 on the rods r secured to the cylinder e coming against the

upper surface of the sleeve *j*, they carry the latter along, whereby the radial holes *b* are closed. However, before these holes are closed, the openings *g* in the cylinder *e* are uncovered by the stationary piston *a* and suction is continued through the said openings *g*. When the cylinder *e* reaches its lowermost position, the operations hereinbefore described are repeated.

It will be seen that according to the longitudinal adjustment of the sleeve *l* relatively to the cylinder *e*, the time when the latter will strike against and operate the sleeve *j* will be adjusted and thus the duration of the injection can be varied as desired.

The details for carrying the invention into effect may be varied without in any way departing from the spirit of the invention.

What I claim is:—

1. A liquid fuel pump comprising a piston with a longitudinal hole and with radial holes communicating therewith, a cylinder also provided with radial holes, the said piston engaging in the said cylinder and one of them being capable of being reciprocated relatively to the other, a sleeve on the piston capable of being reciprocated during certain portions of the said reciprocating relative movement between piston and cylinder, means acting on the said sleeve for adjusting the time when the sleeve on the piston shall uncover the radial slots in the piston during its reciprocating relative movement on the piston in one direction and means which will ensure the relative reciprocating movement of the said sleeve in the opposite direction, the distance between the radial holes in the piston and the end of the latter facing the working space within the cylinder, the position of the radial holes in the cylinder and the relative position between the sleeve on the piston and the means acting on the sleeve being such that during the whole of the suction stroke an open communication is maintained between the suction chamber and the working space of the cylinder either through the radial holes in the piston or the radial holes in the cylinder.

2. A liquid fuel pump as claimed in claim 1, in which the piston is stationary and the cylinder movable relatively thereto, the time adjusting means acting on the sleeve relatively movable on the piston including a longitudinally displaceable sleeve mounted on the cylinder and abutments between the said sleeve on the cylinder and sleeve on the piston which will keep the two sleeves at a distance from one another at least equal to the width of the radial holes in the piston.

3. A liquid fuel pump as claimed in claim 1, in which the piston is stationary and the cylinder movable relatively thereto, the time adjusting means acting on the sleeve relatively movable on the piston including a longitudinally displaceable sleeve mounted

on the cylinder and abutments between the said sleeve on the cylinder and sleeve on the piston which will keep the two sleeves at a distance from one another at least equal to the width of the radial holes in the piston, the means ensuring the movement of the sleeve mounted on the piston in the opposite direction comprising rods secured to the movable cylinder and passing through the sleeve on the piston, heads being provided at the free ends of the rods which carry the sleeve on the piston in the opposite direction during the outward stroke of the cylinder.

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

JOSEF BENES.