April 2, 1940. K. UCCUSIC ET AL 2,195,946

LIQUID FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES OF THE DIESEL TYPE

Filed Jan. 5, 1938

Fig. 1.

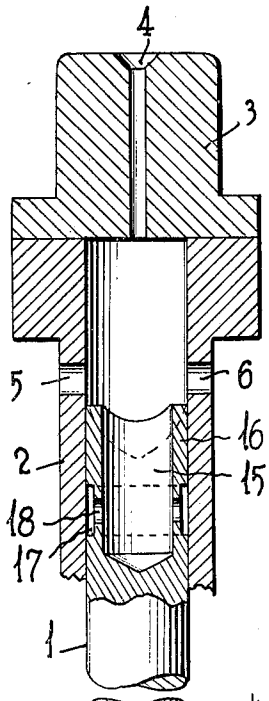


Fig. 2.

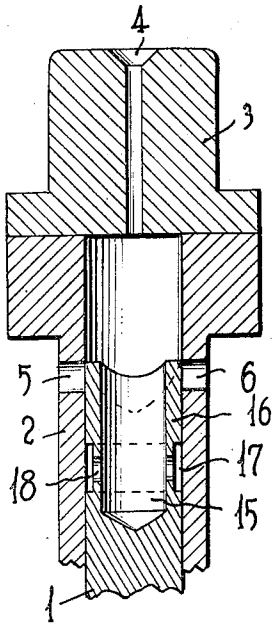
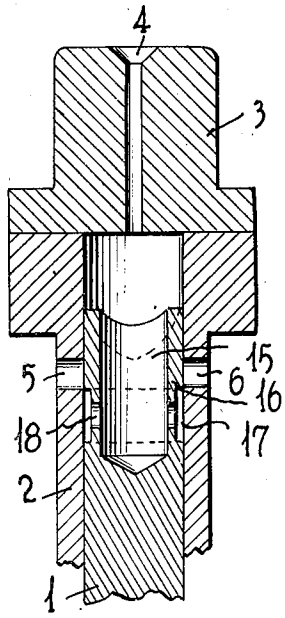


Fig. 3.



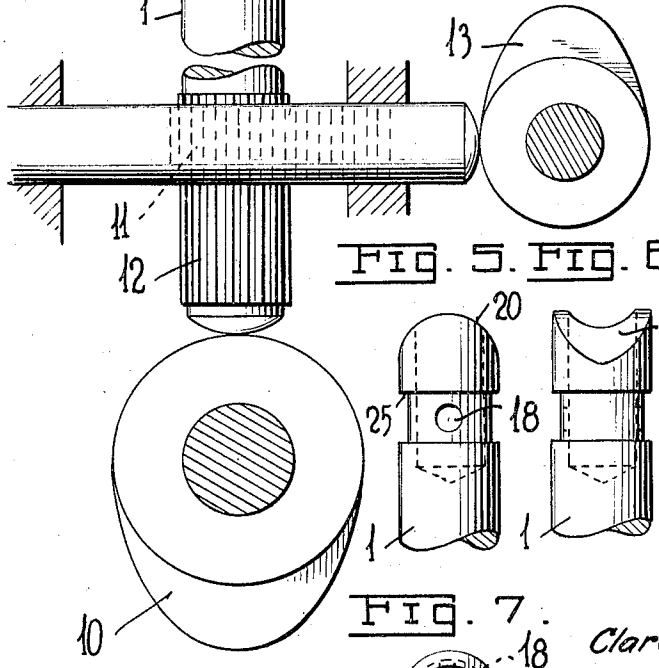


Fig. 4.

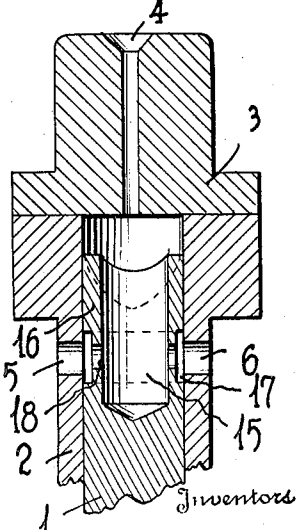
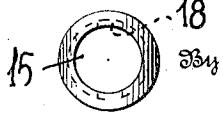


Fig. 5. Fig. 6.

Fig. 7.



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LIQUID FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES OF THE DIESEL TYPE

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Application January 5, 1938, Serial No. 183,556

1 Claim. (Cl. 123—139)

The present invention relates to pumps and more particularly to those of the type used for injecting fuel into Diesel and engines of like type.

More particularly, the invention relates to fuel injection pumps for internal combustion engines of the type having a plunger reciprocable with constant stroke in a cylinder ported to communicate with a fuel supply chamber. The invention relates, also, to fuel injection pumps for airless or solid injection of fuel in internal combustion engines.

In the type of fuel pump disclosed herein, the delivery of fuel is interrupted by connecting the space in front of the piston with a point of reduced pressure. The pump is provided with a piston controlled suction port in which delivery is interrupted by means of conduits such as grooves, passages and the like, which are controlled by the piston in such a manner as to connect the pump space with the suction pipe at the moment of interruption.

The principal object of the invention is to provide an elastic pump, constructed so as to utilize the compression pressure to insure perfect tightness of the piston and render it leak proof.

Another object of the invention is to provide a piston or plunger having a bore which serves the purpose of aiding in the expansion of the piston head and secondarily is used for the return flow of the fuel oil.

Another object of the invention is to make the tightness of the piston or plunger independent of the speed of the piston or plunger.

Another object of the invention is to provide a pump especially adapted to high-speed motors, such as used in airplanes, automobiles, etc.

Still a further object is to provide means for varying the delivery of the pump.

Other objects will appear in the course of the detailed description now to be given with reference to the accompanying drawing, in which:

Figs. 1, 2, 3 and 4 are axial sections of the pump showing various positions of its piston;

Fig. 5 is a full view of a portion of the plunger or piston;

Fig. 6 is a view of Fig. 5 turned 90° about its vertical axis; and

Fig. 7 is a plan view of the plunger or piston shown in Fig. 5.

Figs. 1, 2, 3 and 4 show the plunger angularly disposed in the cylinder to afford maximum delivery of the fuel oil. Referring to these figures, there is shown a plunger or piston 1, slidably mounted in a cylinder 2, the cylinder being provided with a terminal head 3 having a discharge port 4 therein communicating with the injector pipe line (not shown). The cylinder is provided with lateral fuel intake ports 5 and 6, in axial alignment.

A cam 10 reciprocates the piston 1, by its rotation and a rack 11 and pinion 12, coacting with the piston, rotate the latter when the rack is actuated by cam 13. The piston and pinion may be slidably engaged with the rack in any suitable manner. In fact, elements 10 to 13 inclusive form no part of this invention but are shown merely to illustrate how the piston can be reciprocated as well as rotated to accomplish certain results. The mode of actuating the piston may be widely varied.

The piston 1 is provided for a portion of its length with a bore 15, leaving that portion of the piston surrounding the bore with a relatively thin wall 16, capable of being expanded under certain conditions hereinafter referred to; in other words, the inner bore in relation to the outer diameter is so wide and deep that the wall of the hollow portion of the piston will stand elastic expansion. The bore may also be considered as an inner bore or relief chamber and it is essential that it be made axially of the piston and concentrically therewith. The piston is also provided with an annular groove 17 limited vertically by horizontal parallel walls and this annular groove is brought into communication with the bore 15 by means of ports 18 which are in alignment with each other. The bore, groove and ports are designed to vary the beginning of the pressure stroke. The inner end surface of the piston is shaped as shown in Figs. 5, 6 and 7, wherein a rounded steering edge 20 is provided. The steering edge is an arc of a circle and in rounding the piston in this manner, two surfaces 21 are also formed, said surfaces being symmetrical. The surfaces, conceivably, might assume the shape of a parabola or hyperbola.

The pump operates in the following way: Fluid fuel is fed to the cylinder 2 through the intake ports 5 and 6, the source of fuel oil being adjacent to the cylinder; in fact the cylinder is surrounded by fuel oil or is permanently in contact with it. In Figure 1 the piston is shown at its lowest stroke-end position, fuel oil having been sucked into the cylinder through the intake ports 5 and 6. This also marks the beginning of the upward stroke of the piston. Figure 1 also shows the piston at lower dead-center position. In Figure 2, the piston has moved so that the

upper steering edge 20 has covered the intake ports 5 and 6 and prevented the back flow of fuel oil from the cylinder. From this position upwards, compression on the delivery stroke begins, the fuel oil being compressed until the piston reaches the position shown in Fig. 3, which is a position where compression ends on the delivery stroke. Both of Figs. 2 and 3 indicate the maximum power stroke and the fuel oil under certain conditions can be compressed to a pressure of 500 and even up to 700 atmospheres. In actual practice, the piston is forced a little further upward, than is shown in Fig. 3, by the cam 10, whereupon the controlling edge 25 of the piston uncovers both of the intake ports and a back flow of fuel oil occurs, through the bore 15, ports 12, and intake ports 5 and 6. This back flow continues until the piston reaches the position shown in Fig. 4, which is the end of the upper stroke and also the upper dead center position of the piston. When the controlling edge 25 uncovers both of the intake ports, a rapid decrease in pressure within the cylinder also occurs. When the piston moves downwardly from the position in Fig. 4, to the position in Fig. 3, fuel oil is again sucked in, and up to this point, an equalization of pressure, with that of the compression chamber of the cylinder, has been established. In the position shown in Fig. 3, on the downward stroke, because of the covering of the intake ports, suction is impossible until the position of Fig. 2 is reached, and only then when the upper steering edge 20 in downward stroke has uncovered the intake ports, or as shown in Fig. 1, which means that lower pressure has taken place within the cylinder and only by uncovering the intake ports, can further suction begin. Fuel oil is thus drawn in at greater speed because of the existing lower pressure in the cylinder. Figures 1 to 4 inclusive show the piston under maximum fuel oil feeding conditions. By rotating the piston about its vertical axis 90°, as for instance by means of the rack and pinion actuated by cam 13, the power stroke may be reduced to zero, this because the length from the steering edge 20 in Fig. 6 to the controlling edge 25 is the same as the diameter of the intake ports 5 and 6. When the piston is thus rotated 90°, the compression stroke is cut off and the engine is stopped.

As the piston head is shaped as shown, the uncovering of the intake ports 5 and 6 can, by a rotary displacement of the piston, be effected at different points of the pressure stroke, and the duration of the feed can thus be regulated to meet the load on the engine.

It has been stated that a portion of the piston is provided with a thin wall 16. This construction is specifically for the purpose of utilizing the compression pressure to effect perfect tightness of the piston head and make it leak proof. This tightness, it will be seen, will be independent of the speed of the piston. By providing the bore 15, provision is made for the return flow of the fuel oil. The peculiar shape of the piston head described as rounded, accounts for the fact that the fall in the power-stroke is more gradual than is the case with the shapes of piston heads heretofore employed. It is evident, that as the pressure within the compression chamber increases, the greater will be the tendency of the piston head to expand and press against the inner wall of the cylinder. This feature of expansion or elasticity and pressing results in a tightening action, which, in pumps in use today, is not the case. Leakage of fuel oil is greatly diminished by the use of this pump. Tests have shown that a non-elastic piston of 6 mm. and guide length (ground) of 12 mm. is not as tight or leak proof as an elastic piston of 6 mm. and guide length (ground) of 5 mm.

The invention affords advantages in operation and simplification of manufacture which will be evident. The manufacture of the piston and cylinder is greatly facilitated by a saving in time and consequently cost. The finishing is more accurate and especially measurable, which in the case of milled steering edges is almost impossible. For multiple cylinders, the fuel oil rate of delivery or the amount fed is constant and therefore each cylinder generates the same efficiency, whereas in non-synchronous pumps, carbon deposits are formed within the cylinder. Since the piston is symmetrically rounded in form and the steering edge 20 is formed as shown, the piston takes on the form of a structural unit such as a girder, and therefore bending and distortion in the hardening process is averted. The provision of two ports in the cylinder instead of more is favorable in mass production and since the upper edge 20 and the lower edge 25 can be finished by machine, a saving in cost is effected as against those pistons wherein a milled edging on the shaft necessitates skilled and scrupulous handiwork.

We claim:

A fuel injection pump comprising a cylinder, a plunger reciprocable with constant stroke in the cylinder, said plunger being arranged for relative angular adjustment, a discharge duct at the upper end of said cylinder, a fuel supply chamber adjacent the cylinder, a plurality of fuel inlet ports in the cylinder wall disposed to be covered by the plunger except when the plunger is near its lower limit of stroke, said plunger being formed with an axial bore for a portion of its length which communicates with a compression space, the portion of the plunger surrounding said bore constituting a relatively thin wall, said plunger bore also having a plurality of lateral ports communicating with an annular groove and said fuel inlet ports, said thin wall portion being adapted to be forced against the cylinder wall by the hydraulic pressure of the compressed fuel in said compression space, said plunger having a head so rounded as to form a cylindrical surface having its axis normal to and intersecting the plunger axis and a radius equal to that of the plunger, said head serving to cut off said inlet ports at various points along the edge of said surface if said plunger is turned around its longitudinal axis, and means for effecting said relative angular adjustment of the plunger about its longitudinal axis to vary the time of the closing of said fuel inlet ports by said head.

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