Dec. 7, 1937. R. L'ORANGE 2,101,221

LIQUID FUEL PUMP

Filed April 20, 1933

Fig. 1

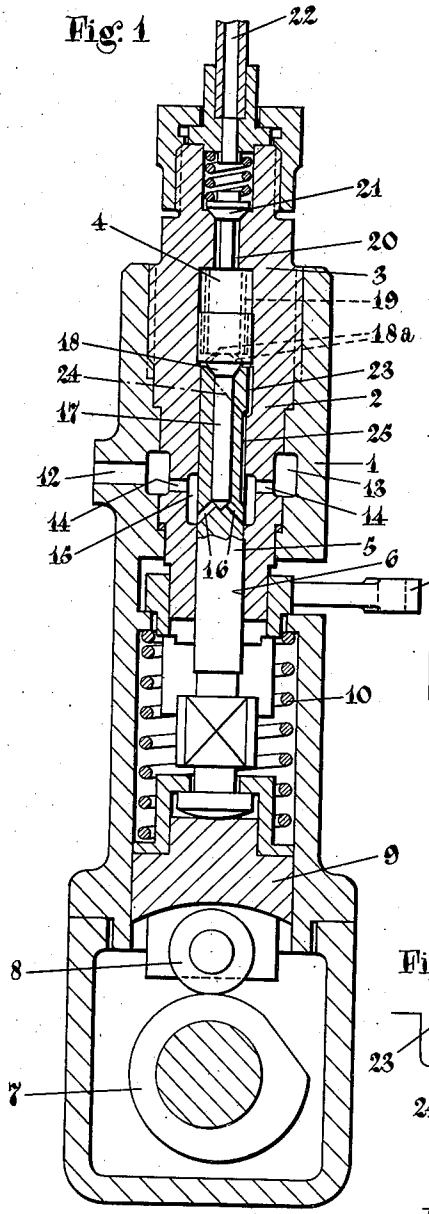


Fig. 2

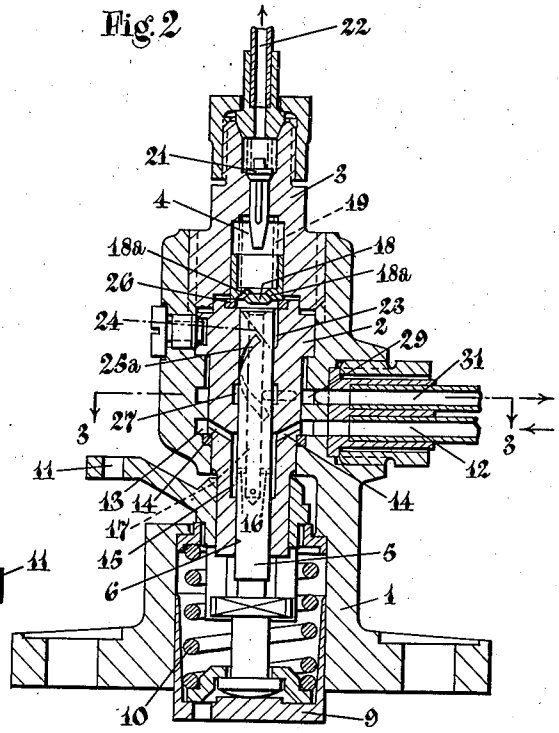


Fig. 3

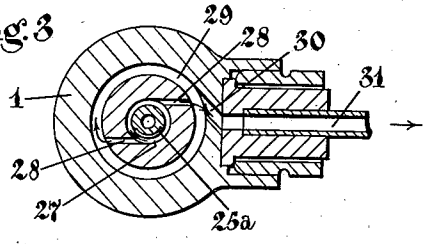


Fig. 6

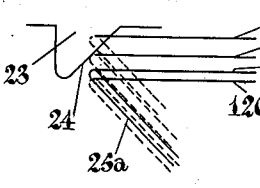


Fig. 7

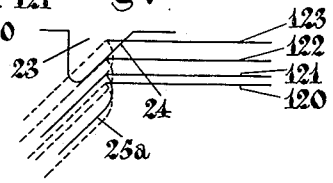
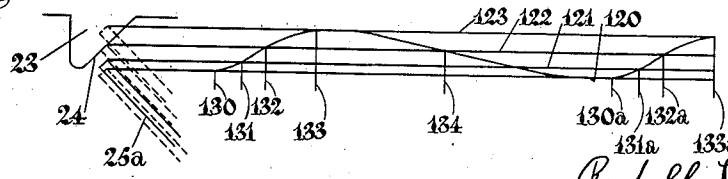


Fig. 4

Fig. 5



Inventor
Rudolf L'Orange,
By: Smith, Michael and Gardiner,
Attorneys.

Patented Dec. 7, 1937 2,101,221

UNITED STATES PATENT OFFICE

2,101,221

LIQUID FUEL PUMP

Rudolf L'Orange, Stuttgart, Germany, assignor of one-half to Frederick Richard Simms, London, England

Application April 20, 1933, Serial No. 667,125
In Germany December 5, 1932

2 Claims. (Cl. 103—41)

This invention is for improvements in liquid fuel pumps of the reciprocating piston or plunger type in which a variable portion of the fuel in the pump cylinder is arranged to be discharged or by-passed from the cylinder under the control of the plunger through an outlet distinct from the normal delivery outlet, the fuel so by-passed being termed the "spill" and the variation in which is governed by rotation of the plunger in its cylinder so as to bring different portions of an inclined or oblique control edge for the "spill" into the operative position. The invention relates more particularly to pumps of this type employed as injection pumps for compression ignition internal combustion engines.

It is the principal object of the invention to provide a fuel injection pump of an extremely simple construction in which not only is all interference avoided between the incoming fuel in the suction passages of the pump leading to the cylinder space and the fuel discharges in the form of spill, by completely separating the suction and spill passages, but also wherein unbalanced eddy formations and partial vacuum effects in the working space of the pump cylinder are avoided.

A further object of the invention is to ensure at all times a maximum area for the discharge of the spill at the moment when such discharge commences.

Another object of the invention is to provide a pump of the kind above referred to in which the volume of the working space of the cylinder is made as small and as free of pockets and lateral enlargements as is possible so as further to avoid undesirable eddy effects during the circulation of the fuel in the cylinder.

Another object of the invention is to provide discharge passages for the spill of a character such that the momentum imparted to the by-passed fuel is employed to assist the discharge action and avoid unregulated swirling, frothing and heating of the spilled fuel.

A still further object is to provide a construction of pump in which the cylinder space can be automatically flushed through with fuel during that portion of each cycle of operations of the pump in which fuel is not being delivered by the pump; in this way the cylinder space is maintained full of fuel in a very reliable manner and is free from bubbles even when the pump operates at very high speeds.

It is to be observed that the avoidance of eddy effects in the cylinder space and passages of a fuel pump are of the greatest importance in connection with modern compression ignition engines due to the fact that such engines operate at relatively high speeds particularly in the case of transport engines and the fuel pressures employed amount to anything from 1500 to 5000 pounds per square inch involving enormous speeds of travel of the fuel in the pump passages and cylinder so that even small eddy effects which would not be of material importance when operating at relatively low speeds, assume a magnitude which can easily mar the action of the pump to a very serious extent. Thus the construction of pumps forming the object of the present invention as specified in the appended claims is of the utmost importance as regards the avoidance or material reduction of the eddy effects referred to.

In order that the invention may be fully understood, reference is directed to the accompanying drawing, in which:

Figure 1 illustrates a fuel pump constructed in accordance with the invention;

Figure 2 illustrates a vertical section of the upper portion of a modified form of fuel pump constructed in accordance with the invention;

Figure 3 is a section on the line 3—3 of Figure 2, and

Figures 4, 5, 6 and 7 are diagrams illustrating methods of controlling the "spill" of pumps constructed in accordance with the invention in a manner hereinafter described.

Referring to Figure 1, a pump is illustrated which comprises a body member 1 within which a cylindrical sleeve or liner 2 is located and is locked in position by a cylinder head 3 which is screwed into the said body and within which a compression space 4 is provided. A reciprocatable plunger 5 is slidably mounted within the cylindrical bore 6 of the liner 2 and is arranged to be moved in an upward direction for the delivery stroke by a rotatable cam 7 arranged to bear against a roller 8 mounted upon a cylindrical slide 9 to which the lower end of the plunger 5 is secured and which slides in a guideway formed in the body 1; the downward or suction stroke of the plunger 5 is effected by a spring 10 and the plunger 5 is shown in its lower dead centre position in the drawing. The cam 7 is of a contour which ensures that the plunger is maintained at the end of its delivery stroke for as long a period as possible.

The piston is rotatable about its longitudinal axis through the medium of a control lever 11 in the usual manner for regulating the amount of "spill" during each delivery stroke of the plunger in the manner hereinafter described.

The fuel inlet opening 12 in the body 1 leads to an annular passage 13 formed between the said body and the liner 2 and radial passages 14 in the liner establish communication between the passage 13 and an annular recess 15 formed in the bore of the liner around the plunger 5. Passages 16 formed in the plunger 5 establish a permanent communication between the recess 15 and a bore 17 formed axially of the plunger and which constitutes the suction passage to the compression space 4. The upper end of the bore 17 is closed by a valve 18, the enlarged upper portion of which is arranged to slide within the compression space 4 and the valve is normally maintained upon its seating by a compression spring 19 which reacts against the end wall of the compression chamber. Passages 18a are provided in the bottom of the enlargement of the valve 18 to enable the fuel to flow from the bore 17 into the space 4 upon the upper side of the enlargement. A fuel discharge opening 20 in the head 3 is normally closed by a spring controlled delivery valve 21 past which fuel is arranged to be discharged through an outlet pipe 22.

The upper end of the liner 2 is provided with a recess or pocket 23, the lower edge 24 of which, constituting the control edge for the "spill" is inclined relatively to a plane extending transversely to the longitudinal axis of the liner. A groove 25 is formed in the periphery of the plunger 5 in the axial direction thereof, the lower end of which is in permanent communication with the recess 15 and the upper end of which is arranged to overlap the control edge 24 at a point during the delivery stroke of the plunger 5 dependent upon the rotational setting of the plunger by the lever 11; this point determines the end of the effective delivery stroke and the commencement of the period during which the "spill" is discharged through the recess 23 and groove 25.

It will be appreciated that the suction passage 17 in the plunger 5 is completely separate from the passages 23, 25 arranged exteriorly of the plunger and through which the "spill" is discharged, thus entirely avoiding interference between the "spill" and the fuel in the said suction passage.

Referring to Figures 2 and 3, the same reference numerals have been employed where possible for similar parts of the pump as those employed in connection with Figure 1. In this construction the plunger 5 is operated in a similar manner to that described with reference to Figure 1. The fuel enters the pump through a pipe 12 leading to an annular passage 13 formed between the body member 1 and the liner 2 in which the bore for the plunger 5 is formed. Passages 14 place the passage 13 in communication with an annular recess 15 formed in the liner around the plunger and radial passages 16 in the plunger establish communication between the recess 15 and the suction passage 17 formed axially of the plunger 5. The upper end of the passage 17 is arranged to be closed by a suction valve 18, an upward enlarged extension of which is arranged to slide in the compression chamber 4. The downward movement of the valve 18 under the influence of its spring 19 is limited by a stop 26 carried by the liner 2 so that during the movement of the plunger through the lower portion of the suction stroke and the commencement of the delivery stroke, the said valve is maintained off its seating on the plunger 5. The control edge 24 (indicated in dot and dash lines) of the recess 23 in the bore of the liner 2 is arranged to cooperate with the upper end of a groove 25a formed helically around the plunger 5 for the purpose of controlling the "spill" of the pump. The lower end of the groove 25a is in permanent communication with an annular groove 27 formed in the liner 2 around the plunger and passages 28 arranged tangentially with respect to the said annular groove (Figure 3) establish communication between the said groove and an annular passage 29 formed in the body member 1. A passageway 30 arranged tangentially with respect to the passage 29 establishes communication between the latter and an outlet pipe 31 arranged to discharge the "spill" into the fuel tank or other receiver.

In order that the operation of the pump illustrated in Figure 2 may be readily appreciated, reference is directed to Figure 5 in which the curve indicates the plunger movement effected under the control of the cam 7; one complete cycle of operation from an initial position at bottom dead centre is indicated by the portion of the curve marked 130—130a. Assuming the fuel is delivered to the pipe 12 under pressure it flows through the passages 13, 14, 15, 16 and 17 into the compression space 4 during the upward movement of the plunger until the upper end of the plunger is closed by the suction valve 18 at the point indicated at 131 in Figure 5, thereafter fuel is delivered past the valve 21 through the delivery pipe 22 until the upper end of the groove 25a meets the control edge 24 at a point, for example, which is indicated at 132 in Figure 5. Thereafter fuel is discharged into the recess 23 and passages 25a, 27, 28, 29 and 30 to the "spill" outlet 31 during the whole of the remainder of the upward stroke of the plunger. As soon as the plunger reaches the top dead centre at the point indicated at 133 in Figure 5, the valve 18 opens under the pressure of the fuel supply and fuel flows through the suction passages past the said valve, through the compression space 4 and thence through the recess 23, passage 25a and so on out of the outlet 31 until the end of the groove 25a passes the control edge 24 at the point indicated at 134 in Figure 5 when the suction stroke proper commences and continues to the point 130a. Figure 4 shows the various positions of the end of the groove 25a in relation to the control edge 24 at the points corresponding to those indicated in Figure 5; thus bottom dead centre corresponding to points 130 and 130a is indicated at 120, the point 131 is indicated at 121, the point 132 is indicated at 122 and the top dead centre 133 is indicated at 123.

The cylinder space above the plunger is thus flushed with fuel during more than half the period of each cycle of operation of the pump and the presence of bubbles in the cylinder is avoided. The valve 18 is maintained open during the downward stroke of the plunger due to the force of the opposing column of incoming oil and the inertia of the valve.

The discharge of the "spill" through the helical groove 25a causes the discharged fuel to circulate rapidly in the annular passage 27 so that it is discharged by centrifugal action through the tangentially arranged passages 28 into the annular passage 29 in which it again swirls and is discharged through the passage 30 to the outlet pipe 31; the rapidity with which the cycles of operation of the pump follow one another maintains a constant swirling motion of the discharged fuel in the passages 27 and 29. The discharge of the

"spill" in the manner described is in many cases sufficient to convey the discharged fuel to the tank, especially where a number of pumps are embodied in one unit with a discharge opening common to all the pumps.

As shown in Figure 6, the edge of the helical groove **25***a* may be semi-circular, the groove being directed at right angles to the control edge **24**. It is preferable, however, that the end of the groove should be straight and parallel to the control edge as shown in Figure 4.

A particularly large passage area is afforded by the arrangement of the helical groove as shown in Figure 7, wherein the side of the groove is disposed parallel to the control edge and the end of the groove is curved so as to deflect the fuel easily into the groove.

In Figures 6 and 7, the various positions of the groove **25***a* for the different positions of the plunger have been indicated by the same reference numerals as in Figure 4.

It is to be understood that in any of the above described constructions the recess **23** having the control edge **24** may be provided upon the plunger and the groove **25** or **25***a* formed in the wall of the cylinder bore, the recess then being inverted and arranged to co-operate with the lower end of the groove in the cylinder wall.

It will be obvious that where necessary in order to obtain a more rapid discharge of the "spill" two or more recesses with inclined control edges and a corresponding number of grooves in the plunger may be provided evenly spaced around the periphery of the cylinder wall and the plunger.

If only one groove for the discharge of the "spill" is provided in the plunger, an additional recess or pocket may be provided in the cylinder wall opposite to that which co-operates with the said groove and in this case the said pocket need not have the inclined control edge although if such an edge is provided it enables the same to be employed as an alternative to the first in case the latter should become damaged.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In a liquid fuel injection pump of the type in which the output is varied by by-passing fuel from the pump chamber at the end of the injection stroke, the combination comprising a cylinder, a plunger reciprocable therein, suction and spill passages formed distinct from one another, the suction passage being disposed interiorly of said plunger and communicating with the exterior of said plunger through at least one lateral suction passage therein, means for closing said suction passage during a portion of the stroke of said plunger, said spill passage being disposed wholly exteriorly of said plunger and being constituted by one part formed in the outer surface of said plunger and another part formed in the wall of said cylinder, one of said parts of said spill passage comprising a groove extending down to a discharge chamber for the spill fuel in said cylinder wall, said groove having a closed end cooperating with said another part of the spill passage to control the spill, said another part of the spill passage being in constant communication with the pump chamber, a discharge chamber for the spill fuel in said cylinder wall extending substantially completely around said plunger and arranged to be in constant communication with said spill groove, and an inlet chamber for the fuel supply also in said cylinder wall and extending substantially completely around said plunger and communicating to supply fuel to said suction passage formed interiorly of said plunger through said lateral suction passage therein, said discharge chamber for the spill fuel being arranged in said cylinder wall above said inlet chamber for the fuel supply so as to maintain the spill fuel entirely separate from the suction fuel and so that any spill fuel leaking from said discharge chamber will be caught underneath in said inlet chamber, the arrangement being such that a complete uniflow action of the fuel in said pump is obtained by maintaining the suction and spill fuels entirely separate from one another in their passage respectively to and from the pump chamber.

2. In a liquid fuel injection pump of the type in which the output is varied by by-passing fuel from the pump chamber at the end of the injection stroke, the combination comprising a main pump body, a cylinder disposed within said pump body, a plunger reciprocable in said cylinder, suction and spill passages formed distinct from one another, the suction passage being disposed interiorly of said plunger and communicating with the exterior of said plunger through at least one lateral suction passage therein, means for closing said suction passage during a portion of the stroke of said plunger, said spill passage being disposed wholly exteriorly of said plunger and being constituted by one part formed in the outer surface of said plunger and another part formed in the wall of said cylinder, one of said parts of said spill passage comprising a groove extending down to an inner annular discharge chamber for the spill fuel in said cylinder wall, said groove having a closed end cooperating with said another part of the spill passage to control the spill, said another part of the spill passage being in constant communication with the pump chamber, an inner annular discharge chamber for the spill fuel in said cylinder wall into which said spill groove is arranged to discharge the spill fuel, an inner annular inlet chamber for the fuel supply also in said cylinder wall and communicating to supply fuel to said suction passage formed interiorly of said plunger through said lateral suction passage therein, said inner annular discharge chamber for the spill fuel being arranged in said cylinder wall above said inner annular inlet chamber for the fuel supply, and two outer annular chambers, at least a part of each of which is formed in said main pump body, said two outer annular chambers being superposed one above the other so as to be completely separate from one another and communicating the one through a suction passage with said inner annular inlet chamber for the fuel supply and the other through a discharge passage with said inner annular discharge chamber for the spill fuel, the sealing between the main pump body and the cylinder for the upper edge of the top outer annular spill discharge chamber being effected by the direct seating of an enlarged portion of the cylinder on a shoulder of the main pump body, the sealing between the two outer annular chambers being effected by a close circumferential fit of the cylinder in the main pump body and the sealing of the lower edge of the lower outer annular inlet chamber for the supply fuel being effected by means of a packing material compressed between a shoulder on the cylinder and the main pump body.

RUDOLF L'ORANGE.