Sept. 28, 1937. J. F. HOFFER 2,094,171

TRANSFER FUEL PUMP

Filed May 1, 1933 2 Sheets-Sheet 1

Fig. 1.

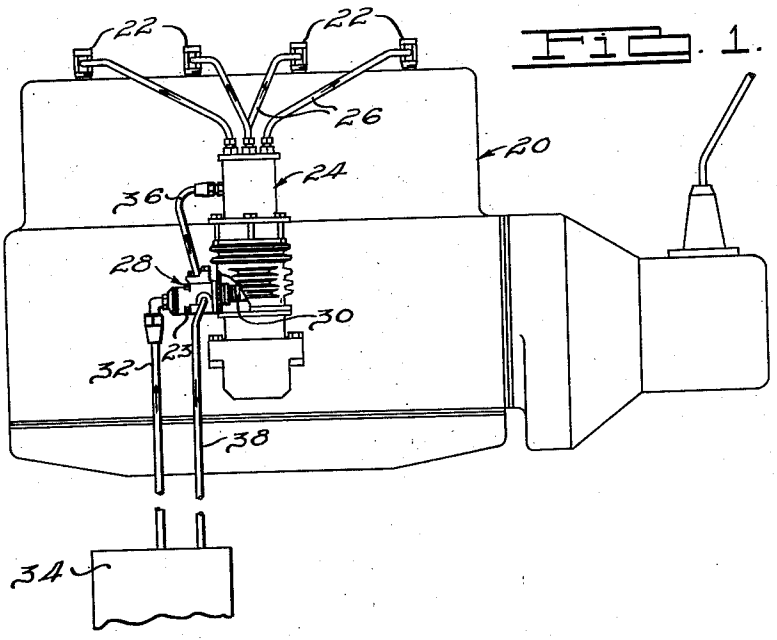


Fig. 2.

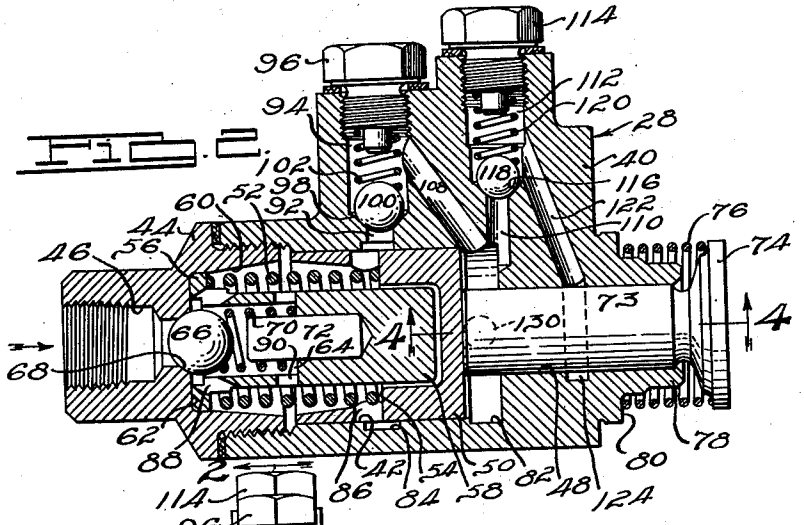
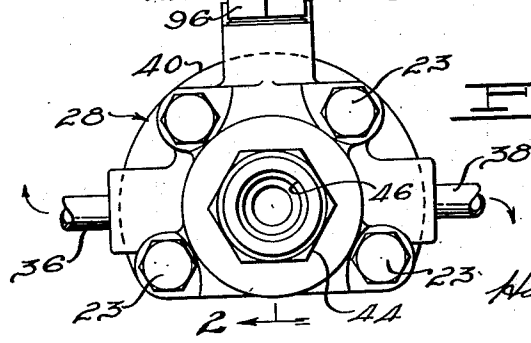


Fig. 3.



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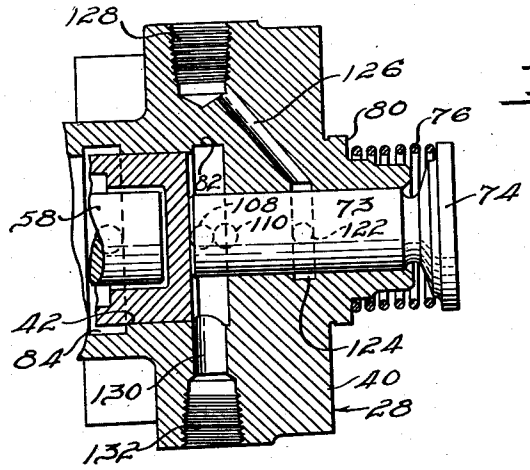


FIG. 4.

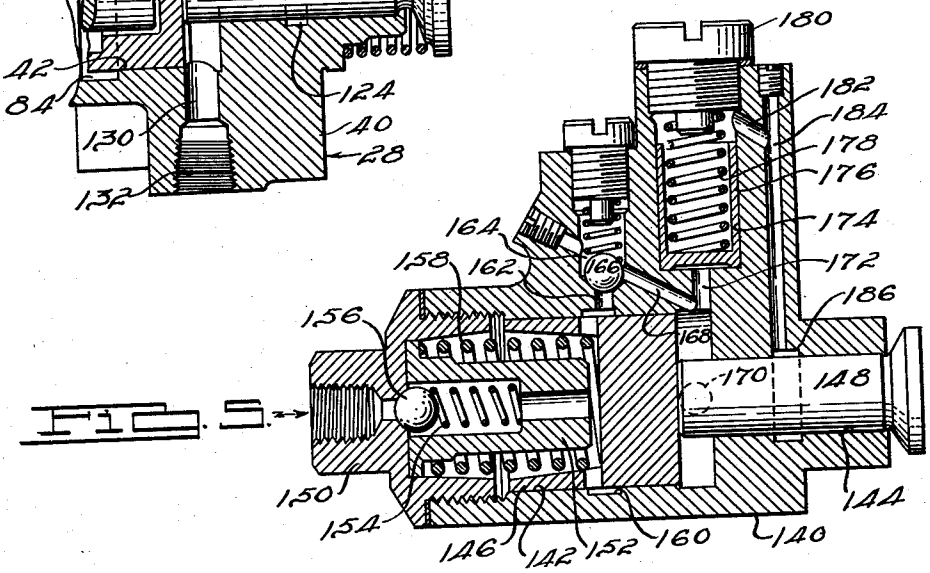


FIG. 5.

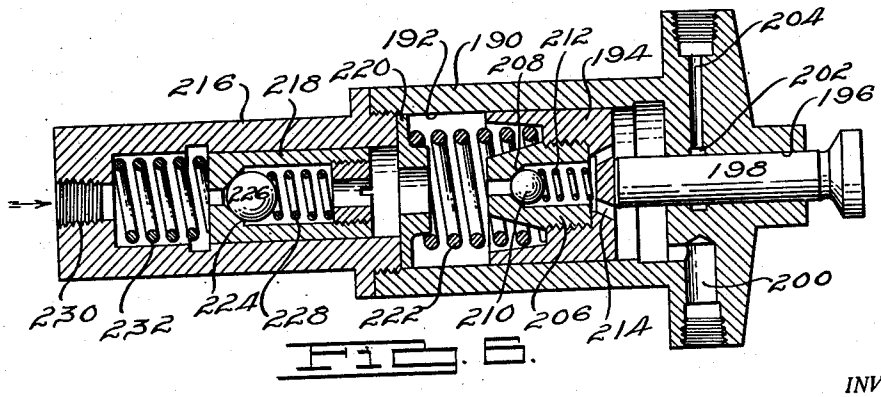


FIG. 6.

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TRANSFER FUEL PUMP

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Application May 1, 1933, Serial No. 668,708

4 Claims. (Cl. 103—37)

This invention relates to pumping mechanisms and particularly to that type thereof including a reciprocating piston, the principal object being the provision of a pump of this type that is simple in construction, efficient in operation and which offers the advantages of a rotary type of pump while eliminating certain disadvantages thereof.

Other objects include the provision of a single piston reciprocating type of pump by means of which a substantially constant discharge pressure may be maintained upon the fluid being pumped; the provision of a single piston reciprocating type of pump in which a substantially constant discharge pressure may be maintained upon the fluid being pumped regardless of the position or direction of travel of the piston; the provision of a single piston reciprocating type of pump in which the pressure of the fluid discharged thereby is maintained substantially constant during all stages of movement of the pump piston regardless of the quantity of fluid required to be delivered by the pump as long as such quantity is not in excess of that for which the pump is designed to deliver.

Other objects include the provisions of a pump having a reciprocable piston resiliently urged in one direction and an independently reciprocable plunger adapted to positively move the piston in opposition to the resilient means, the plunger being adapted to displace liquid from the cylinder when it is moving toward the piston and relative to it.

A further object of the present invention is the provision of a pumping mechanism including a cylinder having a one-way inlet at one end thereof and an outlet, a piston reciprocable between the inlet and outlet, a one-way by-pass adapted to by-pass fluid from the inlet end of the piston to the outlet end thereof, and a member projecting through the outlet end of the cylinder adapted to move the piston in at least one direction and so reducing the effective cross-sectional area of the discharge end of the piston that when the piston is moved toward the inlet end of the cylinder the volume of liquid displaced from the inlet end of the cylinder through the by-pass to the outlet end of the cylinder is in excess of the volume created between the outlet end of the cylinder and the outlet end of the piston during such movement.

The above being among the objects of the present invention, the same consists of certain novel features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawings, and then claimed, having the above and other objects in view.

In the accompanying drawings which illustrate suitable embodiments of the present invention and in which like numerals refer to like parts throughout the several different views:

Fig. 1 is a more-or-less diagrammatic side elevational view of an internal combustion engine having mounted thereon a pump constructed in accordance with the present invention, to illustrate one use thereof.

Fig. 2 is an enlarged vertical sectional view taken centrally through the pump shown in Fig. 1 in a plane parallel to the paper, and as on the line 2—2 of Fig. 3.

Fig. 3 is an end elevational view of the pump shown in Fig. 2, taken from the left hand end thereof.

Fig. 4 is a fragmentary sectional view taken on the line 4—4 of Fig. 2.

Fig. 5 is a view similar to Fig. 2 showing a modified form of construction, and

Fig. 6 is a view similar to Figs. 2 and 5 showing another modified form of construction.

Pumps of the character embodying the present invention are adaptable to a wide variety of uses and are particularly desirable for use where a pump is required to deliver a fluid at varying volume but at a substantially constant pressure. The construction of the pump will be explained in connection with but one of its many applications and after its construction for this purpose and in this connection is made known, its application to other specific uses, and such modifications in the structure described necessary to meet any change in conditions caused thereby, will be readily apparent to those skilled in the art.

The particular application of the present invention which will be described is in connection with its use on internal combustion engines of the fuel injection type, chief among which are those types of engines commonly known as "Diesel" engines embodying the compression ignition principle of operation. Accordingly, there is indicated generally in Fig. 1, an engine 20 of the Diesel type and presumed to have four cylinders (not shown) enclosed within the casing thereof, each of the cylinders being provided with a fuel injection valve 22. Suitably mounted upon the side of the engine 20 is a fuel injection pump indicated generally as at 24, which may be of any suitable type such as is commonly employed in connection with such engines and which

is connected by individual tubes 26 to each of the fuel injection valves 22, the pump 24 being so arranged and constructed as to deliver to each of the valves 22 a metered quantity of fuel at high pressure and at timed intervals as is well understood in the art. The pump 24 may be driven in timed relation with the engine 20 in any suitable or conventional manner.

In engines in the type described, it is conventional practice to provide what is commonly known as a transfer pump for drawing fuel from a source of supply and supplying it to the pump 24 at a moderate pressure which may be, for instance, twenty pounds per square inch. In the present instance, the present invention is illustrated as being incorporated in such a transfer pump and such pump is indicated generally in Fig. 1 at 28 and as being suitably secured as by bolts 23 to the side of the injection pump from which it is driven by means of a cam or eccentric 30 provided within the pump 24 although, as will be readily recognized, any other suitable means for effecting reciprocation of the pump plunger to be hereinafter described will suffice in any case. The pump 28 is illustrated as being provided with a suction line 32 connecting it with a supply tank 34 for the engine fuel, and with a discharge line 36 connecting it with the suction side of the fuel injection pump 24. The pump 28 is also provided with an overflow line 38 connected with the tank 34 and through which any excess in the desired amount of fuel pumped is returned to the tank 34 in a manner which will be described in detail later.

Referring now to Figs. 2, 3 and 4 and particularly to Fig. 2, it will be noted that the pump 28 includes a body or casing 40, shown as of cast construction, in which is formed a cylinder 42 opening upon one end thereof. The open end of the cylinder 42 is threaded for cooperative engagement with the plug 44 which serves as a closure therefor, the plug being provided with a central opening or aperture 46 therethrough in which one end of the suction line 32 is adapted to be threably secured. The opposite end of the body 40 is provided with a bore 48 of less diameter than the cylinder 42 and concentric therewith.

Reciprocably received within the cylinder 42 is a piston 50 shown as a skirted type of piston for the purpose of enabling it to partially receive within it the compression spring 52 which constantly urges it to the right as viewed in Fig. 2. The spring 52 is constantly maintained under compression between a shoulder 54 formed interiorly of the piston 50 adjacent the head thereof and the outwardly extending flange 56 of a plug member 58 received within the cylinder 42. The flange 56 is received within the enlargement 60 of the opening 46 in the plug 44 which thus provides a shoulder 62 against which it may seat and against which it is maintained by the compressive force of the spring 52. The right hand end of the plug 58 is extended in close proximity to the head of the piston 50 which is shaped to loosely receive it when the piston is in its extreme position of movement to the left, as viewed in Fig. 2, for the purpose of reducing the effective clearance volume in the cylinder as much as possible.

The left hand end of the plug 58 is bored out to provide a blind opening 64 therein in which is partially received a ball 66 constantly urged toward its seat 68 provided at the junction between the shoulder 62 and the smaller portion of the opening 46, by means of the compression spring 70. The right hand end of the compression spring 70 is guided about the projecting end of a smaller plug 72 secured within the plug 58 centrally of its hollow end and which plug 72 not only serves to additionally reduce the effective clearance volume in the cylinder 42 but also serves to limit the distance which the ball valve 66 may lift from its seat 68. As will be observed, the ball valve 66 serves as a check valve for permitting flow of fuel through the opening 46 in the direction of the cylinder 42 only. It may be noted at this point that the purpose of making the piston 50 of the skirt type and providing the plugs 58 and 72 to reduce the effective volume in the cylinder is to permit a greater suction effect to be built up in the pump and thereby enable the pump to lift the fuel through a greater height than would otherwise be possible under certain conditions.

Reciprocably received within the bore 48 is a pump plunger or tappet 73 provided at its outer projecting end with an enlarged head 74 which is adapted for engagement with the cam or eccentric 30 of the pump 24 as indicated in Fig. 1 so as to be reciprocated thereby. Preferably, a spring 76 surrounds the extension 78 of the casing 40 provided at the right hand end thereof, as viewed in Fig. 2, and through which the bore 48 centrally extends, and is maintained under compression between the shoulder 80 formed on the casing and the head 74 of the plunger 73 so as to constantly urge the head 74 to the right into contact with the cam or eccentric 30. The use of the spring 76, while desirable, is not necessary in all cases for it will be apparent that the spring 52 in urging the piston 50 to the right will, when in contact with the plunger 73, urge the plunger 73 in the same direction and, as will hereinafter be apparent, whenever the plunger 73 separates from the piston 50 the pressure of the fluid at the right hand end of the piston 50 will itself serve to force the plunger 73 outwardly into contact with the cam 30.

The head end of the cylinder 42, or the right hand end thereof as viewed in Figs. 2 and 4, is slightly counter-bored as at 82 and intermediate its opposite ends the cylinder 42 is annularly recessed as at 84. As indicated in Fig. 2, the piston 50 is provided with one or more openings 86 in the walls of the skirt thereof through which communication is constantly maintained between the interior of the piston and the recess 84 during reciprocation of the piston in normal operation. Communication is established between the opening 64 in the plug 58 and the inside of the piston 50 by openings 88 and 90 formed in the plug 58.

The annular recess 84 in the cylinder 42 communicates through an opening 92 with a larger opening or passage 94 opening onto an exterior wall of the casing 40 and normally closed by a plug 96. A shoulder or seat 98 is formed at the junction of the openings 92 and 94 and against which a ball check valve 100 is constantly urged by means of a compression spring 102 maintained under compression between the ball 100 and the inner end of the plug 96. A passage 108 connects the counter-bored head portion of the cylinder 42 with the opening 94 outwardly of the ball 100. Another passage 110 connects the counterbored portion 82 of the cylinder 42 with a larger passage 112 opening onto an exterior face of the casing 40 and normally closed by a plug 114. A shoulder 116 is formed at the junction

of the passages 110 and 112 which forms a seat for a ball valve 118 constantly urged thereagainst by the spring 120 constantly maintained under compression between the ball 118 and the plug 114. The passage 112 outwardly of the ball 118 communicates through a passage 122 with an annular recess 124 formed in the bore 48 midway between the ends thereof and, as indicated in Fig. 4, the recess 124 communicates by a passage 126 with an opening 128 in the casing 40 in which an end of the overflow pipe 38 shown in Fig. 1 is threadably secured. As best indicated in Fig. 4, a passage 130 connects the undercut portion 82 at the head of the cylinder 42 with an opening 132 in which an end of the discharge tube 36 is adapted to be threadably secured.

It may be desirable, before proceeding with the description of the operation of the pump, to point out that the balls 66 and 100 serve solely as check valves and, accordingly, their respective springs 70 and 102 need be only of sufficient strength to maintain the operativeness of their respective balls. The ball 118, in addition to functioning as a check valve, also serves the purpose of limiting the maximum pressure which may be built up in the pump and, accordingly, the strength of the corresponding spring 120 must be such as to insure its functioning to maintain its seat whenever the discharge pressure of the pump does not exceed the desired figure. Also for reasons which will hereinafter be more apparent, the relative strength of the spring 120 should be slightly greater than that of the spring 52 so that the pressure on the discharge side of the pump built up solely by movement of the piston 50 under the influence of the spring 52 will not be sufficient to raise the valve 118 off its seat.

In the operation of the pump 28 it will be apparent that the spring 52 constantly urges the piston 50 to the right as viewed in Fig. 2, and that the head 74 of the pump plunger 73 will be constantly pressed against the cam 30 which, in rotating, will cause reciprocation of the plunger 73. Upon reciprocation of the plunger 73 to the left, as viewed in Fig. 2, and considering the piston 50 as contacting with the plunger 73, the piston 50 will be moved to the left against the compression of the spring 52. When the piston 50 moves to the right from such position under the influence of the spring 52, it will create a suction within the cylinder 42 at its left hand end which will cause the ball valve 66 to be lifted from its seat and allow fuel to be drawn into the cylinder 42 through the suction line 32. When the piston next moves to the left under the influence of the plunger 73, a portion of the fuel which has thus been drawn into the left hand end of the cylinder 42 will be placed under compression by the piston 50 and a portion of it will flow out through the openings 86 into the annular recess 84, into the opening 92 and will force the check valve 100 off of its seat. The fuel which thus flows past the check valve 100 will flow into the passage 94 and thence through the passage 108 to the head end of the cylinder 42 and piston 50.

It will be apparent, however, that under such conditions when the piston 50 moves to the left it will displace from the left hand end of the cylinder 42 a volume of fuel equal to the cross-sectional area of the piston multiplied by such travel, but the increased volume between the head of the piston and the head or right hand end of the cylinder 42 during such movement will only equal the cross-sectional area of the piston minus the cross-sectional area of the plunger 73 multiplied by the distance traveled. Accordingly, it will be apparent that upon movement of the piston 50 to the left, as viewed in Fig. 2, under the influence of the plunger 73, a greater volume of fuel will be forced from the left hand side of the piston to the right hand side thereof than there is volume at the right hand side thereof to accommodate it. Consequently this fuel at the right hand end of the piston 50 will be placed under pressure, and if the requirement of the fuel injection pump 24 at such time is not sufficient to use this excess in the volume of fuel passed to the right hand end of the cylinder, such quantity of such excess in excess of the requirement of the fuel injection pump 24 will be forced out past the check valve 118 into the passages 112 and 122 to the recess 124 from which it will flow through the passage 126 and opening 128 to the overflow pipe 38 and be discharged back to the fuel tank 34.

Inasmuch as the pump 28 is preferably designed to meet the requirements of the pump 24 under all conditions, such excess in the amount of fuel required by the pump 24 will constantly be present and, accordingly, a more or less constant flow of fuel through the overflow line 38 back to the tank 34 will continue during operation of the engine although the amount of such overflow will, of course, vary in accordance with the needs of the engine and the respective capacities of the pumps 24 and 28. It might also be noted at this point that it is desirable to return such excess fuel to the tank rather than to the intake side of the pump so as to eliminate any possibility of any air that might be picked up by the overflowing fuel from being carried into the pump. At the same time it may be noted that in carrying such excess fuel back to the supply tank 34 through the recess 124 in the bore 48 for the plunger 73 any fuel that may tend to leak from the cylinder along the plunger 73 will be collected in the recess 124 which is under atmospheric pressure and be carried back to the supply tank 34. Accordingly, this construction also serves as a means for limiting the leakage of fuel from the pump.

Upon return of the pump plunger 73 to the right, as viewed in Fig. 2, the spring 52 of course tends to cause the piston 50 to follow the plunger 73 so as to maintain its contact therewith. The spring 52, however, is proportioned so as to exert through the piston 50 on the fuel at the right hand end of the piston the discharge pressure which it is desired to maintain on the discharge side of the pump. Accordingly, it will be apparent that where the requirement of the fuel injection pump 24 is not as great as would be provided by a movement of the piston 50 to the right at a sufficient speed to maintain in contact with the plunger 73, such movement of the piston 50 to the right will be retarded and the plunger 73 will pull away from it. This has the effect of increasing the available volume for reception of the fuel at the right hand end of the piston 50, thus permitting a relatively greater movement of the piston to the right than would otherwise be possible in order to maintain the proper pressure upon the fuel at such end of the piston. However, under the conditions assumed the left hand end of the plunger 73 will actually separate from the right hand end of the piston during such movement. Accordingly, upon the next reversal of movement of the plunger 73 it will move to the left a greater or lesser distance before it actually contacts with the piston 50 to again move the piston 50 to the left and, as will be apparent, during such movement of the plunger 73 to the left prior to

actual contact with the piston 50 it will tend to discharge from the right hand end of the cylinder 42 a volume of fuel equal to its effective diameter multiplied by such distance. Where such volume of fuel displaced by the plunger 73 is in excess of the requirement of the injection pump 24, the pressure on the fuel at the right hand end of the cylinder 42 will be raised sufficiently to permit such excess to be discharged out past the ball valve 118 and back to the tank 34.

From the above it will be apparent that with the above described structure there is a constant tendency to build up pressure on the fuel at the right hand or head end of the piston 50, and consequently at the outlet of the pump, regardless of the direction of movement or position of the piston 50, and that a substantially constant pressure will be maintained on the fuel at the discharge side of the pump regardless of any variation in the amount of fuel being pumped as long as such amount is not in excess of that which the pump is designed to deliver.

Referring now to Fig. 5, a modified form of the above described transfer pump is shown as including a casing 140 in which is formed a cylinder bore 142 and a tappet or plunger bore 144 in which is received a piston 146 and tappet or plunger 148 respectively. The left hand end of the cylinder 142 is closed by an apertured plug 150 corresponding to the plug 44 previously described and within the left hand end of the cylinder 142 is received a displacement plug 152 corresponding with the plug 58 in the previously described construction and enclosing a spring 154 urging a ball check valve 156 constantly toward its seat. A spring 158 corresponding to spring 52 in the previously described construction cooperates to hold the plug member 152 in position and to urge the piston 146 constantly toward the right as viewed in the figure. The cylinder 142 is medially recessed as at 160 and communicates through the opening 162 with a passage 164 normally closed by the ball check valve 166, the passage 164 communicating through the passage 168 with the cylinder 142 at the right hand end thereof in substantially the same manner as described in connection with the corresponding parts and passages in the previously described construction.

The right hand end of the cylinder 142 is provided with a discharge passage 170 but, instead of providing a spring pressed check valve for limiting the maximum pressure which may be built up on the discharge side of the pump, as in the previously described construction, in the present case the maximum pressure capable of being built up in the pump is controlled by the provision of an elastic or variable volume chamber connected with the discharge side of the pump and serving as a reservoir for any excess in the amount of fuel pumped and delivering such amounts thereof back to the pump as may be necessary to maintain the discharge pressure constant and to eliminate pulsations and surges. While such chamber may take any one of a number of conventional forms such as, for instance, an air bell or dome, a flexible metallic bellows or other like means, as a means of illustration in the present case the head end or right hand end of the cylinder 142 connects by a passage 172 with a cylinder 174 in which is slidably received a piston 176 constantly urged in a downwardly direction by means of the compression spring 178 maintained under compression between the head of the piston 176 and the plug 180 closing the open end of the cylinder. In order to take care of any leakage past the piston 176, the upper end of the cylinder 174 communicates through passages 182 and 184 with a medial recess 186 in the bore 144 which may be drained back to the supply tank in a manner similar to that described in connection with the same parts and passages of the previously described construction.

It will be apparent that the structure described in connection with Fig. 5 will operate in substantially the same manner as the construction previously described except that any excess in the amount of fuel displaced by the piston 146 or plunger 148 over the simultaneous requirement of the fuel injection pump 24 will increase the pressure on such fuel and cause sufficient movement of the piston 176 in the cylinder 174 to compensate for such added volume without substantially varying the pressure on the fuel at the discharge side of the pump. Otherwise the operation and characteristics of the pump described in connection with Fig. 5 are identical to the construction previously described.

In the construction illustrated in Fig. 6 a body member 190 is provided with a cylinder bore 192 in which is reciprocably received a piston 194. The right hand end of the casing or body member 190 is provided with a smaller bore 196 in which a plunger or tappet member 198 is reciprocably received. The right hand end of the casing 190 is also provided with a pump discharge passage 200 and the bore 196 is provided with an annular recess 202 in connection with a passage 204 for conveying away any leakage of fuel about the plunger 198.

In this modification instead of by-passing the fuel from one side of the piston to the other through passages formed in the casing itself, the left hand end of the piston is recessed so as to threadably receive therein the plug member 206 which is axially apertured so as to provide a shoulder or seat 208 against which the ball valve 210 is constantly urged by means of the compression spring 212. The bore of the plug 206 communicates with the right hand end of the piston 194 through passages 214 formed in the head of the piston. The open or left hand end of the cylinder 192 is closed by an auxiliary cylinder member 216 in which is reciprocably received an auxiliary piston 218. An apertured spring seat member 220 bears against the right hand end of the auxiliary cylinder 216 and provides a seat for the spring 222 maintained under compression between it and the left hand end of the piston 194 and which, accordingly, constantly urges the piston 194 toward the right as viewed in the figure. The auxiliary piston 218 is axially apertured therethrough and formed to provide a valve seat 224 against which a check valve 226 is constantly urged by means of a compression spring 228. The left hand end of the auxiliary cylinder 216 is provided with an intake opening 230 and received within this end of the auxiliary cylinder 216 is a compression spring 232 normally maintaining the piston 218 in spaced relation to such end.

With this construction illustrated in Fig. 6, movement of the tappet 198 and piston 194 causes a pumping action on the fuel in the pump in substantially the same manner as that described in the previously described constructions. However, with this construction in case the plunger 198 displaces a greater volume of fuel at the right hand end of the piston 194 than is required for the simultaneous need of the fuel injection pump, such excess in displacement will

force the piston 194 to the left and the fuel to the left of the piston 194 thus displaced thereby will act against the auxiliary piston 218 and force it to the left against the compression of the spring 232 to compensate therefor. Accordingly, it will be observed that the auxiliary cylinder 216 in this construction function in substantially the same manner and for the same purposes as the cylinder 174 and piston 176 in Fig. 5.

With the above disclosure before them and an understanding of the construction and operation of the structures herein described, it will of course be obvious to those skilled in the art that many variations in the constructions disclosed may be made to effect the same results and, accordingly, it will be understood that formal changes may be made in the specific embodiments of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

I claim:

1. In a pump structure for liquids, in combination a casing provided with a bore and an inlet and outlet therefor, a skirted piston reciprocable in said bore and provided with an opening in the skirt thereof, the open end of said skirt communicating with the inlet end of said bore, said casing having a passage formed therein connecting the outlet end of said bore with said bore intermediate the ends thereof and in a position to register with said opening in said skirt, and a check valve in said passage limiting the flow of fluid therethrough to one direction only.

2. In a pump structure for liquids, in combination, a casing provided with a bore and an inlet and outlet therefor, a skirted piston reciprocable in said bore and provided with an opening in the skirt thereof, the open end of said skirt opening toward the inlet end of said bore, said casing having a passage formed therein connecting the outlet end of said bore with said bore intermediate the ends thereof and in a position to register with said opening in said skirt, a check valve in said passage limiting the flow of fluid therethrough to one direction only, means for positively moving said piston in one direction, and resilient means constantly urging said piston in the opposite direction.

3. In a pump structure, in combination, a cylinder having an inlet at one end, a piston in said cylinder, a second piston between said inlet and the first piston and spaced from the latter, resilient means for urging said second piston toward the first piston, a discharge outlet adapted to receive fluid discharged from the space between said pistons, means for moving said first-mentioned piston toward said second piston for discharging fluid from said outlet, said second piston being adapted to move toward said inlet against the action of said last-mentioned resilient means in response to excess pressure between said pistons to relieve said pressure, and a one-way valve in said second piston adapted to permit flow from said inlet into the space between said pistons.

4. In a pump structure, in combination, a cylinder having an inlet at one end, a piston reciprocable in said cylinder, an outlet in constant communication with the opposite end of the cylinder, a passageway connecting said outlet with the cylinder on the inlet side of said piston, a one-way valve in said passage adapted to permit flow from the inlet end of the cylinder into the passageway, resilient means constantly urging said piston toward said opposite end of the cylinder, a plunger reciprocable independently of said piston projecting into said opposite end of the cylinder and adapted to move said piston against the urge of said resilient means when moving in opposition to said resilient means, a second piston located between the inlet and said first piston, resilient means for urging said second piston toward the first piston, said second piston being adapted to move toward said inlet in response to excess pressure between said pistons to relieve said pressure, and a one-way valve in said second piston adapted to permit flow of fluid from said inlet into the space between said pistons.

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