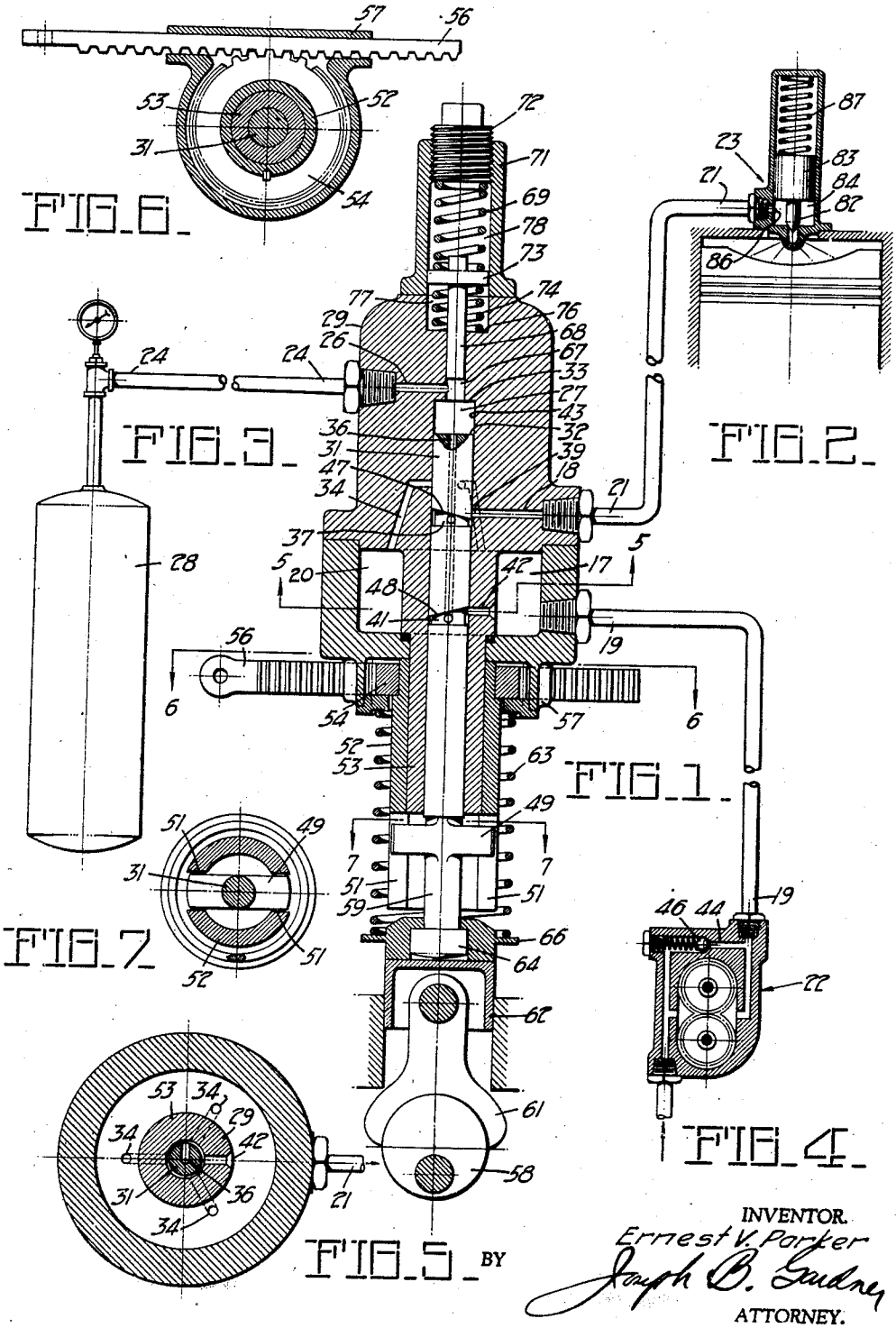
Oct. 3, 1939. E. V. PARKER 2,174,526

HIGH-PRESSURE FLUID DELIVERY APPARATUS

Filed March 27, 1937 2 Sheets-Sheet 1



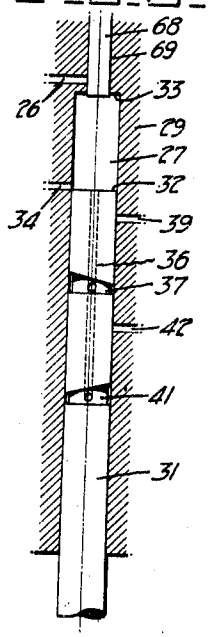
INVENTOR.
Ernest V. Parker
BY Joseph B. Gardner
ATTORNEY.

Oct. 3, 1939. E. V. PARKER 2,174,526

HIGH-PRESSURE FLUID DELIVERY APPARATUS

Filed March 27, 1937 2 Sheets-Sheet 2

FIG. 8.



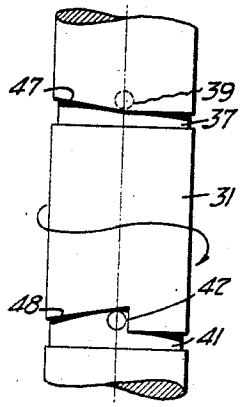


FIG. 9.

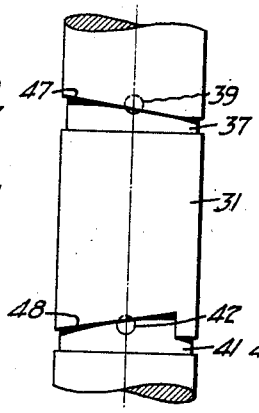


FIG. 10

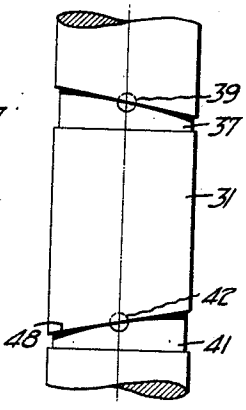


FIG. 11.

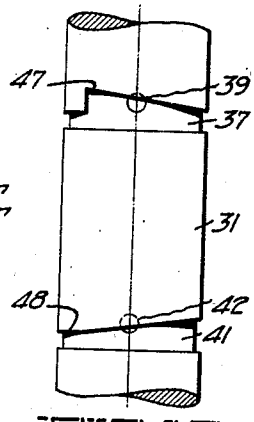


FIG. 12.

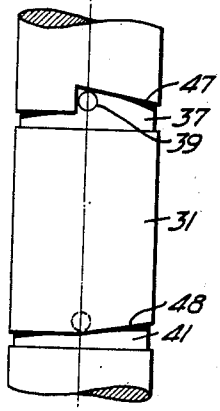


FIG. 13.

FIG. 15.

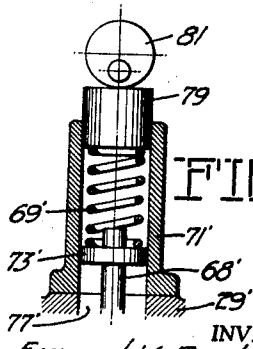


FIG. 14.

INVENTOR.
Ernest V. Parker
BY
Joseph B. Gardner
ATTORNEY.

Patented Oct. 3, 1939 2,174,526

UNITED STATES PATENT OFFICE

2,174,526

HIGH-PRESSURE FLUID DELIVERY APPARATUS

Ernest V. Parker, Oakland, Calif.

Application March 27, 1937, Serial No. 133,295

8 Claims. (Cl. 123—139)

The invention relates to apparatus designed to deliver measured quantities of fluid at high pressures and relates more particularly to high pressure oil delivery apparatus, such as used for introducing fuel into Diesel engines, and the like.

As will be clear in connection with fuel injection systems for Diesel engines, there are two substantially distinct types of apparatus, one being the so-called constant pressure or rail system and the other the so-called jerk or independent pump system. The former most generally consists of an oil pump which is connected to a reservoir or accumulator by way of a hollow rail or manifold from which connections are made to the injection valves of the several cylinders of the engine. Fuel injection is effected by opening and closing these valves in proper timed relation to the operation of the engine and upon opening of the valve oil flows under pressure from the rail to the injection valve and then into the engine cylinder. While this system provides a substantially constant pressure of fuel injection which is highly desirable in the operation of Diesel engines, the same has a considerable number of disadvantages. One of these disadvantages is the fact that the oil pressure is substantially always applied against the fuel injection or spray valve and tends to produce a poor seating of the valve and very materially affects the rate of opening and closing of this valve under mechanical operation, the oil pressure tending to cause a rapid opening of the valve and a slow closing of the valve. Also, since the quantity of fuel injected into the cylinder is a function of the distance of the opening of the injection valve and since the entire movement of this valve is only a few thousandths of an inch, the adjustment of the quantity of fuel injected is attended with difficulty and accomplished only by the use of relatively complicated mechanisms, which, as will be understood, must produce a substantially uniform quantity of fuel injection in each of the engine cylinders. Furthermore, the injection valves are by reason of their position directly in the head of the engine cylinder subjected to severe heat and pressure strain and any wear of the valves or their seats or passages leading thereto affects the amount of fuel oil injected and thereby adds further difficulty to the maintenance of a uniform fuel injection for the cylinders. Also, the use of a separate fuel pump and timing apparatus in the so-called constant pressure or rail system requires a resetting and adjustment of the timing mechanism for each engine overhaul or dis-assembly of any of the fuel injection valves.

The so-called jerk or independent pump system overcomes some of the disadvantages of the constant pressure type system, but has certain defects or disadvantages of its own, particularly in the lack of uniformity of output. This type of fuel injection usually consists of a pump connected directly to a pressure responsive fuel injection valve and the injection pressure will vary from the minimum opening pressure of the injection valve to the maximum output pressure of the pump, in some cases being a difference of several thousand pounds per square inch. Also the pump pressure is affected by the engine speed and hence the quantity of fuel injected into a cylinder is not constant for various engine speeds. Furthermore, the pump and spray valve must be accurately coordinated as to size and capacity for satisfactory operation and different pump and spray valve combinations are thus required for different sized engines and also for engines operating at different speeds.

In accordance with the present invention, and as a principal object thereof, I have provided a high pressure fluid delivery apparatus which may be used for the injection of fuel into a Diesel type engine and combines the features of advantage in both the constant pressure or rail system and the jerk or independent pump system and at the same time overcomes all of the disadvantages of these systems above enumerated. The present apparatus will provide for the accurate metering and injection of fuel into Diesel engines with but a few pounds variation in pressure and will provide for the immediate and sharp starting and stopping of the fluid injection and will be simply and readily adjustable by the operator of the engine for controlling the quantity of fuel oil injection. Furthermore, in accordance with the present apparatus substantially all oil pressure strain is removed from the fuel injection valve immediately at the end of the injection period and the injection valve itself need only operate as a simple check valve. The present apparatus also provides a considerable simplification as to number and type of parts over the so-called constant pressure or rail systems, the present apparatus containing some 150 parts less than the rail system in a standard four-cylinder engine. Also by comparison, the present apparatus is much quieter in operation and has all of the operating parts thereof for controlling the pressure and metering of the fuel entirely removed from direct communication

with the interior of the engine cylinders and in position where the same may be maintained cool, well lubricated and under substantially no strain.

A further object of the invention is to provide a high pressure fluid delivery apparatus which may be used to supply liquids or other fluids in accurately metered quantities at high, substantially constant, pressures, the apparatus having a relatively broad application to various types of pressure lubricating systems and other fluid receiving apparatus requiring the supply of fluids under the above specification.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawings and the description may be adopted within the scope of the invention as set forth in the claims.

Referring to said drawings:

Figure 1 is a longitudinal cross-sectional view of a fluid pump constructed in accordance with the present invention.

Figure 2 is a cross-sectional view of a fuel injection valve for a Diesel type engine.

Figure 3 is a side elevation of a fluid reservoir or accumulator used in the present apparatus.

Figure 4 is a cross-sectional view of a fluid supply means operating as a source of fluid.

Figures 5, 6, and 7 are cross-sectional views of the pump illustrated in Figure 1 and are taken substantially upon the planes of lines 5—5, 6—6, and 7—7 respectively of Figure 1.

Figure 8 is a vertical cross-sectional view of a part of the pump illustrated in Figure 1 and showing a different position of the pump piston.

Figures 9, 10, 11, 12 and 13, are fragmentary side elevations showing various adjusted positions of the pump piston.

Figure 14 is a fragmentary vertical sectional view of a modified form of a part of the pump illustrated in Figure 1.

Figure 15 is a chart illustrating a typical pressure volume curve of the present apparatus.

The fluid delivery apparatus of the present invention, and as illustrated in the accompanying drawings, comprises a fluid pump 16 which is provided with inlet and discharge passages 17 and 18 which are adapted for connection, as by conduits 19 and 21, with a source 22 of fluid and a receiving apparatus here shown in the form of a fuel injection valve 23 for a Diesel engine. The source 22 is here shown in the form of a gear pump although, as will be understood, the fluid may be supplied to the pump either by gravity or other pressure induced flow or by the suction of the pump itself. The pump is also connected as by conduit 24 communicated by passage 26 with a pump cylinder 27, to a fluid reservoir or accumulator 28 which operates, as will be more fully hereinafter understood, to stabilize the output pressure of the pump.

The pump proper consists of the cylinder 27 which extends longitudinally through a pump casing 29 and within which is reciprocally mounted a pump piston 31 which compresses between the inner or head end 32 thereof and the inner end 33 of the cylinder, and in what may be termed a pressure chamber 43, a charge of fluid for delivery to the spray valve or other receiving apparatus. The inlet passage 17 of the pump is here formed in part by an annular fluid chamber 20 which is communicated by way of a plurality of passages 34 with a side of the cylinder 27 so that on movement of the piston head 32 away from the cylinder end 33 and to a position uncovering the cylinder opening ends of the passages 34, a charge of fluid will be drawn into the cylinder above the piston for compression and discharge on return movement of the piston towards the end 33 of the cylinder.

Discharge of the compressed charge of fluid in the cylinder into the passage 18 is effected by way of a longitudinal passage 36 formed in the piston 31 and leading from the head thereof to a side annular port or scroll 37, which at the inner end of the piston stroke is placed in registration with a cylinder port 39 of the passage 18. As an important feature of the present pump, I provide a relief or venting means for the fluid in the cylinder under pressure other than the discharge passage 18 and also provide for an adjustable proportioning of the fluid thus vented and the fluid discharged so as to accurately and easily control the pressure and quantity of the fluid discharged. The means for effecting this relief and venting of the fluid under pressure consists of a second annular port or scroll 41 provided on the piston in spaced longitudinal relation to the scroll 37 and which is communicated with the piston passage 36 and is positioned on the piston for registration with a relief passage 42 in the cylinder when the piston is moved to substantially the inner end of its stroke. Preferably, the fluid relieved through the passage 42 is returned to the source and to this end the passage 42 is communicated with the low pressure inlet chamber 20. Where a gear pump is used, as here illustrated, between the source proper and the pump 16, I prefer to incorporate in the gear pump casing a by-pass 44 and check valve 46 so as to permit the return of fluid thus discharged from the passage 42 around the gear pump and to the source.

The proportioning of the fluid flow from the pressure chamber 43 through the inlet and discharge passages 17 and 18 upon movement of the piston to substantially the inner end of its stroke and upon registration of the annular ports 37 and 41 with the cylinder ports 39 and 42, is effected by the provision of inclined annular scroll surfaces 47 and 48 on the ports 37 and 41 which, depending upon the rotated position of the piston, will register with various areas of the cylinder ports 39 and 42. As will be seen from Figures 1, and 9 to 13, the inclinations of the scrolls 47 and 48 are of substantially spiral configuration and are of opposite pitch so that on rotation of the piston 31 with the ports 37 and 41 in communication with the ports 39 and 42, one of the latter ports will be successively opened while the other port will be successively closed. As illustrated in Figures 1 and 9 the piston is so rotated that the scroll 47 will not uncover and register with the discharge port 39 upon movement of the piston to the end of its stroke while the scroll 48 completely clears the relief port 42. This rotated position of the piston corresponds to a no-load output of the pump, since, upon reciprocation of the piston, no fluid will be discharged to the receiving apparatus, the fluid being merely drawn into the cylinder through passage 34 and discharged through passage 46. As the piston is rotated, as from left to right, as viewed in Figures 1, and 9 to 13, and as indicated by the arrow in Figure 9, the port 39 is slowly opened in the successive positions of the

piston while the port 42 is slowly closed in the successive positions of the piston. In the position of the piston illustrated in Figure 10, the port 39 is barely open at the inner end of the piston stroke while the port 42 is substantially completely open although not entirely, so that a small quantity of fluid will be discharged to the receiving apparatus 36. This position of the piston corresponds to a light load output such as would be used for an idling throttle in a Diesel engine. On further rotation of the piston to a position as shown in Figure 11, the ports 39 and 42 are each substantially half uncovered. This position of the piston corresponds to a medium output of the pump. In the position of the piston illustrated in Figure 12 the discharge port 39 is substantially three-fourths uncovered while the relief port 42 is substantially three-fourths covered and this position of the piston corresponds to a heavy fluid output. The final position of the piston is illustrated in Figure 13 wherein the discharge port 39 is fully uncovered while the relief port 42 is fully closed and in this position of the piston all of the fluid is discharged to the receiving apparatus and corresponds to a full maximum output of the pump. Preferably the various outputs of the pump from no-load to full load is effected by a rotation of the piston through substantially 180° although, as will be understood, such adjustment may be effected over a greater or less portion of the piston circumference.

Any suitable means may be used for adjusting the rotated position of the piston. As here shown, the piston is provided adjacent the lower end thereof with a key 49 which is reciprocally mounted in opposed slots 51 in a sleeve 52 mounted over a cylindrical portion 53 of the pump casing and which sleeve is provided with a gear 54 which is rotated by means of a manually movable rack 56 carried in a supporting portion 57 of the pump. The rack may be connected with a governor or any suitable manually engageable means which, in the case of Diesel operated vehicles, may be connected by an appropriate mechanism to a control lever in the operator's compartment.

Reciprocation of the piston 31 may be effected, as here shown, by means of an eccentric 58 connected to the lower end 59 of the piston by means of a slipper 61 and cross-head 62. Preferably the piston is urged in the direction of the cross-head by means of a spring 63 which may surround the sleeve 52 and which is connected to the lower end 64 of the piston by a spring rest 66 carried by the end 64 and which is preferably engaged directly by the cross-head 62 so as to space the end of the piston from the cross-head and to permit free rotation of the piston relative to the cross-head. In the case of a Diesel engine the eccentric is preferably driven in timed relation to the engine shaft.

As an important feature of the present apparatus, I provide in the pump 16 a resiliently expansible cylinder head which is responsive to the pressure in the chamber 43 to open and close the passage 26 to the reservoir or accumulator 28. In the present form of the invention, this reservoir is in the form of a fluid bottle or casing having a capacity sufficient to stabilize the pressure in the chamber 43 during the discharge period. By way of example, the accumulator may have a volume of approximately ten to twenty cubic inches for a medium sized Diesel engine say from 50 to 80 H. P. per cylinder, and in the present apparatus a single proper sized accumulator may be used with a plurality of pump units. In the present construction, the passage 26 is connected to the side of a reduced bore or cylinder 67 communicated with the cylinder 27 at the inner end 33 thereof. Reciprocally mounted in the bore 67 is a piston or stem 68 which is adapted to move longitudinally in the bore in response to various pressures in the cylinder chamber 43 and in the innermost position thereof, such as illustrated in Figure 8, the same covers and closes off the passage 26 while at higher pressures the stem 68 is moved outwardly in the bore 67 so as to uncover the passage 26, as shown in Figure 1. The outward movement of the stem 68 to expand the size of the chamber 43 is resiliently resisted by means of a spring 69 mounted in a part 71 of the pump casing and is compressed between an adjustable end plug 72 here shown threaded into the casing 71 and a spring seat 73 carried by the stem 68. On the other hand, the inward movement of the stem 68 is resiliently resisted by the spring 74 which is compressed between the spring seat 73 and an inner end 76 of an enlarged bore 77 provided in the pump casing 29 in registration with the spring chamber 78 in the casing 71. As will be understood, the adjustment of the tension of the springs 69 and 74 and particularly the former, will control the critical operative pressure at which the cylinder chamber is communicated with the fluid reservoir and to a large extent also control the discharge pressure of the pump. In the present embodiment of the apparatus the adjustment of the spring tension may be effected by rotating the threaded plug 72 and in most Diesel engines, a single adjustment of this spring tension will suffice for all operating conditions. However, I have illustrated in Figure 14 a slightly modified form wherein the spring tension is adjusted by means of a slidable plug 79 which is carried in the pumping casing 71', against one end of the spring 69' and may be variously positioned within the casing and against the spring by means of a cam 81 connected by any suitable means for manual operation. The injection valve 23 may be of substantially any form and only need be provided with a suitable check or pressure closing valve so that at the end of the fuel injection period and upon the collapse of pressure in the discharge line, the spray valve will automatically close and seal the combustion chamber of the engine. In the present showing the injection valve is of a more or less common type including a needle valve 82 which is motivated by a pressure responsive piston 83 carried in a valve cylinder 84 which is communicated by way of passage 86 with the conduit 21. A spring 87 is mounted within the valve casing and engageable with the piston 83 to maintain the needle valve closed except on establishing an intake pressure over a certain predetermined amount. While the injecton valve here shown, operates to control in a measure the operating pressure of the valve, I may use, as above mentioned, a mere check valve inasmuch as the controlling pressure of the system and the amount of fluid discharged is taken care of in the pump mechanism itself.

With reference to Figures 1 and 15, the operation of the apparatus based on the foregoing and assuming a medium load position of the piston as shown in Figure 11, may be summarized as follows: Starting with the piston 31 in lowered position away from the end 33 of the cylinder, the stem 68 will be drawn toward the cylinder 27

and across the passage 26 so as to shut off communication of the pump cylinder with the reservoir 28. At the bottom of the piston stroke the intake passages 34 are uncovered, as will be seen in Figure 8, and a charge of fluid is taken into the cylinder above the head end 32 of the piston. As the piston starts its upward stroke the intake passages 34 are shut off by the movement of the sides of the piston thereover and the charge is compressed between the head end 32 of the piston and the inner end of the cylinder and against the tension of spring 69. As the pressure increases in the chamber 43 of the cylinder to a predetermined amount the stem 68 will have been backed up in the bore 67 by a distance sufficient to uncover the passage 26 and the pressure chamber 43 is thereupon communicated with the fluid reservoir which is maintained at substantially this predetermined pressure. As the piston further moves in its upward stroke the annular piston ports 37 and 41 are brought into registration with the relief and discharge passages and one or both of these passages, depending upon the rotated position of the piston, is communicated with the pressure chamber of the cylinder. The pressure drop which would normally follow the discharge of fluid from the pressure chamber of the cylinder is off-set and maintained relatively constant during the injection period by the further upward movement of the piston, the action of the accumulator 28, and the tension of spring 69 so that the discharge of fluid is effected at substantially constant pressure. As the piston reaches approximately its innermost position the pressure starts to fall, due to the discharge of fluid, and immediately on reaching the aforesaid predetermined pressure, the stem 68 will again cover the passage 26 leading to the accumulator and thereby close off this principal source of maintaining the pressure. The pressure in the cylinder thereupon immediately collapses causing a closure of the injection valve and by the time the piston has lowered sufficiently to close off the discharge port 39 the pressure in the discharge line will have been reduced to substantially the pressure in the intake chamber 20. Thus the injection valve 23 is relieved of fluid pressure immediately at the end of the injection period. Further downward movement of the piston is permitted by a drawing of the stem 68 towards the cylinder to compensate for the piston displacement and such stem movement is resisted by the spring 74 which reduces the pressure in the cylinder to below the pressure in the inlet chamber and provides on movement of the piston to the lower end of its stroke and the uncovering of passages 34 for the drawing into the cylinder a proper charge of fluid.

The pressure volume diagram illustrated in Figure 15 is plotted with the pressure shown on a vertical scale or ordinate and the volume along the abscissa. The chart is used for illustrative purposes only and is not intended to indicate quantitatively the pressures existing at different portions of the operating cycle. For typical operation of a medium-sized four-cylinder Diesel engine the injection pressure may be approximately 4500 pounds per square inch. In such case the valve mechanism controlling the opening and closing of passage 26 leading to the accumulator is preferably adjusted to automatically open and close at a pressure between approximately 4200 and 4500 pounds per square inch. Also such an engine will use a substantially less pressure at low loads and this pressure variation is automatically taken care of in the present apparatus upon rotation of the piston to control the output of the apparatus, the discharge pressure following to a large extent and being proportional to the quantity of fluid discharged. It will thus be noted that the variation in discharge pressure for various engine speeds and loads is automatically controlled, together with the control of the quantity of fuel injection and I have found that in most cases no further pressure adjusting means need be provided. For this reason a single adjustment of the tension of the spring 69 for any given engine is generally all that is required. However, further adjustment of discharge pressure may be effected by regulating the tension of the spring 69 during operation of the engine which feature is facilitated by the use of the construction, such as shown in Figure 14. The low pressure point of the diagram will be approximately the pressure of the supply except for the slight suction produced by the downward stroke of the piston against the action of spring 74 and may be any suitable or convenient value. The present gear type pump here used may be conveniently used to supply oil at a pressure of approximately twenty pounds per square inch.

It will be noted the pressure volume chart illustrated in Figure 15 is shown for a medium output condition of the apparatus. Variation of the output will cause a different time of opening and closing of the discharge and relief ports, as will be understood, and to this extent affect the shape of the chart. However, in all instances other than full load the period of registration of the relief passage with the cylinder is sufficient to cause a substantial depletion of the pressure in the cylinder and in the discharge line.

I claim:

1. A fluid pump having inlet and discharge passages and a fluid pressure chamber, passage means separate from said passages registering with said chamber and adapted for connection with a reservoir of fluid under pressure, a pressure control valve in said passage means responsive to the pressure in said chamber and operative to close said passage upon existence of a pressure in said chamber below a predetermined amount and to open said passage means upon establishing a chamber pressure above said amount, means operative to control the pressure in said chamber, and means operative at substantially maximum pressure to communicate said inlet and discharge passages with said chamber, said last named means being adjustable to control the time of communication of said inlet and discharge passages to control the amount of fluid flow from said chamber to said inlet and discharge passages.

2. A fluid pump comprising, a casing provided with a pump cylinder and having passage means connected to the head of said cylinder and adapted for connection to a fluid reservoir and fluid inlet and discharge passages opening to the sides of said cylinder, a pressure control valve in said passage means for opening and closing the same upon existence of relatively high and relatively low pressures in said cylinder, a piston mounted for reciprocation in said cylinder and having ports connected to the head thereof and adapted for registration with said inlet and discharge passages adjacent the head end position of said piston, said ports being formed to register with said inlet and discharge passages at different longitudinal positions of said piston at different

rotated positions of said piston in said cylinder, and means for adjusting the rotated position of said piston in said cylinder to control the relative time of communication of said chamber with said inlet and discharge passages.

3. A fluid pump comprising, a casing having a pump cylinder, a piston reciprocally mounted within said cylinder for compressing fluid therein, a container for storing fluid under pressure, passage means connecting the head end of said cylinder with said container, a pressure responsive valve in said passage means operable to open and close under pressures in said cylinder above and below a predetermined amount respectively, inlet and discharge passages opening to the side of said cylinder at spaced longitudinal positions, inclined annular ports on said piston communicated with the head end of said piston and adapted for substantially simultaneous registration with said inlet and discharge passages after movement of said piston to establish said predetermined pressure in said cylinder to simultaneously relieve said pressure through said inlet and discharge passages and means for rotating said piston for adjusting the area of communication of said ports with said inlet and discharge passages for controlling the ratio of compressed fluid discharged from said chamber through said inlet and discharge passages.

4. A fuel pump for solid injection type engines comprising, a casing providing a pump cylinder, a piston reciprocally mounted in said cylinder to compress a charge of oil in the head of said cylinder, a container for storing oil under pressure, passage means connecting said container with the head of said cylinder, pressure responsive valve means in said passage means operable to open and close the latter upon establishment of pressures in said cylinder head above and below a predetermined amount, an oil discharge passage connected to said cylinder and adapted for connection to an engine injection nozzle, a low pressure oil inlet passage connected to said cylinder, means operable to communicate said discharge passage to said cylinder head at substantially maximum pressure and to establish a simultaneous connection of said discharge passage and said inlet passage with said cylinder head at substantially the end of the discharge period of the pump to deplete the pressure in said discharge passage and provide a sharp cut-off of the injection period, and means for adjusting the time of connection of said inlet passage to said cylinder head relative to the time of connection of said discharge passage to control the duration of the injection period and the quantity of oil injected.

5. A fuel pump for solid injection type engines comprising, a casing providing a pump cylinder, a piston reciprocally mounted in said cylinder to compress a charge of oil in the head of said cylinder, a container for storing oil under pressure, passage means connecting said container with the head of said cylinder, pressure responsive valve means in said passage means operable to open and close the latter upon establishment of pressures in said cylinder head above and below a predetermined amount, an oil discharge passage connected to said cylinder and adapted for connection to an engine injection nozzle, a low pressure oil inlet passage connected to said cylinder, said piston having ports adapted for registration with said inlet and discharge passages for communication thereof with said cylinder head adjacent the head end position of said piston, said ports having a circumferential longitudinal pitch on the periphery of said piston, and means for rotating said piston for controlling the area and period of registration of said ports with said inlet and discharge passages.

6. A high pressure fluid delivery apparatus comprising, a pump casing providing a cylinder and formed with a passage opening to the head end of said cylinder and fluid inlet and discharge passages opening to a side of said cylinder, a piston reciprocally mounted in said cylinder for movement to and from said cylinder head and for compressing a fluid charge therein and adapted to normally cover and close said inlet and discharge passages, a container for storing fluid under pressure, passage means connecting said container to said first passage, means providing a chamber at the outer end of said first passage, a stem member reciprocally mounted in said first passage and movable longitudinally therein in response to pressure variations in said cylinder head and being adapted to close said passage means in the inner position thereof and extending into said chamber, a spring seat on said member in said chamber, a spring compressed between the outer end of said chamber and said seat for urging said member inwardly in said first passage, a lighter spring compressed between said seat and the inner end of said chamber for resisting the inner movement of said member, said springs being balanced to normally position said member to close said passage means and to afford a resilient outward displacement of said member to open said passage means upon movement of said piston to adjacent its head end position in said cylinder and offering a resilient resistance to the inward displacement of said member upon movement of the piston to its opposite end position in said cylinder, and passage means communicated with said inlet passage and opening to said cylinder at a position uncovered by said piston in its last named position whereby fluid will be drawn into said cylinder on uncovering of said last named passage means by the resilient retraction of said stem member by said second named spring, said piston being provided with ports positioned for registration with said inlet and discharge passages upon movement of said piston to adjacent its head end position to communicate said passages with the head end of said cylinder.

7. A high pressure fluid delivery apparatus comprising, a casing providing a pump cylinder, a piston reciprocally mounted in said cylinder to compress a charge of fluid in the head of said cylinder, a container for storing fluid under pressure, passage means connecting said container with said cylinder head, pressure responsive valve means operable to open and close the latter upon establishment of pressures in said cylinder head above and below a predetermined amount, a fluid discharge passage connected to said cylinder, a low pressure fluid inlet passage connected to said cylinder, and means operable to communicate said discharge passage to said container at substantially maximum pressure and to establish a connection of said discharge passage with said inlet passage at substantially the end of the discharge period of the pump to deplete the pressure in the discharge passage and provide a sharp cut-off of the discharge flow, said last named means being adjustable to vary the timing of the connection of said discharge passage to said chamber.

8. A fuel pump for solid injection type engines

comprising, a casing providing a pump cylinder, a piston reciprocally mounted in said cylinder to compress a charge of oil in the head of said cylinder, a container for storing oil under pressure, passage means connecting said container with the head of said cylinder, a discharge passage connected to said container, valve means operated in timed relation with said piston and positioned between said container and discharge line to meter fuel into said discharge line from said container, and pressure responsive valve means connected to said container and operable to maintain the latter at a predetermined minimum pressure.

ERNEST V. PARKER.