March 8, 1960

T. L. TYSON
POSITIVE DISPLACEMENT PUMP AND
CONTROL MEANS THEREFOR

2,927,557

Filed Nov. 30, 1956

2 Sheets-Sheet 1

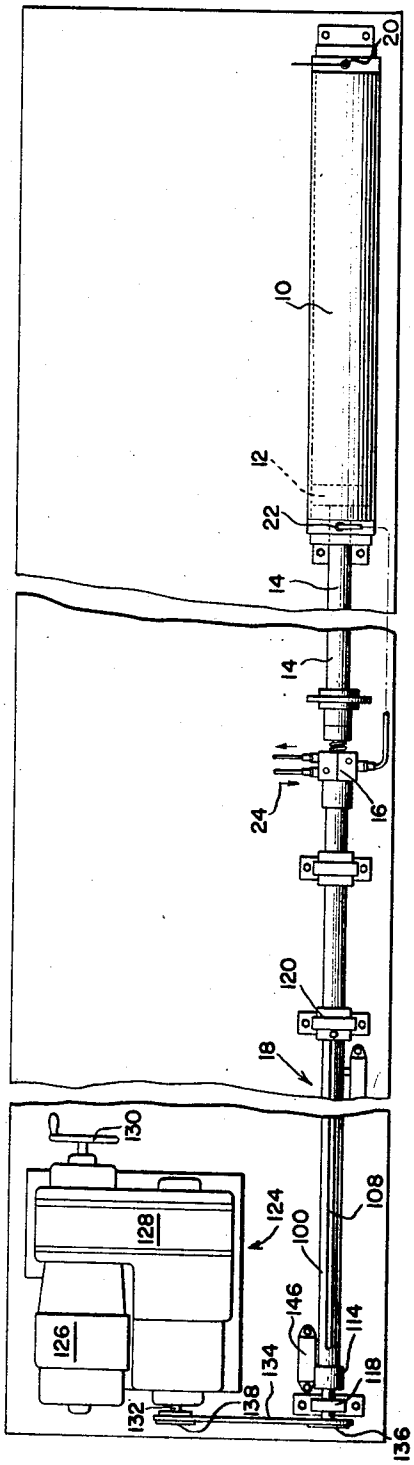


FIG. 1.

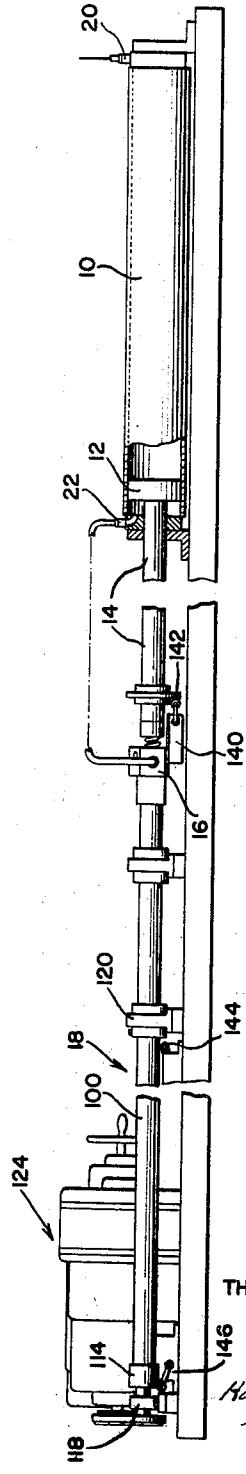


FIG. 2.

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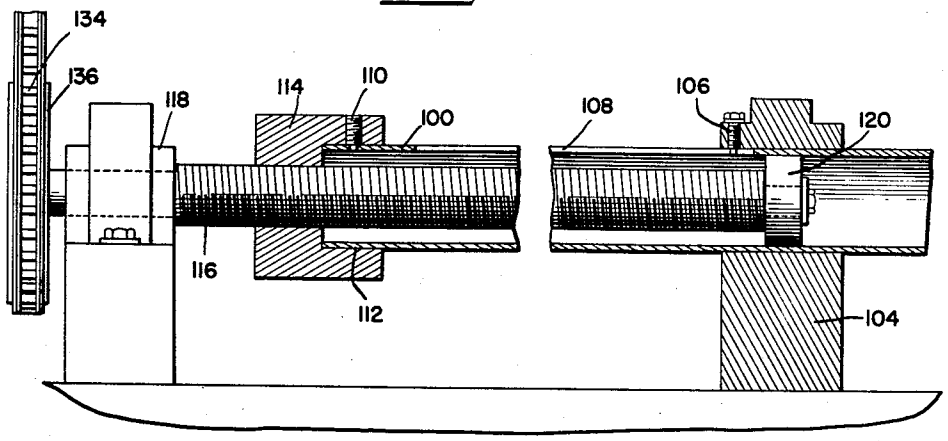
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2 Sheets-Sheet 2

Fig. 3.



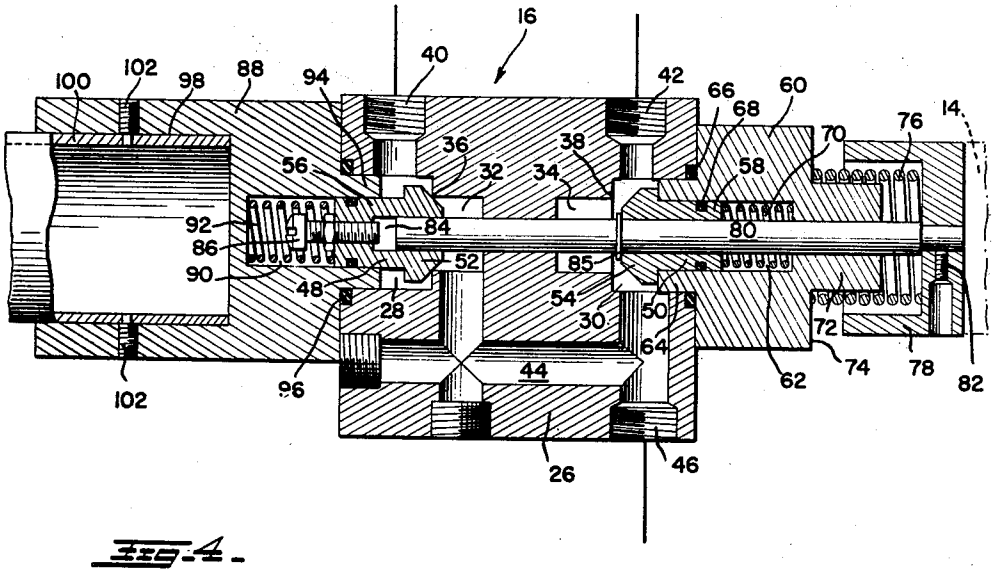


Fig. 4.

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POSITIVE DISPLACEMENT PUMP AND CONTROL MEANS THEREFOR

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5 Claims. (Cl. 121—41)

The present invention relates generally to the art of pumps and more specifically to new and useful improvements in positive displacement type pumps such as could be utilized, for example, as fuel injectors.

It is a principal object of this invention to provide a novel and highly useful pump construction which will operate to deliver a metered and constant rate of discharge.

Another object of this invention resides in the provision of a new and useful pump construction of the positive displacement type which is insensitive to pressure and temperature variations reflected in the pump during pumping operations.

A furher object of this invention lies in the provision of a positive displacement type pump of the general character described which has a minimum requirement for driving power to effect a constantly, accurately metered discharge delivery.

Another object of this invention is the provision of a pump of the type and character described which is relatively simple and inexpensive in construction having a minimum of simple and efficient structural and control components.

Still further objects and additional advantages of this invention will become evident to those skilled in the art when the following description and disclosures are considered together with the appended drawings.

The nature of the present invention may be stated in general terms as relating to a positive displacement type pump which consists of a tank cylinder containing a movable piston, a source of pressurized fluid in operable communication with one side of the piston, valve means controlling admission of pressure fluid to the piston, and a constant speed followup mechanism operatively connected with and controlling said admission valve.

Referring now to the accompanying drawings in which like numerals designate similar parts throughout the several views:

Fig. 1 is a top plan view of the pump constituting the present invention;

Fig. 2 is a side elevation of the pump shown in Fig. 1;

Fig. 3 is a fragmentary elevation in partial vertical section illustrating the control valve follow-up mechanism; and

Fig. 4 is a sectional elevation of the pump control valve.

The structure constituting the present invention is disclosed and described as a fuel injection apparatus, however, it is not intended that the application or structure and function of this invention be so limited since it is fully contemplated that it is readily useful in any application wherein it is desired to pump predetermined quantities of a fluid at a continuously and precisely controlled rate.

Generally, the present invention includes a piston type positive displacement pump utilizing a pressure fluid as the driving power for the pump piston. Additionally incorporated with the pressure fluid driven piston is a mechanically driven reference motion component, the movement of which is correlated with the piston so as to detect

any variations in the movement of the piston and actuate a valving means to automatically adjust the flow of the power to the piston.

Referring now in particular to Figs. 1 and 2 of the drawings the pump structure constituting the present invention may be seen to generally include a fluid tank cylinder 10 housing a movable piston 12 provided with an outwardly extending, elongated piston rod 14. Associated with the extended end of the piston rod is a valve mechanism 16, to be hereinafter described in greater detail, and a mechanical follow-up or reference motion component 18.

Assuming, for the purposes of illustration, that the pump embodiment shown in the drawings is utilized as a fuel injector, the cylindrical tank 10 takes the form of a fuel storage chamber containing a fixed quantity of fuel to be discharged through an outlet fitting 20 at one end of the tank by movement of the piston 12 in the direction of the discharge end thereof. That end of the tank 10 remote to the discharge outlet is provided with a fitting 22 through which a pressurized fluid is introduced into the tank behind the discharge piston 12. The fitting 22 is connected by flexible tubing through the valve mechanism 16 (in a manner to be hereinafter described) to a source of pressurized power fluid as indicated by arrow 24.

The valve mechanism 16 includes a substantially rectangular body 26 supported, in a manner to be hereinafter described, in axial alignment with the piston rod 14.

The valve body 26 is provided with two valve chambers 28 and 30 located one at each end of the body and each opening outwardly through the adjacent end of the body. Each of the valve chambers is provided at its innermost end with a projected cavity, 32 and 34 respectively, which defines about its juncture with the chamber an annular seat, 36 and 38 respectively. In one side face of the valve body an inlet port 40 provides communication between the source of pressurized fluid and valve chamber 28, and a return port 42 provides communication between a return side of the pressure fluid source and valve chamber 30.

A passage 44, substantially peripherally located within the valve body 26 interconnects cavity 32 of valve chamber 28 with valve chamber 30 and communicates intermediate its length with a discharge port 46 which has connection through flexible tubing with fitting 22 on the tank cylinder 10.

Each of the valve chambers 28 and 30 is provided with a valve, 48 and 50 respectively, including a head portion 52 and 54 respectively which seats inwardly of the open end of the chamber against the associated valve seat 36 or 38, and an extended cylindrical stem portion, 56 and 58 respectively, which projects outwardly of the valve chamber opening in the valve body.

Associated with the valve body at that end thereof through which valve chamber 30 opens is a guide block 60 which is provided in one end with a tubular socket 62 defined by a projecting flange 64 about its open end. The flange 64 is telescopically received in the open end of the valve chamber 30 and the stem 58 of the valve 50 is telescopically positioned inwardly of the socket 62 in the guide block. An O ring or like seal 66 is provided between the abutting faces of the guide block 60 and the end of the valve body 26 and the valve stem 58 is provided with an O ring seal 68 in contact with the inner wall of the tbuular socket 62 in the guide block 60. A coil spring 70 is seated against the bottom of the tubular socket 62 and guide block 60 and abuts the inner end of the valve stem 58.

The extended end of guide block 60 is provided with a projecting portion 72 of reduced diameter forming an outwardly disposed annular shoulder 74 against which

is seated one end of a coil spring 76. The other end of the spring 76 bears against a cup-shaped plunger cap 78. The outermost face of the plunger cap 78 is directly aligned with and normally abuts the extreme extended end of the piston rod 14.

Associated with the valve body 26 and valves 48 and 50 is an elongated cylindrical rod 80 which has one end secured by set screw 82 or the like to plunger cap 78 to extend axially through provided passages in the guide block 60, valve 50 and valve body 26 to position its second end within a central tubular socket 84 opening inwardly of the head portion 52 of valve 48. A lock ring 85 provided on rod 50 limits the movement of valve 50 along the rod. An adjusting screw 86 is longitudinally received from the outer projected end of stem 56 of valve 48 into the base end of socket 84 to abut that end of rod 80 telescopically received therein and selectively limits the extent of projection of the rod into the socket 84.

Associated with that end of the valve body through which valve chamber 28 opens is secured, by set screws not shown, to a mounting block 88 similar to guide block 60 providing a tubular socket 90 adapted to receive valve stem 56 therein in abutment with a coil spring 92 seated in the socket. Mounting block 88 is also provided with a projecting flange 94 defining the opening of socket 90 and serving with O-ring seal 96 to close and seal the open end of valve chamber 28.

The outermost end of guide block 88 is provided with a central tubular socket 98 which receives therein one end of an elongated cylindrical tube 100 which is secured by lock screws 102 in the socket.

The cylindrical tube 100, one end of which is anchored in mounting block 88, forms a part of the reference motion component 18 which is mounted in axial alignment with the valve body to control operation of the valve in its function of admitting pressurized fluid to and from the power side of piston 12 in tank 10.

In the reference motion component cylindrical tube 100 is slidably supported in a bearing block 104. The bearing block 104 is provided with a screw pin 106 which engages a longitudinal slot 108 formed through an intermediate portion of the length of the tube 100 and prevents rotation of the tube and limits its longitudinal sliding movement. The extreme extended end of the tube 100 is rigidly secured by set screw means 110 or the like in a socket 112 in a screw block or drive nut 114. Screw block or drive nut 114 is axially threaded on an elongated worm 116 the extended end of which is rotatably mounted in a fixed bearing block 118. The other end of worm 116 extends concentrically within tube 100 where it is provided with a guide ring 120 in slidable, telescopic engagement with the inner walls of the tube. Worm 116 is provided with drive connection to a variable speed motor or like power source 124.

The drive connection includes a constant speed electric motor 126, a conventional variable speed transmission 128 provided with a speed adjusting control handle 130 and an output shaft 132. The output shaft 132 is coupled to the worm or lead screw 116 by "Timing Belt" or similar flexible draft means 134 which passes over pulley 136 secured to the lead screw and pulley 138 secured to the output shaft 132.

Operation

In operation of the pump described, assuming that tank cylinder 10 is filled with a predetermined quantity of fuel and the piston, valve, tube 100 and lead screw 116 are positioned substantially as shown in Figs. 1 and 2 of the drawings, pressurized fluid from a source of pressure fluid is admitted to the valve mechanism 16 through inlet port 40 simultaneously with the starting of the motor 126 which is preset to run at a preselected rate of speed to determine by the rate at which fuel is to be injected. The actual driving force for the piston of the pump is provided by the pressurized fluid admitted into the valve means and communicating through fitting 22 to the power side of the piston 12. Operation of the variable speed motor serves to rotate lead 116 causing drive nut 114 to move longitudinally thereof in a direction toward the tank 10 at a fixed constant rate of speed thereby moving the valve body supported on the tube 100 coupled to the drive nut in longitudinal coincidence with movement of the piston rod 14 against which the plunger cap 78 of the valve mechanism abuts.

The spring seated arrangement of the valves within the valve body are such that should the piston rod, under influence of the pressure fluid, move in a discharge direction at a rate of speed greater than the rate of movement of the valve body under the control of movement of tube 100 the plunger cap 78 will under influence of spring 76 be urged outwardly away from the valve body thereby axially moving rod 80 within the valve body in a direction causing spring 92 to move valve 48 toward seat 36 and valve 50 iln a direction away from valve seat 38 against the bias of spring 70, which is of lesser compressive strength than spring 76, thereby increasing the valve opening to return port 42 by passing an increased quantity of the pressurized fluid and reducing delivery of the pressure fluid through port 46 to the power side of the piston thereby slowing down discharge movement of the piston.

Conversely, should the rate of speed of piston movement in a discharge direction fall below the rate of movement of the valve body under influence of drive nut 114, plunger cap 78 will be compressed inwardly against the bias of spring 76 thereby serving to restrict the valve opening to return port 42 and at the same time, through the coupling of the extended end of rod 80 with valve 48, increase the valve opening of valve 48 to permit an increased inlet flow of pressure fluid to reach discharge port 46 for distribution to the power side of the piston thus increasing the rate of speed of piston movement in a discharge direction.

In actual practice and under normal operating conditions the above two described operations of the valve mechanism are constantly reversing with the valves being in substantially constant motion regulating slight variations in pressure at great rapidity. However, because of the constant and fixed rate of linear movement of drive nut 114 and tube 100 coupled thereto a substantially balanced equilibrium is maintained between the movement of tube 100 and valve body 26 supported thereon and piston rod 14. This balanced equilibrium insures a constant rate of fuel flow from the delivery side of the pump for the preselected time interval.

Several cut-off control switches are provided for the drive motor to prevent over-running or undesired pump operation. One such switch, 140, is supported on valve body 26 presenting a contact point in operable association with a collar 142 on the piston rod 14. The interrelated positioning of collar 142 and switch 140 are such that contact will be made, actuating an indicator, when the cylinder is full of fuel.

A second switch 144 is positioned to be actuated by drive nut 114 when it has moved to its extreme discharge position thereby preventing overrunning of the mechanically driven component. A third limit switch 146 is actuated by drive nut 114 at the other extreme end of its travel and stops the drive mechanism when it is being reversed.

From the foregoing disclosure it is now evident that a positive displacement pump of novel structure and operation has been provided by the present invention which attains all of the objects and advantages herebefore stated and accomplishes the new, useful and unexpected results explained.

I claim:

1. Displacement pump apparatus comprising a cylinder having opposed heads at opposite ends thereof, a piston

slidably mounted in the cylinder, a piston rod connected to one face of the piston for movement therewith, said piston rod extending from said face of the piston through an opening in one of the heads of said cylinder, valve means controlling the flow of pressure fluid from a source of pressure fluid to an opening in said one of said cylinder heads of the cylinder to bring about movement of the piston and piston rod toward the other of the heads of the cylinder, an outlet for a fluid to be pumped adjacent the said other of the cylinder heads, spring means normally urging said valve means in the closed position to prevent flow of pressure fluid to the cylinder, a linearly movably reference mechanism supporting said valve means in axial alignment with the piston rod, means for moving said reference mechanism to bring said valve means into operable communication with the piston rod against the force of said spring means to open said normally closed valve means whereby pressure fluid from the source of pressure fluid moves said piston toward the outlet for the fluid to be pumped.

2. The construction defined in claim 1 wherein said reference mechanism comprises a screw driven element supporting the valve means in axial alignment with the piston rod.

3. The construction defined in claim 1 wherein said valve means includes further port control elements for releasing pressure fluid from said one end of the cylinder when the valve is displaced away from operable communication with the piston rod.

4. Pump apparatus as defined in claim 1 wherein said reference mechanism includes a screw driven element supporting said valving means, and power means operably connected to and driving said screw at a predetermined fixed speed.

5. A construction as defined in claim 1 wherein said reference mechanism consists of a rotatable screw, a drive nut threadedly engaged on said screw, an elongated arm supported on said drive nut at one end and mounting said valving means at the extended end, and power means having drive connection with said screw.

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