

[54] ELECTROMAGNETIC PLUNGER PUMP

[76] Inventor: Tadashi Nakamura, 3-7,
Minamizawa 3-chome,
Higashikurume-shi, Tokyo, Japan

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Primary Examiner—William L. Freeh
Assistant Examiner—G. P. LaPointe
Attorney, Agent, or Firm—Wenderoth, Lind & Ponack

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[58] Field of Search 417/416, 417, 307, 311,
417/505, 568; 137/512.4, 512.5, 525

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[57] ABSTRACT

An electromagnetic plunger pump which is capable of continuously controlling the discharge pressure at a predetermined level by effectively dealing with such factors as the heating of the electromagnetic plunger pump and a fluctuation of the input voltage which are unavoidable in practice, and is capable of making a smooth adjustment of the pressure even to a minute change in the discharge pressure, and also is capable of making a smooth and stable adjustment of the pressure even to a variation in the discharge pressure.

6 Claims, 2 Drawing Figures

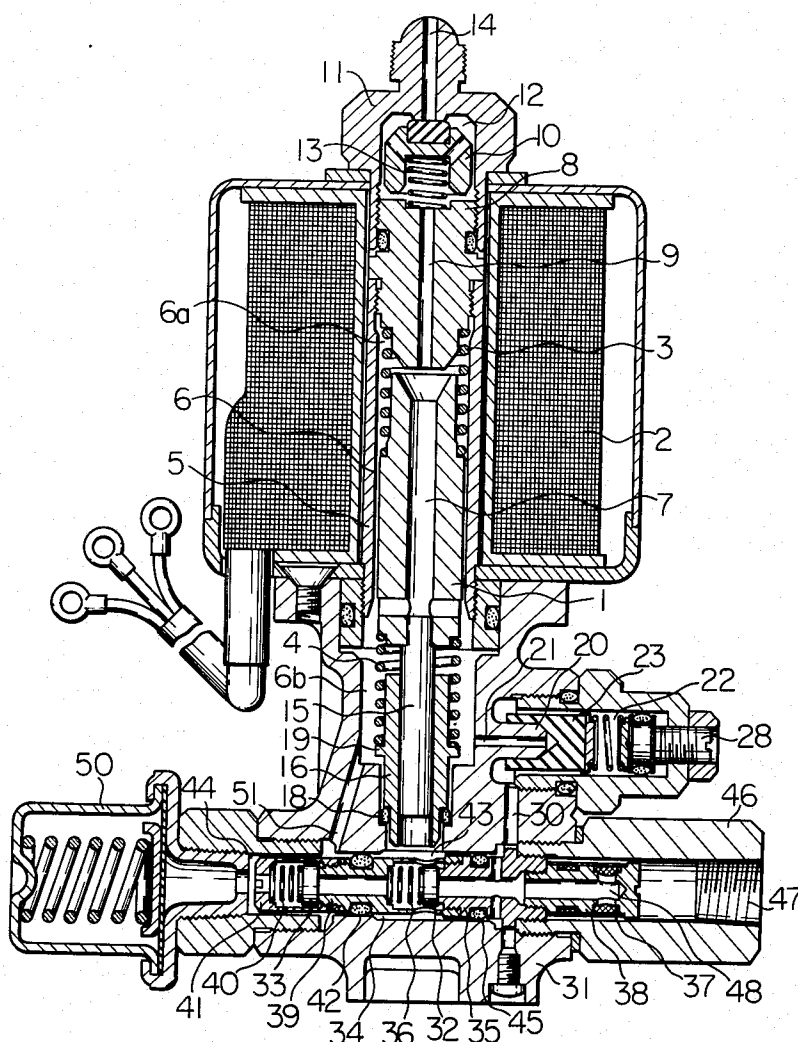


Fig. 1

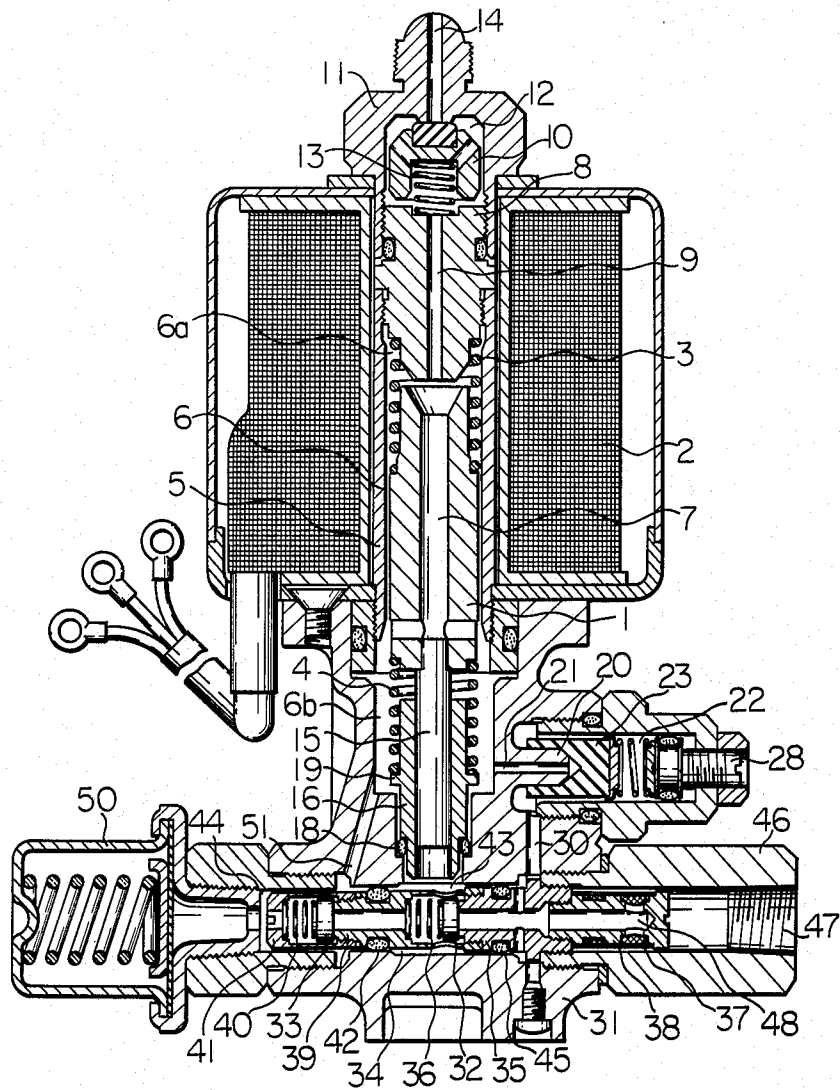
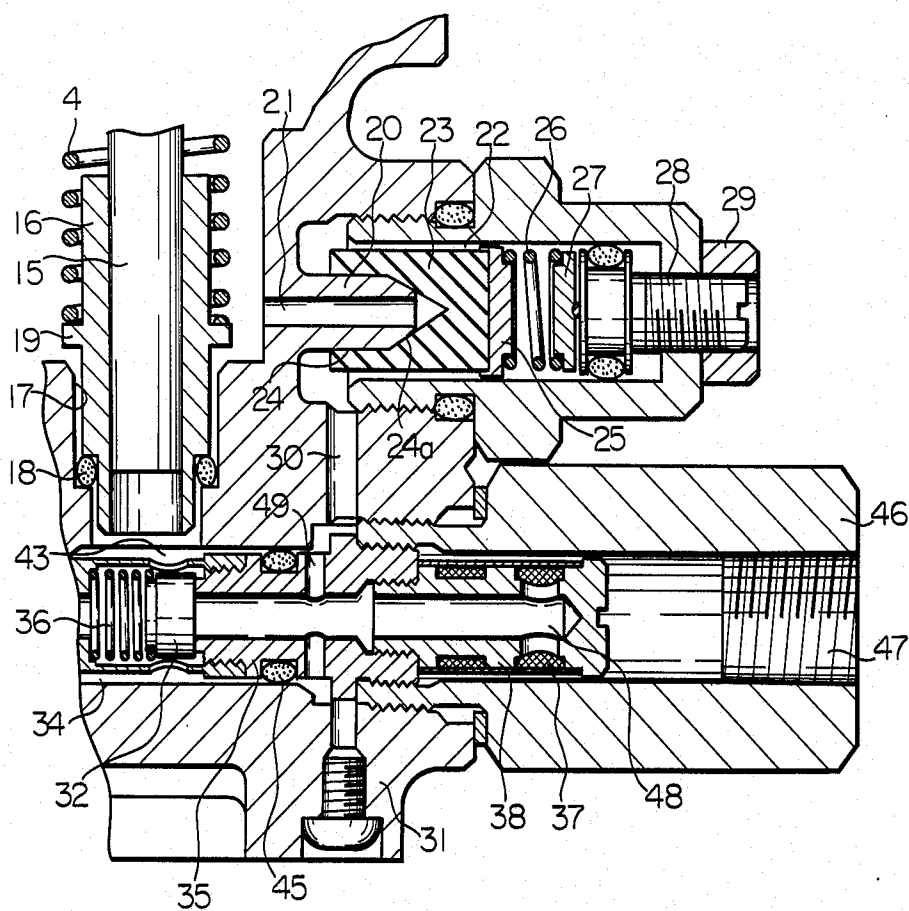


Fig. 2



ELECTROMAGNETIC PLUNGER PUMP**BACKGROUND OF THE INVENTION:**

The present invention relates to an electromagnetic plunger pump, and more particularly to an electromagnetic plunger pump having such a construction that the discharge pressure of the fluid pumped out of the discharge port by the pump function is always maintained stable.

In electromagnetic plunger pumps of conventional designs, adjustment of discharge pressure was effected in such a way that by changing the relative distance between the magnetic force adjusting rod and the electromagnetic plunger carrying the pressure plunger, the magnetic attraction, as well as the pressure plunger stroke, was changed with the result that the discharge flow rate (and the discharge pressure) was adjusted.

However, with such pumps, even if the magnetic force adjusting rod was set at a predetermined position in the beginning, because the saturation temperature of the electromagnetic coil as well as the friction temperature rose over time, the pump efficiency dropped and inevitably, the discharge pressure dropped. Also it was unavoidable that when the supply voltage fluctuated, the magnetic force also fluctuated, resulting in a fluctuation in the discharge pressure.

With a view to overcoming this defect, an electromagnetic plunger pump having a discharge pressure adjusting device comprising a discharge pressure detecting means and an excess pressure relieving means which relieves pressure above a predetermined value detected by the detecting means at the suction side, was proposed. In this design, however, because the relief valve is such a simple construction, the valve is pressed on a flat seat surface with a spring, the open-close response of the valve to small pressure variations is unsatisfactory and also valve opening response to a large pressure excess was extremely unstable.

Such a fluctuation in the discharge pressure is undesirable to various equipments receiving the fluid under this discharge pressure; for example, when such a pump is used as the fuel supply pump for a kerosene burner, it has the fatal defect of causing incomplete combustion.

SUMMARY OF THE INVENTION

A first object of the present invention is to provide an electromagnetic plunger pump which is capable of continuously controlling the discharge pressure at a predetermined level by effectively dealing with such factors as the heating of the electromagnetic plunger pump and a fluctuation of the input voltage which are unavoidable in practice.

A second object of the present invention is to devise an electromagnetic plunger pump which is capable of making a smooth adjustment of the pressure even to a minute change in the discharge pressure.

Furthermore, a third object of the present invention is to devise an electromagnetic plunger pump capable of making a smooth and stable adjustment of the pressure even to a variation in the discharge pressure.

In order to achieve these objects, in the electromagnetic plunger pump based on the present invention, effecting the pumping function by the reciprocating motion of a pressure plunger carried by an electromagnetic plunger caused by the electromagnetic force of an electromagnetic coil the following are provided a nozzle

through which the discharge pressure after passing through a lower spring chamber is vented out; a relief valve covering this nozzle; and a relief fluid passage hole for returning the fluid escaping through said relief valve, so that any excess pressure over a preset discharge pressure is caused to escape, with the result that the discharge pressure is always continuously controlled at a predetermined level. An embodiment of the present invention will be explained in the attached drawings as well as in the detailed description that follows.

It should be understood however, many minute modifications and variations on the details of the construction are possible within the scope of the claims given hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS:

FIG. 1 is a vertical sectional view of an electromagnetic plunger pump representing an embodiment of the present invention, and

FIG. 2 is an enlarged sectional view of an essential part of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS:

In an electromagnetic plunger pump representing a preferred embodiment of the present invention shown in FIG. 1 and FIG. 2, an electromagnetic plunger 1 actuated by an electromagnetic coil 2 is supported, within an electromagnetic plunger actuation chamber 6 that is composed of a hollow guide case 5, between an upper spring 3 and a lower spring 4, and said electromagnetic plunger actuation chamber 6 is divided into an upper spring chamber 6a and a lower spring chamber 6b by said electromagnetic plunger 1.

Said electromagnetic plunger 1 is provided with an axial passage hole 7 connecting said upper spring chamber 6a and said lower spring chamber 6b.

Above said electromagnetic plunger 1, there is provided a magnetic force adjusting rod 8, being threadedly engaging in the upper part of said guide case 5. Through this magnetic force adjusting rod 8, an axial passage hole 9 is provided.

A movable valve 10 installed in a chamber 12 provided in a discharge fitting 11 is biased by a spring 13 closing a discharge port 14.

A pressure plunger 15 that is firmly connected to said electromagnetic plunger 1 is inserted in a cylinder 16.

Said cylinder 16 is disposed within a cylinder insertion hollow space 17 that is in communication with said lower spring chamber 6b in a spaced relationship; the cylinder being supported by an elastic member 18.

A portion of said cylinder 16 forms a spring seat 19 for seating said lower spring 4, in such a way that said cylinder 16 is acted upon by the tension of said spring.

A nozzle 20 projecting into a relief valve chamber 22 is provided with a central passage hole 21, that is in communication with said lower spring chamber 6b, and therefore, the discharge pressure is sent to it via a discharge chamber 44, a passage hole 51 and said lower spring chamber 6b.

The relief valve 23 covering said nozzle 20 is made of an elastic material such as rubber or synthetic resin, and a nozzle insertion cavity therein includes an inner conical portion 24a inside.

Said relief valve 23 is held in its place by a relief valve holding cap 25, and a spring 26 is disposed between this

cap 25 and an adjusting screw 28 with an intermediary of a thrust spring seat 27. On said adjusting screw 28 there is provided a lock nut 29 threadedly engaging therewith.

A relief fluid outlet hole 30 is drilled through a pump body 31 providing a relief fluid outlet passage from said relief valve chamber 22 to the suction side of the pump body.

A suction side check valve 32 and a discharge side check valve 33 are disposed within an integrally connected pair of valve seat members, which in turn are positioned within a valve insertion hole 34 in the pump body 31.

The check valve 32 is biased against the suction side valve seat member 35, by a spring 36, while on one end of said suction side valve seat member, a member 38 having a strainer 37 is connected, and on the other end is connected the discharge side valve seat member 39. The discharge side check valve 33 is biased against seat member 39 by a spring 40, and also on this discharge side valve seat member 39, a valve cylinder 41 for holding said spring 40 is screwed on.

An O ring 42 disposed around said valve seat member 39 tightly engages the walls of the valve insertion hole 34 to separate a pressure chamber 43 from a discharge chamber 44. Another O ring 45 is disposed around said valve seat member 35.

Through a suction port 47 provided through a suction side fitting 46 that is connected to said pump body 31 with a screw engagement, fluid is introduced, and, over the strainer 37 and through a duct 48, is led into said pressure chamber 43. This duct 48 is provided with a connecting passage 49 that is connected with said relief fluid outlet hole 30.

Said discharge chamber 44 is provided with an accumulator 50 for smoothing out the discharge pressure.

Below, an exemplary functioning of the present invention is described.

When the electromagnetic coil 2 is energized, the electromagnetic plunger 1 is driven by it and is set in a vertical reciprocating motion, forcing the pressure plunger 15 to also reciprocate within the cylinder 16, thereby creating a pumping function in conjunction with the suction side check valve 32 and discharge side check valve 33 fluid is drawn in through the suction port 47, pressurized in the pressure chamber 43, and sent to the discharge chamber 44, wherefrom its pulsive pressure is smoothed in the accumulator 50. The smoothed fluid is discharged into the lower spring chamber 6b via the passage hole 51. Thence, the discharge fluid flows through the passage hole 7 in the electromagnetic plunger 1 to fill the upper spring chamber 6a and thence into the chamber 12 via the passage hole 9 provided in the magnetic force adjusting rod 8. The fluid sent into the chamber 12 is then sent through the movable valve 10, which is kept open during the time the electromagnetic coil 2 is in an energized condition, to the outside via the discharge port 14.

In the meantime, the fluid filling said lower spring chamber 6b applies a thrust force on the relief valve 23 through the central passage hole in the nozzle 20, and because a preset spring force is applied to said relief valve by means of the adjusting screw 28, as soon as the discharge pressure rises above a preset value, the relief valve 23 is displaced to let out a quantity of fluid through the space thus created between the relief valve

23 and the nozzle 20 with the result that the discharge pressure is maintained always at a constant value. The fluid expelled from the relief valve is accumulated in the relief valve chamber 22 and thence sent back to the duct 48 via the outlet hole 30 and the connecting passage 49.

When there is a fluctuation in the discharge pressure, e.g., the discharge pressure either rises or drops due to a rise or drop in the supply voltage, the spring 26 is correspondingly shortened or extended and the relief valve 23 is displaced over the nozzle 20 to the right or to the left as viewed on the drawing, thereby maintaining the opening degree of the space between the nozzle 20 and the relief valve 23 in a stable condition.

However, when the fluctuation of the discharge pressure is minute, the relief valve remains in its position without a displacement, and the space between the relief valve and the nozzle is minutely changed by the elastic deformation of the relief valve itself 23 to provide the required adjustment to cope with such small fluctuations.

What is claimed is:

1. In a reciprocating electromagnetic pump including a cylinder, a magnetic piston having a flow passage therethrough and having inlet and outlet ends and slidably mounted in the cylinder, said cylinder defining a pumping chamber surrounding the inlet end of said piston and receiving fluid therein, means for reciprocating the piston including an electromagnetic coil coaxial to said magnetic piston, a power source coupled to said electromagnetic piston for selective activation thereof, and a check valve mounted on the piston in the fluid flow-passage, the improvements which comprise a pump body having a passageway therein, one end of said passageway being a fluid inlet, a suction side check valve and a discharge side check valve positioned within said passageway and normally biased closed, said passageway communicating with said pumping chamber in the vicinity of said suction side check valve, whereby the suction stroke of said piston opens said suction side check valve and draws fluid into said passageway, said fluid forcing open said discharge side check valve, said pumping chamber also communicating with said passageway in the region of said discharge side check valve, fluid being drawn into said pumping chamber therefrom, and a relief valve means communicating with said pumping chamber and said passageway of said pump body.

2. The device of claim 1 further comprising an accumulator mounted at a second end of said passageway of said pump body, said pumping chamber communicating with said passageway in the region intermediate said accumulator and said discharge side check valve.

3. The device of claim 1 wherein said relief valve means is comprised of a relief valve operatively seated over a nozzle, and wherein said check valve includes a fixed valve seat and a movable valve member of magnetic material cooperating with the seat to close said passage, said movable member being so positioned as to be drawn away from its seat by the attraction of the electromagnetic coil during operation of the pump to allow fluid flow, said check valve being positioned at the outlet end of said magnetic piston.

4. An electromagnetic plunger pump according to claim 3, in which said relief valve means is made of a flexible material such as rubber and synthetic resin.

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5. An electromagnetic plunger pump according to claim 3, said relief valve forming a cavity provided with a tapered portion.

6. An electromagnetic plunger pump according to claim 1, in which a cap is provided on said relief valve, 5

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a spring is disposed between this cap and a thrust spring seat, and an adjusting screw thrustingly engaging with said thrust spring seat is also provided.

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