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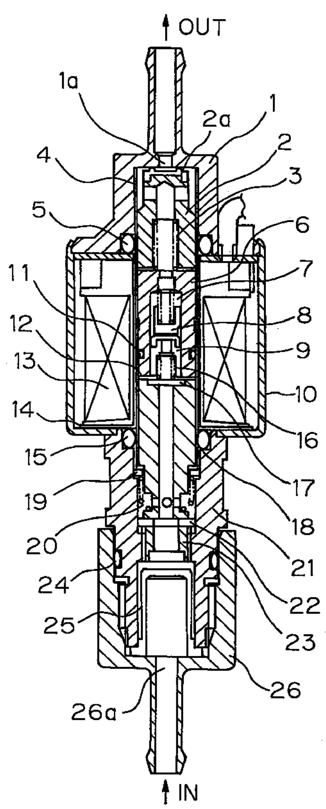
(54) Metering type electromagnetic pump

(57) It is sought to accurately control the discharge rate of a pump according to the frequency of a current pulse output applied to an electromagnetic coil.

The pump comprises an electromagnetic solenoid 13, a plunger 18 driven thereby, a check valve 2 disposed downstream the plunger 18 and driven by the electromagnetic solenoid 13, and an suction valve 17 provided in the plunger 18 and a discharge valve 8 provided in an inner yoke 6, the check valve 2 being opened when a current pulse output for energizing the electromagnetic solenoid 13 is turned on, thus causing a discharge stroke of the plunger 18.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to a metering type electromagnetic pump for supplying liquid fuel or the like and, more particularly, to a metering type electromagnetic pump, which can simply and accurately control the discharge and, doe not require an on-off valve disposed between an apparatus, to which liquid fuel is supplied, and a pump.

Prior Art

[0002] Electromagnetic pumps for supplying fuel or the like are two types. One is a metering type, the other, a pressure control type. In the metering type electromagnetic pump, the discharge is determined by the volume displaced by one stroke of a plunger. In the electromagnetic pump of pressure control type, a pressure control mechanism such as a diaphragm or the like is made constant by reciprocating a plunger at a constant speed.

[0003] In the metering type electromagnetic pump, the flow rate is controlled by the plunger driving frequency. In the electromagnetic pump of pressure control type, the flow rate is controlled with an orifice or a released valve. In the pressure control type electromagnetic pump, for changing the flow rate it is necessary to make orifice replacement or like operation. Therefore, it is cumbersome to control the flow rate. The electromagnetic pump requires an on-off valve for stopping supplying fuel or the like.

[0004] Fig. 2 shows a prior art example of the electromagnetic pump for supplying fuel. As shown in the Figure, a sleeve 4 is fitted on an end yoke 1 and an outer yoke 10. An inner yoke 6 is secured in position in the sleeve 4. A shock absorbing sheet 12 is applied to the lower end of the inner yoke 6. A plunger 18 is slidably fitted in the sleeve 4, such that it is biased downward by a compression coil spring 20 between a ring 19 and a lower flange and is held in forced contact with a packing 22. The compression coil spring 20 has a lower portion with a reduced diameter.

[0005] The outer periphery of the sleeve 4 is sealed by an O-ring 15. An electromagnetic coil 13 is disposed in the outer yoke 10. A current flowing through the electromagnetic coil 13 generates a magnetic flux in an magnetic circuit, which is formed by the outer yoke 10, the end yoke 1, the inner yoke 6 and the plunger 18.

[0006] A discharge valve sheet 28 is secured in position at the bottom of a central bore formed in the inner yoke 6. An intake valve 17 is biased by a compression coil spring 16 such that it enters a recess provided in the upper end surface of the plunger 18. A discharge valve 27 is slidably disposed in the center bore of the inner yoke 6, and is biased by a compression coil spring 7 to be in forced contact with the discharge valve sheet 28. The discharge valve 27 has a flow path groove formed in its outer periphery.

[0007] A nipple 26 is fitted via a sealing O-ring 24 on a lower end portion of the outer yoke 10. The filter 25 is disposed and secured in a space defined by the outer yoke 10 and the nipple 26. The nipple 26 has a fuel suction port 26a. The inner yoke 6 has a fuel discharge port 6a.

[0008] In the above construction, when the electromagnetic coil 13 is not energized, the plunger 18 is held in forced contact with the packing 22 by the compression coil spring 20, and a space defined by the shock absorbing sheet 12, the plunger 18 and the top of the valve 17 is filled with liquid fuel.

[0009] When the electromagnetic coil 13 is energized, a flux is generated in the magnetic circuit formed by the outer yoke 10, the end yoke 1, the inner yoke 6 and the plunger 18, thus causing the plunger 18 to be raised by the attraction force in the magnetic gap between the plunger 18 and the inner yoke 6 against the elastic force of the compression coil spring 20. At this time, a liquid fuel pressure is generated to rise the discharge valve 27 against the elastic force of the compression coil spring 7, thus discharging liquid fuel through a central hole formed in the discharge valve sheet 28, the gap between the discharge valve sheet 28 and the discharge valve 27, a groove formed in the outer periphery of the discharge valve 27 and the fuel discharge port 6a in the center hole of the inner yoke 6.

[0010] When the electromagnetic coil 13 is de-energized, the plunger 18 is pushed down by the elastic force of the compression coil spring 20. At this time, a negative pressure is generated between the plunger 18 and the inner yoke 6, causing the discharge valve 27 to be pushed down by the elastic force of the compression coil spring 7 and close the discharge valve sheet 28.

[0011] The negative pressure generated between the plunger 18 and the inner yoke 6 generates a gap between the intake valve 17 and the plunger 18, and liquid fuel flowing in through the fuel suction port 26a passes through the gap and fills the space, which is defined by the shock absorbing sheet 12, the plunger 18 and the top of the intake valve 17.

[0012] In the above way, by applying a current pulse to the electromagnetic coil 13, the liquid fuel corresponding to the displacement volume of the plunger 18 is pumped out from the electromagnetic pump. The fuel discharge rate can be controlled according to the frequency of the current pulse output applied to the electromagnetic coil 13.

[0013] An example of the pressure control type electromagnetic pump is disclosed in Japanese Patent Disclosure No. 52-38243. This electromagnetic pump is an electromagnetic piston pump, in which a pressure piston is driven by a spring and an electromagnetic piston, which is driven by an electromagnetic coil energized by a current obtained by half-wave rectifying commercial power. A spring-biased electromagnetic movable piece is provided in the liquid passage. The liquid passage is normally held closed by the electromagnetic movable piece, and is opened when the half-wave rectified current is applied to the electromagnetic coil. Since this electromagnetic pump is of pressure control type, the discharge pressure is controlled to be constant by a pressure control mechanism provided on the discharge side of the pump. The pressure control mechanism controls a flow control valve with a diaphragm such that pressure in a constant pressure chamber is constant.

[0014] In the prior art metering type electromagnetic pump shown in Fig. 2, it is necessary to provide an electromagnetic or manual on-off valve, which closes the the fluid passage when the electromagnetic coil is deenergized. This increases the installation cost of the entire pump. Another problem in this pump is the generation of the phenomenon of commonly called blow-by, i.e., an increase of the actual flow rate beyond the theoretical flow rate of the pump.

[0015] The blow-by phenomenon occurs due to the opening of the intake valve caused by the inertia of fluid in a pulsating current generated by the pump action, that is, the flow of fluid in the discharging direction through the intake valve in a theoretically closed state. This phenomenon results in flow rate changes due to the suction side pressure variations or like cause, thus making it difficult to obtain accurate pump discharge rate control.

[0016] In the electromagnetic pump disclosed in the Japanese Patent Disclosure No. 52-38243, the fluid passage is held closed by the electromagnetic movable piece when the electromagnetic coil is not energized, hence the electromagnetic or manual on-off valve as noted above is not necessary. However, since the pump is the pressure control type electromagnetic pump as noted above, it has a problem that it is difficult to control the flow rate due to using an orifice or a relief valve.

[0017] The present invention was made in view of the foregoing, and its object is to provide a metering type electromagnetic pump, which permits flow control to be done simply and does not require any electromagnetic or a manual on-off valve for closing the fluid passage.

SUMMARY OF THE INVENTION

[0018] The metering type electromagnetic pump according to the invention comprises a metering type electromagnetic solenoid, a plunger driven thereby, a check valve disposed downstream the plunger and driven by the electromagnetic solenoid, and a discharge valve provided in an inner yoke, the check-valve being opened and the plunger being in a discharge stroke state when a current pulse output is turned on to energize the electromagnetic solenoid.

[0019] In addition, in the above metering type electromagnetic pump according to the invention, the discharge rate is controlled by the frequency of the current pulse output for energizing the electromagnetic solenoid.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a sectional view showing an embodiment of the metering type electromagnetic pump according to the invention;. and

Fig. 2 is a sectional view showing a prior art metering type electromagnetic pump.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] An embodiment of the metering type electromagnetic pump for supplying fuel according to the invention will now be described with reference to the drawings. Fig. 1 is a sectional view showing the embodiment of the metering type electromagnetic pump according to the invention. Referring to the Figure, a sleeve 4 is fitted in an end yoke 1 and a nipple base 21. An inner yoke 6 is accommodated and secured in position in the sleeve 4. A shock absorbing sheet 12 is bonded to the lower end of the inner yoke 6. A plunger 18 is slidably accommodated in the sleeve 4. The plunger 18 is biased downward by a compression coil spring 20 provided between a ring 19 and a lower flange, and is held in forced contact with a packing 22 supported by a stopper 23. The compression coil spring 20 has a lower portion having a reduced diameter.

[0022] The outer periphery of the sleeve 4 is sealed by O-rings 15 and 5. The outer yoke 10 accommodates an electromagnetic coil 13 disposed via spacer 14 in it. A current caused to pass through the electromagnetic coil 13 generates a flux in a magnetic circuit, which is formed by the outer yoke 10, the end yoke 1, a check valve 22, the inner yoke 6, the plunger 18 and the nipple base 21.

[0023] The check valve 2 is slidably guided along the sleeve 4 and has a bore serving as a fluid passage, and its upper end has a projection 2a for closing a fuel discharge port 1a formed in the end yoke 1. The check valve 2 is normally closing the fuel discharge port 1a as sheet surface of the end yoke 1 is held in forced contact with the projection 2a by a compression coil spring 3.

[0024] A discharge valve sheet 9 is secured in position at the bottom of a central bore formed in the inner yoke 6. The outer periphery of the inner yoke 76 is sealed by an O-ring 11. A suction valve 17 is energized by a compression coil spring 16 such as to enter a recess formed in the upper end surface of the plunger 18.

[0025] A discharge valve 8 is slidably disposed in a central bore formed in the inner yoke 6, and is biased by a compression coil spring 7 to be in forced contact with a discharge valve sheet 9. The outer periphery of the discharge valve 8 has a groove forming a flow passage.

[0026] A nipple 26 is fitted on a lower end portion of the nipple base 21 secured to the outer yoke 10. A filter 25 is secured in position between the nipple base 21 and the nipple 6. The nipple 26 has a fuel inlet port 26a.

[0027] In the above construction, when the electromagnetic coil 13 is not energized, the plunger 18 is held in forced contact with the packing 22 by the elastic force of the compression coil spring 20, and the space defined by the shock absorbing sheet 12, the plunger 18 and the top of the suction valve 17 is filled with liquid fuel. At this time, the check valve 2 is held in forced contact with the sheet surface of the end yoke by the elastic force of the compression coil spring 3, and is thus closing the fuel outlet port 1a.

[0028] When the electromagnetic coil 13 is energized, a flux is generated in the magnetic circuit formed by the outer yoke 10, the end yoke 1, the check valve 2, the inner yoke 6, the plunger 18 and the nipple base 21, and the resultant suction force generated in the magnetic gap between the plunger 18 and the inner yoke 6 raises the plunger 18 against the elastic force of the compression coil spring 20. The liquid fuel pressure that is generated at this time raises the discharge valve 8 against the elastic force of the compression coil spring 7, causing liquid fuel to flow through the central hole of the discharge valve sheet 9, the gap between the discharge valve sheet 9 and the discharge valve 8 and the groove formed in the outer periphery of the discharge valve 8 into the hole of the check valve 2.

[0029] At this time, the check valve 2 is lowered againt the elastic force of the compression coil spring 7 by the suction force generated in the gap between the check valve 2 and the inner yoke 6, thus opening the fuel discharge port 1a to cause liquid fuel to be discharged through the hole in the check valve 2 and the the fuel outlet port 1a.

[0030] When the electromagnetic coil 13 is de-energized, the plunger 18 is lowered by the elastic force of the compression coil spring 20. At this time, a negative pressure is generated in the gap between the plunger 18 and the inner yoke 6, and the check valve 8 is lowered by the elastic force of the compression coil spring 7 and closes the discharge valve sheet 9.

[0031] Also, a negative pressure generated between the plunger 18 and the inner yoke 6 generates a gap between the suction valve 17 and the plunger 18, and liquid fuel flowing from the fuel suction port 26a passes through the gap and fills the space defined by the shock absorbing sheet 12, the plunger 18 and the top of the suction valve 17.

[0032] When the electromagnetic coil 13 is de-energized, the check valve 2 is raised by the elastic force of the compression coil spring 3 and closes the fuel discharge port 1a. In the above way, since the fuel discharge port 1a is closed in the liquid fuel suction stroke, the blow-by phenomenon descried before in connection with the prior art can be suppressed. While both the check valve 2 and the discharge valve 8 are closed in the suction stroke, the dicharge valve 8 which has little mass is quickly brought into forced contact with the discharge valve sheet 9,and a negative pressure occures such that the suction valve 17 is opened, thus preventing reverse flow that may otherwise be cause in the suction stoke with the suction valve 17 in the closed state.

[0033] In the above way, by applying a current pulse output to the electromagnetic coil 13, liquid fuel corresponding to the displacement volume of the plunger 18 is pumped out by the electromagnetic pump. Since the blow-by phenomenon does not take place, the fuel discharge rate can be accurately controlled by the frequency of the current pulse output applied to the electromagnetic coil 13. In addition, the check valve 2 closes the fuel discharge port 1a in response to the de-energization of the electromagnetic coil 13, and it is thus not necessary to provide an electromangetic or a manual on-off valve for closing the passage of fluid.

Claims

1. A metering type electromagnetic pump comprising an electromagnetic solenoid, a plunger driven thereby, a check valve disposed downstream the plunger and driven by the electromagnetic solenoid, and a discharge valve provided in an inner yoke, the check-valve being opened and the plunger being in a discharge stroke state when a current pulse output is turned on to energize the electromagnetic solenoid.

2. The metering type electromagnetic pump according to claim 1, the discharge rate being controlled by the frequency of the current pulse output for energizing the electromagnetic solenoid.

FIG. 1

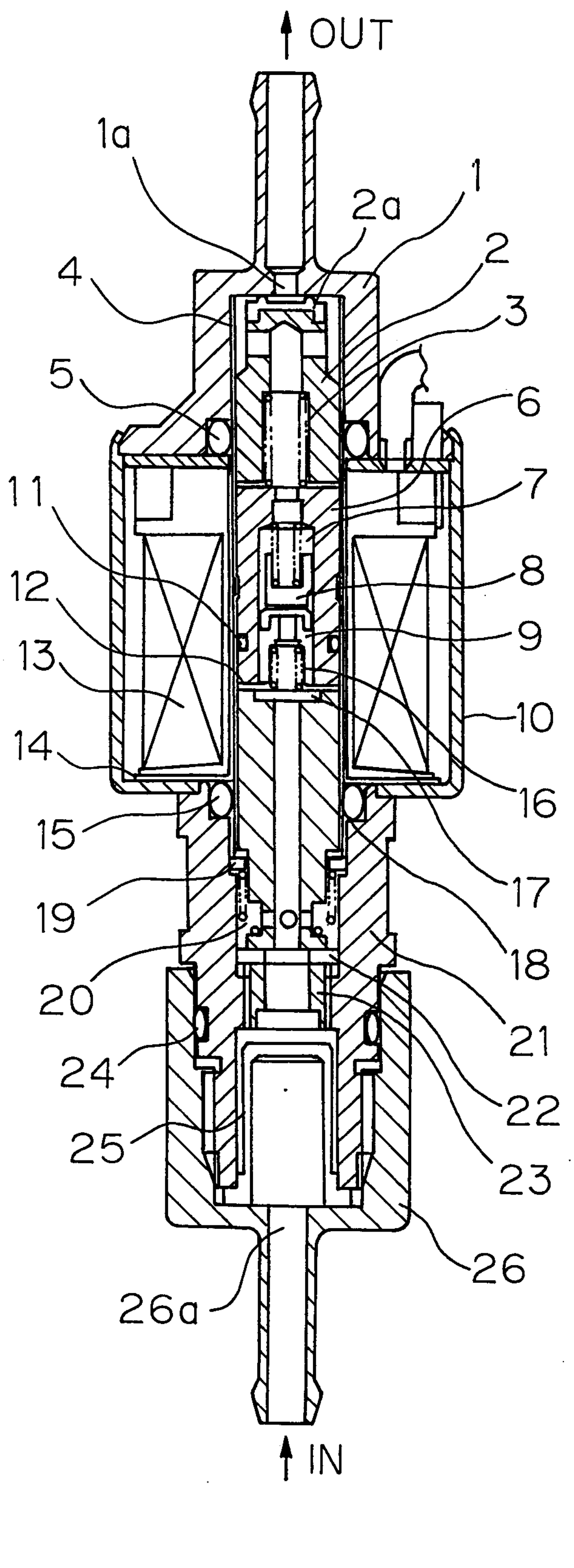
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FIG. 2