United States Patent [19]

La Flame et al.

[11] **3,824,974**

[45] **July 23, 1974**

[54] **FUEL SUPPLY SYSTEM WITH PRESSURE REGULATOR**

[75] Inventors: **Frank E. La Flame**, Dayton; **William L. Sones**, Kettering, both of Ohio

[73] Assignee: **General Motors Corporation**, Detroit, Mich.

[22] Filed: **Nov. 3, 1972**

[21] Appl. No.: **303,483**

[52] **U.S. Cl.** **123/136**, 338/42

[51] **Int. Cl.** **F02m 51/00**

[58] **Field of Search** 338/42; 123/136

[56] **References Cited**

UNITED STATES PATENTS

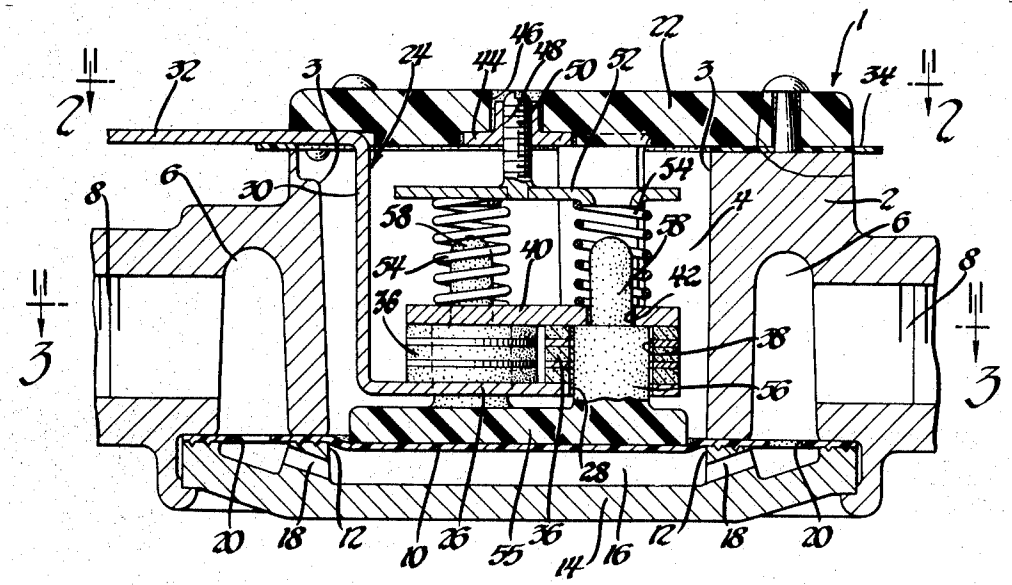
2,431,006	11/1947	Wolfe	338/42
2,474,662	6/1949	Fuller	338/42
2,515,867	7/1950	Fuller	338/42
2,633,146	3/1953	Witt	123/136 X
3,357,687	12/1967	Vanderpoel	123/136 X

Primary Examiner—J. V. Truhe
Assistant Examiner—David A. Tone
Attorney, Agent, or Firm—Paul Fitzpatrick

[57] **ABSTRACT**

A fluid pressure regulator to control the pressure of fuel pumped by an electric motor fuel pump. Carbon piles are sandwiched between two conducting plates in series with the fuel pump motor; springs cause the conducting plates to compress the carbon piles between them; and a chamber in the fuel line downstream from the pump has a flexible diaphragm linked to one of the conducting plates to vary the pressure on the carbon piles inversely with the pressure in the fuel line.

1 Claim, 4 Drawing Figures



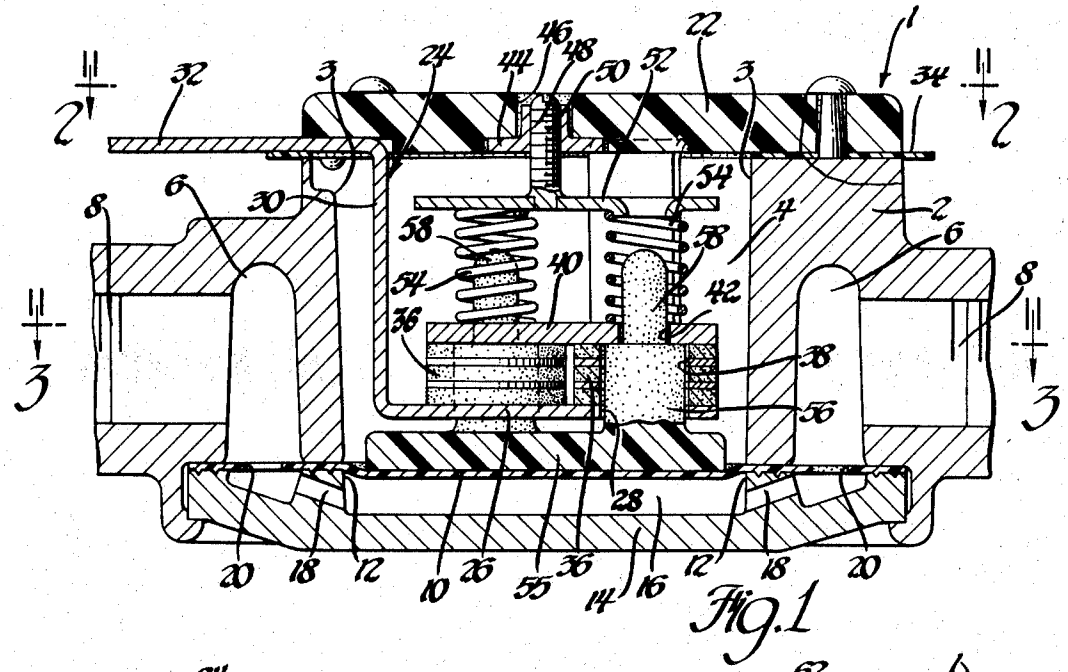


Fig. 1

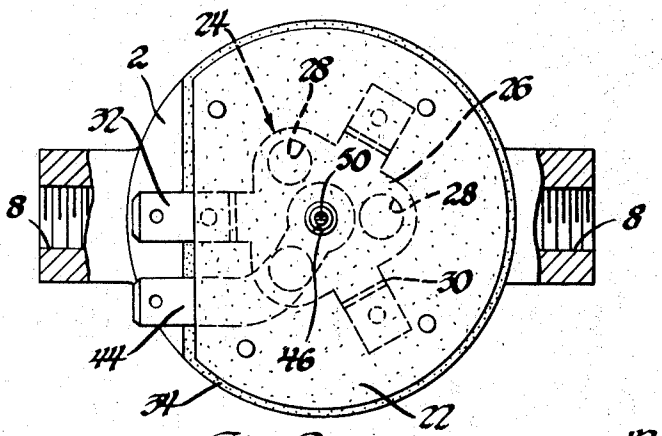


Fig. 2

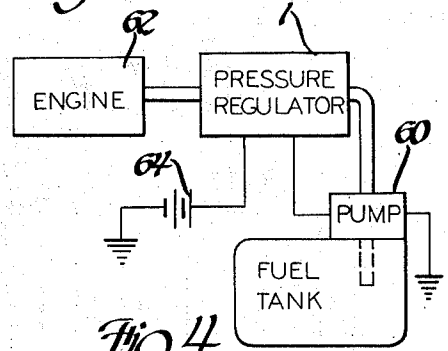


Fig. 4

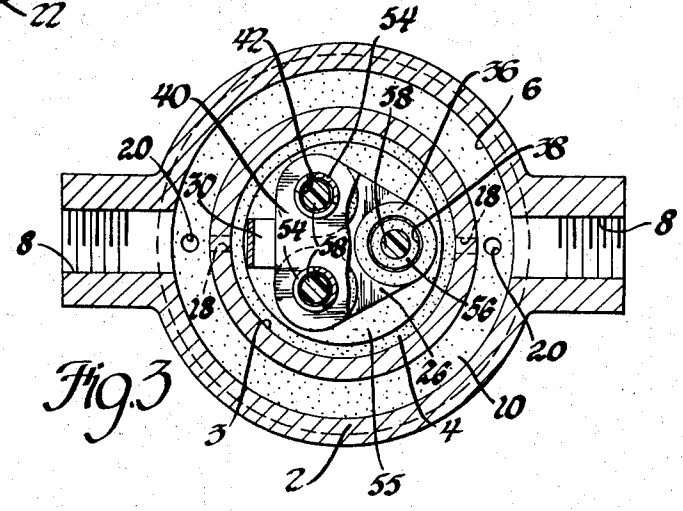


Fig. 3

FUEL SUPPLY SYSTEM WITH PRESSURE REGULATOR

SUMMARY OF THE INVENTION

My invention relates to the pressure regulation of fluid pumped by an electric motor pump. It has specific application to the fuel supply line of a vehicle engine, where constantly changing engine speed and load conditions require a changing fuel flow rate at a substantially constant fuel pressure. My device uses a carbon pile as a variable resistor to control speed of the fuel pump electric motor and a flexible diaphragm to transmit the pressure of the fuel line to the carbon pile and vary its resistance accordingly. The flexible diaphragm and carbon pile are elements which are easy and inexpensive to manufacture and reliable in operation; my device is therefore well suited for manufacture and use in the motor vehicle industry. Further features and advantages of my invention can be seen in the accompanying description and drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of the preferred embodiment of my invention.

FIG. 2 is a view along line 2—2 in FIG. 1.

FIG. 3 is a view along line 3—3 in FIG. 1.

FIG. 4 shows my invention connected in an engine fuel system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a pressure regulator 1 has a housing 2 with a generally cylindrical internal wall 3 defining a central chamber 4. The housing 2 also contains a fuel flow chamber 6, which is open at the bottom of the housing 2 and connects with openings 8 threaded for connection with the fuel line. An expansible chamber motor comprising a flexible diaphragm 10 is sandwiched tightly between the internal wall 3 of housing 2 and the matching raised wall 12 of a lower cover plate 14 which is secured to the bottom of the housing 2. The flexible diaphragm 10 and lower cover plate 14 define a fuel pressure chamber 16, which communicates with the fuel flow chamber 6 through fuel flow ducts 18 in the lower cover plate 14 and holes 20 in the flexible diaphragm 10.

The top of the central chamber 4 is closed by an upper cover plate 22 of non-conducting material. A stationary conductor 24 is positioned within the central chamber 4. This stationary conductor 24 consists of a flat, horizontal, generally triangular plate 26 containing three circular holes 28, as seen in FIG. 2, and supported near the flexible diaphragm 10 by three vertical supporting strips 30, the upper ends of which are fixed to the upper cover plate 22. One of the vertical strips 30 extends between the upper cover plate 22 and housing 2 to form a terminal 32; and an insulating gasket 34 insulates the terminal 32 and any other portion of the stationary conductor 24 from the metal housing 2.

One or more carbon piles 36 are positioned against the top of the horizontal plate portion 26 of the stationary conductor 24. In this embodiment three such carbon piles 36 are used, one centered on each hole 28 in the triangular plate 26. Each carbon pile 36 consists of a horizontal stack of sheets of a carbon material such as graphite, the resistance of which measured vertically

across the stack varies inversely with the pressure exerted vertically across the stack, since the contact between each two neighboring sheets improves with increasing pressure across them. Each stack is formed with a vertical hole 38, as seen in FIG. 3, which is coaxial with, and has substantially the same diameter as, one of the holes 28 in the stationary conductor 24. Against the top surfaces of the carbon piles 36 is positioned a movable conducting plate 40, which has holes 42 which are coaxial with, and smaller than the holes 28 in the stationary conductor 24.

A second terminal 44 disposed just underneath the cover plate 22 extends from the center of the cover plate 22 out between it and the insulating gasket 34. The center of the upper cover plate 22 contains a hole 46 into which a portion of the terminal 44 projects; and at this point the terminal 44 contains a vertical hole 48 in which is threadably mounted a screw 50, which can be adjusted from outside the regulator 1. The lower end of the screw 50 engages, but is free to rotate with respect to, an adjustable conducting plate 52. Disposed between the adjustable conducting plate 52 and the movable conducting plate 40 are a plurality of coil springs 54, one of which is coaxial with each of the holes 42 in movable conducting plate 40. The coil springs 54 and the screw 50 are made of conducting materials so that a current flow path is established between terminals 32 and 44 which includes the screw 50, adjustable conducting plate 52, springs 54, the movable conducting plate 40, the carbon piles 36 and the stationary conductor 24.

The top of the flexible diaphragm 10 is engaged by an actuator 55, made from a non-conducting material, which has a plurality of cylindrical stops 56, one of which projects through each of the larger diameter holes 28 and 38 in the stationary conductor 24 and carbon pile 36, respectively, but abuts the movable conducting plate 40 at the corresponding smaller diameter hole 42. A smaller diameter finger 58 projects upward coaxially from each of the cylindrical stops 56 through the corresponding hole 42 in the movable conducting plate 40 into the coil spring 54. The actuator 55 converts fluid pressure on the flexible diaphragm 10 into an upward force on the movable conducting plate 40 acting with the force of the compressed carbon piles 36 in opposition to the downward force exerted on the movable conducting plate 40 by the springs 54.

Referring to FIG. 4, the pressure regulator 1 is connected as part of the fuel line between the electric fuel pump 60 and the engine 62 so that the fuel must pass through the fuel pressure chamber 16. The pressure regulator is electrically connected by terminals 32 and 44 in series with the electric current source 64 and the fuel pump 60. The combination forms a feedback control system.

In operation, fuel is pumped by the fuel pump 60 through the fuel pressure chamber 16; and the fluid pressure of this fuel is exerted on the bottom of the diaphragm 10. The upward force on the diaphragm 10 due to this pressure is transmitted by the actuator 55 to the movable conducting plate 40 and is added to the expansion force of the compressed carbon piles 36 to be balanced against the downward force exerted by the springs 54. Assuming an equilibrium pressure within the fuel pressure chamber 16, an increase in this pressure causes a slight upward movement of the movable conducting plate 40 which greatly reduces the pressure

across, and consequently increases the resistance of, the carbon piles **36.** The increased total resistance of the carbon piles **36** causes less current to flow to the electric fuel pump **60** for a slower fuel pumping rate which causes a decrease in fluid pressure within the fuel pressure chamber **16** toward the equilibrium pressure. Conversely, a decrease in the fluid pressure within fuel pressure chamber **16** allows the springs **54** to move the movable conducting plate **40** slightly downward and thus greatly increase the pressure on the carbon piles **36.** This decreases the resistance of the carbon piles **36** and causes the pump current to increase, the fuel pumping rate to increase and the fluid pressure within fuel pressure chamber **16** to increase back toward the equilibrium pressure. The device, in conjunction with the electric fuel pump, tends to maintain a substantially constant fluid pressure within the fuel pressure chamber **16,** which results in a substantially constant fuel pressure in the fuel line. The desired pressure within the fuel pressure chamber **16** can be set by means of the screw **50,** which is slotted on the outside of the regulator for receiving a screwdriver to adjust the force exerted in the movable conducting plate **40** by the springs **54.**

We claim:

1. An engine fuel supply system including a fuel tank, an electric motor fuel pump for pumping fluid from the tank to the engine, a source of electric current and a fluid pressure regulator, the fluid pressure regulator comprising:

a housing;

a stationary conducting plate in the housing, the stationary plate having a plurality of holes therethrough;

a movable conducting plate in the housing substantially parallel to the stationary conducting plate, the movable conducting plate having a plurality of holes axially aligned with, and of smaller diameter than, the holes in the stationary conducting plate;

a plurality of carbon piles sandwiched between the conducting plates in electrical contact therewith, each carbon pile having a hole axially aligned with, and of larger diameter than, a hole in the movable conducting plate, each carbon pile being connected through the conducting plates in parallel with each other and in series with the electric motor fuel pump and the source of electric current to vary the speed of the electric motor fuel pump inversely with the resistance of the carbon piles;

a plate in the housing adjustable with respect thereto, the adjustable plate being substantially parallel to the movable plate;

a plurality of coil springs between the adjustable and movable plates, each of the springs being axially aligned with a hole in the movable plate;

an actuator having a plurality of stops projecting therefrom, each of the stops projecting through holes in the stationary conducting plate and carbon pile and abutting on the movable conducting plate, each of the stops having a finger projecting therefrom through one of the holes in the movable conducting plate and coaxially within one of the coil springs to anchor the spring;

and an expansible chamber motor in the housing through which fuel is pumped on its way to the engine, the expansible chamber motor comprising a flexible diaphragm, the flexible diaphragm biasing the actuator against the movable conducting plate in opposition to the coil springs to vary the pressure across each carbon pile inversely with the pressure in the fuel line and thereby vary the resistance of the carbon piles.

* * * * *