United States Patent [19]

Igarashi et al.

[11] **3,871,797**

[45] **Mar. 18, 1975**

[54] **FUEL PUMP FOR AUTOMOBILES**

[75] Inventors: **Osamu Igarashi; Yukio Hohsho,** both of Katsuta, Japan

[73] Assignee: **Hitachi, Ltd.,** Tokyo, Japan

[22] Filed: **Mar. 20, 1973**

[21] Appl. No.: **343,037**

[30] **Foreign Application Priority Data**

Mar. 22, 1972 Japan 47-28161

[52] **U.S. Cl.** .... **417/423,** 415/53 T, 415/106, 415/199, 415/213

[51] **Int. Cl.** **F04b 17/00**

[58] **Field of Search** .... 417/423, 365, 366; 415/104, 106, 53 T, 199 T, 213 T

[56] **References Cited**

UNITED STATES PATENTS

1,619,286	3/1927	Burks	415/213 T
3,160,108	12/1964	Sence	415/106
3,180,267	4/1965	Bemmann et al.	417/365
3,259,072	7/1966	Carpenter	415/213 T
3,395,853	8/1968	Zoehfeld	417/423 R
3,418,991	12/1968	Schultze et al.	417/423 R
3,545,890	12/1970	Hubbard et al.	417/423 R
3,658,444	4/1972	Rhodes et al.	417/423 R
3,676,025	7/1972	Schultze et al.	417/423
3,720,372	3/1973	Jacobs	415/52 T

Primary Examiner—C. J. Husar
Attorney, Agent, or Firm—Craig & Antonelli

[57] **ABSTRACT**

As electric fuel pump for automobiles suspended in a fuel tank, use is made of a vortex pump comprising a casing having an annular groove and an inlet port and an outlet port respectively provided at both ends of said annular groove, and a D.C. motor driven runner arranged opposite to said casing and having a plurality of chambers annularly disposed at an end face of the runner divided by radially extending vane portions, wherein the outlet port of said pump and the backside of the runner are communicated with each other to act the output fuel pressure of the pump on the backside of the runner and thereby to receive thrusts acting on the runner and maintain a gap between the runner and the casing constant.

7 Claims, 6 Drawing Figures

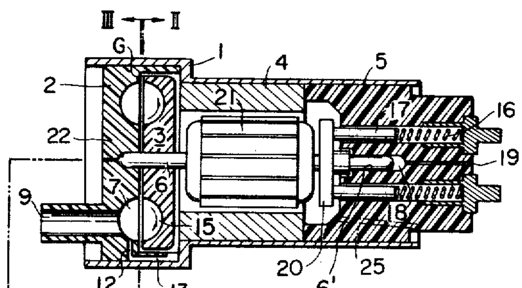


FIG. 1

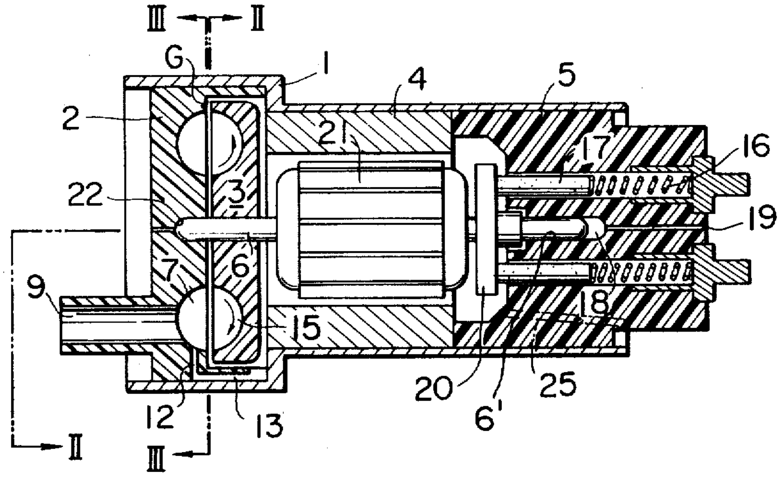


FIG. 2

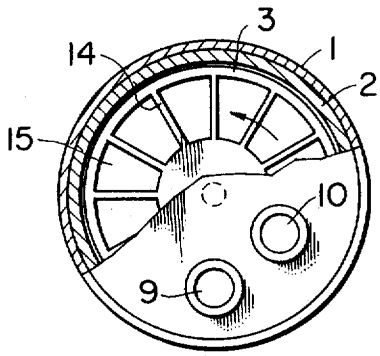


FIG. 3

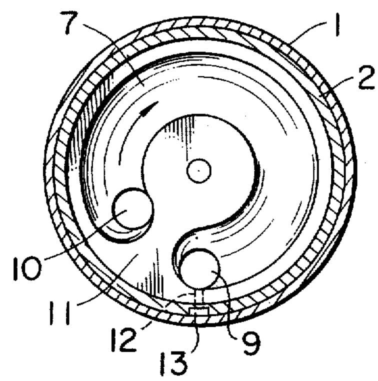


FIG. 6

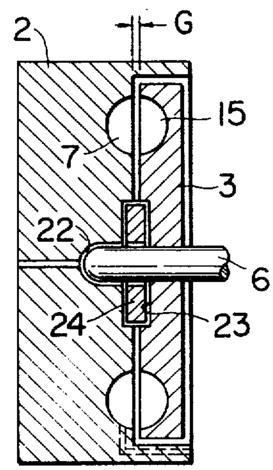


FIG. 4

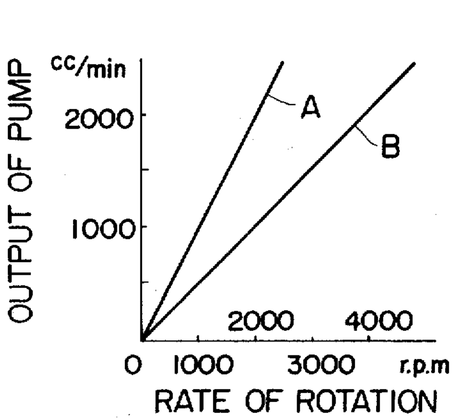
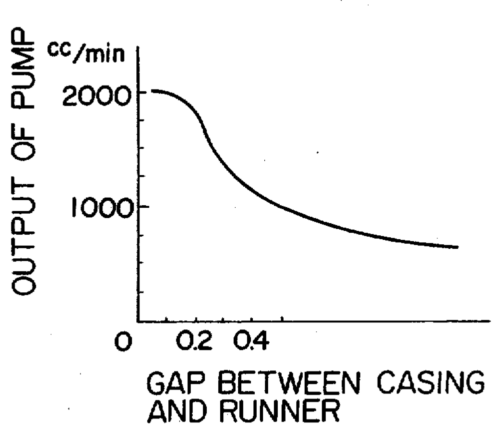


FIG. 5



FUEL PUMP FOR AUTOMOBILES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an electric motor driven fuel pump for automobiles which is suspended in fuel in a fuel tank of automobile.

2. Description Desription of the Prior Art

As this type of fuel pump, a peripheral pump has generally been used (see, for example, U.S. Pat. No. 3,418,991). The peripheral pump is advantageously used as a suspended-type fuel pump because it is small in size and inexpensive and provides a relatively high flow rate of fuel, but on the other hand, has the disadvantage that the rotational speed of the pump for obtaining the necessary flow rate of fuel is as high as 4,000 - 5,000 r.p.m. and noises accompained by keen metallic sounds are generated during operation.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a small-sized, inexpensive fuel pump operating at a low noise level and capable of discharging fuel at the necessary rate.

The feature of the present invention resides in the use of a vortex pump as fuel pump, which is so arranged that the thrusts occurring in the pump runner incident to pumping action is received by the output fuel pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view of one embodiment of the fuel pump according to the present invention;

FIG. 2 is an end view of the fuel pump partially in section taken on the line II—II of FIG. 1;

FIG. 3 is a sectional view of the fuel pump taken on the line III—III of FIG. 1;

FIG. 4 is a graph showing in comparison the characteristics of a vortex pump and a peripheral pump;

FIG. 5 is a graph showing the relationship between the gap between the casing and runner of the vortex pump and the pump output; and

FIG. 6 is a vertical sectional view of the essential portion of another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described by way of example hereunder with reference to the drawings: According to one embodiment of the invention shown in FIGS. 1, 2 and 3, the fuel pump has a housing **1** enclosing the entire fuel pump, which consists of a zinc-plated iron cylinder and serves simultaneously as the yoke of a motor. This housing **1** is set at the bottom of a fuel tank. In the housing **1** are disposed a casing **2**, a magnet **4** and a bracket **5**. A runner **3** is arranged in opposed relation to the casing **2** and a shaft **6** supporting the armature **21** of the motor is press-fitted into said runner **3**. The shaft **6** is journaled in a bearing hole **22** formed in the casing **2** and a shaft **6'** on the other side of the armature **21** is journaled in a bearing hole **18** formed in the bracket **5**. Since the shafts **6, 6'** are respectively supported by the bearing holes **18, 22** of simple shape as shown, said shafts **6, 6'** and the armature **21** are slidable in the axial direction.

The casing **2** and runner **3** respectively are formed with a circumferential groove **7**, and a plurality of chambers **15** each having a semicircular cross section, which defines a doughnut-shaped space when put together. The casing **2** is provided with an outlet port **9** and an inlet port **10** communicating with the outside of the pump. The outlet port **9** is connected to the radially outer side of the groove **7** and the inlet port **10** to the radially inner side of said groove **7**. At a narrow portion between the outlet port **9** and inlet port **10** of the groove **7** is formed a land **11** by which said portion of the groove is filled and the outlet port **9** and inlet port **10** are spaced from each other.

A short channel **12** is formed in the casing **2** extending radially outwardly from a portion of the surface of the groove **7** adjacent the outlet port **9**, and this channel **12** is communicated with a channel **13** formed in the outer portion of said casing **2** in the widthwise direction. The channel **13** is communicating with the inside of the magnet **4** through the motor side of the runner **3**.

The runner **3** is provided with a plurality of chambers annularly disposed on one end face thereof and a plurality of vane portions **14** disposed at a certain interval therealong. The area of each chamber **15** defined by the adjacent vane portions **14** and outer and inner surfaces of each chamber **15** is made smaller than that of land **11**, so that the chamber **15** may be out of communication with the groove **7** at the land **11**.

The bracket **5** has disposed therein brushes **17** in contact with a commutator **20** and springs **16** respectively urging said brushes **17** into contact with the commutator **20**, and is provided with the motor bearing hole **18** at the center thereof. Further, a narrow channel **19** is provided in the bracket **5** extending axially from the outer end of the bearing hole **18** to the outside, which constitutes a fuel relief passage. Instead of forming the fuel relief passage by the bearing hole **18** and channel **19**, a separate channel **25** may be formed in the bracket **5** to release fuel directly from the pump to the outside.

The motor driven fuel pump of the construction described above will operate in fuel in the following manner:

Namely, when the runner **3** is rotated in the direction of the arrow in FIG. **2**, the fuel flows into the pump through the inlet port **10**, passes in the groove **7** in the axial direction of the motor and moves into the chambers **15** of the runner **3**. In the chambers **15**, the fuel undergoes a circumferential force imparted by the vanes **14** and a centrifugal force is created in the fuel. Thus, the fuel passes in the groove **7**, chamber **15** while spiraling therein and being pressurized incident to the rotation of the runner **3**, and reaches the outlet port **9**. Since the outlet port **9** is isolated from the inlet port **10** by the land **11**, a pressure differential occurs between the outlet port **9** and inlet port **10** and the fuel is discharged from the outlet port **9** with high pressure. The fuel thus discharged is supplied to a carburetor (not shown) through a pipe and thence to an engine in a metered quantity.

According to the vortex fuel pump of the invention, a demanded flow rate of fuel can be obtained at a relatively low speed of rotation of the pump. In FIG. **4** is shown a comparison between the characteristics of the vortex pump A of the invention and a conventional peripheral pump B. In either pump, the outer diameter of the runner is 30 mm. It will be seen that with the vortex pump of the invention a fuel supply at the rate of 2,000 cc/min normally required for automobile fuel pump can be obtained at the rate of rotation of about 2,000 r.p.m. which is about half of that of the peripheral pump at which the same rate of fuel supply is obtained. This is of great advantage in respect of noise reducing effect. Namely, the oil slashing noises generated by the runner and the noises of collision between the runner and casing due to fluctuation of the runner proper can be substantially reduced.

In the present invention, the fuel flows also into the channel **12** with high pressure and pushes the runner from the backside. During the rotation of the runner **3**, spiral flows of fuel occurs in the groove **7**, chambers **15** as indicated by the arrows in FIG. **1** and, as a reaction of these spiral flows, thrusts occur in the runner **3** urging said runner towards the motor. These thrusts are borne by the counter-acting pressure of fuel introduced on the backside of the runner **3** through the channel **12** and the biasing forces of the springs **16**. This counter-acting pressure of fuel is substantially equal to the fuel pressure in the outlet port **9**, and the force determined by the product of this fuel pressure and the backside area of the runner **3** plus the biasing forces of the springs **16** is balanced with the thrust occurring in the runner **3**, whereby the gap G between the runner **3** and casing **2** is maintained constant. In case of the vortex pump comprising a runner of about 30 mm outer diameter, this gap G is preferably within the range of about 0.1 – 0.2 mm. This is because, in this type of pump, the gap G and the pump output are in the relation shown in FIG. **5** and, if the gap G is larger than about 0.2 mm, the pump output will decrease abruptly (when the pump is rotating at 2,000 r.p.m.), whereas if the gap G is too small, the pump will become inoperative or otherwise abnormal noises will generate due to contact between the runner and casing. The occurrence of such undesirable conditions may be avoided by using thrust bearings to support the shafts **6, 6'**. However, the use of the thrust bearings which are expensive will add to the cost of the pump and diminish the primary advantageous feature of this type of vortex pump, i.e., of bearing small in size and inexpensive. These conditions may also be avoided by increasing the strength of the springs **16**, but increasing the strength is subjected to limitation by reason of increasing wear of the brushes **17** and other reasons.

According to the invention, the thrust acting on the runner can be borne by a simple construction, i.e., by leading a portion of the output fuel pressure of the pump to the backside of the runner. It is also possible by the construction to minimize the contact pressure of the brushes. Strictly speaking, the fuel, though in a very small amount, leaks from a gap between the outer periphery of the runner **3** and the casing, but the pressure of such leaking fuel is insufficiently high. The channels **12, 13** in the present invention are provided for making positive use of the fuel pressure and, therefore, must be of a certain size. For instance, when the outer diameter of the runner is 30 mm, the diameter of the channels **12, 13** are necessarily in the range of about 0.8 – 1.0 mm.

The fuel flowing into the motor from the backside of the runner discharges to the outside of the pump through the bearing hole **18** and channel **19** formed in the bracket, while cooling the motor and lubricating

the bearing portions. The construction of the invention is advantageous also in removing the metal dust resulting from wear of the brushes and thereby preventing a failure of electrical insulation. It is also to be noted that the fuel pressure acting on the backside of the runner **3** can be adjusted by the pressure relief channel **25** when said channel is provided.

For maintaining the gap G always exactly, irrespective of the non-uniformity of the component parts resulting from the maufacturing procedure and the characteristic change of the pump during use of the pump over an extended period of time, gap adjusting means, such as a washer, may be interposed between the runner and casing. Another embodiment of the invention having such means is shown in FIG. **6.** In the embodiment of FIG. **6,** a thrust washer **24** is disposed in a space defined by cutouts **23** formed in the runner **3** and casing **2.** This thrust washer is set free relative to the runner **3,** the casing **2** and the shaft **6,** but is machined in an exact thickness so as to maintain exactly the gap G between the casing **2** and runner **3.** In such construction, the force applied to the shaft **6,** i.e., the fuel pressure acting on the runner and the biasing forces of the springs, is transmitted to the casing **2** through the washer **24,** so that the binding of the end face of the shaft **6** in the bearing hole, otherwise occurring, under the strong pressure, can be avoided.

We claim:

1. A fuel pump for automobiles, suspended in a fuel tank and used for supplying fuel in the fuel tank to the carburetor of the like, comprising a casing having an inlet port and an outlet port at the opposite ends of an annular groove formed therein, a runner having formed at an end face thereof a plurality of annularly disposed chambers opposed by the annular groove said casing and having a shaft press-fitted into the center thereof, means for axially movably supporting one end of said shaft in said casing, a D. C. motor having an armature integral with said shaft, another shaft provided on that side of said D. C. motor opposite to said first shaft, means for axially movably supporting another shaft in a bracket, spring means for urging said armature towards the runner through brushes for said D. C. motor, passage means provided in the casing for leading fuel from the outlet port to the backside of the runner, and further passage means for discharging the fuel from the backside of the runner to the outside of the pump through the interior of the D. C. motor and neighboring portions of the brushes.

2. A fuel pump for automobiles, as claimed in claim **1,** wherein bearing holes of simple shapes are respectively provided in the casing and bracket as the means for supporting the shafts in said casing and bracket.

3. A fuel pump for automobiles, as claimed in claim **2,** wherein a thrust washer is disposed in a space defined by cutouts respectively formed in the confronting faces of the runner and casing at locations radially inwardly of the respective annular grooves, and the thickness of said thrust washer is selected such that the axial gaps formed between said thrust washer and said runner and casing will become equal to the adequate gap between the runner and casing at the annular grooves.

4. A fuel pump for automobiles, as claimed in claim **2,** wherein said further passage means is provided in said bracket and communicates with the bearing hole provided therein.

5. A fuel pump for automobiles, suspended in a fuel tank and used for supplying fuel in the fuel tank to a carburetor or the like, comprising a casing having an inlet port and an outlet port at the opposite end of an annular groove formed therein, a runner having formed at an end face thereof a plurality of annularly disposed chambers opposed by the annular groove of said casing and having a shaft press-fitted into the center thereof, means for axially movably supporting one end of said shaft in said casing, a D. C. motor having an armature integral with said shaft, another shaft provided on that side of said D. C. motor opposite to said first shaft, means for axially movably supporting said another shaft in a bracket, spring means for urging said armature towards the runner through brushes for said D. C. motor, passage means provided in the casing for leading fuel from the outlet port to the backside of the runner, and means for adjustaby relieving the pressure on the backside of the runner.

6. A fuel pump for automobiles, as claimed in claim 5, wherein said pressure relieving means includes a channel formed in the bracket.

7. A fuel pump for automobiles, as claimed in claim 5, wherein means are provided on said first mentioned shaft for maintaining a perdetermined gap between said runner and said casing.

* * * * *