

[54] **ELECTRIC IN-TANK FUEL PUMP**

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[52] U.S. Cl. **417/424; 417/366**

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

[58] Field of Search **417/366, 424**

[56] **References Cited**

UNITED STATES PATENTS

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Primary Examiner—C. J. Husar

[57] **ABSTRACT**

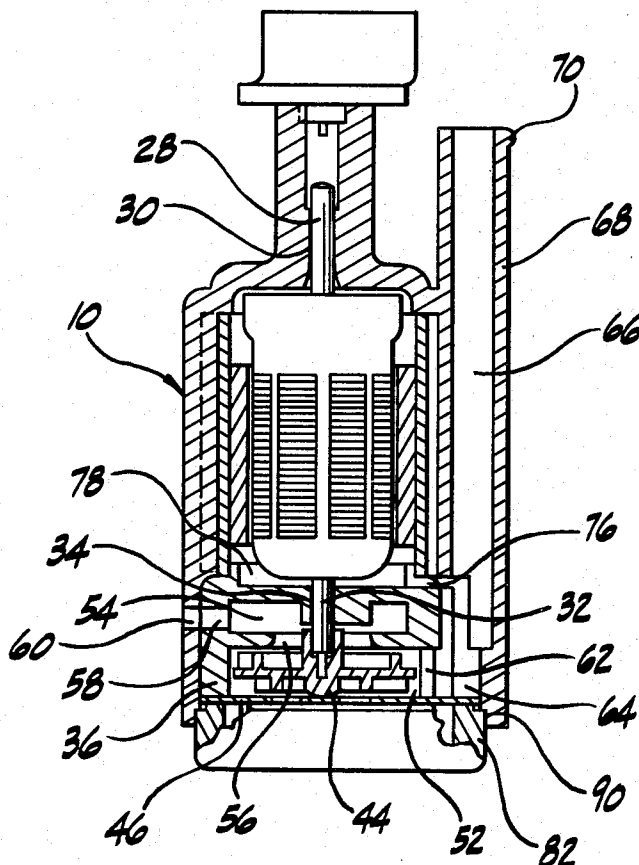
An in-tank centrifugal liquid fuel pump assembly is disclosed which comprises an outer housing enclosing

an electric motor driving a fuel pump. A fuel-pump-enclosing portion of the outer housing and a pump volute have mating tear-drop shapes which provide angular indexing of these two components relative to one another; and the volute has an indexing tab which mates with an indexing notch on a stator shell to provide angular indexing between the volute and the stator shell. This structure enables the manufacture of the pump assembly by a process of first assembling the volute, the stator shell and an armature relative to one another and then inserting this assembly into the outer housing. The outer housing has an outlet column formed thereon which extends from a salient of the tear-drop-shaped pump portion of the housing, parallel to an armature axis, for conveying fuel from the pump to an attached fuel line. An auxiliary fuel-flow passage is provided through an armature cavity to outside the fuel pump assembly.

The volute forms two chambers, an impeller chamber and a vapor chamber, which are coupled by a central vapor port. There is a vapor port in the vapor chamber which registers with a vapor port in the outer housing for expelling vapor flowing from the impeller chamber through the central vapor port.

A volute plate and the volute are retained in the pump portion of the housing by a retainer, which is sonic welded to the housing. The retainer forms an inlet passage and has a filter sock attached thereto for filtering fluid entering the inlet passage.

7 Claims, 7 Drawing Figures



SHEET 2 OF 3

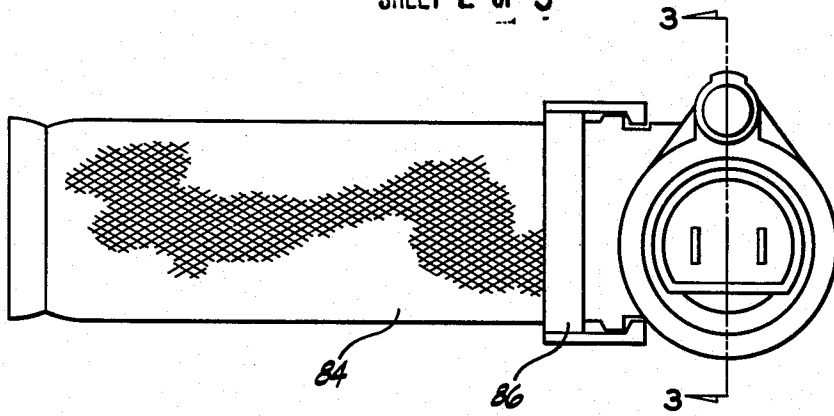


FIGURE 2.

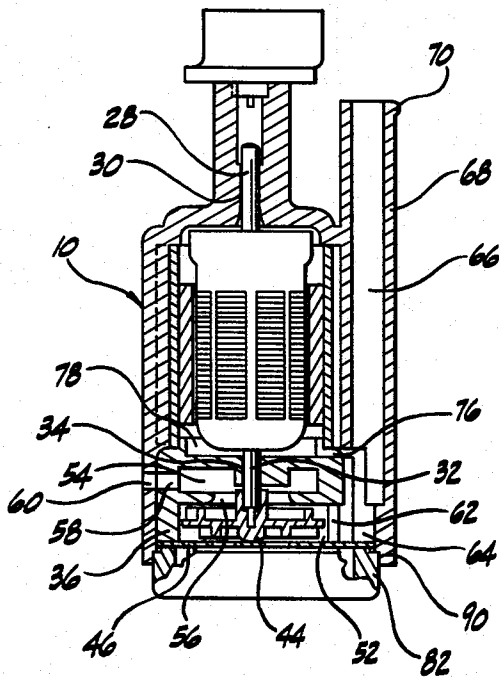


FIGURE 3.

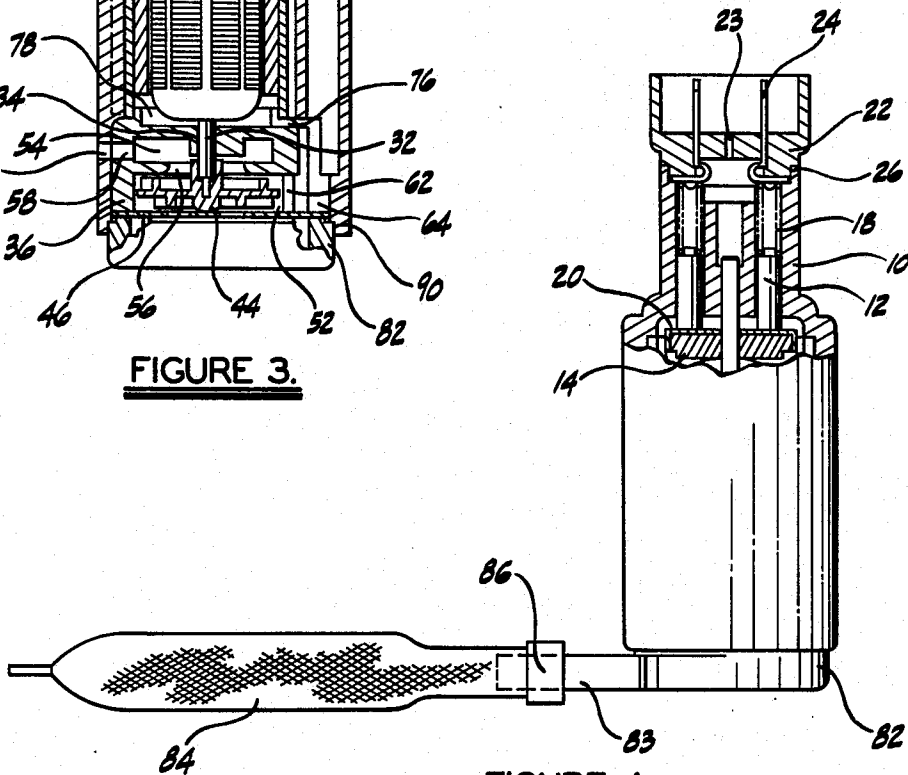


FIGURE 4.

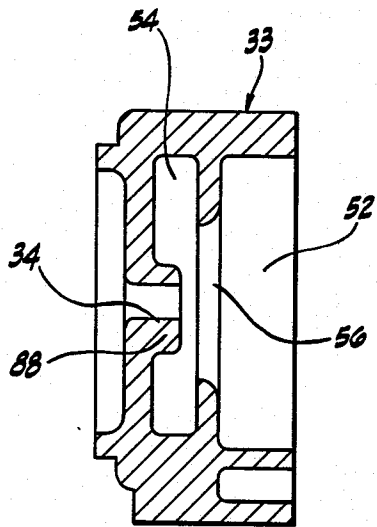


FIGURE 5.

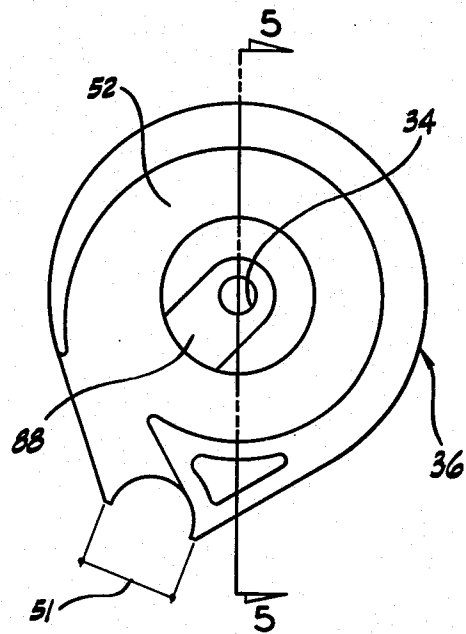


FIGURE 6.

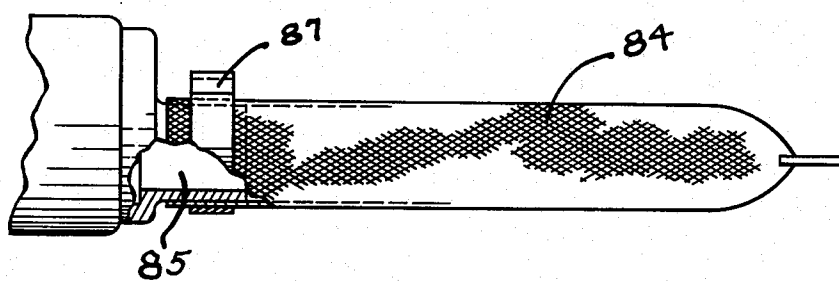


FIGURE 7.

ELECTRIC IN-TANK FUEL PUMP**BACKGROUND OF THE INVENTION**

This invention relates broadly to the art of vehicle fuel systems, and more particularly to centrifugal fuel pumps adapted to be submerged in the fuel tanks of automobiles.

Important desirable characteristics of such fuel pumps are freedom from vapor lock, compactness, efficient cooling of a pump motor, simple structure and assembly and unimpeded operation for an indefinitely long time without servicing. It is an object of this invention to meet these requirements to a greater degree than achieved by many previous in-tank fuel pumps.

A particular problem with in-tank fuel pumps is that they tend to generate vapor which can cause vapor lock or which may be pumped through fuel lines. Such pumped vapor bubbles can be especially troublesome in fuel injection systems where there is little chance to eliminate these bubbles before they are injected into compression chambers. Thus, it is an object of this invention to provide an in-tank fuel pump assembly which effectively reduces generated vapor so that it is not especially subject to vapor lock and so that it does not pump an undue amount of vapor bubbles.

Outer housings for prior-art in-tank fuel pumps have sometimes been formed of single integral members which enclose both electric motors and fuel pumps, see U.S. Pat. No. 3,418,991 to Schultz et al. and U.S. Pat. No. 3,507,582 to Jeep, Jr. et al. In both of these patents the relative angular positions of stator magnets, brushes and fuel passages must be indexed relative to one another. In Jeep, for example, this indexing is keyed to the outer housing because the outer housing forms a segment of an outlet passage which must register with a pump outlet. It is an object of this invention to provide a pump-assembly outer housing for enclosing an electric motor and a fuel pump which is relatively uncomplicated in construction, forms an outlet passage, and includes a means for easily indexing the angular positions of pump passages relative to the housing.

SUMMARY OF THE INVENTION

According to principles of this invention, in an in-tank fuel pump assembly, a fuel-pump portion of an outer housing, and a volute of a centrifugal pump, are tear-shaped so that the position of the volute is indexed relative to the outer housing. In addition, a stator shell is indexed relative to the volute by means of an indexing tab and an indexing notch. The outer housing forms an outer column which defines an outlet passage communicating with a salient of the tear-shaped pump portion and which extends parallel to the axis of a motor armature. This structure allows a method of assembly wherein the volute, the stator shell and an armature are first put together and then inserted into the outer housing, with all necessary members then being properly indexed relative to one another.

The volute forms two chambers, an impeller chamber and a vapor chamber. The vapor chamber communicates through a volute vapor port and a housing vapor port with a surrounding fuel tank, and through a central vapor port with the impeller chamber. An impeller in the impeller chamber creates a centrifugal action on liquid fuel thereby causing lighter vapor to move to the center of the impeller chamber and out through the central vapor port. This vapor then escapes to the sur-

rounding fuel tank through the volute and housing vapor ports.

The fuel pump assembly is held together by means of retainers which are sonic welded to the outer housing.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings in which reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed on illustrating the principles of the invention in a clear manner.

FIG. 1 is an exploded isometric view of a centrifugal liquid fuel pump employing principles of this invention; FIG. 2 is an end view of the centrifugal liquid pump of FIG. 1;

FIG. 3 is a sectional view taken on lines 3—3 in FIG. 2;

FIG. 4 is a partially cutaway side elevation of the centrifugal liquid fuel pump of FIGS. 1, 2 and 3;

FIG. 5 is a sectional view taken on line 5—5 of the volute shown in FIG. 6;

FIG. 6 is a plan view of a volute employed in the centrifugal fuel pump of FIGS. 1—4; and

FIG. 7 is a side elevation of a modified embodiment of this invention wherein a retainer forms an inlet passage which is parallel to a motor armature axis.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to FIGS. 1—4 there is depicted a centrifugal liquid fuel pump which comprises an outer housing 10 enclosing both an electric motor and a centrifugal liquid fuel pump.

The electric motor basically includes brushes 12, a potted armature 14, and stator magnets 16. As shown in FIG. 4, the brushes 12 are urged by coiled springs 18 against a commutator 20 of the armature 14. A terminal cap 22, supporting terminals 24, is sonic welded to the outer housing 10 at a weld line 26 to retain the springs 18 and the brushes 12 in the housing 10. The coiled springs 18 maintain electrical contact between the terminals 24 and the brushes 12. The terminal cap 22 has a terminal-cap inlet port 23 (FIG. 4) and a terminal-cap outlet port 25 (FIG. 1).

An armature shaft has a first end 28 (FIGS. 1 and 3) which is mounted in a bearing bore 30 formed by the outer housing 10, and a second end 32 which is supported by a bearing bore 34 (FIGS. 3, 5 and 6) in a volute 36 which is described below.

The stator magnets 16 (FIG. 1) are mounted on the inside surface of a cylindrical, metallic stator shell 38. The stator shell 38 defines an indexing notch 40 which faces, and meshes with, an indexing tab 42 on the volute 36.

The centrifugal liquid fuel pump basically includes the volute 36, an impeller and a volute plate 46.

The volute 36 (FIGS. 1, 5 and 6) is mounted in a pump portion 48 (FIG. 1) of the outer housing 10 and it should be particularly noted that both the pump portion 48 and the volute 36 have tear-drop shapes such that they both have salient portions, as are respectively indicated by numerals 50 and 51 (FIGS. 1 and 6).

The volute 36 defines an impeller chamber 52 (FIG. 3) and a vapor chamber 54 which are interconnected

by a central vapor port 56. A volute vapor outlet port 58 (FIG. 3) communicates with the vapor chamber 54 and registers with a housing vapor port 60; thus, the vapor chamber 54 is in communication with a surrounding fuel tank through the volute vapor outlet port 58 and the housing vapor port 60. An impeller-chamber port 62 provides communication with a salient passage 64 (FIG. 3) defined by the salient portions 50 and 51 of the tear-shaped volute 36 and the outer housing 10. The salient passage 64, in turn, communicates with a main outlet passage 66 (FIG. 3) of an outlet column 68 which is connected at an outlet end 70 thereof to a fuel line (not shown). The outlet column 68 is an integral part of the outer housing 10.

The impeller 44 is mounted on the second end 32 of the armature shaft in the impeller chamber 52. The impeller 44 has arcuate vanes 72 (FIG. 1) formed thereon which are basically the same type as described in U.S. Pat. No. 3,526,465 to Compton, and therefore, not described in detail here.

The volute 36 has a circular flange 74 (FIG. 1) which fits snugly inside the stator shell 38; however, the flange 74 has a passage notch 75 therein which communicates with the salient passage 64 (FIG. 3) so as to form an auxiliary passage 76 which leads into an armature chamber 78.

The volute plate 46 (FIGS. 1 and 3) is insertable in the pump portion 48 of the outer housing 10, behind the volute 36, and has volute-plate inlet ports 80 (FIG. 1) to allow fluid to flow into the impeller chamber 52 (FIG. 3).

The volute plate 46 is retained in position in the pump portion by means of a retainer cap 82. The retainer cap 82 forms an inlet-passage nipple 83 (FIG. 4) extending at right angles to the axis of the armature 14 for defining an inlet passage which communicates with the volute-plate inlet ports 80 (FIG. 1). A filter sock 84 (FIGS. 2 and 4) is clamped to the inlet-passage nipple 83 by means of a band or clamp 86 so as to filter fluid entering the volute plate ports 80 (FIG. 1). The band or clamp 86 can be metal or plastic, it can be shrunk in place if plastic and can be secured in any conventional manner if metal. The filter sock 84 is constructed of a polymeric mesh material which is preferentially wet by hydrocarbons such as gasoline. Such a filter, when wet, is relatively impervious to air. A nylon filter as is described in U.S. Pat. No. 2,788,125 to Edmond F. Webb, is an example of such a filter. Thus, the filter sock 84 serves not only to filter fuel, but also to establish a seal so that inlet-passage suction continues to draw fuel into the inlet passage even when a fuel level is below an inlet passage opening.

FIG. 7 depicts an embodiment of this invention wherein a retainer-cap nipple inlet passage is longitudinal with the axis of the armature 14 rather than lateral, as was the case in the device of FIG. 4. In this embodiment the filter sock 84 slips over a longitudinal integral nipple 85 and is secured in place by a band or clamp 87. In other respects the centrifugal liquid fuel pump assembly of FIG. 7 is similar to that of the assembly of FIGS. 1-6.

A reinforcing beam 88 (FIG. 6) is integral with the volute 36 so as to strengthen the volute's support of the armature shaft's second end 32 in the bearing bore 34.

To assemble a centrifugal liquid fuel pump assembly constructed according to principles of this invention, the armature 14 (FIG. 1) is first inserted into the stator

shell 38. The stator shell 38 is then brought into contact with the volute 36 such that the indexing notch 40 and the indexing tab 42 are in registry. The armature 14, the stator shell 38, and the volute 36 are then inserted into the outer housing 10 and rotated until the tear-shaped volute 36 enters into the tear-shaped pump portion 48 of the outer housing 10. This rotation provides proper registration between brushes, motor magnets, and passages. Next the impeller 44 is mounted on the second end 32 of the armature shaft. The volute plate 46 is then inserted into the pump portion 48 of the outer housing 10 so as to cover the impeller chamber 52. The retainer cap 82 is then sonic welded to the edge of the outer housing 10 at a weld line 90 (FIG. 3). The brushes 12 (FIG. 4) and coil springs 18 are inserted into the outer housing 10 and the terminal cap 22 is then sonic welded to the outer housing at the weld line 26.

In operation, electrical energy is applied to the terminals 24 and this energy is applied, via the coiled springs 18 and the brushes 12, to the armature 14. This electrical energy, in combination with the permanent magnets 16, causes the armature 14 to rotate the pump impeller 44 in a counterclockwise direction as seen in FIG. 1. Centrifugal action of the impeller on liquid fuel propels the fuel outwardly through the impeller chamber outlet port 62 (FIGS. 1 and 3), to the salient passage 64, (FIG. 3) the main outlet passage 66 and to a fuel line attached to the outlet end 70. Some fuel also travels through the auxiliary passage 76, the armature chamber 78, the bearing bore 30 (FIG. 3), the terminal-cap inlet port 23 (FIG. 4) and the terminal-cap outlet port 25 (FIG. 1) to return to a surrounding fuel tank. This fuel helps lubricate the bearing bore 30 and cool the armature 14.

Vapor bubbles, on the other hand, tend to seek an area of reduced pressure and therefore do not move outwardly and pass through the impeller-chamber outlet port 62 (FIG. 3), but rather move to the center of the impeller and pass through the center vapor port 56, the volute vapor outlet port 58 and the housing vapor port 60 to the surrounding fuel tank.

Fresh fuel is continually entering the impeller chamber 52 through the filter sock 84 (FIG. 4) the retainer-cap nipple 83 and the volute-plate inlet ports 80 (FIG. 1).

It should be understood by those skilled in the art that the centrifugal liquid fuel pump assembly described herein is relatively uncomplicated in structure and rather inexpensive to manufacture. Further, the shape of the outer housing, in conjunction with the shape of the volute, simplifies construction to a large extent by allowing easy angular indexing of parts. Further, the arrangement of the vapor ports provides an exceptionally vapor-reduced pumping performance.

While the invention has been particularly shown and described with reference to preferred embodiments, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

The embodiments of the invention in which an exclusive property or privilege are claimed are defined as follows:

1. A centrifugal liquid fuel pump assembly of the type enclosed in liquid fuel tanks comprising:

an elongated integral housing having a fluid-inlet end and a fluid-outlet end, wherein a portion of said housing at said fluid-inlet end forms a pump-enclosing portion of said housing and other portions of said housing form a motor-enclosing portion and an outlet column;

a motor armature mounted in said motor-enclosing portion of said housing for rotating about an armature axis, said armature including an armature shaft and a commutator;

motor stator magnets mounted in said motor-enclosing portion of said housing surrounding said armature;

motor brushes resiliently mounted by brush springs in said motor-enclosing portion of said housing to make contact with said commutator; and

a pump mounted in said pump-enclosing portion of said housing, said pump including a pump impeller mounted on said armature shaft for rotation therewith, said pump having an inlet port and an outlet port;

wherein said pump portion of said housing has a tear-drop shape in a plane perpendicular to said armature so as to define a salient housing portion which includes a salient passage and wherein said pump outlet port communicates with said housing salient passage; and

wherein said outlet column extends parallel to said armature axis and defines a main outlet passage which communicates with said salient passage.

2. A fuel pump assembly as in claim 1 wherein said pump comprises:

a volute which is separate from said outer housing but which has a tear-drop shape corresponding to said tear-drop shape of said pump portion of said outer housing and which fits snugly in said pump portion, said volute defining an impeller chamber and a vapor chamber, said chambers communicating with one another through a central vapor port and said volute further defines a volute vapor outlet port leading from said vapor chamber to outside said volute, and further, said pump outlet port leads from said impeller chamber to a volute salient portion in communication with said salient passage;

wherein said housing defines a housing vapor-outlet port which registers with said volute vapor-outlet port, thereby providing communication between said vapor chamber and said surrounding gas tank; and

wherein said impeller includes vanes for imparting centrifugal forces to liquid fuel located in said impeller chamber to drive said liquid fuel outwardly through said pump outlet port, but yet for allowing vapors to move inwardly to an area of less pressure, and pass through said central vapor port to said vapor chamber and thereafter to escape from said housing through said volute and housing vapor-outlet ports.

3. A liquid fuel pump assembly as claimed in claim 2 wherein said pump further comprises a volute plate having volute-plate inlet ports therein, said volute plate having a tear-drop shape and fitting snugly in said pump portion of said outer housing.

4. A liquid fuel pump assembly as claimed in claim 3 wherein is further included a retainer cap which is

sonic welded to said outer housing for retaining said volute plate and said retainer cap defining an inlet passage which communicates with said volute-plate inlet ports and which extends at right angles to said armature axis; and

a filter sock mounted to cover an opening into said inlet passage for filtering fuel entering said inlet passage and for creating a seal to enable a negative pressure at said opening to suck fuel into said opening when a fuel level is below the top of said opening.

5. A liquid fuel pump assembly as claimed in claim 3 wherein is further included:

a retainer cap which is sonic welded to said outer housing for retaining said volute plate and said volute in said pump portion of said outer housing, said volute cap defining an inlet passage for guiding liquid fuel to said volute-plate inlet ports, said inlet passage extending parallel with said armature axis; and

a filter sock covering an inlet opening into said inlet passage for filtering liquid fuel entering said inlet passage and for providing a seal to enable a negative pressure at said opening to suck liquid fuel into said inlet opening when the level of said liquid fuel is below the top of said inlet opening.

6. A liquid fuel pump assembly as claimed in claim 3 wherein:

is further included a stator shell on which said motor stator magnets are mounted, said stator shell being mounted inside said motor portion of said housing surrounding said armature;

said armature shaft has first and second ends, said first end being mounted in a first bearing bore at said fluid-outlet end of said outer housing and said second end of said shaft being mounted in a second bearing bore defined by said volute;

said liquid fuel pump assembly further includes a terminal cap which is sonic welded to said outer housing over an outer end of said first bearing bore for retaining said brush springs and brushes in said outer housing, said terminal cap including terminals which are in electrical communication with said brush springs and brushes, said terminal cap defining a terminal-cap cavity, a terminal-cap inlet port, which communicates between said first bearing bore and said terminal-cap cavity, and a terminal-cap outlet port which communicates between said inner cavity and said surrounding gas tank; and

said volute and said stator shell define an auxiliary passage leading from said salient passage to said armature chamber, whereby a liquid fuel flow is created through said armature chamber, said first bearing bore, said terminal cap inlet port and said terminal-cap outlet port to said surrounding gas tank.

7. A liquid fuel pump as claimed in claim 2 wherein: is further included a stator shell on which stator magnets are mounted, said stator shell being mounted in said motor portion of said housing surrounding said armature;

wherein, said volute and said stator shell form a tab and notch interconnection such that their angular positions relative to each other are indexed.

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