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MacManus

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[54] **SUBMERGED FUEL PUMP WITH BEVEL SIDED IMPELLER BLADES**

[75] Inventor: **Daniel C. MacManus,** Owosso, Mich.

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

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[52] **U.S. Cl.** ..... **415/213 T;** 417/423 R

[51] **Int. Cl.²** **F04D 29/24**

[58] **Field of Search** ..... 415/53 T, 198 T, 199 T, 415/213 T; 417/423 R; 416/223, 237

[56] **References Cited**

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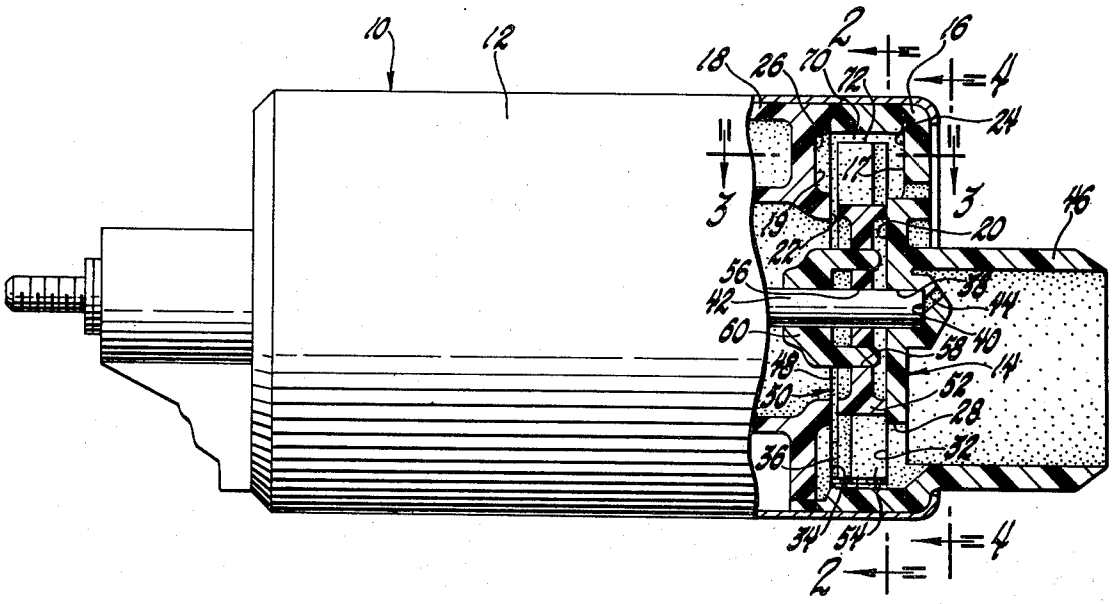
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Primary Examiner—Carlton R. Croyle
Assistant Examiner—O. T. Sessions
Attorney, Agent, or Firm—Robert M. Sigler

[57] **ABSTRACT**

In a peripheral fluid pump designed for operation submerged in a vehicle fuel tank and comprising an impeller raceway with an outer annular channel, appropriately placed stripper abutments and an inlet and outlet on opposite sides of the raceway in communication with the annular channel, an impeller in the raceway has a hub and a plurality of vanes projecting radially outward into the annular channel. Each vane has front and rear sides in the direction of impeller rotation which are parallel to the axis of impeller rotation, an inlet side adjacent the inlet side of the pump forming an acute angle with the front side and an outlet side adjacent the outlet side of the pump forming an acute angle with the rear side.

2 Claims, 4 Drawing Figures



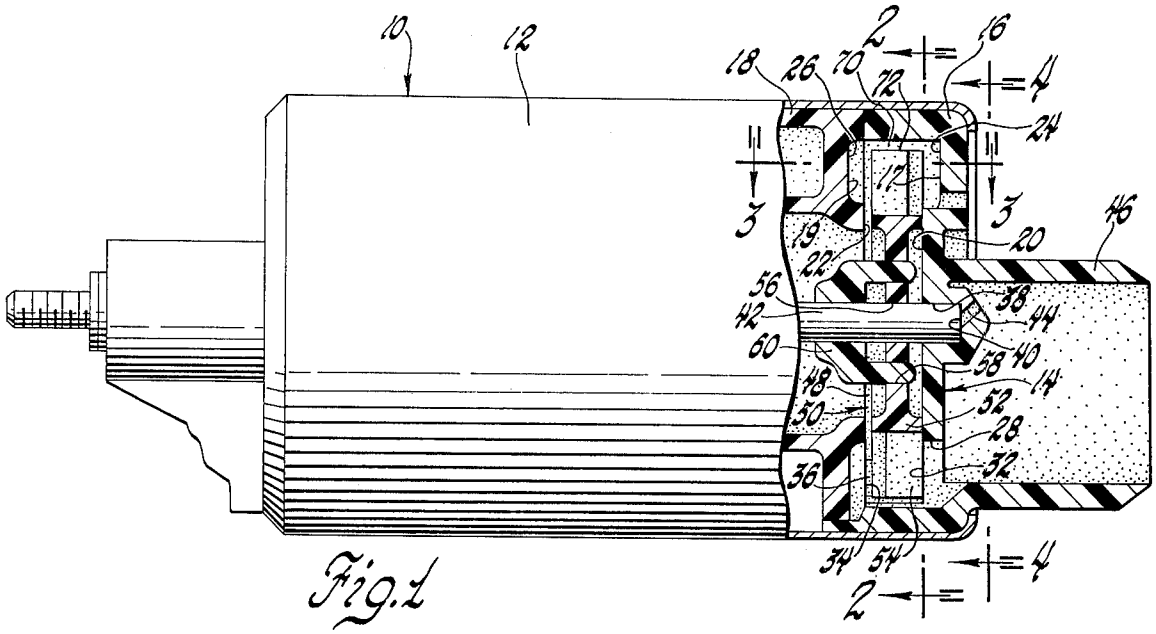


Fig. 1

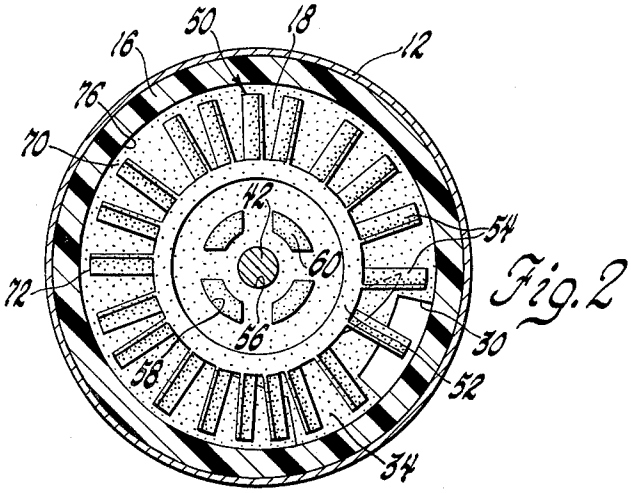


Fig. 2

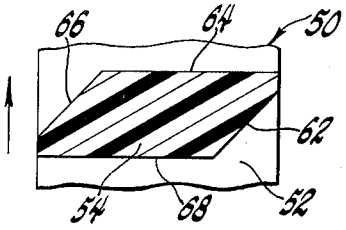


Fig. 3

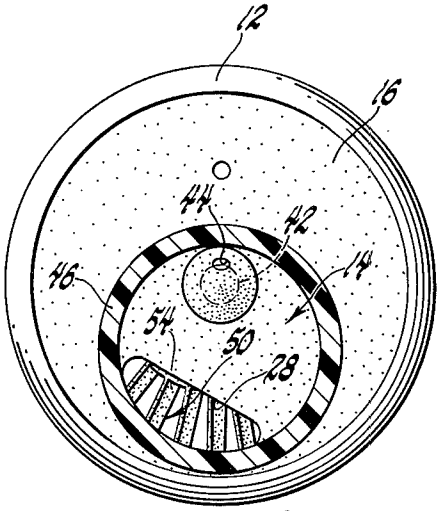


Fig. 4

SUBMERGED FUEL PUMP WITH BEVEL SIDED IMPELLER BLADES

BACKGROUND OF THE INVENTION

This invention relates generally to vehicle fuel pumps of the submerged type and particularly to peripheral pumps containing vaned rotating impellers adapted to be driven by electric motors.

Electrically driven submergible fuel pumps designed for operation in the vehicle fuel tank are well known for their decreased tendency to produce vapor lock, their dependability and the flexibility of a separate switchable power source, which enables engine operation to be automatically stopped in situations where great engine damage is threatened, such as loss of oil pressure. Of course, these advantages are not without their price; since the electric motor of such a pump is an additional element added to the vehicle fuel system which may occasionally fail.

Although the failure rate of such pumps has been quite low, improvements in the dependability or expected life of vehicle fuel pumps are always welcome, since the result of a failed vehicle fuel pump is generally an inoperable vehicle.

A more efficient fuel pump — that is, a pump that produces a greater fluid output flow at a given rotational speed — could be run at a lower speed, thus reducing wear in the pump and the electric motor for longer pump life and more dependable operation.

SUMMARY OF THE INVENTION

The pump of this invention includes an impeller having vanes whose axial sides are beveled so that a cross section of the vane forms a parallelogram with the axial side of the inlet side of the pump forming an acute angle with the front side in the direction of pump rotation and the axial side on the outlet side of the pump forming an acute angle with the rear side. The beveled blade sides have been found to contribute to greater flow efficiency through the pump and result in a greater pump output at a given rotational speed.

Further details and advantages of this invention will be apparent from the accompanying drawings and following description of the preferred embodiment.

SUMMARY OF THE DRAWINGS

FIG. 1 shows a submergible fuel pump according to this invention partially cut away to show the peripheral pump.

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

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

FIG. 4 is a cutaway view along line 4—4 in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a submergible electrically driven fuel pump **10** of the type shown in the U.S. Patent to Shultz et al. No. 3,418,991 dated Dec. 31, 1968, hereby incorporated by reference, includes a cylindrical housing **12** which contains at one axial end, a peripheral pump, generally denoted as **14.** Peripheral pump **14** comprises a cylindrical casing **16** and a cover **18,** both preferably formed of a synthetic resin material such as fiberglass reinforced acetal resin. Casing **16** and cover **18** together respectively have confronting spaced-apart side walls **17** and **19** defining lateral surfaces or annular lands **20** and **22** and outwardly extending annular channels **24** and **26,** respectively. Casing **16** has an inlet port **28** communicating with its annular channel **24,** while cover **18** has an outlet port **30** communicating with its annular channel **26.** These ports **28** and **30** are separated from each other by side stripper abutments **32** and **34,** respectively in the casing **16** and cover **18,** and a peripheral stripper abutment **36** in casing **16.** Side stripper abutments **32** and **34** are extensions of lateral surfaces **20** and **22,** respectively, and therefore are spaced apart the same lateral distance to effect fluid isolation for a seal between inlet and outlet ports **28** and **30** during operation of pump **14.**

Casing **16** is provided with a center bearing bore **38** that terminates in a bearing seat **40.** Bore **38** provides a journal support for the end of an armature shaft **42** of an electric motor, not shown, within cylindrical housing **12** which provides rotary power to pump **14.** Bearing seat **40** includes a bleed hole **44** which exhausts to a tubular shaped extension **46** of casing **16** a small amount of leakage fuel that passes between the armature shaft **42** and bore **38** to provide bearing cleansing and lubrication. Tubular shaped extension **46,** which communicates with inlet port **28,** provides an inlet storage area for incoming fuel and a mounting for a filter element, not shown, to clean the fuel as described more completely in the reference patent.

Lateral surfaces **20** and **22** define therebetween a raceway **48** which has revolvably positioned therein an impeller **50,** which may be made of the same material as casing **16** and cover **18** or of an easily die-casted metal such as aluminum. Impeller **50** includes a hub **52** that has substantially the same outer diameter as the inner diameter of annular channels **24** and **26.** Extending radially outward from hub **52** are a series of vanes **54** which have random but carefully selected variable spacings and which are disconnected from each other so that crossflow of fuel can take place between the individual vanes **54.** The random disposition of the vanes reduces pump noise.

Impeller hub **52** has a center opening **56** with slightly rounded or tapered edges for easy insertion of the end of armature shaft **42** and a series of slots **58** spaced as shown in FIG. **2** about opening **56** for reception of a driver element **60** afixed to armature shaft **42,** as shown in FIG. **1.** Driver element **60** causes impeller **50** to turn with armature shaft **42;** but the loose connection allows for slight variations resulting from manufacturing tolerances.

As can be seen in FIG. **3,** a cross section of a vane **54** forms the shape of a parallelogram. Vane **54** has an inlet side **62** on the axial side of the impeller **50** adjacent inlet port **28** which forms an acute angle with front side **64** of vane **54** in the direction of vane rotation. Likewise, vane **54** has an outlet side **66** on the axial side of impeller **50** adjacent outlet port **30** which forms an acute angle with the rear side **68** of vane **54** in the direction of impeller rotation. Front side **64** and rear side **68** are parallel to each other and to the axis of rotation of impeller **50.** Inlet side **62** and outlet side **66** are preferably, though not necessarily, parallel to one another; and the acute angle that they form with front side **64** and rear side **68,** respectively, is, in this embodiment, 45°, although the invention is not to be construed as limited to that angle only. The parallel inlet and outlet sides **62** and **66** provide an additional advantage in that, in pump assembly, impeller **50** cannot be inserted backward.

In operation, impeller **50**, in passing over inlet port **28**, creates a suction that initiates fuel flow into the spaces between impeller vanes **54** from the inlet tubular extension **46**. Due to centrifugal force the fuel is moved outwardly into an annular peripheral channel **70** defined between the peripheral edges **72** of the vanes **54** and the outer diameter **76** of the annular channels **24** and **26**. The continuing force thereon causes the fuel to move into channels **24** and **26** inwardly toward the impeller hub at the same time it is advancing peripherally in the direction of impeller rotation at a speed slower than that of the impeller **50**. It competes successfully with other fuel to re-enter the space between the impeller vanes **54** where centrifugal force again increases the energy of this fuel. Since the fuel is retained by the relatively close fits, it recirculates and spirals around the impeller **50**. As impeller **50** continues to rotate, the fuel is acted upon several times and, therefore, acquires more energy than would be imparted to it by an equivalent size centrifugal pump. This results in a desired greater pressure than that attained in an equivalent centrifugal pump. Due to this increased energy, the fuel has its pressure progressively and continuously increased as it proceeds from the inlet port **28** to outlet port **30**.

As impeller **50** passes over outlet port **30**, the fuel in annular channel **26**, as well as some of that in annular peripheral channels **70** and between vanes **54**, is pushed out through outlet port **30**.

It has been found that the angled inlet and outlet sides **62** and **66** of vanes **54** increase the fluid output of the pump through outlet port **30** at a given rotational speed of impeller **50**. It is believed that the angled inlet side **62** contributes to this by creating a larger area between inlet side **62** of one vane **54** and front side **64** of the following vane into which fuel can flow and that angled outlet side **66** contributes to this effect by imparting a direct component of axial momentum to some of the fuel in the direction of outlet port **30**.

The impeller **50** of this invention, in which front side **64** and rear side **68** of vanes **54** are parallel to the axis of impeller rotation and only inlet and outlet sides **62** and **66** are slanted, should be differentiated from an impeller in which the front and rear sides **64** and **68** are themselves slanted with respect to the axis of impeller rotation. The cross-sectional shape of the vanes of this invention is a relatively thick, stubby, strong vane which nevertheless produces the benefits of the invention. On the other hand, slanted vanes would have to be made considerably thinner than the typical 0.05 - 0.06 inch width between front and rear sides **64** and **68** of the impeller vanes **54** or the flow space between blades would become smaller and more constricted. Such thinner slanted blades would not have the strength of the vanes **54** of this invention and might be subject to an increased rate of failure which would cancel the very advantages sought.

The embodiment of this invention as described above is a preferred embodiment, but equivalents will occur to those skilled in the art. Therefor, the scope of this invention should be limited only by the claim which follows.

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

1. A peripheral fuel pump assembly comprising, in combination:

a casing having confronting spaced-apart sidewalls defining an impeller raceway with an outer annular channel and having confronting side and peripheral stripper abutments in the annular channel and inlet and outlet ports positioned one in each sidewall adjacent to and on opposite sides of the side and peripheral stripper abutments and communicating with the annular channel; and

an impeller revolvable in the raceway, the impeller having a hub and a series of vanes radially extending from the hub into the annular channel in peripherally spaced relationship to allow lateral fluid flow therebetween, each vane having front and rear sides in the direction of impeller rotation parallel to the impeller rotational axis, an axial outlet side forming a first acute angle with the rear side, which first acute angle is of such substantial size that the axial outlet side imparts to the fuel a substantial axial component of momentum toward the outlet, and an inlet side forming a second acute angle with the front side, the angled inlet side providing greater entrance area for fuel between the vanes, the second acute angle being equal in size to the first.

2. The peripheral fuel pump assembly of claim **1** in which the first and second acute angles are approximately 45°.

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