

[54] FUEL PUMP

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[58] Field of Search 415/53 T, 213 T, 168

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UNITED STATES PATENTS

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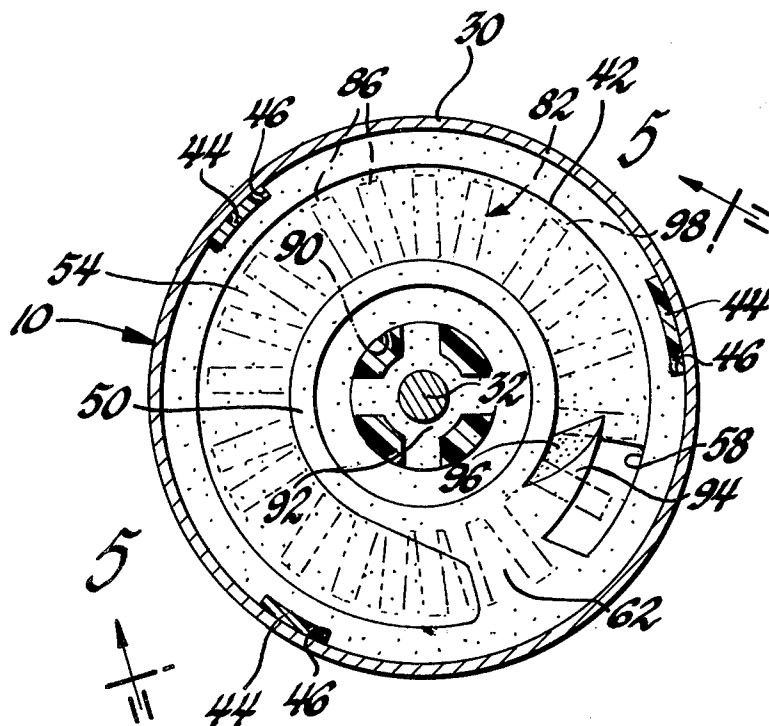
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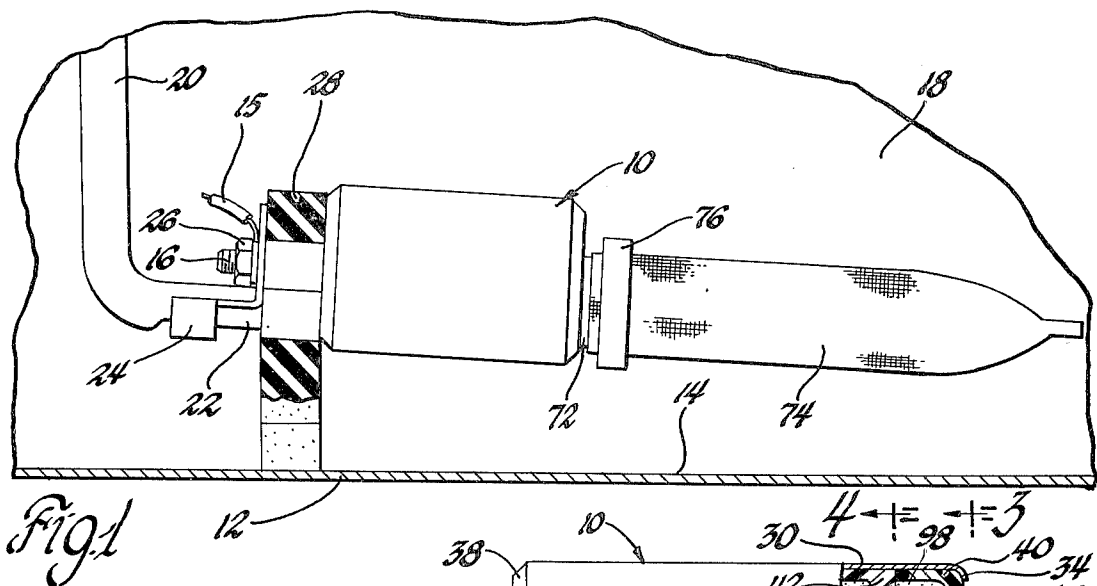
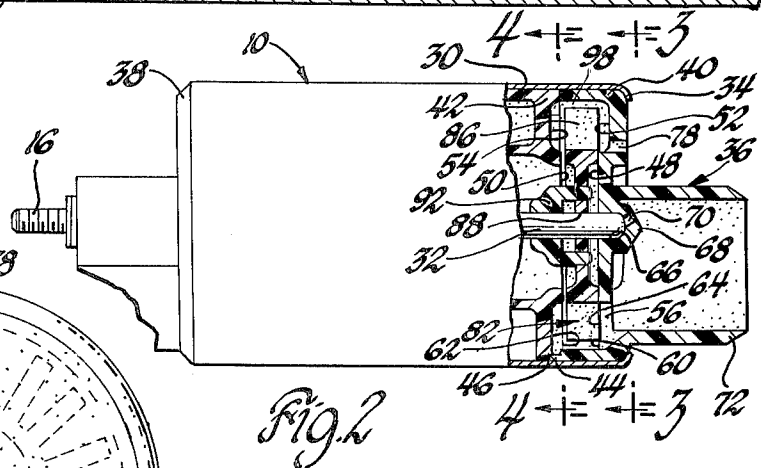
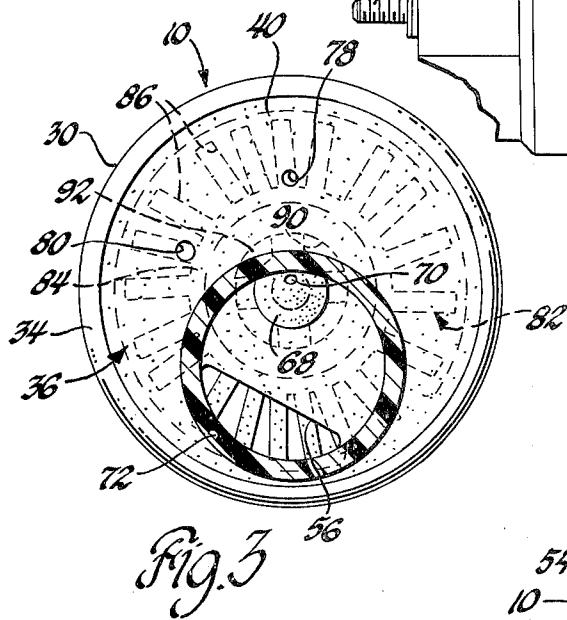
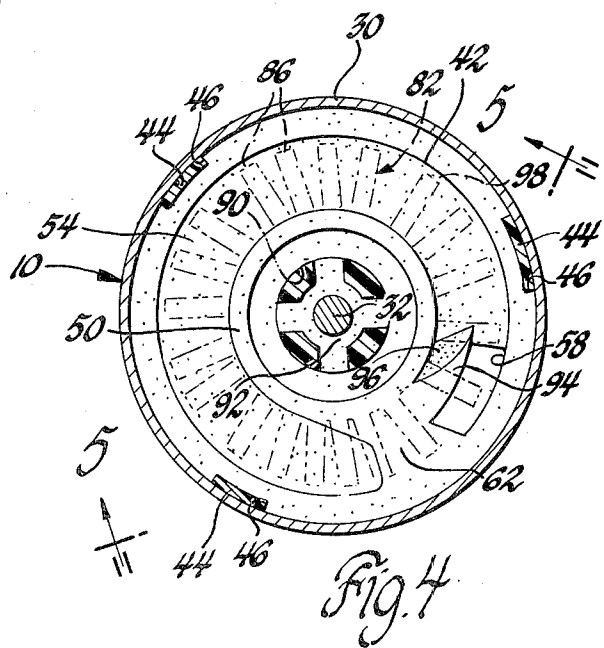
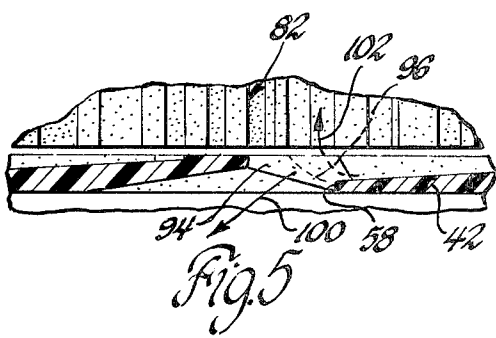
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ABSTRACT

A peripheral type fluid pump adapted to be driven by a small electric motor and the complete assembly to be inserted through the filler neck of a fuel tank for pumping fuel therefrom, including a housing of two parts comprising a casing member and a cover member which together define a circular raceway therebetween. An impeller having radially extending vane portions and a central hub portion is adapted to be supported for rotation in the raceway with the vanes extending into an annular channel through which fluid passes from an inlet in the cover member to an outlet in the casing member. Abutment means formed on the casing and cover members between the inlet and outlet guide fluid flow from the inlet through the annular passage to the outlet. Vaporous fuel is discharged from the annular passageway back into the fuel tank by two vent openings in the cover member and the abutment means on the casing member adjacent the outlet divides fluid flow into an outer fluid path leading to the outlet and an inner fluid path which is intercepted by an inclined wedge or wall portion to direct vaporous fuel back through the vanes toward the inlet and therefrom through the annular passage to the aforesaid vent openings.

2 Claims, 5 Drawing Figures





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FUEL PUMP

This invention relates to peripheral type pumps and, specifically, an improved pump adapted to pump fuel from a tank and having a relatively constant output over a large temperature range.

The subject peripheral fluid pump is an improvement over the pump disclosed in U.S. Pat. No. 3,418,991 to Schultz et al. issued Dec. 31, 1968. The Schultz patent discloses a fluid pump of the same general type which utilizes an impeller with radially extending vanes movable in an annular chamber to cause fluid to flow in a circular path from an inlet to an outlet. Specifically, the present invention modifies the outlet of the Schultz device to improve pump performance under high temperature operating conditions which are conducive to the formation of vaporous fuel in the pump. The vapor bubbles may also be formed within the inlet of the pump by the passage of gasoline through the bearings. Vapor generation substantially decreases pump performance since the vapor travels within the vane portion of the impeller and thus displaces liquid fuel to prevent the vanes from doing work on the liquid.

The Schultz patent discloses a bleed or vent hold located oppositely from the inlet of the pump. The vent hole intersects the annular pumping passage near the hub or root portion of the vanes. It discharges vaporous fuel from the annular pumping passage where it travels with the vanes. The subject improved pump also utilizes the aforementioned vent hole and, in addition, provides a second vent located midway between the inlet and the first vent hole. It has been found that the additional vent strips a substantial portion of the vaporous fuel from the pumping passage and the remainder is removed by the added vent.

The subject improved pump also has a redesigned outlet which, in combination with the aforementioned vents, reduces the problem of vaporous fuel in the pump. Specifically, the pump housing has an abutment adjacent the outlet with a central partition or wall extending into the fluid flow passage in a circumferential direction to separate the flow before it reaches the outlet into outer and inner radial flows. The outlet of the pump has been relocated in the path of the radially outer flow to discharge only that portion of the fluid. The inner fluid flow passes radially inward from the partition and is intercepted by a ramp or wedge portion of the abutment. The wedge portion directs the flow in a generally axial direction back through the vanes of the impeller toward the inlet. Since it has been discovered that generally the vaporous fuel tends to flow near the root of the vanes, the wedge directs most of the vaporous fuel through the vanes and to the aforesaid vents downstream from the inlet.

Therefore, an object of the present invention is to provide an improved peripheral type fuel pump having means for discharging a high percentage of vaporous fuel from the pumping chamber. A further object of the present invention is to provide an improved peripheral type fuel pump including partition means upstream from the pump outlet to separate the flow and direct the outer portion into a tangentially located outlet of the pump and the inner portion against an inclined ramp or wedge means for directing the vaporous fluid back through the vanes toward the pump inlet to be discharged through vent means located downstream.

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A still further object of the present invention is to provide an improved peripheral type fluid pump having an annular pumping chamber in which vane portions of an impeller are revolved to cause fluid to flow therein from an inlet to an outlet and including a partition located radially inward and upstream from the pump outlet for directing the outward portion of the fluid flow into the outlet and the inward portion against ramp means for passage axially between the vanes toward vent means located downstream.

Further objects and advantages of the present invention will be more readily apparent with reference to the following detailed description and the accompanying drawings, in which a preferred embodiment is illustrated.

IN THE DRAWINGS

FIG. 1 is a fragmentary sectional view of a fuel tank with the subject peripheral pump assembly therein;

FIG. 2 is an enlarged view of the pump assembly shown in FIG. 1 and partially sectioned to reveal interior portions of the pump;

FIG. 3 is a sectioned view of the pump taken along section line 3—3 in FIG. 2 and looking in the direction of the arrows;

FIG. 4 is a sectioned view of the pump shown in FIG. 2 taken along section line 4—4 and looking in the direction of the arrows; and

FIG. 5 is a fragmentary sectioned view of the pump taken along section line 5—5 in FIG. 4 and looking in the direction of the arrows.

Referring now to the drawings and first to FIG. 1, the numeral 10 denotes an electric fuel pump assembly mounted in and suspended from a vehicle fuel tank 12 having a wall 14. Electric power derived from a battery (not shown) is supplied through a circuit, including wire 15, to a terminal 16 (another terminal is directly behind terminal 16) to power an electric motor within the fuel pump assembly 10. The fuel pump assembly itself is supported within the interior 18 of the tank 12 by a discharge or outlet conduit 20 which extends toward the bottom of the fuel tank. The discharge conduit 20 has a tapered end at 22 which is inserted into an outlet passageway of the fuel pump assembly 10. A support member 24, welded or otherwise attached to the end 22, is connected to the other terminal (not visible) by a nut 26. This connection holds the tapered end 22 in place in the outlet passage of the fuel pump assembly 10. In addition, it electrically interconnects the other terminal (not visible) to the ground circuit of the vehicle through the outlet conduit 20.

Because the bottom of the fuel tank 12 may flex, assembly 10 may not always contact the bottom wall 14 of the tank. Therefore, a bumper 28 of a resilient material, such as rubber, is positioned on the end of the fuel pump assembly 10 and extends downwardly into engagement with the fuel tank bottom 14 to dampen any vibrations that might otherwise be transferred to the fuel pump assembly 10. The installation of the assembly 10 is made by positioning it from the fuel tank 12 so as to be just out of physical engagement with the tank bottom 14 when the tank 12 is empty. At this time the bumper 28 is initially compressed or preloaded. Then, as the tank bottom 14 moves downwardly as the tank 12 is filled, the preload is released, but the bumper still maintains contact with the tank bottom. Not only does the bumper insulate the assembly 10 from the vi-

brations of the tank bottom but also prevents the tank bottom from striking the assembly 10 when it is deflected by flying rocks or other roadway obstacles.

The details of the fuel pump assembly 10 are shown in more detail in FIG. 2. The numeral 30 designates a cylindrical housing that is made of a magnetic material, such as steel, and is treated by zinc plating so as to be relatively immune to the corrosive effects of the fuel. Positioned within housing 30 is a small DC motor (not visible in FIG. 2) having a drive shaft 32. In the end of housing 30 and against a shoulder 34 is positioned a peripheral type pump 36. The peripheral pump 36 and the adjacent motor are inserted into housing 30 sequentially so that they are coaxially aligned and in end-to-end relationship. Then the end 38 of the housing 30 is mechanically deformed to maintain the placements. For exemplary purposes, this assembly 10 has an approximate diameter of 1½ inches and is about 3¼ inches in overall length.

The peripheral pump 36 comprises a cylindrical casing member 40 and a cover member 42, both preferably formed of a non-metallic, easily moldable synthetic resin material that can withstand the corrosive effects of the fuel but still offer the strength and durability needed for a vehicle fuel pump. A fiberglass reinforced acetal resin has been found suitable. As viewed in FIGS. 2-4, the casing and cover members 40, 42 have at their periphery a number of circumferentially spaced finger and slot locaters 44 and 46. In this particular embodiment the casing 40 has fingers 44 laterally extending therefrom and the cover 42 has slots 46. This, of course, could be reversed. One of the finger and slot locaters is larger than the others so that the cover member 42 can always be aligned the same way relative to the position of casing member 40.

The casing 40 and the cover 42, respectively, have confronting spaced-apart lateral surfaces or annular lands 48 and 50 defining a raceway including radially outwardly located annular channels 52 and 54. Casing 40 has an inlet port 56 best shown in FIGS. 2 and 3, communicating with annular channel 52, while cover 42 has an outlet port 58 best shown in FIGS. 2 and 4, communicating with annular channel 54. Ports 56 and 58 are separated from each other by side stripper abutments 60 and 62, respectively, in casing 40 and cover 42, and a peripheral stripper abutment 64 on the casing 40. As depicted in FIG. 2, the side stripper abutments 60 and 62 are extensions of the annular lands 48, 50, respectively, and therefore are spaced apart the same lateral distance to provide fluid isolation or a seal between the inlet and outlet ports 56, 58, during operation of the pump 38.

Utilizing the suggested material the casing 40 itself provides a bearing for shaft 32 which is the function of a center bearing bore 66 that terminates in a conical-shaped bearing seat 68. This bore 66 provides a journal support for the end of drive shaft 32 which is connected to the armature of the electric motor. The bearing seat 68 includes a bleed hole 70 which discharges to the interior 18 of the tank fuel that passes between the end of shaft 32 and the bore 56 and thus prevents any excessive pressure buildup. This leakage of fuel provides both bearing cleansing and bearing lubrication.

The casing 40 includes a tubular-shaped extension 72 which communicates with the inlet port 56 and provides an inlet storage area for incoming fuel. The inlet storage facilitates the continuous supply of fuel to the

pump 36 during cornering and acceleration. It also serves as a support for an elongated filter element 74 shown in FIG. 1. This filter element 74 is preferably made of a mesh-like material and has a length of 6 inches or more to prevent foreign particles from entering the inlet 56. The filter element 74 may be fastened to the tubular extension 72 by a C-type clamping device 76, also shown in FIG. 1.

The casing 40 has a vent hole or opening 78 which, as best illustrated in FIG. 3, is substantially opposite the inlet port 56 and is located radially inward at the bottom or root of the annular channel 52. Another vent opening 80 is located between the vent 78 and the inlet port 56 and is also placed at the bottom or root of the annular channel 52. The vents 78, 80 extend to the exterior of the casing member 40 and, as will be explained, provide both static and dynamic vapor purging.

Revolvably positioned within the raceway which is formed between the annular lands 48 and 50 of casing 40 and cover 42 is an impeller 82, which may be made of the same material as the casing and cover members 40 and 42, or, if preferred, can be made of an easily die cast metal, such as aluminum. The impeller 82, as viewed in FIGS. 2 and 3, include a hub portion 84 that has substantially the same outer diameter as the inner diameter of the annular lands 48, 50. Vanes 86 extend from the hub portion 84 radially outward therefrom which have random but carefully selected variable spacing. Vanes 86 are disconnected from each other so that cross-sectional or axial flow of fluid can take place between the individual vanes 86 and therefore a greater volume of fuel can be pumped. This random disposition of the vanes considerably reduces the noise generated by the pump 36 because the frequencies emitted from randomly spaced vanes 86 are not the same and hence do not tend to amplify or reinforce one another.

The impeller hub 84 has a central opening or guideway 88 with slightly rounded or tapered edges for easy insertion of the end of the shaft 32. A series of slots 90 spaced as shown in FIGS. 3 and 4, about the opening 88 are adapted for reception of arms of a driver member 92 affixed to the drive shaft 32. This arrangement provides a "floating" connection that facilitates the interconnection of the end of the drive shaft 32 with the impeller 82 during assembly and also allows some wobble and axial movement of the impeller 82 to adjust to any slight dimensional variations that may result from manufacture. The driver element 92 is preferably formed of a suitable synthetic resin material that enables it to be press fitted onto shaft 32.

The side stripper abutment 62 formed on the cover 42 adjacent outlet 58, as best shown in FIG. 4, includes a partition or divider wall 94 extending circumferentially into the channel 54 upstream from outlet 58. Partition 94 divides fluid flowing in channel 54 into two portions, one being radially outward which passes directly into outlet 58 which is formed at a location radially outward from partition 94. An inclined ramp or wedge portion 96 of the abutment 62 is formed radially inward of the partition portion 94. The wedge portion directs the radially inward portion of the fluid flow back through vane members 82 in a generally axial direction toward the inlet 56 in casing 40. The inner portion of flow then passes by the vent holes 78 and 80 which discharge vaporous fuel back into tank interior 18.

In operation, the vanes 86 of impeller 82 in passing by the inlet port 56 creates a suction that initiates fuel flow into the spaces between the vanes from the inlet tubular extension 72. Due to centrifugal force, fuel is continuously moved outwardly into the annular peripheral channel 98 formed between the outer diameter of vanes 86 and the periphery of the casing 40. The force thereon by movement of the vanes causes the fuel to move from the periphery into side channels 52 and 54 (inwardly toward the impeller hub 84). At the same time the fuel advances in the direction in which the vanes are moving, but more slowly. The fuel flows from channels 52, 54 to the spaces between the impeller vanes 86, where centrifugal force is imparted to the fuel, thus increasing its energy. The fuel is retained by the relatively close fit between the impeller 82 and members 40, 42 and it recirculates the spirals around the impeller hub 96. While the impeller 82 continues to rotate, the fuel is acted upon several times by the vanes before it is discharged from channels 52, 54 and therefore acquires more energy than would be imparted to it by an equivalent size centrifugal pump whose vanes act on the fuel only once before discharge of the fuel. Due to the increased energy of this so-called regenerative or cumulative effect, the fuel has its pressure progressively and continually increased as it proceeds from inlet port 56 to outlet port 58. The close fit between the impeller 82 and the peripheral stripper abutment 64 and the side stripper abutments 60 and 62 prevents fluid flow beyond the outlet except as will be discussed presently. These abutments thus effectively provide a seal between the inlet and outlet necessary for the required pump action.

The vents 78, 80 serve two purposes during this pump operation. In describing these purposes it should be kept in mind that vaporized fuel or bubbles within the pump annular channels 52, 54 will interfere with the pumping of fuel. The vents 78, 80 are positioned as illustrated in FIG. 3, the first being located opposite inlet 56 and the second being located between the inlet and the first vent. Both vents are inwardly located substantially at the root or base of the impeller vanes 86. Thereby, the vents discharge from the annular channels 52 and 54 less dense vaporized fuel which tends to accumulate near the root or base of vanes 86. Static purging occurs even when the pump 38 is inoperative, during which time vaporized fuel can accumulate in the annular chambers 52 and 54 and may block the entrance of liquid flow upon startup. This allows the pump 38 to prime or wet itself more easily.

Vents 78, 80 also provide dynamic purging. When the pump impeller 82 is turning at operative speeds close to 4000 rpm's, there is a centrifuging of fuel which causes less dense vaporized fuel to move toward the center of the pump in the area of the vane roots or bases. Also, vaporous fuel in the form of bubbles may be emitted from the bearing bleed hole 70. As previously stated, the flow of fuel through bore 66 is necessary for bearing cooling and lubricating.

It has been observed by looking through a clear case member into the fuel pump that relatively large volumes of vaporous fluid can be stripped from the root area of the vanes by vents such as 78, 80. It was observed that liquid fuel having vapor bubbles mixed therewith tended to separate into a radially outer band or flow path and an inner path. The outer path was observed to consist of substantially liquid fuel. The inner

path consisted of a mixture of liquid and vaporous fuel.

Consequently, the present improved pump utilizes a tangential outlet port located radially outward from the middle of the channels 52, 54 to intercept only the outer flow of fuel which is substantially all liquid. The partition 94 which is located slightly upstream from the outlet 58 separates the fuel into inner and outer flows and the wedge or inclined portion 96 directs the inner flow of liquid and bubbles mixed therewith back through the vanes toward casing 40 to pass by the vents 78 and 80. These vents discharge mostly vaporous fuel back into the tank. It has been found that the vent opening 80 nearest inlet 56 will discharge most of the vapor while the other vent 78 discharges the remainder. FIG. 5 best shows the configuration and operation of the tangential outlet 58 and wedge portion 96 in discharging fuel through outlet 58 as represented by vector 100 and back through the vanes as represented by vector 102. The partition portion 94 and wedge portion 96 direct the inner flow of mixed liquid and vapor axially through the vanes 82 toward casing 40.

The subject peripheral type pump was tested under desert driving conditions and was found to provide higher operating pressures than the Schultz design when gasoline temperatures were higher than 100° F. The operating pressures delivered by the improved pump were more consistent over the observed operating range of from 80° to 120° F. than those obtained with the Schultz design pump.

Although the embodiment illustrated is a preferred embodiment, other embodiments may be adapted.

What is claimed is as follows:

1. In a peripheral fluid pump; the combination of a housing formed in two parts, including a cylindrical casing member and a cylindrical cover member which together define a raceway with a radially outward annular fluid passage means and having confronting side and peripheral stripper abutments in the annular fluid passage means; inlet and outlet ports in said casing member and said cover member, respectively, and positioned on opposite sides of the side peripheral stripper abutments and communicating with the annular fluid passage means to define a fluid flow path from said inlet port to said outlet port; an impeller within the raceway including a hub portion provided with a series of radially extending vanes attached thereto at a base portion; said hub portion having a central drive shaft guideway and drive slots therein spaced circumferentially around the guideway; the casing member having at least two vent openings communicating with the annular fluid passage means near the base portion of the vanes; the first of said vent openings being positioned diametrically opposite from said inlet port and the other vent opening being spaced in a circumferential direction downstream from said inlet port and upstream from said first vent opening whereby a portion of vaporous fluid in said fluid passage means passes through said other vent opening and another portion subsequently passes through said first vent opening; said side stripper abutment adjacent said outlet and on said cover member having partition means extending upstream from said outlet and from said stripper abutment to radially separate fluid flow in said annular fluid passage means into an inward stream adjacent to said base portion of said vanes and a radially outward stream therefrom; said outlet port being located radially outward from said partition to mostly discharge

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said radially outward stream of fluid in said annular fluid passage means; said side stripper abutment having inclined fluid directing means located radially inward from said partition means for diverting the inner stream of fluid back between said vanes for discharge of vaporous fluid through said vent openings.

2. In a peripheral fluid pump; the combination of a housing formed in two parts, including a cylindrical casing member and a cylindrical cover member which together define a raceway with a radially outward annular fluid passage means and having confronting side and peripheral stripper abutments in the annular fluid passage means; inlet and outlet ports in said casing member and said cover member, respectively, and positioned on opposite sides of the side peripheral stripper abutments and communicating with the annular fluid passage means to define a fluid flow path from said inlet port to said outlet port; an impeller within the raceway including a hub portion provided with a series of radially extending vanes attached thereto at a base portion; said hub portion having a central drive shaft guideway and drive slots therein spaced circumferentially around the guideway; the casing member having at least two vent openings communicating with the annular fluid passage means near the base portion of the

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vanes; the first of said vent openings being positioned diametrically opposite from said inlet port and the other vent opening being spaced in a circumferential direction downstream from said inlet port and upstream from said first vent opening whereby a portion of vaporous fluid in said fluid passage means passes through said other vent opening and another portion subsequently passes through said first vent opening; said side stripper abutment adjacent said outlet and on said cover member having a partition wall means extending upstream from said outlet and from said side stripper abutment into said annular fluid passage means to radially separate fluid flow in said annular fluid passage means into an inner stream adjacent to said base portion of said vanes and a radially outward stream therefrom; said outlet port being located radially outward from said partition to mostly discharge said radially outward stream of fluid in said annular fluid passage means; said side stripper abutment having inclined wall means which forms a ramp radially inward from said partition to direct the inner stream of fluid axially back through the vanes whereby vaporous fluids therein flow to said vent openings for exit discharge therethrough from said annular fluid passage means.

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