

April 1, 1947.

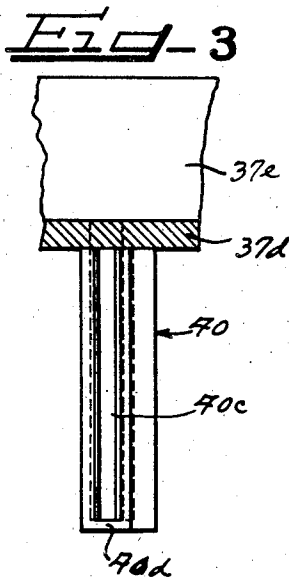
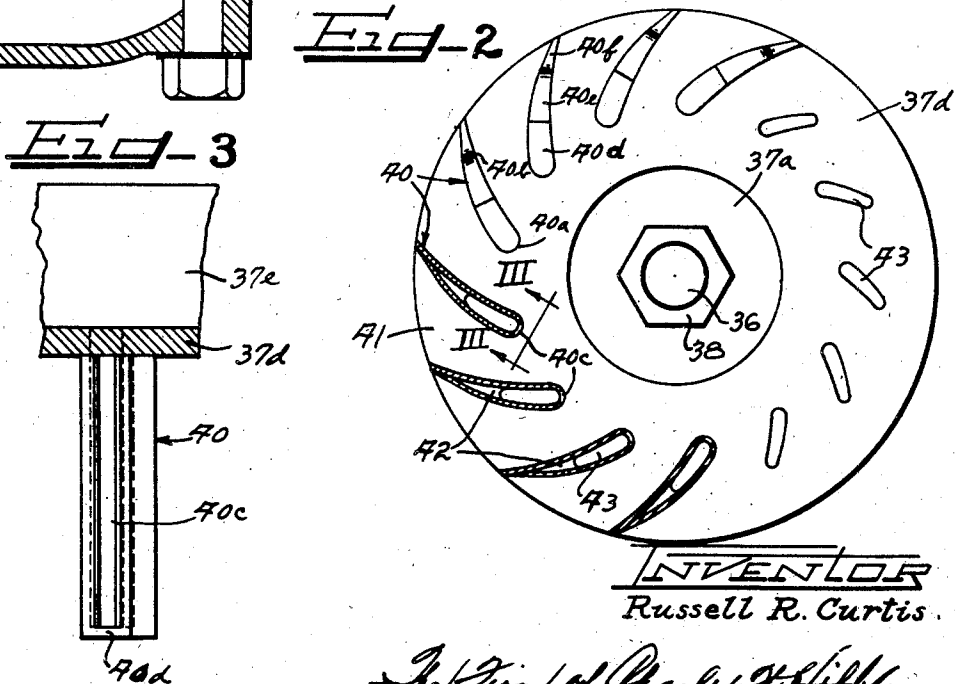
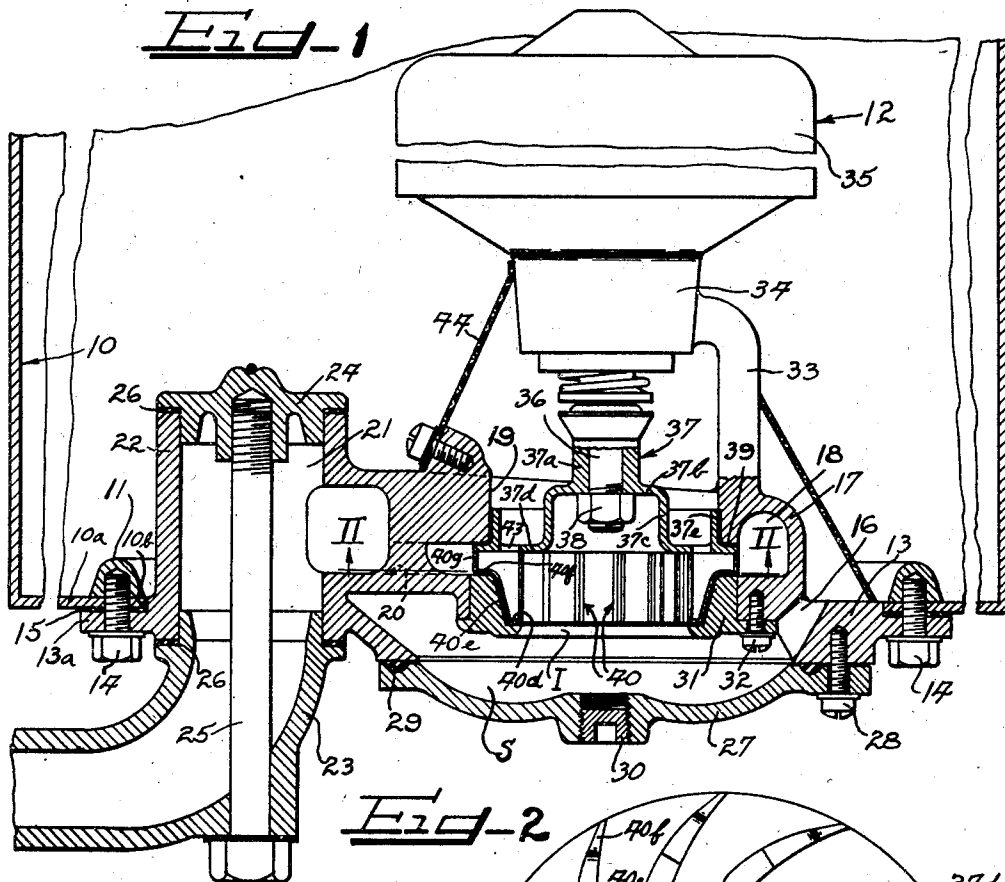
R. R. CURTIS

2,418,221

LIQUID AND VAPOR SEPARATING PUMP

Filed Oct. 30, 1944

2 Sheets-Sheet 1



INVENTOR
Russell R. Curtis.

The Sign of Charles H. Hill

April 1, 1947.

R. R. CURTIS

2,418,221

LIQUID AND VAPOR SEPARATING PUMP

Filed Oct. 30, 1944

2 Sheets-Sheet 2

Fig-4

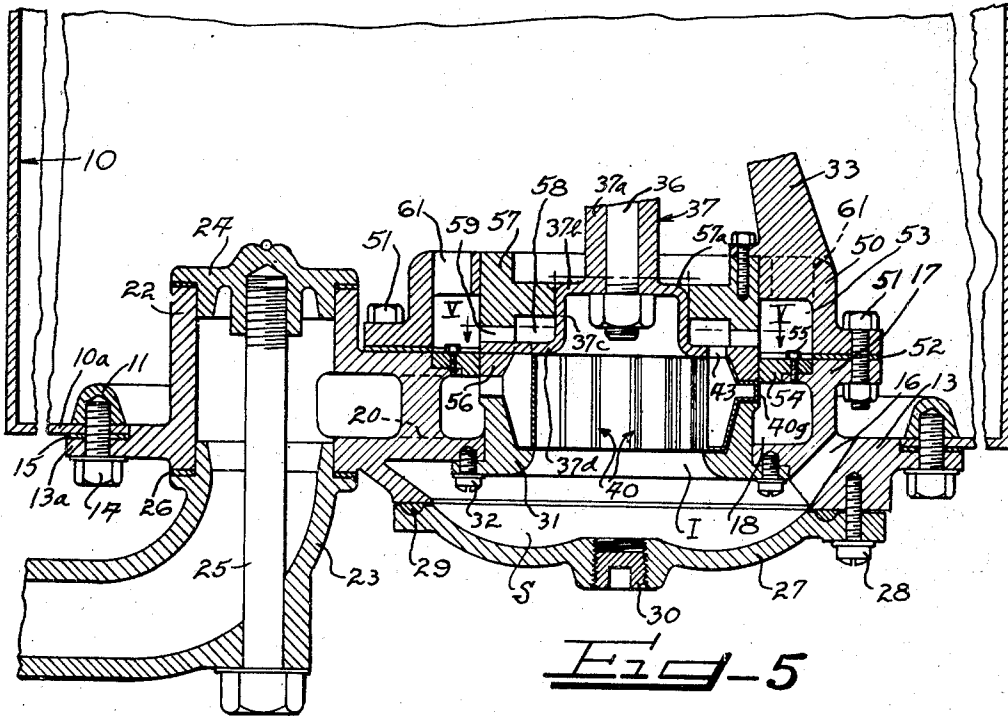
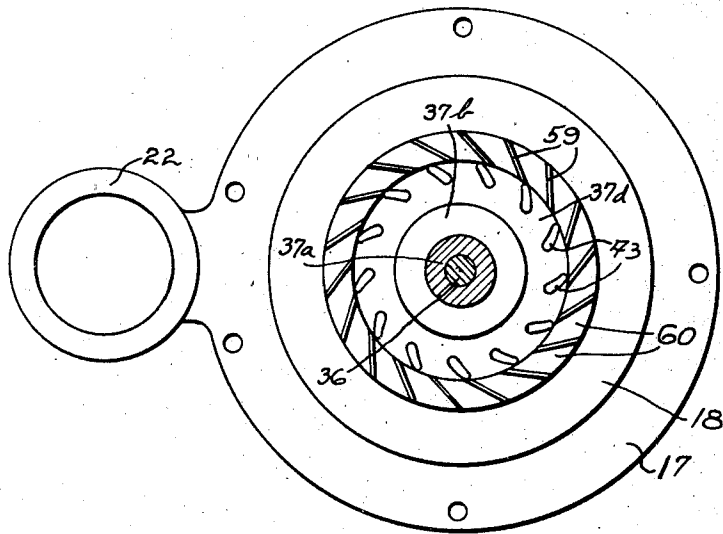


Fig-5



INVENTOR

Russell R. Curtis

The Firm of Charles H. Hill
BY HILL

UNITED STATES PATENT OFFICE

2,418,221

LIQUID AND VAPOR SEPARATING PUMP

Russell R. Curtis, Dayton, Ohio, assignor to
Curtis Pump Company, Dayton, Ohio, a corporation of Ohio

Application October 30, 1944, Serial No. 560,940

18 Claims. (Cl. 103—113)

1

This invention relates to devices for separating liquids and vapors or gases.

Specifically the invention deals with liquid and vapor-separating booster pumps especially adapted for aircraft fuel systems, to prevent vapor lock even at very high altitudes.

According to this invention, pump and motor units are provided for insertion in airplane fuel tanks. The pumps have impellers equipped with a ring of spaced pumping vanes. The inner ends of the vanes surround an axial passageway. The spaces between the vanes form pumping channels. The axial passageway is in full open communication with gasoline or other liquid contained in the tank. The vanes throw the liquid material radially by centrifugal force into a pumping chamber. This radial discharge of liquid through the pumping channels, of course, creates an outward flow from the axial passageway defined by the inner ends of the vanes. The inner ends of the vanes serve as agitators, and liberate occluded gases and vapors in the liquid contained in the passageway. The gases and vapors, being lighter than the liquid, are not thrown radially outward with the liquid by centrifugal force, but rise through the passageway.

In airplane fuel tanks which are vented to ambient air, the volatiles in the gasoline contained in such tanks vaporize as ambient air pressure is reduced when the plane climbs to high altitudes. As the climb in altitude progresses, vapor forms and gathers at the inner edges of the impeller vanes in a gradually widening ring. This widening ring of vapor can ultimately spread all the way to the outer ends of the vanes through the pumping channels between the vanes and, of course, when this occurs, the pump becomes gas-bound and fuel delivery to the airplane engine will stop.

According to this invention, however, the impeller vanes are equipped with passages for vapor-rich liquid to vent the bubbles of gas and vapor from the inner edges of the vanes, back to the interior of the tank. The vanes are preferably hollow and have slotted inner edges in full communication with the periphery of the axial passageway. These hollow vanes will collect bubbles of the gases and vapors liberated from the liquid in the axial passageway and will immediately vent the bubble-rich liquid back to the tank before any ring of vapor can form around the axial passageway. The hollow impeller vanes thus vent the gases and vapors out of the pump as soon as the gases and vapors are liberated from the liquid, and the devices of this invention are much more efficient than hereto-

2

fore-known vapor and liquid separating pumps.

It is, then, an object of the invention to provide vapor and liquid-separating devices with hollow vanes for directly venting vapors and gases out of the device as soon as the vapors and gases are liberated from the liquid acted on by the devices.

A further object of the invention is to provide an impeller for vapor and liquid separating pumps which has a plurality of pumping blades each provided with a passageway therethrough.

A still further object of the invention is to provide pump and motor units for aircraft fuel systems which more effectively separate gases and liquids than heretofore-known pumps by venting bubble-rich liquid through the pumping vanes as soon as the vanes create the bubbles.

A still further object of the invention is to provide submerged-type booster pumps with hollow impeller blades for venting gases and vapors out of the pumps.

A still further object of the invention is to provide vapor and liquid-separating pumps with centrifugal impellers having passaged blades for discharge of gases out of the pump, and means for pumping bubble-rich liquid through the blades.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of preferred examples only, illustrate two embodiments of the invention.

On the drawings:

Figure 1 is a broken fragmentary vertical cross-sectional view, with parts in side elevation, of a submerged pump and motor unit according to this invention mounted in a tank.

Figure 2 is an enlarged bottom plan view of the pump impeller taken along the line II—II of Figure 1, wherein one group of the blades is omitted, another group of the blades is shown in horizontal cross section, and a third group of blades is shown in bottom plan.

Figure 3 is an enlarged vertical cross-sectional view taken along the line III—III of Figure 2.

Figure 4 is a view similar to Figure 1, but illustrating a modified form of unit according to this invention.

Figure 5 is an enlarged top plan view of the pump casing and impeller with parts in horizontal cross section, substantially along the line V—V of Figure 4.

As shown on the drawings:

In Figure 1, the reference numeral 10 designates generally a fuel tank having a bottom wall

3

10a with a large aperture 10b therein. The tank 10 will hereinafter be referred to as an airplane fuel tank which is vented to ambient air, but it should be understood, of course, that any type of container can be used for the units of this invention.

A mounting ring 11 is mounted on the bottom wall 10a of the tank and surrounds the opening 10b.

A pump and electric motor unit 12 is submerged in the tank 10. The unit 12 has a mounting base 13 with a peripheral flange 13a therearound underlying the tank wall 10a. Cap screws 14 are passed through the flange 13a and are threaded into the mounting ring 11 to secure the mounting base 13 to the tank. A gasket 15 is interposed between the flange 13a and the bottom 10a of the tank to seal the opening 10b.

The mounting base 13 is connected through ribs such as 16 with a pump casing 17 defining an annular volute chamber 18 around a central open-ended passageway 19. The volute chamber 18 discharges through a passageway 20 into an upstanding passageway 21 defined by a tubular boss member 22 which is integral with the base 13 and is spaced laterally from the casing 17. As shown, the tubular boss 22 extends beyond the bottom of the base 13 and receives a conduit fitting 23 in the lower end thereof. A cap 24 closes the top end of the base, and a single bolt 25 is passed through the fitting 23 and threaded into the cap 24 to clamp the fitting and cap on the opposite ends of the base. Gaskets 26 are interposed between the ends of the tubular boss 22 and the cap and conduit fitting.

Liquids from the volute chamber 18 are thus propelled through the passageway 20 into the passageway 21 and thence through the conduit fitting 23 to the fuel line of an airplane fuel system. This fuel line customarily supplies the engine-driven main fuel pump of the system (not shown).

The mounting base 13 has a separate closure plate 27 secured thereon by means of cap screws 28 and maintained in sealed relationship therewith by a gasket 29. This closure plate 27 is beneath the bottom wall 10a of the tank and provides a sump S for the tank. This sump can be drained through a plug 30 threaded into the plate 27.

A throat ring 31 is secured to the bottom face of the casing 17 by means of cap screws 32, and defines an inlet I for the pump. This inlet I communicates freely with the sump S and, of course, the sump S communicates freely with the interior of the tank 10.

The casing 17 has an upstanding leg 33 thereon carrying a base 34 for a motor casing 35. The motor in the casing 35 has a drive shaft 36 extending through the base 34 and carrying the impeller 37 for the pump. The impeller 37 has a hub 37a fitting over the shaft 36 and secured on the shaft by means of a nut 38 which is threaded on the shaft. A flange 37b extends outwardly from the bottom of the hub 37a and a skirt 37c depends from the periphery of the flange 37a. The bottom of the skirt 37c merges into an outturned flange 37d which projects into an annular gap 39 connecting the passageway 19 with the volute chamber 18. The gap 39 is provided immediately above the throat ring 31.

An upstanding collar 37e is provided on the flange 37d. This collar has close-running clearance with the wall defining the passageway 19.

4

Hollow blades or vanes 40 depend from the flange 37d. These vanes are arranged in spaced parallel relationship as best shown in Figure 2, and have inner ends surrounding a central chamber that has full open communication with the pump inlet I. The vanes are thus arranged in the form of a ring around a central passage in full open communication with liquid in the tank.

Each vane 40 has a streamlined contour with a rounded inner edge 40a and a tapered tail 40b. The vanes are curved to provide good pumping vanes for a centrifugal type pump, and pumping channels 41 are provided between the vanes.

The rounded inner edge 40a of each vane has a slot 40c extending from the bottom to the top thereof, as best shown in Figure 3. The vanes preferably have bottom walls 40d closing the bottoms of the slots 40c and overlying the throat ring 31 in closely spaced relation.

While the inner ends 40a of the vanes extend along a straight vertical path, the outer ends of the vanes, as best shown in Figure 1, diverge outwardly from the relatively narrow bottoms 40d along sloping wall portions 40e to outturned flanges 40f overlying the throat ring 31 as best shown in Figure 1. These flanges 40f thus extend into the gap 39 and upstanding walls 40g connect the flanges 40f with the peripheral portion of the flange 37d. The vanes thus have elongated inner edges, and increase in width from their bottom ends to wide top portion which project through the gap 39 to the volute chamber 18.

Each hollow vane 40 has a chamber 42 therein extending from the top to the bottom thereof and open along its length through the slot 40c.

The flange 37d has slots 43 therein aligned with the open tops of the chambers 42. These slots 43 are inwardly of the collar 37e, as shown in Figure 1. Passageways are thus provided through each vane 40 connecting the inner edge 40a thereof with the top portion of the passageway 19 thereby venting the inner edge of each vane to the side of the pump casing opposite the inlet I thereof.

A screen 44 surrounds the pump unit, to prevent flow of solid material into the pump.

The unit of Figures 1 to 3 thus receives screened liquid from the tank 10 into the sump S thereof, and liquid from this sump S flows freely through the pump inlet I into the chamber surrounded by the pumping vanes 40. These pumping vanes centrifugally discharge the liquid into the pumping chamber or volute chamber 18 and thence through the passageway 20 into the passageway 21 and conduit fitting 23. The liquid is thrown by centrifugal force through the pumping channels 41 between the vanes 40 into the pumping chamber 18.

The inner ends 40a of the vanes 40 agitate the liquid in the chamber provided above the inlet pump I. The liquid at the inner ends of the pumping chambers, being under the influence of centrifugal force, is at somewhat of a reduced pressure, so that volatiles in the liquid about to be vaporized will be liberated in bubble form, due to the decreased pressure, while vapors or gases otherwise entrained in the liquid will be formed into bubbles by the agitating action of the inner ends of the vanes. As soon as the bubbles are formed, the bubble-rich liquid will pass through the slots 40c into the vane chambers 42 and, being lighter than the surrounding solid liquid, the bubble-rich liquid will flow through the slots 43 into the passageway 19 and out of the open top of the pump. Individual

5

flow passages thus vent the vapors from the inner end of each pumping vane where the vapors are separated from the liquid and discharge the vapors at points remote from the pump inlet.

In the embodiment of the invention disclosed in Figures 4 and 5, parts corresponding with parts described in Figures 1 to 3 have been marked with the same reference numerals.

As shown in Figure 4, the pump casing 17 has a cover 50 thereon connected thereto by means of bolts 51 and maintained in sealed relationship therewith by a gasket 52. This cover 50 defines an annular chamber 53 above the pumping chamber 18, and a seal ring 54 is secured on the casing 17 by means of screws 55, to separate the chambers 18 and 53.

The impeller 37 has the hub 37a, flange 37b, skirt 37c, and flange 37d all as described in connection with the impeller 37 of Figures 1 to 3, but the peripheral portion of the flange 37d has a thickened rim 56 providing a side wall having close-running clearance with the sealing ring 54. The hollow vanes 40 are substantially the same as the vanes 40 described in Figures 1 to 3, but the shallow end walls 40g thereof underlie the thickened portion 56, and these end walls are thus intermediate the top and bottom of the vanes since the inner edges of the vanes extend to the flange 37d.

A ring 57 is secured in the cover 50 and has a central aperture 57a receiving the skirt 37c of the impeller in close-running clearance relationship therewith. The ring 57 defines a chamber 58 around the lower portion of the skirt 37c and above the flange 37d. This chamber 58 communicates through the slots 43 in the flange 37d with the chambers provided in the vanes 40.

Upstanding pumping vanes 59 are provided on the flange 37c outwardly from the slots 43 thereof, and these vanes underlie the ring 57 to provide pumping channels 60 connecting the chamber 58 with the chamber 53. The chamber 53 is vented to the interior of the tank 10 through slots 61 provided in the top of the cover. The chamber 53 thus is in free communication with the interior of the tank 10 on the side of the pump remote from the inlet I thereof.

In operation, the modified pump unit of Figures 4 and 5 acts the same as the unit described in Figures 1 to 3 except that a separate collecting chamber is provided for the gases discharged from the blade chambers. The gases or vapor rich liquid in this collecting chamber is centrifugally impelled out of the chamber by means of separate pumping vanes 59 which discharge the vapor rich liquid back to the interior of the tank through the chamber 53 and vent slots 61.

The pump of Figures 4 and 5 provides for the positive impelling of bubble-rich liquid through the hollow vanes, since pumping vanes 59 are provided for this purpose.

From the above descriptions, it will be clear that the invention provides efficient liquid and vapor separating pumps which cannot become gas-bound because the gases and vapors are liberated from the liquid in bubble form and bubble rich liquid is directed out of the pump through individual passages having inlets right at the places where the vapors and gases are liberated from the liquid.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise

6

than necessitated by the scope of the appended claims.

I claim as my invention:

1. A submerged type pump and motor unit for separating gases from liquids which comprises a mounting base, a pump casing carried by said base having a central inlet and annular pumping chamber, an upstanding open ended hollow boss on said base communicating with said pumping chamber and defining an outlet passageway for the pump adapted to discharge out of either end thereof, a cover plate on said base cooperating therewith to define a sump below the pump inlet, a motor unit mounted on said pump casing in spaced relation therefrom, said motor unit having a shaft depending into the pump casing, a pump impeller secured on said shaft and having a ring of circumferentially spaced pumping blades defining pumping channels connecting the central inlet with the annular pumping chamber, and each of said pumping blades having a passageway therethrough venting the inner edge thereof with the outside of the pump.

2. A device for separating vapors from liquids which comprises a casing having a central passageway therethrough and defining an annular pumping chamber around the passageway in communication with said passageway, a pump impeller in said passageway having a ring of peripherally spaced hollow pumping blades therearound defining pumping channels therebetween which connect the passageway with the pumping chamber, and each of said blades having a passage connecting the inner edge thereof with the upper end of the passage to discharge vapors formed adjacent the inner edge of the blade.

3. A device for pressuring fully liquid material from a source of liquid which comprises a pump assembly having an open-ended passage with a bottom inlet end and an annular outlet intermediate the top and bottom of the passage, means defining an annular pumping chamber adapted to receive fluid from said passageway through said annular outlet, an impeller in said passageway having a ring of hollow vanes arranged for centrifugally discharging liquids from the passageway into the pumping chamber, and said hollow vanes having open inner ends communicating along their lengths with said passageway together with discharge outlets communicating with the upper end of the passageway whereby vapors liberated by said vanes can flow through the vanes to be discharged out of the pump.

4. A liquid and vapor separating device comprising a casing having an annular pumping chamber with a central inlet and a peripheral outlet, an impeller mounted in said casing having a ring of hollow pumping vanes thereon arranged for centrifugally discharging liquid from said inlet through said pumping chamber to said outlet, and each of said vanes having an inlet opening on the inner end thereof and an outlet opening on the top end thereof whereby gases and vapors liberated by the vanes adjacent the inner ends thereof will flow through the vanes to the outside of the pump along individual paths separate from the liquid flow path.

5. A gas and vapor separating pump which comprises a mounting base having a peripheral flange adapted to be secured to a tank or the like liquid container, a pump casing supported on said base in spaced relation thereabove and having a central inlet passageway and an an-

nular pumping chamber around said passageway in communication therewith, an upstanding tubular boss member on said base communicating with said pumping chamber to receive liquids therefrom, a motor casing supported on said pump casing in spaced relation thereabove, a motor shaft depending from said motor casing, an impeller having a hub secured on said shaft together with a flange extending across said central passageway of the pump casing and having openings at spaced intervals therearound, and a plurality of pumping vanes depending from said flange into said passageway and having inner edges disposed in the passageway and outer edges discharging into the pumping chamber, said inner edges of the pumping vanes being slotted and said pumping vanes having passages therethrough communicating with the opening in said flange for conveying gases and vapors from the inner edges of the vanes out of the pump to prevent the pump from becoming gas-bound.

6. A gas and vapor separating pump which comprises a pump casing having a central passageway and an annular pumping chamber therearound, a pump impeller in said passageway, a ring of pumping vanes open at the inner ends of said vanes and on said impeller for centrifugally discharging fluids into said pumping chamber, said vanes having inner ends surrounding the central passageway, and passages through said vanes connecting the inner ends of the vanes with the upper portion of the passageway to accommodate flow of vapors there-through.

7. A vapor separating pump comprising a pump casing having a central passage therethrough and an annular pumping chamber surrounding said passage in communication therewith around the entire inner periphery thereof, an impeller having a flange extending across said passageway, hollow pumping vanes depending from said flange arranged for centrifugally discharging fluids from said passageway through said pumping chamber, said pumping vanes having slotted inner edges for agitating liquids in said passageway to liberate bubbles of gas and vapor therefrom, and said flange having openings therein for passage of bubbles of gas and vapor from the hollow interiors of the blades out of the pump.

8. A vapor separating pump which comprises a casing having an annular pumping chamber with an inner peripheral inlet and an outer peripheral outlet, an impeller in said casing having a ring of pumping vanes arranged for centrifugally discharging liquids through said inner peripheral inlet, said pumping vanes having passages therethrough connecting the inner edges of the vanes with a top outlet, means in said casing defining a receiving chamber for fluids discharged through said top outlet, and additional vanes for centrifugally discharging the fluids in said receiving chamber out of the casing.

9. A vapor and liquid separating pump which comprises a pump casing having a central inlet, an annular pumping chamber communicating with said inlet around the inner periphery thereof and having a peripheral discharge outlet, said casing having a second annular passage therein above said pumping chamber, a pump impeller having a set of hollow vanes defining pumping channels therebetween connecting the inlet with the pumping chamber, means in said casing defining a collecting chamber above said impeller,

an additional set of vanes on said impeller for centrifugally discharging fluids from said collecting chamber to said second annular chamber, and said first mentioned pumping vanes having passages therethrough connecting the inner edges thereof with said collecting chamber whereby gases and vapors liberated at said inner ends of the pumping vanes will flow through said passages in the vanes and be discharged out of said pump by said additional vanes.

10. A pump comprising a casing having a bottom inlet, an annular pumping chamber and a peripheral outlet, an impeller having a ring of hollow pumping vanes disposed in said casing and arranged for pumping fluids from the inlet through said pumping chamber to the outlet, said hollow vanes having slots along the inner edges thereof and outlets along the top ends thereof, and an additional set of vanes on said impeller arranged for pumping gases and vapors through said hollow vanes.

11. In a vapor separating pump the improvement which comprises an impeller having a ring of hollow pumping vanes defining pumping channels therebetween, said hollow vanes having an inlet adjacent their inner ends and an outlet at the tops thereof, and a second set of pumping vanes on said impeller above said pumping blades for flowing fluids through the hollow portions of the vanes.

12. A pump impeller comprising a hub member having an outturned flange, a ring of pumping vanes depending from said flange, said pumping vanes being hollow and having slot-like openings along the inner edges thereof, and said flange having openings therethrough communicating with the tops of the hollow portions of said vanes.

13. A pump impeller comprising a body member having a central hub, a first outturned flange at the end of said hub, a depending skirt on said first flange, a second outturned flange on the end of said skirt and a ring of slots through said second flange, and a ring of hollow pumping vanes depending from said second flange having slotted inner edges and open tops communicating with said slots.

14. A pump impeller which comprises a body member having a central hub portion and a radial flange, a ring of hollow pumping vanes depending from said flange, said pumping vanes having slotted inner ends and open tops, and said radial flange having openings therein aligned with the open tops of said hollow vanes to discharge vapors out of the vanes.

15. A pump impeller comprising a body member having a radial flange, a ring of hollow pumping vanes depending from said flange, said hollow pumping vanes having open inner edges and open tops, and said radial flange having openings therethrough for receiving fluids from the open tops of the pumping vanes.

16. A pump impeller comprising a body member having an outturned flange, a first ring of pumping vanes depending from one face of said flange, a second ring of pumping vanes extending upwardly from the other face of said flange, the pumping vanes of said first ring being hollow and having inlet openings along their inner edges and outlets along the top ends thereof, and said flange having openings therethrough aligned with said outlets and positioned inside of said second ring of pumping vanes.

17. An impeller blade which comprises a streamlined curved vane having an open top, a

rounded inner edge portion and tapering side walls converging from said rounded inner edge portion, said inner edge portion having a slot along a length thereof, and said vane having a passageway therethrough connecting said slot with the open top of the vane.

18. A pumping blade which comprises a hollow streamlined curved centrifugal pumping vane having a rounded inner edge and side walls converging from said inner edge, a bottom wall on said vane, an outer edge wall on said vane, an open top on said vane, and said inner edge of the vane having a slot therein whereby the interior of said vane defined by said walls has an inlet in the inner edge and an outlet in the top thereof.

RUSSELL R. CURTIS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,344,835	Stalker	Mar. 21, 1944

FOREIGN PATENTS

Number	Country	Date
7,401	Netherlands	Aug. 15, 1922
833,532	French	Oct. 24, 1938