Oct. 8, 1946. R. P. GREENWOOD 2,408,775

BOOSTER PUMP

Filed Oct. 14, 1943

Fig. 1

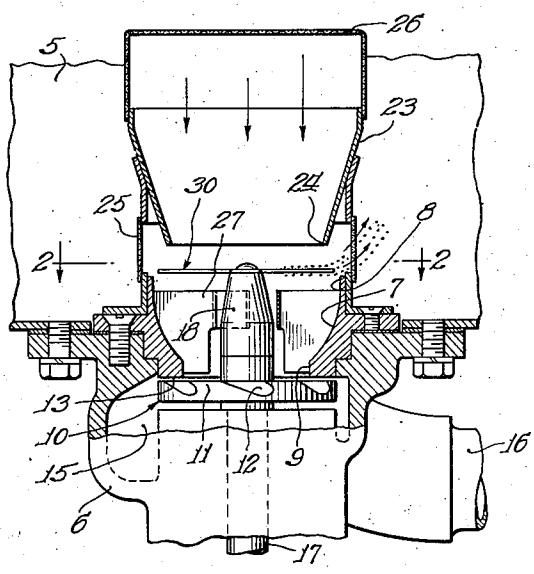


Fig. 2

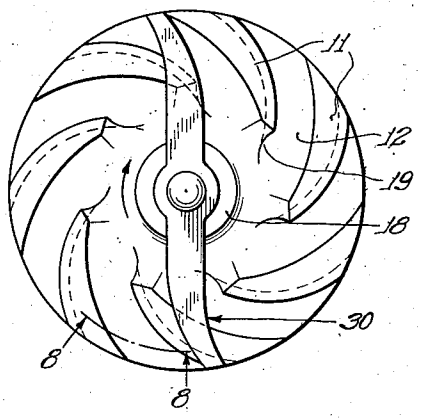


Fig. 3

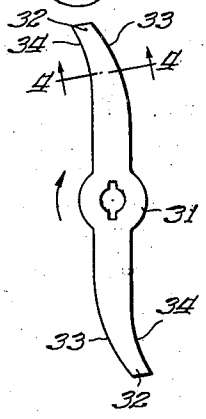


Fig. 5

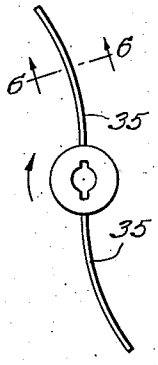


Fig. 7

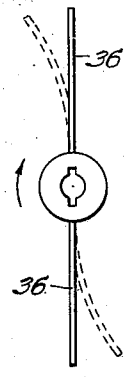


Fig. 8

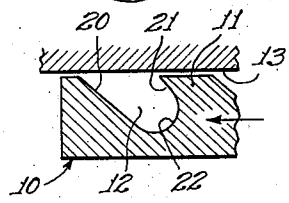


Fig. 4

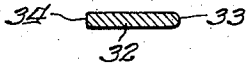


Fig. 6



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UNITED STATES PATENT OFFICE

2,408,775

BOOSTER PUMP

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Application October 14, 1943, Serial No. 506,165

14 Claims. (Cl. 103—113)

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The present invention relates to centrifugal pumps of the booster type, and more particularly to the form and disposition of parts of the structure adapted to prevent admission of air bubbles in the liquid being pumped from entering the impelling elements of the centrifugally acting impeller.

It is the principal object of this invention to simplify the construction of a booster type of centrifugal pump such as contemplated herein, and to improve the efficiency and operation of such pump.

This invention has for an object the provision of a centrifugal booster pump structure that is especially designed for use with high-volatile liquid fuel such as favored for aircraft engines that are required to operate under the wide range of barometric pressures which are encountered between the normal ground level pressure and the pressure of extremely high altitudes as well as of the different atmospheric conditions.

Another object of the present invention is to provide a novel beater for ejecting occluded air bubbles, the structure of such beater being adapted to reduce the required power input and thereby decrease the overall weight as well as consumption of electric current required to operate the driving motor.

A further object is to provide a beater that is of an S-shape having unpitched blades or arms, this shape tending to decrease the torque load on the motor.

A still further object is to provide a beater that operates to cause the bubbles to cling to the surfaces of the blades and gradually move outward along the trailing edge or surface towards the tips of the blades before they are ejected therefrom at a location that is remote to the rotational axis and out of the path of fluid discharging from the pump inlet guide.

When pitched blades are used, the bubbles tend to leave the surfaces of the blades a considerable distance inward from the blade tips and thus mingle directly in the path of the fluid moving towards the impeller. Furthermore, when pitched blades are employed they create a region of considerable turbulence between the inlet head and and the inlet mouth to the impeller increasing the electric power consumption; whereas with the novel beater structure herein disclosed the region of greatest turbulence is outside and beyond the path of the fluid flowing to the inlet mouth so that the bubbles are ejected into a zone beyond the discharge end of the fluid inlet structure. The bubbles in the present structure

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travel in a horizontal plane that is at a right angle to the rotational axis of the beater and parallel to the plane of the impeller element of the pump. The S-shaped curve of the blades preferably conforms substantially with corresponding curved recesses or channels between the fins or blades of the impeller member.

Additional objects, aims, and advantages of the present invention will be apparent to persons skilled in the art after the construction and operation of the booster pump and beater are understood from the following description, taken in connection with the accompanying drawing wherein:

Fig. 1 is a vertical axial section, partly in elevation, disclosing the instrumentalities for practicing the invention contemplated herein in a preferred embodiment thereof.

Fig. 2 is a horizontal section taken on the plane of line 2—2 on Fig. 1 looking in the direction of the arrows, portions of the adjacent structure being omitted for clearness.

Fig. 3 is a top plan view on an enlarged scale of a preferred form of the beater element shown in Fig. 2.

Fig. 4 is a transverse section taken substantially on line 4—4 of Fig. 3.

Fig. 5 is a plan view of a modified form of the beater.

Fig. 6 is a transverse section on line 6—6 on Fig. 5.

Fig. 7 is a plan view of another modified form of beater.

Fig. 8 is an enlarged sectional view taken substantially on line 8—8 of Fig. 2.

The drawing is to be understood as being more or less schematic for the purpose of disclosing typical or preferred forms of the improvements contemplated herein, and in the drawing like reference characters identify the same parts in different views.

Referring to Figs. 1 to 4, there is shown a preferred arrangement of centrifugal pump incorporating in combination my improved vapor beater construction. The liquid fuel tank 5 has an opening in its bottom wall in which the booster pump assembly of the centrifugal type is installed. The pump elements are mounted in a housing 6 having an axially disposed concave inlet throat 7 that converges downwardly from its wide inlet mouth 8 to a lower discharge opening 9. An impeller 10 of the rotary centrifugal type is disposed in close proximity to the discharge opening 9, so that the spirally extending vanes 11 and the intermediate recesses or channels 12 of the

impeller are in closely spaced relation to the adjacent housing wall surface 13. The liquid is discharged into a scroll or volute chamber 15 in the housing surrounding the impeller 10, that has an outlet stub 16 projecting laterally to the housing and adapted to be connected in any suitable manner to a fuel feed line leading to the carburetor or other device where the fuel is to be used. The impeller 10 is suitably connected to and supported upon the upper portion of a vertical shaft 17 that is journaled in the housing beneath the inlet throat member 7 in axial disposition relative thereto, and its upper end is provided with a tapered terminal support 18 that is disposed axially within the inlet throat 7. The lower portion of shaft 17 has operative connection with and is rotated by a small electric motor (not shown) or other suitable prime mover.

The spirally extending vanes 11 and the intermediate recesses or channels 12 are preferably integral with the disk or body of the impeller 10, the channels 12 having a smooth curved contour in cross-section and are undercut obliquely in the disk as shown in detail in Fig. 8, so that the open portions of the channels closely confront the proximate face 13 of the housing wall concentric to the discharge opening 9 of the inlet throat member 7. The inner terminal ends 19 of the vanes 11 provide a plurality of sharp blades disposed concentrically around the axis of the impeller and they are slightly inclined. The thickness of these blades increases towards the periphery of the impeller disk although the transverse dimensions of the intermediate recesses or channels 12 are substantialy uniform in cross-section dimensions from their inner to their outer terminal ends.

Viewed in cross-section (Fig. 8) a recess or channel 12 is defined by the faces 20 and 21 of the adjacent leading and trailing vanes and these faces are connected by an inner curved surface 22. Thus, when the impeller travels in the direction of the arrow (Fig. 8) the blades 19 of the vanes cut sharply into the body of fluid adjacent the discharge opening 9 of the inlet throat, causing the fluid, upon entering the channels between the vanes, to turn at a 90° angle to the general plane of the impeller.

The fluid entering the recesses or channels is at low velocity which will result in a release of any bubbles that may be in the fluid so that these bubbles will move upward into the inlet throat member. The fluid in the channels is moved centrifugally outward to the periphery of the impeller at a constantly increasing velocity, due to centrifugal action and will be discharged into the volute chamber 15. While centrifugally traversing the channels the fluid, due to the shape of the channel chamber, will also be whirled in a helical manner around an axis extending along the axis of each channel, and this rotation of the fluid while it is being forced centrifugally outward is adapted to impart additional energy to the fluid thereby increasing the efficiency of the pump.

Mounted in spaced relation above the inlet throat 7 there is guide 23 having a tapered lower portion that terminates in a discharge opening 24 that is axially aligned with the impeller 10 and serves to direct the fluid into the inlet throat. It will be seen that this discharge opening 24 is of less diameter than the mouth 8 of the inlet throat which permits egress of bubbles laterally through the annular space between these elements as suggested by arrows in Fig. 1. An annular screen 25 is interposed across this space 24 and another screen 26 of cup-shape is mounted on the top of the fluid guide 23.

For the purpose of preventing abnormal swirling of the fluid within the inlet throat 7, a baffling structure may be introduced into the latter, said baffle structure embodying radially disposed sheet metal walls 27 that are secured to the inner face of throat 7.

For cooperation with the above arrangement for effectively accomplishing the ejection of vapor bubbles, I have provided a particular beater construction, a preferred embodiment of which is indicated generally at 30, located in the path of the liquid flowing from the guide opening 24 towards the inlet throat 7 and preferably secured to the top of the terminal end 18 of the shaft 17 for rotation with the impeller 10. The beater is positioned in a horizontal plane that is immediately above the mouth 8 of the throat and between said mouth and the discharge opening 24 of the guide 23. In the more specific aspect of my invention, this beater 30 has a substantially S-shape as will be seen in Figs. 2 and 3, and the curved portions thereof are disposed in the same general trailing directions as the vanes and channels of the pump impeller 10 above which the beater is shown in superimposed relation in Fig. 2. The preferred form of beater 30 embodies a flat piece of metal having a generally rectangular cross-section as shown in Fig. 4, and comprises a central hub 31 with two opositely disposed flat blades 32 extending radially therefrom. It is particularly important to note that blades 32 are unpitched so that the leading and trailing edges 33 and 34 of each blade are always in the same horizontal plane which results in less agitation of the fluid that is moving towards the impeller 10. Consequently, the cut which the blades make in sweeping through the fluid is no greater than the thickness of the flat strip forming the blades. There is no axial pumping tendency, and this eliminates a considerable portion of the friction which blades of the pitched type create.

It will be noted that flat beater 30 is positioned an appreciable axial distance away from the impeller 10 and the discharge opening 9 of the converging throat for more effectively separating the vapor bubbles before the liquid is additionally acted on by the converged throat 7.

In operation, starting at or adjacent the inner portions of the blades, the bubbles will move close to and across the blade surfaces and will collect back of the trailing edges 34 of the blades where, and due to centrifugal action, these collected bubbles then travel in a radially outward path along the trailing edges 34 until they approach the tips of said blades and they are then ejected radially from the tips into an annular zone beyond the edge of the mouth 24 of the fluid flow guide 23, (passing through the screen 25) rising upwardly on the outside of the guide and being returned to the fluid in the tank or reservoir 5. The spiral curvature of the beater arms forming an S-like shape as a whole contributes definitely to the improved operation. The explanation for this would appear to be similar to that accounting for the improved operation of the correspondingly shaped impeller vanes, namely, that the terminal areas offer less resistance to rotation and radial movement of air bubbles by virtue of the fact that the same extend rearwardly trailing in the general direction from which the same are moving in being rotated through the liquid. While the torque

or power required to operate the beater is thus reduced to a minimum, it is important to note that the vapor bubble eliminating capacity of this unpitched beater is equal to that of a pitched propeller type beater.

From comparative tests of a 10° pitch propeller type beater and my unpitched S-shaped beater, I have realized a reduction in current consumption of the order of one ampere and in increased pressure boost of the order of two pounds per square inch. This represents a real advantage in aircraft installation where output per unit of weight is critical.

Thus the use of a flat unpitched beater blade results in an arrangement which gives an increased pressure boost, and a decreased consumption of electric current. This may be attributed largely to the fact that the only pumping action resulting from the operation of this propeller is in a radial direction and only bubbles are pumped by this action. Inasmuch as there is no axial pumping, the motor load is less. Since the load of a series wound D. C. motor is in some inverse ratio to the motor current drawn, the motor has a tendency to speed up while using the flat propeller. As a result of this speeding-up, the impeller operates at higher speed giving even higher pressure than would be the case with the pump operating at a lower speed with an axial pumping propeller. The reason for this increase in pressure with the higher speed is clearly understandable when it is realized that the impeller is far more efficient for pumping than a 10° pitch propeller. Thus it will be seen that I obtain the same vapor separating action which is obtained with a 10° pitch propeller with more efficiency. Since the unpitched blades reduce the torque load on the motor permitting it to operate faster, this results in the back electromotive force being increased and therefore the current consumption through the series field and armature is decreased.

While I have disclosed the preferred form of impeller to be used in combination with my unpitched beater because of the improved results obtained, it will be understood that in the broader aspects of my invention I also contemplate other available forms of impellers.

In lieu of the flat blade beater above described, the beater may embody a wire element such as illustrated in Figs. 5 and 7, which has an arcuate or cylindrical contour in cross-section as shown in Fig. 6. In the structure illustrated in Fig. 5, the wire 35 is preferably of sufficient gauge and stiffness to be formed into a permanent S-shape and suitably mounted upon the terminal end 18 of the actuator or shaft 17. The wire 36 shown in Fig. 7 is of a flexible character and is straight from end to end when not being rotated. When this latter type of beater is rotated through the fluid it will bend backward in a trailing manner and assume an S-shape as shown in dotted lines on Fig. 7. In both of these types of wire beater the bubbles will collect back of the trailing surfaces of the S-shaped blades and they will be ejected radially outward from the tips of said blades. The results attained by these S-shaped wire beaters are substantially the same as with the use of the flat unpitched blades previously explained.

It is important to note that while I have shown an installation in the bottom of a fuel tank by way of example, my invention is equally applicable to other arrangements including booster

pump installations introduced through the roof of the tank as well as side-wall installations.

While this invention has been described in detail in its present preferred form or embodiment, it will be apparent to persons skilled in the art, after understanding the improvements, that various changes and modifications may be made therein without departing from the spirit or scope thereof. It is intended that the appended claims cover all such changes and modifications.

I claim:

1. In a centrifugal pump, a housing having an impeller chamber; a centrifugal impeller rotatable in said chamber, a fluid inlet throat communicating with said chamber forwardly of said impeller; a fluid guide for directing fluid to said inlet; and a beater interposed between said inlet throat and said fluid guide, said beater being arranged coaxially with said impeller for rotation in a plane normal to the axis of rotation of the impeller and consisting of an unpitched member having leading edges and trailing edges conformed and arranged to operate so that rotation of the beater about said axis will cause bubbles of vapor to be generated from fluid directed by said guide to said throat without directly accelerating the speed of the fluid in the direction of the said axis, the trailing edges of said beater being adapted to collect vapor bubbles along the same and move the bubbles radially to the tips of the beater to be ejected therefrom into a zone outside the influence of the fluid guide.

2. In a centrifugal pump adapted for pumping volatile liquid containing vapor, a housing having an impeller chamber; a centrifugal impeller rotatable in said chamber, said impeller formed with spirally curved impelling vanes; an inlet throat communicating with said chamber above said impeller; a fluid guide for directing fluid to said inlet throat; and a beater interposed between said inlet throat and said fluid guide, said beater being arranged co-axially with said impeller for rotation in a plane normal to the axis of rotation of the impeller and consisting of radially opposite blades disposed in said plane, each blade having a portion curved in the general direction of the impeller members and said blades together forming an S-shape, the said blades being conformed and arranged to operate so that rotation of the said beater will cause bubbles of vapor to be generated from fluid directed by said guide to said throat without directly accelerating the flow of fluid in the direction of the said axis, and substantially all the bubbles to be collected along the trailing edges, the said collected bubbles being moved centrifugally along the blades and ejected from the tips thereof into a zone radially outward of the discharge terminal of said fluid guide.

3. In a centrifugal pump adapted for pumping volatile liquid containing vapor, a housing having an impeller chamber; a centrifugal impeller rotatable in said chamber, said impeller formed with spirally curved impelling vanes; an inlet throat communicating with said chamber forwardly of said impeller; a fluid guide for directing fluid to said inlet throat; and an S-shape rotatable beater interposed between said inlet throat and said fluid guide, said beater consisting of radially opposite flat unpitched blades disposed in a plane at a right-angle to the rotational axis of the beater and in spaced relation with said throat, each blade having a spirally curved portion disposed in the general direction of the spiral impeller vanes; the radial inner portions

of the impeller vanes and the leading edges of the beater blades respectively being conformed and arranged to operate so as to generate bubbles of vapor from fluid directed to said throat, and the trailing edges of the curved flat blades adapted to collect vapor bubbles back of the same and to move the said collected bubbles centrifugally to their tips and eject the bubbles radially into a zone outside the influence of the liquid being discharged by said guide.

4. A beater for a centrifugal booster pump, consisting of a plurality of thin, radially opposite blades having closely spaced opposite flat surfaces and arranged for rotation about a central axis normal to the flat surfaces, said blades having leading edges and trailing edges so conformed and arranged that the radially outer portion of each blade curves backwardly and the leading edge of one blade and the trailing edge of an opposite blade form generally an S-curve and that rotation of the beater about said axis in a stream of fluid flowing to the pump and within a body of the fluid will cause bubbles of vapor to be generated from the fluid without directly accelerating the flow of fluid in the direction of the axis and substantially all the bubbles to be collected along the trailing edges and translated therealong to the outer extremities of the beater whence they will be ejected from the stream in a generally radial direction in relation to the axis.

5. A beater for generating bubbles of vapor from a stream of fluid flowing to a centrifugal pump and consisting of a thin blade having opposide flat surfaces of generally S-shape arranged for rotation about a central axis normal to the flat surfaces, said blade having a leading edge, the radially outer portion of which curves backwardly, and the edges of said blade being so conformed and arranged that rotation of the beater in a predetermined direction about said axis in a stream of fluid flowing to the pump and within a body of the fluid will cause bubbles of vapor to be generated from the fluid without directly accelerating the flow of fluid in the direction of the axis and substantially all the bubbles will be collected along the trailing edges and translated therealong to the outer extremities of the beater whence they will be ejected from the stream in a generally radial direction in relation to the axis.

6. A beater for a centrifugal booster pump consisting of a flat strip providing oppositely disposed blades arranged for rotation about a central axis, the said blades being generally of S-shape and having opposite flat surfaces normal to said axis, the radially outer portion of the leading edge of each blade being curved backwardly and the leading and trailing edges of each blade being so conformed and arranged to operate upon rotation in a predetermined direction of said beater in a body of fluid as to generate bubbles of vapor therein and to cause the bubbles so generated to collect along the trailing edges and to be translated therealong to the outer extremities of the blades and thence ejected in a generally radial direction in relation to said axis.

7. In a centrifugal pump assembly, a housing having an impeller chamber, a centrifugal impeller arranged in said chamber for rotation about a vertical axis, a fluid inlet throat arranged in co-axial, spaced relation with said impeller and communicating with said chamber above said impeller, a fluid guide for directing fluid to said inlet throat and arranged in co-axial, spaced relation with said inlet throat, and a beater arranged co-axially with said impeller and intermediately of said inlet throat and said fluid guide for rotation in a plane normal to said axis, said beater consisting of an unpitched member having leading edges and trailing edges conformed and arranged to operate so that rotation of said beater will cause bubbles of vapor to be generated from fluid directed by said guide to said throat without directly accelerating the speed of the fluid in the direction of the said axis and substantially all the bubbles of vapor generated from said fluid to be collected along the trailing edges and translated therealong to the outer extremities of the beater whence they will be ejected in a generally radial direction in relation to the said axis to a zone outside the zone of influence of the fluid guide.

8. In a centrifugal pump assembly, a housing having an impeller chamber, a centrifugal impeller arranged in said chamber for rotation about a vertical axis, a fluid inlet throat arranged in co-axial spaced relation with said impeller and communicating with said chamber above said impeller, a fluid guide for directing fluid to said inlet throat and arranged in co-axial, spaced relation with said throat, and an unpitched beater arranged co-axially with said impeller and intermediately of said throat and said fluid guide for rotation in a plane normal to said axis and in spaced relation with said throat, said beater consisting of radially opposite blades disposed in a horizontal plane and with leading edges and trailing edges arranged and conformed so that the leading edge of one blade and the trailing edge of the opposite blade form generally an S-curve and that rotation of said beater in a predetermined direction will cause bubbles of vapor to be generated from fluid directed by said guide to said throat without directly accelerating the speed of the fluid in the direction of the said axis and substantially all the bubbles of vapor generated from said fluid to be collected along the trailing edges and translated therealong to the outer extremities of the beater whence they will be ejected in a generally radial direction in relation to the said axis to a zone outside the zone of influence of the fluid guide.

9. In a centrifugal pump assembly, a housing having an impeller chamber, a centrifugal impeller arranged in the chamber for rotation about a vertical axis, the impeller being formed with spirally extending impelling vanes arranged in radially spaced relation with the axis, a fluid inlet throat arranged in co-axial, spaced relation with the impeller and communicating with the chamber above the impeller, a fluid guide adapted to be mounted in a body of fluid for directing fluid from the body to the throat and arranged in co-axial, spaced relation with the throat, the vanes being arranged whereby upon rotation of the impeller in a predetermined direction radially inner portions of the vanes will generate bubbles of vapor from fluid directed to the throat and the bubbles will be caused to flow upwardly in the throat and into the body of fluid, and an unpitched beater arranged co-axially with the impeller and within the body of fluid intermediately of the throat and the fluid guide for rotation in a plane normal to the axis and in spaced relation with the throat, the beater consisting of radially opposite, flat unpitched blades disposed in a horizontal plane normal to the axis and having leading edges and trailing edges arranged and conformed so that the leading edge of one blade and the trailing edge of the opposite blade form generally an S-curve and that upon rotation of

the beater in a predetermined direction bubbles of vapor will be generated from fluid directed by the guide to the throat without directly accelerating the speed of the fluid in the direction of the axis and substantially all the bubbles of vapor generated from the fluid will be collected along the trailing edges and translated therealong to the outer extremities of the beater whence they will be ejected in a generally radial direction in relation to the axis to a zone of the body of fluid outside the zone of influence of the fluid guide.

10. In a centrifugal pump assembly including a housing having an impeller chamber, a centrifugal impeller arranged in said chamber for rotation about a vertical axis, a fluid inlet throat arranged in co-axial, spaced relation with said impeller and communicating with said chamber above said impeller, and a fluid guide for directing fluid to said throat and arranged in co-axial, spaced relation with said throat, a beater arranged co-axially with said impeller and intermediately of said throat and said fluid guide for rotation in a plane normal to said axis, said beater having thin, radially opposite blades with closely spaced opposite flat surfaces disposed in parallel relation to the plane of rotation and leading edges and trailing edges so arranged and conformed that the leading edge of one blade and the trailing edge of the opposite blade form generally an S-curve and that rotation of said beater in a predetermined direction will cause bubbles of vapor to be generated from fluid directed by said guide to said throat without directly accelerating the speed of the fluid in the direction of the said axis and substantially all the bubbles of vapor generated from said fluid to be collected along the trailing edges and translated therealong to the outer extremities of the beater whence they will be ejected in a generally radial direction in relation to the said axis to a zone outside the zone of influence of the fluid guide.

11. In a liquid fuel system, a liquid fuel tank having an outlet in the bottom thereof, a centrifugal pump secured to the outside of the tank adjacent said outlet and comprising a housing having an impeller chamber, a spirally-vaned impeller arranged in said chamber for rotation about a vertical axis, an inlet throat arranged in co-axial, spaced relation with said impeller and communicating with said outlet and said chamber above said impeller, a guide mounted in the tank and arranged in co-axial, spaced relation with said inlet throat for directing fuel to said throat, and rotatable beater means disposed intermediately of and in spaced relation with the guide and the throat and in open communication with a body of fuel in said tank, said beater consisting of a thin blade having opposite flat surfaces of generally S-shape arranged for rotation about a central axis normal to the flat surfaces and co-extensive with the said vertical axis, the blade having edges conformed and arranged to operate so that rotation of said beater in a predetermined direction will cause bubbles of vapor to be generated from fuel directed by said guide to said throat without directly accelerating the flow of the fuel in the direction of the said axis and substantially all the bubbles to be collected along the trailing edges and translated therealong to the outer extremities of the beater whence they will be ejected from the fuel directed to the throat in a generally radial direction in relation to the axis.

12. In a liquid fuel system including a liquid fuel tank having an outlet in the lower portion

thereof, a centrifugal pump secured to the outside of the tank adjacent said outlet and comprising a housing having an impeller chamber, a spirally-vaned impeller arranged in said chamber for rotation about a vertical axis, an inlet throat arranged in co-axial, spaced relation with said impeller and communicating with said outlet and said chamber above said impeller, and a guide mounted in the tank and arranged in co-axial, spaced relation with said inlet throat for directing fuel to said throat, a beater arranged in open communication with a body of fuel in the tank and co-axially with said impeller and intermediately of said throat and said guide for rotation in a plane normal to said axis, said beater consisting of an unpitched member having thin, radially opposed blades with closely spaced opposite flat surfaces disposed in parallel relation to the plane of rotation and so conformed and arranged to operate that the leading edge of one blade and the trailing edge of the opposite blade form generally an S-curve and that rotation of said beater in a predetermined direction will cause bubbles of vapor to be generated from fuel directed by said guide to said throat without directly accelerating the flow of the fuel in the direction of the said axis and substantially all the bubbles will be collected along the trailing edges and translated therealong to the outer extremities of the blades whence they will be ejected in a generally radial direction in relation to the said axis to a zone of said body of fuel beyond the zone of influence of the guide.

13. In a centrifugal pump assembly, a housing having an impeller chamber, a centrifugal impeller arranged in the chamber for rotation about a vertical axis, the impeller being formed with spirally extending impelling vanes arranged in radially spaced relation with the axis, a fluid inlet throat arranged in co-axial, spaced relation with the impeller and communicating with the chamber above the impeller, a fluid guide adapted to be mounted in a body of fluid for directing fluid from the body to the throat and arranged in co-axial, spaced relation with the throat, the vanes being arranged whereby upon rotation of the impeller in a predetermined direction radially inner portions of the vanes will generate bubbles of vapor from fluid directed to the throat and the bubbles will be caused to flow upwardly in the throat and into the body of fluid, a baffle arranged transversely of the throat to equalize the flow of fluid therein in the direction of the axis whereby to enable substantially uniform generation of bubbles by the impeller vanes and to direct the upward flow of bubbles generated by the impeller vanes to the zone of operation of the beater, and an unpitched beater arranged co-axially with the impeller and within the body of fluid intermediately of the throat and the fluid guide for rotation in a plane normal to the axis and in spaced relation with the throat, the beater consisting of radially opposite, flat unpitched blades disposed in a horizontal plane normal to the axis and having leading edges and trailing edges arranged and conformed so that the leading edge of one blade and the trailing edge of the opposite blade form generally an S-curve and that upon rotation of the beater in a predetermined direction bubbles of vapor will be generated from fluid directed by the guide to the throat without directly accelerating the speed of the fluid in the direction of the axis and substantially all the bubbles of vapor generated from the fluid will be collected along the trailing edges and translated there-

along to the outer extremities of the beater whence they will be ejected in a generally radial direction in relation to the axis to a zone of the body of fluid outside the zone of influence of the fluid guide.

14. In a centrifugal pump, a housing having an impeller chamber, a centrifugal impeller rotatable in said chamber, a fluid inlet throat communicating with said chamber forwardly of said impeller, a guide for directing fluid to said throat, and a beater consisting of a member having opposite, unpitched surfaces, interposed between said throat and said guide, said beater being arranged coaxially with said impeller for rotation in a

plane normal to the axis of rotation of the impeller and having leading edges and trailing edges conformed and arranged to operate so that rotation of the beater about said axis will cause bubbles of vapor to be generated from fluid directed by said guide to said throat without directly accelerating the speed of the fluid in the direction of the said axis, the trailing edges of said beater being adapted to collect vapor bubbles along the same and move the bubbles to the tips of the beater to be ejected therefrom into a zone outside the influence of the fluid guide.

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