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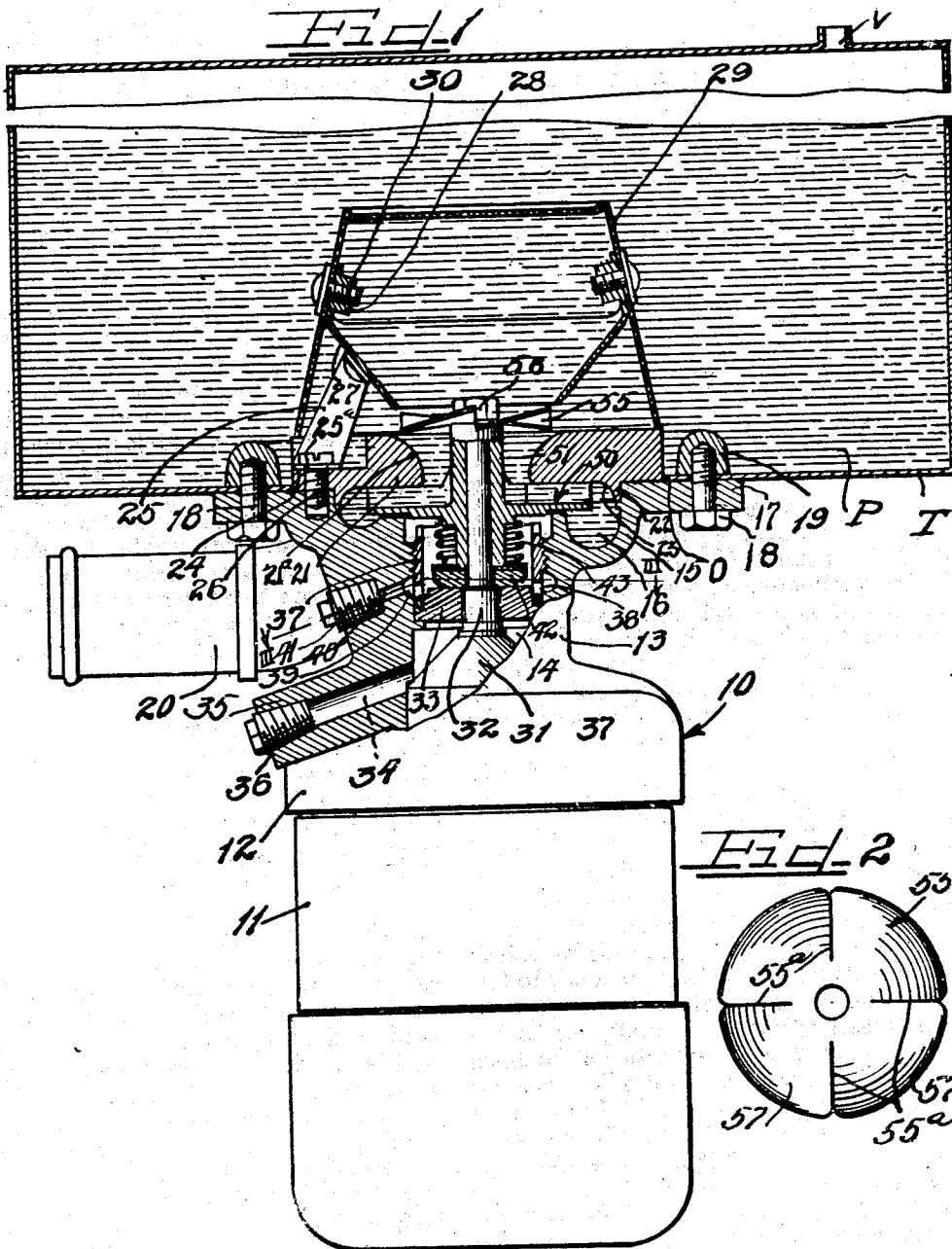
R. R. CURTIS ET AL

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BOOSTER PUMP

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2 Sheets-Sheet 1



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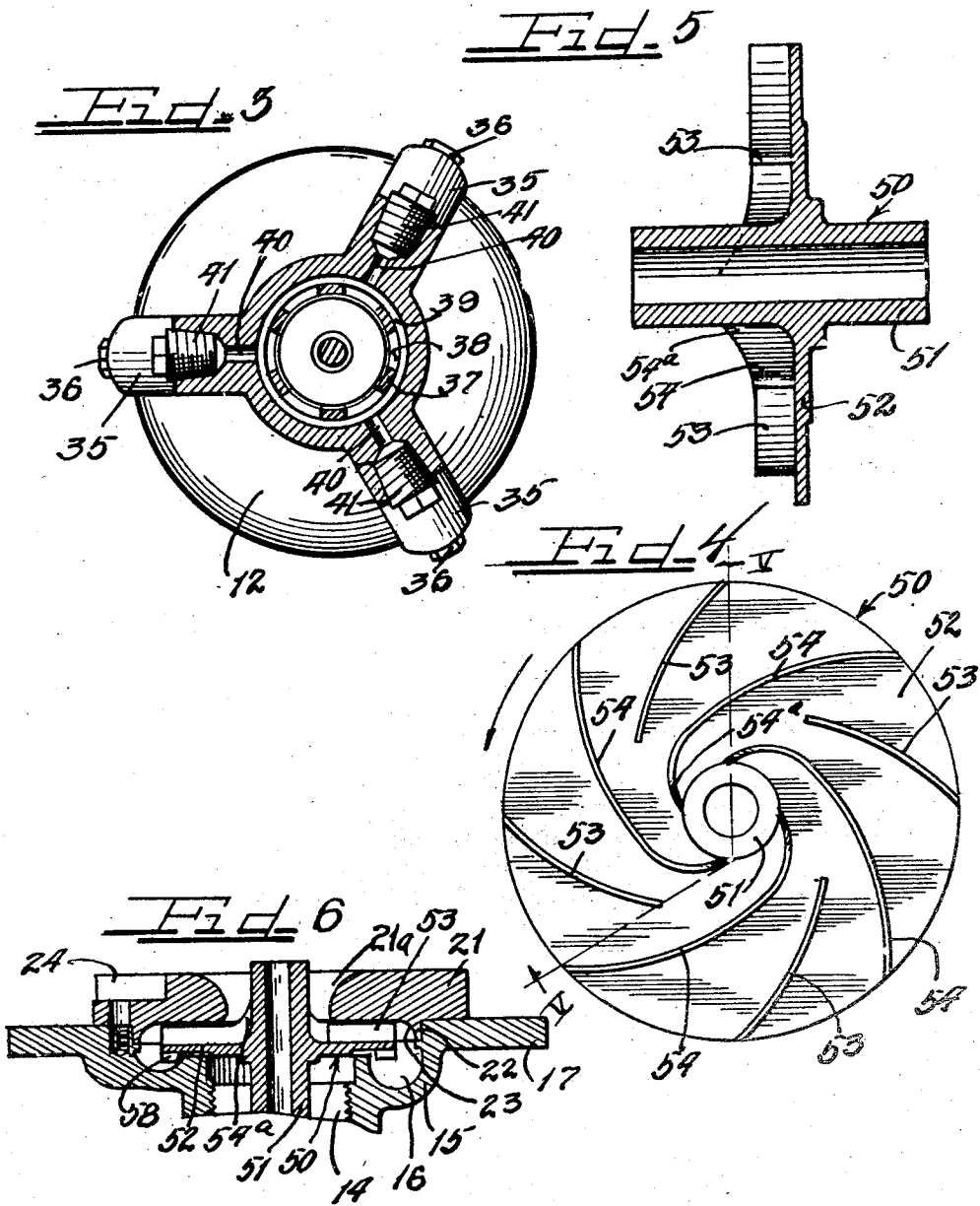
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UNITED STATES PATENT OFFICE

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BOOSTER PUMP

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9 Claims. (Cl. 103—113)

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This invention relates to improvements in booster pump constructions for increasing the efficiency and capacity of the pump.

Specifically the invention relates to an electric motor and pump unit adapted to be suspended on a tank wall with an inlet portion thereof extended into the tank and surrounded by a frusto-conical screen mounted on an inverted frusto-conical guide shield for directing filtered liquid received through the screen from the tank to a propeller which creates a lateral flow of gas-rich liquid away from the pump inlet while allowing gas-freed liquid to flow through the inlet to be initially whirled by whirling vanes on a pump impeller before reaching the pumping vanes of this same impeller.

A feature of the invention is to equip the pump with drain ports in advance of the pump seal so that impurities such as water can be removed from a sump portion of the pump.

Another feature of the invention is the provision of an impeller for a centrifugal type pump which increases the capacity of the pump when operating at high altitudes by swirling liquid being fed to the pump so that the pumping vanes will receive a swirling mass of liquid and will not shear the liquid to the extent encountered when a non-swirling mass is fed to the vanes.

A further feature of this invention is the provision, at the inlet of a centrifugal type pump, of a frusto-conical screen for filtering liquid fed to the inlet and an inverted frusto-conical guide shield within the screen to direct, with its inner face, liquid to the inlet and to direct, with its outer face, bubble-rich liquid away from the inlet.

A still further feature of this invention is to provide, in a device for pumping fully liquid material while rejecting bubble-rich material, a propeller mounted at the inlet of the device for creating, in a pond of liquid material, an outward flow of gas-rich material while swirling the liquid to improve the entrance conditions to the inlet of gas-freed material.

An object of the invention is to improve the efficiency and capacity of a pump for pressuring fully liquid material while rejecting liquid material containing bubbles of gas and vapor.

Another object of the invention is to provide a booster pump assembly adapted for an airplane fuel system which more efficiently pressurizes only gas-freed fuel from a pond of liquid fuel having gas admixed therewith.

A still further object of this invention is to provide drain ports for impurities in a centrifugal type booster pump. Another object of the in-

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vention is to provide a compact, lightweight electric motor-booster pump unit having greater capacity at altitude and higher efficiency than heretofore known similar units.

A still further object of the invention is to increase the pumping capacity of centrifugal type pumps by providing swirling vanes on the pump impeller to swirl fluid in the direction of rotation of the impeller before the fluid reaches the pumping vanes of the impeller.

A still further object of this invention is to provide, at the inlet of a centrifugal type pump, an efficient arrangement of filter screen and guide shield to cooperate with the pump for directing filtered liquid thereto and gas-rich liquid therefrom.

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 example only, illustrate one embodiment of the invention.

On the drawings:

Figure 1 is a broken vertical cross-sectional view, with parts in elevation, of a booster pump according to this invention mounted on a fuel tank to receive fuel directly from the interior of the tank.

Figure 2 is a plan view of the propeller of the booster pump effective for creating a lateral stream of bubble-rich fuel outwardly from the inlet of the pump.

Figure 3 is a cross-sectional view, with parts in elevation, taken along the line III—III of Figure 1.

Figure 4 is an enlarged plan view of the impeller of the pump of Figure 1.

Figure 5 is a cross-sectional view taken along the line V—V of Figure 4.

Figure 6 is a fragmentary cross-sectional view of a pump according to this invention equipped with a modified impeller.

As shown on the drawings:

In Figure 1 the reference numeral 10 designates generally an electric motor-booster pump unit according to this invention mounted on the bottom wall of a tank T filled with a pond P of liquid such as gasoline and having an opening O in the bottom wall through which a portion of the pump projects.

The unit 10 includes a motor casing 11 having an end cap 12 with a hollow neck portion 13 providing a shaft well 14. The upper end of the neck portion 13 has an enlarged annular casing portion 15 defining an open-topped annular pumping chamber 16 around the well 14. An

outturned flange 17 is provided around the upper end of the casing portion 15 and is apertured to receive cap screws 18 therethrough. These cap screws 18 are threaded into a mounting ring 19 on the inside of the tank T resting on the bottom wall of the tank around the opening O. In this manner, the unit 10 is suspended on the bottom wall of the tank.

An outlet conduit 20 is also formed on the casing portion 15 and communicates with the pumping chamber 16 to discharge fluid from the chamber.

A throat ring 21 is mounted on top of the casing portion 15 and has an outside diameter sized to fit within the opening O in the tank wall and act as a pilot to guide the unit into position in the tank. This throat ring 21, as best shown in Figure 6, has a central aperture 21a therethrough providing an inlet to the pumping chamber 16. This aperture 21a flares outwardly so as to provide a flaring throat.

The throat ring 21 has a dependent skirt portion 22 on the bottom thereof adapted to fit within the casing portion 15. The inner face of this skirt portion 22 is curved as at 23 from the bottom of the skirt to continue the configuration of the pumping chamber 16 and provide a pump volute.

The throat ring 21 has peripheral recesses 24 in the top face thereof which, as best shown in Figure 1, receive legs 25. About three such recesses and three such legs are provided at equally spaced intervals around the throat ring. Cap screws 26 project through horizontal feet portions 25a of the legs and through the throat ring into threaded engagement with the casing portion 15 to secure the throat ring and the legs on the casing portion.

The legs 25 carry, at the upper ends thereof, an inverted hollow frusto-conical guide shield 27. This guide shield 27 has ears or lugs 28 spaced around the upper end thereof receiving a frusto-conical wire mesh screen 29 therearound. Screws 30 secure the screen 29 to the ears or lugs 28 of the guide cone.

As shown in Figure 1 the screen 29 has a top wall bridging the small end thereof, together with a conical side wall extending down to the top of the throat ring 21 adjacent the periphery of the throat ring.

Thus the casing 15 carries the throat ring, the throat ring, in turn, carries the guide cone, and the guide cone, in turn, carries the screen.

The small end of the inverted frusto-conical guide shield 27 is positioned in spaced relation above the aperture of the throat ring 21.

As shown in Figure 1 the screen, guide shield, and throat ring all project into the tank T to be submerged in the pond P.

A stationary flame trap member 31 is mounted in the shaft well 14 and receives freely therethrough a drive shaft 32 from an electric motor in the casing 11. This flame trap member has a sloping top wall and cooperates with a stationary seal ring 33 in the well to provide a localized chamber portion which is adapted to be drained through any one of three ports 34 formed in bosses 35 spaced uniformly around the top of the cap 12 as shown in Figure 3 and integral with the cap. The ports 34 that are not being used are closed with plugs such as 36. Any one of the plugs 36 can be replaced with a drain line for removal of material which leaks past the stationary seal 33.

The stationary seal 33 is held in the well 14 on

a shoulder therein by a sleeve 37 which is threaded into the upper end of the well. This sleeve has a plurality of cuts 38 in the bottom thereof providing passageways joining the interior of the sleeve with an annular groove 39 formed in the well about level with the top of the stationary seal 33. The groove 39 communicates with three drain ports 40 as shown in Figure 3. These drain ports 40 are adapted to be closed by means of plugs such as 41. Any one of the plugs 41 can be removed to drain impurities such as water from the portion of the well above the seal ring 33.

A rotating seal ring 42 is disposed around the shaft 32 and is urged by a spring 43 into sliding face engagement with the top face of the stationary ring 33. The stationary ring 33 is preferably formed of compressed graphitic carbon while the rotating ring 42 can be composed of a hard metal such as Nitralloy. The localized chamber between the flame trap member 31 and the stationary ring 33 in the well 14 is sealed by the cooperating rings 33 and 42 but if material should leak into this chamber the same can be drained out of a port 34.

A pump impeller 50, best shown in Figures 4 and 5, has a central hub portion 51 mounted on the drive shaft 32 together with an integral flat disk portion 52 intermediate the ends of the hub portion 51 spanning the inlet 21a of the throat ring 21 and extending into the pump volute chamber. The spring 43 is compressed between the rotating seal ring 42 and the flat disk portion 52 of the impeller 50. The hub 51 can be keyed to the shaft 32.

The disk portion 52 of the impeller has four upstanding pumping vanes 53 thereon spaced equally therearound and having close operating clearance with the bottom face of the throat ring. These pumping vanes 53 terminate in spaced relation from the hub 51 but project slightly beyond the aperture-defining wall of the throat ring aperture 21a so as to be slightly exposed to the inlet.

In accordance with this invention the impeller disk 52 also has four longer vanes 54 thereon between the vanes 53. These vanes 54 are curved in the same general direction as the vanes 53 but are spiralled into the hub 51 and have inner end portions 54a tapering into the inlet aperture 21a as shown in Figure 6.

The impeller is rotated in the direction of the arrow as shown in Figure 4 so that liquid from the pond P entering the throat 21 will be swirled by the vane portions 54a in the direction of rotation of the impeller. By the time this liquid reaches the inner ends of the pumping vanes 53 it is already rotating in the direction of these pumping vanes and the pumping vanes will not shear the liquid to the extent heretofore encountered. The liquid by being first swirled by the vane portions 54a is more readily picked up by the inner ends of the pumping vanes 53 and the angle of attack of these inner ends on the liquid is materially decreased. The vane portions 54 underlying the throat ring 21 of course cooperate with the vanes 53 to act as pumping vanes.

The combination of pumping vanes terminating adjacent the inlet of the pump and alternating with longer vanes which extend into the inlet to swirl the liquid being fed to the pump materially increases the capacity of the pump as well as the efficiency thereof by decreasing the tendency of bubble formation at the impeller.

A propeller 55 is mounted around the shaft

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32 on top of the hub 51 as shown in Figure 1. This propeller can be keyed to the hub and held on the shaft by means of a nut 56 which is threaded onto the end of the shaft.

As shown in Figure 2, the propeller 55 can be stamped from a flat disk of metal by forming four radial cuts 55a therein. The portions 57 of the metal intermediate these cuts are then bent to provide a desired pitch angle to form blades on the propeller. Each blade 57 will have the trailing edge thereof aligned radially with but spaced axially from the leading edge of the next blade. An angle of attack varying from 5 to 25° is quite effective for creating a radial stream of liquid in the pond P above the throat ring 21. This liquid is received from the guide cone 27 and gas-rich liquid is caused to flow laterally from the inlet 21a of the pump. As a result of this propeller construction the unit of this invention rejects bubbles of gas and vapor while the fully liquid material can flow past the propeller into the pump to be pressured by the impeller 50 into the volute chamber 16 and thence through the outlet conduit 20.

From the above descriptions it should be understood that liquid in the pond P flows through the screen 29 into the upper end of the guide cone 27 and thence by gravity to the propeller 55. The propeller 55 acts on this liquid to throw, in a lateral direction along the top of the throat ring 21, the portions of liquid containing myriads of bubbles caused by vaporized fuel and occluded gases in the fuel. This bubble-rich liquid is thus rejected by the pump. The heavier gas-free liquid flows by gravity down through the pump inlet 21a and is whirled by the vane portions 54a of the pump impeller to form a swirling mass. This swirling mass is picked up by the pumping vanes of the impeller and discharged centrifugally into the pumping chamber 16. Liquid discharged into the chamber 16 is whirled through the chamber and discharged under pressure through the conduit 20. It is preferred to have the disk or flange 52 of the impeller 50 extend into the chamber 16 to enhance the whirling of liquid therethrough. The guide cone 27, besides being effective to guide the liquid from the pond P to the impeller 55, is also effective along the outer face thereof to guide the bubble-rich stream from the propeller 55 away from the incoming liquid passing down through the guide cone. This bubble-rich stream flares outwardly and upwardly back into the pond P where the bubbles rise in the pond away from the downwardly flowing stream of liquid to the guide cone. Upon reaching the surface of the pond the bubbles can burst to liberate the gases and vapors contained therein in the top of the tank and out of the tank vent V.

If desired, as shown in Figure 6, the portion of the disk or flange 52 of the impeller 50 extending into the chamber 16 can have short vanes 58 depending from the bottom side thereof around the periphery thereof. These vanes 58 project into the volute chamber 16 and will additionally whirl the liquid in the chamber 16 to the outlet 20 thereby somewhat increasing the capacity of the pump. These vanes 58 thus aid the projecting disk or flange portion 52 in whirling liquid through the volute chamber.

The frusto-conical arrangement of the screen and the inverted frusto-conical arrangement of the guide cone provide for directed passage of liquid toward the pump and directed passage of bubble-rich liquid away from the pump without unduly impeding free flow of liquid. The guide

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cone can be made quite shallow and the screen, by being formed as a frusto cone, need not have much over-all height so that the liquid in the pond P can be drained to a very low level in the tank T and still be sufficient to supply the pump. This liquid, of course, flows to the pump by gravity.

Any material in the pump chamber 16 which leaks into the well 14 can be drained at intervals through the ports 40 by removal of one or more of the plugs 41. Water, which is heavier than gasoline, may collect in the well, and can be drained through these ports 40. In addition, if any liquid should leak past the seals 42 and 33, the same can be drained out of the localized chamber 15 portion in the well 14 above the flame trap member 31 through a drain port 34.

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 than necessitated by the scope of the appended claims.

We claim as our invention:

1. A motor and pump unit comprising a motor casing, an end cap for said casing having a hollow neck portion defining a shaft well, an enlarged upper end portion defining a pumping chamber and an outturned mounting flange around said enlarged portion, a throat ring removably secured to said enlarged portion having a bottom wall projecting into the pumping chamber to cooperate therewith for defining a pump volute with a central inlet, a plurality of upstanding legs on said throat ring, an inverted frusto-conical guide cone carried by said legs, a frusto-conical screen carried by said guide cone having a side wall bottomed on the throat ring and a top wall above the guide cone, a shaft extending from said motor casing through said well and through the throat ring, cooperating seal members around said shaft in said well, said neck portion having a plurality of drain ports therein communicating with said well at a level adjacent said seal means,
- a pump impeller on said shaft having a flange portion spanning the inlet of the pump and projecting into the volute chamber, upstanding pumping vanes on said flange portion underlying said throat ring and terminating adjacent the aperture of the throat ring, additional vanes on said flange portion having inner ends projecting into the aperture of said throat ring, and a propeller on said shaft positioned between the guide cone and the throat ring.

2. A pump assembly comprising a casing defining an open-topped pumping chamber and a central shaft well, an apertured throat ring detachably mounted on said casing covering the open end of the pumping chamber and cooperating therewith to provide an annular chamber around the shaft well, a shaft extending through said shaft well, an impeller on said shaft for pumping material into the pumping chamber, a shaft seal in said well around said shaft, and drain means in said casing adapted to remove liquid entering said well before the same passes said seal means.

3. In a centrifugal type pump having a liquids inlet, a frusto-conical screen mounted on said pump surrounding said inlet and having an end wall in spaced relation from said inlet, and an inverted guide cone inside of said screen having the small open end thereof adjacent the inlet of the pump.

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4. A pump construction comprising a casing defining a shaft well and an annular chamber around said well, a stationary seal ring mounted in said well, a sleeve threaded in said well having a recessed bottom end thrusting against said stationary seal ring, said well having an annular groove therearound communicating with the interior of said sleeve through the recesses in the sleeve, said casing having drain ports communicating with said annular groove, a shaft extending through said stationary seal, a second seal disposed around said shaft, means urging said second seal into sliding face engagement with said stationary seal, and a pump impeller on said shaft having pumping vanes thereon for discharging liquid into said annular chamber.

5. In an electric motor-centrifugal pump unit a casing defining a central shaft well and an annular pumping chamber around said well, a shaft extending through said well, a throat ring mounted on said casing having an aperture receiving said shaft, an impeller having a hub portion mounted on said shaft and a disk portion with upstanding pumping vanes thereon overlapping said throat ring, and a propeller on said shaft on top of said hub having a plurality of wide vanes in advance of the throat ring with the trailing edge of each vane aligned radially with the leading edge of the adjacent vane.

6. In a pump construction an impeller having a central hub portion and a radial flange portion intermediate the ends of the hub portion, upstanding pumping vanes on said flange portion extending from the periphery thereof into spaced relation from the hub portion, and additional vanes on said flange portion intermediate said pumping vanes extending from the periphery of the flange portion into said hub portion, the inner ends of said additional vanes being curved upwardly into said hub portion.

7. A pump impeller comprising a disk having upstanding pumping vanes extending inwardly from the periphery of the disk and terminating in spaced relation from the center of the disk together with additional vanes between said pump-

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ing vanes extending from the periphery of the disk and terminating in higher end portions inwardly of the ends of the pumping vanes and sloping upwardly into the hub portion.

8. A pump impeller comprising a flat disk having a hub and pumping vanes on one face thereof extending inwardly from the periphery thereof to and joining the hub in upwardly tapered portions and having additional vanes on the other face thereof extending inwardly from the periphery for a short distance.

9. In a pump construction, a pump casing having a central inlet, and an impeller in said casing comprising a disk and pumping vanes on a face of the disk extending inward from the periphery thereof to the hub of the disk and having tapered portions extending into the casing inlet and increasing in height toward the hub to form deep uncovered swirling vane areas exposed in the inlet, and additional vanes intermediate said first vanes extending inward from the periphery of the disk a shorter distance than the first mentioned vanes.

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