Jan. 30, 1945. M. L. EDWARDS 2,368,528

PUMP

Filed Feb. 1, 1941 2 Sheets-Sheet 1

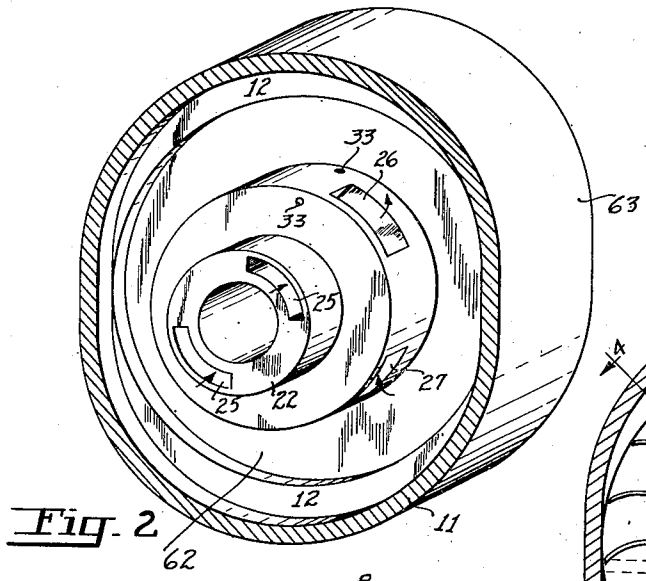

Fig. 2

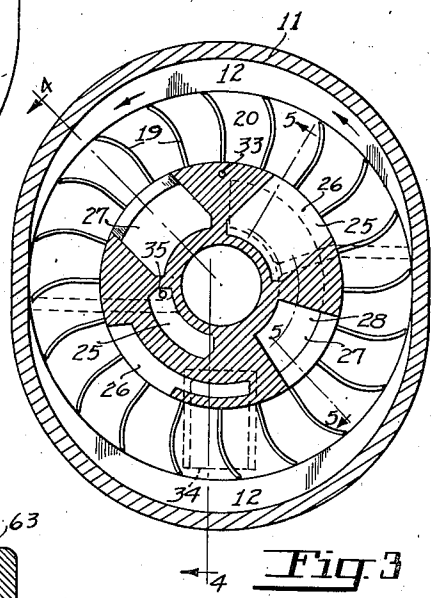

Fig. 3

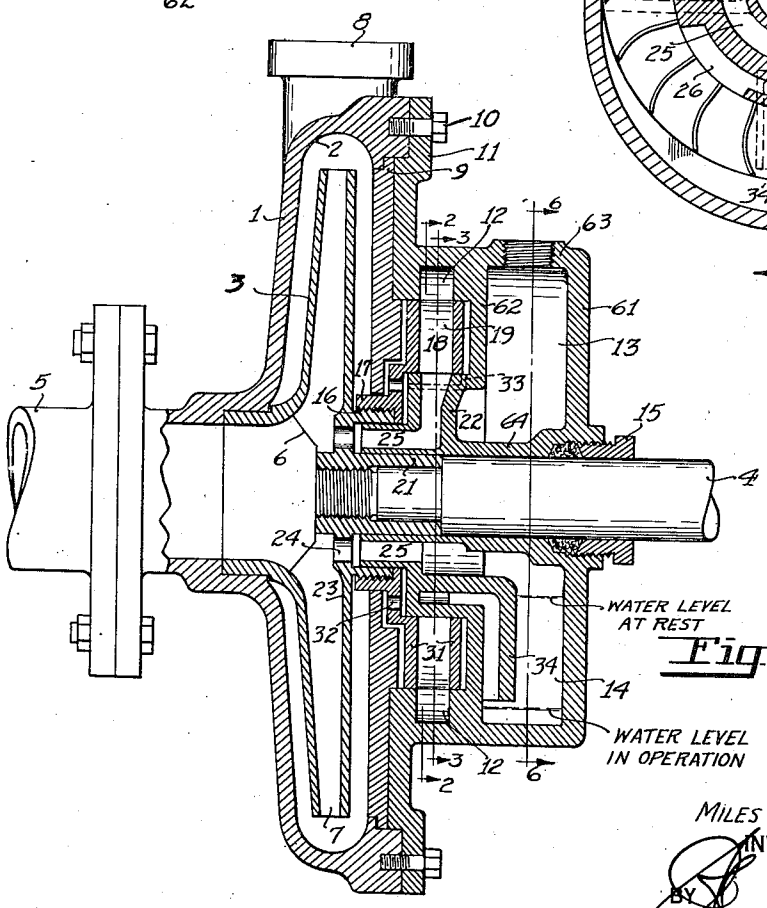

Fig. 1

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Filed Feb. 1, 1941 2 Sheets-Sheet 2

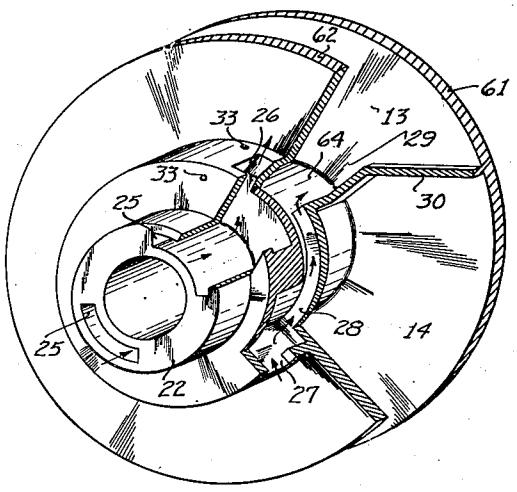

Fig. 5

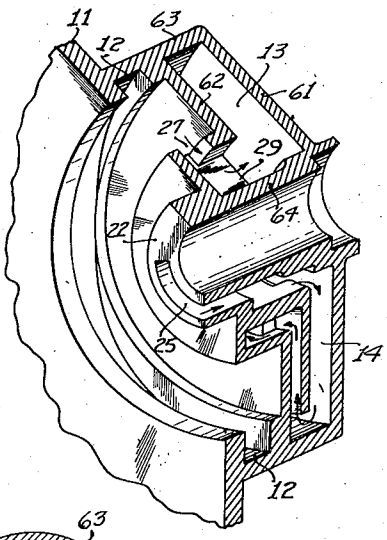

Fig. 4

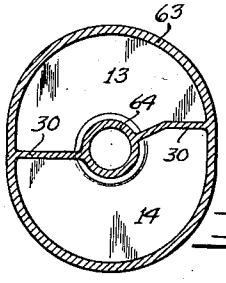

Fig. 6

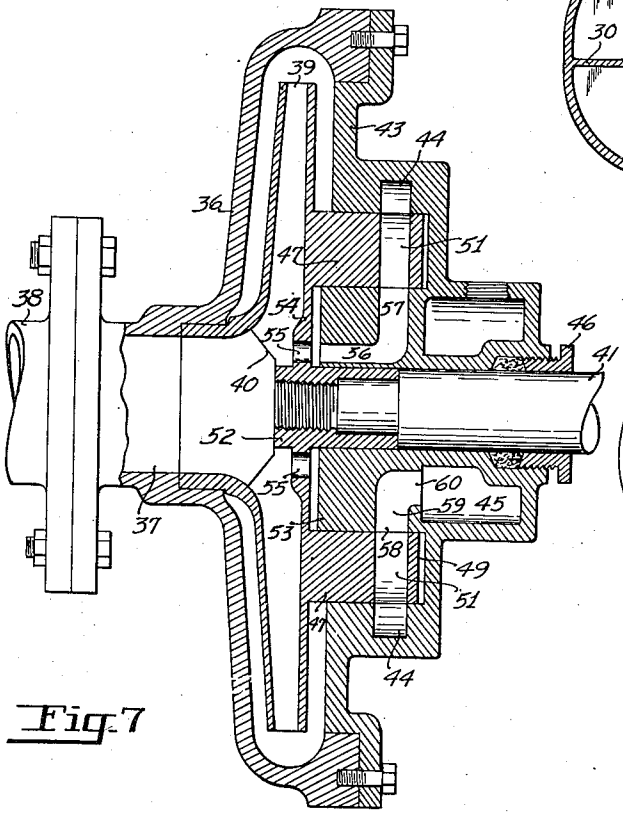

Fig. 7

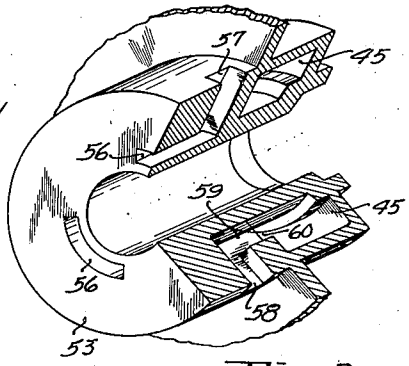

Fig. 8

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UNITED STATES PATENT OFFICE

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PUMP

Miles Lowell Edwards, Longview, Wash.

Application February 1, 1941, Serial No. 377,016

8 Claims. (Cl. 103—113)

This invention relates to centrifugal pumps, and has particular reference to an improved apparatus for relieving such pumps of air or other gases which may be entrained with the liquid during pumping operations, and for exhausting air from the intake pipe to lift liquid to the pump.

It is well known that when acted upon by a rotating impeller the air and gases entrained with the liquid being pumped will collect near the center of the impeller in the inner ends of the passageways between the blades and restrict the flow of liquid through the pump. When this condition occurs the pump is said to be "air bound." The present invention comprises a pump having an impeller of the centrifugal type for pumping liquids, and a displacement impeller of the hydroturbine type for withdrawing gaseous fluids which may collect near the center of the first named impeller and for discharging them from the pump. The hydroturbine pump element employs water as the pumping medium, the water alternately entering and receding from a series of displacement chambers in an impeller rotatably journaled in an eccentric casing. The principle of operation is illustrated and described in Letters Patent No. 2,211,316, issued August 13, 1940, to Miles L. Edwards and Carl Blom, for Wet type gas pump. The present construction embodies a stationary port member upon which the displacement impeller is journaled and within which are passages leading from the centrifugal impeller to provide communication between the area adjacent the eye of the centrifugal impeller and the said displacement chambers. The construction provides a simple, compact unit which may be produced with few parts and with a minimum of time and labor in assembly.

It is the principal object of the invention to provide means for positively withdrawing from the inner ends of the passages between the blades of a centrifugal impeller any accumulation of air or gases entrained with the liquid being pumped.

It is a further object of the invention to provide in a centrifugal pump means enabling continuous and efficient operation when pumping foaming liquids or liquids which contain entrained air or free gases.

It is a further object of the invention to provide a pump of the centrifugal type having an impeller of the hydroturbine type associated therewith for expelling accumulated air and gases from the pump.

It is a further object of the invention to provide a self-priming pump of the centrifugal type.

With these and other objects in view, the invention resides in the novel construction and combination of parts hereinafter described, illustrated in the accompanying drawings, and set forth in the appended claims; it being understood that various changes in form, proportion, size and details of construction within the scope of the claims may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

In the drawings:

Figure 1 is a sectional elevation of a pump embodying the present invention, the rotating element comprising an impeller of the centrifugal type having a displacement impeller of the hydroturbine type mounted on one side thereof, and a port member providing communication between the working chambers of said impellers.

Figure 2 is a perspective view of a portion of the pump housing, and more particularly, of the port member. The view is taken on the line 2—2 of Figure 1. The arrows indicate the direction of flow of air through the intake and discharge ports, respectively.

Figure 3 is a sectional elevation taken transversely of the pump on the line 3—3 of Figure 1, and illustrating the arrangement of the intake and discharge ports in the hydroturbine pump.

Figure 4 is a perspective view of a sector of the pump housing taken on the line 4—4 of Figure 3. The figure shows a sector of one lobe of the hydroturbine pump. The arrows in the lower part of the drawing indicate the flow of air from the eye of the centrifugal impeller through the port member to the intake ports of the hydroturbine pump. The arrows in the upper part of the drawings indicate the flow of air from the discharge ports of the hydroturbine pump to the separation chamber.

Figure 5 is a perspective view similar to Figure 2 except that the outer wall of the pump housing has been removed. The view is of the port member and is taken on the line 2—2 of Figure 1. One set of arrows indicates the flow of air from the eye of the centrifugal impeller to an intake port in the hydroturbine pump; the other set of arrows indicating the flow of air from a discharge port in the hydroturbine pump to the separation chamber. Portions of the walls of the port member are cut away to show the relation of ports and passageways therethrough.

Figure 6 is a sectional elevation taken transversely of the pump on the line 6—6 of Figure 1. The view illustrates the relative positions of the separation chamber into which gas is exhausted from the hydroturbine pump and of the priming

chamber into which water forming the pumping element of the hydroturbine pump may flow when the pump is idle.

Figure 7 is a sectional elevation of a pump embodying the invention and illustrating the details of a modified construction of such a pump. In this figure of the drawings the rotating element is shown as comprising in one piece the impeller for the centrifugal pump and the displacement impeller for the hydroturbine pump.

Figure 8 is a perspective view of that portion of the housing for the pump illustrated in Figure 7 which constitutes the port member and the separation chamber. A sector of the housing has been cut away as on the line 8—8 of Figure 3 to show the course of passages therethrough.

Referring first to Figure 1 and related views of the drawings, the illustrated embodiment of the invention comprises a pump casing 1 forming a pressure chamber commonly referred to as a volute 2. Mounted within the volute is a centrifugal type impeller 3, the impeller threadedly engaging a drive shaft 4 so as to rotate therewith. Liquid to be pumped enters the pump by way of a supply pipe 5, from whence it passes through the eye 6 of the impeller and through passages defined by the impeller vanes 7 and into the area defined by the volute 2. The liquid is discharged from the pump volute through the discharge port 8. A side plate 9 forms one wall of the pump casing housing the volute 2.

Securely fastened to the casing 1, as by bolts 10, is a housing 11, and contained within the housing 11 are the lobes 12—12 of a hydroturbine pump, a separation chamber 13, and a priming chamber 14, presently to be described. The housing 11 is generally cylindrical in form, and the shaft 4 extends centrally therethrough into engagement with the centrifugal impeller 3. A stuffing box 15 is employed to seal the pump at the point where the shaft 4 enters the housing 11.

Extending axially from one side of the impeller 3, opposite the intake port or eye 6, is a threaded cylindrical boss 16. Threadedly engaging the boss 16 is a boss 17 upon which is carried the displacement impeller 18 of a hydroturbine pump. The impeller 18 comprises vanes 19 defining a plurality of passages which form the displacement chambers 20 of the hydroturbine pump. Rotation of the impeller 18 is coincident with rotation of the impeller 3, since one impeller operatively engages the other impeller through the medium of the threaded cylindrical bosses 16 and 17.

In the exemplary embodiment of the invention the threaded boss 16, extending from one side of the impeller 3, is concentric with, but in spaced apart relation from, the hub 21 of the impeller. Likewise, the impeller 18 is mounted in concentric spaced apart relation to the hub of the impeller 3. For convenience of construction the inside diameter of the impeller 18 is somewhat greater than the inside diameter of the boss 16, the impeller 18 extending axially beyond the end of the boss 16. Projecting into the space defined by the inside diameter of the impeller 18 and likewise into the space defined by the inside diameter of the boss 16 so as to completely occupy the space between these elements and the shaft 4 (or hub 21 of the impeller 3) is an extension of the housing 11 forming a port member 22. It should be understood that the impeller 18 is rotatively journaled on the port member 22, the threaded bosses 16 and 17 providing means for driving the impeller 18. Inlet and discharge passages extend through the port member and communicate with ports for inlet to and discharge from the hydroturbine pump.

It will be noted that the vanes 7 extend into the radial area of the eye 6 of the impeller 3 and are integrally joined to the hub 21. Adjacent the hub 21 the shroud 23 of the impeller 3 is provided with a series of openings or ports 24 which provide communication between the inner ends of the passages between the blades 7 of the impeller 3 and intake passages 25 extending through the port member 22. The intake passages 25 communicate with the displacement chambers 20 of the impeller 18 through intake ports 26. Discharge ports 27 communicate by way of passages 28 (see Figure 5) with an exhaust port 29 opening into the separation chamber 13. In this connection it will be noted that the separation chamber 13 is separated from the priming chamber 14 by partitions 30. A comparison of Figures 4 and 5 will reveal that the exhaust port 29 is positioned behind the intake port 26 in the upper lobe of the pump, and that both discharge ports 27 are in communication with the exhaust port 29 by way of cross-over passages 28.

The separation chamber 13 and priming chamber 14 are contained between an outer vertical wall 61 and an inner vertical wall 62, the latter comprising the partition between these said chambers and the lobes 12—12 of the hydroturbine pump. A peripheral wall portion 63 and a hub portion 64 complete this enclosure. The horizontal partitions 30 divide the space thus enclosed into the separation and priming chambers, respectively.

The port member 22 and impeller 18, together with the lobes 12, comprise a displacement pump of the type employing water as the pumping medium, in which the water alternately enters and recedes from the series of displacement chambers 20 in the impeller 18. The impeller 18 is positively driven by the shaft 4 through the medium of the centrifugal element 3 to which it is fastened. The impeller 18 is cylindrical in shape and rotates within a compartment or chamber in the housing 11 closely fitting the impeller at the two sides thereof, as shown in Figure 3, and being spaced therefrom to form the lobes 12 above and below the impeller. In operation the housing 11 is partly filled with water and the impeller is driven at high speed. Propelled by the vanes 19, the water in the housing travels around with the impeller, and centrifugal force and the inertia of the liquid causes it to follow the elliptical path formed by the lobes 12. Thus the water will alternately enter and recede from each displacement chamber 20 to form enlarging and contracting spaces therewithin. As the impeller 18 is rotated the vanes 19 revolve about the port member 22 in rapid succession, their travel being alternately over intake ports 26 and discharge ports 27 which register with the openings in the bottom of each displacement chamber. As these chambers register with intake ports 26 and the liquid piston begins its receding action by reason of the divergence of the lobe 12 of the housing, a positive suction is created through ports 26 and passages 25, and air or gases which have accumulated adjacent the eye 6 of the impeller 3 are positively withdrawn therefrom into the displacement chambers 20 in the impeller 18. After the openings in the bottom of the displacement chambers have passed out of communication with the ports

26, the wall of the lobe 12 begins to converge toward the impeller, causing the liquid piston to approach the center of rotation to compress the air in the displacement chambers. The compression of the air attains its maximum as the displacement chambers reach the horizontal line of the casing, at which point the liquid piston completely fills the displacement chambers. As the displacement chambers pass over the ports 27 the air therewithin is forced through these ports by the liquid piston until the displacement chambers are completely exhausted of the air acted upon by the pump.

Due to running clearances between the peripheral surface of the boss 17 and the adjacent edge of the side plate 9, and between the shrouds 31 of the impeller 10 and the housing 11, a tendency exists for the vacuum created by rotation of the impeller 3 to withdraw the liquid ring from the lobe 12 of the air pump. To overcome this difficulty holes 32 are drilled through the supporting flange of the impeller 18 which register with a passage 33 through the port member 22. The passage 33 provides communication between the spaces at each side of the impeller 18 and serves to equalize any pressure difference created in the spaces between the shrouds 31 of the impeller and the adjacent walls of the pump housing.

The intake passage 25 which communicates with the intake port 26 in the lower lobe of the air pump follows a circuitous path which leads through the priming chamber 14 and under a depending baffle 34 disposed within said chamber, and thence to the intake port 26 in the lower lobe of the air pump. The priming chamber 14 serves as a reservoir into which the liquid ring of the air pump may drain when the pump becomes idle. When the pump begins operation the water in the priming chamber 14 is drawn into the air pump through the lower intake port 26 to form the liquid ring of the pump, thus opening the passage 25 for the withdrawal therethrough of air or gas from the centrifugal pump casing and the inlet pipe 5, evacuating the same and positively priming said centrifugal pump. It will be appreciated that a certain amount of water will be discharged from the air pump through the exhaust port 29 and into the separation chamber 13. A bleed hole 35 (Figure 3) is provided through the vertical wall 62 through which water discharged into the separation chamber 13 may feed back into the priming chamber 14, thus providing for replenishing the liquid ring of the pump.

The pump illustrated in Figure 7 comprises a casing 36 having at one side thereof an intake opening 37. Liquids to be acted upon by the pump are supplied to the intake opening 37 through a supply pipe 38. The casing 36 is in the form of a volute chamber for a centrifugal pump, and rotatably mounted therewithin is an impeller 39 having an eye 40. The impeller is secured to a drive shaft 41 through which power is supplied from any suitable source to drive the impeller. Bolted to the side of the casing 36 is a housing 43 containing the working chambers or lobes 44 of an air pump, presently to be described, and also containing a discharge chamber 45. A stuffing box 46 is employed to seal the pump at the point where the shaft 41 enters the housing 43.

A feature of the invention to be found in the construction illustrated in Figure 7 is the unitary construction of the centrifugal impeller 39 and the displacement impeller 49, these elements being cast in one piece. Extending axially from the side of the impeller 39 opposite the eye 40 is a cylindrical projection 47 upon which is carried the displacement impeller 49 of the air pump. The impeller 49 comprises shrouds between which are a plurality of vanes 51 defining the passages which form the displacement chambers of the pump. Rotation of the impeller 49 and of the impeller 39 is coincidental because of the fact that these two elements are integrally joined. Radially of the projection 47 the housing 43 forms the side wall of the volute casing 36, whereas centrally of the projection 47 the housing 43 functions as a hub for the impeller 49, but more particularly as a port member 53.

The vanes defining the passages of the impeller 39 extend into the radial area of the eye 40 and are integrally joined to the hub 52. Adjacent the hub 52 the shroud 54 of the impeller 39 is provided with a series of passages or ports 55, which provide communication between the inner ends of the impeller passages within the area of the eye 40 of the impeller 39 and intake passages 56 extending through the port member 53. The intake passages 56 communicate with the displacement chambers of the impeller 49 through intake ports 57. Discharge ports 58 communicate by way of passages 59 (see Figure 8) with exhaust ports 60 opening into the discharge chamber 45.

The port member 53 and impeller 49, together with the working chambers or lobes 44, comprise a pump of the type employing water as the pumping medium, the water alternately entering and receding in the displacement chambers of the impeller 49. The operation is similar to that described in connection with the pump illustrated in Figure 1. Operation of the air pump creates a positive suction through ports 55 and passages 56, and air or gases which have accumulated adjacent the eye 40 of the impeller 39 are positively withdrawn therefrom into the displacement chambers of the impeller 49, and are discharged therefrom by way of ports 58 into the discharge chamber 45.

The chief difference between the pump illustrated in Figure 1 and the pump illustrated in Figure 7 is that the latter pump is not equipped with the storage chamber from which priming water is supplied to the liquid piston of the air pump. The pump illustrated in Figure 7 is not intended to be a self-priming pump, and is intended for operation generally where the suction opening of the impeller 39 is subjected to a positive liquid level.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. A pumping apparatus comprising a casing, a volute chamber in said casing having an axial intake port and a peripheral discharge port, an eccentric chamber in said casing having an axial intake port and an axial discharge port, a centrifugal impeller mounted in said volute chamber and comprising therewith a centrifugal pump, a rotor mounted in said eccentric chamber and comprising therewith a hydroturbine pump, a gas and liquid separating chamber in said casing on the discharge side of said hydroturbine pump, a hub for said rotor, ports through said hub providing for the passage of air from the eye of said impeller to the displacement chambers of said rotor, and ports through said hub providing for

the discharge of said air from said displacement chambers to said separating chamber.

2. A pumping apparatus comprising a casing, a volute chamber in said casing having an axial intake port and a peripheral discharge port, a centrifugal impeller mounted in said volute chamber and comprising therewith a centrifugal pump, an eccentric chamber in said casing, a rotor mounted in said eccentric chamber and comprising therewith a hydroturbine pump, said centrifugal impeller having a plurality of vanes extending generally radially from the eye of the impeller, an opening extending axially through the impeller within the radial area of said intake port, said impeller vanes extending to within said area for positively conducting air and gases into said area, said rotor having a plurality of vanes defining displacement chambers therebetween, a cylindrical portion of said casing projecting into the side of said rotor and comprising a hub for said rotor, intake and discharge ports in said hub, a port in the inner end of each said displacement chamber adapted to register successively with said intake and discharge ports as said rotor is rotated about said hub, passages in said hub providing communication between the opening through said impeller and said intake ports, and discharge passages in said hub providing for the discharge of fluids acted upon by said hydroturbine pump.

3. A pump for pumping fully liquid material from a supply of such material, comprising a casing comprising a pump chamber having an axial intake port and a peripheral discharge port, said casing comprising also a second chamber having an axial intake port in axial alignment with said first intake port and having an axial discharge port, first pumping means mounted in said pump chamber for pressuring liquid to said peripheral discharge port, second pumping means mounted in said second chamber for withdrawing gaseous fluids from said first pumping means and discharging said gaseous fluids through said axial discharge port, and a hub for said second pumping means having an intake passage providing communication between said axial intake port and said second pumping means and having a discharge passage providing communication between said second pumping means and said axial discharge port.

4. A pump comprising a casing, a volute chamber in said casing, a centrifugal impeller mounted in said volute chamber and comprising therewith a centrifugal pump, an eccentric chamber in said casing, a rotor mounted in said eccentric chamber and comprising therewith a hydroturbine pump, said centrifugal impeller having a plurality of vanes extending generally radially from the eye of the impeller, an opening through the side of the impeller opposite the eye, said opening being within the radial area of the eye of the impeller, said impeller vanes extending to within said area and sloping toward said side of the impeller for positively conducting air and gases into said area, said rotor having a plurality of vanes defining displacement chambers therebetween, means integrally uniting said centrifugal impeller and said rotor, said rotor being driven by said impeller, a cylindrical portion of said casing projecting into the side of said rotor and comprising a hub for said rotor, intake and discharge ports in said hub, a port in the bottom of each said displacement chamber adapted to register successively with said intake and discharge ports as said rotor is rotated about said hub, passages in said hub providing communication between the opening in the side of said impeller and said intake ports, and discharge passages in said hub providing for the discharge of fluids acted upon by said pump.

5. A pump comprising a casing, a volute chamber in said casing, a centrifugal impeller mounted in said volute chamber and comprising therewith a centrifugal pump, an eccentric chamber in said casing, a rotor mounted in said eccentric chamber and comprising therewith a hydroturbine pump, said centrifugal impeller having a plurality of vanes extending generally radially from the eye of the impeller, openings through the side of the impeller opposite the eye between each two of said impeller vanes and within the radial area of the eye of the impeller, said impeller vanes extending to within said area for positively conducting air and gases into said area, said rotor having a plurality of vanes defining displacement chambers therebetween, means integrally uniting said centrifugal impeller and said rotor, said rotor being driven by said impeller, a cylindrical portion of said casing projecting into the side of said rotor and comprising a hub for said rotor, intake and discharge ports in said hub, a port in the bottom of each said displacement chamber adapted to register successively with said intake and discharge ports as said rotor is rotated about said hub, passages in said hub providing communication between the opening in the side of said impeller and said intake ports, and discharge passages in said hub providing for the discharge of fluids acted upon by said pump.

6. A pump comprising a casing, a volute chamber in said casing, a centrifugal impeller mounted in said volute chamber and comprising therewith a centrifugal pump, an eccentric chamber in said casing, a rotor mounted in said eccentric chamber and comprising therewith a hydroturbine pump, said centrifugal impeller having a plurality of vanes extending generally radially from the eye of the impeller, an opening through the side of the impeller opposite the eye, said opening being within the radial area of the eye of the impeller, said impeller vanes extending to within said area and sloping toward said side of the impeller for positively conducting air and gases into said area, said rotor having a plurality of vanes defining displacement chambers therebetween, said rotor being mounted upon the back plate of said impeller and being driven by said impeller, a cylindrical portion of said casing projecting into the side of said rotor and comprising a hub for said rotor, intake and discharge ports in said hub, a port in the bottom of each said displacement chamber adapted to register successively with said intake and discharge ports as said rotor is rotated about said hub, passages in said hub providing communication between the opening in the side of said impeller and said intake ports, and discharge passages in said hub providing for the discharge of fluids acted upon by said pump.

7. A pump comprising a casing, a volute chamber in said casing, a centrifugal impeller mounted in said volute chamber and comprising therewith a centrifugal pump, an eccentric chamber in said casing, a rotor mounted in said eccentric chamber and comprising therewith a hydroturbine pump, said centrifugal impeller having a plurality of vanes extending generally radially from the eye of the impeller, an opening through the side of the impeller opposite the eye, said

opening being within the radial area of the eye of the impeller, said impeller vanes extending to within said area and sloping toward said side of the impeller for positively conducting air and gases into said area, said rotor having a plurality of vanes defining displacement chambers therebetween, means integrally uniting said centrifugal impeller and said rotor, said rotor being driven by said impeller, a cylindrical portion of said casing projecting into the side of said rotor and comprising a hub for said rotor, intake and discharge ports in said hub, a port in the bottom of each said displacement chamber adapted to register successively with said intake and discharge ports as said rotor is rotated about said hub, a discharge chamber in said casing, passages in said hub providing communication between the opening in the side of said impeller and said intake ports, and passages in said hub providing communication between said discharge ports and said discharge chamber.

8. A pump comprising a casing, a volute chamber in said casing, a centrifugal impeller mounted in said volute chamber and comprising therewith a centrifugal pump, an eccentric chamber in said casing, a rotor mounted in said eccentric chamber and comprising therewith a hydroturbine pump, said centrifugal impeller having a plurality of vanes extending generally radially from the eye of the impeller, an opening through the side of the impeller opposite the eye, said opening being within the radial area of the eye of the impeller, said impeller vanes extending to within said area and sloping toward said side of the impeller for positively conducting air and gases into said area, said rotor having a plurality of vanes defining displacement chambers therebetween, means integrally uniting said centrifugal impeller and said rotor, a cylindrical portion of said casing projecting into the side of said rotor and comprising a hub for said rotor, passages in said hub providing communication between the opening in the side of said impeller and the intake side of said hydroturbine pump.

MILES LOWELL EDWARDS.