Feb. 24, 1953 H. G. BECK 2,629,540

ROTARY SUCTION PUMP

Filed Sept. 29, 1949 2 SHEETS--SHEET 1

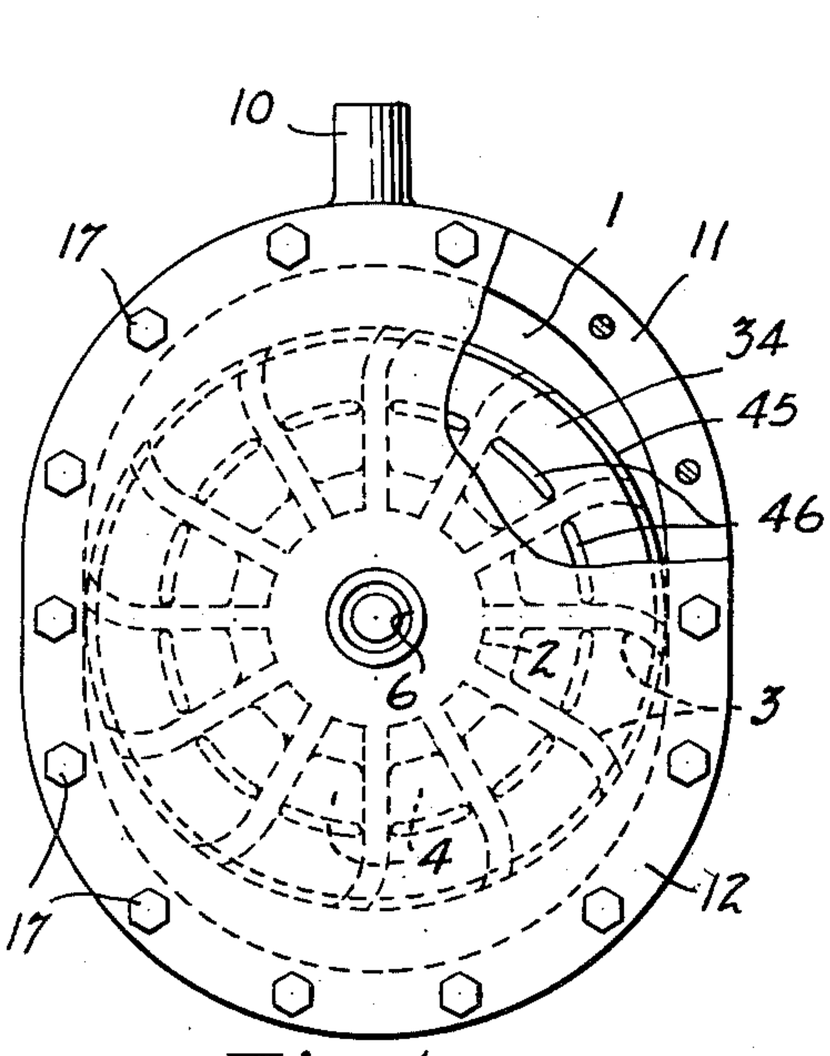

Fig. 1

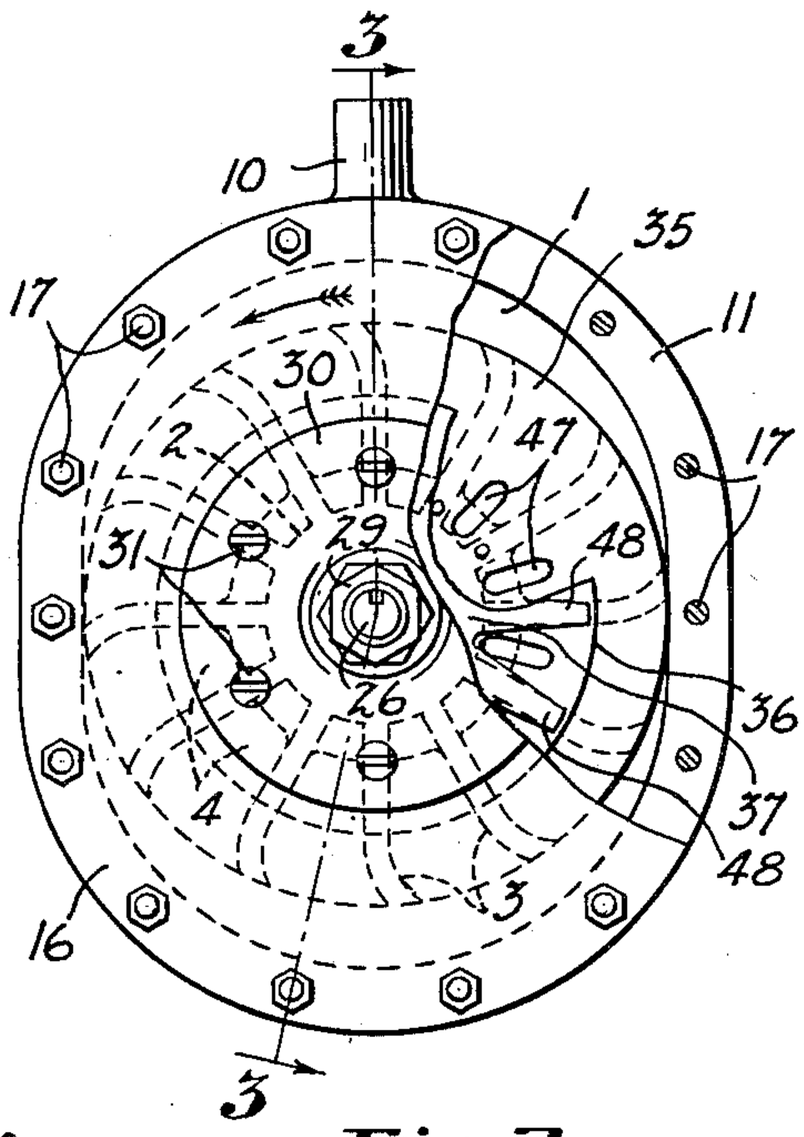

Fig. 2

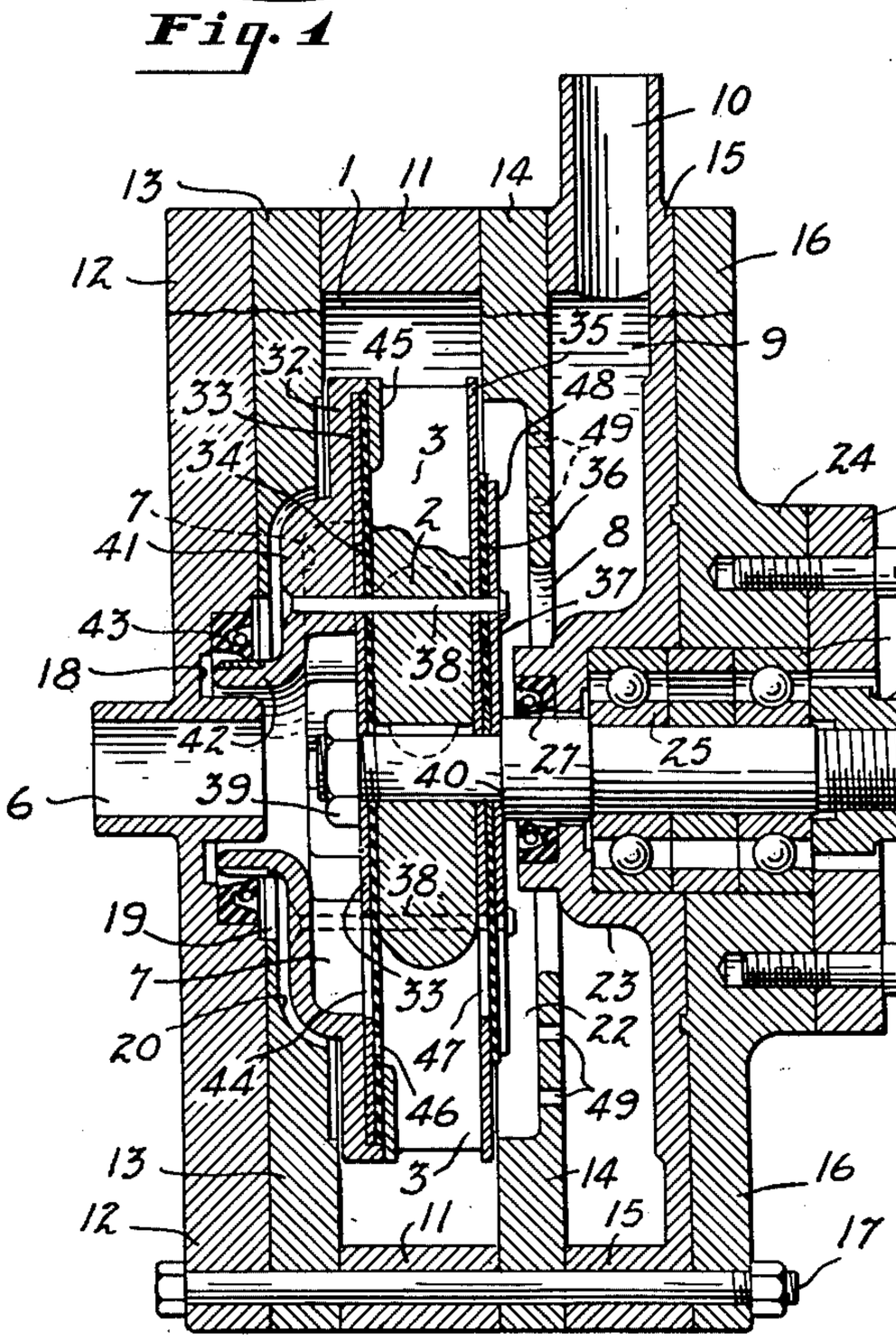

Fig. 3

INVENTOR

Howard G. Beck

BY Evans & McCoy

ATTORNEYS

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2 SHEETS--SHEET 2

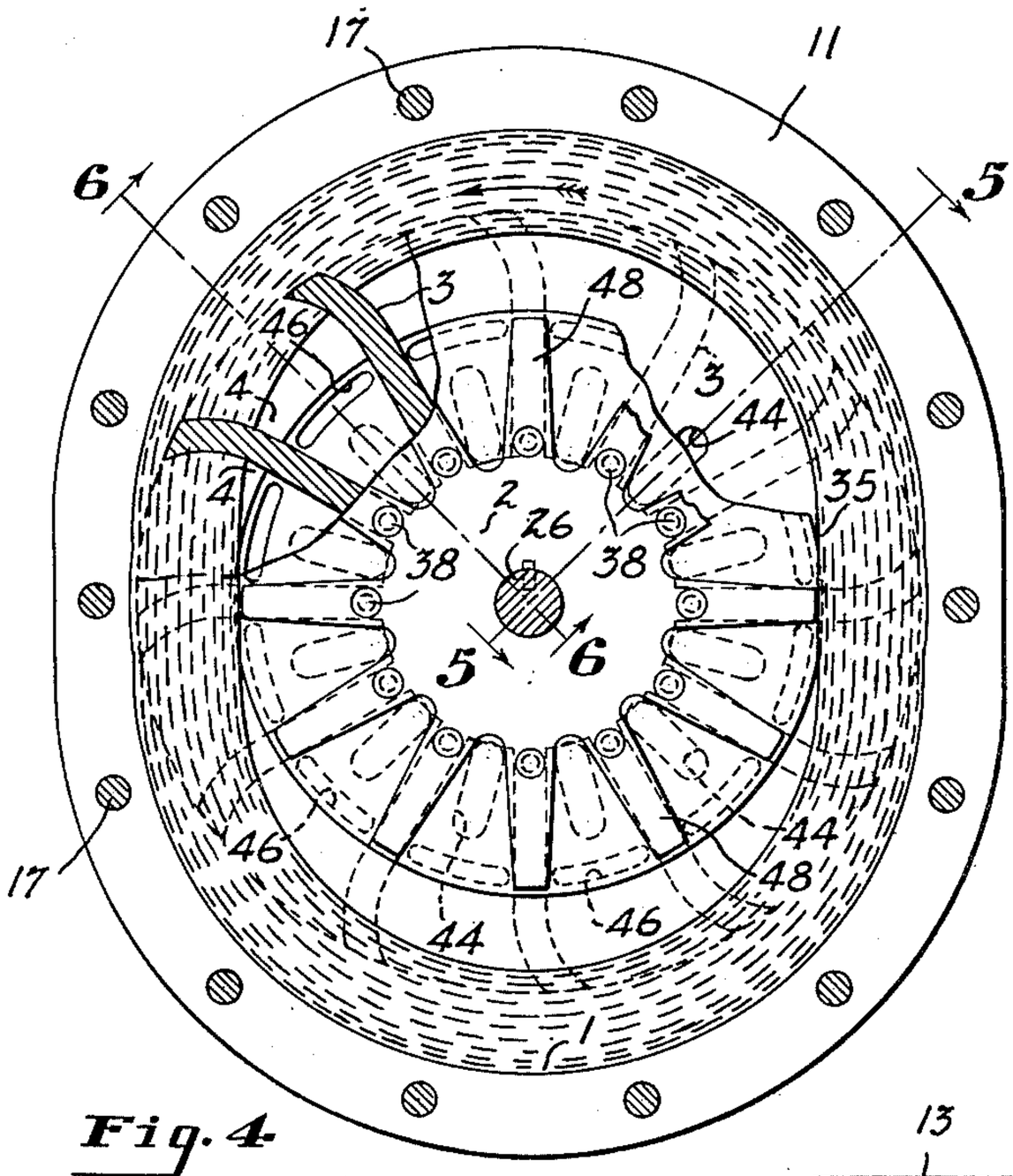

Fig. 4

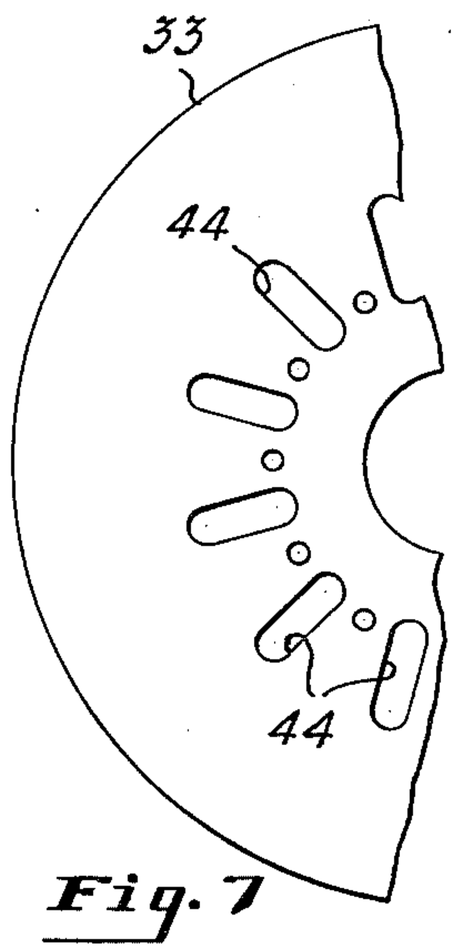

Fig. 7

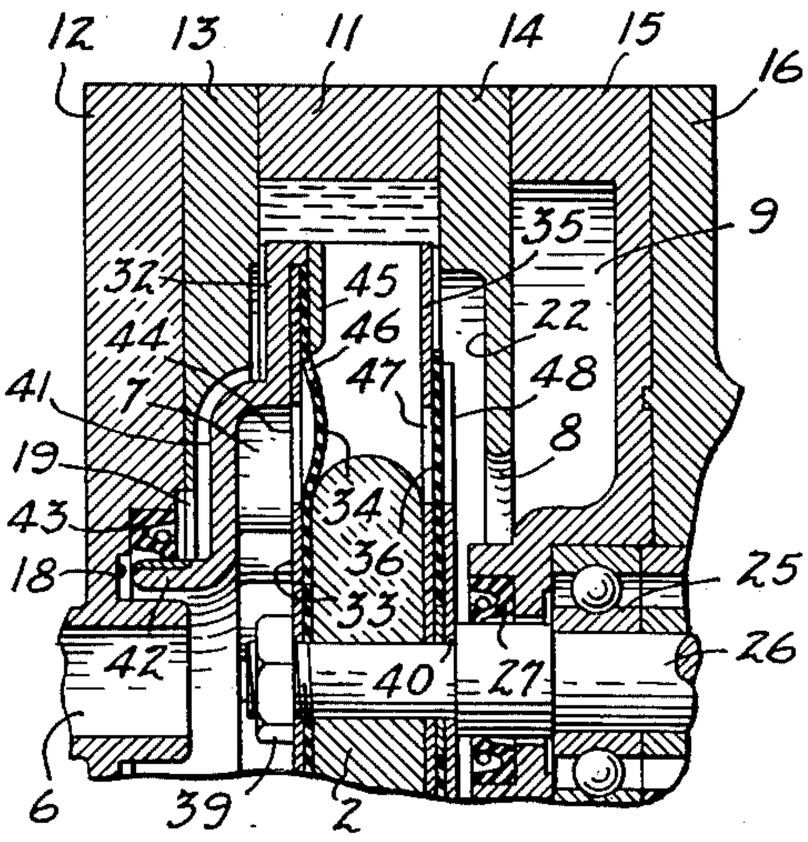

Fig. 5

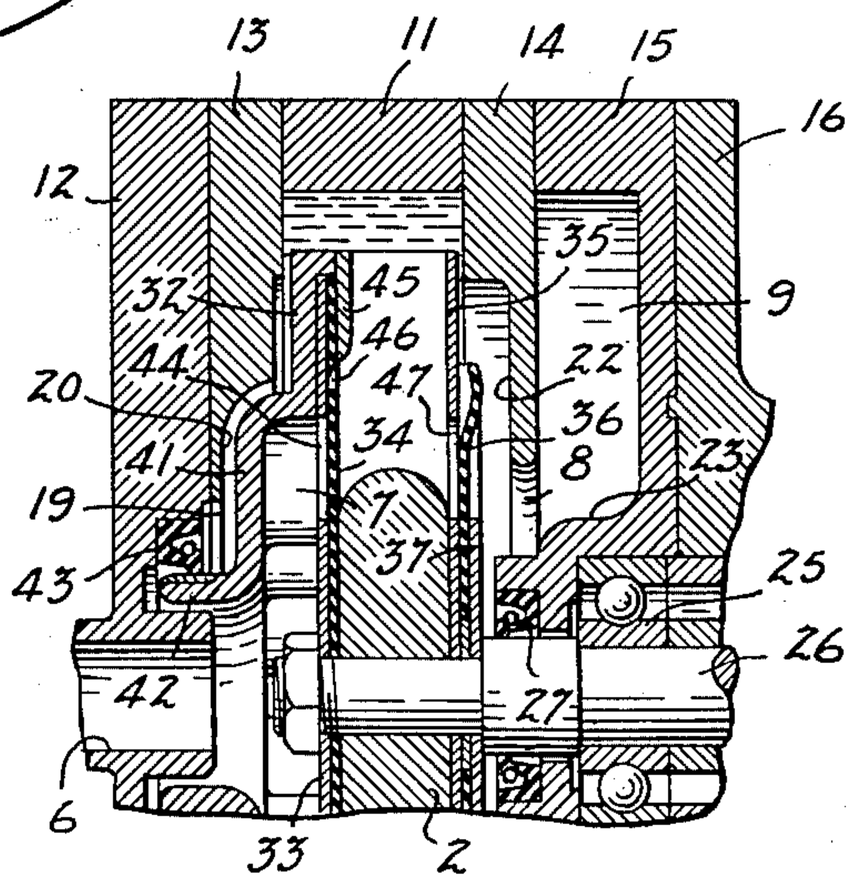

Fig. 6

INVENTOR

Howard G. Beck

BY *Evans + McCoy*

ATTORNEYS

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ROTARY SUCTION PUMP

Howard G. Beck, Wabash, Ind., assignor to The General Tire and Rubber Company, Akron, Ohio, a corporation of Ohio

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7 Claims. (Cl. 230—79)

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This invention relates to rotary suction pumps and has for its object to provide a pump of a simple and economical construction capable of pumping water or air, or a mixture of water and air.

A further object of the invention is to provide a suction pump which is operable to pump liquid and which has a rotor formed to provide one or more displacement chambers and a non-circular pump chamber formed to trap a volume of liquid sufficient to provide a peripheral air displacing ring, and which will operate as a hydro-turbine air pump when flow of liquid to the pump ceases.

A further object of the invention is to provide a pump of the hydro-turbine type which has a rotor so constructed that reverse flow of fluid from the pump outlet into the rotor, or from the rotor into the pump outlet is prevented.

The invention has for a further object to provide inlet and outlet ports for the rotor displacement chambers that are disposed at a radial distance from the axis of the rotor such that the proper amount of liquid can be trapped in the pump chamber to enable the pump to operate as a hydro-turbine vacuum pump.

A further object of the invention is to provide simple and efficient check valves in the form of rubber diaphragms controlling the inlet and outlet ports of the rotor displacement chambers.

With the above and other objects in view the invention may be said to comprise the pump as illustrated in the accompanying drawings and hereinafter described, together with such variations and modifications thereof as will be apparent to one skilled in the art to which the invention pertains.

Reference should be had to the accompanying drawings forming a part of this specification, in which:

Figure 1 is a side elevation of the pump looking toward the inlet side, a portion of the casing being broken away to show parts within the casing;

Fig. 2 is a side elevation of the pump looking toward the outlet side, a portion of the casing being broken away to show internal parts;

Fig. 3 is a section on an enlarged scale taken on the broken line indicated at 3—3 in Fig. 2;

Fig. 4 is a side elevation partially broken away and shown in section, showing the liquid air displacing ring at the periphery of the pump chamber;

Fig. 5 is a fragmentary section taken on the line indicated at 5—5 in Fig. 4;

Fig. 6 is a fragmentary section taken on the line indicated at 6—6 in Fig. 4; and

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Fig. 7 is a fragmentary plan view of a portion of the inner rotor side plate at the inlet side of the rotor.

The pump of the present invention is of the hydro-turbine type in which the rotor provided with air displacement chambers open to its periphery is mounted in a casing formed to provide a pump chamber which is so constructed that it will retain a sufficient volume of liquid to form an air displacing ring at the periphery of the chamber, the rotor periphery being spaced at different distances from circumferentially spaced portions of the peripheral wall of the pump chamber so that air in the displacement chambers of the rotor is displaced by liquid as the chambers pass a portion of the peripheral wall of the pump chamber that is in closer proximity to the rotor periphery than other portions of the wall.

As herein shown, the pump casing has a chamber 1 which is so shaped that the circular periphery of a rotor of the proper size will be in close proximity to the peripheral wall of the chamber at circumferentially spaced points, the space between the peripheral wall of the chamber and the periphery of the rotor gradually increasing from said points toward an intermediate point where maximum clearance is provided between the peripheral wall of the casing and the periphery of the rotor so that air may be drawn into displacement chambers of the rotor and compressed as the chamber moves across the space between the points of close clearance. As herein shown the pump chamber is substantially elliptical in form with the minor axis of the ellipse substantially corresponding to the diameter of the rotor so that the rotor is closely adjacent the peripheral wall of the pump chamber at diametrically opposite points and compression of the air in the displacement chambers occurs twice during each revolution of the rotor.

The rotor herein shown has a hub portion 2 and impeller vanes 3 that radiate from the hub portion to provide displacement chambers 4 between successive vanes. When a ring of liquid is provided in the pump chamber the displacement chambers are partially filled with liquid while passing the points where the rotor has small clearance, and are substantially empty when passing points midway between the points of small clearance. The displacement of air in the displacement chambers 4 by liquid puts the air under compression while the chambers are passing the points of close clearance, and the withdrawal of the chambers from the liquid ring reduces the pressure in the displacement chambers at inter-

mediate points, the chambers passing alternately through high and low pressure zones. As is common practice in hydro-turbine pumps, fluid passes into the displacement chambers while the chambers are passing through the low pressure zones, and is allowed to escape from the displacement chambers while the chambers are passing through the high pressure zones.

The pump casing has a centrally disposed inlet 6 through which fluid is delivered into an inlet chamber 7 formed in the rotor. At the side of the pump chamber opposite the inlet 6 the pump chamber is provided with a central outlet opening 8 which opens into an annular outlet chamber 9 which delivers to a discharge passage 10.

The pump of the present invention is designed to draw liquid from a suitable container such as the tub of a washing machine, and to exhaust air from the container after the liquid is discharged. The casing discharge outlet 10 should be high enough to insure that sufficient liquid will be trapped in the pump casing to provide a liquid seal during periods when the pump is idle.

The pump casing which may be formed in various ways, is shown composed of separable sections, having a central section 11 in the form of a ring which forms the peripheral wall of the pump chamber 1, the ring 11 as herein shown being of substantially elliptical form. The casing has a side wall at the inlet side formed by plates 12 and 13, and a side wall at the opposite side formed by plates 14, 15 and 16. The plates 12 and 13, and the plates 14, 15 and 16 are secured together and to the central ring 11 by means of circumferentially spaced bolts 17.

The outer plate 12 of the inlet side wall has the central inlet 6 formed therein and around the central inlet 6 is provided on its inner face with an annular recess 18. The inner plate 13 has an opening 19 that registers with the annular recess 18 and is provided with a recess 20 in its inner face around the opening 19.

The inner plate 14 of the outlet side wall of the casing has the outlet opening 8 formed therein, and around the opening 8 is provided with a recess 22 on its inner side which extends to near the periphery of the rotor and which provides a space in the pump chamber into which fluid may be discharged from the rotor. The intermediate plate 15 of the outlet side wall has a central inwardly projecting boss 23 which projects into the opening 8, and the outer plate 16 has an outwardly projecting boss 24. The bosses 23 and 24 are bored to receive a ball bearing 25 in which a rotor shaft 26 is journaled. Within the boss 23 at its inner end a sealing ring 27 is mounted which surrounds the shaft 26 and prevents leakage from the pump chamber to the bearing 25. The bearing 25 is retained by means of nuts 28 and 29 on the shaft 26, and by means of a plate 30 clamped to the outer face of the boss 24 by bolts 31.

The rotor is provided at its inlet side with a side wall formed by an outer plate 32, an inner plate 33, and a rubber diaphragm 34. The opposite side wall of the rotor is formed by an inner plate 35, a rubber diaphragm 36 and an outer diaphragm retaining spider 37. The plates and diaphragm forming the opposite side walls of the rotor are secured together and to the body of the rotor by means of a circumferential row of rivets 38 which pass through the hub 2 adjacent the periphery thereof. The central portions of the plates 33 and 35 and of the diaphragms 34 and 36 and spider 37 are clamped to the hub 2 between a nut 39 and a shoulder 40 on the shaft 26.

The outer side wall plate 32 of the rotor has an outwardly bulged central portion 41 which forms the outer wall of the inlet chamber 7 of the rotor, and the portion 41 has a central opening surrounded by a cylindrical flange 42. The bulged portion 41 of the rotor side plate 32 projects into the casing recess 20 and the flange 42 projects outwardly into the annular recess 18 in the pump casing. A sealing ring 43 mounted in the recess 18 engages the exterior of the cylindrical flange 42 and provides a seal between the casing inlet and the pump chamber so that liquid entering the pump through the inlet 6 passes directly into the rotor. The plate 33 forms the inner wall of the rotor inlet chamber 7 and is provided with circumferentially spaced openings 44 through which fluid can flow from the inlet chamber 7 into each of the displacement chambers 4 of the rotor.

The rubber diaphragm 34 is clamped between the plate 33 and the hub 2 of the rotor at its center, and at its periphery is clamped between the plate 33 and an annular web 45 that is formed integrally with the vanes 3 adjacent the periphery of the rotor, the outer face of the web 45 being flush with the side edges of the inner portions of the vanes 3 so that the rubber diaphragm 34 is clamped throughout its periphery between the periphery of the plate 33 and the outer face of the web 45 and to the edges of the vanes 3 between the plate 45 and the hub 2. The diaphragm 34 is a flat circular disk of elastic rubber and normally lies flat against the inner face of the plate 33, in which position it closes the openings 44. The diaphragm has an opening 46 spaced radially outwardly from each of the openings 44 and in the portion of the diaphragm that normally lies flat against the plate 33. When pressure within the displacement chambers 4 is higher than the pressure in the inlet chamber 7 of the rotor, the diaphragm is held tightly against the plate 33 and seals the openings 44. When pressure in the chamber 7 exceeds the pressure in a displacement chamber 4, the portion of the diaphragm covering the opening 44 of the chamber 4 is stretched and forced inwardly as shown in Fig. 5, so that fluid can flow from the chamber 7 through the opening 46 in the diaphragm 34 that is spaced radially outwardly with respect to the opening 44.

The plate 35 at the outlet side of the rotor is provided with openings 47 which establish communication between the displacement chambers and the outlet side of the pump chamber. The diaphragm 36 is clamped to the outer face of the plate 35 by the spider 37 which has arms 48 that radiate from the body of the spider 37 for clamping engagement with the diaphragm 36 along the edge of each vane 3. The diaphragm 36 is a flat disk of elastic rubber and the portions thereof between the arms 48 that cover the openings 47 are adapted to be stretched and forced outwardly to permit flow of fluid through the openings 47 through the outlet side of the pump chamber when the pressure within the displacement chambers 4 exceeds the pressure in the outlet portion of the pump chamber.

The diaphragms 34 and 36 serve as check valves which permit flow of liquid from the inlet into the displacement chambers and from the displacement chambers to the pump chamber outlet, but which prevent reverse flow. The por-

tions of the diaphragms which cover the openings 44 and 46 yield independently under pressure and function as independently operable check valves of the flap type. By utilizing a one piece rubber diaphragm and a single apertured plate at each side of the rotor a large number of independently operable check valves are provided by means of a very simple, compact and inexpensive construction.

In the operation of the pump a sealing ring of liquid is formed at the periphery of the pump chamber by the impelling action of the rotor, and this ring of liquid seals the periphery of the rotor and serves to alternately create pressure and suction in the displacement chambers 4 of the rotor. If the pump chamber is full of water when the rotor is started into operation the impelling action of the rotor will develop a hydrostatic pressure due to centrifugal force which acting upon the diaphragm 36 will expel liquid from the displacement chambers of the rotor to the outlet side of the pump chamber. After sufficient water is displaced from the rotor, fluid will begin to flow into displacement chambers through the rotor inlet chamber 7. If liquid is being delivered to the inlet 6, liquid discharged from the displacement chambers will be replaced by liquid from the inlet chamber 7 and, when the liquid is replaced by air at the inlet, water will continue to be ejected from the rotor until the interior of the displacement ring of liquid is disposed outwardly of the openings 44 and 46, after which the pump acts as a hydro-turbine air pump.

Pressure within each displacement chamber holds the portion of the diaphragm 34 which covers the opening 44 to the chamber tightly against the plate 33 while the portion of the diaphragm 36 covering the opening 46 of the chamber is being forced outwardly to permit fluid to escape from the chamber, so that the pressure developed in the displacement chamber cannot act to back the fluid into the inlet. The openings 44 and 47 are disposed at a sufficient distance inwardly of the periphery of the rotor to trap a sufficient volume of liquid to seal the periphery of the rotor and to displace the desired volume of air in the chambers 4 during rotation of the rotor.

By reason of the check valve action of the diaphragms, the pump is effective to continuously pump water as long as water is supplied to the inlet 6, and to pump a mixture of water and air until the interior of the liquid ring in the pump chamber is disposed radially outwardly of the openings 44 and 47, after which the pump acts as a hydro-turbine air pump.

In order to equalize pressure in the discharge side of the pump chamber and in the outlet chamber 9, openings 49 may be provided in the plate 14 outwardly of the outlet opening 8.

It is to be understood that in accordance with the provisions of the patent statutes, variations and modifications of the specific devices herein shown and described may be made without departing from the spirit of the invention.

What I claim is:

1. A rotary suction pump comprising a pump chamber with a peripheral wall and side walls, each side wall having a central opening, one of said openings providing an inlet and the other an outlet, a rotor having a periphery that is spaced at different distances from circumferentially spaced portions of said peripheral wall, said rotor having spaced side walls the radial outer portions of which have close clearance throughout the rotor circumference with the chamber side walls, said rotor having liquid impelling vanes extending across the space between said side walls to form displacement chambers opening to the rotor periphery, each rotor side wall having an opening to each of the displacement chambers, said rotor side wall openings being spaced inwardly from the periphery of the rotor and connecting each displacement chamber with said inlet and said outlet, and elastic rubber diaphragms normally closing said rotor openings, one of said diaphragms being secured to the interior of the rotor side wall on the inlet side and another of said diaphragms being secured to the exterior of the rotor side wall on the outlet side, said diaphragms being secured to said walls radially inwardly of the opening and between successive openings, the portion of each diaphragm overlying each opening being stretchable and movable away from the opening by fluid pressure upon the portion thereof covering the opening.

2. A suction pump of the hydro-turbine type comprising a pump chamber with a peripheral wall and with an inlet and an outlet centrally disposed and on opposed sides thereof, and a rotor in said casing the periphery of which is spaced at different distances from circumferentially spaced portions of said peripheral wall, said rotor having liquid impelling vanes acting on liquid in the pump chamber to maintain a ring of liquid against the periphery of the chamber that provides a seal between the inlet and outlet sides of the chamber, said rotor having a wall on its inlet side comprising an elastic rubber diaphragm engaging the edges of said vanes and a plate engaging the exterior of the diaphragm and clamping the diaphragm against said edges, said plate having openings normally closed by said diaphragm that register with the spaces between the vanes, the portions of the diaphragm covering each opening being stretchable by fluid pressure and movable away from said opening, said rotor having a wall on its outlet side comprising a plate engaging the opposed edges of said vanes and provided with openings that register with the spaces between the vanes, and an outwardly opening check valve controlling the flow through each of said openings on the outlet side.

3. A suction pump of the hydro-turbine type comprising a rotor and a rotor chamber having a peripheral wall that lies close to the rotor periphery at circumferentially spaced points and that is spaced therefrom intermediate said points, said chamber having an inlet and an outlet centrally disposed and on opposite sides of the rotor, said rotor having a displacement chamber opening to its periphery and having a central inlet chamber with an opening that registers with the pump chamber inlet, said rotor having an opening connecting said displacement chamber with said inlet chamber and an opening connecting said displacement chamber with the interior of the pump chamber on the outlet side, a seal interposed between the rotor and pump chamber side wall around said chamber inlet and rotor opening, and check valves controlling flow into and out of said displacement chamber, said valves permitting flow from said inlet chamber into the displacement chamber and from the displacement chamber to the outlet side of the pump chamber but preventing reverse flow.

4. A suction pump of the hydro-turbine type comprising a rotor and a rotor chamber having a peripheral wall that lies close to the rotor periphery at circumferentially spaced points and that is spaced therefrom intermediate said points,

said chamber having an inlet and an outlet centrally disposed and on opposite sides of the rotor, said rotor having a displacement chamber opening to its periphery and having a central inlet chamber with an opening that registers with the pump chamber inlet, said rotor having an inlet opening connecting said displacement chamber with said inlet chamber and an outlet opening connecting said displacement chamber with the interior of the pump chamber on the outlet side, a seal interposed between the rotor and pump chamber side wall around said chamber inlet and rotor inlet opening, an elastic rubber diaphragm normally covering the opening connecting the displacement chamber to said inlet chamber and yieldable under pressure acting toward the interior of the displacement chamber to uncover the opening, and an elastic rubber diaphragm normally covering the opening connecting the displacement chamber to the outlet side of the rotor and yieldable toward the chamber outlet to uncover the opening.

5. A rotor comprising a body portion consisting of a hub and radiating vanes, side plates secured to opposite sides of the body, each plate having an opening to each space between vanes, an elastic rubber diaphragm clamped between one of the plates and the hub and vanes of the rotor body and having stretchable portions between vanes covering the plate openings, a second diaphragm clamped to the exterior of the other plate radially inwardly of the openings and between successive openings and having yieldable portions covering the plate openings.

6. A rotary suction pump comprising a pump chamber with a peripheral wall and side walls, each side wall having a central opening, one of said openings providing an inlet and the other an outlet, a rotor having a periphery that is spaced at different distances from circumferentially spaced portions of said peripheral wall, said rotor having spaced side walls the radial outer portions of which have close clearance throughout the rotor circumference with the chamber side walls, said rotor having liquid impelling vanes extending across the space between said side walls to form displacement chambers opening to the rotor periphery, each rotor side wall having an opening to each of the displacement

chambers, said rotor side wall openings being spaced inwardly from the periphery of the rotor and connecting each displacement chamber with said inlet and said outlet, and a check valve controlling flow of fluid through each of said rotor side wall openings, each check valve being operable independently of the others, the valves on the inlet side of the rotor permitting flow into said displacement chambers and preventing reverse flow and the valves on the outlet side of the rotor permitting flow out of said displacement chamber but preventing reverse flow.

7. A suction pump of the hydro-turbine type comprising a rotor and a rotor chamber having a peripheral wall that lies close to the rotor periphery at circumferentially spaced points and that is spaced therefrom intermediate said points, said chamber having side walls that have close clearance with opposite sides of the rotor periphery, said chamber having an inlet and an outlet on opposite sides of the rotor and inwardly of its periphery, said rotor having a series of displacement chambers opening to its periphery, each displacement chamber having two openings inwardly of its periphery, one communicating with the pump chamber inlet and the other with the pump chamber outlet, and an independently operable check valve controlling each of said openings, the valves controlling the openings to the pump chamber inlet permitting flow of fluid into said displacement chambers and preventing reverse flow and the valves controlling the openings to the pump chamber outlet permitting flow out of said displacement chambers and preventing reverse flow.

HOWARD G. BECK.

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