

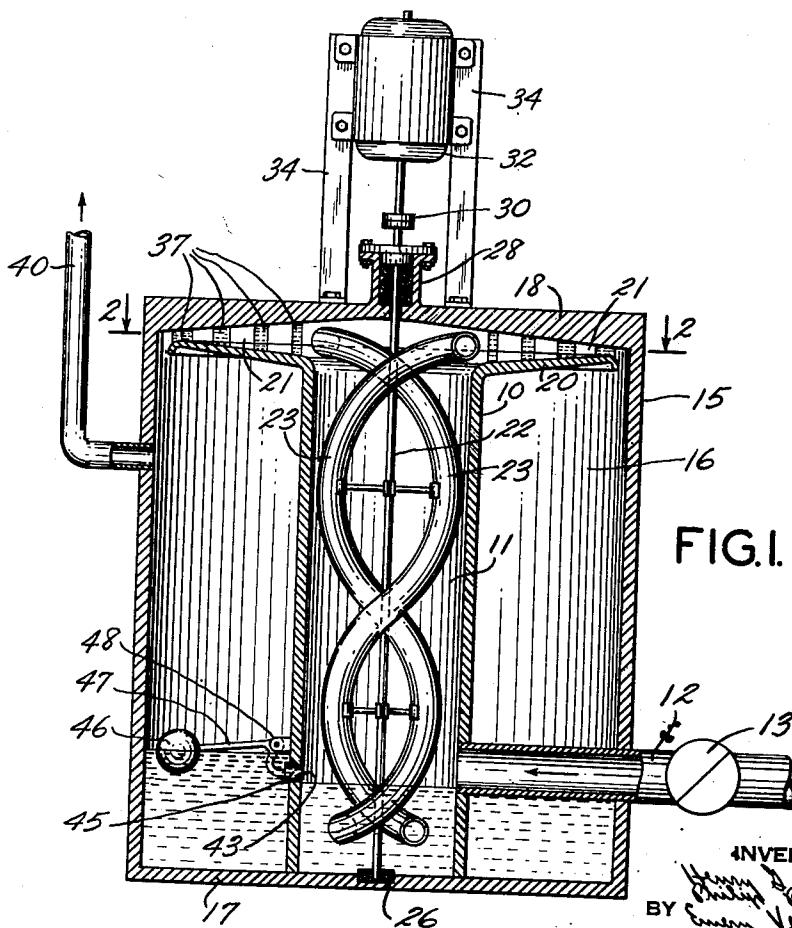
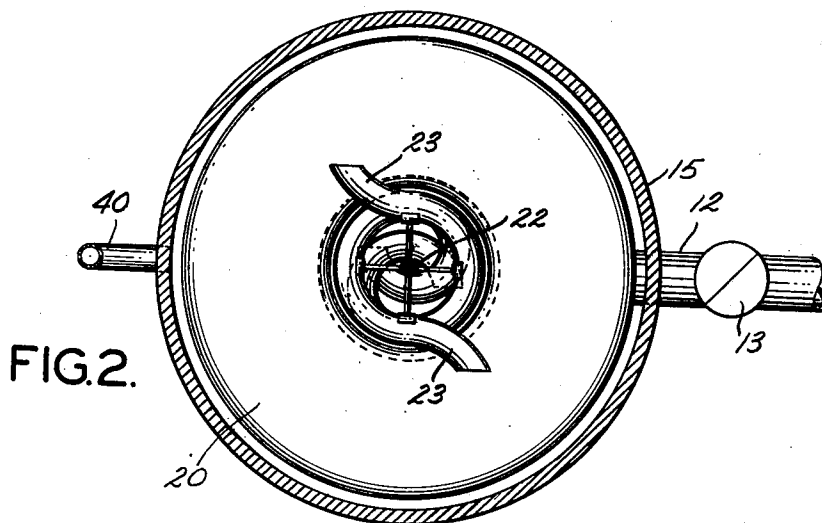
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VACUUM PUMP WITH EXPANDING LIQUID SPIRAL

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VACUUM PUMP WITH EXPANDING
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This invention relates to vacuum pumps and is intended primarily for use with steam heating systems, though the pump is not limited to such uses.

The efficient steam heating of large structures demands the use of mechanical means for evacuating the air from the piping system, and the best refinements in such heating systems involve the control of the steam temperature by the regulation of the vacuum maintained within the piping, radiator and convector assembly, which temperature may be varied to meet the heating needs in accordance with the variations in the outside temperature.

The vacuum pumping equipment of the prior art which has been available for use with heating systems is dependent, almost exclusively, on either mechanical or water jet Venturi evacuation. It is an object of this invention to provide an improved vacuum pump that combines both kinds of evacuation, and that uses the centrifugal force of a rotating jet for evacuating air from a chamber with which the piping of the heating system communicates.

Some features of the invention relate to a vacuum pump construction in which an impeller discharges a stream of water into a discharge passage of substantially greater angular extent than the water stream, and in the preferred construction, the discharge passage is annular and has top and bottom walls that converge toward the outlet end of the passage.

Another feature of the invention relates to the combination in such a pump of an impeller which dips into a supply of hurling water in the bottom of the pump and which is driven by a motor located at an elevation on top of the pump. This position of the motor is particularly desirable when the pump is located at a low place in a cellar, or other location that may at times contain standing water. The high position of the pump puts it at a safe distance above the floor and the water that may be standing on the floor.

Another object of the invention is to provide an improved vacuum pump that hurls water through a discharge passage from a vacuum chamber into another chamber which is at atmospheric pressure and in which the water separates from the air that is trapped between layers of water during the operation of the pump. In this separation chamber the water drains to the bottom and the invention provides a float controlled valve for admitting the hurling water back into the vacuum chamber.

Other objects, features and advantages of the

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invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views,

Fig. 1 is a vertical sectional view through a vacuum pump embodying this invention.

Fig. 2 is a horizontal sectional view taken on the line 2—2 of Fig. 1.

The vacuum pump comprises a cylindrical vessel 10 that encloses a vacuum chamber 11. There is a pipe 12 communicating with the vacuum chamber, and this pipe is connected with the heating system or other enclosure from which air is to be evacuated. The inlet passage provided by the pipe 12 is preferably equipped with a check valve 13 that opens toward the vacuum chamber.

The vessel 10 is surrounded by a housing 15 which is substantially larger than the inner vessel 10 so as to leave a chamber 16 within the housing 15 and outside of the cylindrical vessel 10. This chamber 16 will be referred to as the separation chamber because air and water, discharged by the vacuum pump, separate in this chamber 16, the water dropping to the bottom of the chamber. The inner vessel 10 and the outer vessel or housing 15 are connected to a common bottom wall 17.

The housing 15 has a top 18 which also comprises the top for the cylindrical vessel 10, and there is a flange 20 at the upper end of the vessel 10. This flange 20 is spaced from the inside face of the top 18 and the confronting faces of the top 18 and the flange 20 converge toward the outer edge of the flange. The space between the top 18 and the flange 20 comprises an outlet passage 21 from the vacuum chamber 11.

Within the vessel 10 there is an impeller comprising a rotatable shaft 22 and one or more pipes 23 secured to the shaft 22 and rotatable as a unit with the shaft. The lower end of the shaft 22 turns in a thrust bearing 26 held in the bottom of the vacuum chamber and the upper end of the shaft 22 extends through a bearing in the top 18 and through a stuffing box 28. This stuffing box 28 is merely representative of sealing means that permit rotation of the shaft 22 and prevent any substantial leakage of air into the vacuum chamber.

The upper end of the shaft 22 is connected by a coupling 30 to the armature shaft of a motor 32. This motor is supported from the top 18 of the vacuum pump by brackets 34, and it is these brackets that locate the motor above the top of the pump so that when the pump is located in a cellar or sump, and there is water standing on

the floor on certain occasions, a motor 32 is at sufficient elevation above the floor to be above the level of any water that is likely to accumulate or stand on the floor of the cellar or sump, as previously explained.

Each of the pipes 23 of the impeller has the general shape of a spiral helix, the diameter of the convolutions increasing toward the top of the impeller so that the water is urged toward the upper ends of the pipes by centrifugal force as the impeller rotates. The discharge opening at the end of each of the pipes 23 is of very small angular extent compared to the angular extent of the outlet passage around the axis of the vacuum chamber 11; and as the impeller rotates, the impeller pipes 23 hurl streams of water into the outlet passage in the form of expanding spiral convolutions. These convolutions of the water stream are indicated in Fig. 1 by the reference character 37, and it is important to have the motor 32 drive the impeller at a speed which is co-ordinated with the length and cross section of the outlet passage 21 so that there will always be a plurality of convolutions 37 between the inner and outer ends of this outlet passage.

One of the advantages of using two pipes 23 on the impeller is that the pipes face in opposite directions and counterbalance one another around the axis of rotation of the shaft 22. Another advantage in using two or more pipes 23 is that the additional stream of water hurled into the outlet passage by the second pipe makes it possible to have a plurality of convolutions 37 at lower speeds of rotation of the impeller.

Each successive convolution 37 traps some air between it and the preceding convolution. Back pressure against the liquid convolutions 37 causes them to lose velocity as they travel outward along the discharge passage 21. As the radial velocity of each convolution decreases, the convolution following it comes closer and compresses the air between the convolutions so that by the time the convolutions are discharged into the separation chamber 16, the air trapped between the convolutions is at substantially atmospheric pressure. This air is left in the chamber 16 as the water falls by gravity into the bottom of the chamber 16, and as the amount of air in the chamber 16 increases, some of it escapes through a vent 40 so that pressure in the chamber 16 can never rise substantially above atmospheric pressure.

The lower ends of the pipes 23 extend downward into the bottom portion of the vessel 10 and dip into water in this bottom portion of the vessel. The inlet opening at the bottom of each of the pipes 23 is disposed so that it faces in the direction in which the lower ends of the pipes move during rotation of the impeller. This causes the lower open ends of the pipes 23 to act as scoops as they are driven through the water, and the force developed by this scooping action forces the water at least part way up pipes 23 and makes it possible to operate the vacuum pump at higher vacuums and with vacuum chambers of substantial height. When the vacuum pump is to be used for low vacuum heads, it is not necessary to have the lower ends of the pipes 23 face in the direction in which they move as the impeller rotates.

The lower portion of the vacuum chamber 11 and of the separation chamber 16 comprise reservoirs for holding the hurling water that is used to operate the vacuum pump. The higher pressure in the separation chamber 16 causes water

to flow from the separation chamber 16 through an orifice 43 and into the reservoir in the lower part of the vacuum chamber. In order to stop the flow of water from the chamber 16 before the water level drops below the orifice 43, a valve 45 is provided, and this valve 45 closes the orifice 43 whenever the water level in the chamber 16 drops below a predetermined level, that is safely above the orifice so as to prevent air from entering the vacuum chamber through the orifice.

The valve 45 is operated by a float 46 connected with a bell crank 47. This bell crank 47 rocks about a fulcrum 48 on a bracket secured to the outside of the vessel 10. The lower end of the bell crank 47 is connected to the valve 45. This leverage connection between the float 46 and valve 45 is shown in its simplest form in the drawing for clearer illustration and is merely representative of motion transmitting connections between the float 46 and valve 45. Although the valve 45 can be operated by a float that is responsive to the water level in the vessel 10, it is preferable to have the float in the chamber 16 because this leaves more free space in the vessel 10 for the impeller. With a given quantity of water in the vacuum pump, however, each level of water in the chamber 16 corresponds to a given level of water in the vessel 10.

The pump can be made with various proportions of length to diameter, but it is important to have the outlet passage from the vacuum chamber long enough to contain a plurality of convolutions 37 at every instant. The speed with which the impeller must be driven depends upon the number of discharge outlets of the impeller, as previously explained, and depends also upon the length of the outlet passage from the vacuum chamber and upon the head against which the pump must operate. If the length of the outlet passages is reduced, it is necessary to run the impeller faster in order to have a sufficient number of convolutions 37 in the outlet passage.

The head against which the pump can operate successfully depends upon the number of convolutions in the outlet passage 37 and upon the centrifugal force with which each successive convolution is hurled into the outlet passage. An increase in centrifugal force can be obtained by increasing the speed of rotation of the impeller; or by making the pump with a larger radius for the impeller and the chamber 11 so that the force of the water streams is increased by the greater radius of the circumference about which they travel.

The reservoirs in which the water is held must necessarily be in the lower ends of the vessel 10 and housing 15, but terms of orientation are for the most part relative, and changes and modifications can be made in the illustrated construction without departing from the invention as defined in the claims.

What is claimed is:

1. A vacuum pump comprising a stationary vessel enclosing a vacuum chamber, the lower portion of the vacuum chamber comprising a reservoir for liquid, a fixed outlet passage opening through one side of the vessel and having an angular extent around the longitudinal axis of the vessel, an impeller within the chamber, the impeller having an inlet that communicates with the liquid reservoir in the lower portion of the vacuum chamber, a bearing on which the impeller rotates about an axis extending longitudinally of the chamber, a liquid discharge outlet in the impeller and disposed in position to travel

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around the angular extent of said outlet passage during rotation of the impeller about its axis so as to throw a stream of water into said outlet passage, the angular extent of the discharge outlet of the impeller being substantially less than the angular extent of the outlet passage, and a motor that rotates the impeller at a speed coordinated with the outlet passage length.

2. A vacuum pump including a vessel that encloses a vacuum chamber, said chamber having an inlet passage through which air is drawn into the chamber and having an annular outlet passage surrounding the longitudinal axis of the vessel, an impeller located within the vacuum chamber and rotatable about an axis extending longitudinally of the vessel, said impeller having an inlet through which it takes water from a low part of the vacuum chamber and having a discharge outlet of substantially less angular extent than the outlet passage and in position to hurl liquid by centrifugal force into the annular outlet passage in the form of expanding convolutions of a spiral, and a motor that drives the impeller fast enough to keep a plurality of convolutions within the annular passage at all times during the operation of the pump.

3. The vacuum pump described in claim 2 and in which the annular passage has top and bottom walls that converge toward the outer end of said passage.

4. A vacuum pump including a vacuum chamber having a longitudinal axis and an outlet passage which is of substantial angular extent about said axis and of much smaller extent in a direction parallel to said axis, said outlet passage having top and bottom walls that converge toward the outer end of the passage, an impeller in the chamber rotatable about an axis extending longitudinally of the chamber, and a liquid reservoir in the lower portion of the vacuum chamber and into which the impeller extends, said impeller having an inlet in said reservoir and said impeller having also a discharge outlet of substantially smaller angular extent than the outlet passage, said discharge outlet being located in position to hurl successive spiral convolutions of liquid into the passage with each successive revolution of the impeller, and a motor that drives the impeller at a predetermined speed which is coordinated with the passage length.

5. A vacuum pump as described in claim 4 with an impeller having a plurality of discharge outlets in position to hurl spiral convolutions of liquid into the outlet passage successively so that a plurality of convolutions can be maintained in the passage with lower motor speed.

6. A vacuum pump comprising a stationary cylindrical vessel with its longitudinal axis extending upward, said vessel enclosing a vacuum chamber that has an inlet through which air is drawn and that has a fixed outlet passage of substantial angular extent around the axis of the vessel near the upper end of said vessel, the lower portion of the vacuum chamber comprising a reservoir for liquid, and an impeller located in the vessel and comprising a shaft with its axis extending longitudinally in the cylindrical vessel and with a pipe secured to the shaft for rotation as a unit therewith, said pipe having an upper open end portion extending outward from the center of rotation for discharging liquid by centrifugal force into the outlet passage, and said pipe having a lower open end portion that extends downward into the liquid reservoir in the

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lower portion of the vacuum chamber, the upper and lower open ends of said pipe being of substantially less radial extent than the outlet passage of the vessel, and a motor that drives the impeller at a speed coordinated with the length of the outlet passage.

7. The vacuum pump described in claim 6 and in which the lower portion of the pipe has its inlet opening facing in the direction in which the impeller rotates so that the lower end of the pipe acts as a scoop for driving water into the pipe and for supplying at least a part of the force for raising the water upward in the pipe.

8. A vacuum pump comprising a stationary vessel having a bottom portion that rests on a floor or other supporting surface, said vessel enclosing a vacuum chamber that has an inlet conduit for connection with a space that is to be evacuated, said stationary vessel having also a fixed outlet passage from the upper portion of the vacuum chamber, the outlet passage being of substantial angular extent around the longitudinal axis of the chamber, an impeller in the chamber including a shaft that extends through a top wall of the chamber, said impeller having an inlet that communicates with the vacuum chamber in the lower portion of the vacuum chamber, and said impeller also having a discharge outlet of substantially less angular extent than the outlet passage but in position to sweep across the entrance of said outlet passage with each revolution of the impeller, a motor located on top of the vessel, motion transmitting connections between the motor and the upper portion of the vessel including a shaft that extends through the top of the vessel, and a seal at the region where the shaft extends through the top of the vessel for preventing the entrance of air into the vacuum chamber along the shaft.

9. A vacuum pump comprising a vessel having an inner vacuum chamber and an outer separation chamber, surrounding the vacuum chamber for receiving air and water from the vacuum chamber at substantially atmospheric pressure, the inner vacuum chamber having a passage opening into the separation chamber and also having an air inlet passage for communication with a suction line from which air is to be withdrawn, an impeller in the vacuum chamber with an inlet and with a discharge outlet that hurls successive layers of water into the passage through which the vacuum chamber communicates with the separation chamber, a reservoir at the bottom of each of the chambers for holding water, a valve commanding a passage between the reservoirs in said chambers, and a valve-operating float located in one of the chambers and connected with the valve.

10. A vacuum pump comprising an inner vessel enclosing a cylindrical vacuum chamber, an outer vessel surrounding the inner vessel and providing an atmospheric pressure chamber within the outer vessel, the cylindrical chamber having an annular passage around its longitudinal axis and near its upper end and also having an air inlet passage for communication with a suction line from which air is to be withdrawn, and an impeller in the cylindrical chamber, bearings in which the impeller rotates about an axis extending longitudinally of the cylindrical chamber, said impeller having one or more inlets and having one or more discharge outlets of smaller angular extent than the annular passage and located in position to travel along a path confronting the inner end of the annular passage, a

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motor that drives the impeller fast enough to hurl water from the impeller into the outlet passage in expanding convolutions of a spiral, water reservoirs at the bottoms of both the cylindrical chamber and the atmospheric pressure chamber, a valve commanding an orifice that opens through the wall of the inner vessel between the reservoirs, a float in the reservoir of the atmospheric pressure chamber, and a lever system connecting the float with the valve and movable to open the valve whenever the float rises with the liquid to a predetermined level in the reservoir.

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