July 13, 1926. 1,592,024

I. C. JENNINGS

WET VACUUM PUMP

Filed Jan. 26, 1922 6 Sheets-Sheet 1

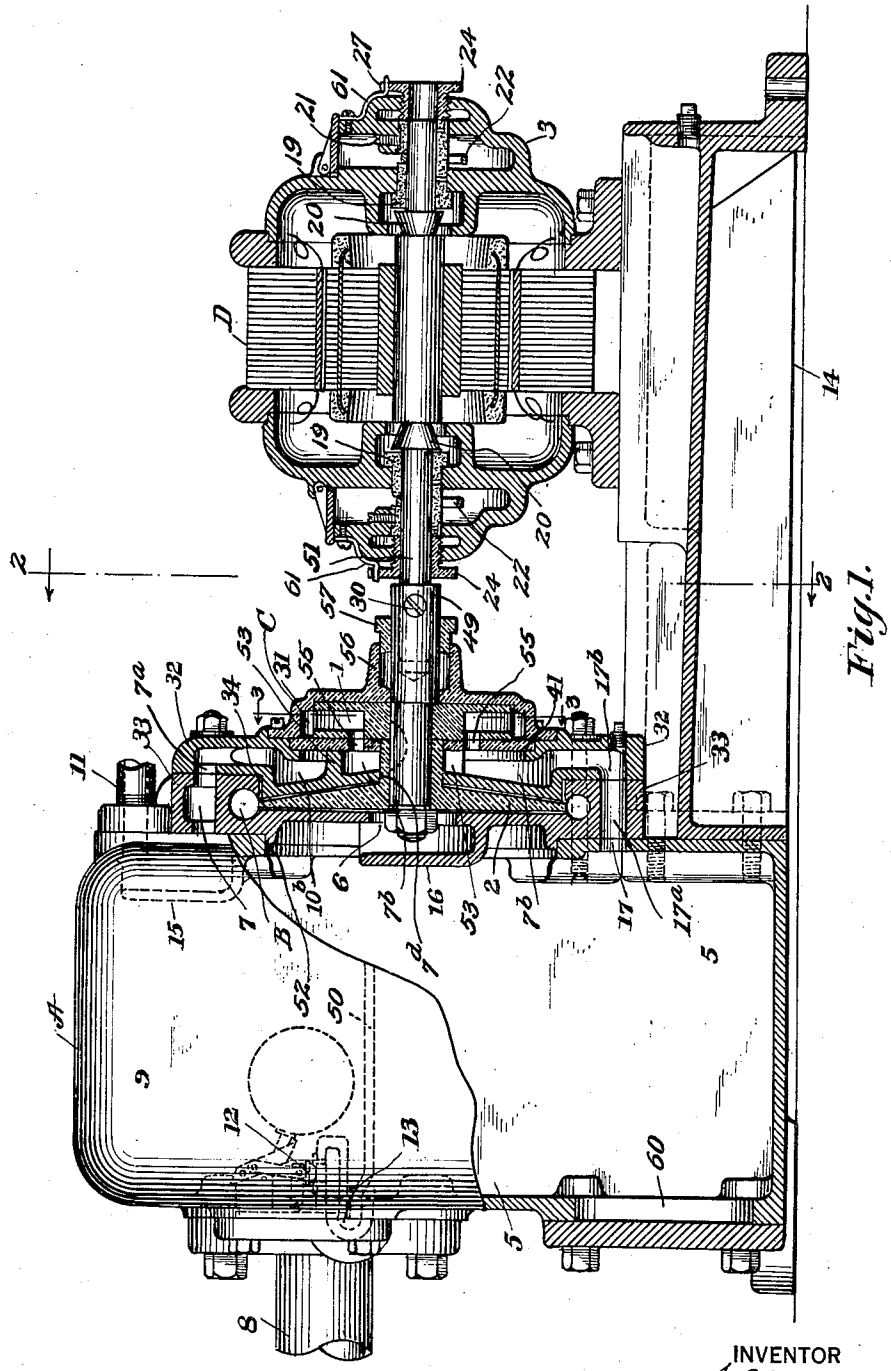


Fig.1.

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WET VACUUM PUMP

Filed Jan. 26, 1922 6 Sheets-Sheet 2

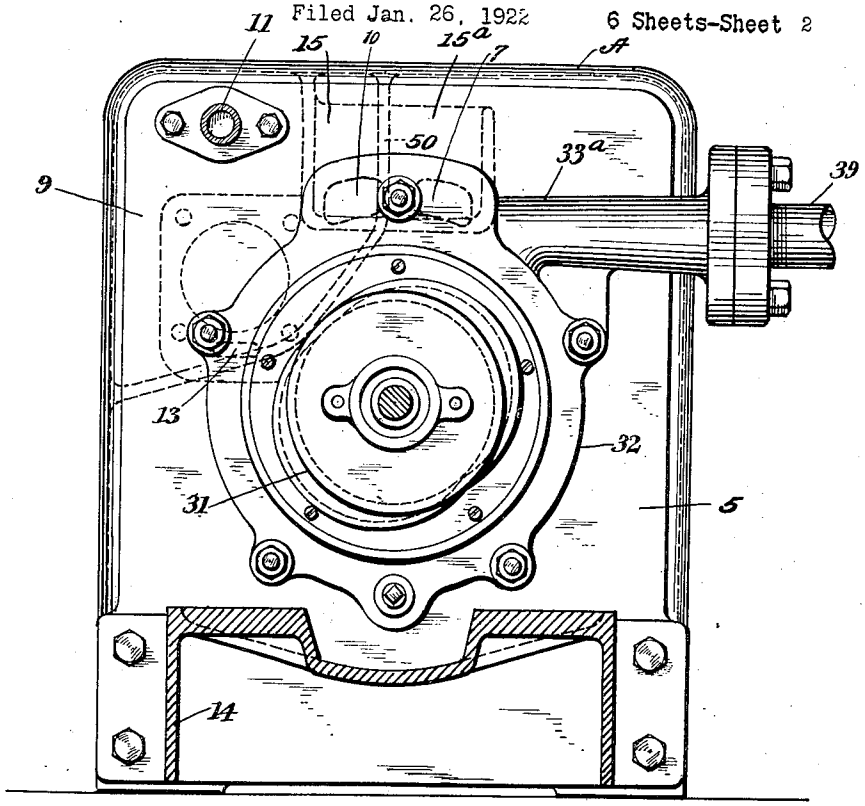


Fig. 2.

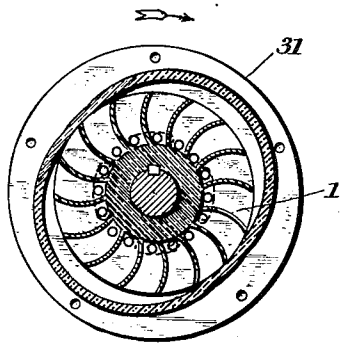


Fig. 3.

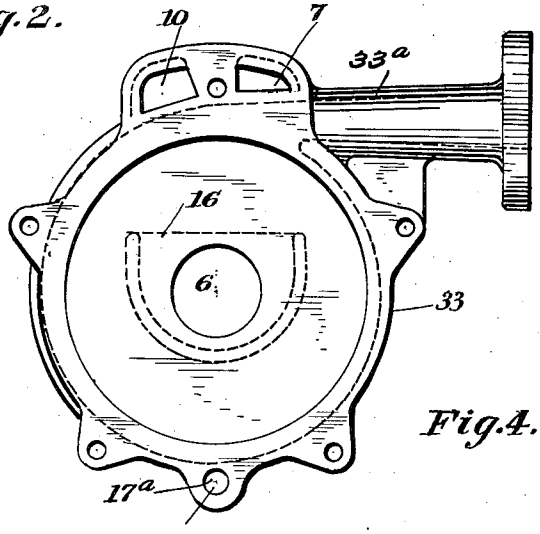


Fig. 4.

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WET VACUUM PUMP

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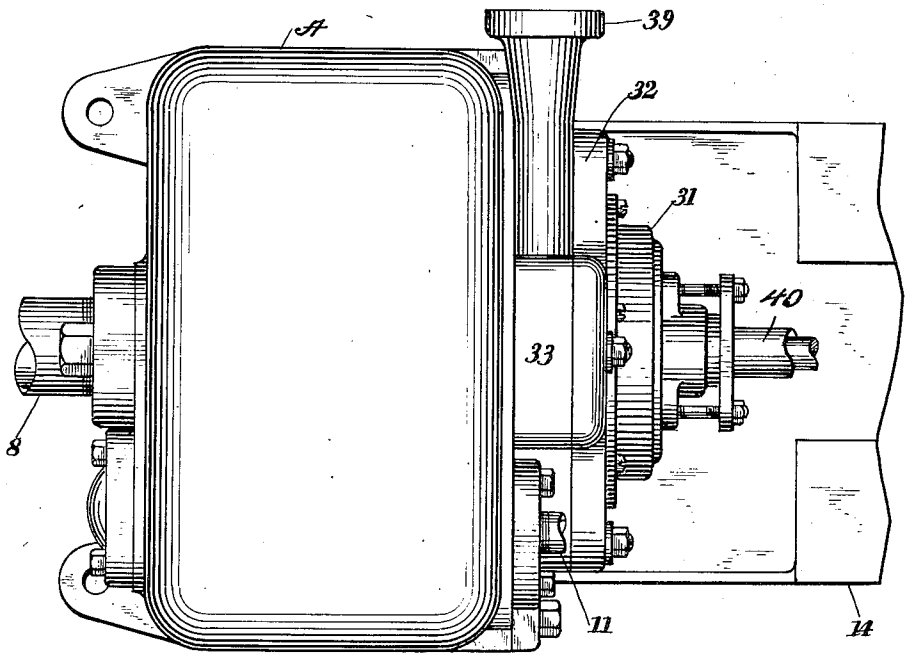


Fig.5.

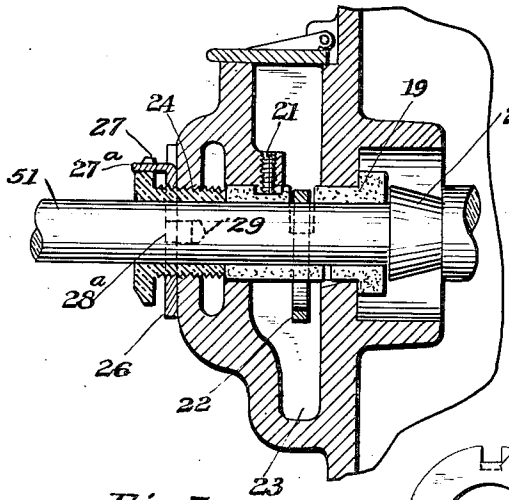


Fig.7.

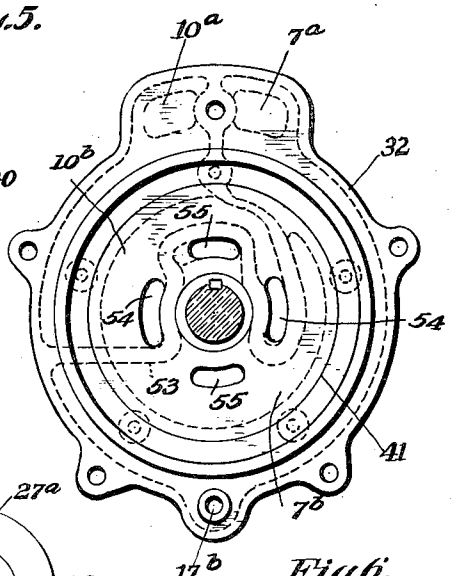


Fig.6.

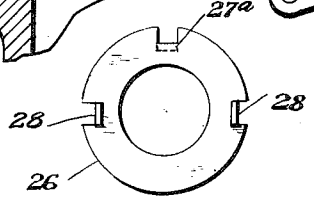


Fig.8.

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WET VACUUM PUMP

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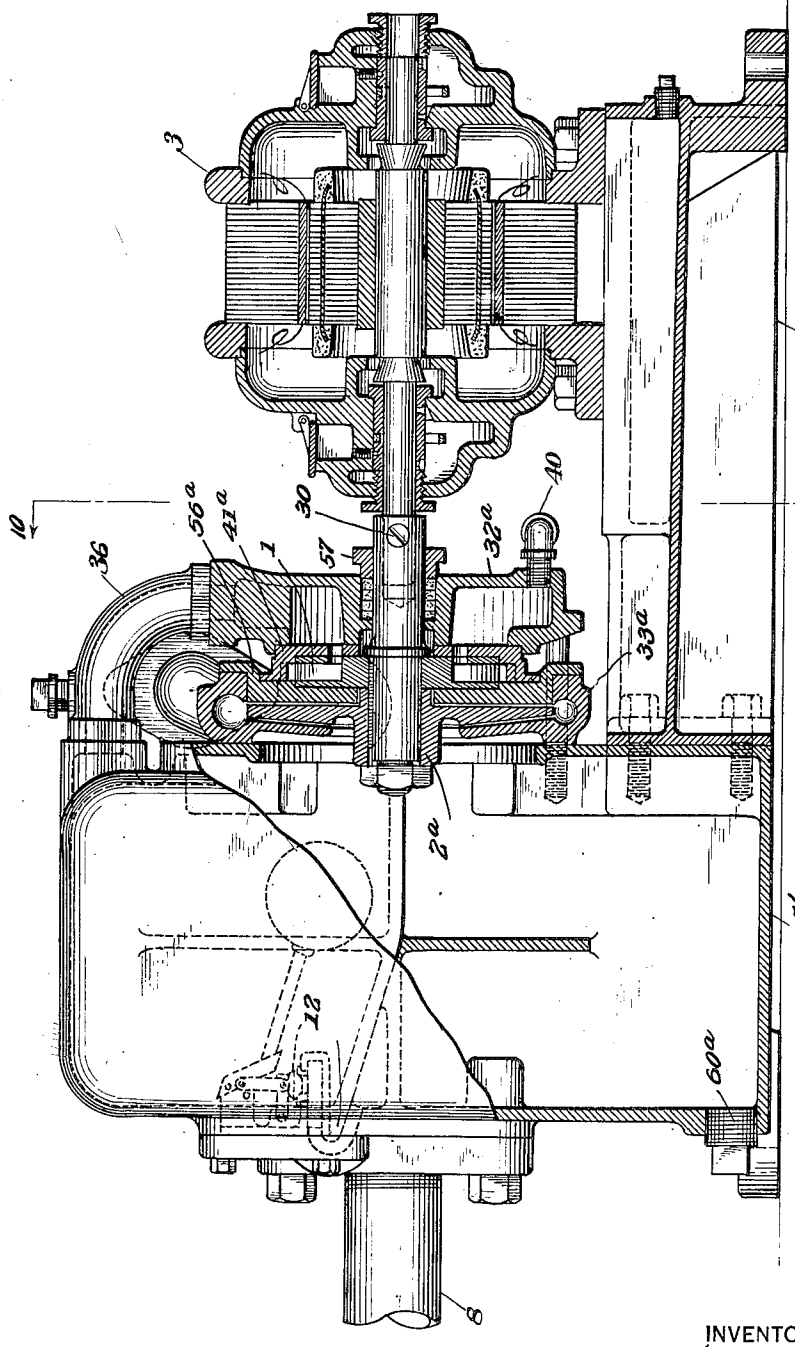


Fig. 9.

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WET VACUUM PUMP

Filed Jan. 26 1922 6 Sheets-Sheet 5

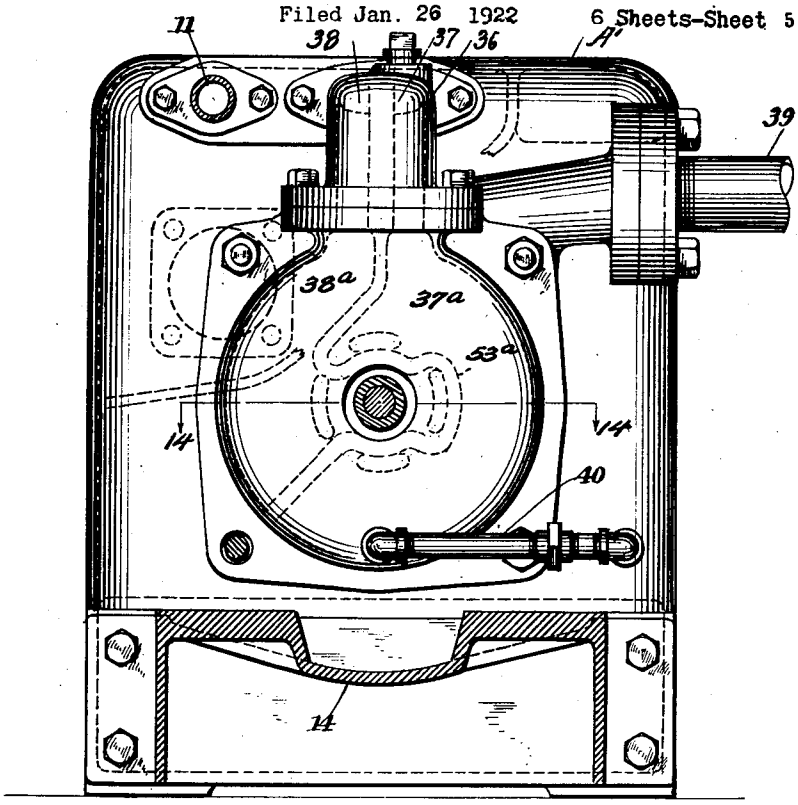


Fig. 10.

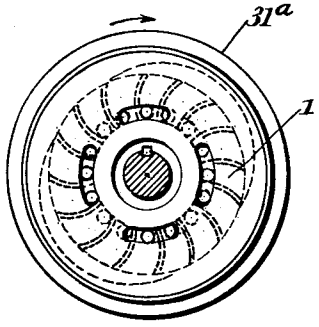


Fig. 11.

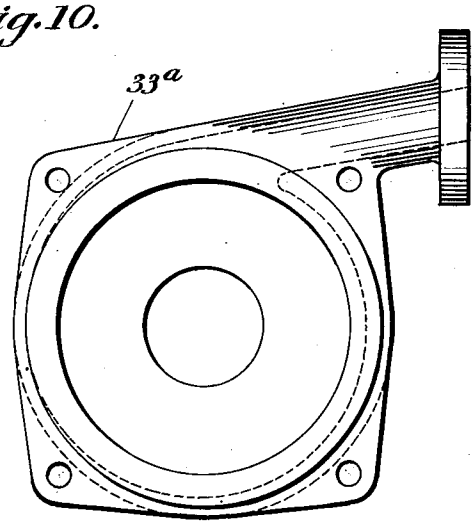


Fig. 12.

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July 13, 1926. 1,592,024

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WET VACUUM PUMP

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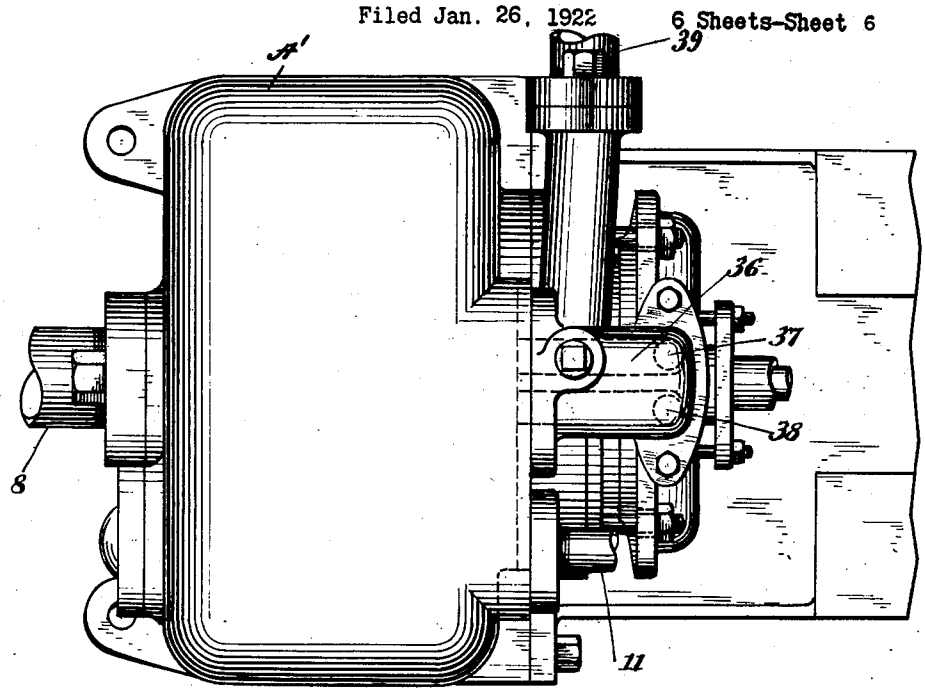


Fig. 13.

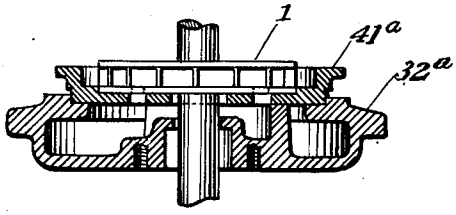


Fig. 14.

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Patented July 13, 1926. 1,592,024

UNITED STATES PATENT OFFICE.

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WET VACUUM PUMP.

Application filed January 26, 1922. Serial No. 532,000.

The present invention relates to pumping apparatus and more particularly to apparatus of the type employed for exhausting liquid and gas from a container, for example air and water. Perhaps the largest field of usefulness resides in abstracting the air and water from the returns of a vacuum steam heating system, the air being discharged into the atmosphere and the water preferably being returned to the boiler.

Heretofore apparatus of this type has comprised a tank into which the returns from the heating system have been discharged, the pumps and the motor for driving the latter. Because the pumps have been located independently of the tank, a more or less complicated system of piping has been required to connect the pumps and tank.

It is the principal aim of the present invention to simplify this old arrangement eliminating the piping and providing a pump construction which is simpler and more dependable.

To these ends, according to the present invention, the preferred apparatus comprises a tank separated by a partition into two compartments; and a water and air pump carried by the tank and having its inlets directly opening into one of the compartments. The air pump discharges into the other compartment and the water pump discharges to any desired point. The motor for driving the pumps is mounted on a base rigid with the tank and the motor shaft carries the pump impellers. In this manner all piping is eliminated and it is possible to employ a pump having no bearings except a bearing for packing.

Another feature of the invention consists in the provision of means whereby the level of water in one of the compartments of the tank never falls below that sufficient to prime the air pump.

Other objects and features of novelty will be apparent from the descriptions taken in connection with the drawings in which—

Figure 1 is a longitudinal section of the pumping unit and part of the tank, the rest of the tank being shown in elevation;

Figure 2 is a section on the line 2—2 of Figure 1, showing the pump casings in elevation;

Figure 3 is a section through the air pump on the line 3—3 of Figure 1;

Figure 4 is a separate view of the water pump volute housing in elevation from the motor side;

Figure 5 is a plan view of the pump and tank;

Figure 6 is a separate view, in elevation from the pump end, of the passage plate, with the port plate in place;

Figure 7 is a longitudinal section of one end of the motor bearing, showing a modified means of adjusting the shaft;

Figure 8 is a detail view of the lock washer of Figure 7;

Figure 9 is a view similar to Figure 1 showing a modified form of pump construction;

Figure 10 is an end elevation of the modified form;

Figure 11 shows the port plate of the modification with the impeller dotted in;

Figure 12 is a separate view of the motor end of the volute housing of the modification;

Figure 13 is a plan of the modified form of pump and tank; and

Figure 14 is a plan or edge view of the air impeller, the port plate and passage plate being shown in section taken on the line 14—14 of Figure 10.

Referring to the drawing the embodiment of the invention illustrated therein comprises essentially a tank A divided by the partition 50 into two compartments 5 and 9. The returns from the heating system are conducted by means of pipe 8 to compartment 5. Associated with the tank A, being aligned with an opening in a side wall thereof are the two pumps B and C, the former being the water pump for withdrawing the water from the compartment 5 and the latter being the air pump for maintaining the vacuum in the compartment 5. This latter pump discharges into the compartment 9 which constitutes a separating chamber for separating the water from the air and returning the water to the compartment 5. Mounted on a base 14 rigid with the tank A is a motor D the shaft of which carries the rotors of the pumps.

Having thus given a general description

of the apparatus the same will now be described more in detail.

Referring first to Figure 1, A designates the tank which receives air and water from the return main 8 of a vacuum steam heating system. This tank is divided into two separate compartments 5 and 9 by a web 50 which encloses one corner, as shown best in Figure 2. The air and water are drawn into the portion 5 and the portion 9 is used as a separating chamber to separate the water entrained in the air discharged by the air pump and thereby prevent its loss from the system. This water is automatically returned to the chamber 5 through a passage 13 governed by a fluid valve 12 which prevents air from being sucked into the low pressure chamber 5. Air is discharged to the atmosphere from the separating chamber 9 through an opening 11. For removing water from the chamber 5, I use the centrifugal pump A whose rotor or impeller is denoted by 2, and for removing air a hydroturbine air pump whose rotor is designated by 1. These rotors are keyed to a bronze shaft 49 which at 30 is rigidly coupled to the shaft 51 of the commercial motor D.

The compartment 5 of the tank is provided with an opening 52 in the side wall thereof and the face of the portion of the wall surrounding the said opening is milled to form a seat for the volute casing 33 of the centrifugal pump, shown separately in Figure 4. When seated, this casing closes the opening 52 except for the port 6 through which the pump draws its supply. The casing 33 is provided with an apron or baffle 16 to maintain a definite head of water in the tank which insures priming of the air pump, as will be later explained. Below the opening 52 in the wall of the chamber 5 is a port 17 which registers with a conduit or passage 17^a in the casing 33 and supplies priming and make up water to the air pump. The volute casing 33 is also provided with passages 7 and 10 registering with corresponding openings in the wall of the tank A and providing intake and exhaust passages for the air pump. Seated on the volute casing and bolted thereto is a hollow passage plate 32, shown separately in Figure 6, which is for the purpose of providing intake, exhaust and make up water conduits for the air pump. This plate is divided into two passageways between the water and air rotors by a tortuous web 53, one of said passageways 7^b surrounding the pump shaft and communicating at one end through the passage 7^a with the chamber 5. At its other end the passage 7^b communicates with the intake ports 55 of the air pump and thus forms a supply or intake conduit for the air pump. The passageway 7^b is provided also with an opening 17^b which registers with the passage 17^a in the volute casing and thus communicates with the lower part of the tank through the port 17. Water is thus admitted to the intake conduit of the air pump and as the level can never be lower than the top of the baffle 16, a supply of water is assured for priming the pump. The other passageway 10^b in the passage plate communicates with the exhaust ports 54 and leads through the passage 10^a to the separating chamber 9 and thus provides an exhaust conduit for the air pump. The inlet and outlet openings 7 and 10 are provided with baffles 15 and 15^a to insure the intake and exhaust of the air at the top of the chambers.

The air pump is provided with a port plate 41, which is seated in a recess provided in the passage plate 32 or, if desired, it may be made integral therewith. The rotor chamber is formed in a casing 31 which is seated on the port and passage plates, and bolted to the latter. This casing is provided with a sleeve 56 and packing gland 57 around the shaft.

The casings 33 and 31 together with passage plate 32 and port plate 41 thus constitute a casing for the dual pump, and this casing is mounted on the tank with openings in direct communication with the interior of the tank through openings in the wall of the tank itself. Just as the two casings constitute a single casing for a combined liquid and gas pump, so do the rigidly connected liquid and gas rotors form a single rotor for said dual pump.

It is to be noted that the various stationary parts of the two pumps are bolted or otherwise fastened directly to the tank. All these parts as well as the tank and motor base are preferably cast. The tank is also preferably bolted and doweled to the base 14 of the motor D, whereby the whole pumping and separating apparatus forms a compact, easily installed, unitary structure. This can be shipped as a unit, and all that is required in installation is connection to two pipes, the main 8 and the boiler feed 39.

An alternative construction of the pump unit is shown in Figs. 9 to 14. This is generally similar to that above described, the chief difference being that the port plate and passage plate are mounted on the motor side of the pump rather than on the tank side. The volute casing 33^a is not provided with passages through to the air pump, and the plate 56^a forms the back plate of both pumps, and is mounted in the opening in the volute casing. The liquid rotor 2^a, and air rotor 1 are keyed on the shaft as usual, the air rotor chamber being formed in the casing 41^a which also contains the ports. The passage plate 32^a is mounted on the motor side of the air pump, and is provided with the web 53^a dividing it into two passages 37^a and 38^a. These form the intake

and exhaust passages respectively, communicating with the chambers of the tank A' through passages 37 and 38 in a connection 36. Make up water is supplied from the tank through pipe 40.

In each construction, the tank extends below the intake of the water pump to provide a settling pocket thus eliminating a strainer in the return mains. This pocket may be closed through an opening 60 or 60ª.

As is well known, in air pumps of this type, the rotor must move within its casing and over the port plates without touching these parts and yet with very small clearance. It has been the custom to provide the pump with bronze port plates, casing, and rotor, as well as an expensive bearing to maintain axial adjustment. I eliminate all bearings in the pump, using the motor bearing to support the rotors. Since most commercial motors have considerable end play, this must be taken up to prevent end play in the pump, and the means used to take up end play also serve to make with great nicety the necessary axial adjustment of the pump clearance.

The motor shaft is provided near each end with a collar 20, see Figs. 1 and 7 and the motor has two similar bearings, each comprising a bushing 19 adapted to form the bearing surface proper and also to constitute a thrust bearing for the collar 20. The usual oil rings are shown at 22. I use threaded collars 24 which may be screwed in or out to position the bushings 19 and consequently the shaft. Each collar is formed with radial notches 27 into one of which fits the end of a spring clip 61, screwed to the motor end frame, and designed to prevent turning of the collar after adjustment. If desired, a set screw 21 may be used as an additional means of retaining the bushing in position. If preferred, a lock washer may be used to retain the collar 24, and as shown in Figs. 7 and 8 this may be provided with a lug 27ª which is bent into a notch 27, and may have two lugs 28, fitting into recesses 28ª in the end frame.

In assembling the apparatus, the volute casing is first placed on the tank, and after the tank has been bolted and doweled to the motor base, the pump shaft, with the rotors in place, and the various plates and casing loosely assembled, is attached to the motor shaft, and the motor set in place, the motor casing being independent of the pump casing. The passage plate carrying the port plate is then bolted to the tank and the air pump casing is pushed back exposing the air rotor to view. By rotating the shaft and inserting feelers between the rotor and the port plate, it can readily be determined when the shaft is square, the motor being shimmed for adjustment and finally bolted and doweled to the base. The shaft is then adjusted axially by turning the collars 24 until the rotor has the desired clearance, the collars being then locked in position to prevent turning. The air pump casing can now be bolted in place.

The removable air pump casing greatly facilitates the adjustment of the rotors and the thrust bearings not only serve as a means for making adjustments but also accurately maintain the adjustments when made and so keep the rotors out of contact with the casing and effectually prevent wear.

The unit is designed to operate either continuously or to be controlled by an automatic switch for intermittent operation. Water and air enter the chamber 5, the water level being prevented from falling below the top of the baffle 16. This is provided to insure at all times a sufficient head to prime the air pump through the passage 17ᵇ and intake ports 55. The water pump draws water through its inlet 6 and discharges it through the outlet nozzle 33ª to the pipe 39, which may lead to the boiler or other desired place. The air pump being primed by the water supply through passage 17 takes in air through port 7 and discharges it through port 10, into the chamber 9, whence it goes to the atmosphere through outlet 11. Small quantities of water are entrained in the air and thus discharged by the air pump, make up for which is supplied automatically and continuously through the priming conduit. The discharged water is collected in the separating tank, and automatically returned through valve 12 to chamber 5.

In addition to the structural features enumerated, vacuum pumping apparatus of this type possesses the advantage that if water comes into the tank 5 faster than it can be withdrawn, or if the unit is for any cause shut down, no damage will result. In systems using reciprocating air pumps excess water tends to flood the air pump, which then expels solid slugs of water and is subjected to great strains. When the water in the vacuum side of the tank A rises high enough to force water through the passage 17 in large quantities the air pump floods and becomes inoperative to discharge air or water to the atmosphere. In the meantime the pump 2 is withdrawing water and as soon as the level is sufficiently lowered, the air pump takes hold and removes air from the system.

Because of the fact that the suction passage of the air pump surrounds the shaft air is prevented from getting into the water pump and making the impeller inoperative. The pressure in the suction passage 7ᵇ is of course less than that in the chamber 5 and therefore no air can get into the water impeller. When the impeller has withdrawn water from the tank down to the level of

the apron 16 it of course becomes air bound. But when more water comes into the chamber it supplies the water pump driving out the air through the top of the passage 6 and around through passage 7 into the air pump. A small quantity of air will remain in the water pump to be forced out through the clearance 7^d into the passage 7^b.

It will be understood that the invention is not limited to the particular details shown by way of illustration, but that many changes may be made within the scope of the appended claims.

Having thus described my invention what is claimed as new and desired to be secured by Letters Patent is:

1. Pumping apparatus of the character described, including in combination, a tank having two compartments and openings in one wall thereof, there being an opening for each compartment, and a pump including a casing mounted on said tank and having inlet and outlet openings registering with the openings in said wall.

2. Pumping apparatus of the character described, including in combination, a tank having three openings in a wall thereof, a combined liquid and gas pump secured to said wall and having an inlet for the liquid pump, a gas inlet for the gas pump and a gas outlet for the gas pump, said inlets and outlet severally being in communication with said openings.

3. In a pumping apparatus, in combination, a tank, a pump casing mounted on and having openings into the tank, a liquid rotor and a hydro-turbine gas rotor mounted in said casing and adapted to withdraw liquid and gas from the tank, and means for priming the gas pump rotor.

4. Pumping apparatus of the character described, including in combination, a tank having four openings in a wall thereof, a liquid and gas pump secured to said wall and having a liquid inlet, a gas inlet, a gas outlet, and an inlet for supplying the gas pump with the liquid necessary for its operation, the gas pump being of the type requiring liquid for operation, said inlets and outlet severally being in communication with said openings.

5. Pumping apparatus of the character described, including in combination, a tank having three openings in a wall thereof, a combined liquid and gas pump including a casing having a liquid inlet, a gas inlet and a gas outlet, and means to secure said casing to said wall with said inlets and outlet severally in communication with the interior of said tank through said openings.

6. Pumping apparatus of the character described, including in combination, a tank having a plurality of independent openings in one wall thereof, a combined liquid and gas pump including a casing having liquid and gas inlets in one side thereof, and means to secure said casing to said wall with said inlets severally in communication with the interior of said tank through said openings.

7. In a pumping apparatus, in combination, a tank, a pump casing forming part of the tank, and a hydro-turbine pump mounted in said casing for withdrawing fluid from the tank, the tank having means to maintain a supply of liquid for priming the pump.

8. In a pumping apparatus, in combination, a tank having openings, a pump casing mounted on the tank having an inlet opening in direct communication with said tank through the first mentioned opening, and a liquid rotor in the casing, the intake of the rotor being below the normal level of liquid in the tank.

9. Pumping apparatus of the character described, including in combination, a tank having a plurality of independent openings in one wall thereof, a combined liquid and gas pump including a casing, said gas pump being of the type requiring liquid for its operation, said casing having an inlet for the liquid pump, an inlet for the gas pump, and a liquid inlet for supplying the gas pump with the liquid necessary for its operation, and means securing said casing to said wall with said inlets severally in communication with the interior of said tank through said openings.

10. Pumping apparatus of the character described, including in combination, a tank for the reception of liquid and gas having independent openings in the wall thereof, a pump casing secured to said wall and having inlet and outlet openings registering with said first mentioned openings, and a pump rotor in said casing adapted to remove liquid and gas from said tank.

11. In a pumping apparatus, in combination, a tank comprising a receiving chamber and a separating chamber, a pump casing mounted on the tank and having openings into said chambers, a pump rotor mounted in the casing adapted to remove gas and liquid from the receiving chamber and to pump gas into the separating chamber.

12. In a pumping apparatus, in combination, a tank comprising a receiving chamber and a separating chamber, a pump casing forming part of the tank, a pump rotor mounted in the casing for withdrawing liquid and gas from the tank, means in the tank for maintaining a supply of liquid for priming the pump, and means in the separating chamber for returning to the receiving chamber liquid entrained in the gas.

13. In a pumping apparatus, in combination, a tank comprising a receiving chamber and a separating chamber, a pump casing mounted on the tank and having openings into the chambers, a pump rotor in the casing for removing liquid from the receiving

chamber, a pump rotor in the casing for pumping gas from the receiving chamber to the separating chamber, and means in the casing for supplying make-up liquid to the gas rotor.

14. Pumping apparatus of the character described, including in combination, a gas and liquid pump comprising a shaft, a liquid rotor and a gas rotor mounted thereon and a casing including a part having a suction passage for said gas rotor located between said rotors, said passage being in communication with two independent openings through the outside of the casing, one of said openings being the gas inlet and the other opening for supplying makeup liquid to the gas pump.

15. Pumping apparatus of the character described, including in combination, a tank having a vertical wall with a plurality of openings therein, a combined rotary liquid and gas pump having a horizontal shaft and including a casing having liquid and gas inlets in one side thereof, and means to secure said casing to said wall with said inlets severally in communication with the interior of said tank through said openings.

16. In a pumping apparatus, in combination, a unitary structure comprising a tank, a pump casing and a motor base, a motor mounted on said base, a pump rotor in said casing supported by the motor shaft, and means in the motor for adjusting the clearance between the pump rotor and casing.

17. In a pumping apparatus, in combination, a unitary structure comprising a tank, a pump casing and a motor base, a motor mounted on the base, a pump rotor in the casing supported by the motor shaft, and adjustable thrust bearings in the motor.

18. In a pumping apparatus, in combination, a unitary structure comprising a tank, a pump casing and a motor base, a motor mounted on the base, a pump rotor in the casing supported by the motor shaft, and means in the motor to maintain the axial adjustment of the rotor.

19. In a pumping apparatus, in combination, a unitary structure comprising a tank, a pump casing and a motor base, a motor on the base, a pump rotor in the casing supported by the motor shaft, part of the casing being removable to facilitate alignment of the motor.

20. In a pumping apparatus, in combination, a unitary structure comprising a tank, a pump casing and a motor base, a motor on the base, a pump rotor in the casing supported by the motor shaft, part of the casing being adapted to slide along the shaft to facilitate alignment of the motor.

21. Pumping apparatus of the character described, including in combination, a tank having a plurality of openings in one wall thereof, a combined rotary liquid and gas pump having a shaft and a casing provided with liquid and gas inlets, means to secure said casing to said wall with said inlets severally in communication with said tank through said openings, a motor having a shaft rigid with said pump shaft, and means to support said motor rigidly with said tank.

22. Pumping apparatus of the character described, including in combination, a liquid and gas pump including a shaft, a liquid rotor and a gas rotor mounted on said shaft, and a casing for said rotors, said casing having a suction passage for said gas rotor located between said rotors and surrounding said shaft, said passage being in communication with the tank outside the periphery of said rotors.

23. In a pumping apparatus, in combination, a tank for the reception of liquid and gas, a pump casing forming part of the tank, a liquid rotor and a gas rotor mounted in said casing, said casing having a suction passage for the liquid rotor and a suction passage for the gas rotor, each of said passages being disposed around the shaft and said gas suction passage being in communication with said tank outside the periphery of said rotors.

24. Pumping apparatus of the character described, including in combination, a tank, a pump casing having an inlet in communication with the interior of said tank and having a stuffing box, a motor having its shaft extending into said casing through said stuffing box, and a rotor on said shaft within said casing, said motor having means for adjusting its shaft axially.

25. Pumping apparatus of the character described, including in combination, a tank having openings in the wall thereof, a pump casing secured to said tank and having an inlet and outlet openings in communication with said first mentioned openings and also having a stuffing box, a motor having its shaft extending into said casing through said stuffing box, and a rotor on said shaft within said casing, said motor having means to adjust its shaft axially.

26. Pumping apparatus of the character described, including in combination, a tank, a water pump and air pump secured thereto and adapted to withdraw water and air therefrom, the air inlet for said air pump being disposed around the hub of the water rotor and in communication with said tank laterally of the water pump whereby air in the water rotor is to some extent withdrawn into said inlet and no air leaks into the water rotor from the air side of the pump because of the reduced pressure in said air inlet.

27. Pumping apparatus of the character described, including in combination, a tank having independent openings, a pump casing secured to said tank and having openings

registering with the first mentioned openings, a second pump casing secured to the first having openings communicating with some of the second set of openings thus placing the second pump in communication with said tank, a motor rigid with the tank having a shaft projecting into said casings, a liquid rotor in one casing, and a gas rotor in the other casing, said rotors being secured to said shaft.

28. Pumping apparatus of the character described, including in combination, a tank, two rotary pumps secured to said tank and in communication with the interior thereof, one pump being a liquid pump and including a casing and rotor, the other pump being a gas pump and including a rotor and casing having a passage plate, said plate being disposed at one side of the gas rotor and provided with gas inlet and outlet passages therein, and means to drive said pumps.

29. Pumping apparatus of the character described, including in combination, a tank having two compartments, a rotary water pump, a rotary air pump, said pumps being carried by said tank, the inlet of the water pump being in communication with one compartment through an opening in the tank, the inlet and discharge of the air pump being in communication with different compartments, the inlet being in communication with the same compartment as the water pump inlet and the discharge with the other compartment, and means to drive said pumps.

30. Pumping apparatus of the character described, including in combination, a tank having two compartments with openings in the walls thereof, a rotary water pump, a rotary air pump, said pumps secured to said tank, the inlet of the water pump being in communication with the interior of one compartment through one of said openings, the casings of said pumps having passages, one connecting the inlet of the air pump and an opening in the same compartment as the water pump inlet, and another connecting the discharge of the air pump and the other compartment, and means to drive said pumps.

31. Pumping apparatus of the character described, including in combination, a tank having two compartments, a rotary water pump, a rotary air pump, said pumps carried by said tank, the inlet of the water pump being in communication with one compartment through an opening in the tank, the inlet and discharge of the air pump being in communication with different compartments, the inlet of the air pump being in communication with the same compartment as the inlet of the water pump, and the discharge of the air pump with the other compartment, the air pump being of the type employing water for its pumping action, means to supply said air pump with the water necessary for its operation from the tank, and means to drive said pumps.

32. Pumping apparatus of the character described, including in combination, a tank having two compartments with openings in the walls thereof, a rotary water pump, a rotary air pump, said pumps secured to said tank, the inlet of the water pump being in communication with the interior of one compartment through one of said openings, the casings of said pumps having passages, one connecting the inlet of the air pump and an opening in the same compartment as the water pump inlet, and another connecting the discharge of the air pump and the other compartment, and means to drive said pumps, said air pump being of the type employing water for its pumping action, and said pump casings having an additional passage for supplying the air pump with water necessary for its operation from the tank.

33. Pumping apparatus of the character described, including in combination, a tank having two compartments and an opening in the wall thereof, a rotary water pump secured to said tank over said opening, and having its inlet directly in communication with said tank through said opening, an air pump secured to the water pump and including a casing, rotor, and passage plate disposed between the water pump casing and the air pump casing, said air pump being of the type employing water for its pumping action, said water pump casing having a passage affording communication between the passage in said plate and one of said compartments, this passage constituting a discharge for the air pump, and two other passages in said water pump casing connecting with passages in said plate and both compartments, one being the inlet and the other to supply make-up water to the water pump, and means to drive said pumps.

34. Pumping apparatus of the character described, including in combination, a tank having two compartments, a liquid pump, and a gas pump, the inlet of the liquid pump being in communication with one compartment through an opening in the tank, the inlet and discharge of the gas pump being in communication with different compartments, the inlet being in communication with the same compartment as the liquid pump inlet and the discharge with the other compartment.

35. Pumping apparatus of the character described, including in combination, a tank having a plurality of independent openings in one wall thereof, a combined liquid and gas pump having a casing provided with liquid and gas inlets in one side thereof, and means to secure said casing to said wall with each inlet in register with one of said openings.

36. A water and air pumping apparatus

for use in a vacuum steam heating system including in combination, a tank having an opening in a vertical wall thereof, a centrifugal pump secured to said tank to take its supply therefrom, a rotary air pump of the type requiring water for its operation aligned with said centrifugal pump, the rotors of both pumps being mounted on a common horizontally disposed shaft, and a conduit to supply the air pump with the water necessary for its operation from the tank arranged at a lower level than the inlet to the centrifugal pump, said air pump being arranged and connected to exhaust the air and maintain a vacuum in the system.

37. A water and air pumping apparatus for use in a vacuum steam heating system including in combination, a tank having an opening in a vertical wall thereof, a centrifugal pump secured to said tank to take its supply therefrom, a rotary air pump of the type requiring water for its operation aligned with said centrifugal pump, the rotors of both pumps being mounted on a common horizontally disposed shaft, and a conduit to supply the air pump with the water necessary for its operation from the tank arranged at a lower level than the inlet to the centrifugal pump, said air pump being arranged and connected to exhaust the air and maintain a vacuum in the system after the centrifugal pump has drawn all the water that it can from the tank.

38. A water and air pumping apparatus for use in a vacuum steam heating system including in combination, a tank having an opening in a vertical wall thereof, a centrifugal pump secured to said tank to take its supply therefrom, a rotary air pump of the type requiring water for its operation aligned with said centrifugal pump, the rotors of both pumps being mounted on a common horizontally disposed shaft, and a conduit to supply the air pump with the water necessary for its operation from the tank arranged at a lower level than the inlet to the centrifugal pump, said air pump being arranged and connected to exhaust the air and maintain a vacuum in the system and so that the water used in the air pump will return to the tank.

39. A water and air pumping apparatus for use in vacuum steam heating systems, including in combination, a tank having an aperture in a vertical wall thereof, a centrifugal pump casing, a fluid pump casing aligned with said centrifugal casing, one of said casings being secured to said tank to take its supply through said aperture, a common horizontally disposed shaft for said pumps, a water impeller secured to the shaft and within the centrifugal pump casing, a fluid impeller secured to said shaft and within the fluid pump casing, the fluid pump being of the type requiring water for its operation, and having an inlet and outlet disposed for exhausting air from the system, and a conduit for supplying the fluid pump with the water necessary for its operation from water in the tank.

In testimony whereof I hereunto affix my signature.

IRVING C. JENNINGS.