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5 SHEETS—SHEET 1.

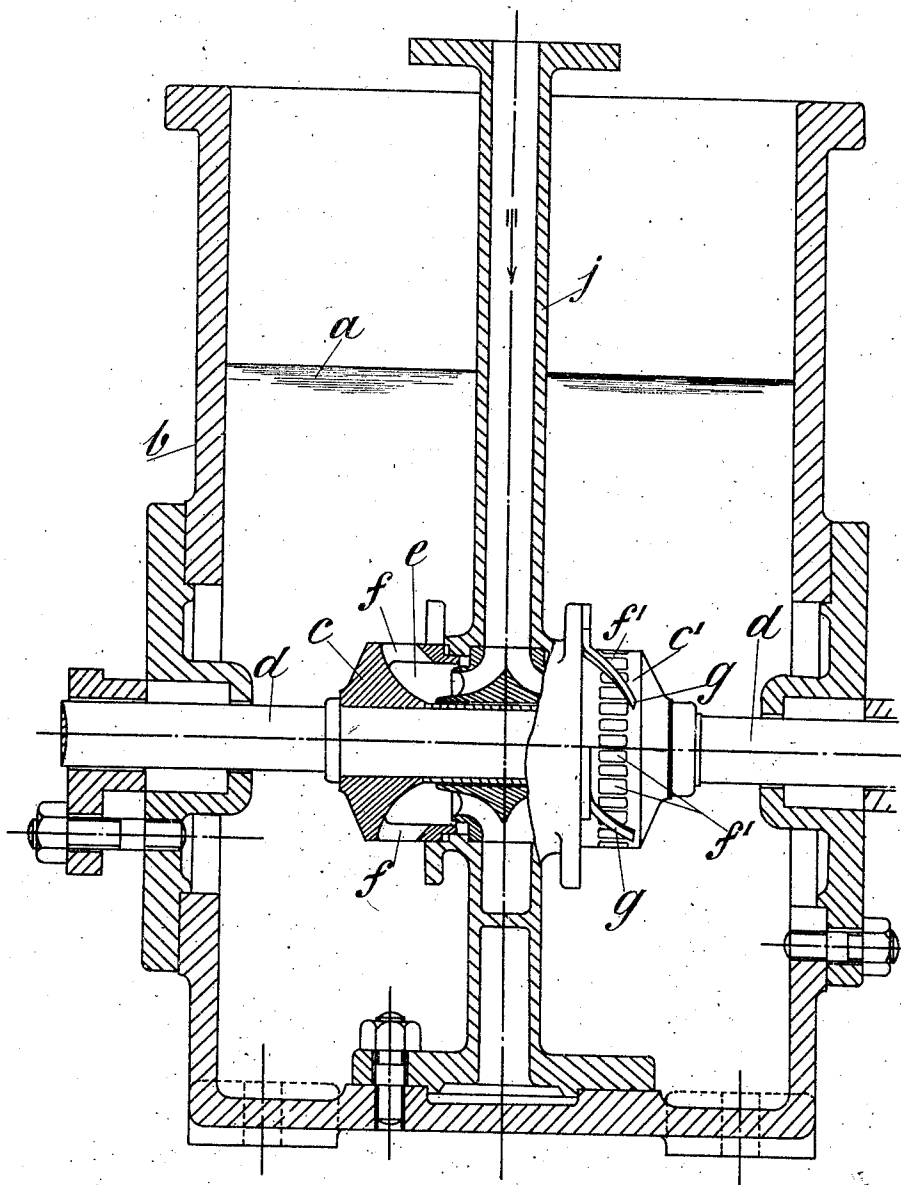


Fig. I.

Inventor
J. Petermüller.

By *J. M. Mune* JEM.

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J. PETERMÖLLER.
ROTARY AIR PUMP.
APPLICATION FILED NOV. 2, 1911.

Patented Jan. 14, 1913.
5 SHEETS—SHEET 2.

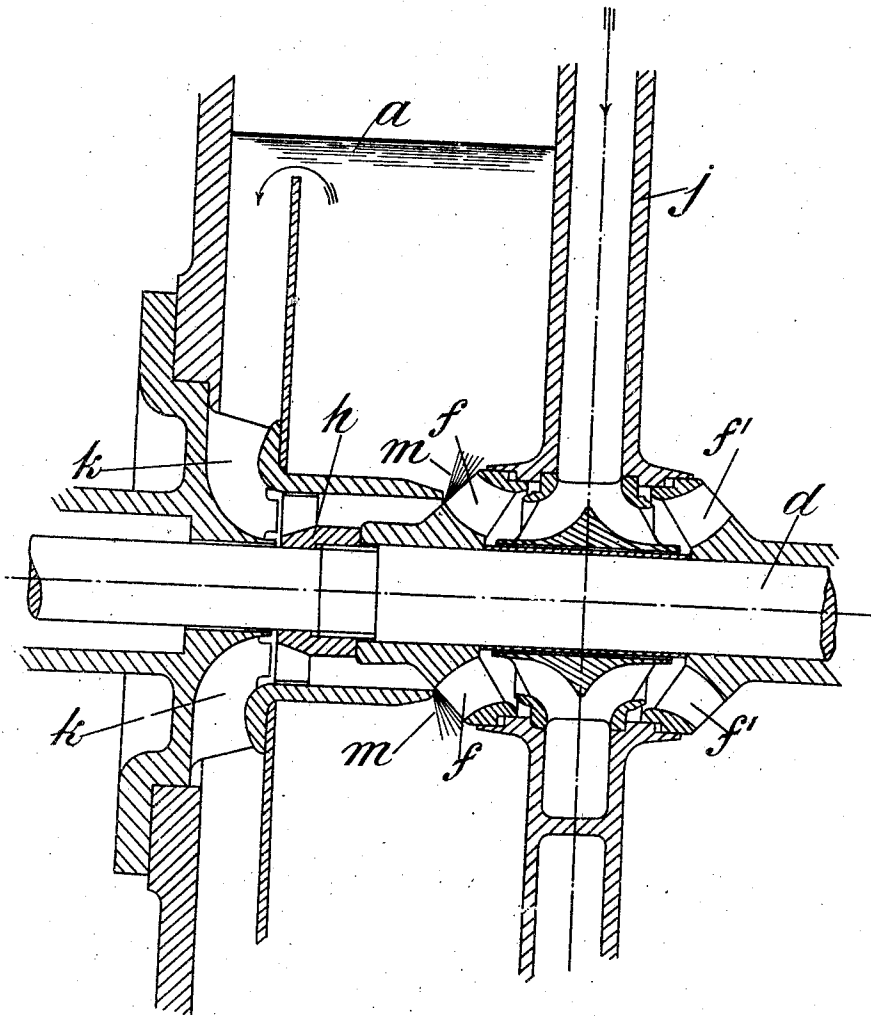


Fig. 2.

Witnesses.

Hynd R. Cornwall

W. A. Williams.

Inventor

J. Petermoller.

By

John M. Mue
Atty.

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5 SHEETS—SHEET 3.

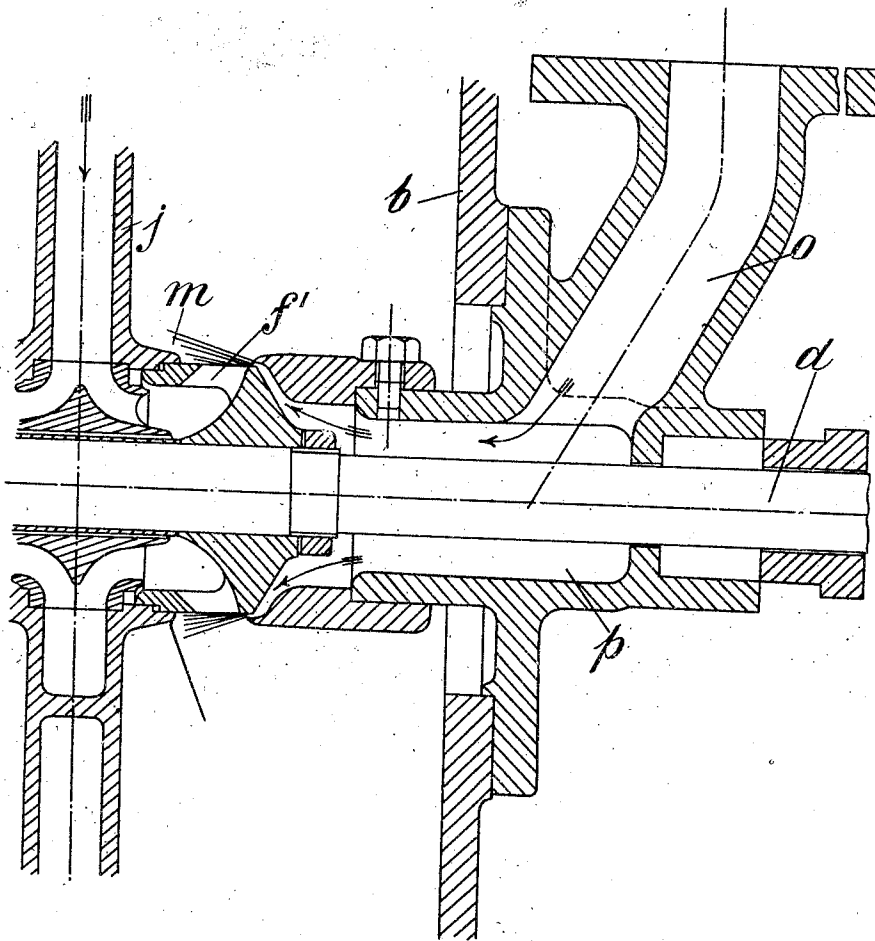


Fig. 3.

Witnesses
Rogd R. Cornwell
W. A. Williams.

Inventor
J. Petermüller.

By *Am. Innie*
Atty.

J. PETERMÖLLER.
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5 SHEETS—SHEET 4.

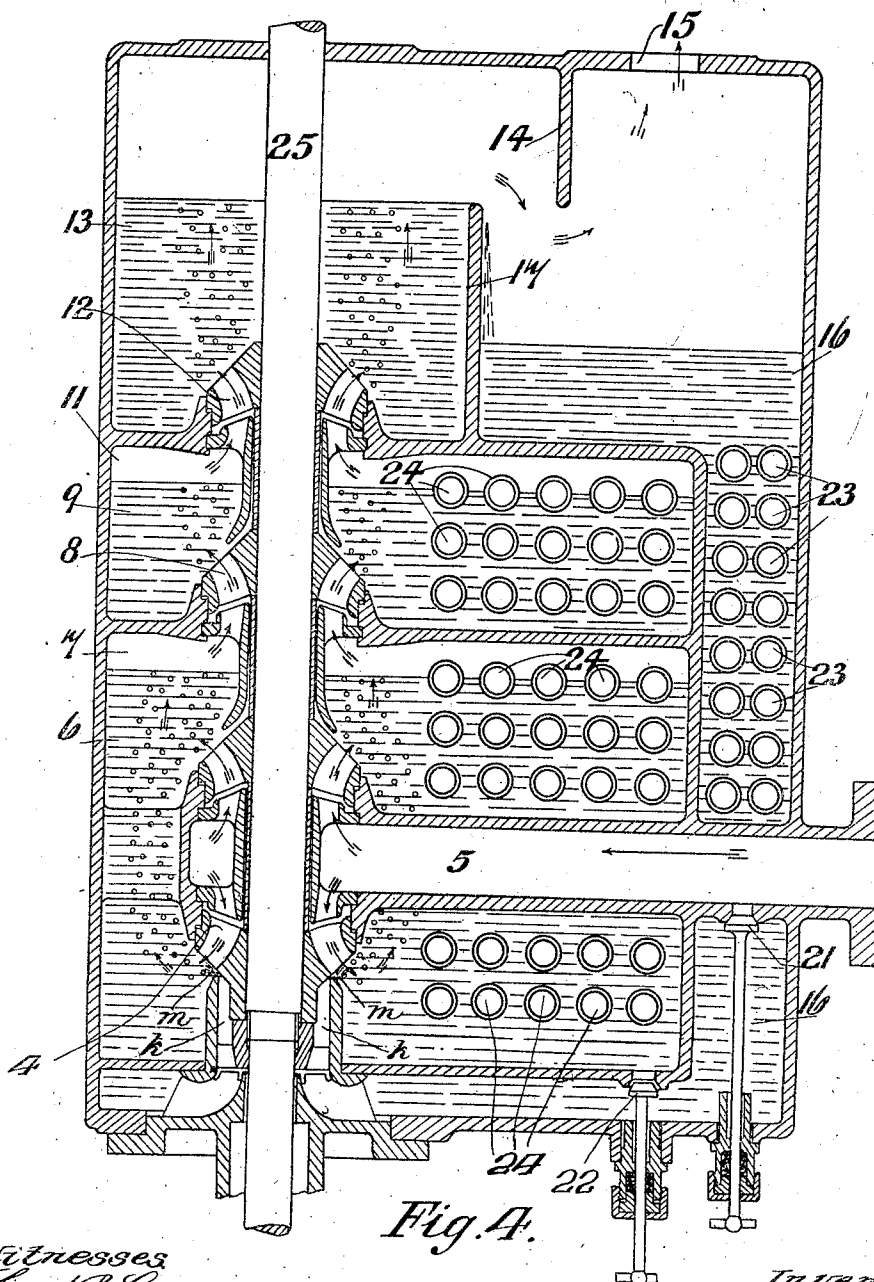


Fig. 4.

Witnesses
 Floyd R. Cornwall
 W. A. Williams.

Inventor
 J. Petermoller.

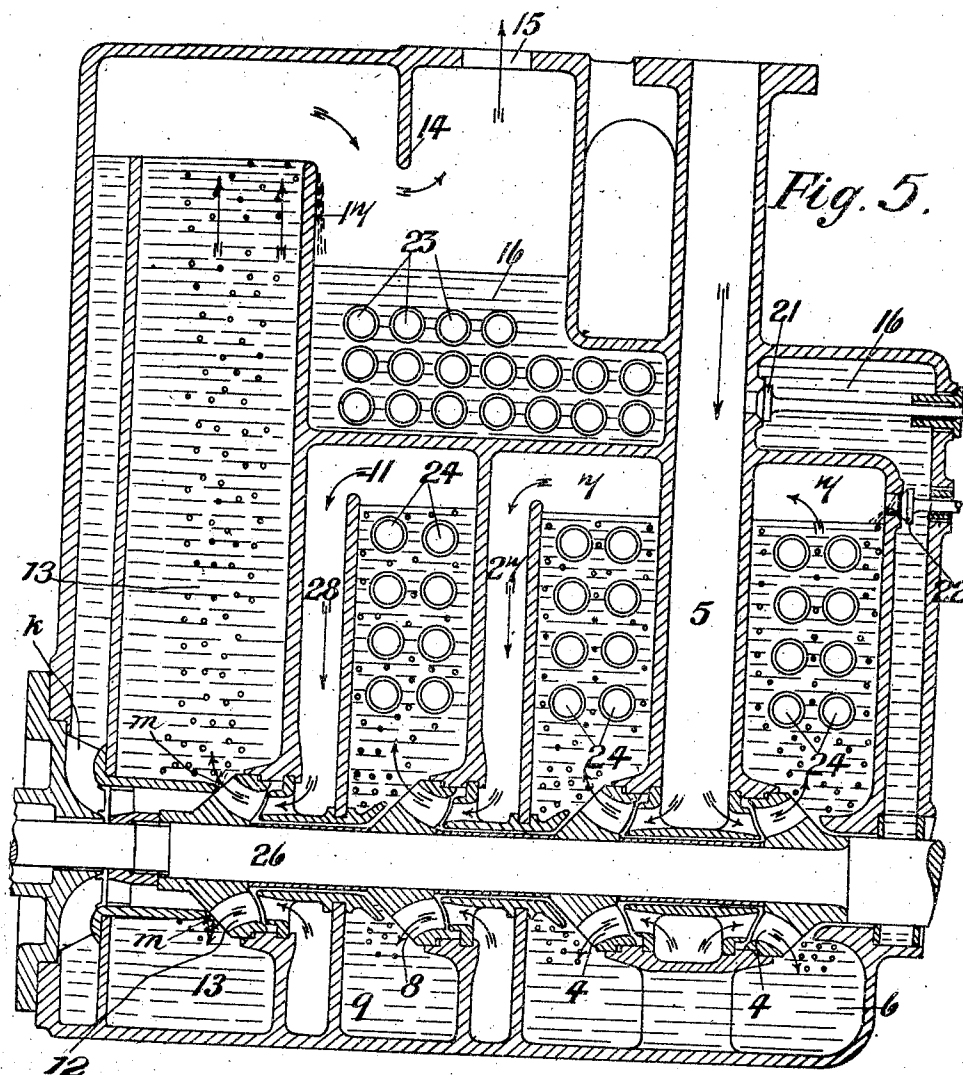
By *James M. Miller* Att'y.

1,050,688.

J. PETERMÖLLER.
 ROTARY AIR PUMP.
 APPLICATION FILED NOV. 2, 1911.

Patented Jan. 14, 1913.

6 SHEETS—SHEET 5.



Witnesses:
 Lloyd R. Cornwall
 W. G. Williams

Inventor
 J. Petermoller

By: *J. M. Miller*

UNITED STATES PATENT OFFICE.

JOSEPH PETERMÖLLER, OF HOLM FOUNDRY, CATHCART, SCOTLAND, ASSIGNOR TO G. AND J. WEIR, LIMITED, OF CATHCART, SCOTLAND.

ROTARY AIR-PUMP.

1,050,688.

Specification of Letters Patent.

Patented Jan. 14, 1913.

Application filed November 3, 1911. Serial No. 658,211.

To all whom it may concern:

Be it known that I, JOSEPH PETERMÖLLER, a subject of the Emperor of Germany, residing at Holm Foundry, Cathcart, in the county of Renfrew, Scotland, have invented certain new and useful Improvements in Rotary Air-Pumps; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

The present invention relates to rotary pumps for dealing with air to other elastic fluids, and is intended chiefly for use in connection with steam condensing plants and more particularly those in which the condenser is under vacuum and it is required to discharge the air from the condenser against atmospheric pressure.

Air pumps other than those of the reciprocating type usually compress the gas by means of a so-called auxiliary liquid medium to which the required energy is primarily transmitted. The energy in the liquid is in turn transmitted to the gas during its compression. Known examples of this type are jet air pumps or ejectors, wherein a water jet is discharged at high speed through nozzle-shaped openings, and entrains with it the gas to be compressed; also pumps wherein the jet or jets are broken up in order to produce as great a surface as possible, with a consequent complete mixing with the gas to be discharged. This mixture is then led through passages in which its remaining velocity energy is used to compress and discharge the entrained gas.

With the object of maintaining the absolute velocity of the auxiliary liquid medium as low as possible, it has heretofore been proposed to produce the relative movement between the liquid and the gas by the motion of the nozzles themselves, the latter consisting, for example, of radial passages arranged in a wheel mounted on a shaft and immersed in water contained in a reservoir, the shaft being rotated by a pulley or otherwise, and the gas being led to the inner ends of these passages, the discharge ends of which are at the periphery of the rotor.

With an apparatus of this nature, when the shaft is rotating, the relative velocity between the liquid and the gas to be discharged is produced at the discharge ends of the passages in the rotor. Gas and liquid are mixed, and the gas rises in the specifically heavier liquid; and in this way a vacuum can be obtained in the duct which conveys the gas to the rotor. The absolute velocity of the liquid may, therefore, be relatively very low.

My invention, which consists in apparatus intended to work on this principle, will be described with reference to the accompanying drawings and more particularly set forth in the claims.

Figure 1 is a vertical section of a single-stage pump. Figs. 2 and 3 are vertical sections of alternative constructions of the single stage pump, and, Figs. 4 and 5 are vertical sections of alternative constructions of a multi-stage pump embodying the principles of the invention.

Referring in the first place to Fig. 1, the pump here illustrated is intended for removing air from surface condensers under vacuum and for discharging this air into the atmosphere. The pump is immersed in water *a*, contained in the tank *b*. The pump wheel, or rotor *c* is fixed on the shaft *d* which is adapted to be rotated directly by a motor or by other suitable means. The wheel is arranged on the double flow principle in order to have no unbalanced axial pressure. The air enters the pump by the conduit *j* and is divided into two portions, one portion passing into the annular chamber *e* contained in the left-hand part *c* of the wheel, while the other portion passes into the corresponding annular chamber in the right-hand part *c'* of the wheel. *f, f'* are the discharge ducts through which the air passes into the water *a*. The rotation of the wheel causes a relative velocity between the periphery of the wheel and the water; and this relative velocity sweeps the air from the ducts *f, f'*. The air when free from the wheel then rises in the specifically heavier water. In this way a vacuum can be produced in the conduit *j*, and air drawn out of the condenser and discharged through the water into the atmosphere. The water is to a certain extent put into motion by the rotation of the wheel, but the absolute velocity

of the water is comparatively low and considerably lower than would require to be given to the auxiliary medium in pumps of the jet or ejector type, such as have hereinbefore been referred to.

In order to prevent the water rotating with the wheel at the same velocity as the periphery of the latter, stationary guide plates or vanes may be provided. Such vanes are shown only at the right hand end of the wheel in Fig. 4 and are indicated by the letters *g*. It will be understood, however, that these vanes will in practice be placed on both ends of the wheel. These plates or vanes serve, moreover, to give to the water a component of velocity at right angles to the peripheral velocity of the wheel and are therefore useful in preventing the air, which is swept from any one of the exit ducts *f*, *f'*, from interfering with the exit duct next behind it.

If the friction between the water and the wheel, in conjunction with the action of the guide plates, is not sufficient to produce the required circulation, a hydraulic pump may be employed for this purpose and mounted on the same shaft as the air pump wheel. Such an arrangement is shown in Fig. 2 in which *h* indicates the hydraulic pump rotor. The water is drawn into the hydraulic pump by way of the passages *k*, *k*, and discharged in the form of an annular jet *m* across the discharge ducts *f* of the air pump, the motion of the fluid being at right angles to the motion of the periphery of the air pump wheel. An alternative manner of obtaining the same effect is shown in Fig. 3. In this case water under pressure, obtained from any convenient source outside of the tank *b*, is conducted along the passage *o* and the annular passage *p* which surrounds the shaft *d* and discharged as an annular jet *m* across the air pump discharge ducts *f*.

In order to reduce the speed of rotation of my pumps and at the same time to improve their quantitative capacity and increase their efficiency, I sometimes compress the air in two or more stages, the compression being accomplished in each case by a rotating wheel or drum acting in the manner hereinbefore described. Each wheel is located in an independent chamber or cell—or at least discharges into this chamber—and is immersed in, or sealed by, water contained in this chamber. The air discharged from each wheel rises through the water and collects at the top of the chamber from which it is led to, or drawn by, the next wheel. The air discharged from the last wheel, after rising through the water in the chamber containing this wheel, is delivered to the atmosphere or to the vessel to which it is desired to be delivered. By thus reducing the pressure difference between the suction and discharge of each wheel, the efficiency

is increased while at the same time I am enabled to reduce the speed of rotation of the pump and also increase the capacity.

A multi-stage pump is illustrated in Fig. 4. 4 is the first-stage wheel and 5 is its suction passage. This wheel is situated within the chamber 6 which contains water, and the air rises in bubbles through the water and collects in the space 7 at the top of the chamber from which it gains access to the second-stage wheel 8 which is located in the chamber 9 which also contains water. The air rises in bubbles through this water and collects in the space 11 from which it gains access to the third-stage wheel 12 which is located in the chamber 13. The second- and third-stage wheels are of the same nature as the first-stage wheel but they are of the single-flow instead of the double-flow type. The air rising through the water in the chamber 13 passes under the baffle plate 14 and leaves the apparatus by the port 15. The baffle plate 14 tends to separate out the water carried in suspension by the air, which water is deposited in the side tank 16. Moreover, a certain amount of water, either in the liquid or vapor form, is carried by the air into the chamber 13 from the chambers of the preceding wheels. The excess of water in the chamber 13 flows over the weir 17 into the tank 16. Water from the tank 16 may be re-admitted to the wheel chambers either by allowing it to flow into the chamber 6 of the first-stage wheel or into the first-stage wheel suction pipe 5. For this purpose valves 21 and 22 may be provided. The water in the tank 16 may be cooled by water or other liquid circulated through the tubes 23 or by other convenient cooling arrangement; or, in place of cooling the water within the tank 16, or in addition thereto, I may provide cooling arrangements, such, for example, as cooling tubes 24 within the water chambers 6 and 9, and, if desired, also within the water chamber 13.

In Fig. 4, three wheels are shown, and all are mounted on the same vertical shaft 25, the first-stage wheel being in the lowest position. I may, however, mount the several wheels on a common shaft arranged horizontally, or at any angle, or I may place them on independent shafts. In every case, each wheel is located in, or discharges into, a separate chamber. In every case also, a plurality of wheels is employed, but the number may vary according to the requirements of the case.

An arrangement of wheels on a horizontal shaft 26, according to the present invention, is illustrated in Fig. 5. As in the previously described arrangement, 4 is the first-stage, 8 the second-stage, and 12 the third-stage wheel, these wheels being located in water chambers, 6, 9 and 13 respectively. With this horizontal arrangement, in order

to allow the second-stage wheel to suck the air from the top of the chamber 6 of the first-stage wheel, it is necessary to provide a duct 27. A similar duct 28 is provided to allow the third-stage wheel to suck the air from the top of the chamber 9.

In Fig. 4, as well as in Fig. 5, the first-stage wheel is illustrated as of the double-flow type, and the other wheels as of the single-flow type, that is, the first-stage wheel discharges the air in two opposite directions while the remaining wheels discharge the air only in one direction. While this is a convenient arrangement, I can of course provide either a double-flow, or a single-flow, wheel for any stage. Whatever arrangement is employed, the vane speeds of the several wheels may be different with the object of obtaining the best results in each case. When the wheels are fixed on the same shaft, the vane speeds can be varied by varying the diameter of the several wheels.

A very important feature of my type of pump is that the absolute velocity of the water is as low as possible and, in the case of a vacuum pump, considerably lower than that necessary to eject it from an absolute vacuum into a space at atmospheric pressure. This constitutes a great advantage of these pumps, because, in all pumps employing an auxiliary fluid medium, losses of energy by the medium naturally tend to increase with the kinetic energy given to the medium; and these losses bear a high ratio to the useful work done in compressing and discharging the air; and, in the majority of rotary air pumps in which an auxiliary fluid medium is employed, the useful work done on the air is only a small proportion of the total; and a very large proportion of the energy in such apparatus is used in constantly accelerating the auxiliary medium up to the necessary velocity. In my pumps, however, no acceleration is required, the energy being initially given to, and retained by, the rotating portion of the pump and usefully employed as long as the pump is at work.

A special advantage of my pump lies in the fact that all the rotating parts are completely immersed in the water, and consequently no stuffing boxes are required through which air could penetrate to the vacuum space.

It is not of course necessary that water should be employed as the auxiliary medium: any other suitable liquid or liquids may be used.

Pumps constructed in accordance with the present invention may be employed for dealing with any elastic fluid.

It will be noted that the multi-stage pumps illustrated in Figs. 4 and 5 also embody any desired number of hydraulic pumps provided with the passages $k-k$ so

as to discharge the water in the form of an annular jet m across the discharge ducts of the air pump, whereby the desired circulation may be maintained. Only one of these is shown in each of Figs. 4 and 5, but it is to be understood that any desired number may be employed, one for each of the hydraulic pumps, for instance.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. A rotary air pump comprising, a pump wheel provided with peripheral air discharge ports, means for rotating said wheel, a tank containing water in which said wheel is completely immersed, a fixed conduit which passes through said water and is adapted to convey the air to said wheel, and means for giving to the water surrounding said wheel a velocity at right angles to the velocity of the said air discharge ports.

2. A rotary air pump comprising, a pump wheel provided with peripheral air discharge ports, means for rotating said wheel, a tank containing water in which said wheel is completely immersed, a fixed conduit which passes through said water and is adapted to convey the air to said wheel, and a hydraulic pump immersed in said water and adapted to discharge an annular jet of water across the said air discharge ports.

3. A rotary air pump including a pump wheel provided with peripheral air discharge ports, means for rotating said wheel, a tank containing water in which said wheel is completely immersed, a conduit which passes through said water and is adapted to convey the air to said wheel, and means for passing water across the peripheral discharge ports at an angle to the motion of the periphery of said wheel.

4. A rotary air pump including a pump wheel provided with peripheral air discharge ports, means for rotating said wheel, a tank containing water in which said wheel is completely immersed, a conduit which passes through said water and is adapted to convey the air to said wheel, and means for discharging an annular jet of water across the said air discharge ports.

5. A rotary air pump including a tank embodying a plurality of separate chambers containing water, a plurality of pump wheels located in said chambers and adapted to compress the air in stages in the said chambers successively, one of said chambers being the outlet chamber and defined on one side by a weir, the tank also being provided with a side chamber containing water and in communication with the outlet chamber and having valve connection with the first stage chamber of the series.

6. A multi-stage rotary air pump including a plurality of pump wheels, a tank in which said wheels are mounted, said tank em-

bodying a plurality of separate chambers containing water, said chambers being arranged in a series, a plurality of pump wheels being located in said chambers respectively, means for rotating said pump wheels; the tank being provided with a side chamber in communication with the last stage chamber of the series, said side chamber being formed with a discharge port, and with baffle plate interposed between said port and the last stage chamber of the series.

7. A multi-stage rotary pump including a tank embodying a plurality of distinct chambers containing water, a series of pump wheels mounted in the respective chambers,

means for rotating said pump wheels, a conduit leading to the first stage pump wheel of the series and adapted to convey air thereto, a side tank communicating with the last stage chamber of the series, and valved connections between said side chamber the air conduit and the first stage chamber of the series.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOSEPH PETERMÖLLER.

Witnesses:

ROBERT MORRISON NEILSON,
DAVID WATT PAGE.