P. A. BANCEL.

CENTRIFUGAL AIR PUMP.

APPLICATION FILED SEPT. 10, 1913.

1,203,841.

Patented Nov. 7, 1916.

3 SHEETS—SHEET 1.

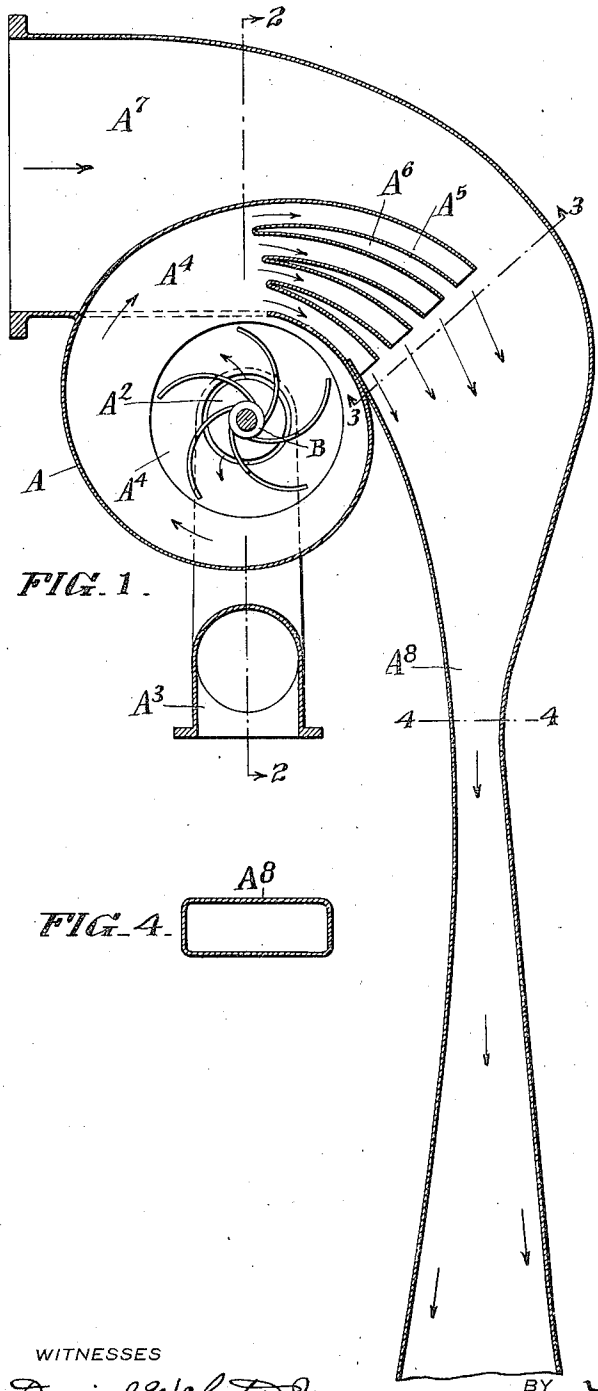


FIG. 1.

FIG. 4.

FIG. 2.

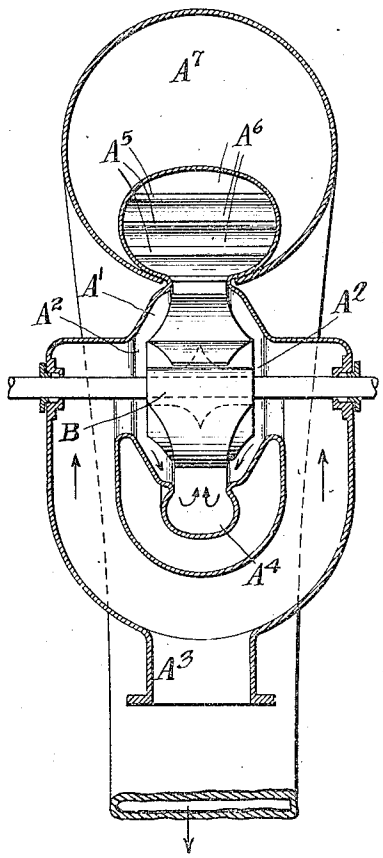
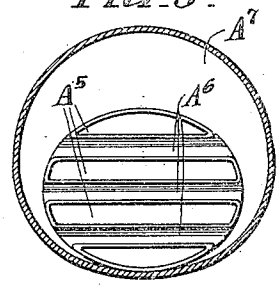


FIG. 3.



WITNESSES

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3 SHEETS—SHEET 2.

FIG. 5.

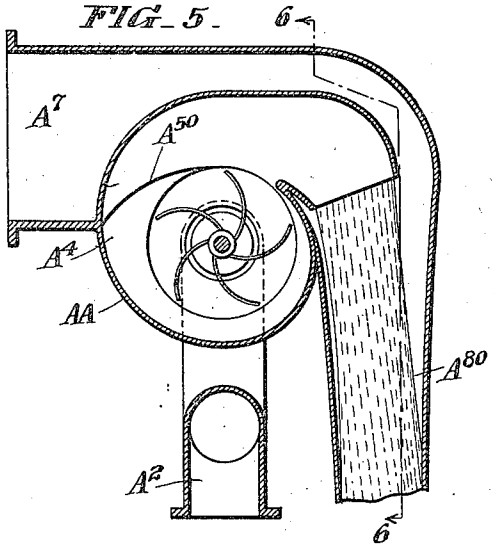


FIG. 6.

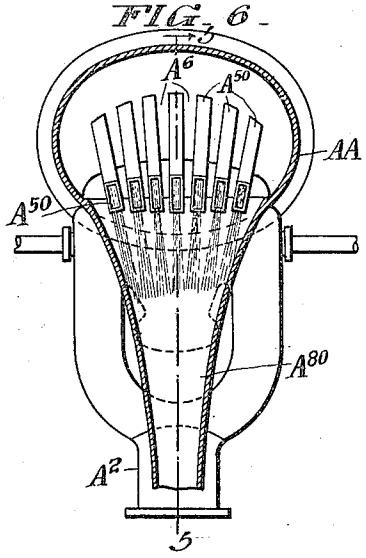


FIG. 7.

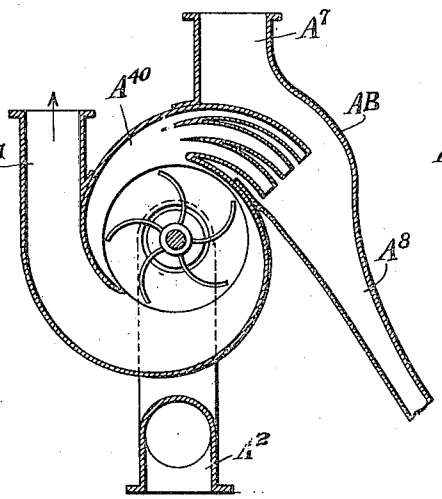


FIG. 9.

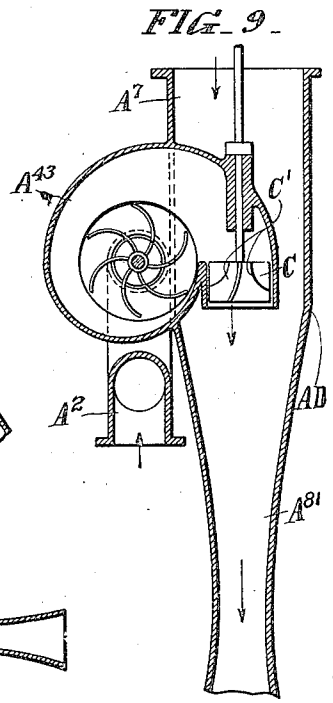


FIG. 10.

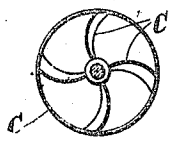
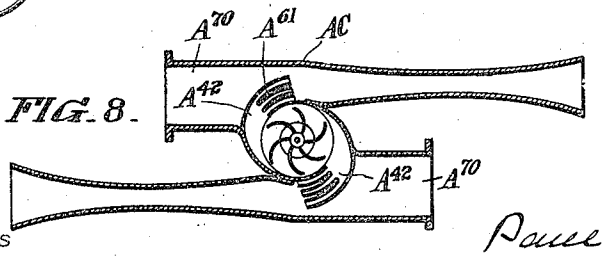


FIG. 8.



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3 SHEETS—SHEET 3.

FIG. 11.

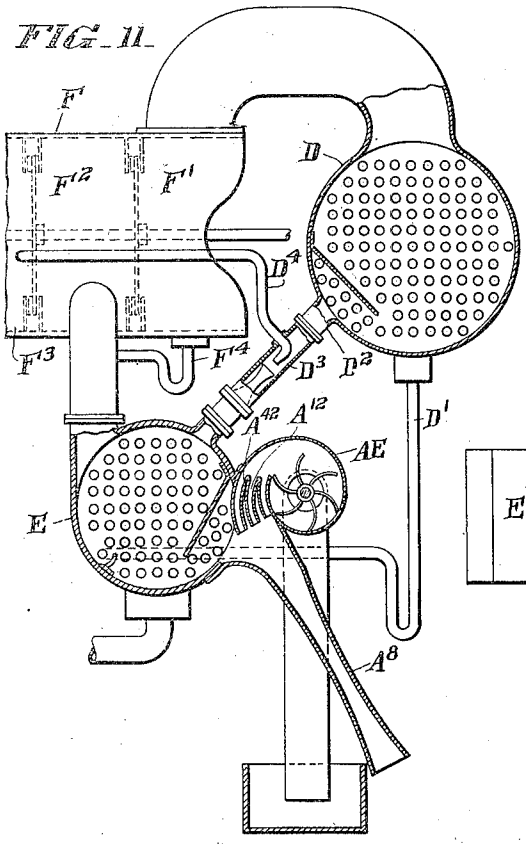


FIG. 12.

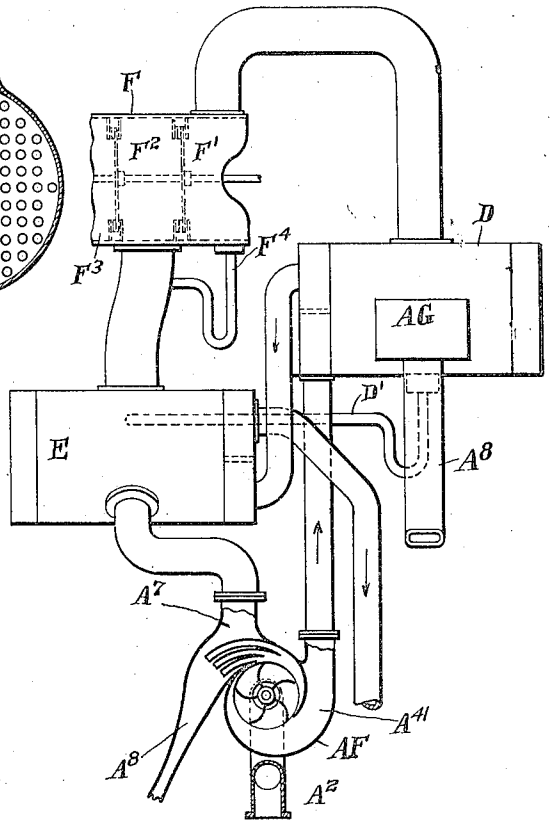
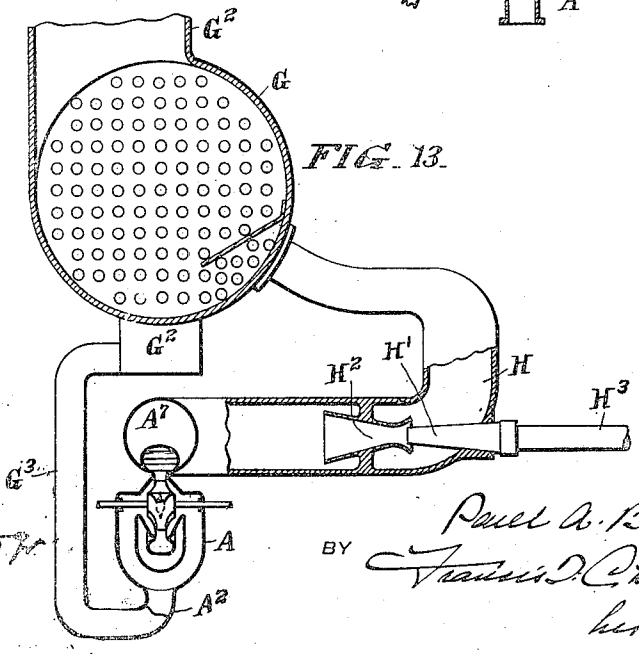


FIG. 13.



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CENTRIFUGAL AIR-PUMP.

1,203,841. Specification of Letters Patent. Patented Nov. 7, 1916

Application filed September 10, 1913. Serial No. 789,020.

To all whom it may concern:

Be it known that I, PAUL A. BANCEL, a citizen of the United States of America, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Centrifugal Air-Pumps, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

My present invention relates to centrifugal air pumps of the type largely used as exhausters for withdrawing air and other uncondensed gases or vapors from steam condensers, and in which the gaseous fluid is set in motion and compressed by means of jets of water or other liquid which forms the fluid passing into contact with and directly set into motion by the rotary impeller of the pump.

The primary object of the invention is to provide a simple and reliable air pump of the kind referred to, adapted for operation at high efficiency and with a relatively large capacity for handling air.

In carrying out my invention I employ a pump which may be like any of the approved and efficient types of centrifugal water pumps in so far as its impeller, impeller chamber and water supply connections are concerned. My improved pump differs from the ordinary forms of pumps, however, in that I provide it with a collecting chamber wholly or partially surrounding the impeller chamber and receiving all or a part of the discharge therefrom which is so shaped that, unlike the ordinary diffusion chamber, it passes the water entering it without any appreciable reduction in velocity and consequently without converting any substantial portion of the velocity energy of the water into energy of pressure. In conjunction with the specially shaped collecting chamber I provide means for separating the water without reduction of velocity other than that due to unavoidable friction losses into a plurality of streams, advantageously of flat ribbon-like shape and discharge these streams through the air chamber of the pump into a discharge nozzle or ejector. The latter is shaped to convert enough of the energy of velocity of the water and the air or other gaseous fluid caught up or entrained by the water into pressure to give the desired delivery pressure at the outlet of the ejector or discharge nozzle.

There is, of course, a certain loss of energy in the operation of my improved pump due to the frictional resistance to the flow of the water through the collecting chamber and the shock losses therein. These losses are minimized, however, by the fact that a portion of the water discharged by the impeller may pass directly without any change in its direction of flow into the air chamber of the pump. To increase the proportional amount of the water directly discharged into the air chamber or air chambers of the pump and further reduce the friction and shock losses, I may provide two or more collecting chambers, each extending along a portion of the periphery of the impeller chamber and discharging into a corresponding air chamber. In some cases also I may discharge a portion of the water into a specially shaped collecting chamber through which the water passes without material reduction in velocity, and discharge another portion of the water passing through the impeller into a diffusion chamber of the ordinary form in which a considerable proportion of the kinetic energy of the water is converted into pressure in the usual manner.

While my invention is capable of general use as an exhauster, it is of special utility when used as a rotary condenser or in, and as a part of, a steam condensing plant in one or another of the ways hereinafter described in detail.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, and of the advantages possessed by it, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described forms in which my invention may be embodied.

Of the drawings: Figure 1 is a sectional elevation of one form of air pump embodying my invention; Fig. 2 is a section on the line 2—2 of Fig. 1; Fig. 3 is a section on the line 3—3 of Fig. 1; Fig. 4 is a section on the line 4—4 of Fig. 1; Fig. 5 is a sectional elevation taken on the line 5—5 of Fig. 6, illustrating a modified form of apparatus; Fig. 6 is a section taken on the line 6—6 of Fig. 5; Fig. 7 is a sectional elevation of another form of pump embodying my invention; Fig. 8 is a sectional elevation of a

pump having two special diffusion chambers; Fig. 9 is a sectional elevation of a pump in which movable means are employed to break up the water into streams or jets; Fig. 10 is a plan view of a part employed in Fig. 9; Fig. 11 is a somewhat diagrammatic representation, partly in sectional elevation, of a condensing plant in which one form of my improved pump is used; Fig. 12 is a diagrammatic representation, partly in sectional elevation, of another form of condensing plant in which my improved air pumping mechanism is employed; and Fig. 13 is a diagrammatic representation, partly in sectional elevation, of a third form of condensing plant in which one form of my improved air pumping mechanism is employed.

In the drawings, and referring first to the construction shown in Figs. 1 to 4, A represents the pump casing formed with an impeller chamber A′ having inlet eyes or openings A^2 at opposite sides which receive water or other liquid through the branched supply pipe A^3. The rotary impeller B working in the impeller chamber A′ may be of the usual type employed in centrifugal water pumps delivering against fairly high heads. The impeller chamber A′ opens at its periphery into a volute collecting or discharge chamber A^4, which unlike the ordinary diffusion chamber is shaped to pass the water discharged into it by the impeller without converting any considerable portion of the kinetic energy of the water into pressure. From the chamber A^4, the water is discharged into the air chamber A^7 into which the air, steam, or other gaseous fluid to be condensed or compressed and set in motion is admitted, and means are provided for dividing the water passing into the chamber A^7 up into separate streams or jets in order to increase the entraining effect of the water. As shown in Figs. 1 to 4, the water issuing from the chamber A^4 is divided into a plurality of flat streams by means of a plurality of spaced apart hollow wedge shaped baffles A^5. Preferably as shown the water spaces between adjacent baffles A^5 are of uniform thickness from one end to the other. The hollow space in each baffle is open at its side and outer end edges to the chamber A^7 and the air or other gaseous fluid admitted to the chamber A^7 is thus free to pass into the spaces A^6 at their side edges. The flat streams or sheets into which the water issuing from the diffusion chamber A^4 is divided by the baffles A^5 give a large aggregate entraining surface and the air or other gaseous fluid to be entrained and condensed or set in motion and compressed may enter the spaces between the streams from the air spaces A^6 as well as directly from the air chamber A^7. The jets of water and air admixed with it are discharged into the converging section of the discharge nozzle A^8, the diverging section of which may open into the atmosphere or into some suitable receptacle or discharge space. When the water passes into the discharge nozzle in parallel sheets of considerable width as may be the case with the construction shown in Figs. 1 to 4 the nozzle A^8 may well be rectangular in outline, as shown in Fig. 4.

With the apparatus shown in Figs. 1 to 4, it will be apparent that the shock losses are reduced to a practical minimum. Furthermore, there is no loss of energy due to the conversion of the energy of velocity of the water discharged by the impeller into pressure and a subsequent conversion of pressure into velocity and its reconversion into pressure, as is inherently involved where a centrifugal water pump of ordinary type discharges into a liquid jet ejector of ordinary type. Inasmuch as the collecting chamber A^4 is shaped to offer a resistance, so small as to be practically negligible, to the discharge from the impeller, and the use of the invention imposes no limitations on the shape of the impeller, impeller chamber or water supply means, other than that the impeller shall deliver water with the desired tangential velocity, it is apparent that the water handling efficiency of the pump may be of the highest order and that the pump may have a very considerable suction effect. Owing to the large aggregate entraining surface of the water discharged into the air chamber A^7, the high velocity with which the water enters this chamber, and the freedom which the air has to flow into contact with the streams of water passing into the chamber the air handling capacity of a given size of my improved pump is large in comparison with centrifugal jet pumps heretofore known.

The device AA shown in Figs. 5 and 6 differs from that shown in Figs. 1 to 4 in that the hollow baffles A^{50} and spaces A^{60} therein are vertical, so that the streams into which the water is divided and between which the air or other gaseous fluid is entrained are transverse to the axis of the impeller instead of parallel to the axis of the impeller as in Figs. 1 to 4. In the construction shown in Figs. 1 to 4 the direction of the flat streams is slightly inclined to the direction of the discharge nozzle, while in Figs. 5 and 6 there is no such inclination. In this respect the construction shown in Figs. 1 to 4 will give higher shock losses in the ejector portion than will the construction of Figs. 5 and 6. The higher ejector efficiency of Figs. 5 and 6 is offset to some extent, however, by the fact that it has a somewhat smaller air entrapping effect. It will be obvious of course that the ejector nozzle of Figs. 5 and 6 might be inclined to

the right or left as seen in Fig. 6, to obtain the same air entrapping effect as is had with the construction shown in Figs. 1 to 4.

The device AB shown in Fig. 7 differs from that shown in Figs. 1 to 4 in that the collecting chamber A^{40} through which the water passes with undiminished velocity into the air inlet chamber A^7 and nozzle A^8 extends only part way around the impeller chamber, which also opens at the remainder of its periphery into a diffusion chamber A^{41} adapted to convert a considerable proportion of the kinetic energy of the water into pressure. The pump shown in Fig. 7 is thus adapted to deliver a portion of the water pumped by it against a high head, as in the ordinary operation of centrifugal pumps, and to deliver another portion of the water at a lower head but at higher velocity and to utilize a portion of the energy thereof in compressing and giving motion to air or other gaseous fluid.

The device AC shown in Fig. 8 differs from the device A shown in Figs. 1 to 4 primarily in that there are two collecting chambers A^{42}, each half encircling the impeller chamber and each discharging into a separate converging nozzle portion A^{61} and drawing air through a separate air inlet conduit A^{70}.

In Figs. 9 and 10 I have shown an air pump construction differing from that shown in Figs. 1 to 4 inclusive, in that kinetic means are employed for subdividing the water passing from the collecting chamber A^{43} of the pump AD into the air chamber A^7. The means employed for this purpose as shown in Figs. 9 and 10, comprise a turbine wheel C mounted in the discharge end of the chamber A^{43} and set in motion by the water passing through it. The vanes C′ of this wheel serve to break up the stream of water passing through the turbine wheel into the converging portion A^{81} of the discharge nozzle.

In Fig. 11 I have illustrated an advantageous use of my present invention in connection with a multistage condensing plant, such as is described and claimed in my copending applications Serial Nos. 734,050 and 789,422, filed November 29, 1912 and September 12, 1913 respectively. In this figure F represents a multistage turbine, the high vacuum stage F′ of which exhausts into a high vacuum condenser section D, while an intermediate turbine stage F^2 exhausts into the lower vacuum condenser section E. Water of condensation drains from the high vacuum section F′ of the turbine and the high vacuum condenser section D into the low vacuum condenser section E through pipes F^4 and D′ respectively. Air is withdrawn from the high vacuum section D of the condenser and compressed up to the pressure in, and delivered to the low vacuum section E by means of the connecting pipe D^2, and the ejector D^3 located therein and supplied with steam through the pipe D^4 from some suitable source as from the high pressure stage F^3 of the turbine. To remove the air from the low vacuum section E of the condenser I employ a pump AE which, as shown, is essentially the same in form as the pump A of Figs. 1 to 4, except that the air chamber A^7 is dispensed with, or rather is formed by the condensing space of the condenser section E.

In Fig. 12 I have illustrated a different use of my present invention in connection with a condensing plant generally like that shown in Fig. 11. In Fig. 12 a pump AF which may be identical with the pump AB shown in Fig. 7 is employed to withdraw air from the low vacuum condenser section E, and also to discharge, through the diffusion chamber A^{41}, cooling water which passes in series as indicated by the arrows through the condenser sections D and E. It will of course be apparent that the air might be withdrawn from the high vacuum condenser section D and discharged into the low vacuum condenser section E as in Fig. 11, but, as shown, a separate pump AG is connected to the shell of the condenser section D to withdraw the air therefrom. The pump AG may be identical in construction and in its mode of connection to the condenser shell D, with the pump AE, and the mode of connection of the latter to the condenser shell E, as shown in Fig. 11. The arrangement shown in Fig. 12 is of special utility when the condensing apparatus for handling the steam from a turbine is divided into high and low vacuum sections. This makes it possible, as is fully explained in my other application referred to above, to greatly reduce the amount of cooling water required. I am thus enabled to increase the head against which the pump AF delivers without unduly increasing the power consumed.

In Fig. 13 I have shown a form of pump which may be and is shown as being identical with the form shown in Figs. 1 to 4, employed to withdraw water from the hot well G^2 of a condenser G through the conduit G^3, and to withdraw the air from the condenser G. As shown the air outlet G′ of the condenser is connected to the air chamber A^7 of the pump, and an ejector H comprising an expanding nozzle H′ and a recompressing nozzle H^2 is employed to raise the pressure of the air withdrawn from the condenser prior to its delivery to the air chamber A^7.

While in accordance with the provisions of the statutes I have illustrated and described the best forms of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed with-

out departing from the spirit of my invention, and that under some conditions certain features of my invention may be used without a corresponding use of other features.

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

1. A pump of the kind described comprising in combination a cylindrical liquid impeller, a casing formed with an impeller chamber, a liquid supply connection thereto, a gaseous fluid chamber, a compressing nozzle outlet from the latter and a collecting chamber into which said impeller chamber opens at its periphery and having an outlet to said gaseous fluid chamber, said collecting chamber and its outlet being shaped to pass the liquid leaving the impeller chamber and discharged into said gaseous fluid chamber with but small change in velocity.

2. A pump of the kind described comprising in combination a cylindrical liqud impeller, a casing formed with an impeller chamber, a liquid supply connection thereto, a gaseous fluid chamber, a compressing nozzle outlet from the latter, a collecting chamber into which said impeller chamber opens at its periphery and having an outlet to said gaseous fluid chamber, said collecting chamber and its outlet being shaped to pass the liquid leaving the impeller chamber and discharged into said gaseous fluid chamber with but small change in velocity and means in said outlet for dividing the stream of liquid entering said gaseous fluid chamber to increase the surface area of the liquid.

3. A pump of the kind described comprising in combination a cylindrical liquid impeller, a casing formed with an impeller chamber, a liquid supply connection thereto, a gaseous fluid chamber, a compressing nozzle outlet from the latter, a collecting chamber into which said impeller chamber opens at its periphery and having an outlet to said gaseous fluid chamber, said collecting chamber and its outlet being shaped to pass the liquid leaving the impeller chamber and discharged into said gaseous fluid chamber with but small change in velocity and means located in said outlet for dividing the stream of water entering said gaseous fluid chamber into a plurality of parallel jets or streams to increase the surface area of the liquid.

4. A pump of the kind described comprising in combination, a centrifugal liquid impeller, a casing formed with an impeller chamber, a liquid supply connection thereto, a collecting chamber into which said impeller chamber opens at its periphery and shaped to pass the liquid entering it with but small conversion of velocity into pressure, a gaseous fluid chamber into which the liquid is discharged from said collecting chamber, a compressing nozzle outlet from the latter, and means for dividing the stream of water entering said gaseous fluid chamber into a plurality of parallel sheets or streams to increase the surface area of the liquid, said means consisting of spaced apart hollow wedge shaped baffles located in the discharge end of said collecting chamber with the hollow space in each baffle open at its side edges and front edge to said gaseous fluid chamber.

5. A pump of the kind described comprising in combination, a centrifugal liquid impeller, a casing formed with an impeller chamber, a liquid supply connection thereto, a collecting chamber into which said impeller chamber opens at its periphery and shaped to pass the liquid entering it with but small conversion of velocity into pressure, a gaseous fluid chamber into which the liquid is discharged from said collecting chamber and a compressing nozzle outlet from the latter, the axis of said nozzle being inclined to the direction of movement of the liquid entering said gaseous fluid chamber.

6. A pump of the kind described comprising in combination, a centrifugal liquid impeller, a casing formed with an impeller chamber, a liquid supply connection thereto, a plurality of receiving chambers spaced about the periphery of said impeller chamber and each receiving a portion of the liquid discharged from the impeller chamber, and provisions operating in conjunction with one or more but not all of said receiving chambers for causing a gaseous fluid to be entrained and compressed by the liquid passing through the corresponding receiving chambers.

7. A pump of the kind described comprising in combination, a centrifugal liquid impeller, a casing formed with an impeller chamber, a liquid supply connection thereto, a plurality of receiving chambers spaced about the periphery of said impeller chamber and each receiving a portion of the liquid discharged from the impeller chamber, one or more of said receiving chambers being shaped to pass the liquid entering it with but small conversion of velocity into pressure, a gaseous fluid chamber for, and receiving the liquid passing through each of said last mentioned receiving chambers and a compressing nozzle outlet from each of said gaseous fluid chambers.

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