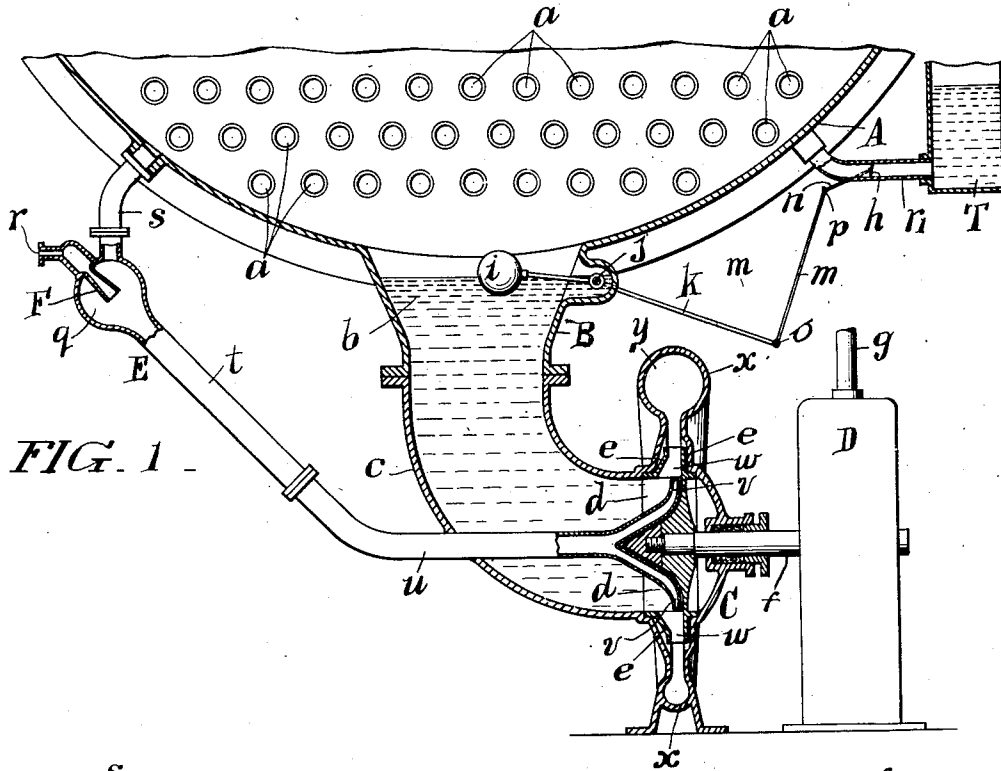


G. L. KOTHNY & R. SUCZEK.
EJECTOR CONDENSATE PUMP.
APPLICATION FILED MAR. 23, 1916.

1,273,876.

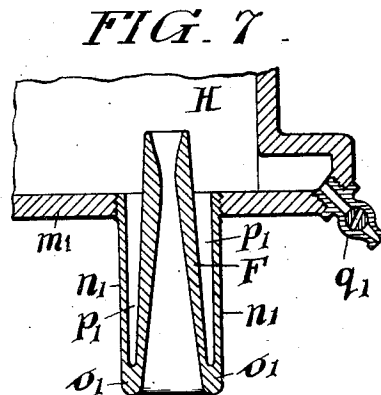
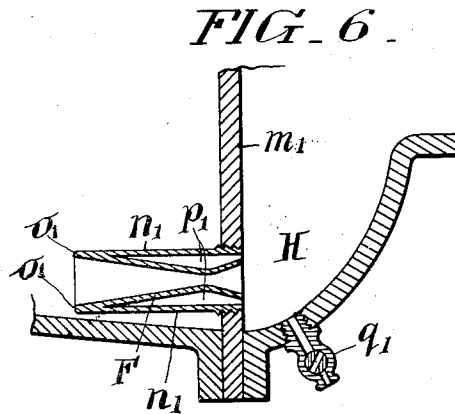
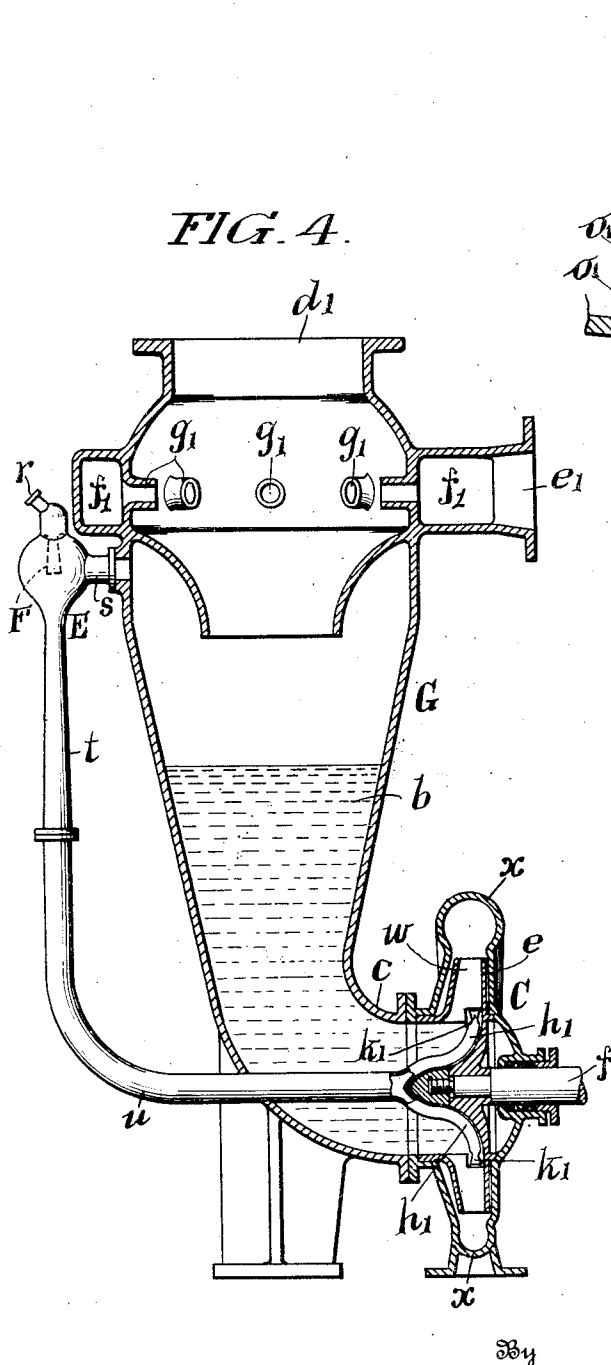
Patented July 30, 1918.
2 SHEETS—SHEET 1.



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EJECTOR CONDENSATE-PUMP.

1,273,876.

Specification of Letters Patent.

Patented July 30, 1918.

Application filed March 23, 1916. Serial No. 86,074.

To all whom it may concern:

Be it known that we, GOTTDANK L. KOTHNY and ROBERT SUCZEK, subjects of the Emperor of Austria-Hungary, residing at Philadelphia, county of Philadelphia, State of Pennsylvania, have invented new and useful Improvements in Ejector Condensate-Pumps, of which the following is a specification.

Our invention relates to apparatus for removing air or other uncondensable gas from a steam condenser or other vessel in which a vacuum is maintained and for removing the condensate collected from a steam condenser or analogous device.

It is characteristic of our invention that the condensate is removed by a pump, preferably a centrifugal pump, with which co-operates an ejector or other air or gas compressing apparatus.

The ejector or like apparatus exhausts the air from the condenser or other vessel and instead of compressing the same to atmospheric pressure or higher compresses the air or gas to a pressure substantially equal to that in the suction of the pump, which pressure is below atmospheric pressure, the pump then further operating upon the air or gas to further compress it to atmospheric pressure or higher and simultaneously removing condensate which is normally below atmospheric pressure and delivering it at or above atmospheric pressure.

Where the ejector is of a type employing steam or other fluid under pressure as the motive fluid, the consumption of motive fluid is economized if the air or gas need not be carried through a great range of pressure. According to our invention therefore the ejector does not itself raise the pressure of the air or gas to atmospheric pressure or higher, but to a pressure corresponding with that in the suction of the centrifugal pump which delivers condensate from the hot well or other receiver against atmospheric pressure. The mixture of air or gas and motive fluid from the ejector is delivered into the impeller of the centrifugal pump and the air or gas is carried along with or by the condensate and thereby raised in pressure to atmospheric pressure or higher, and the steam from the ejector is condensed. In this way the air or gas compression occurs in a plu-

ality of stages, the ejector comprising one stage and the centrifugal pump which is also removing the condensate constituting a later stage.

The centrifugal pump operates best when there is a relatively high head of condensate, that is, when the height from the center of the pump impeller to the level of the condensate is relatively great. This condition, however, requires relatively great space and it is an advantage if the pump can operate under a small condensate head and at variable speed.

In accordance with our invention this is possible because the ejector assists in priming the pump at starting and keeping it primed while running under the difficult conditions existing and when the ejector is in coöperation with the pump the latter will run satisfactorily at variable speed and at small suction head, that is, with a small distance from the center of the impeller to the level of the liquid or condensate to be pumped against atmospheric pressure.

It is a further feature of our invention that the level of the condensate or liquid to be pumped is automatically maintained substantially constant.

For an illustration of some of the various forms our invention may take, reference is to be had in the accompanying drawings, in which:

Figure 1 is a vertical sectional view, some parts in elevation, through apparatus embodying our invention.

Fig. 2 is a fragmentary vertical sectional view through a modified arrangement of ejector and pump impeller.

Fig. 3 is a fragmentary vertical sectional view through a modified form of impeller.

Fig. 4 is an illustration of the mode of application of our invention to a jet condenser, the ejector discharge and pump impeller being of modified construction.

Fig. 5 is a sectional view through an ejector discharge.

Fig. 6 is a vertical sectional view through a horizontal jacketed nozzle and associated parts.

Fig. 7 is a vertical sectional view through a vertical jacketed nozzle and associated parts.

Referring to Fig. 1, A represents the lower

part of the shell of a surface condenser having the usual tubes *a* through which cooling water is circulated in the well known manner, the steam to be condensed passing through the interspaces between the tubes *a* and when condensed collecting as the condensate or liquid *b* in the hot well or other receiver B communicating through the connection *c* with the eye or suction orifice *d* of the impeller or runner *e* of a centrifugal pump C. The impeller *e* is secured upon and driven by the shaft *f* rotated by any suitable motor, as, for example, the steam turbine D receiving its driving steam through the pipe *g*. The float *i* is pivoted at *j* and actuates the valve *h* through the connecting links or bars *k*, *m* and *n*, of which *k* and *m* are pivoted to each other at *o*, and *m* and *n* are pivoted to each other at *p*. The valve *h* controls delivery of water from the feed water tank T or any other supply of water through the pipe *r*¹ into the interior of the condenser A, through which it finds its way back to the receiver B. The ejector E comprises the chamber *q* into which extends the expansion nozzle F to which live steam or other motive fluid is conducted through the connection *r*. The chamber *q* communicates with the interior of the condenser A through the pipe connection *s*, and the chamber *q* communicates with the diffuser *t* which delivers into the pipe connection *u* which extends through the wall of the connection *c* and into the suction *d* of the impeller *e*, where it forms the annular or circumferentially continuous nozzle or discharge *v* terminating with small clearance just inside of the vanes *w* of the impeller *e*. The impeller *e* delivers into the volute discharge casing *x* which has the discharge outlet *y*.

The operation is as follows:

The turbine D is started and rotates the impeller *e* at suitable speed. Steam is admitted through the passage *r* and expands in nozzle F into the chamber *q*, where the jet of steam entrains and carries along into the diffuser *t* air or gas drawn from the condenser A. The mixture of steam of other motive fluid with the air or gas is delivered from the pipe *u* into the nozzle or discharge *v* which is submerged in the liquid *b* which fills the connection *c*. The mixture of steam and air escaping from the discharge *v* passes outwardly into liquid *b*, the liquid as it is acted upon by the impeller *e* carrying the air or gas along, and both are raised in pressure and are delivered through the outlet *y* at atmospheric or higher pressure.

The difference in pressure between the interior of the condenser A and the pressure existing in the suction *d* of the impeller is not as great as the difference in pressure between the interior of the condenser A and atmosphere. The ejector E therefore is re-

quired to compress the air or gas to only relatively lower pressure, and then the mixture of steam and air delivered by the discharge *v* is carried along with the condensate and the air or gas further compressed by the impeller *e* and the gas or air raised in pressure therewith to atmospheric pressure or higher, the pump C thereby completing the compression of the air or gas. The steam is condensed in the condensate as it passes through the pump and this condensation of steam further assists in exhausting air from the condenser.

The impeller *e* of the pump C is said to be submerged, since it is at a level below the level of the liquid or condensate *b*. The extent of submergence is measured by the vertical distance between the center of the shaft *f* and the upper level of the liquid *b*. By recourse to our combination described this submergence may be made small, because of the tendency and action on the part of the ejector E to keep the liquid or fluid moving into and through the impeller *e*. And with such reduced submergence the pump will nevertheless operate reliably even with changes of speed of the impeller.

It is desirable also to maintain the level of the liquid *b* more or less constant, and this is accomplished by the float *i* in cooperation with the valve *h*. Should the head or level of liquid *b* fall the float will descend and in so doing will open the valve *h*, thereby allowing water to pass through the pipe *r*¹ from tank T into the condenser and thence to the receiver B to restore the level of liquid *b* to normal, whereupon the float *i* will close the valve *h*.

While the discharge or nozzle *v* has been described as circumferentially continuous or annular, it will be understood that our invention is not limited to such construction because the discharge may be comprised of one or a plurality of pipes or passages branching from the pipe *u* and spaced preferably at equal intervals around the shaft *f*. In other words, the discharge *v* of Fig. 1 may be considered independent pipes or passages communicating with the pipe *u*.

In Fig. 2 only the ejector and impeller of a combination embodying our invention are illustrated. In this case the ejector E terminates in a pipe or discharge *z* extending into the suction *d* of the impeller and terminating just short of the vanes *w*. In this discharge *z* there is located, near its discharge end, a second expansion nozzle F¹ to which steam or other motive fluid is delivered through the pipe *a*¹ controlled by the valve *b*¹.

The operation is similar to that described in connection with Fig. 1, with the further feature, however, that the second nozzle F¹ accelerates or increases the velocity of the mixture of gas and motive fluid from the

ejector E as it enters the impeller. Such arrangement may be economical in some cases for creating a high steam and gas velocity by means other than the ejector E itself.

In Fig. 3 the arrangement of impeller and discharge or outlet v is similar to that illustrated in Fig. 1, except that there is provided the circumferentially extending partition c^1 which divides the impeller into two passages, each having the vanes w , w with one of which passages the discharge or nozzle v communicates. The larger impeller passage to the left of the partition c^1 delivers condensate or liquid against atmospheric pressure in the ordinary manner, while in and through the impeller passage to the right of the partition c^1 the steam from the pipe u , communicating with the ejector, is condensed and the gas or air is further compressed and delivered with the condensate at atmospheric pressure or higher.

In Fig. 4 our invention is shown as applied to a jet condenser G having the connection d^1 through which exhaust steam is received, and the connection e^1 through which the condensing water is delivered into the manifold or chamber f^1 with which communicate the inwardly directed spouts or nozzles g^1 of well known construction. The water delivered by the spouts g^1 becomes finely divided, and condenses the exhaust steam delivered through d^1 , the resultant condensate and condensing water collecting in the bottom of the condenser G as the condensate or liquid b which is delivered through the connection c to the centrifugal pump C. The ejector E is connected by connection s with the interior of the condenser G, its expansion nozzle F receiving live steam or other motive fluid through the connection r . The diffuser t connects with the pipe u which extends through the connection c into the suction of the impeller e . The pipe u terminates in a plurality of branch pipes h^1 or, as illustrated in Fig. 5, in an annular or bell-shaped passage j^1 . The passages h^1 or j^1 terminate in the expansion nozzle openings k^1 . This construction imparts to the mixture of steam and air or gas arriving from the ejector through the passage u a higher kinetic energy or velocity than exists in the pipe u . As shown, the vanes w may be undercut or notched so as to receive the nozzles k^1 which therefore deliver at a point more remote from the center of the shaft f than the inner limits of the vanes w . That part of the impeller which is not under cut or notched removes substantially only condensate or water, while in the remainder the steam is condensed and the air or gas removed with condensate or water and compressed to atmospheric pressure or higher.

It will be understood that this particular arrangement of ejector and pump is not limited in its application or use to a jet condenser as illustrated in Fig. 4, but is of general application; and that with a jet condenser may be used any of the other arrangements herein described.

For the ejector nozzles F or F¹ may be used jacketed nozzles of the character illustrated in Figs. 6 and 7.

In Fig. 6 the live steam or other motive fluid is admitted to the chamber H on one side of the partition or deck m^1 . Supported in the partition m^1 is the nozzle which comprises the nozzle portion proper F integral with or secured to the jacket wall n^1 at o^1 . In the form shown the jacket wall n^1 is threaded into the plate m^1 . The expansion of any fluid under pressure produces cold or a refrigerating effect, and it is accordingly desirable to protect the walls of the nozzle F proper from external lower temperature, and where the motive fluid is steam, to prevent wasteful condensation of steam on the nozzle. Accordingly there is formed between the nozzle F proper and the jacket wall n^1 the jacket space p^1 which communicates directly with the steam space H whereby live steam comes into contact with the outer surfaces of the nozzle F proper to maintain it at suitable temperature. Any condensate forming in the jacket space p^1 will drain back into the bottom of the chamber H and may be drawn off through the drain cock q^1 .

In Fig. 7 the structure of the nozzle is in general similar to that shown in Fig. 6, and like parts bear like characters. In this case, however, the admission end of the nozzle F proper extends into the steam space H. In this case condensate or hot water will eventually fill the jacket space p^1 and form upon the upper surface of the deck m^1 and may drain off through the drain cock q^1 .

What we claim is:

1. The combination with a condenser, of a condensate receiver in communication with the vacuum space of said condenser whereby the condensate is under vacuum pressure, a submerged pump for delivering the condensate at higher pressure, means for maintaining a vacuum in said condenser comprising an ejector extracting fluid from said condenser and raising its pressure, means for delivering said fluid into said condensate within said pump, a motor for driving said pump, and means for maintaining the level of said condensate substantially constant.

2. The combination with a condenser, of a condensate receiver in communication with the vacuum space of said condenser whereby the condensate is under vacuum pressure, a submerged centrifugal pump for delivering the condensate at higher pressure, means for maintaining a vacuum in said condenser

- comprising an ejector extracting fluid from said condenser and raising its pressure, means for delivering said fluid into said condensate within the pump impeller, a motor for driving said pump, and means for maintaining the level of said condensate substantially constant.
3. The combination with an ejector, of a centrifugal pump impeller, vanes in said impeller between its suction and periphery, and fluid conducting means connecting with said ejector and terminating within said impeller in a passage narrower than said vanes.
4. The combination with an ejector, of a centrifugal pump impeller, fluid conducting means connecting with said ejector and terminating in the suction of said impeller, an accelerating nozzle located within said fluid conducting means near its discharge end in the suction of said impeller, and means for conducting motive fluid to said nozzle.
5. The combination with a nozzle, of a wall surrounding the same and spaced therefrom to form a jacket space, and means for admitting motive fluid to said nozzle and said jacket space.
6. The combination with a nozzle, of a wall surrounding the same and spaced therefrom to form a jacket space, said nozzle supported at its one end on said wall.
7. The combination with an ejector comprising nozzle structure delivering motive fluid, and means for conducting thereto elastic fluid to be raised in pressure, of a rotary impeller, means for delivering liquid thereto, and a conduit projecting into said impeller and delivering into the same the mixture of fluids from said ejector.
8. The combination with an ejector comprising nozzle structure delivering motive fluid, and means for conducting thereto elastic fluid to be raised in pressure, of a rotary impeller, means for delivering liquid thereto, and a conduit projecting into said impeller and discharging radially outwardly into the same the mixture of fluids from said ejector.
9. The combination with an ejector comprising nozzle structure delivering motive fluid, and means for conducting thereto elastic fluid to be raised in pressure, of a rotary impeller having outwardly extending vanes, means for delivering liquid into said impeller, and a conduit projecting into said impeller and delivering into the same adjacent said vanes the mixture of fluids from said ejector.
10. The combination with an ejector comprising nozzle structure delivering motive fluid, and means for conducting thereto elastic fluid to be raised in pressure, of a rotary impeller having outwardly extending vanes, means for delivering liquid into said impeller, and a conduit projecting into said impeller and delivering radially outwardly adjacent said vanes the mixture of fluids from said ejector.
11. The combination with an ejector, of a centrifugal pump impeller, a conduit terminating in the suction of said impeller and delivering therinto fluid from said ejector, and an accelerating nozzle adjacent the discharge end of said conduit.
12. The combination with an ejector comprising nozzle structure delivering elastic motive fluid, and means for conducting thereto elastic fluid to be raised in pressure, of a centrifugal pump impeller, means for delivering liquid to said impeller, a conduit projecting into said impeller and delivering into the same fluid from said ejector, an accelerating nozzle located adjacent the discharge end of said conduit, and means for conducting elastic motive fluid to said accelerating nozzle.
13. The combination with an ejector, of a centrifugal pump impeller, a conduit projecting into said impeller and having a discharge terminal extending radially outwardly delivering fluid from said ejector, and an accelerating nozzle located adjacent the discharge end of said conduit.
14. The combination with an ejector, of a centrifugal pump impeller having vanes, means for delivering liquid to said impeller, a conduit projecting into said impeller and terminating adjacent said vanes and delivering fluid from said ejector, and an accelerating nozzle located adjacent the discharge end of said conduit.
15. The combination with an ejector comprising nozzle structure delivering elastic motive fluid, and means for delivering thereto elastic fluid to be compressed, of a centrifugal pump impeller having vanes, means for supplying liquid to said impeller, a conduit projecting into said impeller and discharging fluid from said ejector adjacent said vanes, an accelerating nozzle located adjacent the discharge of said conduit, and means for conducting motive fluid to said accelerating nozzle.
16. In apparatus of the character described, the combination with a centrifugal pump having an impeller, of a steam ejector arranged on the suction side thereof and terminating in a conduit projecting into the pump impeller, and means for supplying liquid to the suction side of said impeller.
17. In apparatus of the character described, the combination with a centrifugal pump having an impeller, of a steam ejector arranged on the suction side thereof and terminating in a conduit projecting into the pump impeller, and means for supplying liquid around said conduit to the pump impeller.
18. In apparatus of the character described, the combination with a centrifugal

pump having an impeller, of a steam ejector arranged on the suction side thereof and terminating in a conduit projecting into the pump impeller, and means independent of the ejector and connected directly with the inlet of the pump for supplying liquid thereto.

19. In apparatus of the character described, the combination with a centrifugal pump having an impeller, of a conduit connected to the inlet of the pump for supplying liquid thereto, an ejector comprising a nozzle through which motive fluid is admitted, and a conduit projecting into the pump impeller, arranged on the suction side of the pump, said last named conduit being separate from said first named conduit.

20. The combination with a condenser, of a centrifugal pump for removing water therefrom, said pump having an impeller submerged by the water, said impeller having vanes, and a duct for delivering elastic fluid from said condenser from the space above the water level and delivering said elastic fluid adjacent the inner

ends of said vanes into the water prior to action thereon by said impeller, whereby the water and said elastic fluid in mixture are simultaneously acted upon by said impeller.

21. The combination with a condenser, of a centrifugal pump for removing water therefrom, said pump having an impeller submerged by the water, said impeller having vanes, a duct for delivering elastic fluid from said condenser from the space above the water level and delivering said elastic fluid adjacent the inner ends of said vanes into the water prior to action thereon by said impeller, whereby the water and said elastic fluid in mixture are simultaneously acted upon by said impeller, and means delivering motive fluid into said duct to assist removal of said elastic fluid from said condenser.

In testimony whereof we have hereunto affixed our signatures this 21st day of March, 1916.

GOTTDANK L. KOTHNY.
ROBERT SUCZEK.