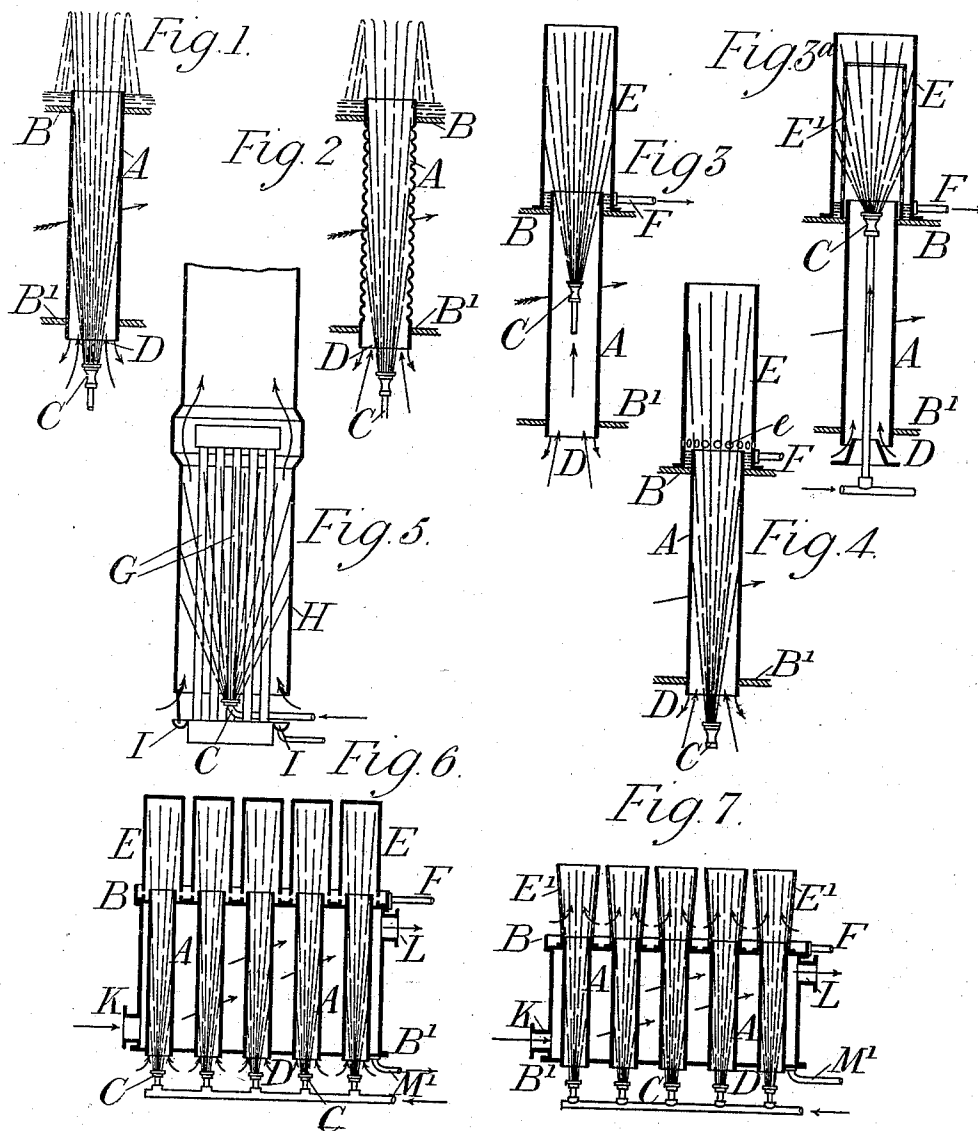


E. THEISEN.
EVAPORATIVE CONDENSER FOR FLUIDS.

No. 550,853.

Patented Dec. 3, 1895.



Witnesses.
Thos. A. Brown
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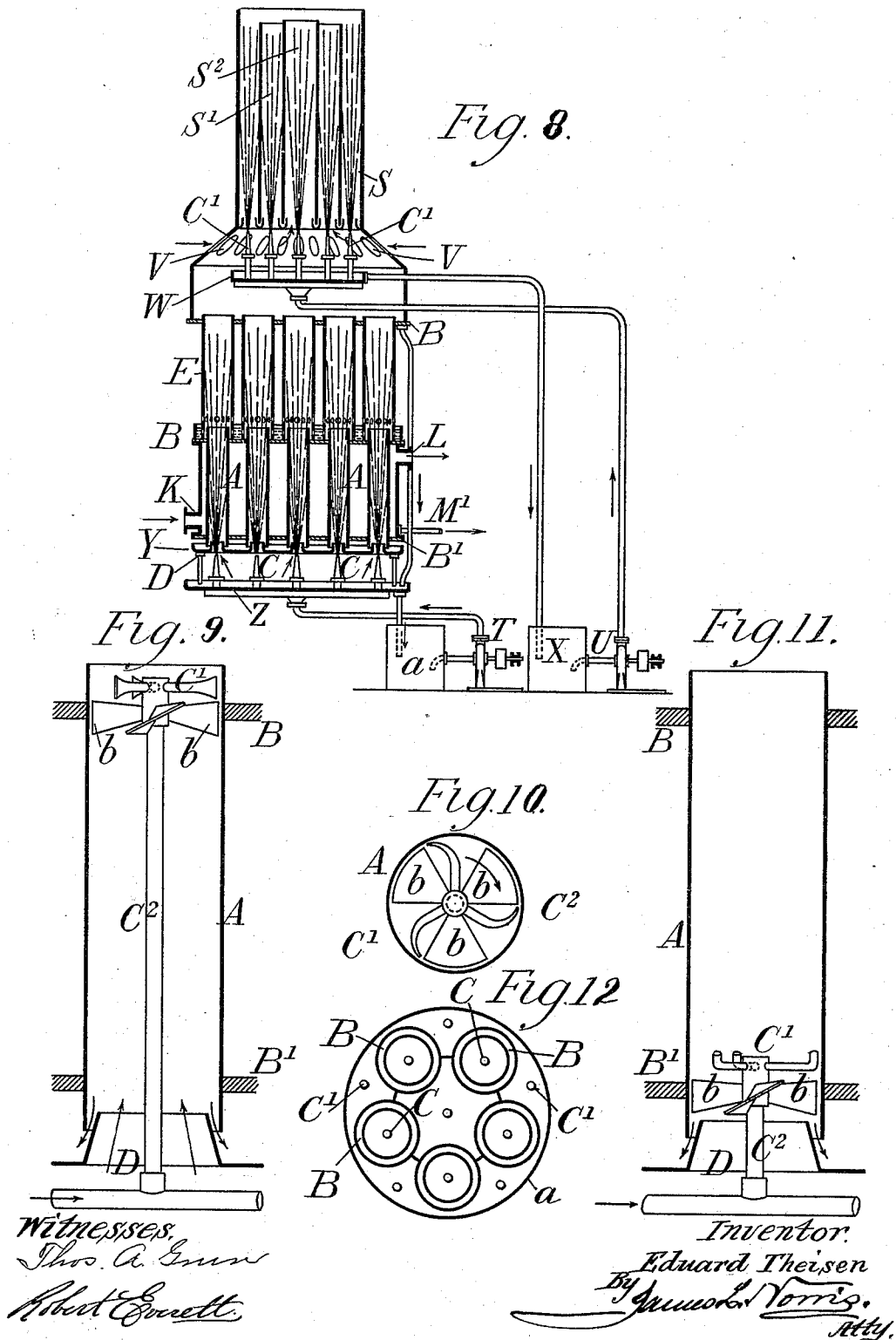
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UNITED STATES PATENT OFFICE.

EDUARD THEISEN, OF BADEN, GERMANY.

EVAPORATIVE CONDENSER FOR FLUIDS.

SPECIFICATION forming part of Letters Patent No. 550,853, dated December 3, 1895.

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To all whom it may concern:

Be it known that I, EDUARD THEISEN, engineer, a citizen of the United States, residing at No. 15 Werderstrasse, Baden, Germany, have invented a certain new and useful Improved Evaporative Condenser for Fluids, of which the following is a specification.

My invention relates to apparatus for evaporating, condensing, and cooling fluids in which these operations are effected by the surface evaporation of liquids.

In order to increase the effectiveness of such apparatus—that is to say, in order to render the abstraction of heat from the one side of the surfaces acted upon, and consequently the absorption of heat by the other side of such surfaces as great as possible relatively to the size of the apparatus—it is, as is well known, necessary on the one hand to cause a thin layer of liquid to flow over the one side of the said surface and on the other hand to cause a current of air or gas to pass over such moistened side, (the other side of the surface being made to take up heat,) which current is made to act as intensively as possible in order to produce an energetic evaporation of the said layer of liquid, inasmuch as the stronger the evaporation on one side of the surface is the greater is the absorption of heat by the other side. This increased evaporative action has mostly been produced, first, by causing a fan or other appliance to propel large quantities of air along the surfaces to be acted upon, and, secondly, for maintaining the flow of liquid over the surface it has been necessary to raise or propel a body of liquid by a pump or other means, so that two separate mechanisms were necessary for carrying out the operation.

My present invention has for its object to simplify the means required for the operation; and it consists in an improved apparatus whereby the one propelling device is dispensed with and the required two-fold effect is produced by the single action of jets of liquid subject to water, steam, gas, or air pressure, which jets are made to produce not only an effectual moistening of the surface to be acted upon but also simultaneously to produce strong currents of air or gas, the frictional contact of which with the layer of liquid

will produce an intense evaporative and cooling action, while at the same time they will increase the velocity which the vapor generated has attained through the difference of temperature. Furthermore, this simple method of operating also has the effect of causing the aqueous vapor resulting from the evaporation from the hot surfaces, and which is carried along by the current of air or gas, to be partially condensed again by contact with the injected liquid spray, while by admission of fresh quantities of air, as will be presently explained, such liquid spray, which furnishes the evaporative liquid, can be cooled down again.

The complete or almost complete condensation of the vapors resulting from the evaporation in the first evaporator or condenser can be effected by subjecting the air charged with the vapors to the condensing action in similar apparatus by means of fresh quantities of air with simultaneous moistening of the condensing-surfaces, so that practically only as much water will be lost as is taken up by the saturation of the cooling air. Thus by my improved apparatus the followings advantageous results are obtained: first, effective moistening of the tubes or evaporative condensing-surfaces; second, the production of a strong air-current for the evaporation; third, recooling of the liquid employed for moistening the evaporative surface; fourth, partial regaining of the vapors resulting from the evaporation of the layer of water.

The invention can be carried out in a variety of ways. On the accompanying drawings I have shown several arrangements of appliances for this purpose.

Figure 1 shows a vertical section of a tube, the inner surface of which is subjected to the action of a water jet and induced air-currents, while the outer surface is in contact with fluid to be condensed or from which heat is to be extracted. Figs. 2, 3, 3^a, and 4 show vertical sections of modified arrangements of the tube and jet shown in Fig. 1. Fig. 5 shows a vertical section of an arrangement in which the water jet and induced air-current are applied to the outside of a series of tubes, while the fluid to be condensed or from which heat is to be extracted passes through the tubes. Fig.

6 shows a vertical section of a condenser with tubes and jets arranged as shown at Fig. 1. Fig. 7 shows a vertical section of a modification of the condenser shown at Fig. 6. Fig. 8 shows a vertical section of a condenser arranged similar to Fig. 6, but in which a second set of water jets and tubes are provided for condensing vapors produced by the evaporation in the lower tubes. Figs. 9, 10, and 11 show vertical sections and a plan of an arrangement in which the liquid under pressure is made to rotate a reaction-wheel which carries round vanes that produce the air-currents. Fig. 12 shows a modification.

In Fig. 1, A is a tube fixed in upper and lower plates B B', forming part of a chamber into which fluid passes that is to be condensed or to have heat abstracted therefrom. Below the lower end of the tube is a fixed nozzle or rose C, through which water or other liquid is forced under any desired pressure, so as to enter the tube at some velocity in the form of spray, whereby air or gas is drawn into the tube at D, while the liquid jets are so directed as to partially serve to moisten the inner surface of the tube and partially to force the induced air-currents against such moistened surface and thus constitute currents flowing in the contrary direction to that of the thin layer of liquid flowing down the inner surface of the tube, whereby the vapors resulting from the vaporization of such liquid will be carried off by the air-currents. According to the greater or less force with which the fluid jets issue from the tube A, a stronger or weaker air-current will be produced. On issuing from the tube the water falls into a tray formed on the top B of the condensing-chamber, whence it passes off, together with the water falling from the lower end of the tube A, to a pump, which again forces it through the nozzle C.

Fig. 2 shows a modification in which the tube A is corrugated instead of being smooth, the arrangement being otherwise the same.

Fig. 3 shows a modification in which the nozzle C for the liquid jet is situated in the upper part of the tube A instead of below it. This arrangement is particularly advantageous where it is desired that the air-currents shall have a comparatively-high velocity. The velocity of the liquid jet is of course highest the moment it leaves the nozzle, from which point it gradually decreases as it rises until it reaches a point where the action of gravity overbalances the *vis viva* and the liquid consequently falls again. As the liquid jets will only have the intended beneficial action as long as the speed of that part thereof which is within the tube A is greater than the desired speed for the air-currents, it follows that it is necessary, if the speed of the latter is to be high, that only the lower portion of the liquid jet shall act within the tube, and consequently that the nozzle C shall be situated in the upper part of the tube A, as at Fig. 3. In this arrangement there is provided

on the tray B an enlarged open tubular extension E, surrounding the top of tube A, for the purpose of confining the spray of the water jet and keeping it separate from the water of contiguous tubes. The water flows down the inner surface of this extension and collects in the annular space between the mouth of A and E, whence a portion is made to flow in a thin layer down the inner surface of A again, while the remainder flows off through a pipe F, and, together with the water falling from the lower end of A, is fed back to the pump to be again forced through the nozzle C. With this arrangement the air that is drawn into A is always dry, as it comes in contact with the wet surface of the tube.

From what has been above stated it will be seen that it would be of advantage to deflect laterally the upper part of liquid jet at a point where the liquid still has a high velocity, so that the speed of the air-currents induced by the lower part of the jet shall not be retarded by coming in contact with the part of the jet traveling at a comparatively low speed.

Fig 3^a shows an arrangement for this purpose in which there is provided within the tube E a second tube E', of wire-gauze, through which the liquid spray passes while still at a high speed, so that the retarded part of the jet is collected and flows downward in the annular space between the tubes E and E' and is thus prevented from interfering with the air-currents passing up through the tubes. This arrangement also has the advantage of preventing the formation within the center of the tube of liquid mist, which would also interfere with the air-currents and which would be produced in the previously-described arrangements by the water jets becoming pulverized in striking with force against the solid surfaces of the tube E. In the present case the liquid jets mostly pass through the meshes of the tube E', and there is consequently no such pulverization.

In the arrangement at Fig. 4 the nozzle C is at the bottom of the tube, as at Fig. 1, and the tube E, similar to that of Fig. 3, has a series of holes *e*, through which air is drawn in by the suction exercised by the water-jets rising through E, which air effects the cooling of the spraying liquid, so that separate means for effecting such cooling can be dispensed with.

In the arrangement shown at Fig. 5 the tubes G have the fluid to be condensed or to have heat abstracted therefrom flowing through them, while the liquid spray from the nozzle is made to impinge upon the outer surfaces of the tubes and at the same time to induce air-currents through the surrounding casing H, which air-currents impinge upon the wet surfaces of the tubes and thus effect the cooling thereof by evaporation. The liquid flowing down the tubes is caught in troughs I I and is led back to the pump.

Fig. 6 shows a vertical section of a complete condenser constructed according to my invention. The exhaust-steam enters the

condensing-chamber B B' through the inlet K, and any uncondensed gases are drawn off at the outlet L. A A are the tubes passing through the chamber, at the lower ends of which are the nozzles C C, delivering water jets into the tubes and inducing air-currents entering at D in the same manner as above described with reference to Figs. 1, 2, and 4. Over the upper ends of the tubes A are provided tubes E with openings for the admission of air, as at Fig. 4. The water falling into the tray is led back, together with that flowing from the lower ends of the tubes A, to the pump supplying the nozzles C. The water of condensation is led from the chamber B B' through the pipe M.

Fig. 7 shows the same construction of condenser, in which the upper tubes E' are made tapering and of wire-gauze or perforated metal, the openings being of sufficient size for the air to afford free access to the air for cooling, this being drawn in by the action of the water jets within the tubes.

Fig. 8 shows a vertical section of a complete condenser in which a second set of liquid and air jets is provided for effecting the cooling of the liquid from the lower jets and also to effect the condensation of the vapor resulting from the evaporation. The lower part of the apparatus is of the same construction as described with reference to Figs. 6 and 7. The parts being indicated by the same letters of reference, they need not be further described. The nozzles C C are supplied by a pump T. The casing has a cylindrical upward extension S, within which are concentric tubes S' S'', through which consequently the mixed vapor and air from the lower tubes A E rise. Below the annular spaces between the tubes S S' S'' are arranged nozzles C' C', supplied by a pump V, from which liquid jets are projected into the annular spaces. These jets induce currents of air entering through the openings V of the casing, which currents, combined with the liquid jets, refrigerate and condense the vapors rising through the tubes. The resulting liquid falls back into the tray W, whence it is led through a pipe into a vessel X, from which the pump V draws its supply. Any liquid collecting at Y is led through a pipe into a tray Z, which also collects the liquid from the lower tubes of the apparatus, and from which the liquid passes through a pipe into the vessel *a*, from which the pump T draws its supply. Should a portion of the vapor escape uncondensed from the top of the tubes S S' S'', it may again be subjected to another series of liquid jets and air-currents for effecting its condensation, so that only so much of the liquid will escape as will be taken up by the air at the temperature at which it passes off from the apparatus. By means of this apparatus, therefore, it is rendered possible to work an engine with practically no loss of water, the same body of water being used over and over again, which is of great importance, both in localities where

water is scarce and in cases where the water contains a large amount of solid impurities that tend to form deposits in the boilers, as by this means the body of water that is used over and over again by degrees becomes almost perfectly pure.

According to another mode of carrying out my said invention, instead of causing the liquid under pressure to directly produce the currents of air or gases, I cause the liquid-pressure to impart rotary motion to an apparatus, such as a turbine or reaction wheel, so arranged that the liquid escaping from the said apparatus is made to flow over the surfaces to be moistened, while the rotating apparatus is caused to impart motion to a fan or equivalent device, which produces the required currents of air or gases.

Fig. 9 of the drawings shows a vertical section, and Fig. 10 a plan, of one arrangement for carrying out my invention in the above-described manner.

A is the tube of a condenser, over the inner surface of which the liquid is to flow.

In place of the nozzle C of the previous arrangement there is provided a reaction-wheel C', rotatably mounted on the end of a pipe C'', through which the liquid under pressure is made to flow, so that the liquid in flowing through the curved channels of the reaction-wheel and issuing onto the surface of the tube A imparts rotary motion to the wheel in the well-known manner. The extended boss of the reaction-wheel carries screw-blades *b b*, which, in rotating with the same, produce the required upward currents of air in the tube for effecting the evaporation of the liquid flowing down the same from the reaction-wheel. The latter might also be so arranged that the liquid will issue therefrom in an upward direction, so as to assist the fan-blades in producing the air-currents. Fig. 11 shows reaction-wheel C' constructed to operate in this manner.

Fig. 12 shows a sectional plan of an arrangement in which a number of annular condensing-chambers B B B are arranged in a group within a casing *a*, and the outer surfaces of which are acted upon by water jets C', in addition to the water jets C acting on the inner surfaces of each chamber, so that air-currents are also produced in the inclosed spaces surrounding the outer surfaces of the chambers in the same manner as above described, so that in this case a double condensing action is obtained.

Having thus described the nature of my invention and the best means I know for carrying the same into practical effect, I claim—

1. An evaporative condenser, wherein a thin layer of liquid flowing over a surface is subjected to the evaporative action of currents of air or gases, comprising a condensing surface, means for admission of air or gas thereto, and a nozzle introducing liquid under pressure to said surface and arranged to produce a current of air or gas and accelerate

the same in its movement over the condensing surface, substantially as described.

2. In an evaporative condenser, the combination with a tube having means for admission of air or gas, of a nozzle arranged at the upper part of said tube, a tubular extension above said tube, and a perforated tube arranged within said tubular extension, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 29th day of July, A. D. 1895.

EDUARD THEISEN.

Witnesses:

ERNEST THERION,
KARL HÄHNLEIN.