No. 753,247. PATENTED MAR. 1, 1904.

H. A. DUC, JR.

APPARATUS FOR CONDENSING STEAM.

APPLICATION FILED OCT. 2, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1

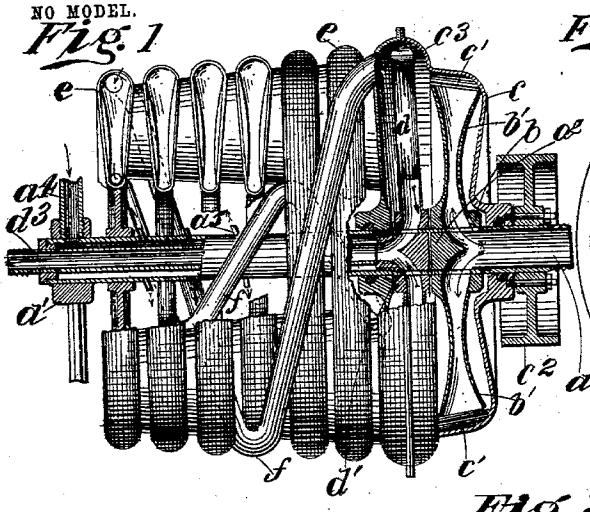


Fig. 2

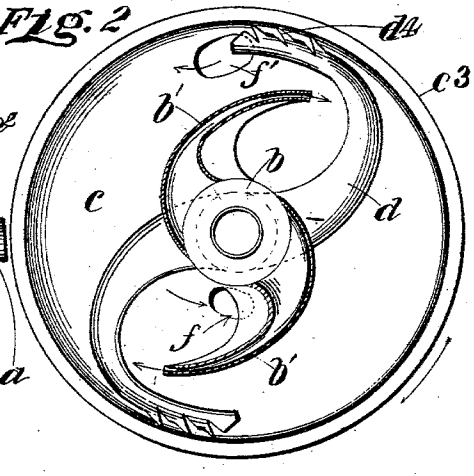


Fig. 3

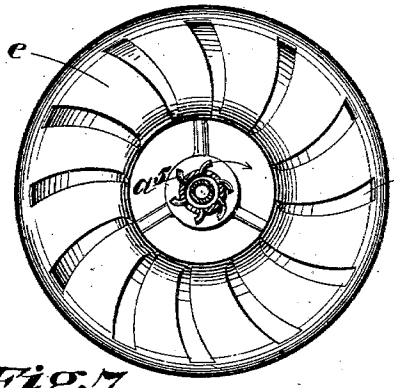


Fig. 4

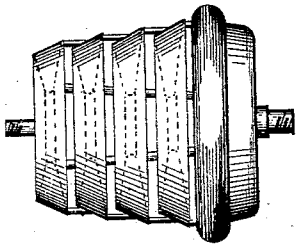


Fig. 5

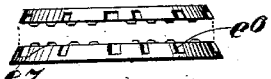


Fig. 6

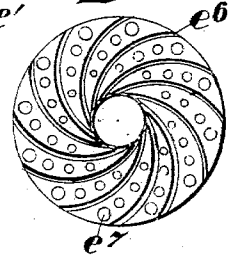
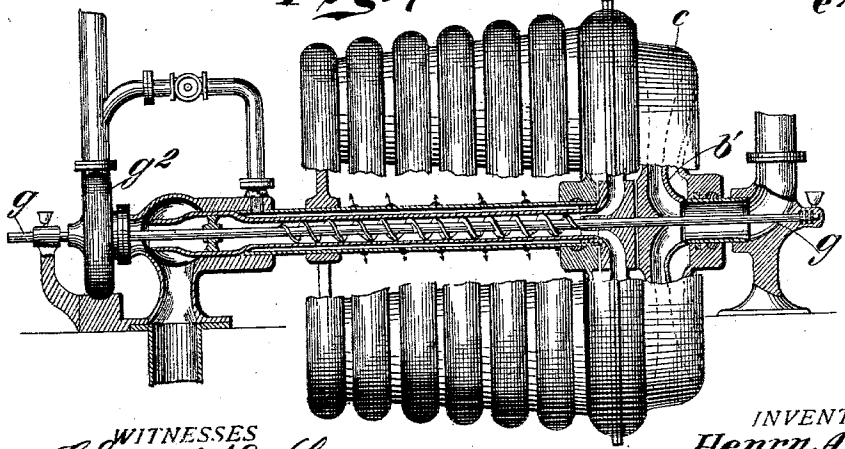


Fig. 7



WITNESSES

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Fig. 8

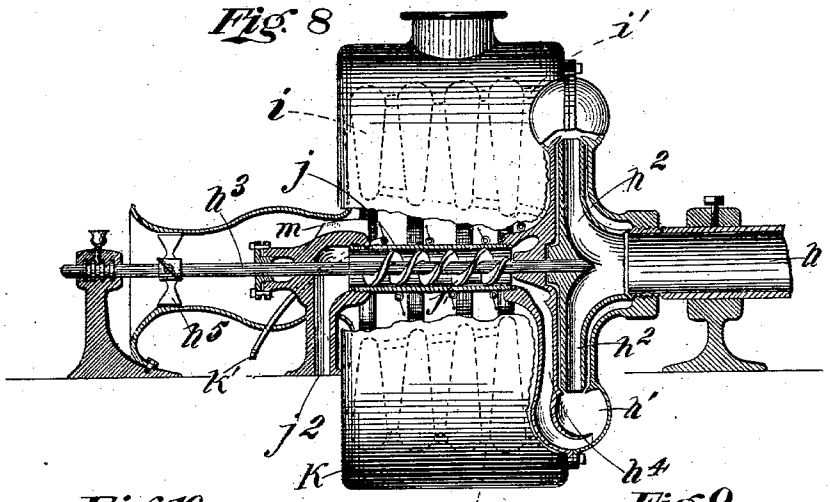

Fig. 10

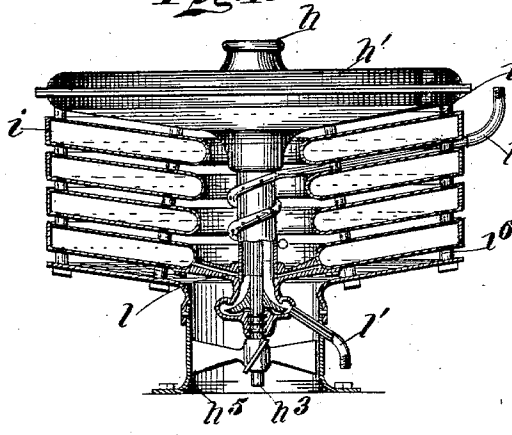

Fig. 9

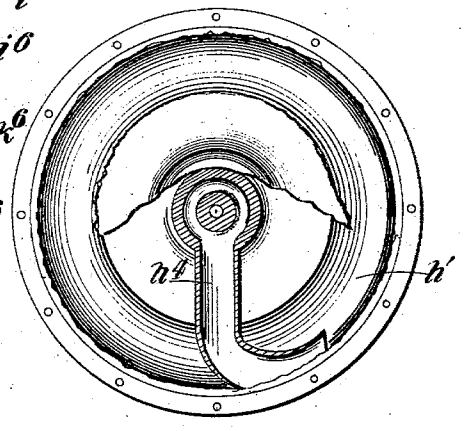

Fig. 11

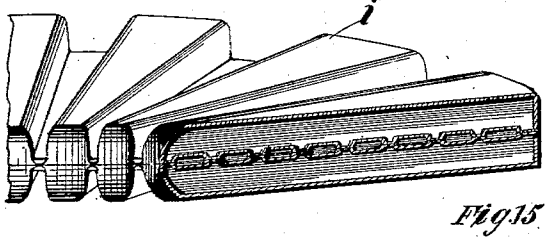

Fig. 15

Fig. 12

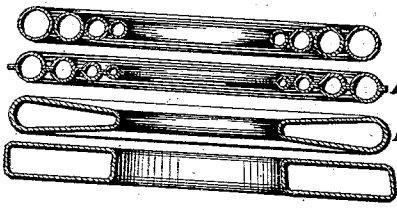

Fig. 13

Fig. 14

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UNITED STATES PATENT OFFICE.

HENRY A. DUC, JR., OF CHARLESTON, SOUTH CAROLINA.

APPARATUS FOR CONDENSING STEAM.

SPECIFICATION forming part of Letters Patent No. 753,247, dated March 1, 1904.

Application filed October 2, 1902. Serial No. 125,701. (No model.)

To all whom it may concern:

Be it known that I, HENRY A. DUC, Jr., of Charleston, in the county of Charleston and State of South Carolina, have invented certain new and useful Improvements in Apparatus for Condensing Steam; and I hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, which form part of this specification.

This invention is an improved apparatus for condensing steam; and its object is to utilize the latent force in steam, which has been heretofore wasted in the condensation thereof, to not only assist in condensing the steam itself, but to produce motion or power—in short, to make the steam in one sense self-condensing and to make a condenser-motor, the motor being driven by the force derived from the condensation of the steam.

The capability of water to expand and lift itself when converted into steam may be called its "potential" energy, and the motion produced during its condensation or returning to water would be probably termed "kinetic" energy. My present invention aims to utilize this kinetic energy derived from steam during its condensation in a simple apparatus operating both to condense steam and produce power, and many kinds of steam wheels or motors or turbines having either radial or tangential vanes may be employed in carrying out my process without affecting the principle of this invention.

Heretofore it has generally been deemed necessary to use a large quantity of water to condense steam in the various types of condensers commonly employed. By my present invention I obtain rapid condensation of the steam with the use of a very small amount of water and render it possible to utilize the potential or kinetic difference existing between steam at atmospheric pressure and that of the water of condensation therefrom and utilize this potential difference to effect the circulation or distribution of the water or air, or both, employed in my method and apparatus to accomplish a rapid condensation of the steam. In my apparatus only so much water is evaporated as is needed to maintain the desired refrigerative effect upon the external surfaces of the condensing-walls, against the inner surfaces of which the steam is condensed, and by my method and apparatus sufficient power may be developed in the condensation of the steam not only to effect its own condensation, but to give surplus power, which can be utilized for various purposes.

In the accompanying drawings I have shown several forms of apparatus which are designed to accomplish the desired ends and in which the process of condensation forming one of the main features of my invention may be carried out.

I refer to the claims appended to this description for a concise summary of the process which I desire to protect herein.

In said drawings, Figure 1 is a part side elevation and part longitudinal section of what I term my "rotary" condenser-motor. Fig. 2 is a front view thereof with the end casing removed. Fig. 3 is a detailed transverse sectional view thereof, showing one of the condensing-chambers. Fig. 4 is a side elevation of a modification. Figs. 5 and 6 are detailed views of a modified form of condensing-chamber. Fig. 7 is a part side elevation and part longitudinal section of modified form of condenser-motor. Fig. 8 is a similar view of another modification. Fig. 9 is a sectional end view of Fig. 8. Fig. 10 is a sectional elevation of another modification of the condenser. Fig. 11 shows a detailed sectional view of the condensing-chambers such as are used in Fig. 10. Figs. 12, 13, 14, and 15 show different sections of condensing-chambers.

Referring to Fig. 1, a designates a tubular shaft or tube, preferably mounted in stationary bearings, which are not shown, but are indicated at a' and may be of any suitable construction. On one end of this tube a is fixed a hub b, having two involute hollow arms b', the hub and arms communicating with the tube through suitable openings, as indicated in Fig. 1, said tube being blocked off by a plug a'' so as to direct the incoming steam into said arms. The hollow arms b' are inclosed within a rotatable casing c, which is provided on its inner periphery with vanes

c', against which the steam emerging from the arms b' impinges, thereby imparting rotary motion to said casing. This casing is rotatably journaled on the tube a and may be provided with packed journals to prevent leakage of steam, and a pulley c'' may be attached to the outer end of the casing. This casing is provided with an enlargement c^3 at its inner side inclosing two curved hollow outlet-arms d, which are connected to a hollow hub d', fixed upon the tube a, which hub in turn communicates with the pipe d^3, which extends out of the tube a and lies axially therein and is adapted to conduct away the water of condensation. The arms d are provided with scoop-like flanges d^4 on their outermost extremities, which are adapted to direct the water into said arms as the casing c rotates, the water of condensation collecting in the larger part of the casing c and rotating therewith.

Adjacent to the casing c are a series of annular condensing-chambers e, which are arranged in parallel series concentric to tube a and are rigidly connected to each other and to the casing c, so as to rotate therewith. The outmost condensing-chamber e may be rotatably supported on the tube a by suitable means, and the intermediate condensing-chambers may be likewise connected, if desired. Thus the whole series of condensing-chambers and the casing can rotate upon the tube a. Each condensing-chamber, as shown in Figs. 1 and 3, is annular in elevation and preferably wedge-shaped in cross-section and is thinner at the center than at the periphery, so that it gradually increases in area as it recedes radially from the tube. The steam escapes from the casing c into the several condensing-chambers through a pipe f, which preferably coils around the tube within the series of chambers, as indicated in Fig. 1, and communicates with the inner or contracted portion of each condensing-chamber. The water of condensation is conducted from each condensing-chamber back to the enlarged portion of the casing c by a pipe f', which preferably is arranged around the series of condensing-chambers and communicates with each one thereof near its outer periphery. The annular space between the pipe d^3 and the tube a forms a water-chamber, to which water is supplied by a pipe a^4, and from this water-chamber the water is admitted in fine streams or jets upon the exterior surfaces of each condensing-chamber e by means of outlets a^5. (See Figs. 1 and 3.)

The operation of this form of condenser-motor is as follows: Steam is admitted into the tube a and passes into the hollow arms b' and projects therefrom against the vanes c' of the casing c, thereby rotating the latter, which turns with it the attached annular series of condensing-chambers e. The steam after being deflected against the vanes c' is directed into the pipe f and passes into the several condensing-chambers e, wherein it is expanded both by its natural elasticity and by the centrifugal action of the rapidly-rotating chambers, which tend to further dilate or distend the steam and deprive it of any water held in suspension therein should the steam be supersaturated. At the same time the steam is rapidly condensed upon the internal conical surface of said condensing-chambers and as it accumulates thereon in the form of mist or dew is thrown outward toward the periphery of said condensing-chambers and escapes in the form of water into pipe f, by which it is conducted back into the casing c. This condensation of the steam on the walls of the chambers e is facilitated by the rapid cooling thereof effected by the exterior application of water from the jets a^5. The minute jets of water delivered upon the exterior surfaces of the chambers are rapidly diffused thereover by the rotation of the said chambers, as the small jet-nozzles a^5 project fine streams of water tangentially onto the external surfaces of the chambers without shock or splashing of the water, which spreads out in a film on the said surfaces in so finely-attenuated condition as to be quickly evaporated, thereby effecting a more rapid refrigeration of said surfaces. The evaporation of water is further facilitated by reason of air-currents which are drawn or forced in between and around the several chambers e. Said chambers may be provided externally with vanes to induce a circulation of the air therebetween, and these vanes may be either projections or depressions. As shown in Figs. 1 and 3, they are made as depressions e', which are of such form and shape as will most efficiently produce air-currents after the manner of rotary fans.

When the method is used to condense steam under considerable pressure, the difference between the potential of the steam and the water of condensation is so great that sufficient kinetic energy is developed in the apparatus to rotate the casing and chambers with great rapidity and with sufficient power to enable the apparatus to be used as a motor, and the power may be taken off by the pulley c''. If operating to condense vapors at only atmospheric pressure, (such steam, for instance, as might be derived from vacuum-pans,) there may not be sufficient kinetic power to rotate the condensing-chambers, and in such case when the apparatus shown in Fig. 1 is employed the chambers e may be rotated by applying external power to pulley c''.

Fig. 4 shows a simple modification of the apparatus, wherein the steam-pipe f and the return water-of-condensation pipe f may be replaced by pipes or connections between the successive condensation-chambers and the casing c, and this figure also shows a slight change in the construction of the condensing-chambers.

Fig. 5 also shows a sectional view of one of the condensing-chambers constructed of two parts having curved grooves e^6 pressed or formed therein and projections e^7 on the surfaces between the grooves to prevent actual contact of the whole intervening surfaces. When the two parts are united in such manner that the curved grooves in top part cover the curved grooves in lower part, the grooves form curved channels passing through said condensing-chamber and are practically equivalent to employing curved tubes passing through such chamber without having joints at their end and making cheap easily-constructed condensing-surfaces.

Fig. 6 is a plan view of one of the condensing-chambers having the grooves indicated in Figs. 5 and 6 and also the projections.

Fig. 7 shows another form of condenser-motor using both the action and reaction of the steam. In this construction the outer shell or casing c is made to revolve by the impact of the steam issuing from arms b', and said hollow arms b' are allowed to rotate in the opposite direction by reaction of the steam, said arms being supported upon a rotating shaft g, which extends axially through the tube a and operates a water-expeller or screw g' within the tube a. On one outer end of the shaft g is a pump g'', which is employed both for the purpose of maintaining a partial vacuum (due to the suction of the pump) throughout the condensing-chambers and shell c, thereby obtaining a higher efficiency in apparatus; but where it is not desirable to elevate water the pump g'' may be dispensed with, and instead of the pump a pulley can be placed on the shaft g, making it into a condenser-motor capable of condensing the steam usually thrown away and utilizing the surplus power. In this figure the water is supplied to the jets for cooling the exterior surfaces of the condensing-chambers from the pump g''.

Fig. 8 shows another modification of condenser utilizing my method of process. In this case the series of condensing-chambers are made stationary; also, the casing. The steam is admitted through a fixed tube h into an annular casing h', in which is a rotatable steam-wheel or reaction-turbine h'', mounted on a shaft h^3, suitably journaled in stationary bearings. The steam passes through the chamber h' successively into the condensing-chamber i, (which may be constructed like the condensing-chambers e, already described,) through pipes i', and is returned into said chamber through pipes i''. The water of condensation collecting in the chambers is returned to chamber h' and is gyrated therein by the jets of steam issuing from the wheel h'' and is drawn out through the passage j^6, which communicates with a central tube j, surrounding the shaft h^3, and within said tube upon said shaft is a spiral water-expeller or forcing-screw j', which communicates with an outlet j''. On the shaft a^3 exterior to the outlet j'' is a fan h^5, by which air is drawn into the apparatus and forced into the casing k, inclosing all the chambers, the air passing centrally into said casing k and between and around the several condensing-chambers, cooling the latter and dissipating thereon the water which is admitted into said chamber by a pipe k', which is coiled around the tube j and is supplied with apertures to admit small jets of water onto the external surfaces of the condensing-chambers. The air entering the casing may be given a whirl or twist by the curved deflector m.

Fig. 9 shows the arrangement of the water-outlet channel h^4 within the chamber h'.

The apparatus shown in Fig. 10 is substantially constructed as in Fig. 8, with the exception that the chambers are arranged in vertical series instead of horizontally, and advantage is taken of the natural gravity of water to cause the water of condensation to drain from the chambers into the central tube l, and the water of condensation may escape through pipe l' and may be forced out by a screw on the shaft h^3, operating the fan h^5. In this construction steam is admitted into the casing h' through the central opening h and escapes thence and enters the successive condensing-chambers i through the connections i^6, as shown. The cooling-water may be supplied through a pipe k^6, entering between the condensing-chambers and around the central tube and supplying water in fine jets onto the surfaces of the condensing-chambers, the water being spread over the upper surfaces of said condensers by a blast of air forced upward by the fan h^5.

Fig. 11 shows how the condensing-chambers may be made out of sheet metal, so as to present very thin walls and a large area of condensing and cooling surfaces. In every instance the steam is admitted to the interior of said chambers and the water and air are distributed over the exterior surfaces thereof, so that a much lower temperature is maintained on the exterior surface of the chambers than on the interior surface, resulting in a rapid condensation of the steam.

Figs. 12, 13, 14, and 15 illustrate various forms or modifications of construction of the condensing-chambers, Fig. 12 showing how it may be made of tubes of increasing diameters and Fig. 13 showing similar construction made of two plates pressed together, forming, substantially, tubes. Fig. 14 illustrates what I consider the preferred form of the condensing-chambers made in one piece, and Fig. 15 shows another form in which they might be made of substantially the same cross-section throughout; but I prefer the gradually-enlarging chamber.

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

1. An apparatus for condensing steam, comprising a series of rotatable chambers, means for introducing steam thereinto and means for diffusing over the exterior of said chambers a thin film of water.

2. An apparatus for condensing steam, comprising a series of rotatable chambers, means for directing air-currents around said chambers and means for diffusing over the exterior of said chambers a thin film of water.

3. An apparatus for condensing steam, comprising a series of gradually-enlarging chambers, into which the steam is admitted and means for cooling said chambers by applying water in thin films thereto.

4. An apparatus for condensing steam, comprising a series of gradually-enlarging chambers, means for cooling said chambers by applying water in thin films externally thereto, and means for directing jets of air thereagainst.

5. An apparatus for condensing steam, comprising a rotating chamber wherein the steam is expanded; means for introducing water onto the exterior surfaces of said chamber, and means for directing air-currents against the wetted exterior surfaces of said chamber to produce rapid evaporation of the water.

6. An apparatus for condensing steam, comprising a rotary series of condensing-chambers, means for introducing steam thereinto, and means for dissipating water in thin films upon the exterior surface of said chambers.

7. The herein-described apparatus for condensing steam, comprising a series of condensing-chambers, a receiving-chamber communicating with said condensing-chambers, jets adapted to admit steam into said receiving-chambers, and means to remove the water of condensation therefrom; with means for supplying water upon the exterior surface of said chambers, substantially as described.

8. The herein-described apparatus for condensing steam, comprising a series of rotatable condensing-chambers, a rotating casing communicating with each of said chambers, means for admitting steam into said casing and causing rotation thereof, and means within the rotating casing to remove the water of condensation therefrom, substantially as described.

9. The herein-described apparatus for condensing steam, comprising a series of rotatable condensing-chambers, a rotating casing communicating with each of said chambers, means for admitting steam into said casing and causing rotation thereof, and means within the rotating casing to remove the water of condensation therefrom; with means for directing water in fine streams upon the exterior surfaces of said chambers, and means for circulating air between the chambers.

10. The herein-described condenser-motor, comprising a rotatable casing, arms therein connected to main shaft and a rotatable condensing-chamber communicating with said casing, means for admitting steam from said casing into the central portions of the condensing-chamber, means for removing the water of condensation from the interior portions of said condensing-chamber to the casing, and means for removing the water of condensation from said casing; with means for applying water upon the exterior surfaces of the condensing-chamber, substantially as described.

11. The herein-described condenser-motor, comprising a rotatable casing, steam-inlet jets therein, a rotatable series of condensing-chambers communicating with said casing, means for admitting steam from said casing into the condensing-chambers, and means for removing the water of condensation; with means for applying water upon the exterior surfaces of the condensing-chambers, and means for circulating air between said condensing-chambers and over the moist surfaces thereof, substantially as described.

12. An apparatus for condensing steam, comprising a chamber, means for introducing steam thereinto to cause relative movement of the steam-inlet and the chamber, means for condensing the steam in the chamber to produce a partial vacuum therein to induce the inflow of steam; and means for removing the water of condensation, substantially as described.

13. An apparatus for condensing steam comprising a rotatable chamber, means for introducing steam into said chamber so as to cause the latter to rotate, and means for cooling the chamber so as to condense the steam therein and produce a partial vacuum in the chamber, thereby inducing the steam to enter therein, substantially as described.

14. An apparatus for condensing steam, comprising a rotary chamber or vessel, means for introducing steam thereinto so as to cause rotation thereof, means for externally cooling the chamber to condense the steam therein thereby producing a partial vacuum in the chamber inducing the steam to enter it, and means for removing the water of condensation, substantially as described.

15. An apparatus for condensing steam, comprising a series of rotatable chambers, means for introducing steam thereinto, means for dissipating water on the exterior surface of said chamber, to condense the steam therein and produce a partial vacuum whereby the steam is induced to flow into the chamber, and means for removing the water of condensation, all substantially as described.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

HENRY A. DUC, JR.

In presence of—
JAMES R. MANSFIELD,
T. H. ALEXANDER.