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E. THEISEN.

APPARATUS FOR EVAPORATING AND CONDENSING LIQUIDS.

No. 538,556. Patented Apr. 30, 1895.

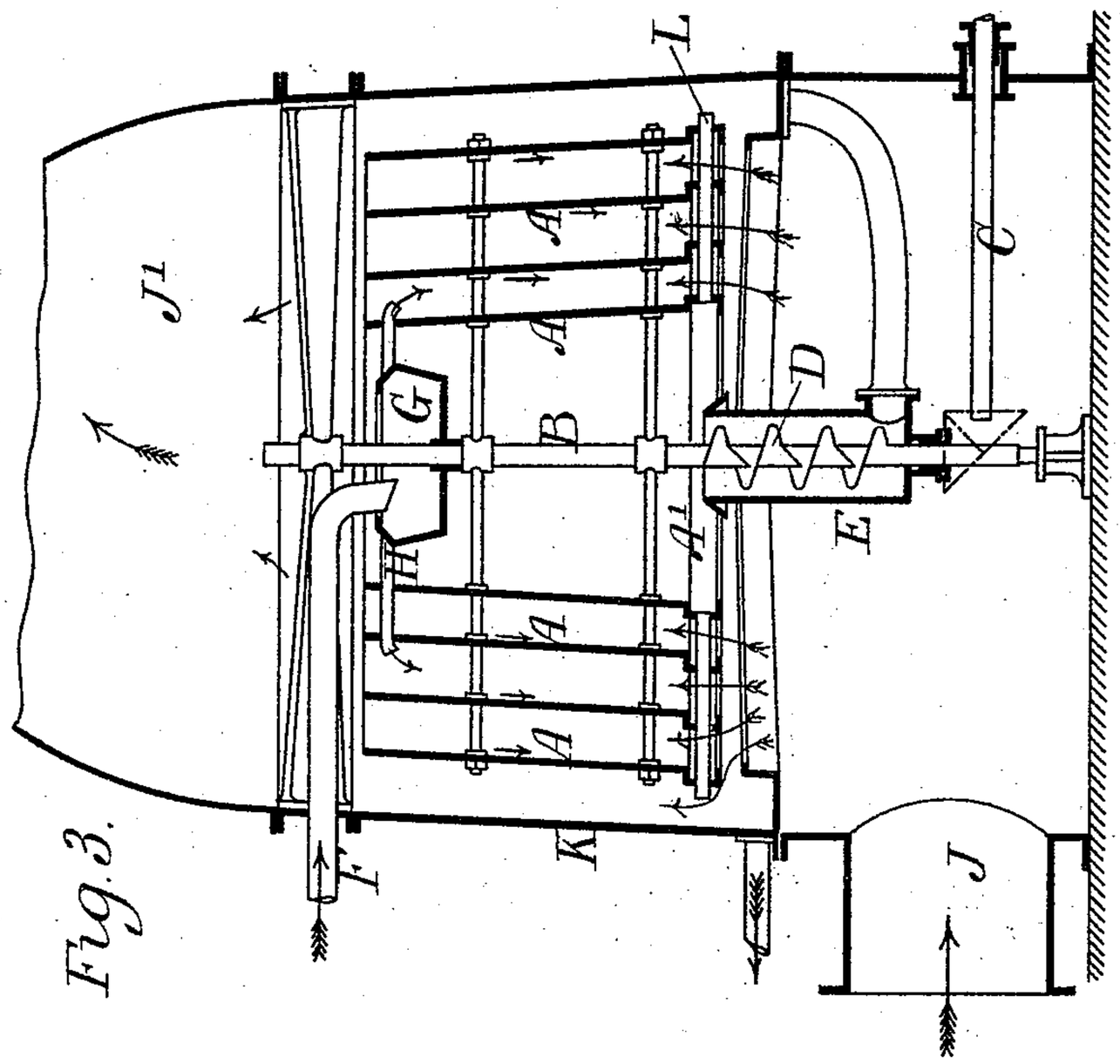

Fig. 3.

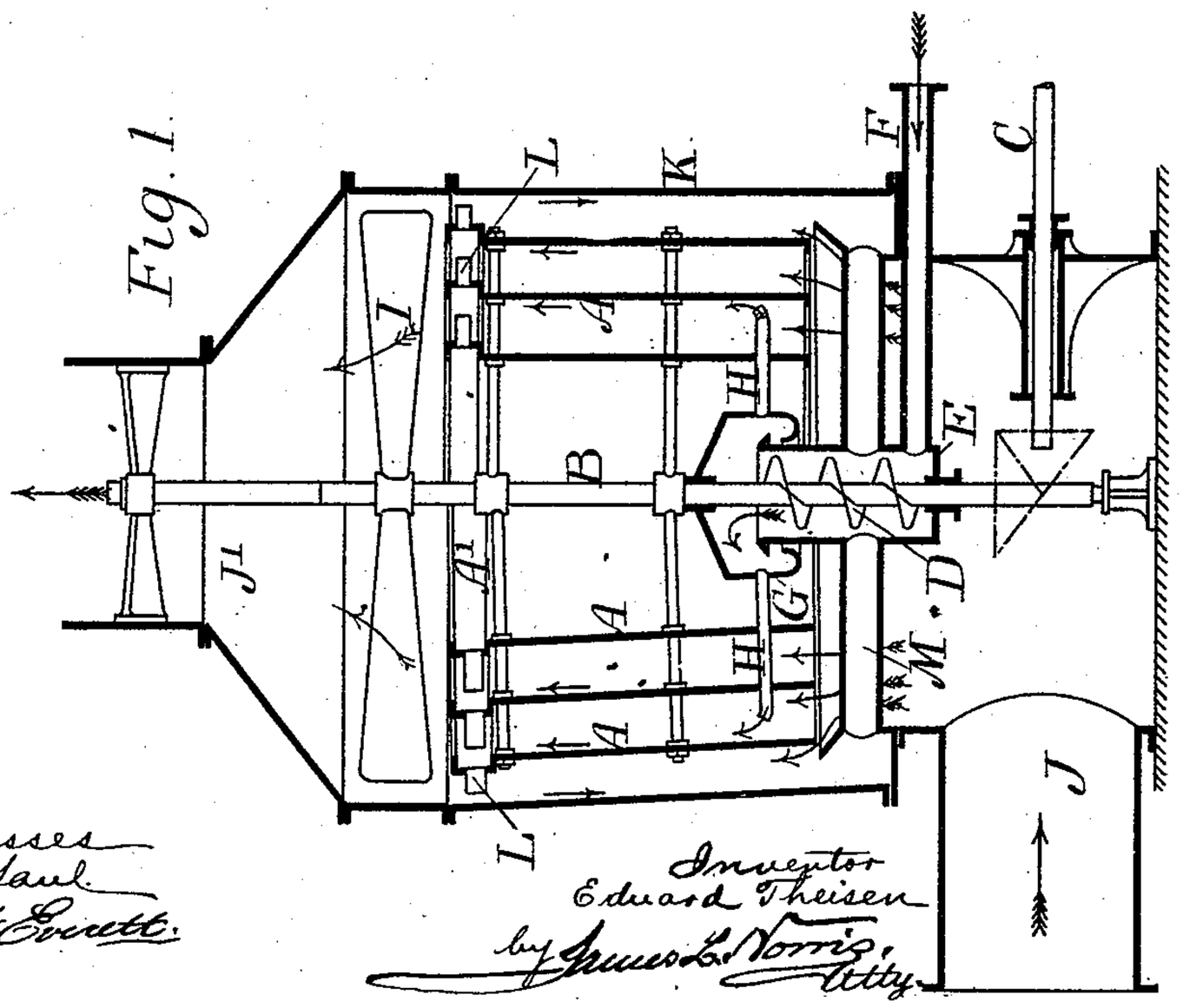

Fig. 1.

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Fig. 4.

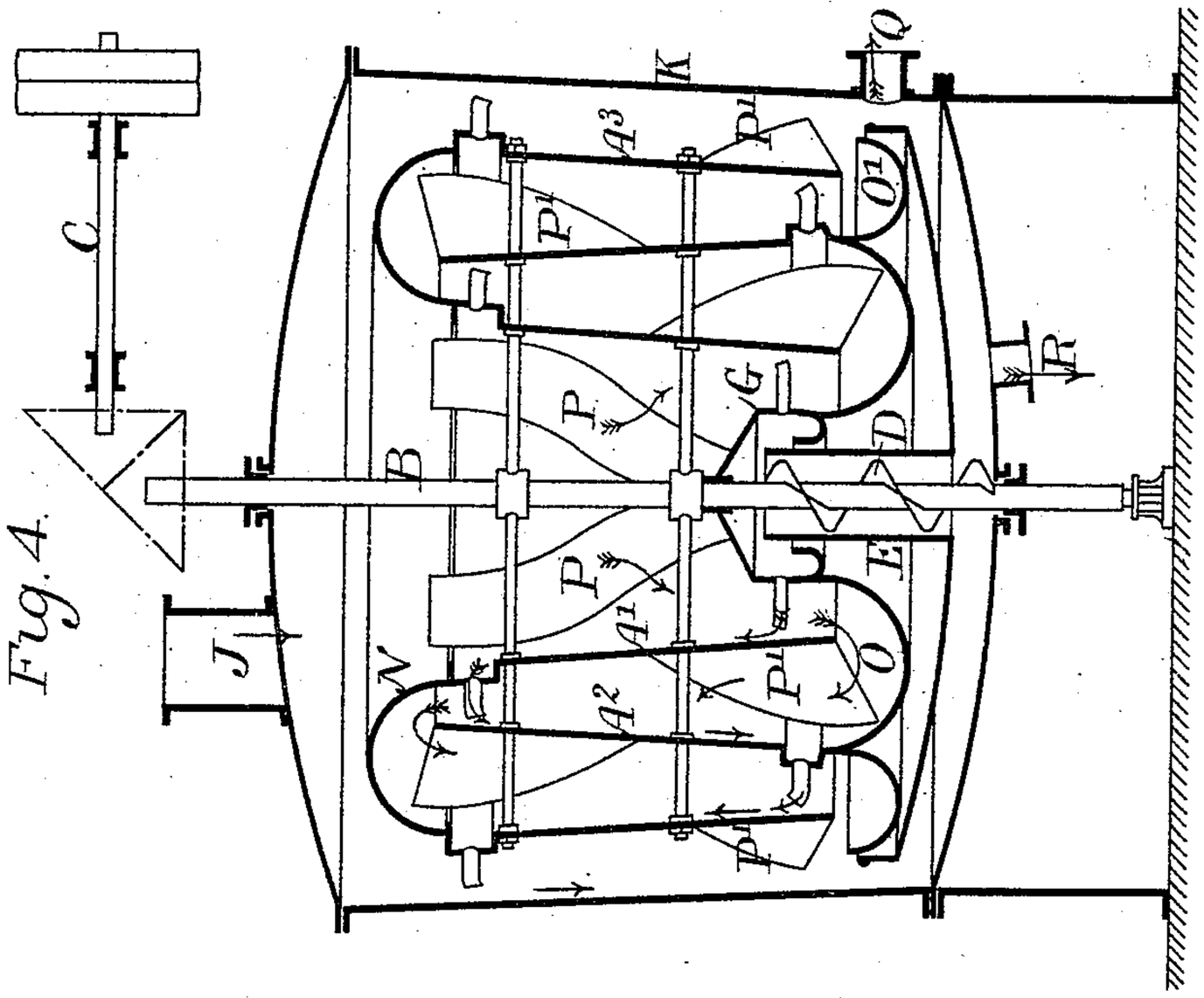
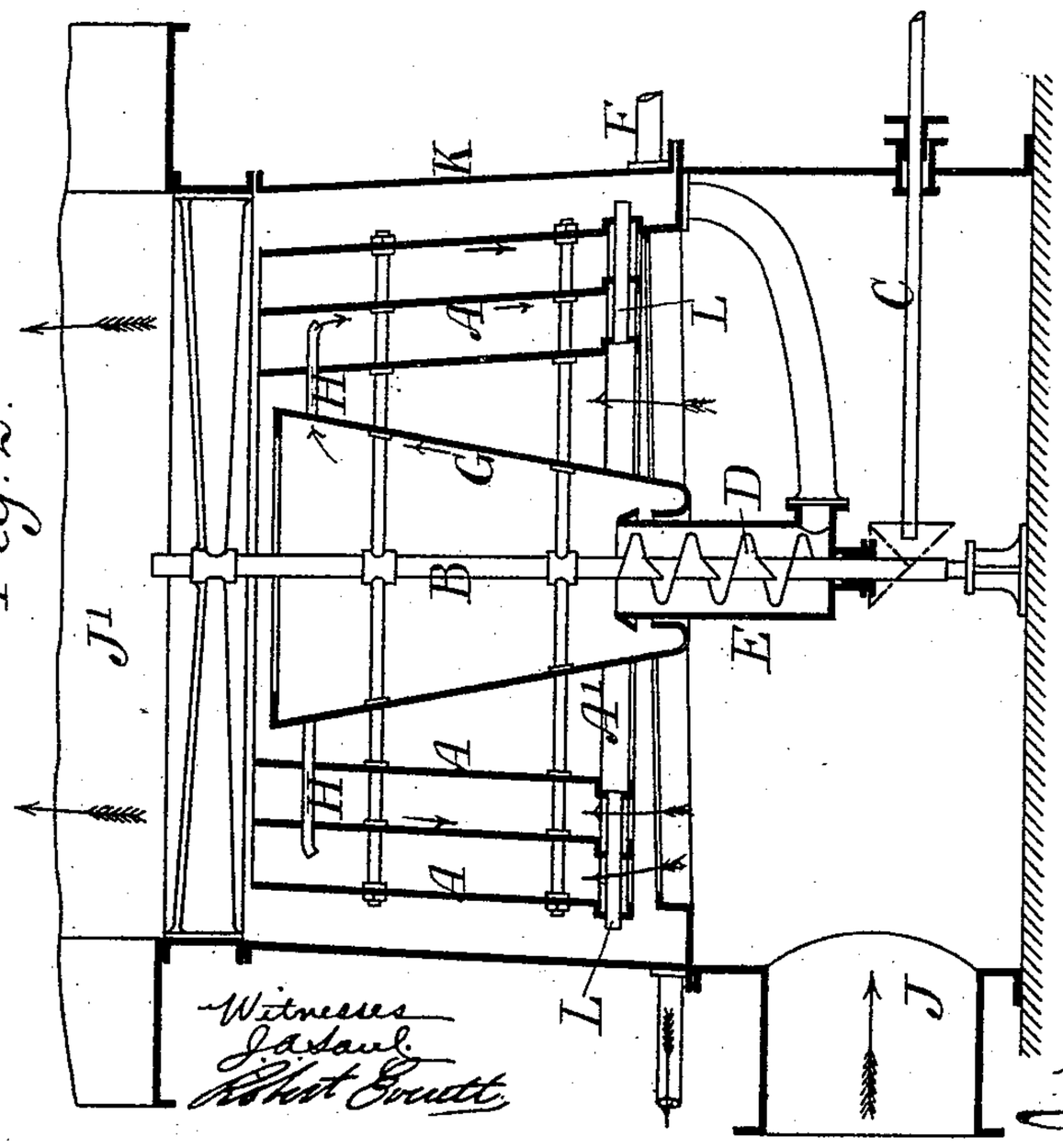


Fig. 2.



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5 Sheets—Sheet 3.

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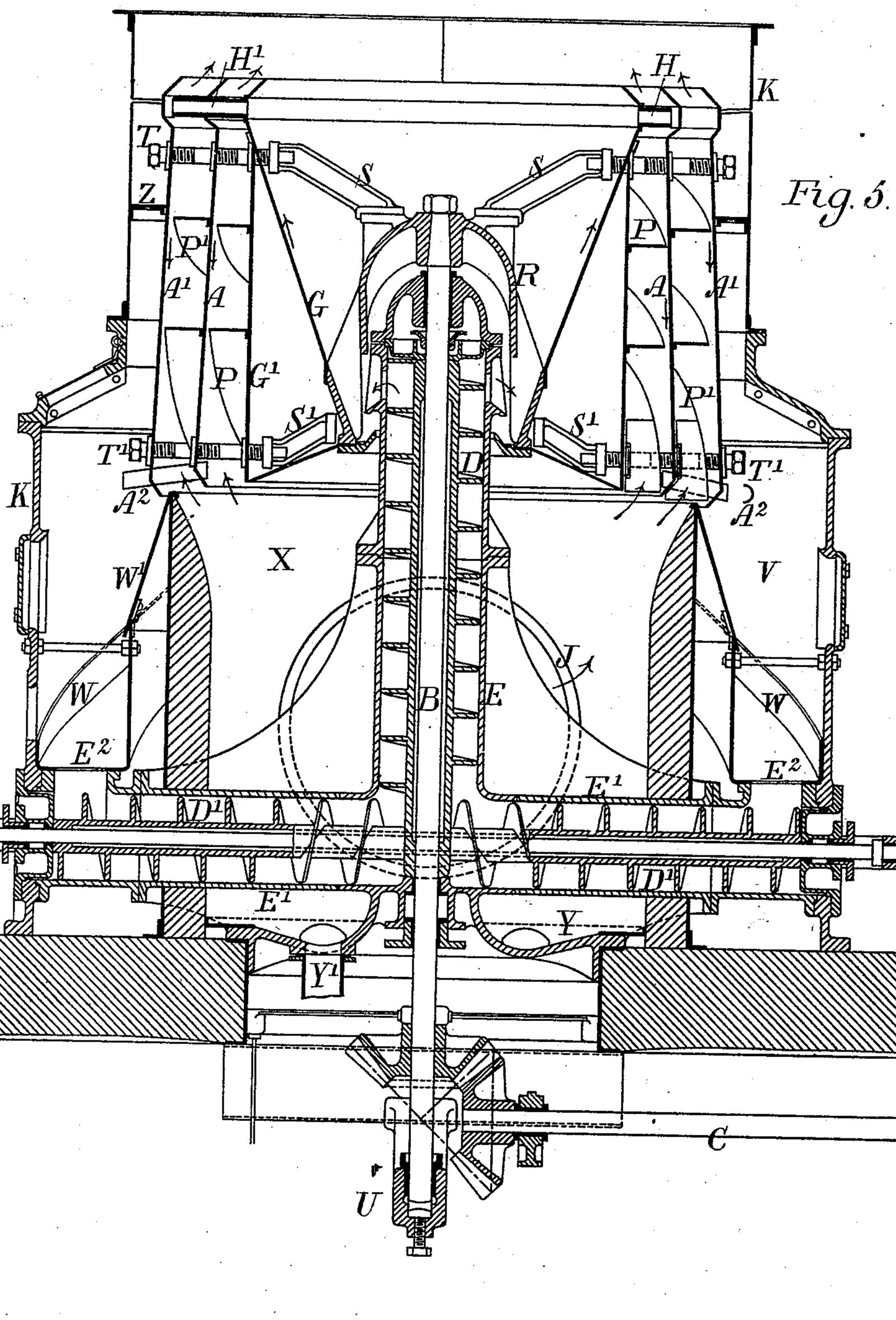

Fig. 5.

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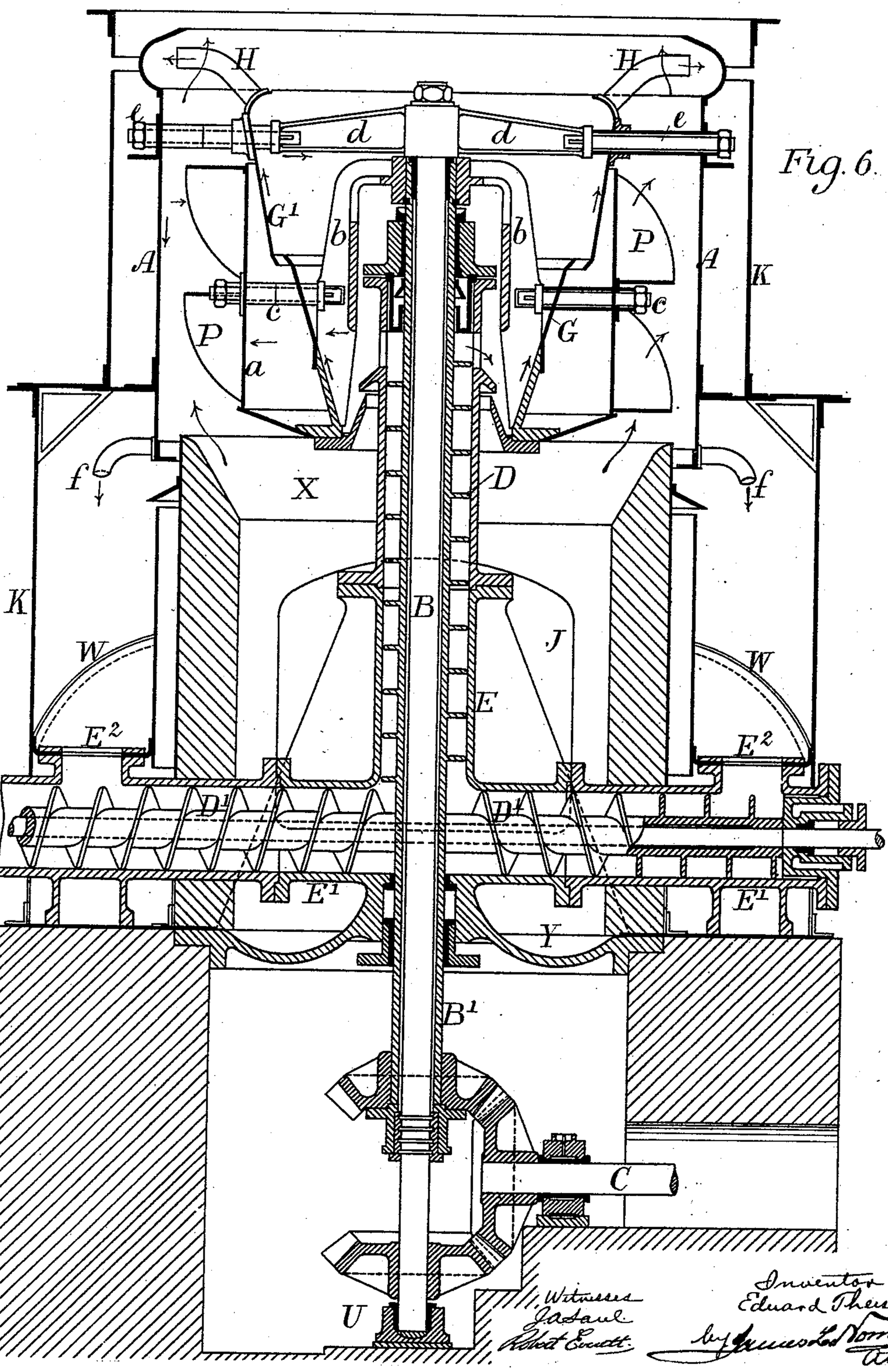

Fig. 6.

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APPARATUS FOR EVAPORATING AND CONDENSING LIQUIDS.

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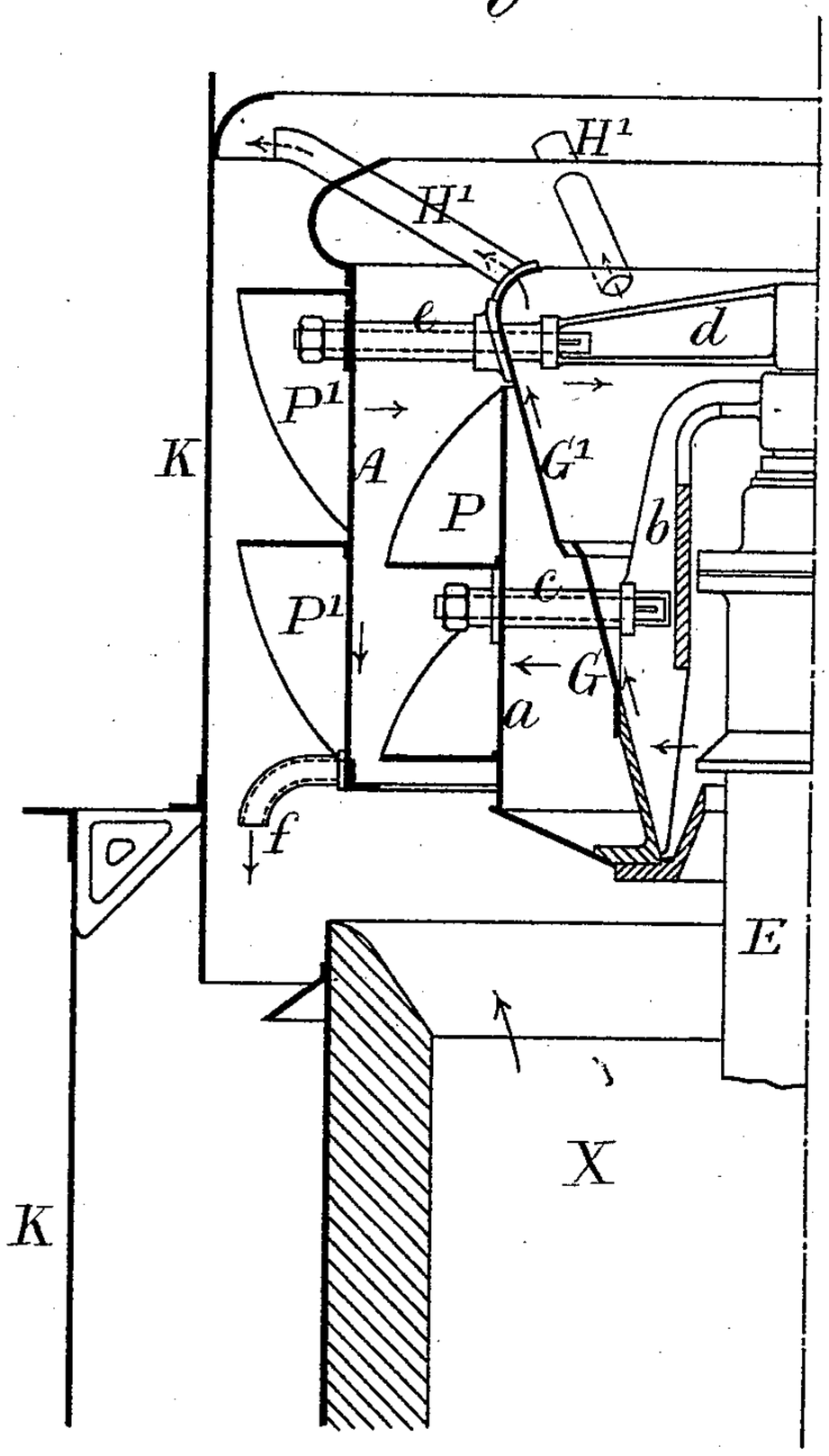
Fig. 7.



Witnesses
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UNITED STATES PATENT OFFICE.

EDUARD THEISEN, OF BADEN-BADEN, GERMANY.

APPARATUS FOR EVAPORATING AND CONDENSING LIQUIDS.

SPECIFICATION forming part of Letters Patent No. 538,556, dated April 30, 1895.

Application filed March 21, 1893. Serial No. 467,056. (No model.) Patented in England September 19, 1892, No. 16,726; in Switzerland September 23, 1892, No. 5,653; in France September 28, 1892, No. 224,610; in Germany October 9, 1892, No. 78,749; in Austria-Hungary March 2, 1893, No. 47,761 and No. 72,033, and in Belgium November 13, 1893, No. 107,284.

To all whom it may concern:

Be it known that I, EDUARD THEISEN, engineer, a citizen of the United States, residing at Kronprinzenstrasse 4, Baden-Baden, Germany, have invented a certain new and useful Apparatus for Evaporating and Condensing Liquids, (for which I have obtained Letters Patent in Great Britain, dated September 19, 1892, No. 16,726; in Belgium, dated November 13, 1893, No. 107,284; in Germany, dated October 9, 1892, No. 78,749; in France, dated September 28, 1892, No. 224,610; in Austria-Hungary, dated March 2, 1893, No. 47,761–43/465, and No. 72,033–27/377, and in Switzerland, dated September 23, 1892, No. 5,653,) of which the following is a specification.

My invention relates to apparatus for producing intimate frictional action between liquids and gases by causing the liquids to flow in thin films or layers over the inner surfaces of rapidly revolving cylindrical or conical drums while at the same time air, gases, or vapors are caused to flow, while also subject to centrifugal action, in intimate contact with such thin layers of liquid, a considerable relative motion being at the same time made to take place between the two. By this means the particles of liquid and air, gas or vapor, are subject either to a rapid interchange of temperature, for effecting the evaporation of the former, or the heating or cooling of the one or the other, or they are caused to be intimately mixed together, or again, when a mixture of liquid and gases is so heated while subject to a greater or less exhaust, the air or gases may be effectually separated from the liquids, or the gas may be made to act chemically upon the liquid.

The apparatus may be variously constructed. I will proceed to describe some arrangements thereof by way of illustration with reference to the accompanying drawings, in which—

Figures 1, 2, 3, and 4 show diagrammatic sections of four different arrangements. Fig. 5 shows a vertical section of an apparatus constructed according to Fig. 2. Fig. 6 shows a vertical section of a modified construction. Fig. 7 shows a part vertical section of a modification of Fig. 7.

In the diagram section at Fig. 1 A A A are three concentric cylinders, made of slightly smaller diameters at the lower ends than at the upper ends, and connected by radial arms to a central shaft B suitably supported in bearings and rotated by a driving shaft C and bevel gear, so that the cylinders A are carried round with it. The shaft B has a worm D fixed on it, inclosed in a cylindrical casing E the lower end of which is supplied through a pipe F with the liquid to be treated, so that by the rotation of the worm D the liquid is raised in the casing E and made to flow from its upper end into an annular trough G carried by the shaft B and from which radial tubes H of varying length project to near the inner surfaces of the several cylinders A. Thus the liquid that is delivered into the trough G is thrown by centrifugal force through the tubes H against the lower end of the inner surfaces of the cylinders, and by the rotation of these it is caused to ascend in a thin film in a helical direction along the slightly outward inclined surfaces thereof. The shaft carries above the upper ends of the cylinders, an air propeller I by means of which air is drawn up from a flue J at the bottom of the casing K, and is caused to pass in intimate frictional contact with the film of liquid on each of the cylinders A.

At their upper ends the cylinders A are provided with an annular trough A′ from which project radial tubes L, so that as the liquid rises on the cylinders as described it is caught in the troughs A′ from which it is discharged by centrifugal force through the tubes L against the sides of the casing K, down which it then flows to the bottom, where it is again conveyed by tubular channels M to the casing, E, to be again raised by the worm and subjected to the above described treatment; or the liquid when sufficiently concentrated or otherwise acted upon, can be discharged through the pipe F or through another pipe.

The air or gas in being carried round in the annular spaces between the cylinders A will also be subject to centrifugal action, whereby it will be forcibly pressed against the liquid at the same time that it travels along the same.

It will be readily seen that the above de-

scribed method of operating may be applied to a variety of purposes. Thus assuming that there exists a difference of temperature between the air or other gas entering the apparatus and the liquid the intimate frictional contact between the two will produce an effective interchange of heat and evaporation or concentration of the liquid, or the liquid may be made to take up a certain proportion of the gases in contact therewith, or a chemical action may be set up between the liquid and the gas.

Fig. 2 shows a vertical section of another arrangement, in which the cylinders A instead of being enlarged toward the upper end are enlarged toward the lower end. The liquid is in this case supplied from the casing E to the revolving conical shell G on which it rises by centrifugal action and from the upper end of which it is thrown, by tubes H on to the concentric cylinders A, down which it descends by the combined action of centrifugal force and gravity and from the trough A′ at the lower end of which it is thrown through the tubes L against the outer casing K. The air or other gas to be brought into frictional contact with the liquid is drawn up from the flue J by means of an air propeller communicating with the upper flue J′. Fig. 3 shows the same arrangement of the cylinders A, but with the liquid supplied thereto at the upper end from a vessel G fixed on the upper end of the shaft B and supplied by a pipe F.

Fig. 4 shows a vertical section in which the innermost and outermost cylinders A′ A^3 are enlarged toward their upper ends, while the middle one A^2 is enlarged toward the lower end, so that the liquid is first made to travel upward on the inner cylinder A′, is then thrown on to the upper end of the middle cylinder A^2, on which it travels downward, and from the lower end of which it is thrown on to the lower end of the outer cylinder A^3, in which it travels upward again and from the upper end of which it is thrown on to the casing. The spaces between the cylinders A′, A^2 and A^3 are inclosed at top by an annular cap N, and the space between A′ and A^2 is separated at bottom from that between A^2 and A^3 by troughs O O′ and within the cylinder A′ are fixed helical blades P while on outer surfaces of all three cylinders are fixed helical blades P′ P′ P′, so that air or other gas entering the closed casing K through the inlet J at top, is first made to pass downward through the inside of cylinder A′, by the action of the blades P, then upward between A′ and A^2 and then downward again between A^2 and A^3 by the action of the blades P′. By thus bringing one and the same body of liquid into long continued and repeated contact with one and the same body of gas, if necessary under pressure (the openings Q and R of the casing being closed) either the liquid may be made to absorb a greater or less quantity of the gases, or the latter may be made to act chemically upon the liquid, or the liquid may be made to give up gases contained therein, the gases being, according to the nature of the operation, either introduced into the casing K through the opening Q and discharged through the opening R or vice versa.

Fig. 5 shows a vertical section of a practical construction of the apparatus similar to that described with reference to the diagram Fig. 2, the apparatus being here supposed to be applied to the evaporation of a liquid by being brought into intimate frictional contact with hot air or hot combustion gases. A A are, as before, two concentric metal cylinders, made slightly larger in diameter at the lower ends than at the upper ends. They are supported from the central shaft B by means of a cap R fixed on the latter, to brackets S S′ fixed on which the cylinders are attached by bolts T T′. The shaft has fixed upon it a worm D inclosed in a cylinder E, the upper end of which carries a neck bearing for the shaft whose lower end is carried in a step bearing U. It receives rapid rotary motion by bevel gearing from a driving shaft C. The cylinder E communicates at its lower end with a horizontal cylinder E′ in which are right and left handed worms D′ driven by the shaft C which convey the liquid falling from the cylinders A back to the worm D. Surrounding the upper end of the cylinder E is a conical shell G, the lower part of which is conveniently formed integral with the casting R while the upper part is formed of thin sheet metal. The liquid raised by the worm D is discharged through the lateral openings of the cylinder E onto the cone G, on the sides of which it is made to rise by centrifugal action so as to be thrown by the pipes H H′ at the upper end of the cone partly on to the recessed upper end of the cylinder A and partly on to that of the cylinder A′. From these parts of the cylinders the liquid is then made to descend in a thin film, partly by gravity and partly by centrifugal action, along the surfaces of the cylinders, the portion thereof which is not evaporated being intercepted at the lower end by a series of half round troughs A^2 by which it is discharged into the annular space V in the casing K. Here it is caught up by inclined gutters W which lead it to openings E^2 through which it passes into the tube E′ to be again raised and submitted to the above described evaporating action.

The cone G is surrounded by a cylinder G′ fixed thereto and upon the outer surface of this cylinder are fixed a number of helical vanes P, while other helical vanes P′ are fixed upon the outer surface of the cylinder A.

Hot air or hot combustion gases being introduced through an opening J into the central space X of the apparatus, such air or gases are drawn upward by the action of the vanes P P′ through the annular spaces between G′ and A and A and A′, and are at the same time thrown by centrifugal action into

close frictional contact with the film of liquid descending upon the surfaces of A A′, whereby an effective interchange of temperature and consequent evaporation of the liquid will be effected, the resulting gases charged with vapor being then made to pass upward to a surface condenser situated either above or at some other point. Any of the liquid that may drop down from the cylinder A is caught by a pan Y at the bottom of the central space, whence it is discharged by a pipe Y′ into a suitable receptacle. Any liquid that drips from the cylinder A′ is directed by the apron W′ into the gutter W. The escape of the hot gases through the annular space between the cylinder A′ and the casing K is prevented by a partition Z fixed to the latter.

Fig. 6 shows a modification of the above described arrangement in which, firstly, there is only a single cylinder A on to which the liquid is delivered from the cone, and, secondly, the distributing cone G is divided into two separate parts that are made to revolve in opposite directions. For this purpose the shaft B is surrounded by a tubular shaft B′ driven by the gearing in the contrary direction to B and to which is attached the lower part of the cone G and cylinder *a* by means of arms *b b* and bolts *c c*, while the upper part G′ of the cone and cylinder A are connected to the shaft B by arms *d d* and bolts *e e*, and consequently these parts revolve in the contrary direction to the parts G and *a*. With this arrangement it will be seen that the liquid supplied by the worm D to the lower cone G will be delivered from the upper edge of the latter with a certain circumferential velocity in one direction on to the lower edge of the cone G′ revolving in the contrary direction. The result hereof will be that in raising up the cone G′ by centrifugal action the liquid will first require to have the circumferential velocity imparted to it by G checked and neutralized before it can begin to follow the direction of the circular motion of G′, and the consequence hereof will be that when it arrives at the upper edge of G′ it will not have had sufficient time to acquire the circumferential velocity thereof, so that the centrifugal force with which it is thrown against the cylinder A from the pipes H will be very considerably less than it would be in the preceding case where the liquid while traveling up the surface of the cone G will have time to acquire the full circumferential speed thereof and thus the violent splashing of the liquid against the cylinder is prevented and its uniform distribution over the surface thereof is insured. The liquid arriving at the bottom of the cylinder A passes away through spouts *f* delivering it onto the gutter W as before. The other parts of the apparatus are the same as previously described.

Fig. 7 shows a part vertical section of a modification of the preceding arrangement in which some of the liquid is delivered from the cone G′ through pipes H′ on to the surface of the casing K so as to flow down the same in the same way as down the cylinder A. In this case the hot air or gases are of course made to pass from the central space X also to the annular space between the cylinder A and the casing, the former being provided with external helical vanes P′ by which such hot gases are both propelled upward and thrown forcibly in contact with the liquid flowing down the casing.

Having described my invention, what I claim is—

1. In apparatus for bringing liquids and gases into intimate frictional contact with each other, the combination of an upright revolving tubular shell, means for supplying the upper end of the inner surface of said shell with liquid which is caused by gravity and centrifugal action to flow in a thin film downward over the surface of the shell, and blades or fans revolving concentrically with the shell for causing a supply of air or gases to rise into the lower end of the shell and be thrown by centrifugal force in contact with the layer of liquid on the shell and upward over the same in the contrary direction to the flow of the liquid, substantially as described.

2. In apparatus for bringing liquids and gases into intimate contact with each other, the combination of an upright revolving tubular shell A, a concentric conical shell G over the inner surface of which liquid is caused to rise by centrifugal action, nozzles H at the upper end of the shell G through which the liquid raised is thrown on to the inner surface of the shell A so as to flow down the same in a thin film, and centrifugal blades P which propel air or gases rising into the lower end of the shell A against the film of liquid thereon and cause it to flow upward in close contact with the liquid, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 16th day of February, A. D. 1893.

EDUARD THEISEN.

Witnesses:
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FRANZ FLEMMANN,
Engineer.