(No Model.) 4 Sheets—Sheet 1.

# E. THEISEN.

## CONDENSER.

No. 477,471. Patented June 21, 1892.

Fig. 2.

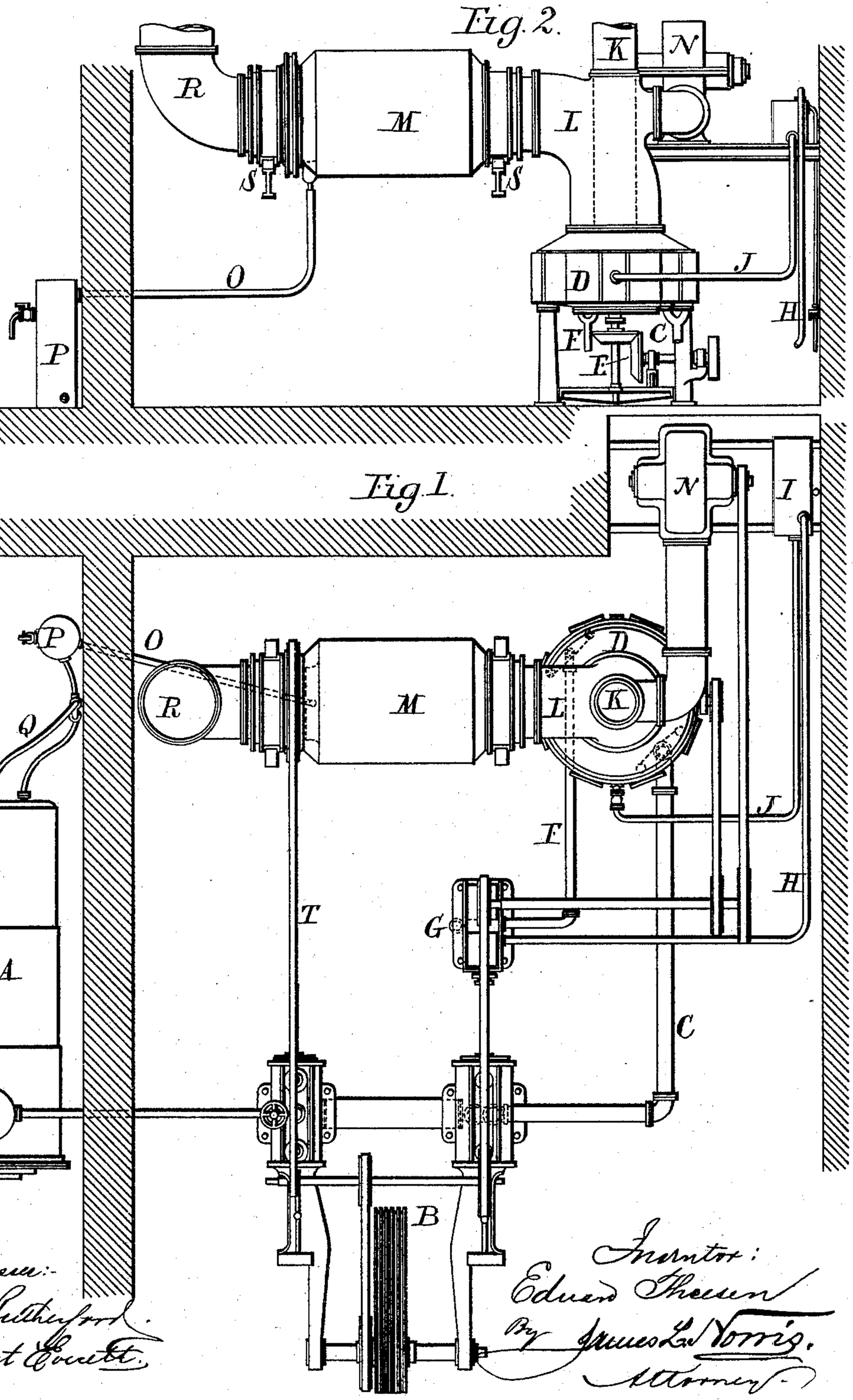


Fig. 1.

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(No Model.) 4 Sheets—Sheet 2.

# E. THEISEN.

## CONDENSER.

No. 477,471. Patented June 21, 1892.

Fig. 4.

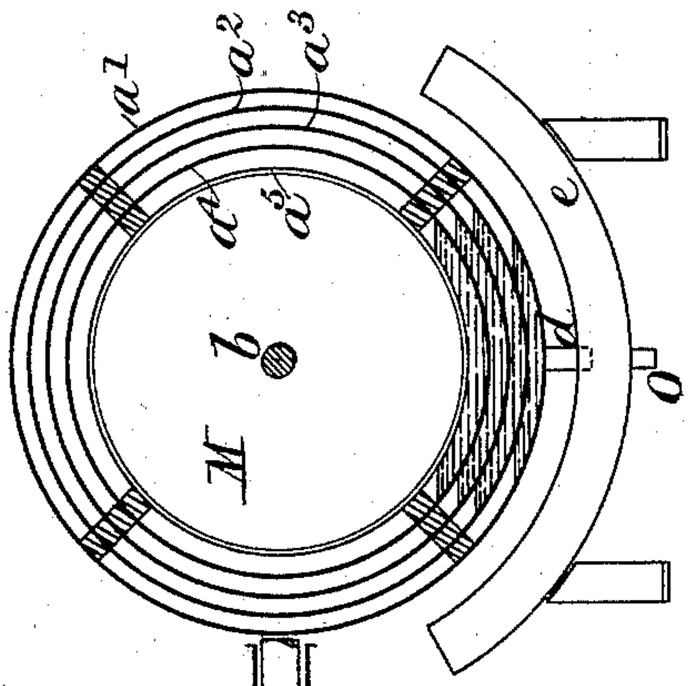



Fig. 6.

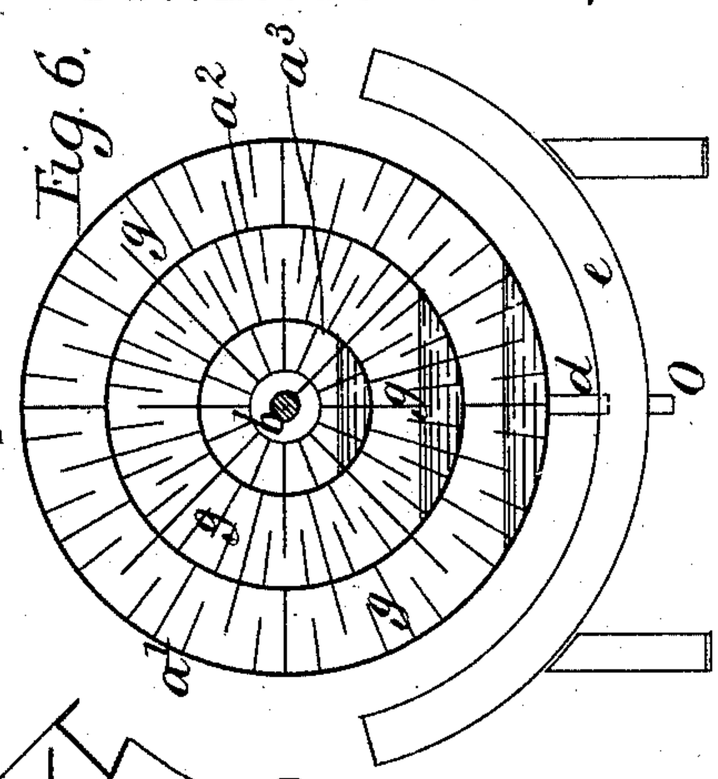



Fig. 3.

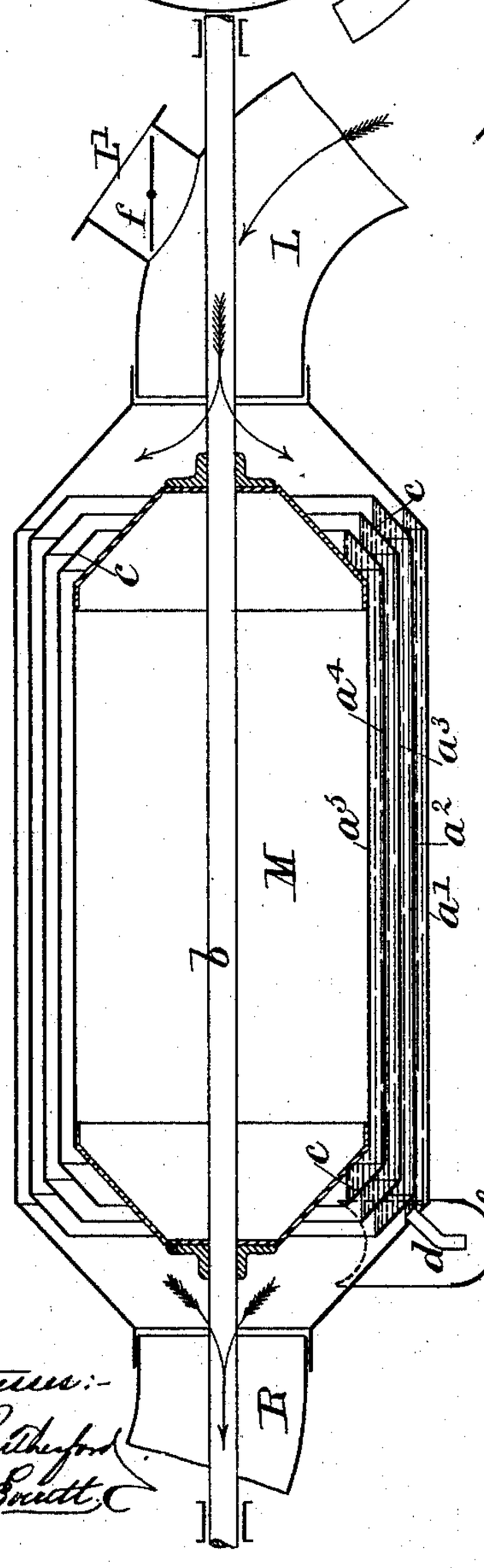
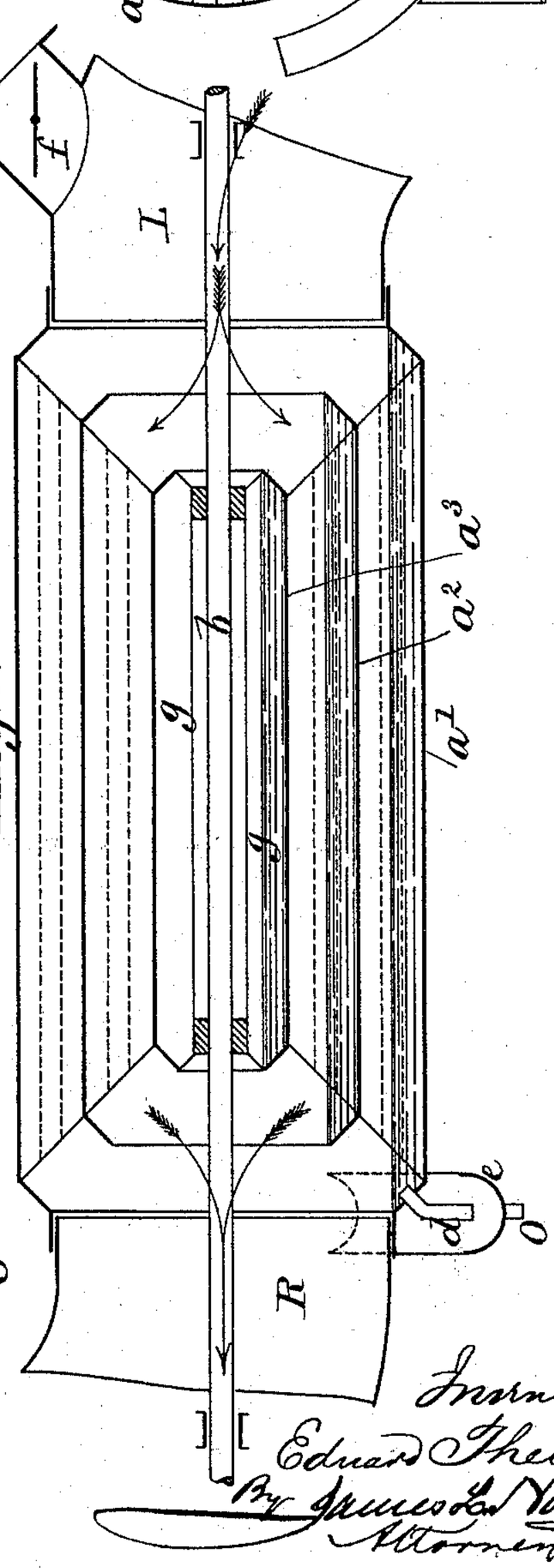



Fig. 5.

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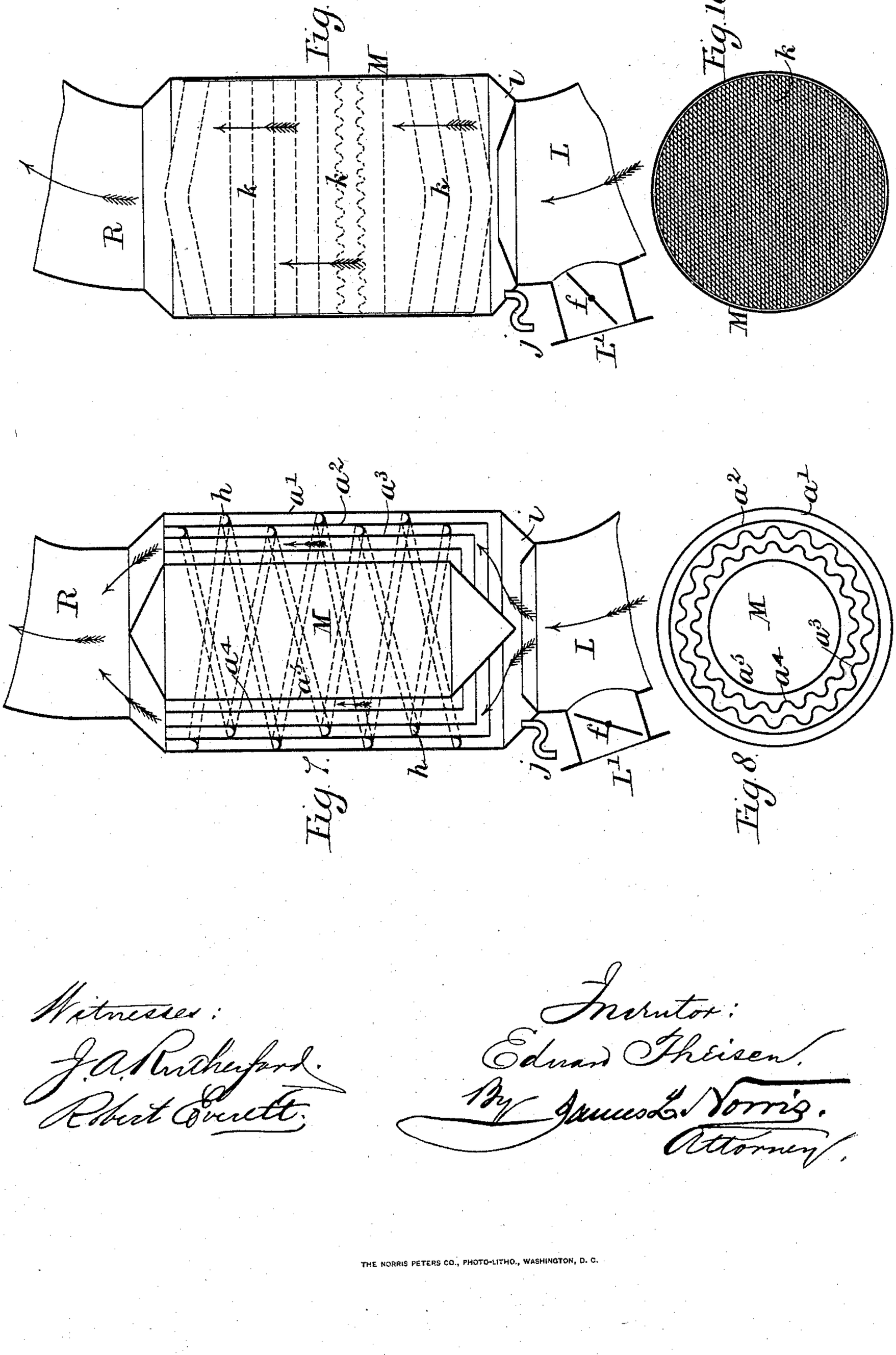
(No Model.) 4 Sheets—Sheet 3.

# E. THEISEN.

## CONDENSER.

No. 477,471. Patented June 21, 1892.

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(No Model.) 4 Sheets—Sheet 4.

# E. THEISEN.

## CONDENSER.

No. 477,471. Patented June 21, 1892.

Fig. 11.

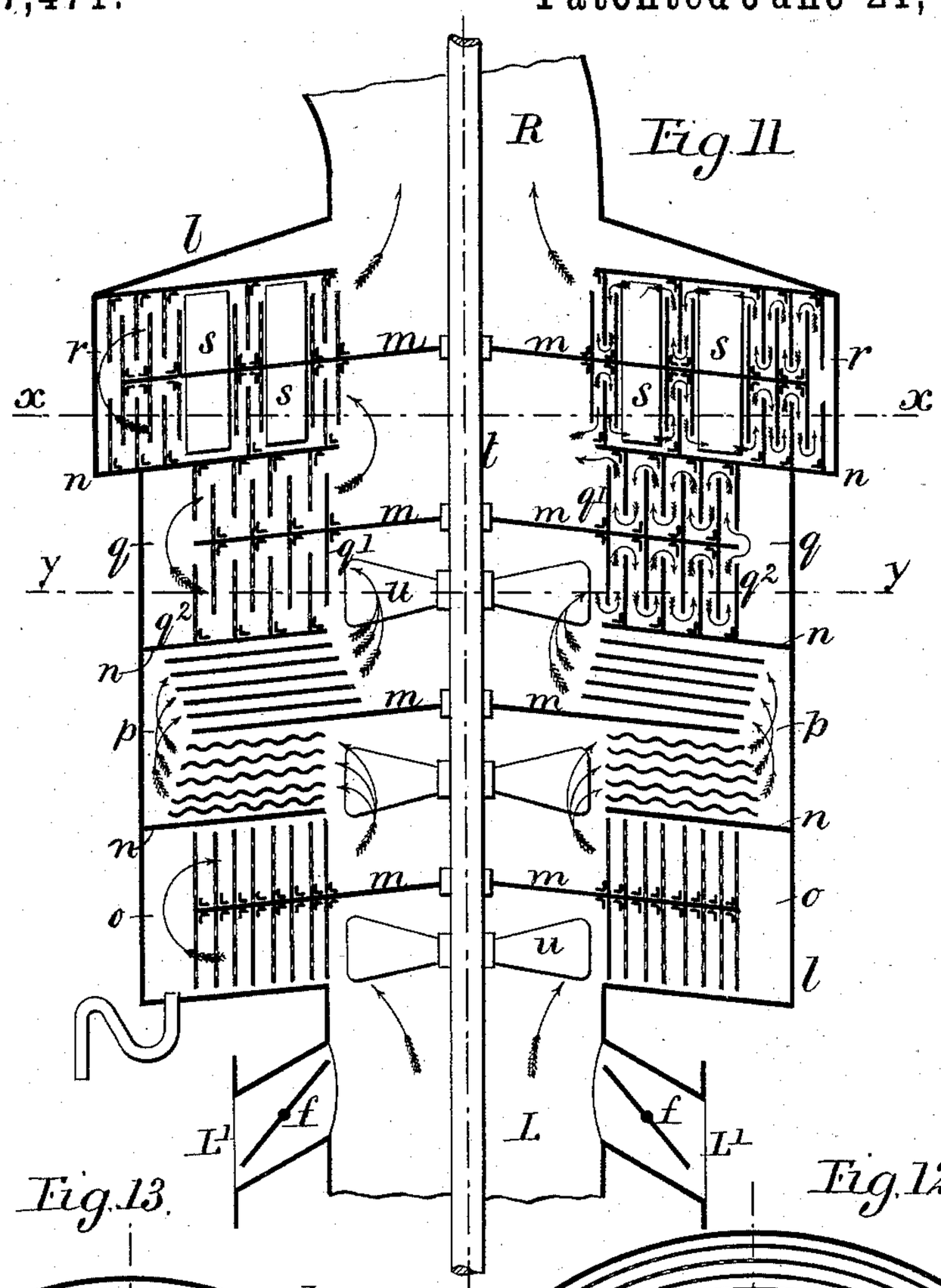



Fig. 13.

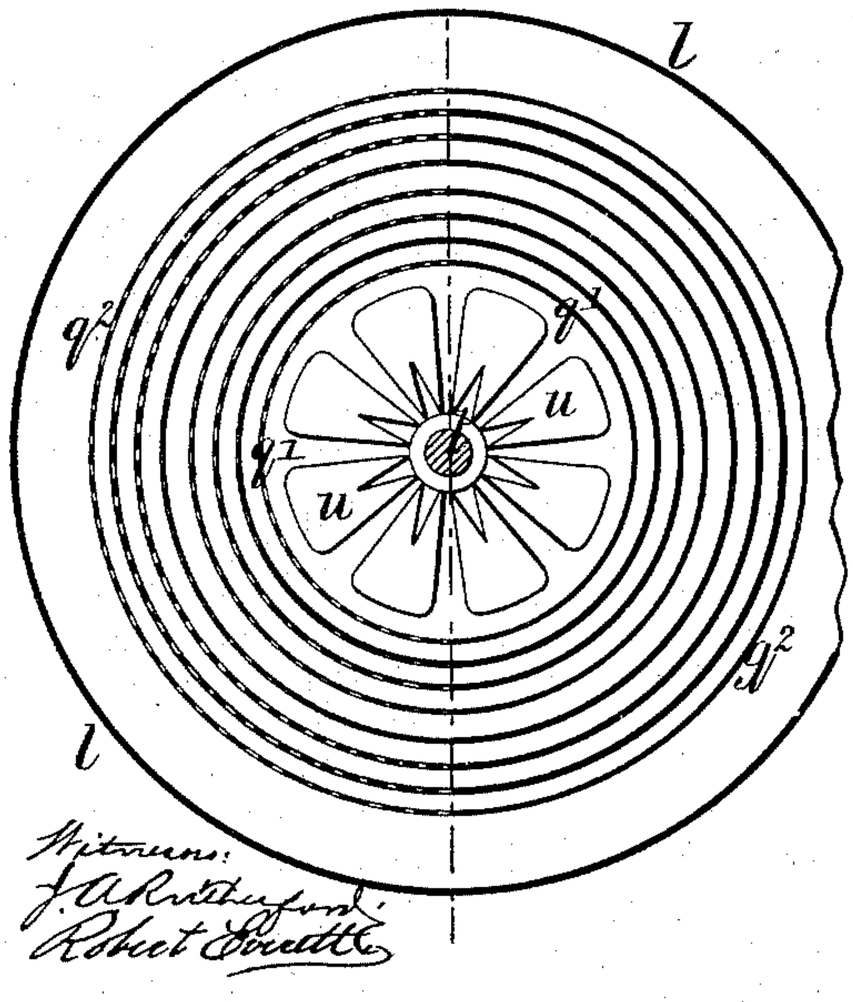
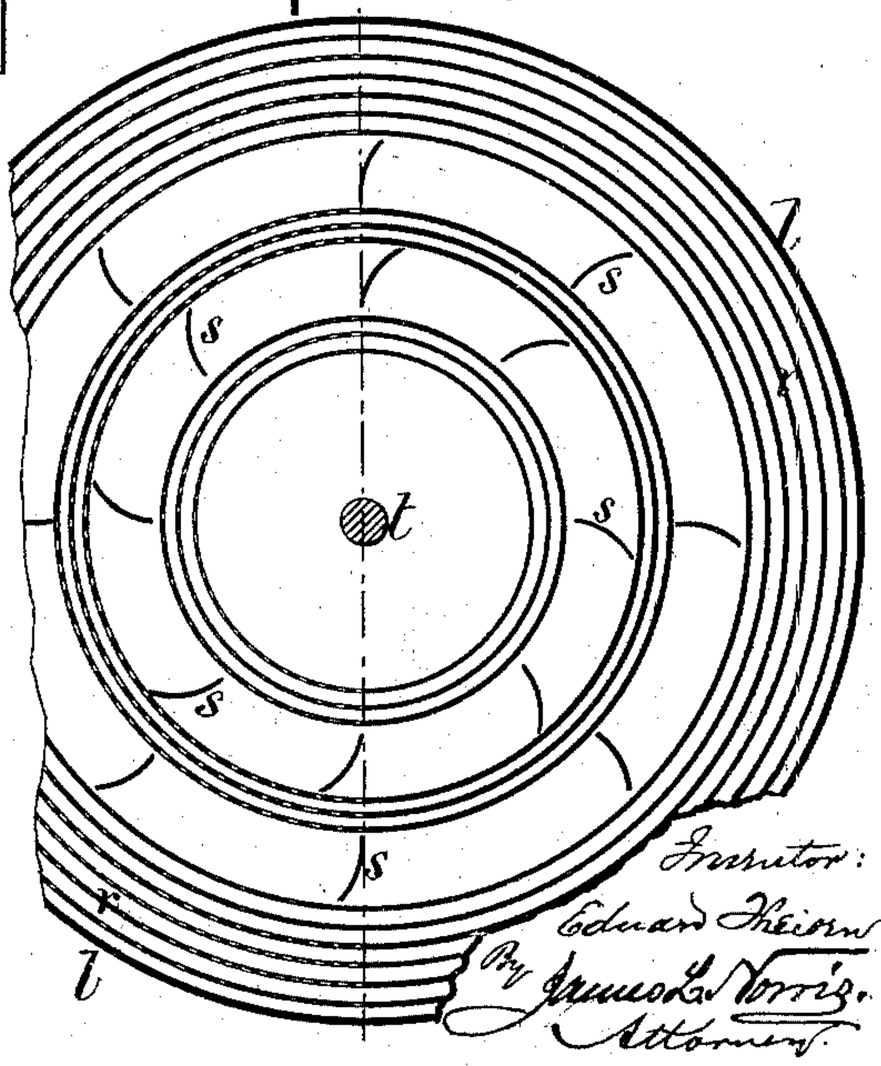



Fig. 12.

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# UNITED STATES PATENT OFFICE.

EDUARD THEISEN, OF SINZIG-ON-THE-RHINE, GERMANY.

## CONDENSER.

SPECIFICATION forming part of Letters Patent No. 477,471, dated June 21, 1892.

Application filed February 23, 1892. Serial No. 422,553. (No model.)

*To all whom it may concern:*

Be it known that I, EDUARD THEISEN, a citizen of the United States, residing at Sinzig-on-the-Rhine, in the German Empire, have invented a certain new and useful Improved Method of and Apparatus for Effecting the Condensation of Steam and other Condensable Vapors, of which the following is a specification.

My invention has mainly for its object to effect the condensation of steam or vapor of water in such manner that instead of conveying the water resulting from the condensation of steam as it comes from the steam-engine or other apparatus where it was used directly into the boiler or other apparatus in which it was generated or where it is to be used, whereby it is liable to carry a considerable quantity of impurities—such as oil from the engine-cylinders—with it into the boiler, I cause such water of condensation to be re-evaporated in effecting the surface condensation of steam in conjunction with an air-blast, and then to be recondensed and conveyed into the boiler. By this means I not only obtain a perfectly-pure supply for the boiler, but also the heat is utilized in the most economic manner possible, as the water evaporated in the surface condenser instead of being carried off into the atmosphere, as is usually done, is condensed and utilized.

For the above purpose I in the first place condense the steam by a construction of surface condenser by preference such as described in the specifications to my Patent No. 445,096, in which the steam is made to pass through pipes over which water is made to flow, while at the same time a current of air at a different temperature is brought by a fan into intimate contact with the wet condensing-surfaces, so as to evaporate and take up the moisture, and the air-currents so charged with moisture I then cause to pass through an apparatus in which the aqueous vapor is condensed out of the air and is then pumped back into the boiler, while, as before stated, the water resulting from the direct condensation of the exhaust-steam from the engine is made to flow over the pipes of the surface condenser to be again evaporated. By this means it will be seen that not only is a perfectly-pure supply of water to the boiler insured, but the heat of the exhaust-steam is effectually utilized, as the aqueous vapor produced thereby being condensed constitutes the feed-water of the boiler.

The above-mentioned second condensing apparatus may be of any suitable constuction for condensing the aqueous vapor from the air. Thus it may consist of a series of concentric metal cylinders or tubes offering narrow annular spaces, through which the air and aqueous vapor are made to pass. The walls of these cylinders being in contact with the atmosphere are maintained by conduction at a lower temperature than the entering air and vapor, and the latter will be to a large extent condensed in contact therewith. The water thus condensed is then fed back into the boiler by a pump, while the water of condensation withdrawn from the evaporative surface condenser is supplied by the air-pump into a tank, from which it is made to flow over the condensing-pipes, as described; or other arrangements, such as will be hereinafter described, may be employed.

It will be readily understood that my said invention is also applicable to other purposes besides condensing the steam of steam-engines. Thus it may be used for economizing water in various evaporating processes, such as for condensing and utilizing the aqueous vapor drawn off from vacuum-pans in the manufacture of sugar in localities where water is scarce. In such cases the steam or aqueous vapor given off would also be condensed in an evaporative surface condenser, as above described, the water of condensation being made to furnish the water flowing over the condenser-pipes, while the water produced by its secondary evaporation and condensation is again employed in the sugar-boiling process, thus saving the water that would otherwise be lost in the vapor carried off by the air-blast in the evaporative surface condenser.

The accompanying drawings show, by way of example, one arrangement of apparatus for carrying out my above-described method of operating, as applied to the condensation of the exhaust-steam of a steam-engine.

Figure 1 shows a plan view of the combined apparatus. Fig. 2 shows a part side eleva-

tion. Figs. 3 to 13 show various constructions of the apparatus for effecting the secondary condensation of steam by contact with heat-absorbing surfaces.

In Figs. 1 and 2, A is a steam-boiler supplying steam to the steam-engine B. From the latter the exhaust-steam passes through pipe C to the evaporative surface condenser D, constructed according to my patent, No. 445,096, in which is a rotary fan driven by toothed gear E for propelling air drawn in through pipe K, over pipes into which the exhaust-steam enters from the pipe C, and from which the water of condensation passes off through pipe F to the air-pump G. This air-pump, after drawing off the water of condensation from the condenser, supplies the same through pipe H to a reservoir I, from which it flows through a pipe J into the condenser D, in order there to be thrown by centrifugal action over the pipes through which the exhaust-steam is passing in order to be evaporated by the combined action of the heat and the air-blast. The resulting air-current charged with aqueous vapor is then led from the condenser D through the trunk L into the second condensing apparatus M, in which the aqueous vapor is condensed out of the air-currents by contact with extended heat-absorbing surfaces. This apparatus may be variously constructed for effecting this object, as will be presently described. For aiding in the absorbtion of heat from the aqueous vapor a fan N is made to blow cold external air in among the mixed air and aqueous vapor passing through the trunk to the condenser M, thereby absorbing heat both from the metal surfaces and from the vapors. The resulting secondary water of condensation is led from the condenser M by a pipe O to a tank P, whence it is drawn by a suitable pump or injector and supplied to the boiler A again through pipes Q. The air, freed more or less entirely from the aqueous vapor, passes off through the trunk-pipe R.

Fig. 3 shows a longitudinal section, and Fig. 4 a cross-section, of a construction of the condenser M which is substantially the same as that shown at Figs. 1 and 2. It consists of an outer shell $a'$, within which are a number of concentric cylindrical shells $a^2$ $a^3$ $a^4$ $a^5$, arranged so as to leave annular spaces between them for the passage of the air and vapor, and which are all secured together by suitable stays, while the central one $a^5$ is carried by a shaft $b$, which is driven by a pulley and belt from the engine, so as to cause them all to rotate slowly together. The arrangement shown at Figs. 1 and 2 only differs from this in that the outer casing is supported with neck-bearings at the ends, carried by suitable rollers S, and is rotated by a belt T. The ends of the outer shell are in both arrangements made to fit with stuffing-boxes over the ends of the trunks L and R. The inner shells $a^2$ $a^3$, &c., are formed with flanges $c$ $c$ at their ends, so that as the aqueous vapor passing in contact with their surfaces, together with the air, as indicated by the arrows, condenses it collects to the height of such flanges in each of the shells, as also in the bottom of the outer shell $a'$. As the shells are rotated by the shaft $b$ their surfaces are consequently kept continuously wet by the said water, and they thus exercise a more favorable condensing action on the aqueous vapor passing in contact therewith than if they were dry. As the water of condensation accumulates, it overflows the inner shells into the outer one $a'$, and from this it is discharged by a pipe $d$ as this travels over the curved trough $e$, from which it is led by pipe O to the tank P, Figs. 1 and 2. The trunk L has a branch L′, through which cold external air is either merely drawn in by the current passing through L, or it may be forced in by a fan, as described with reference to Figs. 1 and 2, the quantity being regulated by a throttle-valve $f$. This cold-air supply absorbs heat both from the cylindrical shells and from the aqueous vapor, and thus assists the condensation of the latter. Figs. 5 and 6 show, respectively, a longitudinal section and a cross-section of a modification of the above-described arrangement, in which the cylindrical shells $a'$ $a^2$ $a^3$ are at a greater distance from each other and have inner and outer longitudinal ribs $g$ for increasing the heat-absorbing surfaces, the water of condensation being discharged through the pipe $d$ during the time that this passes over the curved trough $e$, as before.

Figs. 7 and 8 show, respectively, a vertical cross-section and a cross-section of an arrangement in which the concentric cylindrical shells $a'$ $a^2$ $a^3$, &c., are arranged vertically and are stationary, being connected to the supply-trunk L at bottom and to the discharge-trunk R at top. The annular spaces between the shells may either be quite free, as shown at the inner ones $a^3$ $a^4$, so that the air and vapor pass straight up through them, as indicated by the arrows; or they may be formed into helical passages by the trough-shaped helical partitions $h$ $h$, so that the vapor and air have to pass up in a helical direction through them, the resulting water of condensation being made to flow down into the trough $i$ at bottom, whence it is discharged through the pipe $j$. The shells may either be plain, cylindrical, or corrugated, as indicated in Fig. 8.

In the modification shown in vertical section and cross-section at Figs. 9 and 10 the inner shells are dispensed with, and in lieu thereof are provided a number of horizontal diaphragms $k$ $k$, of perforated metal or open-mesh wire-gauze, which offer very extended heat-absorbing surfaces for the condensation of the vapor as it rises through them. The diaphragms may either be flat or corrugated or dished, as shown. The water of condensation flows down into the trough $i$, as before.

Figs. 11, 12, and 13 show, respectively, a vertical section and cross-sections on lines $x$ $x$ and $y$ $y$ of an arrangement in which the cas-

ing *l* is divided by partitions *m n*, extending alternately from a revolving shaft *t* at the center to near the circumference and from the circumference toward the center, thus forming zigzag passages extending from bottom to top of the casing for the air and vapor to pass through. In these passages are arranged variously-formed metallic surfaces, in contact with which the vapor is made to pass. Thus at *o o* they consist of concentric cylinders of perforated metal or wire-gauze attached to the partition *m*, through which the vapor has to pass. At *p p* they consist of annular plates of metal, either plain or corrugated, between which the vapor passes. At *q q* they consist on the left-hand side of perforated or wire-gauze cylinders *q'*, carried by the disk-shaped partition *m* and arranged intermediately between other perforated or wire-gauze cylinders $q^2$, projecting, respectively, from the upper and lower partitions *n* and leaving sufficient space between them for the partition *m* to revolve in. On the right-hand side the filling consists of the same parts, but of solid metal instead of perforated or wire-gauze, so that in this case the air and vapor have to pass in the zigzag direction indicated by the arrows. At *r r* is shown the same kind of filling; but with intermediate vanes S S, which in revolving with the partition *m* have a centrifugal action upon the air and vapor, accelerating their passage through the casing. Such passage may also be accelerated by fixing upon the revolving shaft *t* suitably-shaped blades or vanes *u u*.

L is, as before, the inlet-trunk, L' the branch inlet for cold air, and R the discharge-trunk.

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

1. The method of obtaining pure water of condensation from steam or aqueous vapor discharged from a steam-engine or other apparatus, wherein, first, such steam is condensed in an evaporative surface condenser, the outer surface of which is acted upon by currents of air and by the water of condensation derived from the said surface condenser, and, secondly, such air charged with the resulting aqueous vapor is passed in contact with heat-absorbing surfaces which effect the condensation of the aqueous vapor without the use of additional water, substantially as described.

2. In an apparatus for condensing vapor, the combination of an evaporative surface condenser, an air-pump connected with the condenser for withdrawing the water of condensation therefrom, a tank into which the air-pump delivers the water of condensation, a pipe connecting the tank with the evaporative surface condenser for supplying the water to be evaporated in the latter, a secondary condenser having extended heat-absorbing surfaces, and a tube or passage connecting the evaporative surface condenser with the heat-absorbing condenser, through which tube or passage the air and aqueous vapor given off by the evaporative surface condenser is made to pass for the purpose of condensing the vapor by contact with the heat-absorbing surfaces of the secondary condenser, substantially as described.

3. An apparatus for condensing steam or vapor, consisting of a series of horizontal concentric cylinders having narrow annular spaces between them through which the steam or vapor is made to pass, said cylinders being provided with flanges at their ends for retaining a portion of the water of condensation in their lower parts and having rotary motion imparted to them, so as to maintain their surfaces in a wet condition, substantially as described.

4. In apparatus for condensing steam or vapor, the combination of a number of horizontal revolving concentric cylinders having narrow annular spaces between them and provided with inward-directed flanges at their ends to retain water therein, inlets at one end for the vapor to be condensed and for a supply of cold external air, an outlet at the other end for the discharge of air and uncondensed vapor, one or more outlets in the outer cylinder for discharging the water of condensation, and a trough for receiving the discharge from such outlets, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 6th day of February, A. D. 1892.

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