(No Model.) 3 Sheets—Sheet 1.

F. WINDHAUSEN.

REFRIGERATING ROOMS AND LIQUIDS AND APPARATUS USED THEREFOR.

No. 323,767. Patented Aug. 4, 1885.

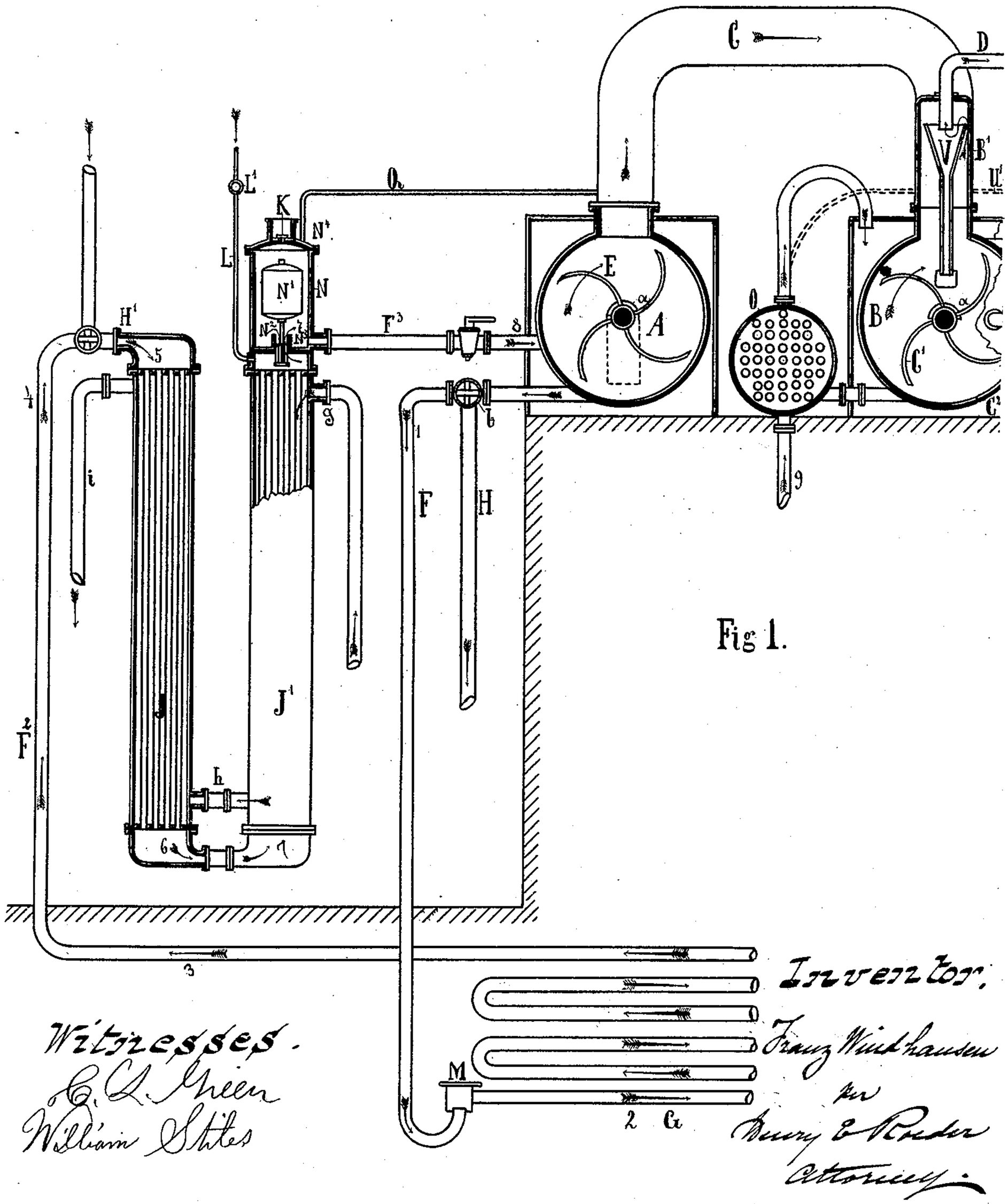

Fig 1.

Witnesses.
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(No Model.) 3 Sheets—Sheet 2.

F. WINDHAUSEN.

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No. 323,767. Patented Aug. 4, 1885.

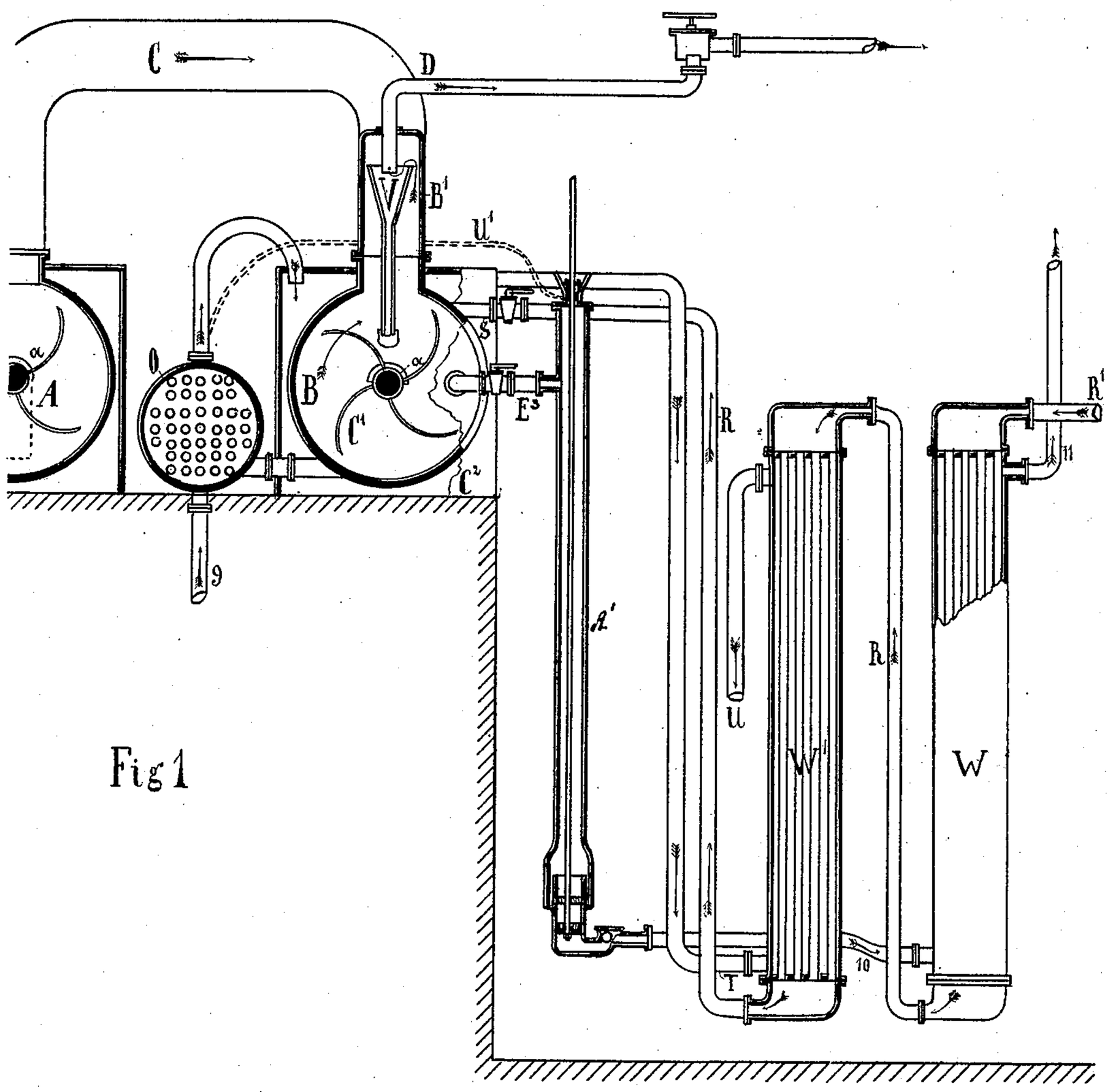
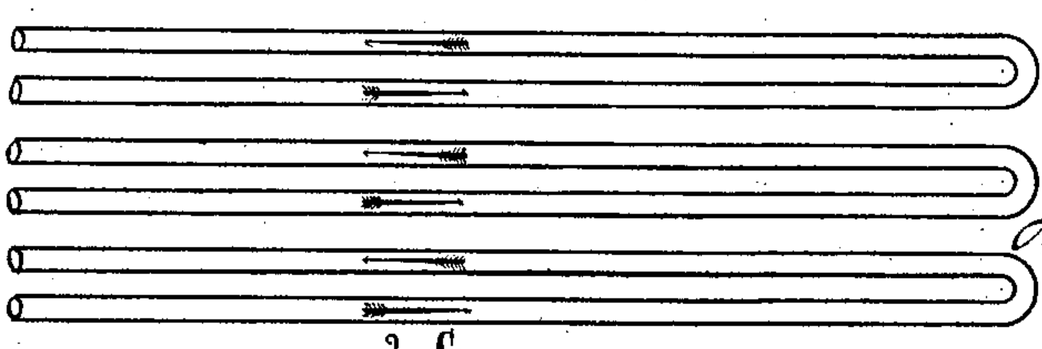


Fig 1



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Witnesses.
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(No Model.) 3 Sheets—Sheet 3.

F. WINDHAUSEN.

REFRIGERATING ROOMS AND LIQUIDS AND APPARATUS USED THEREFOR.

No. 323,767. Patented Aug. 4, 1885.

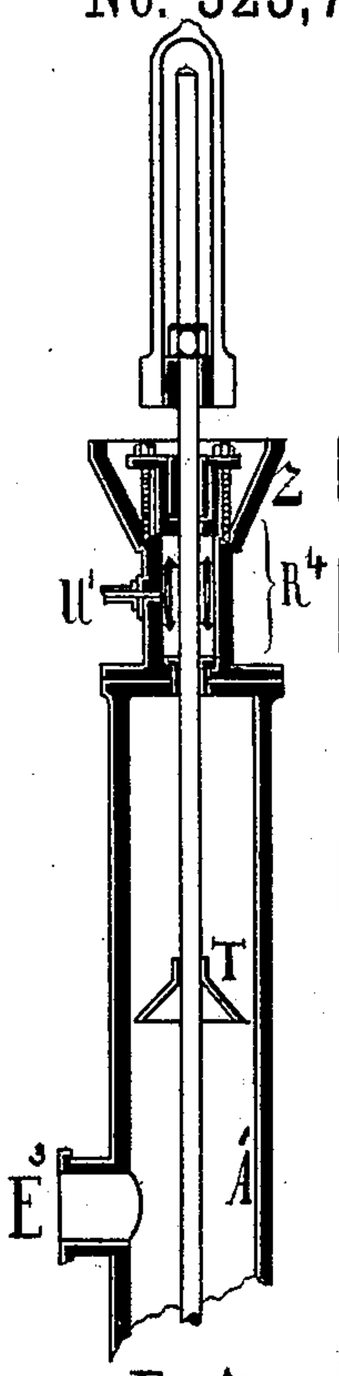


Fig 7.

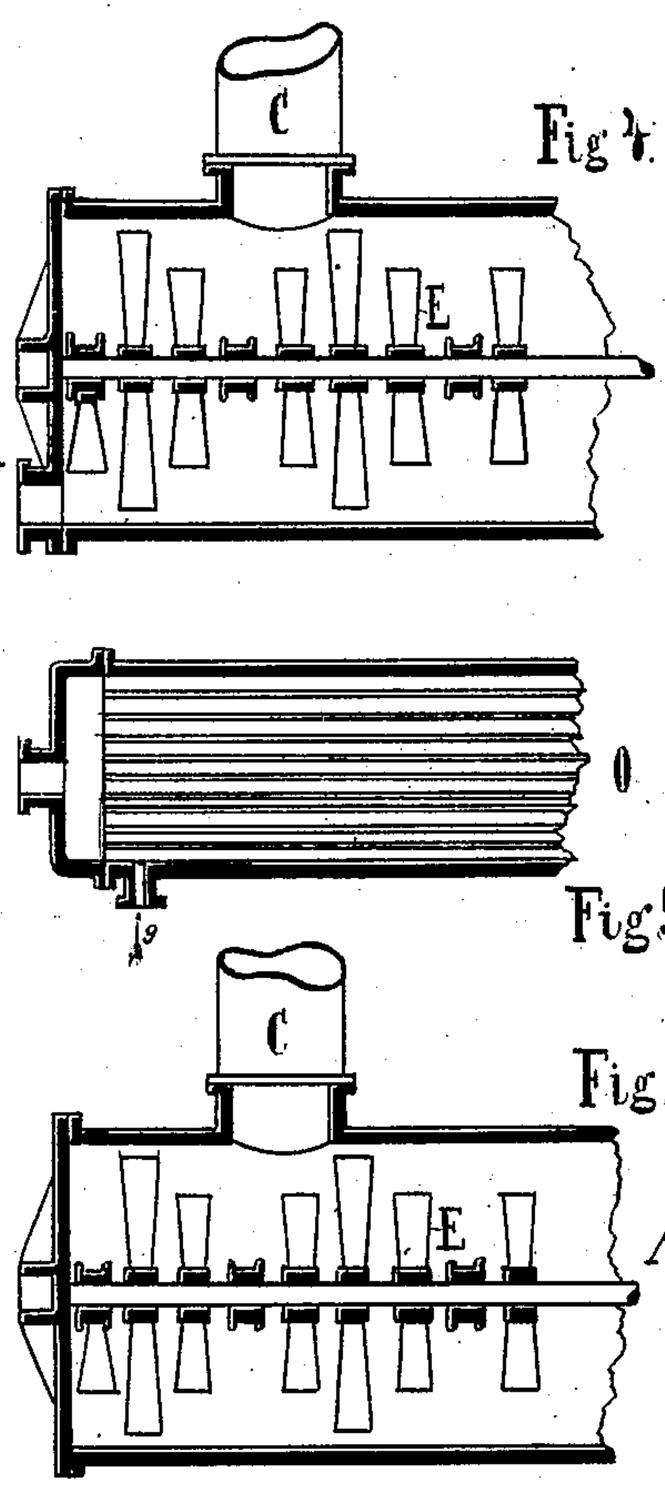


Fig 4.

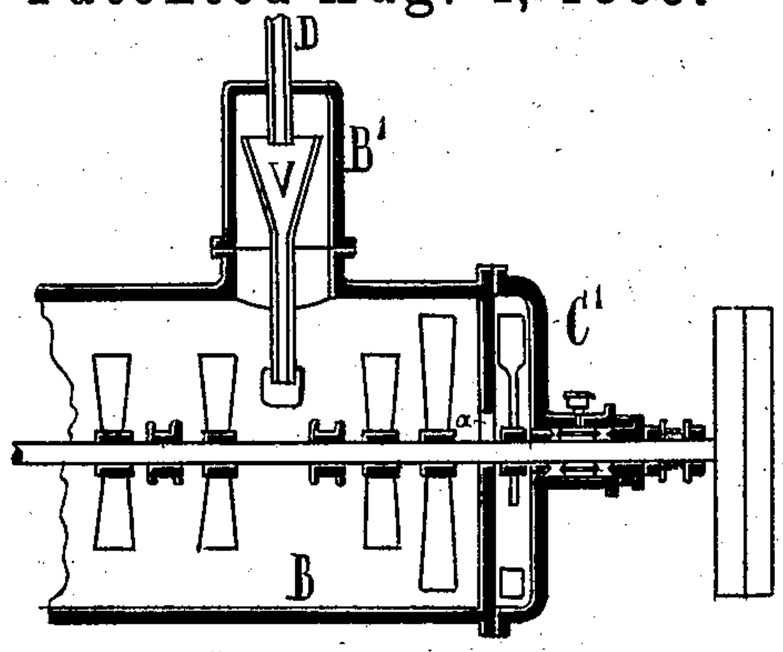
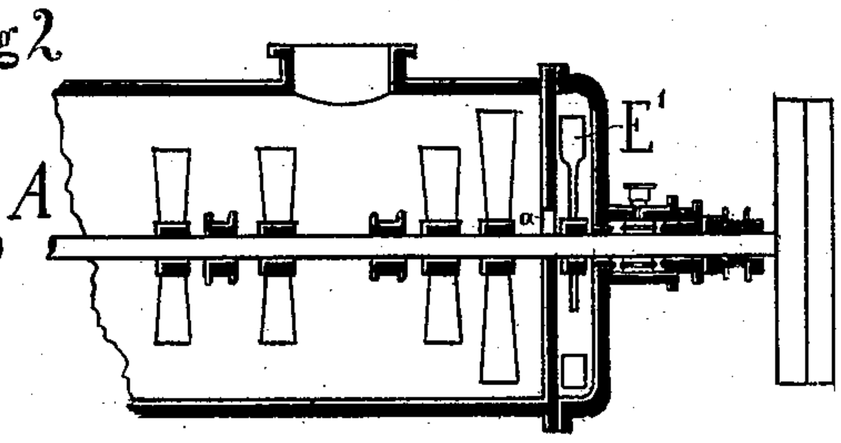
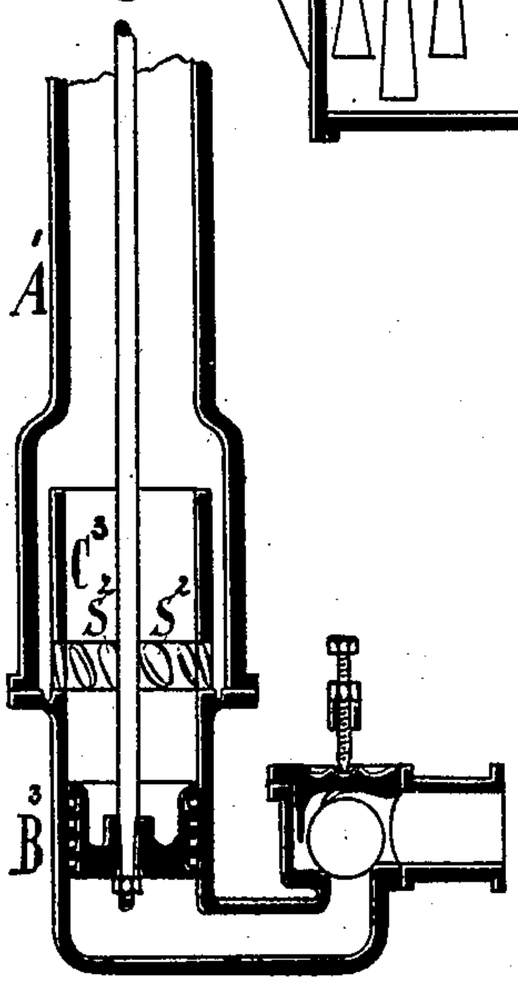


Fig 5

Fig 2.





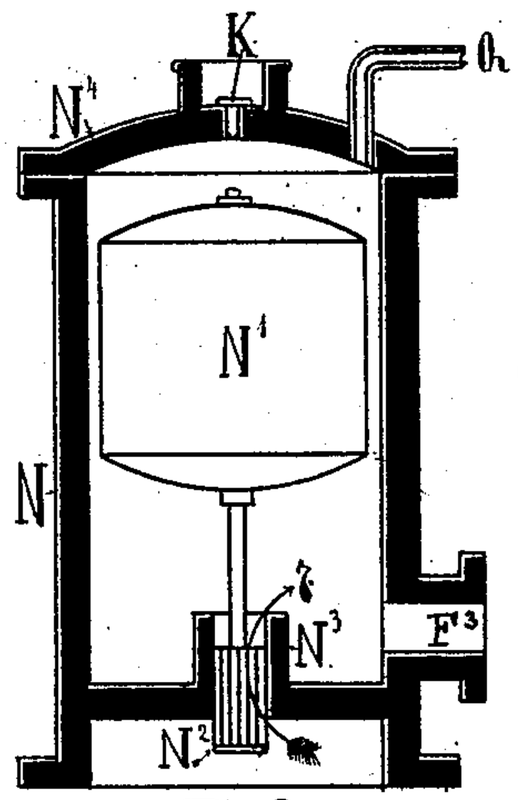


Fig 3.

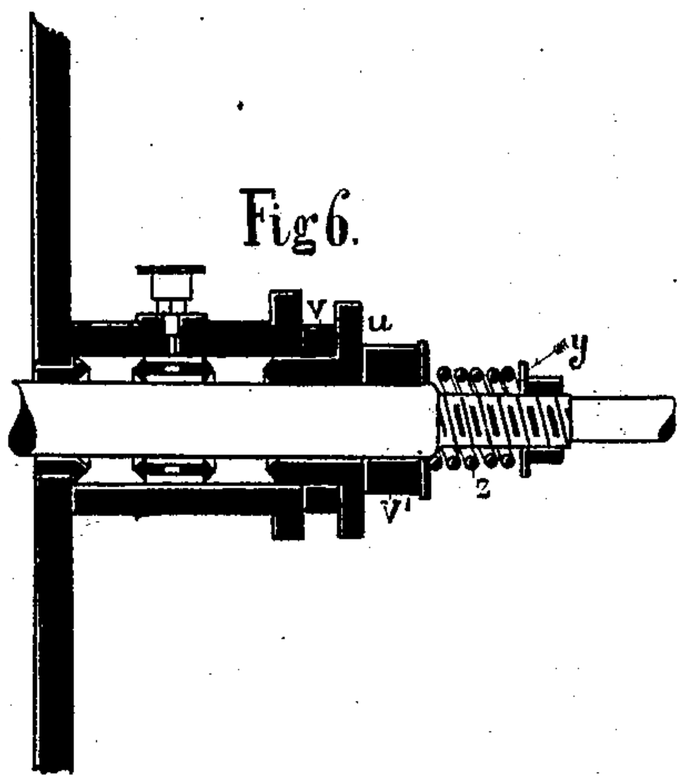


Fig 6.

Witnesses.
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UNITED STATES PATENT OFFICE.

FRANZ WINDHAUSEN, OF BERLIN, GERMANY.

REFRIGERATING ROOMS AND LIQUIDS AND APPARATUS USED THEREFOR.

SPECIFICATION forming part of Letters Patent No. 323,767, dated August 4, 1885.

Application filed November 10, 1884. (No model.)

To all whom it may concern:

Be it known that I, FRANZ WINDHAUSEN, a subject of the King of Prussia and Emperor of Germany, and a resident of the city of Berlin, in the Kingdom of Prussia and German Empire, have invented certain Improvements in the Process of Refrigerating Rooms and Liquids or Fluids, and also in the apparatus used therefor—namely, in the continuously-working vacuum-refrigerator, of which the following is a specification.

This invention relates to refrigerating apparatus in which a circulating current of very cold salt-water or equivalent fluid is employed; and it consists, partly, in the combination of a receptacle in which the salt-water is cooled with another in which the sulphuric acid or other liquid is volatilized, a pipe connecting the two, and a closed circuit of tubes through which the salt-water flows after being made cold by the evaporation of the sulphuric acid.

It consists, further, in the salt-water cooler and acid-absorber or evaporating-chamber for the acid, with condensing devices for restoring the acid to liquid form, a circuit of pipes for conveying it to said condensing devices and returning it to said absorber or evaporating-chamber, and the salt-water cooler and circuit of refrigerating-pipes.

It further consists in a rotating agitator operating in the acid-cooler in combination with said cooler, said absorber or evaporating-chamber, and the circuit of salt-water pipes.

It further consists in a number of details of construction and combination, which will be hereinafter set forth and claimed.

In the accompanying drawings, Figure 1, which is partly on Sheet 1 and partly on Sheet 2, represents a vertical section of my apparatus. Fig. 2 represents a detail longitudinal vertical section of my salt-water cooler. Fig. 3 represents a vertical section on a plane at right angles of my device for preventing the salt-water from rising too high in said salt-water cooler. Fig. 4 represents a longitudinal vertical section of the absorber or acid-refrigerating receptacle. Fig. 5 represents a similar view of the acid-cooler. Fig. 6 represents a detail vertical section of the stuffing-box for the agitator of the salt-water and cooler. Fig. 7 represents a vertical section through the acid-pump.

In each of these figures some of the parts are shown in elevation and not in section.

In said drawings, A designates a cylindrical hermetically-closed vessel, (salt-water cooler,) which is about half filled with a solution of chloride of potassium or of salt-water. This vessel A, Figs. 1 and 2, is connected with a similar cylindrical vessel, B, (absorber,) by means of a pipe, C. By means of the arrangement described hereinafter the absorber B, Figs. 1 and 4, is kept about half filled with sulphuric acid of 50° to 60° Baumé, and the purpose of the latter is to absorb and condense the vapors coming from the salt-cooler A through the pipe C.

In order to effect the evaporation of the salt solution at a low temperature and at a correspondingly approximately complete vacuum, the absorber B is connected by means of pipe-conduit D with an exact-working air-pump, in particular with the air-pump for which I have obtained United States Letters Patent No. 247,456, dated September 20, 1881. This air-pump is able to produce and maintain an almost absolute vacuum in the salt-cooler A and absorber B. In consequence of this the salt solution is cooled down far under 0° by a partial evaporation. With a view to hasten this cooling and to bring about a close mixing of salt solution, a rotating stirring apparatus, E, Fig. 2, is placed in the salt-cooler. It consists of a shaft bedded centrally in the salt-cooler and projecting outside with a tight-closed stuffing-box, and provided inside with a number of radial sweeps. When the shaft is turned, the salt solution is set in violent motion, and thus a thorough mixing of the salt solution is attained and its evaporation accelerated. This stuffing-box for salt-water cooler, which is also applied in similar construction to the absorber, is represented on a large scale in Fig. 6. As may be seen in the drawings, a rubber ring, *v*, is pressed in between the stuffing-box cap *u* and the stuffing-box itself. A second rubber ring, *v'*, on the shaft is pressed by a spring, *z*, the other end of which bears against an adjusting-nut, *y*, on the outer face of the said cap. As there is a vac-

uum in the interior of the spaces to be closed, the pressure of the outer atmosphere on these two rubber rings effects a perfect closing.

For the furtherance and circulation of the salt solution in the circuit of tubes used to cool rooms and fluids by contact, and to produce the closed circular course of the cooling solution, a wing-wheel, E′, is fastened to the stirring-shaft in a concentric chamber at one end of the salt-cooler A. The purpose of this wheel, working like a fan, is to set in rotation the salt solution, which flows through the semicircular opening *a* when the stirring-shaft is turned, and to drive it thereby—*i.e.*, by centrifugal power—into the conduit of tubes. But the wing-wheel can also be applied as an independent centrifugal pump outside of the salt-cooler, which can particularly be recommended in case the wing-wheel has a different velocity from that of the stirring-work. This circuit of tubes for cooling is connected on the one side in F with the web or net of tubes G for cooling, on the other side, by means of the branch pipe H, with a salt-water pump. The purpose of the latter is to suck up the salt solution out of the salt-water cooler and to eject it into a basin in which ice is to be produced in the well-known way in tin cells. By means of a cock, *b*, with three ways, the communication can, as is evident, be made with the salt-water pump or the web of tubes for cooling.

After the salt solution has imparted the cold in the web of tubes for cooling, or in the freezing-basin, wholly or partially, or abstracted the warmth in the room or fluid to be cooled, it runs either direct or passes through the fresh-water coolers T and T′ through the conduit of tubes F^2 and F^3 back into the salt-cooler A in the direction of the arrows 1 2 3 4 in a closed circular course.

The purpose of the fresh-water coolers T and T′ is to cool water or other fluids by means of the backflowing salt solution, on the principle of counter-currents, as this salt solution can still hold warmth. With a view to this the two bodies T and T′ consist of cylindrical vessels intersected by tubes, which have (above or below the tube sides by means of lids screwed in) chambers, through which the salt solution in directions 5 6 7 passes through the cooling-tubes and returns again at 8 into the salt-water cooler.

As the cooling of the salt solution is effected by evaporation in an approximately complete vacuum, so much water must continually be conducted to the salt solution again as is lost by evaporation. This fresh water is conducted through a thin pipe, L, and regulating-cock L′, so that the salt solution in the coolers and the conduit always receives an equal volume and a nearly equal saturation. The fresh water or other fluid that is to be cooled passes, however, at *g* into the cooler T′, and from there through connecting-pipe *h* into the cooler T, and quitting that reaches its destination through the conduit *i*. In passing through the fresh water is cooled down almost to the temperature at which the returning salt-water solution passes at H′ into the first cooler, T.

In case of a deficient closing occurring in the conduit for cooling, or in the salt-water coolers, there is attached, on the one hand, in the conduit F a check-valve, M, and, on the other hand, on the fresh-water cooler (or, in case that is not used, in the respective conduit of tubes) there is an apparatus, N, the purpose of which is to prevent the salt-water cooler from overfilling. This safety apparatus N, Figs. 1 and 3, consists of a hollow cylindrical cast piece screwed on above the tube-cooler T′, closed on top with a lid, and provided with a centrally-perforated partition. In it is contained a float-gage, N′, easily movable, with a piston-slide, N^2, fastened centrally under it, and is easily moved up or down in the concentric hole of the partition N^3. This piston-slide has only at the bottom a full round plate, which is connected with the float-gage N′ by means of ribs. This float-gage is fixed at such a height that at the normal level of salt solution in the cooler A the backflowing salt solution can pass unimpeded through the cylindrical opening in the direction of the arrow 7 into the cooler A. As soon, however, as the level of the salt solution goes beyond the limit, the floating gage rises, and with it the piston-slide, and closes the passage. If the level of the salt solution continues to rise, the floating gage does so too, and by knocking opens in the lid N^4 a safety-valve, K, attached there, through which then atmospheric air enters with a great noise, the vacuum in the salt-cooler diminishes, and thus a further overfilling of the cooler A is rendered impossible.

The interior of the vessel N is connected, as may be seen in Fig. 1, by means of tube Q, with the steam-space of the salt-water cooler A, so that the level of the salt-water in the safety-vessel N always remains the same as that in the salt-water cooler A.

The absorber B, Figs. 1 and 4, is, as regards shape and size, similar to the salt-water cooler A, already described.

In order to attain, however, a perfect cooling of the sulphuric acid in the absorber, a tube-cooler, O, Figs. 1 and 5, is connected with the latter, into which, by means of a wing-wheel, C′, placed on the stirring-shaft of the absorber, the acid is driven through the tubes of the cooler O, and at the other end of the tube-cooler the cooled acid passes back into the absorber. The wing-wheel can likewise be applied as an independent centrifugal pump outside of the absorber. Playing round the cooling-tubes, the cooling-water enters at arrow 9 the acid-cooler O, and runs on from there into the basin C^2, surrounding the absorber, whereby a continual cooling of the sulphuric acid on a large surface takes place. The absorber B is connected with the air-pump by

means of tube D. The said air-pump is not represented here, as it will be understood from my prior patent hereinbefore mentioned.

In order to prevent in the evacuation any particles of acid from passing into tube D, an acid-catching apparatus, Figs. 1 and 4, is fixed, in the shape of a funnel, V, in the steam-dome B′, and into it the air-suction tube D enters so low that the withdrawing vapors and air get a rising-and-falling motion, and thus throw any acid carried away with them into the funnel, out of which it rains back through the narrow opening of the funnel into the absorber. With a view to bring the acid always back again to its original concentration, it is continually conducted through an acid-pump to an acid-vapor apparatus, and out of the latter the concentrated acid runs in an equal measure back into the absorber through the conduit of tubes R. In this acid-pump, which is represented in the arrangement in Fig. 1, and likewise on a larger scale in Fig. 7, the difficulties are avoided which are attendant on common pumps for sucking up fluids out of closed rooms in which a tension under the atmospheric pressure prevails. These difficulties consist in this, that these fluids, and especially corroding ones, when brought in contact with the stuffing-box of the piston-rod, make the stuffing-box loose, and thus prevent the proper working of the pump. Equally troublesome proves the non-operating of the sucking-valves, as pump will not draw under such circumstances.

The pump represented here, and in which these deficiencies are removed, consists of a fluid-collecting pipe, A′, of the real pump-cylinder C^3, which is provided with the slit-openings S^2 S^2, through which the fluid enters, of the pump-pistons B^3, of the double stuffing-box R^4, which is connected by means of the thin tube U′ with the vessel or apparatus to be emptied.

The manner of working of this acid-pump is as follows: The fluid passes through tube E^3 into the collecting-pipe A′ of the pump and reaches in it the level of the fluid in the vessels to be emptied, goes through the peculiarly-arranged slits S^2 S^2 under the piston B^3, and is carried away by the latter in the down-stroke. In order to prevent the fluid, especially acids, from touching the stuffing-box, a sufficiently high free space in the pump-tube is left above the level of the fluid in the collecting-pipe. To avoid any splashing of the fluid, and to hinder its sticking to the upper part of the piston-rod, the shade T is applied. With a view to increase the safety in the working of the pump, the double stuffing-box R^4 is constructed at a certain distance from the level of the fluid, and in such a manner that the middle hollow space in this stuffing-box is brought into connection with the air or rarefied-air room of the vessel or of the absorber to be emptied by means of a small tube, U′, so that an equally high—viz., low—tension prevails in the upper room of the pump and in the air-room of the vessel, and displacement of the fluid column in the chamber of the pump by the air penetrating from outside is thus prevented. In addition to this, a funnel shaped appliance, Z, can be fixed to the upper part of the stuffing-box and filled with acid, water, or oil, so that in case the stuffing-box should get untight only this fluid, and not the atmospheric air, could get into the pump. The function and construction of the concentrator are not further represented here, as they are already described in another patent. In the circular course of this acid from the absorber to the concentrator and from the latter back to the absorber two apparatuses, W and W′, for exchanging warmth, are attached. The acid is pumped out of the absorber by the acid-pump in the direction of the arrows 10 and 11 to the concentrator, and the concentrated acid leaves the latter, flows round the heat-tubes in the warmth-exchanging apparatus W, after the principle of counter-currents, and returns at S into the absorber again. On this route the hot acid gives the greater part of its warmth in the warmth-exchanging apparatus W to the acid led out of the absorber, whereas the acid flowing out of the concentrator to the absorber is cooled down almost to water temperature farther on in the warmth-exchanging apparatus W′ by cooling-water that runs in at T and out at U.

Having now described my invention, and also the process of and the apparatus for performing it, what I desire to claim as my exclusive property is—

1. In combination with a salt-water cooler, A, the pipe E, backstroke-valve M in the cooling-conduit, series of pipes G, coolers J and J′, chamber N, with float-gage N′, piston-slide N^2, alarm inlet-valve K, and pipe F^3, the whole being arranged to operate in the manner and for the purpose substantially as described.

2. The combination of a tube-cooler, O, with the absorber B, and wing-wheel C′, connected by suitable pipes, substantially as described, and for the purpose set forth.

3. In combination with an absorber, B, the acid-catching apparatus B′, with funnel V under the steam-escaping pipe D, in the manner and for the purpose described.

4. In combination with the stuffing-box of the steering-shaft in the salt-water cooler A and absorber B, the rubber ring *v*, pressed between the stuffing-box neck and the stuffing-box gland *u*, and the second rubber ring, *v′*, fixed on the shaft and pressed by the spiral spring *z* and nut *y* to the surface of the stuffing-box gland *u*, substantially as described, and for the purpose set forth.

5. The arrangement of the acid-pump A′ at such a relative height to the level of the acid in the absorber B that sufficient space is left

above this level that the fluid cannot approach the stuffing-box, substantially as and for the purpose described.

6. In combination with the piston-rod of the acid-pump, the shade or plate T, substantially in the manner and for the purpose described.

7. In combination with the stuffing-box of the acid-pump, the funnel-shaped cap-piece Z, filled with acid, water, or oil, as and for the purpose described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

FRANZ WINDHAUSEN.

Witnesess:

MARC M. ROTTER,

B. ROI.