No. 869,342. PATENTED OCT. 29, 1907.

J. ZELLWEGER.

CONDENSER.

APPLICATION FILED JULY 9, 1906.

Fig.1. Fig.5.

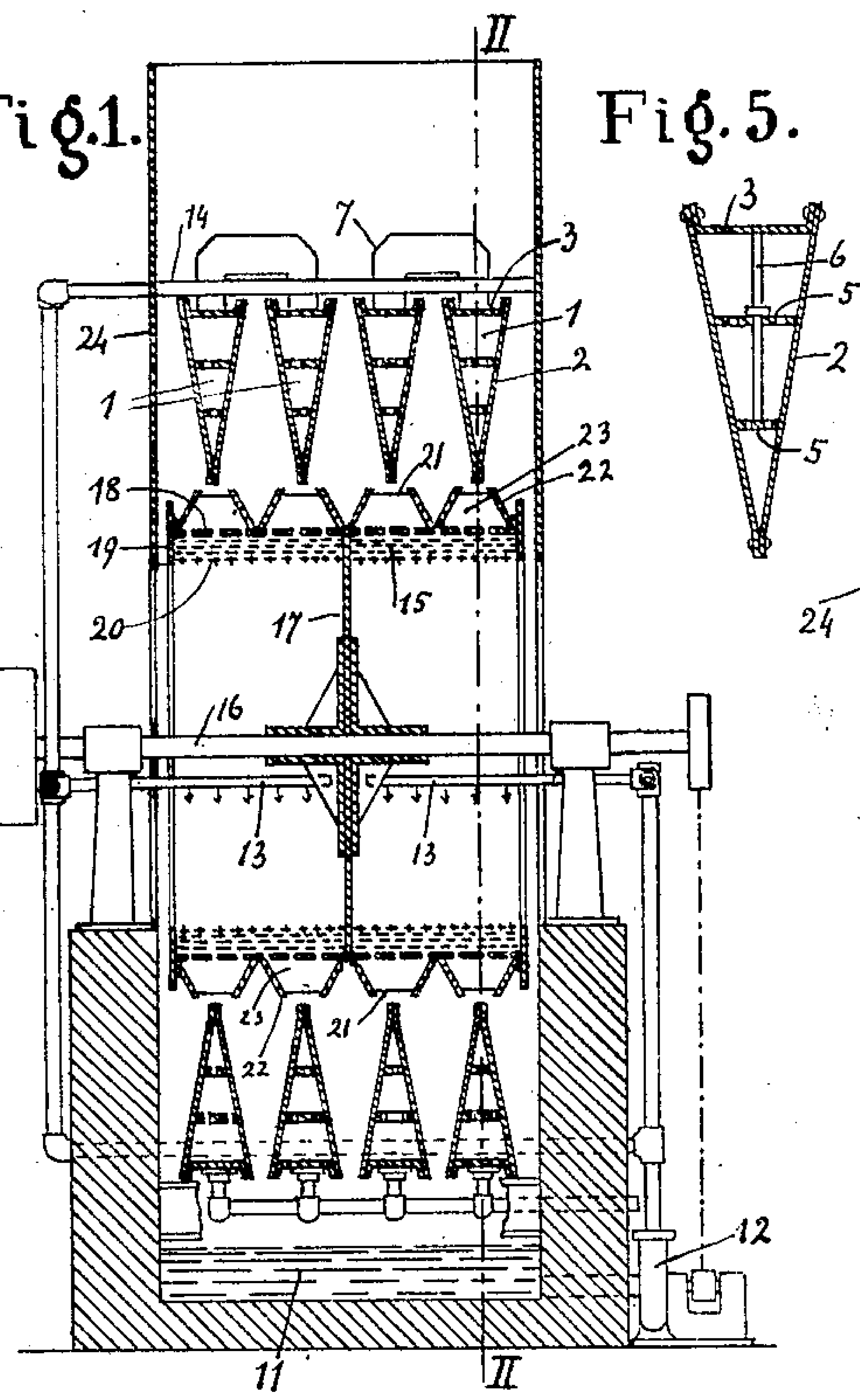


Fig.2.

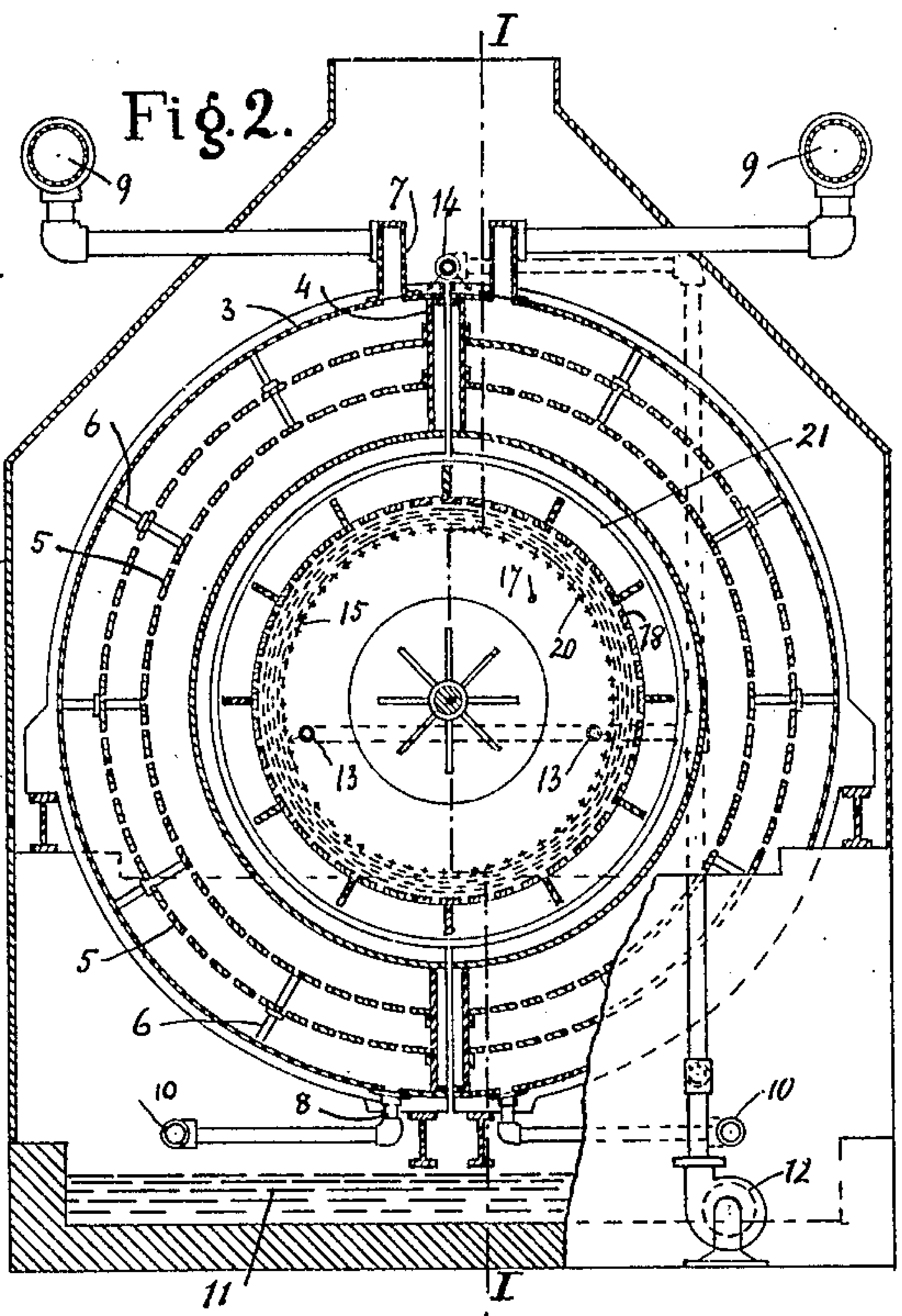


Fig.3.

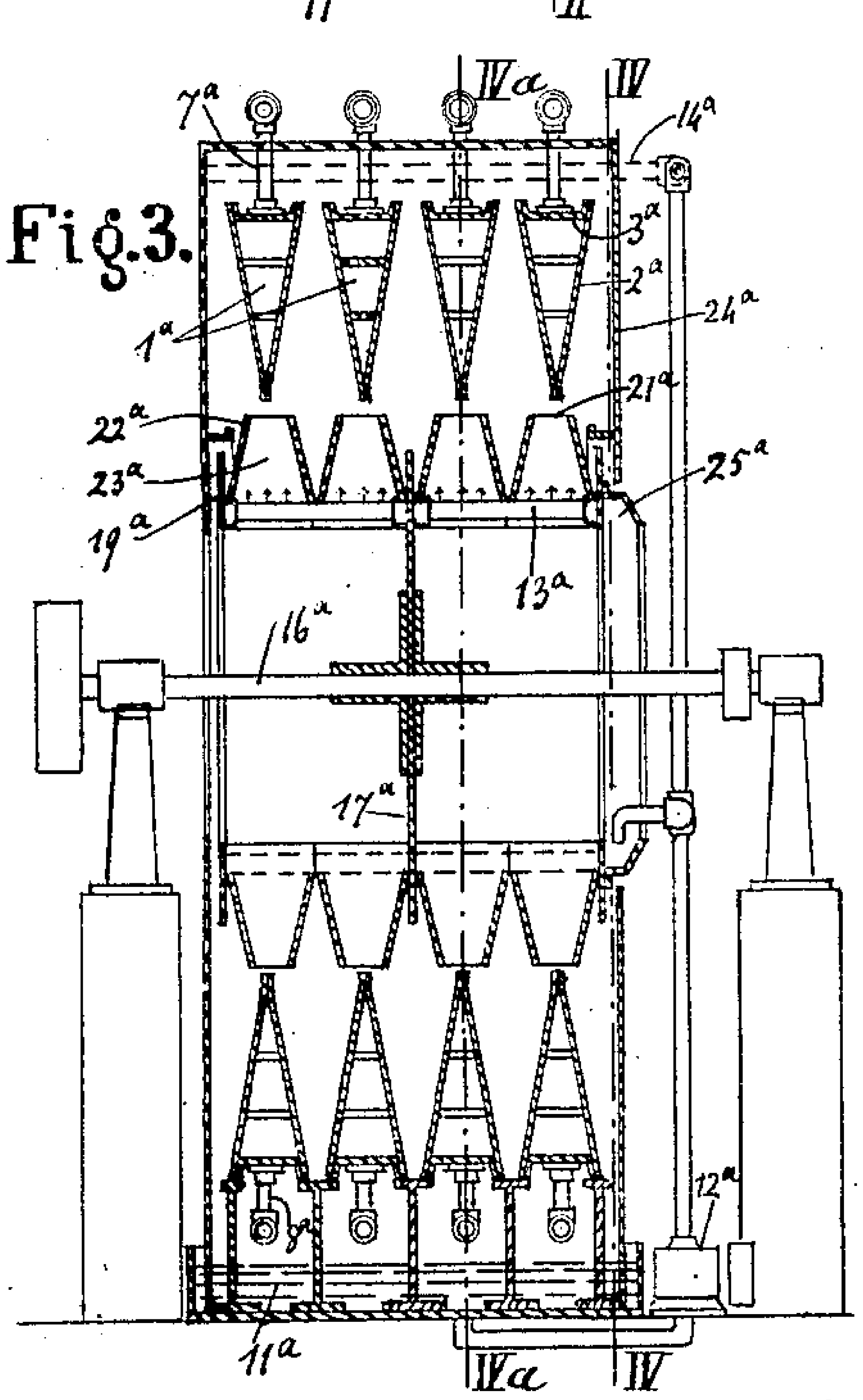
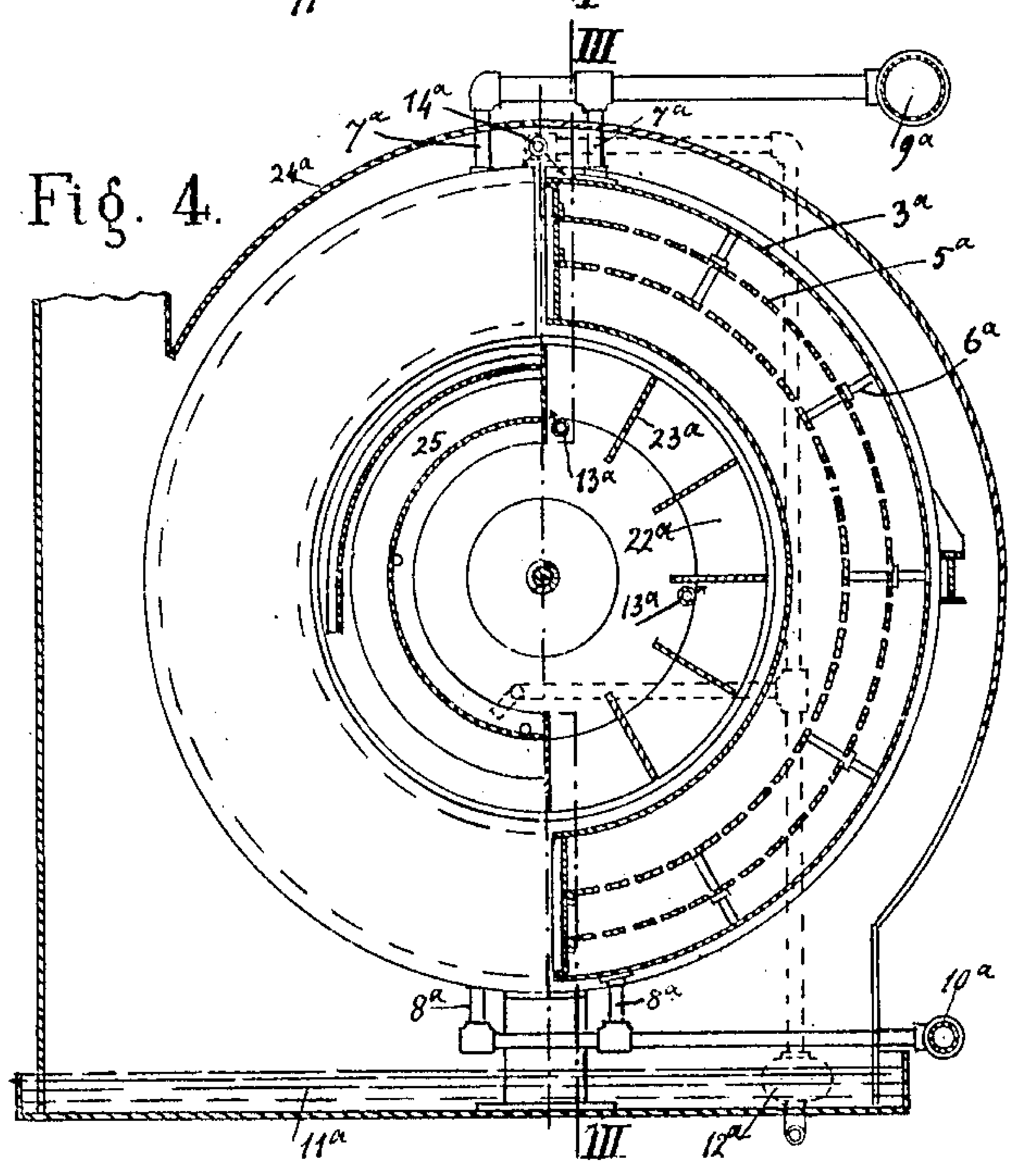


Fig. 4.



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CONDENSER.

No. 869,342. Specification of Letters Patent. Patented Oct. 29, 1907.

Application filed July 9, 1906. Serial No. 325,332.

To all whom it may concern:

Be it known that I, JOHN ZELLWEGER, a citizen of the United States, residing at 1900 Adelaide avenue, in the city of St. Louis, State of Missouri, have invented a certain new and useful Improvement in Self-Cooling Condensers, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a vertical cross sectional view of the preferred form of my self-cooling condenser taken on the line 1—1 of Fig. 2; Fig. 2 is a vertical longitudinal sectional view of the apparatus taken on line 2—2 of Fig. 1, in the lower right-hand corner of this figure the circulating pump and part of the foundation being shown in elevation; Fig. 3 is a vertical cross sectional view of a modified form of my self-cooling condenser taken on the line 3—3 of Fig. 4; Fig. 4 is a view, the left-hand half of which is a vertical section of this apparatus taken on the line 4—4 of Fig. 3, and the right-hand half of which is a vertical section of the same taken on line 4^a—4^a of Fig. 3; and Fig. 5 is a cross sectional view of one of the condensing vessels.

This invention relates to improvements in surface condensers, in which heat is abstracted from a surface by evaporation of water on said surface and in contact with air.

The objects of my invention are as follows: to provide means for the positive distribution of cooled water and air to the condensing surface of the apparatus; to cool the circulating water before it is thrown onto the condensing surface; to produce and maintain a maximum difference between the temperature of the steam inside of the condensing vessel and of the water in contact with the outside of it; and to provide means for the rapid renewal of contact between air and the water on the condensing surface.

In all condensing apparatus the heat which is abstracted from the steam or vapor during its transformation into a liquid has to be carried away from the condensing vessel to permit continuous operation. In surface condensers where water is used as a cooling medium, the heat is carried away in the cooling or circulating water which is then either wasted or cooled by evaporation of a part of it in contact with air. The cooling proper is carried on in a separate apparatus some distance away from the condenser and necessarily, takes place at a mean temperature which is much lower than that of the condenser; consequently, the water after being removed from the condenser cannot heat air to such a degree as it could have done while yet on the condenser.

Since the capacity of air to absorb water vapor varies with the temperature of the air, it follows that in order to abstract a certain amount of heat from the water by evaporation of a part of it in contact with air, it takes more air of lower temperature than would have been required for the consumption of the heat by evaporation of hot water with warmer air on the steam-heated surface of the condenser. The abstraction of heat by evaporation from the circulating water on the condenser surface in contact with hot air has the additional advantage that it takes place at a temperature considerably above that of the atmosphere and for this reason is little affected by the original humidity of the air used.

In order to attain this independence of operation and the economy of operation due to the requirement of only a minimum amount of air in the cooling of circulating water, I combine the steam-condensing means and the means used for cooling the water into one apparatus by constructing the steam vessel of annular form and placing in the center space of the same an evaporative water-cooling member or apparatus which is adapted to cool the water and throw it onto the condensing vessel by centrifugal force and at the same time blow air over the water-covered condensing surface. In such an apparatus the water on the steam vessel will become heated and thus heat the air which is being blown over it, this heated water being then returned from the steam vessel to the cooling me ber where it is again cooled and thrown by centrifugal force onto the steam vessel. The heated air becomes dry and induces rapid evaporation of part of the water on the steam vessel, thereby consuming heat given out by the steam and causing its condensation. In order to provide a large condensing surface in a limited space and permit the free passage of air over it, I preferably divide the annular steam vessel into a number of narrow ring-shaped sub-divisions of great radial depth and separate them by open spaces. These condensing rings I place parallel to a plane of rotation of the cooling apparatus and for the purpose of producing extended surfaces which are exposed to the water thrown out from the cooling apparatus I construct these condensing rings approximately **U**-shaped in cross section, so that they will be narrow at their inner peripheries and then increase in width toward the outer peripheries. Accordingly, the sides of the condensing ring will cross the path of the water thrown off the cooling apparatus at an acute angle so that the water after striking the sides of the ring, slides over them by momentum. In order to eliminate the effects from expansion and contraction of large full ring condensing surfaces due to varying heat, I sub-divide these condensing rings into a number of separate cells and provide each cell with an inlet for steam and an outlet for water, connecting all of said inlets to a common steam supply pipe, and all of the outlets to a common water discharge. For convenience of construction it would be desirable to make these condensing cells small, so that they could be cast in one piece or formed from metal plates connected together, and then arrange these straight-sided cells into polygonal rings, but in view of the fact that a great number of cells would necessitate the use of a great number of steam and water connections, which are apt to leak, I prefer to form each condensing ring from two sections so that each ring comprises two cells. In the preferred form of my self-cooling condenser, as shown in Figs. 1 and 2, the condensing vessel consists of a number of semi-annular cells which in cross section taper inwardly, these cells being preferably placed in pairs in vertical position so as to form complete rings, the several rings being separated from each other by spaces, as shown in Figs. 1 and 2.

Each of the condensing cells 1 is preferably made out of flat plates 2 arranged to form a U and having their inner edges riveted together. The outer edges of the plates are connected to a channel-shaped piece 3 of semi-ring shape and the ends of the cells are closed by fillers 4. To prevent the cells from collapsing under atmospheric pressure, I arrange curved stay-plates 5 between the plates 2, thereby dividing the cells into a number of compartments, the stay-plates being held in position by the plates 2 and by stay-bolts 6. The stay-plates are perforated to permit steam and water to pass through them. Each condensing cell has a steam inlet pipe 7 entering its upper end, and a water outlet pipe 8 leading from its lower end, these pipes being connected respectively to a common steam supply pipe 9, and to a common water discharge pipe 10, so that all of the cells are connected and thus form one condensing vessel. Underneath the condensing vessel is a water tank 11 to which is connected a pump 12 that is employed for raising water into the sprinkling pipe 13 and also into the sprinkling pipe 14 arranged over the top of the condensing vessel.

In the preferred form of my invention, the evaporative cooling apparatus, which is located in the central open space of the condensing rings, consists of a cooling ring 15 formed of porous material such as wood shavings, brush-wood, crushed charcoal or coke, over which a wire netting extends, this ring being confined in place and supported on a central shaft 16 by a carrying disk 17, a perforated cylinder 18, inlet disks 19 and wire netting 20. Mounted on the outside of the carrying member just described and placed opposite each condensing cell 1 are the discharge rings 21 consisting of the guide-cones 22 and the vanes 23. Inside of the cooling ring and reaching in through the open ends thereof, are the stationary sprinkling pipes 13 which have numerous perforations.

The operation of my self-cooling condenser is as follows: Steam is admitted into the condensing cells and the cooling apparatus or member is rotated at high speed and sprinkled with water from the tank 11. The water on the inner periphery of the cooling ring and the air in the open spaces of the cooling ring are then carried along in circular courses and, by centrifugal force, thrown outwardly through the porous material of the ring. The air thus comes forcibly into contact with the water on the small bodies constituting the ring, evaporates a part of the water and thereby causes a consumption of heat which may be taken out of the water or out of the air or out of both. The remaining water and the vapor-laden air are then projected out of the cooling ring 15 into the collecting rings 21. The cooled water and air are compelled to find outlet through the opening between the guide-cones 22 and then to sweep over the full depth of the condensing cells. The collecting rings 21 serve principally to collect the air which is discharged from the cooling ring and to discharge it through a narrow opening so as to produce a strong blast over the full depth of the condensing surface. The cooled water is then thrown by centrifugal force from the cooling member and is spread in a thin film over the condensing cells, and becomes heated rapidly. It then heats the air which is being blown over it and thus enables the air to take up more vapor from the water. By this evaporation heat is abstracted from the water and from the steam, causing condensation of the latter. The air as it passes over the condensing surface continues to take up heat and vapor until it reaches the edge of the condenser where it escapes through the spaces between the condensing rings at high temperature and carries off a large amount of water vapor. The water, which is also hot, escapes through the same openings and then flows down into the water basin or tank 11. From this water reservoir the hot circulating water is pumped into the cooling apparatus where it is cooled by evaporation of a part of it in contact with fresh air and then again projected onto the condenser surface. This cooling of the hot circulating water before it is again thrown onto the condenser, makes it possible to condense steam with the aid of the same circulating water at a temperature considerably below boiling point and thereby produces a vacuum in the condensing vessel.

The vapor-laden air is collected by a housing 24 and is conveyed into the atmosphere through an outlet some distance away from the air inlet to the cooling apparatus so as to prevent the humid air from reëntering the apparatus. The water carried away with the air as vapor is replaced by a fresh supply, which may be advantageously discharged onto the top of the condensing cells or fed into the cooling ring.

The steam entering the cells at the top distributes itself in a downward direction through the outer and largest compartments thereof and from these large compartments inwardly through the perforations of the stay-plates into the inner smaller compartments. The flow of vapor from the outer to the inner compartments is in a direction opposite to the flow of the cooling water and air on the outside of the condensing cells, and by this counter current maintains the greatest difference of temperature between the steam inside and the water and air outside of the cell, causing a maximum rate of condensation of steam. The water formed from the steam falls to the bottom of the condensing cells and is then discharged either by gravity or withdrawn by an air pump.

In Figs. 3 and 4 is shown a modification of my self-cooling condenser in which the water-cooling apparatus instead of having a cooling ring of porous material, is provided with a number of large vanes 23^a arranged between deep guide-cones 22^a which are rotatably mounted on the shaft 16^a by the carrying disk 17^a, with distributing pipes 13^a and inlet disks 19^a. This cooling apparatus has attached to one of its inlet disks an annular trough 25^a which communicates with the distributing pipes 13ᵃ. These distributing pipes are preferably perforated on their rear sides relatively to the direction of movement of the vanes so that a water jet issuing from a perforation strikes a vane at an acute angle in an outward direction. When the shaft with the annular trough, the distributing pipes and the vanes is rotated at high speed and water fed into the annular trough, this water will rotate also and by the action of centrifugal force, will distribute itself in the outer part of the trough, enter the distributing pipes and then be thrown out of their perforations against the vanes. The water then spreads out on the vanes and slides over them in a thin layer exposing a large surface to the air propelled by the vanes and is cooled by the evaporation of part of it. The cooled water and the vapor-laden air are then projected onto the condensing surface and produce a similar effect as previously described in connection with the preferred form of my apparatus.

For condensing cells which are very deep radially, the water thrown onto them near their inner peripheries does not cover the surfaces thereof fully, and it then becomes necessary to throw water on them at some point further out. In such cases I provide the guide-cones with perforations some distance back from their outer edge so that some of the water can there escape and be thrown on the outer part of the condenser surface.

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

1. The combination with a rotary cooling member having a surface over which water is positively spread in a thin film so that said water will be cooled by evaporation in contact with air and adapted to throw the cooled water outwardly by centrifugal force, of a condensing vessel placed in the space radially beyond the zone of rotation of said cooling member, means for conducting steam into the condensing vessel, means for feeding water into the cooling member, and means for producing an air current over the surface of the condensing vessel; substantially as described.

2. The combination with a plurality of condensing vessels arranged to form a ring, of a cooling member placed in the center space of the ring and having a surface over which water is spread so that said water will be cooled by evaporation in contact with air and being adapted to throw this cooled water by centrifugal force onto the condensing vessel, means for positively spreading water in a thin film over said surface, means for conducting steam into the condensing vessel, means for feeding water into the cooling member, means for rotating the cooling member, and means for producing a current of air over the condensing vessels; substantially as described.

3. The combination with a rotary cooling member which is so constructed that it cools the water applied thereto by evaporation in contact with air and being adapted to throw this cooled water and air outwardly by centrifugal force, means for positively spreading the water to be cooled, in a thin film over said member, of a condensing vessel placed in the space radially beyond the zone of rotation of the cooling member, means for conducting steam into the condensing vessel, and means for feeding water into the cooling member; substantially as described.

4. The combination with a plurality of condensing vessels arranged to form a ring, of a rotary cooling member placed in the center space of the ring, said cooling member being provided with a surface over which water is spread so that said water will be cooled by evaporation in contact with air and being adapted to throw this cooling water and air onto the condensing vessel by centrifugal force, means for positively spreading the water over said surface, means for conducting steam into the condensing vessels, means for feeding water into the cooling member, and means for rotating the cooling member; substantially as described.

5. The combination with a rotary member which is so constructed that it cools the water applied thereto by evaporation in contact with air and being adapted to throw this cooled water and air outwardly in vertical planes by centrifugal force, means for positively spreading water in a thin film over said cooling member, of a number of condensing vessels placed in the space radially beyond the zone of rotation of the cooling member and separated by spaces which serve as outlets for water and air projected from the cooling member, means for conducting steam into the condensing vessels, means for feeding water into the cooling member, and means for rotating the cooling member; substantially as described.

6. The combination with a number of condensing vessels arranged to form a plurality of rings, said rings being placed side by side in vertical planes and separated by spaces which constitute passages for water and air, of a rotary cooling member placed in the center space of the rings and provided with an extended cooling surface, means for spreading water in a thin film over said surface so that the water will be cooled by evaporation in contact with air, said cooling member being adapted to throw this water onto the condensing vessels and blow air onto the same, means for conducting steam into the condensing vessels, means for feeding water into the cooling member, and means for rotating the cooling member; substantially as described.

7. The combination with a rotary cooling member having an extended cooling surface, means for positively spreading water over said surface so that said water will be cooled by evaporation in contact with air, said cooling member being adapted to throw off this cooled water and air by centrifugal force, a condensing vessel placed in the space radially beyond the zone of rotation of the cooling member, a tank underneath the condensing vessel, means for conducting steam into the condensing vessel, means for conveying water out of the tank and distributing it over the interior of the cooling member, and tanks for rotating the cooling member; substantially as described.

8. The combination with a number of condensing vessels arranged in vertical planes to form parallel rings and separated by passages for water and air, a rotary cooling apparatus placed in the center space of the rings, said cooling apparatus being provided with a cooling surface, means for positively spreading water in a thin film over said cooling surface so that said water will be cooled by evaporation in contact with air, said cooling apparatus being adapted to throw this cooled water and air onto the condensing vessels by centrifugal force, of a tank underneath the condensing vessels suitable to hold water, means for feeding steam into the condensing vessels, means for feeding water out of the tank into the cooling apparatus, and means for rotating the cooling apparatus; substantially as described.

9. In combination with a rotary cooling apparatus adapted to cool water by evaporation in contact with air and to throw off water by centrifugal force, a condensing vessel placed in the space radially beyond the zone of rotation of the cooling apparatus and having a tapering cross section of which the thin end is in juxtaposition to the circumference of the cooling apparatus, means for feeding steam into the condensing vessel, means for feeding water into the cooling apparatus, means for rotating the cooling apparatus, and means for producing a current of air over the condensing vessel; substantially as described.

10. In combination with a rotary cooling apparatus adapted to cool water by evaporation in contact with air and to throw water outwardly and in a vertical plane by centrifugal force, a ring-shaped condensing vessel placed in vertical position in the space radially beyond the zone of rotation of the cooling apparatus and having a cross section which tapers inwardly, means for feeding steam into the condensing vessel, means for feeding water into the cooling apparatus, means for rotating the cooling apparatus, and means for producing an air current over the condensing vessel; substantially as described.

11. In combination with a rotary cooling apparatus adapted to cool water by evaporation in contact with air and to throw water outwardly and in a vertical plane by

centrifugal force, a number of half-ring-shaped condensing cells placed in vertical position in the space radially beyond the zone of rotation of the cooling apparatus and having a cross section which tapers inwardly, means for feeding steam into the condensing cells, means for feeding water into the cooling apparatus, means for rotating the cooling apparatus, and means for producing an air current over the condensing cells; substantially as described.

12. In combination with a ring-shaped condensing vessel having a cross section which tapers inwardly, a rotary cooling apparatus placed in the center space of the ring, said cooling apparatus being adapted to cool water by evaporation in contact with air and to throw this water and air onto the condensing ring, said cooling apparatus having mounted on its circumference and in juxtaposition to the inner periphery of the condensing ring, a collecting ring of which the cross section tapers outwardly, whereby water and air which enter the collecting ring are discharged near the inner periphery of the condensing ring, means for feeding steam into the condensing vessel, means for feeding water into the cooling apparatus, and means for rotating the cooling apparatus; substantially as described.

13. In combination with a number of condensing vessels and a rotary cooling apparatus adapted to cool water in contact with air and to throw this water and air onto the condensing vessel, a housing around the condensing vessels and having an opening through which air is admitted to the cooling apparatus, and an opening through which air escapes into the atmosphere; substantially as described.

14. A ring-shaped condensing vessel having inclined side walls, and a ring-shaped perforated stay-plate arranged between the side walls of said vessel and dividing it into compartments which communicate with each other through the openings in the stay-plate; substantially as described.

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Witnesses:

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GEORGE JOHN DEUBER.