No. 688,546. Patented Dec. 10, 1901.

C. W. RAMSTEDT.

APPARATUS FOR EFFECTING EXCHANGE OF HEAT BETWEEN LIQUIDS OR FLUIDS.

(Application filed Apr. 6, 1901.)

(No Model.)

4 Sheets—Sheet 1.

Fig. 1.

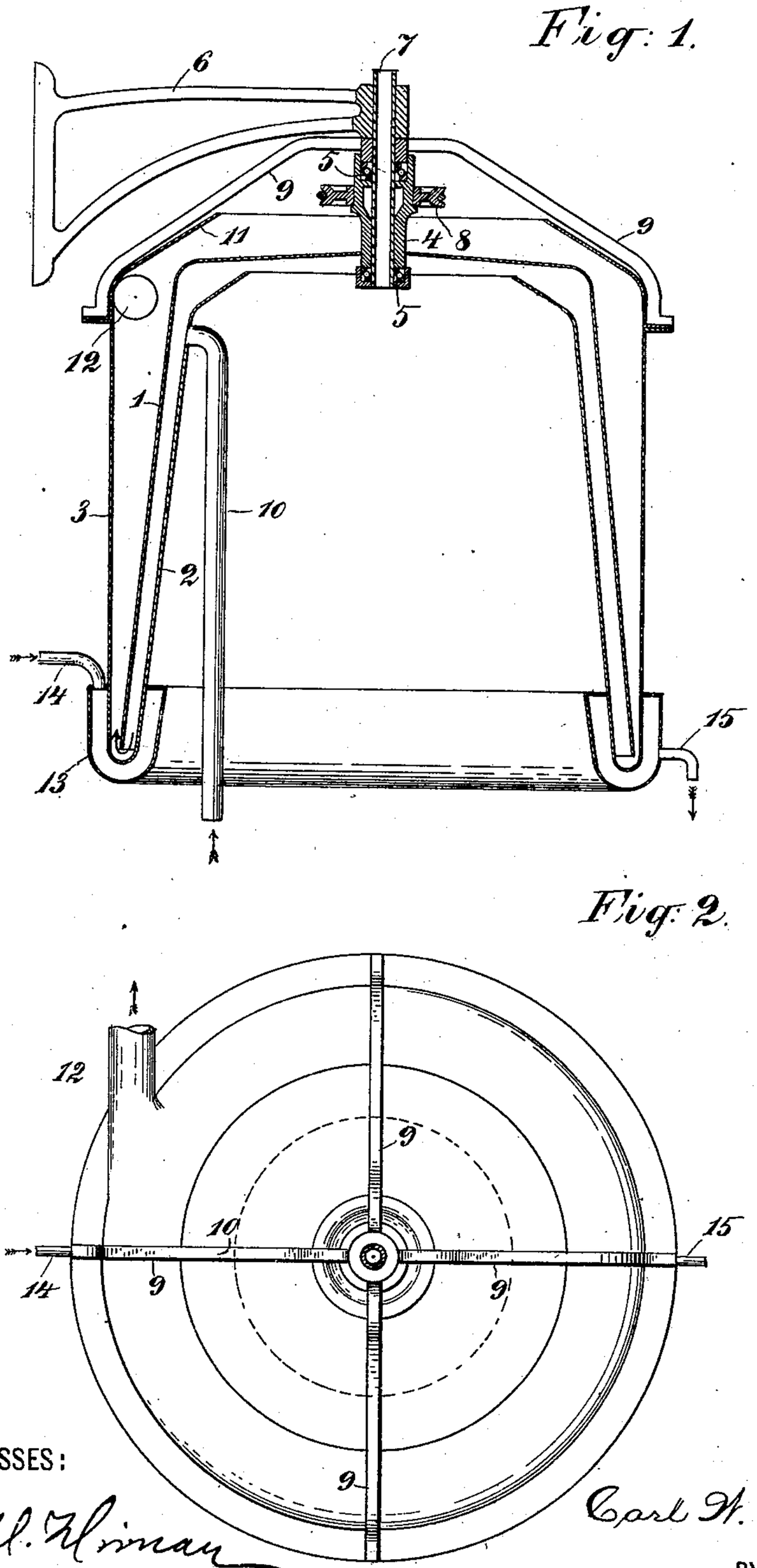

Fig. 2.

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Fig. 3.

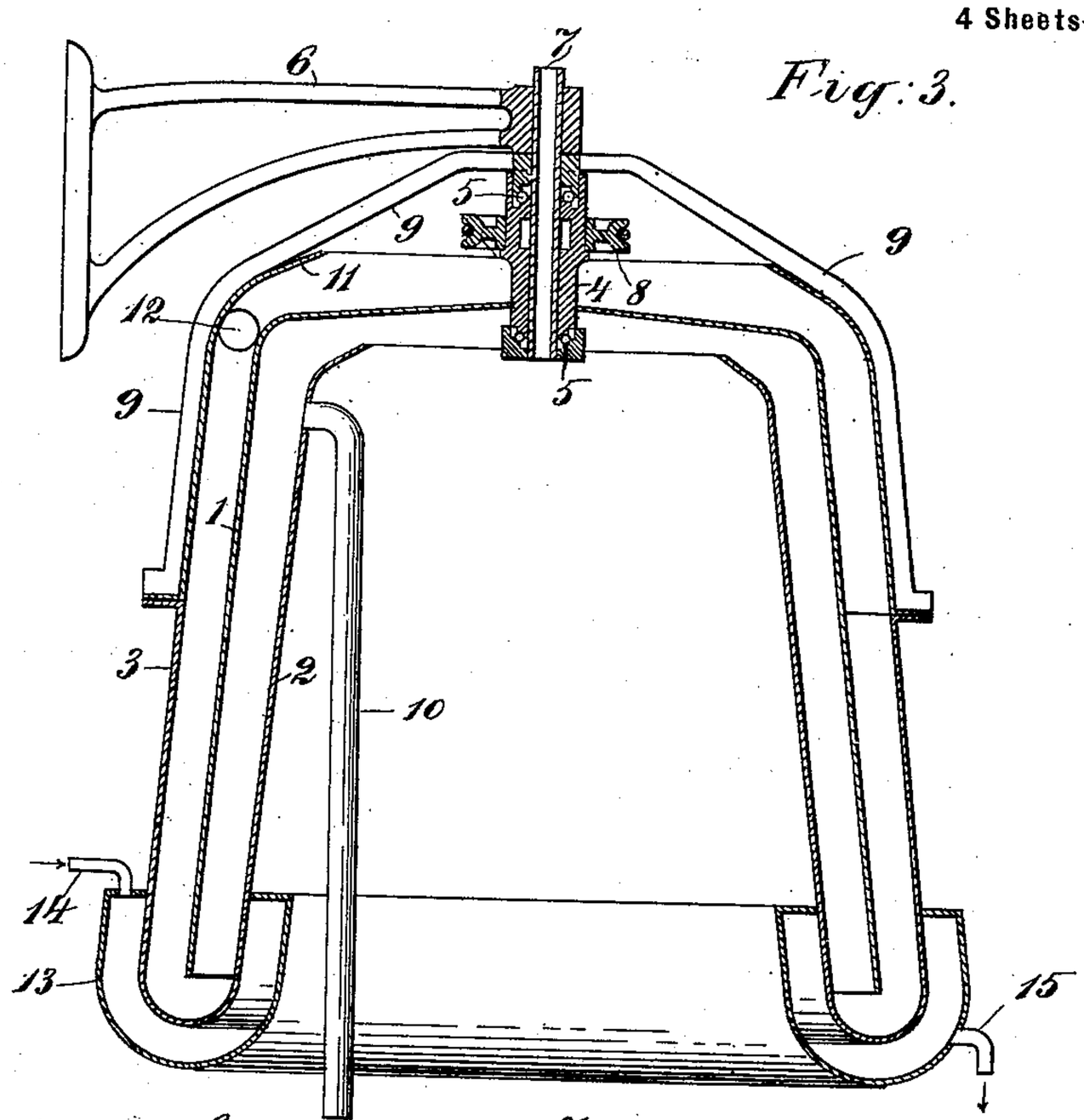
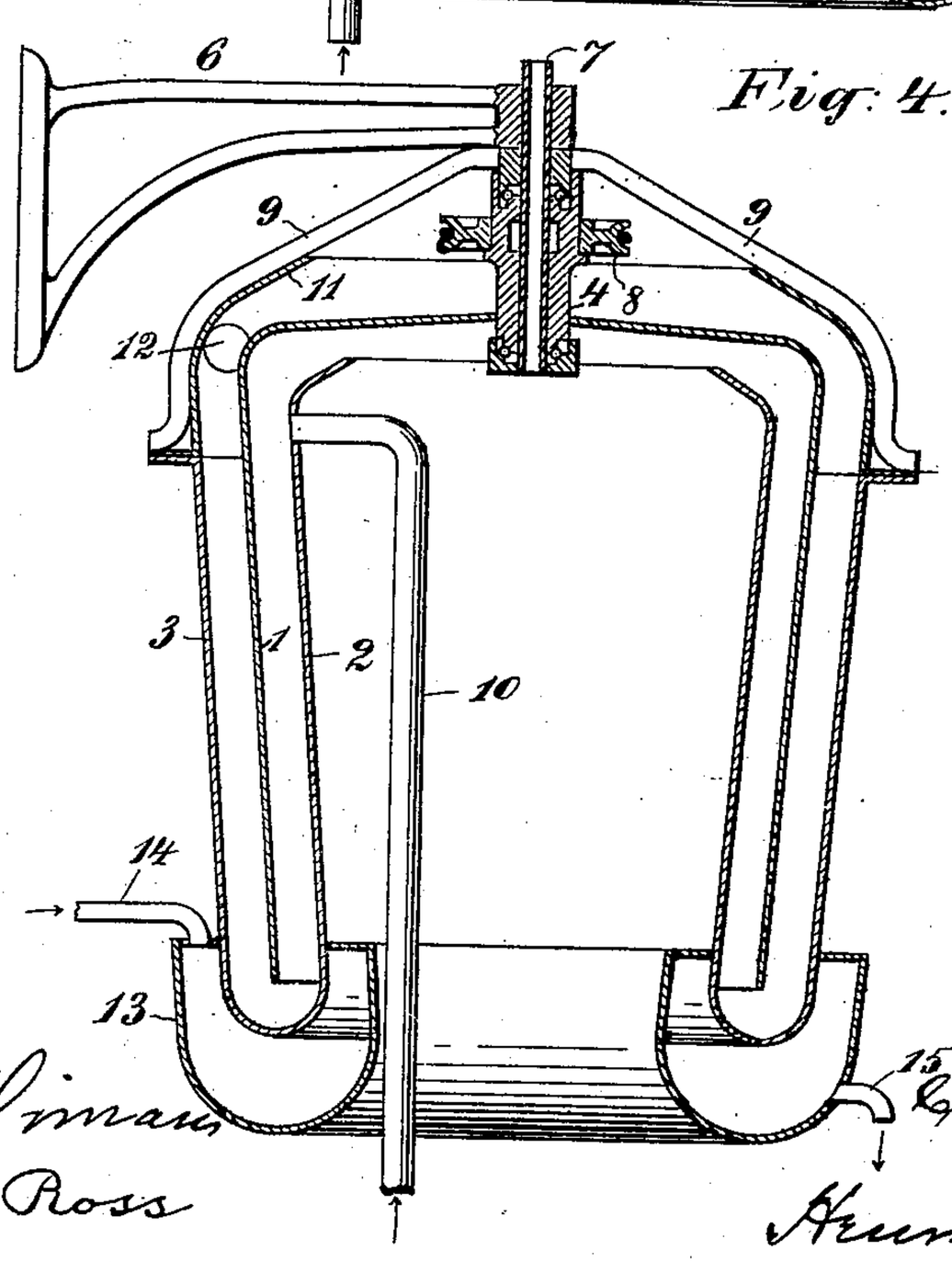


Fig. 4.



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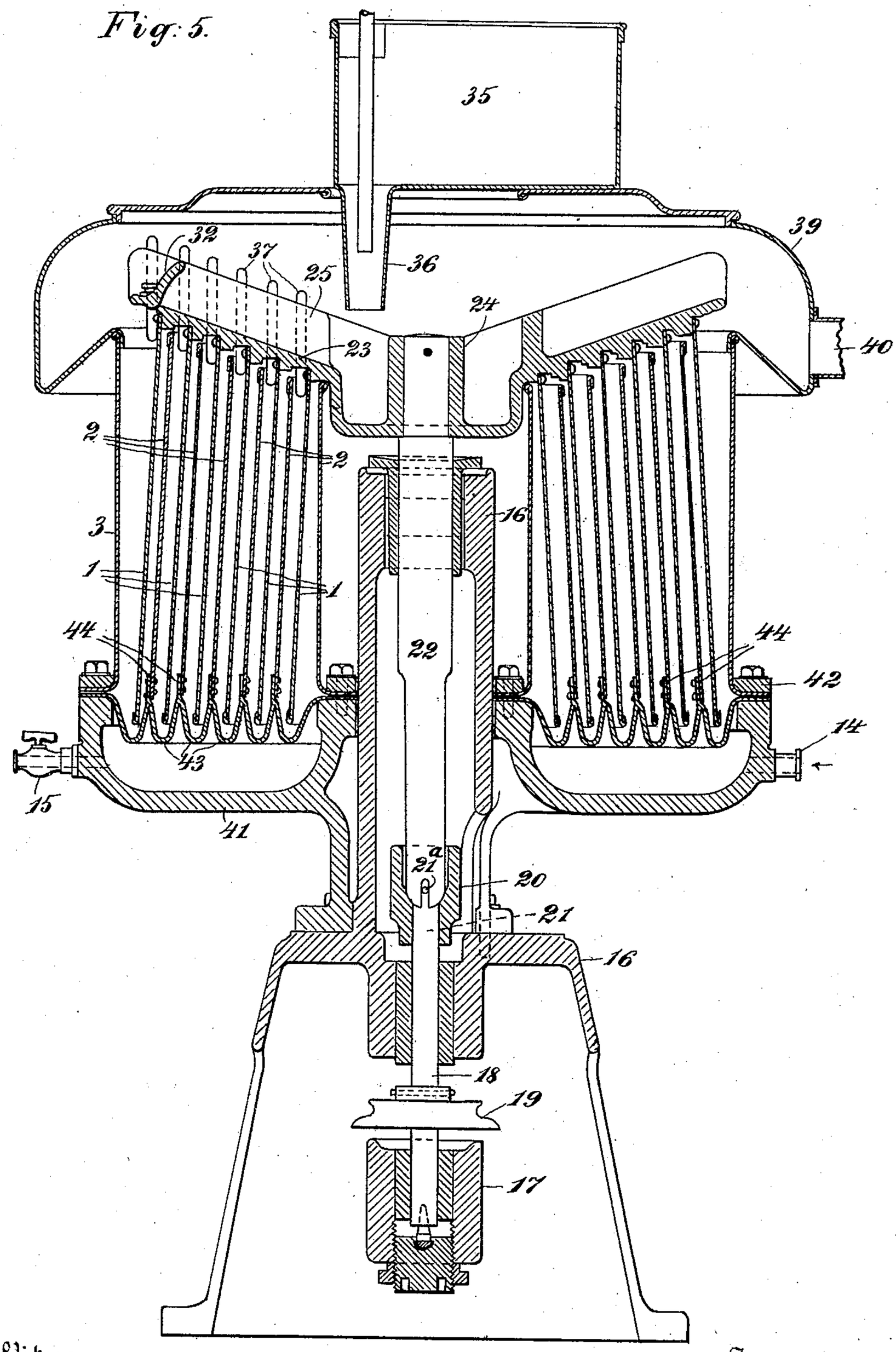
(No Model.) 4 Sheets—Sheet 3.

Fig. 5.



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(No Model.) 4 Sheets—Sheet 4.

Fig. 6.

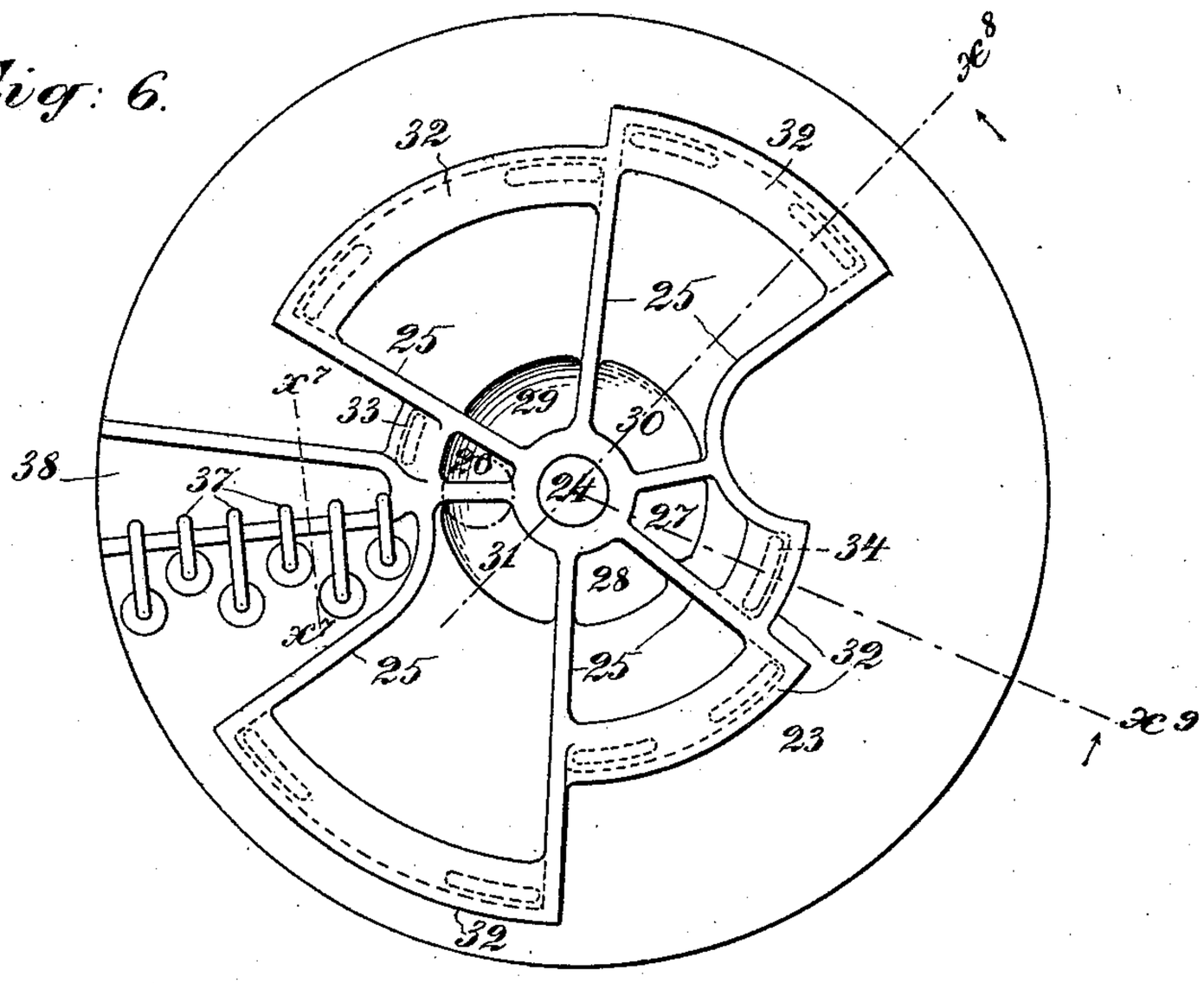


Fig. 8.

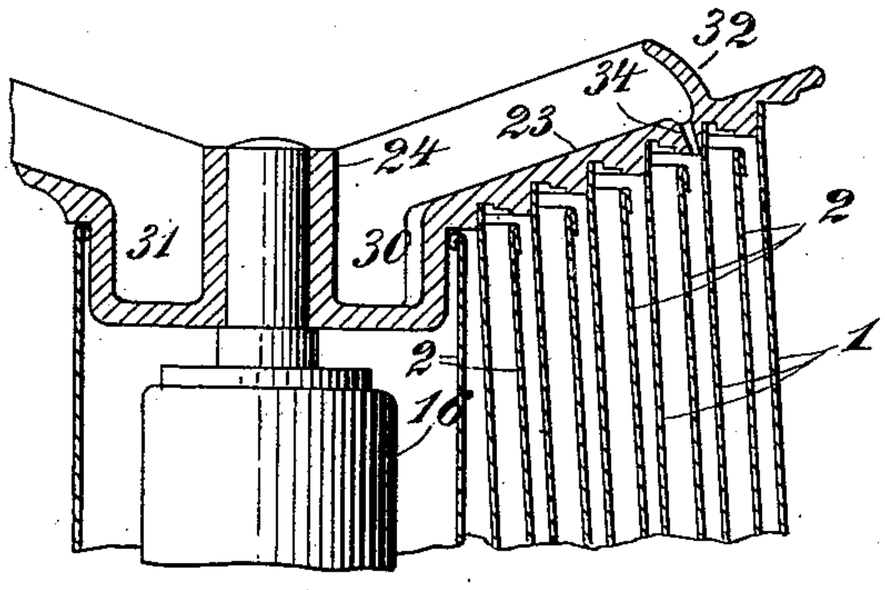


Fig. 9.

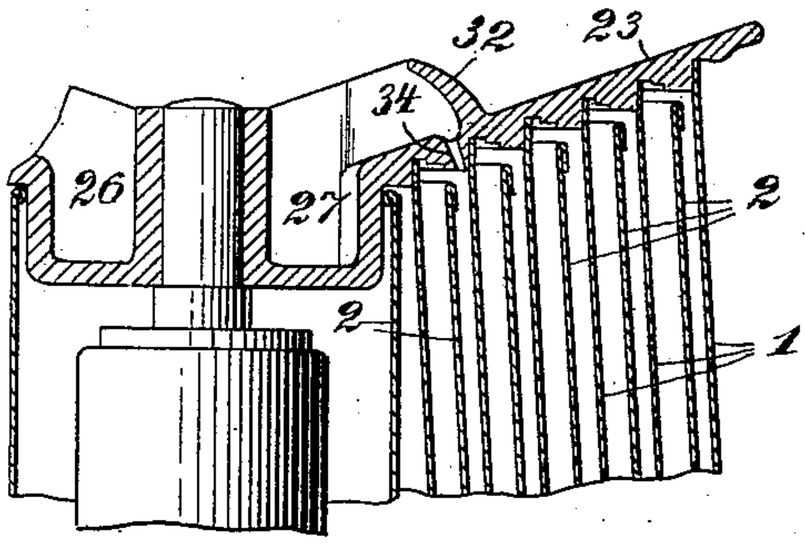
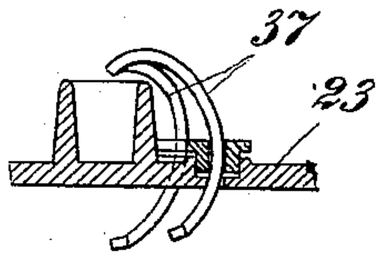


Fig. 7.



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CARL WILHELM RAMSTEDT, OF TRANBYGGE, SWEDEN.

APPARATUS FOR EFFECTING EXCHANGE OF HEAT BETWEEN LIQUIDS OR FLUIDS.

SPECIFICATION forming part of Letters Patent No. 688,546, dated December 10, 1901.

Application filed April 6, 1901. Serial No. 54,599. (No model.)

To all whom it may concern:

Be it known that I, CARL WILHELM RAMSTEDT, Ph. D., a subject of the King of Sweden and Norway, and a resident of Tranbygge, Kungsängen, in the Kingdom of Sweden, have invented certain new and useful Improvements in Apparatus for Effecting Exchange of Heat between Liquids or Fluids, (for which I have filed applications for patent in Sweden the 23d day of April, 1900, under No. 674/00, and in Germany the 26th day of April, 1900, under No. R. 14,226^{I}/17,) of which the following is a specification, reference being had therein to the accompanying drawings.

As is well known, a satisfactory exchange of heat between liquids or fluids is effected by allowing the latter to flow in opposite directions along each side of a cylindrical or conical wall or partition which is a good conductor of heat without any mixing of hot and cold particles of the respective fluids. To communicate the necessary motion to the liquid or fluid to be heated or cooled, the wall or partition is suitably set in rotation, and to prevent mixing of layers differently heated in the said rotation rings or annular depressions have been arranged in the vessel containing the liquid. By this means a nearer approach to the end desired has been made; but the division has been incomplete and the results attained imperfect. I have found that a rotating liquid is divided into perfectly distinct layers having different velocities, so that mixing is prevented if the liquid be caused to rotate between two concentric vessels inserted one into the other and of which one is stationary while the other, which must be inclined to the axis of rotation, rotates. The width of the annular space between the walls of the two vessels must not exceed that at which the liquid adhering to the wall of the rotating vessel will have sufficient cohesive force to participate as a whole or in mass in the rotation of the latter. The liquid is conveniently admitted at the narrow end of the rotating conical vessel, and when the vessel is driven at a sufficient velocity the liquid, owing to the centrifugal action, will move in a spiral curve along the conical heat-exchanging surface. The apparatus is conveniently so arranged that the narrow end of its conical vessel is pointing upward. The force of gravity then assists in moving the liquid along the aforesaid curve. As the coils of the spiral have diameters of different size, the centrifugal force will vary, and the liquid consequently be given different velocities in each coil. The different layers are thus prevented from passing over into one another, and no mixing of cold and hot layers therefore can take place.

The apparatus may alternatively be arranged so as to have the wide end of the vessel at the top. The liquid on being introduced at this end will then during the rotation of the vessel and under the influence of the force of gravity move downward spirally along the surface of the vessel.

Figures 1 and 2 show one form of the invention in a vertical section and a plan view, respectively. Fig. 3 shows a modified form of the apparatus in a vertical section. Fig. 4 shows still another modification. According to Figs. 1, 2, 3, and 4 the apparatus has only one vessel serving as heat-exchanging surface, said vessel rotating between two stationary vessels. Fig. 5 shows in a vertical section an apparatus having several vessels (six in number) rotating between stationary ones. Fig. 6 shows a plan view of a distributing disk or plate for the liquid to be treated in the latter apparatus. Figs. 7, 8, and 9 are respectively sections taken at x^7, x^8, and x^9 in Fig. 6. The apparatus are so arranged that the heated liquid serves to primarily heat the freshly-supplied liquid, thus itself becoming cooled.

1, Figs. 1 and 2, is a rotating vessel in the shape of an upwardly-tapering bell. This vessel depends between two vessels 2 and 3, joined together at the bottom. The rotating vessel or bell 1 is provided with a hub 4 and journaled, by means of common ball-bearings 5, on a pin or pivot 7, secured to a bracket 6, the vessel being set in rotation by means of a cord or belt pulley 8, secured to the hub 4. On the pin or pivot 7 are secured arms 9, to which the vessel 3 is fastened by any suitable means. The vessels 2 and 3 consequently are sustained by the arms 9. The wall of the inner vessel 2 is parallel to the wall of the vessel 1, as shown. The wall of the outer vessel 3 may either have a different direction from the walls of vessels 1 and 2 or be parallel to the walls of the latter vessels, as shown in

Fig. 3. 10 is the supply-pipe for the liquid to be treated—heated or cooled. The pipe 10 enters in the space between the vessels 1 and 2 at its upper part. The outer stationary vessel 3 has a cover 11, which may either extend clear to the hub 4 or only reach slightly in over the vessel 1, as shown. From the curved lower part or outer edge of the cover issues tangentially to the cover a pipe 12, serving as outlet for the liquid treated. The inner vessel 2 may at the top either be closed or open, as shown, with the upper edge bent slightly inward. Around the junction of the two stationary vessels 2 and 3 is placed a ring-shaped vessel 13, of U-section, for containing the heating fluid—steam. 14 is the steam-inlet, and 15 the outlet for the water of condensation.

The liquid to be treated is supplied to the apparatus by the pipe 10 and subsequently passes between the vessels 1 and 2 and the heating vessel 13, and continuing upward between the vessels 1 and 3, finally discharges from the apparatus through the pipe 12. In its said passage the liquid is heated by the vessel or jacket 13 to the required temperature. During its upward flow between the vessels 1 and 3 the liquid yields, through the wall of the vessel 1, a large portion of its heat to the liquid flowing into the apparatus, thus primarily heating the latter while being itself cooled. The distance between the rotating vessel 1 and the stationary one, 2, is so gaged that the liquid contained between said vessels adheres to both vessels, while at the same time the cohesive force within the liquid is sufficient to keep the particles of liquid together. The liquid entering through pipe 10 therefore will be set in rotation by the vessel 1, and, owing to the centrifugal action, as well as the action of the force of gravity, and in consequence of the shape of the vessels 1 and 2, it will flow downward in a spiral line along the wall of vessel 1. As the liquid moves in the direction of the wide end of the vessel 1 it will successively be subjected to an increasing centrifugal force and obtain an increasing velocity. As a consequence mixture is prevented of the layers successively heated to different temperatures in the rotating liquid inclosed between the vessels 1 and 2. The exchange of heat between the heated liquid flowing between the vessels 1 and 3 and the liquid flowing in between the vessels 1 and 2 will be as complete as possible, owing to the extended contact of the current between the vessels 1 and 2 with the heat-transmitting wall 1, the liquid consequently being gradually brought to the high temperature which is finally given to it by the heater 13. At the same time the outward-flowing liquid is successively cooled. The liquid between vessels 1 and 3 is forced upward by the succeeding liquid and ultimately discharges through the pipe 12. Owing to the fact that the pipe 12 is tangential to the stationary vessel 3, the fluid will discharge at the pressure caused by the rotation.

The apparatus shown in Fig. 3 is arranged in the same manner as that illustrated in Figs. 1 and 2, with the exception that the wall of vessel 3 is made parallel to that of vessel 1. By disengaging the vessel 3 from the arms 9, Figs. 1, 2, and 3, the vessels 2 and 3 can be lowered when they, as well as vessel 1, are to be cleaned.

The apparatus shown in Fig. 4 resembles that in Fig. 3, the vessels, however—both the rotating one and the stationary ones—being made widening toward the top. The mode of operating is the same as in the apparatus above described, the liquid, owing to the force of gravity and the rotation of the vessel 1, flowing in a spiral line along the inner side of this vessel. On the outer side of the vessel 1 the centrifugal force also assists in carrying the liquid upward.

In the form of apparatus shown in Fig. 5 the working capacity is multiplied, owing to the introduction of several rotating vessels or partitions 1 (in Fig. 5 six in number) between each pair of stationary walls or partitions 2 2 2 and 3, of which 3 forms the bounding-wall of the apparatus. The apparatus is supported by a standard 16, in which the vertical driving-shaft 18 is journaled in a step-bearing 17. The shaft is driven by means of a belt or cord pulley 19 or by like means. To the upper end of the shaft 18 is coupled, by means of a sleeve 20 and a pin 21, a shaft 22, the upper end of which is journaled in the standard 16. On the said shaft end is secured a disk 23, which is dished or cupped out next to the shaft. The outer part of the disk flares obliquely upward. The rotating vessels or partitions 1 are secured to the latter—for instance, by means of screws or bayonet-clutches. From the hub 24 of the disk 23 project flanges 25, extending toward the circumference of the disk to a greater or less distance. These flanges divide the cupped portion into small compartments 26, 27, 28, 29, 30, and 31, Fig. 6, which are as many in number as the rotating vessels 1. These compartments are continued outward by the respective passages formed on the sloping part of the disk by the flanges 25, as seen in Fig. 6, and these passages are closed at their outer ends by inwardly-inclined flanges 32 on the disk 23, as seen in Figs. 6, 8, and 9. The compartment 26 communicates with the space between the innermost wall 2 and the innermost partition 1 by means of a passage and a hole 33, leading from the outer part of the latter in the disk 23, Fig. 6. The compartment 27, by means of its passage and a hole 34 in disk 23, communicates with the space between the next stationary wall or partition 2 and rotating vessel 1. The case is the same with the compartments 28, 29, 30, and 31, which through a passage and (two) holes leading therefrom in the disk each communicate

with a space between one stationary and one rotating partition of the apparatus. The liquid to be treated is supplied from a holder 35 through an adjustable passage 36 to the compartments 26 to 31 and is carried outward by the centrifugal force through the passages between the flanges 25 and down into the respective spaces between the stationary and rotating vessels. The subsequent action is the same as that described above—*i. e.*, the liquid flows in a spiral course downward along the inner side of each rotating vessel 1 and then beneath the bottom edge of said vessel and upward along the outside of vessel 1. For discharging the liquid so-called "skimming-tubes" 37 are attached to the disk 23, which tubes reach into the respective spaces containing liquid operated on and lead to a passage 38, arranged on the upper side of the disk 23 and opening toward the circumference of the disk. The liquid is thrown from the passages 38 out into a stationary casing 39, provided with an outlet 40. The sizes of compartments 26 to 31 are made to conform to the sizes of the spaces between the walls or partitions 1, 2, and 3 with which they communicate. The slope of the partitions 1 is slight—about five degrees or seven degrees to the vertical—said inclination having been found suitable for the purpose. The heater of the apparatus is formed by a ring and cup shaped disk 41, secured to the standard 16, and a ring-shaped corrugated cover secured to the disk 41 by means of a ring 42 and screws, said cover being composed of annular plates 43, joined at the top and supporting the walls or partitions 2. The latter are removably attached to the said plates by means of bayonet-clutches composed of recesses made in the bottom edges of the walls and pins 44, secured to the plates 43, so that for the daily cleaning the walls or partitions 2 can be taken out of the apparatus on removing the casing 39 and disk 23, together with the walls or partitions 1.

In the apparatus shown in Figs. 5, 6, and 7 each wall or partition, both the stationary and the rotating ones, effects both heating and cooling without extra consumption of heating or cooling fluid, the economical efficiency being therefore multiplied. If, further, it be considered that the two outer vessels in Fig. 5 inclose a plurality of stationary and rotating walls or partitions for the exchange of heat, while in other sterilizing apparatus the outer walls usually effect but one exchange of heat, it is understood that a further increase in effect is gained by the device shown in Fig. 5. To illustrate this fact, it may be mentioned that in apparatus where the heating fluid flows between the wall of an outer vessel and a vessel placed inside the latter for holding the liquid or fluid to be heated two walls are required for one exchange of heat, whereas in the apparatus shown in Fig. 5 only thirteen walls or partitions are required for an elevenfold exchange of heat. The apparatus above described evidently may also be employed for cooling liquids or fluids.

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

1. An apparatus for effecting exchange of heat between fluids, characterized by the combination of a rotating conical vessel or partition 1 with vessels or walls 2, 3 located each side of it and united at one end of the partition, a jacket 13 for containing heating or cooling fluid, and inlets and outlets for the fluid under treatment, said inlets and outlets being situated on opposite sides of the rotating partition, substantially as described.

2. An apparatus for effecting exchange of heat between fluids, characterized by the combination of a rotating conical vessel or partition 1 with stationary vessels or walls 2, 3 located each side of it and united at the wide end of the partition 1, a jacket 13 for heating or cooling fluid, and at opposite sides of the rotating partition 1 inlets and outlets for the fluid under treatment, the distance between the partition 1 and the stationary wall at the inlet side being so gaged in relation to the velocity of rotation that the passing liquid is caused to accompany or take part in the rotation of the partition 1, substantially as described and for the purpose specified.

3. An apparatus for effecting exchange of heat between fluids, characterized by the combination of a rotating conical vessel or partition 1 with stationary vessels or walls 2, 3 located each side of it and united at the wide end of the partition 1, a jacket 13 for containing heating or cooling fluid, said jacket being located around the junction of the walls 2, 3, and at opposite sides of the rotating partition 1 near its narrow end inlets and outlets for the fluid under treatment, substantially as described.

4. An apparatus for effecting exchange of heat between fluids, characterized by the combination of a rotating conical vessel or partition 1 with stationary vessels or walls 2, 3 located each side of it and united at the wide end of the partition 1, around the junction of the walls 2, 3 a jacket 13 for containing heating or cooling fluid, and at opposite sides of the rotating partition 1 near its narrow end inlets and outlets for the fluid under treatment, the outlet being located tangentially to the apparatus, and the stationary wall on the inlet side of the partition 1 being parallel to said partition and located at a distance from it so gaged in relation to the velocity of rotation that the passing fluid is caused to accompany or take part in the rotation of partition 1, substantially as described and for the purpose specified.

5. An apparatus for effecting exchange of heat between fluids, characterized by the combination of two or more rotating conical vessels or partitions 1 inserted one within the others with stationary vessels, walls, or parti-

tions 2, 2, 3 located each side of each partition 1 and united together at one end of each respective partition 1, at the junction of the walls or partitions 2, 2, 3 a jacket for containing heating or cooling fluid, and at opposite sides of the respective rotating partitions 1 inlets and outlets for the fluid under treatment, substantially as described.

6. An apparatus for effecting exchange of heat between fluids, characterized by the combination of two or more rotating conical vessels or partitions 1 inserted one within the others with stationary vessels, walls, or partitions 2, 2, 3 located each side of each partition 1 and united together at the wide end of each respective partition 1, at the junction of the walls or partitions 2, 2, 3 a jacket for containing heating or cooling fluid, on the standard of the apparatus a rotatable shaft having secured to it a disk 23 sustaining the partitions 1 and provided with compartments 26, 27, 28 for receiving fluid to be treated, said compartments respectively communicating by means of passages with the spaces one side of each rotating partition 1 in the apparatus, and skimming-tubes 37 secured to the disk 23 and extending into the space on the other side of each respective partition 1, substantially as described.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CARL WILHELM RAMSTEDT.

Witnesses:

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ROBERT APELGREN.