No. 868,390. PATENTED OCT. 15, 1907.

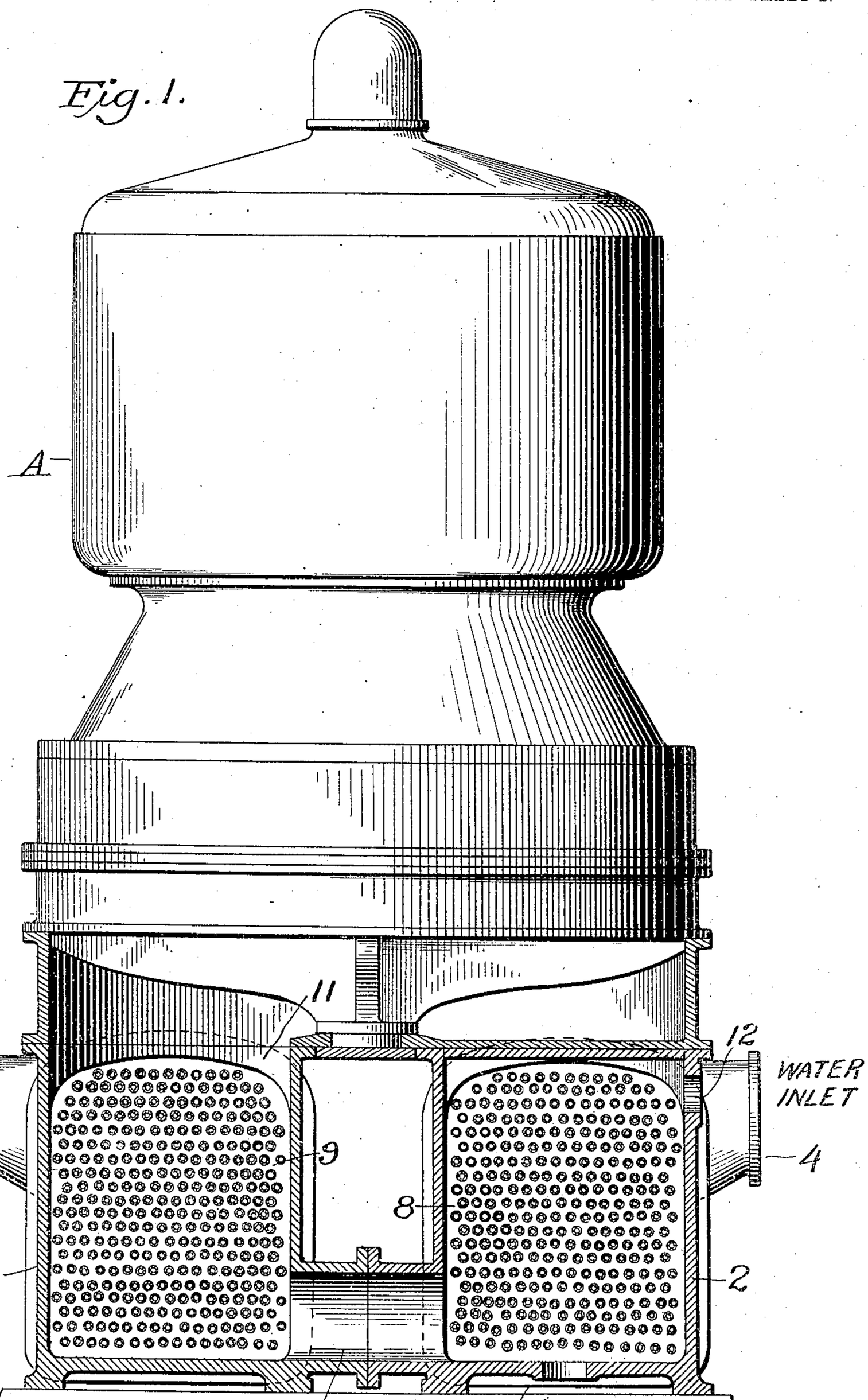
L. R. ALBERGER.

SURFACE CONDENSER.

APPLICATION FILED JULY 28, 1904.

6 SHEETS—SHEET 1.

Fig. 1.



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No. 868,390. PATENTED OCT. 15, 1907.

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6 SHEETS—SHEET 2.

Fig. 2.

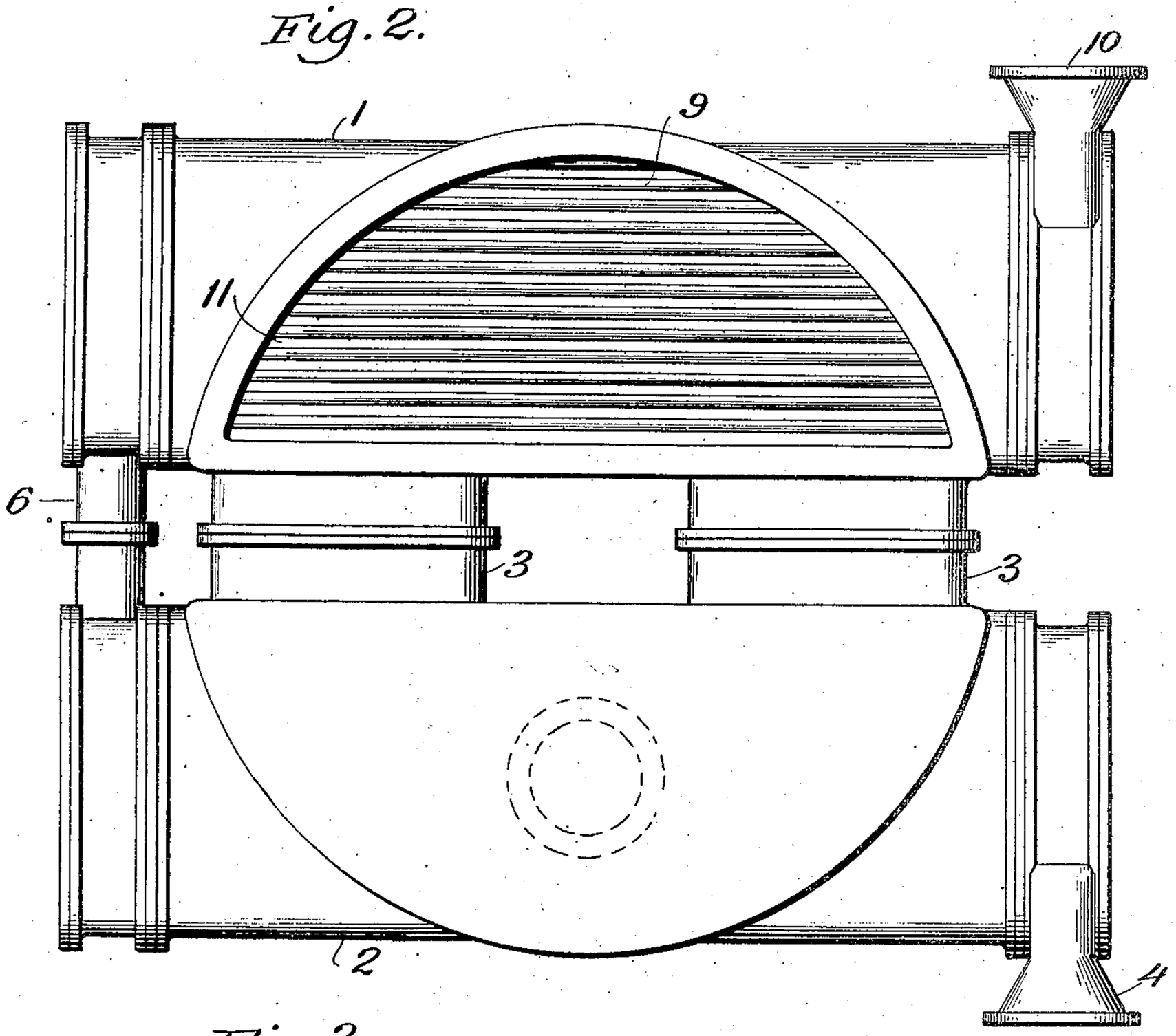
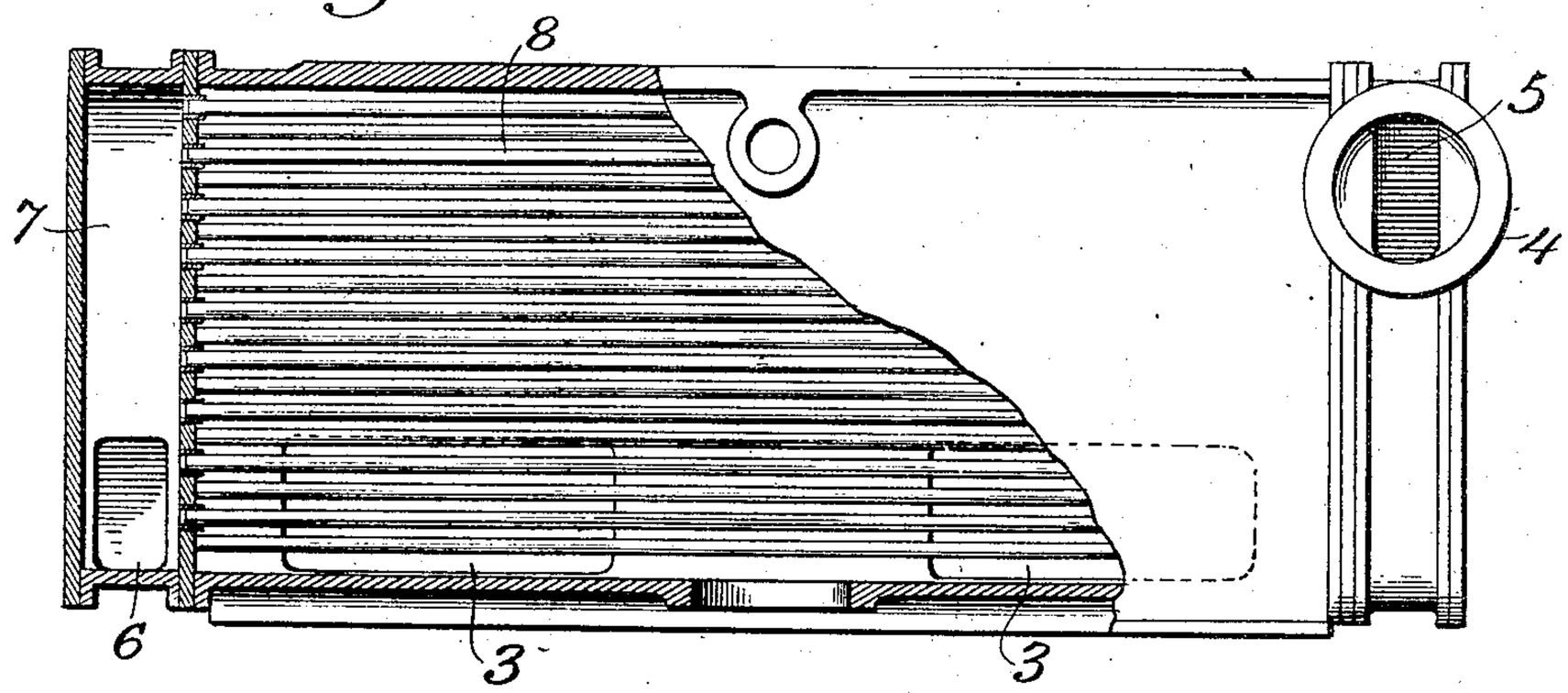


Fig. 3.



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6 SHEETS—SHEET 3.

Fig. 4.

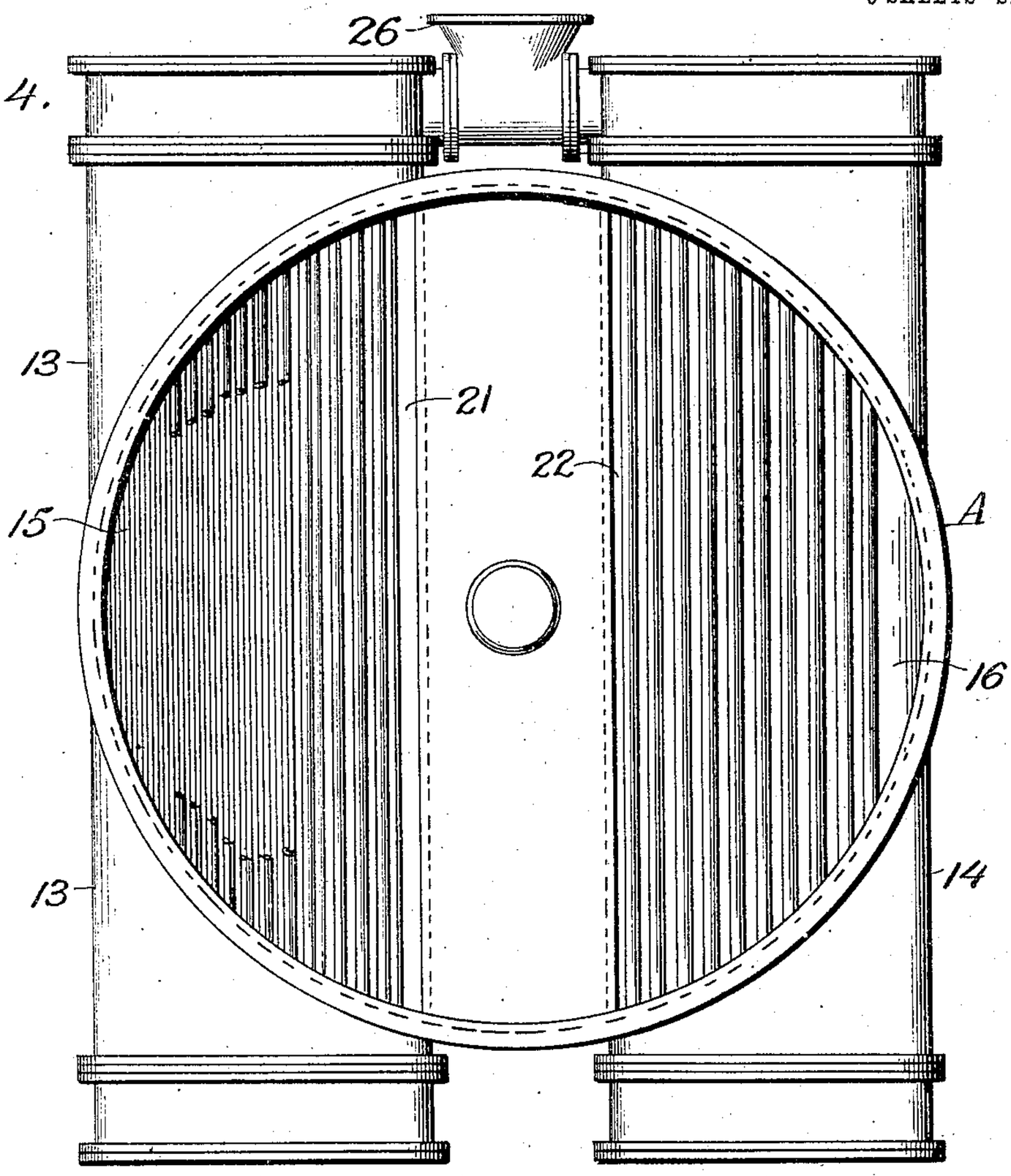
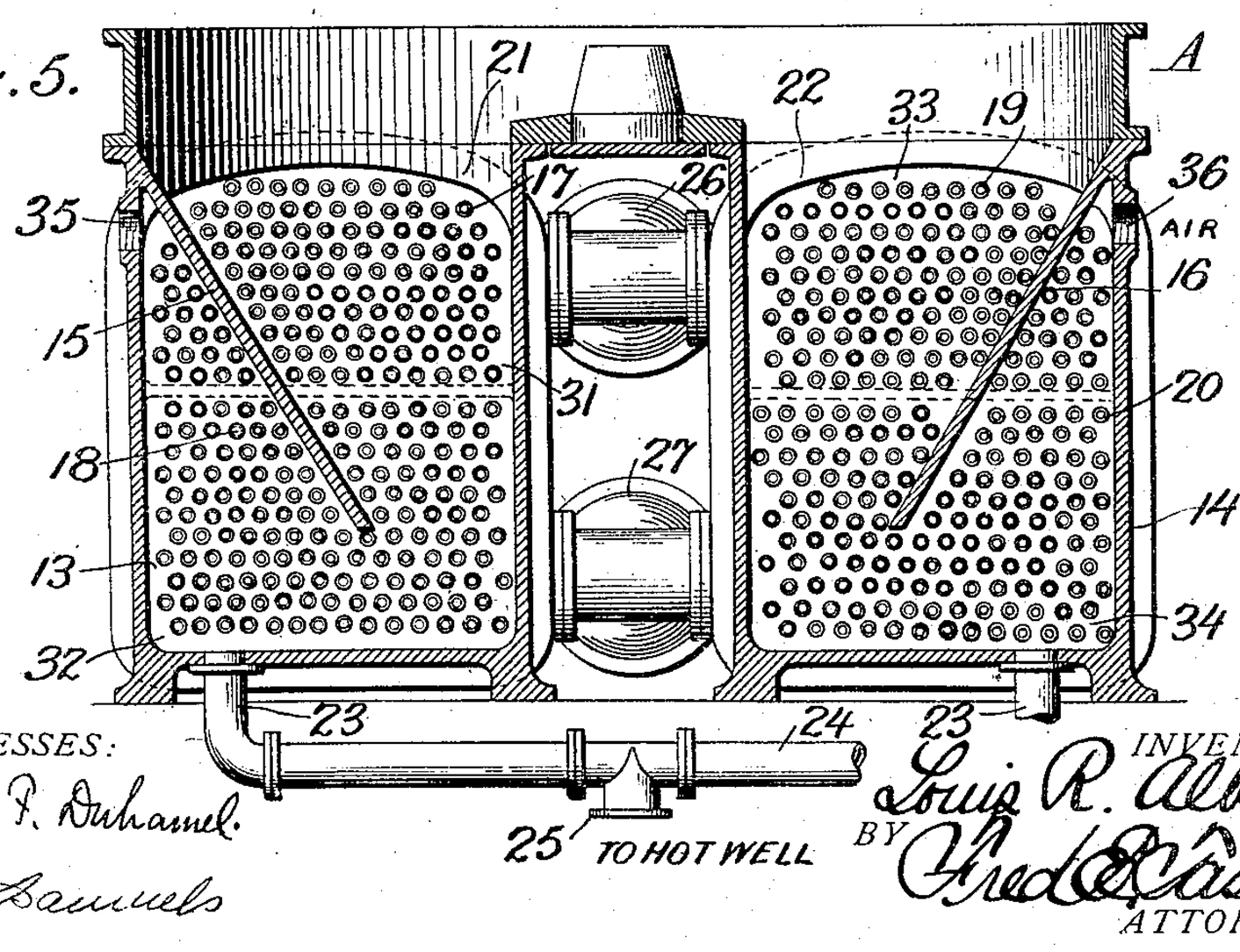


Fig. 5.



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SURFACE CONDENSER.

APPLICATION FILED JULY 28, 1904.

6 SHEETS—SHEET 4.

Fig. 6.

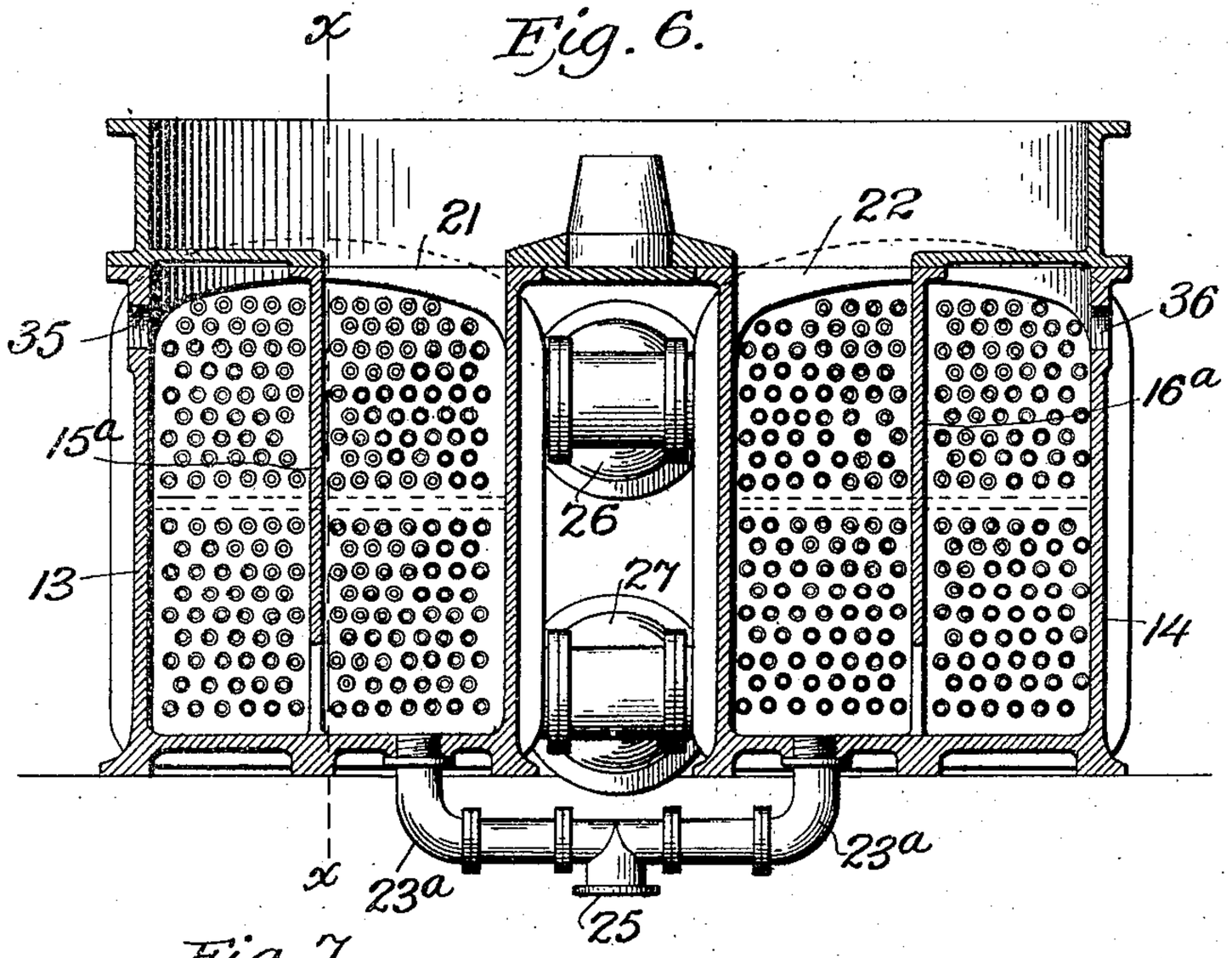
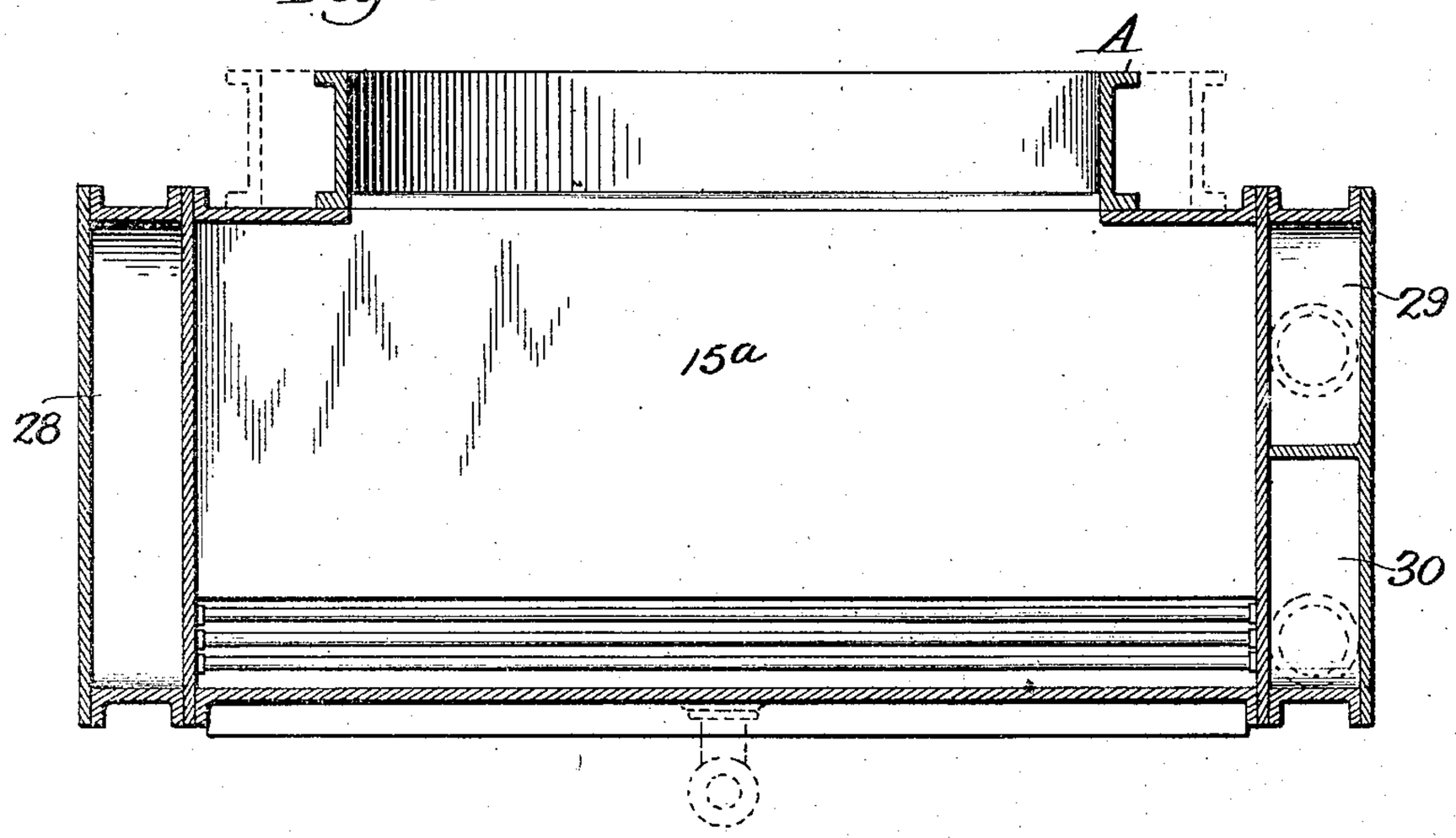


Fig. 7.



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No. 868,390. PATENTED OCT. 15, 1907.

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SURFACE CONDENSER.

APPLICATION FILED JULY 28, 1904.

6 SHEETS—SHEET 5.

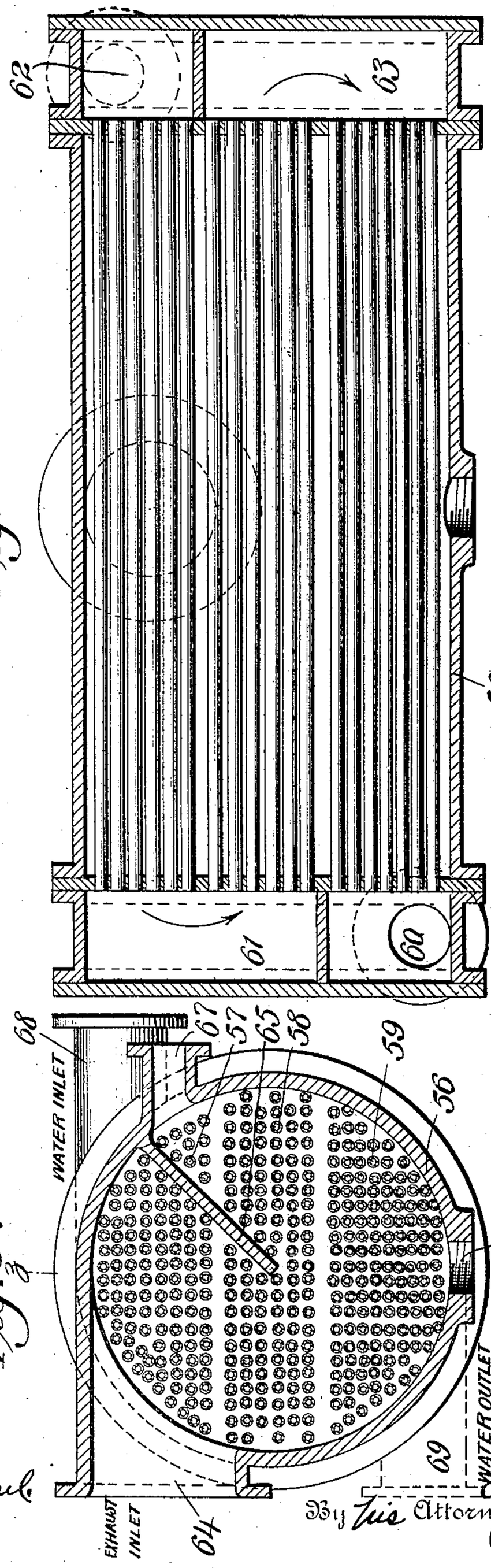

Fig. 9.

Fig. 8.

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No. 868,390. PATENTED OCT. 15, 1907.

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SURFACE CONDENSER.

APPLICATION FILED JULY 28, 1904.

6 SHEETS—SHEET 6.

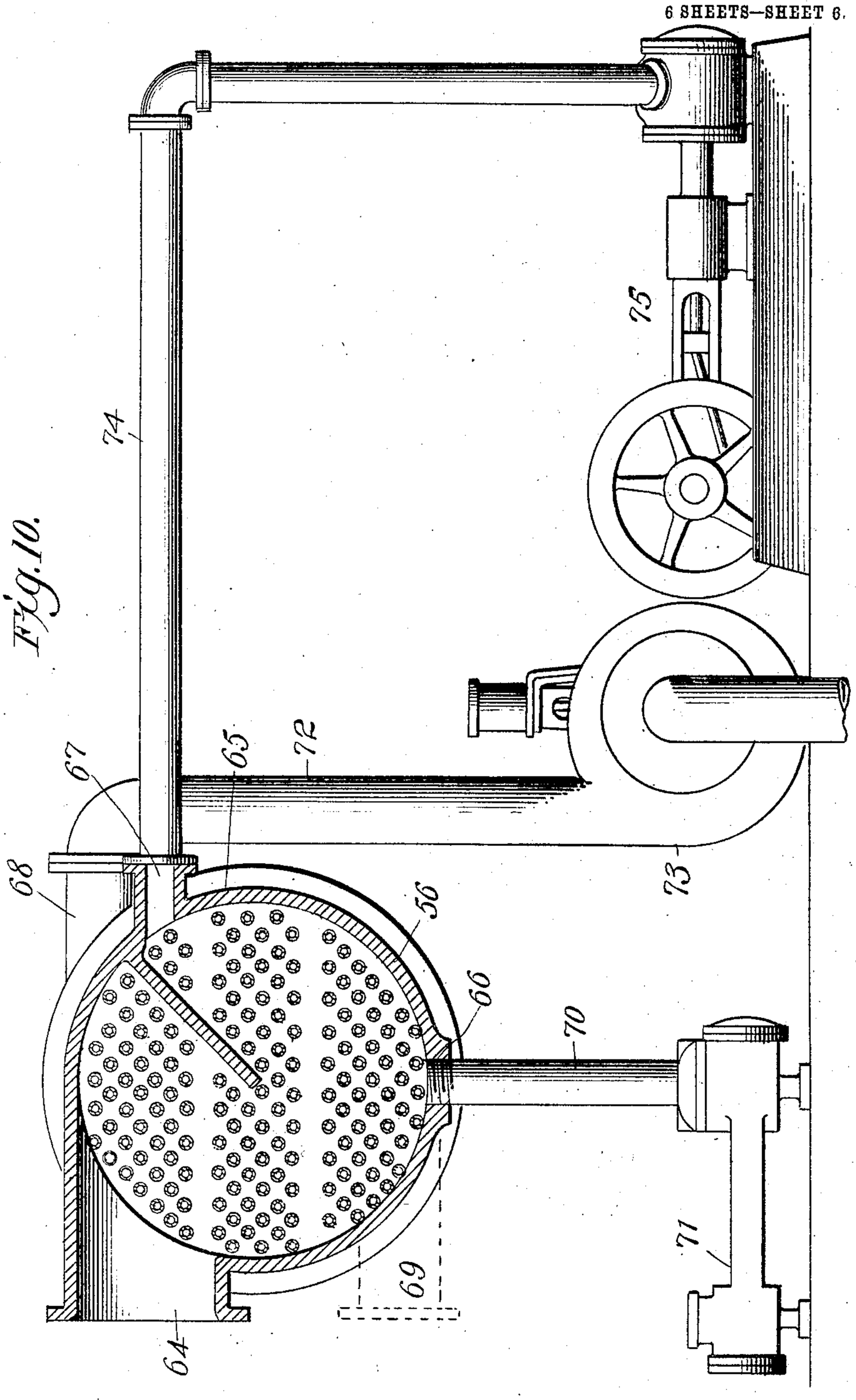

Fig. 10.

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UNITED STATES PATENT OFFICE.

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SURFACE CONDENSER.

No. 868,390. Specification of Letters Patent. Patented Oct. 15, 1907.

Application filed July 28, 1904. Serial No. 218,444.

To all whom it may concern:

Be it known that I, LOUIS R. ALBERGER, a citizen of the United States of America, and a resident of the city, county, and State of New York, have invented certain new and useful Improvements in Surface Condensers, of which the following is a specification.

My present invention relates to the condensation of exhaust steam from engines, steam turbines, and other similar steam motors and to the production of a vacuum by the use of the dry vacuum system, the invention being particularly applicable to that class of apparatus known as surface condensers in which the condensation is effected by the contact of the steam with water-cooled surfaces.

The object of the invention is to promote the efficiency of condensers by providing a surface condenser having a very high efficiency; and furthermore to furnish a condenser of high efficiency suitable for location under a steam engine or steam turbine of which it may constitute the supporting base or frame.

In a surface condenser the highest efficiency can best be obtained by bringing the exhaust steam and commingled air into the condenser at or near the bottom, and bringing the circulating water in at or near the top of the condenser, and causing the circulating water to pass through horizontal tubes exposed to the steam, and causing the water of condensation to gravitate against the incoming steam and air, the air being removed at or near the top of the condenser by means of a dry vacuum pump. There are situations, however, where it is not convenient to introduce the exhaust steam into the bottom of the condenser, as for instance, in the case of a steam turbine, where to economize floor space and to make the connections as short as possible, the condenser may be placed below the turbine and may even form the base on which the turbine rests.

The invention therefore consists essentially in the combination of a form of surface condenser in which the steam and commingled air enter above, come in contact with tubes containing cooling water, by which the steam is partially condensed, and in which form of condenser the steam, air and water of condensation travel in the same direction, with a form of surface condenser in which the steam and commingled air enter below, pass upward and come into contact with tubes containing cooling water until the steam is entirely condensed, the water of condensation falling against the steam, and the air being removed above, or at or near the top of the condenser by a dry vacuum pump. The cooling water may enter at or near the top of the latter form of combination, leaving at or near the bottom, and enter the first form of the combination at or near the bottom and leave at or near the top; or it may pass in two passes, first through the latter form and then through the first form, or in four or more passes, two or more times through each form of condenser making up the combination; or it may flow in parallel passes separately through each form of the condenser.

It is obvious that the steam may not enter exactly at the top nor pass exactly in a vertical direction in either of the forms but may pass obliquely or laterally; the object of the invention is, however, reached when the steam entering at or near the top of the condenser is completely condensed into water which comes into contact with the steam before being removed, and when the air is cooled by tubes containing cool water immediately before being removed by the dry vacuum pump.

The invention consists furthermore in combining the two forms of condensers first referred to in one structure, or in connecting together two or more sections or divisions so that they will jointly act like a single unit; and also, the invention comprises various details in the construction, arrangement and combination of parts substantially as hereinafter described and claimed.

In the accompanying drawings illustrating my invention, Figure 1 is a front elevation of a steam turbine supported on my present improved surface condenser, the latter serving as a base for the turbine and being shown in transverse sectional view. Fig. 2 is a top plan view of my improved surface condenser with the steam turbine removed. Fig. 3 is a longitudinal section with a portion in elevation. Fig. 4 is a top plan view of another form of my improved surface condenser. Fig. 5 is a cross-section of the same. Fig. 6 is a cross-section of still another form of the invention. Fig. 7 is a longitudinal section on the line *x x* of Fig. 6. Fig. 8 is a cross-section of another form of the invention. Fig. 9 is a vertical longitudinal section of the same on the line *z z* of Fig. 8. Fig. 10 is a cross-section of one form of the invention, and shows in a diagrammatic way the location and arrangement of the vacuum pump, the circulating and the hot well pumps.

Similar numerals of reference designate similar parts throughout the different figures of the drawing.

A denotes a steam turbine, the detailed construction of which is not shown, as it is not necessary. This turbine is given simply by way of example in order to illustrate how my improved condenser may serve as the supporting base therefor. It will be understood, however, that I am not restricted to any particular type of steam generator, but my condenser is adapted to be used with all kinds of steam motors.

The frame of the condenser in the particular embodiment of the invention delineated in Figs. 1, 2 and 3 of the drawings consists of two parts, shells, sections, chambers, or divisions, 1 and 2, which are connected together by steam passages 3, 3 and a water passage 6,

so that the two parts act as a single condenser, this division into sections being desirable for the sake of strength and convenience of manufacture and handling. One of the two parts, as 2, is provided with a water inlet 4 at or near the top thereof at one end, while the other part, as 1, is provided with a water outlet 10 at or near the top and at one end. The section 1 belongs to the form of condenser in which the steam enters at the top; the section 2 belongs to the form of condenser in which the steam enters at the bottom; so that the two forms hereinabove referred to are practically conjoined for mutual operation in the condensation of exhaust steam and the production of a vacuum. The shells shown are of rectangular shape but they obviously may be cylindrical or any other form. The right hand section 2 has at one end a chamber 5 provided with a water inlet 4, through which the cooling water enters the apparatus, and at the other end of this section 2 is another chamber 7. The two water chambers 5 and 7 are connected by a plurality of tubes 8 through which the water passes from chamber 5 to chamber 7, said tubes presenting cold surfaces, into contact with which the steam comes during the process of condensation. The left hand section 1 is similarly constructed with chambers at each end connected by a nest of water tubes 9, the chamber opposite to chamber 7 connecting with the latter by the water pipe 6 (see Fig. 2), while the chamber at the other end of section 1 is furnished with the water outlet 10 through which the cooling water leaves the apparatus.

The mixture of steam and air from the turbine A, or in other words, the steam to be condensed with which a certain amount of air is commingled, enters the opening 11 at the top of the left hand section 1 of my improved condenser, flows downward to and in contact with the cooling tubes 9 until it reaches or nearly reaches the bottom of the section 1, where it is directed into the second section 2 through the steam passages 3, 3 (see Fig. 2) and comes in contact in the second section 2 with the cooling tubes 8 therein, which of course are progressively cooler as the water inlet is approached, so that in this way the steam is condensed, while the remaining air and the uncondensable vapor leave the condensing apparatus by a suitable pipe connected to the air outlet 12 and to a dry vacuum pump, as 75, as indicated in Fig. 12. The air outlet 12 is situated at or near the top of the section 2, having the same general location as the water inlet. The water condensed from the exhaust steam, while the latter is traveling downward through section 1, obviously will fall to the bottom of said section, and the water of condensation afterwards condensed while the steam is traveling upwardly through the section 2 over the cooler tubes in said section must necessarily fall back against the exhaust steam and be heated up thereby, so that it will have the highest possible temperature, although it has been in contact with the coolest tubes. There are therefore two portions of water, one the water of condensation in the first section 1, and the other the water of condensation in the second section 2, which two portions are together removed from the bottom of the condenser by a hot well pump, as indicated in Fig. 12, through some suitable outlet, as, for instance, an opening 13 in the bottom of the second section 2, or it may be an opening in the bottom of section 1; and the water thus removed is at a temperature of the steam with which it is in contact and which closely approximates the temperature of the incoming exhaust steam.

Referring now to Figs. 4 and 5, I show therein another form of the invention, by which, however, practically the same ends are attained. Here, instead of having two sections or divisions, one built according to what I have said of the first form of condenser which has an upper steam inlet, and the other according to a second form which has a lower steam inlet, I employ two duplicate condensers or condenser shells, in each one of which there is found a combination of the said first form in which the steam enters above and the said second form in which the steam enters below and the air leaves above. That is to say, each of these duplicate condensers consists of a chamber having a top steam inlet combined with a chamber having a bottom steam inlet. In these Figs. 4 and 5, 13 and 14 denote the two shells, being similar in outer appearance to the condenser sections 1 and 2. Although shells 13 and 14 are rectangular in cross-section they may be cylindrical, or have any other condenser form. The interiors of these shells 13 and 14 are provided with longitudinal inclined partitions 15 and 16 extending from the top on one side downwardly to within a short distance of the bottom, said inclined partition 15 thus dividing the shell 13 into two chambers 31 and 32, the chamber 31 having a top steam inlet, and the chamber 32 having a bottom steam inlet; and said inclined partition 16 dividing the shell 14 into two chambers 33 and 34, the chamber 33 having a top steam inlet and the chamber 34 having a bottom steam inlet. The inclined partitions 15 and 16 may be of any desired length and may project or lie in a variety of different ways. The object thereof is to afford a greater area to the steam inlet for the entrance of the steam, at which time the volume of the steam is the greatest. Consequently, these partitions are preferably connected to the condenser shell at the top on one side, so that the opening or steam inlet at the top can virtually be the entire width of the shell, and said partitions by occupying an inclined position cause the width of the upper chambers to decrease from the top downward, while the width of the other chambers decreases from the bottom upward.

It should also be observed that the partitions 15 and 16 divide the tubes containing the cooling water, the division being on lines that are different from the divisions into nests or batteries, which latter correspond to the passes required of the cooling water back and forth. In the chamber 31 is a group of water-cooled tubes 17; and in the chamber 32 is a similar group of water-cooled tubes 18; also in the chamber 33 is a group of water-cooled tubes 19, and in the chamber 34 is a group of water-cooled tubes 20.

At one end of each of the shells 13 and 14 is a chamber 28, and at the other end two chambers, an upper one 29 and a lower one 30, said chambers 29 and 30 being separated by a horizontal partition. This arrangement of the end chambers gives two passes to the cooling water through these condensers 13 and 14 and requires two nests of tubes, an upper and a lower, the upper nest running from chamber 29 to chamber 28, and the lower nest from chamber 28 to chamber 30. Of course, this is merely an example of arrangement of the tubing, for there may obviously be any number of nests to provide

for any number of passes for the water. With the particular arrangement specified, however, it will be obvious that the tubes 17 and 19, located in the top steam inlet chambers of these duplicate condensers of which we are speaking, will consist in part of tubes belonging to the pass of the water from chamber 28 to chamber 29, and in part of tubes belonging to the pass of the water from chamber 30 to chamber 28; and furthermore that the tubes 18 and 20, located in the bottom steam inlet chambers will consist in part of tubes extending between chamber 30 and chamber 28, and in part of tubes extending from chamber 28 to chamber 29. The two upper chambers 29 are connected together by a water pipe provided with an inlet 26 (see Fig. 4), and the two lower chambers 30 are connected together by a water pipe provided with an outlet 27. (See Fig. 5.)

The circulating water which enters at the inlet mouth 26 flows first into the two upper terminal chambers 29 and thence through the tubes running from chambers 29 to chambers 28, which tubes will obviously be some of the tubes 17, the upper portion of them, and some of the tubes 18, the upper portion of them; and also through some of the tubes 19, the upper portion of them, and some of the tubes 20, the upper portion of them, to the opposite ends of the shells 13 and 14, where the water will enter the chamber 28, whence it returns through the remainder of the tubes 17 and 18 and 19 and 20 to the lower terminal chambers 30 and has an outlet from the condensing apparatus through the eduction mouth 27. Thus it will be seen that the tubes 17 and 19 which occupy the top steam inlet chambers 31 and 33 are progressively warmer from top to bottom, for the tubes in the lower portion of these chambers 31 and 33 belong to the second pass of the water and when making this second pass it has been warmed to a certain extent; while the tubes 18 and 20 which occupy the bottom steam inlet chambers 32 and 34 are progressively cooler from bottom to top, since the lower part of tubes 18 and 20 belong to the second pass of the water, while the upper portion belong to the first pass; it being observed that the partitions 15 and 16 so divide the tubes that this very desirable and novel result is attained. Steam from the turbine A enters the shell 13 through the opening 21 and the shell 14 through the opening 22 and comes first into contact with some of the tubes 17 and some of the tubes 19, which being connected to the chambers 29 and belonging to the first pass of the water are the coldest; and the steam courses downwardly in contact with the tubes and around the lower edges of the partitions 15 and 16 until it reaches the tubes 18 and 20 and flows upwardly in contact therewith; the water of condensation falling back into the bottom of the shells 13 and 14, while the air passes upwardly and out through the opening 35 in shell 13, and 36 in shell 14, the air being withdrawn by a vacuum pump as indicated in Fig. 12. The water of condensation falls to the bottom of the shells 13 and 14 and goes out thence through the outlet pipes 23 having a connection 24, which has a coupling 25 which connects with a hot well pump. Here then the circulating water in each of these duplicate condensers enters at or near the top of the condenser, passes in one direction and then back and leaves at the bottom. It may, however, when the two condensers operate and act as one, pass first through the second section or the one in which the air is cooled before exit, and then through the initial section, or the one into which the exhaust steam and air first enter, or it may pass more than once through each, or either in series or multiple, the main object being to bring the air and the last portion of the steam into contact with the coldest tubes, and to cause the water of condensation to be heated by the exhaust steam to a temperature closely approximating that of the incoming exhaust steam before the removal to the atmosphere. And in the particular arrangement set forth in Figs. 4 and 5, it will be noted that the bottom steam inlet chambers 32 and 34 contain, near their top, some of the coldest tubes which are situated close to the eduction openings 35 and 36 for the air, so that the air is brought into contact with the coldest tubes before being withdrawn, and furthermore the steam heats up the water in the bottom of the two condensing shells so that when the water leaves the condensers it very closely approximates in temperature that of the incoming exhaust steam.

In Figs. 6 and 7, substantially the same construction and arrangement of parts obtains as in Figs. 4 and 5, with the exception that in lieu of the inclined division plates 15 and 16 I employ vertical plates 15^a and 16^a which lie parallel to the side walls of the condenser shells 13 and 14 and which direct and guide the movement of the exhaust steam, first toward the bottom and then upwardly in like manner as it is guided by the plates 15 and 16, the water of condensation being removed from the bottom of the shells 13 and 14 by the pipes 23^a having a coupling 25 by which connection is made with the hot well pump, and the air being removed through the openings 35 and 36 under the action of the vacuum pump as is the case in Figs. 4 and 5. Thus in Figs. 6 and 7, there are duplicate condensers having practically the same construction and each consisting of two chambers in combination, one chamber having a top steam inlet and the other having a bottom steam inlet, so that the water of condensation may be heated up to as high a temperature as possible before removal, while the air may be made as cold as possible before it is withdrawn.

In Figs. 8 and 9, I have delineated another form of the invention. 56 denotes the condenser shell containing three nests of water-cooled tubes, 57, 58 and 59, which nests are situated in vertical series; that is to say, are horizontal nests. At one end of the shell 56 are the two water chambers 60 and 61, and at the other end of the shell are the two water chambers 62 and 63. The nests of tubes 57, 58 and 59 connect with these end chambers in the usual manner, and the circulating water follows the course indicated by the arrows in Fig. 9, it having three passes through the condenser. The shell 56 is of cylindrical form, and the exhaust inlet 64, instead of being directly on top is arranged laterally at the top, thus showing a slight modification from the form of inlet indicated in the other figures of the drawing, but with no change in function or purpose, for it is an upper or top steam inlet. The shell 56 is provided with an inner radial inclined partition 65 which divides the shell into two chambers, an upper one having a top steam inlet, and a lower one having a bottom steam inlet. The shell 56, furthermore, has the outlet 66 for the water of condensation, the outlet 67 for the air, the water inlet 68 and the water outlet 69.

In Fig. 10 I show a cross-section of a condenser shell

and indicate in an outline or diagrammatic way how the different pumps are connected thereto. The form of condenser is the same as that shown in Fig. 8. 70 denotes a pipe leading from the outlet 66 for the water of condensation to the hot well pump 71. 72 denotes a pipe running between the water inlet 68 and the water circulating pump 73 by means of which the cooling water is forced into the cooling tubes and caused to circulate through the condenser. 74 designates a suitable pipe leading from the air outlet nozzle 67 to the vacuum pump 75, by means of which the cooled air is withdrawn from the condenser shell. Obviously the pumps 71, 73 and 75 may be constructed, each of them, after any approved and desired pattern or type, and I do not wish to be restricted to any particular design. The outline form which I delineate in Fig. 10 is offered simply by way of example, and in order to explain the connection of one form of pump for the performance of the function attributed to each.

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

1. In a surface condenser for the condensation of exhaust steam and the production of a vacuum, the combination of a chamber having an inlet at or near the top for the admission of exhaust steam, in which chamber the exhaust steam, the air commingled therewith and the water of condensation all travel in a downward direction, a chamber having an inlet at or near the bottom for the admission of exhaust steam in which chamber the exhaust steam and the air commingled therewith both travel in a reverse direction to that of the water of condensation, and condensing surfaces in the chambers, some of the surfaces being colder than the others and means for introducing the cooling water first into the upper part of the condenser, all arranged so that the air may be brought into contact with the coldest surfaces in the second chamber before removal and the water of condensation into contact with the hottest surfaces and with the exhaust steam before removal.

2. In a surface condenser for the condensation of exhaust steam and the production of a vacuum, said condenser having horizontal tubes containing cooling water, said tubes arranged in groups or nests some of which are colder than the others and those nearest the top receiving the cooling water first, the combination of a chamber having an inlet above for the exhaust steam, in which chamber the exhaust steam, the air commingled therewith and the water of condensation all travel together in the same direction, with a chamber having an inlet for the exhaust steam below, in which chamber the exhaust steam and the air commingled therewith both travel in a reverse direction to that of the water of condensation, the coldest tubes in the second chamber being contiguous to the point where the air is removed, so as to bring the air into contact with said coldest tubes before removal and the water of condensation into contact with the exhaust steam before removal.

3. In a surface condenser, the combination with a steam motor, of a base therefor comprising condensing apparatus consisting essentially of divisions or chambers having horizontal tubes containing cooling water, one of said chambers being a top-steam-inlet chamber and another being a bottom-steam-inlet chamber, means for dividing these chambers from each other so that the exhaust steam may pass readily from one to the other, said means directing the steam away from the outlet for the air, means for causing a water circulation through the tubes, and means for withdrawing the air from the condenser in such a manner that the air may be brought into contact with the coldest surfaces before removal and the water of condensation may be brought into contact with the hottest surfaces and with the exhaust steam before removal.

4. In a surface condenser, the combination with a steam motor, of a base therefor comprising condensing apparatus consisting essentially of a chamber having an inlet above for the exhaust steam, in which chamber the exhaust steam, the air commingling therewith and the water of condensation all travel together in the same direction, and a second chamber which receives the exhaust steam below from the first chamber, in which second chamber the exhaust steam and the air commingled therewith both travel in a direction the reverse of that in the first chamber, condensing surfaces in the two chambers varying as to coldness, means for dividing the chambers from each other, said means directing the steam away from the outlet for the air, all being arranged so that the air may be brought into contact with the coldest surfaces before removal and the water of condensation into contact with the exhaust steam before removal.

5. In a surface condenser, the combination of an upper-steam-inlet chamber in which the exhaust steam, the air commingled therewith and the water of condensation travel in the same direction, a lower-steam-inlet chamber in which the exhaust steam and the air commingled therewith travel in one direction and the water of condensation in another direction, horizontal tubes in said chambers arranged in nests or groups, some colder than the others and the coldest first receiving the circulating water, together with means for introducing the circulating water first into the upper part of the condenser, all arranged so that the air is brought into contact with the coldest surfaces before removal, and the water of condensation with the exhaust steam before removal.

6. In a surface condenser having horizontal tubes containing cooling water of a section in which the exhaust steam enters above, in combination with another section in which the exhaust steam enters below after leaving the first section, while the circulating water enters above, and the air separated from the exhaust steam is removed above, so as to bring the air in contact with the coldest tubes before removal while the water of condensation is brought in contact with the hottest tubes.

7. In a surface condenser for the condensation of exhaust steam and the production of a vacuum, a condensing chamber containing tubes for the cooling water and provided at or near the top with an exhaust inlet, in combination with a second condensing chamber containing cooling tubes for the cooling water and provided with an exhaust inlet at the bottom through which steam is transferred from the first chamber, and provided also with an air outlet at or near the top, and means for first introducing the circulating water into the upper part of the condenser, so that some of the coldest tubes may be in the second chamber adjacent to the air outlet, in order that the air may be brought into contact with said cold tubes before removal.

8. In a surface condenser for the condensation of exhaust steam and the production of a vacuum, a condensing chamber containing a water-cooled surface, in which chamber the exhaust steam and water of condensation travel in the same direction, and the inlet for the exhaust is above, in combination with a second condensing chamber also containing a water-cooled surface and receiving steam from the first chamber, in which second chamber the exhaust steam enters below and travels in a reverse direction, and in the upper part of which is an air outlet, a water inlet for the circulating water in the upper part of the condenser, said water-cooled surfaces being colder in some parts of the condenser than in others, accordingly as they are related to the water inlet, and the air outlet being contiguous to the coldest of said surfaces.

9. In a surface condenser, the combination of a top-steam-inlet chamber, a bottom-steam-inlet chamber, means for dividing the chambers from each other so that the exhaust steam may pass readily from one to the other, said means directing the steam away from the outlet for the air, horizontal water-cooled tubes and means for causing a water circulation through said tubes, and means for withdrawing the air from the condenser at or near the point where the cooling water first enters the tubes.

10. In a surface condenser, a shell having a steam inlet at or near the top and an air exit at or near the top separate from the steam inlet, in combination with a partition directing the steam away from the air exit and dividing the shell into two communicating chambers, and tubes

arranged in nests in said chambers, in one of which chambers the steam, the commingled air and the water of condensation travel together in the same direction, and in the other of which the steam and the commingled air travel in a direction opposite to that of the travel of the water of condensation.

11. In a surface condenser, a shell having a steam inlet, an air outlet, and a water outlet, in combination with means for dividing the shell into two chambers, said means directing the steam away from the air outlet, one of which chambers receives steam from above and in which the steam, the commingled air and the water of condensation travel in the same direction, and the other of which chambers receives steam from below and in which the steam and the commingled air travel in reverse direction, tubes arranged in groups or nests in said chambers, the coldest group being adjacent to the air outlet, a dry vacuum pump for removing the air from the air outlet, and a hot well pump to remove the water of condensation.

12. In a surface condenser, a shell having a steam inlet at or near the top and an air exit at or near the top separate from the steam inlet, in combination with a partition directing the steam away from the air exit and dividing the shell into two chambers, and tubes arranged in nests in said chambers, in one of which chambers the steam, the commingled air and the water of condensation travel in the same direction, and in the other of which the steam and the commingled air travel in a reverse direction, a circulating pump for causing the cooling water to flow through the tubes, a vacuum pump for removing the air, and a hot well pump to remove the water of condensation.

13. In a surface condenser for the condensation of exhaust steam and the production of a vacuum, a shell having a steam inlet at or near the top, in combination with a division plate or wall directing the steam away from the air exit and sending it first downward and then upward, a hot well pump to remove the water of condensation, and a condensing surface which is coldest where the circulating water first enters it, the entrance being first from above, and an air outlet adjacent to the coldest part of the cooling surface, so that the air may be brought into contact therewith before removal.

14. In a surface condenser for the condensation of exhaust steam and the production of a vacuum, a shell having a steam inlet at or near the top, in combination with a division plate or wall directing the steam first downward and then upward, said plate dividing the shell into two chambers, in one of which the steam passes downward and in the other of which it passes upward, and the nests of tubes in said chambers whereby the cooling water makes the requisite number of passes through the condenser, the nest into which the circulating water is first introduced being at the top and the coldest and being located contiguous to the point where the air is removed from the condenser.

15. In a surface condenser for the condensation of exhaust steam, a shell having a steam inlet at or near the top, and an air exit at or near the top separate from the steam inlet, a division plate or wall directing the steam away from the air exit and first downward and then upward, condensing surfaces the coldest of which is at or near the top near the air exit, a hot well pump to remove the water of condensation, and a dry vacuum pump to remove the air.

16. In a surface condenser, a shell having a steam inlet at or near the top, an air exit at or near the top and a water outlet at the bottom, in combination with a division plate or wall directing the steam away from the exit of the air and causing it to flow first downward and then upward, nests of water-cooled tubes situated at both sides of the division plate, a hot well pump to remove the water of condensation, a dry vacuum pump to remove the air, and a circulating pump to cause the cooling water to flow through the tubes.

17. The combination with a surface condenser having an exhaust steam inlet at or near the top, an air exit at or near the top separate from the steam inlet, and a water outlet, of a partition or wall deflecting the steam first away from the opening for the exit of the air, a condensing surface having its coldest part nearest to the air exit, a dry vacuum pump to remove the air, and a hot well pump to remove the water of condensation, and means for introducing the cooling water first into the upper part of the condenser.

18. In a surface condenser, the combination of a chamber admitting exhaust steam above, a second chamber admitting exhaust steam below, means for dividing the chambers from each other so that the exhaust steam may pass readily from one to another, groups or nests of water-cooled tubes arranged longitudinally in said chambers and parallel thereto, means for introducing the circulating water into the tubes first at or near the top and causing it to circulate through the different nests, and an air exit situated in the shell of the condenser contiguous to some of the coldest tubes.

19. In a surface condenser, a shell having a steam inlet at or near the top and an air exit at or near the top separate from the steam inlet, in combination with a partition directing the steam away from the air exit and dividing the shell into two communicating chambers, and tubes arranged in nests in said chambers, said tubes being placed longitudinal of the chambers and parallel to the partition, together with means for introducing and circulating the cooling water through the tubes, said air exit being contiguous to the coolest group of tubes.

20. In a surface condenser, a shell having a steam inlet at or near the top and an air exit at or near the top separate from the steam inlet, in combination with a partition directing the steam away from the air exit and dividing the shell into communicating chambers, nests of tubes in said chambers, which tubes are parallel to the partition, means for causing circulating water to enter the tubes above, so that the air may be brought into contact with the coldest tubes before removal and the water of condensation with the hottest tubes and with the exhaust steam before removal.

21. In a surface condenser, a shell having a steam inlet and an air exit separate from the steam inlet, in combination with a partition directing the steam away from the air exit and dividing the shell into two communicating chambers, and tubes arranged in nests in said chambers, said tubes being longitudinal in the chambers and parallel to the partition, together with means for introducing and circulating the cooling water through the tubes the entrance for the cooling water being first into the upper part of the condenser, said air exit being contiguous to the coolest group of tubes.

22. In a surface condenser, the combination with a steam motor, of a base comprising condensing apparatus consisting essentially of a chamber having an inlet above for the exhaust steam, in which chamber the exhaust steam, the air commingled therewith and the water of condensation all travel together in the same direction, and a second chamber which receives the exhaust steam below from the first chamber, in which second chamber the exhaust steam and the air commingled therewith both travel in a direction the reverse of that in the first chamber, and condensing surfaces in the two chambers varying as to coldness, some of the coldest being in the upper portion of the second chamber, so that the air may be brought into contact with said coldest surfaces before removal and means for introducing the cooling water first into the upper part of the condenser.

23. In a surface condenser, the combination of an upper-steam-inlet chamber in which the exhaust steam, the air commingled therewith and the water of condensation travel in the same direction, a lower-steam-inlet chamber in which the exhaust steam and the air commingled therewith travel in one direction and the water of condensation in another direction, horizontal tubes in said chambers arranged in nests or groups, some colder than the others and the coldest first receiving the circulating water from above, all arranged so that the air is brought into contact with the coldest surfaces before removal.

24. In a surface condenser, the combination with a steam motor, of a base comprising condensing apparatus consisting essentially of divisions or chambers having horizontal tubes containing cooling water, said divisions or chambers primarily receiving the exhaust steam and air commingled therewith at or near the top of the con-

denser and which provide an exit for the air separate from the steam at or near the top of the condenser, while the removal of the water of condensation is below, and means for introducing the cooling water first to the upper part of the condenser.

25. In a surface condenser, the combination with a steam motor, of a base comprising condensing apparatus for the condensation of exhaust steam and the production of a vacuum, consisting essentially of a chamber having an inlet above for the exhaust steam, in which chamber the exhaust steam, the air commingled therewith and the water of condensation all travel together in the same direction, and a second chamber which receives the exhaust steam below from the first chamber, in which second chamber the exhaust steam and the air commingled therewith both travel in a direction the reverse of that in the first chamber, condensing surfaces in the two chambers varying as to coldness, means for dividing the chambers from each other so that the exhaust steam may pass readily from one to the other, said means directing the steam away from the outlet for the air, and means for introducing the cooling water first to the upper part of the condenser.

Signed at New York city this 26th day of July 1904.

LOUIS R. ALBERGER.

Witnesses:
JOHN H. HAZLETON,
I. HEIBERG.