No. 764,541. PATENTED JULY 12, 1904.

L. R. ALBERGER.

SURFACE CONDENSER.

APPLICATION FILED APR. 16, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

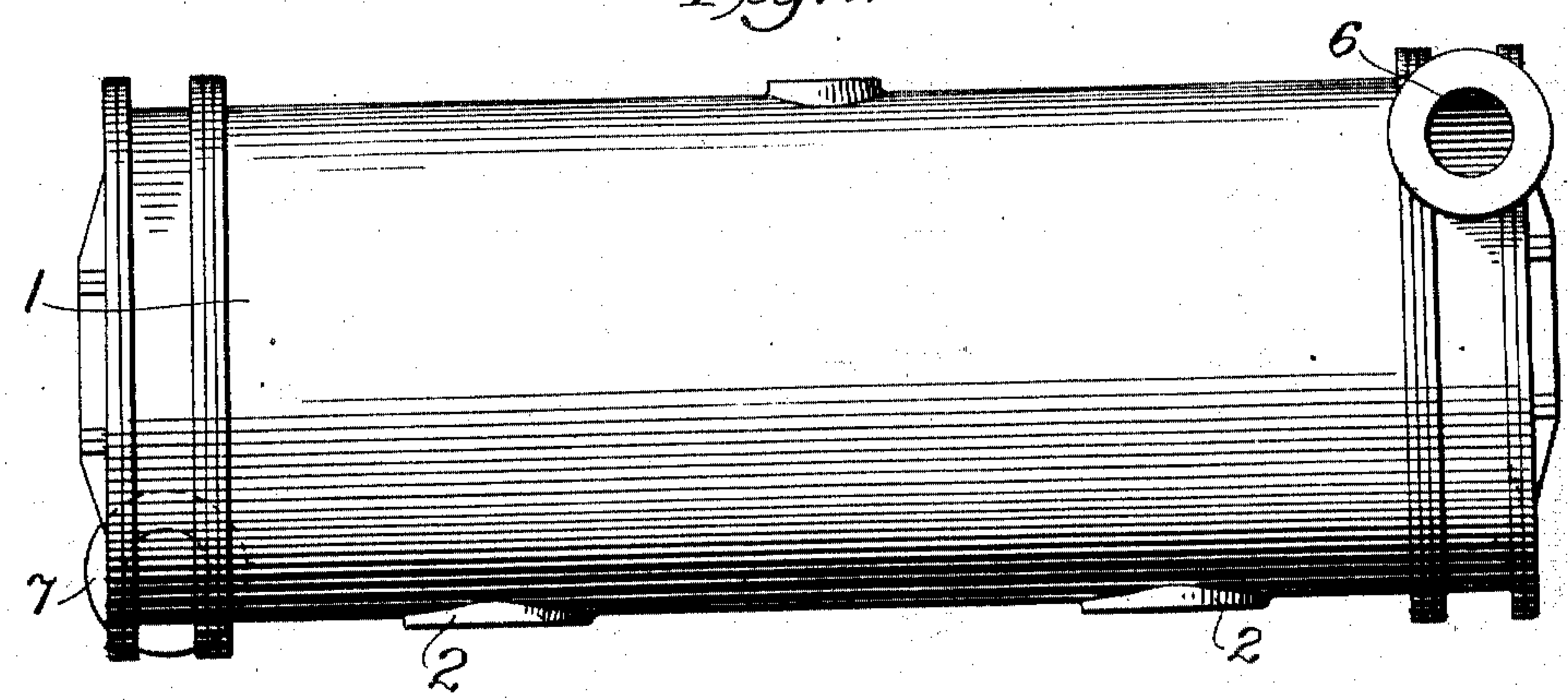
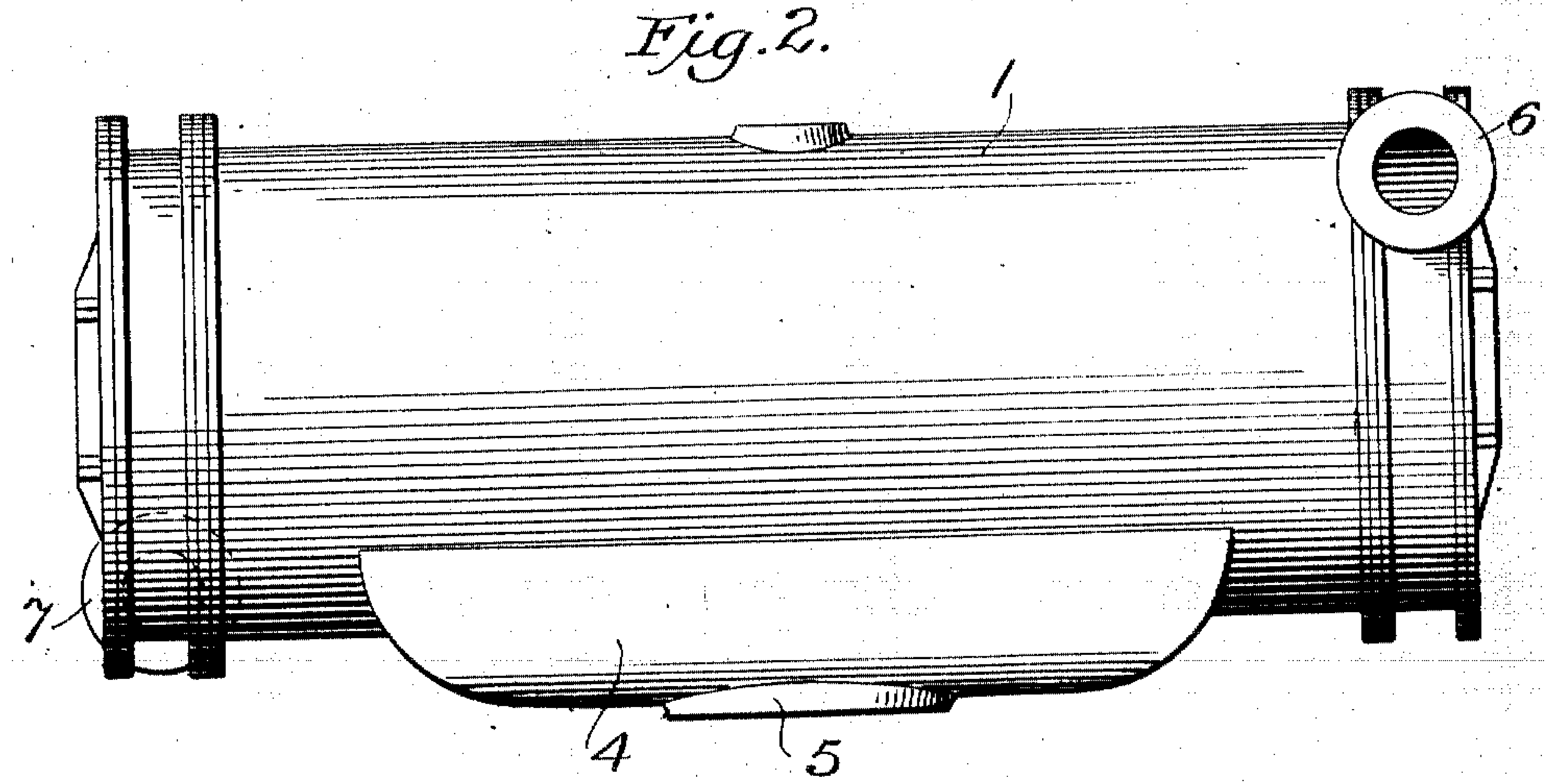


Fig. 2.



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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

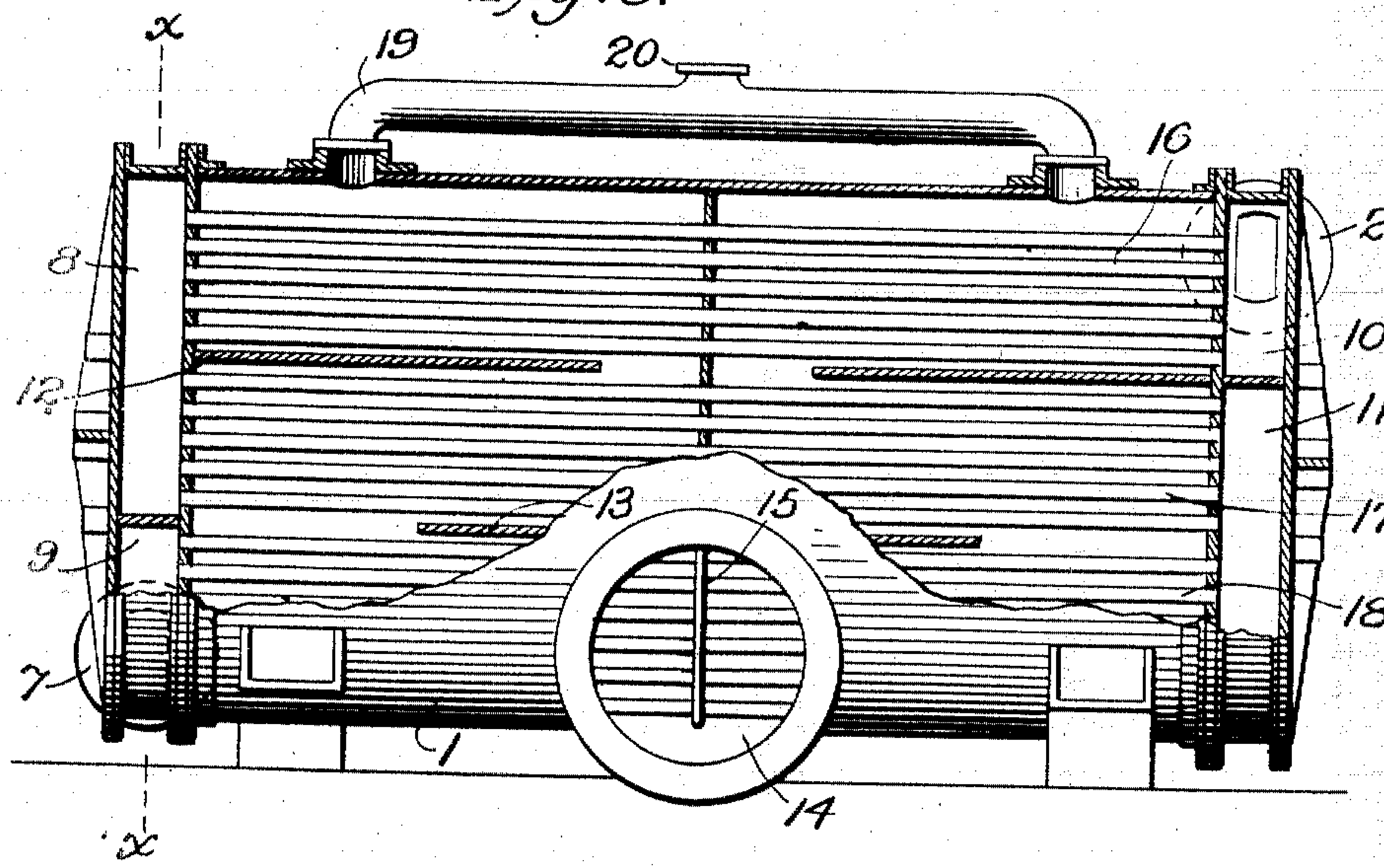
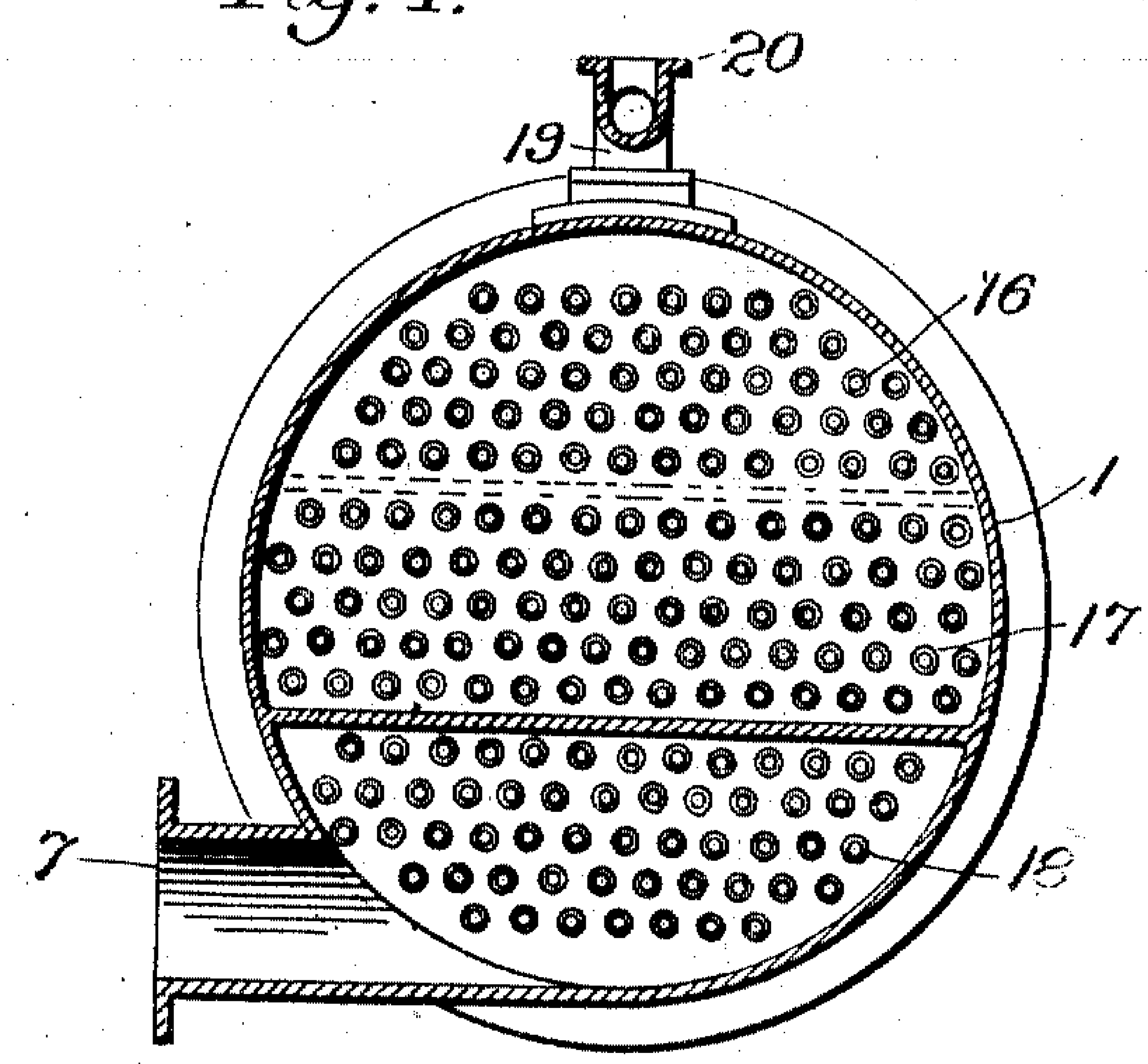


Fig. 4.



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UNITED STATES PATENT OFFICE.

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SURFACE CONDENSER.

SPECIFICATION forming part of Letters Patent No. 764,541, dated July 12, 1904.

Application filed April 16, 1903. Serial No. 152,903. (No model.)

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 Greenwich, in the county of Fairfield, State of Connecticut, have invented certain new and useful Improvements in Surface Condensers, of which the following is a specification.

This invention relates to the production of a vacuum and the condensation of exhaust-steam from engines and other steam-motors, and particularly to that class of apparatus known as "surface" condensers, in which the condensation is produced by the contact of the exhaust-steam with metallic surfaces cooled by water and in which the vacuum is maintained by a vacuum or air pump.

A leading object is to bring exhaust-steam into contact with metallic surfaces usually consisting of tubes and containing the cooling-water in such a manner that the water resulting from the condensation will leave the condenser, which is the vessel in which the condensation takes place, at the highest possible temperature and one approximating that of the steam itself and to withdraw the air from the condenser free of water and cooled to the lowest possible temperature and one approximating that of the incoming cooling-water.

In a surface condenser of the common construction the exhaust-steam is ordinarily introduced into the steam-space of the condenser from above and caused to travel in a downward direction in contact with the tubes that convey the cooling or circulating water, while the water resulting from the condensation of the steam, together with the entrained air and uncondensable vapors, travels in the same direction and is finally removed from the condenser by the vacuum-pump placed below, and also the cooling-water, which usually passes through the tubes, enters at the bottom and circulates through one or more nests or groups of tubes and leaves the condenser at the top.

The condensation of steam in a condenser takes place when the temperature of the steam becomes lower than the temperature due to the vacuum or pressure of water-vapor that obtains. At this time the temperature of the water that results from the condensation is but slightly lower than that of the steam, and if it could be instantly removed from the condenser it would carry with it the greatest possible amount of heat and a high efficiency would be obtained; but in condensers of the common construction the water of condensation as it falls down through the condenser is brought in contact with the tubes containing cool water until it is finally removed after passing through the lower nest of tubes containing the coldest circulating water. As a result it leaves the condenser at a temperature which experience has shown to be about midway between that of the cooling-water and that of the exhaust-steam. The air and uncondensable vapor passing in the same direction and in contact with the water of condensation acquires practically the same intermediate temperature and they are usually both removed by a single pump, known as a "wet" vacuum-pump.

For the attainment of the object and purposes of the present invention the latter may be said to consist, essentially, in a condenser having the steam and cooling-water passing through it in directions the opposite of that just described—that is to say, the direction of flow of each is reversed—and as one of the consequences the water of condensation travels against the entering steam, air, and uncondensable vapors instead of with them; and also the invention consists in means for causing steam to enter at or near the bottom of the condenser on the same center line as the tube-support or at points equally distant therefrom on opposite sides of the latter; and, further, the invention comprises numerous details in the construction, combination, and arrangement of parts, substantially as will hereinafter be described and claimed.

In the annexed drawings, illustrating my invention, Figure 1 is a side elevation of one example of my improved surface condenser having two steam-inlets at the bottom. Fig.

2 is a similar view of another example of the condenser having a single steam-inlet at the bottom. Fig. 3 is a longitudinal section of my improved surface condenser. Fig. 4 is a cross-section on the line $x\,x$ of Fig. 3.

Like numerals of reference denote like parts in all the figures.

This invention shows its greatest value in large machines and in the creation of high ranges of vacuum and where the greatest efficiency is required, as with steam-turbines and vacuum-pans. The old system has many serious objections in such cases, which I am now seeking to overcome. Hitherto it has been found desirable in the production of high ranges of vacuum to pump the air by means of a separate dry vacuum-pump from which water is excluded. Consequently if such a vacuum-pump be connected to the opening at the bottom of the ordinary and common condenser the air will carry with it the water of condensation, and additional means must be provided to separate the latter from the air and remove it from the system by another pump or suitable means. Further, the air being in contact with the water of condensation has a temperature which is considerably above that of the incoming water, and so is not in the best possible condition to be pumped by the vacuum-pump.

Unless the air is cool it is not in the best condition to pump, because the pumping of air by a vacuum-pump from the low pressure of a high vacuum to that of the atmosphere into which it is discharged requires a compression of several volumes into one. For instance, with twenty-eight inches of vacuum or one pound absolute pressure the ratio of compression is fifteen to one, and the lower the temperature during the compressions the higher the efficiency of the vacuum-pump, and this is best obtained by starting with the lowest temperature attainable. Again, the steam that is condensed by the tubes containing the heated circulating water falls down and is cooled by the lower tubes containing the cooler incoming water, so that the water of condensation when it is finally removed at the bottom of the condenser has a temperature considerably below that of the exhaust-steam entering the condenser and is not at the most desirable temperature for boiler-feeding. The loss of efficiency by this method can be made plain by taking a case in which the temperature of the exhaust-steam is 125° Fahrenheit and that of the circulating water 75° Fahrenheit. The condensed water usually has a temperature about 100° Fahrenheit, or 25° below that of the steam. It is a well-established fact that a fuel loss of about one per cent. is made by each decrease of 10° in the temperature of the boiler feed-water, and as the water of condensation is usually employed for that purpose the loss in economy as compared with having feed-water at the same temperature as the steam, or 125° Fahrenheit, is about two and one-half per cent. of the fuel consumption.

In my present improved condenser the exhaust-steam enters the shell 1 at or near the bottom through the inlet-opening 5, as shown in Fig. 2, or the lateral bottom opening 14, as in Fig. 3, or the twin openings 2 2, as in Fig. 1, or through some other suitable arrangement of inlets and passes upward and comes into contact with the tubes carrying the circulating water. The shell 1 may or may not have the form of bottom 4, and it preferably contains several nests of tubes, as 16, 17, and 18, so that the water may pass several times from one end of the condenser to the other, each pass being made through a separate nest of tubes. The circulating water reaches the condenser through water-inlet 23 and chamber 10, from which it first passes through the upper nest of tubes 16. From tubes 16 it enters the chamber 8, whence it enters the second nest of tubes 17 and flows again through the condenser. At the opposite end of tubes 17 the water enters chamber 11 and from the latter flows into the lowest nest of tubes 18, through which it again passes through the condenser and finds its way into chamber 9. From this chamber the cooling-water has exit through the eduction-opening 7. Thus the circulating water passes through the upper nest of tubes first and then downward and out at the lower side of the condenser. Consequently exhaust-steam strikes the hottest tubes first, and the air and uncondensable vapor remaining after the condensation of the exhaust-steam comes in contact with the upper or coolest nest of tubes before being withdrawn from the top of the condenser by the dry vacuum-pump. The withdrawal of the air and uncondensable vapor is made at one or more points—as, for example, through the pipe 19, which connects with the top of the condenser-shell 1 at two points, as shown in Fig. 3, and is furnished with a middle exit 20, which communicates with the air-pump. The water resulting from the condensation of the exhaust-steam falls downward by gravity, and whatever its temperature may be at the time of condensation it is heated up to a temperature approximating that of the exhaust-steam by contact with the latter before said water leaves the condenser at the bottom. The general result is that a more complete transfer of heat is obtained and greater efficiency secured, less circulating water is needed, and the water resulting from the condensation is at a higher temperature and more desirable for boiler-feed. The air is removed in a cooled condition and free from water.

In the well-known construction of surface condensers in order to subdivide the water to as great a degree as possible and in that way obtain a large exposed tube-surface it becomes necessary to use a very large number of tubes of small diameter. As these tubes are usually secured to the tube-heads by stuffing-boxes to allow for the expansion and contraction of the tubes due to change in temperature, it follows that a number of stuffing-boxes must be provided, so that the longer the tubes can be made the fewer will be required and the fewer stuffing-boxes will be needed for a given amount of surface. For the same reason if fewer tubes are needed the tube-heads will be smaller in diameter. Accordingly it has come to be the practice to make tubes very long, and on account of their length it has become necessary to support them at about the center of their length by a vertical plate, as 15, on which rests the weight of the tubes and the water contained therein. Without this supporting-plate the tubes would have to be made shorter and the machine would be more expensive and less efficient. In order that the flow of air and steam through the condenser may be uniform and not disturbed or prevented by this supporting-plate, it is desirable to place the exhaust-steam inlet at or near the bottom of the condenser and either at the middle of its length, as shown at 14 and 5, or at points on opposite sides of the plate 15 and equally distant therefrom, as shown at 2 2, and to place the exit-opening for the air at or near the top of the condenser and either at the middle of its length or at points on opposite sides of the plate 15 and equally distant therefrom, as in the case with the two openings with which pipe 19 connects, as shown in Fig. 3.

What I claim is—

1. In a surface condenser, a shell containing tubes for the cooling-water, which are supported at a point or points between their ends, said shell having an exhaust-entrance for admitting steam at both sides and near the bottom of the tube-support.

2. In a surface condenser, a shell containing tubes for the cooling-water which are supported at a point or points between their ends, said shell having an exhaust-entrance at or near the bottom for admitting steam at both sides of the tube-support.

3. In a condenser, a shell containing a plurality of nests of tubes for the cooling-water, which tubes are supported at a point or points between their ends, said shell having also an exhaust-entrance at or near the bottom for admitting steam at both sides of the tube-support, an inlet above for the cooling-water to enter the tubes, and an outlet below for it to leave them, all arranged so that the exhaust-steam comes first into contact with the lowermost nest of tubes.

4. In a surface condenser, a plurality of nests of tubes for the cooling-water whereby it is passed back and forth, chambers connecting the ends of the nests of tubes, means for supporting the tubes at one or more points between their ends, an inlet above for the cooling-water to enter the tubes, and an outlet below for it to leave them, and a shell surrounding the tubes and having an exhaust-entrance for admitting steam at both sides and near the bottom of the tube-support, and bringing it first into contact with the lowermost nest of tubes containing the warmest water.

5. In a surface condenser for the condensation of exhaust-steam and the production of a vacuum, a condenser-shell containing tubes for the cooling-water which are supported at one or more points between their ends, said shell having an inlet below for admitting the exhaust-steam at both sides of the tube-support, and an outlet above for the air, the latter outlet being connected with a vacuum-pump, the object being to allow the exhaust-steam to travel in a direction opposite to that of the circulating water and opposite to that of the water of condensation.

6. In a surface condenser for the condensation of exhaust-steam and the production of a vacuum, a shell containing tubes for the cooling-water which are supported at or near their center, said shell having an inlet at or near the bottom at one or more points for the entrance of the exhaust-steam, which inlet admits steam equally at both sides of the tube-support, and said shell having also an upper outlet for the air at one or more points, connected with the vacuum-pump, said outlet being arranged symmetrically with reference to the said support.

7. In a surface condenser, a condenser-shell containing tubes for the cooling-water, and provided below with an inlet for the exhaust-steam, and above with an outlet for the air, from which outlet connection is made with a vacuum-pump, and an inlet above for the cooling-water to enter the tubes and an outlet below for it to leave them; in combination with means for supporting the tubes at one or more points between their ends, the exhaust-steam being admitted through its inlet equally at both sides of the tube-support.

8. In a surface-condenser for the condensation of exhaust-steam and the production of a vacuum, a condenser-shell containing tubes for the cooling-water which enters above and leaves below, and provided below the middle with an inlet for the exhaust-steam, and provided also above the middle with an outlet for the air; in combination with means for supporting the tubes at one or more points between their ends.

Signed at New York city this 15th day of April, 1903.

LOUIS R. ALBERGER.

Witnesses:
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A. E. SAMUELS.