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L. R. ALBERGER.

SURFACE CONDENSER.

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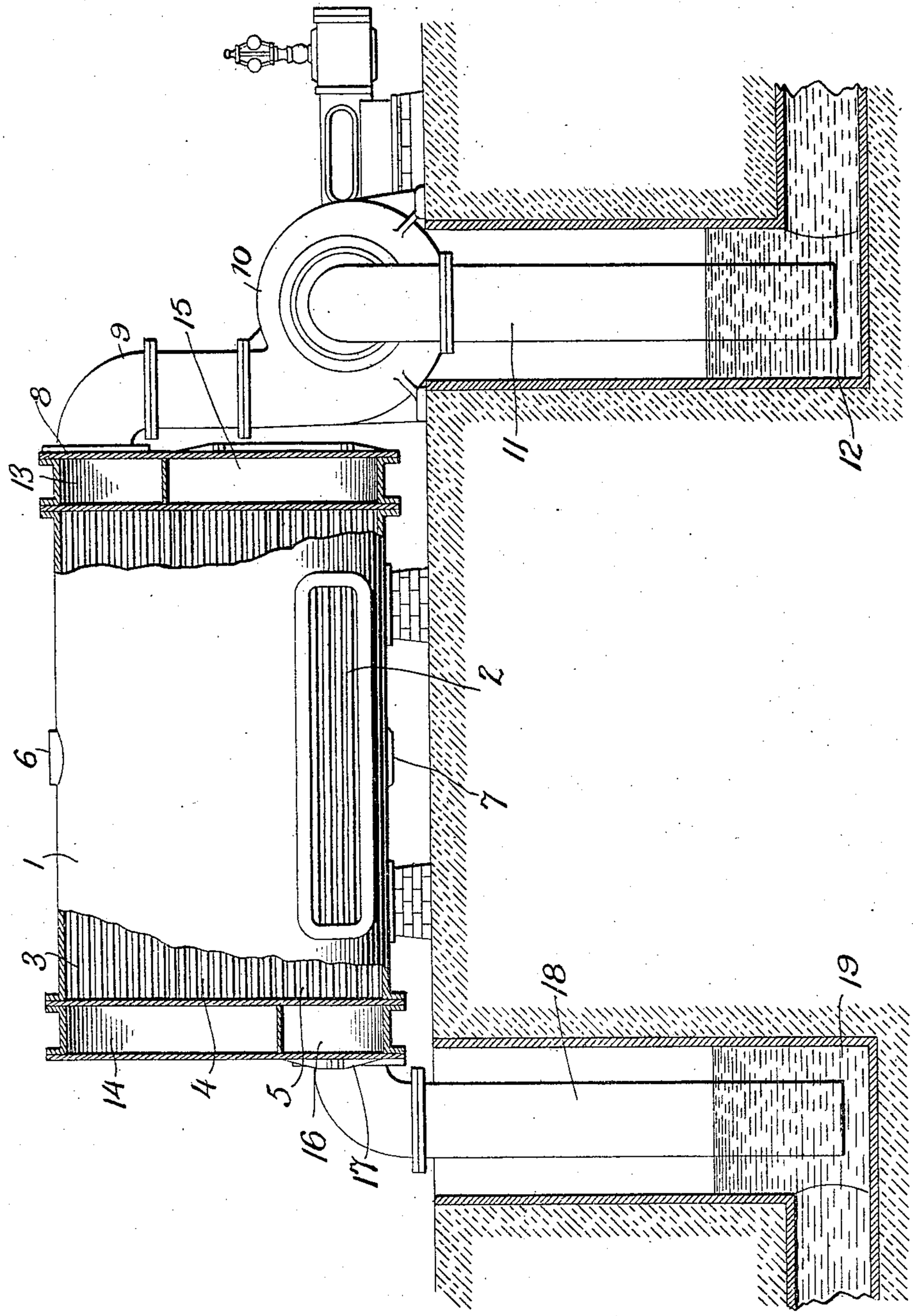

Witnesses
James F. Duhamel
A. E. Samuels.

Inventor
Louis R. Alberger,
By his Attorney
Fred C. Fisher.

UNITED STATES PATENT OFFICE.

LOUIS R. ALBERGER, OF NEW YORK, N. Y., ASSIGNOR TO ALBERGER CONDENSER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SURFACE CONDENSER.

No. 868,389. Specification of Letters Patent. Patented Oct. 15, 1907.

Application filed February 15, 1904. Serial No. 193,511.

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 consists in certain improvements in the condensation of exhaust steam from engines and other steam motors, and relates 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 the water, and in which a vacuum is maintained by a vacuum or air pump; and it relates moreover to that subdivision of the general class of surface condensers wherein the condenser is constructed and arranged to obtain a balanced column effect upon the circulating water passing through the condenser and its tubes, there being a circulating pump, an ascending column of water, and a descending column of water, so that the actual work of the pump is greatly minimized and economy in the operation subserved.

Heretofore it has generally been found desirable in using surface condensers in which a circulating pump draws the cooling water from a source of supply and discharges it through the condenser, to submerge the lower end of the pipe that receives the heated water after its passage through the condenser in a hot well or discharge conduit, whose level is the same or nearly the same as that of the cold well of the cold water supply, in order that a balanced column effect may be produced upon the circulating water passing through the condenser tubes, by which the descending column of water assists the ascending column of water, and the actual work exerted by the circulating pump is then only that due to the friction caused by the flow of the water through the piping and tubes of the condenser, and the energy required to put the water in motion. Aside from the economical feature of this method, the fact that a limited change in the levels of the hot and cold wells does not change the load upon the pump, makes the arrangement especially advantageous where there is a fluctuation in these levels, such as is caused by tides, freshets, or otherwise. This is preëminently so when centrifugal or turbine pumps are used to produce the circulation of the water, because they operate to best advantage and with least attention when under constant load. In a case of this kind, should the descending column of heated water from the condenser tubes to the hot well be too long vertically, or the water be too highly heated for the vertical distance that it has to fall, vaporization would take place on account of the vacuum in the descending column, and the balanced column action would be impaired, because the equilibrium would be broken. When this occurs, a sudden increase of load will be thrown upon the circulating pump, and if the latter be of the centrifugal or turbine type, this increase of load will result in a rapidly decreasing flow of water, until, in a very short time, the flow may cease entirely. This is especially so if the centrifugal pump is operated at a constant speed. The action is usually so rapid that it is impracticable to attempt to increase the speed of the pump to meet the emergency. Furthermore, if the motor driving the pump is capable of such increase in speed and consequent increase in load, it will, under ordinary conditions, be considerably underloaded, with a resulting loss of efficiency and greater first cost of the plant.

If the circulating water ceases to flow, the engines exhausting into the condenser will at once be thrown into a non-condensing condition, which would interfere more or less with their smooth operation, and greatly with their economy. It would also involve some difficulty in again getting the condenser in operation. It is, therefore, of great importance to safeguard the equilibrium of such a system.

The cooler the water is in the descending column and the greater the atmospheric pressure, the greater the height that may be employed, and vice versa. Frequently in practice, on account of overloads on the engines or turbines exhausting into the condenser, at which times steam greatly in excess of the normal amount may be condensed, or a partial stoppage of the flow of water by debris, the discharge water is heated to an abnormally high degree, and for this reason it becomes desirable for safe and uninterrupted operation, to have the descending column as short in vertical height as possible. As the ascending column contains water which has not yet reached the condenser, it is obvious that this column is not affected by the change in temperature produced in the condenser.

Therefore the object of this invention is to shorten the descending column of water to a considerable and very advantageous extent, and still obtain the best possible effect in the condensing apparatus. In shortening the column of water I obviously diminish the length of the pipe leading from the condenser to the hot well. This decrease in the length of the pipe is made possible by the peculiar arrangement of the condenser shell and its contained tubes, whereby the incoming exhaust steam is first brought into contact with the tubes containing the warmest water, and afterwards into contact with those tubes containing the coolest water. In this arrangement the cooling water is caused to enter at or near the top of the condenser, and after circulating through the various nests of tubes and performing its cooling function, it leaves at or near the bottom of the condenser, having become by that time heated to a greater or less extent. The steam enters at or near the bottom of the condenser, at any rate not at

the top, and is thus brought first into contact with the lowermost tubes which contain the circulating water in the warmest condition; and the air is brought last into contact with the tubes containing the coldest water before this air is removed by the dry vacuum pump. As the descending column of water is carried through a pipe attached to the discharge outlet at or near the bottom of the condenser, it is manifest that this descending column will be shortened several feet in condensers of ordinary size. It is moreover possible to use a balanced column in connection with my inproved condensers when the latter are of extremely large size where the height of the descending column may be shortened as much as 12 or 15 feet, or about one-half of the extreme possibility of use at sea level, and at normal temperature. In other words my invention makes practical the use of the balanced column idea in a great number of situations, and with water of higher temperatures, and permits of the use of the centrifugal or turbine type of pump for the circulation of water under a practically constant head or load.

In the annexed drawing illustrating an example of my invention, the figure shown is a vertical sectional view representing the relative arrangement of the different parts of my improved balanced column surface condenser.

The form of surface condenser illustrated in the drawing is similar to that shown and described in my copending application for Letters Patent filed April 16, 1903, Serial No. 152,903. The exhaust steam enters the shell 1 at or near the bottom through the lateral inlet opening 2, and passes upward and comes into contact with the tubes carrying the circulating water. The exhaust steam may however enter the shell higher up; or it may come in directly at the bottom. These circulating tubes are preferably arranged in nests 3, 4 and 5, 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 withdrawal of the air and uncondensable vapor is made at the top of the shell at some suitable point, as for instance the opening 6, which communicates with some suitable pump, as for instance a dry vacuum pump; and the water resulting from the condensation of the exhaust steam falls downward by gravity and leaves the condenser at the bottom through the opening 7.

The circulating water reaches the condenser through the water inlet 8, at or near the top of the shell 1, to which inlet 8 is attached the water supply pipe 9 leading from the centrifugal or turbine pump 10. 11 designates a suction pipe extending vertically for example, from the cold well 12 to the pump 10. Thus it will be seen that the circulating pump 10 when actuated delivers water to the cooling tubes, the delivery being at or near the top of the condenser, and that the pipes 9 and 11 convey an ascending column of cold water from the cold well to the condenser.

The cooling water which enters the condenser through inlet 8 first enters the chamber 13 from which it passes through the upper nest of tubes 3 to the chamber 14. From the chamber 14 it flows through the nest of tubes 4 to the chamber 15 and returns thence through the lower nest of tubes 5 to the chamber 16, from which the cooling water has exit through the eduction opening 17. Attached to this opening is for example, a pipe 18 which leads into the hot well 19. The direction in which this pipe runs may be simply vertical as shown, or it may lead in any other direction. The levels of the water in the cold well 12 and hot well 19 vary very little and may be considered as remaining practically the same. It will be manifest that the circulating water passing back and forth through the nests of tubes exposed to the exhaust steam will be warmest when it leaves the condenser and passes downward and outward at the lower side thereof into the discharge pipe 18. The lowermost nest of tubes with which the steam first comes in contact contains the warmest water, and the uppermost nest of tubes with which the air last comes in contact contains the coolest water, so that consequently the air is the coolest and the circulating water the warmest at the times respectively when they are about to leave the condenser. Inasmuch as the discharge pipe 18 for the circulating water is attached to the condenser shell at or near the bottom of the latter, it will be obvious that the descending column of discharging water will be very much shorter than the ascending column of incoming water, it being remembered that the water level in both wells remains practically the same. This shortening of the descending column of water is made possible by reason of the induction of the circulating water at or near the top of the condenser and its withdrawal at or near the bottom thereof.

It may here be remarked that generally the two wells, that is to say, the cold well from which the supply of circulating water is taken and the hot well into which it is discharged, are both a part of or connect with the same body of water, as for instance, a river, pond, or the sea, and hence the levels of both are virtually the same and subject to the same fluctuations. The levels being therefore practically the same, and when one fluctuates the other fluctuating similarly, it is evident that with the ascending and descending water columns there is a water system which is balanced statically or equilibrated. In speaking of hot and cold wells in connection with the present invention I have been employing terms well known in the art, but it is evident that cases may arise where the wells are omitted and where the supply and discharge pipes extend directly into the river, pond or other body of water, in which case there is merely a submergence or water-sealing of the ends of these pipes without the utilization of wells separate from but communicating with some main body of water, and my invention covers broadly all these modifications in the connection of the water columns with the water supply and the water body into which discharge is made. Furthermore, in cases where distinct wells are used, or distinct quantities of supply and discharge water, and where pipes connect them with a main body of water the flow of the water through the pipe from the hot well to the main body is retarded by the friction in the pipe, and the result is that the water in the hot well may rise slightly higher than the level of the water in the cold well, in which case there is a slight difference of levels, thus accounted for, but both levels are subject to the same fluctuation and are practically the same or would be were it not for the circumstance explained.

From the foregoing it will be understood that the water supply may be an ordinary cold well, or the main body of water in the river or pond; and that the hot well,

or discharge body of water, or discharge as I sometimes call it, may be the usual hot well, or the main body of water in the river, or any other means for receiving the heated water from the heated column.

When once the entire circulating system has been primed with water a double balanced column will be established including the ascending and descending columns of water and the tubes in the condenser, and when once this balanced condition has been established it will continue so long as the conditions remain the same, and the only work then done by the circulating pump when it is operated will be that due to the friction caused by the flow of the water; and since the descending column of water through pipe 18 is short there will be little danger of vaporization, and little danger of a resulting breaking of the descending column which would destroy the effect of the double balanced column.

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

1. The combination with a surface condenser located above the level of the water supply, of a pump circulating cooling water through a balanced water system comprising essentially means containing an ascending column to the top of the condenser and means containing a descending column from the bottom of the condenser, the ascending column being drawn by the pump from the supply, and the descending column delivering into a discharge body of water, both the supply and discharge body being on substantially the same level.

2. The combination with a surface condenser located above the level of the water supply, of a balanced water system comprising essentially means containing an ascending column of cool water to the top of the condenser and means containing a descending column of heated water from the bottom of the condenser, these columns statically balancing each other, and a pump taking water from the supply and circulating it through the system and delivering it into the discharge body of water, both supply and discharge body being on substantially the same level.

3. The combination with a surface condenser located above the level of the water supply, of a balanced water system comprising essentially the condenser, means containing an ascending column of cool water to the top of the condenser, means containing a descending column of heated water from the bottom of the condenser, these columns statically balancing each other, and a pump circulating water through the system, said pump being located between the supply from which the water is taken and the discharge body into which it is delivered, and the load upon said pump being unchanged by fluctuations in the water level.

4. The combination with a surface condenser located above the level of the water supply, of an equilibrated water system comprising essentially the condenser, means containing an ascending column of water to the top of the condenser and means containing a descending column of water from the bottom of the condenser, these columns statically balancing each other, and a centrifugal or turbine pump circulating water through the system from the supply to the discharge, both the supply and the discharge body of water being on substantially the same level.

5. The combination with a surface condenser located above the level of the water supply, of an equilibrated water system comprising essentially the condenser, means containing an ascending column to the top of the condenser and means containing a descending column from the bottom of the condenser, these columns statically balancing each other, and a centrifugal or turbine pump located between the supply from which it takes the water and the discharge body into which it delivers the water, both supply and discharge body being on substantially the same level which is below the condenser.

6. The combination with a surface condenser located above the level of the water supply, of an equilibrated water system comprising essentially the condenser, means containing a column of cool water passing upward to the top of the condenser, and means containing a column of heated water passing downward from the bottom of the condenser, these columns statically balancing each other, the descending column being the shorter of the two, and a pump circulating cooling water through the system, the load on the pump being unaffected by changes of level in the water supply.

7. The combination with a surface condenser of a pump circulating cooling water through a balanced column system comprising essentially the condenser, means containing a column of cool water passing upward to the top of the condenser, and means containing a column of heated water passing downward from the bottom of the condenser, these columns statically balancing each other, and the heated column being the shorter of the two, and the hot and cold wells both on the same level which is below that of the condenser, the water being drawn from the cold well and discharged into the hot well.

8. The combination with a surface condenser located above the level of the water supply, in which condenser the exhaust steam enters at or near the bottom, of a balanced water system comprising essentially the condenser, means containing an ascending column to the top of the condenser and means containing a descending column from the bottom of the condenser, the descending column being shorter than the ascending column, and a pump circulating water through the system.

9. The combination with a surface condenser located above the level of the water supply, in which condenser the exhaust steam enters at or near the bottom, of a centrifugal or turbine pump circulating water through an equilibrated water system comprising essentially the condenser, means containing an ascending column to the top of the condenser and means containing a descending column from the bottom of the condenser, the descending column being the shorter of the two, the ascending column being lifted from the supply and the descending column delivered into the discharge, both the supply and discharge being on substantially the same level.

10. The combination with a surface condenser into which steam is admitted from below, of a centrifugal or turbine pump circulating water from the cold well through an equilibrated water system comprising essentially means containing an ascending column of cool water to the top of the condenser and means containing a descending column of heated water from the bottom of the condenser, the descending column being the shorter of the two, and both the supply and discharge body of water being on substantially the same level which is below the condenser.

11. The combination with a surface condenser, in which the exhaust steam enters at or near the bottom, and the air leaves at or near the top, of a pump circulating water through a balanced column system, consisting essentially of means containing a column of cool water, and means containing a column of heated water, the latter leaving the condenser below the entrance of the former and being the shorter of the two, said pump being located between the supply and discharge of the system.

12. The combination of a surface condenser in which inlet for the exhaust steam is below the outlet for the air, of a centrifugal or turbine pump circulating water from a supply through a balanced column system having the exit of the heated column of water below the inlet of the cool column of water, the heated column being shorter than the cool column, and means containing the columns of water.

13. The combination of a surface condenser located above the level of the water supply and in which the inlet for the exhaust steam is below the outlet for the air, and a centrifugal or turbine pump circulating water from the supply through a balanced column system having the outflow of the heated column of water below the inflow of the cool column of water, the heated column being shorter than the cool column, together with means containing the columns of water.

14. The combination with a surface condenser, of a centrifugal or turbine pump circulating water through an equilibrated water system of which the condenser forms a part, said pump being located between the supply and

the discharge of the system, means containing a column of cool water flowing to the top of the condenser, and means containing a column of heated water flowing from the bottom of the condenser, the heated column being the shorter of the two.

15. The combination with a surface condenser, in which the exhaust steam enters at or near the bottom, of a centrifugal or turbine pump circulating water from a supply through a balanced column system, the latter including means containing an ascending column of cool water and means containing a descending column of heated water, the heated column being the shorter.

16. The combination with a surface condenser in which exhaust steam enters at or near the bottom of the condenser and the air leaves at or near the top of the condenser, of a centrifugal or turbine pump circulating water from a supply through a balanced column system, the latter comprising essentially means containing a column of cool water and means containing a column of heated water, the latter leaving the condenser below the entrance of the former, the heated column being the shorter.

17. The combination with a surface condenser in which the exhaust steam enters at or near the bottom and the air leaves at or near the top, of a centrifugal or turbine pump circulating water through a balanced column system, means for carrying the cool water to the top of the condenser, means for carrying the warm water from the bottom of the condenser, the column of warm water being shorter than the column of cool water.

18. The combination with a surface condenser in which the inlet for the exhaust steam is below the outlet for the air, of a cold well and a hot well, both wells being on substantially the same level and both located below the condenser, and a pump intermediate of the wells and circulating water through a balanced column system of which the condenser forms a part, said system comprising essentially means containing a column of cool water and means containing a column of heated water, the latter leaving the condenser below the entrance of the former, the heated column being shorter than the cool column.

19. The combination with a surface condenser in which the inlet for the exhaust steam is below the outlet for the air, of a cold well and a hot well, both located below the condenser, and a pump intermediate of the wells and circulating water through a balanced column system of which the condenser forms a part, said system comprising essentially means containing a column of cool water and means containing a column of heated water, the heated column being shorter than the cool column.

20. The combination with a surface condenser consisting essentially of a shell containing a plurality of nests or groups of tubes for the cooling water, and in which the exhaust steam comes first in contact with the lowest nest of tubes containing the warmest water, of a pump circulating water from a suitable supply through a balanced column system consisting essentially of means containing ascending and descending columns, the former communicating with the uppermost nests of tubes and the latter communicating with the lowermost nest of tubes, the descending column being shorter than the ascending column.

21. The combination with a surface condenser consisting essentially of a shell containing a plurality of nests of tubes for the cooling water and in which the exhaust steam comes first into contact with the lowermost nests containing the warmest water, of an inlet above for the cooling water to enter the tubes, an outlet below for it to leave them, a centrifugal or turbine pump circulating water through a balanced column system which includes the condenser, means for carrying an ascending column of water to the upper inlet, and means for conveying the descending column of water from the lower outlet, the descending column being shorter than the ascending column.

22. The combination with a surface condenser in which the exhaust steam comes first into contact with the tubes below the point at which the air leaves them, of a pump circulating cooling water through an equilibrated water system, consisting essentially of the condenser, means containing an upwardly moving stream of water and means containing a downwardly moving stream of water, the latter being shorter than the former.

23. The combination with a surface condenser situated above the level of the water supply in which the exhaust steam enters at or near the bottom, and the cooling water enters at or near the top, of a balanced column system consisting of the condenser, means containing an ascending column of water to the top thereof, means containing a descending column of water from the bottom thereof, a cold well from which the ascending column rises, a hot well into which the descending column flows, and circulating means for establishing and maintaining the flow, both wells being on substantially the same level which is below that of the condenser.

24. The combination with a surface condenser in which the exhaust steam enters at or near the bottom and the cooling water enters at or near the top, of a balanced column system including the condenser, means containing a column of water flowing from the bottom thereof, said column being shorter than the column of cool water entering at the top, means carrying the latter column, and a centrifugal or turbine pump included within the system for establishing and maintaining the flow, said pump being located between the supply and discharge of the system.

25. The combination with a surface condenser comprising a shell containing nests or groups of tubes and in which the exhaust steam comes first into contact with the tubes containing the warmest water, and the air comes last into contact with the tubes containing the coolest water, of a centrifugal or turbine pump circulating water through a balanced column system consisting of means containing an ascending column, the tubes of the condenser, means containing a descending column, the latter column being shorter than the ascending column.

26. The combination with a surface condenser containing nests or groups of tubes for the cooling water, through which tubes the water flows from the top of the condenser to the bottom so that the warmest tubes are at the bottom and the coolest at the top, and in which the exhaust steam first comes into contact with the warmest tubes and the air last in contact with the coolest tubes, of a pump to remove the air, and water-circulating means to circulate water through a balanced column system whose descending column is shorter than the ascending column, and means containing the water columns.

Signed at New York this 4th day of February 1904.

LOUIS R. ALBERGER.

Witnesses:

JOHN H. HAZELTON,

A. E. SAMUELS.