No. 888,637. PATENTED MAY 26, 1908.

D. B. MORISON.

STEAM CONDENSING PLANT.

APPLICATION FILED MAR. 9, 1907.

4 SHEETS—SHEET 1.

Fig. 1.

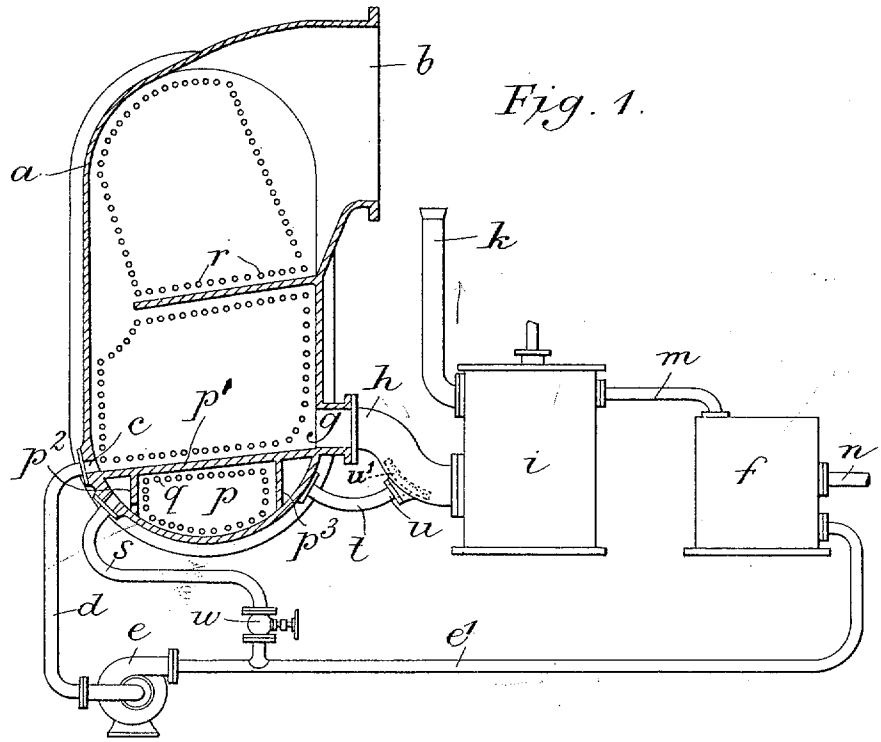
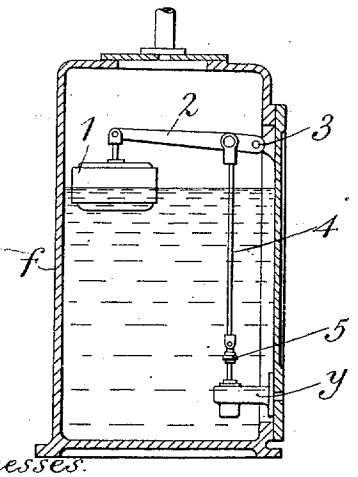
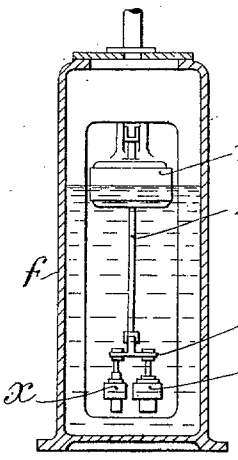


Fig. 2.



Witnesses.
W. Henry Simms
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Fig. 3.



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4 SHEETS—SHEET 2.

Fig. 4.

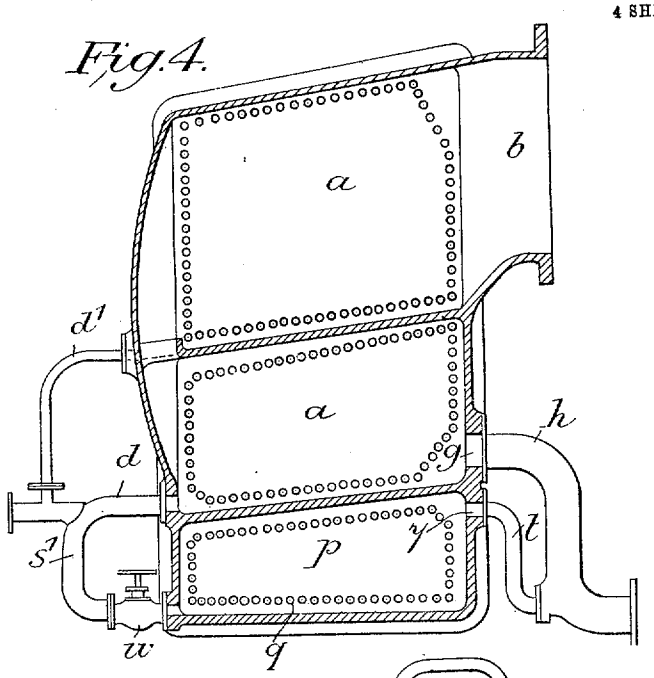
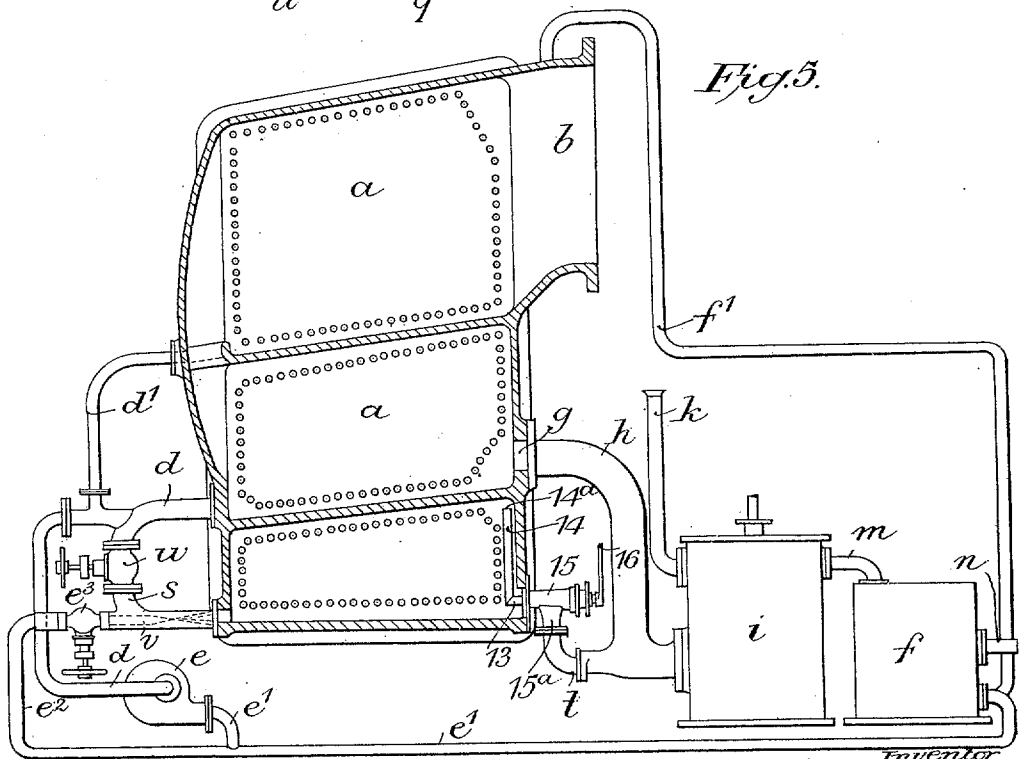


Fig. 5.



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No. 888,637. PATENTED MAY 26, 1908.

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STEAM CONDENSING PLANT.

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4 SHEETS—SHEET 3.

Fig. 6.

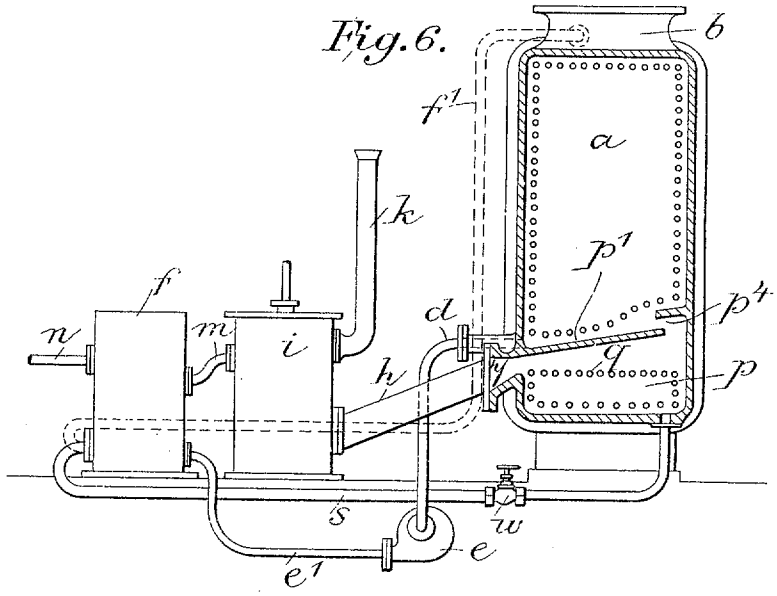
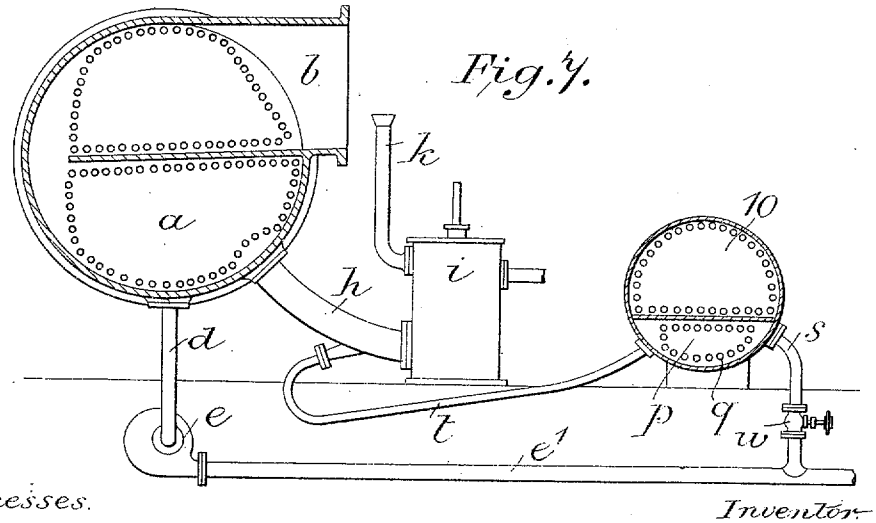


Fig. 7.



Witnesses.

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No. 888,637. PATENTED MAY 26, 1908.

D. B. MORISON.

STEAM CONDENSING PLANT.

APPLICATION FILED MAR. 9, 1907.

4 SHEETS—SHEET 4.

Fig. 8.

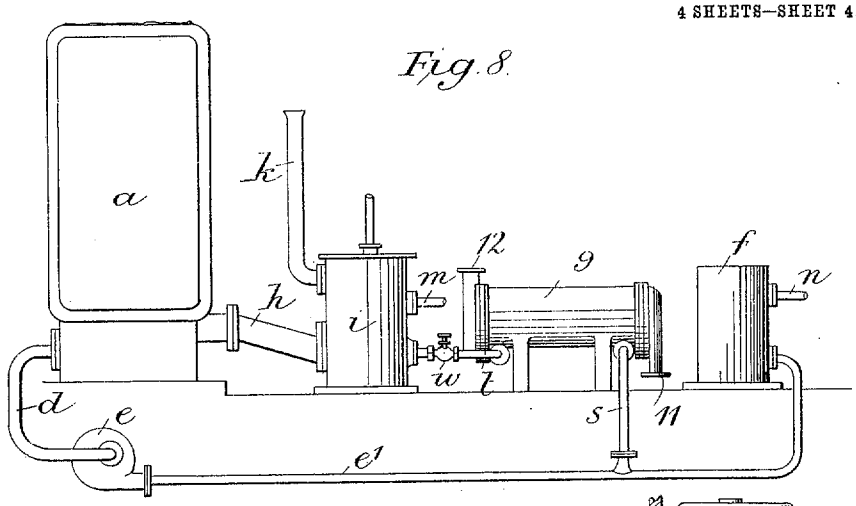


Fig. 9.

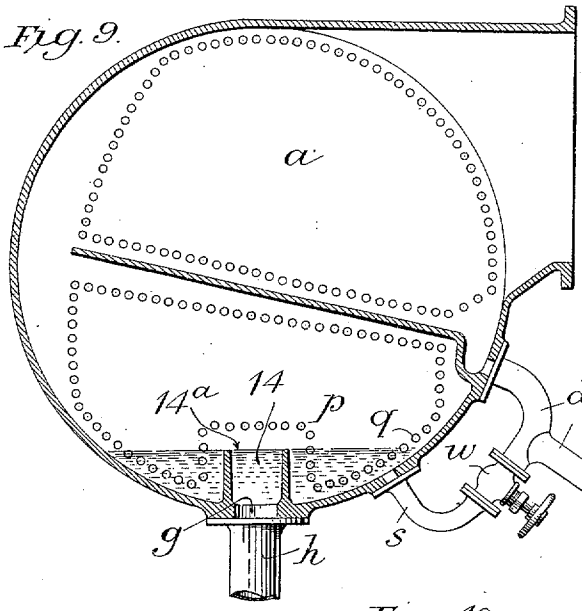


Fig. 12.

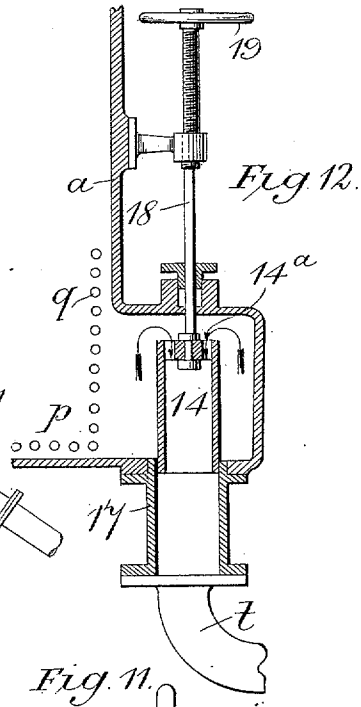


Fig. 10.

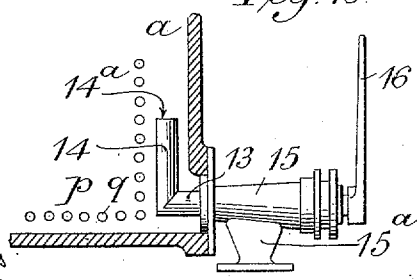
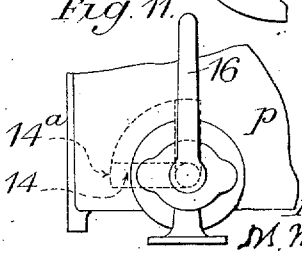


Fig. 11.



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UNITED STATES PATENT OFFICE.

DONALD BARNS MORISON, OF HARTLEPOOL, ENGLAND.

STEAM-CONDENSING PLANT.

No. 888,637. Specification of Letters Patent. Patented May 26, 1908.

Application filed March 9, 1907. Serial No. 361,544.

To all whom it may concern:

Be it known that I, DONALD BARNS MORISON, a subject of the King of Great Britain and Ireland, residing at Hartlepool, in the county of Durham, England, have invented Improvements in or Relating to Steam-Condensing Plants, of which the following is a specification.

In steam condensing plants in which air saturated with water vapor is withdrawn by an air pump from a condenser wherein steam is condensed by contact with water, or with metallic tubes through or over which cooling or condensing water is circulated, it is desirable to reduce the temperature of the air and vapor to a minimum before or on reaching the air pump, as thereby, not only is the air reduced in volume, but more or less of the water vapor is condensed, thus diminishing the volume of fluid to be dealt with by the pump and so reducing the weight, bulk and cost of the latter, and likewise the power required to drive it, or, for the same capacity of pump, promoting an increase in the degree of vacuum in the condenser. This question of the temperature of the air and vapor is of special importance when high vacua are required.

With the object of reducing the temperature of the air and increasing the condensation of the water vapor for the purposes mentioned, it has heretofore been proposed to inject water, obtained from an external source, into the air pump suction system, or into the air pump cylinder, but, owing to the liberation of air from such injection water, a greater amount of work has to be done by the air pump than would otherwise be necessary, and the degree of vacuum in the condenser is also impaired. Moreover, if the available injection water be impure, as for example sea water, and therefore unsuitable for boiler feeding purposes, the water of condensation resulting from the condensation of the water vapor is necessarily wasted and has to be made up by other pure water, which, in many cases, as for example in the case of steam condensing plant for marine engines, is very inconvenient and costly.

To avoid the above mentioned objections, the water of condensation produced in the main condenser has been allowed to fall into an open well or receptacle in the lower end of the condenser where it is lowered in temperature by contact with the condenser tubes traversing that part of the condenser and through which the circulating water for the condenser first flows. The whole of the water of condensation is thus cooled and is caused to overflow from the well or receptacle into the air pump suction system and flows therethrough to the air pump in conjunction with the vapor and air escaping from the condenser. With this arrangement, however, it is not practicable to control the temperature to which the water of condensation is lowered in the bottom of the condenser, the temperature varying with variations in the load, or with variation in the temperature of the circulating water flowing through the condenser tubes, due to atmospheric temperature variations, or, in the case of marine condensing plants, to such water being obtained from time to time from seas or waterways of different temperatures, so that the cooling and condensing action of the cooled water of condensation on the air and vapor passing to the air pump, and the final temperature of the water delivered from the air pump, and consequently the thermal efficiency of the whole plant, is not capable of being controlled to suit varying conditions. Consequently the efficiency of the air pump, the degree of vacuum in the condenser, and the thermal efficiency of the condenser cannot be maintained approximately constant. Furthermore, in the case of a condenser for use on board ship, owing to the uncontrolled movement of the water in the open well or receptacle at the bottom thereof, resulting from the pitching and rolling of the ship, the tubes in such well or receptacle will be subject to such stresses as may result in leakage or breakage of the tubes, or some of them, and the supply of water of condensation to the air pump may be irregular and intermittent, thereby causing variable efficiency of the pump and so seriously interfere with the proper working of the condensing plant, especially when the pump is of the direct acting crankless type.

Now the present invention has for object to enable the cooling of the air and the condensation of water vapor flowing from a condenser to an air pump to be carried out in an effective, simple and advantageous manner and so as to avoid or minimize the above mentioned objections. For this purpose, according thereto, the air and water vapor flowing from the condenser to the air pump are subject to the cooling and condensing action of the whole or any desired proportion

of the water of condensation that has been produced in the condenser and is consequently practically free from air, and which is cooled and introduced into the air pump suction system at a regulated temperature and in controllable quantity and so as to come into intimate contact with the air and vapor flowing through such system. In this way the air can be cooled in a simple and advantageous manner to a practically constant low temperature relatively to the temperature of the circulating water, thus reducing to a minimum the volume of water vapor, while the approximately constant temperature and controlled uniform amount of the air pump discharge water allows of the efficiency of the air pump being approximately maintained, and likewise the thermal efficiency of the condensing system.

The water of condensation admitted to the air pump suction system for air cooling and vapor condensation purposes, and hereinafter called for distinction the injection water, can be caused to flow under pressure, produced in various ways, through a cooling device that may be arranged to form part of the condensing plant, or of an adjacent condensing plant, or be separate from such plant.

Conveniently, the cooling device may be arranged at and form part of the lower portion of the main condenser, or of an auxiliary condenser, or of a supplementary air cooler, and comprise a closed or a nearly closed chamber traversed by some of the tubes through which the circulating water of the condenser passes, one part of the chamber being connected to the air pump suction system and another part to a source from which the injection water can be caused to flow through the cooling device and thence into the air pump suction system at a suitable rate that is controlled, as by a cock or valve, to suit requirement and so that the temperature of the air pump discharge can be maintained practically constant. The injection water may be obtained from the pipe leading to a feed water tank into which water of condensation is delivered direct from the condenser by a pump, or it may be obtained direct from the said tank, which is open to the atmosphere, so that the flow of water into the cooling device is caused to take place by atmospheric pressure; or it may be supplied by a pump or its equivalent direct from the lower part of the condenser to the cooling device; or it may be supplied under gravity from an upper part of the condenser in the case of a condenser comprising a series of superimposed and connected condensing compartments. Or it may be supplied by gravity assisted by a water jet obtaining its water from a tank into which the air pump may discharge and which is under atmospheric pressure.

In the accompanying illustrative drawings, Figure 1 shows diagrammatically and partly in section and partly in elevation, one construction of steam condensing plant embodying the present invention. Figs. 2 and 3 are sections at right angles to one another, showing one convenient form of feed tank employed in carrying the invention into effect. Figs. 4 to 9 inclusive are similar views to Fig. 1, showing modified arrangements. Figs. 10, 11 and 12 are detail views showing modified arrangements for controlling the temperature of the injection water.

Referring to Fig. 1, *a* is a surface condenser of the multiple chamber type having an exhaust steam inlet at *b* and an outlet *c* for water of condensation which is led by a pipe *d* to a water pump *e* which may be connected to the feed water tank *f* by a pipe e^1 as shown, or the pipe e^1 may lead direct to a boiler. *g* is the outlet from the bottom of the condenser *a* for air and water vapor which are led by the air pump suction pipe *h* to the air pump *i* which has an air delivery pipe *k* leading to the external atmosphere and a water discharge pipe *m* leading to the feed tank *f* the water in which is subjected to atmospheric pressure, *n* being the pipe leading to the boiler feed pump.

The cooling device for cooling a controllable amount of injection water for admission to the air pump suction system according to the present invention, is, in the example now being described, constituted by a chamber *p* that is formed in the lower portion of the condenser *a* by the aid of a partition p^1, and is traversed by water tubes *q* through which the circulating or condensing water for the water tubes *r* of the condenser *a* first passes, so that the tubes *q* will be maintained at a relatively low temperature by the circulating water available. The cooling chamber *p* has a water inlet pipe *s* that is connected to the pipe e^1, and an outlet pipe *t* that is connected at *u* to a pipe u^1 in the pipe *h*, by which the injection water can be delivered in a divided state and brought into intimate contact with the air and vapor passing to the air pump *i*. One of the pipes *s* or *t*, (*s* in the example) is provided with a water controlling device such as a valve *w*.

As will be seen, by the arrangement described, upon opening the valve *w* to a suitable extent, a controllable amount of water of condensation, constituting the injection water, will be forced by the pressure of the external atmosphere through the pipe *s* into the cooling chamber *p* where it will be cooled by surface contact with the cooling pipes *q* therein and be afterwards delivered through the pipe *t* into the pipe *h*, it may be in a divided state, so as to come into intimate contact with the air and water vapor flowing to the air pump *i*, thereby cooling the air to a relatively low temperature and causing condensation of water vapor. The injection

water, together with the resulting water of condensation and cooled air, pass on to the air pump *i* by which they are removed in the ordinary way from the pipe *h*, the air escaping to the atmosphere through the pipe *k*, and the water flowing through the pipe *m* to the feed tank *f*. By ascertaining, from time to time, the temperature of the water discharged by the air pump *i* and suitably adjusting the valve *w*, when necessary, so as to vary the rate at which the injection water will be forced through the cooling chamber *p*, and therefore the temperature at which such water will be forced into the pipe *h*, it is possible to approximately maintain the air pump discharge at a desired temperature, notwithstanding considerable variations in load and in the temperature of the circulating water available from time to time for the tubes *q* of the cooling device. This is a feature of great practical value because at low powers, as for example at the cruising power of a warship, a minimum quantity of water can be passed through the cooler into the air pump, thereby raising the thermal efficiency of the condenser to a maximum; and at full power the quantity of water passing through the cooler can be increased so as to approximately maintain the temperature of discharge from the air pump, and, therefore, to approximately maintain the efficiency of the air pump, whereas an ordinary practice, when water of condensation flows through the air pump, it is cooled in the condenser to an unnecessary degree at low powers, thereby sacrificing thermal efficiency, and at high powers the water of condensation becomes hotter and thereby decreases the efficiency of the air pump just at the time when a high efficiency is most desirable, consequently reducing the vacuum and prejudicially affecting the power of the engine.

The cooling chamber *p* may be provided with diaphragms with the object of lengthening the path of the injection water, increasing the velocity of flow of the water, and producing uniformity in its temperature. p^2 and p^3 represent such diaphragms which may however be otherwise arranged to suit the design of the cooler or the requirements of the case.

To prevent the water level falling so low in the tank *f* as to allow air to enter the pipe e^1 and so impair the vacuum in the condenser, the tank is provided with a float-controlled valve *x* (Fig. 3). The float 1 for this valve may, and as shown in Figs. 2 and 3, be attached to a lever 2 pivoted at 3 and connected by a link 4 to a crosshead 5 to which the valve *x*, in the form of a piston valve, is connected. The arrangement is such that should the water level in the tank *f* fall to a predetermined extent, the float 1 will fall and close the valve *x* and thus automatically close the communication between the tank *f* and the pipe e^1. The same float, or another one, may be employed to operate a valve such as *y*, for repassing cooled water from the tank *f*, as through a pipe f^1 (Fig. 6), into the steam space of the condenser *a*, so that it may become further heated therein. Or the float may be used to operate the steam control valve of the feed pump.

Steam condensing plants embodying the present invention can be constructed in various forms without departing from the essential features of the invention.

Fig. 4 shows a modified arrangement wherein the outlet pipes d^1 and *d* for leading water of condensation from the upper and lower compartments respectively of the condenser *a* to the water pump are connected by a branch pipe s^1, provided with a controlling valve *w*, to the cooling device *p* so that a regulated amount of injection water can be passed direct from the condenser to the cooling device *p*—*q*, the chamber of which is isolated from the condensing chambers above, as in Fig. 1. From the cooling device the cooled injection water passes into the suction pipe *h* through a passage 7 independent of the passage *g*, through which the air and vapor enter the said pipe from the condenser *a*. In this case, the water flows by gravity from the condenser *a*, to the suction pipe *h* through the cooling chamber *p*. A pump may be placed in the pipe s^1 to deliver the water to the cooling chamber at any desired pressure, or a water injector or its equivalent may be employed for this purpose. Fig. 5 shows an arrangement by means of which the velocity of flow of water into the cooler *p* is increased by means of a water jet device *v* which receives its supply through a pipe e^2 and valve e^3 from the feed discharge pipe e^1 or from the feed tank *f* into which the air pump discharges by pipe *m*.

Fig. 6 shows a modified arrangement wherein the partition p^1 does not completely close the top of the cooling chamber *p* but is arranged to leave a port p^4 through which the air and vapor can pass from the condensing chamber above and flow over the surface of the injection water in the cooling chamber and thence into the suction pipe *h* through an opening 7 through which the cooled injection water also enters the said pipe from the cooling chamber at a rate that is controllable by the valve *w*. In this example, the injection water is obtained by way of the pipe *s* from the feed tank *f* into which the water of condensation flowing off from the bottom of the condenser above the partition p^1 is delivered by a pump *e* as in Fig. 1.

Fig. 7 shows an arrangement wherein the cooling chamber *p* with cooling tubes *q* are arranged at the bottom of a separate condenser 10 which does not form part of the condensing plant into which the injection

water is introduced. Such separate condenser may be that used for auxiliary engines. In this example, the inlet pipe *s* to the cooling device is connected through the valve *w* to the pipe e^1, and the cooled injection water is delivered by the pipe *t* into the air pump suction pipe *h*.

Fig. 8 shows one example wherein a separate cooling device for the injection water is used. The said device comprises a casing 9 traversed by tubes through which the cooling water flows from the inlet 11 to the outlet 12. The injection water passes from the pipe e^1 to the cooling chamber by the pipe *s*, the water being delivered through the pipe *t*, under the control of the valve *w*, to the base of the air pump *i* to mix with the air and vapor therein.

Fig. 9 shows in cross section a condenser having two condensing compartments. The water of condensation from the upper compartment is led to a water pump by pipe d^1 and when desired a portion of the water can be passed into the lower compartment by the control valve *w* and pipe *s*. In the base of the condenser a trough 14 extends longitudinally within the condenser and causes the lower tubes to be submerged and to act as water coolers. The cooled water overflows into the trough 14 and passes, together with the air and vapor, to the air pump through the pipe *h*. By this arrangement a high thermal efficiency is obtained from the water condensed in the upper compartment, and the steam with its increased percentage of air is in contact with tubes of lower temperature, the resultant condensed water, after being further cooled by direct contact with submerged tubes, passing into the air pump suction pipe *h* and acting advantageously on the efficiency of the air pump.

Figs. 10 and 11 show part of an open cooling chamber with modified means for controlling the temperature of the injection water passing therethrough. In this case, the outlet for the injection water supplied to the cooling chamber *p* comprises a bent pipe 13—14 the horizontal portion 13 of which is mounted to turn in a pipe connection 15 and is connected to a hand lever 16 and the remaining portion 14 of which can, by operating the hand lever 16, be raised and lowered so as to vary the height of the inlet end 14^a thereof and thereby the depth of the injection water in contact with the cooling tubes *q* in the chamber *p*, and, consequently, the temperature of such water. The cooled water passes through the outlet branch 15^a to the pipe *t* for delivery into the air pump suction system as before (Fig. 5).

Fig. 12 is a similar view to Fig. 10 showing a modified arrangement, for the same purpose, wherein the outlet pipe 14 is arranged vertically and capable of being raised and lowered in a fixed pipe 17 by a screw threaded rod 18 having a hand wheel 19, so that the height of its inlet end 14^a, and consequently the height of the injection water in the cooling chamber *p* and the temperature of such water, can be readily varied to suit requirement for the purposes hereinbefore set forth.

In a multiple compartment condenser, the temperature of the condensed steam water in any or all of the compartments may also be varied by submerging tubes, at will, as set forth, and so enable the final temperature of the condensed steam water to be controlled.

Although a surface condenser has been taken to illustrate the application of the present invention, the latter may be carried into effect with other forms of condenser; and although a single reciprocating air pump *i* has been shown on the drawings, and a centrifugal type of water pump *e*, it will be understood that these are only diagrammatic and that any suitable arrangement and design of pump or pumps or injector or other air and vapor withdrawing apparatus may be employed. Such equivalents are included in the general terms, air pump and water pump, adopted in the claims.

The invention is particularly advantageous in connection with steam condensers for use with steam engines or turbines as it admits of a higher vacuum being carried at full power than can be obtained by ordinary arrangements and thereby increases the power efficiency of the engines or turbines, while at low powers it admits of a high thermal efficiency, which, in the case of warships especially, may both be of very great strategical and tactical value.

What I claim is:—

1. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device having its outlet connected to said suction system and through which condensed steam water obtained from said condenser can be caused to flow into said suction system, and means whereby the quantity of water which enters said suction system from said cooling device can be controlled.

2. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device having its outlet connected to said suction system and into which condensed steam water can be caused to flow directly from said condenser and means whereby the rate of flow of the condenser steam water through said cooling device can be controlled.

3. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device having its outlet connected to said suction system, a conduit

between the outlet for condensed steam water from said condenser and the inlet of said cooling device and through which condensed steam water can flow from said condenser to said cooling device, and means for controlling the flow of said water through said cooling device.

4. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device having its outlet connected to said suction system, a conduit between the outlet for condensed steam water from said condenser and the inlet of said cooling device and through which condensed steam water can flow from said condenser to said cooling device, and propelling means for causing water to flow through said conduit.

5. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber and pipes for cooling water extending therethrough, said chamber having its inlet in connection with said condenser and its outlet in connection with said suction system, and means for controlling the flow of condensed steam water through said chamber from said condenser to said suction system.

6. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber located in the lower part of said condenser, and tubes traversing said chamber and through which condensing water to be subsequently used in other parts of said condenser flows, said chamber being arranged to allow of condensed steam water flowing into it from the condenser and having an outlet in connection with said suction system, and means for controlling the flow of water from said chamber to said suction system.

7. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber located in the lower part of said condenser, and tubes traversing said chamber and through which condensing water to be subsequently used in other parts of said condenser flows, said chamber being arranged to allow of condensed steam water flowing into it from the condenser and having an outlet in connection with said suction system, and means for controlling the amount of water flowing through said chamber.

8. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber located in the lower part of said condenser, and tubes traversing said chamber and through which condensing water to be subsequently used in other parts of said condenser flows, said chamber having an inlet for condensed steam water in connection with a part of said condenser above said chamber and its outlet in connection with said suction system, and means for controlling the flow of condensed steam water through said chamber.

9. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber located in the lower part of said condenser and tubes traversing said chamber and through which condensing water to be subsequently used in other parts of said condenser flows, said chamber having a top plate or partition between its upper end and the lower end of said condenser, a conduit between the outlet for condensed steam water from said condenser and the inlet of said chamber, means connecting the outlet of said chamber to said suction system, and means for controlling the flow of condensed steam water through said chamber.

10. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber located in the lower part of said condenser and tubes traversing said chamber and through which condensing water to be subsequently used in other parts of said condenser flows, said chamber having an outlet in communication with said suction system, a partition between the cooling chamber and the steam condensing chamber above it, an outlet pipe for condensed steam water from said condenser chamber, a branch pipe between said outlet pipe and the inlet of said cooling chamber, and means for controlling the amount of water flowing through said branch pipe and cooling chamber.

11. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber located in the lower part of said condenser and tubes traversing said chamber and through which condensing water to be subsequently used in other parts of said condenser flows, said chamber having an outlet in communication with said suction system, a partition between the cooling chamber and the steam condensing chamber above it, an outlet pipe for condensed steam water from said condenser chamber, a branch pipe between said outlet pipe and the inlet of said cooling chamber, and means for causing a controlled amount of water to flow from said

outlet pipe into and through said branch pipe and cooling chamber.

12. In a steam condensing plant, the combination with a condenser having a plurality of condensing compartments, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber located in the lower part of said condenser and tubes traversing said chamber and through which condensing water to be subsequently used in other parts of the condenser flows, said chamber having an outlet in connection with said suction system, a partition between the said cooling chamber and the lower condensing compartment, connected condensed steam water outlet pipes leading from separate compartments of said condenser, a branch pipe connected to said outlet pipes and to said cooling chamber, and means for controlling the amount of water passing through said branch pipe and cooling chamber from the different parts of said condenser.

13. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber located in the lower part of said condenser and tubes traversing said chamber and through which condensing water to be subsequently used in other parts of said condenser flows, a partition completely separating the cooling chamber from the condensing chamber above it, a conduit arranged to lead condensed steam water from said condenser to said chamber, means connecting the outlet of said chamber to said suction system, and means for controlling the flow of condensed steam water through said chamber.

14. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device having its outlet in communication with said suction system, a tank open to the atmosphere, a conduit between the outlet of said condenser for condensed steam water and the inlet of said cooling device, said conduit comprising pipes in communication with each other and with said tank, means for withdrawing water from said condenser and delivering it into said tank, said withdrawing means being located in the portion of the conduit between said condenser and cooling chamber and means for controlling the flow of water through said cooling device from said conduit.

15. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber having its outlet in connection with said suction system, and tubes traversing said chamber and through which cooling water flows, a condensed steam water outlet pipe from said condenser, means for causing water to flow through said pipe, a second pipe connected to the inlet of said cooling chamber and in communication with the first mentioned pipe, and means for controlling the flow of water through the second pipe and cooling device.

16. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber having its outlet in connection with said suction system, and tubes traversing said chamber and through which cooling water flows, a condensed steam water outlet pipe from said condenser, means for causing water to flow through said pipe, a second pipe connected to the inlet of said cooling chamber and in communication with the first mentioned pipe, at a point beyond the means used for causing water to flow through the first mentioned pipe, and means for controlling the flow of water through the second pipe and cooling device.

17. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber having its outlet in connection with said suction system, and tubes traversing said chamber and through which cooling water flows, a condensed steam water outlet pipe from said condenser, a second pipe connected to the inlet of said cooling device and in connection with the first mentioned pipe, a water pump arranged to cause water to flow through the first mentioned pipe, and means for controlling the flow of water through the second pipe and the cooling device.

18. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber having its outlet in connection with said suction system, and tubes traversing said chamber and through which cooling water flows, a condensed steam water outlet pipe from said condenser, a water pump for causing water to flow through said pipe, a branch pipe connected to the first pipe between said condenser and pump and to said cooling device, and means for controlling the flow of water through said second pipe and the cooling device.

19. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber having its outlet in connection with said suction system, and tubes traversing said chamber and through which cooling water flows, a condensed steam water outlet pipe from said condenser, a water pump for causing water to flow through said pipe, a branch pipe in communication with the first pipe beyond the outlet of said pump, and means for con-

trolling the flow of water through said second pipe and cooling device.

20. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber having its outlet in connection with said suction system, and tubes traversing said chamber and through which cooling water flows, a condensed steam water outlet pipe from said condenser, a water pump for causing water to flow through said pipe, and pipes with separate controlling valves connecting the inlet of said cooling device to said first mentioned pipe at a part thereof between said condenser and pump and to a part thereof at the outlet side of said pump.

21. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber having its outlet in connection with said suction system, and tubes traversing said chamber and through which cooling water flows, a condensed steam water outlet pipe from said condenser, a water pump for causing water to flow through said pipe, a second pipe with controlling valve connecting the inlet of said cooling device to the first pipe at a part thereof between said condenser and pump, a third pipe with controlling valve in communication with the first pipe at a part beyond said pump and connected to the second pipe, said third pipe being adapted to cause water flowing therethrough to induce water to flow through the second pipe from the first pipe to said cooling device.

22. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber having its outlet in connection with said suction system, and tubes traversing said chamber and through which cooling water flows, a condensed steam water outlet pipe from said condenser, a tank open to the atmosphere, a pump for forcing water to flow through said pipe into said tank, a second pipe connected to said cooling device and in communication with the first pipe and the tank beyond said pump, and means for controlling the flow of water through said pipe and cooling device.

23. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device comprising a chamber having its outlet in connection with said suction system, and tubes traversing said chamber and through which cooling water flows, a condensed steam water outlet pipe from said condenser, a tank open to the atmosphere, a pump for forcing water to flow through said pipe into said tank, a second pipe connected to said cooling device and in communication with the first pipe and the tank beyond said pump, means for controlling the flow of water through said pipe and cooling device, and a third pipe with controlling valve connecting the first pipe at a part thereof between said condenser and pump to the second pipe and cooling device.

24. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device having its outlet connected to said suction system, a tank open to the atmosphere and into which condensed steam water is delivered, a pipe in communication with the lower part of said tank and with the inlet of said cooling device, means for controlling the flow of water through said pipe to and through said cooling device, and float controlled means arranged to close the inlet to said pipe when the level of water in said tank falls to a predetermined amount.

25. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a cooling device having its outlet connected to said suction system, a tank open to the atmosphere and into which condensed steam water is delivered, a pipe with water withdrawing means whereby condensed steam water can be withdrawn from said condenser and delivered into said tank, a pipe in communication with the lower part of said tank and the inlet of said cooling device, means for controlling the flow of water through the last mentioned pipe to and through said cooling device, and float controlled means arranged to close the inlet to said last mentioned pipe when the level of water in said tank falls to a predetermined amount.

26. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a tank open to the atmosphere, means for withdrawing water of condensation from said condenser and delivering it into said tank, a pipe connecting the lower part of said tank with the interior of said condenser, and float controlled means arranged to close the inlet to said pipe when the level of water in said tank falls to a predetermined amount.

27. In steam condensing plant, the combination with a condenser, an air pump, and an air pump suction system between said parts, of a tank open to the atmosphere, means for withdrawing water of condensation from said condenser and delivering it into said tank, a cooling device having its outlet connected to said suction system, a pipe in communication with the lower portion of said tank and the inlet of said cooling device, a pipe connecting the lower portion of said tank with the interior of said condenser, means for controlling the flow of

water through said cooling device, and float operated means for cutting off the supply of water to both pipes upon the level of the water in the tank falling to a predetermined extent.

28. In steam condensing plant, the combination with a condenser, an air pump and an air pump suction system between said parts, of a cooling device comprising a chamber located in the lower part of said condenser and tubes traversing said chamber and through which cooling water to be subsequently used as condensing water in other parts of the said condenser flows, a tank into which condensed steam water is delivered, a pipe connecting said tank with the inlet of said cooling device, means for controlling the flow of water through said cooling device and means for conveying cooled water from said cooling device to said suction system.

29. In steam condensing plant, the combination with a condenser, an air pump and an air pump suction system between said parts, of a cooling device comprising a chamber located at the bottom of said condenser, and tubes traversing said chamber and through which cooling water to be subsequently used as condensing water in other parts of the condenser flows, a partition separating the cooling chamber from the adjacent condensing chamber above it, and a conduit adapted to allow condensed steam water to flow by gravity from said condenser to said cooling chamber, the outlet from the cooling chamber being connected to said suction system.

30. In steam condensing plant, the combination with a condenser having a plurality of condensing compartments, an air pump, and an air pump suction system between said parts, of a cooling device located at the bottom of said condenser, a condensed steam water outlet pipe leading from an upper compartment of said condenser, a branch pipe connected to said outlet pipe and to said cooling device, means for controlling the amount of water passing through the said branch pipe, and means for conveying cooled water from said cooling device to said suction system.

Signed at West Hartlepool in the county of Durham, England, this twenty second day of February 1907.

DONALD BARNS MORISON.

Witnesses:
HARRY MILLER,
W. B. STROVER.