

D. B. MORISON.
STEAM CONDENSING PLANT WORKING UNDER VACUUM.
APPLICATION FILED FEB. 23, 1910.

1,006,975.

Patented Oct. 24, 1911.

3 SHEETS—SHEET 1.

Fig. 1.

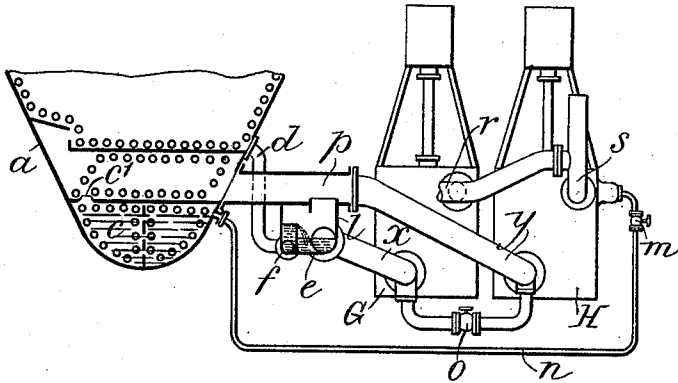
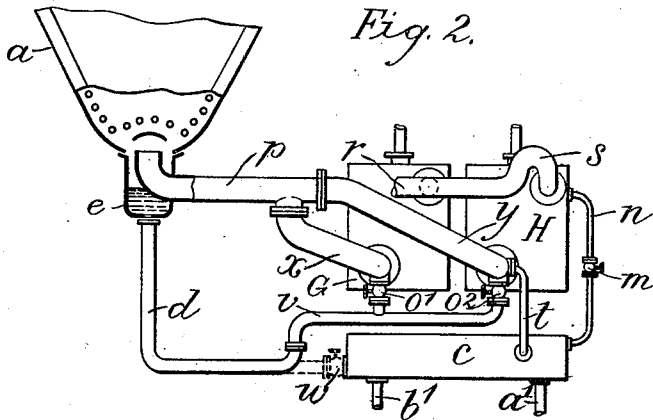


Fig. 2.



Witnesses.

C. P. Wright, Jr.
S. L. Burkett.

Inventor.

D. B. Morison,
By A. S. Pattison,
Att'y

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3 SHEETS—SHEET 2.

Fig. 3.

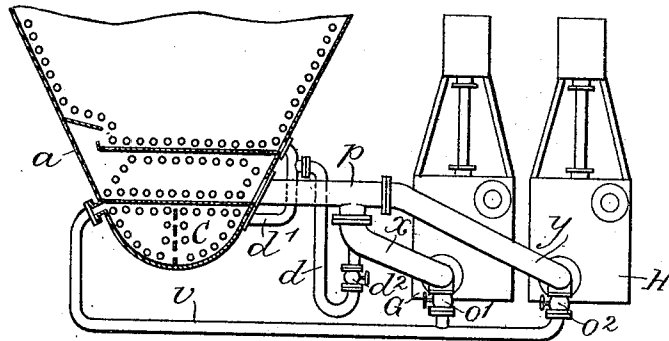


Fig. 4.

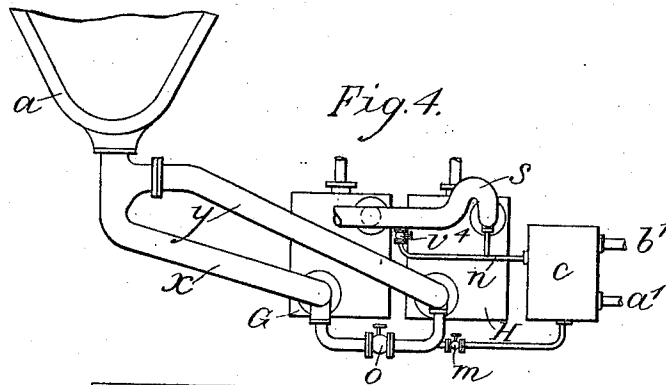
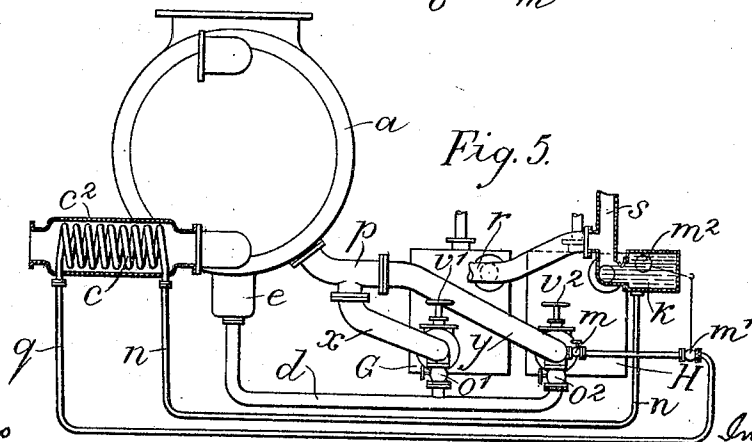


Fig. 5.



Witnesses
 C. P. Wright, Jr.
 L. L. Burkett.

Inventor,
 D. B. Morison
 By A. S. Patterson,
 Atty

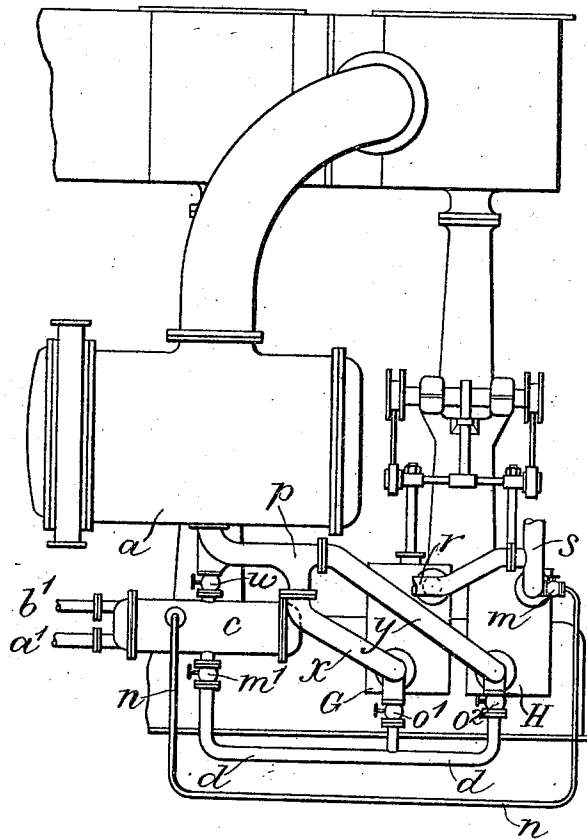
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3 SHEETS—SHEET 3.

Fig. 6.



Witnesses.

C. P. Wright Jr.
 L. L. Buckner.

Inventor.

D. B. Morison,
 By A. S. Patterson,
 Atty

UNITED STATES PATENT OFFICE.

DONALD BARNES MORISON, OF HARTLEPOOL, ENGLAND.

STEAM-CONDENSING PLANT WORKING UNDER VACUUM.

1,006,975.

Specification of Letters Patent.

Patented Oct. 24, 1911.

Application filed February 23, 1910. Serial No. 545,538.

To all whom it may concern:

Be it known that I, DONALD BARNES 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 Working Under Vacuum, of which the following is a specification.

This invention relates to steam condensing plant, working under vacuum, in which the mixture of air and vapor is normally withdrawn from the condenser by a pump supplied with a uniform quantity of water at a temperature less than the temperature of the water of condensation formed in the condenser, and in which the water of condensation is withdrawn from the condenser by another pump which is also capable of withdrawing air and vapor, but which normally withdraws water of condensation only from the condenser.

The invention has for object *inter alia*:—

(a) to obtain with a given size of pump, which withdraws air and vapor from a condenser, and is hereinafter sometimes called for distinction and brevity the air pump, a very large air withdrawing capacity by reducing the temperature within such pump below the temperature within the pump which withdraws the water of condensation and which for distinction and brevity is sometimes hereinafter called the water pump, whereby a lower absolute pressure is obtained in the air pump barrel than in the condenser, and the volumetric capacity of the air pump for air per stroke is in effect considerably increased, thus enabling the vacuum in the condenser to be maintained notwithstanding the presence of a large quantity of air in the condensing system; (b) to withdraw the water of condensation from the condenser by a pump at a relatively high temperature and in a condition in which it contains a minimum amount of air when delivered to the boilers; (c) to obtain great safety in the event of accident, derangement or stoppage of either the air pump or the water pump, by so constructing and arranging these pumps and their connections that in the event of either pump failing, the remaining pump is capable of withdrawing the air and vapor together with the water of condensation from the condenser without causing any substantial alteration in the direction of flow of vapor

over the condensing surface, or without causing any such flooding of condensing tubes, or of the air pipe connections, as would substantially reduce the condensing surface, or substantially impair the normal flow of air to the withdrawing pump; and (d) to enable both pumps to simultaneously withdraw air, vapor and water from the condenser when there is an abnormal amount of water to be withdrawn from the condenser, as may result for instance from priming of the boilers, leakage of the condenser tubes, or the working of the engines at abnormal power, as in a warship, when it is desired to obtain maximum possible power and speed regardless of steam economy.

The above described objects are obtained according to the present invention by special arrangements of the condenser, air and water pumps, water cooler and their connections, the whole constituting improved steam condensing plant or apparatus. By means of such apparatus not only can either pump be used to withdraw air, vapor and water of condensation from the condenser in case of stoppage of the other, and both pumps can be used simultaneously as air, vapor and water withdrawing pumps when there is an abnormal amount of water, or of air, or of both, to be withdrawn from the condenser, but high thermal efficiency of feed water can be obtained with minimum aeration of such feed water, and a great air withdrawing effect is obtainable with an air pump of given size by cooling it below the temperature of the water pump, as set forth, these results constituting technical features of great practical value. The air pump may be cooled to a temperature below that of the water pump, for the purpose set forth, by maintaining in circulation through such air pump a constant quantity of water of condensation in a condition of minimum aeration, such water, on being discharged by the said pump, passing through a water charged water cooler and thence again into the said pump, where it is augmented in quantity by the amount of water of condensation formed by the condensation of vapor, the excess of water passing into the water of condensation discharged by the water pump. In the event of accident to the water cooler, provision is made whereby a uniform and constant supply of water of condensation coming from the condenser is passed into the air pump,

so that this pump can still work with great regularity and high speed. Or provision may be made whereby a constant quantity of water of condensation may be passed direct from the condenser through a water cooler and thence into the air pump. Or, when the air leakage or other conditions demand the use of both pumps in parallel for simultaneously withdrawing air, vapor and water, the arrangement may be such that the water will be cooled in the cooler before passing through both of the pumps, thereby greatly increasing their combined capacity for withdrawing large quantities of air, with only a slight loss in thermal efficiency.

The invention can be applied to surface condensing plants of various kinds but is particularly applicable to steam condensing plants of steamships of large power, as for example to ships of war in which any breakdown in connection with the air withdrawing apparatus might result in the stoppage of propelling machinery, and in which it is of very great importance for the vacuum in the condenser to be maintained over the largest possible range of air leakage into the condensing system, especially in connection with turbine engines in which a fall in vacuum seriously decreases the efficiency of the steam and reduces the power of the propelling machinery and therefore reduces the speed of the ship.

In order that the nature of the invention may be fully understood, reference will now be made to the accompanying illustrative drawings, wherein Figs. 1 to 6 inclusive show diagrammatically and in elevation, with parts in section in some of the figures, various arrangements of steam condensing plants embodying the invention.

In the arrangement shown in Fig. 1, *a* is the lower portion of a surface condenser provided with a water cooler *c* at its base, and *d* is a pipe by which water of condensation is led from the condenser and discharged into the compartment *f* of a receiver *e* having another compartment *l* that communicates with and extends upward slightly within the air and vapor outlet or suction pipe *p*, so that normally the water flowing from the water cooler *c* through the outlet *c*¹ into the suction pipe *y* through the pipe *p*, will not flow into the receiver *e*. *G* and *H* are two independently driven pumps each adapted to withdraw air, vapor and water, *r* and *s* being their respective discharge pipes. Under normal conditions, the pump *G* withdraws the water of condensation from the receiver *e* through a pipe *x*, and the pump *H* withdraws the mixture of air and vapor through the pipes *p* and *y*, the temperature within the pump *H* being cooled below the temperature within the pump *G* by causing water to pass in continuous circulation from the discharge from

the pump *H* through a pipe *n*, the water cooler *c*, and pipes *p* and *y*, whereby a maximum and preferential air withdrawing effect is obtained in pump *H* by reason of the lower pressure thereby obtaining within this pump. The water normally passing through the water cooler *c* and pump *H* results from the condensation of vapor and is regulated by a valve *m*, the surplus water passing through pipe *s* and mingling with the water discharged by pump *G* through the pipe *r*, the air being discharged from the top of the pipe *s*. When starting, the necessary water for injection into the air pump *H* may be obtained by opening a valve *o* in a pipe connection between the two pumps.

In ordinary working, the pump *G* withdraws the water of condensation from the condenser through the pipe *d*, receiver *e* and pipe *x* at a high temperature relatively to the water admitted to the pump *H*, and in a condition of minimum aeration, but in the case of accident or derangement of the pump *H*, pump *G* will automatically act to withdraw the mixture of air and vapor from the condenser through the pipe *p*, receiver *e* and pipe *x*. Or, if the pump *G* should break down, the pump *H* will then act to withdraw the water of condensation, together with air and vapor, from the condenser *a*, the water overflowing from the top of the receiver *e* into the pipes *p* and *y*. In the event of an abnormal supply of water from the condenser *a*, communication between the pumps can be effected by opening the valve *o*, thereby enabling both pumps to simultaneously withdraw air, vapor and water of condensation from the condenser.

Fig. 2 shows a modified arrangement comprising the two pumps *G* and *H*, the condenser *a* and a separate water cooler *c* in which the supply of cooling water, as for example sea water, enters at *a*¹ and after cooling the water used for injection into the cooled air pump *H*, is discharged by a pipe *b*¹. The discharge pipe *s* from the pump *H* is so bent or formed, as shown, as to cause the water discharged by this pump to flow through the pipe *n* into the water cooler *c* and thence by a pipe *t* back into the pump *H*, the excess of water, caused by the condensation of vapor in the pump *H*, flowing over the bend in the pipe *s* and being discharged together with the water from the pump *G*. The water of condensation from the condenser *a* flows into a receiver *e* from which it passes through the pipes *d* and *v* to the pump *G* through a valve *o*¹, the pump *G* normally withdrawing the water of condensation; or the water may be caused to flow into either pump, or into both pumps, by opening the corresponding valves *o*¹ and *o*².

As an alternative arrangement, a predetermined proportion of the water of conden-

sation from the condenser *a* may be passed through the pipe *d* and a valve *w* into the water cooler *c* and thence through the pipe *t* into the air pump H, the valve *m* being closed. In the event of stoppage or breakdown of either pump, the other pump will automatically act to withdraw the air and vapor together with the water of condensation from the condenser, or should an excessive amount of water be present, both pumps will, by opening the valve *o*², in addition to the valve *o*¹, discharge the water of condensation as well as withdraw the mixture of air and vapor from the condenser. Also, if the cooler *c* is out of action from any cause and the valve *w* closed a uniform quantity of water of condensation can be admitted to the pump H, when used for withdrawing air and vapor, by partly opening the valve *o*², the remaining variable portion of the water of condensation being delivered into and discharged by the pump G. Both pumps would then be of equal temperature, but if independently driven, the pump H can be worked at a much higher speed than pump G by reason of the uniform supply of water to it, and its relatively small volume. The utility of this arrangement would be great if, by any accident, a large air leakage developed when a warship was maneuvering at varying speeds, as although varying quantities of water would be delivered to the pump G, thereby limiting its safe speed of working, a much higher speed could be obtained by the pump H, by reason of the uniform and smaller supply of water to it, thereby increasing its air withdrawing capacity.

In Fig. 3, wherein the water cooler *c* is situated in the base of the condenser *a*, water of condensation flows through the water sealed pipe *d* and valve *d*² into the pipe *x* from whence it flows to the pump G, and the water supplied to the air pump H instead of being maintained in repeated circulation through the water cooler *c*, as in the arrangement shown in Fig. 1, is a regulated portion of the water of condensation from the condenser which flows by the pipe *d*¹ through the water cooler *c* and thence to the air pump H by way of pipe *v* and valve *o*². Under normal conditions of working, the valve *o*¹ is closed and the valve *o*² opened to a sufficient extent to allow a constant and small amount of the cooled water of condensation to enter the pump H. In case of breakdown of the pump H, the pump G will then be required to withdraw the air and vapor as well as the water of condensation, and to obtain the highest air withdrawing capacity of such pump, it is necessary that the water passing through such pump should be at a temperature as much as possible below that corresponding to the vacuum in the condenser. To attain this

result, the valve *o*² is closed and the valve *o*¹ fully opened, when the water from the condenser will flow to the pump G through the water cooler *c* instead of by way of the pipe *d*, the air and vapor passing through the pipes *p* and *x*. Or, if the pump G should break down, the valve *o*¹ is closed and valve *o*² fully opened. The pump H will then withdraw the mixture of air and vapor through pipes *p* and *y* and also the cooled water of condensation through the pipe *v*. Or all the water of condensation may pass through the water cooler and be delivered to both pumps equally or in any desired proportion by suitably manipulating the valves *o*¹ and *o*². Under these conditions of working, when water is passed through the water cooler *c* by pipe *d*¹, it will have the effect of decreasing the temperature within both pumps and thereby increasing their air withdrawing effect. By this method of working, the temperature of both pumps would be at a minimum, and the air withdrawing capacity of both pumps would be at a maximum, so that, in combination, they would be in a condition to control large leakages of air into the system, which, in warships, would be a very valuable feature, as heavy air leakage is liable to occur under excessive strain, as in warfare, and which, if not controlled, has the effect of decreasing the vacuum in the condenser and consequently decreasing the speed of the ship.

In the arrangement shown in Fig. 4 a separate water cooler *c* is provided as in Fig. 2, cold sea water entering at *a*¹ and leaving at *b*¹, and the pipes *x* and *y* being connected direct to the bottom of the condenser. The pump H is cooled by water which is in continuous circulation from the discharge of such pump, the flow through the cooler being caused by the difference in the pressures within the discharge pipe *s* and the said pump. At the starting of the pumps G and H, water may be supplied to the water cooler *c* by a by-pass valve *v*⁴, or by way of the valve *o* and pump H.

In steamships propelled by steam turbines, in order to effectively drain the low pressure turbine, the water of condensation in the low pressure turbine section may be led into the pump H of lowest temperature and lowest pressure, and may be cooled by passing it through a pipe or coil of pipe in the water cooler before it enters the pump. The cooling of this water of condensation is a feature of importance as it prevents the raising of the pressure in the pump by increasing its temperature, and provides for the maximum difference in pressure between the low pressure turbine and the pump.

In Fig. 5 a tubular water cooler *c* is situated in the main circulating water pipe *c*² delivering water, such as sea water, to

the tubes in the condenser *a*. During the ordinary working of the plant, the cooled air pump H, by reason of its lower temperature and pressure, preferentially withdraws the air and vapor from the condenser *a* by way of pipes *p* and *y*, the pump G withdrawing the water of condensation from the condenser *a* through the pipe *d*, the valve *o*¹ being open and the valve *o*² closed. The discharge from pump H is shown in this case as fitted with a tank *k* containing a float *m*² controlling a valve *m*¹, so that if the pump H stops, the water by falling in the tank *k*, will cause the float *m*² to close valve *m*¹ and so prevent flow of air into the system. A water control of this description may be fitted to any of the arrangements herein described.

Fig. 6 shows the two pumps G and H connected to the main condenser *a* of reciprocating engines such as are used in marine practice and the cooler *c* connected direct to the condenser *a* through a valve *w*, as well as to the circulating pipe *n*. Under normal conditions of working, the valve *w* is closed and the water of condensation flows from the condenser *a* through the pipes *p* and *x* to the pump G, the air and vapor being withdrawn through the pipes *p* and *y* to the pump H which is maintained at a lower temperature than pump G, as hereinbefore described, by water flowing in continuous circulation through it and pipe *n*, cooler *c* and pipe *d*, the valves *w* and *o*¹ being closed and valves *m*, *m*¹ and *o*² opened, the water being forced through the cooler by the difference in pressure between the discharge from the pump H and the pressure within the pump H, any excess of water, resulting from vapor condensation, is discharged through the pipe *s* into the water discharged by the pump G. Or, by closing the valve *m* and partially opening valves *w*, *m*¹ and *o*², a small and regulated portion of the water of condensation can flow direct from the condenser *a* through the water cooler *c* to the air withdrawing pump H. In the case of abnormal load, and when maximum vacuum is required even at a sacrifice of thermal efficiency, the whole of the water of condensation can be passed direct through the cooler *c* by valve *w* and both pumps G and H worked as cooled air pumps, the flow of water to the respective pumps being regulated, as desired, by operating the valves *o*¹ and *o*². Or, should the water cooler *c* become disabled, the valves *w*, *m*¹ and *m* can be closed and valves *o*¹ and *o*² opened, so as to allow water to pass from the pipe *x* through the pipe *d* to the pump H. In the apparatus just described it will be seen that provision is made whereby one or both pumps can be effectively cooled, and also that in the event of breakdown of either pump, the other will withdraw air and

vapor together with the water from the condenser. Although two methods are shown whereby, according to one method, a portion of the water of condensation formed in the condenser is directly cooled, and by the other method water discharged from the air pump H passes in continuous circulation through the water cooler *c* and through the said pump, it is to be understood that either method alone may be adopted independently of the other.

The inlet to the pump G and the inlet to the pump H may, in each of the arrangements described, and as shown in Fig. 5, be fitted with valves *v*¹ and *v*² respectively whereby the connection between the pumps and the respective air and vapor supply pipes *x* and *y* can be closed when desired.

The water cooler *c* may be of any known or suitable type, such as for example one in which the water to be cooled flows through tubes and the cooling water circulates outside the tubes, or vice versa.

The pumps may be driven by any suitable means. If driven by a steam engine, each is preferably driven independently of the other, but one steam cylinder may be employed, if desired, the second pump being driven by a beam in the well known manner. Or a beam may be provided when there are two steam cylinders so that the piston in either cylinder can drive the pumps in the event of the derangement of the other.

Although two pumps are described, it is to be understood that more than two may be employed if desired, and that any type or construction of pump adapted to withdraw air vapor and water may be adopted.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed I declare that what I claim is:—

1. Steam condensing plant comprising a surface condenser, a pump capable of withdrawing air, vapor and water arranged normally to withdraw air and vapor from said condenser, a second pump also capable of withdrawing air, vapor and water arranged normally to withdraw water of condensation from said condenser, said pumps being connected together on their suction sides, a water cooler wherein water of condensation is cooled to a temperature below the temperature of the water in the condenser, means whereby water can be admitted from said water cooler to the first mentioned pump and means whereby cooled water can also be admitted to the second pump when desired.

2. Steam condensing plant comprising two air pumps each capable of withdrawing air, vapor and water, one of said pumps being arranged normally to withdraw air and vapor from the condenser and the other

being arranged normally to withdraw the water of condensation from the said condenser, a water cooler having its outlet and inlet connected respectively to the suction and delivery sides of one of the pumps and water controlling means whereby a regulated and uniform amount of water can be forced through the water cooler into the suction side of the last mentioned pump.

3. Steam condensing plant comprising two air pumps each capable of withdrawing air, vapor and water, one of said pumps being arranged normally to withdraw air and vapor from the condenser and the other being arranged normally to withdraw the water of condensation from the said condenser, and a valve controlled connection between the suction sides of the two pumps below the water level in the water suction pipe of one of the pumps.

4. Steam condensing plant comprising two air pumps each capable of withdrawing air, vapor and water, one of said pumps being arranged normally to withdraw air and vapor from the condenser and the other being arranged normally to withdraw the water of condensation from the said condenser, a water cooler having an inlet connected to the delivery of one of the pumps and an outlet connected to the suction of both pumps and means for separately controlling the flow of water from said water cooler to each pump.

5. Steam condensing plant comprising two air pumps each capable of withdrawing air, vapor and water, one of said pumps being arranged normally to withdraw air and vapor from the condenser and the other being arranged normally to withdraw the water of condensation from the said condenser, a connection between the water outlet of said condenser and the suction side of each pump and means for controlling the flow of water from said condenser to the suction side of each pump.

6. Steam condensing plant comprising two air pumps each capable of withdrawing air, vapor and water, one of said pumps being arranged normally to withdraw air and vapor from the condenser and the other being arranged normally to withdraw the water of condensation from the said condenser, a water cooler connected to the water outlet of said condenser and to the suction side of one of the pumps and means for controlling the flow of water through said cooler to said pump.

7. Steam condensing plant comprising two air pumps each capable of withdrawing air, vapor and water, one of said pumps being arranged normally to withdraw air and vapor from the condenser and the other being arranged normally to withdraw the water of condensation from the said condenser, a water cooler connected to the water

outlet of said condenser and to the suction side of each pump and means for separately controlling the flow of water from said cooler to each pump.

8. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor outlet of said condenser and also with each other independently of the steam space of said condenser, means for supplying cooled water to the air pump and means for supplying water of condensation from the condenser to the water pump.

9. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor outlet of said condenser and also with each other independently of the steam space of said condenser, means for supplying cooled water to the air pump and means for supplying water of condensation from the condenser to the water pump, the pumps having separate delivery outlets.

10. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor outlet of said condenser and also with each other independently of the steam space of said condenser, means for supplying cooled water to the air pump and means for supplying water of condensation from the condenser to the water pump, the said pumps having separate delivery outlets in communication with each other.

11. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor outlet of said condenser and also with each other independently of the steam space of said condenser, means for supplying cooled water to the air pump and means for supplying water of condensation from the condenser to the water pump, the said pumps having separate delivery outlets, the outlet of the air pump being connected to a vessel having an air escape outlet and a connection above its bottom to the outlet of the water pump.

12. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor outlet of said condenser and also with each other independently of the steam space of said condenser, means for supplying cooled water to the air pump, means for supplying water of condensation from the condenser to the

water pump, and means for placing the suction sides of the pumps in communication with each other.

13. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor space in said condenser and also with each other independently of the steam space of said condenser, means for supplying cooled water to the air pump, means for supplying water of condensation from the condenser to the water pump, means for placing the suction sides of said pumps in direct communication with each other and means for supplying cooled water to the water pump.

14. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor space in said condenser and also with each other independently of the steam space of said condenser, a water cooler connected between the delivery and suction sides of the air pump and means for supplying water of condensation from the condenser to the water pump.

15. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor space in said condenser and also with each other independently of the steam space of said condenser, a water cooler arranged between the water outlet of said condenser and the suction of said air pump and means controlling flow of water from the cooler* to the said air pump.

16. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor space in said condenser and also with each other independently of the steam space of said condenser, a water cooler connected to the delivery side of said air pump and separate controllable connections between said water cooler and the suction sides of the air and water pumps.

17. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor space in said condenser and also with each other independently of the steam space of said condenser, a water cooler connected to the outlet for water of condensation from said condenser and separate controllable connections between said water cooler and the suction sides of the air and water pumps.

18. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor space in said condenser and also with each other independently of the steam space of said condenser, a water cooler connected to the outlet for water of condensation from said condenser and separate controllable connections between said water cooler and the suction sides of the air and water pumps, the suction side of the water pump being also connected to the water outlet of the condenser independently of the water cooler.

19. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor space in said condenser and also with each other independently of the steam space of said condenser, a valve controlled pipe connecting the suction sides of said pumps and a water cooler having its inlet connected to the delivery of the air pump and its outlet connected to said valve controlled pipe.

20. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having their suction inlets in communication with an air and vapor space in said condenser and also with each other independently of the steam space of said condenser, a valve controlled pipe connecting the suction sides of said pumps, and a water cooler having its inlet connected to said condenser and its outlet to said valve controlled pipe.

21. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having suction pipes in communication with the air and vapor space in said condenser and also with each other independently of the steam space of said condenser, the suction pipes being arranged so that water from the condenser can pass into the suction pipe of the water pump but not into the suction pipe of the air pump but can overflow from the former pipe into the latter one, a water cooler connected between the delivery and suction of the air pump and means for controlling the flow of water through said cooler and into said air pump.

22. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having suction pipes in communication with the air and vapor space in said condenser and also with each other independently of the steam space of said condenser, the suction pipes being arranged so that water from the condenser can pass into the suction pipe of the water pump but not

into the suction pipe of the air pump but can overflow from the former pipe into the latter one, a water cooler connected to the water outlet of said condenser and the suction sides of the said pumps and means for independently controlling the supply of cooled water from said water cooler to each pump.

23. Steam condensing plant comprising a steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having suction pipes in communication with the air and vapor space in said condenser and also with each other independently of the steam space of said condenser, the suction pipes being arranged so that water from the condenser can pass into the suction pipe of the water pump but not into the suction pipe of the air pump but can overflow from the former pipe into the latter one, a water cooler, valve controlled connections between said water cooler and the lower portion of said condenser and the delivery of said air pump and valve controlled connections between said water cooler and the suction sides of the air and water pumps.

24. Steam condensing plant comprising a

steam condenser, air and water pumps each adapted to withdraw air, vapor and water and having suction pipes in communication with the air and vapor space in said condenser and also with each other independently of the steam space of said condenser, the suction pipes being arranged so that water from the condenser can pass into the suction pipe of the water pump but not into the suction pipe of the air pump but can overflow from the former pipe into the latter one, a water cooler arranged below said condenser, a valve controlled connection between the condenser and water cooler, a pipe connecting said water cooler to the suction side of the air and water pumps, separate valves for controlling the admission of cooled water to the respective pumps, and a pipe with controlling valve connecting the delivery of the air pump to the water cooler.

Signed at London England this tenth day of February, 1910.

DONALD BARNES MORISON.

Witnesses:

R. WESTACOTT,

H. D. JAMESON.