D. B. MORISON.

APPARATUS FOR WITHDRAWING AIR AND WATER FROM STEAM CONDENSERS.

APPLICATION FILED OCT. 15, 1908.

967,810. Patented Aug. 16, 1910.

4 SHEETS—SHEET 1.

Fig. 1

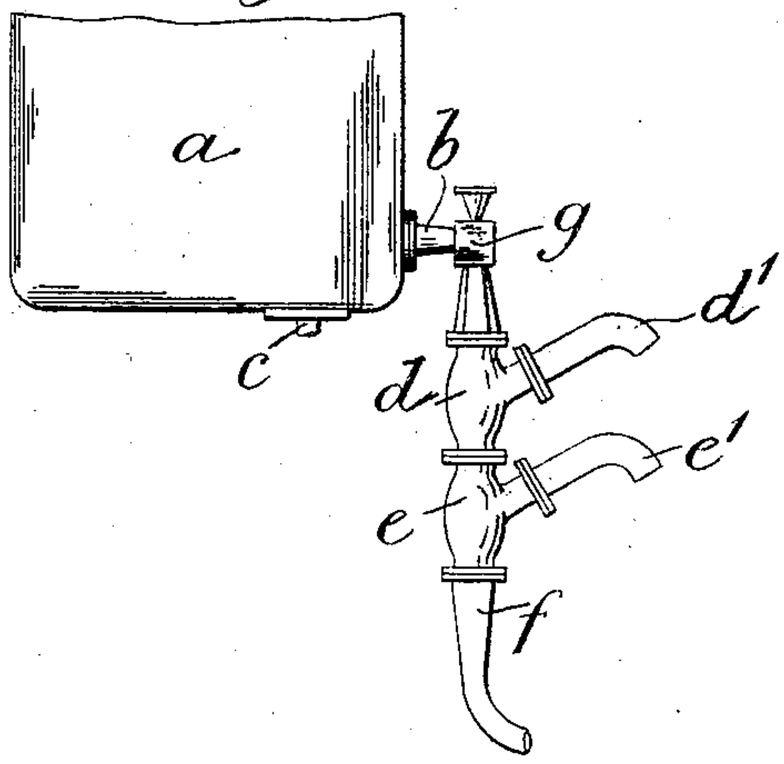
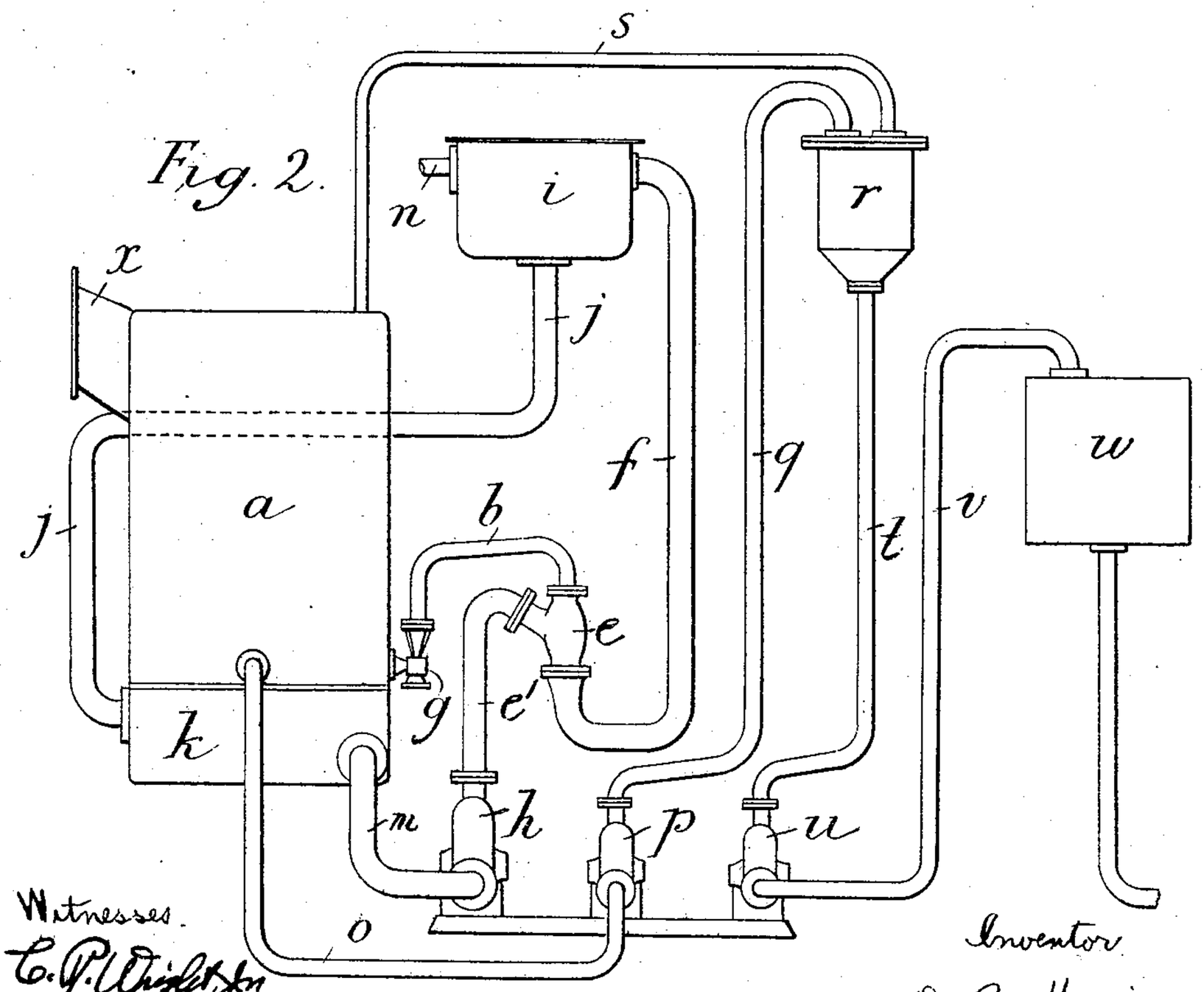


Fig. 2.



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4 SHEETS—SHEET 2.

Fig. 3.

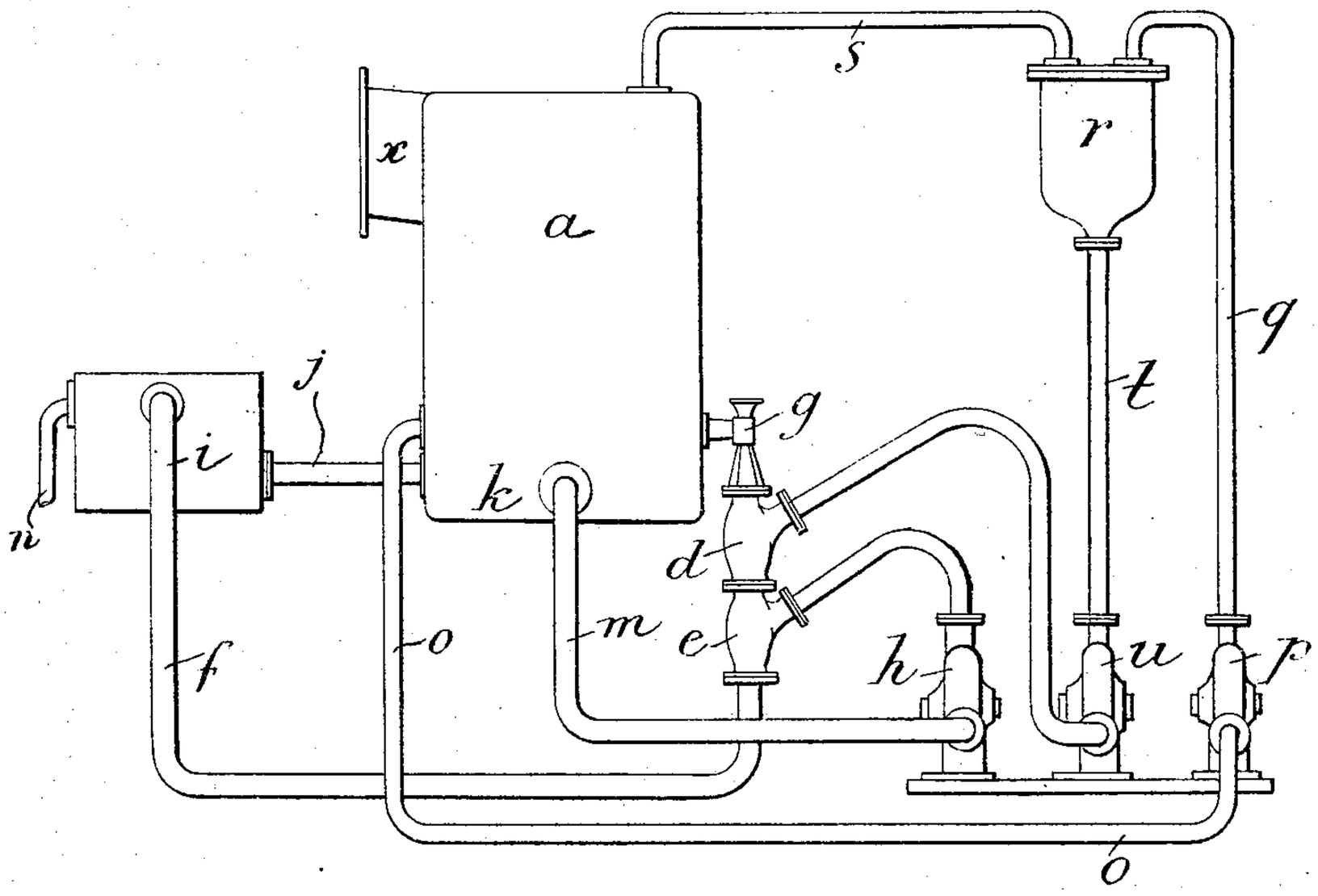
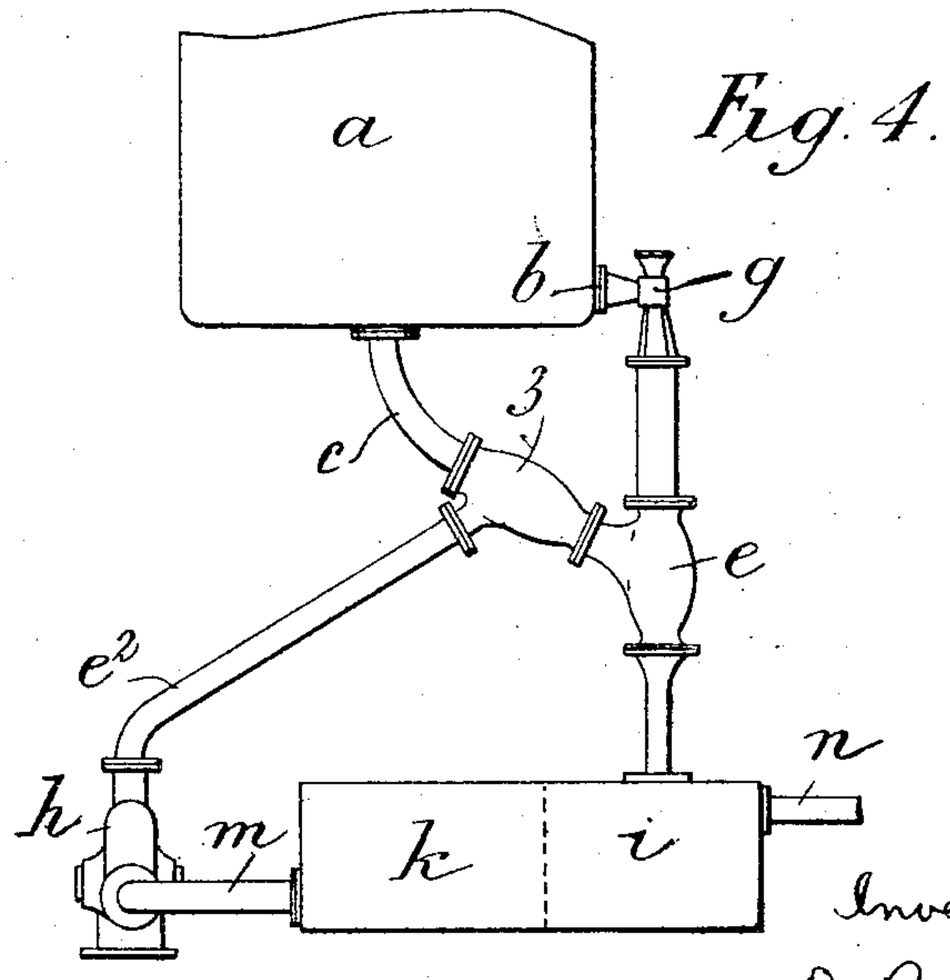


Fig. 4.



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4 SHEETS—SHEET 3.

Fig. 5.

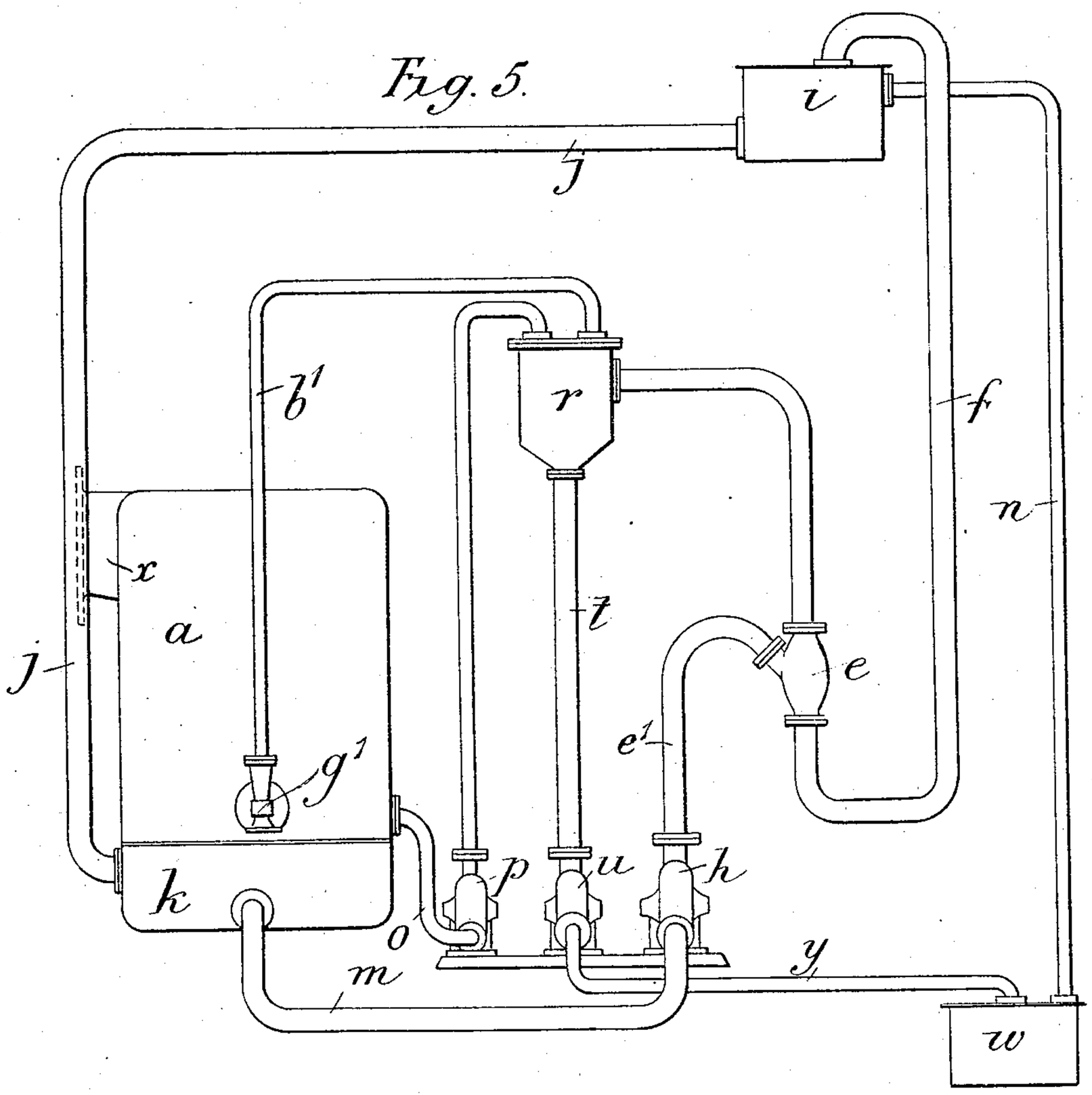
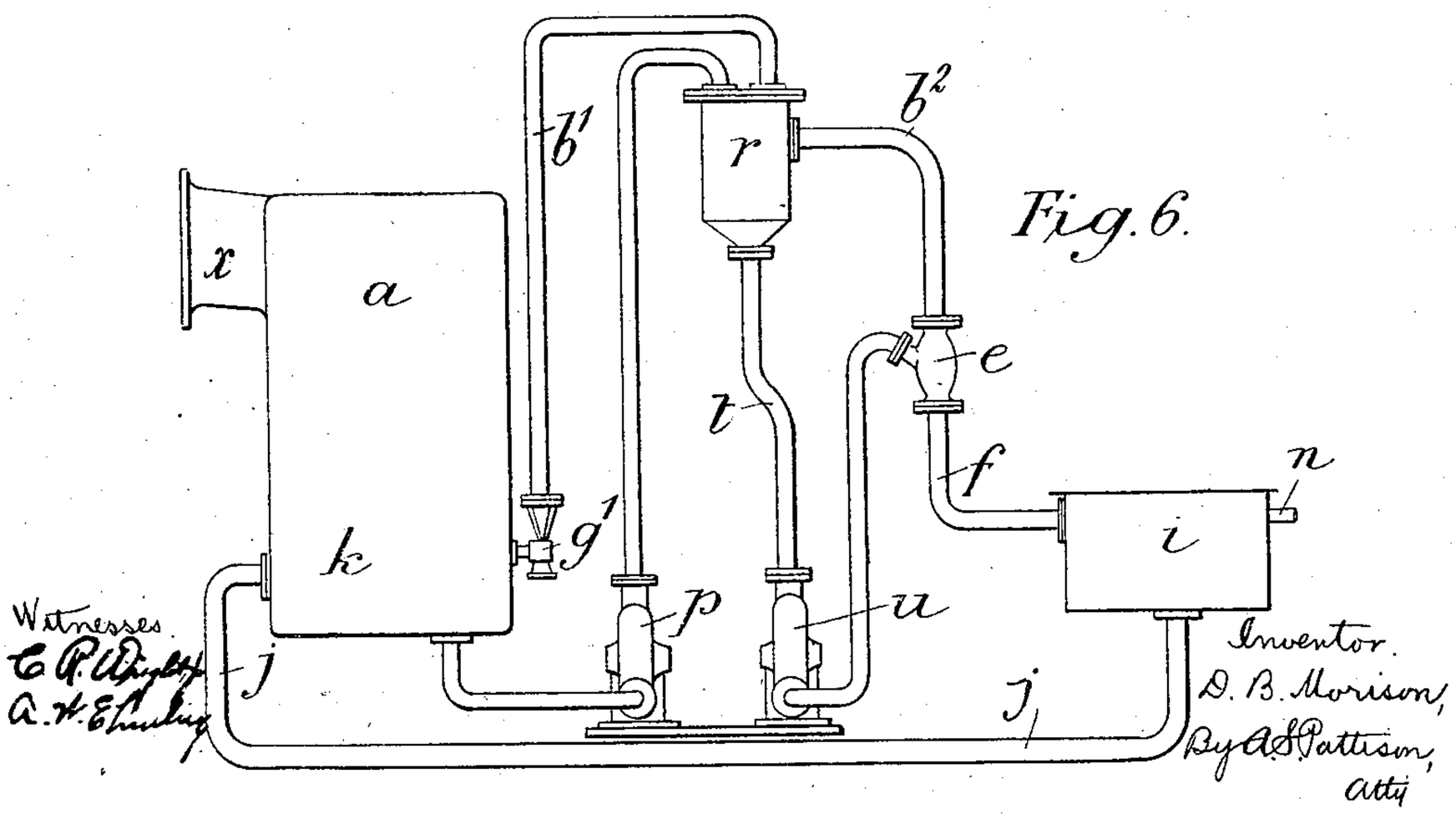


Fig. 6.



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APPLICATION FILED OCT. 15, 1908.

967,810.

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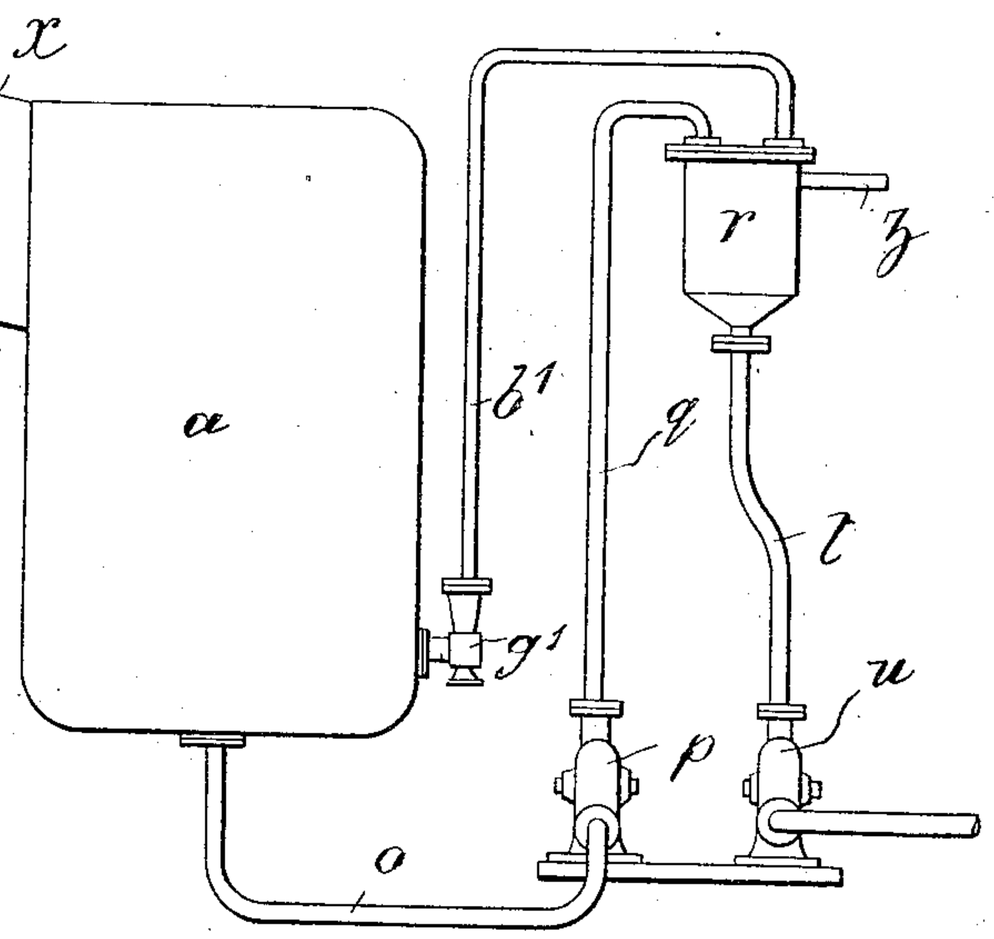
4 SHEETS—SHEET 4.

Fig. 4.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR WITHDRAWING AIR AND WATER FROM STEAM-CONDENSERS.

967,810. Specification of Letters Patent. Patented Aug. 16, 1910.

Application filed October 15, 1908. Serial No. 457,880.

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 Apparatus for Withdrawing Air, Vapor, and Water from Steam-Condensers, of which the following is a specification.

This invention relates to apparatus for withdrawing and discharging air and vapor, and, it may be, water of condensation, from steam condensers, and is applicable to condensers working under a vacuum and in which the water of condensation and the mixture of air and vapor are withdrawn and discharged from the condenser through separate outlets, the condenser being of the surface contact, direct contact or water jet ejector types.

The principal object of the invention is to enable aerated vapor to be withdrawn from a condenser and discharged by means of a steam jet in a more effective and advantageous manner than heretofore. The present invention is characterized for this purpose by the fact that the aerated vapor is withdrawn and discharged from the condenser by the action of a steam jet arranged behind and in series with a water jet ejector, the steam jet being arranged to discharge into the aerated vapor before the same reaches the water jet ejector. When aerated vapor is withdrawn and discharged from a condenser by a steam jet and water jet ejector arranged as described, the minute particles of water resulting from the condensation of the steam are in a condition highly favorable to their being coated and supercharged with the air into which they are discharged, and of being by their kinetic energy, impelled forward and caused to combine or coalesce with each other and, in their momentarily supercharged condition, to be, by their momentum, driven into the water of the water jet ejector and be thereby discharged in a very effective manner. This utilization of the kinetic energy of the steam jet for causing the air to be effectually absorbed and incorporated with the water of the water jet ejector, constitutes a technical effect of considerable practical value and is an important feature of the invention. This action is to be differentiated from the known ejector apparatus in which steam and water jets are arranged concentrically and near together in such a manner as to first combine to form a combined jet of steam and water which is then used to induce air and vapor to enter the ejector apparatus in a lateral direction from the condenser and be discharged thereby. In such an arrangement, water particles resulting from condensation of the steam jet cannot be supercharged with air before coming in contact with the water jet and caused to coalesce and by their momentum be driven into and combined with the water jet so as to be thereby instantly and effectually discharged with the contained air according to the present invention, so that such apparatus cannot act very effectually to withdraw aerated vapor from the condenser. The action of the new aerated vapor ejecting apparatus is also to be differentiated from the action of a steam jet in the known arrangement of air pump system in which the steam from the steam jet used to withdraw air and vapor from a condenser is delivered into and condensed within an auxiliary condenser and the air withdrawn from the latter by a reciprocating or equivalent mechanically operated air pump. In the latter arrangement, the kinetic energy of the steam jet is uselessly dissipated in the supplementary condenser and the heat in the steam from the steam jet is largely absorbed by the condensing water in such auxiliary condenser and discharged with such water, thereby involving thermal loss. On the other hand, by the present invention, not only are the water particles resulting from the condensation of the steam supercharged with air and their kinetic energy utilized to cause them to coalesce with each other and with the water in the water jet ejector but the latent heat of the steam from the steam jet and also the latent heat of the water vapor withdrawn from the condenser, is, to a large extent, absorbed by the water flowing through the water jet ejector and can thereby be conserved and usefully employed. It has been found by careful experiment that (*a*) the temperature of the water passing through the water jet ejector may be very considerably higher than the water of condensation in the condenser and that therefore this water can be passed through the water jet ejector and afterward be in part used as feed water for the boilers, with great thermal advantage, and (*b*) that the cooling of this water, or such part thereof as is

continuously circulated through the water jet ejector, need only be resorted to when the amount of condensed water in the main condenser is curtailed by reason of the power of the engine being diminished, or by the engine being stopped.

The water jet ejector may be of various kinds. It may comprise a static water spraying device, or a mechanically operated water spraying device of known kind; or a solid water jet device, or both a water spraying device and a water jet device combined. These devices are all hereinafter included in the term, water jet ejector.

In the case of direct contact condensers, the water of condensation may be discharged independently of the water jet ejector which may be supplied by other water. Where however the water available for use in the water jet ejector is unfit for use in boilers, as in the case of sea water on ship board, the water supplied to the water jet ejector may, with advantage, be water of condensation that is in part repeatedly used.

In some cases the water may be supplied to the water jet ejector by a pump either from a vessel or reservoir into which it is delivered by another pump from the condenser, or from a tank into which the water jet ejector delivers. Sometimes the water may be cooled before being delivered into the water jet ejector.

The condensed steam water may in some cases be withdrawn from the condenser by head and pressure pumps through an elevated pipe or receiver whereby an artificially produced head or pressure of water can be obtained when such a head or pressure is necessary but is not conveniently obtained with known arrangements, for the satisfactory working of the system.

In order to maintain an approximately constant and adequate supply of water to the water jet ejector under varying conditions of load in the main condenser, the discharge pipe from the said water jet ejector may be provided with means such as a valve or pump which discharges the said water either directly or through a cooler; or in some cases, the inducing action of this water can be utilized in lieu of, or as an auxiliary to, the said pump for causing the discharge of condensed steam water from the condenser to the receiver and be at the same time itself discharged into the receiver. By these means the supply of water through the water jet ejector can be maintained normally adequate and constant at all loads.

When the air and vapor are withdrawn from the condenser by a steam jet and discharged into the receiver, the steam may be condensed in the receiver by contact with condensed steam water simultaneously delivered into the receiver, preferably in the form of a spray. The air and uncondensed vapor may be led from the receiver to the water jet ejector with or without the aid of a jet of steam, the water being drawn off from the receiver by a pump, and water being supplied to the water jet ejector by any convenient means, as by another pump.

If the condensed steam water supplied from the receiver be discharged directly by a pressure pump, air and vapor may be withdrawn from the condenser, or from the receiver, or from each of these devices by, and be discharged through, a separate water jet ejector to which water may be supplied under pressure by any convenient means, as by another pressure pump.

Apparatus according to the present invention is applicable to condensers of both the surface and jet types. The pumps may advantageously be of the centrifugal type, but may, if desired, be of the reciprocating or other suitable type. The water jet ejector may be of the single or multiple nozzle type, and be provided with the usual fittings. If desired, two or more water jet ejectors may be used, arranged in parallel or in series, and the number used at any one time may be varied to suit the load on the condenser and the amount of air leakage.

In the accompanying drawings, Figures 1 to 7 inclusive, show, in elevation, various arrangements of apparatus embodying the present invention, the several figures being, for simplicity, shown more or less diagrammatically.

According to Fig. 1, *a* is a condenser of the surface type having an outlet pipe *b* for air and vapor and a separate outlet pipe *c* for water of condensation. *g* is a steam nozzle whereby a jet of steam can be caused to enter the pipe *b* and become mixed with the air and vapor therein. The pipe *b* is connected to a water jet ejector comprising, in this example, a supplementary spraying jet nozzle *d* provided with a water inlet pipe d^1, and a main water jet nozzle *e* arranged in series with the nozzle *d* and having a water inlet e^1.

Either the water spraying nozzle *d*, or the water jet nozzle *e*, may be used independently, or both may be used together in series as illustrated.

The arrangement is such that when the apparatus is in action, air and vapor entering the pipe *b* are acted upon by the steam jet *g* the water particles of which rapidly become superaerated by contact with the air present in the pipe and, traveling at a high velocity, gradually approach each other and coalesce and by their momentum are driven into the water of the water jet ejector, as hereinbefore described, the whole then traveling onward at a high velocity through the discharge pipe *f*, the discharge being assisted by the water jet issuing through the nozzle *e*, if this nozzle be also used.

Fig. 2 shows air and vapor withdrawing apparatus according to the invention combined with a steam condenser from which the condensed steam water is withdrawn by head and pressure pumps. In this example, the air and vapor outlet pipe b with steam nozzle g is arranged to deliver directly into the main water jet ejector e, which, in this example, is shown without the spraying nozzle.

x is the exhaust steam inlet of condenser a.

To prevent the loss of the water resulting from the condensation of the vapor coming from the main condenser and from the steam jet, when the latter is used, and when it is important that this water loss should not take place, as in marine installations, the water supplied to the ejector may be previously cooled condensed steam water. In the example (Fig. 2), such water is delivered to the ejector e through pipe e^1 by a centrifugal pump h, the resulting mixture of condensing water, condensed steam water and air being discharged through the pipe f into an open tank i whence the water flows through a pipe j into a cooler k located at the bottom of but separate from the main condenser a, and thence through a pipe m to the pump h for re-use. Excess of water, due to the condensation of the vapor withdrawn with the air from the condenser a, escapes from the tank i through an overflow pipe n. Condensed steam water is withdrawn from the main condenser a through a pipe o by a head pump p which delivers it through a pipe q into a raised receiver r which is connected to the top of the condenser a by a pressure equalizing pipe s, and from which the water passes downward through a pipe t to a pressure pump u for delivery through a pipe v into a feed water tank w.

The condensed steam water may be delivered to the water jet ejector by a pump which obtains the water for this purpose from the receiver into which the condensed steam water from the condenser is discharged by another pump, additional water being however delivered to the water jet ejector from the cooler. An arrangement of this kind is shown in Fig. 3, the condensed steam water, which is delivered from the receiver r to the ejector d by the pump u, being used in the ejector d, which, as in Fig. 1, is placed in series with the ejector e, which receives cooled water from the cooler k through the pump h.

As in Fig. 2, the pump p withdraws water of condensation from the condenser a through the pipe o and discharges it through the pipe q, into the receiver r which is connected to the top of the condenser by a pressure equalizing pipe s, and the air and water delivered from the water jet ejector are delivered through pipe f into the tank i from which the air escapes and whence some of the water returns through pipe j, cooler k and pipe m to the pump h for reuse, the remainder of the water escaping through the overflow pipe n.

In the modified arrangement shown in Fig. 4, only one pump, namely h, is employed. The air and vapor are discharged by the steam jet g from the condenser a to the water jet ejector e which discharges into the tank i whence the water passes into the cooler k, which is here shown as being independent of the condenser, but may be constructed integrally with it if desired. Thence the water passes by a pipe m to the pump h by which it is delivered through a pipe e^2 to the water jet ejector e. The pipe c leads from the bottom of the condenser to a water jet device 3 where the kinetic energy of the water delivered by the pump h through the pipe e^2 is utilized, by an inducing and propelling action, to deliver the condensed steam water from the condenser a into the main ejector e.

In the modified arrangement shown in Fig. 5, a steam jet at g^1 is used to discharge air and vapor by pipe b^1 from condenser a to receiver r to which the water of condensation from condenser a is also delivered by pump p through pipes o and q, steam from the jet g^1 being simultaneously condensed in the said receiver. Air and vapor are withdrawn from the receiver by the water jet ejector e which receives cooled water by way of the pipe e^1 and discharges the air and vapor through pipe f into tank i, whence the water flows by pipe j into the cooler k. Water is withdrawn from the cooler by pump h, through the pipe m, and again delivered at a suitable pressure to the water jet ejector e. Any surplus water produced in the water jet circulating system by condensation of steam, can flow by pipe n from tank i to the boiler feed tank w into which pump u, which withdraws the water from the receiver r by pipe t, discharges this water through pipe y.

Although it is usually desirable for thermal reasons to pass the condensed steam water from the condenser to the boiler feed tank without cooling it, as in Figs. 2 and 5, it may sometimes be desired to cool the condensed steam water and thereafter employ it in the receiver or water jet ejector. For example, in Fig. 6, the cooler is located in the bottom of the condenser a and consists of an open well. The condensed steam water falls into this well where it is cooled and is discharged by pump p into receiver r into which the air and vapor are conducted from the condenser a through pipe b^1 provided with a steam jet g^1, as in Fig. 5, the steam and vapor being condensed to a greater or less extent in receiver r by the water simultaneously admitted thereto from pump p.

Air and uncondensed vapor pass from receiver r through pipe b^2 into the water jet ejector e into which the cooled water from the receiver is discharged by pump u and whence it passes with the air to the tank i. From this tank the required proportion of the water may be led back to the cooler k by way of the pipe j as before, the surplus passing away by the overflow pipe n.

As will be seen the arrangement shown in Figs. 2, 3, 5 and 6 according to which the condensed steam water is withdrawn from the condenser a by a head pump p and delivered into an elevated receiver r whence the water is drawn off by a pressure pump u and delivered to a feed water tank w or elsewhere, forms a convenient means for artificially producing a head or pressure of water in cases where this is necessary for the satisfactory working of water pumps used for withdrawing condensed steam water from a steam condenser. Such an arrangement can advantageously be used in cases where air and vapor are withdrawn from the main condenser by apparatus other than the improved apparatus hereinbefore described for this purpose.

In the modified arrangement shown in Fig. 7, the receiver r is not connected to the condenser by an equalizing pipe, and the air and vapor are drawn from the condenser and discharged into the receiver by means of a steam jet g^1 suitably disposed in pipe b^1 the air and vapor being withdrawn through the pipe z by any suitable air extractor. The condensed steam water is delivered into the receiver as before by the pump p; and when the vacuum in the receiver is less than that in the condenser and the boiling point therefore higher, this water can advantageously condense steam from the jet as well as the steam coming with the air from the condenser. All the water condensed in the receiver is withdrawn by way of the pipe t by the water pump u, or may be withdrawn by the same air pump which withdraws air and vapor. In the latter case, the air and vapor may, if desired, be withdrawn from the receiver by a reciprocating air pump by the same pipe that withdraws the water.

What I claim is:—

1. In steam condensing plant, the combination with a main steam condenser of a conduit connected to the air and vapor outlet of said condenser, a steam jet device arranged to deliver steam into said conduit in a direction away from said air and vapor outlet, and means for delivering liquid into said conduit at a part thereof in advance of said steam jet device and in a direction away from said device.

2. In steam condensing plant, the combination with a main steam condenser of a fluid ejecting device operative by liquid flowing therethrough, means for causing liquid to flow in a continuous manner through said fluid ejecting device, a conduit between the air and vapor outlet of said condenser and said fluid ejecting device and forming a continuous passage with the latter and a steam jet device arranged to deliver steam into said conduit in a direction toward said fluid ejecting device.

3. In steam condensing plant, the combination with a main condenser and a conduit for leading air and vapor therefrom, of a water ejecting device connected to said conduit and forming a continuation thereof, means for causing water to flow continuously through said water ejecting device and a steam jet device arranged to deliver steam into said conduit in a direction toward said water ejecting device so that the resulting superaerated water particles resulting from the condensation of the steam will be driven into the water flowing through the water ejecting device and be discharged with the issuing water.

4. In steam condensing plant, the combination with a main condenser and a conduit for leading air and vapor therefrom, of a water ejecting device connected to said conduit so as to form a continuation thereof, a water cooling device, means for causing water to circulate through said water cooling device and water ejecting device, and a steam jet device arranged to deliver steam into said conduit in a direction toward said water ejecting device.

5. An air withdrawing and discharging device having an inlet at one end adapted to be connected to a steam condenser and a water discharge outlet at the other end and comprising a water jet ejector and a steam jet device terminating within said device and directed toward said water jet ejector.

6. An air withdrawing and discharging device comprising an inlet pipe for air, a steam jet device extending into said pipe and a water jet ejector having an inlet for water, said steam jet device and water jet ejector being co-axially arranged.

7. An air withdrawing and discharging device comprising an air conduit having a steam jet device extending into it, and a water jet ejector having a water spraying device into which air can be discharged by the action of steam issuing from said steam jet device.

8. An air withdrawing and discharging device comprising an air inlet and outlet pipe with co-axially arranged steam and water ejecting devices.

9. An air withdrawing and discharging device comprising an air inlet pipe, a steam nozzle extending into said pipe and a water spraying device arranged in line with said steam nozzle and having an outlet for discharge of the combined jet of air and water produced in said withdrawing device.

10. An air withdrawing and discharging device comprising an inlet pipe, a steam nozzle therein, a water spray-nozzle ejector and a water jet nozzle, said nozzles being arranged in series with each other.

11. An air withdrawing and discharging device comprising a pipe with steam inlet nozzle, a water spraying nozzle and a water jet nozzle, said nozzles being arranged co-axially, the said pipe having a lateral inlet for air and the water nozzles having separate inlets for water.

12. An air and vapor withdrawing and discharging device comprising a steam ejecting device with separate inlet for air and vapor, a water spraying nozzle and a water jet nozzle, these parts being arranged co-axially and in series with each other in the order mentioned with separate water inlets for the water nozzles and a common outlet for combined air, vapor and water.

13. An air and vapor withdrawing and discharging device comprising a straight pipe or conduit having at one end a lateral branch for connection to a steam condenser and a steam jet device extending co-axially into it, a water spray nozzle connected to the outlet end of said pipe and having a lateral inlet for water and a water jet nozzle connected to the outlet end of the water spray nozzle and having a lateral inlet for water and a coaxial outlet for a combined jet of air, vapor and water.

14. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof, and means for causing water to flow through said water jet ejector.

15. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof, a tank into which said water jet ejector discharges, and means for causing water to flow from said tank back into said water jet ejector.

16. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof, a water cooling device, and means for causing water to flow through said water cooling device and water jet ejector.

17. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof, a tank open to the external atmosphere and into which said water jet ejector discharges, a water cooling device connected to said tank, and means for causing water to circulate through said water cooling device, water jet ejector and tank.

18. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof, a tank open to the external atmosphere and into which said water jet ejector discharges, a water cooling device connected to said tank and arranged at the base of said condenser, and means for causing water to circulate through said water cooling device, water jet ejector and tank.

19. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof, and means for delivering water from said condenser into said water jet ejector.

20. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof and comprising multiple nozzles, and means whereby water can be caused to flow through one or other or each of the nozzles at will.

21. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof, and comprising a

water spraying jet nozzle and a water jet nozzle arranged in series with each other and with said outlet pipe and steam jet device, and means for causing water to flow through either or both of said water nozzles at will.

22. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof and comprising a water spraying jet nozzle and a water jet nozzle arranged directly in line with each other and with said outlet pipe and steam jet device so that condensed steam water with air and vapor will be delivered direct into said water jet ejector and means whereby water can be caused to flow through either or both of said water nozzles at will.

23. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof and comprising multiple nozzles, a tank into which said water jet ejector discharges, a water cooling device connected to said tank, means for causing water to circulate through said water cooling device, part of said water jet ejector and said tank, and means for delivering water from said condenser through another part of said water jet ejector.

24. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof, a tank into which said ejector discharges, a receiver in communication with said condenser and water jet ejector, means for causing water to flow from said tank, through said water jet ejector, means for delivering water from said condenser into said receiver and means for withdrawing water from said receiver.

25. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof and comprising a water spray jet nozzle and a water jet nozzle arranged in series with each other and with said pipe and steam jet device, a tank into which said water jet ejector discharges, a water cooling device connected to said tank, means for causing water to circulate through said water cooling device, water jet nozzle and tank, and means for causing water to flow from said condenser through the water spray jet nozzle.

26. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air and vapor outlet pipe connected to the air and vapor outlet and provided with a steam jet device whereby steam can be discharged into said pipe, a water jet ejector connected to said outlet pipe so as to form a continuation thereof and comprising multiple nozzles, a tank into which said water jet ejector delivers, a water cooling device arranged at the base of said condenser and connected to said tank, a pump for causing water to circulate through said cooling device and one of the nozzles of said water jet ejector, a receiver connected to said condenser, a pump for withdrawing water from said condenser and delivering it into said receiver and a pump for withdrawing water from said receiver and delivering it into another nozzle of the water jet ejector.

27. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of a receiver connected to said condenser and into which air and vapor can pass from said condenser means for producing a partial vacuum in said receiver, means for delivering water of condensation from said condenser into said receiver and means for withdrawing fluid from said receiver.

28. The combination with a steam condenser, of a water jet ejector, an air and vapor conduit connecting said ejector to said condenser, a vessel or receiver, a pump for withdrawing water of condensation from said condenser and delivering it into said receiver, and a pump arranged to continuously withdraw water from said receiver and force it through said ejector.

29. The combination with a steam condenser, of a water circulating system including a water jet ejector having an air and vapor inlet connected to said condenser, a vessel into which water of condensation is delivered from said ejector and a pump receiving water from said vessel and discharging it through said ejector.

30. The combination with a steam condenser, of a water circulating system including a water jet ejector connected to the air and vapor outlet of said condenser, a vessel having an outlet for surplus water and into which said ejector discharges, a pump for circulating water through said system and

means for delivering water of condensation from the condenser to the circulating system.

31. The combination with a steam condenser, of a water circulating system comprising a vessel, a water conduit forming with said vessel a continuous circuit, a water jet ejector arranged in said circuit and connected to the air and vapor outlet of said condenser, a pump arranged to cause water to circulate through said conduit and ejector and discharge into said vessel, and means for delivering water of condensation from said condenser into said circuit.

32. The combination with a steam condenser, of a closed receiver arranged at a higher level than the bottom of said condenser and in free communication with said condenser, a pump into which water flows from said condenser and which delivers the water into said receiver, and a second pump of the centrifugal type into which water flows from said receiver and by which such water is discharged, said second pump being placed at a sufficient distance below said receiver to produce the head of water on its inlet side necessary for the uniform and reliable working of a centrifugal pump.

33. The combination with a steam condenser, of a tank having an outlet for excess water, a water jet ejector arranged to withdraw air from said condenser, a pump receiving water from said tank and delivering it to said ejector, said ejector delivering air from the condenser and water from the pump into said tank and a pump for delivering water of condensation from said condenser to said tank.

34. The combination with a steam condenser having separate outlets for air and vapor and for water of condensation, of an air outlet pipe with steam jet device connected to the air and vapor outlet, a water jet ejector connected to said outlet pipe so as to form a continuation thereof and into which aerated condensed steam particles are directly delivered by their kinetic energy, a tank into which said water jet ejector delivers, a water cooling device connected to said tank, a pump adapted to cause water to circulate through said water cooling device, part of the water jet ejector and tank, a receiver connected to said condenser by a pressure equalizing pipe, a pump adapted to withdraw water from said condenser and deliver it into said receiver, and a pump adapted to withdraw water from said receiver and deliver it into another part of said water jet ejector.

35. The combination with a steam condenser of a water jet ejector connected to the air and vapor outlet of said condenser, a tank into which said ejector discharges and means for circulating water through said ejector and tank.

36. The combination with a steam condenser of a water jet ejector connected to the air and vapor outlet of said condenser, a tank into which said ejector discharges and which receives water of condensation from said condenser, and a pump for circulating water through said ejector and tank.

37. The combination with a steam condenser and a vessel, of a water circulating system comprising a water conduit arranged to form with said vessel and the lower part of the interior of the condenser a continuous circuit, a water jet ejector arranged in said circuit and connected to the air and vapor outlet of said condenser and a pump arranged to circulate water through said circuit.

Signed at West Hartlepool in the county of Durham England this fifth day of October 1908.

DONALD BARNS MORISON.

Witnesses:

C. J. SNOW,

H. BOWEN.